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List of Abbreviations

AB	Assembly Bill
ACGMA	Amador County Groundwater Management Authority
AF	acre-feet
AFY	acre-feet per year
AL	Action Levels
ARB	American River Basin
ARBS	American River Basin Study
ARSA	Amador Regional Sanitation Authority
ASR	Aquifer Storage and Recovery
AWA	Amador Water Agency
Basin	Cosumnes Subbasin
BLM	Bureau of Land Management
BMP	Best Management Practices
C&E	Communication and Engagement
CalGEM	California Geologic Energy Management Division
CARWSP	Camanche Area Regional Water Supply Plan
CASGEM	California Statewide Groundwater Elevation Monitoring
CBI	Consensus Building Institute
CCR	California Code of Regulations
CDEC	California Data Exchange Center
CDFW	California Department of Fish and Wildlife
CDPR	California Department of Pesticides Regulation
CEDEN	California Environmental Data Exchange Network
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CGA	Cosumnes Groundwater Authority
CGO	California Groundwater Observatory
CGQMP	Comprehensive Groundwater Quality Management Plan
CIMIS	California Irrigation Management Information System
COC	Constituent of Concern
CoSANA	Cosumnes, South American, and North American Subbasins
COWRP	Castle Oaks Water Reclamation Plant
CSC	Central Sacramento County
CVHM	Central Valley Hydrologic Model
CVP	Central Valley Project

CWC	California Water Code
C2VSimFG	California Central Valley Groundwater-Surface Water Simulation Model Fine Grid
DAC	Disadvantaged Community
Delta	Sacramento-San Joaquin Delta
DEM	digital elevation model
DEW	Drier with Extreme Warming
DFW	Department of Fish and Wildlife
DMM	Demand Management Measure
DMS	Data Management System
DOGGR	California Department of Conservation, Division of Oil, Gas, and Geothermal Resources
DPE	dual phase extraction
DRINC	Drinking Water Information Clearinghouse
DRIP	Drought Resilience Impact Platform
DTSC	Department of Toxic Substances Control
DTW	depth to groundwater
DWR	Department of Water Resources
EBMUD	East Bay Municipal Utility District
EIR	Environmental Impact Report
EMD	Environmental Management Department
ERT	electrical resistivity tomography
ESJ	Eastern San Joaquin
ESJGA	Eastern San Joaquin Groundwater Authority
ESJWRM	Eastern San Joaquin Water Resources Model
ET	Evapotranspiration
ETS	electrotelluric sounding
FSC	Folsom South Canal
ft	feet
ft bgs	feet below ground surface
ft msl	feet above mean sea level
ft/day	feet per day
ft/yr	feet per year
ft^2/day	Square feet per day
GAMA	Groundwater Ambient Monitoring and Assessment
GDE	Groundwater Dependent Ecosystem
GIC	Groundwater Information Center
GICIMA	Groundwater Interactive Center Interactive Map Application

GID	Galt Irrigation District
GIS	Geographic Information Systems
GMA	Groundwater Management Area
GNSS	Global Navigation Satellite System
GPS	global positioning system
GRMP	Groundwater Regional Monitoring Program
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GWA	Groundwater Authority
GWC	groundwater conditions
GWE	groundwater elevation
GWL	groundwater level
GWMP	Groundwater Management Plan
HC	Historical Climate
HCM	Hydrogeologic Conceptual Model
ID	Identifier
IDC	IWFM Demand Calculator
ILRP	Irrigated Lands Regulatory Program
IM	Interim Milestone
InSAR	Interferometric Synthetic Aperture Radar
IRMP	Integrated Resource Management Plan
IRWMP	Integrated Regional Water Management Plan
ISW	Interconnected Surface Water
ITRC METRIC	Irrigation Training and Research Center modified Mapping of ET with Internal Calibration
IWFM	Integrated Water Flow Model
IWMP	Integrated Water Master Plan
JPA	joint powers authority
JVID	Jackson Valley Irrigation District
LOP	Local Oversight Program
LTT	long-term trend
LU	Land use
LUST	Leaking Underground Storage Tank
M&I	municipal and industrial
MAC	Mokelumne/Amador/Calaveras
MAF	million acre-feet
MCL	Maximum Contaminant Level

meq/L	milliequivalents per liter
mg/L	milligrams per liter
MHI	median household income
MN	Monitoring Network
MO	Measurable Objective
MT	Minimum Threshold
MTBE	methyl tert-butyl ether
MW	monitoring well
MWH	MWH Global, Inc.
NA	Not Analyzed
NAD	North American Datum
NAD83	North American Datum of 1983
NAHC	Native American Heritage Commission
NASA	National Aeronautics and Space Administration
NAVD	North American Vertical Datum
NAVD88	North American Vertical Datum of 1988
NCCAG	Natural Communities Commonly Associated with Groundwater
NEPA	National Environmental Policy Act
NFM	National Field Manual
NGS	Nuclear Generating Station
NMR	Nuclear Magnetic Resonance
NO3	nitrate
NOAA	National Oceanic Atmospheric Association
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
Numerical Model	Cosumnes, South American, and North American Subbasins model
NWIS	National Water Information System
NWQMC	National Water Quality Monitoring Council
O&M	operations and maintenance
OHWD	Omochumne-Hartnell Water District
OSWCR	Online System of Well Completion Report
PA	Plan Area
PI	Plan Implementation
PLSS	Public Land Survey System
PMA	Project and Management Actions
PRISM	Parameter-elevation Regressions on Independent Slopes Model

PWS	Public Water System
QAQC	quality assurance and quality control
Regional San	Sacramento Regional County Sanitation District
RMG	Representative Monitoring Gauge
RMS	Representative Monitoring Site
RMW	Representative Monitoring Wells
RP	Reference Point
RPE	Reference Point Elevation
RWA	Regional Water Authority
RWQCB	California Regional Water Quality Control Board
RZ	Root Zone
SAFCA	Sacramento Area Flood Control Agency
SASb	South American Subbasin
SAWQA	Sacramento/Amador County Water Quality Alliance
SB	Senate Bill
SCGA	Sacramento Central Groundwater Authority
SDAC	Severely Disadvantaged Communities
SDWA	Safe Drinking Water Act
SDWIS	Safe Drinking Water Information System
SGMA	Sustainable Groundwater Management Act
SGMO	Sustainable Groundwater Management Office
SMC	Sustainable Management Criteria
SMUD	Sacramento Municipal Utility District
SNMP	Salt and Nitrate Management Plan
SRCD	Sloughhouse Resource Conservation District
SSCAWA	Southeast Sacramento County Agricultural Water Authority
SSHCP	South Sacramento Habitat Conservation Plan
SSURGO	Soil Survey Geographic Database
SW	surface water
SWAG	Surface Water Stakeholder Advisory Group
SWRCB	State Water Resources Control Board
SY	Sustainable Yield
TAC	Technical Advisory Committee
TBD	To be determined
TDS	total dissolved solids
TEM	Time-Domain Electromagnetic

TNC	The Nature Conservancy
TSS	Technical Support Services
UCWSSRI	University of California Water Security and Sustainability Research Initiative
ug/L	micrograms per liter
UNAVCO	University NAVSTAR Consortium
UR	Undesirable Result
USBR	United States Bureau of Reclamation
USDA-NRCS	United States Department of Agriculture and Natural Resources Conservation Service
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground Storage Tank
UWMP	Urban Water Management Plan
WB	Water Budget
WCR	Well Completion Report
WDL	Water Data Library
WDR	waste discharge requirement
WG	Working Group
WQCP	Water Quality Control Plan
WQO	Water Quality Objective
WQP	Water Quality Portal
WRIME	Water Resources & Information Management Engineering
WSO	Sacramento Winter Storm Outlook
WWTP	Wastewater Treatment Plant
WY	Water Year
µmhos/cm	micromhos per centimeter

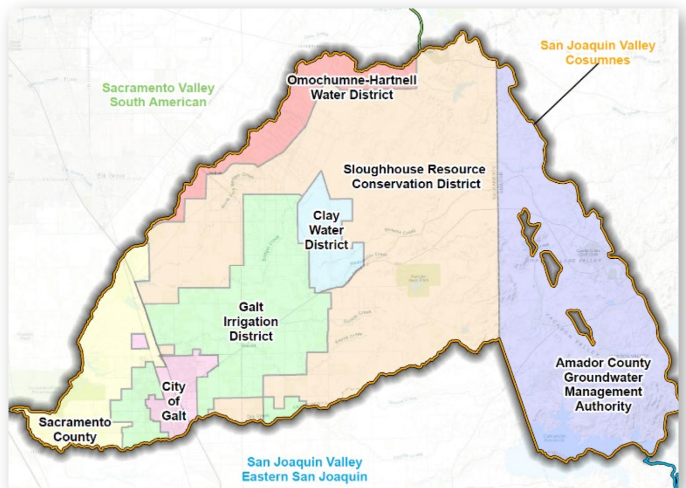
EXECUTIVE SUMMARY

§ 354.4. Each Plan shall include the following general information:
(a) An executive summary written in plain language that provides an overview of the Plan and description of groundwater conditions in the basin.

ES.1. Introduction

On 16 September 2014, the California legislature enacted the Sustainable Groundwater Management Act (SGMA) to halt overdraft and bring groundwater basins into balanced levels of pumping and recharge. SGMA empowers local agencies to form Groundwater Sustainability Agencies (GSAs) to manage basins sustainably pursuant to one or more Groundwater Sustainability Plans (GSPs). The Cosumnes Subbasin (also referred to herein as "the Basin"), California Department of Water Resources (DWR) Basin No. 5-022.16, is located at the northern end of the San Joaquin Valley (within Sacramento and Amador Counties) and is classified by DWR as a medium priority basin.

Seven GSAs have been established within the Basin, each acting as the exclusive GSA in their respective areas. The seven GSAs form the Cosumnes Subbasin SGMA Working Group (Working Group): Amador County Groundwater Management Authority (ACGMA), City of Galt, Clay Water District, Galt Irrigation District (GID), Omochumne-Hartnell Water District (OHWD), Sacramento County, and Sloughhouse Resource Conservation District (SRCD). The Working Group developed this single coordinated GSP to meet SGMA regulatory requirements, reflect stakeholder values, and preserve local control over management of the groundwater resource.



Cosumnes Subbasin GSAs

Under SGMA, GSPs are required to contain certain elements, the most significant of which include: a Sustainability Goal; a description of the area covered by the GSP ("Plan Area"); a description of the Basin Setting, including the hydrogeologic conceptual model, historical and current groundwater conditions, and a water budget; locally-defined sustainability criteria; networks and protocols for monitoring sustainability indicators; and a description of projects and/or management actions that will be implemented to achieve or maintain sustainability. SGMA also requires a significant element of stakeholder outreach to ensure that beneficial uses and users of groundwater are given the opportunity to provide input into the GSP development and implementation process. This GSP developed by the Working Group provides a path to maintain and document sustainable groundwater management within 20 years following GSP adoption. The Basin GSAs adopted a joint exercise of powers agreement (JPA) in November 2021 that establishes the Cosumnes Groundwater Authority (CGA) for the purpose of implementing the GSP.The CGA JPA is included as **Appendix B**.

ES.2. Sustainability Goal

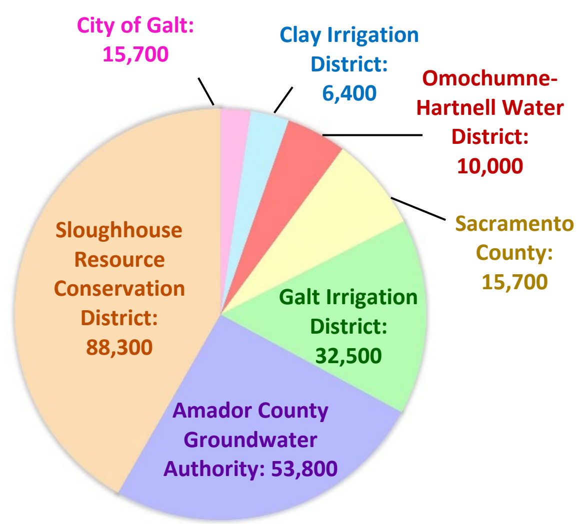
The Working Group adopted the following Sustainability Goal:

The Sustainability Goal of the Cosumnes Subbasin (Basin) is to ensure that groundwater in the Basin continues to be a long-term resource for beneficial users and uses including urban, domestic, agricultural, industrial, environmental and others. This goal will be achieved by managing groundwater within the Basin's sustainable yield, as defined by sustainable groundwater conditions and the absence of undesirable results.

ES.3. Plan Area

The Basin encompasses approximately 210,300 acres in the northern region of the San Joaquin Valley Basin, within Amador and Sacramento Counties. Adjacent subbasins include the South American Subbasin (SASb), which lies to the north and west, and the Eastern San Joaquin (ESJ) Subbasin, which lies to the south. The eastern boundary of the Basin is defined by non-alluvial bedrock of the Sierra Nevada foothills.

In the western portion of the Basin, agriculture is the dominant land use, and higher concentrations of vegetation on undeveloped land areas predominate moving eastward. Approximately two-thirds of the Basin is covered by undeveloped lands supporting naturally occurring vegetation or riparian vegetation, and one-quarter by irrigated agriculture. The most abundant agricultural land uses are vineyards, pasture, and grain. Urban areas, which include cities, communities, Ag-Res, and Industrial uses, totaling approximately 18,000 acres, constitute just under 9% of the total Basin area.



Cosumnes Subbasin GSA Acreages

Approximately 16,850 acres of California Protected Areas and public lands lie within the Basin, including areas managed at the Federal, State, and local levels, and 26,770 acres of California Conservation Easement areas which limit land uses to maintain open spaces (e.g., farmed, grazed, forested, nature reserves). The Nature Conservancy (TNC) owns 3,510 acres of land along the western reaches of the Cosumnes River which form the Cosumnes River Preserve. Three Native American tribal communities are directly present within the Basin, and each relies on a combination of surface water from the Cosumnes River and/or groundwater to support their needs. Various other tribes utilize or have some interest in the Basin and are present within Amador and Sacramento Counties but are not necessarily located directly within the Basin boundaries.

Approximately 9% of the Basin (18,236 acres) is covered by DWR-designated disadvantaged communities

(DACs) or severely disadvantaged communities (SDACs), including 8,263 residents of the City of Galt (U.S. Census Bureau 2018). Of these 8,263 Galt residents, approximately 5,133 are designated as DACs and approximately 3,130 are designated as SDACs. The additional DACs occur within farmlands, non-irrigated lands, and small rural residential areas in the western portion of the Basin.

The seven GSAs have water management responsibilities established through SGMA. Other entities within the Basin have water management responsibilities established through other means, including: Cities (City of Galt and City of Ione), Counties (Amador and Sacramento counties), Water/Irrigation Districts (Clay, Galt, OHWD, Jackson Valley, and Amador Water Agency), Utility Districts (East Bay Municipal Utility District and Sacramento Municipal Utility District), and Joint Power Authorities (Amador County Groundwater Management Authority and Southeast Sacramento County Agricultural Water Authority). Additionally, there are over 20 public water systems (PWS) within the Basin.

ES.4. Stakeholder Outreach Efforts

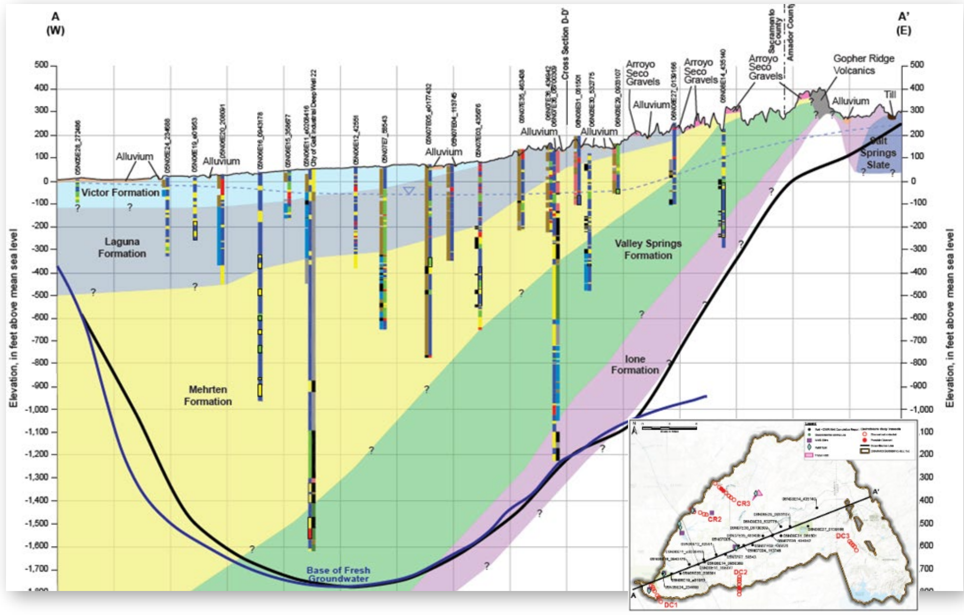
The GSA adopted a Communication and Engagement (C&E) Plan in June 2018 that fulfilled SGMA notice and communications requirements and documented the GSAs' efforts to encourage input from beneficial groundwater users throughout GSP development. The C&E Plan identified key stakeholders, interests, and issues and was updated throughout GSP development to reflect outreach efforts and stakeholder communications. The C&E Plan will continue to be updated during GSP implementation.

Working Group and individual GSA Board meetings, stakeholder workshops, and direct outreach strategies including outreach to Native American Tribes located within the Basin and stakeholder surveys sent to all landowners within the Basin, have been and will continue to be implemented in order to engage the public in the GSP process. Materials from the Working Group meetings and links to the individual GSA's websites, where materials from the individual GSA board meetings can be found are available at the Basin's SGMA website: http://cosumnes.waterforum.org/sustainable-groundwater-management-act-sgma. This website also contains meeting materials and the schedule for past and planned meetings and workshops that are open to the public.

ES.5. Hydrogeologic Conceptual Model

The Basin hydrogeology can be generalized into two physiographic subareas: the "Basin Plain" in the western and central areas and the "Basin Foothills" in the eastern area. The Basin is bounded by surface water features to the north, south, and west, which contain no known impediments to groundwater flow; the eastern Basin boundary is formed by low permeability metamorphic rocks in the Sierra Nevada foothills region that are known to impede groundwater flow. For the purposes of SGMA, the bottom of the Basin is defined as either: (a) the bottom of the Ione Formation or (b) the base of fresh groundwater, whichever is highest in elevation at a particular location. Six hydraulically connected sedimentary formations comprise the unconfined to semi-confined Principal Aquifer within the Basin and include younger alluvium, Victor, Laguna, Mehrten, Valley Springs, and Ione formations.

Approximately 50% of all known production wells in the Basin are 400 feet deep or less in depth, and 90% of all production wells are less than 900 feet deep. The deepest well in the Basin is 1,720 feet deep.



Cross Section A-A'

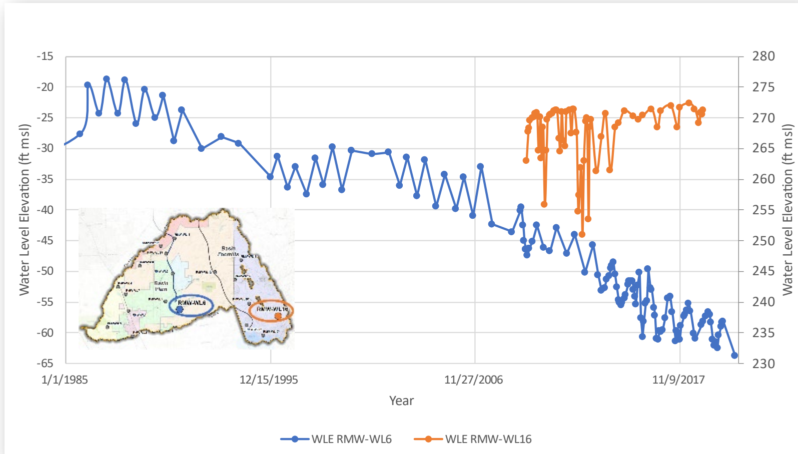
Inflows to the groundwater system include rainfall infiltration, leakage from surface water, percolation of surface water that originates outside the Basin, and subsurface flows from adjacent basins. Outflows from the groundwater system include seepage to surface water, subsurface flows to adjacent basins, evapotranspiration, and consumption of groundwater extracted by wells.

ES.6. Existing Groundwater Conditions

Information on the Basin's current groundwater conditions with respect to the six "Sustainability Indicators" defined under SGMA are presented in this GSP and include the following:

- Chronic Lowering of Groundwater Levels
- Reduction in Groundwater Storage
- Seawater Intrusion
- Degraded Water Quality
- Land Subsidence
- Depletion of Interconnected Surface Water

Water Levels: During the historical averaging period (Water Year [WY] 1999-2018), measured groundwater levels in the Basin have generally declined. The statistically significant downward trends, based on a ten-year period having the greatest number of wells with data (2009-2018), range from -0.1 to -1.5 feet per year. Most of the observed declines are reported in the western portion of the Basin (i.e., the Basin Plain). Groundwater elevations in this portion of the Basin generally appear to be correlated with climatic conditions, with storage increases occurring during or after wet years and storage decreases occurring during or after dry years. In the Basin Foothills subarea, trend directions are both upward and downward suggesting that overall groundwater levels in that subarea have remained stable.



Long-Term Groundwater Level Trends

Groundwater Storage: The change in groundwater storage during the period WY 1999-2018 was calculated from the difference in groundwater levels, as measured in wells. In the Basin Plain, the declining water levels correspond to an approximate 10,000 acre-feet per year (AFY) average annual decline in storage. In contrast, in the Basin Foothills, the average annual storage decrease is assumed to be small because water levels have been relatively stable. Annual groundwater storage changes calculated by the numerical groundwater model developed for the Basin range from 54,500 AFY to -49,400 AFY, with an estimated average annual change in storage of -10,600 AFY. The depletion of Basin storage indicates that groundwater consumption has exceeded groundwater recharge on average by about 10,000 AFY during the 20-year period, which is supported by the long-term hydrographs that show declining water levels for several decades.

Water Quality: Within the Basin, potential constituents of concern (COCs; e.g., arsenic and nitrate) are identified by well water samples having constituent concentrations that exceed their Primary Maximum Contaminant Level (MCL). While total dissolved solids (TDS) is not generally considered a constituent affecting human health, it can serve as an indication of general water quality, specifically aesthetic characteristics, and therefore it is included as a COC for the purposes of this GSP.

Active point-source contamination sites within the Basin include three Leaking Underground Storage Tank (LUST) projects, a Cleanup Program project, and several Department of Toxic Substances Control (DTSC) projects. The LUST sites are located within the City of Galt, and the Cleanup Program site is located near the City of Ione. Two of the LUST sites have mapped plumes, and these plumes will be considered if GSP projects or management actions alter recharge and pumping patterns in the vicinity of these sites.

Subsidence: Land surface elevation changes within the Basin have been measured since July 2006 by a global positioning system (GPS) station located near the deepest groundwater depths in the Basin and suggest a long-term subsidence rate of 0.008 feet per year. However, this change in land surface elevation is within the uncertainty of the measurements. Measurements using other technology in and near the Basin (GPS surveying and remote sensing) confirm subsidence rates are negligible. Land subsidence is therefore of low concern in the Basin.

Seawater Intrusion: The Basin is not directly connected to the Pacific Ocean, but its western boundary is adjacent to the Sacramento-San Joaquin Delta, which is influenced by the Pacific Ocean. However, surface water management methods have been in place for many decades that prevent seawater from reaching far into the Delta. Groundwater with relatively high chloride concentrations does exist in the Basin but are associated with brines located at and below the bottom of the Principal Aquifer. Hence, the Basin is at little to no risk of seawater intrusion.

Interconnected Surface Water: The two most prominent surface water bodies are the Cosumnes River and Dry Creek, which form the north and portions of the southern Basin boundaries, respectively. Comparisons between available data from streamflow gauges (stage), estimated channel bottom elevation, and groundwater levels measured in shallow wells indicate that Cosumnes River flows are disconnected from the Principal Aquifer beneath most of its reach within the Basin. Similar data are not available for Dry Creek or other surface water drainages in the Basin, but measured groundwater depths in the Principal Aquifer are typically at depths substantially greater than 30 feet below ground surface (ft bgs), suggesting the surface water flows and groundwater are likely disconnected across most of the Basin. West of its confluence with Deer Creek, the Cosumnes River may be interconnected for part of the year (one or more months), but not in all years, and further down river and west of Highway 99 the river is understood to be more regularly interconnected. The actual relationships between surface water and the underlying Principal Aquifer near the Cosumnes River is complex and additional monitoring will be conducted as part of GSP implementation to better understand the system dynamics.

Groundwater Dependent Ecosystems (GDEs): DWR and TNC developed a map of "Natural Communities Commonly Associated with Groundwater" (NCCAG) data set, which was studied in detail as part of a GDE verification effort conducted by the Basin GSAs. The verification effort included review of the NCCAG and other datasets and classified the vegetated areas as: (1) GDEs, either confirmed by all criteria or assumed when some criteria were incomplete, (2) disconnected from the Principal Aquifer and therefore not considered GDEs, or (3) unknown as a result of one or more significant data gaps (absence of shallow well data). Within the Basin, the NCCAG data set shows 6,960 acres of potential GDEs while the desktop evaluation that took place as part of the verification effort showed almost 19,700 acres of potential GDE areas. The outcome of the subsequent field verification study identified 990 acres of confirmed GDE areas and 820 assumed-confirmed GDE areas in the westernmost part of the Basin, west of Highway 99, in an area where groundwater and surface water are likely interconnected. An additional 4,020 acres of potential GDEs that have unknown GDE status were identified in the eastern part of the Basin (i.e., in the Basin Foothills Subarea where groundwater level data are sparse and highly variable). The total area of GDEs in the Basin is therefore conservatively assumed to be 5,830 acres. Because of the often co-located nature of GDEs and potential reaches of interconnected surface water, perched groundwater, or other shallow water sources, for the purposes of this GSP, GDEs are grouped with the Interconnected Surface Water Sustainability Indicator.

ES.7. Water Budget

To generate a water budget for the Basin, a numerical groundwater flow model was developed that utilized the DWR-supported Integrated Water Flow Model (IWFM). The IWFM application is called the Cosumnes-South American-North American (CoSANA) model (Numerical Model). It is a three-dimensional, finite element model, which integrates groundwater and surface water dynamics to simulate natural and anthropogenic processes relevant to calculating groundwater elevation changes and the groundwater budget.

Results from the numerical model are presented for the historical water budget period (WY 1999-2014), the current water budget period (WY 2015-2018), and the 20-year long-term model evaluation period (WY 1999-2018). Results from the 20-year long-term model-calculated water budget allocated groundwater inflows to the Basin as follows: 73% from percolation, 24% from stream leakage, and 3% from subsurface flows from adjacent watershed. Outflows from the Basin over the same period are quantified as follows: 85% from groundwater extraction, 11% as seepage to streamflow from groundwater, and 4% as subsurface flow to adjacent basins. Within the category of groundwater pumping, approximately 75% of the Basin’s outflows were used for agriculture and 10% supported uses in developed areas including urban, domestic (Ag-Res), and industrial water uses (includes aquaculture).

During the 20-year long-term model evaluation period, the Basin lost approximately -213,500 AF of storage, with the average annual change in storage calculated at -10,600 AFY. A comparison with DWR’s San Joaquin Valley Water Year Hydrologic Classification Index demonstrates a clear relationship between Water Year type and change in groundwater storage, with storage increases during wetter years and storage declines during drier years. The current water budget (WY 2015-2018) calculated using the Numerical Model shows an average annual decrease in storage of 7,400 AFY.

Sustainable Yield (SY) refers to the amount of groundwater that can be pumped annually from the Principal Aquifer within a Basin without causing Undesirable Results pursuant to SGMA’s six Sustainability Indicators. Applying the methodology articulated in the Best Management Practices (BMPs) developed by DWR, the SY range for the Basin is calculated to fall between 119,000 AFY and 125,700 AFY.

Uncertainty in model input data results in uncertainty in model-calculated output and the calculation of SY under future conditions. For example, uncertainty related to future climatic conditions (e.g., rainfall and evapotranspiration) can contribute to uncertainty in the estimated SY volume. Similarly, changes in land use and groundwater consumption can also effect the estimated SY volume. The projected water budgets for the Basin calculated by the model included several scenarios used to represent model uncertainty due to potential climate change and land use (current and projected land use conditions). Application of these scenarios suggest that the SY of the Basin in the future could range from 125,700 AFY to 134,900 AFY.

ES.8. Sustainable Management Criteria

SGMA introduces several terms to measure sustainability, including:

Sustainability Indicators – Sustainability indicators refer to adverse effects caused by groundwater conditions occurring throughout the Basin that, when significant and unreasonable, cause undesirable results. DWR identifies six Sustainability Indicators:

- Chronic Lowering of Groundwater Levels
- Reduction in Groundwater Storage
- Seawater Intrusion
- Degraded Water Quality
- Land Subsidence
- Depletions of Interconnected Surface Water

Undesirable Results – Undesirable Results (URs) are the significant and unreasonable impacts that adversely affect groundwater conditions in the Basin.

Minimum Thresholds – Minimum Thresholds (MTs) are the numeric criteria for each Sustainability Indicator that, if exceeded, may cause Undesirable Results. Where appropriate, the Minimum Thresholds for the Sustainability Indicators have been set using groundwater levels as a proxy.

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

Interim Milestones – Interim Milestones (IMs) are a set of target values representing measurable groundwater conditions in increments of five years.

Collectively, the Sustainability Goal, IMs, MOs, and MTs are referred to as Sustainable Management Criteria (SMC). Chronic Lowering of Groundwater Levels is arguably the most fundamental Sustainability Indicator, as it influences several other key Sustainability Indicators including Reduction of Groundwater Storage, Land Subsidence, and potentially Depletions of Interconnected Surface Water and Land Subsidence. The SMCs for the Basin were developed using a combination of measured and model-calculated data and considering applicable beneficial uses and users of groundwater in the Basin and conditions in adjacent basins.

The SMCs for Chronic Lowering of Groundwater Levels were based on consideration of model-calculated historical trends in groundwater levels in the Basin (as represented by 19 Representative Monitoring Wells [RMW-WLs]), historical low groundwater levels, water year types, projected water use in the Basin, the relationships to other Sustainability Indicators and beneficial users in the Basin, and the SMCs in the adjacent basins. The MTs are based on the projected long-term, water level trends or historical low groundwater levels at the RMW-WLs. The MOs are set at Fall 2015 groundwater levels.

Groundwater storage is closely linked to groundwater levels; therefore, the SMCs set for Chronic Lowering of Groundwater Levels are used as a direct proxy for Reduction of Groundwater Storage. Land Subsidence in the Basin is also assessed using Chronic Lowering of Groundwater Levels as a proxy.

The SMCs for Degraded Water Quality were set using data from 14 water quality monitoring wells (RMW-WQ). Arsenic and nitrate have been identified as COCs in the Basin groundwater and MTs were established as the Primary MCLs as set by the United States Environmental Protection Agency (USEPA) and established by the California State Water Resources Control Board's (SWRCB) Division of Drinking Water The MO for arsenic is set at 80% of the MCL, the MO for nitrate is set at 80% of the MCL, which is also the Irrigated Lands Regulatory Program (ILRP) monitoring trigger. Additionally, TDS has been identified as COC, as it can serve as an indication of general water quality. The MT for TDS was established as the "upper limit" Secondary MCL, and the MO for TDS is set at the "recommended" Secondary MCL.

The SMCs for Depletions of Interconnected Surface Water have been preliminarily defined, as the interconnectedness of the lower reaches of the Cosumnes River and the mapped GDE areas to the Principal Aquifer remains a significant source of uncertainty. The MTs are established at nine monitoring wells (RMW-ISW) based on a combination of measured and model-calculated values. Two additional stream gauges have been installed and new monitoring well sites identified to provide more complete data in the future. These data are needed to better understand the relationship (if any) between GSA management of the Principal Aquifer and the Basin's surface water bodies and GDE areas. The SMCs may be modified in the future accordingly.

Seawater Intrusion is not considered an issue within the Basin due to its current isolation from the Pacific Ocean and marine tidal influences and SMCs were not developed.

In the Basin, Undesirable Results are defined as follows:

Sustainability Indicator	Undesirable Results Definition
Chronic Lowering of Groundwater Levels	Undesirable Results would be experienced when a chronic decline in groundwater levels in the Principal Aquifer negatively affects the long-term viable access to groundwater for urban, domestic, agricultural, industrial, and other beneficial users and uses within the Basin. (Note that environmental beneficial users [GDEs] are addressed in Undesirable Results for Depletions of Interconnected Surface Water).
Reduction of Groundwater Storage	Undesirable Results would be experienced when a reduction in storage in the Principal Aquifer negatively affects the long-term viable access to groundwater for the urban, domestic, agricultural, industrial, and other beneficial users and uses within the Basin.
Seawater Intrusion	Groundwater conditions in the Basin show that Seawater Intrusion does not occur and is not anticipated to occur in the future. The Sustainability Indicator is therefore not applicable to the Basin.
Degraded Water Quality	Undesirable Results for Degraded Water Quality would be experienced in the Basin when water quality conditions of the Principal Aquifer are degraded such that they negatively impact the long-term viability of the groundwater resource for beneficial users and uses.
Land Subsidence	Undesirable Results would be experienced when land subsidence due to groundwater level declines in the Principal Aquifer negatively affects the ability to use existing critical or non-critical infrastructure within the Basin.
Depletions of Interconnected Surface Water	Undesirable Results would be experienced in the Basin when surface water depletions occur because of SGMA-related groundwater management activities such that they negatively impact the urban, domestic, agricultural, industrial, environmental, and other beneficial users and uses of surface water.

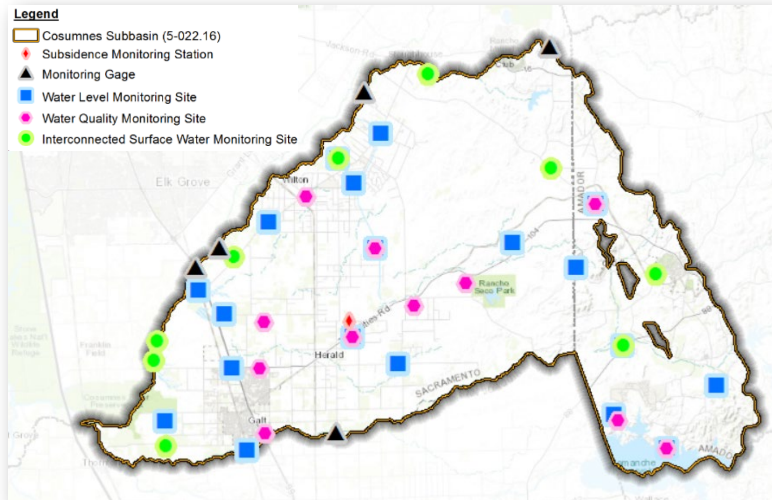
ES.9. Monitoring Network

The objectives of the Basin Monitoring Network are to: (1) collect sufficient data for the assessment of the Sustainability Indicators relevant to the Basin, including those for which SMCs have been established and those for which additional data are needed, (2) evaluate potential impacts to the beneficial uses and users of groundwater, and (3) assess the effectiveness of Projects and/or Management Actions (PMAs) intended to promote sustainable conditions.

The Monitoring Network for SGMA compliance consists of representative monitoring sites for each sustainability indicator. For each Representative Monitoring Site (RMS), the SMCs are established and data are routinely collected for comparison to the criteria. Additionally, the Monitoring Network relies upon supplemental sites, where SMCs are not established but data are collected to confirm the representativeness of each RMS and to support the wider understanding of the Basin hydrology and response to PMAs.

For the Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage Sustainability Indicators, 19 RMW-WLs have been identified, with a spatial density of approximately six wells per 100 square miles (mi^2). Information for these wells (e.g., location, construction, use, and responsible GSA) is provided in **Table MN-2**.

For the Degraded Water Quality Sustainability Indicator, 14 RMW-WQs have been identified, with a spatial density of approximately four wells per 100 mi^2. Information for these wells (e.g., location, construction, use, and responsible GSA) is provided in **Table MN-3**.



SGMA Monitoring Networks

For the Land Subsidence Sustainability Indicator, one University NAVSTAR Consortium (UNAVCO) Global Positioning System (GPS) station has been identified to monitor groundwater surface elevation changes along with the 19 RMW-WLs, for a total of 20 RMS. Because the number of sites for Land Subsidence is determined by proximity to critical infrastructure, spatial density across the entire Basin is not a relevant metric.

For the Depletions of Interconnected Surface Water Sustainability Indicator, nine RMW-ISWs and five stream gauges (one currently inactive) have been identified, for a total of 14 RMS. Because the number of sites measuring interconnectedness of surface water is determined by local hydrogeologic conditions, spatial density across the entire Basin is not a relevant metric. Information on these wells (e.g., location, construction, use, responsible GSA, etc.) is provided in **Table MN-4**.

Data collected from the SGMA Monitoring Network will be reviewed and uploaded to the Data Management System (DMS) maintained for the Basin and reported to the DWR in accordance with the Monitoring Protocols developed for the Basin. Additional data collected by other entities as part of other regular monitoring programs may also be used for annual reporting and five-year updates. For example, various information including climate, groundwater levels, satellite imagery, and surface water flow data will be considered to assess GDE health and evaluate possible triggers as part of the five-year update.

ES.10. Projects and Management Actions

Achieving and maintaining sustainability will require the implementation of PMAs, which will be used to address conditions that may lead to Undesirable Results. The GSAs have identified the following six PMAs for potential implementation within the Basin:

1. OHWD Agricultural Flood Managed Aquifer Recharge (Flood-MAR).
2. Sacramento Area Flood Control Agency (SAFCA) Flood-MAR.
3. OHWD Cosumnes River Flow Augmentation.
4. City of Galt Recycled Water Project.
5. Voluntary Land Repurposing.
6. Groundwater Banking and Sale.

The main objective for PMAs #1-#4 is water supply and promoting long-term sustainability. Model-calculated water levels under projected future Basin conditions indicate the PMAs effectively mitigate against continued water level declines. Under assumed climate change conditions, without the PMAs the projected water levels in most wells decrease below the MTs, indicating Undesirable Results, whereas with the PMAs the water levels in many of the wells are maintained near the MOs that define the Sustainability Goal for the Basin. The objective for PMA #5 and #6 is generating revenue to financially support GSP implementation through the sale of some portion of stored/banked groundwater. One of the first steps for PMA implementation will be to identify a willing urban water supplier or other entity interested in purchasing the stored/banked water as supplemental dry year supply.

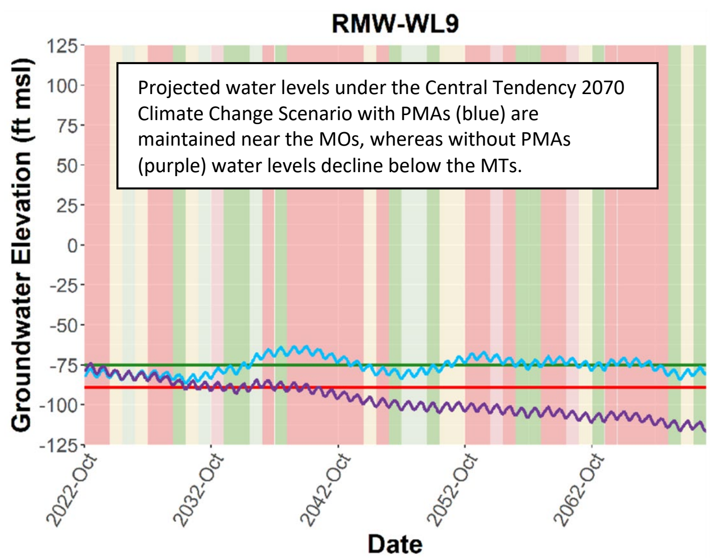


Table PMA-1 and **Table PMA-2** provide a summary of each PMA along with expected costs, benefits (on an average annual basis), timelines, and other relevant details specific to each PMA. PMA #1 (OHWD Agricultural Flood-MAR project) is projected to provide an almost 700 AFY augmentation to Basin storage . PMA #2 (SAFCA Flood-MAR) is projected to augment water supply between 4,000 and 6,000 AFY when complete. PMA #3 (OHWD Cosumnes River Flow Augmentation) is expected to augment water supply by 100 AFY. PMA #4 (City of Galt Recycled Water Project) is projected to augment water supply by 300 AFY. The purpose for PMAs #5 (Voluntary Land Repurposing) and #6 (Groundwater Banking and Sale) are primarily to generate revenue to support GSP implementation, though these actions will also provide a groundwater storage benefit from the planned water leave-behind component whereby groundwater recovery will be limited to 90% of the water stored.

Supplementary PMAs are also under consideration, such as: expanded land repurposing (e.g., expanded voluntary land fallowing); water use and efficiency projects; increased recharge with multi-benefit projects that include off stream impoundment of floodwater, reconnecting drainages to their floodplains combined with habitat preservation; local recharge projects as part of stormwater management on private lands; low impact development requirements; conservation efforts; participation in regional water banking projects (e.g., in adjacent basins); and others summarized in Section 18.2.4 *Other Projects*. The available information on these conceptual projects is insufficient to estimate implementation costs and benefits at this time.

ES.11. GSP Implementation

Key GSP implementation activities to be undertaken by the GSAs over the next five years include:

- Monitoring and Data Collection, including semi-annual water level measurement, annual water quality sampling, and additional data collected at variable frequencies. Data will be included in the DMS and required reporting;
- Data Gap Filling Efforts;
- Intra-Basin Coordination and Inter-Basin Coordination with adjacent basins;
- Stakeholder Engagement and Outreach;
- PMA Implementation;
- Annual Reporting;
- Enforcement and Response Actions, if necessary; and,
- Periodic GSP Evaluation and Updates.

SGMA requires achievement of the Sustainability Goal within 20 years of GSP adoption, which means by 2042. Annual Reports that track GSP progress are due on April 1 of every year following GSP submission, with the first report due April 1, 2022, for the Water Year ending on September 30, 2021 (this first report will also include WYs 2015 to 2021). Periodic evaluations are required at least every five years, meaning this GSP will be first updated no later than January 31, 2027.

ES.12. GSP Implementation Costs and Funding

Costs to implement this GSP are divided into several categories as follows.

- Groundwater monitoring and data collection;
- Data gap filling;
- Intra-Basin and Inter-Basin coordination;
- Stakeholder engagement;
- Annual reporting;
- Periodic GSP evaluations and updates;
- Other administration activities such as legal, financial audits, applying for grants and other funding; and,

- Implementation of PMAs, including feasibility studies, environmental analysis, capital/one-time costs and ongoing operating/maintenance costs.

A high-level estimate of the annual program costs for the above groups over the first five-year period (i.e., Fiscal Year 2021-2025) range between approximately $407,500 to $525,000 per year, not including GSA staff time or costs for PMA implementation. The estimated annual costs for PMAs are subject to change, pending specific PMA implementation, and range from $330,000 to $685,000 per year. The combined annual cost over the next five years ranges from $740,000 to $1,200,000 per year. The estimated costs will likely be met using a combination of user fees, parcel fees, SAFCA contribution, Department of Conservation (DoC) Grant, DWR Sustainable Groundwater Management Grant Program, and SGMA Technical Support Services and Facilitation Grants.

ES.13. Conclusion

The passage of SGMA in 2014 ushered in a new era of groundwater management in California. The law and regulations emphasize the use of best available science, local control and decision-making, and active engagement of affected stakeholders. Because of the breadth and scope of the groundwater sustainability problem in California and the legislative and regulatory response to this declining resource, SGMA presents significant challenges both for local implementing agencies and groundwater users alike. Achieving and maintaining sustainability in the face of uncertain future water supply conditions while addressing and balancing the needs of all beneficial uses and groundwater users will require significant effort, creative solutions, and unprecedented collaboration. The Basin GSAs recognize the importance of maintaining groundwater sustainability for the Basin. Therefore, as the implementing agencies, the CGA and it's member GSAs are committed to facing these challenges in a manner that upholds the interests of local landowners and constituents within the Basin.

INTRODUCTION

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) of 2014. The 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." Undesirable Results (URs) are defined by SGMA as any of the following effects caused by groundwater conditions occurring throughout a basin:

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply;
- Significant and unreasonable reduction of groundwater storage;
- Significant and unreasonable seawater intrusion;
- Significant and unreasonable degraded water quality;
- Significant and unreasonable land subsidence; and
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

The Cosumnes Subbasin (referred to herein as "the Basin") of the San Joaquin Valley Basin (California Department of Water Resources [DWR] Basin No. 5-022.16) is a medium priority basin located in Sacramento and Amador Counties (DWR, 2019). This GSP has been developed to meet SGMA regulatory requirements by the January 31, 2022 deadline for medium priority basins while reflecting local needs and preserving local control over water resources. This GSP provides a path to maintain and document sustainable groundwater management within 20 years following Plan adoption and preserves the long-term sustainability of locally-managed groundwater resources.

2. SUSTAINABILITY GOAL

> *§ 354.24 Sustainability Goal*
>
> *Each Agency shall establish in its Plan a sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline. The Plan shall include a description of the sustainability goal, including information from the basin setting used to establish the sustainability goal, a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon.*

The Sustainable Groundwater Management Act (SGMA) requires that a Sustainability Goal be defined for each basin (California Water Code [CWC] § 10727(a)). The Groundwater Sustainability Plan (GSP) Regulations further clarify that the Sustainability Goal should culminate "in the absence of undesirable results within 20 years of the applicable statutory deadline" (23 California Code of Regulations [CCR] § 354.24).

> *The Sustainability Goal of the Cosumnes Subbasin (Basin) is to ensure that groundwater in the Basin continues to be a long-term resource for beneficial users and uses including urban, domestic, agricultural, industrial, environmental and others. This goal will be achieved by managing groundwater within the Basin's sustainable yield, as defined by sustainable groundwater conditions and the absence of undesirable results.*

3. AGENCY INFORMATION

> *§ 354.6. When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:*
> *(a) The name and mailing address of the Agency.*
> *(b) The organization and management structure of the Agency, identifying persons with management authority for implementation of the Plan.*
> *(c) The name and contact information, including the phone number, mailing address and electronic mail address, of the plan manager.*
> *(d) The legal authority of the Agency, with specific reference to citations setting forth the duties, powers, and responsibilities of the Agency, demonstrating that the Agency has the legal authority to implement the Plan.*
> *(e) An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.*

3.1. Name and Mailing Address of the Agency

The Cosumnes Subbasin (herein referred to as the "Basin") of the San Joaquin Valley Basin (California Department of Water Resources [DWR] Basin No. 5-022.16) is a medium priority basin that is located in Sacramento and Amador Counties (DWR, 2019). The Basin is fully covered by seven Groundwater Sustainability Agencies (GSAs), each acting as the exclusive GSA in their respective portions of the Basin (**Figure PA-1**).

The GSAs are:

(1) Amador County Groundwater Management Authority (ACGMA) GSA;

(2) City of Galt GSA;

(3) Clay Water District GSA;

(4) Galt Irrigation District (GID) GSA;

(5) Omochumne-Hartnell Water District (OHWD) GSA;

(6) Sacramento County GSA; and

(7) Sloughhouse Resource Conservation District (SRCD) GSA.

Together, the GSAs formed the Cosumnes Subbasin Sustainable Groundwater Management Act (SGMA) Working Group (herein referred to as the "Working Group") and various committees (see Section 3.2 *Organization and Management Structure of the Agency*, below) which all worked together to develop this Groundwater Sustainability Plan (GSP). The Working Group requested that Mr. Austin Miller, with SRCD GSA, serve as the interim overall "Plan Manager" and point of contact for the planning work in the Basin. Prior to December 2020, the Plan Manager was John Lowrie, with the Sacramento Water Forum. The GSAs adopted a joint exercise of powers agreement (JPA) in November 2021 that established the Cosumnes Groundwater Authority (CGA) for the purpose of implementing this GSP (see **Appendix B** for the CGA JPA). As part of GSP implementation, the CGA will hire a Basin Executive Director who will take over the Plan

Manager role.

The interim mailing address for the Cosumnes SGMA Working Group and Plan Manager is:

Sloughhouse Resource Conservation District GSA
Attn. Mr. Austin Miller/Interim Plan Manager
8698 Elk Grove Boulevard, Suite 1-207
Elk Grove, CA 95624

3.2. Organization and Management Structure of the Agency

The GSAs adopted a Framework Agreement, the most recent version is dated January 9, 2020[1] (**Appendix B**), which formed the Working Group and formalized the GSAs' intentions of collaborating in the planning and development of this single, coordinated GSP for the Basin by January 31, 2022. As described above, the Working Group transitioned into a JPA which established the CGA in November 2021. The CGA JPA enables the GSAs to collaboratively comply with SGMA, implement the GSP, seek and secure grant or other funding to support implementation, and work collaboratively with GSAs or other entities managing the adjoining South American Subbasin ([SASb], DWR Basin No. 5-021.65) and Eastern San Joaquin (ESJ) Subbasin (DWR Basin No. 5-022.01). The CGA JPA will hire a Basin Executive Director who will serve as Plan Manager and be delegated the authority to implement the GSP, assisted by the Watershed Coordinator. The Watershed Coordinator was hired by the Southeast Sacramento County Agricultural Water Authority ([SSCAWA] which is a JPA made up of three of the GSAs: OHWD, GID and Clay Water District), to help focus watershed interests on developing multi-benefit projects, seek input from diverse stakeholders and identify and apply for funding. Additionally, the Working Group formed a Long-Term Governance Committee that actively meets to coordinate long-term financing and management of the Basin.

The following GSA representatives have management authority for implementation of the Plan, listed in alphabetical GSA order:

- Rick Ferriera (ACGMA GSA)
- Mark A. Clarkson or Michael Selling (City of Galt GSA)
- Gary Silva Jr. (Clay Water District GSA)
- Leo VanWarmerdam (GID GSA)
- Mike Wackman (OHWD GSA)
- Linda Dorn or Kerry Schmitz (Sacramento County GSA)
- Austin Miller or Herb Garms (SRCD GSA)

[1] January 2020 http://cosumnes.waterforum.org/wp-content/uploads/2020/03/Phases-3-and-4_Framework-Agreement_01_09_2020.pdf

Information regarding the GSAs and current Working Group representatives can be found on the Basin's SGMA website: http://cosumnes.waterforum.org/sustainable-groundwater-management-act-sgma.

The work of the GSAs was coordinated and supported by the Sacramento Water Forum and facilitated by the Consensus Building Institute (CBI) and the Watershed Coordinator. The following committees have provided input and recommendations to the Working Group on various aspects of the GSP development and implementation:

- Working Group – GSA representatives who attend monthly meetings with the technical consultant, Water Forum, and CBI. This committee makes the final decisions during GSP development. The Working Group has been meeting monthly since 2017.
- Technical Advisory Committee (TAC) – GSA representatives who provided recommendations to the Working Group on technical issues related to SGMA implementation during the early planning stages of the GSP development (2017 & 2018). The TAC does not currently meet separately from the Working Group.
- Outreach and Engagement Committee – GSA representatives who actively implement the Communication and Engagement (C&E) Plan, which seeks to improve outreach and engagement amongst stakeholders and other interested parties during GSP development and implementation.
- Long-Term Governance Committee – GSA representatives who began meeting regularly in September 2020 to develop recommendations for long-term governance and funding for implementation of the GSP.
- Ad-Hoc Committee – GSA representatives who began meeting at least once a month starting in September 2020 to discuss and provide feedback on various technical topics during GSP development.
- Project and Management Actions (PMA) Committee – A group of select GSA representatives who collaboratively developed various PMAs during GSP development.
- Tribal Outreach Committee – A select group of GSA representatives who are working to ensure open lines of communications are available with the state and federally recognized sovereign Native American tribes with interest in the Basin. The Tribal Outreach Committee was formed in December 2020 to increase outreach efforts during the final stages of GSP development.
- Monitoring Committee – A select group of GSA representatives who are working to manage, coordinate, and schedule routine monitoring for the proposed monitoring networks.

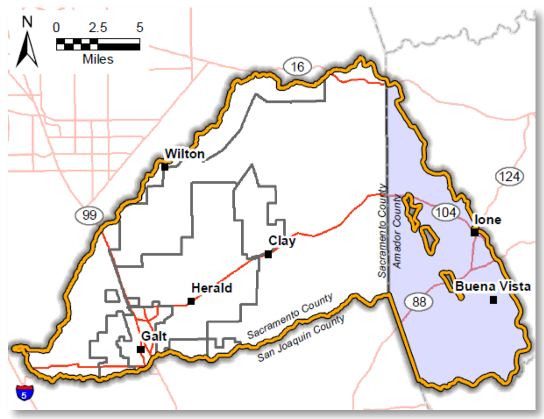
Working Group meetings are open to the public and include opportunities for public comment. These meetings are held the third Wednesday of each month, between 9:00 am and 12:00 pm. These meetings were typically held, unless otherwise noticed, at the Galt Police Department Community Room, 455 Industrial Drive, Galt, CA, and then virtually per the requirements of the Governor's Executive Order N-29-20. Meeting details, materials, and links to virtually attend meetings can be found on the Basin's

SGMA website[2]: http://cosumnes.waterforum.org/meetings.

3.2.1. Description of the Basin GSAs

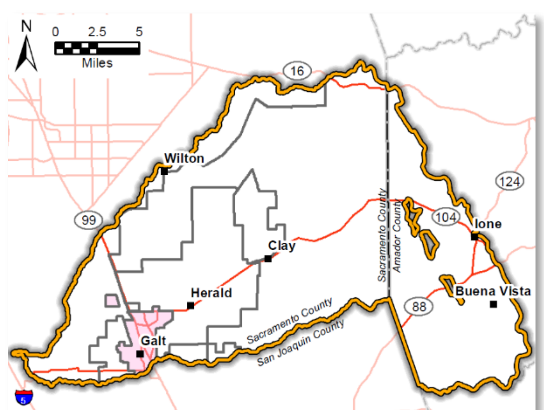
A brief description of each GSA is provided below in alphabetical order, including a small inset figure showing the location of the GSA within the Basin. The GSA boundaries are shown in more detail on **Figure** PA-1 and the land use within each GSA is shown on **Figure PA-2** through **Figure PA-8**.

Amador County Groundwater Management Authority GSA



The ACGMA GSA encompasses approximately 53,800 acres in western Amador County and covers the eastern region of the Basin. Within the Basin, the ACGMA GSA boundaries are coincident with Amador County. Land use is predominantly undeveloped and urban, with localized agriculture in Jackson Valley near the towns of Buena Vista and Ione (**Figure PA-2**). The ACGMA is a JPA between three public agencies: (1) Amador County, which has land use authority throughout Amador County; (2) Amador Water Agency (AWA), which has the authority to provide water service to all properties within Amador County and primarily utilizes the Mokelumne River and groundwater as its water supply; and (3) Jackson Valley Irrigation District (JVID), which utilizes both Jackson Creek and the Mokelumne River as water supplies for servicing its district. The ACGMA Board of Directors meets on the first Monday of each even month (i.e., February, April, June, August, October, and December) at 3:00 p.m. in the JVID Board Room at 7300 Lake Amador Dr. Ione CA 95640.

City of Galt GSA

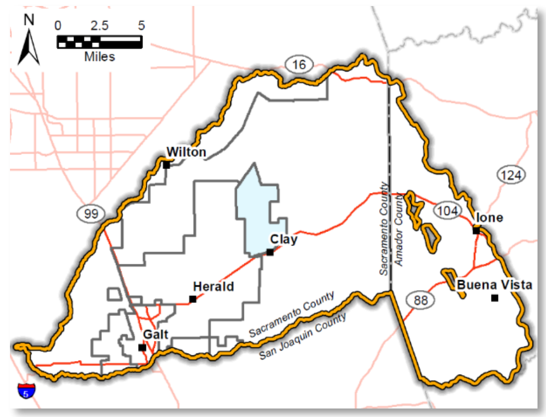


The City of Galt GSA encompasses approximately 5,000 acres in Sacramento County and is located approximately 20 miles south of Sacramento along Highway 99 in the southwestern part of the Basin along the boundary with San Joaquin County. The City of Galt (City) is an incorporated city (U.S. Census Bureau, 2012) and is the largest public water supplier in the Basin. The City of Galt GSA area includes the incorporated City as well as recent and planned annexations. The land use is predominantly designated as urban with a small fraction designated to agriculture (**Figure PA-3**). The City is a growing community with a population of roughly 26,500 people and relies solely on groundwater for its water supply. The City's water supply includes six active municipal wells that supply water to residential,

[2] Cosumnes website will change during Implementation, but the user will be redirected from the old site to the new site.

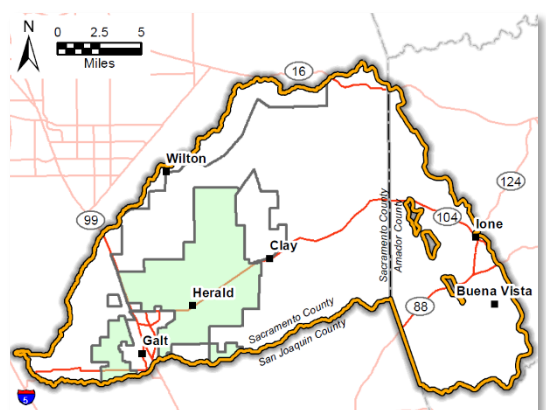
commercial, institutional, and industrial customers within the service area. The City also owns and operates a wastewater treatment plant that collects and treats all wastewater generated within the City's service area. The City anticipates it can supply all of its water demands with groundwater through the GSP implementation horizon. Unless otherwise noticed, City of Galt GSA items are discussed at the City of Galt City Council meetings, which are typically held every first and third Tuesday at 6:00 p.m. in the City Council Chambers located at 380 Civic Drive, Galt, CA 95632. For more information visit: http://www.ci.galt.ca.us/i-want-to/city-meetings.

Clay Water District GSA



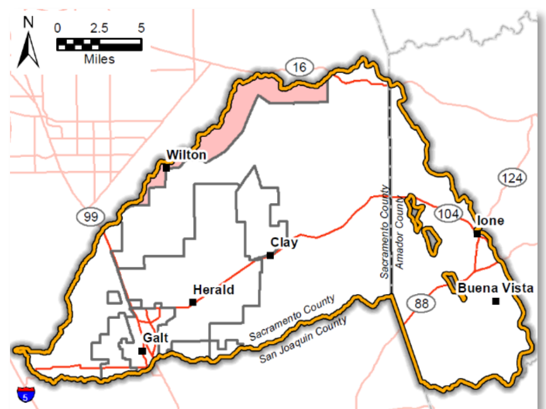
The Clay Water District GSA is located in southeastern Sacramento County in the central area of the Basin and intersects the town of Clay along its southern boundary and has boundaries coincident with those of the Clay Water District. The Clay Water District GSA encompasses 6,400 acres of predominantly agricultural land (vineyard, pasture, and fruit trees) with some agricultural residential properties (**Figure PA-4**). The district area is mostly dependent on groundwater for residential and agricultural uses, with a small amount of supplemental water from surface water diversions (eWRIMS, 2020). Clay Water District was formed to contract with the United States Bureau of Reclamation (USBR) to divert water from the Folsom South Canal (FSC) to support regional agriculture and purchased surface water discharged from the lake at Rancho Seco Park between 1975 and 2010. Clay Water District is a member of the Southeast Sacramento County Agricultural Water Authority (SSCAWA), which is a JPA that formed in 2002 to manage water resources (Robertson-Bryan, Inc., 2002). Unless otherwise noticed, GSA items are discussed at the Clay Water District Board of Directors meetings which are held quarterly at the Herald Fire Protection District, 11620 Clay Station Road, Herald, CA.

Galt Irrigation District GSA



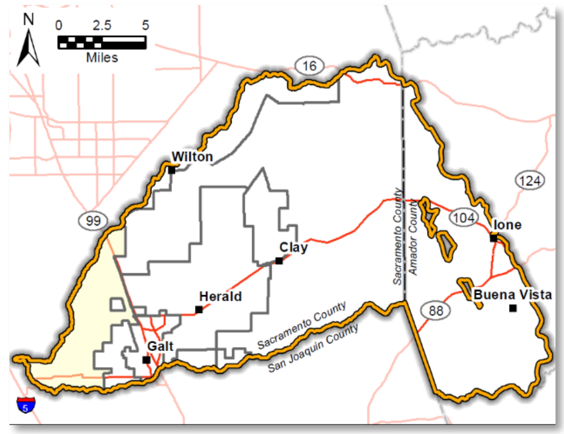
The GID GSA boundaries are largely coincident with the GID boundaries with some additional land to the west of the City of Galt. The GID GSA encompasses approximately 32,500 acres in southern Sacramento County within the central to southwestern part of the Basin and includes the town of Herald and areas around the City of Galt. The predominant land use is agricultural, including vineyard, pasture, field crops, and fruit trees (**Figure PA-5**). Most of the landowners within GID depend on groundwater to meet their water needs, including three aquaculture farms (fish farms). Aquaculture practices require pumping groundwater year-round; the water is recycled through multiple ponds and tanks before being discharged into a recharge pond or used by nearby farmers to irrigate their crops during irrigation season. GID was formed in 1953 to deliver water from Laguna Creek to local irrigators and is a member of the SSCAWA. Intermittently between 1975 and 2010, GID purchased surface water discharged from the lake at Rancho Seco Park to supplement irrigation water supplies (Robertson-Bryan, Inc. and Water Resources & Information Management Engineering [WRIME], 2011). Unless otherwise noticed, GSA items are discussed at the GID Board of Directors meetings that are held on the second Tuesday of the month at its office, 12716 Herald Road, Herald, CA. Additional information can be found on the GID website: https://gid.specialdistrict.org/

Omochumne-Hartnell Water District GSA



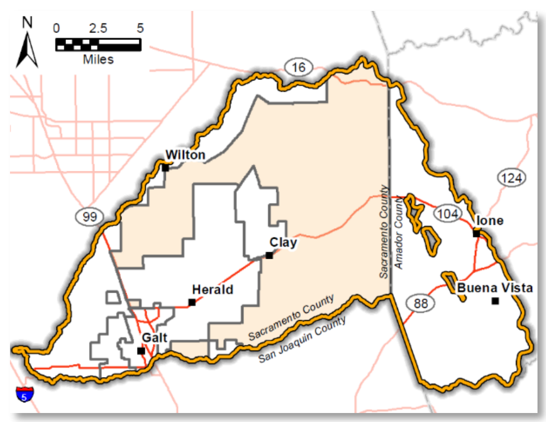
The OHWD GSA encompasses 30,000 acres along the Cosumnes River, with 10,000 acres within the Basin and 20,000 acres extending north into the South American Subbasin (SASb). The OHWD GSA has coincident boundaries with the portions of OHWD within the Basin. The predominant land use is agricultural lands, including vineyards, grain and hay crops (**Figure PA-6**). Additionally, two aquaculture farms, which similarly require year-round groundwater pumping, are located within OHWD. Although groundwater supplies most of the water demand for this area, OHWD has historically purchased and managed supplemental water from the Central Valley Project (CVP) for the benefit of agricultural users adjacent to the Cosumnes River and Deer Creek. Currently, a few riparian diverters supplement their groundwater supply with surface water diversions. The OHWD was formed in 1953 and is a member of the SSCAWA. The OHWD operates four temporary flashboard dams on the Cosumnes River to facilitate riparian use of the surface water via higher water levels and greater storage within the river channel. In addition, this practice increases percolation of groundwater by increasing the wetted perimeter of the channel during latter part of each wet season. The OHWD currently is involved in recharge projects within their service boundary north of the Basin. Unless otherwise noticed, GSA items are discussed at OHWD Board of Directors meetings, which are held on the third Tuesday of the month at 10:00 a.m. at 8970 Elk Grove Boulevard, Elk Grove, CA. Due to requirements set forth by Governor's Executive Order N-29-20, these meetings are now held virtually. Additional information can be found on the OHWD website: http://www.ohwd.org/

Sacramento County GSA



The Sacramento County GSA encompasses approximately 15,700 acres in the western part of the Basin, mostly west of Highway 99. Sacramento County Water Agency combined with the Sacramento County as the GSA in this portion of the Basin in April 2017. The predominant land uses in this area include agricultural lands (riparian vegetation, vineyards, and grains) and undeveloped areas, such as the Cosumnes Floodplain Mitigation Bank and portions of the Cosumnes River Preserve (i.e., the Arno Unit, McFarland Unit, and Dillard Unit; **Figure PA-7**; **Figure PA-9**). The water supply sources for this area are mostly groundwater, with seasonal diversions from the Cosumnes River and Dry Creek. Unless otherwise noticed, GSA items are discussed, as necessary, when the Sacramento County Board of Supervisors meets at least twice per month on various Tuesdays at 9:30 a.m., with some meetings held on select Wednesdays at various times. For more information visit: https://bos.saccounty.net/Pages/AboutBoardMeetings.aspx.

Sloughhouse Resource Conservation District GSA



The SRCD GSA encompasses approximately 88,300 acres in southeastern Sacramento County, making it the largest GSA, by area, in the Basin. The SRCD itself extends into the SASb (and includes OHWD, Clay Water District and parts of GID), but within the Basin, SRCD GSA encompasses most of the central portion of the Basin, with the eastern boundary along the Sacramento / Amador County line and with the southern boundary along the Sacramento / San Joaquin County line. The predominant land use is agriculture, but also includes a substantial amount of undeveloped land areas (i.e., non-irrigated lands; **Figure PA-8**). Most of the area is dependent on groundwater for residential, agricultural (including one aquaculture farm operation), and public water supplies. At least historically, some seasonal diversions were taken from the Cosumnes River. The SRCD was formed in 1956 by local farmers and ranchers to address local soil conservation issues. Unless otherwise noticed, GSA items are discussed at SRCD Board of Directors meetings that are held on the second Wednesday of each month at 1:00 p.m. at 8698 Elk Grove Boulevard, Ste 1-207, Elk Grove, CA 95624. In compliance with the Governor's Executive Order N-29-20, meetings are now being held virtually. For more information visit:

http://sloughhousercd.org/meetings/.

3.3. Plan Manager

At the point of adoption, the Plan Manager and point of contact for the Basin GSP is Mr. Austin Miller with the SRCD GSA. Until December 2020, the point of contact for the Basin GSP was Mr. John Lowrie of the Sacramento Water Forum. Mr. Miller will serve as the interim point of contact until the CGA hires a Plan Manager and can be reached at:

Mailing Address:

Sloughhouse Resource Conservation District
8698 Elk Grove Boulevard, Suite 1-207
Elk Grove, CA 95624

Phone: (916) 526-5447

Email: Austin@SloughhouseRCD.org and/or info@SloughouseRCD.org

3.4. Legal Authority of the GSA

The Basin is fully covered by the following seven exclusive GSAs, all which applied for and were granted exclusive GSA status under SGMA (California Water Code [CWC] § 10723(c)):

(1) ACGMA GSA;

(2) City of Galt GSA;

(3) Clay Water District GSA;

(4) GID GSA;

(5) OHWD GSA;

(6) Sacramento County GSA; and

(7) SRCD GSA.

All seven GSAs are members of the Working Group and the CGA and are committed to developing and implementing this single, coordinated, SGMA-compliant GSP to foster plan effectiveness, coordination and efficiencies.

3.5. GSP Implementation Cost Estimate

As discussed in more detail in Section 19.2 *Plan Implementation Costs*, costs associated with continued CGA activities, including monitoring, reporting, and stakeholder outreach, are estimated to range between approximately $407,500 to $525,000 per year, not including CGA and CGA member agency staff time. Estimated annual costs for individual PMAs is estimated to range between approximately $330,000 to $685,000 annually as the CGA moves forward with specific PMA implementation. The CGA will likely meet the estimated costs through a combination of user fees, parcel fees, Sacramento Area Flood Control

Agency (SAFCA) contribution, Department of Conservation (DoC) grant, and Sustainable Groundwater Management Office (SGMO) Services Grant.

4. GSP ORGANIZATION

This Groundwater Sustainability Plan (GSP) is organized as follows:

- Sections 1 through 4 comprise the **Introduction**, including the following sections:
    - Section 1. Purpose of the Groundwater Sustainability Plan
    - Section 2. Sustainability Goal
    - Section 3. Agency Information
    - Section 4. GSP Organization
- Section 5 provides a **Description of the Plan Area**.
- Sections 6 through 11 present the **Basin Setting**, including the following sections:
    - Section 6. Introduction to Basin Setting
    - Section 7. Basin Data Management System
    - Section 8. Hydrogeologic Conceptual Model
    - Section 9. Current and Historical Groundwater Conditions
    - Section 10. Water Budget Information
    - Section 11. Management Areas
- Sections 12 through 16 present the **Sustainable Management Criteria**, including the following sections:
    - Section 12. Introduction to Sustainable Management Criteria
    - Section 13. Sustainability Goal
    - Section 14. Undesirable Results
    - Section 15. Minimum Thresholds
    - Section 16. Measurable Objectives and Interim Milestones
- Section 17 presents the **Monitoring Network**.
- Section 18 presents the **Projects and Management Actions**.
- Section 19 presents **Plan Implementation**.
- **References and Technical Studies** are included at the end of this document.
- Supporting information is provided in Appendices as follows:

    - **Appendix A**. GSP Submittal Checklist

- **Appendix B.** Framework Agreement and Cosumnes Groundwater Authority Joint Powers Agreement
- **Appendix C.** Excerpts from General and Specific Plans
- **Appendix D.** Communication and Engagement Plan
- **Appendix E.** Meetings Held during GSP Development
- **Appendix F.** Public Comments during GSP Development
- **Appendix G.** Summary of Water Quality Data Sources
- **Appendix H.** Graphical and Statistical Relationships between Groundwater Quality and Time, and Groundwater Quality and Water
- **Appendix I.** Prop 68 Geophysics Report
- **Appendix J.** EKI Isotope Report
- **Appendix K.** The Nature Conservancy Freshwater Species List for the Cosumnes Subbasin
- **Appendix L.** Prop 68 GDE Report
- **Appendix M.** CoSANA Report from Woodard and Curran
- **Appendix N.** Cosumnes Subbasin QAQC Plan
- **Appendix O.** PMA Forms

PLAN AREA

5. DESCRIPTION OF THE PLAN AREA

This section presents a description of the Plan Area, and a summary of the relevant jurisdictional boundaries and other key land use features potentially relevant to the sustainable management of groundwater in the Cosumnes Subbasin (Basin; California Department of Water Resources [DWR] basin No. 5-022.16). This section also describes the water monitoring programs, water management programs, and general plans relevant to the Basin and their influence on the development and execution of this Groundwater Sustainability Plan (GSP).

5.1. Summary of Jurisdictional Areas and Other Features

§ 354.8. Each Plan shall include a description of the geographic areas covered, including the following information:
(a) One or more maps of the basin that depict the following, as applicable:
  (1) The area covered by the Plan, delineating areas managed by the Agency as an exclusive Agency and any areas for which the Agency is not an exclusive Agency, and the name and location of any adjacent basins.
  (2) Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.
  (3) Jurisdictional boundaries of federal or state land (including the identity of the agency with jurisdiction over that land), tribal land, cities, counties, agencies with water management responsibilities, and areas covered by relevant general plans.
  (4) Existing land use designations and the identification of water use sector and water source type.
  (5) The density of wells per square mile, by dasymetric or similar mapping techniques, showing the general distribution of agricultural, industrial, and domestic water supply wells in the basin, including de minimis extractors, and the location and extent of communities dependent upon groundwater, utilizing data provided by the Department, as specified in Section 353.2, or the best available information.

5.1.1. Plan Area Setting

The Basin encompasses approximately 210,300 acres at the northern end of the San Joaquin Valley Groundwater Basin within Sacramento and Amador Counties (see **Figure PA-1**). As shown in **Figure PA-1**, the Basin is entirely covered by seven exclusive Groundwater Sustainability Agencies (GSAs): (1) Amador County Groundwater Management Authority (ACGMA) GSA; (2) City of Galt GSA; (3) Clay Water District GSA; (4) Galt Irrigation District (GID) GSA; (5) Omochumne-Hartnell Water District (OHWD) GSA; (6) Sacramento County GSA; and (7) Sloughhouse Resource Conservation District (SRCD) GSA. Collectively these GSAs have formed the Cosumnes Subbasin Sustainable Groundwater Management Act (SGMA) Working Group (Working Group) for development of the GSP and entered into a joint exercise of powers agreement (JPA) in November 2021 to establish the Cosumnes Groundwater Authority (CGA) for the purpose of implementing the GSP (included as **Appendix B**).

As shown in **Figure PA-1**, the Basin shares boundaries with two adjacent groundwater basins. To the north and west is the high priority South American Subbasin (SASb) of the Sacramento Valley Groundwater Basin (DWR Basin No. 5-021.65) and to the south is the high priority, critically overdrafted Eastern San Joaquin (ESJ) Subbasin of the San Joaquin Valley Groundwater Basin (DWR Basin No. 5-022.01). The eastern Basin boundary is defined by the transition to non-alluvial bedrock in the foothills of the Sierra Nevada mountains.

5.1.2. Adjudicated Areas, Other Agencies, and Alternative Area

The Basin is not adjudicated and does not contain any areas covered by an Alternative.

5.1.3. Jurisdictional Boundaries

The following section describes the jurisdictional boundaries within the Basin. These boundaries include cities, counties, California protected areas, local, state and federal lands, Native American Tribal communities and lands, disadvantaged communities, and entities with water management responsibilities within the Basin.

Cities and Counties

The Basin falls within Sacramento and Amador Counties, wherein Sacramento County covers the western portion of the Basin and Amador County covers the foothills in the eastern portion of the Basin (see **Figure PA-9**).

California Protected Areas, California Conservation Easement Areas, and Local, State and Federal Lands

As shown on **Figure PA-9,** approximately 16,850 acres of California Protected Areas are located within the Basin and are managed by federal, state, city, county or special district agencies that are protected for open space and natural resource purposes (California Protected Areas Database, 2018)[3]:

- Approximately 260 acres of federally owned lands are located in the southwestern portion of the Basin and are managed by the Bureau of Land Management (BLM). Smaller areas of BLM land (totaling approximately 380 acres) are scattered along the eastern boundary of the Basin in Amador County.
- Approximately 4,800 acres of state-owned lands are located mostly along the Cosumnes River in the western portion of the Basin. These state-owned lands encompass the Cosumnes River Ecological Reserve and Apricum Hill Ecological Reserve, managed by the California State Lands Commission and California Department of Fish and Wildlife (CDFW), and Grizzly Slough, managed by DWR.
- Approximately 3,510 acres of lands are owned by The Nature Conservancy (TNC). These lands encompass the Cosumnes River Preserve.

[3] GreenInfo Network, 2018, California Protected Areas Database. Retrieved from https://www.calands.org/cpad/

- Approximately 7,000 acres of special District Lands are owned by: (1) East Bay Municipal Utility District (EBMUD) encompassing Camanche Reservoir, and (2) Sacramento Municipal Utility District (SMUD) encompassing Rancho Seco Recreational Park.
- Approximately 140 acres are owned by either the City of Galt or the City of Ione. Additionally, 760 acres are owned by Sacramento County.

Approximately 26,770 acres of California Conservation Easement areas are located within the Basin as shown on **Figure PA-9.** These areas define easement and deed-based restrictions on private land which limit land uses to maintaining open spaces (e.g., farmed, grazed, forested, nature reserves) (California Conservation Easement Database, 2018)[4]:

- Approximately 11,890 acres of easements are managed by United States Natural Resources Conservation Service (NRCS) including the Wetlands Reserve Program and Emergency Watershed Protection Program – Floodplain Easement.
- Approximately 8,090 acres of easements are managed by CDFW including the Grizzly Slough Conservation Easement, Upper Cosumnes River Easement, Deer Creek Conservation Easement and Arroyo Seco Conservation Easement.
- Approximately 3,350 acres of easements are managed by Sacramento Valley Conservancy which includes the Sacramento Valley Conservation Easement
- Approximately 2,280 acres of easements are managed by TNC including the Cosumnes River Macrosite Easement and TNC Easement.
- Approximately 1,070 acres of easements are managed by Wildlife Heritage Foundation including the Brown's Creek Mitigation Preserve, Cosumnes Floodplain Mitigation Bank, Laguna Terrace East and Twin Cities.
- Approximately 100 acres of easements are managed by California Farmland Trust which includes the Rocha/Mello Farm.

Native American Tribal Communities and Lands

The Basin is also home to several Native American tribal communities and lands (**Figure PA-9**):

- The Wilton Rancheria tribe is located in Sacramento County in the northwestern portion of the Basin, adjacent to the Cosumnes River. The mission statement for the Wilton Rancheria Department of Cultural Preservation describes the importance of protecting resources committed to the Tribe[5], including the Cosumnes River which is considered a valuable resource by the Tribe. The Tribal Chairman was interviewed as part of initial stakeholder outreach efforts and has attended multiple Working Group meetings.

[4] GreenInfo Network, 2018, California Protected Easement Database. Retrieved from https://www.calands.org/cced/
[5] From the Wilton Rancheria Website http://wiltonrancheria-nsn.gov/TribalOffice/CulturalPreservation/tabid/312/Default.aspx

- The Buena Vista Rancheria of Me-Wuk Indians tribe is located in Amador County in the southeastern portion of the Basin. The Buena Vista Rancheria of Me-Wuk Indians rely on both groundwater and surface water to meet demands (EKI, 2009).
- The Ione Band of Miwoks tribe is located in Amador County and is a public water supplier dependent upon groundwater, serving a population of 62 residents (Safe Drinking Water Information System [SDWIS], 2018). The Ione Band of Miwoks has at least two groundwater wells. Typical groundwater use by the Tribe is approximately 5.0 acre-feet per year (AFY; 2014-2016 use data[6]).

In addition to the tribes mentioned above, an additional eleven tribes are listed by the Native American Heritage Commission (NAHC) within Amador and Sacramento counties who utilize or have some interest in the Basin. The NAHC Tribes include: the Calaveras Band of Mi-Wuk Indians, the Colfax-Todds Valley Consolidated Tribe, the Jackson Rancheria Band of Miwuk Indians, the Nashville Enterprise Miwok-Maidu-Nishinam Tribe, the Tsi Akim Maidu, the Shingle Springs Band of Miwok Indians, the Jackson Rancheria, the confederated Villages of Lisjan, the United Auburn Indian Community of the Auburn Rancheria, the Washoe Tribe of Nevada and California, and the Yocha Dehe Wintun Nation (Kronick, 2020).

Through inclusion on the Interested Person Email List, interviews, and additional outreach efforts by the Tribal Outreach Committee, the Working Group has sought to integrate these Native American tribal communities into GSP planning efforts. Outreach efforts are on-going and will continue throughout GSP implementation.

Disadvantaged Communities

The DWR presents information regarding U.S. Census Blocks, Tracts and Places that are defined as disadvantaged communities (DAC) or severely disadvantaged communities (SDAC) based on the median household income (MHI) of an area compared to the statewide MHI.[7] The DAC communities are those with a MHI of less than 80% the statewide MHI and SDAC communities are those with a MHI of less than 60% of the statewide MHI (California Code, Public Resources Code § 75005(g)).

Figure PA-10 shows the DAC/SDAC designations within the Basin based on 2018 MHI from the 2013-2017 American Community Survey Five-Year Estimates. Approximately 9% of the Basin (18,236 acres) is covered by DWR-designated DACs or SDACs, including 8,263 residents of the City of Galt (U.S. Census Bureau 2018). Of the 8,263 residents within City of Galt, 5,133 are designated as DACs and 3,130 are designated as SDACs. The remaining DACs fall within the western portion of the Basin which includes mostly farmlands, undeveloped areas (i.e., non-irrigated lands), and small areas of rural residential.

Entities with Water Management Responsibilities

The seven GSAs and other entities and agencies with water management responsibilities within the Basin

[6] Data from Annual Reports downloaded from Drinking Water Information Clearinghouse: https://drinc.ca.gov/drinc/DWPRepository.aspx
[7] SGMA Data Viewer: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer

include:

- Cities and Counties: City of Galt, City of Ione, Amador County, and Sacramento County;
- Water Districts, Irrigation Districts, and Water Agencies: Clay Water District, GID, OHWD, JVID, and Amador Water Agency (AWA);
- Utility Districts: EBMUD, which operates and manages Camanche Reservoir and SMUD, which operates and manages Central Valley Project (CVP) imported surface water from the Folsom South Canal (FSC) at Rancho Seco Park; and
- Joint Powers Authorities: Amador County Groundwater Management Authority formed by Amador County, AWA, and JVID (AWA, County of Amador, & JVID, 2017)[8], Southeast Sacramento County Agricultural Water Authority (SSCAWA), formed in 2002 by Clay Water District, OHWD, and GID to manage water resources (Robertson-Bryan, Inc., 2002) and the CGA formed by the GSAs for the purpose of implementing the GSP.

The Basin is located within the General Plan areas of Sacramento County, Amador County, City of Galt and City of Ione. These plans are discussed in more detail below in Section 5.3.1 *General Plans and Other Land Use Plans*. The City of Galt General Plan further identifies the Eastview Specific Plan area which covers a smaller portion of the Basin and is also discussed in Section 5.3.1 *General Plans and Other Land Use Plans*.

5.1.4. Existing Land Use and Water Use

Table PA-1 summarizes the current land use designations within the Basin, based on information provided by DWR (DWR, 2015 and Land IQ, 2014) as well as modifications made according to aerial imagery and input from the Working Group. Undeveloped lands are represented in the land use data sets as either native vegetation[9] or riparian vegetation. Undeveloped lands, as represented in the land use data set, cover approximately 135,800 acres within the Basin, while all other designations are considered developed lands and cover the remaining area within the Basin. Of the developed lands, agriculture is currently the primary land use. Approximately 44,100 acres within the Sacramento County portion of the Basin are irrigated agriculture and approximately 3,200 acres in the Amador County portion of the Basin are irrigated agriculture. The irrigated lands within the Sacramento County portion of the Basin are primarily supplied by groundwater and supplemented with surface water. In Amador County groundwater pumping is more limited as JVID supplies water from Jackson Creek and the Mokelumne River to agricultural lands within its service area.

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[8] JPA downloaded from SGMA Portal: https://sgma.water.ca.gov/portal/

[9] The term "native vegetation" is the land use classification assigned by DWR to undeveloped areas. In this GSP, the term is used for consistency with the original data provided by DWR and does not distinguish between native and non-native species.

Table PA-1. Land Use Designations within the Basin

Land Use Category	Total Area (acres)	Percent of Basin Area
Undeveloped		
Native Vegetation	132,400	63.2 %
Riparian Vegetation	3,440	1.6 %
Developed		
Urban[1]	18,020	8.6 %
Vineyards	16,860	8.0 %
Pasture	12,330	5.9 %
Grain	9,700	4.6 %
Idle	6,440	3.1 %
Corn	3,030	1.4 %
Alfalfa	1,740	0.8 %
Other Field	1,340	0.6 %
Citrus & Subtropical	1,180	0.6 %
Other Deciduous	1,160	0.6 %
Almonds & Pistachios	950	0.5 %
Other Truck	440	0.2 %
Dry Beans	280	0.1 %
Tomato	260	0.1 %
Safflower	110	0.1 %
Cucurbits	5	0.0 %

Note:
(1) Urban land use includes cities, communities, Ag-Res, and industrial uses (see **Figure PA-2** through **Figure PA-8**).

As discussed above, approximately 16,850 acres of California Protected Areas and approximately 26,770 acres of California Conservation Easement Areas are located within the Basin. These lands are owned by governments, non-profits, or private entities and are protected for open space and natural resource purposes. The Cosumnes River Preserve is located in the western portion of the Basin along the Cosumnes River and Lake Camanche in the eastern portion of the Basin and constitutes the majority of the Basin's California Protected Area land.

The potable consumption of groundwater in the Basin includes use by domestic well owners and public water systems (PWS). Over 20 PWS were identified within the Basin, see **Table PA-2** and **Figure PA-11**, serving populations from 27 to 26,536 people (SDWIS, 2018). The largest PWSs within the Basin are the City of Galt, which has six active wells and two standby wells that serve 26,536 people, and AWA – Camanche Village, which has four active wells that serve 2,384 people (SDWIS, 2018). To develop a subset of information on private wells, a stakeholder survey was sent out to landowners within the Basin. Out of the 213 responses, 166 landowners indicated that they own and operate private wells (as of April 15, 2019).

Table PA-2. PWS identified in the Cosumnes Subbasin

PWS #	PWS Name	Population Served	Water Source
CA0300037	Jackson Valley Irrigation District	2,000	Surface Water
CA0300058(1)	Camanche Hills Hunting Preserve, Inc(1)	400	Groundwater
CA0300062	Hope Foundation/Moriah Heights	30	Groundwater
CA0300078	Ione Band of Miwok Indians	62	Groundwater
CA0300524	MP Associates, Inc.	170	Groundwater
CA0310002	AWA - Ione	6,170	Surface Water
CA0310008	Camanche North Shore Inc.	255	Groundwater
CA0310020	The Oaks Mobile Home Park	600	Surface Water
CA0310021	AWA - Camanche Village	2,384	Groundwater
CA3400181	Laguna Del Sol Inc	470	Groundwater
CA3400232	Rancho Seco NGS (SMUD)	27	Groundwater
CA3400254	Dillard Elementary School	350	Groundwater
CA3400271	Arcohe Elem School - Main Campus	465	Groundwater
CA3400273	Wilton Bible Church	125	Groundwater
CA3400302	Rancho Seco Park	40	Groundwater
CA3400376	Sloughhouse Inn	200	Groundwater
CA3400432	Cosumnes River Preserve Visitor (BLM)	300	Groundwater
CA3400442(2)	Arcohe Elem School - East Campus(2)	280	Groundwater
CA3400460	Church of Latter Day Saints, Galt	800	Groundwater
CA3400464	River City Recovery Center, Inc.	60	Groundwater
CA3400469	Dillard Store (Sws)	50	Groundwater
CA3410005	Rancho Murieta Community	5,542	Surface Water
CA3410011	City of Galt	26,536	Groundwater
CA3410802	Richard A. Mcgee Training Center	300	Groundwater

Abbreviations:
PWS = public water system

Notes:
(1) Public water system type is "non-transient non-community system" that changed from public to non-public on 6 February 2015.
(2) Public water system type is "non-transient non-community system" that changed from public to non-public on 2 March 2017.

Sources:
(1) State Water Resources Control Board (SWRCB), SDWIS Drinking Water Watch, available online at https://sdwis.waterboards.ca.gov/PDWW/
(2) United States Environmental Protection Agency (USEPA), SDWIS Federal Reports Search, available online at https://ofmpub.epa.gov/apex/sfdw/f?p=108:200:::NO:::

5.1.5. Well Density per Square Mile

Figure PA-12 shows the density of wells per square mile within the Basin, based on Well Completion Report (WCR) records compiled by DWR.[10] According to these records, 2,258 domestic, 433 production[11], and 23 public supply wells have been installed within the Public Land Survey System (PLSS) sections[12] that fall within the Basin. This DWR dataset is known to have limitations but is accepted to be the most complete dataset currently available. However, it is likely that wells included in the dataset may not be in use, well locations may not always be accurate[13], and well construction information may not always be accurate. For example, the well density per PLSS section only considers wells that are specifically classified as having domestic, production and public supply uses. There are other well uses within the Basin (e.g., monitoring, vapor extraction, etc.), wells with unknown uses (~200 wells), and wells with no use classification (~700 wells), which are not included in the mapping analysis. Despite its limitations, the DWR WCR dataset was used to inform some aspects of GSP development (e.g., potential well impacts analysis, see Section 15.1.2 *Domestic Well Impact Analysis*).

The Cosumnes Basin Data Management System (DMS) was populated with well data from various public sources that were available for compilation and verification through June 2019 (see Section 7 *Cosumnes Basin Data Management System*). The DMS contains detailed information (e.g., well coordinates, well construction information, well use, water level data, water quality data, etc.) for 101 domestic or mixed domestic use (i.e., irrigation/domestic), 282 production[14], and 68 public supply wells where these details can be confirmed. **Figure PA-12** also shows the wells within the Basin that are integrated into the current DMS.

A comparison between the density of wells based on DWR's WCRs and the wells in the DMS, shows that DWR reports much higher counts for domestic and production wells than the DMS reports, whereas the DMS reports more public supply wells than the DWR reports. The DWR's WCR data was used for the domestic well impact analysis in Section 0

Domestic Well Impact Analysis and will be added to the DMS as the well data are verified. Data reconciliation efforts (i.e., a better understanding of the nature, location, and construction of active wells within the Basin) and verification of the DWR's Well Completion Reports[15] are expected to continue as

[10] DWR Well Completion Report Map Application website: https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37, accessed 10/23/2018.

[11] Production well counts include public supply wells.

[12] Each PLSS represents approximately 1 square mile of area (i.e., 640 acres).

[13] In 2019 DWR released a shapefile of the well locations to accompany the WCRs with the guidance that the well location information should be used for informational purposes only and that all attributes should be verified by reviewing the original WCRs.

[14] Wells designated with a site use type of commercial, industrial, irrigation, stock, or unknown in the Cosumnes Subbasin DMS were assigned to the production category.

[15] Sacramento County GSA is actively reviewing well completion reports and reviewed all available reports in the Amador County portion of the Basin.

part of GSP implementation.

5.2. Water Resources Monitoring and Management Programs

> *§ 354.8. Each Plan shall include a description of the geographic areas covered, including the following information:*
> *(c) Identification of existing water resource monitoring and management programs, and description of any such programs the Agency plans to incorporate in its monitoring network or in development of its Plan. The Agency may coordinate with existing water resource monitoring and management programs to incorporate and adopt that program as part of the Plan.*
> *(d) A description of how existing water resource monitoring or management programs may limit operational flexibility in the basin, and how the Plan has been developed to adapt to those limits.*
> *(e) A description of conjunctive use programs in the basin.*

5.2.1. Existing Monitoring and Management Programs

Existing Monitoring Programs

The Basin has a variety of existing monitoring programs. Data, where available, were utilized to support characterization of the Basin Setting (e.g., groundwater conditions, hydrogeological conceptual model [HCM], and water budget), and when appropriate compiled into the DMS (see Section 7 *Cosumnes Basin Data Management System).* Many of the existing programs and data sources discussed herein are also compiled/reported in the DWR SGMA Data Viewer[16]. Relevant data were obtained from the following existing programs:

- DWR's California Statewide Groundwater Elevation Monitoring program (CASGEM)[17], which tracks seasonal and long-term groundwater elevation trends in basins throughout the state. The program's mission is to establish a permanent, locally managed program of regular and systematic monitoring in all of California's alluvial groundwater basins. The Basin is covered by two CASGEM monitoring entities: (1) SSCAWA, through a 2017 agreement with Sacramento County, and the City of Galt, and (2) AWA. All entities include at least one of the Basin's GSAs. After GSP adoption, CASGEM wells in the GSP will be transferred to the SGMA GSP program for this Basin and the data will be available on the SGMA Data Viewer. Other wells could remain in the CASGEM system.
- United States Geological Survey (USGS) Groundwater Ambient Monitoring and Assessment Program (GAMA) is a statewide, comprehensive assessment of groundwater quality used to understand and identify risks to groundwater resources. GAMA includes datasets from the following entities that have wells within the Basin:
    - State Water Resources Control Board (SWRCB) Division of Drinking Water monitors groundwater quality from PWS wells. The program requires sampling and reporting of PWS,

[16] SGMA Data Viewer https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer
[17] CASGEM website: https://water.ca.gov/Programs/Groundwater-Management/Groundwater-Elevation-Monitoring--CASGEM

which are defined as water conveyances systems that have 15 or more service connections or serve at least 25 individuals daily for at least 60 days out of the year (USEPA, 2007).

- SWRCB Site Monitoring Program, also known as GeoTracker, tracks and archives water quality and groundwater elevation data from Leaking Underground Storage Tanks (LUST) cleanup sites, permitted underground storage tank (UST) facilities, Cleanup Program sites, Military sites, Land Disposal sites (Landfills), waste discharge requirement (WDR) sites, and the agricultural waivers program (Irrigated Lands Regulatory Program) sites.
- Water quality sampling through the California Department of Pesticides Regulation (CDPR) Groundwater Protection Program evaluates and samples for pesticides to identify if these compounds contaminate groundwater, identifies areas sensitive to pesticide contamination, and develops mitigation measures to prevent that movement.
- DWR datasets include groundwater quality and groundwater level elevation data provided from the DWR Water Data Library (WDL). Samples are collected from various types of wells including irrigation, stock, domestic or public supply.
- The GAMA-Priority Basin Project provides an assessment of statewide groundwater quality that helps identify and understand the risks to California's groundwater resources. Priority groundwater basins account for 90% of all groundwater used in the state and include 116 of the DWR defined groundwater basins in the state. The Basin is classified as Priority 3 (Belitz and others, 2003)). Data are collected by the USGS and a majority of wells sampled are PWS wells. The GAMA-Priority Basin Project helps reach the main GAMA Program goals by providing an assessment of current groundwater quality, identifying the natural and human factors affecting groundwater quality, detecting changes in groundwater quality over time, and providing the data to be included in the GeoTracker and GAMA groundwater information systems.
- National Water Information System (NWIS) is a dataset that includes water samples from supply wells that are collected and analyzed for chemical, physical and biological properties. The data are part of the Water Quality Portal (WQP) which is a service managed by the USGS, the US Environmental Protection Agency (USEPA), and the National Water Quality Monitoring Council (NWQMC). The WQP includes data from over 400 state, federal, tribal and local agencies.

- Global Positioning System (GPS) subsidence monitoring through University Navstar Consortium (UNAVCO), which handles data management tasks for GPS/Global Navigation Satellite System (GNSS) data, thousands of globally distributed permanent stations, and tens of thousands of globally distributed campaign sites.
- Surface water monitoring by the USGS NWIS, which includes yearly time-series data of stream levels, streamflow (discharge), reservoir and lake levels, surface water quality, and rainfall measurements. The data are collected by automatic recorders and manual field measurements at data collection installations (i.e., monitoring sites).

- Surface water and precipitation monitoring from the DWR California Data Exchange Center (CDEC) and/or the WDL. The CDEC provides a centralized database which contains an extensive hydrologic data collection network, including automatic snow reporting gauges for the Cooperative Snow Surveys Program, precipitation, and river stage sensors for flood forecasting.
- Surface water diversion data are provided by the SWRCB Electronic Water Rights Information Management System (eWRIMS), which facilitates SWRCB ability to track water rights information and contains data from Statements of Water Diversion and Use that are uploaded by water diverters.
- Precipitation data from JVID's Lake Amador rain gauge station. Active California Irrigation Management Information System (CIMIS) stations are not located within the Basin. However, precipitation data from the closest station (Fair Oaks station), located approximately 12 miles north of the Basin, is included in the DMS.
- Data from the Comprehensive Groundwater Quality Management Plan (CGQMP), which is discussed further below, as part of the Central Valley Regional Water Quality Control Board (CVRWQCB) long-term Irrigated Lands Regulatory Program (ILRP), are also monitored. The Basin falls within the Sacramento/Amador Water Quality Alliance of the Sacramento Valley Water Quality Coalition, which along with other coalitions are working together with the CVRWQCB to develop a Groundwater Regional Monitoring Program (GRMP). The GRMP would develop a coordinated approach to groundwater monitoring to help create a more efficient and effective assessment of groundwater quality to help avoid degradation of groundwater quality. In 2019, the monitoring network was expanded to include one domestic well within the Basin.
- Central Valley-Salinity Alternatives for Long-term Sustainability (CV-SALTS), which is a collaborative stakeholder driven and managed program to develop sustainable salinity and nitrate management planning for the Central Valley. Cosumnes Basin is not currently prioritized by the Salt and Nitrate Management Plan (SNMP) but will need to comply with the SNMP nitrate requirements in the future.
- Buena Vista Rancheria conducts groundwater monitoring and reporting to comply with the Intergovernmental Services Agreement between Buena Vista Rancheria of Me-Wuk Indians and Amador County. Groundwater monitoring and reporting includes water level, water quality, and well production rates of the production wells from the Rancheria's monitoring well network (EKI, 2020).
- Lower Cosumnes River Flow Monitoring Program was established by OHWD for Rooney Dam and Mahon Dam. This program was established to collect streamflow data, better characterize groundwater recharge conditions, collect stream temperature data in compliance with National Marine Fisheries Service requirements, and assist SSCAWA in management of future conjunctive use programs. The monitoring network within the Basin is being expanded as part of GSP development.
- The University of California Water Security and Sustainability Research Initiative (UCWSSRI), which

has established the California Groundwater Observatory (CGO), provides real-time monitoring of shallow wells along the north and south sides of the Cosumnes River.

Other sources of information were also used in preparation of this GSP and are archived in the Basin's bibliography, which the GSAs have on file.

Data from the above networks have been used to characterize the conditions of the Basin. Furthermore, from the above-mentioned monitoring programs, SSCAWA and AWA CASGEM Monitoring Plans and the Buena Vista Rancheria Groundwater Monitoring Program have been incorporated into the Representative Monitoring Network for the Chronic Lowering of Groundwater Levels (RMW-WLs; see Section 17.1.1 *Monitoring Network for Chronic Lowering of Groundwater Levels*). Groundwater levels will also serve as proxy indicator for reduction of groundwater storage and land subsidence (Section 17.1.2 *Monitoring Network for Reduction of Groundwater Storage* and Section 17.1.5 *Monitoring Network for Land Subsidence*).

One existing UNAVCO GPS station will be used for monitoring land subsidence in addition to the above-mentioned RMW-WLs, as detailed in Section 17.1.5 *Monitoring Network for Land Subsidence*.

The Representative Monitoring Wells for Degraded Water Quality (RMW-WQ) include select PWS wells, including two wells from the City of Galt. The established Representative Monitoring Network for the Depletions of Interconnected Surface Water (RMW-ISW) include surface water stream gauges administered by USGS, CDEC, and Lower Cosumnes River Flow Monitoring Program as well as selected shallow groundwater wells from UCWSSRI. More information on the monitoring network is described in Section 17.1.6 *Monitoring Network for Depletions of Interconnected Surface Water*. Data from these existing monitoring programs will continue to inform the GSP implementation.

Existing Management Plans

The Basin is located within overlapping areas of various management plans, including multiple Integrated Regional Water Management Plans (IRWMP), Groundwater Management Plans (GWMP), and Urban Water Management Plans (UWMPs), and is subject to the South Sacramento Habitat Conservation Plan (SSHCP). Although this GSP supersedes the existing groundwater management plans, brief summaries of these other programs are included below for completeness. The GSP development has considered each of the following plans and incorporated them directly or by reference into this GSP. Ongoing coordination with the responsible agencies will be a critical part of GSP implementation.

American River Basin (ARB) IRWMP

The Basin falls within the Upper Mokelumne and Upper Cosumnes watersheds and is in the ARB IRWMP region. The ARB IRWMP is a water resources planning and development program developed with stakeholders' input that identifies and proposes solutions for major water management related issues in the ARB area (Regional Water Authority, 2018). The ARB IRWMP outlines goals, objectives, and proposes action specific-strategies to achieve them. In addition, the ARB IRWMP ranks water resources projects in the ARB, based on their alignment with regional priorities and implementability, to prioritize projects that help implement IRWMP.

The main goals and objectives for the region, as specified in the IRWMP, that are potentially related to the implementation of the GSP include:

- Provide reliable and sustainable water resources, sufficient to meet the existing and future needs of the region.
- Protect and enhance the quality of surface water and groundwater.
- Protect and enhance the environmental resources of the watersheds within the region.
- Protect the people, property, and environmental resources of the region from damaging flooding.

The 2018 ARB IRWMP update included a new objective and strategy to support the close relationship between SGMA and IRWMP efforts.

- Objective 18: Manage the region's groundwater basin sustainability.
- Strategy WR7: Develop and adopt groundwater sustainability plans by 2022.

As appropriate, the GSAs will work to include groundwater sustainability projects in the ARB IRWMP project database.

Mokelumne/Amador/Calaveras (MAC) IRWMP

The ACGMA GSA jurisdictional area of the Basin falls within the Mokelumne River Watershed in the MAC IRWMP region. The MAC IRWMP was created to better manage existing resources and plan for future conditions (RMC Water and Environment, 2018). The document outlines regional goals, objectives, and implementation steps to better manage and integrate water resources. In addition, the MAC IRWMP prioritizes projects, based on the overall benefit, implementation readiness, and importance to the region.

The main goals, as specified in the MAC IRWMP, are as follows:

- Maintain and improve water quality.
- Improve water supply reliability and ensure long-term balance of supply and demand.
- Practice resources stewardship.
- Focus on areas of common ground and avoid prolonged conflict.
- Prepare for climate change.

The MAC Region Water Management goals and specific problems that will be addressed by the IRWMP with potential to affect the Basin's GSP are listed below:

- Goal: Promote water conservation, recycling, and reuse for urban and agricultural uses.
- Goal: Develop appropriate drought mitigation measures.
- Goal: Mitigate against climate change.

- Goal: Adapt to climate change.

As appropriate, the GSAs will work with the appropriate entities to ensure that groundwater sustainability projects are included in the MAC IRWMP project database.

Cosumnes & Mokelumne Rivers Floodplain Integrated Resources Management Plan

The Cosumnes and Mokelumne Rivers Floodplain Integrated Resource Management Plan (IRMP) is a local, multi-partner effort to develop a management strategy to enhance floodplain conditions and functions of the lower Cosumnes and the Mokelumne. The main goal of this plan is to "guide implementation of prioritized management actions that will effectively enhance floodplain and riparian habitats, flood management, and groundwater recharge along the lower Cosumnes and Mokelumne rivers" (Robertson-Bryan, Inc., 2006). The lower reach of the Cosumnes River is the northern boundary of the Basin. As such, coordination is anticipated to take place with the IRMP stakeholders and appropriate entities during GSP implementation.

AWA Urban Water Management Plan

The AWA is one of the entities that make up the ACGMA GSA. In 2020, the AWA served more than 3,000 AFY to more than 3,000 customers and was therefore required to develop a UWMP to comply with California Water Code (CWC) § 10617. The AWA UWMP outlines the agency's long-term water resources plan to ensure adequate water supplies are available to meet existing and future water demands.

The AWA manages multiple PWSs, including the Amador Water System in the City of Ione and Lake Camanche Village (Woodard & Curran, 2021). In 2020, the AWA served 7,743 AFY of water to 7,387 municipal service connections (15,161 = 2020 population retail customers only) (Woodard & Curran, 2021). Approximately 91% of service area demand is met through surface water from the Mokelumne River watershed while the remaining demand is met through pumping groundwater from the Basin (Woodard & Curran, 2021). As the AWA has not experienced cutbacks in supply under multiple dry years in the past, the AWA expects supply to always exceed demand under any hydrologic condition (Woodard & Curran, 2021). A variety of projects to increase supply to the service area are discussed such as the Camanche Area Regional Water Supply Project Phase II project which will replace use of 400 AFY of groundwater supplies in the Camanche area with regional surface water (Woodard & Curran, 2021). To decrease system demand, the AWA plans to continue implementation of various Demand Management Measures (DMMs) such as conducting water surveys and promoting residential plumbing retrofits (Woodard & Curran, 2021).

City of Galt 2020 Urban Water Management Plan

The City of Galt is the largest PWS within the Basin and is dependent on groundwater supply from the Basin to meet demands. The City of Galt 2020 UWMP was also developed to comply with CWC § 10610 et seq. and is a local water supply management plan, prepared in coordination with nearby agencies and the public. The City of Galt 2020 UWMP aims to maintain efficient use of urban water supplies, continue to promote conservation programs and policies, ensure that sufficient water supplies are available for future beneficial use, and provide a mechanism for response during drought conditions (EKI, 2021).

In 2020, the City of Galt supplied 4,781 acre-feet (AF) of water to 7,243 service connections (2020 population = 26,536) (EKI, 2021). As previously mentioned, the City's sole supply of potable water is groundwater pumped from the Basin (EKI, 2021). The City expects this source of water to be 100% reliable even during multiple dry years. According to the 2020 UWMP, projects to increase potable water supply are not planned; however, by 2030 the City will require all new landscape connections to use recycled water via a purple pipe distribution system (EKI, 2021). Additionally, as discussed further in Section 18.2.2 *Groundwater Augmentation from New Supplies* subsection *PMA #4 City of Galt Recycled Water Project,* expansion of recycled water for agricultural land near the waste water treatment plant (WWTP) is planned, although the project is still in the early developmental phase (EKI, 2021). Examples of DMMs utilized to decrease demand in the service include providing weekly leak detection reports to residential accounts, providing water conservation guidance on the City's website, and encouraging water conservation in the Galt Connections residential newsletter (EKI, 2021).

Water Quality Control Plan for the Sacramento River Basin and The San Joaquin River Basin

The Water Quality Control Plan for the Sacramento River Basin and the San Joaquin River Basin (WQCP), adopted and amended by the CVRWQCB, is a regulatory reference for meeting the state and federal requirements for water quality in these regions (CVRWQCB, 2018). The WQCP sets multiple water quality objectives and regulates a wide range of beneficial uses of water; the beneficial uses and water quality standards for groundwater are particularly relevant to this GSP. The WQCP determines quantitative or qualitative thresholds and goals for the following contaminant classes in groundwater: Bacteria; Chemical constituents; Radioactivity; Tastes and odors; and Toxicity. Within the Basin, arsenic and nitrate are identified as two potential constituents of concern (see Section 9.4

Groundwater Quality Concerns). For these constituents, the WQCP uses federal Maximum Contaminant Levels (MCLs) to define the maximum concentrations permissible. Arsenic is a natural constituent in groundwater and the MCL is 0.01 milligrams per liter (mg/L). The MCL is 45 mg/L for nitrate (10 mg/L for nitrate as N)[18]. These thresholds were considered during development of Sustainable Management Criteria (SMC), (see Section 15.4 *Minimum Threshold for Degraded Water Quality*).

SSCAWA Groundwater Management Plan

The SSCAWA, comprised of three of the Basin's GSAs (GID, OHWD, and Clay Water District), covers the southeastern portion of Sacramento County. Its members are almost entirely dependent on groundwater to meet agricultural and rural-residential water demands (Robertson-Bryan Inc, 2002). The SSCAWA developed but never formally adopted a Coordinated GWM in 1997, and further expanded the GWMP in 2002 in accordance with CWC § 10750 et seq., § 10753.7, and § 10753.8. Of relevance to implementation of the Basin's GSP are the following goals of the SSCAWA 1997 GWMP to ensure the protection and sustainable management of the groundwater supply:

- Establish a contract for surface water.

[18] Nitrate concentrations are based on the State's drinking water standard

- Maintain local control of groundwater management.
- Preserve agricultural activities in the area.
- Maintain local control of water distribution, advocacy, and planning.
- Maintain each District's independence in representing its respective voters and water users.

Building upon previous goals, the 2002 SSCAWA GWMP developed objectives and protocols related to the following:

- Groundwater Levels and Groundwater Volume in Storage
    - Objective: Provide data necessary to determine changes in groundwater storage, net recharge, and depletion over time.
- Groundwater Quality
    - Objective: Setting numerical standards for water quality data collected by the Authority for all groundwater uses, past and present.
    - Protocol: Development and implementation of a well-monitoring program using other local, state or federal monitoring programs as a guide where applicable.
- Surface Water Contributions to Groundwater
    - Objective: Determine surface water contributions to groundwater and collaborate across agencies and private parties to increase groundwater recharge from available surface water inputs.
    - Protocol: Installation of streamflow gauges at locations where recharge exists and seeking out other available surface water flow data from other agencies and private parties.
- Water Conservation
    - Objective: Educational materials made distributable across the Groundwater Management Area (GMA) on current literature for best water conservation practices.
    - Protocol: The Authority's protocol implementation is contingent on available information for water use efficiency within the GMA.
- Conjunctive Use
    - Objective: Collaboration with other agencies and or interested parties to determine a conjunctive use program fit to reach management goals
    - Protocol: No conjunctive use protocols have yet been implemented; however, when feasible programs become available, the GMA will implement the program.
- Identify, Protect, and Enhance Groundwater Recharge Areas
    - Objective: Identify and protect areas of recharge.

- Protocol: Develop protocol as the Authority identifies areas of recharge.

- Well Abandonment and Well Destruction
    - The county will continue to require permits for well abandonment, identify locations of operating versus abandoned wells, provide available groundwater data, advise well owners on proper destruction to ensure protection of water quality, and finally determine if potentially abandoned wells could serve as monitoring or pretreated injection wells.

South Basin Groundwater Management Plan

Pursuant to CWC § 10750 et seq., § 10753.7, and § 10753.8, the South Basin GWMP provides a framework that focuses on managing and monitoring all portions of the Basin within Sacramento County to benefit all users within the management area (Robertson-Bryan, Inc. and Water Resources & Information Management Engineering [WRIME], 2011). The South Basin GWMP was the third SSCAWA document and, though this GSP supersedes the South Basin GWMP, several goals and objectives set forth by the South Basin GWMP are relevant to GSP implementation, including:

- Goal 1: Maintain long-term reliable groundwater supplies.
- Goal 2: Maintain or improve groundwater quality.
- Goal 3: Maintain and enhance related natural resource features of the South Basin.
- Goal 4: Maintain local control of groundwater management.

Central Sacramento County Groundwater Management Plan

In early 2006, the non-Delta portion of Sacramento County was divided into the North, Central, and South Basins and the Central Sacramento County (CSC) GWMP was prepared for the Central Basin which included portions of the current Basin (MWH Global, Inc., Water Forum, and Sacramento County Water Agency, 2006). The CSC GWMP included the OHWD area along the northern boundary of the Basin and a majority of the Sacramento County GSA area of the Basin (west of GID and City of Galt). The CSC GWMP led to the creation of the Sacramento Central Groundwater Authority (SCGA) in late 2006. The SCGA relinquished its interest in the areas south of the Cosumnes River after implementation of SGMA and the formation of GSAs. The SCGA and the other GSAs are preparing a GSP for the SASb, formerly known as the Central Basin, which will supersede the CSC GWMP.

Irrigated Lands Regulatory Program

The ILRP, created in 2003 and updated in 2013, serves to protect both surface and groundwater from irrigated agricultural waste throughout the Central Valley. The CVRWQCB, with support from the SWRCB, implements the ILRP through Orders with Waste Discharge Requirements. Order R5-2014-0030-07 (Order) regulates the discharges in the Sacramento River Basin. The ILRP allows a collaboration of stakeholders to fulfill regional requirements and conditions as well as certain management activities. The Sacramento/Amador County Water Quality Alliance (SAWQA) is a third-party agency responsible for upholding the ILRP in the Amador and Lower Cosumnes Resource Conservation Districts. As a large portion of the Basin is designated as irrigated land, the goals and objectives of the ILRP are pertinent to Water

Quality Goals set forth in this GSP. The SAWQA is responsible for upholding the Order and all subsequent amendments. One of the main overall goals of the ILRP for the Sacramento River Basin is to maintain the economic viability of agriculture in California's Central Valley, which this GSP also sets out to do.

South Sacramento Habitat Conservation Plan (SSHCP)

In 2018, the County of Sacramento, City of Rancho Cordova, City of Galt, Sacramento County Water Agency, and the Southeast Connector JPA collaborated on the SSHCP, which is a streamlined permitting process intended to protect and further enhance wetlands and upland habitats from issues related to new development. The SSHCP establishes an interconnected regional preserve system to cover 36,282 acres over the next 50 years and requires all new development projects and building permits to attain approval through the Sacramento County Office of Planning and Environmental Review within the 317,656-acre Planned Area. The SSHCP addresses issues related to urban development, habitat conservation, and agricultural protection throughout the Planned Area. Of particular relevance to the Basin are Groundwater Dependent Ecosystems (GDEs), which must be identified and considered in the development of the GSP.

The following goal of the SSHCP directly relates to GDE health:

- Goal 4: Maintain or improve habitat value of natural land covers (including cropland and irrigated pasture/grass).
  - Objective (RIP5): Monitor groundwater table as it relates to status and trends for Riparian habitat.
    - During assembly of SSHCP Preserve System, identify parcels that have existing water wells.
    - Obtain history of depth to groundwater table from property owners/managers.
    - Take depth to groundwater measurements at each well.
    - Repeat depth to groundwater measurements annually at consistent time of year to allow comparison between years.
    - Monitor any groundwater depletion or recharge.

Other Planning Efforts

In addition to the management plans mentioned above, the GSAs are also coordinating with various agencies on concurrent planning efforts within the Basin. These other planning efforts are currently being conducted by the Sacramento Area Flood Control Agency (SAFCA), Regional Water Authority (RWA), Cosumnes Coalition, OHWD, SSCAWA, and others. The efforts include stormwater master plans, flood control plans, IRWMP and UWMP updates, and recharge projects.

5.2.2. Operational Flexibility Limitations

The above water resource monitoring programs are not expected to limit operational flexibility in the Basin. In fact, the CASGEM monitoring network, now integrated into the SGMA Data Viewer portal, and SWRCB's Division of Drinking Water PWS water quality sampling and reporting will be integral to the ongoing monitoring and reporting that will be conducted pursuant to this GSP (see Section 17 *Monitoring Network*).

The IRWMP and GSP development are complementary management processes. To the extent that the issues identified for the greater IRWMP regions affect the Basin, these issues will be discussed in the following sections of this GSP. The implementation of this GSP will contribute to the sustainable use of water supplies within the IRWMP regions and the IRWMPs are not expected to limit operational flexibility in the Basin.

Information regarding future demands from both the City of Galt and AWA UWMPs have been integrated into water budget and model development within the Basin (see Section 10 *Water Budget Information*) and have provided key information for the buildout of potential Project and Management Actions (PMAs). The use of information from these relevant UWMPs is consistent with the goal of maintaining a long-term sustainable groundwater supply.

Most of the groundwater management objectives in the prior GWMPs are consistent with the issues and objectives identified in the following sections of this GSP. The implementation of this GSP will contribute to sustainable groundwater use within the former GWMP areas. Therefore, this GSP compliments and supersedes the GWMPs.

5.2.3. Conjunctive Use Programs

Formal active conjunctive use programs have not been established within the Basin. However, various IRWMPs, UWMPs, and former GWMPs prepared for the Basin have shown interest in conjunctive use, and such projects are being explored by the CGA as part of PMA development and GSP implementation. Further, water providers in the Sacramento region are developing the Sacramento Regional Water Bank (Water Bank), which will expand over the North American Subbasin, SASb, and potentially the Basin. The Water Bank will be a groundwater storage program that will improve regional water supply reliability by coordinating the use of surface water and groundwater (RWA, 2019).

5.3. Land Use Elements or Topic Categories of Applicable General Plans

§ 354.8. Each Plan shall include a description of the geographic areas covered, including the following information:
(f) A plain language description of the land use elements or topic categories of applicable general plans that includes the following:
(1) A summary of general plans and other land use plans governing the basin.
(2) A general description of how implementation of existing land use plans may change water demands within the basin or affect the ability of the Agency to achieve sustainable groundwater management over the planning and implementation horizon, and how the Plan addresses those potential effects.
(3) A general description of how implementation of the Plan may affect the water supply assumptions of relevant land use plans over the planning and implementation horizon.
(4) A summary of the process for permitting new or replacement wells in the basin, including adopted standards in local well ordinances, zoning codes, and policies contained in adopted land use plans.
(5) To the extent known, the Agency may include information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management.

5.3.1. General Plans and Other Land Use Plans

Four General Plans have been developed for various portions of the Basin: (1) Sacramento County General Plan, (2) Amador County General Plan, (3) City of Galt General Plan, and (4) City of Ione General Plan. General Plan Elements on Land Use, Conservation, and Open Space were reviewed for policies that are relevant to water resources or water sustainability. Some plan elements and policies are summarized below due to their particular relevance to this GSP. For a complete description of the potentially relevant General Plan policies, please refer to each General Plan directly. Specific policies related to the Land Use and Conservation and Open Space elements have been included in **Appendix C**.

Sacramento County General Plan

Most of the Basin is located in the Sacramento County General Plan area (Sacramento County, 2011), which was first adopted in 1993 and has since undergone several amendments. The most recent amendment was approved in 2017 (Circulation section). The planning horizon of the County's previous General Plan was 1990 to 2010, whereas the updated General Plan's planning horizon extends to 2030.

As excerpted in **Appendix C**, the Land Use Element (Chapter 12) of the General Plan Elements and Policy Maps Section includes objectives, policies, and implementation measures that are related to groundwater or land use management. The General Plan land use designations for the Sacramento County portion of the Basin primarily include agricultural, agricultural-residential areas, and a small medium-density residential and urban development area around the City of Galt (Land Use map included in **Appendix C**). An increase in agricultural-residential population is also anticipated for unincorporated areas within Sacramento County as well as urban expansion around the City of Galt (discussed below). Associated increases in future groundwater demand have been factored into the analysis completed as part of the GSP (see Section 10 *Water Budget Information*).

City of Galt General Plan

The City of Galt General Plan area sets out a long-term vision for Galt's growth and outlines policies to guide decisions concerning development through the year 2030 (City of Galt, 2009). Since the City of Galt is located in Sacramento County, only the policies that are unique to the City and do not overlap with the policies listed in the Sacramento County General Plan section are discussed below.

One of the Land Use Element Goals of the General Plan is to expand the City as necessary in an orderly pattern consistent with economic, social, and environmental needs (Goal LU-1, City of Galt, 2009). This goal will potentially influence the implementation of the GSP as groundwater is the sole source of water for the City and demand is anticipated to increase (see Section 10 *Water Budget Information*). The City of Galt General Plan area includes 4,802 acres outside the current city limits, of which 2,931 acres are expected to be developed into residential, commercial, industrial, public, and park spaces to accommodate the anticipated population increase[19] (Land Use Map included in **Appendix C**).

Amador County General Plan

The Basin is partially located in the Amador County General Plan area (Amador County, 2016), which was released in October 2016 and has a planning horizon that extends to 2030. Policies that are relevant within the Conservation and Land Use Elements can be found in **Appendix C** and are summarized below.

The Amador County General Plan land use designations primarily include general agricultural, industrial, and mineral resources areas. Several objectives, policies, and implementation measures of the Land Use Element could potentially influence the implementation of this GSP and include encouragement of development patterns that support water quality objectives (LU-1.3; Amador County, 2016), protection of agricultural land and natural resources (LU-1.3; Amador County, 2016), encouragement of regional coordination to implement recycled water reuse opportunities (LU-4.4; Amador County, 2016), and encourage water conservation and reuse to reduce effluent disposal needs (LU-4.5; Amador County, 2016).

Anticipated land (and water) use changes that were considered in this GSP include expansion of urban areas around the City of Ione identified as "Urban Planning Area" and Camanche Village areas identified as "Rural Residential" (see Section 10 *Water Budget Information*).

City of Ione General Plan

The City of Ione General Plan lays out the framework for all future growth and development within the City and is a long-range planning document (City of Ione, 2019). The current version was released in August 2019 and has a planning horizon that extends to 2030. The City of Ione land use policies overlap and are largely consistent with the Amador County General Plan's Land Use Element, as described above. Relevant policies of the Conservation and Open Space Element can be found in **Appendix C**. The City of Ione General Plan includes 1,350 acres within the Sphere of Influence that is likely to be developed into residential,

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[19] Rural residential areas have not been annexed into the City limits and therefore are not included in the areas expected to be developed.

commercial, industrial, public services, or park areas.

Anticipated changes to land and water use due to the expansion within the Sphere of Influence in the City of Ione were considered in the GSP (see Section 10 *Water Budget Information*).

Specific and Community Plans (Specific Plans)

Most Specific Plans within Sacramento and Amador Counties are in urban areas outside the Basin and, therefore, are not relevant to this GSP. One exception is the Eastview Specific Plan, located within the City of Galt General Plan area, which provides a logical extension of the City's plans for growth and is complementary to existing neighborhoods (City of Galt, 2016). Specific Plans are similar to General Plans but include more detailed direction of a particular development. For instance, the Eastview Specific Plan identifies land uses, circulation, development standards, design guidelines, infrastructure improvements, and the subsequent approval process for projects within the Plan area.

The Eastview Specific Plan has a section that discusses the relationship between the Specific Plan and the General Plan and demonstrates how the Specific Plan is responding to key policies that are applicable to the Specific Plan area. The following policies outlined in the General Plan Consistency Analysis Section that are related to groundwater are summarized below and included in **Appendix C**.

- Policy COS-1.1 Flood Control includes deepening Deadman Gulch to increase flood water retention capacity, which would provide groundwater recharge.
- Policy COS-2.2 Wetlands and Riparian Communities Management includes restoration and enhancement of the wetland community along Deadman Gulch, which is within the area of potential GDEs (see Section 9.7 *Groundwater Dependent Ecosystems*).
- Policy PFS-2.7 Water Capacity and Infrastructure for New Developments includes the plan of potentially installing an additional groundwater well if the existing wells cannot reliably produce the amount of water needed for the development expansions.

Anticipated changes to land and water use within this Specific Plan are already considered in the City of Galt General Plan, the City of Galt 2020 UWMP, and this GSP (see Section 10 *Water Budget Information*).

5.3.2. Implementation of Existing Land Use Plans

The above goals, policies, and implementation measures established by the General and Specific Plans are complementary to sustainable groundwater management of the Basin relative to future land use development and conservation. In general, the General and Specific Plans encourage sustainable development and growth of their jurisdictional area (i.e., the plans outline specific policies that aim to preserve natural resources, such as surface and groundwater, while still meeting their projected goals). In addition, given that General and Specific Plans are updated regularly and that their current planning horizons extend to 2030, future General and Specific Plans must consider this GSP and incorporate water supply assumptions consistent with this GSP over the 2040 planning horizon. The GSAs within the Basin will coordinate with the respective land use authority ensuring the GSP is considered in land use decisions.

General and Specific Plans within the Basin have policies that focus on ensuring that an adequate, safe, and reliable water supply is available for existing and planned urban and agriculture developments, as well as protecting and enhancing the qualities of surface water and groundwater features. In addition, the General and Specific Plans promote water conservation, educational programs that inform the public about natural resources, use of recycled water, increased efficiency of existing water systems, and protection of aquifer systems against overdraft. Therefore, implementation of General and Specific Plan policies is not expected to interfere with the Basin's ability to achieve groundwater sustainability.

5.3.3. Implementation of the GSP

Successful implementation of this GSP will help to ensure that the Basin groundwater supply is managed sustainably. In general, implementation of this GSP is not anticipated to significantly affect current water supply assumptions or land use plans.

5.3.4. Well Permitting Process

Since the Basin extends over two counties, a well permit must be obtained from the appropriate agency, depending on the location of the well. Well permits within Sacramento County are issued by the Environmental Compliance Division of the Environmental Management Department (EMD), whereas well permits within Amador County are issued by the Environmental Health Department.

In Sacramento County, the Environmental Management Wells Program is responsible for oversight of the construction, modification, repair, inactivation, and destruction of all wells in accordance with Sacramento County Code, Section 6.28, and the DWR's Bulletin 74-81 and Bulletin 74-90, except as modified by subsequent revisions. In addition, Sacramento County Department of Water Resources worked with the Sacramento County Wells Program to notify GSAs within the County when supply well permits are requested. Sacramento County Department of Water Resources could be a liaison with EMD for developing any management actions regarding wells in the Sacramento County GSA portion of the Basin.

In Amador County, the Environmental Health Department Well Program is responsible for oversight of the construction, destruction, deepening, and repair of all wells in accordance with Amador County Code, Section 14.06, and the DWR's Bulletin 74-81 and Bulletin 74-90, except as modified by subsequent revisions. These ordinances require that domestic and agricultural wells be installed a minimum distance from potential pollution and contaminant sources, that water quality be tested for new and reconstructed wells, and that the final well construction be inspected by County staff.

5.3.5. Implementation of Land Use Plans Outside the Basin

The Basin shares its northern boundary with the SASb, a high-priority basin, which is preparing a GSP. In addition to the Sacramento County land use plan, SAFCA is evaluating groundwater banking potential (e.g., flood- managed aquifer recharge [Flood-MAR]) and such projects would convert existing lands to flooded fields during the wet season of an above-normal water year. Furthermore, the Sacramento County General Plan includes land use changes within the SASb which were integrated into land use assumptions in the projected water budget scenarios (see 10.4 *Projected Water Budget*. As such, these land use plans have been considered in this GSP.

The Sacramento County Regional Sanitation District operates a region-wide wastewater treatment facility on the north side of the Cosumnes River and has been developing a recycled water irrigation project, known as the Harvest Water Program, for several years. This project will utilize up to 50,000 AFY of recycled water for irrigation of agricultural lands in-lieu of pumping groundwater and wintertime irrigation for recharge just north of the river. Using recycled water in lieu of pumping groundwater for irrigation and wintertime spreading of recycled water will likely benefit groundwater in the adjacent portions of the Basin.

The Basin shares its southern boundary with the ESJ Subbasin, a critically overdrafted subbasin, which is subject to an adopted GSP that was submitted to DWR in January 2020. According to the Eastern San Joaquin Groundwater Authority (ESJGA), land use in the northern portion of the ESJ Subbasin, immediately adjacent to the southern boundary of the Basin, is largely cropland or undeveloped lands with no immediate plans of conversion to other land use types (ESJGA, 2019). For consistency, this GSP assumes that no land use changes will occur in the ESJ Subbasin near the Basin boundary.

5.4. Additional GSP Elements

§ 354.8. Each Plan shall include a description of the geographic areas covered, including the following information:
(g) A description of any of the additional Plan elements included in Water Code Section 10727.4 that the Agency determines to be appropriate.

5.4.1. Other Elements

Control of saline water intrusion

As discussed in further detail below in Section 9.3 *Seawater Intrusion*, the Basin is not directly connected to the Pacific Ocean, but its western boundary is adjacent to the Sacramento-San Joaquin Delta (the "Delta") which is influenced by the Pacific Ocean. However, under present-day conditions, the Basin is at little to no risk of seawater intrusion.

Wellhead protection

As discussed in Section 5.3.4 *Well Permitting Process*, two counties govern wellhead protection, depending on location. For wells in Sacramento County, the Environmental Management Wells Program is responsible for oversight of the construction, modification, repair, inactivation, and destruction of all wells and is assumed to be responsible for wellhead protection. In Amador County, the Environmental Health Department Well Program is responsible for oversight of the construction, destruction, deepening, and repair of all wells. Wellhead protection measures include a 4-inch thick concrete pad around the well head that extends two feet and slopes away from the casing.

Migration of contaminated groundwater

The mitigation, remediation, and management of groundwater contamination plumes is regulated by the

CVRWQCB, Department of Toxic Substances (DTSC), Sacramento County Local Oversight Program (LOP), and Amador County. Currently, five active point-source contamination sites are located within the Basin. Of those five sites, two sites with mapped plumes were analyzed for alterations in plume dimension and patterns due to groundwater recharge or pumping patterns (Apex, 2010 and Apex, 2016). Further discussion of groundwater contamination is in Section 9.4.4 *Point-Source Contamination Sites*.

Well abandonment and well destruction program

As previously discussed in Section 5.3.4 *Well Permitting Process*, the counties are responsible for governing well abandonment and well destruction (i.e., the Environmental Management Wells Program in Sacramento County and the Environmental Health Department Well Program in Amador County).

Replenishment of groundwater extractions

The Basin does not have an existing program to replenish groundwater extractions. The groundwater system underlying the Basin is recharged from rainfall infiltration, stream leakage, return flows from the application of surface water or groundwater to land, and water added to the Basin as runoff from adjacent lands and subsurface inflow from adjacent basins and the bedrock groundwater system on east (see Section 8.3.4 *Groundwater Recharge and Discharge*). Additionally, groundwater extractions will be replenished from the proposed PMAs (see Section 0 *Projects and Management Actions*

Projects and Management Actions).

Conjunctive use and underground storage

Existing conjunctive use projects have not been established within the Basin. However, conjunctive use projects and increased groundwater storage are being considered as part of the proposed PMAs (see Section 0 *Projects and Management Actions*

Projects and Management Actions).

Well construction policies

As previously discussed in Section 5.3.4 *Well Permitting Process*, Amador County and Sacramento County have established ordinances governing well construction, including a permitting process. In Sacramento County, after securing a permit for well construction from the Sacramento County Environmental Compliance Division of the EMD, well construction must be done in accordance with Sacramento County Code, Section 6.28, and the DWR's Bulletin 74-81 and Bulletin 74-90, except as modified by subsequent revisions. In Amador County, after receiving a permit for well construction from the Amador County Environmental Health Department, all wells must be constructed in accordance with Amador County Code, Section 14.06, and the DWR's Bulletin 74-81 and Bulletin 74-90, except as modified by subsequent revisions.

Groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects

- Five active point-source contamination sites that may potentially influence shallow groundwater quality within the Basin. The sites are described further in Section 9.4.4 *Point-Source Contamination Sites*.
- Groundwater recharge and diversions to storage are discussed further in section 8.3.4 *Groundwater Recharge and Discharge*. Additionally, proposed groundwater recharge projects are discussed in Section 18 *Projects and Management Actions*.
- Water conveyance/extraction projects are in development as planned PMAs, see Section 18 *Projects and Management Actions*.
- Water conservation practices are described in Section 5.2.1 *Existing Monitoring and Management Programs.*
- Recycled water is currently available from the City of Galt and used by the City to irrigate fodder crops adjacent to the wastewater treatment plant, and this program is expected to be expanded during the next few years, as discussed in Section 5.2.1 *Existing Monitoring and Management Programs*. Sacramento Regional County Sanitation District (Regional San) is proceeding with its plan for a large recycled water program that will provide irrigation water (50,000 AFY) to agricultural lands immediately north of the Cosumnes River, west of Highway 99, in the SASb.

Efficient water management practices

Groundwater within the Basin is primarily used for agricultural irrigation and urban water supply. The CGA will encourage implementation of efficient irrigation and water management techniques to reduce water use as described in the plans summarized in Section 5.2.1 *Existing Monitoring and Management Programs.*

Relationships with state and federal regulatory agencies

Groundwater monitoring will be closely coordinated with state and federal regulatory agencies. The SGMA Monitoring Networks include sites that are currently monitored as part of the following programs: DWR's CASGEM, SWRCB Division of Drinking Water, USGS NWIS, and DWR's CDEC (see Section 5.2.1 *Existing Monitoring and Management Programs).* The CGA will continue to coordinate with state and federal regulatory agencies throughout the GSP implementation.

Land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity

Applicable land use planning documents and processes are discussed in Section 5.3 *Land Use Elements or Topic Categories of Applicable General Plans.* The CGA plans to continue cooperating with those planning agencies as part of GSP implementation.

Impacts on Groundwater Dependent Ecosystems

As discussed in further detail below in Section 9.7 *Groundwater Dependent Ecosystems*, potential GDEs have been identified and evaluated within the Basin.

5.5. Notice and Communication

§ 354.10. Each Plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:
(a) A description of the beneficial uses and users of groundwater in the basin, including the land uses and property interests potentially affected by the use of groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties.
(b) A list of public meetings at which the Plan was discussed or considered by the Agency.
(c) Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.
(d) A communication section of the Plan that includes the following:
(1) An explanation of the Agency's decision-making process.
(2) Identification of opportunities for public engagement and a discussion of how public input and response will be used.
(3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin.
(4) The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.

The GSAs adopted a Communication and Engagement (C&E) Plan in June 2018 to fulfill notice and communication requirements. The C&E Plan is a living document and the most updated version is included herein as **Appendix D.** The C&E Plan is available on the Basin's SGMA website (http://cosumnes.waterforum.org/sustainable-groundwater-management-act-sgma).

5.5.1. Beneficial Uses and Users of Groundwater

As part of the C&E Plan, beneficial uses and users of groundwater in the Basin were identified (see **Appendix D;** C&E Section *Stakeholders in the Cosumnes Subbasin*) and include the following: agricultural users, domestic well owners, municipal well operators, PWSs, local land use planning agencies, environmental users of groundwater, surface water users, the federal government, California Native American tribes, disadvantaged communities, and neighboring GSAs. Additionally, a Stakeholder Constituency "Lay of the Land" exercise was developed to identify Basin stakeholders, key interests and issues, and the level of engagement expected with each stakeholder (see **Appendix D**; C&E Plan Appendix A "Lay of the Land" table). This exercise will be updated during select phases of GSP implementation.

5.5.2. Public Meetings Summary

The list below identifies public meetings, workshops, and direct outreach specific to GSP development.

- Working Group/ Technical Advisory Committee (TAC) Meetings
- Stakeholder/ Technical Workshops
    - Galt Public Workshops (15 March 2017 & 4 April 2019)

- Amador Public Workshops (12 October 2017 & 27 March 2019)
- Mid-County Public Workshops (24 October 2017 & 28 March 2019)
- West-County Public Workshops (26 October 2017)
- Groundwater Modeling Workshop (04 April 2019)
- Geophysical Workshop (21 August 2019)
- Online Public Workshops/ Webinars
  (1) SGMA Overview for the Cosumnes Subbasin (05 August 2020)
  (2) Implementation and Funding (02 June 2021)
  (3) Draft GSP (26 August 2021)
  (4) Draft GSP (06 October 2021)
- Online Tribal Outreach Workshop for GSAs (15 December 2020)
- Online and In Person (Herald & Rancho Murieta) Public Workshop (24 March 2021)
- Herald Workshop (03 June 2021)
- In-Person (Wilton) Open House (16 September 2021)

- Surface Water Stakeholder Advisory Group (SWAG) Meetings
  - SWAG Meeting #1 (31 July 2020)
  - SWAG Meeting #2 (25 September 2020)
  - SWAG Meeting #3 (04 December 2020)
  - SWAG Meeting #4 (26 February 2021)
- Direct Outreach
  - Website and Interested Parties List maintenance
  - Fact Sheet development/ distribution
  - Stakeholder survey distribution and respondence
  - Landowner data request distribution and respondence
  - Public Water System data request distribution and respondence
  - Stakeholder well and land access inquiry
  - Tribal Communication workshop
  - Presentations made by GSA members to their local governing bodies as part of regular public City Council or Board meetings.

This list will be updated throughout the GSP implementation. Dates for previous Working Group/TAC

Meetings, Stakeholder workshops, SWAG meetings, and direct outreach efforts can be found in **Appendix E**. Detailed meeting minutes and materials are available on the Basin's SGMA website (http://cosumnes.waterforum.org/sustainable-groundwater-management-act-sgma).

5.5.3. Public Comments on the GSP

Appendix F includes tables that summarize the public comments received during the GSP development and on the draft GSP and the Working Group's responses and revisions made to the GSP.

5.5.4. Communication

The C&E Plan (**Appendix D**) outlines the Working Group's communication goals.

Decision-making process

The C&E Plan Section *Public Input into GSP Development* outlines the decision-making process (Working Group, TAC, etc.) in the Basin.

Public engagement opportunities

The C&E Plan Section *Public Input into GSP Development* also discusses public engagement opportunities (GSA Board Meetings, Public Workshops, Project Website, etc.) and how public input and responses will be handled.

Stakeholder Involvement

The C&E Plan Section *Purpose, Outcome and Goals* describes the following:

- Purpose of C&E – sharing of information, fostering active engagement, soliciting informed feedback, and developing widespread support for SGMA implementation in the Cosumnes Subbasin.
- Desired outcome of C&E – achieve adoption of the GSP with input from and in consideration of the Cosumnes Subbasin's diverse people, economy and ecosystems.
- C&E Plan Goals – Enhance understanding and inform the public about local water and groundwater resources, the purpose and need for sustainable groundwater management; Engage a diverse group of interested parties and stakeholders and promote informed feedback from stakeholders throughout the GSP preparation and implementation process; Coordinate communication and involvement between GSAs and the general public; Employ a variety of outreach methods and hold meetings at times and venues that encourage broad participation; Respond to public concern and provide accurate up-to-date information; and Manage the public engagement process in a manner that provides maximum value to the public and an efficient use of GSA and local agency resources.

In January 2019, the GSAs sent direct mailings of a Basin Fact Sheet and a Stakeholder Survey to all landowners in the Basin (mailing list included: 2,772 addresses in SRCD GSA, >7,000 addresses in City of Galt GSA, 2,055 addresses in GID GSA, and 33 addresses in Clay Water District GSA). The Fact Sheet summarized SGMA mandates, provided a map of the GSA boundaries, provided contact information for each GSA, and described how stakeholders can acquire additional information. The Stakeholder Survey included questions that helped the GSAs gain additional knowledge on Basin stakeholders. A total of 211 Stakeholder Survey responses were received and indicate that:

- Approximately 80% of respondents within the Basin are domestic well owners/users; of the respondents, approximately 23% are agricultural groundwater users; approximately 10% are surface water users; and the remaining stakeholders are either public water system users or city residents;
- Approximately 88% of respondent stakeholders were willing to share well location information; approximately 63% of respondent stakeholders were willing share total well depth; approximately 41% of respondent stakeholder were willing to share water level data; approximately 34% of respondent stakeholder were willing to share water quality data; and less than 30% of respondent stakeholders were willing to share screened interval data, reference point elevation data, well completion reports, pumping test reports and other data; and,
- Most respondent stakeholders have concerns about groundwater management, and topics of particular concern include:
    - Long-term sustainability of groundwater;
    - Groundwater contamination from over-development;
    - Governmental overreach; and
    - Ability to continue farming.

As a result of the Stakeholder Survey, 17 stakeholders provided data on their wells to the Working Group for consideration and inclusion in the GSP. Data included well locations, well construction information, depth to water measurements, estimated pumping rates, water quality data, and/or pumping tests. These data were added to the Basin DMS and considered during assessment of groundwater conditions (Section 9 *Current and Historical Groundwater Conditions*).

Stakeholders also directly participated in the development of this GSP in the following ways:

- Two stakeholder wells (wells not included in a current public monitoring program) are included in the Monitoring Networks (see Section 17 *Monitoring Network*).
- Additional stakeholders have volunteered to have their wells monitored to provide supplemental data.
- Nineteen stakeholders volunteered to have wells sampled as part of the Isotopic Recharge Characterization Study.
- Three stakeholder volunteered to have meters installed on their production wells.
- Multiple stakeholders allowed access to their properties as part of the geophysical investigation and the GDE field verification studies.

Additionally, six months before major GSP components were made ready for formal public review, the

Working Group drafted the 15 December 2020 Addendum to the C&E Plan. The Addendum highlights specific strategies, goals, and tactics to raise awareness of SGMA, engage as many people as possible, and ensure opinions, ideas and concerns are noted and integrated into the GSP by the Working Group. The Addendum included the following tactics:

- Use a combination of free media, print collateral, posters in public places, website information, online surveys, social media, stakeholder membership contact lists, and public workshops to reach the broadest cross-section of people.
- Host public workshops in March 2021 and May 2021 to provide basic information and then focus on listening to input. (See the workshop outline below.)
- Conduct an online survey as alternative for gathering opinions from people unable to participate in workshops.

The GSAs used their own discretion for selection and implementation of tactics to provide the public with general information, invitation to public meetings, and encouragement to fill out online surveys.

Public Notification

The C&E Plan sections *Public Input into GSP Development*, *Communication Tools, and Advertising Public Engagement Opportunities* details the various venues that are being used to inform the public on GSP updates, status, and actions.

5.5.5. Interbasin Coordination

Throughout the GSP development process, the Working Group has coordinated with the neighboring ESJ Subbasin and SASb as well as other non-subbasin entities.

The Basin coordinated with the ESJ Subbasin in a variety of capacities throughout the GSP development. Basin representatives have regularly attended ESJGA Steering Committee and Board meetings, the first Technical Advisory Committee meeting, and some of the Northern San Joaquin Water Conservation District meetings. Additionally, Basin representatives have provided constructive review and feedback on the Draft ESJ Subbasin GSP and met with ESJ Subbasin representative to discuss the modeling and water budget results.

Coordination with the SASb[20] has included regular attendance at meetings of the SCGA Board, Budget subcommittee, and Work Group, as well as all public meetings and attendance at North Delta GSA Board meetings and reclamation districts in the Delta (as requested). In turn, SASb representatives have attended SWAG meetings. Coordination with the SASb has also focused on development of the Cosumnes-South American-North American (CoSANA) model (Numerical Model); isotope study coordination and sampling with the SASb technical team; and planning/coordination on the installation of monitoring wells. In addition, the GSAs in each basin have expressed the intent to actively coordinate as part of GSP

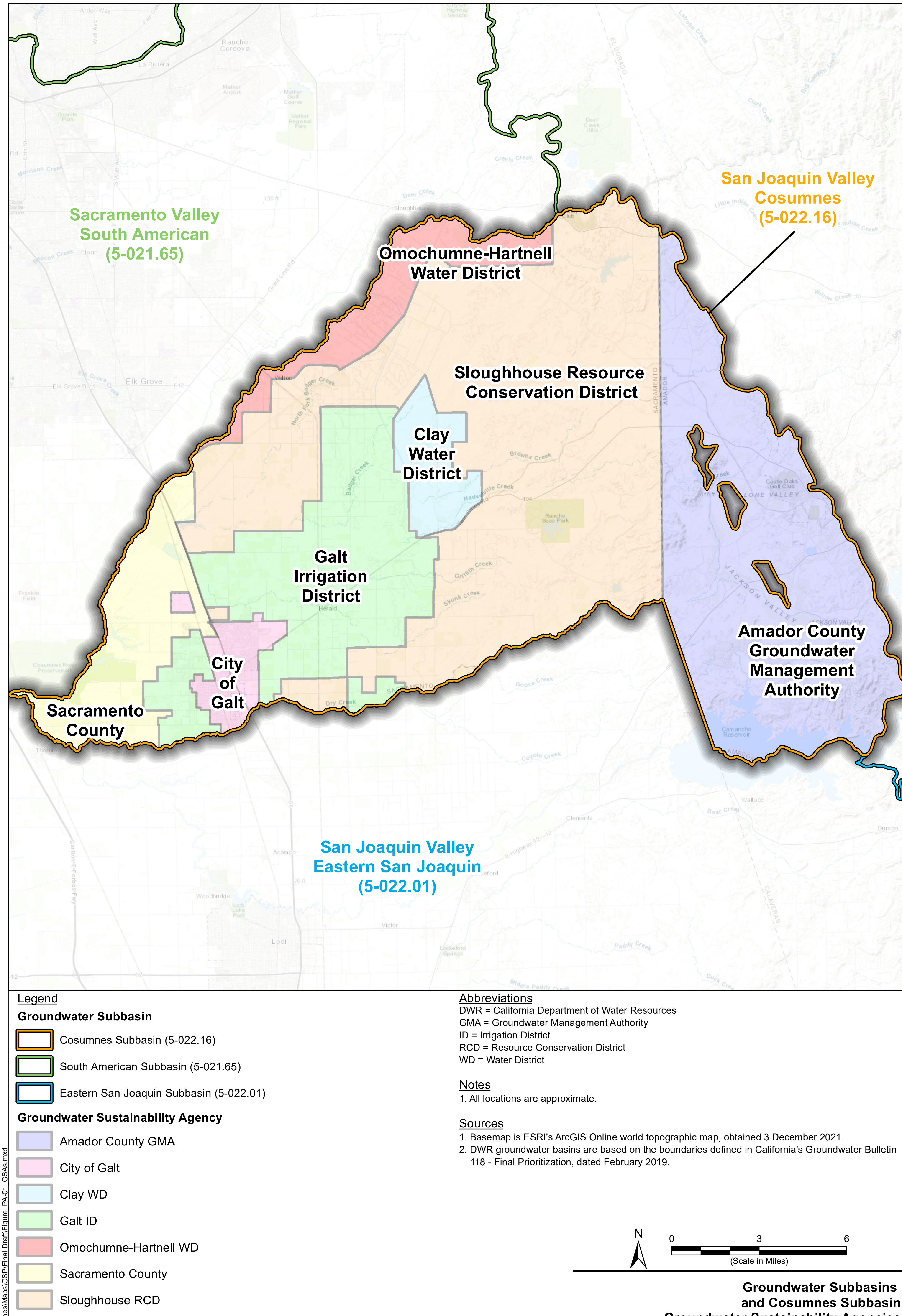
[20] SRCD, OHWD and Sacramento GSAs are in both Cosumnes Subbasin and SASb.

implementation.

Coordination with other Basin and non-Basin entities included:

- Regularly attending OHWD, SRCD, and Southeast Sacramento Country Agricultural Water Authority (SSCAWA) Board meetings;
- Coordinating with the Cosumnes Coalition with data sharing and accessing properties as part of GSP development studies;
- Coordinating with Regional San in the SASb regarding recognition of the likely benefit from the Harvest Water Project to the Basin; and
- Coordinating with SAFCA, EBMUD, and SMUD about potential PMAs.

Interbasin coordination is ongoing and will continue throughout GSP implementation.



Abbreviations
DWR = California Department of Water Resources
GMA = Groundwater Management Authority
ID = Irrigation District
RCD = Resource Conservation District
WD = Water District

Notes
1. All locations are approximate.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.

Groundwater Subbasins and Cosumnes Subbasin Groundwater Sustainability Agencies

Working Group
Cosumnes Subbasin
December 2021
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Figure PA-1

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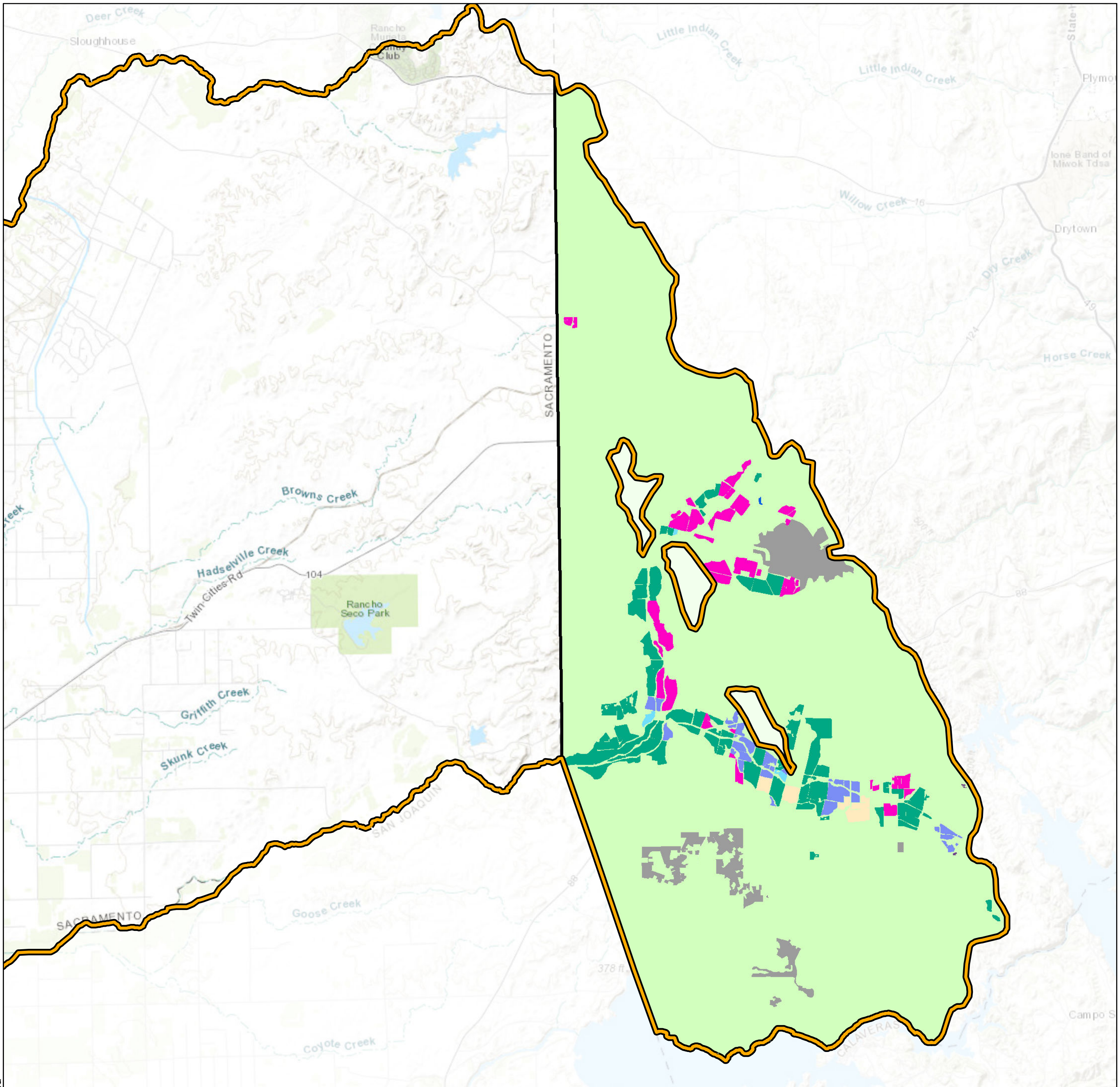

Legend

- Cosumnes Subbasin (5-022.16)
- GSA Boundary

Land Use

- Alfalfa
- Almonds & Pistachio
- Citrus
- Corn
- Cucurbits
- Dry Beans
- Grain
- Idle
- Native Vegetation
- Other Deciduous
- Other Field
- Other Truck
- Pasture
- Riparian Vegetation
- Safflower
- Tomato
- Urban
- Vineyards

Notes

1. All locations are approximate.

Abbreviations

DWR= California Department of Water Resources
GSA = Groundwater Sustainability Agency

Sources

1. Land use based on 2015 DWR land use survey within Sacramento County, 2014 LandIQ for land within Amador County and modifications made based on stakeholder input and aerial imagery.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.

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(Scale in Miles)

Land Use Summary
Amador County Groundwater Management Authority
Groundwater Sustainability Agency

Working Group
Cosumnes Subbasin
December 2021
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Figure PA-2

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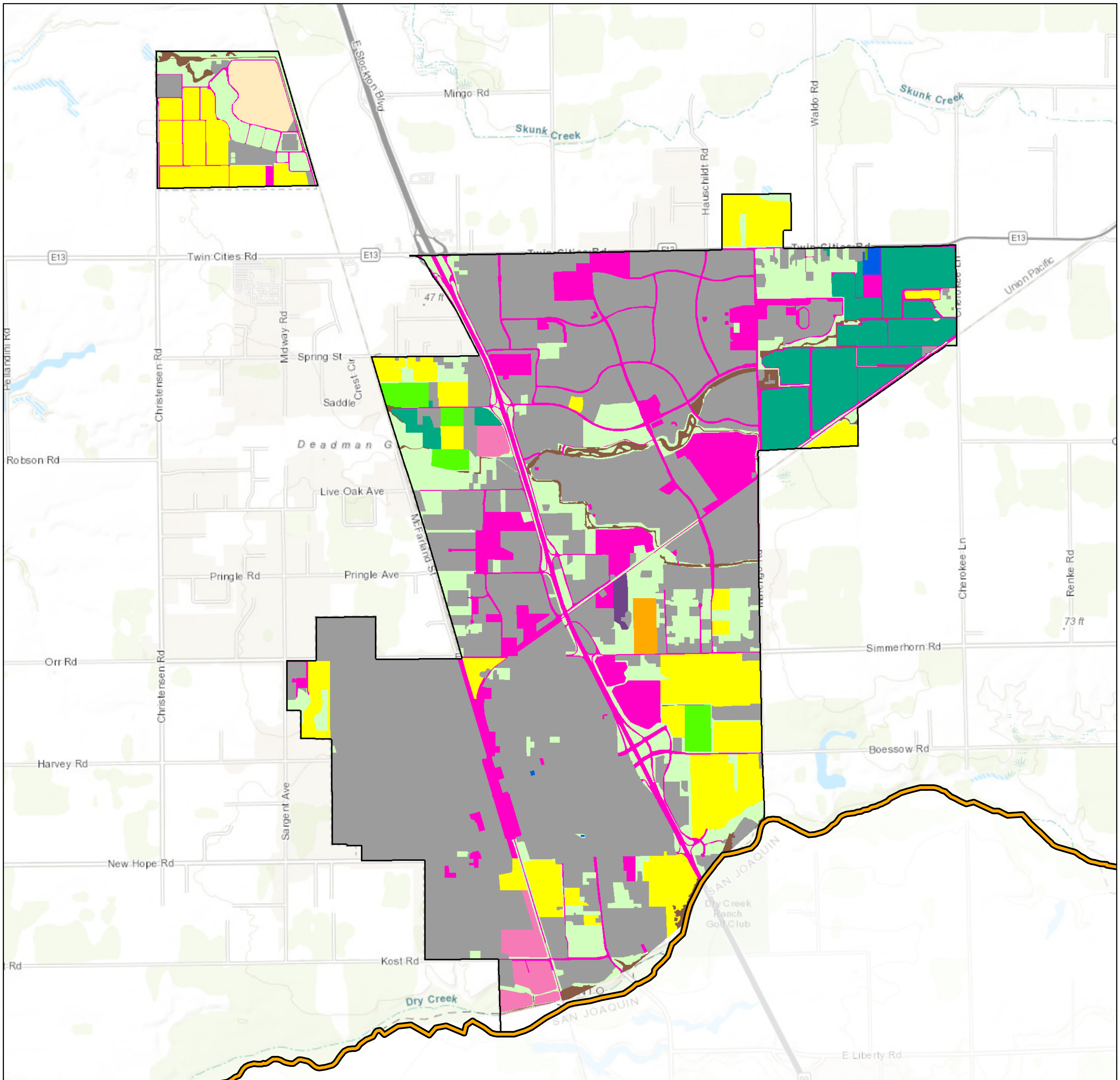

Legend

Cosumnes Subbasin (5-022.16)

GSA Boundary

Land Use

Alfalfa	Other Deciduous
Almonds & Pistachio	Other Field
Citrus	Other Truck
Corn	Pasture
Cucurbits	Riparian Vegetation
Dry Beans	Safflower
Grain	Tomato
Idle	Urban
Native Vegetation	Vineyards

Notes
1. All locations are approximate.

Abbreviations
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GSA = Groundwater Sustainability Agency

Sources
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2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.

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(Scale in Miles)

Land Use Summary
City of Galt
Groundwater Sustainability Agency

Working Group
Cosumnes Subbasin
December 2021
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Figure PA-3

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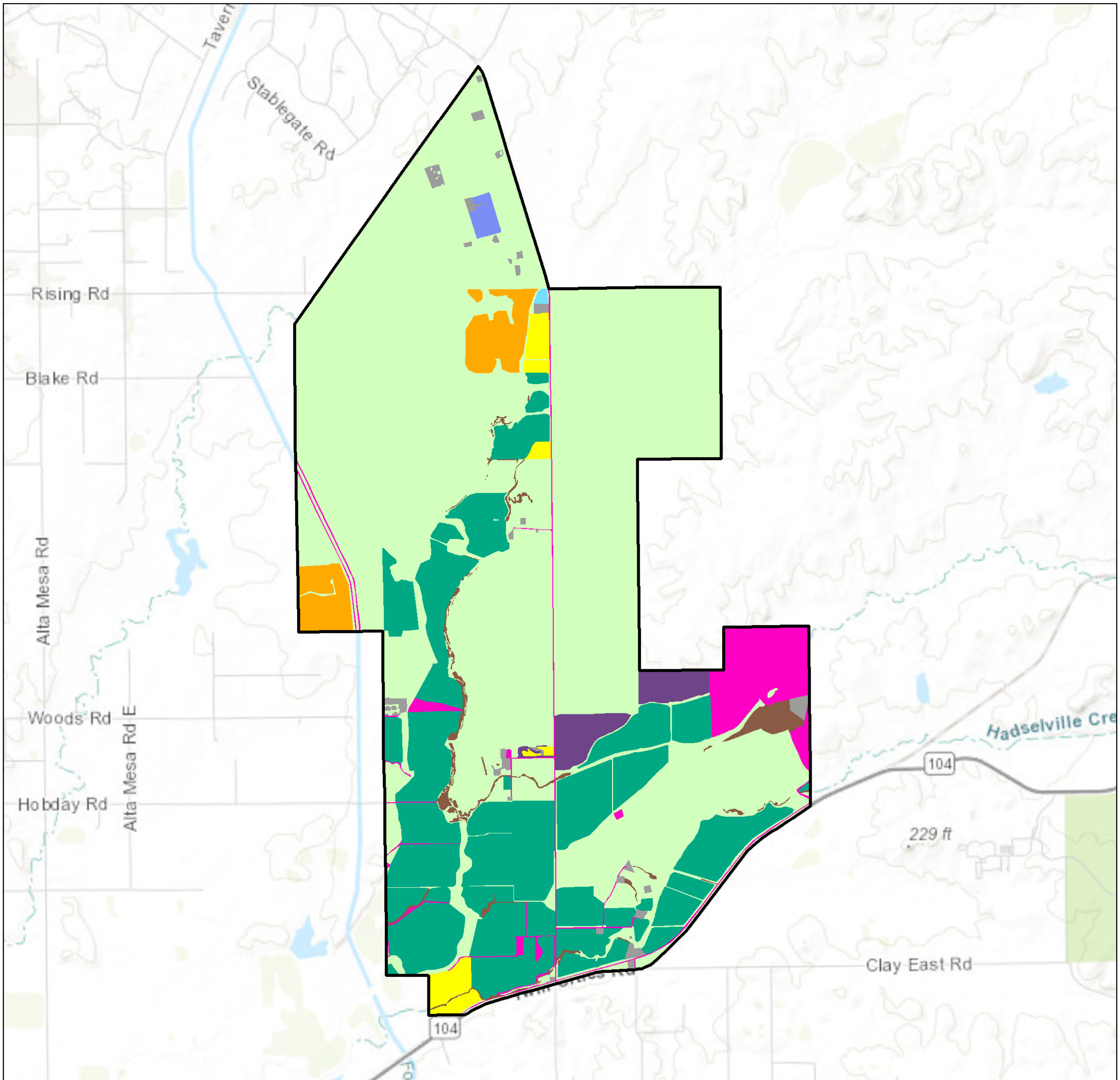

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Cosumnes Subbasin (5-022.16)

GSA Boundary

Land Use

Alfalfa	Other Deciduous
Almonds & Pistachio	Other Field
Citrus	Other Truck
Corn	Pasture
Cucurbits	Riparian Vegetation
Dry Beans	Safflower
Grain	Tomato
Idle	Urban
Native Vegetation	Vineyards

Notes
1. All locations are approximate.

Abbreviations
DWR= California Department of Water Resources
GSA = Groundwater Sustainability Agency

Sources
1. Land use based on 2015 DWR land use survey within Sacramento County, 2014 LandIQ for land within Amador County and modifications made based on stakeholder input and aerial imagery.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.

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(Scale in Miles)

Land Use Summary
Clay Water District
Groundwater Sustainability Agency

Working Group
Cosumnes Subbasin
December 2021
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Figure PA-4

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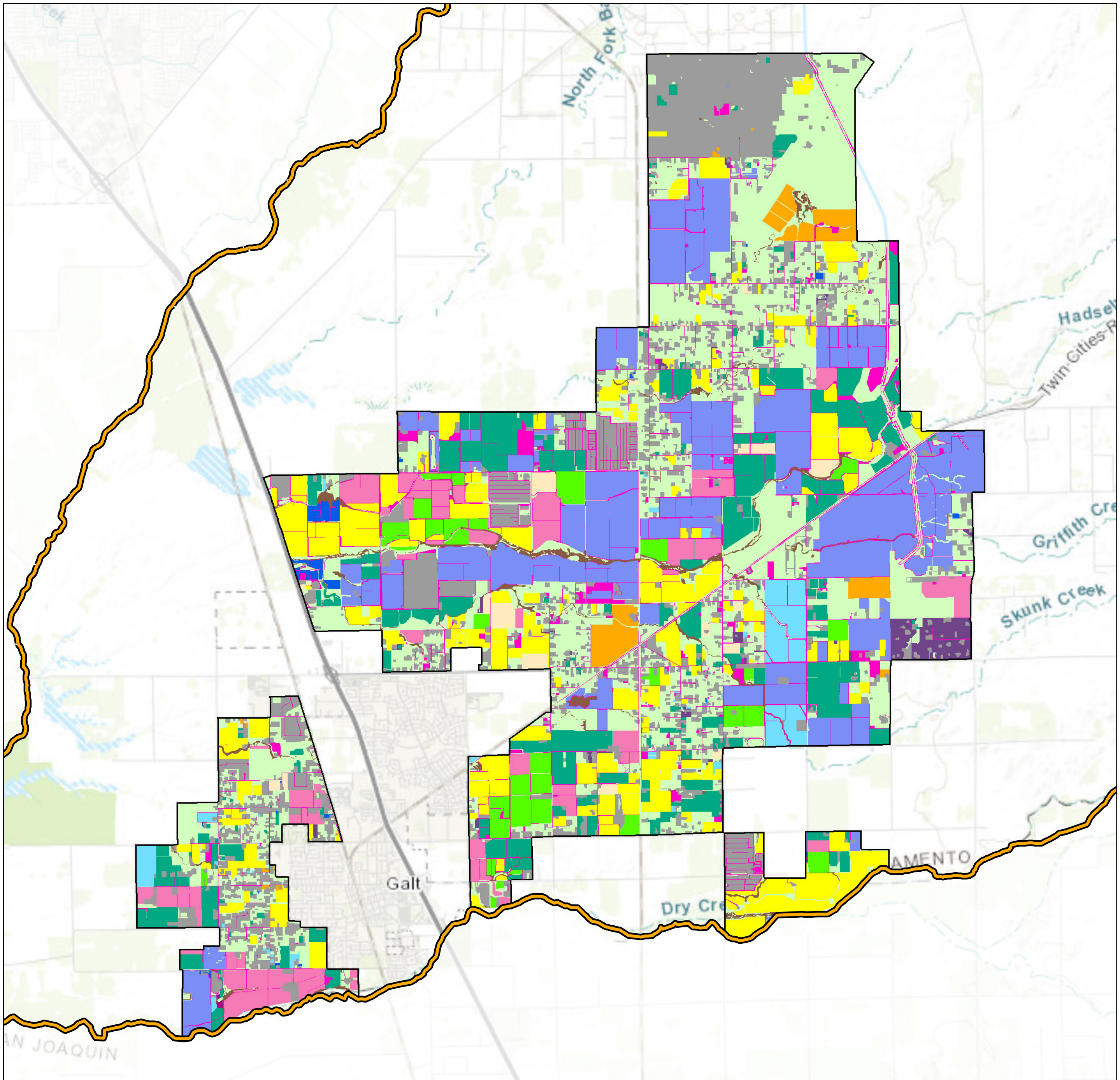

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Cosumnes Subbasin (5-022.16)

GSA Boundary

Land Use

Alfalfa	Other Deciduous
Almonds & Pistachio	Other Field
Citrus	Other Truck
Corn	Pasture
Cucurbits	Riparian Vegetation
Dry Beans	Safflower
Grain	Tomato
Idle	Urban
Native Vegetation	Vineyards

Notes
1. All locations are approximate.

Abbreviations
DWR= California Department of Water Resources
GSA = Groundwater Sustainability Agency

Sources
1. Land use based on 2015 DWR land use survey within Sacramento County, 2014 LandIQ for land within Amador County and modifications made based on stakeholder input and aerial imagery.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.

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(Scale in Miles)

Land Use Summary
Galt Irrigation District
Groundwater Sustainability Agency

Working Group
Cosumnes Subbasin
December 2021
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Figure PA-5

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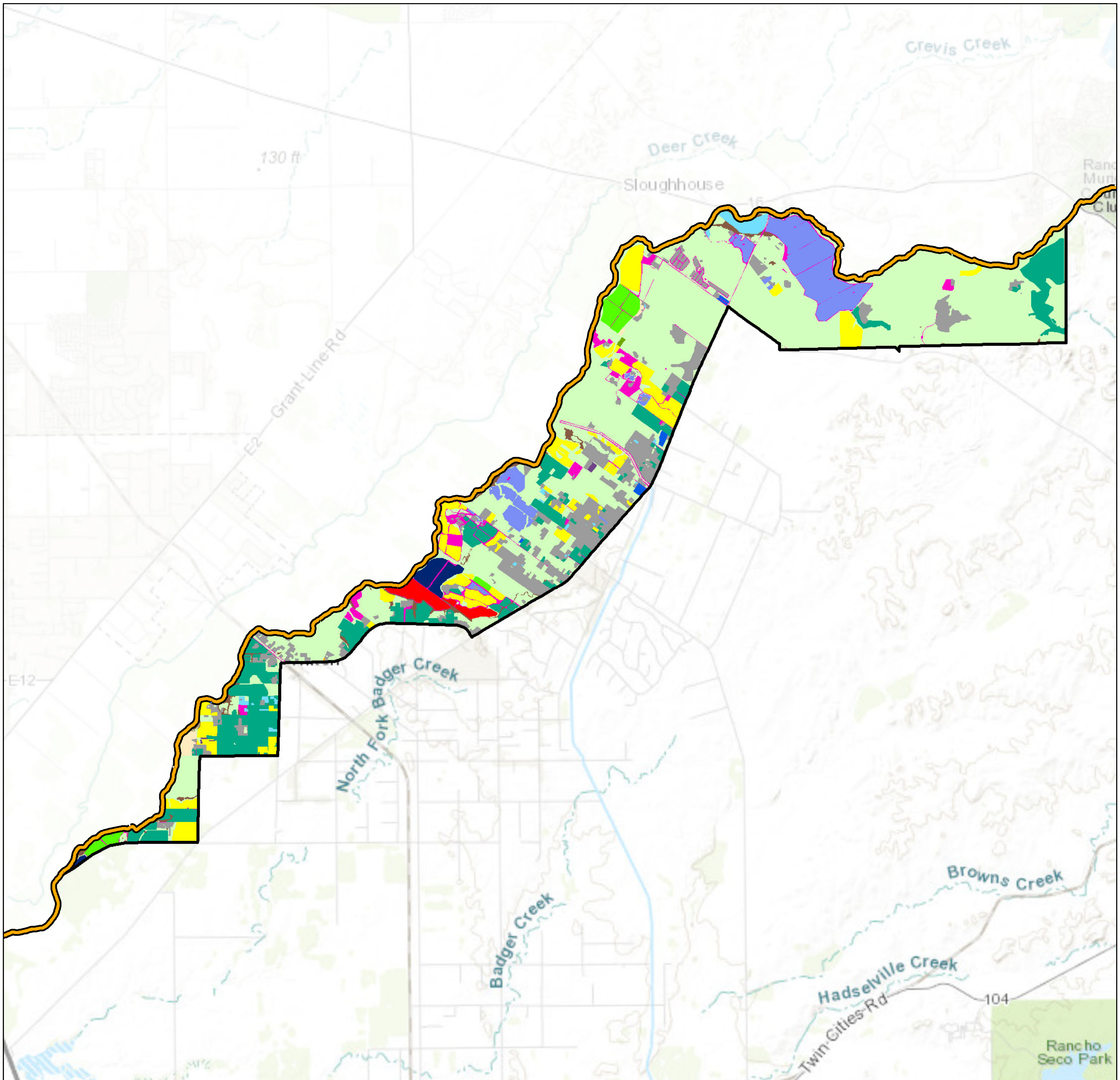

Legend

- Cosumnes Subbasin (5-022.16)
- GSA Boundary

Land Use

- Alfalfa
- Almonds & Pistachio
- Citrus
- Corn
- Cucurbits
- Dry Beans
- Grain
- Idle
- Native Vegetation
- Other Deciduous
- Other Field
- Other Truck
- Pasture
- Riparian Vegetation
- Safflower
- Tomato
- Urban
- Vineyards

Notes

1. All locations are approximate.

Abbreviations

DWR= California Department of Water Resources
GSA = Groundwater Sustainability Agency

Sources

1. Land use based on 2015 DWR land use survey within Sacramento County, 2014 LandIQ for land within Amador County and modifications made based on stakeholder input and aerial imagery.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.

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(Scale in Miles)

Land Use Summary
Omochumne-Hartnell Water District
Groundwater Sustainability Agency

Working Group
Cosumnes Subbasin
December 2021
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Figure PA-6

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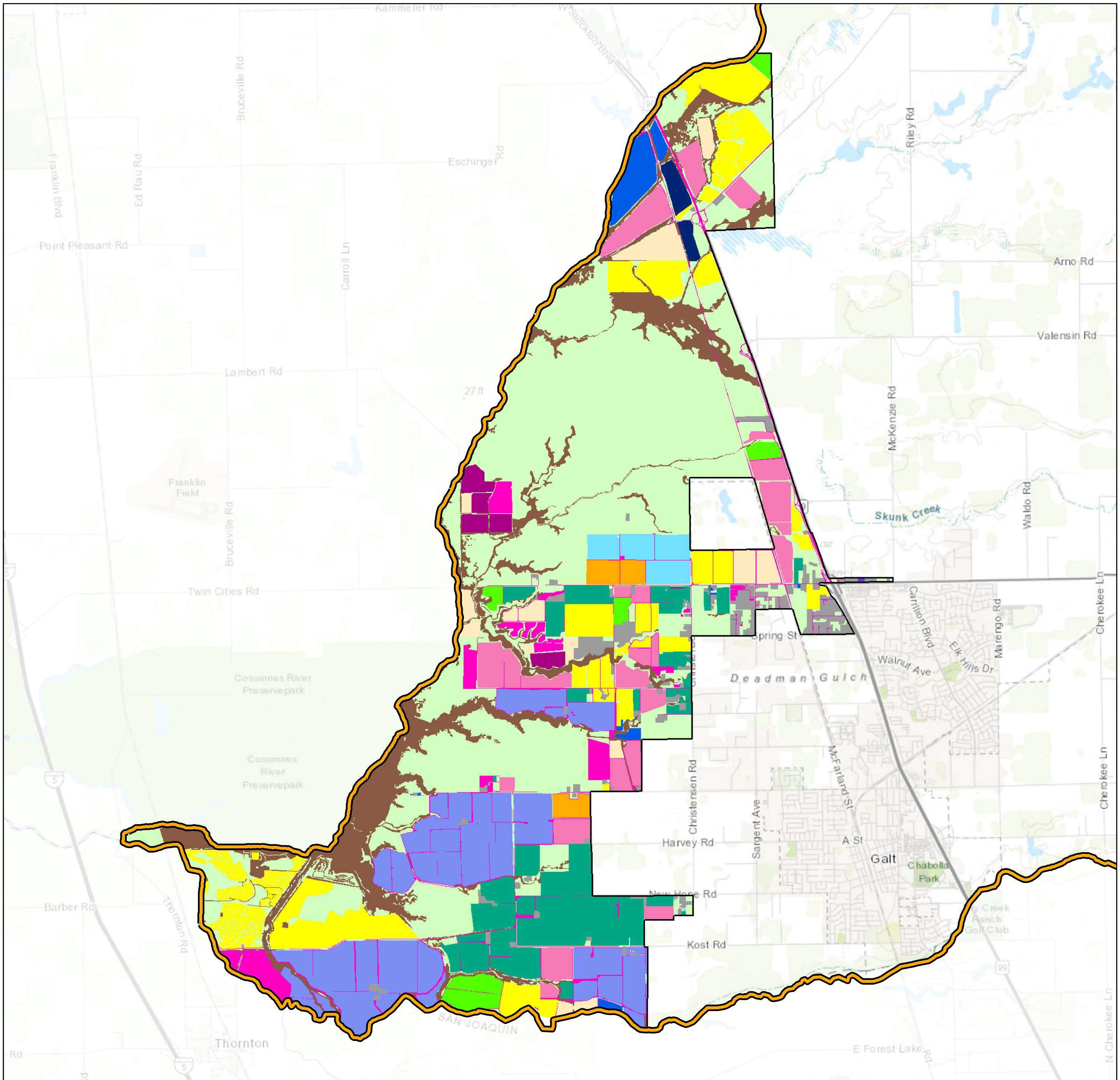

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Cosumnes Subbasin (5-022.16)

GSA Boundary

Land Use

- Alfalfa
- Almonds & Pistachio
- Citrus
- Corn
- Cucurbits
- Dry Beans
- Grain
- Idle
- Native Vegetation
- Other Deciduous
- Other Field
- Other Truck
- Pasture
- Riparian Vegetation
- Safflower
- Tomato
- Urban
- Vineyards

Notes

1. All locations are approximate.

Abbreviations

DWR= California Department of Water Resources
GSA = Groundwater Sustainability Agency

Sources

1. Land use based on 2015 DWR land use survey within Sacramento County, 2014 LandIQ for land within Amador County and modifications made based on stakeholder input and aerial imagery.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.

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(Scale in Miles)

Land Use Summary
Sacramento County
Groundwater Sustainability Agency

Working Group
Cosumnes Subbasin
December 2021
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Figure PA-7

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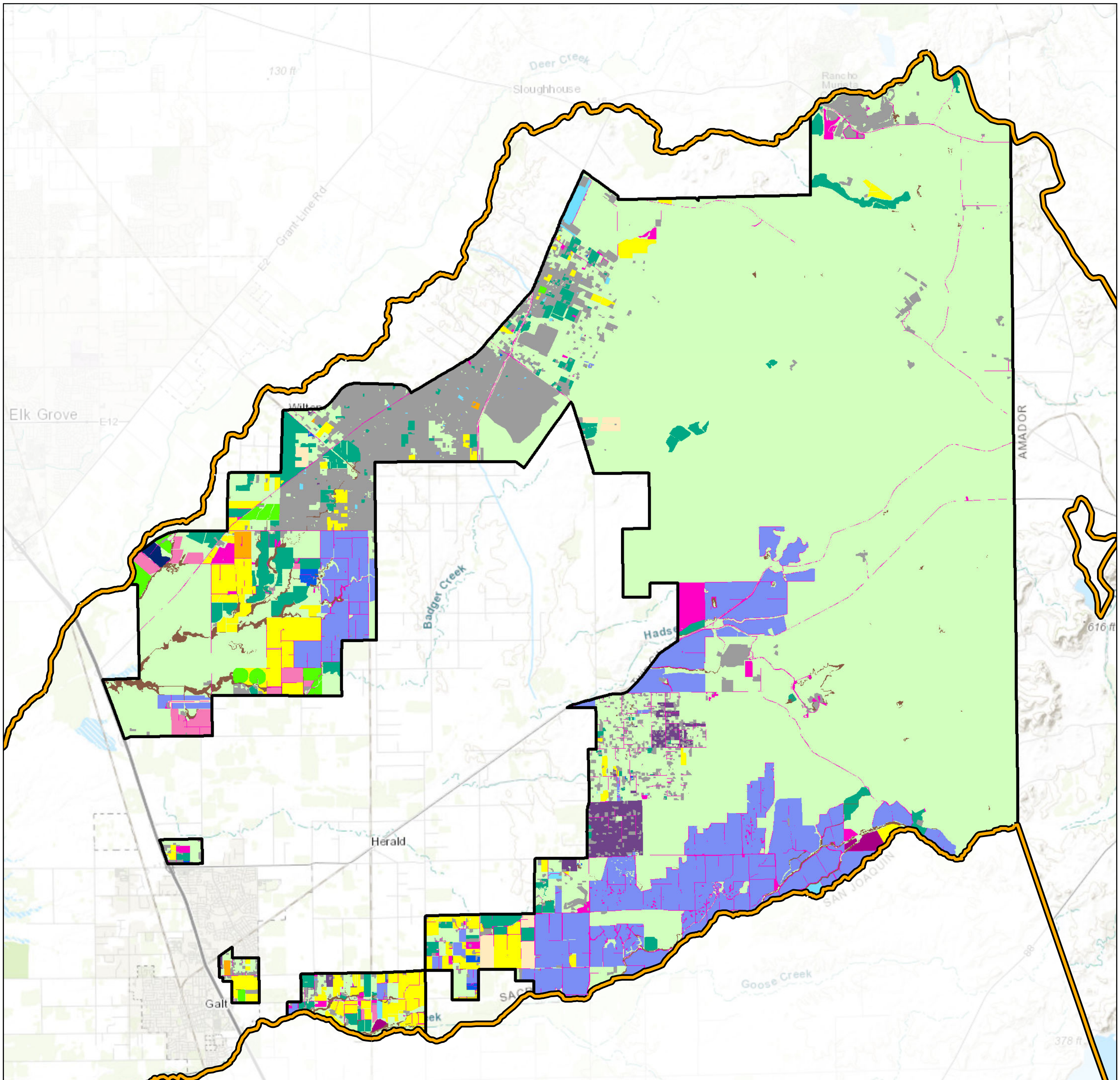

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Legend

- Cosumnes Subbasin (5-022.16)
- GSA Boundary

Land Use

- Alfalfa
- Almonds & Pistachio
- Citrus
- Corn
- Cucurbits
- Dry Beans
- Grain
- Idle
- Native Vegetation
- Other Deciduous
- Other Field
- Other Truck
- Pasture
- Riparian Vegetation
- Safflower
- Tomato
- Urban
- Vineyards

Notes

1. All locations are approximate.

Abbreviations

DWR= California Department of Water Resources
GSA = Groundwater Sustainability Agency

Sources

1. Land use based on 2015 DWR land use survey within Sacramento County, 2014 LandIQ for land within Amador County and modifications made based on stakeholder input and aerial imagery.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.

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(Scale in Miles)

Land Use Summary
Sloughhouse Resource Conservation District Groundwater Sustainability Agency

Working Group
Cosumnes Subbasin
December 2021
B80081.00

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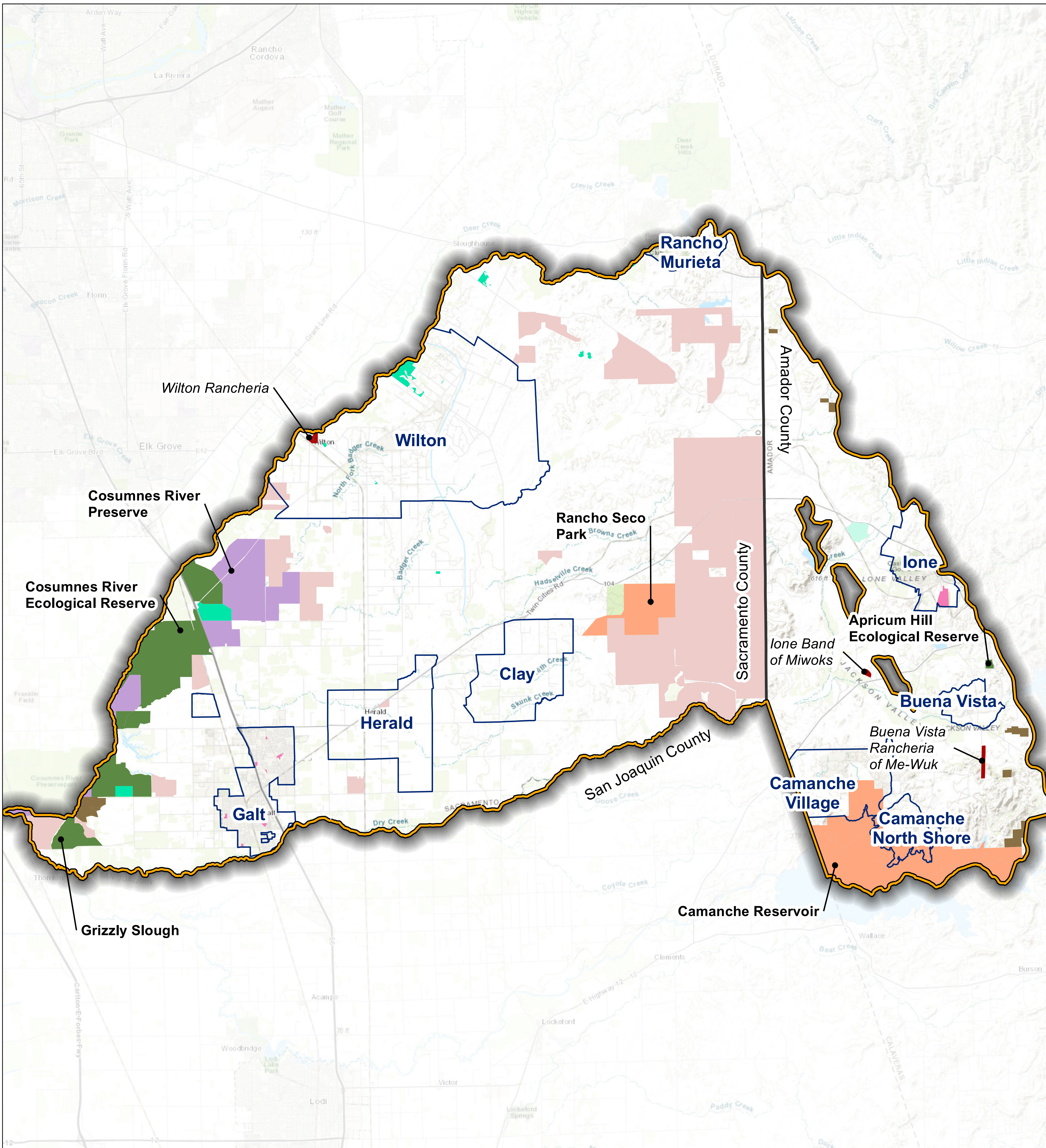
Figure PA-8



Legend

- Cosumnes Subbasin (5-022.16)
- Census Designated Places
- Conservation Lands
- Tribal Trust Boundary

California Protected Areas

- City Lands
- County Lands
- Federal Lands
- Non Profit - Land Trust Lands
- State Lands
- Water District Lands
- Conservation Easement Area

Abbreviations

DWR = California Department of Water Resources
CPAD = California Protected Areas Database
SGMA = Sustainable Groundwater Management Act

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Locations of tribal lands are downloaded on 26 March, 2020 from SGMA Data Viewer: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#gwlevels.
4. Federal and State Lands from California Protected Areas Database (CPAD) August 2017. www.calands.org
5. California Conservation Easement Database 2018. www.calands.org

N 0 3 6 (Scale in Miles)

Cosumnes Subbasin Jurisdictional Boundaries

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Cosumnes Subbasin
December 2021
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Figure PA-9

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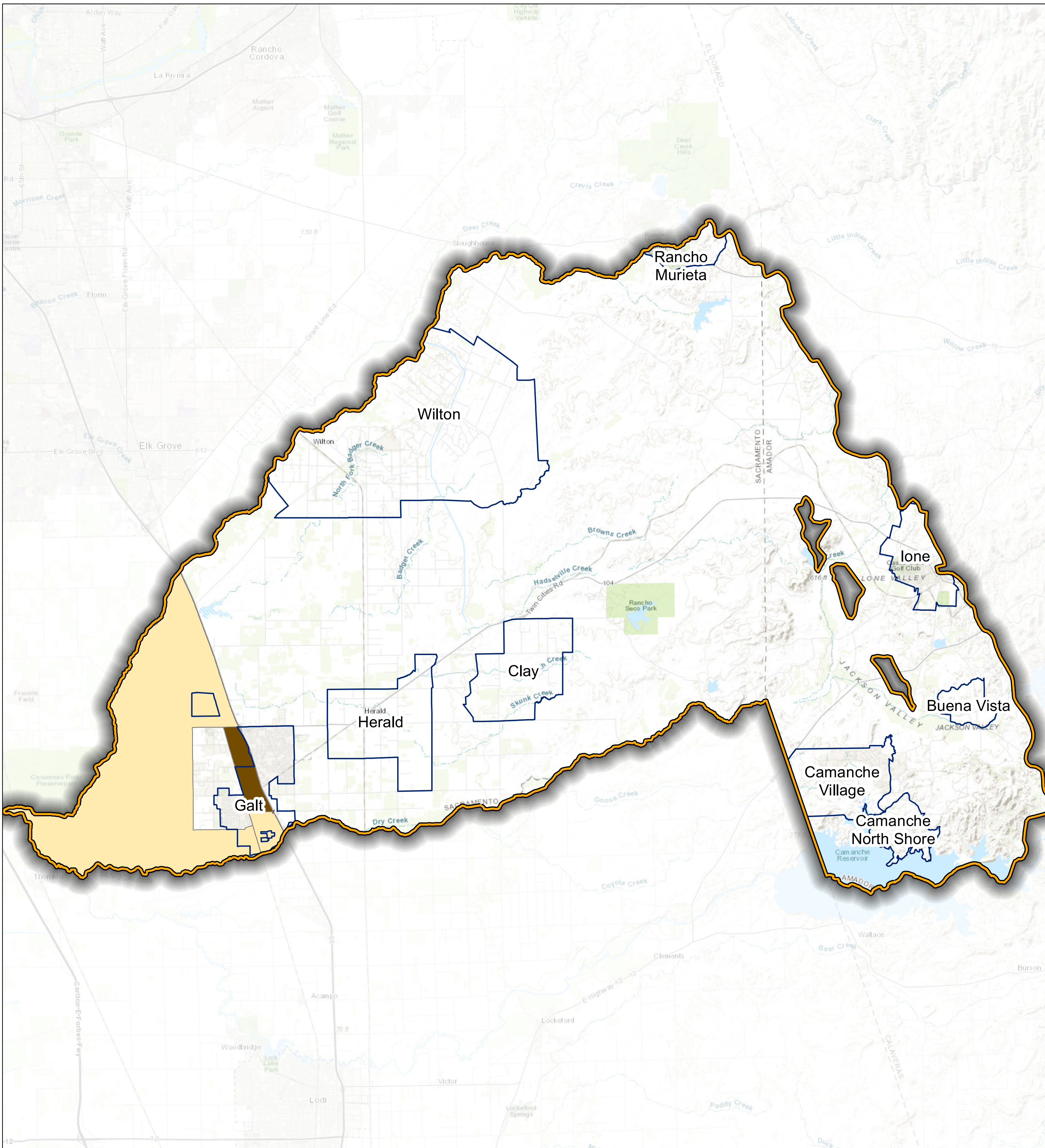

Legend

- Cosumnes Subbasin (5-022.16)
- Census Desginated Places
- Severely Disadvantaged Communities
- Disadvantaged Communities

Abbreviations

DAC = Disadvantaged Communities
DWR = California Department of Water Resources

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - 2018.
3. Disadvantaged communities data from DWR DAC Mapping tool, 2018 Census Tract, obtained 11 November 2020.

N

0 3 6

(Scale in Miles)

Disadvantaged and Severely Disadvantaged Communities

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Cosumnes Subbasin
December 2021
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Figure PA-10

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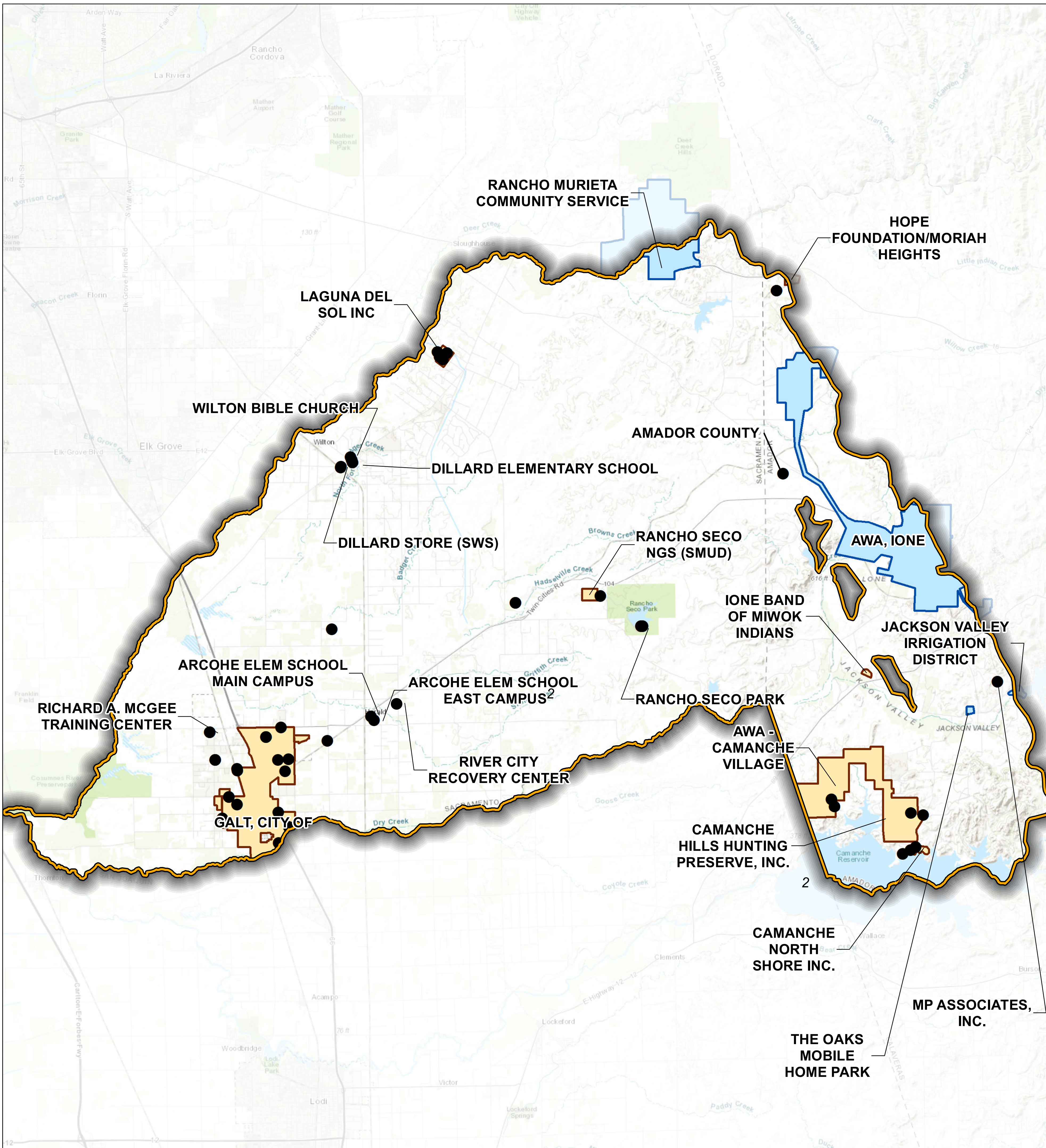

Legend

● Public Supply Wells

Water Source

Groundwater

Surface Water

Cosumnes Subbasin (5-022.16)

Abbreviations

AWA= Amador Water Agency

DWR = California Department of Water Resources

INC.= Incorporated

SMUD= Sacramento Municipal Utility District

Notes

1. All locations are approximate.
2. Camanche Hills Hunting Preserve, Inc and Arcohe Elem School - East Campus are "non-transient non-community system" which is changed from public to non-public.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Public Water System data: downloaded on August 6, 2019 from Tracking California: https://trackingcalifornia.org/water-systems/water-systems-landing.

N

0 3 6

(Scale in Miles)

Public Water Systems

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Cosumnes Subbasin
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B80081.00

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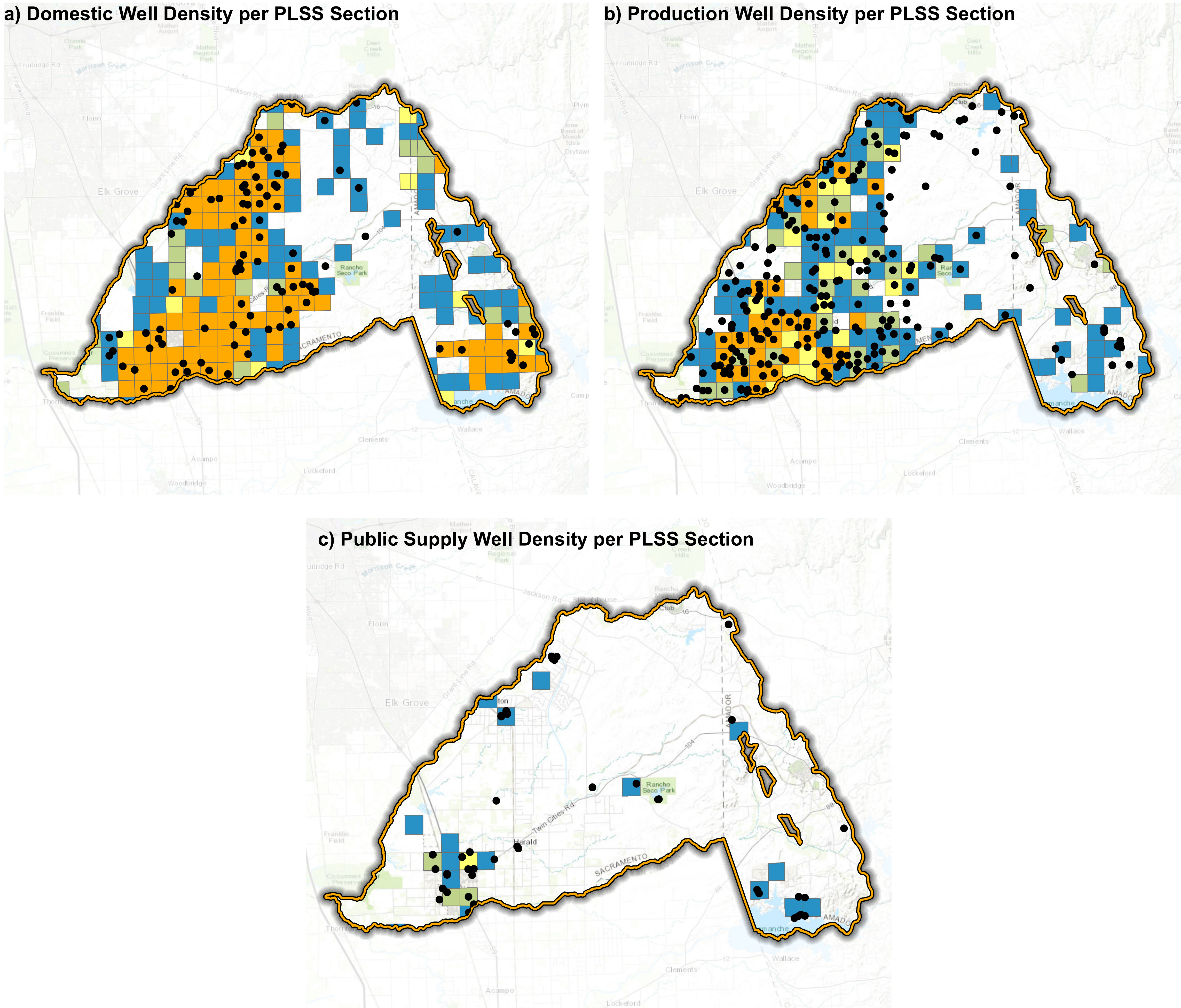
Figure PA-11

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Figure_PA-11_PWS.mxd



Legend

- Well in Cosumnes Subbasin DMS
- Cosumnes Subbasin (5-022.16)

Well Density per PLSS Section

- 1 - 2
- 2 - 3
- 3 - 4
- > 4

Abbreviations

DMS = Data Management System
DWR = Department of Water Resources
PLSS = Public Land Survey System

Notes

1. All locations are approximate.
2. Production well counts include domestic and public supply wells.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Well count per square mile (PLSS section) from Well Completion Report Map Application, obtained on 23 October 2018 (https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37).

N

0 4 8

(Scale in Miles)

Well Density from DWR Well Completion Reports

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Figure PA-12

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BASIN SETTING

6. INTRODUCTION TO BASIN SETTING

> *§ 354.12. Introduction to Basin Setting*
> *This Subarticle describes the information about the physical setting and characteristics of the basin and current conditions of the basin that shall be part of each Plan, including the identification of data gaps and levels of uncertainty, which comprise the basin setting that serves as the basis for defining and assessing reasonable sustainable management criteria and projects and management actions. Information provided pursuant to this Subarticle shall be prepared by or under the direction of a professional geologist or professional engineer.*

This section presents Basin Setting information for the Basin (**Figure HCM-1**). In some cases, Basin Setting information for areas proximal to, but outside of, the Basin is provided for context. Basin Setting information includes: the Data Management System (DMS) that consists of tabular data in a Microsoft Access database file linked with spatial data in a Geographic Information Systems (GIS) geodatabase of the best available data within and proximal to the Basin; the Hydrogeologic Conceptual Model (HCM) which provides, through descriptive and graphical means, an understanding of the physical characteristics of the Basin that affect the occurrence and movement of groundwater, including geology, hydrology, land use, aquifer and aquitard layers, and water quality; the Groundwater Conditions (GWC) which presents information on historical and current groundwater conditions within the Basin based on available data; and the Water Budget (WB) which provides an accounting of the total annual volume of water entering and leaving the Basin for historical, current, and projected future conditions.

7. COSUMNES BASIN DATA MANAGEMENT SYSTEM

The Groundwater Sustainability Plan (GSP) Regulations[21] provide explicit requirements for the Data Management System (DMS) employed to support GSP preparation: "*Each Agency shall develop and maintain a data management system that is capable of storing and reporting information relevant to the development or implementation of the Plan and monitoring of the basin*" [§352.6]. Additionally, the GSP Regulations specify the format in which Groundwater Sustainability Agencies (GSAs) are to submit information to the California Department of Water Resources (DWR) as part of GSP submission and on-going annual reporting (i.e., [in] "*both tabular and geodatabase-compatible shapefile form*.").

Per GSA specification, the Basin DMS consists of tabular data in a Microsoft Access database file linked with spatial data in a Geographic Information Systems (GIS) geodatabase. The Basin DMS complies with the Sustainable Groundwater Management Act (SGMA) reporting standards and systematically archives the available data for the Basin, including:

- Well location, use, status, and construction (e.g., well depth, hole depth, screened intervals);
- Water level records (e.g., depth to water, water level elevation, date of measurement);
- Constituent concentrations and temperature data in well-water samples (water quality);
- Surface water site information and data (e.g., location, flow, stage, temperature, and water quality);
- Climate station sites and data (e.g., temperature, precipitation, and potential evapotranspiration data);
- Aquifer property data from aquifer test results and well log data (e.g., transmissivity, specific capacity, storativity, hydraulic conductivity); and,
- Pumping data.

The development of the Basin DMS entailed acquisition, compilation, and collation of available data from public sources through June 2019 (**Table DMS-1**). Additionally, data received from the GSAs and other Basin stakeholders were also integrated into the DMS, as applicable. These efforts collectively resulted in data archived in the DMS for 706 sites in the Basin, including individual wells and piezometers (666 sites), surface water sites (26), two climate stations, and 12 "Other" sites that include lysimeters (devices employed to quantify the amount of water percolating through the soil to calculate evapotranspiration by plants).

[21] California Code of Regulations (CCR) Title 23 – Waters, Division 2 – Department of Water Resources, Chapter 1.5 – Groundwater Management, Subchapter 2 – Groundwater Sustainability Plans and Alternatives.

Table DMS-1. Public Sources Mined for Data

Public Data Source	Groundwater Level Data	Groundwater Quality Data	Surface Water Data	Climatological Data
California Department of Water Resources (DWR) California Statewide Groundwater Elevation Monitoring Program (CASGEM)	X			
DWR Groundwater Information Center (GIC)	X			
DWR Water Data Library (WDL)	X		X	
United States Geological Survey (USGS) National Water Information System (NWIS)	X	X	X	
DWR California Data Exchange Center (CDEC)			X	X
State Water Resources Control Board (SWRCB) Electronic Water Rights Information Management System (eWRIMS)			X	
SWRCB Groundwater Ambient Monitoring and Assessment (GAMA) Program		X		
SWRCB GeoTracker Database[22]		X		
Water Quality Portal (WQP)		X		
California Environmental Data Exchange Network (CEDEN)		X		
Safe Drinking Water Information System (SDWIS)		X		
DWR California Irrigation Management Information System (CIMIS)				X

The GSAs will be provided access to the DMS for their on-going use. Updates to the DMS will be made under the direction of the Plan Manager of the Cosumnes Groundwater Authority (CGA) with help from the Watershed Coordinator. Future uses of the DMS by the GSAs will include reporting for annual reports

[22] SWRCB GeoTracker Database includes cleanup sites, permitted facilities (waste discharge requirements sites, land disposal sites, irrigated lands regulatory program sites, etc.) and other records/field points/wells (project sites, non-case information sites, field points, public water wells, etc.).

and five-year GSP updates, facilitating comparisons to applicable Sustainable Management Criteria (SMC), evaluating the effectiveness of the Projects and Management Actions (PMAs), determining if modifications of PMAs are needed through adaptive management, and groundwater model updates.

Additional efforts to compile and characterize water level, water quality, and surface water data from additional data sources will continue as part of GSP implementation. For example, **Appendix G** includes a list and description of potential water quality datasets that may be analyzed to further assess groundwater quality conditions in the Basin in the future including, California Environmental Protection Agency's (CalEPA) Regulated Site Portal, Cortese List, Drinking Water Watch, GAMA-Priority Basin Project, California Pesticide Information Portal, United States Environmental Protection Agency's (USEPA) National Priorities List, and California Geologic Energy Management Division (CalGEM), CalStim'D and WellFinder datasets.

8. HYDROGEOLOGIC CONCEPTUAL MODEL

> *§ 354.14. Hydrogeologic Conceptual Model*
> *(a) Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterizes the physical components and interaction of the surface water and groundwater systems in the basin.*

This section presents the Hydrogeologic Conceptual Model (HCM) for the Cosumnes Subbasin (Basin). As described in the HCM Best Management Practices (BMP) document (California Department of Water Resources [DWR], 2016a), the HCM provides, through descriptive and graphical means, an understanding of the physical characteristics of an area that affect the occurrence and movement of groundwater, including geology, hydrology, land use, aquifers and aquitards, and water quality. This HCM serves as a foundation for subsequent analyses including water budgets, the development of sustainable management criteria, and monitoring network selection.

8.1. General Description

> *§ 354.14. Hydrogeologic Conceptual Model*
> *(b) The hydrogeologic conceptual model shall be summarized in a written description that includes the following:*
> *(1) The regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.*
> *(2) Lateral basin boundaries, including major geologic features that significantly affect groundwater flow.*
> *(3) The definable bottom of the basin.*
> *(4) Principal aquifers and aquitards, including the following information:*
> *(A) Formation names, if defined.*
> *(B) Physical properties of aquifers and aquitards, including the vertical and lateral extent, hydraulic conductivity, and storativity, which may be based on existing technical studies or other best available information.*
> *(C) Structural properties of the basin that restrict groundwater flow within the principal aquifers, including information regarding stratigraphic changes, truncation of units, or other features.*
> *(D) General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.*
> *(E) Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.*
> *(5) Identification of data gaps and uncertainty within the hydrogeologic conceptual model*

8.1.1. Geological and Structural Setting

The Basin is located at the northern end of the San Joaquin Valley, which is part of the California Central Valley, also known as the "Great Valley of California." The San Joaquin Valley is a sedimentary trough filled with marine and nonmarine continental sedimentary rocks and volcanic detritus (DWR, 1974; Piper and others, 1939). In the main portion of the Basin, the sediments and rocks have a shallow dip to the southwest (DWR, 1974) and become slightly more inclined to the east (Creely and Force, 2007). Moving west to east, the Basin includes several physiographic areas: deltaic deposits (Delta Plain), low alluvial plains and fans (Victor Plain), dissected uplands (Arroyo Seco Pediment), and the Sierra Nevada Section (see **Figure HCM-1**; Piper and others, 1939).

Based on the information described below, spatial trends in Basin characteristics can be conceptually generalized according to changes in topography, surficial geology, well yields, and water quality. Two physiographic subareas of the Basin have been defined herein: the “Basin Plain” subarea and the “Basin Foothills” subarea. As shown on **Figure HCM-1**, the Basin Plain subarea primarily covers the western and central portions of the Basin, and the remaining portions of the Basin to the east represent the Basin Foothills subarea. In general, the land surface in the Basin Plain is gently sloping to the west whereas the Basin Foothills subarea encompasses the portion of the Basin that is most influenced by tectonics and has greater topographic variability. From a groundwater perspective, the Basin Plain subarea represents the portion of the Basin that contains thick deposits of alluvial sediments in the Laguna Formation and Mehrten Formation, whereas the Basin Foothills subarea represents the portion of the Basin where these relatively younger formations are thin or absent. Hence, wells located in the Basin Plain subarea are screened primarily within the Laguna Formation and/or Mehrten Formation, whereas wells in the Basin Foothills subarea are screened primarily within the relatively older Valley Springs Formation and/or Ione Formation.

8.1.2. Lateral Basin Boundaries

The Basin is bounded by surface water features on the north, south and west, and by low-permeability metamorphic basement rocks on the east. The Cosumnes River forms the northern Basin boundary. The southern boundary falls along Dry Creek, which separate Sacramento and San Joaquin Counties and then follows the San Joaquin/Amador County line south to the Mokelumne River, which follows the southern Amador County line. The western boundary is located at the confluence of the Cosumnes River and Dry Creek. Finally, the eastern boundary occurs along the westernmost strand of the northwest-trending Foothills Fault System (i.e., Bear Mountain Fault Zone) and the surficial contact between Basin sediments and the Jurassic age basement rock, which is composed of metamorphosed slate, sandstone, schist, and volcanic rocks such as greenstone (DWR, 1974; Piper and others, 1939; **Figure HCM-2**[23]).

The northern, southern, and western boundaries of the Basin are underlain by Quaternary and Tertiary deposits and do not have known structural restrictions to groundwater flow. The eastern boundary of the Basin is the only boundary with a structural restriction to groundwater flow, caused by thinning sediments abutting low-permeability metasedimentary and metavolcanic rocks (i.e., basement) and faults within the Foothills Fault System (i.e., the Ione Fault of the Bear Mountain Fault Zone; CGS, 2010).

8.1.3. Bottom of the Basin

For purposes of the Sustainable Groundwater Management Act (SGMA), multiple sources of information

[23] As discussed below in Section 8.3.2 *Surficial Geology*, multiple published surficial geologic maps cover portions of the Cosumnes Subbasin. This Groundwater Sustainability Plan (GSP) relies upon the Piper and others (1939) geologic map as it covers the entire Basin and provides clear delineation of the formations which comprise the Principal Aquifer.

can be relied on to define the lower boundary of the Basin or "bottom of the basin", including: elevation maps of underlying low permeability rocks (the "basement bedrock surface"); information on the lower limit or base of "fresh" groundwater; the presence, location and depth of oil and gas fields; the identification of "exempted" aquifers under the Safe Drinking Water Act (SDWA); and groundwater extraction depths (the depths of water supply wells). The nature and extent of these conditions is discussed below, with depth information presented as feet below ground surface (ft bgs) or feet above/below mean sea level (ft msl), based on the original source information. A summary comparison is included in **Table HCM-1**.

Based on the structure of the Basin and available information outlined below, the bottom of the Basin is defined as the approximated bottom of the Ione Formation, which represents the contact between the continental and marine deposits, or the base of fresh groundwater, whichever is highest in elevation. Contours of depth to the bottom of the Basin are presented in **Figure HCM-3**.

Basement Bedrock

In general, the elevation of the basement bedrock (**Figure HCM-4**), which forms the impermeable floor of the San Joaquin Valley, generally decreases from east to west across the Basin as alluvial sediments thicken from the Sierra Nevada block towards the main Basin floor. Elevation of the basement bedrock has been extensively mapped in the eastern portions of the Basin where it ranges from -300 ft msl to 400 ft msl (**Figure HCM-4**), corresponding to an approximate range in overlying sediment thicknesses up to 930 feet (Chapman and Bishop, 1975). The basement bedrock rises to the surface midway through the Basin Foothills subarea, forming the Carabas Paleo-Ridge (Chapman and Bishop, 1975; Creely and Force, 2007). **Figure HCM-2** shows Jurassic age basement rocks outcropping as the Carabas Paleo-Ridge and **Figure HCM-4** shows the elevation of the basement bedrock increasing in this area.

Moving west across the Basin, the elevation of the basement bedrock decreases and generally occurs at elevations ranging from approximately -7,750 ft msl near the City of Galt to -10,000 ft msl near Thornton at the western Basin boundary (California Department of Conservation, Division of Oil, Gas, and Geothermal Resources [DOGGR], 1982). However, the elevation of the basement bedrock has not been consistently mapped beneath the Basin and continental deposits containing fresh groundwater do not extend as deep as the basement bedrock would imply. Therefore, the elevation of the basement bedrock was not used to represent the basin bottom in all areas of the Basin.

Base of Fresh Groundwater

Despite the substantial thickness of sedimentary strata overlying basement bedrock, it is appropriate to consider water quality when delineating the Basin bottom (DWR, 2016a). The United States Geological Survey (USGS) mapped the base of fresh groundwater as that with measured specific conductance of less than 3,000 micromhos per centimeter (µmhos/cm), which is approximately equal to 2,000 milligrams per liter (mg/L) of total dissolved solids (TDS) (Berkstresser, 1973).[24] The vertical extent of fresh groundwater

[24] The United States Environmental Protection Agency (US EPA) defines water with a TDS concentration of less than 3,000 mg/L

in the Basin is deepest in the center of the Basin and rises near the western and eastern boundaries. In the western portion of the Basin, the base of fresh groundwater rises due to the proximity to the Sacramento-San Joaquin Delta, which was influenced by saltwater in the past, whereas in the eastern portion of the Basin the base of fresh groundwater is determined by thinning continental deposits and increasing influence from the underlying marine deposits.

As shown on **Figure HCM-5**, based on the available data, the base of fresh groundwater ranges in elevation from -800 to -1,600 ft msl, corresponding to approximate sediment thicknesses that range from 810 to 1,750 feet, respectively.

Oil and Gas Fields

As shown on **Figure HCM-6**, the Thornton Gas (ABD) natural gas field underlies 3,136 acres of the western portion of the Basin (DOGGR, 2019). The average depth to this natural gas field ranges from 2,315 to 3,300 ft bgs (i.e., -2,305 to -3,290 ft msl; DOGGR, 1982). Freshwater in the Basin is encountered at depths substantially above the depth of natural gas deposits.

Exempted Aquifers

Under the SDWA, the United States Environmental Protection Agency ([USEPA], and through a primacy agreement, the State Water Resources Control Board [SWRCB]) regulates injections into underground sources of drinking water. One such type of injection, known as Class II injections, involves either injection of fluids to enhance oil recovery or the disposal of fluids associated with oil and gas production. In general, Class II injections are prohibited under the SDWA, except in “exempted aquifers.” For example, more than 35 years ago, saline waste was injected into the Ione Formation north of the Basin in an area east of the City of Sacramento. The California Geologic Energy Management Division (CalGEM), formally known as California Department of Conservation, Division of Oil, Gas, and Geothermal Resources (DOGGR), and SWRCB consider proposals for aquifer exemptions on a case-by-case basis. Exempted aquifers have not been designated within the Basin.[25]

Deepest Groundwater Extractions

DWR’s HCM BMP (DWR, 2016a) states that “the definable bottom of the basin should be at least as deep as the deepest groundwater extractions.” As shown on **Figure HCM-7**, well construction information

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to be suitable for livestock consumption or crop irrigation. Water between 3,000 mg/L and 10,000 mg/L is defined as “usable quality water” and water exceeding 10,000 mg/L is defined as “brine.” The USGS commonly refers to water with a TDS concentration of less than 1,000 mg/L as freshwater. A separate USGS report (Osborn et al., 2013) completed as part of the Brackish Groundwater Assessment defined saline groundwater as follows: “slightly saline” groundwater containing a TDS concentration between 1,000 and 3,000 mg/L; “moderately saline” groundwater containing a TDS concentration between 3,000 and 10,000 mg/L; “very saline” groundwater containing a TDS concentration between 10,000 and 35,000 mg/L; and “brine” containing a TDS concentration exceeding 35,000 mg/L. For the purposes of this GSP, the USGS definition used for mapping the base of fresh groundwater within the Sacramento area (~2,000 mg/L; Berkstresser, 1973) was utilized to describe the base to fresh groundwater.

[25] https://epa.maps.arcgis.com/apps/MapSeries/index.html?appid=426ef9d346f9487e96ee5899ab67a2e4

compiled for 295 production wells[26] within the Basin indicate that water supply wells (production wells) are less than 1,720 ft deep, and over 90% are 900 ft deep or less. Hence, most production wells constructed in the Basin are considerably shallower than the bottom of the basin delineated in **Figure HCM-3**.

Table HCM-1. Information used to Define the Bottom of the Basin

Type of Information	Source(s)	Elevation Range (ft msl)	Depth Range (ft bgs)
Depth to Basement Bedrock (**Figure HCM-4**)	Chapman and Bishop, 1995	Basin Foothills: -300 to 400	Basin Foothills: 0 to 930
	DOGGR, 1982	Thornton Area: -10,000 Galt Area: -7,750	Thornton Area: 10,010 Galt Area: 7,780
Base of Fresh Groundwater (**Figure HCM-5**)	Berkstresser, 1973	-1,600 to -800	810 to 1,750
Gas Fields (**Figure HCM-6**)	DOGGR, 1982	Thornton Gas: -3,290 to -2,305	Thornton Gas: 2,315 to 3,300
Deepest Groundwater Extractions from Well Construction Information (**Figure HCM-7**)	Cosumnes Subbasin Data Management System	-1673 to 340	100% of wells < 1,720 feet deep

Note:
(1) Shaded cells indicate estimated values based on approximate ground surface elevation.

8.1.4. Principal Aquifers and Aquitards

In the GSP Regulations (23-California Code of Regulations [CCR] §351), Principal Aquifers are defined as "aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems" (23-CCR §351(aa)). As discussed in more detail below, while multiple water-bearing formations have been identified in the Basin, the available data supports a delineation of a single Principal Aquifer because: (1) the formations within the Basin are all hydraulically-connected; (2) no significant and/or basin-wide continuous barriers to vertical groundwater flow have been identified in borehole data, geophysical survey results, or interpreted from existing cross-sections (**Figure HCM-15**, **Figure HCM-16**, **Figure HCM-17**, and **Figure HCM-18**); (3) the ionic composition of groundwater is generally similar between formations and depths (**Figure HCM-12**); and (4) wells have

[26] Irrigation, domestic, public supply, industrial, commercial, and stock wells with screen, completed well depth, and/or borehole depth information

been constructed throughout the entire Basin and at all formation depths (**Figure HCM-7**).

Formation Names and Occurrence

The Basin is underlain by six hydraulically-connected formations that store and transmit water (**Figure HCM-14**): (1) Younger Alluvium, (2) Older Alluvium –Victor Formation, (3) Older Alluvium – Laguna Formation, (4) Mehrten Formation, (5) Valley Springs Formation, and (6) Ione Formation. These six formations collectively comprise the Principal Aquifer. **Table HCM-2** summarizes the relationships between formation name and geologic age. Formation depths and thicknesses were inferred during cross-sectional development, discussed in more detail in Section 8.2 *Cross Sections* and shown in **Figure HCM-14** through **Figure HCM-18.**

Table HCM-2. Stratigraphic Nomenclature

Aquifer	Formation Name	Geologic Age	Symbol on Surficial Geologic Map (Figure HCM-2)
Principal	Younger Alluvium	Holocene	Qal
	Victor	Pleistocene	Qv
	Laguna	Pliocene	Tl
	Mehrten	Miocene/Pliocene	Tma/Tm
	Valley Springs	Oligocene/Miocene	Tv
	Ione	Eocene	Ti

The **Younger Alluvium** includes recent sediments deposited by the Cosumnes River, Dry Creek, and Deer Creek. The maximum thickness of Younger Alluvium, where it exists, is 100 feet and is comprised of unconsolidated silt, fine- to medium-grained sand, and gravel (DWR, 2003). The sand and gravel deposits are highly permeable and can yield significant quantities of water to wells (DWR, 2003). These deposits also provide important areas for groundwater recharge.

The **Older Alluvium** is comprised mostly of the Victor Formation and underlying Laguna Formation. The **Victor Formation** consists of loose to moderately compacted sand, silt, and gravel with discontinuous clay lenses; the sediment grain size fines to the west and the thickness ranges from 90 to 150 feet (DWR, 1974). The Victor Formation has a relatively higher permeability than the underlying Laguna Formation (DWR, 1974). Evaluation of well-borings indicated the Victor Formation was likely deposited in a shallow body of water (DWR, 1974), and interpretation of electrotelluric sounding (ETS[27]) results indicate predominantly fine-grained, clay deposits at depths that correspond to the approximate interface between the Victor and underlying Laguna formations (**Appendix I**). The Victor Formation approximately extends over the

[27] The ETS method employs a portable receiver that transforms the electrical fields generated by geomagnetically induced currents flowing in subsurface geologic formations into an audible signal, and changes in the signal are correlated to lithologic descriptions in boring or well logs at available control points. The readings are insensitive to nearby power lines and other cultural electrical noise.

western third of the Basin (**Figure HCM-8**), which is consistent with the likely western extent of the clay, based on geophysical survey results. The inferred clay bed therefore is likely not continuous, but where present can impede percolating recharge, support a relatively shallow water table, and result in greater drawdowns as a result of groundwater extractions. The **Laguna Formation** is exposed in the eastern part of the Basin, west of the Victor Formation, and consists of loose to moderately compacted non-volcanic sand, silt, and gravel with discontinuous clay lenses (DWR, 1974). Its thickness ranges from 100 feet in the east to 400 feet in the west, with a westward dip of less than one degree (DWR, 1974). The lithologic characteristics of Laguna and Victor Formations are similar, making it difficult to differentiate between the two based on well boring log data alone. Moreover, their heterogeneous lithologies makes it difficult to correlate these formations between wells. A transition zone occurs between the Laguna Formation and underlying Mehrten Formation where non-volcanic sediments of the Laguna Formation are interbedded with the volcanic sediments of the Mehrten Formation (DWR, 1974). The environment of deposition was similar for both formations, and the transition represents the exposure of the intrusive rocks of the Sierra Nevada batholith.

The **Mehrten Formation** consists of two distinct units: (1) black volcanic sand, silt, and clay layers ("Black Sands"); and, (2) dense tuff breccia (DWR, 1974). The Black Sands are generally five to 20 feet thick, highly permeable, and yield moderate to high quantities of groundwater to wells, whereas the tuff breccia beds act as local confining layers (DWR, 1974). Near the base of the Mehrten Formation is a thick bed of hard gray sandstone (DWR, 1974). In the eastern portion of the Basin, the Mehrten Formation is exposed and is as much as 200 feet thick (Bishop and Chapman, 1975). Formation thickness increases to about 500 feet in the west, and possibly reaching up to 1,200 feet in total thickness beneath the Sacramento-San Joaquin Delta (DWR, 1974).

The **Valley Springs Formation** is of volcanic origin and contains greenish clay members along with volcanic ejecta (DWR, 1974). Its thickness ranges from 75 to 200 feet. The Valley Springs Formation is exposed on the east side of the Basin from Dry Creek northward, and dips gently (1.5 to 2 degrees) to the west (DWR, 1974). In and near its outcrop areas, the formation produces good water quality although yields are low. Where the formation lies below the surface, much of it is deeper than existing well depths. Page (1974) mapped the bottom elevation and thickness of the post-Eocene continental deposits, which corresponds to the bottom of the Valley Springs Formation. Page (1974) reported that the post-Eocene continental deposits (alluvium, Laguna, Mehrten, and Valley Springs) contain most of the fresh groundwater in the valley, and Berkstresser (1973) reported that fresh groundwater is contained almost exclusively in these deposits.

The **Ione Formation** is the oldest freshwater bearing formation in the Basin, but yields from existing wells are generally low (DWR, 1974; DWR, 1978). The Ione Formation is exposed in the eastern part of the Basin and exists at least as far west as the Sacramento River. It is Eocene age, and about 400 feet thick where exposed. The Ione Formation is composed of three distinct members: (1) an uppermost member composed principally of uniformly graded medium to coarse-grained sandstone, (2) a thick bed of white clay, and (3) a thick blue to gray clay (DWR, 1974). The formation dips at about five degrees to the west (DWR, 1974), and therefore these clay beds may form significant barriers to vertical flow in the western portions of the Basin. In the east, the potential water-bearing zones are found in the uppermost sand and gravels above the clay beds (Jones & Stokes, 2007).

Physical Properties of Aquifers and Aquitards

Groundwater moves through subsurface sediments called **aquifers**, which are comprised primarily of a mixture of coarse-grained beds of sand and gravel. In contrast, fine-grained beds of silt and clay restrict groundwater flow and are called **aquitards**. Due to the depositional history of the Basin, continuous beds of silt or clay do not form Basin-wide aquitards within the current production zones; rather, relatively smaller fine-grained beds locally limit vertical groundwater movement between coarse-grained beds. As such, the Basin is defined as having only one Principal Aquifer.

In general, wells drilled into the Principal Aquifer encounter enough water-bearing sediments to meet overlying domestic, municipal and industrial (M&I), and agricultural demands for water. The Principal Aquifer is comprised of variable lithologies and sediment grain sizes, ranging from gravels and sands, to silts and clays. Hence, its physical aquifer properties (the water transmitting properties, or the aquifer "transmissivity" and "hydraulic conductivity", and the aquifer storage properties, or "storativity") can vary both laterally and with depth. These physical properties can be; (1) measured by conducting and analyzing results from controlled well pumping tests (aquifer tests), or (2) inferred from the specific capacity of wells and the lithology recorded from boreholes.

The available **aquifer test results** for wells located in the Basin are summarized in **Table HCM-3** and shown on **Figure HCM-9**. The limited data indicate that water-bearing sediments in the Basin Plain subarea are more transmissive than the water-bearing sediments in the Basin Foothills subarea. However, nine of the 10 available tests summarized in **Table HCM-3** were conducted on wells located in the eastern portion of the Basin, and additional data collection and analyses are needed to improve characterization of the western portion of the Basin.

Transmissivity and **hydraulic conductivity** represent the capacity of an aquifer to transmit water. Aquifer tests traditionally are the most reliable method to evaluate transmissivity and storativity. Based on the available data (**Table HCM-3**), the transmissivity of water bearing sediments in the Basin Plain subarea is approximately 1,900 square feet per day (ft^2/day). The median transmissivity of water bearing sediments in the Basin Foothills subarea, based on several aquifer tests, is approximately 240 ft^2/day. The transmissivity values correspond to approximate hydraulic conductivities of 16 and 12 feet per day (ft/day), respectively.[28] These results are at the lower end of the hydraulic conductivity range reported from previous numerical models that included the Basin as part of their model domain (0.03 to 1,580 ft/day per [Meirovitz, 2010; Fleckenstein et al., 2006; Faunt, 2009]). Representative hydraulic conductivity values used in the numerical model of the Basin to support GSP development range from about 25 ft/day for the Victor Formation to less than 10 ft/day for the Ione Formation (see Section 10.1

[28] Hydraulic conductivity [ft/d] is approximated by dividing transmissivity [ft^2/day] by the length of well perforations [ft].

Water Budget Methods and Data Sources for a description of the model).

Storativity, or storage coefficient, is the volume of water released from storage per unit decline in water level in the aquifer per unit area of the aquifer and represents its capacity to store water. The generally low storativity values reported for wells located in the Basin Foothills subarea indicate that groundwater is confined by relatively less permeable sediments that overlie the primary water-bearing sediments. Aquifer test results have not included storativity for the Basin Plain subarea, but calibrated values used in the numerical model of the Basin to support GSP development range from 0.07 to 0.18, with a median value of about 0.11 (see Section 10.1 *Water Budget Methods and Data Sources* for a description of the model).

Table HCM-3. Physical Properties based on Aquifer Tests in the Basin

Parameter	Basin Plain	Basin Foothills
Aquifer Tests: Median (Min to Max)		
Horizontal Hydraulic Conductivity (ft/day)	16 (single value)[2]	12 (4 - 31)[1]
Transmissivity (ft^2/day)	1,914 (single value)[2]	236 (95 – 12,200)[1,3]
Storativity (-)	--	0.00034 (0.000021 - 0.014)[1,3]

Abbreviations:
ft/day = feet per day
ft^2/day = feet squared per day
Sources:
(1) Dunn Environmental, 2012a
(2) Dunn Environmental, 2012b
(3) Jones & Stokes, May 2007

Specific capacity is defined as the quantity of water produced by a well per unit drawdown in the well and can be used to infer aquifer transmissivity and hydraulic conductivity. The interpretation of specific capacity values is limited because they represent the productivity of both the well and the aquifer and thus include aspects of well construction and well condition in addition to the water transmitting properties of the aquifer. The specific capacity was calculated for a total of 42 wells in the Basin that had both reported pumping rates and water level drawdown data (**Figure HCM-10**). In general, specific capacity indicates that the transmissivity of the Primary Aquifer decreases from west to east. The specific capacity of Basin Plain subarea wells ranged from 0.3 to 453 gallons per minute per foot (gpm/ft) with a median specific capacity of 54 gpm/ft, which corresponds to a median transmissivity of about 110,000 gallons per day per foot (gpd/ft) or 14,700 square feet per day (ft^2/day) (Driscoll, 1995).

In contrast, the specific capacity of Basin Foothills wells ranged from 0.1 to 2.3 gpm/ft with a median specific capacity of 0.5 gpm/ft, which corresponds to a median transmissivity of about 1,000 gpd/ft or almost 135 ft^2/day. Accordingly, the median specific capacity values suggest that the water transmitting properties of the Principal Aquifer are spatially variable and can vary by a factor of 100 between the Basin Plain to the Basin Foothills subareas.

Lithologic data from well completion reports (WCRs) can characterize relative fractions of coarse-grained sediment from which to infer the spatial variability in aquifer transmissivity. The lithologic data from 102 WCRs (DWR, 2018a)[29] were combined with similar data from 38 additional WCRs digitized into the Basin Data Management System (DMS) to characterize the spatial distribution of coarse-grained sediment within the Basin. The lithologic descriptions from these 140 WCRs were digitized using numerical codes assigned to the relatively fine- and coarse-grained sediment descriptions (texture) following the classification scheme employed by DWR. Sediments characterized by a relatively high fraction of coarse-grained material (e.g., sands and gravels) are generally indicative of relatively permeable sediments (high hydraulic conductivity). In contrast, sediments characterized by a relatively low fraction of coarse-grained material (e.g., silts and clays) are generally indicative of sediments with relatively low permeability (low hydraulic conductivity).

The fraction of coarse-grained sediment for depth intervals that correspond to the Victor, Laguna and Mehrten Formations are mapped in **Figure HCM-10**. The fraction of coarse-grained sediment shows significant spatial variability across the Basin and with depth. In general, the fraction of coarse-grained sediment, and presumably aquifer hydraulic conductivity, is greatest near the Cosumnes River and Dry Creek and decreases to the west. The fraction of coarse-grained sediment also generally increases with depth. The average fraction of coarse-grained sediment is about 20% in the Victor and Laguna Formations and increases to almost 30% in the Mehrten Formation. The specific capacity results are also mapped in **Figure HCM-10**, and generally support the spatial texture trends whereby the greatest specific capacity values are located near surface water drainages, and specific capacity tends to decrease to the west.

Geophysical data from ETS conducted near the Cosumnes River and Dry Creek indicate subsurface lithology is comprised of alternating sediments characterized as predominantly “fine-grained,” “clay,” and “coarse-grained” intervals of variable thickness. The fine-grained intervals likely include variable mixtures of silt, clayey sand, fine-grained cemented sand, and possibly fine-grained clayey gravel deposits but in relatively small quantities. The clay intervals represent relatively low permeability clay, silty clay, and sandy clay deposits, but may include small quantities of coarse-grained sediment. The coarse-grained intervals include sand, gravel, and possibly small quantities of clayey sand and clayey gravel. The ETS results identified mobile water associated with the predominantly coarse-grained intervals, and the fine-grained and clay intervals impede or restrict percolating recharge. At some locations, the ETS results helped identify potential channel deposits within the coarse-grained intervals based on a signal identifying a very coarse-grained material, or an anomalous thickening of the coarse-grained interval relative to adjacent soundings. Good agreement exists between these channel locations identified by ETS and maps constructed by DWR showing inferred channel deposits based on boring logs (DWR, 1974).

Structural Properties of the Basin that Restrict Groundwater Flow Within the Principal Aquifers

Within a limited portion of the Basin Foothills subarea, exposed metavolcanic basement bedrock outcrops form the Carabas Paleo-Ridge (Chapman and Bishop, 1975) (**Figure HCM-2**). This paleo-ridge was formed pre-Eocene, and sediments were deposited around the paleo-ridge during the following Eocene and Post-Eocene periods (Creely and Force, 2007). Hence, the Ione, Valley Springs, and Mehrten Formations

[29] https://data.cnra.ca.gov/dataset/svsim, accessed 29 July 2019

forming the Principal Aquifer are partially dissected by these paleo-ridge outcrops.

Clay beds at variable depths can partially restrict recharge and vertical groundwater movement, but these clay beds are discontinuous and their effects localized. As discussed above, interpretation of ETS geophysical survey results indicate predominantly fine-grained, clay deposits may extend approximately over the western third of the Basin, but are not likely continuous across the Basin. Where present, these clay beds can impede percolating recharge and support a relatively shallow water table.

General Water Quality of the Principal Aquifer(s)

General water quality types can be inferred from the ionic composition of water samples, plotted on either a **Piper Diagram** (trilinear diagram) or **Stiff Diagram** which display the relative proportions of cations and anions in water samples. The ionic composition is typically derived from the minerals that the groundwater contacts during its flow downgradient, and in the case of bicarbonate/carbonate anions are further influenced by the partial pressure of carbon dioxide in the atmosphere and soil zone. All water samples considered were from the DMS, and only samples having a charge balance error less than or equal to 10% were plotted in the diagrams.

In a Piper Diagram, the proportions of anions (chloride, sulfate, bicarbonate and carbonate) and cations (calcium, magnesium, potassium, and sodium) are plotted as points in lower triangles and the data points are projected into the central diamond along parallel lines. The Stiff Diagram plotting technique uses parallel horizontal axes extending on each side of a vertical zero axis. Concentrations of cations (sodium, calcium, and magnesium, in milliequivalents per liter [meq/L]), are plotted sequentially on each axis to the left of zero. Similarly, anion concentrations (chloride, bicarbonate, and sulfate) are plotted sequentially on each axis to the right of zero. The resulting points are connected to give an irregular polygonal shape or pattern, which can provide a distinctive method of showing water composition differences and similarities. The width of the pattern is proportional to the sample's total ionic content.

The Piper Diagram presented in **Figure HCM-11** plots water quality samples collected from wells within the Basin between 1995 and 2018 and show that the Basin Plain wells produce mostly mixed-cation bicarbonate waters but some wells produce sodium-bicarbonate waters, as shown by the alignment of symbols from the central, mixed-cation triangle (no dominance) to the apex of the sodium triangle. In contrast, the Basin Foothills wells show more variability in water quality, particularly the anion composition. Half of these wells produce mixed-cation-bicarbonate water while the remaining wells produce mostly sodium-mixed-anion to -sulfate or -chloride water. The Basin Foothills wells also show a linear trend between the mixed cation and sodium triangles.

The Stiff Diagrams presented in **Figure HCM-12** are consistent with the Piper Diagram and show that the ionic composition of groundwater is approximately uniform across the Basin Plain subarea but more variable in the Basin Foothills. Discussions of specific constituents are provided in Section 9.4 *Groundwater Quality Concerns* and address the beneficial uses of variable quality groundwater, including maps showing the spatial distribution of these constituents in well-water samples.

Primary Uses of Each Aquifer

The primary uses for groundwater extracted from the Principal Aquifer are irrigated agriculture, public supply, and rural domestic. **Figure HCM-13** shows the distribution of wells and their uses (types) recorded on WCRs (monitoring, irrigation, public supply, rural domestic, commercial, and unknown). Well density is greatest in the western half of the Basin. The predominant well type within the Basin is "monitoring" (i.e., non-production) wells. Irrigation wells are the most frequent type of production wells, comprising 20% of the wells. Public supply wells represent about 10% of the wells in the Basin, and rural domestic wells represent about 15% of the wells. The histogram in **Figure HCM-7** shows a continuous distribution of production well screen bottom depths, and about 50% of the extraction wells are less than 400 feet deep and about 50% of the wells are greater than 400 feet deep. The total number of wells greater than 400 feet gradually decline with depth to a maximum of 1,720 feet). The lack of a discernable relationship between the spatial distribution of well use and well depth indicate that wells are constructed in all formations, and suggests factors like intended use, desired yield, and economic constraints have relatively greater influence on well depth than subsurface structural conditions.

8.2. Cross Sections

> *§ 354.14. Hydrogeologic Conceptual Model*
> *(c) The hydrogeologic conceptual model shall be represented graphically by at least two scaled cross-sections that display the information required by this section and are sufficient to depict major stratigraphic and structural features in the basin.*

Figure HCM-14 shows the locations of four regional geologic cross-sections based primarily on lithologic descriptions in well driller reports (A-A', B-B', C-C', and D-D') and used to characterize hydrologic conditions and the spatial and vertical distribution of geologic formations and aquifer materials within the Basin. The cross-sections characterize conditions beneath the center of the Basin along a transect between the eastern and western boundaries (A-A'), beneath the northern and southern boundaries along transects aligned with the Cosumnes River and Dry Creek (B-B' and C-C', respectively), and beneath the center of the Basin along a transect between the northern and southern boundaries (D-D') (see **Figure HCM-15, Figure HCM-16, Figure HCM-17,** and **Figure HCM-18**, respectively). Additionally, three focused cross-sections were developed from lithologic descriptions in well driller reports and available geophysical survey results. These focused sections are approximately orthogonal to the Cosumnes River (**Figure HCM-14**) and characterize subsurface conditions near its upper, middle, and lower reaches (**Figure HCM-19**).

Regional Cross-Sections

The regional cross-sections depict materials that comprise the Principal Aquifer and all materials that could reasonably be tapped for groundwater supply. As such, the cross-sections include the entire zone above the Basin bottom (**Figure HCM-3**). Cross-sections A-A', B-B', and D-D' extend vertically downwards to an elevation of -1,800 ft msl, and cross-section C-C' extends vertically downward to an elevation of -1,900 ft msl. The four cross-sections are constructed based on the following information sources:

- Land surface elevation extracted from the USGS 10-meter digital elevation model (DEM);

- Wells proximal to the cross-section lines (see map inserts for well locations)[30], the perforated/screened interval, when known, and generalized lithologic information from WCRs or supplemental boring logs including sediment color and depth intervals (e.g., clay, silt, fine sand, sand, gravel, volcanic material, and so forth);
- Surficial geology informed by Piper and others, 1939 (**Figure HCM-14**)(Dawson, 2009; Gutierrez et. al, 2015; Holland, 2016);
- Subsurface formation depths by or modified from:
    - Pre-existing cross-sections (DWR, 1974; Whiteaker et al., 2012),
    - Lithologic texture and color extracted from DWR WCRs (e.g., records cited "Black Sands" deposits identify the Mehrten Formation),
    - Contoured elevations of the Post-Eocene deposits (i.e., above Ione Formation) as mapped by Page (1974) and used to delineate the bottom of Valley Springs Formation/top of Ione Formation,
    - Contoured elevations of the Basement surface (i.e., bottom of Ione Formation) as mapped by Chapman and Bishop (1975), where available,
    - Descriptions of formation thicknesses provided by DWR (1974), and
    - Geophysical survey results (Geoconsultants, Inc., 2020; Vista Clara, Inc., 2021; Ramboll 2021);
- Base of fresh groundwater as mapped by Berkstresser (1973);
- Depth to bottom of the basin as mapped in **Figure HCM-3;**
- Fall 2018 groundwater elevations as mapped in **Figure GWC-2**.

The subsurface geologic units shown on the cross-sections in stratigraphic sequence include the Victor Formation, Laguna Formation, Mehrten Formation, Valley Springs Formation, Ione Formation and Salt Springs Slate. Specific information pertaining to each cross-section and these formations is summarized below.

Cross-Section A-A' (**Figure HCM-15**) extends for approximately 28 miles in a southwest-northeast direction through the center of Basin (parallel to dip). The surficial geology encountered in the southwest portion of the Basin is mapped in **Figure HCM-14** as alluvium ("Qal"). Moving northeasterly along section A-A', the alluvium transitions to the Victor Formation ("Qv"), which covers about one-third of the section line. Moving eastward, the Laguna Formation ("Tl"), Valley Springs Formation ("Tv"), and Ione Formation ("Ti") cover the remainder of the section. A very small area of the Mehrten Formation ("Tm") outcrops along Cross-Section A-A'. The Ione Formation outcrops on the east side of the Carabas Paleo-Ridge (Jurassic age).

[30] Data were included from wells within 1 mile of the section lines.

In the southwestern portion of Cross-Section A-A’, the shallowest formation is the Victor Formation, which overlies the much thicker Laguna and Mehrten Formations (**Figure HCM-15**). The Laguna and Mehrten Formations thin to the northeast. The Valley Springs and Ione Formations underly the Mehrten Formation and are fairly uniform in thickness, but shallow to the northeast where they abut the Carabas Paleo-Ridge. On the eastern side of the Carabas Paleo-Ridge, the Ione Formation thickens, and the Jurrasic age Salt Springs Slate (i.e., basement bedrock) is encountered as a lateral boundary at the most northeastern portion of the section (Gutierrez et. al, 2015; Holland, 2016). Most production wells in proximity to Cross-Section A-A’ are constructed in the Laguna and Mehrten Formations.

Beneath the western Basin boundary and near the Sacramento-San Joaquin Delta, the boundary between fresh and saline groundwater is relatively shallow (the elevation of the base of fresh groundwater is approximately -375 ft msl). Moving eastward, the base of fresh groundwater deepens to an elevation of almost -1,800 ft msl and then rises again where it intersects the approximated bottom of the Ione Formation.

Cross-Section B-B’ (**Figure HCM-16**) extends for approximately 30 miles generally along the northern Basin boundary formed by the Cosumnes River. Surficial geology along the cross-section is characterized primarily as recent alluvium (“Qal”) (see **Figure HCM-14**). In the southwest, small areas are mapped as Victor Formation (“Qv”) or as Laguna Formation (“Tl”) where the cross-section follows the eastward bend in the Cosumnes River. At the most northern portion of the Basin, a small area is mapped as the Ione Formation (“Ti”).

Undifferentiated alluvium and Victor Formation are the shallowest aquifer materials and underly most of the Cosumnes River (**Figure HCM-16**). Based on ETS results, there is an inferred fine grained clay bed at the interface between the Victor and Laguna Formations; this clay layer is not continually present beneath the Cosumnes River. The Laguna and Mehrten Formations underly the Victor Formation and are thickest in the southwestern portion of the Basin. Most production wells in proximity to Cross-Section B-B’ increase in depth to the east and are screened within the Laguna or Mehrten Formations.

The base of fresh groundwater is shallowest in the west near the Sacramento-San Joaquin Delta (approximately -400 ft msl). Moving eastward, the base of fresh groundwater deepens to an elevation of about -1,700 ft msl and then rises eastward and approximately levels out at an elevation of approximately -750 ft msl.

Cross-Section C-C’ (**Figure HCM-17**) extends for approximately 30 miles in a southwest-northeast direction along Dry Creek and bends in a southeast direction to capture subsurface conditions beneath Jackson Valley in Amador County. In the southwest, surficial geology is characterized by recent alluvium (“Qal”) and transitions to Victor Formation (“Qv”) in most of the western one-third to half of the section line. Based on ETS results, there is an inferred fine-grained clay bed at the interface between the Victor and Laguna Formations; this clay layer is not continually present beneath Dry Creek. The remainder of the section line includes Laguna Formation (“Tl”), recent alluvium along Dry Creek (“Qal”), and Mehrten Formation (“Tm”) extending into the Basin Foothills subarea, where the surficial geology transitions to

Valley Springs Formation ("Tv") and Ione Formation ("Ti") (**Figure HCM-14**).

The Mehrten Formation is the thickest formation beneath Cross-Section C-C' and is delineated by the presence of black sands reported in available well boring logs (**Figure HCM-17**). Most production wells in the proximity of Cross-Section C-C' are completed within the Mehrten Formation. However, moving eastward, the Mehrten Formation thins and a greater proportion of wells are completed in the Valley Springs Formation.

The base of fresh groundwater is shallowest in the west at an approximate elevation of -800 ft msl. Moving eastward, the base of fresh groundwater deepens to an elevation of almost -1,900 ft msl, and then rises further to the east where it intersects the approximated bottom of the Ione Formation.

Cross-Section D-D' (**Figure HCM-18**) extends approximately 13 miles in a northwest-southeast direction through the center of Basin and is orthogonal to Cross-Section A-A' (parallel to strike). The surficial geology mapped along Cross-section D-D' is mostly Laguna Formation ("Tl") with portions of Victor Formation ("Qv") and alluvium ("Qal") in the middle and southern portions of the cross-section, respectively (**Figure HCM-14**).

The subsurface formations are approximately uniformly layered throughout Cross-Section D-D'. The Laguna Formation extends down to about -50 ft msl, then transitions into the Mehrten Formation which extends down to about -400 ft msl (**Figure HCM-18**). Wells are screened or have completed depths in the Laguna, Mehrten, and Valley Springs Formations. The thickest formation in the cross-section is the Valley Springs Formation, which extends down to an elevation of about -1,100 ft msl. The Ione Formation extends down to about -1,600 ft msl, however wells have not been completed in the Ione Formation in proximity to Cross-Section D-D'.

The base of fresh groundwater ranges in elevation from about -750 ft msl to -1,700 ft msl, and generally deepens from north to south across the Basin.

Focused Cross-Sections

The three focused cross-sections (Lower Reach, Middle Reach, and Upper Reach) are orthogonal to the Cosumnes River and Cross-Section B-B' (**Figure HCM-19**). The sections are about 12,000 feet in length, extend down to an elevation of -200 ft msl, and represent subsurface conditions beneath the lower, middle, and upper reaches of the Cosumnes River corridor, respectively. The Fall 2018 groundwater elevations projected on the cross-sections suggest that there is a hydraulic disconnect between the Cosumnes River and the water table in the Principal Aquifer, which is discussed in further detail in Section 9.6 *Interconnected Surface Water Systems*. The focused cross-sections were constructed using the following information:

- Information extracted from geophysical survey methods (ETS, Nuclear Magnetic Resonance [NMR], and Time-Domain Electromagnetic Method [TEM]) (see **Appendix I**). The geophysical information identified zones of primarily coarse-grained deposits, clay beds, mobile water, and possibly perched groundwater conditions.[31] Where available, the geophysical information are shown on the inset map in **Figure HCM-19**, and shaded "Channel" areas within the surrounding relatively fine-grained materials as mapped by DWR (1974).

- Stream channel deposits identified in boring logs and mapped by DWR (1974). These channels are shown on the cross sections.
- Well boring logs located proximal to the cross-section lines (see inset map on **Figure HCM-19**), showing the generalized color and lithologic information recorded in the boring logs, and perforated/screened interval, when known. Some of the wells plotted on the focused cross-sections extend below the bottom of the focused cross-sections.
- Depth to groundwater based on contoured water levels measured in Fall 2018 and mapped in **Figure GWC-4**.
- Approximate ground surface elevation extracted from the USGS 10-meter DEM, when not shown on the ETS transects.

The surficial geology encountered along the focused cross-sections primarily include alluvium ("Qal") and Victor Formation ("Qv") along the middle and lower reaches, and alluvium ("Qal") and Laguna Formation ("Tl") along the upper reach (**Figure HCM-14**). Subsurface conditions are represented by "paleochannels" which are relatively coarse-grained sediment remnants of inactive stream channels that have been partially filled and buried by younger, fine-grained sediment. These paleochannels are typically discontinuous and contribute to variable surface water leakage and groundwater seepage characteristics beneath and near the Consumes River and Dry Creek.

The distribution of coarse and fine-grained materials produce variable degrees of hydraulic connectivity between surface water, the uppermost saturated zone (the groundwater table), and groundwater in deeper saturated zones tapped by extraction wells.

[31] "Perched" groundwater occurs when percolating water is retarded by a low-permeability bed, often separating unconfined groundwater in underlying saturated zones by an unsaturated zone.

8.3. Physical Characteristics

> *§ 354.14. Hydrogeologic Conceptual Model*
> *(d) Physical characteristics of the basin shall be represented on one or more maps that depict the following:*
> *(1) Topographic information derived from the U.S. Geological Survey or another reliable source.*
> *(2) Surficial geology derived from a qualified map including the locations of cross- sections required by this Section.*
> *(3) Soil characteristics as described by the appropriate Natural Resources Conservation Service soil survey or other applicable studies.*
> *(4) Delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas, including significant active springs, seeps, and wetlands within or adjacent to the basin.*
> *(5) Surface water bodies that are significant to the management of the basin.*
> *(6) The source and point of delivery for imported water supplies.*

8.3.1. Topographic Information

Figure HCM-21 shows the topography within the Basin. Ground surface elevations in the Basin range from approximately 0 ft msl to 450 ft msl. The lowest elevations are in the southwestern portion of the Basin near the Sacramento-San Joaquin Delta and elevations increase across the Basin to the northeast toward the foothills of the Sierra Nevada where elevations begin to increase significantly. The contributing watersheds to the Basin extend to as high as 8,000 ft msl.

8.3.2. Surficial Geology

Figure HCM-14 shows the surficial geology within the Basin based on the *Geologic and Hydrologic Map of the Mokelumne Area, California* (Piper and others, 1939), and the formations discussed relative to the Principal Aquifer above in Section 8.1.4 *Principal Aquifers and Aquitards*. The map by Piper and others (1939) provides clear delineation of formations for the entire Basin. While more recent surficial geologic maps are available, they represent only portions of the Basin (i.e., Dawson, 2009; Gutierrez et. al, 2015; Holland, 2016). Moreover, the more recent maps are generally consistent with Piper and others (1939), and do not provide additional information on the surficial extent of formations.[32] The 1939 map by Piper and others was therefore used to characterize surficial geology and infer the geologic structure of the Principal Aquifer.

[32] Readers interested in potentially more detailed map information for local parts of the Basin are referred to the more recent sources available from the California Geological Survey (https://www.conservation.ca.gov/cgs/maps-data/rgm/preliminary) including:

- Dawson (2009) Preliminary Geologic Map of the Lodi 30’ x 60’ Quadrangle, California. California Geological Survey.
- Gutierrez et. al (2015) Preliminary Geologic Map of the Ione 7.5' Quadrangle, Amador County, California. Version 1.0. California Geological Survey.
- Holland (2016) Preliminary Geologic Map of the Irish Hill 7.5' Quadrangle, Amador County, California. Version 1.0. California Geological Survey.

The predominant surficial geologic units covering the Basin are the Victor Formation (“Qv”), Laguna Formation (“Tl”), and the Mehrten Formation (“Tm”). Moving eastward, the surficial geology transitions predominantly into the Valley Springs Formation (“Tv”) and Ione Formation (“Ti”). Other minor units include alluvium (“Qal”) near the Cosumnes River and Dry Creek areas and Arroyo Seco Gravel (“Qas”) in the northern most portion of the Basin. The central portion of the Basin is primarily mapped as Laguna Formation (“Tl”).

8.3.3. Soil Characteristics

Soil types in the Basin are mapped in **Figure HCM-22** and were determined from the United States Department of Agriculture and Natural Resources Conservation Service (USDA-NRCS) Soil Survey Geographic Database (SSURGO). **Figure HCM-22** also shows areas of existing or high potential for groundwater recharge and discharge, which are discussed below in Section 8.3.4 *Groundwater Recharge and Discharge*. The Hydrologic Soil Group identification (USDA-NRCS, 2007) provides an indication of the relative runoff and infiltration (recharge) potential of the soil, and ranges from the lowest runoff and highest infiltration potentials (Hydrologic Soil Group A) to the highest runoff and lowest infiltration potentials (Hydrologic Soil Group D). More than 50% of the Basin area is comprised of soils classified as Hydrologic Soil Group D, indicating high runoff potential and low recharge potential. Lesser areas are comprised of Hydrologic Soil Group C (~30%). Hydrologic Soil Groups A and B constitute the remainder of the Basin and occur primarily along the Cosumnes River and other creek beds, indicating these areas near the surface water drainages have relatively low runoff and high recharge potential.

8.3.4. Groundwater Recharge and Discharge

Recharge and discharge represent additions and subtractions of water as a result of interactions between the Principal Aquifer and surface water, land surface/root zone, and groundwater systems. Recharge includes leakage from surface water in creeks, rivers and reservoirs; deep percolation of precipitation, applied irrigation water (both surface- and groundwater), and return flow from septic systems out of the land surface/root zone; and, the exchange of water between groundwater systems as subsurface inflow across the Basin boundaries (interbasin flow). Discharge includes seepage of groundwater into the surface water systems; well extractions for urban, rural farmstead (e.g., in the communities of Galt, Wilton and Herald), agriculture, and aquaculture land uses; and subsurface outflow across Basin boundaries to adjacent groundwater systems (interbasin flow).

Recharge

Leakage from the Cosumnes River, Dry Creek, and other smaller creeks have been previously identified as sources of Basin recharge from the surface water system (Robertson-Bryan, Inc. and WRIME, 2011). Water samples from wells analyzed for stable oxygen and hydrogen isotopes indicate the presence of Cosumnes River water in both the South American Subbasin (5-021.65) (SASb) and the Basin. The magnitude and extent of river contributions are influenced by the distribution of coarse-grained channel deposits in the subsurface inferred from boring logs and mapped by DWR (DWR, 1974), and geophysical surveys conducted in support of this GSP (**Figure HCM-20**).

Infiltration is that portion of water that percolates into the soil, whereas deep percolation is the fraction of infiltration that moves past the land surface/root zone system and is ultimately intercepted by the water table in the Principal Aquifer. Deep percolation is the primary source of recharge to the Principal Aquifer. Most of the Basin is comprised of moderately-high and high-runoff soils having low infiltration potential and therefore relatively low potential to provide recharge. Water samples from wells analyzed for stable oxygen and hydrogen isotopes confirm that groundwater in and downslope from the areas of exposed Laguna Formation and Mehrten Formation are relatively important for recharging wells that extract water from these formations (see **Figure HCM-22** which delineates the exposed areas of Laguna Formation and Mehrten Formation and **Figure 5** in **Appendix J** "*Isotopic Recharge Study*"). The water samples also showed evidence of leakage from the Cosumnes River on the North and South side of the river (see **Figure HCM-20**).

Water originating outside the Basin can recharge the Principal Aquifer as subsurface inflow from the groundwater systems in neighboring basins. Subsurface flows into the Basin can originate from the SASb, the Eastern San Joaquin (ESJ) Subbasin (5-022.01), and from the bedrock to a limited extent, along the eastern Basin boundary.

These fluxes described above were estimated using a numerical groundwater-flow model, and the modeling results are discussed in detail in Section 10.2 *Water Budget Results.*

<u>*Discharge*</u>

Seepage into surface water features can occur when the adjacent water table in the Principal Aquifer is greater than the level, or stage of the surface water, which can occur year-round (for example, in their uppermost reaches) or seasonally (for example, in temporarily or regularly interconnected reaches). Well extractions represent the primary discharges from the Principal Aquifer; the locations and uses of wells in the Basin are shown on **Figure HCM-13**. Groundwater can also leave the Basin as subsurface outflow to neighboring groundwater systems, including the SASb and ESJ Subbasin. These fluxes were estimated using a numerical groundwater-flow model, and the results are discussed in detail in Section 10.2 *Water Budget Results.*

8.3.5. Surface Water Bodies

Figure HCM-23 shows mapped surface water features in the Basin. The Cosumnes River, Dry Creek, Laguna Creek, Hadselville Creek, Jackson Creek, and Badger Creek are some of the larger drainage features within the Basin. As discussed in Section 8.3.3 *Soil Characteristics*, most of the Basin is characterized by surface soils with moderately high runoff potential and low infiltration rates (**Figure HCM-22**). As such, most of the rainfall that falls in the Basin likely does not infiltrate into the soil but becomes runoff, which can leave the Basin as surface water, be diverted for use, or retained by numerous ponds. For example, during the period 1999-2018 estimated diversions from the Cosumnes River and Dry Creek totaled about 22,000 acre-feet per year (AFY) (30 cubic feet per second [cfs]), and about 50 permitted stock ponds diverted and stored from 0.2 AFY to 9.5 AFY (less than 0.01 cfs per pond) for irrigation and stock watering.[33]

Cosumnes River, Dry Creek, and Jackson Creek also receive runoff from higher elevation watersheds. The Cosumnes River is the last major undammed river in California, and historically supported fall runs of Chinook salmon and a diversity of groundwater dependent ecosystems (Snider and Reavis, 2000; Azat, 2019). Diversions from these and the relatively smaller drainages throughout the Basin are utilized to meet a portion of the local irrigation water demand (Robertson-Bryan, Inc. and WRIME, 2011).

Two significant surface water storage features are located in the Basin. Camanche Reservoir, a 410,000 AF reservoir, was constructed on the Mokelumne River on the southeastern side of the Basin and is operated by East Bay Municipal Utilities District (EBMUD)[34]. Camanche Reservoir provides a limited supply of domestic water to the local community. The second feature is a 160-acre lake within Rancho Seco Park and is located in the center of the Basin. Rancho Seco Park receives imported water from the American River—outside the Basin—through the Folsom South Canal (FSC) and is maintained by Sacramento Municipal Utilities Department (SMUD)[35].

Lake Amador is a 22,000 AF lake located adjacent to, but east of, the Basin boundary. Lake Amador and Pardee Reservoir support Jackson Creek flows, which is a source of surface water supply for The Oaks Mobile Home Park Public Water System (CA0310020) and Jackson Valley Irrigation District (JVID). The JVID supplies Jackson Creek water to over 200 irrigators located along the creek, within a service area of about 13,000 acres[36]. Numerous, relatively smaller private stock ponds[37] exist primarily in the eastern half of the Basin which can capture rainfall runoff in the Basin.

8.3.6. Source and Point of Delivery for Imported Water Supplies

Imported surface water is and has been delivered to the Basin through the FSC and via the Cosumnes River. Since the early 1970s, SMUD has obtained Central Valley Project (CVP) surface water from the FSC for use at the former Rancho Seco power facility and lake (**Figure HCM-23**). Intermittently between 1975 and 2010, Galt Irrigation District (GID) and Clay Water District purchased the surface water discharged from the Rancho Seco Lake to supplement irrigation water supplies (Robertson-Bryan, Inc. and WRIME, 2011). Omochumne-Hartnell Water District (OHWD) also historically purchased and managed supplemental CVP water from FSC releases to Deer Creek between 1975 and 1987 (Robertson-Bryan, Inc. and WRIME, 2011), however while these flows represent purchased water its source is the Cosumnes River and therefore not an imported supply. Imported water is not known to have been delivered to and

[33] Source: eWRIMS, https://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/
[34] https://www.ebmud.com/recreation/sierra-foothills/camanche-reservoir/
[35] https://www.smud.org/en/In-Our-Community/Visit-our-Recreational-Areas/Rancho-Seco
[36] According to Jackson Valley Irrigation District's 2016 Aggregated Farm-Gate Delivery Data.
[37] Permitted stock ponds from SWRCB Electronic Water Rights Information Management System:

used for irrigation within the Basin after 2010[38].

8.3.7. Hydrogeologic Conceptual Model Data Gaps

The GSP Regulations define "data gap" as "*a lack of information that significantly affects the understanding of the basin setting or evaluation of the efficacy of [GSP] implementation, which could limit the ability to assess whether the basin is being sustainably managed*" [§351(l)].

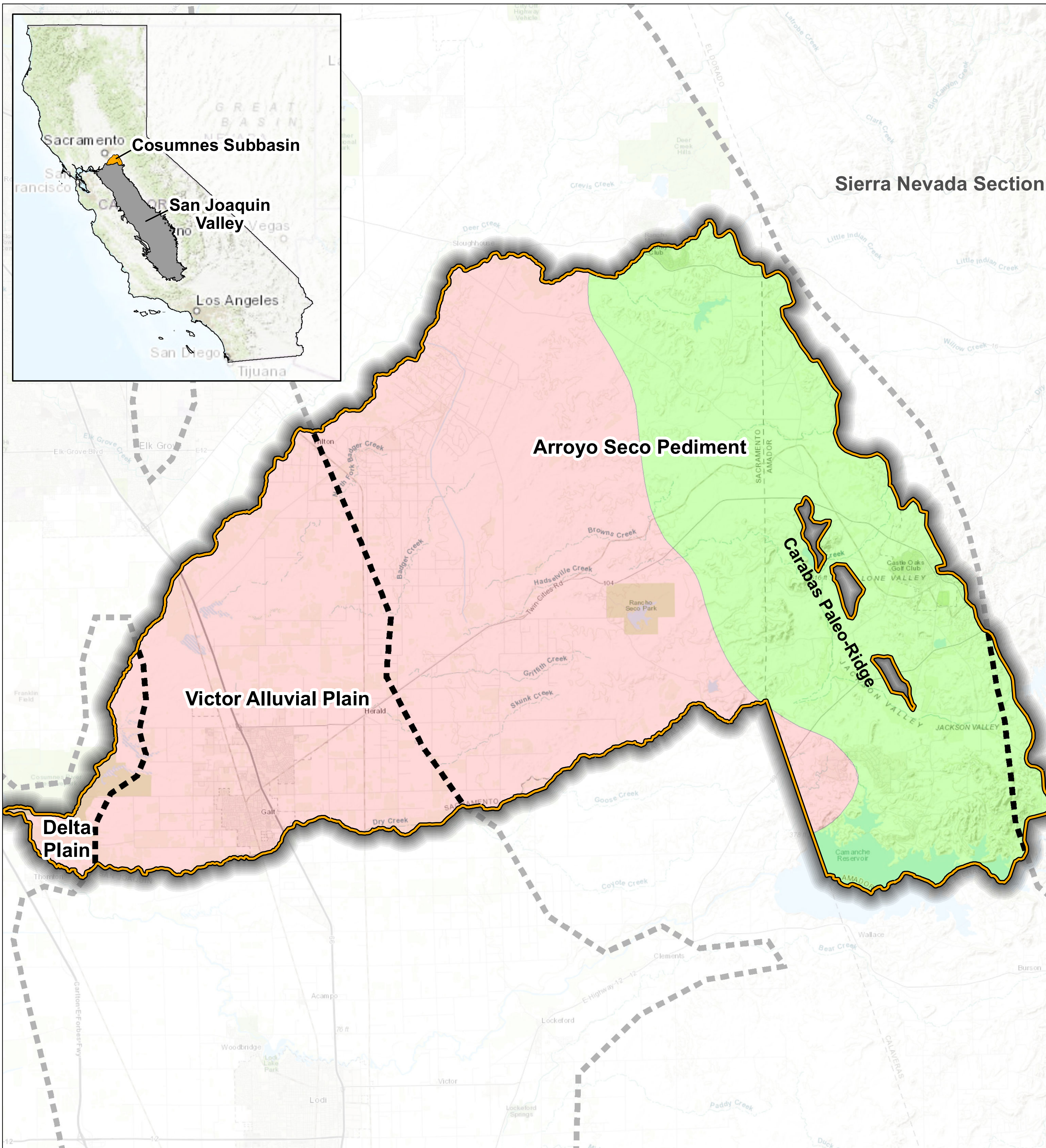
Key data gaps and uncertainties identified during development of the Basin HCM include:

- Well construction information (i.e., borehole depth, well completion depth, and perforated intervals) is required to determine the depth interval represented by a well (e.g., the depth interval represented by water level, water quality, and use). Well construction information was obtained from DWR's Online System of Well Completion Reports (OSWCR) database, but more than half of the 665 wells in the Basin DMS have no associated depth information (336 wells), and even more wells (465 wells) do not have reported perforation (screened) intervals. Moreover, the OSWCR database does not include all wells in the Basin and does not include coordinates to reliably locate the wells in the database in the Basin.
- Information on reported well type (i.e., commercial, residential, irrigation, or public supply well) identifies the beneficial uses for the water extracted from the Principal Aquifer. Well use is reported for 82% of the wells in the Basin DMS, but their extraction rates (pumpage) are only reported for 19 wells. The status (active, inactive, abandoned, or destroyed) of most wells in the Basin DMS (72%) are unknown. Well status is utilized to prioritize data gathering efforts, and to accurately characterize the spatial distribution of groundwater use in the Basin.
- Aquifer properties quantify water transmitting and storage properties (e.g., hydraulic conductivity and specific yield). Well-specific aquifer property data in the DMS are limited to 10 aquifer test locations summarized in **Table HCM-3** (one located in the Basin Plain subarea and nine located in the Basin Foothills subarea), and 42 results for specific capacity mapped in **Figure HCM-10.** Limited spatial and vertical distribution of aquifer property data creates uncertainty regarding the characterization of the distribution and fate of recharge, water movement across the interior Basin, and cross-boundary subsurface flows.
- The ionic composition of groundwater can reflect its recharge source, as it is influenced by the mineral composition of the materials through which it travels and its residence time within both the soil root zone and the groundwater system (Hem, 1970). The Basin DMS includes 153 wells (23% of all wells) with water quality data, but only 61 of those wells (9% of all wells) have a complete suite of standard ion data that characterize water quality. Spatial gaps in standard ion data include areas near the Basin boundaries and associated surface water features, in the central portion of the Basin and the Sacramento County and Amador County boundary, and eastern portion of the Basin in Amador County.

[38] Written communication, John Lowrie, Water Forum, 13 November 2019, monthly usage data for GID.

- Cross-section development data gaps include: well logs and associated lithology for wells located in Amador County, deep well logs and associated lithology for wells screened within the Valley Springs and Ione formations in the Basin Plain subarea, shallow lithology adjacent to the Cosumnes River represented by the focused cross-sections, uncertainty in the depth to the top of Valley Springs Formation across most of the Basin, and depth to the bottom of Ione Formation in Sacramento County.

Additional data gaps related to the definition of groundwater conditions are discussed at the end of Section 9.7.1 *Groundwater Conditions Data Gaps* below.



Legend

Cosumnes Subbasin (5-022.16)

Physiographic Section

Physiographic Subarea

Basin Foothills

Basin Plain

Abbreviations

DWR = California Department of Water Resources

U.S. = United States of America

Notes

1. All locations are approximate.
2. Cosumnes Basin subareas are delineated based on distinct aquifer characteristics, see Section 8.1.1. Geological and Structural Setting for more details.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Physiographic sections from: Piper and others, 1939, "Geology and Ground-Water Hydrology of the Mokelumne Area." U.S. Geological Survey Water-Supply Paper 780, Plate 2.

N

0 3 6

(Scale in Miles)

Cosumnes Subbasin
Physiographic Subareas

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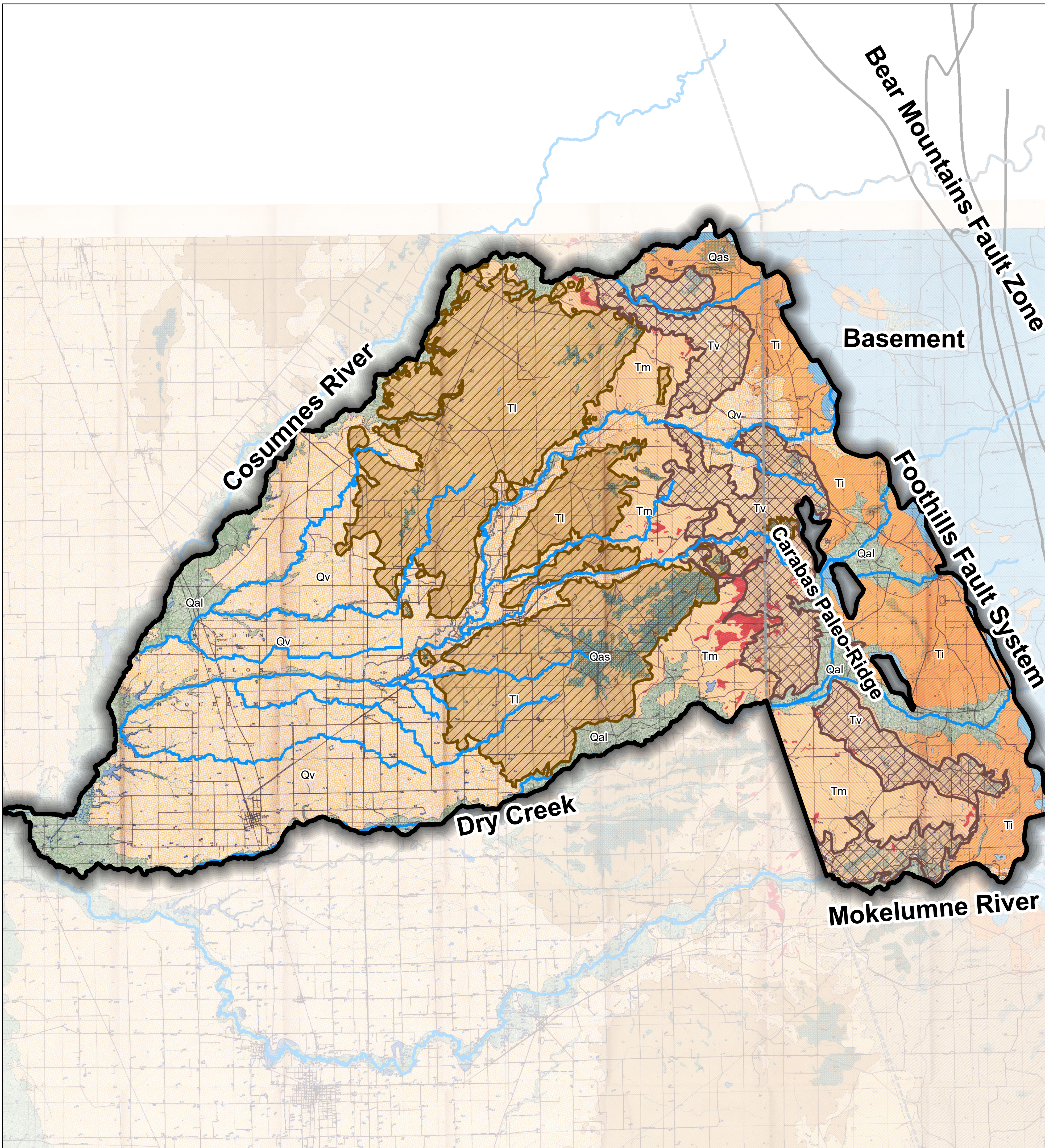
Figure HCM-1

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_HCM-01_Physiographic Subareas.mxd



Legend

- Major Stream
- Fault
- Cosumnes Subbasin (5-022.16)

- Qal Alluvium
- Qv Victor Formation
- Qas Arroyo Seco gravel
- QTu Gravel deposits of uncertain age
- Tl Laguna Formation
- Tma Tm Mehrten Formation
- Tv Valley Springs Formation
- Ti Ione Formation
- JC Pre-Cretaceous crystalline rocks

Abbreviations
DWR = California Department of Water Resources
USGS = United States Geological Survey

Notes
1. All locations are approximate.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Geology from:
"Geology and Ground-Water Hydrology of the Mokelumne Area, California" compiled by USGS, 1939. USGS Water-Supply Paper 780.
4. Faults from:
"Preliminary intergrated geologic map databases for the United States" Western States. Version 1.3. Updated December 2007. Compiled by USGS Open-File Report 2005-1305.

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0 3 6
(Scale in Miles)

Surficial Geology Map and Lateral Basin Boundaries

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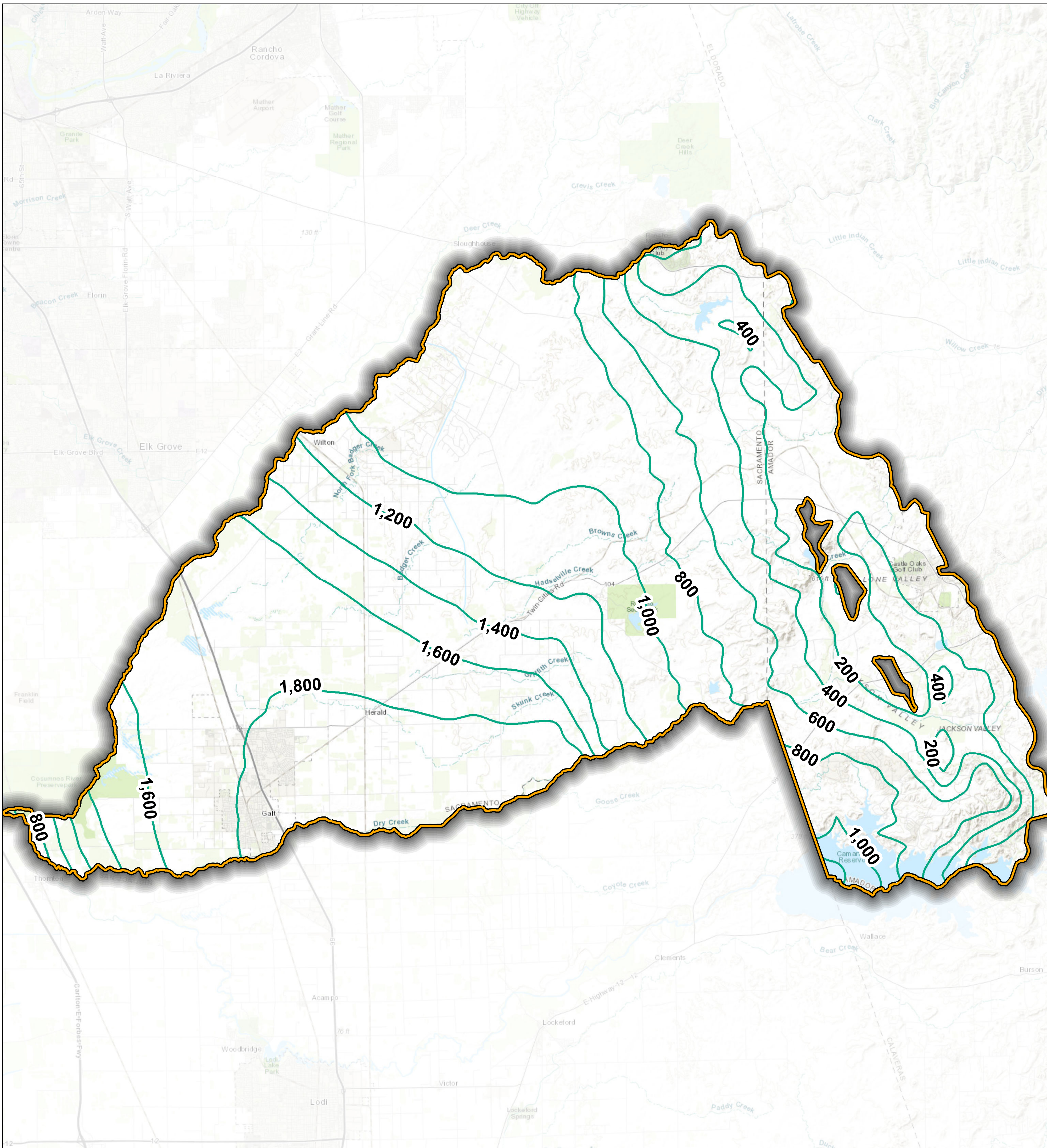
Figure HCM-2

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_HCM-02_Lateral Basin Boundaries.mxd



Legend

Depth to Bottom of Basin Contour (ft bgs)

Cosumnes Subbasin (5-022.16)

Abbreviations

DWR = California Department of Water Resources
ft bgs = feet below ground surface
USGS = United States Geological Survey

Notes

1. All locations are approximate.
2. Bottom of basin contours inferred from bottom of the Ione Formation or base of fresh groundwater, whichever is highest.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Bottom of Basin contours from:
   - Berkstresser, 1973, Base of fresh ground water - Approximately 3,000 micromhos - in the Sacramento Valley and Sacramento-San Joaquin Delta, California, USGS WRI 40-73
   - Chapman and Bishop, 1975, Geophysical Investigations in the Ione Area, Amador, Sacramento, and Calaveras Counties, California Division of Mines and Geology Special Report 117,27 pp.
   - Page, 1974, Base and thickness of the post-Eocene continental deposits in the Sacramento Valley, California, USGS WRI 45-73, 16 pp.

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(Scale in Miles)

Depth to Bottom of Basin

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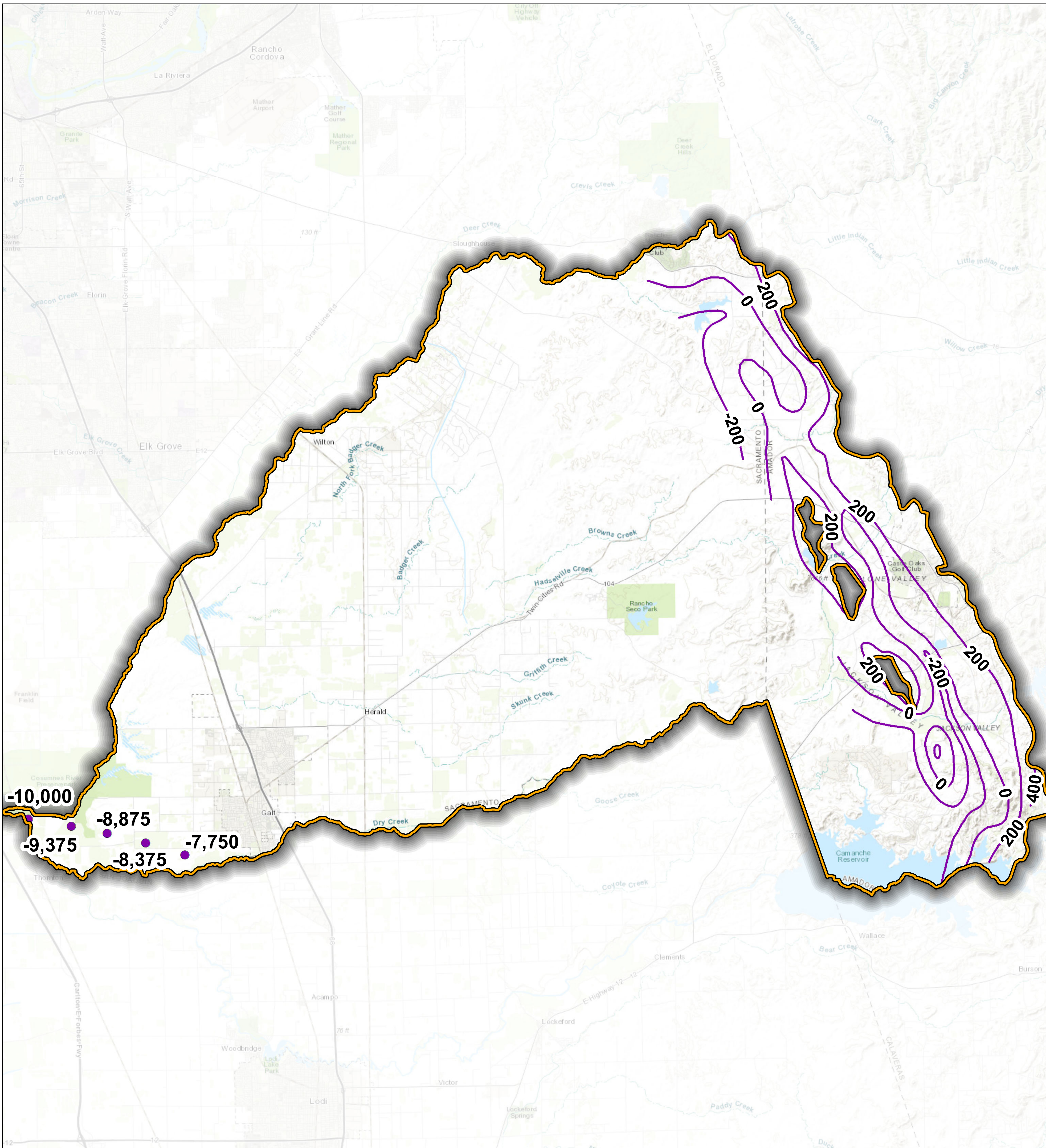
Figure HCM-3

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_HCM-03_Bottom of Basin.mxd



Legend

Cosumnes Subbasin (5-022.16)

Elevation of Basement Bedrock Contour (ft MSL)

Elevation of Basement Bedrock (ft MSL)

Abbreviations

DWR = California Department of Water Resources

DOGGR = California Division of Oil, Gas, and Geothermal Resources

ft MSL = feet above mean sea level

Notes

1. All locations are approximate.
2. Point values for elevation of basement bedrock extracted along cross-section C-D from DOGGR (1982) at approximately 6,000 foot intervals.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Elevation of Basement Bedrock from:
   - Chapman and Bishop, 1975, Geophysical Investigations in the Ione Area, Amador, Sacramento, and Calaveras Counties, California Division of Mines and Geology Special Report 117, 27 pp.
   - DOGGR, 1982, California Oil and Gas Fields Volume III - Northern California (CD-1) Contour maps, cross sections, and data sheets for California's oil and gas fields, 330 pp.

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0 3 6

(Scale in Miles)

Elevation of Basement Bedrock

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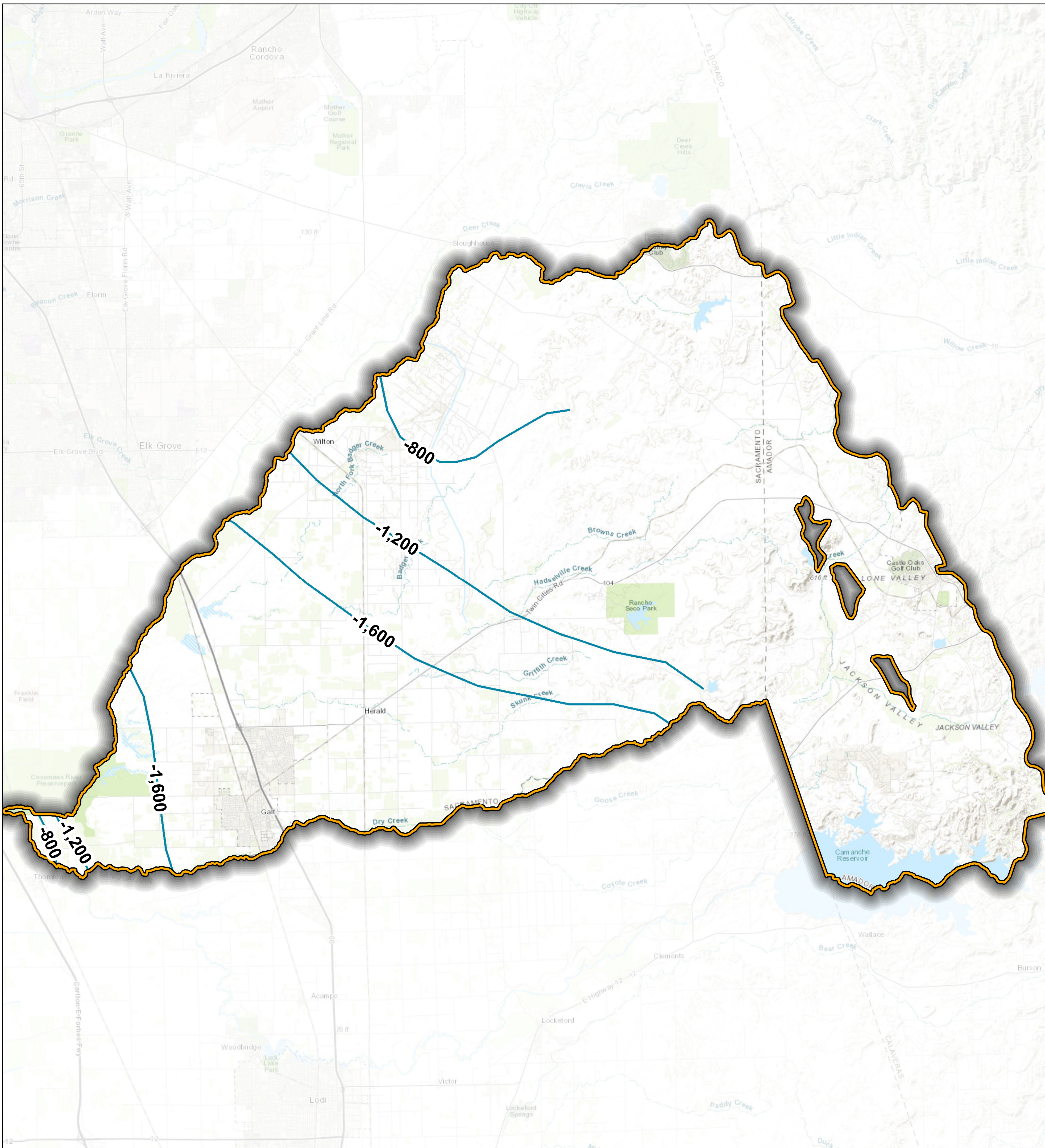
Figure HCM-4

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_HCM-04_BedrockElevation.mxd



Legend

Base of Fresh Groundwater Elevation (ft MSL)

Cosumnes Subbasin (5-022.16)

Abbreviations

DWR = California Department of Water Resources

ft MSL = feet above Mean Sea Level

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Base of fresh groundwater contours from: Berkstresser, 1973. Base of Fresh Ground Water -Approximately 3,000 micromhos-in the Sacramento Valley and Sacramento-San Joaquin Delta, California.

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(Scale in Miles)

Base of Fresh Groundwater

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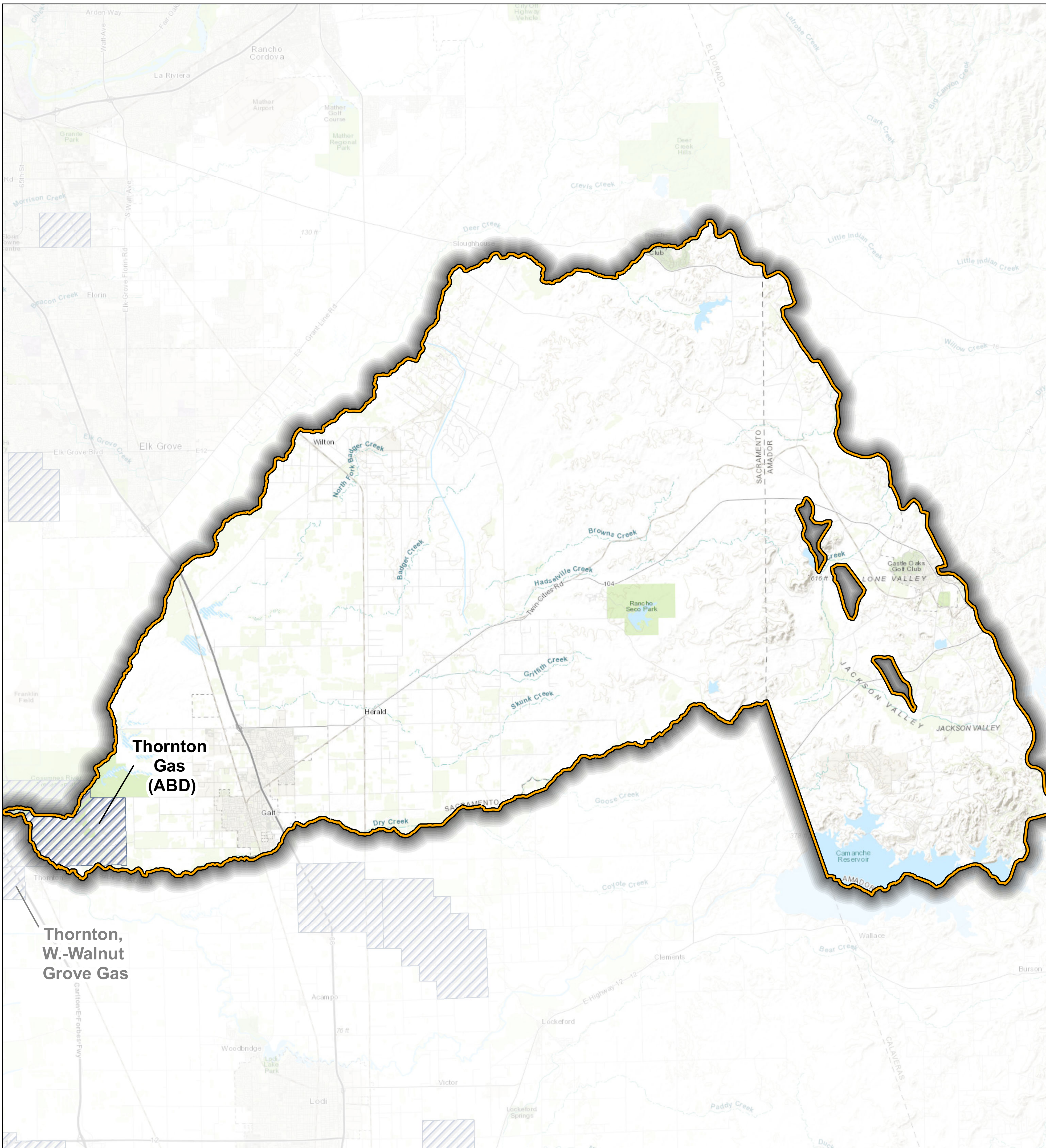
Figure HCM-5

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_HCM-05_Base of Fresh Groundwater.mxd



Legend

Oil/Gas Field

Cosumnes Subbasin (5-022.16)

Abbreviations

CalGEM= California Geologic Energy Management Division

DWR = California Department of Water Resources

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Oil/Gas field boundaries downloaded from CalGEM website: https://maps.conservation.ca.gov/doggr/wellfinder/#openModal/

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(Scale in Miles)

Oil and Gas Fields

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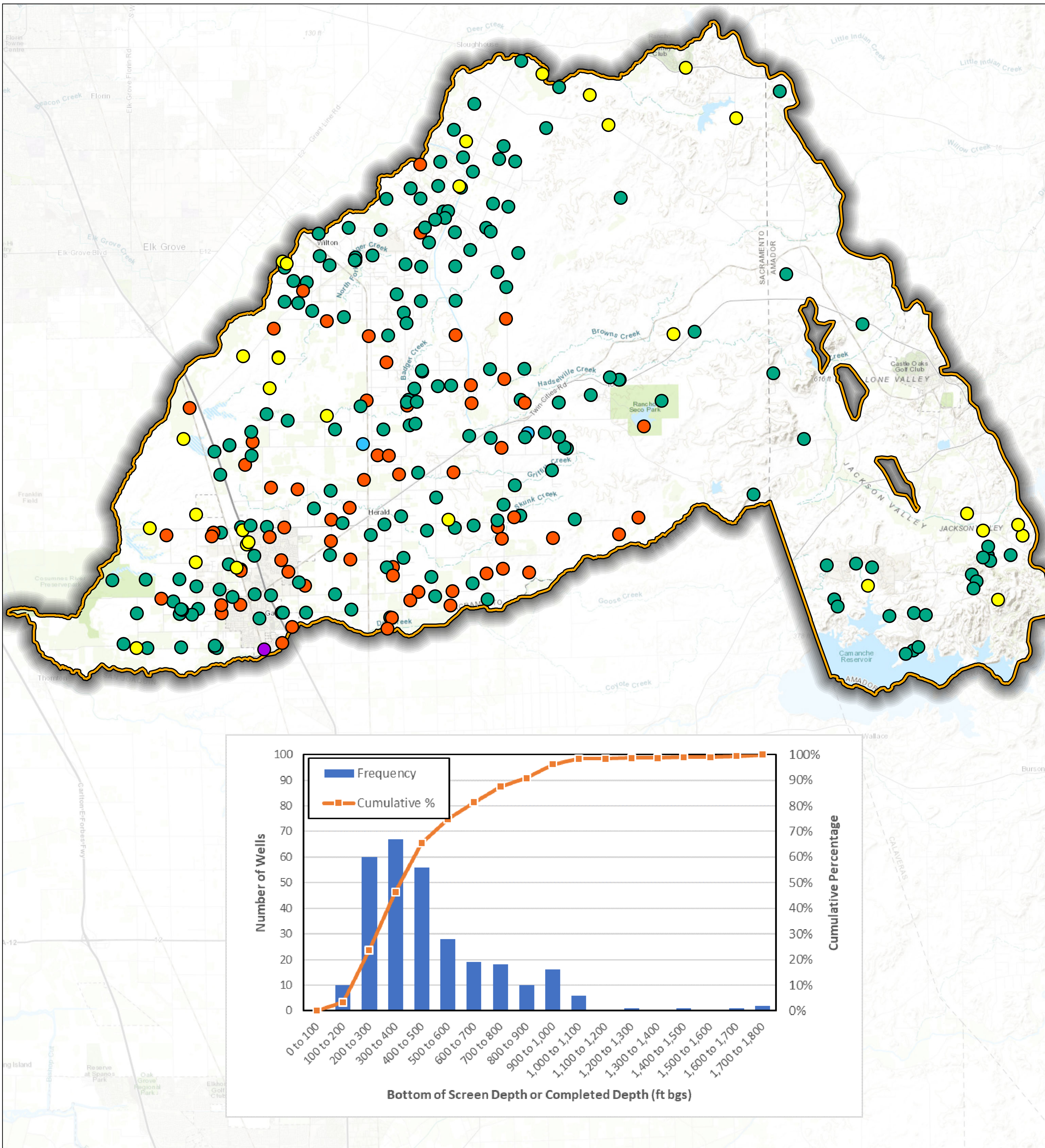
Figure HCM-6

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_HCM-06_Oil Gas Fields.mxd



Legend

Well Depth (ft bgs)

- < 150
- 151 - 500
- 501 - 1,000
- 1,001 - 1,500
- > 1,500

Cosumnes Subbasin (5-022.16)

Abbreviations

DMS = Data Management System
DWR = California Department of Water Resources
ft bgs = feet below ground surface

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Well data is from the Cosumnes DMS.

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0 3 6

(Scale in Miles)

Summary of Production Well Depths

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Figure HCM-7

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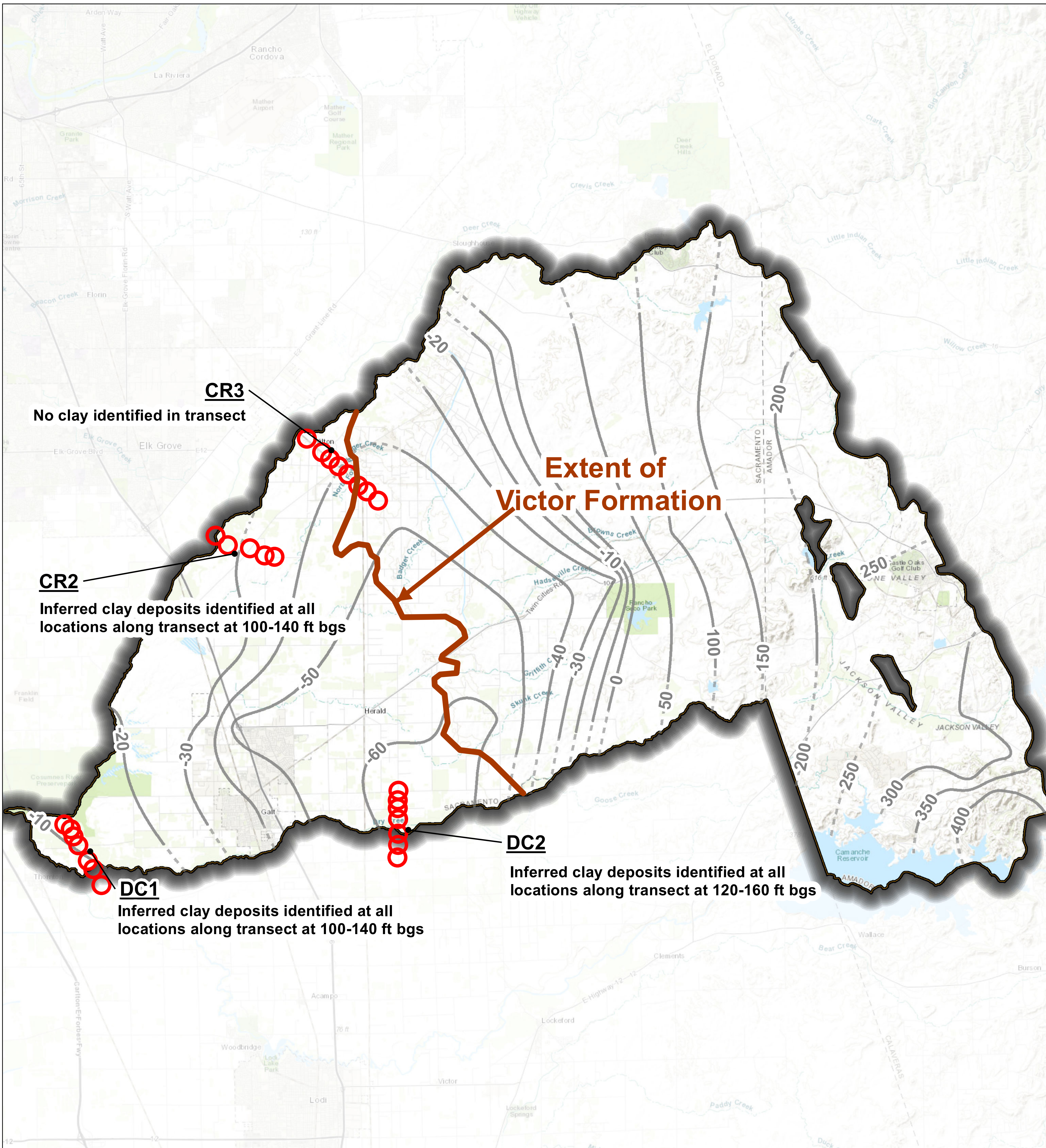
Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_HCM-07_Deepest GW Extractions.mxd



Legend

DC1 Transect Label

ETS Site Location

Extent of Victor Formation

Fall 2018 GWE Contour (ft), dashed where uncertain

Cosumnes Subbasin (5-022.16)

Abbreviations

DWR= California Department of Water Resources
GWE = Groundwater Elevation
ETS= Electrotelluric Sounding
ft bgs = feetbelow ground surface

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. ETS from Wire (2020) Hydrogeologic Study Using Electrotelluric Transects for the Cosumnes Subbasin,

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(Scale in Miles)

Depth and Thickness of Clay Deposit Inferred from Electrotelluric Sounding Results

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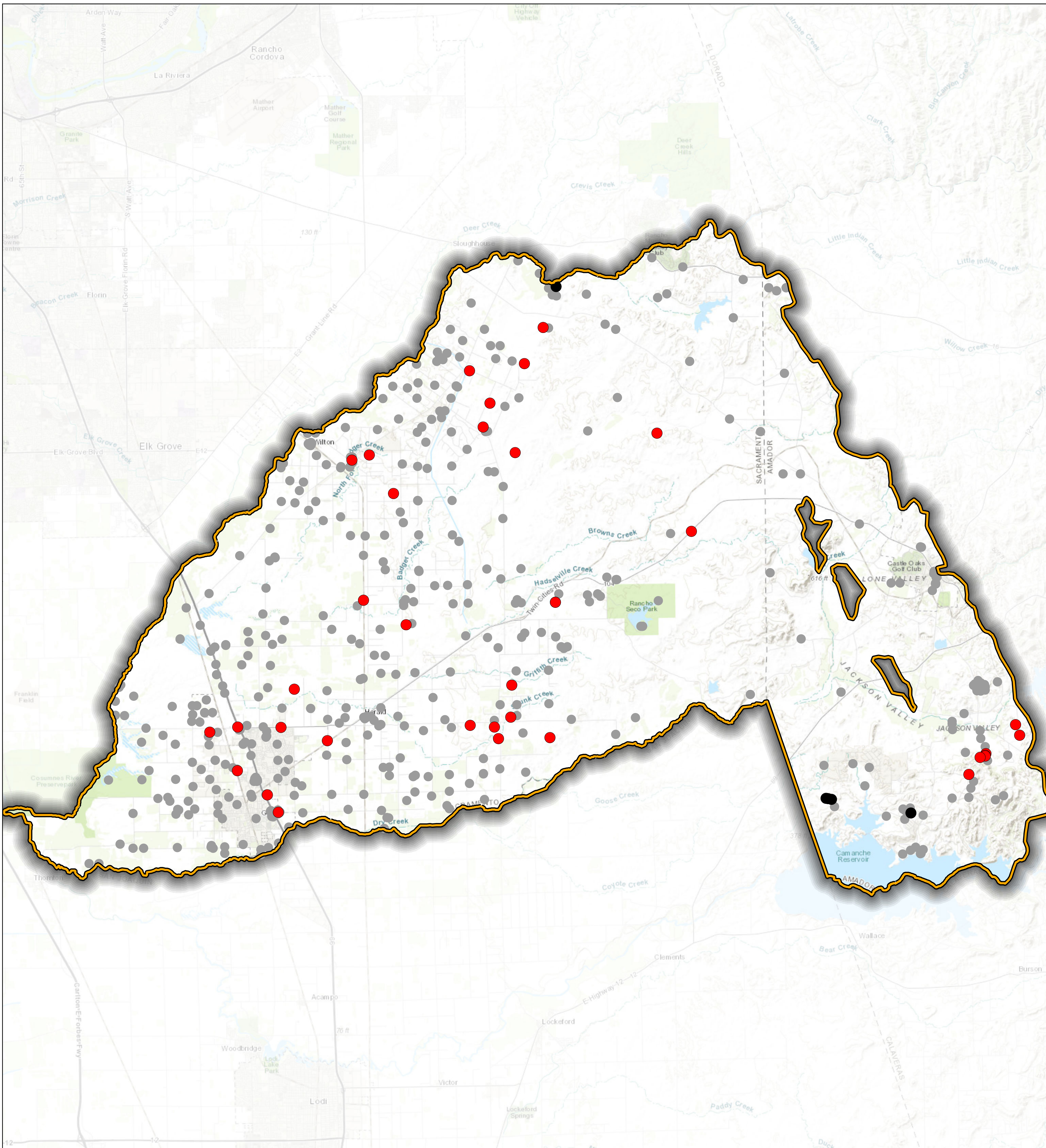
Figure HCM-8

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_HCM-08_Electrotelluric Sounding Results.mxd



Legend

- Aquifer Test Data
- Specific Capacity Data
- No Aquifer Test Data
- Cosumnes Subbasin (5-022.16)

Abbreviations

DMS = Data Management System

DWR = California Department of Water Resources

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Well data from Cosumnes DMS.

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0 3 6

(Scale in Miles)

Well-Specific Aquifer Property Data

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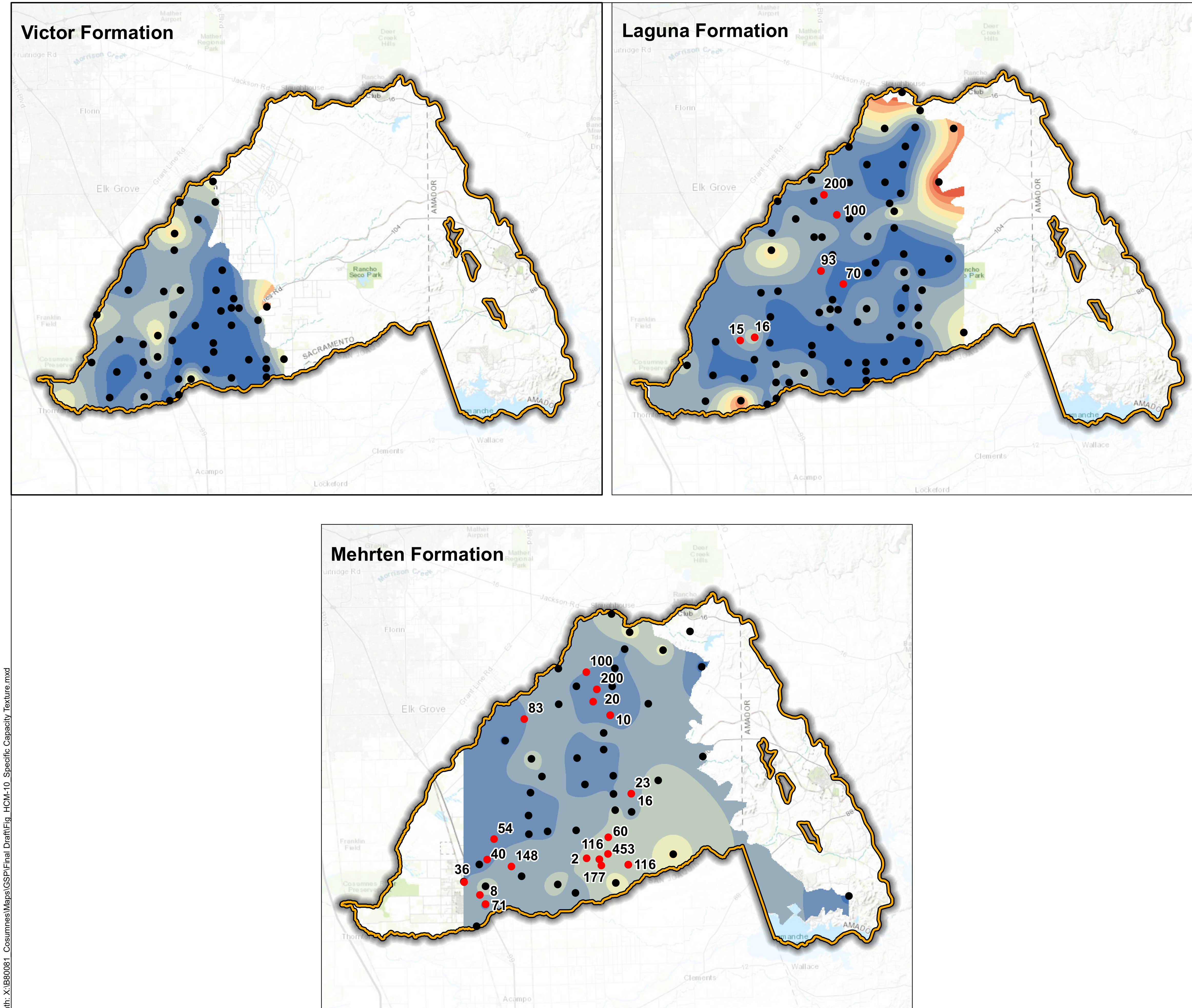
Figure HCM-9

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_HCM-09_Well specific aquifer property.mxd



Legend

Cosumnes Subbasin (5-022.16)

Specific Capacity Data Point (labeled with value)

Texture Data Point

Fraction Coarse-grained Sediments

- 0.0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1.0

Abbreviations

DWR = Department of Water Resources
gpm/ft = gallons per minute per foot

Notes

1. All locations are approximate.
2. Specific capacity at each well calculated by dividing estimated yield by drawdown.
3. Fraction of coarse-grained sediments calculated at each well point for the depth interval of each formation.
4. Map of fraction of coarse-grained sediments interpolated from the point data using the Kriging interpolation method.
5. Specific Capcity values are in units of gpm/ft.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Lithology, drawdown, and estimated yield information obtained from DWR well completion reports.

N

0 4 8

(Scale in Miles)

Distribution of Sediment Texture and Specific Capacity of Wells

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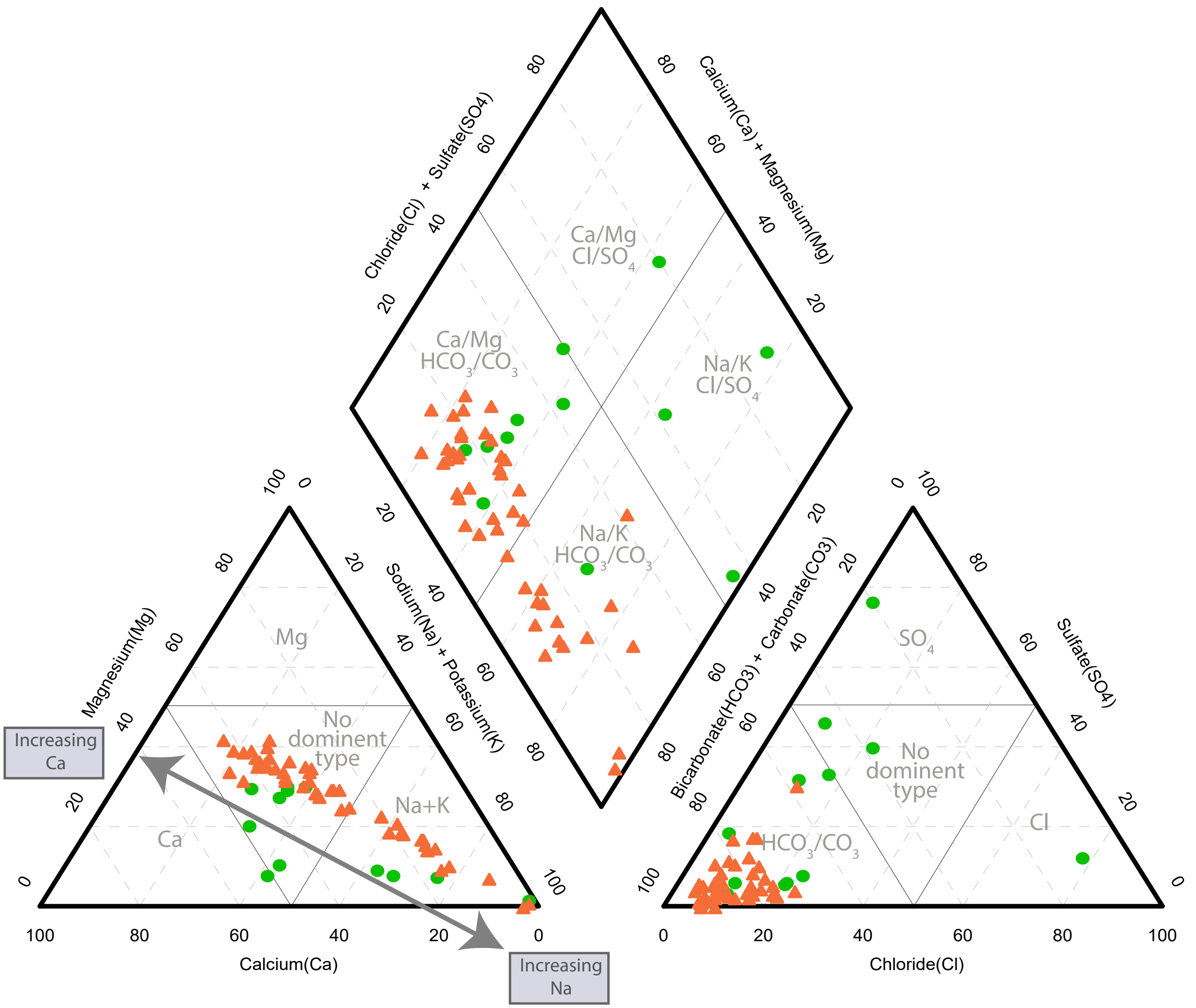
Figure HCM-10

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_HCM-10_Specific Capacity Texture.mxd



Legend

Well with Standard Ion Concentrations Data

- Basin Plain
- Basin Foothills

Abbreviations

Ca = Calcium
Cl = Chloride
CO_3 = Carbonate
HCO_3 = Bicarbonate
K = Potassium
Mg = Magnesium
Na = Sodium

Notes

1. Water quality samples collected between 1995 and 2018. Only the most recent sample is shown.
2. Dominant water type is labeled in grey.

Sources

1. Water quality data from the Cosumnes Subbasin Data Management System.

General Groundwater Chemistry - Piper Diagram

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December 2021
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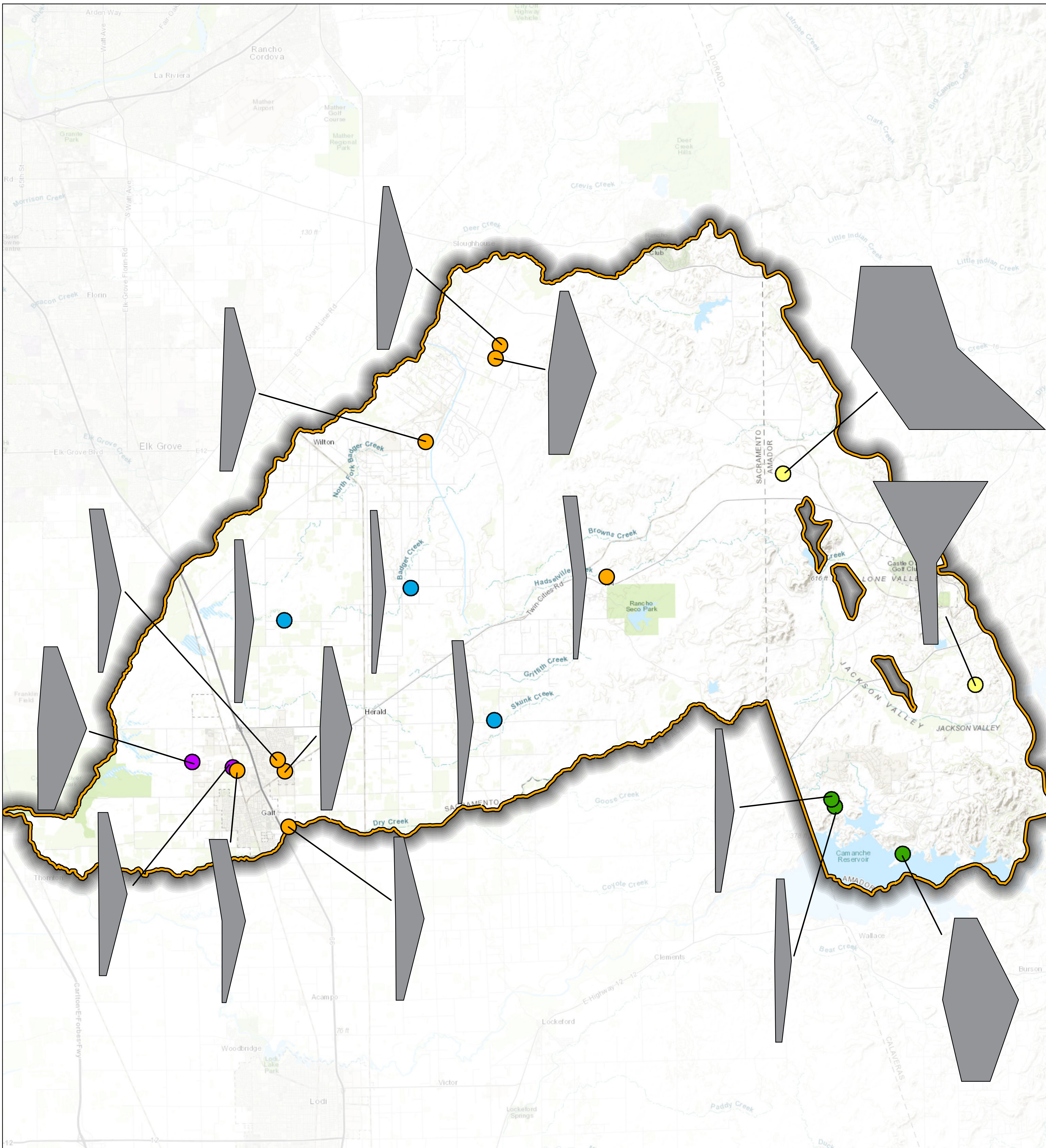
Figure HCM-11



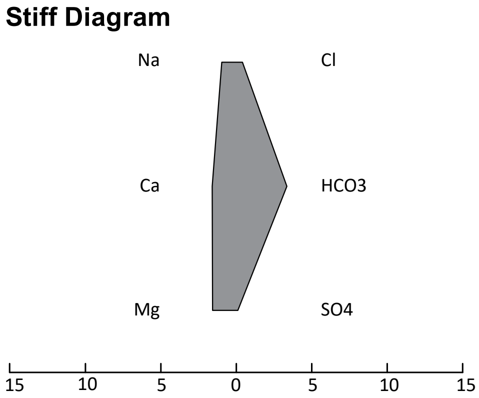
Legend

Cosumnes Subbasin (5-022.16)

Well Primarily Screened in One Formation

- Victor Formation
- Laguna Formation
- Mehrten Formation
- Valley Springs Formation
- Ione Formation

Stiff Diagram



Abbreviations

Ca = calcium
Cl = chloride
DMS = Data Management System
DWR = California Department of Water Resources
HCO_3 = bicarbonate
Mg = magnesium
Na = sodium
SO_4 = sulfate

Notes

1. All locations are approximate.
2. Stiff Diagrams plot the most recent water quality sample, collected between 1995 and 2018.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Water quality data from Cosumnes DMS.

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0 3 6
(Scale in Miles)

General Groundwater Chemistry - Stiff Diagrams

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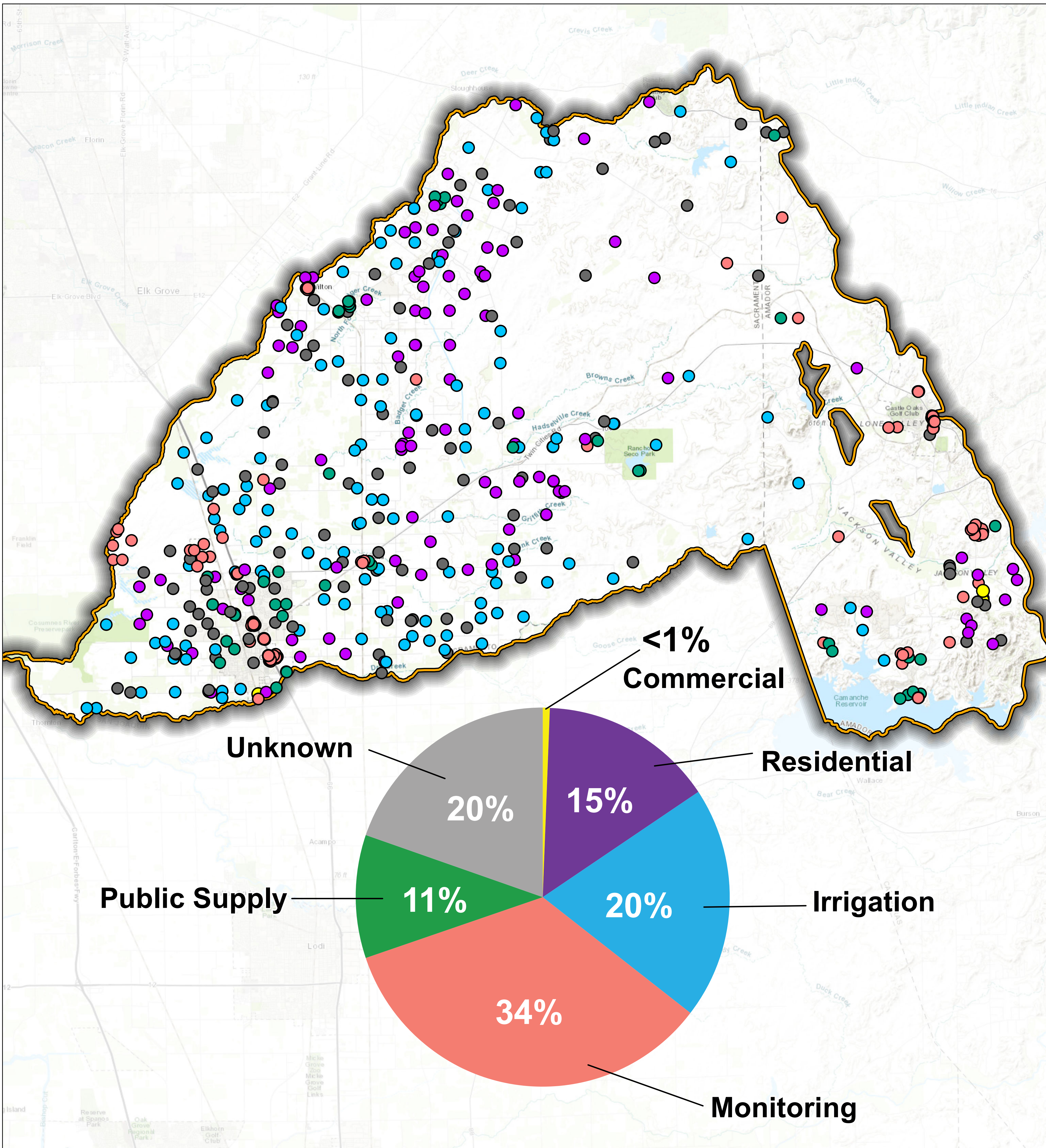
Figure HCM-12

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_HCM-12_Stiff Diagrams.mxd



Legend

Well Use

- Commercial
- Residential
- Irrigation
- Monitoring
- Public Supply
- Unknown

Cosumnes Subbasin (5-022.16)

Abbreviations
DMS = Data Management System
DWR = California Department of Water Resources

Notes
1. All locations are approximate.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Well data from Cosumnes DMS.

N 0 3 6 (Scale in Miles)

Primary Well Uses

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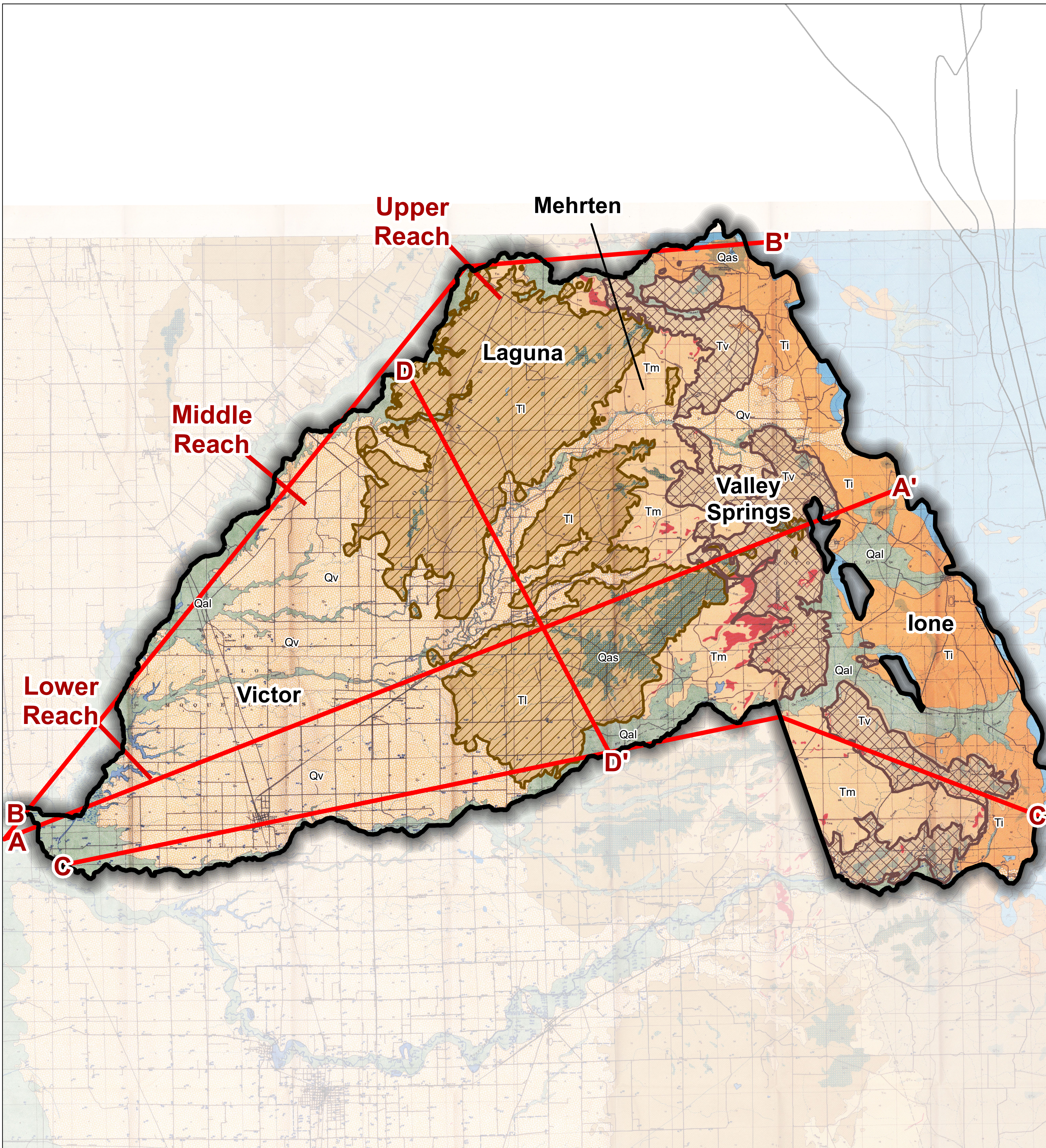
Figure HCM-13

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_HCM-13_Well Use.mxd



Legend

Cross Section Location

Fault

Cosumnes Subbasin (5-022.16)

Qal	Alluvium
Qv	Victor Formation
Qas	Arroyo Seco gravel
QTu	Gravel deposits of uncertain age
Tl	Laguna Formation
Tma Tm	Mehrten Formation
Tv	Valley Springs Formation
Ti	Ione Formation
JC	Pre-Cretaceous crystalline rocks

Abbreviations
DWR = California Department of Water Resources
USGS = United States Geological Survey

Notes
1. All locations are approximate.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Geology from:
"Geology and Ground-Water Hydrology of the Mokelumne Area, California" compiled by USGS, 1939. USGS Water-Supply Paper 780.
4. Faults from:
"Preliminary intergrated geologic map databases for the United States" Western States. Version 1.3. Updated December 2007.compiled by USGS. Open-File Report 2005-1305.

N

0 3 6
(Scale in Miles)

Surficial Geology and Cross-Section Locations

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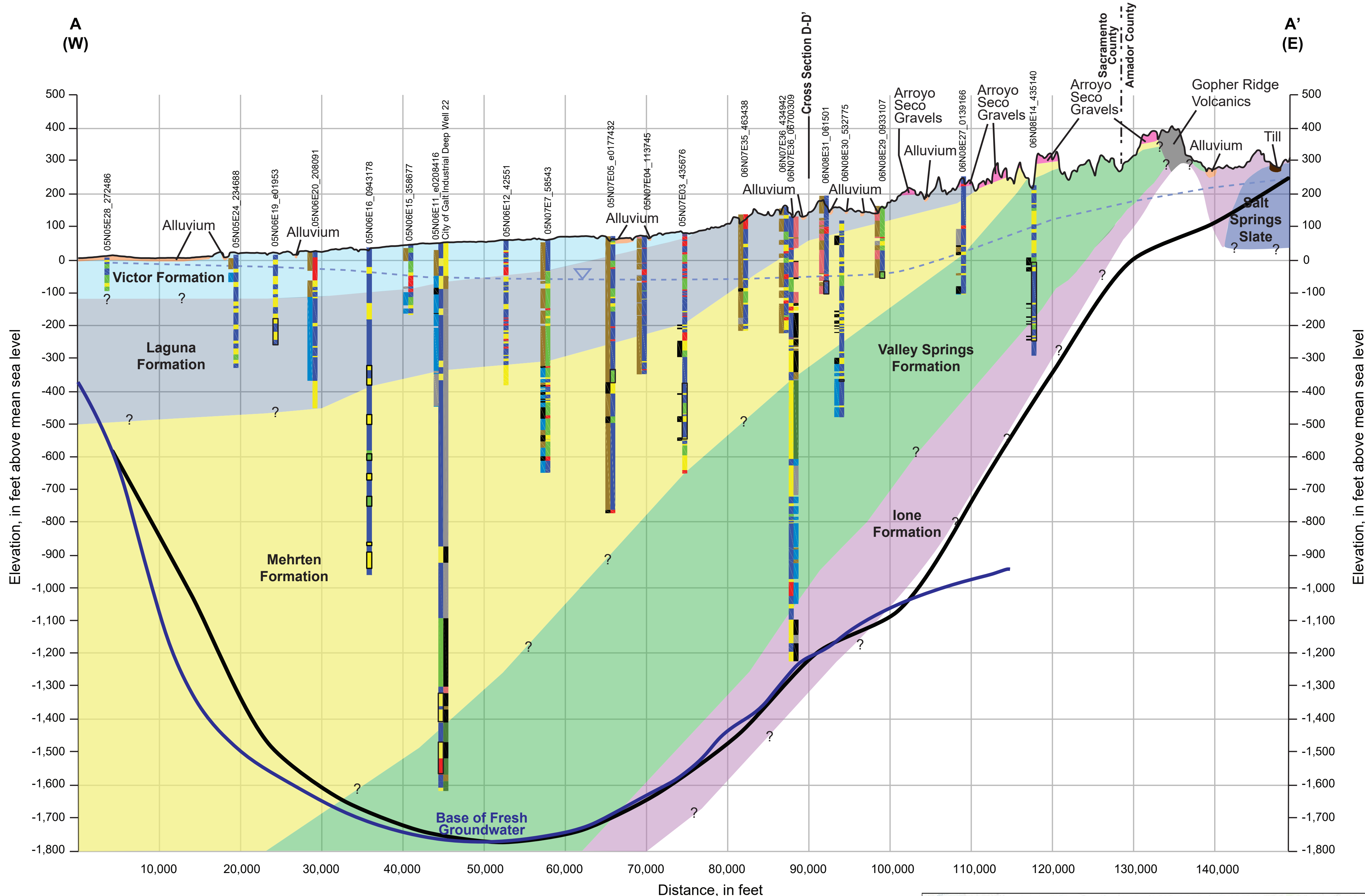
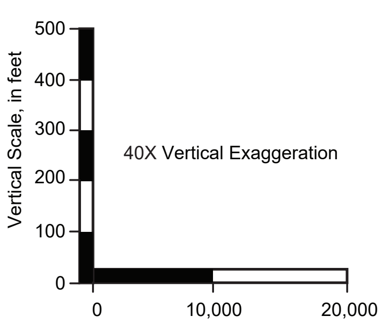
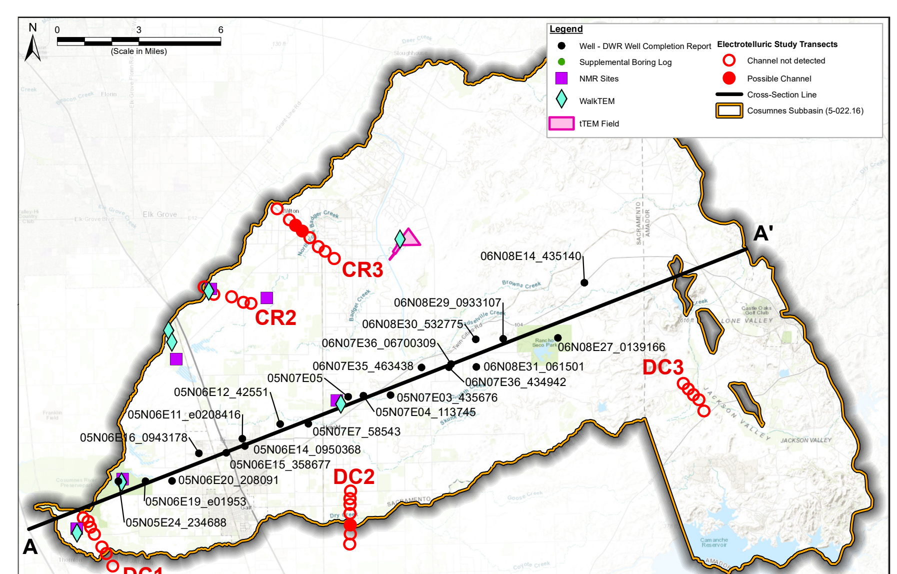
Figure HCM-14

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_HCM-14_Surficial Geology.mxd







Legend:

Wells

- Well Identification
- DWR Well Completion Report Number
- Section
- Range
- Township

06N08E14_435140

Lithology - Derived from Well Logs

Generalized Texture
- Fine-Grained Materials (i.e., clay, silt)
- Fine Sand
- Sand
- Gravel
- Volcanic
- Well Screen

Color
- Gray
- Brown/Tan
- Black
- Blue
- Red
- Green
- White
- Yellow

Selected Subsurface Geologic Units (See Note 2)

- Alluvium
- Undifferentiated Victor Formation
- Laguna Formation
- Mehrten Formation
- Valley Springs Formation
- Ione Formation
- Salt Springs Slate
- Gopher Ridge Volcanics
- Arroyo Seco Gravels
- Base of Fresh Groundwater (Berkstresser, 1973)
- Basin Bottom
- Groundwater Elevation - Fall 2018

Abbreviations:

DWR = California Department of Water Resources
USGS = United States Geological Survey

Sources:

1. USGS 10-Meter Digital Elevation Model (https://viewer.nationalmap.gov/basic/).
2. Dawson T, 2009, Preliminary Geologic Map of the Lodi 30' x 60' Quadrangle, California. California Geological Survey.
3. Holland PJ, 2016, Preliminary Geologic Map of the Irish Hill 7.5' Quadrangle, Amador County, California. Version 1.0. California Geological Survey.
4. DWR, 1974, Evaluation of Ground Water Resources: Sacramento County. Bulletin No. 118-3, July 1974 (Reprinted April 1980).
5. Piper AM, Gale HS, Thomas HE, Robinson TW, 1939, "Geology and Ground-Water Hydrology of the Mokelumne Area, California." USGS Water-Supply Paper 780.
6. Berkstresser, 1973, "Base of Fresh Ground Water in the Sacramento Valley and Sacramento-San Joaquin Delta, California." USGS WRI 40-73.
7. Page RW, 1974, Base and thickness of the post-Eocene continental deposits in the Sacramento Valley, California, USGS WRI 45-73.
8. Chapman RH and Bishop CC, 1975, Geophysical Investigations in the Ione Area, Amador, Sacramento, and Calaveras Counties, California, California Division of Mines and Geology Special Report 117.

Notes:

1. Well identification based on Public Land Survey System.
2. Subsurface geologic units based on DWR (1974) cross-section F-F', surficial geologic maps (Dawson, 2009; Holland, 2016; Piper and others, 1939), contours representing the top of Ione Formation (Page 1974), contours representing the top of basement bedrock (Chapman and Bishop, 1975), and informed by lithology derived from DWR Well Completion Report records. Contacts are queried where uncertain.
3. Wells shown on cross-section are located within 1 mile of cross-section line.
4. Groundwater elevation is based on groundwater elevation contours for Fall 2018, as mapped on Figure GWC-2.
5. Basin bottom is based on depth to bottom of the Basin as mapped on Figure HCM-3.

Geologic Cross-Section A - A'

Working Group
Cosumnes Subbasin
December 2021
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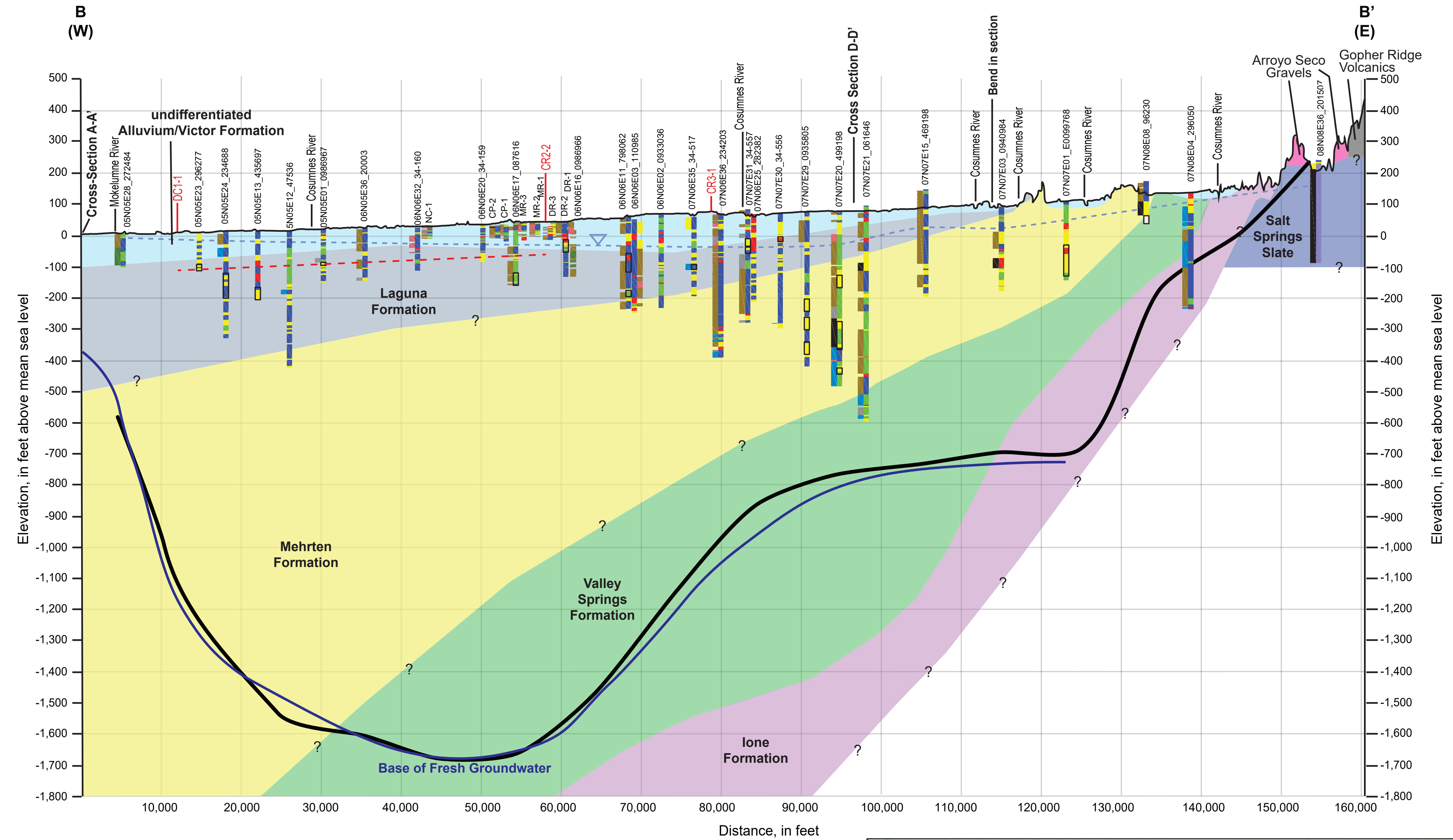
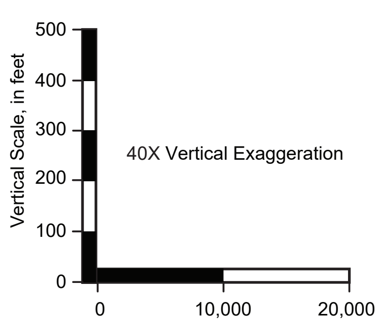
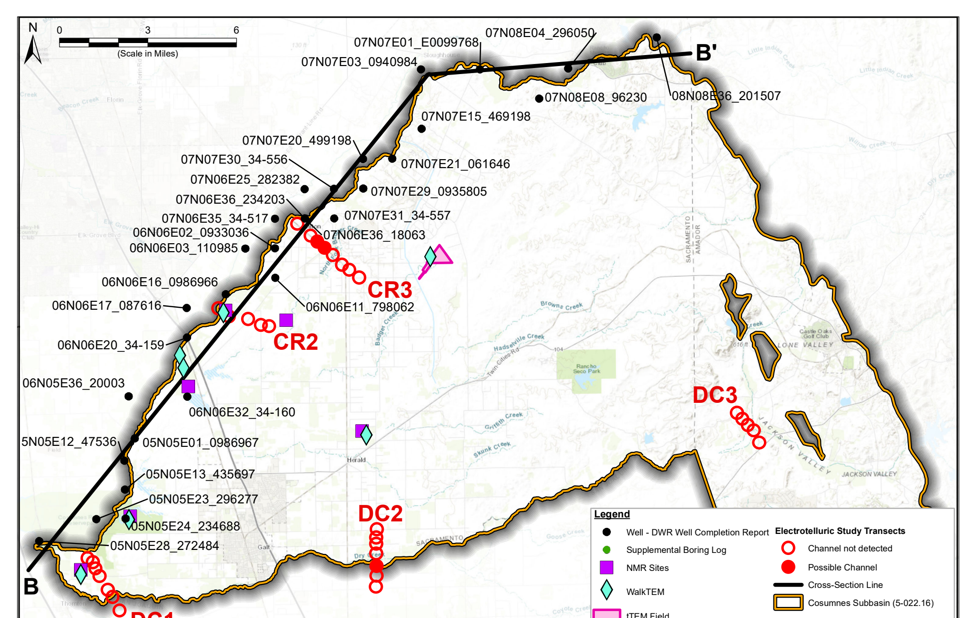
Figure HCM-15







Legend:

Wells

- Well Identification
- DWR Well Completion Report Number
- Section
- Range
- Township

(07N07E15_469198)

Other

CR3-1 Electrotelluric Survey Transect Identification

Lithology - Derived from Well Logs

Generalized Texture

- Fine-Grained Materials (i.e., clay, silt)
- Fine sand
- Sand
- Gravel
- Volcanic
- Slate
- Well Screen

Color

- Gray
- Brown/Tan
- Black
- Blue
- Red
- Green
- White
- Yellow

Selected Subsurface Geologic Units (See Note 2)

- Undifferentiated Alluvium/Victor Formation
- Laguna Formation
- Mehrten Formation
- Valley Springs Formation
- Ione Formation
- Salt Springs Slate
- Gopher Ridge Volcanics
- Arroyo Seco Gravels
- Base of Fresh Groundwater (Berkstresser, 1973)
- Top of Clay Interval inferred from Electrotelluric Survey (ETS, See Note 4)
- Basin Bottom
- Groundwater Elevation - Fall 2018

Abbreviations:

DWR = California Department of Water Resources
USGS = United States Geological Survey

Sources:

1. USGS 10-Meter Digital Elevation Model (https://viewer.nationalmap.gov/basic/).
2. Dawson T, 2009, Preliminary Geologic Map of the Lodi 30' x 60' Quadrangle, California. California Geological Survey.
3. Holland PJ, 2016, Preliminary Geologic Map of the Irish Hill 7.5' Quadrangle, Amador County, California. Version 1.0. California Geological Survey.
4. DWR, 1974, Evaluation of Ground Water Resources: Sacramento County. Bulletin No. 118-3, July 1974 (Reprinted April 1980).
5. Piper AM, Gale HS, Thomas HE, Robinson TW, 1939, "Geology and Ground-Water Hydrology of the Mokelumne Area, California." USGS Water-Supply Paper 780.
6. Berkstresser, 1973, "Base of Fresh Ground Water in the Sacramento Valley and Sacramento-San Joaquin Delta, California." USGS WRI 40-73.
7. Page RW, 1974, Base and thickness of the post-Eocene continental deposits in the Sacramento Valley, California, USGS WRI 45-73.
8. Chapman RH and Bishop CC, 1975, Geophysical Investigations in the Ione Area, Amador, Sacramento, and Calaveras Counties, California, California Division of Mines and Geology Special Report 117.
9. Meirovitz CD, 2010, Influence of American River Incised Valley Fill on Sacramento County Hydrogeology. Master's Thesis. University of California, Davis.
10. Geoconsultants, Inc., 2020, Hydrogeologic Study using Electrotelluric Transects Cosumnes Groundwater Subbasin Sacramento, San Joaquin, and Amador Counties, California.

Notes:

1. Well identification based on Public Land Survey System.
2. Subsurface geologic units based on DWR (1974) cross-section intersections, surficial geologic maps (Dawson, 2009; Holland, 2016; Piper and others, 1939), contours representing the top of Ione Formation (Page 1974), contours representing the top of basement bedrock (Chapman and Bishop, 1975), and informed by lithology derived from DWR Well Completion Report records. Contacts are queried where uncertain.
3. Wells shown on cross-section are located within 1 mile of cross-section line.
4. Electrotelluric Survey (Geoconsultants, Inc., 2020) is included as Appendix I.
5. Groundwater elevation is based on groundwater elevation contours for Fall 2018, as mapped on Figure GWC-2.
6. Basin bottom is based on depth to bottom of the Basin as mapped on Figure HCM-3.

Geologic Cross-Section B - B'

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Cosumnes Subbasin
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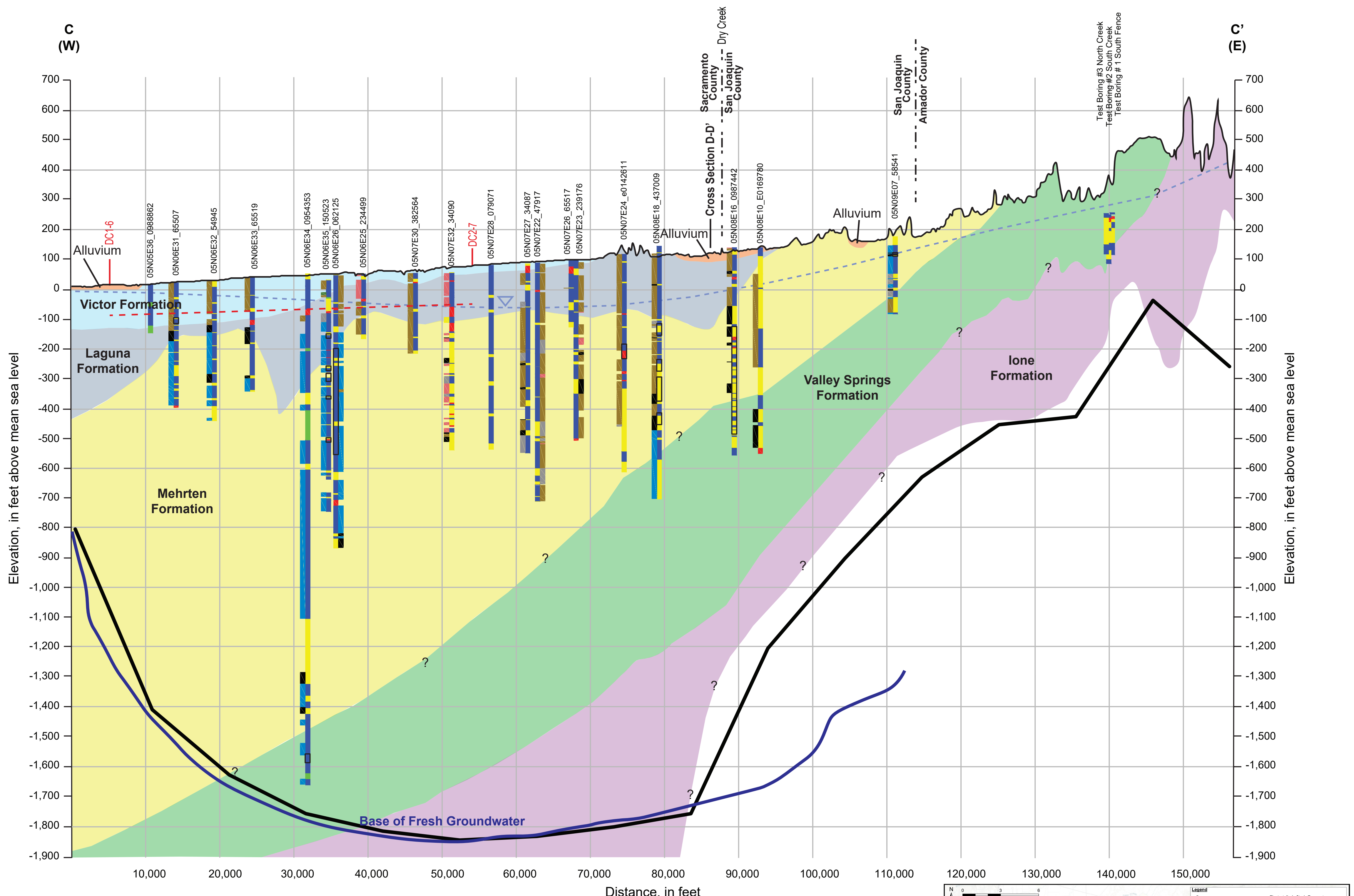
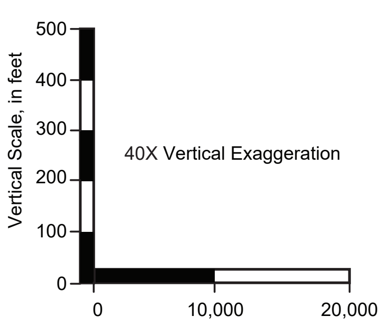
Figure HCM-16





Legend:

Wells

- Well Identification
- DWR Well Completion Report Number
- Section
- Range
- Township

(Example: 05N07E30_382564)

Other

DC1-6 Electrotelluric Survey Transect Identification

Lithology - Derived from Well Logs

Generalized Texture

- Fine-Grained Materials (i.e., clay, silt)
- Fine Sand
- Sand
- Gravel
- Volcanic
- Well Screen

Color

- Gray
- Brown/Tan
- Black
- Blue
- Red
- Green
- White
- Yellow

Selected Subsurface Geologic Units (See Note 2)

- Alluvium
- Undifferentiated Victor Formation
- Laguna Formation
- Mehrten Formation
- Valley Springs Formation
- Ione Formation
- Arroyo Seco Gravels
- Base of Fresh Groundwater (Berkstresser, 1973)
- Basin Bottom
- Groundwater Elevation - Fall 2018

Abbreviations:

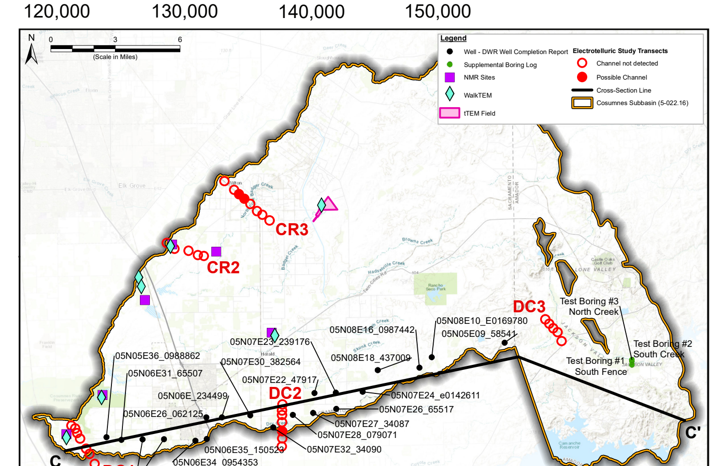
DWR = California Department of Water Resources
USGS = United States Geological Survey

Sources:

1. USGS 10-Meter Digital Elevation Model (https://viewer.nationalmap.gov/basic/).
2. Dawson T, 2009, Preliminary Geologic Map of the Lodi 30' x 60' Quadrangle, California. California Geological Survey.
3. Holland PJ, 2016, Preliminary Geologic Map of the Irish Hill 7.5' Quadrangle, Amador County, California. Version 1.0. California Geological Survey.
4. DWR, 1974, Evaluation of Ground Water Resources: Sacramento County. Bulletin No. 118-3, July 1974 (Reprinted April 1980).
5. Piper AM, Gale HS, Thomas HE, Robinson TW, 1939, "Geology and Ground-Water Hydrology of the Mokelumne Area, California." USGS Water-Supply Paper 780.
6. Berkstresser, 1973, "Base of Fresh Ground Water in the Sacramento Valley and Sacramento-San Joaquin Delta, California." USGS WRI 40-73.
7. Page RW, 1974, Base and thickness of the post-Eocene continental deposits in the Sacramento Valley, California, USGS WRI 45-73.
8. Chapman RH and Bishop CC, 1975, Geophysical Investigations in the Ione Area, Amador, Sacramento, and Calaveras Counties, California, California Division of Mines and Geology Special Report 117.
9. Geoconsultants, Inc., 2020, Hydrogeologic Study using Electrotelluric Transects Cosumnes Groundwater Subbasin Sacramento, San Joaquin, and Amador Counties, California.

Notes:

1. Well identification based on Public Land Survey System.
2. Subsurface geologic units based on DWR (1974) cross-section intersections, surficial geologic maps (Dawson, 2009; Holland, 2016; Piper and others, 1939), contours representing the top of Ione Formation (Page 1974), contours representing the top of basement bedrock (Chapman and Bishop, 1975), and informed by lithology derived from DWR Well Completion Report records. Contacts are queried where uncertain.
3. Wells shown on cross-section are located within 1 mile of cross-section line; supplemental boring logs are located within 2 miles of cross-section line.
4. Electrotelluric Survey (Geoconsultants, Inc., 2020) is included as Appendix I.
5. Groundwater elevation is based on groiundwater elevation contours for Fall 2018, as mapped on Figure GWC-2.
6. Basin bottom is based on depth to bottom of the Basin as mapped in Figure HCM-3.



Geologic Cross-Section C - C'

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Cosumnes Subbasin
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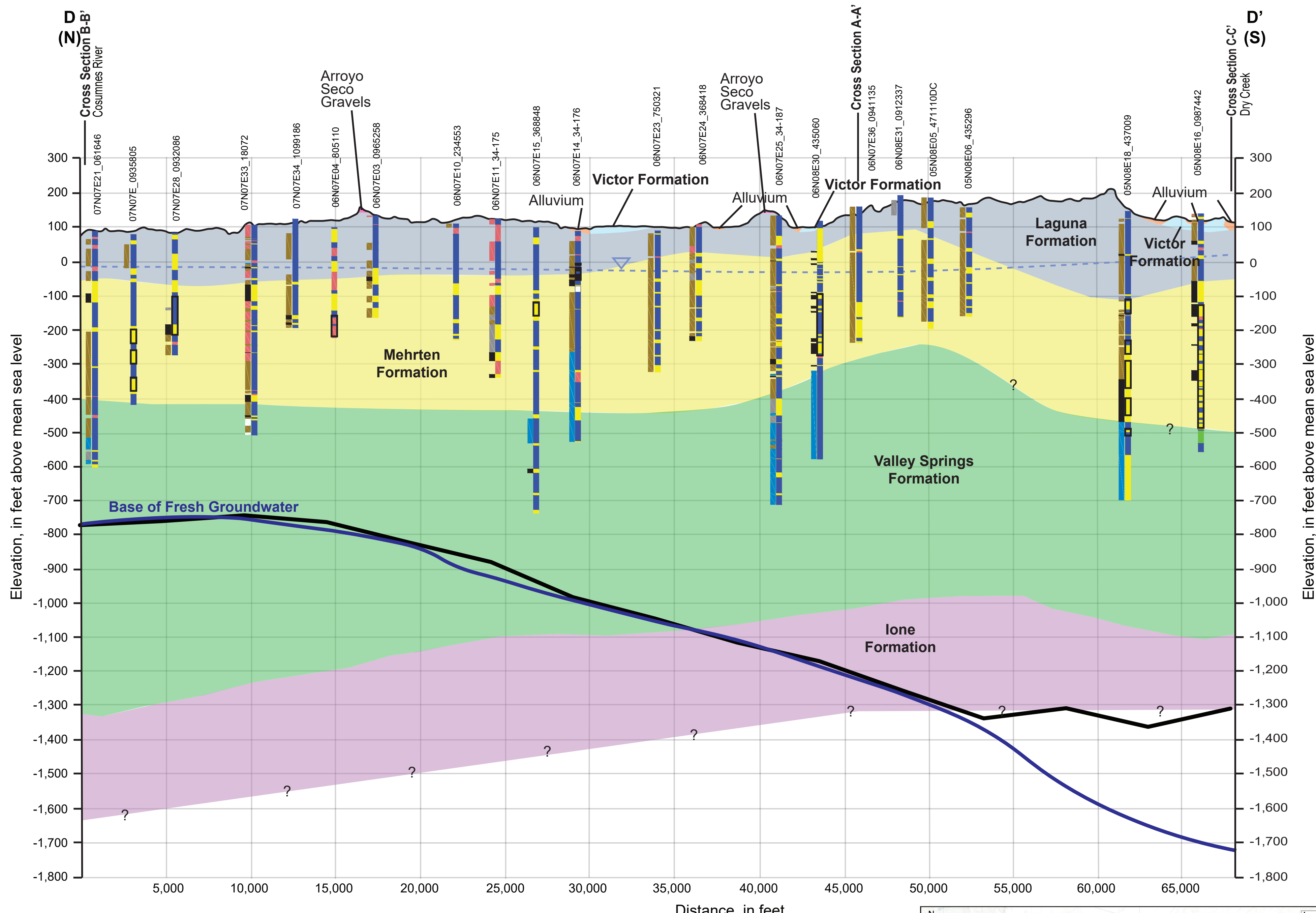
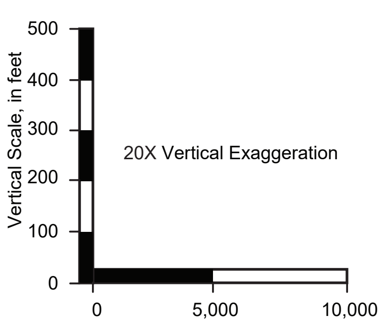
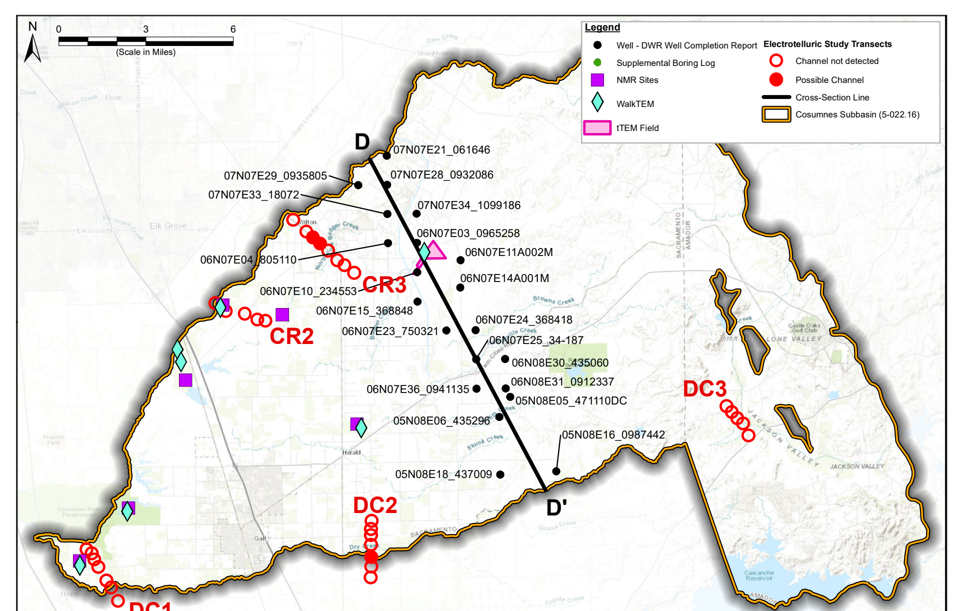
Figure HCM-17







Legend:

Wells

06N08E14_435140
- Well Identification
- DWR Well Completion Report Number
- Section
- Range
- Township

Lithology - Derived from Well Logs

Generalized Texture
- Fine-Grained Materials (i.e., clay, silt)
- Fine Sand
- Sand
- Gravel
- Volcanic
- Well Screen

Color
- Gray
- Brown/Tan
- Black
- Blue
- Red
- Green
- White
- Yellow

Selected Subsurface Geologic Units (See Note 2)
- Alluvium
- Undifferentiated Victor Formation
- Laguna Formation
- Mehrten Formation
- Valley Springs Formation
- Ione Formation
- Arroyo Seco Gravels
- Base of Fresh Groundwater (Berkstresser, 1973)
- Basin Bottom
- Groundwater Elevation - Fall 2018

Abbreviations:

DWR = California Department of Water Resources
USGS = United States Geological Survey

Sources:

1. USGS 10-Meter Digital Elevation Model (https://viewer.nationalmap.gov/basic/).
2. Dawson T, 2009, Preliminary Geologic Map of the Lodi 30' x 60' Quadrangle, California. California Geological Survey.
3. Holland PJ, 2016, Preliminary Geologic Map of the Irish Hill 7.5' Quadrangle, Amador County, California. Version 1.0. California Geological Survey.
4. DWR, 1974, Evaluation of Ground Water Resources: Sacramento County. Bulletin No. 118-3, July 1974 (Reprinted April 1980).
5. Piper AM, Gale HS, Thomas HE, Robinson TW, 1939, "Geology and Ground-Water Hydrology of the Mokelumne Area, California." USGS Water-Supply Paper 780.
6. Berkstresser, 1973, "Base of Fresh Ground Water in the Sacramento Valley and Sacramento-San Joaquin Delta, California." USGS WRI 40-73.
7. Page RW, 1974, Base and thickness of the post-Eocene continental deposits in the Sacramento Valley, California, USGS WRI 45-73.
8. Chapman RH and Bishop CC, 1975, Geophysical Investigations in the Ione Area, Amador, Sacramento, and Calaveras Counties, California, California Division of Mines and Geology Special Report 117.

Notes:

1. Well identification based on Public Land Survey System.
2. Subsurface geologic units based on DWR (1974) cross-section G-G', surficial geologic maps (Dawson, 2009; Holland, 2016; Piper and others, 1939), contours representing the top of Ione Formation (Page 1974), and informed by lithology derived from DWR Well Completion Report records. Contacts are queried where uncertain.
3. Wells shown on cross-section are located within 1 mile of cross-section line.
4. Groundwater elevation is based on groundwater elevation contours for Fall 2018, as mapped on Figure GWC-2.
5. Basin bottom is based on depth to bottom of the Basin as mapped on Figure HCM-3.

Geologic Cross-Section D - D'

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Cosumnes Subbasin
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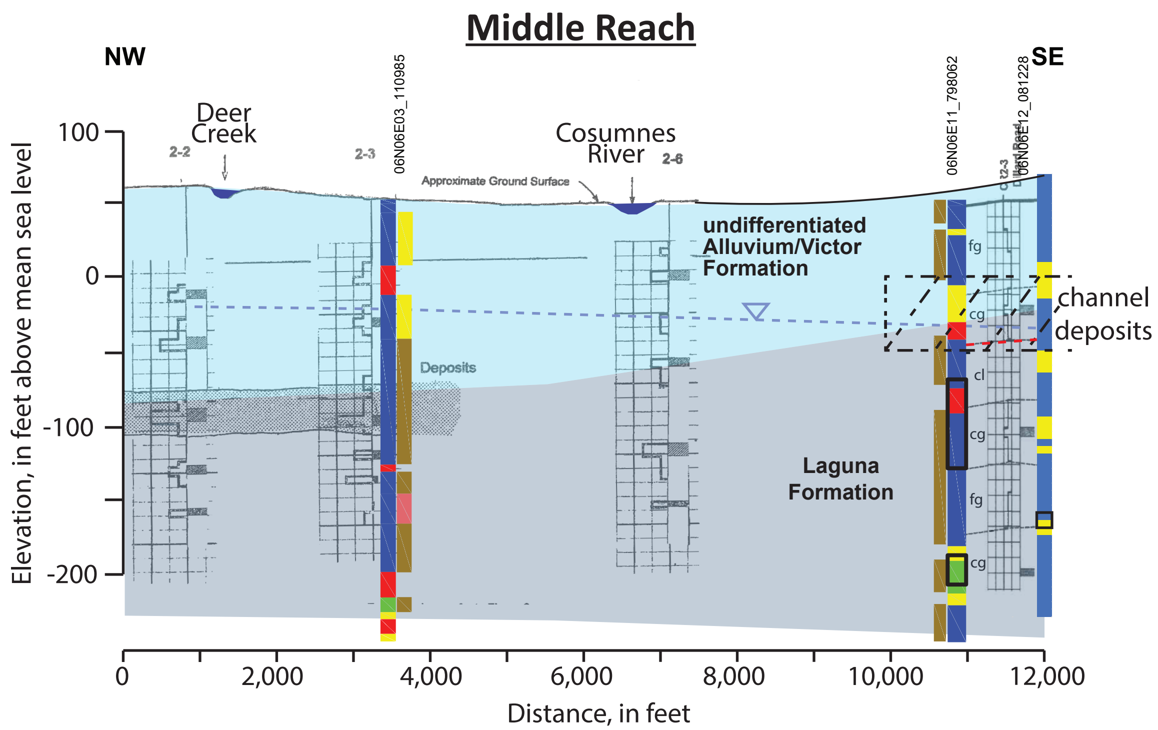
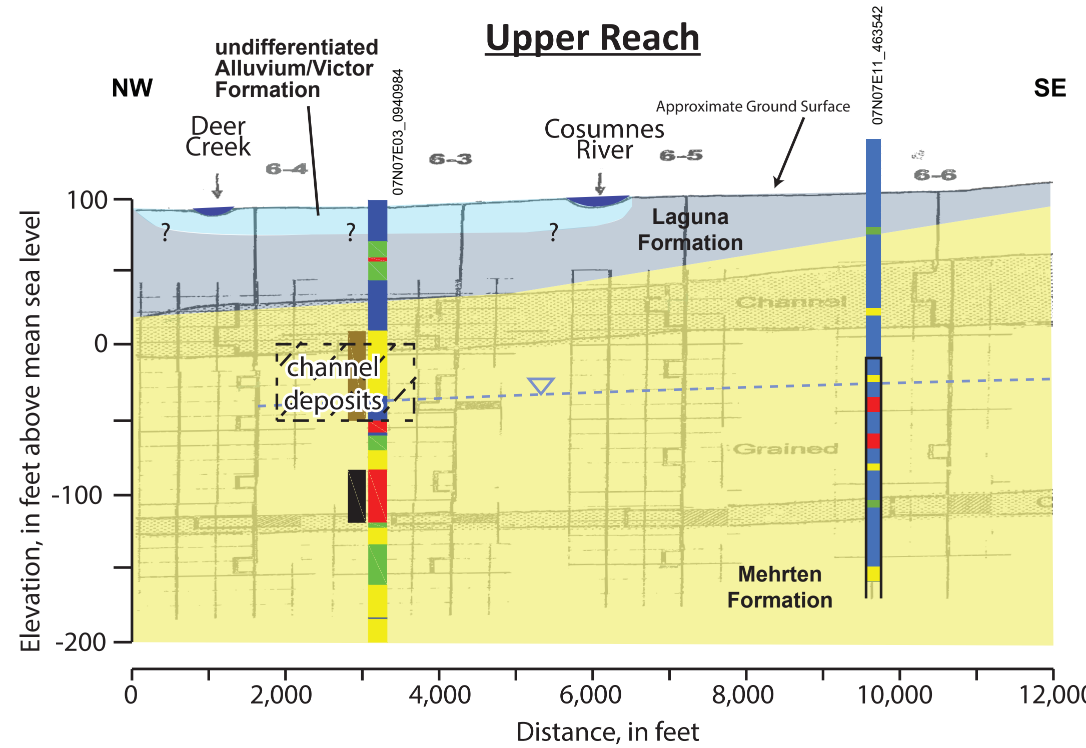
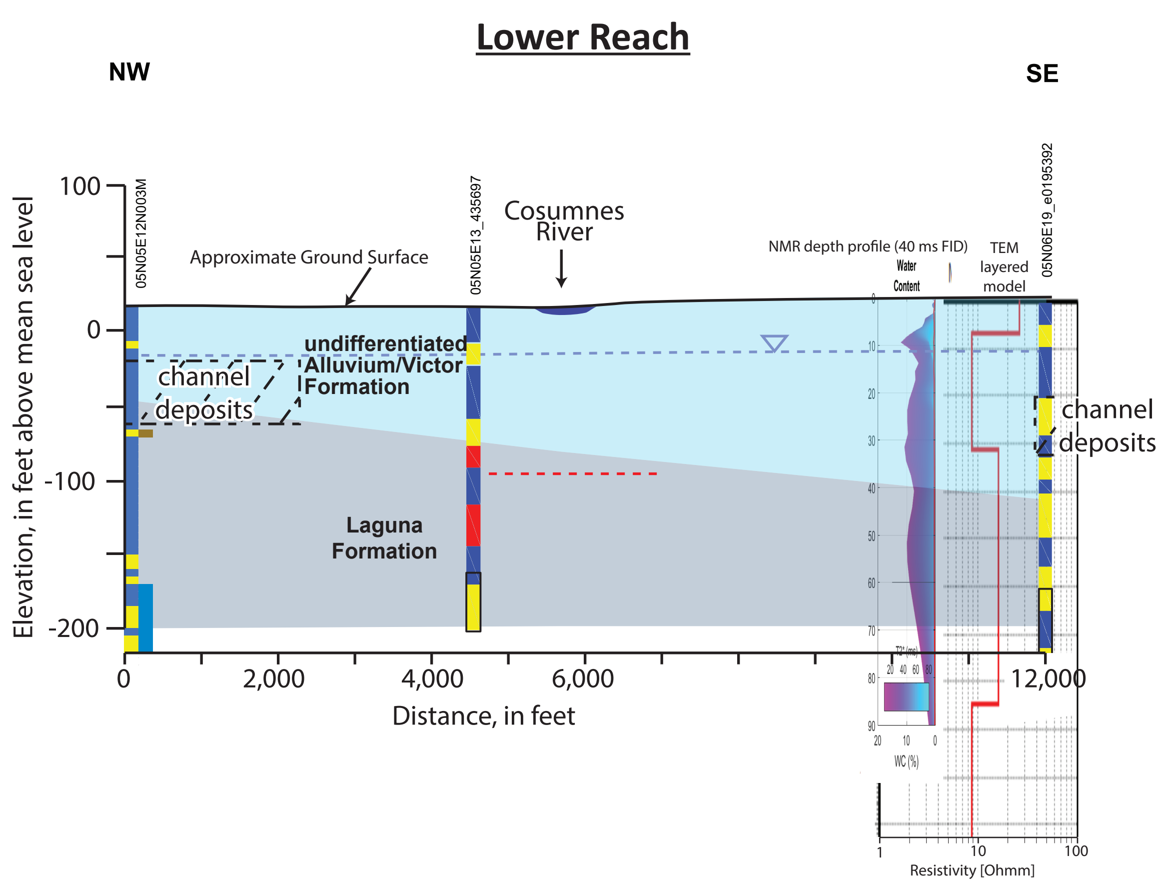
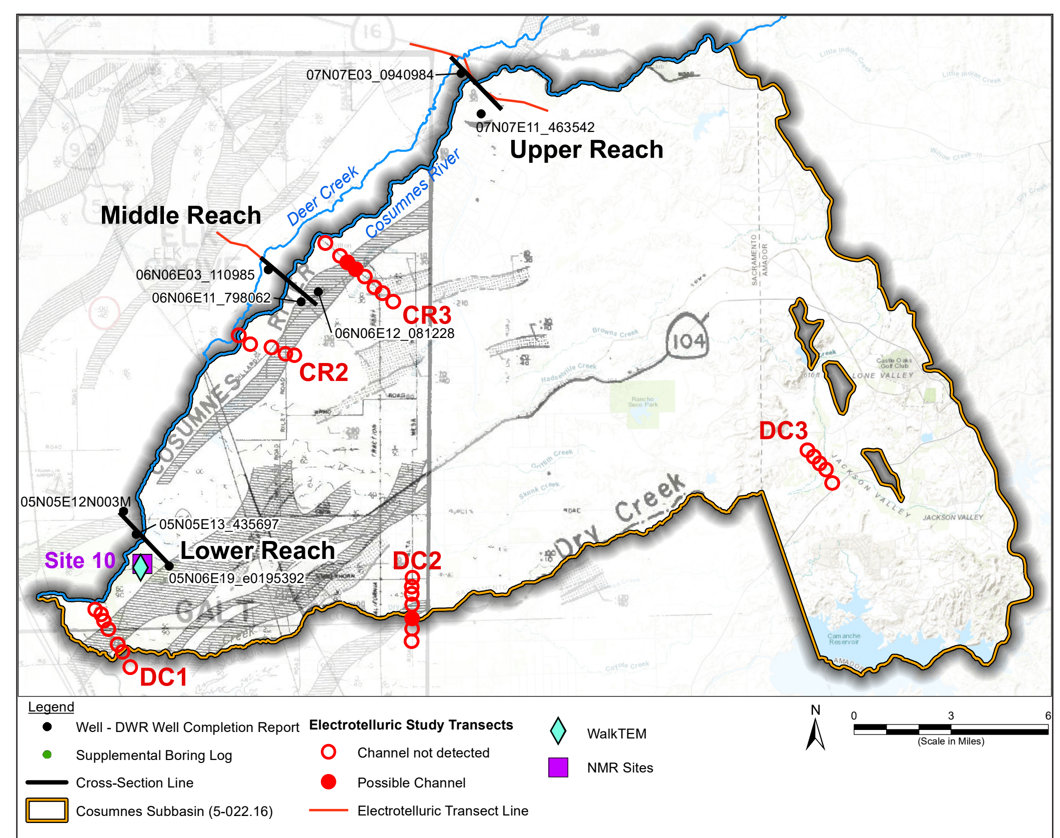
Figure HCM-18









Legend:

Wells

Well Identification
DWR Well Completion Report Number
Section
Range
Township

Lithology - Derived from Well Logs

Generalized Texture
- Fine-Grained Materials (i.e., clay, silt)
- Fine Sand
- Sand
- Gravel
- Well Screen

Color
- Brown/Tan
- Black
- Blue
- Red
- Yellow

Selected Subsurface Geologic Units (See Note 6)
- Undifferentiated Alluvium/Victor Formation
- Laguna Formation
- Mehrten Formation
- Groundwater Elevation - Fall 2018
- Top of Clay Interval inferred from Electrotelluric Survey (ETS, See Note 3)

Abbreviations:

DWR = California Department of Water Resources
NMR = Nuclear Magnetic Resonance
TEM = Transient Electro Magnetics
USGS = United States Geological Survey

Sources:

1. USGS 10-Meter Digital Elevation Model (https://viewer.nationalmap.gov/basic/).
2. Geoconsultants, Inc., 2016, Geological and Geophysical Survey for Proposed Basin Boundary Adjustment Sloughhouse Resource Conservation District Sacramento County, California. Prepared for Jay Schneider Vice-Chairman Sloughhouse Resource Conservation District, dated March 2016.
3. DWR, 1974, Evaluation of Ground Water Resources: Sacramento County. Bulletin No. 118-3, July 1974 (Reprinted April 1980).
4. Piper AM, Gale HS, Thomas HE, Robinson TW, 1939, "Geology and Ground-Water Hydrology of the Mokelumne Area, California." USGS Water-Supply Paper 780.
5. Dawson T, 2009, Preliminary Geologic Map of the Lodi 30' x 60' Quadrangle, California. California Geological Survey.
6. Geoconsultants, Inc., 2020, Hydrogeologic Study using Electrotelluric Transects Cosumnes Groundwater Subbasin Sacramento, San Joaquin, and Amador Counties, California.
7. Vista Clara Inc., 2021, Surface NMR Survey Cosumnes River Basin.
8. Ramboll, 2021, TEM Geophysical Investigations Cosumnes tTEM & WalkTEM Surveys.

Notes:

1. Middle reach cross section falls along Electrotelluric Transect 2 (Geoconsultants, Inc., 2016). Electrotelluric Survey Transect CR2-3 (Geoconsultants, Inc., 2020) is projected onto middle reach cross section.
2. Upper reach cross section falls along Electrotelluric Transect 6 (Geoconsultants, Inc., 2016).
3. Groundwater elevation is based on depth to groundwater contours for Fall 2018, as mapped on Figure GWC-4.
4. Channel deposit extents and approximate elevations inferred from Figure 3 and Figure 5 in DWR, 1974.
5. Well identification based on Public Land Survey System.
6. Subsurface geologic units based on DWR (1974) cross-section intersections, surficial geologic maps (Dawson, 2009; Piper and others, 1939), and informed by lithology derived from DWR Well Completion Report records. Contacts are queried where uncertain.
7. Electrotelluric Survey (Geoconsultants, Inc., 2020), NMR (Vista Clara Inc., 2021), and WalkTEM (Ramboll, 2021) are included as Appendix I.

Cosumnes River Focused Cross Sections

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Cosumnes Subbasin
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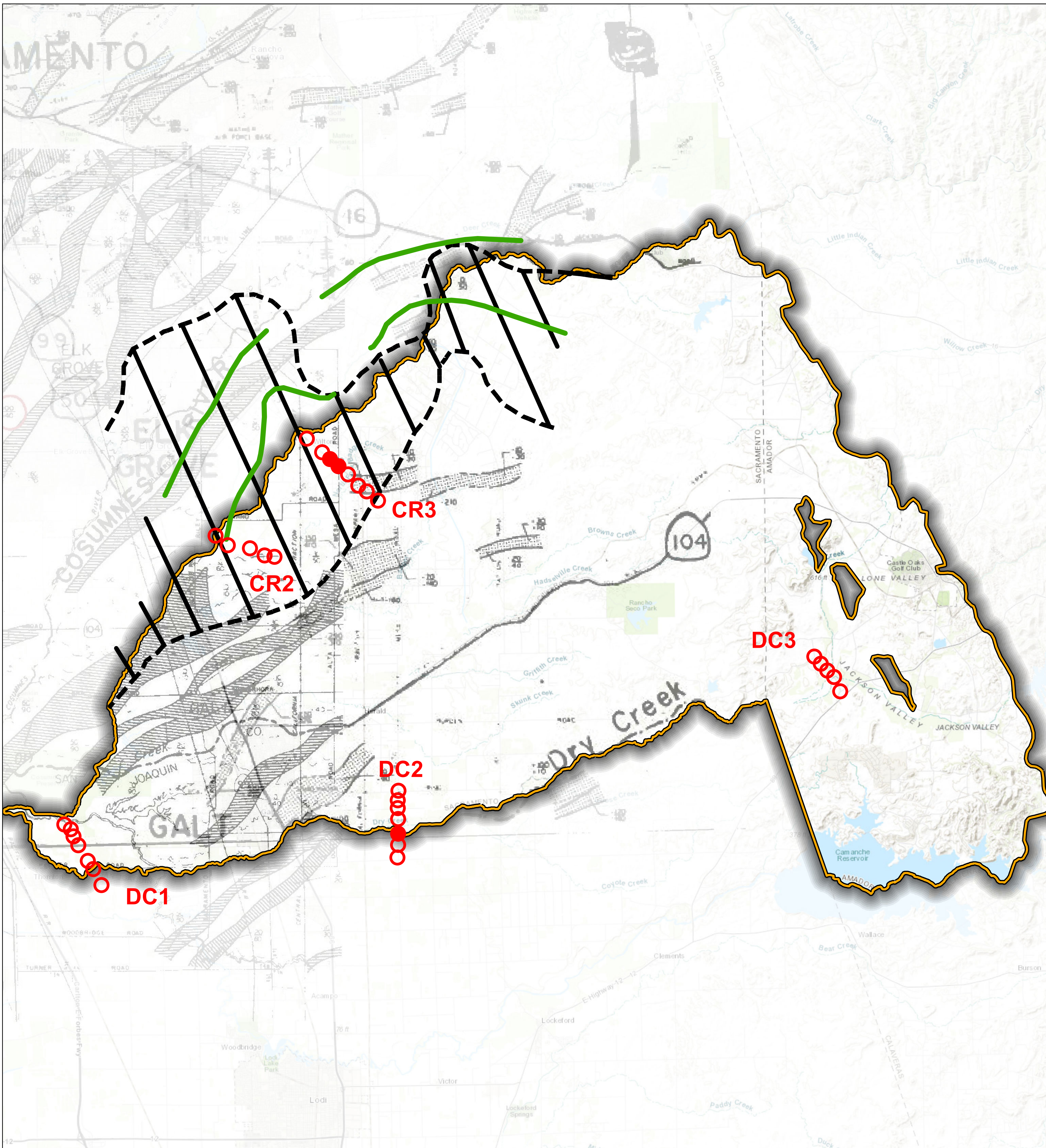
Figure HCM-19



Legend
Electrotelluric Study Transects

- Channel not detected
- Possible Channel
- Subsurface Channel Deposits
- Inferred Extent of Cosumnes River Recharge
- Cosumnes Subbasin (5-022.16)

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Channel deposits inferred from DWR, 1974, Evaluation of Ground Water Resources: Sacramento County. Bulletin No. 118-3, July 1974 (Reprinted April 1980).
4. Subsurface Channel Deposits from Geoconsultants, Inc. 2016, Geological and Geophysical Survey for Proposed Basin Boundary Adjustment Sloughhouse Resource Conservation District, Sacramento, California.
5. Electrotelluric Transects from Geoconsultants, Inc., 2020, Hydrogeologic Study using Electrotelluric Transects Cosumnes Groundwater Subbasin Sacramento, San Joaquin, and Amador Counties, California.
6. Inferred Extent of Cosumnes River Recharge from Figure 5 of EKI Environment and Water, Inc. 2021, Isotopic Recharge Study, Cosumnes Subbasin included as Appendix J.

N
0 3 6
(Scale in Miles)

Abbreviations
DWR = California Department of Water Resources
ft bgs = feet below ground surface

Notes
1. All locations are approximate.

Channel Deposits

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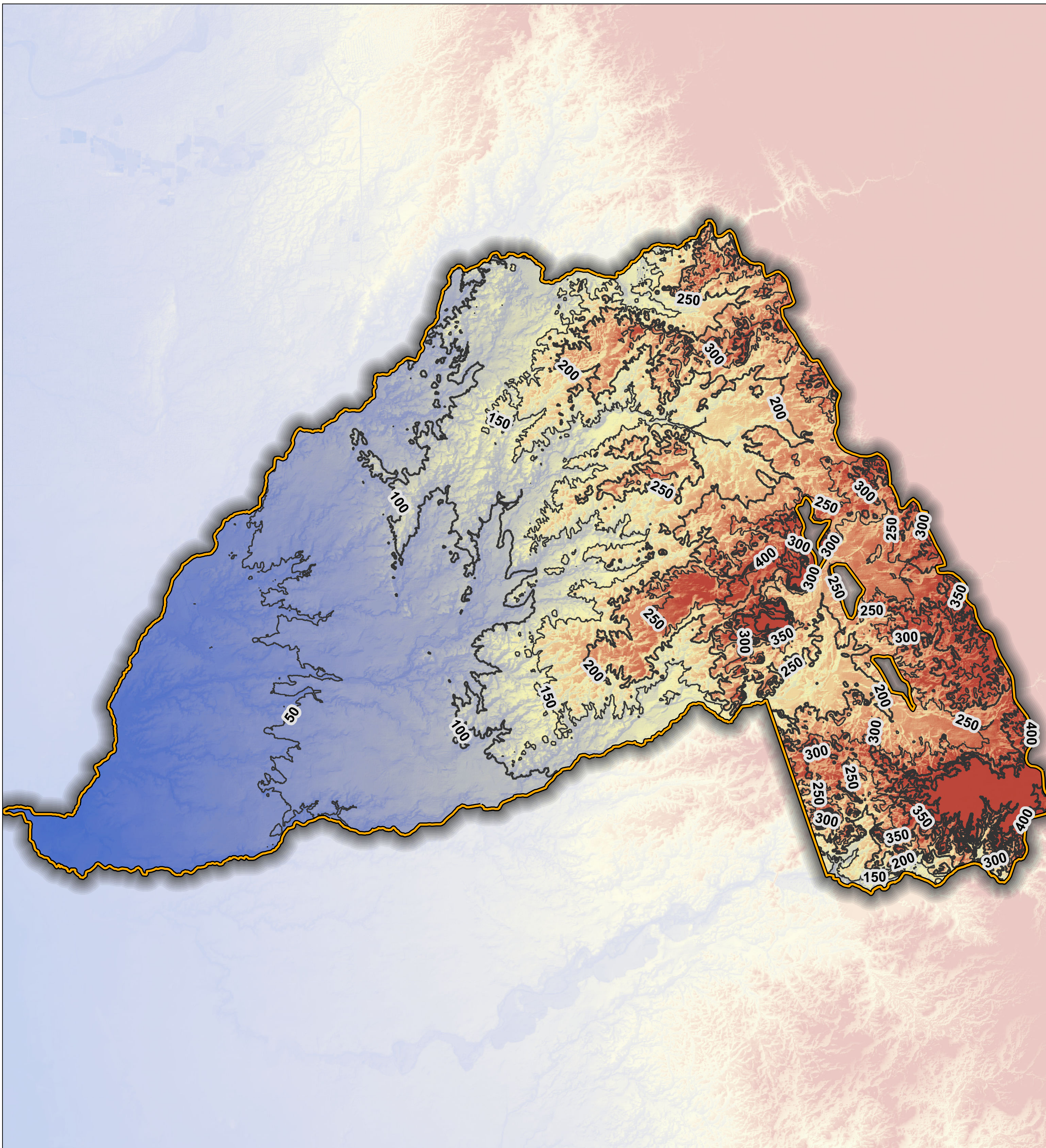
Figure HCM-20

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_HCM-20_Channel_Deposits.mxd



Legend

Cosumnes Subbasin (5-022.16)

Land Surface Elevation (ft MSL)

Land Surface Elevation (ft MSL)

High : 400

Low : 0

Abbreviations

DWR = California Department of Water Resources
ft MSL = feet above mean sea level
NED = National Elevation Dataset
USGS = United States Geological Survey

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Land surface elevation data obtained from USGS NED (https://viewer.nationalmap.gov/basic/).

N

0 3 6

(Scale in Miles)

Topography

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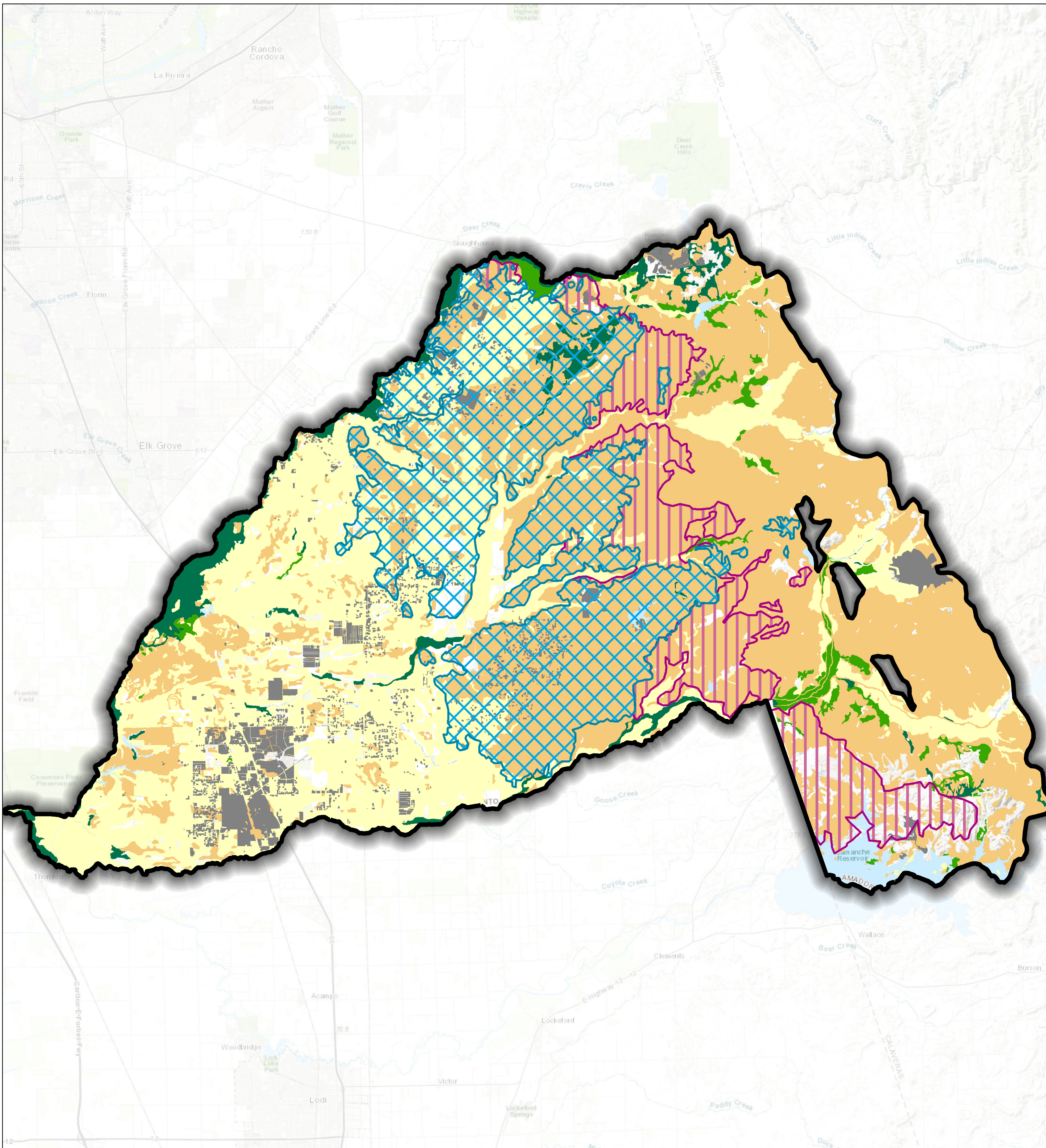
Figure HCM-21

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_HCM-21_Topography.mxd



Legend

- Cosumnes Subbasin (5-022.16)
- Exposed Laguna
- Exposed Mehrten
- Urban Area/No Recharge

Hydrologic Soil Group

- A: Low runoff, highest infiltration
- B: Moderately low runoff, high infiltration
- C: Moderately high runoff, low infiltration
- D: High runoff, lowest infiltration
- Not Identified

Abbreviations

DWR = California Department of Water Resources
USDA SCS = United States Department of Agriculture Soil Conservation Service
USGS = United States Geological Survey

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.
3. Soil data from:
   Soil Survey of Sacramento County, California, USDA SCS, April 1993
   Soil Survey, Amador Area, USDA SCS, September 1965.
4. Geology data from:
   "Geology and Ground-Water Hydrology of the Mokelumne Area, California" compiled by USGS, 1939. USGS Water-Supply Paper 780.

N

0 3 6

(Scale in Miles)

Soil Characteristics and Recharge Areas

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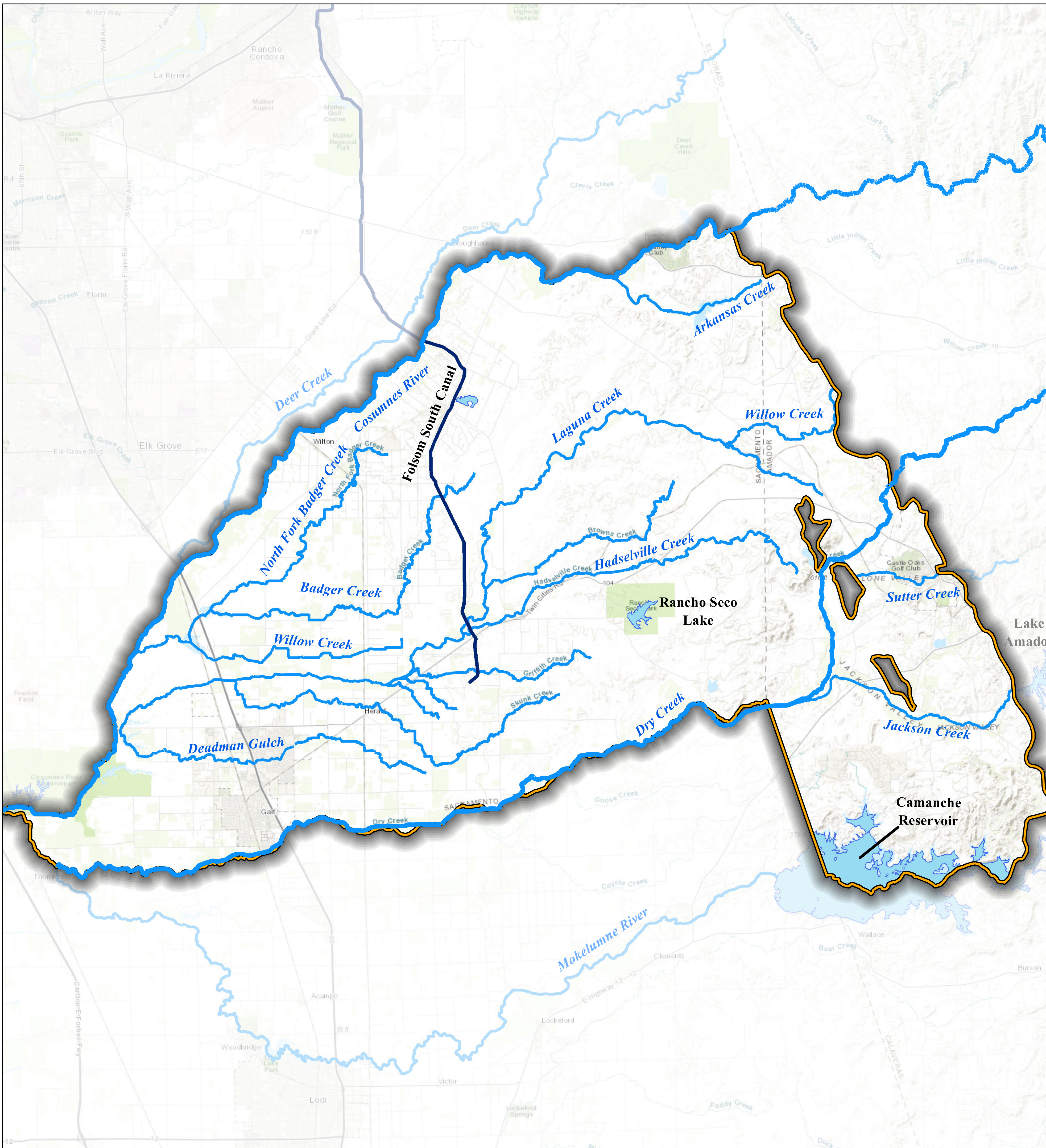
Figure HCM-22

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_HCM-22_Soil and Recharge areas.mxd



Legend

- Major Stream
- Folsom South Canal
- Reservoir
- Cosumnes Subbasin

Abbreviations

DWR = California Department of Water Resources

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.

N 0 3 6 (Scale in Miles)

Major Surface Water Bodies

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Figure HCM-23

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_HCM-23_Surface Water Bodies.mxd

9. CURRENT AND HISTORICAL GROUNDWATER CONDITIONS

> *§ 354.16. Groundwater Conditions*
> *Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes the following:*

This section presents information on historical and current groundwater conditions within the Cosumnes Subbasin (Basin) based on data in the Data Management System (DMS). For the purpose of this assessment, "current conditions" refers to conditions in calendar year 2018. For historical conditions, the available data for the last 20 years (i.e., 1999 through 2018) have been examined, including data over the January 2015 to 2018 time period.

9.1. Groundwater Elevations and Flow Direction

> *§ 354.16. Groundwater Conditions*
> *(a) Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:*
> *(1) Groundwater elevation contour maps depicting the groundwater table or potentiometric surface associated with the current seasonal high and seasonal low for each principal aquifer within the basin.*
> *(2) Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.*

For the purposes of this analysis, the periods of Spring and Fall 2018 are used to represent seasonal high and low conditions under current land and water use conditions. Representative Spring and Fall ranges were determined by examining long-term hydrographs and identifying the time periods during which the highest and lowest water level measurements were collected. The Spring 2018 map (**Figure GWC-1**) includes water level measurements taken between 1/15/2018 and 5/15/2018, and the Fall 2018 map (**Figure GWC-2**) includes water level measurements taken between 8/15/2018 and 11/15/2018.

9.1.1. Groundwater Elevation Contour Maps

Groundwater elevation contours of the Principal Aquifer for Spring 2018 and Fall 2018 ("current conditions") are shown on **Figure GWC-1** and **Figure GWC-2**, respectively. The groundwater contours in both figures are similar in shape and general magnitude near the Basin boundaries when compared to contours reported for the South American Subbasin (SASb) Alternative Plan (Sacramento Central Groundwater Authority and GEI, 2019), contours from the California Department of Water Resources (DWR) Groundwater Interactive Center Interactive Map Application (GICIMA)[39], and the Eastern San Joaquin (ESJ) Subbasin Groundwater Sustainability Plan (GSP) (Eastern San Joaquin Groundwater

[39] https://gis.water.ca.gov/app/gicima/

Authority [ESJGA], 2019).

The maps indicate the following:

- During Spring 2018, groundwater elevations generally ranged from 400 to -50 feet above mean sea level (ft msl), and during Fall 2018 groundwater elevations generally ranged from 400 to -60 ft msl.
- The difference between Spring and Fall 2018 water levels ranges from 0 feet to approximately 10 feet.
- During Spring and Fall 2018, the horizontal component of groundwater flow (i.e., the gradient) is primarily from the east and from the west towards the depression in the groundwater elevation surface (the center of the cone of depression, or groundwater elevation low), located in the central portion of the Basin. The groundwater low shifted towards the southern Basin boundary and became deeper and larger during the irrigation season.
- The groundwater elevation low has been shown previously in maps prepared by the Sacramento County Water Agency, beginning in Spring 1970, and those maps show the groundwater low as deep as -50 feet msl during the late 1970s and early 1980s, and then rising to mostly -40 feet msl thereafter.

Vertical Gradients

The vertical component of groundwater flow is evaluated from water levels in two or more proximal wells screened across different depth intervals. The well pairs in the Basin DMS utilized to evaluate vertical flow have contemporaneous depth to water measurements on variable dates during the period 2015-2018 (water levels measured in the same year and season), located a half mile or less from each other, and screened across different depth intervals. Furthermore, vertical gradients were also calculated for two Technical Support Services (TSS) clustered monitoring well sites with contemporaneous depth to water measurements in 2021. The 10 well pairs and that meet these criteria are shown on **Figure GWC-3** and the vertical gradient is calculated as the difference between the most recent water level elevation in each well divided by the distance between the mid-points of their respective well screens. A negative value indicates the gradient is upward, whereas a positive value indicates the gradient is downward.

The calculated vertical gradients at each of these well pairs (see **Table GWC-1**) indicate both upward and downward potentials of groundwater flow. Downward gradients can be associated with areas where groundwater extractions from deeper portions of the Principal Aquifer induce downward flow from the shallower portions of the Principal Aquifer. Most of the vertical gradients are downward in the western portion of the Basin corresponding to the Basin Plain subarea (four of the five pairs), where the greatest quantities of groundwater are likely extracted from variable depths beneath the Basin. In contrast, most of the vertical gradients are upward in the eastern portion of the Basin corresponding to the Basin Foothills subarea (four of five pairs), where extractions from the shallower wells may induce upward flow from deeper portions of the formations that comprise the Principal Aquifer (for example, the Valley Springs and Ione Formations). Alternatively, groundwater in the Valley Springs and Ione Formations originates from higher elevations, and combined with confined or semi-confined aquifer conditions, may create the higher groundwater heads at depths in the Basin Foothills subarea.

Table GWC-1. Calculated Vertical Gradients (2015 through 2018)

Well Pair Site	Well	Screen Interval (ft bgs)		Formation	Measurement Date	Groundwater Elevation (ft msl)	Calculated Gradient[2]	Gradient Direction
		Top	Bottom					
1	USGS-381735121152901	155	212	Laguna	9/9/2015	-68	0.01	Downward
	05N06E12R001M	na[1]	na	Mehrten	10/8/2015	-73.3		
2	T0606701083_MW-2	30	45	Victor	5/5/2015	-5.86	0.25	Downward
	05N06E10P001M	169	193	Laguna	4/23/2015	-41.3		
3	06N06E33J002M	0	167	Laguna	11/2/2018	-28.25	-0.03	Upward
	06N06E33L001M	134	206	Laguna	11/3/2018	-35.22		
4	07N07E33G001M	133	180	Laguna	11/2/2018	-28.25	0.07	Downward
	USGS-382444121123301	236	290	Mehrten	11/3/2018	-35.22		
5	BVR_W-4	145	205	Ione	2/6/2019	268.06	-0.07	Upward
	BVR_W-2	160	485	Ione	2/6/2019	278.06		
6	BVR_W-5	50	265	Ione	2/6/2019	272.38	-0.03	Upward
	BVR_W-2	160	485	Ione	2/6/2019	278.06		
7	BVR_W-5	50	265	Ione	2/6/2019	272.38	0.25	Downward
	BVR_W-4	145	205	Ione	2/6/2019	268.06		
8	AWA MW-1S	232	307	Valley Springs	12/3/2018	134.21	-0.33	Upward
	AWA MW-1D	420	495	Valley Springs	12/3/2018	195.32		
9	OHWD TSS Shallow	125	175	Laguna	5/29/2021	-26.537	0.003	Downward
	OHWD TSS Grant Well-Deep	425	500	Mehrten	5/29/2021	-27.544		
10	ACGMA Bamert Rd MW S	58	68	Valley Springs	1/27/2021	171.98	-0.002	Upward
	ACGMA Bamert Rd MW D	148	153	Ione	1/27/2021	172.17		

Notes:

(1) Well 05N06E12R001M is completed to a depth of 850 feet below ground surface (ft bgs), but screened interval information is not available. In this portion of the Basin, the Laguna Formation extends down to approximately 300 ft bgs and the Mehrten Formation extends from 300 ft bgs to over 1,000 ft bgs. It therefore is assumed that the screen interval is located in the deepest half of the well (i.e., in the Mehrten Formation).

(2) Vertical gradients are calculated for each well pair as the difference in groundwater elevation between the shallow and the deep well divided by the vertical distance between the midpoints of the screened intervals. A negative vertical gradient signifies upward flow within the aquifer whereas a positive vertical gradient signifies downward flow.

<u>*Depth to Groundwater*</u>

Depth to groundwater was calculated by subtracting contoured groundwater elevations from land surface elevation represented by the United States Geological Survey (USGS) 10-meter Digital Elevation Model (DEM). As shown on **Figure GWC-4**, depth to groundwater for "current conditions" in Fall 2018 ranges from less than 10 feet below ground surface (ft bgs) to more than 200 ft bgs. Groundwater is generally shallow in the western portion of the Basin Plain subarea, near the Sacramento-San Joaquin Delta (Delta), and deepens to the northeast diverging from the general rise in land surface elevation. This condition is consistent with depth to water contours from DWR's GICIMA. In the Basin Foothills subarea, depth to groundwater shows greater spatial variability due to relatively high topographic variability (**Figure HCM-21)** and variability in water levels, with the water level in some wells being above land surface as a result of artesian conditions (flowing wells).

In some areas groundwater may be perched and have limited hydraulic connection to groundwater at depths influenced by extraction wells. Surface Nuclear Magnetic Resonance (NMR)[40] was employed at the six sites shown in **Figure GWC-4** and results utilized to infer groundwater content and porosity with depth (**Appendix I**). In the westernmost portion of the Basin, near the Cosumnes River and where contoured well-water levels indicate relatively shallow depths to water, the NMR results indicated conditions consistent with partially saturated sand within about 30 ft bgs (for example, see NMR results in the Lower Reach section on **Figure HCM-19**). The water content decreased beneath the shallow sand and transitioned with increasing depth to conditions consistent with a higher water content and more permeable sand. The deeper, relatively mobile groundwater identified by NMR was consistent with the mobile water identified independently by the electrotelluric sounding (ETS) at nearby sites described above in Section 8.1.4 *Principal Aquifers and Aquitards*, and associated with the Principal Aquifer. Whereas the shallow perched water is likely disconnected from the Principal Aquifer. This mapped occurrence of perched water is likely a source for many of the Groundwater Dependent Ecosystems (GDEs) mapped in the Basin, rather than the Principal Aquifer[41] (see **Figure GWC-17).** As such, GDEs have appropriately been addressed as part of the Interconnected Surface Water Sustainability Indicator as described in Section 14.6 *Undesirable Results for Depletions of Interconnected Surface Water,* Section 15.6 *Minimum Threshold for Depletions of Interconnected Surface Water* and Section 16.6 *Measurable Objective and Interim Milestones for Depletion of Interconnected Surface Water*, rather than the other Sustainability Indicators that focus on the Principal Aquifer.

[40] The NMR method circulates an electric current through surface coils to perturb the equilibrium alignment of hydrogen in groundwater to the natural geomagnetic field, and then measures the voltage generated as the hydrogen returns back to its equilibrium conditions. The amplitude and decay time of the measured signal is proportional to the amount of groundwater present and porosity of the water bearing formation. Under appropriate conditions, the resulting depth distribution of water content and sediment porosity can provide unambiguous evidence of perched groundwater (for example, mobile water present in relatively large pores overlying bound water in smaller pores).

[41] The shallow groundwater levels near interconnected surface water and GDE areas are influenced by stage, the exchange of surface- and groundwater, recharge and pumping. As a result, the shallow groundwater levels can be poorly correlated with the groundwater levels at greater depths and greater distances from surface water, and the protection of interconnected surface water relies on its own monitoring network and criteria.

9.1.2. Long-Term Groundwater Elevation Trends

Long-term groundwater elevation trends represented by hydrographs of water level data from wells are shown in **Figure GWC-5**. The hydrographs indicate that water levels have generally declined in the Basin over the available period of record. The statistical significance of the trends was determined on a subset of the wells having at least one measurement per year during the period 2009-2018 so that the trends reflect the same climatic sequence and overall historical conditions in the Basin. The trends were characterized using a Mann-Kendall test that determines whether the water level data exhibit significant upward (increasing) or downward (decreasing) trends with time. For the purpose of this analysis, a trend identified from the Mann-Kendall test was considered significant when its p-value was less than or equal to 0.05, and results indicated that most hydrographs have statistically-significant downward trends that range from -0.1 to -1.5 feet per year (ft/yr), with a representative trend based on a median of about -0.6 ft/yr (**Figure GWC-6**). In the easternmost portions of the Basin corresponding to the Basin Foothills subarea, trends are both upward and downward (depending on the well), suggesting that groundwater levels have generally remained stable over the 2009-2018 time period.

As described in Section 8.1.1 *Geological and Structural Setting*, the Basin is located in the San Joaquin Valley and **Table GWC-2** below summarizes DWR's San Joaquin Valley Water Year Hydrologic Classification Index ("Water Year Type")[42,43]. For the 20-year period represented by 1999 through 2018, five water years (WY) were classified as critical (dry), five were dry, three were below normal, three were above normal, and four were wet. The first third of the 20-year period (1999-2004) started relatively wet but ended relatively dry (average WY index: 2.8 versus normal WY index of 3.1). The middle of the time period (2005-2011) included a mix of wet and dry years (average WY index of 3.8 or wet). The more recent years (2012-2018) were extremely dry (average WY index of 2.5) having the driest year on record (WY index of 0.8) during 2015 and only one wet year (2017; WY index of 6.5, third wettest for 120-year record). The climatic effects on groundwater conditions are reflected in hydrographs shown on **Figure GWC-5**, which show relatively increasing or stable water levels in the wet period during the late 1990s and early 2000s and general water level declines during the extremely dry years that began around WY 2012 and continued through 2016. These trends are also consistent with the groundwater level trends analyzed and reported in California's Groundwater Bulletin 118, San Joaquin Valley Groundwater Basin Cosumnes Subbasin (DWR, 2003).

[42] http://cdec.water.ca.gov/reportapp/javareports?name=wsihist

[43] DWR defines a Water Year as extending from October 1 of the previous year to September 30 of the year in question. For example, Water Year 2015 extends from October 1, 2014 through September 30, 2015.

Table GWC-2. Summary of DWR Water Year Types, 1999-2015

Water Year	SJ Valley WY Index		Water Year	SJ Valley WY Index	
1999	3.59	Above Normal	**2009**	2.72	Below Normal
2000	3.38	Above Normal	**2010**	3.55	Above Normal
2001	2.20	Dry	**2011**	5.58	Wet
2002	2.34	Dry	**2012**	2.18	Dry
2003	2.81	Below Normal	**2013**	1.71	Critical
2004	2.21	Dry	**2014**	1.16	Critical
2005	4.75	Wet	**2015**	0.81	Critical
2006	5.90	Wet	**2016**	2.35	Dry
2007	1.97	Critical	**2017**	6.46	Wet
2008	2.06	Critical	**2018**	3.03	Below Normal

Abbreviations:
SJ = San Joaquin.
WY = Water Year
Notes:
(1) Normal Water Year (WY) = 3.1

9.2. Change in Groundwater Storage

§ 354.16. Groundwater Conditions
(b) A graph depicting estimates of the change in groundwater in storage, based on data, demonstrating the annual and cumulative change in the volume of groundwater in storage between seasonal high groundwater conditions, including the annual groundwater use and water year type.

Change in groundwater storage was estimated for selected periods of interest. Storativity (S) is an aquifer property that represents the volume of water released from the aquifer per unit water level decline per unit area of the aquifer and is calculated as the product of the Specific Storage (Ss) and saturated aquifer thickness (b). In an unconfined aquifer, or water table aquifer, "S" can be approximated by the drainable porosity of the aquifer, referred to as the Specific Yield (Sy).

The volume of water removed from aquifer storage (the storage change or "storage depletion") is calculated as follows:

$$Change\ in\ storage = [Water\ Level\ Change] * [S] * [Area]$$

The equation above was employed to preliminarily calculate the historical change in Basin storage during the period of WY 1999 through 2018. Most of the storage change is assumed to have occurred in the Basin Plain subarea of the Basin, where consistent and statistically-significant downward water level trends were observed in wells distributed across the Basin (as seen on **Figure GWC-6** and discussed above in Section 9.1.2 *Long-Term Groundwater Elevation Trends)*. The storage change in the eastern portion of the

Basin corresponding with the Basin Foothills subarea was assumed to be small to negligible because no consistent trends were observed in water level changes. This condition is consistent with findings in California's Groundwater Bulletin 118, San Joaquin Valley Groundwater Basin Cosumnes Subbasin (DWR, 2003), which reports that water levels were approximately stable in the eastern portion of the Basin.

The average aquifer thickness (b) of the Principal Aquifer beneath the Basin Plain subarea, based on the geologic cross-sections in **Figure HCM-15** through **Figure HCM-18**, is about 1,400 feet, and the area of the Basin Plain is approximately 131,000 acres. The water level change was estimated from the difference between Fall 1999 and Fall 2018 groundwater elevation contour maps in **Figure GWC-7** (-15.6 feet average, or -0.82 ft/yr). The value for S is based on the drainable porosity represented by the Sy. In the Basin, S ranges from 0.06 to 0.25, and the calculated change in storage used a representative value of 0.10 (Fleckenstein et al., 2006).

$$Change\ in\ storage = [-0.82\ ft/yr] * [S] * [131{,}000\ acres]$$

The resultant change in storage for the range in Sy values ranges from -6,400 to -26,900 acre feet per year (AFY), and -10,700 AFY using the representative value for Sy of 0.10. The depletion of Basin storage indicates that groundwater consumption has exceeded groundwater recharge on average by about 10,000 AFY during the 20-year period, which is supported by the long-term hydrographs that show declining water levels for several decades (**Figure GWC-5**).

For comparison purposes, a review was conducted on change in storage estimates for the Basin reported by others over a similar time period.

- The USGS Central Valley Hydrologic Model (CVHM) simulated -22,500 AFY of average annual groundwater depletion in the Basin over the 1993 to 2004 time period (Faunt, 2009).
- The Eastern San Joaquin Water Resources Model (ESJWRM) simulated -41,000 AFY decline in groundwater storage during the period 1996-2015, but in the portion of the model that represents the Basin the calculated storage increased by 6,600 AFY. However, the model calculated storage change for the Basin is more uncertain than that for the ESJ Subbasin because the ESJWRM was constructed to manage the ESJ Subbasin, not provide groundwater storage changes for the Basin. As such, substantially greater effort would have been invested to develop model input data for the ESJ Subbasin with less effort to develop data for the Basin.

The model-calculated storage change summarized above for the USGS model are consistent with the storage depletion estimates described above based on the range in water level trends (-0.1 to -1.5 ft/yr) represented by the hydrographs in **Figure GWC-6** (average annual storage depletion ranging from -6,400 AFY to -26,900 AFY, respectively). The estimated depletion rate is also consistent with the average annual storage depletion calculated by the Numerical Model utilized to support this GSP and discussed in Section 10.2 *Water Budget Results* (-10,600 AFY).

9.3. Seawater Intrusion

> *§ 354.16. Groundwater Conditions*
> *(c) Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.*

The Basin is not directly connected to the Pacific Ocean, but its western boundary is adjacent to the Delta which is influenced by the Pacific Ocean. Before human intervention, seawater originating from the Pacific Ocean flowed inland through San Francisco Bay and flooded the vast Delta marshes during dry periods. The gradient was then reversed during the wintertime and during high-runoff periods. Under present-day conditions, surface water management methods are utilized to prevent seawater from reaching far into the Delta and include: (i) hydraulic barriers created by the upstream release of fresh water to repel downstream seawater; (ii) physical barriers, such as low-level dams and gates, which also separate the fresh- and saltwater; and, (iii) physical alterations to the Delta channels to improve flow patterns. Hence, under present-day conditions, the Basin is at little to no risk of seawater intrusion.

Groundwater with elevated concentrations of chloride does exist in the Basin as a result of the historical depositional environment. Marine waters (brines) are currently associated with formations below the Ione Formation, formed prior to the Eocene period and during ancient marine conditions (Page, 1974; Berkstresser, 1973). Water associated with these formations are not considered “useable,” and chloride originating from these brines can influence the quality of water produced by wells screened near the interface or where up-coning occurs beneath substantial pumping centers. The chloride concentrations measured in Basin groundwater can therefore reveal the influence, if any, of these ancient marine waters on groundwater quality. The interface between useable and unusable groundwater therefore represents the lower boundary of the fresh aquifer system (base of freshwater) and its depth is variable across the Basin (**Figure HCM-5**). The interface is considered the “bottom of the Basin” (Section 8.1.3 *Bottom of the Basin*) and is deepest beneath central portions of the Basin but becomes relatively shallow near the western boundary and near the Delta.

DWR’s Best Management Practices (BMP) #6 Sustainable Management Criteria (DWR, 2017) recommend that the minimum threshold metric for seawater intrusion be the location of a chloride isocontour. As an example, some coastal agencies identify seawater intrusion using a chloride concentration of 500 milligrams per liter (mg/L) (Monterey County Water Resources Agency, 2018). Similarly, the minimum threshold for seawater intrusion in the adjacent ESJ Subbasin is 2,000 mg/L (ESJGA, 2019). As shown in **Figure GWC-8**, chloride concentrations in most well-water samples collected from wells in the Basin between 2015 and 2019 had concentrations less than 50 mg/L, indicating that intrusion from deep brines or seawater has not occurred to date. One well in the Basin Foothills subarea, which is a monitoring well at the Lake Camanche Village Wastewater Treatment Plant, had a concentration greater than 250 mg/L, but all the wells around it had concentrations less than 50 mg/L.

9.4. Groundwater Quality Concerns

> *§ 354.16. Groundwater Conditions*
> *(d) Groundwater quality issues that may affect the supply and beneficial uses of groundwater, including a description and map of the location of known groundwater contamination sites and plumes.*

Groundwater quality concerns occur when dissolved constituent concentrations in water exceed a prescribed limitation. Considerations for evaluating water quality concerns in the Basin (per GSP Regulations and DWR's BMP #2 Monitoring Networks and Identification of Data Gaps [DWR, 2016b]) may include:

- Applicable local, state, and federal drinking and agricultural water quality standards (Moran and Belin, 2019);
- Number and locations of potentially impacted supply wells;
- Historical water quality trends;
- Point and non-point sources of constituents of concern;
- Spatial and vertical extents of major contaminant plumes in the basin, if any, and how the plume migration can be affected by regional pumping patterns; and,
- Adjacent basin's minimum thresholds.

Plots of available concentrations versus time are presented in **Appendix H** for the constituents listed in **Table GWC-3**, and the Mann-Kendall test for trends was conducted on the data set to identify statistically significant downward or upward trends. The Mann-Kendall results are presented in the time-series plots in **Appendix H**. For the purpose of this analysis, a trend identified from the Mann-Kendall test having a p-value less than or equal to 0.05 are considered significant. The results are summarized below for each potential constituent of concern considered for this GSP.

Well-water sample results and concurrent water level data are limited. In the DMS, only 19 wells in the Basin have four or more water quality and water level data points as part of their record, and only ten of the 19 show statistically significant relationships between concentration and groundwater elevation for at least one constituent. Over half of these wells (eight of the 10 wells) are monitoring wells associated with the Galt Wastewater Treatment Plant, and therefore do not provide water for beneficial use, and the remaining two wells are production wells at different locations in the Basin. The correlation results are summarized below and in **Appendix H**.

- Samples from the eight monitoring wells show an inverse relationship between nitrate concentrations and groundwater levels, whereby nitrate as nitrogen concentrations decrease as water levels increase (less than 0.6 mg/L decrease per foot of water level increase), and two of the eight monitoring wells show a direct relationship between chloride concentrations and groundwater levels, whereby the chloride concentrations increase as water levels increase (3.0 to

6.0 mg/L increase per foot of water level increase).

- Several of the monitoring wells show variable relationships between dissolved constituent concentrations and groundwater levels: total dissolved solids (TDS) (3 wells), sodium (1 well), and arsenic (2 wells).
- Samples from one of the two production wells (City of Galt Well 20) showed an inverse relationship between arsenic concentrations groundwater levels, whereby the concentrations decrease as water levels increase (less than 0.05 mg/L decrease per foot of water level increase). Samples from the other production well shows an inverse relationship between chloride concentration and groundwater levels, whereby the chloride concentrations decrease by less than 0.5 mg/L per foot of water level increase.

The limited spatial extent and temporal frequency obscure application of these apparent statistical results to Basin-wide conditions and the potential nexus between water quality, groundwater management actions, and possible future changes owing to GSP implementation (for example, changes in well extractions, groundwater elevations, and storage).

9.4.1. Concentration Criteria

Water quality objectives are defined as "the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area" (CWC § 13050(h)). Groundwater quality standards set forth in the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (California Regional Water Quality Control Board [RWQCB], 2018) are consistent with the Water Quality Objectives (WQOs).

The applicable water quality standards within the Basin include:

- Primary Maximum Contaminant Levels (MCLs) established in Title 22 of the California Code of Regulations (CCR). Primary MCLs are drinking water standards set by the United States Environmental Protection Agency (USEPA) and promulgated by the California State Water Resources Control Board’s (SWRCB) Division of Drinking Water, based on human health considerations.
- Secondary MCLs are non-health related standards based on aesthetic characteristics of drinking water. For common constituents in groundwater – TDS, chloride, and sulfate – the SWRCB sets three levels of Secondary MCLs for consumer acceptance and are referred to (lowest to highest concentration) as “recommended”, “upper”, and “short term.”
- For constituents that do not have Primary or Secondary MCLs, other criteria were utilized: Action Levels (AL) set by the USEPA for public water systems (PWS), and Health Advisory limits set by the USEPA for non-cancer health effects. The PWS that exceed the AL are required to conduct additional sampling, and if 10% of the follow-up sample results continue to exceed the AL, the PWS is required to notify customers and take steps to reduce concentrations in the water supply (e.g., the distributor of a water supply that exceeds the AL for lead can be required to replace old lead pipes in the distribution system). A summary of key constituents in the Basin DMS and the

basis for their corresponding water quality standards is summarized in **Table GWC-3.**

Table GWC-3. Limitations for Key Constituents

Constituent	Limitation (mg/L)	Limit Type and Source
Arsenic	0.01	Primary MCL (Title 22)
Fluoride	2.0	Primary MCL (Title 22)
Lead	0.015	AL (Title 22), formerly limited by Primary MCL
Nitrate (reported as nitrogen)	10	Primary MCL (Title 22)
Selenium	0.05	Primary MCL (Title 22)
TDS	500	Secondary MCL-Recommended (Title 22)
Chloride	250	Secondary MCL-Recommended (Title 22)
Sulfate	250	Secondary MCL-Recommended (Title 22)
Iron	0.3	Secondary MCL (Title 22)
Manganese	0.05	Secondary MCL (Title 22)
Boron	0.5	WQO (USEPA Health Advisory)

When a concentration is greater than the applicable standard, it is considered herein as a "Water Quality Exceedance." For the purpose of this analysis, if one or more wells have samples with a Water Quality Exceedance then the constituent is further evaluated as a potential Constituent of Concern (COC). The comparisons are summarized in **Table GWC-4**, and their results evaluated below.

Table GWC-4. Key Constituents Listed in Table GWC-3 with Water Quality Exceedances

Constituent	# of Wells Sampled	# of Wells Exceeding MCL/WQO	% of Wells Exceeding MCL/WQO
Primary MCL			
Arsenic	47	21	45%
Nitrate as N	90	6	7%
AL (Title 22), formerly limited by Primary MCL			
Lead	44	12	27%
Secondary MCL			
TDS	126	17	14%
Chloride	183	4	2%
Sulfate	112	2	2%
Iron	96	30	31%
Manganese	100	48	48%
Water Quality Objective			
Boron	39	1	3%

9.4.2. <u>Constituents and Primary MCLs</u>

Drinking water limits are the most stringent of the concentration limits, and constituents that exceed their Primary MCL are classified as COC. The results in **Table GWC-4** above indicate that 45% and 7% of samples collected to date from Basin wells exceed the primary MCL's for arsenic and nitrate, respectively, and therefore are considered COCs. Prior to revisions to Title 22, the Primary MCL for lead was 0.015 mg/L, which is now considered an AL. **Table GWC-4** indicates that 27% of the samples exceeded the MCL/AL for lead, and lead was therefore initially considered as a COC, but as described below, further analysis justified removing it from the list of COCs. There were no Primary MCL exceedances in the 21 samples analyzed for fluoride and 47 samples analyzed for selenium, and therefore these constituents are not considered COCs for the purposes of this GSP.

Maps and boxplots characterize water quality conditions related to arsenic, nitrate, and lead for historical conditions (based on data collected prior to 2015) and current conditions (based on data collected between 2015 and 2018). The resultant maps (**Figure GWC-9, Figure GWC-10,** and **Figure GWC-11**) illustrate the geographic distribution of water quality across the Basin, and the boxplots provide a side-by-side visual comparison of the differences between median concentrations, the extent of overlap in concentration ranges, and potential influences of well screen depth and Basin formation thicknesses.

<u>Arsenic</u>

Arsenic is a naturally-occurring element, and ingestion has been associated with an increased risk of cancer and other chronic health effects. Concentrations that exceed the MCL (0.01 mg/L) in drinking water sources are a significant human health concern (Title 22 CCR Article 18 § 64465). **Figure GWC-9** shows the available arsenic data, and most of the data for analysis occurs in the southwest portion of the Basin near the City of Galt. The data points include monitoring wells located at the Galt wastewater treatment plant and City of Galt public supply wells; the City currently treats the water produced by affected wells for arsenic (EKI, 2021). While the arsenic results show no visual differences between historical and current conditions, the Mann-Kendall analysis (**Appendix H**) indicates that eight of the 47 wells sampled in the Basin have statistically significant trends: six wells previously had concentrations that exceeded the MCL, but concentrations have declined and are currently below the MCL, and two wells previously had concentrations below the MCL but concentrations are trending upwards and towards the MCL.

The boxplots in **Figure GWC-9** show that all samples representing the Victor Formation come from monitoring wells, which are the shallowest wells and do not provide water for beneficial use. These samples have historical arsenic concentrations that exceeded the MCL, but currently sample concentrations are below the MCL. All samples from the Laguna Formation and Mehrten Formation come from deeper production wells and arsenic concentrations have exceeded the MCL. Most samples from production wells screened in the deeper Valley Springs and Ione Formations are below the MCL.

Nitrate

Nitrate is typically associated with septic discharge and agricultural practices (fertilizers, stock yards, dairies) although naturally occurring nitrate can also be present. Concentrations that exceed the MCL (10 mg/L as N) in drinking water are a significant health concern for pregnant women and infants as these elevated concentrations cause methemoglobinemia (“blue baby syndrome”) (Title 22 CCR Article 18 § 64465).

In the Basin, six of the 90 wells sampled for nitrate (7%) exceeded the MCL, which is similar to the percentage reported in the Groundwater Quality Assessment Report for the Sacramento-Amador Watershed (which includes the Basin) which found that 4% of the samples exceeded the MCL (CH2MHill, 2016). **Figure GWC-10** shows that the historical and current distributions of exceedances are similar with most wells having concentrations below 3.0 mg/L.

A Mann-Kendall analysis indicated that 11 of the 90 wells sampled have statistically significant trends (**Appendix H)**. One of the 11 wells has a statistically significant downward concentration trend, and the concentrations are below the MCL. Ten of the 11 wells have significant upward trends: recent samples from two of the wells exceed the MCL, and samples from the remaining wells are below the MCL. If the upward trends persist, concentrations could exceed the MCL in the future.

The boxplots in **Figure GWC-10** show that the nitrate exceedances occurred in wells screened primarily in the Victor and Valley Springs Formations. All the affected wells were monitoring wells that represent relatively shallow conditions in the Basin Plain subarea (Victor Formation) and in the Basin Foothills area (Valley Springs Formation) and therefore exceedances are likely caused by anthropogenic nitrate sources such as agricultural practices or septic system discharge.

Lead

Lead is a toxic, naturally occurring metal that can be indicative of anthropogenic impacts. Relatively low concentrations in drinking water are harmful to human health and can bioaccumulate in the body over time causing delays in physical or mental development. Lead was previously regulated by the Primary MCL of 0.015 mg/L for the production of potable water, and the USEPA established a goal of zero as the maximum contaminant level for lead. Recently, however, the regulations have been revised to include the water within the distribution system and the AL of 0.015 mg/L was established to protect public health, which is the same value as the MCL. The lead concentrations in 12 of 44 wells (27%) exceeded the AL, however, all of the exceedances were in samples from monitoring wells that do not supply water for beneficial use. Moreover, as shown on **Figure GWC-11,** the samples that exceeded the AL were all collected prior to 2015 (the lead concentrations in the most recent samples are all less than 0.005 mg/L). The Mann-Kendall analysis did not identify significant trends in the data from any of the wells. Because lead concentration exceedances were not found in water supply wells, current concentrations in all wells are below the AL, there are no trends in the lead concentrations, and PWS wells are required to monitor for lead, lead was not considered further as a COC for the purposes of this GSP.

9.4.3. Constituents and Secondary MCLs and WQOs

TDS, chloride, sulfate, iron and manganese have Secondary (i.e., aesthetically based) MCLs, while boron has a WQO. These regulatory criteria were exceeded by a variable percentage of samples: TDS (14%), chloride (2%), sulfate (2%), iron (31%), manganese (48%), and boron (3%). These constituents are further evaluated below to determine whether or not they represent a potential COC.

- **TDS** is a measure of the total dissolved ionic constituents in a water sample, and although TDS does not generally affect human health, it is an aesthetic characteristic of drinking water (Hem, 1970). Seventeen of the 126 wells exceeded the Secondary MCL (14%), and the Mann-Kendall analysis indicates that 14 of the 17 wells (82%) have statistically significant trends, including five trending downward and nine trending upward. One of the five downward-trending wells was above the Secondary MCL in the past but has since declined and is now below the Secondary MCL. The concentrations from the remaining four declining wells have been below the Secondary MCL. For the nine wells with increasing trends, concentrations in two wells have concentrations above the Secondary MCL and are continuing to increase. Both wells are relatively shallow and located at either the City of Galt Wastewater Treatment Plant (WWTP) or at the Buena Vista Landfill in Amador County. These two monitoring wells do not provide water for beneficial use. Concentrations in the remaining seven wells are currently below the Secondary MCL, but the trend analysis indicated the concentrations are increasing with time. As stated above, TDS does not generally affect human health, but is an aesthetic characteristic, and therefore is retained as a COC for the purpose of this GSP.
- **Chloride** is present in natural waters, but concentrations are generally low in groundwater (Hem, 1970). Chloride is one of the primary constituents dissolved in ocean water and, as discussed previously, its concentration is utilized to evaluate seawater intrusion. Four of 183 wells exceeded the secondary MCL (2%), and the Mann-Kendall analysis indicates that 16 wells have statistically significant trends (eight wells have declining trends and eight wells have increasing trends). The concentrations

of these trending wells did not exceed the Secondary MCL, although the chloride concentrations are approaching the Secondary MCL in one monitoring well at the Buena Vista Landfill in Amador County. Chloride is not considered a COC for the purposes of this GSP because the exceedances do not result in health-related concerns, and monitoring of TDS serves as an indicator of general drinking water quality.

- **Sulfate** is naturally- occurring and present in soil and water (Hem, 1970) due to the oxidation of sulfide minerals but also from anthropogenic sources. The concentrations in one of 112 wells exceeded the Secondary MCL (1%), and the Mann-Kendall analysis indicates that eight wells have statistically significant trends (one well shows declining concentrations and seven wells show increasing concentrations). One sulfate exceedance occurs in a monitoring well at the Buena Vista Landfill in Amador County and the concentrations are trending upward and will likely continue to increase with time. This monitoring well does not supply water for beneficial use and the SWRCB lists the site as an active facility under Title 27 – Municipal Solid Waste Landfill and there are no outstanding violations regarding the permitted underground fuel storage tanks on file (Amador County Planning Department, 2020). The concentrations in the remaining wells that show significant trends are all below the Secondary MCL. Sulfate is not considered a COC for the purposes of this GSP because the sulfate exceedances do not result in health-related concerns, and monitoring of TDS serves as an indicator of general drinking water quality.
- **Iron** is an essential element in the metabolism of animals and plants, however if concentrations are excessive, the iron can stain laundry and plumbing fixtures and is therefore considered an objectionable impurity in domestic and industrial water supplies (Hem, 1970). The iron concentrations in 30 of 96 wells exceeded the Secondary MCL (31%), and the Mann-Kendall analysis indicates that 10 of the 96 wells have statistically significant declining concentrations (no statistically significant upward trends). Nine of the 10 wells exceeded the Secondary MCL in the past, but current data are below the secondary MCL. Over half of the wells that exceed the Secondary MCL (19 of the 30 wells) are monitoring wells at the City of Galt WWTP or the Buena Vista Landfill. These monitoring wells do not supply water for beneficial use and the WWTP wells are monitored under the current RWQCB Central Valley Region National Pollutant Discharge Elimination System (NPDES) Order R5-2015-0125, which allows for secondary treated effluent irrigation to designated areas, and the Landfill wells are monitored by SWCRB. Iron is not considered a COC for the purposes of this GSP because the iron exceedances do not result in health-related concerns, and most of the exceedances occur in monitoring wells at local sites regulated by the RWQCB.
- **Manganese** is an essential element for plants and animals, but is an undesirable impurity in water supplies. When manganese concentrations are sufficiently high, the water can deposit black oxide stains (Hem, 1970). Samples from 48 of 100 wells exceeded the secondary MCL (48%), and over half of the 48 wells are monitoring wells (27 wells) at the City of Galt WWTP or the Buena Vista Landfill. These monitoring wells do not supply water for beneficial use and the WWTP wells are monitored under the current RWQCB Central Valley Region National Pollutant Discharge Elimination System (NPDES) Order R5-2015-0125, which allows for secondary treated effluent irrigation to designated areas, and the Landfill wells are monitored by SWCRB. Mann-Kendall analyses indicate that eight of

the 100 wells show statistically significant trends. Five of the eight wells show declining concentration trends, but the concentrations are below the Secondary MCL. One of the eight wells are owned by the City of Galt and show increasing trends that have exceeded the Secondary MCL. Many of the City's public supply wells are treated for manganese prior to distribution (EKI, 2021). The two other wells that show increasing trends and have exceeded the Secondary MCL are public water supply wells and are monitored under Title 22 as part of the PWS monitoring requirements. Manganese is not considered a COC for the purposes of this GSP because the manganese exceedances do not result in health-related concerns, and most of the exceedances occur in monitoring wells at local sites regulated by the RWQCB.

- **Boron** is essential for plant functions, but high concentrations can be harmful to sensitive crops (Ayers and Westcot, 1985). Few boron sensitive plants are grown in the Basin, and only one of the 39 wells sampled for boron exceeded the advisory level (3%). The Mann-Kendall analysis indicates that concentrations in samples from two of the wells have statistically significant upward trends, but the current boron concentrations at both wells are below the WQO. Boron is not considered a COC for the purposes of this GSP because boron sensitivity and its related toxicity to plants is not a concern in the Basin, and only one well produced water that exceeded the WQO.

In summary, the concentrations of the constituents above in most samples do not exceed the applicable Secondary MCLs or WQO. Statistically significant constituent trends occur in a small subset of the wells, and the trends are both upwards and downwards. Most often, well samples that exceed the MCLs and show statistically significant upward trends were found at monitoring wells, which do not provide water for beneficial use, and are located at sites regulated by the RWQCB Hence, these constituents are not considered COCs for the purposes of this GSP.

9.4.4. Point-Source Contamination Sites

In addition to various non-point source groundwater quality COCs, numerous point-source contamination sites (70) are located in the Basin and can influence shallow groundwater quality (**Figure GWC-12**). These sites are typically associated with industrial or commercial land uses (e.g., gas stations), and are comprised of four active Leaking Underground Storage Tank (LUST) Cleanup sites, 31 closed LUST Cleanup sites, nine permitted Underground Storage Tanks (USTs), one active Cleanup Program site, one inactive Cleanup Program site, three closed Cleanup Program sites, 13 California Department of Toxic Substances Control (DTSC) Cleanup sites, seven land disposal sites, and one closed military cleanup site. The specifics of each site are summarized below and listed in **Table GWC-5**.

- Three of the active LUST Cleanup sites are located near the City of Galt and the fourth site is located near the City of Ione (see **Figure GWC-12**). All four sites are being managed under the oversight of the Regional Water Quality Control Board (RWQCB) and associated County. These sites have gasoline and other fuel oxygenates as potential COCs (see **Table GWC-5** for complete list of COCs). The three sites located near the City of Galt are active (open) sites in the verification monitoring phase, and the site near Ione is active in the site assessment phase.
- The permitted USTs require no cleanup actions.

- The active cleanup site "MP Associates" is located near Buena Vista in Amador County and is in the site assessment phase. The potential COCs include metals, heavy metals, and perchlorate. Soil is currently under investigation and might not impact groundwater. The inactive cleanup site "Denier Property" is located near the City of Galt and is being managed under the oversight of the RWQCB. The site has agricultural chemicals listed as potential COCs (e.g., insecticides, pesticides, and herbicides) introduced to soil by runoff from a concrete equipment cleaning pad.

The DTSC Cleanup sites include two military evaluation sites, two school investigation sites, three school sites that have certified or received no action required status, two evaluation sites in which no further actions are needed, one inactive evaluation site, one inactive voluntary cleanup site, and two state response sites which have certified cleanup status.

Table GWC-5. Summary of Active Point-Source Contamination Sites

Site ID (see Figure GWC-12)	Site Name	Site Type	Regulatory Oversight Agencies	Potential Contaminants of Concern	Status
1	Cheaper #183	LUST Cleanup Site	Sacramento County Local Oversight Program (LOP) & CVRWQCB	Gasoline	Open, verification monitoring
2	Express Lane Chevron	LUST Cleanup Site	CVRWQCB & Sacramento County LOP	Benzene, fuel oxygenates, gasoline, MTBE/other fuel oxygenates	Open, verification monitoring
3	Express Lane Chevron – Case 2	LUST Cleanup Site	CVRWQCB & Sacramento County LOP	Gasoline, MTBE/other fuel oxygenates	Open, verification monitoring
4	Sierra Trading Posts #2	LUST Cleanup Site	CVRWQCB & Amador County	Gasoline	Open, remediation
5	MP Associates	Cleanup Program Site	DTSC & CVRWQCB	Metals/Heavy metals, perchlorate	Open, site assessment

Considerations for evaluating water quality concerns include the spatial and vertical extent of contaminant plumes and how plume migration might be affected by regional pumping patterns. Two of the five active point-source contamination sites have mapped plumes.

- The Express Lane Chevron/Express Lane Chevron Case 2 site has a methyl tert-butyl ether (MTBE) plume that has impacted multiple domestic and irrigation wells (Apex Envirotech Inc., 2010). The impacted wells have been destroyed but COCs are still detected in monitoring wells and downgradient private wells are still at potential risk from plume migration. In 2017, the SWRCB concluded that the site did not meet all criteria to be classified as a Low-Threat Underground Storage Tank Case Closure Policy because the plume was greater than 250 feet in length and its maximum dissolved benzene concentration was greater than 3,000 micrograms per liter (ug/L) and MTBE concentration was greater than 1,000 ug/L. Cleanup efforts included an immediate over-excavation, groundwater extraction and remediation and soil vapor extraction.

- Sierra Trading Posts #2 site includes a gasoline plume, as defined by analyses of total petroleum hydrocarbons (TPHg) (Apex Envirotech Inc., 2016). In 2016, the plume was 240 feet in length and within 100 feet of a domestic well. A dual phase extraction (DPE) system was put in place and operated until March 2017. Monitoring has not been conducted since 2017.

These sites are already under the oversight of multiple agencies (RWQCB, DTSC, and Amador County), but changes in groundwater recharge, pumping patterns, and groundwater-flow directions and rates will be considered during GSP implementation (e.g., as a result of Projects and Management Actions).

9.5. Land Subsidence

> *§ 354.16. Groundwater Conditions*
> *(e) The extent, cumulative total, and annual rate of land subsidence, including maps depicting total subsidence, utilizing data available from the Department, as specified in Section 353.2, or the best available information.*

Vertical displacement of the land surface (including subsidence) can be caused by tectonic activity, groundwater withdrawals, natural gas and oil extractions, and oxidization of organic matter. As described below, measured vertical displacement in the Basin has been minor to date, and indicate that land subsidence is not likely to be a significant concern in the Basin.

Figure GWC-13 illustrates recent land surface changes, based on Interferometric Synthetic Aperture Radar (InSAR) data collected between March 2015 and March 2016 with an inset plot that shows continuous data collected from July 2006 through September 2019 from a University NAVSTAR Consortium (UNAVCO) Global Positioning System (GPS) station (P275) located within the Basin[44] in the vicinity of the groundwater depression. The recent data collected from the UNAVCO station show daily variability that includes both positive and negative displacement, but the overall trend has been a slight negative (declining land surface). Linear regression of the data show a long-term trend in vertical displacement of -0.008ft/yr. That rate equates to a decline in land surface of about 0.1 feet during the period July 2006 through September 2019, which falls within the range of possible error in subsidence measurement methods using remote sensing (i.e., on the order of 0.25 to 1 inch [Farr et. al, 2016]). Two UNAVCO sites located west and southwest of the Basin show similar, minor vertical displacement rates for that period (-0.009 ft/yr, site P273; -0.007 ft/yr, site P274).

[44] https://www.unavco.org/instrumentation/networks/status/pbo/overview/P275; The UNAVCO maintains a database of data collected from continuous GPS stations located throughout the world including the area around the Basin. These stations measure horizontal and vertical displacement of the ground surface at these sites.

In 2008, DWR established a network of monuments for the purpose of monitoring subsidence in the Sacramento Valley. Elevations at the monuments were surveyed using GPS surveying methods. Those monuments were surveyed again in 2017 using the same methods to determine the change in monument height between 2008 and 2017. This subsidence monitoring network includes northern Sacramento County, but does not extend into the Basin, which is in the San Joaquin Valley. At the eight southernmost monuments, located in the SASb, the change in elevation between the 2008 and 2017 surveys ranged from -0.028 to -0.178 feet and averaged -0.099 feet (DWR, 2018b).

Recent land surface changes within the Basin have also been measured using InSAR, which is a remote sensing technique that uses radar imagery taken at different times to estimate the change in land surface elevation during the period between the acquisition dates. Vertical displacement of land surface derived from InSAR data collected by the European Space Agency and processed by TRE ALTAMIRA Inc. is available for the Basin for the period January 2015 and October 2020 (**Figure GWC-13**)[45]. Within the Basin, the vertical displacement during this period ranged from -0.25 to 0.03 feet, with a mean change of -0.05 feet. During this same period, a vertical displacement of -0.09 feet was measured at the UNAVCO site in the Basin.

9.6. Interconnected Surface Water Systems

> *§ 354.16. Groundwater Conditions*
> *(f) Identification of interconnected surface water systems within the basin and an estimate of the quantity and timing of depletions of those systems, utilizing data available from the Department, as specified in Section 353.2, or the best available information.*

Interconnected surface water is defined in the GSP regulations [23-CCR §354(o)] as "*surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.*" Measured groundwater levels and streamflow are fundamental data required to characterize the nature and occurrence of interconnected surface water. Specifically, maps showing depth to groundwater can identify areas where saturated and unsaturated conditions might exist beneath a surface water body, and streamflow gains (seepage from groundwater) or losses (leakage to groundwater) can be identified from measured changes in flow between two points along a creek, stream, or river.

Interconnected surface water can be affected by changes in groundwater levels and aquifer storage. Surface water "depletions" refer to reduced streamflow (discharge) due to the capture of groundwater recharge that otherwise seeps into the stream or increased hydraulic gradients that induce greater leakage out of the stream. In areas of declining groundwater levels, the depletion rate increases until the water table falls beneath the bottom of the river/stream channel and surface water becomes "disconnected" from the underlying groundwater. Under these disconnected conditions, the potential for surface water leakage is greatest and maximum depletion rates occur. Hence, once a surface water body

[45] Data available online at: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#landsub

has become disconnected from the underlying groundwater system, the surface water depletion rate is independent of future changes (i.e., reductions) in groundwater levels and aquifer storage. Available groundwater level and stream data compiled for the Basin and simulated historical conditions by the numerical model were considered in the evaluation of the potential for interconnected surface water and surface water depletions.

9.6.1. Measured Relationship Between Groundwater Levels and Streamflow

Water table and streamflow changes can be characterized by groundwater levels in shallow wells located near stream gauging stations (locations where surface water level elevation [stage] and/or volumetric discharge [flow] are measured). Comparisons between shallow groundwater levels and surface water stage are utilized to infer groundwater movement toward or away from the stream (seepage or leakage, respectively), and the difference between measured discharge at two stations can be used to estimate the seepage or leakage rate after all surface water diversions and/or returns are accounted for.

Figure GWC-14 shows wells within the Basin that are known to be constructed to depths less than 150 ft bgs ("shallow" wells) and located less than two miles from surface water features, and stream gauging stations that have historical stage data. While several shallow wells are located near surface water features, few of them are located adjacent to an existing gauging station, which introduces uncertainty when comparing groundwater level and stream stage data. Further, comparisons between the available shallow groundwater levels and stream gauge measurements show limited overlap in their respective recording periods (see inset in **Figure GWC-14**). Only one station exists on Dry Creek and it is currently inactive, and the flow in other creeks within the Basin are not measured.

As described below, comparisons between available stage, estimated channel bottom elevation, and groundwater levels measured in shallow wells suggest that Cosumnes River flows are disconnected from the Principal Aquifer beneath most of its reach within the Basin (**Figure GWC-15**). In the Basin Plain Subarea, evidence of disconnected conditions beneath upper portions of the river were reported in the early 1920's (Gross, 1922). The fall water levels measured in wells located as far west as approximately Wilton Road were below the bottom of the adjacent riverbed, and consistent with contemporaneous reports of low fall flows and frequent dry conditions in the lower reaches of the Cosumnes River from October to December (Fleckenstein and others, 2004). Previous studies have reported that interconnected surface water does not exist until approximately the Cosumnes River's confluence with Laguna Creek and likely continues to the area of tidal influence at the westernmost boundary of the Basin (Robertson-Bryan Inc., 2011). Most recently, electrical resistivity tomography (ERT) geophysical surveys in the riparian forest areas adjacent to the Cosumnes River found groundwater availability increases downstream due to shallower depths to groundwater and increasing clay content, which has a higher water retention than sand (Rohde et al., 2019).

Data are not available to directly compare stage and groundwater levels along Dry Creek or other surface water features in the Basin. However, the depth to groundwater (DTW) contours mapped for the Basin indicate that groundwater in the Principal Aquifer is typically encountered at depths substantially greater than 30 ft bgs, suggesting that surface water flows and groundwater are likely disconnected across most of the Basin (**Figure GWC-4**).

9.6.2. Model-Calculated Relationship Between Groundwater Levels and Streamflow Depletions

Most of the Cosumnes River, Dry Creek, and smaller surface water features are underlain by a water table that is 30 to over 150 ft bgs (**Figure GWC-4**), and therefore disconnected from the Principal Aquifer. However, available data indicate that the portions of the Cosumnes River west of its confluence with Deer Creek may be interconnected for part of the year (one or more months), but not in all years. Moving further down river and west of Highway 99, the Cosumnes River is understood to be more regularly interconnected. These westernmost areas of the Basin are conservatively considered to have "interconnected surface water," at least for part of the year, but the actual relationships between surface water and the underlying Principal Aquifer is complex and remains a data gap in the GSP.

Depletions of interconnected surface water is a rate or volume of water removed from the stream. Available data are insufficient to directly calculate surface water depletions from streamflow measurements or estimate depletions from a surface water budget. Estimates of depletions to groundwater therefore rely on application of the numerical surface-water groundwater model. **Figure** GWC-16 compares model-calculated depletions for the period WY 1999-2018 for "seasonally disconnected" and "assumed interconnected" portions (reaches) of the Cosumnes River. These reaches are approximately 700 feet in length, and adjacent to monitoring wells whose water level data were used to classify them as disconnected or interconnected. Where the reach is seasonally disconnected, meaning it may at times be interconnected but for only one or more months during some but not all years, the depletion rate is determined primarily by river flow and stage, hydraulic conductivity of the streambed, and hydraulic conductivity of the underlying aquifer materials. Hence, the model-calculated depletions in the disconnected reach can be described as "flashy," whereby the greatest depletions occur during high runoff events in winter and substantially decrease to near zero during the late summer and fall when there is much less flow in the river. In the interconnected reach, the depletion rate is determined by river flow and stage, hydraulic conductivity of the streambed, hydraulic conductivity of the underlying aquifer materials, and the difference between river stage and adjacent groundwater levels. The long-term average annual depletion within the interconnected reach (almost 300 AF) is lower than the average annual depletion from the disconnected reach (almost 400 AF), but the monthly depletions shown in the figure are much less variable in the interconnected reach.

The influence of depletions on surface water flows and the beneficial users of the surface water is uncertain due to the lack of quantitative diversion, return flow, and consumption data. The insert in **Figure** GWC-16 plots model-calculated Cosumnes River depletions and adjacent observed groundwater levels in the seasonally disconnected reach (RMW-ISW2 and RMW-ISW3), and results show that there is no simple correlation between depletions and groundwater levels. The depletions in **Figure GWC-16** occur when surface-water leakage out of the river channel is greater than groundwater seepage into the river, resulting in a net depletion (loss) of surface water from the river. During low flow conditions, groundwater levels are substantially below the streambed, but depletions are typically near zero because of low surface-water flow and stage. During high flow conditions, the greatest depletions occur during runoff when groundwater is at its lowest levels following the dry summer and fall. In contrast, interconnected conditions occur when groundwater levels exceed the streambed elevation. Under interconnected conditions, depletions occur when groundwater levels are below the river stage. The relationships between groundwater levels and depletions can be complicated by the hydraulic gradient between groundwater systems on either side of the river. For example, near RMW-ISW3 model-calculated groundwater levels generally exceed river stage resulting in seepage into the river, whereas model-calculated groundwater levels north of RMW-ISW3 and the river are generally below the river stage resulting in leakage out of the river.

9.7. Groundwater Dependent Ecosystems

> *§ 354.16. Groundwater Conditions*
> *(g) Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or the best available information.*

Groundwater dependent ecosystems (GDEs) are defined in the GSP regulations [23-CCR §351(m)] as "*ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface.*" DWR and The Nature Conservancy (TNC) have developed a map of "Natural Communities Commonly Associated with Groundwater" (NCCAG) for use by GSAs in identifying potential GDEs. Based on TNC's "*Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act Guidance for Preparing Groundwater Sustainability Plans*" guidelines, natural communities are considered disconnected from the Principal Aquifer when located where DTW contours are greater than 30 ft bgs or within 3.1 miles of a well with a DTW measurement greater than 30 ft bgs (TNC, 2018).

Detailed investigation of the NCCAG data set included a desktop evaluation to identify potentially missing GDEs, followed by on- and off-site (remote) study of select sites for vegetation type, health, species composition, ecosystem change, geomorphic setting, inferred source aquifer, and man-made modifier (**Appendix L**). The results were evaluated and identified the maximum possible extent of potential GDEs. The vegetated areas were classified as: (1) GDEs, either confirmed by all criteria or assumed when some criteria were incomplete, (2) disconnected from the Principal Aquifer and therefore not considered GDEs, or (3) unknown as a result of one or more significant data gaps. The most influential data gap was the absence of shallow well data to confirm whether the water table in the Principal Aquifer is accessible to plant roots.

Figure GWC-17(a) shows the 6,960 acres of potential GDEs in the Basin, based on the NCCAG data set, **Figure GWC-17(b)** shows the almost 19,700 acres of total maximum potential GDE areas, based on the desktop evaluation, and **Figure GWC-17(c)** shows confirmed and assumed-confirmed GDE areas (990 and 820 acres, respectively) in the westernmost part of the Basin, west of Highway 99. The 1,810 acres of confirmed and assumed-confirmed GDEs occur in an area where groundwater and surface water are likely interconnected. Historical data show that seasonal water levels can range about 10 feet between spring and fall (see hydrographs in **Figure GWC-5**), and the confirmed GDE area is consistent with the area determined to be underlain by water within 30 ft bgs. Remote sensing data indicate an overall upward trend in average annual greenness in the Basin, and the contrast in greenness between spring and fall conditions provided confirmation of identified GDE areas. The results from the GDE study are consistent with previous surveys that found the health of the GDEs located near the Consumnes River increased downstream when quantified by six metrics (growth, diversity, regeneration, structure, native plant dominance, and survivorship) (Rohde et al., 2019).

An additional 4,020 acres of potential GDEs in the Basin Foothills subarea have unknown GDE status. In this eastern part of the Basin, the DTW is highly variable making it difficult to reliably delineate between areas where DTW is less than or greater than 30 ft bgs. Accordingly, these areas were conservatively assumed GDEs. The remaining potential areas are not characterized as GDEs, including approximately 2,430 acres of vegetation that obtain moisture from surface water and/or perched water and 11,440 acres where groundwater depths are greater than 30 ft bgs. Vegetation in these two areas are not classified as GDEs.

Table GWC-6 below summarizes the final distribution of potential GDEs mapped in **Figure GWC-17** and reports their maximum plant rooting depths as compiled by TNC.[46] Reported maximum rooting depths range from 1.0 to 7.0 feet for the potential GDEs located in the westernmost portion of the Basin and 1.0 to 13 feet for potential GDEs located in the Basin Foothills subarea.

The GSAs recognize the importance of GDEs and intend to maintain considerations of GDEs during GSP implementation. As discussed further in Section 19.1.1 *Monitoring and Data Collection,* various monitoring and data collection activities are planned for observing GDE health including plans to assess monitoring data to evaluate possible triggers as part of the five-year update.

[46] https://groundwaterresourcehub.org/sgma-tools/gde-rooting-depths-database-for-gdes

Table GWC-6. Maximum Plant Rooting Depths for Potential GDEs

Potential GDE		Maximum Rooting Depth (feet)(1)
Scientific Name/NCCAG Category	**Common Name**	
Potential GDE with DTW < 30 ft bgs (Western Boundary near Delta)		
Arid West freshwater emergent marsh	N/A	
Lepidium latifolium	Broadleaf Pepper-grass	
Persicaria lapathifolia - Xanthium strumarium	Curlytop Knotweed	
Salix exigua (Salix lasiolepis) Rubus discolor	Narrowleaf Willow	3 to 7(2)
Salix gooddingii Quercus lobata / wetland herb	Gooding's Willow	7
Salix lasiolepis	Arroyo Willow	3(2)
Schoenoplectus acutus Typha latifolia	Hardstem Bulrush	1 to 2
Western North American Freshwater Aquatic Vegetation	N/A	
Western North American Freshwater Marsh	N/A	
Potential GDE with DTW < 30 ft bgs (Basin Foothills)		
Acer negundo	Box-elder	7 to 13
Ailanthus altissima - provisional	Tree-of-Heaven	4
Alnus rhombifolia	White Alder	2(2)
California Warm Temperate Marsh/Seep	N/A	
Californian Warm Temperate Marsh/Seep Group	N/A	
Fraxinus latifolia	Oregon Ash	6(2)
Heterotheca oregona	Oregon Goldenaster	
Juncus arcticus (var. balticus, mexicanis)	Arctic Rush	1
Riparian Evergreen and Deciduous Woodland	N/A	
Rubus armeniacus	Himalayan blackberry	1 to 4(2)
Salix laevigata	Red Willow	3(2)
Schoenoplectus (acutus, californicus)	Hardstem Bulrush	2
Typha (angustifolia, domingensis, latifolia)	Narrowleaf Cattail	1
Potential GDE with DTW > 30 ft bgs but not within 3 miles of well with DTW data		
Juglans hindsii and hybrids	Northern California Black Walnut	6 to 15(2)
Populus fremontii	Fremont Cottonwood	1 to 7
Quercus lobata	Valley Oak	24(3)
Salix exigua	Narrowleaf Willow	3 to 7(2)
Salix gooddingii	Gooding's Willow	7

Notes:

(1) Maximum rooting depth was not available for all potential GDEs.
(2) Rooting depth based on similar species
(3) There is a significant presence of Blue Oak in the Basin, largely in the drier (non-riparian/wetland) portions of the Basin Foothills Subarea, and it coexists with Live Oak. References to the potentially deep (80 ft bgs) rooting depths for Blue Oak pertain to trees growing in shallow soils (Lewis and Burgy, 1964). However, the Principal Aquifer is comprised of unconsolidated sediment – not fractured rock. Moreover, Blue Oak has low soil moisture requirements, and is not

groundwater dependent or associated with wetland/riparian habitats. The 30 ft bgs is therefore utilized as the lower depth to water for GDEs.

The TNC also compiled a list of freshwater species in addition to potential vegetative and wetland GDEs located within each groundwater basin for use by GSAs to evaluate species reliant on surface water.[47] The list includes 243 unique species grouped into eight taxonomic groups: birds, crustaceans, fishes, herps (i.e., reptiles), insects and other inverts, mammals, mollusks, and plants. **Appendix K** contains copies of the TNC freshwater species lists for the Basin. The species on this list, including the special status species listed below, may be present within the Basin. However, additional work supported by wildlife surveys would be needed to confirm the list.

As of April 2015, species on the Federal Endangered Species list that may be present within the Basin are listed below, but not all species in list are reliant on groundwater or interconnected surface water (for example, vernal pool fairy shrimp).

- Bird of Conservation Concern: bald eagle, tricolored blackbird, and willow flycatcher
- Threatened: vernal pool fairy shrimp, Central Valley steelhead, California tiger salamander, California red-legged frog, and giant garter snake
- Endangered: vernal pool tadpole shrimp, Sacramento Orcutt grass
- Under review in the candidate or petition process: foothill yellow-legged frog and western spadefoot

As of April 2015, species on the California Endangered Species or Sensitive Species lists that may be present within the Basin include the following:

- Endangered: bald eagle, willow flycatcher, Sacramento Orcutt grass, fleshy owl's-clover
- Special Concern: American white pelican, canvasback, redhead, tricolored blackbird, yellow-breasted chat, yellow-headed blackbird, vernal pool fairy shrimp, vernal pool tadpole shrimp, California fairy shrimp, midvalley fairy shrimp, Central Valley steelhead, western pond turtle, foothill yellow-legged frog, California red-legged frog, western spadefoot, California floater, western pearlshell, dwarf downingia, Tuolumne coyote-thistle, pincushion navarretia, false Venus'-looking-glass, and sanford's arrowhead
- Threatened: bank swallow, California tiger salamander and giant garter snake
- Watch List: white-faced ibis

The Cosumnes River is also home to the fall-run Chinook salmon, which were surveyed between Michigan Bar and Meiss Road Bridge by the California Department of Fish and Wildlife (DFW) from 1953 to 1988 and 1998 to 2018 (Snider and Reavis, 2000; Azat, 2019). **Figure GWC-18** shows the Chinook Salmon escapement counts for the fall-run Chinook Salmon along the Cosumnes River. Limited and/or non-existent fall flows have been identified as the inhibitor to salmon migration (Fleckenstein et al., 2004).

[47] https://groundwaterresourcehub.org/sgma-tools/environmental-surface-water-beneficiaries/

Recent improvements to the fish ladders at Granlees Dam and flashboard dam foundation by The Fishery Foundation of California has restored passage for salmon to reach their spawning habitats.[48]

The interconnected surface water monitoring conducted as part of GSP implementation (see Section 17 *Monitoring Network*) and data generated following the planned construction of new monitoring wells will improve characterization of GDEs and other surface-water dependent species with an emphasis on water table conditions, seasonal and annual climate fluctuations, and instream flow requirements.

9.7.1. Groundwater Conditions Data Gaps

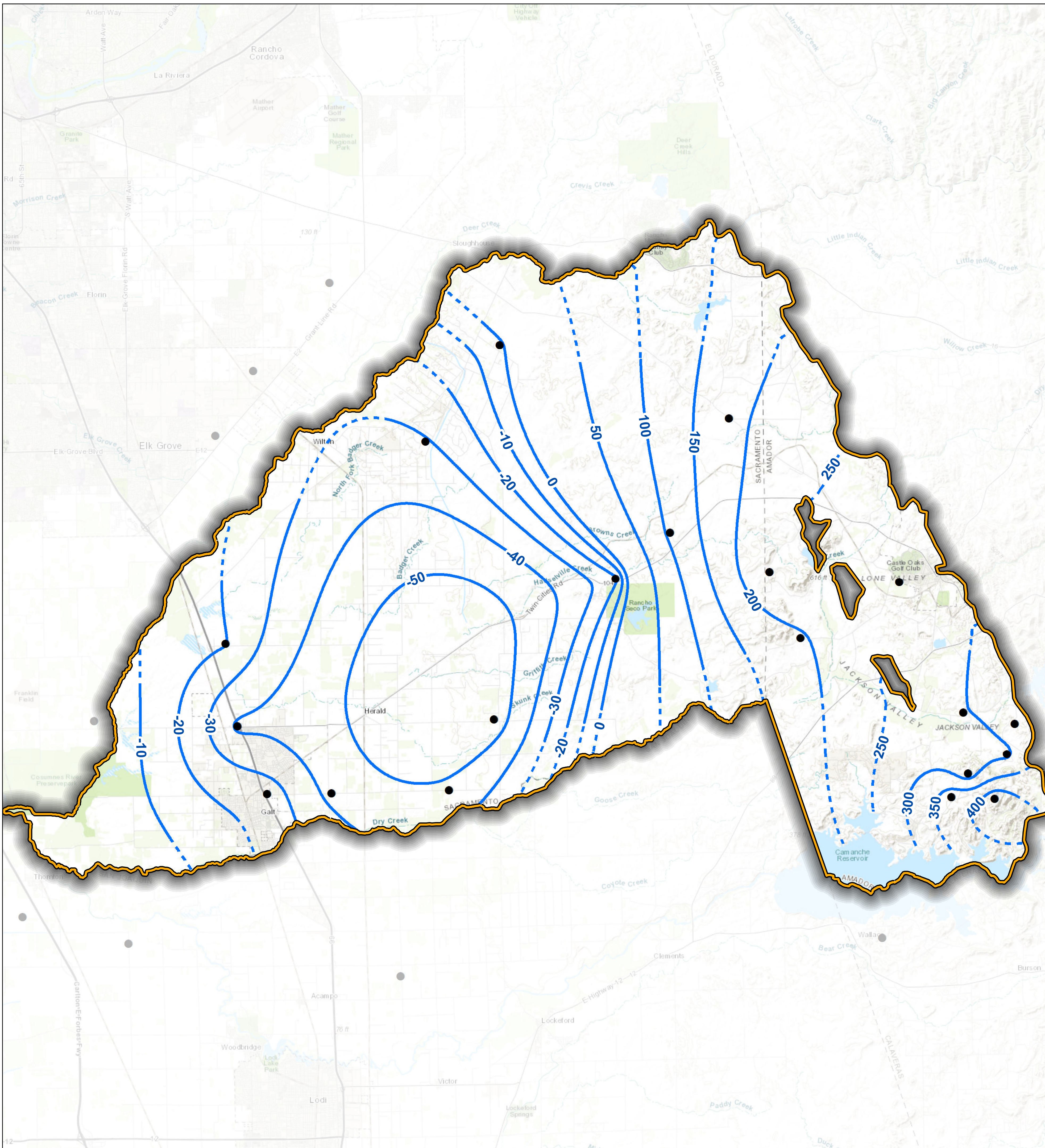
Data gaps and uncertainties identified during development of the Groundwater Conditions for the Basin include:

- Water level data are important for evaluating groundwater conditions in the Basin and can be used to estimate both horizontal and vertical groundwater flow directions and used as proxy to evaluate changes in groundwater storage over time. Well construction information (i.e., completed depth and perforated intervals) is required to link the water level data to a depth within the Principal Aquifer. Water level data exists for 194 (29%) of the wells (including water level data for periods prior to the late 1990s) within the Basin DMS, however the completed perforated interval is known for only 40% of these wells.
- The DWR recommends that historical water budget assessments use at least the most recent 10 years of information and develop water year types based on 30-year averages (DWR, 2016c). A total of 55 wells have at least 10 consecutive years of annual groundwater level records during the last 30 years and can provide "representative" hydrologic trends in the Basin (28% of all 194 wells having water level data records). Of these 55 wells, well depth is known for 44 (80%) and perforated interval is known for 35 (64%). These data sets may be useful to characterize historical groundwater trends during parts of the past 30 years, but their utility can be limited by lack of continuous records and well construction information.
- Well pairs can provide measured differences in groundwater levels with depth, infer vertical groundwater flow gradients in the Principal Aquifer, and identify perched groundwater conditions. Only ten sites with shallow/deep well pairs have been identified within the Basin, and none of the wells are shallow enough to represent potentially perched groundwater. The available well pairs are limited to areas near the northeastern and western portion of the Basin in Sacramento County, and the southeastern portion of the Basin in Amador County, indicating also lack of potential sites and data within a large interior portion of the Basin.
- The Basin DMS contains information for 61 shallow wells that are constructed to depths less than 150 ft bgs. While several shallow wells are located near surface water features, few to none are located adjacent to an existing river/stream gauging station, and no pairs are shallow enough and close enough to identify potentially perched groundwater conditions. These deficiencies introduce uncertainty when comparing shallow groundwater level and stream stage data. Four gauging

[48] http://www.fisheryfoundation.org/projects/current/CR_salmon_passage.html

stations on the Cosumnes River have recorded flow or stage, indicating that there are multiple potential reaches where flows may be able to be compared to estimate seepage or leakage. However, only one inactive station exists on Dry Creek while stations have not been established on the remaining creeks. Comparisons between the available shallow well water levels and stream gauge measurements show there is limited overlap in their respective recording periods. The well and gauging station data in the Basin DMS are therefore inadequate for quantifying shallow conditions and represent a data gap in the evaluation of GDEs as well as interconnected surface water and groundwater.

- Available water quality data identifies potential water quality concerns, based on samples exceeding Primary MCLs, Secondary MCLs, and AL. Most of the water quality data are limited spatially to monitoring wells and public water supply wells around City of Galt and few areas in Amador County.



Legend

- ● Well with Spring 2018 GWE
- Spring 2018 GWE Contour (ft MSL), dashed where most uncertain
- Cosumnes Subbasin (5-022.16)

Abbreviations

DWR = California Department of Water Resources
ft MSL = feet above Mean Sea Level
GWE = Groundwater Elevation

Notes

1. All locations are approximate.
2. Contours are inferred from GWE values.
3. Spring 2018 GWE values outside Basin used to control contouring at boundaries.
4. Wells located outside the Basin are colored in gray.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.

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(Scale in Miles)

Groundwater Elevation Contours
Spring 2018

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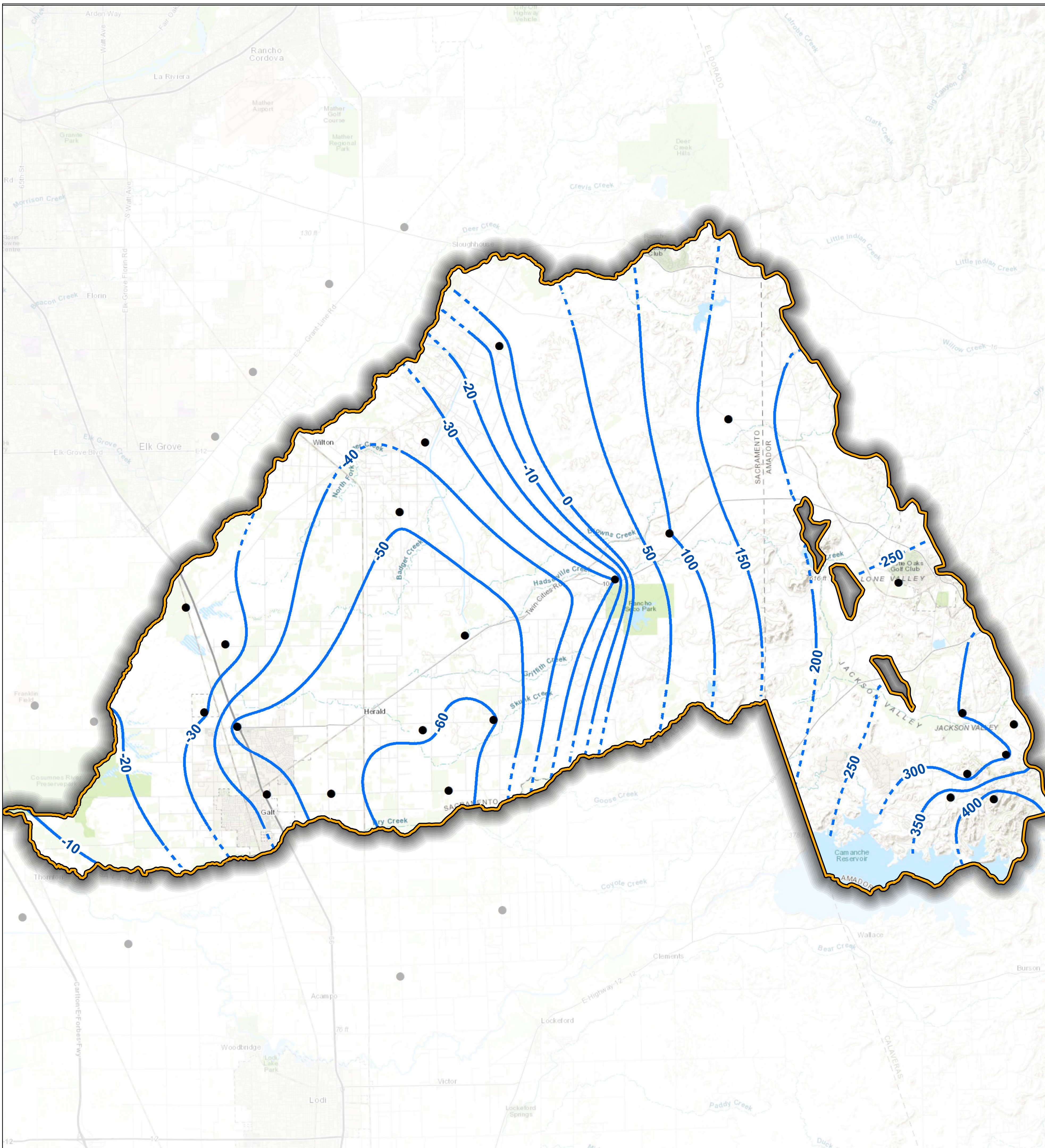
Figure GWC-1

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_GWC-01- Groundwater Elevation Contours - Spring 2018.mxd



Legend

- ● Well with Fall 2018 GWE
- Fall 2018 GWE Contour (ft MSL), dashed where most uncertain
- Cosumnes Subbasin (5-022.16)

Abbreviations

DWR = California Department of Water Resources
ft MSL = feet above Mean Sea Level
GWE = Groundwater Elevation

Notes

1. All locations are approximate.
2. Contours are inferred from GWE values.
3. Fall 2018 GWE values outside Basin used to control contouring at boundaries.
4. Wells located outside of the Basin are colored in gray.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.

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(Scale in Miles)

Groundwater Elevation Contours
Fall 2018

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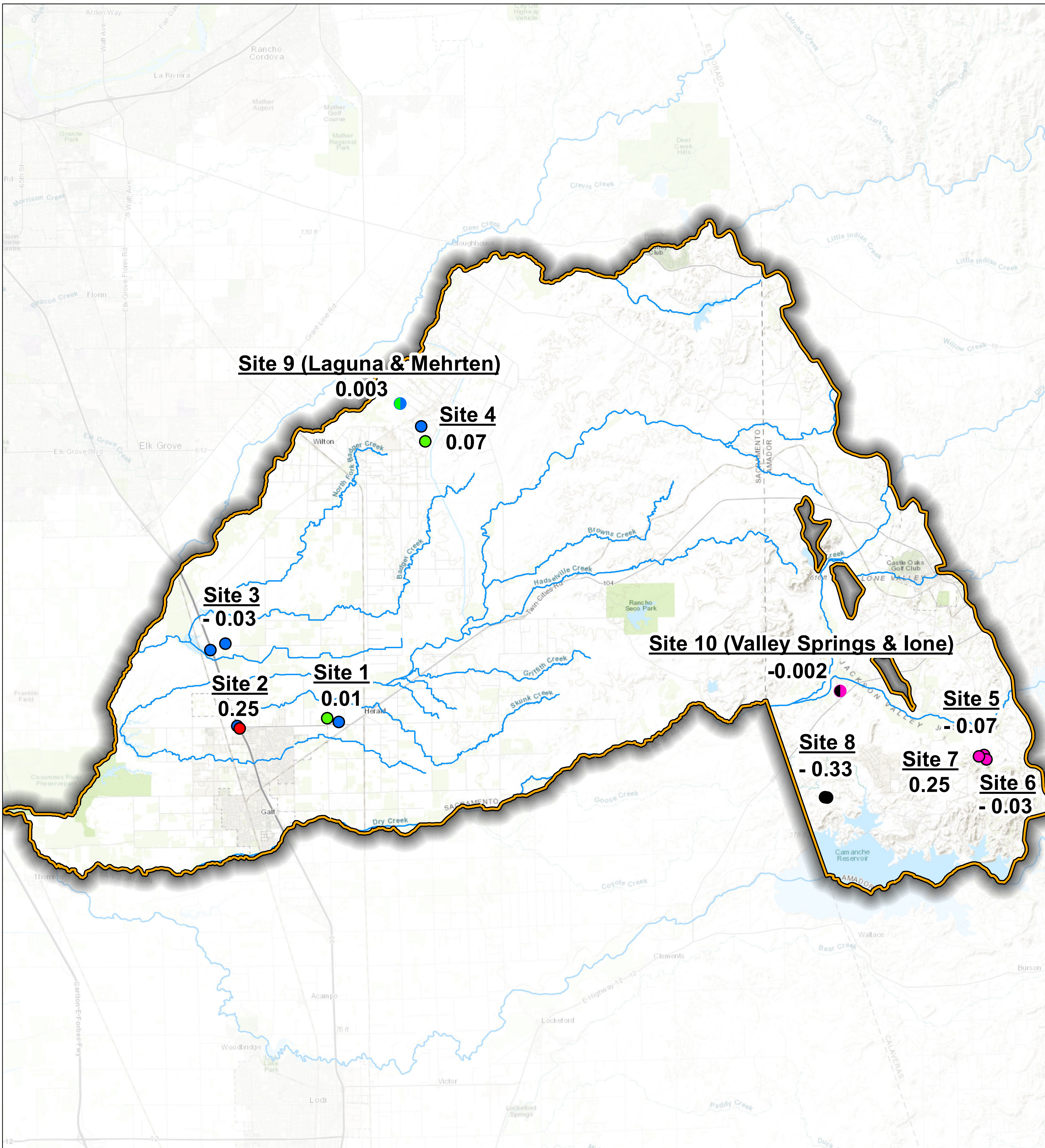
Figure GWC-2

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_GWC-02- Groundwater Elevation Contours - Fall 2018.mxd



Legend

Wells Screened Primarily in One Formation

- Victor Formation
- Laguna Formation
- Mehrten Formation
- Valley Springs Formation
- Ione Formation
- Major Stream

Abbreviations

DWR = California Department of Water Resources
TSS = Technical Support Services

Notes

1. All locations are approximate.
2. Negative values indicate upward gradient and positive values indicate downward gradient.
3. Sites 9 and 10 were installed with TSS Grant funding and have multiple wells at varying depths at each location.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.

Calculated Vertical Gradients
Variable Dates between 2015-2021

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Figure GWC-3

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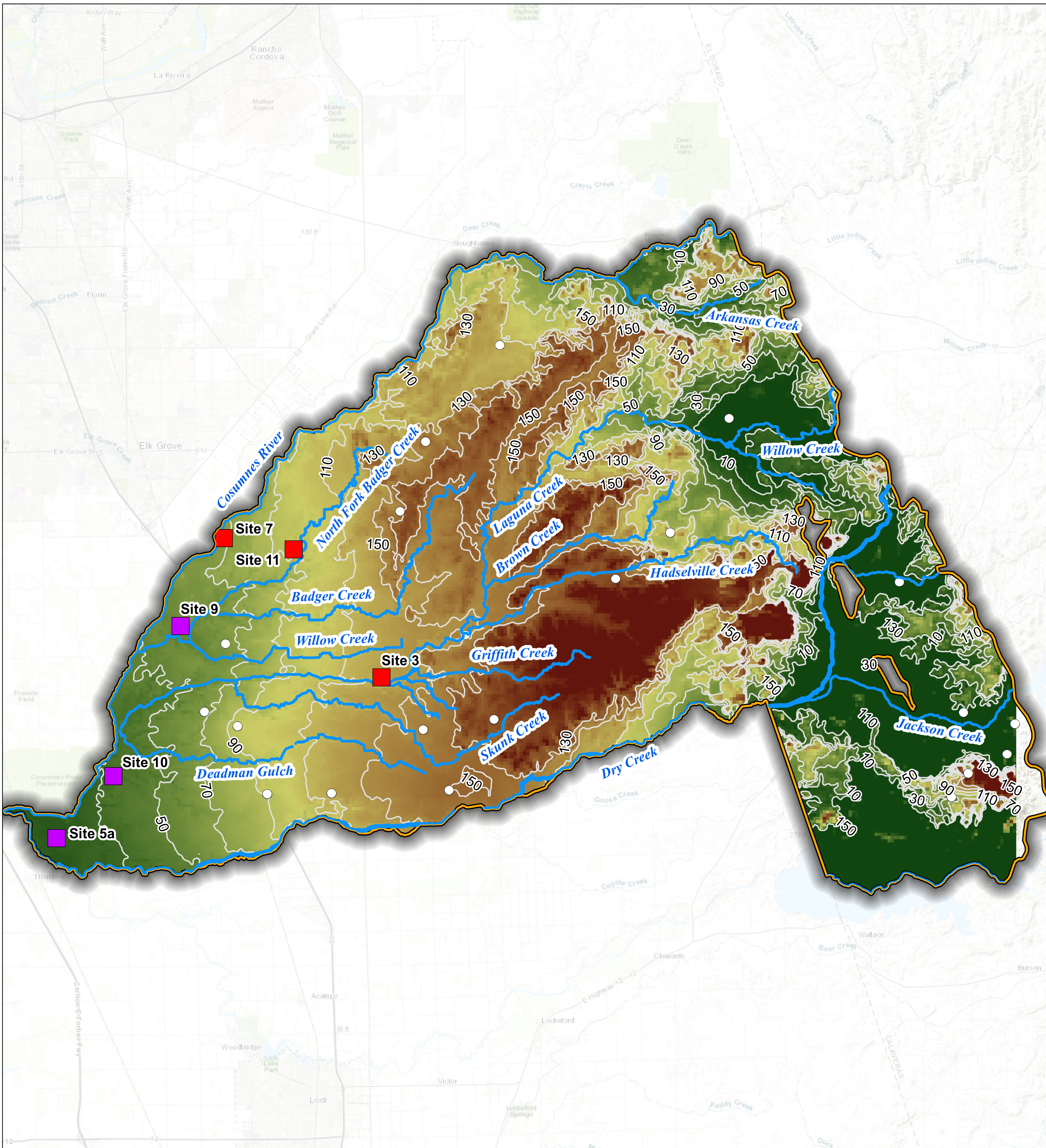
Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_GWC-03_Vertical Gradients.mxd



Legend

Well with Fall 2018 Depth to Water Measurement (ft bgs)

Fall 2018 Depth to Water Contour (ft bgs)

Major Stream

Nuclear Magnetic Resonance (NMR) Survey Sites (November, 2020)

Dry to 50 ft or more below ground surface

Possible Perched Groundwater

Depth to Groundwater (ft bgs)

Deep : 200

Shallow : 0

Abbreviations

DWR = California Department of Water Resources

ft = feet

ft bgs = feet below ground surface

NMR = Nuclear Magentic Resonance

Notes

1. All locations are approximate.
2. Contours are inferred from groundwater elevation contours subtracted from land surface elevation.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.

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(Scale in Miles)

Calculated Depth to Groundwater
Fall 2018

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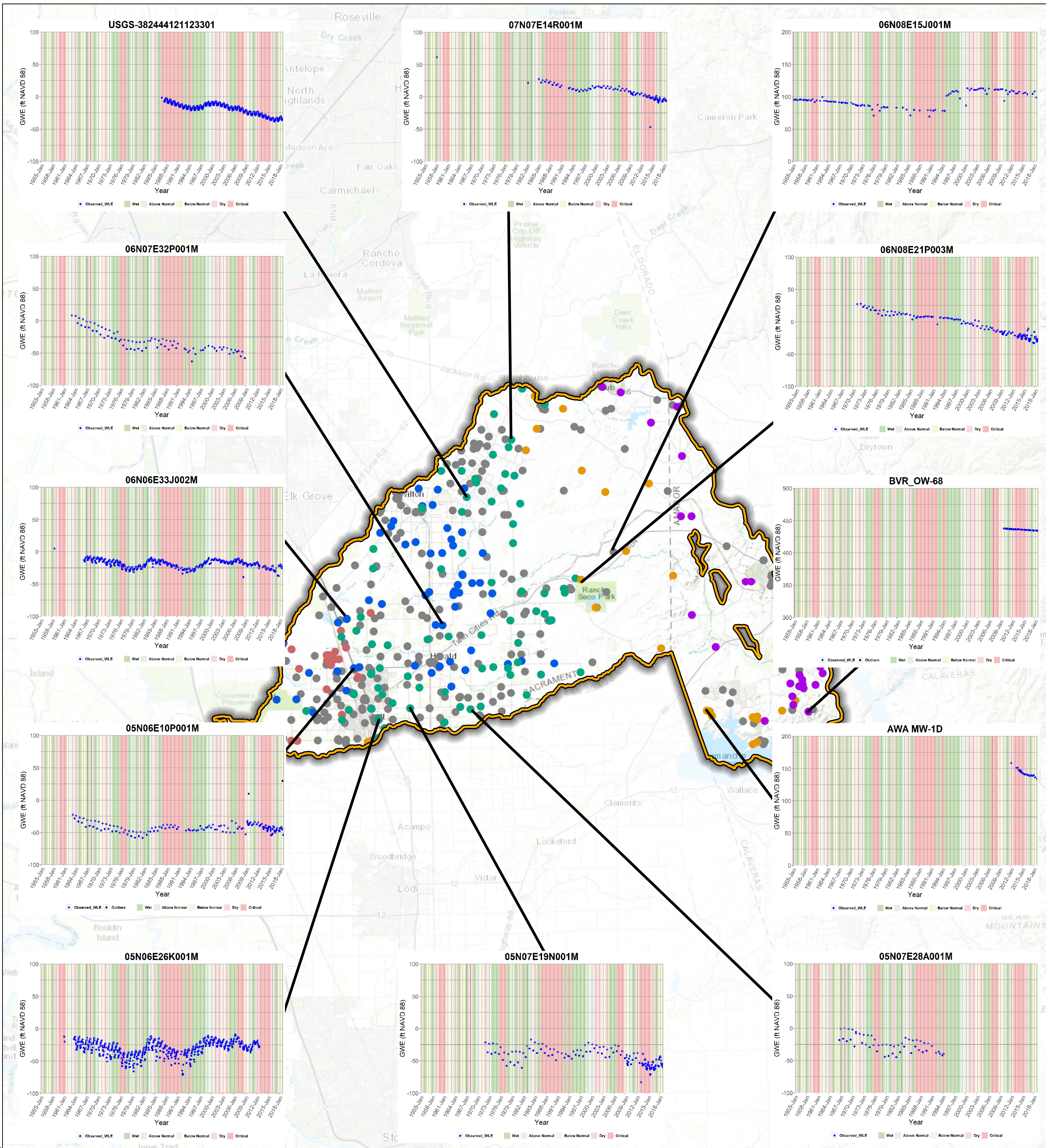
Figure GWC-4

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_GWC-04_Depth to Groundwater - Fall 2018.mxd



Legend

Well Screened Primarily in One Formation

- Victor Formation
- Laguna Formation
- Mehrten Formation
- Valley Springs Formation
- Ione Formation
- Unknown Formation
- Cosumnes Subbasin (5-022.16)

DWR Water Year Type

- Wet
- Above Normal
- Below Normal
- Dry
- Above Normal

Hydrograph Key

- Observed Groundwater Elevation (ft-msl)
- Observed Groundwater Elevation Outlier (ft-msl)

Abbreviations

DWR = Department of Water Resources
ft msl = feet above mean sea level

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 20 May 2019.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.

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(Scale in Miles)

Historical Groundwater Elevation Hydrographs 1955 - 2018

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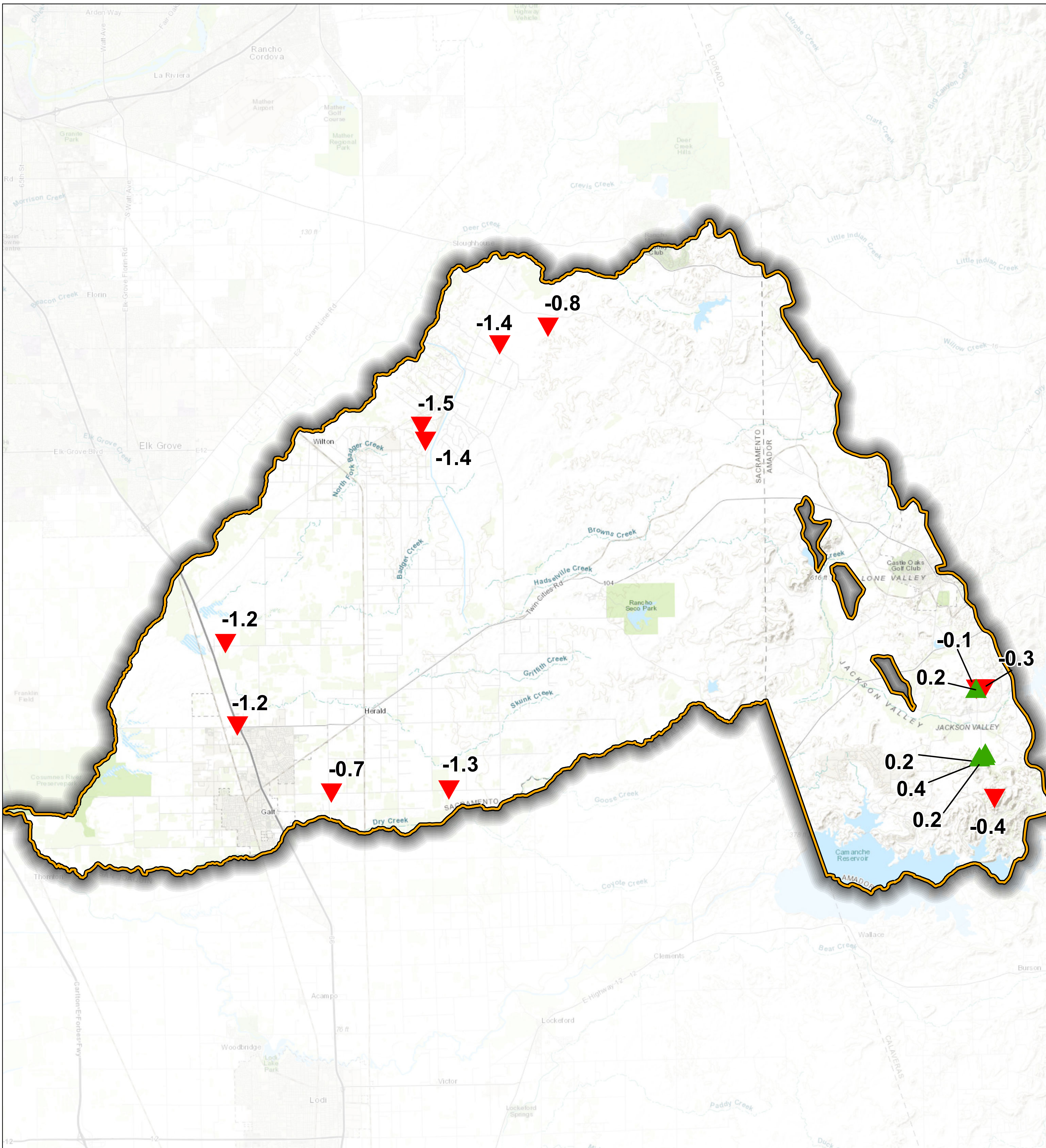
Figure GWC-5

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_GWC-05_Historical Long-Term Groundwater Elevation Hydrographs.mxd



Legend

▲ Well with Upward Water Level Trends (ft/yr)

▼ Well with Downward Water Level Trends (ft/yr)

▭ Cosumnes Subbasin (5-022.16)

Abbreviations

DWR = California Department of Water Resources

ft/yr = feet per year

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.

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(Scale in Miles)

Statistically Significant Groundwater Level Trends
WY 2009 - WY 2018

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Figure GWC-6

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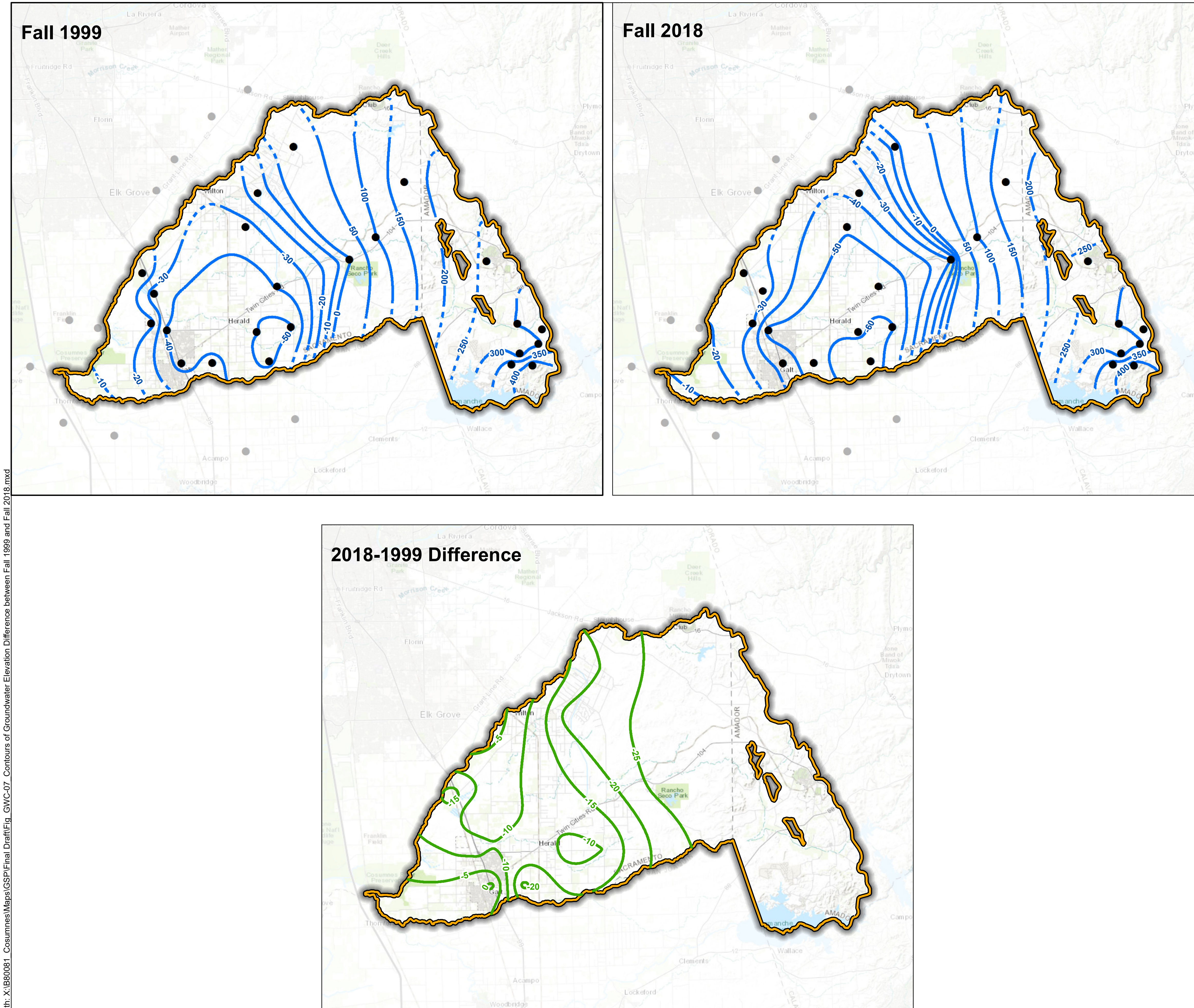
Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_GWC-06_Groundwater Level Trends.mxd



Legend

Cosumnes Subbasin (5-022.16)

GWE Difference (ft), Fall 2018 - Fall 1999

GWE Contour (ft MSL), dashed where most uncertain

Well with GWE Value

Abbreviations

DMS = Data Management System
DWR = Department of Water Resources
ft = feet
ft MSL = feet above Mean Sea Level
GWE = Groundwater Elevation

Notes

1. All locations are approximate.
2. Contours are inferred from GWE measurements.
3. GWE difference contours are Fall 2018 minus Fall 1999.
4. GWE values outside Basin used to control contouring boundaries.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.
3. GWE measurements are from the Cosumnes DMS.

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(Scale in Miles)

Difference Between Fall 1999 and Fall 2018 Groundwater Elevation Contours

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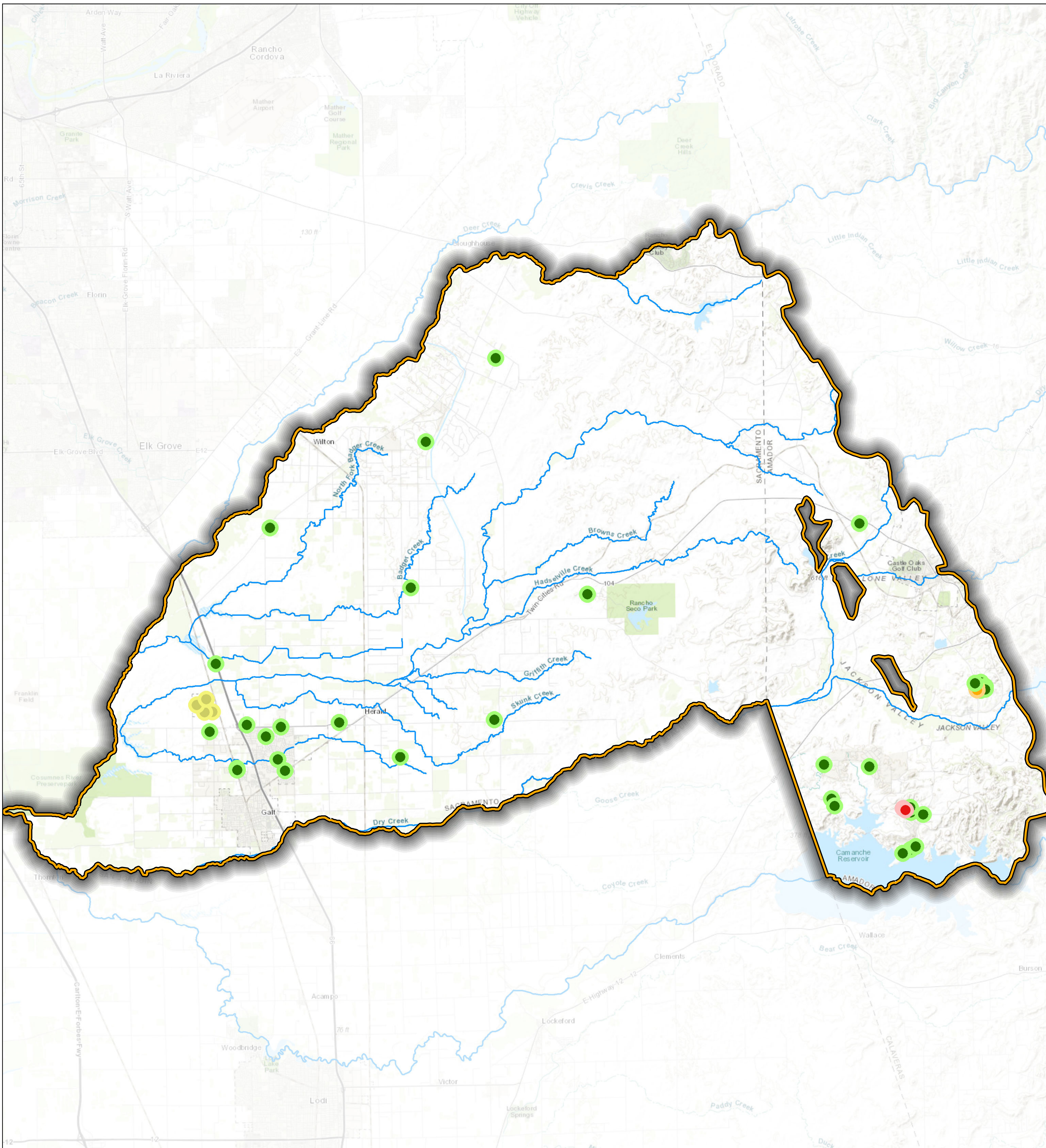
Figure GWC-7

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_GWC-07_Contours of Groundwater Elevation Difference between Fall 1999 and Fall 2018.mxd



Legend

Maximum Chloride Concentration (mg/L)

- < 50
- 50 - 125
- 125 - 250
- > 250 (Exceeding Secondary MCL)
- Major Streams

Abbreviations

DMS = Data Management System
DWR = California Department of Water Resources
MCL = Maximum Contamination Limit
mg/L = milligram per liter

Notes

1. All locations are approximate.
2. Constituent concentration is the maximum observed for each well between 2015 and 2019.
3. Chloride has a Secondary MCL of 250 mg/L.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.
3. Groundwater quality data from Cosumnes DMS, which was compiled from various sources.

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(Scale in Miles)

Maximum Chloride Concentrations in Well Water Samples

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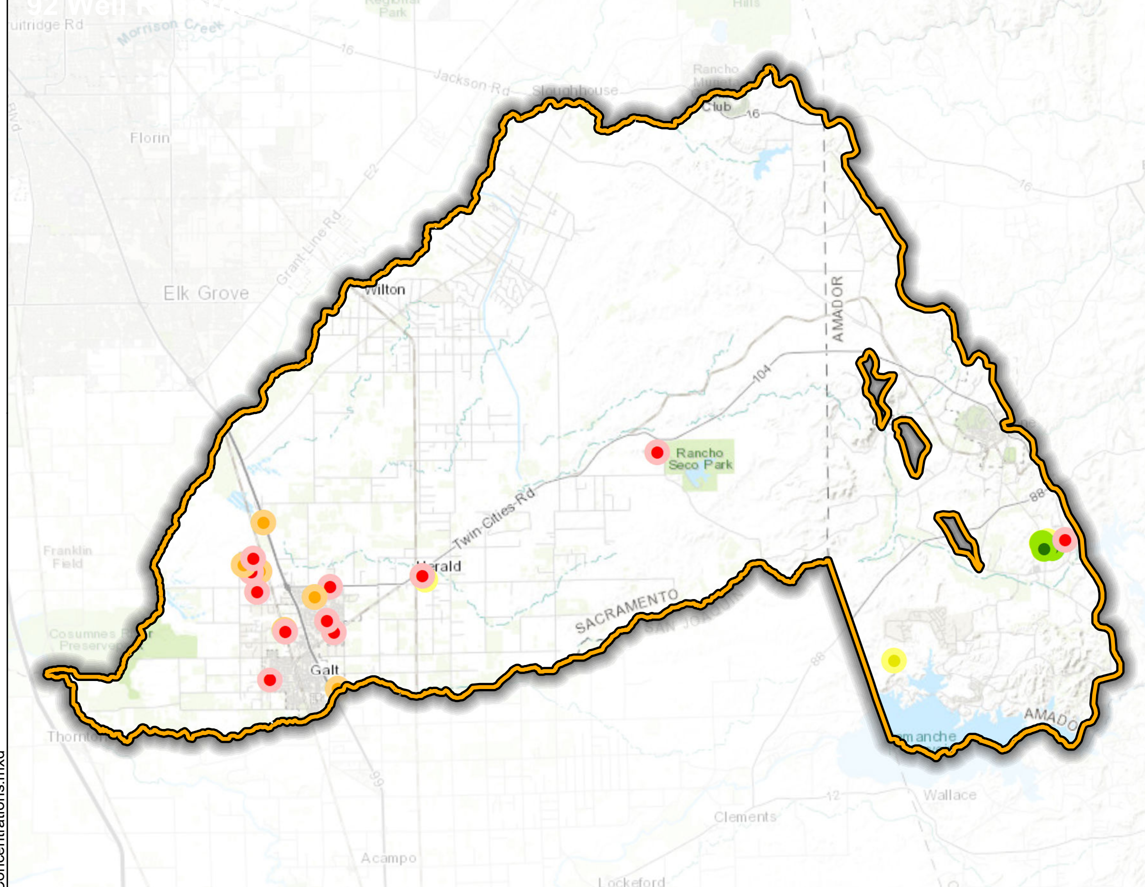
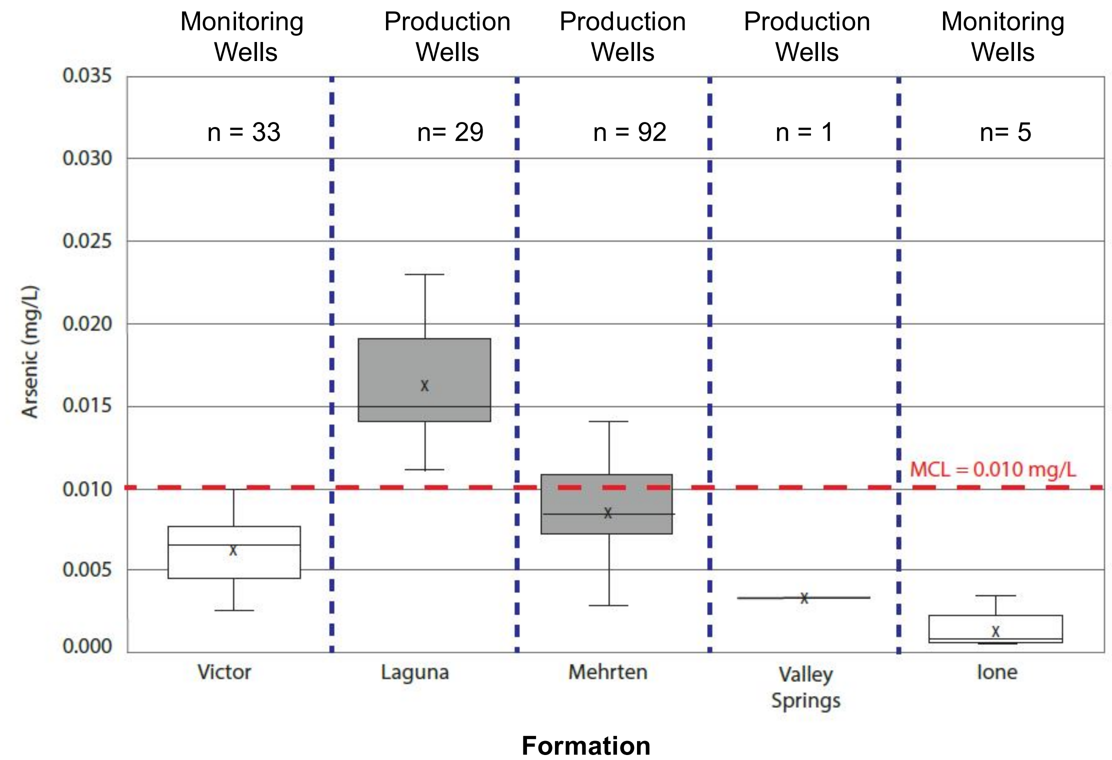
Figure GWC-8

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_GWC-08_Maximum Chloride Concentrations.mxd

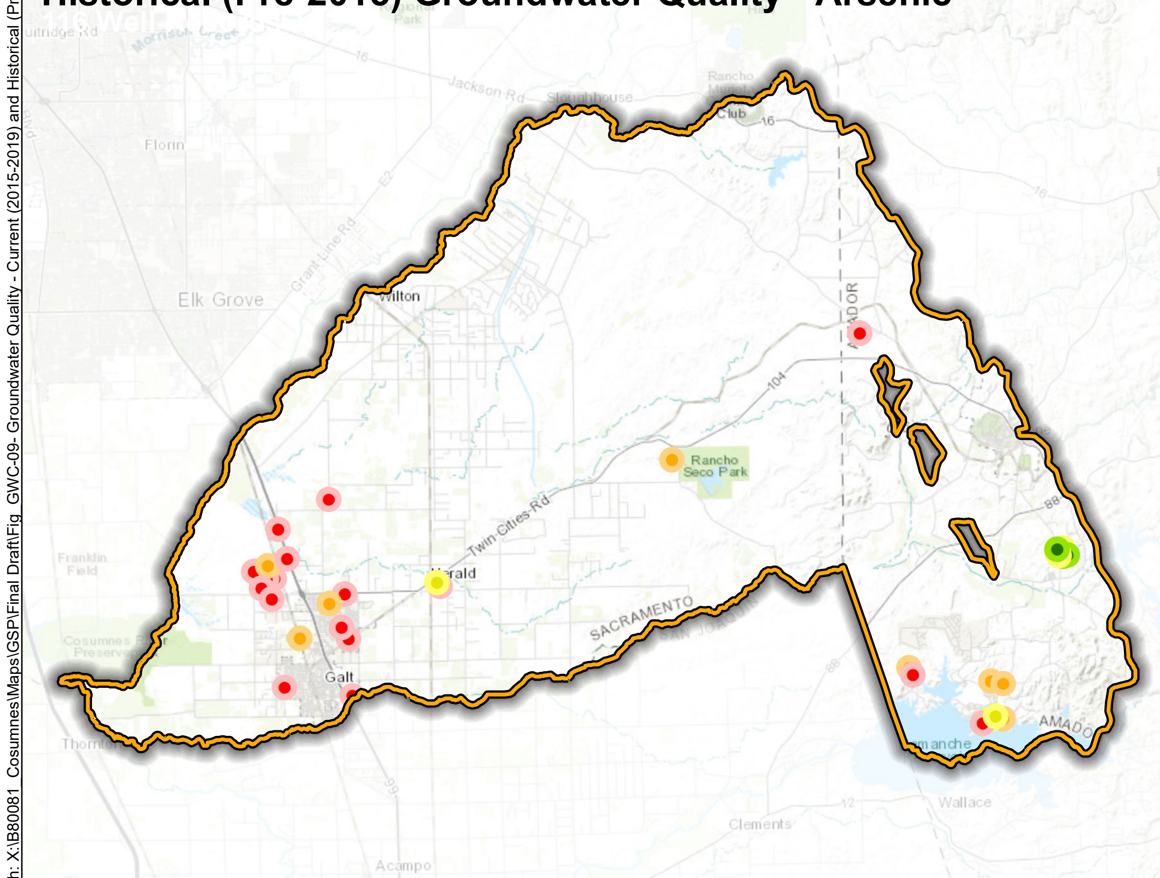
Current (2015-2019) Groundwater Quality - Arsenic



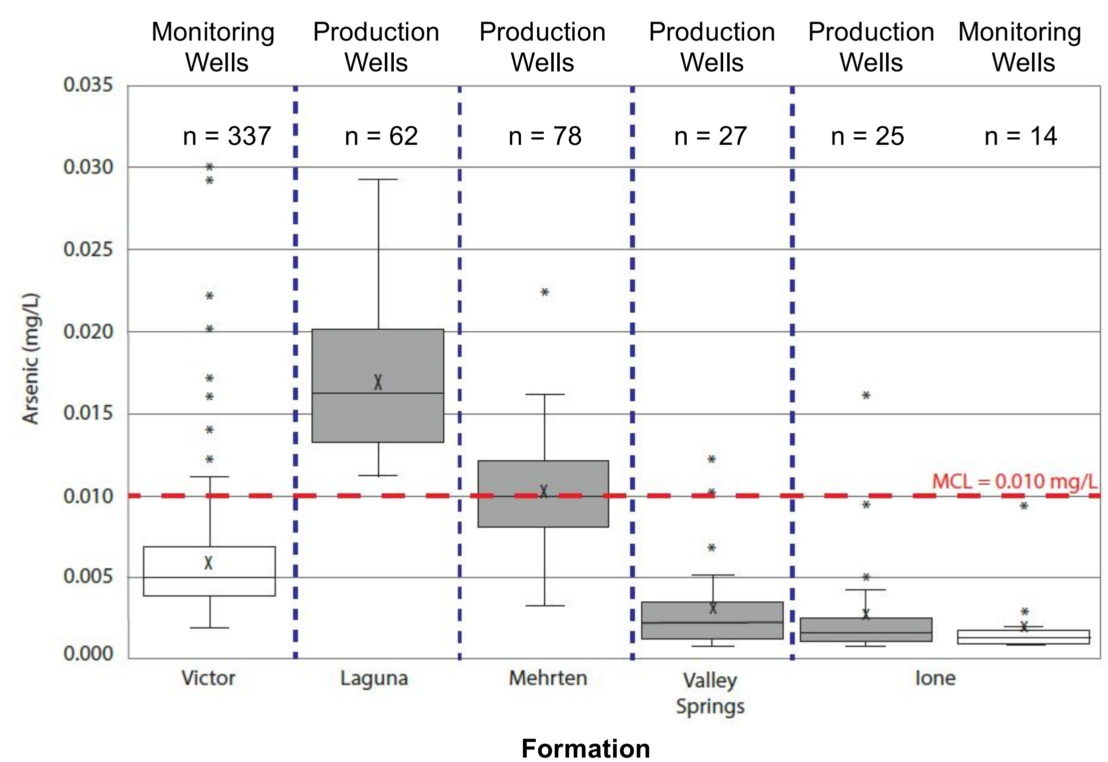
Current Boxplots - Arsenic



Historical (Pre-2015) Groundwater Quality - Arsenic



Historical Boxplots - Arsenic



Legend

Arsenic Concentration (mg/L)

- < 0.001
- 0.001 - 0.004
- 0.004 - 0.009
- > 0.01 (Exceeding MCL)
- Cosumnes Subbasin (5-022.16)

- * outlier
- maximum
- 75th percentile
- median
- 25th percentile
- minimum

Abbreviations

DMS = Data Management System
DWR = California Department of Water Resources
MCL = Maximum Contamination Limit
mg/L = milligram per liter

Notes

1. All locations are approximate.
2. Constituent concentration is the maximum observed for each well.
3. Arsenic has a Primary MCL of 0.01 mg/L.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.
3. Groundwater quality data from Cosumnes DMS, which was compiled from various sources.

N
0 4 8
(Scale in Miles)

Groundwater Quality Current (2015-2019) and Historical (Pre-2015) Arsenic Concentrations in Well Water Samples

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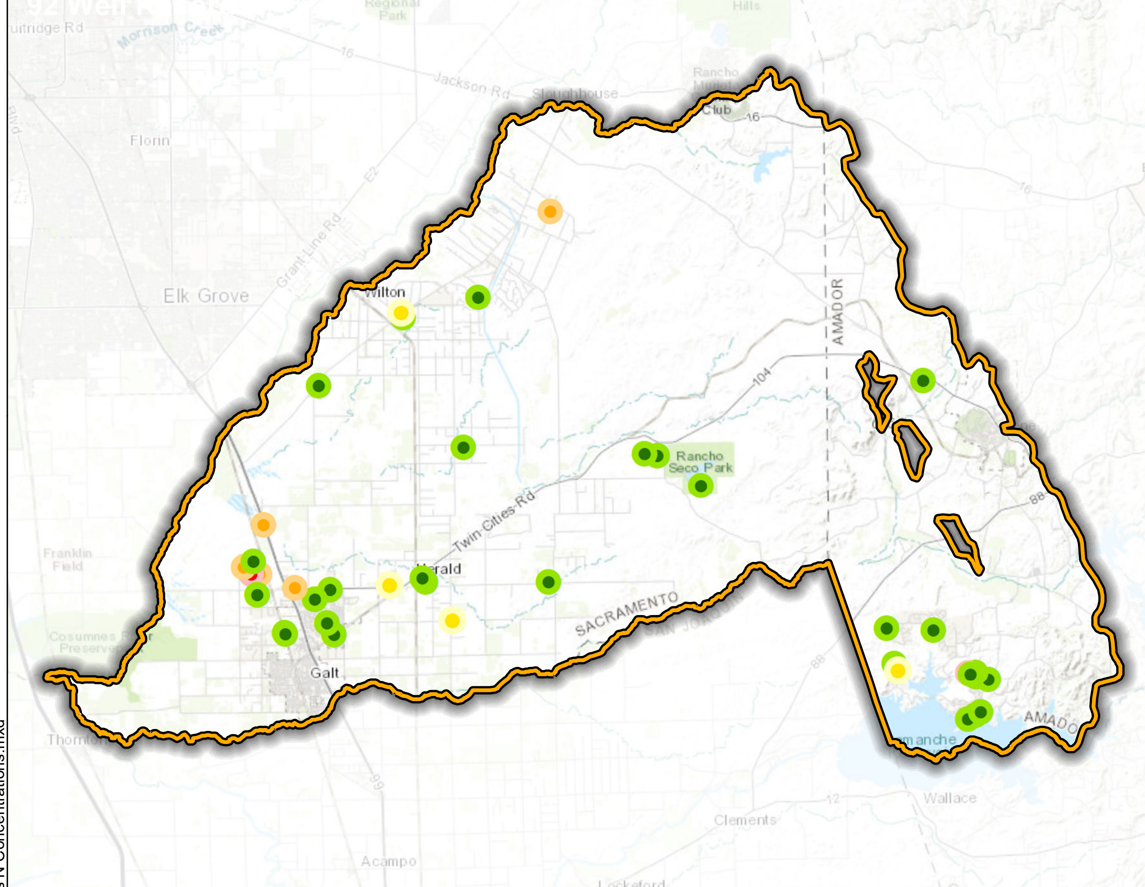
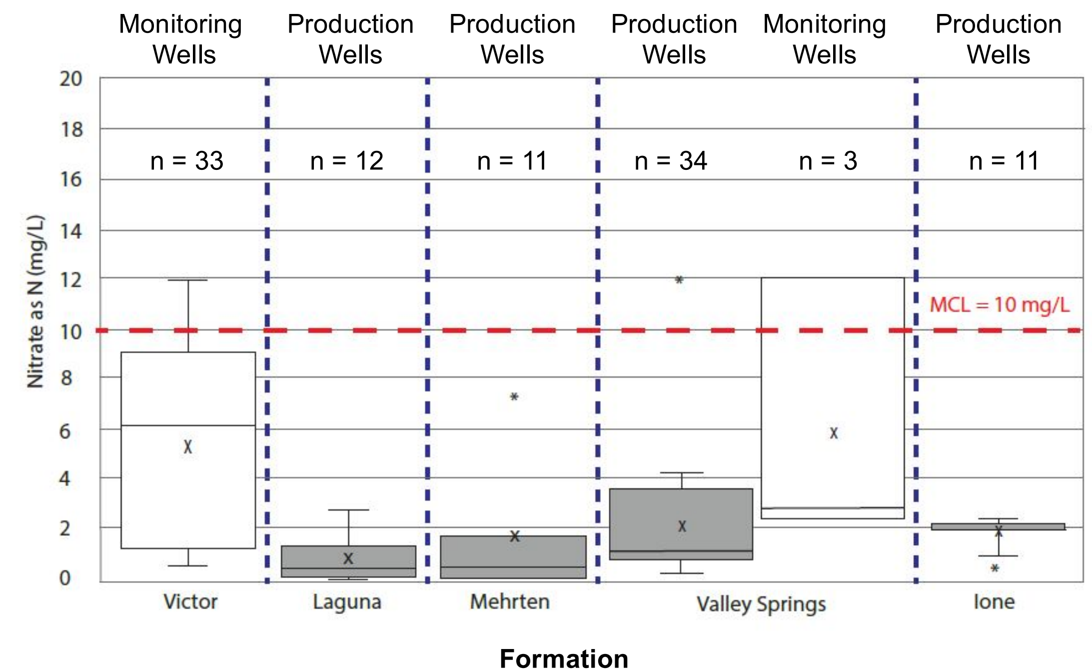
Figure GWC-9

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_GWC-09- Groundwater Quality - Current (2015-2019) and Historical (Pre-2015) Arsenic Concentrations.mxd

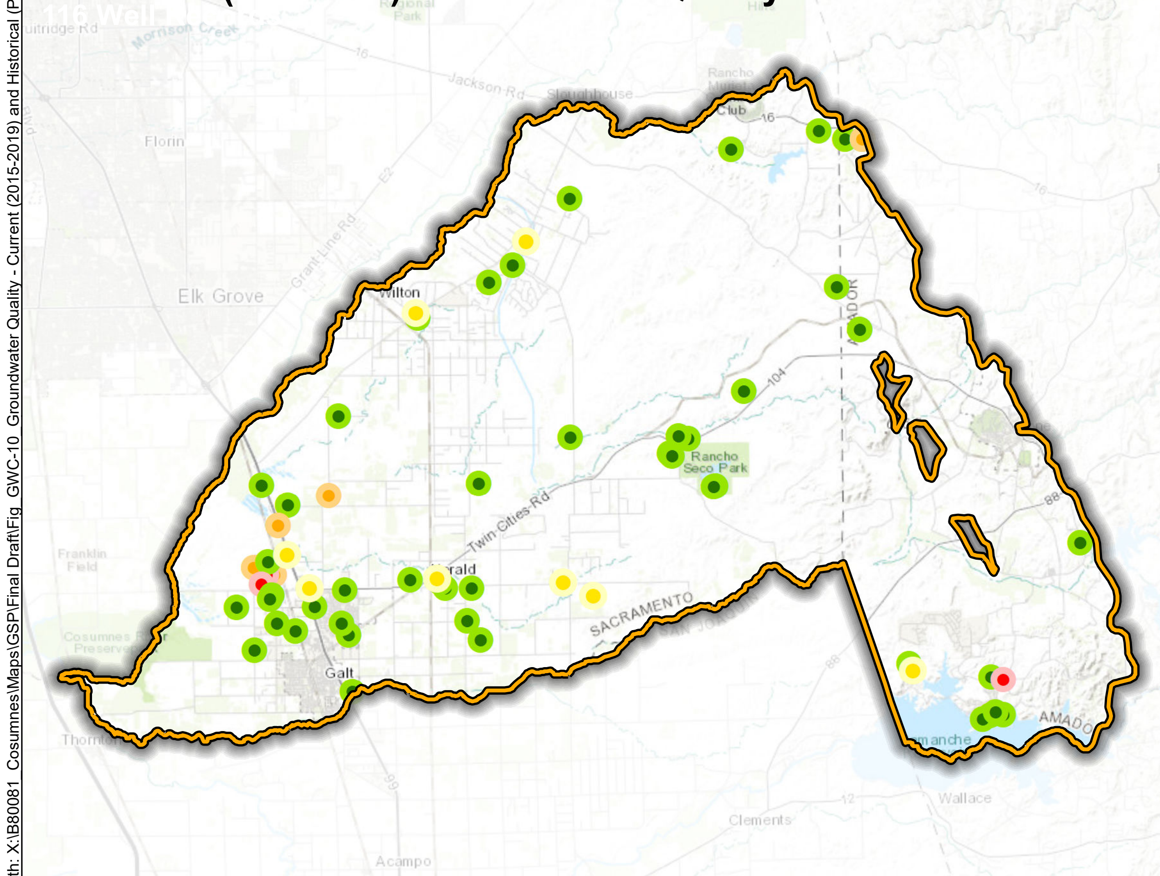
Current (2015-2019) Groundwater Quality - Nitrate



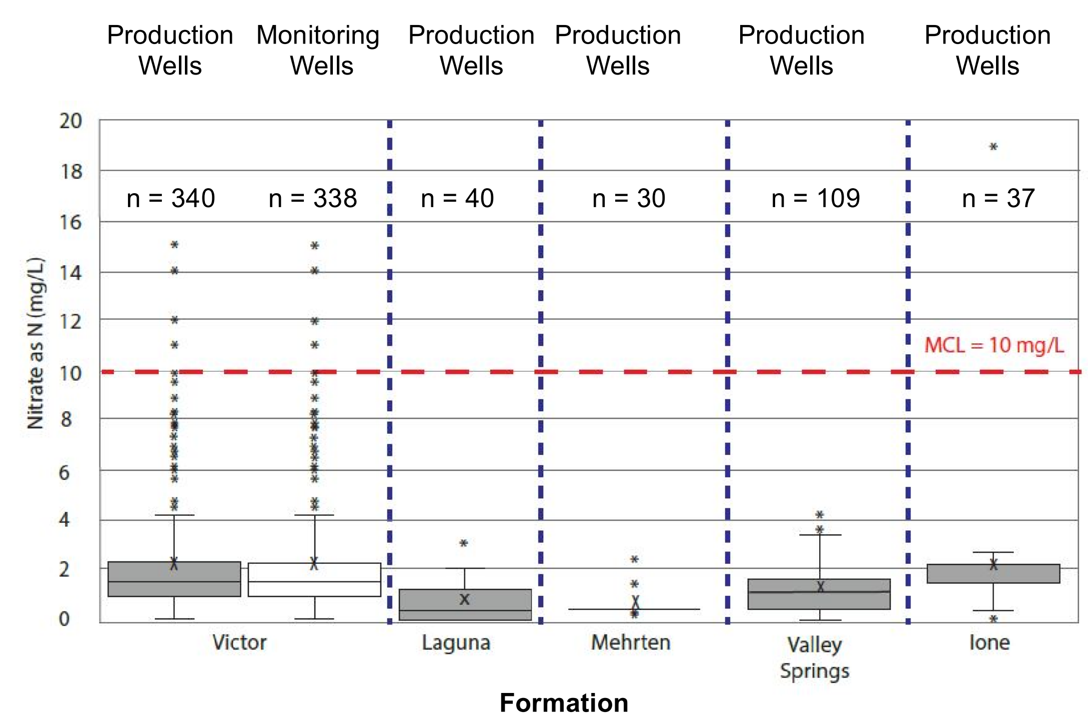
Current Boxplots - Nitrate



Historical (Pre-2015) Groundwater Quality - Nitrate



Historical Box Plots - Nitrate



Legend

Maximum Nitrate Concentration [as N (mg/L)]

- < 3
- 3 - 6
- 6 - 10
- > 10 (Exceeding MCL)
- Cosumnes Subbasin (5-022.16)
- outlier
- maximum
- 75th percentile
- median
- 25th percentile
- minimum

Abbreviations

DMS = Data Management System
DWR = California Department of Water Resources
MCL = Maximum Contamination Limit
mg/L = milligram per liter
N = Nitrogen

Notes

1. All locations are approximate.
2. Constituent concentration is the maximum observed for each well.
3. Nitrate as Nitrogen has a Primary MCL of 10 mg/L.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.
3. Groundwater quality data from Cosumnes DMS, which was compiled from various sources.

Groundwater Quality Current (2015-2019) and Historical (Pre-2015) Nitrate Concentrations in Well Water Samples

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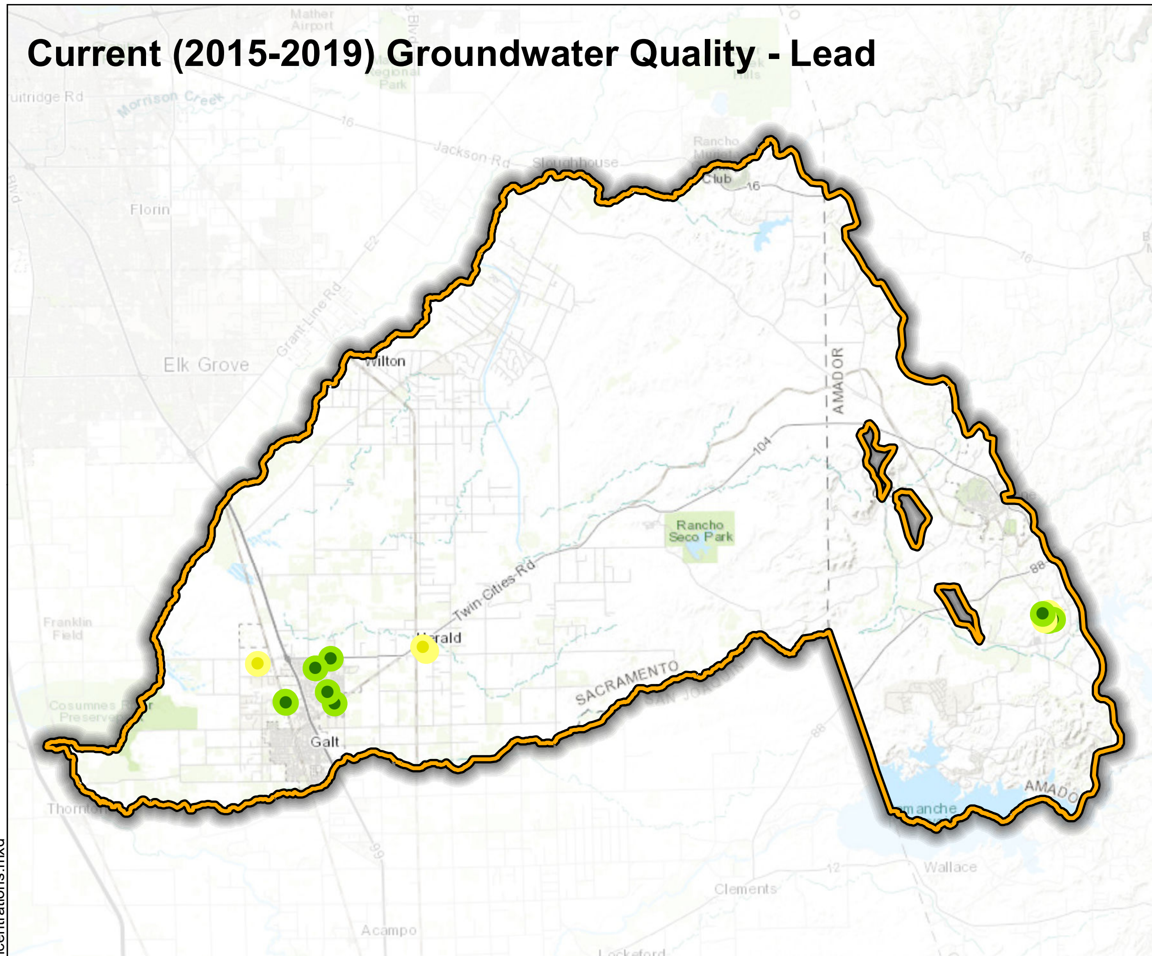
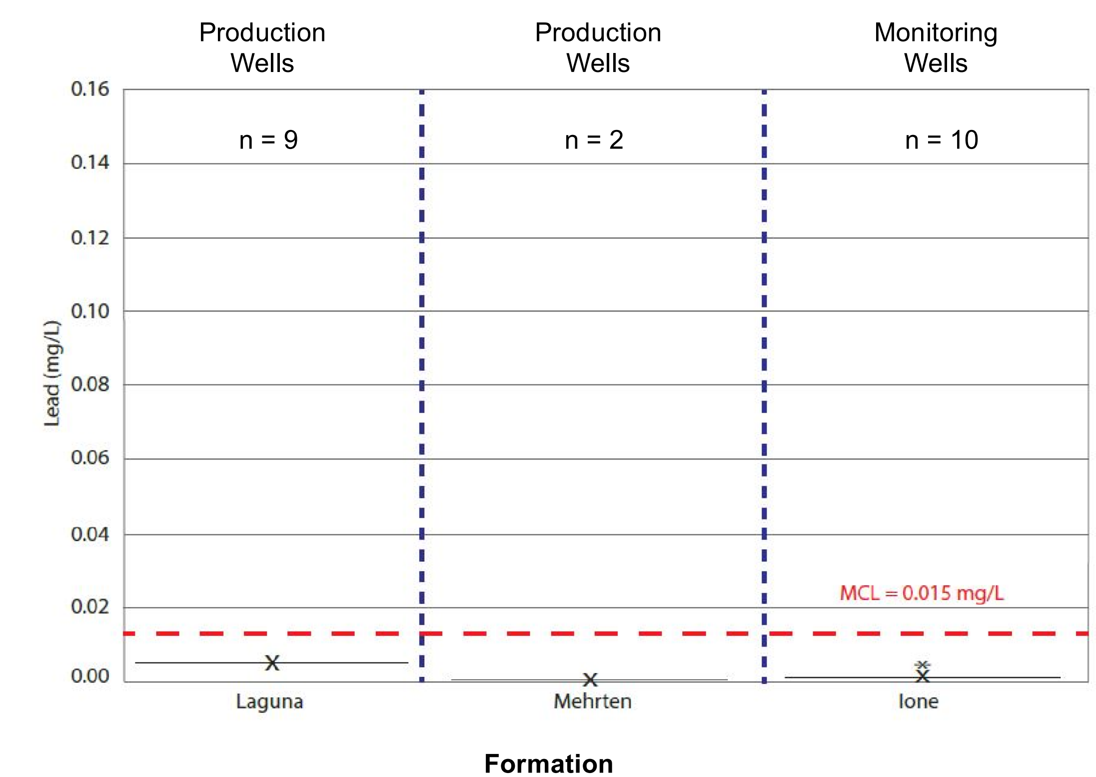
Figure GWC-10

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_GWC-10_Groundwater Quality - Current (2015-2019) and Historical (Pre-2015) Nitrate as N Concentrations.mxd

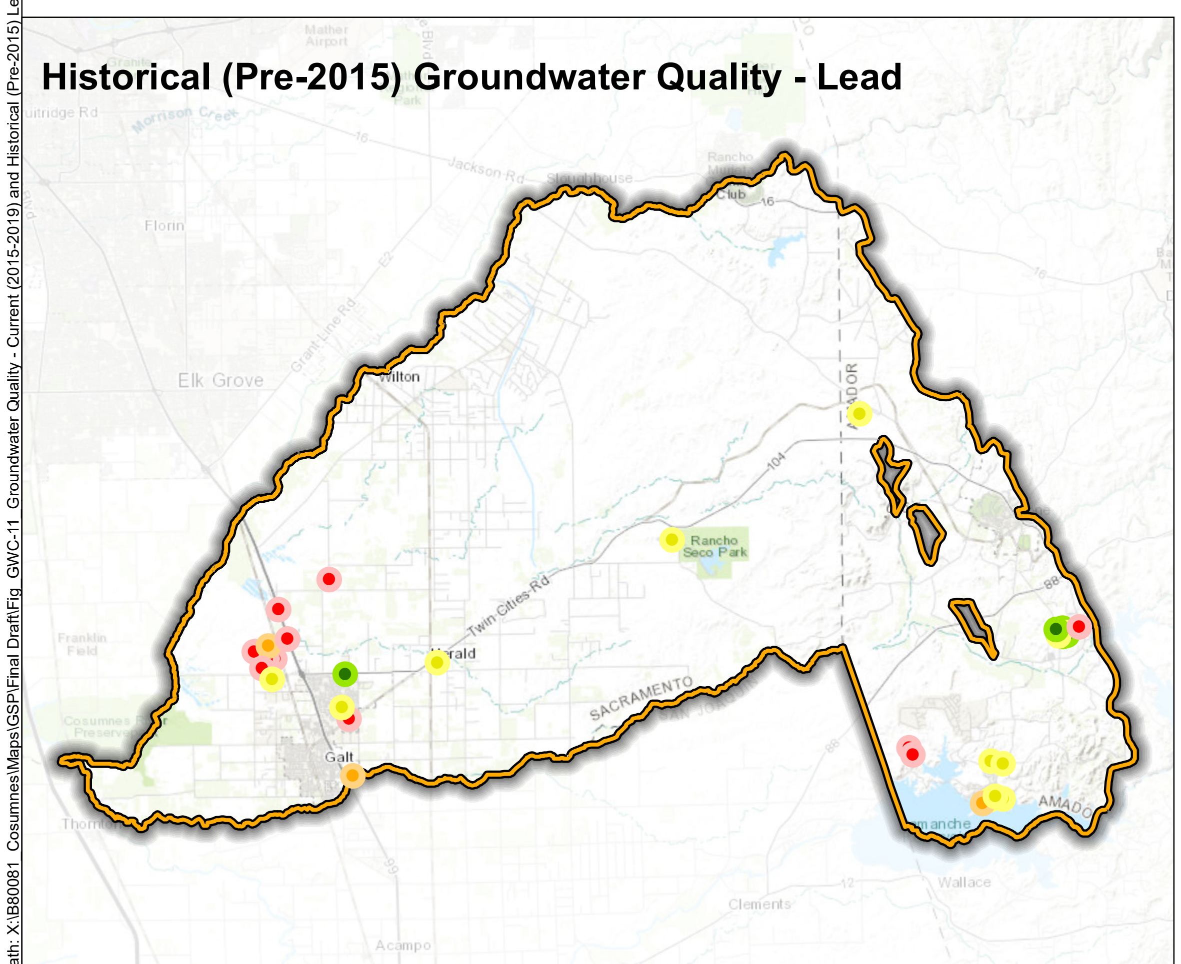
Current (2015-2019) Groundwater Quality - Lead



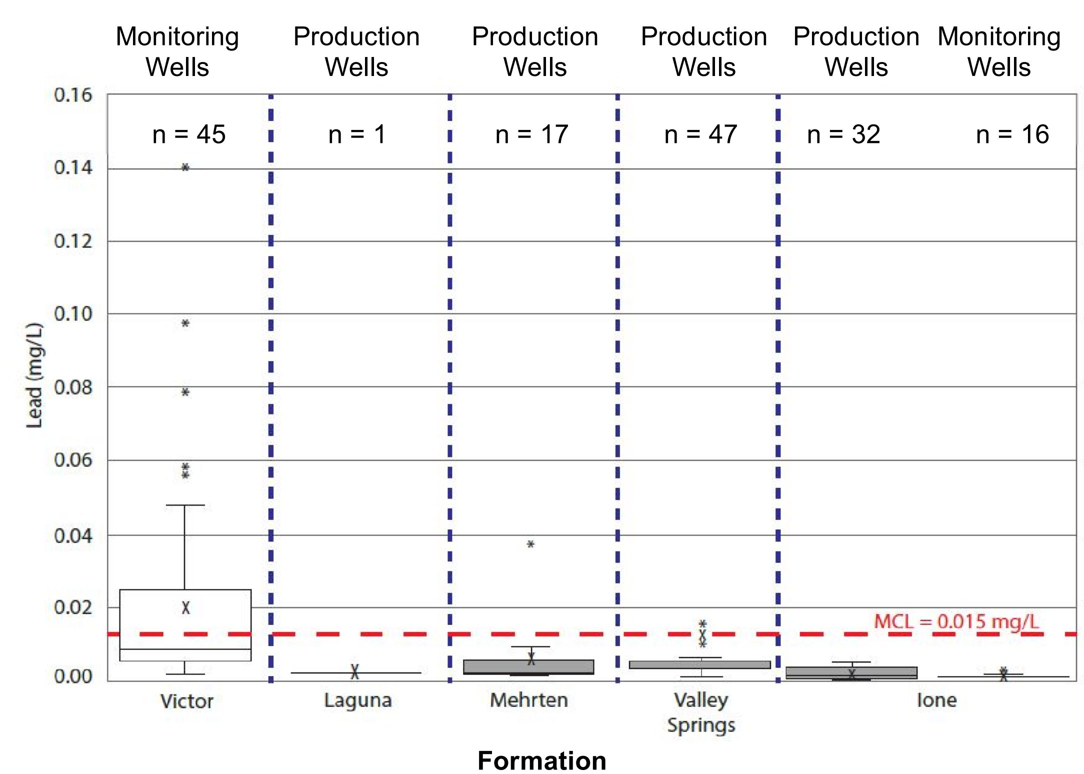
Current Box Plots - Lead



Historical (Pre-2015) Groundwater Quality - Lead



Historical Box Plots - Lead



Legend

Maximum Lead Concentration (mg/L)

- < 0.0005
- 0.0005 - 0.005
- 0.005 - 0.015
- > 0.015
- Cosumnes Subbasin (5-022.16)

- outlier
- maximum
- 75th percentile
- median
- 25th percentile
- minimum

Abbreviations

DMS = Data Management System
DWR = California Department of Water Resources
MCL = Maximum Contamination Limit
mg/L = milligram per liter

Notes

1. All locations are approximate.
2. Constituent concentration is the maximum observed for each well.
3. Lead has a Primary MCL of 0.015 mg/L.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.
3. Groundwater quality data from Cosumnes DMS, which was compiled from various sources.

N 0 4 8 (Scale in Miles)

Groundwater Quality Current (2015-2019) and Historical (Pre-2015) Lead Concentrations in Well Water Samples

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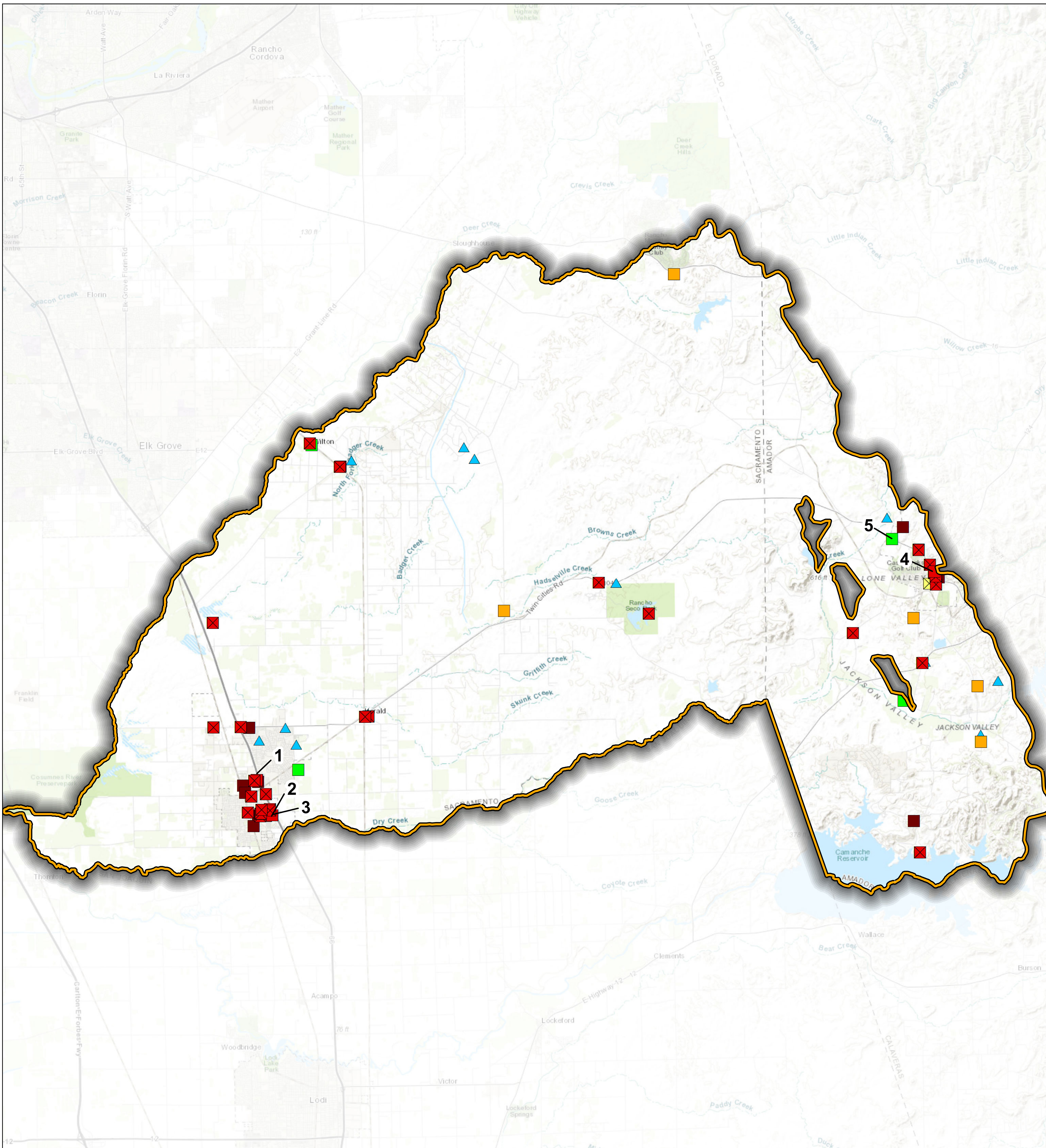
Figure GWC-11

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_GWC-11_Groundwater Quality - Current (2015-2019) and Historical (Pre-2015) Lead Concentrations.mxd



Legend

Geotracker Sites

- LUST Cleanup - Case Closed
- LUST Cleanup - Case Open
- Permitted USTs
- Cleanup Program
- DTSC Cleanup
- Land Disposal
- Military Cleanup
- Cosumnes Subbasin (5-022.16)

Abbreviations

DTSC = Department of Toxic Substances Control
DWR = California Department of Water Resources
GMA = Groundwater Management Agency
ID = Irrigation District
LUST = Leaking Underground Storage Tank
RCD = Resource Conservation District
SGMA = Sustainable Groundwater Management Act
USTs = Underground Storage Tanks
WD = Water District

N 0 3 6
(Scale in Miles)

Notes
1. All locations are approximate.
2. GeoTracker site statuses as of 5 September 2019.
3. Numbers 1-5 correspond to Active Point-Source Contamination Sites as shown in Table GWC-5.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.
3. Geotracker site locations downloaded from Geotracker Site (https://geotracker.waterboards.ca.gov/) on 5 September 2019.

Known Point Source Contamination Sites

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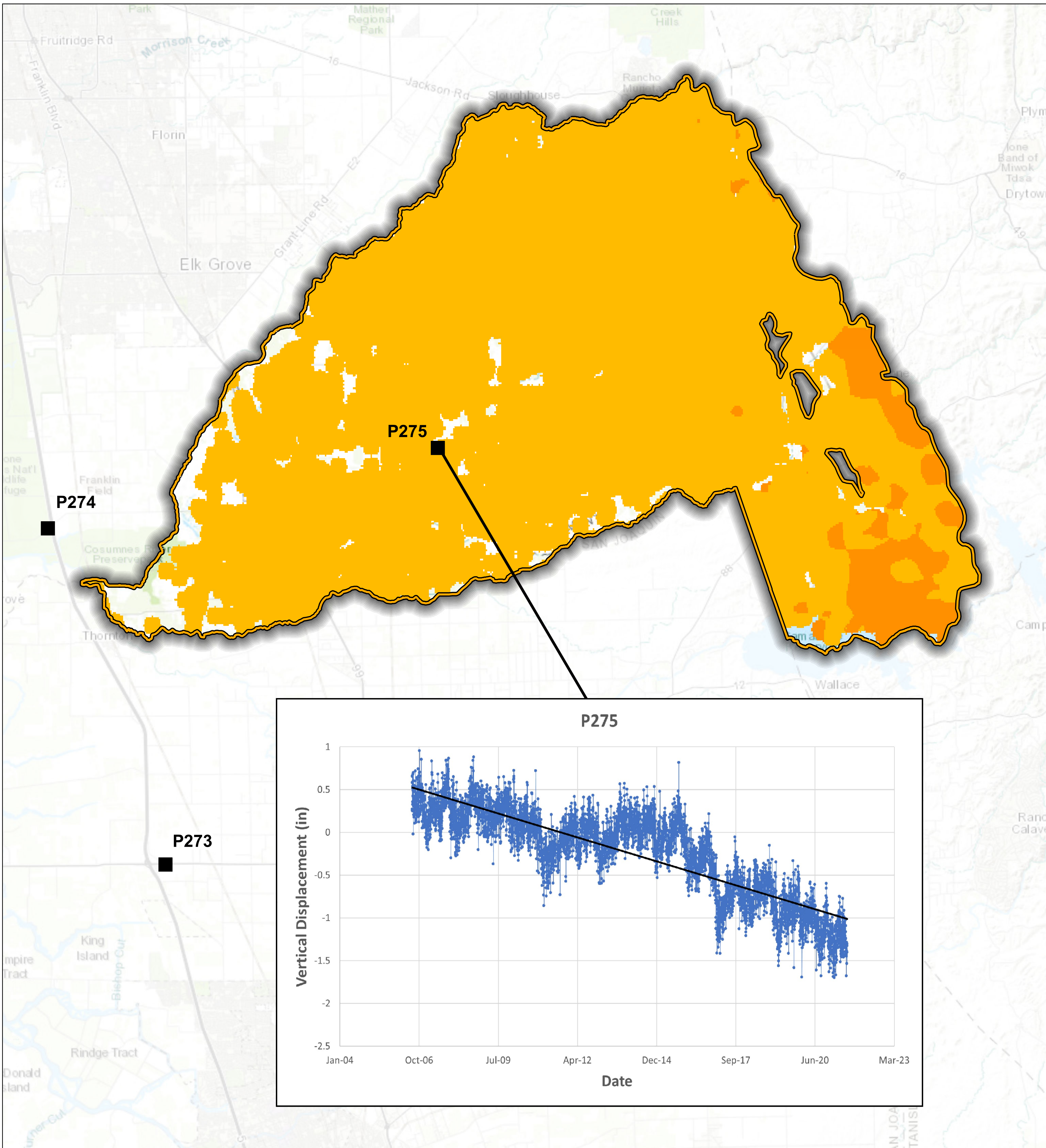
Figure GWC-12

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_GWC-12_Known Point Source Contamination Sites.mxd



Legend
- ■ Subsidence Monitoring Station
- Cosumnes Subbasin (5-022.16)

Vertical Displacement (inches)
- -3.5 to -3.0
- -3.0 to -2.5
- -2.5 to -2.0
- -2.0 to -1.5
- -1.5 to -1.0
- -1.0 to 0.5
- -0.5 to 0
- 0 to 0.5
- 0.5 to 1
- 1.0 to 1.5

Abbreviations
DWR = California Department of Water Resources
SGMA = Sustainable Groundwater Management Act
in = inches
UNAVCO = University NAVSTAR Consortium

Notes
1. All locations are approximate.
2. Postive vertical displacement signifies accretion;
Negative vertical displacement signifies subsidence.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.
3. Subsidence monitoring stations are from UNAVCO's Plate Boundary Observatory database. (https://www.unavco.org/instrumentation/networks/map/map.html#/)
4. Vertical displacement data from DWR, provided by TRE ALTAMIRA Inc. Downloaded on 6 September, 2019. (https://data.cnra.ca.gov/dataset/tre-altamira-insar-subsidence)

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(Scale in Miles)

Land Subsidence

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Figure GWC-13

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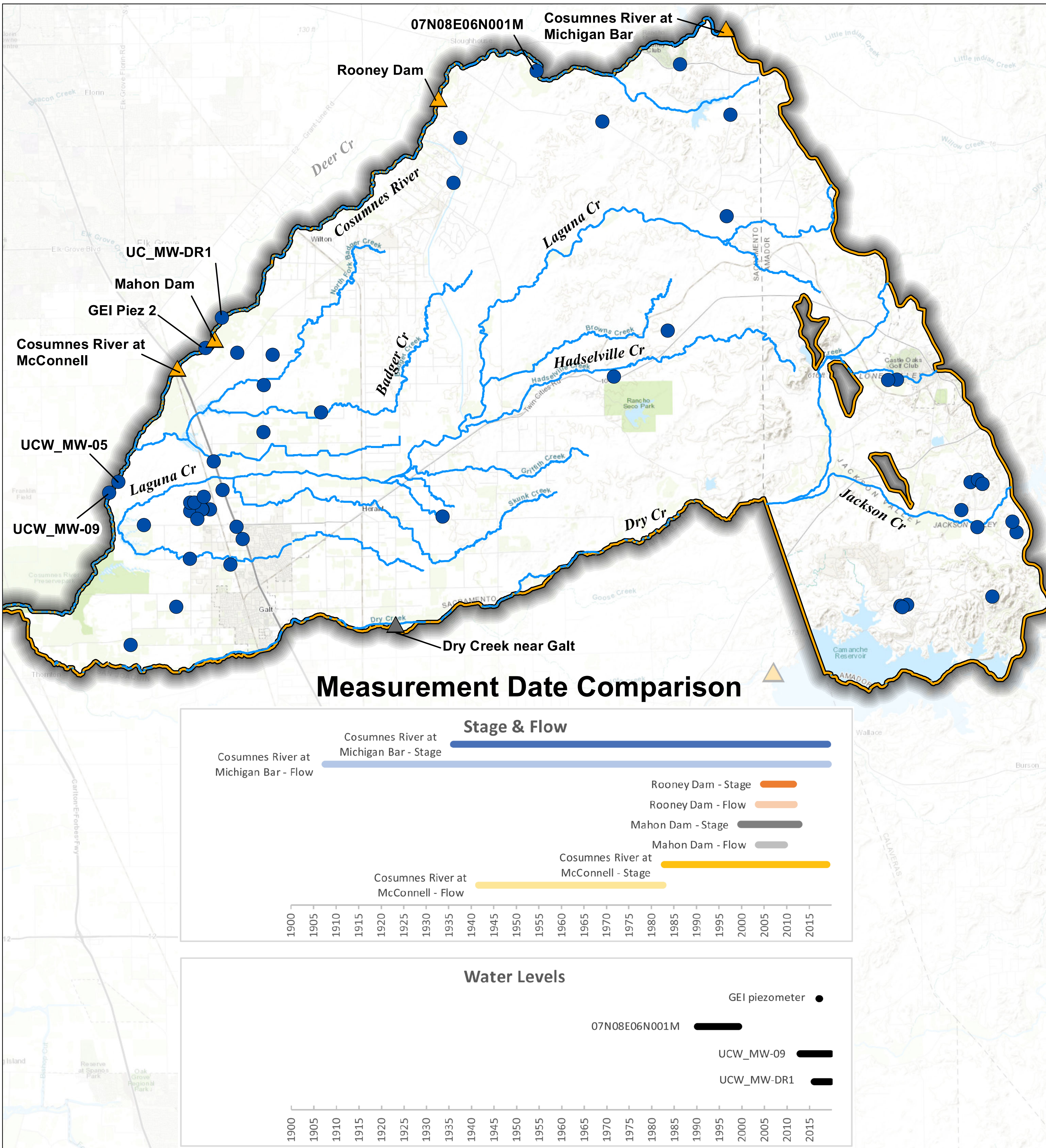
Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_GWC-13_Land Subsidence.mxd



Legend

Shallow Well (depth < 150 ft)

with Water Level Data

without Water Level Data

Surface Water Site (Flow & Stage Data)

Active

Inactive

Major Stream

Cosumnes Subbasin (5-022.16)

Abbreviations

Cr = Creek
DWR = California Department of Water Resources
ft = feet
SGMA = Sustainable Groundwater Management Act

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.

N

0 3 6

(Scale in Miles)

Shallow Wells and Surface Water Sites

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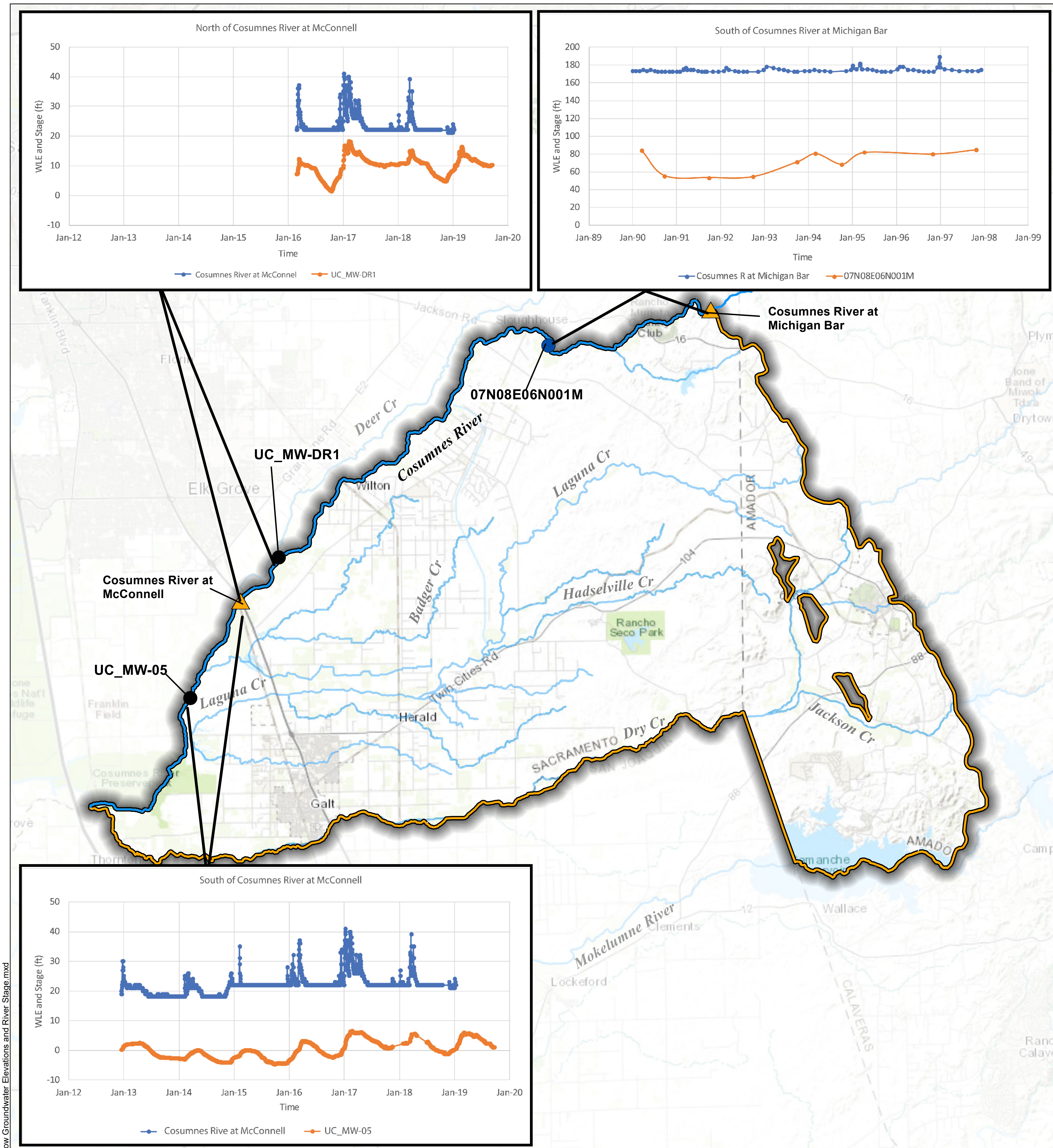
Figure GWC-14

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_GWC-14_Shallow Wells and Surface Water Sites.mxd



Legend

- Shallow Well (depth < 150 ft) with Water Level Data
- Surface Water Site (Flow & Stage Data)
- Major Streams
- Cosumnes Subbasin (5-022.16)

Abbreviations

DWR = California Department of Water Resources
Cr = creek
ft = feet
SGMA = Sustainable Groundwater Management Act

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.

N
0 3 6
(Scale in Miles)

Interconnected Surface Water Comparisons Between Shallow Groundwater Elevation and River Stage

Working Group
Cosumnes Subbasin
December 2021
B80081.00

Figure GWC-15

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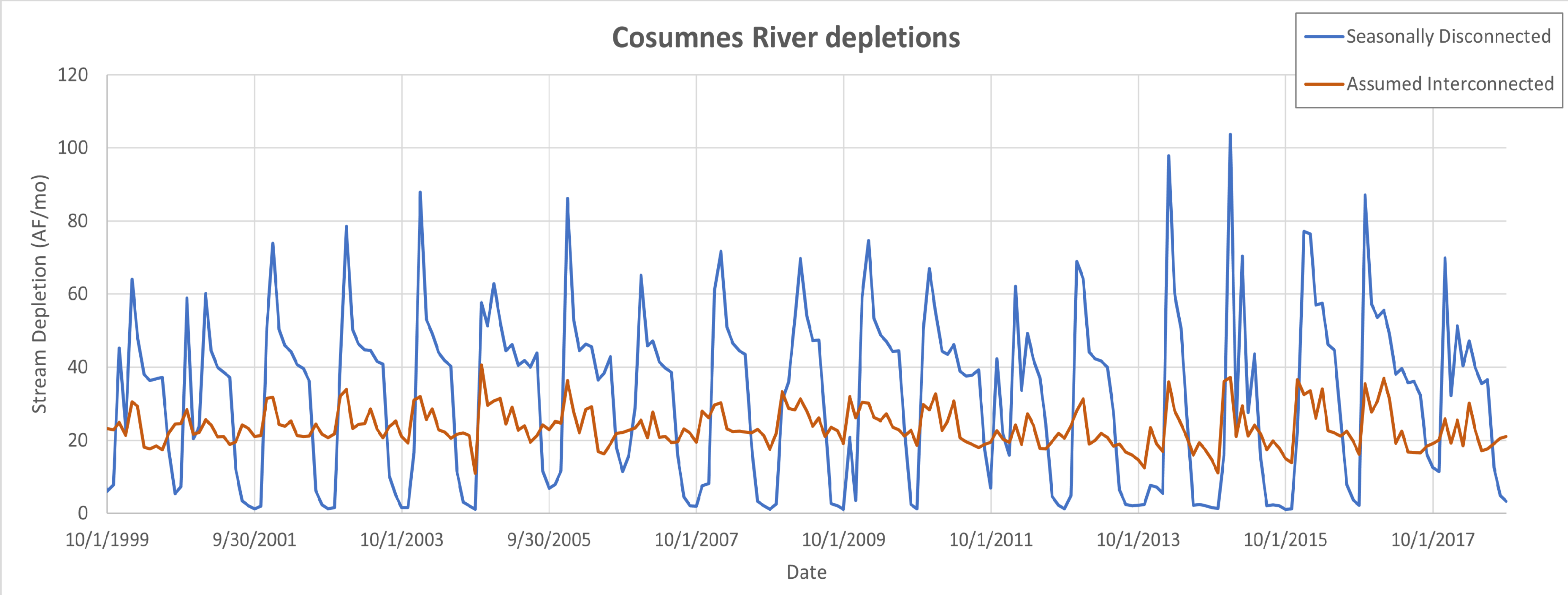
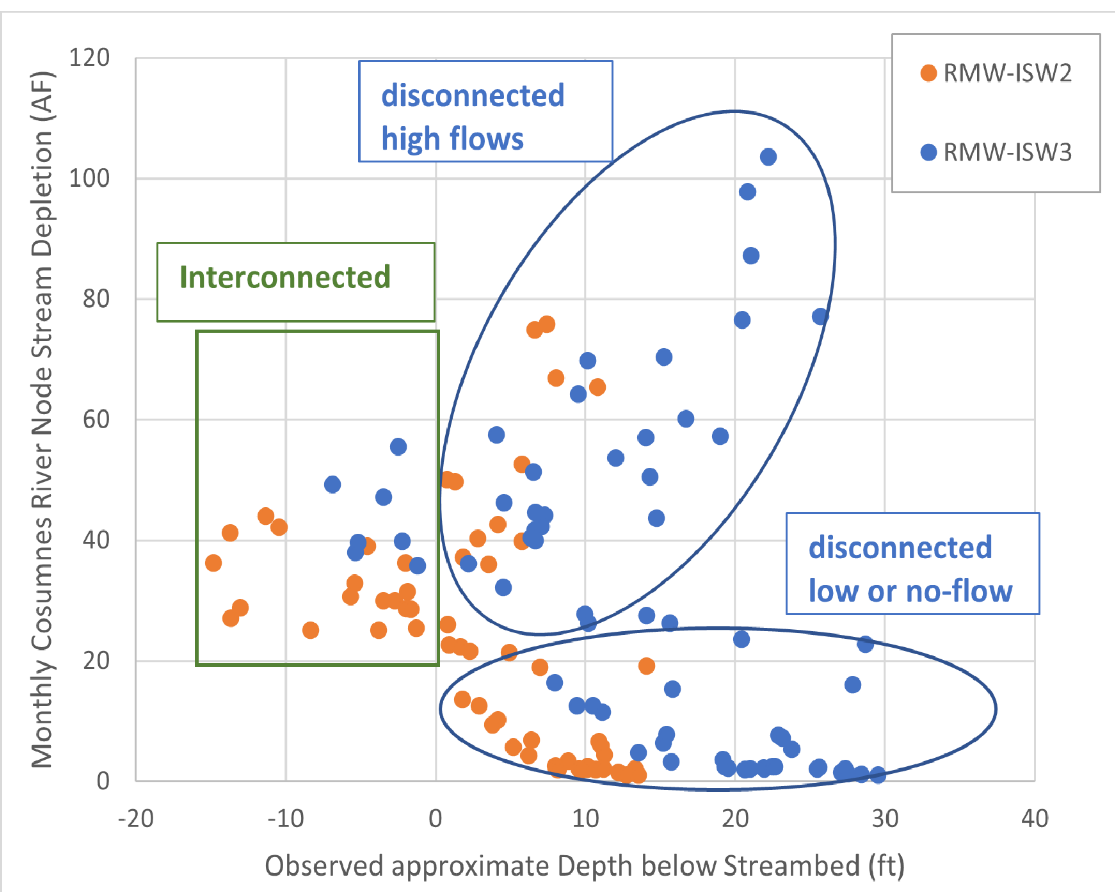
Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_GWC-15_Interconnected Surface Water Analysis - Comparisons of Shallow Groundwater Elevations and River Stage.mxd



	Average Depletion for 700 feet of Assumed Interconnected Reach (AF/mo)	Average Depletion for 740 feet of Seasonally Disconnected Reach (AF/mo)
January	28	51
February	26	52
March	25	47
April	23	43
May	21	38
June	20	28
July	22	16
August	23	6.9
September	20	4.1
October	26	18
November	28	34
December	29	54



Legend

- RMW-ISW
- Cosumnes Subbasin (5-022.16)
- Numerical Model Stream Depletion Calculation Reach

Abbreviations

AF = acre-feet
AF/mo = acre-feet per month
DWR = California Department of Water Resources
ft = feet
RMW-ISW = Representative Monitoring Well for Interconnected Surface Water

Notes

1. All locations are approximate.
2. Observed approximate depth below streambed calculated using the nearest adjacent streambed elevation and the last available monthly observed groundwater elevation.

Sources

1. Stream depletion rates from the Numerical Model.
2. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
3. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.

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0 2 4

(Scale in Miles)

Model-Calculated Cosumnes River Depletions

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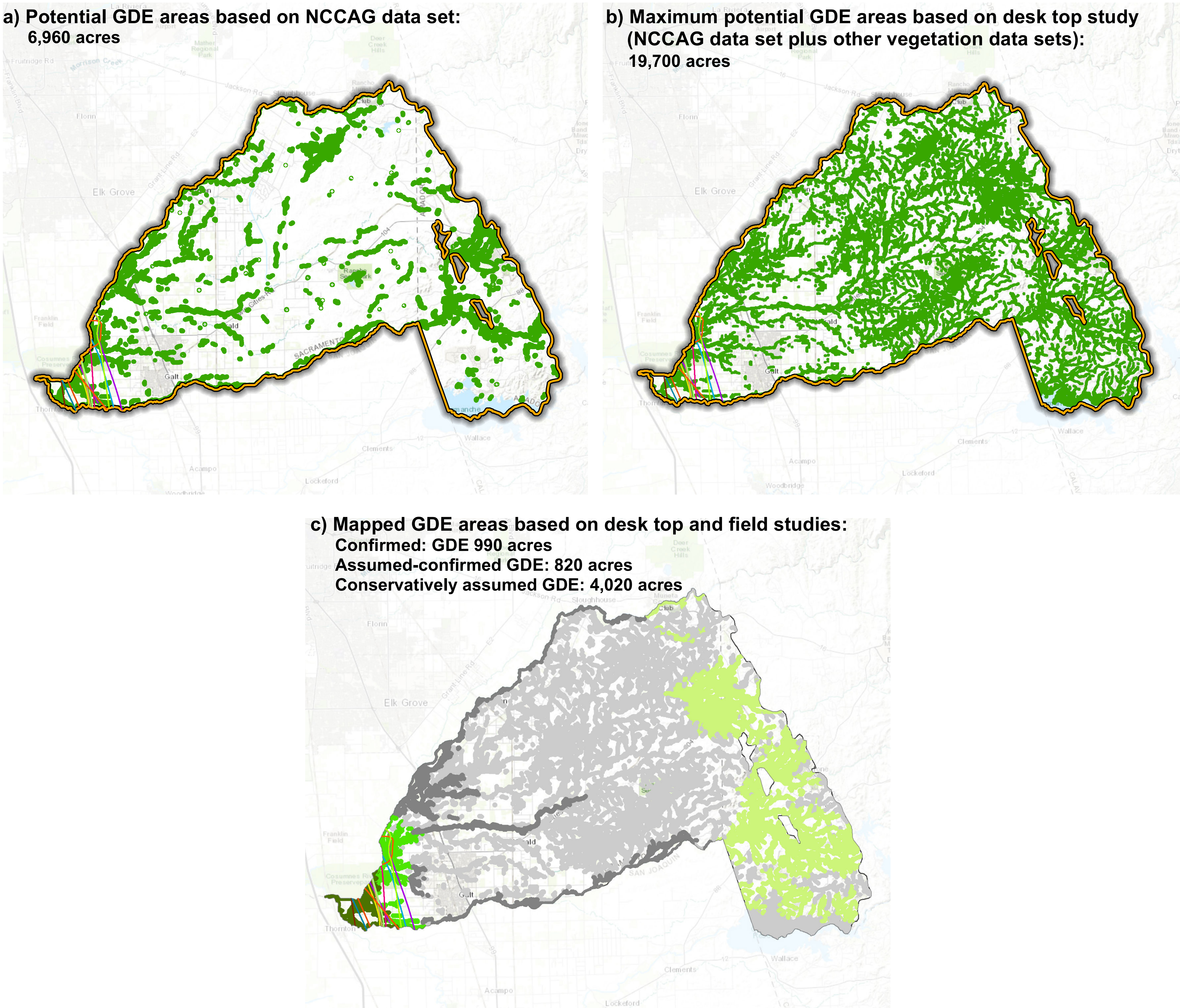
Figure GWC-16

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_GWC-16_CR depletions 3 panel.mxd



Legend

GICIMA 30ft bgs Depth to Water Contours (ft bgs)

- 2018 - Spring
- 2017 - Spring
- 2017 - Fall
- 2016 - Spring
- 2016 - Fall
- 2015 - Spring
- 2015 - Fall
- 2014 - Spring
- 2014 - Fall
- 2013 - Spring
- 2013 - Fall
- 2012 - Spring
- 2011 - Spring

Cosumnes Subbasin (5-022.16)

GDE Evaluation (a) and (b)

Potential GDE

GDE Evaluation (c)

- Confirmed GDE
- Assumed-confirmed GDE
- Conservatively assumed GDE in areas with uncertain water table depths
- Not GDE (supported by surface water and/ or perched water rather than Principal Aquifer)
- Not GDE (disconnected from water table)

Abbreviations

DTW = Depth to Water
DWR = Department of Water Resources
ft bgs = feet below ground surface
GDE = Groundwater Dependent Ecosystem
GICIMA = Groundwater Information Center Interactive Map Application
NCCAG = Natural Communities Commonly Associated with Groundwater
SGMA = Sustainable Groundwater Management Act

Notes

1. All locations are approximate.
2. Edges of GDE areas are increased for visability.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.
3. GICIMA contours downloaded from: https://gis.water.ca.gov/app/gicima/
4. GDE areas adapted from GeoSystem Analysis, Inc. report "An Evaluation of Groundwater Dependant Ecosystems in the Cosumnes Sub-Basin (DWR 5-022.16), dated June 2021.

N

0 4 8

(Scale in Miles)

Natural Communities Commonly Associated with Groundwater and Potential Groundwater Dependent Ecosystems

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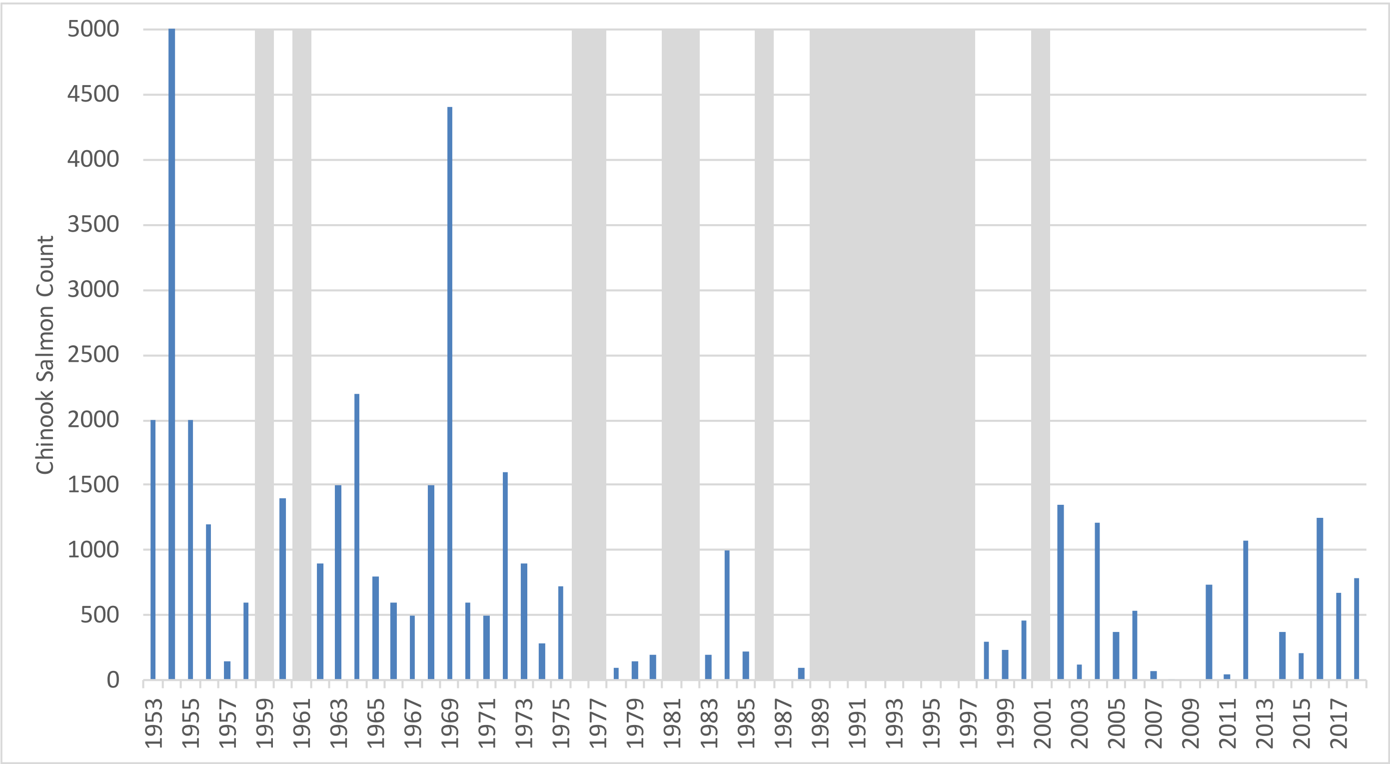
Figure GWC-17

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_GWC-17_NCCAG and Potential GDEs.mxd



Notes

1. Grey shading indicates year with no data.
2. Data from 2009-2018 are preliminary.

Sources

1. Chinook Salmon Escapement - Fall Run Section 4 San Joaquin River System: Tributaries Cosumnes River, from Azat J, 2019, GrandTab 2019.05.07. California Central Valley Chinook Population Database Report. California Department of Fish and Wildlife. Available online at: https://www.wildlife.ca.gov/Conservation/Fishes/Chinook-Salmon/Anadromous-Assessment or http://www.calfish.org/ProgramsData/Species/CDFWAnadromousResourceAssessment.aspx

Fall-Run Chinook Salmon Counts
Cosumnes River

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Working Group
Cosumnes Subbasin
December 2021
B80081.00

Figure GWC-18

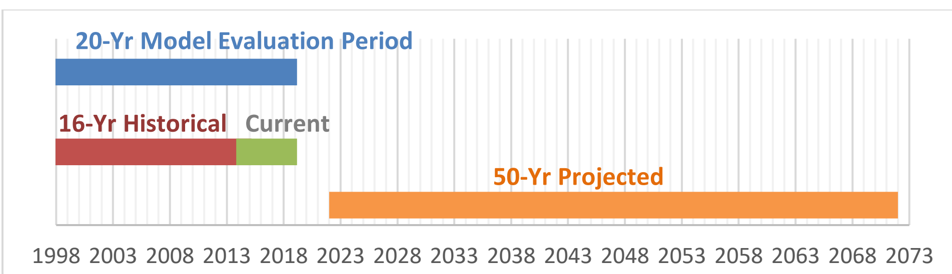
10. WATER BUDGET INFORMATION

§ 354.18. Water Budget
(a) Each Plan shall include a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions, and the change in the volume of water stored. Water budget information shall be reported in tabular and graphical form.

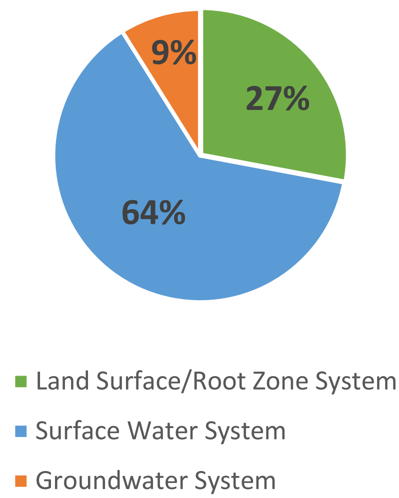
This section presents information on the water budget for the Cosumnes Subbasin (Basin). Consistent with the Groundwater Sustainability Plan (GSP) Regulations (23-California Code of Regulations [CCR] Division 2 Chapter 1.5 Subchapter 2) and California Department of Water Resources' (DWR's) Best Management Practices (BMP) #4 Water Budget (DWR, 2016c), this water budget provides an accounting of the total annual volume of water entering and leaving the Basin for historical, current, and projected future conditions.

Four water budget time periods are presented herein:

- A 20-year model evaluation period representing Water Years (WY) 1999-2018. The model is calibrated to the historical data from this 20-yr period and is the basis of the water budget analyses.
- A historical water budget period representing the first 16 years of the model evaluation period (WY 1999-2014).
- A current conditions water budget period representing average conditions over the last four years of the model evaluation period (WY 2015-2018).
- A 50-year projected water budget period (WY 2022-2071).



As discussed in Section 10.1 *Water Budget Methods and Data Sources* below, the water budgets are presented for the three interconnected water budget systems quantified by the numerical model: (1) surface water system, (2) land surface/root zone system, and (3) groundwater system. The vadose zone between the land surface/root zone system and the groundwater system is not represented in the numerical model. Flow is assumed to occur directly and instantaneously from the land surface/root zone system to the groundwater system. When the three systems are integrated, the volumetric fluxes from the surface water system predominate (see pie chart). However, most of the surface water fluxes are "through-flows" that occur along the Basin boundaries, and most have a limited influence on the budget of the groundwater system. Therefore, to facilitate planning for future sustainability, this GSP focuses primarily on the groundwater system and future changes in groundwater storage.



As shown in **Table WB-1** below, the inflows to the groundwater system under historical and current water budget periods have been less than the outflows, resulting in the net depletion of groundwater storage over time. However, the net storage varies between depletions (losses) and accretions (gains) under projected water budget conditions, depending upon the assumptions for land use and climate conditions. These assumptions and model-calculated output for the groundwater system components are summarized in detail in **Table WB-5** and **Table WB-10**. The historical range in estimated sustainable yield is 119,000 acre feet per year (AFY) to 125,700 AFY (**Table WB-8**) and is considered a reasonably conservative estimate for future planning purposes.

Table WB-1. Summary of Groundwater System Water Budgets

Scenario	Average Volumetric Flux (AFY)			
	GW Inflows	GW Outflows	Change in Storage	Sustainable Yield
Historical and Current Water Budget Periods				
20-Year Model Evaluation Period (WY1999-2018)	144,200	-154,900	-10,600	120,600
Historical Water Budget Period (WY1999-2014)	143,300	-154,700	-11,400	119,300
Current Conditions Water Budget Period (WY2015-2018)	148,000	-155,300	-7,400	125,700
Projected Water Budget Period (WY 2022-2071)				
Current Conditions Baseline	149,800	-150,200	-400	127,500
Current Conditions DWR 2030 CT Climate Change	150,100	-148,700	1,400	127,100
Projected Conditions Baseline	148,700	-150,400	-1,700	126,600
Projected Conditions ARBS CT 2070 Climate Change	144,500	-154,500	-10,000	127,300
Projected Conditions DWR Extreme I 2070 Climate Change	137,900	-156,500	-18,600	125,700
Projected Conditions DWR Extreme II 2070 Climate Change	163,800	-160,000	3,800	134,900
Projected Conditions Baseline and PMA Scenario	155,200	-148,100	7,100	127,700

Abbreviations:
AFY = acre-feet per year
ARBS = American River Basin Study
CT = Central Tendency
DWR = California Department of Water Resources
GW = groundwater
PMA = Projects and Management Actions
WY = Water Year

10.1. Water Budget Methods and Data Sources

§ 354.18. Water Budget

(d) The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:
  (1) Historical water budget information for mean annual temperature, mean annual precipitation, water year type, and land use.
  (2) Current water budget information for temperature, water year type, evapotranspiration, and land use.
  (3) Projected water budget information for population, population growth, climate change, and sea level rise.

(e) Each Plan shall rely on the best available information and best available science to quantify the water budget for the basin in order to provide an understanding of historical and projected hydrology, water demand, water supply, land use, population, climate change, sea level rise, groundwater and surface water interaction, and subsurface groundwater flow. If a numerical groundwater and surface water model is not used to quantify and evaluate the projected water budget conditions and the potential impacts to beneficial uses and users of groundwater, the Plan shall identify and describe an equally effective method, tool, or analytical model to evaluate projected water budget conditions.

(f) The Department shall provide the California Central Valley Groundwater-Surface Water Simulation Model (C2VSIM) and the Integrated Water Flow Model (IWFM) for use by Agencies in developing the water budget. Each Agency may choose to use a different groundwater and surface water model, pursuant to Section 352.4.

The water budget information presented herein is based on the use of a numerical groundwater flow model for the Basin using the regional model for the Cosumnes, South American, and North American Subbasins (herein referred to as the "Numerical Model" or "CoSANA"; see **Appendix M**). The Numerical Model is a three-dimensional (3-D) groundwater flow model that uses DWR's finite-element Integrated Water Flow Model (IWFM) groundwater modeling platform. Like all finite-element numerical groundwater flow models, the Numerical Model divides the spatial model domain into a network of finite-element cells (3-D mesh), applies estimates for groundwater flow properties represented by the mesh, and calculates water fluxes between element nodes by solving a system of equations based on groundwater flow principles. The node and mesh orientation in the model domain is shown in **Figure WB-1**. The northernmost portion of the Eastern San Joaquin (ESJ) Subbasin is included in the model domain to ensure reasonable results for the southern boundary of the Basin.

The IWFM, and therefore the Numerical Model, simulates the interrelated processes associated with the surface water system, the land surface/root zone system, and the groundwater system. As shown in **Figure** WB-2, the surface water system interacts with both the land surface/root zone system (e.g., diversions from streams become applied water) and the groundwater system (e.g., stream leakage and/or seepage to and from groundwater, fraction of precipitation and applied water that ultimately becomes deep percolation to groundwater). As described in DWR's BMP #4 Water Budget (DWR, 2016c), it is useful in some basins to develop water budgets with additional detail beyond what is explicitly required by the GSP

Regulations.[49] These additional details are necessary because of the complex interrelationships between water use practices, groundwater conditions, subsurface groundwater flows across Basin boundaries, and groundwater/surface-water interactions and their net influence on the Basin water budget. For details on the surface water system, see Section 10.2.1 *Surface Water System Inflows and Outflows*; for details on the land surface/root zone system see Section *10.2.2 Land Surface/Root Zone System Inflows and Outflows*; and for details on the groundwater system, see Section 10.2.3 *Groundwater Inflows and Outflows*. The Numerical Model represents the Basin using the characteristics, processes, and data summarized below.

- Node and mesh orientation follow jurisdictional, geographical, and surface water features;
- Five model layers representing the five primary formations which comprise the Principal Aquifer (Victor, Laguna, Mehrten, Valley Springs, and Ione formations), consistent with the Basin Hydrogeological Conceptual Model (HCM);
- Surface water use by riparian vegetation, runoff routing, specified inflows, channel geometry and properties representing groundwater surface-water interactions for the Cosumnes River, Dry Creek, Jackson Creek and other relatively minor drainages;
- Specifications for diversions from streams in and adjacent to the Basin, including diversions by Jackson Valley Irrigation District (JVID), Amador County, and Rancho Murieta;
- Camanche Reservoir stage height, runoff routing, and properties representing groundwater and surface-water interactions;
- Addition of reported and estimated pumping rates and extraction depth intervals for wells operated by the City of Galt, Amador Water Agency (AWA), aquaculture sites, small public water systems (PWS), and agricultural-residential (Ag-Res) areas within the Cosumnes Subbasin;
- Estimated depth distribution of unreported agricultural pumpage; and
- City of Galt indoor/outdoor water use, runoff, and wastewater treatment plant operations.

As discussed in **Appendix M,** the Numerical Model adequately represents the conditions of the Basin and adjacent subbasins to support development of this GSP. Therefore, the Numerical Model is appropriate to use for water budget purposes.

10.1.1. Data Sources

Per 23-California Code of Regulations (CCR) §354.18(e), the best-available data were used to evaluate the water budget for the Basin and include the following:

- Precipitation records, mapped to the Numerical Model mesh, from the 800-meter grid in the Parameter-elevation Regressions on Independent Slopes Model (PRISM), provided by DWR, March 2021.

[49] https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-4-Water-Budget_ay_19.pdf

- Evapotranspiration (ET) datasets from the California Central Valley Groundwater-Surface Water Simulation Model Fine Grid (C2VSimFG).
- Land use distribution based on the DWR land use surveys[50] listed below. The land use distribution was interpolated annually between surveys and urban land was considered approximately constant throughout the period[51].
    - Amador County Land Use Survey of 1997;
    - Sacramento County Land Use Survey of 2000;
    - Amador County LandIQ of 2014; and
    - Sacramento County Land Use Survey of 2015.
- Stream inflows for three major waterways entering the Basin:
    - Cosumnes River - measured at the United States Geological Survey (USGS) “Cosumnes River at Michigan Bar” gauge;
    - Dry Creek - estimated from C2VSim through Water Year (WY) 2015 and thereafter, based on a linear regression with inflows at the Cosumnes River at Michigan Bar ($r^2 = 0.91$)[52]; and
    - Jackson Creek - measured at the JVID “Jackson Creek below Lake Amador” gauge. Flows for missing months were estimated as the average monthly flow calculated from the measured data.
- Surface water imports and diversions:
    - Urban imports from Lake Tableaud, which is located outside the Basin and stores water from the Mokelumne River, are delivered to the City of Ione. From 1998 onward, these imports were estimated from total water treated at the wastewater treatment plant, as provided by AWA.
    - Castle Oaks Golf Course is irrigated with tertiary treated wastewater from the Castle Oaks Water Reclamation Plant (COWRP). The COWRP receives secondary treated water from Mule Creek State Prison and the Amador Regional Sanitation Authority (ARSA). The ARSA transports treated water from the Sutter Creek area, which is located outside the model domain, to Preston Reservoir and ultimately to the COWRP. Average monthly recycled water use at the Castle Oaks Golf Course was estimated from the irrigated area and an assumed average monthly demand, calibrated to match the irrigation demand for the water, as specified in the AWA 2015 Urban Water Management Plan (UWMP). This average

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[50] DWR land use surveys available at DWR’s Land Use portal under “County Land Use Download”: https://gis.water.ca.gov/app/CADWRLandUseViewer/. Note that the “Native Vegetation” category in the water budget summaries include Native Water, Managed Wetlands, Riparian and all Undeveloped (non-irrigated) land uses.
[51] https://water.ca.gov/Programs/Water-Use-And-Efficiency/Land-And-Water-Use/Land-Use-Surveys
[52] Linear regression equation was also used to update the Dry Creek inflow for January 1997. In the original dataset Cosumnes River inflow for January 1997 was the highest of any month, whereas Dry Creek inflow was zero, clearly indicating a lack of reporting for the high-flow period.

monthly golf course water use is repeated annually beginning in January 2004. The water delivered to the golf course is added to the City of Ione monthly water supply and specified as a monthly delivery to the Ione Subregion of the model, and the total delivery is then allocated by the model to urban land, including the golf course, within the Ione Subregion.

- Urban water supply for Rancho Murieta, as estimated by monthly demand per connection from the 2010 Integrated Water Master Plan (IWMP) Update and average number of connections reported in the 2006 IWMP and 2010 IWMP Update. The monthly demand time series was repeated each year over the entire model period assuming the monthly demand and number of connections did not substantially change during the water budget periods.
- Agricultural diversions of surface water were compiled for the Basin from water rights information available from the Electronic Water Rights Information Management System (eWRIMS). Annual reports from diversion points along major streams within the Basin[53] account for approximately one third of the diversion licenses, with remaining diversions originating from unnamed streams and creeks.[54] Annual reports by diversion point of variable availability and completeness were available for the period 2009-2018. Cosumnes River diversion records for the period 1999-2008 were compiled by Omochumne-Hartnell Water District (OHWD) and combined with the eWRIMS dataset. For the months with missing data, the diversions were estimated based on the available data and the variability between water year types.
- Agricultural diversions from the Folsom South Canal (FSC) during the water budget period were developed as follows:
  - No deliveries from the FSC to OHWD.
  - For the years 1999-2011, Galt Irrigation District (GID) purchased FSC surface water from Sacramento Municipal Utilities District (SMUD). Monthly deliveries were extracted from usage tables provided by GID and the Sacramento Water Forum for 2001-2010. For 1999, 2000, and 2011, previous estimates were relied upon for monthly deliveries (RMC and WRIME, 2011). GID received no FSC deliveries after 2011.
  - For the years 1999-2011, Clay Water District purchased FSC surface water from SMUD, and no FSC water was used after 2011. Previous estimated monthly deliveries reported by RMS and WRIME (2011) were utilized for the water budget

[53] Major streams include the Cosumnes River, Dry Creek, Laguna Creek, Jackson Creek, Badger Creek, North Fork Badger Creek, Browns Creek, Arkansas Creek, Deadman Gulch, Deer Creek, Griffith Creek, Hadselville Creek, Mokelumne River, Rolling Draw, Skunk Creek, Sutter Creek, Willow Creek, Windmill Draw.

[54] Diversions reported as Stockponds were not considered or included in the agricultural diversions. These stockpond diversions are generally small in-stream impoundments and are not used to supply water to irrigate crops. Due to years of soil compaction from livestock at these sites, it was assumed that this water does not infiltrate to the water table to become recharge and either evaporates or is consumed.

calculations.

- The decommissioned Rancho Seco nuclear power facility is located in Sloughhouse Resource Conservation District (SRCD) Groundwater Sustainability Agency (GSA), is owned by SMUD, and receives cooling water supply from the FSC. Previous estimates were relied on for monthly deliveries from the FSC to SMUD during 1999-2002 (RMC and WRIME, 2011). During 2003-2014, FSC deliveries to SMUD were provided by the United State Bureau of Reclamation (USBR). Beyond 2014, deliveries were approximated using average monthly deliveries based on the 2003-2014 data provided by USBR.

- Pumpage from wells was based on available records, and, when reported values were unavailable, the values were estimated as described below.
    - City of Galt – the City of Galt has 18 wells, although only six are active and two are stand-by. The monthly pumpage from wells and the estimated allocation between indoor/outdoor water use were reported by the City of Galt.[55]
    - AWA - monthly pumpage from four Camanche wells and two Camanche North Shore wells, as reported by AWA.
    - Aquaculture - total pumpage was assumed to total 11,000 AFY (Robertson-Bryan and WRIME, 2011). The annual pumpage was distributed between six wells based on the area of the fishponds and timing of their construction, as observed using Google Earth aerial photographs. Current and projected pumpage for aquaculture is a data gap.
    - PWS - pumpage for nine wells which had available monthly volumes reported to the Drinking Water Information Clearinghouse (DRINC) portal[56] for 2013 through 2016.
    - Ag-Res – outdoor and indoor water use estimates were used to determine total Ag-Res pumpage, and the total annual pumpage was distributed into monthly values using proportions based on reported water use for the nearby City of Galt. Outdoor water use was determined from per-parcel water demand and estimated total number of occupied Ag-Res parcels in the parts of the Basin containing the greatest concentration of Ag-Res parcels. The estimated average per-parcel outdoor water demand is 2.5 AFY based on a detailed inspection of land use for 10 random parcels. Estimates made from visual inspection of Google Earth aerial photographs identified approximately 3,200 occupied Ag-Res parcels in this zone containing the concentration of Ag-Res parcels, resulting in an average annual outdoor water use of 8,000 AFY. Estimated indoor water use was based on population and reported per capita water use. Population statistics suggest on average 3.0 persons per parcel, for an approximate total population of 9,600 people distributed

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[55] City of Galt well #22 pumping rate was increased for Jan-Apr 2016 and Nov 2016-Apr 2017 based on total monthly pumpage reported to State Water Board. Total City of Galt pumpage over these months were unrealistically low and the additional pumping was assumed to come from Well #22.

[56] https://drinc.ca.gov/drinc/DWPRepository.aspx and Small Supplier Annual Conservation Reports – Archive available at: https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/conservation_reporting.html

between the 3,200 occupied parcels. The average 1990-2005 Sacramento County and Amador County per capita water use, as reported by the USGS,[57] was approximately 90 gallons per day, which translates into almost 1,000 AFY for the population of almost ten thousand people. Total estimated Ag-Res pumpage is therefore 9,000 AFY (8,000 AFY of outdoor use and 1,000 AFY of indoor use), but most of the water 1,000 AFY extracted for indoor use returns to the subsurface through septic systems. Hence, the net extraction of groundwater is 8,000 AFY (9,000 AFY total pumpage less the 1,000 AFY return flows from indoor water use), and this net extraction was distributed uniformly as pumpage across the area occupied by the approximately 3,200 Ag-Res occupied parcels.

  - Agriculture - "Ag" pumpage was calculated by the Numerical Model using the IWFM Demand Calculator (IDC). Data inputs to IDC include land use, ET, soil properties (i.e., wilting point, field capacity, soil porosity, and saturated hydraulic conductivity), curve numbers for runoff, and rooting depths. Data sources included DWR's C2VSimFG model input data sets and the Soil Survey Geographic Database (SSURGO).

- Monthly Camanche Reservoir stage as provided by East Bay Municipal Utility District (EBMUD).[58]
- Groundwater elevation records from the Basin's Data Management System (DMS).
- Cosumnes River flow and stage records from the Basins' DMS and Cosumnes River dry periods based on aerial imagery[59] and Google Earth images.

10.1.2. Historical Water Budget Period

Within the 20-year model evaluation period, the historical water budget for the Basin was determined from a 16-year period (WY 1999-2014). DWR's BMP #4 Water Budget recommends quantification of historical water budget components for at least the past 10 years (DWR, 2016c). Additionally, per DWR, the water budget should represent average hydrology, with both wet and dry years.

The long-term average precipitation recorded at the Sacramento Winter Storm Outlook National Oceanic and Atmospheric Administration (WSO NOAA) station 47633 was 17.9 inches per year (in/yr) between 1888 and 2018. As shown in **Table WB-2** and **Figure WB-3**, the 16-year average precipitation for the Basin represented in the Numerical Model for the Historical Period between WY 1999-2014 was 17.9 in/yr. The average precipitation for the Historical Period is the same as the 130-year record at the Sacramento WSO NOAA station, but slightly lower than Current Conditions represented by WY 2015-2018 (20.6 in/yr). Further, within the 16-year historical budget evaluation period, there are a mix of wet and dry years (three wet years, three above-normal years, two below-normal years, four dry years, and four critical [dry] years, based on DWR's San Joaquin Valley WY Hydrologic Classification Index). Precipitation was below normal in 68% of the years.[60] Hence, the 16-year period from WY 1999-2014 was considered to adequately represent average hydrologic conditions for purposes of quantifying the historical water budget for the

[57] https://waterdata.usgs.gov/ca/nwis/wu
[58] Personal communication, Ken Minn, EBMUD, 21 May 2020.
[59] Personal communication, Laura Foglia, Larry Walker and Associates, 29 August 2020.
[60] http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST

Basin.

Table WB-2. Summary of Precipitation Represented in the Numerical Model, WY 1999-2018

Water Year	Annual Precipitation (inches)	Water Year Type[(a)]	Water Year Index[(a)]
1999	16.9	AN	3.59
2000	22.1	AN	3.38
2001	15.7	D	2.2
2002	17.1	D	2.34
2003	19.3	BN	2.81
2004	15.1	D	2.21
2005	23.5	W	4.75
2006	25.9	W	5.90
2007	12.1	C	1.97
2008	13.6	C	2.06
2009	16.2	BN	2.72
2010	20.1	AN	3.55
2011	26.7	W	5.58
2012	13.9	D	2.18
2013	15.8	C	1.71
2014	11.9	C	1.16
Historical Period Average (WY 1999-2014)	***17.9***	***D***	***3.01***
2015	14.4	C	0.81
2016	18.0	D	2.35
2017	33.4	W	6.46
2018	16.6	BN	3.03
Current Period Average (WY 2015-2018)	***20.6***	***AN***	***3.16***

Notes:

(1) DWR Water Year types are based on the San Joaquin Valley Water Year Hydrologic Classification Index that is based on unimpaired natural water runoff to the San Joaquin Valley, and are as follows: W = wet, AN = above normal, BN = below normal, D = dry, C = critical.

10.2. Water Budget Results

§ 354.18. Water Budget

(a) Each Plan shall include a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions, and the change in the volume of water stored. Water budget information shall be reported in tabular and graphical form.

(b) The water budget shall quantify the following, either through direct measurements or estimates based on data:

(A) Total surface water entering and leaving a basin by water source type.

(B) Inflow to the groundwater system by water source type, including subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems, such as lakes, streams, rivers, canals, springs and conveyance systems.

(C) Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.

(D) The change in the annual volume of groundwater in storage between seasonal high conditions.

(E) If overdraft conditions occur, as defined in Bulletin 118, the water budget shall include a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.

(F) The water year type associated with the annual supply, demand, and change in groundwater stored.

(G) An estimate of sustainable yield for the basin.

Modeled water budget values were calculated on a monthly time step period; however, results are presented below in as long-term average annual values over the 20-year model evaluation period (WY 1999-2018)[61], as well as average annual values over the 16-year historical water budget period (WY 1999-2014) and four-year current water budget period (WY 2015-2018). Information presented below in Section 10.3 *Current and Historical Water Budget* meets the regulatory requirements to report current and historical water budgets, and this budget information is therefore not repeated in the subsequent section.

10.2.1. Surface Water System Inflows and Outflows

Per 23-CCR §354.18(b)(1), **Table WB-3** presents annual summaries of the total inflows to and outflows from the surface water system in the Basin for the model evaluation period (WY 1999-2018). Inflows to the surface water system include: (1) natural streamflow into the Basin, (2) surface water imports, (3) tributary inflows, (4) runoff of precipitation, and (5) return flows from applied water runoff. Outflows from the surface water system include: (6) natural streamflows out of the Basin, (7) net stream leakage to groundwater[62], (8) riparian evapotranspiration (ET), and (9) diversions (stream diversions and surface

[61] Water Years run from October of the previous year to September of the current year (e.g. WY 2018 is October 2017 to September 2018).

[62] Surface water-groundwater interactions occur in both directions but are predominantly in the direction of leakage from streams to groundwater. Therefore, only the net leakage from streams to groundwater is presented here.

water imports). **Figure WB-4** shows the total surface water inflows and outflows by type, and each are discussed in more detail below.

Natural Streamflow into the Basin

The Cosumnes River and Dry Creek are two of the larger surface water features within the Basin, and they form substantial portions of the Basin boundaries and are key sources of groundwater recharge (see Section 8.3.5 *Surface Water Bodies*). The Mokelumne River and Camanche Reservoir are also large surface water features, but represent only a small portion of the southern Basin boundary (see **Figure HCM-23**). In **Table WB-3,** all the rivers and creeks are represented within the streamflow inflows and account for 82% of the total inflows to the surface water system in the Basin (see **Figure WB-5** and **Table WB-3**). Most of these inflows occur in the Cosumnes River and Dry Creek, and much lesser quantities inflows occur in the smaller tributaries (about 1% of total inflows to the surface water system).

Imported Water Supplies

Imported surface water has been delivered to the Basin through the FSC (see Section 8.3.6 *Source and Point of Delivery for Imported Water Supplies*). Since the early 1970s, SMUD has obtained Central Valley Project (CVP) surface water from the American River via FSC for use at the former Rancho Seco power facility and lake (**Figure HCM-23**). Excess water is ultimately discharged to Hadselville Creek. Intermittently between 1975 and 2011, GID and Clay Water District purchased the surface water discharged from the Rancho Seco Park Lake to supplement irrigation water supplies (Robertson-Bryan, Inc. and WRIME, 2011). Since 2012, all water in the FSC was used by SMUD and no diversions have been delivered and used for irrigation within the Basin. The City of Ione imports water into the Basin from AWA to meet the City's urban demands (RMC, 2016), and a Public Water System is supplied by surface water from Jackson Valley Irrigation District. **Table WB-3** summarizes annual surface water imports as <2% of total inflows to, and <2% of total outflows from, the surface water system in the Basin.

Runoff of Precipitation

Precipitation falling on the Basin either becomes surface water runoff that is channeled to nearby drainages, or wets the near-surface soil where it either evaporates or continues to infiltrate into the subsurface where it can be consumed by agricultural crops and natural vegetation growing on undeveloped lands, or continues to percolate downwards to the groundwater table. **Table WB-3** summarizes annual precipitation runoff as 13% of the total inflows to the surface water system in the Basin.

Return Flows

Return flows are the fraction of applied water that either runs off surfaces to nearby drainages or percolates past the root zone as deep percolation that eventually recharge groundwater. The surface water fraction of the return flows is routed to the Cosumnes River, Badger Creek, Laguna Creek, or Dry Creek (**Figure HCM-23**). **Table WB-3** summarizes annual return flows as 2% of the total inflows from the surface water system in the Basin.

Stream – Groundwater Interactions

Flows within creeks, streams, and rivers can leak to the underlying groundwater system (i.e., a losing stream condition). Alternatively, groundwater can seep into the surface water feature (i.e., a gaining stream condition). Therefore, leakage signifies a loss of streamflow to groundwater and seepage signifies a gain of streamflow from groundwater. Both losing and gaining stream reaches are located within the Basin and their net effect, based on model results, represent an addition to groundwater from leakage. The model-calculated overall annual stream-groundwater interactions comprise about 4% of total outflows from the surface water system in the Basin (see **Table WB-3**).

Riparian ET

Riparian vegetation along stream corridors can uptake surface water directly from the adjacent streams to meet some or all of their demand for water. As shown in **Table WB-3**, model-calculated riparian ET is 1% of total outflows from the surface water system in the Basin.

Stream Diversions

Water is diverted for irrigation at various points along the Cosumnes River, Laguna Creek, Dry Creek, Badger Creek, Jackson Creek, Hadselville Creek and the Mokelumne River (**Figure HCM-23**). The diversions account for 1% of total surface water outflows (see **Table WB-3**).

Natural Streamflow out of the Basin

Interior creeks within the Basin flow to either the Cosumnes River or Dry Creek. Because Dry Creek merges with the Mokelumne River at the south-western edge of the Basin, all streamflows out of the Basin are discharged through the Cosumnes River or Mokelumne River. The model-calculated streamflows account for approximately 93% of the total outflows from the surface water system in the Basin (see **Figure WB-5** and **Table WB-3**).

Table WB-3. Annual Surface Water System Inflows and Outflows

Water Year	INFLOWS (AFY)							OUTFLOWS (AFY)					
	Streamflow	Tributary Inflow	Precipitation Runoff[2]	Return Flow[2]	SW Imports		Total Inflows	Streamflow	Riparian ET[2]	Leakage to GW[2]	Diverted to Land for Ag		Total Outflows
					FSC	Ione					Streamflow	SW Imports	
1999	1,307,400	13,600	121,100	22,800	17,400	1,300	1,483,600	-1,396,200	-7,000	-43,100	-18,500	-18,700	-1,483,500
2000	1,026,300	20,900	216,800	23,200	17,500	1,500	1,306,200	-1,218,400	-7,600	-44,200	-16,900	-19,000	-1,306,100
2001	412,000	6,900	104,900	23,400	17,500	1,600	566,300	-489,900	-8,300	-32,600	-16,400	-19,100	-566,300
2002	512,700	10,900	128,300	23,800	17,300	1,600	694,600	-612,600	-8,600	-38,000	-16,500	-18,900	-694,600
2003	621,500	13,500	161,000	22,900	17,300	1,600	837,800	-752,100	-8,600	-40,400	-17,700	-18,900	-837,700
2004	533,100	10,900	120,100	24,500	19,400	2,200	710,200	-626,000	-9,800	-35,300	-17,400	-21,600	-710,100
2005	1,393,800	20,700	178,200	22,300	16,800	2,300	1,634,100	-1,537,500	-8,600	-53,200	-15,700	-19,100	-1,634,100
2006	2,391,400	33,600	275,700	22,800	16,400	2,500	2,742,400	-2,641,800	-8,600	-57,000	-16,000	-18,900	-2,742,300
2007	439,100	7,000	70,900	23,800	17,800	2,400	561,000	-483,200	-10,100	-30,700	-16,900	-20,200	-561,100
2008	359,900	8,900	116,000	24,400	18,700	2,200	530,100	-449,600	-9,900	-33,100	-16,600	-20,900	-530,100
2009	462,500	6,400	95,600	24,500	18,900	2,200	610,100	-520,500	-9,300	-37,500	-21,600	-21,100	-610,000
2010	788,900	12,200	145,700	23,300	18,400	2,100	990,600	-895,700	-7,900	-45,800	-20,800	-20,500	-990,700
2011	2,161,100	28,100	243,900	22,700	17,600	2,100	2,475,500	-2,372,200	-7,300	-55,400	-21,000	-19,700	-2,475,600
2012	555,100	9,400	87,200	24,800	10,200	2,100	688,800	-605,800	-9,000	-34,900	-26,800	-12,300	-688,800
2013	461,400	9,500	123,200	25,000	7,900	2,200	629,200	-555,400	-8,800	-36,100	-18,700	-10,100	-629,100
2014	325,300	7,500	74,300	25,400	6,200	2,000	440,700	-378,100	-9,100	-31,800	-13,600	-8,200	-440,800
2015	336,100	10,700	128,300	24,200	7,700	1,700	508,700	-440,100	-8,900	-36,700	-13,700	-9,400	-508,800
2016	622,600	15,100	150,100	24,100	8,000	1,800	821,700	-743,000	-8,600	-48,900	-11,400	-9,800	-821,700
2017	3,328,000	45,000	387,300	23,000	13,200	2,000	3,798,500	-3,700,900	-7,200	-64,100	-11,100	-15,200	-3,798,500
2018	826,800	14,000	126,000	24,500	13,200	2,100	1,006,600	-925,700	-9,000	-43,000	-13,600	-15,300	-1,006,600
20-Year Average (WY1999-2018)	943,300	15,200	152,700	23,800	14,900	2,000	1,151,800	-1,067,200	-8,600	-42,100	-17,000	-16,800	-1,151,800
Percent of Total	82%	1%	13%	2%	1%	0%	--	93%	1%	4%	1%	1%	--
Historical Average (WY1999-2014)	859,500	13,800	141,400	23,700	16,000	2,000	1,056,300	-970,900	-8,700	-40,600	-18,200	-18,000	-1,056,300
Current Average (WY2015-2018)	1,278,400	21,200	197,900	24,000	10,500	1,900	1,533,900	-1,452,400	-8,400	-48,200	-12,500	-12,400	-1,533,900

Abbreviations:

AFY = acre-feet per year
FSC = Folsom South Canal
SW = Surface Water
ET = Evapotranspiration
GW = Groundwater
WY = Water Year

Notes:

(1) Values rounded to the nearest hundred acre-feet. Minor discrepancies between inflows and outflows are attributed to rounding.

(2) The Basin boundaries are formed by surface water features. The surface water budgets therefore include components of inflow and outflow that contribute to the Basin Water Budget and also the water budgets for the adjacent basins (South American and Eastern San Joaquin Subbasins). Values reported in the above table may therefore not agree with values reported in other tables that are represent water budget components within the Basin boundaries only.

10.2.2. Land Surface/Root Zone System Inflows and Outflows

Per 23-CCR § 354.18(b)(2) and (b)(3), **Table WB-4** and **Figure WB-6** provide an annual summary of inflows to and outflows from the land surface/root zone system by water source type for WY 1999-2018. The Basin boundaries are formed by surface water features. Therefore, the surface water system budget presented above in Section 10.2.1 *Surface Water System Inflows and Outflows* includes components that occur on both sides of the stream (i.e., runoff, return flows, riparian ET, and leakage to groundwater) and contribute to the Basin water budget and also the budgets for the adjacent basins (South American Subbasin [SASb] and Eastern San Joaquin [ESJ] Subbasin). Land surface/root zone system budgets presented herein only include the proportion of these surface water system components that occur within the Basin.

Sources of inflow to the land surface/root zone system include:

- Precipitation;
- Stream inflow for ET, which is the amount of water entering the land surface/root zone system to meet the riparian ET demand for riparian lands located within the Basin. This component is also included as a surface water outflow in the surface water system budget.
- Surface water deliveries into the Basin, which include water diverted from streams and the FSC to meet either irrigation or SMUD demands; and
- Groundwater pumpage that is being applied to meet either irrigation or urban demands across the Basin.

Sources of outflow from the land surface/root zone system include:

- ET from the crops, natural vegetation growing on undeveloped lands (e.g., by Groundwater Dependent Ecosystems [GDEs]), and urban lands across the Basin;
- Runoff of precipitation;
- Return flow from water applied to meet crop and urban water demands that runs off to nearby drainages; and
- Return flow from applied water that infiltrates past the root zone and becomes deep percolation to the groundwater system.

Figure WB-6 provides a summary of the 20-year (WY 1999-2018) long-term annual average inflows to and outflows from the land surface/root zone system. As shown in **Table WB-4**, total inflows to the land surface/root zone system averaged almost 489,000 AFY. Approximately 66% of total inflows to the land surface system were from precipitation, 27% from applied groundwater, 6% from applied surface water diversions and 1% from riparian use of streamflows (stream inflow for ET). Total outflows from the land surface/root zone system averaged approximately 489,000 AFY for the same 20-year period. Approximately 49% of total outflows from the land surface system were from ET, 26% to runoff, 21% to deep percolation to the groundwater system, and 3% from return flow and reused water. Within the category of evapotranspiration, approximately 27% of the Basin outflow is from agriculture areas, 5% from urban areas, and 17% from undeveloped lands (including GDEs).

Table WB-4. Annual Land Surface/Root Zone System Inflows and Outflows

Water Year	INFLOWS (AFY)					OUTFLOWS (AFY)							Change in Storage (AFY)
	Precipitation	Stream Inflow for ET	SW Deliveries	GW Pumpage	Total Inflows	Evapotranspiration			Runoff	Return Flow	Deep Percolation	Total Outflows	RZ Storage Change
						Agriculture	Urban	Native					
1999	297,300	4,500	27,600	132,100	461,500	-128,400	-20,600	-87,600	-104,100	-16,100	-108,400	-465,200	-3,700
2000	390,100	4,900	28,000	134,800	557,800	-134,300	-22,700	-93,900	-177,600	-16,400	-109,200	-554,100	3,700
2001	277,600	5,400	28,800	135,200	447,000	-135,000	-23,000	-87,200	-87,600	-16,500	-99,200	-448,500	-1,400
2002	301,000	5,700	28,700	137,400	472,800	-132,900	-22,500	-88,800	-106,000	-16,700	-106,700	-473,600	-900
2003	340,300	5,700	28,300	129,900	504,200	-131,900	-24,100	-91,200	-134,800	-16,100	-102,800	-500,900	3,400
2004	266,100	6,500	31,200	140,800	444,600	-133,700	-20,800	-74,200	-100,300	-17,100	-99,800	-445,900	-1,300
2005	414,500	5,700	26,600	119,400	566,200	-128,800	-27,200	-112,200	-150,600	-15,600	-129,200	-563,600	2,600
2006	456,700	5,700	27,800	126,400	616,600	-130,500	-25,600	-95,600	-230,900	-15,900	-120,300	-618,800	-2,300
2007	213,900	6,700	30,600	134,500	385,700	-128,800	-22,600	-71,400	-61,600	-16,600	-85,500	-386,500	-800
2008	240,400	6,600	32,800	139,300	419,100	-130,300	-20,600	-64,800	-95,300	-17,000	-94,300	-422,300	-3,200
2009	285,600	6,200	30,400	127,000	449,200	-130,900	-27,200	-88,300	-81,100	-17,600	-100,100	-445,200	3,900
2010	354,500	5,300	28,700	117,000	505,500	-124,000	-29,200	-93,600	-123,800	-16,800	-119,000	-506,400	-900
2011	471,200	4,900	27,400	110,200	613,700	-121,500	-31,100	-103,000	-205,100	-16,300	-135,100	-612,100	1,600
2012	245,600	6,000	25,600	133,500	410,700	-128,400	-27,900	-74,700	-77,400	-17,800	-88,300	-414,500	-3,800
2013	278,800	5,900	26,500	135,300	446,500	-127,500	-26,500	-72,600	-100,900	-17,900	-97,100	-442,500	3,900
2014	209,200	6,100	24,400	139,100	378,800	-127,100	-27,700	-61,800	-64,800	-18,200	-81,000	-380,600	-2,100
2015	254,400	5,900	24,400	138,500	423,200	-127,100	-23,800	-64,800	-106,300	-16,900	-88,000	-426,900	-3,800
2016	317,100	5,700	22,400	135,200	480,400	-132,800	-28,500	-77,900	-125,200	-16,900	-98,600	-479,900	300
2017	588,400	4,800	21,400	121,800	736,400	-130,600	-32,800	-95,800	-317,000	-16,100	-143,000	-735,300	1,000
2018	291,800	6,000	23,100	136,800	457,700	-136,600	-29,500	-77,300	-109,000	-17,100	-89,000	-458,500	-900
20-Year Average (WY1999-2018)	324,700	5,700	27,200	131,200	488,900	-130,100	-25,700	-83,800	-128,000	-16,800	-104,700	-489,100	-200
Percent of Total	66%	1%	6%	27%	--	27%	5%	17%	26%	3%	21%	--	--
Historical Average (WY1999-2014)	315,200	5,700	28,300	130,700	480,000	-129,600	-25,000	-85,100	-118,900	-16,800	-104,800	-480,000	-100
Current Average (WY2015-2018)	362,900	5,600	22,800	133,100	524,400	-131,800	-28,700	-79,000	-164,400	-16,800	-104,700	-525,200	-900

Abbreviations:
AFY = acre-feet per year
ET = evapotranspiration
GW = groundwater
RZ = Root Zone
SW = surface water
WY = Water Year

Notes:
(1) Values rounded to the nearest hundred acre-feet. Minor discrepancies between inflows and outflows are attributed to rounding.
(2) The "Native" category includes Native Water, Managed Wetlands, Riparian and all Undeveloped (non-irrigated) land uses.

10.2.3. Groundwater Inflows and Outflows

Per 23-CCR § 354.18(b)(2) and (b)(3), **Table WB-5** and **Figure WB-7** provide an annual summary of inflows to and outflows from the groundwater system by water source type for WY 1999-2018.

Sources of inflow to the groundwater system include:

- Leakage from surface water systems to the Principal Aquifer (e.g., rivers, creeks, and Camanche Reservoir).
- Deep percolation of precipitation and applied surface water or groundwater; and,
- Subsurface groundwater inflow and surface water percolation from small watersheds along the eastern boundary of the Basin.

Sources of outflow from the groundwater system include:

- Seepage from groundwater to surface water systems (e.g., rivers, creeks, and Camanche Reservoir).
- Groundwater extraction (i.e., pumpage); and,
- Subsurface groundwater outflows to adjacent basins.

Figure WB-7 provides a summary of the 20-year (WY 1999-2018) annual average inflows to and outflows from the groundwater system. As shown in **Table WB-5**, the total inflows to the groundwater system averaged 144,200 AFY. Approximately 73% of total inflows to the groundwater system were from percolation of precipitation and applied water, 3% from net subsurface flows from adjacent watersheds, and 24% from leakage from surface water systems. Within the category of percolation from precipitation and applied water, approximately 35% of the Basin's inflows comes from agriculture areas, 31% from vegetation in undeveloped areas, and 7% from urban areas. Total outflows from the groundwater system averaged 154,900 AFY over the WY 1999-2018 time period. Approximately 85% of total outflows from the groundwater system were from groundwater pumping, 4% to net subsurface groundwater outflows to neighboring basins, and 11% from seepage to surface water systems. Within the category of groundwater pumping, approximately 75% of the Basin's outflows were used for agriculture, whereas 10% were for developed areas and includes urban, domestic (Ag-Res), and industrial water uses (includes aquaculture).

Table WB-5. Annual Groundwater System Inflows and Outflows, and Change in Groundwater Storage

Water Year	INFLOWS (AFY)							OUTFLOWS (AFY)								CHANGE IN STORAGE	
	Leakage from Camanche Reservoir[3]	Leakage from Streamflow to GW	Percolation from Precipitation and Applied Water			Net Subsurface Flow from Adjacent Watersheds	Total Inflows	Seepage to Camanche Reservoir[3]	Seepage to Streamflow from GW	Groundwater Extractions			Net Subsurface Flow between Adjacent Basins[2]		Total Outflows	Storage Change (AFY)[5]	Cumulative Storage Change since WY 1999 (AF)
			Ag. Areas	Native Veg. Areas	Urban Areas					Pumpage for Ag. Areas	Pumpage for Developed Areas[4]	Total Pumpage	Net Flow to ESJ	Net Flow to SASb			
1999	300	35,400	49,800	49,500	9,100	4,900	149,000	0	-17,400	-118,500	-13,600	-132,100	-4,000	-3,000	-156,500	-7,500	-7,500
2000	400	35,700	52,900	47,100	9,100	5,100	150,300	0	-16,800	-120,900	-13,900	-134,800	-3,800	-3,800	-159,200	-8,900	-16,400
2001	200	29,200	47,700	43,300	8,100	4,600	133,100	0	-16,400	-121,100	-14,100	-135,200	-3,300	-4,400	-159,300	-26,200	-42,600
2002	200	31,900	51,300	45,900	9,600	4,800	143,700	0	-16,300	-122,500	-14,900	-137,400	-2,700	-5,300	-161,700	-18,000	-60,600
2003	400	33,100	49,900	43,700	9,100	4,100	140,300	0	-16,000	-115,600	-14,300	-129,900	-2,300	-5,300	-153,500	-13,200	-73,800
2004	400	30,200	50,700	39,600	9,600	3,800	134,300	0	-15,600	-126,200	-14,700	-140,900	-2,200	-6,200	-164,900	-30,600	-104,400
2005	500	40,900	56,300	61,200	11,700	7,400	178,000	0	-17,000	-105,500	-13,900	-119,400	-2,100	-4,900	-143,400	34,600	-69,800
2006	500	43,600	56,600	52,400	11,300	5,600	170,000	0	-17,600	-112,500	-13,800	-126,300	-2,400	-5,500	-151,800	18,200	-51,600
2007	300	27,800	43,900	34,000	7,600	3,300	116,900	0	-16,200	-120,100	-14,300	-134,400	-2,200	-6,900	-159,700	-42,800	-94,400
2008	0	28,900	49,500	35,400	9,400	3,200	126,400	0	-15,600	-125,100	-14,200	-139,300	-2,100	-7,900	-164,900	-38,500	-132,900
2009	200	31,300	47,100	43,300	9,700	4,800	136,400	0	-15,500	-110,200	-16,700	-126,900	-1,300	-6,900	-150,600	-14,200	-147,100
2010	600	36,400	54,000	53,000	11,900	5,700	161,600	0	-16,400	-100,600	-16,400	-117,000	-1,600	-5,100	-140,100	21,500	-125,600
2011	500	42,900	59,200	61,400	14,600	7,200	185,800	0	-18,000	-93,700	-16,500	-110,200	-2,200	-3,100	-133,500	52,300	-73,300
2012	300	30,600	43,100	36,600	8,500	4,000	123,100	0	-16,800	-115,900	-17,600	-133,500	-2,300	-3,500	-156,100	-33,000	-106,300
2013	500	30,800	49,600	36,100	11,400	3,100	131,500	0	-16,200	-117,800	-17,500	-135,300	-2,500	-5,000	-159,000	-27,500	-133,800
2014	100	28,000	41,400	31,100	8,400	3,200	112,200	0	-15,200	-120,900	-18,200	-139,100	-1,300	-5,900	-161,500	-49,300	-183,100
2015	0	30,600	45,400	32,600	10,000	3,700	122,300	-300	-15,200	-123,300	-15,100	-138,400	-1,200	-5,600	-160,700	-38,400	-221,500
2016	200	37,300	47,400	40,600	10,600	5,100	141,200	0	-15,500	-119,500	-15,700	-135,200	-1,600	-4,600	-156,900	-15,700	-237,200
2017	600	47,900	63,600	63,200	16,300	7,600	199,200	0	-17,800	-106,900	-15,000	-121,900	-2,000	-3,000	-144,700	54,500	-182,700
2018	700	34,800	44,000	35,800	9,200	4,700	129,200	0	-16,300	-121,400	-15,400	-136,800	-2,400	-3,500	-159,000	-29,800	-212,500
Total	6,900	687,300	1,003,400	885,800	205,200	95,900	2,884,500	-300	-327,800	-2,318,200	-305,800	-2,624,000	-45,500	-99,400	-3,097,000	-212,500	
20-Year Average[2]	300	34,400	50,200	44,300	10,300	4,800	144,200	0	-16,400	-115,900	-15,300	-131,200	-2,300	-5,000	-154,900	-10,600	--
Percent of Total	0%	24%	35%	31%	7%	3%	--	0%	11%	75%	10%	85%	1%	3%	--	--	--
Historical Average[2]	300	33,500	50,200	44,600	9,900	4,700	143,300	0	-16,400	-115,400	-15,300	-130,700	-2,400	-5,200	-154,700	-11,400	-89,000
Current Average[2]	400	37,700	50,100	43,100	11,500	5,300	148,000	-100	-16,200	-117,800	-15,300	-133,100	-1,800	-4,200	-155,300	-7,400	-213,500

Abbreviations:

AF = acre-feet
AFY = acre-feet per year
Ag. = Agricultural
ESJb = Eastern San Joaquin Subbasin
GW = groundwater
SASb = South American Subbasin
Veg. = Vegetation
WY = Water Year

Notes:

(1) Values rounded to the nearest hundred acre-feet. Minor discrepancies between inflows and outflows are attributed to rounding.
(2) The "Native Vegetation Areas" category includes Native Water, Managed Wetlands, Riparian and all Undeveloped (non-irrigated) land uses.
(3) 20-Year average period is WY1999-2018; Historical Average period is WY1999-2014; Current Average Period is WY2015-2018.
(4) Inflows and outflows associated with Camanche Reservoir and subsurface flow from neighboring Basins are summarized as the net inflow or outflow for each year.
(5) Groundwater pumpage for developed areas includes urban and aquaculture; agricultural pumpage includes Ag-Res.
(6) Storage change calculated as the sum of total inflows and total outflows. A negative value represents an inflow to the Basin water budget. In other words, a negative storage change compensates for the budget deficit by removing water from storage.

10.2.4. Change in Groundwater Storage

Per 23-CCR § 354.18(b)(4), **Figure WB-8, Figure WB-9**, and **Table WB-6** present the annual and cumulative change in groundwater storage between seasonal high conditions, which are defined in this GSP to be February of a given year through January of the following year (e.g., February 2013 through January 2014). Note that this time window is different from DWR's definition of the "Water Year", which runs from October of the previous year to September of the current year (e.g., October 2013 through September 2014). The annual change in groundwater storage between seasonal highs for the 16-year period from February 1999 through January 2015 averaged -11,700 AFY, with a cumulative change in storage of -187,200 AF (**Table WB-6**; **Figure WB-8**).

Figure WB-10, **Figure WB-11**, and **Table WB-7** compare the annual and cumulative change in storage to the WY type, based on DWR's San Joaquin Valley Water Year Hydrologic Classification Index for WY 1999-2018, and averaging period (20-year average [WY 1999-2018], Historical Average [WY 1999-2014], and Current Average (WY 2015-2018]). Annual change in groundwater storage ranged from -7,400 AFY (Current Average) to -11,500 AFY (Historical Average). There is a clear relationship between change in groundwater storage and WY type, whereby the annual change in storage becomes more positive with an increasing "wet" condition (storage accretion) and more negative with an increasing "dry" condition (storage depletion). The net benefit of a "wet" period on groundwater conditions is especially evident in WYs 2005, 2006, 2010, 2011, and 2017, whereas the impact of a severe multi-year drought becomes increasingly evident over the period of WY 2013-2016. As evident from these three exhibits, as well as from the groundwater hydrographs shown in **Figure GWC-5**, the groundwater system is sensitive to climatic conditions.

Table WB-6. Annual and Cumulative Change in Groundwater Storage between Seasonal Highs (February – January)

Period of Reference (month/year)	Annual Change in Groundwater Storage (AFY)	Cumulative Change in Groundwater Storage (AF)
2/99 – 1/00	-20,000	-20,000
2/00 – 1/01	-3,300	-23,300
2/01 – 1/02	-13,700	-37,000
2/02 – 1/03	-26,400	-63,400
2/03 – 1/04	-13,100	-76,500
2/04 – 1/05	-5,100	-81,600
2/05 – 1/06	15,300	-66,300
2/06 – 1/07	-2,200	-68,500
2/07 – 1/08	-25,400	-93,900
2/08 – 1/09	-50,700	-144,600
2/09 – 1/10	1,800	-142,800
2/10 – 1/11	40,500	-102,300
2/11 – 1/12	14,400	-87,900
2/12 – 1/13	-7,600	-95,500
2/13 – 1/14	-70,700	-166,200
2/14 – 1/15	-21,000	-187,200
Total	-187,200	--
Average	-11,700	--

Abbreviations:
AF = acre-feet
AFY = acre-feet per year

Notes:
(1) Values rounded to the nearest hundred AF.

Table WB-7. Annual Change in Groundwater Storage vs. DWR Water Year Type

Water Year (Oct - Sept)	Water Year Type[1]	Annual Change in Groundwater Storage (AFY)[2]	Cumulative Change in Groundwater Storage (AF)[2]
1999	AN	-7,300	-7,300
2000	AN	-8,900	-16,200
2001	D	-26,200	-42,400
2002	D	-18,000	-60,400
2003	BN	-13,100	-73,500
2004	D	-30,600	-104,100
2005	W	34,700	-69,400
2006	W	18,200	-51,200
2007	C	-42,800	-94,000
2008	C	-38,600	-132,600
2009	BN	-14,300	-146,900
2010	AN	21,500	-125,400
2011	W	52,100	-73,300
2012	D	-33,000	-106,300
2013	C	-27,500	-133,800
2014	C	-49,400	-183,200
2015	C	-38,300	-221,500
2016	D	-15,800	-237,300
2017	W	54,500	-182,800
2018	BN	-29,800	-212,600
Total		-212,600	--
20-Year Average (WY1999-2018)		-10,600	--
Historical Average (WY1999-2014)		-11,500	--
Current Average (WY2015-2018)		-7,400	--

Abbreviations:
AF = acre-feet
AFY = acre-feet per year
DWR = California Department of Water Resources
Oct = October
Sept = September
WY = Water Year

Notes:
(1) DWR Water Year types are based on the San Joaquin Valley Water Year Hydrologic Classification Index, and are as follows: W = wet; AN = above normal; BN = below normal; D = dry; C = critical
(2) Values rounded to the nearest hundred acre-feet.

Sources:
(1) DWR's Water Year Hydrologic Classification Indices for the San Joaquin Valley. http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST

10.2.5. Overdraft Conditions

The Basin has been classified by DWR in its 2019 Basin Prioritization (DWR, 2019) as a "medium priority" basin, and is not designated as being in a condition of critical overdraft. With respect to basins in overdraft conditions, DWR has made the following statements:

- "A basin is subject to critical conditions of overdraft when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts." (DWR, 1980)
- Groundwater overdraft is "... the condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions. Overdraft can be characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years. If overdraft continues, significant adverse impacts may occur, including increased extraction costs, costs of well deepening or replacement, land subsidence, water quality degradation, and environmental impacts." (DWR, 2003)
- "Overdraft occurs where the average annual amount of groundwater extraction exceeds the long-term average annual supply of water to the basin. Effects of overdraft can include seawater intrusion, land subsidence, groundwater depletion, and/or chronic lowering of groundwater levels".[63]

While evaluating basins for critical overdraft conditions in its most recent Bulletin 118 update, DWR considered the time period from WY 1989-2009 (DWR, 2016d). This period was selected because it excludes the recent drought which began in 2012, includes both wet and dry periods, is at least 10 years in length (it is 21 years in length), and includes precipitation close to the long-term average.

The water budget information discussed herein covers the period from WY 1999-2018, and therefore only partially overlaps DWR's evaluation period. However, the 11 years of WY 1999-2009 (October 1998 through September 2009) from the 20-year average water budget overlap the DWR overdraft evaluation period and generally meets the same climatic criteria utilized by DWR. The cumulative departure from statewide average precipitation increased by a total of 9% during the WY 1999-2009 period (DWR, 2016d, Figure 1), indicating that on average each year was slightly wetter than the long-term average (i.e., less than 1% annually). Over the WY 1999-2009 period, the cumulative change in storage within the Basin decreased by approximately 147,100 AF, averaging a decrease of approximately 13,400 AFY. Therefore, more groundwater was consumed than recharged over the WY 1999-2009 period. However, as discussed in Section 10.4.3 *Projected Groundwater Budget Results*, under the Current Conditions Baseline Scenario using current land use assumptions and 50-years of historical hydrology, model calculations indicate that the Basin would be approximately balance due in part to the slightly greater rainfall over the past 50-years relative to WY 1999-2009 period.

[63] https://water.ca.gov/Programs/Groundwater-Management/Bulletin-118/Critically-Overdrafted-Basins, accessed 1 July 2018.

10.2.6. Sustainable Yield

The Sustainable Groundwater Management Act (SGMA) defines sustainable yield 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" (California Water Code [CWC], §10721(w)). DWR's BMP #4 Water Budget (DWR, 2016c) further states that "Water budget accounting information should directly support the estimate of sustainable yield for the basin and include an explanation of how the estimate of sustainable yield will allow the basin to be operated to avoid locally defined undesirable results." Inherent to the codified definition and the BMP statement is the avoidance of the SGMA-specified "Undesirable Results", which include significant and unreasonable effects for any of the six SGMA Sustainability Indicators, most of which are based either directly or by proxy on groundwater levels.

While no exact method for defining the sustainable yield is required by SGMA or promoted by DWR in its Water Budget BMP, the BMP does emphasize that water budget accounting information should be used. It follows that an estimate of the sustainable yield can be made by subtracting the average annual groundwater pumpage, which is negative by definition, from the average annual change in storage (whether positive or negative). This simplified approach provides a sustainable yield estimate corresponding to the total volume of water that, if pumped over the water budget period of interest, would have resulted in zero change in storage due to pumping – a reasonable metric for sustainability. For the Basin, using the average annual change in groundwater storage over the 20-year average water budget period from WY 1999-2018 (i.e., -10,600 AFY) and the average annual groundwater pumpage (i.e., -131,200 AFY), the sustainable yield is estimated at approximately 120,600 AFY.

Table WB-8 below provides a summary of the range of potential sustainable yield estimates for different selected time periods. Under historical conditions (WY 1999-2014), the sustainable yield estimate is 119,300 AFY, whereas under current supply and demand conditions (WY 2015-2018) the sustainable yield estimate is 125,700 AFY. For the period WY 1999-2009 that overlaps 11-years of DWRs overdraft evaluation period, the sustainable yield estimate is 119,000 AFY. These historical evaluations produce sustainable yield estimates for the Basin that range from 119,000 AFY to 125,700 AFY and represent a reasonably conservative estimate for planning purposes.

Model calculations discussed below in Section 10.4 *Projected Water Budget* indicate that under current conditions and a repeat of the last 50-years of hydrology, there will be an average annual decrease in groundwater storage of 400 AFY and projected sustainable yield of 127,500 AFY, which is greater than the sustainable yield estimates based on the different historical averaging periods. However, if future climatic conditions are drier than the past 50-years, the sustainable yield decreases and the likelihood of Undesirable Results can increase.

Table WB-8. Estimated Sustainable Yield for Selected Time Periods[1]

Time Period	Relevance of Time Period	Average Annual Change in Groundwater Storage (AFY)	Average Annual Groundwater Pumpage (AFY)	Sustainable Yield (AFY)[2]
WY 1999-2018	Water Budget Calculation Period	-10,600	-131,200	120,600
WY 1999-2014	Historical Water Budget Period	-11,400	-130,700	119,300
WY 2015-2018	Current Water Budget Period	-7,400	-133,100	125,700
WY 1999-2009	Overdraft Evaluation Period (Section *10.2.6*)	-13,400	-132,400	119,000

Abbreviations:
AFY = acre-feet per year
WY = Water year

Notes:
(1) Values rounded to the nearest hundred acre-feet.
(2) Sustainable Yield is calculated as average annual change in groundwater storage minus average annual groundwater pumpage.

10.3. Current and Historical Water Budget

§ 354.18. Water Budget

(c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:

(1) Current water budget information shall quantify current inflows and outflows for the basin using the most recent hydrology, water supply, water demand, and land use information.

(2) Historical water budget information shall be used to evaluate availability or reliability of past surface water supply deliveries and aquifer response to water supply and demand trends relative to water year type. The historical water budget shall include the following:

(A) A quantitative evaluation of the availability or reliability of historical surface water supply deliveries as a function of the historical planned versus actual annual surface water deliveries, by surface water source and water year type, and based on the most recent ten years of surface water supply information.

(B) A quantitative assessment of the historical water budget, starting with the most recently available information and extending back a minimum of 10 years, or as is sufficient to calibrate and reduce the uncertainty of the tools and methods used to estimate and project future water budget information and future aquifer response to proposed sustainable groundwater management practices over the planning and implementation horizon.

(C) A description of how historical conditions concerning hydrology, water demand, and surface water supply availability or reliability have impacted the ability of the Agency to operate the basin within sustainable yield. Basin hydrology may be characterized and evaluated using water year type.

10.3.1. Current Water Budget

This section presents results for the "current" water budget, based on average values for the WY 2015-2018 time period. Per 23-CCR §354.18(c)(1), total inflows and outflows are summarized by hydrologic system: (1) land surface/root zone system, (2) surface water system, and (3) groundwater system. The reporting periods of WY 1999-2018 summarized previously in **Table WB-3**, **Table WB-4**, **Table WB-5**, and **Figure WB-4, Figure WB-6,** and **Figure WB-7** include the Current Water Budget period of WY 2015-2018.

As shown in **Table WB-9** and **Figure WB-12**, for WY 2015-2018 the total inflows to the Basin (precipitation, surface water inflow and subsurface inflow) averaged 1,680,600 AFY. Approximately 78% of total inflows were from the surface water system, 22% from precipitation, and less than 1% from the groundwater system. During WY 2015-2018, the net effect of surface flows routed to and from adjacent basins resulted in an average net inflow to the Basin of 9,200 AFY. Hence, the adjusted total inflow to the Basin sums to 1,689,800 AFY.

The total outflows from the Basin (evapotranspiration, surface water outflow and subsurface outflow) averaged 1,697,900 AFY (**Table WB-9** and **Figure WB-12**). Approximately 14% of total outflow was attributed to ET, 86% to streamflow, and less than 1% to net subsurface outflow. The resulting net deficit between adjusted total inflow and total outflow is about -8,000 AFY. The water budget deficit was met primarily by groundwater storage (a reduction of over 7,000 AFY), and the remainder met by a depletion of root zone storage (a reduction of almost 1,900 AFY).

Table WB-9. Annual Inflows to and Outflows from the Water Budget Domain, and Change in Storage

Water Year	INFLOWS (AFY)				OUTFLOWS (AFY)				Net Streamflow Routed between Adjacent Basins[4]	CHANGE IN STORAGE[2]	
	Precipitation	Surface Water (including Imports)	Net Subsurface Flow from Adjacent Watersheds	Total Inflows	Evapotranspiration	Surface Water	Net Subsurface Flow between Adjacent Basins[3]	Total Outflows		GW Storage Change (AFY)	Root Zone Storage Change (AFY)
1999	297,300	1,340,000	4,900	1,642,200	-236,600	-1,396,200	-7,000	-1,639,800	-13,500	-7,500	-3,700
2000	390,100	1,066,600	5,100	1,461,800	-250,900	-1,218,400	-7,600	-1,476,900	10,100	-8,900	3,700
2001	277,600	438,200	4,600	720,400	-245,200	-489,900	-7,700	-742,800	-5,200	-26,200	-1,400
2002	301,000	542,700	4,800	848,500	-244,200	-612,600	-8,000	-864,800	-2,600	-18,000	-900
2003	340,300	654,300	4,100	998,700	-247,200	-752,100	-7,600	-1,006,900	-1,500	-13,200	3,400
2004	266,100	566,000	3,800	835,900	-228,700	-626,000	-8,400	-863,100	-4,600	-30,600	-1,300
2005	414,500	1,434,100	7,400	1,856,000	-268,200	-1,537,500	-7,000	-1,812,700	-6,100	34,600	2,600
2006	456,700	2,444,400	5,600	2,906,700	-251,700	-2,641,800	-7,900	-2,901,400	10,700	18,200	-2,300
2007	213,900	466,600	3,300	683,800	-222,800	-483,200	-9,100	-715,100	-12,500	-42,800	-800
2008	240,400	389,700	3,200	633,300	-215,700	-449,600	-10,000	-675,300	300	-38,500	-3,200
2009	285,600	490,200	4,800	780,600	-246,400	-520,500	-8,200	-775,100	-15,700	-14,200	3,900
2010	354,500	822,200	5,700	1,182,400	-246,800	-895,700	-6,700	-1,149,200	-12,600	21,500	-900
2011	471,200	2,209,400	7,200	2,687,800	-255,600	-2,372,200	-5,300	-2,633,100	-1,000	52,300	1,600
2012	245,600	577,100	4,000	826,700	-231,000	-605,800	-5,800	-842,600	-20,800	-33,000	-3,800
2013	278,800	481,500	3,100	763,400	-226,600	-555,400	-7,500	-789,500	2,700	-27,500	3,900
2014	209,200	341,100	3,200	553,500	-216,600	-378,100	-7,200	-601,900	-2,700	-49,300	-2,100
2015	254,400	356,200	3,700	614,300	-215,700	-440,400	-6,800	-662,900	6,300	-38,400	-3,800
2016	317,100	647,700	5,100	969,900	-239,200	-743,000	-6,200	-988,400	3,300	-15,700	300
2017	588,400	3,388,800	7,600	3,984,800	-259,200	-3,700,900	-5,000	-3,965,100	35,900	54,500	1,000
2018	291,800	856,800	4,700	1,153,300	-243,400	-925,700	-5,900	-1,175,000	-8,900	-29,800	-900
Total Current	1,451,700	5,249,500	21,100	6,722,300	-957,500	-5,810,000	-23,900	-6,791,400	36,600	-29,400	-3,400
Current Average (WY2015-2018)	362,900	1,312,400	5,300	1,680,600	-239,400	-1,452,500	-6,000	-1,697,900	9,200	-7,400	-900
Percent of Total	22%	78%	0%	--	14%	86%	0%	--		--	
Historical Average (WY1999-2014)	315,200	891,500	4,700	1,211,400	-239,600	-970,900	-7,600	-1,218,100	-4,700	-11,400	-100

Abbreviations:
AF = acre-feet
AFY = acre-feet per year
GW= groundwater
N/A = not applicable
SW = surface water
WY = Water Year

Notes:
(1) All values rounded to the nearest hundred acre-feet. Minor discrepancies between inflows and outflows are attributed to rounding.
(2) The sum of groundwater storage change and root zone storage change equals the balance of inflows and outflows.
(3) Inflows and outflows associated with subsurface flow from neighboring Basins are summarized as the net inflow or outflow for each year.

(4) Because Basin boundaries are represented by surface water features (e.g., Cosumnes River and Dry Creek), some portions of surface water system components are routed between the adjacent basins (i.e., runoff, return flows, riparian ET, and diversions) and must be included to achieve a water balance for the water budget domain.
(5) Blue shading represents the current water budget time period (WY 2015-2018).

10.3.2. Historical Water Budget

Water budget results for the Historical Water Budget (WY 1999-2014) are included above in Section 10.2 *Water Budget Results*, including associated figures and tables, and are not repeated here. Rather, this section focuses on providing:

(a) a quantitative evaluation of historical surface water availability and reliability (23-CCR §354.18(d)(2)(A));

(b) a quantitative assessment of the historical water budget (23-CCR §354.18(d)(2)(B)); and,

(c) a description of how historical conditions have impacted the ability of the Basin to be operated within its sustainable yield (23-CCR §354.18(d)(2)(C)).

Surface Water Availability and Reliability

Imported surface water has been delivered to the Basin through the FSC (see Section 8.3.5 *Surface Water Bodies*). According to USBR records, the only current diverter of FSC water for use within the Basin is SMUD.[64] SMUD's maximum contract amount is 30,000 AFY,[65] but over the water budget period SMUD has never used their full contractual amount (**Figure WB-13**).

The City of Ione receives water from AWA's Amador Water System. The Amador Water System has a contractual right to divert up to 15,000 AFY of Mokelumne River water (RMC, 2016). The AWA 2015 UWMP projects water demands through 2040 that are below AWA's Mokelumne River contractual rights.

Quantitative Assessment of Historical Water Budget

Based on DWR's San Joaquin Valley WY Hydrologic Classification Index for the 16-year Historical Averaging period (WY 1999-2014), the period is characterized by alternating two- to four-year sequences of relatively dry and wet conditions. The climatic effects are clearly reflected in the water budget, whereby the groundwater system shows consistent increases in storage with "wetter" conditions and decreases in storage under "drier" conditions (see **Figure WB-10**, **Figure WB-11**, and **Table WB-7**).

Table WB-9 and **Figure WB-14** breakdown annual total Basin inflows and outflows for the Historical Averaging period. Annual total inflows averaged 1,211,400 AFY and include precipitation, surface water inflow, and subsurface inflow. Annual total outflows averaged 1,218,100 AFY and include evapotranspiration, surface water outflow, and subsurface outflow. The net effect of surface flows routed to adjacent basins resulted in an average net outflow of -4,700 AFY. Hence, the adjusted total outflows from the Basin sum to 1,222,800 AFY, and the net deficit between inflows and outflows was -11,400 AFY. The water budget deficit was met by removing groundwater from storage.

Operation within Sustainable Yield

The average annual decline in groundwater storage during the Historical Averaging period (WY 1999-2014) was -11,500 AFY, and corresponds to a cumulative change in groundwater storage over the 16-year period

[64] Written communication, Georgiana Gregory, US Bureau of Reclamation, 25 November 2014.
[65] https://www.usbr.gov/mp/cvp-water/docs/latest-water-contractors.pdf

of -183,200 AF (**Table WB-7**; **Figure WB-11**). Average total annual pumpage was 130,700 AFY (**Table WB-5**), and exceeded the range in estimated sustainable yield reported in **Table WB-8** (119,000 AFY to 125,700 AFY). The sustainable yield is sensitive to climatic conditions, and the Basin experiences storage decreases during dry periods and storage increases during wet periods (see **Figure GWC-5**). Hence, as a metric, the sustainable yield is substantially influenced by the consumption of extracted groundwater and the climatic averaging period. As future climatic conditions are difficult to project, and could result in greater reliance of groundwater storage to balance the water budget (see **Table WB-10**), actions that reduce groundwater consumption (demand reduction) and increase recharge will support long-term groundwater sustainability.

10.4. Projected Water Budget

§ 354.18. Water Budget
(c) Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:

(3) Projected water budgets shall be used to estimate future baseline conditions of supply, demand, and aquifer response to Plan implementation, and to identify the uncertainties of these projected water budget components. The projected water budget shall utilize the following methodologies and assumptions to estimate future baseline conditions concerning hydrology, water demand and surface water supply availability or reliability over the planning and implementation horizon:

(A) Projected hydrology shall utilize 50 years of historical precipitation, evapotranspiration, and streamflow information as the baseline condition for estimating future hydrology. The projected hydrology information shall also be applied as the baseline condition used to evaluate future scenarios of hydrologic uncertainty associated with projections of climate change and sea level rise.

(B) Projected water demand shall utilize the most recent land use, evapotranspiration, and crop coefficient information as the baseline condition for estimating future water demand. The projected water demand information shall also be applied as the baseline condition used to evaluate future scenarios of water demand uncertainty associated with projected changes in local land use planning, population growth, and climate.

(C) Projected surface water supply shall utilize the most recent water supply information as the baseline condition for estimating future surface water supply. The projected surface water supply shall also be applied as the baseline condition used to evaluate future scenarios of surface water supply availability and reliability as a function of the historical surface water supply identified in Section 354.18(c)(2)(A), and the projected changes in local land use planning, population growth, and climate.

Per the GSP Regulations (23-CCR §354.18(c)(3)), projected water budgets are required to estimate future conditions of water supply and demand within a basin, as well as the aquifer response to GSP implementation over the planning and implementation horizon. The numerical model was employed to develop projected water budgets that considered updated inputs for climate variables, land use, and planned project and management actions (PMAs).

10.4.1. Development of 50-Year Analog Period

Per the GSP Regulations 23-CCR §354.18(c)(3)(A), the projected water budgets must use 50 years of historical precipitation, ET, and streamflow information as the basis for evaluating future conditions under baseline and climate-modified scenarios. To develop the required 50 years of projected hydrologic input information, an "analog period" was created by repeating the previous 50 years of historical hydrologic record. Therefore, the hydrology for the projected 50-year analog period is based on the hydrology for actual years 1970 to 2019. The mapping of actual years to analog years within the required 50-year projected water budget period applies to the precipitation, ET, streamflow, and most diversion datasets.

10.4.2. Development of Projected Water Budget Scenarios

Six projected scenarios were used for this water budget analysis per DWR guidance (DWR, 2018c):

- Current Conditions Baseline Scenario;
- Current Conditions DWR 2030 Central Tendency Climate Change Scenario;
- Projected Conditions Baseline Scenario;
- Projected Conditions American River Basin Study (ARBS) Central Tendency 2070 Climate Change Scenario;
- Projected Conditions DWR Extreme I (drier with extreme warming) 2070 Climate Change Scenario; and,
- Projected Conditions DWR Extreme II (wetter with moderate warming) 2070 Climate Change Scenario.

The two Current Conditions scenarios above represent the Basin water budget using current land use conditions, and the four Projected Conditions scenarios above represent the Basin water budget using future land use conditions. The Baseline Conditions scenarios are for comparison purposes and do not include any expected effects of climate change. The DWR 2030 Central Tendency and the ARBS Central Tendency 2070 Climate Change scenarios reflect a moderate level of climate change effects, whereas the DWR Extreme 2070 Climate Change scenarios incorporate more severe climate change assumptions. All six scenarios are used to project the 50-year water budget for the Basin (e.g., WY 2022-2072), and provide insight into the sensitivity of the water budget to uncertainty in climate and land use conditions.

In addition, six proposed PMAs described in Section 18.2 *List of Projects and Management Actions* were considered for the water budget analysis:

- PMA #1 Omochumne-Hartnell Water District (OHWD) Agricultural Flood Managed Aquifer Recharge (Flood-MAR) Project,
- PMA #2 Sacramento Area Flood Control Agency (SAFCA) Flood-MAR Project,
- PMA #3 OHWD Cosumnes River Flow Augmentation Project,
- PMA #4 City of Galt Recycled Water Project,
- PMA #5 Voluntary Land Repurposing Project includes pumping reductions achieved through

temporary fallowing and/or land use changes and the saved water stored in the Basin; and,

- PMA #6 Groundwater Banking and Sale includes periodic recovery of banked groundwater to sell as supplemental dry year supply to generate revenue to finance GSP implementation.

The PMAs above are considered adequately defined to be quantitatively represented in the numerical groundwater model, and therefore were incorporated into the Projected Conditions Baseline Scenario to calculate the 50-year Basin water budget. The resulting PMA Scenario, with and without climate change (Projected Conditions ARBS Central Tendency 2070 Climate Change Scenario), is in addition to the six projection scenarios listed above (a total of eight model scenarios). The PMAs scenario includes the well-defined and recently (or soon-to-be) activated projects in the SASb and the six PMAs described for the Basin (see Section 18.2 *List of Projects and Management Actions*). Model input to represent conservation, a regional conjunctive use program, and new supplies (e.g., the Harvest Water regional recycled water project) in the SASb was provided by Woodard & Curran.[66]

Current Conditions Baseline Scenario

Per the GSP Regulations 23-CCR §354.18(c)(3)(B) and 23-CCR §354.18(c)(3)(C), the projected water budgets must use "the most recent land use, evapotranspiration, and crop coefficient information" and "the most recent water supply information as the baseline condition for estimating future surface water supply." The Current Conditions Baseline Scenario utilizes historical climate, current land use, and current water demands through the 50-year projection period.

Current land use (**Figure PA-2 through Figure PA-8**) includes updates based on input from the Groundwater Sustainability Agencies (GSAs) and from contemporaneous aerial imagery. These land use changes likely occurred during the period 2016-2020, near the end and after the 20-year average period (WY 1999-2018):

- Vineyards to Almonds in GID and Clay Water District GSAs,
- Native (undeveloped) to Grains and Hay in Sacramento County GSA,
- Native (undeveloped) to Urban in Camanche Village area of Amador County Groundwater Management Authority (ACGMA) GSA, based on occupied parcels identified from satellite imagery, and
- Native (undeveloped) or Idle to Vineyards in Jackson Valley area of ACGMA GSA.

The groundwater pumping from the Basin includes public supply, domestic, and irrigation uses. Under current conditions, monthly groundwater pumpage from domestic wells (Ag-Res) and PWSs are repeated and equal to the average monthly pumpage in the Current Water Budget period (WY 2015-2018). Agricultural pumpage was calculated from the current land use and repeated 50-year climate data. Surface water deliveries to the City of Ione and SMUD were assumed constant and equal to average WY 2015-2018 conditions.

[66] Woodard & Curran, June 1 2021, written communication.

Current Conditions DWR 2030 Central Tendency Climate Change Scenario

To estimate the potential effects of climate change on the projected Current Conditions Baseline Scenario, the climate data utilized by the scenario was modified based on the 2030 climate change factors published by DWR (2018). The DWR climate change factors represent spatial variability in historical monthly precipitation and ET records from 1915 through 2011 based on various models of projected climate conditions centered around the years 2030. The analog years 1970 through 2011 were used directly from the DWR data set, and the remaining eight years for the 50-year projection period (2012-2019) were constructed by repeating the change factors provided for years with similar hydrology. Specifically, the climate change factors for 2012-2019 utilized the factors from 1972, 1989, 1987, 1988, 1979, 1982, 1979, and 1986, respectively. The application of the monthly change factors to the 50-year climate record simulated by the model resulted in annual adjustments to precipitation, ET, and streamflow that ranged from 1% to 15%, -5% to 10%, and -10% to 50%, respectively (depending on water year type). These adjustments resulted in an average decrease in ET of 0.3%, an average increase in precipitation of 4%, an average increase in Cosumnes River flows of 2%, and an average increase in Dry Creek streamflows of 18%.

Projected Conditions Baseline Scenario

Per the GSP Regulations 23-CCR §354.18(c)(3)(B) the projected water budgets must include "projected changes in local land use planning, population growth, and climate." The Projected Conditions Baseline Scenario assumptions are shown in **Figure WB-15** and represent the following changes to the Current Conditions described above:

- Agricultural land use is assumed to be the same as in the Current Conditions Baseline Scenario except where converted to urban land (described below);
- Urban land use represented by the City of Galt was expanded to represent the 2030 projections reported in the City's General Plan (includes newly and proposed annexations), which results in a corresponding reduction of agricultural land area;
- The undeveloped areas represented in Amador County's General Plan as "Urban Planning Area" in the City of Ione and "Rural Residential"[67] in Camanche Village were converted to urban, and reduced an equal quantity of agricultural and undeveloped land areas; and,
- The footprint of the Buena Vista Rancheria was converted from undeveloped to urban.

The projected groundwater pumping from the Basin includes known and anticipated public supply, domestic, and irrigation uses, and is estimated using the following assumptions:

- Pumpage for rural domestic use (Ag-Res) was increased according to projected population increases for the Ag-Res area represented in the model;[68]

[67] Excluded "Camanche Village Special Planning Area" (left as undeveloped).

[68] The Census between 2000 and 2010 for Wilton Census Designated Place (CDP) reports a population increase of 812 (approx. 80 persons per year/ ~1.8% growth per year). Alternatively, unincorporated areas of Sacramento County increased by ~0.3%

- Three Buena Vista Rancheria production wells (W-1, W-2, and W-3) were added to the model with an assumed pumping rate based on reported data from May 2019 through April 2020;
- City of Galt PWS production wells: The 2040 City of Galt water demand (7,663 AFY), as specified in the City's 2015 UWMP, was distributed to the six currently active wells proportional to their historical maximum annual yield. The proportional distribution of annual pumpage was based on current conditions, except for Well 22 whose monthly distribution was based on WY 2019 operations (Well 22 came online in 2018);
- Camanche PWS: The current conditions pumpage from the four active wells was doubled based on expansion and development of currently vacant parcels (Dunn Environmental, 2012a). The proportional distribution of annual pumpage between months remains the same as specified in the Current Condition Scenario;
- Camanche North Shore PWS: Pumpage from the two active wells was increased by a total of 11 AFY based on a projected maximum daily treated water demand increase of 10,000 gallons per day (draft Camanche Area Regional Water Supply Plan [CARWSP] Feasibility Study and Conceptual Design, 2012). The proportional distribution of annual pumpage between months remains the same as specified in the Current Condition Scenario; and
- All other PWSs and aquaculture were assumed to have the same rate of pumpage as specified in the Current Condition Scenario.

City of Ione surface water use was doubled based on the projected demand increases as specified in the AWA 2015 UWMP.

There was no change in the Castle Oaks golf course recycled water use or FSC diversions to SMUD Rancho Seco.

Projected Conditions ARBS Central Tendency 2070 Climate Change Scenario

Potential climate change effects on the projected water budget were evaluated using the 2070 "central tendency" climate change factors established for the ARBS[69] (USBR, August 2020). For the 2070 ARBS Central Tendency Climate Change Scenario, the 50-year historical precipitation, ET, and streamflow were

between 2019 and 2020. An average value of 1% per year was therefore employed to scale the specified Ag-Res water use as follows. A 1% per year increase in population (22% increase between 2018 and 2040) results in a projected population of 11,263. This population increase translates into 3,754 occupied parcels by 2040, assuming 3 persons per parcel. Consistent with the historical condition model runs, all indoor water use is assumed to return to groundwater, and there is no net change in groundwater consumption. In contrast, outdoor water use consumes groundwater at an assumed rate of 2.52 AFY per parcel. The projected annual groundwater consumption in 2040 is estimated to be 9,448 AFY and was distributed monthly as specified in the historical condition model.

[69] The numerical model includes the North American Subbasin, which depends in part on runoff from the American River Watershed. Accordingly, the North American Subbasin and SASb employed the Central Tendency climate change scenario data set from the Bureau of Reclamation's American River Basin Study during development of their GSPs. The differences between the Bureau of Reclamation and DWR data sets representing the Basin were modest, and much smaller than the overall range in uncertainty represented by DWR's extreme climate change conditions. To maintain consistency between the SASb, the Central Tendency scenario for the Basin also relied on the ARBS data set.

adjusted based on the reported factors, and the changes ranged from -32% to +13%, +1% to +13%, and -42% to 25%, respectively (depending on water year type). The adjustments on average resulted in a 6% increase in ET, 3% increase in precipitation, and 12% decrease in streamflow.

Projected Conditions DWR Extreme I 2070 Climate Change Scenario

The DWR Extreme I 2070 Climate Change Scenario was used to develop a projected water budget scenario which reflects projected dry conditions with extreme warming. For the Projected Conditions DWR Extreme I 2070 Climate Change Scenario, the 50-year historical monthly precipitation, ET, and streamflows were adjusted according to DWR's reported change factors. The precipitation change factors varied between -10% to -22%, averaging -16% annually; ET change factors varied between +14% to +24%, averaging +19% annually; Cosumnes River streamflow varied between -50% and +26%, averaging -20% annually; and, Dry Creek streamflow varied between -51% and +94%, averaging 12% annually.

Projected Conditions DWR Extreme II 2070 Climate Change Scenario

The DWR Extreme II 2070 Climate Change Scenario was used to develop a projected water budget scenario which reflects wetter conditions with moderate warming. For the Projected Conditions DWR Extreme II 2070 Climate Change Scenario, the 50-year historical monthly precipitation, ET, and streamflows were adjusted according to DWR's reported change factors. The precipitation change factors varied from up to -6% to +41%, averaging +17% annually; ET change factors varied between +2% to +4%; averaging +3% annually; Cosumnes River streamflow varied between +22% and +433%, averaging +70% annually; and, Dry Creek streamflow varied between +27% and +362%, averaging 127% annually.

PMA Scenarios

The PMA water budget scenario simulates the well-defined and soon-to-be activated projects in the SASb combined with the six Basin PMAs. Detailed information on the Basin PMAs is provided in **Table PMA-1** and **Table PMA-2** in Section 18.2 *List of Projects and Management Actions*.

10.4.3. Projected Groundwater Budget Results

Results of the projected groundwater budget analyses are summarized in **Table WB-10** and **Figure WB-16.** The model-calculated water budgets are presented as averages over the 50-year analog period, and the resulting groundwater budget component output grouped into inflows and outflows. Also shown in **Table WB-10** is the model-calculated average annual change in groundwater storage and estimated sustainable yield based on each scenario. Average projected changes in storage over the 50-year analog period are presented for each scenario in **Figure WB-16.**

Current Conditions Baseline Scenario

In the Current Conditions Baseline Scenario, the groundwater budget components differ from the historical 20-year average primarily from differences in long-term average rainfall (the average rainfall in the 50-year analog is slightly greater than the 20-year average during WY 1999-2018), and the model-calculated adjustments to Basin inflows and outflows. These changes resulted in greater percolation and less pumpage, and the net effect was a 400 AFY average annual depletion in groundwater storage. The sustainable yield represented by the Current Conditions Baseline Scenario is 127,500 AFY, which is in the upper range of yields represented by the historical evaluations summarized in **Table WB-8** (119,000 to 125,700 AFY).

Current Conditions DWR 2030 Central Tendency Climate Change Scenario

In the Current Conditions Scenario with 2030 Central Tendency Climate Change, the pumpage decreases relative to the Current Condition Baseline Scenario by 2,200 AFY, resulting in an increase in storage from -400 AFY to 1,400 AFY. Under the 2030 Central Tendency Climate Change Scenario, the sustainable yield is 127,100 AFY.

Projected Conditions Baseline Scenario

In the Projected Conditions Baseline Scenario, the groundwater budget components differ from the Current Conditions Baseline Scenario primarily due to differences in land use and corresponding water demand assumptions, whereby urban areas, population, and urban water demands are projected to increase. These assumptions related to land use and water demand projections result in a storage depletion of -1,700 AFY. The sustainable yield represented by the Projected Conditions Baseline Scenario is 126,600 AFY, which is greater than the range represented by the historical summarized in **Table WB-8** (119,000 to 125,700 AFY).

Projected Conditions ARBS Central Tendency 2070 Climate Change Scenario

In the Projected Conditions ARBS Central Tendency 2070 Climate Change Scenario, deep percolation decreases and pumpage increases relative to the Projected Conditions Baseline Scenario, resulting in an increase in storage depletion from -1,700 AFY to -10,000 AFY. Under the ARBS Central Tendency 2070 Climate Change Scenario, the sustainable yield is estimated as 127,300 AFY.

Projected Conditions DWR Extreme I 2070 Climate Change Scenario

In the Projected Conditions DWR Extreme I 2070 Climate Change Scenario, projected extreme warming cause a 13% decrease in deep percolation and a 12% increase in pumpage relative to the Projected Conditions Baseline Scenario, resulting in an increase in storage depletion from -1,700 AFY to -18,600 AFY. Under the DWR Extreme I 2070 Climate Change Scenario, the sustainable yield is estimated as 125,700 AFY.

Projected Conditions DWR Extreme II 2070 Climate Change Scenario

In the Projected Conditions DWR Extreme II 2070 Climate Change Scenario, the projected wetter conditions cause an 11% increase in deep percolation and a 16% increase in seepage to streamflow relative to the Projected Conditions Baseline Scenario, resulting in a storage accretion of 3,800 AFY. Under the DWR Extreme II 2070 Climate Change Scenario, the sustainable yield is 134,900 AFY.

PMA Scenarios

The PMAs improve the sustainability of the Basin indicated by acretions in groundwater storage and higher water levels. **Table WB-10** indicates the average annual change in storage ranges from a depletion of -1,700 AFY (Projected Conditions Baseline), to an accretion in storage of 7,100 AFY (Projected Conditions Baseline with PMAs), representing a net addition of water to storage of 8,800 AFY. **Figure WB-17 and Figure WB-18** indicate that the PMAs generally increase water levels, and at some locations the water levels can be as much as 25 feet higher than projected without the PMAs. Three of the five PMAs bring imported surface water for groundwater recharge and supplemental surface water flows to the Basin or adjacent to the Basin boundary (PMAs #1, #2, and #3). Another PMA (PMA #4) utilizes existing tertiary treated recycled water that is currently discharged from the Basin as surface water to replace groundwater irrigation and initiate winter irrigation practices to increase recharge and groundwater storage. The last PMAs (PMA #5 and #6) reduce pumpage through voluntary land repurposing, and the water saved is banked in the Basin for later extraction to sell as supplemental supply during dry years.

The average annual change in storage for the "Projected Conditions Baseline and PMA Scenarios" is 7,100 AFY, representing an almost 9,000 AFY increase relative to the "Projected Conditions Baseline" Scenario (-1,700 AFY). The PMAs were simulated incrementally to provide insight into the volumetric budget changes that occur because of the actions and results are summarized in **Table WB-11**. The model calculations indicate the storage change increases from -1,700 AFY (Projected Conditions Baseline) to 800 AFY because of altered conditions in the SASb (conservation, regional conjunctive use, and Harvest Water) and the OHWD Agricultural Flood-MAR Project (PMA #1), which represents a net increase of 2,500 AFY. More than 90% of this increase (2,300 AFY) occurs in the Basin Plain Subarea. The addition of PMAs #2-6 further increase the average annual change in storage from 800 AFY to 7,100 AFY, representing a net increase of 6,300 AFY as a result of PMAs #2-6.

Close inspection of the water budget components in **Table WB-11** show how the Basin water budget responds to the PMAs. The PMAs increase average annual deep percolation from 107,900 AFY (Projected Conditions Baseline Scenario) to 116,600 AFY (Projected Conditions Baseline and PMA Scenarios), which is a net increase of 8,700 AFY. Groundwater levels increase because of the increase in deep percolation, and the other water budget components adjust to the groundwater level changes accordingly. For example, the average annual net recharge from river and creek leakage decreases from 16,800 AFY (Projected Conditions Baseline and PMA Scenarios) to 5,200 AFY, representing a net decrease of 11,600 AFY. Hence, one consequence of increased deep percolation from the PMAs is a reduction in annual average surface water depletions.

Table WB-10. Summary of Projected Groundwater Budget Estimates[1,2]

Scenario	Climate Period	Land Use	INFLOWS (AFY)								OUTFLOWS (AFY)						Storage Change (AFY)	Sustainable Yield (AFY)[3]
			Net Leakage from Camanche Reservoir[4]	Leakage from Streamflow to GW	Injection from PMA	Percolation from Precipitation and Applied Water Past Plant Roots			Net Subsurface Flow from Adjacent Watersheds	Total Inflows	Seepage to Streamflow from GW	Groundwater Pumpage			Net Subsurface Flow between Adjacent Basins[4]	Total Outflows		
						Ag. Areas	Native Veg. Areas	Urban Areas				Pumpage for Ag. Areas	Pumpage for Developed Areas	Total Pumpage				
20-Year Water Budget Period	WY 1999-2018	Historical	300	34,400	--	50,200	44,300	10,300	4,800	144,200	-16,400	-115,900	-15,300	-131,200	-7,300	-154,900	-10,600	120,600
Current Conditions Baseline	WY 1970-2019	Current	400	34,100	--	51,500	45,200	12,400	6,200	149,800	-18,500	-113,100	-14,800	-127,900	-3,800	-150,200	-400	127,500
Current Conditions DWR 2030 CT Climate Change	WY 1970-2019 with DWR 2030 CT climate change	Current	400	33,800	--	51,900	45,500	12,400	6,100	150,100	-18,600	-110,900	-14,800	-125,700	-4,400	-148,700	1,400	127,100
Projected Conditions Baseline	WY 1970-2019	Projected	400	34,800	--	49,500	44,000	14,500	5,500	148,700	-17,900	-109,000	-19,300	-128,300	-4,200	-150,400	-1,700	126,600
Projected Conditions ARBS CT 2070 Climate Change	WY 1970-2019 with ARBS CT 2070 climate change	Projected	600	37,300	--	47,400	41,000	13,100	5,100	144,500	-16,100	-118,000	-19,300	-137,300	-1,100	-154,500	-10,000	127,300
Projected Conditions DWR Extreme I 2070 Climate Change	WY 1970-2019 with DWR 2070 DEW Climate Change	Projected	600	38,100	--	45,800	36,500	12,100	4,800	137,900	-14,100	-125,000	-19,300	-144,300	1,900	-156,500	-18,600	125,700
Projected Conditions DWR Extreme II 2070 Climate Change	WY 1970-2019 with DWR 2070 WMW Climate Change	Projected	400	36,300	--	54,900	48,900	16,500	6,800	163,800	-20,800	-111,800	-19,300	-131,100	-8,100	-160,000	3,800	134,900

Scenario	Climate Period	Land Use	INFLOWS (AFY)								OUTFLOWS (AFY)						Storage Change (AFY)	Sustainable Yield (AFY)[3]
			Net Leakage from Camanche Reservoir[4]	Leakage from Streamflow to GW	Injection from PMA	Percolation from Precipitation and Applied Water Past Plant Roots			Net Subsurface Flow from Adjacent Watersheds	Total Inflows	Seepage to Streamflow from GW	Groundwater Pumpage			Net Subsurface Flow between Adjacent Basins[4]	Total Outflows		
						Ag. Areas	Native Veg. Areas	Urban Areas				Pumpage for Ag. Areas	Pumpage for Developed Areas	Total Pumpage				
Projected Conditions Baseline and PMA Scenarios[5]	WY 1970-2019	Projected	400	27,500	5,100	57,400	44,400	14,800	5,600	155,200	-22,300	-101,000	-24,700	-125,700	-100	-148,100	7,100	127,700
Projected Conditions Baseline ARBS CT 2070 and PMA Scenarios	WY 1970-2019 with ARBS CT 2070 climate change	Projected	500	30,600	5,100	55,000	41,400	13,400	5,800	151,800	-21,400	-108,400	-24,000	-132,400	2,800	-151,000	600	133,200

Abbreviations:
AFY = acre-feet per year
ARBS = American River Basin Study
CT = Central Tendency
DEW = Drier with Extreme Warming
DWR = California Department of Water Resources
GW = groundwater
PMA = project and management actions
WMW = Wetter with Moderate Warming
WY = Water Year

Notes:
(1) Values rounded to the nearest one hundred acre-feet. Minor discrepancies between inflows and outflows are attributed to rounding.
(2) Water budget components are presented as an average over their respective simulation period (i.e., 20 years for the Historical scenario and 50 years for the Projected scenarios).
(3) Sustainable Yield is calculated as the Storage Change (positive or negative) minus the Total Pumpage (always negative).
(4) Inflows and Outflows associated with Camanche Reservoir subsurface flow from neighboring Basins are summarized as the net average inflow or outflow.
(5) Includes average annual extractions to recover water saved by volunteer land fallowing over the 50-year planning period (assumed 18,000 AFY during dry and critically dry years). “Pumpage for Developed Areas” includes groundwater use for urban and aquaculture. Ag pumpage includes domestic (Ag-Res) and agriculture. Under the Basin PMAs, it also includes injection as part of PMA #2. The net effect from injection is a 5,100 AFY reduction in pumpage.

Table WB-11. Summary of Projected Groundwater Budget Estimates with Variable Projects and Management Actions (PMAs)

Water Budget Component (AFY)	PCBL			PCBL + SASb + PMA #1[1]			PCBL + SASb + PMA #1-2[2]			PCBL + SASb + PMAs #1-6[3]		
	Plain	Foothills	Basin	Plain	Foothills	Basin	Plain	Foothills	Basin	Plain	Foothills	Basin
Deep Percolation	69,600	38,300	107,900	69,600	38,300	107,900	78,800	38,300	117,100	78,300	38,300	116,600
River & Creeks	33,800	-17,000	16,800	24,700	-17,000	7,700	23,000	-17,300	5,700	22,500	-17,300	5,200
Boundary Flows												
East and South of Foothills	---	1,500	1,500	---	1,500	1,500	---	1,500	1,500	---	1,500	1,500
South American	-4,200	1,000	-3,200	9,300	1,000	10,300	5,600	900	6,500	5,900	900	6,800
Eastern San Joaquin	5,600	-2,000	3,600	3,700	-2,000	1,700	1,200	-2,000	-800	-500	-2,000	-2,500
Foothills/Plain	19,000	-19,000	0	18,800	-18,800	0	18,100	-18,100	0	18,200	-18,200	0
Wells												
Agriculture	-107,200	-1,800	-109,000	-107,200	-1,800	-109,000	-107,000	-1,800	-108,800	-99,100	-1,800	-101,000
Urban	-19,100	-200	-19,300	-19,100	-200	-19,300	-19,100	-200	-19,300	-19,100	-200	-19,300
Recovery	0	0	0	0	0	0	0	0	0	-5,400	0	-5,400
Injection	0	0	0	0	0	0	5,100	0	5,100	5,100	0	5,100
Change in Storage	-2,500	800	-1,700	-200	1,000	800	5,700	1,300	7,000	5,900	1,200	7,100
Sustainable Yield	123,800	2,800	126,600	126,100	3,000	129,100	131,800	3,300	135,100	129,500	3,200	127,700

Abbreviations:
AFY= acre-feet per year
Flood-MAR= Flood Managed Aquifer Recharge
OHWD= Omochumne-Hartnell Water District
PMA= Projects and Management Actions
SAFCA= Sacramento Area Flood Control Agency
SASb= South American Subbasin

Notes:
1) PCBL plus well-defined or soon-to-be activated projects in SASb including conservation, a regional conjunctive use program, and new supplies (Harvest Water regional recycled water project), plus Basin PMA #1.

2) PCBL, SASb PMAs, Basin PMA #1, and PMA #2; PMA #2 is the SAFCA Flood-MAR projects in the Basin (field flooding only and no injection wells). Diversions do not occur in every year. In the years diversion are available for field flooding, the rates vary from 2,400 AFY to 19,040 AFY (50-year average annual diversion rate of about 8,100 AFY). In the years diversions are available for injection, the rates vary from 3,000 AFY to 12,000 AFY (50-year average annual diversion rate of 5,100 AFY). The average annual addition of water to the Basin in the forms of spreading and injection is therefore 13,200 AFY.
3) PCBL, SASb PMAs, plus all Basin PMA's including OHWD Agricultural Flood-MAR Phase 2. PMA #5 includes voluntary land fallowing and recovery of the saved water. The land fallowing resulted in an average annual decrease in groundwater consumption of 5,800 AFY (results not reported in Table above), and the recovery of 18,000 AFY of saved water in dry and critically dry years resulted in an average annual extraction rate increase of 5,400 AFY.

10.5. Water Budget Uncertainty and Limitations

In this analysis, "uncertainty" refers to the incomplete understanding of the physical setting, characteristics, and current conditions that significantly affect the GSAs ability to sustainably manage the Basin. Uncertainty can influence the calculation of groundwater storage and the reliability of the estimated sustainable yield. Moreover, because of the direct, interdependent relationship between changes in groundwater storage and groundwater levels, water budget uncertainty can also influence the evaluation of the effectiveness of PMAs designed to attain Measurable Objectives (MOs) for groundwater levels and protect against Undesirable Results. Section 10.1.1 *Data Sources* identifies the most important input data to the calculated water budget. These data are subject to uncertainty, and factors that create uncertainty in the most influential water budget inputs represent key "data gaps." Data gaps can refer to limitations in the spatial coverage and timing of measured data, like the various inputs utilized to calculate groundwater recharge and pumpage, or the quantification of physical properties that determine the model-calculated storage and groundwater level response to recharge and pumpage, like the water transmitting and storage properties of the aquifer (i.e., transmissivity and storativity).

10.5.1. Primary Volumetric Inflows and Outflows

Model-calculated inflows and outflows are most influenced by rainfall and evapotranspiration. Under the 20-year average calculation period (1999-2018) reported in **Table WB-4**, the average annual infiltration of water past the soil surface (344,100 AFY) is the difference between total inflow (488,900 AFY) and combined runoff and return flow (144,800 AFY). Most of the infiltration (70%) is consumed by evapotranspiration (239,600 AFY) with the remainder percolating past the plant roots and recharging the aquifer as deep percolation. Agricultural pumping was significant and represented both outflows and inflows to the groundwater system because, in the Basin, pumping wells extracted more than 131,000 AFY of groundwater yet after use the return flows contributed 27% of the water that ultimately returns to the aquifer. On average, rainfall contributed 66% of the water that recharged the aquifer, and the remaining recharge (6%) was from surface water diversions.[70] The uncertainty in rainfall and evapotranspiration is approximately plus or minus 20% each, and when combined can account for most of the uncertainty in model-calculated recharge.

The model-calculated groundwater budget summarized in **Table WB-10** provides insight into the uncertainty in water budget results owing primarily to uncertainty in rainfall and evapotranspiration. As explained in Section 10.4.2 *Development of Projected Water Budget Scenarios*, the various future scenarios adjusted monthly rainfall by -22% to +41% and adjusted monthly evapotranspiration by -6% to +24%, resulting in a range in model-calculated recharge of about 25%. The resulting adjustments to associated model-calculated stresses, boundary flows, and so forth result in projected sustainable yields that range from about 125,700 AFY to 134,900 AFY.

The PMAs improve the sustainability of the Basin under climate change. **Table WB-10** indicates that under

[70] The breakdown of water sources contributing to groundwater recharge (deep percolation) are reported in the Root Zone Budget reported by the Numerical Model, but the results are not explicitly reported in the Water Budget tables.

the ARBS CT 20270 Climate Change Scenario, the projected average annual depletion in groundwater storage increases from -10,000 AFY (without PMAs) to an accretion of 600 AFY with PMAs if implemented as planned, representing a net benefit of 10,600 AFY. **Figure WB-19** and **Figure WB-20** show that under climate change conditions, without the benefits from the PMAs, the Basin cannot reach it sustainability goal as represented by the MOs. The hydrographs in these figures show that without the PMAs, the water levels in most wells decrease below the Minimum Thresholds (MTs) indicating Undesirable Results, whereas, with the PMAs the water levels in many of the wells are maintained near the MOs.

10.5.2. Aquifer Properties

Model-calculated groundwater levels are most sensitive to changes in aquifer storage properties, particularly the storativity of the Laguna and Mehrten Formations (most production wells in the Basin are constructed in these two formations). Available data from which to estimate the storage properties are limited to a small number of values based on sediment types and calibration of other previous models. One earlier modeling effort reported specific storage values that range from 1E-03 per foot to 2E-05 per foot; a median value of 3E-04 is assumed representative specific storage in the Basin.[71] The calibrated Numerical Model employs a representative value of about 4E-05 per foot, which is at the low end of the above range, and about ten (10) times smaller than the median.

The sensitivity to storativity was tested by increasing the specific storage for the Laguna and Mehrten Formations by a factor of 10. The updated results include the net effect of model-calculated changes in groundwater storage, groundwater levels, and boundary flows due to the estimated uncertainty in storativity. Under the 50-year projected conditions, the average change in model-calculated groundwater levels at Representative Monitoring Well sites ranged from -0.4 to about 10 feet. These changes correspond to an approximate 30% change in the annual average model-calculated change in groundwater storage. However, the annual pumping rate was not influenced by the change in storativity, and the resulting sustainable yield estimate increased by only 3%. Hence, the 10-fold change in storativity resulted in a relatively insignificant change in estimated sustainable yield. These test results indicate: (1) the water budget is most sensitive to uncertainty in the principal water inflows (precipitation and evaporation) like recharge, and less sensitive to the uncertainty in aquifer parameters; and, (2) the uncertainty in sustainable yield is small relative to the uncertainty in recharge considered by the various future scenarios summarized in **Table WB-10**.

10.5.3. Data Gaps

The Numerical Model is an integrated surface water-groundwater flow model, and dynamically simulates the interactions between land surface, surface water, and groundwater system processes. A reliable model is one that can produce field-measured water levels and groundwater flow within an acceptable range of error. Error exists because information on the real-world system is always incomplete, and the information that is available has associated errors. The model utilized for the Basin was considered adequate to support GSP planning and development.

[71] Fleckenstein, J. H., Niswonger, R. G., and Fogg, G. E., "River-Aquifer Interactions, Geologic Heterogeneity, and Low Flow Management," GROUND WATER, Special issue from MODFLOW and more conference, 2003.

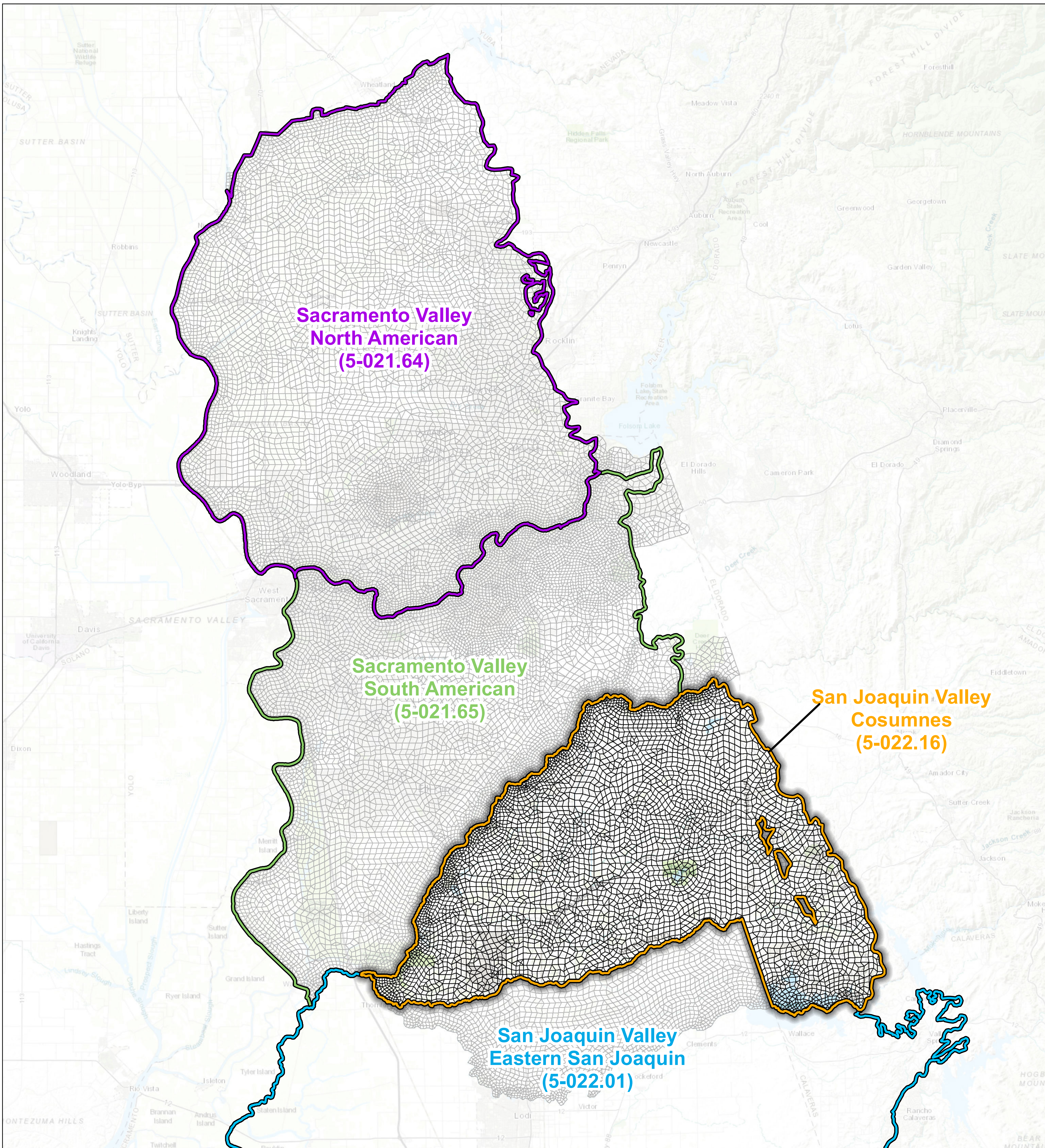
Future improvements in model input data and the corresponding model-calculated water budget will improve water budget reliability. A summary of potential data improvements is proved below, and when completed provide more reliable and precise water budget information.

Land surface system processes recommended for improvement:

- The model estimates the water demand for urban areas. The historical, current, and projected land use maps can incorrectly assign agricultural residential land uses (Ag-Res) as urban areas, and roads can also be classified as urban land use. In both cases, the model estimates water demand, and the associated pumping, to this erroneous land use interpretation. Routine field-verification and updating of mapped land use utilized by the model will improve the future reliability of the water budget.
- As mentioned above in Section 10.1.1 *Data Sources*, agricultural diversions were compiled from reported water rights information. However, the reports are limited in detail, and more accurate tracking and reporting is required to reduce the significant uncertainty in timing, magnitude, and location of diversions and the land areas where the water is used, particularly along the Cosumnes River.

Groundwater system processes recommended for improvement:

- Streambed elevations and streambed conductance values were approximated and/or calibrated during model development using the best available data. However, the discrepancy between modeled and reported streambed elevations can be upwards of 15 feet in some areas. Improved representation of modeled streambed elevations and adjacent land surface elevations would improve the reliability of model-calculated stream depletions and representation of wet and dry streambed conditions.
- The model calculates water levels that are above land surface in some areas of the Basin Foothill Subarea, which cannot be confirmed by available data and may indicate model errors in calculated watershed inflows, root zone properties influencing recharge and runoff, and representation of the aquifer in the model (e.g., the number and thicknesses of model layers, water transmitting properties, and water storage properties).
- Except for the City of Galt, groundwater pumping is estimated by the model. Agriculture accounts for most of the pumping, and field verification of pumping estimates will improve water budget calculations. Similarly pumping for aquaculture (fish farms) is based on previous estimates that are over ten years old, and domestic well use (Ag-Res) was estimated based on assumed average domestic demand and parcel size. Field verification of aquaculture and domestic pumping can improve the reliability of the model-calculated water budget.



Legend

Groundwater Subbasin

- Cosumnes Subbasin (5-022.16)
- North American Subbasin (5-021.64)
- South American Subbasin (5-021.65)
- Eastern San Joaquin Subbasin (5-022.01)
- Model Elements

Abbreviations
DWR = California Department of Water Resources

Notes
1. All locations are approximate.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.

N

0 6 12
(Scale in Miles)

Numerical Model Mesh

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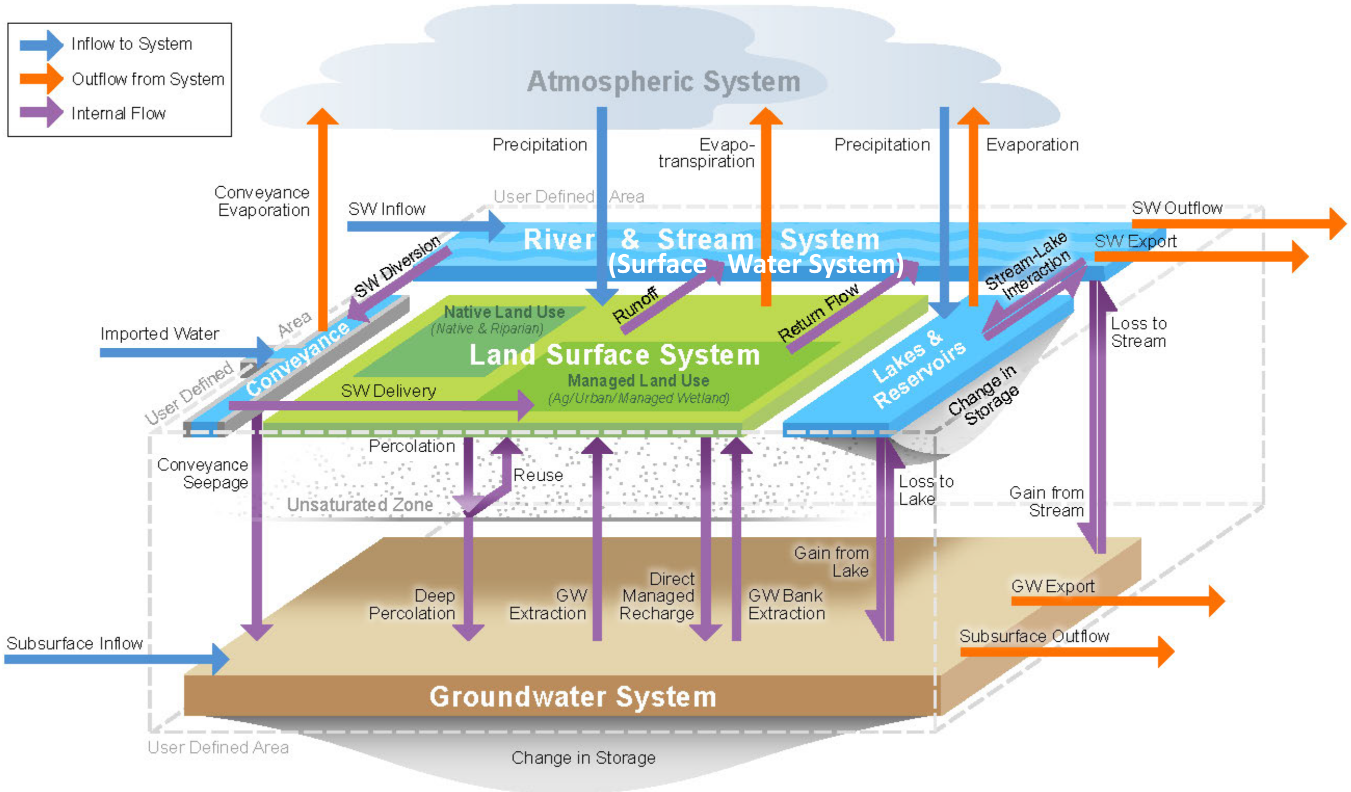
Figure WB-1

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_WB-01_CoSANA Mesh.mxd



Abbreviations

BMP	= Best Management Practices
DWR	= California Department of Water Resources
GW	= groundwater
IWFM	= Integrated Water Flow Model
SW	= surface water

Notes

1. Figure reproduced from DWR (2016).
2. IWFM simulates three systems: (1) the surface water system, (2) the land surface/root zone system, and (3) the groundwater system. Each of these systems have interconnections within their respective water budgets.

Sources

1. DWR (2016) Best Management Practices for the Sustainable Management of Groundwater Water Budget BMP

Conceptual Water Budget Systems

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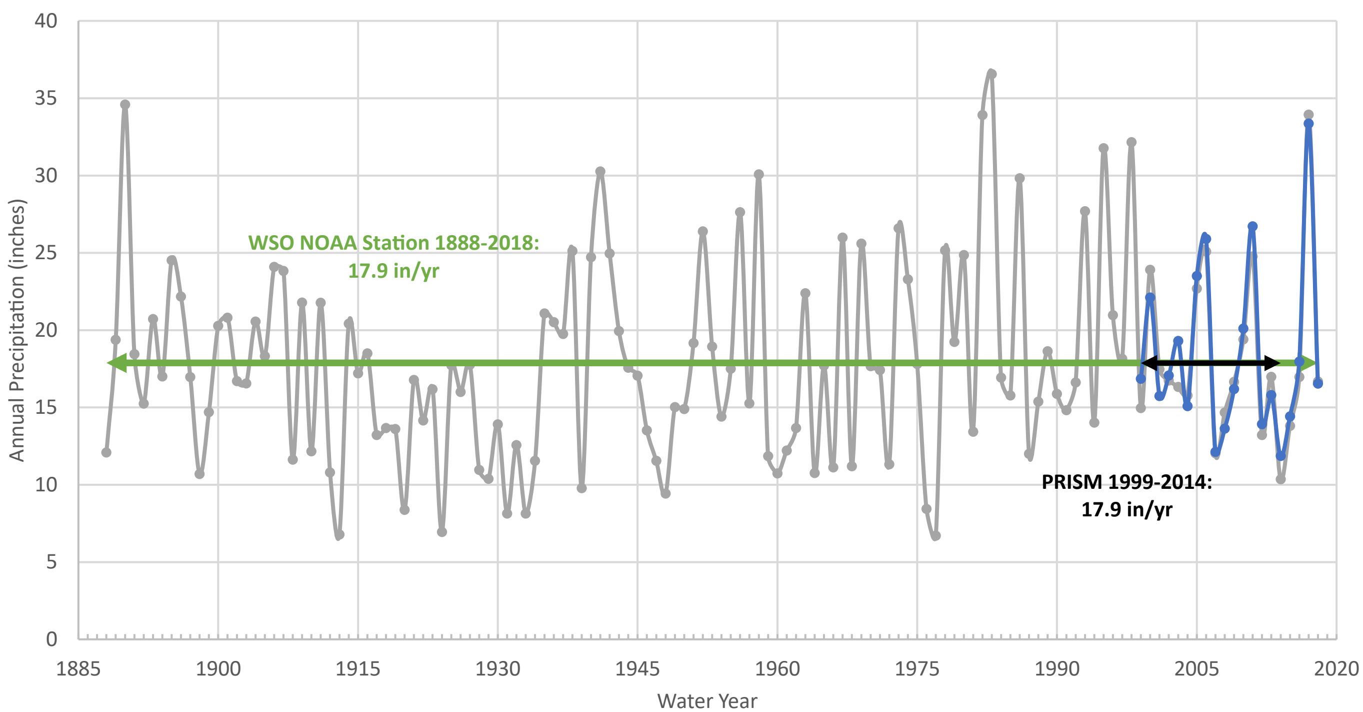
Figure WB-2



Legend

- PRISM Annual Precipitation
- WSO Annual Precipitation
- PRISM Average Precipitation (WY 1999-2014)
- WSO Average Precipitation (WY 1888-2018)

Abbreviations

DWR	=	California Department of Water Resources
in/yr	=	inches per year
NOAA	=	National Oceanic and Atmospheric Administration
PRISM	=	Parameter-elevation Regressions on Independent Slopes Model
WSO	=	Winter Storm Outlook
WY	=	Water Year

Notes

1. Water Year is defined as the October of the previous year through September of the current year.

Sources

1. NOAA Sacramento WSO climate station Coop ID #47633.
2. PRISM grid mapped to the Numerical Model mesh provided by DWR, March 2021.

Long-Term Precipitation Record

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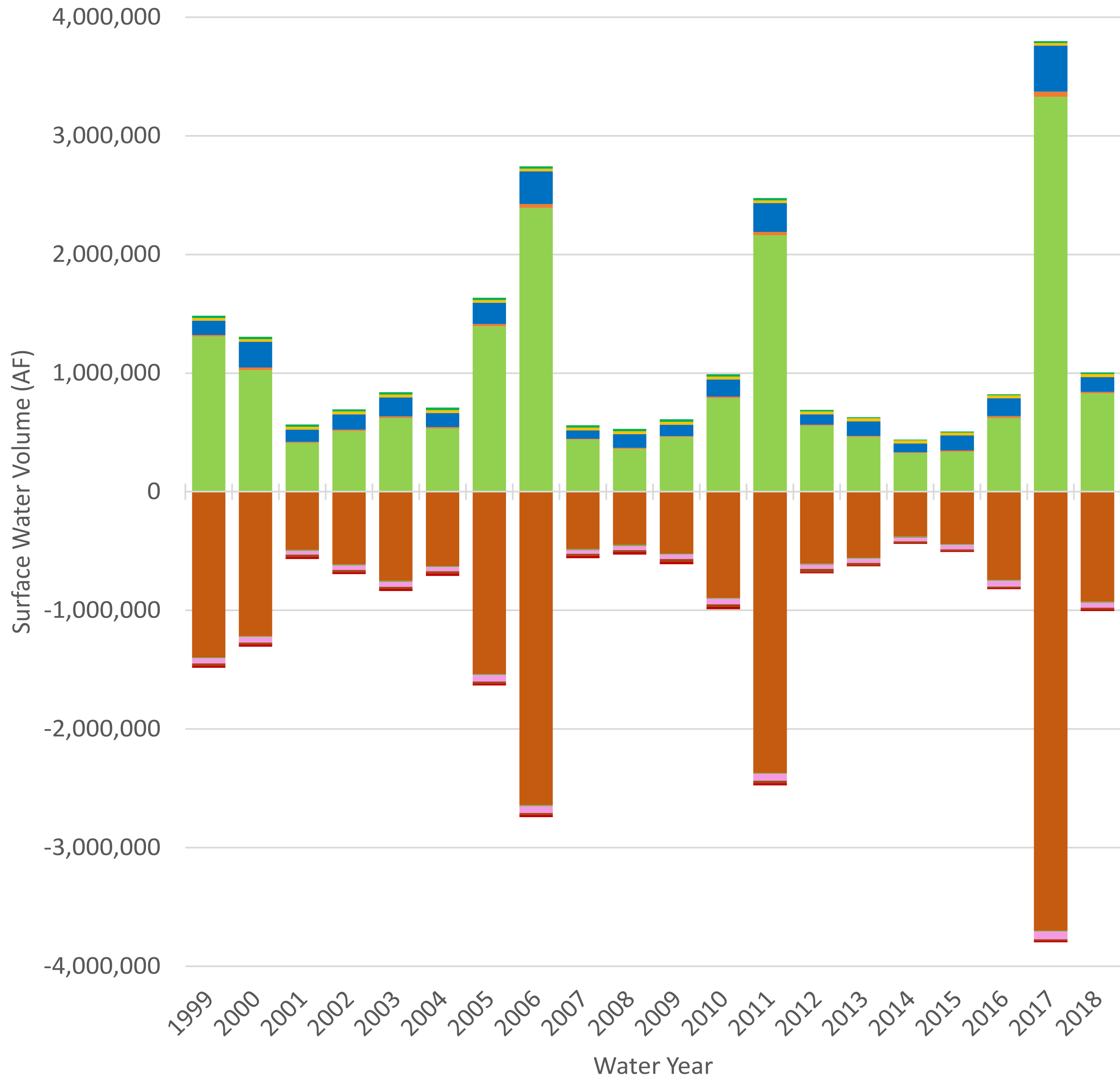
Figure WB-3



Legend

Surface Water Inflows

- Streamflow
- Tributary Inflow
- Runoff
- Return Flow
- Surface Water Imports

Surface Water Outflows

- Streamflow
- Riparian ET
- Leakage to Groundwater
- Diversions
- Applied SW Imports

Abbreviations

AF = acre-feet
ET = Evapotranspiration
SW = surface water

Notes

1. Water Year is defined as the October of the previous year through September of the current year.
2. A positive volume corresponds to a surface water inflow and a negative volume corresponds to a surface water outflow.

Sources

1. Numerical Model

Annual Surface Water System Inflows and Outflows

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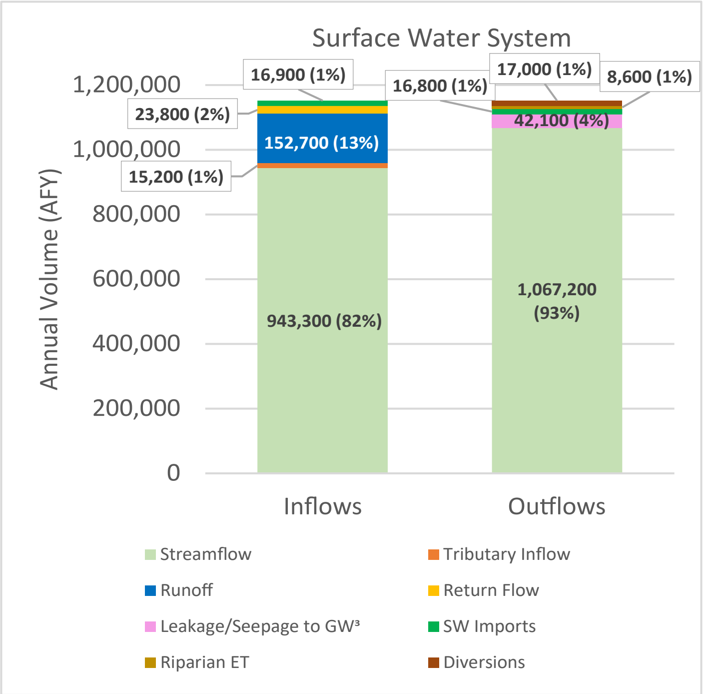
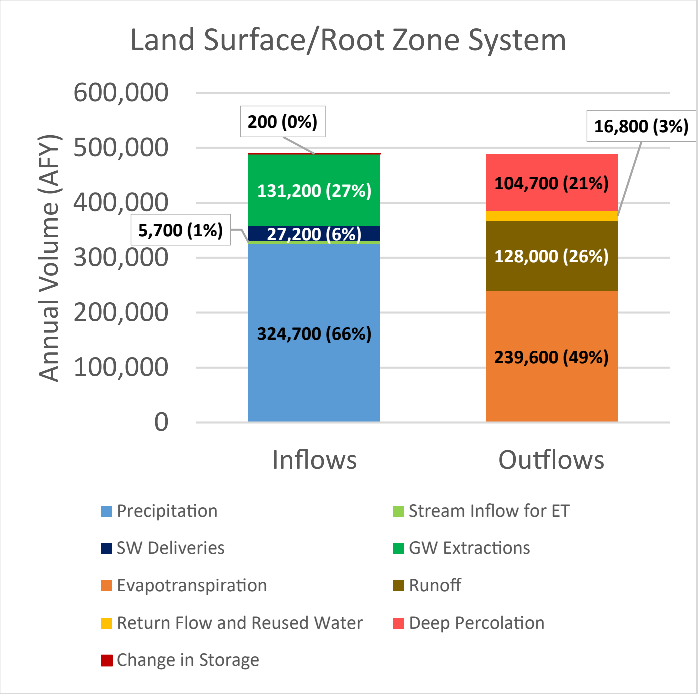
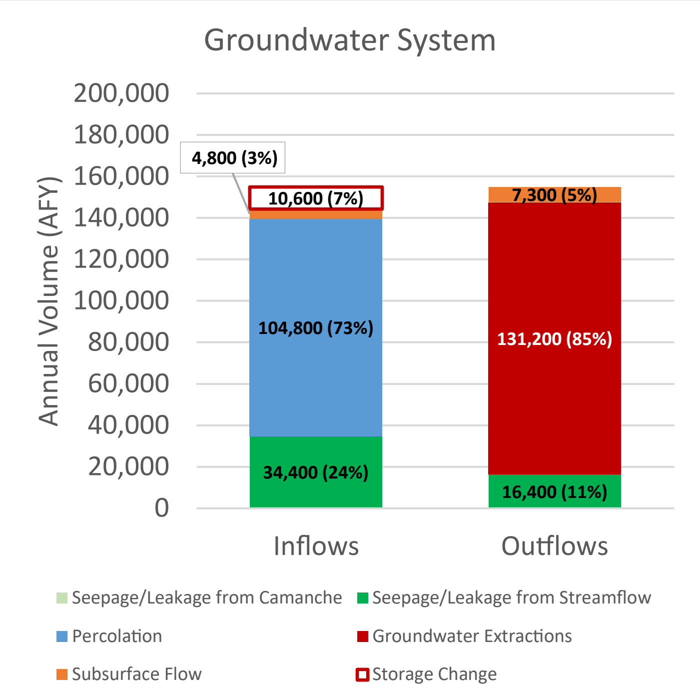
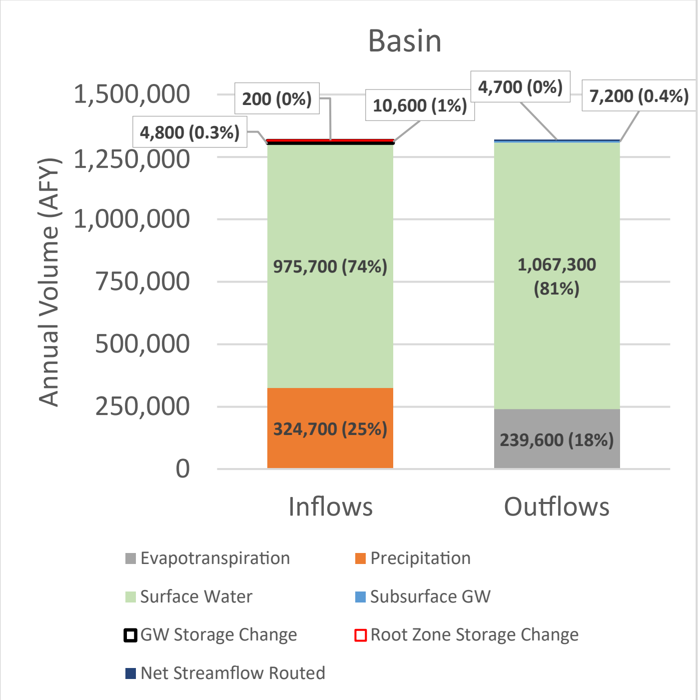
Figure WB-4









Abbreviations

AFY	= acre-feet per year
ET	= evapotranspiration
GW	= groundwater
SW	= surface water

Notes

1. Water Year is defined as the October of the previous year through September of the current year.
2. A positive volume corresponds to an inflow and a negative volume corresponds to an outflow.
3. Leakage/Seepage to South American, Cosumnes, and Eastern San Joaquin Subbasins.
4. Seepage/Leakage from Camanche Reservoir in the groundwater system domain is less than 1%.

Sources

1. Numerical Model

Average (Water Year 1999-2018) Inflows and Outflows

Cosumnes Subbasin Working Group
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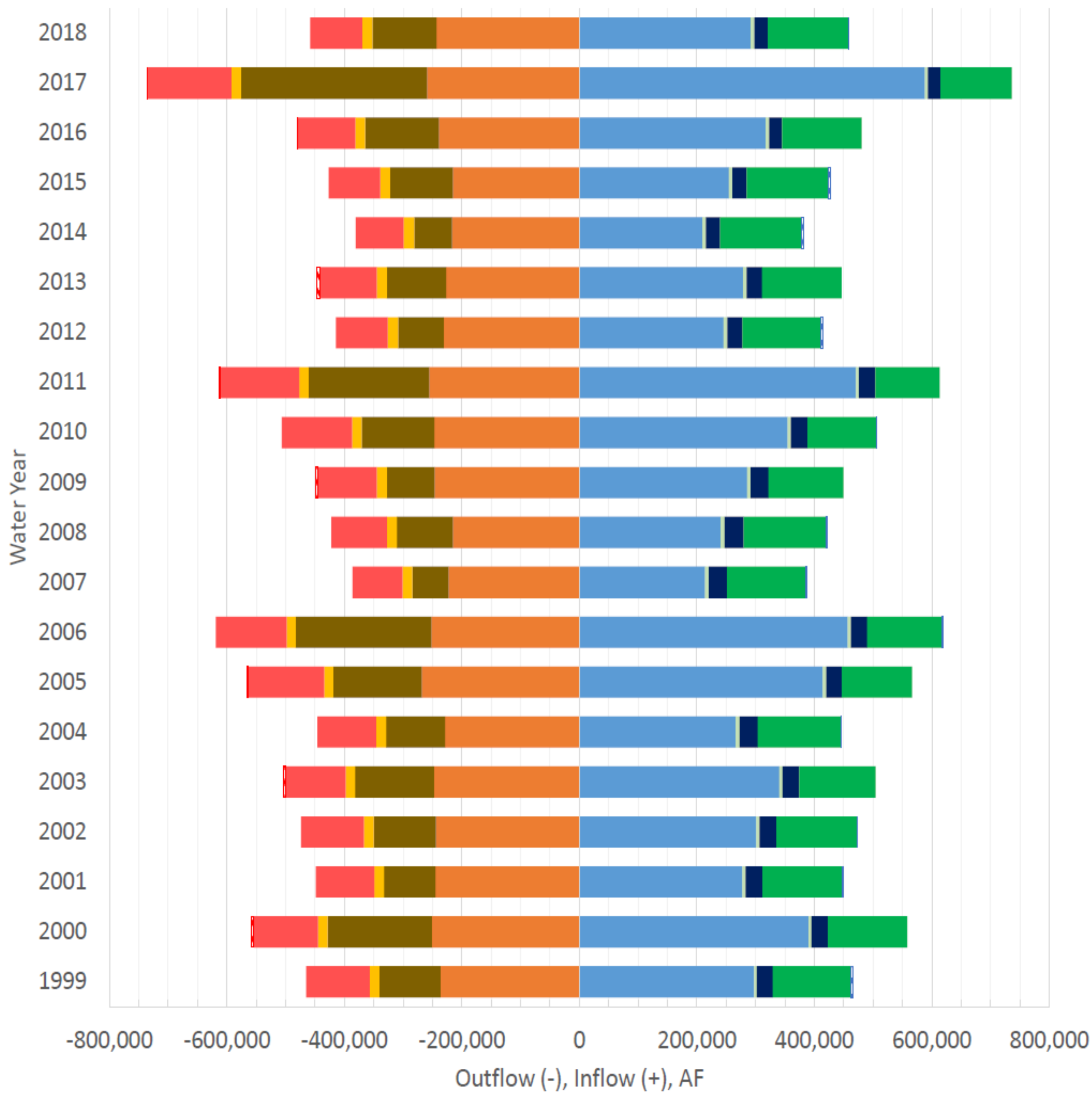
Figure WB-5



Legend

Inflows

- Precipitation
- Stream Inflow for ET
- SW Deliveries
- GW Extractions

Outflows

- Evapotranspiration
- Runoff
- Return Flow
- Deep Percolation

Change in Root Zone Storage

- Gain in Storage
- Reduction in Storage

Abbreviations

AF = acre-feet
ET = evapotranspiration
GW = groundwater
SW = surface water

Notes

1. Water Year is defined as the October of the previous year through September of the current year.
2. A positive volume corresponds to a root zone system inflow and a negative volume corresponds to a root zone system outflow.

Sources

1. Numerical Model

Annual Land Surface/Root Zone System Inflows and Outflows

Cosumnes Subbasin Working Group
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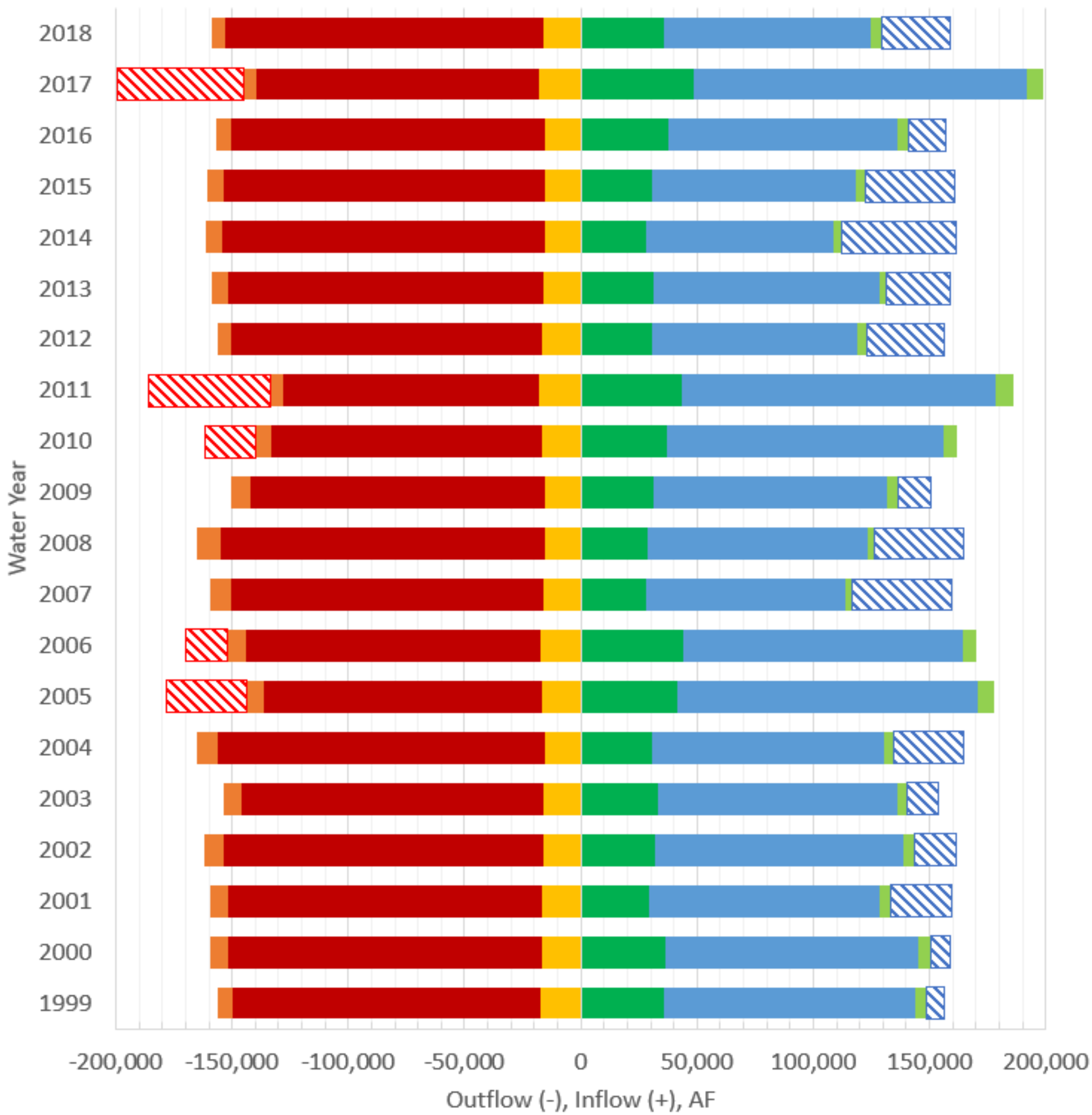
Figure WB-6



Legend

Groundwater Inflows

- Seepage from Camanche Reservoir
- Percolation from Precipitation and Applied Water
- Seepage from Streamflow
- Subsurface GW Inflow

Groundwater Outflows

- Leakage to Camanche Reservoir
- Groundwater Extractions
- Leakage to Streamflow
- Subsurface GW Outflow

Change in Groundwater Storage

- Gain in GW Storage
- Reduction in GW Storage

Abbreviations

AF = acre-feet
GW = groundwater

Notes

1. Water Year is defined as the October of the previous year through September of the current year.
2. A positive volume corresponds to a groundwater inflow and a negative volume corresponds to a groundwater outflow.

Sources

1. Numerical Model

Annual Groundwater System Inflows and Outflows

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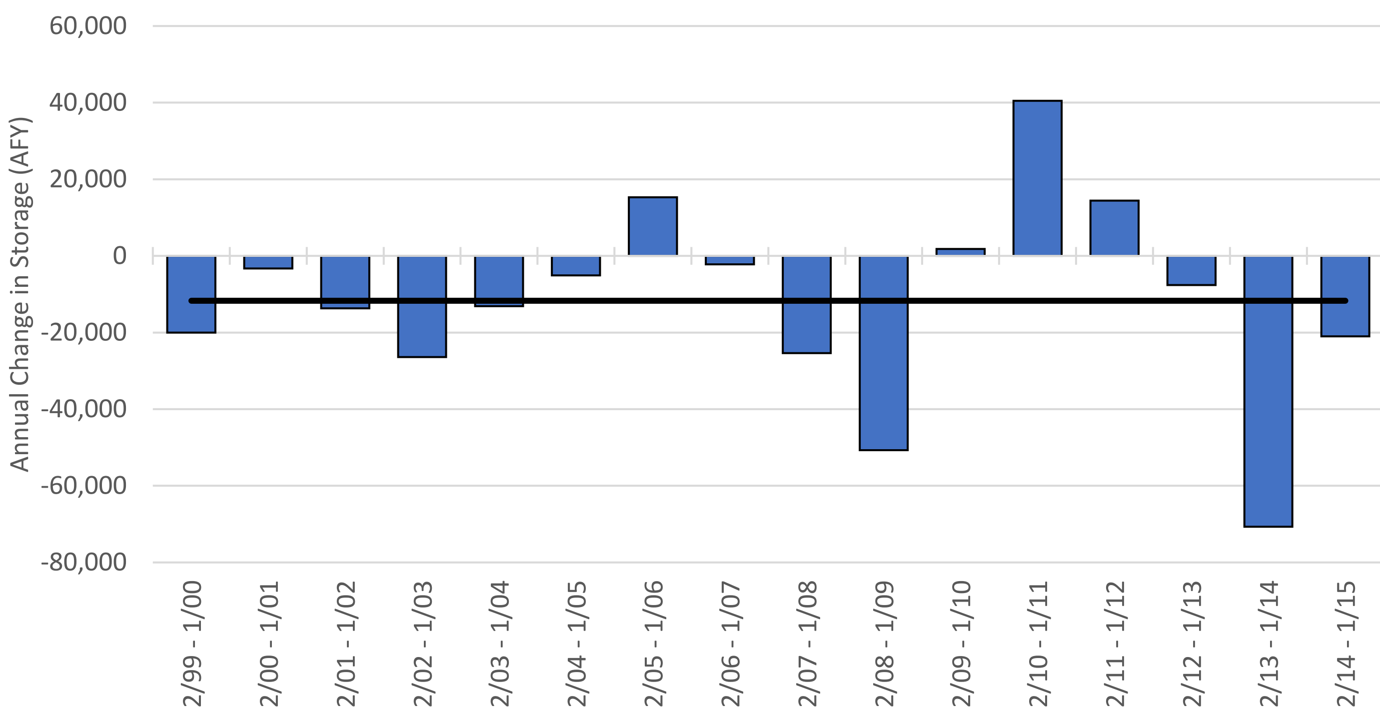
Figure WB-7



Legend

Annual Change in Storage between Seasonal Highs (February - January)

Average Annual Change in Storage, February 1999 - January 2018

Abbreviations

AFY = acre-feet per year

Notes

1. “Seasonal high” is defined as February of the current year through January of the following year.

Sources

1. Numerical Model

Annual Change in Storage between Seasonal Highs

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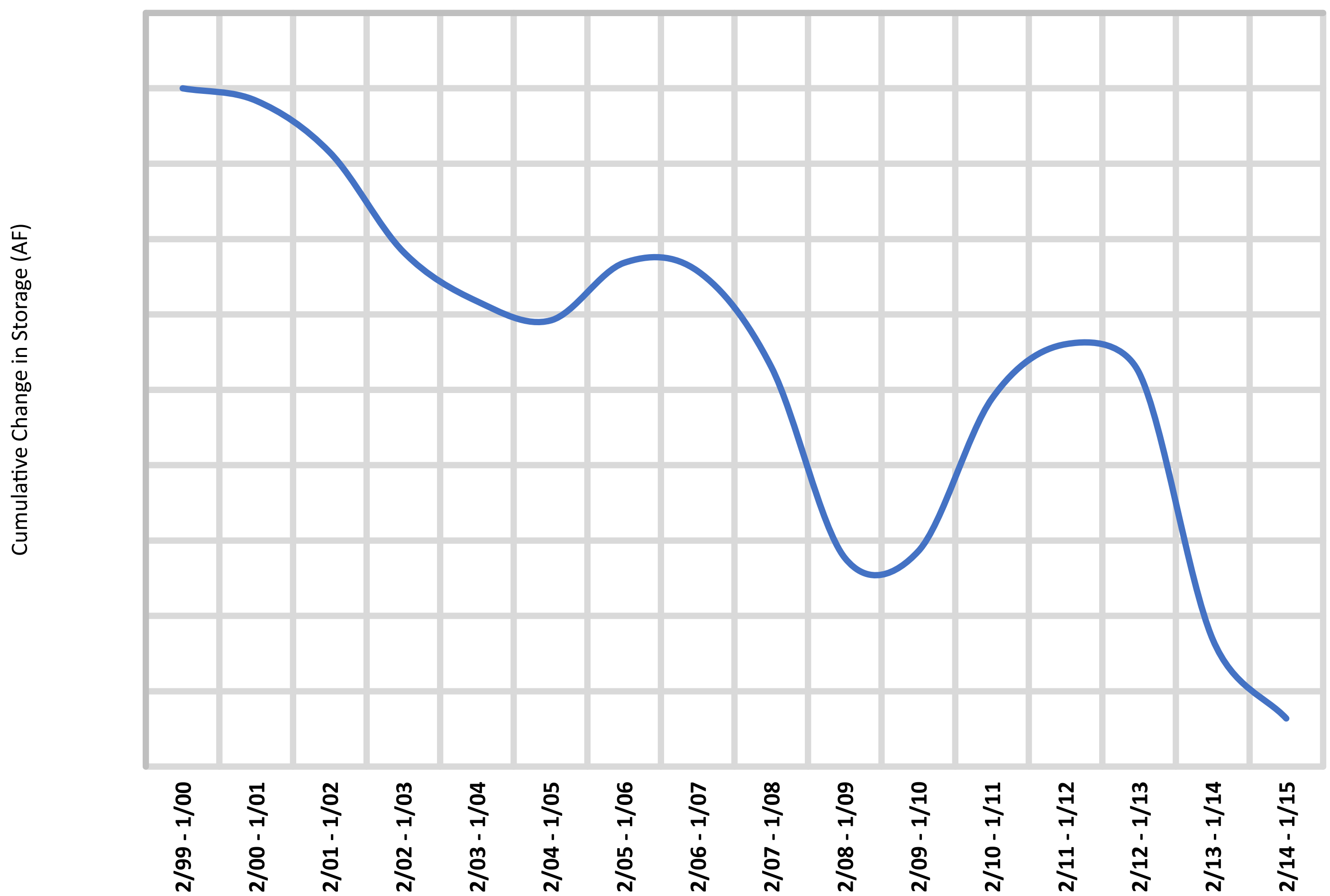
Figure WB-8



Legend

Cumulative Change in Storage

Abbreviations

AF = acre-feet

Notes

1. Values represent cumulative change in storage since the first "seasonal high" of the water budget period (February 1999).
2. "Seasonal high" is defined as February of the current year through January of the following year.

Sources

1. Numerical Model

Cumulative Change in Storage, February 1999 - January 2015

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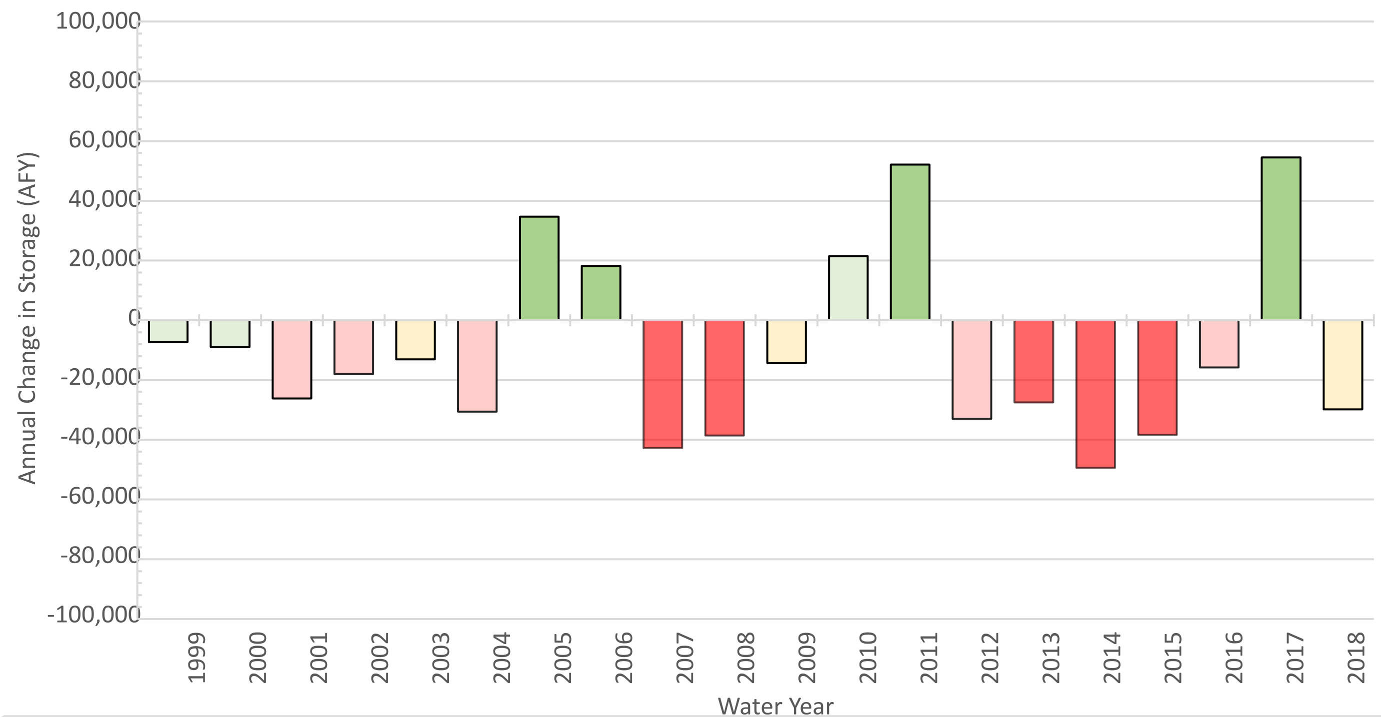
Figure WB-9



Legend

DWR Water Year Type

- Wet
- Above Normal
- Below Normal
- Dry
- Critical

Abbreviations

AFY = acre-feet per year
DWR = California Department of Water Resources

Notes

1. Water Year is defined as the October of the previous year through September of the current year.

Sources

1. DWR Water Year type is from DWR's Water Year Hydrologic Classification Indices for the San Joaquin Valley (http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST)
2. Numerical Model

Annual Change in Storage vs. DWR Water Year Type

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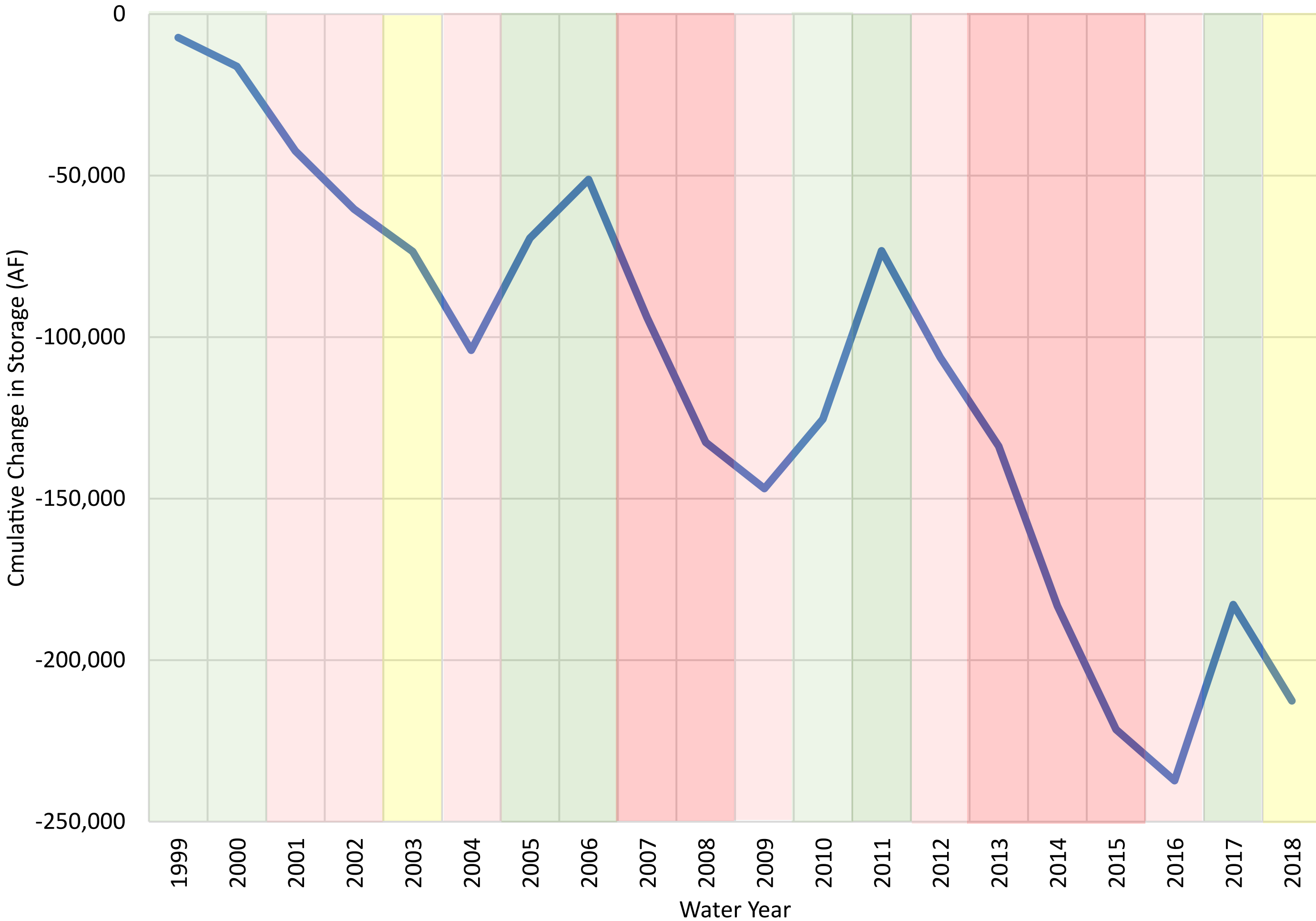
Figure WB-10



Legend

DWR Water Year Type

- Wet
- Above Normal
- Below Normal
- Dry
- Critical

Cumulative Change in Storage

Abbreviations

AFY = acre-feet per year
DWR = California Department of Water Resources

Notes

1. Water Year is defined as the October of the previous year through September of the current year.

Sources

1. DWR Water Year type is from DWR's Water Year Hydrologic Classification Indices for the San Joaquin Valley (http://cdec.water.ca.gov/reportapp/avareports?name=WSIHIST)
2. Numerical Model

Cumulative Change in Storage vs. DWR Water Year Type

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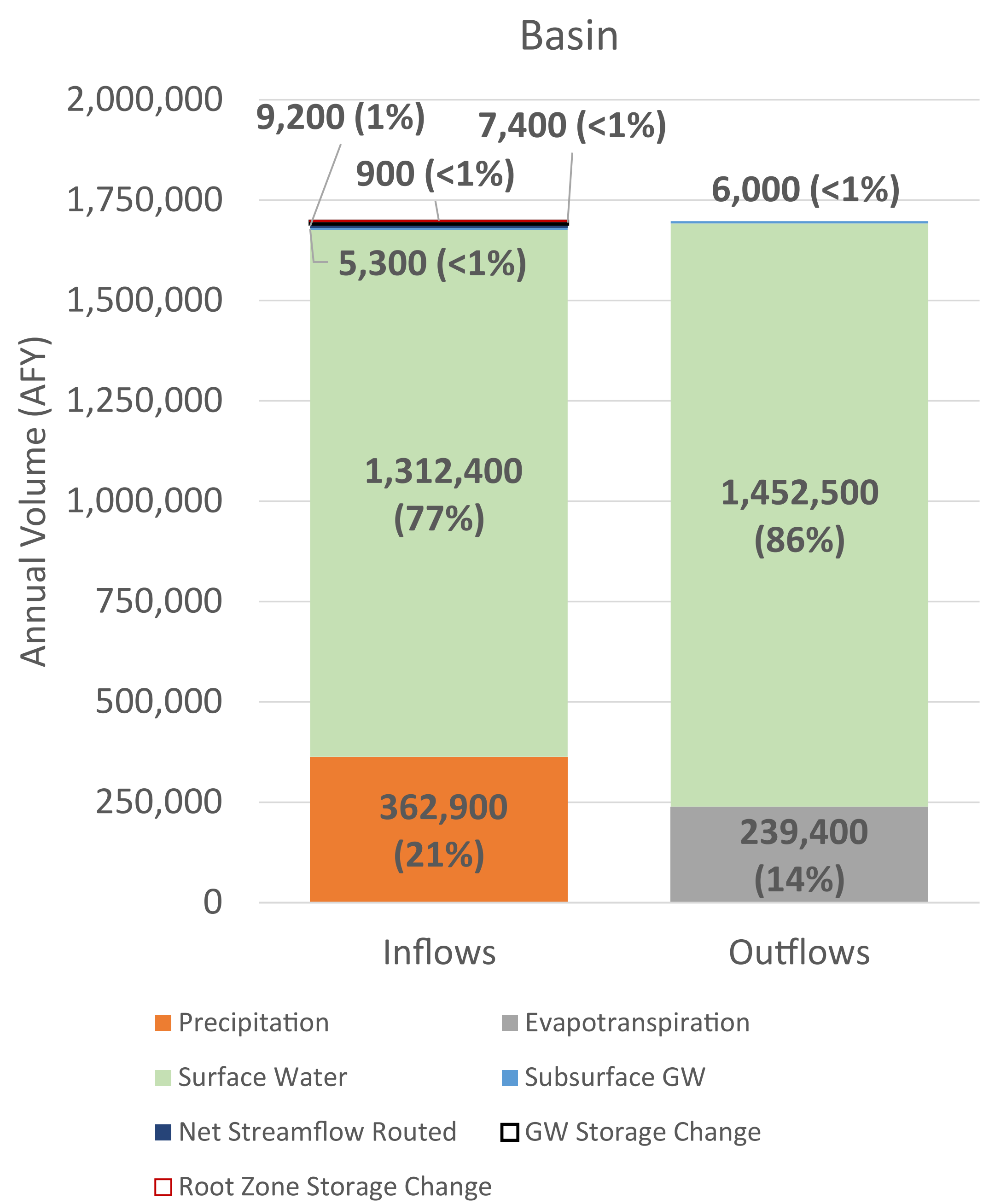
Figure WB-11



Abbreviations

AFY = acre-feet per year
GW = groundwater

Notes

1. Average annual volume over the current water budget period (i.e., WY 2015-2018).
2. Values are reported as fraction of total inflow, or total outflow, and percent of total inflow, or outflow, in parenthesis.

Sources

1. Numerical Model

Current Average (WY 2015-2018)
Basin Inflows and Outflows

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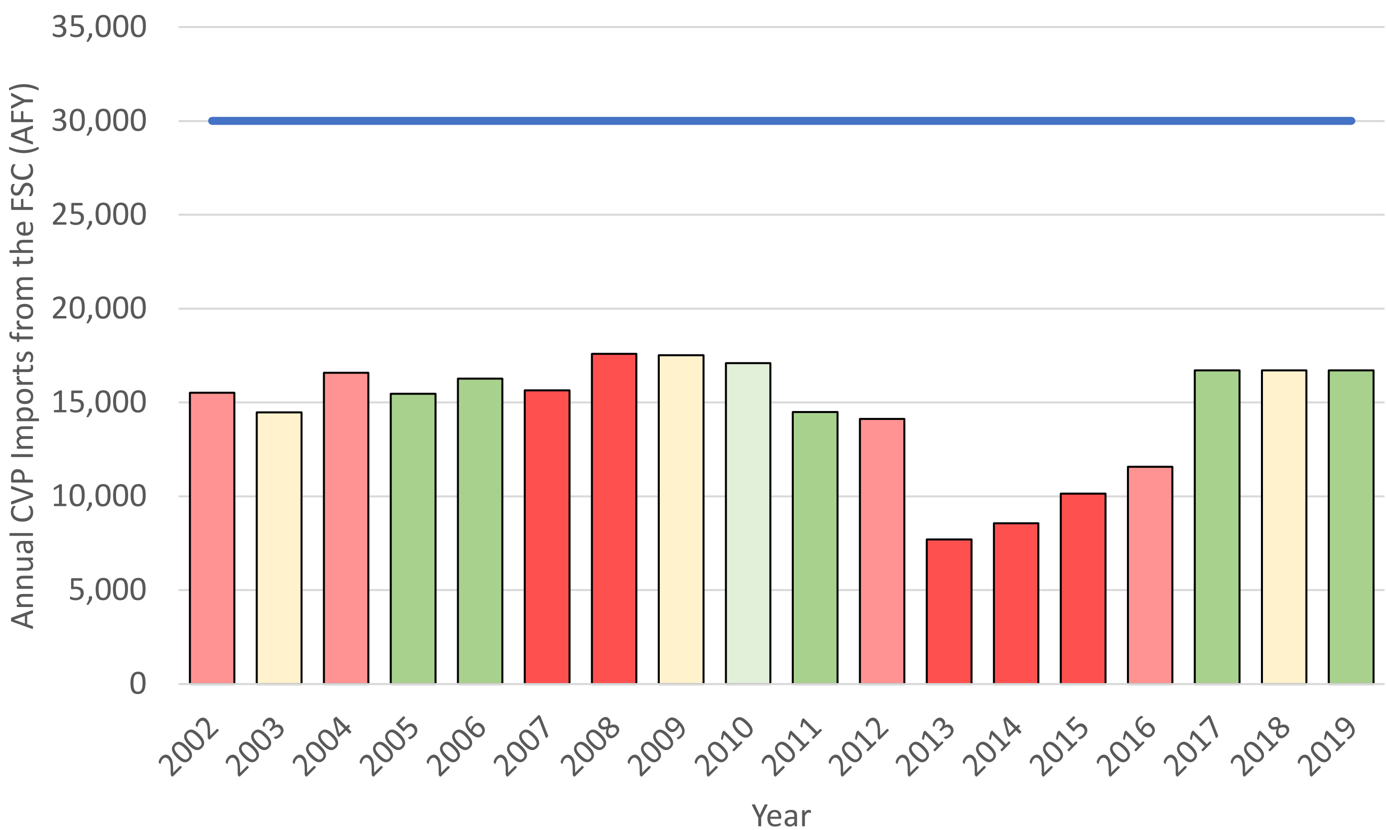
Figure WB-12



Legend

DWR Water Year Type

- Wet
- Above Normal
- Below Normal
- Dry
- Critical
- SMUD CVP Contract

Abbreviations

AFY = acre-feet per year
CVP = Central Valley Project
DWR = California Department of Water Resources
FSC = Folsom South Canal
SMUD = Sacramento Municipal Utility District
USBR = United States Bureau of Reclamation

Notes

1. SMUD's CVP contract with the USBR is for 30,000 AFY.

Sources

1. DWR Water Year type is from DWR's Water Year Hydrologic Classification Indices for the San Joaquin Valley (http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST)
2. SMUD CVP diversions from the FSC from written communication, Georgiana Gregory, USBR, 25 November 2014.
3. SMUD CVP contract amount from https://www.usbr.gov/mp/cvp-water/docs/latest-water-contractors.pdf

Annual CVP Surface Water Imports vs. Contracted Supply

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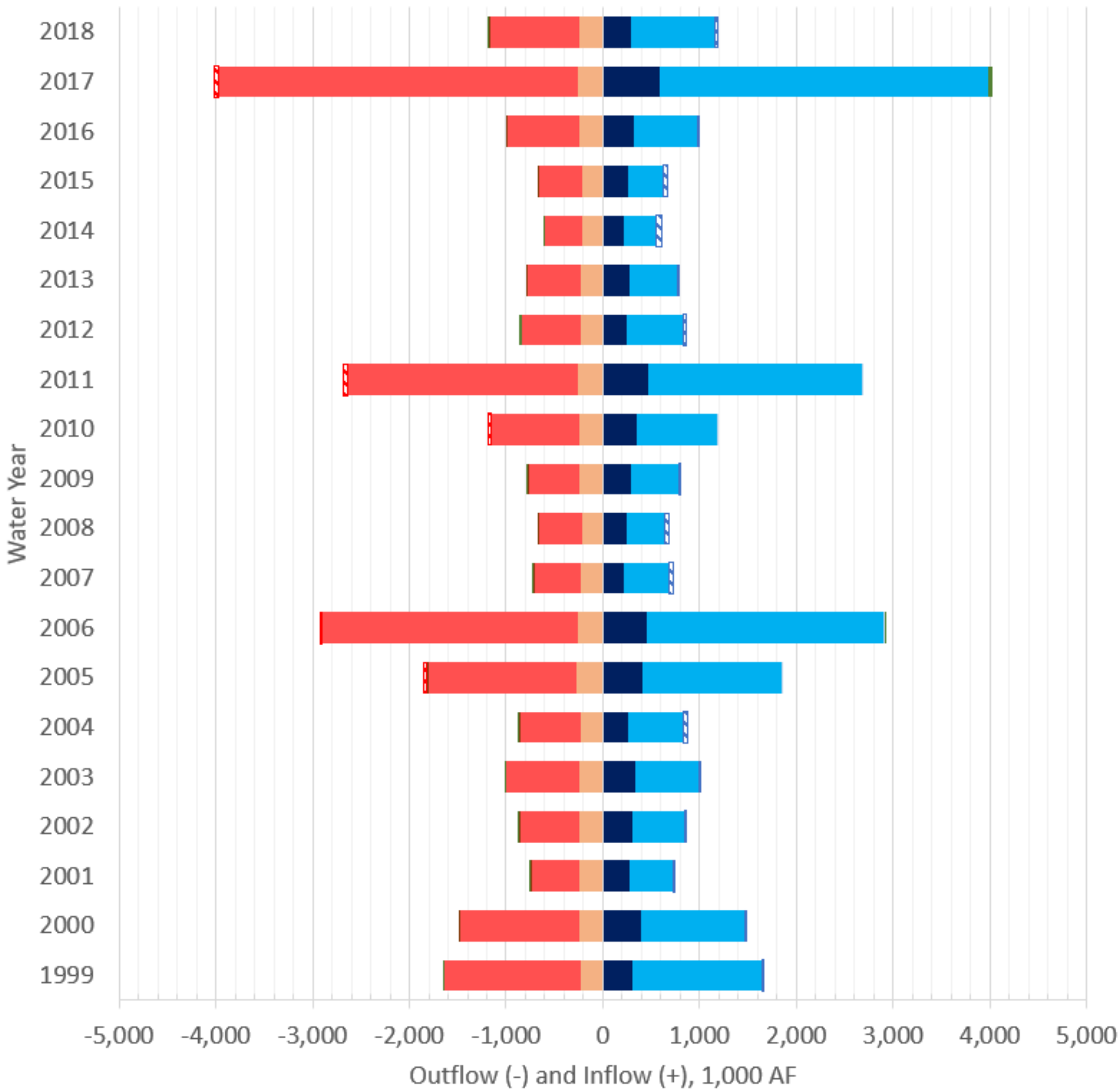
Figure WB-13



Legend

Inflows

- Precipitation
- Surface Water (including Imports)
- Subsurface Flow from Adjacent Watersheds
- Streamflow Routed between Adjacent Basins

Outflows

- Evapotranspiration
- Surface Water
- Net Subsurface Flow between Adjacent Basins
- Streamflow Routed between Adjacent Basins

Change in Groundwater and Root Zone Storage

- Gain in Storage
- Reduction in Storage

Abbreviations

AF = acre-feet

Notes

1. Water Year is defined as the October of the previous year through September of the current year.
2. A positive volume corresponds to an inflow and a negative volume corresponds to an outflow.

Sources

1. Numerical Model

Annual Basin Inflows and Outflows, Water Year 1999-2018

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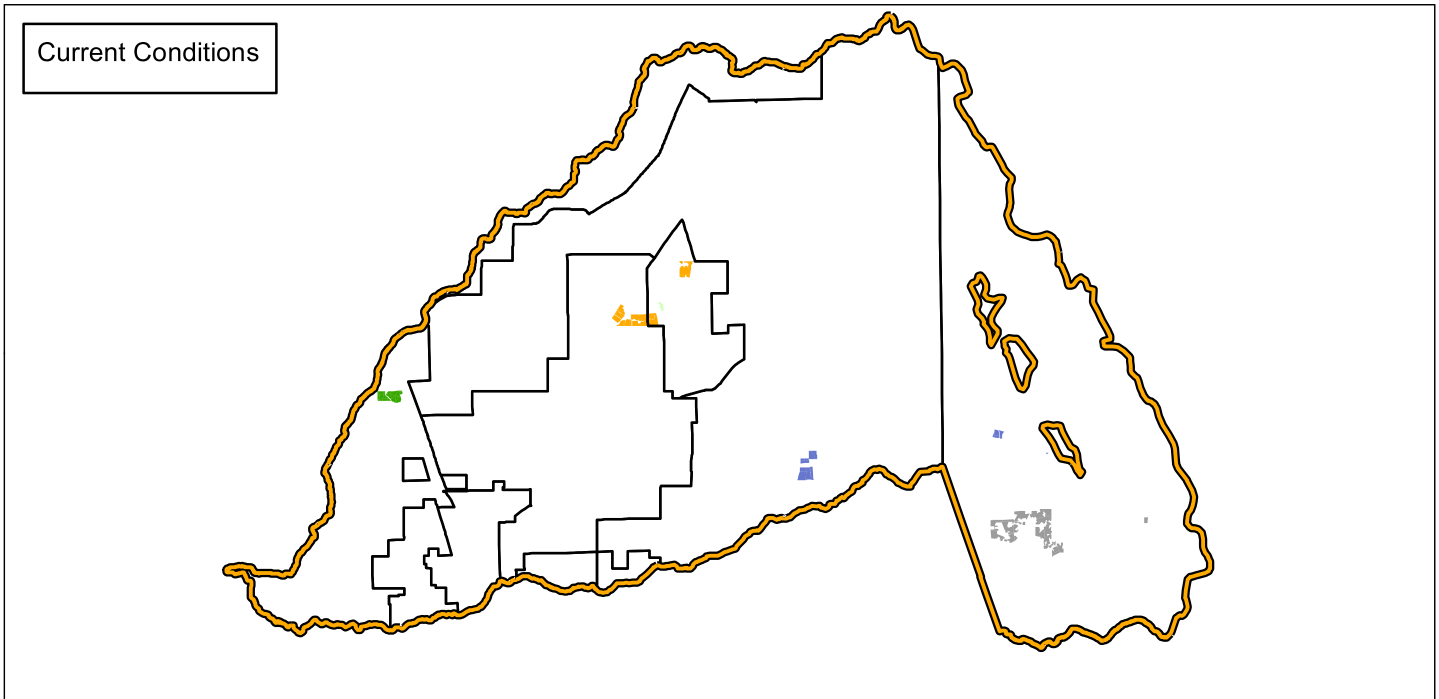
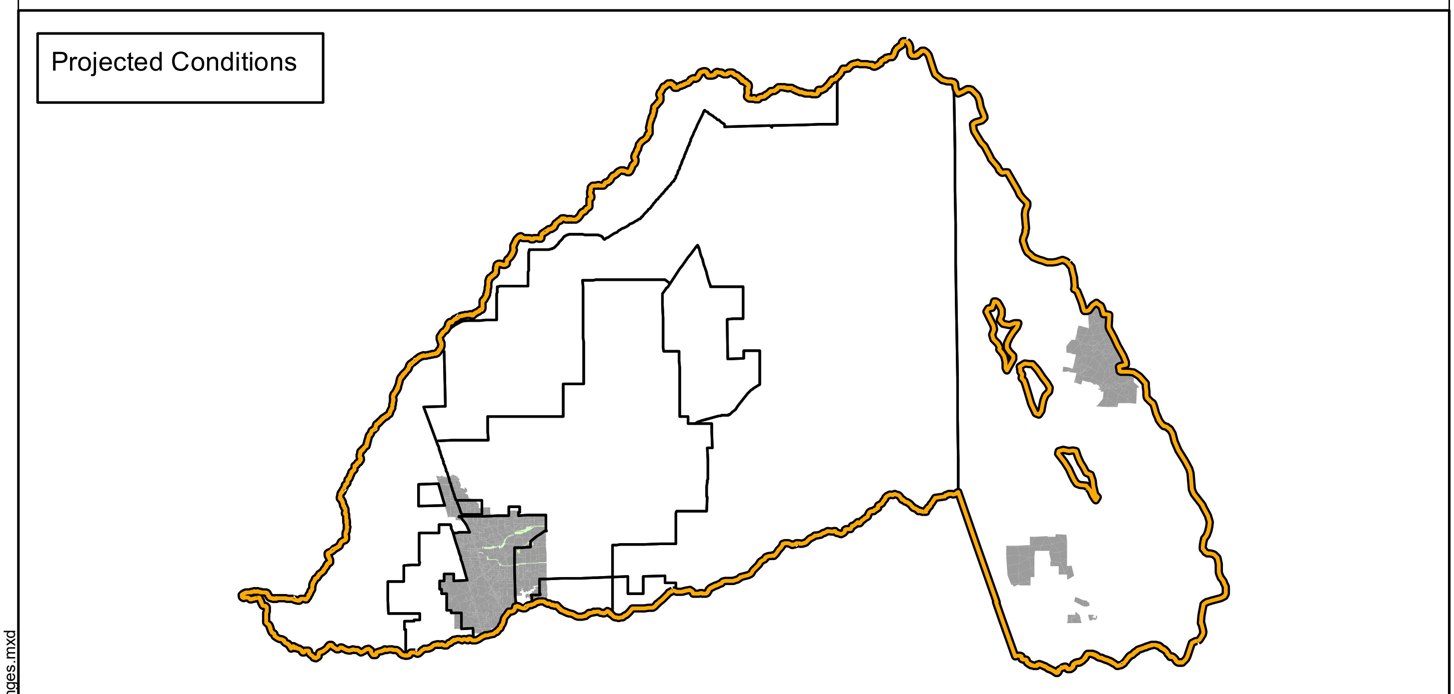
Figure WB-14





Legend

Cosumnes Subbasin (5-022.16)

Groundwater Sustainability Agency Boundary

Land Use Changes

Current Conditions

- Native Vegetation
- Urban
- Almonds/Pistachio
- Grain
- Vineyard

Projected Conditions

- Native Vegetation
- Riparian Vegetation
- Urban

Notes

1. All locations are approximate.

N

0 3 6

(Scale in Miles)

Land Use Changes Represented in Numerical Model

Sources

1. Current Conditions: Cosumnes Subbasin Working Group comments and aerial photos.
2. Projected Conditions:
   - Figure LU-1 in 2030 Galt General Plan Policy Document, City of Galt, dated April 2009.
   - Figure LU-1 in Amador County General Plan, dated October 2016.

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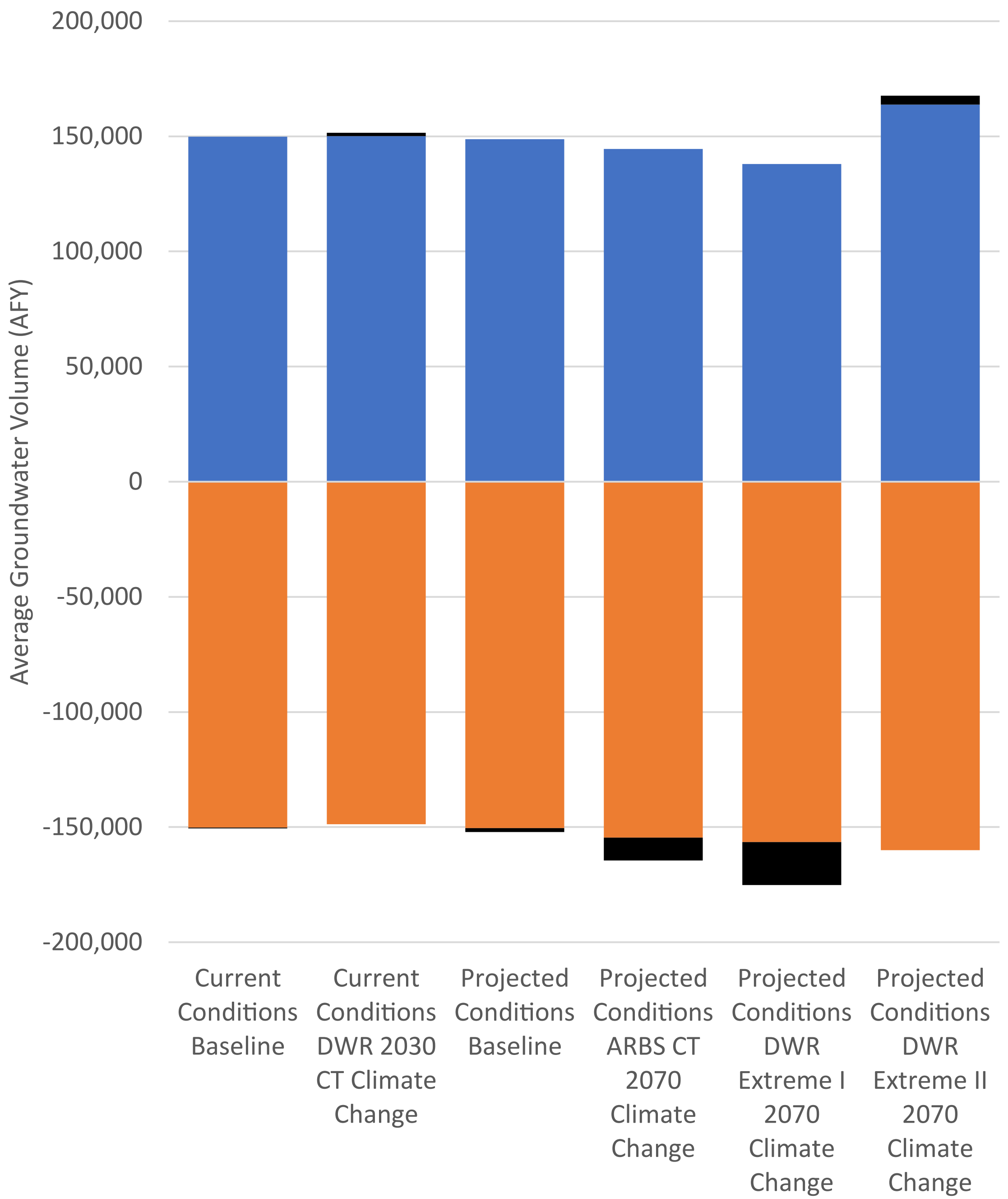
Figure WB-15

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\WB-15 CoSANA Land Use Changes.mxd



Legend

- Groundwater Inflows
- Groundwater Outflows
- Change in Groundwater Storage

Abbreviations

AFY = acre-feet per year
ARBS = American River Basin Study
CT = Central Tendency
DWR = California Department of Water Resources

Notes

1. Aveage groundwater volume over a 50-year projected simulated period.
2. A positive volume corresponds to a groundwater inflow and a negative volume corresponds to a groundwater outflow.
3. See **Table WB-10** for a breakdown of groundwater system inflows and outflows.

Sources

1. umerical Model

Projected 50-Year Average Groundwater System Inflows and Outflows

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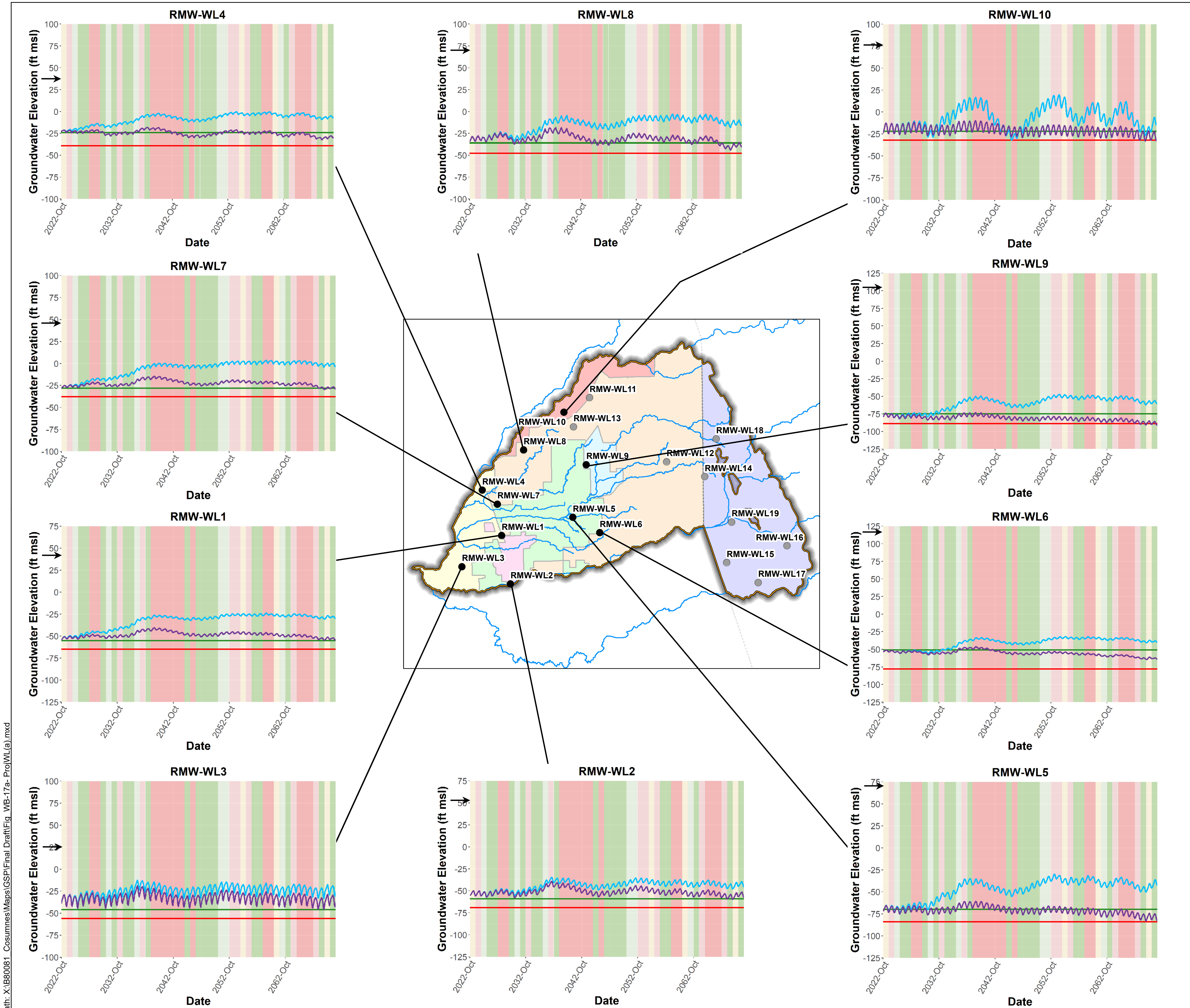
Figure WB-16



Legend

Cosumnes Subbasin (5-022.16)

Groundwater Sustainability Agency

- Amador County Groundwater Management Authority
- City of Galt
- Clay Water District
- Galt Irrigation District
- Omochumne-Hartnell Water District
- Sacramento County
- Sloughhouse Resource Conservation District

County Line

Major Stream

RMW-WL

Ground Surface Elevation

Scenarios

- MT
- MO
- Hydrograph-Projected
- Hydrograph-Projected with PMA

Water Year Type

- Wet
- Above Normal
- Below Normal
- Dry
- Critical

Abbreviations

ft msl = feet above mean sea level
MO = Measurable Objective
MT = Minimum Threshold
PMA = Projects and Management Actions
RMW-WL = Represenatitve Monitoring Well for Chronic Lowering of Water Levels

Notes

1. All locations are approximate.
2. See Figure WB-17b for RMW-WL11 through RMW-WL19.
3. Model-calculated water levels adjusted to match measured Fall 2015 or most recent water level exactly.
4. Ground surface elevations are reported in Table MN-1 and marked with an arrow on each graph.

N
0 8 16
(Scale in Miles)

Model-calculated Projected Water Level Trends in Chronic Lowering of Groundwater Level Monitoring Wells With and Without Projects and Management Actions

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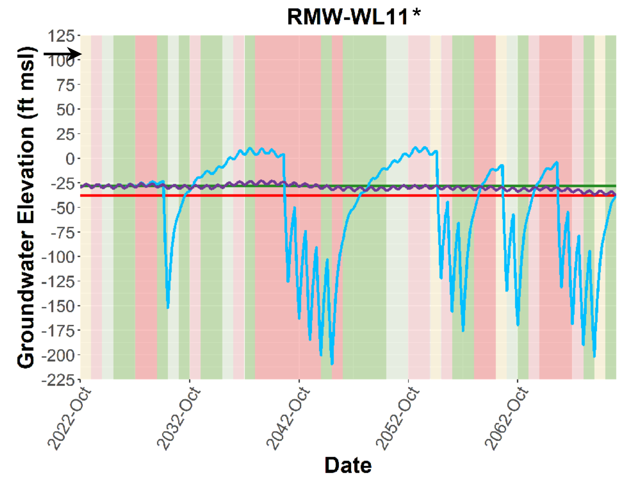
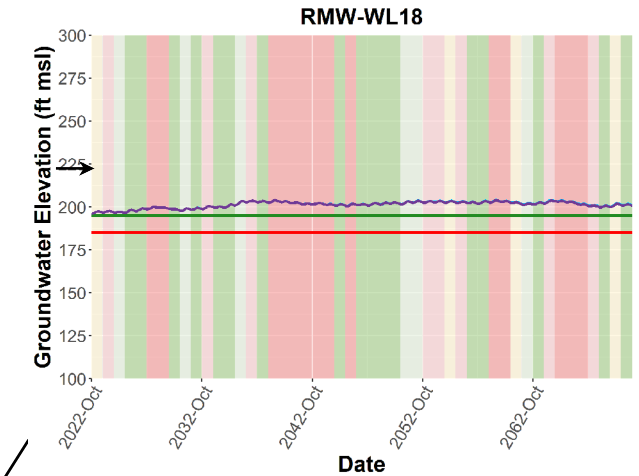
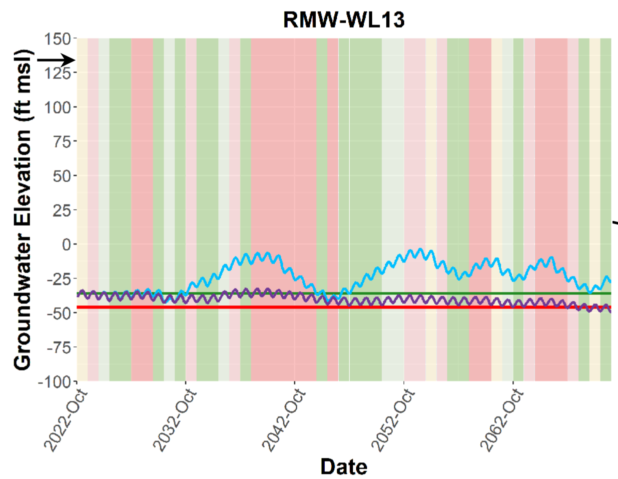
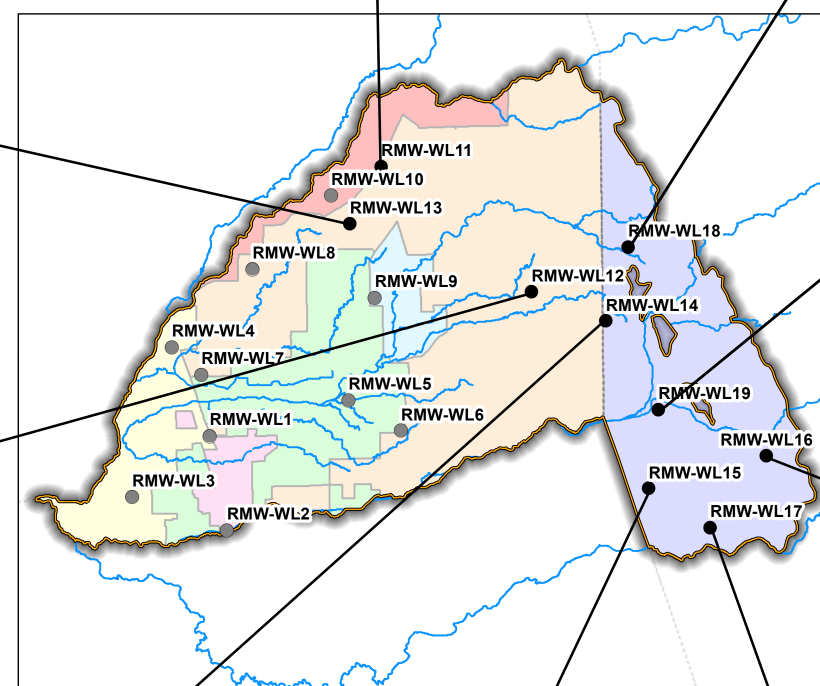
Figure WB-17a

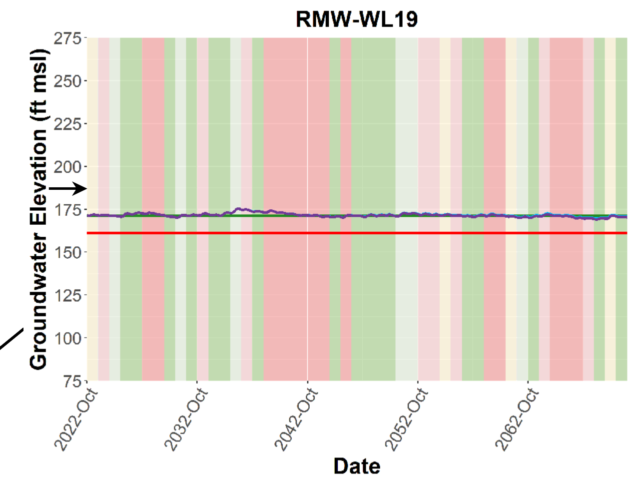
* Model-calculated water levels in RMW-WL11 temporarily decline below the MO and MT when the intentionally stored groundwater is recovered by extraction wells. The modeled recovery well locations and extraction rates were assumed for planning purposes, but these results show how actual well locations identified during project planning and implementation will need to consider the potential short-term impacts on water levels in nearby RMW-WL during recovery operations.

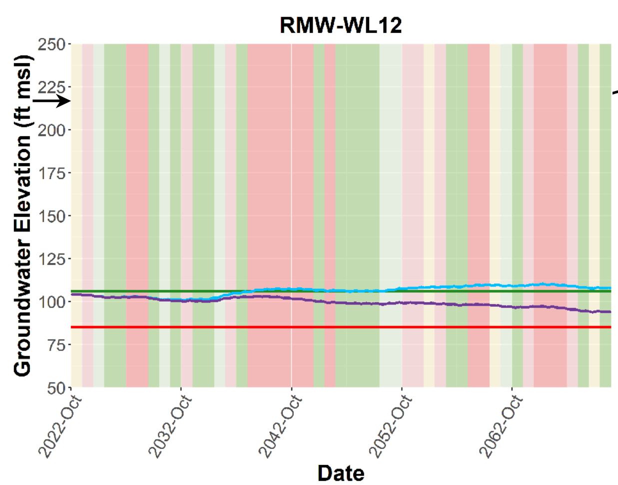


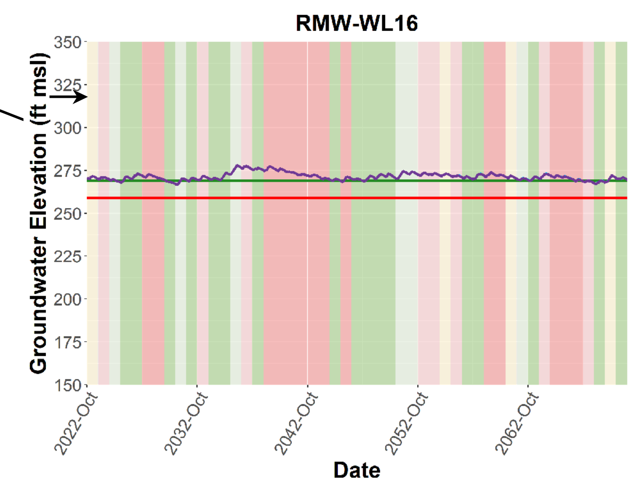


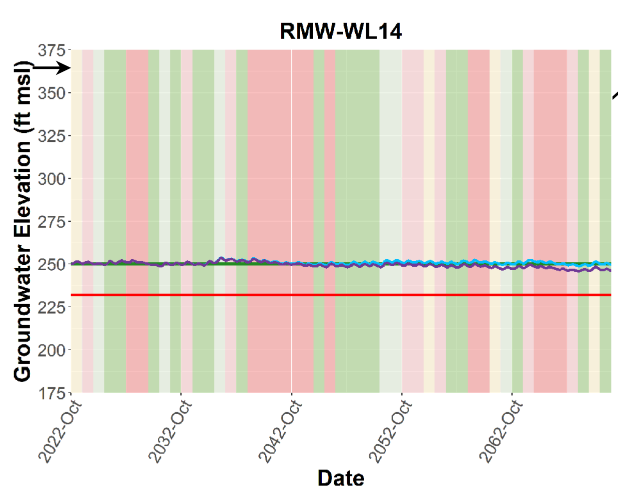


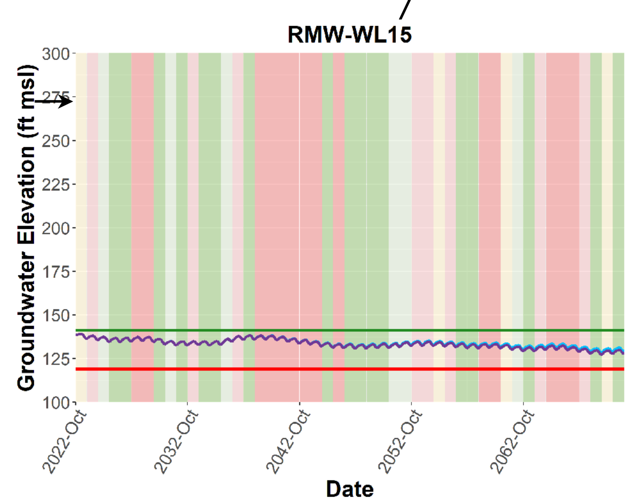


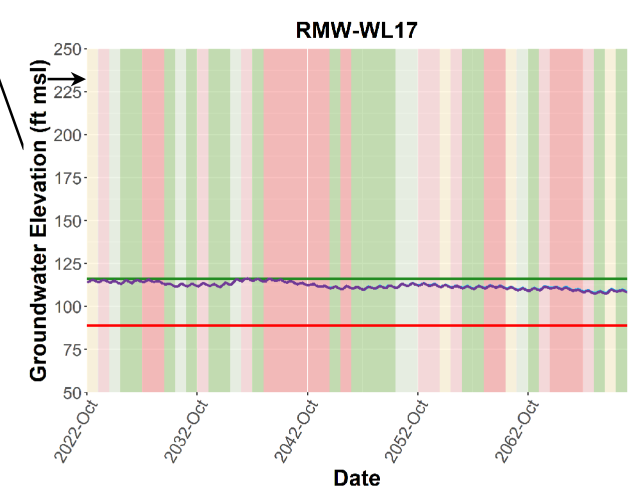












Legend

- Cosumnes Subbasin (5-022.16)

Groundwater Sustainability Agency

- Amador County Groundwater Management Authority
- City of Galt
- Clay Water District
- Galt Irrigation District
- Omochumne-Hartnell Water District
- Sacramento County
- Sloughhouse Resource Conservation District
- County Line
- Major Stream
- RMW-WL
- Ground Surface Elevation

Scenarios

- MT
- MO
- Hydrograph-Projected
- Hydrograph-Projected with PMA

Water Year Type

- Wet
- Above Normal
- Below Normal
- Dry
- Critical

Abbreviations

ft msl = feet above mean sea level
MO = Measurable Objective
MT = Minimum Threshold
PMA = Projects and Management Actions
RMW-WL = Representative Monitoring Well for Chronic Lowering of Water Levels

Notes

1. All locations are approximate.
2. See Figure WB-17a for RMW-WL1 through RMW-WL10.
3. Model-calculated water levels adjusted to match measured Fall 2015 or most recent water level exactly.
4. Ground surface elevations are reported in Table MN-1 and marked with an arrow on each graph.

N

0 8 16

(Scale in Miles)

Model-calculated Projected Water Level Trends in Chronic Lowering of Groundwater Level Monitoring Wells With and Without Projects and Management Actions

Working Group
Cosumnes Subbasin
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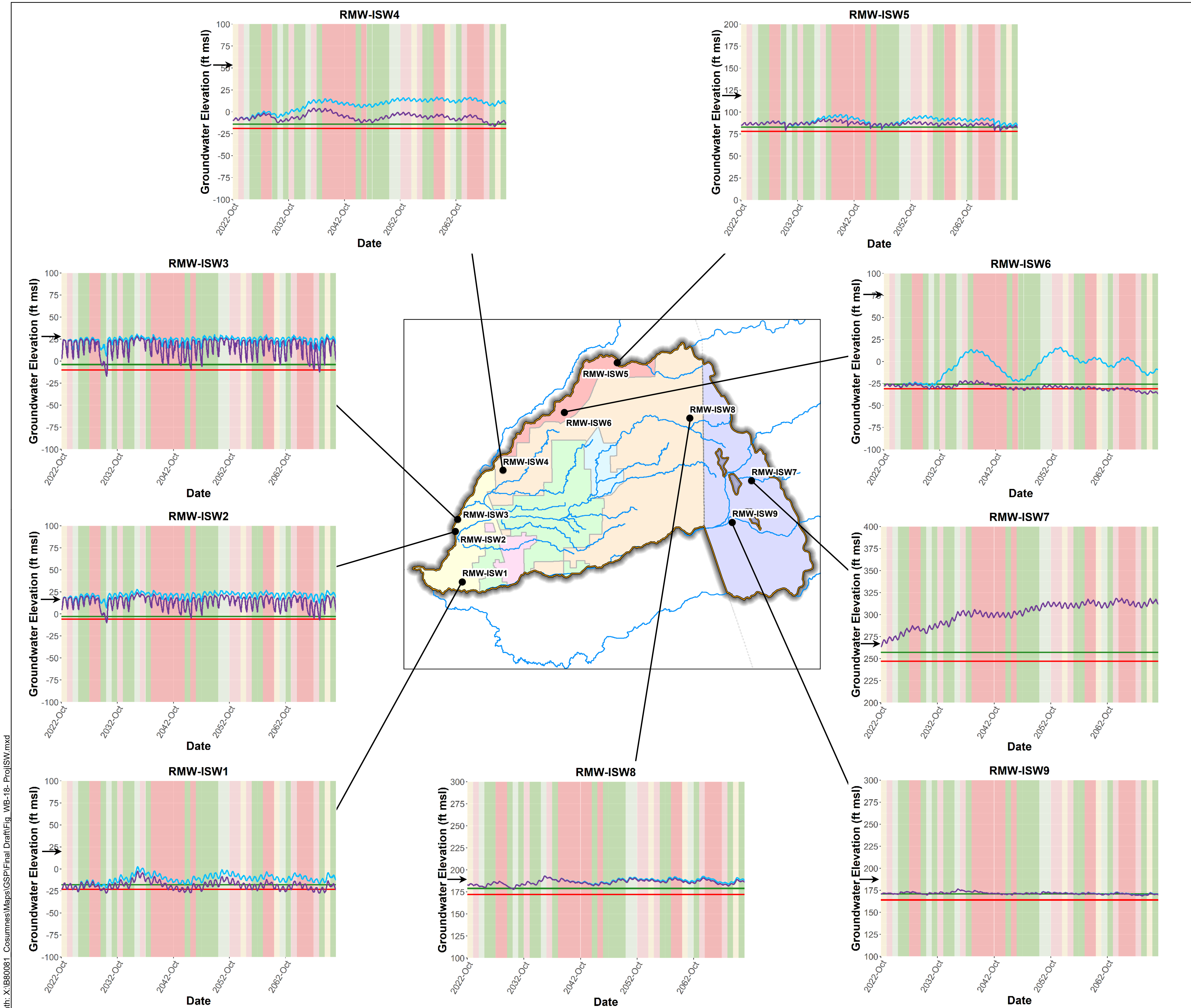
Figure WB-17b



Legend

- Cosumnes Subbasin (5-022.16)

Groundwater Sustainability Agency

- Amador County Groundwater Management Authority
- City of Galt
- Clay Water District
- Galt Irrigation District
- Omochumne-Hartnell Water District
- Sacramento County
- Sloughhouse Resource Conservation District
- Major Stream
- County Line
- RMW- ISW
- Ground Surface Elevation

Scenarios

- MT
- MO
- Hydrograph-Projected
- Hydrograph-Projected with PMA

Water Year Type

- Wet
- Above Normal
- Below Normal
- Dry
- Critical

Abbreviations

ft msl = feet above mean sea level
MO = Measurable Objective
MT = Minimum Threshold
PMA = Projects and Management Actions
RMW-ISW = Representative Monitoring Well for Interconnected Surface Water

Notes

1. All locations are approximate.
2. Model-calculated water levels adjusted to match measured Fall 2015 or most recent water level exactly.
3. Ground surface elevations are reported in Table MN-4 and marked with an arrow on each graph.

N

0 8 16

(Scale in Miles)

Model-calculated Projected Water Level Trends in Depletion of Interconnected Surface Water Monitoring Wells With and Without Projects and Management Actions

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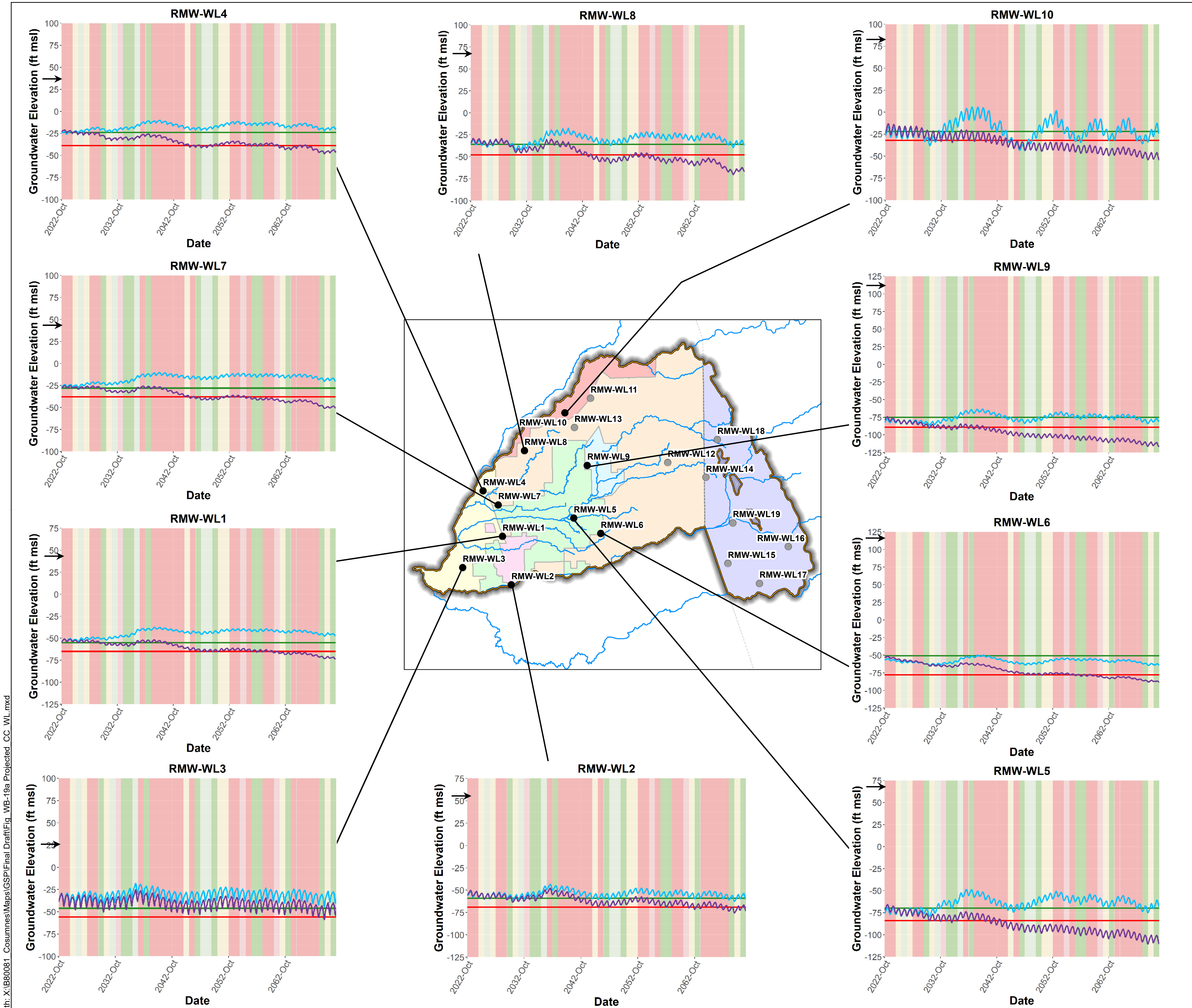
Figure WB-18



Legend

- Cosumnes Subbasin (5-022.16)

Groundwater Sustainability Agency

- Amador County Groundwater Management Authority
- City of Galt
- Clay Water District
- Galt Irrigation District
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- Sacramento County
- Sloughhouse Resource Conservation District
- County Line
- Major Stream
- RMW-WL
- Ground Surface Elevation

Scenarios

- MT
- MO
- Hydrograph-Projected
- Hydrograph-Projected with PMA

Water Year Type

- Wet
- Above Normal
- Below Normal
- Dry
- Critical

Abbreviations

ft msl = feet above mean sea level
MO = Measurable Objective
MT = Minimum Threshold
PMA = Projects and Management Actions
RMW-WL = Represenatative Monitoring Well for Chronic Lowering of Water Levels

Notes

1. All locations are approximate.
2. See Figure WB-19b for RMW-WL11 through RMW-WL19.
3. Model-calculated water levels adjusted to match measured Fall 2015 or most recent water level exactly.
4. Ground surface elevations are reported in Table MN-1 and marked with an arrow on each graph.

N
0 8 16
(Scale in Miles)

Model-calculated Projected Water Level Trends in Chronic Lowering of Groundwater Level Monitoring Wells under ARBS Central Tendency 2070 Climate Change Scenario With and Without Projects and Management Actions

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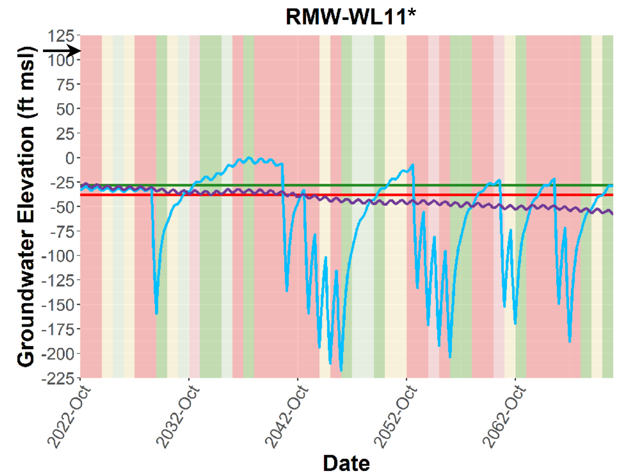
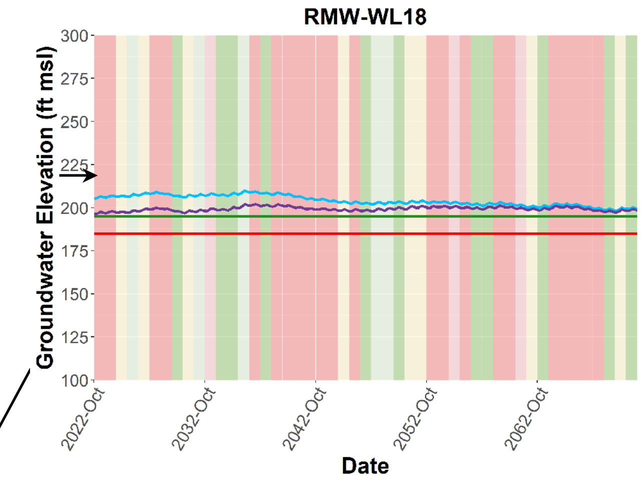
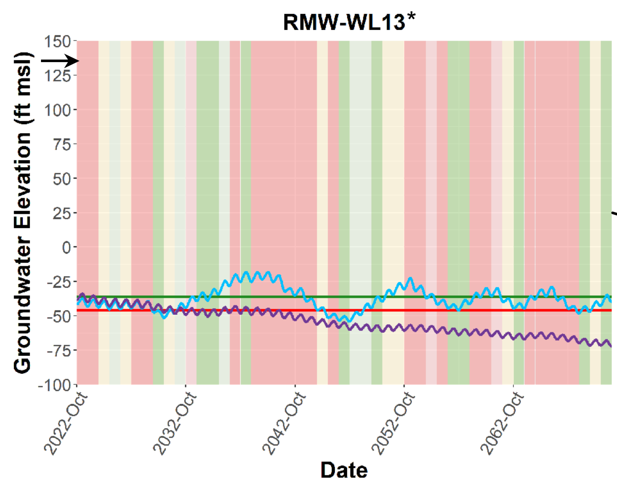
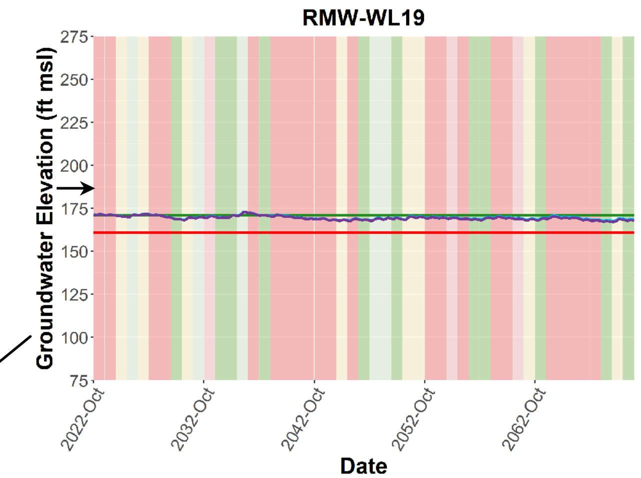
Figure WB-19a

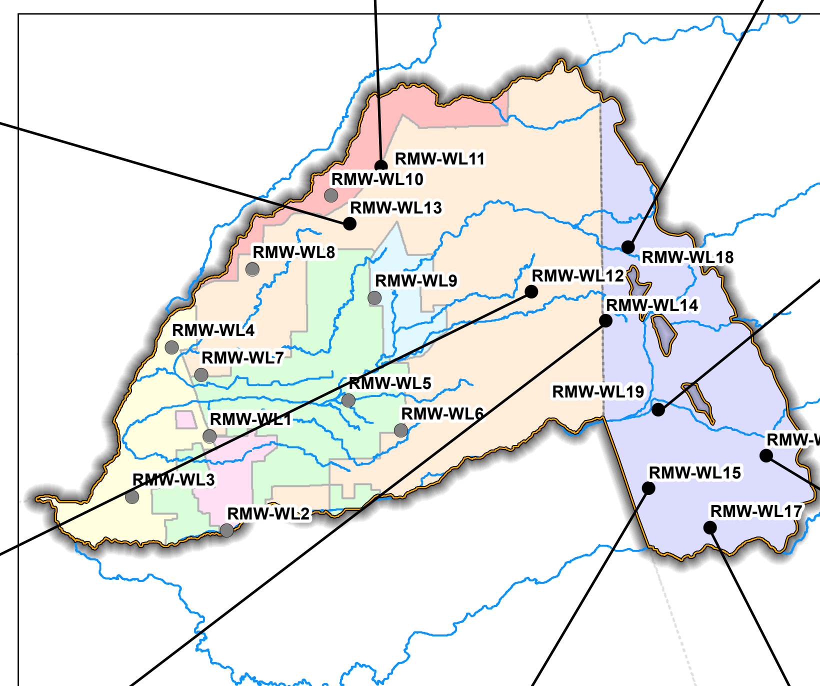
* Model-calculated water levels in RMW-WL11 and RMW-WL13 temporarily decline below the MO and MT when the intentionally stored groundwater is recovered by extraction wells. The modeled recovery well locations and extraction rates were assumed for planning purposes, but these results show how actual well locations identified during project planning and implementation will need to consider the potential short-term impacts on water levels in nearby RMW-WL during recovery operations.

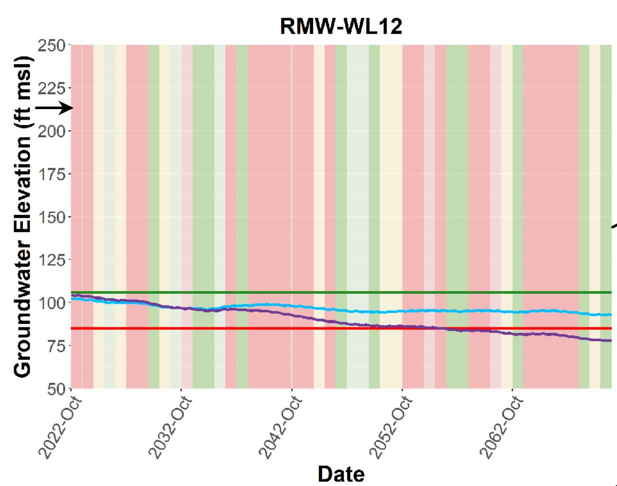


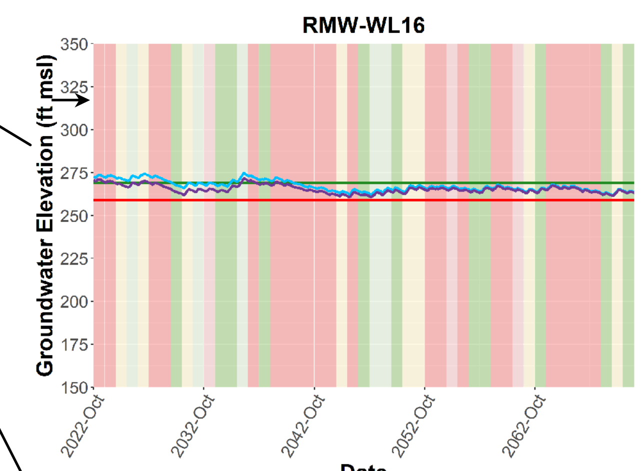


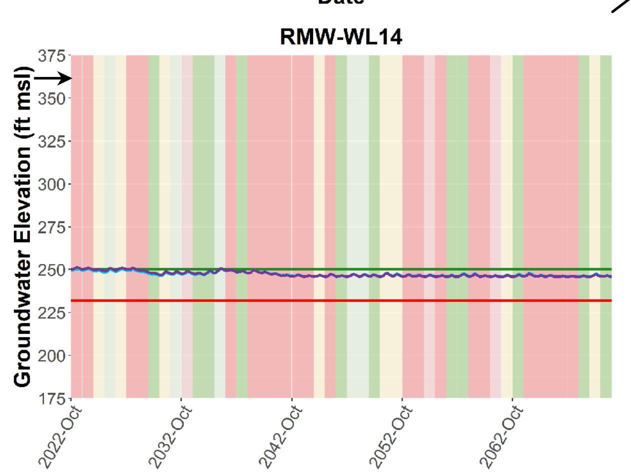


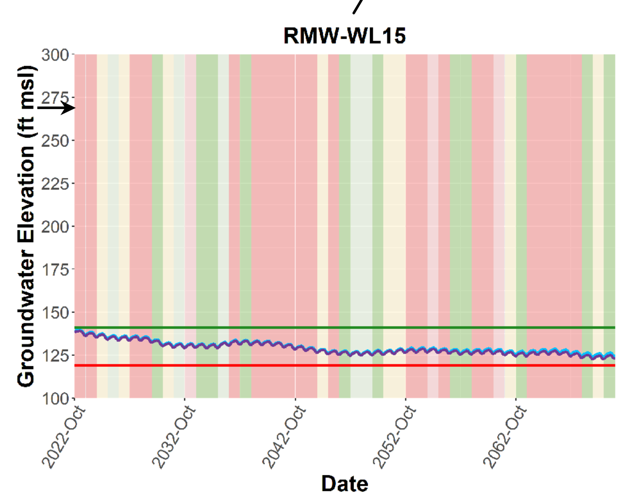


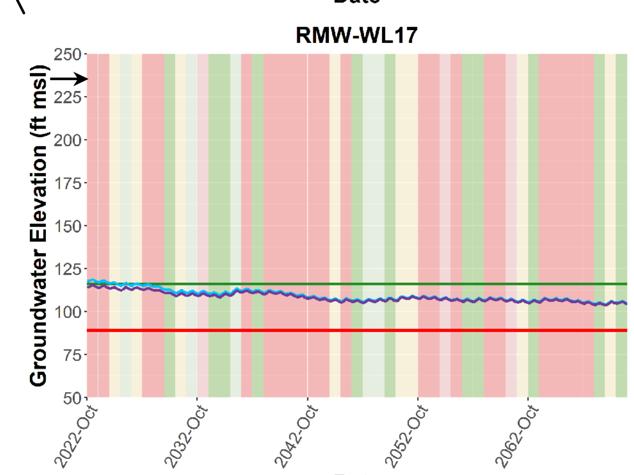












Legend

- Cosumnes Subbasin (5-022.16)

Groundwater Sustainability Agency

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- County Line
- Major Stream
- RMW-WL
- Ground Surface Elevation

Scenarios

- MT
- MO
- Hydrograph-Projected
- Hydrograph-Projected with PMA

Water Year Type

- Wet
- Above Normal
- Below Normal
- Dry
- Critical

Abbreviations

ft msl = feet above mean sea level
MO = Measurable Objective
MT = Minimum Threshold
PMA = Projects and Management Actions
RMW-WL = Representative Monitoring Well for Chronic Lowering of Water Levels

Notes

1. All locations are approximate.
2. See Figure WB-19a for RMW-WL1 through RMW-WL10.
3. Model-calculated water levels adjusted to match measured Fall 2015 or most recent water level exactly.
4. Ground surface elevations are reported in Table MN-1 and marked with an arrow on each graph.

N
0 8 16
(Scale in Miles)

Model-calculated Projected Water Level Trends in Chronic Lowering of Groundwater Level Monitoring Wells under ARBS Central Tendency 2070 Climate Change Scenario With and Without Projects and Management Actions

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Figure WB-19b

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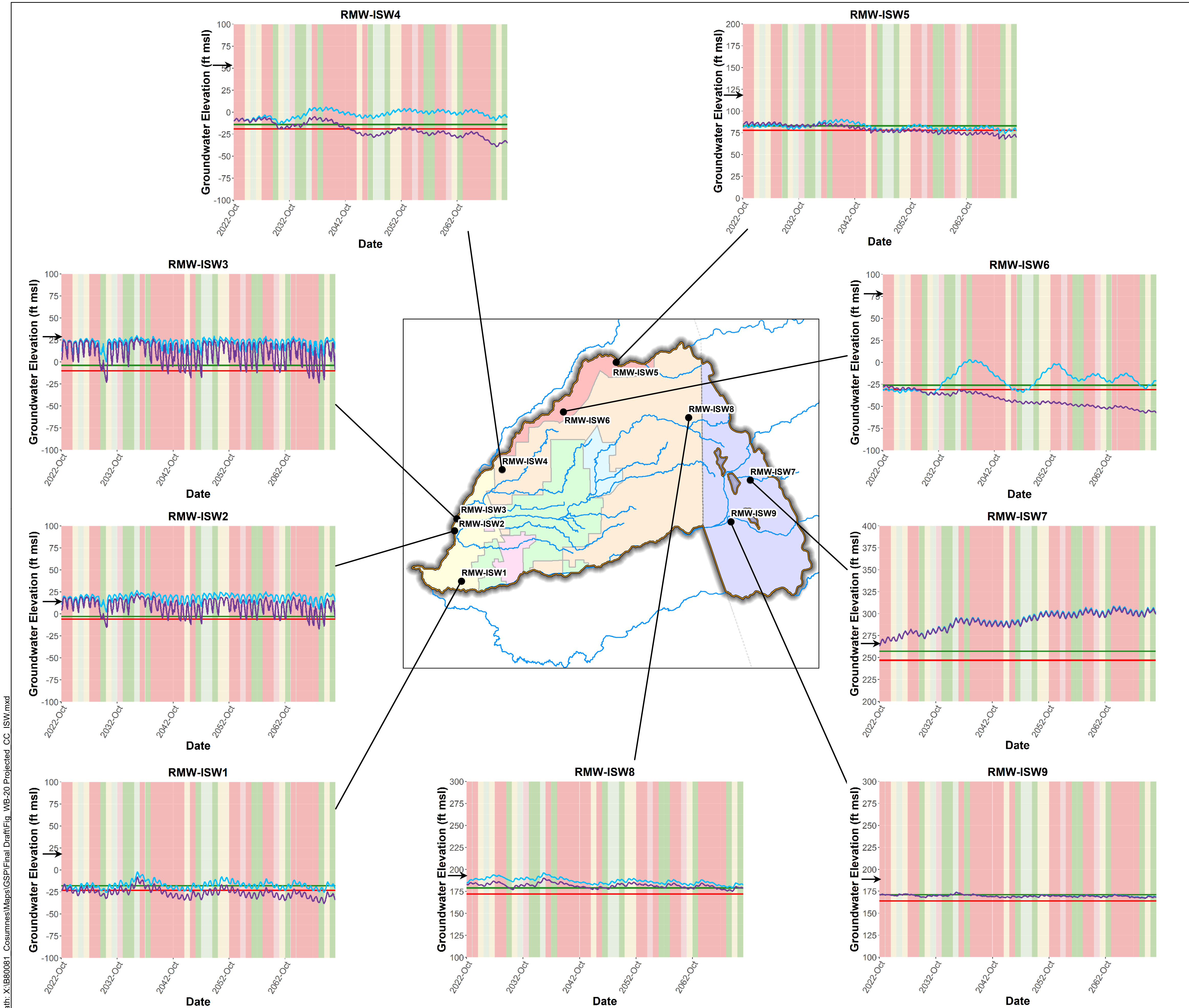

Legend

Cosumnes Subbasin (5-022.16)

Groundwater Sustainability Agency

- Amador County Groundwater Management Authority
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- Galt Irrigation District
- Omochumne-Hartnell Water District
- Sacramento County
- Sloughhouse Resource Conservation District

Major Stream

County Line

RMW- ISW

Ground Surface Elevation

Scenarios

- MT
- MO
- Hydrograph-Projected
- Hydrograph-Projected with PMA

Water Year Type

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- Below Normal
- Dry
- Critical

Abbreviations

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MT = Minimum Threshold
PMA = Projects and Management Actions
RMW-ISW = Representatitve Monitoring Well for Interconnected Surface Water

Notes

1. All locations are approximate.
2. Model-calculated water levels adjusted to match measured Fall 2015 or most recent water level exactly.
3. Ground surface elevations are reported in Table MN-4 and marked with an arrow on each graph.

N

0 8 16

(Scale in Miles)

Model-calculated Projected Water Level Trends in Representative Interconnected Surface Water Monitoring Wells under ARBS Central Tendency 2070 Climate Change Scenario With and Without Projects and Management Actions

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Figure WB-20

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11. MANAGEMENT AREAS (AS APPLICABLE)

> *§ 354.20. Management Areas*
> *(a) Each Agency may define one or more management areas within a basin if the Agency has determined that creation of management areas will facilitate implementation of the Plan. Management areas may define different minimum thresholds and be operated to different measurable objectives than the basin at large, provided that undesirable results are defined consistently throughout the basin.*

The Cosumnes Subbasin Sustainable Groundwater Management Act Working Group is not considering Management Areas at this time.

SUSTAINABLE MANAGEMENT CRITERIA

12. INTRODUCTION TO SUSTAINABLE MANAGEMENT CRITERIA

> *§ 354.22. Introduction to Sustainable Management Criteria*
> *This Subarticle describes criteria by which an Agency defines conditions in its Plan that constitute sustainable groundwater management for the basin, including the process by which the Agency shall characterize undesirable results, and establish minimum thresholds and measurable objectives for each applicable sustainability indicator.*

Sustainable Groundwater Management Act (SGMA) legislation defines a "Sustainability Goal" as "the existence and implementation of one or more groundwater sustainability plans [GSPs] that achieve sustainable groundwater management by identifying and causing the implementation of measures targeted to ensure that the applicable basin is operated within its sustainable yield" (California Water Code [CWC] § 10721(u)). SGMA requires Groundwater Sustainability Agencies (GSAs) to develop and implement GSPs to meet the Sustainability Goal (CWC § 10727(a)). The SGMA legislation and GSP Regulations California Code of Regulations Title 23 [23-CCR] Division 1 Chapter 1.5 Subchapter 2 define the following terms related to achievement of the Sustainability Goal, including:

- Undesirable Result (UR) – "one or more of the following effects caused by groundwater conditions occurring throughout the basin:
    (1) 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.
    (2) Significant and unreasonable reduction of groundwater storage.
    (3) Significant and unreasonable seawater intrusion.
    (4) Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.
    (5) Significant and unreasonable land subsidence that affects critical and non-critical infrastructure and surface land uses.
    (6) Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water" (CWC § 10721(x)).
- Minimum Threshold (MT) – "a numeric value for each sustainability indicator used to define undesirable results" (23 CCR § 351(t));
- Measurable Objective (MO) – "specific, quantifiable goals for the maintenance or improvement of

specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin" (23 CCR § 351(s)); and

- Interim Milestone (IM) – "a target value representing measurable groundwater conditions, in increments of five years, set by an Agency as part of a Plan" (23 CCR § 351(q)).

Collectively, the Sustainability Goal, URs, MTs, MOs, and IMs are referred to herein as the "Sustainable Management Criteria" (SMCs).

Each of the following are referred to as "Sustainability Indicators", which, as stated above, can constitute URs if they are "significant and unreasonable"

(1) Chronic Lowering of Groundwater Levels,

(2) Reduction of Groundwater Storage,

(3) Seawater Intrusion,

(4) Degraded Water Quality,

(5) Land Subsidence, and

(6) Depletions of Interconnected Surface Water[72] (CWC § 10721(x)).

The GSP Regulations specify how GSAs must establish SMCs for each applicable Sustainability Indicator. Sections 13, 14, 15, and 16 of this GSP describe the Sustainability Goal, URs, MTs, MOs, and IMs, respectively, that have been developed by the Working Group to define and support groundwater sustainability in the Cosumnes Subbasin (Basin).

Table SMC-1 summarizes the UR and MT definitions, criteria, and justifications, for each applicable Sustainability Indicator as defined for the Basin.

[72] Groundwater Dependent Ecosystems (GDEs) are considered herein under the Depletions of Interconnected Surface Water Sustainability Indicator.

Table SMC-1. Summary of Undesirable Results and Minimum Thresholds Definitions, Criteria, and Justification

Sustainability Indicator	Undesirable Result (UR) Causes	Potential Effects on Beneficial Users	UR Definition	Minimum Threshold (MT) Definition	MT Justification	UR Criteria	UR Justification
Chronic Lowering of Groundwater Levels	**Increased pumping** due to (a) increase in water use per acre on irrigated land, (b) new land put into agricultural production, and/or (c) additional urban demand met by groundwater. **Reduced recharge** due to (a) increased agricultural irrigation efficiency, (b) climate change resulting indecreased precipitation, (c) decreased surface water inflows from contributing watersheds, (d) Increased runoff due to the expansion of impervious land areas, (e) reduced cross-boundary inflows and/or increased cross-boundaryoutflows, and/or (f) increased ET.	**Groundwater well dewatering** and associated effects (e.g., increased maintenance costs, possible well deepening/replacement, and reducedwell lifespan). **Increased pumping lift** and associated effects (i.e., greater energy use, higher pumping costs, increased wear and tear on well pump motors, reduced well efficiency, and lower well yield). **Effects on correlated sustainability indicators** (i.e., groundwater storage and subsidence.	**URs** would be experienced when a chronic decline in groundwater levels in the Principal Aquifer negatively affects the long-term viable access to groundwater for urban, domestic, agricultural, industrial, and other beneficial users and uses within the Basin. (Note that Environmental beneficial users are addressed in the UR for Depletions of Interconnected Surface Water). Domestic wells are greatest in number and generally shallowest in depth. Hence, **Significant and Unreasonable effects** associated with URs occur when the number of completely dewatered domestic wells exceeds the assumed natural well replacement rate projected to occur over the 20-year implementation horizon (i.e., exceeds 26%, which is the estimated natural well replacement rate assuming that the existing domestic wells that are 40 years old or older will have to be replaced due to well lifespan issues).	**MTs are set at 19 RMW-WLs**, which exceeds guidelines for monitoring network well density based on Basin area. For RMW-WLs with historical groundwater levels showing long-term negative trends: - MT set at projected future water level based on a 20-year extension of the historical trend. For all other RMW-WLs (not showing long-term negative trends): - MT set at the historical low groundwater level.	RMW-WLs are representative of groundwater levels in their vicinity, based on representativeness analysis,and the network is designed to ensure that it reflects groundwater conditions in the vicinity of beneficial uses and users. RMW-WL network is made up of 35% irrigation wells, 35% monitoring wells, 20% domestic wells and 10% public supply wells. MTs are set at levels that avoid depletion of supply that may lead to URs, based on the most sensitive beneficial users (domestic wells). MTs consider historical groundwater level trends. A **20-year trend extension** for RMW- WLs with declining trends allows the Groundwater Sustainability Agencies (GSAs) reasonable and sufficient time to implement Projects and Management Actions (PMAs) to halt trends and is consistent with the period in which the Basin is required to achieve its Sustainability Goal. Water Level Impacts to wells have occurred to some degree in the past, as evident by anecdotal need for some well owners to lower their pumps; however, historical low groundwater levels are not known to have caused Undesirable Results (significant and unreasonable impacts to beneficial uses and users of groundwater), based on the best available information. **Domestic well impact analysis** showsthat 3.5% of domestic wells (83 wells) could be partially dewatered and 2% (48 wells) could be completely dewatered if MTs were reached at <u>all</u> RMW-WLs. **Based on the MT comparison analysis, MTs will not negatively affectadjacent basins**.	URs occur **when MTs are exceeded in 25% or more of the RMW-WLs (5 out of 19), because of SGMA- related groundwater management, for two (2) consecutive years**.	Exceeding MTs at 25% or more of RMW-WLs could result in partial dewatering of approximately 1% of domestic wells and complete dewatering of approximately 0.5% of domestic wells, based on the domestic well impact analysis and assuming proportional impacts on domestic wells from each MT exceedance at an RMW-WL. Thus, the UR definition is protective of the most sensitive beneficial users while ensuring the effects are representative of Basin-scaleand not localized conditions. Requiring two years of consecutive non-drought years of MT exceedances provides **confirmation that the chronic lowering of groundwater levels is not drought related**, consistent with the definition of URs for this Sustainability Indicator in CWC 10721(x)(1). The Basin GSAs will strive through the use of PMAs to maintain water levels at or above the Measurable Objectives (MOs), which are in all cases above the MTs.

Sustainability Indicator	Undesirable Result (UR) Causes	Potential Effects on Beneficial Users	UR Definition	Minimum Threshold (MT) Definition	MT Justification	UR Criteria	UR Justification
Reduction of Groundwater Storage	**Same causes as the Chronic Lowering of Groundwater Levels sustainability indicator.**	**Reduced groundwater supply reliability** due to reduced quantity of water available.	**URs** would be experienced when a reduction in storage in the Principal Aquifer negatively affects the long-term viable access to groundwater for the urban, domestic, agricultural, industrial, and other beneficial users and uses within the Basin. **Significant and unreasonable** effects associated with URs would include reduction in usable groundwater storage of more than 10% over the 20-year implementation horizon, based on the estimated Fall 2018 groundwater storage volume.	**MTs for Chronic Lowering of Groundwater Levels are used as a proxy**: For RMW-WLs with historical groundwater levels showing long-term negative trends: - MT set at projected future water level based on a 20-year extension of the historical trend. For all other RMW-WLs (not showing long-term negative trends): - MT set at the historical low groundwater level	MTs for Reduction in Groundwater Storage may be set by using MTs for Chronic Decline in Groundwater Levels as a proxy if it is demonstrated that a correlation exists between the two metrics. The following calculation demonstrates this correlation: The volume of “usable storage” theoretically accessible to existing wells was conservatively estimated using the CoSANA model as the storage above the 400-feet depth interval, as 50% of wells are 400 feet deep or less. The usable storage volume is about 11.7 million acre-feet (MAF). The volume of groundwater above the Chronic Lowering of Groundwater Levels MTs and the 2018 groundwater elevations is estimated at almost 400,000 AF, which is less than 4% of the estimated volume of usable storage. **Because estimated usable storage is much greater than the volume of water above the MTs, the MTs for Chronic Lowering of Groundwater Levels are considered protective for the Reduction of Groundwater Storage Sustainability Indicator.**	URs occur **when MTs are exceeded in 25% or more of the RMW-WLs (5 out of 19) because of SGMA-related groundwater management for two (2) consecutive years**.	The use of MTs for the Chronic Lowering of Groundwater Levels as a proxy for Reduction of Groundwater Storage has been demonstrated to be appropriate and protective. The amount by which groundwater storage would be reduced if all RMW-WLs declined to their respective MTs represents only 4% of total usable groundwater storage. Given that the UR definition is based on only 25% of RMW-WLs exceeding their MTs, the definition avoids significant and unreasonable effects for the Reduction of Groundwater Storage Sustainability Indicator. The Basin GSAs will strive through the use of PMAs to maintain water levels at or above the MOs, which are in all cases above the MTs.
Seawater Intrusion	Groundwater conditions in the Basin show that Seawater Intrusion is not present within the Basin and is not anticipated to be present in the future, and therefore the Sustainability Indicator is **not applicable to the Basin**.						

Sustainability Indicator	Undesirable Result (UR) Causes	Potential Effects on Beneficial Users	UR Definition	Minimum Threshold (MT) Definition	MT Justification	UR Criteria	UR Justification
Degraded Water Quality	Causes related to **hydraulic conditions potentially influenced by groundwater level management**: - **Lateral migration from adjacent areas** with poor quality groundwater, - **Releases from internal sources** such as fine-grained, clay-rich interbeds, - **Upwards vertical flow** from deeper zones below the bottom of the Basin, and - **Recharge** from spreading basins, injection wells, and other forms of intentional recharge.	**Increased costs to treat groundwater** to drinking water standards if it is to be used as a potable supply source. **Increased costs to blend** relatively poor-quality groundwater with higher quality sources for drinking water users. **Increased well construction costs** to deepen wells in search of higher quality water, or complete well rehabilitation to seal off poor water quality zones. **Reduced crop yields** because of higher irrigation water salinity and/or constituent concentrations that exceed plant sensitivity and toxicity levels. **Potential reduction in "usable storage" volume of groundwater** in the Basin if large areas are impaired to the point that they cannot be used to support beneficial uses and users.	**URs** for Degraded Water Quality would be experienced in the Basin when water quality conditions of the Principal Aquifer are degraded such that they negatively impact the long-term viability of the groundwater resource for beneficial users and uses **Significant and unreasonable effects** associated with URs would include an increase in concentrations of identified constituents of concern above levels of state and federal regulatory thresholds on a regional rather than well-specific basis**.**	**MTs are set at 14 RMW-WQs**, which is consistent with guidelines based on Basin area. MTs are set for the following three identified constituents of concern **based on regulatory thresholds for drinking water beneficial use set by US EPA and State of CA,** as follows: Arsenic: 10 ug/L (Primary MCL) Nitrate as N: 10 mg/L (Primary MCL) TDS: 1,000 mg/L (Secondary MCL upper limit)	**MTs were set for arsenic, nitrate, and TDS** because these constituents are(a) most likely to affect the beneficial uses and users of groundwater throughout the Basin, and (b) potentially influenced by groundwater level management actions under the purview of GSAs (see Causes of Undesirable Results). The State of CA and US EPA have set primary maximum contaminant levels (MCLs) for water quality constituents that may cause harm to human health, and secondary MCLs for constituents based on consumer acceptance (aesthetic) considerations. MTs were set based on their respective MCLs, as **MCLs are the water quality standards for the most sensitive beneficial use (i.e., drinking water).** The MOs for Degraded Water Quality are set at levels below the applicable MCLs. It should be noted that other State, federal, and local entities have greater authority than the GSAs to enforce water quality standards, especially for anthropogenic-derived pollutant constituents.	URs occur **when MTs for a constituent of concern are exceeded in 25% or more of the RMW-WQ (for example, the MTs for arsenic are exceeded in 4 out of the 14 RMW-WQ), because of SGMA-related groundwater management, for two (2) consecutive years**.	Groundwater management decisions can influence local well water quality while having little to no influence on overall basin water quality conditions and sustainability. The criteria of 25% or more of RMW-WQs exceeding their MTs is justified because it addresses the potential cumulative effects from management decisions on basin-scale water quality conditions, while conservatively **identifying a potential basin-scale rather than well-specific water quality issue**. Requiring two consecutive non-drought years of MT exceedances provides **confirmation that the degraded water quality is not drought related.**

Sustainability Indicator	Undesirable Result (UR) Causes	Potential Effects on Beneficial Users	UR Definition	Minimum Threshold (MT) Definition	MT Justification	UR Criteria	UR Justification
Land Subsidence	**Depressurization of aquifers and aquitards due to lowering of groundwater levels**, which can lead to compaction of compressible strata (clay) and lowering of the ground surface. Therefore, the causes of Undesirable Results due to Land Subsidence are the same as the potential causes listed above for Undesirable Results due toChronic Lowering of Groundwater Levels.	**Damage to critical infrastructure**, including gravity-driven water conveyance infrastructure (e.g., Folsom South Canal [FSC]), canals, municipal water lines and others that results in a loss of function or capacity of the infrastructure. Critical infrastructure also includes roadways, bridges and railroad tracks. **Damage to non-critical infrastructure** such as individual groundwater well heads, discharge lines, and casings.	**URs** would be experienced when land subsidence due to groundwater level declines in the Principal Aquifer negatively affects the ability to use existing critical or non-critical infrastructure within the Basin. **Significant and unreasonable effects** associated with URs would include subsidence-related damage to water conveyance infrastructure resulting in a loss of functional capacity of the infrastructure that prevents conveyance of available volumes of water that could otherwise be conveyed if the subsidence had not occurred.	**Groundwater levels are used as a proxy** for monitoring potential land subsidence. **No specific MTs are established for Land Subsidence**. Rather, the MTs established for Chronic Lowering of Groundwater Levels are deemed to be protective against Undesirable Results for Land Subsidence.	The MTs for Chronic Lowering of Groundwater Levels (discussed above) are set with consideration of beneficial uses and users, historical low groundwater levels, and an adequate timeframe for implementation of necessary PMAs to halt downward trends, if any. Based on the best available information, **significant subsidence has not occurred within the Basin** (see Section 9.5 *Land Subsidence*). Extrapolation of the measured historical subsidence rate at the one continuous GPS monitoring location 20-years into the future (i.e., the maximum time required to reach the established Groundwater Level MTs in the absence of any future PMAs) is only 1.7 inches, which is unlikely to negatively affect existing critical infrastructure within the Basin.	**No specific URs criteria are set for Land Subsidence**. Rather, the criteria established for Chronic Loweringof Groundwater Levels are deemed to be protective against Undesirable Results for Land Subsidence.	Given that there is no evidence that significant and unreasonable land subsidence has occurred in the Basin in the past, and that potential future subsidence under current/historical rates during the 20-year implementation horizon are also not significant and unreasonable, **definition of specific UR criteria for Land Subsidence is not applicable or necessary**. **Ongoing monitoring** of groundwater levels in the RMW-WL monitoring network, supplemented by available regional-scale subsidence monitoring data (i.e., DWR's InSAR datasets), will allow the GSA to monitor for and track potential subsidence, and to modify SMCs in the future, as necessary.

Sustainability Indicator	Undesirable Result (UR) Causes	Potential Effects on Beneficial Users	UR Definition	Minimum Threshold (MT) Definition	MT Justification	UR Criteria	UR Justification
Depletion of Interconnected Surface Water	**The same causes that contribute toURs due to Chronic Lowering of Groundwater Levels** (i.e.,increased groundwater pumping and reduced recharge; see above). **Additional causes directly related to surface water bodies** include: - hydrology (e.g., climate change), - increased diversions, - reduced return flows, and - water consumption by non-native vegetation.	**Impacts to beneficial uses and users of surface water**, including: - **Impacts on permitted diversions** from the Cosumnes River and Dry Creek due to reduced surface water flows. - **Impacts to environmental uses and users of surface water**, including Groundwater Dependent Ecosystems (GDEs) and surface flows required for fish migration.	**URs** would be experienced in the Basin when surface water depletions occur because of SGMA-related groundwater management activities such that they negatively impact the urban, domestic, agricultural, industrial, environmental, and other beneficial users and uses of surface water. **Significant and unreasonable effects** associated with URs would include depletions of surface water at a rate greater than the maximum pre-2015 historical rate of depletion during below-average rainfall years, and a reduction in GDE area, vigor and recruitment demonstrated by its correlation with groundwater level trends in the Principal Aquifer**.**	**MTs are set at nine (9) RMW-ISWs.** Two (2) wells are in the approximately 11-mile reach of the Cosumnes River that is assumed interconnected, four (4) wells are in the disconnected reach of the Cosumnes River, and three (3) wells are in the Basin Foothills Subarea and near creeks and streams in conservatively assumed GDE areas. Groundwater levels are used as a proxy for depletions of interconnected surface water. For the 2 RMW-ISWs along assumed interconnected Cosumnes River reaches: - MT set at the highest seasonal low elevation during below-average rainfall years from the start of monitoring through 2015. For the 4 RMW-ISWs on disconnected reaches: -Same approach employed for Chronic Lowering of Groundwater Levels MTs. For the 3 RMW-ISWs in assumed GDE areas: -MTs were set at 20 feet below ground surface.	**The Cosumnes River includes disconnected and interconnected reaches**. The timing and spatial extentof interconnected reach is considereda data gap, and the assumed interconnected reach was identified using various information, including comparing groundwater level elevations in shallow wells to the elevation of the bottom of the streambed (where data were available), model results, and satellite imagery. MTs for RMW-ISWs along the assumed interconnected reach are established by using seasonal-low groundwater elevations over the period of record through 2015 to **prevent depletions that are greater than the maximum that occurred prior to 2015**. MTs for RMW-ISWs along disconnected reaches employ the same justification as MTs for Chronic Lowering of Groundwater Levels, which considers historical lows and a 20-year trend extension for RMW- ISWs with declining trends. A 20-year trend extension allows the GSAs reasonable and sufficient time to implement PMAs to halt trends and is consistent with the period in which the Basin is required to achieve its Sustainability Goal. MTs for RMW-ISWs in assumed GDE areas are conservatively set to a depth that is 10 feet above the lower limit recommended by TNC (natural communities are disconnected from the Principal Aquifer where depth to water is greater than 30 ft bgs) (TNC, 2018).	URs occur **when MTs are exceeded in one or more RMW-ISW (1 of 9), because of SGMA-related groundwater management, for two (2) consecutive years**.	The UR definition is set to be consistent with and protective against the significant and unreasonable effects. Requiring two consecutive non-drought years of MT exceedances provides confirmation that the depletion of interconnected surface water is not drought related, consistent with the definition of Undesirable Results in CWC 10721(x)(1).

Abbreviations:

AF = acre-feet
CoSANA = Cosumnes, South American, and North American
DWR = Department of Water Resources
EPA = Environmental Protection Agency
ET = Evapotranspiration
FSC = Folsom South Canal
GDE = Groundwater Dependent Ecosystems
GPS = Global Positioning System
GSA = Groundwater Sustainability Agency
InSAR = Interferometric Synthetic Aperture Radar
ISW = Interconnected Surface Water
MAF = million acre-feet
MCL = Maximum Constituent Level
MO = Measurable Objective
MT = Minimum Threshold
PMA = Project and Management Action
RMW = Representative Monitoring Well
SGMA = Sustainable Groundwater Management Act
SMC = Sustainable Management Criteria
TDS = Total Dissolved Solids
TNC = The Nature Conservancy
UR = Undesirable Results
WL = Water Level
WQ = Water Quality

13. SUSTAINABILITY GOAL

> *§ 354.24 Sustainability Goal*
> *Each Agency shall establish in its Plan a sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline. The Plan shall include a description of the sustainability goal, including information from the basin setting used to establish the sustainability goal, a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon.*

Sustainable Groundwater Management Act (SGMA) requires that a Sustainability Goal be defined for each medium- or high-priority basin (California Water Code [CWC] §10727(a)). The Groundwater Sustainability Plan (GSP) Regulations further clarify that the Sustainability Goal should culminate "in the absence of undesirable results within 20 years of the applicable statutory deadline" (23 California Code of Regulations [CCR] § 354.24).

The Sustainability Goal of the Cosumnes Subbasin (Basin) is to ensure that groundwater in the Basin continues to be a long-term resource for beneficial users and uses including urban, domestic, agricultural, industrial, environmental and others. This goal will be achieved by managing groundwater within the Basin's sustainable yield, as defined by sustainable groundwater conditions and the absence of undesirable results.

14. UNDESIRABLE RESULTS

§ 354.26. Undesirable Results

(a) Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.

(b) The description of undesirable results shall include the following:

(1) The cause of groundwater conditions occurring throughout the basin that would lead to or has led to undesirable results based on information described in the basin setting, and other data or models as appropriate.

(2) The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for each applicable sustainability indicator. The criteria shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.

(3) Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.

(c) The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.

(d) An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.

Undesirable Results are defined in Sustainable Groundwater Management Act (SGMA) as when "significant and unreasonable" effects for any of the sustainability indicators are "caused by groundwater conditions occurring throughout the basin" (California Water Code [CWC] §10721(x)). This section describes the specific Undesirable Results (URs) definitions for each applicable Sustainability Indicator that have been developed by the Groundwater Sustainability Agencies (GSAs) for the Cosumnes Subbasin (Basin). As discussed below, and indicated in *italicized text*, the quantitative criteria for determining Undesirable Results (URs) refer to exceedances of the Minimum Thresholds (MTs) that have been established within the Basin (see Section 15 *Minimum Thresholds*).

14.1. Undesirable Results for Chronic Lowering of Groundwater Levels

Per SGMA, an UR for the Chronic Lowering of Groundwater Levels means a "chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon" (CWC § 10721(x)). However, it is important to note that SGMA also states that "[o]verdraft 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" (CWC § 10721(x)(1)).

The UR for Chronic Lowering of Groundwater Levels is defined herein as follows:

> *Undesirable Results would be experienced when a chronic decline in groundwater levels in the Principal Aquifer negatively affects the long-term viable access to groundwater for urban, domestic, agricultural, industrial, and other beneficial users and uses within the Basin.* (Note that Environmental beneficial users are addressed in Section 14.6 *Undesirable Results for Depletions of Interconnected Surface Water*).
>
> *Significant and Unreasonable effects associated with Undesirable Results occur when the number of completely dewatered domestic wells exceeds the assumed natural well replacement rate projected to occur over the 20-year implementation horizon.*

The primary[73] beneficial users of groundwater from the Principal Aquifer are groundwater pumpers. Pumping for agricultural purposes is currently the greatest use of groundwater, but domestic wells are greatest in number and generally shallowest in depth. Hence, the GSAs have determined that significant and unreasonable effects will occur if the number of completely dewatered domestic wells exceeds the assumed natural well replacement rate projected to occur over the 20-year GSP implementation horizon (i.e., 26% of existing domestic wells in the Basin are at least 40 years old and would likely have to be replaced or rehabilitated due to age)[74]. Therefore, it cannot be considered "significant and unreasonable" if fewer wells in the Basin were impacted due to chronic lowering of groundwater levels in the Principal Aquifer than the assumed natural well replacement rate (26%).

14.1.1. Potential Causes of Undesirable Results

Potential causes of URs related to Chronic Lowering of Groundwater Levels could include increased pumping and/or reduced recharge.

Because the current primary use of groundwater in the Basin is for agricultural purposes, increased groundwater pumping could occur if water use per acre on irrigated land increases or if new land is put into agricultural production. Similarly, although groundwater pumping for urban uses is a relatively small share of overall pumping in the Basin, additional urban development (expected within the Basin) could lead to an increase in groundwater use.

Reduced recharge could occur due to increased urbanization and agricultural irrigation efficiency climate change which could cause decreased precipitation, and/or increased evapotranspiration (ET), decreased surface water inflows from contributing watersheds, and/or reduced cross-boundary flows.

[73] Environmental beneficial users of groundwater are addressed related to the Deletion of Interconnect Surface Water Sustainability Indicator as their reliance on the Principal Aquifer is highly uncertain. The shallow groundwater levels near interconnected surface water and the groundwater dependent ecosystem areas (GDEs) are influenced by stage, the exchange of surface- and groundwater, recharge and pumping. As a result, the shallow groundwater levels can be poorly correlated with the groundwater levels at greater depths and greater distances from surface water, and the protection of interconnected surface water relies on its own monitoring network and criteria.

[74] Similar studies have assumed 20-33 years as the lifespan of a well (i.e., wells older than 40 years have been excluded from impacts analysis); therefore using 40 years is a conservative approach as more wells are included (Pauloo et al, 2021).

14.1.2. Potential Effects of Undesirable Results

The primary potential effects of URs caused by Chronic Lowering of Groundwater Levels on beneficial uses and users of groundwater in the Basin is groundwater well dewatering. Well dewatering can be detrimental to wells as it can lead to increased maintenance costs (e.g., well rehabilitation/redevelopment/deepening and/or pump lowering) and reduced well lifespan due to corrosion of well casings and screens. A well impact analysis was conducted as part of MT development (see Section 15.1.2 *Domestic Well Impact Analysis*).

Additional potential effects include increased pumping lift and effects on correlated Sustainability Indicators. Increased pumping lift results in more energy use necessary per unit volume of groundwater pumped and corresponding higher pumping costs, as well as increased wear and tear on well pump motors and reduced well efficiency. Correlated Sustainability Indicators include groundwater storage, land subsidence, and potentially depletion of interconnected surface waters, and degraded water quality, each of which is discussed below and were considered in developing the Sustainable Management Criteria (SMCs) for the Basin.

14.1.3. Criteria Used to Define Undesirable Results

As discussed further below in Section 15 *Minimum Thresholds* the MTs for groundwater levels have been established at 19 Representative Monitoring Wells for Chronic Lowering of Groundwater Levels (RMW-WLs) by considering historical groundwater levels and trends, well depths (i.e., in relation to impacts to groundwater pumpers as one major class of beneficial users), and other potential sensitive beneficial uses/users. Per Section 354.26(b)(2) of the Groundwater Sustainability Plan (GSP) Regulations, the description of URs must include the criteria used to define when and where the effects of groundwater conditions cause URs, based on a quantitative description of the combination of MT exceedances that cause significant and unreasonable effects in the Basin.

Based on the significant and unreasonable effects described above, the criteria for URs for Chronic Lowering of Groundwater Levels are as follows:

> *Undesirable Results occur when MTs are exceeded in 25% or more of the RMW-WLs (5 out of 19), because of SGMA-related groundwater management, for two (2) consecutive years.*

The above criteria are justified based on results from a domestic well impact analysis which showed that approximately 2% of all existing domestic wells within the Basin would be completely dewatered if water levels in all RMW-WLs reached their MTs, and 4% would be partially dewatered (see Section 15.1.2 *Domestic Well Impact Analysis*). This number of completely and/or partially dewatered domestic wells is well below the 26% of wells that are likely to require replacement over the next 20-years based on well age and lifespan. Furthermore, the number of domestic wells that would be completely dewatered at the point where only 25% of RMW-WLs reach their MTs is likely much less than 2% and 4%, respectively, based on the unlikely occurrence that all RMW-WLs reach their MTs. Thus, the criteria limit domestic well impacts to a small fraction of the wells within the Basin and therefore avoid significant and unreasonable effects.

The component of the criteria requiring more than two consecutive years of MT exceedances provides for confirmation that the chronic lowering of groundwater levels is persistent, consistent with the definition of URs for this Sustainability Indicator in CWC 10721(x)(1). As discussed in Section 18 *Projects and Management Actions*, the Basin GSAs will strive through the use of Projects and Management Actions (PMAs) to maintain water levels at or above the Measurable Objectives (MOs), which are in all cases above the MTs.

14.2. Undesirable Results for Reduction of Groundwater Storage

Per SGMA, an UR for the Reduction of Groundwater Storage means a “significant and unreasonable reduction of groundwater storage” (CWC § 10721(x)(1)). The UR for Reduction of Groundwater Storage is defined herein as follows:

> *Undesirable Results would be experienced when a reduction in storage in the Principal Aquifer negatively affects the long-term viable access to groundwater for the urban, domestic, agricultural, industrial, and other beneficial users and uses within the Basin.*
>
> *Significant and unreasonable effects associated with Undesirable Results would include reduction in usable groundwater storage of more than 10% over the 20-year implementation horizon, based on the estimated Fall 2018 groundwater storage volume.*

14.2.1. Potential Causes of Undesirable Results

Reduction of Groundwater Storage is directly correlated to Chronic Lowering of Groundwater Levels. Therefore, the potential causes of URs due to Reduction in Groundwater Storage are generally the same as the potential causes listed above for URs due to Chronic Lowering of Groundwater Levels (i.e., increased groundwater pumping and reduced recharge). Because of the direct correlation between groundwater elevation and groundwater storage volume, groundwater levels are used to measure conditions for this sustainability indicator.

14.2.2. Potential Effects of Undesirable Results

The primary potential effect of URs caused by Reduction of Groundwater Storage on beneficial uses and users of groundwater in the Basin would be reduced groundwater supply reliability. Since groundwater supplies most users in the Basin, most beneficial users would be affected. The effect would be most significant during periods of reduced recharge due to drought conditions, regulatory restrictions, natural disasters, or other causes. However, as discussed in Section 15.2 *Minimum Threshold for Reduction of Groundwater Storage,* significant, usable, stored groundwater is present within the Basin, and so these effects are unlikely to occur over the GSP implementation horizon.

14.2.3. Criteria Used to Define Undesirable Results

The criteria used to define URs for Reduction of Groundwater Storage are consistent with the criteria used to define URs for Chronic Lowering of Groundwater Levels. Based on the significant and unreasonable effects described above, the criteria for URs for Reduction of Groundwater Storage are as follows:

Undesirable Results occur when MTs are exceeded in 25% or more of the RMW-WLs (5 out of 19) because of SGMA-related groundwater management for two (2) consecutive years.

The above criteria are justified based on calculations of the usable storage volume in the Basin (approximately 11.7 million acre-feet [MAF] above the 400 foot [ft] average well depth) and the volume of storage depletion that would occur if groundwater levels declined from 2018 elevations to the Chronic Lowering of Groundwater Levels MTs (approximately 400,000 acre-feet [AF]). These calculations indicate that if all RMW-WLs were to decline to their Chronic Lowering of Groundwater Levels MTs, the percent of usable storage in the Basin would decrease by approximately 3.4%, which is much less than the level deemed to be significant and unreasonable (10%). As such, the criteria set for Chronic Lowering of Groundwater Levels are considered protective against significant and unreasonable effects for Reduction of Groundwater Storage, and thus serve as a reasonable proxy.

14.3. Undesirable Results for Seawater Intrusion

The GSP Regulations state “An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators” (23- CCR § 354.26(d)).

The Basin is not directly connected to the Pacific Ocean, although its western boundary is adjacent to the Sacramento-San Joaquin Delta (the “Delta”) which is influenced by the Pacific Ocean. As described in Groundwater Conditions Section 9.3 *Seawater Intrusion*, significant and unreasonable effects from seawater intrusion are not present in the Basin and not likely to occur. The Seawater Intrusion Sustainability Indicator is therefore not applicable to the Basin and URs for this Sustainability Indicator have not been defined.

14.4. Undesirable Results for Degraded Water Quality

SGMA defines an UR for Degraded Water Quality as “significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies” (CWC § 10721(x)). The UR for Degraded Water Quality is defined herein as follows:

Undesirable Results for Degraded Water Quality would be experienced in the Basin when water quality conditions of the Principal Aquifer are degraded such that they negatively impact the long-term viability of the groundwater resource for beneficial users and uses.

Significant and unreasonable effects associated with Undesirable Results would include an increase in concentrations of identified constituents of concern above levels of state and federal regulatory thresholds on a regional rather than well-specific basis.

The component of the significant and unreasonable effects definition regarding a regional basis draws a distinction between local (e.g., well specific) effects, that are not generally under the purview of the GSAs to manage, and broader effects which are under a GSA’s purview, consistent with the SGMA’s definition of URs meaning “…effects caused by groundwater conditions occurring throughout the basin” (CWC §

10721(x)). However, as discussed below in Section 16.4 *Measurable Objective and Interim Milestones for* Degraded Water Quality, “trigger thresholds” are employed at each RMW-WQ to notify GSAs of water quality changes that may require investigation as part of Basin management activities.

The above definition of significant and unreasonable effects also recognizes the fact that SGMA does not require GSPs to address URs that occurred before and have not been corrected by January 1, 2015. (CWC § 10727.2(b)(4)).

It should be noted that regulatory oversight authority for drinking water quality rests with the State Water Resources Control Board (SWRCB), not with the GSAs, and therefore general measures to address drinking water quality served to the public in accordance with the Human Right to Water Policy[75] are beyond the purview of this GSP. Those regulatory oversight and enforcement actions have and will occur on their own mandated timelines. Water quality issues related to deep percolation of agricultural chemicals such as nitrate are also regulated separately under the Regional Water Quality Control Board’s (RWQCB’s) Irrigated Lands Reporting Program (ILRP). The GSAs will continue to coordinate with these entities and programs in the collection, sharing and analysis of applicable data.

14.4.1. Potential Causes of Undesirable Results

The URs due to Degraded Water Quality are caused by increases in concentration of constituents of concern (COCs) in the Principal Aquifer. These increases in concentration can occur through a variety of processes, some of which could be caused by groundwater management activities. The processes related to groundwater management could include:

- Lateral migration from adjacent areas with poor quality groundwater;
- Release of constituents from internal sources such as fine-grained, clay-rich interbeds;
- Upwards vertical flow from deep zones below the bottom of the Basin; and,
- Intentional recharge from projects (e.g., spreading basins, injection wells, etc).

Additional potential causes of URs for Degraded Water Quality which are not related to groundwater level management activities under the authority of GSAs include:

- Deep percolation of precipitation;
- Leakage from natural and man-made channels; ponds, and reservoirs;
- Irrigation system backflow into wells and flow through well gravel packs and screens from one formation to another; and,
- Deep percolation of irrigation water and other water applied for cultural practices (e.g., for soil

[75]The SWRCB describes the Human Right to Water Policy as “every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes.” The SWRCB publishes a list of public water systems “that do not have, or are at risk of not having, safe, clean, affordable, and accessible water for drinking, cooking, and sanitary purposes.“ None of the public water systems in the basin are listed as being at risk. https://www.waterboards.ca.gov/water_issues/programs/hr2w/

leaching), and recharge from septic system discharge.

In the case of deep percolation of irrigation water and leaching from soils, such activities are regulated separately under CVRWQCB's ILRP.

14.4.2. Potential Effects of Undesirable Results

The potential effects of URs caused by Degraded Water Quality on beneficial uses and users of groundwater may include: decreased availability to usable potable water; increased costs to treat groundwater to drinking water standards if used as a potable supply source; increased costs to blend relatively poor-quality groundwater with higher quality sources for drinking water users; and potential reduction in "usable storage" volume of groundwater in the Basin if large areas are impaired to the point that they cannot be used to support beneficial uses and users.

As discussed in Section 17.1.4 *Monitoring Network for Degraded Water Quality*, the RMW-WQs consist of Public Water System (PWS) wells, which are already regularly monitored, and other potable- and non-potables wells (e.g., agricultural and domestic supply wells) that are representative of the beneficial uses of groundwater in the Basin. As further discussed in Section 5.2.1 *Existing Monitoring and Management Programs*, periodic monitoring for groundwater quality is also routinely conducted across the Basin as part of other programs (e.g., Groundwater Ambient Monitoring and Assessment [GAMA] program, the ILRP, and the Buena Vista Rancheria Me-Wuk Indians groundwater monitoring program). These groundwater quality monitoring programs are expected to continue during the GSP implementation horizon and will be incorporated into future SGMA-related reporting and analysis. Furthermore, consideration of all of the above programs and their objectives was included as part of SMC development.

14.4.3. Criteria Used to Define Undesirable Results

As discussed further below in Section 15 *Minimum Thresholds* and in Section 17 *Monitoring Network,* the MTs for Degraded Water Quality are established in 14 Representative Monitoring Wells for Water Quality (RMW-WQ). As discussed in Section 0

Groundwater Quality Concerns, most wells in the Basin have limited groundwater quality data. The limited spatial extent and temporal frequency of the available groundwater quality data make analysis of water quality trends and their potential nexus to groundwater elevations and/or groundwater management actions in the Basin difficult. Additional data collection and analysis will be needed to confirm the validity and consistency, both in space and over time, of potential relationships. Therefore, until additional groundwater level and groundwater quality information is available to refine this definition, URs are based on criteria defined for a select number of potential COCs at the RMW-WQs.

Based on the significant and unreasonable effects described above, the criteria for UR for Degraded Water Quality are as follows:

> *Undesirable Results occur when MTs for a constituent of concern are exceeded in 25% or more of the RMW-WQ (for example, the MTs for arsenic are exceeded in 4 out of the 14 RMW-WQ), because of SGMA-related groundwater management, for two (2) consecutive years.*

The above criteria are justified because they relate to a level of impact (25% of RMW-WQs) that corresponds to a regional, rather than a well-specific, water quality issue. Similar to the criteria for Chronic Lowering of Groundwater Levels, the component of the criteria requiring more than two consecutive years of MT exceedances provides for confirmation that the degraded water quality conditions persistent. As discussed below in Section 16.4 *Measurable Objective for Degraded Water Quality*, "trigger thresholds" are employed at each RMW-WQ to notify GSAs of local water quality changes that may require investigation as part of Basin management activities.

14.5. Undesirable Results for Land Subsidence

SGMA defines an UR for Land Subsidence as "significant and unreasonable land subsidence that substantially interferes with surface land uses" (CWC § 10721(x)).

The UR for Land Subsidence is defined herein as follows:

> *Undesirable Results would be experienced when land subsidence due to groundwater level declines in the Principal Aquifer negatively affects the ability to use existing critical or non-critical infrastructure within the Basin.*
>
> *Significant and unreasonable effects associated with Undesirable Results would include subsidence-related damage to water conveyance infrastructure resulting in a loss of functional capacity of the infrastructure that prevents conveyance of available volumes of water that could otherwise be conveyed if the subsidence had not occurred.*

The above definition of significant and unreasonable effects is developed recognizing that small amounts of subsidence could occur without negatively affecting the ability to use the critical infrastructure, and that only to the extent that subsidence causes a loss of functional capacity does it qualify as significant and unreasonable.

14.5.1. Potential Causes of Undesirable Results

Land subsidence can be caused by several mechanisms, but the mechanism most relevant to groundwater management activities under the authority of GSAs is the depressurization of aquifers and aquitards due to lowering of groundwater levels, which can lead to compaction of compressible strata and lowering of the ground surface. Therefore, the potential causes of URs due to Land Subsidence are generally the same as the potential causes listed above for URs due to Chronic Lowering of Groundwater Levels (i.e., increased pumping and/or reduced recharge).

14.5.2. Potential Effects of Undesirable Results

Potential effects of URs caused by land subsidence could include damage to critical infrastructure, including gravity-driven water conveyance infrastructure (e.g., the Folsom South Canal [FSC]), canals, municipal water lines and others. Critical infrastructure also includes roadways, bridges and railroad tracks. Potential effects could also include damage to other non-critical infrastructure such as groundwater well heads, discharges, casings, roadways and bridges.

14.5.3. Criteria Used to Define Undesirable Results

As discussed in Section 9.5 *Land Subsidence,* measured vertical displacement in the Basin has been minor to date indicating that land subsidence and damage to critical infrastructure is not a significant concern in the Basin, based on the best available information. Furthermore, given that land subsidence and lowering of groundwater levels are closely related, it is reasonable to expect that given continued trends in groundwater levels there would be continued trends in observed subsidence rates. Based on extrapolation of the observed rate of subsidence at the one continuous global positioning system (GPS) monitoring location in the Basin, if the rate were allowed to continue for 20 years (i.e., the maximum time allowable for continuation of declining groundwater level trends by the established Chronic Lowering of Groundwater Level MTs), additional subsidence would amount to only approximately 1.7 inches, which is not likely to negatively affect the use of existing infrastructure within the Basin. The MTs for Chronic Lowering of Groundwater Levels are therefore expected to prevent significant and unreasonable effects from land subsidence in the Basin. As such, specific MTs and specific UR criteria for land subsidence have not been defined at this time.

Publicly available subsidence data will continue to be evaluated as part of GSP implementation. Should any indication of subsidence begin to be observed in the Basin, that issue will be addressed in future GSP updates, as needed.

14.6. Undesirable Results for Depletions of Interconnected Surface Water

SGMA defines an UR for Depletions of Interconnected Surface Water as “Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water” (CWC § 10721(x)). The UR for Depletions of Interconnected Surface Water is defined as follows:

> *Undesirable Results would be experienced in the Basin when surface water depletions occur because of SGMA-related groundwater management activities such that they negatively impact the urban, domestic, agricultural, industrial, environmental, and other beneficial users and uses of surface water.*
>
> *Significant and unreasonable effects associated with Undesirable Results would include depletions of surface water at a rate greater than the maximum pre-2015 historical rate of depletion during below-average rainfall years, and a reduction in GDE area, vigor and recruitment demonstrated by its correlation with groundwater level trends in the Principal Aquifer.*

The above definition of significant and unreasonable effects recognizes the fact that SGMA does not require GSPs to address URs that occurred before and have not been corrected by January 1, 2015. (CWC § 10727.2(b)(4)). Moreover, given that quantitative descriptions of the hydraulic connections between the Principal Aquifer and surface water (and GDE areas) are limited, the UR definition for Depletion of Interconnected Surface Water is considered preliminary, and can be revisited during GSP implementation when more data are available (for example, during the GSP five-year updates).

14.6.1. Potential Causes of Undesirable Results

Depletion of Interconnected Surface Water can occur from reduced recharge, changes to runoff characteristics, increased diversions, reduced return flows, transpiration by non-native vegetation and increased evaporation, and potentially increases in groundwater pumping. Quantitative data are currently limited regarding the impacts from these contributing causes to depletions of surface water features (or impacts to GDE areas) within the Basin.

14.6.2. Potential Effects of Undesirable Results

Potential effects of URs from Depletion of Interconnected Surface Water may include impacts to beneficial users of surface water and groundwater. Reduced surface flows can negatively affect permitted diversion points from both the Cosumnes River and Dry Creek. Moreover, environmental users of surface water may be impacted by reduced flows, including surface flows required for fish migration and moisture within the rooting depths of groundwater dependent vegetation. Accordingly, beneficial users of surface water and groundwater, where the groundwater levels in the Principal Aquifer is near ground surface, were both considered by the SMC development for Interconnected Surface Water.

14.6.3. Criteria Used to Define Undesirable Results

As discussed further below in Section 15 *Minimum Thresholds* and in Section 17 *Monitoring Network,* the MTs for Interconnected Surface Water are established at nine (9) Representative Monitoring Wells for Interconnected Surface Water (RMW-ISWs). As discussed in Section 9.6 *Interconnected Surface Water Systems* the best available information indicates that the surface water streams include disconnected and interconnected reaches and that in the potential GDE areas, groundwater levels are highly variable.

Most of the Cosumnes River and other surface water features in the Basin (for example, Dry Creek) are disconnected from the Principal Aquifer, but likely become connected at lower elevations in the westernmost portion of the Basin, at least for part of some years. For example, available data indicate that portions of the Cosumnes River west of its confluence with Deer Creek may be temporarily interconnected for one or more months during some years (but not all), and for less than the entire year. The westernmost reach of the Cosumnes River is understood to be more regularly interconnected. For the purpose of establishing SMCs, these areas of the Basin are conservatively considered to have “interconnected surface water,” at least for brief time periods, but the actual relationships between surface water and the water table in the underlying Principal Aquifer is complex and considered a data gap in the GSP.

Detailed investigation of available vegetation mapping data sets (e.g., Natural Communities Commonly Associated with Groundwater [NCCAG]) and field investigation identified GDE areas in the Basin Plain and Basin Foothills subareas (**Appendix L**). The investigation confirmed 1,810 acres of GDEs areas (or assumed confirmed when some evaluation criteria were incomplete) in the westernmost portion of the Basin Plain Subarea and where surface water and groundwater are assumed interconnected (see **Figure GWC-17**). About 4,000 acres in the Basin Foothills Subarea have unknown GDE status because of one or more significant data gaps, the most influential being the absence of shallow well data to confirm the water table in the Principal Aquifer is accessible to plant roots, and the areas are conservatively assumed to be

GDEs. The remaining areas were not considered GDEs owing to the substantial depths to the water table, or because the vegetation relies on surface water or perched groundwater.

As the GSAs work to fill data gaps, the SMCs for interconnected surface water can be revised. As described below in Section 15.6 *Minimum Threshold for Depletions of Interconnected Surface Water*, different methodologies are used to calculate the MT for the different types of reaches; however, the criteria used herein to define an Undesirable Result refers to the entire RMW-ISW network. Based on the significant and unreasonable effects described above, the criteria for URs for Depletions of Interconnected Surface Water are as follows:

> *Undesirable Results occur when MTs are exceeded in one or more RMW- ISW (1 of 9), because of SGMA-related groundwater management, for two (2) consecutive years.*

The above criteria are justified as they conservatively assume that the amount of depletion associated with the exceedance of any MT in the RMW-ISW network would constitute a significant and unreasonable effect by way of a negative impact to the beneficial users and uses of surface water and groundwater (a conservative assumption that is not necessarily proven based on the best available information). Like the criteria for Chronic Lowering of Groundwater Levels, the component of the criteria requiring more than two consecutive years of MT exceedances provides for confirmation that the depletions associated with an exceedance of an MT in the RMW-ISW network are persistent.

14.7. Undesirable Results Summary

Table SMC-2 below provides a summary of the criteria for URs for each Sustainability Indicator.

Table SMC-2. Summary of Undesirable Results Criteria

Sustainability Indicator	Undesirable Results Criteria
Chronic Lowering of Groundwater Levels	Undesirable Results occur when MTs are exceeded in 25% or more of the RMW-WLs (5 out of 19), because of SGMA related groundwater management, for two (2) consecutive years.
Reduction of Groundwater Storage	MT exceedance for Chronic Lowering of Groundwater Levels used as a proxy.
Seawater Intrusion	Sustainability Indicator not applicable within the Basin; URs criteria are not given.
Degraded Water Quality	Undesirable Results occur when MTs for a constituent of concern are exceeded in 25% or more of the RMW-WQ (for example, the MTs for arsenic are exceeded in 4 out of the 14 RMW-WQ), because of SGMA-related groundwater management, for two (2) consecutive years.
Land Subsidence	MT exceedance for Chronic Lowering of Groundwater Levels used as a proxy.
Depletion of Interconnected Surface Water	Undesirable Results occur when MTs are exceeded in one or more RMW-ISW (1 of 9), because of SGMA-related groundwater management, for two (2) consecutive years.

Abbreviations:
MT = Minimum Threshold
RMW-ISW = Representative Monitoring Well for Interconnected Surface Water
RMW-WL = Representative Monitoring Well for Chronic Lowering of Groundwater Levels
RMW-WQ = Representative Monitoring Well for Degraded Water Quality
SGMA = Sustainable Groundwater Management Act

15. MINIMUM THRESHOLDS

§ 354.28. Minimum Thresholds

(a) Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26.

(b) The description of minimum thresholds shall include the following:

(1) The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.

(2) The relationship between the minimum thresholds for each sustainability indicator, including an explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.

(3) How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.

(4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.

(5) How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.

(6) How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.

Minimum Thresholds (MTs) are the numeric criteria for each Sustainability Indicator that, if exceeded, may cause Undesirable Results (URs) for that indicator or for other indicators by proxy. This section describes the MTs that have been developed to avoid URs for each applicable Sustainability Indicator in the Cosumnes Subbasin (Basin).

Table SMC-3 shows the spatial scale at which MTs are defined for each Sustainability Indicator. The MTs within the Basin are defined, as applicable, at representative monitoring wells (RMW) for water levels (RMW-WL), water quality (RMW-WQ) and interconnected surface water (RMW-ISW). Where appropriate, the MTs for the Sustainability Indicators have been set using groundwater levels as a proxy, based on demonstration “that there is a significant correlation between groundwater levels and the other metrics” (California Department of Water Resources [DWR] Sustainable Management Criteria Best Management Practices [BMP] document; DWR, 2017). Additional monitoring for each Sustainability Indicator (in addition to planned monitoring at the RMWs) is described in Section 17 *Monitoring Network*.

Table SMC-3. Spatial Scale of Minimum Threshold Definition

Sustainability Indicator	Minimum Threshold Metric(s) defined in GSP Regulations (CCR § 354.28(c))	Sites for Minimum Threshold Compliance
Chronic Lowering of Groundwater Levels	Groundwater elevation	19 RMW-WLs
Reduction of Groundwater Storage	Total volume of groundwater	19 RMW-WLs *(Chronic Lowering of Groundwater Levels used as a proxy)*
Seawater Intrusion	Chloride concentration isocontour	No MTs defined. Sustainability Indicator not applicable to the Basin.
Degraded Water Quality	- Number of supply wells - Volume of groundwater - Location of isocontour	14 RMW-WQs
Land Subsidence	Rate and extent of land subsidence	19 RMW-WLs *(Chronic Lowering of Groundwater Levels used as a proxy)*
Depletion of Interconnected Surface Water	Rate or volume of surface water depletions	9 RMW-ISWs

Abbreviations:
CCR = California Code of Regulations
GSP = Groundwater Sustainability Plan
MT = Minimum Threshold
RMW-ISW = Representative Monitoring Well for Interconnected Surface Water
RMW-WL = Representative Monitoring Well for Chronic Lowering of Groundwater Levels
RMW-WQ = Representative Monitoring Well for Degraded Water Quality

15.1. Minimum Threshold for Chronic Lowering of Groundwater Levels

§ 354.28. Minimum Thresholds

(c) Minimum thresholds for each sustainability indicator shall be defined as follows:
(1) Chronic Lowering of Groundwater Levels. The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Minimum thresholds for chronic lowering of groundwater levels shall be supported by the following:
(A) The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.
(B) Potential effects on other sustainability indicators.

Chronic Lowering of Groundwater Levels is arguably the most fundamental Sustainability Indicator, as it influences several other key Sustainability Indicators, including Reduction of Groundwater Storage, Land

Subsidence, and potentially Depletions of Interconnected Surface Water and Degraded Water Quality. Groundwater levels are also the most readily available and measurable metrics of groundwater conditions, which allows for a systematic, data-driven approach to development of MTs. There are no local, state or federal standards that relate to the Chronic Lowering of Groundwater Levels Sustainability Indicator.

15.1.1. Minimum Threshold Development

Consistent with the GSP Regulations (23-CCR § 354.28(c)), the definition of MTs for Chronic Lowering of Groundwater Levels is based on consideration of model-calculated historical trends in groundwater levels, model-calculated historical low groundwater levels, water year types, projected water use in the Basin, and its relationships to other Sustainability Indicators[76]. Specifically, the information and criteria relied on to establish the MTs for Chronic Lowering of Groundwater Levels includes:

- Long-term water level trends from selected wells (RMW-WLs);
- Historical low groundwater levels; and
- Well construction information (i.e., for consideration of impacts to beneficial users).

The approach used to establish MTs, discussed below, allowed for the most complete and representative historical water level information to inform the MTs, while also allowing for potentially different wells (i.e., other than those with the best historical records like, for example, recently constructed high-quality monitoring well sites) to be used as RMWs.

Minimum Threshold Determination

Minimum Thresholds for Chronic Lowering of Groundwater Levels were developed using a multi-step process that included evaluation of model-calculated historical groundwater elevation data, projected trends, and analysis of potential impacts to domestic wells. Initial MT estimates were developed for each RMW-WL location, as follows:

- Model-calculated recent/historical trends in groundwater levels and projected water use are addressed by extending the trend for 20 years (the "Trend Extension Period"). The rationale for this approach is to allow time for implementation of any Projects and Management Actions (PMAs) that may be needed to manage declining trends, and thereby avoid potential rapid disruption to land uses.
    - The time period for water level trend calculation is defined as Water Year (WY) 1999 – 2018. The period includes the recent significant drought (WY 2012-2016),

[76] The MT for Chronic Lowering of Groundwater Levels was determined from water levels during 1999-2018. However, the measured water level data sets available for the representative monitoring wells are incomplete, and some wells have no data during the 1999-2018 period. To fill in the missing data and minimize potential bias in water level magnitudes and trends owing to the data set variability between wells, the MTs are based on model-calculated water levels. This approach is considered reasonable because it reduces the potential biases that can result from variability in the water level data between wells and the differences in the sequence of hydrologic Water Year types the individual data sets represent.

and therefore considers the effects from potential future long-term droughts.

- The Trend Extension Period was set to 20 years for the following reasons:
    - Twenty years is considered reasonable and necessary to implement the various PMAs that may be required to address declining groundwater level trends considering the potential regulatory, environmental, logistical, engineering, socioeconomic and other challenges that PMA implementation may involve, as well as the time required to measure the groundwater system response to such actions; and
    - Twenty years is the length of the Sustainable Groundwater Management Act (SGMA) implementation period, by which time the Basin must achieve the Sustainability Goal. Hence, there is no justification or need for aa longer Trend Extension Period.

- For wells with a negative (i.e., downwards) trend, the initial MTs were set at the 20-year trend-projected water levels.
- For wells with positive (i.e., upward) trends and wells with 20-year trend-projected water levels greater than the Measurable Objectives (MOs) (discussed below in Section 16 *Measurable Objectives and Interim Milestones*), the initial MTs were set at the Historical Low groundwater levels, based on the fact that significant and unreasonable impacts to beneficial uses and users of groundwater due to historical low groundwater levels , based on the best available information.

Figure SMC-1 presents the hydrographs that were used to determine the MTs, which are evaluated for potential effects on beneficial users below.

15.1.2. Domestic Well Impact Analysis

By design, the RMW-WLs were chosen to be representative of groundwater levels in their portion of the Principal Aquifer as discussed in Section 17.1.1 *Monitoring Network for Chronic Lowering of Groundwater Levels.* As shown in **Figure SMC-2**, water level changes observed in an RMW-WL would also be expected to occur at nearby wells and potential impacts to those wells (e.g., dewatering) could occur depending on the levels and the well construction details. Because domestic wells are greatest in number and generally shallowest in depth, a domestic well impact analysis was conducted to evaluate the potential for well dewatering that could occur at the chosen MTs to ensure that conditions associated with the MTs would not constitute significant and unreasonable effects to this sensitive beneficial user. As discussed previously, environmental beneficial users and uses are addressed in Section 14.6 *Undesirable Results for Depletions of Interconnected Surface Water* which addresses shallow groundwater conditions in the Basin.

The well impact analysis relied on well construction information from the Department of Water Resources (DWR's) Online System of Well Completion Reports (OSWCR) database. Well location information in the OSWCR database is limited to the square-mile section of the Public Land Survey System (PLSS) in which the well is reportedly located. Hence, the primary assumption underpinning the well impact analysis is that groundwater levels in each PLSS section are equivalent to the groundwater level MT at the nearest

RMW-WL. The analysis was conducted in two steps: first, determine the depth to groundwater at each PLSS section based on the groundwater level MT at the nearest RMW-WL, and then determine the total number and location of fully and partially dewatered domestic wells in each section.

Determine the Depth to Groundwater from the Groundwater Level MT

The depth to groundwater in each PLSS section within the Basin was determined first by assuming the groundwater level was equal to the MT at the nearest RMW-WL as follows.

1. Determine the nearest RMW-WL based on the linear distance between the well and centroid of the PLSS sections.
2. Determine the elevation of the PLSS section centroid based on GIS analysis of the Digital Elevation Model (DEM) raster data.
3. Convert the elevation of the groundwater level MT from feet above mean sea level (ft msl) to feet below ground surface (ft bgs) by subtracting the nearest RMW-WL's MT elevation from the ground surface elevation.

Determine the Number of Fully and Partially Dewatered Wells in each PLSS Section

The depth to groundwater determined above was utilized to determine potential dewatering of existing wells if all RMW-WLs reached their MTs, an unlikely condition in a managed groundwater basin. Impacted wells are considered fully dewatered if the depth to groundwater is deeper than the total well depth, and partially dewatered if the depth to groundwater is deeper than a prescribed fraction of the total well depth. In the Basin, domestic well information indicates the average depth to the top of screen is 58% of the total well depth, and the midpoint of the well screen on average corresponds to 79% of the total well depth. The comparisons between depth to water and well construction provided by the OSWCR database were conducted as follows.

1. Determine if the well would be fully dewatered by comparing the depth to groundwater corresponding to the MT to the total well depth.
2. Calculate the depth at which the well would be considered partially dewatered by multiplying the total well depth by the partially dewatered well depth fraction based on the midpoint of the well screen (79% of the total well depth).
3. Determine if a well would be partially dewatered by comparing the depth to groundwater at the MT level to the partially dewatered well depth calculated under Step 2.

Domestic wells were excluded if they were older than 40 years (Pauloo et al., 2021). The same analysis was performed to determine the number and location of impacted wells when using the Fall 2015 groundwater elevation at the nearest RMW-WLs. The results from this second assessment provides an estimate of the number of fully and partially dewatered wells in 2015. Results from the well impact analysis are summarized in **Table SMC-4** below and in graphical form (see **Figure SMC-2**).

Table SMC-4. Number of Fully and Partially Dewatered Wells at Given Groundwater Elevations

Well Impact Condition	Wells Impacted at Fall 2015 Level		Wells Impacted at Minimum Threshold Level	
	Number	% of Total [1]	Number	% of Total [1]
Partially Dewatered [2]	65	2.8%	83	3.5%
Fully Dewatered [2]	36	1.5%	48	2.0%

Notes:

(1) The total number of domestic wells in the OSWCR database is 2,349.

(2) A well is considered to be fully dewatered if the depth to groundwater is deeper than the total well depth and is considered to be partially dewatered if the depth to groundwater is deeper than the midpoint of the well screen (79% of the total well depth).

The domestic well impact analysis suggests that if water levels across the entire Basin reached the proposed MTs, approximately 83 domestic wells (3.5%) could be partially dewatered and 48 domestic wells (2.0%) could be completely dewatered. This condition represents a net increase above 2015 from 65 to 83 partially dewatered wells (a net increase of 18 wells), and 36 to 48 fully dewatered wells (a net increase of 12 wells). These limited projected incremental impacts are not considered to be "significant and unreasonable" since the number of completely and/or partially dewatered domestic wells is far below the 26% of wells that are likely to require replacement based on well age and lifespan alone. The Domestic Well Impact Analysis provides a baseline estimate of potential impacts to domestic wells, which the GSAs recognize can be refined by addressing several data gaps (e.g., well age and use, verification, and analysis of active wells, and so forth). Individual GSAs may consider the need for additional studies and possible measures (depending on need, funding availability and landowner support) as part of GSP implementation if negative effects to the wells are because of SGMA-related groundwater management activities.

As a result of this analysis, the initial MTs are deemed appropriate for the reasons outlined above. Furthermore, MTs are by definition the water levels that GSAs want to avoid in all RMW-WLs, and the GSAs will strive through the use of PMAs to maintain water levels at or above the MOs, which are in all cases above the MTs (see Section 16.1 *Measurable Objective and Interim Milestones for Chronic Lowering of Groundwater Levels*).

15.1.3. Consideration of Adjacent Basins

Two neighboring groundwater basins are required to develop and adopt GSPs (the Eastern San Joaquin [ESJ] Subbasin and South American Subbasin [SASb]). The ESJ was designated as a critically overdrafted basin and adopted and submitted their GSP to DWR prior to the January 31, 2020 deadline. The SASb is designated as a high priority basin, and like this Basin, is scheduled to adopt and submit their GSP to DWR prior to January 31, 2022. Significant connections exist across the shared basin boundaries, and the MTs have been developed in consideration of and in coordination with the neighboring basins.

The potential effects of the Basin's Sustainable Management Criteria (SMCs) on the ability of the adjacent basins to achieve sustainability goals was evaluated by considering conditions when MTs are reached at the RMW-WLs. **Figure SMC-4** compares the MTs and shows that they are generally similar in magnitude. The differences between several select wells were graphed and provided as inserts, and the results show that the MTs result in hydraulic gradients similar in magnitude and direction to current conditions. The results of these comparisons suggest that the Basin SMCs will not hinder sustainability efforts in the ESJ Subbasin or SASb. If gradients toward the Basin were to have increased as a result of reaching the MTs, the efforts by the adjacent basins to achieve sustainability could be hindered. Alternatively, if the gradients decreased, or reversed, the efforts by the adjacent basins to achieve sustainability would be enhanced.

15.1.4. Minimum Thresholds for Chronic Lowering of Groundwater Levels

The MTs for Chronic Lowering of Groundwater Levels at each RMW-WL, after having considered the possibility of the domestic well impacts and the MTs set in adjacent subbasins, are summarized in **Table SMC-5** and on **Figure SMC-3**.

Table SMC-5. Minimum Threshold, Interim Milestones, and Measurable Objective for Chronic Lowering of Groundwater Levels

RMW-WL	Minimum Threshold (ft msl)	Measurable Objective (ft msl)	Margin of Operational Flexibility (ft)	Interim Milestones (ft msl)			*"Current" (Fall 2018) WL Date* [(1)]	*"Current" WL (ft msl)*
				2027	2032	2037		
RMW-WL1	**-65**	**-55**	-10	-56	-57	-56	10/17/2018	-54
RMW-WL2	**-69**	**-59**	-10	-62	-64	-61	10/15/2018	-59
RMW-WL3	**-56**	**-46**	-10	-49	-50	-48	7/14/2020	-41
RMW-WL4	**-39**	**-24**	-15	-30	-33	-29	11/10/2016	-34
RMW-WL5	**-84**	**-70**	-14	-73	-77	-73	--	--
RMW-WL6	**-78**	**-51**	-27	-63	-68	-59	9/5/2018	-61
RMW-WL7	**-38**	**-28**	-10	-32	-33	-30	10/17/2018	-24
RMW-WL8	**-48**	**-36**	-12	-39	-43	-39	12/8/2016	-27
RMW-WL9	**-89**	**-75**	-14	-78	-82	-78	5/25/2021	-74
RMW-WL10	**-32**	**-22**	-10	-25	-28	-25	10/15/2020	-26
RMW-WL11	**-38**	**-28**	-10	-31	-33	-30	8/1/2020	-29
RMW-WL12	**85**	**106**	-21	97	93	100	10/15/2018	99
RMW-WL13	**-46**	**-36**	-10	-39	-41	-39	11/10/2018	-35
RMW-WL14	**232**	**250**	-18	243	239	245	9/14/2017	251
RMW-WL15	**119**	**141**	-22	133	129	135	11/13/2017	139
RMW-WL16	**259**	**269**	-10	265	263	266	11/19/2018	269
RMW-WL17	**89**	**116**	-27	105	100	108	11/13/2018	140
RMW-WL18	**185**	**195**	-10	192	190	192	8/13/2020	198
RMW-WL19	**161**	**171**	-10	168	167	169	8/13/2020	172

Abbreviations:
ft = feet
ft msl = feet above mean sea level
WL = water level
RMW-WL = Representative Monitoring Well for Chronic Lowering of Groundwater Levels

Notes:
(1) For wells that have no Fall 2018 data, water levels from the nearest Fall after 2015 are used as surrogate.

15.2. Minimum Threshold for Reduction of Groundwater Storage

§ 354.28. Minimum Thresholds

(c) Minimum thresholds for each sustainability indicator shall be defined as follows:
(2) Reduction of Groundwater Storage. The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.

As discussed above, the URs definition for Reduction of Groundwater Storage equates to a decrease in storage associated with a decline in groundwater levels below the MTs established for Chronic Lowering of Groundwater Levels at 25% or more of the RMW-WLs. Integrating these two Sustainability Indicators together is logical, as the amount of groundwater in storage is directly, if not linearly, related to groundwater levels. Because of the close relationship between these two Sustainability Indicators, and because the MTs for Chronic Lowering of Groundwater Levels (discussed above) are protective of the beneficial uses and users of groundwater, a unique MT for Reduction of Groundwater Storage is not necessary. Rather, MTs for Chronic Lowering of Groundwater Levels will be used as a proxy for the Reduction of Groundwater Storage Sustainability Indicator. This Sustainability Indicator is not subject to local, state, or federal standards.

15.2.1. Use of Groundwater Levels as Proxy

Pursuant to the GSP Regulations (23-CCR § 354.28(d)) and as further described in the DWR's BMP #6 Sustainable Management Criteria (DWR, 2017), MTs for Reduction of Groundwater Storage may be set by using groundwater levels as a proxy if a correlation exists between the two metrics. One approach to using groundwater levels as a proxy, described in the BMP #6, is to demonstrate that MTs for Chronic Lowering of Groundwater Levels are sufficiently protective to ensure prevention of significant and unreasonable effects of the Sustainability Indicator in question. To demonstrate that the MTs for Chronic Lowering of Groundwater Levels are sufficiently protective, the calculation described below was performed to estimate the volume of groundwater that would be removed from the Principal Aquifer if groundwater levels were to decline from current (Fall 2018) levels to their respective MTs for Chronic Lowering of Groundwater Levels.

The volume of "usable storage" was estimated from the numerical groundwater model by comparing the simulated storage volume theoretically accessible to existing extraction wells to the storage volume between Fall 2018 water levels and the MTs for Chronic Lowering of Groundwater Levels. **Figure HCM-7** shows that 50% of the production wells are 400 feet deep or less. Groundwater in storage above the 400-foot depth interval was selected to represent a highly conservative estimate for usable storage, and the model results indicate the total usable storage in the Basin's Principal Aquifer is about 11.7 million acre-feet (MAF).

On average, 2018 groundwater elevations in the Basin Plain subarea monitoring wells are about 20 feet greater than their corresponding MTs, and in the Basin Foothills subarea groundwater elevations are on average about 30 feet greater than their corresponding MTs. The model-calculated volume of groundwater in this depth interval above the MTs is almost 400,000 acre-feet (AF), which is less than 4% of the estimated volume of total usable storage. Because estimated total usable storage is much greater than the volume of water above the MTs, the MTs for Chronic Lowering of Groundwater Levels are considered protective for the Reduction of Groundwater Storage Sustainability Indicator.

15.3. Minimum Threshold for Seawater Intrusion

> *§ 354.28. Minimum Thresholds*
>
> *(c) Minimum thresholds for each sustainability indicator shall be defined as follows:*
> *(3) Seawater Intrusion. The minimum threshold for seawater intrusion shall be defined by a chloride concentration isocontour for each principal aquifer where seawater intrusion may lead to undesirable results. Minimum thresholds for seawater intrusion shall be supported by the following:*
> *(A) Maps and cross-sections of the chloride concentration isocontour that defines the minimum threshold and measurable objective for each principal aquifer.*
> *(B) A description of how the seawater intrusion minimum threshold considers the effects of current and projected sea levels.*

As discussed in Section 14.3 *Undesirable Results for Seawater Intrusion* this Sustainability Indicator is not applicable for the Basin; thus, MTs were not defined for Seawater Intrusion.

15.4. Minimum Threshold for Degraded Water Quality

> *§ 354.28. Minimum Thresholds*
>
> *(c) Minimum thresholds for each sustainability indicator shall be defined as follows:*
> *(4) Degraded Water Quality. The minimum threshold for degraded water quality shall be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum threshold shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin.*

The GSP Regulations (23-CCR § 354.28(c)) state that the MT for Degraded Water Quality shall be the "degradation of water, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results." The GSP Regulations further state that the MT "shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin," and that "the Agency shall consider local, state, and federal water quality standards applicable to the basin." This language indicates that MTs for Degraded Water Quality can reasonably be based on concentrations of water quality constituents of concern (COCs), as quantified by sampling measurements at the RMW-WQs and existing water quality standards applicable to the Basin.

15.4.1. Minimum Threshold Development

Constituents of Concern

The powers granted to the GSAs to effect sustainable groundwater management under SGMA generally revolve around managing the quantity, location, and timing of groundwater pumping. SGMA does not empower GSAs to develop or enforce water quality standards; that authority rests with the State Water Resources Control Board (SWRCB) Division of Drinking Water. Because of the limited purview of GSAs with respect to water quality, and the rightful emphasis on those constituents that may affect the supply and beneficial uses of groundwater on a regional basis (see discussion in Section 14.4 *Undesirable Results for Degraded Water Quality)*, SMCs for water quality in the Basin are only developed at the designated RMW-WQs for three constituents of regional importance: arsenic, nitrate and total dissolved solids (TDS).

As described in Section 0

Groundwater Quality Concerns*,* arsenic and nitrate have been identified as COCs in the Basin groundwater that can pose risks to human health at elevated concentrations. As such, these constituents have been assigned Primary Maximum Contaminant Levels (MCLs) and are regulated by the SWRCB in public drinking water systems. Additionally, TDS has been identified as a COC in the Basin. Although TDS is not considered to be a constituent with risk to human health, it can serve as an indication of general water quality, specifically aesthetic characteristic (i.e., taste, odor, color, etc.) (Hem, 1970), and is regulated in by SWRCB in public drinking water systems with a Secondary MCL. As described in Section 0

Groundwater Quality Concerns*,* certain other constituents with Secondary MCLs (including chloride, sulfate, iron and magnesium) have been measured in wells in the Basin at concentrations exceeding their respective Secondary MCLs. Since these constituents do not pose risks to human health, and because monitoring TDS serves as an indicator of general drinking water quality, SMCs were not developed for these other constituents. However, they will continue to be monitored, along with TDS, arsenic, and nitrate, as part of the existing monitoring programs, and the GSAs may re-evaluate SMCs for these or other constituents or at additional well locations in the future if analysis of monitoring data suggests the need to do so.

Consideration of State, Federal and/or Local Standards

As mentioned above, the State of California and the U.S. Environmental Protection Agency (USEPA) set Primary MCLs for constituents which affect human health and Secondary MCLs for constituents which affect consumer acceptance (i.e., aesthetic concerns). MCLs are appropriate to consider when establishing MTs for Degraded Water Quality, as this approach would meet the requirement to consider the beneficial uses and users of groundwater. According to Title 22 California Code of Regulations (CCR) Article 18 § 64465, the primary MCLs for arsenic and nitrate are 10 micrograms per liter (μg/L) and 10 milligrams of nitrogen per liter (mg/L) respectively, and the “upper limit” Secondary MCL for TDS is 1,000 mg/L.

Consideration of Pre-Existing Water Quality Issues

As discussed in Section 14.4 *Undesirable Results for Degraded Water Quality*, the definition of significant and unreasonable effects recognizes the fact that SGMA does not require GSPs to address undesirable results that occurred before, and have not been corrected by January 1, 2015 (CWC § 10727.2(b)(4)).

15.4.2. Final Minimum Threshold for Degraded Water Quality

Considering the state and federal standards and the potential pre-existing water quality issues discussed above, the MTs for Degraded Water Quality are set for arsenic and nitrate at their respective Primary MCLs and the MT for TDS is set to the Secondary "upper limit" MCL at the RMW-WQs in the Basin. The final MTs are shown in **Table SMC-6** and **Figure SMC-5** shows the locations of the RMW-WQs and water quality trends over the past 30+ years for the COCs. Because the MTs are based on criteria for drinking water quality, which is the most sensitive beneficial use, this definition implicitly considers the other beneficial uses and users of groundwater in the Basin.

It should be noted, however, that monitoring for water quality will continue to be conducted at the RMW-WQs for additional constituents for which SMCs are not set, as discussed further in Section 17.1.4 *Monitoring Network for Degraded Water Quality.*

Table SMC-6. Summary of Minimum Thresholds, Interim Milestones, and Measurable Objectives for Degraded Water Quality

RMW-WQ	Constituent of Concern	Unit	Minimum Threshold	Measurable Objective	Margin of Operational Flexibility	Trigger Threshold[2]
All RMW-WQs	Arsenic	µg/L	**10**	**8**	2	9
	Nitrate[1]	mg/L	**10**	**8**	2	9
	TDS	mg/L	**1,000**	**500**	500	750

Abbreviations:
mg/L = milligrams per liter
RMW-WQ = Representative Monitoring Well for Degraded Water Quality
µg/L = micrograms per liter
Notes:
(1) Nitrate concentrations are reported as nitrogen (N).
(2) Trigger Threshold used in place of Interim Milestones, see Section 16.4 *Measurable Objective and Interim Milestones for* Degraded Water Quality for detailed discussion.

15.5. Minimum Threshold for Land Subsidence

> *§ 354.28. Minimum Thresholds*
>
> *(c) Minimum thresholds for each sustainability indicator shall be defined as follows:*
> *(5) Land Subsidence. The minimum threshold for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results. Minimum thresholds for land subsidence shall be supported by the following:*
> *(A) Identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin, including an explanation of how the Agency has determined and considered those uses and interests, and the Agency's rationale for establishing minimum thresholds in light of those effects.*
> *(B) Maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.*

Land Subsidence can be caused by several mechanisms, but the mechanism most relevant to sustainable groundwater management is the depressurization of aquifers and aquitards due to lowering of groundwater levels, which can lead to compaction of compressible strata (clay) and lowering of the ground surface. As discussed above in Section 9.5 *Land Subsidence,* measured vertical displacement in the Basin has been minor to date indicating that land subsidence is not a significant concern in the Basin, based on the best available information.

15.5.1. <u>Use of Groundwater Levels as Proxy</u>

Pursuant to the GSP Regulations (23-CCR § 354.28(d)) and as further described in the DWR Sustainable Management Criteria BMP (DWR, 2017), MTs for Land Subsidence may be set by using groundwater levels as a proxy if it is demonstrated that MTs for Chronic Lowering of Groundwater Levels are sufficiently protective to ensure significant and unreasonable occurrences of land subsidence will be prevented. As discussed above, the MTs for Chronic Lowering of Groundwater are based on either a 20-year trend-projected water level (for RMW-WLs with a declining recent/historical trend) or the historical low (for other RMW-WLs). Based on the observed rate of subsidence at the one continuous Global Positioning System (GPS) monitoring station, located within the groundwater depression in the Basin, (i.e., the best available information) and if the observed subsidence rate were allowed to continue for 20 years (i.e., the maximum time allowable for continuation of declining groundwater level trends by the established Chronic Lowering of Groundwater Level MTs), additional subsidence would amount to only approximately 1.7 inches. This amount is not considered significant and unreasonable, and therefore would not constitute an Undesirable Result. Therefore, this theoretically ensures that avoidance of the MTs for Chronic Lowering of Groundwater Levels will also be sufficiently protective to ensure significant and unreasonable land subsidence will not occur. As such, MTs for Land Subsidence are not established herein.

In addition to groundwater levels monitoring, as described in Section 17.1.5 *Monitoring Network for Land Subsidence*, the potential for subsidence will continue to be monitored directly through ground surface elevation measurements by DWR at their survey benchmark locations and by the University Navstar Consortium (UNAVCO) at their GPS sites. InSAR information from DWR will also be reviewed annually to further evaluate the potential for subsidence. The monitoring data will be compiled together with other readily available data for analysis of any subsidence impacts as part of the next five-year update of the GSP.

15.6. Minimum Threshold for Depletions of Interconnected Surface Water

§ 354.28. Minimum Thresholds

(c) Minimum thresholds for each sustainability indicator shall be defined as follows:
(6) Depletions of Interconnected Surface Water. The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results. The minimum threshold established for depletions of interconnected surface water shall be supported by the following:
(A) The location, quantity, and timing of depletions of interconnected surface water.
(B) A description of the groundwater and surface water model used to quantify surface water depletion. If a numerical groundwater and surface water model is not used to quantify surface water depletion, the Plan shall identify and describe an equally effective method, tool, or analytical model to accomplish the requirements of this Paragraph.

The GSP Regulations (23-CCR § 354.28(c)) state that the MT for Depletions of Interconnected Surface Water “shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results.”

The GSP Regulations (23 CCR § 354.28(d)) and DWR Sustainable Management Criteria BMP (DWR, 2017) allow groundwater elevations to be used as a proxy for interconnected surface water, provided the GSP demonstrates a significant correlation between groundwater levels and depletions. Available data are currently insufficient to directly calculate surface water depletions from streamflow measurements or estimate depletions from a surface water budget. Estimates of depletions therefore rely on application of the numerical surface-water groundwater model that has been developed for the Basin.

Figure SMC-7 shows the approximate extent of likely interconnected and disconnected reaches on the Cosumnes River and other surface water features. As discussed in Section 9.6 *Interconnected Surface Water Systems*, most of the Cosumnes River and other surface water features in the Basin are disconnected due to deep groundwater levels in the Principal Aquifer. Similarly, mapped Groundwater Dependent Ecosystem (GDE) areas are delineated in part by depth to groundwater. In the disconnected reaches, where groundwater levels are deep, model-calculated depletions show no correlation to groundwater levels, rather depletions appear primarily influenced by the magnitude of flows and stage (**Figure GWC-16**). As shown on **Figure SMC-7**, there are portions of the Cosumnes River where interconnected conditions are assumed to occur, at least temporarily for portions of some years, and where groundwater levels are less deep. In these assumed interconnected reaches, the correlation between model-calculated depletions and measured groundwater levels is similarly limited due to uncertainty in model-calculated depletions, the limited number of RMW-ISWs, and a lack of river stage data; this uncertainty is recognized as a significant data gap in the GSP.

The influence of depletions on surface water flows and beneficial uses of surface water is complicated by natural hydrologic variability, and the lack of surface water diversion, return flow, and consumption data. Nevertheless, water levels are considered a reasonably effective criteria for this sustainability indicator because they can be utilized to help maintain conditions and instream flows in the interconnected reaches at levels no worse than occurred in 2015. Water levels are considered an effective criterion for GDEs because it can consider rooting depths. Accordingly, historical water level data from shallow groundwater wells within the Basin were utilized to determine SMCs for the Depletion of Interconnected Surface Water.

15.6.1. Minimum Threshold Development

Different approaches were utilized to determine the MTs for disconnected reaches, assumed interconnected reaches, and mapped GDE areas. The monitoring network for Interconnected Surface Water is comprised of a total of nine (9) RMW-ISWs, four in disconnected reaches, two in likely interconnected reaches and three in the assumed GDEs area. For the disconnected reaches, the MTs are established at RMW-ISWs utilizing the same methodology as used to establish MTs for Chronic Lowering of Groundwater Levels. In the assumed interconnected reaches, the MTs are established based on measured seasonal-low shallow groundwater elevations over the period of record through 2015. In the mapped GDE areas, the MTs are based on typical rooting depths and Best Practice guidance provided by The Nature Conservancy (TNC; TNC, 2018).

Minimum Threshold Determination

The approach to calculate initial MT estimates for Depletions of Interconnected Surface Water were developed for disconnected and interconnected surface water reaches and assumed GDEs as follows.

- Disconnected Approach: The MT is the projected 20-year water level based on long-term trend for wells with negative long-term trends or the historical low for wells with positive long-term trends (i.e., the same approach as for MT for Chronic Lowering of Groundwater Levels, but applied at shallow groundwater wells).
- Interconnected Approach: The MT is the highest seasonal low elevation during a below normal water year from the start of monitoring through 2015. **Figure SMC-6** shows the water levels in three monitoring wells located in the assumed interconnected reach and western most area of the GDEs (RMW-ISW1, RMW-ISW2 and RMW-ISW3). At RMW-ISW1, the seasonal lows typically occur during late summer to mid-winter, depending on the year. The highest seasonal low (the MT) is about -33 feet below mean sea level (ft msl) and occurred at the end of September 2012, which was a dry year. At RMW-ISW2, the highest seasonal low (the MT) is about -6 ft msl and similarly at RMW-ISW3 the highest seasonal low (the MT) is about -10 ft msl; the seasonal highs in both wells occurred at the end of January 2014. The rationale for this approach is that, if groundwater levels are maintained above these MTs, the associated rate of depletion of interconnected surface water will theoretically be less than the rate prior to the 1 January 2015, the effective date of the SGMA, thus being protective and avoiding Undesirable Results for Depletions of Interconnected Surface Water.
- Assumed GDE Approach: The water levels in RMW-ISW7, RMW-ISW8, and RMW-ISW9 are shallow but lack the seasonal variability represented in the interconnected reach wells. TNC's

"Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act Guidance for Preparing Groundwater Sustainability Plans" guidelines suggest that natural communities are disconnected from the Principal Aquifer where depth to water is greater than 30 feet below ground surface (ft bgs; TNC, 2018). The MTs for RMW-ISW7 and RMW-ISW8, were therefore conservatively set to a depth of 20 ft bgs, which is considered conservative because it is 10 ft higher than the lower limit recommended by TNC. RMW-ISW9 has a well depth of only 15 ft bgs, and the MT was therefore set at the historical low in measured water levels.

As part of the SGMA Monitoring Network for Depletions of Interconnected Surface Water, four representative monitoring gauges (RMG) are located along the Cosumnes River and will record stage (surface water level) periodically throughout each day. The volume of flow will be measured periodically to develop a stage-discharge rating curve to better estimate the flow volume for daily stage values. One RMG is located on Dry Creek on the south side of the Basin. These stage and flow data, combined with improved surface water accounting (diversions and return flows), will better quantify relationships between measured changes in groundwater levels and surface water flows that can help refine the SMC approach over time.

By design, the RMW-ISW were chosen to be representative of groundwater levels in their areas as discussed in Section 17.1.6 *Monitoring Network for Depletions of Interconnected Surface Water.* As shown in **Figure SMC-7**, all confirmed GDEs and assumed-confirmed GDEs are within 3.1 miles of RMW-ISW1, RMW-ISW2 and RMW-ISW3, which meets TNC's Best Practice #4 (TNC, 2019) to reflect the local conditions relevant to the ecosystem. The MT for these wells ensures water levels beneath these GDE areas do not fall below the highest seasonal low elevation measured during a below normal water year prior to 2015. In the Basin Foothills subarea, most of the area mapped as having unknown GDEs is within 3.1 miles of RMW-ISW7, RMW-ISW8 and RMW-ISW9. The MTs for these wells ensure water levels do not fall below a depth of (at most) 20 ft bgs. The MTs are therefore considered to protect against "significant and unreasonable" effects on GDEs. Furthermore, MTs are by definition the water levels that GSAs want to avoid in all RMW-ISWs, and the Basin GSAs will strive through the use of PMAs to maintain water levels at or above the MOs, which are in all cases above the MTs (see Section 16.6 *Measurable Objective and Interim Milestones for Depletion of Interconnected Surface Water*). As described in Section 19.1 *Plan Implementation Activities*, GDEs health, vigor and recruitment shall be monitored and assessed based on an evaluation of satellite imagery, Cosumnes River flows, and periodic site visits to verify GDE conditions and couple to changes in climate and water levels.

Consideration of Adjacent Basins

The Basin GSAs have and will continue to consider the effects of SMCs in the Basin on the ability of the adjacent ESJ Subbasin and SASb to achieve their respective sustainability goals. **Figure SMC-8** compares the Basins' interconnected surface water MTs to the interconnected surface water MTs established for the adjacent basins. The ESJ monitoring network and MTs are the same as those established for the Chronic Lowering of Groundwater Levels, and as such the network does not have monitoring wells located immediately adjacent to Dry Creek; the network monitoring well closest to the shared boundary has a MT similar to that of nearby RMW-ISW1. The SASb monitoring well network near the Cosumnes River is comprised of a single well, and the MT established for this well is lower than the corresponding values established for the Basin. The results of these comparisons suggest that the Basin SMCs will not hinder sustainability efforts in the ESJ Subbasin or SASb.

15.6.2. Minimum Thresholds for Depletions of Interconnected Surface Water

The MTs for Depletions of Interconnected Surface Water at each RMW-ISW are summarized in **Table SMC-7** and on **Figure SMC-7.**

Table SMC-7. Minimum Threshold, Interim Milestones, and Measurable Objective for Interconnected Surface Water

RMW-ISW	Minimum Threshold (ft msl)	Measurable Objective (ft msl)	Margin of Operational Flexibility (ft)	Interim Milestones (ft msl)			Trigger Threshold (ft msl)(1)
				2027	2032	2037	
RMW-ISW1[D,G]	-23	-18	5	--	--	--	-21
RMW-ISW2[I,G]	-6	-3	3	--	--	--	-4.5
RMW-ISW3[I,G]	-10	-4	6	--	--	--	-7.0
RMW-ISW4[D]	-19	-14	5	-14	-15	-14	--
RMW-ISW5[D]	78	83	5	85	86	85	--
RMW-ISW6[D]	-31	-26	5	-26	-28	-27	--
RMW-ISW7[G]	247	257	10	--	--	--	252
RMW-ISW8[G]	172	179	7	--	--	--	176
RMW-ISW9[G]	164	171	7	--	--	--	167

Abbreviations:
D = well in disconnected reach
ft = feet
ft msl = feet above mean sea level
G = well in GDE area
I = well in interconnected reach
ISW = interconnected surface water
RMW-ISW = Representative Monitoring Well for Depletions of Interconnected Surface Water
Notes:
(1) Trigger thresholds are established for the interconnected reaches and assumed GDE areas where water levels in RMW-ISWs don't exhibit long-term upward or downward trends. See Section 16.6 *Measurable Objective and Interim Milestones for Depletion of Interconnected Surface Water* for an explanation of the use of trigger thresholds.

15.7. Relationship between Minimum Thresholds and Other Sustainability Indicators

23-CCR § 354.28 requires an evaluation of the relationships between MTs for each Sustainability Indicator. This includes describing why or how a MT set at a particular RMS is similar or different to the MT specified at nearby RMSs and confirm that a MT will not trigger an UR for another Sustainability Indicator (for example, confirm that the MT for the Chronic Lowering of Groundwater Levels does not produce a UR for Land Subsidence). With the exception of Degraded Groundwater Quality, the planned metric is groundwater levels, directly for the Chronic Lowering of Groundwater Levels, or proxy for Reduction of Groundwater Storage, Subsidence, and Depletion of Interconnected Surface Water (although this later one is based on a different monitoring network that is focused on shallow groundwater conditions). The planned metrics for Degraded Groundwater Quality are the concentrations of specific constituents of concern, and Seawater Intrusion is not a concern in the Basin and therefore does not have a monitoring network or specified SMCs.

Chronic Lowering of Groundwater Levels, Reduction of Groundwater Storage, and Subsidence rely on the same RMW-WLs and SMCs. The SMCs at each RMW-WL are calculated from their site-specific water levels and represent the spatial variability in groundwater conditions in the Principal Aquifer across the Basin. As discussed above in Section 15.2 *Minimum Threshold for Reduction of Groundwater Storage*, the estimated volume of groundwater in the interval above the Chronic Lowering of Groundwater Levels MTs is less than 4% of the usable storage volume. As discussed above in Section 15.5 *Minimum Threshold for Land Subsidence*, if water levels continued to decline at their historical rates and the observed historical subsidence rate also continued, the corresponding estimated increase in subsidence is only 1.7 inches and not significant or unreasonable.

The Chronic Lowering of Groundwater Level and Depletion of Interconnected Surface Water MTs each employ a unique set of RMSs. However, in disconnected reaches (and GDE areas), the water levels in both RMW-ISW and RMW-WL are influenced mostly by recharge and pumping. Accordingly, the water levels in both sets of RMWs are expected to be somewhat correlated, and similarly protective. However, because the RMW-ISW tend to be located near surface water, which is a significant source of groundwater recharge, and are generally less deep than the RMW-WL, the water levels in the RMW-ISWs are not expected to decline below their respective MTs at the same rate as the RMW-WLs. In contrast, the water levels in the RMW-ISW near interconnected reaches are influenced by river stage, the exchange of surface- and groundwater, recharge and pumping. As a result, the water levels in RMW-ISW can be poorly correlated with the water levels in RMW-WL, and the relationship between URs in the Depletion of Interconnected Surface Water and that of Chronic Lowering of Groundwater Level MTs is currently not well understood. These relationships, if any, can be explored using the improved data set generated by the Basin monitoring program that will be implemented by the GSP.

A significant and unreasonable condition for Degraded Groundwater Quality is a concern if caused by PMAs implemented by the GSP. However, as described above in Section 9.4 *Groundwater Quality Concerns*, historical well-water sample results and concurrent water level data are limited, thereby obscuring potential relationships between water level based MTs and Degraded Groundwater Quality. These relationships, if any, can be explored using the improved data set generated by the Basin monitoring program and planned projects that are implemented by the GSP.

15.8. Action Plan Related to Minimum Threshold Exceedances

This GSP defines sustainability under the SGMA as the avoidance of URs determined by a percentage or number of RMWs that exceed their MTs. While a single or isolated exceedance will not, by itself, cause an UR for most of the Sustainability Indicators, such an exceedance may be indicative of future or trending exceedances which could result in URs.

The GSAs are responsible for monitoring groundwater conditions, complying with SGMA requirements, and coordinating with other agencies and entities (e.g., public water systems, etc.) within the Basin. It is important to monitor compliance with MTs and MOs over time to understand the Basin's progress and likelihood of achieving sustainability and avoiding URs. The following action plan is recommended to investigate MT exceedances if they occur.

1. Identify Exceedance and Investigate the RMS Area:

After each annual report, the GSAs will review the data, identify any MT exceedance(s) at RMS(s), and evaluate whether the exceedance is a localized issue associated with the affected RMS, or indicates a potential regional issue. For example, questions to answer include: Are similar trends occurring in nearby RMW or supplemental monitoring wells? If so, how large of an area appears affected? Has a change in land or water use occurred, like a shift to higher water demand crop type or expansion in operations, has a new well been installed, and so forth? Is the problem related to area-wide drought conditions?

2. Evaluate Potential for Outside Contributing Factors:

Declining water levels or degraded water quality in a portion of the Basin may be the result of operations within the Basin or in an adjacent subbasin. In this situation, a coordinated effort to evaluate conditions, adjusting MTs to avoid exceedances in the future, and/or adding or moving a RMS if the existing RMS is determined not sufficiently representative of the area.

3. Consider the Need for Increased or Expanded Monitoring:

Evaluate the efficacy of increasing the monitoring frequency, expanding the monitoring area, adding or re-assigning RMS(s), or other actions necessary to identify the cause of the exceedances.

4. Consider Initiating and/or Expanding Projects and Management Actions (P/MAs):

If there are repeated MT exceedances observed, the GSAs can consider initiating one of the other proposed PMAs (*see Section* 18.2.4 *Other PMAs*).

5. Consider Enforcement Action:

MT exceedances that result in UR(s) as defined in the GSP (see Section 14 *Undesirable Results*) may require enforcement of PMAs by GSAs in accordance with applicable laws and authorities.

16. MEASURABLE OBJECTIVES AND INTERIM MILESTONES

§ 354.30. Measurable Objectives

(a) Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.

(b) Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.

(c) Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.

(d) An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.

(e) Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.

(f) Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.

(g) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for a finding of inadequacy of the Plan.

This section discusses the development of Measurable Objectives (MO) and Interim Milestones (IMs) for all relevant Sustainability Indicators for the Cosumnes Subbasin (Basin). Also presented below is the concept of "trigger thresholds" which are non-regulatory levels for various sustainability indicators that, if reached at a certain specific combination of Representative Monitoring Well (RMW) locations, will "trigger," or prompt additional actions by the Basin Groundwater Sustainability Agencies (GSAs).

16.1. Measurable Objective and Interim Milestones for Chronic Lowering of Groundwater Levels

16.1.1. Measurable Objectives for Chronic Lowering of Groundwater Levels

The MOs for Chronic Lowering of Groundwater Levels are based on the Fall 2015 groundwater levels at the 19 Representative Monitoring Wells for Chronic Lowering of Groundwater Levels (RMW-WLs). Fall 2015 was selected because it is the first seasonal low water level after adoption of the Sustainable Groundwater Management Act (SGMA). California Water Code (CWC) §10727.2(b)(4) states that the GSP is not required to address undesirable results (URs) that occurred before, and have not been corrected by, January 1, 2015.

As described Department of Water Resources' (DWR's) Best Management Practices (BMP) #6 Sustainable Management Criteria (DWR, 2017), "Measurable Objectives should be set such that there is a reasonable margin of operation flexibility (or 'margin of safety') between the minimum threshold and measurable objective that will accommodate temporary droughts, climate change, conjunctive use operations, or other groundwater management activities." Therefore, the margin of operational flexibility within the Basin is the difference between the Minimum Threshold (MT) and the MO. The MOs and margins of operational flexibility for the RMW-WLs within the Basin are shown in **Table SMC-5** and **Figure SMC-9**.

16.1.2. Interim Milestones for Chronic Lowering of Groundwater Levels

The IMs for Chronic Lowering of Groundwater Levels are based on the MT, the MO, and the projected long-term trajectory for groundwater levels (the projected path to the sustainability goal within 20 years of GSP adoption). This trajectory allows for and assumes a continuation of current groundwater level trends for the first two five-year periods, which provides time to implement the multi-phased projects and management actions described in Section 10.4 *Projected Water Budget* and Section 18 *Projects and Management Actions*. Each project has a projected timeline for establishing agreements, constructing infrastructure, and grow to maximum planned operations. Accordingly, historical trends (without project and management actions) were conservatively employed to project the path during the first 5 to 10 years, and then recover water levels to the MOs over the third and fourth five-year periods when the projects and management actions are fully operational. The trajectory for groundwater levels prescribed in the IMs is as follows:

Table SMC-8. Interim Milestone Trajectory for Chronic Lowering of Groundwater Levels

Calendar Year	Interim Milestone for Chronic Lowering of Groundwater Levels	Basis for Interim Milestone
2027	*IM-5$_{GWL}$*	*LTT extended for 5 years*
2032	*IM-10$_{GWL}$*	*LTT extended for 10 years*
2037	*IM-15$_{GWL}$*	*½ * (MO$_{GWL}$- IM-10$_{GWL}$)*
2042	MO$_{GWL}$	MO$_{GWL}$

where:

- *IM-5$_{GWL}$*, *IM-10$_{GWL}$*, and *IM-15$_{GWL}$* are the Interim Milestones for Chronic Lowering of Groundwater Levels after 5 years, 10 years and 15 years, respectively;
- *LTT* is the long-term trend; and,
- *MO$_{GWL}$* is the Measurable Objective for Chronic Lowering of Groundwater Levels (defined previously)

The MOs, and IMs for Chronic Lowering of Groundwater Levels are presented in **Table SMC-5** and shown on each RMW-WL hydrograph in **Figure SMC-1**. The margin of operational flexibility for Chronic Lowering of Groundwater Levels was set at a minimum of 10 feet, which was the average range between measured fall water levels for the RMW-WLs. Ten feet provides a sufficient buffer between the MO and MT to accommodate droughts, climate change and groundwater management activities.

16.1.3. Consideration of Adjacent Basins

The Basin GSAs have and will continue to consider the effects of SMCs in the Basin on the ability of the adjacent Eastern San Joaquin (ESJ) Subbasin and South American Subbasin (SASb) to achieve their respective sustainability goals. The MOs at each RMW-WL are spatially shown in **Figure SMC-9** and **Figure** SMC-10 and compares the Basin's water level MOs to the corresponding MOs established by the ESJ Subbasin and SASb. In general, the Basin MOs are similar in magnitude and distribution, and will approximately maintain current gradients when the basins reach their respective sustainability goals.

16.2. Measurable Objective and Interim Milestones for Reduction of Groundwater Storage

As with the MTs, the MOs for Chronic Lowering of Groundwater Levels are used as proxy for the Reduction of Groundwater Storage Sustainability Indicator (see Section 15.3 *Minimum Threshold for Reduction of Groundwater Storage*). Accordingly, the associated IMs and Margin of Operational Flexibility for the Groundwater Storage Sustainability Indicator are the same as used for the Chronic Lowering of Groundwater Levels.

16.3. Measurable Objective and Interim Milestones for Seawater Intrusion

Seawater intrusion is not a threat to groundwater resources within the Basin; thus, MOs and IMs are not defined for this Sustainability Indicator.

16.4. Measurable Objective and Interim Milestones for Degraded Water Quality

As with the MTs, the MOs for Degraded Water Quality are defined at Representative Monitoring Wells for Degraded Water Quality (RMW-WQs) in the Basin for the three Constituents of Concern (COCs). The MO for arsenic is set at 80% of the Primary Maximum Contaminant Level (MCL) (i.e., 8.0 micrograms per liter [μg/L]). For nitrate, the MO is set at 80% of the Primary MCL (i.e., 8.0 milligrams per liter [mg/L] as nitrogen), which is also the Irrigated Lands Regulatory Program (ILRP) monitoring trigger (CH2M, 2017). The MO for total dissolved solids (TDS) is set at the "recommended" Secondary MCL (i.e., 500 mg/L).

As most concentrations are currently below the MO, setting IMs for Degraded Water Quality based on current concentrations and the MO would promote a degradation in water quality. Therefore, IMs are not applicable to water quality. Instead, "trigger thresholds" have been established for Degraded Water Quality whereby if the concentration of a COC in a RMW-WQ reaches 50% of its MCL as a result of SGMA-related management actions, the GSAs will consider whether additional action is necessary. The MOs and trigger thresholds for Degraded Water Quality are presented in **Table SMC-6.**

16.5. Measurable Objective and Interim Milestones for Land Subsidence

The MOs for Chronic Lowering of Groundwater Levels are used as proxy for the Land Subsidence Sustainability Indicator, including the associated Margin of Operational Flexibility for groundwater levels.

16.6. Measurable Objective and Interim Milestones for Depletion of Interconnected Surface Water

16.6.1. Measurable Objectives for Depletion of Interconnected Surface Water

The MOs for Depletion of Interconnected Surface Water are based on measured or model-calculated groundwater levels in the nine Representative Monitoring Wells for Interconnected Surface Water (RMW-ISWs). The approach to calculate initial MO estimates for Depletions of Interconnected Surface Water were developed differently for surface water (disconnected and interconnected reaches) and groundwater dependent ecosystem (GDE) areas.

- Disconnected Approach: The MO is set at the model-calculated Fall 2015 water level (same as the MO for Chronic Lowering of Groundwater Levels, but applied at shallow groundwater wells).
- Interconnected Approach: The MO is calculated using the range in measured seasonal-low elevations over the period of record through 2015. **Figure SMC-6** shows measured water levels in two monitoring wells located in the assumed interconnected reach (RMW-ISW2 and RMW-ISW3). At RMW-ISW2, the seasonal lows typically occur during late summer to mid-winter, depending on the year; the seasonal lows prior to 2016 range from about -6 feet mean sea level (ft msl) to approximately -9 ft msl (a net difference of 3 ft). Hence, this range is added to the RMW-ISW2's MT (-6 ft) to obtain its MO of -3 ft msl. Similarly, at RMW-ISW3, the seasonal lows prior to 2016 range from about -10 ft msl to almost -16 ft msl (a net difference of 6 ft). Hence, this range is added to the RMW-ISW3's MT (-10 ft) to obtain its MO of -4 ft msl.
- Assumed GDE Approach: The MO is the model-calculated Fall 2015 water level, which is the same as the MO for Chronic Lowering of Groundwater Levels, but applied at shallow groundwater wells, and above the MT for all three wells.

The Margin of Operational Flexibility within the Basin is the difference between the MT and the MO. The MOs and Margins of Operational Flexibility for the RMW-ISWs are shown in **Table SMC-7** and **Figure SMC-11**.

16.6.2. Interim Milestones for Depletions of Interconnected Surface Water

The IMs for Interconnected Surface Water are based on the MTs and MOs. The approach to calculate the IMs for Interconnected Surface Water were developed uniquely for the disconnected and interconnected surface water reaches.

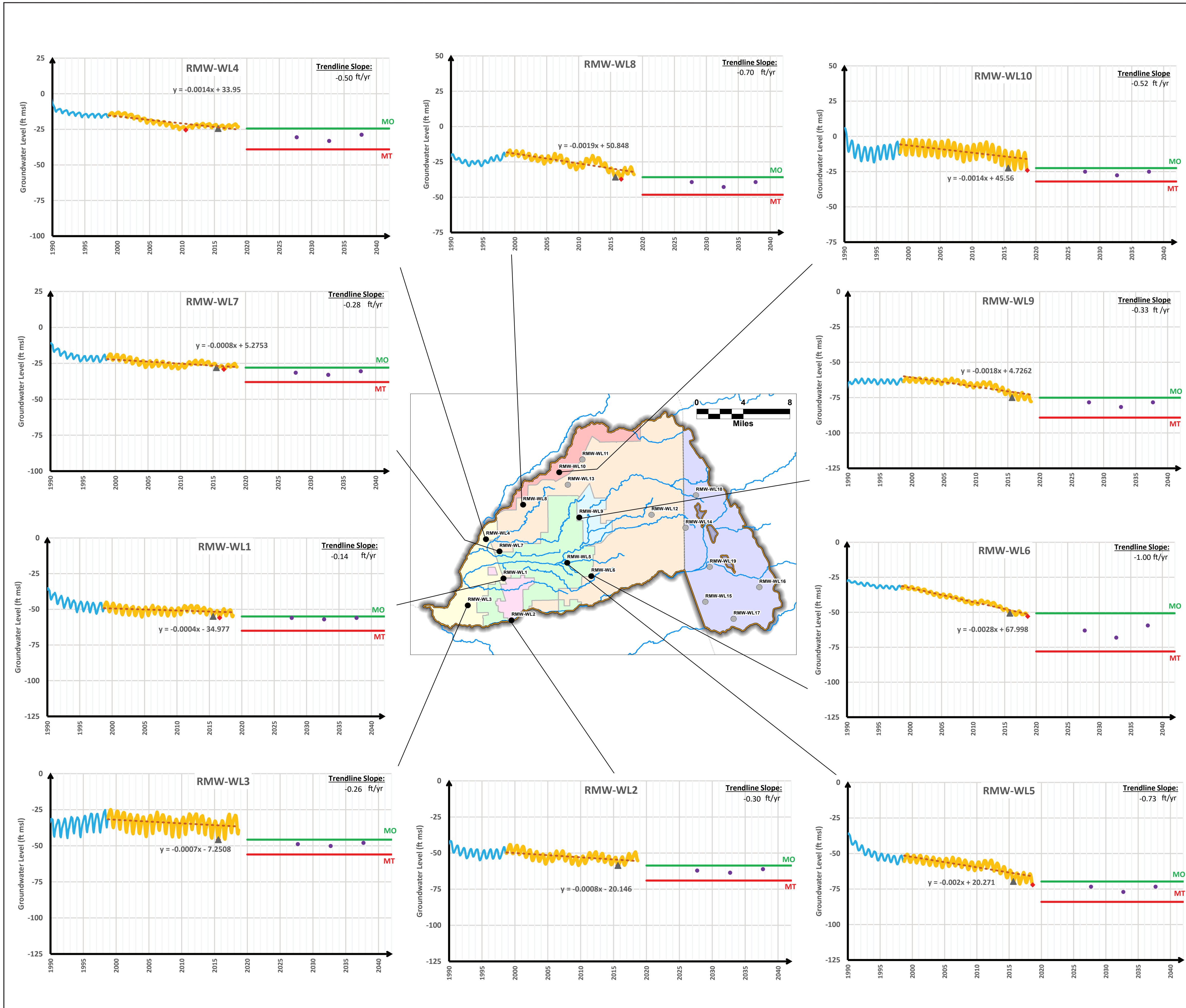
- Disconnected Approach: The IMs are based on a long-term trajectory of groundwater levels, the MTs, and the MOs (same IM approach for Chronic Lowering of Groundwater Levels, but applied at shallow groundwater wells).
- Interconnected and Assumed GDE Approach: As seen in the hydrographs in **Figure SMC-6,** the groundwater levels are cyclical and do not exhibit a long-term trend. Therefore, setting variable IMs is not applicable. Instead, "trigger thresholds" have been established. If the groundwater levels in the RMW-ISW fall below the mid-point between the MO and MT as a result of SGMA-related groundwater management, the GSAs will then consider the need for a management response.

The MOs, IMs and trigger thresholds for Depletions of Interconnected Surface Water are presented in **Table SMC-6** and shown on each RMW-ISW hydrograph in **Figure SMC-6.** The MOs at each RMW-ISW are spatially shown on **Figure SMC-11**.

16.6.3. Consideration of Adjacent Basins

The Basin GSAs have and will continue to consider the effects of SMCs in the Basin on the ability of the adjacent ESJ Subbasin and SASb to achieve their respective sustainability goals.

Figure SMC-12 compares the Basin's interconnected surface water MOs to the corresponding MOs established for the adjacent basins. The ESJ Subbasin monitoring network and MOs are the same as those established for water levels, and as such the network does not have monitoring wells located immediately adjacent to Dry Creek; the network monitoring well closest to the shared boundary has a MO similar to that of nearby RMW-ISW1. The SASb monitoring well network near the Cosumnes River is comprised of a single well, and the MO established for this well is lower than the corresponding values established for the Basin. These comparisons suggest that the Basin SMCs will not hinder sustainability efforts in the ESJ Subbasin or the SASb.



Legend:

- Hydrograph
- Trend Period
- Linear (Trend Period)
- Measurable Objective
- Minimum Threshold
- Interim Milestone
- Historical Low
- Fall 2015
- Cosumnes Subbasin (5-022.16)

Groundwater Sustainability Agency

- Amador County Groundwater Management Authority
- City of Galt
- Clay Water District
- Galt Irrigation District
- Omochumne-Hartnell Water District
- Sacramento County
- Sloughhouse Resource Conservation District
- County Line
- Major Stream
- RMW-WL

Abbreviations:

DWR = California Department of Water Resources
ft msl = feet above mean sea level
ft/yr = feet per year
MO = Measurable Objective
MT = Minimum Threshold
RMW-WL = Representatitve Monitoring Well for Chronic Lowering of Water Levels

Notes:

1. All locations are approximate.
2. See Figure SMC-1b for RMW-WL11 through RMW-WL19.
3. Model-calculated water levels adjusted to match measured Fall 2015 or most recent water level exactly.

Water Level Sustainability Criteria - Hydrograph Analysis

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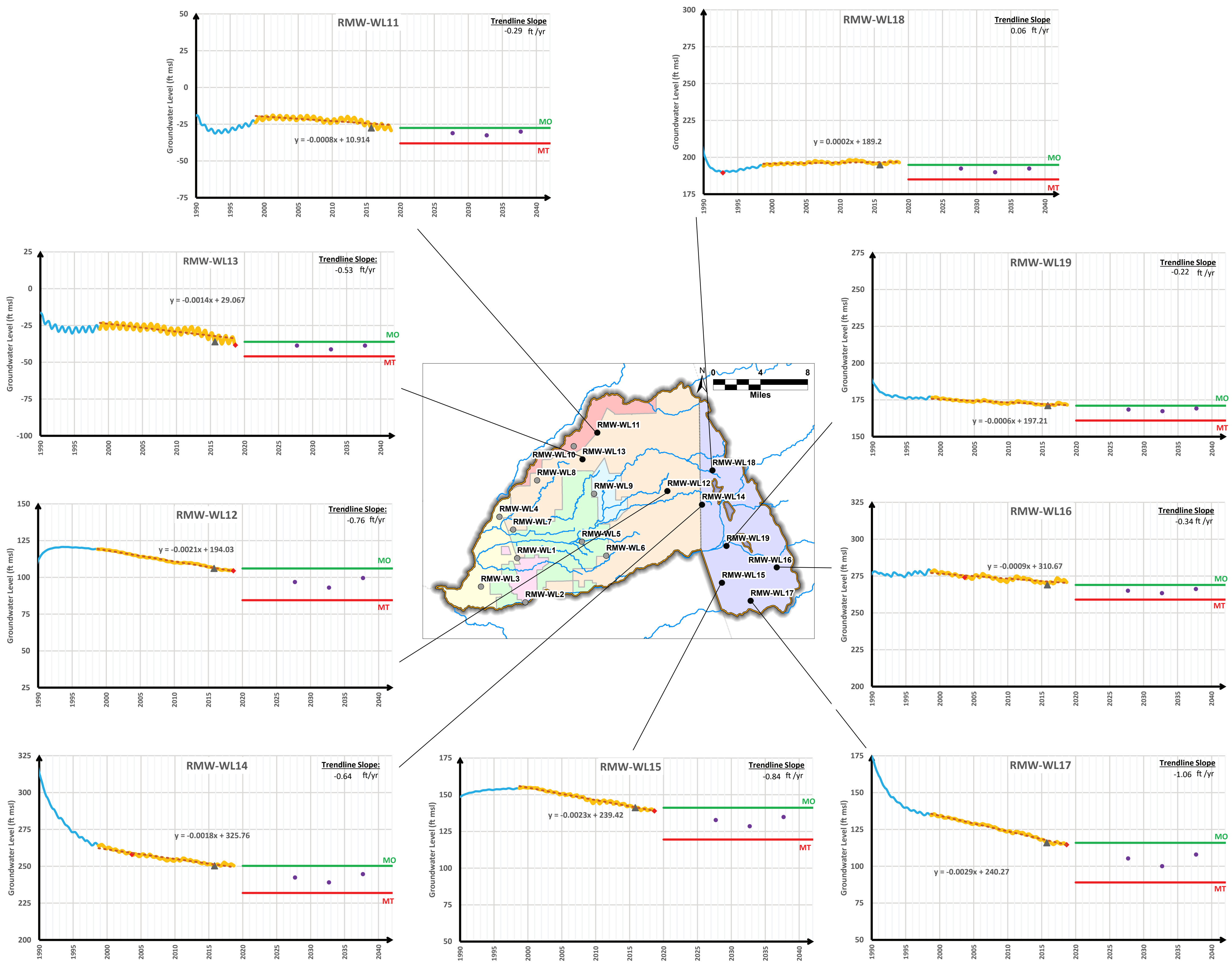
Figure SMC-1a



Legend:

- Hydrograph
- Trend Period
- Linear (Trend Period)
- Measurable Objective
- Minimum Threshold
- Interim Milestone
- Historical Low
- Fall 2015
- Cosumnes Subbasin (5-022.16)

Groundwater Sustainability Agency

- Amador County Groundwater Management Authority
- City of Galt
- Clay Water District
- Galt Irrigation District
- Omochumne-Hartnell Water District
- Sacramento County
- Sloughhouse Resource Conservation District
- County Line
- Major Stream
- RMW-WL

Abbreviations:

DWR = California Department of Water Resources
ft msl = feet above mean sea level
ft/yr = feet per year
MO = Measurable Objective
MT = Minimum Threshold
RMW-WL = Representatitve Monitoring Well for Chronic Lowering of Water Levels

Notes:

1. All locations are approximate.
2. See Figure SMC-1a for RMW-WL1 through RMW-WL10.
3. Model-calculated water levels adjusted to match measured Fall 2015 or most recent water level exactly.

Water Level Sustainability Criteria - Hydrograph Analysis

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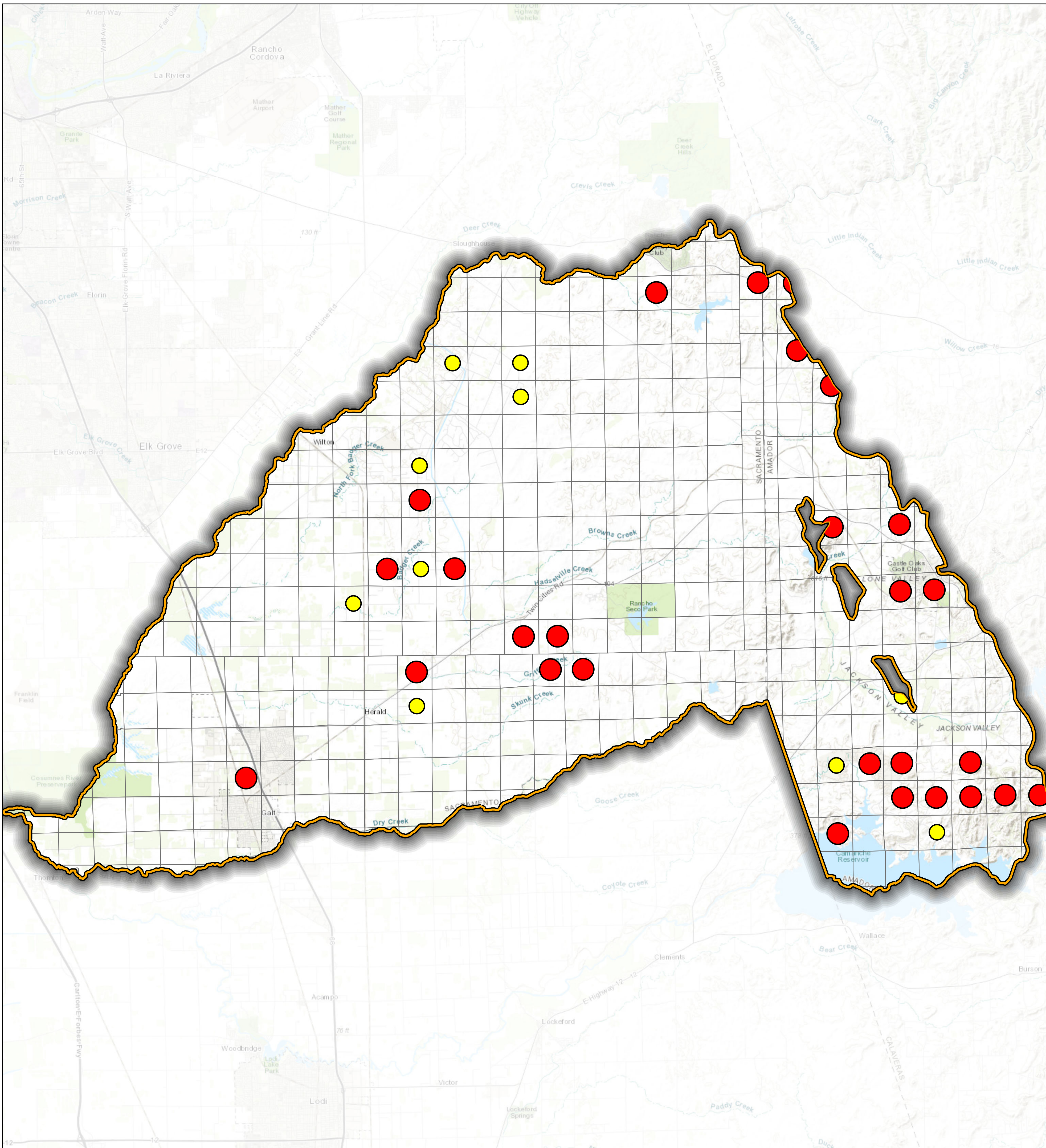
Figure SMC-1b



Legend

Wells

Partially Dewatered at Minimum Threshold

Fully Dewatered at Minimum Threshold

Cosumnes Subbasin (5-022.16)

Section Number

Abbreviations

DWR = California Department of Water Resources
MO = Measurable Objective.
MT = Minimum Threshold

Notes

1. All locations are approximate.
2. Points represent sections that experience dewatered wells at the MT or MO.
3. Number of wells vary by section.
4. Only domestic wells are included in this analysis.
5. Wells over 40 years old are excluded.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.
3. California Department of Water Resources Online Well Completion Report database.

N

0 3 6

(Scale in Miles)

Well Impact Analysis

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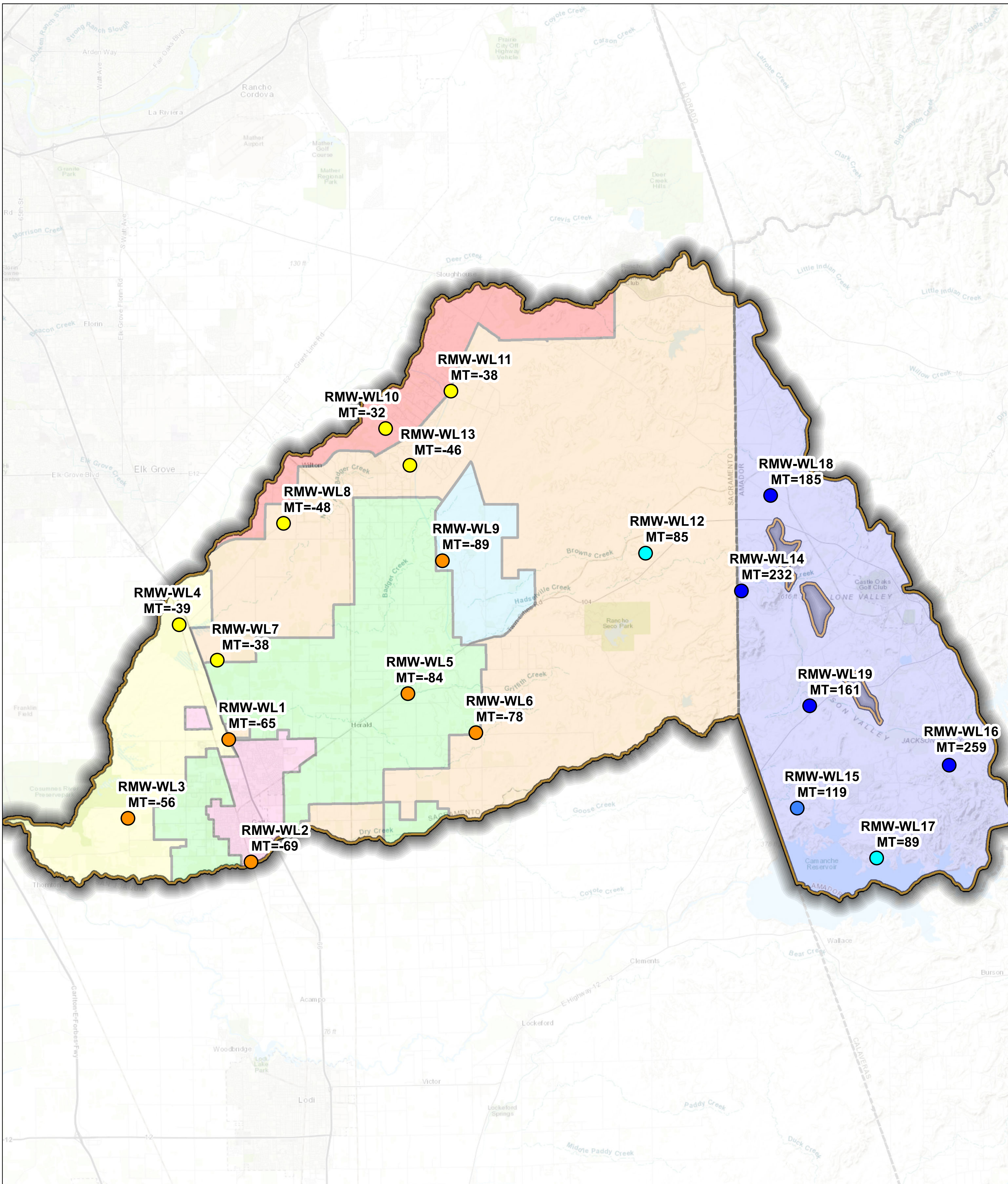
Figure SMC-2

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\SMC-2 Well Impact.mxd



Legend

Minimum Threshold (ft msl)

- -100 to -50
- -50 to 0
- 0 to 50
- 50 to 100
- 100 to 150
- > 150

Cosumnes Subbasin (5-022.16)

Groundwater Sustainability Agency

- Amador County Groundwater Management Authority
- City of Galt
- Clay Water District
- Galt Irrigation District
- Omochumne-Hartnell Water District
- Sacramento County
- Sloughhouse Resource Conservation District

Abbreviations

DWR = California Department of Water Resources
ft msl = feet above mean sea level
MT= Minimum Threshold
RMW-WL = Representative Monitoring Network for Chronic Lowering of Groundwater Level

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118- Final Prioritization, dated February 2019.

N 0 3 6 (Scale in Miles)

Water Level Minimum Thresholds

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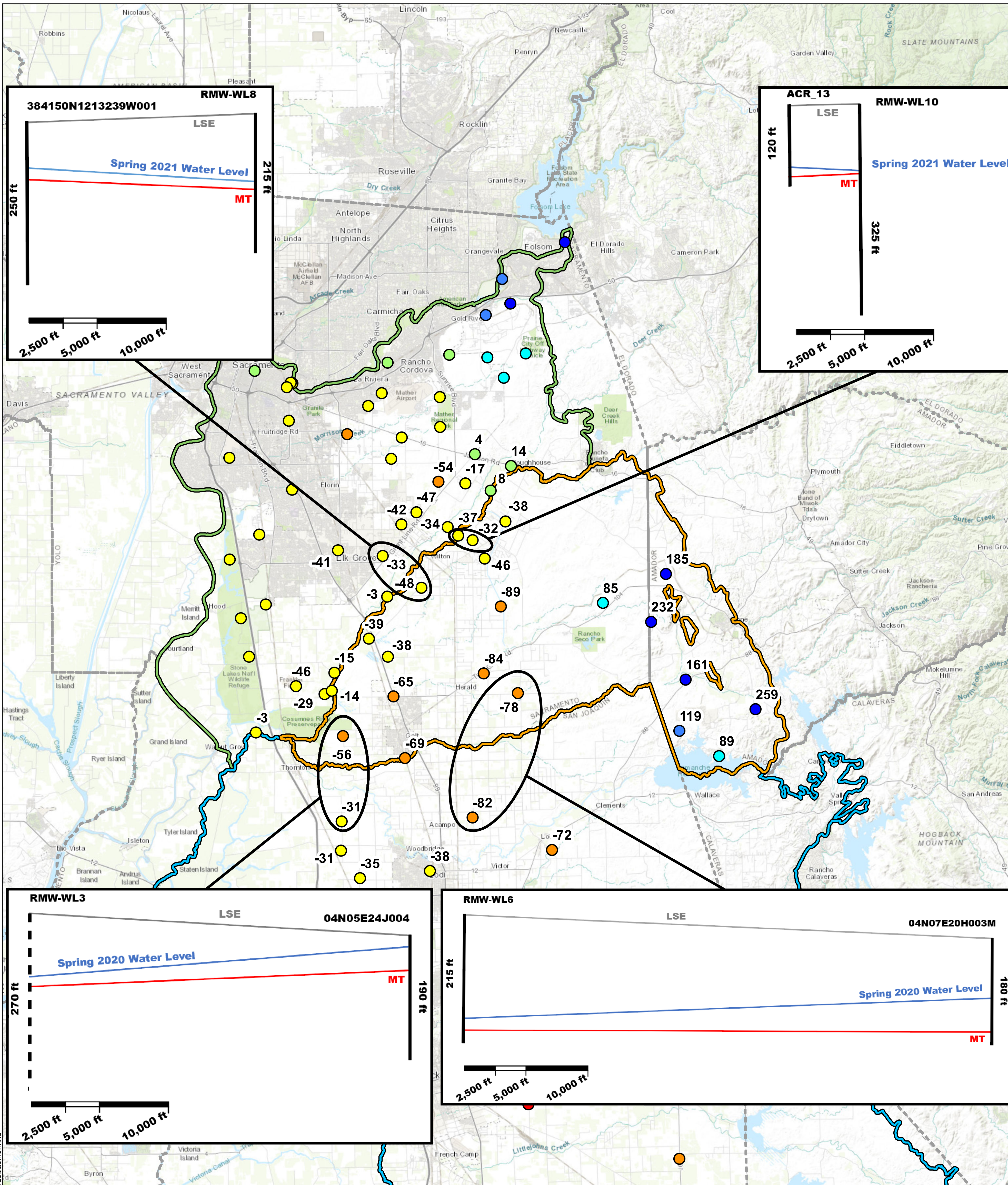
Figure SMC- 3

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\SMC-3 Water Level Minimum Thresholds.mxd



Legend

Minimum Threshold (ft msl)

- < -100
- -100 to -50
- -50 to 0
- 0 to 50
- 50 to 100
- 100 to 150
- > 150

- Cosumnes Subbasin (5-022.16)
- Eastern San Joaquin Subbasin (5-022.01)
- South American Subbasin (5-021.65)
- Well Depth
- Well Depth Unknown
- Minimum Threshold
- Land Surface Elevation
- Groundwater Elevation

Notes

1. All locations are approximate.
2. Depth of RMW-WL3 is unknown, therefore the average well depth in the Basin was used as a proxy.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019
3. ESJ well locations and MT values from ESJ GSP. A complete copy can be found here: http://www.esjgroundwater.org/
4. South American Subbasin well location data provided by Larry Walker and Associates, 9 June 2021.

N 0 6 12 (Scale in Miles)

Abbreviations

DWR = California Department of Water Resources
ESJ = Eastern San Joaquin
ft = feet
ft msl = feet above mean sea level
GSP = Groundwater Sustainability Plan
GWE = Groundwater Elevation
LSE = Land Surface Elevation
MT = Minimum Threshold
RMW-WL = Representative Moniotring Network for Chronic Lowering of Groundwater Levels

Comparison of Water Level Minimum Thresholds witth Adjacent Subbasins

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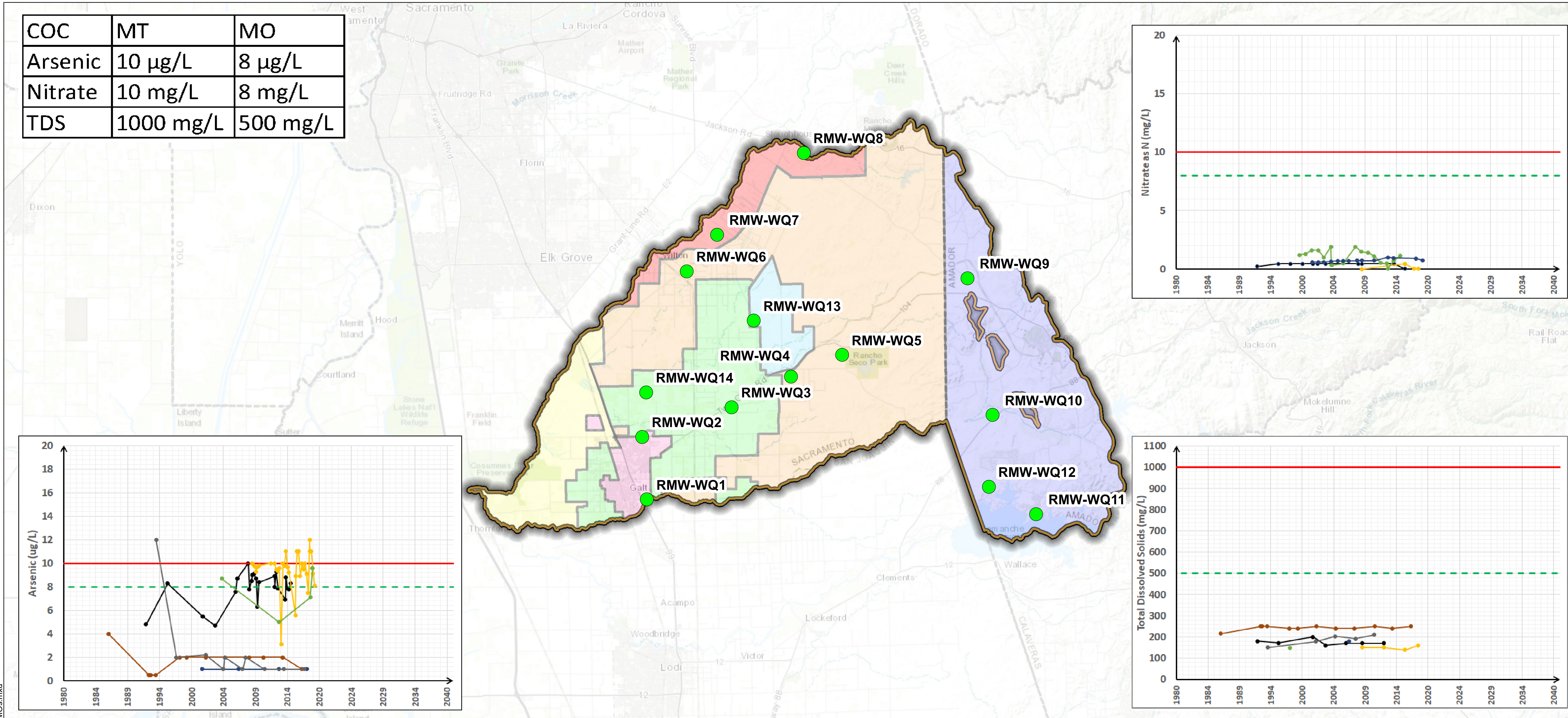
Figure SMC- 4

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\SMC-4 Comparison of Water Level MTs with Adjacent Subbasins.mxd

COC	MT	MO
Arsenic	10 µg/L	8 µg/L
Nitrate	10 mg/L	8 mg/L
TDS	1000 mg/L	500 mg/L



Legend

RMW-WQ

Cosumnes Subbasin (5-022.16)

Minimum Threshold

Measurable Objective

RMW-WQ1

RMW-WQ2

RMW-WQ5

RMW-WQ6

RMW-WQ11

RMW-WQ12

Groundwater Sustainability Agency

Amador County Groundwater Management Authority

City of Galt

Clay Water District

Galt Irrigation District

Omochumne-Hartnell Water District

Sacramento County

Sloughhouse Resource Conservation District

Abbreviations

COC = Constituents of Concern
DWR = California Department of Water Resources
mg/L = milligrams per liter
MO = Measureable Objective
MT = Minimum Threshold
RMW-WQ = Representative Monitoring Well for Degraded Water Quality
TDS = Total Dissolved Solids
µg/L = microgram per liter

Notes

1. All locations are approximate.
2. Nitrate concentrations are shown in nitrogen (N).
3. Historic water quality data not availible for RMW-WQ3, RMW-WQ4, RMW-WQ7, RMW-WQ8, RMW-WQ9, RMW-WQ10, RMW-WQ13 and RMW-WQ14.
4. Historic Nitrate data not availible for RMW-WQ11 and RMW-WQ12.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.

N 0 6 12 (Scale in Miles)

Water Quality Minimum Thresholds and Measurable Objectives

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Figure SMC-5

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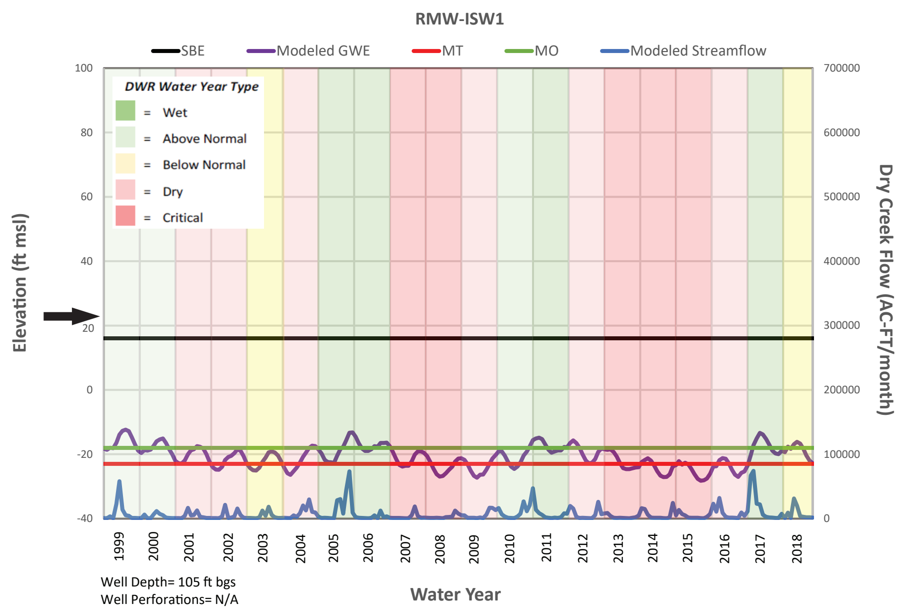
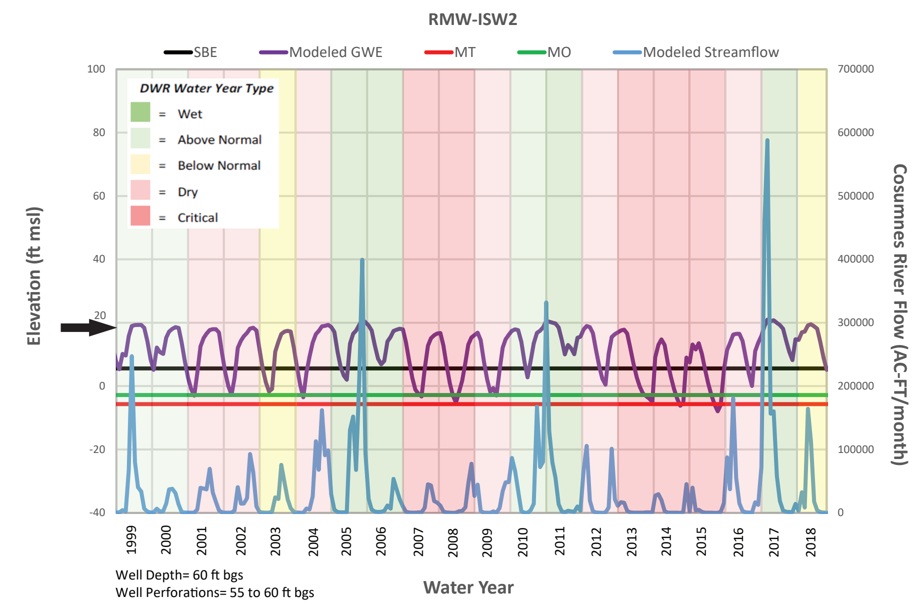
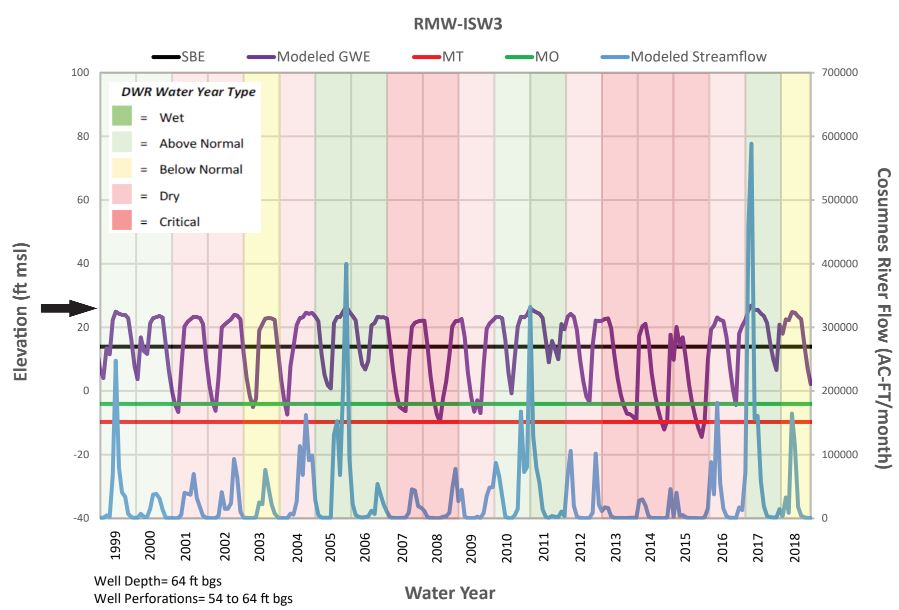
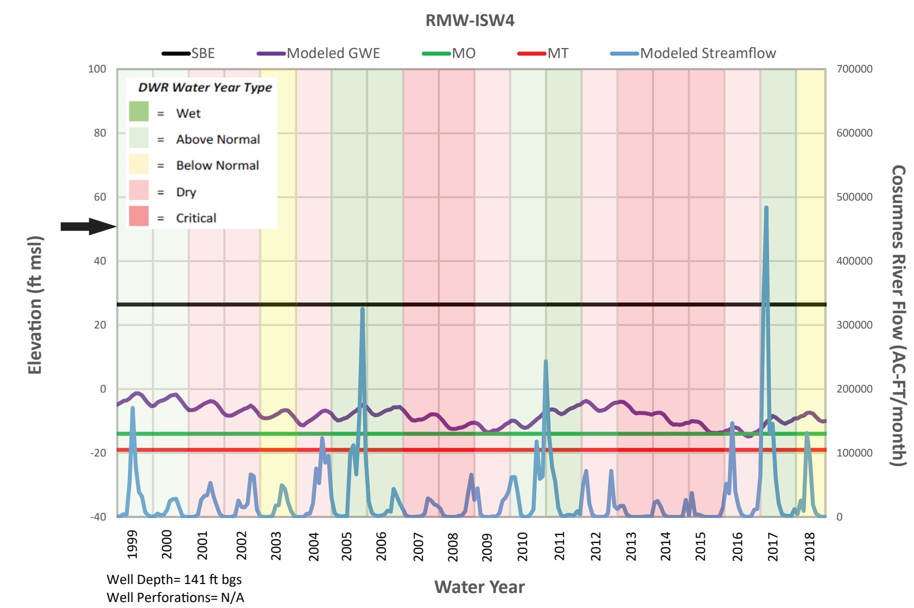
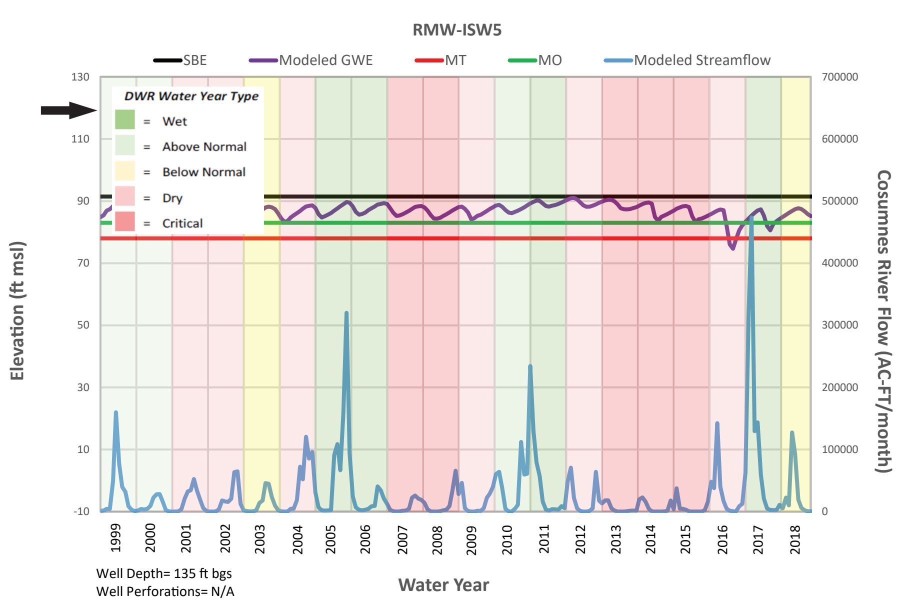
Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\SMC-5 Water Quality MTs and MOs.mxd

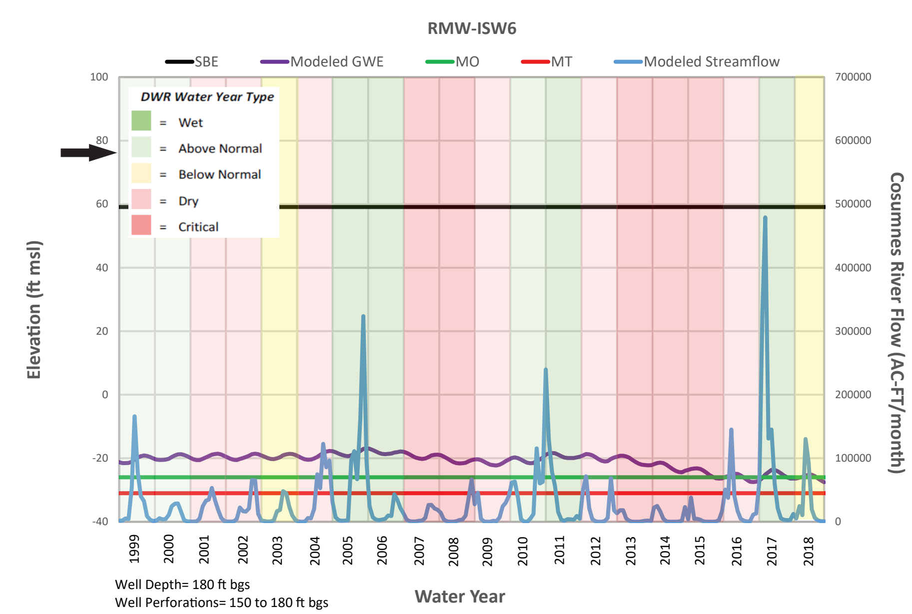












Legend:

Modeled Groundwater Elevation
MO
MT
Streambed Elevation
Modeled Streamflow
Ground Surface Elevation
RMW-ISW
Major Stream
Cosumnes Subbasin (5-022.16)
County Line

DWR Water Year Types

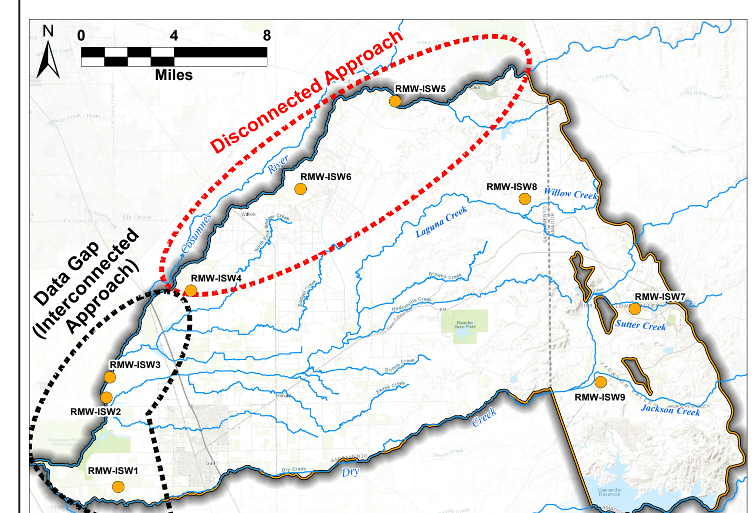
= Wet
= Above Normal
= Below Normal
= Dry
= Critical

Abbreviations:

AC-FT = acre-feet
DWR = California Department of Water Resources
ft bgs = feet below ground surface
ft msl = feet above mean sea level
GWE = Groundwater elevation
MO = Measurable Objective
MT = Minimum Threshold
N/A = not available
RMW-ISW = Represenatitve Monitoring Well for Interconnected Surface Waters
SBE = Streambed elevation

Notes:

1. All locations are approximate.
2. Streamflow is model-calcuallted Dry Creek streamflow for RMW-ISW1.
3. Streamflow is model-calculated Cosumnes River streamflow for RMW-ISW2 through RMW-ISW6.
4. Model-calculated water levels adjusted to match measured Fall 2015 or most recent water level exactly.
5. Ground surface elevations are reported in Table MN-4 and marked with an arrow on each graph.



Interconnected Surface Water Sustainability Criteria - Hydrograph Analysis

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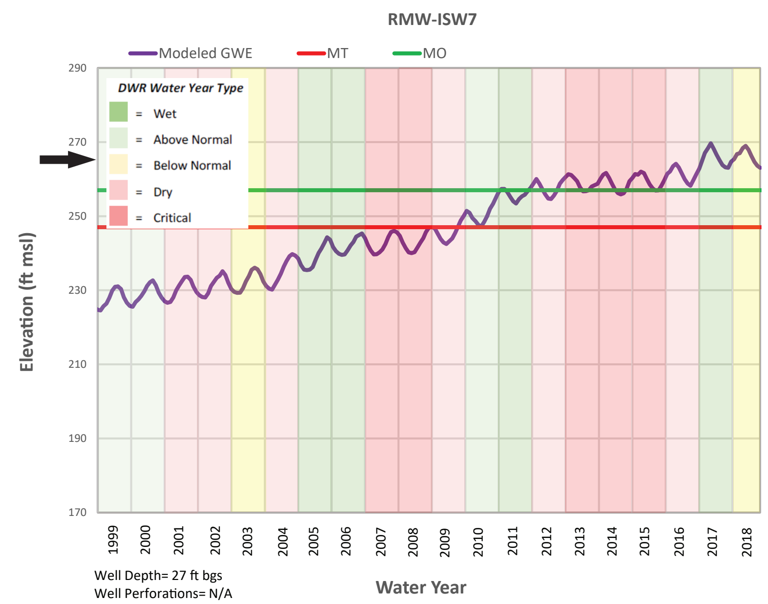
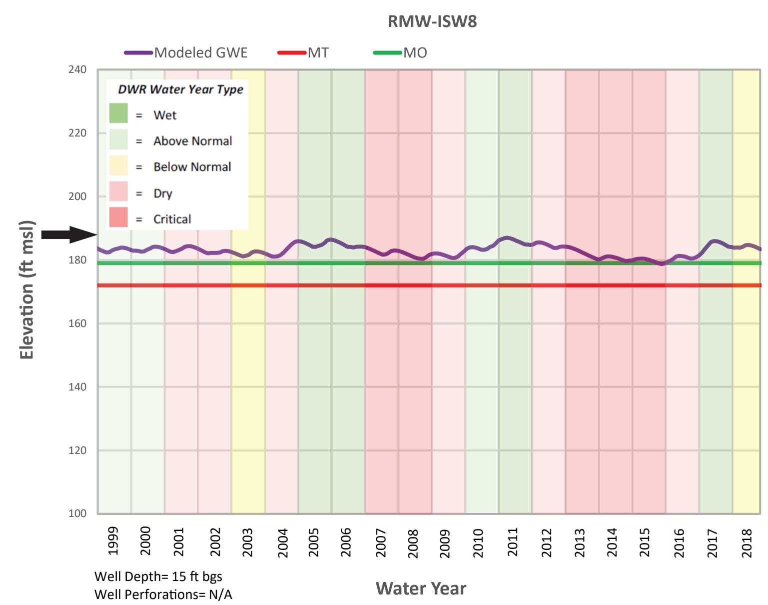
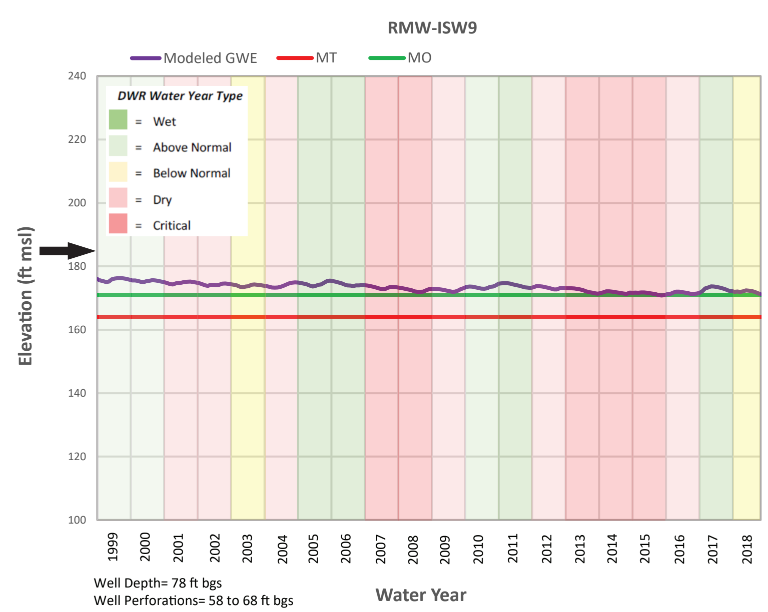
Figure SMC-6a







Legend:

Modeled Groundwater Elevation
MO
MT
Ground Surface Elevation
RMW-ISW
Major Stream
Cosumnes Subbasin (5-022.16)
County Line

DWR Water Year Types

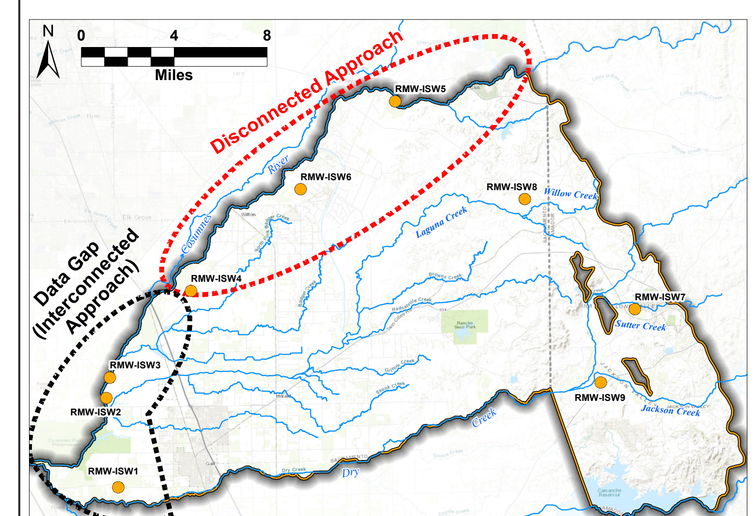
= Wet
= Above Normal
= Below Normal
= Dry
= Critical

Abbreviations:

AC-FT	= acre-feet
DWR	= California Department of Water Resources
ft bgs	= feet below ground surface
ft msl	= feet above mean sea level
GWE	= Groundwater elevation
MO	= Measurable Objective
MT	= Minimum Threshold
N/A	= not available
RMW-ISW	= Represenatitve Monitoring Well for Interconnected Surface Waters

Notes:

1. All locations are approximate.
2. Model-calculated water levels adjusted to match measured Fall 2015 or most recent water level exactly.
3. Ground surface elevations are reported in Table MN-4 and marked with an arrow on each graph.



Interconnected Surface Water Sustainability Criteria - Hydrograph Analysis

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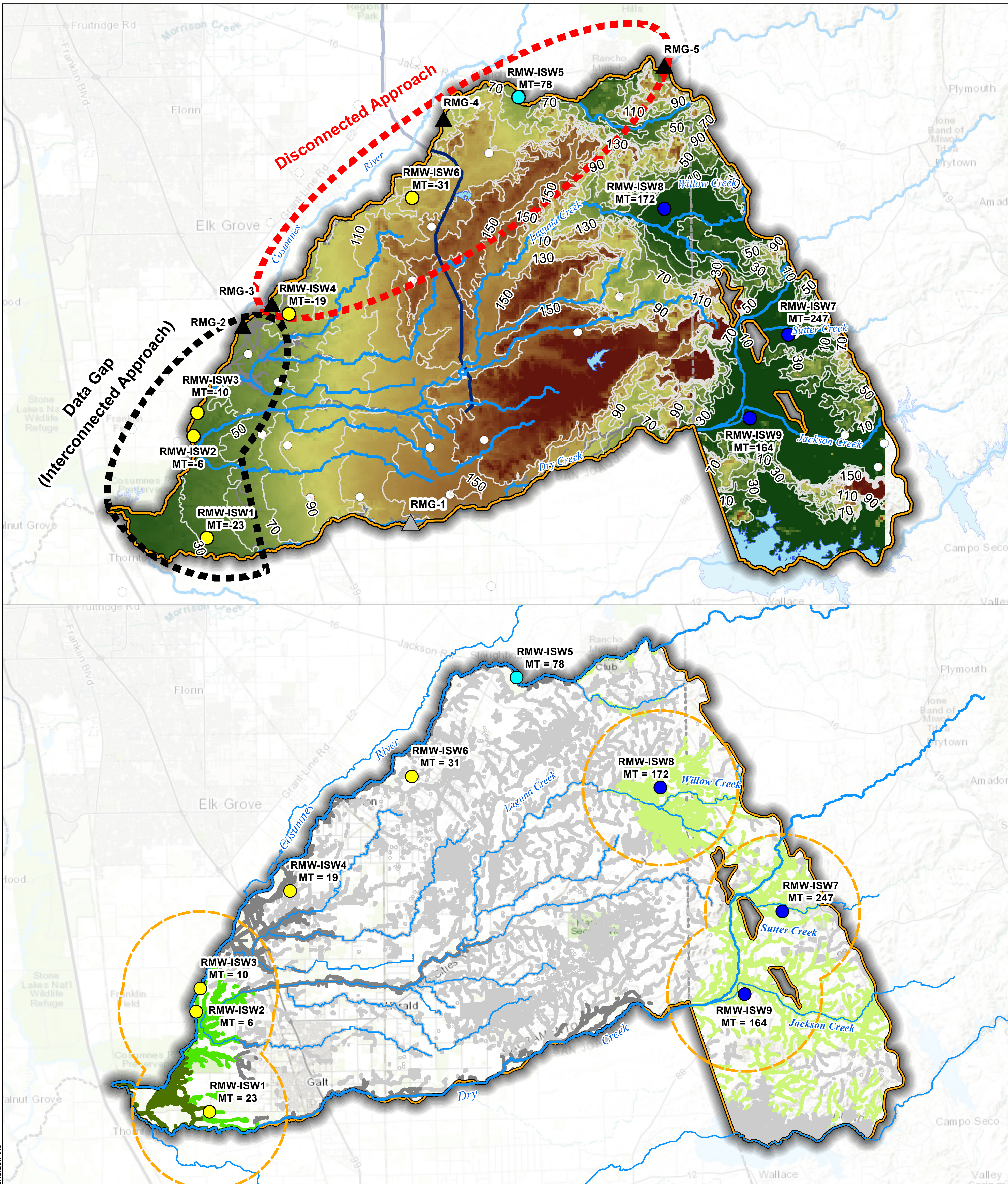
Figure SMC-6b



Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\SMC-7 Interconnected Surface Water Minimum Thresholds.mxd

Legend

Minimum Threshold (ft msl)

- -50 to 0
- 0 to 50
- 50 to 100
- 100 to 150
- > 150

Representative Monitoring Gage

- Active
- Inactive
- Major Stream
- Folsom South Canal
- Reservoir
- Cosumnes Subbasin (5-022.16)
- 3 mile Buffer

- Well with Fall 2018 Depth to Water Measurement (ft bgs)
- Fall 2018 Depth to Water Contour (ft bgs)

Depth to Groundwater (ft bgs)

Deep : 200

Shallow : 0

GDE Evaluation Results

- Confirmed GDE
- Assumed Confirmed GDE
- Unknown (uncertain water table conditions and conservatively assumed GDE)
- Not GDE (supported by surface water and/ or perched water rather than Principal Aquifer)
- Not GDE (disconnected from water table)

Abbreviations

DWR = California Department of Water Resources
GDE = Groundwater Dependant Ecosystem
RMG= Representative Monitoring Gauge
ft msl = feet above mean sea level
MT= Minimum Threshold
RMW-ISW = Representative Monitoring Well for Interconnected Surface Water

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.

N 0 3 6 (Scale in Miles)

Interconnected Surface Water Minimum Thresholds

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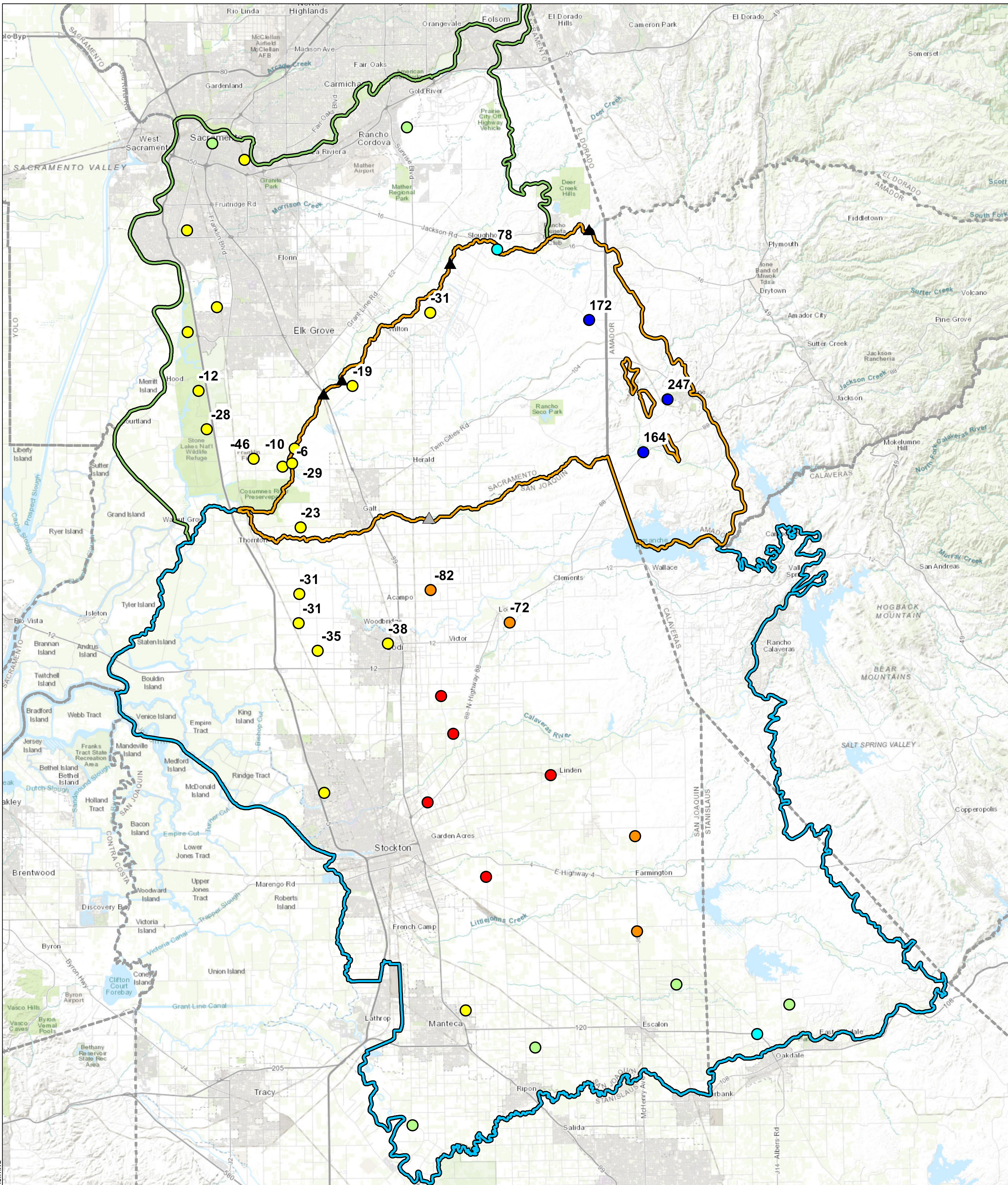
Figure SMC-7



Legend

Minimum Threshold (ft msl)

- < -100
- -100 to -50
- -50 to 0
- 0 to 50
- 50 to 100
- 100 to 150
- > 150

Cosumnes Subbasin (5-022.16)

Eastern San Joaquin Subbasin (5-022.01)

South American Subbasin (5-021.65)

Representative Monitoring Gage

- Active
- Inactive

Abbreviations

DWR = California Department of Water Resources

ft msl= feet above mean sea level

MT= Minimum Threshold

ESJ = Eastern San Joaquin

GSP = Groundwater Sustainability Plan

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118- Final Prioritization, dated February 2019.
3. ESJ well locations and MT values from ESJ GSP. A complete copy can be found here: http://www.esjgroundwater.org/
4. South American Subbasin well location data provided by Larry Walker and Associates, 9 June 2021.

N 0 6 12 (Scale in Miles)

Comparison of Interconnected Surface Water Minimum Thresholds with Adjacent Subbasins

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Figure SMC-8

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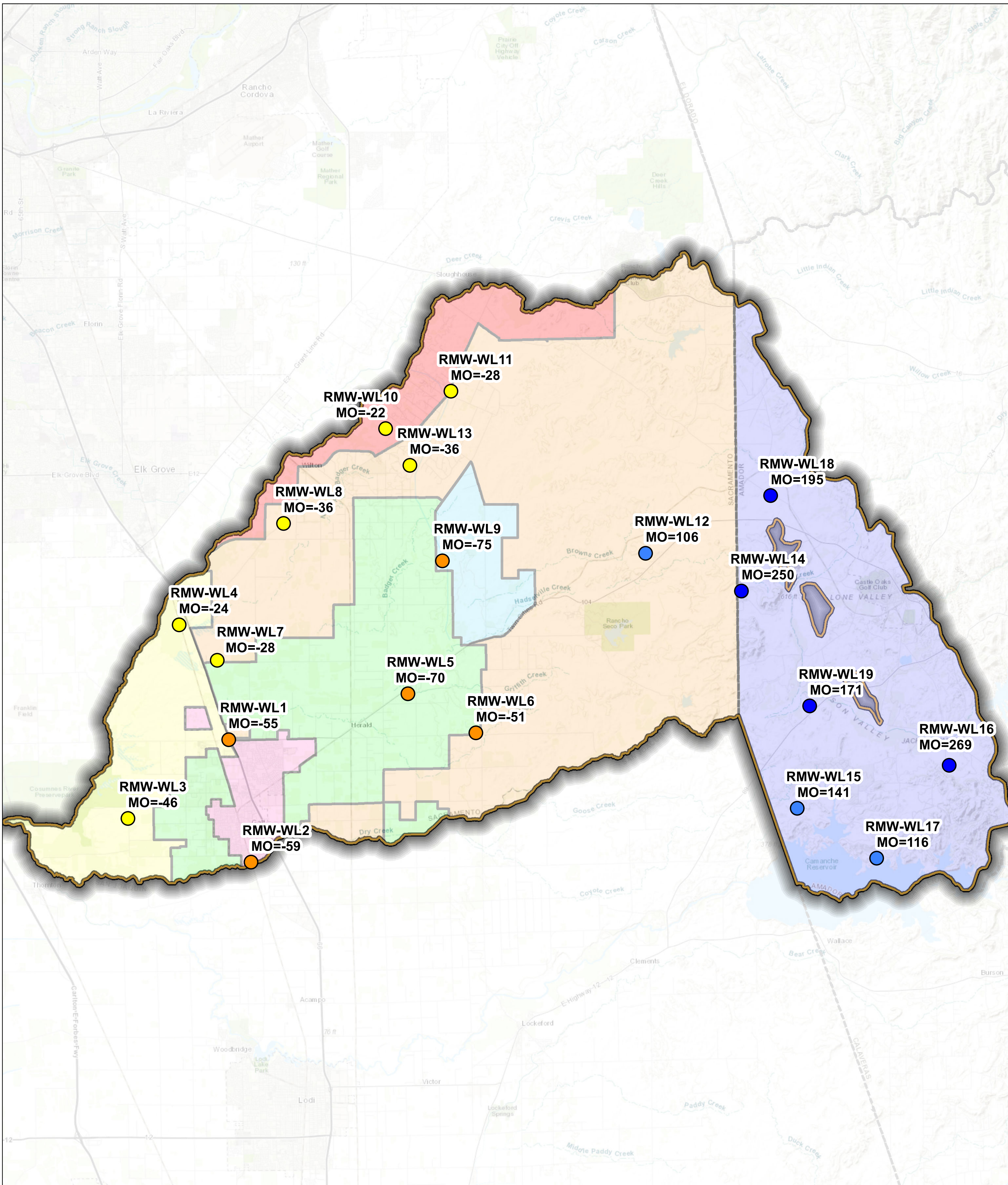
Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\SMC-8 Comparison of ISW MTs with Adjacent Subbasins.mxd



Legend

Measurable Objective (ft msl)

- -100 to -50
- -50 to 0
- 0 to 50
- 50 to 100
- 100 to 150
- > 150

Cosumnes Subbasin (5-022.16)

Groundwater Sustainability Agency

- Amador County Groundwater Management Authority
- City of Galt
- Clay Water District
- Galt Irrigation District
- Omochumne-Hartnell Water District
- Sacramento County
- Sloughhouse Resource Conservation District

Abbreviations

DWR = California Department of Water Resources
ft msl = feet above mean sea level
MO= Measurable Objective
RMW-WL= Representative Monitoring Network for Chronic Lowering of Groundwater Level

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.

N 0 3 6 (Scale in Miles)

Water Level Measurable Objectives

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Figure SMC-9

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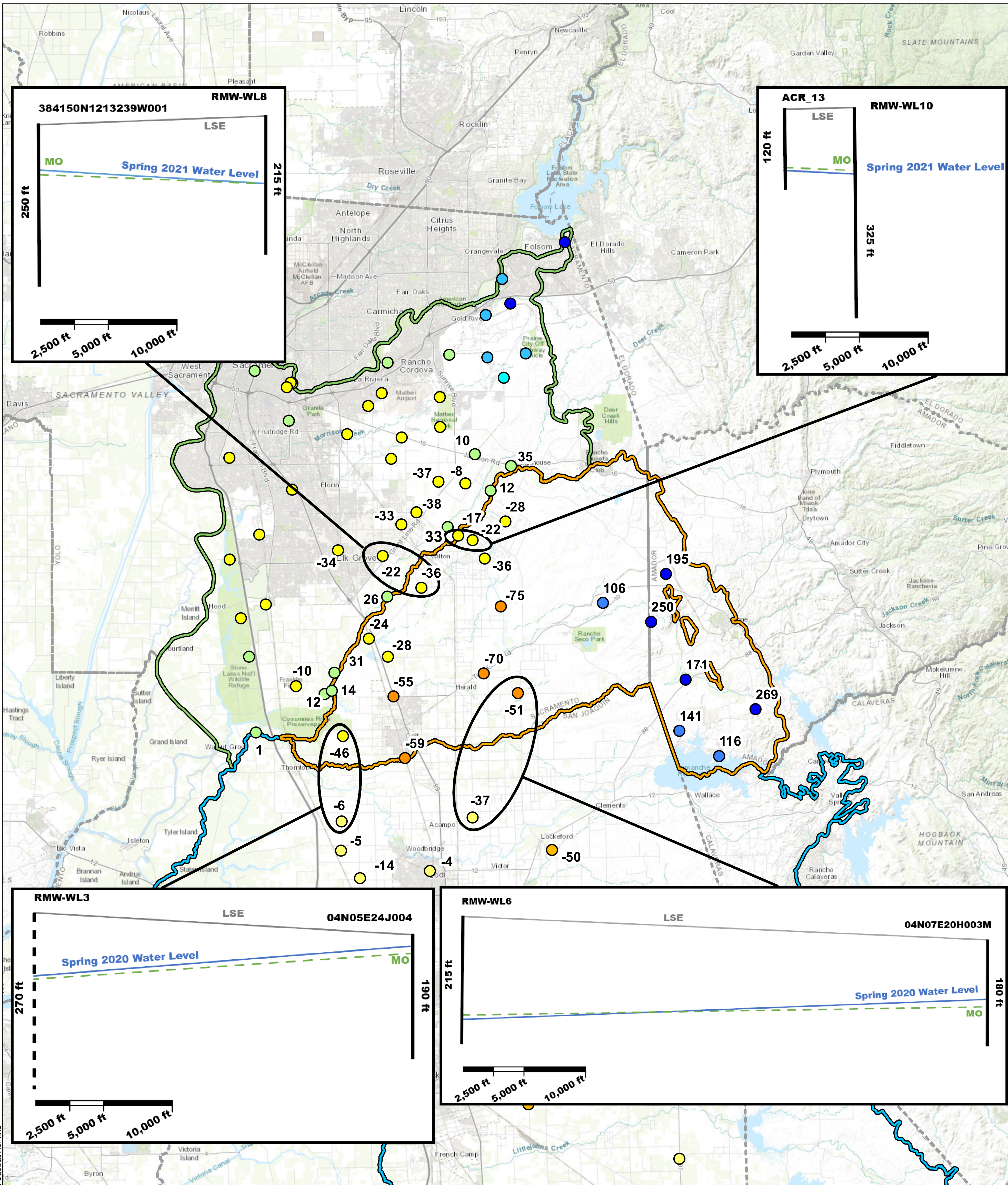
Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\SMC-9 Water Level Measurable Objectives.mxd



Legend

Measurable Objective (ft msl)

- -100 to -50
- -50 to 0
- 0 to 50
- 50 to 100
- 100 to 150
- > 150

- Cosumnes Subbasin (5-022.16)
- Eastern San Joaquin Subbasin (5-022.01)
- South American Subbasin (5-021.65)
- Well Depth
- Well Depth Unknown
- Measurable Objective
- Land Surface Elevation
- Groundwater Elevation

Notes

1. All locations are approximate.
2. Depth of RMW-WL3 is unknown, therefore the average well depth in the Basin was used as a proxy.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.
3. ESJ well locations and MO values from ESJ GSP. A complete copy can be found here: http://www.esjgroundwater.org/
4. South American Subbasin well location data provided by Larry Walker and Associates, 9 June 2021.

N

0 6 12

(Scale in Miles)

Abbreviations

DWR = California Department of Water Resources
ESJ = Eastern San Joaquin
ft = feet
ft msl = feet above mean sea level
GSP = Groundwater Sustainability Plan
GWE = Groundwater Elevation
LSE = Land Surface Elevation
MO = Measurable Objective
RMW-WL = Representative Moniotring Network for Chronic Lowering of Groundwater Levels

Comparison of Water Level Measurable Objectives with Adjacent Subbasins

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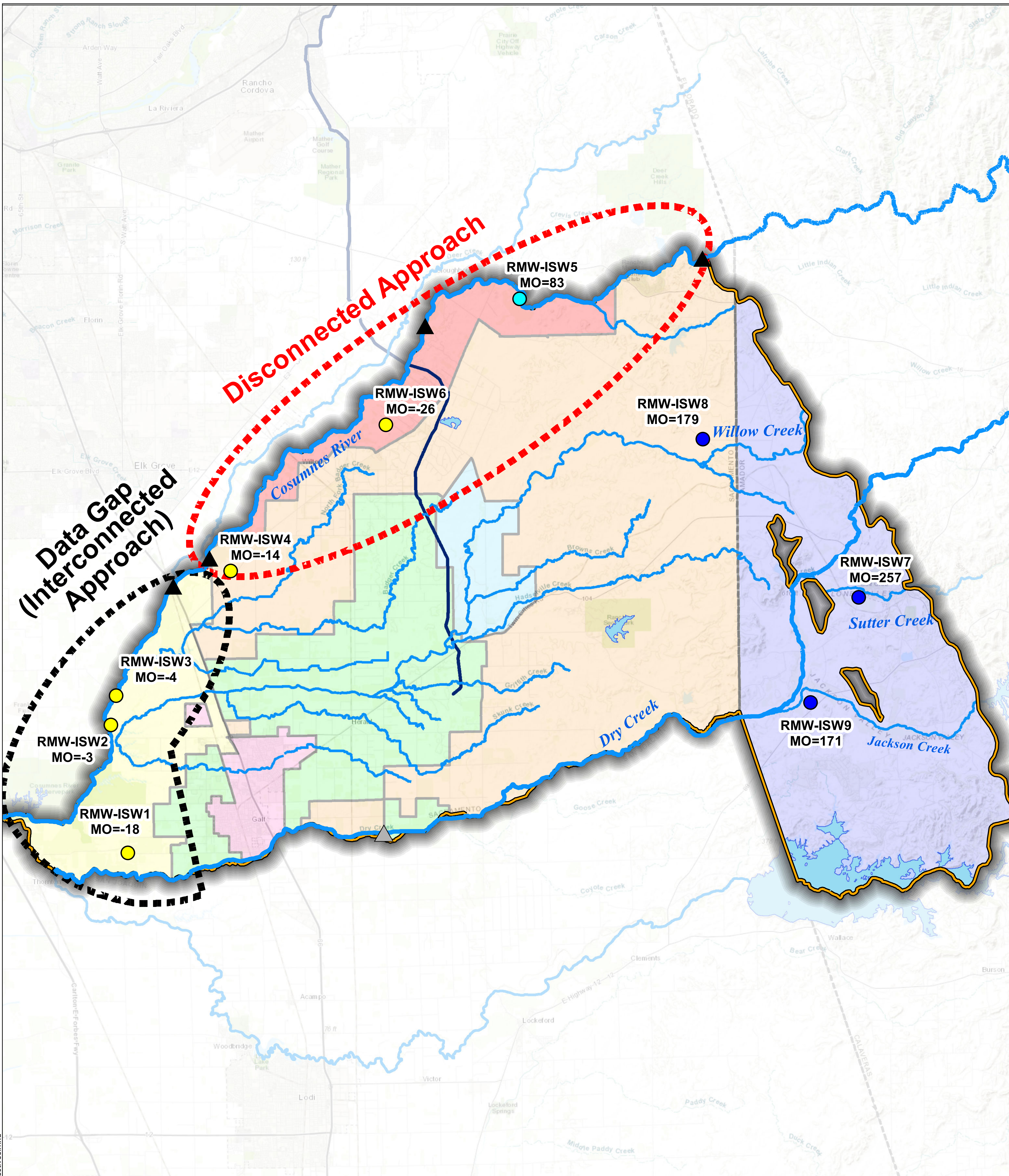
Figure SMC-10

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\SMC-10 Comparison of Water Level MOs with Adjacent Subbasins.mxd



Legend

Measurable Objective (ft msl)

- -50 to 0
- 0 to 50
- 50 to 100
- 100 to 150
- > 150

Representative Monitoring Gage

- Active
- Inactive
- Major Stream
- Folsom South Canal
- Reservoir
- Cosumnes Subbasin

Groundwater Sustainability Agency

- Amador County Groundwater Management Authority
- City of Galt
- Clay Water District
- Galt Irrigation District
- Omochumne-Hartnell Water District
- Sacramento County
- Sloughhouse Resource Conservation District

Abbreviations

DWR = California Department of Water Resources
ft msl = feet above mean sea level
MO= Measurable Objective
RMG= Representative Monitoring Gauge
RMW-ISW= Represnetative Montioring Well for Interconnected Surface Waters

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater Bulletin 118 - Final Prioritization, dated February 2019.

N 0 3 6 (Scale in Miles)

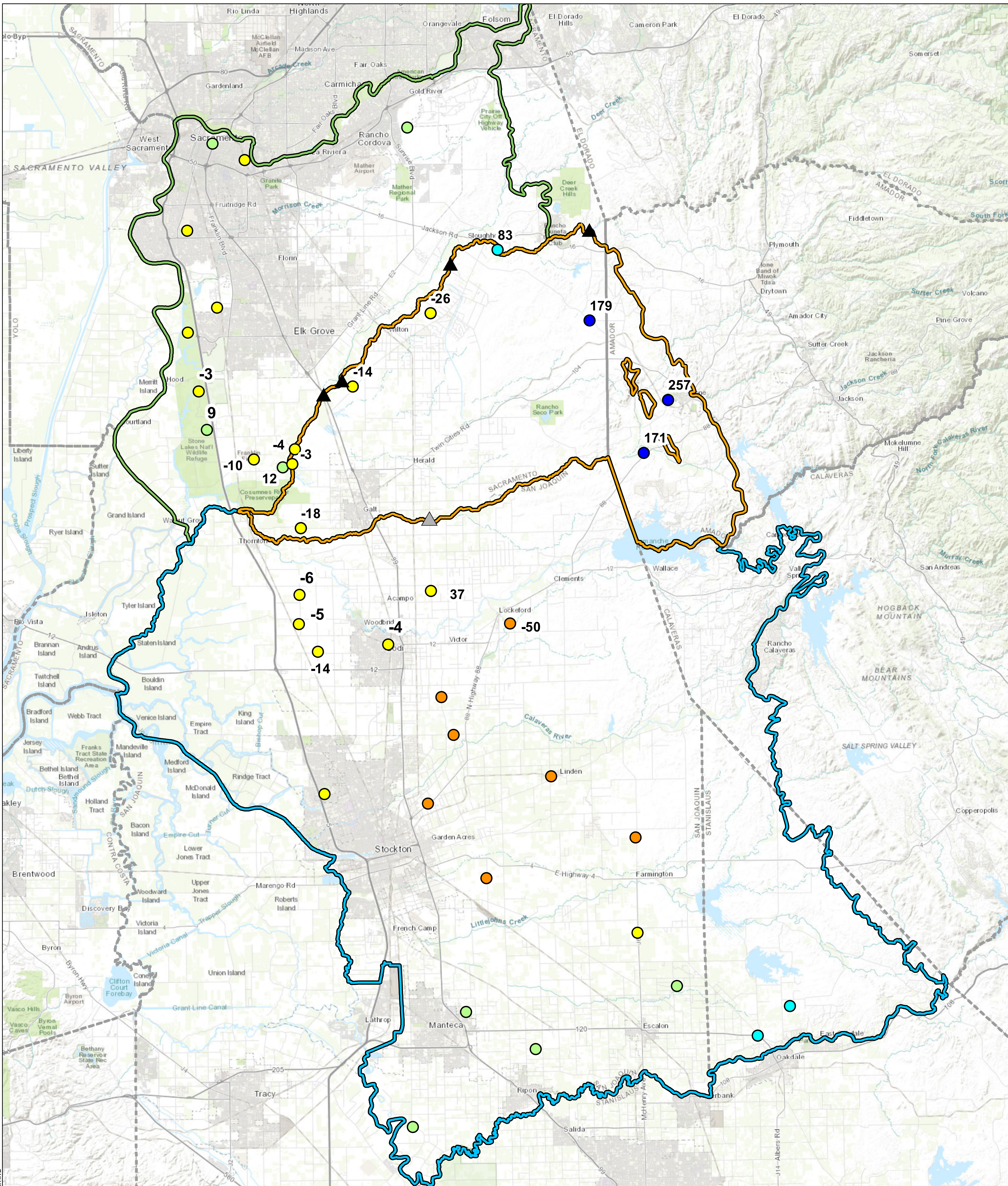
Interconnected Surface Water Measurable Objectives

Working Group
Cosumnes Subbasin
December 2021
B80081.00

eki environment & water

Figure SMC -11

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\SMC-11 Interconnected Surface Water Measurable Objectives.mxd



Legend

Measurable Objective

-100 to -50

-50 to 0

0 to 50

50 to 100

100 to 150

> 150

Representative Monitoring Gage

Active

Inactive

Cosumnes Subbasin (5-022.16)

Eastern San Joaquin Subbasin (5-022.01)

South American Subbasin (5-021.65)

Abbreviations

DWR = California Department of Water Resources

ft msl= feet above mean sea level

ISW = Interconnected Surface Water

ESJ = Eastern San Joaquin

GSP = Groundwater Sustainability Plan

MO = Measurable Objective

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.
3. ESJ well locations and MT values from ESJ GSP. A complete copy can be found here: http://www.esjgroundwater.org/
4. South American Subbasin well location data provided by Larry Walker and Associates, 9 June 2021.

N 0 6 12 (Scale in Miles)

Comparison of Interconnected Surface Water Measurable Objectives with Adjacent Subbasins

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December 2021
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Figure SMC-12

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\SMC-12 Comparison of ISW MOs with Adjacent Basins.mxd

MONITORING NETWORK

17. MONITORING NETWORK

§ 354.32. Introduction to Monitoring Networks

This Subarticle describes the monitoring network that shall be developed for each basin, including monitoring objectives, monitoring protocols, and data reporting requirements. The monitoring network shall promote the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan.

This section describes the Sustainable Groundwater Management Act (SGMA) monitoring network in the Cosumnes Subbasin (Basin), subsequently referred to as the "SGMA Monitoring Network." Pursuant to the Groundwater Sustainability Plan (GSP) Regulations (23-California Code of Regulations [CCR] Division 2 Chapter 1.5 Subchapter 2), the objective of the design and management of the SGMA Monitoring Network is to collect sufficient data to support assessment of the Sustainability Indicators relevant to the Basin, and the impacts to the beneficial uses and users of groundwater.

Per 23-CCR § 354.32(e), the SGMA Monitoring Network incorporates elements, to the extent possible, from existing monitoring programs that are active within the Basin (see Section 5.2.1 *Existing Monitoring and Management Programs*) and includes additional components to comply with the GSP Regulations. All monitoring will be performed in accordance with the protocols developed for the Basin, as described below in Section 17.2 *Protocols for Data Collection and Monitoring.*

17.1. Description of Monitoring Network

§ 354.34. Monitoring Network

(a) Each Agency shall develop a monitoring network capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions, and yield representative information about groundwater conditions as necessary to evaluate Plan implementation.

(b) Each Plan shall include a description of the monitoring network objectives for the basin, including an explanation of how the network will be developed and implemented to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater, with sufficient temporal frequency and spatial density to evaluate the affects and effectiveness of Plan implementation. The monitoring network objectives shall be implemented to accomplish the following:

(1) Demonstrate progress toward achieving measurable objectives described in the Plan.

(2) Monitor impacts to the beneficial uses or users of groundwater.

(3) Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.

(4) Quantify annual changes in water budget components.

…

(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.

(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.

(f) The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:

(1) Amount of current and projected groundwater use.

(2) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.

(3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.

(4) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.

(g) Each Plan shall describe the following information about the monitoring network:

(1) Scientific rationale for the monitoring site selection process.

(2) Consistency with data and reporting standards described in Section 352.4. If a site is not consistent with those standards, the Plan shall explain the necessity of the site to the monitoring network, and how any variation from the standards will not affect the usefulness of the results obtained.

(3) For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.

(h) The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.

§ 354.34. Monitoring Network

(i) The monitoring protocols developed by each Agency shall include a description of technical standards, data collection methods, and other procedures or protocols pursuant to Water Code Section 10727.2(f) for monitoring sites or other data collection facilities to ensure that the monitoring network utilizes comparable data and methodologies.

(j) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish a monitoring network related to those sustainability indicators.

As shown on **Figure MN-1** through **Figure MN-4**, the SGMA Monitoring Network includes multiple Representative Monitoring Sites (RMS) that include: 19 Representative Monitoring Wells for Chronic Lowering of Groundwater Levels (RMW-WLs) shown on **Figure MN-1**, 14 Representative Monitoring Wells for Degraded Water Quality (RMW-WQs) shown on **Figure MN-2**, one subsidence monitoring site shown on **Figure MN-3**, and nine shallow water table Representative Monitoring Wells for Interconnected Surface Water (RMW-ISWs) and five Representative Monitoring stream gauges (RMG) shown on **Figure MN-4.**

The objective of this SGMA Monitoring Network is to collect data with sufficient temporal frequency and adequate spatial density to evaluate GSP implementation in the Basin as it relates to:

- Monitoring short-term, seasonal, and long-term trends in groundwater and related surface water conditions;
- Demonstrating progress toward achieving the Measurable Objectives (MOs) described in the GSP*;*
- Monitoring impacts to the beneficial uses and users of groundwater;
- Monitoring changes in groundwater conditions relative to the MOs and Minimum Thresholds (MTs);
- Quantifying annual changes in water budget components; and,
- Monitoring impacts of Project and Management Actions in adjacent basins, such as the Harvest Water Project in the South American Subbasin (SASb).

The SGMA Monitoring Network consists of a series of RMSs that meet the following criteria: (1) RMSs are included in the monitoring programs already implemented by one or more of the Groundwater Sustainability Agencies (GSAs) within the Basin and/or other existing monitoring programs that are active within the Basin; (2) RMSs have been demonstrated to be representative of groundwater or other relevant conditions within the Basin; and (3) RMSs are spatially distributed and located in proximity to beneficial uses and users of groundwater (e.g., public supply wells, production wells, and potential groundwater dependent ecosystems [GDEs]). Each RMS are assigned Sustainable Management Criteria (SMCs) (e.g., MOs, MTs and Interim Milestones) to address the relevant Sustainability Indicators for the Basin[77]:

[77] As discussed below in Section 17.1.3 *Monitoring Network for Seawater Intrusion*, the Basin is at little to no risk for seawater intrusion and therefore the Sustainability Indicator is not applicable.

- Chronic Lowering of Groundwater Levels;
- Reduction of Groundwater Storage;
- Degraded Water Quality;
- Land Subsidence; and,
- Depletions of Interconnected Surface Water.

Per 23-CCR § 354.32(g), other factors considered in the development of the SGMA Monitoring Network and the selection of each RMS include:

- Availability of existing technical information about the RMS (e.g., well location, construction information, condition, status, etc.);
- Quality and reliability of historical data at the RMS;
- "Representativeness" to local groundwater conditions and nearby well populations inferred from the SGMA Monitoring Network (per 23-CCR § 354.36); and,
- Projected availability of long-term access to the RMS.

Pursuant to 23-CCR § 354.32(f), the spatial distribution, spatial density, and temporal frequency of measurements collected from each RMS is determined for each applicable Sustainability Indicator based on considerations of:

- Amount of current and projected groundwater use;
- Aquifer characteristics, including any vertical and/or lateral barriers to groundwater flow;
- Potential impacts to beneficial uses and users of groundwater, land uses and property interests affected by groundwater production, and other adjacent basins (and GSAs within the Basin); and,
- Availability of historical data to evaluate long-term trends in groundwater conditions associated with the above factors.

Table MN-1 summarizes the RMS type, site count, measured constituent(s), measurement frequency, and spatial density of the SGMA Monitoring Network for each of the relevant Sustainability Indicators mentioned above. As discussed in Section 17.3 *Representative Monitoring,* the RMW-WLs will be used as a proxy to address the Groundwater Storage and Land Subsidence Sustainability Indicators. Further details about the SGMA Monitoring Network for each Sustainability Indicator can be found in Sections 17.1.1 through 17.1.6.

Pursuant to 23-CCR § 354.32(i), in all cases the SGMA Monitoring Network will adhere to the monitoring protocols specified for the Basin as described in Section 17.2 *Protocols for Data Collection and Monitoring*.

Table MN-1. Summary of Proposed SGMA Monitoring Network

Sustainability Indicator	RMS Type	Site Count	Measurement	Measurement Frequency	Spatial Density (# sites/100 mi^2)
Chronic Lowering of Groundwater Levels	RMW-WL	19	Water Level	Semiannually	6
Reduction of Groundwater Storage	RMW-WL	19	Water Level	Semiannually	6
Degraded Water Quality	RMW-WQ	14	See constituent list in *Section 17.1.4*	Annually	4
Land Subsidence	Stationary GPS	1	Ground Surface Elevation	Daily	NA
	RMW-WL	19	Water Level	Semiannually	6
Depletions of Interconnected Surface Water	RMW-ISW	9	Water Level	Daily	NA[1]
	RMG	5	Stage and/or Streamflow	Daily	NA[1]

Abbreviations:
GPS = Global Positioning System
mi^2 = square miles
NA = not applicable
RMG = Representative Monitoring Gauge
RMS = Representative Monitoring Site
RMW-ISW = Representative Monitoring Well for Depletions of Interconnected Surface Water
RMW-WL = Representative Monitoring Well for Chronic Lowering of Groundwater Levels
RMW-WQ = Representative Monitoring Well for Degraded Water Quality

Notes:
(1) The number of gauges and wells is determined by local hydrogeologic conditions (i.e., where there is known surface water groundwater connection), sections where diversion and return flows are known (or don't exist), and the number and length of interconnected surface water bodies.

17.1.1. Monitoring Network for Chronic Lowering of Groundwater Levels

§ 354.34. Monitoring Network

(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:
(1) Chronic Lowering of Groundwater Levels. Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:
(A) A sufficient density of monitoring wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.
(B) Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.

Semiannual monitoring events shall be conducted during March and October to characterize changes in long-term groundwater level trends in the Basin's Principal Aquifer. The SGMA Monitoring Network for Chronic Lowering of Groundwater Levels consists of 19 RMW-WLs, a network of supplemental wells, and planned wells, to be drilled as part of the Basin GSP Development and Well Installation Project, distributed across the Basin. Sustainable Management Criteria (SMCs) are not established for the supplemental wells, but the data collected are used to confirm the representativeness of each RMS and support the wider understanding of the Basin's hydrology and response to Projects and Management Actions (PMAs). Specific details regarding these RMW-WL wells are listed in **Table MN-2**, and the RMW-WL well locations are shown on **Figure MN-1**. Per 23-CCR § 354.32(e), the selection of these RMW-WLs has been informed by the existing local monitoring programs, including the California Statewide Groundwater Elevation Monitoring (CASGEM) program and GSA monitoring programs, and leverages historical data wherever possible, to help assess and quantify Basin response to GSP implementation relative to historical and projected future groundwater conditions. The selection of the RMW-WLs was based on the following considerations:

- **Current and projected groundwater use** – To the extent possible, the RMW-WLs are located within and near the major urban water use area (i.e., near the City of Galt), distributed across the Basin Plain agricultural water use area, located near pumping centers in the Basin Foothills, and located near the Basin boundaries, which are defined by Cosumnes River and Dry Creek. The RMW-WLs located near these boundary surface water features will preferably have companion wells in the adjacent basins so that water levels and SMCs can be compared and hydraulic connections across the basin boundaries can be evaluated.
- **Aquifer characteristics** – All of the RMW-WLs screen the alluvial materials that form the Basin's Principal Aquifer. The well depths and screen lengths are variable and can intercept one or more formations. However, as described in Section 8.1.4 *Principal Aquifers and Aquitards*, the formations are hydraulically connected, and significant barriers to groundwater flow are not present. Moreover, the ionic composition of groundwater is generally similar between formations and across the Basin, and wells have been constructed throughout the entire Basin. As such, this

RMW-WL network comprised of variable well depths and screen intervals is sufficient to delineate groundwater occurrence, flow directions and hydraulic gradients.

- **Potential impacts to beneficial uses and users of groundwater, land uses or property interests, and adjacent basins (or GSAs)** – Four of the RMW-WLs are situated within one mile of the Basin boundaries. These wells will be used to monitor cross-boundary flows between the Basin, the South American Subbasin (SASb), and the Eastern San Joaquin (ESJ) Subbasin, respectively. As discussed below in Section 17.1.6 *Monitoring Network for Depletions of Interconnected Surface Water*, water levels in the RMW-ISW will be monitored to determine the relative timing, magnitude and scope of hydraulic connections between surface- and groundwater and depth to water beneath GDEs. The SGMA Monitoring Network also includes RMW-WLs within the City of Galt GSA, where a majority of the municipal and industrial production wells are located within the Basin and near the pumping centers in the Basin. The RMW-WLs include various use types (i.e., domestic, public supply, irrigation, etc.) to monitor impacts on most beneficial uses and users of groundwater.
- **Availability of historical data** – About 26% of the RMW-WLs have water level records that are 10 or more years in length and have at least one water level measurement recorded in the last five years (i.e., since January 2015); 36% of the RMW-WLs have water records that are seven or more years in length.
- **Availability of site-specific technical information** – Most of the RMW-WLs have known geographic coordinates, ground surface elevations, and reference point elevations. Moreover, known well depths and well screen intervals are documented in California Department of Water Resources (DWR) well logs (i.e. Well Completion Reports or Water Well Drillers Report), where available. For the RMW-WLs where well construction information is incomplete or currently unavailable, the GSAs developed plans to fill these data gaps in accordance with 23 CCR § 354.38 and as part of GSP implementation and is described further in Section 19 *Plan Implementation*.
- **Quality and reliability of historical data** – In preparing and populating the Basin Data Management System (DMS), Quality Assurance and Quality Control (QAQC) checks were implemented to help ensure entry and maintenance of valid and accurate data consistent with the QAQC Plan for the Basin (**Appendix N**).
- **"Representativeness" to local groundwater conditions** – The RMW-WL "representativeness" to local groundwater conditions is determined by well construction (i.e., that the well depth and perforated interval, when available, are sufficient to represent the Principal Aquifer), the well location is representative of land and water use practices in the surrounding area, and the measured water level response to short- and longer-term conditions (i.e., seasonal and multi-year trends) is consistent with measurements in other nearby wells.
- **Long-term access –** All of the Basin GSAs have at least one monitoring well located within their boundaries. For each RMW-WL, DWR's Best Management Practices (BMP) #2 Monitoring Networks and Identification of Data Gaps (DWR, 2016b) recommends that GSAs secure long-term agreements with associated landowners/well owners allowing local GSA representatives year-

round, long-term access to the site to conduct monitoring for SGMA compliance purposes. The Basin GSAs have copies of the long-term access agreements.

Monitoring Well Density

According to DWR's BMP #2 Monitoring Networks and Identification of Data Gaps (DWR, 2016b), monitoring well density should be between 0.2 and ten wells per 100 square miles. The recommended minimum monitoring well density for the Basin is four wells per 100 square miles because the Basin produces more than 10,000 acre-feet per year (AFY) pumping per 100 square miles (DWR, 2016b). Accordingly, the 309-square-mile Basin produces more than 100,000 AFY, and the recommended number of RMW-WLs is at least 13 wells. The 19 RMW-WL SGMA Monitoring Network complies with this recommendation.

Table MN-2. Proposed SGMA Monitoring Network for Chronic Lowering of Groundwater Levels

Network ID	DMS ID	State Well Number	State Plane Zone 2 (ft NAD 83)		Ground Surface Elevation	Reference Point Elevation	GSA	Basin Subarea	CASGEM ID	Use	Well Depth	Well Screen	Formation	Water Level Record	Notes
			X Coordinate	Y Coordinate	(ft amsl NAVD 88)						ft bgs				
Representative Monitoring Wells															
RMW-WL1	05N06E10P001M	05N06E10P001M	6,758,821	1,868,652	43.5	44.8	Sacramento County	Plain	4824	Irrigation	384	169-361	Laguna	Monthly/semiannually 1963-2021	SCGA monitoring well
RMW-WL2	City of Galt_MW 1654	--	6,762,433	1,848,924	53	54.08	City of Galt	Plain	52075	Monitoring	1654	1614-1644	Valley Springs	Quarterly 2015-2021	
RMW-WL3	Gallo North Well	--	6,742,615	1,855,948	24.5	--	Sacramento County	Plain	--	Irrigation	--	--	Laguna	Annual 2020	
RMW-WL4	06N06E29K001M	06N06E29K001M	6,750,851	1,887,130	35.4	36.40	Sacramento County	Plain	5610	Irrigation	600	--	Mehrten	Semiannually 1965-2003; Monthly 2015-2017	
RMW-WL5	SH_Mulrooney	--	6,787,661	1,876,013	70.3	--	Galt Irrigation District	Plain	--	Irrigation	--	--	Mehrten	None	
RMW-WL6	USGS-381737121102501	05N07E11R002M	6,798,594	1,869,723	117.3	117.29	Galt Irrigation District	Plain	--	Public Supply	228	187-228	Laguna	1968, 1982, Semiannually 2017-2018	
RMW-WL7	06N06E33J002M	06N06E33J002M	6,757,003	1,881,421	48.1	48.50	SRCD	Plain	27447	Domestic	167	80-167	Laguna	Monthly 1966-2018	
RMW-WL8	06N06E11J003M	06N06E11J003M	6,767,685	1,903,413	69.4	71.36	SRCD	Plain	27151 (V)	Domestic	215		Laguna	Monthly 2012-2016	
RMW-WL9	75 HP Wohle	--	6,793,193	1,897,420	105.6	--	Clay Water District	Plain	--	Irrigation	725	--	Mehrten, Valley Springs	Annualy 1980-1985, 1990-1997, 2002-2005, 2019 & 2021	Meter installed on well
RMW-WL10	OHWD TSS Grant Well mid	--	6,784,078	1,918,666	75.9	85.41	OHWD	Plain	--	Monitoring	325	250-325	Mehrten	Daily 8/2020-Current	TSS Grant well site
RMW-WL11	SH_Washburn	--	6,794,567	1,924,705	106.2	--	SRCD	Plain	--	Domestic	165	110-165	Mehrten	Annually 2000, 2004, 2020 & 2021	Meter installed on well
RMW-WL12	06N08E15J001M	06N08E15J001M	6,825,884	1,898,636	216.3	217.34	SRCD	Plain	28352	Irrigation	150	--	Valley Springs	Semiannually 1953 - 2020	
RMW-WL13	USGS-382444121123301	07N07E33Q001M	6,787,967	1,912,796	134	134.00	SRCD	Plain	51651	Domestic	280	250-280	Mehrten	Weekly 1987-2018	
RMW-WL14	AWA ARM-5	--	6,841,323	1,892,564	363.0	366.86	ACGMA	Foothills	50498	Irrigation	184	84-184	Valley Springs	Monthly/quarterly 2014-2018	
RMW-WL15	AWA MW-1D	--	6,850,283	1,857,597	274.0	274.71	ACGMA	Plain	48615	Monitoring	505	420-495	Valley Springs	Monthly/quarterly 2012-2018	
RMW-WL16	BVR_MW-01	--	6,874,750	1,864,520	287.2	318.21	ACGMA	Foothills	--	Monitoring	200	160-190	Ione	Monthly/quarterly 2009-2019	
RMW-WL17	Camanche North Shore_Well 2	05N09E35Q001M	6,863,055	1,849,572	232.9	232.94	ACGMA	Foothills	--	Public Supply	366	150-350	Valley Springs	Monthly 2012-2019	
RMW-WL18	ACGMA Carbondale	--	6,846,025	1,907,916	222.2	--	ACGMA	Foothills	--	Monitoring	215	--	Ione	2020-2021	TSS Grant well site
RMW-WL19	ACGMA Bamert Rd MW D	--	6,852,295	1,874,075	184.2	--	ACGMA	Foothills	--	Monitoring	163	148-153	Ione	2020-2021	TSS Grant well site

Abbreviations:

ACGMA = Amador County Groundwater Management Authority
amsl = above mean sea level
bgs = below ground surface
CASGEM = California Statewide Groundwater Elevation Monitoring
DMS = Data Management System
ft = feet
GSA = Groundwater Sustainability Agency
ID = Identifier
NAD 83 = North American Datum of 1983
NAVD 88 = North American Vertical Datum of 1988
RMW-WL = Representative Monitoring Well for Chronic Lowering of Groundwater Levels
OHWD = Omochumne-Hartnell Water District
SCGA = Sacramento County Groundwater Authority
SGMA = Sustainable Groundwater Management Act
SRCD = Sloughhouse Resource Conservation District
TSS = Technical Support Services

Notes:

(1) Shaded cells represent SGMA-compliant accuracy.
(2) CASGEM ID followed by (V) indicates voluntary CASGEM well.

Monitoring Schedule

Water levels will be measured bi-annually (Spring and Fall) to document seasonal fluctuations in groundwater levels. Specifically, Spring levels will be measured in March to represent a seasonal high prior to summer irrigation demands. Fall levels will be measured in October to represent a seasonal low after the summer irrigation demands. All RMW-WLs will be monitored in accordance with the monitoring protocols described in Section 17.2 *Protocols for Data Collection and Monitoring*. All data will be incorporated into the Basin DMS and reported to DWR per the requirements specified under Section 17.5 *Reporting Monitoring Data to the Department*.

17.1.2. Monitoring Network for Reduction of Groundwater Storage

> *§ 354.34. Monitoring Network*
>
> *(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:*
>
> *(2) Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage*

As discussed in Section 14.2 *Undesirable Results for Reduction of Groundwater Storage*, a direct correlation exists between groundwater elevation and groundwater storage volume, so groundwater levels are used to measure conditions for this Sustainability Indicator. As such, the SGMA Monitoring Network for Reduction of Groundwater Storage is comprised of the same RMSs described in Section 17.1.1 *Monitoring Network for Chronic Lowering of Groundwater Levels*. The information collected from this SGMA Monitoring Network will be sufficient to estimate the change in annual groundwater in storage.

17.1.3. Monitoring Network for Seawater Intrusion

> *§ 354.34. Monitoring Network*
>
> *(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:*
>
> *(3) Seawater Intrusion. Monitor seawater intrusion using chloride concentrations, or other measurements convertible to chloride concentrations, so that the current and projected rate and extent of seawater intrusion for each applicable principal aquifer may be calculated.*
>
> *…*
>
> *(j) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish a monitoring network related to those sustainability indicators.*

Under present-day conditions, the Basin is at little to no risk of seawater intrusion, and chloride concentrations in most groundwater samples collected in the Basin since 2015 are less than 50 milligrams per liter (mg/L), indicating that intrusion has not occurred. As described in Section 9.3 *Seawater Intrusion*, Seawater Intrusion is not applicable Sustainability Indicator to the Basin and, per the stipulations defined under 23-CCR §354.34(j), a monitoring network has not been defined.[78]

17.1.4. Monitoring Network for Degraded Water Quality

> *§ 354.34. Monitoring Network*
>
> *(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:*
>
> *(4) Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.*

The powers granted to GSAs under SGMA to effect sustainable groundwater management are generally limited to managing the quantity, location, and timing of groundwater pumping and recharge, whereas regulatory oversight authority for drinking water quality rests with the State Water Resources Control Board (SWRCB) and not with the GSAs. As discussed in Section 14.4 *Undesirable Results for Degraded Water Quality,* Undesirable Results would only be experienced if the water quality conditions are degraded as a result of SGMA-related groundwater activities. To monitor the effects of SGMA-related groundwater activities it requires adequate spatial well density, depth discrete well perforation interval, and measurements that capture temporal water quality and level conditions in the Principal Aquifer.

Monitoring data can represent the potential nexus between groundwater elevations in the Basin and constituent concentrations in the water produced by wells. Per 23-CCR § 354.32(e), the selection of these RMSs has been informed by existing local monitoring programs and leverages historical data wherever possible to help assess and quantify Basin response to GSP implementation relative to historical and projected future groundwater conditions.

Existing local water quality monitoring programs in the Basin are almost solely limited to routine sampling and reporting by public water systems (PWS). The PWS are required by SWRCB Drinking Water Program to monitor water quality and provide results that are publicly available through the Safe Drinking Water Information System (SDWIS) Drinking Water Watch website. The benefits of using monitoring data from PWS wells for the SGMA Monitoring Network include: (1) consider the groundwater quality of beneficial users of groundwater; (2) are required to sample for constituents of health concern on a regular and known schedule; and, (3) are pumped regularly and the water sampled is therefore representative of formation water. Irrigation wells are not routinely sampled as part of an existing Basin water quality monitoring program, but some PWS wells located in Sloughhouse Resource Conservation District (SRCD) GSA and Galt Irrigation District (GID) GSA are surrounded by agriculture lands and are therefore representative of those land uses.

The SGMA Monitoring Network for Degraded Water Quality consists of the RMW-WQs listed in **Table MN-3** and shown on **Figure MN-2**. The selection of these RMW-WQs were based on the following

[78] The SGMA Monitoring Network for Degraded Water Quality includes the analysis for chloride, among other constituents, in samples collected for major ions. These results could reveal future concentration changes, should they occur and exceed 50 mg/L.

considerations:

- **Current and projected groundwater use** – The RMW-WQs are largely comprised of PWS wells in urban and agricultural areas of the Basin, and these wells are already sampled and analyzed relative to drinking water quality standards, which are the most stringent current and projected water quality standards in the Basin. Additional wells listed in **Table MN-3** and shown on **Figure MN-2** include four agricultural production wells (i.e., irrigation well), one domestic well, and several dedicated monitoring wells constructed as part of DWR's Technical Support Services (TSS) Grant Program[79].
- **Aquifer characteristics** – All RMW-WQs are screened in the alluvial materials that form the Basin's Principal Aquifer. The well depths and screen lengths are variable and can intercept one or more formations. However, the ionic composition of groundwater is generally similar between formations, and production wells have been constructed throughout the entire Basin at various formation depths. As such, the network is sufficient to delineate groundwater quality changes due to management actions in the Basin.
- **Potential impacts to beneficial uses and users of groundwater, land uses or property interests, and adjacent Basins (or GSAs)** – The PWS wells are required to meet drinking water standards in the Basin, and compliance with Title 22-CCR drinking water regulations for Maximum Contaminant Levels (MCLs) as the governing regulatory criteria. Historical water quality data indicate that some Basin wells have exceeded primary MCLs for arsenic (As) and nitrate as Nitrogen (NO_3-N). Arsenic is a naturally-occurring element and most of the arsenic exceedances occur in the southwest portion of the Basin near the City of Galt, where active public supply wells are treated for arsenic; most of the nitrate exceedances are from samples collected from relatively shallow dedicated monitoring wells that do not supply water for beneficial use (See Section 9.4.2 *Constituents and Primary MCLs*).
- **Availability of historical data** – Historical data for six of the 14 RMW-WQs are available and have been compiled into the Basin DMS. Of the eight remaining wells, three are new dedicated monitoring wells installed as part of DWR's TSS Grant Program, one a domestic well, and the four remaining wells are agricultural production wells. Data records for these eight wells will commence when first accessed and results included as part of the first Annual Report.
- **Availability of site-specific technical information** – As shown in **Table MN-3**, most of the RMW-WQs have known coordinates, but most are lacking in elevation and well construction information (including total depth and perforated intervals). For the RMW-WQs where well construction information is incomplete or currently unavailable, the GSAs developed plans to fill these data gaps in accordance with 23-CCR § 354.38 and as part of GSP implementation (see Section 19.1.2 *Data Gap Filling Efforts*).

[79] These TSS Grant wells are also part of the SGMA Monitoring Network for Chronic Lowering of Water Levels.

- **Quality and reliability of historical data** – In preparing and populating the Basin DMS, QAQC checks were implemented to help ensure entry and maintenance of valid and accurate data consistent with the Cosumnes QAQC Plan (**Appendix N)**.
- **"Representativeness" to local groundwater conditions** – As mentioned above, the RMW-WQs are considered representative of local conditions given that the well depths and perforated intervals are sufficiently deep and long to represent Principal Aquifer conditions, and the wells are located throughout the Basin in GSAs that represent urban, domestic, and agricultural land uses.
- **Long-term access** – For each RMW-WQ that is not a PWS, the GSAs have secured long-term agreements with associated land/ well owners allowing local GSA representatives year-round access to the site to conduct monitoring for SGMA compliance purposes. Basin GSAs have copies of the long-term access agreements. Data from the PWS wells will be accessed via the SDWIS Drinking Water Watch website.

The non-PWS RMW-WQs will be sampled annually, ideally in the Fall, in accordance with the monitoring protocols described in Section 17.2 *Protocols for Data Collection and Monitoring,* and the samples will be analyzed for the following Constituents of Concern (COCs)[80]:

- Total Dissolved Solids (TDS) in milligrams per liter (mg/L);
- Arsenic (As) in micrograms per liter (ug/l); and,
- NO_3 in mg/L as N (nitrogen).

Additionally, the non-PWS RMW-WQs will be sampled annually, ideally in the Fall, for other relevant groundwater quality constituents which may include constituents within some or all the following categories:

- Descriptive parameters (e.g., Temperature, pH, Specific Conductance, etc.)
- Major ions, which includes Sodium, Chloride, Sulfate, and others.

Most of the RMW-WQs are PWS wells and are already regularly sampled for Title 22 constituents. These data will be downloaded on an annual basis from the SDWIS Drinking Water Watch website. Missing constituents will be added to the annual sample analyses for these wells as part of the SGMA Monitoring Program[81]. The analytical results from these wells shall be incorporated into the Basin DMS and reported to DWR per the requirements specified under Section 17.5 *Reporting Monitoring Data to the Department*.

[80] Few to none boron sensitive plants are grown in the Basin, and only one of the wells sampled for boron exceeded the agricultural water quality goal. Sodium is also not considered a concern, and existing water quality sampling programs for municipal supply wells (City of Galt) and the small PWS in the Basin (i.e., wells supplying groundwater to schools, churches, etc.) include a broader suite of constituents (e.g., Title 22) which can continued to be tracked and included in the Basin DMS.
[81] Constituents that may be analyzed from PWS well water samples include TDS, major ions, or other potential COCs not sampled on an at least annual basis.

Monitoring Well Density

The recommended monitoring well density is at least four wells per 100 square miles (see discussion above for the water level monitoring network in Section 17.1.1 *Monitoring Well Density*). Accordingly, the recommended number of RMW-WQ wells is 13. The 14 wells proposed for the water quality monitoring network exceeds these criteria, and except for Sacramento County GSA, all GSAs have at least one RMW-WQ site located within their boundaries.

Monitoring Schedule

Well-water samples shall be collected or downloaded annually, ideally in the Fall, for the RMW-WQs in accordance with the monitoring protocols described in Section 17.2 *Protocols for Data Collection and Monitoring.* All data will be incorporated into the Basin DMS and reported to DWR per the requirements specified under Section 17.5 *Reporting Monitoring Data to the Department.*

Table MN-3. Proposed SGMA Monitoring Network for Degraded Water Quality

Network ID	DMS ID	State Well Number	State Plane Zone 2 (feet NAD 83)		Ground Surface Elevation	Reference Point Elevation	GSA	Basin Subarea	CASGEM ID	Use	Well Depth	Well Screen	Formation	Water Quality Record	Notes
			X Coordinate	Y Coordinate	(ft amsl NAVD 88)						ft bgs				
Representative Monitoring Wells															
RMW-WQ1	City of Galt_Well 14	--	6,766,737	1,853,177	44	44	City of Galt	Plain	--	Public Supply	750	270-740	Mehrten	As 1992-2015, NO3 1992-2014, TDS 1992-2012	
RMW-WQ2	City of Galt_Well 20	--	6,765,535	1,868,622	51	51	City of Galt	Plain	--	Public Supply	890	355-850	Mehrten	As & TDS 2009-2018, NO3 2009-2016	
RMW-WQ3	SH_Mulrooney	--	6,787,661	1,876,013		--	Galt Irrigation District	Plain	--	Irrigation	--	--	Mehrten	None	
RMW-WQ4	SH_Garcia	--	6,802,422	1,883,578		--				Domestic	--	--	Mehrten	None	
RMW-WQ5	Rancho Seco NGS_MAIN WELL	--	6,815,008	1,888,933	--	--	SRCD	Plain	--	Public Supply	--	--	Mehrten, Valley Springs	As 2004-2018, NO3 1999-2018, TDS 1998	
RMW-WQ6	Dillard Elementary_Dom Well	--	6,776,611	1,909,654	--	--	SRCD	Plain	--	Public Supply	--	--	Laguna, Valley Springs	As, NO3 2001-2018, TDS 2007	
RMW-WQ7*	OHWD TSS Grant Well Mid	--	6,784,078	1,918,666		85.412	OHWD	Plain	--	Monitoring	325	250-325	Mehrten	None, proposed well	TSS Grant well site
RMW-WQ8	07N08E06N001M	07N08E06N001M	6,805,551	1,938,936	119.89	119.89	OHWD	Plain	--	Irrigation	135	--	Valley Springs	--	
RMW-WQ9*	ACGMA Carbondale	--	6,846,025	1,907,916	--	--	ACGMA	Foothills	--	Monitoring	215	--	Ione	None, new well	TSS Grant well site
RMW-WQ10*	ACGMA Bamert Rd MW D	--	6,852,295	1,874,075	--	--	ACGMA	Foothills	--	Monitoring	163	148-153	Ione	None, new well	TSS Grant well site
RMW-WQ11*	Camanche North Shore_Well 2	05N09E35Q001M	6,863,055	849,572	232.94	232.94	ACGMA	Foothills	--	Public Supply	366	150-350	Valley Springs	As, NO3, TDS 1987-2017	
RMW-WQ12	Camanche Well 9	--	6,851,328	1,856,331	316	316	ACGMA	Foothills	--	Public Supply	406	118-312	Valley Springs	As 1994-2008, NO3 1994-2018, TDS 1994-2011	
RMW-WQ13	75 HP Wohle	--	6,793,193	1,897,420	105.6	--	Clay Water District	Plain	--	Irrigation	725	--	Mehrten, Valley Springs	None	Well with meter
RMW-WQ14	SH_Vanwarmerdam		6,766,594	1,879,638		--	Galt Irrigation District	Plain	--	Irrigation	700	--	Mehrten	None	

Abbreviations:

ACGMA = Amador County Groundwater Management Authority
amsl = above mean sea level
As = arsenic
bgs = below ground surface
CASGEM = California Statewide Groundwater Elevation Monitoring
DMS = Data Management System
ft = feet
GSA = Groundwater Sustainability Agency
ID = Identifier
NAD 83 = North American Datum of 1983
NAVD 88 = North American Vertical Datum of 1988
NO3 = nitrate
RMW-WQ = Representative Monitoring Well for Degraded Water Quality
OHWD = Omochumne-Hartnell Water District
SGMA = Sustainable Groundwater Management Act
SRCD = Sloughhouse Resource Conservation District
TDS = total dissolved solids
TSS = Technical Support Service

Notes:

(1) Asterisk (*) denotes wells that are also Representative Monitoring Sites for Chronic Lowering of Groundwater Levels.
(2) Shaded cells represent SGMA-compliant accuracy.

17.1.5. Monitoring Network for Land Subsidence

§ 354.34. Monitoring Network

(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:

(5) Land Subsidence. Identify the rate and extent of land subsidence, which may be measured by extensometers, surveying, remote sensing technology, or other appropriate method.

Interferometric Synthetic Aperture Radar (InSAR) data and a network of subsidence monitoring network monuments, within the Basin and neighboring basins, indicate vertical displacement in the Basin has been minor and therefore land subsidence is not a significant concern. The continuous data collected from the existing University NAVSTAR Consortium (UNAVCO) Global Positioning System (GPS) station located within the Basin (**Figure MN-3**) and the water level collected from the SGMA Monitoring Network for Chronic Lowering of Groundwater Levels will be sufficient to monitor land subsidence changes within the Basin.

17.1.6. Monitoring Network for Depletions of Interconnected Surface Water

§ 354.34. Monitoring Network

(c) Each monitoring network shall be designed to accomplish the following for each sustainability indicator:

(6) Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:

(A) Flow conditions including surface water discharge, surface water head, and baseflow contribution.

(B) Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.

(C) Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.

(D) Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.

The GSP Regulations (23-CCR § 354.28(c)) state that the SMCs for Depletions of Interconnected Surface Water "*shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results*." Monitoring the depletion of interconnected surface water must therefore characterize the spatial and temporal changes in the exchange between surface water and groundwater conditions by collecting data to characterize the following:

- Flow conditions including surface water discharge, surface water stage (i.e., water level in channel), and baseflow contribution;

- Approximate dates and locations where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable;
- Temporal change in conditions due to variations in stream discharge and regional groundwater extraction; and,
- Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water, like environmental uses.

The relationships between mapped GDE areas and the RMW-ISW monitoring network is shown in **Figure SMC-7**. In the Basin Plain subarea, confirmed GDE areas are mapped where the estimated depth to water (DTW) in the Principal Aquifer is within 30 feet of the ground surface (ft bgs) (the darkest green areas), and assumed-confirmed GDEs are within areas having an estimated DTW that ranges from 30 to 50 ft bgs (the medium-light green areas). The groundwater levels in this latter area are relatively deep, but the spatial and temporal variability in seasonal water levels were assumed adequate to support deeper rooting species and therefore assumed to be GDEs (GSA, 2021). In the Basin Foothills subarea, a portion of the area was mapped as having an unknown GDE status due to uncertainty in DTW (the light green areas). These areas in the Basin Foothills subarea having unknown GDE status were conservatively retained as potential GDEs.

According to The Nature Conservancy's (TNC's) Best Practice #4 (TNC, 2019), potential GDE areas should be monitored by a well within 3.1 miles of the ecosystem to reflect the local conditions relevant to the ecosystem. **Figure SMC-7** shows that in the Basin Plain subarea all confirmed GDEs and assumed-confirmed GDEs are within 3.1 miles of RMW-ISW1, RMW-ISW2 and RMW-ISW3; no confirmed or assumed-confirmed GDEs are mapped outside the 3.1-mile range of these three wells. In the Basin Foothills subarea, most of the area mapped as having unknown GDEs is within 3.1 miles of RMW-ISW7, RMW-ISW8 and RMW-ISW9. No shallow wells exist to represent water table conditions in the assumed GDE areas outside of the 3.1 mile radius from RMW-ISW8 and RMW-ISW9. For example, the three Chronic Lowering of Groundwater Level monitoring wells south of these wells (RMW-WL16, RMW-17, and RMW-18) are 200 to 500 feet deep. The lack of shallow monitoring wells in the portion of the Basin represents a data gap, but it is not considered a high priority data gap to fill because the vegetation status for the communities near this well are unknown and only conservatively assumed to be GDEs. Moreover, the monitoring coverage afforded by the existing wells represents conditions for most of the relevant Basin Foothills subarea. Lastly, the Basin Foothills subarea is not characterized by declining water levels and GSP implementation is not expected to influence the vegetation in these areas.

The SGMA Monitoring Network for Depletions of Interconnected Surface Water considered Environmental Defense Fund (EDF) recommendations for addressing regional surface water depletions EDF, 2018), and is comprised of existing shallow wells (RMW-ISW) and stream gauging stations (RMG) shown on **Figure MN-4** and summarized in **Table MN-4**. The selection of RMSs is based on the following considerations:

- **Current and projected groundwater use** – To the extent possible, the RMW-ISWs are located near surface water features, GDE areas, and the Basin boundaries. Most extractions occur from aquifer depths significantly below the RMW-ISW depths.

- **Aquifer characteristics** – All RMW-ISWs screen the upper 140 feet or less of alluvial materials. These relatively shallow well depths are considered representative of water table conditions.
- **Potential impacts to beneficial uses and users of groundwater, land uses or property interests, and adjacent Basins (or GSAs)** – Available data and previous studies suggest that Cosumnes River flows are disconnected from underlying groundwater along most of its reach within the Basin. Data are not available to directly compare stage and groundwater levels along Dry Creek or other surface water features in the Basin. However, the DTW contours mapped for the Basin indicate that groundwater in the Principal Aquifer is typically encountered at depths greater than 30 ft bgs, suggesting that surface water flows and groundwater are likely disconnected across most of the Basin (See Section 9.6 *Interconnected Surface Water Systems*). RMW-ISW7, RMW-ISW8, and RMW-ISW9 are shallow wells located in the proximity of relatively minor drainages and included in the Depletions of Interconnected Surface Water network to monitor groundwater levels near potential GDEs.
- **Availability of historical data** – All nine RMW-ISWs have historical water level data, however the most recent data for three of them are from before 2000, the data for two begin in 2012, two begin in 2014 and the remaining two did not begin until 2020 or later. Four gauging stations exist on the Cosumnes River with flow and stage data going back as far as 1926 and as recent as 2019, but only one gauging station exists on Dry Creek and its period of record is 1926-1997. Gauging stations have not been established on the remaining creeks within the Basin. Moreover, comparisons between shallow well water levels and stream gauge measurements show limited overlap between their respective recording periods.
- **Availability of site-specific technical information** – As shown in **Table MN-4**, all the RMW-ISWs have location coordinates but only four of the nine have construction information that includes perforated intervals. While four of the nine are located near the Cosumnes River and Dry Creek, only one RMW-ISW (RMW-ISW4) is located adjacent to a gauging station (RMG-3: Mahon Dam) For the RMW-ISWs where construction information is incomplete or currently unavailable, the GSAs developed a plan to fill these data gaps in accordance with 23-CCR § 354.38 and as part of GSP implementation.
- **Quality and reliability of historical data** – In preparing and populating the Basin DMS, QAQC checks were implemented to help ensure entry and maintenance of valid and accurate data consistent with the Cosumnes QAQC Plan (**Appendix N**).
- **"Representativeness" to local groundwater conditions** – As mentioned above, the RMW-ISW "representativeness" to local groundwater conditions is determined by well construction and location relative to the Cosumnes River, Dry Creek, or relatively minor drainages in areas of GDEs. Specifically, the well depth and perforated interval are sufficient to represent the water table and surface-groundwater interactions. **Table MN-4** shows that most of the wells are less than 140 feet deep, and **Figure MN-4** identifies the wells located within 1,500 feet of the Cosumnes River or Dry Creek. The RMW-ISWs are thus representative of water table conditions near these surface water features.

- **Long-term access** – The GSAs have secured long-term agreements with associated land/well/gauge owners allowing local GSA representatives year-round long-term access to the site to conduct monitoring for SGMA compliance purposes. Some RMG sites data can be accessed online through the California Data Exchange Center (CDEC; RMG-2) or the United States Geological Survey (USGS) National Water Information System (NWIS; RMG-5).

Monitoring Well Density

While several shallow wells are located near the Cosumnes River and Dry Creek, few to none of the wells are located adjacent to an existing gauging station, which introduces uncertainty when comparing well water level and stream stage. For the RMGs that lack adjacent RMW-ISWs, the GSAs developed plans to fill these data gaps in accordance with 23-CCR § 354.38 and as part of GSP implementation.

Monitoring Schedule

All RMW-ISWs shall be instrumented to record daily, or of higher frequency, water level changes and all RMG sites shall be instrumented to record daily, or of higher frequency, stage and flow in accordance with the monitoring protocols described in Section 17.2 *Protocols for Data Collection and Monitoring.* All data will be incorporated into the Basin DMS and reported to DWR per the requirements specified under Section 17.5 *Reporting Monitoring Data to the Department.*

Table MN-4. Proposed SGMA Monitoring Network for Depletions of Interconnected Surface Water

Network ID	DMS ID	State Well Number	StatePlane Zone 2 (feet NAD 83)		Ground Surface Elevation	Reference Point Elevation	GSA	Basin Subarea	CASGEM ID	Use	Well Depth	Well Screen	Formation	Water Level Record / Flow or Stage Record	Accessibility	Notes
			X Coordinate	Y Coordinate	(ft amsl NAVD 88)						ft bgs					
Representative Monitoring Wells																
RMW-ISW1	05N06E31E003M	05N06E31E003M	6,742,619	1,849,924	22.26	24.76	Sacramento County	Plain	4830 (V)	Unknown	105	--	Victor	Semiannual 1990-1999	Confirmed	
RMW-ISW2	UCW_MW-19	--	6,739,893	1,870,482	18	--	Sacramento County	Plain	--	Monitoring	60	55-60	Victor	Daily 2012-2019	Confirmed	
RMW-ISW3	UCW_MW-5	--	6,740,722	1,875,204	26	--	Sacramento County	Plain	--	Monitoring	64	54-64	Victor	Daily 2012-2019	Confirmed	
RMW-ISW4	06N06E22C001M	06N06E22C001M	6,759,136	1,895,204	52.36	53.36	SRCD	Plain	5607 (V)	Irrigation	141	--	Victor, Laguna	Semiannual 1963-1997	Confirmed	
RMW-ISW5	07N08E06N001M	07N08E06N001M	6,805,551	1,938,936	119.89	119.89	OHWD	Plain	--	Irrigation	135	--	Mehrten	Semiannual 1990-1999	Confirmed	
RMW-ISW6	OHWD TSS Shallow	--	6,784,078	1,918,666	75.9	85.353	OHWD	Plain	--	Monitoring	175	125-175	Laguna	Daily 2020-2021	Confirmed	
RMW-ISW7	AWA Col MW-4	--	6,860,055	1,890,990	267	268.77	ACGMA	Foothills	50500	Monitoring	27	--	Ione	Semiannual 2014-2018	Confirmed	
RMW-ISW8	07N08E36B001M	07N08E36B001M	6,835,016	1,916,394	187.4	189.35	SRCD	Foothills	29338	Monitoring	15	--	Valley Springs	Semiannually 1953-2018	Confirmed	
RMW-ISW9	ACGMA Bamert Rd MW S	--	6,852,295	1,874,075	184.2	--	ACGMA	Foothills	--	Monitoring	78	58-68	Ione	2020-2021	Confirmed	
Representative Monitoring Stream Gauges																
RMG-1	Dry C NR Galt CA	NA	6783708	1853088	--	52.83	SRCD	Plain	NA	NA	NA	NA	NA	Flow: Daily 1926-1997 Stage: Bi-monthly/Quarterly 1995-1997	Uncertain	Inactive
RMG-2	Cosumnes River at McConnell	NA	6749854	1892755	5	5.75	Sacramento County	Plain	NA	NA	NA	NA	NA	Flow: Monthly 1941-1982 Stage: Daily 1982-2019	Uncertain	
RMG-3	Mahon Dam	NA	6755673	1897249	--	--	OHWD	Plain	NA	NA	NA	NA	NA	Flow: Daily 2003-2009 Stage: Daily 2004-2012	Confirmed	
RMG-4	Rooney Dam	NA	6790359	1934592	--	--	OHWD	Plain	NA	NA	NA	NA	NA	Flow: Daily 2003-2011 Stage: Daily 2004-2011	Confirmed	
RMG-5	Cosumnes River at Michigan Bar	NA	6834905	1945415	--	170.48	SRCD	Foothills	NA	NA	NA	NA	NA	Flow: Daily/monthly 1907-2019 Stage: Monthly/quarterly 1936-2019	Uncertain	

Abbreviations:

ACGMA=Amador County Groundwater Management Authority
amsl = above mean sea level
bgs = below ground surface
CASGEM = California Statewide Groundwater Elevation Monitoring
DMS = Data Management System
ft = feet
GSA = Groundwater Sustainability Agency
ID = Identifier
NA = not applicable
NAD 83 = North American Datum of 1983
NAVD 88 = North American Vertical Datum of 1988
RMG = Representative Monitoring Gauge
RMW-ISW = Representative Monitoring Well for Depletions of Interconnected Surface Water
OHWD = Omochumne-Hartnell Water District
SGMA = Sustainable Groundwater Management Act
SRCD = Sloughhouse Resource Conservation District

Notes:

(1) Shaded cells represent SGMA-compliant accuracy.
(2) CASGEM ID followed by (V) indicates voluntary CASGEM well.

17.2. Protocols for Data Collection and Monitoring

§ 352.2. Monitoring Protocols
Each Plan shall include monitoring protocols adopted by the Agency for data collection and management, as follows:
- *(a) Monitoring protocols shall be developed according to best management practices.*
- *(b) The Agency may rely on monitoring protocols included as part of the best management practices developed by the Department,or may adopt similar monitoring protocols that will yield comparable data.*
- *(c) Monitoring protocols shall be reviewed at least every five years as part of the periodic evaluation of the Plan, and modified as necessary.*

Pursuant to 23-CCR § 354.32(i), in all cases the SGMA Monitoring Network will adhere to the monitoring protocols developed by the Working Group. Monitoring is needed to track changes in Basin conditions, Sustainability Indicators, and the effectiveness of GSP implementation to achieve groundwater sustainability. Data collection protocols for groundwater levels, groundwater quality, and surface water are detailed below, and are designed for compatibility with the GSP Regulations and DWR's Best Management Practices (BMP) #1 Groundwater Monitoring Protocols, Standards, and Sites (DWR, 2016e). BMP #1 identifies several guidance documents that were incorporated into the Basin monitoring protocols including the DWR Groundwater Elevation Monitoring Guidelines (DWR, 2010), the CASGEM Monitoring Plan for water level monitoring (Sacramento Central Groundwater Agency [SCGA], 2012; Dunn Environmental, 2014), and the USGS Groundwater Technical Procedures (Cunningham and Schalk, 2011), and the National Field Manual for the Collection of Water-Quality Data (NFM) (USGS, variously dated).

The Basin monitoring protocols are designed to ensure the following:

- Data are collected from the correct location and site identification;
- Data are accurate and reproducible;
- Data represent conditions in the Basin;
- All salient information is recorded to check and correct data; and,
- Data are handled in a way that ensures data integrity.

17.2.1. <u>Protocols for Groundwater Level Measurements</u>

Groundwater-level measurements shall be collected, at a minimum, semiannually (Spring and Fall) to document seasonal fluctuations in groundwater levels. Specifically, Spring levels will be measured in March to represent the seasonal high prior to summer irrigation demands and Fall levels will be measured in October to represent the seasonal low after the increased summer irrigation demands. The groundwater level data will be the basis for the development of basin-wide groundwater elevation maps. The following data collection protocols should be followed by the field technician:

- Water level measurements should be taken in wells that are not influenced by recent pumping. Measurements should be taken at least two hours, and preferably longer, after the well was last pumped. Multiple measurements can be collected from the well to verify that equilibrium has been reached.
- DTW shall be measured by an electronic sounder, chalked steel tape, or datalogging pressure transducer. As required by 23-CCR § 352.4(a)(3), DTW shall be recorded to at least the nearest 0.1 foot and preferably to the nearest 0.01 foot. Other measurement methods such as airlines and acoustic sounders may not provide the required accuracy of 0.1 foot.
- DTW shall be measured from a specific, easily identifiable, and clearly marked reference point (RP) on the well casing. As required by 23-CCR § 352.4(a)(4), the reference point elevation (RPE) should be surveyed relative to the North American Vertical Datum of 1988 (NAVD 88) to an accuracy of 0.5 foot and preferably to an accuracy of 0.1 foot or less. Hand-held GPS units likely will not provide vertical elevation measurements accurate enough to meet these requirements.
- For artesian or flowing wells, site-specific procedures should be developed to collect accurate water level data. This procedure may require the installation of a temporary manometer where the flow is directed to a vertical tube that is tall enough to prevent the flow so the height of the water can be measured above the RP. Alternatively, the well could be capped with a valve and a separate pressure gauge and the water pressure is measured after closing the valve and the pressure converted to feet of water (one pound per square inch equals 2.31 feet of water height).
- Groundwater elevation shall be calculated as:

  $$GWE = RPE - DTW$$

  Where:

  GWE = Groundwater Elevation;

  RPE = Reference Point Elevation; and

  DTW = Depth to Water
- Consistent units of feet, tenths of feet, and hundredths of feet should be used, and measurements should not be recorded in units of feet and inches.
- Record the site identifier, date, time (24-hour format), method of measurement, height of RPE above or below the ground surface, DTW, groundwater elevation, name of technician, and any factors that may influence the DTW measurements such as weather, nearby irrigation or pumping, flooding, or well condition. If a measurement cannot be obtained, record the reason the measurement was not collected.
- Any well caps, plugs, or locks should be replaced and access points such as doors or gates returned to the condition found upon arrival at the site.
- The measurement devices shall be rinsed or cleaned as necessary after measuring each well and routinely maintained and tested in accordance with manufacturer's instructions to ensure measurement accuracy.

Where and when deemed appropriate, data loggers may be implemented to record water levels more frequently (e.g., hourly, daily, weekly, and so forth). Groundwater levels may be recorded using pressure transducers equipped with data loggers installed in monitoring wells. The following general protocols must be followed when installing a pressure transducer in a monitoring well or for recording stream stage:

- Utilize protocols above to determine the water levels in the monitoring well (or stilling well of streamflow station) and properly program and reference the installation.
- Record the well identifier, the associated transducer serial number, transducer range, transducer accuracy, and cable serial number.
- Employ transducers able to record groundwater levels with an accuracy of at least 0.1 foot, and confirm the instrument has sufficient battery life, and data storage capacity, and can accommodate a range of groundwater level fluctuations and natural pressure drift.
- If employing non-vented units, consistent and coincident logging of barometric pressures is required.
- Follow manufacturer specifications for installation, calibration, data logging intervals, battery life, correction procedure (if non-vented cables used), and anticipated life expectancy to assure that data quality objectives are being met for the GSP.
- Secure the cable to the well head with a well dock or another reliable method. Monitor against potential future cable slippage by marking cable at the same elevation of the RP.
- The transducer data should periodically be checked against hand measured groundwater levels to monitor electronic drift or cable movement. This should happen during routine site visits, at least annually or as necessary to maintain data integrity.

The data should be downloaded as necessary to ensure data are not lost and entered into the Basin's DMS following the Cosumnes QAQC Plan (**Appendix N**). Data collected with non-vented data logger cables should be corrected for atmospheric barometric pressure changes, as appropriate. After the technician is confident that the transducer data have been safely downloaded and stored, the data should be deleted from the data logger to ensure adequate memory storage remains.

17.2.2. Protocols for Water Quality Sampling

Water quality samples shall be collected annually. General steps for water quality sampling include depth to groundwater measurement prior to purging, multi-meter calibration, installation of sampling pump, if required, purging of the well casing, water quality sample collection in lab-specified bottles, and following standard chain-of-custody guidelines for sample preservation and transport. All analyses should be performed by a laboratory certified under the State Environmental Laboratory Accreditation Program. The following data collection protocols should be followed by the field technician in addition to protocols identified in the USGS National Manual for the Collection of Water-Quality Data:

- Record the site identifier, date, time (24-hour format), condition of the well, DTW measurement, meter calibration information[82], purge volumes, meter readings during purging, water quality samples that were collected and preservation methods used, and the name of technician.
- Production wells shall be sampled while the well pump is running, with well-water collected from a spigot near the wellhead. Samples should not be collected from storage tanks, at a long distance from the wellhead, or after any water treatment. Sample ports and sampling equipment must be cleaned prior to sample collection.
- Monitoring wells without a permanent pump installation shall be purged and sampled using a submersible pump or bailer. Submersible pump, tubing, and sampling equipment shall be cleaned between sample sites.
- If possible, a minimum of three casing volumes shall be purged from the well prior to sample collection. For larger wells and wells with permanent pump installations, purging of three casing volumes may not be necessary or practical depending on the well's operational history and operational constraints. If a well is pumped dry, the well will be allowed to recover within 90% of original water level prior to sampling. Professional judgment shall be used to determine well purging required to achieve a representative sample from the well.
- If applicable, field parameters (e.g., pH, specific conductance, temperature, and dissolved oxygen) shall be monitored using a multi-meter and flow cell during purging. Field parameters shall be allowed to stabilize during purging so that variation of each parameter is within appropriate pre-defined limits for three casing volumes. In cases where purging of three casing volumes is not practical, field parameters shall be stable for three successive measurements collected at least three minutes apart. All field instruments shall be calibrated daily and evaluated for drift throughout the day.
- Prior to collection, new sample bottles appropriate to each analysis shall be obtained from the analytical lab contracted for chemical analysis. Each sample bottle shall be clearly labeled after sampling with the site identifier, sample personnel, date, time of sample collection (24-hour format), preservative used, and required analysis. Samples shall be collected according to appropriate standards such as those listed in the Standard Methods for the Examination of Water and Wastewater, the USGS National Field Manual for the Collection of Water-Quality Data (USGS, variously dated) or other appropriate guidance. The specific sample collection procedure should reflect the type of analysis to be performed. Sample should be collected under laminar flow conditions which may require reducing the flow rate prior to sample collection. Samples shall be filtered as recommended for the specific analytes.
- After collection, all sample bottles shall immediately be preserved as required, dried, sealed in zip-closure polyethylene bags, and placed on ice in an insulated cooler for temporary storage and

[82] Ideally, a multi-meter shall be used to collect field parameters prior to sample collection. As applicable, multi-meter probes shall be calibrated per manufacturer specifications using standards closest to that of the anticipated well-water.

transport to the analytical lab. All samples shall be delivered to the laboratory following standard chain-of-custody control guidelines within their prescribed holding times.

- Field duplicates and field blank samples shall be collected and analyzed for QAQC purposes. Duplicate samples will be collected, processed, and analyzed in the field using the same methodology for the primary sample, with an assigned dummy site identifier. Field blanks shall be collected for quality assurances purposes. Field blanks will be collected using deionized water, processed in the field, and then submitted to the laboratory with a dummy site identifier.

17.2.3. Protocols for Streamflow Measurements

Monitoring of streamflow is important for water budget analysis and evaluation of stream depletions associated with groundwater conditions. The following guidelines have been adopted from the GSP Regulations and DWR's BMP#1 (DWR, 2016e):

- The use of existing streamflow monitoring sites will be incorporated to the greatest extent possible.
- Establishment of new streamflow monitoring sites will consider the existing network and the objectives of the new locations. Professional judgement will be used to determine the appropriate permitting that may be necessary for the installation of any monitoring location along surface water bodies. Regular and frequent access will be necessary for these sites for data collection, site maintenance, and development of rating curves.
- To establish a new streamflow monitoring site, special consideration must be made to select an appropriate location for measuring stage and discharge. Once a site is selected and established, a relationship of stream stage and discharge is necessary to provide continuous estimates of streamflow. Numerous measurements of discharge at several different stream stages are necessary to develop a rating curve(s) correlating stage and discharge. A stilling well and pressure transducer with a datalogger can be used to record stage on a continuous basis and discharge can be estimated using the rating curve.
- Streamflow measurements shall be collected, analyzed, and reported in accordance with the procedures outlined in USGS Water Supply Paper 2175, *Volume 1 – Measurement of Stage and Discharge* and *Volume 2 – Computation of Discharge* (Rantz and others, 1982a; 1982b). This methodology is currently being used by the USGS and DWR for existing streamflow monitoring and existing streamflow monitoring locations may use this methodology.
- Coordinate with the adjacent subbasins on the use of existing streamflow monitoring sites and on the installation of new sites, including the SASb for the Cosumnes River and the ESJ Subbasin for Dry Creek and the Mokelumne River.

17.2.4. Protocols for Data Management and Reporting

Records of all data collected will be maintained in the Basin DMS. Prior to importation, standard QAQC checks will be undertaken to help ensure the validity and accuracy of data.

- DTW measurements shall be converted to groundwater elevation by subtracting the DTW from the reference point elevation following the protocols for groundwater level measurements described above.
- Groundwater elevation shall be plotted on individual well hydrographs. Groundwater elevations which vary significantly from previous measurements shall be evaluated to determine if the measurement is questionable due to a substantial change relative to historical conditions. If determined that the measurement is anomalous, the measurement will be flagged as questionable in the Basin DMS.
- Laboratory reports shall be checked to ensure all samples were analyzed within the prescribed holding times.
- Laboratory reports shall be checked to ensure all laboratory blank analyses were determined acceptable by the laboratory.
- Constituent detections in the field blank shall be tabulated and compared to their respective practical quantitation limit.
- Field duplicate results shall be compared to the primary sample results. Ideally, concentrations should agree within 10% or have differences within their respective practical quantitation limit. If concentrations from duplicate samples vary by more than 25%, the GSA may ask the laboratory to reanalyze the constituent to confirm the result is reasonable.
- Major cations and anions possess positive and negative charges, respectively, and therefore, the sum of cations should equal the sum of anions for each water sample. An anion-cation charge balance shall be calculated for each sample using mass-charge concentrations in milliequivalents per liter (meq/L), with the difference between the two sums reported as a percentage where:

  $$\frac{Anions - Cations}{Anions + Cations} \times 100$$

  In general, a 5% or less difference is acceptable. Deviations can be greater if other constituents in the groundwater are not accounted for within the major anions and cations categories. If the anion/cation balance difference exceeds 15%, the GSA may ask the laboratory to reanalyze certain constituents or the entire sample to confirm the result is accurate.
- At a minimum, TDS, nitrate as nitrogen, and arsenic concentrations shall be plotted on individual well chemographs to monitor trends and ensure concentrations are reasonable.

After QAQC, all quality data shall be imported into the Basin DMS as soon as practical. Applicable data will also be integrated into Annual Reports, as required by DWR, and will be uploaded to the SGMA data portal. Per the GSP Regulations (23-CCR § 352.4), the following reporting standards apply to all categories of information, unless otherwise indicated:

- Water volumes shall be reported in acre-feet (AF).
- Surface water flow shall be reported in cubic feet per second (cfs) and water volumes shall be reported in AF.

- Field measurements of elevations of groundwater, surface water, and land surface shall be measured and reported in feet to an accuracy of at least 0.1 feet relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement described.
- Reference point elevations shall be measured and reported in feet to an accuracy of at least 0.5 feet, or the best available information, relative to NAVD88, or another national standard that is convertible to NAVD88, and the method of measurement described.
- Geographic locations shall be reported in GPS coordinates by latitude and longitude in decimal degree to seven decimal places, to a minimum accuracy of 30 feet, relative to NAD83, or another national standard that is convertible to NAD83.

17.3. Representative Monitoring

§ 354.36. Representative Monitoring
Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:

(a) Representative monitoring sites may be designated by the Agency as the point at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim milestones are defined.

(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:

(1) Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.

(2) Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

(c) The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.

"Representative monitoring" refers to monitoring sites within a broader network of sites that typifies one or more conditions within the Basin or a subarea of the Basin. As described in Section 17.1 *Description of Monitoring Network*, the Basin GSAs have defined a SGMA Monitoring Network for each relevant Sustainability Indicator. The rationale for selecting RMS is described for each Sustainability Indicator in the above sections.

The RMSs and associated data collection activities are comprised primarily of a subset of sites and activities that are already part of existing monitoring and reporting programs that will now also be used for SGMA reporting purposes. The data from these RMS will be used to monitor the Sustainability Indicators and evaluate GSP implementation with respect to meeting the Sustainability Goal defined for the Basin. This objective can be achieved by data showing compliance with the SMCs.

Water level measurements and calculated groundwater elevations may be used as a proxy for monitoring other Sustainability Indicators when they are correlated, uncertainty is adequately represented by the specified margin of operational flexibility, and the RMS are shown to reflect general conditions in the Basin or subarea of the Basin. Reduction in Groundwater Storage and Subsidence are correlated to water levels. Because groundwater storage changes are quantified by the physical properties of the aquifer (storativity) and water level change, Reduction in Groundwater Storage is correlated to water levels. Similarly, Subsidence occurs when water levels decrease to a point where the burden of overlying sediments compress clay beds within the aquifer and result in a lowering of the land surface. Accordingly, Land Subsidence is also correlated to water levels. The SGMA Monitoring Network for Chronic Lowering of Groundwater Levels will therefore be used as a proxy to monitor Reduction in Groundwater Storage and Land Subsidence, and the SMCs shall be defined to be protective of Reduction in Groundwater Storage and Land Subsidence.

Surface water can be depleted by leakage to groundwater. The depletion rate is influenced by the difference between surface water stage, the water table elevation adjacent and beneath the riverbed, and the water transmitting properties of the aquifer and riverbed. The maximum depletion rate occurs when the water table is below the bottom of the riverbed. Under these conditions, the depletion rate is controlled entirely by the amount of water in the channel and the water transmitting properties of the underlying aquifer and riverbed. The water table is substantially deeper than the Cosumnes River channel bottom along most of its reach in the Basin (See Section 9.6 *Interconnected Surface Water Systems*).

17.4. Assessment and Improvement of Monitoring Network

§ 354.38. Assessment and Improvement of Monitoring Network

(a) Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.

(b) Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.

(c) If the monitoring network contains data gaps, the Plan shall include a description of the following:

(1) The location and reason for data gaps in the monitoring network.

(2) Local issues and circumstances that limit or prevent monitoring.

(d) Each Agency shall describe steps that will be taken to fill data gaps before the next five- year assessment, including the location and purpose of newly added or installed monitoring sites.

(e) Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:

(1) Minimum threshold exceedances.

(2) Highly variable spatial or temporal conditions.

(3) Adverse impacts to beneficial uses and users of groundwater.

(4) The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.

Data gaps identified in the SGMA compliant monitoring program will be filled as part of GSP implementation and include:

- Incomplete or unavailable construction information for some of the RMW-WLs, RMW-WQs, and RMW-ISWs.
- Inactive surface water gauges or inactive measurement and recording of flow and/or stage on Dry Creek.
- Dedicated monitoring wells representing multiple depths are limited but needed to quantify relationships between water table elevation changes and extractions from deeper water supply wells especially near the Cosumnes River and Dry Creek. These multi-depth monitoring sites can also help evaluate possible perched groundwater conditions in areas with GDEs.

The Working Group is filling data gaps, that will be completed before the next five-year assessment, by installing planned wells as part of the Basin GSP Development and Well Installation Project. The plans include a multi-depth site designed to measure water levels in an inferred perched aquifer (less than 50 feet beneath groundwater surface) and water levels at deeper depths associated with the perforated intervals of extractions wells (greater than 100 feet below groundwater surface). The SGMA Monitoring Network will be reevaluated in each five-year GSP update, including a determination of uncertainty and whether there are additional data gaps that could affect the ability of the GSP to achieve the Sustainability

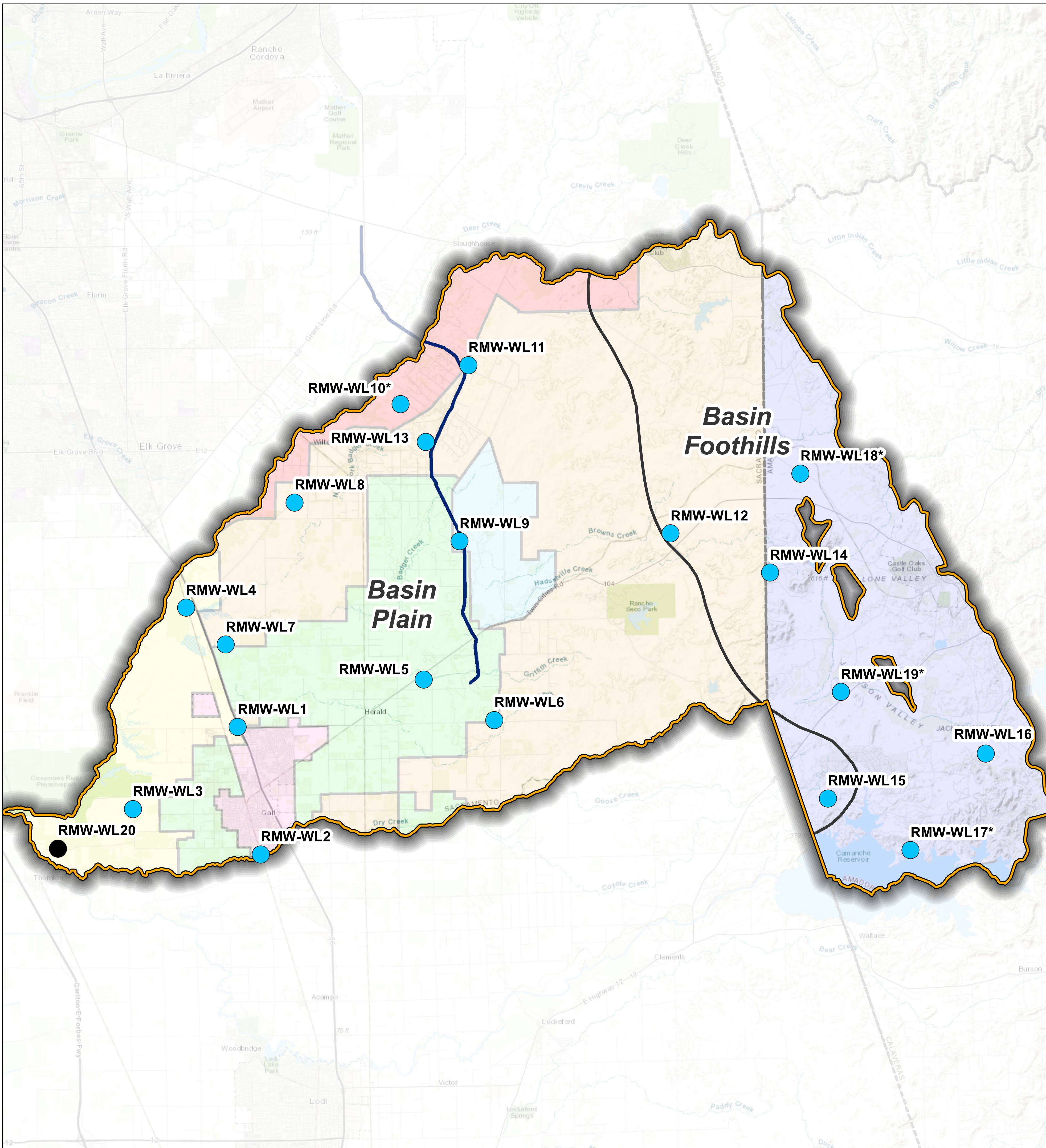
Goal for the Basin. The SGMA Monitoring Network developed for each Sustainability Indicator includes a sufficient density and spatial distribution of monitoring sites to meet the monitoring objectives outlined in Section 17.1 *Description of Monitoring Network*. In most cases, the existing RMS selected for each Sustainability Indicator conform to DWR's BMP #2 Monitoring Networks and Identification of Data Gaps (DWR, 2016b).

17.5. Reporting Monitoring Data to the Department

§ 354.40. Reporting Monitoring Data to the Department

Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.

Data collected from the SGMA Monitoring Network will be uploaded to the Basin DMS and reported to the DWR in accordance with the Monitoring Protocols developed for the Basin. Additional data collected as part of other regular monitoring programs implemented within the Basin (see Section 5.2.1 *Existing Monitoring and Management Programs*) may be used in conjunction with data collected from the SGMA Monitoring Network to meet compliance with GSP Regulations regarding annual reporting (23-CCR § 356.2) or as otherwise deemed necessary by the GSAs.



Legend

- Planned Representative Monitoring Well Site
- Representative Monitoring Well
- Cosumnes Subbasin (5-022.16)
- Cosumnes Subbasin Areas
- Folsom South Canal

Groundwater Sustainability Agency

- Amador County Groundwater Management Authority
- City of Galt
- Clay Water District
- Galt Irrigation District
- Omochumne-Hartnell Water District
- Sacramento County
- Sloughhouse Resource Conservation District

Abbreviations

DWR = California Department of Water Resources
RMW-WL = Representative Monitoring Well for Chronic Lowering of Groundwater Levels
SGMA = Sustainable Groundwater Management Act

Notes

1. All locations are approximate.
2. Asterisk (*) denotes wells that are also Representative Monitoring Sites for Degraded Water Quality.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.
3. Planned monitoring well site funded by Prop 68; preliminary design includes three wells ranging in depth from 50 to 200 feet below ground surface.

N

0 3 6

(Scale in Miles)

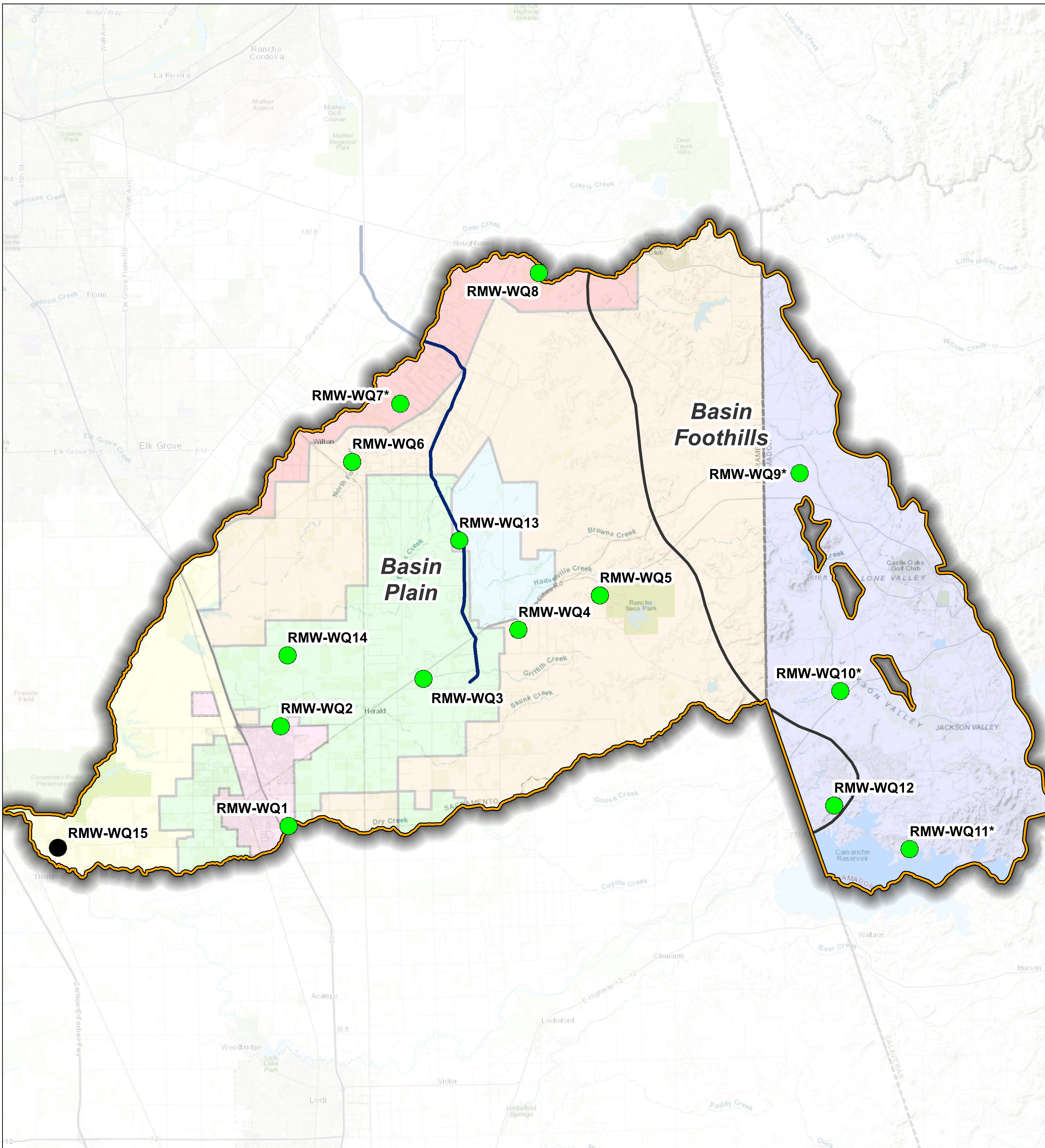
SGMA Monitoring Network for Chronic Lowering of Groundwater Levels

eki environment & water

Working Group
Cosumnes Subbasin
December 2021
B80081.00

Figure MN-1

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_MN-01_Monitoring Well Sites_wlvl.mxd



Legend

- ● Planned Representative Monitoring Well Site
- ● RMW-WQ
- Folsom South Canal
- Cosumnes Subbasin (5-022.16)
- Cosumnes Subbasin Areas

Groundwater Sustainability Agency

- Amador County Groundwater Management Authority
- City of Galt
- Clay Water District
- Galt Irrigation District
- Omochumne-Hartnell Water District
- Sacramento County
- Sloughhouse Resource Conservation District

Abbreviations

DWR = California Department of Water Resources
RMW-WQ = Representative Monitoring Well for Degraded Water Quality
SGMA = Sustainable Groundwater Management Act

Notes

1. All locations are approximate.
2. Asterisk (*) denotes wells that are also Representative Monitoring Sites for Chronic Lowering of Groundwater Levels.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.
3. Planned monitoring well site funded by Prop 68; preliminary design includes three wells ranging in depth from 50 to 200 feet below ground surface.

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(Scale in Miles)

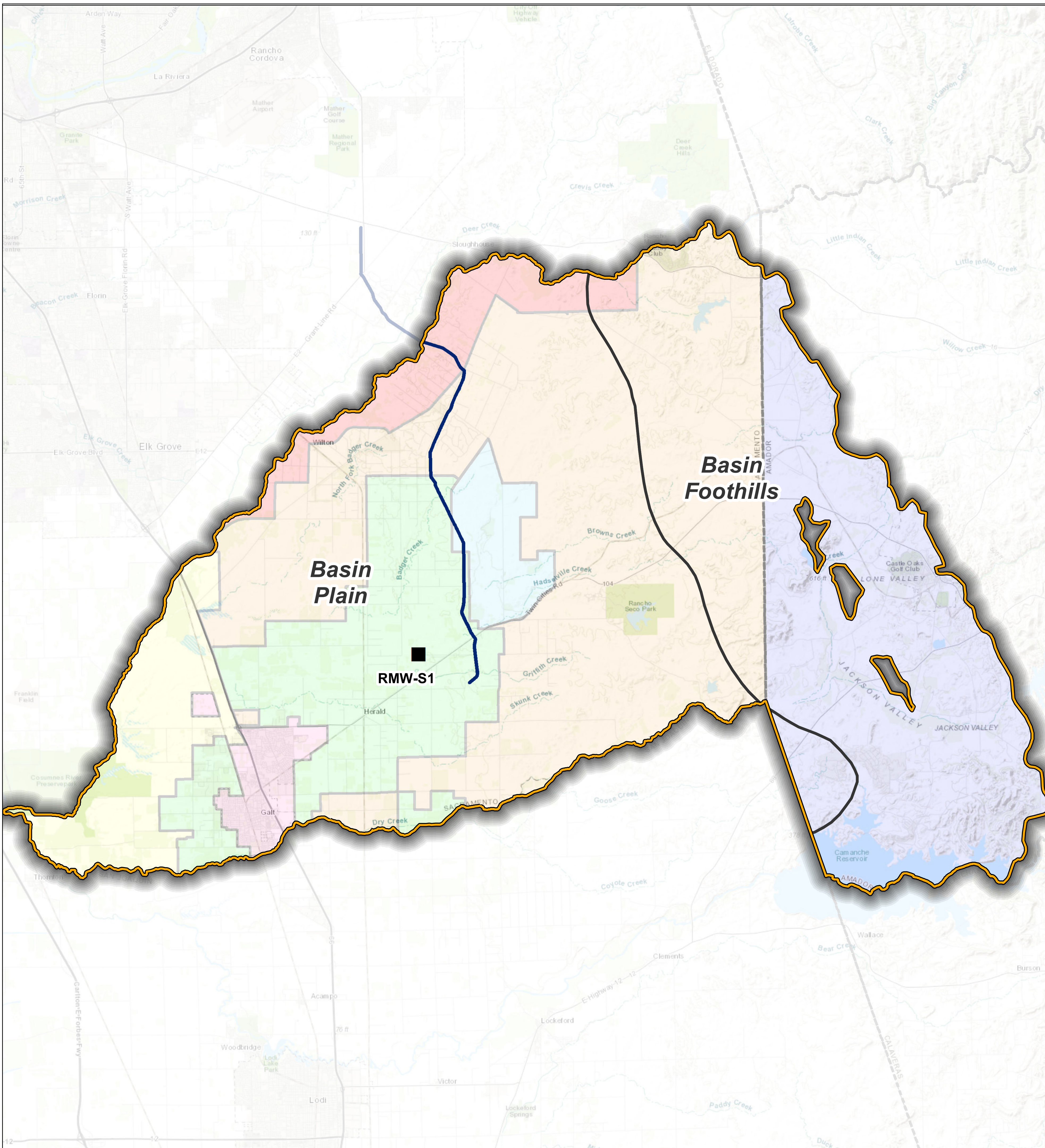
SGMA Monitoring Network for Degraded Water Quality

Working Group
Cosumnes Subbasin
December 2021
B80081.00

eki environment & water

Figure MN-2

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_MN-02_Monitoring Well Sites_wq.mxd



Legend

■ Subsidence Monitoring Station

Folsom South Canal

Cosumnes Subbasin (5-022.16)

Cosumnes Subbasin Areas

Groundwater Sustainability Agency

- Amador County Groundwater Management Authority
- City of Galt
- Clay Water District
- Galt Irrigation District
- Omochumne-Hartnell Water District
- Sacramento County
- Sloughhouse Resource Conservation District

Abbreviations

DWR = California Department of Water Resources
SGMA = Sustainable Groundwater Management Act
UNAVCO = University NAVSTAR Consortium

Notes

1. All locations are approximate.
2. The RMW-WLs (Figure-MN-1) will be used as proxy to supplement the SGMA Monitoring Network for Land Subsidence.
3. RMW-S1 is UNAVCO subsidence monitoring station P275.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.
3. Subsidence monitoring stations are from UNAVCO's Plate Boundary Observatory database. (https://www.unavco.org/instrumentation/networks/map/map.html#/)

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(Scale in Miles)

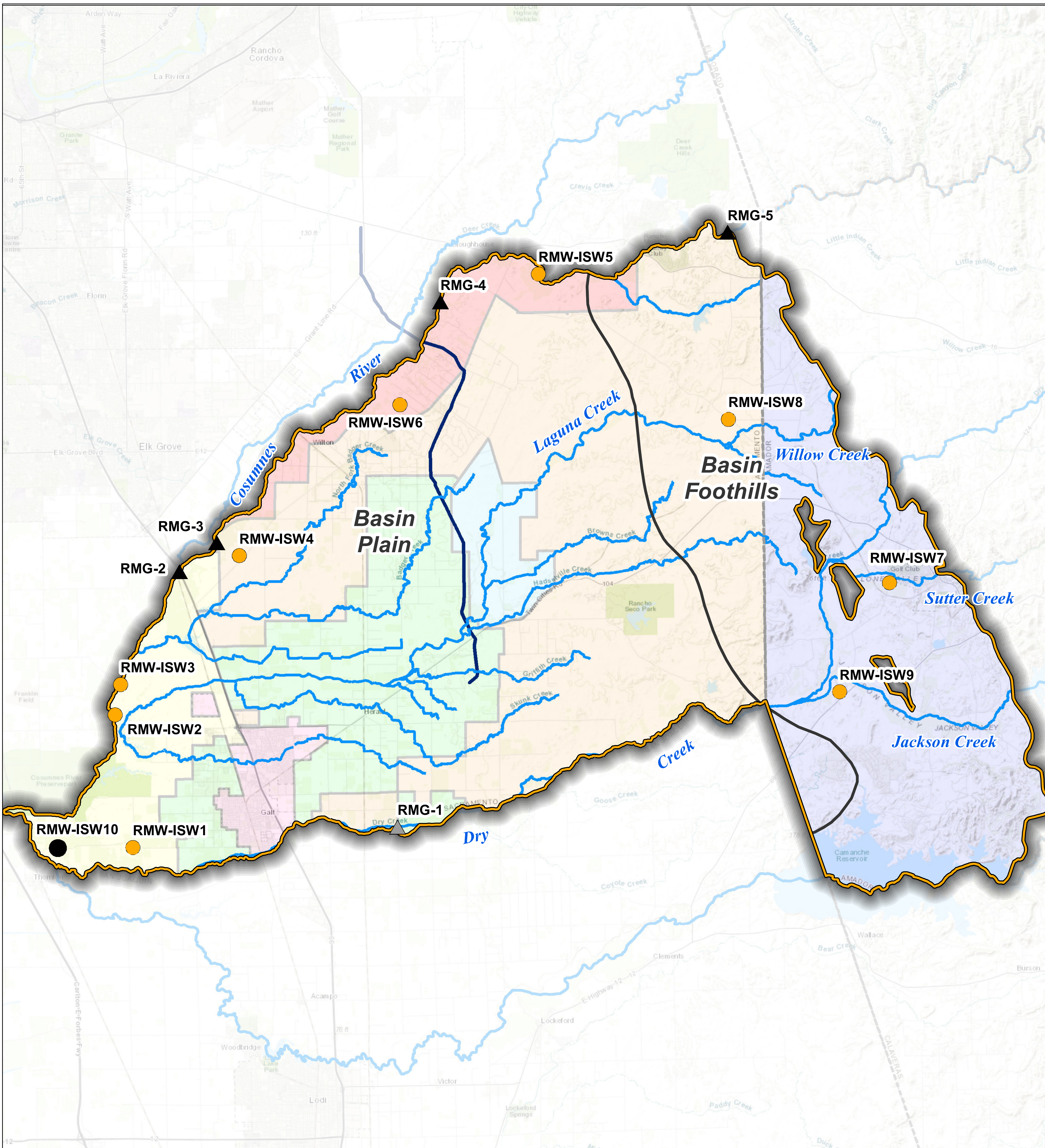
SGMA Monitoring Network for Land Subsidence

Working Group
Cosumnes Subbasin
December 2021
B80081.00

Figure MN-3

eki environment & water

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_MN-03 Map Showing Subsidence Monitoring Network.mxd



Legend

- ● Planned Representative Monitoring Well Site
- Representative Monitoring Well

Representative Monitoring Gage

- ▲ Active
- ▲ Inactive
- Major Stream
- Folsom South Canal
- Cosumnes Subbasin (5-022.16)
- Cosumnes Subbasin Areas

Groundwater Sustainability Agency

- Amador County Groundwater Management Authority
- City of Galt
- Clay Water District
- Galt Irrigation District
- Omochumne-Hartnell Water District
- Sacramento County
- Sloughhouse Resource Conservation District

Abbreviations

DWR = California Department of Water Resources
RMW-ISW = Representative Monitoring Well for Depletion of Interconnected Surface Water
RMG = Representative Monitoring Gage
SGMA = Sustainable Groundwater Management Act

Notes

1. All locations are approximate.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 6 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.
3. Planned monitoring well site funded by Prop 68; preliminary design includes three wells ranging in depth from 50 to 200 feet below ground surface.

N

0 3 6

(Scale in Miles)

SGMA Monitoring Network for Depletions of Interconnected Surface Water

Working Group
Cosumnes Subbasin
December 2021
B80081.00

eki environment & water

Figure MN-4

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_MN-04_Monitoring SW Sites.mxd

PROJECTS AND MANAGEMENT ACTIONS

18. PROJECTS AND MANAGEMENT ACTIONS

§ 354.42. Introduction to Projects and Management Actions
This Subarticle describes the criteria for projects and management actions to be included in a Plan to meet the sustainability goal for the basin in a manner that can be maintained over the planning and implementation horizon.

Pursuant to the Sustainable Groundwater Management Act (SGMA) and Groundwater Sustainability Plan (GSP) Regulations, this section presents the Projects and Management Actions (PMAs) proposed to achieve the Sustainability Goal within the Cosumnes Subbasin (Basin) (23-California Code of Regulations [CCR] § 354.42):

> *The Sustainability Goal of the Cosumnes Subbasin is to ensure that groundwater in the Basin continues to be a long-term resource for beneficial users and uses including urban, domestic, agricultural, industrial, environmental and others. This goal will be achieved by managing groundwater within the Basin's sustainable yield, as defined by sustainable groundwater conditions and the absence of undesirable results.*

To the extent that information was available, the PMAs presented herein were developed by the PMA Committee under the direction of the Cosumnes Subbasin SGMA Working Group (Working Group). The PMA Committee is comprised of Groundwater Sustainability Agency (GSA) representatives (supported by technical consultants) that collaboratively identified the proposed PMAs and developed the necessary supporting information for inclusion in the GSP. In November 2021 the Working Group developed a joint exercise of powers agreement (JPA) that established the Cosumnes Groundwater Authority (CGA) for the purpose of implementing the GSP, which includes implementating the PMAs (see **Appendix B**).

The GSAs preliminarily considered feasibility, costs and benefits when finalizing the recommended list of PMAs. However, the PMAs will require further evaluation (e.g., engineering, economic, environmental, legal, etc.) as part of implementation and will be designed with the best available information and best available science. In addition to the PMAs presented herein, the GSAs in coordination with the CGA will conduct data gap filling activities as part of GSP implementation that may include, for example, validating the status of existing wells (i.e., active/inactive), performing feasibility studies, refining the Basin water budget parameters based on additional data and modeling, collecting additional data related to aquifer conditions and properties, and conducting additional data compilation and analysis of groundwater conditions information (see Section 19.1 *Plan Implementation Activities*).

This section presents the goals and objectives of the PMAs, including the guiding principles used to prioritize the PMAs, the relevant Sustainability Indicators they address, and the expected benefits from their implementation. A list of specific PMAs is presented and summarized in **Table PMA-1** (PMA Information Forms are included in **Appendix O**) and groups the PMAs by benefit category and type. In addition, an explanation is provided for how the PMAs address the following:

- Sustainability Indicators and Undesirable Results (URs);
- Potentially applicable permitting and regulatory requirements;
- Status and implementation timeline;
- Expected benefits and/or how expected benefits will be evaluated;
- Description of the sources of water that will support PMA implementation;
- Legal authority required to implement the PMAs; and,
- A summary of estimated PMA costs and how the GSAs plans to fund PMA implementation.

18.1. Goals and Objectives of Projects and Management Actions

18.1.1. Guiding Principles

The PMAs are based on the following guiding principles:

- Groundwater Augmentation from Wet Year Supplies: Preference for supply sources available during wet years.
- Groundwater Augmentation from New Supplies: Preference for new supply sources over demand reduction (e.g., increase groundwater recharge preferred over fallowing agricultural lands).
- Offset Costs with Revenue-Generating PMAs: Develop PMAs to generate revenue and minimize the financial burden on Basin stakeholders. This principle includes potentially developing a water banking operation, wherein groundwater saved through a voluntary land fallowing program is stored in the Basin for sale later as supplemental dry year supply for other agencies. The money generated by the water sales can be used to fund GSP implementation.

In addition to these principles, the preferred PMAs are cost effective, provide multiple benefits (e.g., environmental, flood control, groundwater recharge, etc.), have a high probability for success, and maintain the viability of current beneficial uses of groundwater within the Basin.

18.1.2. Relevant Sustainability Indicators

Per the GSP Regulations, GSPs must include PMAs to address existing or potential future URs for relevant Sustainability Indicators (23-CCR § 354.44). As summarized in **Table PMA-1**, each PMA addresses one or more of these applicable Sustainability Indicators.

Projected conditions for the Basin indicate Sustainable Management Criteria (SMCs) may be exceeded for Chronic Lowering of Groundwater Levels without active groundwater management efforts. Accordingly, the PMAs are directed toward avoiding projected URs from the Chronic Lowering of Groundwater Levels, which is also protective of the Depletion of Groundwater Storage and Land Subsidence Sustainability Indicators.

Avoiding URs from lowering of water levels can also potentially protect against water quality changes that might occur due to alterations in vertical and horizontal groundwater-flow. Water quality changes from other factors, like increased deep percolation of applied water, are already regulated under the Central Valley Regional Water Quality Control Board's (RWQCB's) Irrigated Lands Regulatory Program (ILRP), and therefore also protective of water quality. Moreover, PMAs determined to potentially impact water quality can include focused monitoring and evaluation to prevent URs.

The shallow groundwater levels near interconnected surface water are influenced by stage, the exchange of surface- and groundwater, recharge and pumping. As a result, the shallow groundwater levels can be poorly correlated with the groundwater levels at greater depths and greater distances from surface water, and the protection of interconnected surface water relies on its own monitoring network and criteria.

18.1.3. Benefit Categories

The primary water management "tools" by which the GSAs can address conditions that may lead to URs for the applicable Sustainability Indicators pertain to management of water inflows (supplies) and outflows (demands). The expected benefits are groundwater augmentation, both from wet-year and new supplies, and to generate revenue to support GSP implementation. The PMAs can provide for one or more secondary benefits such as flood control, data gap filling, and so forth.

18.2. List of Projects and Management Actions

§ 354.44. Projects and Management Actions

(b) Each Plan shall include a description of the projects and management actions that include the following:

(1) A list of projects and management actions proposed in the Plan with a description of the measurable objective that is expected to benefit from the project or management action. The list shall include projects and management actions that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent. The Plan shall include the following:

(A) A description of the circumstances under which projects or management actions shall be implemented, the criteria that would trigger implementation and termination of projects or management actions, and the process by which the Agency shall determine that conditions requiring the implementation of particular projects or management actions have occurred.

(B) The process by which the Agency shall provide notice to the public and other agencies that the implementation of projects or management actions is being considered or has been implemented, including a description of the actions to be taken.

This section provides a list of the PMAs that have been preliminarily identified, and their approximate locations in the Basin are shown in **Figure PMA-1**. The PMAs were organized into three categories: (1) Groundwater Augmentation (wet year supplies), (2) Groundwater Augmentation (new supplies), and (3) Revenue Generation. Their descriptions and benefits determined by the Numerical Model are provided below, and in the summaries provided in **Table PMA-1** (Sustainability Benefits and Implementation Process), **Table PMA-2** (Expected Benefits, Water Source, and Costs), and the PMA forms provided by the GSAs are included in **Appendix O**.

18.2.1. Groundwater Augmentation from Wet Year Supplies

PMA #1 Omochumne-Hartnell Water District (OHWD) Agricultural Flood Managed Aquifer Recharge (Flood-MAR)

As part of the *OHWD Agricultural Flood-MAR* project, winter diversions will be applied on up to 1,800 acres of dormant vineyards, orchards, and other farmlands for recharge to increase groundwater levels and groundwater storage. Although the targeted farmlands are located directly north of the Cosumnes River (in the South American Subbasin [SASb]), as shown on **Figure PMA-1**, the resulting storage changes are expected to increase groundwater levels in the Cosumnes Subbasin and provide an almost 700 AFY augmentation to groundwater storage.

During Phase 1 of project implementation (anticipated to start in 2022), winter river flows from the Cosumnes River will be diverted at an anticipated average annual rate of 1,200 acre-feet per year (AFY), and the water will be applied to approximately 1,200 acres of dormant fields to percolate and recharge the aquifer. Diversions will be based on minimum daily flows on the Cosumnes River measured at the Michigan Bar gauging station as follows:

- less than 76 cubic feet per second (cfs), no diversions;
- greater than 76 cfs but less than 175 cfs, 6.5 cfs can be diverted; and
- greater than 175 cfs, a maximum of 16 cfs can be diverted.

Using historical average daily flows measured at Michigan Bar and the diversion rule set above, the estimated average annual diversion would be almost 1,400 AFY. The estimated benefit to the Cosumnes Subbasin is less than 100 AFY.

During Phase 2 of project implementation (anticipated to start in 2028), additional winter flood water from the American River will be delivered to the OHWD recharge area from Folsom Reservoir by way of the Folsom South Canal (FSC) to supplement the recharge from diversions under Phase 1. Hydrologic and reservoir operations modeling under a set of conservative assumptions and constraints indicate that, on average, more than 20,000 AFY of water could be available for spreading on up to 1,800 acres during mid-November through mid-March (MBK, written communication, March 22, 2021). For the purposes of this GSP, Phases 1 and 2 are assumed to operate until the end of the 50-year SGMA implementation period (2072).

Model-calculations indicate that the OHWD Flood-MAR project could reduce projected annual declines in groundwater storage within the Basin by almost 700 AFY. Implementation of this project will be led by the OHWD GSA and will be coordinated with other GSAs in the SASb. The project benefits will be routinely re-assessed as part of the Basin's adaptive management strategy.

PMA #2 Sacramento Area Flood Control Agency (SAFCA) Flood-MAR

The *SAFCA Flood-MAR* project includes augmenting Basin storage with excess winter American River flows released from Folsom Reservoir and delivered to the Basin by the FSC. Recharge operations will include "flooding" up to 2,000 acres of dormant fields and/or passive injection from dry wells located along FSC

(**Figure PMA-1**). During Phase 1 (2022 to 2027) the GSAs will conduct pilot studies to assess the feasibility of aquifer recharge in various locations throughout the Basin. In addition, outreach to landowners will be conducted to assess interest in participating in the recharge program. Lastly, agreements for water deliveries to participating farm fields will be secured. During this same time period, SAFCA plans to work with the United States Bureau of Reclamation (USBR), Sacramento Water Forum participants, and other interested stakeholders to reach agreement on SAFCA Flood-MAR project implementation. This includes storage of winter floodwater in the Folsom Reservoir, resolution of the water rights associated with this stored water, diversion of a portion of the stored water down the FSC and other regional conveyance systems for infiltration beneath land areas in the South American and Cosumnes subbasins, and acquisition of the right to place dry wells in the right of way of the FSC. Water diversions will commence during Phase 2 (2028 to 2042). For the purposes of this GSP, Phase 2 is assumed to continue after 2042 continuously through the 50-year sustainability period required by SGMA (through 2072).

Hydrologic and reservoir operations modeling under a set of conservative assumptions and constraints project that, on average, more than 9,000 AFY of water could be available to the Basin during November through March for spreading, and almost 6,000 AFY of additional water could be available to the Basin from November through May for passive injection through dry wells (MBK, written communication, March 22, 2021). The former diversions would be applied up to 2,000 acres of farm fields, and the latter diverted to about 50 dry wells for passive injection.

The Numerical Model was employed to analyze the benefits from the planned spreading and injection operations. Results indicated that the aquifer recharge would result in about 4,000 AFY decrease in projected storage decline in the Basin. Similarly, injection would result in more than 2,000 AFY for a total storage benefit of over 6,000 AFY.

18.2.2. <u>Groundwater Augmentation from New Supplies</u>

<u>PMA #3 OHWD Cosumnes River Flow Augmentation</u>

The *OHWD Cosumnes River Flow Augmentation* PMA releases water from the FSC into the Cosumnes River during late-October through December when the Cosumnes River typically does not flow continuously between reaches. The discontinuity in surface flows impedes fish migration and spawning. The introduction of additional instream flows will support fish requirements and provide additional flows to increase leakage from the river that will recharge the Basin. A pilot project was completed in 2005, and full implementation is contingent on securing a water source and funding (Robertson-Bryan, Inc. and Fisheries Foundation of California, 2006).

During Phase 1 (2022 – 2027), an agreement with the United States Bureau of Reclamation (USBR) for Central Valley Project (CVP) water (or other source) will be secured for release into the Cosumnes River from the FSC. During Phase 2 (2028-2042), project implementation will begin and 1,500 AFY to 5,000 AFY of CVP water (or other source) will be released from FSC into the Cosumnes River during late October through December.

For the purposes of this GSP, Phase 2 is assumed to release 1,000 AF per month during the period October through December (3,000 AFY) during the period 2028-2072.

Model calculated benefits were over 17 cfs of instream flow but the additional leakage increased groundwater storage in the Cosumnes Subbasin by less than 100 AFY.

PMA #4 City of Galt Recycled Water Project

The City of Galt currently provides secondary treated wastewater (recycled water) to more than 160 acres of nearby farmland for summer irrigation. The approximate location of farmlands and the wastewater treatment plant (WWTP) are shown on **Figure PMA-1**. This PMA will expand the program to apply more of the existing recycled water supply (secondary or tertiary treated as determined) to 640 acres of Basin farmland year-round. During Phase 1 (2022-2027) agreements will be secured with landowners to expand the area of fields that will receive recycled water and the discharge permit from the National Pollutant Discharge Elimination System (NPDES) will be modified to include year-round irrigation. The current RWQCB Central Valley Region NPDES Order R5-2015-0125 allows for secondary treated effluent irrigation to the designated areas. During Phase 2 (2028-2042), the application area will be expanded, and treated wastewater will be applied year-round. The winter applications are expected to increase recharge, and the summer growing season deliveries will decrease demands for groundwater. The model-calculated storage benefit of this PMA is approximately 300 AFY. For the purposes of this GSP, Phase 2 is assumed to extend continuously through the 50-year sustainability period required by SGMA (through 2072).

18.2.3. Revenue Generation

PMA #5 Voluntary Land Repurposing

The *Voluntary Land Repurposing* PMA includes land fallowing and potentially other methods to reduce groundwater extractions and use by agriculture. The land repurposing activity decreases groundwater use by temporarily removing a portion of the approximately 11,000 total acres in the Basin Plain that is irrigated solely with groundwater (more than 7,300 acres of pasture, more than 1,100 acres of alfalfa, and more than 2,500 acres of corn). In Phase 1 (2022-2027), approximately 750 to 1,000 acres of active farmland irrigated with groundwater will be repurposed (for example, 7-9% of the candidate lands will be voluntarily fallowed), and increased to as much as 2,000 acres (about 18% of the candidate lands) during Phase 2 (2028-2042). For the purposes of this GSP, Phase 2 is assumed to extend continuously through the 50-year sustainability period required by SGMA (through 2072). The potential candidate farmlands are shown on **Figure PMA-1**. The program will be voluntary, and participating landowners will be compensated by the GSAs for the cessation of groundwater use on their land.

Initial estimates indicate that repurposing 750 acres can reduce groundwater consumption by 2,700 AFY during Phase 1 and decrease consumption by more than 6,300 AFY when fully implemented in Phase 2. The repurposed land could include voluntary fallowing for short time periods (1-2 years) or extend longer and represent relatively permanent changes in land use. The water not consumed and retained in storage can be extracted and sold as supplemental dry year supply.

PMA #6 Groundwater Banking and Sale

The *Groundwater Banking and Sale* PMA utilizes the available storage in the Basin to store water that can be extracted later and sold to out-of-Basin users for dry year supply augmentation. This PMA depends on demand for dry year water supply augmentation, a partnering urban water agency, and construction of necessary pipelines and recovery wells. The PMA can generate significant revenue from water sales, thereby reducing the cost to Basin landowners to support GSP implementation. The sale of stored water will only occur once external flood and/or recycled water enter the Basin in sufficient amounts to offset the volume sold. Exported water will be guided by a leave-behind policy, whereby a set fraction of the banked water intentionally remains in the Basin. As a starting point, it has been suggested that for every 1.0 AF of banked water that is sold, 3.0 AF of water will have been added to the Basin aquifer. Additional stakeholder and GSA input is needed to formalize the policy and identify the appropriate criteria to manage the groundwater bank.

During Phase 1 (2022-2027), the Cosumnes Groundwater Authority (CGA) will work with Basin landowners, GSA members, and regional stakeholders to develop necessary policies and procedures that define how the water banking and recharge programs will be implemented. This will include governance, groundwater monitoring, and establishment of a verifiable accounting system to track the amount of water entering the Basin and the amount that is sold. Once these policies and procedures are in place, an interested urban water purveyor has been identified, construction activities are completed, and recharge of winter flood water has begun, the banking and sale of stored water could commence in Phase 2 (2028-2042) after. For the purposes of this GSP, Phase 2 is assumed to extend continuously through the 50-year sustainability period required by SGMA (through 2072).

18.2.4. <u>Other PMAs</u>

Other PMAs are also under consideration, but details are currently insufficient to estimate implementation costs and benefits. For example, consistent with existing law, the GSAs can implement agricultural water conservation and management practices, including conjunctive use, to reduce extraction volumes, increase groundwater recharge, and manage the Basin water budget. To accomplish these goals, the GSAs may develop programs and Best Management Practices (BMPs) to increase water use efficiency. For example, effective BMPs that reduce overall groundwater consumption could include improved irrigation practices, conversion of land uses from relatively high-water demand to lower water demand crops, improved water tracking and accounting methods, installation of higher efficiency irrigation delivery and application systems, employment of soil moisture sensors for more precise irrigation scheduling and application volumes, and promotion of other actions that can help reduce overall groundwater consumption. The GSAs may consider creating incentives or providing funding to promote these improvements based upon available financial resources and landowner participation.

Other potential PMAs that may be considered by the GSAs include:

- Expand incentives to expand the voluntary land fallowing program, or shift land use to growing less water intensive crops (land repurposing);
- Provide technical and financial incentives that support landowners wanting to implement local water use efficiency/conservation projects;

- Explore multi-benefit opportunities for off stream impoundments to store floodwater, including potential stormwater diversions from the Cosumnes River to augment storage/recharge on the south side of the river;
- Coordinate with Agency and Nongovernmental Organization (NGO) partners working with willing landowners near the Cosumnes River to develop multi-benefit projects that offer recharge and agricultural and/or habitat preservation benefits;
- Explore recharge projects that utilize potentially available surface water from Amador County and existing infrastructure;
- Explore multi-benefit opportunities for diversions to interior Basin drainages to increase recharge from leakage and reconnect their lower reaches in the floodplains;
- Evaluate the efficacy of local recharge projects such as catch ponds, dry wells, seepage pits, and other water substitution practices. For example, a distributed network of dry wells throughout the Basin could help manage stormwater and increase groundwater recharge beneath private lands;
- Implement Low Impact Development practices in the City of Galt (including the use of dry wells to redirect stormwater runoff for recharge);
- Implement the Drought Resilience Impact Platform for verifying Basin pumping, conservation efforts and land repurposing effectiveness;
- Participate in regional water supply and water banking projects, such as the Harvest Water Project[83];
- Review implementation of the Deer Creek Hills Aquifer Storage and Recovery (ASR) project, initially proposed in 1997 as part of the water supply for the proposed Deer Creek Hills development, which utilizes high flows from the Cosumnes for ASR immediately north of the community of Rancho Murieta. Based on the initial application to appropriate water by permit with the SWRCB, 4,800 AFY of excess high flows (10 cfs max diversion rate) from the Cosumnes River (between November and June) would be diverted from the existing Rancho Murieta Community Service District Pump Station near Granlees Dam. The diversions are then injected into nearby private wells (consolidated aquifer) for storage and recovery at a later time; and,
- Construct a new well for Arcohe School and develop a groundwater recharge program for the students.

[83] The Harvest Water project is in the SASb, and implementation is similar in concept to the City of Galt Recycled Water Project (PMA #4) whereby groundwater irrigation is replaced by treated wastewater and the water is applied year-round. The combined reduction in groundwater use and greater recharge north the Basin is projected to increase groundwater levels, benefiting groundwater storage in the SASb and Basin, and reduce Cosumnes River depletions ("South Sacramento County Agriculture and Habitat Lands Recycled Water, Groundwater Storage, and Conjunctive Use Program, Integrated Groundwater and Surface Water Modeling Results Technical Memorandum," RMC, 2017).

These additional PMAs provide flexibility to the Basin to adaptively address unforeseen conditions. For example, one or more of the additional PMAs may be implemented should projected climatic conditions be drier than represented in this evaluation. Additional PMAs may also be needed should the expected benefits from the planned PMAs be unrealized, or unforeseen circumstances restrict implementation (e.g., failure to secure outside water sources). If the institutional partnerships needed to implement the SAFCA Flood-MAR program are not realized, and voluntary land repurposing in combination with the other PMAs described above cannot achieve the deficit reduction anticipated in the GSP, the GSAs must be prepared to use the required five-year update to examine alternatives, including more extensive demand reduction measures within the CGA's control.

Table PMA-1. Projects and Management Actions – Sustainability Benefits and Implementation Process[1]

PMA Name	Summary Description	Relevant Sustainability Indicators Affected: Groundwater Levels	Groundwater Storage	Interconnected Surface Water	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation
Groundwater Augmentation (Wet Year Supplies)									
#1 OHWD Agricultural Flood Managed Aquifer Recharge	Phase 1 (2022-2027): 1,200 AF per year of winter diversions anticipated from Cosumnes River during high flows to flood 1,200 acres of dormant vineyards, orchards, etc. (Estimated benefit toward reducing the projected storage decline is almost 700 AFY). Phase 2 (2028-2042): Anticipated average annual diversions of 20,000 AFY excess American River winter water released from Folsom Reservoir and delivered to Basin by the FSC during the period November 15 – March 15 (See SAFCA Flood-MAR project described below). Diversion applied to 1,800 acres dormant vineyards, orchards, etc. (Estimated benefit toward reducing the projected storage decline is approximately 700 AFY).[2]	x	x		Phase 1 is underway. Phase 2 requires secured agreement with SAFCA and grant funding	Dependent on Permitting and Regulatory Process Requirements	OHWD annual permits from SWRCB 2022-2027, 2028-2042; USBR (uncertain) CEQA, Neg Dec	Planning	Upon agreement with SAFCA; USBR: completion of infrastructure; and grant funding.
#2 SAFCA Flood Managed Aquifer Recharge	Phase 1 (2022-2027): Perform feasibility studies, develop agency partnerships and agreements for water deliveries, and secure agreements with landowners in the Basin to receive water to percolate recharge. Phase 2 (2028-2042): Average annual diversions of more than 9,000 AFY excess American River winter water anticipated for release from Folsom Reservoir and delivered to Basin by FSC to up to 2,000 acres of dormant farm fields during the period November 15 -March 15. (Estimated benefit toward projected storage decline in Basin is approximately 4,000 AFY).[1] Average annual diversions of more than 6,000 AFY excess American River winter water released from Folsom Reservoir and delivered to Basin by FSC to dry wells during the period November 1 through May 31. (Estimated benefit toward reducing the projected storage decline is approximately 2,000 AFY).[2]	x	x		Requires secured agreement with SAFCA and grant funding	Dependent on Permitting and Regulatory Process Requirements	CEQA; NEPA	Planning	Upon agreement with SAFCA; USBR; completion of infrastructure; and grant funding
Groundwater Augmentation (New Supplies)									
#3 OHWD Cosumnes River Flow Augmentation	Phase 1 (2022-2027): Secure agreement with USBR for CVP water (or other source) to release from FSC into Cosumnes River. Phase 2 (2028-2042): Release 1,500 AFY- 5,000 AFY CVP water (or other source) from FSC into Cosumnes River during late Oct-Dec to improve flows for fish migration and increase recharge from river leakage. (Estimated benefit from releasing 3,000 AFY towards reducing the projected storage decline is less than 100 AFY).[2]			x	Upon contract for water supply	TBD	CEQA Neg Dec/NEPA	Pilot project completed	On-going
#4 City of Galt Recycled Water Project	Phase 1 (2022-2027): Secure agreements with landowners to expand area of fields that receive recycled water. Phase 2 (2028-2042): Expand existing summer irrigation of 160 acres with plant effluent to include year-round irrigation to a total of 640 acres. (Estimated benefit toward reducing the projected storage decline is approximately 300 AFY).[2]	x	x		Upon agreement with nearby farmers, completion of necessary infrastructure and completion of necessary permit modifications	None other than signage along perimeter of area to warn/preclude public from potential contact	Current RWQCB Central Valley Region Order R5-2015-0125 allows for secondary treated effluent irrigation to designated areas. Expansion of receiving area or tertiary treatment for winter use may require permit modification, CEQA	Planning	Project development and implementation

PMA Name	Summary Description	Relevant Sustainability Indicators Affected: Groundwater Levels	Groundwater Storage	Interconnected Surface Water	Circumstances for Implementation	Public Noticing Process	Permitting and Regulatory Process Requirements	Status	Timetable / Circumstances for Initiation
Revenue Generation									
#5 Voluntary Land Repurposing	Phase 1 (2022-2027): Incentivize farmers to voluntarily repurpose up to ~1,000 acres (for example, temporary land fallowing) to provide a net reduction in groundwater consumption of about 2,700 AFY. (Estimated benefit toward reducing projected storage decline is Phase 2 (2028-2042): Incentivize farmers to voluntarily repurpose as many as 2,000 acres to provide at full implementation a net reduction in groundwater consumption of 6,300 AFY, of which about 5,000 AFY would be available for extraction and sale.	x	x		Upon secured agreements with landowners	None	None	Planning	Secured agreements with landowners
#6 Groundwater Banking and Sale	Phase 1 (2022-2027): Develop agreements with local water management agencies and interested water purveyors to design water banking and recharge policies, governance procedures, groundwater monitoring and accounting methods, and terms and conditions for the export of stored water (for example, a "leave behind policy"). Phase 2 (2028-2042): Initiate water banking and sale once SAFCA Flood-MAR construction activities are complete and recharge of winter flood water has begun.	x	x		Agreement with water purveyor; construction of infrastructure	Dependent on Permitting and Regulatory Process Requirements	CEQA Neg Dec	Planning	Agreement with water purveyor; construction of infrastructure

Notes:
(1) Summary table developed based off information provided by the Basin PMA Committee, *see* **Appendix O** for detail.
(2) Model estimated storage benefits include SASb PMAs (conservation, water bank, and Harvest Water).

Abbreviations:
AFY = acre-feet per year
CEQA = California Environmental Quality Act
CWC = California Water Code
DEW = Climate Change - Dry Extreme Warming
Flood-MAR= Flood-Managed Aquifer Recharge
FSC= Folsom South Canal
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
HC = Repeat of Historical Climate
OHWD= Omochumne-Hartnell Water District
Neg Dec= Negative Declaration
NEPA = National Environmental Protection Act
PMA = Project and/or Management Action
SAFCA= Sacramento Area Flood Control Agency
SWRCB = State Water Resources Control Board
TBD = to be determined
UR = Undesirable Result
USBR= United States Bureau of Reclamation
WWTP= Wastewater Treatment Plant

Table PMA-2. Projects and Management Actions – Expected Benefits, Water Source, and Costs

PMA Name	Timetable for Implementation	Timetable for Accrual of Expected Benefits	Expected Benefits: Primary – Groundwater Storage	Expected Benefits: Secondary – Flood Control	Expected Benefits: Secondary – Policy Project	Expected Benefits: Secondary – Develop New Supplies	Source(s) of Water, if applicable	Legal Authority Required	Estimated Costs: Capital	Estimated Costs: Operations and Maintenance (per year)	Estimated Costs: Potential Funding Source(s)
Groundwater Augmentation (Wet Year Supplies)											
#1 OHWD Agricultural Flood Managed Aquifer Recharge	Phase 1: 2022 -2027 Phase 2: 2028 -2042	Upon project initiation	--- 700 AFY	x		x	Phase 1: Cosumnes River Phase 2: American River via FSC	Phase 1: Consistent with OHWD's authority as a water district Phase 2: OHWD, USBR, SAFCA, and others TBD	Phase 1: Completed Phase 2: \$20,000,000[2]	\$660,000	Sale of stored water
#2 SAFCA Flood Managed Aquifer Recharge	2028 - 2042	Upon project initiation	4,000 to 6,000 AFY	x		x	American River via FSC	Consistent with SAFCA's authority as the regional flood-control agency	\$18,000,000[2]	\$1,980,000	Sale of stored water, Grants
Groundwater Augmentation (New Supplies)											
#3 OHWD Cosumnes River Flow Augmentation	2028	Upon Project initiation	<100 AFY			x	Imported CVP surface water or other source	Consistent with OHWD's authority as a water district	Completed	\$100,000	Sale of stored water
#4 City of Galt Recycled Water Project	2028	Upon project initiation	300 AFY			x	Recycled water	Consistent with City of Galt	TBD	\$50,000	Sale of stored water
Revenue Generation											
#5 Voluntary Land Repurposing	Phase 1: 2022 -2027 Phase 2: 2028 -2042	Upon project initiation	~2,700 AFY ~6,300 AFY		x		NA	Consistent with Basin GSAs authority pursuant to CWC Section 10726.2(b)	N/A	\$430,000 to \$935,000	User fees and sale of stored water
#6 Groundwater Banking and Sale	2028	Upon project initiation			x		Imported Surface Water	Consistent with Basin GSAs authority pursuant to CWC Section 10726.2(b)	\$1,000,000	\$130,000	Banking revenue

Abbreviations:
AFY = acre-feet per year
CEQA = California Environmental Quality Act
CWC = California Water Code
DEW = Climate Change - Dry Extreme Warming
Flood-MAR= Flood-Managed Aquifer Recharge
FSC= Folsom South Canal
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
HC = Repeat of Historical Climate
OHWD= Omochumne-Hartnell Water District
Neg Dec= Negative Declaration
NEPA = National Environmental Protection Act
PMA = Project and/or Management Action
SAFCA= Sacramento Area Flood Control Agency
SWRCB = State Water Resources Control Board
TBD = to be determined
UR = Undesirable Result
USBR= United States Bureau of Reclamation
WWTP= Wastewater Treatment Plant

Note:
(1) Summary table developed based off information provided by the Basin PMA Committee, *see* **Appendix O** for detail.
(2) Capital costs funded by SAFCA and anticipated Grant Funds.

18.3. Circumstances for Implementation

This section describes the circumstances under which PMAs shall be implemented, the criteria that would trigger implementation and/or termination of PMAs, and the process by which the GSAs confirm implementation has occurred. At this time, the GSAs anticipate that all six PMAs listed above are necessary to ensure sustainability of the Basin under the uncertainty of future climate and land use conditions.

This GSP will be the first adopted plan for coordinated Basin-wide management of the water resources. The GSP and PMA implementation efforts will require forging agreements between relatively newly-formed GSAs and creation of funding mechanisms to support GSP implementation. While the GSAs have proactively pursued the conceptual development of PMAs through participation in committee meetings, monthly Working Group meetings, conducting pilot projects, coordinating with potential partners, and initiating negotiations to secure relevant agreements, amongst other actions, considerable effort remains before PMA start-up occurs and the benefits measurably accrue in the Basin.

As indicated in **Table PMA-1,** the PMA implementation will occur in phases, and as explained in Section 18.7 *Status and Implementation Timetable*, the phased approach (or "glide path") will accommodate the necessary start-up period to address outstanding issues and begin accruing benefits to the Basin. Accordingly, PMA implementation is planned to occur in two phases. During Phase 1 (2022-2027), a small number of PMAs will be implemented and the groundwork established to implement the remaining PMAs. The trigger for Phase 1 is adoption of an updated fee structure to replace the pre-GSP implementation fees adopted by the GSAs in 2021. The trigger for Phase 2 (2028-2042) will be the five-year GSP update. At that point, it is assumed that the institutional and legal relationships to implement the SAFCA Flood-MAR project will be in place (PMA #2), which will allow the Cosumnes GSAs to incorporate groundwater banking and sale into an updated fee structure to fund GSP implementation during Phase 2.

The PMAs implemented during Phase 1 include the groundwater recharge project currently underway in OHWD *(*PMA #1 *OHWD Flood-MA*R with Cosumnes River diversions) and the initial phase of voluntary land repurposing (for example, land fallowing) (PMA #5 *Voluntary Land Repurposing*). The Harvest Water project which is occurring in the SASb and described above under Section 18.2.4 *Other PMAs* will also be implemented during Phase 1.

The transition between Phase 1 and Phase 2 will be triggered by the five-year update to the GSP. For planning purposes, at this point agreements we be in place with resource agencies to increase surface water sources, and additional landowner participation will have been secured to expand the programs initiated in Phase 1. The Phase 2 Water Supply Augmentation PMAs listed in **Table PMA-1** will be initiated after agreements are in place between SAFCA and the USBR that enable the GSAs to purchase water released from Folsom Reservoir and have it delivered to the Basin by way of the FSC, and a separate water supply is negotiated to augment Cosumnes River flows. Essential to negotiating these complex arrangements is hiring an experienced Plan Manager for the CGA to guide GSP implementation.

The following Water Augmentation PMAs require agreements to be in place before shifting from Phase 1 to Phase 2 of implementation:

- *PMA #1 OHWD Flood-MAR* shifts from about 1,200 AFY of Cosumnes River flows on average to 20,000 AFY of excess American River winter water.
- *PMA #2 SAFCA Flood-MAR* acquires almost 10,000 AFY on average of excess American River winter flood water to percolate beneath dormant fields and an additional 6,000 AFY on average introduced into the Basin using dry wells.
- *PMA #3 OHWD Cosumnes River Flow Augmentation* acquires 1,500 to 5,000 AFY of CVP water (or other source) to release to Cosumnes River.

The Phase 2 Water Supply Augmentation PMA using existing recycled water available from the City of Galt (*PMA #4 City of Galt Recycled Water Project*) will be initiated when agreements are in place with landowners, necessary infrastructure is in place to deliver the water (conveyance pipes and ditches, potential field leveling and berm construction, and so forth), and necessary NPDES permit modifications are completed.

The revenue generating PMAs (*PMA #5 Voluntary Land Repurposing and #6 Groundwater Banking and Sale*) are essential to support GSP implementation including participation in the SAFCA Program. These PMAs will be initiated when efforts are made between the GSAs and potential partnering agencies like SAFCA and one or more urban water agencies. Phase 1 includes establishing formal relationships to plan and prepare for implementation of the banking operations. The trigger that transitions Phase 1 into Phase 2 is the establishment of the formal agreements necessary to support the SAFCA Flood-MAR Program, which is assumed to occur by 2027. The PMA will be considered in place when the agreements, infrastructure, and accounting methods are completed to acquire, deliver, store, and extract the water.

The other PMAs discussed in Section 18.2.4 *Other PMAs* will be under consideration throughout GSP implementation and identified needs depending partly on the accrual of quantifiable benefits from the implemented PMAs, and their effectiveness for avoiding URs. Additional triggers include grant funding availability, feasibility study results, economic evaluations, and/or other relevant planning studies.

18.4. Public Notice Process

Public notice requirements vary for each PMA (see **Table PMA-1**). Some PMAs that involve infrastructure improvements may not require specific public noticing (other than that related to construction). In general, the PMAs being considered for implementation will be discussed during regular CGA meetings, which are open to the public. They will also each be subject to California Environmental Quality Act (CEQA) review and other permitting process that are subject to public notice and review. Additional stakeholder outreach efforts will be conducted prior to and during PMA implementation by the project proponent(s), as needed and as required by law.

18.5. Addressing Overdraft Conditions

> *§ 354.44. Projects and Management Actions*
>
> *(1) Each Plan shall include a description of the projects and management actions that include the following:*
>
> *…*
>
> *(2) If overdraft conditions are identified through the analysis required by Section 354.18, the Plan shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft.*

As discussed in Section 9.2 *Change in Groundwater Storage,* the Basin shows a negative cumulative change in storage over the historical water budget period (i.e., Water Years 1999 through 2018). Most of the almost -11,000 AFY average annual decline in storage (>90%) has occurred in the Basin Plain portion of the Basin, where groundwater levels in wells have shown persistent decreasing trends over the available period of record (see **Figure GWC-6**). The projected rate of decline in storage decreases over the next 50 years to almost -2,000 AFY (assuming the past 50 years of rainfall and temperature repeat). The 50-year historical average rainfall is about 11% greater than the 1999-2018 average, contributing to 3,000 AFY of additional deep percolation. Groundwater inflow across the Basin boundaries increases (or groundwater outflows across Basin boundaries decrease) as Basin water levels continue to decline, resulting in an almost 4,000 AFY of additional recharge. The continuing decline in water levels reduces recharge from stream leakage by about -1,000 AFY. Lastly, the projected annual average future pumping is almost -3,000 AFY less due partially to the differences in rainfall and temperature, and partially to changes in land and water use. These factors combine to reduce annual average depletion of storage in the Basin by about 9,000 AFY (see **Table WB-10**).

The projected conditions summarized above without PMAs show groundwater levels and storage changes stabilizing somewhat as the demand patterns change within the Basin. The annual changes in groundwater storage are influenced primarily by climate, whereas the long-term depletion of groundwater storage is influenced primarily by the consumption of extracted groundwater. Hence, uncertainty in future climatic conditions and its influence on recharge and pumping create the most uncertainty in future groundwater storage conditions. The Numerical Model was employed to evaluate the uncertainty in future Basin storage due to near and longer-term climate uncertainty, and model calculations indicated that future groundwater storage will continue to decline (see **Table WB-10** and **Figure WB-16**) and under some climate change scenarios URs are projected to occur late in the scenario timeframes. The PMAs presented herein are expected to result in benefits (discussed below) to avoid URs within the range of uncertainty in future conditions, including climate change scenarios, and thus maintain sustainability in the Basin.

18.6. Permitting and Regulatory Process

> *§ 354.44. Projects and Management Actions*
>
> *(b) Each Plan shall include a description of the projects and management actions that include the following:*
>
> *…*
>
> *(3) A summary of the permitting and regulatory process required for each project and management action.*

As shown in **Table PMA-1**, the permitting and regulatory requirements vary for the different PMAs depending on whether they are recharge projects, developing new supplies, and so forth. The various types of permitting and regulatory requirements (not all applicable to every PMA) include the following:

1. Federal
   - National Environmental Policy Act (NEPA) documentation if federal grant funds are used; and
   - USBR permits to acquire stored water from Folsom Reservoir and access to the Folsom South Canal for water conveyance to the Basin.
2. State
   - CEQA documentation, including one or more of the following: Categorical Exemption, Initial Study, Negative Declaration (Neg Dec), Mitigated Negative Declaration, and/or Environmental Impact Report (EIR); and/or
   - State Water Resources Control Board (SWRCB) and Central Valley Regional Water Quality Control Board permits and regulations regarding water rights permits and recycled water use permits; and/or
   - Right of Entry/Access permits – any physical work on State lands requires an agreement to access their property. Also required for Cosumnes River Preserve lands owned by The Nature Conservancy.
3. County/Local
   - Sacramento County Environmental Management Department well construction permit; and/or
   - Encroachment permits – Sacramento County Department of Transportation for public right aways; and/or
   - Sacramento County Groundwater and Surface Water Export permit if groundwater or surface water is proposed for transport outside of the County.

Specific, currently-identified permitting and regulatory requirements for each PMA are listed in **Table PMA-1**. Upon initiation of each PMA, the regulatory and permitting requirements of the PMA will be reexamined. As with any PMA planned or implemented under SGMA, actions undertaken will remain in compliance with existing water rights constraints and processes under California and Federal law.

18.7. Status and Implementation Timetable

> *§ 354.44. Projects and Management Actions*
>
> *(b) Each Plan shall include a description of the projects and management actions that include the following:*
>
> *…*
>
> *(4) The status of each project and management action, including a time-table for expected initiation and completion, and the accrual of expected benefits.*

As discussed above in Section 18.3 *Circumstances for Implementation,* most PMAs will be developed, implemented, and expanded in phases. **Table PMA-1** presents preliminary estimates of the time required to complete, and/or implement, each PMA and a timetable for accrual of expected benefits. Expected benefits are based on the PMAs estimated contribution toward reducing the projected annual average decline in groundwater storage, and their efficacy toward preventing URs as indicated by projected long-term water levels. These estimates will be refined, as necessary, upon further evaluation and/or initiation of the PMAs.

18.8. Expected Benefits

> *§ 354.44. Projects and Management Actions*
>
> *(b) Each Plan shall include a description of the projects and management actions that include the following:*
>
> *…*
>
> *(5) An explanation of the benefits that are expected to be realized from the project or management action, and how those benefits will be evaluated.*

The different categories of expected benefits of each PMA are presented in **Table PMA-2**. Below is a discussion of how the expected benefits will be evaluated. As stated previously, most PMAs have expected benefits related to water quantity. Once a PMA is implemented, it is important to evaluate and quantify the benefits resulting from a given PMA as part of monitoring and data collection activities. The specific ways in which PMA benefits are evaluated and/or quantified depends on the PMA.

The goals and objectives of PMA implementation are not necessary to achieve a certain water budget outcome, but rather to increase the likelihood that URs for relevant Sustainability Indicators are avoided by the end of the GSP implementation period (i.e., by 2042). For this reason, while the relative effectiveness of each PMA is based on benefits to the water budget, the success of the collective implementation of PMAs are ultimately determined by whether the Sustainability Goal for the Basin is achieved.

To assess the effects of PMA implementation, the Numerical Model was utilized to calculate the hydrologic responses to GSP implementation relative to proposed SMCs for Chronic Lowering of Groundwater Levels, Reduction in Groundwater Storage, and Depletion of Interconnected Surface Waters. In all three, the criteria metrics are water levels. Where detailed information was available for each PMA, the modeled results of the PMAs were determined and used to assess the benefit of each PMA and is discussed in Section 18.2 *List of Projects and Management Actions* and summarized in **Table PMA-2**. When details were limited, an estimated benefit was determined by an assessment of available information and potential benefits. As discussed previously in Section 10.4 *Projected Water Budget*, and Section 10.5 *Water Budget Uncertainty and Limitations*, the PMAs improve sustainability by increasing groundwater levels. **Figure WB-17 and Figure WB-18** show that projected water levels with the PMAs at some locations can be as much as 25 feet higher than without the PMAs. Similarly, under the ARBS CT 20270 Climate Change Scenario the projected water levels in most wells decrease below the Minimum Thresholds (MTs), indicating Undesirable Results, whereas with the PMAs the water levels in many of the wells are maintained near the MOs.

18.9. Source and Reliability of Water from Outside the Basin

§ 354.44. Projects and Management Actions

(b) Each Plan shall include a description of the projects and management actions that include the following:

…

(6) An explanation of how the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.

Several of the PMAs discussed below and shown in **Table PMA-2** rely on additional water supplies from outside of the Basin. Water supply sources for each PMA is discussed below:

- *PMA #1 OHWD Agricultural Flood-MAR* depends on winter flow conditions of the Cosumnes River (2022-2027) and American River winter flood-control releases from Folsom Reservoir (2028-2042).
- *PMA #2 SAFCA Flood-MAR* depend on excess winter flood flows from the American River released from Folsom Reservoir (2028-2042).

Both PMA #1 and PMA #2 depend on the availability of precipitation runoff from upgradient watersheds during wet years to create significant stormflow in the Cosumnes River. The PMAs also depend on precipitation runoff from the American River watershed and flood control operations. As runoff is naturally controlled by climate, the future frequency, volume and reliability of stormflows entering the system is uncertain.

- *PMA #3 Cosumnes River Flow Augmentation* relies on surface water imports, pending agreement for water and flow conditions. The reliability of said water will depend on the partner agency involved.

- *PMA #4 City of Galt Recycled Water Project* is fairly reliable because the community will produce wastewater year-round.
- *PMA #5 Voluntary Land Repurposing* does not rely on water from outside the Basin.
- *PMA #6 Groundwater Banking and Sale* depends on the volume of flood and/or wastewater entering the Basin to satisfy the leave-behind policy.

PMA #1 (Phase 1) depends on the availability of precipitation runoff from upgradient watersheds during wet years to create significant stormflow in the Cosumnes River. PMA #1 (Phase 2), PMA #2, and PMA #3 depend on precipitation runoff from the American River watershed and downstream flood control operations that determine the timing and volumes of downstream releases. As runoff is naturally controlled by climate, the frequency, volume and reliability of surplus water from these watersheds is uncertain. The effectiveness of these PMAs will be periodically assessed, and should imported and local surface water supplies become restricted in the future, or be required for other beneficial uses, Basin conditions and the particulars of the implementation will be re-assessed at that time.

18.10. Legal Authority Required

> *§ 354.44. Projects and Management Actions*
>
> *(b) Each Plan shall include a description of the projects and management actions that include the following:*
>
> *…*
>
> *(7) A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.*

Per California Water Code (CWC) § 10725 through 10726.8, the Basin GSAs possess the legal authority to implement the supply augmentation and demand management PMAs described herein and will enforce these PMAs as necessary. Legal authority for each of the PMAs is detailed in **Table PMA-2**; however, pending project implementation, authority may switch depending on the agencies involved.

18.11. Estimated Costs and Plans to Meet Them

> *§ 354.44. Projects and Management Actions*
>
> *(b) Each Plan shall include a description of the projects and management actions that include the following:*
>
> *…*
>
> *(8) A description of the estimated cost for each project and management action and a description of how the Agency plans to meet those costs.*

Estimated costs for each PMA are presented in **Table PMA-2**. These costs include "one-time" costs and ongoing costs. The one-time costs may include capital costs associated with construction, feasibility studies, permitting, environmental compliance (e.g., NEPA and CEQA), or any other costs required to initiate a given PMA. The ongoing costs are associated with operations and maintenance (O&M), water purchases, and/or costs to otherwise continue implementing a given PMA. Note that the one-time costs may or may not be incurred entirely at the beginning of the PMA, depending on the source and nature of funding; in some instances, grants or other financing options may allow for spreading out of "one-time" costs over time.

Potential sources of funding for PMAs one-time costs and ongoing costs are presented in **Table PMA-2**. One-time costs are typically paid by partner agencies, like SAFCA, state and federal grant funding sources, or local agencies. On-going costs are expected to be paid by user fees and by revenue from the sale of stored water and from groundwater banking. The GSA proposing the PMA will be responsible for securing funding for the PMA. Upon implementation of any given PMA, the available funding sources for that PMA will be confirmed.

18.12. Management of Recharge and Groundwater Extractions

§ 354.44. Projects and Management Actions

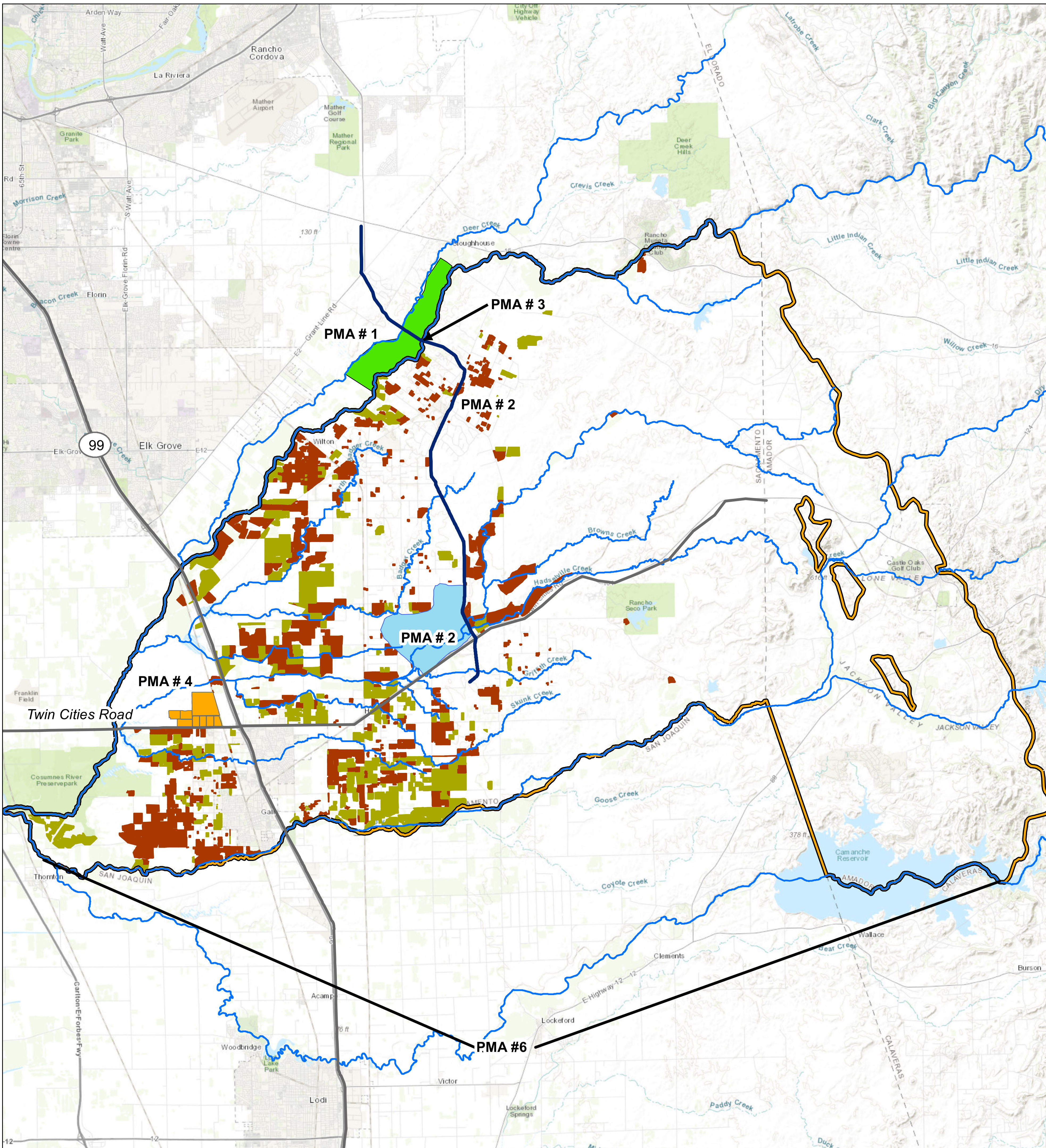
(b) Each Plan shall include a description of the projects and management actions that include the following:

…

(9) A description of the management of groundwater extractions and recharge to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods.

As stated previously in Section 18.5 *Addressing Overdraft Conditions*, under historical conditions (Water Years 1999 – 2018), and under the Projected Conditions Baseline Scenario, there is a decline in the cumulative storage for the Basin. Historical long-term trends in groundwater levels and storage are decreasing and driven primarily by the extraction and consumption of groundwater. The scenarios used to project future water budget conditions show that, on average, groundwater storage is projected to decrease by about -1,400 AFY, but projected water levels do not exceed MTs and therefore do not indicate Undesirable Results. Of the climate change scenarios, URs were projected to occur in only the later years of the Projected Conditions American River Basin Study (ARBS) Central Tendency 2070 Climate Change Scenario and Projected Conditions DWR Extreme I (drier with extreme warming) 2070 Climate Change Scenario. The estimated benefits to groundwater storage summarized in **Table PMA-2** range from 100 to 6,000 AFY. Therefore, the Basin's PMA efforts are designed to increase the likelihood that groundwater level and storage declines during future drought periods will be offset, to the extent possible, by increases in groundwater levels and storage during other periods, especially during wet years.

As discussed in Section 18.2.4 *Other PMAs*, additional PMAs provide flexibility to the Basin to adaptively address unforeseen conditions (e.g., failure to secure outside water sources and/or drier climatic conditions). The PMA committee has devised a ramp up on the Other PMAs to meet the Sustainability Goal. The ramp-up includes expanding the land repurposing, acquiring winter water from other sources for recharge, and/or developing a system to allocate use of existing groundwater between users.



Legend

- Folsom South Canal
- Major Roads
- Major Streams
- Cosumnes Subbasin (5-022.16)
- PMA #1 OHWD Agricultural Flood Managed Aquifer Recharge

PMA #2 SAFCA Flood Managed Aquifer Recharge

- Dry Wells
- Fields for Recharge

- PMA #4 City of Galt Recycled Water Project

PMA #5 Voluntary Land Repurposing

- Candidate Lands
- Other Groundwater Irrigated Land in the Basin Plain

Abbreviations

DWR = California Department of Water Resources
Flood-MAR= Flood Managed Aquifer Recharge
FSC= Folsom South Canal
OHWD= Omochumne-Hartnell Water District
PMA= Project and Management Action
SAFCA = Sacramento Area Flood Control Agency

Notes

1. All locations are approximate.
2. Under PMA #3 OHWD Cosumnes River Flow Augementation, water is released from the FSC into the Cosumnes River.
3. PMA #4 City of Galt Recycled Water Project extent based on exisiting diversions and additional fields in close proximity to the Wastewater Treatment Plant.
4. PMA # 6 Groundwater Banking and Sale is a Basin-wide project.

Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 3 December 2021.
2. DWR groundwater basins are based on the boundaries defined in California's Groundwater, Bulletin 118 - Final Prioritization, dated February 2019.
3. PMA # 1 OHWD Agricultural Flood-MAR and PMA # 2 SAFCA Flood-MAR based on map provided by PMA Committee.

N

0 3 6

(Scale in Miles)

Approximate Locations of Proposed PMAs

Working Group
Cosumnes Subbasin
December 2021
B80081.00

eki environment & water

Figure PMA-1

Path: X:\B80081_Cosumnes\Maps\GSP\Final Draft\Fig_PMA-1 Approximate Locations of Proposed PMAs.mxd

PLAN IMPLEMENTATION

19. PLAN IMPLEMENTATION

§ 351. Definitions

(y) "Plan implementation" refers to an Agency's exercise of the powers and authorities described in the Act, which commences after an Agency adopts and submits a Plan or Alternative to the Department and begins exercising such powers and authorities.

Per the Groundwater Sustainability Plan (GSP) Regulations, "plan implementation" refers to "an [Groundwater Sustainability] Agency's exercise of the powers and authorities described in the Act, which commences after an Agency adopts and submits a Plan or Alternative to the Department and begins exercising such powers and authorities" (23-California Code of Regulations [CCR] § 351(y)). This section describes the activities that will be performed by the seven Groundwater Sustainability Agencies (GSAs)[84] and, when in place, the Cosumnes Groundwater Authority (CGA) as part of GSP implementation within the Cosumnes Subbasin (Basin), with a focus on the first five years (i.e., through 2026). Key GSP implementation activities to be undertaken over the next 20 years include:

- Monitoring and data collection;
- Data gap filling;
- Intra-basin coordination between GSAs and inter-basin coordination with the South American Subbasin (SASb) and Eastern San Joaquin (ESJ) Subbasin;
- Continued stakeholder outreach and engagement;
- Annual reporting;
- Enforcement and response actions;
- GSP evaluation and updates, as necessary, as part of the required periodic evaluations (i.e., "five-year updates"); and,
- Projects and Management Actions (PMA) implementation.

Each of these activities is discussed in more detail in the sections below under "Plan Implementation Activities."

[84] The seven Groundwater Sustainability Agencies (GSAs) include Amador County Groundwater Management Authority (ACGMA), City of Galt, Clay Water District, Galt Irrigation District (GID), Omochumne-Hartnell Water District (OHWD), Sacramento County, and Sloughhouse Resource Conservation District (SRCD).

19.1. Plan Implementation Activities

19.1.1. Monitoring and Data Collection

Sustainable groundwater management relies on a foundation of data to support decision making. As such, data collection within the Basin will be a key part of GSP implementation. These data collection efforts will include collecting data from the monitoring well network to measure the depth to groundwater and/or water quality for comparisons to applicable Sustainability Indicators (e.g., Chronic Lowering of Groundwater Levels, Degraded Water Quality, and Depletions of Interconnected Surface Water) as well as collecting other data and information required for management and reporting under the SGMA, as described below. Monitoring and data collection will be done under the direction of the CGA, as the successor agency to the Working Group, it's Plan Manager (PM), and with support from the Watershed Coordinator and technical consultants, as needed.

Section 17 *Monitoring Network* discusses the SGMA Monitoring Network and associated Representative Monitoring Sites (RMS) and protocols that will be used for the applicable Sustainability Indicators in the Basin. In addition, the Reduction of Groundwater Storage and Land Subsidence indicators will be monitored by groundwater levels as a proxy. Data collected will be incorporated into the Basin's Data Management System (DMS) and used to support annual reporting (see Section 19.1.6 *Annual Reporting*). Furthermore, monitoring results will be evaluated against applicable Sustainable Management Criteria (SMCs)[85] to confirm Basin sustainability and the absence of Undesirable Results (URs).

The CGA anticipates that within the first five years of GSP implementation (i.e., in the WY 2022 through WY 2026 timeframe), the following monitoring related efforts will be performed:

- Semiannual (March and October) water level monitoring at the Representative Monitoring Well for Chronic Lowering of Groundwater Levels (RMW-WL) and Depletions of Interconnected Surface Water (RMW-ISW) networks. Additional monitoring may occur at supplemental well site(s) to provide data from a broader network to support RMWs representation;
- Where and when deemed appropriate, install datalogging pressure transducers to record water levels more frequently than semiannual manual measurements;
- Quality assurance and quality control (QAQC);
- Data Management System (DMS) updates; and,
- Data gap filling efforts that pertain to the monitoring network (see Section 19.1.2 *Data Gap Filling Efforts* below).

As discussed in Section 17.1.4 *Monitoring Network for Degraded Water Quality*, the CGA anticipates that the following water quality related monitoring efforts will be performed within the first five years of GSP implementation:

[85] The SMCs include Minimum Thresholds (MTs), Measurable Objectives (MOs), and Interim Milestones.

- Annual water quality sampling from RMW Water Quality (RMW-WQ) network wells to establish baseline water quality conditions;
    - Public Supply wells will be sampled, or available data will be downloaded from Safe Drinking Water Information System (SDWIS) Drinking Water Watch website, as needed;
    - Remaining RMW-WQ wells representing domestic, monitoring, and irrigation wells will be sampled;
- Compilation and review of potential supplemental water quality data from public water systems that are not part of the RMW-WQ network but publicly available through the SDWIS website;
- QAQC checks; and,
- Updates to the DMS.

In addition to the well data described above, collection and reporting of other types of information is required under SGMA (see further discussion below in Section 19.1.6 *Annual Reporting*). The additional information includes:

- Groundwater extraction information. Groundwater extraction information is currently measured by the totalizer on flow meters of available production wells. Groundwater use can also be estimated annually, based on the updated land use maps (e.g., Department of Water Resources [DWR] surveys or Land IQ data), remote-sensing of evapotranspiration (ET) data (e.g., Irrigation Training and Research Center modified Mapping of ET with Internal Calibration [ITRC METRIC]), and recent climate information;
- Surface water supply data from Cosumnes River surface water gauging stations;
- Annual verification and update of land use that employs periodically published DWR maps and verification by GSAs (e.g., verification of repurposed land uses like the voluntary land fallowing program);
- Utilizing satellite imagery to identify the spatial and temporal distribution of dry stream reaches in the Basin (e.g., Cosumnes River and Dry Creek). Satellite imagery can be coupled with stream gauge and groundwater-level data to assess the impact of groundwater conditions on surface water;
- Location, quantity, and timing of diversions from, and return flows to the Cosumnes River;
- Land subsidence data collected from the existing University Navstar Consortium (UNAVCO) Global Positioning System station located within the Basin;
- Land subsidence data provided by the Interferometric Synthetic Aperture Radar (InSAR) data from DWR; and
- Conduct Groundwater Dependent Ecosystem (GDE) monitoring and assessments, based on an evaluation of climate, groundwater levels, satellite imagery, and timing and magnitude of Cosumnes River flow (e.g., utilizing the GDE Pulse tool[86]). Evaluation of these data can be coupled

[86] https://gde.codefornature.org/#/home

with periodic site visits to verify condition and extent of GDEs. These activities are planned for observing GDE health and to evaluate possible triggers that initiate specific PMAs as part of the five-year update.

19.1.2. Data Gap Filling Efforts

The Basin GSAs will prioritize and begin to fill the key data gaps identified in this GSP related to monitoring, the hydrogeological conceptual model, groundwater conditions, and water budgets. Data gap filling efforts will be done under the direction of the CGA PM with support from the Watershed Coordinator and technical consultants, as needed. These data gap filling efforts will include, but are not limited to:

- Conduct well census and inventory projects to verify well use, status, construction, and density within the Basin;
- Develop system to inventory surface water diversions and return flows to support surface water budget calculations and quantify surface water depletions;
- Verify the lands that utilize surface water only, groundwater only, or both; Routine/annual field-verification and updating of mapped land use utilized by the model will improve the future reliability of the water budget. Land use verification activities by the GSAs will include delineation of Managed Wetlands as a refinement of the current land use categories of “Native Water” and the Riparian component of “Native Vegetation.”
- Compile available well construction information to update incomplete information for wells in the DMS. The RMW network wells are a priority, and efforts can include video logging to identify well perforation intervals where information is not available. This effort might be supported with grants from DWR’s Technical Support Services (TSS) program;
- Reach out to well owners to identify changes in groundwater conditions (for example, potential dewatering and well failures), and estimate groundwater extraction volumes for annual reporting and establishment of fees. GSAs might consider adopting ordinances to require metering and reporting of groundwater use. GSAs can also consider investment in remote sensing data. For example, the Drought Resilience Impact Platform (DRIP)[87] uses on-site sensors that wirelessly transmit data to monitor pump operation and develop estimates of groundwater use. Groundwater use data are coupled with satellite-based remote sensing data to determine current groundwater conditions and aid in future management and planning;
- Expand paired multiple depth well monitoring sites across Basin boundaries to improve characterization of interconnected surface water, conditions that influence GDEs (like perched groundwater), and cross-boundary flows. These sites will provide additional data for monitoring the impacts of PMAs in adjacent basins, such as the Harvest Water Project in the SASb. The GSAs can apply for TSS program to construct these additional monitoring wells;
- Assess the hydraulic connection between the Principal Aquifer and potential perched aquifers. This can be accomplished with aquifer pumping test(s) when possible, requiring multiple monitoring

[87] https://www.colorado.edu/center/mortenson/DRIP

well depths, and monitoring water level changes over short time periods in paired monitoring wells;

- Add monitoring sites in Amador County to address spatial variability and uncertainty in water table conditions in the Basin Foothills Subarea. TSS Grants might be a source of funds to construct these additional monitoring wells;
- Coordinate additional geophysical surveys integrated with monitoring well construction to map the thickness and extent of the inferred clay bed thought to be present beneath the western third of the Basin and possibly associated with the interface between the Victor Formation and Laguna Formation;
- Activate Dry Creek surface water gauging station and incorporate into monitoring network;
- Coordinate monitoring with SASb and ESJ Subbasin to quantify and track changes in cross-boundary flows; and,
- Continue the routine download of public datasets and tools employed to support management activities as they become available (e.g., GDE Pulse tool, Groundwater Ambient Monitoring and Assessment [GAMA] data, etc.).

19.1.3. Intra-Basin Coordination

Intra-basin coordination will be accomplished through the work of the CGA comprised of all GSAs in the Basin. Monthly meetings and special committee meetings will facilitate coordination among the GSAs. The formation of the Citizen Advisory Committee will help coordinate the work of the CGA and landowners in the Basin. These Intra-Basin Coordination efforts will be done under the direction of the CGA PM with support from the Watershed Coordinator and GSA members.

19.1.4. Stakeholder Engagement

The Cosumnes Subbasin Communication and Engagement Plan ([C&E]; **Appendix D**) will continue to be refined, updated, and executed during GSP implementation. Anticipated stakeholder engagement activities include, but are not limited to:

- Public participation in continued monthly CGA meetings;
- Continued monthly GSA Board meetings;
- Periodic public workshops;
- Continuation of Surface Water Advisory Stakeholder Group (SWAG) meetings;
- Develop the Citizens Advisory Committee;
- Develop an Inter-Basin Coordination Agreement with adjacent basins; and,
- Posting of relevant announcements and information on the websites of each GSA and the Basin website (cosumnes.waterforum.org).

Stakeholder Engagement will be facilitated by the CGA PM with support from the Watershed Coordinator.

19.1.5. Project and Management Action Implementation

Phase 1 PMA implementation will begin in 2022-2023 after CGA submits the GSP to DWR and has advanced the process of adopting a new fee structure to replace the pre-GSP structure put in place for fiscal year 2021-2022. The new fee structure will support implementation activities described below carried out under the guidance of the CGA PM with support from the Watershed Coordinator, the member GSAs, and technical consultants. As noted, for the most part these activities will focus on refining concepts into actionable projects that can be implemented in Phase 2 of the GSP (2028-2042).

As described in Section 18 *Projects and Management Actions*, a portfolio of PMAs has been developed with the goal of achieving the Sustainability Goal for the Basin. **Table PMA-1** provides the details about each PMA, including the circumstances under which they may be implemented. PMA Implementation will be guided by the CGA PM with support from the Watershed Coordinator, the member GSAs, and technical consultants. The following describes the GSP's phased approach to implement the PMAs described in Section 18.

PMA implementation will be conducted on parallel tracks, and one of the first tasks for the CGA will be to assess landowner interest participating in the land repurposing project (e.g., voluntary land fallowing program) and conservation efforts. Information is needed on the necessary compensation to participate, the time periods for agreements, number of landowners to involve, and so forth. At the same time, the CGA will conduct outreach efforts to develop more detailed descriptions for the projects listed in Section 18.2.4 *Other PMAs*, or identify new potential projects not previously considered. The refined PMA list will be considered when making funding decisions and applying for future grant opportunities.

OHWD Recharge (PMA #1): This PMA is currently being implemented by Omochumne-Hartnell Water District (OHWD) in partnership with Sacramento Area Flood Control Agency (SAFCA) on approximately 1,200 acres of vineyards and grassland on the north side of the Cosumnes River between the river and Deer Creek. To date, OHWD has secured a temporary permit to divert winter flood water from the Cosumnes River onto these lands, following specified flow criteria for Agricultural Flood Managed Aquifer Recharge (Flood-MAR). Modeling suggests that an average of about 1,400 AFY could be diverted under this permit. With successful implementation of PMA #2 (SAFCA Flood-MAR), the land area subject to recharge could be expanded to 1,800 acres starting in 2028 to receive winter water from the American River delivered down the Folsom South Canal (FSC). The annual volume of water available for recharge could increase by an average of 20,000 AFY. Land application of these diversions are expected to influence groundwater levels and storage in the Cosumnes Subbasin.

SAFCA Flood-MAR (PMA #2): This PMA is part of a larger regional climate adaptation effort. As seasonal temperatures in the American River Basin warm, droughts are expected to occur more frequently and for longer periods of time. During wet periods, more of the annual precipitation is expected to occur as rain rather than snow, however reservoir storage capacity is limited during these runoff events by flood control requirements. The SAFCA Flood-MAR project is a concept to capture a portion of this winter-time runoff by changing the operation of Folsom Dam and using the FSC to divert water to the SASb and Cosumnes Subbasin for groundwater storage. To move the project forward, modification of Folsom Dam's current water control manual is needed, which is likely to require policy approval by Congress. Use of the water created by this modification will require an agreement with the U. S. Bureau of Reclamation and resolution of water rights issues that may be raised by others outside the SASb and Cosumnes Subbasin. Delivery of the water down the FSC will need regional support from the participants in the Regional Water Authority and the Sacramento Water Forum. Further, because this water will be available only in wet years, extensive infrastructure will be required to infiltrate large volumes of water into the SASb and Cosumnes Subbasin in a limited timeframe. SAFCA is the lead agency for addressing these issues.

The Cosumnes GSP anticipates sufficient progress will be made in the next five years to allow the Flood-MAR program to get underway. During Phase 1 of PMA #2, SAFCA will work with the CGA to identify appropriate locations in the Basin for agricultural field spreading and dry well installation. This will involve outreach to interested landowners and implementation of a series of field spreading and dry well pilot projects to confirm infiltration rates. SAFCA will provide base funding for these pilot projects and CGA will pursue grant funding from available state and federal sources to broaden the scope of these feasibility efforts. An early example of this approach is occurring at the Laguna Del Sol property located in the Basin at the intersection of the FSC and Cosumnes River. With SAFCA funding, the OHWD GSA is leading a pilot project that involves small scale field spreading and installation of one dry well adjacent to the FSC to measure infiltration rates. During the winter of 2021–2022, water to support this pilot project will be provided by existing wells on the site. Based on pilot study results, CGA will seek grant funding to expand the project footprint, number of dry wells, and water volumes from the FSC.

Cosumnes River Flow Augmentation (PMA #3): The 2005 Pilot Flow Augmentation/Pre-wetting Project showed it is possible to mimic historical river channel conditions by releasing water into the Cosumnes River from the FSC to support an earlier connection to tidewater and allow fall run Chinook salmon to migrate to upstream spawning areas. This project will establish a longer-term program for pre-wetting the Cosumnes River channel. Working with Sacramento Municipal Utility District (SMUD) and the United States Bureau of Reclamation (USBR), OHWD will seek to develop a contractual arrangement whereby 500- to 1200-acre feet of water could be delivered down the FSC to the Cosumnes River channel on October 1st until flows reach the Oneto Denier reach, or storms provide sufficient runoff to connect the river. Pre-wetting would only be implemented when the river is disconnected (e.g., in high runoff years the pre-wetting may not be necessary), and the pre-wetting flows managed so that the delivered water does not reach the perennially wet tidal zone of the Cosumnes River. Water deliveries from FSC will be accordance with the Water Forum Agreement.

Galt Recycled Water Project (PMA #4): The City of Galt will expand its current practice of delivering existing recycled water supply (secondary or tertiary treated as determined) for summer irrigation to additional land areas and extending the application period into the winter. Initially, a pilot study will be conducted to assess the feasibility of winter recharge on agricultural lands in the vicinity of the Wastewater Treatment Plant (WWTP). Subsequently, agreements with landowners willing to accept this water will be secured, costs estimates will be developed, and the current National Pollutant Discharge Elimination System (NPDES) permit modified to include year-round application of the water. Beginning in 2025, procurement of materials needed to expand the infrastructure will begin, followed by construction of pipeline extensions and initiation of preliminary operations. Monitoring will be conducted to verify proper implementation of the project. By 2028, it is anticipated this project will be fully operational.

Voluntary Land Repurposing (PMA #5): This PMA focuses on securing agreements with landowners in the Basin to voluntarily repurpose current irrigated land uses, including land fallowing, to reduce groundwater pumping in the Basin. Participating landowners will be compensated for the resulting loss of income. To maximize water savings, outreach will focus on irrigated pasture, a crop type that involves higher irrigation rates relative to other land uses in the Basin. During Phase 1 of the GSP (2022 to 2027), the objective is to enroll 750 to 1,000 acres in the program depending on landowner interest and the availability of funds from the CGA fee. Based on the success of the SAFCA Flood-MAR project, this level of participation would be doubled to about 2,000 acres in Phase 2 of the GSP (2028 to 2042). Most of the water saved would be stored in the Basin and could be extracted and sold to help pay costs for GSP implementation.

Groundwater Banking and Sale (PMA #6): Under this PMA, the groundwater saved through land repurposing, including voluntary fallowing, can be sold during Phase 2 by CGA to an urban water purveyor for dry year supply augmentation. It is anticipated that the price paid to CGA for this water would be four or five times greater than the amount paid by CGA to landowners to support their voluntary participation in the land repurposing project (e.g., voluntary land fallowing program). This mark-up, reflecting the relative value of the water to urban users versus its agricultural use would generate sufficient revenue to fund all or a substantial portion of the cost for the CGA to participate in the SAFCA Flood-MAR project (PMA #5), thereby helping to control GSP implementation costs and the financial burden from fees placed on Basin landowners. Water sales will be contingent on a formal "leave-behind" policy developed jointly by the GSAs and their constituents to ensure no negative impacts to groundwater storage in the Basin. The leave-behind policy and other required elements of PMA #6 (interested urban purveyor, banking governance structure, system of monitoring and accounting for Basin deposits and withdrawals, etc.) will be developed during Phase 1. Banking and sale activities would commence in Phase 2 at the same time the voluntary land repurposing project (PMA #5) and SAFCA Flood-MAR (PMA #2) projects are implemented.

Other PMAs: In addition to the PMAs described above, the GSP identified additional potential PMAs that are either being implemented by others outside the Basin or are conceptual and require further assessment to be carried forward for implementation by the GSAs. The Harvest Water project being implemented by the Sacramento Regional County Sanitation District in the SASb is a notable activity being implemented outside the Basin. This project is expected to start during Phase 1 of the GSP and involves delivery of approximately 30,000 AFY of treated wastewater (or 'recycled water') to farmers in the southwestern portion of the SASb in lieu of pumping groundwater. The curtailment of groundwater consumption and recharge from the treated wastewater is expected to substantially raise groundwater elevations on both sides of the Cosumnes River upstream and downstream of Highway 99. This will improve conditions associated with verified GDEs adjacent to the river and contribute to reducing the depletion of groundwater storage under current conditions.

Other PMAs under consideration for implementation in the Basin include water use efficiency (or conservation) based on identifying reliable methods of water accounting; local stormwater capture and recharge projects aided by dry wells, when necessary, on private lands and public rights of way; and, employment off-stream ponds for surface storage and recharge and other practices that increase recharge and groundwater storage or reduce groundwater consumption. The CGA plans to provide funding from fee collections and successful grant applications to explore these concepts in Phase 1 with the goal of screening and prioritizing the projects for implementation during Phase 2.

After necessary preliminary studies and California Environmental Quality Act (CEQA) requirements are completed, the PMAs will undergo, as necessary, final engineering design (in the case of infrastructure projects) and public noticing and outreach, after which construction projects can occur followed by ongoing operations and maintenance. Each implemented PMA will have its own set of monitoring objectives and data collection requirements to allow for PMA evaluation and confirmation assessments, and, if necessary, modifications to improve PMA effectiveness.

19.1.6. Annual Reporting

§ 356.2. Annual Reports.
Each Agency shall submit an annual report to the Department by April 1 of each year following the adoption of the Plan. The annual report shall include the following components for the preceding water year:

(b) A detailed description and graphical representation of the following conditions of the basin managed in the Plan:

(1) Groundwater elevation data from monitoring wells identified in the monitoring network shall be analyzed and displayed as follows:

(A) Groundwater elevation contour maps for each principal aquifer in the basin illustrating, at a minimum, the seasonal high and seasonal low groundwater conditions.

(B) Hydrographs of groundwater elevations and water year type using historical data to the greatest extent available, including from January 1, 2015, to current reporting year.

(2) Groundwater extraction for the preceding water year. Data shall be collected using the best available measurement methods and shall be presented in a table that summarizes groundwater extractions by water use sector, and identifies the method of measurement (direct or estimate) and accuracy of measurements, and a map that illustrates the general location and volume of groundwater extractions.

(3) Surface water supply used or available for use, for groundwater recharge or in-lieu use shall be reported based on quantitative data that describes the annual volume and sources for the preceding water year.

(4) Total water use shall be collected using the best available measurement methods and shall be reported in a table that summarizes total water use by water use sector, water source type, and identifies the method of measurement (direct or estimate) and accuracy of measurements. Existing water use data from the most recent Urban Water Management Plans or Agricultural Water Management Plans within the basin may be used, as long as the data are reported by water year.

(5) Change in groundwater in storage shall include the following:

(A) Change in groundwater in storage maps for each principal aquifer in the basin.

(B) A graph depicting water year type, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage for the basin based on historical data to the greatest extent available, including from January 1, 2015, to the current reporting year.

Per the GSP Regulations, an Annual Report on basin conditions and GSP implementation status for each Water Year (WY) is required to be submitted to DWR by April 1 of each year following GSP adoption (23-CCR § 356.2). These annual reports will be prepared, under the direction of the CGA PM with support from the Watershed Coordinator and technical consultants, as needed, by using data collected during GSP implementation, as described above. Annual reports will include, but are not limited to, the following:

- Groundwater elevation contour maps for both Fall and Spring conditions;
- Hydrographs of groundwater elevations in the RMWs;

- Annual groundwater extraction volumes for the entire Basin, an explanation as to how groundwater extraction volumes were estimated, an accounting of accuracy and uncertainty, and an explanation as to how accuracy and uncertainty was determined;
- Annual surface water supply volumes used for the entire Basin, quantified by source type, as applicable;
- Annual total water use for the entire Basin, quantified by water use sector and water year type; and,
- Estimates of annual change in groundwater storage. The Numerical Model will be updated, and the time period extended to include the groundwater elevation data, groundwater extraction volumes, and hydrology datasets (i.e., precipitation and evapotranspiration) required to estimate agricultural pumping and annual changes in groundwater storage.

19.1.7. Enforcement and Response Actions

Part of successful Basin management involves the ability to adapt and respond to unforeseen circumstances. To the extent possible, methods to address foreseeable problems should be developed before those problems arise. The CGA PM and the GSAs will develop an enforcement program in accordance with applicable laws and authorities, and GSAs will be responsible for enforcement and response actions within their jurisdictional boundaries and constituencies. The Annual Report will describe each enforcement action undertaken to achieve sustainability.

19.1.8. Periodic GSP Evaluations

§ 356.4. Periodic Evaluation by Agency
Each Agency shall evaluate its Plan at least every five years and whenever the Plan is amended and provide a written assessment to the Department. The assessment shall describe whether the Plan implementation, including implementation of projects and management actions, are meeting the sustainability goal in the basin, and shall include the following:

(a) A description of current groundwater conditions for each applicable sustainability indicator relative to measurable objectives, interim milestones and minimum thresholds.

(b) A description of the implementation of any projects or management actions, and the effect on groundwater conditions resulting from those projects or management actions.

(c) Elements of the Plan, including the basin setting, management areas, or the identification of undesirable results and the setting of minimum thresholds and measurable objectives, shall be reconsidered and revisions proposed, if necessary.

(d) An evaluation of the basin setting in light of significant new information or changes in water use, and an explanation of any significant changes. If the Agency's evaluation shows that the basin is experiencing overdraft conditions, the Agency shall include an assessment of measures to mitigate that overdraft.

(e) A description of the monitoring network within the basin, including whether data gaps exist, or any areas within the basin are represented by data that does not satisfy the requirements of Sections 352.4 and 354.34(c). The description shall include the following:

(1) An assessment of monitoring network function with an analysis of data collected to date, identification of data gaps, and the actions necessary to improve the monitoring network, consistent with the requirements of Section 354.38.

(2) If the Agency identifies data gaps, the Plan shall describe a program for the acquisition of additional data sources, including an estimate of the timing of that acquisition, and for incorporation of newly obtained information into the Plan.

(3) The Plan shall prioritize the installation of new data collection facilities and analysis of new data based on the needs of the basin.

(f) A description of significant new information that has been made available since Plan adoption or amendment, or the last five-year assessment. The description shall also include whether new information warrants changes to any aspect of the Plan, including the evaluation of the basin setting, measurable objectives, minimum thresholds, or the criteria defining undesirable results.

(g) A description of relevant actions taken by the Agency, including a summary of regulations or ordinances related to the Plan.

(h) Information describing any enforcement or legal actions taken by the Agency in furtherance of the sustainability goal for the basin.

(i) A description of completed or proposed Plan amendments.

(j) Where appropriate, a summary of coordination that occurred between multiple Agencies in a single basin, Agencies in hydrologically connected basins, and land use agencies.

§ 356.4. Periodic Evaluation by Agency

(k) Other information the Agency deems appropriate, along with any information required by the Department to conduct a periodic review as required by Water Code Section 10733

(l) Where appropriate, a summary of coordination that occurred between multiple Agencies in a single basin, Agencies in hydrologically connected basins, and land use agencies.

(m) Other information the Agency deems appropriate, along with any information required by the Department to conduct a periodic review as required by Water Code Section 10733

Per the GSP Regulations (23-CCR § 356.4), under the direction of the CGA PM and support from a technical consultant, a periodic evaluation of the GSP will be conducted at least every five years, and the GSP modified as necessary to ensure that the Sustainability Goal for the Basin is achieved. For this GSP, the first five-year update occurs in 2027 and will provide a basis for the transition from Phase 1 to Phase 2 of GSP Implementation. The 2027 Plan will likely require revisions on matters related to the Basin Setting, SMCs, and PMA sections, as key data gaps are filled, the historical monitoring data record is extended, and the numerical model is updated. If the institutional partnerships needed to implement the SAFCA Flood-MAR program are not realized, and voluntary land repurposing in combination with the other PMAs described above cannot achieve the deficit reduction anticipated in the GSP, the GSAs must be prepared to use the required five-year update to examine alternatives, including more extensive demand reduction measures within the CGA's control.

Sustainability Evaluation

This section will evaluate the current groundwater conditions for each applicable Sustainability Indicator, including progress toward achieving Interim Milestones and Measurable Objectives (MOs).

Plan Implementation Progress

This section will evaluate the current implementation status of PMAs, along with an updated implementation schedule and PMAs not analyzed or identified for this GSP.

Reconsideration of GSP Elements

Per 23-CCR § 356.4(c), elements of the GSP, including the Basin Setting, SMCs, and PMAs sections will be reviewed and revised as necessary.

Monitoring Network Description

This section will provide a description of the SGMA Monitoring Network, including identification of data gaps, assessment of monitoring network function with an analysis of data collected to date, identification of actions that are necessary to improve the monitoring network, and development of plans or programs to fill data gaps.

<u>New Information</u>

This section will provide a description of significant new information that has become available since the adoption or amendment of the GSP, or the last five-year assessment, including data obtained to fill identified data gaps. For example, various monitoring and data collection activities are planned for observing GDE health and this new information will be assessed to identify possible triggers that can be utilized to initiate PMAs that help protect conditions that have supported GDEs. As discussed above under subsection *Reconsideration of GSP Elements*, if evaluation of the Basin Setting or SMCs warrant changes to the GSP, this new information would also be included.

<u>Regulations or Ordinances</u>

The GSAs possess the legal authority to implement regulations and establish ordinances related to the GSP. This section will provide a description of relevant actions taken by the GSAs, including a summary of related regulations and ordinances, as appropriate.

<u>Legal or Enforcement Actions</u>

This section summarizes legal or enforcement actions taken by the GSAs in relation to the GSP, along with how such actions support sustainability in the Basin. Enforcement action could be required by a GSA to address unsustainable activities by a constituent. Conversely, a constituent or stakeholder could take legal actions against a GSA related to groundwater management.

<u>Plan Amendments</u>

This section provides a description of proposed or completed amendments to the GSP.

19.2. Plan Implementation Costs

> § 354.6. Agency Information
> *When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:*
>
> (b) An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.

Per the GSP Regulations (23-CCR § 354.6(e) and 354.44(b)(8)), this section provides estimates of the costs to implement this GSP and potential sources of funding to meet those costs.

19.2.1. <u>Estimated Costs</u>

The WG has developed the following estimated costs to implement this GSP which are divided into several groups, as follows:

- Groundwater monitoring and data collection;
- Data gap filling;

- Intra-Basin coordination;
- Stakeholder outreach;
- Annual reporting;
- Periodic GSP evaluations;
- Other administration activities such as legal, financial audits, applying for grants and others; and,
- Implementation of PMAs, including feasibility studies, environmental analysis, capital/one-time costs and ongoing costs.

Table PI-1 provides a high-level estimate of the annual costs for the above groups over the first five-year period (i.e., Fiscal Year 2021-2025). Costs associated with continued GSA activities are estimated to range between approximately $405,000 to $525,000 per year, not including GSA and GSA member agency staff time or costs associated with implementation of PMAs. Estimated annual costs for individual PMAs are also provided below in **Table PI-1;** however, these costs are subject to change, pending specific PMA implementation, and range from $330,000 to $685,000.

19.2.2. Sources of Funding to Meet Costs

As shown in **Table PI-1**, GSP implementation costs are estimated to range between approximately $735,000 to $1,200,000 annually over the next five years. The CGA will likely meet the estimated costs through a combination of user fees, parcel related fees, Sacramento Flood Control Agency (SAFCA) contribution, Department of Conservation (DoC) Grant, and DWR TSS Grants for GSP implementation. The specific combination and amounts of these revenue sources will be determined by the CGA through a Nexus Study that will coincide with the completion of the GSP. Funding for this study has been included in the Year 1 and Year 2 budget as shown on **Table PI-2**.

Table PI-1. Estimated GSP Implementation Costs

Groundwater Management Activity	Estimated Average Annual GSP Implementation Costs[1]				
	Year 1	Year 2	Year 3	Year 4	Year 5
Monitoring and Data Collection					
Monitoring	$30,000	$30,000	$30,645	$31,290	$31,935
Data Management System	$15,000	$25,000	$25,538	$26,075	$26,613
Data Gap Filling					
Address Data Gaps	$25,000	$45,000	$45,968	$46,935	$47,903
Intra-Basin Coordination					
GSA Coordination and Technical Support	$20,000	$30,000	$30,645	$31,290	$31,935
Stakeholder Engagement					
Public Outreach	$10,000	$20,000	$20,430	$20,860	$21,290
Annual Reporting					
Annual Report	$45,000	$45,000	$45,968	$46,935	$47,903
Enforcement and Response Actions					
Enforcement and Response Actions	NA	NA	NA	NA	NA
Periodic GSP Evaluations					
Five-Year GSP Update	--	$40,000	$40,860	$41,720	$42,581
Other					
Address State Comments	$25,000	--	--	--	--
Establish Governance Structure	$25,000	--	--	--	--
Legal	$30,000	$20,000	$20,430	$20,860	$21,290
Financial Audit	$20,000	$20,000	$20,430	$20,860	$21,290
Personnel Including Recruitment	$90,000	$150,000	$153,226	$156,452	$159,677
Prepare DWR Grant	$40,000	--	--	$40,000	--
Contingency (8.6% to 9.4%)	32,500	$40,000	$40,860	$41,723	$42,583
Annual Subtotal	**$407,500**	**$465,000**	**$475,000**	**$525,000**	**$495,000**
Costs to Implement Projects and Management Actions					
Fallowing Program Development and Outreach	$40,000	$80,000	$155,000	$30,000	$30,000
Flood-MAR/Dry Well Feasibility Studies	$160,000	$280,000	$280,000	$140,000	$140,000
Pursue Groundwater Banking Agreement	$30,000	$110,000	$110,000	--	--
Implement Voluntary Fallowing Program	--	--	--	$505,000	$505,000
Implement Groundwater Banking	--	--	--	--	--
SAFCA Program	--	--	--	--	--
Future Unidentified Projects	--	$195,000	$120,000	--	--
Post-GSP Fee Process	$100,000	$20,000	--	--	--
Annual Subtotal	**$330,000**	**$685,000**	**$665,000**	**$675,000**	**$675,000**
Total Required Costs of GSP Implementation	***$0.74M***	***$1.15M***	***$1.14M***	***$1.20M***	***$1.17M***

Abbreviations:
DWR = Department of Water Resources
Flood-Mar = Flood Managed Aquifer Recharge
GSP = Groundwater Sustainability Plan
M = Million
NA = Not Applicable

Notes:
(1) Costs are estimated and are subject to change.
(2) FY 2021, Year 1, begins in July 2021 and continues through June 2022, as such costs are reduced in comparison to other years.

Table PI-2. Revenue Estimates for GSP Activities

Funding Sources	Estimated Average Annual GSP Funding Sources
	Year 1
Outside Funding Assistance	
SAFCA Contribution	$100,000
DoC Grant	$60,000
SGMA TSS Grant	$70,000
Subtotal Outside Funding	**$230,000**
Contributions	
GSAs and Other Agencies	$20,000
Rate Revenue and Fee	
Irrigated Acreage Revenue	$485,820
Groundwater Fee	--
Parcel-Based Fee	--
Total Funding	***$0.74M***

Abbreviations:
DoC = Department of Conservation
GSA = Groundwater Sustainability Agency
GSP = Groundwater Sustainability Plan
GW = Groundwater
SAFCA = Sacramento Area Flood Control Agency

Notes:
(1) Funding sources are estimated and are subject to change.
(2) The specific combination and amounts of these revenue sources will be determined by the GSAs, in coordination with the CGA, through a Nexus Study that will coincide with the completion of the GSP. Costs for conducting this study have been included in the Year 1 and Year 2 Estimated Average Annual GSP Implementation Costs.

19.3. Plan Implementation Schedule

This section discusses a general estimated schedule for GSP implementation. The GSP Regulations do not specifically require the submittal of a schedule for the 20-year GSP implementation period (i.e., 2022 through 2042). Moreover, any such schedule would be subject to considerable uncertainty. However, the following factors and constraints inherent to the GSP process guide the schedule for GSP implementation:

- The GSP Regulations require achievement of the Sustainability Goal (i.e., avoidance of Undesirable Results) within 20 years of GSP adoption, which means by 2042; and,
- Annual reports are due on April 1 of every year following GSP submission.

Periodic evaluations are required at least every five years, meaning this GSP will be updated no later than January 31, 2027.

REFERENCES AND TECHNICAL STUDIES

> *§ 354.4. General Information*
>
> *Each Plan shall include the following general information:*
> *(b) A list of references and technical studies relied upon by the Agency in developing the Plan. Each Agency shall provide to the Department electronic copies of reports and other documents and materials cited as references that are not generally available to the public.*

Amador County, 1997, DWR Land Use Survey. Available online at: https://gis.water.ca.gov/app/CADWRLandUseViewer/

Amador County, 2014, Amador County LandIQ of 2014. Available online at: https://gis.water.ca.gov/app/CADWRLandUseViewer/

Amador County, 2016, *Current General Plan (2016)*, https://www.amadorgov.org/departments/planning/general-plan-update-draft-environmental

Amador County Planning Department, 2020, *Public Review Draft Environmental Assessment, Buena Vista Landfill Project 2020,* dated September 2020.

Apex Envirotech Inc., 2010*,* Evaluation for Commingled Plume Allocation Technical Memorandum. Express Lane Chevron, 301 Pine Street, Galt, California.

Apex Envirotech Inc., 2016, Remediation System Optimization Report. Sierra Trading Post #2 39 Preston Avenue, Ione, California, Apex Project No. PRY02.001

Amador Water Agency (AWA), 2017, County of Amador, & JVID, 2017 https://sgma.water.ca.gov/portal/

Ayers RS and DW Westcot, 1985, Water Quality for Agriculture, FAO Irrigation and Drainage Paper 29.

Azat J, 2019, GrandTab 2019.05.07. California Central Valley Chinook Population Database Report. California Department of Fish and Wildlife. Available online at: https://www.wildlife.ca.gov/Conservation/Fishes/Chinook-Salmon/Anadromous-Assessment or http://www.calfish.org/ProgramsData/Species/CDFWAnadromousResourceAssessment.aspx

Belitz K, Dubrovsky N, Burow K, Jurgens B, and Johnson T, 2003. Framework for a Ground-Water Quality Monitoring and Assessment Program for California, U.S. Geological Survey, Water-Resources Investigations Report 03-4166 available online at: https://pubs.usgs.gov/wri/wri034166/pdf/wri034166.pdf

Berkstresser CF, 1973, *Base of Fresh Ground Water – Approximately 3,000 micromhos – in the Sacramento Valley and Sacramento-San Joaquin Delta*, California. U.S. Geological Survey Open-File Report 40-73, 1 plate.

California Natural Resources Agency, 2021, *SVSim: Sacramento Valley Groundwater-Surface Water Simulation Model*. https://data.cnra.ca.gov/dataset/svsim

Chapman RH and Bishop CC, 1975, *Geophysical Investigations in the Ione Area*, Amador, Sacramento, and Calaveras Counties, California, California Division of Mines and Geology Special Report 117, 27 pp.

CH2M, 2016*, Draft Comprehensive Groundwater Quality Management Plan. Prepared for Central Valley Regional Water Quality Control Board on behalf of Northern California Water Association Sacramento Valley Water Quality Coalition*, dated 22 November 2016.

CH2M, 2017, *Comprehensive Groundwater Quality Management Plan*, dated 10 July 2017.

City of Galt, 2009, 2030 Galt *General Plan Policy Document. Prepared by Mintier Harnish in association with Environmental Science Associates, Applied Development Economics, and Omin-Means. Final, dated April 2009.* https://www.ci.galt.ca.us/home/showdocument?id=14104

City of Ione, 2019, City of Ione General Plan, dated August 2009. Available online at: https://www.ione-ca.com/city-government/general-plan

Creely S and Force ER, 2007, Type Region of the Ione Formation (Eocene), Central California: Stratigraphy, Paleogeography, and Relation to Auriferous Gravels. U.S. Geological Survey Open-File Report 2006-1378.

Cunningham WL and Schalk CW, comps., 2011, Groundwater technical procedures of the U.S. Geological Survey: U.S. Geological Survey Techniques and Methods 1–A1, 151 p. https://pubs.usgs.gov/tm/1a1/pdf/tm1-a1.pdf

CVRWQCB, 2018, *The Water Quality Control Plan (Basin Plan) For the California Regional Water Quality Control Board Central Valley Region Fifth Edition*, https://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/sacsjr_201805.pdf

Driscoll FG, 1995, "Groundwater and Wells". Second Edition. U.S. Filter/Johnson Screens: St. Paul.

DOGGR, 1982, California Oil & Gas Fields Volume III – Northern California (CD-1) Contour maps, cross sections, and data sheets for California's oil and gas fields, 330 pp.

DOGGR, 2019, Oil and Gas Field Administrative Boundaries, available online at: https://www.conservation.ca.gov/dog/maps/Pages/GISMapping2.aspx

Dunn Environmental, 2012a, Groundwater Supply Study and Integrated Regional Groundwater Management Plan for the Lake Camanche Water Improvement District No. 7, prepared by Dunn Environmental, Inc., dated June 2012

Dunn Environmental, 2012b, Technical Memorandum No. 1 – New Water Well Background Data Summary, Surface Geophysics, Hydrogeologic conceptual Model and Proposed Testhole Locations, prepared by Dunn Environmental, Inc., dated 24 September 2012

Dunn Environmental, 2014, Updated Amador County Monitoring Plan for Portions of the Cosumnes Ground Water Subbasin for the California Statewide Groundwater Elevation Monitoring Program (CASGEM). Prepared for Amador Water Agency, dated September 2014.

DWR, 1974, Bulletin 118-3, Evaluation of Ground Water Resources: Sacramento County, 141 pp.

DWR, 1978, Bulletin 118-6, Evaluation of Ground Water Resources: Sacramento Valley, 136 pp.

DWR, 1980, Bulletin 118, California's Groundwater, 73 pp.

DWR, 2003, Bulletin 118, Update 2003, California's Groundwater, 246 pp.

DWR, 2010, *Department of Water Resources Groundwater Elevation Monitoring Guidelines*, dated December 2010. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/CASGEM/Files/CASGEM-DWR-GW-Guidelines-Final-121510.pdf

DWR, 2015, Sacramento County Land Use Survey. Available online at: https://gis.water.ca.gov/app/CADWRLandUseViewer/

DWR, 2016a, Best Management Practices for the Sustainable Management of Groundwater: #3 Hydrogeologic Conceptual Model BMP, dated December 2016.

DWR, 2016b, Best Management Practices for the Sustainable Management of Groundwater: #2 Monitoring Networks and Identification of Data Gaps BMP, dated December 2016.

DWR, 2016c, Best Management Practices for the Sustainable Management of Groundwater: #4 Water Budget BMP, dated December 2016.

DWR, 2016d, California Department of Water Resources, Bulletin 118 – Interim Update 2016, California's Groundwater, Working Towards Sustainability, 58 pp.

DWR, 2016e, Best Management Practices for the Sustainable Management of Groundwater: #1 Monitoring Protocols, Standards, and Sites BMP, dated December 2016.

DWR, 2017, Best Management Practices for the Sustainable Management of Groundwater: #6 Sustainable Management Criteria BMP dated November 2017, 38 pp.

DWR, 2018a, SVSim: Sacramento Valley Groundwater-Surface Water Simulation Model Texture Data. Available online at: https://data.cnra.ca.gov/dataset/svsim, accessed 29 July 2019

DWR, 2018b, 2017 GPS Survey of the Sacramento Valley Subsidence Network, December 2018.

DWR, 2018c, DWR guidance document for "Climate Change Data Use During Groundwater Sustainability Plan Development", dated July 2018.

DWR, 2019, Sustainable Groundwater Management Act 2019 Basin Prioritization Process and Results, April 2019, 64pp.

East Bay Municipal Utility District, 2021, *Camanche Reservoir*. East Bay Municipal Utility District: Camanche Reservoir (ebmud.com)

Eastern San Joaquin Groundwater Authority (ESJGA), 2019 Eastern San Joaquin Subbasin Groundwater Sustainability Plan, dated November 2019.

Erler & Kalinowski, Inc., 2009, Monitoring Well Work Plan, Buena Vista Rancheria of Me-Wuk Indians Gaming and Entertainment Facility, Amador County, California, dated July 2009.

EKI Environment & Water, Inc. 2020, Annual Monitoring Report August 2019-July 2020 Buena Vista Ranceria of Me-Wuk Indians Amador County, California, dated 15 September 2020.

EKI Environment & Water, Inc., 2021, 2020 Urban Water Management Plan, dated June 2021.

Electronic Water Rights Information Management System (eWRIMS), 2020 [database] https://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/index.html, accessed 2020

Environmental Defense Fund, 2018, Addressing Regional Surface Water Depletions in California: A Proposed Approach for Compliance with the Sustainable Groundwater Management Act.

Farr TG, Jones CE, Liu Z, 2016. Progress Report: Subsidence in California, March 2015-September 2016. Jet Propulsion Laboratory California Institute of Technology, 37pp.

Faunt CC, ed., 2009, Groundwater Availability of the Central Valley Aquifer, California: U.S. Geological Survey Professional Paper 1766, 225 p.

Fishery Foundation of California, 2021, *Cosumnes River Salmon Passage*. http://www.fisheryfoundation.org/projects/current/CR_salmon_passage.html

Fleckenstein J, Anderson M, Fogg G, Mount J, 2004, Managing Surface Water-Groundwater to Restore Fall Flows in the Cosumnes River. *Journal of Water Resources Planning and Management* 130(4): 301-310. doi: 10.1061/(ASCE)0733-9496(2004)130:4(301)

Fleckenstein JH, Niswonger RG, Fogg GE, 2006, River-Aquifer Interactions, Geologic Heterogeneity, and Low Flow Management. *Ground Water* 44(6): 837-853. https://doi.org/10.1111/j.1745-6584.2006.00190.x

Gailey, R.M., Lund, J.R. & Medellín-Azuara, J. Domestic well reliability: evaluating supply interruptions from groundwater overdraft, estimating costs and managing economic externalities. Hydrogeol J 27, 1159–1182 (2019). https://doi.org/10.1007/s10040-019-01929-w

Geoconsultants, Inc., 2016, Geological and Geophysical Survey for Proposed Basin Boundary Adjustment, Sloughhouse Resource Conservation District, Sacramento County, California, 14 pp.

Gross, Joseph W., "Answers to Protest, Application #2296 before the Division of Water Rights," submitted to the Department of Public Works, State of California, July 3, 1922.

Hem JD, 1970, Study and Interpretation of the Chemical Characteristics of Natural Water. U.S. Geological Survey Water-Supply Paper 2254, 263 pp

Jones & Stokes, 2007, Final Tribal Environmental Impact Report for the Buena Vista Rancheria of Me-Wuk Indians of California Gaming Facility, prepared by Jones & Stokes, dated May 2007.

Kronick, 2020, *Tribal Considerations in SGMA Implementation Cosumnes Working Group* PPT. (http://cosumnes.waterforum.org/wp-content/uploads/2020/12/2020-12-14-Tribal-Considerations-in-SGMA-Implementation_PresentationSlides.pdf)

Lewis, D.C. and Burgy, R.H., 1964, The Relationship between Oak Tree Roots and Groundwater in Fractured Rock as Determined by Tritium Tracing," Journal of Geophysical Research, vol. 69, No. 12, 1964

MWH, Water Forum, and Sacramento County Water Agency, 2006, Central Sacramento County Groundwater Management Plan, dated February 2006.

Meirovitz CD, 2010, Influence of American River Incised Valley Fill on Sacramento County Hydrogeology. Unpublished Master's Thesis: University of California, Davis.

Monterey County Water Resources Agency, 2018, Historical Seawater Intrusion Map Pressure 180-Foot Aquifer – 500 mg/L or Greater Chloride Areas, dated 11 April 2018.

Moran T and Belin A, 2019, A Guide to Water Quality Requirements Under the Sustainable Groundwater Management Act. Stanford Digital Repository. Available at: https://purl.stanford.edu/dw122nb4780.

Osborn NI, Smith SJ, and CH Seger, 2013, Hydrogeology, distribution, and volume of saline groundwater in the southern midcontinent and adjacent areas of the United States. U.S. Geological Survey Scientific Investigations Report 2013–5017

Page RW, 1974, Base and thickness of the Post-Eocene continental deposits in the Sacramento Valley, California, U.S. Geological Survey Water-Resources Investigations Report 73-45, 16 pp.

Pauloo, R., Bostic, D., Monaco, A. and Hammond, K., 2021. GSA Well Failure: forecasting domestic well failure in critical priority basins. Berkeley, California. Available at https://www.gspdrywells.com.

Piper AM, Gale HS, Thomas HE, Robinson TW, 1939, Geology and Ground-Water Hydrology of the Mokelumne Area, California. U.S. Geological Survey Water-Supply Paper 780.

Rantz SE and others, 1982a, Measurement and Computation of Streamflow: Volume 1. Measurement of Stage and Discharge, U.S. Geological Survey Water Supply Paper 2175, 313 pp. https://pubs.usgs.gov/wsp/wsp2175/wsp2175.pdf

Rantz SE and others, 1982b, Measurement and Computation of Streamflow: Volume 2. Computation of Discharge, U.S. Geological Survey Water Supply Paper 2175, 373 pp. https://pubs.usgs.gov/wsp/wsp2175/wsp2175_vol2.pdf

Regional Water Authority, 2018, American River Basin Integrated Regional Water Management Plan 2018 Update, dated July 2018. https://rwah2o.org/programs/integrated-regional-water-management/american-river-basin-irwmp-2018-update/

Regional Water Authority, 2019, Sacramento County Regional Water Bank, 4 pp. (https://rwah2o.org/wp-content/uploads/2019/04/WaterBank_Insert_9-FINAL.pdf)

RMC Water and Environment, Inc., 2016, Amador Water Agency 2015 Urban Water Management Plan, dated Jun 2016.

RMC Water and Environment, Inc., 2017, South Sacramento County Agriculture and Habitat Lands Recycled Water, Groundwater Storage, and Conjunctive Use Program, Integrated Groundwater and Surface Water Modeling Results Technical Memorandum," August 7, 2017.

RMC Water and Environment, Inc., 2018, Mokelumne/Amador/Calaveras Integrated Regional Water Management Plan Update, dated November 2018.

Robertson-Bryan, Inc., 2002, Southeast Sacramento County Agricultural Water Authority Groundwater Management Plan, dated December 3, 2002. pp 81. (https://img1.wsimg.com/blobby/go/76fe740c-00bf-49fa-9470-05ce2a1df16c/downloads/2002_ GMP.pdf?ver=1625853559366)

Roberston-Bryan, Inc., 2006, Cosumnes and Mokelumne River Floodplain Integrated Resources Management Plan (IRMP), Floodplain Resources Characterization Report, dated January 2006.

Robertson-Bryan, Inc., and Fisheries Foundation of California, 2006, Cosumnes River Flow Augmentation Project, 2005 Pilot Project prepared for Southeast Sacramento County Agricultural Water Authority, The Nature Conservancy, and Sacramento County Water Agency, dated September 2006.

Robertson-Bryan, Inc. and WRIME, 2011, South Basin Groundwater Management Plan, Prepared for South Area Water Council, dated October 2011.

Rohde MM, Sweet SB, Ulrich C, Howard J, 2019, A Transdisciplinary Approach to Characterize Hydrological Controls on Groundwater-Dependent Ecosystem Health. *Frontiers in Environmental Science* 7:175.

doi: 10.3389/fenvs.2019.00175

RWQCB, 2018, The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board Central Valley Region Fifth Edition: The Sacramento River Basin and The San Joaquin River Basin. Revised May 2018 with Approved Amendments.

Sacramento County, 2000 Sacramento County Land Use Survey of 2000. Available online at: https://gis.water.ca.gov/app/CADWRLandUseViewer/

Sacramento County, 2011, Sacramento County General Plan of 2005-2030. Amended November 9, 2011. https://planning.saccounty.net/PlansandProjectsIn-Progress/Pages/GeneralPlan.aspx

Sacramento County, 2015, Sacramento County Land Use Survey of 2014. Available online at: https://gis.water.ca.gov/app/CADWRLandUseViewer/

Sacramento Central Groundwater Authority and GEI Consultants, Inc., 2019, 2018 SGMA Annual Report South American Subbasin (5-021.65) Sacramento Central Groundwater Authority, dated March 2019.

SCGA, 2012, Sacramento Central Groundwater Authority Groundwater Elevation Monitoring Plan, dated February 2012, 26 pp.

SDWIS, 2018, https://sdwis.waterboards.ca.gov/PDWW/index.jsp, accessed 2018

Sacramento Municipal Utilities District, 2021, *Rancho Seco Recreational Area*. https://www.smud.org/en/In-Our-Community/Visit-our-Recreational-Areas/Rancho-Seco

Snider B and Reavis B, 2000, Cosumnes River Chinook Salmon Spawner Escapement, Rearing and Emigration Surveys 1998-99. California Department of Fish and Game Habitat Conservation Division Native Anadromous Fish and Watershed Branch Stream Evaluation Program, dated August 2000.

SWRCB, 2016, Drinking Water Information Clearinghouse [Repository]. Retrieved from https://drinc.ca.gov/drinc/DWPRepository.aspx

TNC, 2018, Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act Guidance for Preparing Groundwater Sustainability Plans, dated January 2018. https://groundwaterresourcehub.org/public/uploads/pdfs/GWR_Hub_GDE_Guidance_Doc_2-1-18.pdf

TNC, 2019, Identifying GDEs under SGMA, Best Practices for using the NC Dataset, dated July, 2019.

UNAVCO, 2021, *P-275 Overview/Station Page*, https://www.unavco.org/instrumentation/networks/status/nota/overview/P275

USBR, 2016, *Central Valley Project (CVP) Water Contractors*. https://www.usbr.gov/mp/cvp-water/docs/latest-water-contractors.pdf

United States Census Bureau, 2018, American Community Survey 2013-2017 5-year Data Release, dated 6 December 2018. (https://www.census.gov/newsroom/press-kits/2018/acs-5year.html)

Unites States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), 2007, Part 630 Hydrology National Engineering Handbook. Chapter 7 Hydrologic Soil Groups. Issued May 2007.

United States Department of Agriculture and Natural Resources Conservation Service (USDA-NRCS, 2007)

University of Colorado, 2021, *Ending Drought Emergencies*. Mortensen Center for Engineering. https://www.colorado.edu/center/mortenson/DRIP

USGS, variously dated, *National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations*, book 9, chaps. A1-A10, available online at http://pubs.water.usgs.gov/twri9A.

USGS, 2021, Water Use Data for California, https://waterdata.usgs.gov/ca/nwis/wu

Whiteaker TL, Jones N, Strassberg G, Lemon A, Gallup D, 2012, GIS-based data model and tools for creating and managing two-dimensional cross sections. *Computers & Geosciences* 39: 42-49.

Wilton Rancheria. (2019). *Department of Cultural Preservation, Mission*. (http://wiltonrancheria-nsn.gov/TribalOffice/CulturalPreservation/tabid/312/Default.aspx)

Wilcox, Lindsey, Camanche Area Regional Water Supply Plan (CARWSP) Feasibility Study and Conceptual Design, prepared for Project Partners Committee (PPC), dated 02 January, 2012, available online at: http://www.umrwa.org/uploads/130103_CARWSP_Draft_Report_2jan13_compressed.pdf

Woodard & Curran, 2018, Eastern San Joaquin Water Resources Model (ESJWRM) Final Report, dated August 2018.

Woodard & Curran, 2021, Amador County 2020 Urban Water Management Plan, 1747 pp. dated June 2021. (https://amadorwater.org/wp-content/uploads/2021/06/AWA-UWMP-2020_Final.pdf)