SUTTER SUBBASIN

Groundwater Sustainability Plan

SUTTER COUNTY CALIFORNIA

WOODARD & CURRAN

DEPARTMENT OF WATER RESOURCES STATE OF CALIFORNIA

PROP 1 GOVERNOR EDMUND G. BROWN, JR. WATER BOND 2014 RELIABILITY | RESTORATION | RESILIENCE

NOVEMBER 2021

This page intentionally left blank

FINAL DRAFT

Groundwater Sustainability Plan

for the Sutter Subbasin Groundwater Sustainability Plan

Sutter Subbasin

November 2021

Prepared for Sutter Subbasin Groundwater Management Coordination Committee

Sutter County GSA
Butte Water District GSA
City of Live Oak GSA
Sutter Extension Water District GSA
Sutter Community Services District GSA
City of Yuba City GSA
Reclamation District 70 GSA
Reclamation District 1660 GSA
Reclamation District 1500 GSA

This page intentionally left blank.

Difficulty Accessing Material

If you have difficulty accessing any material in this document, please contact us in writing or via telephone and we will work with you to make the information available. You can direct your request to:

Attn: Guadalupe Rivera
Sutter County Development Services
1130 Civic Center Blvd
Yuba City, CA 95993
Telephone: 530.822.7400 Ext. 305
Email: GRivera@co.sutter.ca.us

This page intentionally left blank.

LIMITATION

The work products presented in this Groundwater Sustainability Plan (GSP) are a compilation of work completed by multiple professionals under the direction of a Professional Geologist (PG) or Professional Engineer (PE) as indicated by the stamps shown below. The signatures here represents work completed in Hydrogeologic Conceptual Model, and the signing Professional Engineer assumes no responsibility for any errors or misleading statements presented therein. Compilation of the Common Chapter, exclusive of work conducted for the individual GSPs, has been prepared under the oversight of Leslie Dumas, P.E. and the signature below is specifically for that compilation.

information provided pursuant to the Basin Setting was prepared under the direction of a professional geologist

Responsible Engineer Seal (If required)

Leslie Dumas, PE
Woodard & Curran
Sutter Subbasin GSP

Responsible Engineer Seal (If required)

Joseph Turner, PG
Geosyntec
Hydrogeologic Conceptual Model

This page intentionally left blank

Contents

Figures

Tables

Appendices

Acronyms

AB	Assembly Bill
ADVM	acoustic doppler velocity meter
AF	acre-feet
AF/ac	acre-feet per acre
AFY	acre-feet per year
ASR	aquifer storage and recovery
AWMP	Agricultural Water Management Plan
AZ	Aquifer Zone
Bgs	below ground surface
BMP	best management practice
BWD	Butte Water District
BWGWD	Biggs-West Gridley Water District
C2VSimFG-Sutter	California Central Valley Groundwater-Surface Water Simulation Model – Fine Grid, Sutter Subbasin
CALSIMETAW	California Simulation of Evapotranspiration Applied Water
CARB	California Air Resources Board
CASGEM	California Statewide Groundwater Elevation Monitoring
CCR	California Code of Regulations
CDEC	California Data Exchange Center
CDFW	California Department of Fish and Wildlife
CDP	Census Designated Place
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
COC	chain of custody
COC	constituents of concern
CSD	Community Services District
CT	Central tendency
CVJV	Central Valley Joint Venture
CVP	Central Valley Project

CV-RWQCB	Central Valley Regional Water Quality Control Board
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
CWC	California Water Code
DAC	Disadvantaged Community
DDW	Division of Drinking Water, California State Water Resources Control Board
DMS	Data Management System
DPR	Department of Pesticide Regulation
DTW	depth to water
DWR	California Department of Water Resources
EC	electrical conductivity
EDA	Economically Distressed Area
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
ET	evapotranspiration
FRRAWMP	Feather River Regional Agricultural Water Management Plan
GAMA	Groundwater Ambient Monitoring and Assessment
GDE	groundwater dependent ecosystem
GIS	geographic information system
GMP	Groundwater Management Plan
GPS	Global Positioning System
GQTM	Groundwater Quality Trend Monitoring
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GWE	groundwater elevation
HCM	Hydrolgeologic Conceptual Model
IC	Irrigation Company
ILRP	Irrigated Lands Regulatory Program
IRWM	Integrated Regional Water Management
IRWMP	Integrated Regional Water Management Plan

ITRC	Cal Poly Irrigation Training & Research Center
LAFCO	Local Agency Formation Commission
JPA	joint powers authority
MAF	million acre-feet
MCL	Maximum Contaminant Level
mg/L	milligrams per liter
MHI	median household income
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MSL	mean sea level
MW	monitoring well
MWC	Mutual Water Company
NASA JPL	National Aeronautics and Space Administration Jet Propulsion Laboratory
NCCAG	National Communities Commonly Associated with Groundwater
NEPA	National Environmental Protection Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NPDES	National Pollution Discharge Elimination System
NRCS	National Resources Conservation Service
NSVIRWMP	Northern Sacramento Valley Integrated Regional Water Management Plan
NWIS	United States Geological Survey National Water Information System
PLSS	Public Land Survey System
PMAs	projects and management actions
PRISM	Precipitation-Elevation Regressions on Independent Slopes Model
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Program Plan
RD	Reclamation District
RP	reference point

RPE	reference point elevation
RWQCB	Regional Water Quality Control Board
SAGBI	Soil Agricultural Groundwater Banking Index
SB	Senate Bill
SCADA	Supervisory Control Data Acquisition
SCEHD	Sutter County Environmental Health Division
SDAC	Severely Disadvantaged Community
SEWD	Sutter Extension Water District
SGMA	Sustainable Groundwater Management Act
SHPO	State Historic Preservation Office
SMC	sustainable management criteria
SMCL	Secondary Maximum Contaminant Level
SMWC	Sutter Mutual Water Company
SNMP	Salt and Nutrient Management Plan
SSGMCC	Sutter Subbasin Groundwater Management Coordination Committee
SVWQC	Sacramento Valley Water Quality Coalition
SWP	State Water Project
SWPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
SWRCB-DDW	State Water Resources Control Board, Division of Drinking Water
SWRP	Storm Water Resource Plan
TAF	thousand acre-feet
TDS	total dissolved solids
TNC	The Nature Conservancy
TSS	Technical Support Services
UCCE	University of California Cooperative Extension
USBR	United States Bureau of Reclamation
USFWS	United States Fish & Wildlife Service
USGS	United States Geological Survey

UWMP	Urban Water Management Plan
VIC	Variable Infiltration Capacity
WA	Wildlife Area
WDL	Water Data Library
WDR	Water Discharge Requirement
WWTF	Wastewater Treatment Facility
WY	Water Year
μS/cm	microsiemens per centimeter
2070CT	2070 central tendency

This page intentionally left blank.

PREFACE

Development of the Sutter Subbasin Groundwater Sustainability Plan (GSP), along with nearly all other GSPs developed for non-critically overdrafted high- and medium-priority basins in California, has coincided with one of the most severe and extensive recorded droughts in the western United States. As of this writing (in November 2021), the Sutter Subbasin GSP has been assembled as the impacts of a second dry year are beginning to be felt and a third dry year is anticipated for Water Year (WY) 2022. Drought conditions in much of California, including the Sutter Subbasin, are classified as "exceptional," the most extreme classification defined by the U.S. Drought Monitor[1]. Observed impacts during exceptional droughts, according to U.S. Drought Monitor, may include:

- Widespread water shortages
- Surface water depletions
- Extremely low Central Valley Project and State Water Project irrigation water deliveries
- Curtailment of both junior and senior water rights
- Extremely high water prices
- Dry wells
- Drilling of more and deeper wells
- Increased groundwater pumping to meet demands, resulting in increased pumping costs
- Poor water quality
- Fallowed fields, orchard removal, and low vegetable yields
- Extensive wildfires
- Impacts to recreational activities
- Wildlife impacts, including impacts to survival and mortality
- High agricultural unemployment

Governor Gavin Newsom declared a drought emergency on April 21, 2021 in Mendocino and Sonoma Counties[2] due to drought conditions in the Russian River Watershed. This emergency declaration was later extended to the Klamath River Watershed Counties, Sacramento-San Joaquin Delta Watershed Counties (including

[1] Available at: https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?CA
[2] Governor Newsom's State of Emergency Proclamation from April 21, 2021 declaring a drought emergency is available at: https://www.gov.ca.gov/wp-content/uploads/2021/04/4.21.21-Emergency-Proclamation-1.pdf.

Sutter County, which contains the entirety of the Sutter Subbasin), and the Tulare Lake Watershed Counties[1] on May 10, 2021. On July 8, 2021, Executive Order N-10-21 was signed by Governor Newsom[2] calling on all Californians to voluntarily reduce their water use by 15% compared to 2020 levels. On August 20, 2021, the State Water Resources Control Board (SWRCB) issued curtailment orders[3] to approximately 4,500 water rights (out 6,600 total water rights holders) holders in the Sacramento-San Joaquin Delta to protect drinking water supplies, prevent salinity intrusion, and minimize impacts to fisheries and the environment for a period of one year with periodic evaluation of the orders. Most recently, on October 19, 2021, Governor Newsom issued a proclamation extending the drought emergency statewide and further urging Californians to conserve water as the western United States faces a potential third dry year.

As of November 2021, no widespread reports of water supply issues from groundwater wells have been observed in the Sutter Subbasin. Several water purveyors have implemented drought policies and management strategies in an effort to alleviate water supply impacts as a result of the current drought. For example, Sutter Extension Water District has implemented a drought policy including a basis for water allocations based on historical land use and conversions from rice growing to other crop types, irrigation reductions, penalties for water waste, and guidelines for intra-district water transfers. Butte Water District has implemented a similar drought policy including reduction of surface water allocations, irrigation practices, use of private wells, and penalties for taking of water during curtailment. The City of Yuba City has incorporated its Water Shortage Contingency Plan into its adopted 2020 Urban Water Management Plan, which includes the City's strategy for allocating water during water supply shortages while assuring customers at all times that it will meet the minimum health and safety requirements for a drinking water purveyor (pursuant to Water Code Section 10632 of the Urban water Management Planning Act).

Technical work and public involvement informing development of the Sutter Subbasin GSP began in September 2020 with the complete public draft of the GSP released in October 2021. The best available science, tools, and data have been utilized for the development of this GSP, with the use of available WY 2020 and WY 2021 data where appropriate and applicable. Drought conditions in WY 2020 and WY 2021 have coincided with development of this GSP and the timeline has not permitted a complete evaluation and inclusion of data from these years at this time. Due to the schedule

---

[1] Governor Newsom's State of Emergency Proclamation from May 10, 2021 extending the April 21, 2021 drought emergency is available at: https://www.gov.ca.gov/wp-content/uploads/2021/05/5.10.2021-Drought-Proclamation.pdf.
[2] Executive Order N-10-21 is available at: https://www.gov.ca.gov/wp-content/uploads/2021/07/7.8.21-Conservation-EO-N-10-21.pdf.
[3] Media release for curtailment orders is available at: https://www.waterboards.ca.gov/press_room/press_releases/2021/pr08202021_delta_curtailments.pdf.

mandated by the Sustainable Groundwater Management Act (SGMA) for completion and submittal of this GSP to the California Department of Water Resources (DWR) by January 31, 2022, it has not been possible to include conditions that have manifested due to the current drought in development of the Sutter Subbasin GSP. Complete data sets encompassing the current drought are not available at this time due to time need to compile such data and perform quality control prior to review and adoption of this GSP. However, these conditions will be factored into future required GSP annual reports and five-year evaluations of this GSP as available.

With a 20-year implementation period and a 50-year planning horizon, the Sutter Subbasin GSP is considered to be a “living” document. The Sutter Subbasin Groundwater Sustainability Agencies (GSAs) will implement this GSP using adaptive management strategies to respond to challenges related to groundwater sustainability, including monitoring of conditions in the Subbasin according to a prescribed schedule and implementing projects and management actions (PMAs). Conditions will be evaluated on an annual basis (or more frequently, as warranted) utilizing monitoring data collected as part of this GSP, as well as other publicly available sources, and PMAs will be added or revised in the GSP annual reports. During five-year GSP evaluations, the GSP will also be reviewed and revised, as needed, as more is known about the effects of current and future conditions.

With the unknowns associated with the compounding impacts of a third dry year, the Sutter Subbasin GSAs recognize the severe impacts that all beneficial users of water in the Subbasin may continue to face and are committed to an open, transparent, and inclusive process in implementing this GSP in the short and long term. The long-term sustainability of the Sutter Subbasin is the end goal and the Sutter Subbasin GSAs are committed to tackling important local issues and adapting to changing conditions to the benefit of all stakeholders.

This page intentionally left blank.

Executive Summary

SUTTER SUBBASIN
GROUNDWATER SUSTAINABILITY PLAN

This page intentionally left blank

EXECUTIVE SUMMARY

ES-1. INTRODUCTION

In 2014, the California legislature enacted the Sustainable Groundwater Management Act (SGMA) in response to continued overdraft of California's groundwater resources. The Sutter Subbasin (Subbasin) is one of 127 alluvial basins and subbasins identified by the California Department of Water Resources (DWR) as a high or medium priority groundwater basin and therefore subject to the requirements of SGMA. SGMA requires the preparation of a Groundwater Sustainability Plan (GSP) to provide a path to achieve and document sustainable groundwater management within 20 years following GSP adoption, promoting the long-term sustainability of locally-managed groundwater resources. Within the framework of SGMA, sustainability is generally defined as the long-term reliability of groundwater supply to meet the needs of existing and future beneficial uses and users of groundwater in the Subbasin with the absence of undesirable results.

SGMA requires development of a GSP that achieves groundwater sustainability in the Subbasin by 2042. This GSP provides a framework for sustainable groundwater management moving forward, including water budgets, sustainable management criteria, projects and management actions, monitoring, and implementation activities such as stakeholder outreach and the development of annual reports and five-year evaluations and assessments to this GSP.

ES-2. PLAN AREA

The Sutter Subbasin covers approximately 445 square miles of the Sacramento Valley floor and surrounds the foothills of the Sutter Buttes (**Figure ES-1**). The Sutter Subbasin is part of the larger Sacramento Valley Groundwater Basin and neighbors the following subbasins: Butte, Wyandotte Creek, North Yuba, South Yuba, North American, Yolo, and Colusa. The Sutter Subbasin is bounded on the west by the Sacramento River and on the east by the Feather River. Both rivers serve beneficial uses including recreation, agricultural, and wildlife. Other major features within the Sutter Subbasin include the Sutter Bypass (an artificial flood corridor), Sutter National Wildlife Refuge, and portions of the Sutter Buttes.

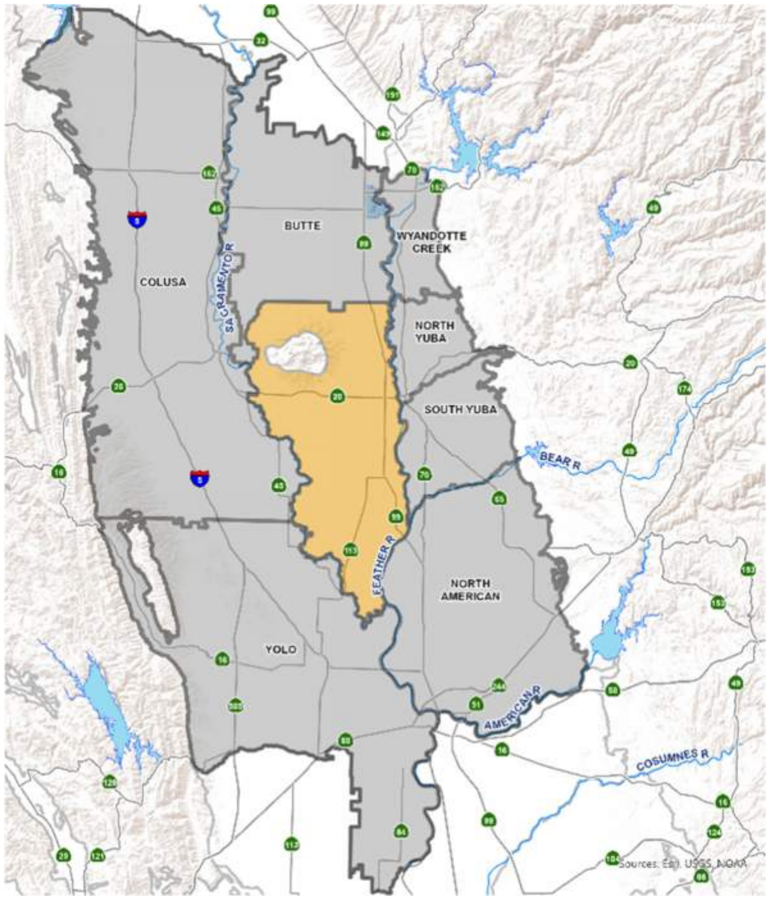


Figure ES-1. GSP Plan Area and Neighboring Subbasins

Land use within the Sutter Subbasin is managed by the cities of Live Oak and Yuba City, as well as Sutter County, and is predominantly agricultural with the production of rice as its primary crop. Surface water and groundwater are the water sources for irrigation, managed wetland, municipal, industrial, and urban/domestic purposes. Implementation of existing land use plans is unlikely to affect the water supply and groundwater sustainability over the planning and implementation horizon as the largest planned changes are related to urban growth with a reduction of agricultural lands.

Existing water resources monitoring and management plans are currently in place throughout the Subbasin, including the Irrigated Lands Regulatory Program (ILRP), Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS), and California Statewide Groundwater Elevation Monitoring (CASGEM) program, as well as Sutter County well standards and permitting. These existing programs can help inform SGMA activities through coordination with monitoring and management entities on overlapping activities and goals.

ES-3. GOVERNANCE AND ADMINISTRATION

This GSP was developed by the nine Sutter Subbasin Groundwater Sustainability Agencies (GSAs): Butte Water District – Sutter, City of Live Oak, City of Yuba City, County of Sutter, Reclamation District No. 70, Reclamation District No. 1500, Reclamation District No. 1660, Sutter Extension Water District, and Sutter Community Service District. Each GSA has its own individual organization and management structures as well as legal authority under which it operates.

The Sutter Subbasin Groundwater Management Coordination Committee (SSGMCC) contains one representative from each GSA and was created to cooperatively carry out the purposes of SGMA by coordinating the development, adoption, and implementation of this GSP. Activities of the SSGMCC include providing technical direction for GSP development, identifying projects and management actions, reporting to their respective GSA boards, and coordinating approval and adoption of this GSP by their respective GSA boards.

ES-4. OUTREACH AND COMMUNICATION

The goal of the public engagement effort related to GSP development and implementation is to understand the needs of stakeholders and groundwater uses and users in the Subbasin; consider the interests of diverse social, cultural, and economic elements of the population; increase awareness and understanding of SGMA and the GSP; and promote active involvement in the process to achieve and maintain sustainability.

Public workshops were held approximately once per quarter during GSP development (five in total) to update interested residents and stakeholders about the GSP preparation process and included presentations on data, information, and analyses, as well as activities to solicit input and feedback from participants. Beyond these meetings, information regarding plan development, noticing, and public comments periods was distributed via the project website (http://suttersubbasin.org/), e-mail notices, social media postings, press releases, and mailings, and utility bill notifications (**Figure ES-2**). Supporting materials (online and hard copy) were prepared in English, Spanish, and Punjabi.

Outreach efforts will continue throughout the implementation of this GSP and plan to include continuing SSGMCC meetings, regular updates at GSA board or city council meetings, maintenance of the project website, local outreach at public events, and distribution of a quarterly newsletter to interested parties.

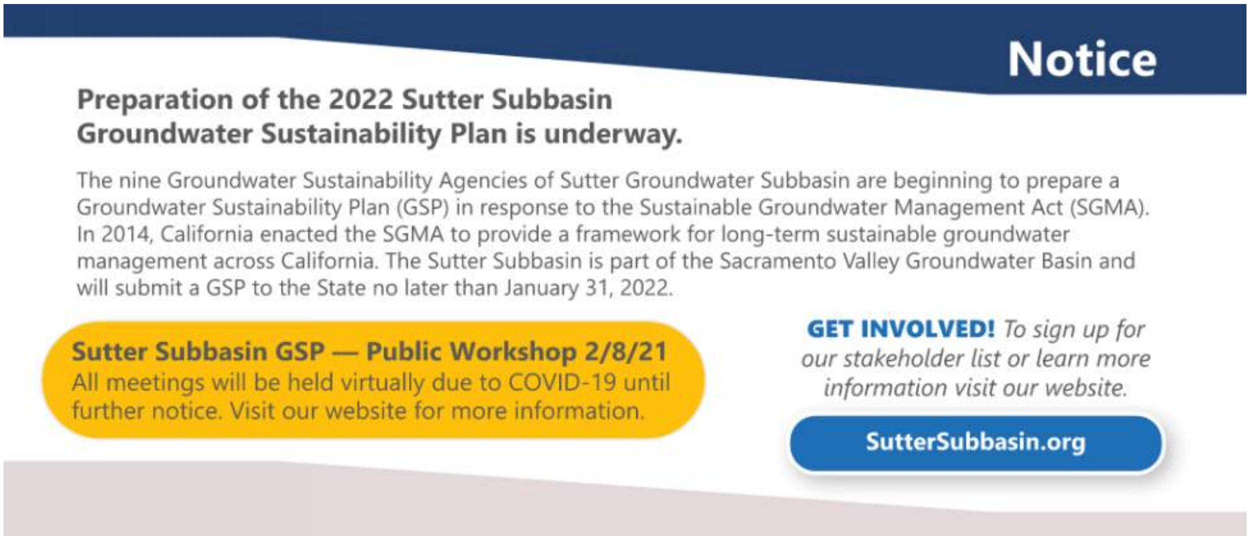


Figure ES-2. Sample Utility Bill Insert for Public Workshop

ES-5. BASIN SETTING

The Basin Setting chapter of this GSP includes the Hydrogeologic Conceptual Model, Groundwater Conditions, and Water Budgets sections which describe the Subbasin's physical setting, characteristics, and current conditions. This information serves as a basis for defining and assessing reasonable sustainable management criteria and projects and management actions.

Hydrogeologic Conceptual Model

Lying within the Sacramento Valley Groundwater Basin, the regional geology of the Sutter Subbasin consists of freshwater sediments that are underlain by marine sediments and igneous or metamorphic rocks. The freshwater sediments consist of the volcanoclastic rocks of the Sutter Buttes and sediments weathered from the Sierra Nevada to the east. The Willows Fault is the primary active fault structure within Sutter County and lies to the southwest and west of the Sutter Buttes. The Sutter Buttes, which form an elliptical lateral boundary, is the only prominent topographic feature, located in the northern part of the Subbasin, abruptly rising 2,000 feet above the surrounding valley floor. The topography of the Sutter Subbasin, aside from the Sutter Buttes, is primarily comprised of gentle flatlands with elevations ranging from 80 feet above mean sea level (MSL) in the northeast to 20 feet above MSL in the south. Soils consist mainly of poorly drained clay and clay loam soils, but near the rivers, well drained loam to sandy loam may be present.

The Sutter Subbasin groundwater system is composed of a single principal aquifer comprised of various formations that create zones with varying hydrogeologic properties. As such, this GSP recognizes three Aquifer Zones (AZ) within the principal aquifer: AZ-1 (surface to 150 feet below ground surface [ft bgs]), AZ-2 (150 to 400 ft bgs), and AZ-3 (greater than 400 ft bgs). In subsequent sections of this GSP, AZ-1 has been further subdivided to include the Shallow AZ (surface to 50 ft bgs) to assess and monitor for impacts related to interconnected surface water and groundwater dependent ecosystems (GDEs), with AZ-1 then including depths from 50 to 150 ft bgs.

Groundwater Conditions

Groundwater level trends in the Sutter Subbasin are largely flat over time, indicating sustainable conditions, as aquifer rebound is observed during all water year types (**Figure ES-3**). Shallow groundwater levels are relatively stable over time and indicate that most groundwater production is occurring below this aquifer zone. More groundwater appears to be produced from the deeper aquifer zones, as indicated by large fluctuations in groundwater elevations where responses to groundwater pumping are observed with rebound following the irrigation season as the aquifer recharges and returns to pre-pumping levels on a seasonal basis.

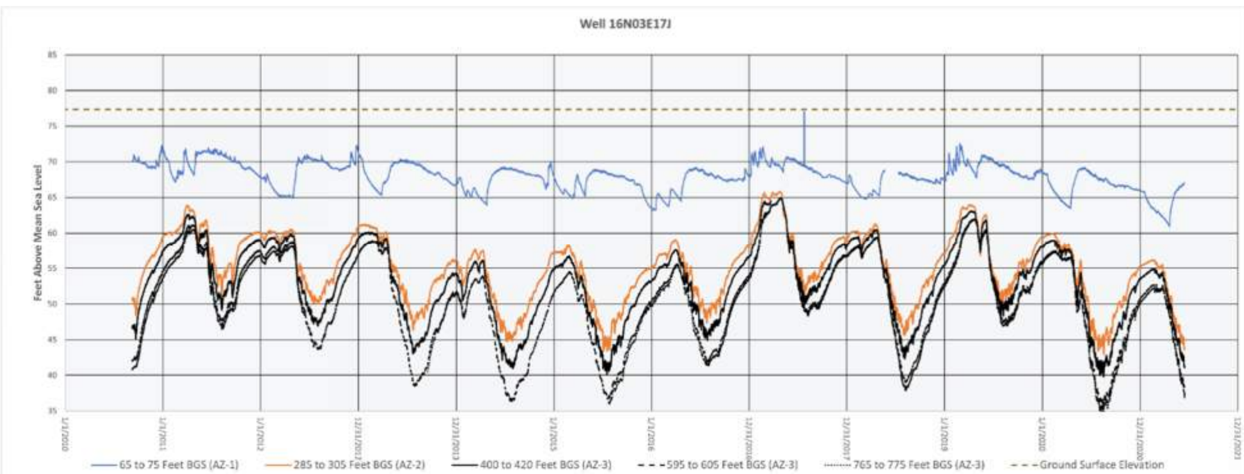


Figure ES-3. Sample Nested Well Hydrograph in Sutter Subbasin

As with groundwater levels, groundwater storage volumes in the Sutter Subbasin have been generally stable over at least the past 30 years (the length of available record). The volume of groundwater in storage increases as groundwater levels rise and decreases as groundwater levels fall; thus, stable groundwater level conditions also result in stable groundwater storage conditions. Total groundwater storage in the Sutter Subbasin is estimated to be 49 million acre-feet (AF) based on the C2VSimFG-Sutter integrated flow model.

Due to its location inland from the Pacific Ocean and set back from the Sacramento-San Joaquin Delta, seawater intrusion and related groundwater conditions are not applicable to the Sutter Subbasin.

Groundwater quality in the Sutter Subbasin varies by location. Several constituents have been detected at levels that exceed the maximum contaminant level (MCL) for drinking water, including arsenic, boron, total dissolved solids (TDS), and nitrate.

Median arsenic concentrations have decreased since 1952 and most recently are below the Primary MCL of 0.01 mg/L. Median boron concentrations peaked between 2009 and 2012 but remained below the agricultural water quality objective of 0.7 mg/L, and maximum concentrations of boron have decreased over time. Maximum TDS concentrations have substantially decreased since 1952, peaking in 2006, with the most recently observed maximum concentration occurring below the Upper Secondary MCL of 1,500 mg/L. Median nitrate concentrations have increased since 1952 and have been detected above the Primary MCL of 10 mg/L for nitrate as N as of 2012. The most recently observed maximum concentration exceeds the Primary MCL for nitrate by over 10 times. All constituents were found to be naturally occurring, except nitrate, detections of which are few and scattered throughout the Subbasin.

Land subsidence within the Sutter Subbasin has been minimal in recent years and there has been no reported negative impacts of land subsidence on critical infrastructure. While elastic land subsidence is observed as a result of seasonal fluctuations in groundwater levels and associated aquifer pressure, evidence of inelastic land subsidence has not been recorded within the Subbasin.

Interconnected surface waters (surface waters that are hydraulically connected by a saturated zone to the groundwater system) are categorized as “losing” when the groundwater elevations adjacent to a river or stream decline causing the river or stream to “lose” water to the underlying aquifer, or “gaining” when hydraulic gradients flow from the groundwater aquifer to the river or stream. The Sutter Bypass, Feather River, and Sacramento River were all found to have fluctuating gaining and losing conditions throughout the Subbasin.

GDEs in the Sutter Subbasin exist primarily where vegetation is reliant on shallow groundwater supply for survival. Potential GDEs have been identified along the Feather River and the most northeastern portion of the Sutter flyway.

Water Budgets

Water budgets are developed to provide a quantitative account of water (including surface water and groundwater) entering and leaving the Sutter Subbasin under historical, current, projected, and projected with climate change conditions. The water budgets were estimated using C2VSimFG-Sutter, a numerical groundwater and surface water model developed specifically for the Sutter Subbasin. The primary components of the groundwater budget include (also depicted in **Figure ES-4**):

- Inflows:
    - Deep percolation from rainfall, irrigation-applied water, and applied water for refuge use
    - Stream seepage
    - Land subsidence inflow

  - Conveyance seepage
  - Subsurface inflow from adjacent subbasins
- Outflows:
  - Groundwater outflow to streams
  - Groundwater pumping
  - Subsurface outflow to adjacent subbasins
- Change in groundwater storage

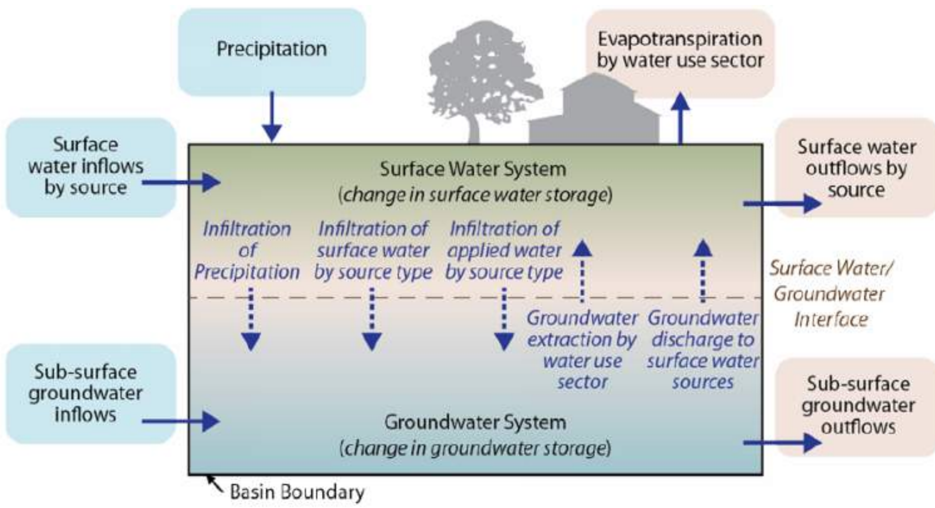


Figure ES-4. Overview of Water Budget Components

The average annual change in groundwater storage is stable under all water budget scenarios, with a net 0 AF change in storage under projected conditions (both with and without climate change). **Figure ES-5** shows the average annual volume of inflow and outflow from the groundwater budget for all water budget scenarios.

The sustainable yield for the Sutter Subbasin is estimated as 182,000 acre-feet per year (AFY). The estimated sustainable yield is higher than simulated average annual groundwater pumping in all four water budget scenarios – historical, current conditions, projected conditions, and projected conditions with climate change. Therefore, it can be reasonably stated that the Subbasin is currently operating under sustainable conditions and is expected to continue to be sustainable if changes estimated in the projected conditions scenario hold true into the future. Additionally, sustainable yield is a long-term value and groundwater pumping may exceed the estimated sustainable yield value during certain years, balanced by other years with reduced pumping so that the long-term average remains at or below the sustainable yield.

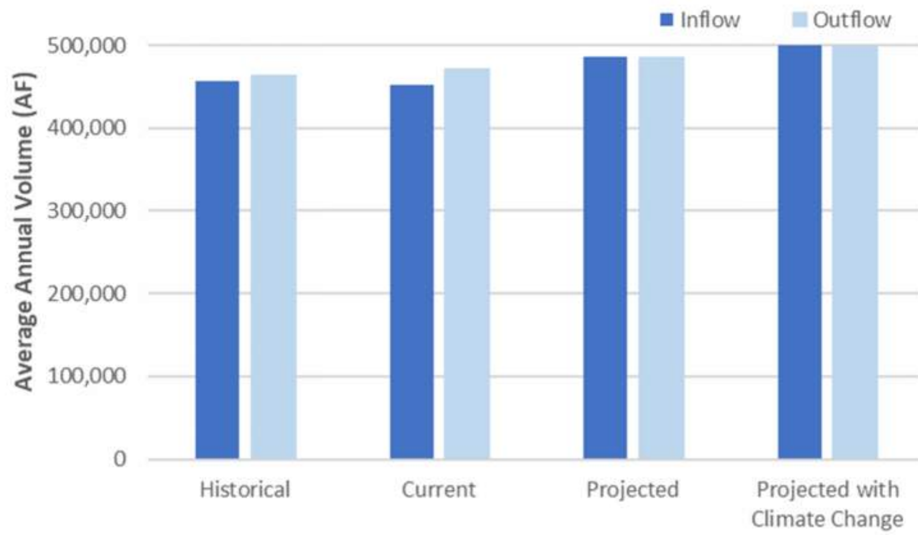


Figure ES-5. Sutter Subbasin Average Annual Groundwater Budget

ES-6. SUSTAINABILITY MANAGEMENT CRITERIA

SGMA introduces several terms to measure sustainability including (**Figure ES-6**):

- **Sustainability Indicators** – Sustainability indicators refer to adverse effects caused by groundwater conditions occurring throughout the Subbasin that, when significant and unreasonable, cause undesirable results. The six sustainability indicators identified by DWR are the following:
    - Chronic lowering of groundwater levels
    - Reduction of groundwater storage
    - Seawater intrusion
    - Degraded water quality
    - Land subsidence
    - Depletions of interconnected surface water
- **Sustainability Goal** – This goal is the culmination of conditions resulting in the absence of undesirable results within 20 years.
- **Undesirable Results** – The condition at which for each sustainability indicator significant and unreasonable impacts are likely to be observed.
- **Minimum Thresholds** – Minimum thresholds are a numeric value for each sustainability indicator and are used to define when undesirable results occur.
- **Measurable Objectives** – Measurable objectives are a specific set of quantifiable goals for the maintenance and improvement of groundwater conditions.

- **Interim Milestones** – Targets set in five-year increments over the GSP implementation period to reach the measurable objectives within 20 years.
- **Margin of Operational Flexibility or Operating Range** – The range of active management between the measurable objective and minimum threshold.

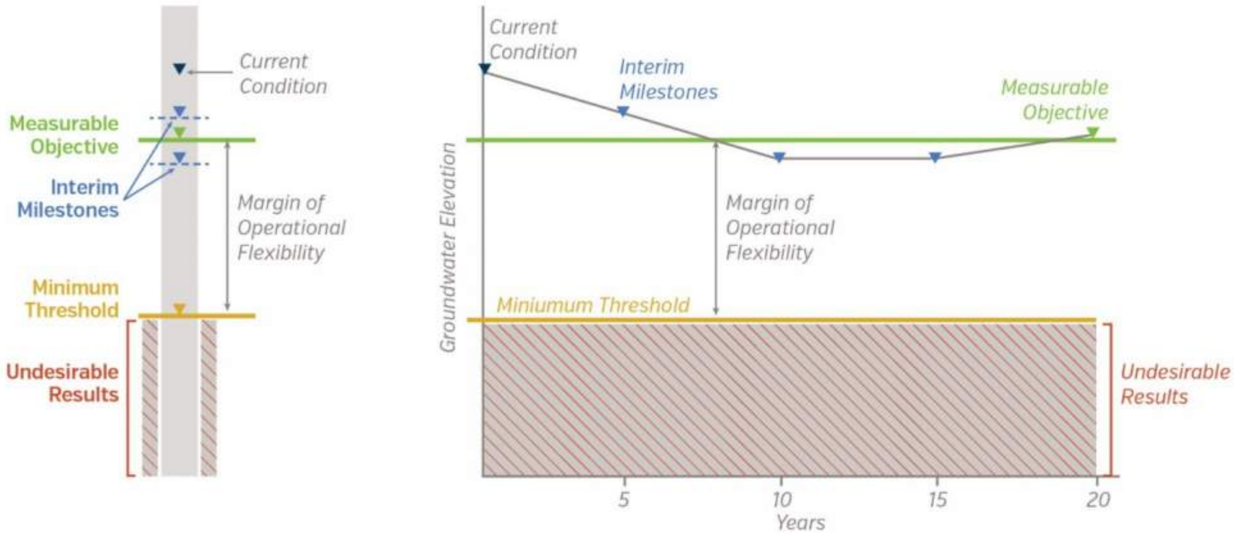


Figure ES-6. Sustainable Management Criteria Schematic for Groundwater Levels

The sustainability goal for the Sutter Subbasin is as follows:

> *The Sutter Subbasin will maintain locally-managed groundwater resources for existing and future beneficial uses and users that are economically viable and sustainable by managing groundwater use within the sustainable yield, resulting in the avoidance of undesirable results. This goal will be achieved through implementation of proposed projects and management actions and monitoring activities aiding in reaching or maintaining established interim milestones and measurable objectives culminating in the absence of undesirable results by 2042. Water managers in the Sutter Subbasin will work together and collaboratively with stakeholders and neighboring subbasins through GSP implementation and beyond to achieve this goal.*

The method prescribed by SGMA to measure undesirable results and achieve the sustainability goal involves setting minimum thresholds and measurable objectives for a series of representative monitoring sites. The Sustainable Management Criteria (SMC) are summarized in **Table ES-1**.

This page intentionally left blank

Table ES-1. Summary of Sustainable Management Criteria

Sustainability Indicator	Undesirable Results	Identification of Undesirable Results	Minimum Threshold	Measurable Objective
Chronic lowering of groundwater levels	Groundwater levels dropping to a level at which domestic or irrigation wells go dry or lose functional pumping capacity, resulting in significantly higher pumping costs and/or the significant and unreasonable effort to maintain or deepen production wells.	25% of representative monitoring locations across all aquifer zones drop below the minimum threshold criteria concurrently over two consecutive seasonal high water level measurements.	The deepest of: 1. The historic low from available record at each representative monitoring site; or 2. 90% of the average groundwater elevation from the projected water budget (baseline condition over 60-year period using C2VSimFG-Sutter) at each representative monitoring site with a 50% artificial increase in evapotranspiration; or 3. The average operating range using the above criteria for the following aquifer zones: - Shallow AZ and AZ-1 = 8.0 feet - AZ-2 and AZ-3 = 16.5 feet.	Average of the available historical record at each representative monitoring site.
Reduction of groundwater storage	Same as chronic lowering of groundwater levels. Groundwater levels are used as proxy.	Same as chronic lowering of groundwater levels. Groundwater levels are used as proxy.	Same as chronic lowering of groundwater levels. Groundwater levels are used as proxy.	Same as chronic lowering of groundwater levels. Groundwater levels are used as proxy.
Seawater intrusion	Undesirable results related to seawater intrusion are not applicable to the Sutter Subbasin.	Undesirable results related to seawater intrusion are not applicable to the Sutter Subbasin.	Minimum thresholds are not developed because undesirable results related to seawater intrusion are not applicable to the Sutter Subbasin.	Measurable objectives are not developed because undesirable results related to seawater intrusion are not applicable to the Sutter Subbasin.

Sustainability Indicator	Undesirable Results	Identification of Undesirable Results	Minimum Threshold	Measurable Objective
Degraded water quality	A result stemming from a causal nexus between groundwater-related activities, such as groundwater extraction or recharge, and a degradation in groundwater quality that causes a significant and unreasonable reduction in long-term viability of domestic, agricultural, municipal, or environmental uses over the planning and implementation horizon of this GSP.	50% of representative monitoring wells across all aquifer zones exceed the minimum threshold for two consecutive measurements at each location during non-drought years and where these minimum threshold exceedances can be tied to a causal nexus between SGMA-related activities and water quality.	The higher of: 1. The Upper Secondary Maximum Contaminant Level (SMCL) for TDS of 1,000 mg/L and Primary MCL for nitrate as N of 10 mg/L; or 2. Current water quality conditions for TDS and nitrate as N based on available data from 2000 to the time of GSP development at each representative monitoring well or nearby well in the same aquifer zone.	The higher of: 1. Current water quality conditions for TDS and nitrate as N based on available data from 2000 to the time of GSP development at each representative monitoring well or nearby well in the same aquifer zone. 2. The Recommended SMCL for TDS of 500 mg/L and 70% of the Primary MCL for nitrate as N of 7 mg/L.
Land subsidence	A result due to groundwater extraction that causes a significant reduction in the viability of the use of infrastructure for water distribution and flood control.	At least 25% of representative subsidence monitoring sites exceed the minimum threshold for subsidence over the 5-year monitoring period.	0.5 feet of subsidence over a 5-year period, representing the point at which water conveyance and levee infrastructure become sensitive to land subsidence ant twice the operational error of land survey measurements.	0.25 feet of subsidence over a 5-year period, representing the range of error for land survey measurements.
Depletions of interconnected surface water	A result that causes significant and unreasonable adverse effects on beneficial uses and users of interconnected surface water within the Sutter Subbasin over the GSP planning and implementation horizon.	25% of representative monitoring locations across all aquifer zones drop below the minimum threshold concurrently over two consecutive seasonal high water level measurements.	Same as chronic lowering of groundwater levels. Groundwater levels used as proxy.	Same as chronic lowering of groundwater levels. Groundwater levels used as proxy.

ES-7. SUSTAINABILITY IMPLEMENTATION

The Sutter Subbasin GSP contains the required sections for sustainability implementation, including Projects and Management Actions and a Representative Monitoring Network monitoring program.

Projects and Management Actions

As the Sutter Subbasin is currently sustainable and projected to remain sustainable, there are no projects or management actions required to achieve sustainability. However, projects and management actions can enhance understanding of the groundwater system and improve the ability to adaptively manage the Subbasin so that undesirable results can be prevented. Most projects and management actions contained in this GSP will be implemented as-needed and as funding is available.

Projects and management actions listed in the Sutter Subbasin GSP include select on-going and planned projects and management actions, such as:

- System modernization by water purveyors
- Boundary flow and primary spill measurement and drainage recovery
- Multi-benefit recharge
- Grower education
- Installation of shallow monitoring wells

As-needed projects and management actions will be implemented, as deemed necessary, to support sustainability, allow for adaptation to changing conditions, and achieve other water management objectives, such as:

- Direct and in-lieu groundwater recharge
- Wetland habitat improvement, such as through securing firm water supplies or fish screen projects
- Surface water supply augmentation through backwash recovery
- Updated electrical Supervisory Control and Data Acquisition (SCADA) and telemetry
- Water quality enhancement through replacement of sewer mains
- Projects to address data gaps, such as:
    - Investigations of interactions between rivers and changes in groundwater levels
    - Investigation of source of elevated salinity in the shallow aquifer zone
    - Study of aquifer properties
    - Data collection to improve the HCM
    - Comprehensive groundwater quality investigation

- Investigation and characterization of the Sutter Buttes, including salinity monitoring, airborne electromagnetic (AEM) survey, and an inter-basin working group focused on water quality
- Groundwater dependent ecosystem mapping confirmation
- Well census
- Land subsidence monitoring evaluation

A living list of projects and management actions will be maintained and updated in the Subbasin data management system (DMS) using the Opti platform, reflecting the current status of each and continually adjusting as needed to meet changing basin conditions. The list of projects and management actions in the DMS constitutes the required list for the Sutter Subbasin GSP per the GSP Emergency Regulations Subarticle 5. Projects and Management Actions.

Monitoring

The Sutter Subbasin GSP includes monitoring networks for the five applicable sustainability indicators, where seawater intrusion is not applicable to the Sutter Subbasin. The objective of these monitoring networks is to monitor conditions across the Subbasin and detect trends toward undesirable results such that adaptive management actions and projects can be implemented to prevent the onset of undesirable results. Specifically, the monitoring networks were developed to:

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

Five monitoring networks were developed for the Sutter Subbasin GSP: groundwater levels by aquifer zone (also used as proxy for reduction in groundwater storage sustainability indicator), groundwater quality by aquifer zone, land subsidence, and interconnected surface water. All monitoring networks described in this GSP are representative monitoring networks and are used to determine compliance with the quantitative minimum thresholds and measurable objectives established at each representative monitoring site.

The monitoring networks were designed by evaluating existing monitoring programs, such as CASGEM, monitoring conducted by DWR, or local agency monitoring programs. The monitoring networks largely consist of monitoring sites that have historical monitoring data and no significant barriers to future monitoring events. Data gaps identified in the Sutter Subbasin monitoring network include unknown construction details for several groundwater quality monitoring wells and limited shallow monitoring wells currently available along identified interconnected surface waters. Progress will be made to fill these identified data gaps prior to the first five-year evaluation and assessment, where updated monitoring networks will be included in future GSP updates.

Monitoring frequencies vary by sustainability indicator. For groundwater levels and interconnected surface water, measurements will be taken during seasonal high (March through April) and seasonal low (September through October) conditions. Additional groundwater level measurements may be taken in areas where rice growing activities substantially alter the timing of seasonal highs and lows in shallow aquifer zones. Groundwater quality for identified constituents of concern (TDS and nitrate as N) will be analyzed annually with samples collected in September. Measurements for interconnected surface waters will be collected concurrently with those for groundwater levels. Land subsidence will be monitored by DWR using the Sacramento Valley Global Positioning System (GPS) Subsidence Monitoring Network every five years, with the next survey to be completed in 2022. Publicly available Interferometric Synthetic Aperture Radar (InSAR) and stream gage data will be collected and evaluated on an annal basis.

ES-8. PLAN IMPLEMENTATION

Implementing the Sutter Subbasin GSP will require numerous management activities by the Sutter Subbasin GSAs, including:

- GSA administration and activities associated with the SSGMCC
- Conducting outreach and stakeholder engagement
- GSP-related monitoring activities at specified timing and frequency and analysis of monitoring data relative to established SMC
- Updating the Subbasin DMS
- C2VSim-FG model refinements
- Implementing adaptive management strategies as needed
- Implementing projects and management actions, as needed and as funding is available
- Annual Report development and submittal to DWR by April 1 each year
- Evaluating and updating the GSP at least every five years

Implementation of the Sutter Subbasin GSP will require funding from the GSAs as well as external sources. Outside grants will be sought to assist with reducing the cost of implementation to participating agencies, residents, and landowners in the Subbasin. The estimated initial cost of GSP implementation activities is between approximately $632,000 and $1,212,000 per year during the initial years of implementation, excluding implementation of projects and management actions. Costs associated with the implementation of identified projects and management actions will vary depending on the project type and stage of the project (e.g., planning or construction). The Sutter Subbasin GSAs will individually fund implementation of projects in their respective areas unless otherwise agreed upon by the GSAs' governing bodies.

ES-9. REFERENCES AND TECHNICAL STUDIES

Lists of references used to develop this GSP are included following each GSP chapter. Technical studies relied upon in developing the Sutter Subbasin GSP are included as a chapter of this GSP.

C H A P T E R   O N E

Introduction

SUTTER SUBBASIN
GROUNDWATER SUSTAINABILITY PLAN

This page intentionally left blank

1. INTRODUCTION

This section introduces the purpose and organization of this Groundwater Sustainability Plan and includes the sustainability goal and a description of the Sutter Subbasin.

1.1 Purpose of the Groundwater Sustainability Plan

In 2014, the State of California enacted the Sustainable Groundwater Management Act (SGMA), which is comprised of regulatory requirements set forth in a three-bill legislative package consisting of Assembly Bill (AB) 1739 (Dickinson), Senate Bill (SB) 1168 (Pavley), and SB 1319 (Pavley). The Sutter Groundwater Subbasin (Sutter Subbasin or Subbasin) has been identified by the California Department of Water Resources (DWR) as a medium-priority basin. Therefore, Groundwater Sustainability Agencies (GSAs) in the Subbasin are tasked with developing and submitting a Groundwater Sustainability Plan (GSP or Plan) to DWR by no later than January 31, 2022.

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” (SGMA Regulations §10721(v)). “Undesirable results” are defined by SGMA as any of the following effects caused by groundwater conditions occurring throughout the basin (SGMA Regulations §10721(x)):

- 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
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water

This GSP has been developed by the Sutter Subbasin GSAs and addresses SGMA regulatory requirements while reflecting local needs and preserving local control over water resources. The Sutter Subbasin GSP provides a path to achieve and document sustainable groundwater management within 20 years following Plan adoption and promotes the long-term sustainability of locally-managed groundwater resources. As defined by SGMA, this GSP’s planning and implementation horizon is a “50-year time period over which a groundwater sustainability agency determines that plans and measures will be implemented in a basin to ensure that the basin is operated within its sustainable yield.”

1.2 Sutter Subbasin Sustainability Goal

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

The sustainability goal for the Sutter Subbasin is as follows:

> *The Sutter Subbasin will maintain locally-managed groundwater resources for existing and future beneficial uses and users that are economically viable and sustainable by managing groundwater use within the sustainable yield, resulting in the avoidance of undesirable results. This goal will be achieved through implementation of proposed projects and management actions and monitoring activities aiding in reaching or maintaining established interim milestones and measurable objectives culminating in the absence of undesirable results by 2042. Water managers in the Sutter Subbasin will work together and collaboratively with stakeholders and neighboring subbasins through GSP implementation and beyond to achieve this goal.*

Additional discussion of the sustainability goal can be found in **Chapter 6** *Sustainable Management Criteria*.

1.3 Description of the Sutter Subbasin

The Plan Area covered by this GSP includes the entirety of the Sutter Groundwater Subbasin, identified by DWR in Bulletin 118 as Subbasin No. 5-021.62 (DWR, 2018). The Sutter Subbasin covers approximately 445 square miles of the Sacramento Valley floor and surrounding the foothills of the Sutter Buttes, and is part of the larger Sacramento Valley Groundwater Basin located within the Sacramento River Hydrologic Region. More detail on the Sutter Subbasin is provided in **Section 2.1**.

1.4 Groundwater Sustainability Plan Organization

This GSP has been organized to comply with the GSP Emergency Regulations (California Code of Regulations, Title 23. Waters, Division 2. Department of Water Resources, Chapter 1.5. Groundwater Management. Subchapter 2. Groundwater Sustainability Plans) and generally follow the DWR Preparation Checklist for GSP Submittal (DWR, 2016). **Appendix 1-A** includes DWR's GSP elements guide for this GSP, indicating the page numbers as well as section, figure, and table numbers of all required GSP elements.

1.5 References

California Department of Water Resources (DWR). 2018. 5-021.62 Sacramento Valley – Sutter Basin Boundaries Description. https://cadwr.app.box.com/s/rhqaflj4t5d063he9o314ojzz394idec/file/764121944134. Accessed: July 28, 2021.

California Department of Water Resources (DWR). 2016. Guidance Document for the Sustainable Management of Groundwater: Preparation Checklist for GSP Submittal. December. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Preparation-Checklist-for-GSP-Submittal.pdf. Accessed: July 28, 2021.

This page intentionally left blank.

CHAPTER TWO

Plan Area

This page intentionally left blank

2. PLAN AREA

2.1 Plan Area Description

The Plan Area covered by this GSP includes the entirety of the Sutter Groundwater Subbasin (California Department of Water Resources [DWR] Basin 5-021.62), covering approximately 445 square miles of the Sacramento Valley floor and surrounding the foothills of the Sutter Buttes. The Sutter Subbasin is part of the larger Sacramento Valley Groundwater Basin located within the Sacramento River Hydrologic Region. Major features within the Sutter Subbasin include portions of the Sutter Buttes, the Feather and Sacramento Rivers, Sutter Bypass, the cities of Live Oak and Yuba City, and Sutter National Wildlife Refuge.

This section of the Sutter Subbasin GSP describes the Sutter Subbasin and includes the following:

- A detailed description of geographic areas covered by the GSP in relation to SGMA governing entities, jurisdictional boundaries, existing land use and related water sources, well density, and areas of de minimis groundwater pumping.
- Descriptions of existing water resources monitoring and management programs, including discussions of how they may limit operational flexibility and how the Plan will adapt to such limits.
- Descriptions of existing conjunctive use programs in the Subbasin.
- Discussion of general plans and other land use plans and how implementation of existing land use plans (both within and outside of the Subbasin) may change water demands or impact sustainable groundwater management, and how the Plan addresses such potential effects is also discussed.
- Descriptions of local relevant well permitting processes as they relate to land use planning.
- Any additional Plan elements included per California Water Code (CWC) §10727.4, as appropriate.

In total, this section of the Sutter Subbasin GSP satisfies §354.8 of the GSP Emergency Regulations.

2.1.1 Plan Area Definition

The Sutter Subbasin is located in the Sacramento Valley Groundwater Basin and adjoins the following seven subbasins: Butte, Wyandotte, North Yuba, South Yuba, North American, Yolo, and Colusa. The northern boundary of the Sutter Subbasin consists of the Sutter County-Butte County line, except for the portion of Biggs-West Gridley Water District Groundwater Sustainability Agency (GSA) within Sutter County that is included within the Butte Subbasin. The eastern boundary consists primarily of the Sutter County-Yuba County line to its terminus just north of Nicolaus Census

Designated Place (CDP), where the Feather River forms Sutter Subbasin's eastern boundary until the Feather River reaches the Yolo County line. The southern and western boundaries of the Sutter Subbasin follow the Sutter County boundary shared with Yolo and Colusa Counties. The Plan Area covered by this GSP, the entirety of the Sutter Subbasin, is shown in **Figure 2-1**.

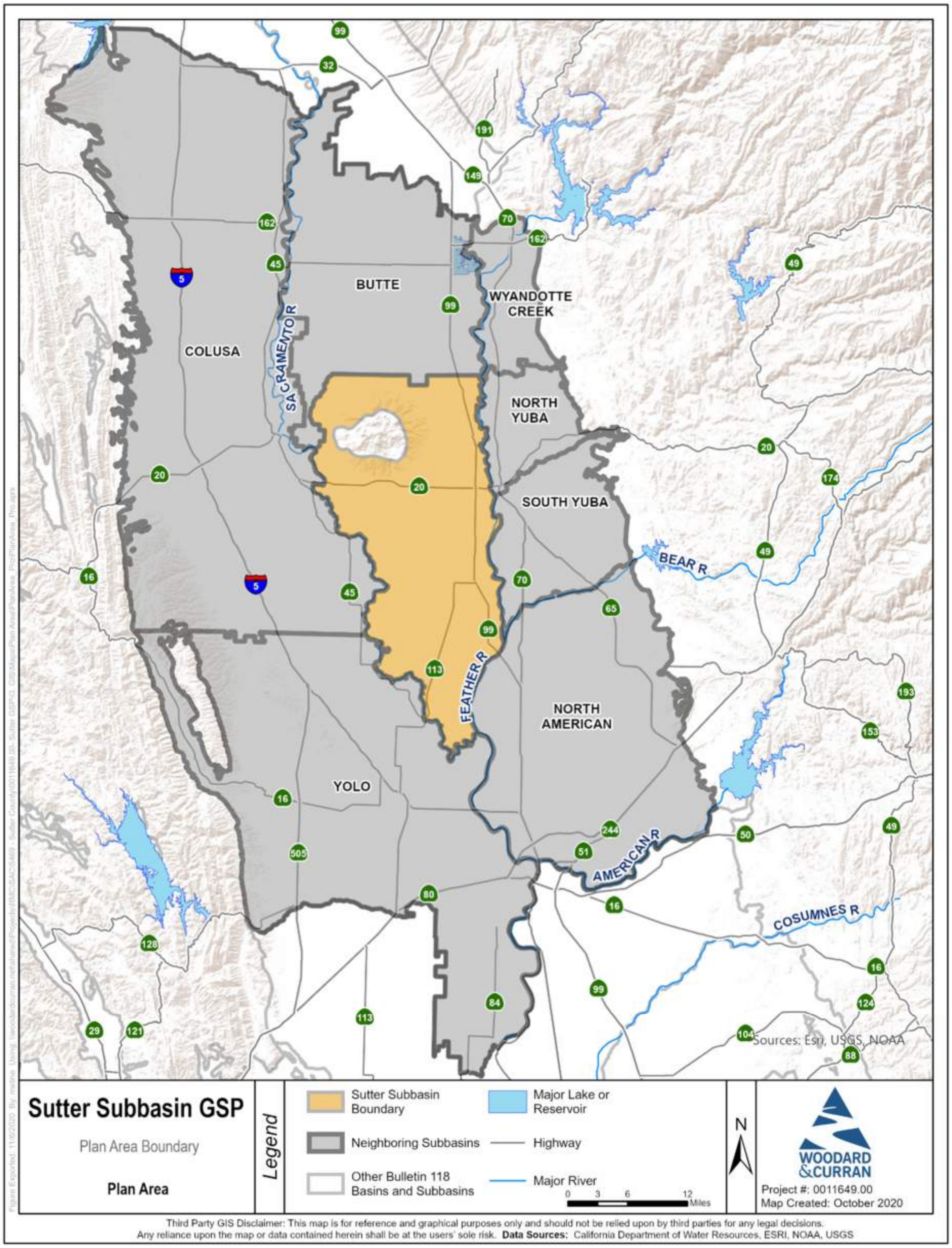


Figure 2-1. Plan Area

2.1.2 Plan Area Jurisdictional Boundaries

The Plan Area for this GSP consists of the entire Sutter Subbasin of the Sacramento Valley Groundwater Basin, which includes the following nine GSAs (**Figure 2-2**):

- Butte Water District - Sutter
- City of Live Oak
- City of Yuba City
- County of Sutter
- Reclamation District No. 70
- Reclamation District No. 1500
- Reclamation District No. 1660
- Sutter Extension Water District
- Sutter Community Service District

All GSAs within the Sutter Subbasin are exclusive GSAs. There are no adjudicated areas or areas covered by an Alternative Plan within the Sutter Subbasin.

Table 2-1 summarizes the jurisdictional areas within the Sutter Subbasin. These include counties, cities, water districts, irrigation districts, reclamation districts, mutual water companies, and state and federal agencies. Federal lands within the Sutter Subbasin consist primarily of the Sutter National Wildlife Refuge (operated by the United States Fish and Wildlife Service) and state lands consist primarily of a portion of Sutter Buttes State Park and wildlife and ecological preserve land along the Sutter Bypass and Feather River operated by the California Department of Parks and Recreation and California Department of Fish and Wildlife, respectively (**Figure 2-3**). The Subbasin also includes wildlife areas, such as Gray Lodge Wildlife Area and Lake of the Woods State Wildlife Area, as well as protected areas and private and publicly managed easements in addition to the following private duck clubs (**Figure 2-4**):

- Live Oak Duck Club
- North Butte Duck Club
- Sutter Butte Duck Club
- Sutter Basin Duck Club
- Duck Blind at Sutter Refuge

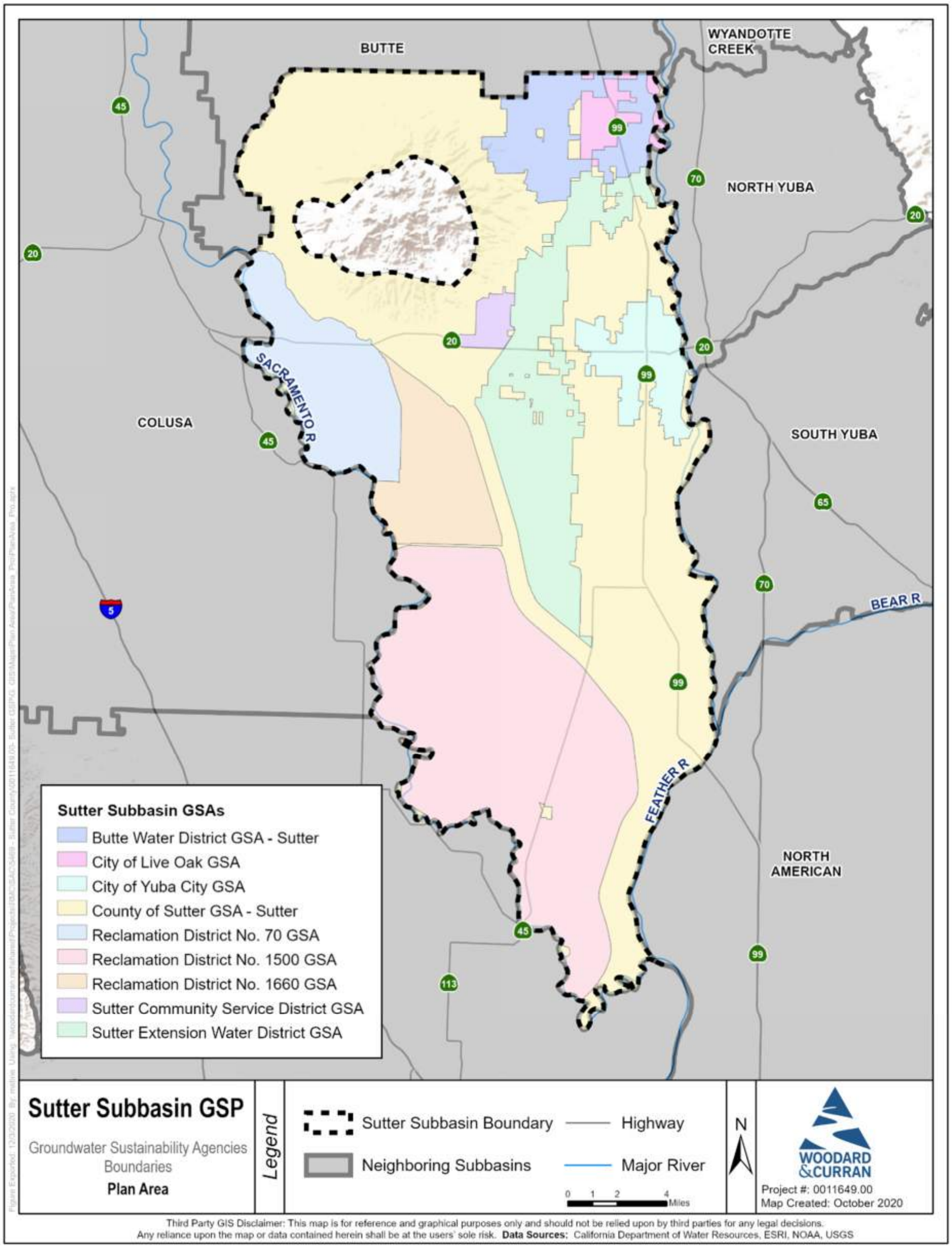


Figure 2-2. Sutter Subbasin Groundwater Sustainability Agencies

Table 2-1. Jurisdictional Areas in the Sutter Subbasin

Jurisdictional Area	List of Entities
Counties	• Sutter County
Cities	• City of Live Oak • City of Yuba City
Tribal Land	• N/A
Agencies with Water Management Responsibilities	• Butte Slough Irrigation Company (IC) • Butte Water District (WD) • East Nicolaus Mutual Water Company (MWC) • Feather WD • Garden Highway MWC • M Chaplin, B Lewis, D Lewis • Meridian Farmers Water Company (WC) • Mitzue Oji Family Partnership • Newhall Land & Farming Co. • Oji Brothers Farm Inc. • Oswald WD • Pelger MWC • Sutter Bypass Butte Slough Water Users Association • Sutter County Water Works District No. 1 (Robbins) • Sutter Extension WD • Sutter MWC • Tisdale Irrigation & Drainage Co. • Tudor MWC • Sutter Community Service District (CSD) • City of Yuba City • City of Live Oak • Reclamation District 70 • Reclamation District 777 • Reclamation District 783 • Reclamation District 1500 • Reclamation District 1660 • Reclamation District 2054 • Reclamation District 2056
Areas Covered by Relevant General Plans	• Sutter County • City of Live Oak • City of Yuba City
Federal Land	• United States Fish and Wildlife Service
State Land	• California Department of Parks and Recreation • California Department of Fish and Wildlife

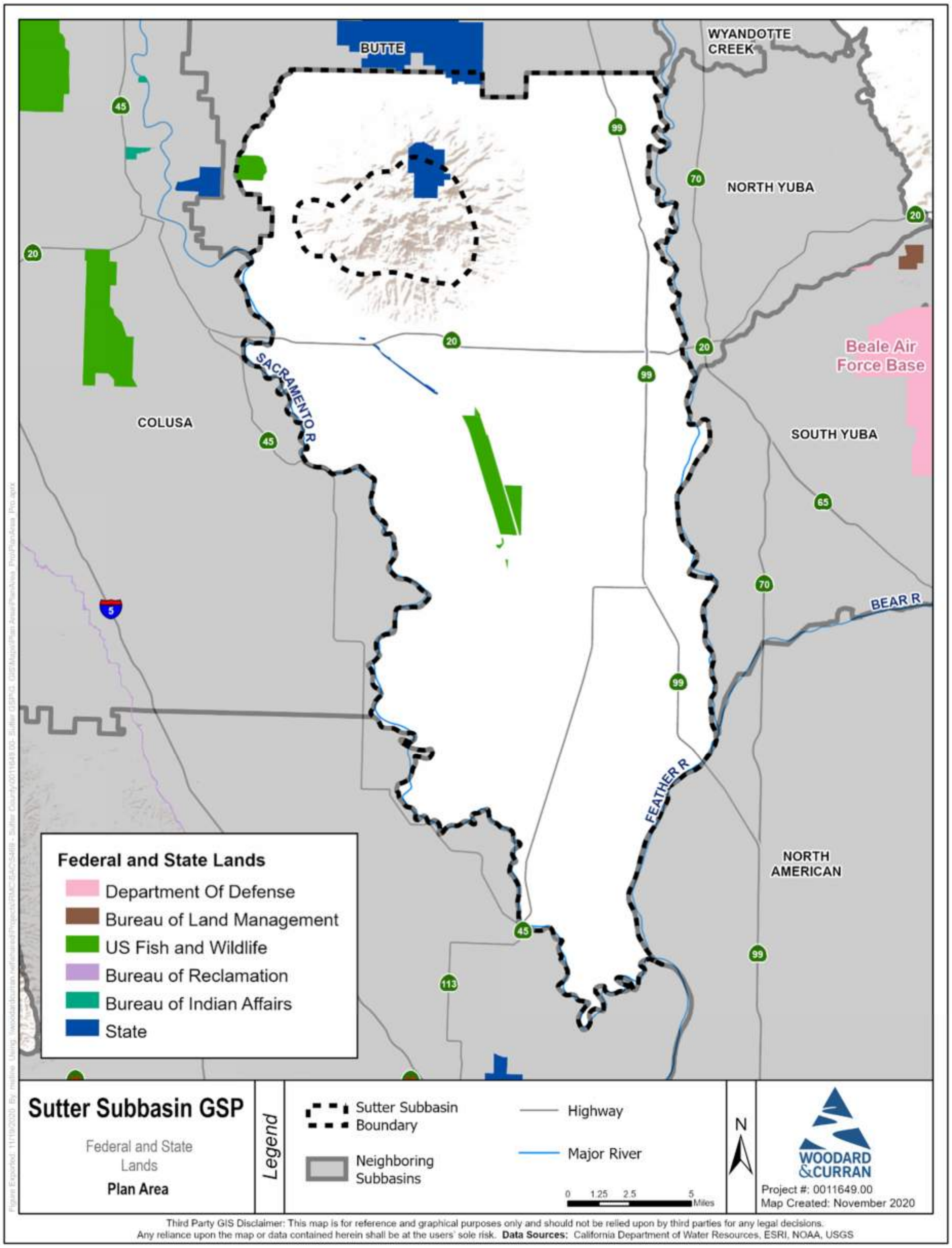


Figure 2-3. Federal and State Lands in the Sutter Subbasin

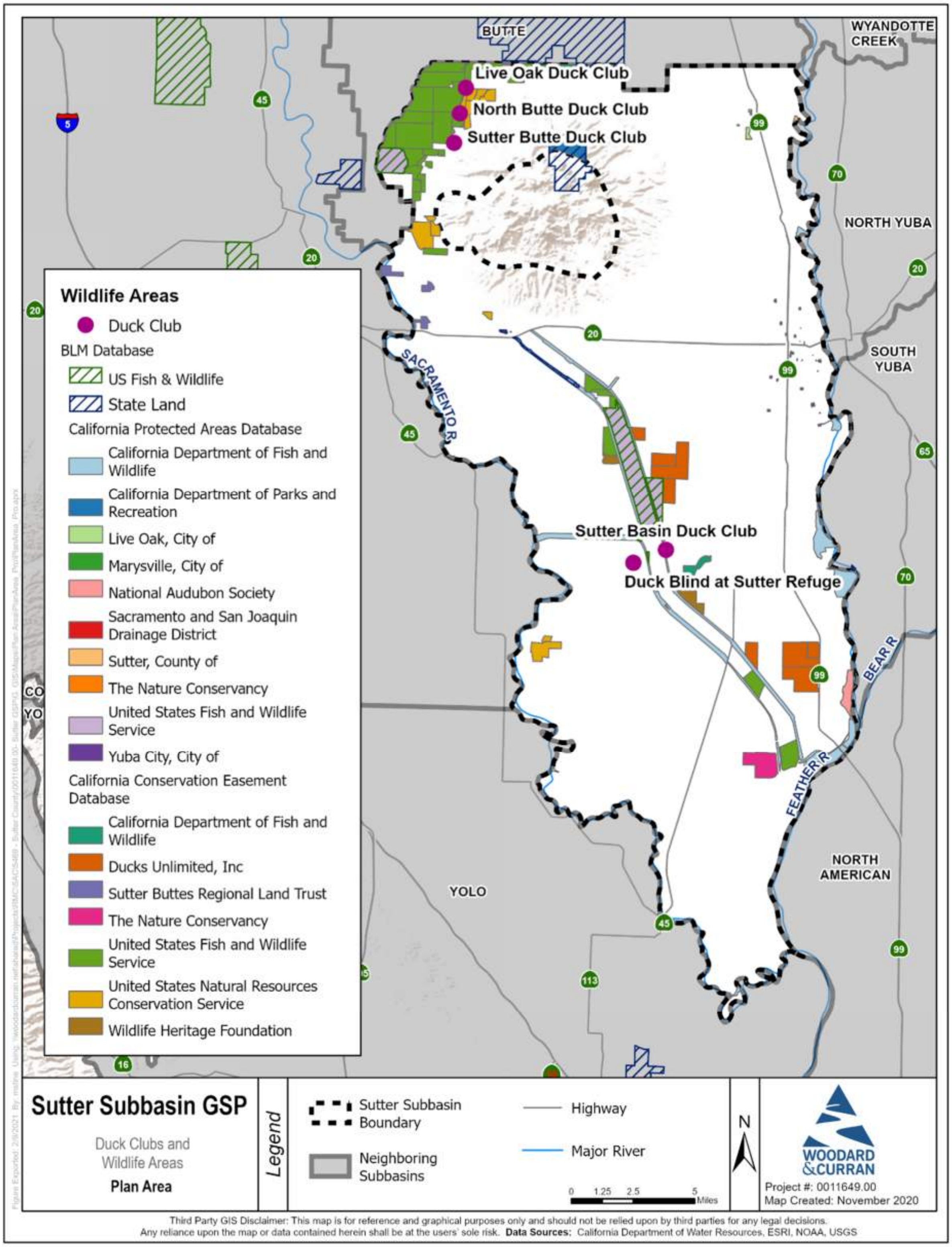


Figure 2-4. Duck Clubs and Wildlife Areas

Cities within the Sutter Subbasin include the City of Live Oak and the City of Yuba City. Sutter County is the only county overlying the Sutter Subbasin (**Figure 2-5**). There are no federal- or state-recognized tribal communities in the Sutter Subbasin; however, the following tribes have been identified as possibly having a cultural and traditional affiliation within the County:

- Estom Yumeka Maidu Tribe of the Enterprise Rancheria
- Mooretown Rancheria of Maidu Indians
- United Auburn Indian Community of the Auburn Rancheria
- Yocha Dehe Wintun Nation
- Shingle Springs Band of Miwok Indians
- Pakan'yani Maidu of Strawberry Valley Rancheria

Agencies with water management authority include reclamation districts, water districts, cities, mutual water companies, irrigation companies, and private farmland shown in **Figure 2-6** and listed in **Table 2-1**.

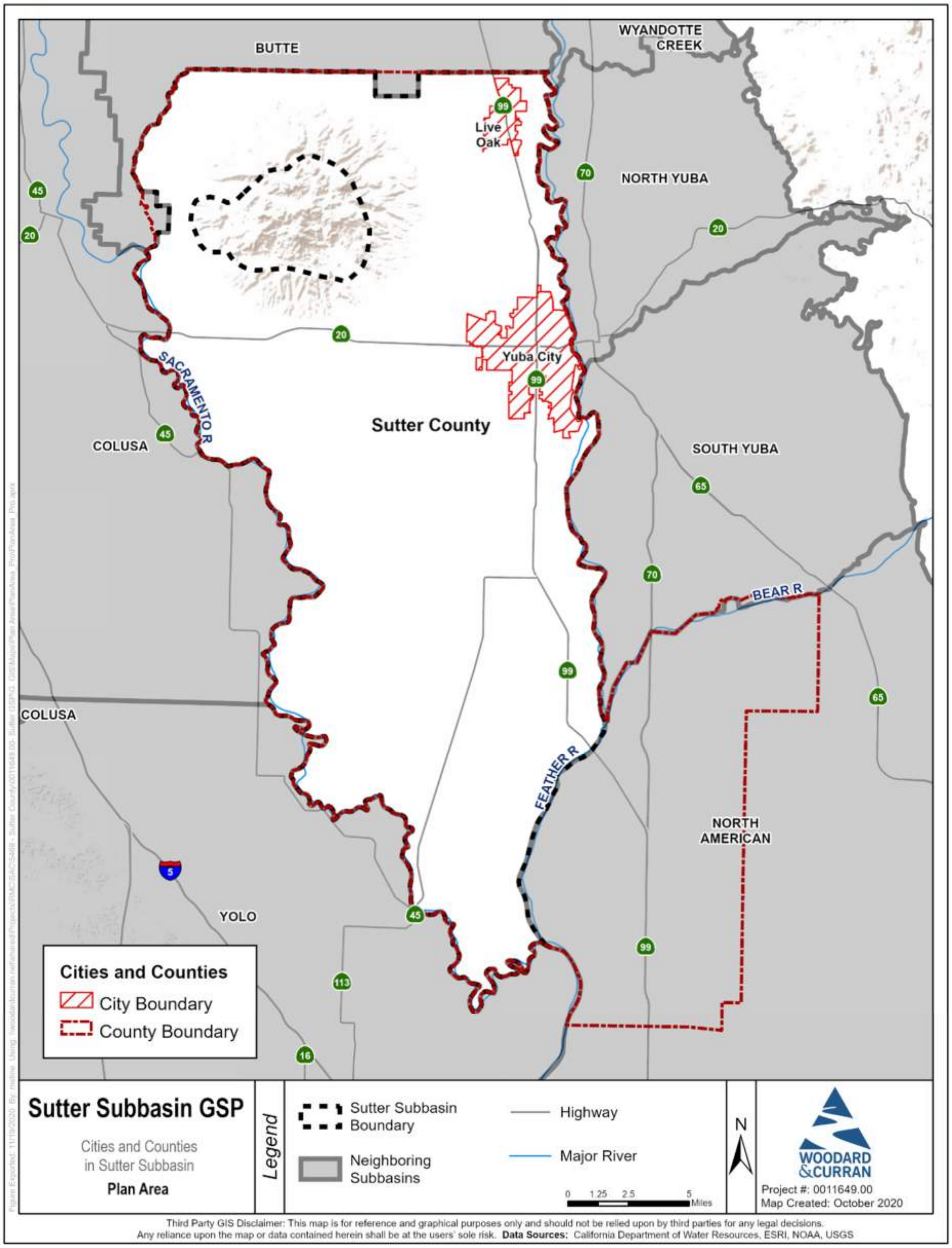


Figure 2-5. Cities and Counties in the Sutter Subbasin

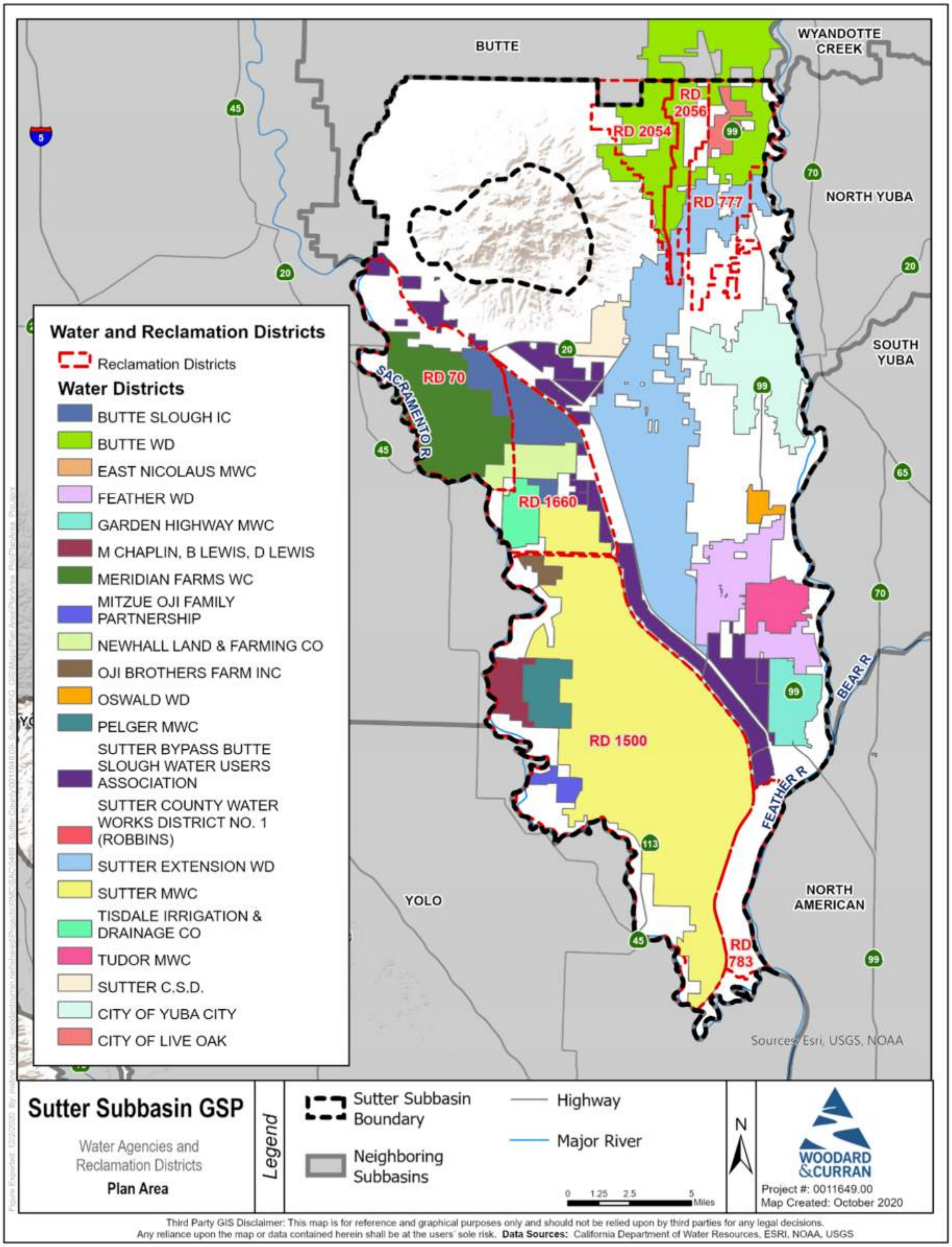


Figure 2-6. Agencies with Water Management Responsibilities in the Sutter Subbasin

2.1.3 Plan Area Setting

Water use within the Sutter Subbasin is largely supplied by a mix of surface water and groundwater. Approximately 60 percent of agricultural users utilize only surface water for irrigation purposes, while 20 percent utilize only groundwater and 20 percent irrigate with a mix of surface water and groundwater (Wood Rodgers, 2012). The predominant source of water for permanent crops is groundwater. Smaller communities and individual domestic well owners rely exclusively on groundwater while the City of Yuba City provides mostly surface water and a smaller proportion of groundwater.

2.1.3.1 Groundwater Use

Groundwater in the Sutter Subbasin is used for municipal, industrial, irrigation, domestic, stock watering, frost protection, and other purposes. Communities reliant upon groundwater include Sutter, Meridian, Robbins, and Live Oak (**Figure 2-7**). Users within white areas not served by a water purveyor, primarily within the Sutter County GSA, are reliant upon groundwater and are considered *de minimis* groundwater extractors (**Figure 2-8**).

Figure 2-9 show the density per square mile (PLSS Section) of domestic, production, and public wells in the Sutter Subbasin as identified by the California Department of Water Resources' (DWR) Well Completion Report Map Application. Domestic wells are defined as individual domestic wells which supply water for the domestic needs of an individual residence or system of four or less service connections (DWR, 1981). Within the Sutter Subbasin, there are an estimated total of 2,482 domestic wells, where the majority of PLSS Sections contain five or fewer domestic wells (195 out of 283 PLSS Sections with five or fewer domestic wells) (**Figure 2-9**). One PLSS section, southeast of the Sutter Buttes, is estimated to contain 225 domestic wells.

Production well statistics include wells that are designated as irrigation, municipal, public, and industrial on well completion reports, generally indicating wells designed to obtain water from productive zones containing good quality water (DWR, 1991). There are estimated to be 1,210 production wells in the Sutter Subbasin, where the majority of PLSS Sections contain only between one and three production wells (216 out of 337 PLSS Sections with three or fewer production well) and only 21 PLSS sections have 10 or more production wells (**Figure 2-10**). Public wells are defined as wells that provide water for human consumption to 15 or more connections or regularly serve 25 or more people daily for at least 60 days out of the year (SWRCB, n.d.(b)). Within the Sutter Subbasin, there are 69 public wells listed in the DWR database where 36 PLSS Sections have only 1 public well and 11 PLSS Sections have more than two public wells (**Figure 2-11**). The status of the wells (e.g., active, abandoned, or destroyed) contained in the DWR Well Completion Report Map Application have not been independently confirmed and it should be noted the well quantities are only estimated since not all well completion reports are in the map application and, at times, the well location has been mislocated on the well completion report.

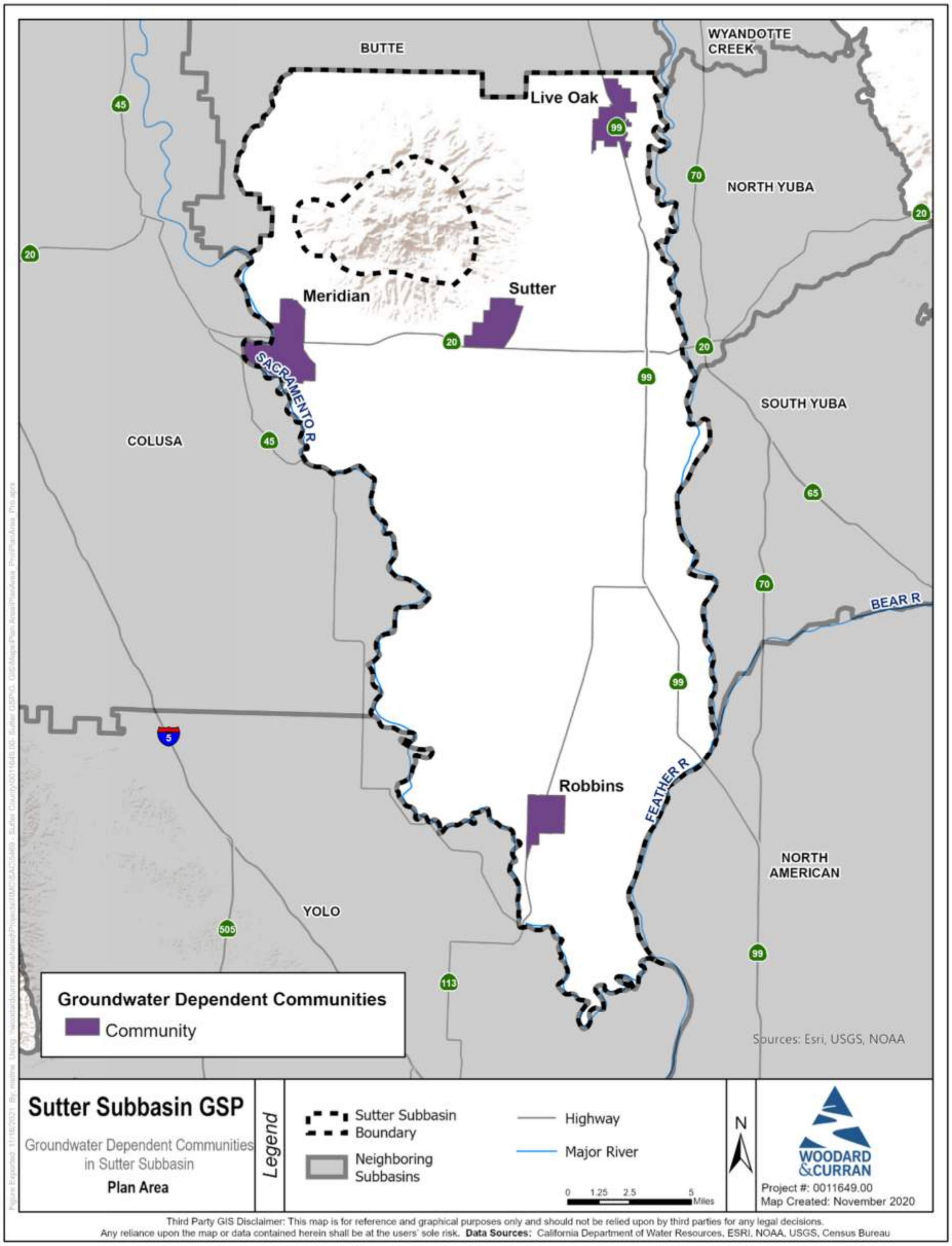


Figure 2-7. Communities Dependent Upon Groundwater in the Sutter Subbasin

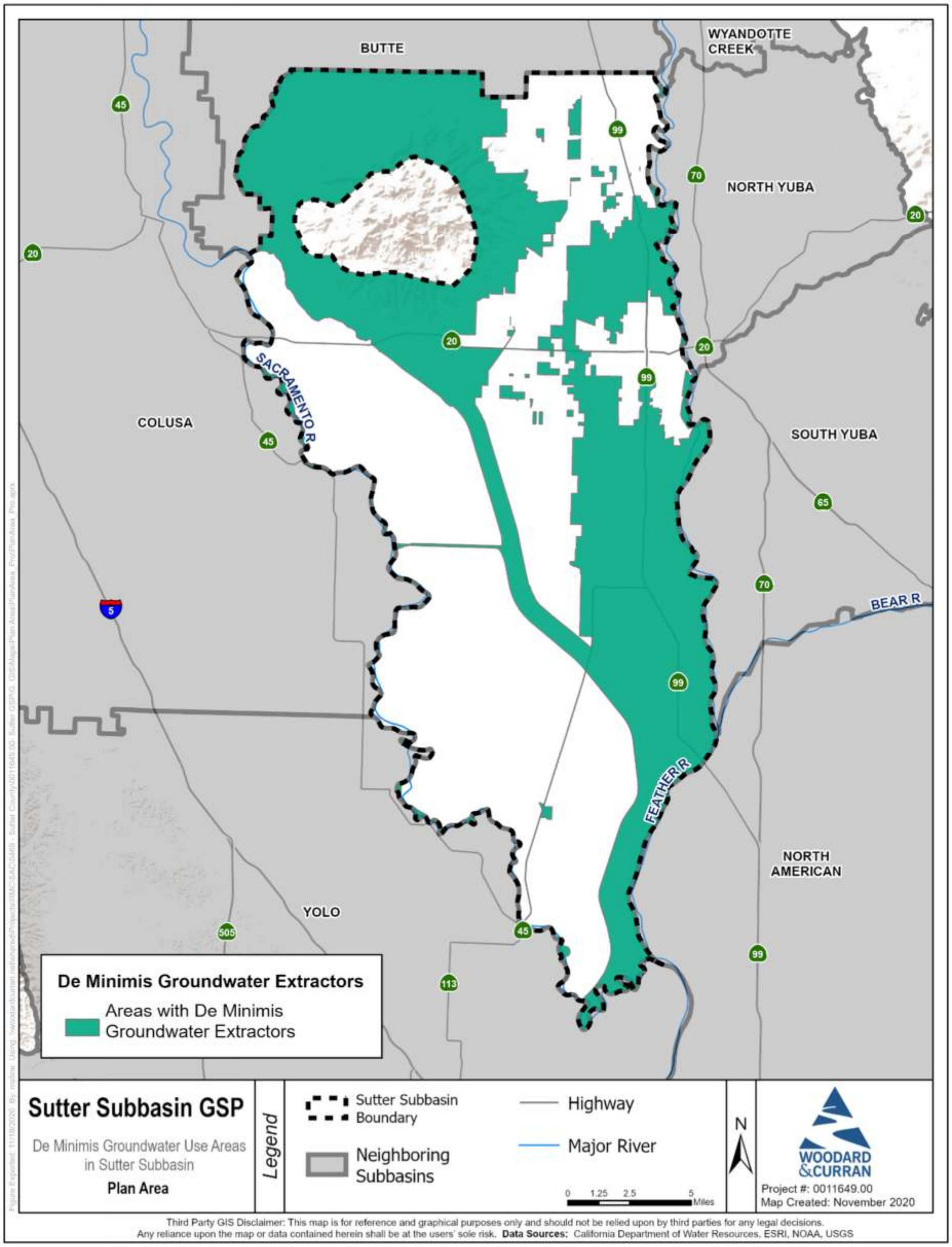


Figure 2-8. De Minimis Groundwater Production Areas in the Sutter Subbasin

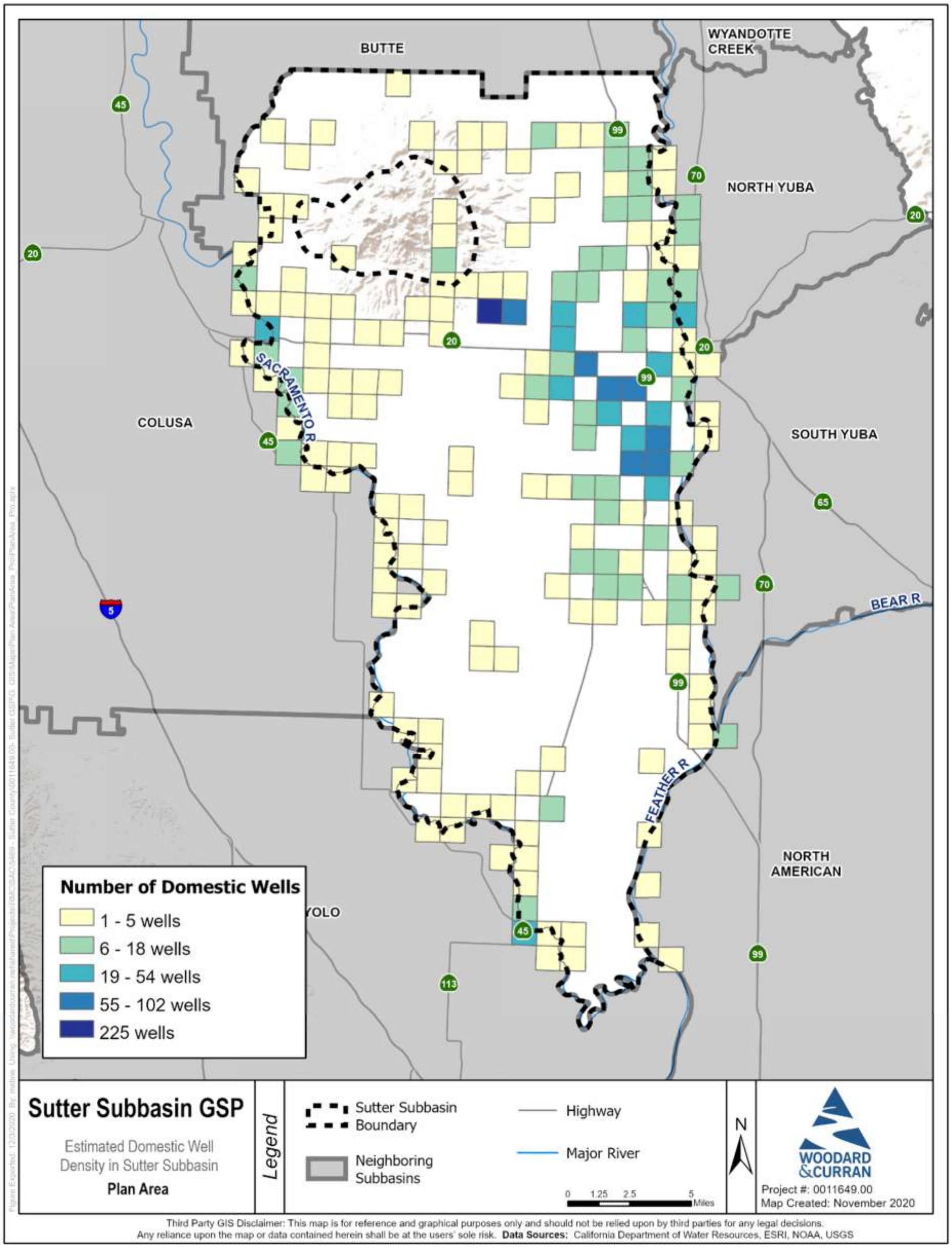


Figure 2-9. Density of Domestic Wells Per Square Mile

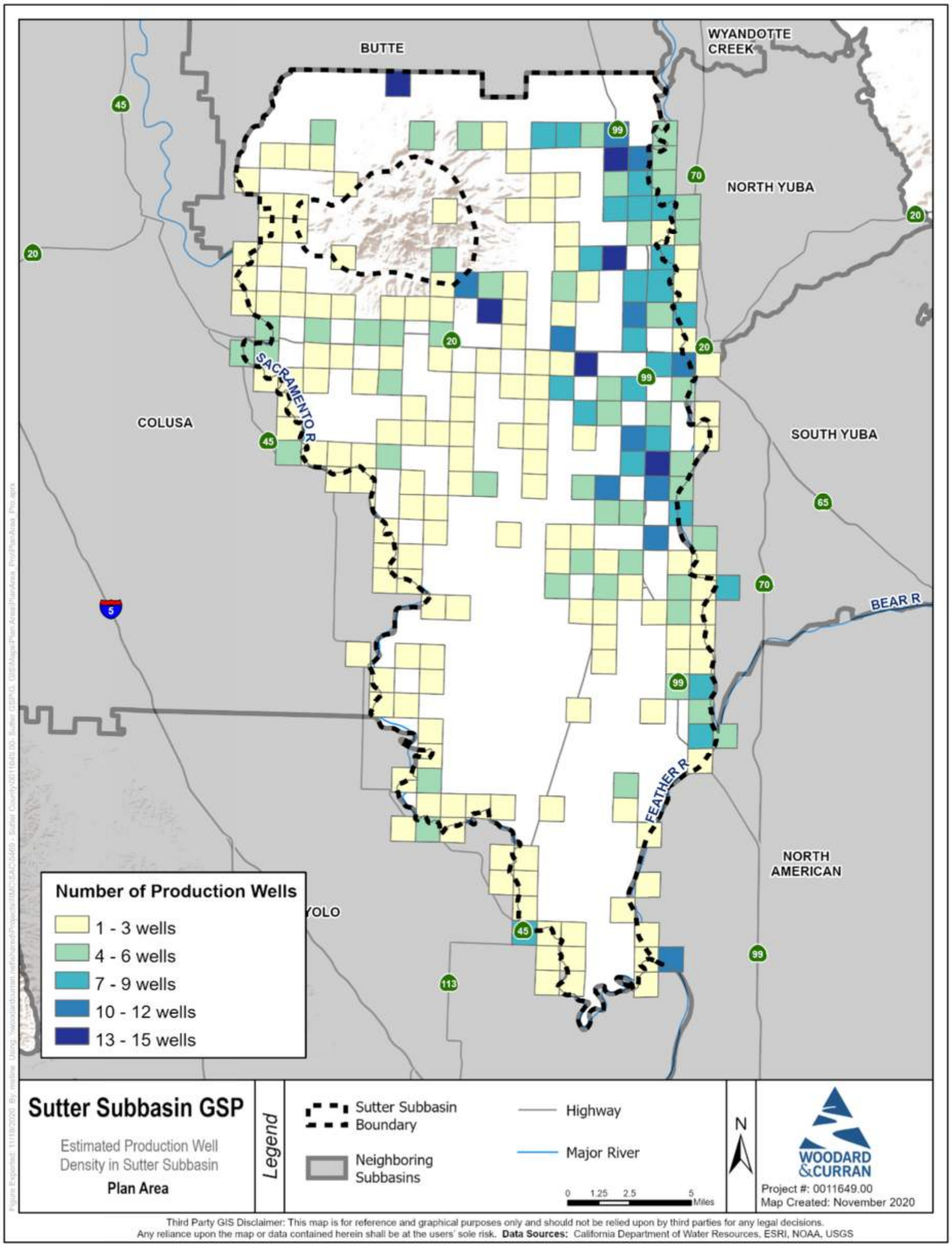


Figure 2-10. Density of Production Wells Per Square Mile

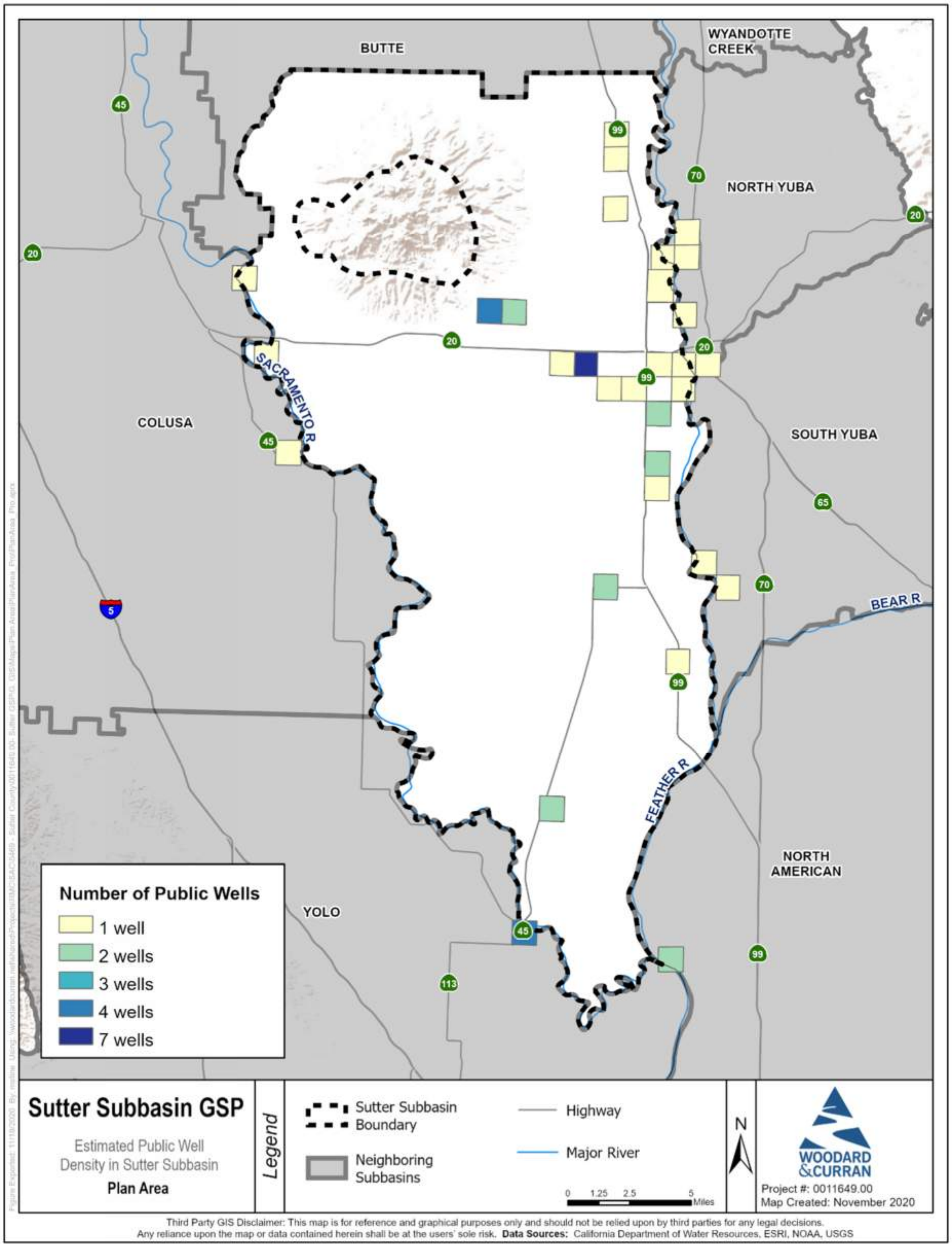


Figure 2-11. Density of Public Wells Per Square Mile

2.1.3.2 Surface Water

The following subsections describe watershed and surface water features, flood management, and surface water use within the Sutter Subbasin.

2.1.3.2.1 Watershed and Surface Water Features

The Sutter Subbasin is located within the Sacramento River watershed, which is bounded on the west by the Sacramento River and east by the Feather River (Wood Rodgers, 2012). The Sacramento River watershed includes tributaries originating in the Sierra Nevada, the Coast Range, and the Cascade Mountains. The main tributaries to the Sacramento River that impact surface water supplies within the Sutter Subbasin include Feather River and Bear River.

The Sacramento River is the major surface water feature within the Sutter Subbasin, defining the western boundary of the Sutter Subbasin with the Butte, Colusa, and Yolo Subbasins. Running north-south along the western part of the Subbasin, the Sacramento River is the main drainage for the Sacramento Valley watershed on its way to the Sacramento-San Joaquin Delta and San Francisco Bay. The Sacramento River supports many beneficial uses including recreational, agricultural, and wildlife.

The Feather River is a major tributary of the Sacramento River and outlines a major portion of Sutter Subbasin's eastern boundary shared with the North Yuba and South Yuba Subbasins. The river trends north-south along the northern and central portions of the Subbasin to the convergence with the Bear River, where it changes course and flows southwest through the south-central portion of the County until it intersects the Sutter Bypass and the Sacramento River. Like the Sacramento River, the Feather River provides beneficial uses including recreation, agricultural, and wildlife.

The Bear River is a tributary to the Feather River and enters Sutter County from Placer County near the City of Wheatland in Yuba County. It roughly forms the boundary between Sutter and Yuba Counties up to the convergence with the Feather River. The Bear River generally flows west until it converges with the Feather River, approximately one mile upstream from the rural community of Nicolaus. Although smaller than the Sacramento and Feather Rivers, the Bear River also provides beneficial uses that include recreation, agricultural, and wildlife. Discharges within the river are partially controlled by several upstream reservoirs. The Camp Far West Reservoir (located in the counties of Yuba, Placer, and Nevada) is the last downstream reservoir on the river and subsequently regulates surface water discharges to downstream users.

2.1.3.2.2 Flood Management

The Sutter Bypass is another major surface water feature in the Sutter Subbasin. An artificial flood corridor constructed in the 1930s, the Sutter Bypass is described by the Army Corp of Engineers as "… a leveed portion of the natural floodway in the Sutter Basin. The bypass is south of the Sutter Buttes from Colusa to Verona between the

Sacramento and Feather Rivers. Flows enter the Sutter Bypass from the Butte Basin at its upper end near Colusa at the Butte Slough. Other flows enter from Wadsworth Canal, interior drainage from pumping plants, and the Sacramento River by way of the Tisdale Weir and Bypass. Flows exit the Sutter Bypass and combine with the Sacramento River, Feather River, Natomas Cross Canal, and Yolo Bypass upstream from the Fremont Weir near the town of Verona" (Wood Rodgers, 2012). During periods of heavy precipitation and runoff, a portion of the flow within the Sacramento River is diverted through the Sutter Bypass to alleviate the flood control system along the Sacramento River.

Flows in all of the major rivers in Northern California are managed by dams, such as Lake Oroville and Lake Shasta. The reservoirs are managed to provide flood protection while collecting runoff from the watershed. Releases from the reservoirs occur from spring through summer to provide irrigation water for agriculture as well as provide drinking water and base flows downstream. Aside from the major rivers and tributaries within Sutter County, there are no significant surface water storage reservoirs within the Sutter Subbasin.

2.1.3.2.3 Surface Water Use

Surface water is primarily used for agricultural purposes within the Sutter Subbasin and obtained through Sacramento River Settlement Contracts Central Valley Project (CVP) contracts, Feather River diverters, and surface water rights held by individual users. The Sacramento River is currently not used for municipal or domestic water supplies within the Sutter Subbasin. Yuba City obtains a large portion of its annual water supplies for municipal and domestic use from the Feather River.

The U.S. Bureau of Reclamation (USBR) currently contracts with approximately 145 water districts, water purveyors, or private users for water rights to the Sacramento River (Wood Rodgers, 2012). The total amount of water under the settlement contacts is approximately 2.2 million acre-feet and covers a total of almost 440,000 acres of land bordering the Sacramento River and its tributaries between Redding and Sacramento. The Settlement Contracts were originally executed in 1964 with a term not to exceed 40 years. Since 2004, new contracts have been executed with approximately 145 existing Sacramento River Settlement Contracts.

The Settlement Contracts include a Base Supply and Project Water. The Base Supply is the amount that reflects the agreed upon water right of the respective entity. This is generally regarded as pre-1914 water rights and also water rights perfected after 1914 and reflect water that would be available to the respective entities under "natural" conditions. Project Water represents the amount of water USBR agrees to provide from its CVP yield. Under the provisions of the Settlement Contracts, both the Base Supply and Project Supply could be reduced by 25 percent of the total contract amount, but only in certain water year types.

In accordance with the CVP Improvement Act (CVPIA), USBR negotiated long-term water services contracts in 2007. According to Section 3404c of the CVPIA, Renewal of Existing Long-Term Contracts requires the USBR to renew any existing long-term repayment or water service contract for the delivery of water from the CVP for a period of 25 years and may renew such contracts for successive periods of up to 25 years each.

The long-term renewal contracts, unlike the Settlement Contracts, have no specified reductions in delivery; during critically dry or water-short years, the water supply available from the Project will be allocated among the contractors. The long-term renewal contracts also contain a tiered pricing provision. The Base Supply is 80 percent of the total contract amount, and Tier 1 and Tier 2 supplies represent 10 percent each of the remaining contract amount. Each tier has an incrementally higher water cost. The Tier 1 and Tier 2 water, which is available in most years, is typically not used due to the incremental higher cost of water.

Feather River diverters in the Sutter Subbasin hold diversion agreements with DWR to transport water from the Feather River using State Water Project facilities for both diversion and storage. Butte Water District and Sutter Extension Water District entered into agreement with DWR in May 1969 along with the Biggs-West Gridley Water District and Richvale Irrigation District. Feather Water District and Garden Highway Mutual Water Company hold separate contracts with DWR for diversion of Feather River water. These diversion agreements do not alter or modify existing water rights held on the Feather River by these districts/agencies.

2.2 Land Use Elements

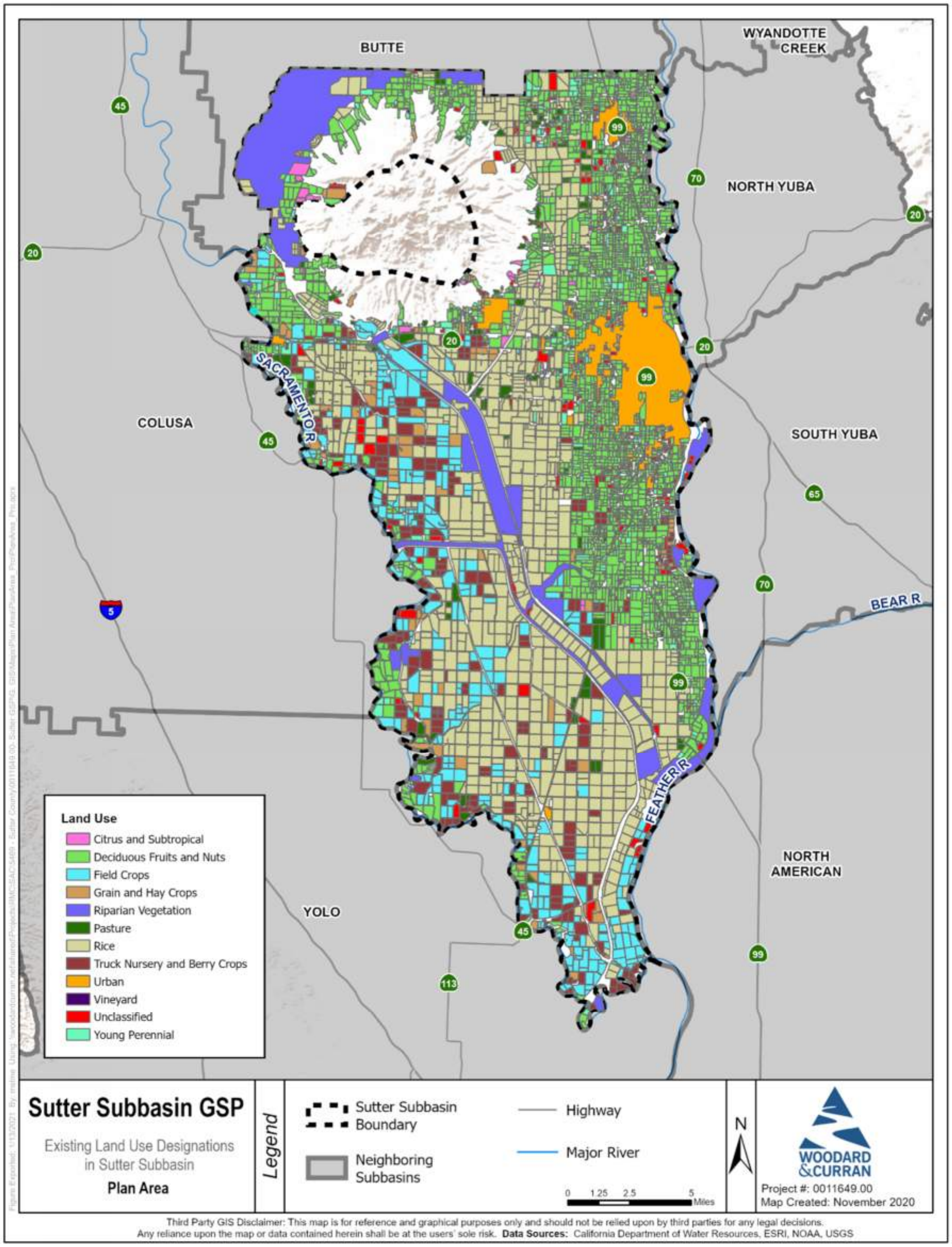
Land use within the Sutter Subbasin is managed by the cities of Live Oak and Yuba City, as well as Sutter County, and is predominantly agricultural. Rice is the predominant permanent crop grown in the Subbasin along with walnuts, stone fruits, tomatoes, and sunflowers. **Figure 2-12** shows the distribution of different land use types across the subbasin, while **Table 2-2** summarizes the respective acreage of land use in the Sutter Subbasin by land use type.

Surface water from the Feather and Sacramento Rivers and groundwater are the water sources used for irrigation, managed wetland, municipal and industrial, and urban/domestic purposes (**Figure 2-13**). Areas served by water agencies primarily utilize surface water as the primary supply source, with the exception of the City of Live Oak and Sutter Community Services District (**Figure 2-14**). Although surface water is available in areas served by water agencies, supply may also be augmented by groundwater, particularly during prolonged dry or drought periods. Most of the area served by Sutter County GSA (known as the County "white areas") relies on groundwater, where there are large areas of ranchland surrounding the Sutter Buttes that is not irrigated.

Table 2-2. Crop Category Acreage in the Sutter Subbasin

Statewide Crop Mapping Category	Acres
Citrus and Subtropical	1,020
Deciduous Fruits and Nuts	57,358
Field Crops	22,263
Grain and Hay Crops	5,771
Riparian Vegetation	21,291
Pasture	4,311
Rice	77,400
Truck Nursery and Berry Crops	14,249
Urban	11,775
Vineyard	59
Unclassified	4,610
Young Perennial	4,310
Total Acreage	**224,417**

Source: California Natural Resources Agency (January 2020)
Note: Crop categories and acreage are consistent with the source data.



Source: California Natural Resources Agency (January 2020)
Note: Crop categories and acreage are consistent with the source data.

Figure 2-12. Existing Land Use Designations in the Sutter Subbasin

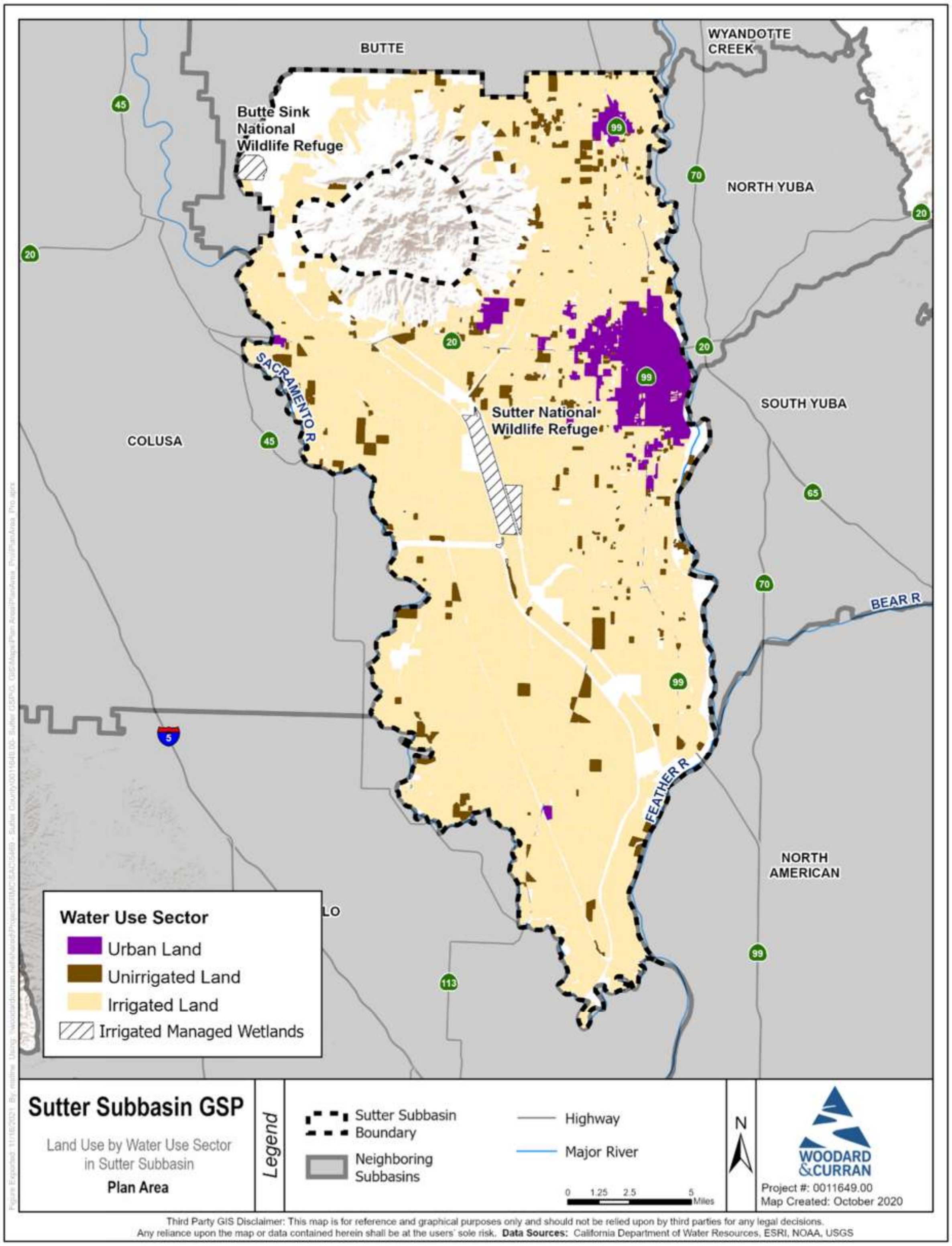


Figure 2-13. Land Use by Water Use Sector in the Sutter Subbasin

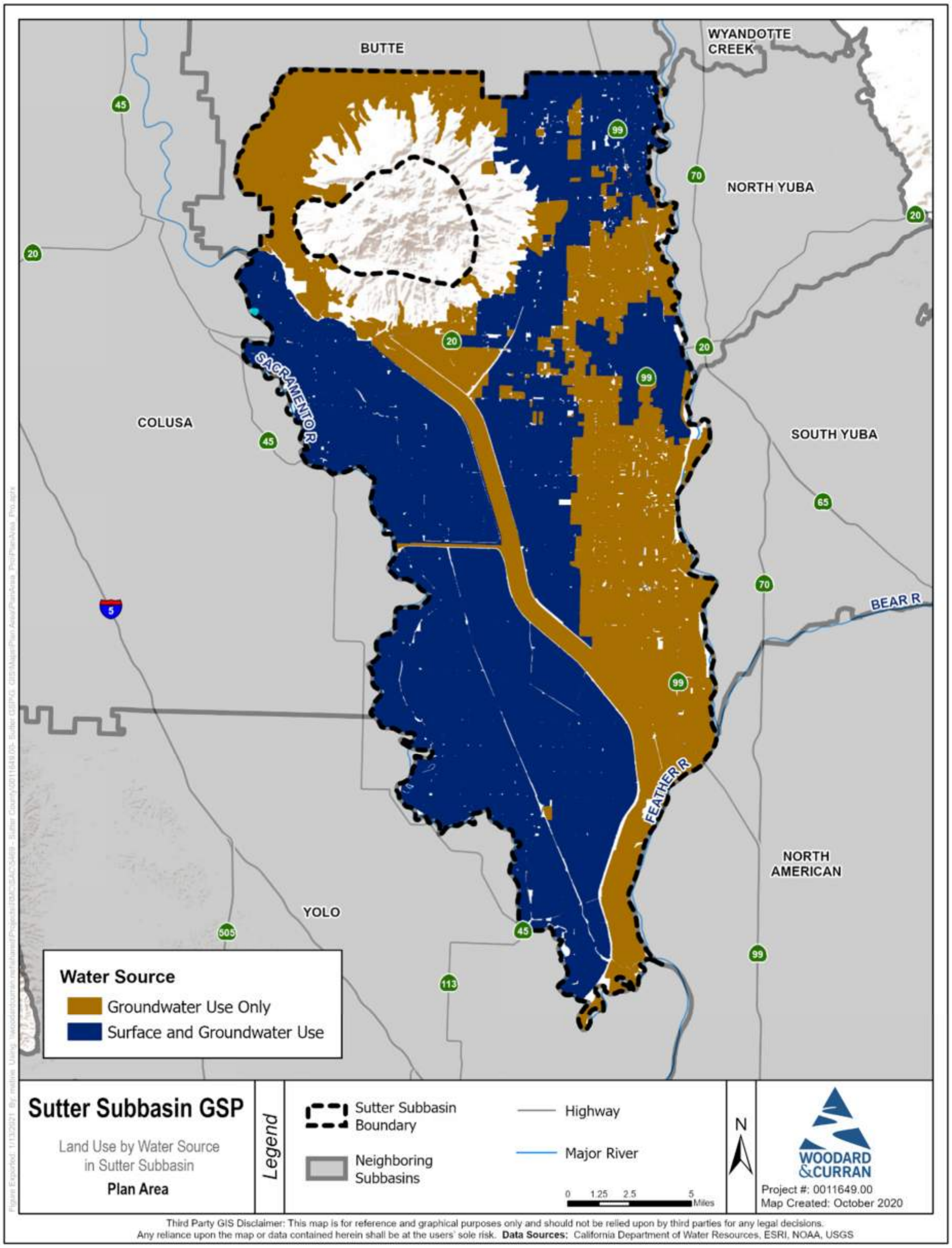


Figure 2-14. Land Use by Water Source in the Sutter Subbasin

2.2.1 General Plans in the Plan Area

Sutter County and the cities of Live Oak and Yuba City have developed General Plans to plan and guide land use within their respective spheres of influence. The following sections provide a general description of these General Plans and how implementation of existing land use plans may change water demands within the Subbasin, how implementation of this GSP may affect water supply assumptions of relevant land use plans, and how implementation of land use plans outside of the Subbasin could impact sustainable groundwater management within the Sutter Subbasin.

Figure 2-15 shows the location of relevant General Plans. The following section describes the General Plan policies and objectives relevant to water resources management in the Sutter Subbasin. This section satisfies §354.5(f) of the GSP Emergency Regulations under SGMA.

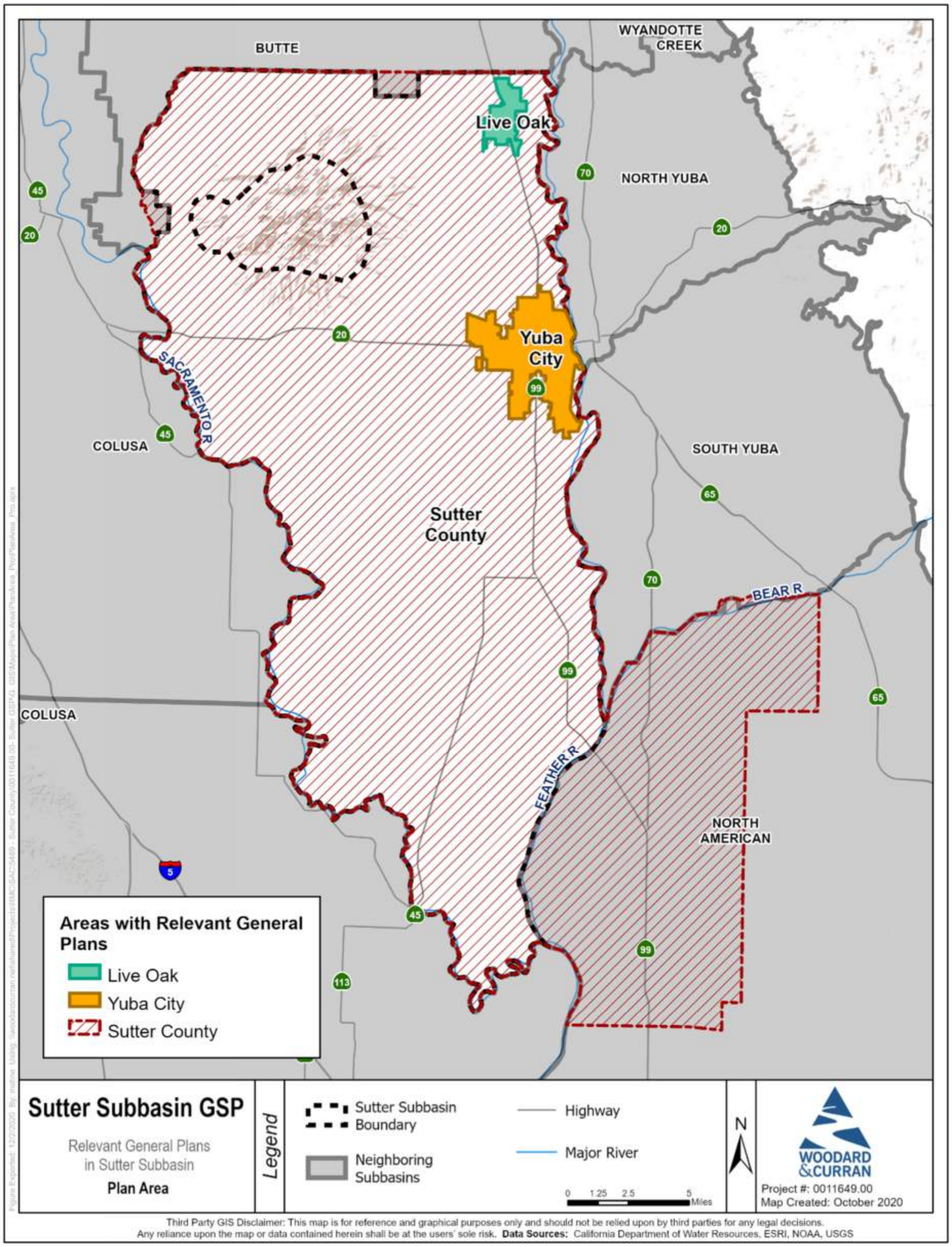


Figure 2-15. Relevant General Plans

2.2.1.1 Sutter County 2030 General Plan

The Sutter County 2030 General Plan (Sutter County, 2011) presents a vision for the County through 2030 and beyond. The General Plan is a result of the collective efforts of elected and appointed officials, citizens, business owners, and County staff who all contributed to defining a desired framework for growth and conservation in unincorporated Sutter County. It is the intent of the General Plan to ensure a future for Sutter County that is distinguished by its livable nature – a place that is sustained in the long term by striking a suitable balance between strong agricultural traditions, natural resource preservation, and economic growth opportunities.

The following policies from each relevant General Plan Element, as well as implementation programs, may potentially influence implementation of the GSP or be influenced by GSP implementation.

2.2.1.1.1 Land Use Element

- **Goal LU 9.** Designate adequate and compatible sites for governmental/public uses and take a lead role when feasible on regional issues of importance to Sutter County, its residents, and businesses.
    - **Policy LU 9.5.** Regional Planning Efforts. Support and participate as appropriate in countywide, regional, and other multi-agency planning efforts related to land use, housing, revenue, economic development, tourism, agriculture, natural resources, air quality, habitat conservation, transportation, transit, infrastructure, water supply, flood control, solid waste disposal, emergency preparedness, and other issues relevant to the County.

2.2.1.1.2 Agricultural Resources Element

- **Goal AG-3.** Protect the natural resources needed to ensure that agriculture remains an essential and sustainable part of Sutter County's future.
    - **Policy AG 3.1.** Efficient Water Management. Support the efficient management and use of agricultural water resources where economically feasible to support agriculture.
    - **Policy AG 3.2.** Water Conservation and Recycling. Support the efforts of the multiple water agencies operating in Sutter County to adopt water conservation practices and explore the feasibility of water recycling for agriculture.
    - **Policy AG 3.3.** Water Quality and Quantity. Support efforts to maintain water resource quality and quantity for the irrigation of productive farmland.
    - **Policy AG 3.4.** Water Competition from Urban Uses. Oppose the loss of agricultural water due to competition from urban water consumption both within and outside the County.

- **Policy AG 3.5.** Water Use Reduction. Encourage reduction measures in the Climate Action Plan targeted to manage agricultural water use. Such measures may include encouraging agricultural water users to conserve water and providing information on technologies that reduce agricultural water use.
- **Policy AG 3.6.** Groundwater Resources. Support the efforts of the local water agencies to promote groundwater recharge, conjunctive use, conservation of significant recharge areas, and other activities to protect and manage Sutter County's groundwater resources.
- **Policy AG 3.7.** Alternative Energy. Support the use of energy-saving technologies and alternative energy sources (solar, wind, biofuels) in all agricultural industries and operations such as the pumping of irrigation water, food processing, and water treatment. Support the use of alternative energy-powered farm vehicles and trucks.
- **Policy AG 3.8.** Habitat Protection. Promote wildlife friendly agricultural practices. Encourage habitat protection and management that is compatible with and does not preclude or restrict on-site agricultural production.
- **Policy AG 3.9.** Chemical Use. Support the efforts of growers to follow state and federal regulations concerning the use of pesticides, herbicides, and manufactured fertilizers.
- **Policy AG 3.10.** Soil Management. Implement, as appropriate, reduction measures in the Climate Action Plan targeted to promote soil management practices that reduce nitrogen dioxide emissions.

- **Goal AG-4.** Provide for growth, expansion, and diversification of Sutter County's agricultural industries.
  - **Policy AG 4.3.** New Technologies. Support the development and use of new technologies that facilitate resource efficient operation of agriculturally related industries, including food processing. These technologies may include energy development technologies, such as wind, solar and waste sources; energy and water conservation technologies; cultivation practices; global positioning system (GPS) applications; and others that improve the profitability of agriculture in Sutter County.

2.2.1.1.3 Economic Development Element

- **Goal ED 2.** Maintain a business-friendly environment for both existing and new companies.
  - **Policy ED 2.1.** Infrastructure for New Business. Ensure the provision of adequate infrastructure for business development, including flood control, road

and rail networks, telecommunications backbone, sewer, drainage facilities, and water supply.

2.2.1.1.4 Infrastructure Element

- **Goal I 1.** Ensure the availability of an adequate, reliable, and safe potable water supply for current and future County residents, businesses, and other water users.
    - **Policy I 1.1.** Availability. Require new development to study, coordinate, and plan the provision of potable water services to support the new development and demonstrate the availability of a long-term, safe, and reliable potable water supply.
    - **Policy I 1.2.** Infrastructure Planning. Require the establishment of potable water master plans for areas served, or to be served, by County-owned or County-operated water systems or private water companies. Ensure that the required infrastructure is successfully planned and designed.
    - **Policy I 1.3.** Capital Funding. Require new development to construct or fully fund its needed potable water infrastructure.
    - **Policy I 1.4.** Efficient Infrastructure. Require potable water infrastructure that is to be owned or operated by the County to be designed and constructed to minimize the long-term life cycle costs of the infrastructure. Require the plans and design of potable water infrastructure to be owned or operated by another public agency or private utility be approved by the servicing agency/utility.
    - **Policy I 1.5.** Dedications. Require fee title dedication of land (or easements if determined appropriate by the Public Works Director) to the County to ensure adequate space for, access to, operation of, maintenance of, and repair of the potable water infrastructure.
    - **Policy I 1.6.** Operations and Maintenance Funding Plans. Require new development to establish funding plans to cover the long-term operation, maintenance, and repair of the development’s potable water infrastructure.
    - **Policy I 1.7.** Provision of Services. Minimize County operated potable water systems serving urbanized areas. Transfer County operated potable water systems in urban areas to incorporated cities, public community service districts, or private utility companies where and when feasible and beneficial to the customers.
    - **Policy I 1.8.** Require new development to provide water systems supporting the development based on the following guidelines for water supply:
        - Urban development, and suburban development on parcels less than 1 acre in size, shall utilize community water systems. Demonstrate adequate and safe long-term water supply can be provided without negatively impacting

adjacent land uses or water supplies prior to development of new or expanded community water systems.

- Rural development, and suburban development on parcels 1 acre or larger in size, shall utilize community water systems where feasible and cost effective as determined by the County. If utilizing a community water system is not feasible, individual wells may be used where the water demand/intensity of new development is appropriately limited and where adequate and safe long-term water supply can be provided without negatively impacting adjacent land uses or water supplies.
- Agricultural areas may utilize individual water wells.

- **Policy I 1.9.** Connection to Community Water System. Connect existing developed areas to community water systems where practical.
- **Policy I 1.10.** Individual Water Wells. New individual wells shall meet County well construction and water quality standards.
- **Policy I 1.11.** Improve Water Availability. Support the creation of new water projects in appropriate locations that improve water availability for urban, rural, and agricultural water uses in Sutter County, including recycled water projects.
- **Policy I 1.12.** Water Conservation. Support water conservation programs that increase water use efficiency and provide incentives for adoption of water-efficiency measures.
- **Policy I 1.13.** Water-Efficient Landscaping. Require the use of water-efficient landscaping in new development.

- **Goal I 2.** Ensure efficient and safe collection, treatment, and disposal of wastewater, biosolids, and septage.
  - **Policy I 2.1.** Availability. Require new development to study, coordinate, and plan the provision of wastewater services to support the new development and demonstrate the availability of long-term, safe, and reliable wastewater collection, treatment, and disposal.
  - **Policy I 2.2.** Establish wastewater collection and treatment master plans for areas served, or to be served, by County-owned or County-operated wastewater systems. Ensure that the required infrastructure is successfully planned and designed.
  - **Policy I 2.3.** Capital Funding. Require new development to construct or fully fund its needed wastewater infrastructure.
  - **Policy I 2.4.** Efficient Infrastructure. Require wastewater infrastructure that is to be owned or operated by the County to be designed and constructed to minimize the long-term life cycle costs of the infrastructure. Require the plans and design

of wastewater infrastructure to be owned and/or operated by another public agency or private utility be approved by the servicing agency/utility.

- **Policy I 2.5.** Dedications. Require fee title dedication of land (or easements if determined appropriate by the Public Works Director) to the County to ensure adequate space for, access to, operation of, maintenance of, and repair of the wastewater infrastructure.
- **Policy I 2.6.** Operations and Maintenance Funding Plans. Require new development to establish funding plans to cover the long-term operation, maintenance, and repair of the development's wastewater infrastructure.
- **Policy I 2.7.** Provision of Services. Minimize County operated wastewater systems serving urbanized areas. Transfer County operated wastewater systems in urban areas to incorporated cities or public community service districts where and when feasible and beneficial to the customers.
- **Policy I 2.8.** New Development. Require new development to provide wastewater systems supporting the development based on the following guidelines for wastewater collection and disposal:
    - Urban development shall utilize publicly owned treatment works (POTW).
    - Rural development and suburban development shall utilize POTW when feasible and cost effective as determined by the County. If utilizing a POTW is not feasible, individual wastewater treatment and disposal systems may be used where soil conditions are acceptable; all County, state, and federal requirements can be met; the wastewater generation/ intensity of new development is appropriately limited; and long-term disposal can be provided without negatively impacting adjacent land uses or groundwater supplies.
    - Agricultural areas may utilize individual wastewater treatment and disposal systems where soil conditions are acceptable and all County, state, and federal requirements can be met.
- **Policy I 2.9.** Connection to Publicly Owned System. Connect existing developed areas to publicly owned treatment works where practical.
- **Policy I 2.10.** Groundwater Protection. Continue to regulate the siting, design, construction, and operation of wastewater disposal systems in accordance with County regulations to minimize contamination of groundwater supplies.

- **Goal I 3.** Ensure stormwater runoff is collected and conveyed safely and efficiently.
    - **Policy I 3.1.** Availability. Require new development to study, coordinate, and plan the provision of stormwater services to support the new development and demonstrate the availability of long-term, safe, and reliable stormwater collection, and reliable stormwater collection, and conveyance.

- **Policy I 3.2.** Infrastructure Planning. Establish stormwater collection master plans for areas served, or to be served, by County-owned or County-operated stormwater systems. Ensure that the required infrastructure is successfully planned and designed.
- **Policy I 3.3.** Capital Funding. Require new development to construct or fully fund its needed stormwater infrastructure.
- **Policy I 3.4.** Efficient Infrastructure. Require stormwater infrastructure that is to be owned or operated by the County to be designed and constructed to minimize the long-term life cycle costs of the infrastructure. Require the plans and design of stormwater infrastructure to be owned and/or operated by another public agency or private utility be approved by the servicing agency/utility.
- **Policy I 3.5.** Dedications. Require fee title dedication of land (or easements if determined appropriate by the Public Works Director) to the County to ensure adequate space for, access to, operation of, maintenance of, and repair of the stormwater infrastructure.
- **Policy I 3.6.** Operations and Maintenance Funding Plans. Require new development to establish funding plans to cover the long-term operation, maintenance, and repair of the development's stormwater infrastructure.
- **Policy I 3.7.** Provision of Services. Minimize County operated stormwater systems serving urbanized areas. Transfer County operated stormwater systems in urban areas to incorporated cities, water agencies, County drainage districts, or public community service districts where and when feasible and beneficial to the customers.
- **Policy I 3.8.** New Development. Require new development to provide stormwater systems supporting the development based on the following guidelines for stormwater collection and conveyance:
    - Urban development shall utilize underground storm drain systems sized to collect and convey peak flows from the 10-year storm; and may utilize overland flow systems and open channels sized to convey peak flows from the 100-year storm. Detention facilities shall be consolidated at publicly owned points in the system.
    - Rural development and suburban development shall utilize underground storm drain systems where feasible and cost effective as determined by the County, sized to collect and convey peak flows from the 10-year storm; and may utilize overland flow systems and open channels sized to convey peak flows from the 100-year storm. If utilizing an underground system is not feasible, detention facilities and open channels for stormwater collection and conveyance may be utilized, provided these systems prevent property damage from a 100-yearstorm event.

- Agricultural areas may utilize detention facilities and open channels for stormwater collection and conveyance, provided these systems prevent property damage from a 100-year storm event.

- **Policy I 3.9.** Connection to Publicly Owned System. Connect existing developed areas to publicly owned stormwater drains or open channel systems where practical.
- **Policy I 3.10.** Mitigation of Stormwater Flows. Require new development to adequately mitigate increases in stormwater flow rates and volume.
- **Policy I 3.11.** Stormwater Quality. Ensure that new development protects water quality in runoff, streams, and rivers.
- **Policy I 3.12.** Joint Use of Open Channels and Detention Basins. Parks or sports fields may be located within stormwater detention basins where practical. Bicycle paths and walkways may be located within stormwater conveyance channels, or on service roads for channels, where practical. Open channels and stormwater detention basins shall normally not be used for habitat purposes.

- **Implementation Program I 1-A**
  - Review new development applications in unincorporated areas to ensure that adequate water service will be available through the County, or other service providers, to serve the new development. Require evidence of service availability.
- **Implementation Program I 1-B**
  - Condition new development to perform a water supply assessment in accordance with the requirements of state law.
- **Implementation Program I 1-C**
  - Develop potable water service guidelines and possible agreements with the cities of Live Oak and Yuba City for the provision of potable water within the cities' spheres of influence.
- **Implementation Program I 1-D**
  - Apply, and update as necessary, County improvement standards for potable water infrastructure planning, design, and construction.
- **Implementation Program I 1-E**
  - Develop a Countywide potable water master plan consistent with this General Plan. The design and construction of potable water systems are to be consistent with the approved master plan.

- **Implementation Program I 1-F**
  - Condition new development to construct infrastructure and dedicate land to support development as identified in the Countywide potable water master plan or other development studies. Condition new development to construct necessary potable water infrastructure prior to the issuance of building permits for residential development or certificate of occupancy for non-residential development; or if appropriate, ensure the potable water infrastructure is adequately financed through development impact fees, by agreement, or other mechanisms.
- **Implementation Program I 1-G**
  - Where the development's contribution to the potable water infrastructure exceeds its fair share, require the development to fully fund, or finance, the infrastructure and be reimbursed as the County receives impact fees/funding from other future development benefitting from the improvements.
- **Implementation Program I 1-H**
  - Condition new development to develop and implement a financing mechanism to fund the long-term operations and maintenance needs of potable water infrastructure. Funding plans shall ensure the collection of sufficient funds to cover current and anticipated future expenditures, capital replacements, and cost increases.
- **Implementation Program I 1-I**
  - Review new development to ensure that proposed water systems are adequate and appropriate for the type of development and are consistent with federal, state, and local codes and standards, and master plans.
- **Implementation Program I 1-J**
  - Require a groundwater study prior to development of new well systems serving urban/suburban and rural/suburban development to identify potential effects on aquifer volume and groundwater levels and the extent to which existing municipal and agricultural wells could be affected. The results of the study shall be used to develop the proper siting, design, and operation of new or expanded well systems, including a process for ongoing monitoring and contingency planning.
- **Implementation Program I 1-K**
  - Require existing development currently utilizing private wells for potable water supply to connect to a community water system when the community system is within 200 feet of the development, the community system agrees to allow the connection, and the private well no longer complies with applicable regulations or requires significant repairs.

- **Implementation Program I 1-L**
  - Support the California State Regional Water Quality Control Board's efforts to monitor known groundwater contamination areas and ensure that existing water sources are protected and contamination is as limited as is feasible.
- **Implementation Program I 1-M**
  - Apply the County's water well standards and applicable development standards to ensure safe and sanitary water supplies for development utilizing wells for potable water. Update the County's water well standards as needed.
- **Implementation Program 2-A**
  - Review new development applications in unincorporated areas to ensure that adequate wastewater service will be available through the County, or other service providers, to serve the new development. Require evidence of service availability.
- **Implementation Program 2-B**
  - Develop wastewater service guidelines and possible agreements with the cities of Live Oak and Yuba City for the provision of wastewater service within the cities' spheres of influence.
- **Implementation Program 2-C**
  - Apply, and update as necessary, County improvement standards for wastewater infrastructure planning, design, and construction.
- **Implementation Program 2-D**
  - Develop a Countywide wastewater master plan consistent with this General Plan; require design of wastewater systems to be consistent with the approved master plan; and ensure wastewater systems are constructed consistent with the approved designs.
- **Implementation Program 2-E**
  - Condition new development to construct infrastructure and dedicate land to support development as identified in the Countywide wastewater master plan or other development studies. Condition new development to construct necessary wastewater infrastructure prior to the issuance of building permits for residential development or certificate of occupancy for non-residential development; or if appropriate, ensure the wastewater infrastructure is adequately financed through development impact fees or by agreement.

- **Implementation Program 2-F**
  - Where the development's contribution to the wastewater infrastructure exceeds its fair share, require the development to fully fund the infrastructure and be reimbursed as the County receives impact fees/funding from other future development benefitting from the improvements.
- **Implementation Program 2-G**
  - Condition new development to establish and implement a financing mechanism to fund the long-term operations and maintenance needs of the wastewater infrastructure. Funding plans shall ensure the collection of sufficient funds to cover current and anticipated future expenditures, capital replacements, and cost increases. Funding should normally be collected through service fees and assessments.
- **Implementation Program 2-H**
  - Review new development to ensure that proposed wastewater systems are adequate and appropriate for the type of development and are consistent with federal, state, and local codes and standards, and master plans.
- **Implementation Program 2-I**
  - Apply, and update as necessary, County code and development standards regarding on-site wastewater disposal. Permit on-site wastewater treatment and disposal on existing lots only when appropriate for the type of development, where a publicly owned collection system is not reasonably available, and where such disposal will not constitute a hazard to health or water supplies.
- **Implementation Program 2-J**
  - Condition new development, where authorized to utilize individual wastewater treatment and disposal systems as an interim measure, to connect to a publicly owned wastewater collection system and treatment works when the publicly owned collection system is within 200 feet of the development, and the system owner agrees to allow the connection.
- **Implementation Program 2-K**
  - Require existing development using individual wastewater treatment and disposal systems to connect to a publicly owned wastewater collection system and treatment works when the publicly owned collection system is within 200 feet of the development, the system owner agrees to allow the connection, and the individual system no longer complies with applicable regulations or requires significant repairs.

- **Implementation Program 2-L**
  - Restrict new development use of septic systems in areas that are prone to flooding or that have a seasonal high-water table and/or water seepage problems.
- **Implementation Program I 1-N**
  - Develop water conservation standards for new development to increase water use efficiency.
- **Implementation Program I 3-A**
  - Review new development applications in unincorporated areas to ensure that adequate stormwater service will be available through the County, or other service providers (including the State for any State-owned pump stations), to serve the new development. Require evidence of service availability. If the use of State-owned pump stations is proposed, sufficient capacity shall be demonstrated through completion of a drainage study that is incorporated into any countywide or master drainage study.
- **Implementation Program I 3-B**
  - Develop stormwater service guidelines and possible agreements with the cities of Live Oak and Yuba City for the provision of stormwater service within the cities' spheres of influence.
- **Implementation Program I 3-C**
  - Develop a Countywide stormwater master plan consistent with this General Plan; require design of stormwater systems to be consistent with the approved master plan; and ensure stormwater systems are constructed consistent with the approved designs.
- **Implementation Program I 3-D**
  - Apply, and update as necessary, County improvement standards regarding stormwater drainage, infrastructure, planning, and design and construction disposal.
- **Implementation Program I 3-E**
  - Condition new development to construct infrastructure and dedicate land to support development as identified in the Countywide stormwater master plan or other development studies. Condition new development to construct necessary stormwater infrastructure prior to the issuance of building permits for residential development or certificate of occupancy for non-residential development; or if appropriate, ensure the stormwater infrastructure is adequately financed through development impact fees or by agreement.

- **Implementation Program I 3-F**
  - Where the development's contribution to the stormwater infrastructure exceeds its fair share, require the development to fully fund the infrastructure and be reimbursed as the County receives impact fees/funding from other future development benefitting from the improvements.
- **Implementation Program I 3-G**
  - Condition new development to develop and implement a financing mechanism to fund the long-term operations and maintenance needs of the stormwater infrastructure. Funding plans shall ensure the collection of sufficient funds to cover current and anticipated future expenditures, capital replacements, and cost increases. Funding should normally be collected through service fees and assessments.
- **Implementation Program I 3-H**
  - Review new development to ensure that proposed stormwater systems are adequate and appropriate for the type of development and are consistent with federal, state, and local codes and standards, and master plans.
- **Implementation Program I 3-I**
  - Require existing development using individual detention or retention facilities to connect to a publicly owned stormwater collection system when the publicly owned collection system is within 200 feet of the development and the system owner agrees to allow the connection.
- **Implementation Program I 3-J**
  - Condition new development to adequately study and plan local drainage for the development. Require that new development conform to the relevant County, State, and Federal requirements and standards governing stormwater drainage and water quality.
- **Implementation Program I 3-K**
  - Consider opportunities for joint recreational use of new public detention basins and open channels.

2.2.1.1.5 Environmental Resources Element

- **Goal ER 2.** Conservation. Incorporate energy efficiency and water conservation, including the potential use of recycled water, in park design, development, and operations.
  - **Policy ER 2.1.** No Net Loss. Require new development to ensure no net loss of state and federally regulated wetlands, other waters of the United States

(including creeks, rivers, ponds, marshes, vernal pools, and other seasonal wetlands), and associated functions and values through a combination of avoidance, restoration, and compensation.

- **Goal ER 6.** Preserve and protect the County's surface water and groundwater resources.
    - **Policy ER 6.1.** Integrated Water Management Programs. Integrate water management programs that emphasize multiple benefits and balance the needs of agricultural, rural, and urban users.
    - **Policy ER 6.2.** Surface Water Resources. Protect the surface water resources in the County including the Sacramento, Feather, and Bear Rivers and their significant tributaries.
    - **Policy ER 6.3.** Groundwater Sustainability. Protect the sustainability of groundwater resources.
    - **Policy ER 6.4.** Groundwater Recharge Areas. Require new development to preserve areas that provide important groundwater recharge, stormwater management, and water quality benefits such as undeveloped open spaces, natural habitat, riparian corridors, wetlands, and natural drainage areas.
    - **Policy ER 6.5.** Regional Coordination on Groundwater Use. Coordinate with local and regional jurisdictions on groundwater use to minimize overdraft conditions of aquifers.
    - **Policy ER 6.6.** Groundwater Protection. Regulate stormwater collection and conveyance, as necessary, to protect groundwater supplies from contamination.
    - **Policy ER 6.7.** Water Rights. Support the protection of the existing water rights of water agencies and providers within Sutter County. Do not support out-of-area water transfers where they would adversely impact water supply within Sutter County. Support either out-of-area, or in-basin water transfers that would not negatively impact water supply within Sutter County.
    - **Policy ER 6.8.** Recycled Water. Explore the feasibility of utilizing recycled water, where appropriate, cost effective, and safe.
    - **Policy ER 6.9.** Water Use Reduction. Encourage the reduction measures in the Climate Action Plan targeted to reduce water use. Such measures may include adopting a per capita water use reduction goal; implementing a water conservation and efficiency program; providing incentives for new development to reduce potable water use; installing water meters for uses not using wells; encouraging water suppliers to adopt a water conservation pricing schedule; encouraging upgrades in water efficiency; providing training and education on water efficiency; and increasing recycled water use.

  - **Policy ER 6.10.** Stormwater Quality. Control pollutant sources from construction and operational activities, and improve stormwater runoff quality, through the use of stormwater protection measures in accordance with County, state, and federal regulations.
  - **Policy ER 6.11.** New Development. Require new development to protect the quality of water resources and natural drainage systems through site design, and use of source controls, stormwater treatment, runoff reduction measures, best management practices, and Low Impact Development.
  - **Policy ER 6.12.** Natural Watercourses. Require new development to integrate natural watercourses and provide buffers between waterways and urban development to minimize disturbance of watercourses and to protect water quality.
  - **Policy ER 6.13.** Education. Educate the public about practices and programs to minimize water pollution.
- **Implementation Policy ER 6-A**
  - Develop a Countywide Groundwater Management Plan and participate in the development and implementation of an Integrated Regional Water Management Plan.
- **Implementation Policy ER 6-B**
  - Conduct a study to determine the feasibility of utilizing recycled water, where appropriate, cost effective, and safe.
- **Implementation Policy ER 6-C**
  - Update and revise the joint Yuba City–Sutter County Stormwater Management Plan to include the growth areas.
- **Implementation Policy ER 6-D**
  - Require new development that incorporates or is adjacent to natural watercourses to consult with the U.S. Army Corps of Engineers, California Department of Fish and Game, and/or the Regional Quality Control Board to determine the appropriate buffer width between waterways and urban development.

2.2.1.2 City of Live Oak 2030 General Plan

The City of Live Oak 2030 General Plan (City of Live Oak, n.d.) serves as a tool to identify and provide policy guidance to achieve the community's version of the future. The following policies from each relevant General Plan Element as well as implementation programs may potentially influence implementation of the GSP or be influenced by GSP implementation.

2.2.1.2.1 Land Use Element

- **Goal LU-2.** Make improvements to existing developed areas as the city grows.
  - **Policy LU-2.2.** The City will encourage infill development, which is defined as development that has access to water and wastewater infrastructure in adjacent existing streets, by:
    - analyzing infrastructure deficiencies in the existing City;
    - identifying infrastructure investment priorities needed to encourage reinvestment in the existing city;
    - coordinating infill infrastructure priorities with redevelopment planning and capital improvements planning; and,
    - exploring opportunities to provide incentives for infill development, such as lower impact fees.
- **Implementation Program LU-2.1**
  - The City will maintain water, wastewater, and drainage master plans that identify and prioritize infrastructure improvements to the City. The City will incorporate improvements to existing City infrastructure in capital improvements planning, consistent with these master plans. The City also will identify federal, state, and regional grant and loan programs for infrastructure improvements in the existing developed City.
- **Implementation Program LU-2.2**
  - The City will update development impact fees, following the adoption of the 2030 General Plan update. The fees developed as a part of this update will take into account existing infrastructure availability. Infill development will have lower fees, where it is shown to have lower costs. Infill development is defined as development that has access to water and wastewater infrastructure in adjacent existing streets.
- **Implementation Program LU-4.1**
  - The City's water, wastewater, and drainage master plans will provide for infrastructure improvements designed to induce redevelopment in the downtown core area. The City will incorporate downtown infrastructure in capital improvements planning. The City will identify federal, state, and regional grant and loan programs for design, planning, and implementation of the City's polices for downtown core area redevelopment and revitalization, including infrastructure improvements. The City will consult with Sacramento Area Council of Governments to identify priority transit projects that serve development downtown.

2.2.1.2.2 Community Character Element

- **Goal DESIGN-14.** Incorporate Live Oak's natural amenities into the community's built environment.
  - **Policy DESIGN-14.3.** The City will encourage the use of site landscaping that uses appropriate native plant materials in order to enhance the natural character of the region; to reduce water and pesticide use; and to provide habitat to native species.

2.2.1.2.3 Conservation and Open Space Element

- **Goal AGRICULTURAL-1.** Preserve agricultural resources and support the practice of farming.
  - **Policy Agriculture-1.5.** The City will work with farmers, property owners, extensions, agencies, and agricultural organizations to enhance the viability of agricultural uses and activities.
- **Implementation Program Biological-3**
  - The City will adopt development standards that require a riparian protection buffer (RPB) specifying an appropriate setback distance from existing riparian habitat or natural water bodies for development or other significant disturbance. This habitat is known to occur near the west bank of the Feather River. In areas with existing development, the RPB shall not be less than 25 feet, measured from top of the bank. In all other areas, the RPB shall not be less than 100 feet, measured from top of bank. If existing riparian vegetation is greater than 100 feet in width, the RPB shall encompass all of the riparian habitat; however, in no case shall the RPB be required to exceed 250 feet. Where feasible, the riparian buffers shall be incorporated into open space corridors, public landscapes, and parks. Trails and other recreation development should be designed and constructed to be compatible with riparian ecosystem.
- **Goal AIR-1.** Plan and design the community to encourage walking, bicycling, and use of transit.
  - **Policy Air-1.4.** The City will encourage and provide incentives for infill development, defined as development that has water and sewer infrastructure available in adjacent streets and does not require extension of such infrastructure to serve the subject project. (See also the Public Utilities, Services and Facilities Element and the Land Use Element.)
- **Goal WATER-1.** Maintain and improve groundwater and surface water quality.
  - **Policy Water-1.1.** New development shall incorporate drainage system design that emphasizes infiltration and decentralized treatment (rather than traditional

piped approaches that quickly convey stormwater to large, centralized treatment facilities), to the greatest extent feasible.

- **Policy Water-1.2.** Existing swales and sloughs should be preserved, restored, and used for stormwater drainage whenever possible.
- **Policy Water-1.3.** The City will require developments to use best management and design practices to reduce stormwater runoff levels, improve infiltration to replenish groundwater sources, and reduce pollutants close to their sources. The City will require new development to use permeable surfaces for hardscape wherever possible. Impervious surfaces such as driveways, streets, and parking lots should be interspersed with vegetated areas that allow for infiltration of stormwater. Low impact development (LID) techniques, such as rain gardens, filter strips, swales, and other natural drainage strategies, should be used to absorb stormwater, reduce polluted urban runoff, recharge groundwater, and reduce flooding.
- **Policy Water-1.4.** The City will require development projects to incorporate appropriate scaled stormwater facilities. The City will place emphasis on making these holding areas serve multiple functions, such as soccer fields or passive recreation areas.

- **Goal WATER-2.** Ensure adequate and efficient long-term water supply.
  - **Policy Water-2.1.** The City will incorporate into its entitlement review process compliance with portions of state law that require demonstration of adequate long-term water supply for large development projects (Senate Bills 610 and 221).
  - **Policy Water-2.2.** The City will condition approval of new development on the availability of sufficient water supply, storage, and fire flow (water pressure), per City standards.
  - **Policy Water-2.3.** The City will encourage the use of native, drought-tolerant landscaping throughout the City to conserve water and filter runoff.
  - **Policy Water-2.4.** Native and drought-tolerant landscaping should comprise at least 50 percent of landscapes in commercial and industrial projects and 100 percent of all medians and right-of-way landscaped areas along public streets.
  - **Policy Water-2.5.** The City will require the use of water conservation technologies, such as low-flow toilets, efficient clothes washers, and more efficient water-using industrial equipment, in all new construction and retrofitted and substantially remodeled buildings, consistent with building code requirements.
  - **Policy Water-2.6.** The City will support the retrofitting of existing buildings throughout Live Oak with water-saving fixtures.

  - **Policy Water-2.7.** The City will participate in regional groundwater basin planning and regional water-management planning efforts to ensure that future demand for water does not overdraft the groundwater supply.
  - **Policy Water-2.8.** The City will adopt water conservation pricing (e.g., tiered rate structures) to encourage efficient water use.
- **Implementation Program Water-1**
  - The City will revise the Public Works Improvement Standards, as necessary, to encourage use of natural drainage systems and low impact development principles in order to reduce stormwater infrastructure costs and improve water quality. The City will make revisions required to emphasize the slowing down and dispersing of stormwater by using existing landscaped swales and constructing new swales to convey stormwater runoff, encouraging sheet flow and the use of landscaped infiltration basins in planter strips along roadways, and employing other best management practices, as appropriate. The City will establish standards and fee programs to require and/or provide incentives for methods to slow down and filter stormwater, as outlined in this Element. These measures include, but are not limited to, reduced pavement, permeable pavement, vegetation that retains and filters stormwater, and the use of drainage sheet flow and filtration.
- **Implementation Program Water-2**
  - The City will revise landscaping requirements to include drought-tolerant, low-maintenance plants.
- **Implementation Program Water-3**
  - The City will participate, as appropriate, in the Sutter County Groundwater Management Plan to ensure perennial sustainable yield and avoidance of overdraft and long-term drawdown within and adjacent to the [former] East Butte subbasin, while accommodating land use change as described in the 2030 General Plan.

2.2.1.2.4 Public Utilities, Services, and Facilities Element

- **Goal PUBLIC-1.** Provide a safe and reliable water supply and delivery system.
  - **Policy PUBLIC-1.1.** The City will maintain a water master plan that provides for phased, efficient extension of water delivery and water quality infrastructure, including new wells, new pumping and storage capacity, and treatment systems, as necessary, to meet the needs of new development.
  - **Policy PUBLIC-1.2.** The City will maintain and improve water quality according to state and federal standards.

- **Policy PUBLIC-1.3.** New development shall provide land for wells and other water infrastructure and shall construct and dedicate water infrastructure as directed by the City.
- **Policy PUBLIC-1.4.** New development shall contribute on a fair-share basis toward new groundwater wells, water treatment improvements, conveyance facilities, and water supply projects, consistent with the City's water master plan and City standards.
- **Policy PUBLIC-1.5.** City approval of new development requires analysis and demonstration of secure and reliable water supply prior to approval. A formal water supply assessment, as defined in California Water Code Sections 10910–10912, will be required as part of City environmental review and project approval for projects that meet the minimum size requirements defined by this state law.
- **Policy PUBLIC-1.6.** New development shall contribute on a fair-share basis toward City strategies to increase water storage capacity for domestic water supply, back-up emergency supply, and fire flow.
- **Policy PUBLIC-1.7.** The City will improve water conveyance and fire flow in the existing city to encourage redevelopment, as necessary and as funding is available.
- **Policy PUBLIC-1.8.** The City will proactively leverage state, regional, and federal funding for water supply and water quality improvements to serve developed areas.
- **Policy PUBLIC-1.9.** When water delivery improvements are made in areas adjacent to developed areas, the City will identify opportunities for existing developed properties to connect into new City water systems.
- **Policy PUBLIC-1.10.** The City will establish long-term financing mechanisms and phased improvements planning to improve water infrastructure in the existing developed city to induce infill development. The goal of the City's financing and capital improvements planning will be to fund improvement of water distribution infrastructure in developed city neighborhoods, without increasing service fees for existing customers.

- **Goal PUBLIC-2.** Ensure reliability of the City's water supply through water conservation and an efficient water distribution system.
  - **Policy PUBLIC-2.1.** The City will ensure that new groundwater well sites are located where the aquifer is stable enough to avoid long-term drawdown.
  - **Policy PUBLIC-2.2.** The City will explore the use of recycled water from the City's wastewater treatment plant for landscape irrigation and other appropriate uses.

- **Policy PUBLIC-2.3.** The City will plan for, and new development shall be consistent with state law requirements for water conservation through the City's Urban Water Management Plan (California Water Code sections 10630–10656).
- **Policy PUBLIC-2.4.** New development should install water-conserving appliances and faucets, drought-tolerant landscaping, recycled water systems, and other water conservation improvements and programs, to the greatest extent feasible.
- **Policy PUBLIC-2.5.** The City will encourage water conservation measures not required by state law, such as recycled water systems.
- **Policy PUBLIC-2.6.** The City will establish use-based water rates. The City will consider adopting relatively low rates for a basic water allocation, and higher water rates beyond this basic allocation.
- **Policy PUBLIC-2.7.** The City will provide education to residents and businesses on benefits and methods of water conservation.

- **Implementation Program PUBLIC-1.1**
  - The City will adopt a water master plan that is consistent with the 2030 General Plan, to provide for phased improvements to meet future needs. The master plan will include an inventory of existing development, estimates of future demand within the existing city, and estimates of future growth within areas planned for annexation, consistent with the General Plan. The City will incorporate analysis from the water master plan into its capital and ongoing fee programs.
  - The master plan will identify improvements to serve the needs of new development and will also identify any deficiencies in the existing developed city. The master plan will provide a plan to address any such deficiencies.
  - The master plan will identify potential locations for new well sites where a stable and reliable supply should be available, and where City use would not cause long-term drawdown.
  - The City will also prepare and adopt an Urban Water Management Plan for water conservation in the City, consistent with state law requirements. The City will implement the Urban Water Management Plan through enforcement of standards for new growth. The City will identify improvements that should be made to the existing City to conserve water and will phase in these improvements, as feasible.
  - The City will explore opportunities in the water master plan, as well as the Urban Water Management Plan, to encourage water conservation measures not required by state law. The City will, if feasible, provide incentives that are substantial enough to encourage new and existing development to install and use recycled water systems and other water-conserving improvements.

Incentives could include lower up-front water hookup fees and lower ongoing water rates, depending on the extent of water conservation measures included.

- The City will update the water master plan, as necessary, to address growth needs, regulatory changes, and water quality issues.

- **Implementation Program PUBLIC-1.2**
  - The City will continue the arsenic removal program, as necessary, in order to meet all federal and state standards for all groundwater wells in the city. The City will implement a study to investigate the need for additional programs for water treatment, monitoring, and cleanup of other constituents (pollutants), as necessary. The City will implement a nitrate monitoring program that will include periodic monitoring and impose time standards for any cleanup needed.
- **Goal PUBLIC-3.** Use environmental best practices and provide cost effective wastewater collection, conveyance, and treatment systems to serve new and existing portions of the city.
  - **Policy PUBLIC-3.1.** The City will prepare a wastewater master plan that provides for phased, efficient extension of wastewater collection and improvements to wastewater treatment and disposal systems, to meet existing and future needs.
  - **Policy PUBLIC-3.4.** City sewer connection fees and ongoing sewer rates should be proportionally lower for properties that fund and install recycled water systems and are able to reduce overall wastewater demand.
  - **Policy PUBLIC-3.9.** The City will ensure compliance with state and federal standards for wastewater disposal. Monitoring and reporting programs may be required, as appropriate.
- **Implementation Program PUBLIC-3.1**
  - The City will adopt a wastewater master plan that is consistent with the 2030 General Plan, to provide for phased improvements to meet future needs. The master plan will include an inventory of existing development, estimates of future demand within the existing city, and estimates of future demand within areas planned for annexation. The wastewater master plan will provide cost-effective methods for expanding the system to meet future growth needs without raising sewer rates in the existing city. The master plan will identify deficiencies in the existing developed city that need to be addressed prior to, or in advance of infill development.
  - The Wastewater Master Plan will identify improvements and funding required to comply with Regional Water Quality Control Board and other applicable state and federal water quality standards.

- The City will update the wastewater master plan, as necessary, to address growth needs, regulatory changes, technological innovations, and regional plans for wastewater treatment and disposal. As part of the wastewater master planning process, the City will identify improvements needed to meet applicable state and federal wastewater disposal standards. The City will incorporate analysis from the wastewater master plan into its capital and ongoing fee programs.
- The City will examine whether installation of recycled water systems and/or installation of drought tolerant landscaping would substantially reduce the costs of wastewater treatment plant capacity upgrades and conveyance facilities compared to a scenario that does not use these water-saving features. The City will explore opportunities to pass savings related to wastewater infrastructure to properties that install and use recycled water and install drought tolerant landscaping, as feasible.

- **GOAL PUBLIC-4.** Provide storm drainage systems that protect property and public safety and that prevent erosion and flooding.
  - **Policy PUBLIC-4.2.** As part of the master plan and capital improvements planning, the City will set priorities and make repairs to the City's existing stormwater drainage system.
  - **Policy PUBLIC-4.3.** The City will develop a funding mechanism to improve existing drainage systems and develop new ones in existing City areas that currently lack stormwater drainage infrastructure.
  - **Policy PUBLIC-4.12.** New development shall be designed to control surface runoff discharges to comply with City standards, National Pollutant Discharge Elimination System Permit requirements, and Regional Water Quality Control Board standards, as applicable.
- **Implementation Program PUBLIC-4.1**
  - The City will adopt a drainage master plan, consistent with the policy direction in the 2030 General Plan, to provide for phasing and financing of drainage improvements in the existing developed city and in the new growth area.
  - The master plan will include an inventory of existing development, estimates of future needs in the existing city, and estimates of future growth in the new growth area. The drainage master plan will address how to meet future growth needs, if possible, without any rate increases in the existing city.
  - The drainage master plan will also identify deficiencies and provide for drainage improvements in the existing developed city. As part of both the Drainage Master Plan and capital improvements planning, the City will set priorities and make repairs to the City's existing stormwater drainage system. Areas in the existing

developed city that lack drainage infrastructure will take priority in the improvement schedule.

- The City will update the drainage master plan, as necessary, to address growth needs, regulatory changes, and technological innovations. The City will incorporate analysis from the wastewater master plan into its capital and ongoing fee programs.

- **Goal PUBLIC-5.** Use best environmental practices in the City's drainage systems to ensure water quality and take advantage of cost-saving multi-use opportunities.
  - **Policy PUBLIC-5.1.** The City's drainage master plan will plan and provide for appropriate components of natural drainage systems, which not only can be less costly to construct and maintain compared to a traditional piped system, but also provide water quality benefits and allow stormwater facilities to provide community amenities.
  - **Policy PUBLIC-5.2.** The City's drainage master plan should incorporate the use of newly constructed, appropriately landscaped drainage swales to filter, slow down, and better convey stormwater runoff.
  - **Policy PUBLIC-5.3.** Existing Reclamation District 777 and Reclamation District 2056 drainage channels should be improved, to the greatest extent feasible, to create more naturalized swales that provide stormwater conveyance. These channels should be restored with native, low-maintenance landscaping to filter stormwater and enhance neighborhood aesthetics.
  - **Policy PUBLIC-5.8.** New development should use LID techniques such as preserving or restoring natural landscape features for drainage, minimizing hard (impervious) surfaces, and using other methods that reduce, recycle, and filter stormwater.
- **Implementation Program PUBLIC-5.1**
  - The City will adopt a drainage master plan, consistent with the policy direction in the 2030 General Plan, to provide for phasing and financing of drainage improvements in the existing city and in the new growth area.
  - The City's drainage master plan will implement natural drainage systems that use newly constructed or restored drainage swales to convey stormwater runoff.
  - The City's drainage and parks and recreation planning and fees should account for the cost savings of this dual-use application of both park and drainage impact fees. Planning and fees should consider savings of LID techniques, where appropriate.
- **Goal PUBLIC-11.** Ensure that adequate infrastructure, water supply, water storage, and water pressure is available for fire flow requirements.

- **Policy PUBLIC-11.1.** The City will provide adequate water supply, storage, and appropriately-sized distribution pipelines to provide appropriate fire flows and emergency reserve, according to County fire flow standards until such time as the City adopts its own standards.
- **Policy PUBLIC-11.2.** New development shall provide adequate minimum fire flow pressures and emergency fire reserve capacity, as required by the City, to ensure public safety and protection of property.

Public Safety

- **Goal PS-2.** Minimize the loss of life and damage to property caused by flood events.
  - **Policy PS-2.7.** As feasible, new development should incorporate stormwater treatment practices that allow percolation to the underlying aquifer and minimize off-site surface runoff (and therefore flooding).
- **Goal PS-4.** Protect the community from the harmful effects of hazardous materials.
  - **Policy PS-4.3.** The City will coordinate with appropriate federal, state, and regional agencies to address local sources of groundwater and soil contamination, including underground storage tanks, septic tanks, agriculture, and industrial uses.
  - **Policy PS-4.5.** The City will support efforts to identify and remediate soils and groundwater contaminated with toxic materials, and to identify and eliminate sources contributing to such contamination.

2.2.1.3 City of Yuba City General Plan

The City of Yuba City General Plan was adopted in 2004 and was coordinated with and supports ideas in the Sutter County General Plan. The General Plan was developed with the vision of a growing community that preserves much of its small town feel and social fabric with an improved economy, new job opportunities, affordable housing, improved public services and facilities, new parks, an urban growth boundary that protects the much-prized rural agricultural landscape, and an overall improved quality of life.

The following policies from each relevant General Plan Element as well as implementation programs may potentially influence implementation of the GSP or be influenced by GSP implementation.

2.2.1.3.1 Public Utilities Element

- Guiding Policies
  - **7.1-G-1.** Ensure that an adequate supply of water is available to serve existing and future needs of the City.

- **7.1-G-2.** Ensure that necessary water supply infrastructure and storage facilities are in place prior to construction of new development.
- **7.1-G-3.** Maintain existing levels of water service by preserving and improving infrastructure, replacing water mains as necessary, and improving water transmission facilities.
- **7.1-G-4.** Encourage water conservation with incentives for decreased water use and active public education programs.
- **7.2.-G-1.** Ensure that adequate wastewater treatment capacity is available to serve existing and future needs of the City.

- Implementing Policies
  - **7.1-I-1.** Evaluate the adequacy of water infrastructure in areas where intensification of land use is anticipated to occur and develop a strategy to implement projects in the Water Supply Master Plan to offset deficiencies in capacity.
  - **7.1-I-2.** Coordinate capital improvements planning for all municipal water service infrastructure with the direction, extent, and timing of growth.
  - **7.1-I-3.** Decline requests for extension of water beyond the sphere of influence, except in cases of existing documented health hazards and in areas where the City has agreements to provide services.
  - **7.1-I-4.** Establish equitable methods for distributing costs associated with providing water service to development, including impact mitigation fees where warranted.
  - **7.1-I-5.** Explore ways to encourage use of reclaimed water for irrigation and landscaping purposes.

    Utilizing reclaimed water is currently not cost-effective. Should the costs of reclaimed water become more attractive, the City should define a program for encouraging reclaimed water use.
  - **7.1-I-6.** Establish guidelines and standards for water conservation and actively promote use of water-conserving devices and practices in both new construction and major alterations and additions to existing buildings.
  - **7.2-I-1.** Maintain existing levels of wastewater service by preserving and improving infrastructure, including replacing sewer mains as necessary.
  - **7.2-I-2.** Evaluate the adequacy of sewer infrastructure in areas where land use intensification is anticipated to occur and develop a strategy to address potential deficiencies in capacity.

- **7.2-I-3.** Coordinate capital improvements planning for all sewer service infrastructure with the direction, extent, and timing of growth.
- **7.2-I-4.** Decline requests for sewer extensions beyond the urban growth boundary, except in cases of existing documented health hazards and in areas where the City has prior agreements to provide services.
- **7.2-I-5.** Establish equitable methods for distributing costs associated with providing wastewater services to development, including impact mitigation fees where warranted.

2.2.1.3.2 Environmental Conservation Element

- Guiding Policies
  - **8.5-G-1.** Enhance the quality of surface water and groundwater resources and prevent their contamination.
  - **8.5-G-3.** Ensure that the City's drinking water continues to meet or exceed water quality standards.
- Implementing Policies
  - **8.5-I-1.** Establish conservation programs and measures for Yuba City employers, residents, and service providers.
  - **8.5-I-2.** Comply with the Central Valley Regional Water Quality Control Board's regulations and standards to maintain and improve the quality of both surface water and groundwater resources.
  - **8.5-I-3.** Continue to control stormwater pollution and protect the quality of the City's waterways, by preventing oil and sediment from entering the river.
  - **8.5-I-4.** Encourage State and regional agencies to monitor groundwater supplies and take steps to prevent overuse, depletion, and toxicity.
  - **8.5-I-5.** Continue to regularly monitor water quality to maintain high levels of water quality for human consumption and ecosystem health.
  - **8.5-I-6.** Protect waterways by prohibiting the dumping of debris and refuse in and near waterways and storm drains.
  - **8.5-I-7.** Require new construction to utilize best management practices such as site preparation, grading, and foundation designs for erosion control to prevent sediment runoff into waterways, specifically the Feather River.

    Best management practices include:

    - *Requiring that low berms or other temporary facilities be built between a construction site and drainage area to prevent sheet-flooding stormwater from entering storm drains and waterway;*

- *Requiring installation of storm drains or other facilities to collect stormwater runoff during construction; and*
- *Requiring onsite retention where appropriate.*

- **8.5-I-8.** Prepare and disseminate information about the potentially harmful effects of toxic chemical substances and safe alternative measures.
- **8.5-I-9.** If areas of groundwater contamination are identified, the City shall develop plans to limit further contamination and to protect public health.
- **8.5-I-10.** Support the application of reclaimed water to reduce the demand on municipal water supplies, if economically feasible.

  Water reclamation not only extends water supplies, it can also reduce wastewater disposal costs, save users' costs, save energy, and reduce the discharge of pollutants to the environment. The City supports only safe and practical applications of reclaimed water.

2.2.2 Existing Land Use Plans and Impacts to Sustainable Groundwater Management

The vast majority of the land uses in Sutter County are preserved for agriculture (Sutter County, 2011). Sutter County consists of 389,120 acres that predominantly overlie two groundwater subbasins, the Sutter and North American Subbasins (with a small portion of the Butte Subbasin located within Sutter County). The General Plan and the following discussion cover the entire County and does not divide the information by subbasin.

Approximately 92 percent of the total County area is predicted to remain stable and is not expected to change in character within the timeframe (25-year planning horizon) of the Sutter County General Plan. The areas of change are relatively few and small in size. In total, approximately 32,681 acres, or slightly over 8 percent of unincorporated lands, have been identified as potential urban growth areas. **Table 2-3** provides the projected growth areas and population as contained within the Sutter County General Plan (2011).

Table 2-3. Sutter County Population, Historical and Projected

Town or City	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Live Oak	4,090	4,280	4,543	4,842	4,976	5,282	5,536	5,698	5,865	5,971	6,090	6,229
Yuba City	26,000	27,000	28,728	30,180	31,385	33,395	34,071	34,543	35,030	35,574	36,040	36,758
Balance Of County	31,700	32,450	32,888	33,575	34,217	33,525	33,941	34,332	34,804	35,112	35,333	35,943
County Total	**61,800**	**63,700**	**66,159**	**68,597**	**70,578**	**72,202**	**73,548**	**74,573**	**75,699**	**76,657**	**77,463**	**78,930**

Town or City	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Live Oak	6,295	6,339	6,380	6,473	6,603	7,266	7,890	8,255	8,355	8,422	8,517	8,243
Yuba City	45,506	46,792	48,505	51,034	57,975	60,197	61,835	62,974	64,042	64,818	65,487	66,096
Balance Of County	27,921	27,955	28,133	27,590	22,519	21,901	21,838	21,754	21,521	21,525	21,587	21,609
County Total	**79,722**	**81,086**	**83,018**	**85,097**	**87,097**	**89,364**	**91,563**	**92,983**	**93,918**	**94,765**	**95,591**	**95,948**

Town or City	2013	2014	2015	2016	2020	2025	2030	2035	2040
Live Oak	8,184	8,339	8,331	8,346	8,441	8,558	8,765	8,792	8,909
Yuba City	66,513	66,716	67,779	68,052	82,390	95,513	110,725	128,361	148,806
Balance Of County	21,490	21,470	20,838	20,910	18,108	15,342	13,610	14,299	14,760
County Total	**96,187**	**96,525**	**96,948**	**97,308**	**108,939**	**119,413**	**133,100**	**151,452**	**172,475**

Implementation of existing land use plans is unlikely to affect the water supply and groundwater sustainability over the planning and implementation horizon. The largest planned changes are related to urban growth with a reduction of agricultural lands.

2.2.2.1 Urban Water Supply

Sutter County has had limited urban growth since 1989, with its population increasing by about 50 percent. Urban development has occurred in Yuba City, Live Oak, and a few small towns and communities including Robbins, Sutter, and Tisdale. **Table 2-3** provides the historical and projected future population for the entire Sutter County. Urban growth in the Subbasin is summarized in **Table 2-3**, while the remaining “Balance of County” is essentially within the North American Subbasin. The population in the Sutter County portion of the Sutter Subbasin as of 2016 is projected to double by 2040, almost entirely in Yuba City.

The source of water for the increased population in Yuba City will be surface water. Groundwater is not anticipated to be used for future growth (Carollo Engineers, 2016), but a couple of wells will be maintained for use during droughts. The City of Live Oak is planning to support its growth with eight new wells (EcoLogic, 2009). The estimated groundwater supply is expected to increase from 3,100 acre-feet (AF) in 2015 to 11,800 AF by 2030 (EcoLogic, 2009).

Population in the Sutter Community Services District area has the capacity to grow on groundwater, but without a new wastewater treatment plant the community will not be allowed to increase its population. The Sutter County Development Services Department is currently prohibiting further development within the community of Robbins due to high wastewater treatment usage compared to treatment capacity, therefore restricting population growth within the community. Golden State Water Company received authorization from the California Public Utility Commission in 2021 to acquire the Robbins water system from Sutter County, with the transfer completed in late 2021. Improvements to the Robbins water system include drilling a new well, rehabilitating the existing well, and customer meters.

2.2.2.2 Agricultural Water Supply

The County has been historically, and continues to be, an agricultural community. Irrigated agricultural land accounts for about 70 percent of the total area in the County. The remaining land is used for habitat preserves, open range land grazing, roads, and other infrastructure. The largest land use is for rice production, averaging about 40 percent of the total County and has ranged from 31 to 46 percent. Pasture is the next largest land use followed by orchards which average about 16 percent and has ranged from 12 to 19 percent. Since about 1994, agricultural land use has been relatively stable with a slight decline in rice acreage and a slight increase in orchards.

Existing agricultural irrigation entities in Sutter County include the following: Garden Highway Mutual Water Company; Meridian Farms Water Company; Sutter Bypass Butte Slough Water User Association; Butte Slough Irrigation Company; Sutter Extension Water District; Sutter Mutual Water Company; Tisdale Irrigation and Drainage Company; Tudor Mutual Water Company; Butte Water District; Feather Water District; and Oswald Water District. These entities supply surface water from the Feather and Sacramento Rivers. Reclamation districts have the capacity to place pumps in drainage canals and reuse water.

The types of crops that can be grown are determined by soil types, water supply market conditions, availability of surface water, and water quality. In many areas, the soil types are conducive to rice production and access to good quality surface water has been secure relative to many other areas of California. These conditions have supported stability in both the amount of land devoted to agricultural production and in the types of crops grown on these lands.

As noted above, an important reason for the stability of both irrigated acreage and of cropping patterns in the Subbasin is the large area within the Subbasin having soils suitable for rice cultivation. Rice is mainly grown on soils favorable to the maintenance of standing water: specifically, clay soils with low vertical hydraulic conductivity. Soil features, such as fine-texture or cemented layers with low vertical hydraulic conductivity, are common over broad areas in the Subbasin and are considered advantageous for flooded rice culture. Although deep ripping of restrictive layers can make these soils more suitable for non-flooded crops, it would also reduce suitability for rice planting.

Sacramento Valley rice farmers use mainly surface water for irrigation. The quality of this water is generally high having been derived from melting snow that enters rivers through managed reservoir discharge. Salinity is removed from the land by runoff and percolating water, mostly fairly early in the reclamation process, so there is little residual salinity in established rice fields.

Sutter County's agricultural water usage for the entire county is approximately 60 percent surface water, 20 percent groundwater, and 20 percent that is irrigated by both surface water and groundwater. The predominant source of water for permanent crops is groundwater (Wood Rodgers, 2012), whereas rice and irrigated truck crops typically use surface water. Groundwater use has varied from 122,000 to 235,000 AFY.

2.2.2.3 Managed Wetlands Water Supply

The Central Valley Project Improvement Act (CVPIA) Refuge Water Supply Program (RWSP) ensures annual water deliveries to identified wetland habitat areas of a specified quantity, of suitable flow rate and timing, and suitable quality to maintain and improve wetland habitat areas (CDFW, n.d.). CVPIA RWSP mandates are to acquire or secure the water supply necessary to meet delivery requirements, convey water, and upgrade or build new conveyance facilities. USBR implements long-term water supply contracts through the refuge managing agencies, which include U.S. Fish and Wildlife Service, California Department of Fish and Wildlife, and Grassland Resource Conservation District. Each refuge managing agency provides an annual water delivery schedule and updates the schedule monthly based on their allocated Level 2 water supply and the estimated acquisition of Incremental Level 4 water supply. Level 2 water supply represents the historical average amount of water deliveries prior to CVPIA enactment in 1992 and is the baseline water required for wildlife habitat management. Incremental Level 4 water supply represents the additional increment of water required for optimal wetland habitat. Full Level 4 water deliveries are satisfied when both Level 2 and Incremental Level 4 supply requirements are met in full.

Almost all Level 2 water supply requirements are secured annually and received by refuges due to long-term contracts with USBR (CDFW, n.d.). Only 43% of Incremental Level 4 allocations were required and delivered each year from willing sellers on an average annual basis from 2005 to 2014 due to too few willing sellers and/or too little funding to buy willing seller's water. Incremental 4 water supplies may be acquired through voluntary measures such as water conservation, conjunctive use, purchase, lease, donation, or similar activities. Currently, both the Gray Lodge Wildlife Area and Sutter National Wildlife Refuge are not able to receive full Level 4 water based on incomplete water conveyance infrastructure. A small portion of the Gray Lodge Wildlife Area is located in the Sutter Subbasin and refuge water delivery points are located in the Butte Subbasin. For the Sutter National Wildlife Refuge, the Level 2 water contract quantity is 23,500 AFY and the 100% Incremental Level 4 water contract quantity is 6,500 AFY, therefore Full Level 4 water deliveries are 30,000 AFY (USBR, July 2004).

2.2.2.4 Land Use Plans Outside Sutter Subbasin

Land use plans outside of the Sutter Subbasin generally include general plans in Butte, Yuba, Placer, Yolo, and Colusa Counties. Areas neighboring the Sutter Subbasin within Butte, Placer, Yolo, and Colusa Counties are generally projected to continue present agricultural uses. The North Yuba and South Yuba Subbasins, located within Yuba County, submitted a joint GSP to DWR in January 2020. Implementation of the Yuba Subbasins GSP is anticipated to continue sustainable management of groundwater in the Yuba Subbasins and is not anticipated to affect the water supply assumptions in the relevant general plans within the subbasins. Therefore, it is anticipated that land use plans within the neighboring North Yuba and South Yuba Subbasins will not affect the ability of the Sutter Subbasin to achieve sustainable groundwater management.

2.3 Existing Water Resources Monitoring and Management Programs

As required by §354.8(c) and (d) of the GSP Emergency Regulations, the following section describes existing water resources-related management and monitoring plans, and a discussion of how these programs will either impact GSP implementation and/or will be incorporated into the GSP.

2.3.1 Water Resources Management Programs

Existing water resources management programs include local Groundwater Master Plans (GMPs), the City of Yuba City Water Treatment Plant and Distribution System Master Plan, the City of Yuba City 2015 Urban Water Management Plan, Agricultural Water Management Plans, the North Sacramento Valley Integrated Regional Water Management Plan (IRWMP), Irrigated Lands Regulatory Program (ILRP), and Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS).

2.3.1.1 Sutter County Groundwater Management Plan

Sutter County developed a Groundwater Management Plan (Wood Rodgers, 2012) that is compliant with Assembly Bill (AB) 3030, Senate Bill (SB) 1938, and AB 359 legislation. The Sutter County GMP was prepared with input and direction from County stakeholders, with financial and technical assistance from DWR, with the purposes of:

- Summarizing the currently understanding of groundwater underlying Sutter County and its role in the County's overall water supply, making that information publicly available.
- Formulating goals and objectives that can be used as guidelines to help manage groundwater resources to meet current and future demands in Sutter County.
- Establish a plan for the County's involvement in ongoing monitoring and management of groundwater to promote these goals and objectives.
- Maintain eligibility for grant funding administered by DWR to increase the understanding of groundwater basins underlying Sutter County.

The plan covers the entire county, including the entire Sutter Subbasin. The GMP will continue to be implemented by Sutter County until the adoption of this GSP by the Sutter Subbasin GSAs.

2.3.1.2 Butte Water District Groundwater Management Plan

The Butte Water District GMP (No author, 1996) is compliant with AB 3030 and developed with the purpose of managing and monitoring groundwater resources existing and available within the District boundaries. The Butte Water District GMP has been implemented in a cooperative manner with other local private and or public water-purveying public agencies for the purpose of preserving, protecting, and monitoring basin area groundwater extraction, distribution, allocation, or exportation to ensure compliance with Water Code Section 1745.10.

The GMP covers the existing boundaries of the Butte Water District and will continue to be implemented by Butte Water District until the adoption of this GSP by the Sutter Subbasin GSAs.

2.3.1.3 Feather Water District Groundwater Management Plan

The Feather Water District GMP (No author, 2005) is compliant with AB 3030 with the objective and purpose to manage, monitor, and preserve groundwater resources existing and available within its current and future boundaries in order to maintain and maximize long-term reliability of the groundwater supply, to prevent significant depletion of the groundwater storage over the long term, to prevent significant degradation of the quality of the groundwater, and to protect natural recharge and investigate possible use of intentional recharge of groundwater supply. Feather Water District has coordinated with other local private or public water purveying public agencies for the purpose of preserving, protecting, and monitoring basin area groundwater extraction, distribution, allocation, and exportation to ensure compliance with Water Code Sections 1745.10, et seq.

The GMP covers the existing boundaries of the Feather Water District and will continue to be implemented by Feather Water District until the adoption of this GSP by the Sutter Subbasin GSAs.

2.3.1.4 Reclamation District No. 1500 Groundwater Management Plan

The Reclamation District No. 1500 GMP (CH2M Hill, 2012) was developed in association with Sutter Mutual Water Company and Pelger Mutual Water Company and is compliant with SB 1938. The GMP supports effective and sustainable groundwater management, which includes delivering cost-effective, quality irrigation water for sustainable agricultural protection and environmental benefit. The objectives of the GMP include:

- Maintaining Sutter Basin long-term agricultural viability
- Promoting resource sustainability
- Increasing long-term water supply reliability
- Promoting cooperative regional outreach and regulatory compatibility

The GMP covers the Reclamation District No. 1500, Sutter Mutual Water Company, and Pelger Mutual Water Company boundaries and will continue to be implemented until the adoption of this GSP by the Sutter Subbasin GSAs.

2.3.1.5 Sutter Extension Water District Groundwater Management Plan

The Sutter Extension Water District GMP (No author, 1995) is compliant with AB 3030 and developed with the purpose of managing and monitoring groundwater resources existing and available within the District boundary. Sutter Extension Water District has coordinated and cooperated with other local private or public water purveying public agencies for the purpose of preserving, protecting, and monitoring basin area groundwater extraction, distribution, or exportation ensuring compliance with Water Code Sections 1745.10, et seq.

The GMP covers the existing boundaries of the Sutter Extension Water District and will continue to be implemented by Sutter Extension Water District until the adoption of this GSP by the Sutter Subbasin GSAs.

2.3.1.6 City of Yuba City Water Treatment Plant and Distribution System Master Plan

The City of Yuba City's Water Treatment Plant and Distribution System Master Plan (Water Master Plan) (West Yost Associates, 2019) identifies strategies for cost-effectively meeting the City's water treatment plant and distribution system needs; guides capital expenditures for the water treatment plant and distribution system; and presents comprehensive renewal and replacement strategies. The resulting Water Master Plan provides a comprehensive road map for the City for future planning.

2.3.1.7 City of Yuba City 2020 Urban Water Management Plan

The City of Yuba City's 2020 Urban Water Management Plan (UWMP) (Tully & Young, 2021) addresses the City's water management planning efforts to assure adequate water supplies to meet forecast demands over the next 25 years. As required by the Urban Water Management Planning Act, the City's 2020 UWMP specifically assesses the availability of its supplies to meet forecast water uses during average, single-dry, and five consecutive drought years through 2045. Verification that future demands will not exceed supplies and assuring the availability of supplies in dry-year conditions are critical outcomes of the City's 2020 UWMP. UWMPs are prepared every 5 years by law to support urban water suppliers' long-term resources planning.

2.3.1.8 Yuba City Basin Storm Water Resource Plan

The Yuba City Basin Storm Water Resources Plan (SWRP) (West Yost Associates, 2018) is a comprehensive document that identifies, prioritizes, and schedules storm water projects within the Yuba City Basin. Development of the SWRP was led by the City of Yuba City and meets the requirements of SB 985, as the Yuba City Basin SWRP has been reviewed and approved by the State Water Resources Control Board (SWRCB) and Central Valley Regional Water Quality Control Board (CV-RWQCB) (California Water Boards, June 2020). SWRP content includes an introduction and description of the watershed and subwatersheds; public outreach and coordination; data collection; quantitative methods; SWRP project evaluations, quantitative methods, and project ranking/prioritization; implementation strategy and schedule; standard provisions; and SWRP checklist and self-certification.

2.3.1.9 Agricultural Water Management Plans

No agricultural water suppliers in the Sutter Subbasin are required to submit 2020 Agricultural Water Management Plans (AWMPs). However, Butte Water District voluntarily elected to update their individual supplier AWMP components in the Feather River Regional 2020 AWMP Update, even though Butte Water District serves less than 25,000 acres and is therefore exempt from the requirements set forth by DWR (NCWA, April 2021).

There are three agricultural water suppliers within the Sutter Subbasin that were required to submit 2015 AWMPs to DWR. Butte Water District (NCWA, December 2016) and Sutter Extension Water District (NCWA, December 2016) participated in the development of the *2015 Feather River Regional AWMP*. Sutter Mutual Water Company submitted the *Sacramento Valley Regional Water Management Plan Annual Update* (No author, 2012), *SBx7-7 Water Measurement Compliance Program* (MBK Engineers, October 2016), *Water Balance Summary* (CH2M Hill and MBK Engineers, October 2016a), and *Drought Management Plan* (CH2M Hill and MBK Engineers, October 2016b) to meet 2015 AWMP requirements. AWMPs must include background and description of the service area covered by the Plan, an inventory of water supplies, a water balance analysis, evaluation of potential climate change impacts and adaptation strategies, and an evaluation of water management activities and opportunities related to efficient water management practices and water use efficiency improvements.

2.3.1.10 North Sacramento Valley 2014 Integrated Regional Water Management Plan

The 2014 North Sacramento Valley Integrated Regional Water Management Plan (IRWMP), updated in March 2020, includes all or portions of Butte, Colusa, Glenn, Shasta, Sutter, and Tehama Counties. The IRWM region is managed by the North Sacramento Valley Regional Water Management Group (NSV RWMG), which consists of three members selected by the respective county Board of Supervisors.

The NSV RWMG, with the help of its Technical Advisory Group, began development of the IRWMP in 2012 in an open and transparent process with all NSV Board meetings held in compliance with the Brown Act. Collaboration with the public and other local, state, and federal agencies throughout the IRWMP development and implementation process has been a key component in developing and carrying out the goals and objectives of the IRWMP. As a basis for the broad category goals and specific objectives identified in the IRWMP, the following statement of intent was established for the NSV IRWMP:

> *To establish a regional collaborative structure with the objective of ensuring an affordable, sustainable water supply that supports agricultural, business, environmental, recreational, and domestic needs in the Northern Sacramento Valley.*

The following goals and objectives were drafted to support and further the region's statement of intent for the IRWMP.

- **Goal 1:** Water Supply Reliability
  - **Objective 1-1:** Document baseline conditions and trends for surface water and groundwater resources.
  - **Objective 1-1a:** Adaptation to changes in the amount, intensity, timing, quality, and variability of runoff recharge.
  - **Objective 1-2:** Quantify current and future water demands.
  - **Objective 1-3:** Maximize efficient utilization and reliability of surface and groundwater supplies in coordination with local GMPs.
  - **Objective 1-4:** Coordinate and protect regional groundwater resources, consistent with locally developed GMPs that monitor groundwater levels, groundwater quality, and inelastic land subsidence. The effects of sea level rise on groundwater quality have been considered and determined to be inapplicable to the NSV region.
  - **Objective 1-5:** Develop regional water transfer guidelines to facilitate efficient management of water supplies that recognize the NSV Region as having the first priority for use.
  - **Objective 1-6:** Protect existing and established surface water rights.
  - **Objective 1-7:** Honor and preserve area-of-origin statutory protections.
  - **Objective 1-8:** Protect existing and established regional CVP and State Water Project (SWP) water contract supplies.
  - **Objective 1-9:** Increase surface water storage and hydropower generation within the region.
  - **Objective 1-10:** Develop and implement a regional drought preparedness strategy to minimize socio-economic impacts.
  - **Objective 1-11:** Develop and improve water resources infrastructure to increase water supply reliability within our region.
  - **Objective 1-12:** Develop, update, and implement GMPs through local jurisdictions.

- **Goal 2:** Flood Protection and Planning
  - **Objective 2-1:** Develop and coordinate flood risk reduction plans and projects consistent with current law and regulation to provide protection for agricultural, urban, and rural communities.
  - **Objective 2-2:** Evaluate new flood control projects that have potential economic impacts on agricultural land.
  - **Objective 2-3:** Develop and coordinate flood preparedness programs and alert systems for flood-prone areas consistent with existing flood and hazard mitigation plans.
  - **Objective 2-4:** Implement mutually beneficial flood risk reduction and floodplain ecosystem enhancement programs and projects on a voluntary basis.
- **Goal 3:** Water Quality Protection and Enhancement
  - **Objective 3-1:** Develop and improve infrastructure to meet State and Federal standards for drinking water quality.
  - **Objective 3-2:** Develop and improve infrastructure for wastewater collection, treatment, discharge, and reuse.
  - **Objective 3-3:** Meet State and Federal standards for water quality in surface water bodies and groundwater basins.
  - **Objective 3-4:** Minimize adverse water quality impacts from point sources to surface and groundwater.
  - **Objective 3-5:** Minimize adverse water quality impacts from non-point sources to surface and groundwater.
- **Goal 4:** Watershed Protection and Management
  - **Objective 4-1:** Aggressively manage invasive species within the watershed.
  - **Objective 4-2:** Integrate mutually beneficial agricultural production and habitat conservation programs and projects that do not redirect impact to neighbors.
  - **Objective 4-3:** Improve and protect riparian and fish habitat, and fish passage.
  - **Objective 4-4:** Implement healthy forest/foothill management activities that improve watersheds
  - **Objective 4-5:** Protect wetlands that are critical to hydrologic function.
  - **Objective 4-6:** Integrate recreational opportunities within water resource programs and projects.

  - **Objective 4-7:** Evaluate habitat conservation and ecosystem improvement programs and projects that have potential economic impacts on agricultural lands.
- **Goal 5:** IRWM Sustainability
  - **Objective 5-1:** Preserve the autonomy of local governments, special districts, and Tribes.
  - **Objective 5-2:** Enhance communication and coordination among federal, state, Tribal, and local governments, and other stakeholders.
  - **Objective 5-3:** Maintain a governance structure to update the IRWMP and support IRWMP project implementation.
  - **Objective 5-4:** Coordinate with neighboring IRWM regions to identify opportunities to enhance water management.
  - **Objective 5-5:** Pursue funding opportunities to implement programs and projects consistent with the IRWMP.
  - **Objective 5-6:** Coordinate IRWM activities with land-use planning.
- **Goal 6:** Public Education and Information Dissemination
  - **Objective 6-1:** Conduct public education and outreach to promote IRWMP goals.
  - **Objective 6-2:** Develop and disseminate information to protect regional water supplies.
  - **Objective 6-3:** Disseminate information on flood risks, Federal Emergency Management Agency's (FEMA's) flood insurance rate maps (FIRM), and new FEMA policies.
  - **Objective 6-4:** Develop and disseminate water quality information throughout the region.
  - **Objective 6-5:** Develop and disseminate scientific information on aquatic, riparian, and watershed resources.

2.3.1.11 Irrigated Lands Regulatory Program

Groundwater quality from agricultural lands in the area is managed under the Irrigated Lands Regulatory Program (ILRP) by the SWRCB, which has separate requirements for rice land and irrigated land. Groundwater quality sampling in selected monitoring wells occurs every two years. The ILRP, initially implemented in 2003, regulates wastes from commercially-irrigated lands that discharge into surface water and groundwater under the Porter-Cologne Water Quality Control Act. The CV-RWQCB works directly with regional or crop-based coalitions as well as growers to reduce impacts of irrigated agricultural discharges to waters of the State. Pollutants of concern regulated under the

ILRP include pesticides, fertilizers, salts, pathogens, and sediment. The Sutter Subbasin is within two different voluntary coalitions related to ILRP: The California Rice Commission and the Sacramento Valley Water Quality Coalition, specifically the Butte-Yuba-Sutter Subwatershed. These coalition groups work directly with member growers to assist in compliance with CV-RWQCB requirements by conducting surface water monitoring and preparing regional plans to address water quality issues.

2.3.1.12 CV-SALTS

The Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) is a joint effort between CV-RWQCB, SWRCB, and stakeholders to reduce salt and nitrate impacts, restore groundwater quality, and provide safe drinking water supplies throughout the Central Valley. CV-SALTS was established in 2006 as a collaborative basin planning effort aimed at developing and implementing comprehensive salinity and nitrate management throughout the Central Valley. The Central Valley Salt and Nitrate Management Plan (SNMP) (CV-SALTS, December 2016) was adopted by the CV-RWQCB in March 2016 and the SWRCB adopted amendments to the Sacramento and San Joaquin Basin Plan and Tulare Lake Basin Plan to incorporate the Central Valley SNMP in October 2019.

Implementation of the Central Valley SNMP occurs under two programs – the Nitrate Control Program and the Salinity Control Program. For the Nitrate Control Program, dischargers are provided two compliance pathways: (1) traditional permitting as an individual discharger or as a coalition (i.e., irrigated lands coalition), or (2) groundwater management zone permitting. Zone permitting allows dischargers to work as a collective in collaboration with the CV-RWQCB to provide safe drinking water with the option to extend time to achieve nitrogen balance. The Sutter Subbasin is ranked as "Not Prioritized by SNMP" in the Central Valley SNMP, meaning the Sutter Subbasin will need to comply with the SNMP in the future but implementation of SNMP requirements will be phased in by the CV-RWQCB as resources allow. For the Salinity Control Program, discharges are also provided two compliance pathways: (1) traditional permitting as an individual discharger or as a coalition (i.e., irrigated lands coalition), or (2) participation in the Prioritization and Optimization (P&O) Study. Implementation of the Salinity Control Program does not prioritize groundwater subbasins as under the Nitrate Control Program and Notices to Comply with the Salinity Control Program were issued in January 2021.

2.3.2 County Well Construction/Destruction Standards and Permitting

Sutter County Environmental Health Division (SCEHD) is the well permitting agency Sutter Subbasin. One permit application is used for a new well or to deepen, reconstruct, recondition, or destroy a well (SCEHD, July 2013). The permit application requires a site plan showing the location of the well and the accessor's parcel number. A C-57 Water Well Contractor's license and signature of licensee is required by the contractor completing the permit and work. The design and construction of the well shall be in conformance with the State's Water Well Standards as denoted in Bulletin 74-81, "Water Standards: State of California" and Bulletin 74-90, "California Well Standards" as referenced in the County of Sutter Department of Public Works Improvement Standards (2005, rev. 2010). Water wells are also addressed in the Sutter County Code of Ordinances, 700 – Health and Sanitation, Chapter 765 Water Wells (Sutter County, n.d.).

2.3.3 Water Resources Monitoring Programs

Existing water monitoring programs in the Sutter Subbasin are operated by federal, state, and local agencies to quantify and track groundwater and surface water conditions. Descriptions of existing water monitoring programs within the Sutter Subbasin are included in the following subsections.

2.3.3.1 Groundwater

2.3.3.1.1 CASGEM

The California Statewide Groundwater Elevation Monitoring (CASGEM) program is implemented by DWR to collect groundwater level monitoring data from a network of representative wells within basins and subbasins throughout the state to facilitate collaboration between local monitoring entities and DWR and report such information to the public. Four designated monitoring entities have notified DWR of their intent to monitor the entirety of the Sutter Subbasin: Sutter County, Reclamation District No. 1500, Sutter Extension Water District, and Feather Water District. Sutter County submitted a Groundwater Monitoring Plan and Reclamation District No. 1500, Sutter Extension Water District, and Feather Water District submitted their respective Groundwater Management Plans to DWR to monitor for seasonal and long-term groundwater level trends.

Groundwater levels are measured at 63 active CASGEM mandatory monitoring wells and 175 voluntary wells in the Subbasin (**Figure 2-16**). These wells have records extending back as far as 1929 and 70 wells have records extending back prior to 1968. The majority of wells in the CASGEM program have at least a 10-year historical record.

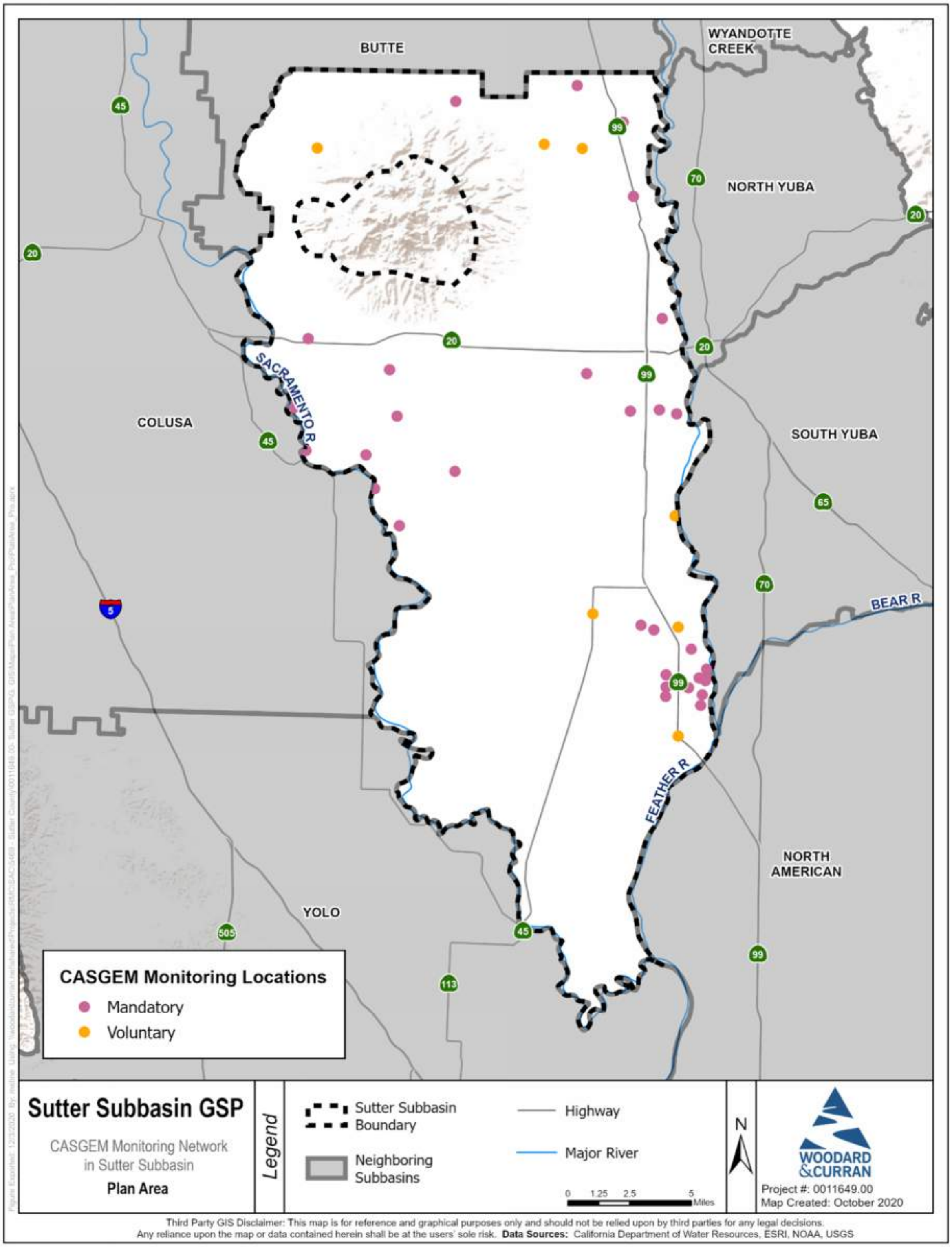


Figure 2-16. Sutter Subbasin CASGEM Monitoring Network

2.3.3.1.2 Department of Water Resources, Groundwater Levels and Quality

DWR's Water Data Library (WDL) includes a compendium of groundwater level and quality data. DWR's statewide groundwater level monitoring network consists of approximately 1,300 wells covering 78 Bulletin 118-2003 defined groundwater basins, 17 non-alluvial basins, and six hydrologic regions (DWR, 2003). Approximately half of the wells monitored by DWR are located within the Sacramento River Hydrologic Region (DWR, 2003). DWR monitors 237 wells for groundwater levels within the Sutter Subbasin, with data reported to the CASGEM and WDL databases. DWR is currently reassessing its water quality monitoring program. Water quality monitoring in the Subbasin is suspended while DWR performs this assessment.

2.3.3.1.3 Irrigated Lands Regulatory Program

As part of the ILRP, growers in the Sutter Subbasin participate in Groundwater Quality Trend Monitoring (GQTMs) through the California Rice Commission and Butte-Yuba-Sutter Subwatershed of the Sacramento Valley Water Quality Coalition. The GQTM Program is intended to monitor shallow groundwater to ensure irrigated agricultural discharges do not impair access to safe and reliable drinking water.

The objectives of the GQTM Program developed by the California Rice Commission (CH2M Hill, March 2016) are to determine current water quality conditions of groundwater relevant to rice operations and to develop long-term groundwater quality information that can be used to evaluate the regional effects of rice operations and its practice. The California Rice Commission has selected 20 active wells in the U.S. Geological Survey (USGS) groundwater monitoring network as part of the trend network surrounded by land used to grow rice is located closer to the edges of rice fields. Field parameters, including conductivity, pH, dissolved oxygen, and temperature, as well as total dissolved solids, nitrate + nitrite as nitrogen, and total ammonia as nitrogen will be monitored annually at each well, while anions (carbonate, bicarbonate, chloride, and sulfate) and cations (boron, calcium, sodium, magnesium, and potassium) will be monitored for initially (beginning in 2017) and then once every 5 years at each well. **Figure 2-17** shows the location of the California Rice Commission trend monitoring wells, with 3 wells located in the Sutter Subbasin. These 3 wells in the Sutter Subbasin were sampled for water quality parameters in 2018 and 2020. As of May 2020, the California Rice Commission has not recommended future monitoring of these 3 wells under the ILRP (Jacobs and Montgomery & Associates, May 2020).

The Sacramento Valley Water Quality Coalition has identified one well within the Sutter Subbasin portion of the Butte-Yuba-Sutter Subwatershed GQTM Program (**Figure 2-18**) (LSCE, July 2018). Well SVWQC_002 will be monitored for nitrate as N, electrical conductivity, pH, dissolved oxygen, temperature, oxidation-reduction potential, and turbidity on an annual basis and total dissolved solids, carbonate, bicarbonate, chloride, sulfate, boron, calcium, sodium, magnesium, and potassium every 5 years.

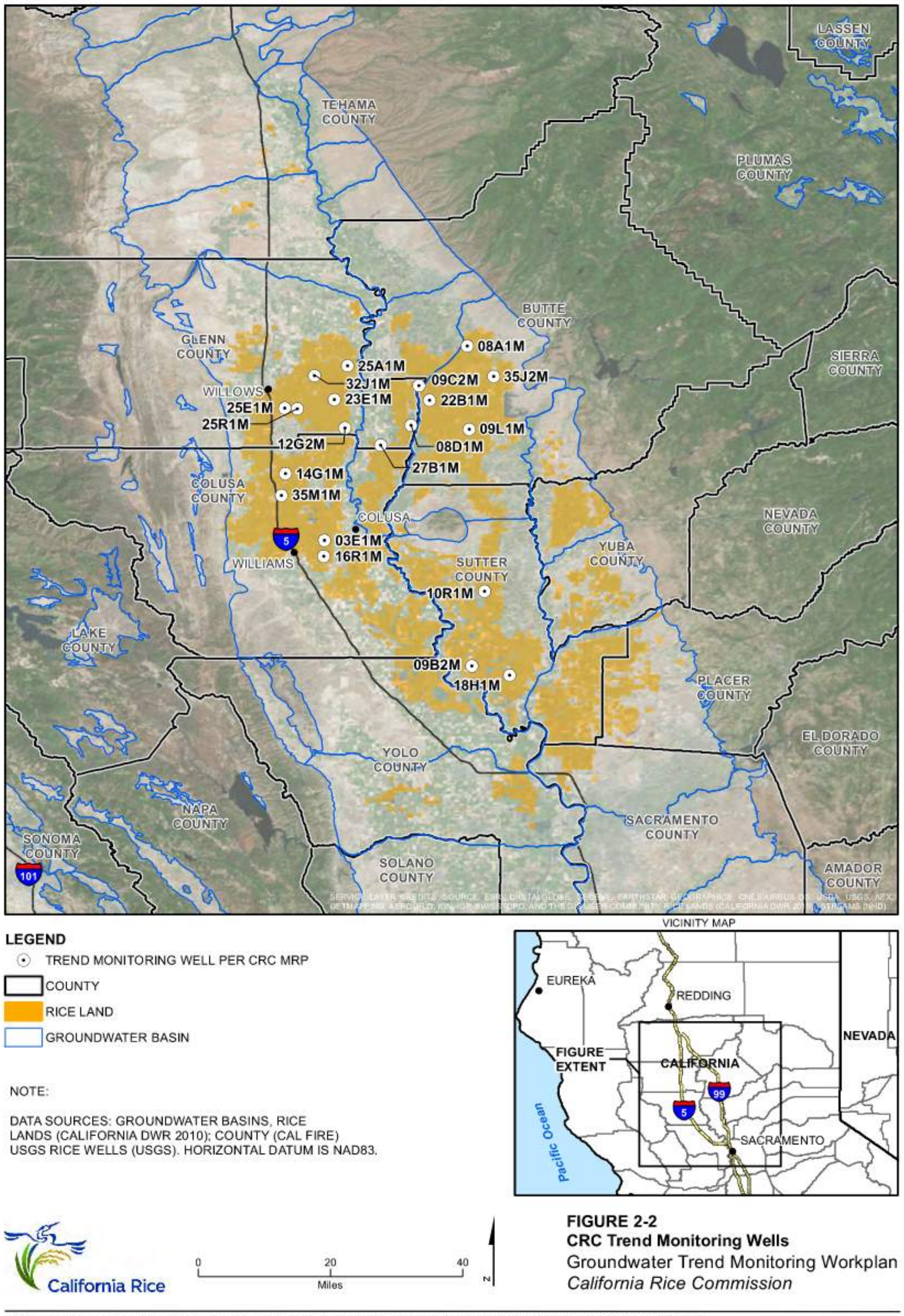


Figure 2-17. California Rice Commission GQTM Program Network

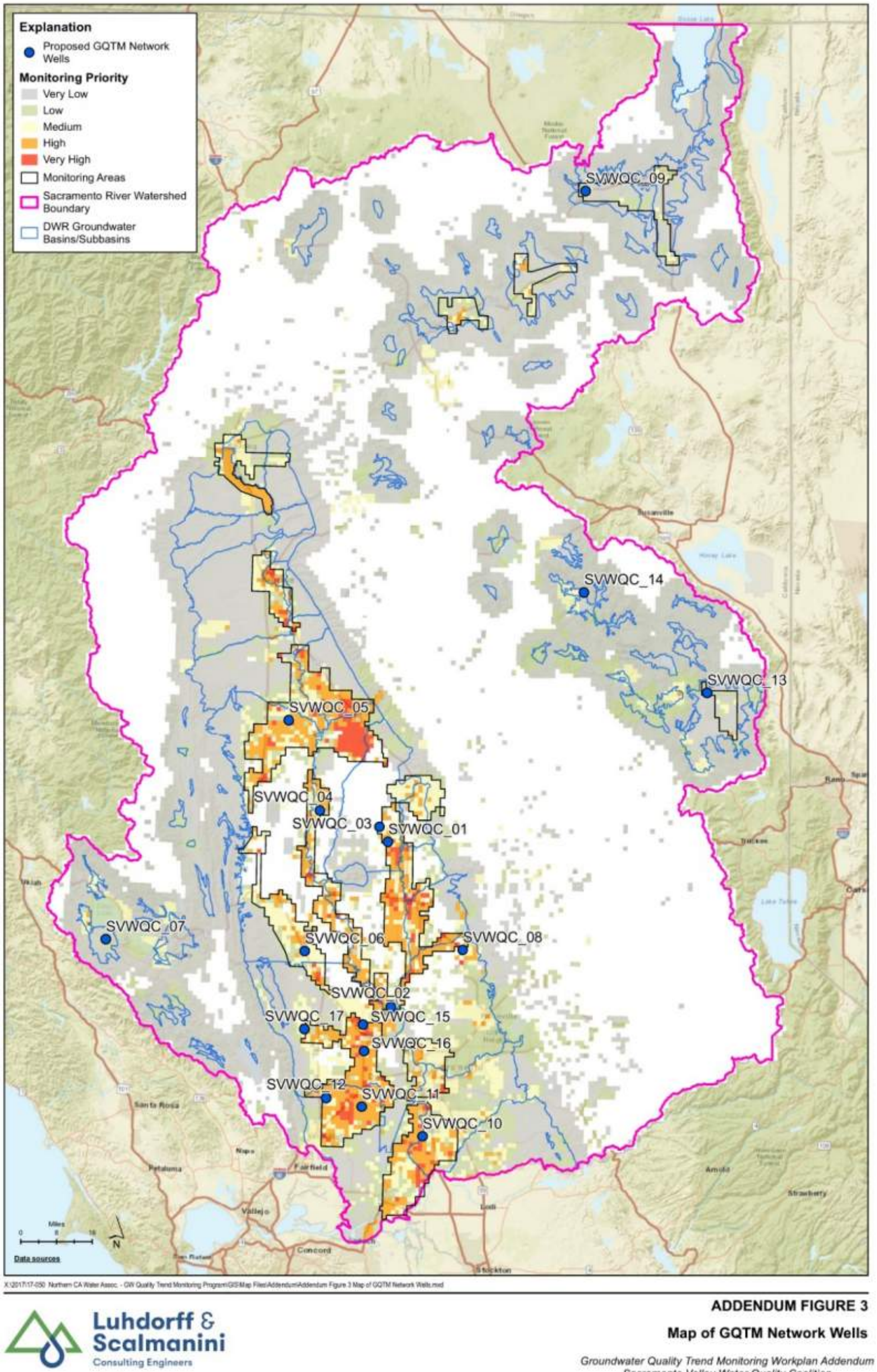


Figure 2-18. Sacramento Valley Water Quality Coalition GQTM Program Network

2.3.3.1.4 Groundwater Ambient Monitoring and Assessment Program

The Groundwater Ambient Monitoring and Assessment (GAMA) Program, established in 2000, is a statewide groundwater quality monitoring program based on interagency collaboration among the SWRCB and the Regional Water Quality Control Boards, DWR, Department of Pesticide Regulation (DPR), USGS, and Lawrence Livermore National Laboratory, and cooperation with local water agencies and well owners (California Water Boards, July 2020). The primary goals of GAMA are to improve statewide comprehensive groundwater monitoring and increase the availability to the general public of groundwater quality and contamination information. Additional goals of GAMA include to establish ambient groundwater quality on a basin wide scale, continue periodic groundwater sampling and groundwater quality studies in order to characterize chemicals of concern and identify trends in groundwater quality, and centralize the availability of groundwater information to the public and decision makers to better protect California's groundwater resources.

GAMA includes several projects to monitor groundwater quality. Within the Sutter Subbasin, the Middle Sacramento Valley Deep Aquifer Assessment (Bennett et al., 2011) was conducted as part of the Priority Basin Project, which provides a comprehensive statewide assessment of groundwater quality to help identify and understand the risks to groundwater. Monitoring data collected under the GAMA program are available via several online tools (California Water Boards, December 2020(a)), including GeoTracker GAMA.

2.3.3.1.5 GeoTracker

GeoTracker is the SWRCB's data management system for sites that impact, or have the potential to impact, water quality in California, with emphasis on groundwater. GeoTracker contains records for sites that require cleanup, such as Leaking Underground Storage Tank (LUST) sites, Department of Defense sites, and Cleanup Program sites. GeoTracker also contains records for various unregulated projects as well as permitted facilities including Irrigated Lands, Oil and Gas production, operating Permitted USTs, and Land Disposal Sites. A search of GeoTracker for the Sutter Subbasin indicates that there approximately 265 active groundwater monitoring wells in the Subbasin (SWRCB, n.d.(a)).

2.3.3.1.6 State Water Resources Control Board, Division of Drinking Water

The SWRCB's Division of Drinking Water (DDW) monitors public water system wells for California Code of Regulations Title 22 requirements relative to levels of organic and inorganic compounds such as metals, microbial compounds, and radiological analytes. Data are available for active and inactive drinking water sources, for water systems that serve the public, and wells defined as serving 15 or more connections, or more than 25 people per day for 60 or more days per year. DDW wells throughout the state are monitored for Title 22 requirements, including pH, alkalinity, bicarbonate, calcium, magnesium, potassium, sulfate, barium, copper, iron, zinc, and nitrate.

2.3.3.1.7 SGMA Data Viewer

DWR's SGMA Data Viewer provides access to groundwater-related datasets that are organized by the requirements of SGMA and the GSP regulations for the purposes of supporting GSP development and implementation (DWR, n.d.(b)). SGMA Data Viewer provides centralized data access to improve coordination of datasets collected and displayed across various state and federal portals and applications for the purpose of helping GSAs meet the requirements of SGMA and the GSP regulations. Data types presented within SGMA Data Viewer include periodic and continuous groundwater level measurements from DWR and U.S. Geological Survey; groundwater level contours; Well Completion Reports; land subsidence data including extensometers, continuous GPS, and InSAR; CDEC stations; climate change factors; land use; soil and geologic data; and jurisdictional boundaries.

2.3.3.1.8 National Water Information System

The U.S. Geological Survey's National Water Information System (NWIS) database contains surface water data collected by automatic recorders and field measurements as well as chemical, physical, and biological sampling results from wells across the country and within the Sutter Subbasin (USGS, n.d.). Real-time and daily data daily data are available to describe river state, streamflow, lake levels, surface water quality, rainfall, groundwater levels, and groundwater quality.

2.3.3.2 Surface Water

2.3.3.2.1 State Water Resources Control Board Surface Water Ambient Monitoring Program

The SWRCB's Surface Water Ambient Monitoring Program (SWAMP) operates four primary statewide monitoring programs to evaluate the condition of surface waters: Bioaccumulation Monitoring Program, Bioassessment Program, Freshwater CyanoHABs Program, and Stream Pollution Trends Program (California Water Boards, December 2020(b)). Data for the Sutter Subbasin is available in the California Environmental Data Exchange Network (CEDEN) from August 2007 through February 2020 (California Water Boards, n.d.).

2.3.3.2.2 Department of Pesticide Regulation Surface Water Protection Program

The California Department of Pesticide Regulation's (DPR's) Surface Water Protection Program monitors agricultural and non-agricultural sources of pesticide residues in surface water. The goal of the Surface Water Protection Program is to characterize pesticide residues, identify the source of contamination, determine the mechanisms of off-site movement of pesticides to surface water, and develop site-specific mitigation strategies (CDPR, n.d.). The program includes both a preventative and response component toward reducing the presence of pesticides in surface water. The preventative component includes local outreach to promote management practices that reduce pesticide runoff, while the response component includes mitigation options to meet water quality goals and identify self-regulating efforts to reduce pesticide exposure. Data are available in CEDEN from January 1998 through April 2005.

2.3.3.2.3 Sacramento Watershed Coordinated Monitoring Program

The Sacramento Watershed Coordinated Monitoring Program is a coordinated effort between the CV-RWQCB and DWR Northern Region to monitor water quality trends in the Sacramento River Watershed (California Water Boards, June 2019). Coordinated monitoring was initiated in the fall of 2008 and monitoring sites are sampled on a quarterly basis for water column toxicity, total organic carbon, nutrients, and E. coli, where a subset of monitoring sites are also monitored for sediment toxicity (California Water Boards, 2009). There are two sampling sites within the Sutter Subbasin: Butte Slough near Meridian and Sutter Bypass at RD-1500 Powerplant. Both sites within the Sutter Subbasin are integrator sites for SWAMP Statewide Stream Contaminant Trend Monitoring. Additionally, there are four sampling sites directly adjacent to the Sutter Subbasin located within neighboring subbasins: Sacramento River above Colusa Basin Drain near Knights Landing, Colusa Basin Drain near Knights Landing, Feather River near Verona, and Sacramento River near Knights Landing (California Water Boards, February 2009). Data by water quality parameter is available for download at the Sacramento River Watershed Data Portal website (Sacramento River Watershed Data Program, n.d.).

2.3.3.2.4 California Data Exchange Center Monitoring Program

The California Data Exchange Center (CDEC) installs, maintains, and operates an extensive hydrologic data collection network including automatic snow reporting gages for the Cooperative Snow Surveys Program and precipitation and river stage sensors for flood forecasting (DWR, n.d.(a)). CDEC provides provisional real-time data along with historical 15-minutes, hourly, and daily data for monitoring sites on the Sacramento River, Feather River, and Sutter Bypass within the Sutter Subbasin. CDEC displays real-time data from DWR as well as the following cooperative agencies: National Weather Service, U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, U.S. Geological Survey, California Department of Fish and Wildlife, Sacramento Municipal Utilities District, Pacific Gas & Electric Company, East Bay Municipal Utilities District, and local entities.

2.3.3.2.5 National Water Information System

Refer to **Section 2.3.3.1.8** for an overview of the U.S. Geological Survey's NWIS.

2.3.3.3 Land Surface

2.3.3.3.1 DWR and USBR Subsidence Monitoring

DWR, in coordination with local, State, and federal partners (including Sutter County), monitors for potential land subsidence throughout the Sacramento Valley. The existing subsidence monitoring network consists of 32 GPS monuments and one extensometer located within Sutter County (Wood Rodgers, 2012). A baseline survey of the GPS monuments was conducted in 2008 by DWR and USBR in coordination with the Sacramento Valley Height-Modernization Project (DWR and USBR, September 2008). The primary purpose of this survey (the Sacramento Valley GPS Subsidence Project) was to provide a comprehensive Sacramento Valley GPS subsidence network to serve as a framework for monitoring land subsidence resulting from groundwater extractions. The baseline observations began on March 17, 2008 and were concluded on June 17, 2008. The network was planned for monitoring every 5 years, although 2013 monitoring did not occur due to budget limitations.

DWR resurveyed the monument network in 2017 with assistance from 19 state, county, and local agencies and a private entity (DWR NRO, December 2018). The methodology used was similar to the DWR survey. Analysis of the results was performed to depict the change in height at each monument from 2008 to 2017. Observed subsidence during this time period was less than 0.4 feet throughout the Sutter Subbasin.

2.3.4 Implications of Existing Monitoring and Management Programs in this GSP

Existing monitoring and management programs within the Sutter Subbasin support groundwater management and are not anticipated to limit operational flexibility. Monitoring under the Sutter Subbasin GSP will be coordinated to the extent possible with these other, existing monitoring programs.

2.4 Existing and Planned Conjunctive Use Programs

Several agencies within the Subbasin conduct short-term groundwater transfer programs as part of conjunctive use of groundwater in the Subbasin. These agencies are Sutter Extension Water District, Butte Water District, and Garden Highway Mutual Water Company. Substitution transfers are completed by these agencies not using their full allotment of surface water. These agencies transfer a portion of their allotment to agencies south of the Sacramento-San Joaquin Delta and pump groundwater in-lieu of using their surface water. These agencies began the water transfers in 2009 and the volume of water transferred since 2009 is presented in **Table 2-4**.

Table 2-4. Groundwater Substitution Transfers in Sutter Subbasin in Acre-Feet per Year, 2009 through 2021

Water Year	Sutter Extension Water District	Butte Water District	Garden Highway Mutual Water Company	Total Water Transfers
2009	4,105	2,730	4,068	**10,903**
2010	2,870	4,082	3,846	**10,798**
2011	-	-	-	**-**
2012	-	-	-	**-**
2013	2,863	3,854	3,837	**10,554**
2014	4,105	3,971	5,364	**13,440**
2015	1,725	1,140	-	**2,865**
2016	17,433*	-	-	**17,433**
2017	-	-	-	**-**
2018	4,540*	-	6,000*	**10,540**
2019	-	-	-	**-**
2020	-	-	6,500*	**6,500**
2021	-	-	2,000*	**2,000**
Total	**37,641**	**15,777**	**31,615**	**85,033**

Sources: GEI, 2016; California Water Boards, 2016; California Water Boards, 2018; California Water Boards, 2020; California Water Boards, 2021

*Indicates approved transfer amount, as reported by California State Water Board. Actual transfer amount may vary slightly.

Yuba City completed an aquifer storage and recovery (ASR) feasibility assessment (Carollo Engineers et al., November 2010) and is developing plans for an ASR demonstration project in one or two targeted aquifer zones at the City's water treatment plant site. In 2015, the City completed construction of three multiple-completion groundwater monitoring wells at the water treatment plant site for the purpose of more fully characterizing the hydrogeology of the site and to assess groundwater flow gradients and groundwater quality in the two targeted aquifer zones. The City is conducting ongoing groundwater monitoring to establish baseline conditions prior to implementing an ASR demonstration project.

2.5 Plan Elements from California Water Code Section 10727.4

2.5.1 Control of Saline Water Intrusion

The Sutter Subbasin does not experience saline water intrusion; therefore, this element is not applicable. See **Section 6.4.2** for an explanation of why the saline water intrusion sustainability indicator does not apply to the Sutter Subbasin.

2.5.2 Wellhead Protection Areas and Recharge Areas

Wellhead Protection Areas, as defined under the Federal Wellhead Protection Program (§1428 of the State Drinking Water Act Amendments of 1986), are the surface and subsurface areas surrounding a water well or well field supply for a public water system through which contaminants are reasonably likely to move toward and reach such water or well field. The SWRCB-DDW's Drinking Water Source Assessment and Protection program (DWSAP) serves as the State's Wellhead Protection Program. There are no existing local wellhead protection programs in the Sutter Subbasin; therefore, agencies within the Subbasin adhere to federal, state, and county regulations governing wellhead protection.

Groundwater recharge areas are discussed in **Section 5.1.7**.

2.5.3 Mitigation of Contaminated Groundwater

Details on migration of contaminated groundwater are discussed in **Section 5.2.5.1**.

2.5.4 Well Abandonment and Well Destruction Programs

A summary of well abandonment and destruction programs within the Sutter Subbasin are detailed in **Section 2.3.2**.

2.5.5 Activities Implementing, Opportunities for, and Removing Impediments to Conjunctive Use or Underground Storage

Details regarding existing and planned conjunctive use programs are discussed in **Section 2.4** and opportunities for and removing impediments to conjunctive use or underground storage are discussed in **Section 7.1**.

2.5.6 Measures Addressing Groundwater Contamination Cleanup, Groundwater Recharge, In-Lieu Use, Diversions to Storage, Conservation, Water Recycling, Conveyance, and Extraction Projects

Details on projects that may include, but are not limited to, addressing groundwater contamination cleanup, groundwater recharge, in-lieu use, diversion to storage, conservation, water recycling, conveyance, and extraction are discussed in **Section 7.1**.

2.5.7 Efficient Water Management Practices, as defined in Section 10902, for the Delivery of Water and Water Conservation Methods to Improve the Efficiency of Water Use

Details on efficient water management practices are discussed in **Section 2.3.1**.

2.5.8 Efforts to Develop Relationships with State and Federal Regulatory Agencies

The GSAs will continue to coordinate with DWR on groundwater level and groundwater quality monitoring and with DWR and USBR on subsidence monitoring. The GSAs will coordinate with entities implementing the ILRP and CV-SALTS to discuss water quality information and needs. The GSAs will continue to coordinate with CV-RWQCB and Sutter County regarding groundwater contaminant plumes. Environmental organizations and California Department of Fish and Wildlife (CDFW) will be engaged to discuss opportunities to improve the understanding of groundwater dependent ecosystems (GDEs) and potential depletions of interconnected surface water.

2.5.9 Processes to Review Land Use Plans and Efforts to Coordination with Land Use Planning Agencies to Assess Activities that Potentially Create Risk to Groundwater Quality and Quantity

Entities with land use authority in the Sutter Subbasin include Sutter County and the cities of Live Oak and Yuba City. These same entities are also individual GSAs participating in the development and implementation of this GSP. As such, land use planning is integrally combined with through groundwater management through the implementation of this GSP.

2.5.10 Impacts on Groundwater Dependent Ecosystems

Impacts on groundwater dependent ecosystems have not been assessed at this time due to a lack of available information and relative data necessary to analyze impacts to GDEs, as well as location, timing, and quantity of interconnected surface waters. Data to evaluate possible impacts to GDEs will be collected during the first five years of GSP implementation and will be evaluated in the GSP five-year update. For more information about the identification of GDEs in the Sutter Subbasin, refer to **Section 5.2.8**.

2.6 References

Bennett, G.L., M.S. Fram, and K. Belitz. 2011. *Status of Groundwater Quality in the Southern, Middle, and Northern Sacramento Valley Study units, 2005-08: California GAMA Priority Basin Project*. U.S. Geological Survey Scientific Investigations Report 2011-5002, 120 p. https://pubs.usgs.gov/sir/2011/5002/. Accessed: January 13, 2021.

California Department of Fish and Wildlife (CDFW). n.d. *Refuge Water Supply Program Details*. https://wildlife.ca.gov/Conservation/Watersheds/Refuge-Water/Details. Accessed: November 11, 2021.

California Department of Pesticide Regulation (CDPR). n.d. *Overview of the Surface Water Protection Program*. https://www.cdpr.ca.gov/docs/emon/surfwtr/overvw.htm. Accessed: January 13, 2021.

California Department of Water Resources (DWR). 1981. *Water Well Standards: State of California, Bulletin 74-81*. https://www.acwd.org/DocumentCenter/View/169/Bulletin-74-81-Water-Well-Standards---State-of-California?bidId=. Accessed: January 14, 2021.

California Department of Water Resources (DWR). 1991. *California Well Standards, Bulletin 74-90*. https://www.countyofglenn.net/sites/default/files/Environmental_Health/WP_DWR_Bulletin_74-90.pdf. Accessed: January 14, 2021.

California Department of Water Resources (DWR). 2003. *Bulletin 118-2003: California's Groundwater*. https://cawaterlibrary.net/document/bulletin-118-californias-groundwater-2003/. Accessed: January 13, 2021.

California Department of Water Resources (DWR). 2016. Water Districts shapefile. https://data.cnra.ca.gov/dataset/water-districts. Accessed: March 31, 2016.

California Department of Water Resources (DWR). 2019. CA Bulletin 118 Groundwater Basins shapefile (updated 2018). https://data.cnra.ca.gov/dataset/ca-bulletin-118-groundwater-basins. Accessed: June 4, 2019.

California Department of Water Resources (DWR). n.d.(a). *California Data Exchange Center*. https://cdec.water.ca.gov/misc/CDEC_Brochure.pdf. Accessed: January 14, 2021.

California Department of Water Resources (DWR). n.d.(b). *SGMA Data Viewer*. https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#gwlevels. Accessed January 13, 2021.

California Department of Water Resources (DWR). n.d.(c). Groundwater Monitoring (CASGEM). https://water.ca.gov/Programs/Groundwater-

Management/Groundwater-Elevation-Monitoring--CASGEM. Accessed: October 30, 2020.

California Department of Water Resources (DWR). n.d.(d). Well Completion Report Mapp Application. https://www.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37. Accessed: November 16, 2020.

California Department of Water Resources, Northern Region Office (DWR NRO). December 2018. *2017 GPS Survey of the Sacramento Valley Subsidence Network*.

California Department of Water Resources, SGMA Portal. February 2017a. City of Live Oak GSA shapefile. https://sgma.water.ca.gov/portal/gsa/print/136. Accessed: August 24, 2020.

California Department of Water Resources, SGMA Portal. February 2017b. Sutter Community Service District GSA shapefile. https://sgma.water.ca.gov/portal/gsa/print/114. Accessed: August 24, 2020.

California Department of Water Resources, SGMA Portal. February 2017c. Sutter Extension Water District GSA shapefile. https://sgma.water.ca.gov/portal/gsa/print/121. Accessed: August 24, 2020.

California Department of Water Resources, SGMA Portal. March 2017. Reclamation District No. 1500 GSA shapefile. https://sgma.water.ca.gov/portal/gsa/print/239. Accessed: August 24, 2020.

California Department of Water Resources, SGMA Portal. April 2017. City of Yuba City GSA shapefile. https://sgma.water.ca.gov/portal/gsa/print/264. Accessed: August 24, 2020.

California Department of Water Resources, SGMA Portal. June 2017a. Reclamation District No. 70 GSA shapefile. https://sgma.water.ca.gov/portal/gsa/print/320. Accessed: August 24, 2020.

California Department of Water Resources, SGMA Portal. June 2017b. Reclamation District No. 1660 GSA shapefile. https://sgma.water.ca.gov/portal/gsa/print/321. Accessed: August 24, 2020.

California Department of Water Resources, SGMA Portal. July 2019a. Butte Water District GSA – Sutter shapefile. https://sgma.water.ca.gov/portal/gsa/print/119. Accessed: August 24, 2020.

California Department of Water Resources, SGMA Portal. July 2019b. County of Sutter GSA – Sutter shapefile. https://sgma.water.ca.gov/portal/gsa/print/218. Accessed: August 24, 2020.

California Department of Water Resources (DWR) and United States Bureau of Reclamation (USBR). September 2008. *2008 DWR/USBR Sacramento Valley Subsidence Project – Project Report*.

California Natural Resources Agency. January 2020. 2016 Statewide Crop Mapping GIS Map Service. https://data.cnra.ca.gov/dataset/statewide-crop-mapping/resource/653de2ff-d734-4a9a-b7a5-417c45ed83b5. Accessed: January 13, 2021.

California State Water Resources Control Board (SWRCB). n.d.(a). *GeoTracker – Download ESI Data by County*. https://geotracker.waterboards.ca.gov/data_download_by_county. Accessed: October 4, 2020.

California State Water Resources Control Board (SWRCB). n.d.(b). *What is a Public Water System?*. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/waterpartnerships/what_is_a_public_water_sys.pdf. Accessed: January 12, 2021.

California Water Boards. February 2009. *SWAMP Monitoring Plan – Sacramento Watershed Coordinated Monitoring Program*. https://www.waterboards.ca.gov/water_issues/programs/swamp/docs/workplans/regionalworkplan2.pdf. Accessed: January 14, 2021.

California Water Boards. 2009. *SWAMP Achievements Report – Sacramento Watershed Coordinated Monitoring Program*. https://www.waterboards.ca.gov/water_issues/programs/swamp/achievements/2009/monitoring/sac_coordmp.pdf. Accessed: January 14, 2021.

California Water Boards. 2016. *State Water Board 2016 Water Transfers*. https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_transfers/docs/2016transfertable.pdf. Accessed: July 19, 2021.

California Water Boards. 2018. *State Water Board 2018 Water Transfers*. https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_transfers/docs/2018transfertable.pdf. Accessed: July 19, 2021.

California Water Boards. June 2019. *SWAMP – Sacramento River Basin*. https://www.waterboards.ca.gov/centralvalley/water_issues/swamp/sacramento_river_basin/. Accessed: January 13, 2021.

California Water Boards. 2020. *State Water Board 2020 Water Transfers*. https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_transfers/docs/2020transfertable.pdf. Accessed: July 19, 2021.

California Water Boards. June 2020. *Storm Water Grant Program (SWGP) – Storm Water Resource Plans*.

https://www.waterboards.ca.gov/water_issues/programs/grants_loans/swrp/. Accessed: January 13, 2021.

California Water Boards. July 2020. *GAMA – About*. https://www.waterboards.ca.gov/water_issues/programs/gama/about.html. Accessed: January 13, 2021.

California Water Boards. December 2020(a). *GAMA Online Tools*. https://www.waterboards.ca.gov/water_issues/programs/gama/online_tools.html. Accessed: January 13, 2021.

California Water Boards. December 2020(b). *Surface Water Ambient Monitoring Program (SWAMP) – Statewide Monitoring Programs*. https://www.waterboards.ca.gov/water_issues/programs/swamp/monitoring/statewide_monitoring_programs.html. Accessed: January 13, 2021.

California Water Boards. 2021. State Water Board 2021 Water Transfers. https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_transfers/docs/2021transfertable_rev2.pdf. Accessed: July 19, 2021.

California Water Boards. n.d. *California Environmental Data Exchange Network*. https://ceden.waterboards.ca.gov/AdvancedQueryTool. Accessed: January 13, 2021.

Carollo Engineers, Pueblo Water Resources, and ASR Systems. November 2010. *Aquifer Storage Recovery Feasibility Assessment Report Prepared for City of Yuba City, California*.

Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS). December 2016. *Central Valley Region Salt and Nitrate Management Plan – Final Document for Central Valley Water Board Consideration*. https://www.cvsalinity.org/docs/central-valley-snmp/final-snmp.html. Accessed: January 13, 2021.

CH2M Hill. 2012. *Reclamation District No. 1500 Groundwater Management Plan*. February.

CH2M Hill. March 2016. *Groundwater Trend Monitoring Workplan and Data Gap Assessment Plan – Prepared for Central Valley Regional Water Quality Control Board On Behalf of California Rice Commission*. https://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/water_quality/coalitions_submittals/california_rice_commission/ground_water/2016_03_rice_gar.pdf. Accessed: January 13, 2021.

CH2M Hill and MBK Engineers. October 2016a. *Sacramento River Settlement Contactors Drought Management Plan*. https://wuedata.water.ca.gov/public/awmp_attachments/6089756608/Drought%20Mgmt%20Plan.pdf. Accessed: January 13, 2021.

CH2M Hill and MBK Engineers. October 2016b. *Water Balance Summary Prepared for Sacramento River Settlement Contractors*. https://wuedata.water.ca.gov/public/awmp_attachments/6360883414/Water%20Balance%20Summary_12.29.16.pdf. Accessed: January 13, 2021.

City of Live Oak. n.d. City of Live Oak 2030 General Plan. https://www.liveoakcity.org/Home/ShowDocument?id=494. Accessed: January 13, 2021.

City of Yuba City. 2004. Yuba City General Plan. https://www.yubacity.net/UserFiles/Servers/Server_239174/File/Development%20Services/Planning/Plans/General/YC-GPAC-APR-04-FINAL.pdf. Accessed: January 13, 2021.

Ducks Unlimited and The Trust for Public Land. 2021. National Conservation Easement Database. https://www.conservationeasement.us/interactivemap/. Accessed: February 5, 2021.

EcoLogic. 2009. City of Live Oak Water Master Plan.

GEI. 2016. *Alternative Submittal to a Groundwater Sustainability Plan for Sutter Subbasin, Sutter County, California*. 19 December.

GreenInfo Network. 2021. California Protected Areas Database, Version 2020b. http://www.mapcollaborator.org/cpad/?base=map&y=37.50973&x=-123.94775&z=6&layers=mapcollab_cpadng_cpad_ownlevel%2Cnotes%2Cpolygons%2Cuploads&opacs=50%2C100%2C25%2C90. Accessed: February 5, 2021.

Jacobs and Montgomery & Associates. May 2020. *2020 Rice-Specific Groundwater Assessment Report Update – Prepared for Central Valley Regional Water Quality Control Board On Behalf of California Rice Commission*.

Luhdorff & Scalmanini Consulting Engineers (LSCE). July 2018. *Groundwater Quality Trend Monitoring Workplan Addendum for the Sacramento Valley Water Quality Coalition*. https://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/water_quality/coalitions_submittals/sacramento_valley/ground_water/2018_0731_svwqc_gqtmp_add.pdf. Accessed: January 13, 2021.

MBK Engineers. October 2016. Sutter Mutual Water Company SBx7-7 Water Measurement Compliance Program. https://wuedata.water.ca.gov/public/awmp_attachments/3454450309/SMWC%20Water%20Measurement%20Program.pdf. Accessed: January 13, 2021.

No author. 1995. *Sutter Extension Water District Groundwater Management Plan*. August.

No author. 1996. *Butte Water District Groundwater Management Plan*. May.

No author. 2005. *Groundwater Management Plan of Feather Water District*. November.

No author. 2012. *2012 Sacramento Valley Regional Water Management Plan Annual Update*. https://wuedata.water.ca.gov/public/awmp_attachments/8930585563/2012%20RWMP%20Annual%20Update%209.6.13.pdf. Accessed: January 13, 2021.

Northern California Water Association (NCWA). September 2016. *Feather River Regional Agricultural Water Management Plan - Volume II: Supplier Plan Components Sutter Extension Water District*. https://wuedata.water.ca.gov/public/awmp_attachments/8171979606/II.6.%20SEWD%20AWMP%20Final.pdf. Accessed: January 13, 2021.

Northern California Water Association (NCWA). December 2016. *Feather River Regional Agricultural Water Management Plan – Volume II: Supplier Plan Components Butte Water District*. https://wuedata.water.ca.gov/public/awmp_attachments/2549176871/Butte%20WD%202016%20AWMP.pdf. Accessed: January 13, 2021.

Northern California Water Association (NCWA). April 2021. *Feather River Regional Agricultural Water Management Plan – Volume I: Regional Plan Components*. https://static1.squarespace.com/static/56f3336d9f7266fac154ef8b/t/609c3443b381117ad8bd97d6/1620849749379/I.1-7+Regional+AWMP_final.pdf. Accessed: August 5, 2021.

Northern Sacramento Valley Integrated Regional Water Management Group. March 2020. *2014 Northern California Sacramento Valley Integrated Regional Water Management Plan, Updated March 2020*. https://nsvwaterplan.org/mdocuments-library/#. Accessed: January 13, 2021.

Sacramento River Watershed Data Program. n.d. *About the Sacramento River Coordinated Monitoring Program*. https://data.sacriver.org/explore_data_custom/sacramento-river-watershed-cmp. Accessed: January 14, 2021.

Sutter County. 2011. *Sutter County General Plan – Policy Document*. https://www.suttercounty.org/assets/pdf/cs/ps/General_Plan_Policy_Document_Dec_2015_Amended_Sep2019.pdf. Accessed: January 13, 2021.

Sutter County. n.d. *Sutter County Code of Ordinances, 700 – Health and Sanitation, Chapter 768 Water Wells*. https://library.municode.com/ca/sutter_county/codes/code_of_ordinances?nodeId=n700HESA_CH765WAWE. Accessed: January 13, 2021.

Sutter County Environmental Health Division (SCEHD). July 2013. *Water Well Permit Application*.

https://www.suttercounty.org/assets/pdf/cs/ehs/well_permit_application.pdf. Accessed: January 13, 2021.

Tully & Young. 2021. *City of Yuba City 2020 Urban Water Management Plan*. https://wuedata.water.ca.gov/public/uwmp_attachments/8303815543/Yuba%202020%20UWMP%20%28Final%29.pdf. Accessed: August 5, 2021.

United States Bureau of Reclamation (USBR). July 2004. *Evaluation of Groundwater Potential for Incremental Level 4 Refuge Water Supply*. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=92276&inline. Accessed: November 11, 2021.

United States Department of the Interior, Bureau of Land Management. 2018. BLM National Surface Management Agency Area Polygons shapefiles. https://catalog.data.gov/dataset/blm-national-surface-management-agency-area-polygons-national-geospatial-data-asset-ngda. Accessed: November 30, 2020.

United States Geological Survey (USGS). n.d. *National Water Information System: Web Interface*. https://waterdata.usgs.gov/nwis. Accessed: January 13, 2021.

West Yost Associates. 2018. *Yuba City Basin Storm Water Resource Plan*. https://www.yubacity.net/UserFiles/Servers/Server_239174/File/Public%20Works/Engineering/Stormwater%20Management/SWRP/SWRP%20Final/Yuba%20City_FINAL%20Storm%20Water%20Resource%20Plan%20July%202018_reduced.pdf. Accessed: January 13, 2021.

West Yost Associates. 2019. *City of Yuba City Water Treatment Plant and Distribution System Master Plan – Volume I and Volume II*. https://www.yubacity.net/UserFiles/Servers/Server_239174/File/Public%20Works/Utilities/Water/City%20of%20Yuba%20City%20WMP_Vol%201.pdf and https://www.yubacity.net/UserFiles/Servers/Server_239174/File/Public%20Works/Utilities/Water/City%20of%20Yuba%20City%20WMP_Vol%202.pdf. Accessed: January 13, 2021.

Wood Rodgers. 2012. *Sutter County Groundwater Management Plan*. Available at: https://www.suttercounty.org/contents/pdf/pw/wr/gmp/Sutter_County_Final_GMP_20120319.pdf. Accessed: January 12, 2021.

This page intentionally left blank.

CHAPTER THREE

Governance & Administration

This page intentionally left blank

3. GOVERNANCE AND ADMINISTRATION

This chapter includes information pursuant to Article 5. Plan Contents, Subarticle 1. Administrative Information, § 354.6 (Agency Information), as well as Subarticle 8. Interagency Agreements (§ 357.2 Interbasin Agreements and § 357.4 Coordination Agreements), as required by the Groundwater Sustainability Plan (GSP) Emergency Regulations. Agency Contact information for the Sutter Subbasin GSP and the plan manager is included herein. The organization and management structure, as well as the legal authority of each Groundwater Sustainability Agency (GSA) in the Sutter Subbasin, is detailed and accompanied by a GSA boundary map and a description of agreements in place for development of the Sutter Subbasin GSP and associated costs.

3.1 Agency Contact Information

This GSP was prepared in a cooperative manner by nine GSAs in the Sutter Subbasin. The following GSAs submitted a Notification of Intent to the California Department of Water Resources (DWR) to develop a single GSP for the Sutter Subbasin on May 29, 2020:

- Butte Water District GSA – Sutter
- City of Live Oak GSA
- City of Yuba City GSA
- County of Sutter GSA – Sutter
- Reclamation District No. 70 GSA
- Reclamation District No. 1500 GSA
- Reclamation District No. 1660 GSA
- Sutter Community Services District GSA
- Sutter Extension Water District GSA

The location and proximity of these GSAs are shown in **Figure 3-1**.

The GSP Emergency Regulations require the GSP to designate a plan manager to serve as a point of contact with DWR. Contact information for the Sutter Subbasin GSP is as follows:

Mr. Guadalupe Rivera, Plan Manager
Sutter County Public Works
1130 Civic Center Blvd
Yuba City, CA 95993
Phone: (520)-822-7400 / Fax: (530)-822-7457
grivera@co.sutter.ca.us

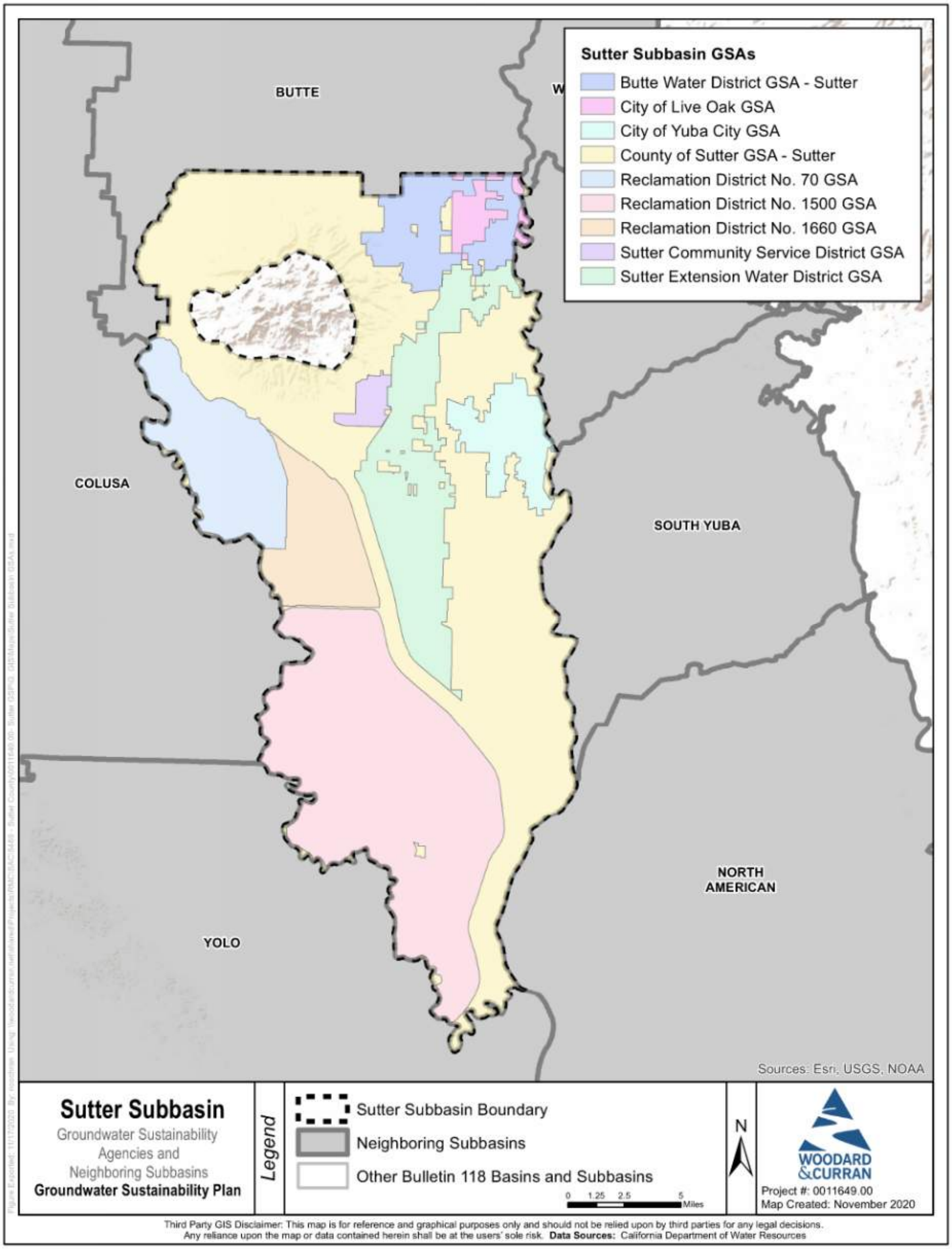


Figure 3-1. Sutter Subbasin GSA Boundaries

3.2 Sutter Subbasin Groundwater Sustainability Agencies

The nine Sutter Subbasin GSAs each have their own individual organization and management structures as well as legal authority under which they operate. The following subsections include a description of the organization and management structure and persons with management authority to implement the GSP; the legal authority of the GSA setting forth the duties, powers, and responsibilities of the GSA to implement the GSP; and the name and mailing address for the GSA (also included in **Table 3-1**). **Figure 3-1** shows the boundaries of the nine GSAs.

3.2.1 Butte Water District GSA - Sutter

The Butte Water District GSA – Sutter operates within its current organization and management structure under the Butte Water District Board of Directors, as well as its legal authority as a special district. Butte Water District exercises all relevant duties, powers, and responsibilities as a GSA to implement the Sutter Subbasin GSP. Public notices and permanent records are maintained on the Butte Water District website at buttewaterdistrict.org.

3.2.2 City of Live Oak GSA

The City of Live Oak GSA operates within its current city organization and management structure. Its legal authority as a City is described in the City Charter. The City of Live Oak has the ability to exercise all relevant duties, powers, and responsibilities to implement the Sutter Subbasin GSP. Public noticing and records regarding decisions made to support the Sutter Subbasin GSP are maintained as part of City Council records in accordance with City ordinances and protocols. Public notices and permanent records are maintained on the City's website at www.liveoakcity.org.

3.2.3 City of Yuba City GSA

The City of Yuba City GSA operates within its current city organization and management structure. As with the City of Live Oak, the City of Yuba City's legal authority is described in the City Charter. The City of Yuba City has the ability to exercise all relevant duties, powers, and responsibilities to implement the Sutter Subbasin GSP. Public noticing and records regarding decisions made to support the Sutter Subbasin GSP are maintained as part of City Council records in accordance with City ordinances and protocols. Public notices and permanent records are maintained on the City's website at www.yubacity.net.

3.2.4 County of Sutter GSA – Sutter

The County of Sutter GSA – Sutter represents communities, water districts, and other entities within Sutter County which are outside of the other GSA boundaries but within the county limits of the Sutter Subbasin. The County of Sutter GSA operates within its current organization and management structure under the Sutter County Board of

Supervisors. Public notices and permanent records are maintained on Sutter County's website at suttercounty.org. The County-default provision in the Sustainable Groundwater Management Act (SGMA) (Section 10724) is used to provide coverage in the Subbasin for the "white areas" or other areas of non-GSA coverage within Sutter County.

3.2.5 Reclamation District No. 70 GSA

The Reclamation District No. 70 GSA operates within its current organization and management structure under the Reclamation District No. 70 Board of Trustees, as well as its legal authority as a special district and provisions of the California Reclamation District Law (California Water Code Division 15). Reclamation District No. 70 exercises all relevant duties, powers, and responsibilities as a GSA to implement the Sutter Subbasin GSP. Public notices and permanent records are maintained at the District's office.

3.2.6 Reclamation District No. 1500 GSA

The Reclamation District No. 1500 GSA operates within its current organization and management structure under the Reclamation District No. 1500 Board of Trustees, as well as its legal authority as a special district and provisions of the California Reclamation District Law (California Water Code Division 15). Reclamation District No. 1500 exercises all relevant duties, powers, and responsibilities as a GSA to implement the Sutter Subbasin GSP. Public notices and permanent records are maintained at the District's office.

3.2.7 Reclamation District No. 1660 GSA

The Reclamation District No. 1660 GSA operates within its current organization and management structure under the Reclamation District No. 1660 Board of Trustees, as well as its legal authority as a special district and provisions of the California Reclamation District Law (California Water Code Division 15). Reclamation District No. 1660 exercises all relevant duties, powers, and responsibilities as a GSA to implement the Sutter Subbasin GSP. Public notices and permanent records are maintained at the District's office.

3.2.8 Sutter Community Services District GSA

The Sutter Community Services District GSA operates within its current organization and management structure under the Sutter Community Services District Board of Directors, as well as its legal authority as a special district. Sutter Community Services District exercises all relevant duties, powers, and responsibilities as a GSA to implement the Sutter Subbasin GSP. Public notices and permanent records are maintained on the Sutter Community Services District website at sutterwater.com.

3.2.9 Sutter Extension Water District GSA

The Sutter Extension Water District GSA operates within its current organization and management structure under the Sutter Extension Water District Board of Directors, as well as its legal authority as a special district. Sutter Extension Water District exercises all relevant duties, powers, and responsibilities as a GSA to implement the Sutter Subbasin GSP. Public notices and permanent records are maintained on the Sutter Extension Water District website at sutterewd.com.

This page intentionally left blank.

Table 3-1. Sutter Subbasin GSAs Contact Information

GSA	Point of Contact	Mailing Address	Phone Number	Email
Butte Water District	Mark Orme	735 Virginia St Gridley, CA 95948	(530) 846-3100	MOrme@buttewater.net
City of Live Oak	Nicole Rosser	1129 D St P.O. Box A Marysville, CA 95901	(530) 742-5982	NDelerio@yubasutterlaw.com
City of Yuba City	Katherine Willis	302 Burns Dr Yuba City, CA 95991	(530) 645-6346	kwillis@yubacity.net
County of Sutter	Guadalupe Rivera	1120 Civic Center Blvd Yuba City, CA 95993	(530) 822-7400	GRivrea@co.sutter.ca.us
Reclamation District No. 70	Andy Duffey	P.O. Box 129 Meridian, CA 95957	(530) 696-2456	aduffey@succeed.net
Reclamation District No. 1500	Jon Scott	P.O. Box 96 Robbins, CA 95676	(530) 738-4423	jscott@sutterbasinwater.com
Reclamation District No. 1660	Andy Duffey	P.O. Box 35 Meridian, CA 95957	(530) 696-0349	aduffey@succeed.net
Sutter Community Services District	Leland Correll	P.O. Box 710 Sutter, CA 95982	(530) 755-1733	Sutterwater@aol.com
Sutter Extension Water District	Lynn Phillips	4525 Franklin Rd Yuba City, CA 95993	(530) 870-1712	LPhillips@sutterewd.com

This page intentionally left blank.

3.3 GSA Coordination and Governance

The Sutter Subbasin GSAs are coordinating with each other to develop a single GSP for the Subbasin under a Memorandum of Understanding (MOU), included in **Appendix 3-A** *Memorandum of Understanding for Sustainable Groundwater Management* of this GSP.

3.3.1 Memorandum of Understanding for Sustainable Groundwater Management

Effective April 27, 2021, the County of Sutter GSA, Butte Water District GSA, City of Live Oak GSA, Sutter Extension Water District GSA, Sutter Community Services District GSA, City of Yuba City GSA, Reclamation District No. 70 GSA, Reclamation District No. 1500 GSA, and Reclamation District No. 1660 GSA (collectively referred to as the Sutter Subbasin GSAs) entered into a MOU for sustainable groundwater management. Referred to as the Coordination Agreement, the purpose of the MOU/Coordination Agreement is to:

- Cooperatively carry out the purposes of SGMA;
- Provide for coordination among the GSAs to develop and implement a GSP and/or facilitate a Coordination Agreement;
- Develop, adopt, and implement a legally-sufficient GSP covering those portions of the Subbasin that are within the jurisdictional boundaries of the GSAs; and
- Satisfy the requirements of SGMA for coordination among GSAs.

Key principles of the Coordination Agreement include:

1. The GSAs working together in mutual cooperation to develop one GSP in compliance with SGMA for the sustainable management of groundwater in the Subbasin.
2. The designation of a Plan Manager for the GSP and delegation of management authority to that person for submitting the Plan and any subsequent documents required under SGMA and for serving as the point of contact between the GSAs and DWR.
3. Mutual cooperation to the extent possible to jointly implement the GSP within the Subbasin.
4. The ability of a GSA to implement the GSP within its boundaries and to coordinate such implementation in accordance with the requirements of SGMA.

The Coordination Agreement does not limit or interfere with the right and authority of any GSA over its own internal matters, nor does it limit a GSA's legal rights to surface water supplies and assets, groundwater supplies and assets, facilities, operations, water management and water supply matters. However, the Sutter Subbasin GSAs intend, through the Agreement, to cooperate to identify mechanisms for the expected

Subbasin management and to use the same data and consistent methodologies for developing and implementing a GSP.

Activities performed under the Coordination Agreement will be guided by the Sutter Subbasin Groundwater Management Coordination Committee (SSGMCC). The Committee contains one representative from each GSA, with a pre-determined alternate. Through the Coordination Committee, the GSAs are working collaboratively under the terms of the Agreement to develop recommendations for the technical and substantive Subbasin-wide issues. Recommendations are reached primarily by consensus; but if a vote is required, a simple majority vote of the Coordination Committee is conducted and the recommendation is submitted to each GSA's governing board for final approval. The governing body of each GSA must approve the recommendations of the Coordination Committee prior to them becoming effective.

Coordination Committee activities may include, but are not limited to, the following:

1. Providing technical direction for GSP development, including development of sustainable management criteria (SMC);
2. Identifying projects and management actions to be included for GSP implementation;
3. Recommending budget(s) and appropriate cost sharing for any project or program that requires funding;
4. Providing guidance and options for obtaining grant funding;
5. Recommending adoption of rules, regulations, policies, and procedures related to the Agreement;
6. Recommending approval of any contracts with consultants or subcontractors that would undertake work on behalf of the GSAs;
7. Reporting to GSA respective governing boards when dispute resolution is needed to resolve an impasse or inability to make a consensus recommendation;
8. Recommending action and/or approval of a GSP.

3.4 Interbasin Agreements

The Sutter Subbasin GSAs have not entered into any formal agreements with other GSAs in adjacent groundwater subbasins to date. Existing collaborative relationships between the Sutter Subbasin GSAs and GSAs in adjacent subbasins are maintained through ongoing voluntary participation in meetings of the SGMA Coordination - Sacramento River Basin group convened by the Northern California Water Association (NCWA). These relationships will be maintained and fostered throughout GSP development and implementation to establish compatible sustainability goals and understanding regarding fundamental elements of each GSP as they related to sustainable groundwater management.

3.5 Coordination Agreements

A single GSP will be developed and implemented by the nine GSAs in the Sutter Subbasin; therefore, a coordination agreement, as defined under § 357.4 of the GSP Emergency Regulations, is not required. The Sutter Subbasin GSAs have entered into an MOU for sustainable groundwater management, which is described in **Section 3.3.1**.

3.6 Estimated Cost Share of Implementing the GSP

An estimated cost of implementing the Sutter Subbasin GSP and a general description of how the Sutter Subbasin GSAs plan to meet these costs are discussed in **Chapter 8** *Plan Implementation*.

This page intentionally left blank.

CHAPTER FOUR

Outreach & Communication

This page intentionally left blank

4. OUTREACH AND COMMUNICATION

This chapter includes information pursuant to Article 5. Plan Contents, Subarticle 1. Administrative Information, §354.10 (Notice and Communication), as required by the Groundwater Sustainability Plan (GSP) Emergency Regulations.

The outreach strategies and communication methods presented in this chapter were developed to support the preparation and implementation of a well-informed GSP through effective communication with stakeholders during the GSP development. The desired outcome was, and continues to be, to consider the interests of all beneficial uses and users of groundwater in addition to the diverse social, cultural, and economic elements of the population within the Sutter Subbasin. This includes stakeholder input and coordination with adjacent subbasins.

4.1 Description of Beneficial Uses and Users in Plan Area

Pursuant to Section 10723.2 of the California Water Code, each Groundwater Sustainability Agency (GSA) must consider the interests of all beneficial uses and users of groundwater within the Subbasin, as well as those responsible for implementing GSPs. These interests include the following:

- Agricultural users (including farmers, ranchers, and dairy professionals)
- Domestic well owners
- Municipal well operators
- Public water systems
- Local land use planning agencies
- Environmental users of groundwater
- The federal government (not limited to the military and managers of federal lands)
- California Native American tribes
- Disadvantaged communities
- Adjacent subbasins

A list of beneficial users identified is included in **Table 4-1**.

Table 4-1. Beneficial Users

Category of Interest	Stakeholder Group/ Organization
Agricultural Users	• Holders of overlying groundwater rights • Small farms throughout the County • County Farm Bureau • County Agricultural Commission • Agricultural district representatives
Domestic Well Owners	• Domestic wells overlying the Subbasin; most well owners are *de minimis users* as defined by SGMA.
Municipal Well Operators and Public Water Systems	• City of Live Oak • City of Yuba City • Sutter Community Services District • East Nicolas Mutual Water Company • Golden State Water Company
Local Land Use Planning Agencies	• Sutter County • City of Live Oak • City of Yuba City • Adjacent GSAs with land use planning authority
Environmental Users of Groundwater	• American Rivers • The Audubon Society • The Nature Conservancy • South Yuba River Citizens League
Surface Water Users	• City of Yuba City • Butte Slough Irrigation Company • Garden Highway Mutual Water Company • Pelger Mutual Water Company • Meridian Farms Water Company • Tisdale Irrigation District • Tudor Mutual Water Company • Sutter Bypass Butte Slough Water Association • Sutter Extension Water District • Butte Water District • Feather Water District • Sutter Mutual Water Company • Individual water rights holders

Category of Interest	Stakeholder Group/ Organization
	• Sutter National Wildlife Refuge • Butte Sink Wildlife Management Area
Federal Government Agencies	• United States Department of Agriculture Farm Services Agency • United States Fish and Wildlife Service
California Native American Tribes	• Estom Yumeka Maidu Tribe of the Enterprise Rancheria • Mooretown Rancheria of Maidu Indians • Shingle Springs Band of Miwok Indians • Pakan'yani Maidu of Strawberry Valley Rancheria • United Auburn Indian Community of the Auburn Rancheria • Yocha Dehe Wintun Nation
Disadvantaged Communities	• Yuba City • Meridian • Robbins • Live Oak
Adjacent Subbasins	• Butte • Colusa • North American • North Yuba • South Yuba • Wyandotte Creek • Yolo
Additional Stakeholders	State and Local Agencies • California Department of Water Resources • State Water Resources Control Board • California Department of Fish and Wildlife • California Department of Parks and Recreation • California Wildlife Conservation Board • California Natural Resources Agency Business Interests • Workers and laborers in Sutter County • Colusa Produce Corporation • California Rice Commission

Category of Interest	Stakeholder Group/ Organization
	Local Communities and Community Organizations • Shady Creek Outdoor Education Foundation • Community Alliance with Family Farmers • Local Government Commission Environmental Interests and Organizations • American Rivers • Union of Concerned Scientists • Audubon California • Sierra Club • Sutter Buttes Regional Land Trust • The Nature Conservancy • Sacramento Valley Quality Coalition • California Rice Commission

4.1.1 Human Right to Water

Assembly Bill (AB) 685 was signed on September 25, 2012 and made California the first state to legislatively recognize the human right to water. California Water Code (CWC) Section 106.3 recognizes that "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes." This right extends to all Californians, including disadvantaged, rural, and urban communities. Senate Bill (SB) 200 was signed on July 24, 2019 and established an ongoing fund to help communities access safe drinking water. In accordance with SB 200, the State Water Board developed the Aquifer Risk Map to help prioritize areas where domestic wells and state small water systems may be accessing groundwater that does not meet primary drinking water standards.

The Aquifer Risk Map includes a combined risk layer that melds a water quality risk layer and a well density layer to assign percentile scores to each Census block group. Areas with high risk of exceeding water quality standards and high well densities receive higher scores, indicating high risk, while areas with low risk of exceeding water quality standards and low densities receive lower scores, indicating low risk (SWRCB, 2021). Results of the Aquifer Risk Map for the Sutter Subbasin indicate high combined risk in the eastern portion of the Subbasin, particularly in areas in and near Yuba City (**Figure 4-1**).

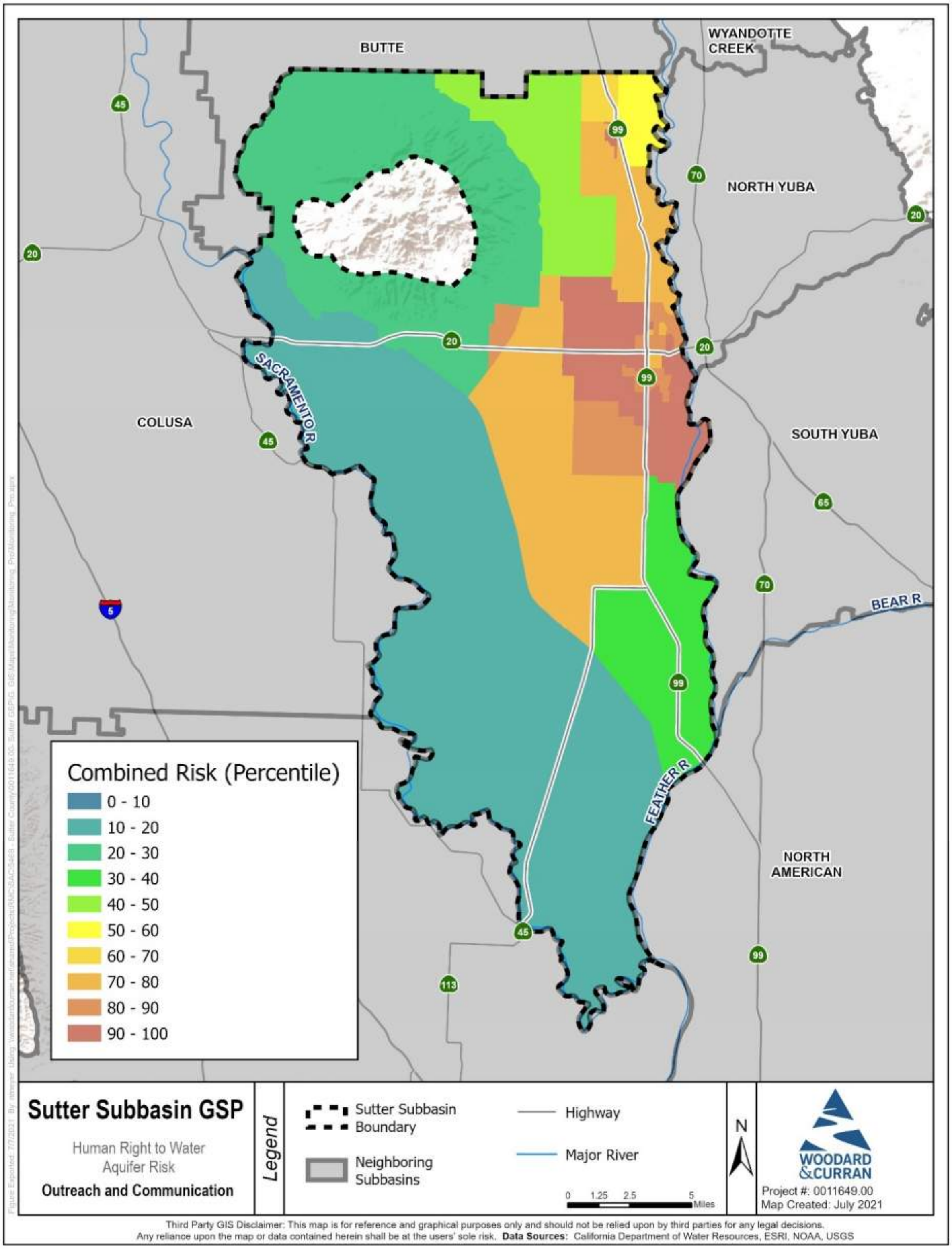


Figure 4-1. Combined Aquifer Risk

4.1.2 Underrepresented Communities

Underrepresented Communities consist of Disadvantaged Communities (DACs), Severely Disadvantaged Communities (SDACs), Economically Distressed Areas (EDAs), Environmentally Disadvantaged Communities (EnvDACs), and/or Fringe Communities in the Sutter Subbasin. DACs, SDACs, and EDAs in the Sutter Subbasin are defined and mapped using American Community Survey data from the U.S. Census (consistent with the DAC and EDA mapping tools). EnvDACS and Fringe Communities in the Sutter Subbasin are defined based on CalEnviroScreen 4.0 Pollution Burden and Population.

4.1.2.1 Disadvantaged and Severely Disadvantaged Communities

DACs are defined by the California Department of Water Resources (DWR) as areas with a median annual household income (MHI) less than 80% of the Statewide annual MHI. SDACs are defined as areas with a MHI less than 60% of the Statewide annual MHI (DWR, n.d.). The most recent dataset used by the DWR DAC Mapping Tool is the U.S. Census Bureau's American Community Survey (ACS) 2014-2018 dataset. According to the ACS 2014-2018 dataset, the MHI in California was $71,228. Communities in the Sutter Subbasin with MHIs of $56,982 (80% of $71,228) or less are therefore considered DACs, and communities with an MHI of $42,737 (60% of $71,228) or less are therefore considered SDACs.

Communities defined as DACs and SDACs make up a large portion of the Sutter Subbasin, covering the entire southern portion of the Subbasin, and include the communities of Yuba City, Meridian, Robbins, and Live Oak (**Figure 4-2**). A significant portion of the geographic area of the Subbasin (67.8%) contains DACs and SDACs. **Table 4-2** includes the proportion of DACs and SDACs in the Subbasin based on geographic area.

Table 4-2. DACs and SDACs as a Percentage of the Sutter Subbasin Geographic Area

Area	Geographic Area (Square Miles)	% Based on Geographic Area
SDAC	14.6	3.3%
DAC (including SDAC)	302.8	67.8%
Sutter Subbasin	*446.6*	*100%*

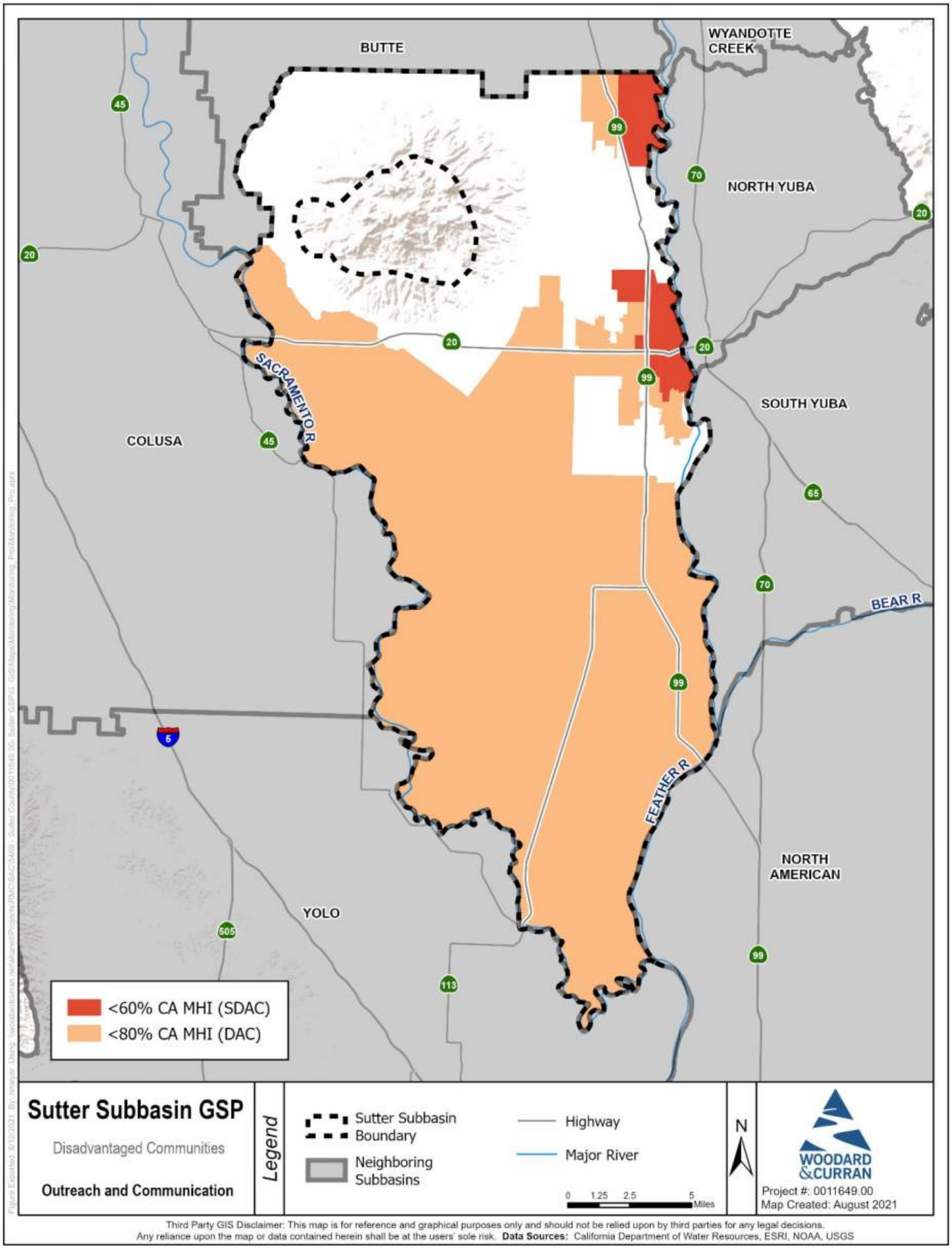


Figure 4-2. Disadvantaged Communities

4.1.2.2 Economically Distressed Areas

EDAs are defined as a municipality or isolated and divisible segment of a larger municipality with a population of 20,000 persons or less, an annual median household income that is less than 85% of the Statewide median household income, and with one or more of the following conditions:

1. Financial hardship;
2. Unemployment rate at least 2% higher than the Statewide average; or
3. Low population density (100 people/mi^2 or less).

The most recent dataset used by the DWR EDA Mapping Tool is the U.S. Census Bureau's ACS 2012-2016 dataset. According to the ACS 2012-2016 dataset, the MHI in California was $63,783. Communities in the Sutter Subbasin with MHIs of $54,215 or less are considered EDAs if paired with one other criterion listed above and has a population of less than 20,000 people.

Using the ArcGIS Map Package from the DWR EDA Mapping Tool, an EDA analysis was performed for the Sutter Subbasin. The results from that analysis were compiled in a figure representing a combination of census place, tract, and block group level geography. As shown in **Figure 4-3**, Criterion 2 (unemployment rate at least 2% higher than Statewide average) and Criterion 3 (low population density) were used to determine EDAs within the Sutter Subbasin.

A significant portion of the geographic area of the Subbasin contains EDAs. In all, 63.8% of the geographic area within the Subbasin consists of areas considered to meet either EDA Criterion 2 or Criterion 3. **Table 4-3** includes the proportion of EDAs in the Subbasin based on geographic area.

Table 4-3. EDAs as a Percentage of the Sutter Subbasin Geographic Area

Area	Geographic Area (Square Miles)	% Based on Geographic Area
EDA Criterion 2	284.9	63.8%
EDA Criterion 3	224.0	50.2%
EDA Criterion 2 or 3	284.9	63.8%
Sutter Subbasin	*446.6*	*100%*

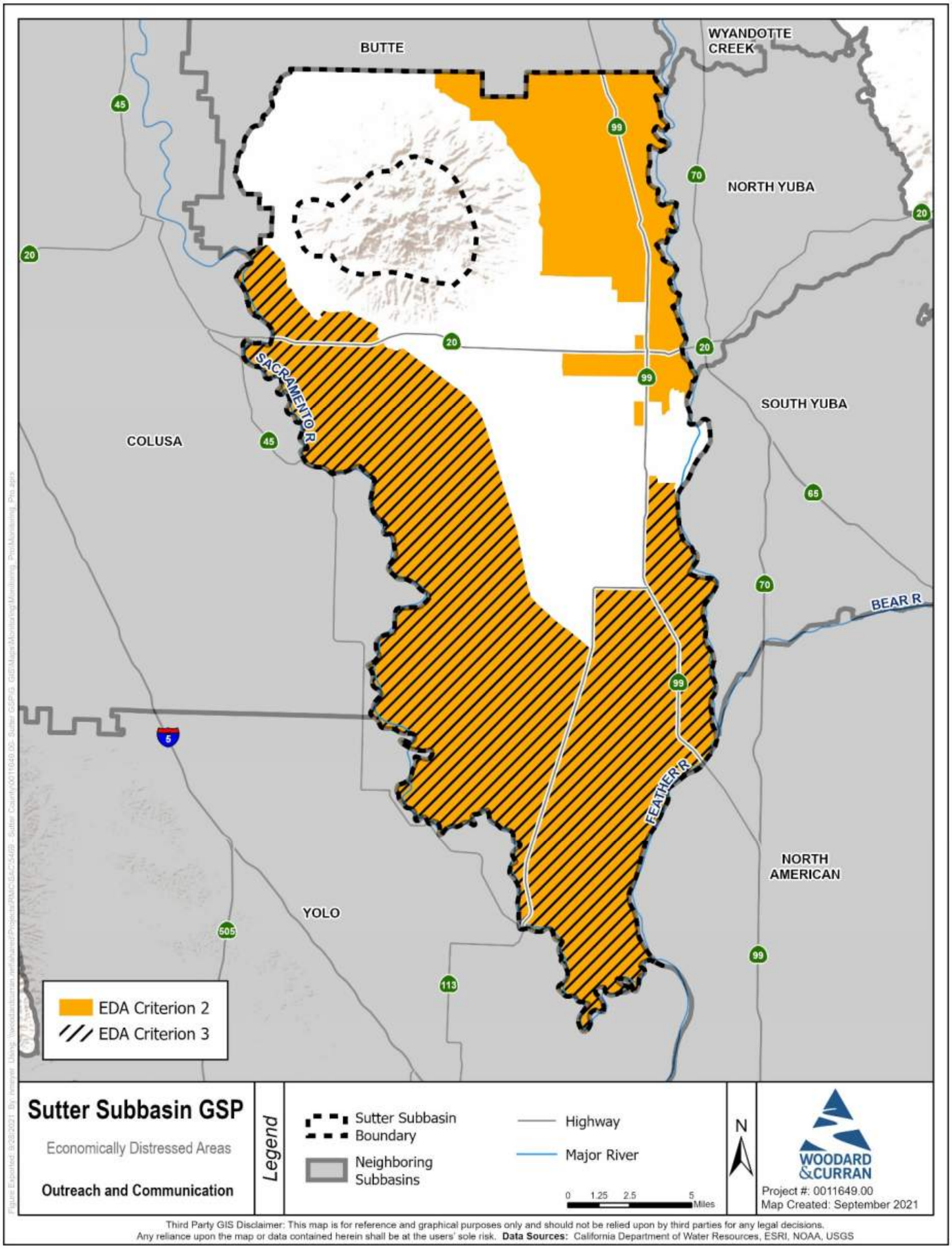


Figure 4-3. Economically Distressed Areas

4.1.2.3 Environmentally Disadvantaged Communities

As defined in DWR's Sustainable Groundwater Management Program, an environmentally disadvantaged community (EnvDAC) is a census tract that scores in the top 25% of CalEnviroScreen version 4.0 scores, or a census tract that scores in the highest 5% of Pollution Burden scores but does not have an overall CalEnviroScreen score because of unreliable socioeconomic or health data.

Figure 4-4 shows the results from the EnvDAC analysis performed for the Sutter Subbasin. **Table 4-4** includes the proportion of EnvDACs in the Subbasin based on geographic area.

Table 4-4. EnvDACs as a Percentage of the Sutter Subbasin Geographic Area

Area	Geographic Area (Square Miles)	% Based on Geographic Area
EnvDAC	5.2	1.2%
Sutter Subbasin	*446.6*	*100%*

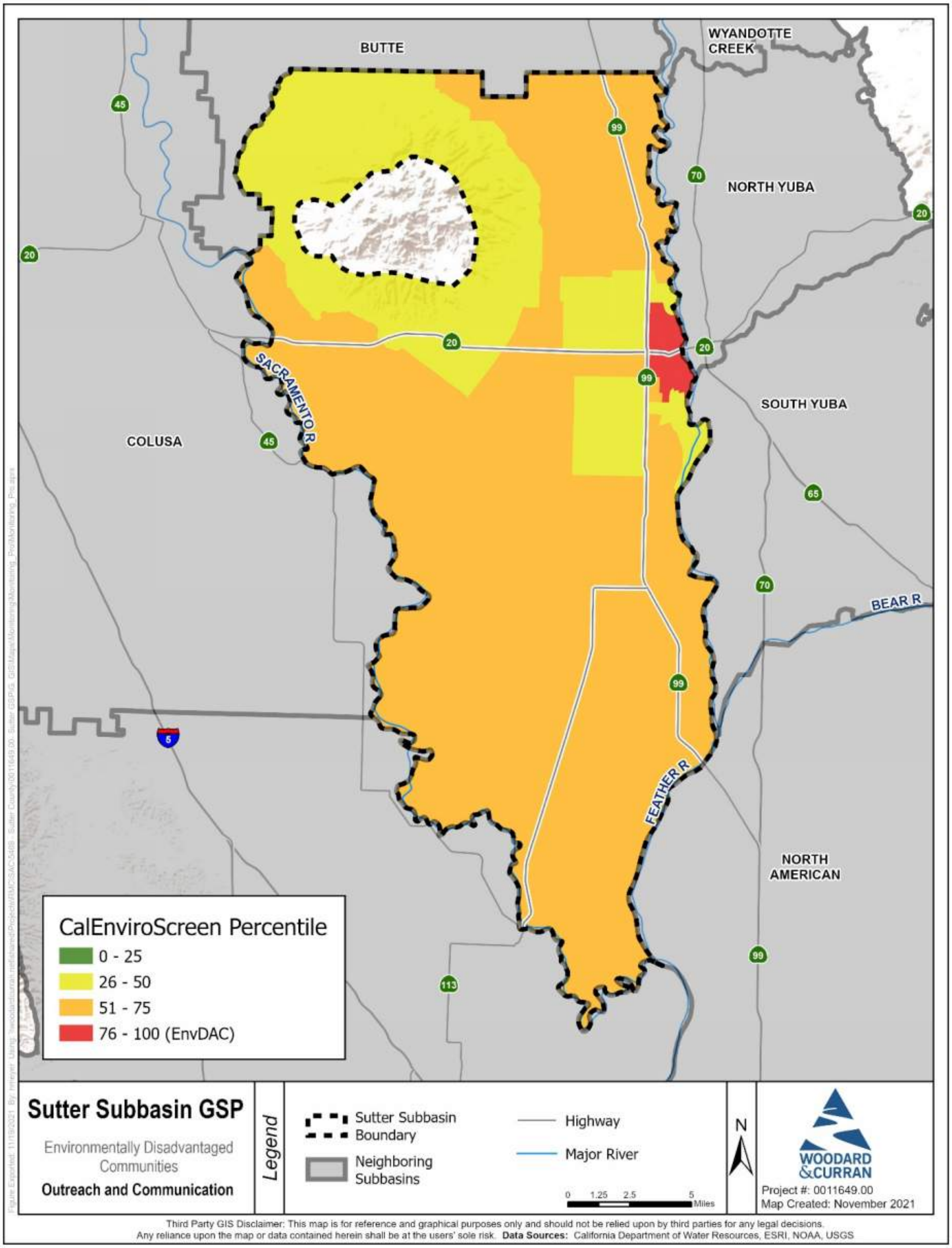


Figure 4-4. Environmentally Disadvantaged Communities

4.1.2.4 Fringe Communities

As defined in DWR's Sustainable Groundwater Management Program, a "Fringe Community" is a community that does not meet the established DAC, SDAC, and EDA definitions but can show that they score in the top 25% of either the Pollution Burden or Population Characteristics score using the CalEnviroScreen version 4.0.

All areas in the Sutter Subbasin that score in the top 25% of the Pollution Burden or Population Characteristics score using the CalEnviroScreen version 4.0 meet established DAC, SDAC, and/or EDA definitions. Therefore, no areas defined as Fringe Communities exist in the Sutter Subbasin.

4.1.2.5 California Native American Tribes

The GSAs contacted the Native American Heritage Commission (NAHC) to obtain a tribal contact list. The NAHC identified four tribes with potential cultural and traditional affiliation to the Sutter Subbasin (as noted in **Table 4-1**). Tribal representatives were invited to participate in the GSP development process. However, there were no tribal interests or water issues specific to Native American Tribal Communities identified through this outreach process.

4.2 Plan Development

The Sutter Subbasin Groundwater Management Coordination Committee (SSGMCC) and the GSA Boards worked with Contributing Parties and Stakeholders during the GSP development (**Figure 4-5**). These groups are defined in more detail in the sections below.

Figure 4-5. Levels of Engagement

4.2.1 Decision Making Process / Governance

4.2.1.1 GSA Boards

The GSA Boards are the designated decision-making entities for the GSP development and implementation process. Only applicable Board meetings affecting the Subbasin in its entirety are noticed on the Sutter Subbasin website, including for the adoption of the final GSP; individual board meetings are noticed on their individual websites.

The respective GSA's Boards assigned their SSGMCC members to work on the day-to-day development of the GSP and to conduct stakeholder communication and engagement. The GSA Boards are responsible for:

- Ensuring appropriate communication and engagement is executed per the approved Communication and Engagement (C&E) Plan on behalf of their GSAs (included herein as **Appendix 4-A**)
- Approving interim milestones to meet the mandated schedule for sustainability as set forth in the final GSP
- Being informed about the GSP development by their designated SSGMCC members
- Providing their respective SSGMCC members with their insights, perspectives, and opinions
- Ultimately adopting the final GSP prior to submittal to DWR by January 31, 2022

4.2.1.2 Sutter Subbasin Groundwater Management Coordination Committee

The SSGMCC acts as the primary body for providing input relative to GSP development, briefing the GSAs Boards, and assisting with stakeholder engagement throughout the Subbasin. The SSGMCC hosted public workshops periodically throughout the GSP development process, in addition to holding open regular meetings noticed according to Brown Act requirements. Both the public workshops and the SSGMCC meetings were noticed a minimum of 72 hours in advance, and agendas, meeting materials, and minutes were made available on the Sutter Subbasin website (http://suttersubbasin.org/). SSGMCC members include:

- Guadalupe Rivera, Sutter County GSA
- Mark Orme, Butte Water District GSA
- Scott Rolls, City of Live Oak GSA
- Lynn Phillips, Sutter Extension Water District GSA
- Leland Correll, Sutter Community Services District GSA
- Kathy Willis, City of Yuba City GSA
- Andy Duffey, Reclamation District No. 70 GSA & Reclamation District No. 1660 GSA
- Jon Scott, Reclamation District No. 1500 GSA

The SSGMCC was originally formed to support development of the Subbasin's Alternative Plan. With the preparation of the GSP, the SSGMCC prepared a memorandum of understanding (MOU), adopted on April 27, 2021, to guide development and implementation of the GSP.

The SSGMCC is comprised of voting representatives from each of the nine GSAs within the Subbasin along with non-voting representatives from non-GSA entities contributing to the development of the GSP. The SSGMCC generally follows a consensus-based decision-making structure where each representative receives an equal voice; however, voting members provide the final decision-making structure and generally follows a simple majority vote process. The SSGMCC held publicly-noticed regular coordination meetings to discuss GSP technical development and public outreach and engagement activities in order to prepare a GSP for ultimate adoption by the respective GSA Boards. Meeting notices and materials are posted on the Subbasin's website (http://suttersubbasin.org).

The SSGMCC agreed to a set of principles for engagement and operation intended to provide a framework of commitments among the members to work collaboratively, efficiently, and with the necessary dedication to promote the development, adoption, and submission of a SGMA compliant GSP by the statutory deadline of January 31, 2022.

The SSGMCC is responsible for:

- Sharing feedback from their respective GSA's related to GSP development
- Making recommendations to their respective GSA Boards regarding the consideration and adoption of the GSP
- Providing or ensuring the provision of timely responses and supporting information related to GSP development to the consultants preparing the GSP upon request in order to meet the state-mandated deadline
- Performing and supporting appropriate and coordinated outreach to stakeholders within the Subbasin
- Ultimately delivering an acceptable GSP to all GSA Boards for adoption

4.2.1.3 Contributing Members

Contributing Members supported the SSGMCC and GSP development and implementation. These members include:

- Andy Duffey, Meridian Farms Water Company, Butte Slough Irrigation Company, and Tisdale Irrigation and Drainage Company
- Jon Munger, Garden Highway Mutual Water Company & Sutter Bypass Butte Slough Water Users Association
- Todd Duncan, Tudor Mutual Water Company

- Dan Duncan, Feather Water District
- Paul Schubert, Golden State Water Company

4.2.1.4 Stakeholders

Stakeholders, which include interested parties and members of the public, were invited to review and provide input at important stages throughout the GSP development process. A full list of stakeholders and interested parties is attached as **Appendix 4-B** and include both environmental, regulatory, and local stakeholders.

4.2.2 Comments Received Regarding the Plan

During the development of the GSP development, individual public draft chapters were posted to the project website to allow for public review and comment (**Table 4-5**). In addition, the full Public Draft GSP was released on October 1, 2021 for review and comment period through November 12, 2021. With each release, notice was provided via an E-blast and an announcement was placed on the project website.

In total, the Sutter Subbasin GSAs received 75 comments. All comments received have been compiled in a comment matrix. This summary table, as well as copies of the original comments, are attached as **Appendix 4-C**. The Sutter Subbasin GSAs have made note of all comments received and will provide responses to public review period comments along with responses to comments received during DWR's 75-day public comment period following GSP submittal and comments received from DWR as a result of evaluation of the Sutter Subbasin GSP.

Table 4-5. Public Review and Comment Periods

Public Draft	Public Review and Comment Period
Plan Area Chapter	April 16, 2021 to May 17, 2021
Governance Chapter	April 16, 2021 to May 17, 2021
Hydrogeologic Conceptual Model Section	July 9, 2021 to August 9, 2021
Groundwater Conditions Section	August 2, 2021 to August 27, 2021
Public Draft GSP	October 1, 2021 to November 12, 2021

4.3 Outreach

Public outreach includes both stakeholder coordination and general public involvement. The goal of the public engagement effort is to understand the needs of stakeholders and groundwater users in the Subbasin, increase awareness and understanding of SGMA and the purpose and goals of the GSP, solicit feedback on draft sections of the GSP, and to promote active involvement in the process to achieve and maintain sustainability. Many outreach types and efforts were utilized to support this goal, as described in the sections below.

4.3.1 Noticing

Pursuant to GSP Emergency Regulations §357.2(a), the Sutter Subbasin GSAs submitted notice to DWR stating their intent to develop a GSP on May 29, 2020 (included herein as **Appendix 4-D**). Upon completion of the GSP, notice was provided to the counties and cities within the Subbasin regarding Plan adoption. This notice was distributed on October 5, 2021, and is included herein as **Appendix 4-E**.

Following the initial notice to DWR, outreach related to major project junctions and milestones was conducted. Notices for public workshops were sent at least 30 days in advance via email, with reminders sent approximately 72 hours in advance, and were also promoted via social media posts, flyers, and informational materials in local water bill inserts as summarized in **Table 4-6**.

Table 4-6. Communication Log

Date	Description of Communication
January 24, 2020	Update to Justine Dutra, Yuba-Sutter Farm Bureau
February 2, 2020	Presentation to Natural Resource & Land Use Committee
October 7, 2020	Update at Yuba-Sutter Farm Bureau Meeting
October 7, 2020	Follow up with Lisa Herbert, Ag Commissioner, following Farm Bureau meeting
October 9, 2020	Stakeholder List E-blast 1
October 19, 2020	Stakeholder List E-blast 2
October 20, 2020	Update at Tisdale Irrigation and Drainage Company Board Meeting by Andy Duffey
October 27, 2020	Update at Butte Slough Irrigation Board Meeting by Andy Duffey
November 4, 2020	Update at Reclamation District 70 Board Meeting by Andy Duffey
November 10, 2020	Update at Reclamation District 1660 and Meridian Farms Water Company Board Meetings by Andy Duffey
November 13, 2020	Public Workshop #1 E-blast
November 18, 2020	Sutter County Facebook Post for Public Workshop #1
November 18, 2020	Agricultural Commissioner shared Facebook Post for Public Workshop #1
November 30, 2020	Update to Justine Dutra to share at Yuba-Sutter Farm Bureau meeting
December 2, 2020	Update at Reclamation District 70 Board Meeting by Andy Duffey
December 3, 2020	Public Workshop #1 E-blast – Tribes
December 8, 2020	Update at Reclamation District 1660 and Meridian Farms Water Company Board Meetings by Andy Duffey
December 10, 2020	Public Workshop #1 E-blast – Reminder
December 11, 2020	City of Yuba City Facebook Post
December 11, 2020	City of Live Oak Facebook Post and website banner with link to GSP website

Date	Description of Communication
January 6, 2021	Update at Reclamation District 70 Board Meeting by Andy Duffey
January 12, 2021	Update at Reclamation District 1660 and Meridian Farms Water Company Board Meetings by Andy Duffey
January 12, 2021	Public Workshop #2 E-blast
January 15, 2021	Public Workshop #2 E-blast – Follow up to bounces
January 19, 2021	Update at Tisdale Irrigation and Drainage Company Board Meeting by Andy Duffey
January 21, 2021	Bill Insert Mailing: Sutter County – Community of Robbins
January 24, 2021	Update to Justine Dutra, Yuba-Sutter Farm Bureau meeting
January 26, 2021	Update at Butte Slough Irrigation Board Meeting by Andy Duffey
February 3, 2021	Update at Reclamation District 70 Board Meeting by Andy Duffey
February 4, 2021	Public Workshop #2 E-blast – Reminder
February 9, 2021	Update at Reclamation District 1660 and Meridian Farms Water Company Board Meetings by Andy Duffey
March 3, 2021	Update at Reclamation District 70 Board Meeting by Andy Duffey
March 3, 2021	Live Oak City Council Presentation
March 9, 2021	Update at Reclamation District 1660 and Meridian Farms Water Company Board Meetings by Andy Duffey
April 7, 2021	Update at Reclamation District 70 Board Meeting by Andy Duffey
April 13, 2021	Update at Reclamation District 1660 and Meridian Farms Water Company Board Meetings by Andy Duffey
April 13, 2021	Public Workshop #3 E-blast
April 15, 2021	Bill Insert Mailing: Montna Farms to Sutter Bypass Slough Association Members
April 16, 2021	Notice of Plan Area and Governance Chapters for Public Review

Date	Description of Communication
April 20, 2021	Update at Tisdale Irrigation and Drainage Company Board Meeting by Andy Duffey
April 20, 2021	Public Workshop #3 E-blast – Tribes and Adjoining Basins
April 27, 2021	Update at Butte Slough Irrigation Board Meeting by Andy Duffey
May 5, 2021	Update at Reclamation District 70 Board Meeting by Andy Duffey
May 11, 2021	Update at Reclamation District 1660 and Meridian Farms Water Company Board Meetings by Andy Duffey
May 17, 2021	Bill Insert Mailing: City of Live Oak GSA
June 2, 2021	Update at Reclamation District 70 Board Meeting by Andy Duffey
June 7, 2021	Public Workshop #3 E-blast – Reminder
June 8, 2021	Update at Reclamation District 1660 and Meridian Farms Water Company Board Meetings by Andy Duffey
June 11, 2021	Invitation to Submit Projects and Management Actions
July 7, 2021	Update at Reclamation District 70 Board Meeting by Andy Duffey
July 8, 2021	Notice of Hydrogeologic Conceptual Model Section for Public Review
July 9, 2021	Public Workshop #4 E-blast
July 13, 2021	Update at Reclamation District 1660 and Meridian Farms Water Company Board Meetings by Andy Duffey
July 20, 2021	Update at Tisdale Irrigation and Drainage Company Board Meeting by Andy Duffey
July 21, 2021	Bill Insert Website Posting: Sutter Extension Water District
July 27, 2021	Update at Butte Slough Irrigation Board Meeting by Andy Duffey
August 2, 2021	Notice of Groundwater Conditions Section for Public Review
August 4, 2021	Update at Reclamation District 70 Board Meeting by Andy Duffey
August 6, 2021	Public Workshop #4 E-blast – Reminder

Date	Description of Communication
August 10, 2021	Update at Reclamation District 1660 and Meridian Farms Water Company Board Meetings by Andy Duffey
August 10, 2021	Public Workshop #4 Yuba City Facebook Post
September 21, 2021	Public Workshop #5 E-blast
October 1, 2021	Notice of Public Draft GSP for Public Comment
October 1, 2021	Press Release Notice of Public Draft to Media Outlets
October 4, 2021	Public Workshop #5 Yuba City Facebook Post
October 6, 2021	The Appeal Democrat – Groundwater Sustainability Plan Available for Public Comment
October 12, 2021	Public Workshop #5 E-blast – Reminder
November 1, 2021	Reminder Notice of Public Draft GSP for Public Comment

4.3.2 Public Engagement

Public outreach and engagement is an integral part of developing and implementing the GSP and consists primarily of open meetings of the SSGMCC, information and updates to the project website, and public workshops held at important stages of the groundwater sustainability planning process to present key aspects of the GSP and to seek feedback on the proposed draft GSP chapters.

4.3.2.1 Public Workshops

Public workshops give residents and stakeholders of the Sutter Subbasin and adjoining subbasins the opportunity to learn about the condition and future of the Subbasin, participate in the GSP development process, understand what needs to be done to protect the quality and availability groundwater, and learn why maintaining a sustainable groundwater subbasin matters to the economy, environment, and quality of life of all communities in the Subbasin. The workshops also allow decision-makers to better consider the variety of beneficial uses and users of groundwater, as well as the diverse social, cultural, and economic elements of the population within the Sutter Subbasin.

Public workshops were held approximately quarterly to update interested residents and stakeholders about the GSP development process. Due to the ongoing COVID-19 pandemic, and as authorized by the Governor’s Executive Order N-29-20 and Assembly Bill 361 allowing local legislative bodies to hold meetings via teleconferencing while still meeting state transparency requirements, all meetings were held virtually. Public workshop noticing was distributed in English, Spanish, and Punjabi, and was distributed via email blasts, postings on the Sutter Subbasin website and GSA websites, and through public platform postings (Facebook and Twitter). The workshops included presentations on data, information, and analyses completed for the planning process, as well as activities to solicit input and feedback from participants on plan direction; the content of these public workshops is summarized in **Table 4-7**. All interested residents, businesses, and public agencies were invited to join and provide input at the public workshops. All public workshops were recorded, and the workshop recordings were posted on the Sutter Subbasin website with closed captions in English, Spanish, and Punjabi.

Table 4-7. Summary of Public Workshop Content

Meeting Date	Workshop Content
Workshop 1: December 14, 2020	• Overview of SGMA • Water management planning in the Sutter Subbasin • Development of Sutter Subbasin GSP • Basin Conditions
Workshop 2: February 8, 2021	• Review of Basin Conditions • Hydrogeologic Conceptual Model • Introduction to Groundwater Flow Modeling • Significant and Unreasonable Undesirable Results • Preliminary List of Projects and Management Actions
Workshop 3: June 15, 2021	• Hydrogeologic Conceptual Model Update • Basin Conditions Update • Mapping Groundwater Dependent Ecosystems and Interconnected Surface Water • Water Budgets • Projects and Management Actions
Workshop 4: August 11, 2021	• Sustainable Management Criteria • Sustainable Yield Estimate • Monitoring Networks • GSP Implementation
Workshop 5: October 19, 2021	• Public Draft GSP

4.3.2.2 Other Public Engagement Opportunities

Two online surveys were made available through the project website and used to solicit stakeholder feedback and input. The Stakeholder Engagement Survey was posted on the project website in advance of Workshop #1 and was open for four months. The Project and Management Action Survey was posted on the project website in advance of Workshop #2 on February 8, 2021 and was open and available for responses through Workshop #3 on June 15, 2021. One Project and Management Action Submittal Form was submitted to the GSAs for consideration. Responses to the surveys were compiled and are attached herein as **Appendix 4-F**.

4.3.3 Outreach to Diverse Social, Cultural, and Economic Areas of the Population

As not all Sutter Subbasin residents have access to email and the internet, outreach methods included both online access and traditional means of hard copy information dissemination (e.g., utility bill inserts). Identified underrepresented communities were targeted with mailers. Copies of mailers and additional documentation distributed as part of the public review process are included in **Appendix 4-G**. Sutter County also has a substantial population that only speak Spanish or Punjabi; therefore, supporting materials (online and hard copy) were prepared in both languages in addition to English. As noted above, workshops were recorded and dubbed via closed captioning in English, Spanish, and Punjabi. Additional translation services were offered to GSAs, including direct translation at public workshops.

4.3.4 Methods for Disseminating Information

The Sutter Subbasin GSAs use a variety of communications and engagement tools to keep the public informed and engaged in the GSP planning process.

4.3.4.1 Website

The GSP website (http://suttersubbasin.org/) houses information about SGMA, the GSP process, the GSA Boards, SSGMCC, public meetings, project newsletters, project reports and studies, and groundwater data and information. The website provides options for contacting the planning team via email or in writing. The website also provides information in Spanish (http://suttersubbasin.org/espanol) and Punjabi (http://suttersubbasin.org/punjabi).

The website includes landing pages with a general overview of SGMA, information on outreach, scheduled meetings, SGMA resources (including links to completed deliverables and workshop materials), and the GSAs' contact information. Each page of the website includes an opportunity to sign-up for project emails.

4.3.4.2 Interested Parties List

The SSGMCC maintains a list of interested persons and routinely distributed meeting notices and relevant information to the stakeholders who requested to be included.

E-mail notices, the primary method of communication, were sent to announce the availability of new materials on the website, project milestones, and workshop dates. Announcements were distributed in English, Spanish, and Punjabi as appropriate.

4.3.4.3 Informational Materials

The SSGMCC developed a range of materials to successfully educate interested parties and circulate consistent, accurate information. These materials, made available on the website and included in **Appendix 4-G**, included:

- **Fact Sheets and Flyers** were used to describe the GSP planning process, including, "What is SGMA" at the beginning of the GSP planning process.
- **Links** to other publicly available materials about SGMA and the GSP process were included on the Subbasin website.
- **Press Releases** were used as a method of correspondence in local newspapers to notice for the release of the Public Draft GSP for public review and comment. Media contacts contacted as part of the GSP public review process included:
    - ABC 10
    - Appeal-Democrat
    - CBS
    - FOX 40
    - Gridley Herald
    - KUBA Radio
    - Sutter County News Center
    - Territorial Dispatch Online Newspaper

4.3.4.4 Mailings, Utility Bill Notifications and Public Media noticing

Bill inserts and flyers were used to notify the public about the GSP Planning process in addition to upcoming workshops to encourage engagement. These bill inserts were distributed in utility bill notifications. Notices were also included in feeds to media platforms such as Twitter and Facebook.

4.3.4.5 Public Workshops

Information was disseminated at public workshops, as described in **Section 4.3.2.1**.

4.4 References

California Department of Water Resources (DWR). n.d. DAC Mapping Tool. https://gis.water.ca.gov/app/dacs/. Accessed: August 4, 2021.

California Department of Water Resources (DWR). n.d. EDA Mapping Tool. https://gis.water.ca.gov/app/edas/. Accessed: August 4, 2021.

California State Water Resources Control Board (SWRCB). 2021. 2021 Aquifer Risk Map. https://gispublic.waterboards.ca.gov/portal/apps/webappviewer/index.html?id=17825b2b791d4004b547d316af7ac5cb. Accessed: August 4, 2021.

This page intentionally left blank.

CHAPTER FIVE

Basin Setting






This page intentionally left blank

5. BASIN SETTING

The Basin Setting chapter contains three sections as follows:

- **Hydrogeological Conceptual Model** – The Hydrogeologic Conceptual Model (HCM) section (**Section 5.1**) provides the geologic and hydrogeologic information needed to understand how water moves through the Sutter Subbasin. This section includes information about geologic formations, aquifers, structural features, and topography.
- **Groundwater Conditions** – The Groundwater Conditions section (**Section 5.2**) describes historic groundwater conditions in the Sutter Subbasin, including data from January 1, 2015 to current conditions. Groundwater trends, groundwater levels, hydrographs, contour maps, estimated change in groundwater storage, groundwater quality issues, land subsidence, identification of interconnected surface water systems over historic conditions through present day are presented in this section. Identification of groundwater dependent ecosystems within the Sutter Subbasin is also presented in this section.
- **Water Budget** – The Water Budget section (**Section 5.3**) describes the data used to develop the required historic water budget, current water budget, and projected water budgets. This section also discusses how the water budgets were calculated as well as the sustainable yield estimate for the Sutter Subbasin.

The Basin Setting chapter serves as a basis for defining and assessing reasonable sustainable management criteria and projects and management actions. This chapter addresses required elements of the GSP Emergency Regulations Article 5. Plan Contents, Subarticle 2. Basin Setting (§354.12 – 354.18). Management areas were not established for this GSP and therefore are not addressed (GSP Emergency Regulations §354.20).

5.1 Hydrogeologic Conceptual Model

This section describes the HCM for the Sutter Groundwater Subbasin (Sutter Subbasin or Subbasin) in accordance with Section 354.14 of the Groundwater Sustainability Plan (GSP) Emergency Regulations. The HCM is a “big picture” framework that represents (and visualizes) the current understanding of the general physical characteristics related to regional hydrology, land use, geology and geologic structure, water quality, principal aquifers, and principal aquitards of the basin setting. The HCM also provides the context for developing water budgets, mathematical (analytical or numerical) models, and monitoring networks, and provides a tool for stakeholder outreach and communication. Specific objectives of the HCM are to:

- Provide the information necessary to evaluate sustainability within the Sutter Subbasin with regards to the six sustainability indicators.

- Provide the framework and information needed to conduct additional analyses for GSP preparation, such as development of water budget, construction of mathematical (analytical or numerical) models, and development of monitoring systems and management actions and projects.
- Develop an understanding and description of the Sutter Subbasin, specifically the structural and physical characteristics that control the flow, storage, and quality of surface and groundwater.
- Identify data gaps towards evaluation of sustainability indicators that will be used to develop investigations and data collection programs during the implementation period of the GSP.

The HCM presented in this GSP provides the current understanding of water movement and water quality through the Sutter Subbasin based on current publicly-available information as well as the Sutter Subbasin Alternative Plan (GEI, 2016). Updates to the HCM should be conducted as new information is obtained to ensure that sustainability of the Subbasin is maintained.

For this GSP, data supporting development of the HCM are available to the public from a variety of local, state, and federal agencies, as well as from non-governmental entities. The data presented herein were compiled from numerous studies conducted in the Subbasin. Information from several online databases that support ongoing monitoring and development of the groundwater resources within the Sutter Subbasin and throughout California was amassed, evaluated, and reconfigured in support of the HCM. The following subsections present the information as outlined in the GSP Regulations.

5.1.1 Regional Geologic Structural Setting

GSP Regulations state that the HCM shall include a description of the regional and structural setting of the basin, including the immediate surrounding area, as necessary for geologic consistency. **Figure 5-1** shows the geologic map of the Sutter Subbasin.

The regional geology of the Sutter Subbasin is similar to that of the greater Sacramento Valley with the exception of the volcanic rocks of the Sutter Buttes. The Sutter Subbasin consists of unconsolidated and consolidated freshwater bearing sediments that are underlain by marine sediments and igneous or metamorphic rocks. The freshwater bearing sediments consist of the volcanoclastic rocks of the Sutter Buttes and sediments weathered from the Sierra Nevada to the east. The sediments derived from the Sutter Buttes consist of debris (sand to boulder size blocks) and sedimentary deposits of the volcanic apron that extends radially about 10 miles to the north and to 8 to 10 miles to the south from the Sutter Buttes (Springhorn, 2008).

The Subbasin lies within the Sacramento Valley Groundwater Basin, which is a north-south trending structural trough that is filled with marine and non-marine sediments. The oldest and deepest sediments were emplaced under a marine sedimentary depositional environment. Marine sediments in the deepest portions of the basin generally range in age from Late Jurassic to early Miocene (160 million years ago to 24 million years ago; Wood Rodgers, 2012). Younger nonmarine sediments and volcanic rocks are of early Miocene to Holocene age (Harwood and Helley, 1987). Within the greater Sacramento Valley Groundwater Basin, the deposits have been disrupted by deformational stresses derived from east-west compressional forces associated with regional uplift along the western margin of the valley and extensional forces to the east, within the Basin and Range Province (Harwood and Helley, 1987). These forces have created fold and fault structures.

The Willows Fault, discovered in the 1950s during the development of a nearby gas field, is the primary fault structure within Sutter County, and lies to the southwest and west of the Sutter Buttes. The fault is classified as active and northwest-trending with a 74 degree or steeper dip to the northeast. The fault exhibits approximately 1,610 feet of reverse displacement, indicating the ground east of the fault has moved up relative to the west side (Redwine, 1972). **Figure 5-2** presents a cross-section developed by Harwood and Helley (1987) showing off-set of the Willows Fault within the Subbasin. As shown in **Figure 5-1**, the Willows Fault enters into the Subbasin from Colusa County southwest of the Sutter Buttes and extends to the southeast portion of the Subbasin towards Sacramento, presumably following the boundary between the ophiolite basement of the west and the Sierra basement to the east (Harwood and Helley, 1987). **Figure 5-1** also shows several quaternary faults identified within the area of the Sutter Buttes.

The Sutter Buttes is the prominent topographic feature in Sutter County, rising from the valley floor to an elevation of 2,100 feet, over 2,000 feet higher than the valley floor in the northern part of the basin. The Sutter Buttes themselves are not within the boundaries of the Subbasin, as shown in **Figure 5-1**. The Sutter Buttes are composed of late Cenozoic volcanic rocks emplaced between 2.4 and 1.4 million years ago over a northwest-trending tectonic boundary that juxtaposes a basement of dense magnetic, presumed oceanic crust on the west against metamorphic and plutonic rocks of the Sierra basement on the east (Harwood and Helley, 1987). When the volcanic rocks rose, they folded upward and exposed at ground surface older marine sediments, including the Ione and Capay Formations. They also created an apron of volcanic sediments, the Sutter Buttes Rampart Formation, which extends outward in a shield-like apron.

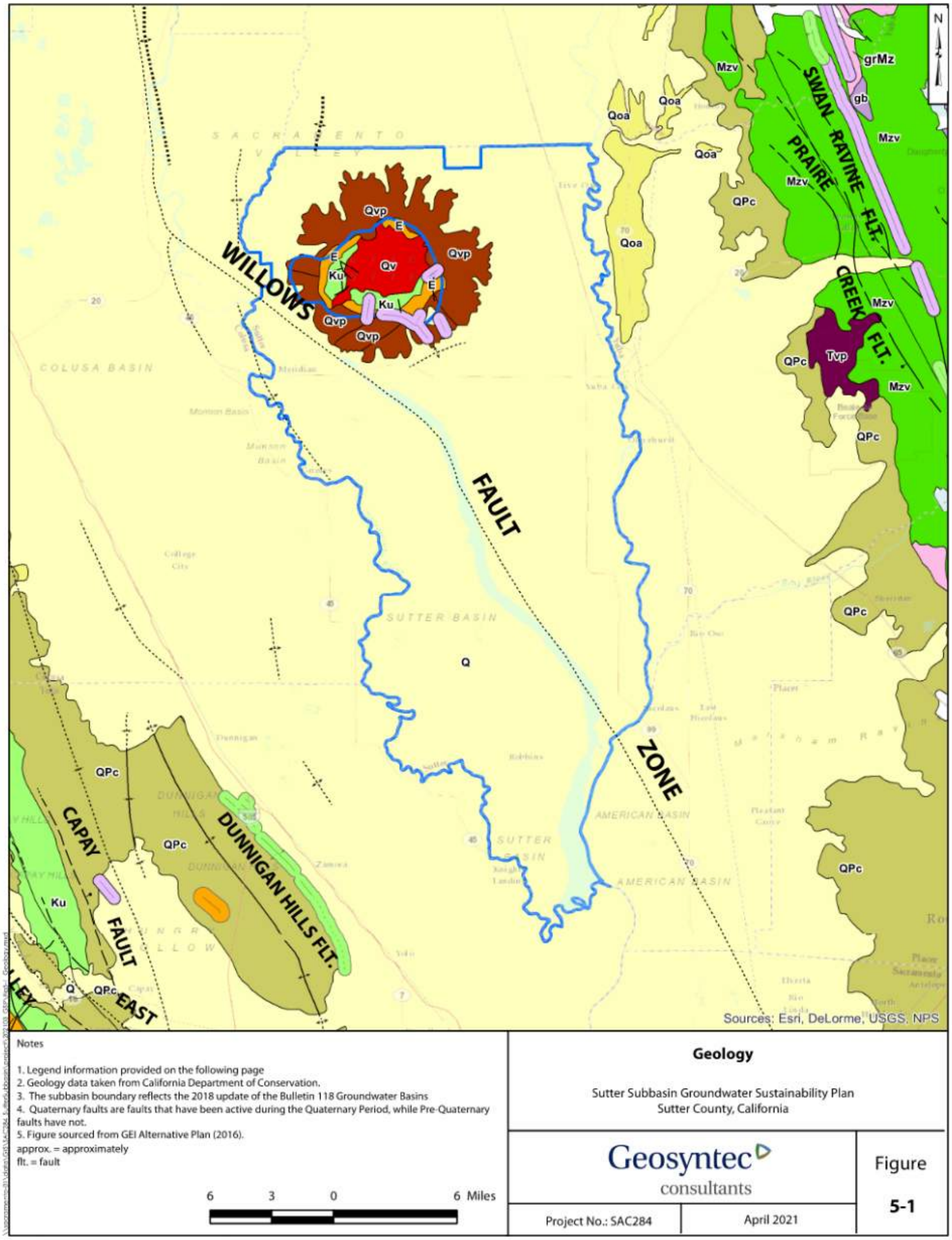


Figure 5-1. Surface Geology, Sutter Subbasin

Figure 5-1. Surface Geology, Sutter Subbasin (continued)

This page intentionally left blank.

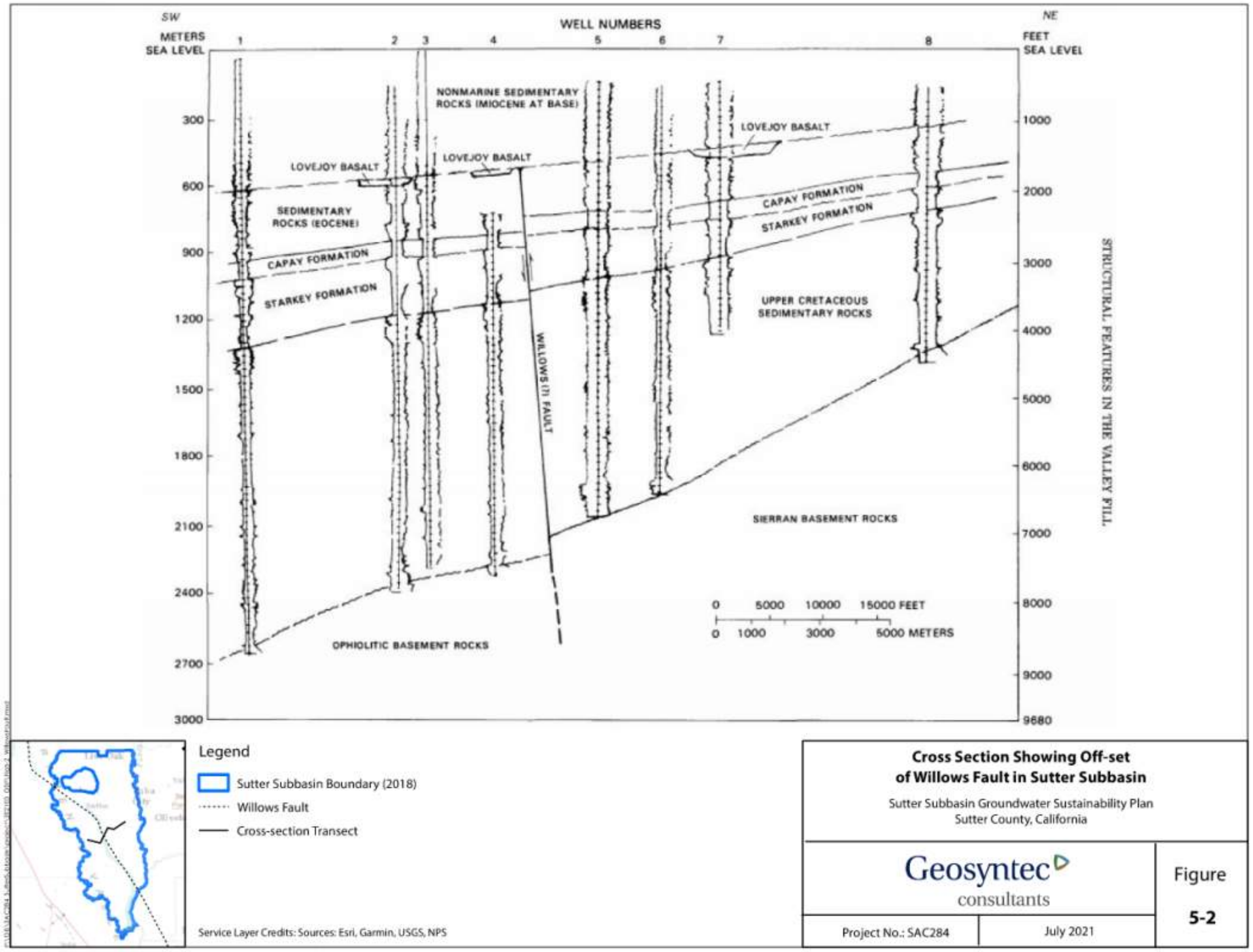


Figure 5-2. Willows Fault Cross-Section

This page intentionally left blank.

5.1.1.1 Topography

With the exception of the Sutter Buttes, the topography of the Sutter Subbasin is comprised primarily of the gentle flatlands of the Sacramento River Valley with elevations decreasing from the northeast to south ranging from 80 feet above mean sea level (MSL) in the northeast corner to 20 feet above MSL in the south. The Sutter Buttes is the only prominent topographic feature in the northern part of the Subbasin, a Pliocene volcanic plug which rises abruptly 2,000 feet above the surrounding valley floor. **Figure 5-3** shows the topography of the Sutter Subbasin.

5.1.1.2 Soils

Soil characteristics play a major role in cropping patterns and farming practices, and influences the retention and infiltration of water and nutrients/pesticides through the subsurface. In general:

- The soils in the Subbasin mainly consist of clay and clay loam soils; but, near the rivers, loam to sandy loam may be present.
- Most of the soils consist of poorly and very poorly drained soils. Along the rivers, soils are well drained.

Hydrologic grouping of the soil types and their distribution are provided in **Figure 5-4**. About 70 percent of the soils in the Subbasin are characterized as having slow to very slow infiltration.

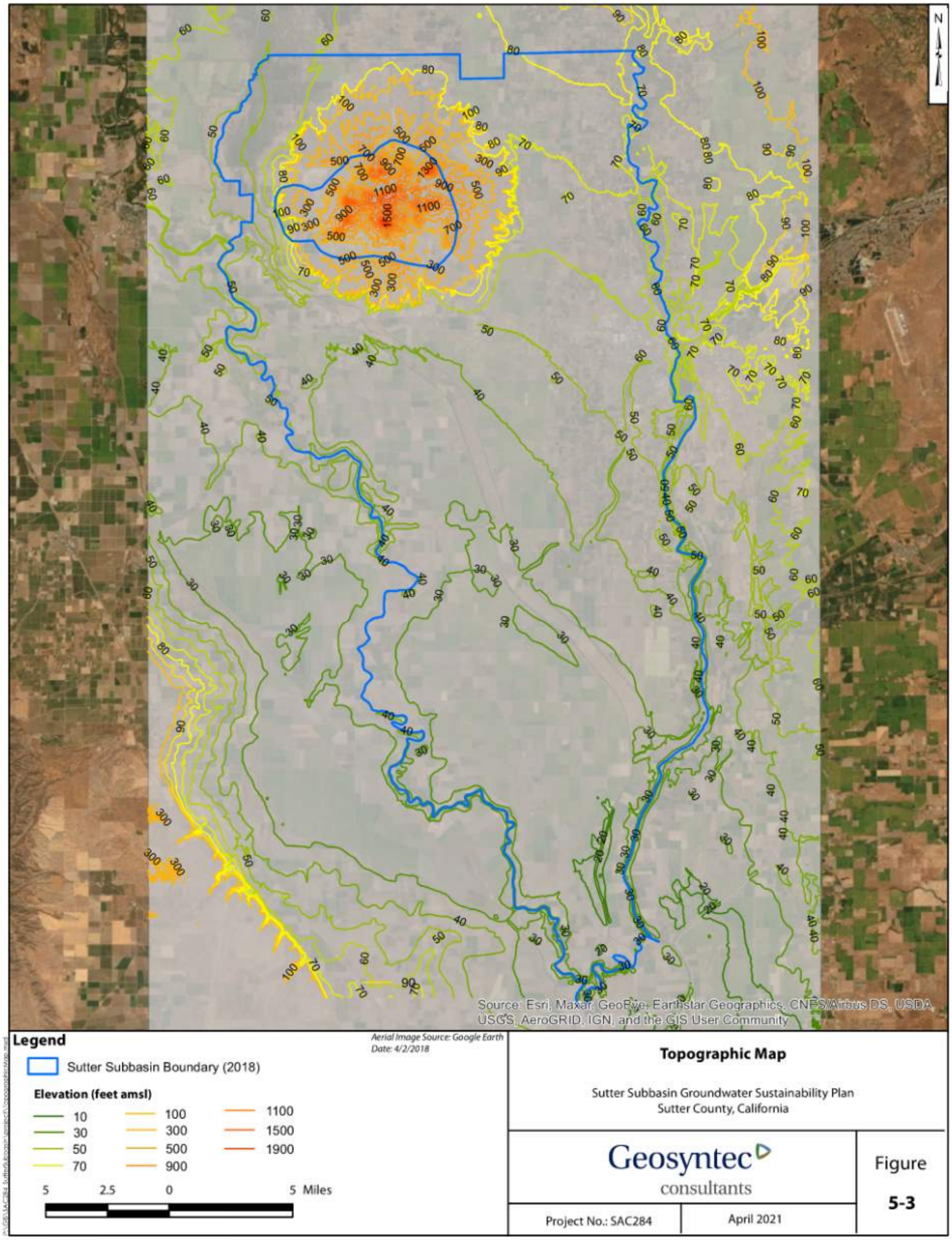


Figure 5-3. Topographic Map, Sutter Subbasin

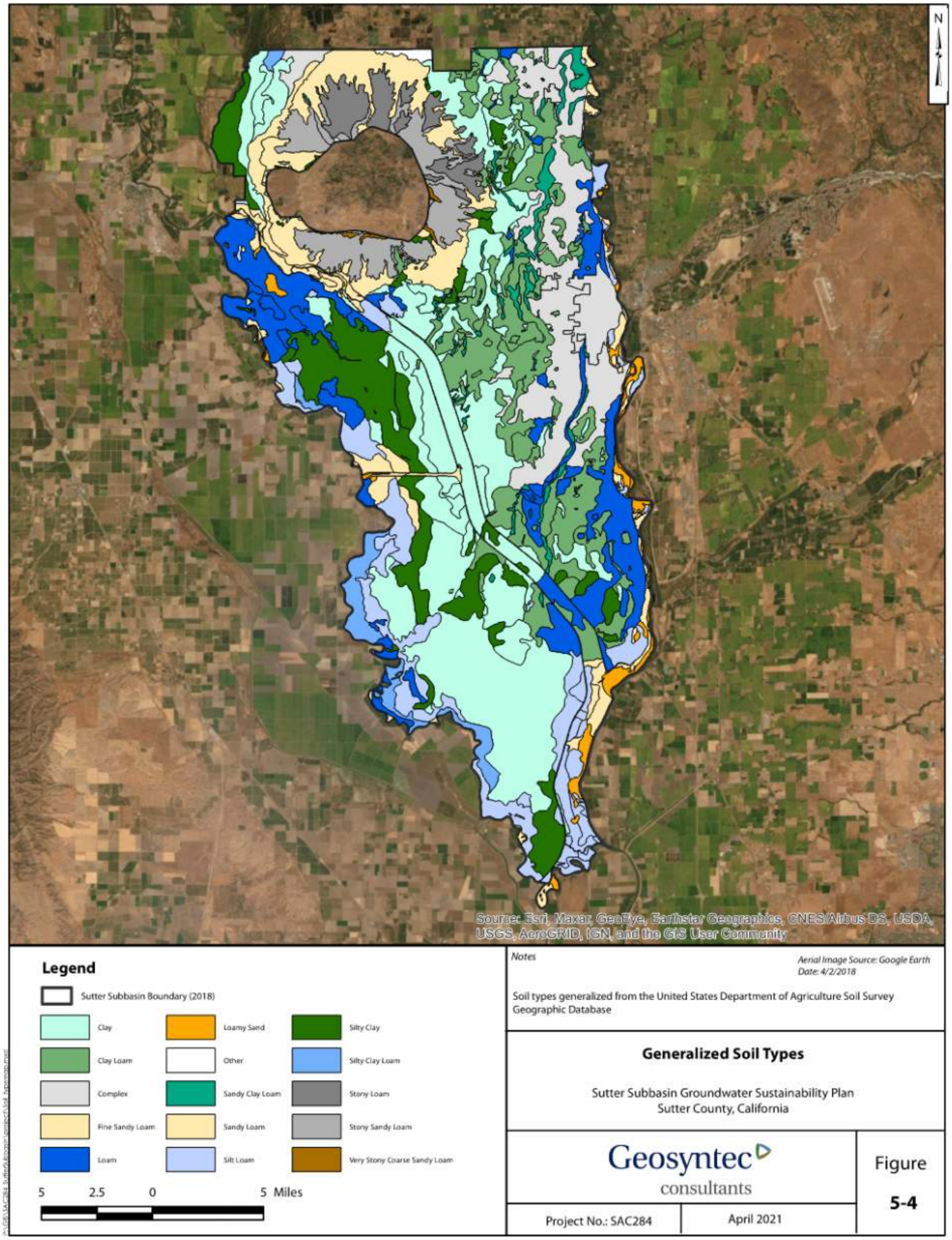


Figure 5-4. Generalized Soil Types, Sutter Subbasin

5.1.2 Lateral Basin Boundaries

The Sutter Subbasin lies in the eastern central portion of the Sacramento Valley Groundwater Basin. As shown in **Figure 2-1**, it is bounded on the north by the boundary with Butte County (except for the portion of Biggs-West Gridley Water District within Sutter County included in the Butte Subbasin), on the west and south by the Sutter County boundary shared with Yolo and Colusa Counties, and on the east by the shared Sutter County and Yuba County boundary to its terminus just north of Nicolaus where Feather River then forms the boundary until the river reaches the Yolo County line. The Sutter Buttes forms an elliptical lateral boundary just south of the Sutter County-Butte County line (**Figure 2-1**).

The Subbasin lies entirely within the Sacramento River watershed, with the most notable hydrological features being the Sacramento and Feather Rivers. Other notable features are Tisdale Bypass and Sutter Bypass. The manmade Sutter Bypass acts as a flood control overflow for the Sacramento River. The boundary of the Sutter Subbasin is coincident with the seven adjacent subbasins and is not separated by any distinct geologic features. Adjacent basins include Butte, Wyandotte Creek, North Yuba, South Yuba, North American, Yolo, and Colusa Subbasins (**Figure 2-1**).

The majority of the Subbasin consists of sedimentary deposits except for the Sutter Buttes. The Sutter Buttes are composed of a prominent set of hills and are a remnant of an old volcanic center that intruded the Central Valley between 2.4 and 1.4 million years ago (Harwood and Helley, 1987). Volcanic deposits consist of two major deposits: (1) a rhyolite and andesite core surrounded by coarse vent tuff-breccia; and (2) alluvial fans caused by erosion (Harwood and Helley, 1987). The Buttes divert groundwater around their flanks, and marine sediments surrounding them have been flushed of their saline water by precipitation to great depths. This flushing action may be related to the shallow connate water found in the Sutter Subbasin to the south (California Department of Water Resources [DWR], 1980). There are no indications that the Willows Fault controls groundwater flow in the Sutter Subbasin and, as shown in **Figure 5-2**, offset on this fault does not appear to occur in sediments younger than Eocene.

5.1.3 Definable Bottom of Basin

The bottom of the basin is the base of fresh water (Berkstresser, 1973) below which the water is brackish and not suitable without treatment for either agriculture or potable water use, as illustrated in **Figure 5-5**. This definition was presented in the 1978 Bulletin 118 publication that shows the base of fresh water occurring between 400 to 1,600 feet below MSL. The approximate bottom of the basin is also illustrated in the geologic cross sections discussed in **Section 5.1.5**.

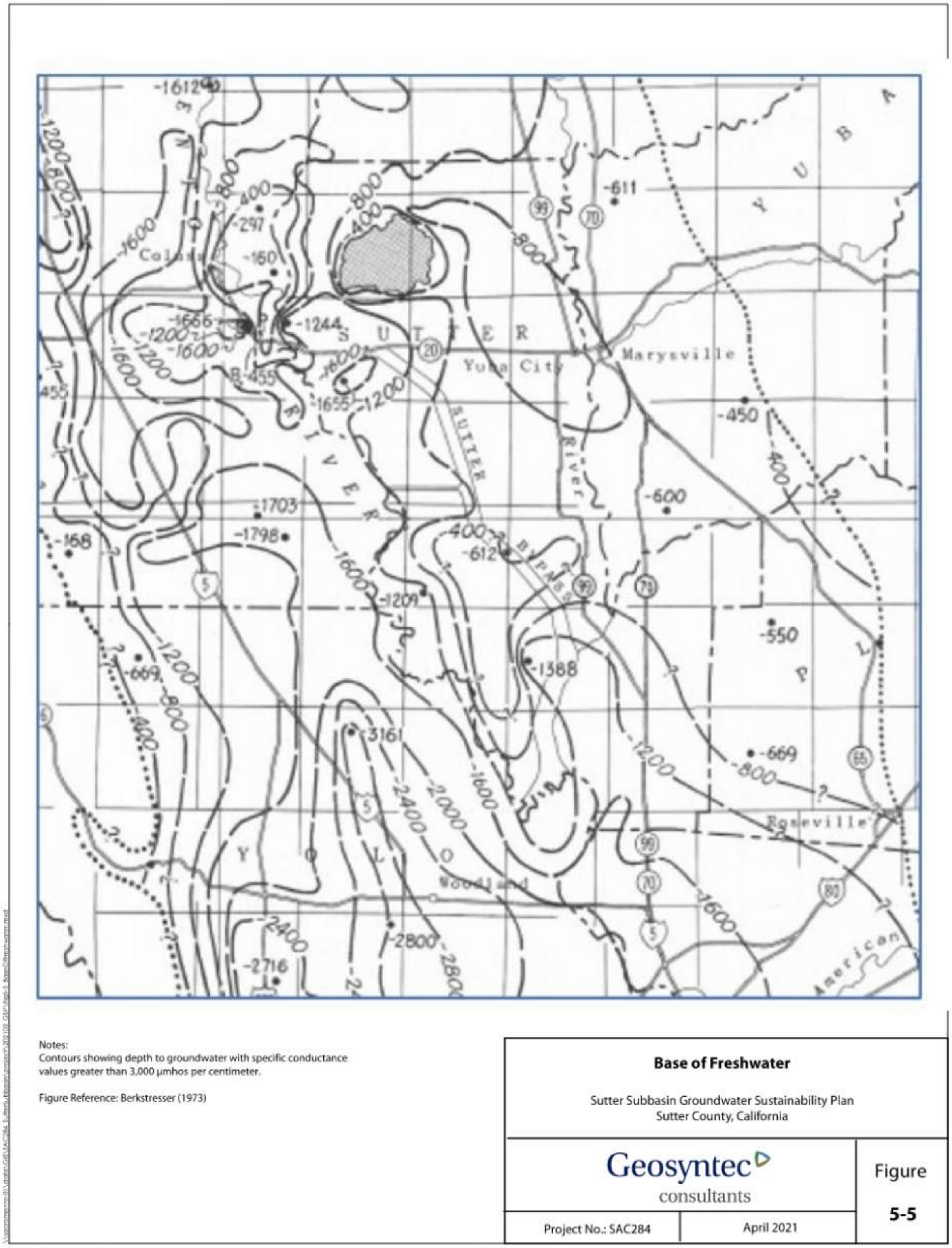


Figure 5-5. Base of Freshwater (Berkstresser, 1973)

5.1.4 Geologic Formations and Stratigraphy

As part of GSP development, the identification of both geologic and hydrogeologic units is critical to the overall understanding of how groundwater flows through the environment. Identification of geologic formations, such as the Laguna Formation, is based on explicit practices for classifying and naming all formally defined geologic units as presented in the North American Stratigraphic Code (North American Commission on Stratigraphic Nomenclature [NACSM], 2005). Specifically, the geologic formation, always capitalized when used for recognized geologic units (e.g., Laguna Formation), is the fundamental unit in lithostratigraphic (layers of rock in the ground) classification. As defined by the NACSM (2005), "a formation is a body of rock identified by lithic (rock or stone) characteristics and stratigraphic position; it is prevailingly, but not necessarily, tabular and is mappable at the Earth's surface or traceable in the subsurface." The key portion of this definition for this GSP is mappable, or easily identified, at the Earth's surface or traceable in the subsurface.

Prior to passage of the Sustainable Groundwater Management Act (SGMA), most drilling programs for groundwater wells did not develop criteria for identifying geologic formations. Identification of geologic formation boundaries from existing well logs is difficult. As such, for this GSP, the nomenclature and cross sections produced for Sutter Basin Alternative Plan (GEI, 2016) were used. However, for successful future groundwater management of the Sutter Subbasin, it is recommended that a program to standardize the identification of geologic formations from drill cuttings collected during the drilling of future groundwater wells be completed similar to the program developed by Blair et al. (1991) for the area around the Wyandotte Creek and Vina Subbasins. Further, it is recommended that an initial identification of geologic boundaries should be completed during the drilling of wells and included on the geologic well logs.

Figure 5-6 shows the geologic map of the project area, location of geologic cross-sections, and well borings used for the geologic cross-sections. The following sections provide a description of the geologic formations identified in the basin for water bearing units and non-water bearing/non-fresh water bearing units.

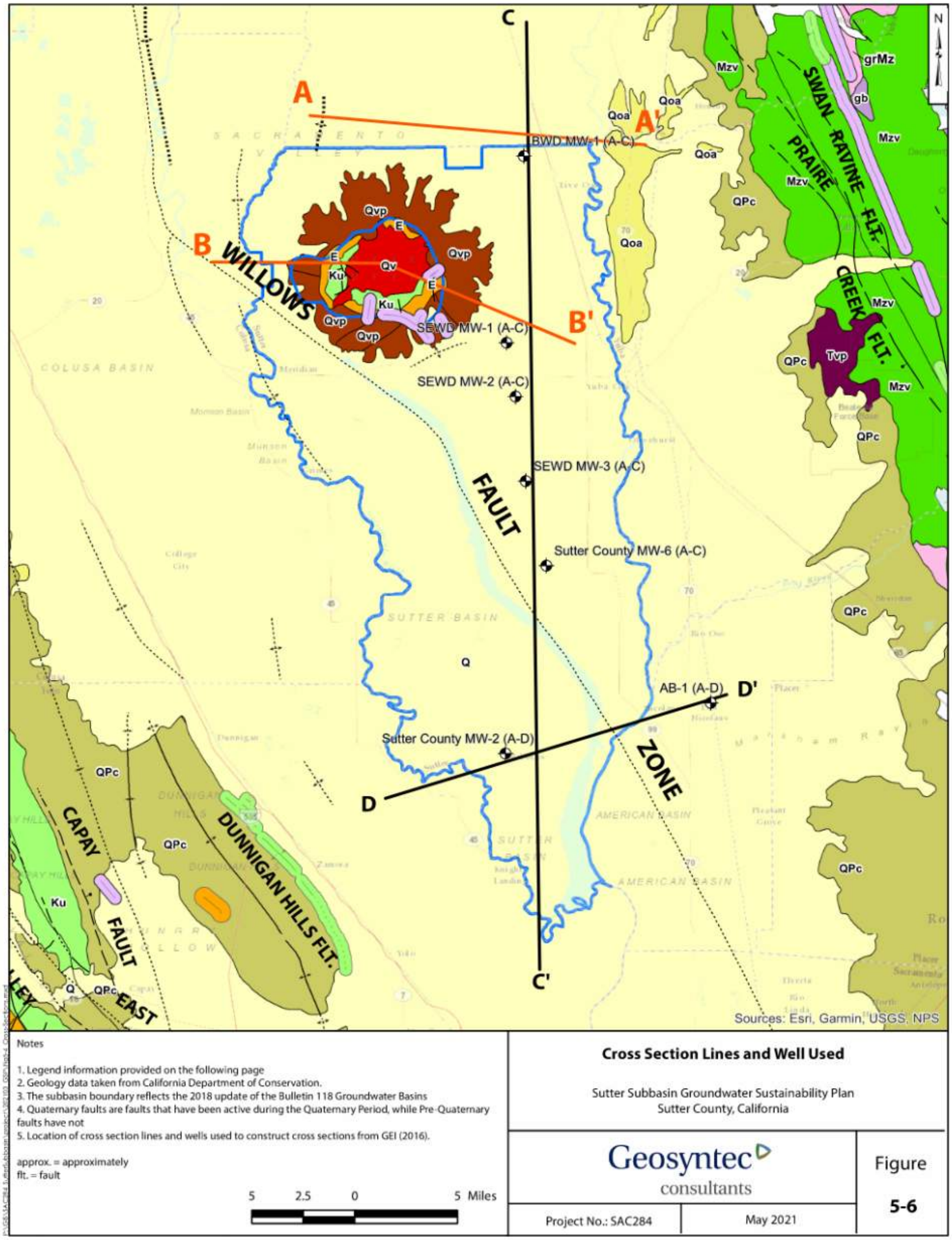


Figure 5-6. Cross-Section Lines and Well Boring Locations

5.1.4.1 Water Bearing Formations

Various reports from the 1960s through present describe the stratigraphic units within the east-central Sacramento Valley. In these different reports, numerous formations have described sedimentary deposits during the Quaternary and Tertiary periods. Stratigraphic units identified in these reports are described below and are referenced from the DWR Bulletin 118 description for the Sacramento Valley Groundwater Basin, Sutter Subbasin.

DWR Bulletin 118 (2006 Update) for the Suter Subbasin classified sediments up to 100 feet as **Alluvium** (Holocene Stream Channel and Floodplain Deposits). This unit consists of coarse sand and gravel deposited from the present-day Yuba, Feather, and Sacramento Rivers. Sediments are up to about 100 feet thick near the riverbeds (Harwood and Helley, 1987). Deposits further from the riverbeds thin in thickness and become finer gained. These sediments are highly permeable and provide areas where groundwater can be recharged. Wells in these areas can yield from 2,000 to 4,000 gallons per minute (gpm; DWR, 2006).

Underlying the Alluvium is older alluvium (Pleistocene Floodplain Deposits) that consists of units designated as the **Modesto, Riverbank**, and **Victor** Formations. The numerous Quaternary formations others have proposed are based on geomorphic or buried-soil information rather than on criteria by which formal formations are distinguished as discussed above. More importantly, the criteria used by others cannot be easily distinguished in drill cuttings. The Alternative Plan recognized this issue and grouped these units together in the cross-sections. As stated in **Section 5.1.3**, it is recommended that a program to standardize identification of geologic formations from drill cuttings collected during the drilling of future groundwater wells be completed.

Within the Subbasin, the **Modesto** Formation is characterized mostly by gravels, cobbles, and sand with some silt and clay. GEI (2016) designated sediments representing this formation from the ground surface to about 70 to 120 feet below ground surface (bgs) just to the west of Yuba City near SEWD MW-1 and indicated the formation is thicker to the south and thins to the north, with beds that are generally flat-lying.

The **Riverbank** Formation underlies the Modesto Formation and is also sedimentary in origin. This formation is composed of silts and clays with 10- to 20-foot-thick sand and gravel layers. The sand and gravel beds of the Riverbank Formation are thinner and less laterally extensive than those of the overlying Modesto Formation, and are therefore more difficult to identify where they may occur. Similar to the Modesto Formation, the Riverbank Formation is thicker to the south, and thins closer to the Sutter Buttes, with beds that are generally flat (GEI, 2016).

The **Victor** Formation is approximately 100 feet of Sierran alluvial fan deposits consisting of a mix of sand, silt, and clay deposited by shifting streams that drained the

Sierra Nevada during Pleistocene age. Grain size and clay content vary considerably both laterally and vertically within the formation, and the yield from wells indicates this variability. Deposits of this formation thin with distance to the west of the Yuba River and the foothills, and wells can yield up to 1,000 gpm.

The **Laguna** Formation occurs above the **Sutter Buttes Rampart** and is unconformably overlain by the Riverbank Formation. The formation consists of sandy gravel channel facies, sandy channel facies, and sandy clay to clay floodplain facies (Blair et al., 1991). The Alternative Plan placed the **Nomlaki Tuff Member**, an upper Pliocene, white, pumice-rich, water lain vitric tuff, as the base of the Laguna Formation, consistent with Busacca et al. (1989). As cited in Blair et al. (1991), others have placed the Nomlaki Tuff as the top of the Mehrten or Tuscan Formations. Blair et al. (1991) isolated this unit as a formal formation because it is easily identifiable in drilling samples and separates the Laguna Formation from the underlying volcanic rich sediments of the Mehrten and Tuscan Formations. The Laguna Formation in the Sutter Subbasin is thinner to the north and thickens to the south, with the thickness ranging from about 80 feet in the north to almost 700 feet to the south.

The **Sutter Buttes Rampart** geologic unit is mapped as lying beneath the Alluvium around the Sutter Buttes. This unit consists of volcanic debris shed off the Sutter Buttes in a radial pattern. The volcanic debris consists of sand to boulder size material which slopes and thins to the south, away from the Buttes. The gamma log signature of the Sutter Butte Rampart has a recognizable and correlative “kick,” which was more distinct near the Sutter Buttes. Few wells in the area use this formation for water supply.

The **Sutter** Formation is generally characterized by black, blue, gray, and greenish gray, angular to sub-rounded sand gravel. As presented in the Alternative Plan, the Sutter formation (as such lower case “formation”) is an informal unit and consists of sediments interpreted to be the distal portion of the upper Princeton Valley Fill, Mehrten Formation, Nomlaki Tuff, and Tuscan Formation (Springhorn, 2008). The presence of either of these units varies with the relative location of the Sutter formation with the Sutter Buttes. Cross-sections presented in this GSP list these units as part of the Sutter formation.

The Alternative Plan has interpreted the presence of a unit referred to as the **Upper Princeton Valley Formation.** As defined by Redwine (1972), the Princeton Submarine Valley System is a morphological feature of the ancestral Sacramento River Basin and contains the geologic formations described below. For example, the Ione Formation is used by Redwine (1972) to separate the lower and upper Princeton Valley fills, and the Lovejoy Basalt is interpreted to represent the rimrock of the upper Princeton Valley Fill. As stated above, the Sutter formation has also been designated to consist of several of these units. For this GSP, the nomenclature of Upper Princeton Valley Formation or Fill is not used unless referring to the morphological feature defined by Redwine (1972).

The **Mehrten** Formation and its stratigraphic correlative to the north **Tuscan** Formation consist of purple volcanic debris-flow deposits and interbedded water lain fluvial deposits rich in volcanic detritus but also containing Sierran crystalline basement-derived clasts and rare tuff beds (Blair et al., 1991). The occurrence of both channel-lain, clast supported, gravel-facies and interbedded volcanic rich debris flows in these formations suggests that debris flows, probably related to volcanic events, episodically choked the ancestral river systems in the area.

The **Valley Springs** Formation of the Sierra Nevada, located greater than 2,000 feet deep in the Sacramento Valley or found shallower near the eastern margin of the valley, consists of tan, white, and green rhyolitic fragments and is the equivalent to the Princeton Valley Fill defined by Springhorn (2008). The Valley Springs Formation was originally included in the Ione Formation as the "clay rock or tuff," the highest of three subdivisions of the Ione (United States Geological Society [USGS], 2007). Bartow (1992) recognized the fundamental lithologic difference between the Ione proper and the "clay rock and tuff," and noted that the two units are separated by a disconformity. The Valley Springs Formation was formally defined by Gale et al. (1939) from a type section near the town of Valley Springs in Calaveras County.

The Alternative Plan did not include the Ione Formation within the water-bearing formations of the Sutter Subbasin due to the occurrence of brackish water in this unit in several areas. However, the Ione Formation has been observed to contain fresh water in many areas around the Sutter Subbasin including in the Butte, Vina, and Wyandotte Subbasins (Brown and Caldwell, 2013). As such, a description of the geologic unit is also presented herein. The name "Ione Formation" was first used by Lindgren (1894) for the beds of clay and sand containing layers of lignite that crop out along the foothills of the Sierra Nevada; the name derives from the town of Ione in Amador County. The Ione Formation consists of variably cemented, fine to coarse sandstone, siltstone, lignite, and claystone with variegated colors including red, yellow, white, blue, gray, orange, and black. Interbedded lenticular pebble-and-cobble “auriferous” or “greenstone” gravels are locally present and become more abundant eastwardly. The Ione Formation has long been considered to be composed of the deposits of a fluvial-deltaic system formed under a humid, subtropical climate on the basis of the occurrence of lignite and carbonaceous shale, the identified flora, and the presence of kaolinite cement (Blair et al., 1991).

5.1.4.2 Non-Water or Non-Fresh Water Bearing Geologic Formations

The Princeton Submarine Valley (Redwine, 1972) was filled with various marine and near continental formations. All these formations have been folded and faulted by both regional tectonics and intrusion of the Sutter Buttes volcanic. **Figure 5-1** shows the locations of recognized faults and folds within the Sutter Subbasin.

Tertiary formations include the Eocene **Capay, Ione**, and **Lovejoy Basalt**. The Ione Formation underlies the Sutter formation. For most of the area, this boundary marks the base of the fresh water; however, while the Ione Formation typically has brackish water, as discussed above, this unit contains fresh water just south of the Sutter Buttes. Underlying the Ione Formation, the Capay Formation consists predominantly of a black to greenish black to greenish-gray marine claystone and shale with fossiliferous intervals (Springhorn, 2008).

Upper Cretaceous formations and units include the **Forbes, Kione, Sacramento Shale, Winter Sands and Shales**, and the **Starsky Sands**. Many of these formations are the source of natural gases. The locations of gas exploration borings and wells are shown in **Figure 5-7**. Many of these formations are exposed in a circular pattern around Sutter Buttes due to the folding and faulting associated with the emplacement of the Buttes. The Starsky Sands are not exposed at ground surface but are projected to be in contact with the freshwater aquifer within the Sutter Subbasin. All the formations and sediments mentioned above are underlain by igneous rocks from the Sutter Buttes or igneous and metamorphic rocks, potentially like those exposed in the Coast Ranges and in the Sierra Nevada.

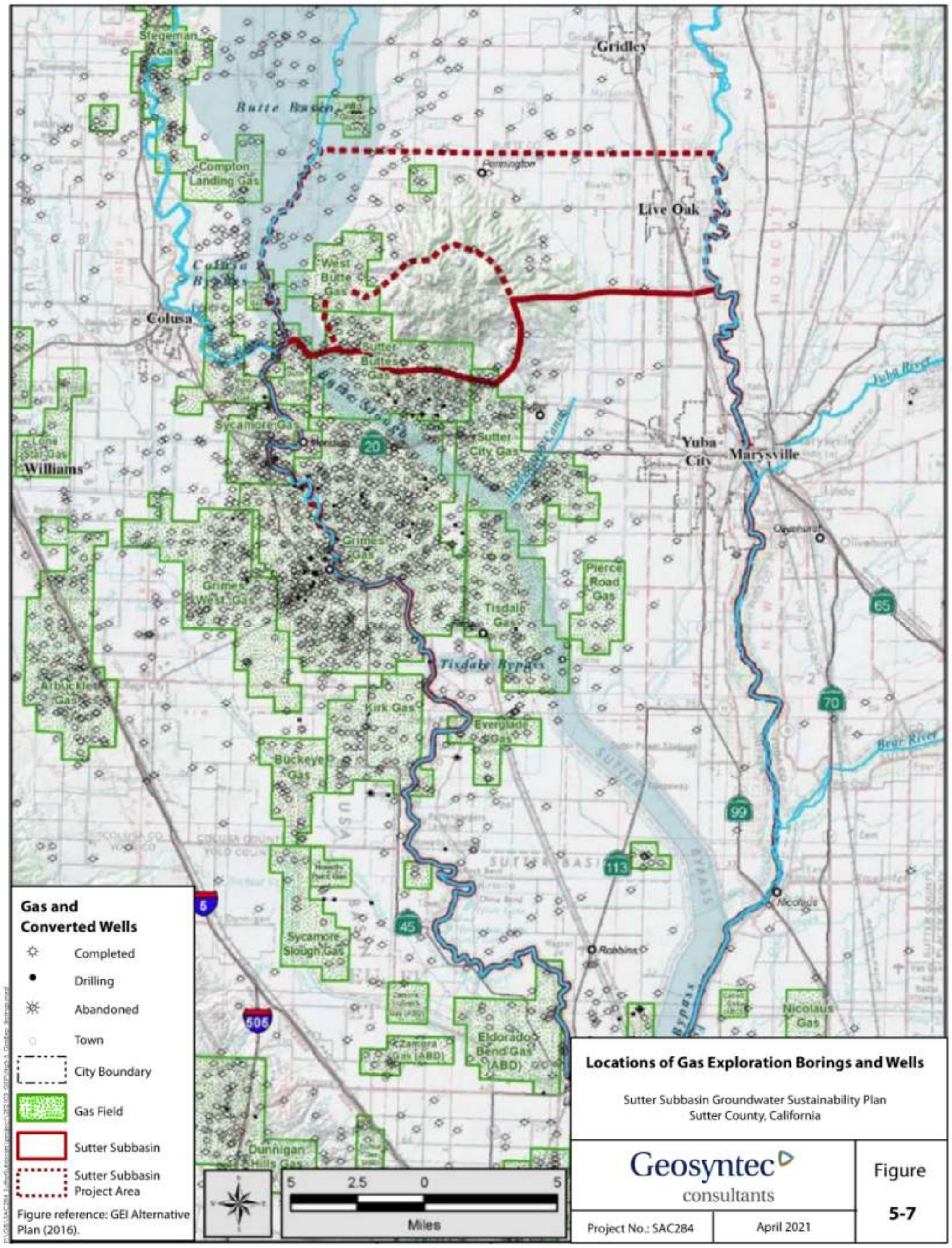


Figure 5-7. Gas Exploration Borings and Wells Locations[1]

[1] Figure sourced from Sutter Subbasin Alternative Plan (GEI, December 2016), reflecting basin boundaries as of Alternative Plan development. A Basin Boundary Modification Request was approved by DWR in 2019 consolidating the East Butte Subbasin ("Sutter Subbasin Project Area") with the Sutter Subbasin as well as minor jurisdictional boundary modifications. Such boundary modifications have not resulted in material changes that would alter understanding of basin conditions.

5.1.5 Geologic Profiles

Geologic profiles (cross-sections) have been developed for the Subbasin by many authors. Pertinent profiles are discussed and presented to illustrate the relationships and distribution of the formations and coarse-grained sediments that will constitute principal aquifers. The locations of these profiles are shown in **Figure 5-6**.

More regional geologic sections have been prepared across the Sutter Subbasin that show the geologic formation names and some lithologic indications. East-west geologic profiles (Springhorn, 2008) across the northern Subbasin boundary and along the Sutter and Butte County lines where inflow to the Subbasin occurs are provided in **Figure 5-8** and **Figure 5-9**.

Basin-level profiles that show sediment types and formation were developed that cross the entire Subbasin. **Figure 5-10** shows a regional northwest-southeast profile. **Figure 5-11** shows a regional east-west profile. **Appendix 5-A** contains the well logs used to create these geologic profiles.

In addition to these geologic profiles, geotechnical investigations (to depths of up to 140 feet) have been performed along significant portions of the Feather and Sacramento River levees, along the east and west sides of the Subbasin. Profiles were developed along the Sutter Bypass levees, located in the central portion of the basin. The investigations show sediment types where groundwater and surface water interactions occur, and where the river (bathometric elevations) has incised partially or entirely through coarse-grained sediments that make up the shallow aquifer zone. They also show where slurry walls have been constructed and where they are planned. **Appendices 5-B** through **5-D** provide these geologic profiles for each of the rivers and the bypass. These sections do not contain a breakout of the geologic formations but in general, dependent upon the location, would include Alluvium and Older alluvium.

This page intentionally left blank.

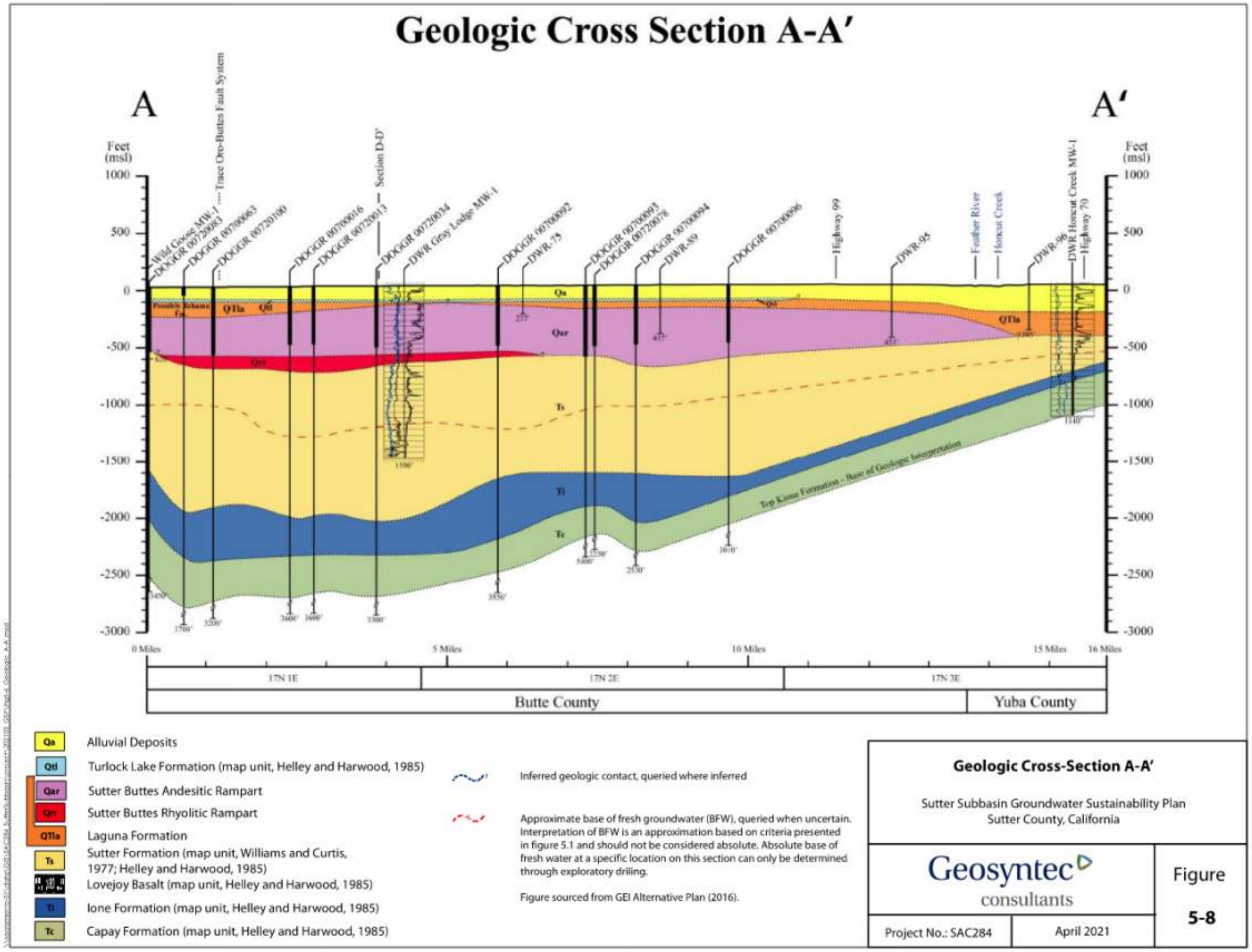


Figure 5-8. Geologic Cross-Section A-A’

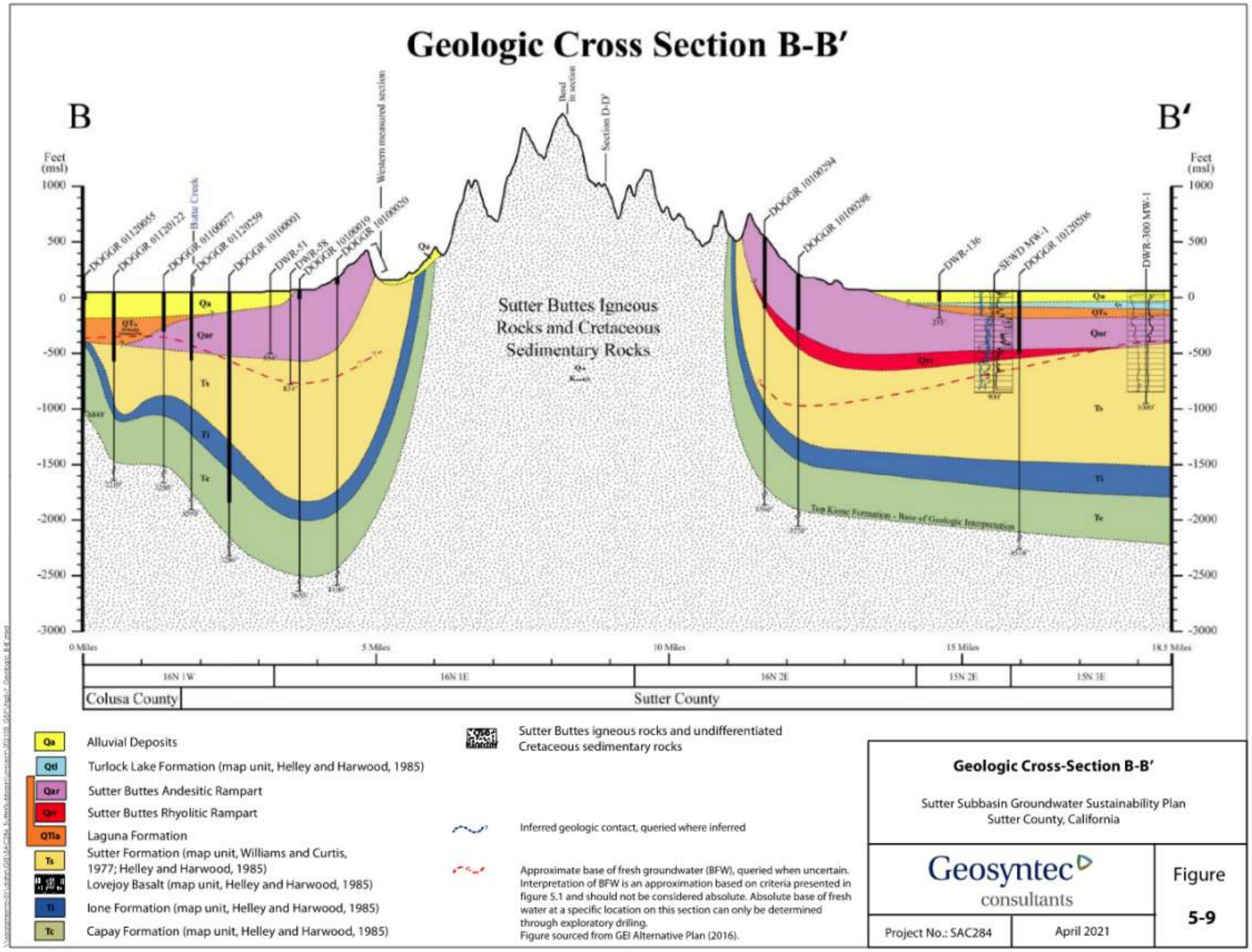


Figure 5-9. Geologic Cross-Section B-B'

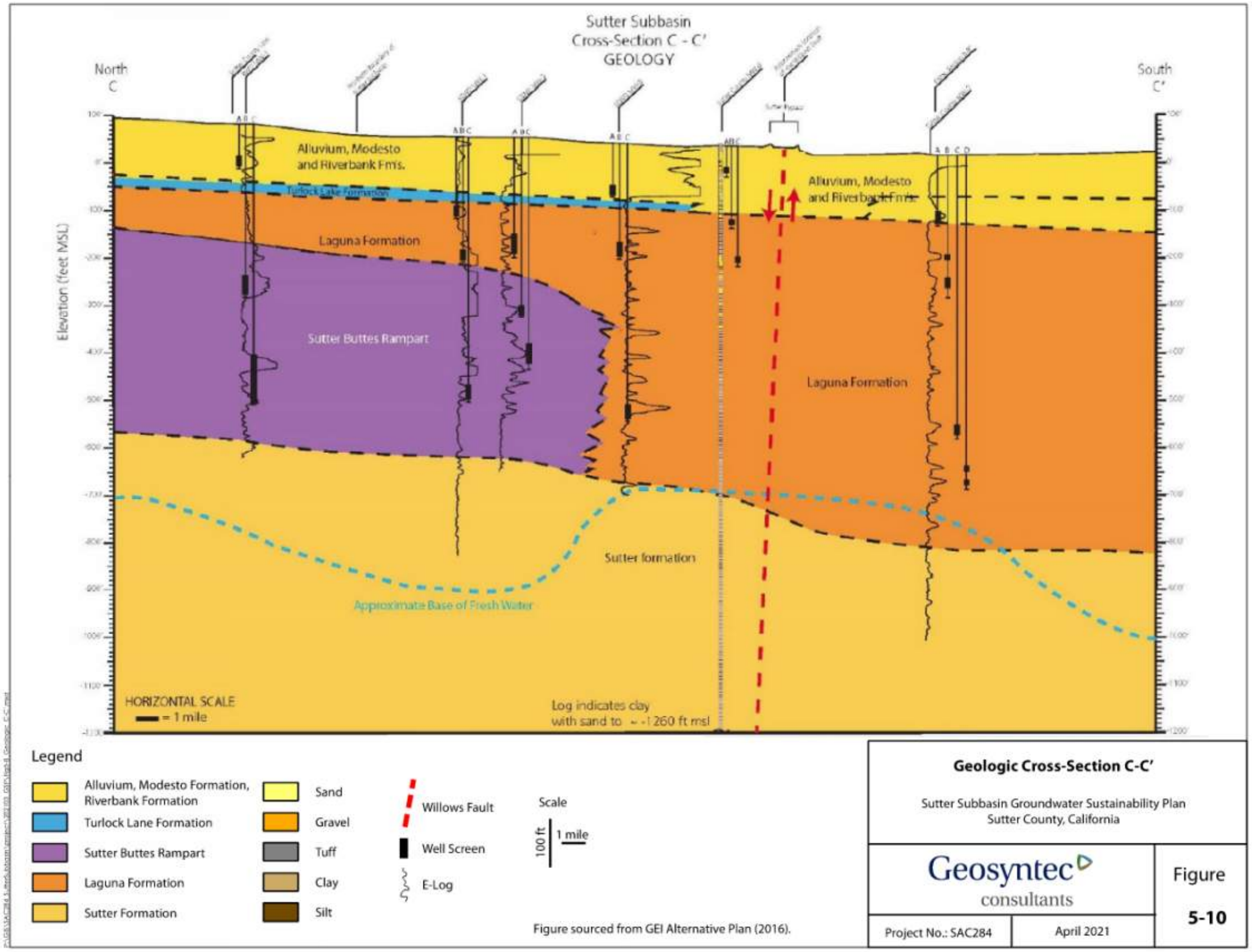


Figure 5-10. Geologic Cross-Section C-C'

This page intentionally left blank.

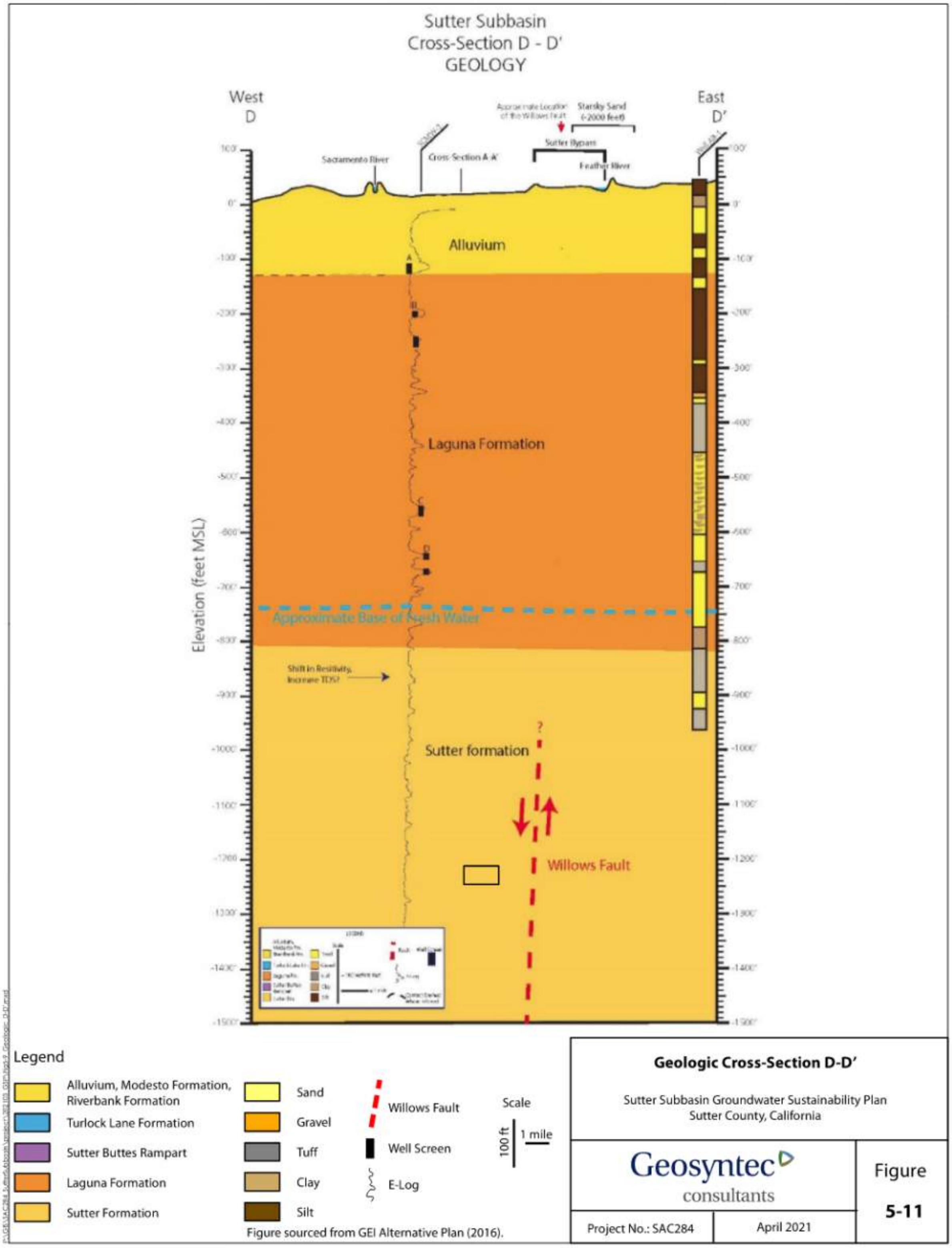


Figure 5-11. Geologic Cross-Section D-D'

5.1.6 Principal Aquifers and Aquitards

As stated in the GSP Regulations, the HCM is to include a description of the principal aquifers and aquitards including the following information:

- Formation names.
- Physical properties of aquifers and aquitards, including the vertical and lateral extent, hydraulic conductivity, and storativity.
- Structural properties of the basin that restrict groundwater flow within the principal aquifers, including information regarding stratigraphic changes, truncation of units, or other features.
- General water quality of the principal aquifers.
- Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply (discussed in **Section 2.1.3.1**).

The following sections provide this information.

5.1.6.1 Formation Names

The Sutter Subbasin groundwater system is comprised of a single principal aquifer composed of the Modesto Formation, Riverbank Formation, Sutter Buttes Rampart, Victor Formation, and Laguna Formation. These formations create various zones with different hydrogeologic properties with both unconfined and semi-confined conditions. This leaky aquifer system has resulted in varied hydraulic connectivity between different depth zones in different areas of the Subbasin.

The Alternative Plan recognized three aquifer zones within the principal aquifer that are designated in this GSP as Aquifer Zones (AZ) 1, 2, and 3. Each of these aquifer zones is separated over portions of the Subbasin by single or multiple layers of silt and clay (or aquitards) that slow the vertical movement of groundwater within the overall aquifer. Geologic units identified within the shallow AZ-1 includes the Modesto Formation and Riverbank Formation. Geologic units identified within the intermediate AZ-2 include the Sutter Buttes Rampart and Laguna Formation. The AZ-2 has been further subdivided into 2A for the area within the Sutter Buttes Rampart and 2B for the area within the Laguna Formation. Units identified within the deep AZ-3 include the Laguna Formation, Sutter Buttes Rampart, and Sutter formation.

5.1.6.2 Aquifer Interactions

Figure 5-12 and **Figure 5-13** provide hydrostratigraphic cross-sections constructed as part of the Alternative Plan that illustrate the vertical and lateral extent of each of the AZs interpreted from the geology, electric log responses, groundwater levels, and water quality. As shown in these cross-sections, the shallow AZ-1 extends from the ground surface to depths ranging from 120 feet to 150 feet bgs at MW-1, nearest the Sutter Buttes in the north, to a depth of about 150 to 200 feet at MW-3, furthest south from the

Sutter Buttes. Although, as discussed below, there are no known aquifer tests conducted in this aquifer, it is believed to be unconfined to semiconfined, a conclusion supported by the response of hydrographs as discussed below.

The intermediate AZ-2 slopes away in a radial pattern from the Sutter Buttes and extends from about 180 to 450 feet bgs, as illustrated in **Figure 5-12** and **Figure 5-13**. The deep AZ-3 extends from about 480 to about 700 feet or more beneath the Subbasin. The low permeability zone between AZ-1 and AZ-2 ranges in thickness from 20 to 60 feet, and the low permeability zone between AZ-2 and AZ-3 ranges in thickness from 30 to 80 feet.

To further assess the interactions between the three aquifer zones, hydrographs for 12 nested monitoring wells (contain multiple separate wells at same location) within the Subbasin were assessed. The locations of these wells are shown in **Figure 5-14**. Nine of these wells (shown as red in **Figure 5-14**) are equipped with pressure transducers and record water levels hourly. The following presents the results of the assessment for the nine wells equipped with pressure transducers going from north to south. The complete hydrographs for each of the nested wells are presented in **Appendix 5-E**. **Figure 5-15** through **Figure 5-23** provide hydrographs for individual years from each of the nine wells with pressure transducers. This smaller scale allows for observations of differences in responses to yearly stresses on the aquifer zones, such as from seasonal pumping, and provides more insight for interactions between the aquifer zones. For each of these hydrographs, AZ-1 wells hydrographs are in green, AZ-2 in blue, and AZ-3 in red. Where a nested well has two screens within the same aquifer zone, the deeper well hydrograph is dashed.

This page intentionally left blank.

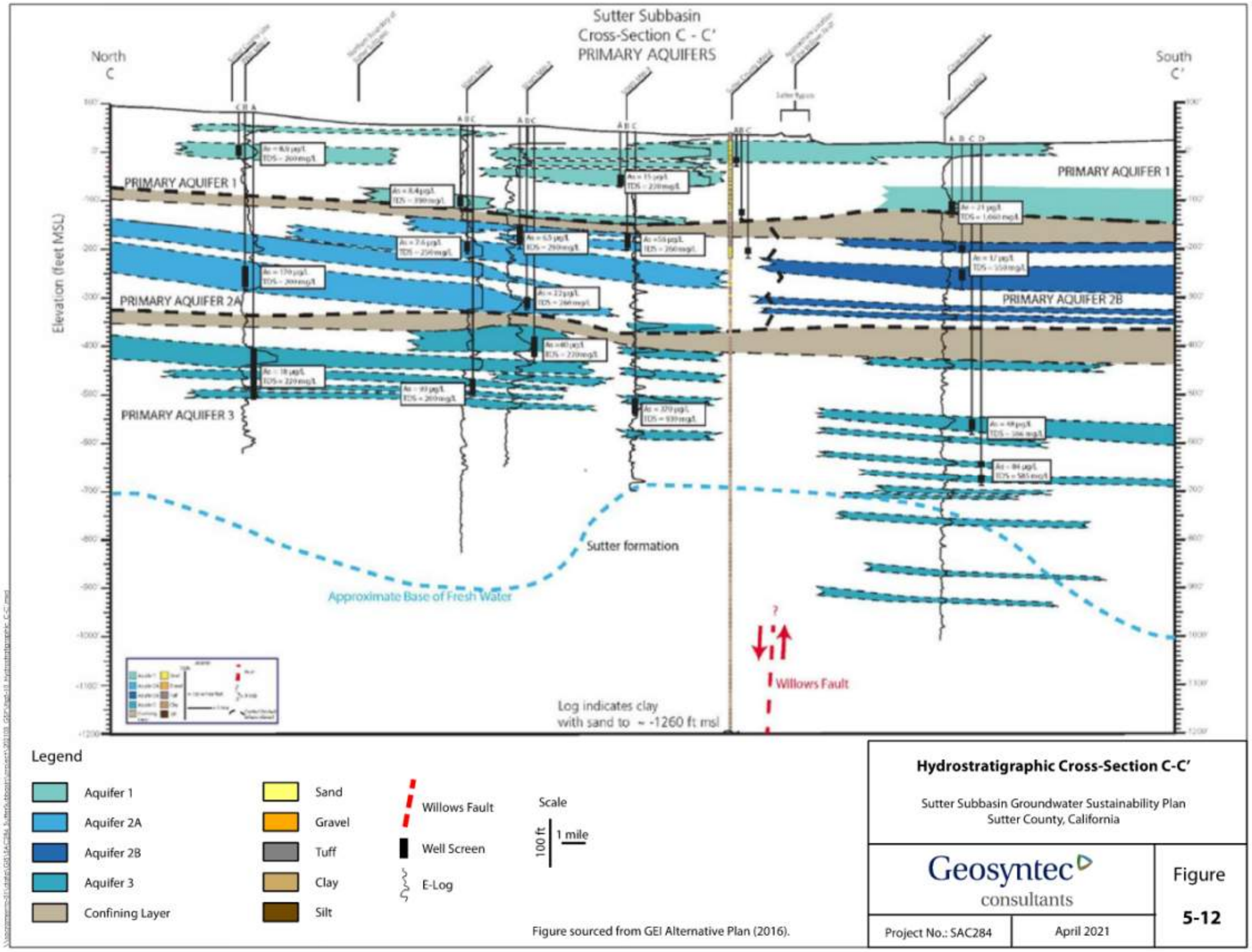


Figure 5-12. Hydrostratigraphic Cross-Section C-C'

This page intentionally left blank.

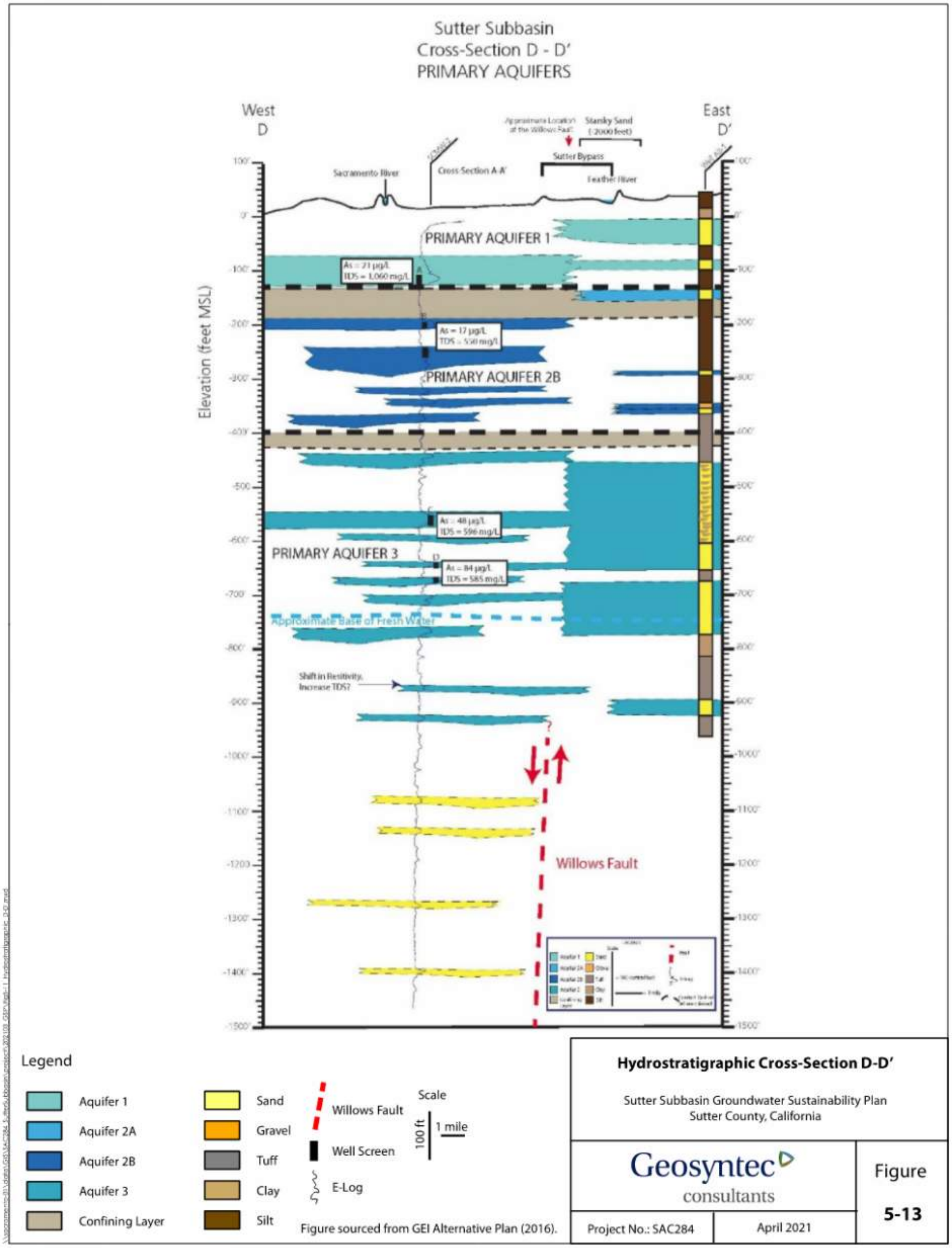


Figure 5-13. Hydrostratigraphic Cross-Section D-D'

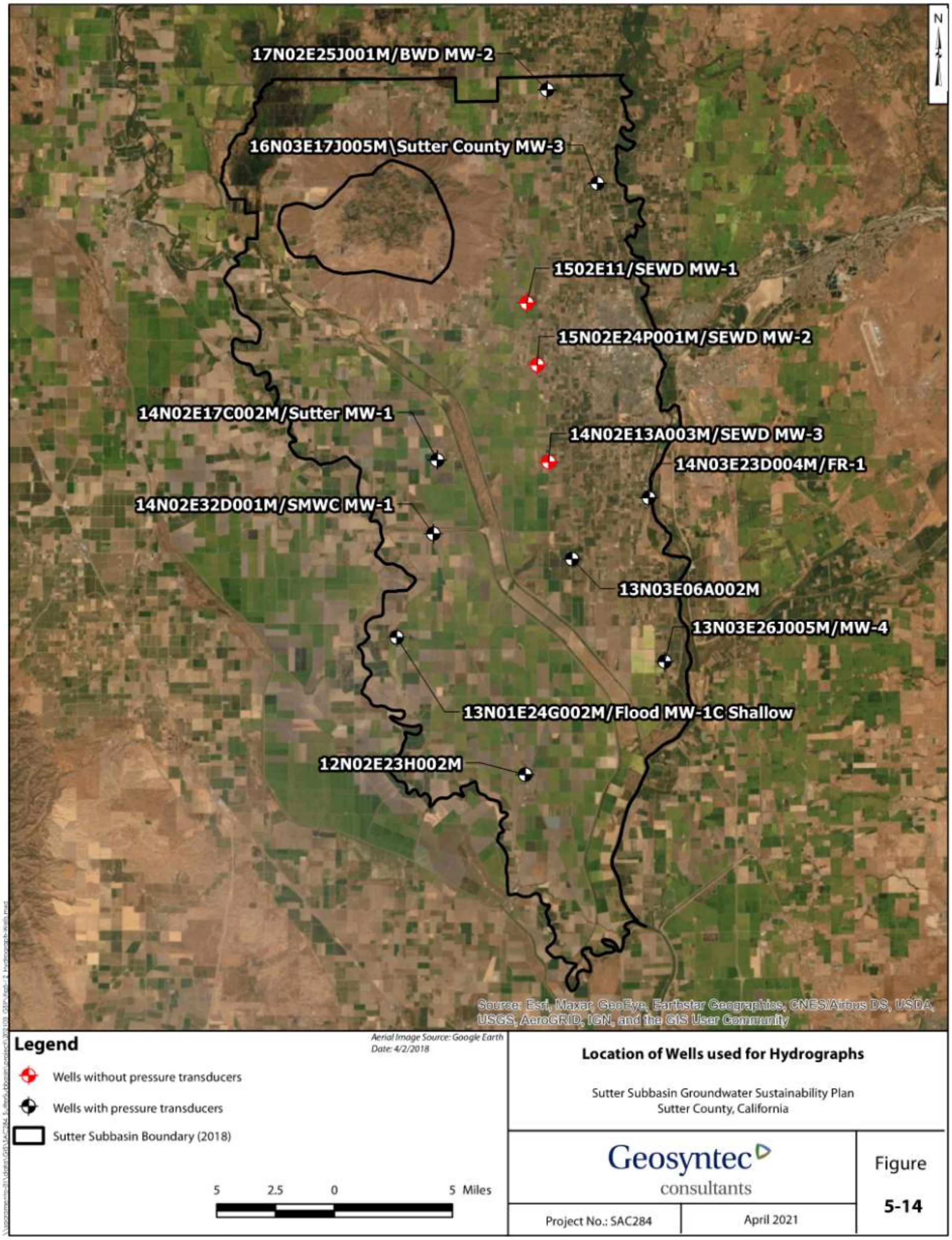
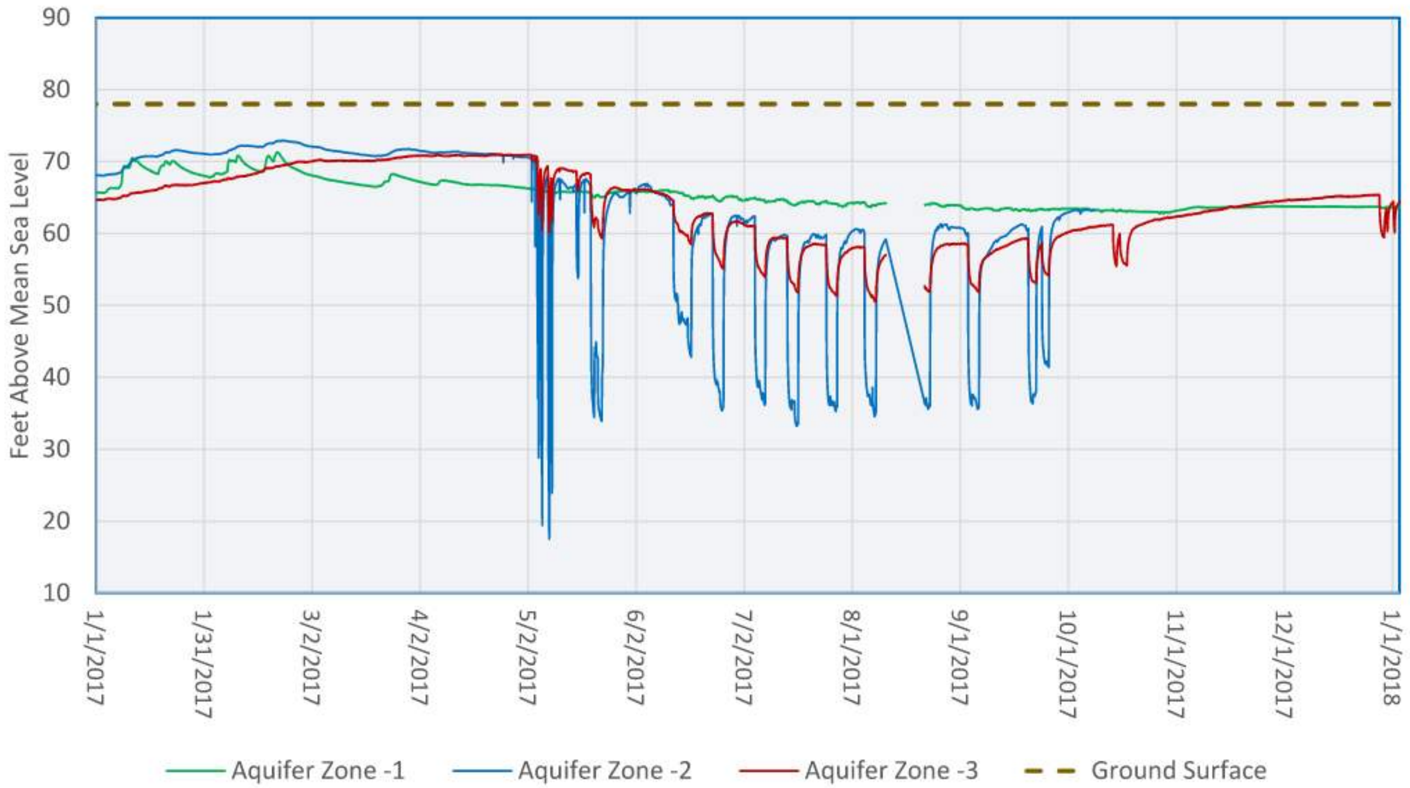
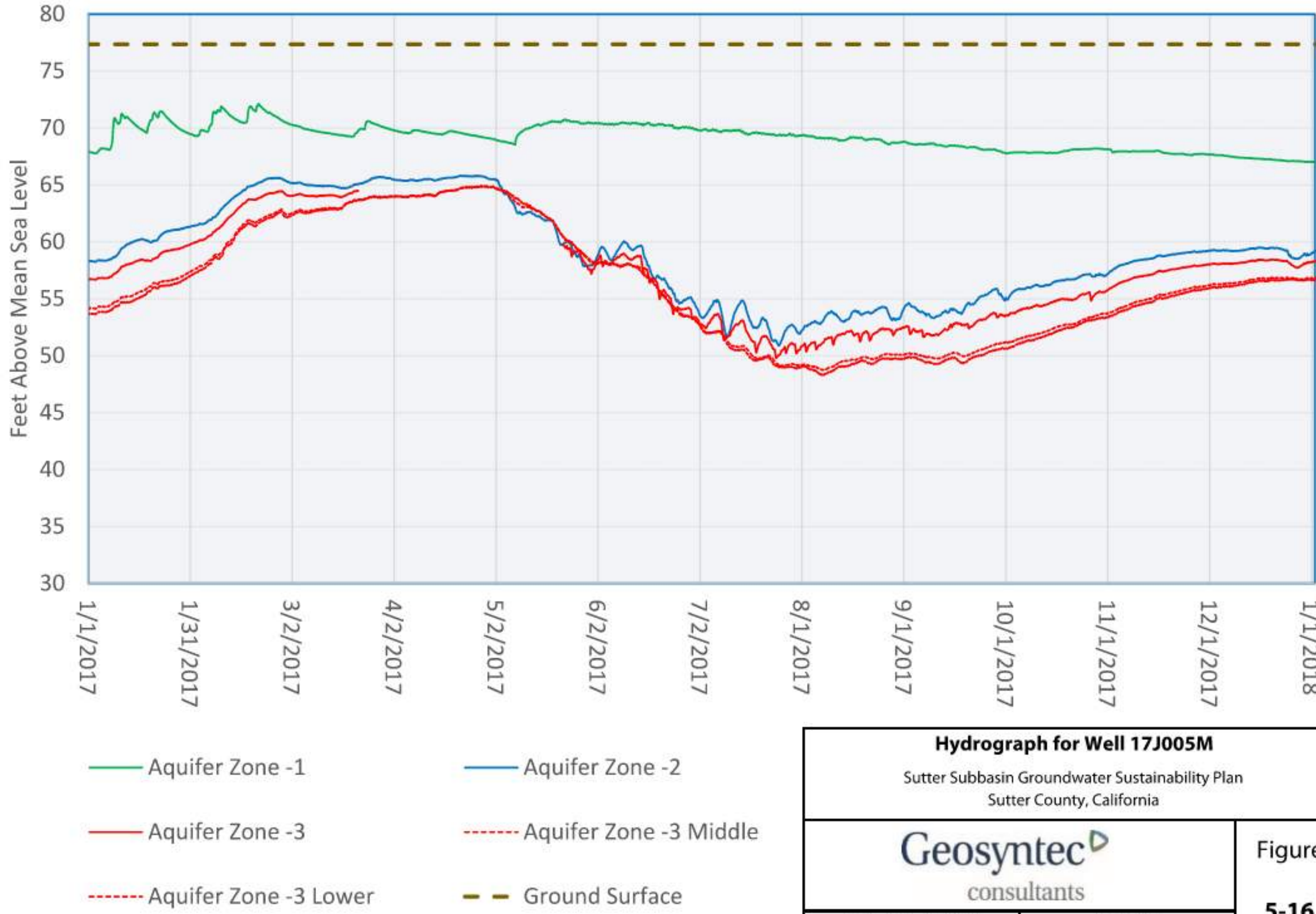


Figure 5-14. Location of Wells Used for Hydrographs



Hydrograph for Well 25J001M Sutter Subbasin Groundwater Sustainability Plan Sutter County, California		
Geosyntec consultants		Figure 5-15
Project No.: SAC284	April 2021	

Figure 5-15. Hydrograph for Well 25J001M



Hydrograph for Well 17J005M Sutter Subbasin Groundwater Sustainability Plan Sutter County, California		
Geosyntec consultants		Figure 5-16
Project No.: SAC284	April 2021	

Figure 5-16. Hydrograph for Well 17J005M

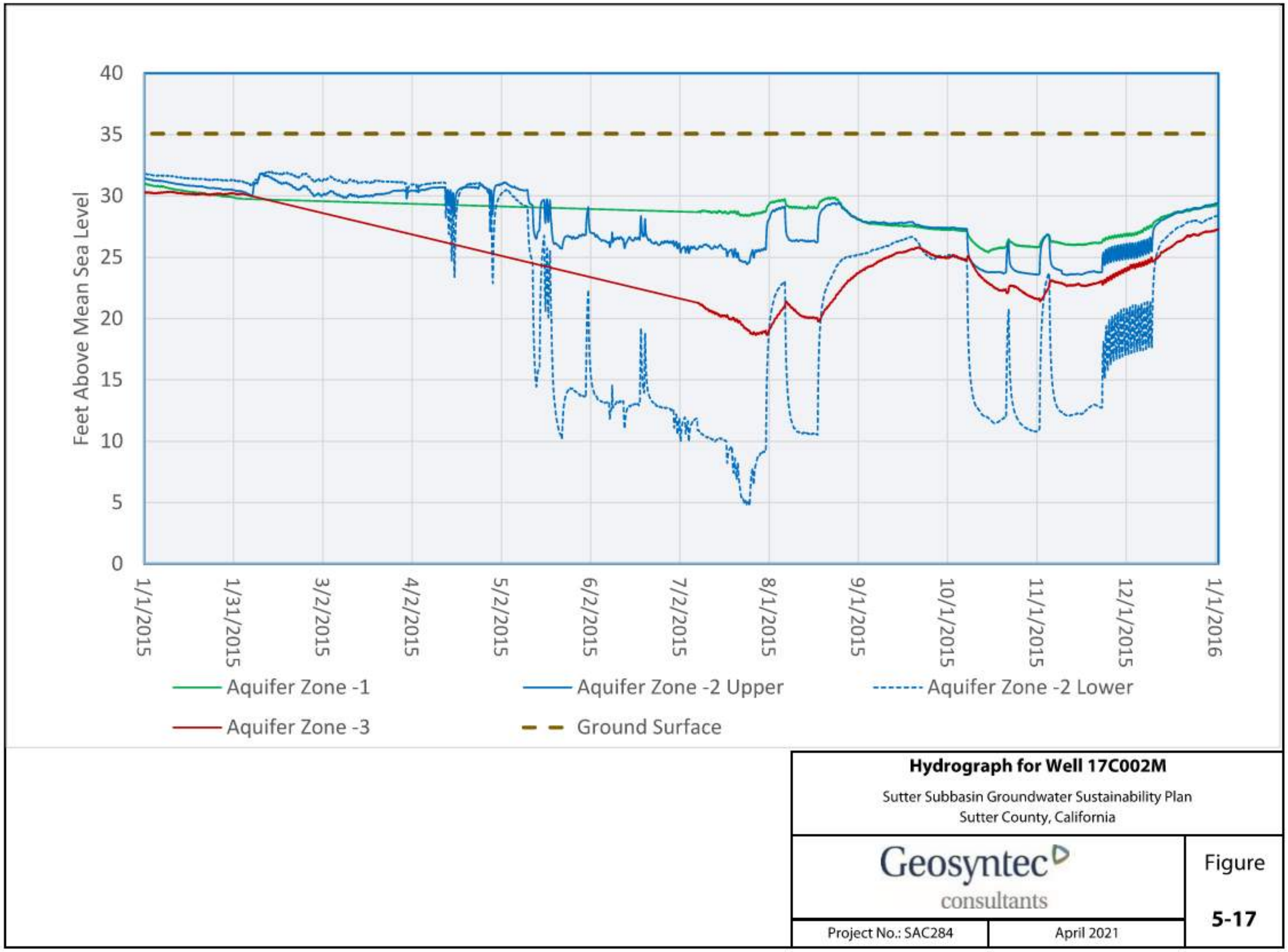


Figure 5-17. Hydrograph for Well 17C002M

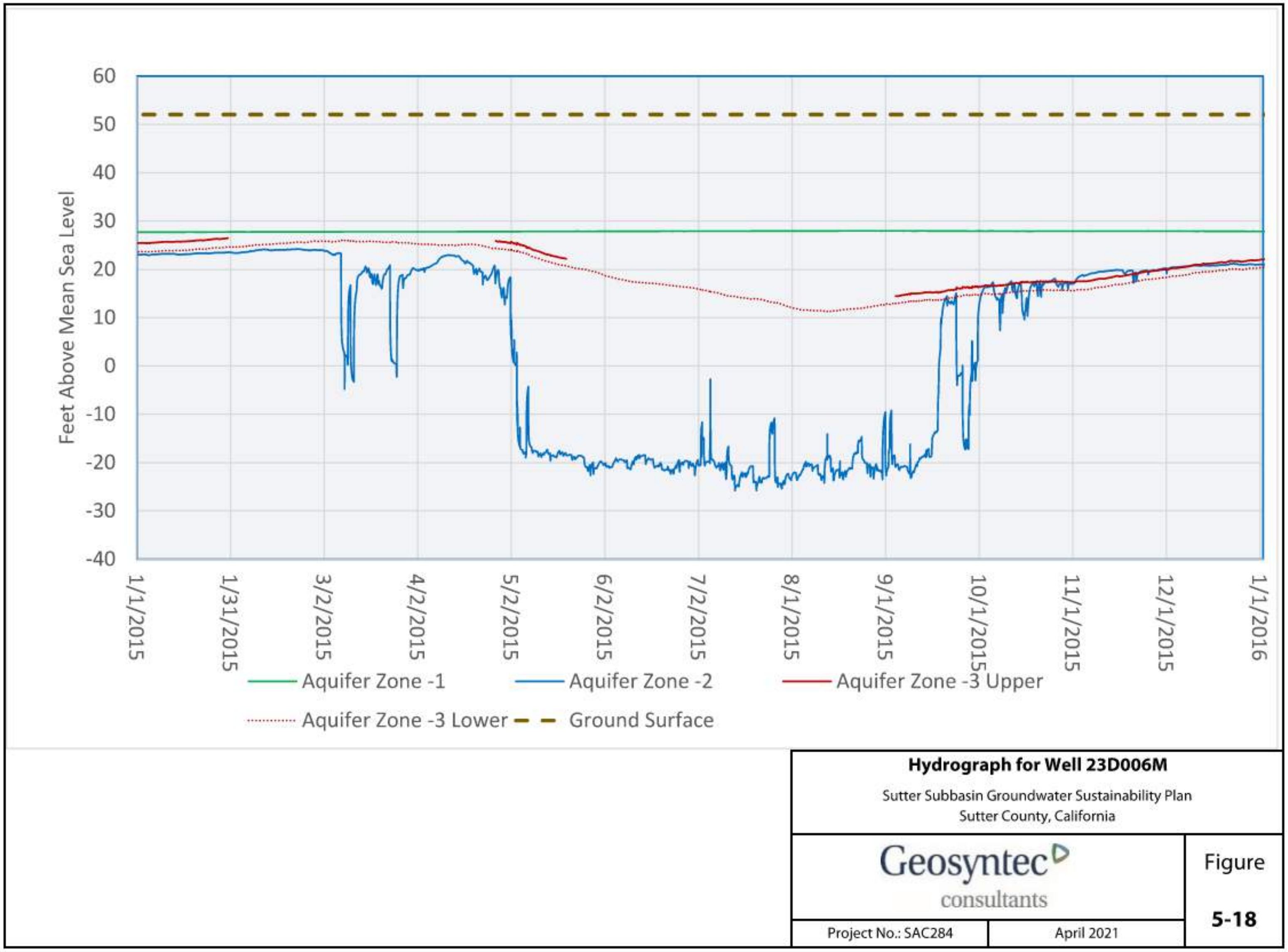


Figure 5-18. Hydrograph for Well 23D006M

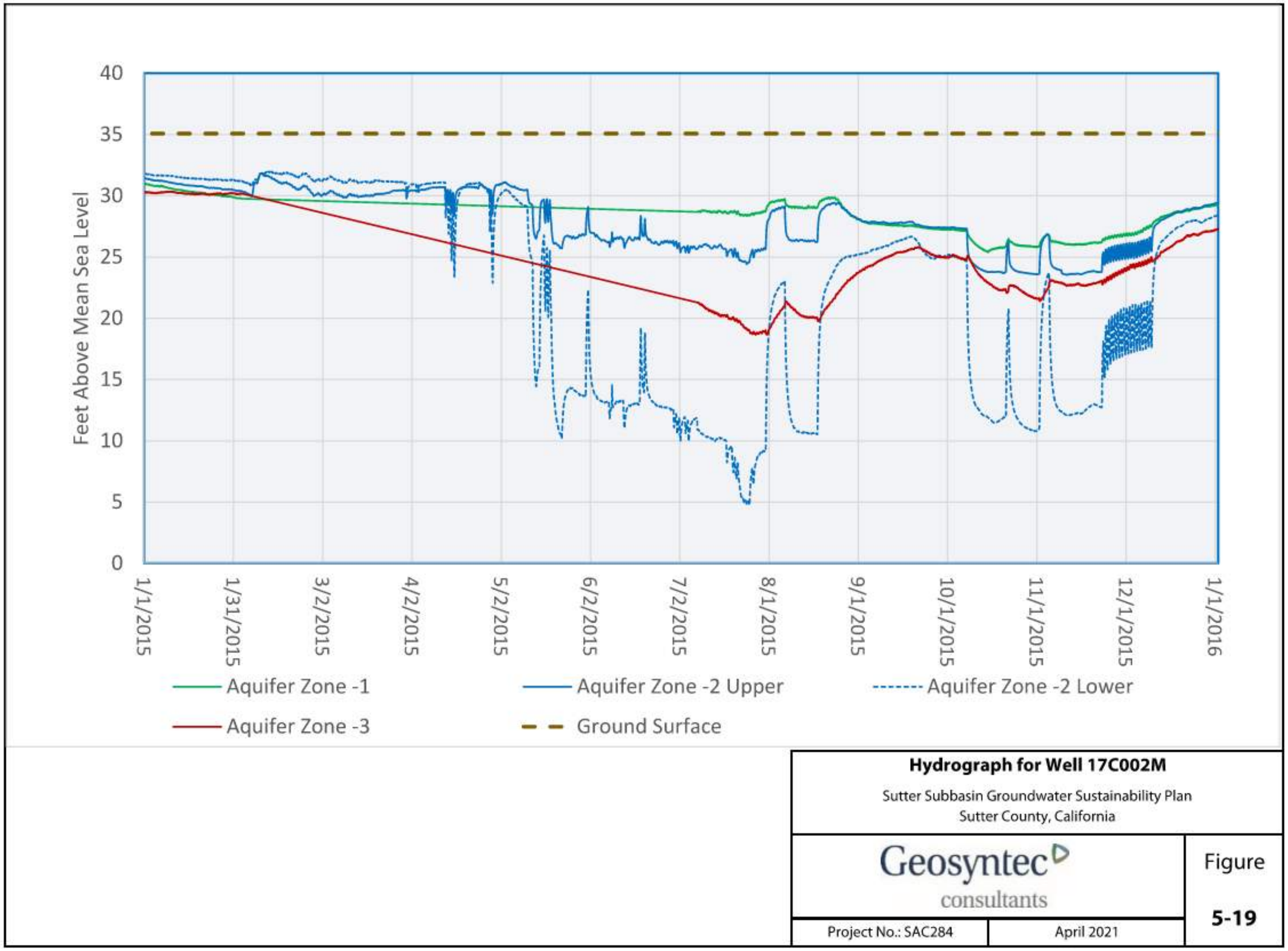


Figure 5-19. Hydrograph for Well 17C002M

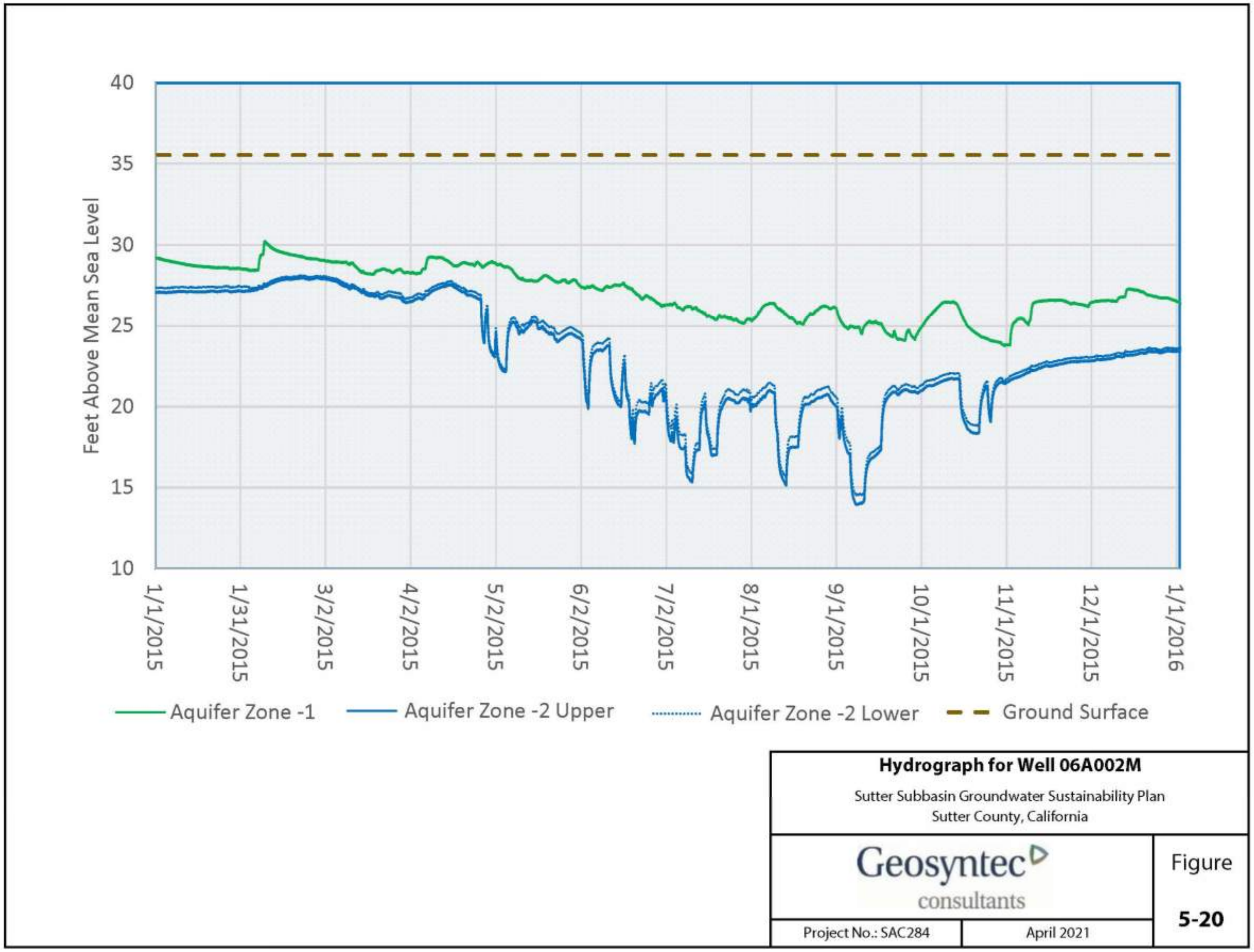


Figure 5-20. Hydrograph for Well 06A002M

Hydrograph for Well 24G002M Sutter Subbasin Groundwater Sustainability Plan Sutter County, California		
Geosyntec consultants		Figure 5-21
Project No.: SAC284	April 2021	

Figure 5-21. Hydrograph for Well 24G002M

Hydrograph for Well 26J005M

Sutter Subbasin Groundwater Sustainability Plan
Sutter County, California

Geosyntec consultants

Figure 5-22

Project No.: SAC284 | April 2021

Figure 5-22. Hydrograph for Well 26J005M

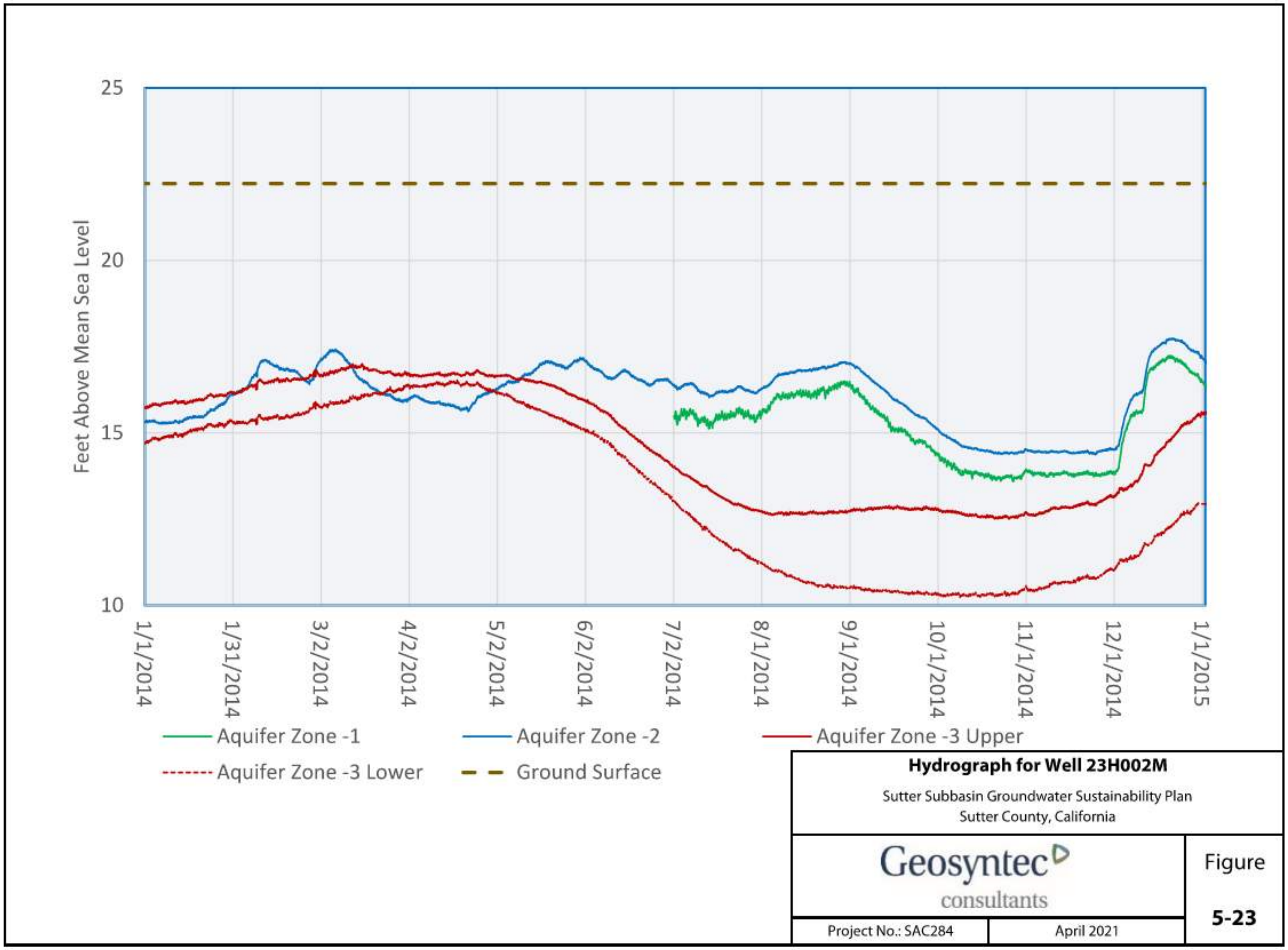


Figure 5-23. Hydrograph for Well 23H002M

This page intentionally left blank.

Well BWD-MW-2 (17N02E25J001M): This well contains separate screen zones within each of the aquifer zones. **Figure 5-15** shows the hydrograph for the year 2017. Observations from this hydrograph are summarized below:

- Primary pumping appears to occur within AZ-2, where significant drawdown occurs in this zone during the period from May through October. The pattern shown for AZ-2 indicates the well is within the zone of influence of pumping wells in the area.
- Drawdowns in the AZ-3 well mimic the same pattern as the AZ-2 well, suggesting a hydraulic connection between these two aquifer zones. The drawdown within this zone is significantly less than the AZ-2 drawdowns with a slight delay in response that suggests the low permeability zone between units limits the direct hydraulic connection.
- The drawdown curves for both AZ-2 and AZ-3 are indicative of a confined aquifer.
- AZ-1 is not hydraulically connected to the lower aquifer zones. There does appear to be some response in this aquifer during the cycling of pumping observed in AZ-2, suggesting leakage through the underlying aquitard.
- The pattern for AZ-1 in January and February of this year suggests response to increase flows in surface water or reduced groundwater pumping in the area. AZ-2 shows a similar muted response during this period, suggesting leakage between these zones.
- During periods of non-pumping, an upward vertical gradient occurs between lower zones and AZ-1.

Sutter County Well MW-3 (16N03E17J005M): This well contains five separate screen zones: one within AZ-1, two within AZ-2, and two within AZ-3. **Figure 5-16** shows the hydrograph for the year 2017. Observations from this hydrograph are summarized below:

- AZ-1 is not in direct hydraulic connection with lower zones. The pattern of this hydrograph also shows no indication of leakage to the lower zones.
- The response for the two AZ-2 wells and two AZ-3 wells indicates drawdown from May to September due to regional pumping.
- The AZ-2 wells and AZ-3 wells indicate direct hydraulic communication within the individual aquifer zones. Both aquifer zones indicate downward vertical gradients.
- The patterns indicate that there is not a direct hydraulic connection between AZ-2 and AZ-3, but there is leakage through the aquitard separating the two zones.

Sutter County Well MW-1 (14N02E17C002M): This well contains four separate screen zones: one within AZ-1, two within AZ-2, and one within AZ-3. **Figure 5-17** shows the hydrograph for the year 2015. Observations from this hydrograph are summarized below:

- Primary pumping appears to occur within the deeper of the two AZ-2 wells (screened from 395 to 415 feet bgs), where significant drawdown occurs in this zone during the period from May through December. The pattern shown for AZ-2 indicates the well is within the zone of influence of pumping wells in the area.
- Drawdowns in the upper AZ-2 well mimic the pattern of the deeper AZ-2 well, indicating hydraulic connection between within the overall AZ-2. The drawdown within this upper part is significantly less than the lower AZ-2 well drawdowns, indicating that there are lower permeability units between the two zones. During the observed pumping, there is a downward vertical gradient. When pumping is not occurring, there are periods where there is an upward vertical gradient within AZ-2.
- The drawdown curves observed in the AZ-2 wells during pumping indicate confined conditions.
- The hydrographs for the wells within both AZ-1 and AZ-3 indicate limited hydraulic connection through leakage of the aquitards.

Feather River (FR) Well 1 (14N03E23D006M): This well contains four separate screen zones: one within AZ-1, one within AZ-2, and two within AZ-3. **Figure 5-18** shows the hydrograph for the year 2015. Observations from this hydrograph are summarized below:

- Primary pumping appears to occur within AZ-2, where significant drawdown occurs in this zone during the period from March through October. The pattern shown for AZ-2 indicates the well is within the zone of influence of pumping wells in the area and that AZ-2 is confined.
- The hydrographs for both the AZ-1 and AZ-3 wells indicate no hydraulic connection with AZ-2. However, both patterns indicate that there is leakage through aquitards, with a stronger connection between AZ-1 and AZ-2.
- AZ-3 has a slight downward vertical gradient.

Sutter Mutual Water Company (SMWC) Well MW-1 (14N02E32D002M): This well contains three separate screen zones: one within AZ-1, one within AZ-2, and one within AZ-3. **Figure 5-19** shows the hydrograph for the year 2015. Observations from this hydrograph are summarized below:

- The hydrographs for AZ-1 and AZ-2 indicate these aquifer zones are hydraulically connected and may be the same aquifer to a depth of 200 feet (bottom of AZ-2 well) in this area. Both wells show patterns during this year that may be in response to surface water flow within the adjacent Tisdale Bypass.
- For 2015, there is an upward vertical gradient within AZ-1 and AZ-2. During periods when there are artesian conditions (e.g., 2017; **Appendix 5-E**), the vertical gradient is downward.

- The hydrograph for AZ-3 indicates no direct hydraulic connection with AZ-1 and AZ-2. The hydrograph for AZ-3 also indicates drawdown to regional pumping. This aquifer zone also exhibits artesian conditions during wet periods (e.g., 2017; **Appendix 5-E**).

Sutter County Well MW-6 (13N03E06A002M): This well contains three separate screen zones: one within AZ-1 and two within AZ-2. **Figure 5-20** shows the hydrograph for the year 2015. Observations from this hydrograph are summarized below:

- The hydrographs indicate that AZ-1 and AZ-2 are not in direct hydraulic connection.
- Primary pumping appears to occur within AZ-2, with both AZ-2 wells showing drawdown patterns consistent with nearby pumping wells. The hydrographs for the two AZ-2 wells also show a downward vertical gradient in this aquifer zone and the patterns are consistent with a confined aquifer. Data from other years (e.g., 2017; **Appendix 5-E**) indicate that pumping from this zone does not occur every year.
- The hydrograph for the AZ-1 well suggests response to surface water flows from the nearby Gilsizer Slough and that there is some leakage to the lower aquifer zone.

Flood Well MW-1 (13N01E24G002M): This well contains three separate screen zones: two within AZ-1 and one within AZ-2. **Figure 5-21** shows the hydrograph for the year 2018. Observations from this hydrograph are summarized below:

- The hydrographs show that all three zones screened are in direct hydraulic connection, indicating AZ-1 and AZ-2 are one aquifer zone in this area.
- Primary pumping appears to occur within the lower part of AZ-2, where significant drawdown occurs in this zone during the period from May through August. The other two wells show a similar pattern but to a lesser degree, suggesting the presence of some lower permeability zones between the depths. The patterns shown indicate these wells are within the zone of influence of pumping wells in the area.
- The full hydrographs indicate that pumping does not occur every year (e.g., 2017; **Appendix 5-E**). During these years, drawdown does occur consistent to regional pumping and possibly leakage to lower aquifer zones.

Sutter County Well MW-4 (13N03E26J00XM): This well contains four separate screen zones: one within AZ-1, one within AZ-2, and two within AZ-3. **Figure 5-22** shows the hydrograph for the year 2015. Observations from this hydrograph are summarized below:

- The hydrographs show that AZ-1 and AZ-2 are hydraulically connected. The AZ-1 well is screened near the bottom (145 to 165 feet bgs) and may be part of AZ-2.
- There is a downward vertical hydraulic gradient between the AZ-1 and AZ-2 well. Both AZ-1 and AZ-2 show responses between January and April that may indicate connection to surface water in the Feather River.

- Primary pumping appears to occur within the interval screened by both the AZ-1 and AZ-2 wells, where significant drawdown occurs in this zone during the period from June through October. The patterns shown indicate these wells are within the zone of influence of pumping wells in the area.
- The hydrographs for the two AZ-3 wells also indicate hydraulic connection with a downward vertical gradient. The hydrographs also show response to regional pumping and response from leakage upward due to pumping in AZ-2. The initial response to pumping in AZ-2 from the shallower of the two AZ-3 wells is an increase in water level. This response is referred to as a Noordbergum effect that occurs because pumping instantly compresses the aquifer to force water up the well (Verruijt, 1969).

Sutter County Well MW-2 (12N02E23H002M): This well contains four separate screen zones: one within AZ-1, one within AZ-2, and two within AZ-3. **Figure 5-23** shows the hydrograph for the year 2014. Observations from this hydrograph are summarized below:

- The hydrographs show that AZ-1 and AZ-2 are hydraulically connected and that there is an upward vertical gradient between these zones. The hydrographs for these wells also show response to regional pumping and may be showing response that indicates they are on the fringes of the influence of pumping wells.
- The hydrographs for the two AZ-3 wells also indicate hydraulic connection between the upper and lower zones but with a downward vertical gradient. The hydrographs also indicate response to regional changes and not direct response to pumping wells.

5.1.6.3 Physical Properties of Aquifers and Aquitards

Limited aquifer tests with observation wells are available to provide reliable estimates of the aquifer characteristics. The aquifer tests available were conducted in 2007 for SEWD Wells #1 and #2 (GEI, 2016). The results of these tests are summarized in **Table 5-1**.

Table 5-1. Aquifer Zone Hydraulic Characteristics from Aquifer Tests, Sutter Subbasin

Aquifer Zone	Transmissivity (ft^2/day)	Specific Yield or Storativity (unitless)	Source
AZ-1	N/A	N/A	N/A
AZ-2	N/A	N/A	N/A
AZ-3	7,619 to 8,957	0.000556 to 0.000898	SEWD, Well #1, 2007
	7,352 to 8,556	0.00108 to 0.000978	SEWD, Well #2, 2007

N/A = No aquifer tests available. ft^2/day = square feet per day.

To provide an additional assessment of aquifer properties in the basin, transmissivity (T) values were calculated using an empirical equation where T is calculated by multiplying the specific capacity by an assumed value estimated using the Theis equation. The multiplying factor can be based on unconfined or confined assumptions. As a general rule, T in units of gallons per day per foot (gpd/ft) is calculated by multiplying the specific capacity by 2,000 for a confined aquifer and by 1,500 for an unconfined aquifer (Driscoll, 1986). Specific capacities were obtained from data obtained at DWR's web page for well completion reports[1] that includes data if reported for pumping rates and total drawdowns.

Appendix 5-F provides all of the wells that included this information in the DWR's well completion report database for the Sutter Subbasin, along with calculated T values using the empirical formulas stated above (units of T converted to square feet per day [ft^2/day]). As seen in this table, calculated specific capacities ranged from 0.45 to 189 gallons per minute per foot of drawdown (gpm/ft) with an average value of about 19 gpm/ft. This table also separates calculations by aquifer zones based on completed depths and estimates hydraulic conductivity (K) values using average thickness of each of aquifer zones, as discussed in **Section 5.1.6**. **Table 5-2** summarizes the results of calculations for T and K using the empirical equation for specific capacities.

Table 5-2. Summary of Calculated T and K Values

Aquifer Zone	# of Records	Min T Value (ft^2/day)	Max T Value (ft^2/day)	Average T Value (ft^2/day)	Min K Value (ft/day) [3]	Max K Value (ft/day)	Average K Value (ft/day)
1 [1]	58	90	14,964	1,975	1	100	13
2 [2]	71	141	50,501	6,407	1	230	30
3 [2]	10	1,205	16,825	9,303	5	76	42

ft/day = feet per day.
[1] Uses empirical value for unconfined aquifer, multiplies specific capacity by 1,500 for units of gpd/ft. See Appendix 5-F for range of calculated specific capacities.
[2] Uses empirical value for confined aquifer, multiplies specific capacity by 2,000 for units of gpd/ft. See Appendix 5-F for range of calculated specific capacities.
[3] K Values calculated using aquifer zone thickness of 150 feet for AZ-1 and 220 feet for AZ-2 and AZ-3.

As shown in **Table 5-3**, the average K value for each aquifer zone is consistent with well sorted sands and gravels. Typically, T values of less than 100 ft^2/day will supply only enough water for domestic wells or other low-yield purposes. In wells with T values greater than 1,300 ft^2/day, the production yields are typically sufficient for industrial, municipal, or irrigation use.

[1] Well completion reports obtained from DWR's Well Completion Report Map Application (https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37)

Table 5-3. Hydraulic Conductivity Values of Common Aquifer Materials (Modified from Bear, 1972)

K Values in units of feet per day (ft/day)	Aquifer Quality	Typical Aquifer Material
100,000	Good	Well Sorted Gravel
10,000	Good	Well Sorted Gravel
1,000	Good	Well Sorted Sand or Sand and Gravel
100	Good	Well Sorted Sand or Sand and Gravel
10	Good	Well Sorted Sand or Sand and Gravel
1	Poor	Very Fine Sand
0.1	Poor	Very Fine Sand
0.01	Poor	Very Fine Sand
0.001	Poor	Very Fine Sand
0.0001	None	Clay
0.00001	None	Clay

5.1.7 Groundwater Recharge Areas

Groundwater recharge to the Subbasin occurs from various areas within and outside of the Subbasin. The location of groundwater recharge areas is based on groundwater flow contours and geologic profiles. Groundwater contours and flow directions are discussed in detail in **Section 5.2**. For those areas outside of the Subbasin, the recharge areas are discussed in the narrative but not shown on the maps. As GSPs are developed for the adjacent subbasins, recharge areas will become better refined.

5.1.7.1 Recharge Areas Outside of the Subbasin

Groundwater contours show recharge to the Subbasin occurs predominantly in the northern and eastern portions of the Subbasin. Recharge areas present in the North Yuba and Butte Subbasins would contribute groundwater to the connected principal aquifer of the Sutter Subbasin.

The amount of subsurface inflow to the Sutter Subbasin from these recharge areas outside of the Subbasin is presented in **Section 5.3**.

5.1.7.2 Recharge Areas Inside of the Subbasin

Significant areas likely to contribute groundwater to shallow aquifer zones include creeks, rivers, and applied water where the water can move vertically through the sediments. The entire area of the Subbasin provides recharge to the groundwater system to some extent and at variable rates depending upon soil types and availability of water. **Figure 5-24** shows the Soil Agricultural Groundwater Banking Index (SAGBI) map of the Subbasin. This index provides a composite evaluation of soil suitability to accommodate groundwater recharge while maintaining healthy soils, crops, and a clean groundwater supply. The SAGBI is based on five major factors that are critical to successful agricultural groundwater banking: deep percolation, root zone residence time, topography, chemical limitations, and soil surface condition. As shown in **Figure 5-24**, most soils across the Sutter Subbasin are rated as poor to very poor for accommodating groundwater recharge. Areas that are rated as moderately good to good are located around the Sutter Buttes and adjacent to the Feather River on the east and the Sacramento River on the west.

In response to California Executive Order D-5-99, California State Water Board staff created a map where published hydrogeologic information indicates soil or rock conditions that may be more vulnerable (or susceptible) to groundwater contamination, referred to as Hydrogeological Vulnerable Areas (HVAs). The map was created due to groundwater concerns over releases of methyl-tert-butyl ether (MTBE), primarily from leaking underground storage tank sites. The map was created in 2000 using DWR and USGS publications. Data from these publications were used to identify areas where geologic conditions are more likely to allow recharge at rates substantially higher than in lower permeability or confined areas of the same groundwater basin. **Figure 5-25** shows the HVA map for the Sutter Subbasin, indicating what appears to be highly permeable sediments in similar areas as the SAGBI map; however, the HVA mapping does show some areas where recharge could occur in the southern areas of the Sutter Subbasin.

Some of the major sources of groundwater recharge in the area include agricultural lands, the area around the Sutter Buttes, and rivers and bypasses. Much of the water applied for irrigation of agricultural areas in the Sutter Subbasin is surface water diverted from the Feather and Sacramento Rivers, with applied water being supplemented by precipitation. The average annual recharge of applied water in the area covered by the Feather River Regional Agricultural Water Management Plan is 1.25 acre-feet per acre (AF/ac), while comparable recharge of precipitation is 0.35 AF/ac (Davids Engineering, 2014).

The most prominent agricultural land use in the Sutter Subbasin is rice production, followed by fruit and nut orchards and a variety of other crops. Rice production is characterized by flooding of relatively impermeable soils, while irrigation of other crops is performed either by traditional irrigation techniques or by newer low-volume methods including drip and micro-jet systems.

In recent years, growers have been changing orchards from fruits to nuts (almonds). Fruit and nut orchards have an average crop evapotranspiration (ETc) of about 36.3 inches per year which converts to 3.0 AF/ac. Therefore, shifts between fruit and nut crops have little impact on water use; however, changes in irrigation practices have been accompanying these changes in cropping. For example, new orchards are being irrigated almost exclusively with drip and micro-jet systems. This shift away from flood irrigation practices applies less water to fields, so while crop consumption may actually increase due to better timing of applications, deep percolation diminishes. In addition, the low-volume systems are often supplied by wells, which can be turned on and off, rather than from canal deliveries. Both the reduction in deep percolation from newly established orchards and the increased reliance on groundwater to irrigate these lands have implications on the water budget.

The Sutter Buttes Rampart Formation is exposed in an apron surrounding Sutter Buttes, allowing precipitation and agricultural applied water to migrate horizontally along the principal aquifer beds. The amount of recharge, based on surface exposure of the Sutter Buttes Rampart Formation and an average precipitation of 18 inches per year (about 10 percent recharged), is about 220 acre-feet per year (AFY), or less than 1 percent of the total inflow to the basin based on the water budget.

Detailed geotechnical investigations along the rivers and bypasses show multiple sand and gravel layers are present which could allow surface water to recharge the shallow aquifer zone at a relatively high rate. Water can still recharge through silt and clayey layers, but at a much slower rate. The amount of water recharge, based on C2VSimFG-Sutter, is presented in **Section 5.3**.

Prior to 2013, some areas along the rivers and bypasses had low permeability slurry walls installed to stabilize the levees (on the order of 10 percent or less of the total leveed area). Starting in 2013 and continuing through 2016, slurry walls have been installed just north of the confluence of the Feather and Bear Rivers, as shown on the profiles contained in **Appendices 5-C** through **5-E**. This ongoing work has extended the slurry wall coverage to about 50 percent of the river. The depths of the slurry walls have ranged/will range between 21 and 105 feet and reduce, though not stop surface water recharge or portions of the subsurface inflow from the Yuba Subbasins to the east. Estimates on the of reduction of groundwater recharge were not described in the California Environmental Quality Act documentation for the slurry wall installations (ICF International, 2013).

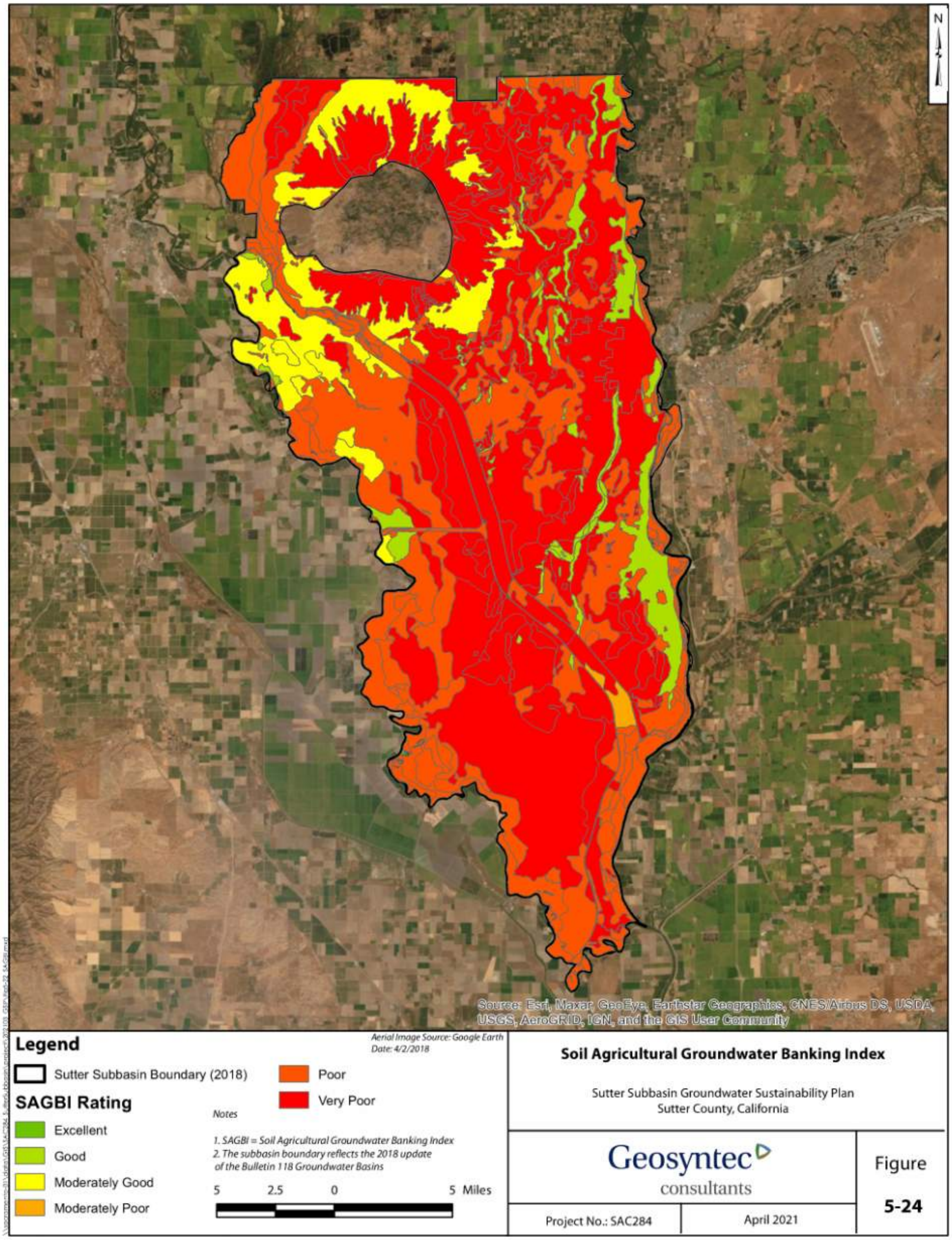


Figure 5-24. SAGBI Map, Sutter Subbasin

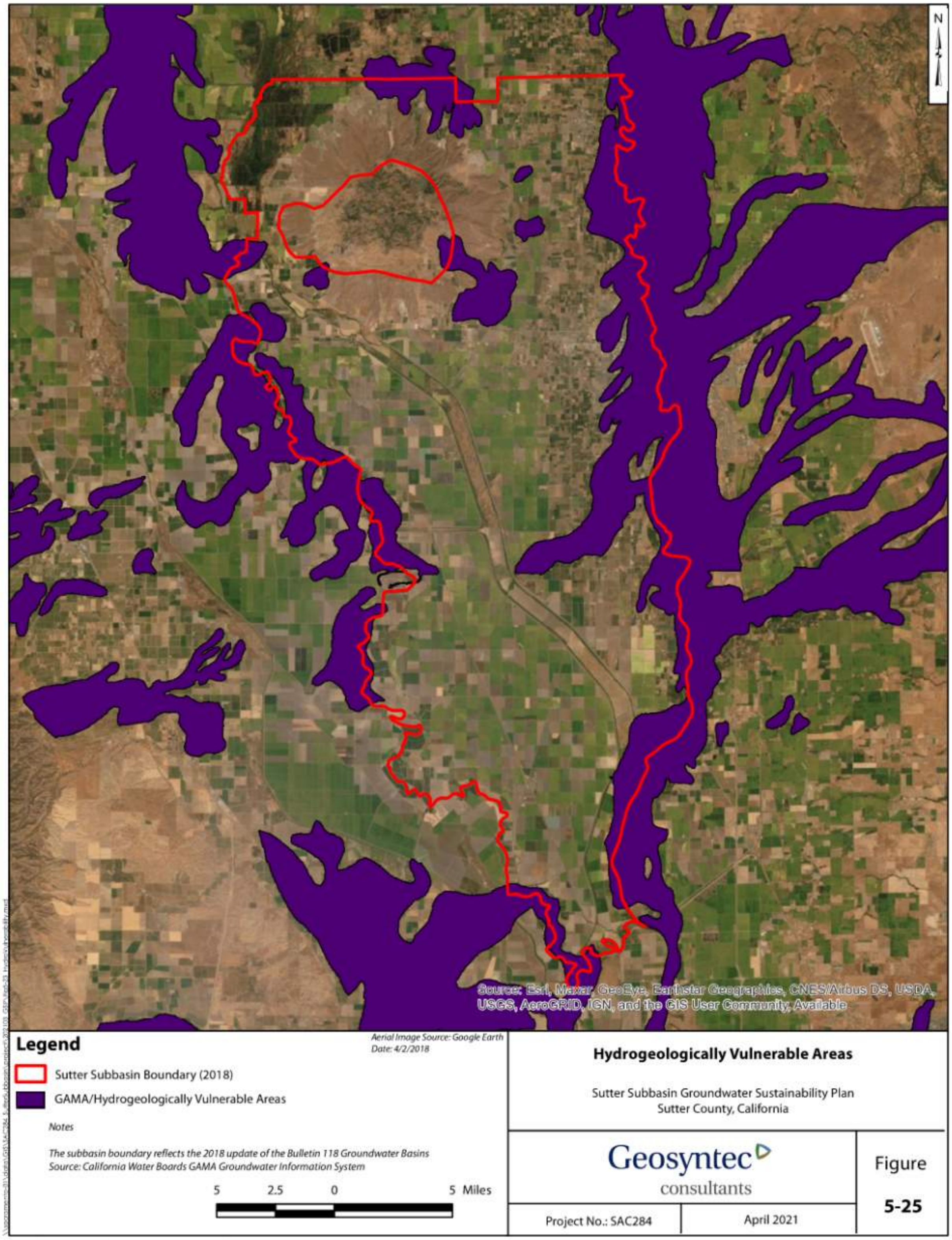


Figure 5-25. Hydrologically Vulnerable Areas, Sutter Subbasin

5.1.8 Groundwater Discharge Areas

Significant sources of groundwater discharge in the Sutter Subbasin include the Sacramento and Feather Rivers, the Butte Sink Wildlife Management Area, and Sutter and Tisdale Bypasses (**Figure 5-26**). Groundwater discharge also occurs along creeks and sloughs though are not considered to be substantial sources of groundwater discharge.

The Sacramento River is topographically at the bottom of the basin and therefore would act under predevelopment conditions as a drain for groundwater within the shallow aquifer zones. Groundwater also may discharge to the Feather River along the southern portion where slurry walls and levee improvements are not planned. The low-lying Butte Sink Wildlife Management Area, located around the Sutter Buttes, constitutes an area of significant groundwater discharge (CH2MHill, 2014).

Detailed geotechnical investigations along the Sacramento River and the Sutter and Tisdale Bypasses, as discussed in the **Section 5.1.5**, showed that multiple sand and gravel layers are present adjacent to the surface water courses. These permeable layers could allow groundwater to discharge to surface water from the shallow aquifer at a relatively high rate. Water can still discharge through silt and clayey layers, but at a much slower rate. The average discharge from the basins is presented in **Section 5.3**.

5.1.9 Water Quality

Groundwater quality was evaluated in the Alternative Plan, in the Sutter County Groundwater Management Plan (Wood Rodgers, 2012), and during the preparation of the Rice Coalition Groundwater Assessment Report (CH2M, 2016). The Alternative Plan utilized available data and developed water quality profiles for three general depths that generally correspond to the three aquifer zones defined in this GSP. For the Alternative Plan, AZ-1 extends to 150 feet bgs, AZ-2 to 400 feet bgs, and AZ-3 to greater than 400 feet bgs. This water quality compilation is a composite of sampling events that span almost 40 years and includes data from DWR and the USGS Shallow Rice, Shallow Domestic, and Groundwater Ambient Monitoring and Assessment Program (GAMA) well networks. To support these data, this GSP also assessed data from DWR's Water Data Library located at https://wdl.water.ca.gov/waterdatalibrary/WaterQualityDataLib.aspx for wells completed in all three aquifer zones across the Sutter Subbasin. Many of these wells are nested wells, with separate screen zones within each aquifer zone. The location of the wells used for this assessment are provided in **Figure 5-27** and well construction details for these wells are provided in **Table 5-4**.

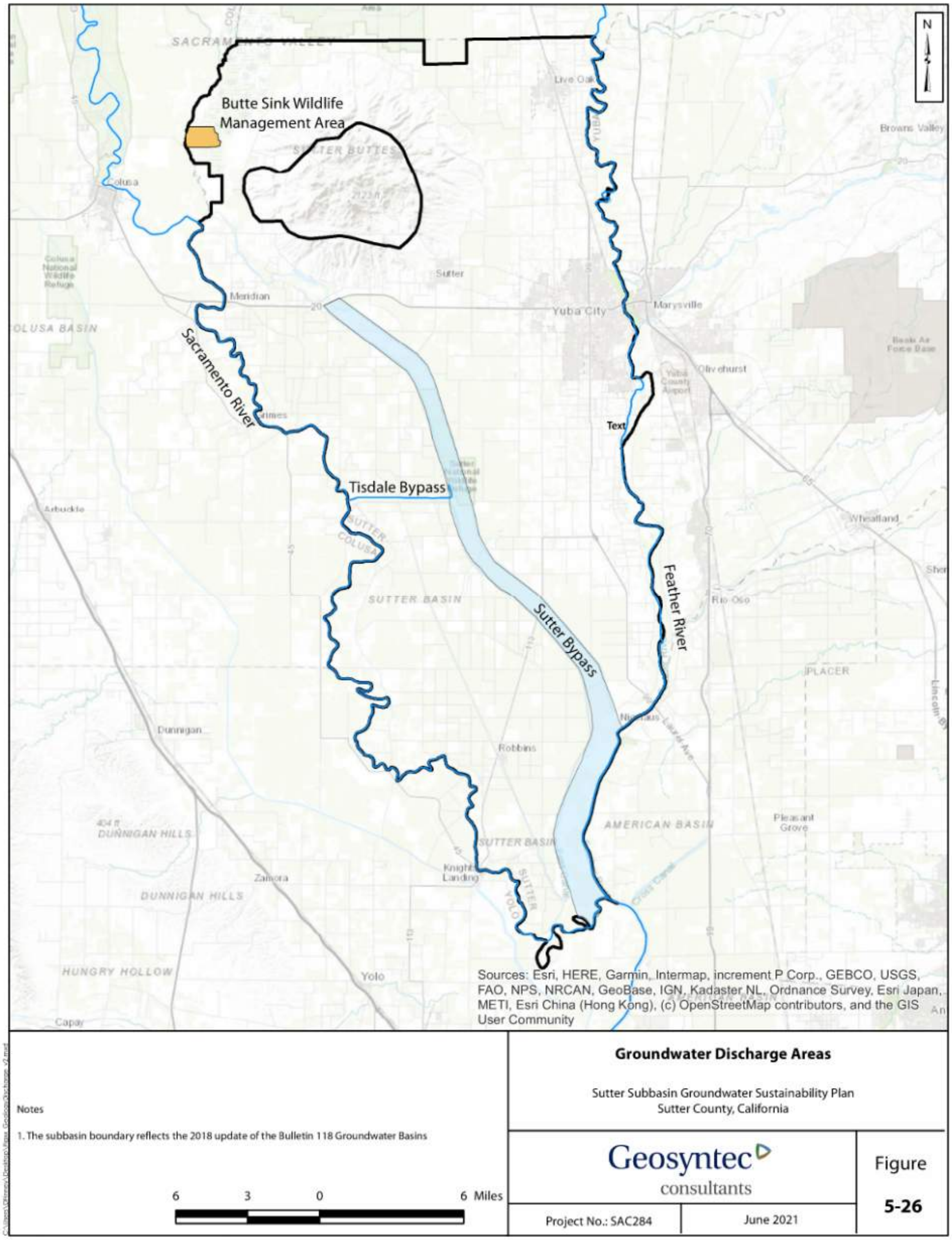


Figure 5-26. Groundwater Discharge Areas

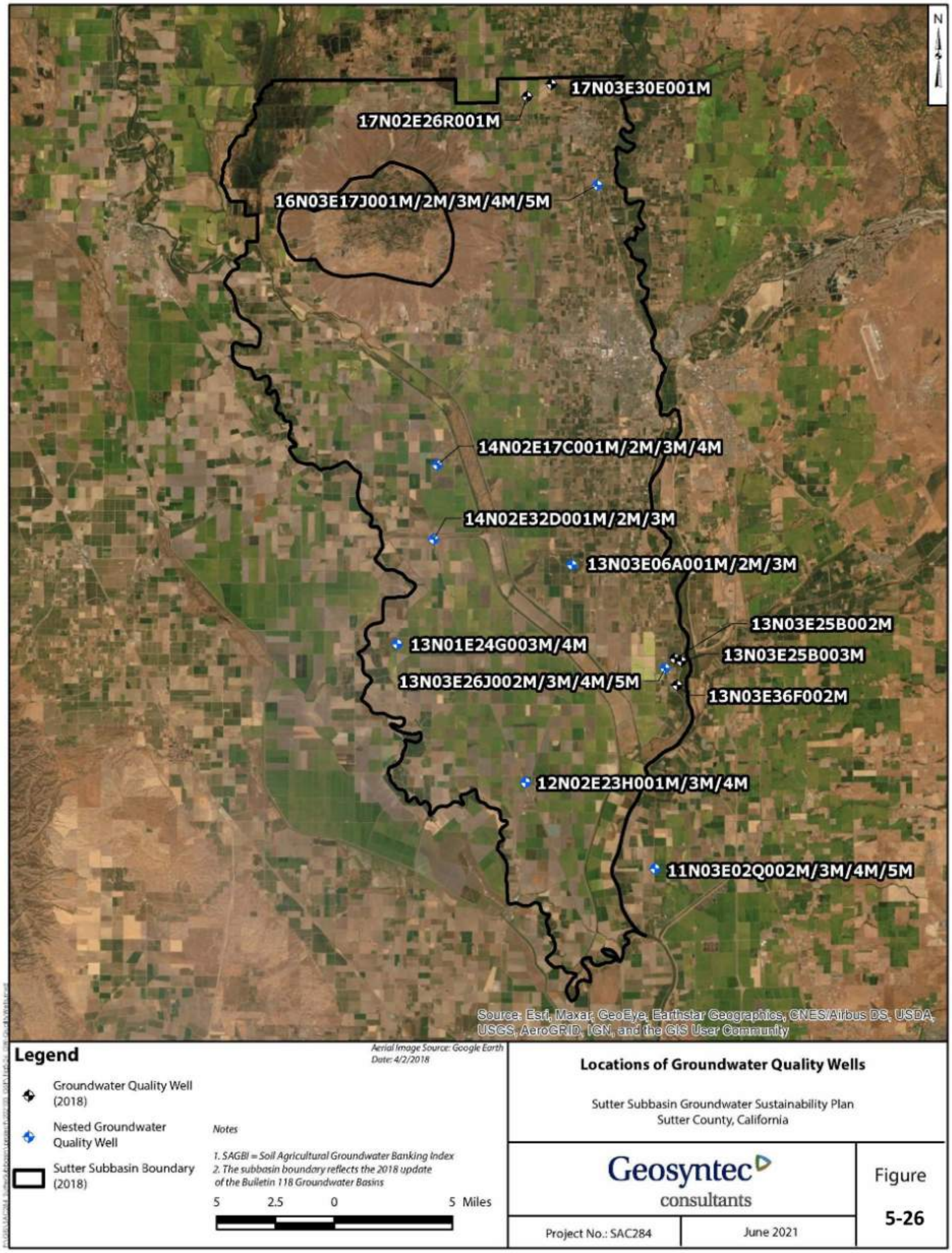


Figure 5-27. Locations of Groundwater Quality Wells

Table 5-4. Well Construction Details for Wells with Water Quality Information

Well ID	Latitude	Longitude	Total Depth	Screen Interval	Aquifer Zone
12N02E23H001M	38.8761	-121.709	150	120-140	1
12N02E23H003M	38.8761	-121.709	600	570-590	3
12N02E23H004M	38.8761	-121.709	705	655-695	3
16N03E17J001M	39.2394	-121.651	85	65-75	1
16N03E17J004M	39.2394	-121.651	615	595-605	3
16N03E17J005M	39.2394	-121.651	785	765-775	3
16N03E17J002M	39.2394	-121.651	315	285-305	2
16N03E17J003M	39.2394	-121.651	430	400-420	2
13N03E26J002M	38.945159	-121.599	175	145-165	1
13N03E26J003M	38.945159	-121.599	445	425-435	2
13N03E26J004M	38.945159	-121.599	610	590-600	3
13N03E26J005M	38.945159	-121.599	1005	985-995	3
11N03E02Q002M	38.823236	-121.6076	170	130-160	1
11N03E02Q003M	38.823236	-121.6076	675	655-675	3
11N03E02Q004M	38.823236	-121.6076	930	910-920	3
11N03E02Q005M	38.823236	-121.6076	1225	1205-1215	3
13N01E24G003M	38.9605	-121.81	160	130-160	1
13N01E24G004M	38.9605	-121.81	100	70-90	1
14N02E32D001M	39.024429	-121.781	64	34-54	1
14N02E32D002M	39.024429	-121.781	210	170-200	1
14N02E32D003M	39.024429	-121.781	500	460-490	3
13N03E06A001M	39.008641	-121.672	65	45-55	1
13N03E06A002M	39.008641	-121.672	175	155-165	1
13N03E06A003M	39.008641	-121.672	265	245-255	2
14N02E17C001M	39.0696	-121.778	60	30-50	1
14N02E17C002M	39.0696	-121.778	245	205-235	2
14N02E17C003M	39.0696	-121.778	425	395-415	2
14N02E17C004M	39.0696	-121.778	755	725-745	3
17N02E26R001M	39.2935	-121.706	601	279-601	2 and 3
17N03E30E001M	39.3012	-121.687	610	263-610	2 and 3
13N03E25B002M	38.951044	-121.5913	248	148-168	1
13N03E36F002M	38.934758	-121.5896	365	160-170	1
13N03E25B003M	38.9494	-121.5863	200	115-200	1

California Code of Regulations Title 22 establishes water quality standards for drinking water contaminants. A primary maximum contaminant level (MCL) or secondary MCL (SMCL) is defined for a variety of parameters. The Alternative Plan identified several constituents within the Sutter Subbasin that exceed these standards for drinking water, the highest beneficial use category. Although groundwater quality in the Sutter

Subbasin is generally sufficient to meet beneficial uses, these constituents of concern are either currently impacting groundwater use or have the potential to impact it in the future. Depending on the water quality constituent, the source may be anthropogenic in origin or naturally occurring, and the issue may be widespread or localized. The primary naturally-occurring water quality constituents of concern are arsenic, boron, salinity, iron, and manganese. Primary water constituents detected related to human activity include salinity, nitrates, and various point-source contaminants.

The sections herein provide information on the historical and current groundwater quality conditions starting with the general water quality within the Sutter Subbasin followed by trends for specific constituents, including:

- Arsenic
- Boron
- Salinity
- Nitrate
- Iron and manganese
- Point-source contamination, which includes petroleum hydrocarbons, solvents, and emerging contaminants

For the purposes of this GSP, comparing parameter concentrations to their MCL or SMCL is used as the basis for describing groundwater quality concerns in the Sutter Subbasin. Comparisons to the MCL or SMCL must be considered in context, as the measured concentrations represent raw water that may be treated or blended prior to delivery to meet the standard or may not be used for potable uses.

5.1.9.1 General Water Quality

As stated above, several nested monitoring wells, along with irrigation wells with longer screens, within the Subbasin have been monitored for general water quality issues since 2009 by DWR (see **Figure 5-27** for location and **Table 5-4** for well construction details). The nested wells sampled by DWR have separate well screens within each of the three aquifer zones discussed in **Section 5.1.6**, allowing an overall assessment of general water quality changes with depth across the Sutter Subbasin. **Table 5-5** summarizes the general chemical parameters collected from each of these wells.

This page intentionally left blank.

Table 5-5. Summary of Water Quality Data Used for General Chemical Analysis

Well ID	Sample Date	Boron (mg/L)	Total Alkalinity (mg/L)	Arsenic (mg/L)	Calcium (mg/L)	Chloride (mg/L)	Specific Conductance (µS/cm)	Iron (mg/L)	Magnesium (mg/L)	Manganese (mg/L)	Nitrate (mg/L)	Potassium (mg/L)	Sodium (mg/L)	TDS (mg/L)	Sulfate (mg/L)	pH	Temperature (Degrees C)
12N02E23H001M	5/18/2010	0.8	198	0.021	44	517	1938	0.008	37	0.154	<0.1	3.7	290	1060	2	7.54	18.80
12N02E23H003M	5/18/2010	0.8	209	0.048	13	151	922	0.021	5	0.073	<0.1	4.2	173	596	26	8.23	21.50
12N02E23H004M	5/18/2010	0.9	194	0.084	15	191	1004	0.032	7	0.088	<0.1	6.1	185	585	20	8.05	20.60
16N03E17J004M	8/12/2010	0.5	134	0.09	19	111	625	0.038	9	0.191	<0.1	5.5	81	386	4	7.69	20.84
16N03E17J005M	8/12/2010	1.8	108	0.013	65	488	1801	0.036	14	0.194	<0.1	12	309	1060	24	7.64	20.42
13N03E26J002M	8/12/2010	0.9	120	0.006	63	472	1728	<0.005	22	0.155	<0.1	26.2	256	951	5	8.91	20.25
13N03E26J003M	8/12/2010	0.7	157	0.008	88	355	1528	0.01	28	0.178	0.3	9.2	178	901	23	7.77	20.22
13N03E26J004M	8/12/2010	1.4	141	0.007	10	116	691	0.01	3	0.042	<0.1	3	126	403	8	8.39	20.90
13N03E26J005M	8/12/2010	2.4	109	0.012	70	920	3229	0.038	22	0.16	<0.2	11.9	483	1850	8	7.38	20.67
16N03E17J001M	8/12/2010	<0.1	70	0.002	13	2	150	<0.005	11	<0.005	3.8	<0.5	4	115	3	7.37	19.75
16N03E17J002M	8/12/2010	0.3	132	0.201	12	9	278	<0.005	11	0.329	<0.1	3.7	35	210	<1	7.39	20.04
16N03E17J003M	8/12/2010	0.3	143	0.101	17	13	310	0.039	8	0.145	<0.1	4	41	225	1	7.78	20.47
11N03E02Q002M	3/9/2011	0.3	327	0.02	55	198	1262	0.18	23	0.242	<0.1	3.1	163	716	9	8.05	18.40
11N03E02Q003M	3/9/2011	0.4	112	0.014	125	951	3279	0.062	30	0.289	<0.1	7.3	416	1880	15	8.07	19.40
11N03E02Q004M	3/9/2011	0.5	95	0.012	129	1040	3515	0.029	28	0.151	<0.1	9.2	473	2160	14	8.03	19.20
11N03E02Q005M	3/9/2011	0.5	124	0.014	38	369	1508	0.075	10	0.198	<0.1	4.6	218	866	9	8.02	18.50
13N01E24G003M	9/12/2012	0.1	112	0.011	7	4	250	0.047	8	0.07	<0.1	1.3	37	189	6	7.28	18.64
13N01E24G004M	9/12/2012	0.3	341	0.013	42	12	692	0.974	39	0.039	0.1	2.1	60	428	22	7.15	18.66
14N02E32D003M	6/20/2012	0.5	169	0.022	49	355	1502	0.021	25	0.254	0.1	11.3	221	874	32	7.67	22.13
14N02E32D002M	6/20/2012	0.3	245	0.008	20	84	784	0.184	12	0.161	<0.1	5.1	139	496	26	7.21	21.90
14N02E32D001M	6/20/2012	<0.1	276	0.006	46	11	566	<0.005	41	0.271	<0.1	2.1	20	318	15	7.18	23.87
13N03E06A001M	3/9/2011	0.3	260	0.009	117	606	2461	0.06	85	0.775	<0.1	2.6	186	1370	2	7.27	18.10
13N03E06A002M	3/9/2011	0.5	134	0.01	154	1000	3501	0.082	106	1.17	<0.1	7.6	286	2200	<1	7.18	18.40
13N03E06A003M	3/9/2011	0.7	130	0.023	148	1110	3803	0.137	99	1.42	<0.1	15.4	386	2290	<1	7.28	19.10
14N02E17C001M	3/17/2010	<0.1	408	0.011	57	16	797	<0.005	60	0.125	7	2.1	36	492	26	7.27	19.50
14N02E17C002M	3/17/2010	0.1	143	0.026	18	7	328	<0.005	9	0.074	<0.1	3.1	41	231	17	6.99	20.30
14N02E17C003M	3/17/2010	0.2	122	0.03	18	36	380	<0.005	7	0.029	0.1	3.8	51	228	12	6.78	20.30
14N02E17C004M	3/17/2010	0.7	142	0.017	127	994	3337	0.026	53	0.573	<0.333	27.7	431	2100	9	5.86	20.70
17N02E26R001M	6/17/2009	0.2	119	0.127	12	14	264	0.0161	11	0.228	1.1	4.4	30	201	<1	7.10	21.50
17N02E26R001M	9/23/2009	0.2	118	0.134	12	16	278	0.06	10	0.00022	1.1	4.2	35	202	<1	7.02	22.10
17N03E30E001M	6/17/2009	0.2	121	0.0681	10	9	250	0.0064	9	0.212	0.4	4.4	33	191	<1	7.20	21.50
17N03E30E001M	9/23/2009	0.3	120	0.0686	10	11	265	0.0318	9	0.192	0.4	4.3	38	197	<1	7.30	21.80
13N03E25B002M	8/26/2009	2.2	120	0.007	78	673	2519	0.064	17	0.574	<0.1	7.5	369	1510	<1	7.65	19.80
13N03E36F002M	8/26/2009	2.2	148	0.01	64	632	2246	0.078	17	0.451	<0.1	6.3	344	1290	<1	7.59	20.50
13N03E25B003M	8/26/2009	1.4	146	0.005	9	98	606	0.05	2	0.074	<0.1	2.1	107	361	<1	8.17	19.00

µS/cm – micro-Siemens per centimeter
Degrees C – Degrees Celsius
mg/L – milligrams per liter
TDS – Total dissolved solids
See Table 5-4 for well construction details

This page intentionally left blank.

To assess general chemical trends within the Sutter Subbasin, the cations (metals such as calcium and sodium) and anions (such as chloride and sulfate) were plotted on a piper diagram. A piper diagram is a graphical representation of the chemistry of a water sample or samples. As shown in **Figure 5-28**, piper diagrams are a combination cation triangle (lower left) and anion triangle (lower right) that lie on a common baseline. A diamond shape is placed between them. Information that can be assessed from this diagram includes water type. **Figure 5-28** was developed by USGS (presentation from http://inside.mines.edu/~epoeter/_GW/18WaterChem2 /WaterChem2pdf.pdf) that lists general interpretations for specific water types.

Figure 5-29 presents the piper diagram constructed from the groundwater quality data available for the wells listed in **Table 5-5**. As seen in this figure and listed in **Table 5-5**, water types reported for these samples include magnesium (Mg) – bicarbonate (HCO_3), sodium (Na)-chloride (Cl), and Na-HCO^3. The Mg-HCO_3 is similar to the calcium (Ca) HCO_3 water type shown in **Figure 5-25** and is typical of shallow fresh groundwaters. The Na-Cl water type is typical of marine or ancient groundwaters, but anthropogenic sources could also change waters to this type. The Na-HCO_3 water type is typical of groundwaters that have been in contact with aquifer materials for a longer time period and are influenced by ion exchange processes.

Figure 5-30 through **Figure 5-32** shows the water types reported for each of the aquifer zones at each nested well location. As seen in **Figure 5-30**, within the shallow aquifer zone, AZ-1, the northern to central part of the Subbasin is characterized by Mg-HCO_3 waters that suggests shallow fresh groundwater. From the central part to the southern area of the Sutter Subbasin, water types are classified by Na-HCO_3 and Na-Cl waters. These water types suggest these areas are influenced by ion exchange processes (Na-HCO_3) or typical of marine or ancient groundwaters (Na-Cl). For the shallow groundwater zone, the Na-Cl water type is more likely the result of interactions with agricultural practices within the area. As discussed below for salinity, the wells classified as Na-Cl in the shallow aquifer zone also have total dissolved solids (TDS) reported at values greater than 1,000 milligrams per liter (mg/L), whereas the other wells in the shallow zone with different water types have TDS values below 1,000 mg/L.

This page intentionally left blank.

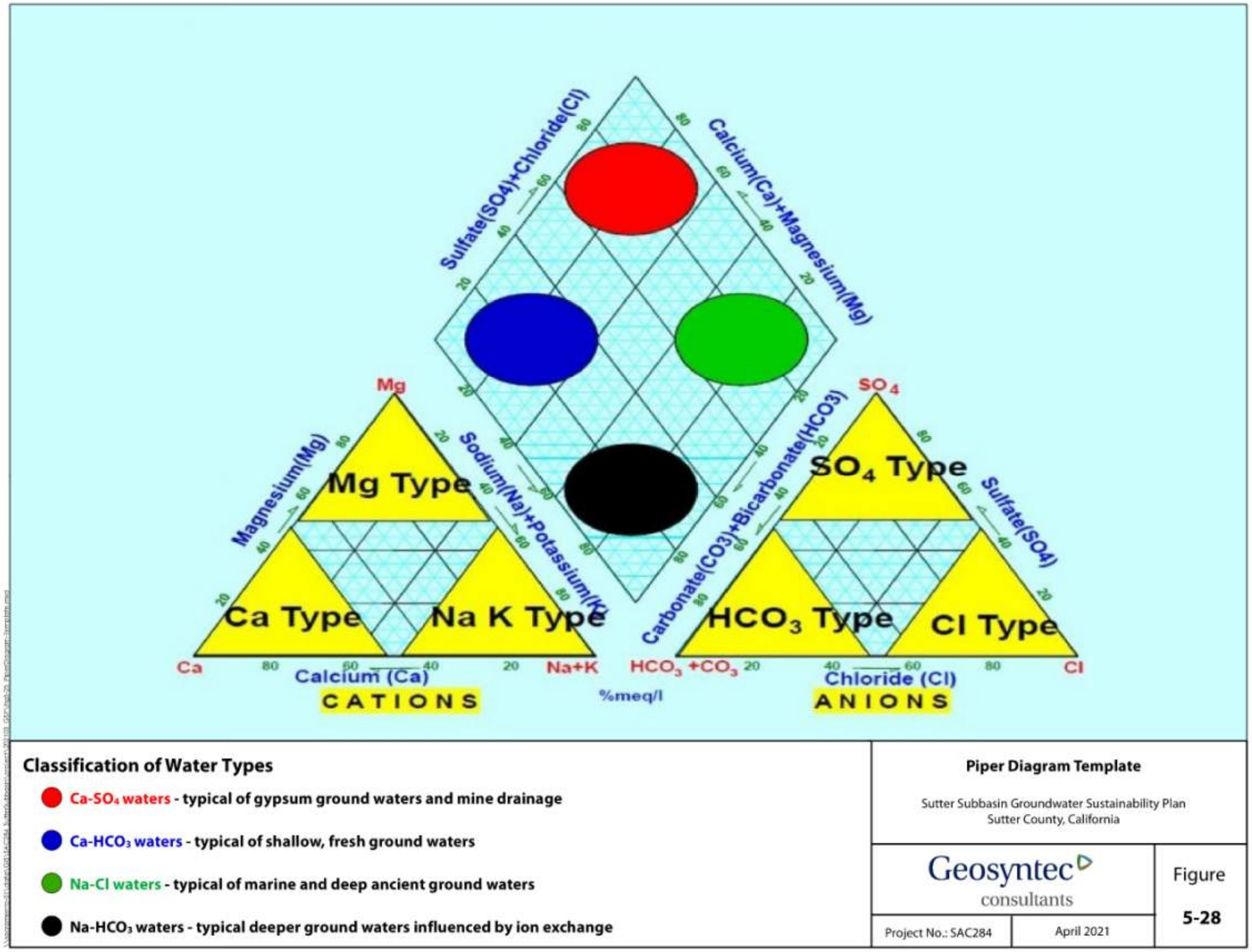


Figure 5-28. Piper Diagram Template

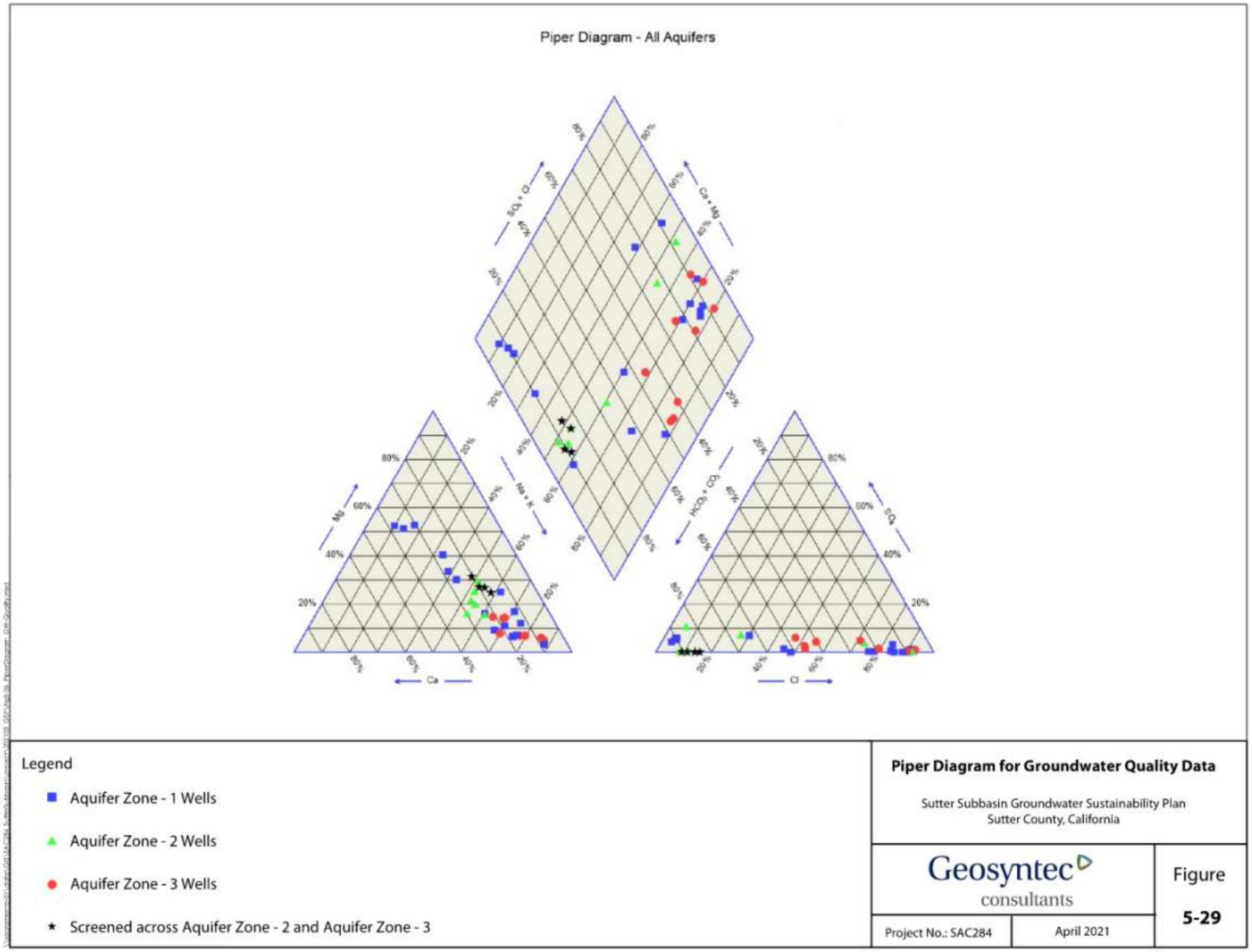


Figure 5-29. Piper Diagram for Water Quality Data by Aquifer Zone

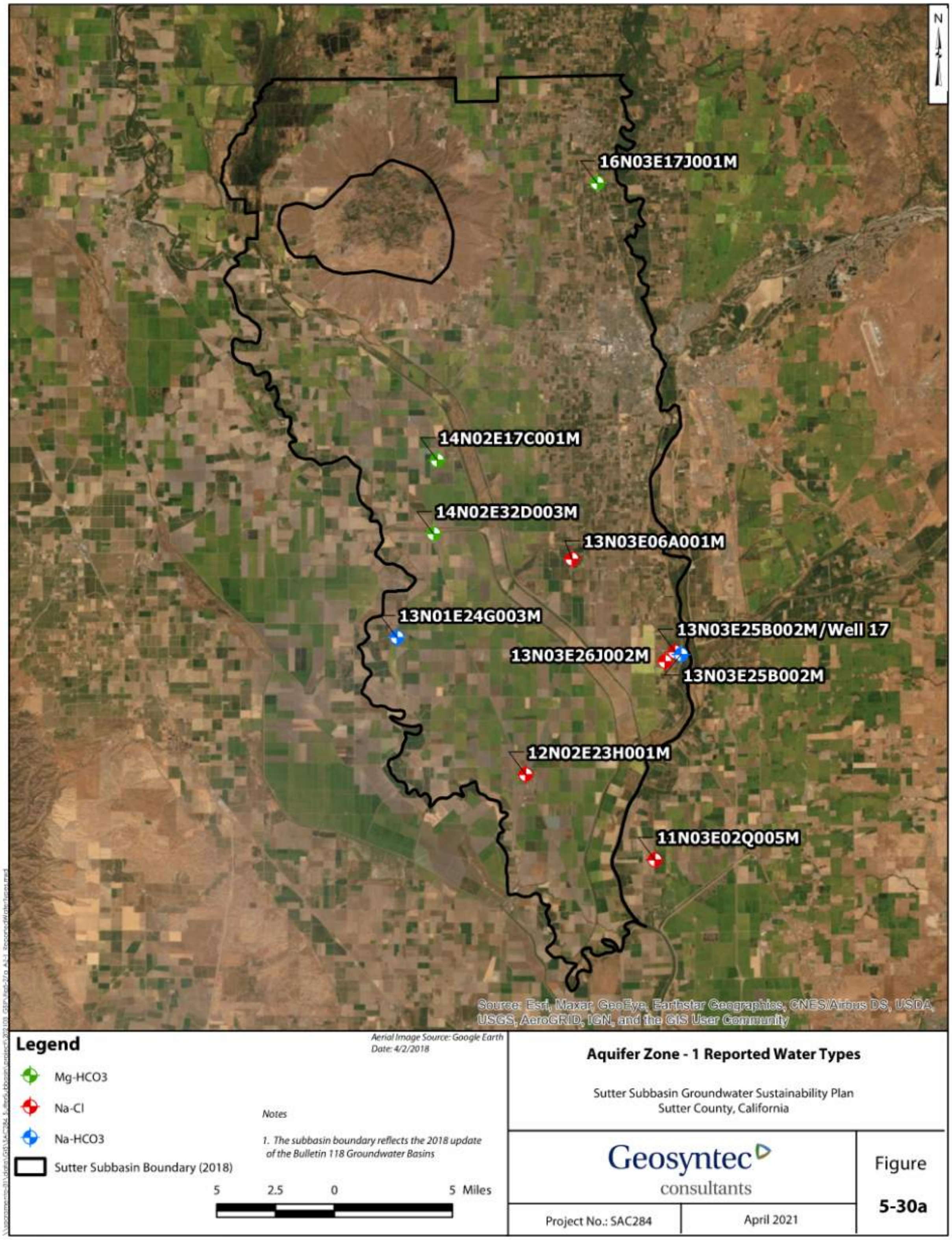


Figure 5-30. Aquifer Zone-1 Reported Water Types

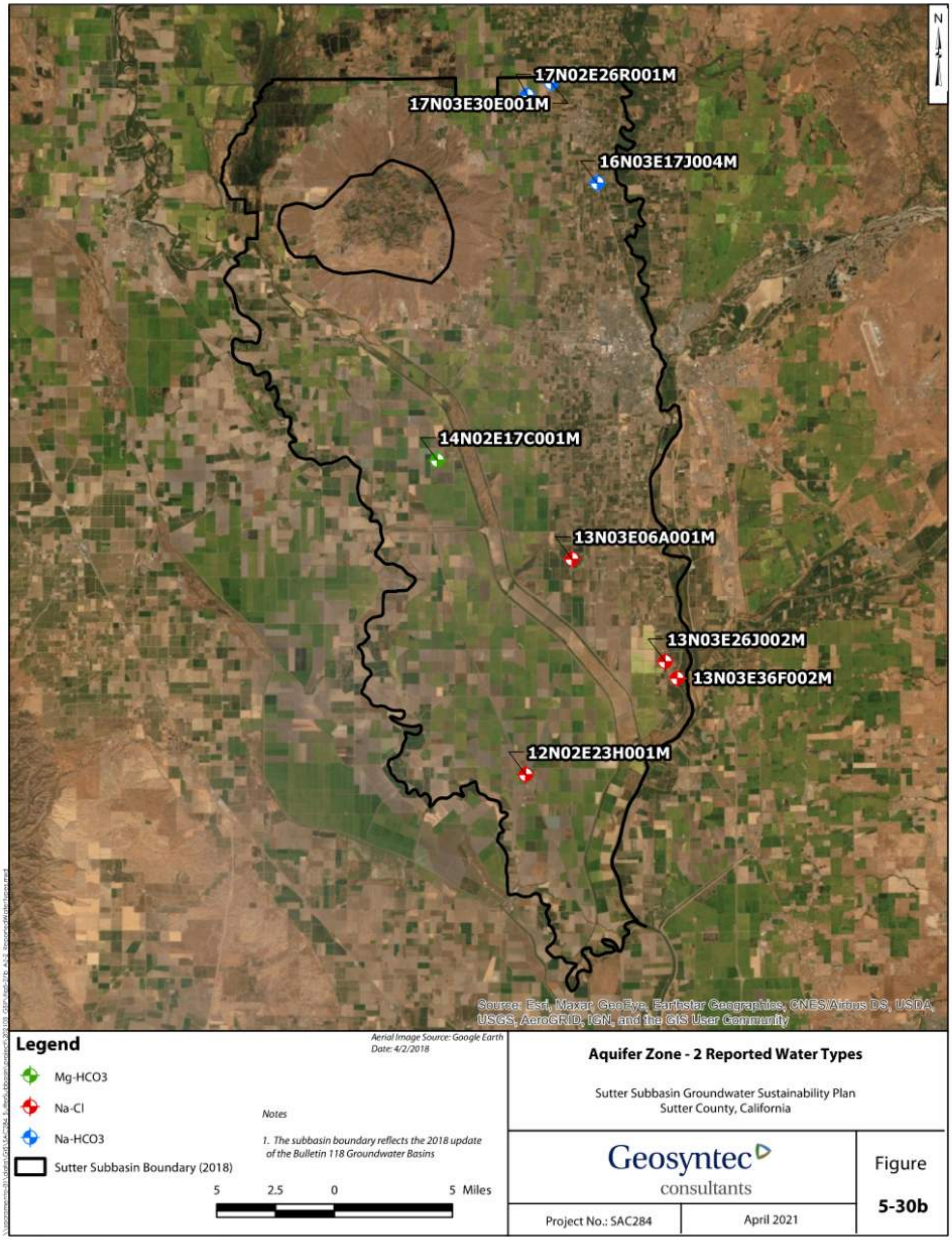


Figure 5-31. Aquifer Zone-2 Reported Water Types

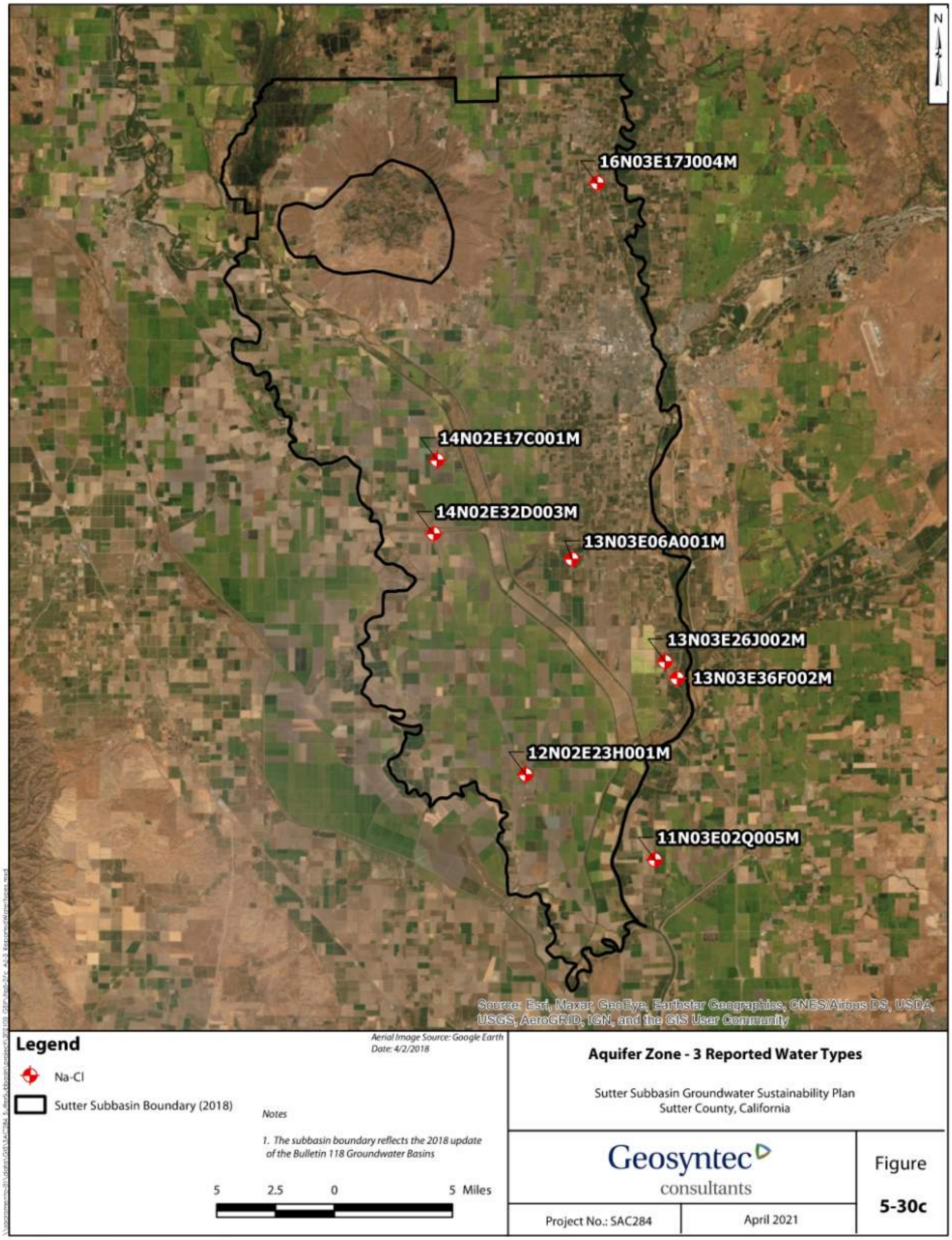


Figure 5-32. Aquifer Zone-3 Reported Water Types

For AZ-2, water types (**Figure 5-31**) in the northern to central part of the Sutter Subbasin are Na-HCO_3, indicative of influence from ion exchange processes. Water types for the central to southern part of the Sutter Subbasin are Na-Cl, suggesting influence from marine or ancient groundwaters or anthropogenic sources. As discussed below for salinity, except for one well screened near the boundary with AZ-1 (06A003M), the TDS values with Na-Cl values are below 1,000 mg/L. All the wells completed within AZ-3 or deeper (screens deeper than 700 feet bgs) have reported water types of Na-Cl (**Figure 5-32**), suggesting influence from marine or ancient groundwaters. As discussed in **Section 5.1.3**, the base of fresh water is encountered between approximately 700 feet bgs to 1,000 feet bgs across the basin. The only well in AZ-3 with reported TDS values above 1,000 mg/L (02Q003M) is screened near this boundary. Only the deepest well screened below AZ-3 (02Q005M – 1,215 feet bgs) had TDS values below 1,000 mg/L.

5.1.9.2 Boron

Boron is a naturally occurring element and, similar to arsenic, is commonly found in alluvial sediments derived from volcanic sources such as the Sutter Buttes Rampart, Mehrten, and Tuscan Formations that make up the intermediate and deep aquifer zones. High concentrations of boron can also be associated with old marine deposits that are known to exist within the basin (USGS, 2011). An MCL has not been established for drinking water, but a Notification Level of 1 mg/L has been established.

Figure 5-33 provides a cross plot of boron versus depth of the bottom of screen interval for the well for the wells shown in **Figure 5-27**. As seen in this figure, most reported boron values are below the 1 mg/L value. However, four wells from AZ-1(17J005M, 25B002M, 36F002M, and 25B003M) and two wells from AZ-3 (26J004M and 26J005M) are above the Notification Level of 1 mg/L. The two AZ-3 locations are located adjacent to the Feather River in the northern part of the Sutter Subbasin. The four AZ-1 wells are located adjacent to the Feather River in the southern part of the Sutter Subbasin.

Figure 5-34 displays the boron concentration distribution by aquifer zone as presented in the Alternative Plan. For these figures, developed as part of the Groundwater Management Plan for the Subbasin (Wood Rodgers, 2012), the AZ-1 zones extends from 0 to 150 feet bgs, the AZ-2 zone from 150 to 400 feet bgs, and the AZ-3 zone from greater than 400 feet bgs. As shown in this figure, boron concentrations in the Sutter Subbasin are generally acceptable, except for some deeper wells which likely encounter more marine sediments. Boron concentrations were not monitored as part of the Rice Coalition Groundwater Assessment Report.

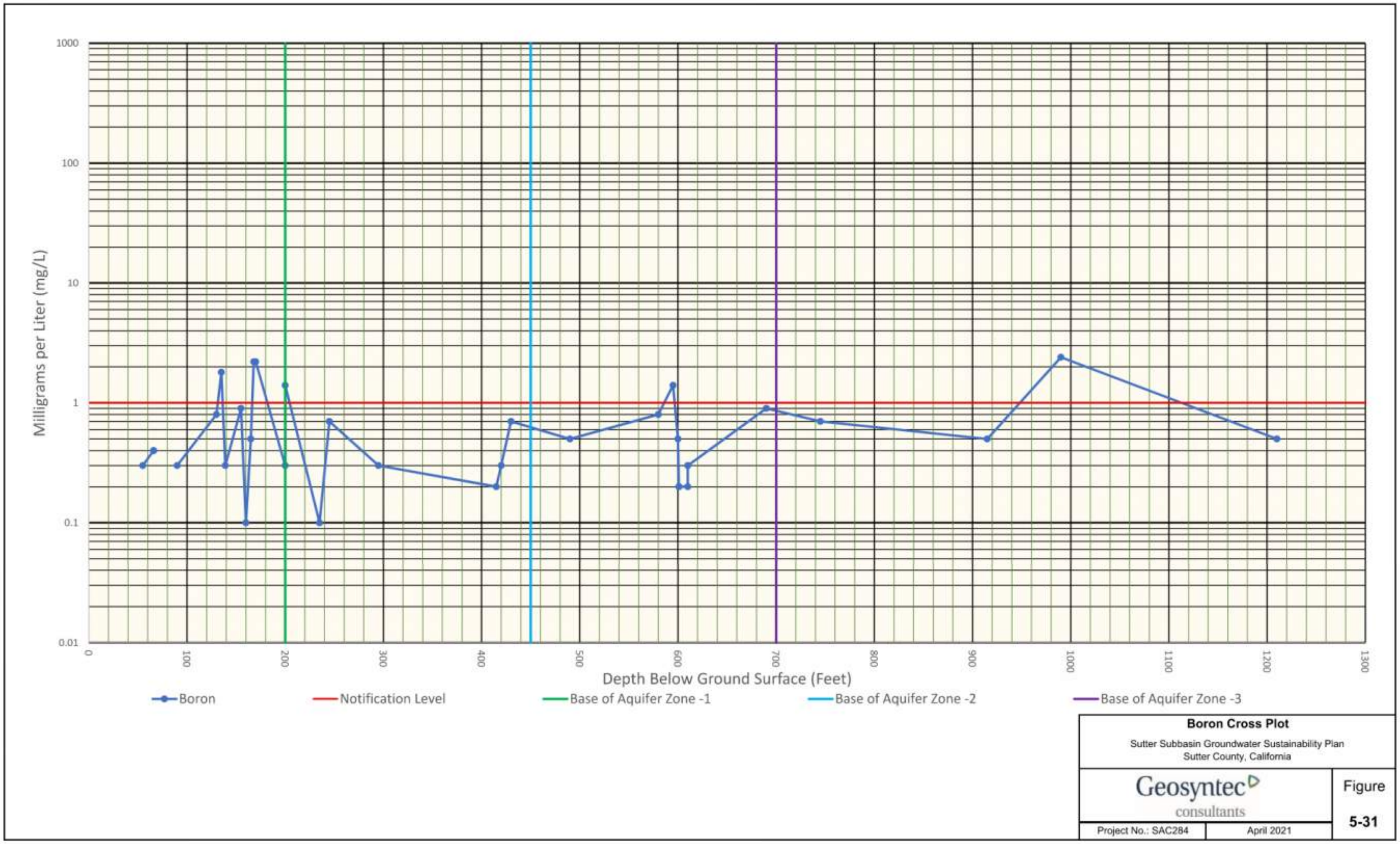


Figure 5-33. Boron Cross Plot

This page intentionally left blank.

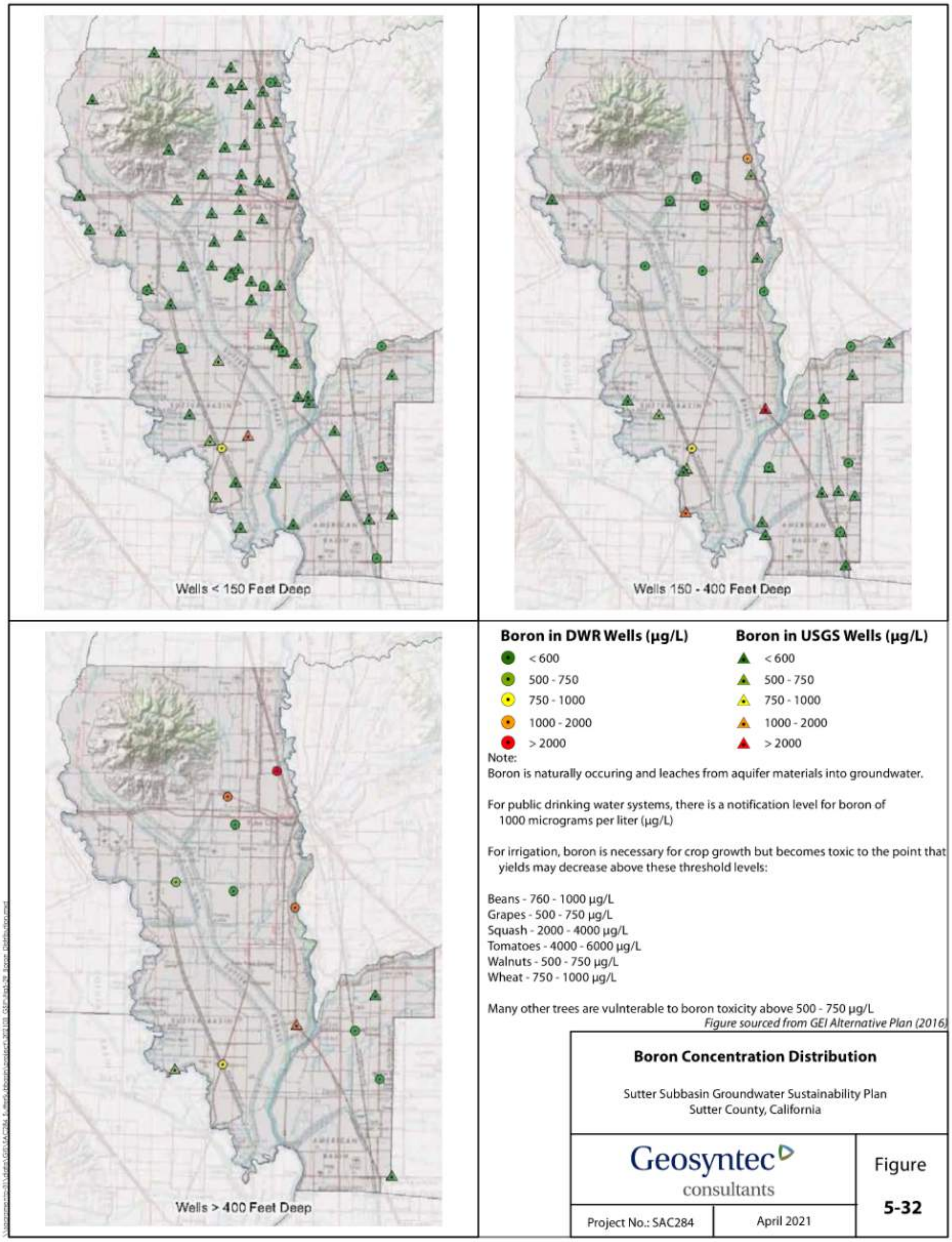


Figure 5-34. Boron Concentration Distribution by Aquifer Zone, Sutter Subbasin

5.1.9.3 Arsenic

As with boron, arsenic is a naturally occurring element commonly found in alluvial sediments derived from volcanic sources such as the Sutter Buttes Rampart, Mehrten, and Tuscan Formations that make up the intermediate and deep aquifer zones. The oxidation-reduction (redox) state of water can affect which compounds are present in that water. Water with chemistry indicating oxidizing chemical reactions is referred to as oxic; water with chemistry indicating reducing chemical reactions is referred to as anoxic. The elevated levels of arsenic within the Sutter Subbasin are most likely the result of the sediments being in contact with groundwaters under reduced conditions that have been correlated with elevated arsenic concentrations in the Sacramento Valley (USGS, 2001). As indicated in USGS (1984), reducing conditions in the Sutter Subbasin most likely produce higher concentrations of arsenic, manganese, and iron. These same conditions reduced nitrate concentrations, probably reflecting denitrification reactions.

Because of the origin of the sediments, arsenic at elevated concentrations is detected throughout the Sutter Subbasin and much of the northern Central Valley. Although oxidation-reduction data were not available for groundwater samples assessed for this GSP, USGS (2011) states that groundwater in the Quaternary alluvium along the Sacramento River and in the Delta commonly has low dissolved oxygen content that reflect reducing conditions. As indicated in the Alternative Plan, arsenic is not a component of materials applied to farmland. The primary MCL for arsenic is 10 micrograms per liter (µg/L).

Figure 5-35 provides a cross plot of arsenic versus depth of the bottom of screen interval for the well for the wells shown in **Figure 5-27**. As seen in this figure, the majority of reported arsenic values are above the MCL of 10 µg/L. The highest levels are reported for wells screened from about 300 feet bgs to 420 feet bgs (AZ-2) and 600 feet bgs to 700 feet bgs (AZ-3).

Figure 5-36 displays the arsenic distribution in the Sutter Subbasin and **Figure 5-37** shows the distribution by aquifer zone as presented in the Alternative Plan. Arsenic concentrations presented in **Figure 5-36** and **Figure 5-37** are from the USGS Rice Wells, Shallow Domestic Wells and from GAMA Well networks, as presented in the Rice Coalition Groundwater Assessment Report (CH2M, 2016). The GAMA well network was used to focus on the deeper portions of the aquifer. These figures divide AZ-1 through AZ-3 as described for boron.

As seen in these figures, arsenic concentrations vary in the shallow aquifer. Most (50 percent) of the locations show arsenic between half the MCL and the MCL and several locations (29 percent) exceed the MCL. Typically, arsenic concentrations increase with depth, in the intermediate and deep aquifer zones, with concentrations exceeding the MCL. Several locations show concentrations are below the MCL along the eastern side of the Sutter Subbasin.

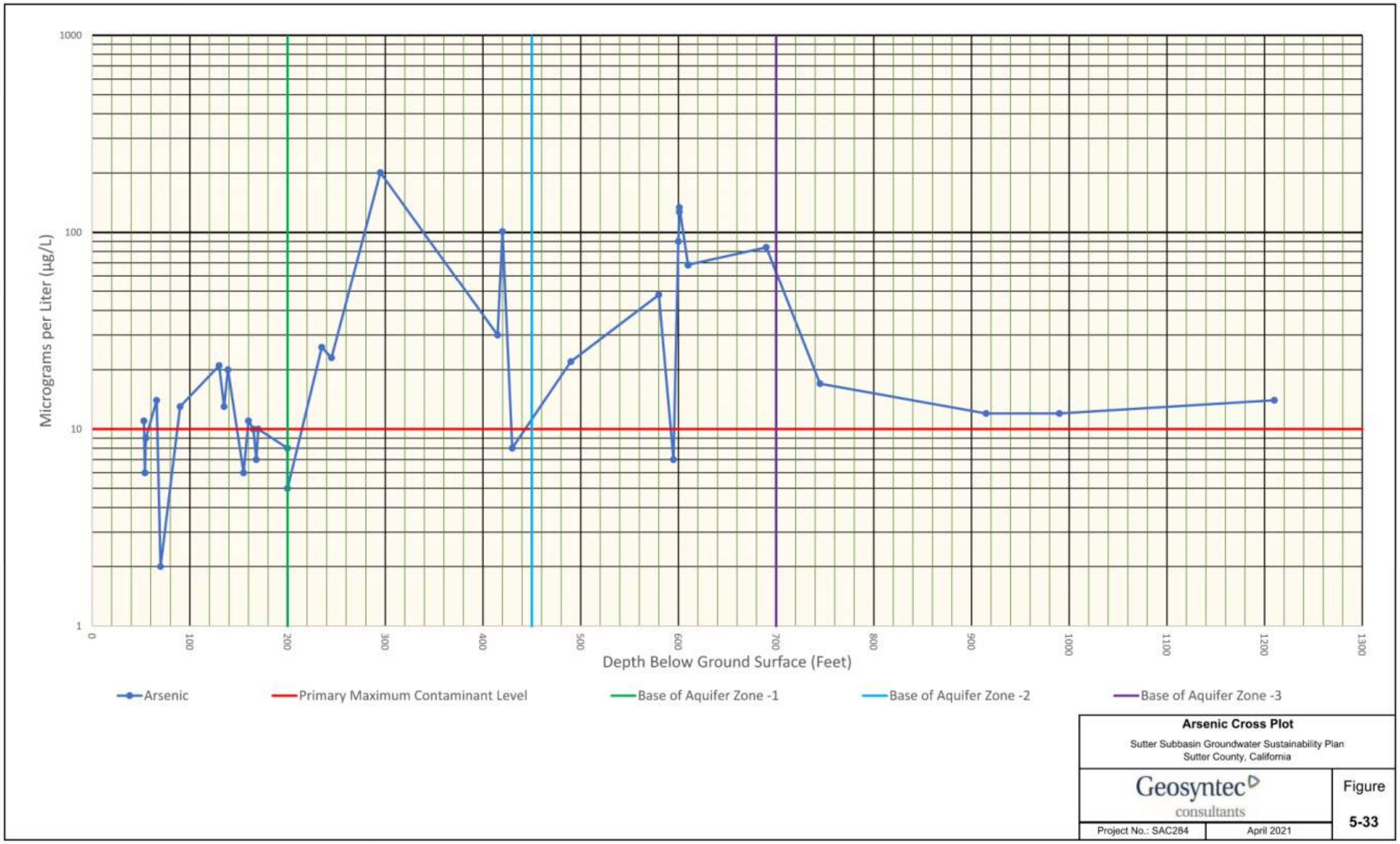


Figure 5-35. Arsenic Cross Plot

This page intentionally left blank.

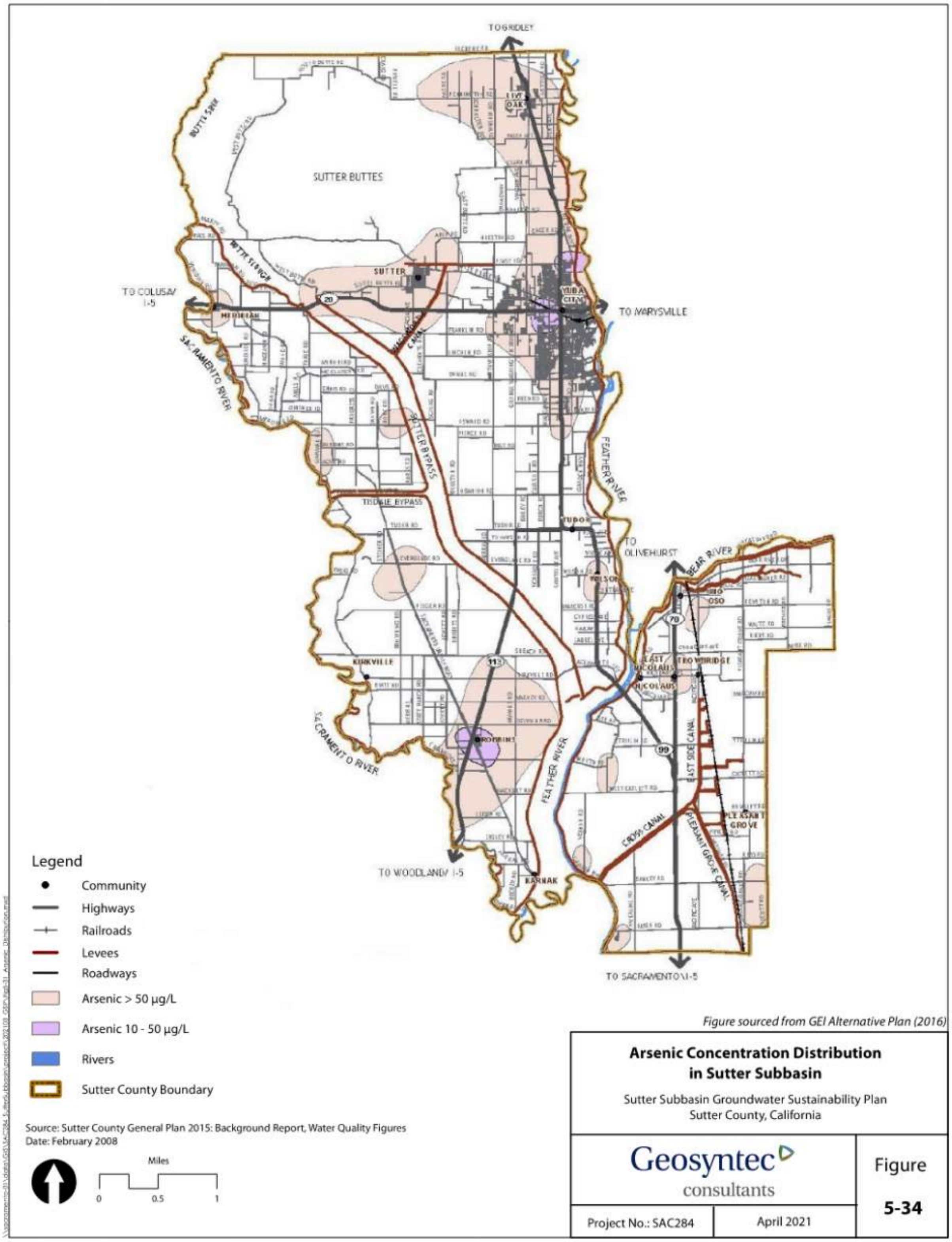


Figure 5-36. Arsenic Concentration Distribution, Sutter Subbasin

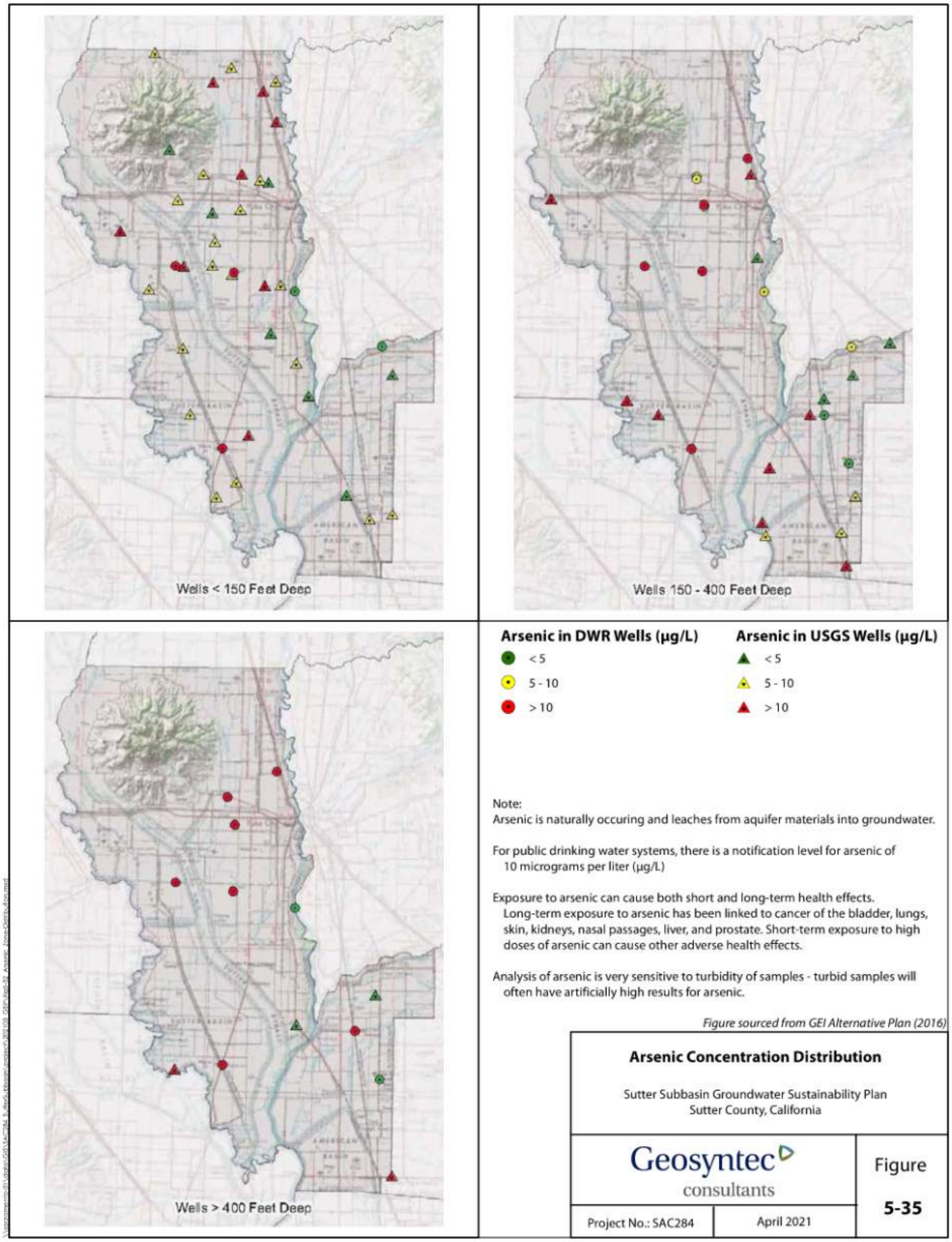


Figure 5-37. Arsenic Concentration Distribution by Aquifer Zone, Sutter Subbasin

5.1.9.4 Salinity

Salinity in groundwater is often caused by the dissolution of soluble minerals, the presence of seawater deposited with marine sediments, in particular geologic formations and/or the presence of mineral springs. The USGS (1984) indicated that a major source of salinity within the Sutter Subbasin is thought to be connate marine water moving upward along fault zones created when Sutter Buttes was emplaced.

Salinity can be assessed using different parameters, including specific conductance, TDS, and chloride. Specific conductance or electrical conductivity is a measure of how effectively water will conduct electricity. When soluble salts dissolve in water, the resulting ions behave as conductors. Therefore, specific conductance provides an indirect measurement of the amount of dissolved solids (salts). This parameter is reported in microSiemens per centimeter (µS/cm) or the equivalent unit micro mhos per centimeter (µmhos/cm). Chloride is often used to identify saline water and can be representative of where high specific conductance water is present.

The recommended SMCL for specific conductance is 900 µS/cm, with an upper SMCL of 1,600 µS/cm and short-term secondary MCL of 2,200 µS/cm. The corresponding TDS SMCLs are 500 mg/L, 1,000 mg/L, and 1,500 mg/L. Constituent concentrations lower than the recommended SMCL (500 mg/L for TDS) are desirable for a higher degree of consumer acceptance. Constituent concentrations ranging to the Upper SMCL are acceptable if it is neither reasonable nor feasible to provide more suitable waters. Constituent concentrations ranging to the short-term SMCL are acceptable only for existing community water systems on a temporary basis pending construction of treatment facilities or development of acceptable new water sources. The SMCL for chloride is 250 mg/L.

Figure 5-38 provides cross plots of specific conductance, TDS, and chloride versus depth of the bottom of screen interval for the wells shown in **Figure 5-27**. As seen in this figure, high salinity values exist from about 50 feet bgs to 245 feet bgs and from below 700 feet bgs. Wells completed between 300 feet bgs and 700 feet bgs have reported specific conductance and TDS values below their respective upper SMCL, although the two wells between 430 feet and 490 feet bgs have chloride values above the SMCL.

Figure 5-39 presents the distribution of specific conductance by aquifer zone as divided in the Alternative Plan. As seen in this figure, specific conductance values in the shallow aquifer zone in the northern half of the Sutter Subbasin are mostly below the SMCL. Elevated values of specific conductance are near to and/or exceed the recommended SMCL in the shallow aquifer between the Feather and Sacramento Rivers, in the intermediate aquifer at one location, and at two locations in the deep aquifer. The Alternative Plan stated that it is unclear why elevated specific conductance occur in the shallow aquifer zone (which suggests an agricultural source), but because nitrate concentrations do not correlate with areas of elevated specific conductance, the salinity does not appear to be related to agriculture. However, as discussed previously discussed, the existence of reducing conditions in the shallow zone could result in lower levels of nitrate due to denitrification suggesting that the high salinity values in the shallow zone are from agricultural sources. In groundwater below 700 feet, the poor water quality is likely due to the underlying marine sediments being in direct contact with the deeper aquifer zones and potentially due to faults that have created pathways that allow water from the older marine sediment to migrate upward (USGS, 1984).

The Rice Coalition Groundwater Assessment Report (CH2M, 2016) also assessed trends in salinity across the Subbasin using trends in TDS. **Figure 5-40** is a snapshot of Figure 5-5 from CH2M (2016) showing trends of TDS within the Sutter Subbasin. As shown in this figure, several areas show increasing trends in salinity across the Subbasin, although many of these areas are still below the upper SMCL of 1,000 mg/L.

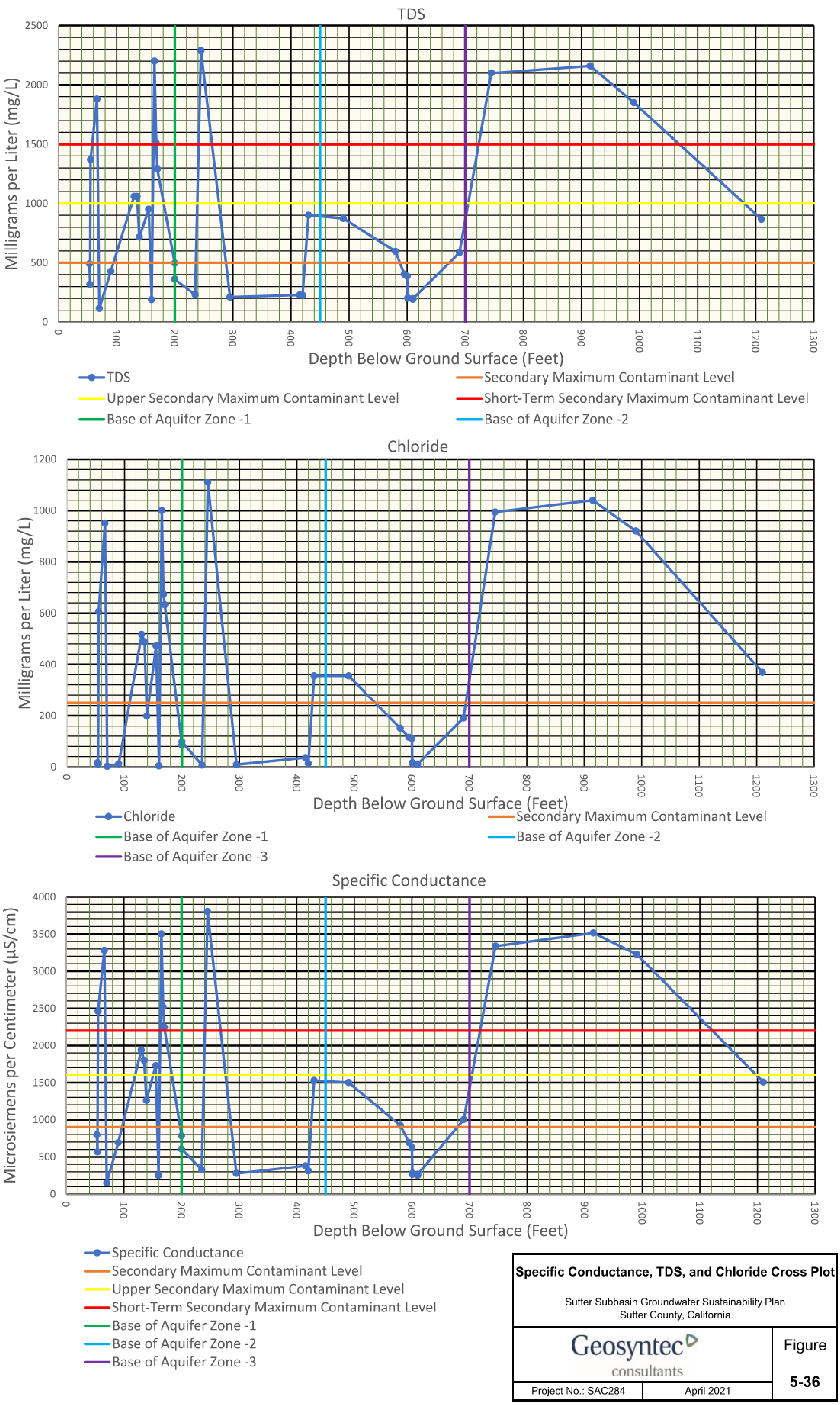


Figure 5-38. Specific Conductance, TDS, and Chloride Cross Plot

This page intentionally left blank.

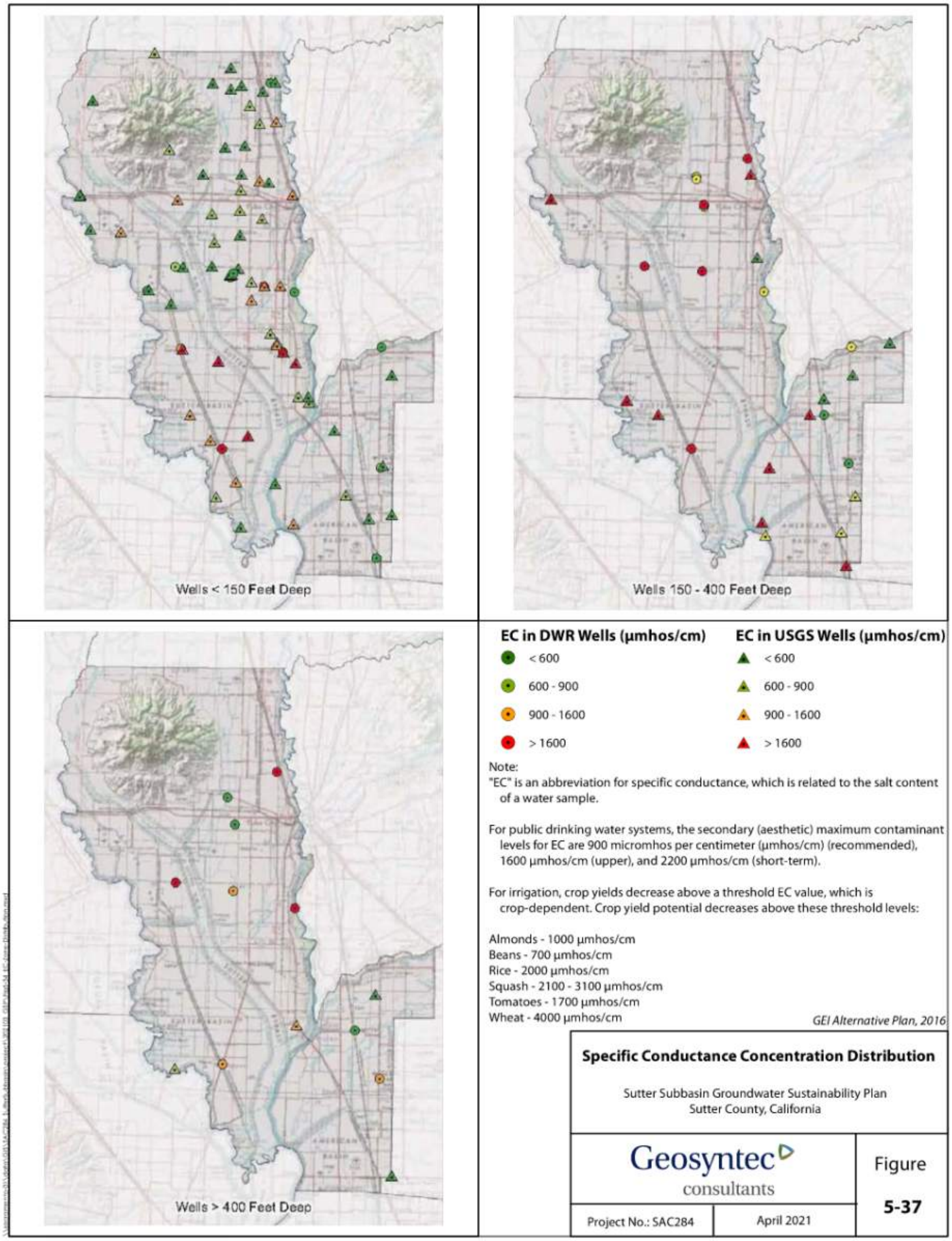


Figure 5-39. Specific Conductance Concentration Distribution by Aquifer Zone, Sutter Subbasin

This page intentionally left blank.

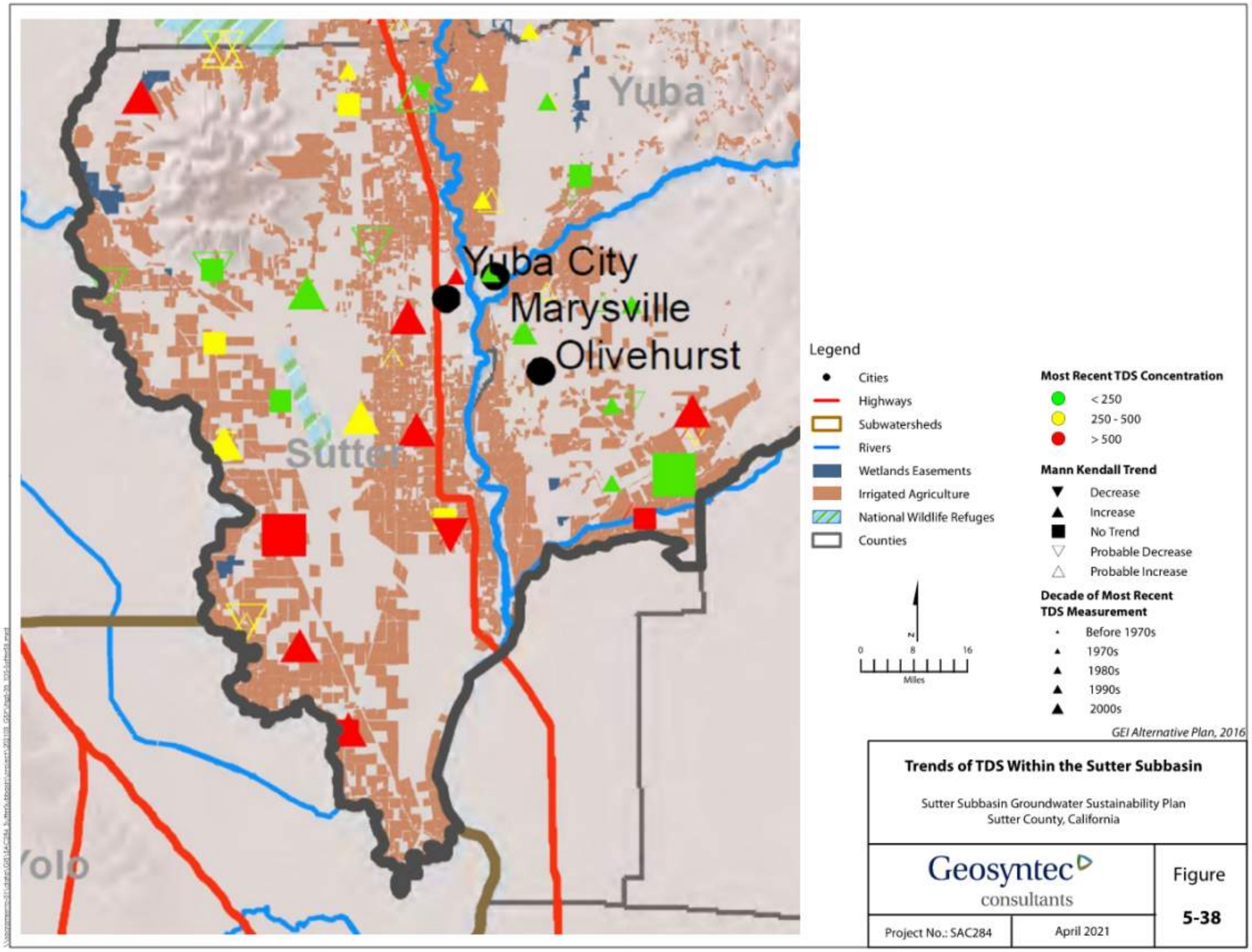


Figure 5-40. TDS Trends, Sutter Subbasin

This page intentionally left blank.

5.1.9.5 Nitrate

Nitrogen is present in water bodies in the following forms that are measured to characterize water quality: nitrate (NO_3), ammonia (NH_3), and organic (Total Kjeldahl nitrogen [TKN] minus NH3). The sum of the concentration of these compounds is referred to as total nitrogen. The primary drinking water MCL for nitrate (as nitrate) is 45 mg/L.

Nitrogen is of particular concern when assessing water quality impacts from agriculture as it is frequently applied as fertilizer. Nitrate concentrations at or exceeding 3 mg/L are generally thought to be caused by anthropogenic sources. Nitrate can occur naturally in groundwater from leaching of soils or bedrock. Nitrate does not generally react with soil particles or sediment and tends to move with groundwater due to its high solubility in water and its generally stable condition. Ammonia is less mobile and is subject to sorption and conversion to nitrate under oxidized conditions (USGS, 2001). Anthropogenic groundwater nitrate sources include synthetic fertilizer, animal manure (including poultry facilities), wastewater treatment plant effluent and biosolids, and septic systems (Esser et al., 2003).

Figure 5-41 provides the cross plot of nitrate versus depth of the bottom of screen interval for the wells shown in **Figure 5-27**. As seen in this figure, all the reported nitrate values are significantly below the MCL of 45 mg/L.

Figure 5-42 shows the distribution of nitrate across the Sutter Subbasin by aquifer zone as presented in the Alternative Plan. Near the Sutter Buttes and Yuba City, nitrate concentrations in several wells in the shallow aquifer (less than 150 feet) exceed the MCL. Some of these populated areas have septic systems that might be the source of the nitrate. Concentrations in the shallow aquifer in the southern portion of the Sutter Subbasin are below the MCL. Concentrations in the intermediate and deep aquifer zones are also below the MCL.

The Alternative Plan further stated that eighty-four percent of the USGS Rice Wells' (CH2M, 2016) samples had nitrate concentrations below 3 mg/L, which is the level generally considered to be indicative of potential impacts by human activities. Therefore, this report states that nitrate levels in these wells are likely to be naturally occurring. However, as indicated in USGS (1984), reducing conditions in the Sutter Subbasin most likely produce higher concentrations of arsenic, manganese, and iron, whereas these conditions reduced nitrate concentrations probably reflecting denitrification reactions. As such, even these lower nitrate levels in these areas could be the result of anthropogenic sources.

The Rice Coalition Groundwater Assessment Report (CH2M, 2016) also assessed trends in nitrate across the Subbasin. **Figure 5-43** is a snapshot of Figure 5-3 from CH2M (2016) showing trends of nitrate within the Sutter Subbasin. As shown in this figure, several areas within the central portion of the Subbasin show increasing trends in nitrate concentration, although many of these areas are below the MCL of 45 mg/L.

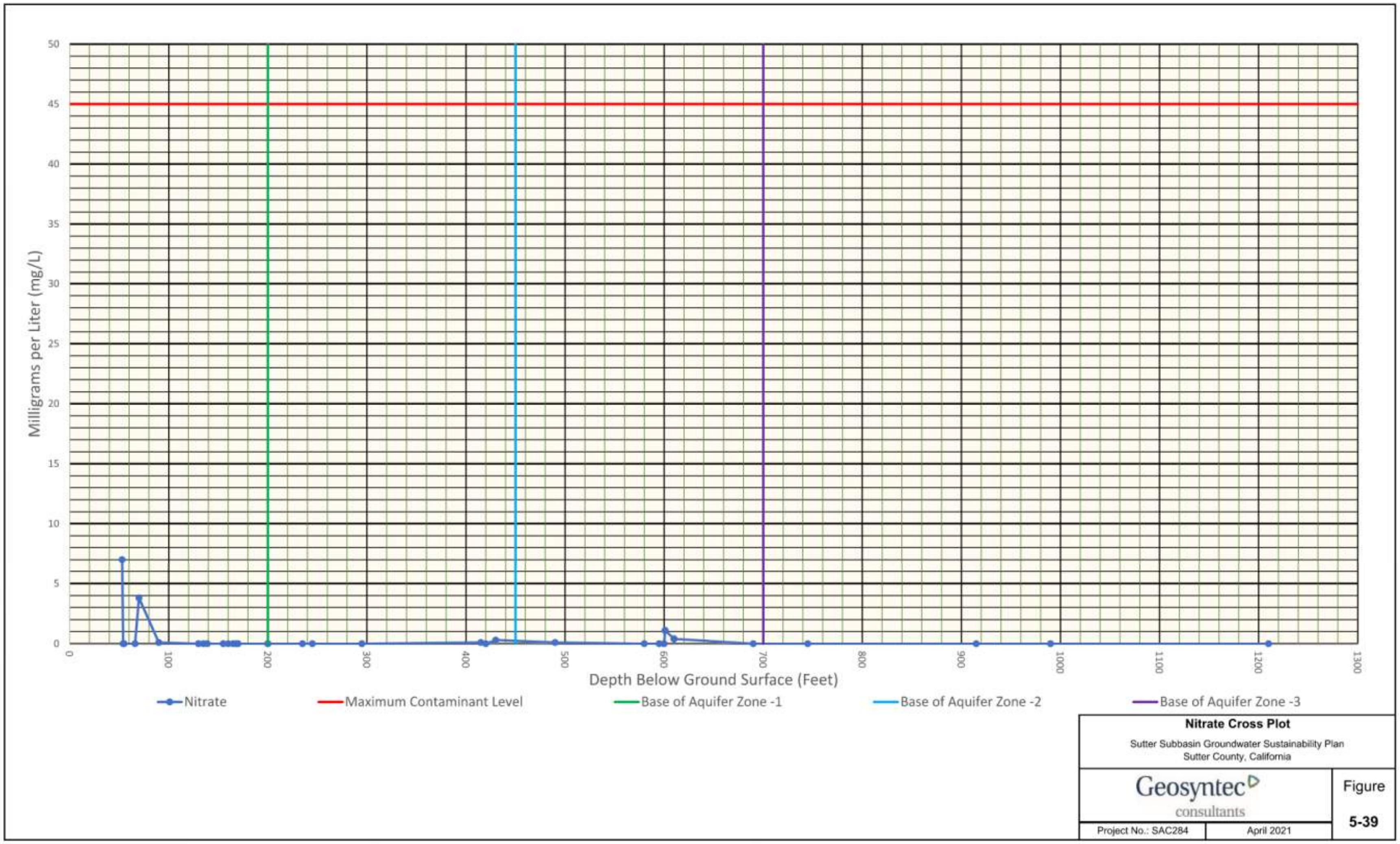


Figure 5-41. Nitrate Cross Plot

This page intentionally left blank.

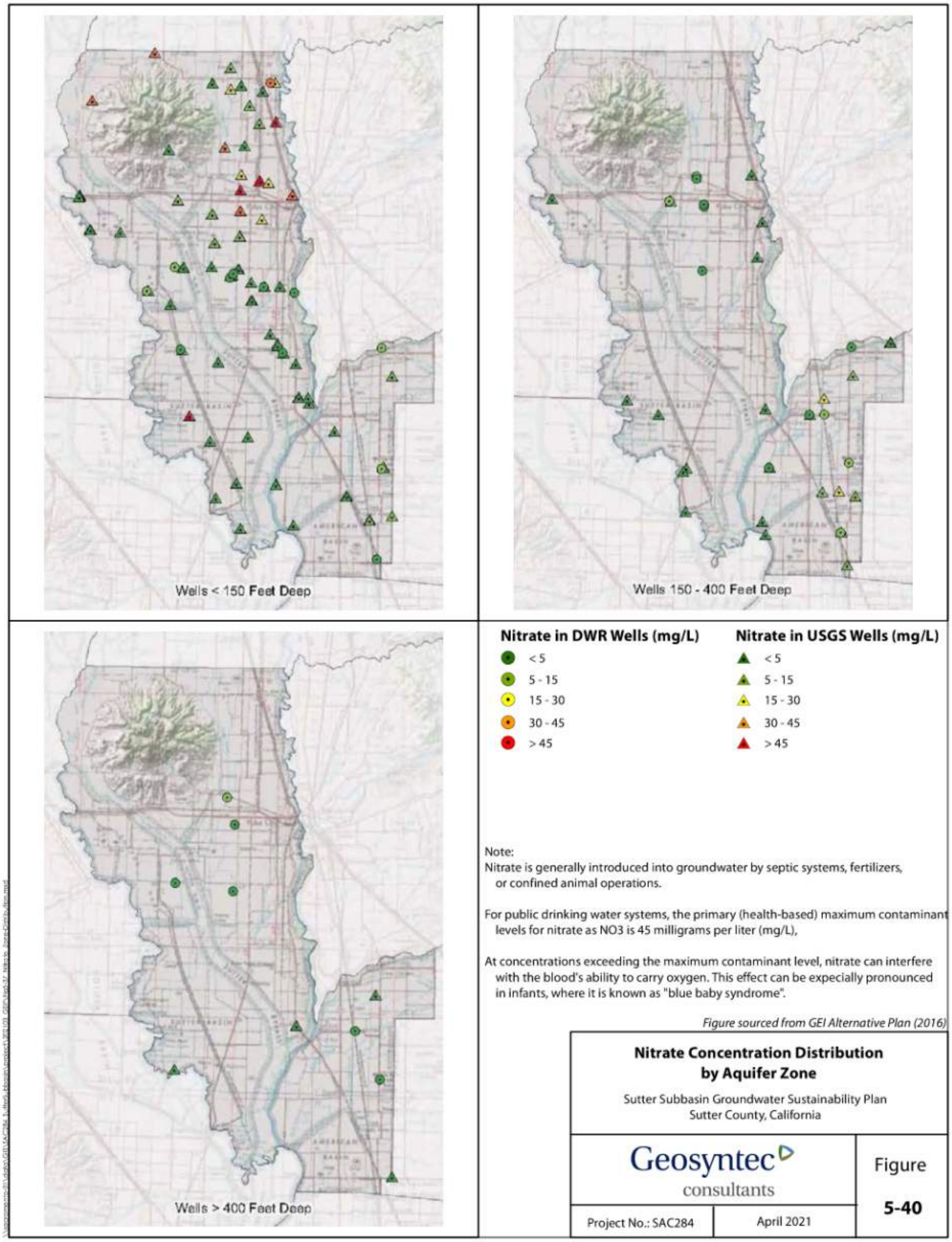


Figure 5-42. Nitrate Concentration Distribution by Aquifer Zone, Sutter Subbasin

This page intentionally left blank.

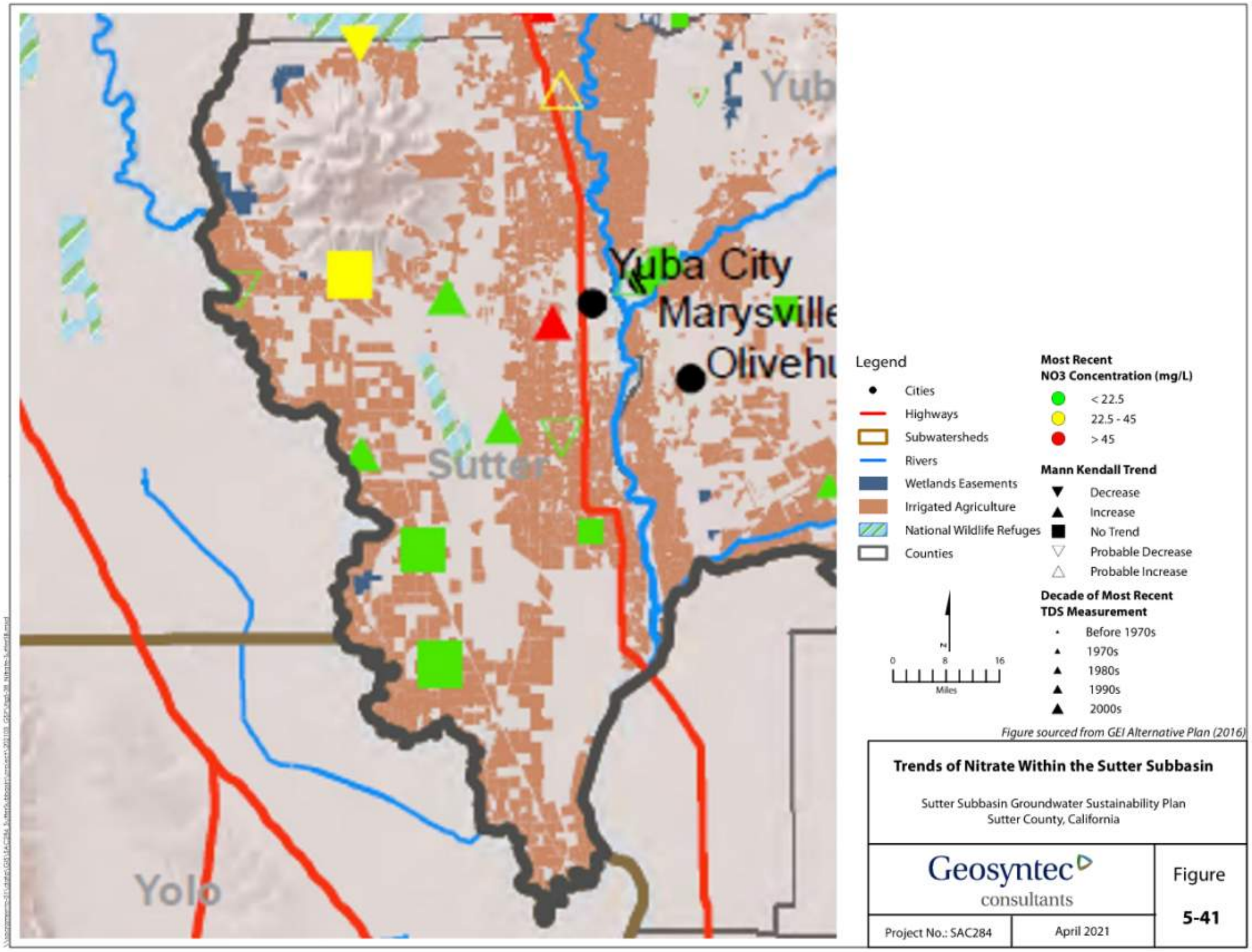


Figure 5-43. Nitrate Trends, Sutter Subbasin

This page intentionally left blank.

5.1.9.6 Iron and Manganese

Iron and manganese are naturally occurring elements in rocks and minerals and the dissolution of these materials can mobilize them into groundwater. These minerals are commonly associated with volcanic derived sediments that form the Sutter Buttes Rampart, Mehrten, and Tuscan Formations. The SMCL for iron is 0.3 mg/L and for manganese is 0.05 µg/L.

Figure 5-44 provides the cross plots for iron and manganese versus depth of the bottom of screen interval for the wells shown in **Figure 5-27**. As seen in this figure, only one well completed at 90 feet bgs (24G004M, **Figure 5-27**) had a reported iron concentration above the SMCL whereas almost all the wells had reported manganese levels above the SMCL. The highest reported manganese levels were within the upper 250 feet. USGS (1984) indicated that reducing conditions in the Sutter Subbasin most likely produce higher concentrations of iron and manganese, and the USGS (2011) has reported that groundwater in the Quaternary alluvium along the Sacramento River and in the Delta commonly has low dissolved oxygen content that reflect reducing conditions.

Figure 5-45 shows the manganese distribution by aquifer zones as presented in the Alternative Plan. As seen in this figure, manganese concentrations in the shallow aquifer are typically below the SMCL in the northern portion of the County, but in the southern half, concentrations typically exceed the SMCL; this trend is consistent with the USGS (2011) report that reducing conditions exist in this area. Manganese concentrations in the deeper aquifer zones typically exceed the SMCL, but there are some occurrences where their concentrations are below the MCL. There are no data (oxidation-reduction potential or dissolved oxygen) to indicate if reducing conditions exist in these areas, but high concentrations of manganese especially above 1 mg/L are indicative of reducing conditions.

Iron concentrations were not monitored as part of the Rice Coalition Groundwater Assessment Report and a figure showing iron distribution by aquifer zones was not included in the Assessment Report. However, **Figure 5-46** shows the iron distribution across the Subbasin as presented in the Alternative Plan and shows elevated iron concentrations above the SMCL in areas along the Feather and American Rivers reported to have reducing conditions (USGS, 2011).

This page intentionally left blank.

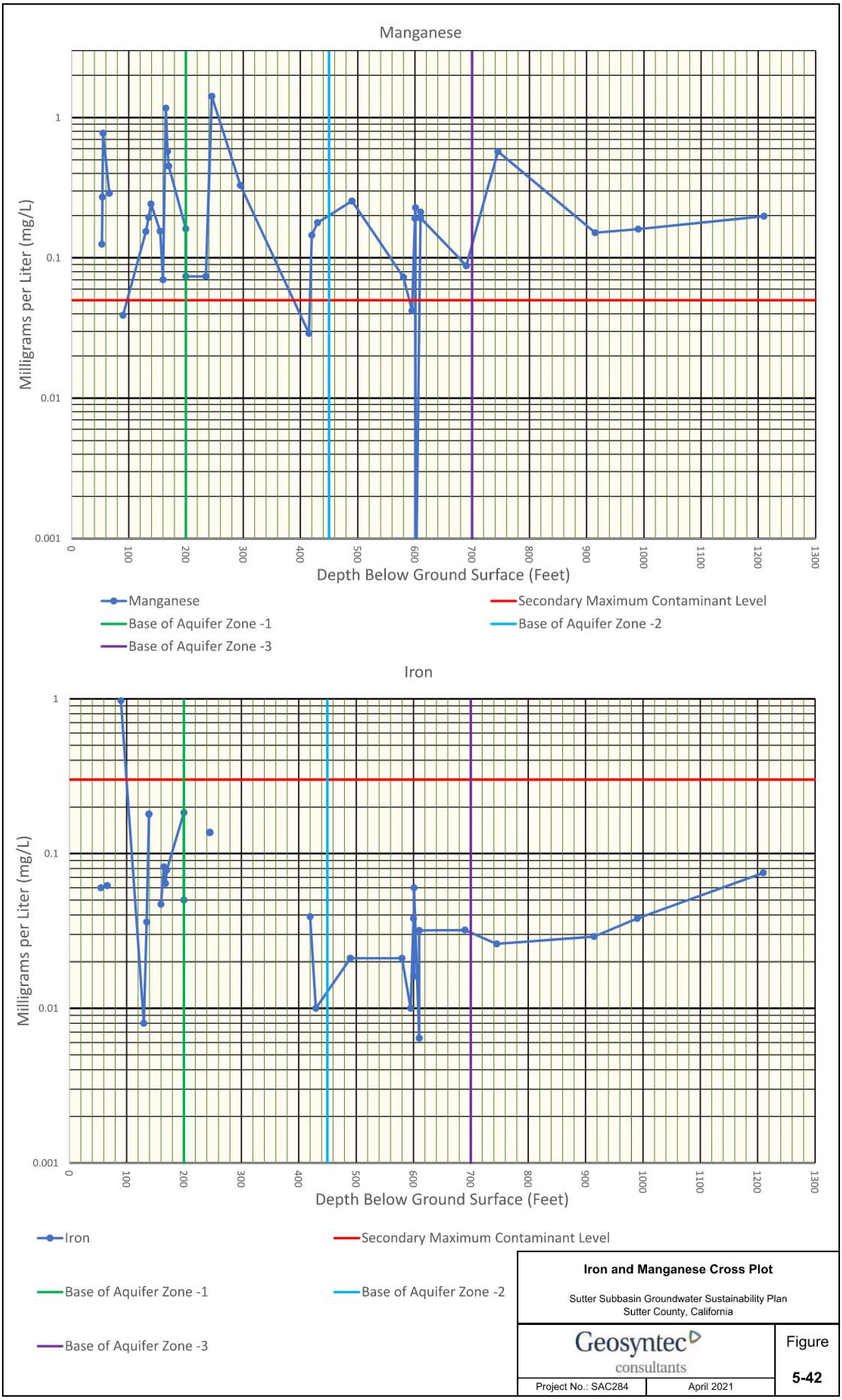


Figure 5-44. Iron and Manganese Cross Plot

This page intentionally left blank.

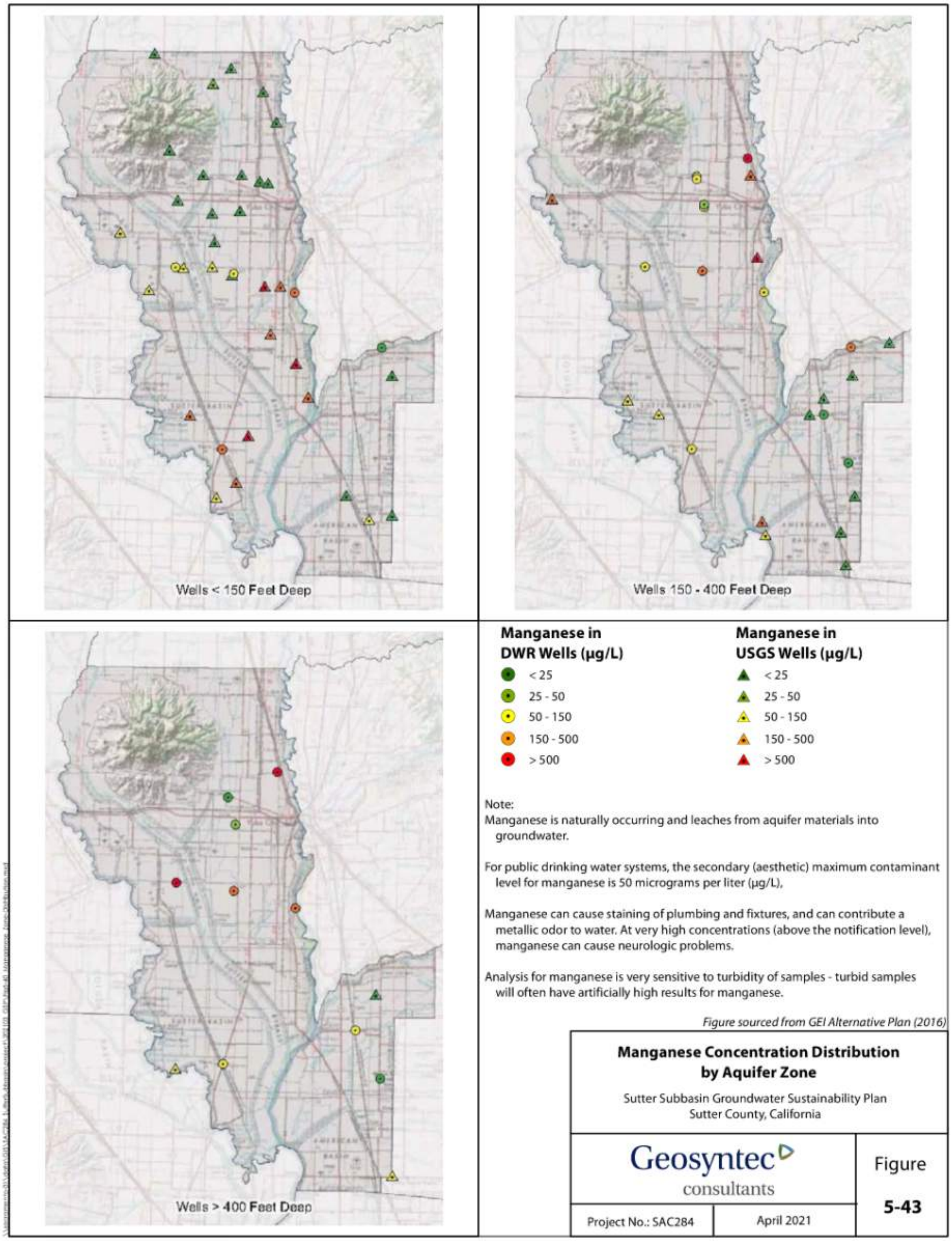


Figure 5-45. Manganese Concentration Distribution by Aquifer Zone, Sutter Subbasin

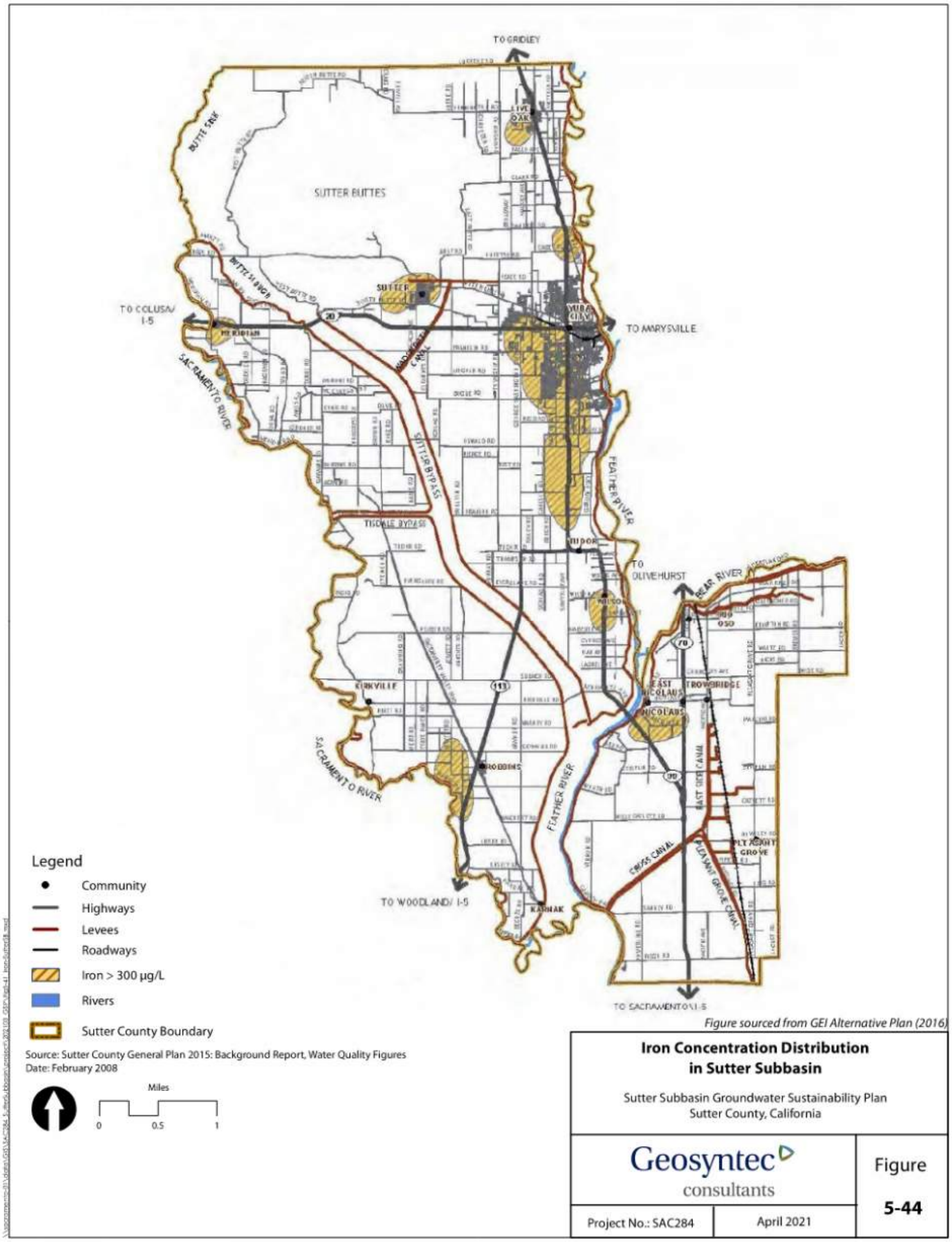


Figure 5-46. Iron Concentration Distribution, Sutter Subbasin

5.1.9.7 Point Sources

The goal of groundwater quality management under SGMA is to supplement information available from other sources with data targeted to assist GSAs in the Sutter Subbasin to comply with the requirements of SGMA. Development of groundwater quality-related sustainable management criteria for the Sutter Subbasin is not intended to duplicate or supplant the goals and objectives of ongoing programs including those by the USGS Rice, Shallow Domestic, and GAMA well programs, Sacramento Valley Water Quality Coalition (SVWQC), and the State Drinking Water Information System (SDWIS).

Because irrigated agriculture is the predominant land use in the Sutter Subbasin, monitoring of the groundwater quality data developed through the Groundwater Quality Trend Monitoring Work Plan (GQTMWP) being implemented by the SVWQC for compliance with the Central Valley Regional Board's Irrigated Lands Regulatory Program (ILRP) will be an important source of information to GSAs in the Subbasin. Pesticides are included in this program as well as part of the Rice Coalition Groundwater Assessment program.

Among the contaminants that may affect groundwater conditions in the future are chemicals of emerging concern (CECs). These are contaminants having toxicities not previously recognized, which may have the potential to cause adverse effects to public health or the environment and are found to be building up in the environment or to be accumulating in humans or wildlife. CECs such as perfluorooctanesulfonic acid (PFOS) and per- and polyfluoroalkyl substances (PFAS) will not be monitored under the groundwater quality monitoring program established for SGMA. However, GSAs will have access to data on CECs collected by other agencies and will be attentive to the effect the presence of CECs may have on groundwater management in specific locations.

The SGMA regulations require that GSPs describe locations, identified by regulatory agencies, where groundwater quality has been degraded due to industrial and commercial activity. Locations of impacted groundwater were identified by reviewing information available on the State Water Resources Control Board GeoTracker/GAMA website, the California Department of Toxic Substances Control (DTSC) EnviroStor website, and the Environmental Protection Agency's (EPA) National Priorities List (NPL). Cases that have been closed by the supervisory agency are not considered.

Figure 5-47 provides the locations of active sites listed in California's EnviroStor and GeoTracker/GAMA databases that could potentially impact groundwater in the Sutter Subbasin. Links to each of these databases that also include locations of National Priorities List (NPL) or "Superfund" sites are as follows:

- EnviroStor - https://www.envirostor.dtsc.ca.gov/public/
- GeoTracker/GAMA - https://geotracker.waterboards.ca.gov/

Table 5-6 lists the information available for these sites from these databases. As shown in **Table 5-6**, only 10 active sites are listed within the Sutter Subbasin.

Under SGMA, GSAs are only responsible for groundwater quality issues related to pumping. Other programs and agencies are responsible for enforcing groundwater quality violations for sites located in the Subbasin. However, GSAs will coordinate with these other agencies if water quality degradation is associated with groundwater pumping.

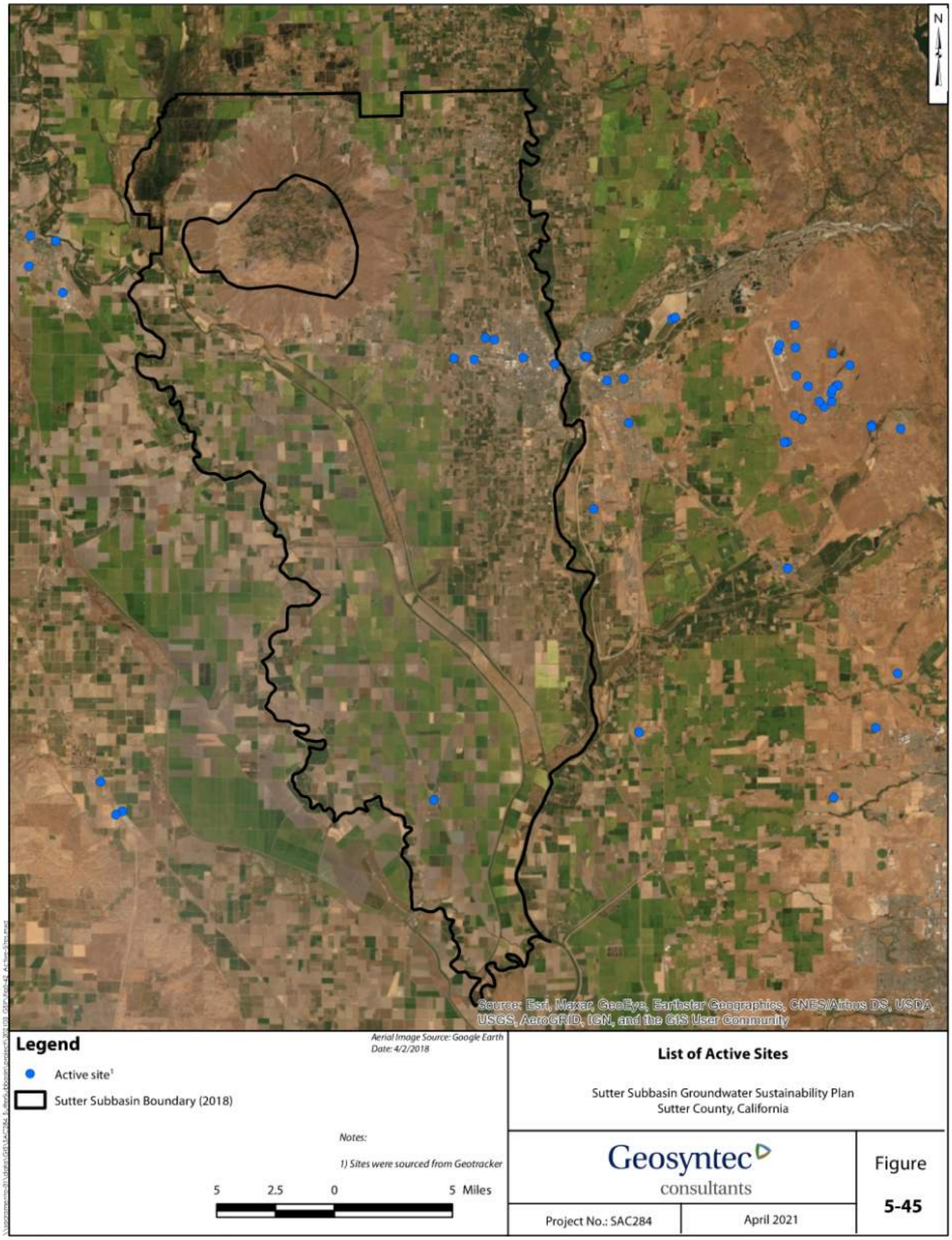


Figure 5-47. Active GeoTracker Sites

This page intentionally left blank.

Table 5-6. Active GeoTracker Sites, Sutter Subbasin

Site Name	Site Type	Status	Address	City	Latitude	Longitude
1st Stop	LUST Cleanup Site	Open - Site Assessment	248 Bridge Street	Yuba City	39.13729214	-121.6092432
Costa Property	Cleanup Program Site	Open - Eligible For Closure	1716 Elmer Road	Yuba City	39.15226123	-121.6567183
John Taylor Fertilizers - Yuba City	Cleanup Program Site	Open – Verification Monitoring	900 North George Washington Boulevard	Yuba City	39.13997456	-121.6728107
Puregro	Cleanup Program Site	Open - Assessment & Interim Remedial Action	4900 Del Monte Avenue	Robbins	38.86930099	-121.7056203
Question Market	LUST Cleanup Site	Open - Verification Monitoring	973 North Township Road (AKA: 937)	Yuba City	39.1408459	-121.6887884
Quick-N-Shop	LUST Cleanup Site	Open - Remediation	2590 Butte House Road	Yuba City	39.1535168	-121.663992
Zelie's Cleaners	Cleanup Program Site	Open - Site Assessment	1222 Colusa Avenue	Yuba City	39.141059	-121.634054
Custom Chrome And Bumper	State Response	Active	335 Garden Highway	Yuba City	39.12433545	-121.6102366
Lomo Airstrip	State Response	Certified O&M - Land Use Restrictions Only	1111 Koch Lane	Yuba City	39.22527814	-121.6341798
Union Pacific Railroad Right-of-way Yuba City	Voluntary Cleanup	Active	Railroad Right-of-Way from Feather River east to Harter Parkway (a distance of 2.8 miles), including a former switching yard and railroad spur lines in the block bounded by Cooper Avenue to the west, Reeves Avenue to the north, and Bridge Street to the southeast	Yuba City	39.13485575	-121.6188626

This page intentionally left blank.

5.1.10 Surface Water Bodies

There are no reservoirs within the Subbasin. The Feather and Sacramento Rivers due to their lengths do, on a dynamic basis, contain surface water in excess of 100 acre-feet (AF). **Figure 2-1** shows these surface water bodies.

5.1.11 Imported Surface Water Supplies

Surface water is primarily used for agricultural purposes within the Sutter Subbasin and obtained through Sacramento River Settlement Contracts Central Valley Project (CVP) contractors, Feather River diverters, and surface water rights held by individual users. For more information about Sacramento River Settlement Contractors and Feather River diverters, refer to **Section 2.1.3.2.3**. Sacramento River Settlement Contractors include Sutter Mutual Water Company, Meridian Farms Water Company, Tisdale Irrigation & Drainage Company, Pelger Mutual Water Company, Oji Brothers Farm, Inc., and Oji Family Partnership (**Figure 5-48**). Imported water is diverted directly from the Sacramento River by the Settlement Contractors in the Sutter Subbasin. Feather River diverters hold diversion agreements with DWR to transport water from the Feather River using State Water Project facilities for both diversion and storage. Butte Water District and Sutter Extension Water District entered into agreement with DWR in May 1969 along with Biggs-West Gridley Water District and Richvale Irrigation District. Feather Water District and Garden Highway Mutual Water Company hold separate contracts with DWR for diversion of Feather River water.

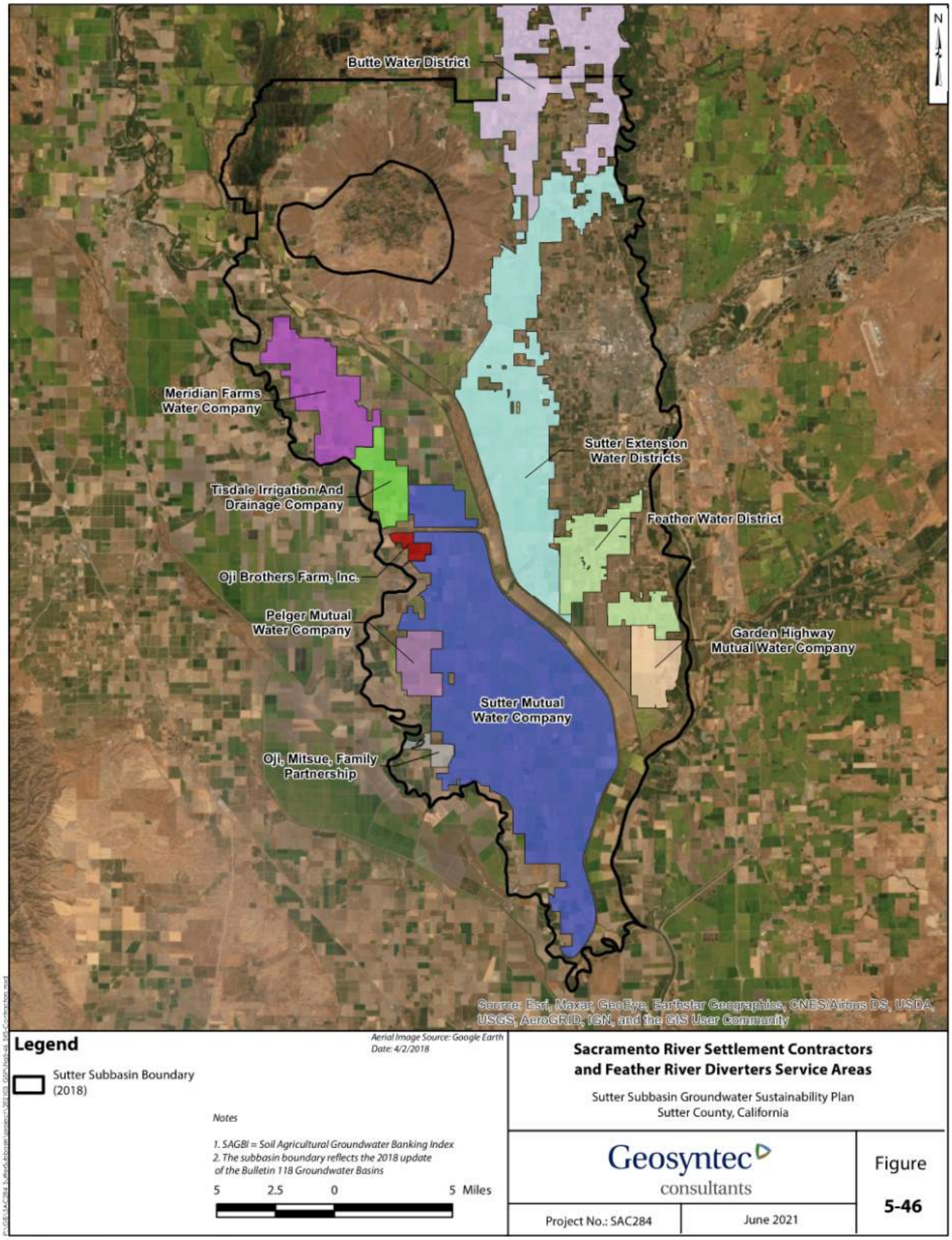


Figure 5-48. Imported Water Supplies, Sutter Subbasin

5.1.12 HCM Data Gaps

The HCM forms the framework for understanding the movement of water from the surface to the subsurface and at the boundaries of the Subbasin based on the available information. An important function of the HCM is the identification of data gaps and uncertainties within this framework that will form the basis for development of future data collection efforts. For successful management of the Subbasin, it is critical that as new data are collected this HCM is updated.

The following presents data gaps identified for the Sutter Subbasin HCM that will be updated with future monitoring, modeling, and data refinement efforts.

5.1.12.1 Interactions between Sacramento, Feather, and Other River Stage Response to Changes in Groundwater Levels

Data needed to develop appropriate sustainable management criteria for interconnected surface waters includes definition of stream reaches and associated priority habitat, streamflow measurements to develop profiles at multiple time periods, and corresponding measurements of groundwater levels directly adjacent to stream channels, for the first water bearing aquifer zone, and for deeper aquifer zones. These data are not available and are a data gap for the GSP. Currently, Sutter County is negotiating with DWR to install 15 nested monitoring wells (**Figure 5-49**) at selected surface water gage locations near rivers and wetlands to collect the data needed to assess these interactions.

Expansion of stream gaging locations should also occur to document and better understand changes in stream-aquifer interactions. In addition to the stream gaging, a series of shallow dedicated monitoring wells equipped with temperature sensors should be installed along stream courses in the recharge corridor and downstream to the Sacramento and Feather Rivers that may help identify what sections of streams are losing or gaining.

5.1.12.2 Source of elevated Salinity within Shallow Aquifer Zone

As noted in **Section 5.1.9**, the Alternative Plan stated that it is unclear why elevated salinity (reported as specific conductance) occurring in the shallow aquifer zone (which suggests an agricultural source) does not appear to correlate with elevated nitrate concentrations as is often found for groundwater impacts related to agriculture. However, the existence of reducing conditions in the shallow zone could result in lower levels of nitrate due to denitrification, suggesting that the high salinity values in the shallow zone are, in fact, from agricultural sources. As such, the source of the elevated salinity in the shallow aquifer is unknown at this time. Studies to address this data gap should include collection of nitrogen isotopes and oxidation-reduction values that will allow assessment of areas with reducing conditions in addition to isotopic analysis.

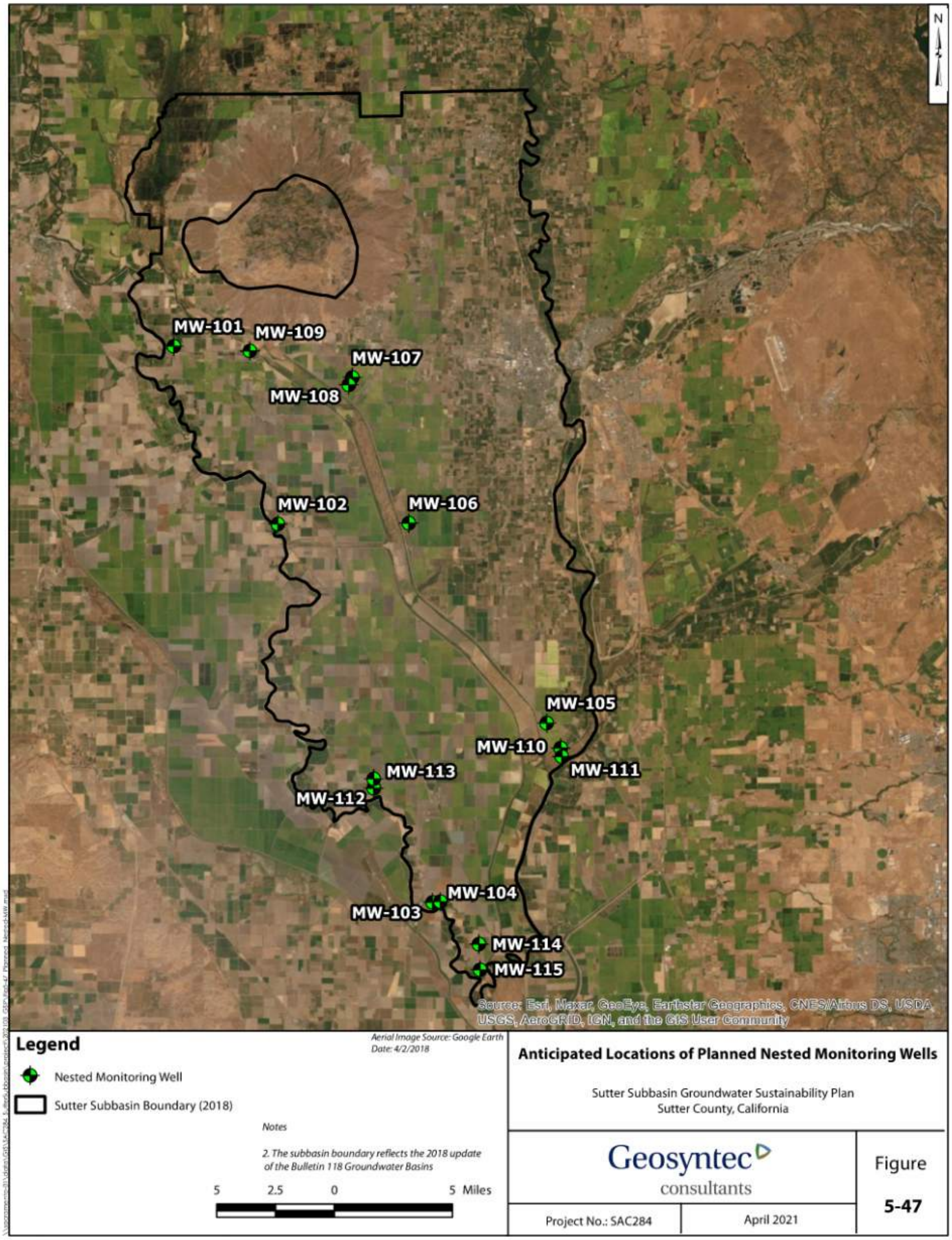


Figure 5-49. Anticipated Locations of Planned Nested Monitoring Wells

5.1.12.3 Aquifer Properties

Only one limited aquifer pumping test was identified to assess aquifer properties for the Sutter Subbasin. This information could be collected by conducting pumping tests as part of existing irrigation practices within the Subbasin by monitoring groundwater elevations in and around pumping wells during pumping start up and following the cessation of pumping. For such a program, existing nested monitoring wells as observation wells would be used to assess groundwater pumping-aquifer interactions. This type of test program will eliminate the need for discharge permits and handling of extracted water and will allow an assessment of the actual stresses on the aquifer during the agricultural season.

5.1.12.4 Further Assess Groundwater Recharge

Future recharge and aquifer studies should include the collection and interpretation of stable isotope data. Methodology considerations include: 1) seasonal sampling should be performed as part of future surface water and groundwater isotope studies for purposes of assessing groundwater recharge; 2) using the existing nested monitoring wells with multiple screened intervals are recommended to assess stable isotope data at different depths; and 3) monitoring wells with relatively short screened zones (20 feet or less) to minimize mixing between aquifer zones or between aquifer zones and residual water retained within the aquitard zones.

5.1.12.5 Recharge Rate

Most well locations and depths should be sampled and analyzed for presence of tritium to help distinguish whether recharge to individual aquifer zones is occurring over periods shorter than about 60 years, or whether recharge is occurring over longer timeframes. This can help better understand the nature of hydraulic connection between different zones in the aquifer system.

5.1.12.6 Hydrogeologic Conceptual Model

Additional data to better understand the hydrogeology of the basin will assist in identifying and improving the understanding of recharge mechanisms and connectivity between aquifer layers and refining the water budget for the Subbasin. Using aerial electromagnetic (AEM) surveys is recommended to help address these uncertainties and the structure of the subbasin.

5.1.12.7 Definition of Stratigraphic Zones

It is recommended that a uniform set of criteria for logging of cuttings from soil boring drilled in the Subbasin be developed. Such an effort would need the participation and cooperation of various agencies and researchers in the region. The criteria adopted should be such that the contacts between geologic formations are easily identifiable from the drill cuttings, such as developed by Blair and others (1991) for the Oroville area. The different studies reviewed for this project use a wide range of definitions and terminology that are not consistent from one investigation to the next. This lack of consistency presents a challenge when attempting to correlate the definition of stratigraphic sequences, aquifer zones, and even geologic formations between different studies. As described in **Section 5.1.4**, many previous studies do not follow USGS standards and the North American Stratigraphic Code, resulting in confusing and sometimes incorrect naming of geologic units. Future studies would benefit from development of a uniform methodology and clearly defined set of stratigraphic terminology so that studies conducted by different investigators can be correlated and the value of the data maximized.

5.2 Groundwater Conditions

This section describes the current and historic groundwater conditions within the Sutter Subbasin and presents data from January 1, 2015 through 2021 as publicly available during the development of this GSP. The current and historic conditions of the following parameters are described herein: groundwater elevations, groundwater storage, groundwater quality, land subsidence, interconnected surface water systems, and groundwater dependent ecosystems (GDEs). Seawater intrusion is not discussed herein as the Sutter Subbasin is inland from the Pacific Ocean and distant from the Sacramento-San Joaquin Delta (Delta) and is not impacted by seawater intrusion.

Baseline conditions are established in this section in order to facilitate the monitoring of changes relative to established sustainable management criteria, and will help support monitoring to demonstrate measurable efforts in achieving the sustainability goal for the Sutter Subbasin. For the purposes of this GSP, “current conditions” are represented by Water Year (WY) 2013 conditions as it is the most recent year with complete data considered “normal” in terms of water use (i.e., not heavily impacted by drought or wet conditions). Data post-WY 2013 through present day are presented when available. This section has been developed pursuant to §354.16 of the GSP Emergency Regulations.

5.2.1 Useful Terminology

This section includes descriptions of the amounts, quality, and movement of groundwater, among other related components. A list of technical terms and a description of those terms are listed below. The terms and their descriptions are identified here to guide readers through the section and are not a definitive definition of each term:

- **Depth to Groundwater** – The distance from the ground surface to first-detected non-perched groundwater, typically reported at a well.
- **Horizontal gradient** – The slope of the groundwater surface from one location to another when one location is higher or lower than the other.
- **Vertical gradient** – Describes the movement of groundwater perpendicular to the ground surface. Vertical gradient is measured by comparing the elevations of groundwater in wells that are screened at different depths. A downward gradient is one where groundwater is moving down into the ground towards deeper aquifers, and an upward gradient is one where groundwater is upwelling towards the ground surface.
- **Contour Map** – A contour map shows changes in groundwater elevations by interpolating groundwater elevations between monitoring sites. The elevations are shown on the map with the use of a contour line, which represents groundwater being at the indicated elevation along the contour line. Contour maps can be presented in two ways:

  - Elevation of groundwater above mean sea level (MSL), which can be used to identify the horizontal gradients of groundwater, and
  - Depth to water (i.e., the distance from the ground surface to groundwater), which can be used to identify areas of shallow or deep groundwater.

- **Hydrograph** – A graph that shows changes in groundwater elevation or depth to groundwater over time at a specific location. Hydrographs show how groundwater elevations change over the years and indicate whether groundwater is rising or descending over time.
- **Maximum Contaminant Level (MCL)** – MCLs are standards that are set by the State of California and the U.S. Environmental Protection Agency for drinking water quality. MCLs are legal threshold limits on the amount (concentration) of an identified constituent that is allowed in public drinking water supplies. At both the State and Federal levels, there are Primary MCLs, set to be protective of human health, and Secondary MCLs (SMCLs) for constituents that do not pose a human health hazard but do pose a nuisance through either smell, odor, taste, and/or color. MCLs differ for different constituents and not all constituents found in groundwater currently have either a federal or state Primary or Secondary MCL.
- **Elastic Land Subsidence** – Reversible and temporary fluctuations in the elevation of the earth's surface in response to seasonal periods of groundwater extraction and recharge.
- **Inelastic Land Subsidence** – Irreversible and permanent decline in the elevation of the earth's surface resulting from the collapse or compaction of the pore structure within the fine-grained portions of an aquifer system.
- **Gaining Stream** – A stream in which groundwater flows into a streambed and contributes to a net increase in surface water flows across an identified reach.
- **Losing Stream** – A stream in which surface water is lost through the streambed to the underlying groundwater aquifer, resulting in a net decrease in surface water flows across an identified reach.

5.2.2 Groundwater Elevations

Historic and current groundwater conditions within the Sutter Subbasin are assessed to determine flow directions, lateral and vertical gradients, and regional pumping patterns, both spatially and temporally, as depicted in groundwater elevation contour maps and hydrographs.

5.2.2.1 Historic Conditions

Groundwater in the Sutter Subbasin generally follows the topography of the land surface, flowing from the Sierra Nevada on the east toward the center of the Sacramento Valley (east to west) and north to south within the valley (Wood Rodgers, 2012), eventually flowing toward the Sacramento-San Joaquin Delta. Seasonal and short-term fluctuations in groundwater elevations have been observed in the Sutter Subbasin due to irrigation requirements and hydrologic conditions but have generally remained relatively stable for more than 70 years.

One of the earliest groundwater contour maps for the Sutter Subbasin area was prepared in 1923 (Bryan 1923), as shown in **Figure 5-50**, for Fall 1912 and Fall 1913 conditions (prior to the development of the deep well turbine pump). The contours in **Figure 5-50** presents depth to groundwater and show groundwater entering the Subbasin from the north and east, ranging from 70 feet above mean sea level (MSL) to 20 feet above MSL in the southern end of the Subbasin. Groundwater appears to have historically flowed through and beneath the Feather River. The groundwater contours show groundwater discharges to the Sacramento River and to the south towards the Delta.

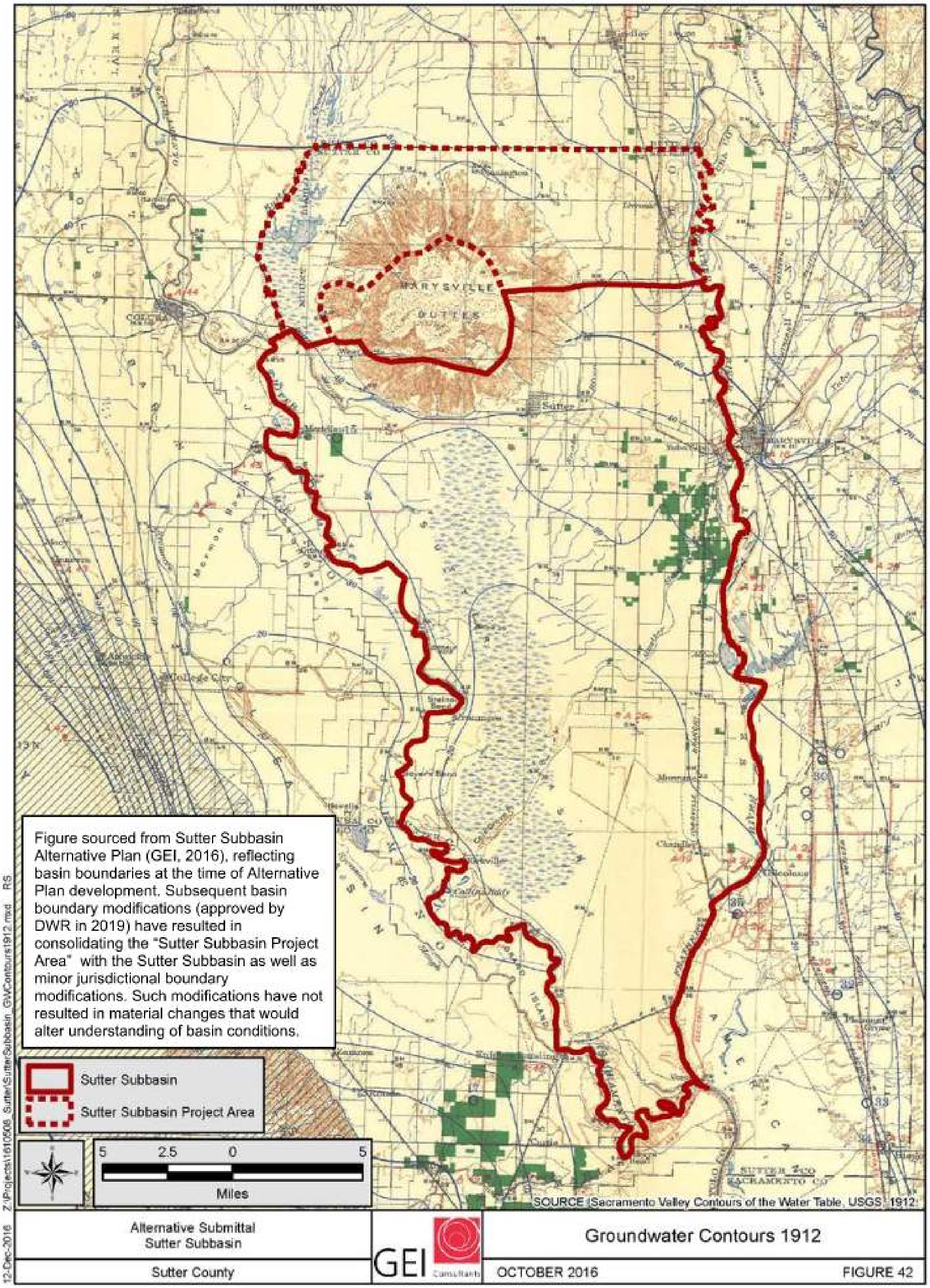


Figure 5-50. Groundwater Elevation Contours, Fall 1912 and Fall 1913

As discussed in the Hydrogeologic Conceptual Model (**Section 5.1**), three aquifer zones have been delineated for the Sutter Subbasin and defined as follows:

- **Aquifer Zone-1 (AZ-1)** roughly aligns with the “shallow aquifer” zone defined in the Sutter Subbasin Alternative Plan (GEI, 2016), extending from the ground surface to a depth of about 50 feet below ground surface (bgs) near the Sutter Buttes and up to 190 feet bgs further away from the Sutter Buttes;
- **Aquifer Zone-2 (AZ-2)** generally aligns with the “intermediate aquifer” zone identified in the Alternative Plan, ranging from 150 to 400 feet bgs; and
- **Aquifer Zone-3 (AZ-3)** generally aligns with the “deep aquifer” zone identified in the Alternative Plan and covers the zone deeper than 400 feet bgs.

Additionally, maps of historic conditions presented in this section represent the Bulletin 118 basin boundaries for the Sutter Subbasin and East Butte Subbasin as available during Alternative Plan development. Basin boundaries modifications have taken place since the Alternative Plan development as part of DWR’s Basin Boundary Modification Request System in 2018, including consolidating the East Butte Subbasin within the Sutter Subbasin and jurisdiction boundary modifications to include Biggs-West Gridley Water District GSA entirely within the Butte Subbasin, and aligning the Sutter Subbasin boundary with the Sutter County jurisdictional boundary. Such boundary modifications have not resulted in material changes that would alter understanding of historic basin conditions within the current Sutter Subbasin boundary but should be noted.

Figure 5-51 through **Figure 5-53** show groundwater elevations within the Sutter Subbasin in the shallow (AZ-1), intermediate (AZ-2), and deep (AZ-3) aquifer zones during Spring 1998, representing the highest groundwater elevations during a Wet year (as classified by the Sacramento River Water Year Index). Groundwater elevations in the shallow aquifer zone range from 21 feet above MSL along the central portion of the western boundary of Subbasin to 75 feet above MSL in the northeastern corner of the Subbasin (**Figure 5-51**). In the intermediate aquifer zone, groundwater elevations range from 15 feet above MSL in the southern portion of the Subbasin to 69 feet above MSL in the northeastern corner of the Subbasin (**Figure 5-52**). Groundwater elevation data are limited for Spring 1998 in the deep aquifer zone, but ranges from approximately 67 feet above MSL in the northern portion of the Subbasin to approximately 14 feet above MSL in the southern portion of the Subbasin (**Figure 5-53**). In all aquifer zones in Spring 1998, the general direction of groundwater flow is from the north and east portion of the Subbasin towards the south.

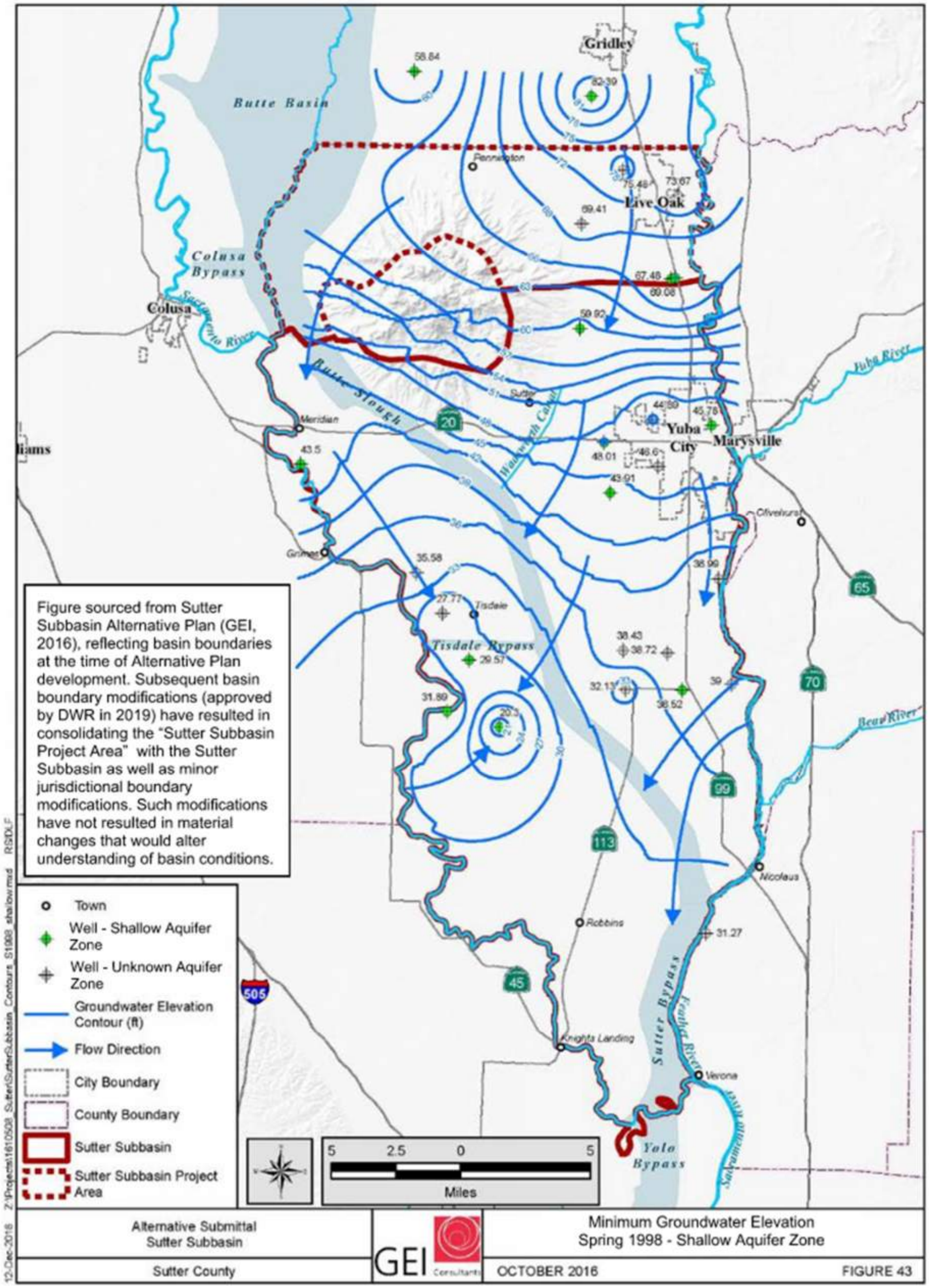


Figure 5-51. Groundwater Elevation in Shallow Aquifer Zone, Spring 1998

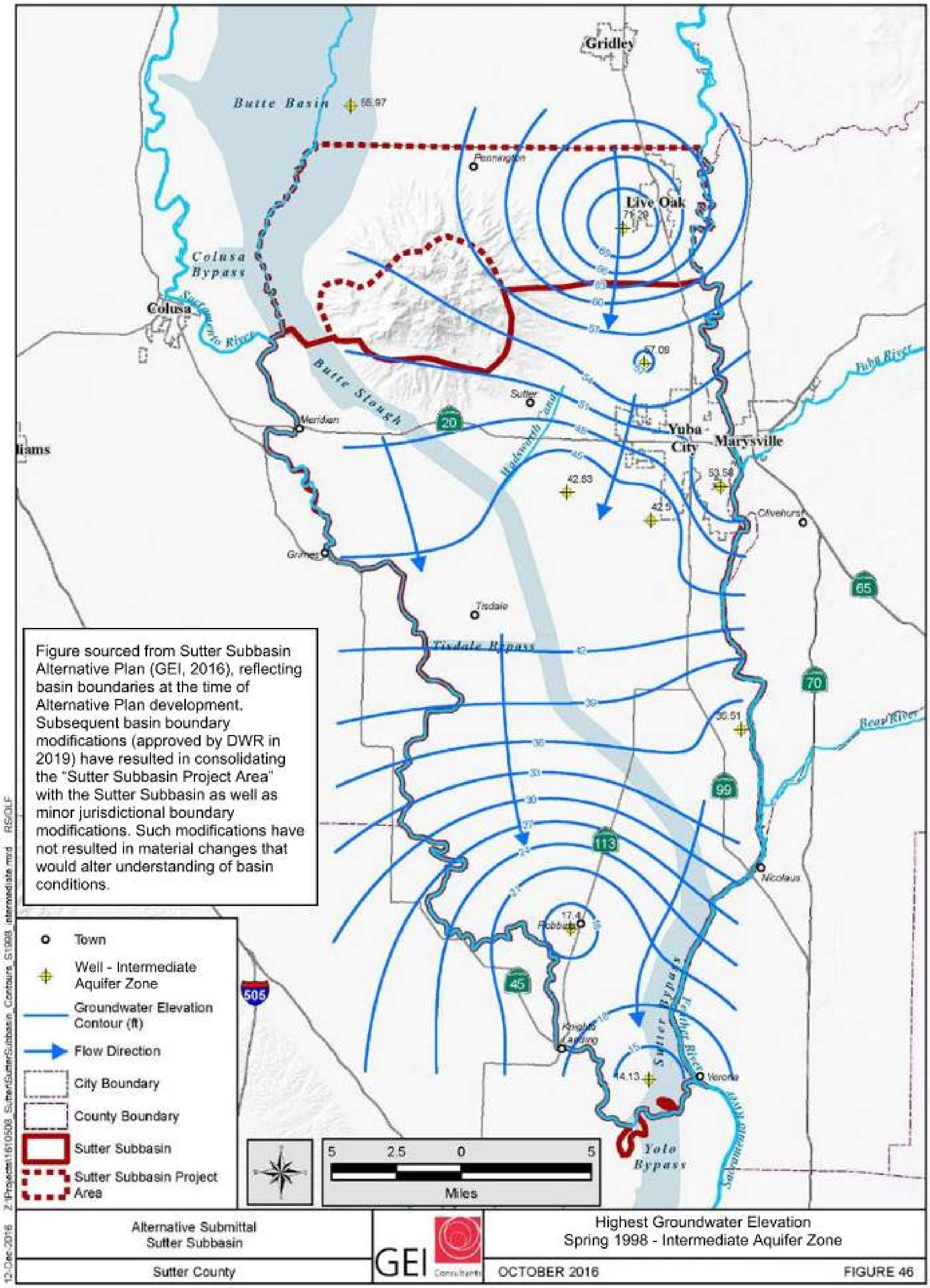


Figure 5-52. Groundwater Elevation in Intermediate Aquifer Zone, Spring 1998

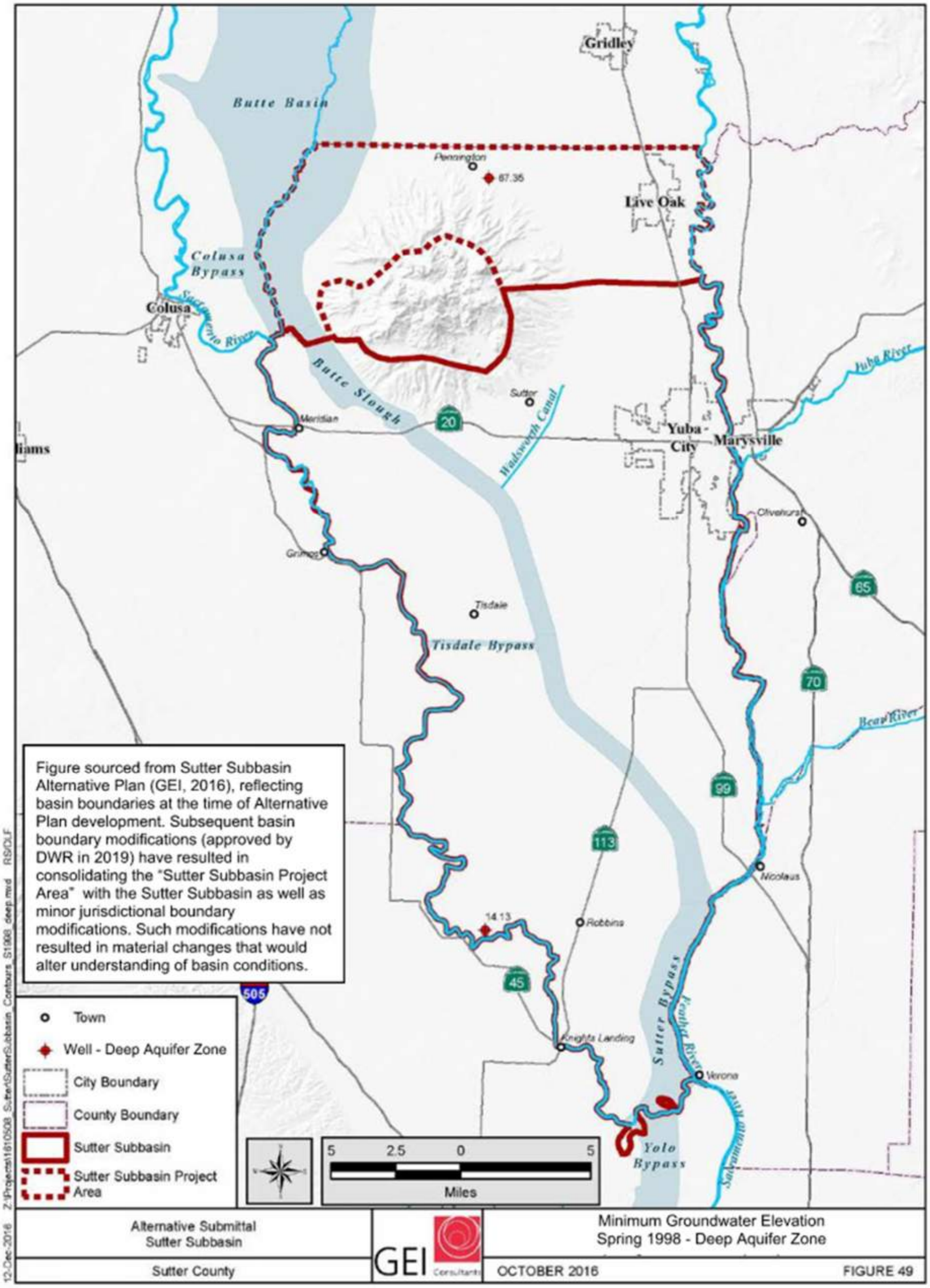


Figure 5-53. Groundwater Elevation in Deep Aquifer Zone, Spring 1998

Figure 5-54 through **Figure 5-56** show groundwater elevations in the Subbasin in the shallow (AZ-1), intermediate (AZ-2), and deep (AZ-3) aquifer zones during Fall 2009, representing the lowest groundwater elevations during a Dry year (as classified by the Sacramento River Water Year Index). Groundwater elevations in the shallow aquifer zone range from 12 feet above MSL in the southern portion of the Subbasin to 69 feet above MSL in the northeastern corner of the Subbasin (**Figure 5-54**). In the intermediate aquifer zone, groundwater elevations range from 15 feet above MSL in the southern portion of the Subbasin to 63 feet above MSL in the northeastern corner of the Subbasin (**Figure 5-55**). Groundwater elevations in the deep aquifer zone range from 15 feet above MSL in the southern portion of the Subbasin to 45 feet above MSL along the northern boundary of the Subbasin (**Figure 5-56**). In all aquifer zones during Fall 2009, the general direction of groundwater flow is similar to Spring 1998, with groundwater entering the Subbasin from the north and east and leaving the Subbasin to the south.

The difference in groundwater elevations from the highest groundwater level in Spring 1998 to the lowest groundwater elevation in Fall 2009 within each zone of the principal aquifer are summarized below:

- **Shallow Aquifer Zone (AZ-1; Figure 5-57)** – East of the Sutter Buttes along the northern Subbasin boundary, the groundwater level difference between Spring 1998 and Fall 2009 is about 6 feet. Along the Feather River (the eastern side of the Subbasin), the differences in groundwater elevations vary between 6 and 20 feet. Along the western edge of the Subbasin, the difference in groundwater elevation is about 10 feet.
- **Intermediate Aquifer Zone (AZ-2; Figure 5-58)** – Groundwater levels between Spring 1998 and Fall 2009 differ by about 10 feet along the northern Subbasin boundary near the Sutter Buttes. Along the Feather River, the differences in groundwater elevation vary between 12 and 22 feet. Along the southern end of the Subbasin, the difference in groundwater elevation is about 0.5 feet.
- **Deep Aquifer Zone (AZ-3; Figure 5-53 and Figure 5-56)** – Only two measurement points were available in Spring 1998 and eight measurement points available in Fall 2009. The northern well in Fall 2009 appears to have been pumping, which results in almost a 20-foot decline in groundwater levels. Comparison of data from the southern well between Spring 1998 and Fall 2009 shows a rise in groundwater levels of about 0.6 feet.

Localized pumping depressions are observed in all zones of the principal aquifer during Spring 1998 and Fall 2009, as shown in **Figure 5-51** through **Figure 5-56.** These localized pumping depressions are primarily located within the northeastern corner and central portion of the Sutter Subbasin.

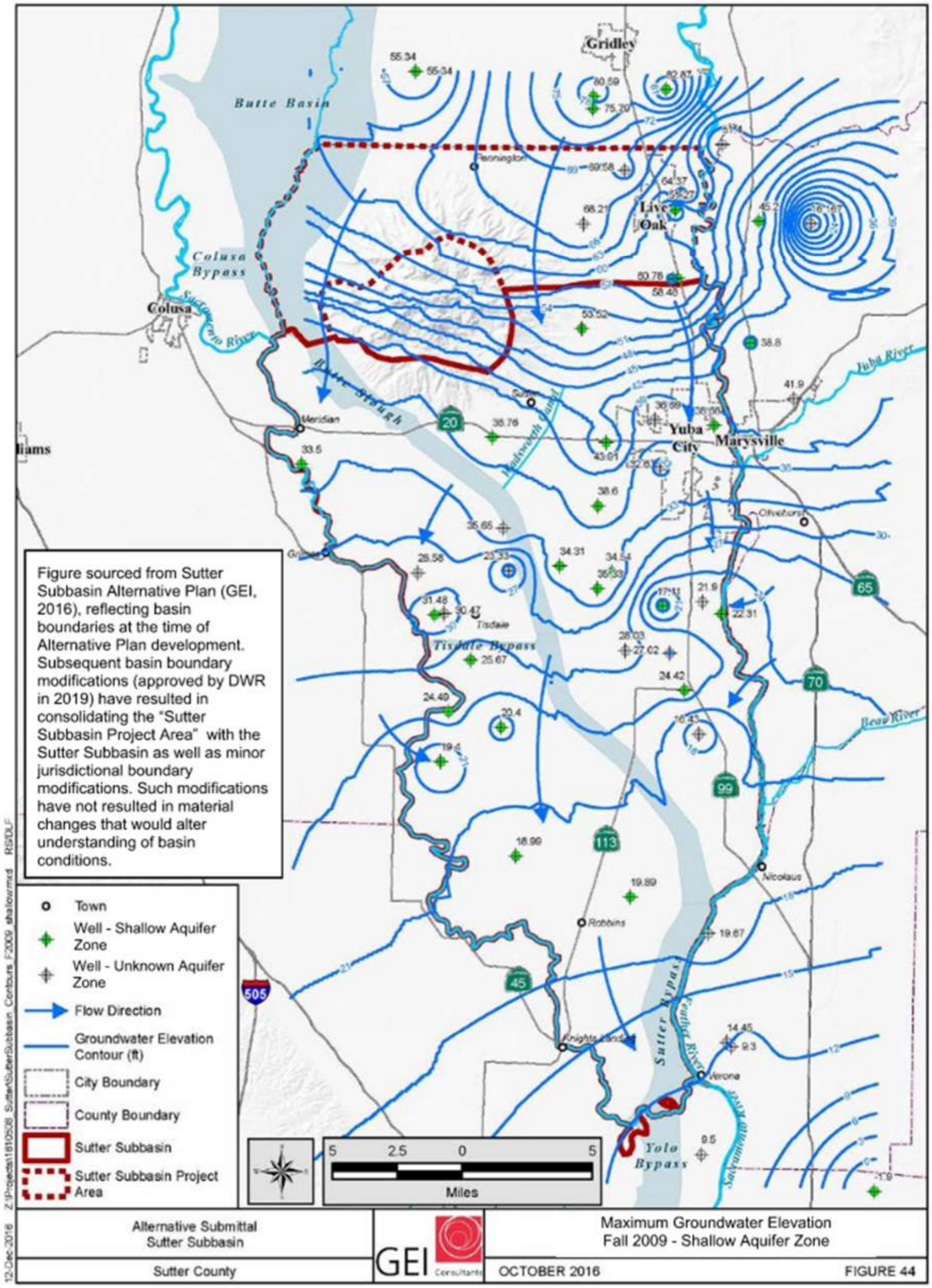


Figure 5-54. Groundwater Elevation in Shallow Aquifer Zone, Fall 2009

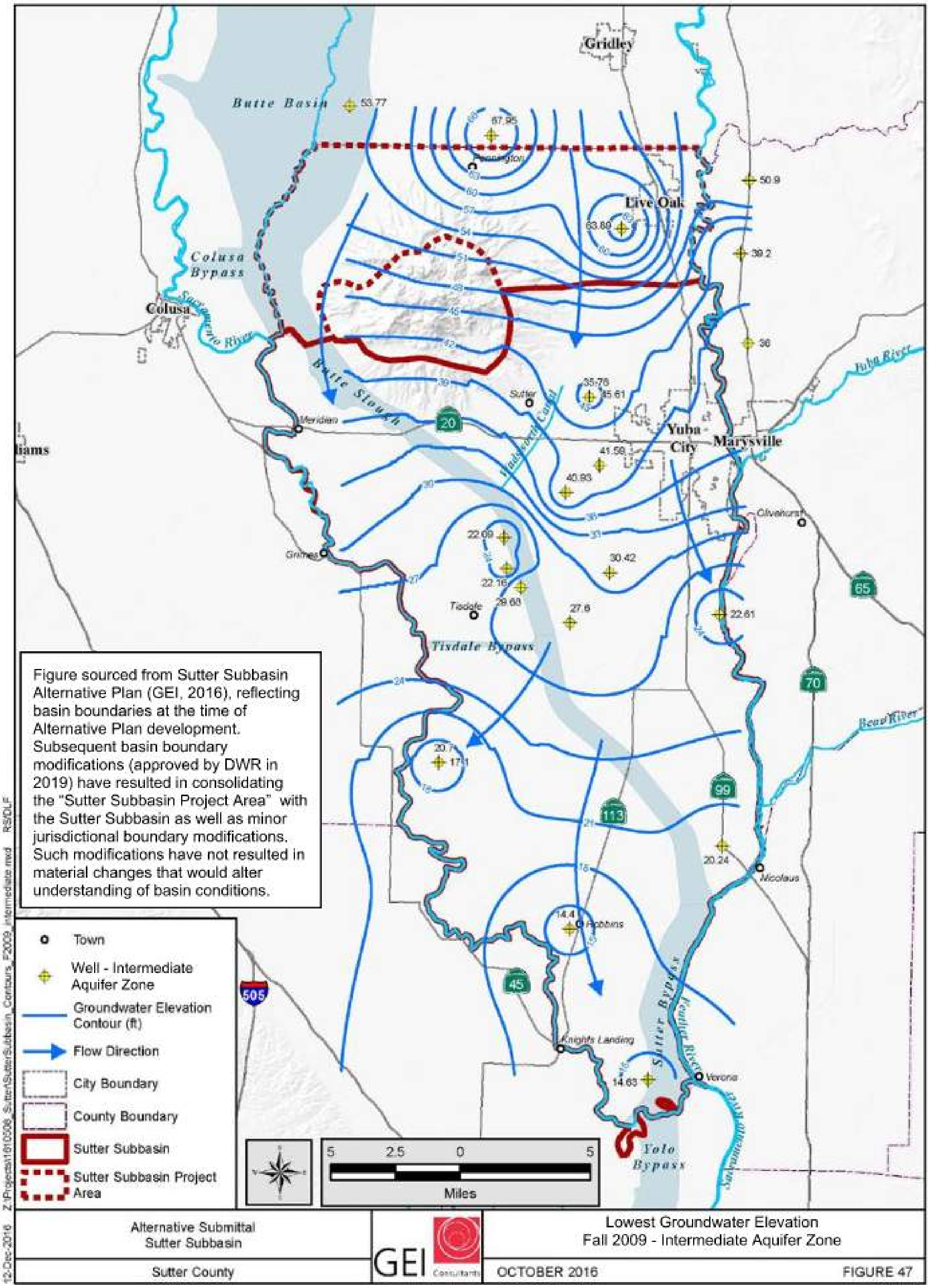


Figure 5-55. Groundwater Elevation in Intermediate Aquifer Zone, Fall 2009

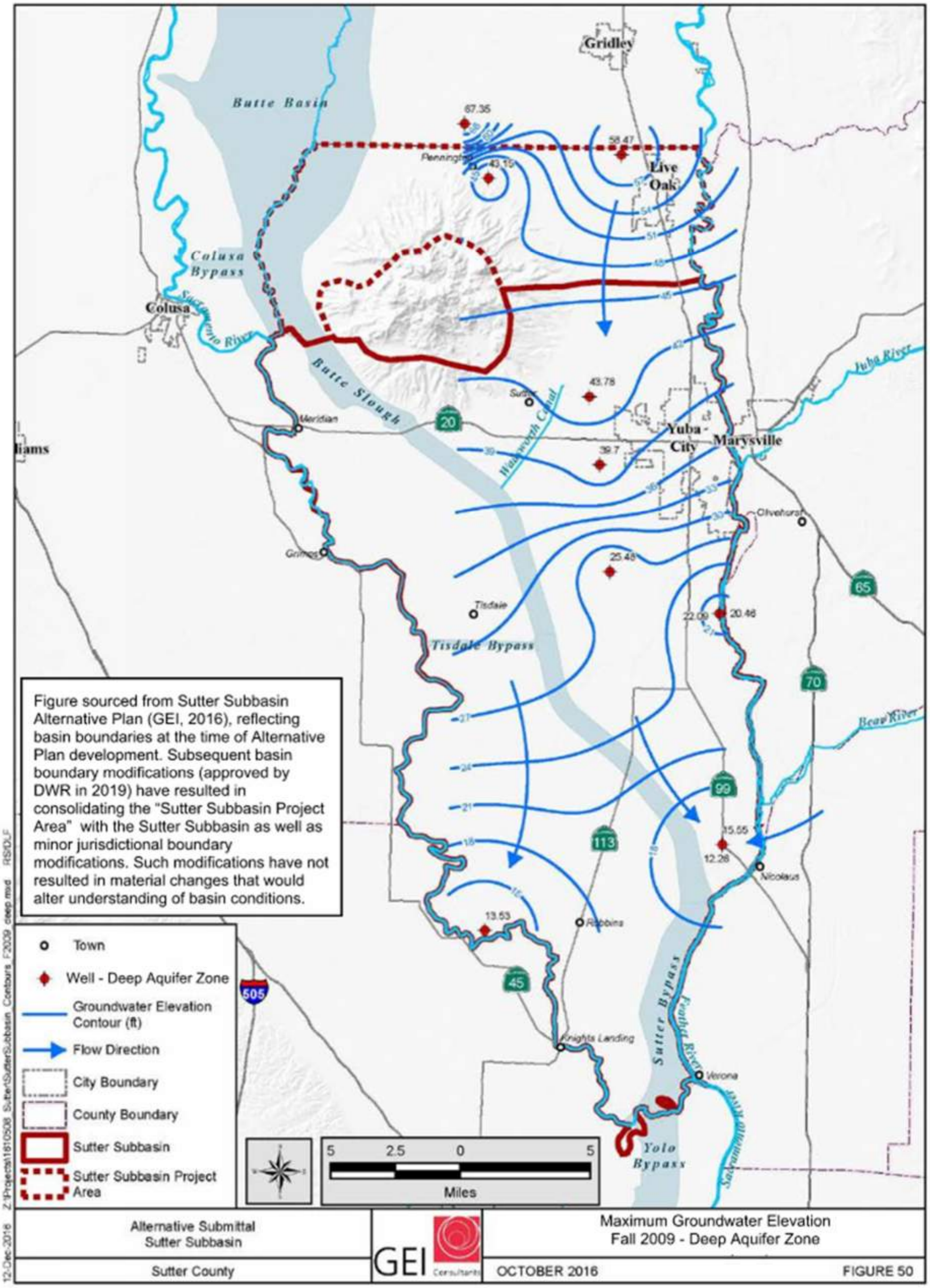


Figure 5-56. Groundwater Elevation in Deep Aquifer Zone, Fall 2009

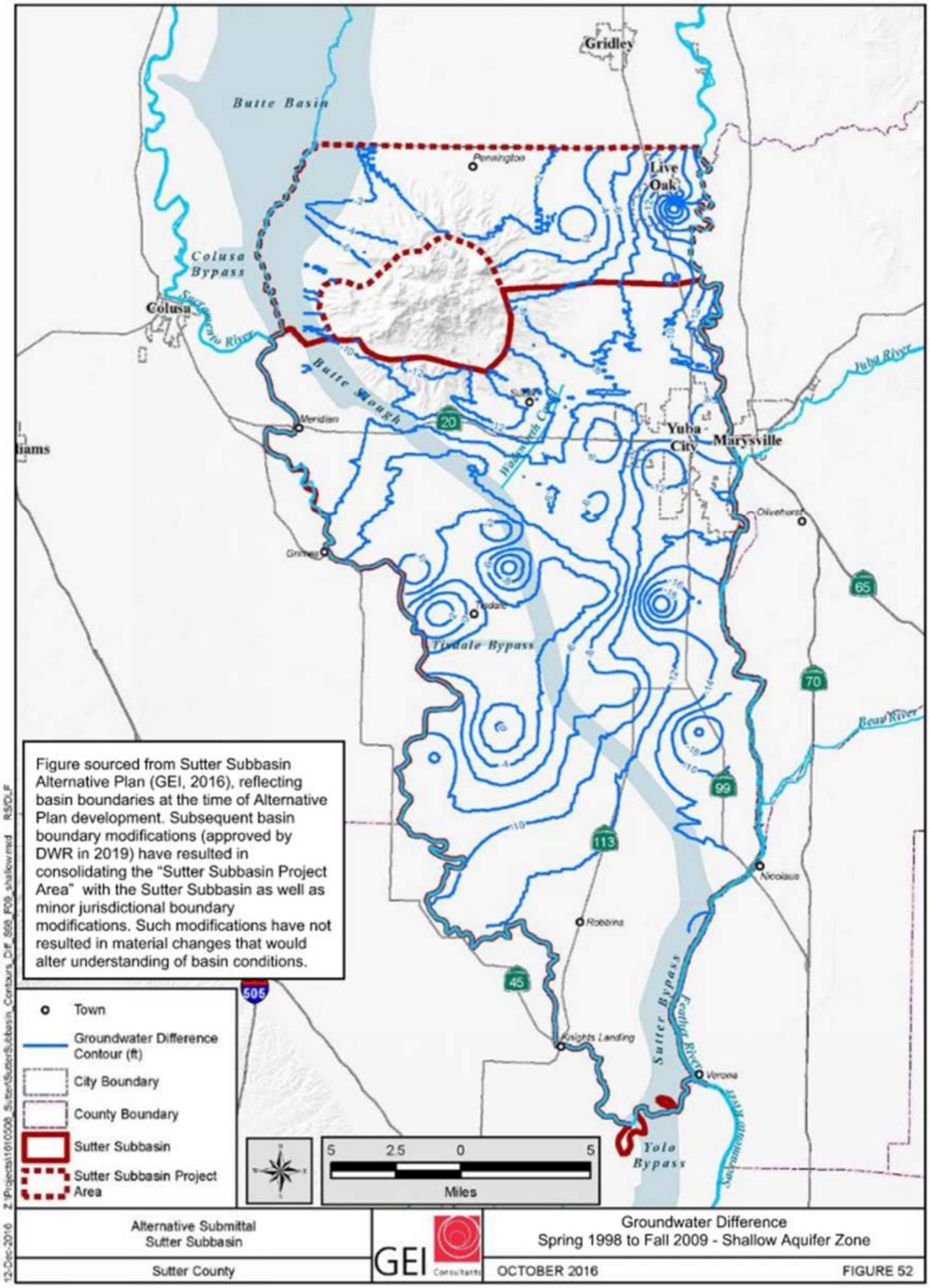


Figure 5-57. Difference in Groundwater Elevation in Shallow Aquifer Zone, Spring 1998 to Fall 2009

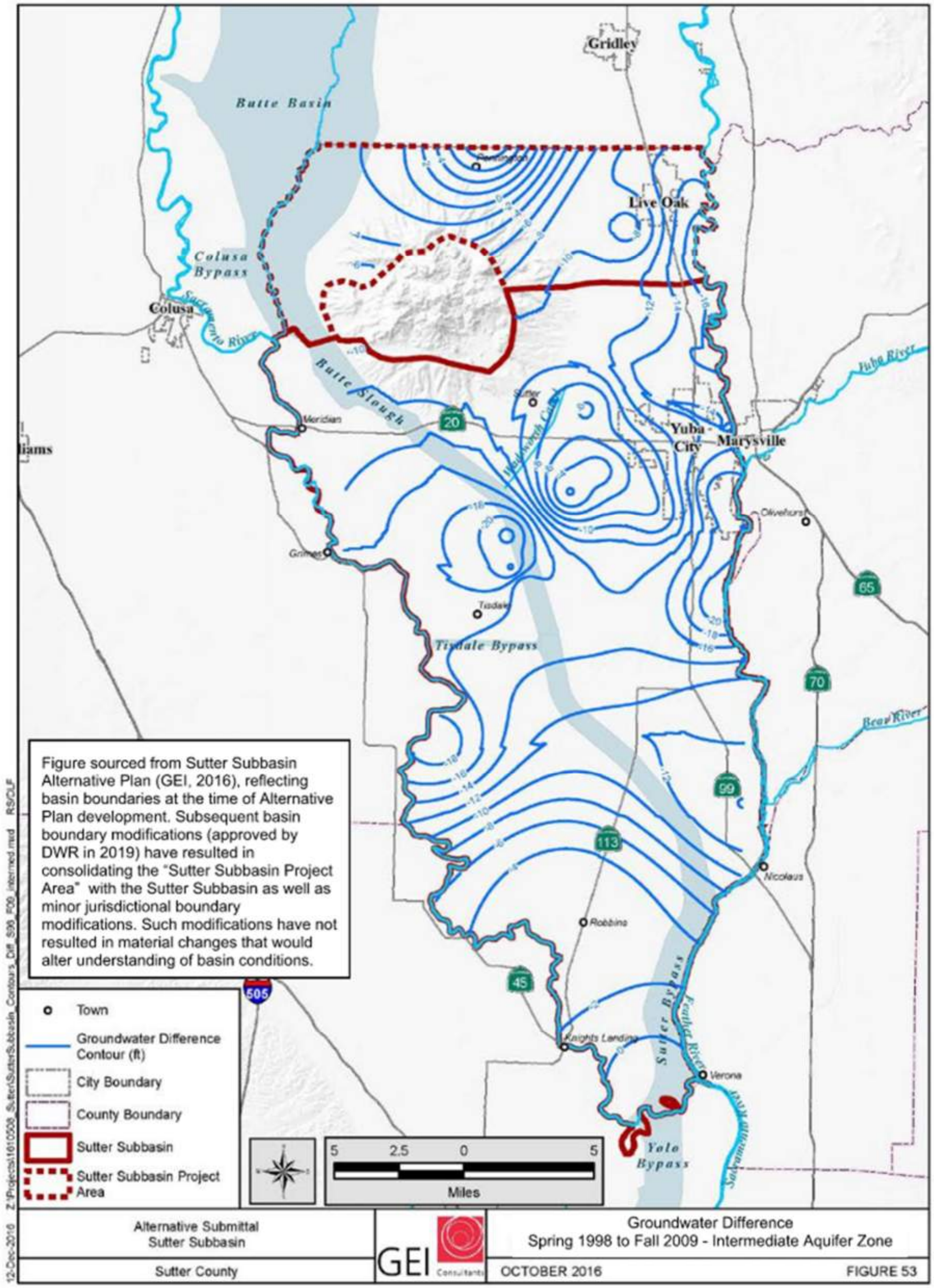


Figure 5-58. Difference in Groundwater Elevation in Intermediate Aquifer Zone, Spring 1998 to Fall 2009

Hydrographs depicting long-term groundwater elevations, historic highs and lows, and hydraulic gradients are shown in **Figure 5-59** through **Figure 5-68**. Groundwater elevations from nine nested wells with 33 perforation intervals with measurements ranging from 2004 through early 2021 are shown. Shallow groundwater levels, largely within the shallow aquifer zone (AZ-1), are relatively stable over time and indicate that most groundwater production is occurring below this zone. More groundwater appears to be produced from the deeper aquifer zones (deeper portion of AZ-1 as well as the intermediate [AZ-2] and deep [AZ-3] aquifer zones) as indicated by large fluctuations in groundwater elevations where responses to groundwater pumping are observed (drawdown) with rebound following the irrigation season as the aquifer recharges and returns to pre-pumping levels on a seasonal basis. Overall, groundwater level trends are largely flat over time, indicating sustainable conditions in the Sutter Subbasin as the aquifer rebound is observed during all water year types.

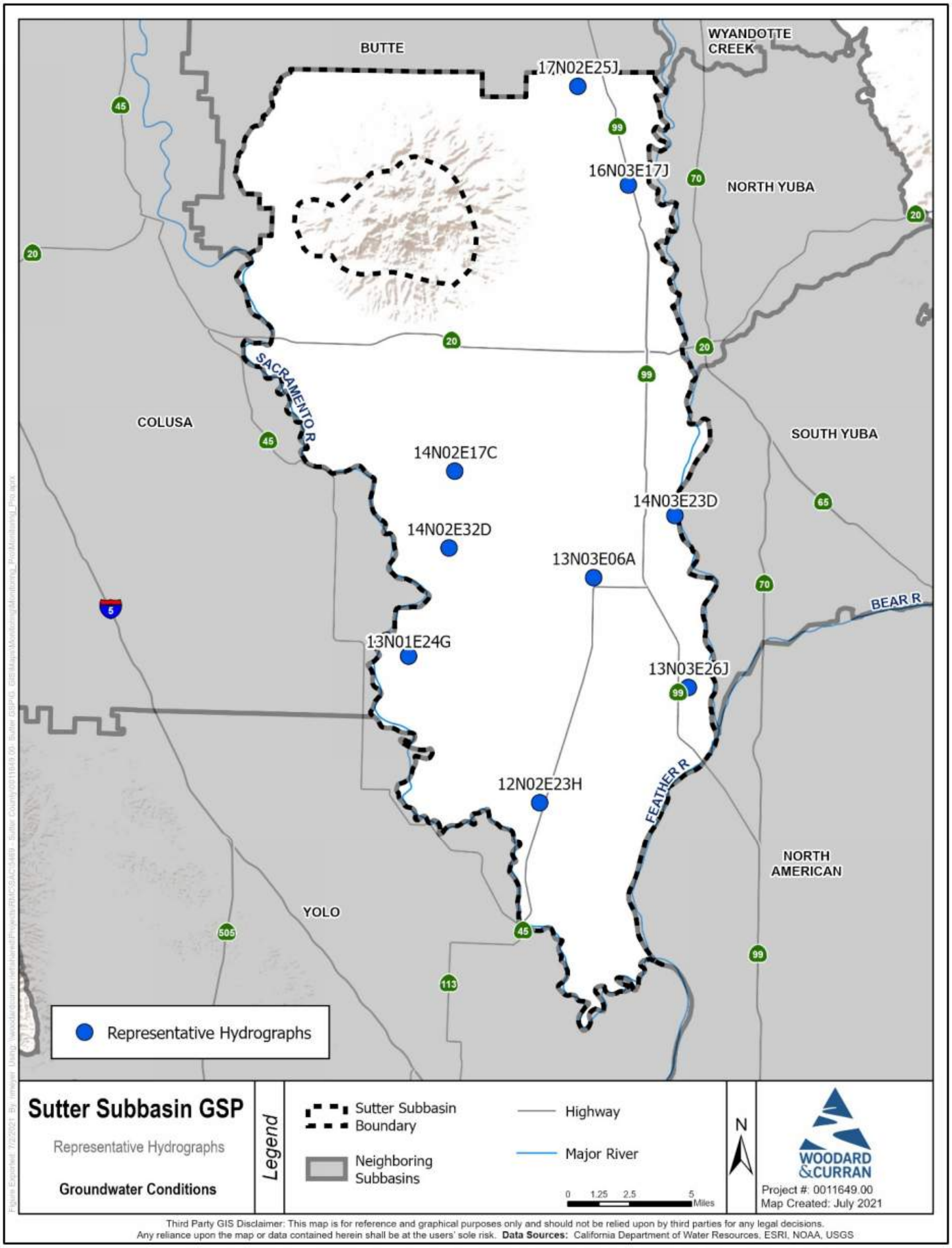


Figure 5-59. Representative Hydrograph Locations

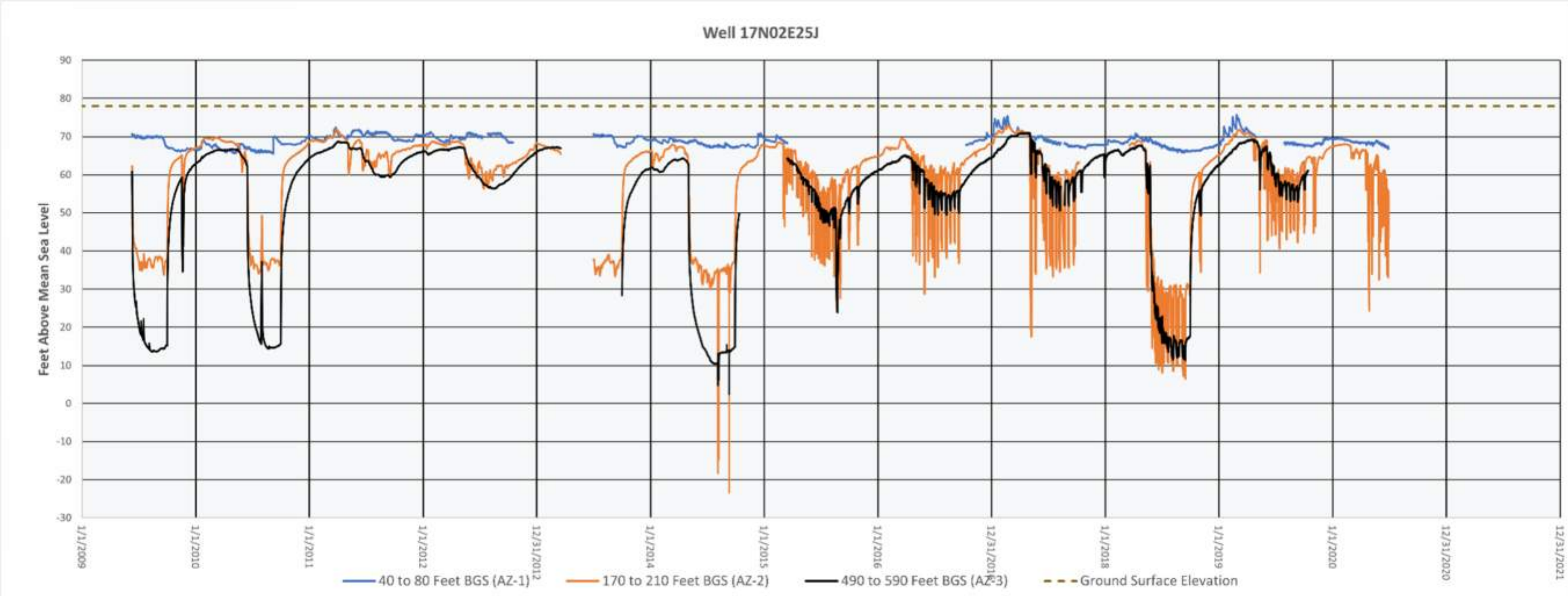


Figure 5-60. Well 17N02E25J Hydrograph

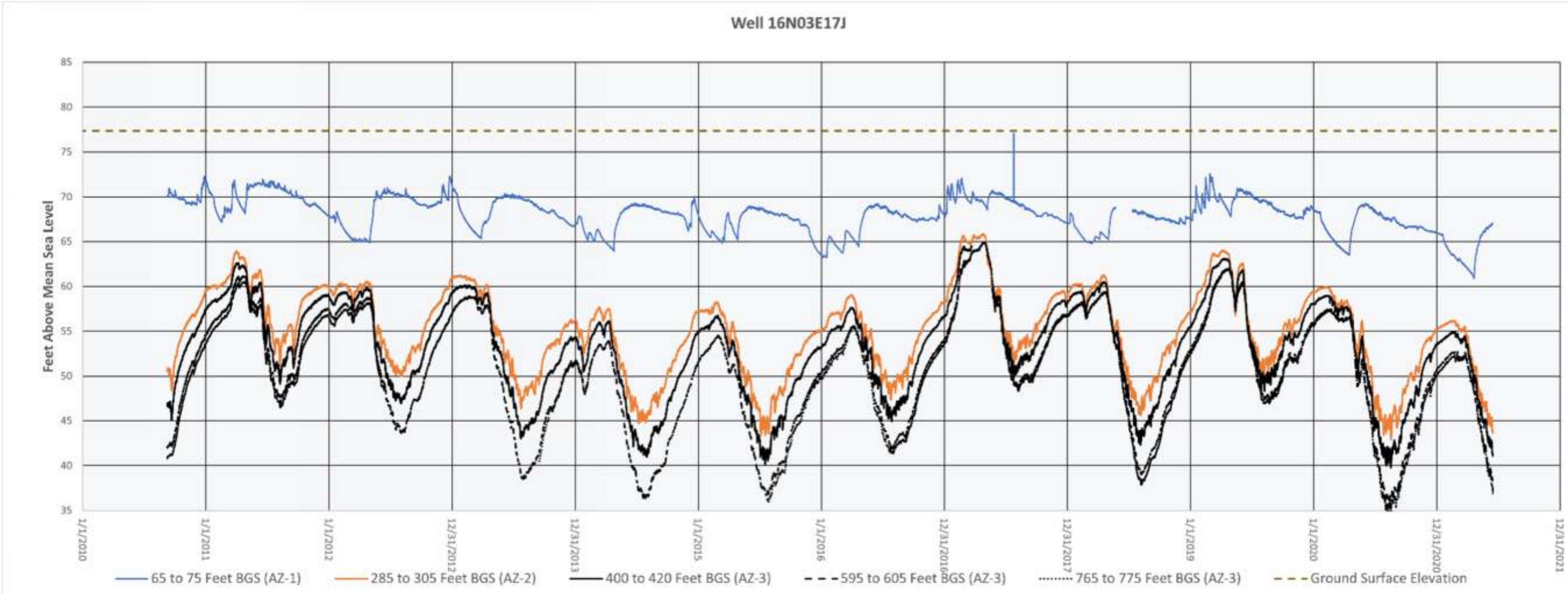


Figure 5-61. Well 16N03E17J Hydrograph

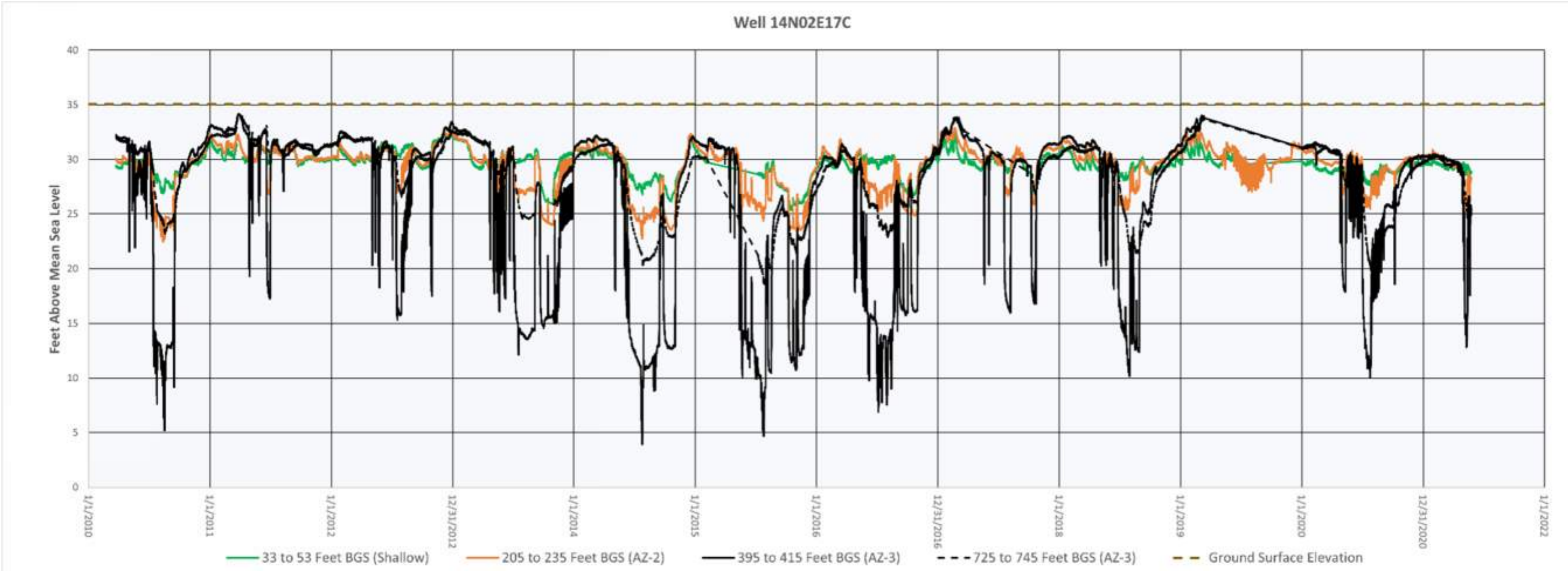


Figure 5-62. Well 14N02E17C Hydrograph

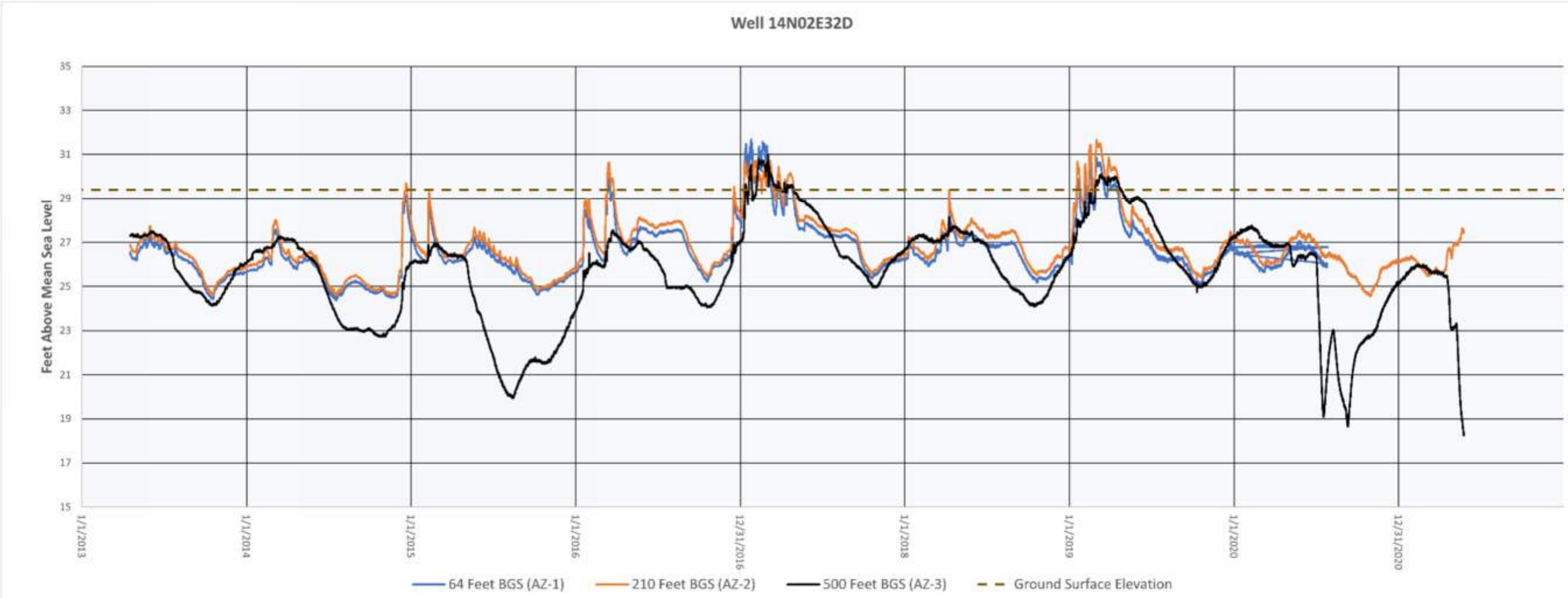


Figure 5-63. Well 14N02E32D Hydrograph

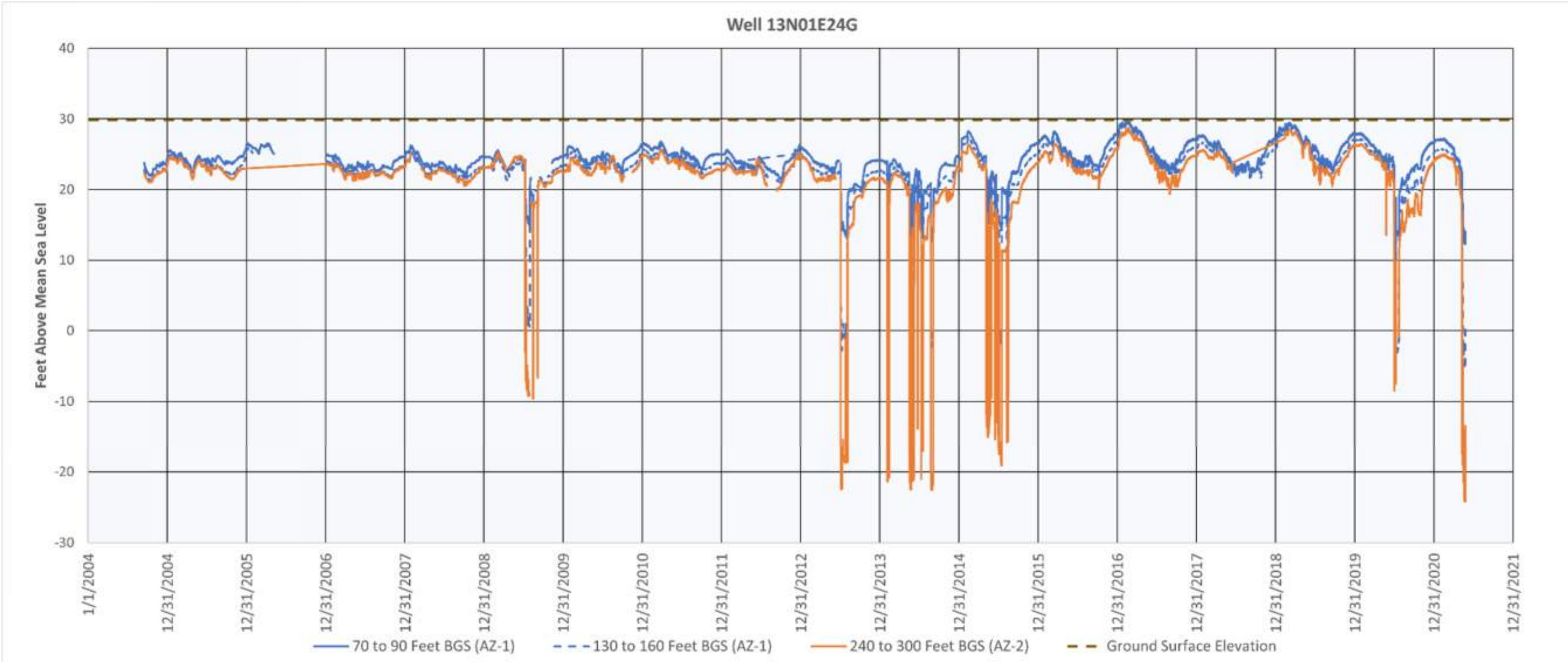


Figure 5-64. Well 13N01E24G Hydrograph

Figure 5-65. Well 13N03E06A Hydrograph

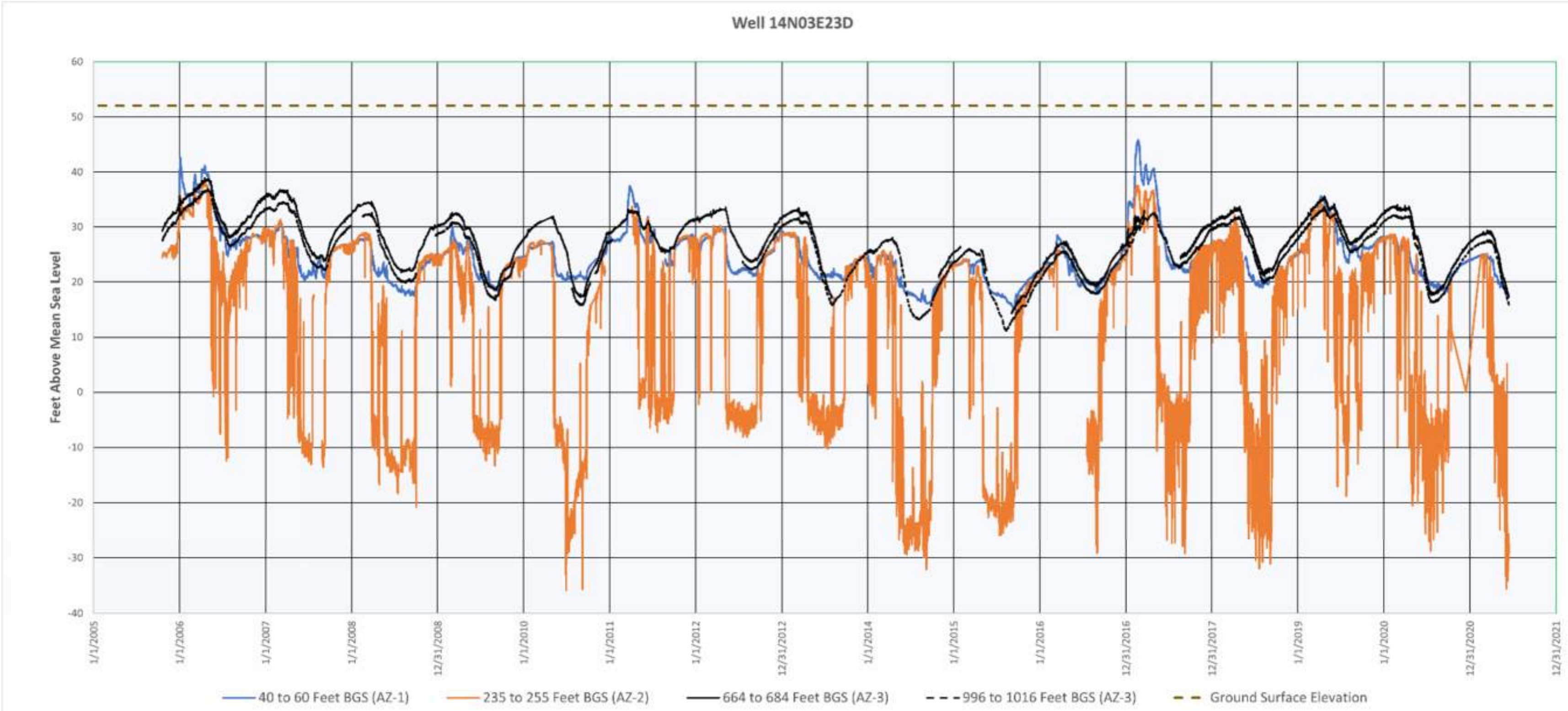


Figure 5-66. Well 14N03E23D Hydrograph

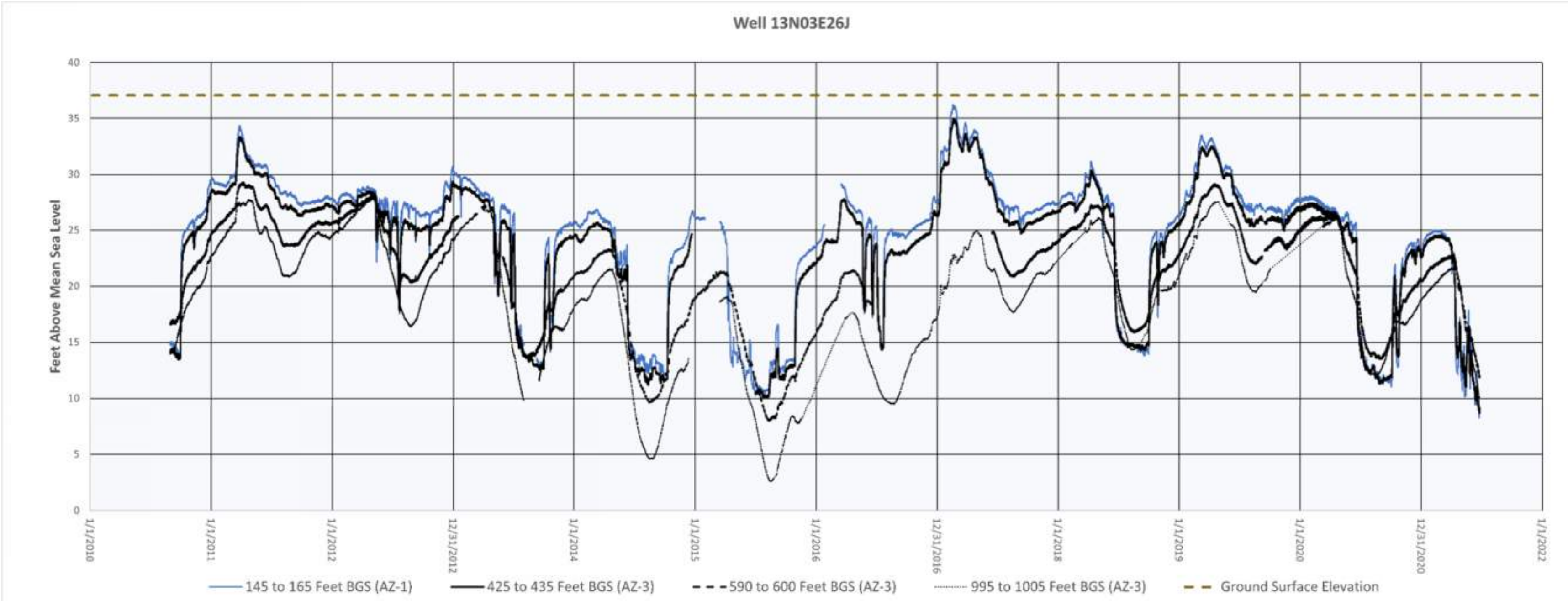


Figure 5-67. Well 13N03E26J Hydrograph

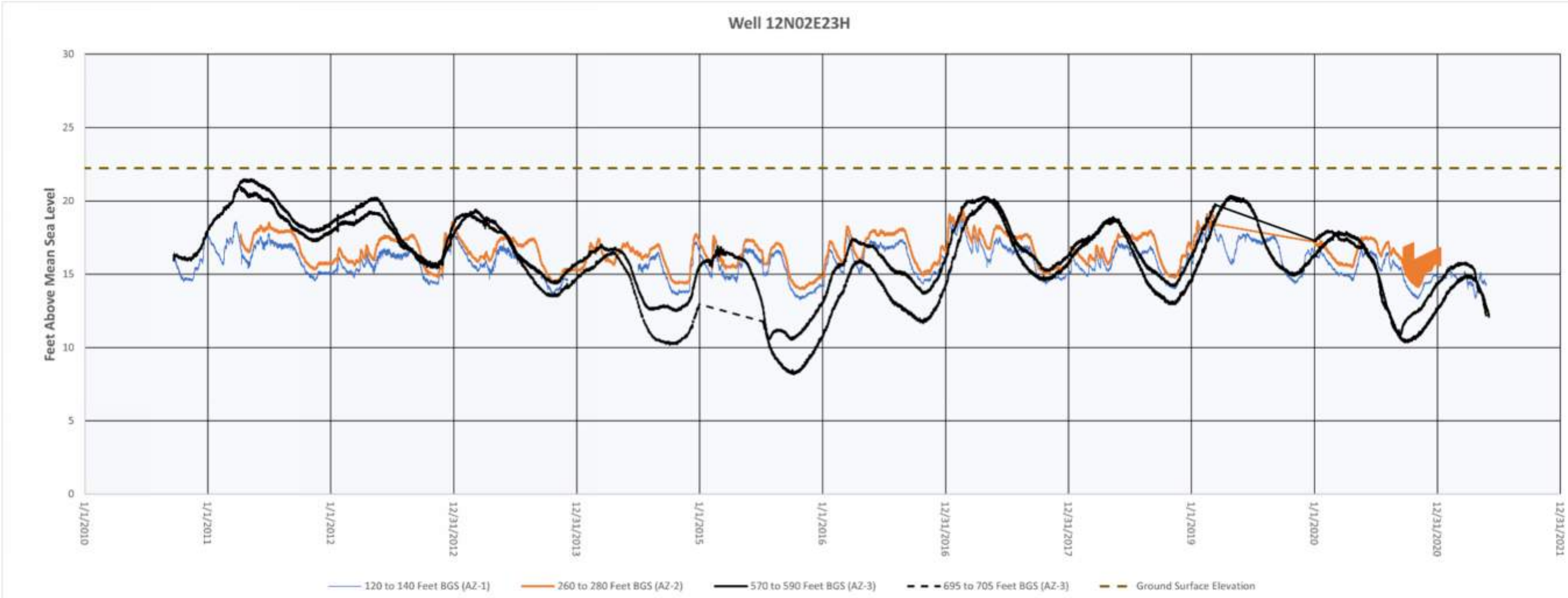


Figure 5-68. Well 12N02E23H Hydrograph

This page intentionally left blank.

5.2.2.2 Current Conditions

As previously noted, WY 2013 was selected to represent "current conditions" as it is the most recent year with complete data considered "normal" in terms of water use (not heavily impacted by drought or wet conditions). Groundwater elevation contour maps for March 2013, representing seasonal high conditions, are shown in **Figure 5-69** through **Figure 5-72**. Groundwater elevation contour maps for October 2013, representing seasonal low conditions following the end of WY 2013, are shown in **Figure 5-73** through **Figure 5-76**. Maps are presented for the following aquifer zones, which together comprise a single principal aquifer:

- **Shallow Aquifer Zone**– up to 50 feet bgs
- **AZ-1** – between 50 feet and 150 feet bgs
- **AZ-2** – between 150 feet and 400 feet bgs
- **AZ-3** – deeper than 400 feet bgs

During March 2013, limited data were available for the Shallow Aquifer Zzone. Based on data that are available, groundwater elevations ranging from 40 to 60 feet above MSL and groundwater flows from east to west directly south of the Sutter Buttes (**Figure 5-69**). Groundwater elevations in AZ-1 range from 20 to 70 feet above MSL (**Figure 5-70**), and between 20 and 60 feet above MSL in AZ-2 (**Figure 5-71**) and AZ-3 (**Figure 5-72**) with flow in the general north to south direction in all three AZs.

During October 2013, limited data are available in the Shallow Aquifer Zone, with groundwater elevations ranging from 40 to 50 feet above MSL and groundwater flowing from east to west directly south of the Sutter Buttes, similar to March 2013 (**Figure 5-73**). In AZ-1, groundwater elevations are approximately 10 feet lower in October 2013 as compared to March 2013, ranging from 10 to 60 feet above MSL with similar flow patterns as March 2013 (**Figure 5-74**). Groundwater elevations in AZ-2 range from 20 to 40 feet above MSL in October 2013, with the highest elevation approximately 20 feet lower than in March 2013 and flowing in the southerly direction (**Figure 5-75**). In AZ-3, groundwater elevations range from 10 to 40 feet above MSL, with the lowest elevation approximately 10 feet lower and the highest elevation approximately 20 feet lower as compared to March 2013 measurements; groundwater follows a similar general flow patterns observed in October 2013 as in March 2013 (**Figure 5-76**).

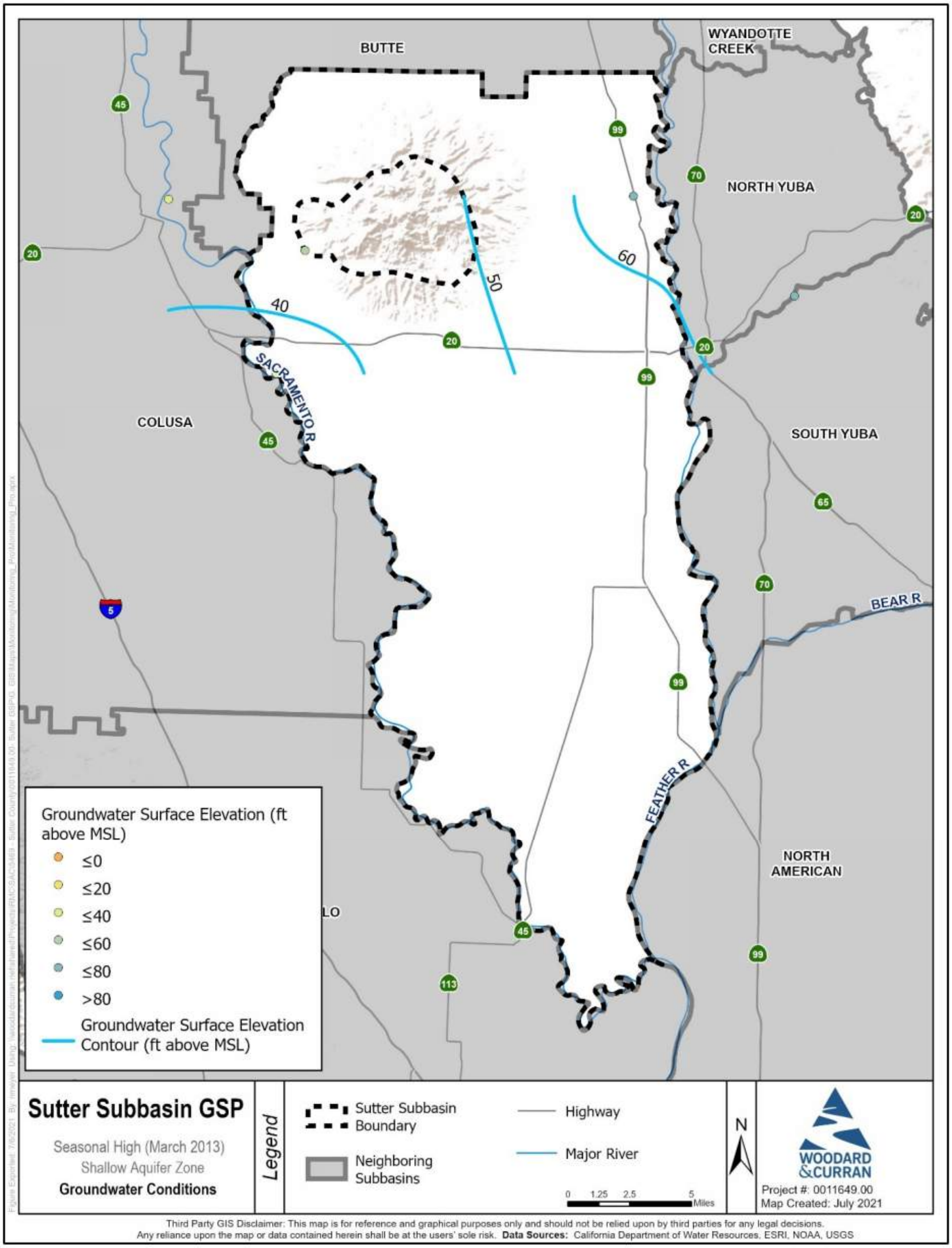


Figure 5-69. March 2013 Groundwater Elevations, Shallow Aquifer Zone

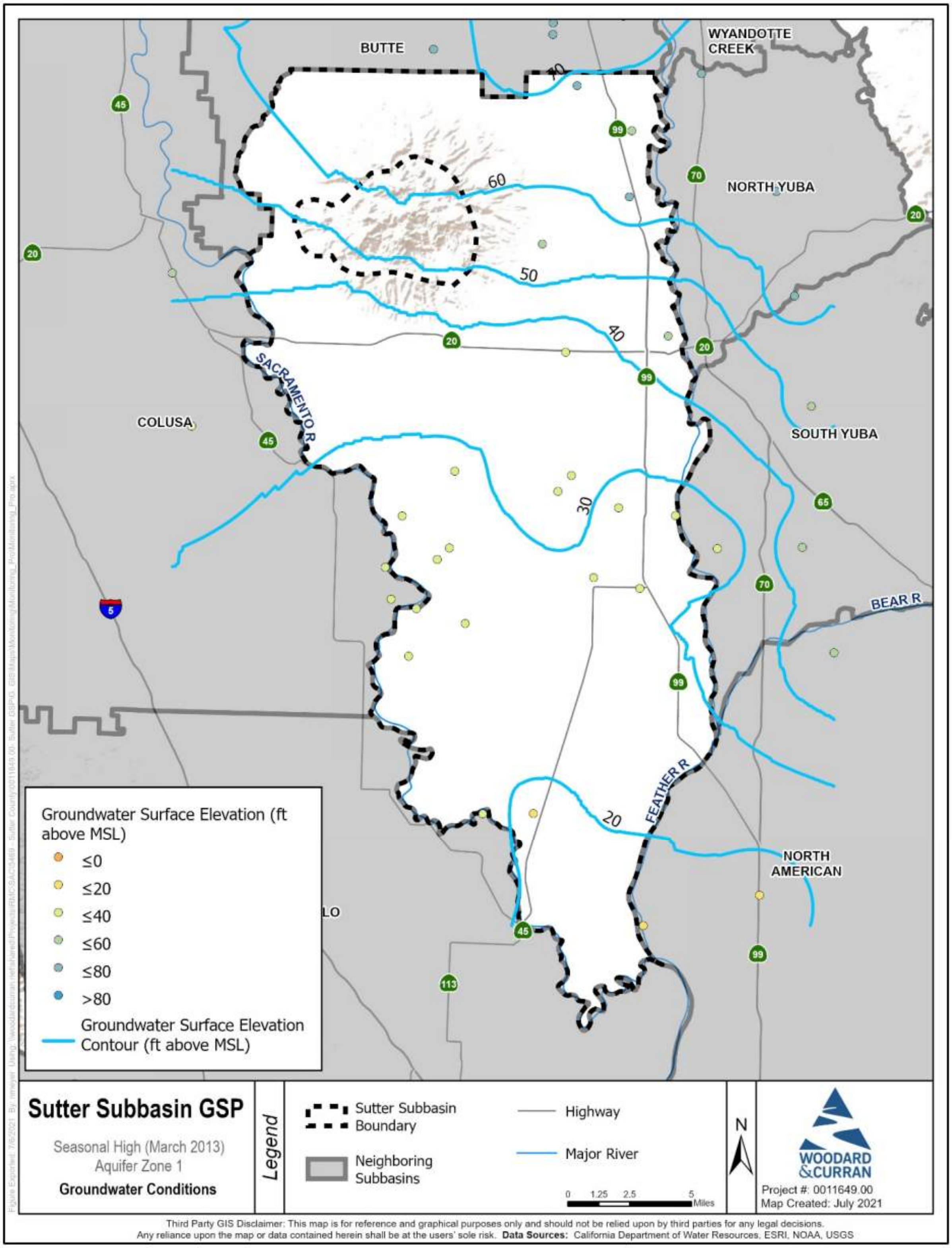


Figure 5-70. March 2013 Groundwater Elevations, AZ-1

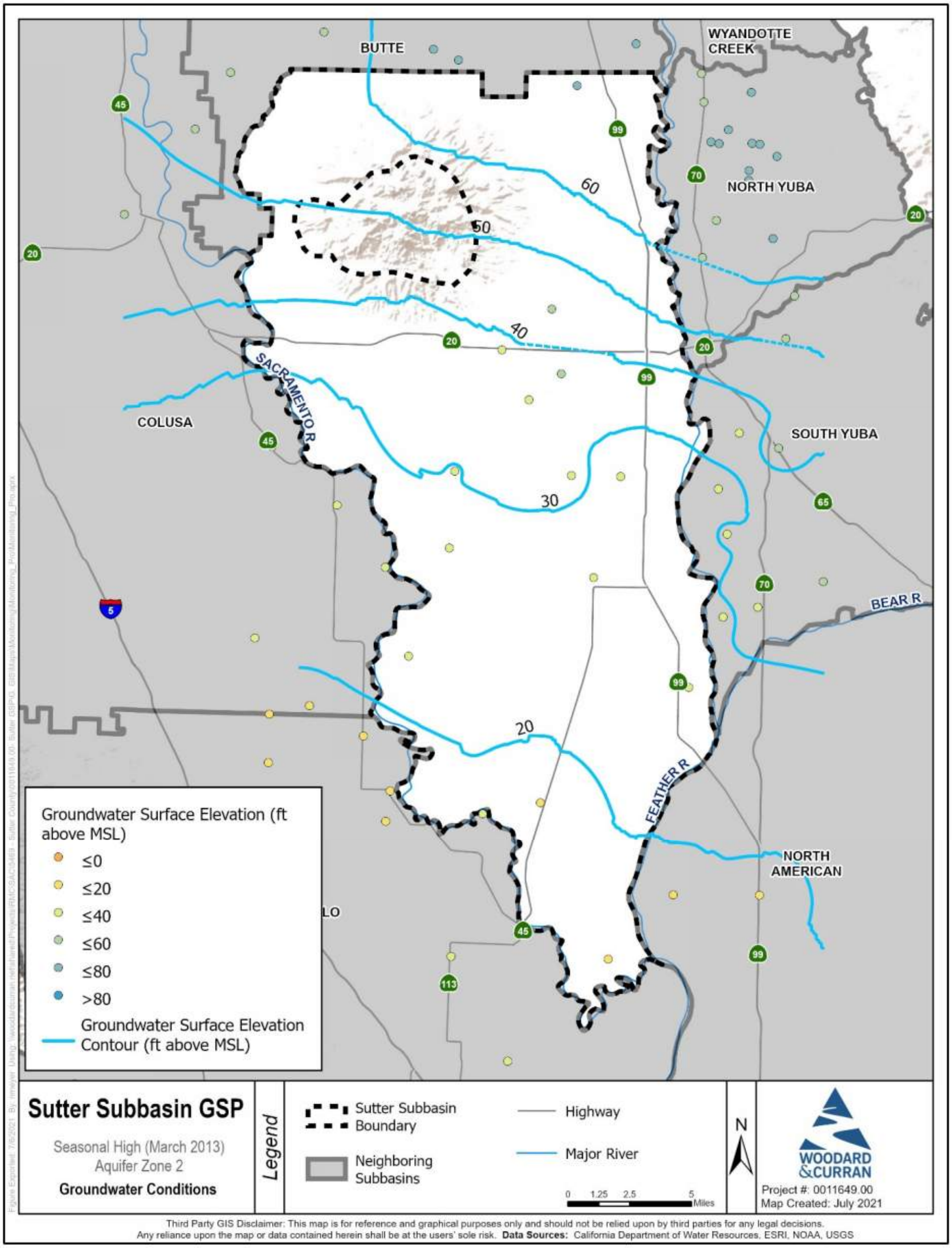


Figure 5-71. March 2013 Groundwater Elevations, AZ-2

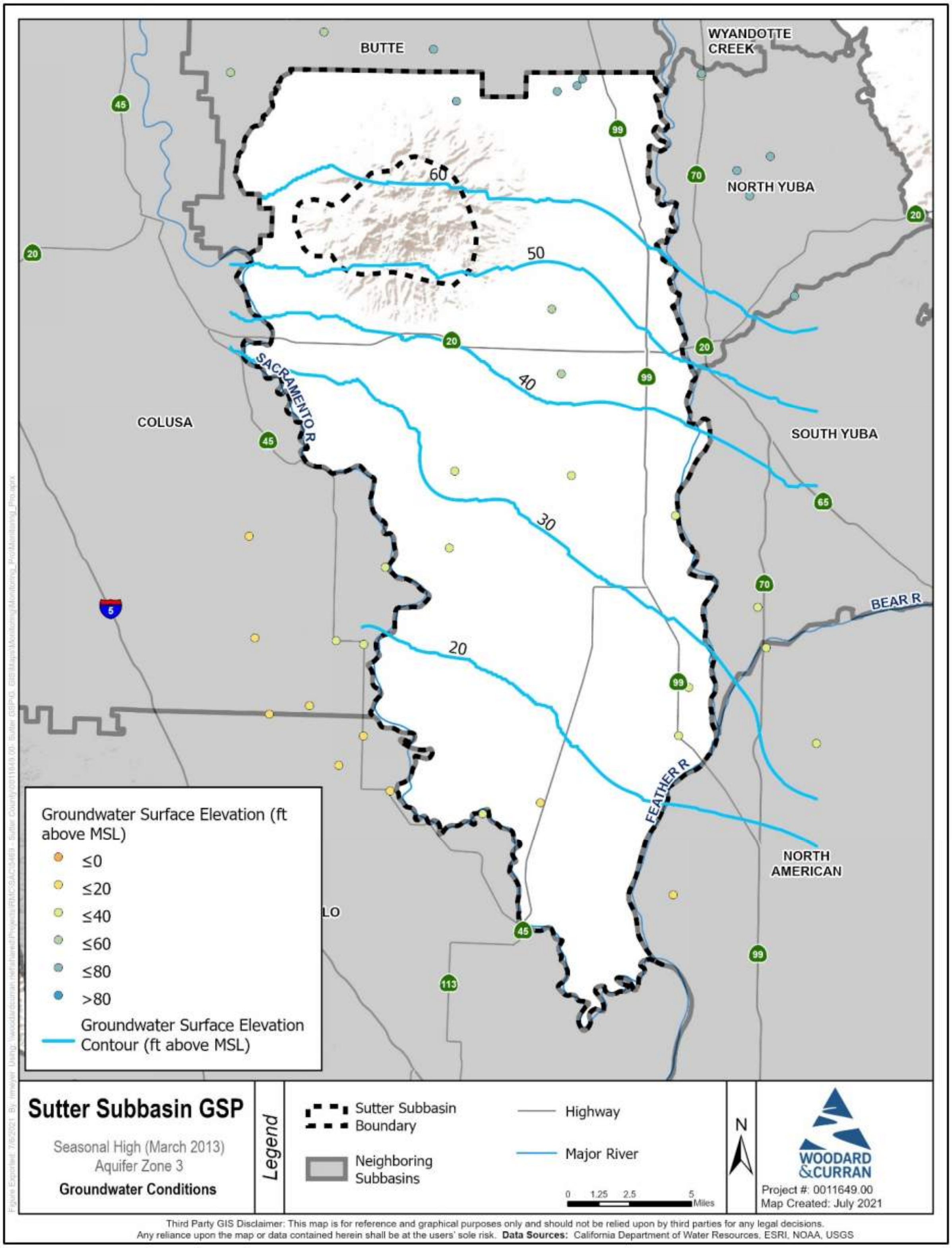


Figure 5-72. March 2013 Groundwater Elevations, AZ-3

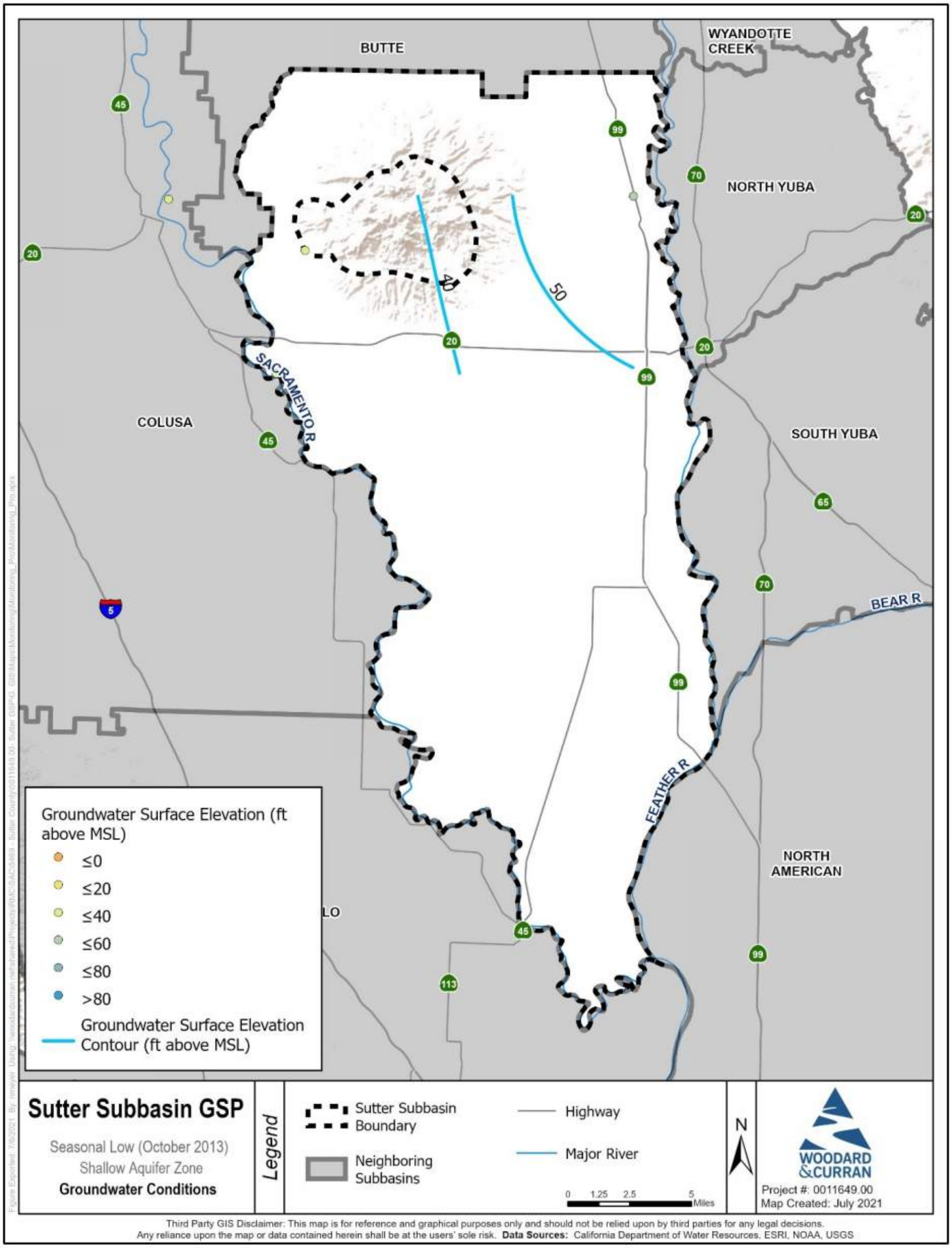


Figure 5-73. October 2013 Groundwater Elevations, Shallow Aquifer Zone

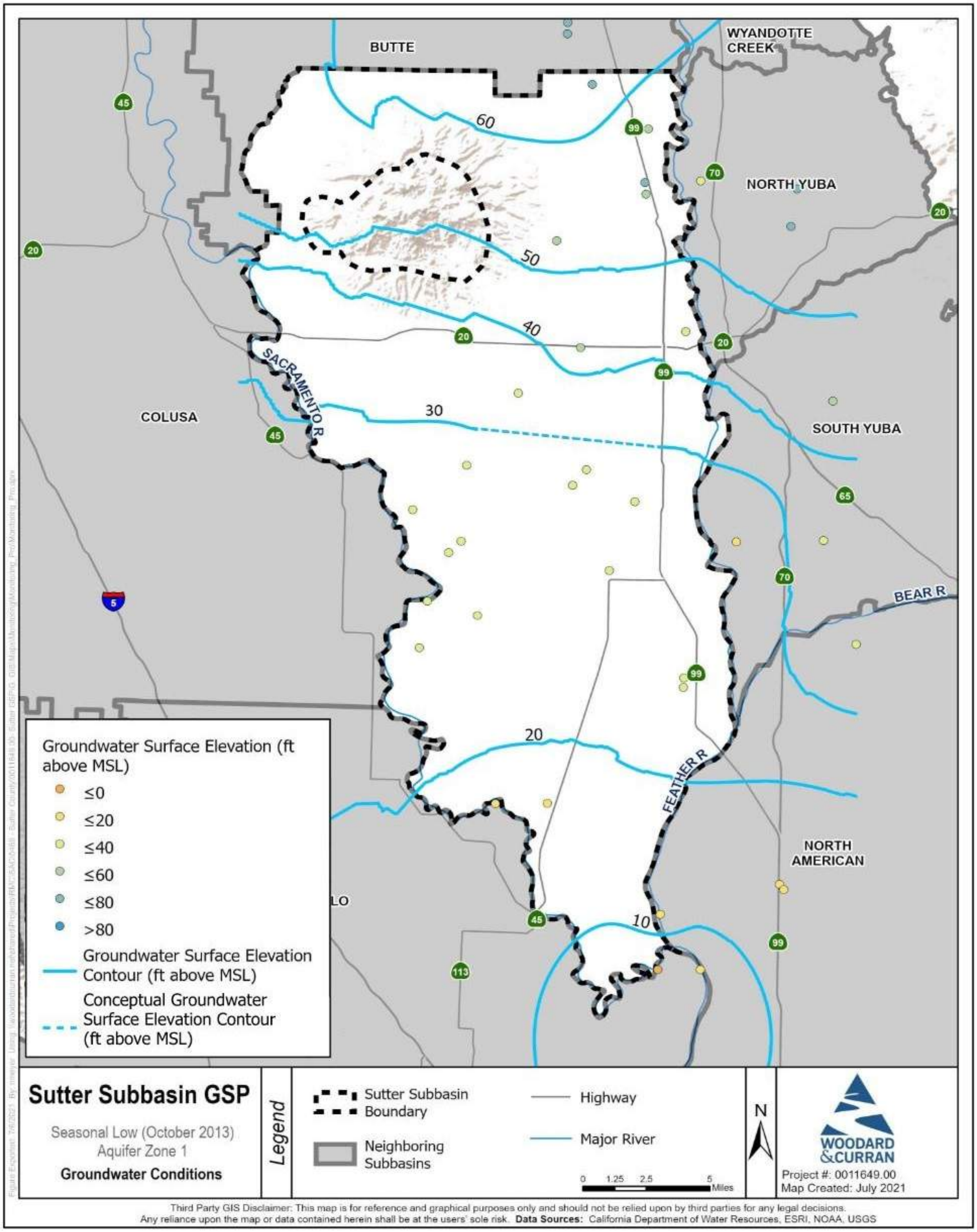


Figure 5-74. October 2013 Groundwater Elevations, AZ-1

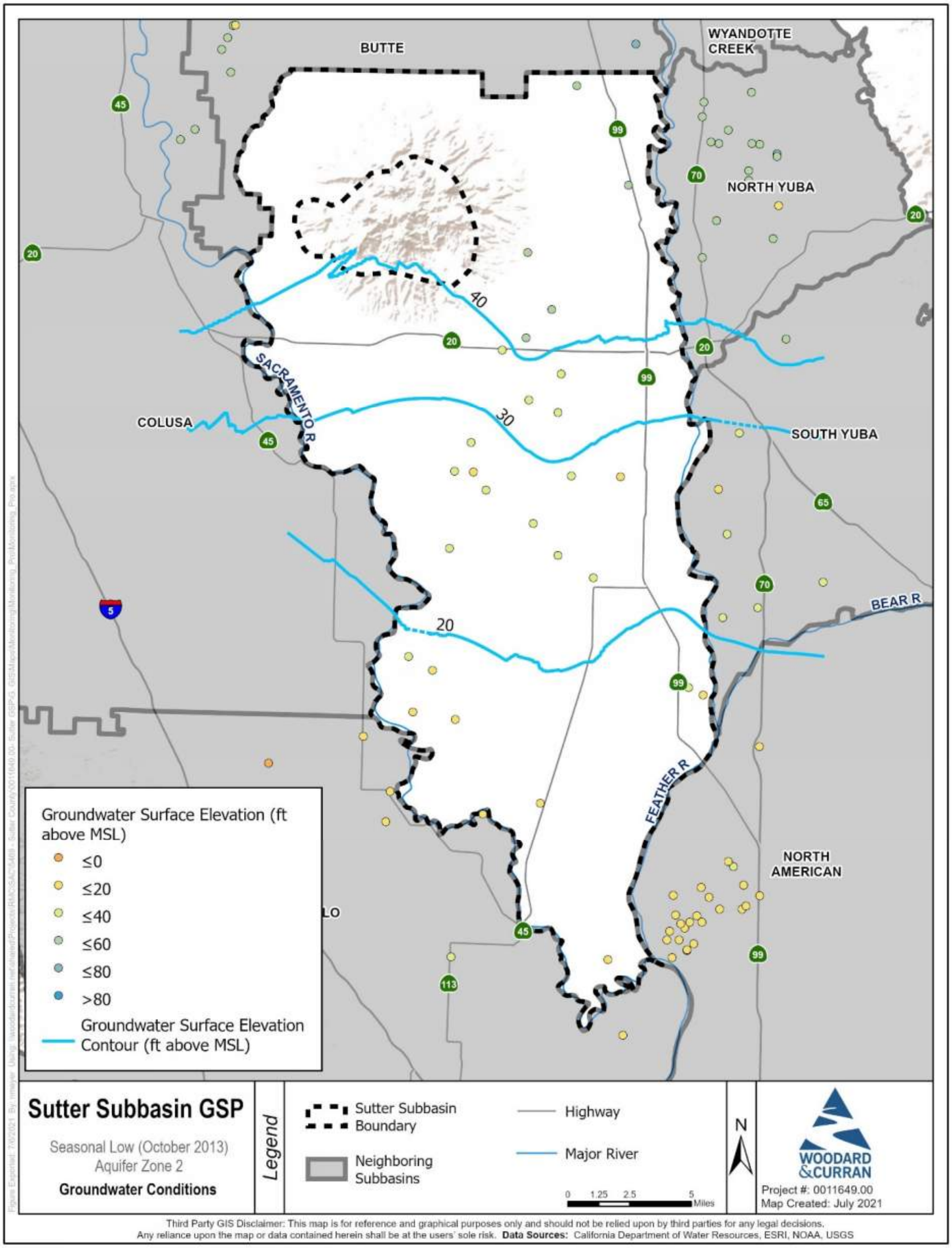


Figure 5-75. October 2013 Groundwater Elevations, AZ-2

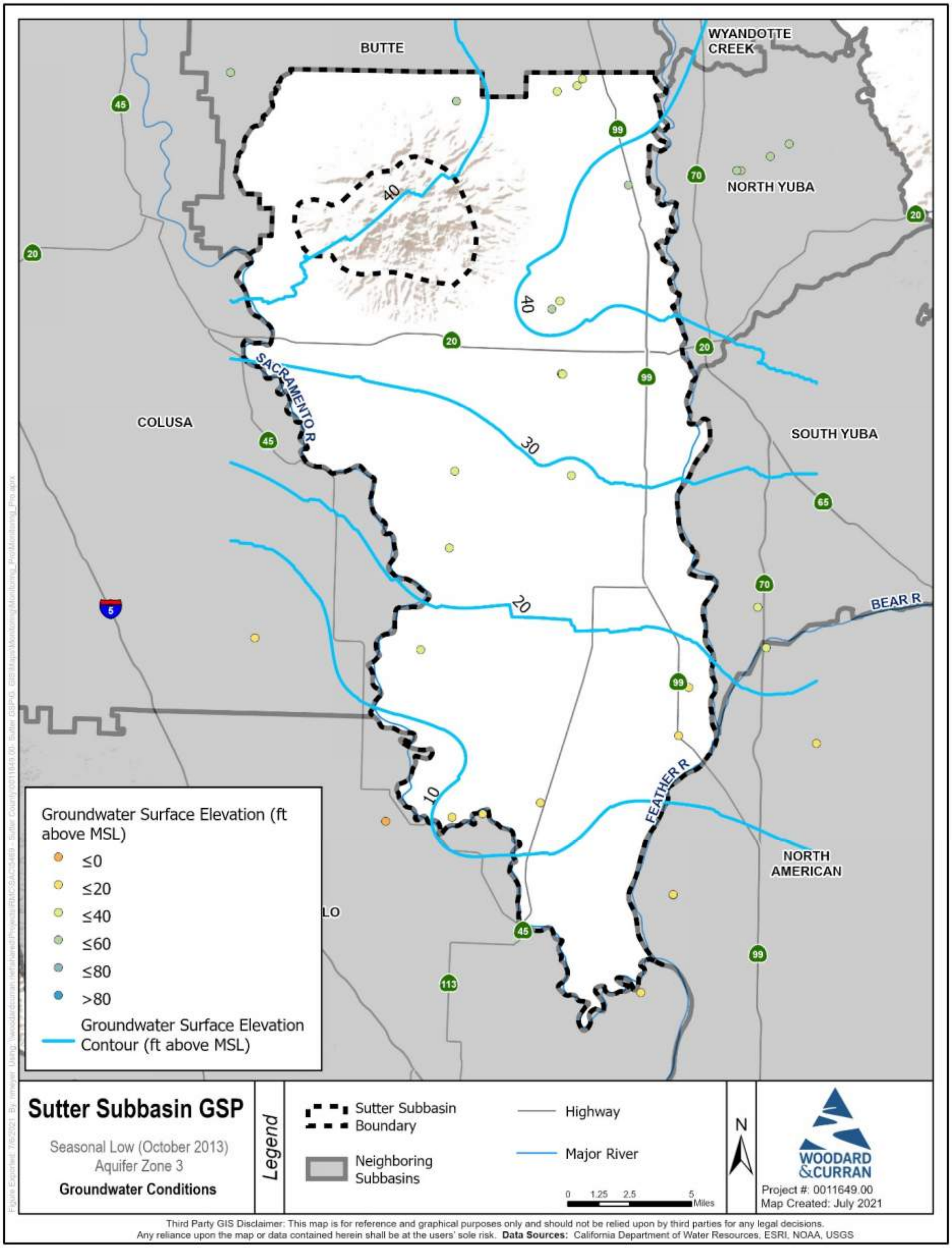


Figure 5-76. October 2013 Groundwater Elevations, AZ-3

Figure 5-77 through **Figure 5-79** present available groundwater elevation contour maps for Fall 2015 in the shallow (AZ-1), intermediate (AZ-2), and deep (AZ-3) aquifer zones, respectively, representing seasonal low groundwater elevations during a Critical year (as classified by the Sacramento Water Year Index). In the shallow aquifer zone (defined in this figure, **Figure 5-77**, as being between the ground surface and a depth of about 50 feet bgs nearest the Sutter Buttes, and to a depth of about 150 to 190 feet bgs at wells furthest from the Sutter Buttes), groundwater elevations range from 18 to 66 feet above MSL with pumping depressions mostly observed along the central portion of the eastern Subbasin boundary. Within the intermediate aquifer (defined in this figure, **Figure 5-78**, as being between 150 to 400 feet bgs), groundwater elevations range from 63 feet below MSL to 57 feet above MSL with a cone of depression observed along the central portion of the eastern Subbasin boundary causing a reversal of groundwater flow from west to east. In the deep aquifer (defined in this figure, **Figure 5-79**, as being at depths below 400 feet bgs), groundwater elevations range from 3 feet below MSL to 54 feet above MSL with a cone of depression observed along the central portion of the western boundary of the Subbasin.

Compared to Fall 2009 groundwater levels, as presented in **Figure 5-54** through **Figure 5-56**:

- **Shallow Aquifer Zone** (defined in these figures as depths from ground surface to around 50 feet bgs near the Sutter Buttes and up to 190 feet bgs at wells distant from the Sutter Buttes) – Groundwater elevations were approximately 1 to 3 feet deeper during Fall 2015.
- **Intermediate Aquifer Zone** (defined in these figures as depths between 150 and 400 feet bgs) – Groundwater elevations were about 1 to 6 feet deeper during Fall 2015, with the exception of a pumping depression near the confluence of the Bear and Feather rivers observed in Fall 2015.
- **Deep Aquifer Zone** (defined in these figures as depths below 400 feet bgs) – Groundwater elevations were about 1 to 3 feet deeper during Fall 2015.

As previously stated, representative hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients (**Figure 5-59** through **Figure 5-68**) show similar trends post-WY 2013 as shown in the available historical record. Shallow groundwater levels, largely within AZ-1, are relatively stable over time. Higher amounts of groundwater production are observed during short periods of time in the deeper portion of AZ-1, as well as AZ-2 and AZ-3, with greater seasonal fluctuations during the 2012 to 2016 drought and seasonal rebound to pre-pumping levels still observed. Post-WY 2013 overall trends are similar to the overall historical trends.

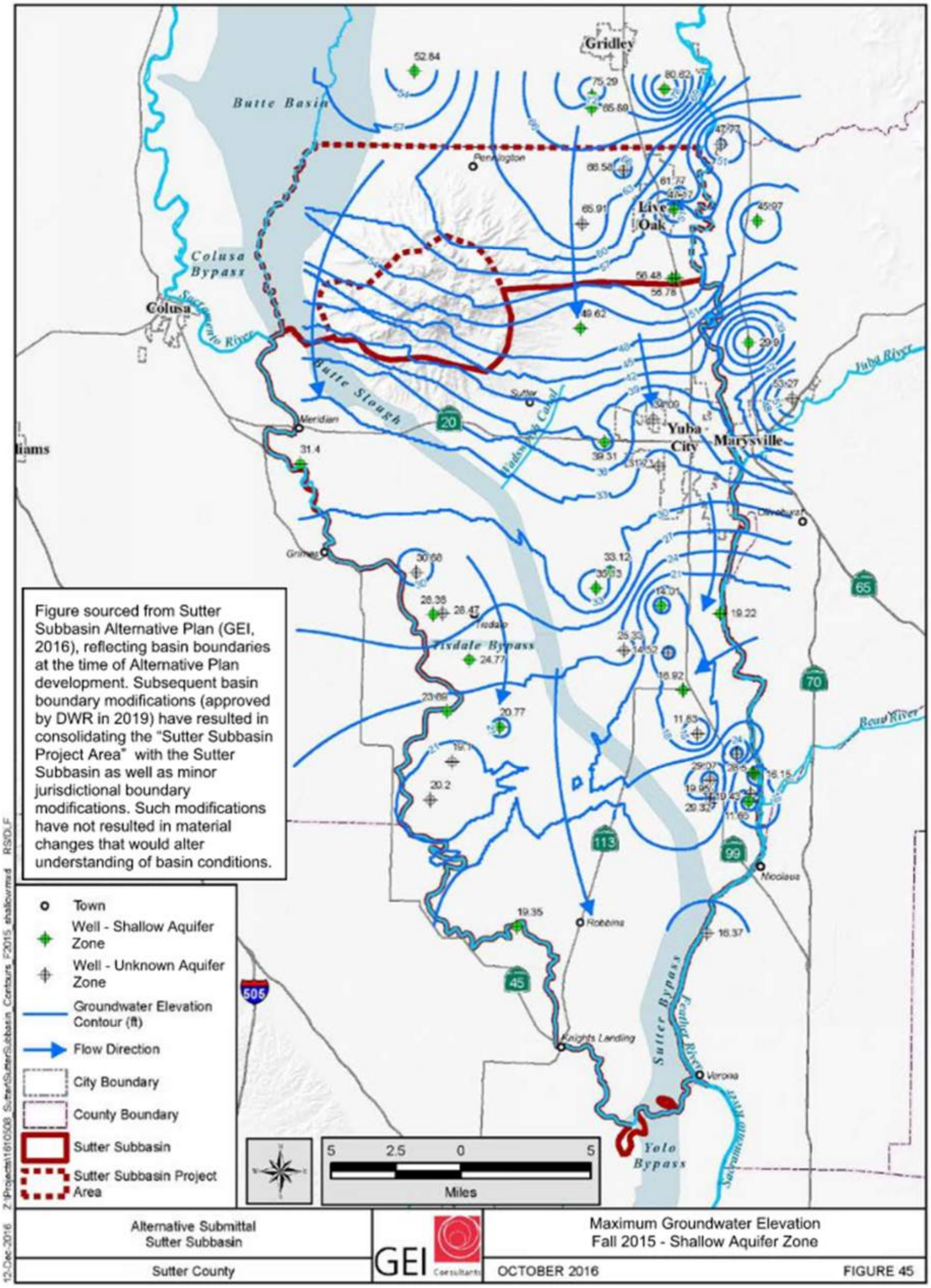


Figure 5-77. Groundwater Elevation in Shallow Aquifer Zone, Fall 2015

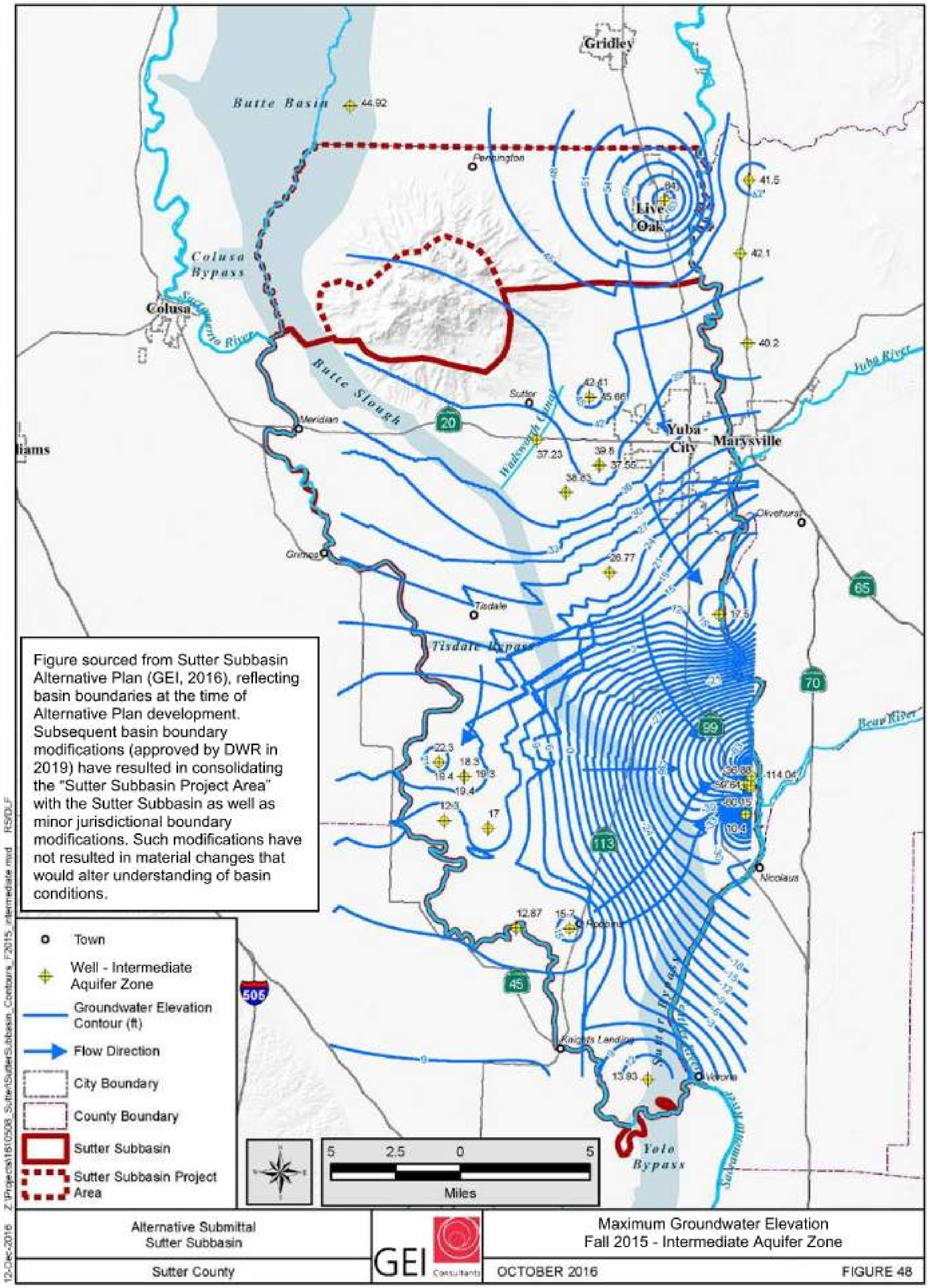


Figure 5-78. Groundwater Elevation in Intermediate Aquifer Zone, Fall 2015

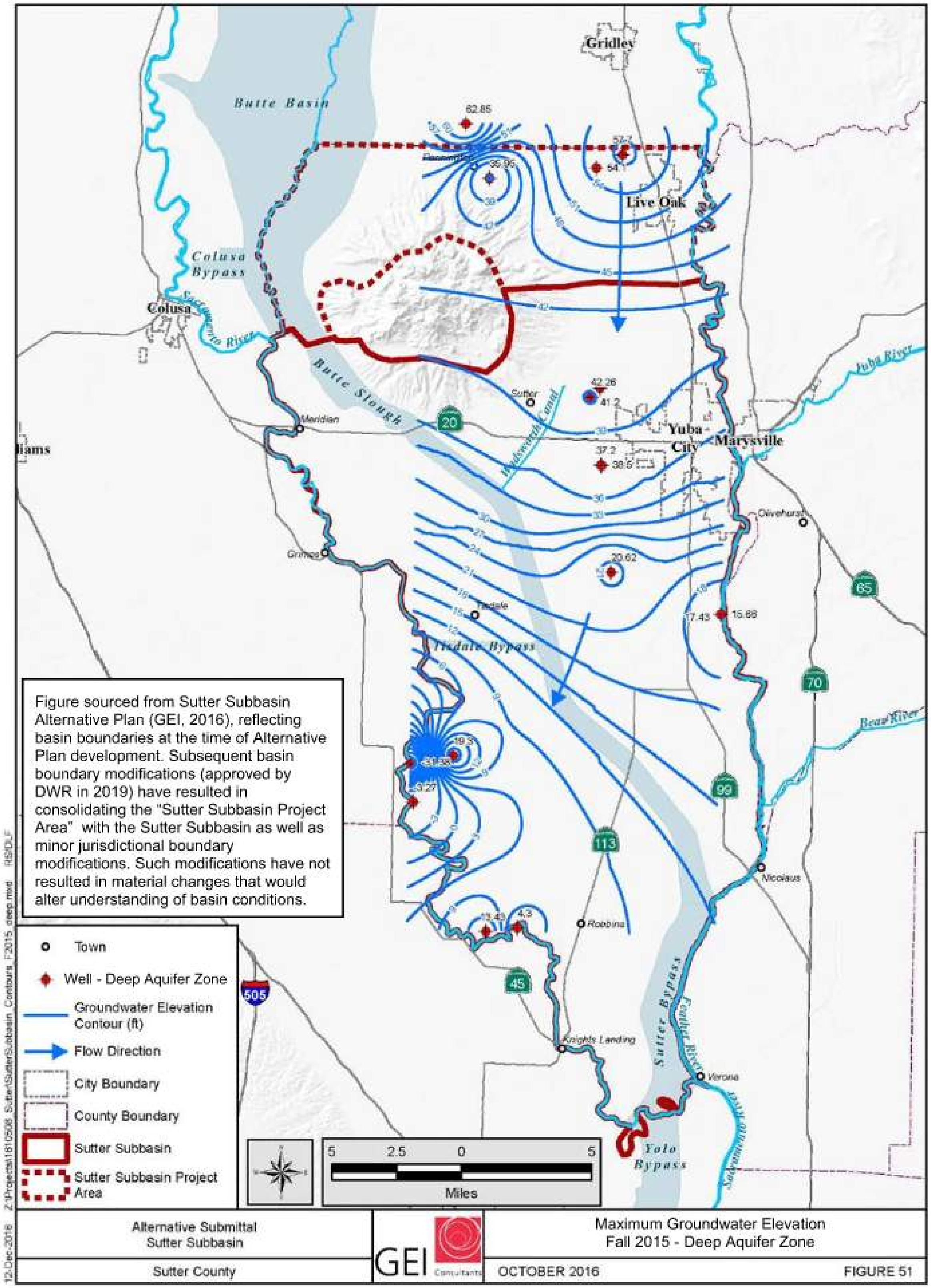


Figure 5-79. Groundwater Elevation in Deep Aquifer Zone, Fall 2015

5.2.2.3 Groundwater Trends

Hydrographs within the Sutter Subbasin show two distinct patterns, the first where groundwater levels in the shallowest portion of the principal aquifer (upper portion of AZ-1) are constantly higher than groundwater levels in the intermediate and deeper portions of the aquifer (deeper portion of AZ-1 as well as AZ-2 and AZ-3) indicating a downward gradient, and the second where groundwater levels in the deeper portion of the aquifer are higher than groundwater levels in the intermediate and shallow portion of the principal aquifer indicating an upward gradient. **Figure 5-80** shows where the upward and downward gradients occur. There is no distinct pattern as to where and when each of these patterns are observed within the Sutter Subbasin. The head differences are typically on the order of a few feet, but may be up to 10 to 20 feet during the summer months (GEI, 2016).

Upward gradients in the deeper portion of the aquifer appear to exist in the southern half of the Sutter Subbasin. In these areas, the base of fresh water is relatively shallow. Pumping in the deeper portion of the aquifer could reduce heads and allow migration of brackish water into the freshwater aquifer. The hydrographs show that pumping is occurring in AZ-3 (deeper than 400 feet bgs) and/or in wells that are screened across all aquifer zones as seasonal reversals of gradients are observed and groundwater levels decline in all of the aquifer zones.

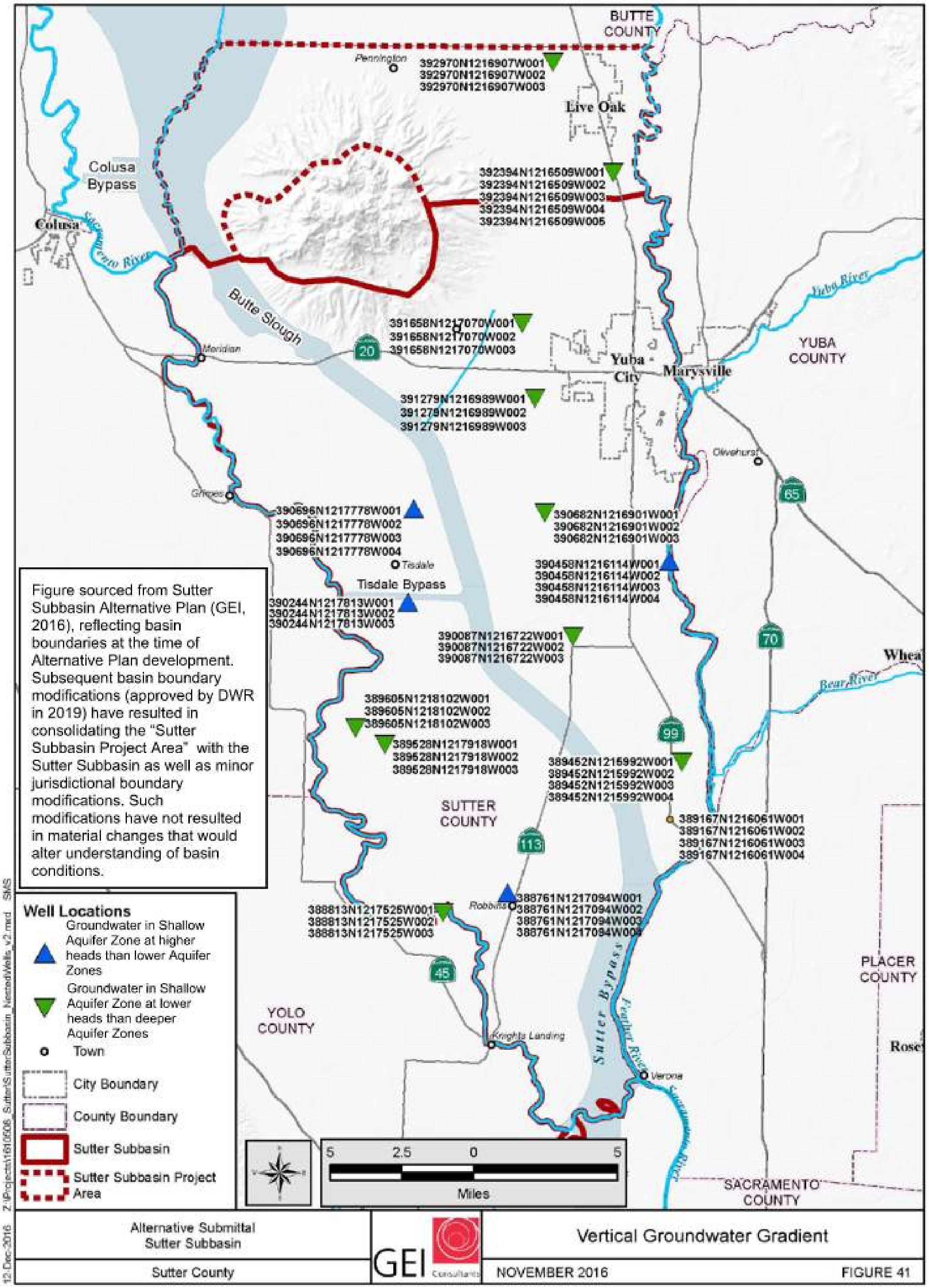


Figure 5-80. Vertical Groundwater Gradients

5.2.3 Groundwater Storage

As with groundwater levels, groundwater storage volumes in the Sutter Subbasin have been generally stable over at least the past 30 years (the length of available record). The volume of groundwater in storage increases as groundwater levels rise and decreases as groundwater levels fall; thus, stable groundwater level conditions also result in stable groundwater storage conditions. Change in storage volumes have been estimated for the Sutter Subbasin using C2VSimFG-Sutter integrated flow model. **Figure 5-81** shows annual (pink) and cumulative change in storage (black line) plotted together for WY 1986 to WY 2015 for all aquifer layers combined (i.e., for the entire principal aquifer). DWR's Sacramento Valley Water Year Type Index is indicated in parenthesis for each year where:

- "C" indicates a Critical Year
- "D" indicates a Dry Year
- "BN" indicates a Below Normal Year
- "AN" indicates an Above Normal Year
- "W" indicates a Wet Year

Annual total groundwater pumping is also plotted in grey (**Figure 5-81**). In drier years, more groundwater is pumped from the Subbasin, which results in reduction of groundwater available in storage (i.e., a negative change in storage bar and a downward sloping cumulative change in storage line). In wetter years, that storage reduction has typically replenished as pumping is reduced (i.e., a positive change in storage bar and an upward sloping cumulative change in storage line). The total available groundwater in storage in the Subbasin was estimated by C2VSimFG-Sutter to be approximately 49 million acre-feet (MAF). Details on the use of C2VSimFG-Sutter for water budgeting purposes is further discussed in **Section 5.3**.

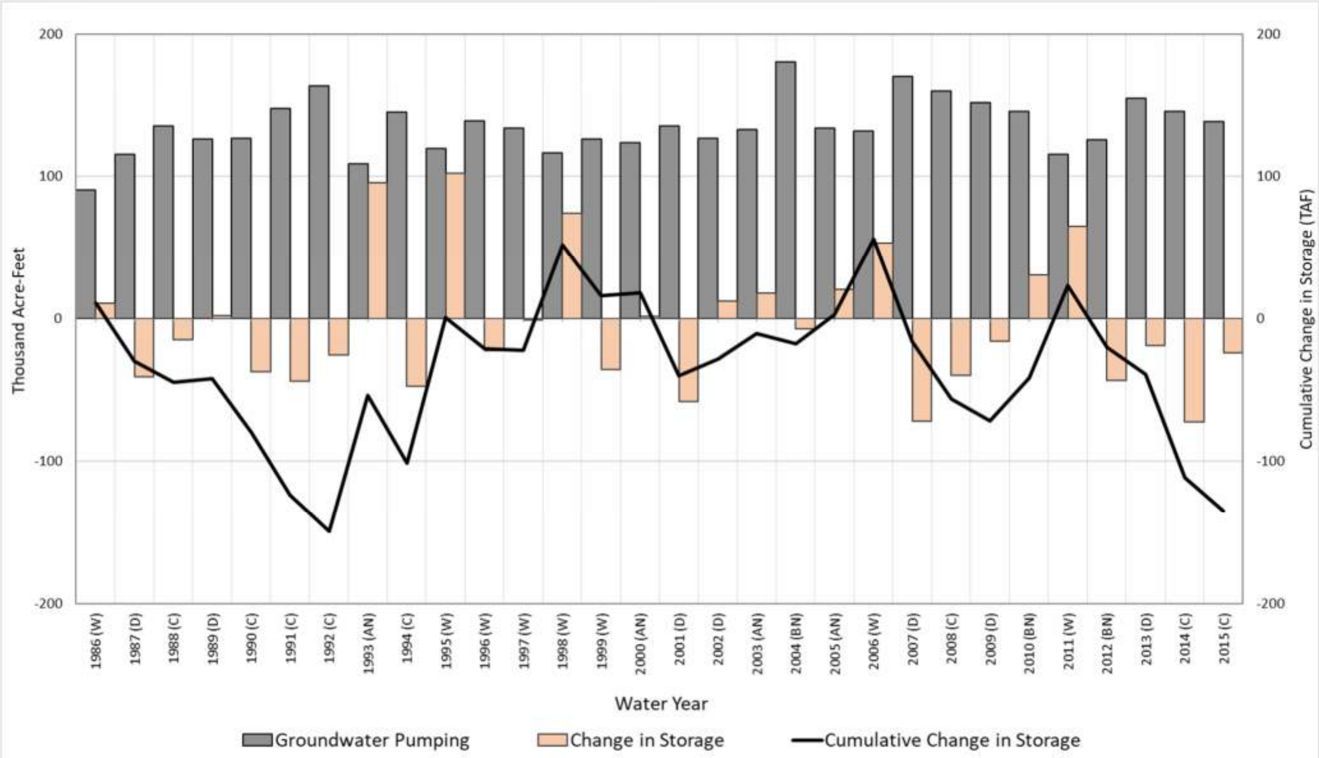


Figure 5-81. Annual and Cumulative Groundwater Storage

5.2.4 Seawater Intrusion

Seawater intrusion is not an applicable sustainability indictor for the Sutter Subbasin as the Subbasin is located inland from the Pacific Ocean and is set back from the Sacramento-San Joaquin Delta. Therefore, groundwater conditions related to seawater intrusion are not applicable to the Sutter Subbasin.

5.2.5 Groundwater Quality

As discussed in **Section 5.1.19**, groundwater quality in the Sutter Subbasin was primarily evaluated via data from the Groundwater Ambient Monitoring and Assessment Program (GAMA) well network (SWRCB, 2021). The *Sutter County Groundwater Management Plan* (Wood Rodgers, 2012) identifies several constituents within the Sutter Subbasin that are at levels that exceed the MCL for drinking water. These constituents include arsenic, boron, total dissolved solids (TDS), and nitrate as N. As discussed in **Section 5.1.19**, all of the constituents, except nitrate, were detected in historic studies but were later found to be naturally occurring. Areas of elevated nitrate and chloride (a measure of salinity) were delineated as part of the *Sutter Subbasin Alternative Plan* (GEI, 2016) and are presented in **Figure 5-82**. Nitrate detections are few and scattered throughout the Subbasin, whereas chloride detections are predominantly in the southern portion of the Sutter Subbasin.

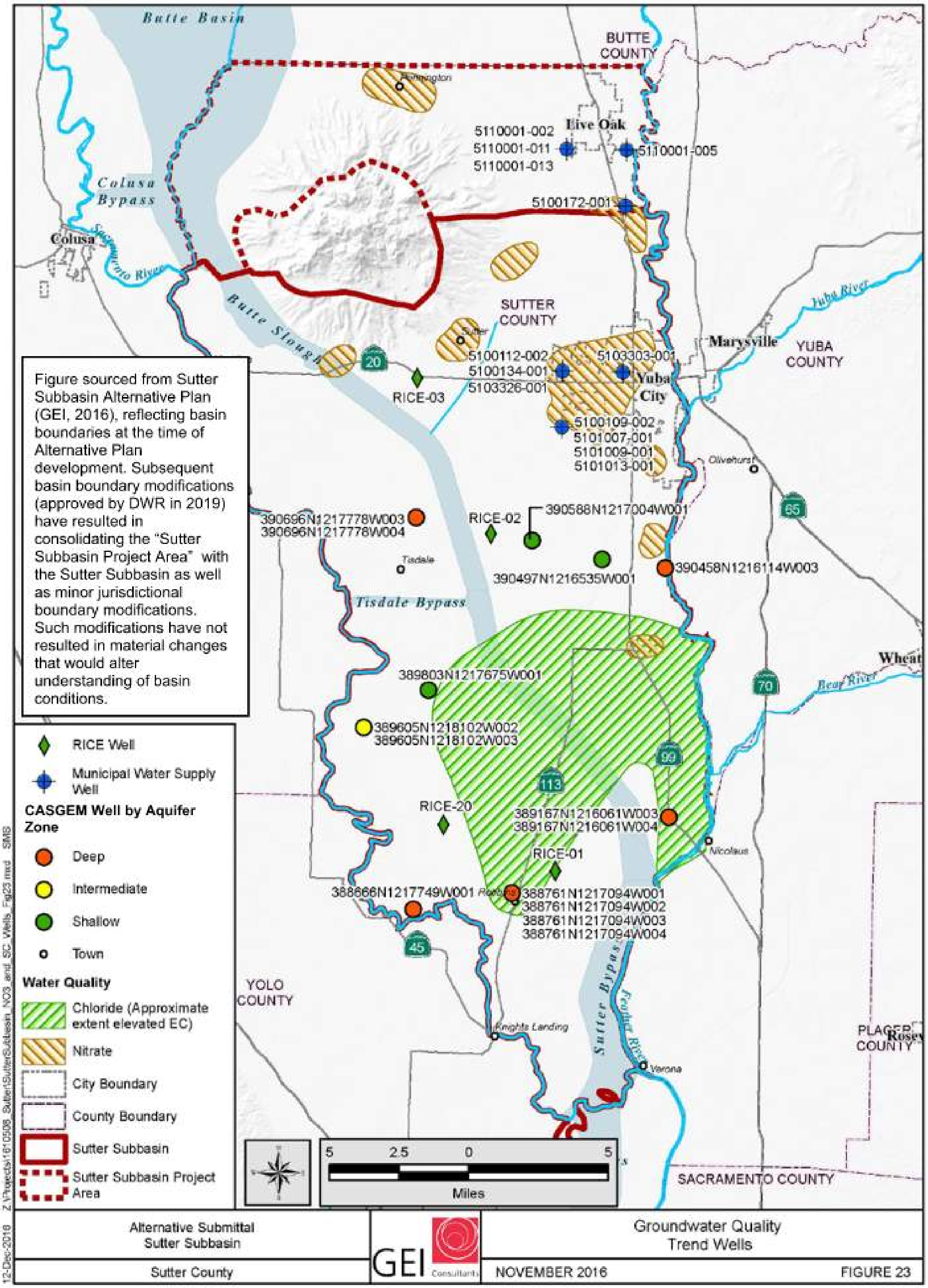


Figure 5-82. Areas of Elevated Nitrate and Chloride Detections

An analysis of the state of these constituents over time is presented in **Table 5-7,** broken into three time periods using data available from the GAMA Program (SWRCB, 2021): 1952 to 2008, 2009 to 2012, and 2013 to 2020. Time periods were selected based on the beginning of the period of record in the GAMA data set (SWRCB, 2021), the general water quality analysis presented in **Section 5.1**, and from the beginning of the current condition water budget (see **Section 5.3** for more information about water budgets) through the latest available water quality data.

Median concentrations of arsenic have decreased since 1952 and most recently are below the Primary MCL. The maximum concentration detected in most recent years (0.190 milligrams per liter or mg/L) does exceed the MCL of 0.01 mg/L.

Median concentrations of boron peaked between 2009 and 2012 but remained below the agricultural water quality objective of 0.7 mg/L. Maximum concentrations of boron have decreased over time with the most recently observed concentrations at 1.0 mg/L.

Maximum TDS concentrations have substantially decreased since 1952, peaking at 8,200 mg/L (in 2006), with the most recently observed maximum concentration (occurring at 1,220 mg/L) below the upper SMCL of 1,500 mg/L.

Median nitrate concentrations have increased since 1952 and have been detected above the Primary MCL as of 2012. The most recently observed maximum concentration of 137 mg/L exceeds the Primary MCL of 10 mg/L by over 10 times.

Groundwater quality varies across the Subbasin based on location and depth by constituent. GAMA data available from 2000 through 2020 (SWRCB, 2021) by well location and aquifer zone for arsenic, boron, TDS, and nitrate as N are presented in **Figure 5-83** through **Figure 5-86**. It should be noted that GAMA data are reflective of ambient groundwater quality prior to treatment. Data are evaluated against the water quality objectives identified in **Table 5-7** for the purpose of using a common metric for the highest beneficial use, which is drinking water. Further treatment or blending may be required prior to groundwater use.

In the Shallow Aquifer Zone (defined as extending from the ground surface to 50 feet bgs), groundwater quality data are limited to a single monitoring event in 2006. All constituents evaluated were at or below their respective water quality objective with the exception of one exceedance of the agricultural water quality objective for boron at 1.26 mg/L in the southern portion of the Subbasin and two exceedances of TDS above the recommended SMCL but below the upper SMCL (**Figure 5-83**). One exceedance of TDS well above the short-term SMCL was observed in the southern portion of the Subbasin at 8,200 mg/L. This measurement may be an outlier, but insufficient data at the site are available to make this determination.

Table 5-7. Summary of Sutter Subbasin Water Quality Constituents

Constituent	Water Quality Limit (mg/L)	Median Measurement (mg/L) (minimum – maximum measurements)		
		1952-2008	2009-2012	2013-2020
Arsenic	0.01 (1)	0.010 *(0.001 – 0.350)* *77 measurements*	0.019 *(0.002 – 0.201)* *38 measurements*	0.007 *(0.001 – 0.190)* *28 measurements*
Boron	0.7 (2)	0.1 *(ND – 5.4)* *225 measurements*	0.5 *(ND – 2.4)* *30 measurements*	0.1 *(ND – 1.0)* *11 measurements*
TDS	500-1,500 (3)	351 *(95 – 8,200)* *344 measurements*	505 *(115 – 2,290)* *46 measurements*	600 *(180 – 1,220)* *47 measurements*
Nitrate as N	10 (1)	2 *(ND – 280)* *199 measurements*	11 *(ND – 92)* *52 measurements*	15 *(ND – 137)* *91 measurements*

(1) Primary drinking water MCL (SWRCB, October 2017; SWRCB, November 2017a)
(2) Agricultural objective (Ayers and Westcot, 1985 [Table 21])
(3) Recommended SMCL is 500 mg/L, Upper SMCL is 1000 mg/L, and Short-Term SMCL is 1500 mg/L (SWRCB, November 2017b)
Key:
mg/L = milligrams per liter
ND = Non-detect (concentration in sample is below detection limit)
Source: GAMA (SWRCB, 2021)

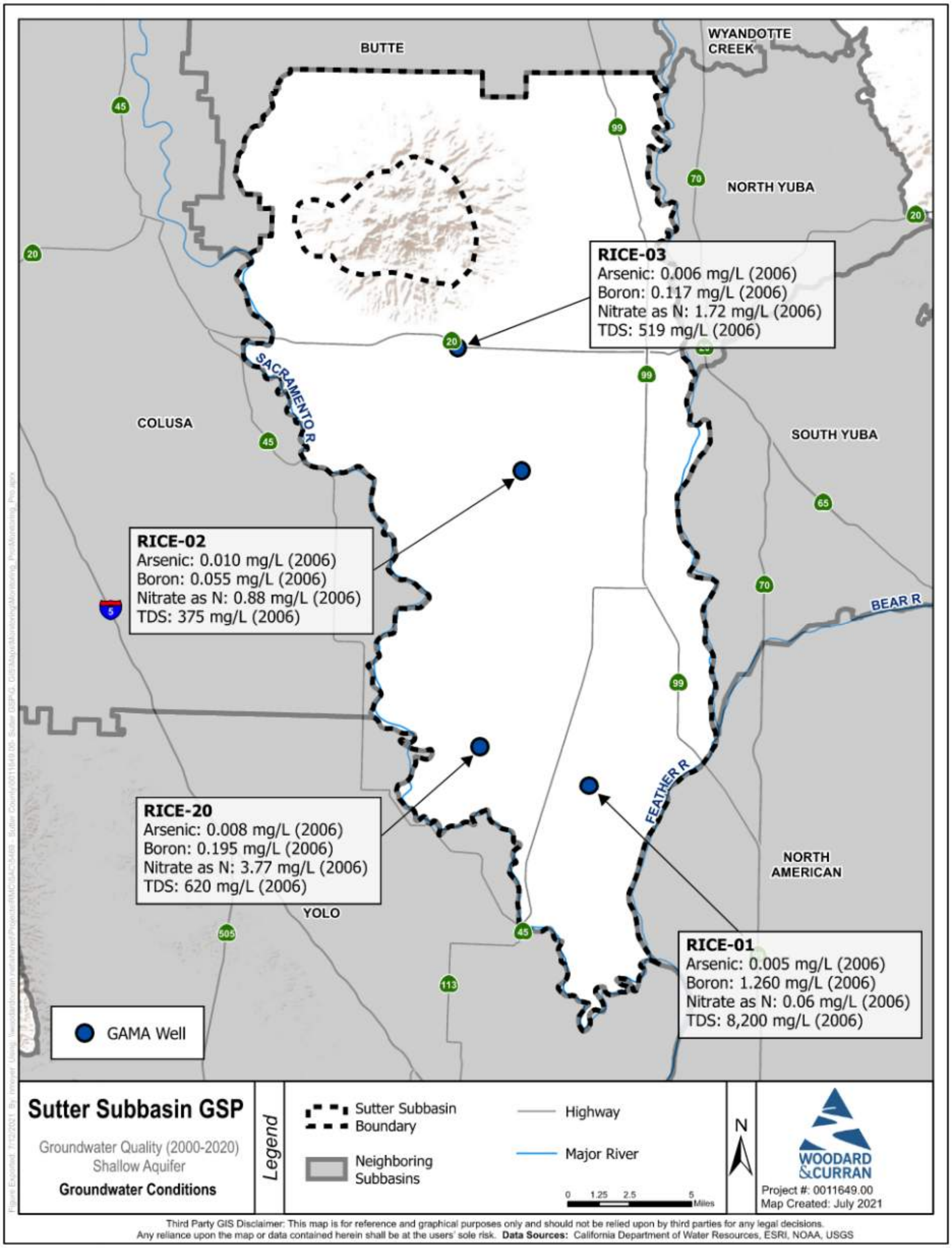


Figure 5-83. Current Groundwater Quality (2000-2020), Shallow Aquifer Zone

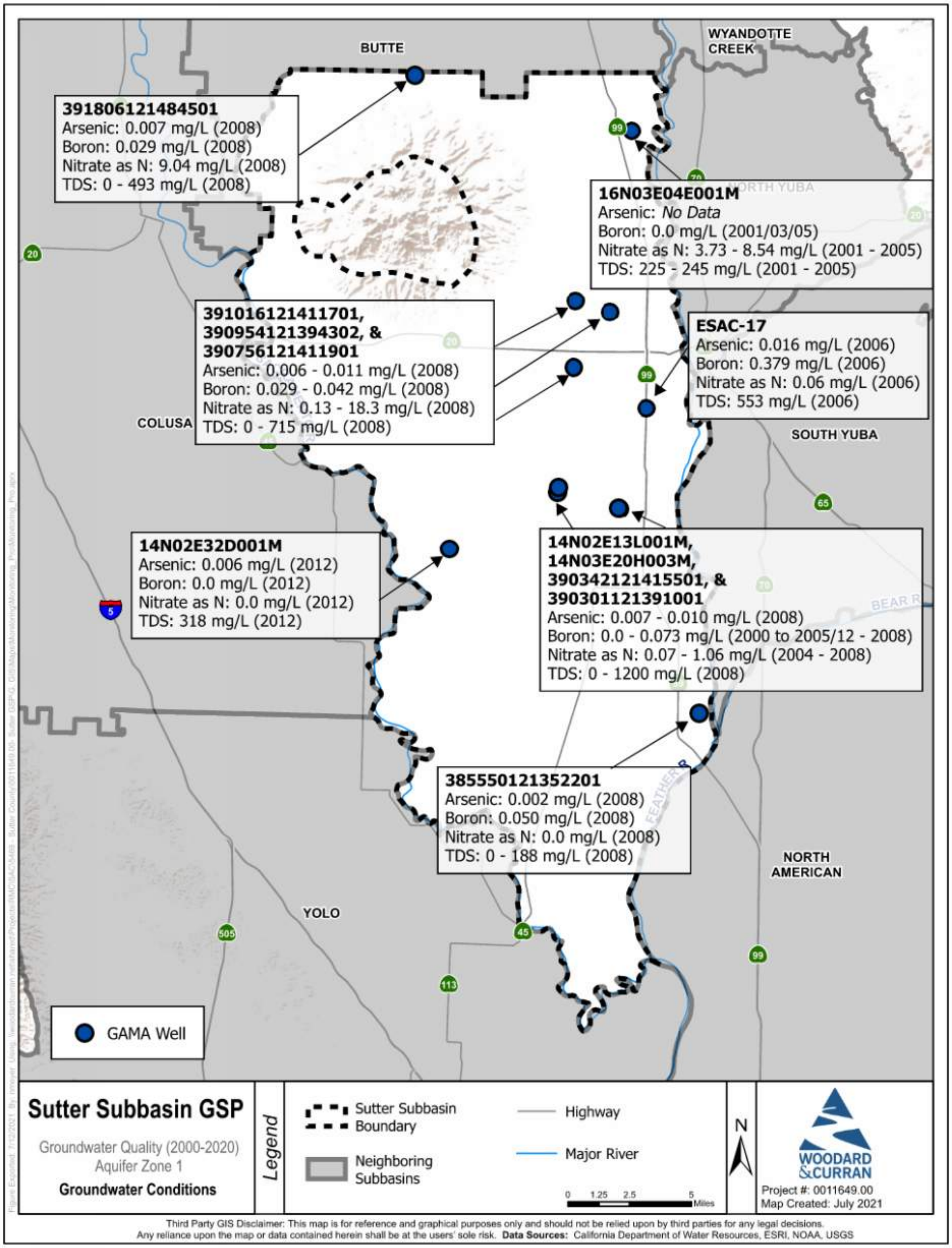


Figure 5-84. Current Groundwater Quality (2000-2020), AZ-1

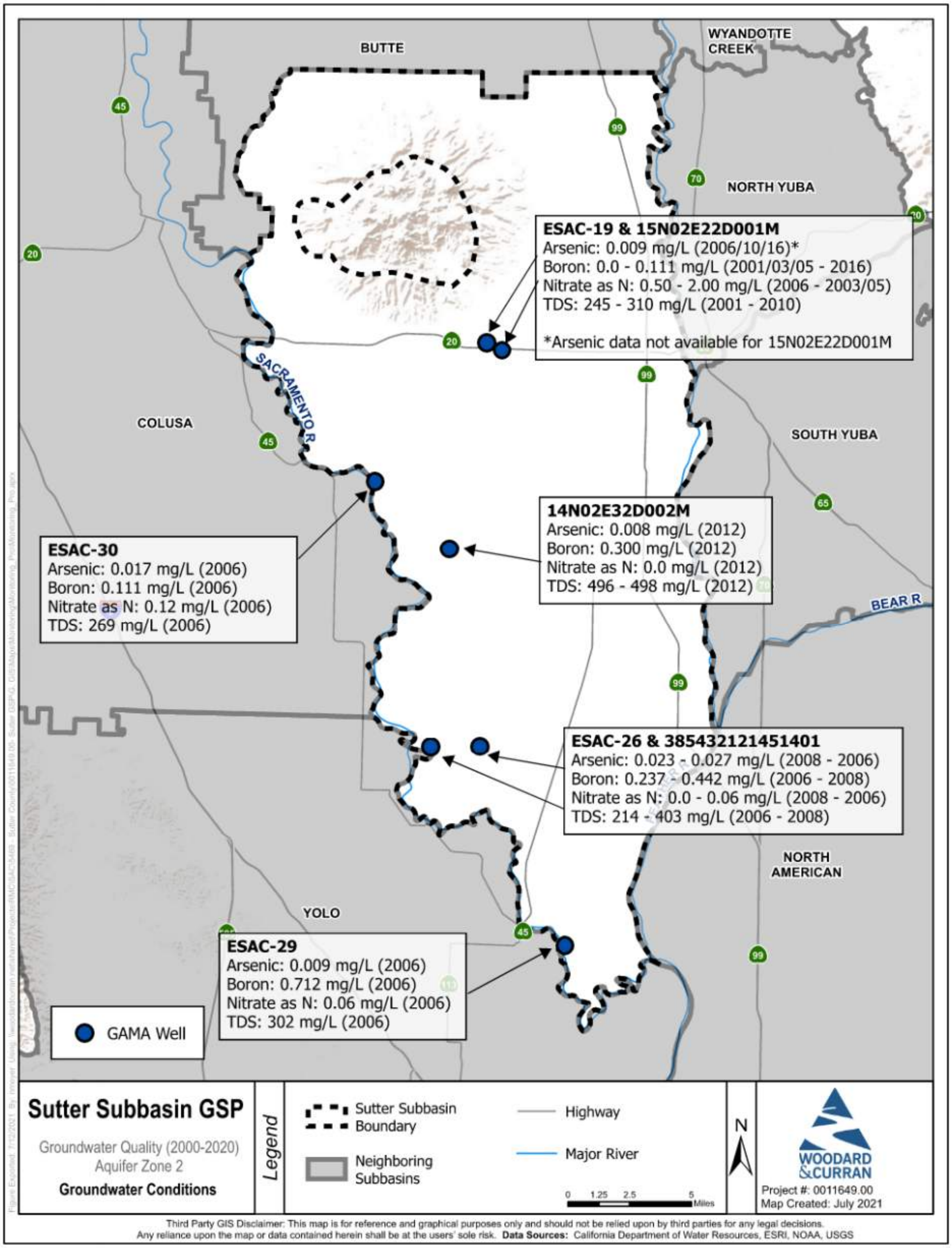


Figure 5-85. Current Groundwater Quality (2000-2020), AZ-2

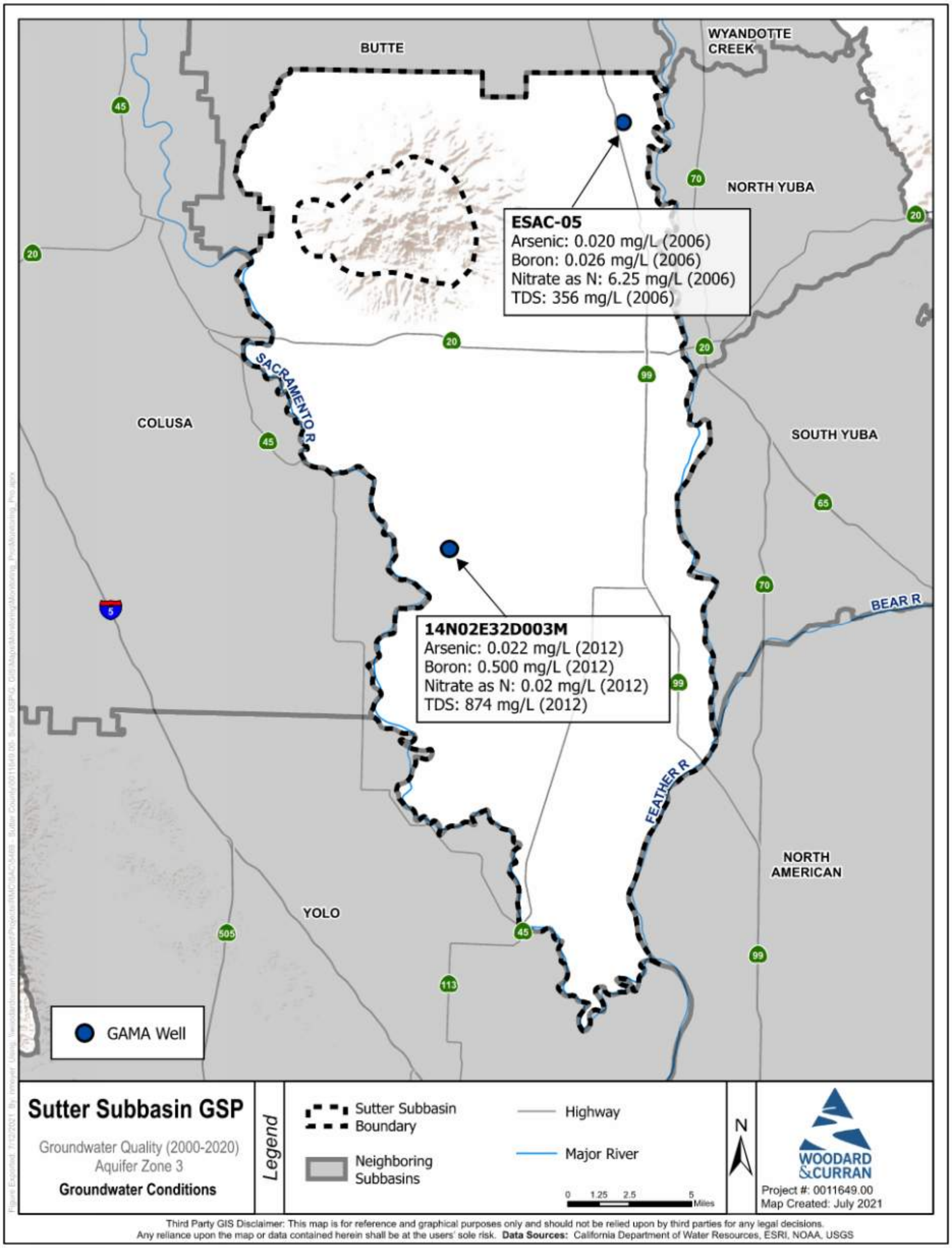


Figure 5-86. Current Groundwater Quality (2000-2020), AZ-3

In AZ-1 (defined as extending from 50 to 150 feet bgs), arsenic concentrations were at or below the Primary MCL except along the eastern boundary of the Sutter Subbasin near the Yuba Subbasins where exceedances of 0.011 mg/L (in 2008) and 0.016 mg/L (in 2006) were recorded (**Figure 5-84**). Similar patterns were observed for boron, where concentrations throughout much of the Subbasin were below the agricultural water quality objective except for exceedances of 0.379 mg/L (in 2006) and 0.073 mg/L (in 2008) along the eastern boundary near the South Yuba Subbasin. Nitrate was below the Primary MCL throughout the Subbasin except along the eastern portion of the Subbasin near the North Yuba Subbasin where a concentration of 18.3 mg/L was recorded in 2008. Exceedances above the recommended SMCL for TDS occurred along the eastern boundary of the Subbasin near the North Yuba Subbasin at 715 mg/L (in 2008) and near the South Yuba Subbasin at 1,200 mg/L (in 2008). An additional TDS exceedance above the short-term SMCL was observed near the South Yuba Subbasin at 5,553 mg/L. For the remainder of the Subbasin in AZ-1, recorded concentrations of TDS were all below the recommended SMCL.

In AZ-2 (defined as extending from 150 to 400 feet bgs), only exceedances of arsenic and boron were recorded (**Figure 5-85**). All nitrate concentrations were below the Primary MCL and all TDS concentrations were below the recommended SMCL. Arsenic concentrations above the Primary MCL were recorded along the Sacramento River bordering the Colusa Subbasin at 0.017 mg/L (in 2006) and near the Yolo Subbasin boundary at a maximum of 0.027 mg/L (in 2008). Boron concentrations above the agricultural water quality objective were observed in the southern portion of the Subbasin along the Yolo Subbasin boundary at 0.712 mg/L.

In AZ-3 (defined as depths deeper than 400 feet bgs), arsenic concentrations exceedances occurred at both sampled sites in the northeast corner and central portion of the Subbasin at 0.02 mg/L (in 2006) and 0.022 mg/L (in 2012), respectively (**Figure 5-86**). Boron concentrations were below the agricultural water quality objective and nitrate concentrations were below the Primary MCL at both sites. In the central portion of the Subbasin, observed TDS concentrations were above the recommended SMCL but below the upper SMCL at 874 mg/L (in 2012).

5.2.5.1 Contaminated Sites

A review of active sites listed in California's EnviroStor and GeoTracker/GAMA databases that could potentially impact groundwater in the Sutter Subbasin is included in **Section 5.1.9**. **Table 5-6** lists the open/active sites in the Subbasin and the type of program the site is managed under, and **Figure 5-45** shows their locations. Typically, the Clean-up Program Sites and leaking underground storage tank (LUST) Clean-up Sites are associated with leaky underground fuel tanks (LUFTs) and underground storage tanks (USTs). Their typical constituents of concern are fuel hydrocarbons and/or chlorinated solvents and the contaminant extent is small.

No large groundwater contamination plumes are known to be present in the Subbasin (GEI, 2016).

5.2.6 Land Subsidence

Land subsidence and its associated impacts have not been recorded within the Sutter Subbasin (Wood Rodgers, 2012). While elastic land subsidence is observed as a result of seasonal fluctuations in groundwater levels and associated aquifer pressure, inelastic land subsidence has not been recorded within the Sutter Subbasin. Sutter County actively coordinates with DWR to monitor for potential land subsidence within the county boundaries as part of the Sacramento Valley Subsidence Network (DWR North Region Office, 2018). Land subsidence has also been measured within the Sutter Subbasin by the National Aeronautics and Space Administration's (NASA's) Jet Propulsion Laboratory (JPL) using Interferometric Synthetic Aperture Imagery (InSAR), available through DWR's SGMA Data Viewer (DWR, 2021b).

5.2.6.1 Historic and Current Conditions

Land subsidence monitoring within the Sutter Subbasin has a relatively short period of record. DWR, in cooperation with federal, state, and local agencies, installed and surveyed monuments to measure and monitor ground surface elevations over time in the Sacramento Valley. The Sacramento Height-Modernization Project consists of 339 monuments, spaced approximately 7 kilometers apart in 10 counties (Wood Rodgers, 2012). The network is intended to be monitored on a 5-year schedule and was initially surveyed in 2008. DWR was unable to survey the monuments in 2013 due to budgetary limitations and the second survey was completed in 2017. Twenty-two monuments are located within the Sutter Subbasin (**Figure 5-87**) with recorded subsidence values between 2008 and 2017 ranging from 0.05 to 0.33 feet of subsidence (**Table 5-8**).

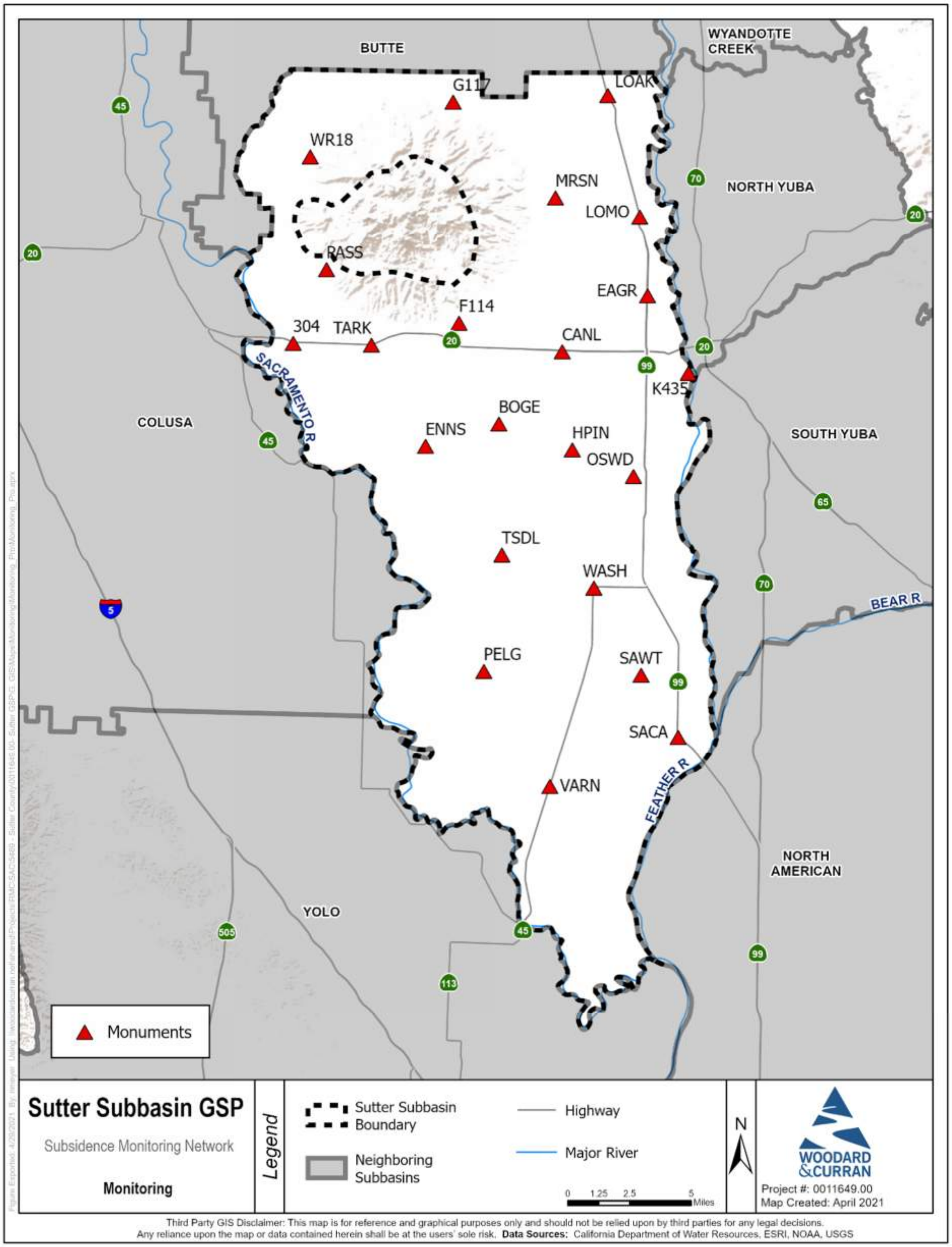


Figure 5-87. Sacramento Valley Subsidence Monitoring Network, Sutter Subbasin

Table 5-8. DWR Sacramento Valley Subsidence Network in the Sutter Subbasin, Ellipsoid Height Difference from 2008 to 2017

DWR Station ID	DWR Station Name	Station Differences* in Ellipsoid Height from 2008 to 2017 (feet)
304	HPGN CA 03 04	-0.203
BOGE	BOGUE	-0.227
CANL	CANAL KS1836	-0.139
EAGR	EAGER	-0.109
ENNS	ENNIS	-0.231
F114	F 114	-0.188
G117	G 1175	-0.046
HPIN	HOPPIN	-0.185
K435	K 1435	-0.131
LOAK	LIVE OAK	-0.078
LOMO	LOMO	-0.089
MRSN	MORRISON	-0.112
OSWD	OSWALD	-0.148
PASS	PASSBUTTE	-0.22
PELG	PELGER	-0.168
SACA	SACRAMENTO AVENUE	Data not available
SAWT	SAWTELLE	-0.098
TARK	TARKE	-0.334
TSDL	TISDALE	-0.196
VARN	VARNEY	-0.118
WASH	WASHINGTON	-0.137
WR18	DWR18	-0.082

*Negative values indicate that elevations were lower in 2017 compared to 2008. The Department of Water Resources, North Central Region Office (2018) noted an error of uncertainty of approximately 0.17 feet and that any change of less than 0.17 feet was not considered to be statistically significant.

NASA's JPL uses InSAR to evaluate land surface fluctuations from satellite imagery. Between June 2015 and October 2020, between -0.25 and +0.25 feet of vertical displacement was observed within much of the Sutter Subbasin, with a small area of between -0.5 to -0.75 feet of vertical displacement observed along the Colusa Subbasin boundary just north of the Yolo Subbasin (**Figure 5-88**). Similar vertical displacement measurements (-0.25 to +0.25 feet) were also observed between October 2019 and October 2020 (**Figure 5-89**). Therefore, land subsidence within the Sutter Subbasin has been minimal in recent years and there has been no reported negative impacts of land subsidence on critical infrastructure.

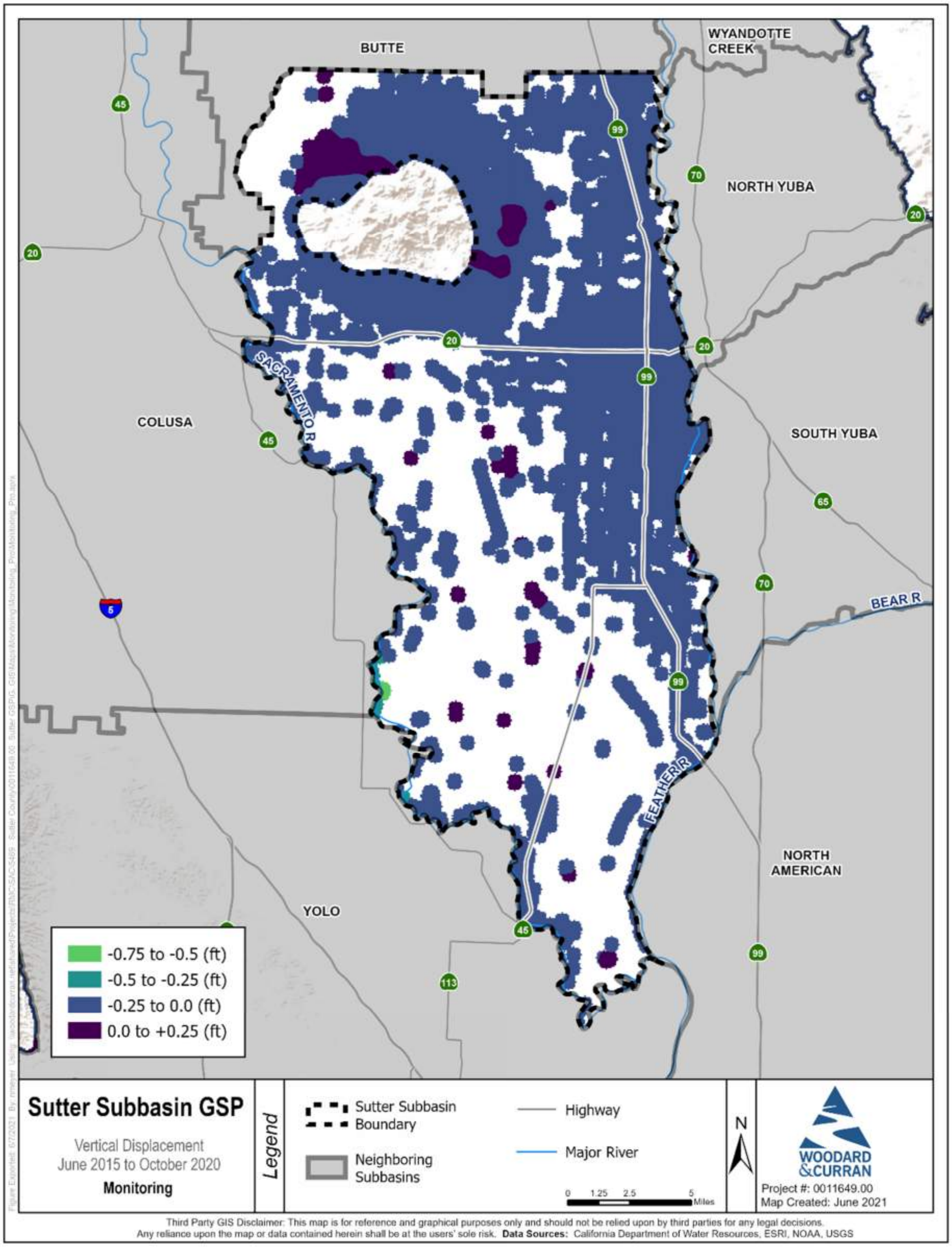


Figure 5-88. Vertical Displacement in the Sutter Subbasin, June 2015 to October 2020

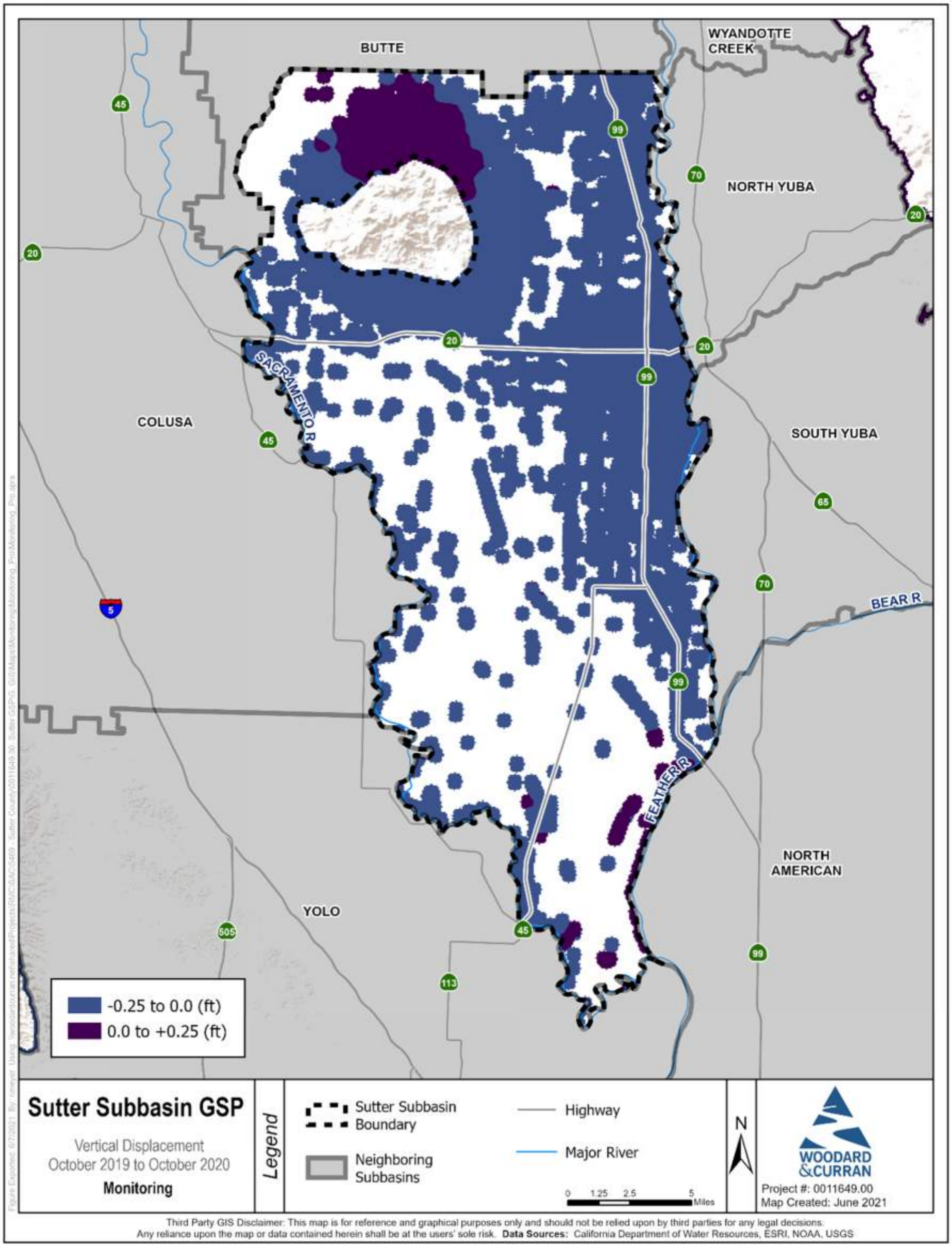


Figure 5-89. Vertical Displacement in the Sutter Subbasin, October 2019 to October 2020

5.2.7 Interconnected Surface Water Systems

Interconnected surface waters are surface water features that are hydraulically connected by a saturated zone to the groundwater system. In these systems, the water table and surface water features intersect at the same elevations and locations. Interconnected surface waters can be categorized as gaining (when the surface water feature is gaining water from the aquifer system) or losing (when the surface water feature is losing water to the aquifer system) (**Figure 5-90**).

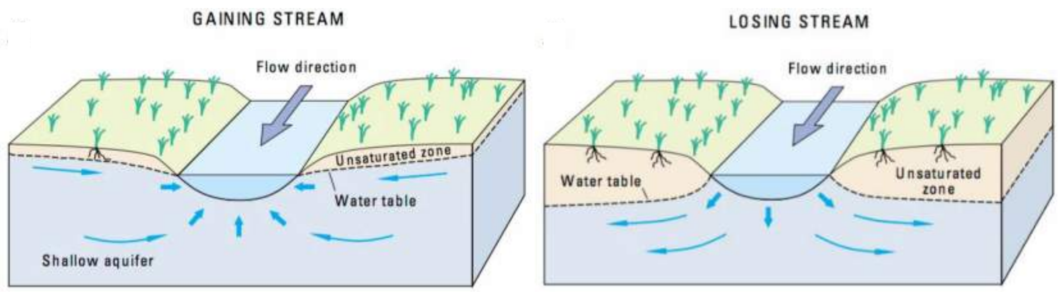


Figure 5-90. Gaining and Losing Surface Water Features

Interactions between groundwater and surface water in the Sutter Subbasin were analyzed by comparing water table elevations to streambed elevations. As in most areas of California, the direct measurement of the gain or loss to groundwater from surface water bodies is not feasible in the Sutter Subbasin. Therefore, the C2VSimFG-Sutter integrated flow model was used to characterize the interconnected surface waters of simulated streams and to approximate the rates of gains and losses. The elevation of the water table was calculated by the historical model for the Sacramento River, Feather River, and Sutter Bypass, represented by 316 stream nodes that touch the Sutter Subbasin boundary. The gradient created by the difference in elevation between the groundwater and surface water feature was evaluated at the stream node scale. The portions of the stream that were found to be gaining or losing in at least 80% of the simulated months from WY 1996 to WY 2015 were categorized as such (gaining or losing nodes), while stream nodes that did not meet the 80% threshold for either categorization were classified as having mixed conditions (**Figure 5-91**). Average monthly streamflow gains and losses from WY 1996 to 2015 from C2VSimFG-Sutter are shown in **Table 5-9** for the Sacramento River, Feather River, and Sutter Bypass. Positive values indicate average gains to stream from groundwater and negative values indicate average loses to stream from groundwater. These averages cover all nodes with monthly gaining and losing conditions. Since no stream has all nodes behaving consistently in any month, the averages follow the trends of the majority of the nodes. Various thresholds were assessed, but an 80% threshold was determined to best align with local knowledge of the Subbasin and The Nature Conservancy's Interconnected Surface Water in the Central Valley (ICONS) dataset (**Figure 5-92**) (TNC, 2021).

Table 5-9. Average Monthly Streamflow Gains and Losses, Water Year 1996 to 2015 (AF)

Stream/ Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Overall Annual
Sacramento River	153	99	-101	29	31	101	152	130	132	113	142	129	93
Feather River	27	47	-7	28	23	34	48	25	15	-31	-1	28	20
Sutter Bypass	-13	-32	-86	-74	-55	-28	44	46	69	45	30	-1	-5

The ICONS dataset utilizes groundwater elevation data from DWR for WY 2011 to WY 2018. Disconnected streams, where groundwater depth is greater than 50 feet below the stream surface, will always be losing streams, whereas connected streams may be either losing or gaining depending on the surface water and groundwater conditions.

Both the model results and ICONS datasets indicate that Sutter Bypass has mostly mixed or gaining conditions throughout Sutter Subbasin. The Feather River at the border near North Yuba Subbasin has fluctuating gaining and losing conditions as it moves southward, while near the South Yuba Subbasin, the Feather River has longer, more distinct stretches of either gaining or losing conditions. For the Sacramento River, model results show more variable conditions at the node scale than the ICONS dataset. This difference may be due to differing thresholds for which gaining or losing conditions are defined. The C2VSimFG-Sutter model does not contain stream nodes in the Sutter Buttes foothills, and therefore the interaction between those streams and the underlying water table were not evaluated.

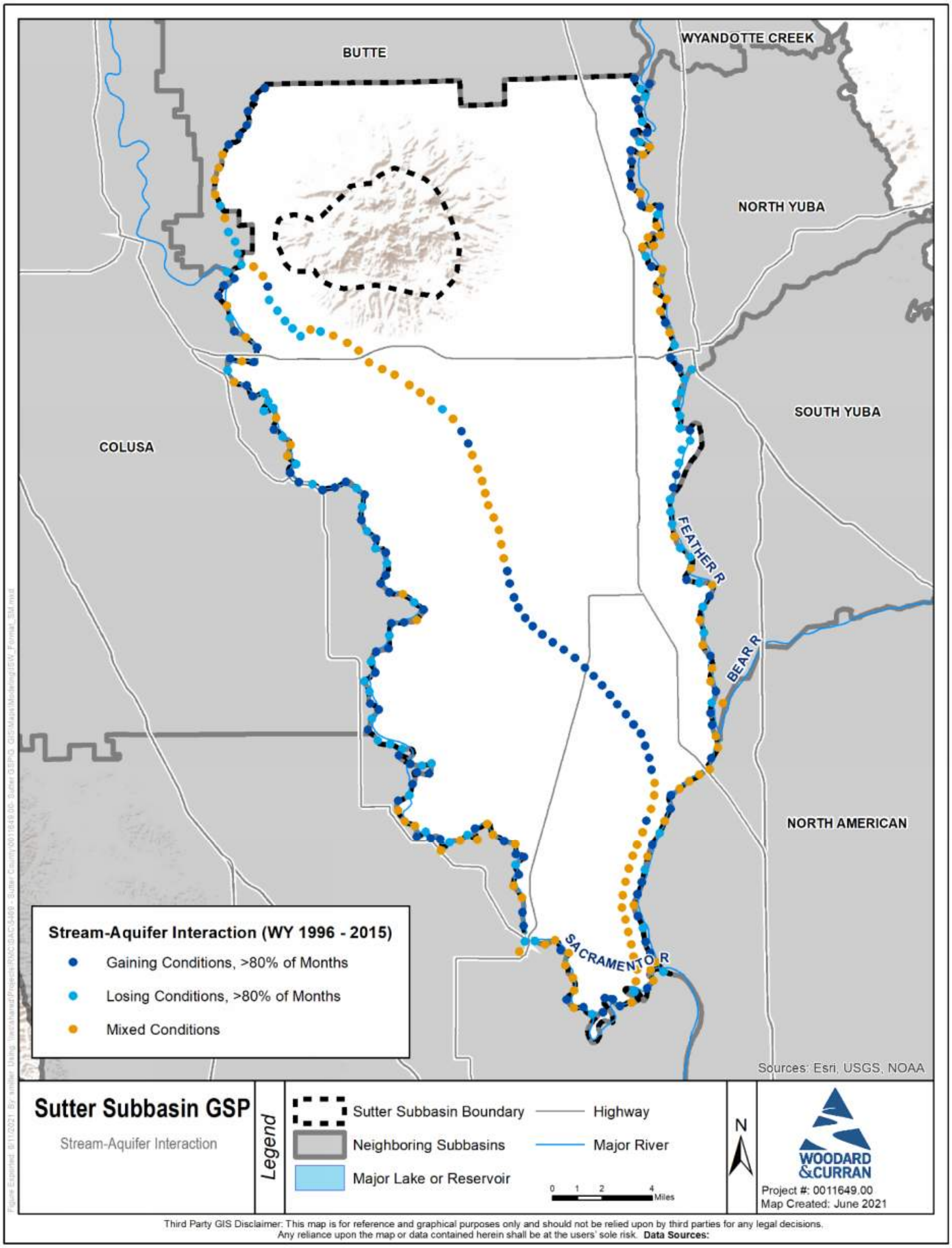


Figure 5-91. Losing and Gaining Streams, C2VSimFG-Sutter Model

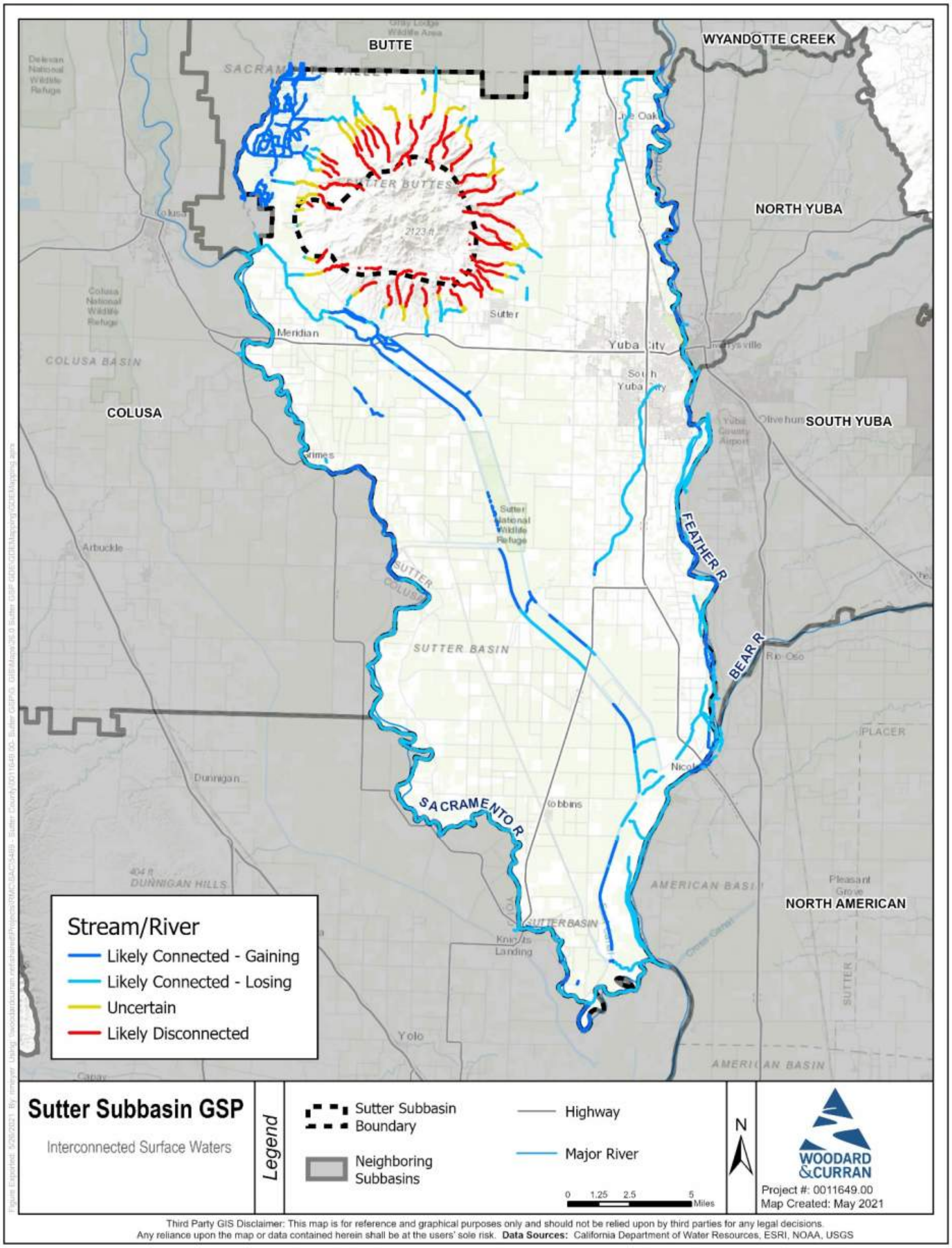


Figure 5-92. Losing and Gaining Streams, ICONS

5.2.8 Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (GDEs) are defined as "ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (GSP Emergency Regulations § 351(m)). Identification of GDEs is used to assess whether groundwater management could affect the beneficial uses of groundwater associated with GDEs.

In the Sutter Subbasin, GDEs exist primarily where vegetation is reliant on shallow groundwater supply for survival. Therefore, the identification of GDEs in the Sutter Subbasin was based on the following question: "Would the ecosystem exist if groundwater levels were deeper?" If the answer is "no," then it was determined to be a GDE; if "yes," then it was not selected as a GDE. This analysis demonstrates the nature of shallow groundwater as critical to maintaining ecosystem health.

To identify GDEs, an analysis of the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset was performed (DWR, 2018). Developed by DWR, California Department of Fish and Wildlife (CDFW), and The Nature Conservancy, the NCCAG database was created by reviewing publicly available state and federal agency maps of California vegetation, wetlands, springs, and seeps and by conducting a screening process to retain types and locations commonly associated with groundwater. Two classes of the results were defined: 1) wetland features commonly associated with the surface expression of groundwater under natural, unmodified conditions and 2) vegetation types commonly associated with the subsurface presence of groundwater (i.e., phreatophytes).

Noting that no land use protections are conferred on GDEs or NCCAGs through this document or other documents, the distinction between GDEs and NCCAGs that are not GDEs is important from a management perspective. As noted above, SGMA focuses on beneficial uses, rather than on the simple existence of surface water and other possible GDEs. Management of NCCAGs may require more focus on land use or irrigation activities more so than groundwater management. The analysis methodology to identify GDEs was developed to focus groundwater management activities on the most appropriate areas.

Potential GDEs in normal (2013), dry (2015), and wet (2017) years in the Sutter Subbasin were identified through the creation of elimination criteria. The following criteria identify NCCAG areas with likely access to non-groundwater supplies that were removed from consideration as potential GDEs, as shown in **Figure 5-93** through **Figure 5-95**:

1. **Areas with a depth to groundwater greater than 30 feet during winter months (January through March) –** Oak trees are considered the deepest-rooted plant in the region with a root zone of roughly 25 to 30 feet, with mature trees reaching rooting depths of up to 80 feet. Groundwater depths deeper than 80 feet are highly unlikely to support vegetative growth dependent on groundwater, as groundwater

in such areas would be inaccessibly deep. In evaluating available groundwater level data during the winter (January through March) of 2013, 2015, and 2017 used in this analysis, all groundwater levels in the Sutter Subbasin were shallower than 30 feet with the exception of a depression anomaly observed near the Sutter Buttes in 2017 (a wet year). NCCAGs in the area impacted by the depression anomaly in 2017 are retained as potential GDEs until further evaluation is performed.

2. **Areas adjacent to losing surface water bodies –** Rivers and streams recharge groundwater systems in the Sutter Subbasin. It was assumed that vegetation within 150 feet of such areas would be accessing this surface water recharge and therefore dependent on surface water flows, not groundwater. As such, NCCAGs within 150 feet of rivers and streams were eliminated from consideration as a GDE.
3. **Areas adjacent to irrigated lands –** Irrigated areas benefit not only targeted crops but surrounding vegetation through the recharge of groundwater systems with applied surface water. Therefore, NCCAGs within 50 feet of Fish and Wildlife Service-irrigated land, State-irrigated land, and irrigated farmland were eliminated from consideration as a GDE. A 150-foot elimination buffer was used for irrigated rice cropland due to extent of percolation and lateral seepage associated with rice fields that apply surface water, resulting in more extensive recharge of the underlying aquifer and adjacent areas than typical irrigation methods for other crops.

Based on the screening process above, all remaining NCCAG areas were identified as potential GDEs, as shown in **Figure 5-96** through **Figure 5-98**. The results of the GDE analysis are shown in the two NCCAG habitat classes: vegetation and wetlands. Potential GDEs have been identified along the Feather River and the most northeastern portion of the Sutter flyway. Due to potential inaccuracies in the wet year groundwater depth data in 2017, NCCAGs within the area of depression anomalies (as shown by the hatched area in **Figure 5-95** and **Figure 5-98**) in the northwestern portion of the Subbasin were assumed to be potential GDEs in the wet year, as they had qualified in the normal and dry years, until further evaluation is performed. **Table 5-10** includes all species within the Sutter Subbasin region, as identified by TNC, that have been observed or have the potential to exist within the region and may be reliant on groundwater (TNC, n.d.). Further efforts in GDE mapping will be performed as part of subsequent 5-Year GSP Updates to further confirm the presence of and refine the delineation of GDEs in the Sutter Subbasin, using the preliminary analyses contained in this multi-year evaluation approach as a starting point for further analyses (refer to **Section 7.1.6.3.1** for more information about GDE mapping confirmation).

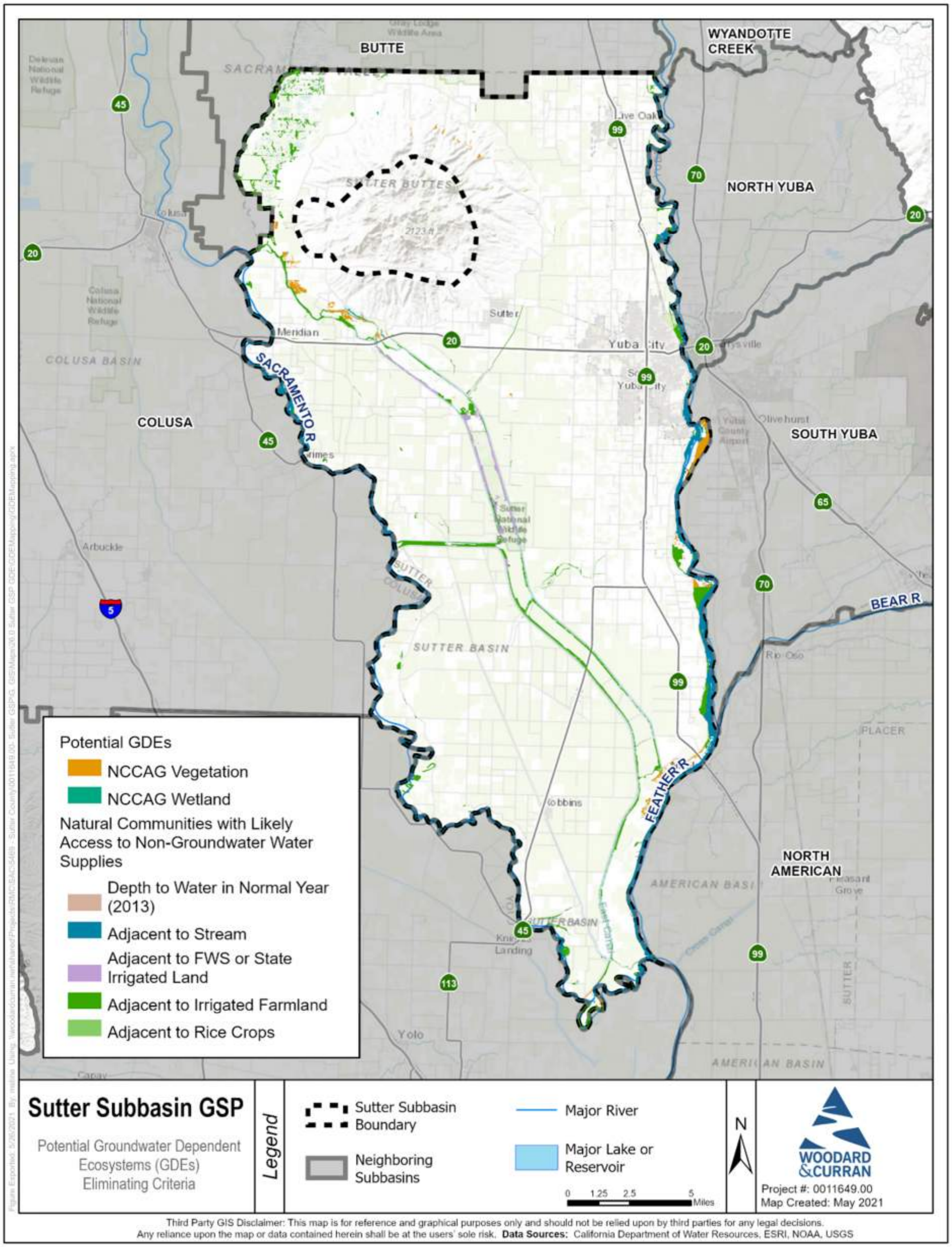


Figure 5-93. GDE Elimination Criteria in Sutter Subbasin, Normal Year (2013)

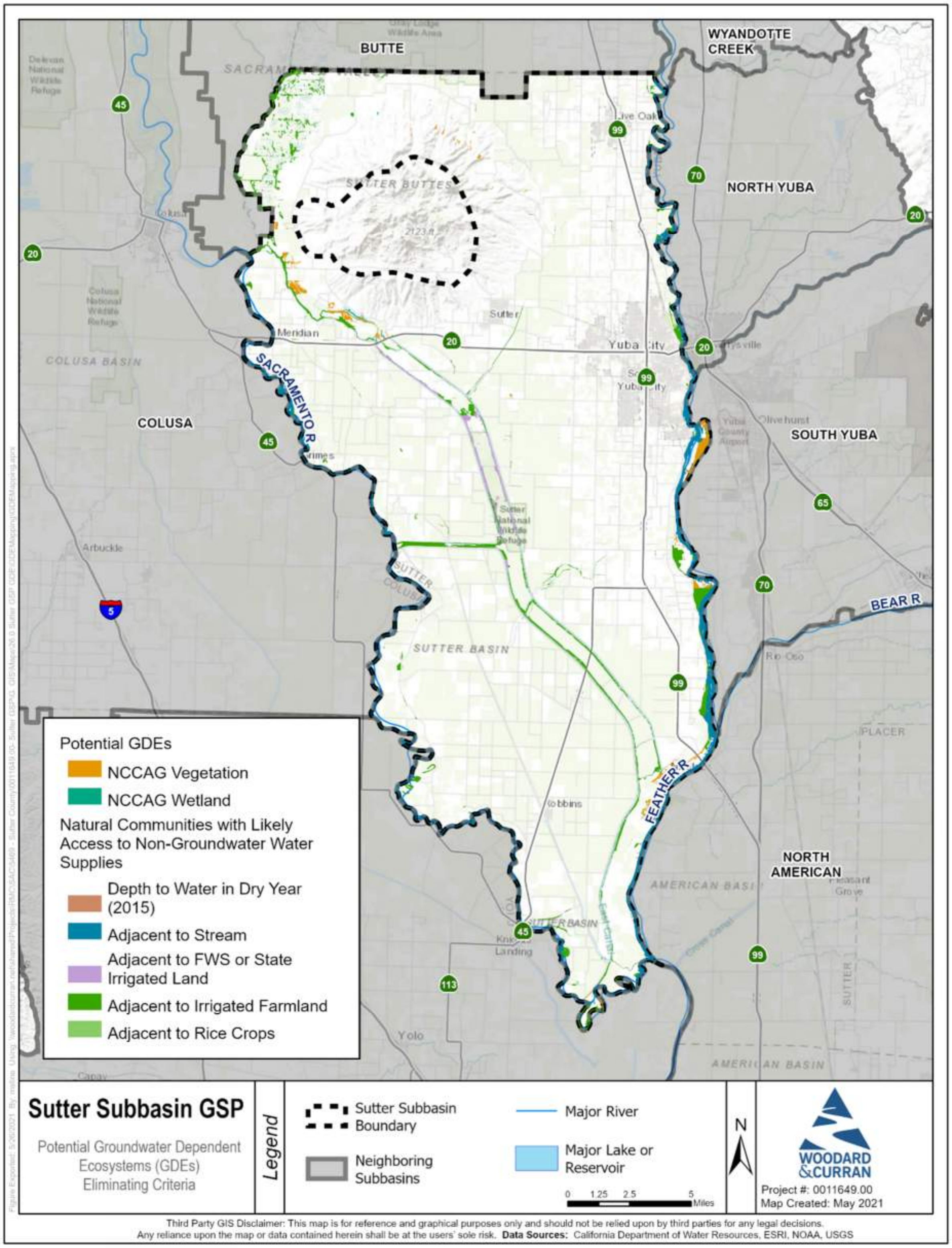


Figure 5-94. GDE Elimination Criteria in Sutter Subbasin, Dry Year (2015)

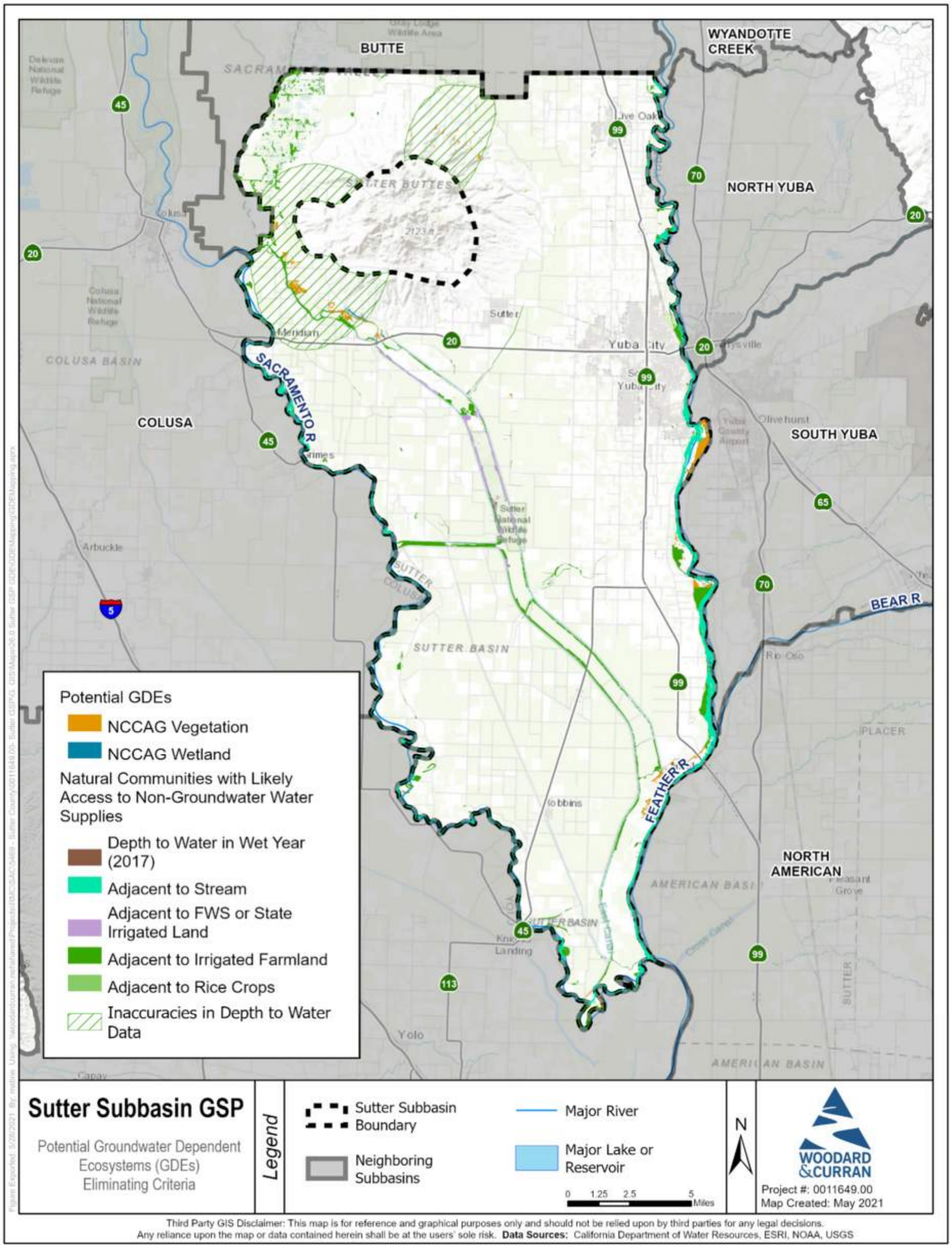


Figure 5-95. GDE Elimination Criteria in Sutter Subbasin, Wet Year (2017)

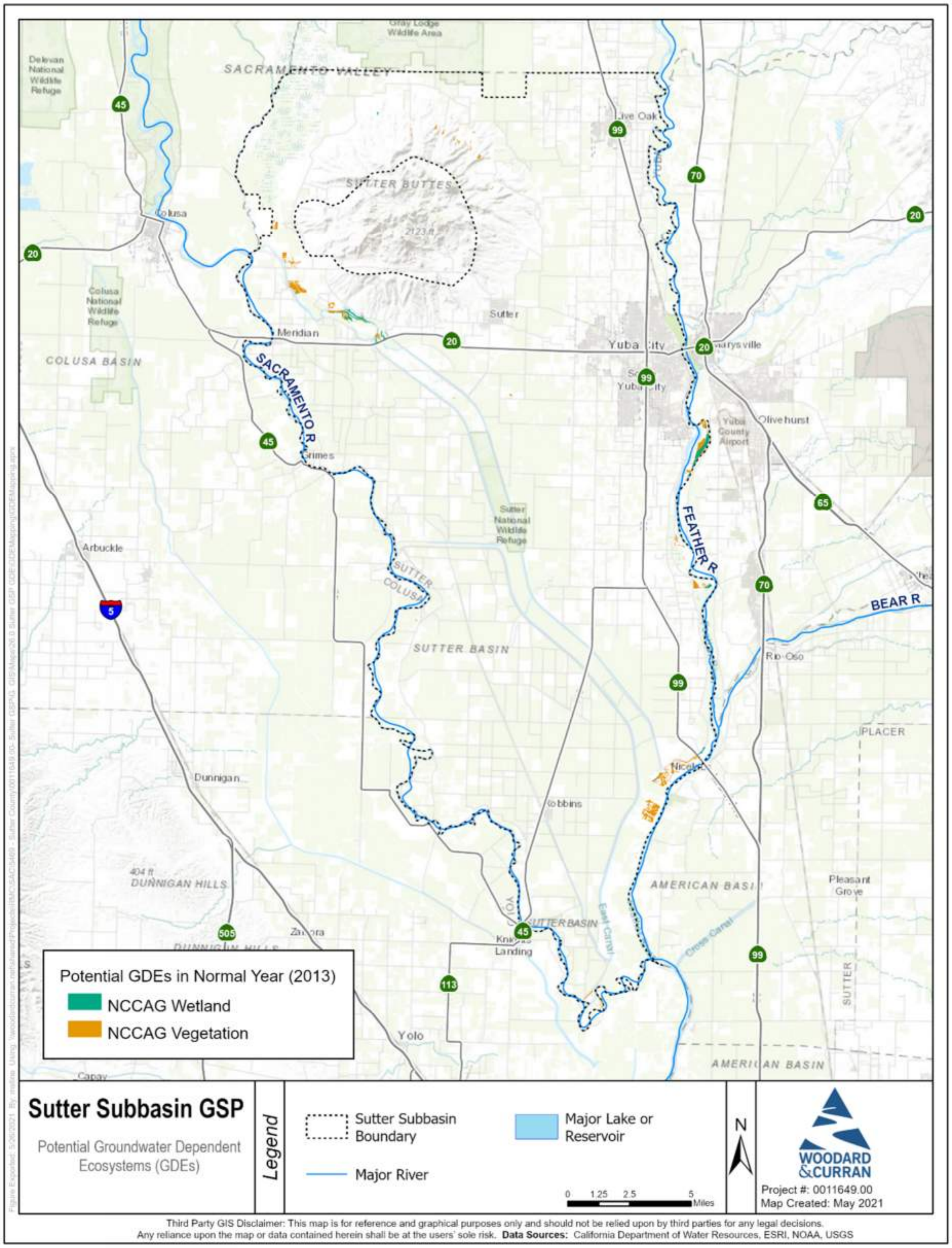


Figure 5-96. Potential GDEs in Sutter Subbasin, Normal Year (2013)

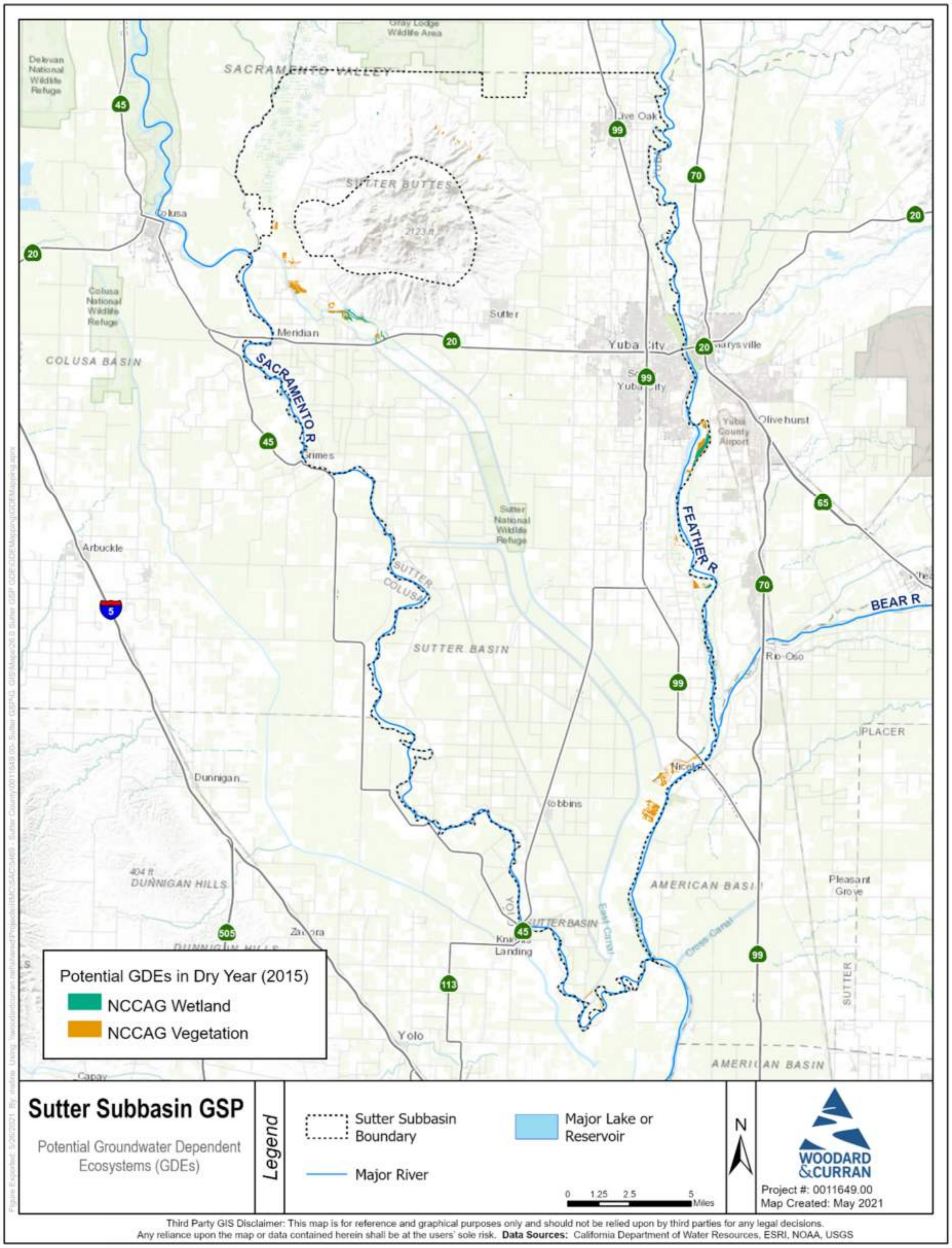


Figure 5-97. Potential GDEs in Sutter Subbasin, Dry Year (2015)

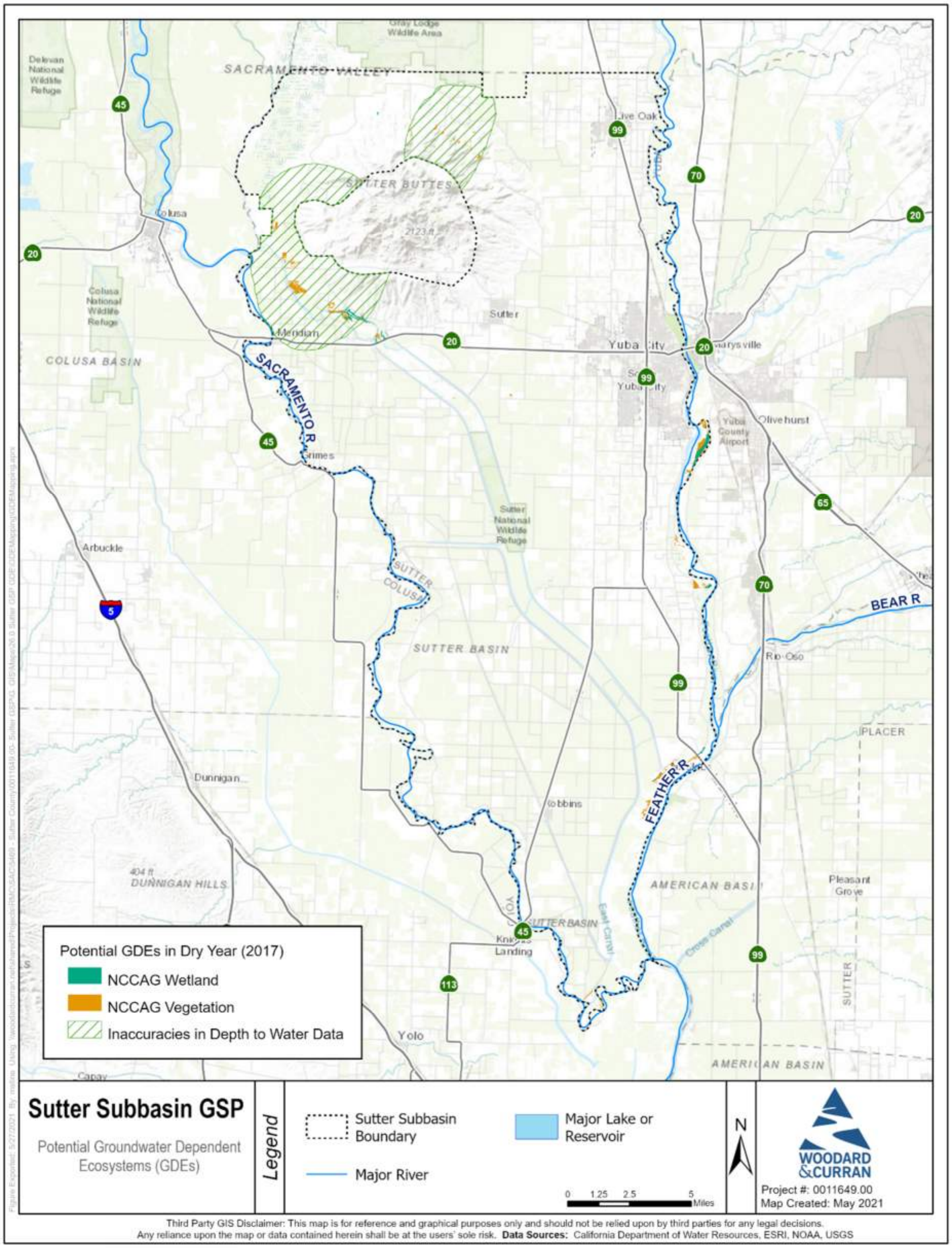


Figure 5-98. Potential GDEs in Sutter Subbasin, Wet Year (2017)

Table 5-10. List of Potential Freshwater Species, Sutter Subbasin

Scientific Name	Common Name	Group	Federal Protection Status	State Protection Status
Ambystoma californiense	California tiger salamander	Amphibians	Threatened	Threatened
Rana boylii	foothill yellow-legged frog	Amphibians	None	Endangered
Agelaius tricolor	tricolored blackbird	Birds	None	Threatened
Antigone canadensis tabida	greater sandhill crane	Birds	None	Threatened
Athene cunicularia	burrowing owl	Birds	None	None
Branta hutchinsii leucopareia	cackling (Aleutian Canada) goose	Birds	Delisted	None
Buteo swainsoni	Swainson's hawk	Birds	None	Threatened
Coccyzus americanus occidentalis	western yellow-billed cuckoo	Birds	Threatened	Endangered
Laterallus jamaicensis coturniculus	California black rail	Birds	None	Threatened
Melospiza melodia	song sparrow ("Modesto" population)	Birds	None	None
Nycticorax nycticorax	black-crowned night heron	Birds	None	None
Riparia riparia	bank swallow	Birds	None	Threatened
Spinus lawrencei	Lawrence's goldfinch	Birds	None	None
Vireo bellii pusillus	least Bell's vireo	Birds	Endangered	Endangered
Branchinecta lynchi	vernal pool fairy shrimp	Crustaceans	Threatened	None
Lepidurus packardi	vernal pool tadpole shrimp	Crustaceans	Endangered	None
Linderiella occidentalis	California linderiella	Crustaceans	None	None
Amsinckia lunaris	bent-flowered fiddleneck	Dicots	None	None
Astragalus tener var. ferrisiae	Ferris' milk-vetch	Dicots	None	None
Brasenia schreberi	watershield	Dicots	None	None
Cuscuta obtusiflora var. glandulosa	Peruvian dodder	Dicots	None	None
Delphinium recurvatum	recurved larkspur	Dicots	None	None
Hibiscus lasiocarpos var. occidentalis	woolly rose-mallow	Dicots	None	None
Layia septentrionalis	Colusa layia	Dicots	None	None

Scientific Name	Common Name	Group	Federal Protection Status	State Protection Status
Monardella venosa	veiny monardella	Dicots	None	None
Navarretia leucocephala ssp. bakeri	Baker's navarretia	Dicots	None	None
Pseudobahia bahiifolia	Hartweg's golden sunburst	Dicots	Endangered	Endangered
Trichocoronis wrightii var. wrightii	Wright's trichocoronis	Dicots	None	None
Oncorhynchus mykiss irideus pop. 11	steelhead - Central Valley DPS	Fish	Threatened	None
Oncorhynchus tshawytscha pop. 11	chinook salmon - Central Valley spring-run ESU	Fish	Threatened	Threatened
Pogonichthys macrolepidotus	Sacramento splittail	Fish	None	None
Spirinchus thaleichthys	longfin smelt	Fish	Candidate	Threatened
Thaleichthys pacificus	eulachon	Fish	Threatened	None
Northern Hardpan Vernal Pool	Northern Hardpan Vernal Pool	Herbaceous	None	None
Anthicus antiochensis	Antioch Dunes anthicid beetle	Insects	None	None
Anthicus sacramento	Sacramento anthicid beetle	Insects	None	None
Cicindela hirticollis abrupta	Sacramento Valley tiger beetle	Insects	None	None
Desmocerus californicus dimorphus	valley elderberry longhorn beetle	Insects	Threatened	None
Antrozous pallidus	pallid bat	Mammals	None	None
Dipodomys californicus eximius	Marysville California kangaroo rat	Mammals	None	None
Erethizon dorsatum	North American porcupine	Mammals	None	None
Lasiurus blossevillii	western red bat	Mammals	None	None
Lasiurus cinereus	hoary bat	Mammals	None	None
Perognathus inornatus	San Joaquin pocket mouse	Mammals	None	None
Coastal and Valley Freshwater Marsh	Coastal and Valley Freshwater Marsh	Marsh	None	None
Gonidea angulata	western ridged mussel	Mollusks	None	None
Heteranthera dubia	water star-grass	Monocots	None	None
Sagittaria sanfordii	Sanford's arrowhead	Monocots	None	None

Scientific Name	Common Name	Group	Federal Protection Status	State Protection Status
Wolffia brasiliensis	Brazilian watermeal	Monocots	None	None
Emys marmorata	western pond turtle	Reptiles	None	None
Thamnophis gigas	giant gartersnake	Reptiles	Threatened	Threatened
Great Valley Cottonwood Riparian Forest	Great Valley Cottonwood Riparian Forest	Riparian	None	None
Great Valley Mixed Riparian Forest	Great Valley Mixed Riparian Forest	Riparian	None	None
Great Valley Willow Scrub	Great Valley Willow Scrub	Riparian	None	None

This page intentionally left blank.

5.3 Water Budget

5.3.1 Water Budget Background

Water budgets are developed to provide a quantitative account of water entering and leaving the Sutter Subbasin. Water entering and leaving the Subbasin includes flows at the surface and in the subsurface environment. Water enters and leaves due to natural conditions, such as precipitation and streamflow, and/or through human activities, such as groundwater pumping or recharge from applied water. Additionally, the interconnection between the groundwater system and rivers/streams accounts for other components of the water budget. **Figure 5-99** depicts the major components of a water budget and their interconnection as presented in the context of surface and groundwater systems.

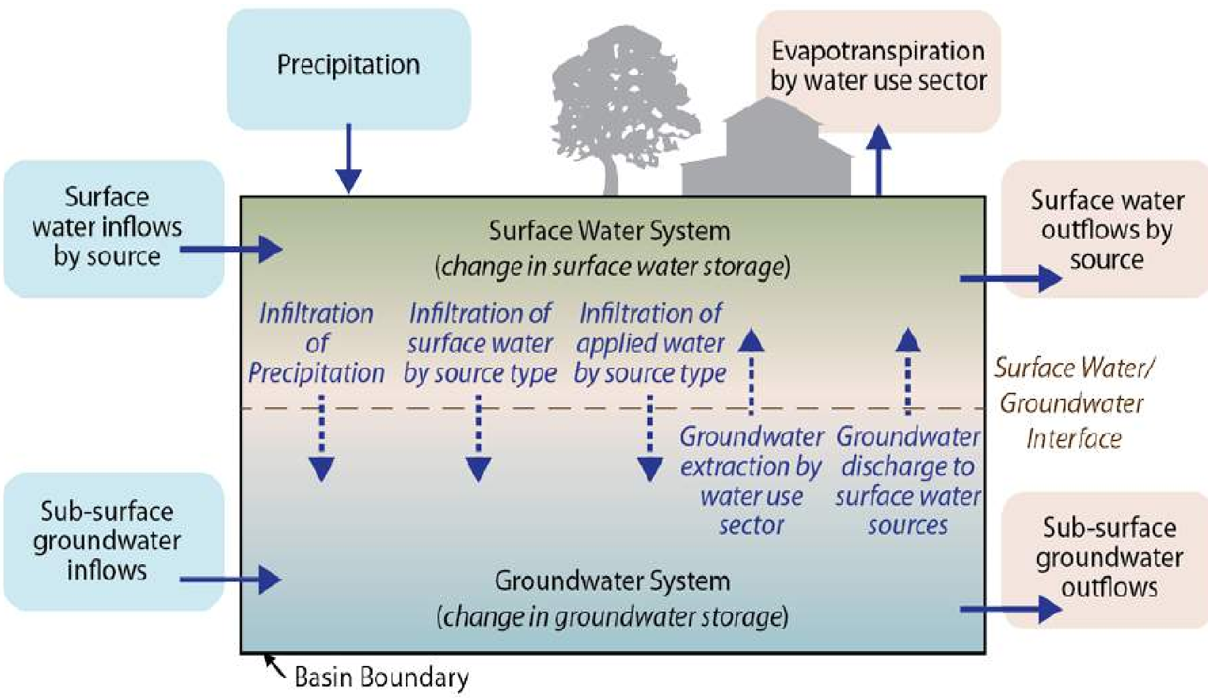


Figure 5-99. Generalized Water Budget Diagram

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

Water Simulation Model – Fine Grid, Sutter Subbasin (C2VSimFG-Sutter) integrated water flow model.

C2VSimFG-Sutter was developed to be the primary analytical tool supporting the development of the GSP water budgets and simulates water years (WY) 1986 through 2015. The C2VSimFG-Sutter model was adapted from C2VSimFG v1.0, released by DWR in December 2020, with updates to better represent local conditions (SGMO, 2020). C2VSimFG-Sutter model includes the entire C2VSimFG model extent of the California Central Valley, but with data updates and calibration focused only on the area within and immediately surrounding Sutter Subbasin. The Subbasin, plus a five-mile buffer around the Subbasin boundaries, was chosen as the groundwater level and water budget calibration area for the model. More details regarding the local refinements and calibration of C2VSimFG-Sutter model are included in the model report (**Appendix 5-G**). Water budget results shown in this section of the GSP represent only the water budgets of the Subbasin and do not include the five-mile calibration buffer. Simulated flows from Sutter Subbasin to surrounding groundwater subbasins are also derived from C2VSimFG-Sutter.

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

The GSP Regulations require that the annual water budget quantify three different conditions: historical, current, and projected. Budgets are developed to capture typical conditions during these time periods. Typical conditions are developed by selecting historical hydrologic periods that incorporate droughts, wet periods, and normal periods. By incorporating these varied conditions within the budgets, the Subbasin is analyzed under varying hydrologic conditions, such as drought or very wet events, along with long-term averages.

This GSP relies on historical hydrology to identify time periods for water budget analysis and uses the C2VSimFG-Sutter model and associated data to develop the water budget and resulting budget estimates. The water budget components developed for the Sutter Subbasin are based upon estimates developed from historical and projected data as well as modeling assumptions. As both the C2VSimFG and C2VSimFG-Sutter models are updated and the availability of data continues to improve, the water budget assumptions may be refined in the future, the water budget may change, and the conclusions and recommendations derived from the water budget may also change.

5.3.2 Identification of Hydrologic Periods

The historical hydrologic periods used in this GSP were selected to meet the SGMA requirements for developing historical, current, and projected conditions water budgets.

The GSP Regulations require that the projected conditions water budget reflect at least a 50-year hydrologic period in order to project how the Subbasin's surface and groundwater systems may react under long-term average hydrologic conditions. Consistent with the Regulations, the minimum 50-year historical record characterizes future conditions with respect to precipitation, evapotranspiration, and streamflow. Historical precipitation or rainfall in the Sutter Subbasin was used to identify a hydrologic period that would provide a representation of wet and dry periods and long-term average conditions needed for water budget analyses. Rainfall data for the Subbasin are derived from C2VSimFG v1.0 and are from the PRISM (Precipitation-Elevation Regressions on Independent Slopes Model) dataset of DWR's California Simulation of Evapotranspiration of Applied Water (CALSIMETAW) model. PRISM is a spatial estimation of rainfall data developed using monitoring network point data and interpolated using a variety of factors (OSU, 2021).

Wet and dry hydrologic periods were identified by evaluating various historical periods between which average precipitation was similar to the long-term average precipitation conditions and that had representative water year type distributions using the Sacramento Valley Water Year Hydrologic Classification (DWR, 2021a). Ultimately, the 20-year period between Water Year (WY) 1996-2015 was found to have the same 18.8 inches of average precipitation as the 99-year long-term average from 1922-2020. During this period, there was also a similar distribution of water year types as the 99-year long-term average.

The latest year in the historical simulation that is still representative of conditions in the Subbasin today is WY 2013, which has an annual average rainfall of 17.3 inches, but still has land use, demands, and surface water supplies similar to current values. For this reason, WY 2013 in the historical calibration was selected to best represent the Subbasin current conditions.

Figure 5-100 shows the Subbasin annual precipitation, average precipitation, and cumulative departure from mean precipitation in each year. This plot represents the spatially-averaged precipitation across Sutter Subbasin elements. The long-term average precipitation is subtracted from annual precipitation within each water year to develop the departure from average precipitation for each water year. Wet years have a positive departure and dry years have a negative departure. Subsequently, a year with exactly average precipitation would have zero departure. Starting at the first year analyzed, the departures are added cumulatively for each year. For example, if the departure for Year 1 is 5 inches and the departure for Year 2 is -2 inches, the cumulative departure would be 5 inches for Year 1 and 3 inches (5 plus -2) for Year 2. The figure includes bars displaying annual precipitation for each water year from 1922 through 2020 and a horizontal line representing the mean precipitation of 18.8 inches. The cumulative departure from average precipitation is based on these data sets and is displayed as a line that highlights wet periods with upward slopes (positive departure) and dry periods with downward slopes (negative departure). More severe events are shown by steeper slopes and greater changes. For example, the most recent drought period can be observed as a decline between 2011 and 2016 where there is approximately a 3.7-inch decline per year in cumulative departure within that 5-year period.

The PRISM estimates for rainfall in the Subbasin were confirmed by comparing the cumulative departure from mean precipitation results to the water year types in the Sacramento Valley Water Year Hydrologic Classification (DWR, 2021a), which classifies WYs 1901 through 2020 as wet, above normal, below normal, dry, and critical based on inflows to major reservoirs or lakes. Wet (W) or Above Normal (AN) years generally show upward sloping cumulative departures, while Below Normal (BN), Dry (D), or Critical (C) water year types show downward trending cumulative departures (**Figure 5-100**).

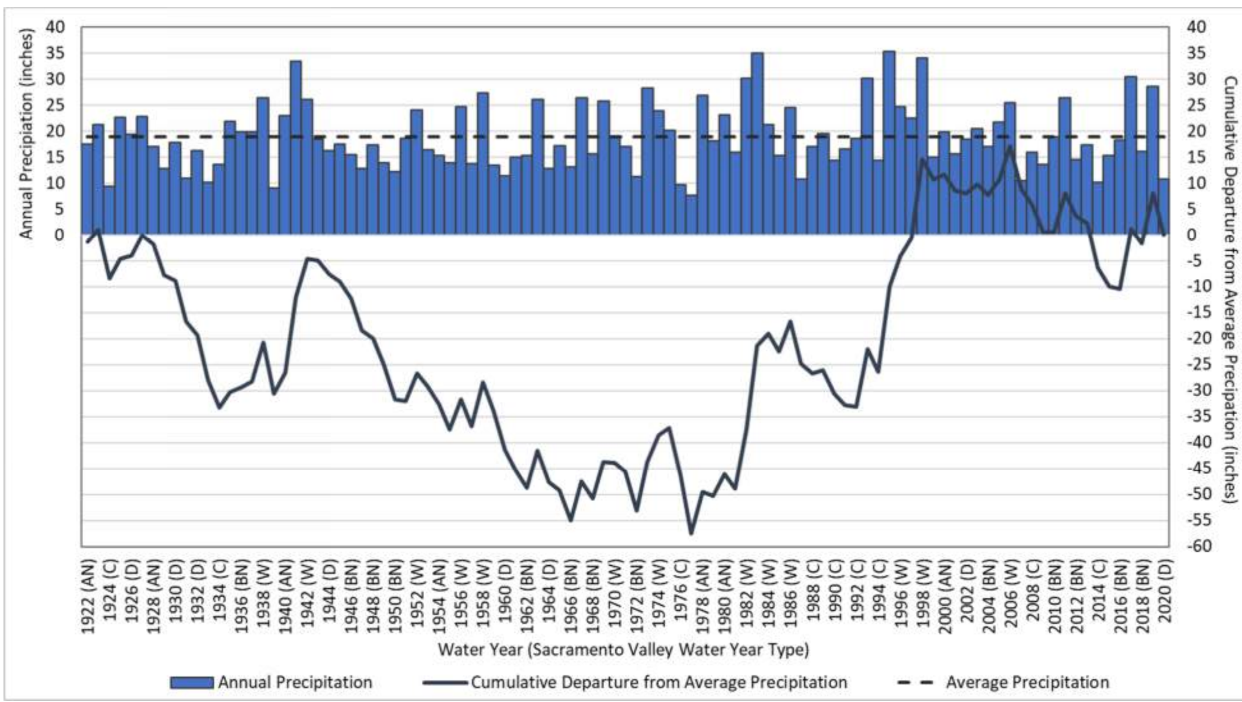


Figure 5-100. 99-Year Historical Precipitation and Cumulative Departure from Mean Precipitation

5.3.3 Use of C2VSimFG-Sutter and Associated Data in Water Budget Development

This GSP includes water budgets developed utilizing the C2VSimFG-Sutter model, a fully integrated surface and groundwater flow model covering the entire Central Valley, calibrated to the Sutter Subbasin area.

With C2VSimFG-Sutter as the underlying framework, three model scenarios were developed representing historical, current, and projected conditions in the Sutter Subbasin, as discussed below:

- **Historical conditions water budget** represents the average over the historical model period from WYs 1996 through 2015 (20 years).
- Current conditions water budget is a single year in the historical model calibration that represents current trends in level of development, water supply, and water demand. WY 2013 was selected for demands and supplies that were not yet heavily impacted by the drought and land use that is still comparable to present land use.
- Projected conditions water budget represents estimated long-term conditions of the Subbasin under the foreseeable future level of development over a long-term period of hydrologic conditions (20-year period from WYs 1996 through 2015 repeated three times).
- Projected conditions water budget with climate change represents estimated long-term conditions of the Subbasin under the foreseeable future level of development over a long-term period of hydrologic conditions (20-year period from WYs 1996 through 2015 repeated three times) with additional modifications to precipitation, evapotranspiration, and streamflow to reflect impacts of climate change.

5.3.4 Water Budget Definitions and Assumptions

Definitions and assumptions for the historical, current, and projected conditions water budgets are provided in the sections below and summarized in **Table 5-11**.

Table 5-11. Summary of Water Budget Assumptions – Historical, Current, and Projected Periods

Water Budget Type	Historical	Current	Projected Conditions	Projected Conditions with Climate Change
Tool	C2VSimFG-Sutter	C2VSimFG-Sutter	C2VSimFG-Sutter	C2VSimFG-Sutter
Scenario	Historical Calibration	Current Conditions	Projected Conditions	Projected Conditions with Climate Change
Hydrologic Years (WYs)	1996-2015	2013	1996-2015 [3]	1996-2015 [3]
Level of Development	Historical [2]	Current (2013)	Projected 2040 conditions based on local information [1]	Projected 2040 conditions based on local information [1]

Water Budget Type	Historical	Current	Projected Conditions	Projected Conditions with Climate Change
Agricultural Demand [2]	Historical [2]	Current (2013)	Projected based on recent historical local data	Projected based on recent historical local data, increased to reflect 2070 climate change conditions
Urban Demand	Historical [2]	Current (2013)	Projected based on recent historical population growth rates	Projected based on recent historical population growth rates
Managed Wetlands Demand	Historical	Current (2013)	Projected based on recent historical local data and for Sutter NWR, monthly ideal delivery schedule for Level 4 water supply demand through the Refuge Water Supply Program provided by USBR.	Projected based on recent historical local data and for Sutter NWR, monthly ideal delivery schedule for Level 4 water supply demand through the Refuge Water Supply Program provided by USBR.
Water Supplies	Historical [2]	Current (2013)	Projected based on recent historical local data	Projected based on recent historical local data, modified to reflect 2070 climate change conditions

[1] Yuba City and Live Oak are assumed to buildout to sphere of influence boundaries.
[2] For more information on historical assumptions, see the model report (Appendix 5-G).
[3] Hydrologic years WYs 1996-2015 are repeated 3 times for a total of 60 years of projected conditions hydrology.

5.3.4.1 Assumptions Used in the Historical Water Budget

The historical water budget is intended to evaluate availability and reliability of past surface water supply deliveries, aquifer response to water supply, and demand trends relative to water year type. The historical water budget period of the C2VSimFG-Sutter model reflects the historical conditions in the Sutter Subbasin over WYs 1996 through 2015. The hydrologic period has an average annual precipitation of approximately 18.8 inches and includes the recent 2012-2015 drought, the wetter years of 1996-2000, and periods of normal precipitation. Furthermore, the GSP Regulations require the use of a minimum of 10 years to develop the historical water budget.

Calibration of the historical model was focused on the Sutter Subbasin within the C2VSimFGv1.0 model area. Calibration of groundwater levels was focused on the Sutter Subbasin in addition to a five-mile buffer around the Subbasin to ensure interbasin flows were simulated accurately. Additional details of the data used in the development of the historical calibration can be found in the model report (**Appendix 5-G**).

The historical water budget includes the following:

- **Hydrologic Period**: WYs 1996 through 2015 (20-year hydrology)
- **Stream Flows**: Based on the published C2VSimFG v1.0
- **Reservoir Operations**: Based on the published C2VSimFG v1.0. While Oroville Dam, Nimbus Dam, Shasta Dam, among others, lie upstream and mediate flow into the Sacramento and Feather Rivers, there are no reservoir operations modeled within the Sutter Subbasin boundary or the five-mile calibration buffer.
- **Land Use and Cropping Patterns**: Based on the published C2VSimFG v1.0. Since 1998, the only area of recent agricultural expansion is near the Sutter Buttes. Otherwise, land use is considered to have changed relatively little since 1998.
- **Urban Water Demand**: Calculated for the Subbasin's urban areas, including the cities of Yuba City and Live Oak. Demands for other domestic areas are estimated based on rural population. Urban water demand is based on:
    - Urban water use is based on the published C2VSimFG v1.0.
    - Urban center population was estimated based on data from the U.S. Census and updated using local data.
- **Surface Water Deliveries**: Deliveries to agricultural and urban areas based on the published C2VSimFG v1.0 with refinements due to local agency information.
- **Groundwater Pumping**: Simulated by C2VSimFG-Sutter.
    - Data on private pumping were not available on a consistent basis across the model, so private pumping was estimated as that which would be required to meet agricultural and rural residential water needs using the C2VSimFG-Sutter model.

5.3.4.2 Assumptions Used in the Current Conditions Water Budget

The current conditions water budget represents a recent level of development and agricultural demand.

The current conditions water budget includes the following assumptions:

- **Hydrologic Period**: WY 2013

- **Stream Flows**: WY 2013
- **Reservoir Operations**: Based on the published C2VSimFG v1.0. While Oroville Dam, Nimbus Dam, Shasta Dam (among others) lie upstream and mediate flow into the Sacramento and Feather Rivers, there are no reservoir operations modeled within the Sutter Subbasin boundary or the five-mile calibration buffer.
- **Land Use and Cropping Patterns**: Consistent with the historical model for WY 2013. Land use from WY 2013 is considered to represent current conditions based on local knowledge that land use changed relatively little between 2013 and 2021.
- **Urban Water Demand**: Urban water demands are consistent with the historical model WY 2013 and calculated for all the urban areas in the model, including the cities of Yuba City and Live Oak.
- **Surface Water Deliveries**: Consistent with the historical model for WY 2013.
- **Groundwater Pumping**: Simulated by C2VSimFG-Sutter.
    - Data on private pumping were not available on a consistent basis across the model, so private pumping was estimated as that which would be required to meet agricultural and rural residential water needs using the C2VSimFG-Sutter model.

5.3.4.3 Assumptions Used in the Projected Conditions Water Budget

The projected conditions water budget is intended to assess the conditions of the Subbasin under future conditions of water supply and agricultural and urban demand, including quantification of uncertainties in the components. The projected conditions scenario applies future land and water use conditions and uses a 60-year hydrologic period simulated by using WY 1996 through 2015 hydrology repeated three times. The model is assumed to represent 2040 conditions in progress toward full buildout. These conditions are represented using projected population, land use, and water demand and supply projections. Results of the projected conditions scenario under potential climate change conditions (changes to precipitation, stream flows, and evapotranspiration) are presented in **Section 5.3.5.3**.

The projected conditions scenario includes the following conditions:

- **Hydrologic Period**: WYs 1996 through 2015, repeated three times for a 60-year projected hydrology.
- **Stream Flows**: Historical model WYs 1996 through 2015, repeated three times for 60-year projected hydrology.
- **Reservoir Operations**: Unchanged from historical model.
- **Land Use and Cropping Patterns**: Based on local information received from the Sutter Subbasin Groundwater Sustainability Agencies (GSAs) on expected changes to their crop distribution at the end of the historical model (WY 2015). The cities of

Live Oak and Yuba City are assumed to buildout to their sphere of influence boundaries.

- **Urban Water Demand**: Calculated for all the urban areas in the model, including the cities of Yuba City and Live Oak, based on growth applied to the last year of the historical simulation (WY 2015). Population in Sutter Subbasin is assumed to grow at the same rate as it did in the last 12 years of the historical simulation, projected out to 2040.
- **Agricultural Operations**: Operations in the projected model are based on the conditions simulated at the end of the historical model.
- **Surface Water Deliveries**: Based on historical diversion time series. The most recent 12 years of diversions were averaged by water year type. These diversions were projected into the future using the 60-year hydrologic period to determine the pattern of water year types.
    - Sutter National Wildlife Refuge (NWR) Diversions: Projected model simulates Sutter NWR Diversions at monthly ideal delivery schedule for full Level 4 water supply demand through the Refuge Water Supply Program (RWSP) provided by US Bureau of Reclamation (G. Young, personal communication, February 24, 2021)[1]. This monthly schedule is used for all years in the projected model.
- **Groundwater Pumping**: Simulated by C2VSimFG-Sutter.
    - Data on private pumping were not available on a consistent basis across the model, so private pumping was estimated as that which would be required to meet agricultural and rural residential water needs using the C2VSimFG-Sutter model.

5.3.4.4 Assumptions Used in the Projected Conditions with Climate Change Water Budget

The projected conditions water budget with climate change is intended to assess the impact of climate change under future conditions of water supply and agricultural and urban demand. The projected conditions with climate change scenario applies the same future land and water use conditions as the projected conditions scenario and uses the simulated 60-year hydrologic period (WYs 1996 through 2015 repeated three times) that is used in the projected conditions scenario. The climate change impacts evaluated in the model are assumed to represent 2070 precipitation, evapotranspiration, and streamflow conditions. Climate change conditions were estimated using 2070 central tendency datasets provided by DWR. These datasets were derived from output produced by an ensemble of global climate models chosen by DWR to best represent

[1] Sutter NWR ideal delivery schedule for Full Level 4 water supply demand was received through email communication from Greg Young of Tully & Young.

impacts of climate change in California. Further detail on how these datasets were developed and adapted to the Sutter Subbasin can be found in **Appendix 5-H**.

The projected conditions with climate change scenario includes the following conditions:

- **Hydrologic Period**: WYs 1996 through 2015, repeated three times for a 60-year projected hydrology.
- **Stream Flows**: Historical model WYs 1996 through 2015, repeated three times for a 60-year projected hydrology, modified by watershed-specific perturbation factors reflecting 2070 climate change conditions provided by DWR.
- **Reservoir Operations**: Unchanged from historical model.
- **Land Use and Cropping Patterns**: Same as projected conditions model.
- **Urban Water Demand**: Same as projected conditions model. Urban landscape evapotranspiration is increased to reflect increasing temperatures under 2070 climate change conditions using the Variable Infiltration Capacity (VIC) model-derived perturbation factors provided by DWR.
- **Agricultural Operations**: Operations in the projected model are based on the conditions simulated at the end of the historical model. Agricultural evapotranspiration is increased to reflect increasing temperatures under 2070 climate change conditions using VIC model-derived perturbation factors provided by DWR.
- **Surface Water Deliveries**: Same as projected conditions model.
- **Groundwater Pumping**: Simulated by the C2VSimFG-Sutter model.
    - Data on private pumping was not available on a consistent basis across the model, so private pumping was estimated as that which would be required to meet agricultural and rural residential water needs using the C2VSimFG-Sutter model.

5.3.5 Water Budget Estimation

The C2VSimFG-Sutter model simulates the major hydrologic processes that affect the surface and groundwater systems in the Sutter Subbasin. The major hydrologic processes can be represented by separate water budgets which detail inflows and outflows occurring at the surface scale (budget balancing how demands on urban, agricultural, and native lands are met by rainfall, surface water deliveries available from streamflow, or groundwater pumping) and at the groundwater scale (budget detailing flows occurring within the groundwater aquifers of the Subbasin).

The primary components of the surface system are:

- **Inflows**:
    - Precipitation

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

The primary components of the groundwater system are:

- **Inflows**:
  - Deep percolation from precipitation, applied water (surface water and groundwater) for agricultural lands, and applied water (surface water and groundwater) for refuge use
  - Stream seepage (i.e., losses from Sacramento River, Feather River, and Sutter Bypass to the groundwater system)
  - Land subsidence inflow
  - Conveyance seepage
  - Subsurface inflow
- **Outflows**:
  - Groundwater outflow to streams (i.e., loss from the groundwater system to or stream gains for Sacramento River, Feather River, and Sutter Bypass)
  - Groundwater pumping
  - Subsurface outflow (i.e., to surrounding subbasins)
- <u>**Change in Groundwater Storage (Inflows Minus Outflows**)</u>: This reflects average annual change in groundwater storage.

The estimated water budgets for the historical, current conditions, projected conditions, and projected conditions with climate change scenarios are provided below, with results summarized in **Table 5-12** and **Table 5-13**.

This page intentionally left blank.

Table 5-12. Average Annual Surface System Water Budget Components

Component	Historical Calibration (AF/year)	Current Conditions (AF/year)	Projected Conditions (AF/year)	Projected Conditions With Climate Change (2070 CT) (AF/year)
Hydrologic Period	**WY 1996-2015**	**WY 2013**	**WY 1996-2015 Repeated 3 Times**	**WY 1996-2015 Repeated 3 Times with Climate Change**
Inflows				
Precipitation	455,000	417,000	454,000	480,000
Surface Water Delivery [1]	572,000	629,000	579,000	578,000
Agricultural	522,000	584,000	479,000	479,000
Urban	14,000	18,000	15,000	15,000
Managed Wetlands	36,000	27,000	85,000	84,000
Groundwater Pumping	139,000	155,000	138,000	157,000
Agricultural	130,000	149,000	105,000	123,000
Urban	8,000	5,000	22,000	22,000
Managed Wetlands	1,000	1,000	11,000	12,000
Riparian Intake from Streams [2]	27,000	28,000	14,000	15,000
Total Inflow	***1,193,000***	***1,229,000***	***1,185,000***	***1,230,000***
Outflows				
Evapotranspiration [3]	604,000	627,000	645,000	690,000
Agricultural	509,000	538,000	548,000	588,000
Urban	9,000	9,000	24,000	25,000
Managed Wetlands	6,000	6,000	20,000	21,000
Native and Riparian Vegetation	80,000	74,000	53,000	56,000
Runoff to Streams [4]	150,000	136,000	143,000	166,000
Return Flow to Streams [5]	252,000	257,000	218,000	200,000
Agricultural	186,000	190,000	107,000	90,000
Urban	13,000	13,000	22,000	22,000
Managed Wetlands	27,000	18,000	57,000	56,000
Pond Drain	26,000	36,000	32,000	32,000
Deep Percolation [6]	189,000	203,000	179,000	174,000
Precipitation	57,000	54,000	54,000	52,000
Applied Surface Water [7]	106,000	120,000	101,000	96,000
Applied Groundwater [8]	26,000	29,000	24,000	26,000
Total Outflow [9]	***1,195,000***	***1,223,000***	***1,185,000***	***1,230,000***
Change in Storage [10]	**-2,000**	**6,000**	**0**	**0**

1 Surface water deliveries shown in this table are the volumes of water delivered to the different areas of the Subbasin. These totals are after losses due to evaporation and canal seepage. Differences between scenarios are due to differences in current and planned surface water deliveries.
2 Riparian intake from streams is the portion of the riparian vegetation evapotranspiration met by stream flows. Differences between scenarios may be due to availability of stream flows or extent of riparian vegetation, which may be affected by growth in urban areas.
3 Evapotranspiration is the demand required by agricultural land (i.e., crops); municipal and domestic areas (i.e., urban demands); and refuge, native, and riparian areas. Differences in evapotranspiration are largely related to differences in urban areas between the scenarios and the loss of agricultural or native/riparian land as urban growth occurs. Temperature increases under climate change account for higher evapotranspiration rates under the projected conditions climate change scenario.
4 Runoff to the stream system is due to precipitation. As urban areas are assumed to have greater runoff of precipitation (resulting from more paved area), the changes in runoff between the model scenarios are largely due to differences in the size of urban areas and the amount of precipitation the occurs in the historical/current/projected scenarios.
5 Return flow to the stream system is due to applied water, either surface water or groundwater used for agricultural, urban, or managed wetland purposes. Differences between the scenarios is primarily related to the urban growth in the projected conditions scenario causing higher urban demand in relation to agricultural demand. This results in less applied water to irrigable lands that can return to the streams. Increases in surface water flows to Sutter National Wildlife Refuge in the projected conditions scenario also accounts for some of the differences.
6 Deep percolation is the amount of infiltrated water ultimately reaching the groundwater system. The source of the water may be from precipitation or applied water used for agricultural, urban, or managed wetland purposes. Differences between scenarios are related to differences already noted between these sources of water and differences in the infiltration parameters related to land use.
7 Applied surface water is the volume of delivered surface water that leaves the surface system as deep percolation after agricultural, urban, and managed wetland demands are met. Differences between scenarios are due to differences in current and planned surface water deliveries and crop types.
8 Applied groundwater is the volume of delivered groundwater that leaves the surface system as deep percolation after agricultural, urban, and managed wetland demands are met. Differences in demand largely drive the amount of groundwater pumped and therefore applied.
9 Summations in table may not match the numbers in the table. This is due to the rounding of model results.
10 Change in storage in the surface system water budget refers to the change in root zone soil moisture.

Table 5-13. Average Annual Groundwater System Water Budget Components

Component	Historical Calibration (AF/year)	Current Conditions (AF/year)	Projected Conditions (AF/year)	Projected Conditions With Climate Change (2070 CT) (AF/year)
Hydrologic Period	**WY 1996-2015**	**WY 2013**	**WY 1996-2015 Repeated 3 Times**	**WY 1996-2015 Repeated 3 Times with Climate Change**
Inflows				
Deep Percolation [1]	189,000	203,000	179,000	174,000
Precipitation [2]	57,000	54,000	54,000	52,000
Applied Surface Water [3]	106,000	120,000	101,000	96,000
Applied Groundwater [4]	26,000	29,000	24,000	26,000
Stream Seepage[5]	143,000	127,000	125,000	137,000
Sacramento River	63,000	60,000	64,000	69,000
Feather River	32,000	28,000	19,000	21,000
Sutter Bypass	48,000	39,000	42,000	47,000
Land Subsidence Inflow	0	0	0	0
Conveyance Seepage	36,000	39,000	37,000	37,000
Subsurface Inflow [6]	88,000	83,000	145,000	152,000
Butte Subbasin	26,000	26,000	36,000	37,000
Colusa Subbasin	21,000	19,000	21,000	20,000
North American Subbasin	1,000	0	15,000	16,000
North Yuba Subbasin	7,000	5,000	16,000	18,000
South Yuba Subbasin	9,000	10,000	28,000	29,000
Wyandotte Creek Subbasin	0	0	0	0
Yolo Subbasin	17,000	17,000	23,000	25,000
Sutter Buttes	7,000	6,000	6,000	7,000
Total Inflow	***456,000***	***452,000***	***486,000***	***500,000***
Outflows				
Groundwater Outflow to Streams [5]	224,000	212,000	268,000	263,000
Sacramento River	125,000	124,000	139,000	141,000
Feather River	54,000	52,000	80,000	77,000
Sutter Bypass	45,000	36,000	49,000	45,000
Groundwater Pumping [7]	139,000	155,000	138,000	157,000
Agricultural	130,000	149,000	105,000	123,000
Urban	8,000	5,000	22,000	22,000
Managed Wetlands	1,000	1,000	11,000	12,000
Subsurface Outflow [6]	100,000	104,000	79,000	79,000
Butte Subbasin	15,000	15,000	13,000	12,000
Colusa Subbasin	34,000	36,000	35,000	36,000
North American Subbasin	13,000	15,000	1,000	1,000
North Yuba Subbasin	7,000	7,000	3,000	3,000
South Yuba Subbasin	5,000	4,000	2,000	2,000
Wyandotte Creek Subbasin	2,000	2,000	2,000	2,000
Yolo Subbasin	24,000	25,000	23,000	23,000
Total Outflow [8]	**463,000**	**471,000**	**485,000**	**499,000**
Change in Groundwater Storage	**-7,000**	**-19,000**	**1,000**	**1,000**

1 Deep percolation is the amount of infiltrated water ultimately reaching the groundwater system. The source of the water may be from precipitation or applied water used for agricultural, urban, or managed wetland purposes. Differences between scenarios are related to differences already noted between these sources of water and differences in the infiltration parameters related to land use.
2 Precipitation includes the amount of precipitation that ultimately enters the groundwater system as deep percolation. Table 5-12 shows the total precipitation that falls in the Sutter Subbasin on an average annual basis.
3 Applied surface water is the volume of delivered surface water that leaves the surface system as deep percolation after agricultural, urban, and managed wetland demands are met. Differences between scenarios are due to differences in current and planned surface water deliveries and crop types.
4 Applied groundwater is the volume of delivered groundwater that leaves the surface system as deep percolation after agricultural, urban, and managed wetland demands are met. Differences in demand largely drive the amount of groundwater pumped and therefore applied.
5 Streams interacting with Sutter Subbasin include Feather River, Sacramento River, and Sutter Bypass. Stream gain from groundwater and stream seepage represent the interactions between surface water and groundwater. Differences between the scenarios are related to differing hydrologic periods and differences in stream flows and long-term average groundwater elevations.
6 Subsurface inter-basin flows are estimated by the C2VSimFG-Sutter model to maintain a reasonable balance between the neighboring groundwater subbasins. Continuing inter-basin coordination may refine these numbers.
7 Groundwater pumping is estimated by the C2VSimFG-Sutter model based on the need for additional water to meet remaining demands after surface water deliveries occur. Differences in demand largely drive the amount of groundwater pumped.
8 Summations in table may not match the numbers in the table. This is due to the rounding of model results.

5.3.5.1 Historical Conditions Water Budget Estimates

The historical water budget in **Table 5-12** and **Table 5-13** is a quantitative tabulation of the historical surface and groundwater systems as represented in the historical simulation of the C2VSimFG-Sutter model covering the 20-year period of WYs 1996 through 2015. The historical calibration is discussed in detail in the historical model documentation (**Appendix 5-G**). Per the GSP Emergency Regulations §354.18, the water budget includes estimates for supply and demand while summarizing flows within the Subbasin, including the movement of all primary sources of water such as precipitation, agricultural water supplies, stream interaction, and subsurface flows. The stream network that borders the Sutter Subbasin supplies water to multiple agricultural water users as well as Yuba City. Stream interactions and managed operations in adjacent groundwater subbasins that share a stream boundary with Sutter Subbasin may impact water budget estimations within Sutter Subbasin. The largest boundary is shared with North and South Yuba Subbasins along Feather River and the Colusa Subbasin along Sacramento River.

The surface system water budget in the historical calibration of the Sutter Subbasin, shown in **Figure 5-101**, estimates almost 1.19 million acre-feet per year (MAF/year) of inflows resulting from a combination of precipitation (455,000 acre-feet [AF]/year), surface water supply (572,000 AF/year), groundwater supply (139,000 AF/year), and riparian intake from streams (27,000 AF/year). The outflow from the surface system in the historical calibration (also estimated to be around 1.19 MAF/year) is comprised of evapotranspiration (close to 604,000 AF/year), runoff to the stream system (150,000 AF/year), return flow of applied water to the stream system (252,000 AF/year), and deep percolation of precipitation or applied water (189,000 AF/year). Approximately 91% of surface water deliveries are used for agricultural use, with 6% for managed wetlands and 2% for urban. The historical model indicates that approximately 84% of evapotranspiration losses occur from agriculture and 13% from native and riparian vegetation, with the remaining 3% for urban and managed wetlands.

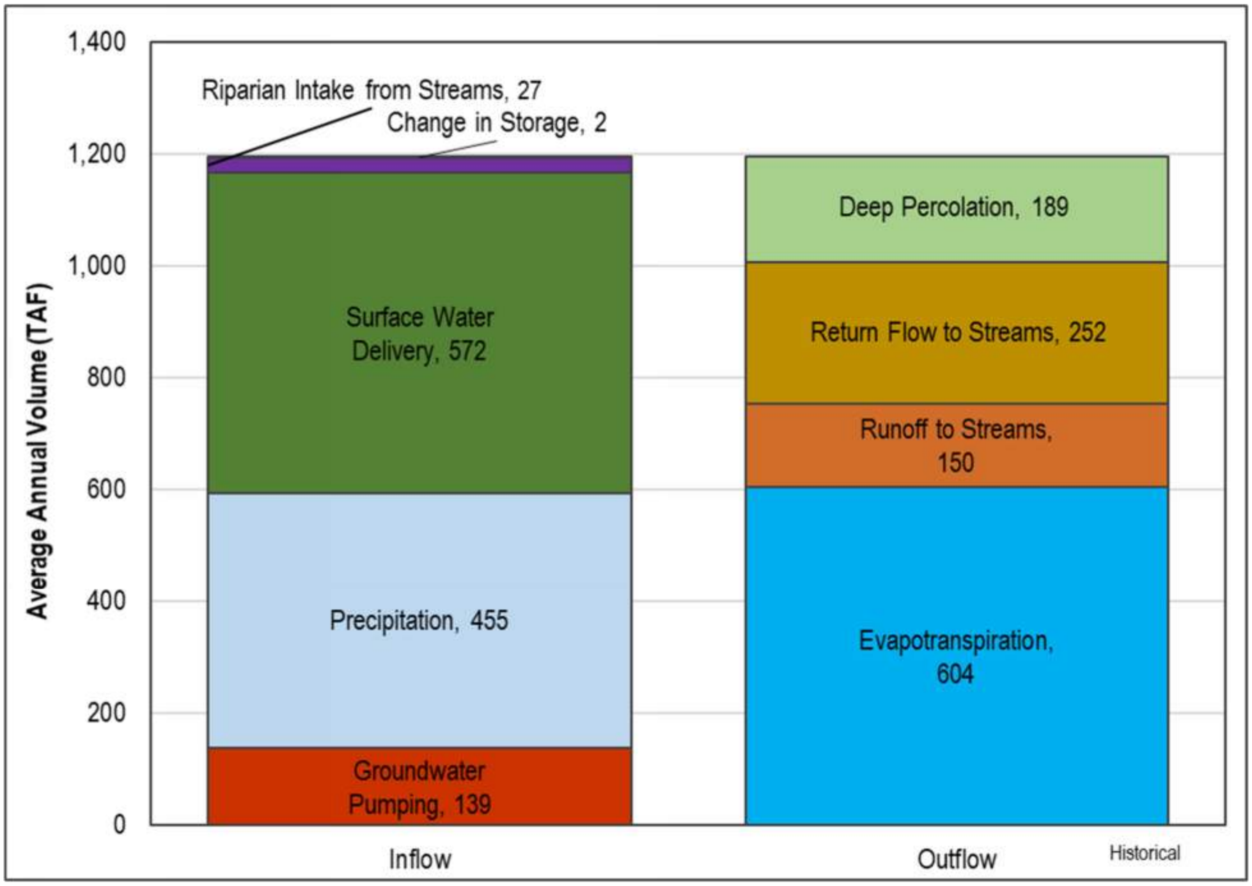


Figure 5-101. Historical Average Annual Water Budget – Surface System

The groundwater system of the Sutter Subbasin includes 456,000 AF/year of inflows in the historical calibration (not including change in groundwater storage), of which 189,000 AF/year is deep percolation of precipitation or applied water (groundwater and surface water). There is also stream seepage (143,000 AF/year), and subsurface inflows (88,000 AF/year) from the neighboring groundwater subbasins of Colusa, Yolo, North American, North and South Yuba, Butte, and a very small portion from Wyandotte Creek Subbasin. Sutter Buttes also contributes subsurface inflows. The primary outflow from the groundwater system is groundwater pumping (139,000 AF/year), followed by loss to streams (net 81,000 AF/year). Subsurface outflow to the neighboring groundwater subbasins is approximately 100,000 AF/year. Approximately 93% of the groundwater pumping from the groundwater system is for agricultural use and 6% for urban use.

The Sutter Subbasin average historical groundwater budget has slightly greater outflows than inflows, leading to an estimated average annual decrease in groundwater storage of approximately 7,000 AF/year. **Figure 5-102** summarizes the average historical calibration groundwater inflows and outflows of the Sutter Subbasin.

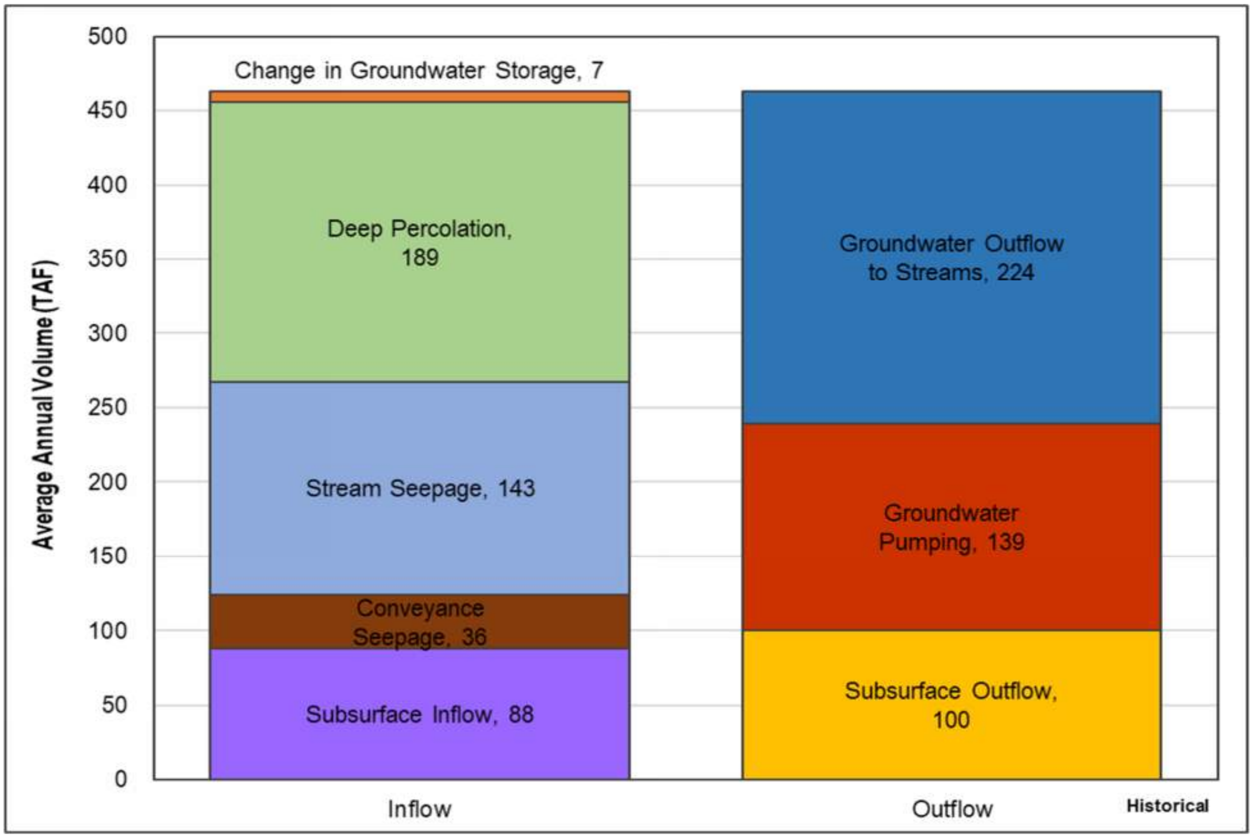


Figure 5-102. Historical Average Annual Water Budget – Groundwater System

Table 5-14 shows a breakdown of the major water budget components of the surface and groundwater systems by percentage use, including a change in overall groundwater storage of 7,000 AF/year. This constitutes a 0.014% change as a percent of the 49 MAF of total storage available.

Figure 5-103 shows the urban, agricultural (ponded and non-ponded crops), and managed wetlands supplies and demands from the previous tables broken down annually. Supplies are divided out by water source, either groundwater or surface water. Supplies are displayed as positive and demands as negative. **Figure 5-104** shows groundwater pumping annually plotted with annual change in storage. The cumulative change in storage is included throughout the water budget calibration period. In dry years with high groundwater pumping, there is a negative annual change in storage and the cumulative change in storage drops. This can be observed during the most recent 2012-2015 drought. In wetter years, the groundwater gains storage and therefore the change in storage is positive and there is an increase in the cumulative change in storage.

This page intentionally left blank.

Table 5-14. Average Annual Water Budget Surface Water and Groundwater Major Components by Use

Component	Historical Calibration (thousand acre-feet [TAF]/year)	Current Conditions (TAF/year)	Projected Conditions (TAF/year)	Projected Conditions With Climate Change (2070 CT) (TAF/year)
Hydrologic Period	**WY 1996-2015**	**WY 2013**	**WY 1996-2015 Repeated 3 Times**	**WY 1996-2015 Repeated 3 Times with Climate Change**
Surface System Major Components				
Precipitation	455	417	454	480
Surface Water Delivery	572	629	579	578
Agricultural	91%	93%	83%	83%
Urban	2%	3%	3%	3%
Managed Wetlands	6%	4%	15%	15%
Evapotranspiration	604	627	645	690
Agricultural	84%	86%	85%	85%
Urban	2%	2%	4%	4%
Managed Wetlands	1%	1%	3%	3%
Native and Riparian Vegetation	13%	12%	8%	8%
Groundwater System Major Components				
Net Groundwater Outflow to Streams	81	85	143	126
Groundwater Pumping	139	155	138	157
Agricultural	93%	96%	77%	79%
Urban	6%	3%	16%	14%
Managed Wetlands	1%	1%	8%	7%
Change in Groundwater Storage	7	19	-1	-1
As Percent of Overall Groundwater Storage (~49 MAFY)	0.014%	0.039%	-0.002%	-0.002%

This page intentionally left blank.

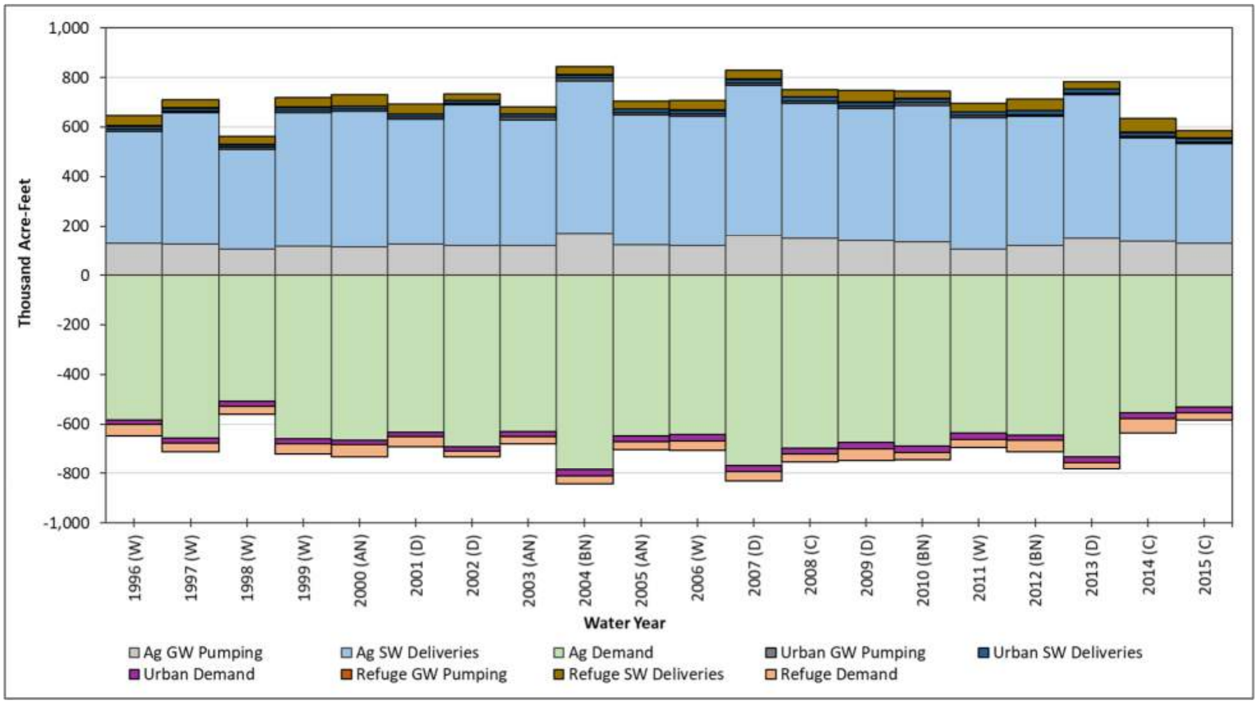


Figure 5-103. Urban, Agricultura, and Refuge Demand and Supply [1]

[1] Refuge in this figure refers to managed wetlands in Sutter Subbasin.

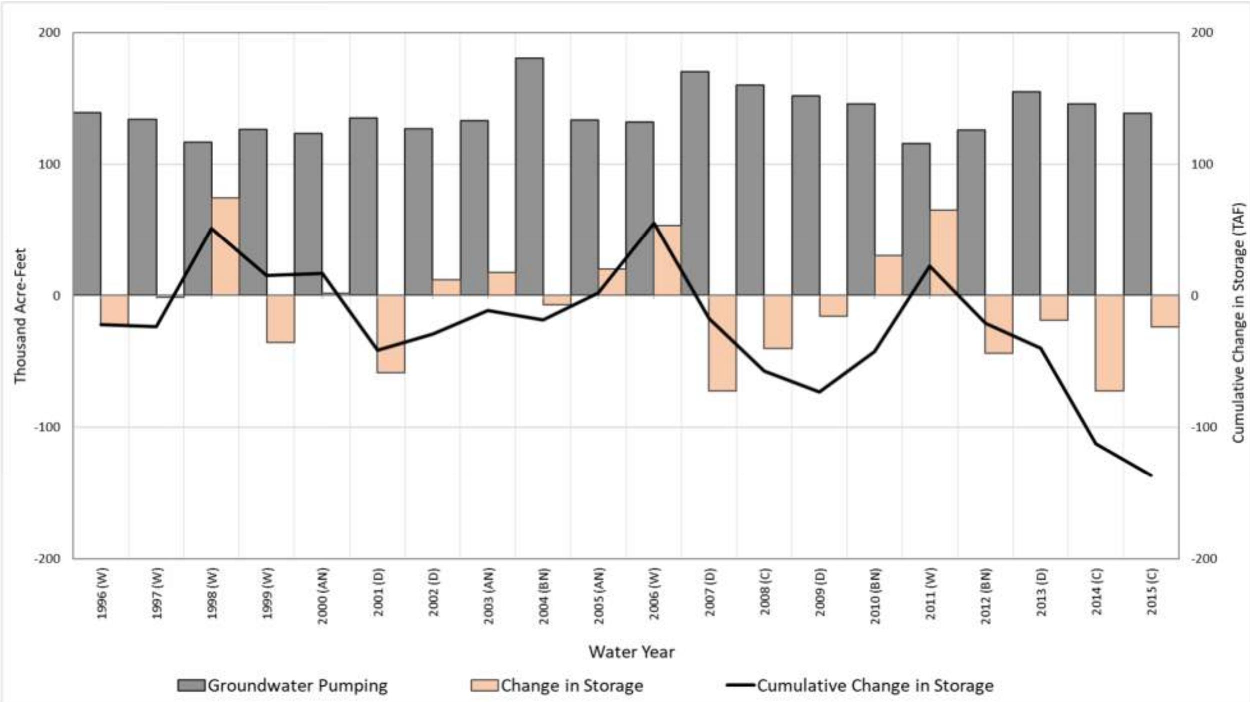


Figure 5-104. Groundwater Pumping and Change in Storage

5.3.5.2 Current Conditions Water Budget Estimates

The current conditions water budget in **Table 5-12** and **Table 5-13** represents a quantitative tabulation of WY 2013 extracted from the historical calibration of the C2VSimFG-Sutter model. As described in **Section 5.3.4**, the current conditions scenario is meant to simulate the most representative conditions available in the model at the time this GSP was written.

The surface system water budget in the current conditions scenario is shown below in **Figure 5-105**. There are an estimated 1.23 MAF/year of inflows, approximately 40,000 AF/year higher than the historical model. This total is a combination of precipitation (417,000 AF/year), surface water supply (629,000 AF/year), groundwater supply (155,000 AF/year), and riparian intake from streams (28,000 AF/year). The outflow from the land surface system in the current conditions scenario estimates evapotranspiration (627,000 AF/year), runoff to the stream system (36,000 AF/year), return flow of applied water to the stream system (257,000 AF/year), and deep percolation of precipitation or applied water (203,000 AF/year). Approximately 93% of surface water deliveries are used for agricultural use, 4% for managed wetlands, and 3% for urban.

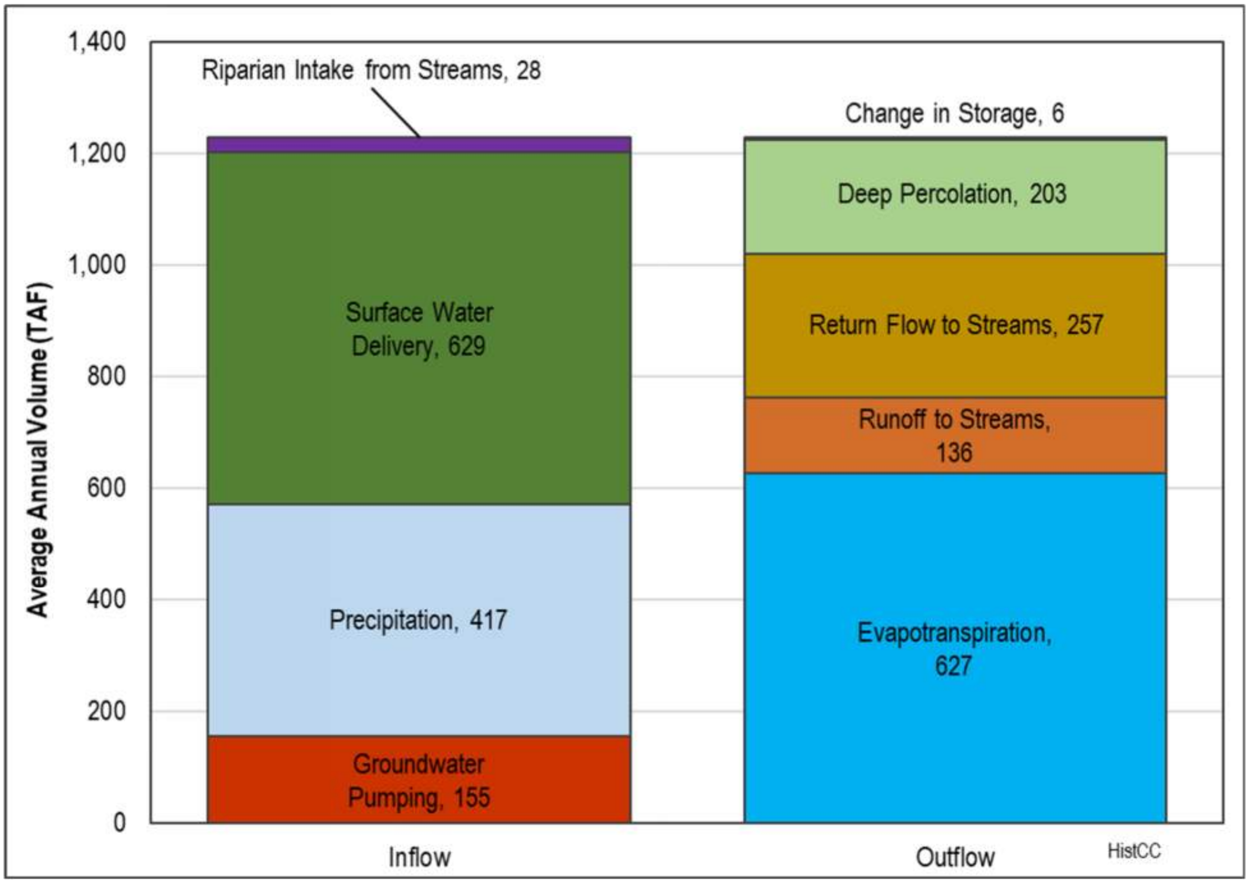


Figure 5-105. Current Conditions Average Annual Water Budget – Surface System

The groundwater system of the Sutter Subbasin (**Figure 5-106**) includes 471,000 AF/year of inflows in the current conditions (not including change in groundwater storage), of which 203,000 AF/year is deep percolation of precipitation or applied water (groundwater and surface water). There is also stream seepage (127,000 AF/year), and subsurface inflows (144,000 AF/year) from the neighboring groundwater subbasins of Colusa, Yolo, North American, North and South Yuba, Butte, and a very small portion from Wyandotte Creek Subbasin. Sutter Buttes also contributes subsurface inflows. Conveyance seepage also contributes water to the groundwater system, estimated to be approximately 39,000 AF/year. The primary outflow from the groundwater system is loss to streams (net 86,000 AF/year), followed by groundwater pumping (155,000 AF/year). Subsurface outflow to the neighboring groundwater subbasins is approximately 104,000 AF/year. Approximately 96% of the groundwater pumping from the groundwater system is for agricultural use and 3% for urban use.

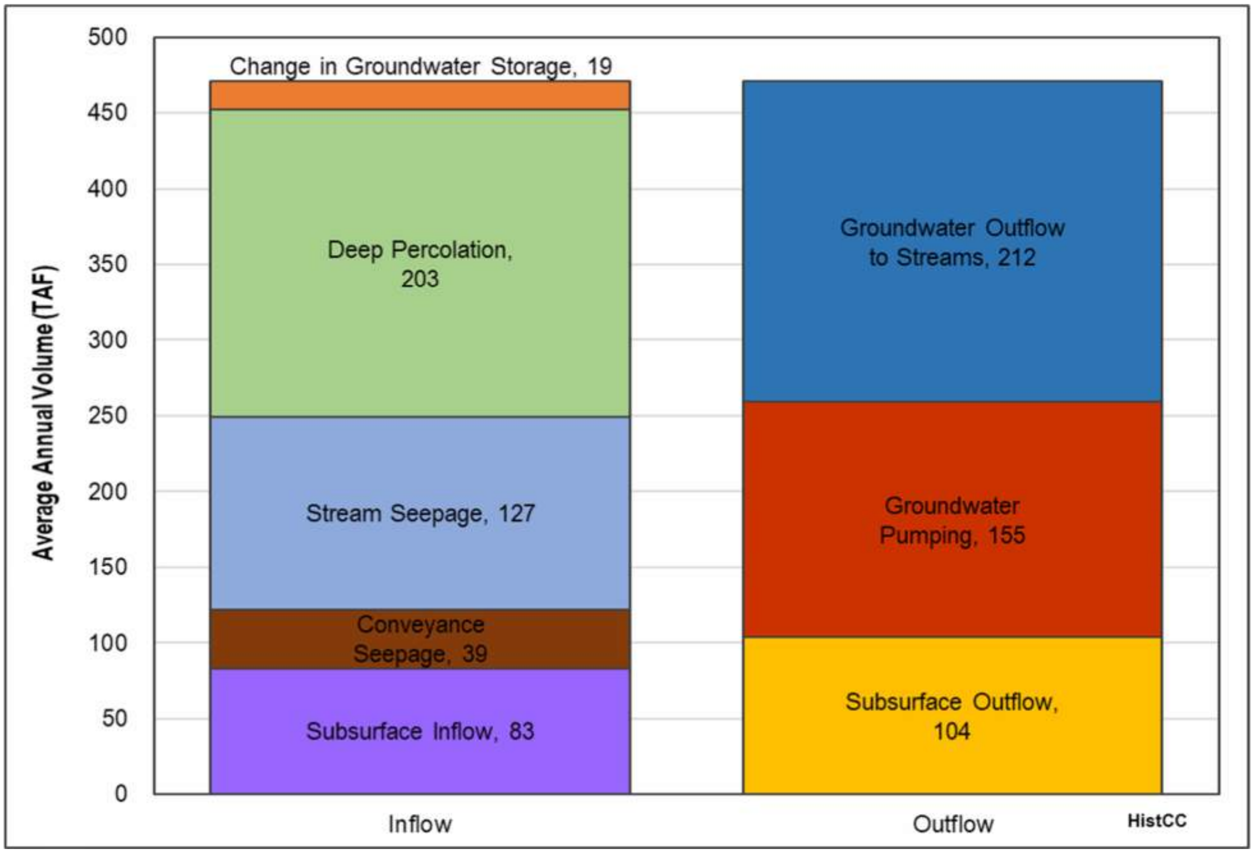


Figure 5-106. Current Conditions Average Annual Water Budget – Groundwater System

The Sutter Subbasin average current conditions groundwater budget has slightly greater outflows than inflows, leading to an estimated average annual decrease in groundwater storage of approximately 19,000 AF/year. This change is storage is approximately 0.039% of the estimated 49 MAF of groundwater in storage, a relatively small change in comparison to the total overall available groundwater storage. **Table 5-14** includes this change is storage as compared to the historical model as well as the surface and groundwater major components broken down by use.

5.3.5.3 Projected Conditions Water Budget Estimates

The projected conditions water budget is used to estimate future baseline conditions of supply, demand, and aquifer response to GSP implementation. The projected conditions scenario of the C2VSimFG-Sutter model is used to evaluate the projected conditions water budget assuming a 2040 level of development and using hydrology from WYs 1996 through 2015, repeated three times to meet the minimum 50-year projection requirement. Results of the projected conditions scenario under potential climate change conditions (changes to precipitation, stream flows, and evapotranspiration) are presented in **Section 5.3.5.4**.

Development of the projected water demand is based on historical population growth trends projected into the future and urban per capita water use consistent with projections in 2015. An important assumption made in the projected conditions water budget analysis is that, due to projected urban buildout in the cities of Live Oak and Yuba City, agricultural acreage is expected to decrease by approximately 15,000 acres over the projected period. This buildout and population growth drives more urban pumping in the projected conditions compared to the historical or current conditions.

The surface water budget for the projected conditions scenario has annual average inflows and outflows of 1,185,000 AF/year. Inflows consist of precipitation (454,000 AF/year), surface water supply (579,000 AF/year), groundwater supply (138,000 AF/year), and riparian intake from streams (14,000 AF/year). The balance of this is the summation of average annual evapotranspiration (645,000 AF/year), runoff of precipitation to the stream system (143,000 AF/year), return flow of applied water to the stream system (218,000 AF/year), and deep percolation (179,000 AF/year). A summary of these flows can be seen below in **Figure 5-107**.

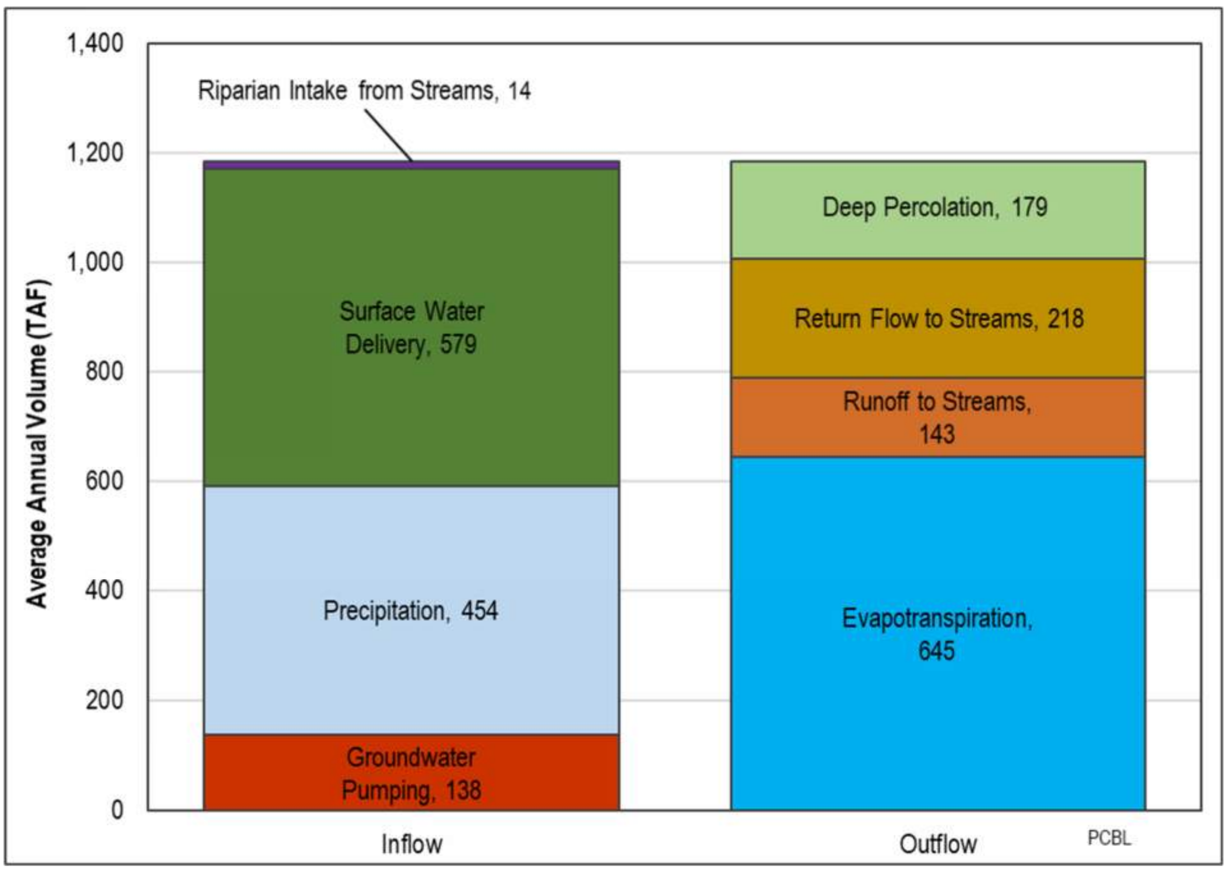


Figure 5-107. Projected Conditions Average Annual Water Budget – Surface System

Figure 5-108 summarizes the average projected groundwater inflows and outflows in Sutter Subbasin under projected conditions. The groundwater system experiences an average of 485,000 AF/year of inflows each year, of which 179,000 AF/year is deep percolation under projected conditions. There is estimated to be 125,000 AF/year of stream seepage inflow, which is less than historical conditions, and subsurface inflows from neighboring subbasins are estimated to be 144,000 AF/year, a significant increase from historical model estimations. Groundwater outflows to streams is approximately 268,000 AF/year and subsurface outflow are estimated to be 80,000 AF/year. Groundwater pumping is not expected to change significantly from historical levels (138,000 AF/year) under projected future conditions.

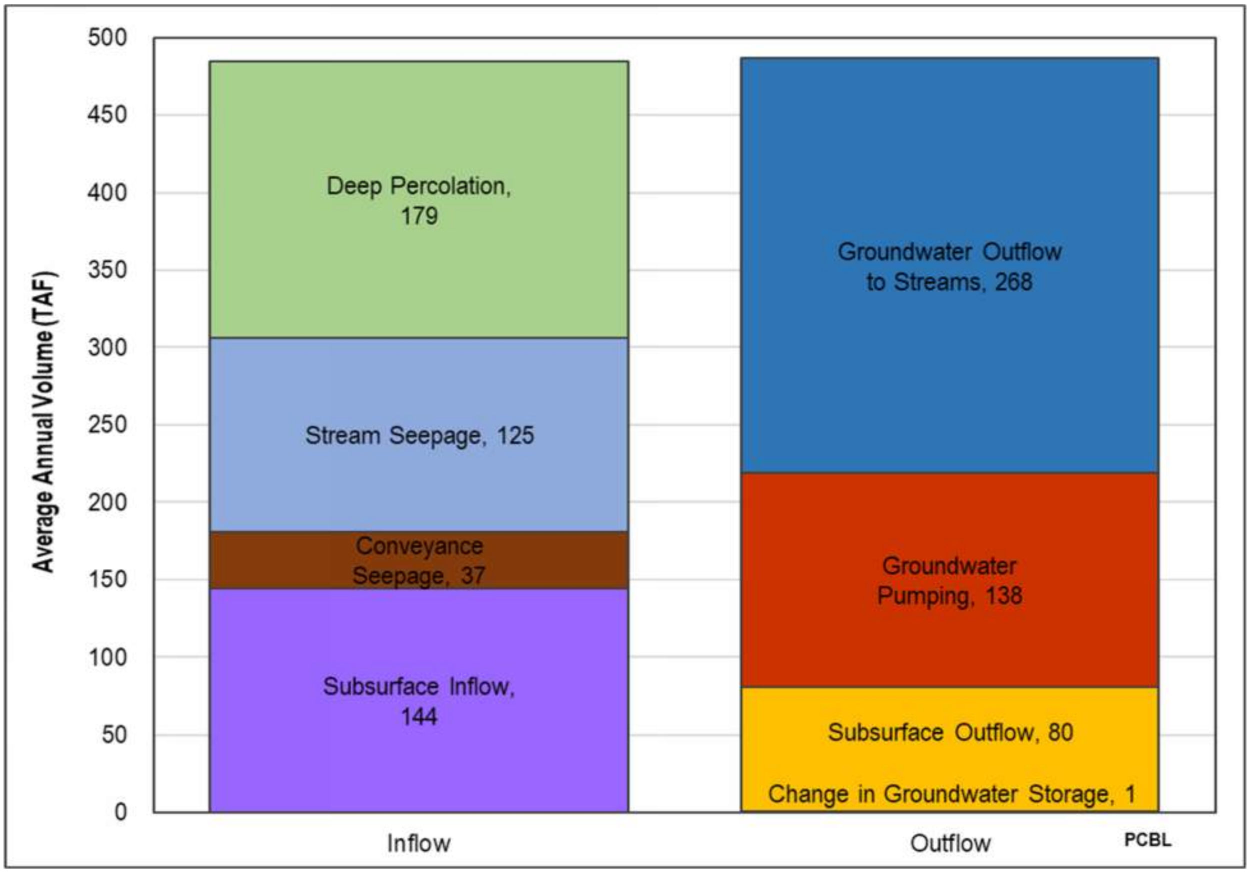


Figure 5-108. Projected Conditions Average Annual Water Budget – Groundwater System

The projected conditions water budget has only slightly greater outflows than inflows, resulting in an average annual increase in groundwater storage of 1,300 AF/year. This is a negligible change in comparison to the overall 49 MAF of groundwater in storage. **Table 5-14** shows the major water budget components of the surface and groundwater systems discussed above for all scenarios. Under projected conditions, only 77% of the groundwater pumping is expected to be for agricultural use in comparison to the historical model's 93% average. There are also decreases in the proportion of surface water delivered for agricultural use in comparison to historical conditions and corresponding increases in the proportion delivered to managed wetlands. Increased urban demand is expected to be met by increasing the proportion of supply from groundwater pumping. Under an ideal delivery schedule to Sutter National Wildlife Refuge, the increased demand for water is expected to come from both groundwater pumping and surface water deliveries. Overall, however, pumping and surface water delivery volumes are not expected to change significantly under projected conditions.

5.3.5.4 Projected Conditions with Climate Change Water Budget Estimates

Consistent with Section 354.18(d)(3) and Section 354.18(e) of the GSP Emergency Regulations, an analysis was performed for the Sutter Subbasin evaluating the projected conditions water budget under the influence of climate change. The regulations require that at least one climate change scenario is incorporated into the GSP. Sutter Subbasin elected to use the datasets DWR developed and provided for SGMA purposes. The following four possible scenarios were provided by DWR:

- 2030 Central Tendency
- 2070 Central Tendency
- 2070 Dry, Extreme Warming
- 2070 Wet, Moderate Warming

The projected conditions in the C2VSimFG-Sutter model were modified to include adjustments to precipitation, evapotranspiration, and streamflow to simulate the impacts of climate change using the 2070 central tendency scenario. This scenario was chosen for its useful long-term planning horizon (about 50 years) and moderate climate change impact estimations. The projected conditions with climate change water budget includes all of the assumptions of the projected conditions water budget, along with more variable precipitation and streamflow and increased evapotranspiration due to increasing temperatures.

The surface water budget for the projected conditions with climate change scenario has annual average inflows and outflows of 1,230,000 AF/year. Inflows consist of precipitation (480,000 AF/year), surface water supply (578,000 AF/year), groundwater supply (157,000 AF/year), and riparian intake from streams (15,000 AF/year). The balance of this is the summation of average annual evapotranspiration (690,000 AF/year), runoff of precipitation to the stream system (166,000 AF/year), return flow of applied water to the stream system (200,000 AF/year), and deep percolation (174,000 AF/year). A summary of these flows can be seen below in **Figure 5-109**.

Results from a comparison between the projected conditions with and without climate change show that the C2VSimFG-Sutter model estimates precipitation to increase by

6% on average and evapotranspiration to increase by 7% on average in the surface system under the 2070 central tendency climate scenario. **Appendix 5-H** includes more detail on how the datasets provided by DWR were derived as well as further explanation regarding the methods used in this analysis.

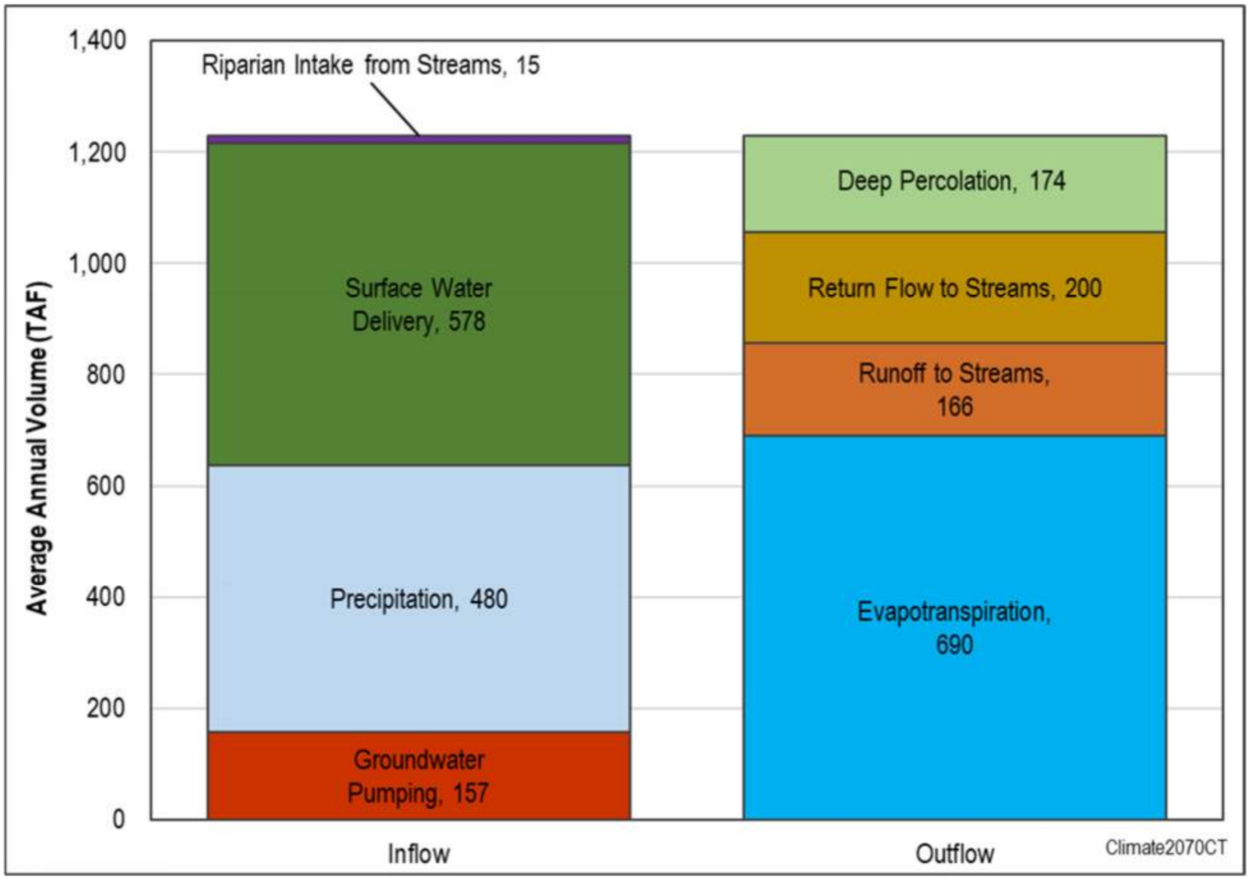


Figure 5-109. Projected Conditions with Climate Change Average Annual Water Budget – Surface System

Figure 5-110 summarizes the average projected groundwater inflows and outflows in Sutter Subbasin under projected conditions with climate change. The groundwater system experiences an average of 499,000 AF/year of inflows each year, of which 174,000 AF/year is deep percolation under projected conditions with climate change - slightly less than projected conditions without climate change. The projected conditions with climate change scenario also shows slightly less stream seepage (137,000 AF/year) than historical conditions, and subsurface inflows of 152,000 AF/year from neighboring subbasins, a significant increase from historical model estimations and also higher than projected conditions without climate change. Groundwater outflows to streams is approximately 263,000 AF/year and subsurface outflow 79,000 AF/year. Groundwater pumping is expected to increase as a result of shifting availability of streamflow and higher agricultural demand (157,000 AF/year).

The principal groundwater budget elements that are impacted by climate change are seepage to groundwater from streams (11% average increase) and groundwater pumping (14% increase), based on C2VSimFG-Sutter's estimates under the 2070 central tendency climate scenario.

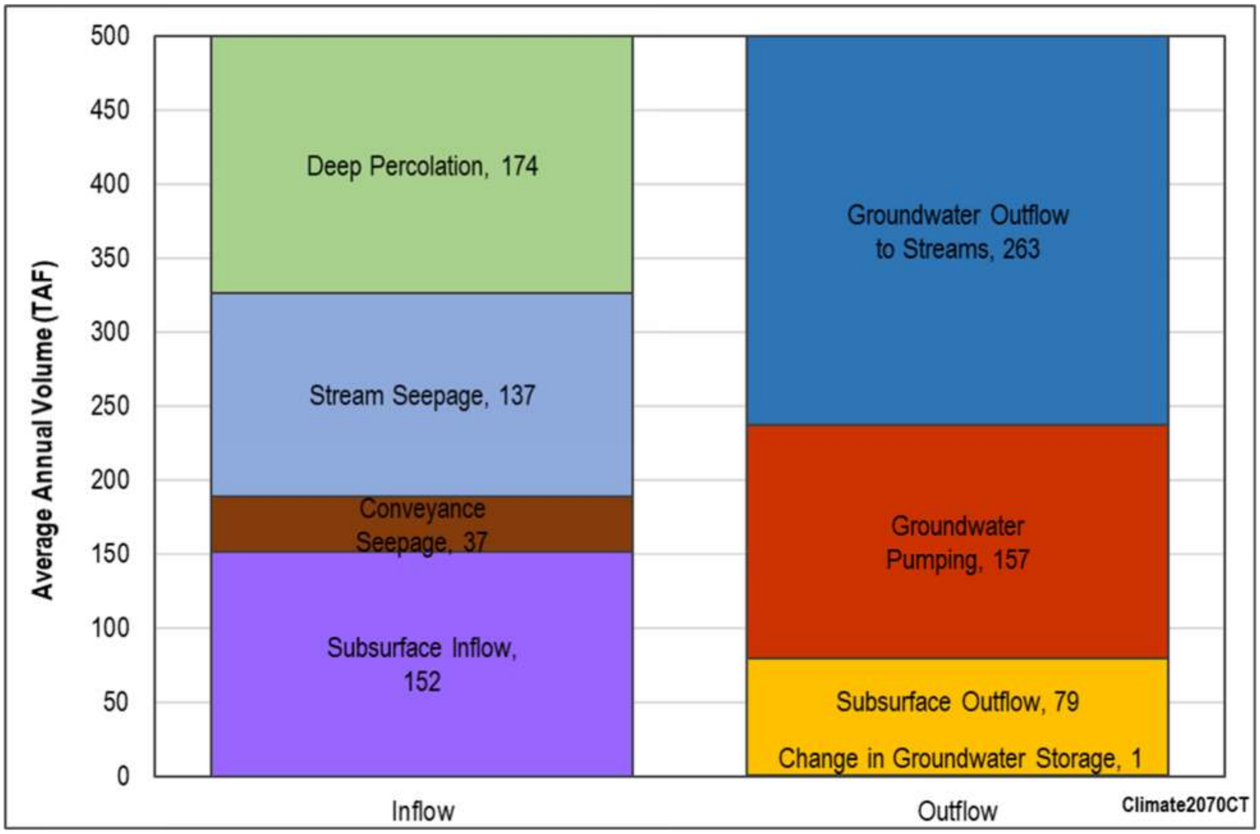


Figure 5-110. Projected Conditions with Climate Change Average Annual Water Budget – Groundwater System

Table 5-14 tabulates each of the major surface system and groundwater system components discussed in this section by the proportion of their use. Most notable may be the shifting distribution of use of groundwater pumping and surface water deliveries between historical conditions and projected conditions with climate change. Groundwater pumping for agricultural use from historical conditions to projected conditions with climate change changes from 93% to 79%. For urban use, groundwater pumping changes from a historic use of 6% to a projected use of 14%, and for managed wetlands, from 1% to 7%. Surface water deliveries change from 91% agricultural to 83% and 6% to 15% for managed wetlands. Only a small amount of surface water is used for urban use and it is not expected to change significantly with climate change conditions.

5.3.6 Estimation of Sustainable Yield

Sustainable yield is defined for SGMA purposes as “the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result.” (CWC §10721(w)).

Sustainable yield for the Sutter Subbasin was calculated by increasing the demand over the 60-year hydrology of the projected conditions model to analyze where the change in storage is close to zero and at what point undesirable results begin to occur and impact the overall water budget balance. Increased demand was simulated in using the C2VSimFG-Sutter model by increasing evapotranspiration in the C2VSimFG model subregions that overlap the Sutter Subbasin. Various scenarios of increased demand were simulated and their water budgets compared to see what level of groundwater production resulted in a long-term change in storage of, or very close to, zero.

The increase in demand that resulted in a change in groundwater storage of almost zero was a 20% increase in evapotranspiration in C2VSimFG subregions 4 and 5. This increased demand leads to a 33% increase in groundwater pumping over the projected conditions scenario. The sustainable conditions scenario results in groundwater outflows almost equal to groundwater inflows, bringing the long-term (60-year) average change in groundwater storage to close to zero. Based on this analysis, the sustainable yield of the Subbasin is 182,000 AF/year. This level of groundwater pumping is higher than what is simulated in all four water budget scenarios - historical, current conditions, projected conditions, and projected conditions with climate change. Therefore, it can be reasonably stated that the Subbasin is currently operating under sustainable conditions and is expected to continue to be sustainable if changes estimated in the projected conditions scenario hold true into the future.

5.4 References

Ayers, R.S. and D.W. Westcot. 1985. *Water quality for agriculture*, Table 1 – Guidelines for Interpretations of Water Quality for Irrigation and Table 21 – Recommended Maximum Concentrations of Trace Elements in Irrigation Water. FAO Irrigation and Drainage Paper 29 Rev. 1. http://www.fao.org/docrep/003/T0234E/T0234E00.htm. Accessed: July 9, 2021.

Bartow, J.A. 1992. *Contact relations of the Ione and Valley Springs Formations in the east-central Great Valley, California*. USGS, Open-File Report 92-588.

Bear. 1972. *Dynamics of Fluids in Porous Media*. Dover Publications, Inc. New York.

Berkstresser. 1973. *Base of Fresh Ground-Water -- Approximately 3,000 micromhos -- in the Sacramento Valley and Sacramento-San Joaquin Delta, California*. U.S. Geological Survey Water-Resource Inv. 40-73.

Blair, T.C., Baker, F.G., and Turner, J.B. 1991. *Cenozoic Fluvial-Facies Architecture and Aquifer Heterogeneity, Oroville, California, Superfund Site and Vicinity, in A.D. Miall and N. Tyler, eds., The Three-Dimensional Facies Architecture of Terrigenous Clastic Sediments and Its Implications for Hydrocarbon Discovery and Recovery, SEPM, Concepts in Sedimentology and Paleontology, Volume 3*.

Brown and Caldwell. 2013. *Final Report, Lower Tuscan Aquifer, Monitoring, Recharge, and Data Management Project*. 21 May.

Bryan, K. 1923. *Geology and ground-water resources of Sacramento Valley, California*. United States Geological Survey Water Supply Paper 495, xi, 285 p. xix pl. https://pubs.er.usgs.gov/publication/wsp495. Accessed: July 7, 2021.

Busacca, A.J., Singer, M.J., and Verosub, K.I.1989. *Late Cenozoic stratigraphy of the Feather and Yuba rivers area, California, with a section on soil development in mixed alluvium at Honcut Creek*: USGS Bulletin 1590-G, p. G!-G132.

California Department of Water Resources (DWR). 1980. *Groundwater Basins in California: Sacramento Valley*. Bulletin 118-80. January.

California Department of Water Resources (DWR). 2006. *California's Groundwater, Bulletin 118 – Update 2003, Sutter Subbasin*, last update January 20, 2006.

California Department of Water Resources (DWR). 2018. Natural Communities Commonly Associated with Groundwater (NCCAG) Dataset. https://gis.water.ca.gov/app/NCDatasetViewer/#. Accessed: January 25, 2021.

California Department of Water Resources (DWR). 2021a. *Chronological Reconstructed Sacramento and San Joaquin Valley Water Year Hydrologic Classifications Indices*. https://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST. Accessed: August 20, 2021.

California Department of Water Resources (DWR). 2021b. TRE Altamira InSAR Dataset. https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#landsub. Accessed: July 9, 2021.

California Department of Water Resources, North Region Office (DWR North Region Office). 2018. *2017 GPS Survey of the Sacramento Valley Subsidence Network. December*.

California State Water Resources Control Board (SWRCB). October 2017. *Groundwater Information Sheet: Arsenic*. https://www.waterboards.ca.gov/water_issues/programs/gama/docs/coc_arsenic.pdf. Accessed: July 9, 2021.

California State Water Resources Control Board (SWRCB). November 2017a. *Groundwater Information Sheet: Nitrate*. https://www.waterboards.ca.gov/water_issues/programs/gama/docs/coc_nitrate.pdf. Accessed: July 9, 2021.

California State Water Resources Control Board (SWRCB). November 2017b. Groundwater Information Sheet: Salinity. https://www.waterboards.ca.gov/water_issues/programs/gama/docs/coc_salinity.pdf. Accessed: July 9, 2021.

California State Water Resources Control Board (SWRCB). 2021. Groundwater Ambient Monitoring and Assessment Program (GAMA) Groundwater Information System. https://gamagroundwater.waterboards.ca.gov/gama/datadownload. Accessed: June 21, 2021.

CH2MHill. 2014. *Sacramento Valley Water Quality Coalition Groundwater Quality Assessment Report*.

CH2MHill. 2016. *Sacramento Valley Water Quality Coalition Groundwater Quality Assessment Report*. January.

Davids Engineering, Inc. 2014. *Feather River Regional Agricultural Water Management Plan, Volume 1: Regional Plan Components*.

Driscoll, F.G. 1986. *Groundwater and Wells*. 2nd Edition, Johnson Division, St Paul, 1089.

Esser, B., Moran, J., Hudson, G., Carle, S., McNab W., Tompson, A., Moore, K., Beller H., Kane, S., Eaton, G. 2003. *Reactive Transport of Nitrate in Northern California Groundwater basins: An Integrated Characterization and Modeling Approach*. AGU Fall Meeting Abstracts.

Gale, H.S., Piper, A.M., and Thomas, H.E. 1939. *Geology* [of the Mokelumne area], in Piper, A.M., Gale, H.S., Thomas, H.E., and Robinson, T.W., *Geology and* *ground-water hydrology of the Mokelumne area, California*: U.S. Geological Survey Water-Supply Paper 780, p. 14-101.

GEI. 2016. *Alternative Submittal to a Groundwater Sustainability Plan for Sutter Subbasin, Sutter County, California*. 19 December.

Harwood, D.S., and Helley, E.J. 1987. *Late Cenozoic Tectonism of the Sacramento Valley, California*. U.S. Geological Survey Professional Paper 1359.

ICF International. 2013. *Final, Feather River West Levee Project, Environmental Impact Report*. April.

Lindgren, W. 1894. USGS, Sacramento Folio, p.3.

National Aeronautics and Space Administration (NASA). 2016. *Progress Report: Subsidence in California, March 2015 – September 2016*.

North American Commission on Stratigraphic Nomenclature (NACM). 2005. North American Stratigraphic Code, AAPG Bulletin, v. 89, no. 11 (November 2005), pp. 1547–1591.

Oregon State University (OSU). 2021. *PRISM Climate Data*. http://prism.oregonstate.edu./. Accessed: August 20, 2021.

Redwine, L.E. 1972. *The Tertiary Princeton submarine valley system beneath the Sacramento Valley, California*: Univ. of California, Los Angeles, unpubl. Thesis (PhD): 480 p.

RMC. 2016. *Groundwater and Stream Interaction in California's Central Valley: Insights for Sustainable Groundwater Management*.

Springhorn, S.T. 2008. *Stratigraphic Analysis and Hydrogeologic Characterization Of Cenozoic Strata In The Sacramento Valley Near Sutter Buttes*. Master Thesis, California State University Chico. Spring.

Sustainable Groundwater Management Office (SGMO), California Department of Water Resources (DWR). 2020. California Central Valley Groundwater-Surface Water Simulation Model - Fine Grid (C2VSimFG) Development and Calibration Version 1.0. https://data.cnra.ca.gov/dataset/c2vsimfg-version-1-0/resource/4f904e97-a47b-4138-81df-9b74bd952948 Accessed: August 20, 2021.

The Nature Conservancy (TNC). n.d. *Identifying Environmental Surface Water Beneficial Users – Freshwater Species List For Each Groundwater Basin, Sacramento Valley – Sutter*. https://groundwaterresourcehub.org/sgma-tools/environmental-surface-water-beneficiaries/. Accessed: July 2, 2021.

The Nature Conservancy (TNC). 2021. ICONS: Interconnected Surface Water in California's Central Valley, Version 1.0.1. https://icons.codefornature.org/. Accessed: June 10, 2021.

United States Geological Survey (USGS). 1984. *Geochemistry of Groundwater in the Sacramento Valley, California*. Central Valley of California RASA Project, Geological Survey Professional Paper 1401-B.

United States Geological Survey (USGS). 2001. *Ground-Water Quality in the Southeastern Sacramento Valley Aquifer, California*, 1996. U.S. Geological Survey Water-Resources Investigations Report 01-4125.

United States Geological Survey (USGS). 2007. *Type Region of the Ione Formation (Eocene), Central California: Stratigraphy, Paleogeography, and Relation to Auriferous Gravels*.

United States Geological Survey. USGS. 2011. *Groundwater Quality in the Southern Sacramento Valley, California*. Fact Sheet 2011-3006. April.

Verruijt. 1969. *Elastic storage of aquifers*. In: Flow Through Porous Media, edited by R.J.M. De Wiest, Academic Press, New York. pp. 331-376.

Wood Rodgers. 2012. *Sutter County Groundwater Management Plan*. March.

CHAPTER SIX

Sustainability Management Criteria

This page intentionally left blank

6. SUSTAINABLE MANAGEMENT CRITERIA

Sustainable Management Criteria define conditions that constitute sustainable groundwater management for the Sutter Subbasin. Sustainable Management Criteria, or SMC, include establishing the Subbasin's sustainability goal and establishing definitions of undesirable results, minimum thresholds, measurable objectives, and interim milestones for each sustainability indicator. This chapter contains information pursuant to the Groundwater Sustainability Plan (GSP) Emergency Regulations Article 5 *Plan Contents*, Subarticle 3 *Sustainable Management Criteria* (§354.22 through 354.30).

The Sustainable Groundwater Management Act (SGMA) defines sustainable groundwater management as "the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results" (California Water Code Section 10721). Sustainable Management Criteria were developed using information presented in **Chapter 5** *Basin Setting*. Input from Subbasin stakeholders was accepted and incorporated into the established SMC through discussion and presentation at public workshops and meetings of the Sutter Subbasin Groundwater Management Coordination Committee (SSGMCC).

Developed SMC will be used to assess progress toward achieving the sustainability goal for the Sutter Subbasin. The quantitative nature of the SMC allows for demonstrated achievement of the sustainability goal for the Sutter Subbasin on or before the 20-year GSP implementation mark (established in the SGMA legislation at 2042 for non-critically overdrafted subbasins such as the Sutter Subbasin). The Sutter Subbasin GSAs will continue to coordinate with adjacent subbasins regarding SMC and related monitoring and ensure that subbasin management activities do not cause undesirable results in either the Sutter Subbasin or for adjacent subbasins.

6.1 Useful Terms

A list and description of technical terms used throughout this section to discuss SMC are presented below. **Figure 6-1** shows a graphic demonstrating the relationship between the SMC terms such as minimum thresholds and measurable objectives using groundwater elevation as an example. The terms and their descriptions are identified here to guide readers through this section and are not a definitive definition of each term.

- **Sustainability Goal** – The sustainability goal qualitatively describes the objectives and desired conditions for the Sutter Subbasin and how the goal will be met through implementation of the GSP.
- **Undesirable Result** – Condition at which for each applicable sustainability indicator significant and unreasonable impacts are likely to be observed. Avoidance of these conditions is used to guide development of GSP components.

- **Minimum Threshold** – Quantitative guidance levels established at each representative monitoring site set just above conditions that could generate an undesirable result for an applicable sustainability indicator.
- **Measurable Objective** – Quantitative target that represents the desired condition at each representative monitoring site for an applicable sustainability indicator. The measurable objective must be reached within 20 years of GSP implementation for all applicable sustainability indicators for the basin or subbasin to be considered sustainable.
- **Interim Milestones** – Targets set in increments of five years over the 20-year implementation period of the GSP to reach the measurable objective by 2042 (as required for the Sutter Subbasin). These ‘check-in’ points are used to put the basin on a path towards achieving or maintaining sustainability.
- **Margin of Operational Flexibility or Operating Range** – The range of active management between the measurable objective and minimum threshold.

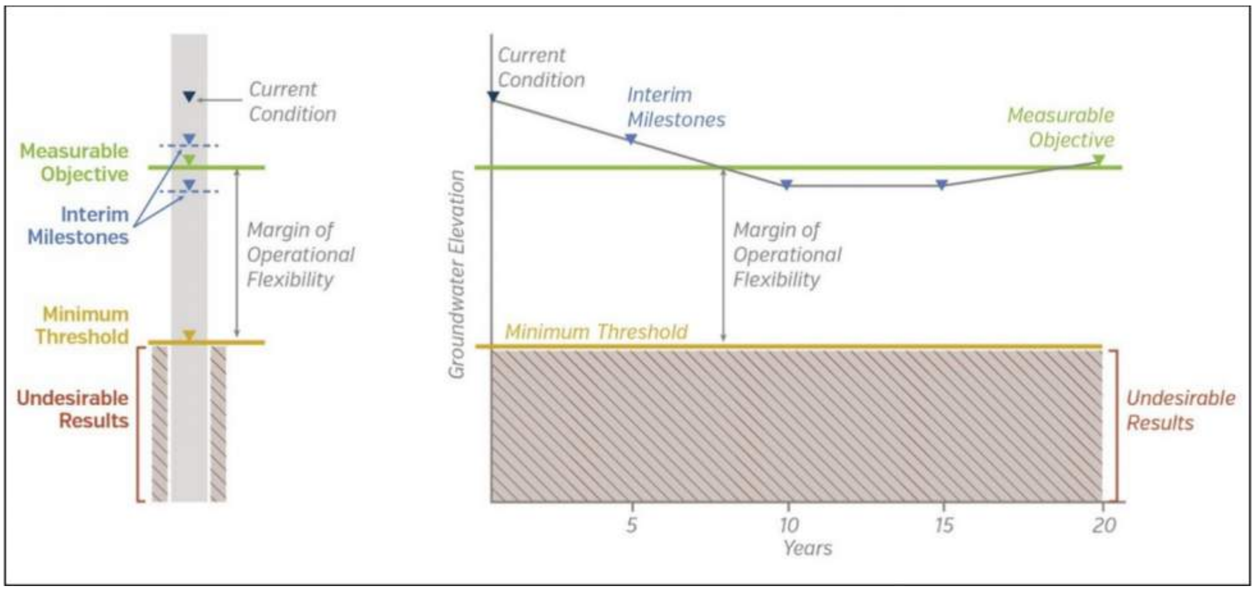


Figure 6-1. Sustainable Management Criteria Definitions Graphic

6.2 Sustainability Indicators

A sustainability indicator is defined under SGMA as one of six effects caused by groundwater conditions that, when significant and unreasonable, cause undesirable results. Undesirable results are one or more of the following effects:

- **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

- Significant and unreasonable **reduction of groundwater storage**
- Significant and unreasonable **seawater intrusion**
- Significant and unreasonable **degraded water quality**, including the migration of contaminant plumes that impair water supplies
- Significant and unreasonable **land subsidence** that substantially interferes with surface land uses
- **Depletions of interconnected surface water** that have significant and unreasonable adverse impacts on beneficial uses of the surface water

SGMA allows several pathways to meet the distinct local needs of each basin or subbasin, including development of SMC, use of other sustainability indicators as proxy, and identification of indicators that are not applicable to the basin or subbasin. Details of these approaches are included in the following sections. Continued data collection and improved understanding of basin conditions in the future may lead to changes in the SMC discussed herein.

Future changes to SMC calculations or methodologies will be detailed in Annual Reports and 5-Year GSP assessments and updates and will be evaluated using the same criteria contained herein to ensure that undesirable results are not caused as a result of revised SMC in the Sutter Subbasin or adjacent subbasins.

6.3 Sustainability Goal

The sustainability goal provides a succinct qualitative description of the objectives and desired conditions that culminates in the absence of undesirable results by 2042 in the Sutter Subbasin. It is supported by the SMC established herein.

The sustainability goal for the Sutter Subbasin is as follows:

> *The Sutter Subbasin will maintain locally-managed groundwater resources for existing and future beneficial uses and users that are economically viable and sustainable by managing groundwater use within the sustainable yield, resulting in the avoidance of undesirable results. This goal will be achieved through implementation of proposed projects and management actions and monitoring activities aiding in reaching or maintaining established interim milestones and measurable objectives culminating in the absence of undesirable results by 2042. Water managers in the Sutter Subbasin will work together and collaboratively with stakeholders and neighboring subbasins through GSP implementation and beyond to achieve this goal.*

The sustainability goal was developed based on information presented in **Chapter 5** *Basin Setting*. As discussed in further detail in the **Section 5.3** *Water Budgets*, the

Sutter Subbasin is anticipated to be sustainable relative to the chronic lowering of groundwater levels, reduction of groundwater storage, and depletions of interconnected surface water sustainability indicators over the 50-year planning horizon of this GSP even with the potential impacts of climate change. Limited recent data relative to the degraded water quality sustainability indicator are available, and improvements to comprehensive groundwater quality monitoring throughout the Sutter Subbasin are detailed in **Section 7.1**. As noted in **Section 5.2** *Groundwater Conditions*, available land subsidence data indicates that inelastic land subsidence has not historically been observed in the Sutter Subbasin.

In order to make progress in meeting the sustainability goal, locally-defined minimum thresholds and measurable objectives have been established for the Sutter Subbasin to define the operating range of the groundwater subbasin and ensure that the Subbasin will be operated within its sustainable yield. These criteria were developed in a coordinated fashion with adjacent subbasins by reviewing public drafts and final drafts of their respective SMC chapters, as well as through discussion by consultant staff throughout the Sacramento Valley. Projects and management actions, as detailed in **Section 7.1**, were selected to avoid undesirable results, provide for adaptive management of the groundwater subbasin, and to fill identified data gaps within the Sutter Subbasin. For more information about sustainable yield and the projects and management actions to be implemented during the 20-year implementation period, refer to **Section 5.3** and **Section 7.1**, respectively.

Over the GSP planning and implementation horizon, Subbasin conditions are expected to fluctuate relative to minimum thresholds, measurable objectives, and interim milestones due to fluctuations in hydrologic conditions (both natural and human-influenced), future changes in land use, modification of basin operations, and implementation of projects and management actions. It is anticipated that, despite seasonal and short-term fluctuations, the Subbasin will be managed to prevent undesirable results. Demonstration of the absence of undesirable results will support a determination that the Subbasin is operating within its sustainable yield (discussed in **Section 5.3**) and support the conclusion that the sustainability goal has been achieved by 2042 and maintained beyond 2042.

6.4 Undesirable Results

Undesirable results are defined under SGMA as one or more significant and unreasonable effects caused by groundwater conditions occurring throughout a basin based on the six sustainability indicators of SGMA: chronic lowering of groundwater levels, reduction of groundwater storage, seawater intrusion, degraded water quality, land subsidence, and depletions of interconnected surface water. A description of undesirable results as defined under SGMA and by the Sutter Subbasin GSAs, identification of undesirable results, potential causes for undesirable results, and potential effects of undesirable results relative to all applicable sustainability indicators for the Sutter Subbasin are detailed below.

6.4.1 Chronic Lowering of Groundwater Levels

The undesirable result related to groundwater levels is defined under SGMA as:

> *Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels in storage during other periods (California Water Code [CWC] Section 10721(x)(1)).*

6.4.1.1 Description of Undesirable Results

An undesirable result for chronic lowering of groundwater levels in the Sutter Subbasin is experience through groundwater levels dropping to a level at which domestic or irrigation wells go dry or lose functional pumping capacity, result in significantly higher pumping costs, and/or the significant and unreasonable effort is required to maintain or deepen production wells.

6.4.1.2 Identification of Undesirable Results

An undesirable result is observed when groundwater elevations drop below the minimum threshold criteria at 25% of representative monitoring locations (16 out of 63 representative wells) concurrently over two consecutive seasonal high water level measurements. Impacts relating to this SMC will be evaluated both by aquifer zone and for the principal aquifer as a whole. Minimum threshold exceedance patterns by aquifer zone will also be monitored and addressed as appropriate. For more information about how identification of undesirable results for chronic lowering of groundwater levels was determined, refer to **Appendix 6-B**.

6.4.1.3 Potential Causes of Undesirable Results

Based on available information about projected changes in the land use in the Subbasin, it is anticipated that the long-term average groundwater use in the Sutter Subbasin is not likely to change to the point where groundwater levels are impacted resulting in undesirable results. Significant increased groundwater pumping as a result of reduced surface water supplies due to instream flow requirements could impact groundwater levels to the point where undesirable results are observed. Other potential localized impacts to groundwater levels could be caused by increases in consumptive use of groundwater due to increased agricultural productivity and changes in the hydrologic system, such as increases in impervious surfaces or significant changes to upstream reservoir releases.

Since groundwater use in the Sutter Subbasin has historically been considered sustainable and conditions are anticipated to remain sustainable even with the effects of climate change (as concluded from the projected water budgets in **Section 5.3**), undesirable results are not expected to occur for the chronic lowering of groundwater levels sustainability indicator.

6.4.1.4 Potential Effects of Undesirable Results

If groundwater levels were to reach levels indicating undesirable results, potential effects could include the following:

- Dewatering of shallow wells
- Increased costs to pump groundwater
- Adverse effects on groundwater dependent ecosystems (GDEs) resulting from losses of connection with the principal aquifer, including difficulty for plants and animals to access groundwater
- Changes in irrigation practices and crops grown
- Adverse effects on property values and the regional economy

6.4.1.5 Reduction of Groundwater Storage

The undesirable result related to reduction of groundwater storage is defined under SGMA as:

> *Significant and unreasonable reduction of groundwater storage (CWC Section 10721(x)(2)).*

6.4.1.6 Identification of Undesirable Results

The same trigger for an undesirable result for the chronic lowering of groundwater levels is applicable to the long-term reduction of groundwater storage. Long-term reductions in storage are not anticipated as the Sutter Subbasin is already sustainable and due to the large volume of water currently in storage in the Subbasin. Therefore, as long as groundwater levels are managed above minimum thresholds, changes in storage should not be significant.

6.4.1.7 Potential Causes of Undesirable Results

Although groundwater has historically been used sustainably in the Sutter Subbasin, dramatic increases in the reliance on groundwater, severe drought, or other major changes in groundwater management over time could cause the volume of fresh groundwater in storage to decline to a significant and unreasonable level. Additionally, regulatory requirements placed on the Central Valley Project (CVP) and State Water

Project (SWP) operations could impact the Sacramento River Settlement Contractors and Feather River diverters, respectively, as well as instream flow requirements on the Sacramento and/or Feather Rivers and their tributaries may result in negative impacts to surface water supplies. Reductions in surface water supplies would result in increased reliance on groundwater resources within the Sutter Subbasin and potentially result in the long-term reduction in groundwater storage.

This undesirable result is driven by the chronic lowering of groundwater levels sustainability indicator and established SMC, which have been determined to be protective of possible undesirable results for the long-term reduction of groundwater storage.

6.4.1.8 Potential Effects of Undesirable Results

If groundwater levels were to reach the point where undesirable results are observed, undesirable effects could include shallow wells going dry and/or losing production capacity resulting in the need to deepen or replace wells; increased pumping costs as deeper wells are required to access groundwater; and an overall reduction in beneficial uses of groundwater.

6.4.2 Seawater Intrusion

Seawater intrusion is not an applicable sustainability indicator for the Sutter Subbasin as the Subbasin is located inland from the Pacific Ocean and is not adjacent to the Sacramento-San Joaquin Delta. Therefore, SMC for seawater intrusion will not be established for the Sutter Subbasin GSP.

6.4.3 Degraded Water Quality

The undesirable result related to degraded water quality is defined under SGMA as:

> *Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies (CWC Section 10721(x)(4)).*

6.4.3.1 Description of Undesirable Results

An undesirable result for degraded water quality in the Sutter Subbasin would be the result stemming from a causal nexus between groundwater-related activities, such as groundwater extraction or recharge, and a degradation in groundwater quality that causes a significant and unreasonable reduction in long-term viability of domestic, agricultural, municipal, or environmental uses over the planning and implementation horizon of this GSP. The causal nexus reflects that the undesirable results are water quality issues associated with groundwater pumping and other groundwater management-related activities rather than water quality issues resulting from land use practices, naturally-occurring water quality issues, or other issues not associated with groundwater pumping and other groundwater-related activities.

Within the Sutter Subbasin, the causal nexus would be related to increased salinity (measured as total dissolved solids [TDS]) and nitrate (measured as nitrate as N) concentration resulting from groundwater pumping or implementation of projects and/or management actions. It should be noted that water quality issues outside of the causal nexus are generally covered by other regulatory frameworks. Contamination sites are regulated by the Regional Water Quality Control Board (RWQCB), California Department of Toxic Substances Control, and the U.S. Environmental Protection Agency (EPA). Drinking water quality is regulated by the State Water Resources Control Board, Division of Drinking Water (SWRCB-DDW). Potential contamination by agricultural practices is regulated through Central Valley Salinity Alternatives for Long-term Sustainability (CV-SALTS), Irrigated Lands Regulatory Program (ILRP), and California Department of Pesticide Regulation (DPR).

Aside from TDS and nitrate related to anthropogenic activities (such as agricultural activities or septic systems), the Sutter Subbasin GSAs do not have control over the presence of naturally-occurring constituents in aquifer materials. In the event that there is a causal nexus determined between elevated concentrations of other constituents of concern (COCs, or other COCs not presently identified) and groundwater management activities, the Sutter Subbasin GSAs will consider establishing SMCs for such COCs. Management actions and studies are presented in **Section 7.1**. Because the Subbasin is considered sustainable, these are, for the most part, identified for adaptive basin management or to meet other needs. As such, implementation of these projects, management actions, and studies will be implemented pending the availability of grant or other funding, as appropriate research partners are identified and partnerships formed, or as needed for Subbasin management with the goal of further evaluating the fate and transport of COCs in the Sacramento Valley as a whole.

6.4.3.2 Identification of Undesirable Results

An undesirable result for degraded water quality is triggered, or considered “significant and unreasonable,” when 50% of representative monitoring wells (14 out of 28 representative wells) across all aquifer zones exceed the minimum threshold for two consecutive measurements at each location during non-drought years and where these minimum threshold exceedances can be tied to a causal nexus between SGMA-related activities and water quality. As with groundwater levels, water quality data will be assessed on an annual basis by both principal aquifer and by aquifer zones. Such criteria in identifying an undesirable result for degraded water quality would provide sufficient data to establish a trend in potential worsening groundwater level as a result of GSP-related activities.

6.4.3.3 Potential Causes of Undesirable Results

TDS and nitrate have been identified as COCs in the Sutter Subbasin and are largely the result of non-point sources. Elevated TDS concentrations are primarily the result of a combination of land use practices, the upwelling of seawater (connate) deposits within marine sediments, dissolvable materials within the alluvial fan complexes, and the naturally poor-draining conditions which tend to result in accumulation of salts. Elevated nitrate is largely the result of anthropogenic sources such as agricultural applications of fertilizer and septic systems in the Sutter Subbasin. For more information about groundwater quality in the Sutter Subbasin, refer to **Sections 5.1.9** and **5.2.5** of the *Basin Setting* chapter.

Conditions that may cause an undesirable result for degraded water quality include changes in the location (both vertically and horizontally) and volume of groundwater pumping or managed groundwater recharge, both resulting in the contribution to and/or potential mobilization of COCs as a result of these activities.

6.4.3.4 Potential Effects of Undesirable Results

If an undesirable result for degraded water quality were to occur, the effect could cause a reduction in economically usable groundwater supply for all beneficial users of groundwater and/or an increased need for groundwater treatment prior to use, with domestic wells being most vulnerable as costs for treatment or access to alternate supplies can be high for small users. For agricultural groundwater users, degraded water quality may cause potential changes in irrigation practices, crops grown, agricultural efficiencies, adverse effects on property values, and other economic impacts, with the potential to adversely impact the larger economy throughout the Subbasin. Water quality degradation could also impact GDEs and impact surface water quality and health of aquatic species. Additionally, reaching undesirable results levels for groundwater quality could adversely affect current and projected municipal uses, which could have to install treatment systems or seek alternate supplies.

6.4.4 Land Subsidence

The undesirable result related to land subsidence is defined under SGMA as:

> *Significant and unreasonable land subsidence that substantially interferes with surface land uses (CWC Section 10721(x)(5)).*

6.4.4.1 Description of Undesirable Results

An undesirable result for land subsidence would be a result due to groundwater extraction that causes a significant reduction in the viability of the use of infrastructure for water distribution and flood control, including impacts to laterals from differential settlement that reduces the ability to deliver surface water supplies or inadequate freeboard on levee systems in wet years impacting conveyance of flood waters.

6.4.4.2 Identification of Undesirable Results

There are 22 monuments surveyed in the Sutter Subbasin on a 5-year schedule as part of the Sacramento Valley Subsidence Network by DWR and its partner agencies.

Undesirable results are considered to occur when at least 25% of representative subsidence monitoring sites (6 out of 22 sites) exceed the minimum threshold for subsidence over the 5-year monitoring period. InSAR data published by DWR via the SGMA Data Viewer (https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#currentconditions) will also be reviewed on an annual basis to ensure subsidence does not become a concern over the 5-year monitoring period.

6.4.4.3 Potential Causes of Undesirable Results

As noted in **Section 5.2.6**, inelastic land subsidence has not historically been observed in the Sutter Subbasin. Potential causes of undesirable results for land subsidence would be tied to significant increases in groundwater production combined with the necessary hydrogeologic conditions that are conducive to land subsidence. Inelastic land subsidence is typically caused by dewatering of compressible clay layers, which are not known to be present in significant quantities of in the Sutter Subbasin.

6.4.4.4 Potential Effects of Undesirable Results

Undesirable results related to land subsidence could potentially cause differential changes in land surface elevation resulting in damage to water conveyance infrastructure, flood control facilities and other infrastructure, and/or causing decreased capacity to convey water or control flood waters. The cost to convey surface water or control flood waters would likely increase as gradients of gravity-driven conveyance and/or flood control structures would require repair and modification or increased energy to pump and move surface or flood waters. These potential effects could result in significant economic costs and adversely impact property value as well as public safety.

6.4.5 Depletions of Interconnected Surface Water

The undesirable result related to depletions of interconnected surface water is defined under SGMA as:

> *Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water (CWC Section 10721(x)(6)).*

6.4.5.1 Description of Undesirable Results

The undesirable result for depletions of interconnected surface water is a result that causes significant and unreasonable adverse effects on beneficial uses and users of interconnected surface water within the Sutter Subbasin over the GSP planning and implementation horizon.

6.4.5.2 Identification of Undesirable Results

Groundwater elevations dropping below the minimum threshold criteria at 25% of representative monitoring locations (6 out of 23 representative wells) concurrently over two consecutive seasonal high water level measurements resulting in a significant loss of aquifer contribution to the interconnected water course (if currently a gaining stream) and/or a reversal of stream connection from gaining to losing streams.

6.4.5.3 Potential Causes of Undesirable Results

The potential causes of undesirable results for the depletions of interconnected surface water include increased groundwater demand along interconnected corridors, specifically the Sacramento and Feather Rivers and Sutter Bypass, and/or significant changes in upstream reservoir releases (as both the Sacramento and Feather Rivers are controlled rivers). See **Section 5.2.7** for identification of interconnected surface waters.

6.4.5.4 Potential Effects of Undesirable Results

If depletions of interconnected surface water were to reach levels causing undesirable results, the adverse effects could potentially include reduced ability of surface water flows to meet instream flow requirements or to deliver surface water supplies to users in the Subbasin. Fisheries, riparian habitat, and recreational opportunities within the Sutter Subbasin could also be impacted by lower instream flows and by increased temperatures. This could also result in increased groundwater production to offset the availability of surface water, changes in irrigation practices and crops grown, and could cause adverse effects on property values and the Subbasin-wide economy.

6.5 Minimum Thresholds

Minimum thresholds are the quantitative values that represent groundwater conditions at a representative monitoring site that, when exceeded in combination with minimum thresholds at other monitoring sites, may cause an undesirable result in the basin or subbasin. This section establishes the numeric minimum thresholds for all applicable sustainability indicators in the Sutter Subbasin by describing how minimum thresholds were identified and different methodologies considered; the relationship of other applicable sustainability indictors in the Subbasin; effects on neighboring subbasins and beneficial uses/users; relevant local, state, or federal standards; and the method of quantitative measurement selected.

6.5.1 Chronic Lowering of Groundwater Levels

6.5.1.1 Identification and Methodology

The minimum threshold for chronic lowering of groundwater levels is established as the deepest of the following:

1. The historic low for the available record at each representative monitoring site; or
2. 90% of the average groundwater elevation from the projected water budget (baseline condition over 60-year period using C2VSimFG-Sutter) at each representative monitoring site with an artificial increase in evapotranspiration (ET) of 50%; or
3. The average operating range (difference between measurable objective and minimum threshold) for all representative monitoring sites using the above criteria for the following aquifer zones (AZs), applied based on the available screen interval or well depth information for each representative monitoring site:
    a. Shallow AZ and AZ-1 = 8.0 feet
    b. AZ-2 and AZ-3 = 16.5 feet

Table 6-1 reflects the minimum thresholds for chronic lowering of groundwater levels at each representative monitoring site. Refer to **Appendix 6-A** for hydrographs for all representative monitoring sites for chronic lowering of groundwater levels plotted with the established minimum thresholds and measurable objectives.

In the Sutter Subbasin, groundwater levels have been sustainable over time as the aquifer rebounds during all water year types following the irrigation season, returning to pre-pumping levels on a seasonal basis (see **Section 5.2** *Groundwater Conditions*). Therefore, undesirable results relative to chronic lowering of groundwater levels have not historically been observed in the Sutter Subbasin.

At each representative monitoring site, the C2VSimFG-Sutter integrated flow model was used to simulate groundwater elevations from the projected water budget to derive an average groundwater elevation over the 60-year simulation period assuming an artificial increase in ET by 50% to induce additional groundwater pumping to meet overlying land use demands to the point where interconnected streams that are gaining become losing. The Sacramento and Feather Rivers act as regulating reservoirs in the Sutter Subbasin, feeding water into the Subbasin as groundwater levels are lowered through natural fluctuations or groundwater pumping. A factor of 90% of the average simulated groundwater levels, where ET is increased by 50%, was applied to be conservative and avoid changes in the direction of stream interconnection while providing for additional operating range in the Sutter Subbasin.

Table 6-1. Minimum Thresholds for Chronic Lowering of Groundwater Levels

Site Code	State Well Number	Local ID / Other ID	Aquifer Zone	Minimum Threshold (feet above MSL, NAVD88)
-	12N02E09B002M	USGS-385431121451401	Shallow	12.30
-	12N03E18H001M	USGS-385314121401701	Shallow	13.32
-	14N02E10R001M	-	Shallow	25.09
-	15N02E20D001M	USGS-390832121463601	Shallow	29.50
391975N1218937W001	16N01E31H001M	-	Shallow	29.90
392328N1216469W001	16N03E21D002M	-	Shallow	44.44
390696N1217778W001	14N02E17C001M	Sutter County MW-1A	Shallow	21.50
390426N1218166W001	14N01E24N001M	USGS-390416121433601	AZ-1	23.58
390588N1217004W001	14N02E13L001M	-	AZ-1	15.93
390176N1217902W001	14N02E31K001M	-	AZ-1	19.08
391051N1217012W001	15N02E36L001M	-	AZ-1	22.54
392712N1216493W001	16N03E04E001M	-	AZ-1	43.18
392970N1216907W003	17N02E25J003M	BWD MW-1C	AZ-1	60.03
390458N1216114W001	14N03E23D003M	Feather River MW-1A	AZ-1	15.78
389605N1218102W003	13N01E24G004M	Flood MW-1C (shall)	AZ-1	13.00
389453N1216159W001	-	GH Well 2	AZ-1	22.09
391456N1218904W001	-	MFWC Prop 50	AZ-1	27.72
387859N1216565W001	11N03E20H003M	RD 1500 Karnak	AZ-1	10.51
390682N1216901W001	14N02E13A003M	SEWD MW-3A	AZ-1	31.57
390244N1217813W001	14N02E32D001M	SMWC MW-1A	AZ-1	18.34
388761N1217094W001	12N02E23H001M	Sutter County MW-2A	AZ-1	7.58
392394N1216509W001	16N03E17J001M	Sutter County MW-3A	AZ-1	45.80
390087N1216722W001	13N03E06A001M	Sutter County MW-6A	AZ-1	21.13

Site Code	State Well Number	Local ID / Other ID	Aquifer Zone	Minimum Threshold (feet above MSL, NAVD88)
-	-	Hillcrest Well #5	AZ-1 and AZ-2	15.47
391414N1217442W001	15N02E22D001M	-	AZ-2	24.00
391283N1218286W001	-	BS2-Franklin	AZ-2	16.77
392970N1216907W002	17N02E25J002M	BWD MW-1B	AZ-2	3.90
390458N1216114W002	14N03E23D004M	Feather River MW-1B	AZ-2	-30.19
389605N1218102W001	13N01E24G002M	Flood MW-1A (deep)	AZ-2	7.20
389605N1218102W002	13N01E24G003M	Flood MW-1B (int)	AZ-2	-7.90
-	-	Hillcrest Well #8	AZ-2	17.34
-	-	Hillcrest Well #9	AZ-2	14.35
391658N1217070W001	15N02E12E001M	SEWD MW-1A	AZ-2	15.66
391658N1217070W002	15N02E12E002M	SEWD MW-1B	AZ-2	23.14
391279N1216989W001	15N02E24P001M	SEWD MW-2A	AZ-2	24.51
391279N1216989W002	15N02E24P002M	SEWD MW-2B	AZ-2	-16.30
390682N1216901W002	14N02E13A004M	SEWD MW-3B	AZ-2	16.81
390244N1217813W002	14N02E32D002M	SMWC MW-1B	AZ-2	10.01
390696N1217778W002	14N02E17C002M	Sutter County MW-1B	AZ-2	12.33
388761N1217094W002	12N02E23H002M	Sutter County MW-2B	AZ-2	-0.08
392394N1216509W002	16N03E17J002M	Sutter County MW-3B	AZ-2	36.89
389452N1215992W001	13N03E26J002M	Sutter County MW-4A	AZ-2	5.09
390087N1216722W002	13N03E06A002M	Sutter County MW-6B	AZ-2	10.21
390087N1216722W003	13N03E06A003M	Sutter County MW-6C	AZ-2	9.91
-	-	WTP well	AZ-2 and AZ-3	21.51
392867N1217825W001	17N02E31A001M	-	AZ-3	21.35
392970N1216907W001	17N02E25J001M	BWD MW-1A	AZ-3	10.10

Site Code	State Well Number	Local ID / Other ID	Aquifer Zone	Minimum Threshold (feet above MSL, NAVD88)
390458N1216114W003	14N03E23D005M	Feather River MW-1C	AZ-3	11.05
390458N1216114W004	14N03E23D006M	Feather River MW-1D	AZ-3	9.49
391658N1217070W003	15N02E12E003M	SEWD MW-1C	AZ-3	22.91
391279N1216989W003	15N02E24P003M	SEWD MW-2C	AZ-3	-13.80
390682N1216901W003	14N02E13A005M	SEWD MW-3C	AZ-3	13.06
390244N1217813W003	14N02E32D003M	SMWC MW-1C	AZ-3	8.85
390696N1217778W003	14N02E17C003M	Sutter County MW-1C	AZ-3	5.77
390696N1217778W004	14N02E17C004M	Sutter County MW-1D	AZ-3	11.91
388761N1217094W003	12N02E23H003M	Sutter County MW-2C	AZ-3	-0.12
388761N1217094W004	12N02E23H004M	Sutter County MW-2D	AZ-3	-0.41
392394N1216509W003	16N03E17J003M	Sutter County MW-3C	AZ-3	34.68
392394N1216509W004	16N03E17J004M	Sutter County MW-3D	AZ-3	31.78
392394N1216509W005	16N03E17J005M	Sutter County MW-3E	AZ-3	31.21
389452N1215992W002	13N03E26J003M	Sutter County MW-4B	AZ-3	4.12
389452N1215992W003	13N03E26J004M	Sutter County MW-4C	AZ-3	2.82
389452N1215992W004	13N03E26J005M	Sutter County MW-4D	AZ-3	0.34

This page intentionally left blank.

For representative monitoring sites with small operating ranges as a result of the application of the first two minimum threshold methodologies listed above, a minimum operating range was applied based on values calculated by applying those methodologies. The average operating range for the Shallow AZ and AZ-1 were combined with the goal of being protective of interconnected surface waters, GDEs, and shallow domestic wells, where the average operating range of AZ-2 and AZ-3 were combined because most groundwater is pumped from these aquifer zones by municipal and agricultural production wells in the Sutter Subbasin. A minimum operating range is applied where applicable in order to allow for a reasonable use of groundwater by all beneficial users in the Sutter Subbasin.

Throughout GSP implementation, additional data collected at each representative monitoring site will be evaluated to determine that the minimum operating range applied does not cause an undesirable result in the Sutter Subbasin or adjacent subbasins. At the time of GSP development, it is not anticipated this method will cause an undesirable result based on the projected absence of undesirable results using the first two calculation methods presented above.

Three other methodologies were considered in establishing minimum thresholds for chronic lowering of groundwater levels: use of Thiessen polygons with consideration of the number of impacted domestic wells in each polygon, minimum saturated thickness required to maintain domestic and/or agricultural groundwater pumping, and operating range using proxy wells where minimal data was available in the historic record for representative monitoring wells. Refer to **Appendix 6-B** for more information about development of minimum thresholds for chronic lowering of groundwater levels and a comparison of considered methodologies.

6.5.1.2 Relationship to Other Sustainability Indicators

The relationship between minimum thresholds for each sustainability indicator, including an explanation of how it was determined that basin conditions at the minimum thresholds for chronic lowering of groundwater levels will avoid undesirable results for each of the other applicable sustainability indictors to the Sutter Subbasin, are described herein. Minimum thresholds for chronic lowering of groundwater levels are selected to avoid undesirable results for the other applicable sustainability indicators in the Sutter Subbasin as follows.

- **Reduction of Groundwater Storage.** Groundwater levels are used as a proxy for the reduction of groundwater storage sustainability indicator, where the chronic lowering of groundwater levels monitoring network and numeric SMC are also used to evaluate conditions relative to reduction of groundwater storage. In the Sutter Subbasin, there is approximately 49 million acre-feet of groundwater in storage. Pumping of groundwater in storage is not projected to reach unsustainable levels in the Sutter Subbasin, even with anticipated impacts of climate change (refer to

Section 5.3 for more information about projected conditions in the Sutter Subbasin). As such, the lowering of groundwater levels is more likely to result in undesirable conditions than the loss of groundwater in storage, and these impacts would be felt sooner. For example, lowered groundwater levels could result in shallow domestic wells going dry without causing any significant impact on the overall amount of groundwater in storage. This typically would occur due to potential localized effects described in **Section 6.5.1.4**.

- **Seawater Intrusion.** This sustainability indicator is not applicable to the Sutter Subbasin.
- **Degraded Water Quality.** Currently, there are limited groundwater quality data available in the Sutter Subbasin to support a connection between groundwater pumping and elevated concentrations of COCs that would cause an undesirable result or exceed drinking water standards or agricultural water quality objectives. Through implementation of the Sutter Subbasin GSP, groundwater quality could potentially be affected by implementation of projects and management actions that have a direct impact on groundwater resources, such as groundwater recharge projects that could potentially result in localized changes in groundwater elevations or gradients and result in mobilization of contaminants. Overall, current groundwater quality in the Sutter Subbasin is considered to be generally good and suitable for all beneficial uses.
- **Land Subsidence.** Land subsidence as a result of groundwater pumping has not historically been observed in the Sutter Subbasin. Therefore, based on current understanding and the best available science at the time of GSP development, the chronic lowering of groundwater levels and land subsidence sustainability indictors are not considered to be related and unlikely to cause undesirable results for the other sustainability indicator.
- **Depletions of Interconnected Surface Water.** Minimum thresholds are established for the depletions of interconnected surface water sustainability indicator using the same methodology as the chronic lowering of groundwater levels sustainability indicator and are intended to be protective of interconnected surface waters to avoid reversing the direction of interconnected surface waters from gaining to losing. Therefore, management of groundwater levels is anticipated to be most protective of beneficial uses of groundwater in the Sutter Subbasin.

6.5.1.3 Effects on Neighboring Subbasins

All seven of the groundwater subbasins adjacent to the Sutter Subbasin (the Butte, Wyandotte Creek, North Yuba, South Yuba, North American, Yolo, and Colusa Subbasins) are required to develop and adopted GSPs by January 31, 2022. A GSP for the North Yuba and South Yuba Subbasins, collectively referred to as the Yuba Subbasins, was adopted by Yuba Water Agency and submitted to DWR ahead of the regulatory deadline for non-critically overdrafted high- and medium-priority basins in early 2020. The remaining adjacent subbasins have developed their respective GSPs in tandem with the Sutter Subbasin, releasing draft GSP chapters for public review as complete. The limited information presently available about neighboring subbasin conditions does not indicate that the Sutter Subbasin or adjacent subbasin activities may negatively impact areas along the common basin boundaries. Data about subbasin conditions along the common subbasin boundaries will be shared as part of GSP implementation.

Minimum thresholds for chronic lowering of groundwater levels in the Sutter Subbasin have been selected to avoid causing undesirable results in adjacent subbasins or affect the ability of adjacent subbasins to achieve sustainability goals, where a description of such is contained herein. The Sutter Subbasin GSAs will continue to coordinate with neighboring subbasins throughout GSP development and implementation to ensure groundwater management activities and established minimum thresholds do not cause undesirable results or affect the ability of adjacent subbasins to achieve their sustainability goals.

6.5.1.3.1 Butte Subbasin

In the Butte Subbasin, minimum thresholds for the primary aquifer were established using a stepwise process:

1. Shallower of:
    a. 100% of range (or 20 feet, whichever is greater) below the historical low
    b. Shallowest 7% of nearby domestic wells
2. Deeper of:
    a. Step 1
    b. Measured historic low + 10 feet

A similar methodology was used to establish minimum thresholds for the very deep aquifer in the Butte Subbasin:

1. Shallower of:
    a. 100% of range below historic low
    b. Shallowest 7% of nearby water supply wells
2. Deeper of:
    a. Step 1
    b. Measured historic low + 10 feet

Overall, it appears that the thresholds established for the Butte Subbasin are comparable to those for the Sutter Subbasin. As such, minimum thresholds for chronic lowering of groundwater levels in the Sutter Subbasin are not anticipated to cause undesirable results or affect the ability of the Butte Subbasin from achieving its sustainability goal relative to chronic lowering of groundwater levels.

6.5.1.3.2 Wyandotte Creek Subbasin

The Sutter and Wyandotte Creek Subbasins share a boundary less than one mile in length and comprised roughly of the Feather River in the very northeastern corner of the Sutter Subbasin where groundwater-related activities are not known to occur. Therefore, it is not anticipated that activities in the Sutter Subbasin will cause an undesirable result for chronic lowering of groundwater levels in the Wyandotte Creek Subbasin.

6.5.1.3.3 North Yuba and South Yuba Subbasins

In the North Yuba and South Yuba Subbasins, the minimum threshold for chronic lowering of groundwater levels is set at the deeper of (1) the bottom of the shallowest domestic well near a monitoring well, adjusted for March measurements, or (2) the historical low March groundwater level from 1985 to present at the monitoring well, where a 75-foot minimum value was applied to the threshold. The Yuba Subbasins are currently in the GSP implementation phase and have not yet experienced an undesirable result for chronic lowering of groundwater levels. Given the role of the Feather River as a ‘regulating reservoir’ that largely forms the boundary between the Sutter Subbasin and Yuba Subbasins, it is not anticipated that minimum thresholds in the Sutter Subbasin for chronic lowering of groundwater levels will cause an undesirable result or affect the ability of the Yuba Subbasins to achieve their sustainability goal.

6.5.1.3.4 North American Subbasin

In the North American Subbasin, the minimum thresholds for the chronic lowering of groundwater levels were established by numerical modeling of expected future conditions. The simulated groundwater elevations at representative monitoring locations under this expected future scenario were then compared to baseline conditions (as approximated as the average of Fall 2014 and 2015 groundwater elevations) to estimate potential changes to Fall water level conditions should these expected projected future conditions occur. For each representative monitoring location, the difference between the projected future water levels and the baseline (Average Fall 2014/2015) water levels was then subtracted from the average Fall baseline water level to calculate the minimum threshold at that location. As a final step, the calculated minimum thresholds were then compared to beneficial uses and users to ensure that potential negative impacts would be avoided.

Given the role of the Feather River as a ‘regulating reservoir’ that forms the boundary between the Sutter Subbasin and North American Subbasin, and the fact that groundwater use in the North American Subbasin, like the Sutter Subbasin, is presently under its sustainable yield, it is not anticipated that minimum thresholds in the Sutter

Subbasin for chronic lowering of groundwater levels will cause an undesirable result or affect the ability of the North American Subbasin to achieve its sustainability goal.

6.5.1.3.5 Yolo Subbasin

In the Yolo Subbasin, management areas have been established for the chronic lowering of groundwater levels sustainability indicator and minimum thresholds have been defined for each management area. The North Yolo management area borders the Sutter Subbasin. The minimum threshold value for the North Yolo management area is equal to the historic minimum groundwater elevation plus 20% of the depth between the historic maximum and historic minimum elevation for the period of record at each representative monitoring well.

Based on a similar methodology used to establish minimum thresholds in the North Yolo management area as compared to the Sutter Subbasin (using the minimum historic elevation plus some additional operating buffer) and the role of the Sacramento River (adjoining both subbasins) in maintaining groundwater elevations in the Sutter Subbasin, minimum thresholds in the Sutter Subbasin are not anticipated to cause undesirable results or affect the ability of the Yolo Subbasin in achieving its sustainability goal relative to chronic lowering of groundwater levels.

6.5.1.3.6 Colusa Subbasin

In the Colusa Subbasin, minimum thresholds for chronic lowering of groundwater levels were calculated at each representative monitoring site by finding the deeper value of: (1) 20th percentile of shallowest domestic well depths in the monitoring well's Thiessen polygon or (2) 50% of range below the historic low groundwater elevation.

Overall, it appears that the minimum thresholds established for the Colusa Subbasin are comparable to those for the Sutter Subbasin. As such, the minimum thresholds for the chronic lowering of groundwater levels in the Sutter Subbasin are not anticipated to cause undesirable results or affect the ability of the Colusa Subbasin from achieving its sustainability goal relative to chronic lowering of groundwater levels.

6.5.1.4 Effects on Beneficial Uses and Users

Beneficial uses and users of groundwater are identified in **Section 4.1** of the *Outreach and Communication* chapter and generally include the following uses or users: domestic, municipal, agricultural, and environmental. All beneficial uses and users of groundwater, and their associated land uses and property interests, were considered in establishing minimum thresholds for chronic lowering of groundwater levels. Stakeholders, including the public, were invited to provide feedback on minimum thresholds during SSGMCC meetings (held bi-weekly and noticed according to the Brown Act) and a public workshop held on August 11, 2021. Municipal and agricultural representatives are members of the SSGMCC and participated in the development of minimum thresholds.

A description of how minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests is contained herein.

- **Domestic.** Minimum thresholds for chronic lowering of groundwater levels are established to avoid undesirable results for domestic well users, where domestic wells are typically screened in the Shallow AZ or AZ-1. If minimum thresholds are exceeded (even if an undesirable result is not observed), there may be some areas of the Subbasin where shallow domestic wells temporarily go dry. This may require the lowering of well pumps in these shallow wells, access to alternative water supplies until water levels recover (in emergency situations only), or the deepening of domestic wells.
- **Municipal.** Municipal wells tend to be deeper than domestic wells, with groundwater pumped typically from the lower portion of AZ-1 as well as AZ-2 and AZ-3. Municipal water supply systems are also designed to include redundancy to adapt to changes in groundwater conditions. Minimum thresholds for chronic lowering of groundwater levels are established to be protective of municipal groundwater production needs. Additionally, exceedances of minimum thresholds are not anticipated to negatively impact municipal groundwater production due to the redundancy and operating flexibility designed into municipal systems.
- **Agricultural.** Similar to municipal users of groundwater, minimum thresholds for chronic lowering of groundwater levels are established to be protective of agricultural groundwater production needs as the primary user of groundwater in the Sutter Subbasin. Minimum threshold exceedances are not anticipated to negatively impact groundwater production for agricultural uses due to seasonal aquifer rebound and the availability of surface water supplies for agricultural purposes.
- **Environmental.** Environmental users of groundwater typically rely on shallow groundwater (within 50 feet of ground surface or less) for recharge to interconnected streams and access by GDEs. If minimum thresholds for chronic lowering of groundwater levels are exceeded (even if an undesirable result is not observed), reduced groundwater recharge to streams and groundwater levels too deep for GDE species to access may be observed.

6.5.1.5 Relevant Federal, State, or Local Standards

Currently, there are no other federal, state, or local standards that relate to the chronic lowering of groundwater levels sustainability indicator in the Sutter Subbasin. SGMA is the prevailing legislation dictating requirements and standards for the chronic lowering of groundwater levels sustainability indicator. Any future federal, state, or local standards relating to chronic lowering of groundwater levels will be evaluated and considered in potential modifications to minimum thresholds during subsequent GSP updates.

6.5.1.6 Method for Quantitative Measurement

For information regarding how minimum thresholds for chronic lowering of groundwater levels will be quantitatively measured, including monitoring protocols as well as frequency and timing of measurement, refer to **Section 7.2** *Monitoring*.

6.5.2 Reduction of Groundwater Storage

The Sutter Subbasin GSP uses minimum thresholds for the chronic lowering of groundwater levels as a proxy for the reduction of groundwater storage sustainability indicator. As such, the minimum thresholds for the reduction of groundwater storage are with the same as the minimum thresholds for the chronic lowering of groundwater levels sustainability indicator.

GSP regulations allow GSAs to use groundwater levels as a proxy metric for any sustainability indicator provided the GSP demonstrates that there is a significant correlation between groundwater levels and other metrics. In order to rely on groundwater levels as a proxy, one approach suggested by DWR is to:

> *Demonstrate that the minimum thresholds and measurable objectives for chronic declines of groundwater levels are sufficiently protective to ensure significant and unreasonable occurrences of other sustainability indicators will be prevented. In other words, demonstrate that setting a groundwater level minimum threshold satisfies the minimum threshold requirements for not only chronic lowering of groundwater levels but other sustainability indicators at a given site (DWR, 2017).*

Minimum thresholds for the chronic lowering of groundwater levels sustainability indicator will effectively avoid undesirable results for reduction of groundwater in storage by ensuring that groundwater elevations (and therefore the volume of groundwater in storage) does not chronically decline in the future and has a demonstrated ability to rebound annually, with greater cumulative increases in storage during wetter years. The minimum thresholds can therefore be used as a proxy for reduction of groundwater storage because the minimum thresholds set for groundwater levels are sufficiently protective against occurrences of significant and unreasonable reductions of groundwater storage and, given the large volume of water in storage in the Sutter Subbasin, it is likely that significant declines in groundwater elevations are likely to result in undesirable results before the loss of groundwater storage is considered significant.

6.5.3 Seawater Intrusion

Seawater intrusion is not an applicable sustainability indicator for the Sutter Subbasin as the Subbasin is located inland from the Pacific Ocean and is not adjacent to the Sacramento-San Joaquin Delta. Therefore, SMC for seawater intrusion will not be established for the Sutter Subbasin GSP.

6.5.4 Degraded Water Quality

6.5.4.1 Identification and Methodology

The minimum threshold for degraded water quality is established as the highest of: (1) the upper SMCL for TDS (1,000 mg/L) and Primary MCL for nitrate as N (10 mg/L) or (2) current water quality conditions for TDS and nitrate as N based on data available from 2000 to the time of GSP development (Summer 2021) at the representative monitoring well or nearby well within the same aquifer zone, as described in **Section 5.2.5** of the *Basin Setting* chapter, using maximum concentration detected of each constituent. **Table 6-2** reflects the minimum thresholds for degraded water quality at each representative monitoring site.

Minimum thresholds for degraded water quality are established consistent with California drinking water standards and California's Antidegradation Policy (State Board Resolution 68-16). Local input through SSGMCC meetings, as well as the August 11, 2021 public workshop, were applied in setting the minimum threshold for degraded water quality. The selected minimum thresholds reflect input from local water purveyors as well as the local agricultural community and is expected to avoid undesirable results in the Sutter Subbasin. It should be noted that the concentrations presented for minimum thresholds reflect ambient groundwater quality, where additional treatment may be necessary to meet state and federal MCLs for drinking water.

Table 6-2. Minimum Thresholds for Degraded Water Quality

Site Code	State Well Number	Local ID / Other ID	Aquifer Zone	Minimum Threshold - TDS (mg/L)	Minimum Threshold - Nitrate as N (mg/L)
391975N1218937W001	16N01E31H001M	-	Shallow	1,000	10
-	-	RICE-01	Shallow	8,200[1]	10
-	-	RICE-02	Shallow	1,000	10
-	-	RICE-03	Shallow	1,000	10
-	-	RICE-20	Shallow	1,000	10
388761N1217094W001	12N02E23H001M	Sutter County MW-2A	AZ-1	1,000	10
389605N1218102W003	13N01E24G004M	Flood MW-1C (shall)	AZ-1	1,000	10
389803N1217675W001	13N02E17A001M	-	AZ-1	1,000	10
390588N1217004W001	14N02E13L001M	-	AZ-1	1,000	10
390497N1216535W001	14N03E20H003M	-	AZ-1	1,081	10
-	-	Hillcrest Well #5	AZ-1 and AZ-2	1,000	10
388761N1217094W002	12N02E23H002M	Sutter County MW-2B	AZ-2	1,000	10
389167N1216061W004	12N03E02G003M	-	AZ-2	1,000	10
389605N1218102W002	13N01E24G003M	Flood MW-1B (int)	AZ-2	1,000	10
-	-	Hillcrest Well #8	AZ-2	1,000	10
-	-	Hillcrest Well #9	AZ-2	1,000	10
-	-	Well-1A / 5110001-011	AZ-2	1,000	10
-	-	Well-2A / 5110001-013	AZ-2	1,000	11
-	-	WTP well	AZ-2 and AZ-3	1,000	10
388666N1217749W001	12N02E20P001M	-	AZ-3	1,000	10
388761N1217094W003	12N02E23H003M	Sutter County MW-2C	AZ-3	1,000	10
388761N1217094W004	12N02E23H004M	Sutter County MW-2D	AZ-3	1,000	10
389167N1216061W003	12N03E02G002M	-	AZ-3	1,000	10

Site Code	State Well Number	Local ID / Other ID	Aquifer Zone	Minimum Threshold - TDS (mg/L)	Minimum Threshold - Nitrate as N (mg/L)
390696N1217778W003	14N02E17C003M	Sutter County MW-1C	AZ-3	1,000	10
390696N1217778W004	14N02E17C004M	Sutter County MW-1D	AZ-3	1,000	10
390458N1216114W003	14N03E23D005M	Feather River MW-1C	AZ-3	1,000	10
-	-	5100172-001	Unknown	1,000	10
-	-	5101007-001	Unknown	1,000	10

[1] Only one data TDS measurement is available at this well. There is little confidence in this data point. As data is collected as part of GSP implementation, the minimum threshold for TDS may be revised.

6.5.4.2 Relationship to Other Sustainability Indicators

Described below are the relationship between minimum thresholds for each sustainability indicator, including an explanation of how it was determined that basin conditions at the minimum thresholds for degraded water quality will avoid undesirable results for each of the other applicable sustainability indicators to the Sutter Subbasin. Minimum thresholds for degraded water quality are selected to avoid undesirable results for the other applicable sustainability indicators in the Sutter Subbasin.

- **Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage.** As previously stated, there are limited groundwater quality data available in the Sutter Subbasin to support a connection between groundwater pumping and elevated concentrations of COCs. Additionally, projects and management actions are not required in order to maintain sustainability in the Sutter Subbasin. However, the minimum thresholds established for degraded water quality could impact direct use of supplemental water supplies for groundwater recharge projects, where ambient water quality may constrain supplies available for recharge or require additional treatment prior to land application or injection, and could thus limit the ability to maintain the measurable objectives established for the chronic lowering of groundwater levels or reduction of groundwater storage sustainability indicator if such projects were to be deemed necessary.
- **Seawater Intrusion.** This sustainability indicator is not applicable to the Sutter Subbasin.
- **Land Subsidence.** Based on local knowledge and the best available science, degraded water quality and land subsidence minimum thresholds are not related. Therefore, minimum thresholds for degraded water quality are not anticipated to cause undesirable results for land subsidence.
- **Depletions of Interconnected Surface Water.** Minimum thresholds for degraded water quality are established to be protective of drinking water standards or current water quality (based on available data from 2000 to present) where current conditions exceed drinking water standards (the highest beneficial use of water in California), consistent with California's Antidegradation Policy. Additionally, the volume of surface water in the interconnected surface water courses is much larger than the volume of water the aquifer is contributing to those streams. As such, while surface water quality is not within the purview of SGMA, the minimum thresholds for degraded water quality are not anticipated to degrade the quality of interconnected surface water.

6.5.4.3 Effects on Neighboring Subbasins

As noted in **Section 6.5.1.3**, there are seven groundwater subbasins adjacent to the Sutter Subbasin. Yuba Water Agency adopted and submitted the Yuba Subbasins GSP covering the North Yuba and South Yuba Subbasins to DWR in early 2020, ahead of the regulatory deadline for non-critically overdrafted high- and medium-priority basins. Butte, Wyandotte Creek, North American, Yolo, and Colusa Subbasins have developed their respective GSPs in tandem with the Sutter Subbasin, releasing draft GSP chapter for public review as complete, and therefore limited information is presently available about their proposed SMC.

Minimum thresholds for degraded water quality in the Sutter Subbasin have been selected to avoid causing undesirable results in adjacent subbasins or affect the ability of adjacent subbasins to achieve sustainability goals. The Sutter Subbasin GSAs will continue to coordinate with neighboring subbasins throughout GSP development and implementation to ensure groundwater management activities and established minimum thresholds do not cause undesirable results or affect the ability of adjacent subbasins to achieve their sustainability goals.

6.5.4.3.1 Butte Subbasin

In the Butte Subbasin, a minimum threshold for degraded water quality has been set at the higher of 900 microSiemens per centimeter (µS/cm) for electrical conductivity (EC; the recommended SMCL) or measured historical high EC concentration at each representative monitoring site. The methodology used to establish the minimum thresholds for degraded water quality in the Butte Subbasin is similar to that of the Sutter Subbasin, using drinking water standards and California's Antidegradation Policy. Therefore, it is not anticipated that minimum thresholds for degraded water quality in the Sutter Subbasin will cause undesirable results or affect the ability of the Butte Subbasin to achieve its sustainability goal.

6.5.4.3.2 Wyandotte Creek Subbasin

The Sutter and Wyandotte Creek Subbasins share a less than one mile boundary, comprised roughly of the Feather River in the very northeastern corner of the Sutter Subbasin where groundwater-related activities are not known to occur. Therefore, it is not anticipated that activities in the Sutter Subbasin will cause an undesirable result for degraded water quality in the Wyandotte Creek Subbasin.

6.5.4.3.3 North Yuba and South Yuba Subbasins

In the North Yuba and South Yuba Subbasins, EC, as a measure of salinity, is established at 1,000 µS/cm at each representative monitoring well, a value similar to the recommended SMCL of 900 µS/cm but below the Upper SMCL of 2,200 µS/cm. The methodology used to establish the minimum thresholds for degraded water quality in the Yuba Subbasins is similar to that of the Sutter Subbasin; therefore, it is not anticipated that minimum thresholds for degraded water quality in the Sutter Subbasin will cause undesirable results or affect the ability of the Yuba Subbasins to achieve its sustainability goal.

6.5.4.3.4 North American Subbasin

In the North American Subbasin, minimum thresholds are established for TDS and nitrate as N, where the minimum threshold is a concentration that exceeds the recommended SMCL of 500 mg/L for TDS and the Primary MCL of 10 mg/L for nitrate as N. This methodology is similar to that used by the Sutter Subbasin in establishing their minimum thresholds.

The Sutter Subbasin GSAs will continue to coordinate with the North American Subbasin GSAs to ensure that the effects of groundwater management activities on groundwater quality do not cause undesirables results or impact achievement of the respective sustainability goal in either subbasin.

6.5.4.3.5 Yolo Subbasin

The Yolo Subbasin Groundwater Agency will rely on current and future water quality standards established for drinking water and agricultural water uses by State and county regulatory agencies. The Yuba Subbasin Groundwater Agency plans to annually review water quality monitoring data, in collaboration with regulating agencies, to determine if water quality is being negatively affected by groundwater management activities. Where future significant impacts to water quality and associated groundwater management activities are identified, the Yuba Subbasin Groundwater Agency will coordinate with stakeholders and regulatory agencies to establish appropriate sustainable management criteria to avoid the occurrence of basin-wide undesirable results.

The Sutter Subbasin GSAs will continue to coordinate with the Yolo Subbasin Groundwater Agency to ensure that the effects of groundwater management activities on groundwater quality do not cause undesirable results or impact achievement of the respective sustainability goals in either subbasin.

6.5.4.3.6 Colusa Subbasin

In the Colusa Subbasin, a similar methodology is used as in the Butte Subbasin for establishing minimum thresholds for degraded groundwater quality (using either the higher of 900 µS/cm for EC or the pre-2015 historical maximum recorded EC value). The methodology used to establish the minimum thresholds for degraded water quality in the Colusa Subbasin is similar to that of the Sutter Subbasin; therefore, it is not anticipated that minimum thresholds for degraded water quality in the Sutter Subbasin will cause undesirable results or affect the ability of the Colusa Subbasin to achieve its sustainability goal.

6.5.4.4 Effects on Beneficial Uses and Users

As noted in **Section 6.5.1.4**, beneficial uses and users of groundwater in the Sutter Subbasin generally include domestic, municipal, agricultural, and environmental uses and users, where all beneficial uses and users of groundwater are identified in **Section 4.1** of the *Outreach and Communication* chapter. All beneficial uses and users of groundwater, and their associated land uses and property interests, were considered in establishing minimum thresholds for degraded water quality.

Stakeholders, including the public, were invited to provide feedback on minimum thresholds during SSGMCC meetings (held bi-weekly and noticed according to the Brown Act) and a public workshop held on August 11, 2021. Municipal and agricultural representatives are members of the SSGMCC and participated in the development of minimum thresholds, indicating that ambient groundwater quality consistent with drinking water standards or current water quality were sufficiently protective of beneficial uses of groundwater as they are consistent with regulatory requirements.

A description of how minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests is contained herein.

- **Domestic.** Minimum thresholds for degraded water quality will protect groundwater quality accessed by domestic well users in some areas of the Sutter Subbasin, ensuring that the groundwater quality is maintained such that treatment is not required to meet drinking water standards. In areas of the Sutter Subbasin where ambient water quality is above drinking water standards for TDS and nitrate as N, minimum thresholds are established to be consistent with California's Antidegradation Policy and not result in additional burden of treatment for domestic well users.
- **Municipal.** Similar to domestic uses and users, minimum thresholds established for degraded water quality will preserve groundwater quality accessed by municipal well users in some areas of the Sutter Subbasin, ensuring that treatment is not necessary to meet drinking water standards, and are consistent with California's Antidegradation Policy, and reduce the need for additional treatment of TDS and/or nitrate as N in areas where groundwater quality currently exceeds drinking water standards.
- **Agricultural.** Drinking water standards for TDS and nitrate as N tend to require higher quality water than for many agricultural uses, which can vary by crop type. Growers in the Sutter Subbasin have adapted to current groundwater quality by either blending groundwater with surface water to dilute elevated concentrations of constituents of concern, installing wellhead treatment, or changing crop types grown. Therefore, minimum thresholds for degraded water quality are not anticipated to negatively impact agricultural uses and users of groundwater and will preserve the quality of groundwater for agricultural use.
- **Environmental.** Similar to domestic uses and users, environmental users of groundwater typically rely on shallow groundwater where accumulation of salts from applied water or nitrates from applied fertilizers or septic systems are most likely to impact these users. As with agricultural uses, drinking water standards for TDS and

nitrate as N typically result in higher quality water than what is required for environmental uses. Therefore, minimum thresholds for degraded water quality will maintain ambient groundwater quality in areas with elevated ambient concentrations and will preserve groundwater quality for its highest and best use as a drinking water supply.

6.5.4.5 Relevant Federal, State, or Local Standards

Minimum thresholds for degraded water quality incorporate state drinking water standards, including Primary and Secondary MCLs, and California's Antidegradation Policy (State Board Resolution 68-16), where existing groundwater quality will be maintained to ensure the highest water quality to the maximum benefit to the people of the State (SWRCB, 1968). Under the Central Valley Regional Water Quality Control Board's (CV-RWQCB) *Water Quality Control Plan for the Sacramento and San Joaquin River Basins* (or Basin Plan) (SWRCB, May 2018), beneficial use designations are assigned to water bodies denoting the water quality objectives for ambient water quality consistent with drinking water standards which are passed down through the various regulatory permitting programs (such as in Waste Discharge Requirements). The Statewide Recycled Water Policy Regulations sets forth water quality standards for recycled-water related projects, in the event recycled water is utilized for groundwater recharge projects. Finally, CV-SALTS sets forth discharge standards for salts and nitrate as part of the Central Valley-wide salt and nutrient management program as does the Irrigated Lands Regulatory Program.

6.5.4.6 Method for Quantitative Measurement

For information regarding how minimum thresholds for degraded water quality will be quantitatively measured, including monitoring protocols as well as frequency and timing of measurement, refer to **Section 7.2** *Monitoring*.

6.5.5 Land Subsidence

6.5.5.1 Identification and Methodology

As discussed in **Section 5.2.6** of the *Basin Setting* chapter, inelastic land subsidence has not historically been observed in the Sutter Subbasin. The minimum thresholds for land subsidence have been established for the Sutter Subbasin based on the Sacramento Valley Subsidence Network developed and monitored jointly by DWR, the U.S. Bureau of Reclamation (USBR), and local partners.

The minimum threshold for land subsidence is directly tied to avoiding undesirable results, which is the point at which differential settlement reduces the ability to delivery surface water supplies or inadequate freeboard on levee systems in wet years impacting conveyance of flood waters. A value of 0.5 feet of subsidence over a 5-year period was selected to represent the point at which water conveyance and levee infrastructure become sensitive to land subsidence within the Sutter Subbasin.

Additionally, 0.5 feet is approximately twice the operational error of measurements taken by DWR and USBR [0.17 feet margin of error (DWR North Region Office, 2018)] in monitoring the Sacramento Valley Subsidence Network, allowing for operational flexibility in the event subsidence is observed in the future in the Sutter Subbasin.

Table 6-3 reflects the minimum thresholds for land subsidence at each representative monitoring site.

Table 6-3. Minimum Threshold for Land Subsidence

DWR Station ID	DWR Station Name	Minimum Threshold (feet of subsidence per 5-year period)
304	HPGN CA 03 04	0.5
BOGE	BOGUE	0.5
CANL	CANAL KS1836	0.5
EAGR	EAGER	0.5
ENNS	ENNIS	0.5
F114	F 114	0.5
G117	G 1175	0.5
HPIN	HOPPIN	0.5
K435	K 1435	0.5
LOAK	LIVE OAK	0.5
LOMO	LOMO	0.5
MRSN	MORRISON	0.5
OSWD	OSWALD	0.5
PASS	PASSBUTTE	0.5
PELG	PELGER	0.5
SACA	SACRAMENTO AVENUE	0.5
SAWT	SAWTELLE	0.5
TARK	TARKE	0.5
TSDL	TISDALE	0.5
VARN	VARNEY	0.5
WASH	WASHINGTON	0.5
WR18	DWR18	0.5

6.5.5.2 Relationship to Other Sustainability Indicators

The relationship between minimum thresholds for each sustainability indicator, including an explanation of how it was determined that basin conditions at the minimum threshold for land subsidence will avoid undesirable results for each of the other applicable sustainability indicators to the Sutter Subbasin, are described herein. Minimum thresholds for land subsidence are selected to avoid undesirable results for other applicable sustainability indicators in the Sutter Subbasin.

- **Chronic Lowering of Groundwater Levels.** Minimum thresholds established for the chronic lowering of groundwater levels are also protective of levels of subsidence that could cause an undesirable result in the Sutter Subbasin, as no historic subsidence has been observed in the Sutter Subbasin.

- **Reduction of Groundwater Storage.** The minimum threshold for land subsidence does not directly impact the reduction of groundwater storage sustainability indicator.
- **Seawater Intrusion.** This sustainability indicator is not applicable to the Sutter Subbasin.
- **Degraded Water Quality.** The minimum threshold for land subsidence does not directly impact the degraded water quality sustainability indicator.
- **Depletions of Interconnected Surface Water.** The minimum threshold for land subsidence does not directly impact the depletions of interconnected surface water sustainability indicator.

6.5.5.3 Effects on Neighboring Subbasins

As noted in **Section 6.5.1.3**, there are seven groundwater subbasins adjacent to the Sutter Subbasin. Yuba Water Agency adopted and submitted the Yuba Subbasins GSP covering the North Yuba and South Yuba Subbasins to DWR in early 2020, ahead of the regulatory deadline for non-critically overdrafted high- and medium-priority basins. Butte, Wyandotte Creek, North American, Yolo, and Colusa Subbasins have developed their respective GPSs in tandem with the Sutter Subbasin, releasing draft GSP chapters for public review as complete. Therefore, limited information may be currently available as to the SMCs set for land subsidence for these subbasins.

Minimum thresholds for land subsidence in the Sutter Subbasin have been selected to avoid causing undesirable results in adjacent subbasins or affect the ability of adjacent subbasins to achieve sustainability goals, where a description of such is included herein. The Sutter Subbasin GSAs will continue to coordinate with neighboring subbasins throughout GSP development and implementation to ensure groundwater management activities and established minimum thresholds do not cause undesirable results or affect the ability of adjacent subbasins to achieve their sustainability goals.

6.5.5.3.1 Butte Subbasin

The minimum threshold for the Sutter Subbasin is the same value in the Butte Subbasin – 0.5 feet of subsidence over a 5-year period using the Sacramento Valley Subsidence Network. Therefore, no undesirable result in the Butte Subbasin is anticipated as a result of the established minimum threshold for land subsidence in the Sutter Subbasin.

6.5.5.3.2 Wyandotte Creek Subbasin

The Sutter and Wyandotte Creek Subbasins share a less than one mile boundary, comprised roughly of the Feather River, in the very northeastern corner of the Sutter Subbasin where groundwater-related activities are not known to occur. Therefore, it is not anticipated that activities in the Sutter Subbasin will cause an undesirable result for land subsidence in the Wyandotte Creek Subbasin.

6.5.5.3.3 North Yuba and South Yuba Subbasins

The minimum threshold for the Sutter Subbasin is the same value in the North Yuba and South Yuba Subbasins – 0.5 feet of subsidence over a 5-year period using the Sacramento Valley Subsidence Network. Therefore, no undesirable result in the North Yuba and South Yuba Subbasins is anticipated as a result of the established minimum threshold for land subsidence in the Sutter Subbasin.

6.5.5.3.4 North American Subbasin

Groundwater levels are used as proxy for minimum thresholds for land subsidence in the North American Subbasin, where at each representative monitoring site either the minimum recorded low groundwater elevation or the projected low groundwater elevation (whichever is lower) is used. Since inelastic land subsidence has not historically been observed in the Sutter Subbasin, it is not anticipated that minimum thresholds for land subsidence in the Sutter Subbasin would cause an undesirable result or affect the ability to reach the established sustainability goal in the North American Subbasin.

6.5.5.3.5 Yolo Subbasin

As previously noted, the North Yolo management area of the Yolo Subbasin borders the Sutter Subbasin. The minimum threshold value for land subsidence in the North Yolo Subbasin has been established as 5.0 cm/year over 25% of the management area using a 5-year running average, consistent with historic conditions. The Yuba Subbasin Groundwater Agency is committed to continued evaluation of subsidence and identification of impacts associated with subsidence. The Sutter Subbasin GSAs will continue to coordinate with the Yuba Subbasin Groundwater Agency to ensure minimum thresholds for subsidence does not cause undesirable results in the Sutter Subbasin.

6.5.5.3.6 Colusa Subbasin

In the Colusa Subbasin, subsidence data available through the Sacramento Valley Height Modernization Project between 2006 and 2017 (monitored using the Sacramento Valley Subsidence Network) was used to establish minimum thresholds for land subsidence. For representative monitoring sites that have experienced more than 1 foot of inelastic subsidence between 2006 and 2017, the minimum threshold has been set at 0.6 feet per year (or 7.2 inches per year). For representative monitoring sites that have experienced less than 1 foot of inelastic subsidence between 2006 and 2017, the minimum threshold has been set at 0.5 feet per year (or 6 inches per year). Since the minimum threshold for land subsidence has been set at a more conservative 0.5 feet per 5-year period in the Sutter Subbasin, minimum thresholds for the Sutter Subbasin are not anticipated to cause undesirable results or affect the Colusa Subbasin from achieving its sustainability goal. The Sutter Subbasin GSAs will continue to coordinate with GSAs in the Colusa Subbasin to ensure additional allowable subsidence in the Colusa Subbasin does not cause undesirable results in the Sutter Subbasin.

6.5.5.4 Effects on Beneficial Uses and Users

As noted in **Section 6.5.1.4**, beneficial uses and users of groundwater in the Sutter Subbasin generally include domestic, municipal, agricultural, and environmental uses and users, where all beneficial uses and users of groundwater are identified in **Section 4.1** of the *Outreach and Communication* chapter. All beneficial uses and users of groundwater, and their associated land uses and property interests, were considered in establishing minimum thresholds for land subsidence.

Stakeholders, including the public, were invited to provide feedback on minimum thresholds during SSGMCC meetings (held bi-weekly and noticed according to the Brown Act) and a public workshop held on August 11, 2021. Municipal and agricultural representatives are members of the SSGMCC and participated in the development of minimum thresholds.

A description of how minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests is contained herein. The minimum threshold for land subsidence is established to avoid undesirable results for all beneficial uses and users of groundwater. Inelastic subsidence has not been observed in the Sutter Subbasin. Potentially effects on beneficial uses and users as a result of minimum threshold exceedances are unlikely but are considered in the event such impacts are observed.

- **Domestic.** Failure of well casings from land subsidence may impact domestic well owners as a result of compaction of fine-grained materials due to groundwater pumping, resulting in well repairs or well replacement.
- **Municipal.** Similar to domestic well owners, effects on municipal users may also result in failure of well casings. Additionally, differential settlement of the land surface may negatively impact distribution of water to customers in gravity-fed distribution systems or reduced ability to divert or convey flood water away from population centers.
- **Agricultural.** Effects on agricultural users may also result in failure of well casings, similar to domestic well owners and municipal users. Additionally, differential settlement of the land surface may negatively impact gravity-fed water conveyance systems. Flood management may also be impacted by differential settlement with the reduced ability to protect against, divert, or convey flood water, impacting crop production and/or resulting in flood-related damages.

- **Environmental.** The slope of streambeds may be impacted as a result of minimum threshold exceedances, causing changes in flow regimes and the creation of pools that can change in-stream temperatures.

6.5.5.5 Relevant Federal, State, or Local Standards

Currently, there are no other federal, state, or local standards within the Sutter Subbasin related to the land subsidence sustainability indicator. SGMA is the prevailing legislation dictating requirements and standards for land subsidence monitoring and management, as they related to GSP implementation.

6.5.5.6 Method for Quantitative Measurement

For information regarding how minimum thresholds for land subsidence will be quantitatively measured, including monitoring protocols as well as frequency and timing of measurement, refer to **Section 7.2** *Monitoring*.

6.5.6 Depletions of Interconnected Surface Water

6.5.6.1 Identification and Methodology

The same methodology that was applied in calculating the minimum thresholds for chronic lowering of groundwater levels is also used for depletions of interconnected surface water.

The minimum threshold for depletions of interconnected surface water is established as the deepest of the following:

1. The historic low for the available record at each representative monitoring site; or
2. 90% of the average groundwater elevation from the project water budget (baseline condition over 60-year period using C2VSimFG-Sutter) at each representative monitoring site with an artificial increase in ET of 50%; or
3. The average operating range (difference between measurable objective and minimum threshold) for all representative monitoring sites using the above criteria for the following AZs, applied based on the available screen interval or well depth information for each representative monitoring site:
    a. Shallow AZ and AZ-1 = 8.0 feet
    b. AZ-2 and AZ-3 = 16.5 feet

Table 6-4 reflects the minimum thresholds for depletions of interconnected surface water at each representative monitoring site. Refer to **Appendix 6-A** for hydrographs for all representative monitoring sites for depletions of interconnected surface water plotted with the established minimum threshold and measurable objectives. Additionally, refer to **Appendix 6-B** for more information about development of minimum thresholds for chronic lowering of groundwater levels and a comparison of considered methodologies, where the same methodologies were also considered for depletions of interconnected surface water.

This page intentionally left blank.

Table 6-4. Minimum Thresholds for Depletions of Interconnected Surface Water

Site Code	State Well Number	Local ID / Other ID	Aquifer Zone	Minimum Threshold (feet above MSL, NAVD88)
-	12N03E18H001M	USGS-385314121401701	Shallow	13.32
-	14N02E10R001M	USGS-390416121433601	Shallow	25.09
-	15N02E20D001M	USGS-390832121463601	Shallow	29.50
391975N1218937W001	16N01E31H001M	-	Shallow	29.90
392328N1216469W001	16N03E21D002M	-	Shallow	44.44
389563N1215843W001	-	GH East MW Site	Shallow	13.03
389571N1215858W001	-	GH North MW Site	Shallow	14.39
389233N1218022W001	12N01E01A001M	-	AZ-1	15.11
389937N1218240W001	13N01E11A001M	-	AZ-1	18.69
390458N1216114W001	14N03E23D003M	Feather River MW-1A	AZ-1	15.78
389453N1216159W001	-	GH Well 2	AZ-1	22.09
389398N1216162W001	-	GH Well 3	AZ-1	17.04
389410N1215884W001	-	GH Well 18	AZ-1	5.65
388869N1216445W002	-	Ma-1	AZ-1	14.36
388813N1217525W001	12N02E21Q001M	SR-1A	AZ-1	14.74
392394N1216509W001	16N03E17J001M	Sutter County MW-3A	AZ-1	45.80
390458N1216114W002	14N03E23D004M	Feather River MW-1B	AZ-2	-30.19
392394N1216509W002	16N03E17J002M	Sutter County MW-3B	AZ-2	36.89
390458N1216114W003	14N03E23D005M	Feather River MW-1C	AZ-3	11.05
390458N1216114W004	14N03E23D006M	Feather River MW-1D	AZ-3	9.49
392394N1216509W003	16N03E17J003M	Sutter County MW-3C	AZ-3	34.68
392394N1216509W004	16N03E17J004M	Sutter County MW-3D	AZ-3	31.78
392394N1216509W005	16N03E17J005M	Sutter County MW-3E	AZ-3	31.21

This page intentionally left blank.

In the Sutter Subbasin, groundwater levels have been sustainable over time as the aquifer rebounds during all water year types following the irrigation season, returning to pre-pumping levels on a seasonal basis (see **Section 5.2** *Groundwater Conditions*). The Sacramento and Feather Rivers act as 'regulating reservoirs' in the Sutter Subbasin, feeding water into the Subbasin as groundwater levels are lowered through natural fluctuations and groundwater pumping. Therefore, undesirable results relative to depletions of interconnected surface water have not historically been observed in the Sutter Subbasin.

At each representative monitoring site, the C2VSimFG-Sutter flow model was used to simulate groundwater elevations from the projected water budget to estimate average groundwater elevations over the 60-year simulation period with an artificial increase in ET by 50% to induce additional groundwater pumping to meet overlying land use demands to the point where interconnected streams that are gaining become losing. A factor of 90% of the average simulated groundwater levels, where ET is increased by 50%, was applied to be conservative and avoid changes in the direction of stream interconnection while providing for additional operating range in the Sutter Subbasin.

For representative monitoring sites with small operating ranges as a result of the application of the first two methodologies for calculating minimum thresholds, a minimum operating range was applied based on values estimated by those two other methods. The average operating range for the Shallow AZ and AZ-1 were combined with the goal of being protective of interconnected surface waters and GDEs, where the average operating range of AZ-2 and AZ-3 were combined because most groundwater is pumped from these aquifer zones in the Sutter Subbasin for municipal and agricultural supply. A minimum operating range is applied where applicable in order to allow for a reasonable use of groundwater by all beneficial users in the Sutter Subbasin.

Throughout GSP implementation, additional data collected at each representative monitoring site will be evaluated to ensure that the minimum operating range applied does not cause an undesirable result in the Sutter Subbasin or adjacent subbasins. At the time of GSP development, it is not anticipated this method will cause an undesirable result based on the projected absence of undesirable results using the first two calculation methods previously described.

6.5.6.2 Relationship to Other Sustainability Indicators

Described below is the relationship between minimum thresholds for each sustainability indicator, including an explanation of how it was determined that basin conditions at the minimum thresholds for depletions of interconnected surface water will avoid undesirable results for each of the other applicable sustainability indicators to the Sutter Subbasin. Minimum thresholds for depletions of interconnected surface water are selected to avoid undesirable results for the other applicable sustainability indicators in the Sutter Subbasin.

- **Chronic Lowering of Groundwater Levels and Reduction of Groundwater Storage.** Minimum thresholds for depletions of interconnected surface water were calculated using the same methodology as for the chronic lowering of groundwater level minimum thresholds (and used as proxy for reduction of groundwater storage). As previously noted, the Sacramento and Feather Rivers are key interconnected surface water sources in the Sutter Subbasin, feeding water into the Subbasin as groundwater levels are lowered through natural fluctuations and groundwater pumping. As minimum thresholds are designed to be protective of interconnected surface water and maintain groundwater levels at sustainable levels for the chronic lowering of groundwater levels and reduction of groundwater in storage SMC, minimum thresholds for depletions of interconnected surface water are not anticipated to cause undesirable results for the chronic lowering of groundwater levels or reduction of groundwater storage sustainability indicators.
- **Seawater Intrusion.** This sustainability indicator is not applicable to the Sutter Subbasin.
- **Degraded Water Quality.** Minimum thresholds for depletions of interconnected surface water are intended to maintain current, sustainable conditions relative to the direction of interconnection and volume exchanged between surface water and groundwater. There is no current evidence indicating that connection between interconnected surface waters and groundwater has any impact on groundwater quality. And the volume of surface water flowing through the interconnected surface water courses is much larger than the volume of water the aquifer is contributing to those streams. Therefore, based on local knowledge and best available science, it is not anticipated that minimum thresholds for depletions of interconnected surface water will cause undesirable results for degraded water quality.
- **Land Subsidence.** Based on local knowledge and the best available science, depletions of interconnected surface water and land subsidence minimum thresholds are not related. Historically, minimal inelastic subsidence has been observed in the Sutter Subbasin. There is no evidence to support large-scale compaction of clay layers in the Sutter Subbasin that may impact interconnection between groundwater and surface water. Therefore, minimum thresholds for depletions of interconnected surface water are not anticipated to cause undesirable results for land subsidence.

6.5.6.3 Effects on Neighboring Subbasins

As noted in **Section 6.5.1.3**, there are seven groundwater subbasins adjacent to the Sutter Subbasin. Yuba Water Agency adopted and submitted the Yuba Subbasins GSP covering the North Yuba and South Yuba Subbasins to DWR in early 2020, ahead of the regulatory deadline for non-critically overdrafted high- and medium-priority basins. Butte, Wyandotte Creek, North American, Yolo, and Colusa Subbasins have developed their respective GPSs in tandem with the Sutter Subbasin, releasing draft GSP chapter for public review as complete and therefore limited information may be available at this time about the established SMC for those subbasins.

Minimum thresholds for depletions of interconnected surface water in the Sutter Subbasin have been selected to avoid causing undesirable results in adjacent subbasins or affect the ability of adjacent subbasins to achieve sustainability goals, where a description of such is contained herein. The Sutter Subbasin GSAs will continue to coordinate with neighboring subbasins throughout GSP development and implementation to ensure groundwater management activities and established minimum thresholds do not cause undesirable results or affect the ability of adjacent subbasins to achieve their sustainability goals.

6.5.6.3.1 Butte Subbasin

In the Butte Subbasin, minimum thresholds for depletion of interconnected surface water were set at 10 feet below the measured historical low for each representative monitoring well. This method was selected to be protective of beneficial use of interconnected surface water and shallow groundwater near streams and rivers, including those of shallower domestic users and potential groundwater dependent ecosystems. The additional 10 feet in depth below the measured historical low is intended to provide an appropriate margin of operational flexibility during GSP implementation. Since the portion of the Feather River bordering the Butte Subbasin is located upstream from the Sutter Subbasin, it is not anticipated that minimum thresholds set for depletions of interconnected surface water along the Feather River in the Sutter Subbasin will cause undesirable results or impact the ability of the Butte Subbasin to achieve its sustainability goal.

6.5.6.3.2 Wyandotte Creek Subbasin

The Sutter and Wyandotte Creek Subbasins share a less than one mile boundary, comprised roughly of the Feather River in the very northeastern corner of the Sutter Subbasin where groundwater-related activities are not known to occur. Therefore, it is not anticipated that activities in the Sutter Subbasin will cause an undesirable result for depletions of interconnected surface water in the Wyandotte Creek Subbasin.

6.5.6.3.3 North Yuba and South Yuba Subbasins

In the North Yuba and South Yuba Subbasins, management of depletions of interconnected surface water are performed using groundwater levels as a proxy, using the same monitoring network and numeric SMC as chronic lowering of groundwater levels to identify undesirable results relative to depletions of interconnected surface water. Since numeric SMC for depletions of interconnected surface water and chronic lowering of groundwater levels were developed using the same methodology for the Sutter Subbasin GSP, minimum thresholds in the Sutter Subbasin are anticipated to avoid causing an undesirable result or affect the ability of the North Yuba and South Yuba subbasins to achieve their sustainability goal.

6.5.6.3.4 North American Subbasin

In the North American Subbasin, minimum thresholds for depletions of interconnected surface water are established using groundwater levels as proxy using the same values as established for the chronic lowering of groundwater sustainability indicator, using a subset of representative monitoring sites considered to be interconnected with the surface water system. Since numeric SMC for depletions of interconnected surface water and chronic lowering of groundwater levels were developed using the same methodology for the Sutter Subbasin GSP, minimum thresholds in the Sutter Subbasin are anticipated to avoid causing an undesirable result or affect the ability of the North American Subbasin in achieving its sustainability goal.

6.5.6.3.5 Yolo Subbasin

Minimum thresholds for the depletions of interconnected surface water sustainability indicator along the Upper Sacramento River (defined in the Yolo Subbasin GSP as from the northern subbasin boundary to the southern boundary of the North Yolo management area, which borders the Sutter Subbasin) are established using the same criteria as for the chronic lowering of groundwater levels sustainability indicator in the North Yolo management area. The minimum threshold value is equal to the historic minimum groundwater elevation plus 20% of the depth between the historic maximum and historic minimum elevation for the period of record at each representative monitoring well.

Based on similar methodologies used to establish minimum thresholds along the Upper Sacramento River portion of the North Yolo management area as compared to the Sutter Subbasin (the use of historic minimum groundwater elevations plus some additional buffer) and the role of the Sacramento River (adjoining both subbasins) as a ‘regulating reservoir’ in the Sutter Subbasin, minimum thresholds in the Sutter Subbasin are not anticipated to cause undesirable results or affect the ability of the Yolo Subbasin in achieving its sustainability goal relative to depletions of interconnected surface water.

6.5.6.3.6 Colusa Subbasin

In the Colusa Subbasin, a similar methodology to the Butte Subbasin was used to set minimum thresholds for depletions of interconnected surface water, where the groundwater elevation at each representative monitoring well closest to October 15, 2015 (considered to be the lowest groundwater elevations during the last drought based on review of historical groundwater levels and hydrologic data) was selected with an additional 10 feet added to this groundwater elevation to provide an appropriate margin of operational flexibility in the future during GSP implementation. In the Sutter Subbasin monitoring network, only one representative monitoring site is available along the

Sacramento River (forming the Colusa-Sutter Subbasins boundary) and it is the same site in both GSPs (13N01E11A001). The minimum threshold in the Colusa Subbasin GSP at 13N01E11A001 is set at 13 feet above mean seal level (MSL) and 18.69 feet above MSL in the Sutter Subbasin (**Table 6-4**). Since 13N01E11A001 is located in the Colusa Subbasin across the Sacramento River, it is not anticipated that localized groundwater pumping in the Sutter Subbasin will impact this monitoring site. Therefore, it is not anticipated that the minimum threshold established at 13N01E11A001 for the Sutter Subbasin GSP will cause an undesirable result or impact the ability of the Colusa GSP to achieve its sustainability goal.

6.5.6.4 Effects on Beneficial Uses and Users

As noted in **Section 6.5.1.4**, beneficial uses and users of groundwater in the Sutter Subbasin generally include domestic, municipal, agricultural, and environmental uses and users, where all beneficial uses and users of groundwater are identified in **Section 4.1** of the *Outreach and Communication* chapter. All beneficial uses and users of groundwater, and their associated land uses and property interests, were considered in establishing minimum thresholds for depletions of interconnected surface water.

Stakeholders, including the public, were invited to provide feedback on minimum thresholds during SSGMCC meetings (held bi-weekly and noticed according to the Brown Act) and a public workshop held on August 11, 2021. Municipal and agricultural representatives are members of the SSGMCC and participated in the development of minimum thresholds.

A description of how minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests is contained herein.

- **Domestic.** Minimum thresholds for depletions of interconnected surface water are established to avoid undesirable results for domestic well users as domestic wells are typically screened in the Shallow AZ or AZ-1. Domestic well users are typically considered to be *de minimis* groundwater users (2 acre-feet or less per year) and are not anticipated to cause an undesirable result for depletions of interconnected surface water. Alternatively, due to the interconnection of the Sacramento and Feather Rivers with the Sutter Subbasin, it is not anticipated that negative impacts on domestic well users near interconnected surface waters will be observed if established minimum thresholds are exceeded.
- **Municipal.** As previously noted, municipal water supply systems are designed to include redundancy to adapt to changes in groundwater conditions. Minimum thresholds for depletions of interconnected surface water are established to be protective of municipal groundwater and surface water production needs. If an undesirable result were observed, a reversal of gaining to losing streams could result in decreased water supply available in streams utilized for municipal use in the Sutter Subbasin.

- **Agricultural.** Similar to municipal users, minimum thresholds for depletions of interconnected surface water are established to be protective of agricultural water needs as the primary use of water in the Sutter Subbasin. If an undesirable result were observed, a reversal of gaining to losing streams could result in decreased water supply available in streams utilized for agricultural purposes in the Sutter Subbasin.
- **Environmental.** If an undesirable result for depletions of interconnected surface water is observed and presently gaining streams become losing streams, this reversal of stream interconnection would affect aquatic systems and potentially GDEs. Overall water supply utilized by environmental beneficial users of water would be reduced, thereby reducing suitable habitat through reduced stream depth, flow velocity, cover, and dissolved oxygen as well as increased temperature.

6.5.6.5 Relevant Federal, State, or Local Standards

Currently, there are no federal, state, or local standards directly related to the depletions of interconnected surface water sustainability indicator. SGMA is the prevailing legislation dictating requirements and standards for the depletions of interconnected surface water sustainability indicator.

In December 2010 the State Water Resources Control Board (SWRCB) adopted Order WQ 2010-0016, a water quality certification that contains instream flow and temperature requirements for the Feather River’s reaches downstream of Oroville Dam (NCWA, November 2019). For the High Flow Channel, which is the reach between the Thermalito Afterbay’s outlet and the Feather River’s confluence with the Sacramento River, instream flow requirements are required to be maintained so long as they are not projected to cause Oroville Reservoir to be drawn below 733 feet (or approximately 1.5 million acre-feet in storage), with reduced instream flow requirements to prevent drawdown below 733 feet provided stream flows would not be reduced more than 25% below requirements. The certification also requires DWR to operate the Oroville project to meet temperature standards in Feather River.

In April 1960, a Memorandum of Agreement (MOA) between USBR and California Department of Fish and Game (now California Department of Fish and Wildlife) originally established flow objectives in the Sacramento River for protection and preservation of fish and wildlife resources, providing for minimum releases into the natural channel of the Sacramento River at Keswick Dam for normal and critically dry years. Modifications to the flow schedule in the MOA were made in October 1981. In 1990 and 1991, the SWRCB issued Water Rights Orders 90-05 and 91-01 modifying USBR’s water rights for the Sacramento River. The orders states USBR shall operate Keswick and Shasta Dams and the Spring Creek Powerplant to meet temperature requirements as far downstream in the Sacramento River as practicable during periods when high temperature would be harmful to fisheries. Pursuant to these orders, USBR configured and implemented the Sacramento-Trinity Water Quality Monitoring Network to monitor temperature and other parameters at key locations in the Sacramento and Trinity Rivers.

6.5.6.6 Method for Quantitative Measurement

For information regarding how minimum thresholds for depletions of interconnected surface water will be quantitatively measured, including monitoring protocols as well as frequency and timing of measurement, refer to **Section 7.2** *Monitoring*.

6.6 Measurable Objectives and Interim Milestones

Measurable objectives are quantitative goals that reflect the subbasin's desired groundwater conditions and allow the Sutter Subbasin GSAs to achieve the sustainability goal within 20 years. Measurable objectives are set such that there is a reasonable margin of operational flexibility that will accommodate droughts, climate change, conjunctive use operations, and other groundwater management activities. Given that the Sutter Subbasin is currently considered sustainable, projects and management actions are not considered necessary to achieve the measurable objectives. However, projects and management actions are included in **Section 7.1** and designed to allow for adaptive management of the groundwater basin, maintain sustainable conditions and improve overall groundwater conditions.

Interim milestones are target values representing measurable groundwater conditions, in increments of 5 years, set to help move a basin towards the sustainability goal over a 20-year period. Interim milestones are set equal to the measurable objective for each applicable sustainability indicator, as the Sutter Subbasin is in a sustainable state, as a means of maintaining that sustainability.

This section describes the methodology used to develop numeric measurable objectives/interim milestones and how the established values will maintain sustainable conditions in the Sutter Subbasin.

6.6.1 Chronic Lowering of Groundwater Levels

The measurable objective for the chronic lowering of groundwater levels is set at the average of the available historical record at each representative monitoring site. The average groundwater level calculated over the historic record for each representative monitoring site reflects a long-term, varied hydrologic record and, along with the identification of undesirable results, is anticipated to maintain sustainable conditions in the Sutter Subbasin as the Subbasin is shown to currently be in a sustainable state (see **Section 5.3** of the *Basin Setting* chapter for more information about sustainable conditions in the Sutter Subbasin). Refer to **Appendix 6-A** for hydrographs for all representative monitoring sites for chronic lowering of groundwater levels plotted with the established measurable objective.

In the process of developing the measurable objectives for the chronic lowering of groundwater levels, several other methods were considered. Other methods considered included the average of measurements between Water Year 2015 and 2020, average of seasonal high groundwater levels over the historic record at each representative monitoring site, and 10 feet below ground surface elevation as established in the Sutter Subbasin Alternative Plan (GEI, 2016). Refer to **Appendix 6-B** for more information about development of measurable objectives for chronic lowering of groundwater levels and a comparison of considered methodologies.

Table 6-5 reflects the measurable objectives and interim milestones for chronic lowering of groundwater levels at each representative monitoring site.

Table 6-5. Measurable Objectives and Interim Milestones for the Chronic Lowering of Groundwater Levels

Site Code	State Well Number	Local ID / Other ID	Aquifer Zone	Measurable Objective / Interim Milestone (feet above MSL, NAVD88)
-	12N02E09B002M	USGS-385431121451401	Shallow	20.30
-	12N03E18H001M	USGS-385314121401701	Shallow	21.32
-	14N02E10R001M	-	Shallow	36.63
-	15N02E20D001M	USGS-390832121463601	Shallow	37.50
391975N1218937W001	16N01E31H001M	-	Shallow	41.46
392328N1216469W001	16N03E21D002M	-	Shallow	61.53
390696N1217778W001	14N02E17C001M	Sutter County MW-1A	Shallow	29.50
390426N1218166W001	14N01E24N001M	USGS-390416121433601	AZ-1	31.58
390588N1217004W001	14N02E13L001M	-	AZ-1	35.80
390176N1217902W001	14N02E31K001M	-	AZ-1	27.08
391051N1217012W001	15N02E36L001M	-	AZ-1	41.09
392712N1216493W001	16N03E04E001M	-	AZ-1	51.18
392970N1216907W003	17N02E25J003M	BWD MW-1C	AZ-1	68.03
390458N1216114W001	14N03E23D003M	Feather River MW-1A	AZ-1	25.14
389605N1218102W003	13N01E24G004M	Flood MW-1C (shall)	AZ-1	23.33
389453N1216159W001	-	GH Well 2	AZ-1	30.09
391456N1218904W001	-	MFWC Prop 50	AZ-1	35.72
387859N1216565W001	11N03E20H003M	RD 1500 Karnak	AZ-1	18.51
390682N1216901W001	14N02E13A003M	SEWD MW-3A	AZ-1	39.57
390244N1217813W001	14N02E32D001M	SMWC MW-1A	AZ-1	26.34
388761N1217094W001	12N02E23H001M	Sutter County MW-2A	AZ-1	15.58
392394N1216509W001	16N03E17J001M	Sutter County MW-3A	AZ-1	67.82
390087N1216722W001	13N03E06A001M	Sutter County MW-6A	AZ-1	29.13

Site Code	State Well Number	Local ID / Other ID	Aquifer Zone	Measurable Objective / Interim Milestone (feet above MSL, NAVD88)
-	-	Hillcrest Well #5	AZ-1 and AZ-2	31.97
391414N1217442W001	15N02E22D001M	-	AZ-2	40.50
391283N1218286W001	-	BS2-Franklin	AZ-2	33.27
392970N1216907W002	17N02E25J002M	BWD MW-1B	AZ-2	43.89
390458N1216114W002	14N03E23D004M	Feather River MW-1B	AZ-2	13.00
389605N1218102W001	13N01E24G002M	Flood MW-1A (deep)	AZ-2	24.50
389605N1218102W002	13N01E24G003M	Flood MW-1B (int)	AZ-2	21.89
-	-	Hillcrest Well #8	AZ-2	33.84
-	-	Hillcrest Well #9	AZ-2	30.85
391658N1217070W001	15N02E12E001M	SEWD MW-1A	AZ-2	46.28
391658N1217070W002	15N02E12E002M	SEWD MW-1B	AZ-2	39.64
391279N1216989W001	15N02E24P001M	SEWD MW-2A	AZ-2	41.01
391279N1216989W002	15N02E24P002M	SEWD MW-2B	AZ-2	29.31
390682N1216901W002	14N02E13A004M	SEWD MW-3B	AZ-2	33.31
390244N1217813W002	14N02E32D002M	SMWC MW-1B	AZ-2	26.51
390696N1217778W002	14N02E17C002M	Sutter County MW-1B	AZ-2	28.83
388761N1217094W002	12N02E23H002M	Sutter County MW-2B	AZ-2	16.42
392394N1216509W002	16N03E17J002M	Sutter County MW-3B	AZ-2	53.39
389452N1215992W001	13N03E26J002M	Sutter County MW-4A	AZ-2	21.59
390087N1216722W002	13N03E06A002M	Sutter County MW-6B	AZ-2	26.71
390087N1216722W003	13N03E06A003M	Sutter County MW-6C	AZ-2	26.41
-	-	WTP well	AZ-2 and AZ-3	38.01
392867N1217825W001	17N02E31A001M	-	AZ-3	50.35

Site Code	State Well Number	Local ID / Other ID	Aquifer Zone	Measurable Objective / Interim Milestone (feet above MSL, NAVD88)
392970N1216907W001	17N02E25J001M	BWD MW-1A	AZ-3	35.01
390458N1216114W003	14N03E23D005M	Feather River MW-1C	AZ-3	27.55
390458N1216114W004	14N03E23D006M	Feather River MW-1D	AZ-3	25.99
391658N1217070W003	15N02E12E003M	SEWD MW-1C	AZ-3	39.41
391279N1216989W003	15N02E24P003M	SEWD MW-2C	AZ-3	29.80
390682N1216901W003	14N02E13A005M	SEWD MW-3C	AZ-3	29.56
390244N1217813W003	14N02E32D003M	SMWC MW-1C	AZ-3	25.35
390696N1217778W003	14N02E17C003M	Sutter County MW-1C	AZ-3	25.72
390696N1217778W004	14N02E17C004M	Sutter County MW-1D	AZ-3	28.41
388761N1217094W003	12N02E23H003M	Sutter County MW-2C	AZ-3	16.38
388761N1217094W004	12N02E23H004M	Sutter County MW-2D	AZ-3	16.09
392394N1216509W003	16N03E17J003M	Sutter County MW-3C	AZ-3	51.18
392394N1216509W004	16N03E17J004M	Sutter County MW-3D	AZ-3	48.28
392394N1216509W005	16N03E17J005M	Sutter County MW-3E	AZ-3	47.71
389452N1215992W002	13N03E26J003M	Sutter County MW-4B	AZ-3	20.62
389452N1215992W003	13N03E26J004M	Sutter County MW-4C	AZ-3	19.32
389452N1215992W004	13N03E26J005M	Sutter County MW-4D	AZ-3	16.84

This page intentionally left blank.

Local input through SSGMCC meetings as well as public workshops was considered in setting the measurable objectives for chronic lowering of groundwater levels. The selected measurable objectives reflect input from local water purveyors as well as the agricultural community and is expected to maintain economically-viable groundwater levels for all beneficial users of groundwater. Interim milestones are equal to the measurable objective for chronic lowering of groundwater levels.

6.6.2 Reduction of Groundwater Storage

Since chronic lowering of groundwater levels is used as a proxy for reduction in groundwater storage, the measurable objectives and interim milestones for the reduction of groundwater storage sustainability indicator are the same as the measurable objectives and interim milestones for the chronic lowering of groundwater levels sustainability indicator as set forth in **Section 6.6.1** and will utilize the same monitoring networks and collected data (in addition to C2VSimFG-Sutter) to evaluate performance and sustainability metrics.

6.6.3 Seawater Intrusion

Seawater intrusion is not an applicable sustainability indicator for the Sutter Subbasin as the Subbasin is located inland from the Pacific Ocean and is not adjacent to the Sacramento-San Joaquin Delta. Therefore, SMC for seawater intrusion will not be established for the Sutter Subbasin GSP.

6.6.4 Degraded Water Quality

The measurable objective for degraded water quality is set as the current water quality conditions for TDS and nitrate as N based on data available from 2000 to the time of GSP development (Summer 2021) at the representative monitoring well or nearby well within the same aquifer zone (as described in **Section 5.2.5** of the *Basin Setting* chapter) using maximum concentration detected of each constituent. In the event that well-specific data or nearby well data in the same aquifer zone are not present, the measurable objective has been set at 500 mg/L for TDS (the recommended SMCL) and 7 mg/L for nitrate as N [70% of the Primary MCL, per the adaptive management trigger system described in the *Framework for a Drinking Water Well Impact Mitigation Program* (Self-Help Enterprises et al., n.d.)]. **Table 6-6** reflects the measurable objectives and interim milestones for degraded water quality at each representative monitoring site.

This page intentionally left blank.

Table 6-6. Measurable Objectives and Interim Milestones for Degraded Water Quality

Site Code	State Well Number	Local ID / Other ID	Aquifer Zone	Measurable Objective / Interim Milestone - TDS (mg/L)	Measurable Objective / Interim Milestone - Nitrate as N (mg/L)
391975N1218937W001	16N01E31H001M	-	Shallow	< 500	< 7
-	-	RICE-01	Shallow	8,200[1]	1
-	-	RICE-02	Shallow	375	1
-	-	RICE-03	Shallow	519	1.72
-	-	RICE-20	Shallow	620	3.77
388761N1217094W001	12N02E23H001M	Sutter County MW-2A	AZ-1	< 500	< 7
389605N1218102W003	13N01E24G004M	Flood MW-1C (shall)	AZ-1	< 500	< 7
389803N1217675W001	13N02E17A001M	-	AZ-1	799	1
390588N1217004W001	14N02E13L001M	-	AZ-1	367	1
390497N1216535W001	14N03E20H003M	-	AZ-1	1,081	1
-	-	Hillcrest Well #5	AZ-1 and AZ-2	< 500	1
388761N1217094W002	12N02E23H002M	Sutter County MW-2B	AZ-2	< 500	< 7
389167N1216061W004	12N03E02G003M	-	AZ-2	< 500	< 7
389605N1218102W002	13N01E24G003M	Flood MW-1B (int)	AZ-2	< 500	< 7
-	-	Hillcrest Well #8	AZ-2	< 500	1
-	-	Hillcrest Well #9	AZ-2	< 500	4
-	-	Well-1A / 5110001-011	AZ-2	420	8
-	-	Well-2A / 5110001-013	AZ-2	450	11
-	-	WTP well	AZ-2 and AZ-3	170	1
388666N1217749W001	12N02E20P001M	-	AZ-3	< 500	< 7
388761N1217094W003	12N02E23H003M	Sutter County MW-2C	AZ-3	< 500	< 7
388761N1217094W004	12N02E23H004M	Sutter County MW-2D	AZ-3	< 500	< 7

Site Code	State Well Number	Local ID / Other ID	Aquifer Zone	Measurable Objective / Interim Milestone - TDS (mg/L)	Measurable Objective / Interim Milestone - Nitrate as N (mg/L)
389167N1216061W003	12N03E02G002M	-	AZ-3	< 500	< 7
390696N1217778W003	14N02E17C003M	Sutter County MW-1C	AZ-3	874	1
390696N1217778W004	14N02E17C004M	Sutter County MW-1D	AZ-3	874	1
390458N1216114W003	14N03E23D005M	Feather River MW-1C	AZ-3	< 500	< 7
-	-	5100172-001	Unknown	< 500	3
-	-	5101007-001	Unknown	< 500	< 7

[1] Only one data TDS measurement is available at this well. There is little confidence in this data point. As data is collected as part of GSP implementation, the minimum threshold for TDS may be revised.

Local input through SSGMCC meetings as well as public workshops were also applied in setting the measurable objectives for degraded water quality. The selected measurable objectives reflect input from local drinking water purveyors as well as the local agricultural community and is expected to maintain beneficial uses of groundwater. It should be noted that concentrations presented for measurable objectives reflect ambient groundwater quality, where additional treatment may currently be necessary to meet state and federal MCLs for drinking water. Interim milestones are equal to the measurable objective for degraded water quality. Measurable objectives/interim milestones have been established consistent with California's Antidegradation Policy.

6.6.5 Land Subsidence

The measurable objective for land subsidence reflects the desired conditions and is set at 0.25 feet of subsidence per 5-year period at each site (0.05 feet over 1 year or 1 foot over 20 years), a rate that is small but reflects the range of error inherent in measurements collected for the subsidence monitoring network [measured with an accuracy of 0.17 feet (DWR North Region Office, 2018)]. Because subsidence has not historically been detected in the Sutter Subbasin, interim milestones are set at the measurable objective value of 0.25 feet per 5-year period. **Table 6-7** reflects the measurable objectives and interim milestones for the land subsidence sustainability indicator.

Local input through SSGMCC meetings as well as public workshops were applied in setting the measurable objective for land subsidence. The selected measurable objective reflects input from local water purveyors, reclamation districts, and the agricultural community who operate and maintain critical infrastructure within the Subbasin that would be directly impact by inelastic land subsidence. Interim milestones are equal to the measurable objective for land subsidence.

Table 6-7. Measurable Objective and Interim Milestone for Land Subsidence

DWR Station ID	DWR Station Name	Measurable Objective / Interim Milestone (feet of subsidence per 5-year period)
304	HPGN CA 03 04	0.25
BOGE	BOGUE	0.25
CANL	CANAL KS1836	0.25
EAGR	EAGER	0.25
ENNS	ENNIS	0.25
F114	F 114	0.25
G117	G 1175	0.25
HPIN	HOPPIN	0.25
K435	K 1435	0.25
LOAK	LIVE OAK	0.25
LOMO	LOMO	0.25
MRSN	MORRISON	0.25
OSWD	OSWALD	0.25
PASS	PASSBUTTE	0.25
PELG	PELGER	0.25
SACA	SACRAMENTO AVENUE	0.25
SAWT	SAWTELLE	0.25
TARK	TARKE	0.25
TSDL	TISDALE	0.25
VARN	VARNEY	0.25
WASH	WASHINGTON	0.25
WR18	DWR18	0.25

6.6.6 Depletions of Interconnected Surface Water

The measurable objective for depletions of interconnected surface water is set at the average of the available historical record at each representative monitoring site. The average groundwater level calculated over the historic record for each representative monitoring site reflects a long-term, varied hydrologic record and, along with the identification of undesirable results, is anticipated to maintain sustainable conditions in the Sutter Subbasin as the Subbasin is shown to currently be in a sustainable state (see **Section 5.3** of the *Basin Setting* chapter for more information about sustainable conditions in the Sutter Subbasin). Refer to **Appendix 6-A** for hydrographs for all representative monitoring sites for depletions of interconnected surface water plotted with the established measurable objective.

The same methodology for establishing measurable objectives for the chronic lowering of groundwater levels is used for depletions of interconnected surface water (see **Appendix 6-B** for more information about development measurable objectives and comparison of considered methodologies). Interconnected surface waters are a key controlling factor for groundwater levels in the Sutter Subbasin, and the Sacramento and Feather Rivers (along with the Sutter Bypass) are the principal surface water courses in connection with the Subbasin.

The average of the historical record at each representative monitoring site was selected to establish the measurable objectives and interim milestones for depletions of interconnected surface water because historically undesirable results relative to this sustainability indicator have not been observed in the Sutter Subbasin, and maintaining current, sustainable conditions is anticipated to avoid undesirable results. **Table 6-8** reflects the measurable objectives and interim milestones for the depletion of interconnected surface water sustainability indicator.

Local input through SSGMCC meetings as well as public workshops were applied in setting the measurable objectives for depletions of interconnected surface water. The selected measurable objectives reflect input from local water purveyors as well as the agricultural community and is expected to maintain sustainable conditions relative to surface water-groundwater interaction. Interim milestones are equal to the measurable objective for depletions of interconnected surface water.

This page intentionally left blank.

Table 6-8. Measurable Objectives and Interim Milestones for Depletions of Interconnected Surface Water

Site Code	State Well Number	Local ID / Other ID	Aquifer Zone	Measurable Objective / Interim Milestone (feet above MSL, NAVD88)
-	12N03E18H001M	USGS-385314121401701	Shallow	21.32
-	14N02E10R001M	USGS-390416121433601	Shallow	36.63
-	15N02E20D001M	USGS-390832121463601	Shallow	37.50
391975N1218937W001	16N01E31H001M	-	Shallow	41.46
392328N1216469W001	16N03E21D002M	-	Shallow	61.53
389563N1215843W001	-	GH East MW Site	Shallow	21.03
389571N1215858W001	-	GH North MW Site	Shallow	22.39
389233N1218022W001	12N01E01A001M	-	AZ-1	23.11
389937N1218240W001	13N01E11A001M	-	AZ-1	27.50
390458N1216114W001	14N03E23D003M	Feather River MW-1A	AZ-1	25.14
389453N1216159W001	-	GH Well 2	AZ-1	30.09
389398N1216162W001	-	GH Well 3	AZ-1	25.04
389410N1215884W001	-	GH Well 18	AZ-1	19.08
388869N1216445W002	-	Ma-1	AZ-1	22.36
388813N1217525W001	12N02E21Q001M	SR-1A	AZ-1	22.74
392394N1216509W001	16N03E17J001M	Sutter County MW-3A	AZ-1	67.82
390458N1216114W002	14N03E23D004M	Feather River MW-1B	AZ-2	13.00
392394N1216509W002	16N03E17J002M	Sutter County MW-3B	AZ-2	53.39
390458N1216114W003	14N03E23D005M	Feather River MW-1C	AZ-3	27.55
390458N1216114W004	14N03E23D006M	Feather River MW-1D	AZ-3	25.99

Site Code	State Well Number	Local ID / Other ID	Aquifer Zone	Measurable Objective / Interim Milestone (feet above MSL, NAVD88)
392394N1216509W003	16N03E17J003M	Sutter County MW-3C	AZ-3	51.18
392394N1216509W004	16N03E17J004M	Sutter County MW-3D	AZ-3	48.28
392394N1216509W005	16N03E17J005M	Sutter County MW-3E	AZ-3	47.71

6.7 References

California Department of Water Resources. 2017. Draft Best Management Practices for the Sustainable Management of Groundwater – Sustainable Management Criteria BMP. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-6-Sustainable-Management-Criteria-DRAFT_ay_19.pdf. Accessed: August 9, 2021.

California Department of Water Resources, North Region Office (DWR North Region Office). 2018. *2017 GPS Survey of the Sacramento Valley Subsidence Network. December*.

California State Water Resources Control Board (SWRCB). 1968. *Resolution 68-16 Statement of Policy with Respect to Maintaining High Quality of Waters in California*. https://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/1968/rs68_016.pdf. Accessed: July 21, 2021.

California State Water Resources Control Board (SWRCB). May 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*. https://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/sacsjr_201805.pdf. Accessed: July 21, 2021.

GEI. 2016. *Alternative Submittal to a Groundwater Sustainability Plan for Sutter Subbasin, Sutter County, California*. 19 December.

Northern California Water Association (NCWA). November 2019. Re-managed Instream Flows in the Sacramento River Basin. https://norcalwater.org/wp-content/uploads/2012/01/Re-managed-Instream-Flows-in-the-Sac-River-Basin.pdf. Accessed: July 21, 2021.

Self-Help Enterprises, Leadership Counsel for Justice and Accountability, and the Community Water Center. n.d. *Framework for Drinking Water Well Impact Mitigation Program*. https://static1.squarespace.com/static/5e83c5f78f0db40cb837cfb5/t/5f3ca9389712b732279e5296/1597811008129/Well_Mitigation_English.pdf. Accessed: July 21, 2021.

This page intentionally left blank.

CHAPTER SEVEN

Sustainability Implementation

This page intentionally left blank

7. SUSTAINABILITY IMPLEMENTATION

7.1 Projects and Management Actions

7.1.1 Introduction

This section describes the projects and management actions (PMAs) that are planned or proposed for implementation by agencies in the Sutter Subbasin (Subbasin). In accordance with SGMA regulations, PMAs were developed to achieve the Subbasin sustainability goal by 2042 and avoid undesirable results over the GSP planning and implementation horizon. Projects generally refer to structural features whereas management actions are typically non-structural programs or policies designed to improve water management, reduce groundwater pumping, or address other undesirable results that may occur in the Subbasin.

7.1.2 Development Approach

PMAs developed for the Sutter Subbasin are described in the sections below in accordance with the GSP Emergency Regulations §354.44. PMAs were identified and categorized, beginning with an initial exploration with stakeholders of various ongoing, planned, and conceptual PMAs. The complete list of PMAs was then refined to a set of ongoing and planned PMAs developed for implementation in the Sutter Subbasin, and a set of other potential, conceptual PMAs that would be further developed and implemented if monitoring indicates they are needed.

Ongoing and planned PMAs in the Sutter Subbasin were evaluated to determine whether they are sufficient to address potential future changes in Subbasin conditions that could cause undesirable results. Potential future changes in Subbasin conditions without PMAs were assessed through comparison of the baseline projected water budget and the projected water budget with future land use and adjustment for 2070 central tendency (2070CT) climate change scenario (see **Section 5.3** for additional information). Water budget results from the C2VSim-Sutter groundwater model represent the best available data and science for describing projected future groundwater conditions in the Sutter Subbasin at the time of GSP development (consistent with the GSP Emergency Regulations §354.44(c)). Use of the 2070CT climate change data set is regarded as a conservative approach for evaluating possible future changes in Subbasin conditions as a result of anticipated climate change. While the 2070CT climate change adjustment assumes that the 2070CT effects are occurring every year in the projected water budget period, in actuality these effects will gradually occur over time with significant uncertainty in their magnitude and interannual variability.

Table 7-1 provides a comparison of key water budget parameters considered in formulation of the PMAs. Average water budget results are presented for two scenarios: the baseline projected conditions water budget scenario and the projected conditions with 2070CT climate change scenario. Both scenarios represent projected conditions in the Subbasin without implementation of PMAs. All water budget quantities are expressed in average annual volumes of acre-feet per year (AFY) over the projected model simulation period.

As indicated in **Table 7-1**, the average annual change in groundwater storage in the Sutter Subbasin is expected to remain approximately the same between the projected conditions baseline and the projected conditions with 2070CT climate change scenario. Despite average increases in evapotranspiration and estimated groundwater pumping demand under the effects of 2070CT climate change, the simulated groundwater storage increases modestly in both scenarios at an average rate of 1,000 AFY over the projected period (in comparison to the estimated 49 million acre-feet of groundwater in storage in the Sutter Subbasin).

Compared to the projected conditions baseline, the average groundwater outflow to streams (i.e., stream gain from groundwater) is estimated to decrease by only -5,000 AFY (-2 percent). This change is within the uncertainty of the model results and is less than the typical ±2.5 percent accuracy of annual volume measurements when calculated from current meter-based stage-discharge functions (Clemmens and Wahlin, 2006). Consequently, the simulated average change in groundwater outflow to streams is not significantly different than the uncertainty of average annual stream flows along these reaches and cannot be measured directly from stream gage measurements with certainty. Compared to the projected conditions baseline, the average net subsurface inflow into the Sutter Subbasin is only expected to increase by approximately 7,000 AFY (11 percent) in the projected conditions with 2070CT climate change scenario. This change is also expected to be within the uncertainty of the model.

These comparisons indicate that projected conditions in the Sutter Subbasin are not expected to cause undesirable results related to changes in groundwater storage or depletions of interconnected surface water over the GSP planning and implementation horizon. Even without PMAs, ongoing operation of the Sutter Subbasin, according to the best estimates of future conditions described in the projected water budgets, is expected to achieve the Subbasin sustainability goal by 2042 and maintain sustainability through 2072.

Even so, the Sutter Subbasin GSAs plan to maintain groundwater sustainability through an adaptive management strategy, continuing to monitor sustainability indicators throughout the GSP implementation horizon, and implementing PMAs as needed to ensure that the sustainability goal is maintained and that undesirable results do not occur. This adaptive management approach will be informed by continued monitoring of groundwater conditions using the monitoring network and methods described in **Section 7.2** *Monitoring*. Both the monitoring section (**Section 7.2**) and **Chapter 5** *Basin Setting* identify data gaps that will be addressed as part of GSP implementation (**Chapter 8**). Addressing data gaps will improve the modeled outputs, water budget parameters, and understanding of groundwater conditions in the Sutter Subbasin. Improvements in understanding of groundwater conditions will inform adaptive management of the Sutter Subbasin.

The following sections summarize the ongoing and planned PMAs developed for implementation in the Sutter Subbasin, and all other PMAs that would be implemented as needed to maintain sustainability.

Table 7-1. Selected Subbasin Water Budget Parameters (Average AFY)

Water Budget Parameter [1]	Projected Conditions Baseline	Projected Conditions with 2070 Climate Change	Difference (With 2070 Climate Change - Baseline)	Difference as Percent of Projected Conditions Baseline
Evapotranspiration	645,000	690,000	45,000	7%
Groundwater Pumping	138,000	157,000	19,000	14%
Stream Seepage	125,000	137,000	12,000	10%
Groundwater Outflow to Streams	268,000	263,000	-5,000	-2%
Net Subsurface Inflow	66,000	73,000	7,000	11%
Change in Groundwater Storage	**1,000**	**1,000**	**0**	**0%**

[1] Results summarized over a projected period representing estimated long-term average conditions of the Subbasin under the foreseeable future level of development over a long-term period of hydrologic conditions (20-year period from Water Years [WYs] 1996 through 2015 repeated three times), with further adjustment for climate change in the projected conditions with 2070 climate change scenario). See **Section 5.3** for additional information.

7.1.3 Summary of Projects and Management Actions

All PMAs identified in the Sutter Subbasin are listed in **Table 7-2**, with a description of the project or management action type, the proponent, and the project status. This table (**Table 7-2**) provides a snapshot of projects as required by the GSP Emergency Regulations §354.44(b). The PMAs are also included in the Sutter Subbasin Data Management System (DMS), which, along with this GSP, is viewed by the Sutter GSAs as a “living” document. As required by the GSP Emergency Regulations, this GSP will be reviewed every five years and updated as required in order to address inevitable hydrologic, ecological, economic, resource, and social changes in a timely and thoughtful manner. Through this effort, old assumptions will be tested and new solutions developed and implemented to ensure the long-term sustainability of the Sutter Subbasin.

The list of PMAs maintained in the Subbasin DMS will be revised periodically and reflects, at any time in the future, the list of PMAs associated with this GSP. When revised, the PMA list will be approved by the Sutter Subbasin Groundwater Management Coordination Committee (SSGMCC) or other body, as appropriate, following updating, and will be made available via the Sutter Subbasin DMS. As such, the list of PMAs maintained in the Sutter DMS is considered to be the official Sutter GSP PMA list; no formal GSP adoption or re-adoption will be required for PMA list updating.

Ongoing and planned PMAs are described in greater detail in this GSP. Ongoing and planned PMAs identified below are expected to “achieve the sustainability goal for the basin… [and] respond to changing conditions in the basin” (GSP Emergency Regulations §354.44(a)), supporting GSAs in meeting the interim milestones and measurable objectives set in this plan and avoiding exceedance of minimum thresholds even under future climate change conditions.

Other potential PMAs are described concisely and more generally, reflecting the conceptual nature and need for future development of these PMAs. Additional development and description will occur as those PMAs are needed, evaluated for feasibility, and selected for implementation. This process will occur if the GSAs find that established measurable objectives cannot be maintained and/or if minimum thresholds are being approached. Adaptive management will be informed by continued monitoring of groundwater conditions, using the monitoring network and methods described in **Section 7.2**. Other PMAs may also be implemented in the future to complement and support groundwater sustainability planning efforts, whether by supporting water management goals, facilitating regional coordination, or improving data and monitoring. As previously mentioned, the PMAs discussed herein are representative of a snapshot in time. Additional information and projects/management actions will be provided in GSP annual reports and periodic, five-year GSP updates when known.

The measurable objectives expected to directly benefit from each type of project or management action are summarized in **Table 7-3**. All proposed PMAs are expected to benefit groundwater levels and groundwater storage, whether through direct or in-lieu groundwater recharge, improved data collection, monitoring, and management of water supplies. Projects that enhance groundwater monitoring and strategic use of available surface water in lieu of groundwater are also expected to reduce groundwater depletion by enhancing understanding and management of surface water. Grower education is also expected to benefit water quality by encouraging on-farm management of nutrient application, tailwater, and pumping to reduce potential degradation of water quality.

Table 7-4 summarizes the estimated groundwater recharge benefit and capital, operating, and maintenance costs of ongoing and planned PMAs. Project cost information is limited for many other proposed projects because a detailed feasibility assessment or preliminary design have not been completed. GSAs will further develop projects and management actions during the GSP implementation period and refine estimated costs as the PMAs are identified for implementation, where project/program information will be periodically updated or added to the living list of projects in the Sutter Subbasin DMS. Additional information about all PMAs is provided in a matrix format in **Appendix 7-A**.

This page intentionally left blank.

Table 7-2. Description of Projects and Management Actions Proposed in the Sutter Subbasin

Project/Management Action Name	Project/ Management Action Type	Proponent	Brief Description	Project Status
Ongoing and Planned Projects and Management Actions: Projects and Management Actions in this category are planned to be completed prior to 2042. The expected yield of these projects and management actions are expected to support GSAs in achieving the GSP sustainability goal and responding to changing conditions in the Subbasin.				
System Modernization	Improved Water Management	Butte Water District	Upgrade and modernize system infrastructure to improve system operability and efficiency, reduce operational spillage, and enhancing the timing of farm deliveries. Modernization improvements to District infrastructure will include: 1. Improvements at canal headings to improve water level control, flow control, flow measurement, Supervisory Control and Data Acquisition (SCADA), and automation/measurement 2. Improvements at customer delivery turnouts to improve delivery flexibility and steadiness	Planned, Looking for grant funding
System Modernization	Improved Water Management	Sutter Extension Water District	Upgrade and modernize system infrastructure to improve system operability and efficiency, reduce operational spillage, and enhance the timing of farm deliveries. Modernization improvements to District infrastructure will include: 1. Improvements at canal headings 2. Improvements to upstream water level control 3. Improvements to spill structures 4. Real-time monitoring through the establishment of a SCADA system.	Planned, Looking for grant funding

Project/Management Action Name	Project/ Management Action Type	Proponent	Brief Description	Project Status
Boundary Flow and Primary Spill Measurement and Drainage Recovery Projects	Improved Water Management	Butte Water District	Install measurement and monitoring equipment at boundary outflow and spillage sites to allow real-time monitoring and adjustment to upstream operations. Real-time monitoring will be implemented through the establishment of a District SCADA system.	Planned, Looking for grant funding
Boundary Flow and Primary Spill Measurement and Drainage Recovery Projects	Improved Water Management	Sutter Extension Water District	Install measurement and monitoring equipment at boundary outflow and spillage sites to allow real-time monitoring and adjustment to upstream operations. Real-time monitoring will be implemented through the establishment of a District SCADA system.	Planned, Looking for grant funding
Dual Source Irrigation Systems	In-Lieu Recharge	Butte Water District	Incentivize the use of irrigation systems capable of using both surface water and groundwater. These systems will increase use of surface water and on-farm recharge of surface water, and offset groundwater pumping.	Planned, Looking for grant funding
Multi-Benefit Recharge	Direct Recharge	Multi-Agency/GSA	A multi-benefit recharge program will provide groundwater recharge through normal farming operations while also providing critical wetland habitat for waterbirds migrating along the Pacific Flyway. Fields with soil and cropping conditions conducive to groundwater recharge will be flooded and maintained with shallow depths. Water will be sourced from existing water rights contracts, depending on availability. GSAs may also consider financial compensation for participation to offset field preparation, irrigation, and water costs.	Planned, Looking for grant funding

Project/Management Action Name	Project/ Management Action Type	Proponent	Brief Description	Project Status
Grower Education	Improved Water Management	Multi-Agency/GSA	A grower education and outreach program is proposed as a management action for the Sutter Subbasin. The program will provide growers with educational resources that help them to plan and implement on-farm practices that simultaneously support groundwater sustainability and maintain or improve agricultural productivity.	Planned, Looking for grant funding
Installation of Additional Shallow Groundwater Monitoring Wells	Additional Data Monitoring	Multi-Agency/GSA	Install 15 shallow monitoring wells in key areas of the Subbasin to support monitoring of interconnected surface water, particularly near the Sutter Bypass.	Planned, Looking for grant funding
Projects and Management Actions to be Implemented As Needed: Projects and Management Actions in this category are proposed as potential projects that GSAs may wish to implement, as needed, to support ongoing sustainability, to adapt to changing conditions in the Subbasin, and to achieve other water management objectives.				
Removal of Bottlenecks on the Sutter-Butte Main Canal	In-Lieu Recharge	Butte Water District	Increased ability to meet irrigation and environmental water needs using available surface water.	As Needed
Improved Delivery Service to Pressurized Irrigation Systems	In-Lieu Recharge	Butte Water District	Increased ability to meet irrigation water needs using available surface water.	As Needed
Wetlands Water Management	Wildlife Habitat Improvement	Central Valley Joint Venture	Securing firm water supplies to wetlands refuges within the Subbasin.	As Needed

Project/Management Action Name	Project/ Management Action Type	Proponent	Brief Description	Project Status
Advanced Treatment and Water Recycling	Direct and In-Lieu Recharge	City of Yuba City	Conduct a feasibility study for constructing a Recycled Water Facility and analyze the possibility of implementing advanced treatment and water recycling at the City's Wastewater Treatment Facility (WWTF) for direct and in-lieu recharge.	As Needed
Aquifer Storage & Recovery and Second Well	Direct Recharge	City of Yuba City	This project involves investigating the feasibility of and implementing an aquifer storage recovery (ASR) well to store water during wet periods and provide additional groundwater in dry periods.	As Needed
Backwash Recovery	Surface Water Supply Augmentation	City of Yuba City	Reduce the amount of water being diverted from the Feather River for supply by 0.42 million gallons per day (MGD) (or 475 acre-feet per year) through treatment and distribution of backwash.	As Needed
Electrical SCADA and Telemetry	Additional Data Monitoring	City of Yuba City	Update the existing 20 year old SCADA and telemetry for water treatment plant and distribution system to help the City monitor, manage data and control processes more effectively, and improve management of local water supplies.	As Needed
Groundwater Well Rehabilitation	Water Quality Enhancement	City of Yuba City	Rehabilitate three Hillcrest Water Company groundwater wells and install treatment facilities to provide emergency groundwater sources to supplement surface water supplies in low-water years.	As Needed

Project/Management Action Name	Project/ Management Action Type	Proponent	Brief Description	Project Status
New Outfall Diffuser Installation	Water Quality Enhancement	City of Yuba City	Construct a new outfall diffuser from the treatment plant into the Feather River to be able to discharge to the river under all river flows, resulting in 6,600 acre-feet (AF) of treated effluent being placed back into the Feather River for beneficial uses.	As Needed
Replacement of Sewer Mains	Water Quality Enhancement	City of Yuba City	Replace old and deteriorated sewer lines throughout the City and reduce groundwater quality impacts resulting from leaking sewer lines.	As Needed
Replacement of Water Distribution Mains	Reduce Groundwater Demand	City of Yuba City	Replace portions of the water distribution close to reaching their end of service life, enabling the City to more effectively control water supply losses due to system leakage and reduce groundwater pumping due to system losses.	As Needed
Feather River Pump Station Fish Screen Feasibility Study	Wildlife Habitat Improvement	Garden Highway Mutual Water Company	Contribute to wildlife habitat improvement by perform a Feasibility Study which analyzes three fish screen and two non-screen alternatives for Feather River surface water diversion pump station.	As Needed
Installation of Fish Screens at Sutter Bypass Pumping Plants	Wildlife Habitat Improvement	Multi-Agency/GSA	Install fish screens to prevent entrainment of endangered juvenile salmonids and other fish species.	As Needed

Project/Management Action Name	Project/ Management Action Type	Proponent	Brief Description	Project Status
Rice Field Infiltration Study to Promote FloodMAR Projects	Direct Recharge	Multi-Agency/GSA	Conduct an infiltration study to promote Flood Managed Aquifer Recharge (FloodMAR) projects and determine the feasibility and amount of infiltration a FloodMAR project in rice could provide.	As Needed
Improved Service to Pressurized Irrigation Systems	In-Lieu Recharge	Sutter Extension Water District	Increased ability to meet irrigation water needs using available surface water.	As Needed
Removal of Main Canal Bottlenecks	In-Lieu Recharge	Sutter Extension Water District	Increased ability to meet irrigation and environmental water needs using available surface water.	As Needed
Sunset Project for Integrated Restoration and Efficiency (SPIRE)	Surface Water Supply Augmentation	Sutter Extension Water District	Provide up to 200 cubic feet per second (cfs) increased conveyance capacity from the Thermalito Afterbay to the District, eliminating the need for the Sunset Pumps Dam as well as the Sunset Pumps to augment surface water supply and improve wildlife habitat.	As Needed

Project/Management Action Name	Project/ Management Action Type	Proponent	Brief Description	Project Status
Projects and Management Actions to be Implemented As Needed to Address Data Gaps: Projects and Management Actions in this category are proposed as potential projects that GSAs may wish to implement, as needed, to support ongoing sustainability, to adapt to changing conditions in the Subbasin, and to achieve other water management objectives that will specifically address data gaps identified in this GSP.				
Investigation of Interactions Between Rivers and Changes in Groundwater Levels	Addressing Additional Data Gaps	Multi-Agency/GSA	Collect additional data to assist in developing appropriate sustainable management criteria for interconnected surface waters and analyzing changes in stream-aquifer interactions.	As Needed
Investigation of Source of Elevated Salinity within Shallow Aquifer Zone	Addressing Additional Data Gaps	Multi-Agency/GSA	Collect additional data needed to evaluate the source of elevated salinity levels within the shallow aquifer zone.	As Needed
Study of Aquifer Properties	Addressing Additional Data Gaps	Multi-Agency/GSA	Conduct additional aquifer pumping tests to assess aquifer properties in the Sutter Subbasin.	As Needed
Additional Assessments of Groundwater Recharge Dynamics and Effects	Addressing Additional Data Gaps	Multi-Agency/GSA	Conduct additional aquifer studies to assess the dynamics and effects of groundwater recharge in the Subbasin, particularly those effects of GSP projects.	As Needed
Analysis of Recharge Rates	Addressing Additional Data Gaps	Multi-Agency/GSA	Conduct additional analyses of recharge rates to assess historical groundwater recharge rates and assess hydraulic connection between different zones in the aquifer system.	As Needed
Data Collection to Improve the Hydrogeologic Conceptual Model	Addressing Additional Data Gaps	Multi-Agency/GSA	Collect additional data to understand the hydrogeology of the Sutter Subbasin and bolster the hydrogeologic conceptual model.	As Needed

Project/Management Action Name	Project/ Management Action Type	Proponent	Brief Description	Project Status
AEM Survey of Sutter Buttes	Addressing Additional Data Gaps	Multi-Agency/GSA	Conduct airborne electromagnetic (AEM) survey to improve understanding of the unique geology and hydrogeology of the Sutter Buttes.	As Needed
Development of Uniform Criteria for Defining Stratigraphic Zones	Addressing Additional Data Gaps	Multi-Agency/GSA	Develop and recommended a uniform set of criteria for defining stratigraphic zones and for logging cuttings from soil boring drilled in the Subbasin.	As Needed
Comprehensive Sutter Subbasin Groundwater Quality Evaluation	Addressing Additional Data Gaps	Multi-Agency/GSA	Conduct a comprehensive groundwater quality evaluation for the Sutter Subbasin.	As Needed
Video Survey RMS Wells with Unknown Construction	Addressing Additional Data Gaps	Multi-Agency/GSA	Conduct video surveys of representative monitoring site (RMS) wells with unknown construction information in order to collect missing information.	As Needed
Monitoring Well Refinements	Addressing Additional Data Gaps	Multi-Agency/GSA	Refine and improve the Subbasin monitoring network by identifying and adding additional, dedicated monitoring wells of known construction, and by collecting and confirming well construction information.	As Needed
Sutter Buttes Salinity Monitoring	Addressing Additional Data Gaps	Multi-Agency/GSA	Monitor groundwater salinity (based on electrical conductivity [EC] measurements) at selected locations near the Sutter Buttes on a temporary or permanent basis.	As Needed

Project/Management Action Name	Project/ Management Action Type	Proponent	Brief Description	Project Status
Sutter Buttes Water Quality Inter-Basin Working Group	Addressing Additional Data Gaps	Multi-Agency/GSA	Participate in an inter-basin working group focused on collaborative discussions, consensus-building and planning to address groundwater quality matters associated with the unique geology of the Sutter Buttes area.	As Needed
Groundwater Dependent Ecosystem Mapping Confirmation	Addressing Additional Data Gaps	Multi-Agency/GSA	Conduct an on-ground survey to confirm mapping of groundwater dependent ecosystems (GDEs) to support ongoing investigation and monitoring of the relationship between the health of GDEs, groundwater levels, and access to water supplies.	As Needed
Well Census	Addressing Additional Data Gaps	Multi-Agency/GSA	Conduct a survey of wells in the Subbasin to identify the location of previously unknown wells, determine their status (e.g., destroyed, active), and/or collect construction information to better inform groundwater use in the Subbasin.	As Needed
Land Subsidence Monitoring Evaluation	Addressing Additional Data Gaps	Multi-Agency/GSA	Conduct an assessment of land subsidence data to determine the optimal frequency for ongoing collection and analysis of data relating to inelastic land subsidence.	As Needed

Table 7-3. Measurable Objectives Expected to Benefit from Projects and Management Action Types Proposed in the Sutter Subbasin

Project/ Management Action Type	Sample Project/Management Action Names	Measurable Objectives Expected to Directly Benefit				
		Groundwater Levels	Groundwater Storage	Water Quality	Surface Water Depletion	Land Subsidence
Improved Water Management	System Modernization, Boundary Flow and Primary Spill Measurement and Drainage Recovery Projects, Backwash Recovery, Sunset Project for Integrated Restoration and Efficiency (SPIRE), Advanced Treatment and Water Recycling	X	X		X	
	Grower Education	X	X	X	X	
In-Lieu Recharge	Dual Source Irrigation Systems, Removal of Bottlenecks on the Sutter-Butte Main Canal, Improved Delivery Service to Pressurized Irrigation Systems	X	X		X	X
Direct Recharge	Multi-Benefit Recharge, Detention Basin & Lateral, Aquifer Storage & Recovery and Second Well, Rice Field Infiltration Study to Promote FloodMAR Projects	X	X		X	
Additional Data Monitoring [1]	Installation of Additional Shallow Groundwater Monitoring Wells, Electrical SCADA and Telemetry	-	-	-	-	-

Project/ Management Action Type	Sample Project/Management Action Names	Measurable Objectives Expected to Directly Benefit				
		Groundwater Levels	Groundwater Storage	Water Quality	Surface Water Depletion	Land Subsidence
Wildlife Habitat Improvement [2]	Wetlands Water Management, Feather River Pump Station Fish Screen Feasibility Study, Installation of Fish Screens at Sutter Bypass Pumping Plants	-	-	-	-	-
Reduce Groundwater Demand	Waterline Replacements, Replacement of Water Distribution Mains	X	X		X	
Water Quality Enhancement	Groundwater Well Rehabilitation, New Outfall Diffuser Installation, Replacement of Sewer Mains			X		
Addressing Additional Data Gaps [1]	Investigation of Interactions Between Rivers and Changes in Groundwater Levels, Investigation of Source of Elevated Salinity within Shallow Aquifer Zone, Study of Aquifer Properties, etc.	-	-	-	-	-

[1] Coordination, data sharing, and additional monitoring are beneficial to GSP implementation and tracking progress toward the Subbasin sustainability goal. However, there are no anticipated direct benefits to specific sustainability indicators.

[2] Projects that improve wildlife habitat support environmental beneficial uses of water and ecosystem health while allowing districts to maintain surface water use in agriculture. While useful for ongoing sustainability, there are no anticipated direct benefits to specific sustainability indicators.

Table 7-4. Benefits and Costs of Ongoing and Planned Projects and Management Actions in Sutter Subbasin

Project/Management Action Name [1]	Proponent	Project Status	Gross Average Annual Benefit at Full Implementation (AFY)	Estimated Capital Cost at Full Implementation ($)	Estimated Annual Cost at Full Implementation ($/yr)
System Modernization	Butte Water District	Planned, Looking for grant funding	3,500	$16,681,000 [3,4]	$1,035,000 [3,4]
System Modernization	Sutter Extension Water District	Planned, Looking for grant funding	9,100	$15,073,000 [3,4]	$1,138,000 [3,4]
Boundary Flow and Primary Spill Measurement and Drainage Recovery Projects	Butte Water District	Planned, Looking for grant funding	7,000	$1,184,000 [3,4]	$117,000 [3,4]
Boundary Flow and Primary Spill Measurement and Drainage Recovery Projects	Sutter Extension Water District	Planned, Looking for grant funding	7,500	$1,154,000 [3,4]	$106,000 [3,4]
Dual Source Irrigation Systems	Butte Water District	Planned, Looking for grant funding	N/A [2]	N/A [2]	N/A [5]
Multi-Benefit Recharge	Multi-Agency/ GSA	Planned, Looking for grant funding	N/A [2]	N/A [5]	N/A [5]
Grower Education	Multi-Agency/ GSA	Planned, Looking for grant funding	N/A [2]	N/A [2]	$10,000
Installation of Additional Shallow Groundwater Monitoring Wells	Multi-Agency/ GSA	Planned, Looking for grant funding	N/A [2]	$1,135,100	N/A [2]

[1] First Year of Implementation has yet to be determined for planned projects.
[2] Not available at this time.
[3] Estimated costs for all phases (Phases 1-4) and levels (levels 1 and 2) of project implementation. All cost components calculated in July 2014 and reported in the 2014 Feather River Regional Agricultural Water Management Plan (FRRAWMP) Volume II.4 (Appendix 7-B) and the 2014 FRRAWMP Volume II.6 (Appendix 7-C).
[4] Cost estimates were escalated to 2021 according to the U.S. Army Corps of Engineers Civil Works Construction Cost Composite Index.
[5] Total costs will vary depending on the configuration and scale of project implementation. Estimated average annual costs on a per-site basis are noted in the project descriptions below.

7.1.4 Ongoing and Planned Projects and Management Actions

This section describes the ongoing and planned PMAs that will be implemented, or are currently being implemented, in the Sutter Subbasin.

Results of the Sutter Subbasin groundwater model (C2VSimFG-Sutter) indicate that the Sutter Subbasin is expected to be managed sustainably by 2042 with anticipated climate change and without undesirable results over the GSP planning and implementation horizon, even without implementation of PMAs. Nevertheless, the GSAs are looking for grant funding to implement several PMAs to support ongoing sustainability and adapt to potential future changes in Subbasin conditions. These PMAs that are ready or nearly ready for implementation are described below and will be scaled as needed to support adaptive management of the Subbasin.

7.1.4.1 System Modernization Projects

7.1.4.1.1 Overview

Butte Water District (BWD) and Sutter Extension Water District (SEWD) have begun early planning for modernization projects for their irrigation distribution systems. The system modernization projects are part of each district's comprehensive plan for system modernization and boundary flow monitoring developed as part of the Feather River Regional Agricultural Water Management Plan (FRRAWMP). Detailed information about each project is included in the FRRAWMP and in project documentation included in **Appendices 7-B** and **7-C**.

Improvements made through each project will help system operators to strategically manage surface water diversions, supporting their ability to increase system efficiency, reduce operational spillage, and/or reduce excess farm deliveries. As part of these projects, the districts will replace and improve existing infrastructure, evaluate existing operations, and develop and implement management strategies and tools to meet local water management objectives, including water conservation at the district scale and improved delivery service to customers, or to meet regional or statewide objectives. Additionally, SEWD has participated in efforts to explore increased system capacity to provide additional water to Sutter National Wildlife Refuge. Specific elements of each district's system modernization project are summarized below, and described in **Appendices 7-B** and **7-C**.

The basic technical objective of each system modernization project is to provide system operators with improved information and tools that help them to better match flows at the headings of individual canals to downstream demands, thereby reducing operational spillage while also improving service to district customers. System modernization is generally implemented to achieve one or more of the following goals:

1. Increase the efficiency of the distribution system to conserve water at the district scale,
2. Increase the efficiency of the distribution system to provide additional surface water (thereby, reducing groundwater pumping) in times of shortage,
3. Increase the level of service provided to growers (increased delivery flexibility; steadier delivery flows) and respond to changes in cropping or irrigation method,
4. Reduce potential risks to the safety of operations staff, and
5. Improve the overall operability and management of the district.

The system modernization projects generally include improvements to three site categories: heading structures, upstream water level control structures, and spill structures. The system modernization strategy for both districts also includes flow measurement as an overarching improvement. **Table 7-5** identifies the modernization objectives of improvements to each site category, and the sustainability indicators expected to benefit from these improvements. Each project is expected to promote the ongoing maintenance of sustainable conditions in the Sutter Subbasin.

Table 7-5. Modernization Objectives and Sustainability Indicator Benefits of System Modernization Site Improvements

Site Category	General Modernization Objective	Sustainability Indicator Benefitted
Heading Structures	• Replace old, aging and/or deteriorated structures and equipment, as needed. • Provide increased accuracy, repeatability, and consistency in downstream deliveries to district customers prevent farm runoff and tail end spills. • Improve ability for flow adjustments to prevent spill and enhance delivery service. • Increase safety of site for operators.	• Groundwater levels (in-lieu recharge benefit) • Groundwater storage (in-lieu recharge benefit)
Upstream Water Level Control Structures	• Replace old, aging and/or deteriorated structures and equipment, as needed. • Maintain constant upstream deliveries by reducing fluctuation in desired upstream water level over a range of canal flow rates. • Simplify operations by reducing the need to add or remove flashboards to maintain water levels across a range of flows.	• Groundwater levels (in-lieu recharge benefit) • Groundwater storage (in-lieu recharge benefit)

Site Category	General Modernization Objective	Sustainability Indicator Benefitted
	• Facilitate the ability to make frequent flow changes through the system, as needed. • Consolidate safety spills by eliminating intermediate safety spills, where practical. • Increase safety site for operators.	
Spill Structures	• Provide accurate and accessible measurement of spillage flow rate from the lateral as feedback on heading operation, general lateral operation, and district water accounting. • Increase safety of operating site.	• Groundwater levels (in-lieu recharge benefit) • Groundwater storage (in-lieu recharge benefit) • Water quality

7.1.4.1.2 Implementation

The system modernization projects would each be generally implemented in four phases that will allow improvements to occur over time at a pace that considers available funds and implements priority improvements first to meet objectives in the most cost-effective manner possible. Sites within each phase may be completed all at once, or on a prioritized basis, but improvements generally begin at the head of the system and proceed downstream to maximize benefits relative to implementation costs.

The first phase of system modernization would generally concentrate on modernizing primary inflow and operational outflow locations. These are generally the primary diversion locations or headings and main or primary canal end outflow points. The type and sophistication of improvement required to meet objectives varies by site, but the general objective is to provide improved control over the water that enters the district, as informed by improved information describing the timing and amount of water leaving the district. For BWD and SEWD, a primary inflow point is the Sutter-Butte Main Canal below the Looney Gates, which are currently undersized for the peak flows which occur during much of the irrigation season. Phase I improvements would include construction of a higher capacity structure to improve water availability for all downstream users, particularly in the Sutter Subbasin. Additionally, the Sutter-Butte Canal below the Cox Spill is undersized to convey the total demand required by SEWD, which requires deficiencies to be met by the Sunset Pumps (at cost to SEWD). Increasing the capacity of the current canal would reduce the need to operate the pumps (a sizable benefit to SEWD) and has been explored by both SEWD and BWD. Phase I improvements would also reconfigure the Smith Weir to provide downstream flow in the near term, with the potential to easily reconfigure the structure for upstream water level control in the future. Finally, Phase I would explore opportunities for improved measurement of primary inflows and outflows, and will provide several benefits, including information for operational adjustments, data for water accounting and billing, and information to support prioritization of additional improvements by quantifying potential benefits.

The second phase of modernization would improve key control points along main supply canal(s) between the headings and outflows to increase conveyance efficiency. This would include main canal water level control structures and lateral headings. Existing control sites may be abandoned in some cases, re-configured, retrofitted, downsized, or retained. The addition of these modernization improvements would generally provide a steadier delivery of water from the main canal to laterals and turnouts, simplify operations by adding automation and increasing the ability to make flow changes, and concentrate primary routing of flow fluctuations along the main canal.

Later phases of the projects would improve primary lateral control structures and primary end spills to improve control and build on lateral heading flow control completed under earlier phases to improve secondary control points along laterals and sublateral control points. Specific system modernization improvements that are recommended or planned for potential implementation in BWD and SEWD are summarized in **Appendix 7-B** and **7-C**, respectively.

7.1.4.1.2.1 Implementation Schedule

The system modernization projects in SEWD and BWD are currently in the planning phase. Thus, the anticipated start and completion dates for each phase of the system modernization projects have yet to be determined but will be provided in GSP annual reports and periodic evaluations (GSP five-year updates) when determined. A typical timeline for implementation of each phase of a system modernization project is provided in **Table 7-6**.

Table 7-6. Potential Implementation Schedule for Each Phase of System Modernization Projects

Timeline Activity	Year Start	Year End
Prepare Final Designs for System Improvements	Year 1	Year 1
Environmental and Cultural Resources Compliance and Permitting	Year 1	Year 2
Construction of System Improvements	Year 2-3	Year 2-3
Training and Implementation Support	Year 2-3	Year 2-3
Monitoring and Verification	Year 1	Year 3+ (Ongoing, as needed)
Public Outreach	Year 1	Year 3+ (Ongoing, as needed)

7.1.4.1.2.2 Notice to Public and Other Agencies

The public and other agencies will be notified of project implementation activities through outreach and communication channels identified in the GSP (see **Chapter 8** *Plan Implementation*).

7.1.4.1.2.3 Construction Activities and Requirements

Specific construction activities are summarized in **Appendix 7-B** and **Appendix 7-C** for the BWD and SEWD system modernization projects, respectively, along with preliminary capital and annual cost estimates for each activity. Infrastructure improvements in the system modernization projects may include construction or installation of the following components:

- Upstream water level control improvements, potentially including:
    - Construction of a new structure at Looney Weir, allowing upstream water level control
    - Construction of new water level control structures at Smith Weir
    - Installation of automated upstream water level controls or flow control gates at main canal primary control points
    - Installation of automated water level controls on lateral headgates
- Improvements in measurement, potentially including:
    - Construction of a concrete-lined control section at the Sutter-Butte Main Canal meter location
    - Installation of flow measurement devices on the Sunset Pumping Plant discharge pipes
    - Installation of acoustic doppler velocity meter (ADVM) equipment
    - Replacement of lined canal sections for ADVM and monitoring site installations
    - Installation of new monitoring equipment and/or Supervisory Control and Data Acquisition (SCADA) equipment on headgates
    - Installation of new monitoring equipment and/or SCADA equipment on spillage sites
- Installation of a SCADA base station
- Conversion of water level control structures to flow control structures
- Development of orifice gate ratings

7.1.4.1.2.4 Water Source

The system modernization projects described in this section are not expected to rely on additional water supplies from outside the jurisdiction of each district. Rather, system modernization is expected to enhance the use of existing surface water sources available to growers through increased reliability and flexibility of surface water deliveries; thereby increasing the grower’s ability to utilize surface water in lieu of groundwater supplies.

7.1.4.1.2.5 Circumstances and Criteria for Implementation

The system modernization projects described in this section are planned for future implementation pending funding and changes in future groundwater conditions in the Sutter Subbasin. The GSAs will monitor groundwater levels in the Subbasin through the monitoring program set forth in this GSP. If groundwater levels decline near or below minimum thresholds, this project may be prioritized to support surface water use and in-lieu recharge in those areas where undesirable results may occur. The GSAs may also decide to implement this project at an earlier time to achieve these multi-benefits for the Subbasin.

Implementation of these projects will be carried out with evaluation and consideration of all interested parties within the project area and GSA. While operation of these system modernization projects is not expected to terminate, any future changes to these projects will be made to align with each District's goals and the overall Subbasin sustainability goal.

7.1.4.1.2.6 Legal Authority, Permitting Processes, and Regulatory Control

Both districts have the authority to plan and implement modernization improvements to their water distribution systems. Permitting and regulatory processes that may affect the system modernization improvement projects include:

- U.S. Army Corps of Engineers Section 404 Permits (plan to file exemption under Section 404(f)(1)(C) of Clean Water Act)
- Regional Water Quality Control Board Section 401 Water Quality Certification (not required if exempt from U.S. Army Corps of Engineers [USACE] Section 404)
- State Water Resources Control Board Construction General Permit and Storm Water Pollution Prevention Plan (SWPPP)
- State Historic Preservation Office (SHPO) and National Historic Preservation Act (NHPA) Section 106 Coordination
- California Endangered Species Act (CESA) Consultation
- Endangered Species Act (ESA) Compliance
- National Environmental Policy Act (NEPA) Compliance
- California Environmental Quality Act (CEQA)

The districts will comply with all applicable permitting and regulatory processes for these projects.

7.1.4.1.3 Operation and Monitoring

The system modernization projects will be accomplished by each district following the implementation schedule that will be determined following further project development. As described above, the schedule will be reported in GSP annual reports and periodic evaluations (GSP five-year updates) when known. Planning, permitting, construction, training, monitoring, and public outreach will be coordinated with outside consultants and professionals, as needed and as identified during further project development.

Performance measures and project monitoring will be developed and used to demonstrate, verify, and report project performance and benefits. Without-project and with-project monitoring will be conducted to quantify the spillage reduction benefits of the project by comparing changes in spillage, diversions, and farm deliveries. With-project data verification will also be conducted.

In addition to comparing without- and with-project spillage, diversions, and farm deliveries, district operators and customers will be consulted to better understand:

- the means by which spillage and farm deliveries are reduced,
- challenges to achieving additional benefits, and
- expected increases in conservation over time as greater experience with utilizing the improvements implemented through the project is gained.

The districts will also monitor and document the use of water conserved by system modernization.

7.1.4.1.4 Project Benefits and Costs

7.1.4.1.4.1 Benefits

Table 7-7 summarizes the estimated average annual volumes of water conservation expected from each system modernization project at full implementation. These benefits are expected to occur primarily through spillage reduction following completion of all project phases. Estimates benefits for each project phase are summarized for BWD and SEWD in **Appendices 7-B** and **7-C**, respectively. Each project is also expected to support the districts in better management of their surface water supplies. Benefits are expected to accrue beginning the first year of project implementation, increasing up to the total estimated average annual water conservation benefit at full project implementation.

Table 7-7. Estimated Water Conservation Benefit of System Modernization Projects

District	Estimated Average Annual Water Conservation Benefit at Full Project Implementation (AFY) [1]
Butte Water District	3,500
Sutter Extension Water District	9,100

Notes:

[1] Average of conserved water range reported for all phases of project implementation in Appendices 7-B and 7-C.

Actual project benefits will be monitored and verified as described in the previous section. Project benefits are expected to occur every year following construction and implementation of modernization improvements. The actual total benefits will vary from year to year, depending on water supply and operational conditions. The district's plan to continue supporting project operations, maintenance, and capital replacement costs into the future.

Water conserved by the projects would also be available for direct or in-lieu recharge within the Sutter Subbasin. To the extent that water conserved by these projects are retained in Lake Oroville, conserved water could be released strategically at desired times and in desired amounts to meet a variety of ecosystem restoration, water quality, or other water supply needs.

7.1.4.1.4.2 Costs

Table 7-8 summarizes the potential estimated costs of the system modernization projects at the time these projects were initially proposed. These costs include all proposed phases and levels of project implementation, updated for 2021. Additional information on costs for specific modernization improvements in BWD and SEWD are summarized in **Appendices 7-B** and **7-C**, respectively.

Total annualized implementation costs for the BWD system modernization project were estimated to be $1,035,000 per year. The estimated annualized project cost per unit of water conserved was estimated to be between approximately $207 to $518 per AF per year. Total annualized implementation costs for the SEWD system modernization project were estimated to be $1,138,000 per year. The estimated annualized project cost per unit of water conserved was estimated to be between approximately $87 to $219 per AF per year.

The districts may finance the capital costs of projects through available state and federal grants and/or assessments through the district governance structures. Operation and maintenance costs may be paid using revenues raised through water rates and/or fees and assessments. The districts could also explore and conduct any necessary studies and decision processes (including Proposition 218 elections) to approve rates, fees, or assessments to provide the required funding.

Table 7-8. Estimated Planning-Level Costs of System Modernization Projects at Full Implementation

District	Annualized Cost ($/yr; Annualized Capital Cost plus O&M) [1]	Annualized Cost Per AF Benefit [2]
Butte Water District	$1,035,000	$207 to $518
Sutter Extension Water District	$1,138,000	$87 to $219

Notes:
[1] Annualized costs for all phases (Phases 1-4) and levels (levels 1 and 2) of project implementation. Original costs calculated in July 2014 and reported in the 2014 FRRAWMP Volume II.4 (Appendix 7-B) and the 2014 FRRAWMP Volume II.6 (Appendix 7-C). Cost estimates were escalated from 2014 to 2021 according to the US Army Corps of Engineers Civil Works Construction Cost Composite Index.
[2] Range of estimated conservation costs reported in the 2014 FRRAWMP Volume II.4 (Appendix 7-B) and the 2014 FRRAWMP Volume II.6 (Appendix 7-C). Cost estimates were escalated from 2014 to 2021 according to the U.S. Army Corps of Engineers Civil Works Construction Cost Composite Index.

7.1.4.2 Boundary Flow and Primary Spill Measurement and Drainage Recovery Projects

7.1.4.2.1 Overview

Butte Water District and Sutter Extension Water District have begun early planning for projects comprised of two related improvement packages: a boundary flow and primary spill measurement component that would improve measurement at boundary outflow sites, and a drain water or tailwater recovery component. These projects are part of each district's comprehensive plan for system modernization and boundary flow monitoring developed as part of the Feather River Regional Agricultural Water Management Plan. Detailed information about the plan is included in the FRRAWMP and in project documentation included in **Appendices 7-B** and **7-C** for BWD and SEWD, respectively.

In these projects, measurement devices and, optionally, SCADA equipment would be installed at boundary outflow, boundary inflow, internal outflow, internal inflow, and/or internal spill sites. Drain water recovery pumps may also be installed at select locations in each district to recapture drain water or tailwater from within the district or from neighboring districts. Definitions of site type classifications and recommended improvement packages are summarized in **Table 7-9**.

Table 7-9. Site Descriptions and Recommended Improvements

Site Category	Site Description	Improvement Package
Boundary Inflow	Flows entering the district boundaries and providing the availability of increased supply.	Boundary Flow and Primary Spill Measurement
Boundary Outflow	Flows leaving the district boundaries and representing excess inflows, intentional releases to satisfy obligations to meet out-of-district demands, or water management issues.	Boundary Flow and Primary Spill Measurement
Internal Outflow	Flows intentionally discharged from district canals to drainage channels for downstream delivery or possible recapture (e.g., deliveries to Secondary).	Boundary Flow and Primary Spill Measurement
Internal Inflow	Additional supply entering the district from within its boundaries (e.g., groundwater wells).	Boundary Flow and Primary Spill Measurement
Internal Spill	Excesses in supply canals that are discharged to drain channels through safety spill structures.	Boundary Flow and Primary Spill Measurement

Site Category	Site Description	Improvement Package
Tailwater Recovery (Pump)	Recapture of tailwater via pump as it passes through the district. Recaptured water may be spillage or tailwater from neighboring districts, or from internal sources.	Drainage Recovery

The overall objectives of these projects are to:

- **Improve water use efficiency:** By improving outflow measurements, districts can make more informed system adjustments, reduce spillage, and reduce diversions. By reducing operational spillage and tailwater, districts may also reduce diversions.
- **Increase operational efficiency:** By improving outflow measurements, operators can make strategic adjustments at lateral headings to reduce spillage and/or diversions and reduce impacts to delivery service caused by canal conditions. Recovering drain water also enables operators to meet demands more quickly and flexibly.
- **Develop water use data:** Measurement of boundary outflows and primary spillage provides the data necessary to better quantify the district water budget, characterize operational efficiencies, and prioritize improvements.
- **Support reporting:** Measurement of spillage, boundary flows and recovered drain water provides information relating to water supply, water use, water quality, environmental benefits, etc. Measurement also supports the district in responding to potential inquiries from landowners regarding water supply, water use, and historical trends.

7.1.4.2.2 Implementation

In these projects, measurement devices would be installed at the following sites in each district:

- BWD:
  - seven boundary outflow locations
  - five boundary inflow sites
  - 17 internal spill sites
  - two internal inflow sites
- SEWD:
  - three boundary outflow locations
  - two boundary inflow sites
  - 13 internal spill sites
  - two internal inflow sites

Additionally, drain water recovery could be implemented at two sites in BWD and seven sites in SEWD. SCADA equipment may optionally be installed at sites, depending on district needs and potential funding. All selected sites were identified as high priority through consultation with district personnel or identified as likely high use sites based on their position in the distribution system, such as at the end of main canals or primary laterals.

Each project would likely be implemented in phases, with two levels of potential site improvements considered for each selected site:

- **Level 1 improvements:** Infrastructure and measurement enhancements that are stand-alone and manually operated or read but designed to be "SCADA-Ready." These improvements include, but not limited to: variable-frequency drive (VFD)-controlled pumps, automated gates, measuring weirs, acoustic Doppler meters, and propeller meters.
- **Level 2 improvements:** Enhancements that build on Level 1 improvements by adding electronic sensors, installing on-site digital display of flow rate or other parameters, or add remote monitoring or control through a SCADA system.

Phased implementation provides the districts with the flexibility to complete Level 1 (which has significant benefits on its own) while assessing the benefits of SCADA, prioritizing sites, establishing the SCADA base station and gradually implement the more complex or more expensive sites.

An inventory of all sites reviewed in each district and preliminary recommendations for measurement at selected sites are provided in **Appendices 7-B** and **7-C**. Recommended improvement sites are subject to revision following refinement of prioritization criteria and more detailed review and analysis.

7.1.4.2.2.1 Implementation Schedule

The boundary flow and primary spill measurement and drainage recovery projects in BWD and SEWD are currently in the planning phase. Thus, the anticipated start and completion dates for the projects have yet to be determined but will be provided in GSP annual reports and periodic evaluations (GSP five-year updates) when determined. A typical timeline for implementation of a boundary flow and primary spill measurement and drainage recovery project is provided in **Table 7-10**.

Table 7-10. Potential Implementation Schedule for Boundary Flow and Primary Spill Measurement and Drainage Recovery Projects

Timeline Activity	Year Start	Year End
Prepare Final Designs for System Improvements	Year 1	Year 1
Environmental and Cultural Resources Compliance and Permitting	Year 1	Year 2
Construction of System Improvements	Year 2-3	Year 2-3
Training and Implementation Support	Year 2-3	Year 2-3
Monitoring and Verification	Year 1	Year 3+ (Ongoing, as needed)
Public Outreach	Year 1	Year 3+ (Ongoing, as needed)

7.1.4.2.2.2 Notice to Public and Other Agencies

The public and other agencies will be notified of project implementation activities through outreach and communication channels identified in the GSP.

7.1.4.2.2.3 Construction Activities and Requirements

Specific construction activities are summarized in **Appendices 7-B** and **7-C** for the BWD and SEWD projects, respectively, along with preliminary capital and annual cost estimates for each activity.

Infrastructure improvements for the boundary flow and primary spill measurement component of these projects may include installation or construction of the following:

- ADVM
- open channel propeller meters
- sharp crested weirs
- RemoteTracker devices
- construction of related infrastructure needed to operate measurement devices, e.g., control sections in channels to facilitate ADVM measurement, or pressure transducers
- SCADA equipment

Recommended measurement devices for the boundary and spill flows vary by site type, site conditions and existing infrastructure or proposed infrastructure. Additionally, the intensity of use (rate and duration) relative to other sites, and the importance of the site to meeting the objectives also factor into the selection of measurement devices. In general, it is recommended that improvement projects or phased modernization employ the same device, or a limited selection of devices, throughout the district to maintain consistency in reporting, accuracy, and operations. This also simplifies training of new employees, maintenance protocols, and troubleshooting, as well as minimizes the required spare parts.

Infrastructure improvements for the drainage recovery component of these projects may include the following activities:

- Rebuilding pumps and motors, as needed
- Installing VFD controllers in pump stations to automate control
- Adding measuring device(s) to measure pump(s) discharge and improve manual operation
- Installing water level sensor in canal downstream of discharge
- Installing SCADA equipment

7.1.4.2.2.4 Water Source

The boundary flow and primary spill measurement and drainage recovery projects described in this section are not expected to rely on additional water supplies from outside the jurisdiction of each district. Rather, these projects are expected to enhance the use of existing surface water sources available to growers through increased reliability and flexibility of surface water deliveries, thereby incentivizing the use of surface water over groundwater for irrigation.

7.1.4.2.2.5 Circumstances and Criteria for Implementation

The boundary flow and primary spill measurement and drainage recovery projects described in this section are planned for future implementation pending funding and changes in future groundwater conditions in the Sutter Subbasin. The GSAs will monitor groundwater levels in the Subbasin through the monitoring program described in this GSP. If groundwater levels decline near or below minimum thresholds, these projects may be prioritized to support in-lieu recharge in those areas where undesirable results may occur. The GSAs may also decide to implement these projects at an earlier time to achieve these multi-benefits for the districts and the Subbasin.

Implementation of these projects will be carried out with evaluation and consideration of all interested parties within the project area and GSA. While operation of these projects is not expected to terminate, any future changes to these projects will be made to align with each districts' goals and the overall Subbasin sustainability goal.

7.1.4.2.2.6 Legal Authority, Permitting Processes, and Regulatory Control

Both BWD and SEWD have the authority to plan and implement projects that improve measurement of distribution system flows. Potential permitting or regulatory processes that could affect the boundary system outflow and primary spill measurement project include:

- State Historic Preservation Office and National Historic Preservation Act Section 106 Coordination
- Endangered Species Act Compliance
- National Environmental Policy Act Compliance[1]

The districts will comply with all applicable permitting and regulatory processes for these projects.

7.1.4.2.3 Operation and Monitoring

The boundary flow and primary spill measurement and drainage recovery projects will be accomplished by each district following the implementation schedule that will be determined following further project development. As described above, the schedule will be reported in GSP annual reports and periodic evaluations (GSP five-year updates) when known. Planning, permitting, construction, training, monitoring, and public outreach will be coordinated with outside consultants and professionals as needed and as identified during further project development.

Performance measures and project monitoring will be developed and used to demonstrate, verify, and report project performance and benefits. Without-project and with-project monitoring will be conducted to quantify the spillage reduction benefits of the project by comparing changes in spillage, diversions, and farm deliveries. With-project data verification will also be conducted.

In addition to comparing without- and with-project spillage, diversions, and farm deliveries, district operators and customers will be consulted to better understand:

- the means by which spillage and farm deliveries are reduced,
- challenges to achieving additional benefits, and
- expected increases in conservation over time as greater experience with utilizing the improvements implemented through the project is gained.

The districts will also monitor and document the use of water conserved by the boundary flow and primary spill measurement and drainage recovery projects.

[1] Despite minimal or no ground-disturbing activities, it is anticipated these projects will require NEPA compliance, including environmental and cultural resources review. Due to the limited ground disturbance to complete the projects, it is anticipated that the projects will qualify for a Categorical Exclusion according to the qualification factors found in Reclamation's NEPA Handbook. Otherwise, the projects will likely require an Environmental Assessment/Finding of No Significant Impact (EA/FONSI).

7.1.4.2.4 Project Benefits and Costs

7.1.4.2.4.1 Benefits

Table 7-11 summarizes the estimated average annual volumes of water conservation expected from each boundary flow and primary spill measurement and drainage recovery project at full implementation. These benefits are expected to occur primarily through reduction in operational spillage, drainage outflows, and tailwater. Estimated benefits for each project phase are summarized for BWD and SEWD in **Appendices 7-B** and **7-C**, respectively. Measurement of boundary flows and spills is also expected to provide system operators the tools to reduce operational losses. Reduction in losses and reuse of operational spillage and tailwater may also result in decreased required diversions.

Benefits are expected to accrue beginning the first year of project implementation, increasing up to the total estimated average annual water conservation benefit at full project implementation. Actual project benefits will be monitored and verified as described in the previous section. Project benefits are expected to occur every year following construction and implementation of modernization improvements. The actual total benefits will vary from year to year, depending on water supply and operational conditions. The district's plan to continue supporting project operations, maintenance, and capital replacement costs into the future.

Water conserved by these projects would also be available for direct or in-lieu recharge within the Sutter Subbasin. To the extent that water conserved by these projects is retained in storage, conserved water could be released strategically at desired times and in desired amounts to meet a variety of ecosystem restoration, water quality, or other water supply needs, and may also be used to increase supply reliability in shortage years.

Table 7-11. Estimated Water Conservation Benefit of Boundary Outflow and Primary Spill Measurement Project

District	Estimated Water Conservation Benefit (AFY; May-Oct) [1]
Butte Water District	7,000
Sutter Extension Water District	7,500

[1] Average of conserved water range reported for in Appendices 7-B and 7-C, estimating that approximately 5 to 15 percent of existing boundary outflows during the irrigation season could be conserved annually (estimate calculated July 2014).

7.1.4.2.4.2 Costs

Table 7-12 summarizes the potential estimated costs of the boundary flow and primary spill measurement and drainage recovery projects at full implementation. These costs include all proposed levels of project implementation, estimated as of 2021. Additional information on costs for specific modernization improvements in BWD and SEWD are summarized in **Appendices 7-B** and **7-C**, respectively.

Total capital costs for the BWD system modernization project were estimated to be $1,184,000, and total annualized costs were estimated to be approximately $117,000 per year. Total capital costs for the SEWD system modernization project were estimated to be $1,154,000, and total annualized costs were estimated to be approximately $106,000 per year.

The districts may finance the capital costs of projects through available state and federal grants and/or assessments through the district governance structures. Operation and maintenance costs may be paid using revenues raised through water rates and/or fees and assessments. The districts could also explore and conduct any necessary studies and decision processes (including Proposition 218 elections) to approve rates, fees, or assessments to provide the required funding.

Table 7-12. Estimated Planning-Level Costs of Boundary Outflow and Primary Spill Measurement Projects at Full Implementation

Project Component	Project Component	Capital Costs ($) [1]	Annualized Cost ($/yr; Annualized Capital Cost plus O&M) [1]
Butte Water District	Boundary Flow and Primary Spill Measurement	$953,000	$91,000
	Drain Water Recovery	$43,000	$3,000
	SCADA Office Base Station, Spare Parts	$188,000	$23,000
	Total	**$1,184,000**	**$117,000**
Sutter Extension Water District	Boundary Flow and Primary Spill Measurement	$603,000	$57,000
	Drain Water Recovery	$363,000	$26,000
	SCADA Office Base Station, Spare Parts	$188,000	$23,000
	Total	**$1,154,000**	**$106,000**

[1] Costs for all levels (levels 1 and 2) of project implementation. Costs calculated in July 2014 and reported in the 2014 FRRAWMP Volume II.4 (Appendix 7-B) and the 2014 FRRAWMP Volume II.6 (Appendix 7-C). Cost estimates were escalated from 2014 to 2021 according to the US Army Corps of Engineers Civil Works Construction Cost Composite Index.

7.1.4.3 Dual Source Irrigation Systems

7.1.4.3.1 Overview

Dual source irrigation systems have been proposed and investigated as a potential opportunity for supporting groundwater sustainability in the Sutter Subbasin. This section describes a program proposed in Butte Water District that would support growers in implementing dual source irrigation systems, though a similar program could be implemented by other GSAs.

The overall goal of promoting dual source irrigation systems is to increase the use of existing, available surface water supplies for irrigation in areas where irrigators have begun to use more groundwater. One of the main challenges to enhancing recharge is the expansion of orchard crops and the shift in irrigation of these crops, from surface irrigation using surface water to low-volume, pressurized irrigation using groundwater. By incentivizing or promoting the use of dual source systems, BWD will encourage growers that currently use groundwater to also use surface water, with in-lieu recharge benefits to the Subbasin. These systems will promote conjunctive use by allowing growers to use either groundwater or surface water for irrigation through the same system depending on availability.

Implementation of dual source irrigation systems in Butte County is proposed in a 2018 study entitled *Evaluation of Restoration and Recharge within the Butte County Groundwater Basins*. Excerpts of this study that focus on dual source irrigation systems are provided in **Appendix 7-D**.

In the 2018 study, dual source irrigation systems were evaluated as a promising opportunity for enhancing in-lieu groundwater recharge by incentivizing the use of surface water in lieu of groundwater whenever available. The study characterized the typical components of dual source irrigation systems and the relative upfront (capital) and ongoing (operations and maintenance) costs of these systems compared to systems that use only groundwater. The study also evaluated the agronomic factors that affect whether growers choose to utilize groundwater, surface water, or both sources when available. Finally, a preliminary economic analysis of local and regional benefits and costs of utilizing dual source systems to address potential groundwater overdraft conditions was presented. General findings and conclusions of this study are summarized as a basis for this GSP project.

A program that promotes dual source irrigation systems is expected to benefit measurable objectives related to groundwater levels and groundwater storage. By encouraging growers to use surface water when it is available, dual source irrigation systems provide:

- **In-lieu groundwater recharge**: In fields formerly irrigated exclusively using groundwater, surface water applied through a dual source irrigation system will offset a similar volume of groundwater pumping, leaving that groundwater in the underlying aquifer for future beneficial use.

- **Direct groundwater recharge**: Irrigation provides a significant volume of recharge through deep percolation of applied water. As irrigators have shifted from surface irrigation toward pressurized irrigation using groundwater, the proportion of deep percolation supplied by surface water has decreased. Even though the low-volume irrigation techniques used to apply groundwater minimize the total volume of water applied to satisfy crop demands, this shift in water source results in a net depletion of groundwater (i.e., more extraction than recharge) rather than the net recharge observed from application of surface water. Irrigating with surface water thus supports groundwater sustainability by supplying more surface water to the groundwater system through in-field recharge.

Expanded use of dual source irrigation systems represents a significant opportunity to preserve the agronomic advantages of groundwater use while mitigating increased reliance on groundwater and supporting groundwater sustainability.

7.1.4.3.2 Implementation

At the district-level, BWD is considering implementing a program to encourage or incentivize grower adoption of dual source irrigation systems, and this program could be expanded to a coordinated program implemented by multiple GSAs. This program can be supported through several mechanisms:

1. **Grower education**: Educating growers on the benefits and advantages of dual source irrigation systems, both at the field level and in the larger context of the Sutter Subbasin, may encourage growers to voluntarily adopt dual source irrigation systems. A sample framework for implementing a grower education program is outlined in **Section 7.1.4.5** of this GSP.
2. **Incentives**: An incentive program to encourage adoption of dual source systems can be developed, offsetting the cost of the additional components needed for these systems. Incentivizes may be funded through local district fees, through a jointly funded regional program, or through external programs such as those offered by the Natural Resources Conservation Service (NRCS), which has provided funding in the past to growers who convert from older and less efficient irrigation systems (such as flood systems) to newer, more efficient systems (such as sprinkler systems). Recent policy in Butte County has been to fund these projects only when the grower retains the use of surface water, promoting the use of dual source irrigation systems.
3. **Surface water delivery improvements**: Enhancing the availability and reliability of surface water supplies to support low-flow, long-duration irrigation events will support growers as they adopt dual source irrigation systems. The advantage of groundwater as an on-demand water supply diminishes if surface water is available with similar consistency and reliability.

Implementation of this program must address the agronomic and economic considerations that led growers to shift from use of surface water delivered through district-owned facilities to pumping of groundwater from grower-owned wells in the first place.

A primary consideration of growers is cost, where the use of a dual source system may or may not result in a net cost savings over time depending on several factors. Dual source irrigation systems require additional components and operating costs beyond a groundwater-only irrigation system, as growers must convey, filter, and pressurize surface water. Specific components and annual operating costs are summarized below in **Section 7.1.4.3.4** and in **Appendix 7-D**. Incentives may help to encourage growers who are hesitant about implementing dual source irrigation systems for economic reasons.

Another primary reason growers prefer groundwater is the reliability of an on-demand water source. If surface water is available on-demand or with greater flexibility during the growing season, this may help to encourage the adoption of dual source irrigation systems and reduce dependence on groundwater. Reliability of water supply is important not just seasonally or annually, but also within a given year when water might be needed on specific days (e.g., for frost protection), or to supply water during particularly dry winter and early spring months.

Another primary factor influencing groundwater use for fruit and nut trees is disease risk. Root and crown rot (Phytophthora) is transmitted through surface water in Butte County and can result in permanent crop damage and yield reduction. Thus, a benefit of using groundwater for orchard irrigation as compared to surface water is reduced risk of root and crown rot; however, there are several management options to prevent contact between wood and water, reducing this risk. Other factors that may result in advantages or disadvantages of using surface water include chemical constituents, such as the resultant introduction of mineral content and nitrates in groundwater and total dissolved solids and related considerations such as infiltration and salinity. Grower education programs can be useful in addressing these concerns of using dual source irrigation systems.

At the field-level, dual source irrigation systems are implemented by installing or integrating four primary components into a groundwater-only or “single source” system: a surface water irrigation “turnout” or point of delivery to the field, a pipeline or ditch to convey water from the turnout to a pump station, a pump or pumps for pressurization, and filtration equipment. The precise layout and specific components for dual source systems will vary from field to field, as described in **Section 7.1.4.3.4**. However, these four components generally account for the additional equipment needed for dual source systems as compared to groundwater only or “single source” systems. Implementation of a district-level program to encourage adoption of dual source systems can be designed to support growers in identifying and sizing the specific components needed for their individual fields.

7.1.4.3.2.1 Implementation Schedule

At this time, the dual source irrigation systems program has been developed and evaluated only at an investigative, planning level. This project will ultimately be selected for implementation according to the criteria identified in **Section 7.1.4.3.2.5**. At that time, any GSA or irrigation district interested in implementing this program will develop the program following the general implementation schedule presented in **Table 7-13**.

Table 7-13. Dual Source Irrigation System Program Implementation Schedule

Phase/Timeline Activity	Description	Year Start	Year End
Program Structure Development and Planning	Identifying program goals, a program structure, and a plan for assisting growers in installing dual source irrigation systems.	Years 1-2 of Project Implementation	Ongoing, as needed
Refinement of dual source irrigation system recommendations	Reviewing dual source irrigation system technology and developing framework for identifying and recommending components and implementation requirements for growers.	Years 1-2 of Project Implementation	Ongoing, as needed
Create Incentive Strategy	Planning potential incentive strategies and investigating funding sources.	Years 2-3 of Project Implementation, As Applicable	Ongoing, as needed
Partnership Development	Identifying and teaming with partner agencies to plan and implement program.	Years 2-3 of Project Implementation, As Applicable	Ongoing, as needed
Program Implementation	Facilitating conversion to dual source irrigation systems and coordinating education and outreach activities with partners, as applicable.	Year 4 of Project Implementation	Ongoing

Initial program planning and refinement of dual source irrigation system recommendations is expected to begin in the first two years of project implementation. A program incentive strategy will be developed and funding opportunities for grower incentives investigated. Partnerships for grower education and program implementation will also be developed, coordinating these efforts with implementation of other grower education programs described in **Section 7.1.4.5**, as applicable. Potential agencies and groups that GSAs may consider partnering with are:

- University of California Cooperative Extension (UCCE)
- California State University, Chico (Chico State)

- University of California, Davis (UC Davis)
- Irrigation Training and Research Center (ITRC) at California Polytechnic State University, San Luis Obispo (Cal Poly)

As the structure of the program and partnerships are developed, implementation of dual source irrigation systems is expected to occur throughout GSP implementation.

7.1.4.3.2.2 Notice to Public and Other Agencies

The public and other agencies will be notified of project implementation activities through outreach and communication channels identified in the GSP.

7.1.4.3.2.3 Construction Activities and Requirements

Construction activities that would be required for this project center on field-level implementation of dual source irrigation systems. The district will refine the specific recommendations for implementing dual source irrigation systems as part of this project. Eventually, this program will help growers identify the specific components that will need to be constructed or installed on a field-by-field basis.

Typical system components required for a dual source system are:

1. **Surface water irrigation "turnout" or point of delivery to the field:** An irrigation turnout provides a method to deliver surface water from a canal to a field or on-farm conveyance system and, when equipped with a screen or trash rack, a method to prevent large debris from entering the on-farm system. Turnouts typically consist of a submerged circular canal gate and a screen or trash rack. In some cases, the inlet piping of the pressure pump is equipped with a rotating, self-cleaning screen or other filter to enable pumping directly from the canal, thereby eliminating the need for a turnout gate.
2. **Pipeline or ditch to convey water from the turnout to a pump station:** The conveyance component includes any additional ditches or pipelines that may be needed to convey surface water to the irrigation system. Surface water supplies in the area are all non-pressurized, so a pump or pumps may be needed to lift the surface water to the field, overcome any pipe friction losses, and/or provide pressurization for the irrigation system. Where water can be delivered via gravity, an open ditch or low head pipeline may be used to convey water to the point of pressurization.
3. **Pump or pumps for pressurization**: Typically, a centrifugal pressure pump or vertical turbine sump pump is used to overcome friction, provide lift, and pressurize surface water.
4. **Filtration**: Surface water typically contains solids, which may include inorganic materials (sand, silt, and clay), aquatic organisms (algae, weeds, and fish), and trash (sticks, litter, etc.). Filtration of surface water may be accomplished in several stages, including construction of a small reservoir to settle solids prior to pumping, pre-screening at the turnout or pump intake using screens or trash racks, primary filtration downstream of the pump, and sometimes backup or

secondary filtration downstream of the primary filter. The need for these different filtration components depends on the conditions of a given field.

Although the layout and specific components for dual source systems will vary from field to field, these four components generally account for the additional equipment needed for dual source systems as compared to groundwater-only or “single source” systems.

The 2018 evaluation of dual source irrigation systems in Butte County (**Appendix 7-D**) provides additional information about required construction activities and requirements, including all the components of a sample dual source system located in a 250-acre walnut orchard in BWD.

7.1.4.3.2.4 Water Source

Existing water rights and supplies are estimated to be sufficient to provide surface water to support the dual source irrigation systems described in this section. This project is not expected to rely on additional water supplies from outside the jurisdiction of the BWD or any other GSA. Rather, dual source irrigation systems are expected to enhance conjunctive use of groundwater and existing surface water sources available to growers.

7.1.4.3.2.5 Circumstances and Criteria for Implementation

The dual source irrigation systems described in this section were originally evaluated as part of a 2018 study in Butte County (**Appendix 7-D**) and are planned for future implementation pending funding and changes in future groundwater conditions in the Sutter Subbasin. BWD and other GSAs will monitor groundwater levels in the Subbasin through the monitoring plan in this GSP. If groundwater levels decline near or below minimum thresholds, this project will be prioritized to support in-lieu recharge in those areas where undesirable results may occur. BWD and other GSAs may also decide to implement this project at an earlier time to augment surface water use.

Ongoing implementation of dual source irrigation systems does not depend on the implementation or performance of other projects or activities, though the increased water delivery flexibility from the system modernization improvements described in **Section 7.1.4.1** will increase the likelihood of growers participating. While operation of these projects is not expected to terminate, any future changes will be made to align with local agency goals and the overall Subbasin sustainability goal.

7.1.4.3.2.6 Legal Authority, Permitting Processes, and Regulatory Control

Water districts and GSAs have the authority to plan, incentivize, and support the use of dual source irrigation systems in their irrigation service areas. Depending on the scale and nature of specific construction activities that will need to be implemented to install dual source irrigation system infrastructure, potential permitting or regulatory processes that could affect the project include:

- State Historic Preservation Office and National Historic Preservation Act Section

106 Coordination
- Endangered Species Act Compliance
- National Environmental Policy Act Compliance
- California Environmental Quality Act
- State Water Resources Control Board Construction General Permit and Storm Water Pollution Prevention Plan (to the extent that any soil disruption occurs from construction related to surface water conveyance)

7.1.4.3.3 Operation and Monitoring

At the field-level, the layout and operation of dual source irrigation systems will vary between locations based on four main factors:

- **Field Size and Crop Water Requirements**: Peak capacity is a function of field size, peak crop evapotranspiration (ET), and the uniformity with which water is applied. For the Sacramento Valley, peak ET is around 0.3 to 0.4 inches per day for most crops, translating to approximately 7 to 9 gallons per minute (gpm) per acre based on a system distribution uniformity of 80%. In many cases, systems may be designed with greater capacity (e.g., 12 gpm per acre) to meet peak crop water requirements while avoiding pumping during peak energy demand periods to reduce electrical costs.
- **Distance**: The distance from the surface water source to the point of application affects the required length of ditch or pipeline required to convey the water. Distances to consider include the distance from the turnout to the pressure pump and the distance from the pressure pump to the point at which the pump discharge ties into the system mainlines. This may be at the groundwater well or other location. In addition to conveyance, the distance from the pressure pump to existing electrical distribution lines is a factor affecting cost for electric pumps.
- **Water Quality**: The type and quantity of solids to be removed through filtration affects the number and types of filtrations required. Generally, some form of pre-screening to remove large solids will be needed, followed by primary filtration downstream of the pressure pump. Selection of filtration also depends upon the orifice size of the sprinkler nozzles or emitters for pressurized systems.
- **Pressure Requirements**: The amount of pressurization required includes any lift required to convey water from the turnout to the point of application, friction losses in the conveyance and irrigation system itself, pressure loss through the filters, and discharge pressure required by the emitters.

The implementing entity may monitor grower adoption and amenability to dual source irrigation systems through periodic grower surveys before and during project implementation. Information gathered from these surveys would be used to refine and guide project implementation. The benefit of dual source irrigation systems to measurable objectives in the Subbasin (groundwater levels and groundwater storage) will be monitored using the monitoring network sites and monitoring practices described in the GSP.

7.1.4.3.4 Project Benefits and Costs

Implementation of dual source irrigation systems is expected to provide several on-farm and basin-wide benefits. Potential benefits and costs of dual source irrigation systems at the field-level and program-level are summarized below.

7.1.4.3.4.1 Field-Level Benefits and Costs

At the field-level, the primary categories of expected benefits are:

- **In-lieu groundwater recharge benefits**: the volume of groundwater pumping offset by implementation of dual source irrigation systems and use of surface water
- **Economic benefits**: the variable cost of groundwater pumping that is offset by implementation of dual source irrigation systems and use of surface water

In-lieu groundwater recharge and economic benefits are expected throughout project implementation, beginning as groundwater-only single-source irrigation systems are converted to dual source systems. The exact volume and cost of groundwater pumping that is offset each year depends on surface water supply availability and the precise crops, irrigation needs, and total agricultural area that is ultimately served by dual source systems. However, in the 2018 Butte County evaluation, dual source irrigation systems were estimated to offset approximately 50 percent of crop water demand in fields served, providing average per-acre benefits of 1.28 AF/acre, or approximately 15 inches/acre. Actual benefits would be monitored during project implementation as described in the operation and monitoring section, above.

Implementation of dual source systems have associated costs that are likely to differ from the costs associated with a single source groundwater system for the same orchard. These cost differences or “marginal” costs include capital, maintenance, and operations costs.

The greatest additional capital costs for a typical dual system are the additional infrastructure needed to convey and pressurize surface water. Some participating fields may need a pressure pump at each dual source pump station and electrical line extensions to bring power to the existing turnout locations. Other participating fields may require gravity pipelines to convey surface water from turnouts to existing well locations. Additional capital costs may include the cost of sump and turnout connections, the cost of extending the mainline to the turnout locations, and the cost of installing filtration equipment. Filtration needs depend on both the quality of the water and the type of irrigation method, with greater filtration needed for drip and microspray systems than for sprinklers.

Operations costs for dual source systems include the cost of surface water and groundwater. Surface water costs include purchasing surface water from the supplier and the cost of pumping and pressurizing the water. Groundwater costs include the cost of lifting the water and pressurizing it.

The additional capital and maintenance costs associated with these components represent an additional upfront investment required to utilize dual source systems, as compared to systems relying solely on groundwater for irrigation; the use of surface water results in a reduction in lift requirements and associated energy requirements compared to the use of groundwater. In some cases, the reduced energy requirements and cost savings may be greater than the capital and maintenance costs of the dual system components, resulting in a net cost savings over time to growers using dual source systems.

Table 7-14 summarizes the estimated annual costs and cost differences for installing and operating all components of a single source and dual source irrigation system for a sample 250-acre walnut orchard. Additional information about specific component costs of dual source systems is summarized in Table 6-4 of **Appendix 7-D**.

Table 7-14. Estimated Annual Costs and Cost Differences for Components of Single Source and Dual Source Systems: Example 250-Acre Walnut Orchard in Butte Water District (Appendix 7-D, Table 6-3)

Cost Item	Estimated Annual Cost [1]		
	Single Source	Dual Source	Difference
Capital			
Pressure Pumps	$1,460	$4,220	$2,760
Electrical Line Extension	$0	$3,300	$3,300
Gravity Pipeline	$0	$220	$220
Sump & Turnout Connection	$0	$920	$920
Subtotal	*$1,460*	*$8,660*	*$7,200*
Operations and Maintenance			
Energy	$52,320	$44,150	-$8,170
Equipment Maintenance	$920	$3,520	$2,600
Subtotal	*$53,240*	*$47,670*	*-$5,570*
Grand Total	***$54,700***	***$56,330***	***$1,630***

[1] Estimated annual costs were escalated from 2018 to 2021 according to the U.S. Army Corps of Engineers Civil Works Construction Cost Composite Index.

7.1.4.3.4.2 Program-Level Benefits and Costs

A program to encourage implementation of dual source irrigation systems is expected to achieve significant economic and groundwater recharge benefits in the Subbasin. **Appendix 7-D** contains a 2018 economic assessment of a selected dual source irrigation systems to evaluate associated costs, benefits to the grower, and benefits accruing to others in the Subbasin.

Economic benefits quantified in the analysis include:

- the value of stable groundwater levels reflected in the avoided cost of groundwater pumping by all groundwater users within the County;
- the benefit of increased future water supply reliability, reflected in reduced water supply risk to growers; and
- avoided costs of fallowing (or other programs) to manage groundwater overdraft.

The basin-wide economic benefits of increased recharge can be disaggregated into avoided energy and capital costs, reduced financial risk, and avoided third-party costs. The district-level economic benefits of dual source irrigation systems also include increased revenue, as growers purchase and use more surface water supply.

Costs quantified in the analysis include:

- The capital cost of the equipment required for the dual system at the farm
- The variable cost of operating the surface system, net of any cost savings over the existing groundwater system
- The capital and operating cost of conveying surface water to the fields included in the dual system
- The cost of purchasing surface water from a willing seller
- The opportunity cost of any capital in the existing groundwater well that is not used (or underutilized) once the dual system is implemented

The preliminary evaluation of local and regional benefits in nearby regions and costs associated with dual source systems (**Appendix 7-D**), although reliant on several key assumptions at the initial stage of investigation, suggest that benefits may significantly exceed the costs and additional investigation could be warranted.

7.1.4.4 Multi-Benefit Recharge Projects

7.1.4.4.1 Overview

The Nature Conservancy (TNC) has provided GSAs with guidelines and support to implement an on-farm, multi-benefit groundwater recharge program in the Sutter Subbasin. The program would build on the successful TNC BirdReturns program by strategically flooding agricultural fields with the goals of (1) recharging groundwater supplies while (2) simultaneously creating critical winter habitat for shorebirds migrating along the Pacific Flyway. GSAs may consider offering financial incentives to growers to compensate them for recharging groundwater through field flooding in the course of normal farming operations, with multiple benefits to the underlying aquifer, waterbirds migrating along the Pacific Flyway, and all beneficial users of groundwater in the subbasin.

With an incentive structure, the program would provide financial compensation for recharging groundwater through normal farming operations while also providing critical wetland habitat for waterbirds migrating along the Pacific Flyway. Fields with soil and cropping conditions conducive to groundwater recharge will be flooded and maintained with shallow depths. The program could be structured to pay for field preparation, irrigation, and water costs to encourage grower participation.

This section summarizes implementation activities, operation and monitoring efforts, and related costs and benefits of a multi-benefit groundwater recharge program in the Sutter Subbasin.

7.1.4.4.2 Implementation

Implementation of a multi-benefit groundwater recharge program in the Sutter Subbasin would occur in multiple phases, with expansion of the program over time as voluntary grower participation increases. Multi-benefit recharge would be implemented at selected sites in the Sutter Subbasin with multiple benefits to groundwater recharge and temporary wetland habitat formation. Recharge and wetland habitat benefits in the early phases of the project would be analyzed, reported, and used to inform development and later implementation of the program.

Implementation of this project will commence with selection of sites suitable for multi-benefit recharge, and initiation of any necessary permitting and environmental documentation. GSAs will use resources provided by TNC to identify fields with soil and cropping conditions conducive to groundwater recharge and temporary wetland habitat formation. In later phases of project implementation, suitable fields will continue to be identified following similar criteria, with refinement according to lessons learned from early project implementation.

Suitable project sites would be selected by the following characteristics:

- Soil characteristics that are conducive to recharge, as indicated by:
  - Soil types
  - Soil Agricultural Groundwater Banking Index (SAGBI) rating relationship
- Crop types that are conducive to high-quality, open wetland habitat suitable for bird stopovers when flooded (i.e., not orchards)
- Crop types that are suitable for recharge (i.e., suitable for flooding in mid-July through mid-October, and conducive to deep percolation)
- Water supply and infrastructure characteristics that are suitable for flooding (i.e., existing flood irrigation infrastructure, existing surface water supply)

The process for identifying and enrolling suitable fields in the program is documented extensively on the TNC BirdReturns project website (https://birdreturns.org/).

GSAs will conduct outreach to local growers to identify willing participants that irrigate fields where multi-benefit groundwater recharge can be implemented. Outreach will be conducted through existing communication pathways described in the GSP. Participant responses will be gathered and organized through surveys that request information regarding:

- Field characteristics (location, size, cropping, field preparation methods)
- Existing water supply characteristics (water supply source(s), timing of water source(s))
- Existing measurement and monitoring infrastructure (flow meters, groundwater well)
- Other relevant information

GSAs, with potential support from TNC and/or other entities, would then coordinate with participating growers to implement on-farm, multi-benefit groundwater recharge. Following initial site selection and completion of any necessary permitting and environmental documentation, fields will be prepared for flooding and monitoring. At that time, necessary monitoring equipment will be installed, as needed. The program could be designed to pay for field preparation, irrigation, and water costs through an GSA-planned incentive structure.

During the “flooding window” (mid-July through mid-October), enrolled fields would then be flooded and maintained at a shallow depth to supply groundwater recharge and temporary open wetland habitat for migrating shorebirds. Finally, after completion of the program requirements, contract fees (if applicable) would be paid to participants.

7.1.4.4.2.1 Implementation Schedule

A typical annual timeline of project implementation is provided in **Table 7-15**. At this time, the multi-benefit groundwater recharge program has been developed and evaluated only at an investigative, planning level. This project will ultimately be selected for implementation according to the criteria identified in **Section 7.1.4.4.2.5**. At that time, GSAs would develop and implement the program annually following the general implementation schedule presented in **Table 7-15**.

Table 7-15. Expected annual implementation timeline for the Sutter multi-benefit groundwater recharge project

Timeline Activity	Start	End
Participant Applications	April 1	August 15
Site Selection	June	September
Construction, Site Preparation	July	September
Operation	mid-July	Mid-October
Financial Incentive Payment	October	December

7.1.4.4.2.2 Notice to Public and Other Agencies

The public and other agencies will be notified of project implementation activities through outreach and communication channels identified in the GSP.

7.1.4.4.2.3 Construction Activities and Requirements

Multi-benefit groundwater recharge will be conducted on existing agricultural fields with flood irrigation system infrastructure.

Prior to field flooding, GSAs could facilitate a survey of the fields and install pressure transducers or flow meters at inlets and outlets and in adjacent wells to facilitate measurement of applied water depths and changes in groundwater depth.

7.1.4.4.2.4 Water Source

Surface water used in this project is expected to be available from existing surface water rights contracts. Existing diversions and conveyance infrastructure will be used to supply surface water for multi-benefit groundwater recharge. Surface water will be delivered during a “flooding window” from mid-July through mid-October.

7.1.4.4.2.5 Circumstances and Criteria for Implementation

The primary constraints on the operation of this project are (1) the availability of sufficient surface water supply, and (2) the participation of growers with fields conducive to groundwater recharge.

Surface water supply conditions needed for this project include:

- Availability of surface water supplies that are sufficient to flood participating fields according to the specified flooding depth and duration
- Appropriate timing of surface water supply availability during the project “flooding window” (mid-July through mid-October), when wetland habitat for waterbirds migrating along the Pacific Flyway is most critically needed
- Reliability of surface water supplies, based on historical reliability and expected future reliability

Grower participation needed for this project includes:

- Willingness of growers to participate in this program, informed by program applications
- Availability of participating fields suitable for groundwater recharge, based on soil texture, crop type, and availability of suitable surface water flood irrigation infrastructure

A multi-benefit groundwater recharge program is planned for future implementation pending funding and changes in future groundwater conditions in the Sutter Subbasin. GSAs will monitor groundwater levels in the Subbasin through the monitoring plan in this GSP. If groundwater levels decline near or below minimum thresholds, this project will be prioritized to support in-lieu recharge in those areas where undesirable results may occur. GSAs may also decide to implement this project at an earlier time to achieve these multi-benefits for the subbasin.

Ongoing implementation of a multi-benefit groundwater recharge program does not depend on the implementation or performance of other projects or activities. While operation of this program is not expected to terminate, any future changes will be made to align with the project goals and the overall Subbasin sustainability goal.

7.1.4.4.2.6 Legal Authority, Permitting Processes, and Regulatory Control

The following agencies have potential permitting roles for the multi-benefit groundwater recharge project: Sutter County, the State Water Resources Control Board (SWRCB), and USBR (if using Central Valley Project [CVP] contract supply). If necessary, the GSAs will obtain land grading permits from the County. If necessary, the GSAs will apply or facilitate applications for permits required from the SWRCB for diversion of surface water to the extent that diversion is not already permitted under existing water rights and contracts. Recharge projects may also require an environmental review process under CEQA. If required, this project would need either an Environmental Impact Report and Negative Declaration or Mitigated Negative Declaration.

7.1.4.4.3 Operation and Monitoring

Following site selection, operation of the multi-benefit recharge project begins with site preparation. Prior to the “flooding window,” field preparation is completed to enhance wetland habitat and recharge potential. Existing vegetation may be removed or incorporated, depending on recommendations or requirements associated with initial field conditions. Flow rate and groundwater level monitoring equipment will also be installed in the fields to facilitate project monitoring. Soil and water samples could be collected to ascertain water quality prior to wetting, as desired. Wooden stakes will also be installed to support monitoring of water depths and bird presence.

After site preparation, multi-benefit groundwater recharge will be implemented through field flooding. During the implementation period (mid-July through mid-October), participants will spread water on their fields and maintain a shallow depth (four inches maximum) for four to six weeks. Participants will record any changes in water flow in an irrigation log. Meanwhile, the GSAs would coordinate monitoring of field depth, bird presence, water delivery, and changes in groundwater depth.

7.1.4.4.4 Project Benefits and Costs

The expected benefits and costs of the multi-benefit recharge program can be summarized as described below.

Actual participation in the program will vary from year to year, depending on grower interest, water availability, changes in cropping, and other factors. The total area suitable for the multi-benefit recharge project could be evaluated based on recharge potential and cropping. Recharge potential can be quantified based on the area-weighted SAGBI rating of fields in the Subbasin, considering only fields with a SAGBI recharge rating “moderately good” or higher (UC Davis, 2021). Crop areas suitable for multi-benefit recharge can be evaluated based on 2018 Land IQ spatial land use data (Land IQ, 2021), filtering land areas by crop type to exclude permanent crops, rice, crops with growing seasons unsuited to the flooding window, and non-agricultural areas.

Based on observed infiltration rates in a pilot multi-benefit recharge pilot project in Colusa County, infiltration rates are expected to range between 0.2 and 1.2 inches per day for participating fields in the Sutter Subbasin. Assuming an average of 30 days of flooding per year, the average expected recharge benefit of the multi-benefit recharge program estimated. While changes in water availability may impact the extent of program participation from year to year, the program is anticipated to continue every year, providing both groundwater recharge and migratory bird habitat along the Pacific Flyway.

Typical program cost components are summarized in **Table 7-16**, on a per site basis. Slightly higher costs are typically incurred in the first year a site participates in the program, as more coordination and site preparation is typically required. As a site continues to participate in the program, lower costs are anticipated from year to year. Costs per site may vary depending on future changes in program requirements and incentives. The total costs of the program will vary over time, depending on the number of sites enrolled and the extent to which new sites are enrolled or returning sites continue to participate in the multi-benefit recharge program.

Table 7-16. Estimated capital cost and average annual operating cost per site for the multi-benefit groundwater recharge project.

Cost Component Per Site	Estimated Average Annual Cost at New Sites ($) [1]	Estimated Average Annual Cost at Established Sites ($) [1]
Equipment and Direct Cost	$2,000	$1,000
Other Cost (Labor, Coordination, Administration, Analysis and Development)	$2,000	$2,000
Total	$4,000	$3,000

[1] Costs estimated based on implementation costs for a multi-benefit recharge pilot project in Colusa County. Typical costs will vary between individual programs, depending on how the GSA and/or participating agencies plan to implement and monitor the program.

7.1.4.5 Grower Education Relating to On-Farm Practices for Sustainable Groundwater Management

7.1.4.5.1 Overview

A grower education and outreach program is proposed as a management action for the Sutter Subbasin. The program will provide growers with educational resources that help them to plan and implement on-farm practices that simultaneously support groundwater sustainability and maintain or improve agricultural productivity. Implementation of these outreach efforts and on-farm practices will be recorded, along with estimated or measured benefits to groundwater sustainability resulting from these practices. This program would be accomplished through workshops and distribution of educational materials, as well as on-site irrigation system evaluations and irrigation water management assistance.

Four categories of on-farm practices, or on-farm management actions, that may be covered in this program are:

1. maximizing the use of surface water (e.g., “in-lieu” recharge),
2. managing soils to improve infiltration and root zone soil moisture storage,
3. reducing (and minimizing) non-beneficial ET, and
4. precision nutrient management.

In aggregate, these on-farm practices will promote agricultural productivity and improve economic benefits with sustainable groundwater management[1]. **Table 7-17** identifies the measurable objectives that will be supported by each category of on-farm management actions.

General topics identified for the grower education program are summarized below. Additional information and topics are summarized in **Appendix 7-E**.

Table 7-17. Measurable Objectives Benefitted by On-Farm Management Actions

On-Farm Management Action	Measurable Objectives Benefitted
Maximizing surface water use	Groundwater levels, groundwater storage
Managing soils to improve infiltration and root zone soil moisture storage	Groundwater levels, groundwater storage
Reducing non-beneficial ET	Groundwater levels, groundwater storage
Precision nutrient management	Water quality

[1] In most cases, not all on-farm practices will be implemented. Also, some practices will not work in tandem with one another. For example, maximizing the use of available surface water and precision irrigation scheduling are not possible on the same field at the same time.

7.1.4.5.1.1 Maximizing use of surface water ("in-lieu" recharge)

The use of surface water for irrigation whenever it is available is a crucial practice to support sustainable groundwater management. The use of surface water both offsets local groundwater demand through reduced groundwater pumping ("in-lieu" recharge) and increases groundwater recharge through the non-consumptive recoverable flow of deep percolation of applied surface water from the land surface to the underlying aquifer. The on-farm practices to maximize the use of surface water include implementing a dual-source irrigation system, reducing tailwater resulting from irrigation, and other actions to promote the conjunctive management of surface water and groundwater.

A dual-source irrigation system is capable of diverting and utilizing surface water for irrigation when available and utilizing groundwater if surface water is unavailable. The benefits of this practice are that every acre-foot of surface water that is utilized is an acre-foot of groundwater that remains in the aquifer ("in-lieu recharge"), supporting sustainable groundwater levels and maintaining groundwater storage. Additionally, the applied surface water will inevitably result in some direct groundwater recharge through deep percolation. These positive impacts will initially occur in the aquifer directly beneath the grower's lands, while also influencing surrounding lands. The potential drawbacks to this system are the initial construction costs and higher maintenance costs associated with a more complex irrigation system that can draw from two water sources, as well as the potential for sediments and debris in surface water to obstruct irrigation systems. If the dual-source irrigation system is designed to accommodate this, surface water and groundwater could be intermixed during irrigation to mitigate these effects.

The on-farm management practice of reducing tailwater from irrigation and holding that water within the irrigated area will either increase the ET, increase the deep percolation, or some combination of the two. The practical steps taken to achieve these will vary from field to field. If there are irrigation application uniformity issues with over- and under-irrigation occurring in certain parts of the field, addressing these issues will promote tailwater reduction. Also, if there are low-lying portions of a field or border strips that are not in agricultural production, excess applied water can be directed to these areas where it can be contained by topography or the construction of low berms and allowed to infiltrate the ground and recharge the underlying groundwater system, rather than flowing off the field.

The two practices above are examples of conjunctive management, a practice which recognizes that surface water and groundwater are interdependent and seeks to combine and balance the beneficial use of both water sources to promote sustainable water use while minimizing any negative economic or environmental impacts which could occur (Dudley and Fulton, 2006). Conjunctive management is often practiced on a larger scale, but it can be applied by individual growers through the practices above (and others) to maximize surface water usage when available and to promote groundwater sustainability.

7.1.4.5.1.2 Managing soil to improve infiltration and root zone soil moisture storage

Another on-farm practice that will promote groundwater sustainability is management of soil at the ground surface and within the root zone to improve infiltration of applied water and reduce runoff or ponding on the ground surface. This can be implemented through a variety of on-farm practices including planting cover crops or utilizing crop rotations to increase organic matter content in the root zone, application of manure or other organic material, limiting soil compaction by minimizing use of heavy equipment, and if there is a restrictive layer near the surface of the ground, potentially using deep ripping or tillage to improve infiltration past the restrictive layer (Sanden et al, 2016; USDA-NRCS, 2014). Improving infiltration will increase direct recharge and improving soil moisture storage may increase effective precipitation and slightly reduce the required volume and frequency of irrigation.

7.1.4.5.1.3 Reducing non-beneficial evapotranspiration

This section describes two potential methods for reducing non-beneficial ET through altering and carefully controlling the timing and volume of applied water.

7.1.4.5.1.3.1 Precision irrigation scheduling

Precision irrigation scheduling has the potential to benefit both grower profits and sustainable groundwater management. Precision irrigation scheduling enables growers to accurately identify the timing and volume of irrigation water to apply to maximize crop productivity while minimizing water application. It typically requires real-time or near real-time information on soil moisture and weather conditions and is crop dependent. When effectively implemented, precision irrigation scheduling promotes sustainable groundwater management through increased water use efficiency; water that otherwise would have been applied to the field remains in the groundwater system or is available for use elsewhere.

7.1.4.5.1.3.2 Regulated deficit irrigation

Regulated deficit irrigation applies irrigation water during important drought-sensitive growth stages for a crop and reduces applied irrigation water (i.e., deficit irrigation) during other growth stages where there will be little to no effect on crop yields. This on-farm management practice needs to be prudently applied, but it has the potential to reduce applied water and associated irrigation costs with little to no impact on crop yields. It promotes sustainable groundwater management through reduced consumptive use; water that otherwise would have been applied to the field is not consumed and remains in the groundwater system or is available for use elsewhere.

7.1.4.5.1.4 Precision nutrient management

Another negative impact to the groundwater system that can result from irrigated agriculture is the degradation of groundwater quality occurring from excess application of nutrients (i.e., nitrogen, phosphorus, etc.), pesticides, or herbicides. As applied water infiltrates the ground and percolates to the aquifer, it can transport excess nutrients, pesticides, or herbicides applied on the land surface during crop production. At high concentrations, these materials are a health concern if this groundwater is pumped and used for human consumption. Improving on-farm nutrient management and efficiency of nutrient application will save on-farm costs and reduce the nutrient influx to the groundwater system.

7.1.4.5.2 Implementation

The GSAs would implement the grower education program by planning, preparing, and conducting outreach efforts related to the topics above. Outreach efforts may include seminars, trainings, workshops, and publications on topics related to on-farm water management and groundwater sustainability. As the GSAs begin to conceptualize and implement specific grower education programs and tools, they may consider partnering with local grower groups, educational and agricultural extension professionals, and others who are experienced in grower outreach and are knowledgeable about local agricultural practices. Potential agencies and groups the GSAs may consider partnering with include:

- University of California Cooperative Extension
- California State University, Chico
- University of California, Davis

Staff and researchers at UCCE, Chico State, and UC Davis regularly partner with counties and other local agencies to conduct applied research and education programs throughout California.

7.1.4.5.2.1 Implementation Schedule

A general implementation schedule for the grower education program is presented in **Table 7-18**. Planning and partnership development are expected to begin in the first two years of GSP implementation, recurring as needed over the GSP implementation period. As topics are planned and partnerships are developed, education programs are expected to take place throughout GSP implementation. It is anticipated that the public and other agencies will be notified of planned grower education activities through outreach and communication channels identified in the GSP.

Table 7-18. Grower Education Program Implementation Schedule.

Phase/Timeline Activity	Description	Year Start	Year End
Education Topic Planning	Identifying specific education topics relevant to local agricultural practices and groundwater conditions	Year 1 of Project Implementation	Ongoing
Partnership Development	Identifying and teaming with partner agencies to plan and implement grower outreach	Year 2 of Project Implementation	Ongoing
Education Program Implementation	Conducting grower education and outreach activities	Year 3 of Project Implementation	Ongoing

7.1.4.5.2.2 Notice to Public and Other Agencies

The public and other agencies will be notified of planned grower education activities through outreach and communication channels identified in this GSP (see **Chapter 8** *Plan Implementation*).

7.1.4.5.2.3 Construction Activities and Requirements

There are no anticipated construction activities associated with the grower education program. The grower education program will primarily require development and distribution of technical and educational resources, which the GSAs will prepare through the partnerships described above.

7.1.4.5.2.4 Water Source

While there is no water source directly used in this program, the grower education program will promote conjunctive use of groundwater and all surface water sources available to growers and will promote reduction in non-beneficial ET of all water sources.

7.1.4.5.2.5 Circumstances and Criteria for Implementation

Grower education programs will add value to other groundwater sustainability efforts at any time during GSP implementation. Because on-farm water management decisions are so impactful to achieving and maintaining groundwater sustainability, implementation of grower education programs is anticipated throughout GSP implementation, with planning efforts beginning the first year of GSP implementation. Over time, programs will be tailored to reflect current technologies and best practices in on-farm water management, especially as the GSA’s understanding of groundwater conditions in the Sutter Subbasin grows.

7.1.4.5.2.6 Legal Authority, Permitting Processes, and Regulatory Control

GSAs have the authority to plan and partner with other groups to implement grower education activities. There are no anticipated permitting or regulatory processes that would affect the grower education program.

7.1.4.5.3 Operation and Monitoring

The grower education program will be accomplished by the GSAs through partnerships with agencies, as described under the implementation section, above. The GSAs and partner agencies will develop and distribute educational materials on topics relevant to local agricultural practices and groundwater conditions. Grower responses to specific educational topics will be assessed and monitored through pre- and post-workshop surveys. These surveys will be designed to identify the extent to which growers adopt recommended practices. All benefits to measurable objectives in the Sutter Subbasin will be evaluated through groundwater monitoring and water quality monitoring at nearby monitoring sites, identified in the GSP.

7.1.4.5.4 Benefits and Costs

Implementation of grower education activities is ultimately expected to benefit groundwater levels, groundwater storage, and water quality. Encouraging growers to implement on-farm water management practices that maximize surface water use and reduce non-beneficial ET is expected to provide in-lieu recharge benefits to the groundwater system. Encouraging soil management to enhance infiltration is expected to enhance direct groundwater recharge. Both in-lieu and direct recharge are anticipated to benefit groundwater levels and groundwater storage. Encouraging growers to implement precision nutrient management is also expected to help manage nutrient loading in the subbasin, with benefits to water quality.

The benefits of grower education are expected throughout program implementation, beginning the first or second year of education program implementation (**Table 7-18**). These benefits will be monitored as described in the operation and monitoring section, above.

The total cost of the grower education program will vary depending on the types and extent of educational outreach. Grower outreach and education through social media communication may be inexpensive or virtually free, while seminars, trainings, workshops, and publications will likely incur planning and development costs. Total costs are expected to be proportional to the expansion of the education program over time. Conceptual-level estimated costs for grower education are approximately $10,000 assuming approximately two workshops per year, and that $5,000 is required for workshop preparation, implementation, and related distributed materials. Refined costs will be developed, and actual costs will be described in the GSP annual reports as specific education activities are planned and implemented.

7.1.4.6 Installation of Additional Shallow Groundwater Monitoring Wells

7.1.4.6.1 Overview

This project will install shallow monitoring wells (less than 350 ft bgs) in areas of the Subbasin where the GSAs are interested in monitoring potential hydrologic impacts to interconnected surface waters (ISW) and groundwater dependent ecosystems (GDEs) in areas where there are not currently shallow groundwater monitoring sites, particularly near the Sutter Bypass. This project is designed to address places where additional data may be helpful and will support ongoing monitoring of interconnected surface water.

7.1.4.6.2 Implementation

The GSAs are planning to install 15 additional shallow wells to improve monitoring relative to interconnected surface water depletion and GDEs. Of these new wells, 13 are planned and two are sited at contingent locations. The new shallow wells will provide for improved monitoring data for evaluating impacts to interconnected surface waters, GDEs related riverine habitats, and will be sited at locations to allow them to be also added to the interconnected surface water representative monitoring network described in in this chapter. Currently, Sutter County has submitted an application to DWR's Technical Support Services (TSS) program to install the monitoring wells near selected surface water gage locations near rivers and wetlands. At the time of this posting, the TSS application is being processed by DWR.

Suitable groundwater/surface monitoring networks should consist of two shallow monitoring wells near a gaging station in order to elucidate a clear relationship of streamflow depletion and groundwater elevation along with timing and quantity. While all shallow groundwater wells facilitate the measurement of interconnected water near the Sutter Bypass, the specific locations identified for improved monitoring include six wells near the Sacramento River, two near McGriff Lakes and the Sacramento River, two near Feather River, two near Butte Slough, one near the Sutter Bypass, one near the Tisdale Bypass, and one near Snake River (**Figure 5-47**). These locations and densities of monitoring sites will follow the guidelines suggested by the Environmental Defense Fund in their publication entitled *Addressing Regional Surface Water Depletions in California* (EDF, 2018).

7.1.4.6.2.1 Implementation Schedule

Implementation is planned to occur as soon as possible, pending permitting and funding. The work will likely consist of the following major tasks:

1. Obtain appropriate permits and file necessary reports.
2. Develop plans and specifications to construct and develop the monitoring wells.
3. Assemble bid documents and release for competitive bid.

4. Drill an 8-inch diameter borehole using the hollow-stem auger drilling method to specified depths. A geologist will collect and classify samples of the cuttings in accordance with the Unified Soil Classification System per American Society for Testing and Materials (ASTM) D2488.
5. Prepare a final well design utilizing a California-licensed professional geologist.
6. Construct the monitoring well per the final design. During construction of the monitoring wells a geologist will be onsite continuously to prepare as-built drawings of the constructed wells.
7. Develop the monitoring wells.
8. Install a lockable security vault imbedded in the concrete sanitary seal.
9. Complete a Water Well Drillers Report and submit copies to California Department of Water Resources (DWR) and the local well permitting agencies.
10. Survey the well location and elevation using a California-licensed land surveyor.

Once the monitoring well construction is completed, the wells will be incorporated into the California Statewide Groundwater Elevation Monitoring (CASGEM) system and the Subbasin’s representative monitoring network for interconnected surface waters.

7.1.4.6.2.2 Notice to Public and Other Agencies

The public and other agencies will be notified of project implementation activities through outreach and communication channels identified in the GSP.

7.1.4.6.2.3 Construction Activities and Requirements

This project will construct 15 shallow wells, each 50 to 255 feet deep and 4-inches in diameter. The shallow monitoring wells will be constructed within road easements owned by Sutter County or other willing landowners. No land will be purchased for this project. Wells will be constructed in accordance with California Well Standards Bulletin 74-90 and 74-81 and County well ordinances.

7.1.4.6.2.4 Water Source

This project is for monitoring purposes only and is not expected to rely on additional water supplies from outside the jurisdiction of the GSAs.

7.1.4.6.2.5 Circumstances and Criteria for Implementation

Implementation is planned to occur as soon as possible, pending permitting and funding.

7.1.4.6.2.6 Legal Authority, Permitting Processes, and Regulatory Control

This project will require preparation of CEQA documentation including a Categorical Exemption under the Information Collection provision of Article 19, Section 15306

(Class 6). The GSAs jointly will post this with the State Clearinghouse and address public comments. This project will also require Sutter County well construction permits prior to construction of the wells. A National Pollutant Discharge Elimination System (NPDES) permit or Waste Discharge Requirements (WDRs) are not anticipated to be required as water from the wells will not be discharged to surface water or land and any discharges associated with well construction can be managed under existing General Permits.

7.1.4.6.3 Operation and Monitoring

The GSAs and partner agencies will accomplish goals as described under the implementation section, as described above. Installation of shallow groundwater monitoring wells will begin with site preparation, followed by construction activities for installation of monitoring wells. Pressure transducers may also be installed in the fields, as needed, to facilitate project monitoring. The GSAs would coordinate monitoring and data collection surrounding monitoring wells.

This project is expected to aid in improving the understanding of Subbasin hydrogeology, assessing the sustainability indicators of groundwater levels, surface water levels, and interconnected surface waters, as well as improving the understanding of system hydrologics for managing groundwater dependent ecosystems. This project is related to all other projects described in this section, as it is foundational to be able to measure the effect of projects on sustainability indicators.

7.1.4.6.4 Benefits and Costs

The estimated cost for this project is approximately $1,135,125. Costs for individual monitoring wells are estimated in **Table 7-19**. Potential funding may come from infrastructure grants, GSP grants, district funding, or other sources. The primary benefit of this project will be to improve understanding of the interconnection between the use of shallow groundwater and the impacts of those uses on interconnected surface waters, particularly near the Sutter Bypass, supporting ongoing GSP implementation and efforts to maintain groundwater sustainability. This project is expected to benefit measurable objectives related to groundwater levels and depletions of interconnected surface water. More specific benefits and costs will be determined as the project is developed further.

Table 7-19. Estimated capital costs for Shallow Groundwater Monitoring Well Installations

Monitoring Well ID	Depth (feet below ground surface)	Nearby Rivers or Water Sources	Estimated Cost
101	115	Sacramento River	$58,425
102	180	Sacramento River	$82,800
103	175	Sacramento River, McGriff Lakes	$80,925
104	175	Sacramento River, McGriff Lakes	$80,925
105	185	Sutter Bypass	$84,675
106	90	Snake River, Sutter Bypass	$49,050
107	165	Butte Slough, Wadsworth Canal	$77,175
108	165	Butte Slough, Wadsworth Canal	$77,175
109	200	Tisdale Bypass	$90,300
110- Contingent Location 1	160	Between Feather River and Sutter Bypass	$75,300
111- Contingent Location 2	160	Between Feather River and Sutter Bypass	$75,300
112	125	Sacramento River	$62,175
113	125	Sacramento River	$62,175
114	140	Sacramento River	$67,800
115	255	Sacramento River	$110,925
Total	**-**	**-**	**$1,135,125**

7.1.5 Other Projects and Management Actions to be Implemented as Needed

To the extent that future monitoring indicates the occurrence of undesirable results in the Subbasin, additional projects and management actions will be implemented to address these changing conditions. Other proposed projects and management actions that will be implemented "as needed" are described in simplified detail below. Additional project development and description will occur as those projects are needed.

7.1.5.1 Butte Water District

Proposed projects that would be implemented by Butte Water District GSA are summarized below.

7.1.5.1.1 Removal of Bottlenecks on the Sutter-Butte Main Canal

This project is part of the comprehensive plan of Butte Water District to enhance water management developed as part of the Feather River Regional Agricultural Water

Management Plan. The project will be supported by the BWD's planned system modernization project and is expected to increase refuge water supply, supply reliability, and delivery flexibility. A summary of project components and their relation to the GSP Emergency Regulations §354.44(b) is included in **Table 7-20**.

Table 7-20. Removal of Bottlenecks on the Sutter-Butte Main Canal: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This project is proposed for implementation on the Sutter-Butte Main Canal, improving delivery service to irrigation customers. The precise location of the project would be determined through further evaluation if/when the project is selected for implementation, depending on the characteristics of the chosen project configuration. The project would increase BWD's ability to meet irrigation water needs using available surface water by reducing capacity constraints that prevent conveyance and full utilization of supplies. Enhancing the availability and reliability of surface water supplies offsets demand for groundwater, providing in-lieu recharge benefits to the Subbasin. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if monitoring indicated a need for more PMAs to maintain sustainability and prevent undesirable results. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This project is currently in the early planning stage. Thus, the start and completion dates for this project have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue beginning the first year of project operation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year GSP updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	Existing BWD surface water Feather River Settlement Contract supplies would be better utilized with a corresponding reduction in groundwater use. This is one of the most reliable supplies in California.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation on CEQA and NEPA will be initiated may include, but is not limited to: DWR, SWRCB, California Department of Fish and Wildlife (CDFW), Central Valley Flood Protection Board (Flood Board), Regional Water

Item in GSP Regulations	Description
	Quality Control Boards (RWQCBs), United States Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), Local Agency Formation Commission (LAFCO), Sutter County, and California Air Resources Board (CARB).
Benefits and benefit evaluation methodology (§354.44(b)(5))	The expected yield of this project has not been estimated at this time. In general, measurable objectives expected to benefit from the project include increased groundwater levels and change in groundwater storage as surface water use is enhanced. This project is currently in the early planning stage. Thus, the expected yield of this project has yet to be determined and will be reported in GSP annual reports and five-year updates when known. Evaluation of benefits will be based on analysis of pre- and post-project measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling may be done with the C2VSimFG-Sutter model used for GSP development.
Costs (§354.44(b)(8)) [1]	The initial cost of this project is estimated at $1,009,000 with $55,000 annualized capital recovery and operations and maintenance costs. More detailed anticipated costs of this project have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

[1] Cost estimates were escalated from 2014 to 2021 according to the U.S. Army Corps of Engineers Civil Works Construction Cost Composite Index.

7.1.5.1.2 Improved Delivery Service to Pressurized Irrigation Systems

As part of the BWD's comprehensive plan to enhance water management developed as part of the FRRAWMP, the BWD plans to make the following improvements: Sunset to Webster Pipeline Conversion and Improved Turnout Configuration and Debris Management. The project is directly related to and supportive of BWD’s dual source irrigation system project described in **Section 7.1.4.3**. The project will also be supported by the BWD’s planned system modernization project described above. This project is expected to improve water quality, conserve energy, and increase water supply and supply reliability. A summary of project components and their relation to the GSP Emergency Regulations §354.44(b) is included in **Table 7-21**.

Table 7-21. Improved Delivery Service to Pressurized Irrigation Systems: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This project is proposed for implementation on the Sunset to Webster Pipeline Conversion. This project will help supply surface water to irrigators that use pressurized irrigation systems, increasing BWD's ability to meet irrigation water needs using available surface water and offsetting groundwater use with in-lieu groundwater recharge benefits to the Subbasin. System modernization improvements that will benefit improved delivery service flexibility and consistency include: heading control structures, upstream water level control structures, spill control structures, and remote monitoring and control equipment. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if monitoring indicated a need for more PMAs to maintain sustainability and prevent undesirable results. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This project is currently in the early planning stage. Thus, the start and completion dates for this project have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue beginning the first year of project operation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	Existing BWD surface water Feather River Settlement Contract supplies would be better utilized with a corresponding reduction in groundwater use. This is one of the most reliable supplies in California.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation on CEQA and NEPA will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, Sutter County, and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	The expected yield of this project has not been estimated at this time. In general, sustainability indicators expected to benefit from the project include increased groundwater levels and change in groundwater storage as surface water use is enhanced. Enhancing the availability and reliability of surface water supplies to support low-flow, long-

Item in GSP Regulations	Description
	duration irrigation events will support growers as they adopt dual source irrigation systems. The advantage of groundwater as an on-demand water supply if surface water is available with similar consistency and reliability. This project is currently in the early planning stage. Thus, the expected yield of this project has yet to be determined and will be reported in GSP annual reports and five-year updates when known. Evaluation of benefits will be based on analysis of pre- and post-project measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling may be done with the C2VSimFG-Sutter model used for GSP development.
Costs (§354.44(b)(8)) [1]	The total cost of this project is estimated at around $3,250,600, with an initial cost of $2,804,800 and a $386,800 annualized capital recovery and operations and maintenance. More detailed anticipated costs of this project have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The project proponent(s) would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

[1] Cost estimates were escalated from 2014 to 2021 according to the US Army Corps of Engineers Civil Works Construction Cost Composite Index.

7.1.5.2 Central Valley Joint Venture

Proposed projects that would be implemented by the Central Valley Joint Venture (CVJV), a collaborative group of private organizations, state and federal agencies and others, are summarized below.

7.1.5.2.1 Wetlands Water Management

The CVJV implementation plan (1990, updated in 2006 and 2020, **Appendix 7-F**) identified conservation objectives for waterfowl, shorebirds, waterbirds, and riparian songbirds:

1. Protect 80,000 additional wetland acres through land acquisitions
2. Secure firm, timely, high quality water supplies for refuges and wildlife areas
3. Secure CVP power to support wetlands management
4. Increase wetlands by 120,000 acres
5. Enhance habitat on 292,000 acres of public and private lands,
6. Enhance waterfowl habitat on 443,000 acres of agricultural lands
7. Identification and evaluation of water needs and challenges

The Central Valley Project Improvement Act (CVPIA) Refuge Water Supply Program has resulted in the construction of new facilities in the region and led to the development of agreements for districts to provide firm water supplies to certain refuges. Specifically, Sutter Extension Water District provides water to Sutter National Wildlife Refuge (NWR). A summary of project components and their relation to the GSP Emergency Regulations §354.44(b) is included in **Table 7-22**.

Table 7-22. Wetlands Water Management: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This project is providing ongoing support to nine refugees throughout the Central Valley, including the Sutter NWR in the Sutter Subbasin. Additional locations for implementation to reach identified conservation objectives may include but are not limited to: private waterfowl hunting clubs in the levees of the Sutter Bypass and protected natural areas in the Feather River Wildlife Area (WA), Sutter Bypass WA, and the Sutter NWR. The precise location of the project would be determined through further evaluation if/when the project is selected for implementation, depending on the characteristics of the chosen project configuration. This project will supply direct recharge through surface water supplies and will improve wildlife habitat. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if monitoring indicated a need for more PMAs to maintain sustainability and prevent undesirable results. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	Although this project is currently ongoing in many locations across the state, a particular project in the Sutter Subbasin is currently in the early planning stage. Thus, the start and completion dates for this project have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue beginning the first year of project operation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	This project would utilize water from the Sacramento River through existing CVP contracts and Feather River water through Settlement contracts. Specifically, SEWD provides water to Sutter NWR.
Legal authority, permitting processes, and regulatory control	The GSA and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation on CEQA and NEPA will be initiated may include, but is not limited to:

Item in GSP Regulations	Description
(§354.44(b)(3); §354.44(b)(7))	DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, Sutter County, and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	The expected yield of this project has not been estimated at this time. In general, sustainability indicators expected to benefit from the project include increased groundwater levels and change in groundwater storage through surface water percolation. This project is currently in the early planning stage. Thus, the expected yield of this project has yet to be determined and will be reported in GSP annual reports and five-year updates when known. Evaluation of benefits will be based on analysis of pre- and post-project measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined.
Costs (§354.44(b)(8))	While the overall project is ongoing, the future implementation of additional acres is currently in the early planning stage. Thus, anticipated costs of this project have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The project proponent(s) would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

7.1.5.3 City of Yuba City

Proposed projects that would be implemented by the City of Yuba City are summarized below.

7.1.5.3.1 Advanced Treatment and Water Recycling

This project would conduct a feasibility study for constructing a recycled water facility and analyze the possibility of implementing advanced treatment and water recycling at the City's Wastewater Treatment Facility (WWTF). The resultant recycled water may be used for multiple purposes, including refuge water supply, landscape irrigation, a recycled water fill station, and possibly a future groundwater recharge project. Once the facilities plan is complete, the City would consider design and construction of advanced treatment facilities at the WWTF and distribution pipelines to provide recycled water for beneficial uses. A summary of project components and their relation to the GSP Emergency Regulations §354.44(b) is included in **Table 7-23**.

Table 7-23. City of Yuba City Advanced Treatment and Water Recycling: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This project is proposed for implementation at the Yuba City Wastewater Treatment Facility. Additional information on where the recycled water would be used would be determined through further evaluation if/when the project is selected for implementation, depending on the characteristics of the chosen project configuration. The project would augment the City's surface water supply for direct and in-lieu groundwater recharge benefits for the Subbasin. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if monitoring indicated a need for more PMAs to maintain sustainability and prevent undesirable results. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This project is currently in the early planning stage. Thus, the start and completion dates for this project have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue beginning the first year of project operation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	Existing Feather River Settlement Contract water supplies would be better utilized and reused with improved management and utilization of existing surface water supplies, and improved quality of wastewater in the Sutter Subbasin.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation on CEQA and NEPA will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, Sutter County, and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	The expected yield of this project has not been estimated at this time. In general, measurable objectives expected to benefit from the project include increased groundwater levels and change in groundwater storage as surface water use and reuse is enhanced. This project is currently in the early planning stage. Thus, the expected yield of this project has yet to be determined and will be reported in GSP annual

Item in GSP Regulations	Description
	reports and five-year updates when known. Evaluation of benefits will be based on analysis of pre- and post-project measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling may be done with the C2VSimFG-Sutter model used for GSP development.
Costs (§354.44(b)(8))	This project is in the early stages of development. Estimated anticipated costs of this project have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

7.1.5.3.2 Aquifer Storage & Recovery and Second Well

This project involves investigating the feasibility of and implementing an aquifer storage recovery (ASR) well in the City of Yuba City. There are currently three monitoring wells in service being used to study the feasibility of storing surplus water during wet periods and providing additional groundwater pumping capacity in dry periods. The City is planning to construct an extraction well at the water treatment plant in spring 2022. If studies indicate that ASR is feasible at this site, the City would propose to convert the well to an ASR well. A summary of project components and their relation to the GSP Emergency Regulations §354.44(b) is included in **Table 7-24**.

Table 7-24. City of Yuba City Aquifer Storage & Recovery and Second Well: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This project is proposed for implementation in the City of Yuba City. The precise location of the project would be determined through further evaluation if/when the project is selected for implementation, depending on the characteristics of the chosen project configuration. The project would augment the City's water supply through direct recharge benefits for the Subbasin when operating in injection mode. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if monitoring indicated a need for more PMAs to maintain sustainability and prevent undesirable results. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Sutter Subbasin.

Item in GSP Regulations	Description
Timeline (§354.44(b)(4))	This project is currently in the early planning stage. Thus, the start and completion dates for this project have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue beginning the first year of project operation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	This project would use existing water supplies and surplus water, particularly during wet periods, and would improve management and conjunctive use of surface and groundwater supplies in the Sutter Subbasin.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation on CEQA and NEPA will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, Sutter County, and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	The expected yield of this project has not been estimated at this time. In general, measurable objectives expected to benefit from the project include increased groundwater levels and change in groundwater storage as direct recharge is implemented. This project is currently in the early planning stage. Thus, the expected yield of this project has yet to be determined and will be reported in GSP annual reports and five-year updates when known. Evaluation of benefits will be based on analysis of pre- and post-project measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling may be done with the C2VSimFG-Sutter model used for GSP development.
Costs (§354.44(b)(8))	This project is in the early stages of development. Estimated anticipated costs of this project have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

7.1.5.3.3 Additional Projects

In addition to the above projects, several additional projects are under consideration by the City of Yuba City. These projects are in the PMA matrix and would be carried out in a manner analogous to the projects described above. Additional details will be provided in annual reports and 5-year plan updates if they are chosen. While the Sutter Subbasin is already sustainable, all of these projects have the potential to increase and/or maintain the sustainability of the basin and provide a backstop of identified projects for consideration for adaptive subbasin management.

Backwash Recovery. This project would recover approximately 0.42 million gallons per day (or 475 acre feet per year) of backwash water for treatment and distribution which would reduce the amount of water being diverted from the Feather River for supply by an equivalent amount.

Electrical SCADA and Telemetry Installation. Current SCADA and telemetry for the water treatment plant and distribution system in the City of Yuba City are approximately 20 years old and nearly obsolete. Updating the systems would help the City monitor and manage data and control processes more effectively and would improve management of local water supplies.

Groundwater Well Rehabilitation. This project which would rehabilitate three Hillcrest Water Company groundwater wells and install treatment facilities to provide emergency groundwater sources to supplement surface water supplies in low-water years.

New Outfall Diffuser Installation. This project would construct a new outfall diffuser from the treatment plant into the Feather River to be able to discharge to the river under all river flows. This would result in approximately 6,600 AF of treated effluent being placed back into the Feather River where the flow will be used to support aquatic and riparian beneficial uses.

Replacement of Sewer Mains. This project which would replace old and deteriorated sewer lines throughout the City and reduce groundwater quality impacts resulting from leaking sewer lines.

Replacement of Water Distribution Mains. This project would replace parts of the water distribution in critical condition, close to reaching their end of service life, enabling the City to more effectively control water supply losses due to system leakage and reduce groundwater pumping because of reduced system losses.

7.1.5.4 Garden Highway Mutual Water Company

Proposed projects that would be implemented by the Garden Highway Mutual Water Company are summarized below.

7.1.5.4.1 Feather River Pump Station Fish Screen Feasibility Study

The Feather River Pump Station Fish Screen feasibility study will analyze the three following potential fish screen alternatives for Garden Highway Mutual Water Company's (GHMWC) Feather River surface water diversion: (1) fish screen at the existing intake pumps; (2) cone screen(s) with a berm at the mouth of the intake channel; (3) a closed pipeline connected to intake pumps and extending to the mouth of the intake channel with a screen at the river end of the pipeline. The feasibility study will also analyze the following two non-screen diversion alternatives: (1) point of diversion located at deeper part of the Feather River, and (2) a shallow well field to pump river underflow. These analyses will include an assessment of the engineering feasibility of each alternative, and the estimated costs of construction, as well as the annual and long-term maintenance requirements and costs. This project would contribute to fisheries and wildlife habitat improvement. A summary of project components and their relation to the GSP Emergency Regulations §354.44(b) is included in **Table 7-25**.

Table 7-25. Feather River Pump Station Fish Screen Feasibility Study: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This project is located at GHMWC's Feather River surface water diversion and will maintain surface water supplies by addressing fisheries concerns with the diversion. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, and interconnected surface waters as needed, if monitoring indicated a need for more PMAs to maintain sustainability and prevent undesirable results. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This project is currently in the early planning stage. Thus, the start and completion dates for this project have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue beginning the first year of project operation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	This project maintains the use of existing water from the Feather River through Settlement contracts by addressing fish health concerns with the diversion intake.

Item in GSP Regulations	Description
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation on CEQA and NEPA will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, Sutter County, and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	This project is currently in the early planning stage. Thus, the expected yield of this project has yet to be determined and will be reported in GSP annual reports and five-year updates when known. Evaluation of benefits will be based on analysis of pre- and post-project measurements. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. If necessary, modeling may be done with the C2VSimFG-Sutter model used for GSP development.
Costs (§354.44(b)(8))	This project is currently in the early planning stage. Thus, anticipated costs of this project have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

7.1.5.5 Multi-Agency/GSA

The following proposed projects would be implemented through coordination between multiple agencies, jurisdictions (e.g., city or county governments), landowners, and/or other agencies in the Subbasin:

Rice Field Infiltration Study to Promote FloodMAR Recharge. This project would determine the feasibility and estimate the amount of infiltration a FloodMAR project could provide from a rice field to increase direct recharge in the Subbasin.

Sutter Bypass Pumping Plants Fish Screens. This project would install fish screens at the Sutter Bypass pumping plants. Fish screens are important to maintain agricultural water supplies while protecting the environment and native habitats. Installation of fish screens prevents entrainment of endangered juvenile salmonids and other fish species. A 2014 United States Forest Service report noted that implementation of this project and others implemented prior to 2014 has resulted in a ten-fold increase in spring-run salmon and steelhead, and a three-fold increase in fall-fun fish. This project allows Districts to maintain surface water use in agriculture while improving wildlife habitat. Additional information is available in the PMA matrix in **Appendix 7-A**.

7.1.5.6 Sutter Extension Water District

Proposed projects that would be implemented by Sutter Extension Water District are summarized below.

7.1.5.6.1 Improved Service to Pressurized Irrigation Systems

As part of the SEWD's comprehensive plan to enhance water management developed as part of the FRRAWMP, SEWD plans to improve Turnout Configuration and Debris Management. This project is directly related to and supportive of the SWED's dual source irrigation system project described in **Section 7.1.4.3**. The project will also be supported by the SEWD's planned system modernization project described above. This project is expected to improve water quality, conserve energy, and increase water supply and supply reliability through in-lieu groundwater recharge. A summary of project components and their relation to the GSP Emergency Regulations §354.44(b) is included in **Table 7-26**.

Table 7-26. Improved Delivery Service to Pressurized Irrigation Systems: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This project is proposed for implementation within SEWD. The precise location of the project would be determined through further evaluation if/when the project is selected for implementation, depending on the characteristics of the chosen project configuration. This project will help supply surface water to irrigators that use pressurized irrigation systems, increasing SEWD's ability to meet irrigation water needs using available surface water and offset groundwater use with in-lieu groundwater recharge benefits to the Subbasin. System modernization improvements that will benefit improved delivery service flexibility and consistency include: heading control structures, upstream water level control structures, spill control structures, and remote monitoring and control equipment. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if monitoring indicated a need for more PMAs to maintain sustainability and prevent undesirable results. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This project is currently in the early planning stage. Thus, the start and completion dates for this project have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue beginning the first year of project operation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination

Item in GSP Regulations	Description
	meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	This project would not directly use available water supplies, but rather would improve management and utilization of existing surface water supplies in the Sutter Subbasin.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation on CEQA and NEPA will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, Sutter County, and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	The expected yield of this project has not been estimated at this time. In general, sustainability indicators expected to benefit from the project include increased groundwater levels and change in groundwater storage as surface water use is enhanced. Enhancing the availability and reliability of surface water supplies to support low-flow, long-duration irrigation events will support growers as they adopt dual source irrigation systems and encourage the use of available surface water supplies in lieu of groundwater pumping. This project is currently in the early planning stage; thus, the expected yield of this project has yet to be determined and will be reported in GSP annual reports and five-year updates when known. Evaluation of benefits will be based on analysis of pre- and post-project measurements potentially supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. If needed, modeling may be done with the C2VSimFG-Sutter model used for GSP development.
Costs (§354.44(b)(8)) [1]	The reconnaissance-level total estimated cost for standardized turnout design and technical specifications is \$5,800 with \$318 annual cost. For design and construction of on-channel pump sump with a self-cleaning screen, the total estimated cost is \$15,800, and \$865 annually. More detailed anticipated costs of this project have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

[1] Cost estimates were escalated from 2014 to 2021 according to the U.S. Army Corps of Engineers Civil Works Construction Cost Composite Index.

7.1.5.6.2 Removal of Main Canal Bottlenecks

This project is part of the comprehensive plan of SEWD to enhance water management developed as part of the FRRAWMP. The project will be supported by the SEWD's planned system modernization project and is expected to increase refuge water supply, supply reliability, and delivery flexibility through in-lieu groundwater recharge. A summary of project components and their relation to the GSP Emergency Regulations §354.44(b) is included in **Table 7-27**.

Table 7-27. Removal of Bottlenecks on the Sutter-Butte Main Canal: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This project is proposed for implementation on the Sutter-Butte Main Canal, improving delivery service to irrigation customers. The precise location of the improvements would be determined through further evaluation if/when the project is selected for implementation, depending on the characteristics of the chosen project configuration. The project would increase SEWD's ability to meet irrigation water needs using available surface water by reducing capacity constraints that prevent conveyance and full utilization of supplies. Enhancing the availability and reliability of surface water supplies offsets demand for groundwater, providing in-lieu recharge benefits to the Subbasin. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if monitoring indicated a need for more PMAs to maintain sustainability and prevent undesirable results. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This project is currently in the early planning stage. Thus, the start and completion dates for this project have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue beginning the first year of project operation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	Existing SEWD surface water Feather River Settlement Contract supplies would be better utilized with a corresponding reduction in groundwater use. This is one of the most reliable supplies in California.

Item in GSP Regulations	Description
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation on CEQA and NEPA will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, Sutter County, and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	The expected yield of this project has not been estimated at this time. In general, measurable objectives expected to benefit from the project include increased groundwater levels and change in groundwater storage as surface water use is enhanced. This project is expected to increase surface water supply and supply reliability to meet refuge, irrigation, and other water user demands, with benefits to wildlife and potentially to irrigation efficiency and water quality. This project is currently in the early planning stage. Thus, the expected yield of this project has yet to be determined and will be reported in GSP annual reports and five-year updates when known. Evaluation of benefits will be based on analysis of pre- and post-project measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling may be done with the C2VSimFG-Sutter model used for GSP development.
Costs (§354.44(b)(8)) [1]	The capital cost of this project is estimated at $5,344,300 with an annual cost of $293,000. More detailed anticipated costs of this project have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

[1] Cost estimates were escalated from 2014 to 2021 according to the US Army Corps of Engineers Civil Works Construction Cost Composite Index.

7.1.5.6.3 Sunset Project for Integrated Restoration and Efficiency (SPIRE)

SPIRE is an infrastructure improvement project that enables removal of the Sunset Pumps and the adjacent dam by improving the Sutter-Butte Main Canal (Main Canal). The proposed project will be carried out by SEWD in coordination with DWR's Fish Passage Improvement Program and provide multiple regional benefits to a diverse stakeholder group. This project will provide up to 200 cubic feet per second increased conveyance capacity from the Thermalito Afterbay, thereby eliminating the need for the Sunset Pumps Dam as well as the Sunset Pumps. This project has broad support at the local, regional, state, and federal levels and is expected to benefit the Subbasin through surface water supply augmentation, water supply reliability, operational efficiency, and ecosystem enhancement.

Table 7-28. Sunset Project for Integrated Restoration and Efficiency: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This project is proposed for implementation on the Sutter-Butte Main Canal, near Live Oak, California on the lower Feather River at River Mile (RM) 38.5. The project would occur in three phases: canal modification, dam removal, and site rehabilitation and monitoring. The project would increase SEWD's ability to meet irrigation water needs using available surface water by reducing capacity constraints that prevent conveyance and full utilization of supplies. Enhancing the availability and reliability of surface water supplies offsets demand for groundwater, providing in-lieu recharge benefits to the Subbasin. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if monitoring indicated a need for more PMAs to maintain sustainability and prevent undesirable results. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This project is currently in the early planning stage. Thus, the start and completion dates for this project have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue beginning the first year of project operation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	This project would not directly use water supplies but would improve management and utilization of existing surface water supplies in the Sutter Subbasin. This project would draw upon the existing Feather River water through Settlement Contracts and would increase water supply reliability and operational efficiency of SEWD's water distribution system.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA and individual project proponents have the authority to plan and implement projects. Required permitting and regulatory review will be project-specific and initiated through consultation with applicable governing agencies. Governing agencies for which consultation on CEQA and NEPA will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, Sutter County, and CARB.

Item in GSP Regulations	Description
Benefits and benefit evaluation methodology (§354.44(b)(5))	This project is currently in the early planning stage. Thus, the expected yield of this project has yet to be determined and will be reported in GSP annual reports and five-year updates when known. Evaluation of benefits will be based on analysis of pre- and post-project measurements potentially supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. If necessary, modeling may be done with the C2VSimFG-Sutter model used for GSP development.
Costs (§354.44(b)(8))	This project is currently in the early planning stage. Thus, the anticipated costs of this project have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The project proponent would identify funding sources to cover project costs as part of project development. These may include grants, fees, loans, and other assessments.

7.1.6 Projects and Management Actions to Address Data Gaps

In addition to the PMAs described above, several additional potential PMAs have been identified to address data gaps in the Sutter Subbasin. PMAs to address data gaps are categorized according to the primary component of the GSP they support:

- Hydrogeologic conceptual model (HCM)
- Monitoring network
- Other

Potential PMAs to address data gaps are summarized in the sections that follow.

7.1.6.1 Projects and Management Actions to Address Hydrogeologic Conceptual Model Data Gaps

Potential PMAs to address data gaps in the Sutter Subbasin HCM are summarized below.

7.1.6.1.1 Investigation of Interactions between Rivers and Changes in Groundwater Levels

This activity would collect additional data needed to develop appropriate sustainable management criteria for interconnected surface waters and is related to the *Installation of Additional Shallow Groundwater Monitoring Wells* project previously discussed. The additional data collected under this investigation would help to characterize the potential stage response of the Sacramento River, Feather River, and other rivers in and around the Sutter Subbasin to changes in groundwater levels.

Data needed include:

- Definition of stream reaches and associated priority habitat,
- Streamflow measurements to develop profiles at multiple time periods, and
- Corresponding measurements of groundwater levels directly adjacent to stream channels for the first water bearing aquifer zone and for deeper aquifer zones.

These data are not available and are a data gap for this GSP.

Expansion of stream gaging locations would be considered (funding permitting) in coordination with the construction of the additional shallow monitoring wells to document and better understand changes in stream-aquifer interactions. In addition to the stream gaging, the new shallow dedicated monitoring wells would equipped with temperature sensors along stream courses in the recharge corridor and downstream to the Sacramento and Feather Rivers to help identify what sections of streams are losing or gaining. A summary of this activity is provided in **Table 7-29**.

Table 7-29. Investigation of Interactions between the Sacramento River, Feather River, and Other Rivers to Changes in Groundwater Levels: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would install additional shallow monitoring wells (previously described) along with instrumentation and stream gages to collect additional data to assist in developing appropriate sustainable management criteria for interconnected surface waters and analyzing changes in stream-aquifer interactions. This activity may be initiated to support GSP implementation, if determined to be necessary or useful for maintaining ongoing sustainability in the Sutter Subbasin, pending future conditions. The details of this effort would be determined through further evaluation if/when the action is selected for implementation. Implementation will be done in the context of the sustainable management criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This activity is currently in the early planning stage. Thus, the start and completion dates for this activity have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue in all years beginning the first year of implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.

Item in GSP Regulations	Description
Water source & reliability (§354.44(b)(6))	This activity will not directly use water supplies and is for monitoring and data collection purposes only.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA and individual proponents have the authority to plan and implement studies. Required permitting and regulatory review will be initiated through consultation with applicable governing agencies. Governing agencies for which consultation on CEQA and NEPA will be initiated may include, but are not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, applicable county(ies), and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	While studies of stream-aquifer interactions are beneficial to GSP implementation and supporting Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators.
Costs (§354.44(b)(8))	This activity is currently in the early planning stage. Thus, the anticipated costs of this activity have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The County and/or other proponents would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

7.1.6.1.2 Investigation of Source of Elevated Salinity within Shallow Aquifer Zone

This activity would evaluate the source of elevated salinity levels within the shallow aquifer zone. It is unclear, based on currently available data, why elevated salinity concentrations that occur in the shallow aquifer zone do not appear to correlate with elevated nitrate concentrations. This study would provide insights into the origins of this higher saline water, allowing for the implementation of appropriate actions to manage these areas of degraded groundwater quality.

The existence of reducing conditions in the shallow zone could result in lower levels of nitrate in shallow groundwater due to denitrification, suggesting that the high salinity values in the shallow zone are, in fact, from agricultural sources. As such, the source of the elevated salinity in the shallow aquifer is unknown at this time. Studies to address this data gap should include collection of nitrogen isotopes and oxidation-reduction values that will allow assessment of areas with reducing conditions in addition to isotopic analysis. A summary of this activity is provided in **Table 7-30**.

Table 7-30. Investigation of Source of Elevated Salinity within Shallow Aquifer Zone: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would collect additional data needed to evaluate the source of elevated salinity levels within the shallow aquifer zone. This activity may be initiated to support GSP PMA implementation, if determined to be necessary or useful for maintaining ongoing sustainability in the Sutter Subbasin, pending future conditions. The details of this effort would be determined through further evaluation if/when an action is selected for implementation. Implementation will be done in the context of the sustainable management criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This activity is currently in the early planning stage. Thus, the start and completion dates for this activity have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue in all years beginning the first year of implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	This activity will not directly use water supplies.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA and individual proponents have the authority to plan and implement studies. Required permitting and regulatory review will be initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but are not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, applicable county(ies), and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	While studies of water quality are beneficial to GSP implementation and support Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators.
Costs (§354.44(b)(8))	This activity is currently in the early planning stage. Thus, the anticipated costs of this activity have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The County and/or other proponents would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

7.1.6.1.3 Study of Aquifer Properties

This activity would conduct additional aquifer pumping tests to assess aquifer properties in the Sutter Subbasin. Only one limited aquifer pumping test was identified to assess aquifer properties of the Sutter Subbasin during GSP development. Additional information could be collected by conducting pumping tests as part of existing irrigation practices within the Subbasin by monitoring groundwater elevations in and around irrigation wells during the initiation and following the cessation of pumping. Existing nested monitoring wells used as observation wells could be used to assess groundwater pumping-aquifer interactions to support this program. This type of test program would eliminate the need for discharge permits and handling of extracted water and would allow an assessment of the actual stresses on the aquifer during the agricultural season. A summary of this activity is provided in **Table 7-31**.

Table 7-31. Study of Aquifer Properties: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would conduct additional aquifer pumping tests to provide additional data related to aquifer properties in the Sutter Subbasin. This activity may be initiated to support GSP implementation (including improvements to the C2VSim-Sutter groundwater model) if determined to be necessary or useful for maintaining ongoing sustainability in the Sutter Subbasin, pending future conditions. The details of this effort would be determined through further evaluation if/when the action is selected for implementation. Implementation will be done in the context of the sustainable management criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This activity is currently in the early planning stage. Thus, the start and completion dates for this activity have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue in all years beginning the first year of implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	This activity will not directly use water supplies.

Item in GSP Regulations	Description
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA and individual proponents have the authority to plan and implement studies. Required permitting and regulatory review will be initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but are not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, applicable county(ies), and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	While studies of aquifer properties are beneficial to GSP implementation and supporting Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators other than improvement in the understanding of Subbasin hydrogeology.
Costs (§354.44(b)(8))	This activity is currently in the early planning stage. Thus, the anticipated costs of this activity have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The County and/or other proponents would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

7.1.6.1.4 Additional Assessments of Groundwater Recharge Dynamics and Effects

This activity would conduct additional aquifer studies to assess the dynamics and effects of groundwater recharge in the Subbasin, particularly those affecting GSP projects. Future recharge and aquifer studies should include the collection and interpretation of stable isotope data. Methodology considerations include:

- Seasonal sampling should be performed as part of future surface water and groundwater isotope studies for purposes of assessing groundwater recharge;
- Using existing nested monitoring wells with multiple screened intervals are recommended to assess stable isotope data at different depths; and
- Using monitoring wells with relatively short screened zones (20 feet or less) to minimize mixing between aquifer zones or between aquifer zones and residual water retained within the aquitard zones between aquifers.

A summary of this activity is provided in **Table 7-32**.

Table 7-32. Additional Assessments of Groundwater Recharge Dynamics and Effects: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would conduct additional aquifer studies to assess the dynamics and effects of groundwater recharge in the Subbasin. This activity may be initiated to support GSP implementation if determined to be necessary or useful for maintaining ongoing sustainability in the Sutter Subbasin, pending future conditions. The details of this effort would be determined through further evaluation if/when the action is

Item in GSP Regulations	Description
	selected for implementation. Implementation will be done in the context of the sustainable management criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This activity is currently in the early planning stage; thus, the start and completion dates for this activity have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue in all years beginning the first year of implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	This activity will not directly use water supplies.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA and individual proponents have the authority to plan and implement studies. Required permitting and regulatory review will be initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but are not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, applicable county(ies), and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	While studies of aquifer properties are beneficial to GSP implementation and supporting Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators.
Costs (§354.44(b)(8))	This activity is currently in the early planning stage. Thus, the anticipated costs of this activity have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The County and/or other proponents would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

7.1.6.1.5 Analysis of Recharge Rates

This activity would conduct additional analyses of recharge rates to assess historical groundwater recharge rates and assess hydraulic connection between different zones in the principal aquifer system. Most well locations and depths should be sampled and analyzed for presence of tritium to help distinguish whether recharge to individual aquifer zones is occurring over periods shorter than about 60 years, or whether recharge is occurring over longer timeframes. This can help better understand the nature of hydraulic connection between different zones in the aquifer system. A summary of this activity is provided in **Table 7-33**.

Table 7-33. Analysis of Recharge Rates: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would conduct additional analyses of recharge rates to assess historical groundwater recharge rates and the hydraulic connection between different zones in the principal aquifer system. This activity may be initiated to support GSP implementation if determined to be necessary or useful for maintaining ongoing sustainability in the Sutter Subbasin, pending future conditions. The details of this effort would be determined through further evaluation if/when the action is selected for implementation. Implementation will be done in the context of the sustainable management criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This activity is currently in the early planning stage; thus, the start and completion dates for this activity have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue in all years beginning the first year of implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	This activity will not directly use water supplies.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, and individual proponents have the authority to plan and implement studies. Required permitting and regulatory review will be initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but are not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, applicable county(ies), and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	While studies of recharge rates and aquifer properties are beneficial to GSP implementation and supporting Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators.
Costs (§354.44(b)(8))	This activity is currently in the early planning stage. Thus, the anticipated costs of this activity have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The County and/or other proponents would identify funding sources to

Item in GSP Regulations	Description
	cover costs as part of development. These may include grants, fees, loans, and other assessments.

7.1.6.1.6 Data Collection to Improve the Hydrogeologic Conceptual Model

This activity would collect additional data to improve understanding of the hydrogeology of the Sutter Subbasin and refine the HCM. Additional data to better understand the hydrogeology of the basin will in improving the understanding of recharge mechanisms and connectivity between aquifer layers and refining the water budget for the Subbasin. Using aerial electromagnetic (AEM) surveys is recommended to help address these uncertainties around the structure of the Subbasin. A summary of this activity is provided in **Table 7-34**.

Table 7-34. Data Collection to Improve the Hydrogeologic Conceptual Model: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would collect additional data to understand the hydrogeology of the Sutter Subbasin and refine the hydrogeologic conceptual model. Use of AEM surveys is recommended to help address uncertainties around the structure of the Subbasin. This activity may be initiated to support GSP implementation if determined to be necessary or useful for maintaining ongoing sustainability in the Sutter Subbasin, pending future conditions. The details of this effort would be determined through further evaluation if/when the action is selected for implementation. Implementation will be done in the context of the sustainable management criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This activity is currently in the early planning stage; thus, the start and completion dates for this activity have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue in all years beginning the first year of implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	This activity will not directly use water supplies.
Legal authority, permitting	The GSAs and individual proponents have the authority to plan and implement studies. Required permitting and regulatory review will be

Item in GSP Regulations	Description
processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but are not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, applicable county(ies), and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	While studies of hydrogeology are useful to refine the understanding of recharge rates and aquifer properties and, thus, are beneficial to GSP implementation and support Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators.
Costs (§354.44(b)(8))	This activity is currently in the early planning stage. Thus, the anticipated costs of this activity have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The County and/or other proponents would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

7.1.6.1.7 AEM Survey of Sutter Buttes

This activity would include an AEM survey specifically to improve understanding of the unique geology and hydrogeology of the Sutter Buttes, which would be incorporated into future updates to the HCM of this GSP and C2VSimFG-Sutter (used to develop water budgets for this GSP). The surface expression of the Sutter Buttes is limited to the Sutter Subbasin, though it is believed that the subsurface extent of volcanic deposits and associated geologic structures extends to all adjacent subbasins to the Sutter Subbasin, with the exception of the North American Subbasin. This activity may be implemented by the Sutter Subbasins GSAs with participation and cooperation by GSAs in neighboring subbasins as appropriate and as funds are available. A summary of this activity is provided in **Table 7-35**.

Table 7-35. AEM Survey of Sutter Buttes: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would include an AEM survey specifically to improve understanding of the unique geology and hydrogeology of the Sutter Buttes within the Sutter Subbasin and adjacent subbasins, as appropriate. Results of this survey would be incorporated into future updates to this GSP, specifically to fill data gaps in the HCM and refine C2VSimFG-Sutter. This activity may be initiated to support GSP implementation if determined to be necessary or useful for maintaining ongoing sustainability in the Sutter Subbasin, pending future conditions. The details of this effort would be determined through further evaluation if/when the action is selected for implementation. Implementation will

Item in GSP Regulations	Description
	be done in the context of the sustainable management criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This activity is currently in the early planning stage; thus, the start and completion dates for this activity have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue in all years beginning the first year of implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	This activity will not directly use water supplies.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSAs and individual proponents have the authority to plan and implement studies. Required permitting and regulatory review will be initiated through consultation with applicable governing agencies. Governing agencies for which consultation will be initiated may include, but are not limited to: DWR, SWRCB, CDFW, Flood Board, RWQCBs, USFWS, NMFS, LAFCO, applicable county(ies), and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	While studies of geology and hydrogeology are useful to refine the understanding of recharge rates and aquifer properties and, thus, are beneficial to GSP implementation and support Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators.
Costs (§354.44(b)(8))	This activity is currently in the early planning stage. Thus, the anticipated costs of this activity have yet to be determined and will be reported in GSP annual reports and five-year updates when known. An estimate provided by SkyTEM, an airborne geophysical survey company, assuming a 200-meter spacing with tie lines covering an area of 200 square kilometers (km^2) would cost approximately \$880/km, with costs decreasing due to economy of scale for larger survey areas (i.e., 1,000 km^2 survey area would cost approximately \$660/km). The County and/or other proponents would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

7.1.6.1.8 Development of Uniform Criteria for Defining Stratigraphic Zones

This activity would develop and recommended a uniform set of criteria for logging cuttings from soil boring drilled in the Subbasin. Such an effort would need the participation and cooperation of various agencies and researchers in the region. The criteria adopted should be such that the contacts between geologic formations are easily identifiable from the drill cuttings, such as developed by Blair and others (1991) for the Oroville area. The different studies reviewed for development of this GSP use a wide range of definitions and terminology that are not consistent from one investigation to the next. This lack of consistency presents a challenge when attempting to correlate the definition of stratigraphic sequences, aquifer zones, and even geologic formations between different studies. As described in **Section 5.1.4**, many previous studies do not follow United States Geological Survey (USGS) standards and the North American Stratigraphic Code, resulting in confusing and sometimes incorrect naming of geologic units. Future studies would benefit from development of a uniform methodology and clearly defined set of stratigraphic terminology so that studies conducted by different investigators can be correlated and the value of the data maximized. A summary of this activity is provided in **Table 7-36**.

Table 7-36. Development of Uniform Criteria for Defining Stratigraphic Zones: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would develop and recommended a uniform set of criteria for defining stratigraphic zones and for logging cuttings from soil boring drilled in the Subbasin. This activity may be initiated to support GSP implementation, including future data collection efforts, if determined to be necessary or useful for maintaining ongoing sustainability in the Sutter Subbasin. The details of this effort would be determined through further evaluation if/when the action is selected for implementation. Implementation will be done in the context of the sustainable management criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This activity is currently in the early planning stage. Thus, the start and completion dates for this activity have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue in all years beginning the first year of implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.

Item in GSP Regulations	Description
Water source & reliability (§354.44(b)(6))	This activity will not directly use water supplies.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSAs and individual proponents have the authority to plan and implement studies and coordination efforts. Required permitting and regulatory review will be initiated through consultation with applicable governing agencies.
Benefits and benefit evaluation methodology (§354.44(b)(5))	While studies and coordination efforts to develop standard criteria for defining stratigraphic zones would be beneficial to GSP implementation and supporting ongoing Subbasin understanding and sustainability, there are no anticipated direct benefits to specific sustainability indicators.
Costs (§354.44(b)(8))	This activity is currently in the early planning stage. Thus, the anticipated costs of this activity have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The County and/or other proponents would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

7.1.6.1.9 Comprehensive Sutter Subbasin Groundwater Quality Evaluation

This activity would conduct a comprehensive groundwater quality evaluation for the Sutter Subbasin. While existing monitoring is considered appropriate to monitor trends in groundwater quality over the GSP planning and implementation horizon, a comprehensive groundwater quality survey of the Sutter Subbasin would provide widespread information at a single point in time. These data would allow the GSAs to better understand spatial variability in groundwater quality and verify that trend monitoring is occurring in the correct locations. Additionally, an aerial survey could help identify refinements to the monitoring network to improve long-term data collection efforts for the Sutter Subbasin. Existing monitoring is largely from private wells, and the GSAs have limited ability to ensure long-term access to those sites. By performing an aerial groundwater quality survey, representative existing monitoring wells with established access by the GSAs can be used as monitoring sites moving forward. A summary of this activity is provided in **Table 7-37**.

Table 7-37. Comprehensive Sutter Subbasin Groundwater Quality Evaluation: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation	This activity would conduct a comprehensive groundwater quality evaluation for the Sutter Subbasin. This activity may be initiated to

Item in GSP Regulations	Description
(§354.44(b)(1)(A); §354.44(b)(6))	support GSP implementation and Subbasin understanding if determined to be necessary or useful for maintaining ongoing sustainability in the Sutter Subbasin. The details of this effort would be determined through further evaluation if/when the action is selected for implementation. Implementation will be done in the context of the sustainable management criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This activity is currently in the early planning stage; thus, the start and completion dates for this activity have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue in all years beginning the first year of implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	This activity will not directly use water supplies.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSAs and individual proponents have the authority to plan and implement studies and monitoring efforts. Required permitting and regulatory review will be initiated through consultation with applicable governing agencies.
Benefits and benefit evaluation methodology (§354.44(b)(5))	While studies and monitoring efforts are beneficial to GSP implementation and supporting ongoing Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators.
Costs (§354.44(b)(8))	This activity is currently in the early planning stage. Thus, the anticipated costs of this activity have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The County and/or other proponents would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

7.1.6.2 Projects and Management Actions to Address Monitoring Network Data Gaps

Potential PMAs to address data gaps in the Sutter Subbasin monitoring network are summarized below.

7.1.6.2.1 Video Survey RMS Wells with Unknown Construction

This activity would conduct downhole video surveys of wells in the representative monitoring networks to collect construction information. Surveys would be conducted for representative monitoring site (RMS) wells with unknown construction information to verify well parameters and characteristics. A summary of this activity is provided in **Table 7-38**.

Table 7-38. Video Survey RMS Wells with Unknown Construction: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would conduct downhole video surveys of RMS wells with unknown construction information in order to collect missing information. This activity may be initiated to support GSP implementation, including improvements to the representative monitoring networks, if determined to be necessary or useful for maintaining ongoing sustainability in the Sutter Subbasin, pending future conditions. The details of this effort would be determined through further evaluation if/when the action is selected for implementation. Implementation will be done in the context of the sustainable management criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This activity is currently in the early planning stage; thus, the start and completion dates for this activity have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue in all years beginning the first year of implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	This activity will not directly use water supplies.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSAs and individual proponents have the authority to plan and implement surveys and monitoring efforts. Required permitting and regulatory review will be initiated through consultation with applicable governing agencies.
Benefits and benefit evaluation methodology	While surveys and monitoring efforts are beneficial to GSP implementation and supporting ongoing Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators.

Item in GSP Regulations	Description
(§354.44(b)(5))	
Costs (§354.44(b)(8))	This activity is currently in the early planning stage. Thus, the anticipated costs of this activity have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The County and/or other proponents would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

7.1.6.2.2 Monitoring Well Refinements

This activity would refine and improve the Subbasin monitoring network by identifying and adding additional, dedicated monitoring wells of known construction. Dedicated monitoring wells would be specifically identified for the groundwater quality monitoring network and the interconnected surface water monitoring network. Existing well data may also be verified by collecting and confirming well construction information (as previously discussed). A summary of this activity is provided in **Table 7-39**.

Table 7-39. Monitoring Well Refinements: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would refine and improve the Subbasin monitoring network by identifying and adding additional, dedicated monitoring wells of known construction, and by collecting and confirming well construction information. This activity may be initiated to support GSP implementation if determined to be necessary or useful for maintaining ongoing sustainability in the Sutter Subbasin and improving understanding of Subbasin hydrodynamics. The details of this effort would be determined through further evaluation if/when the action is selected for implementation. Implementation will be done in the context of the sustainable management criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This activity is currently in the early planning stage; thus, the start and completion dates for this activity have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue in all years beginning the first year of implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.

Item in GSP Regulations	Description
Water source & reliability (§354.44(b)(6))	This activity will not directly use water supplies.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSAs and individual proponents have the authority to plan and implement surveys and monitoring efforts. Required permitting and regulatory review will be initiated through consultation with applicable governing agencies.
Benefits and benefit evaluation methodology (§354.44(b)(5))	While surveys and monitoring efforts are beneficial to GSP implementation and supporting ongoing Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators.
Costs (§354.44(b)(8))	This activity is currently in the early planning stage. Thus, the anticipated costs of this activity have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The County and/or other proponents would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

7.1.6.2.3 Sutter Buttes Salinity Monitoring

This activity would monitor groundwater salinity near the Sutter Buttes. An assessment of temporal data gaps may be considered through the installation of a pressure transducer capable of recording electroconductivity (EC) measurements at selected locations near the Sutter Buttes on a temporary or permanent basis. Monthly sampling on a temporary basis may also be considered instead of transducer installation. The results of this high-frequency data collection would then be used to define recommended modifications to the long-term monitoring frequency, if necessary. A summary of this activity is provided in **Table 7-40**.

Table 7-40. Sutter Buttes Salinity Monitoring: Summary (GSP Emergency Regulations §354.44(b)).

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would monitor groundwater salinity (based on EC measurements) at selected locations near the Sutter Buttes on a temporary or permanent basis. This activity may be initiated to support GSP implementation if determined to be necessary or useful for maintaining ongoing sustainability in the Sutter Subbasin, pending future conditions. The details of this effort would be determined through further evaluation if/when the action is selected for implementation. Implementation will be done in the context of the sustainable

Item in GSP Regulations	Description
	management criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This activity is currently in the early planning stage. Thus, the start and completion dates for this activity have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue in all years beginning the first year of implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	This activity will not directly use water supplies.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSAs and individual proponents have the authority to plan and implement monitoring efforts. Required permitting and regulatory review will be initiated through consultation with applicable governing agencies.
Benefits and benefit evaluation methodology (§354.44(b)(5))	While monitoring efforts are beneficial to GSP implementation and supporting ongoing Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators.
Costs (§354.44(b)(8))	This activity is currently in the early planning stage. Thus, the anticipated costs of this activity have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The County and/or other proponents would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

7.1.6.2.4 Sutter Buttes Water Quality Inter-Basin Working Group

The Colusa Groundwater Authority (CGA), Glenn Groundwater Authority (GGA) and the GSAs in the Butte, Sutter, Yolo, North Yuba, and South Yuba Subbasins will participate in an inter-basin working group focused on collaborative discussions, consensus-building and planning to address groundwater quality matters associated with the unique geology of the Sutter Buttes area. The goals of the working group will be to:

- Identify and prioritize groundwater quality conditions
- Coordinate with local, state and federal agencies

- Develop data and information needs
- Conduct high-level planning for groundwater studies and projects to protect or improve groundwater quality as needed
- Identify and pursue grant funding opportunities for groundwater studies and projects
- Provide a forum supporting cooperation, collaboration, and information sharing during implementation of studies and projects

It is expected that groundwater studies identified by the inter-basin working group would be grant funded and implemented by research entities, such as USGS or DWR. If projects are identified to protect or improve groundwater quality, they would be led and implemented by local entities such as the counties, agricultural water districts and agencies, municipalities, and other public water suppliers using a variety of funding sources, including grants and loans.

Although the surface expression of the Sutter Buttes is limited to the Sutter Subbasin, the subsurface extent of volcanic deposits and associated geologic structures is greater and may influence groundwater quality in the adjacent Butte, Colusa, Yolo, North Yuba, and South Yuba Subbasins. Groundwater in the volcanic sediments of the Sutter Buttes Rampart has arsenic concentrations that frequently and significantly exceed the drinking water standard. The formation of the Sutter Buttes has resulted in the uplift of basement rocks, and corresponding reductions in the depth to the base of fresh groundwater. Faults may provide conduits or otherwise influence the movement of poor-quality groundwater.

Objectives of the working group and the to-be-identified studies are to:

- Propose studies to:
    - Improve knowledge of the subsurface extent of the Sutter Buttes Rampart
    - Improve the understanding of local hydrogeology and faulting in the Sutter Buttes area
    - More fully characterize arsenic geochemistry within the subsurface extent of the Sutter Buttes Rampart
    - Improve knowledge of the depth to the base of freshwater and the structural features (folds and faults) that control the depth to the base of freshwater and groundwater movement in the area
    - Assess the risk of upwelling, or movement along faults, of saline or brackish connate groundwater
    - Assess the potential for mobilization of arsenic and/or connate waters beyond the subsurface extent of the Sutter Buttes Rampart
- Provide a forum for local entities to propose and develop projects to protect or improve groundwater quality

7.1.6.3 Projects and Management Actions to Address Other Data Gaps

Potential PMAs to address other data gaps in the Sutter Subbasin are summarized below.

7.1.6.3.1 Groundwater Dependent Ecosystem (GDE) Mapping Confirmation

This activity would confirm mapping of groundwater dependent ecosystems in the Sutter Subbasin to support ongoing investigation and monitoring of the relationship between the health of GDEs, groundwater levels, and access to water supplies. This effort would conduct an on-ground survey of mapped GDEs to confirm their presence and would document any land use changes that may have occurred since the databases used were published. A summary of this activity is provided in **Table 7-41**.

Table 7-41. Groundwater Dependent Ecosystem Mapping Confirmation: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would conduct an on-ground survey to confirm mapping of GDEs to support ongoing investigation and monitoring of the relationship between the health of GDEs, groundwater levels, and access to water supplies. This activity may be initiated to support GSP implementation if determined to be necessary or useful for maintaining ongoing sustainability in the Sutter Subbasin, pending future conditions. The details of this effort would be determined through further evaluation if/when the action is selected for implementation. Implementation will be done in the context of the sustainable management criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This activity is currently in the early planning stage. Thus, the start and completion dates for this activity have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue in all years beginning the first year of implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	This activity will not directly use water supplies.
Legal authority, permitting processes, and regulatory control	The GSAs and individual proponents have the authority to plan and implement surveys and monitoring efforts. Required permitting and regulatory review will be initiated through consultation with applicable governing agencies.

Item in GSP Regulations	Description
(§354.44(b)(3); §354.44(b)(7))	
Benefits and benefit evaluation methodology (§354.44(b)(5))	While surveys and monitoring efforts are beneficial to GSP implementation and supporting ongoing Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators.
Costs (§354.44(b)(8))	This activity is currently in the early planning stage. Thus, the anticipated costs of this activity have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The County and/or other proponents would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

7.1.6.3.2 Well Census

This activity would conduct a survey of wells in the Subbasin to identify the location of previously unknown wells, determine their status (e.g., destroyed, active), and/or collect construction information to better inform groundwater use in the Subbasin. Downhole video surveys of select wells may be conducted as part of this effort (see **Section 7.1.6.2.1**). A summary of this activity is provided in **Table 7-42**.

Table 7-42. Well Census: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would conduct a survey of wells in the Subbasin to identify the location of previously unknown wells, determine their status (e.g., destroyed, active), and/or collect construction information to better inform groundwater use in the Subbasin. This activity may be initiated to support GSP implementation, including the development of a program to destroy unused wells) if determined to be necessary or useful for maintaining ongoing sustainability in the Sutter Subbasin. The details of this effort would be determined through further evaluation if/when the action is selected for implementation. Implementation will be done in the context of the sustainable management criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This activity is currently in the early planning stage; thus, the start and completion dates for this activity have yet to be determined and will be provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue in all years beginning the first year of implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports

Item in GSP Regulations	Description
	and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	This activity will not directly use water supplies.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSAs and individual proponents have the authority to plan and implement surveys and monitoring efforts. Required permitting and regulatory review will be initiated through consultation with applicable governing agencies.
Benefits and benefit evaluation methodology (§354.44(b)(5))	While surveys and monitoring efforts are beneficial to GSP implementation and supporting ongoing Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators.
Costs (§354.44(b)(8))	This activity is currently in the early planning stage. Thus, the anticipated costs of this activity have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The County and/or other proponents would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

7.1.6.3.3 Land Subsidence Monitoring Evaluation

This activity would conduct an assessment of available land subsidence data and the frequency of data collection in order to determine the optimal frequency for ongoing collection and analysis of data relating to inelastic land subsidence. A summary of this activity is provided in **Table 7-42**.

Table 7-43. Land Subsidence Monitoring Evaluation: Summary (GSP Emergency Regulations §354.44(b))

Item in GSP Regulations	Description
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would conduct an assessment of land subsidence data to determine the optimal frequency for ongoing collection and analysis of data relating to inelastic land subsidence. This activity may be initiated to support GSP implementation, if determined to be necessary or useful for maintaining ongoing sustainability in the Sutter Subbasin. The details of this effort would be determined through further evaluation if/when the action is selected for implementation. Implementation will be done in the context of the sustainable management criteria to ensure sustainable operation of the Sutter Subbasin.
Timeline (§354.44(b)(4))	This activity is currently in the early planning stage. Thus, the start and completion dates for this activity have yet to be determined and will be

Item in GSP Regulations	Description
	provided in GSP annual reports and five-year updates when known. Benefits are expected to accrue in all years beginning the first year of implementation.
Notice to public and other agencies (§354.44(b)(1)(B))	Public and/or Inter-Agency Noticing will be facilitated through GSA board meetings, GSA and/or cooperating agency website(s), GSA and/or cooperating agency newsletters, inter-basin coordination meetings, agency governing body public meetings, GSP annual reports and five-year updates, public scoping meetings, and environmental/regulatory permitting notification.
Water source & reliability (§354.44(b)(6))	This activity will not directly use water supplies.
Legal authority, permitting processes, and regulatory control (§354.44(b)(3); §354.44(b)(7))	The GSAs and individual proponents have the authority to plan and implement assessments and monitoring efforts. Required permitting and regulatory review will be initiated through consultation with applicable governing agencies.
Benefits and benefit evaluation methodology (§354.44(b)(5))	While assessments and monitoring efforts are beneficial to GSP implementation and supporting ongoing Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators.
Costs (§354.44(b)(8))	This activity is currently in the early planning stage. Thus, the anticipated costs of this activity have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The County and/or other proponents would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

7.1.7 Project Financing

The GSAs intend to finance the capital costs of projects through available state and federal grants and/or assessments through the project proponent(s) governance structures. Operation and maintenance costs will be paid using revenues raised through water rates and/or fees and assessments. The GSAs and project proponent(s) will explore and conduct any necessary studies and decision processes (including Proposition 218 elections) to approve rates, fees, or assessments to provide the required funding.

7.1.8 Coordination Between GSAs

As part of the Sutter Subbasin GSP, all GSAs in the Sutter Subbasin have agreed to coordinate with each other and with neighboring GSAs in the surrounding subbasins of the Sacramento Valley. Coordination will continue among these and other agencies as needed to implement projects successfully. Coordination will include teaming efforts, potential pursuit of grant funding, design and construction efforts that affect multiple GSAs, and joint education and outreach efforts.

7.1.9 Subbasin Water Available for Projects

Ongoing and planned projects in the Sutter Subbasin are generally aimed at maximizing use of existing surface water supplies and reducing boundary outflows. Consequently, existing water rights contracts are the primary source of surface water available for and managed by projects. Available surface water in the Sutter Subbasin generally originates from the Feather River or Sacramento River. Diversions are based on a combination of pre-1914, riparian, and appropriative water rights, and based on diversion agreements between Feather River Contractors and the State of California (State). The precise availability of total surface supplies varies from year to year, depending on hydrologic conditions and stipulations in the districts' diversion agreements.

As described at the beginning of this chapter, the Sutter Subbasin is projected to continue being managed sustainably over the GSP planning and implementation horizon. Thus, ongoing and planned projects and management actions, described in detail in **Section 7.1.4** above, are available should monitoring indicate that changing conditions require the implementation of projects and management actions to "achieve the sustainability goal for the basin… [and] respond to changing conditions in the basin" (GSP Emergency Regulations §354.44(a)).

BWD and SEWD each have planned projects. Both districts hold pre-1914 water rights on the Feather River and, as a result, have a relatively reliable surface water supply. **Table 7-44** summarizes the average total diversions, average other inflows, average drainage, and average deliveries that pass through the distribution systems of BWD and SEWD. Averages are summarized from the 2021 or 2016 Feather River Regional Agricultural Water Management Plan, based on the flow paths indicated in **Table 7-45**. Average total diversions are approximately 107,000 AF per water year in BWD (1991-2019 average), and approximately 164,000 AF per water year in SEWD (1999-2014 average). Much of this surface water is delivered to support agricultural and environmental beneficial uses in or around each district. Total deliveries are approximately 76,000 AF per water year in BWD and approximately 133,000 AF per water year in SEWD. Some water also leaves the distribution systems through outflow locations and is available for other beneficial uses downstream, whether inside or outside the Subbasin. A portion of each district's surface water diversions may be beneficially used to support recharge projects to the extent that they are not already used beneficially for other purposes in other locations in the district or the Subbasin.

Table 7-44. Average Annual Diversions, Other Inflows, and Drainage from Districts with Ongoing or Planned Projects and Management Actions

District	Summary Period (Water Years)	Average Total Diversion [1] (AF/water year)	Average Total Other Inflow [1] (AF/water year)	Average Total Drainage (AF/water year)	Average Total Deliveries (AF/water year) [1]
Butte Water District	1999-2019	106,600	86,100	81,000	75,800
Sutter Extension Water District	1999-2014	163,700	121,100	140,900	133,000

Source: NCWA, August 2014a and August 2014b
[1] Data sources listed in Table 7-45 Volumes rounded to 100 AF.

Table 7-45. Summary of Data Sources and Water Budget Flow Paths Included in Annual Diversions, Other Inflows, and Drainage from District Distribution Systems

District	Data Source	FRRAWMP Water Budget Flow Paths Included			
		Diversions	Other Inflows	Drainage	Deliveries
Butte Water District	FRRAWMP, 2021, Volume II, Chapter 4, Table 4.4	Deliveries to Butte Water District	SEWD Conveyance Losses, Other Inflows, Snake Creek, Precipitation, Shallow Groundwater Interception, Runoff of Precipitation, Tailwater	Drains to BWGWD, Other Drains	Deliveries (to Farmed Lands)
Sutter Extension Water District	FRRAWMP, 2016, Volume II, Chapter 6, Table 6.4	Sutter-Butte Canal, Sunset Pumping Station Diversion	Drains from BWD, Other Surface Inflows, Precipitation, Shallow Groundwater Interception, Runoff of Precipitation, Tailwater	Wadsworth Canal Outflow at Weir 4, DWR Pumping Plant 2, Drain Under Highway 113	Deliveries (to Private Ditches and Farmed Lands)

7.1.10 Reliability of Joint Water Districts Supply

BWD and SEWD, along with Biggs-West Gridley Water District (BWGWD) and Richvale Irrigation District (RID), formed the Joint Water Districts Board (Joint Districts) in 1957. The Joint Districts hold pre-1914 appropriative water rights to divert water from the Feather River, a tributary to the Sacramento River, and are parties to the May 27, 1969 Agreement on Diversion of Water from the Feather River, an agreement with the State regarding their diversions from the Feather River. The diversion agreement, included in **Appendix 7-G**, specifies the Joint Districts' water right for diverting up to 555,000 AF from the Feather River at the Thermalito Afterbay, established following its construction and the construction of Lake Oroville as part of the State Water Project (SWP) (Joint Board, 1969). The 555,000 AF diversion amount is available to the Joint Districts during the period from April 1 through October 31. The volume of water available for recharge is affected by the unavailability of supplies specified in the 1969 agreement during the non-allotted water season (November 1 through March 31), subject to reasonable and beneficial use.

The diversion agreement provides a consistent, reliable surface water supply to the Joint Districts. As stipulated in the 1969 agreement, water supply available to the Joint Districts depends on Lake Oroville inflow. Surface water supply can be reduced under the following conditions:

- DWR forecasted April to July unimpaired runoff into Lake Oroville is less than 600,000 AF[1], or
- Total current year predicted and prior year actual deficiencies in unimpaired runoff (as compared to 2,500,000 AF) exceed 400,000 AF for one or more successive prior water years with less than 2,500,000 AF of runoff.

When either of the above conditions are met, the Joint Board diversion amount of 555,000 AF can be reduced by up to 50 percent in any one year, but not by more than 100 percent in any seven consecutive years. Additionally, reductions in any given year cannot exceed the percent reduction experienced for agricultural use by SWP contractors.

Historically during years of reduced diversions, DWR has curtailed Joint Board water supplies by the full allowed amount, 50 percent, in each instance. In consideration of abandoning the Middle Fork Power Project on the Middle Fork of the Feather River, the State of California agreed to supply the Joint Water Districts an additional 35,000 acre-feet of water from the Feather River during drought reduction years under the terms of the 1969 agreement (**Appendix 7-G**). This 35,000 AF is divided equally among the Joint Districts, providing an additional 8,750 AF to each.

[1] The final, official forecast must be made by April 10 of each year.

This page intentionally left blank.

7.2 Monitoring

This section discusses the monitoring networks identified to characterize groundwater and related surface water conditions in the Sutter Subbasin, evaluate changing conditions that occur through implementation of the GSP, and assess progress towards sustainability. Monitoring networks are established for each sustainability indicator relevant to the Subbasin: groundwater levels, groundwater storage, groundwater quality, subsidence, and depletions of interconnected surface waters. Of the six sustainability indicators set forth under SGMA, seawater intrusion is not covered by a monitoring network as undesirable results related to seawater intrusion are not present and are not likely to occur in the Subbasin (see **Section 7.2.6.3**). Additionally, the characterization of groundwater storage and depletions of interconnected surface water are monitored and managed by proxy using groundwater levels. Sustainable Management Criteria (SMC), including minimum thresholds (MTs), measurable objectives (MOs), and interim milestones (IMs), are established for each representative monitoring site and discussed in further detail in **Chapter 6**.

This section includes the monitoring network objectives, rationale for site selection, details on the monitoring networks for each relevant sustainability indicator, monitoring protocols, and data management and reporting methods (GSP Emergency Regulations §352.2 through §352.6 and §354.32 through §354.38). Existing monitoring programs in the Sutter Subbasin are described in **Section 2.3.3**, and existing monitoring programs were used where practical in the development of this GSP's monitoring networks. Identified data gaps, and a plan to fill them, are provided for each monitoring network (GSP Emergency Regulations §354.38).

7.2.1 Useful Terms

A list and description of technical terms used throughout this section to discuss groundwater wells, water quality indicators, subsidence measurements, and other monitoring characteristics are listed below. **Figure 7-1** shows a schematic of a standard monitoring well with key measurements and terms identified. The terms and their descriptions are identified here to guide readers through this section and are not a definitive definition of each term.

- **Best Available Science** – Refers to the use of sufficient and credible information and data, specific to the decision being made and the time frame available for making that decision, that is consistent with scientific and engineering professional standards of practice (California [CA] Code of Regulations 351).
- **Best Management Practice** – Refers to a practice, or combination of practices, that are designed to achieve sustainable groundwater management and have been determined to be technologically and economically effective, practicable, and based on best available science (CA Code of Regulations, Title 23, Article 2).

- **Constituent** – Refers to a water quality parameter measured to assess groundwater quality.
- **Data Gap** – Refers to a lack of information that significantly affects the understanding of the basin setting or evaluation of the efficacy of [GSP] implementation and could limit the ability to assess whether a basin is being sustainably managed (CA Code of Regulations, Title 23, Article 2).
- **Depth to Bottom Perforation** – The distance to the bottom of the perforated (or screen) interval of a well from the ground surface.
- **Depth to Top Perforation** – The distance to the top of the perforated (or screen) interval in a well from the ground surface.
- **Depth to Water** – The distance from the ground surface elevation (or reference point) to water surface elevation.
- **Ground Surface Elevation** – The elevation of the land surface in feet at the monitoring site location. Elevation is commonly expressed as feet above mean sea level (MSL) and is reported relative to the North American Vertical Datum of 1988 (NAVD88) in this document per Sustainable Groundwater Act (SGMA) regulations.
- **Inelastic Subsidence** – Refers to the permanent sinking or downward settling of the Earth's surface. In the context of this GSP, it is primarily due to the unsustainable extraction of groundwater.
- **Interconnected Surface Water** – Refers to surface water that is hydraulically connected at any point in time or space by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.
- **Measurable Objectives** – Refers to 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.
- **Minimum Threshold** – Refers to a numeric value for each sustainability indicator used to define significant and unreasonable undesirable results.
- **NAVD88** – Refers to the North American Vertical Datum of 1988 computed by the National Geodetic Survey, or as modified.
- **Plan Implementation** – Refers to an Agency's exercise of the powers and authorities described in the Sustainable Groundwater Management Act, which commences after an Agency adopts and submits a Plan or Alternative to the Department and begins exercising such powers and authorities.

- **Principal Aquifer** – Refers to an aquifer or aquifer system that stores, transmits, and yields significant or economic quantities of groundwater to wells, springs, or surface water systems.
- **Representative Monitoring** - Refers to a monitoring site within a broader network of sites that typifies one or more conditions within the basin or an area of the basin (CA Code of Regulations, Title 23, Article 2).
- **Reference Point** – Refers to a permanent, stationary, and readily identifiable mark or point on a well, such as the top of casing, from which groundwater level measurements are taken, or other monitoring site (CA Code of Regulations, Title 23, Article 2). Reference point elevation is reported relative to NAVD88 and is used to convert depth to water measurements into water surface elevation values.
- **Screen Interval** – The portion(s) of a well casing that is screened to allow water from the surrounding aquifer into the well pipe. Screen interval is usually reported in feet below ground surface for both the upper-most limit and lower-most limit of the screen.
- **Seasonal High** – Refers to the highest annual static groundwater elevation that is typically measured in the Spring and associated with stable aquifer conditions following a period of lowest annual groundwater demand.
- **Seasonal Low** – Refers to the lowest annual static groundwater elevation that is typically measured in the Summer or Fall and associated with a period of stable aquifer conditions following a period of highest annual groundwater demand.
- **Sustainability Goal** – The existence and implementation of one or more Groundwater Sustainability Plans 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.
- **Sustainability Indicator** – Refers to any of the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, cause undesirable results, as described in Water Code Section 10721(x).
- **Sustainable Groundwater Management** – The management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.
- **Total Well Depth** – The depth that a well is installed to, measured from the ground surface. This depth is often deeper than the bottom of the deepest screen interval.

- **Undesirable Result** – One or more of the following effects caused by groundwater conditions occurring throughout the basin:
    - Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon.
    - Significant and unreasonable reduction of groundwater storage.
    - Significant and unreasonable seawater intrusion.
    - Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.
    - Significant and unreasonable inelastic land subsidence that substantially interferes with surface land uses.
    - Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.
- **Water Surface Elevation** – The elevation in feet relative to NAVD88 that groundwater is encountered inside the well. Elevation is commonly expressed as feet above mean sea level (MSL) and is reported relative to the North American Vertical Datum of 1988 (NAVD88) in this document per SGMA regulations.

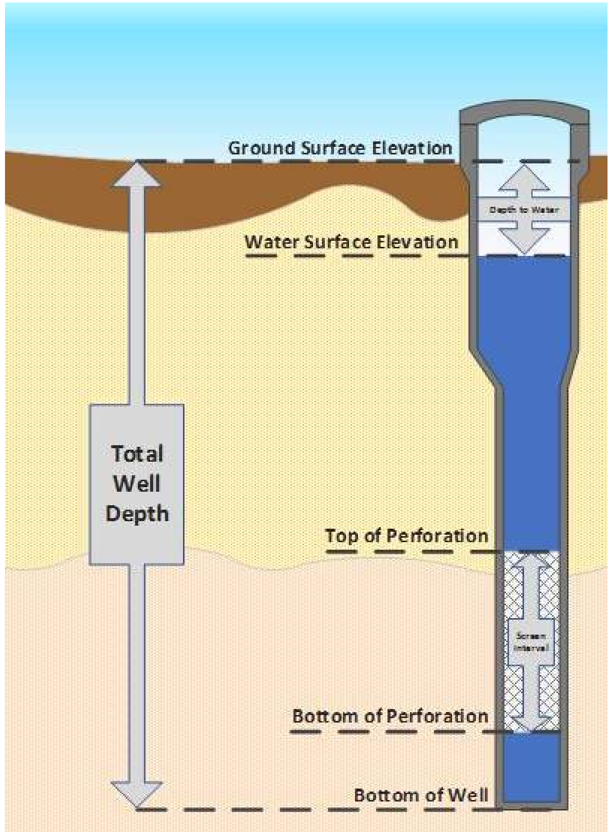


Figure 7-1. Diagram of Key Groundwater Monitoring Well Measurements

7.2.2 Monitoring Networks Objective

The objective of the monitoring networks is to monitor groundwater and related conditions, including, but not limited to, the interconnection of surface water and groundwater, to evaluate the effects and effectiveness of GSP implementation. The monitoring networks are also intended to support improved understanding of subbasin conditions, supporting ongoing subbasin management and future updates to this GSP. The objective will be implemented in a manner to:

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

The monitoring networks were selected specifically to detect short-term, seasonal, and long-term trends in each relevant sustainability indicator. This includes selection of an appropriate temporal frequency and spatial density to evaluate groundwater conditions related to the effectiveness of the GSP.

7.2.3 Representative Monitoring

The monitoring networks contained herein are the representative monitoring networks for the Sutter Subbasin, as defined under the GSP Emergency Regulations §354.36. Groundwater levels are being used to monitor the chronic lowering of groundwater levels sustainability indicator as well as a proxy for data collection and analyses relative to the reduction of groundwater storage and depletions of interconnected surface water sustainability indicators. Land surface elevation is used for assessing sustainability relative to the land subsidence sustainability indicator, while groundwater quality data are used for assessing sustainability relative to the degraded water quality sustainability indicator.

7.2.4 Scientific Rationale for Monitoring Site Selection

The monitoring networks were developed to ensure they can provide the data necessary to detect changes in conditions within the Sutter Subbasin such that the Sutter Subbasin GSAs can proactively manage the Subbasin and ensure that sustainability criteria are met. It is anticipated that these monitoring networks will be refined in future updates to this GSP, with the intent of ensuring that no undesirable results are present after 20 years of Subbasin sustainable management (e.g., post-2042); and, if undesirable results do occur, ensure that conditions will improve and begin trending toward the established measurable objective.

The monitoring networks herein were developed to detect short-term, seasonal, and long-term trends for all sustainability indicators applicable to the Sutter Subbasin. The monitoring networks were also developed to include information about temporal frequency and spatial density so the GSP can evaluate information regarding how groundwater conditions change spatially and temporally as projects and management actions are implemented to aid in maintaining subbasin-wide sustainability by and after 2042.

7.2.4.1 Monitoring Site Selection Criteria

Monitoring site selection criteria specific to the monitoring networks for each applicable sustainability indicator is described in detail in **Section 7.2.6**.

7.2.4.2 Existing Monitoring Programs

Existing monitoring programs were evaluated and utilized to develop the Sutter Subbasin GSP monitoring networks with the ultimate goal of coordinating required monitoring efforts in the Subbasin for all relative programs. Further detail regarding existing monitoring programs can be found in **Section 2.3.3**.

7.2.5 Data and Reporting

The following section describes the data and reporting standards that apply to all monitoring networks and the roles and responsibilities for GSA representatives regarding monitoring and data collection.

7.2.5.1 Data and Reporting Standards

The following reporting standards apply to all categories of information required of a GSP as identified under §352.4 of the GSP Emergency Regulations, unless otherwise indicated (DWR, 2016c):

1. Water volumes shall be reported in acre-feet.
2. Surface water flow shall be reported in cubic feet per second and groundwater flow shall be reported in acre-feet per year.
3. 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.
4. 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.
5. Groundwater quality data shall be analyzed by a State-certified analytical laboratory and reported according to the individual constituent testing method analytical standard. This standard has been added for the Sutter Subbasin GSP and is not currently included under §352.4 of the GSP Emergency Regulations.
6. Geographic locations shall be reported in GPS coordinates by latitude and longitude in decimal degree to five decimal places, to a minimum accuracy of 30 feet, relative to NAD83, or another national standard that is convertible to NAD83.

Monitoring Sites

Monitoring sites shall include the following information (DWR, 2016c):

1. A unique site identification number and narrative description of the site location.
2. A description of the type of monitoring, type of measurement taken, and monitoring frequency.
3. Location, elevation of the ground surface, and identification and description of the reference point.

4. A description of the standards used to install the monitoring site. Sites that do not conform to best management practices shall be identified and the nature of the divergence from best management practices described.

Wells

The following standards apply to wells (DWR, 2016c):

1. Wells used to monitor groundwater conditions shall be constructed according to applicable construction standards, and shall provide the following information in both tabular and geodatabase-compatible shapefile form:
    a. CASGEM well identification number. If a CASGEM well identification number has not been issued, appropriate well information shall be entered on forms made available by DWR, as described in §353.2 under the GSP Emergency Regulations.
    b. Well location, elevation of the ground surface and reference point, including a description of the reference point.
    c. A description of the well use, such as public supply, irrigation, domestic, monitoring, or other type of well; whether the well is active or inactive; and whether the well is a single, clustered, nested, or other type of well.
    d. Casing perforations, borehole depth, and total well depth.
    e. Well completion reports, if available, from which the names of private owners have been redacted.
    f. Geophysical logs, well construction diagrams, or other relevant information, if available.
    g. Identification of principal aquifers monitored.
    h. Other relevant well construction information, such as well capacity, casing diameter, or casing modifications, as available.
2. If an Agency (GSA) relies on wells that lack casing perforations, borehole depth, or total well depth information to monitor groundwater conditions as part of a GSP, the Agency shall describe a schedule for acquiring monitoring wells with the necessary information, obtain the required construction information, or demonstrate to DWR that such information is not necessary to understand and manage groundwater in the basin.
3. Well information used to develop the basin setting shall be maintained in the Agency's data management system.

Maps

Maps submitted to DWR shall meet the following requirements (DWR, 2016c):

1. Data layers, shapefiles, geodatabases, and other information provided with each map, shall be submitted electronically to DWR in accordance with the procedures described in Article 4 of the GSP Emergency Regulations.
2. Maps shall be clearly labeled and contain a level of detail to ensure that the map is informative and useful.
3. The datum shall be clearly identified on the maps or in an associated legend.

Hydrographs

Hydrographs submitted to DWR shall meet the following requirements (DWR, 2016c):

1. Hydrographs shall be submitted electronically to the DWR in accordance with the procedures described in Article 4 of the GSP Emergency Regulations.
2. Hydrographs shall include a unique site identification number and the ground surface elevation for each site.
3. Hydrographs shall use the same datum and scaling to the greatest extent practical.

Groundwater and Surface Water Models

Groundwater and surface water models used for a GSP shall meet the following standards (DWR, 2016c):

1. The model shall include publicly available supporting documentation.
2. The model shall be based on field or laboratory measurements, or equivalent methods that justify the selected values, and calibrated against site-specific field data.
3. Groundwater and surface water models developed in support of a GSP after the effective date of the GSP Emergency Regulations shall consist of public domain open-source software.

7.2.5.2 Monitoring Roles and Responsibilities

The Monitoring / Field Lead for each Sutter Subbasin GSA, as identified in **Table 7-46**, is responsible for GSP-related data collection efforts within their GSA and will ensure all required data for each monitoring network will be collected according to the spatial and temporal frequency described herein. The remaining roles detailed in **Table 7-46** will ensure quality assurance and quality control of the monitoring data prior to reporting it to the data management system (DMS) and to DWR's SGMA Portal Monitoring Network Module.

Table 7-46. GSA Representatives for Monitoring Network Data Collection and Quality Control

Title	Name	Organizational Affiliation	Contact Information
GSA Monitoring / Field Lead		Sutter County GSA Butte WD GSA City of Live Oak GSA Sutter Extension WD GSA Sutter CSD GSA City of Yuba City GSA RD 70 GSA RD 1660 GSA RD 1500 GSA	
GSP Quality Assurance Officer/Data Manager		Sutter County GSA Butte WD GSA City of Live Oak GSA Sutter Extension WD GSA Sutter CSD GSA City of Yuba City GSA RD 70 GSA RD 1660 GSA RD 1500 GSA	
Contract Laboratory Project Manager	To Be Determined	To Be Determined	To Be Determined
Contract Laboratory Quality Assurance Officer	To Be Determined	To Be Determined	To Be Determined

RD – Reclamation District
WD – Water District
CSD – Community Services District

7.2.5.2.1 GSA Monitoring / Field Lead

Each GSA is responsible for coordination between members as required to implement GSP-related monitoring and data collection within their GSA's service area. The GSA Monitoring / Field Lead for each GSA will coordinate the monitoring events within their respective GSA and facilitates the implementation of the GSP Monitoring Protocol, including the coordination of water level measurements, well sampling, laboratory analysis, and data collection analysis and reporting. The GSA Monitoring / Field Lead is responsible for identifying any errors or outliers and asking members of the GSA to collect additional information, if needed. Additionally, the GSP Monitoring / Field Lead will work with the members of their GSA, analytical laboratory(ies), and GSP Quality Assurance (QA) Officer to resolve analytical issues and maintain communication between all parties in regard to laboratory and/or sampling changes.

7.2.5.2.2 GSP Quality Assurance Officer / Data Manager

The GSP QA Officer / Data Manager is responsible for establishing quality assurance/quality control (QA/QC) guidelines for field sampling and analytical procedures conducted as part of the GSP Monitoring Protocol and for coordinating with each GSA to ensure that these protocols are implemented. The GSP QA Officer / Data Manager will also, in coordination with the GSA Monitoring / Field Leads, compile GSA data into standardized forms and perform general quality control checks.

7.2.5.2.3 Contract Laboratory Project Manager and Quality Assurance Officer

The Contract Laboratory Project Manager and QA Officer are employees of the contracted State-certified analytical laboratory utilized for sample analysis. These entities will coordinate with the GSP Representative and GSP QA Officer to resolve any issues relating to accuracy, completeness, and precision for samples collected as part of the GSP monitoring protocol.

7.2.5.3 Data Management System

The Sutter Subbasin GSAs have developed and will maintain a DMS that is capable of storing and reporting information relevant to the development or implementation of the coordinated GSP and monitoring of the Sutter Subbasin (DWR, 2016c). For more information about the Sutter Subbasin DMS, refer to **Chapter 8** *Implementation*.

7.2.6 Monitoring Networks

Each monitoring network was established to collect sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions as well as yield representative information about groundwater conditions as necessary to evaluate GSP implementation. Selected monitoring sites are presented on maps and in tabular form. Monitoring protocols and data reporting requirements, frequency and timing of monitoring events, and spatial density are described in this section. Existing data gaps are identified and described, as well as plans to assess and improve the monitoring networks in future GSP updates.

Monitoring frequency and the density of monitoring sites will be adjusted over time through periodic assessment and refinements to ensure an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under the following circumstances:

1. Minimum threshold exceedances;

2. Highly variable spatial or temporal conditions;
3. Adverse impacts to beneficial uses and users of groundwater; and/or
4. The potential to adversely affect the ability of an adjacent basin to implement its GSP(s) or impede achievement of sustainability goals in an adjacent basin.

Explanations of how identified data gaps in the monitoring network will be filled are provided in **Section 7.1** as individual projects and management actions that the GSAs may undertake as part of GSP implementation. The schedule and costs associated with maintaining and improving monitoring networks is discussed in **Chapter 8** *Implementation*.

7.2.6.1 Groundwater Level Monitoring Network

The groundwater level monitoring network, used to assess the chronic lowering of groundwater levels sustainability indicator, is established to demonstrate groundwater occurrence, flow directions, and hydraulic gradients with the groundwater basin, between adjoining subbasins and between interconnected surface water features by the following methods:

1. A sufficient density of monitoring wells to collect representative groundwater elevation measurements through depth-discrete perforated (or screened) intervals to characterize the groundwater table or potentiometric surface.
2. Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.

Groundwater level monitoring is conducted through a groundwater well monitoring network. The following subsections provide information about how the groundwater level monitoring network was developed, criteria for selecting monitoring wells, spatial density, summary of protocols, monitoring frequency and timing, and identification of and strategies to fill data gaps.

7.2.6.1.1 Selected Monitoring Wells

Wells were selected for the groundwater level monitoring network based on the following criteria:

1. **Well Information** – Only wells with known depths or screen intervals were considered. Wells with barriers to monitoring (e.g., oil in the well, well destroyed, etc.) were not considered.
2. **Measurement Frequency and Record** – Wells with greater frequency of measurements, more recent measurements, and longer periods of record provide insight into current and historical conditions and provide finer resolution details in trends. A well tiering tool, developed using the criteria described in **Table 7-47**, was used to identify and rank these characteristics. When possible, higher ranked tier wells were selected over lower ranked tiers.

Table 7-47. Well Tiering Criteria, Groundwater Levels Monitoring Network

Tier	Measurement Frequency	Last Measurement Date	Measurement Record
1	Continuous or Monthly	2016 or more recent	Data in 10+ years within the last 20 years
2	Twice a year or greater	2016 or more recent	Data in 10+ years within the last 20 years
3	All	2016 or more recent	Data in 10+ years within the last 20 years
4	All	Prior to 2016	Data in 10+ years within the last 20 years
5	All	Prior to 2016	Data in less than 10 years within the last 20 years

3. **Spatial Distribution** – Wells were selected to provide the greatest spatial distribution within each aquifer zone and remove clusters in localized areas, where possible. A goal of approximately ten wells per aquifer zone was set by the GSAs per DWR guidance as set forth in the *Best Management Practices for the Sustainable Management of Groundwater, Monitoring Networks and Identification of Data Gaps* (DWR 2016a).

4. **Consistency with Best Management Practices (BMPs)** – Wells were selected using monitoring BMPs published by DWR to ensure consistency and compliance with established regulations.

5. **Local Knowledge** – Representatives from local agencies and the public were invited to provide any information and insight related to well location, construction, or historical record of the wells comprising the groundwater level monitoring network during Sutter Subbasin Groundwater Management Coordination Committee (SSGMCC) meetings (held bi-weekly and noticed according to the Brown Act) and a public workshop held on August 11, 2021.

6. **Professional Judgement and Best Available Science** – Professional judgement and best available science were used to make the final decision about each well in the network, particularly when more than one suitable well exists in an area of interest.

Wells identified in **Table 7-48** were selected based on the above criteria to evaluate short-term, seasonal, and long-term trends in groundwater levels. Maps of the wells screened in the Shallow Aquifer Zone (AZ), AZ-1, AZ-2, and AZ-3 of the principal aquifer are presented in **Figure 7-2** through **Figure 7-5**, respectively.

This page intentionally left blank.

Table 7-48. Groundwater Level Monitoring Network Wells

Site Code	State Well Number	Local ID / Other ID	Aquifer Zone	Overlying GSA	Status	Well Use	Depth (ft bgs)	Screen Interval (ft bgs)	First Measurement	Latest Measurement	Measurement Count
-	12N02E09B002M	USGS-385431121451401	Shallow	Reclamation District No. 1500 GSA	Active	Unknown	29	-	8/26/1997	8/8/2019	26
-	12N03E18H001M	USGS-385314121401701	Shallow	Reclamation District No. 1500 GSA	Active	Unknown	50	-	8/7/1997	8/8/2019	15
-	14N02E10R001M	USGS-390416121433601	Shallow	Sutter Extension WD GSA	Active	Unknown	44	-	8/7/1997	8/8/2019	14
390696N1217778W001	14N02E17C001M	Sutter County MW-1A	Shallow	Reclamation District No. 1660 GSA	Active	Observation	60	30 - 50	2/24/2010	6/29/2021	100
-	15N02E20D001M	USGS-390832121463601	Shallow	Sutter County GSA	Active	Unknown	35	-	8/7/1997	8/8/2019	12
391975N1218937W001	16N01E31H001M	-	Shallow	Sutter County GSA	Active	Unknown	36	-	12/8/1932	10/5/2020	247
392328N1216469W001	16N03E21D002M	-	Shallow	Sutter County GSA	Active	Residential	30	-	6/28/1962	10/5/2020	304
387859N1216565W001	11N03E20H003M	RD 1500 Karnak	AZ-1	Reclamation District No. 1500 GSA	Active	Industrial	165	135 - 156	10/22/1963	6/2/2021	223
388761N1217094W001	12N02E23H001M	Sutter County MW-2A	AZ-1	Sutter County GSA	Active	Observation	150	120 - 140	5/12/2010	6/29/2021	88
389605N1218102W003	13N01E24G004M	Flood MW-1C (shall)	AZ-1	Reclamation District No. 1500 GSA	Active	Observation	100	70 - 90	9/15/2004	6/29/2021	163
390087N1216722W001	13N03E06A001M	Sutter County MW-6A	AZ-1	Sutter County GSA	Active	Observation	65	45 - 55	3/9/2011	6/29/2021	67
390426N1218166W001	14N01E24N001M	-	AZ-1	Reclamation District No. 1660 GSA	Active	Irrigation	145	-	2/3/2005	7/7/2021	203
390682N1216901W001	14N02E13A003M	SEWD MW-3A	AZ-1	Sutter Extension WD GSA	Active	Observation	115	90 - 110	1/31/2006	3/2/2021	265
390588N1217004W001	14N02E13L001M	-	AZ-1	Sutter Extension WD GSA	Active	Irrigation	82	68 - 82	2/2/2005	7/6/2021	202
390176N1217902W001	14N02E31K001M	-	AZ-1	Reclamation District No. 1500 GSA	Active	Unknown	131	-	10/23/1941	10/7/2021	257
390244N1217813W001	14N02E32D001M	SMWC MW-1A	AZ-1	Reclamation District No. 1500 GSA	Active	Observation	64	34 - 54	6/18/2012	6/29/2021	58
390458N1216114W001	14N03E23D003M	Feather River MW-1A	AZ-1	Sutter County GSA	Active	Observation	65	40 - 60	10/20/2005	6/29/2021	98
391051N1217012W001	15N02E36L001M	-	AZ-1	Sutter Extension WD GSA	Active	Irrigation	150	100 - 150	3/16/2009	3/5/2021	129
392712N1216493W001	16N03E04E001M	-	AZ-1	Butte WD GSA	Active	Irrigation	70	-	2/1/2005	7/6/2021	203
392394N1216509W001	16N03E17J001M	Sutter County MW-3A	AZ-1	Sutter Extension WD GSA	Active	Observation	85	65 - 85	8/4/2010	6/29/2021	68
392970N1216907W003	17N02E25J003M	BWD MW-1C	AZ-1	Butte WD GSA	Active	Observation	127	70 - 90	6/10/2009	7/19/2021	201
389453N1216159W001	-	GH Well 2	AZ-1	Sutter County GSA	Active	Irrigation	70	50 - 70	6/30/2009	6/1/2021	185
391456N1218904W001	-	MFWC Prop 50	AZ-1	Reclamation District No. 70 GSA	Active	Irrigation	320	125 - 155	4/10/2016	4/19/2021	12
-	-	Hillcrest Well #5	AZ-1 and AZ-2	City of Yuba City GSA	Inactive	Public Supply	320	94 - 118; 166 - 180; 264 - 288	7/10/2015	9/22/2021	12
389605N1218102W001	13N01E24G002M	Flood MW-1A (deep)	AZ-2	Reclamation District No. 1500 GSA	Active	Observation	310	240 - 300	9/15/2004	6/29/2021	183
389605N1218102W002	13N01E24G003M	Flood MW-1B (int)	AZ-2	Reclamation District No. 1500 GSA	Active	Observation	160	130 - 160	9/15/2004	6/29/2021	180
-	-	Hillcrest Well #8	AZ-2	City of Yuba City GSA	Inactive	Public Supply	254	-	7/10/2015	9/22/2021	12
-	-	Hillcrest Well #9	AZ-2	City of Yuba City GSA	Inactive	Public Supply	190	-	7/10/2021	9/22/2021	12
390087N1216722W002	13N03E06A002M	Sutter County MW-6B	AZ-2	Sutter County GSA	Active	Observation	175	155 - 165	3/9/2011	6/29/2021	67
390087N1216722W003	13N03E06A003M	Sutter County MW-6C	AZ-2	Sutter County GSA	Active	Observation	265	245 - 255	3/9/2011	6/29/2021	67

Site Code	State Well Number	Local ID / Other ID	Aquifer Zone	Overlying GSA	Status	Well Use	Depth (ft bgs)	Screen Interval (ft bgs)	First Measurement	Latest Measurement	Measurement Count
389452N1215992W001	13N03E26J002M	Sutter County MW-4A	AZ-2	Sutter County GSA	Active	Observation	175	145 - 165	8/4/2010	7/21/2021	106
390682N1216901W002	14N02E13A004M	SEWD MW-3B	AZ-2	Sutter Extension WD GSA	Active	Observation	245	210 - 240	1/31/2006	3/2/2021	265
390696N1217778W002	14N02E17C002M	Sutter County MW-1B	AZ-2	Reclamation District No. 1660 GSA	Active	Observation	245	205 - 215	2/24/2010	6/29/2021	100
390244N1217813W002	14N02E32D002M	SMWC MW-1B	AZ-2	Reclamation District No. 1500 GSA	Active	Observation	210	170 - 200	6/18/2012	6/29/2021	58
390458N1216114W002	14N03E23D004M	Feather River MW-1B	AZ-2	Sutter County GSA	Active	Observation	260	235 - 255	10/20/2005	6/29/2021	98
391658N1217070W001	15N02E12E001M	SEWD MW-1A	AZ-2	Sutter Extension WD GSA	Active	Observation	173	148 - 168	1/31/2006	3/5/2021	266
391658N1217070W002	15N02E12E002M	SEWD MW-1B	AZ-2	Sutter Extension WD GSA	Active	Observation	266	240 - 260	1/31/2006	3/5/2021	266
391414N1217442W001	15N02E22D001M	-	AZ-2	Sutter County GSA	Active	Residential	302	-	5/11/1966	6/7/2021	330
391279N1216989W001	15N02E24P001M	SEWD MW-2A	AZ-2	Sutter Extension WD GSA	Active	Monitoring	254	204 - 244	1/31/2006	3/5/2021	266
391279N1216989W002	15N02E24P002M	SEWD MW-2B	AZ-2	Sutter Extension WD GSA	Active	Monitoring	379	354 - 374	1/31/2006	3/5/2021	266
392394N1216509W002	16N03E17J002M	Sutter County MW-3B	AZ-2	Sutter Extension WD GSA	Active	Observation	315	285 - 305	8/4/2010	6/29/2021	68
392970N1216907W002	17N02E25J002M	BWD MW-1B	AZ-2	Butte WD GSA	Active	Observation	370	320 - 360	6/10/2009	7/19/2021	206
391283N1218286W001	-	BS2-Franklin	AZ-2	Reclamation District No. 70 GSA	Active	Irrigation	300	-	4/10/2016	4/16/2021	12
-	-	WTP well	AZ-2 and AZ-3	City of Yuba City GSA	Active	Public Supply	-	370 - 390; 453 - 473	7/10/2015	9/22/2021	12
388761N1217094W003	12N02E23H003M	Sutter County MW-2C	AZ-3	Sutter County GSA	Active	Observation	600	570 - 590	5/12/2010	6/29/2021	88
388761N1217094W004	12N02E23H004M	Sutter County MW-2D	AZ-3	Sutter County GSA	Active	Observation	705	655 - 665	5/12/2010	6/29/2021	88
389452N1215992W002	13N03E26J003M	Sutter County MW-4B	AZ-3	Sutter County GSA	Active	Observation	445	425 - 435	8/4/2010	7/21/2021	107
389452N1215992W003	13N03E26J004M	Sutter County MW-4C	AZ-3	Sutter County GSA	Active	Observation	610	590 - 600	8/4/2010	7/21/2021	105
389452N1215992W004	13N03E26J005M	Sutter County MW-4D	AZ-3	Sutter County GSA	Active	Observation	1005	985 - 995	8/4/2010	7/21/2021	105
390682N1216901W003	14N02E13A005M	SEWD MW-3C	AZ-3	Sutter Extension WD GSA	Active	Observation	585	550 - 580	1/31/2006	3/2/2021	265
390696N1217778W003	14N02E17C003M	Sutter County MW-1C	AZ-3	Reclamation District No. 1660 GSA	Active	Observation	425	395 - 415	2/24/2010	6/29/2021	100
390696N1217778W004	14N02E17C004M	Sutter County MW-1D	AZ-3	Reclamation District No. 1660 GSA	Active	Observation	755	725 - 745	2/24/2010	6/29/2021	100
390244N1217813W003	14N02E32D003M	SMWC MW-1C	AZ-3	Reclamation District No. 1500 GSA	Active	Observation	500	460 - 490	6/18/2012	6/29/2021	58
390458N1216114W003	14N03E23D005M	Feather River MW-1C	AZ-3	Sutter County GSA	Active	Observation	689	664 - 684	10/20/2005	6/29/2021	98
390458N1216114W004	14N03E23D006M	Feather River MW-1D	AZ-3	Sutter County GSA	Active	Observation	1021	996 - 1016	10/20/2005	6/29/2021	98
391658N1217070W003	15N02E12E003M	SEWD MW-1C	AZ-3	Sutter Extension WD GSA	Active	Observation	559	524 - 554	1/31/2006	3/5/2021	266
391279N1216989W003	15N02E24P003M	SEWD MW-2C	AZ-3	Sutter Extension WD GSA	Active	Monitoring	488	438 - 478	1/31/2006	3/5/2021	266
392394N1216509W003	16N03E17J003M	Sutter County MW-3C	AZ-3	Sutter Extension WD GSA	Active	Observation	430	400 - 420	8/4/2010	6/29/2021	68
392394N1216509W004	16N03E17J004M	Sutter County MW-3D	AZ-3	Sutter Extension WD GSA	Active	Observation	615	595 - 605	8/4/2010	6/29/2021	68
392394N1216509W005	16N03E17J005M	Sutter County MW-3E	AZ-3	Sutter Extension WD GSA	Active	Observation	785	765 - 785	8/4/2010	6/29/2021	68
392970N1216907W001	17N02E25J001M	BWD MW-1A	AZ-3	Butte WD GSA	Active	Observation	591	486 - 586	6/10/2009	7/19/2021	202
392867N1217825W001	17N02E31A001M	-	AZ-3	Sutter County GSA	Active	Irrigation	540	-	3/25/1948	3/11/2021	242

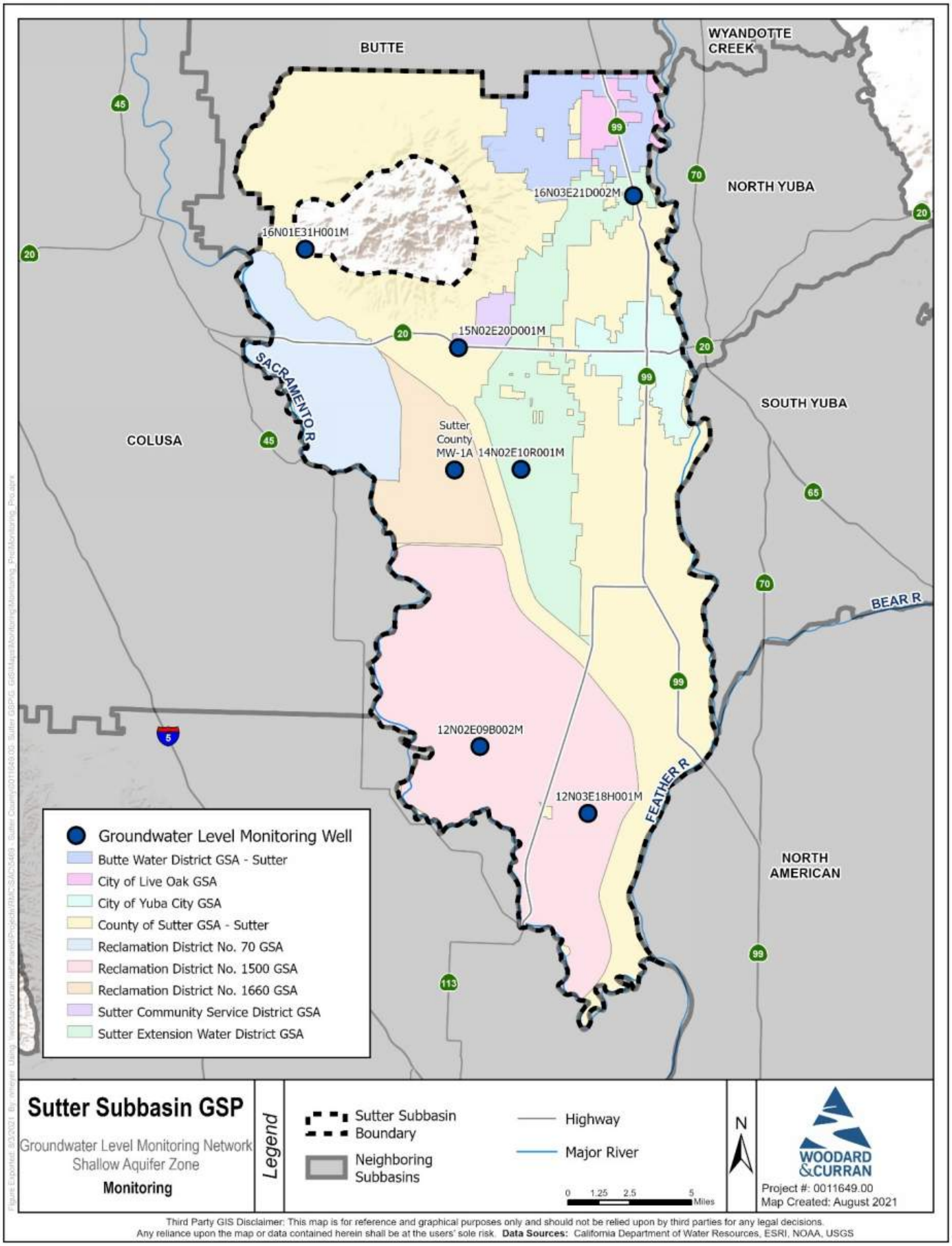


Figure 7-2. Groundwater Level Monitoring Network Wells, Shallow AZ

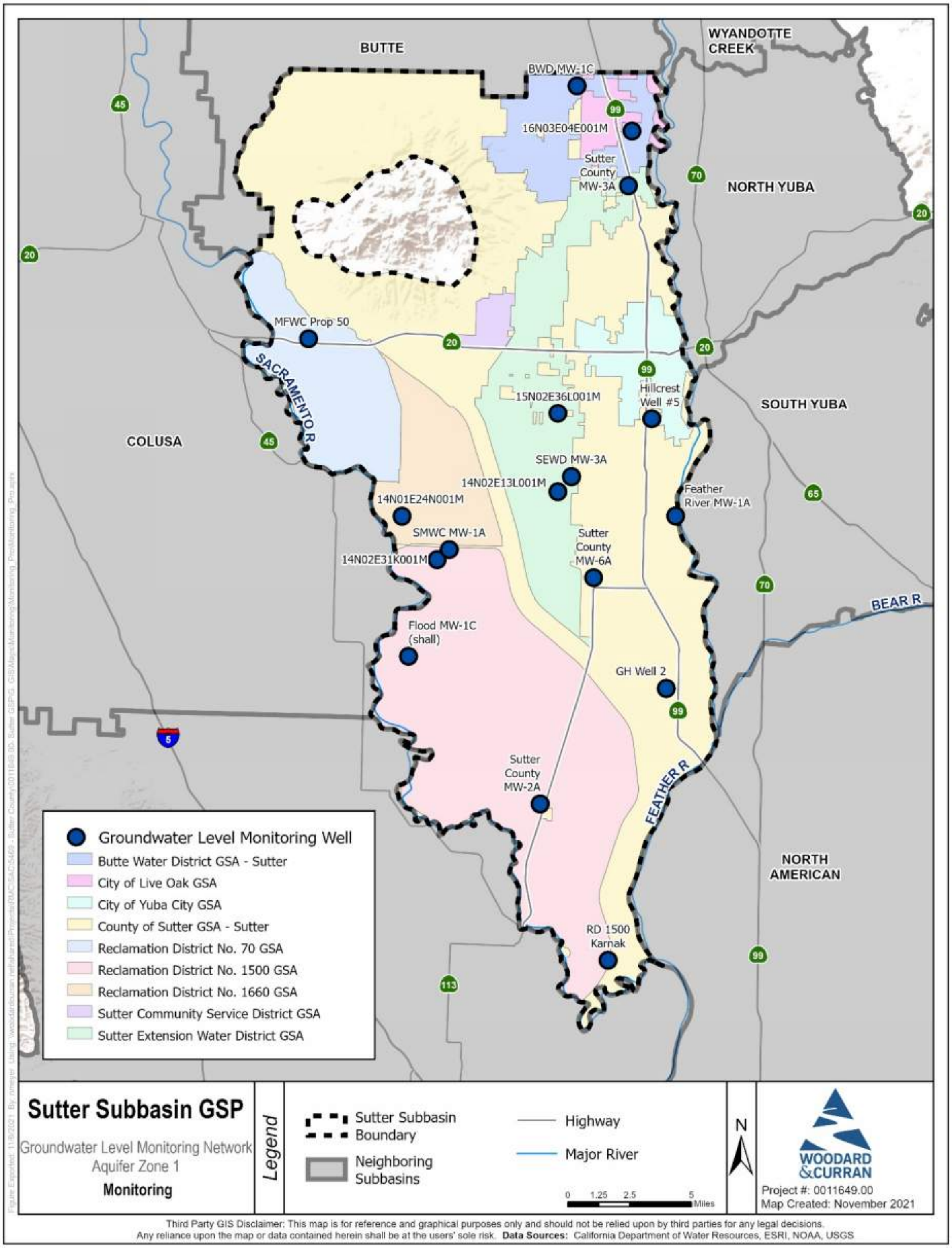


Figure 7-3. Groundwater Level Monitoring Network Wells, AZ-1

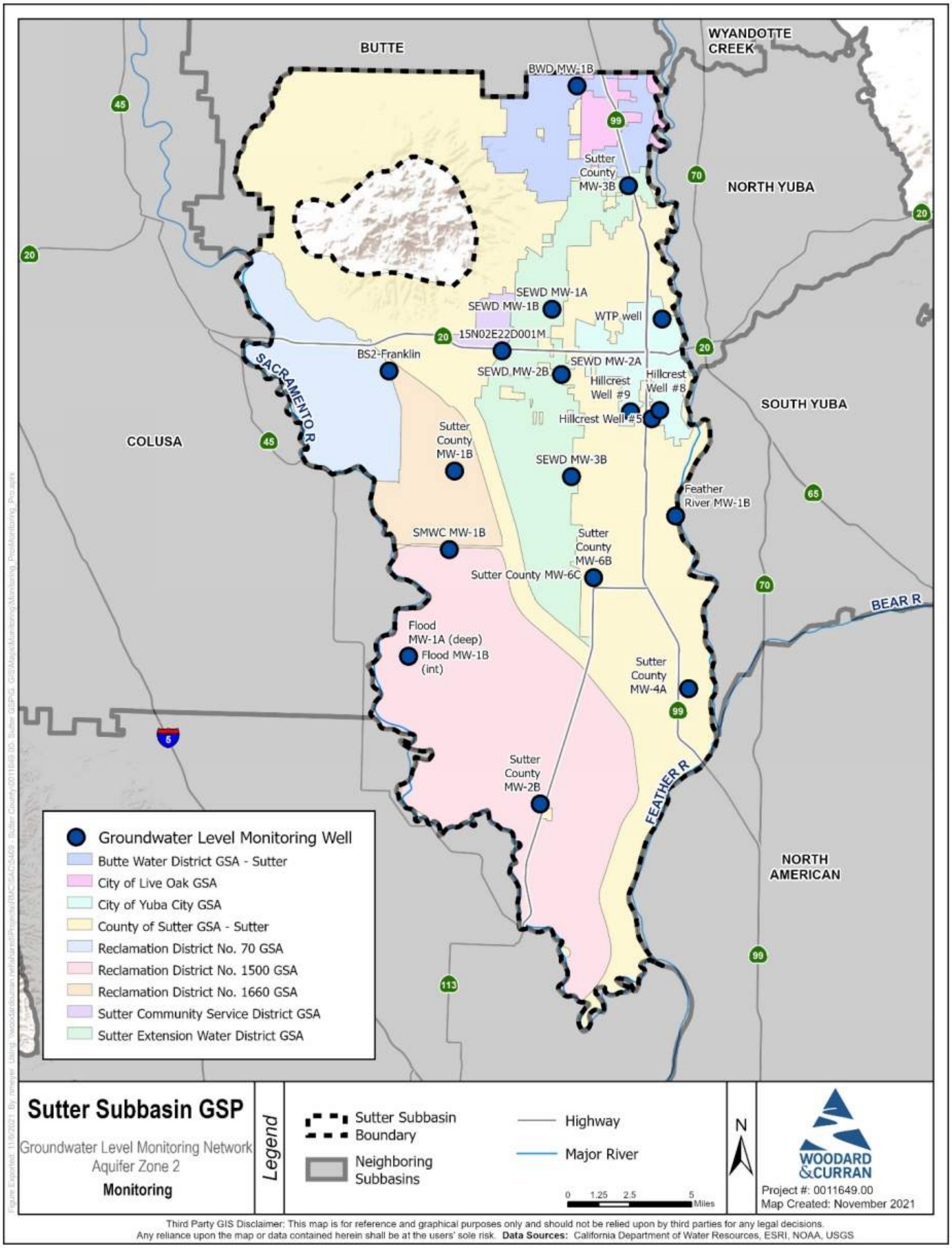


Figure 7-4. Groundwater Level Monitoring Network Wells, AZ-2

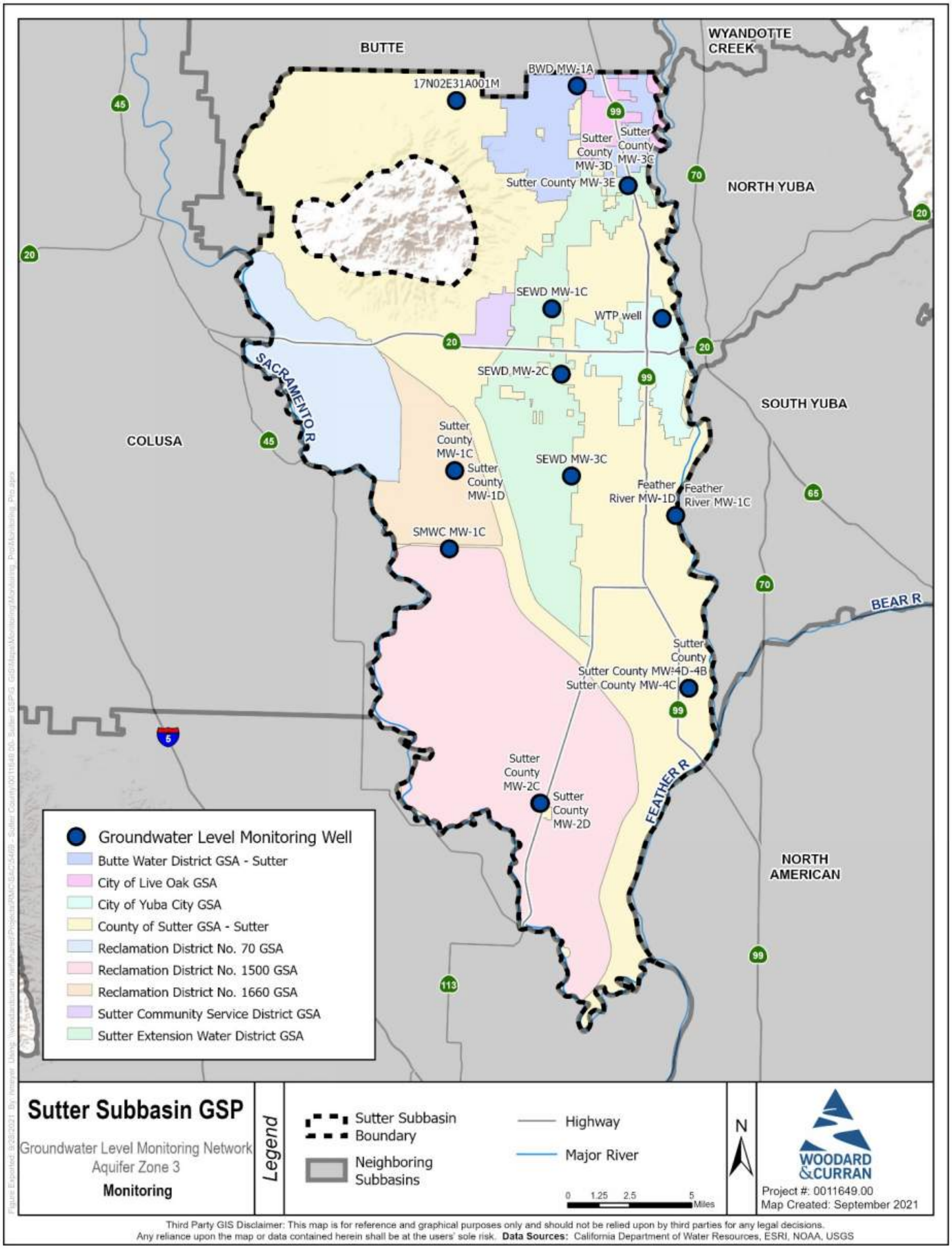


Figure 7-5. Groundwater Level Monitoring Network Wells, AZ-3

7.2.6.1.2 Spatial Density

The goal of the groundwater level monitoring network is to provide adequate spatial coverage of the Subbasin. This includes the ability to monitor and identify changes in groundwater conditions across the Subbasin over time to assess progress toward the sustainability goal by 2042 and beyond. Consideration of the spatial location of monitoring wells included well accessibility, availability of well construction information, proximity to other monitoring wells, and ensuring adequate coverage where undesirable results are occurring or are likely to occur.

The well density of the current groundwater level monitoring network for the Sutter Subbasin is 13.5 wells per square mile, which exceeds the range recommended by DWR's *Monitoring Networks and Identification of Data Gaps* BMP (**Table 7-49**). The spatial density of the groundwater level monitoring networks will be reevaluated during future GSP updates and revised as deemed necessary.

Table 7-49. Groundwater Level Monitoring Well Density Considerations

Reference	Monitoring Well Density (wells per 100 miles^2)
Heath (1976)	0.2 - 10
Sophocleous (1983)	6.3
Hopkins (1984)	
Basins pumping more than 10,000 acre-feet/year per 100 miles^2	4.0
Basins pumping between 1,000 and 10,000 acre-feet/year per 100 miles^2	2.0
Basins pumping between 250 and 1,000 acre-feet/year per 100 miles^2	1.0
Basins pumping between 100 and 250 acre-feet/year per 100 miles^2	0.7

Source: DWR, 2016a

7.2.6.1.3 Monitoring Frequency

Monitoring protocols and data reporting requirements for the groundwater levels monitoring network have been developed in accordance with DWR's guidance entitled *Best Management Practices for the Sustainable Management of Groundwater, Monitoring Protocols, Standards, and Sites BMP* (DWR, 2016b). Monitoring protocols applicable to all Sutter Subbasin GSP monitoring networks are detailed in **Section 7.2.5.1**. Monitoring protocols indicate that static groundwater elevation measurements shall be collected at least two times per year to represent seasonal low and seasonal high groundwater conditions. Seasonal high groundwater level measurements occur between March and April and seasonal low groundwater level measurements occur between September and October within the Sutter Subbasin. Because rice, the predominant crop grown in the Sutter Subbasin, has a significant influence on shallow groundwater levels, monitoring wells adjacent to rice growing areas may collect water level measurements up to four times per year – one each during the periods previously mentioned to support subbasin-wide groundwater elevation mapping, and once between August and October and January and March to capture local seasonal high and low groundwater elevations, respectively.

All GSAs within the Sutter Subbasin are responsible for collecting and reporting seasonal high and seasonal low measurements for compilation and reporting to DWR. Coordination with existing monitoring entities will take place regarding the frequency and timing of monitoring events to ensure access to the well site and ensure proper protocols are followed to ensure static groundwater level readings.

7.2.6.1.4 Monitoring Protocols

Monitoring protocols and data reporting requirements for the groundwater level monitoring network have been developed in accordance with DWR's *Monitoring Protocols, Standards, and Sites* BMP (DWR, 2016b). Monitoring protocols applicable to all Sutter Subbasin GSP monitoring networks are detailed in **Section 7.2.5.1**. Monitoring networks, protocols, and data reporting requirements established for the groundwater level monitoring network will be reviewed every five years and refined as necessary, where any modifications to the monitoring protocols will be documents in detail within future GSP updates.

Measuring Groundwater Elevation

The following guidelines were adopted from DWR's *Monitoring Protocols, Standards, and Sites* BMP (DWR, 2016b):

- Well construction, anticipated groundwater level measuring equipment, field conditions, and well operations will be considered prior to collection of the groundwater level measurement. Depth to water measurements will use procedures appropriate for the measuring device and equipment must be operated and maintained in accordance with manufacturer instructions.
- Depth to groundwater must be measured relevant to an established reference point (RP) on the well casing, usually identified with a permanent market, paint spot, or notch in the lip of the well casing. Depth to groundwater must be measured to an accuracy of 0.1 foot and should be measured to NAVD88. An accuracy of 0.01 foot below the RP is preferable, if possible.
- For measuring wells that are under pressure, a period of time after uncapping will occur during which groundwater levels in the well will equilibrate and stabilize. In these cases, multiple measurements will be collected to ensure the well has reached equilibrium such that no significant changes in water level are observed.

Every effort should be made to ensure that a representative stable depth to groundwater is recorded. If a well does not stabilize, the quality of the value will be appropriately qualified as a questionable measurement. Record the dimension of the extension and document measurements and configuration.

- The sampler will calculate the groundwater elevation as:

  $$GWE = RPE - DTW$$

  Where:

  GWE = Groundwater Elevation
  RPE = Reference Point Elevation
  DTW = Depth to Water

- The sampler must ensure that all measurements are in consistent units of feet, tenths of feet, and hundredths of feet. Measurements and RPEs should not be recorded in feet and inches.
- The sampler will replace any well caps or plugs and lock any well buildings or covers prior to departing the monitoring location.

Recording Groundwater Levels

The following guidelines were adopted from DWR's *Monitoring Protocols, Standards, and Sites* BMP (DWR, 2016b):

- The sampler should record the well identifier, date, time (24-hour format), RPE, height of RP above or below ground surface, DTW, GWE, and comments regarding any factors that may influence the depth to water readings such as weather, nearby irrigation, flooding, potential for tidal influence, or well condition. If there is a questionable measurement or the measurement cannot be obtained, it should be noted. Standardized field forms should be used for all data collection.
- The sampler should replace any well caps or plugs and lock any well buildings or covers following data collection.
- All data should be entered into the data management system (DMS) as soon as possible. Care should be taken to avoid data entry mistakes and the entries should be checked by a second person for compliance with the data quality objectives (DQOs). Should a measurement appear suspicious, a confirmation reading shall be obtained.

Data Reduction, Validation, and Reporting

After field personnel have completed their work, data should be cross-checked and submitted to the GSA Monitoring / Field Lead. All monitoring locations in the Sutter Subbasin GSP monitoring networks have been assigned a unique well identification (ID), and information associated with wells, such as well characteristics and historical hydrologic observations, will be compiled and maintained within the DMS.

Agencies will collect groundwater level measurements during the designated seasonal high and seasonal low time periods (as identified in **Section 7.2.6.1.3**). Each GSA Monitoring / Field Lead is responsible for collecting groundwater level measurements and supplying those data to the GSP QA Officer / Data Manager for compilation and a QA/QC review to avoid data entry mistakes. The GSP QA Officer / Data Manager will then compile the GSA-level data into standard forms for uploading to the Subbasin DMS and check that data have been uploaded correctly. All data from the seasonal high monitoring event will be uploaded to the DMS by May 31 and submitted to DWR by July 1, and all data from the seasonal low monitoring event will be uploaded to the DMS by November 30 and submitted to DWR by January 1. These data will also be included in the Annual Report. The Plan Administrator then reviews data prior to compilation at the Subbasin level for inclusion in the annual report.

7.2.6.1.5 Data Gaps

Due to the sufficient spatial coverage (both horizontally and vertically), temporal coverage, and density of wells throughout the Sutter Subbasin, groundwater level monitoring data gaps do not exist (as defined in the GSP Emergency Regulations § 354.38(b)). There is an abundance of potential monitoring wells in the Subbasin where 'knowledge' gaps in confirmed well construction information are known to occur. **Figure 7-6** includes all groundwater level wells with known location information, with and without construction information, in the Sutter Subbasin stored in the Subbasin DMS.

7.2.6.1.6 Plans to Fill Data Gaps

In order to support completeness of the information contained in the Subbasin DMS, the Sutter Subbasin GSAs are proposing to conduct a well census project to compile information from DWR's Well Completion Report database, identify wells without construction information that could be beneficial to add to the monitoring network in future updates, and conduct downhole video surveys of select wells to determine relevant missing construction information, such as screen interval and total depth data. Refer to **Section 7.1.6.3.2** for more detail regarding this effort.

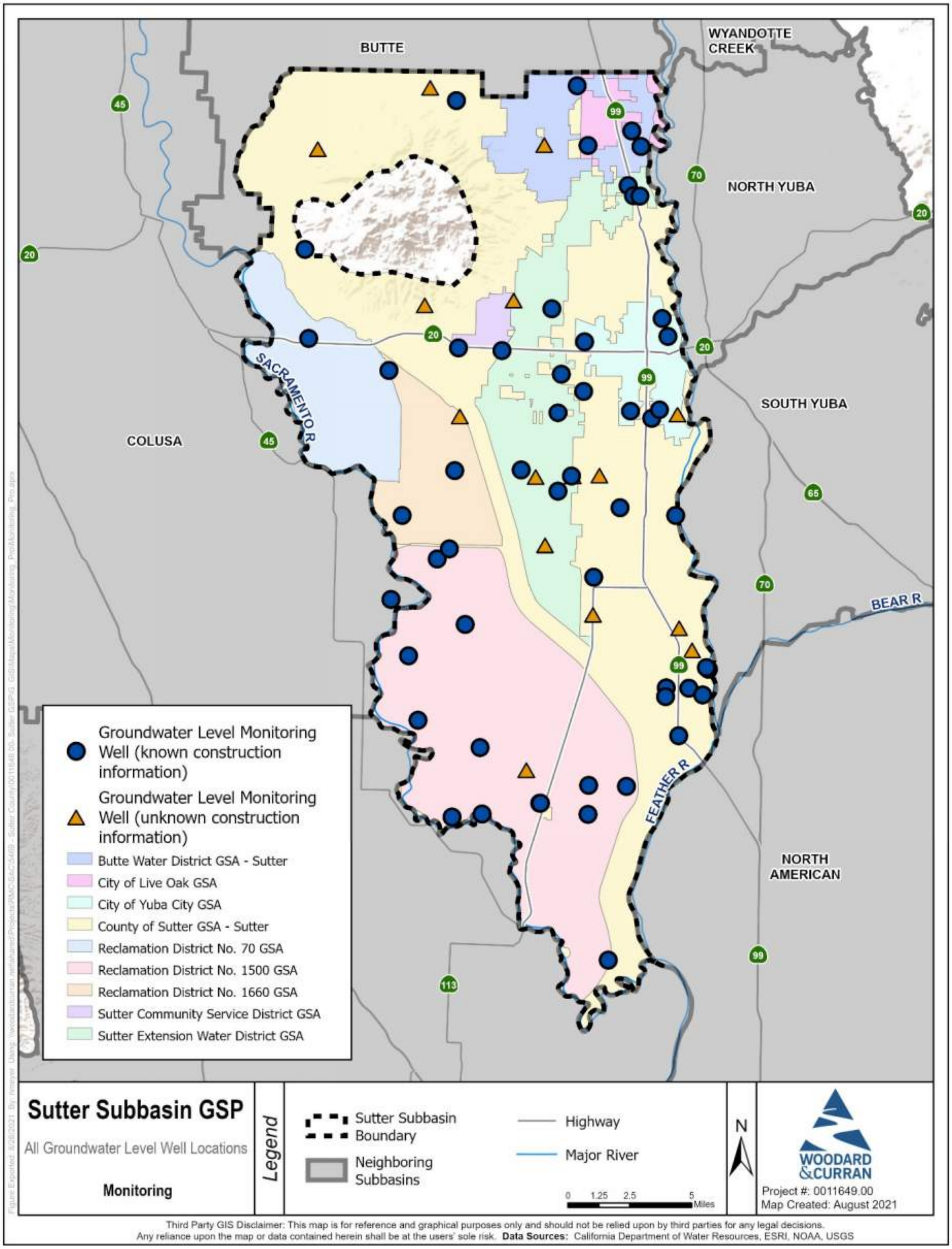


Figure 7-6. All Groundwater Level Wells in Sutter Subbasin

7.2.6.2 Groundwater Storage Monitoring Network

Groundwater levels will be used as a proxy for the reduction of groundwater storage sustainability indicator. Therefore, the groundwater storage monitoring network is the same as that used for the groundwater level monitoring network described in **Section 7.2.6.1**.

7.2.6.3 Seawater Intrusion Monitoring Network

Seawater intrusion is not an applicable sustainability indicator for the Sutter Subbasin as the Subbasin is located inland from the Pacific Ocean and is not adjacent to the Sacramento-San Joaquin Delta. As a result, the Sutter Subbasin is not at risk of seawater intrusion and a monitoring network will not be established for this sustainability indicator (GSP Emergency Regulations § 354.34(j)).

7.2.6.4 Groundwater Quality Monitoring Network

The groundwater quality monitoring network, used to assess the degraded water quality sustainability indicator, is designed to collect sufficient spatial and temporal data to assess groundwater quality trends to address known water quality issues. Total dissolved solids (TDS) and nitrate as Nitrogen (N) have been identified by the Sutter Subbasin as water quality constituents of concern within the Plan area.

This section provides information about how the groundwater quality monitoring network was developed, criteria for selecting monitoring sites, parameters, spatial density, summary of protocols, monitoring frequency and timing, and identification of and strategies to fill data gaps.

7.2.6.4.1 Selected Monitoring Sites

Due to limited recent groundwater quality measurements in the Subbasin since 1990, wells in the groundwater quality monitoring network were selected to maximize representation of current and historical data. Wells were selected to monitor areas of elevated nitrate and elevated TDS and to provide upgradient and cross-gradient data points. Corresponding monitoring wells in all aquifer zones were selected to assess the potential for the vertical movement of poorer quality groundwater.

Wells identified in **Table 7-50** were selected based on the above criteria to evaluate short-term, seasonal, and long-term trends in groundwater quality. Maps of the wells screened in the Shallow AZ, AZ-1, AZ-2, and AZ-3 of the principal aquifer are presented in **Figure 7-7** through **Figure 7-10**, respectively. **Figure 7-11** includes wells in the groundwater quality monitoring network with unknown construction information, and therefore unknow aquifer zone. A plan to fill this data gap is discussed in **Section 7.2.6.4.6**.

Table 7-50. Groundwater Quality Monitoring Network Wells

Site Code	State Well Number	Local ID / Other ID	Aquifer Zone	Overlying GSA	Status	Well Use	Depth (ft bgs)	Screen Interval (ft bgs)	Constituents	First Measurement	Latest Measurement	Measurement Count
391975N1218937W001	16N01E31H001M	-	Shallow	Sutter County GSA	Active	Unknown	36	-	-	-	-	-
-	-	RICE-01	Shallow	Reclamation District No. 1500 GSA	Active	Public Supply	50	40 - 90	TDS and Nitrate as N	7/17/2006	7/17/2006	1 for both TDS and Nitrate as N)
-	-	RICE-02	Shallow	Sutter Extension WD GSA	Active	Public Supply	44	34 - 78	TDS and Nitrate as N	7/18/2006	7/18/2006	1 for both TDS and Nitrate as N)
-	-	RICE-03	Shallow	Sutter County GSA	Active	Public Supply	35	25 - 60	TDS and Nitrate as N	7/18/2006	7/18/2006	1 for both TDS and Nitrate as N)
-	-	RICE-20	Shallow	Reclamation District No. 1500 GSA	Active	Public Supply	29	19 - 48	TDS and Nitrate as N	8/17/2006	8/17/2006	1 for both TDS and Nitrate as N)
388761N1217094W001	12N02E23H001M	Sutter County MW-2A	AZ-1	Sutter County GSA	Active	Observation	150	120 - 140	-	-	-	-
389605N1218102W003	13N01E24G004M	Flood MW-1C (shall)	AZ-1	Reclamation District No. 1500 GSA	Active	Observation	100	70 - 90	-	-	-	-
389803N1217675W001	13N02E17A001M	-	AZ-1	Reclamation District No. 1500 GSA	Active	Other	149	-	TDS and Nitrate as N	8/7/1974	8/25/2005	7 for TDS; 3 for Nitrate as N
390588N1217004W001	14N02E13L001M	-	AZ-1	Sutter Extension WD GSA	Active	Irrigation	82	68 - 82	TDS and Nitrate as N	3/17/1965	8/23/2005	7 for TDS; 6 for Nitrate as N
390497N1216535W001	14N03E20H003M	-	AZ-1	Sutter County GSA	Active	Irrigation	125	68 - 125	TDS and Nitrate as N	3/31/1965	8/18/2004	8 for TDS; 2 for Nitrate as N
-	-	Hillcrest Well #5	AZ-1 and AZ-2	City of Yuba City GSA	Inactive	Public Supply	320	94 - 118; 166 - 180; 264 - 288	Nitrate as N	12/26/2001	6/25/2009	10
388761N1217094W002	12N02E23H002M	Sutter County MW-2B	AZ-2	Sutter County GSA	Active	Observation	300	210 - 220	-	-	-	-
389167N1216061W004	12N03E02G003M	-	AZ-2	Sutter County GSA	Active	Monitoring	321	-	TDS	4/17/1980	4/17/1980	1
389605N1218102W002	13N01E24G003M	Flood MW-1B (int)	AZ-2	Reclamation District No. 1500 GSA	Active	Observation	160	130 - 160	-	-	-	-
-	-	Hillcrest Well #8	AZ-2	City of Yuba City GSA	Inactive	Public Supply	254	-	Nitrate as N	4/8/2002	6/25/2009	9
-	-	Hillcrest Well #9	AZ-2	City of Yuba City GSA	Inactive	Public Supply	190	-	Nitrate as N	12/26/2001	6/25/2010	12
-	-	Well-1A / 5110001-011	AZ-2	City of Live Oak GSA	Active	Public Supply	292	-	TDS and Nitrate as N	12/9/2015	7/6/2021	5 for TDS; 23 for Nitrate as N
-	-	Well-2A / 5110001-013	AZ-2	City of Live Oak GSA	Active	Public Supply	210	-	TDS and Nitrate as N	2/28/2006	7/6/2021	5 for TDS; 26 for Nitrate as N
-	-	WTP well	AZ-2 and AZ-3	City of Yuba City GSA	Active	Public Supply	-	370 - 390; 453 - 473	TDS and Nitrate as N	11/8/1995	1/13/2021	12 for TDS; 5 for Nitrate as N
388666N1217749W001	12N02E20P001M	-	AZ-3	Reclamation District No. 1500 GSA	Active	Irrigation	500	380 - 420	TDS	9/11/1975	9/11/1975	1
388761N1217094W003	12N02E23H003M	Sutter County MW-2C	AZ-3	Sutter County GSA	Active	Observation	600	570 - 590	-	-	-	-
388761N1217094W004	12N02E23H004M	Sutter County MW-2D	AZ-3	Sutter County GSA	Active	Observation	705	655 - 665	-	-	-	-
389167N1216061W003	12N03E02G002M	-	AZ-3	Sutter County GSA	Active	Monitoring	721	-	TDS	4/17/1980	4/17/1980	1
390696N1217778W003	14N02E17C003M	Sutter County MW-1C	AZ-3	Reclamation District No. 1660 GSA	Active	Observation	425	395 - 415	-	-	-	-
390696N1217778W004	14N02E17C004M	Sutter County MW-1D	AZ-3	Reclamation District No. 1660 GSA	Active	Observation	755	725 - 745	-	-	-	-
390458N1216114W003	14N03E23D005M	Feather River MW-1C	AZ-3	Sutter County GSA	Active	Observation	689	664 - 684	-	-	-	-
-	-	5100172-001	Unknown	Butte WD GSA	Unknown	Public Supply	-	-	TDS and Nitrate as N	12/17/1992	7/8/2020	3 for TDS; 5 for Nitrate as N
-	-	5101007-001	Unknown	Sutter County GSA	Unknown	Public Supply	-	-	-	-	-	-

This page intentionally left blank.

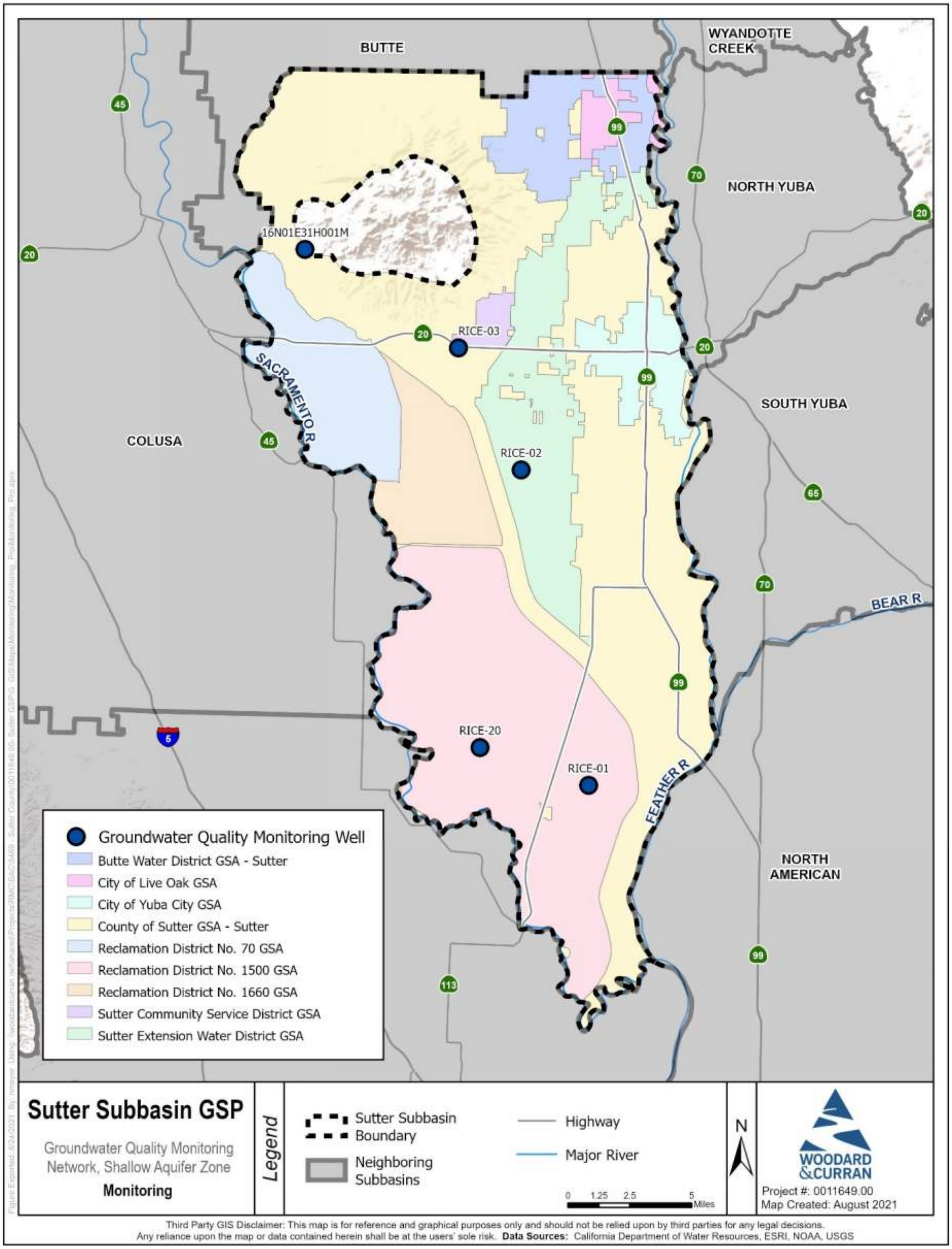


Figure 7-7. Groundwater Quality Monitoring Network Wells, Shallow AZ

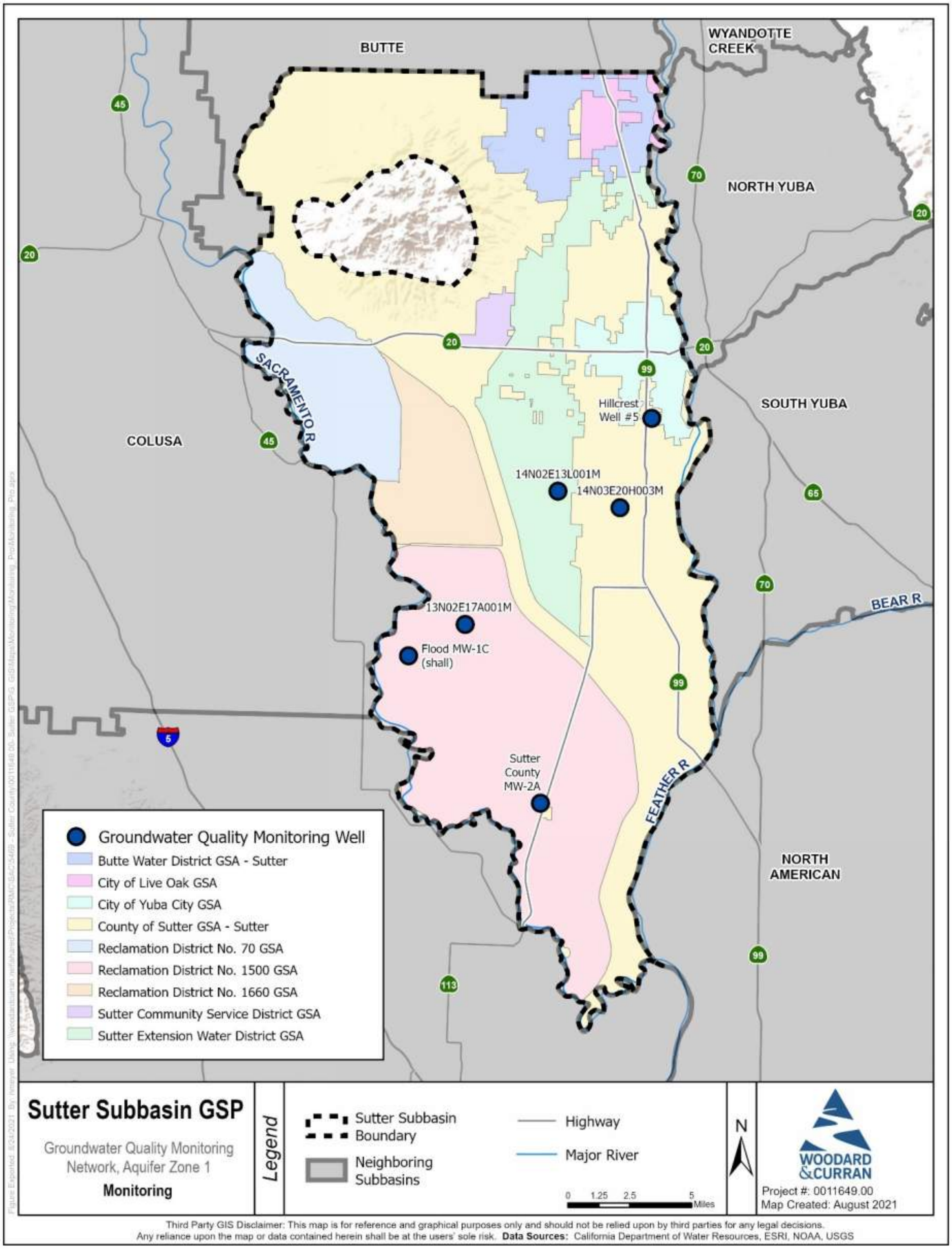


Figure 7-8. Groundwater Quality Monitoring Network Wells, AZ-1

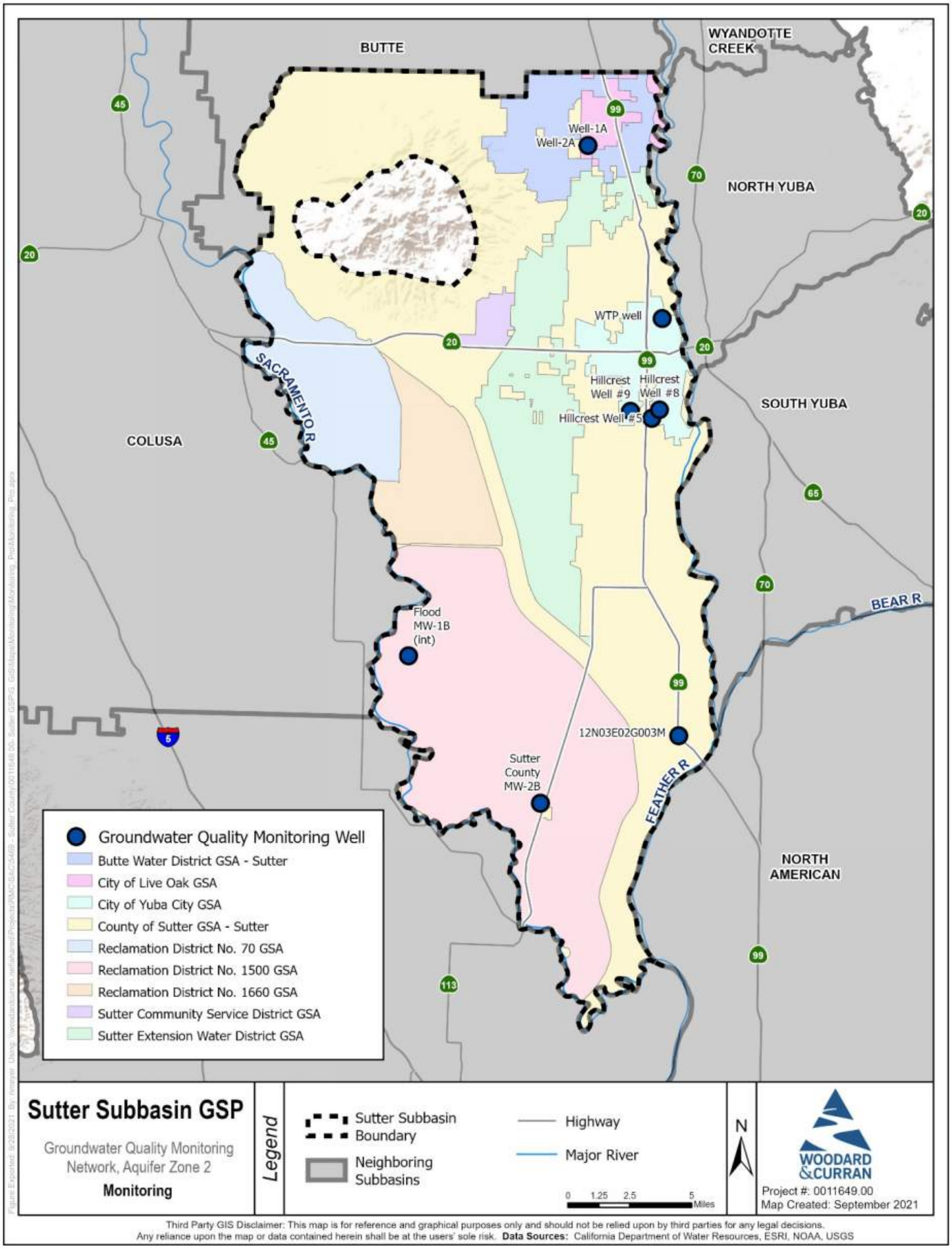


Figure 7-9. Groundwater Quality Monitoring Network Wells, AZ-2

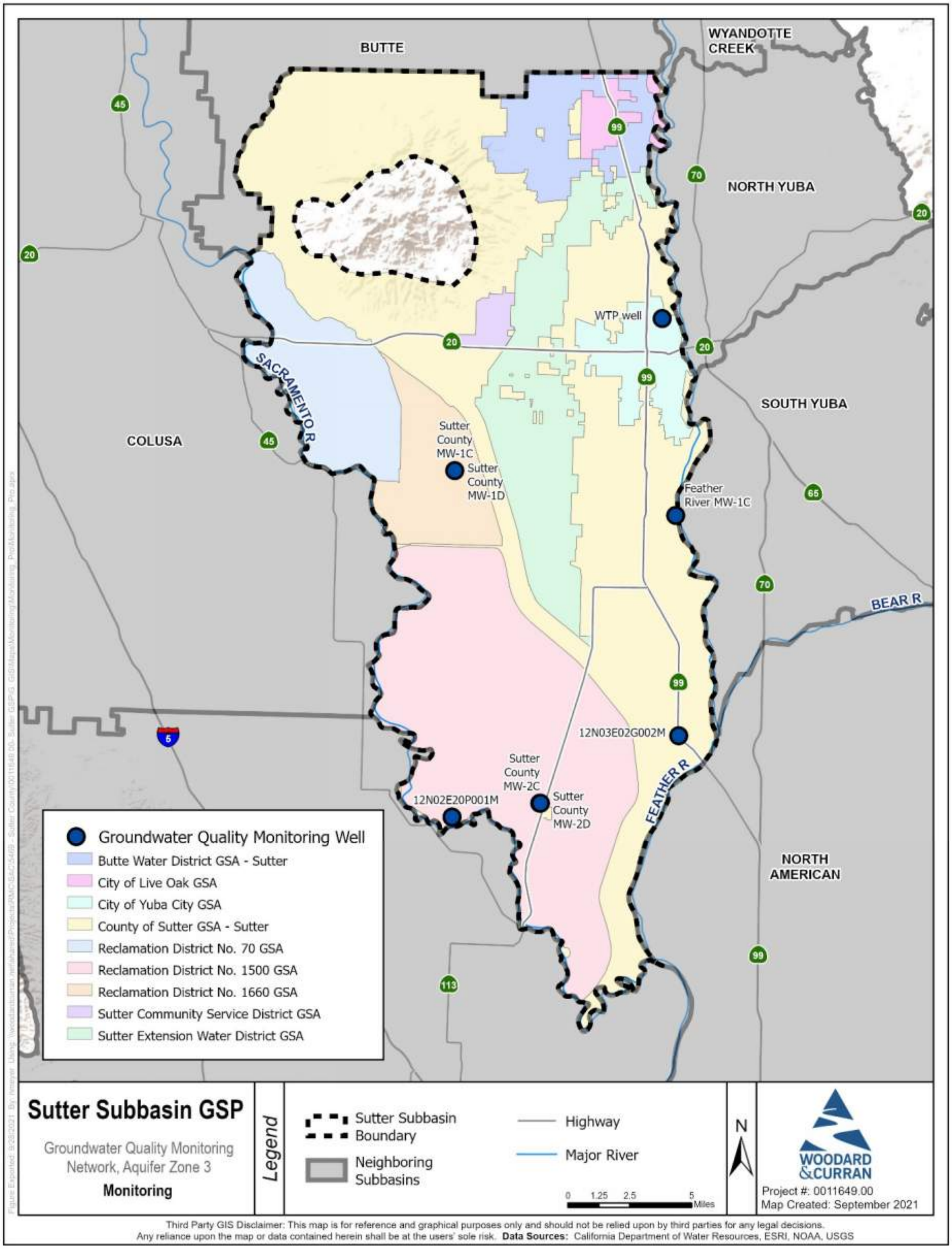


Figure 7-10. Groundwater Quality Monitoring Network Wells, AZ-3

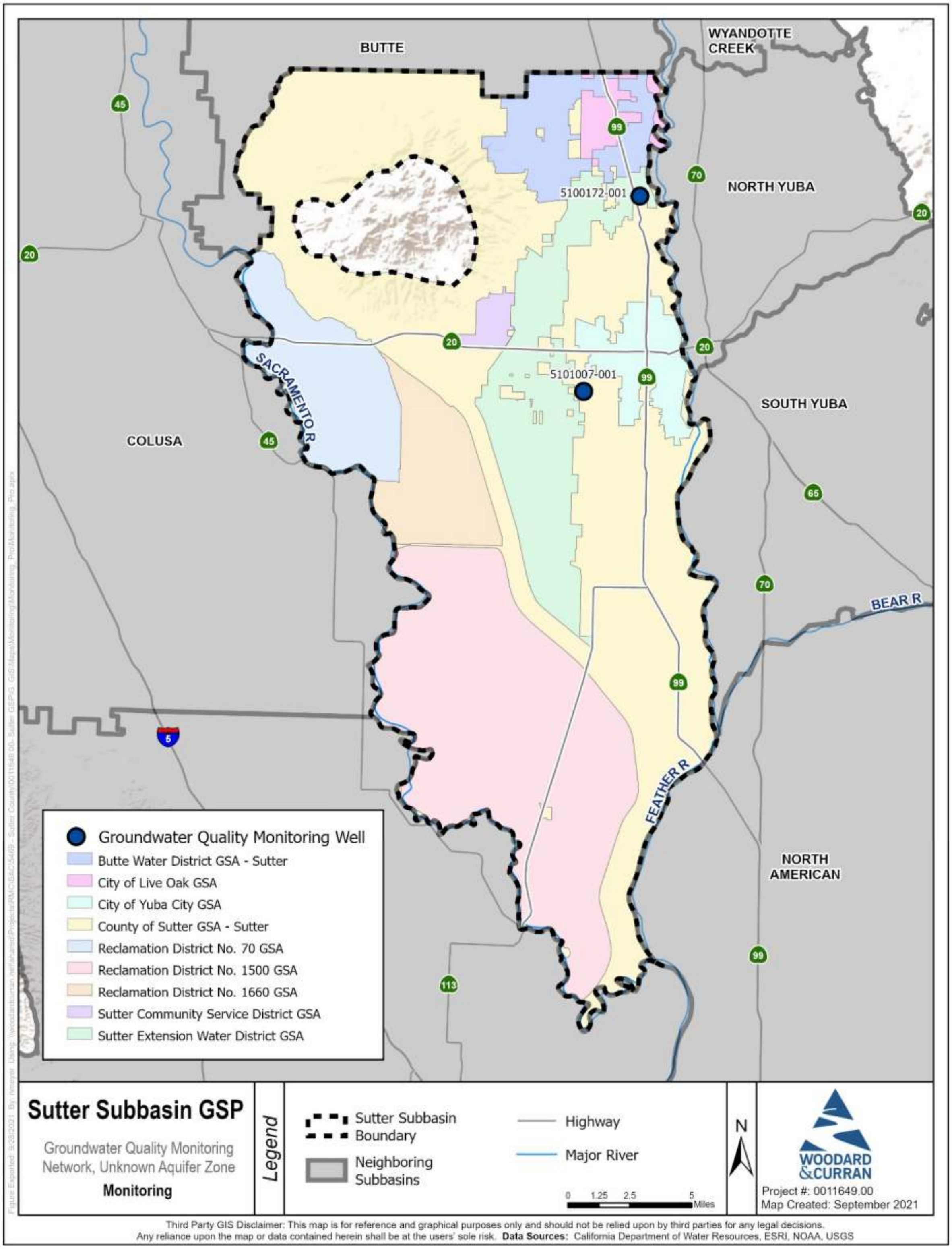


Figure 7-11. Groundwater Quality Monitoring Network Wells, Unknown AZ

7.2.6.4.2 Spatial Density

According to DWR's *Monitoring Networks and Identification of Data Gaps* BMP (DWR, 2016a), "the spatial distribution [of wells] should be adequate to map or supplement mapping of known contaminants." The goal of the groundwater quality monitoring network is to adequately cover the Subbasin to accurately characterize concentrations and trends of constituents of concern. This includes both spatial and temporal coverage in order to identify changes in ambient groundwater quality over time. As such, professional judgement was used, along with available well construction and groundwater quality data, to identify the appropriate spatial density for the groundwater quality monitoring network.

7.2.6.4.3 Monitoring Frequency

Groundwater quality sampling will occur once per year during irrigation season in September. The frequency and timing for groundwater quality monitoring were agreed upon by the Sutter Subbasin GSAs and deemed sufficient for evaluating the long-term trends in water quality. The frequency and timing of water quality monitoring will be reevaluated during future GSP updates and revised as deemed necessary.

7.2.6.4.4 Monitoring Protocols

Monitoring protocols and data reporting requirements for the groundwater quality monitoring network have been developed in accordance with DWR's *Monitoring Protocols, Standards, and Sites* BMP (DWR, 2016b). Monitoring protocols applicable to all Sutter Subbasin GSP monitoring networks are detailed in **Section 7.2.5.1**. Monitoring protocols established for the groundwater quality monitoring network will be reviewed every five years and modified as necessary, particularly as new methods or technology are developed, where any modifications to the monitoring protocols will be documents in detail within future GSP updates.

<u>Sampling Water Quality Data</u>

The following guidelines were adopted from DWR's *Standardized [Groundwater Quality Sampling] Protocols* (DWR, 2016b):

- Prior to sampling, the sampler must contact the State-certified analytical laboratory to schedule laboratory time, obtain appropriate sample containers, and clarify any sample holding times or sample preservation requirements.
- Each well used for groundwater quality monitoring must have a unique identifier. This identifier must appear on the well housing or the well casing to avoid confusion.
- In the case of wells with dedicated pumps, samples should be collected at or near the wellhead. Samples should not be collected from storage tanks, at the end of long pipe runs, or after any water treatment.

- The sampler will clean the sampling port and/or sampling equipment and the sampling port and/or sampling equipment must be free of any contaminants. The sampler must decontaminate sampling equipment between sampling locations or wells to avoid cross-contamination between samples.
- The groundwater elevation in the well will be measured following appropriate protocols described above in the groundwater level measuring protocols prior to purging.
- For any well not equipped with low-flow or passive sampling equipment, an adequate volume of water will be purged from the well to ensure that the groundwater sample is representative of ambient groundwater and not stagnant water in the well casing. Purging three well casing volumes is generally considered adequate. Professional judgment will be used to determine the proper configuration of the sampling equipment with respect to well construction such that a representative ambient groundwater sample is collected. If pumping causes a well to be evacuated (go dry), the condition will be documented and the well allowed to recover to within 90% of original level prior to sampling. Professional judgment should be exercised as to whether the sample will meet the DQOs and adjusted as necessary.
- Field parameters of pH, electrical conductivity (EC), and temperature will be collected for each sample. Field parameters should be evaluated during the purging of the well and should stabilize prior to sampling. Measurements of pH will only be measured in the field; lab pH analysis are typically unachievable due to short hold times. All field instruments will be calibrated daily and evaluated for drift throughout the day.
- Sample containers will be labeled prior to sample collection. The sample label must include sample ID (often well ID), sample date and time, sample personnel, sample location, preservative used, and analytes and analytical method.
- Samples will be collected under laminar flow conditions, when possible, with the goal of reducing turbulence. This may require reducing pumping rates prior to sample collection.
- Samples should be collected according to appropriate standards such as those listed in the *Standard Methods for the Examination of Water and Wastewater*, United States Geological Survey (USGS) *National Field Manual for the Collection of Water Quality Data,* or other appropriate guidance. The specific sample collection procedure should reflect the type of analysis to be performed and DQOs.
- All samples requiring preservation must be preserved as soon as practically possible, ideally at the time of sample collection. The sampler will ensure that

samples are appropriately filtered as recommended for the specific analyte. Entrained solids can be dissolved by preservative leading to inconsistent results of dissolve analytes. Specifically, samples to be analyzed for metals will be field-filtered prior to preservation; do not collect an unfiltered sample in a preserved container.

- Samples will be maintained at a temperature in accordance with the laboratory's Quality Assurance Management Plan's chilling and shipping requirements.
- Samples must be shipped under chain of custody documentation to the appropriate laboratory promptly to avoid violating holding time restrictions.
- The laboratory will be instructed to use reporting limits that are equal to or less than the applicable DQOs or regional water quality objectives/screening levels.

Analytical Methods

Wells in the groundwater quality monitoring network will be sampled in coordination with other ongoing water quality sampling programs. Wells will be appropriately purged in accordance with their type and operational history to ensure that a representative groundwater sample is collected from the well. Wells will be purged for a sufficient time (see basic purging below) to evacuate water held in casing storage before collecting the water sample. This is important to ensure that water collected from a well is representative of groundwater in the aquifer formation outside the well bore.

Prior to sampling of a well, the depth to the water in the well will be measured, if possible, and recorded. It may not be possible to measure the water level due to wellhead accessibility or because the well is actively pumping. The well operational status prior to and at the time of sampling will be noted and any other observations at a well site that may potentially relate to the well or groundwater sampling will be described. Field water quality parameters, including EC, pH, and temperature, will be tested and recorded during sampling. Observed characteristics of the water during sampling, such as color, smell, or other visual observations, will be documented in a field notebook. All instruments used to measure field conditions during sampling will be calibrated on a regular basis in accordance with manufacturer guidelines and recommendations.

Water samples collected for laboratory analytical testing will be collected in appropriate laboratory-approved sample containers and stored in accordance with recommended sample handling procedures indicated by the laboratory. The sample identification, time, date, and any other informational fields indicated on the sample container label will be clearly provided. The associated laboratory chain of custody (COC) for samples will be completed and signed and provided with the samples at the time of delivery of samples to the laboratory for analysis.

Basic Purging. If possible, a minimum of three casing volumes will be purged from the well prior to sample collection. Larger-capacity wells may not need purging (or may need more pumping) depending on their operational history. For smaller-capacity wells, such as domestic wells, achieving a three-casing volume purge may not be practical because of operational constraints relating to the well and water distribution system. In cases where a three-casing volume purge is not achievable, field parameters (EC, pH, temperature, etc.) of the water will be monitored during pumping/purging and a sample will not be collected until the field parameters have sufficiently stabilized. Field parameters will be monitored and recorded at least three times during well pumping/purging.

Low Flow. In addition to the protocols listed above, sampling using low-flow sample equipment should adopt the protocols set forth in the USEPA's *Low-flow (minimal drawdown) ground-water sampling procedures* (Puls and Barcelona, 1996). These protocols are not intended for bailers and apply to low-flow sampling equipment that generally pumps between 0.026 and 0.13 gallons per minute [0.1 and 0.5 liters per minute].

No Flow. For wells lacking pumping equipment and with casing volumes that make well purging difficult or impractical, a no-purge sampling device, such as a HydraSleeve, may be utilized to collect the sample. No-purge sampling methods should be conducted in accordance with recommended guidelines for the sample collection specific to the sampling device. When using a no-purge sampling method, a sufficient water sample should be collected for measuring field parameters and filling all necessary laboratory sample bottles.

For monitoring wells with installed pumping systems, groundwater samples will be collected from a point in the distribution system as near to the wellhead as possible and prior to any filtration or pressure tank, if possible.

Analytical methods for nitrate as N will follow EPA Method 300.0 (Determination of Inorganic Anions by Ion Chromatography), including a maximum hold time of 48 hours, 0.004 mg/L detection limit, and 0.05 mg/L reporting limit. Analytical methods for TDS will follow Standard Method 2540C (Total Dissolved Solids Dried at 180°C), including a maximum hold time of 7 days, 4.224 mg/L detection limit, and 10 mg/L reporting limit.

Data Reduction, Validation, and Reporting

Chain of custody documentation will be used to document sample collection, shipping, storage, preservation, and analysis. All individuals transferring and receiving samples will sign, date, and record the time on the chain of custody form that the samples are transferred. Laboratory chain of custody procedures are described in each laboratory's Quality Assurance Program Manual. Laboratories must receive the chain of custody documentation submitted with each batch of samples and sign, date, and record the time the samples are transferred. Laboratories will also note any sample discrepancies (e.g., labeling or breakage). After generating the laboratory data report for the client, samples will be stored for a minimum of 30 days in a secured area prior to disposal.

Water quality samples should be delivered and tested at a state accredited analytical laboratory. A list of approved laboratories is provided on the State Water Resources Control Board (SWRCB) Environmental Laboratory Accreditation Program (ELAP) website at https://www.waterboards.ca.gov/drinking_water/certlic/labs/.

Data generated or acquired as part of the Sutter Subbasin GSP monitoring networks will be uploaded to the coordinated DMS as soon as possible. All monitoring locations in the GSP monitoring networks of the Sutter Subbasin will be assigned a unique ID and information associated with each monitoring location, such as well characteristics and historical hydrologic observations, will be compiled and maintained within the DMS. The structure of the DMS will be compatible with Geographic Information System (GIS) and other data formats and to facilitate future uploading of data to a state GSP database. Care should be taken to avoid data entry mistakes and electronic data transfers from the analytical laboratory should be used whenever possible.

Each GSA Monitoring / Field Lead is responsible for collecting groundwater quality samples and supplying the resultant data to the GSP QA Officer / Data Manager for compilation and a QA/QC review to avoid data entry mistakes. The GSP QA Officer / Data Manager will then compile the GSA-level data into standard forms for uploading to the Subbasin DMS using import wizards and check that data has been uploaded correctly. All data is to be updated in the DMS by October 31 each year for inclusion in the Annual Report. The Plan Administrator then reviews data uploaded at the Subbasin level for annual reporting. Should a result appear suspicious, a second sample shall be obtained as soon as possible for confirmation of the analytical result.

7.2.6.4.5 Data Gaps

As identified in **Figure 7-11** and **Table 7-50**, there are two wells in the groundwater quality monitoring network with unknown construction information. These wells are included in the groundwater quality monitoring network due to their proximity to the urban centers in the Subbasin, the cities of Yuba City and Live Oak, and their ability to demonstrate ambient groundwater quality that may be associated with human activities.

Due to the sufficient spatial coverage (both horizontally and vertically) and density of wells throughout the Sutter Subbasin, physical groundwater quality monitoring data gaps do not exist (as defined in the GSP Emergency Regulations § 354.38(b)). There is an abundance of potential monitoring wells in the Subbasin, where ‘knowledge’ gaps in confirmed well construction information are known to occur. In particular, lack of borehole diameter information and well status inhibits the GSAs ability to evaluate a potential well for addition to the monitoring network (as three casing volumes must be purged from the well prior to sample collection, wells with large borehole diameters require excessive amounts of water to accomplish this).

In addition, while temporal data gaps have existed in the past, implementation of this GSP will result in more frequent monitoring, as described in **Section 7.2.6.4.3**.

7.2.6.4.6 Plans to Fill Data Gaps

The Sutter Subbasin GSAs will attempt to obtain construction information for the two wells with unknown construction information in the groundwater quality monitoring network using the proposed well census to identify the well log associated with each well, described in **Section 7.1.6.3.2**, or via a downhole video survey. Well construction information for these two wells will be confirmed within the first five years of GSP implementation, with construction information included in the 2027 GSP Update.

As previously mentioned, to fill ‘knowledge’ gaps and collect or confirm well construction information, the Sutter Subbasin GSAs are proposing to conduct a well census project to compile information from DWR’s Well Completion Report database, identify wells without construction information that could be beneficial to add to the monitoring network in future updates, and conduct downhole video surveys of select wells to determine relevant missing construction information, such as borehole diameter and screen interval data. Refer to **Section 7.1.6.3.2** for more detail regarding this effort.

7.2.6.5 Land Subsidence Monitoring Network

The land subsidence monitoring network, used to assess the land subsidence sustainability indicator, is established to identify the rate and extent of inelastic land subsidence, as measured by extensometers, remote sensing technology, or other appropriate methods. Selection of land surface elevation monitoring sites were considered in relation to critical infrastructure in the Sutter Subbasin.

This section provides information about how the land subsidence monitoring network was developed, criteria for selecting monitoring sites, parameters, spatial density, summary of protocols, monitoring frequency and timing, and identification of and strategies to fill data gaps.

7.2.6.5.1 Selected Monitoring Sites

Monitoring of land subsidence in the Sutter Subbasin relies on the Sacramento Valley Subsidence Network. Developed in 2008 by DWR, U.S. Bureau of Reclamation (USBR), and other State and local entities, the network consists of 339 monuments, 22 of which are located within the Sutter Subbasin (**Table 7-51**) (Wood Rodgers, 2012). All 22 monuments within the Subbasin are included within the subsidence monitoring network (**Figure 7-12**).

This page intentionally left blank.

Table 7-51. Subsidence Monitoring Network Sites

DWR Station ID	DWR Station Name	Latitude	Longitude	Monitoring Site Type	Frequency of Measurement
304	HPGN CA 03 04	39.1433	-121.9017	GPS Surveying	5-year interval
BOGE	BOGUE	39.0984	-121.7453	GPS Surveying	5-year interval
CANL	CANAL KS1836	39.1414	-121.6985	GPS Surveying	5-year interval
EAGR	EAGER	39.1750	-121.6348	GPS Surveying	5-year interval
ENNS	ENNIS	39.0845	-121.8003	GPS Surveying	5-year interval
F114	F 114	39.1570	-121.7769	GPS Surveying	5-year interval
G117	G 1175	39.2868	-121.7844	GPS Surveying	5-year interval
HPIN	HOPPIN	39.0840	-121.6896	GPS Surveying	5-year interval
K435	K 1435	39.1301	-121.6030	GPS Surveying	5-year interval
LOAK	LIVE OAK	39.2923	-121.6675	GPS Surveying	5-year interval
LOMO	LOMO	39.2212	-121.6417	GPS Surveying	5-year interval
MRSN	MORRISON	39.2316	-121.7057	GPS Surveying	5-year interval
OSWD	OSWALD	39.0690	-121.6431	GPS Surveying	5-year interval
PASS	PASSBUTTE	39.1869	-121.8776	GPS Surveying	5-year interval
PELG	PELGER	38.9529	-121.7532	GPS Surveying	5-year interval
SACA	SACRAMENTO AVENUE	38.9162	-121.6061	GPS Surveying	5-year interval
SAWT	SAWTELLE	38.9523	-121.6348	GPS Surveying	5-year interval
TARK	TARKE	39.1432	-121.8426	GPS Surveying	5-year interval
TSDL	TISDALE	39.0214	-121.7413	GPS Surveying	5-year interval
VARN	VARNEY	38.8860	-121.7019	GPS Surveying	5-year interval
WASH	WASHINGTON	39.0030	-121.6715	GPS Surveying	5-year interval
WR18	DWR18	39.2530	-121.8917	GPS Surveying	5-year interval

This page intentionally left blank.

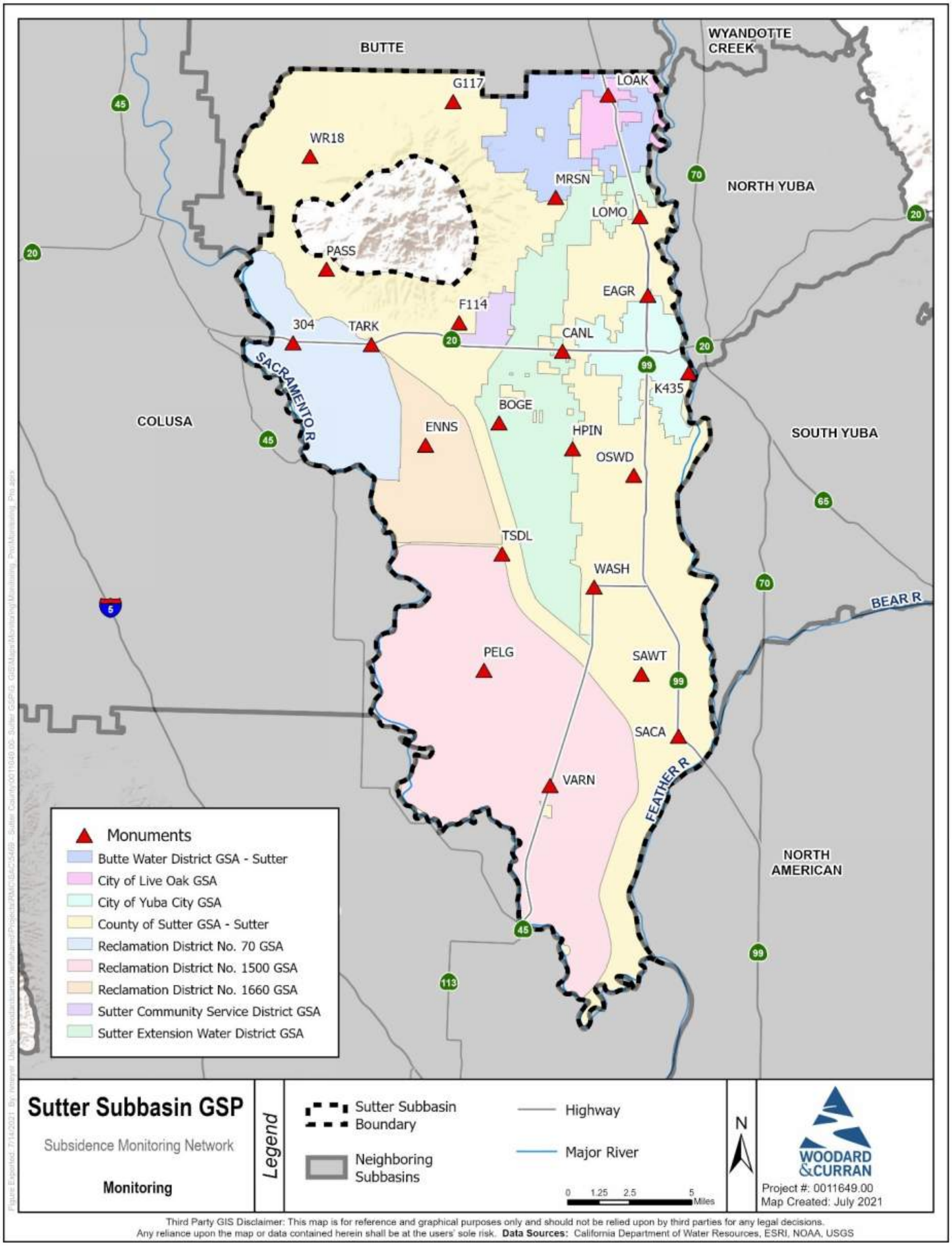


Figure 7-12. Subsidence Monitoring Network

7.2.6.5.2 Spatial Density

Guidance related to the spatial density of land subsidence monitoring sites is not provided in DWR's *Monitoring Networks and Identification of Data Gaps* BMP (DWR, 2016a). It is noted that the land subsidence monitoring network "should be established to observe the sustainability indicator such that the sustainability goal can be met" (DWR, 2016a). Professional judgement, along with historical survey data, existing survey benchmarks, and local experience, was used to establish the appropriate spatial density of land subsidence monitoring networks within the Subbasin.

7.2.6.5.3 Monitoring Frequency

The Sacramento Valley Subsidence Network is intended to be monitored on a 5-year timeframe, with the next survey scheduled to occur in 2022. However, to supplement its monitoring efforts and ensure that concerning levels of subsidence are not observed between the 5-year reporting periods, the Sutter Subbasin GSAs will evaluate Interferometric Synthetic Aperture Imagery (InSAR) data on an annual basis (available via DWR's SGMA Data Viewer: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer). InSAR data is collected monthly by NASA's Jet Propulsion Laboratory and is released quarterly by DWR.

In the event that inelastic land subsidence is observed at a rate that ultimately would result in undesirable results in the Sutter Subbasin or its neighboring subbasins, the frequency of monitoring for subsidence in the Sutter Subbasin would be reevaluated.

7.2.6.5.4 Monitoring Protocols

Monitoring protocols and data reporting requirements for the land subsidence monitoring network have been developed in accordance with DWR's *Monitoring Protocols, Standards, and Sites* BMP (DWR, 2016b). Monitoring protocols applicable to all Sutter Subbasin GSP monitoring networks are detailed in **Section 7.2.5.1**. Monitoring protocols established for the land subsidence monitoring network will be reviewed every five years and modified as necessary, where any modifications to the monitoring protocols will be documented in detail in future GSP updates.

The Sutter Subbasin GSAs will be relying on subsidence data collected by DWR and NASA JPL to monitor for undesirable results relative to land subsidence and will not directly conduct subsidence monitoring as part of the GSP implementation. Protocols for land surveying are described herein in the event modifications are made to the monitoring network or if greater frequency in monitoring is deemed to be required and conducted by the Sutter Subbasin GSAs.

Land Surveying Procedures

The following guidelines for conducting ground surface elevations measurements via land surveying were adopted from the U.S. Department of Agriculture, Natural Resources Conservation Service *Engineering Field Handbook* (2008):

- All surveys will be conducted by a California licensed land surveyor and will tie into established benchmarks.
- Prior to taking the first measurement at a given representative monitoring location, the established benchmark for the monitoring site will be identified and information will be obtained from the appropriate entity prior to field work.
- Maps and photographs of the monitoring site will be made available to the surveyor.
- Proper protocols and procedures will be followed to set up and level the surveying equipment.
- Before taking a reading, ensure the measurement rod is in the vertical position and no foreign material prevents clear contact between the rod and the point to be read.
- The leveling bubble on the surveying equipment will be checked regularly during use by the surveyor to make sure no inadvertent movement has occurred. If necessary, proper protocols and procedures to re-level the surveying equipment will be followed to begin measuring again. Adjustments to the level should never be made part way through a circuit.
- All vertical elevation measurements will be collected relative to NAVD88.
- Field notes will, at a minimum, contain the following information:
    - Location of survey (including coordinates and written description)
    - Date and time of survey
    - Instruments and technique used
    - Established benchmark tied to the monitoring site
    - Monitoring site ID
    - Measured benchmark elevation (to 0.1-foot accuracy)
    - Measured elevation at monitoring site relative to the established benchmark (to 0.1-foot accuracy)
    - Description of any modifications to the monitoring site

<u>Data Reduction, Validation, and Reporting</u>

Data generated or acquired as part of the Sutter Subbasin GSP monitoring networks will be uploaded to the Subbasin DMS as soon as possible following validation. All representative monitoring sites will be assigned a unique ID number and information associated with monitoring site, such as such as location descriptions and associated photographs, will be compiled and maintained within the DMS. The structure of the DMS will be compatible with GIS and other data formats to facilitate future uploading of data to external databases.

The GSA Monitoring / Field Lead is responsible for collecting land survey measurements and supplying the resultant data to the GSP QA Officer / Data Manager for compilation and a QA/QC review to avoid data entry mistakes. The GSP QA Officer / Data Manager will then compile the GSA-level data into standard forms for uploading to the Subbasin DMS and check that data has been uploaded correctly. All data are to be updated by October 31 each year for inclusion in the Annual Report. The Plan Administrator then reviews data uploaded at the Subbasin level for annual reporting. Should a measurement appear suspicious, a second confirmation reading shall be obtained as soon as possible.

In addition to data collected directly by the GSAs, subsidence data will be downloaded from publicly available sources such as DWR's SGMA Data Viewer for assessment with local data. All data will be maintained in the Subbasin DMS.

7.2.6.5.5 Data Gaps

The current level of monitoring is considered appropriate for the Sutter Subbasin based on the limited level of land subsidence observed in recent years and lack of reported negative impacts of land subsidence on critical infrastructure. Should data collected begin to show evidence of subsidence or reports of negative impacts on infrastructure arise, the Sutter Subbasin GSAs may pursue additional monitoring activities, including more frequent monitoring or installation of an extensometer.

7.2.6.5.6 Plans to Fill Data Gaps

As subsidence data gaps other than temporal (e.g., historical data) are absent, the GSAs will evaluate the need to increase monitoring frequency based on the annual evaluation of InSAR data (see **Section 7.1.6.3.3**).

7.2.6.6 Interconnected Surface Water Monitoring Network

A monitoring network for the depletions of interconnected surface water sustainability indicator is designed to monitor surface water and groundwater conditions at locations where interconnected surface water conditions exist to characterize the spatial and temporal relationship between surface water stage and groundwater elevations. This monitoring network is also designed to provide the necessary data for calculating depletions of surface water caused by groundwater extractions. The monitoring network is intended to characterize the following:

1. Flow conditions in interconnected surface water bodies, including surface water discharge, surface water stage, and baseflow contribution.

2. The approximate data and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.

3. Temporal change in conditions due to variations in stream discharge and regional groundwater extractions.

4. Other factors that may be necessary to identify adverse impacts on beneficial uses of surface water.

This section provides information about how the interconnected surface water monitoring network was developed, criteria for selecting monitoring sites, spatial density, summary of protocols, monitoring frequency and timing, and identification of and strategies to fill data gaps.

7.2.6.6.1 Selected Monitoring Sites

Sites in the interconnected surface water monitoring network are made up of groundwater wells and California Data Exchange Center (CDEC) stream gages. Groundwater wells were selected using the same methodology as for the groundwater levels monitoring network, described in **Section 7.2.6.1.1**, with focus on selecting wells in the Shallow AZ and AZ-1 along identified interconnected surface waters (the Sacramento and Feather Rivers as well as the Sutter Bypass). AZ-1 wells near wells in the Shallow AZ were selected to create groupings of two to three wells, utilizing available nested wells where possible. Deeper portions of nested wells with Shallow AZ or AZ-1 perforations were also included to monitor vertical gradients. Proposed nested wells funded by DWR's Technical Support Services (TSS) program are also included. CDEC stream gages along interconnected streams within the Sutter Subbasin, upstream and downstream in neighboring subbasins, and along tributaries to the Sacramento and Feather Rivers were selected for use in coordination with the identified wells.

Wells identified in **Table 7-52** were selected based on the above criteria to evaluate short-term, seasonal, and long-term trends in depletions of interconnected surface water. **Table 7-53** includes stream gages that, along with the wells identified in **Table 7-52**, will be used to monitor for depletions of interconnected surface water. Maps of the wells screened in the Shallow AZ, AZ-1, AZ-2, and AZ-3 are presented in **Figure 7-13** through **Figure 7-16**, respectively.

This page intentionally left blank.

Table 7-52. Depletions of Interconnected Surface Water Monitoring Network Sites

Site Code	State Well Number	Local ID / Other ID	Aquifer Zone	Overlying GSA	Status	Well Use	Depth (ft bgs)	Screen Interval (ft bgs)	First Measurement	Latest Measurement	Measurement Count
-	12N03E18H001M	USGS-385314121401701	Shallow	Reclamation District No. 1500 GSA	Active	Unknown	50	-	8/7/1997	8/8/2019	15
-	14N02E10R001M	USGS-390416121433601	Shallow	Sutter Extension WD GSA	Active	Unknown	44	-	8/7/1997	8/8/2019	14
-	15N02E20D001M	USGS-390832121463601	Shallow	Sutter County GSA	Active	Unknown	35	-	8/7/1997	8/8/2019	12
391975N1218937W001	16N01E31H001M	-	Shallow	Sutter County GSA	Active	Unknown	36	-	12/8/1932	10/5/2020	247
392328N1216469W001	16N03E21D002M	-	Shallow	Sutter County GSA	Active	Residential	30	-	6/28/1962	10/5/2020	304
389563N1215843W001	-	GH East MW Site	Shallow	Sutter County GSA	Active	Monitoring	40	30 - 40	6/10/2014	6/1/2021	121
389571N1215858W001	-	GH North MW Site	Shallow	Sutter County GSA	Active	Monitoring	40	30 - 40	6/10/2014	6/1/2021	119
389233N1218022W001	12N01E01A001M	-	AZ-1	Reclamation District No. 1500 GSA	Active	Unknown	75	-	10/24/1941	3/11/2021	128
388813N1217525W001	12N02E21Q001M	SR-1A	AZ-1	None - Yolo Subbasin	Active	Monitoring	68	54 - 64	4/5/2011	6/28/2021	71
389937N1218240W001	13N01E11A001M	-	AZ-1	None - Colusa Subbasin	Active	Domestic	145	-	7/1/1953	3/18/2021	223
390458N1216114W001	14N03E23D003M	Feather River MW-1A	AZ-1	Sutter County GSA	Active	Observation	65	40 - 60	10/20/2005	6/29/2021	98
392394N1216509W001	16N03E17J001M	Sutter County MW-3A	AZ-1	Sutter Extension WD GSA	Active	Observation	85	65 - 85	8/4/2010	6/29/2021	68
389453N1216159W001	-	GH Well 2	AZ-1	Sutter County GSA	Active	Irrigation	70	50 - 70	6/30/2009	6/1/2021	185
389398N1216162W001	-	GH Well 3	AZ-1	Sutter County GSA	Active	Irrigation	100	52 - 100	6/30/2009	6/1/2021	184
389410N1215884W001	-	GH Well 18	AZ-1	Sutter County GSA	Active	Irrigation	150	90 - 100	6/30/2009	6/1/2021	205
388869N1216445W002	-	Ma-1	AZ-1	Reclamation District No. 1500 GSA	Active	Irrigation	140	103 - 133	7/16/2020	3/11/2021	19
390458N1216114W002	14N03E23D004M	Feather River MW-1B	AZ-2	Sutter County GSA	Active	Observation	260	235 - 255	10/20/2005	6/29/2021	98
392394N1216509W002	16N03E17J002M	Sutter County MW-3B	AZ-2	Sutter Extension WD GSA	Active	Observation	315	285 - 305	8/4/2010	6/29/2021	68
390458N1216114W003	14N03E23D005M	Feather River MW-1C	AZ-3	Sutter County GSA	Active	Observation	689	664 - 684	10/20/2005	6/29/2021	98
390458N1216114W004	14N03E23D006M	Feather River MW-1D	AZ-3	Sutter County GSA	Active	Observation	1021	996 - 1016	10/20/2005	6/29/2021	98
392394N1216509W003	16N03E17J003M	Sutter County MW-3C	AZ-3	Sutter Extension WD GSA	Active	Observation	430	400 - 420	8/4/2010	6/29/2021	68
392394N1216509W004	16N03E17J004M	Sutter County MW-3D	AZ-3	Sutter Extension WD GSA	Active	Observation	615	595 - 605	8/4/2010	6/29/2021	68
392394N1216509W005	16N03E17J005M	Sutter County MW-3E	AZ-3	Sutter Extension WD GSA	Active	Observation	785	765 - 785	8/4/2010	6/29/2021	68

Table 7-53. Selected Stream Gages

Station ID	Station Description	Monitoring Agency	Monitoring Site Type	Type of Measurement	First Measurement	Latest Measurement	Measurement Frequency
BJP	Byron Jackson Pumps	Sutter County	Stream Gage	River Stage	10/17/1997	Present	15-minute data
BPG	Bear River at Pleasant Grove Rd	DWR, North Region Office	Stream Gage	River Stage	1/4/2005	Present	15-minute data
BRW	Bear River near Wheatland	USGS/DWR	Stream Gage	River Stage	1/24/1997	Present	15-minute data
BSL	Butte Slough near Meridian	DWR, North Region Office	Stream Gage	River Stage	3/12/1997	Present	15-minute data
BSO	Butte Slough at Outfall Gates	DWR, North Region Office	Stream Gage	River Stage	10/3/1997	Present	15-minute data
CLW	Sacramento River at Colusa Weir (Crest 60.9')	DWR, North Region Office	Stream Gage	River Stage	2/27/1997	Present	Hourly
COL	Sacramento River at Colusa	USGS/DWR	Stream Gage	River Stage	1/1/1984	Present	15-minute data
FEW	Sacramento River at Fremont Weir East End	DWR, North Region Office	Stream Gage	River Stage	6/25/2019	Present	15-minute data
FLO	Feather River at Live Oak	Sutter County	Stream Gage	River Stage	9/10/1997	Present	15-minute data
FRE	Sacramento River at Fremont Weir (Crest 32.0')	DWR, North Region Office	Stream Gage	River Stage	1/1/1984	Present	15-minute data
FSB	Feather River at Boyd's Landing above Star Bend	DWR, North Region Office	Stream Gage	River Stage	11/17/2008	Present	15-minute data
GRL	Feather River near Gridley	DWR, Operations and Maintenance	Stream Gage	River Stage	1/1/1984	Present	15-minute data
KNL	Sacramento River at Knights Landing	DWR, North Region Office	Stream Gage	River Stage	9/16/1997	Present	15-minute data
LNB	Sutter Bypass at Longbridge	Sutter County	Stream Gage	River Stage	9/16/1997	Present	15-minute data
MLW	Sacramento River at Moulton Weir (Crest 76.2')	DWR, North Region Office	Stream Gage	River Stage	2/27/1997	Present	15-minute data
MPS	Meridian Pumps	Sutter County	Stream Gage	River Stage	10/3/1997	Present	Hourly
MRY	Yuba River near Marysville	US Geological Survey	Stream Gage	River Stage	3/5/1997	Present	15-minute data
NIC	Feather River near Nicolaus	DWR, North Region Office	Stream Gage	River Stage	1/1/1984	Present	15-minute data
PM1	Pumping Plant 1	DWR, Sutter Maintenance Yard	Stream Gage	River Stage	1/24/2003	Present	15-minute data
PM2	Pumping Plant 2	DWR, Sutter Maintenance Yard	Stream Gage	River Stage	1/24/2003	Present	15-minute data
PM3	Pumping Plant 3	DWR, North Region Office	Stream Gage	River Stage	1/24/2003	Present	15-minute data
SB1	Sutter Bypass Channel at Pumping Plant 1	DWR, North Region Office	Stream Gage	River Stage	10/18/2007	Present	15-minute data
SB2	Sutter Bypass Channel at Pumping Plant 2	DWR, North Region Office	Stream Gage	River Stage	10/18/2007	Present	15-minute data
SB3	Sutter Bypass Channel at Pumping Plant 3	DWR, North Region Office	Stream Gage	River Stage	10/18/2007	Present	15-minute data
SBS	Sacramento River at Butte Slough	DWR, North Region Office	Stream Gage	River Stage	10/3/1998	Present	15-minute data
TIS	Sacramento River at Tisdale Weir (Crest 44.1')	DWR, North Region Office	Stream Gage	River Stage	2/25/1997	Present	Hourly
VON	Sacramento River at Verona	USGS/DWR	Stream Gage	River Stage	1/1/1984	Present	15-minute data
WLK	Sacramento River below Wilkins Slough	USGS	Stream Gage	River Stage	1/1/1984	Present	15-minute data
YR7	Yuba River above HWY 70	DWR, North Region Office	Stream Gage	River Stage	9/4/2019	Present	15-minute data
YUB	Feather River at Yuba City	DWR, North Region Office	Stream Gage	River Stage	1/1/1984	Present	15-minute data

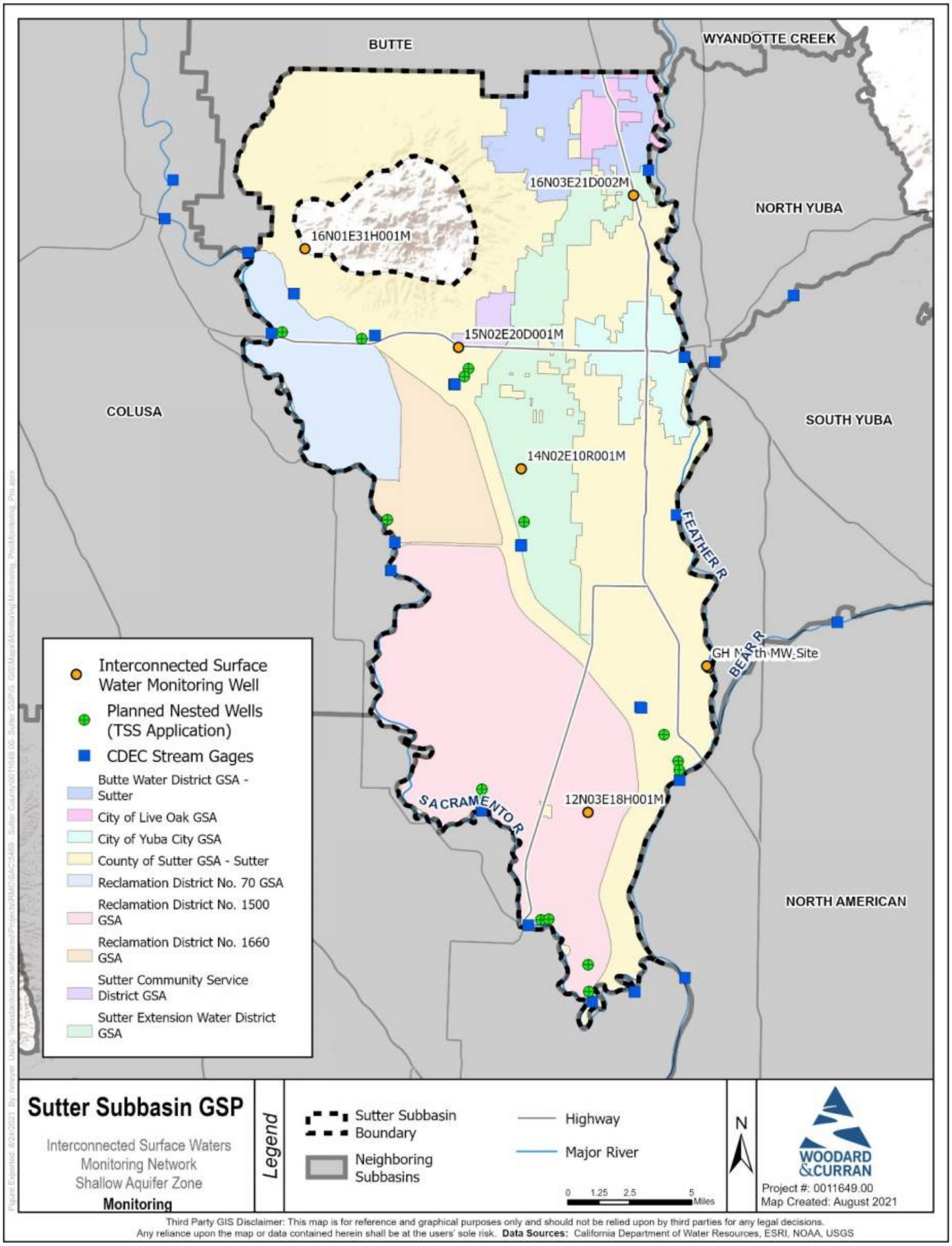


Figure 7-13. Interconnected Surface Water Monitoring Network Sites, Shallow AZ

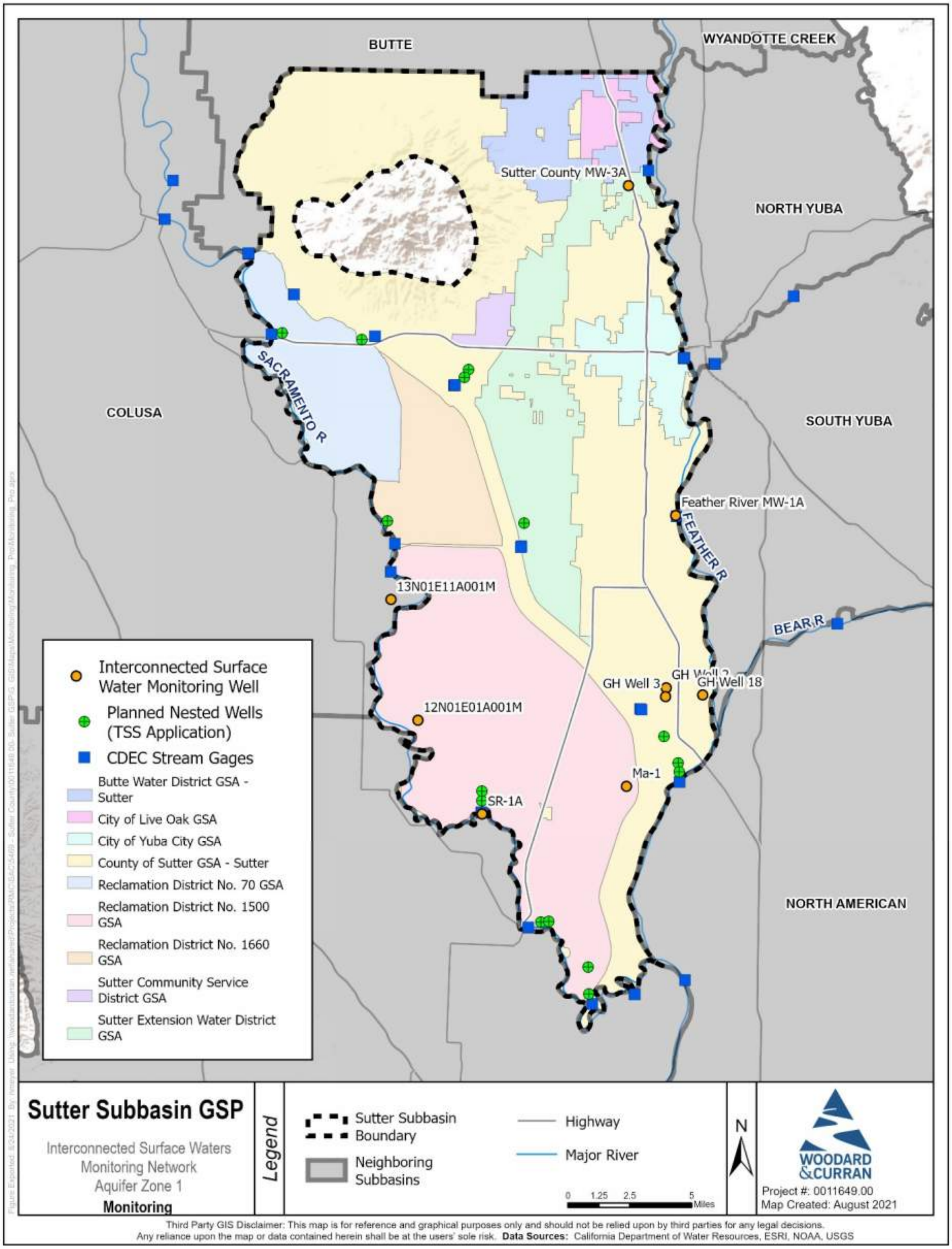


Figure 7-14. Interconnected Surface Water Monitoring Network Sites, AZ-1

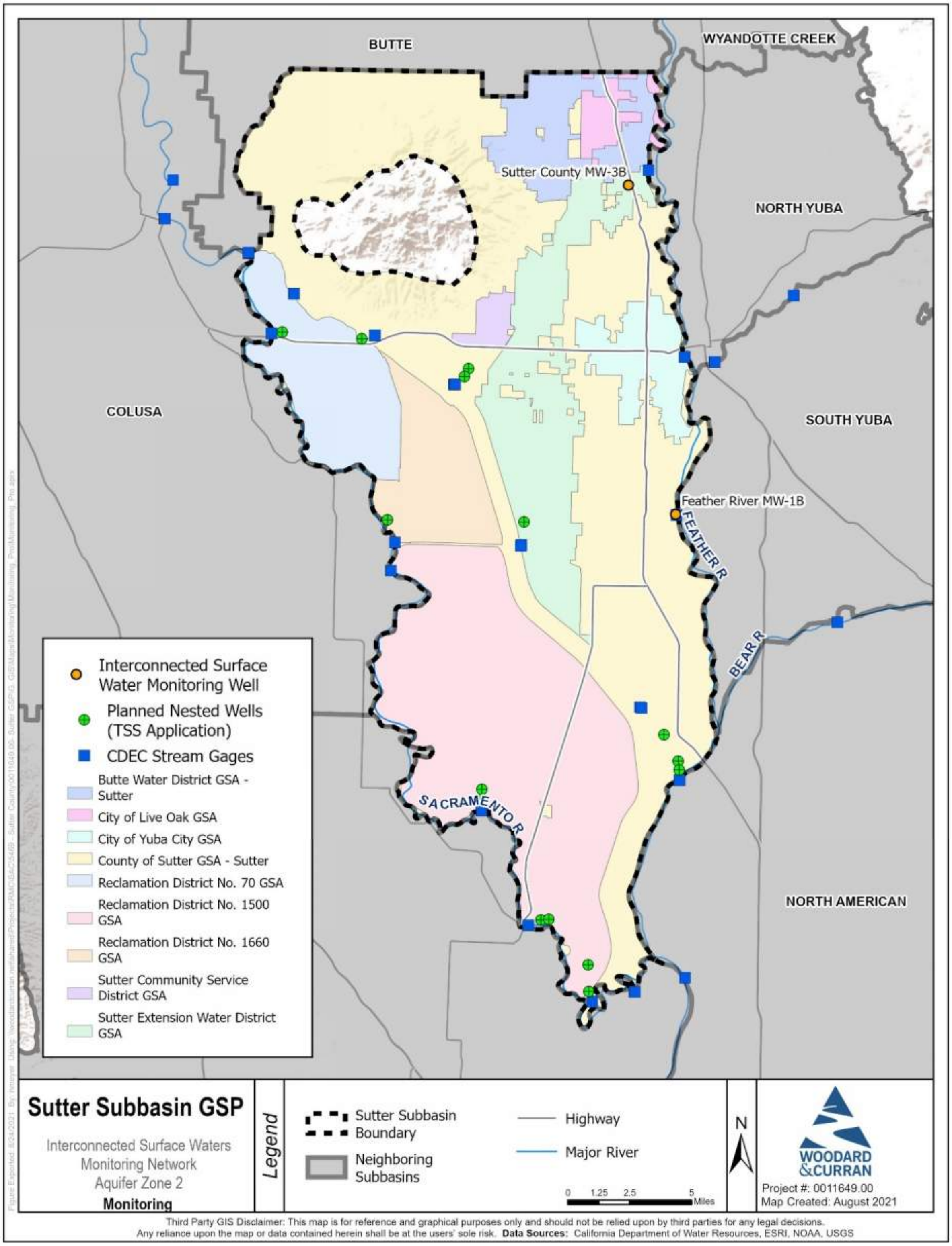


Figure 7-15. Interconnected Surface Water Monitoring Network Sites, AZ-2

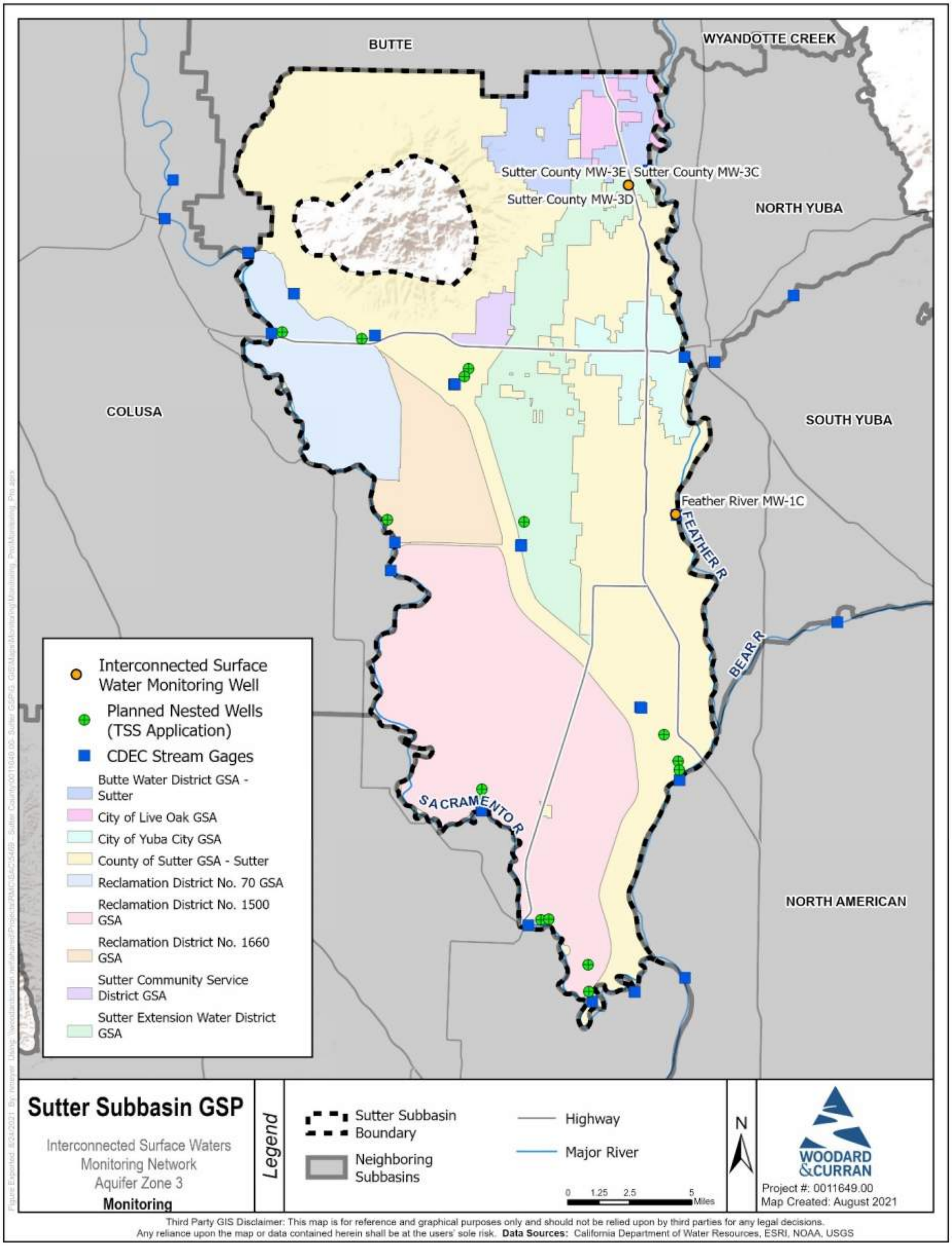


Figure 7-16. Interconnected Surface Water Monitoring Network Sites, AZ-3

7.2.6.6.2 Spatial Density

Guidance related to the spatial density for the interconnected surface water monitoring network is not provided in DWR's *Monitoring Networks and Identification of Data Gaps* BMP (DWR, 2016a). Professional judgement was used along with available data and monitoring locations to determine the appropriate density of monitoring sites.

7.2.6.6.3 Monitoring Frequency

Since groundwater levels are being used as a proxy for monitoring depletions of interconnected surface water, the frequency and timing of monitoring events can be found in **Section 7.2.6.1.3**. Publicly available stream gage data, such as from DWR's CDEC, will be paired with groundwater level and extraction data to evaluate for any significant and sustained change in gradient between monitoring wells and the Sacramento and Feather Rivers and Sutter Bypass, potentially indicating a significant and unreasonable loss of interconnected surface water as a result of groundwater extractions.

7.2.6.6.4 Monitoring Protocols

The depletions of interconnected surface water sustainability indicator will be assessed using groundwater levels as a proxy. As such, the monitoring protocols for the groundwater level monitoring network are also applicable for collecting information relevant to the monitoring network for the depletions of interconnected surface water sustainability indicator.

Monitoring protocols for the groundwater level monitoring network have been developed in accordance with DWR's *Monitoring Protocols, Standards, and Sites* BMP (DWR, 2016b). Monitoring protocols applicable to all Sutter Subbasin GSP monitoring networks are detailed in **Section 7.2.5.1**. Monitoring protocols established for the groundwater level monitoring network will be reviewed every five years and modified as necessary, where any modifications to the monitoring protocols will be documents in detail in each future GSP update.

Streamflow and/or surface water stage data will be downloaded from publicly available databases and combined with groundwater elevation data for assessing the status of this sustainability criterion. Specifically, future data collection efforts will attempt to link groundwater elevations and gradients with river stage, groundwater pumping data and hydrologic conditions to establish a relationship between groundwater use and interconnected surface water. All data collected and utilized will be uploaded to the Subbasin DMS.

<u>Protocols for Measuring Streamflow</u>

The following guidelines were adopted from DWR's *Monitoring Protocols, Standards, and Sites* BMP (DWR, 2016b):

- The use of existing streamflow monitoring locations will be incorporated to the greatest extent possible.
- Establishment of new streamflow monitoring sites should consider existing representative monitoring networks and the objectives of the new location. Professional judgment should be used to determine the appropriate permitting that may be necessary for the installation of any surface water monitoring locations along surface water bodies. Regular frequent access will be necessary to these sites for the development of ratings curves and maintenance of equipment.
- To establish a new streamflow monitoring station, special consideration must be made in the field to select an appropriate location for measuring flows and/or stage. Once a site is selected, development of a relationship between stream stage and discharges will be necessary to provide continuous estimates of streamflow. Several measurements of discharge at a variety of stream stages may be necessary to develop the ratings curve correlating stage to discharge. Following development of the ratings curve, a simple stilling well and pressure transducer with data logger can be used to evaluate state on a frequent basis.
- Streamflow measurements will be collected, analyzed, and reported in accordance with the procedures outlined in USGS Water Supply Paper 2175, *Volume 1. – Measurement of Stage Discharge* (Rantz et al., 1982a) and *Volume 2. – Computation of Discharge* (Rantz et al., 1982b). This methodology is currently being used by both USGS and DWR for existing streamflow monitoring throughout the State.

Data Reduction, Validation, and Reporting

After field personnel have completed collection of groundwater level measurements and river stage (if appropriate), data should be entered into the Sutter Subbasin DMS as soon as possible. Each GSA Monitoring / Field Lead is responsible for collecting the appropriate groundwater and surface water level data during the designated seasonal high and seasonal low time periods and supplying the resultant data to the GSP QA Officer / Data Manager for compilation and a QA/QC review to avoid data entry mistakes. The GSP QA Officer / Data Manager will then compile the GSA-level data into standard forms for uploading to the Subbasin DMS and check that data have been uploaded correctly. All data are to be updated by October 31 each year for inclusion in the Annual Report. The Plan Administrator then reviews data uploaded at the Subbasin level for annual reporting. Should a measurement appear suspicious, a second confirmation reading shall be obtained as soon as possible.

For river discharge and stage data collected from publicly available sources, a visual check of the data will be performed to ensure that the reported value matches stream conditions. The same protocol will be followed to enter stream-related data into the Subbasin DMS as for groundwater level data.

7.2.6.6.5 Data Gaps

Due to a lack of spatial coverage, the understanding of depletions of interconnected surface water could be improved through additional groundwater level data along interconnected streams within the Sutter Subbasin, upstream and downstream in neighboring subbasins, and along tributaries to the Sacramento and Feather Rivers.

7.2.6.6.6 Plan to Fill Data Gaps

The Sutter Subbasin GSAs filed a Technical Support Services (TSS) Well Service Request with DWR in April 2021 to support the construction of 13 nested equipped groundwater monitoring wells. The purpose of this undertaking is to construct wells to varying depths at selected CDEC stream gage locations (**Figure 7-13** to **Figure 7-16**) to add to the interconnected surface water monitoring network. These wells will monitor areas where groundwater recharge from rivers occurs, based on groundwater contours, broaden data collection efforts, and support better understanding of interconnected waters. See **Section 7.1.6.1.1** for more details regarding investigations of interactions between rivers and changes in groundwater levels.

This page intentionally left blank.

7.3 References

Blair, T.C., Baker, F.G., and Turner, J.B. 1991. *Cenozoic Fluvial-Facies Architecture and Aquifer Heterogeneity, Oroville, California, Superfund Site and Vicinity, in A.D. Miall and N. Tyler, eds., The Three-Dimensional Facies Architecture of Terrigenous Clastic Sediments and Its Implications for Hydrocarbon Discovery and Recovery, SEPM, Concepts in Sedimentology and Paleontology, Volume 3*.

California Department of Water Resources and Joint Board. May 1969. *Agreement on Diversion of Water from the Feather River*.

California Department of Water Resources (DWR). 2016a. *Best Management Practices: Monitoring Networks and Identification of Data Gaps.* https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-2-Monitoring-Networks-and-Identification-of-Data-Gaps_ay_19.pdf. Accessed: August 11, 2021.

California Department of Water Resources (DWR). 2016b. *Best Management Practices: Monitoring Protocols Standards and Sites.* https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-1-Monitoring-Protocols-Standards-and-Sites_ay_19.pdf. Accessed: August 11, 2021.

California Department of Water Resources (DWR). 2016c. *California Code of Regulations, Title 23 Waters, Division 2 Department of Water Resources, Chapter 1.5 Groundwater Management.* https://govt.westlaw.com/calregs/Browse/Home/California/CaliforniaCodeofRegulations?guid=I74F39D13C76F497DB40E93C75FC716AA. Accessed: August 11, 2021.

Clemmens, A.J. and B.T. Wahlin. 2006. *Accuracy of Annual Volume from Current-Meter-Based Stage Discharges*. Journal of Hydrologic Engineering, 11(5), pp.489-501.

Dudley, T. and Fulton, A. 2006. *Conjunctive Water Management: What is it? Why consider it? What are the challenges?* University of California. https://ucanr.edu/sites/Tehama/files/20596.pdf. Accessed: September 23, 2021.

Environmental Defense Fund (EDF). 2018. Addressing Regional Surface Water Depletions in California: A Proposed Approach for Compliance with the Sustainable Groundwater Management Act. https://www.edf.org/sites/default/files/documents/edf_california_sgma_surface_water.pdf. Accessed: June 30, 2021.

Land IQ, LLC. 2021. Land Use Datasets: Statewide Crop Mapping 2018. https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#waterbudget. Accessed: September 23, 2021.

Northern California Water Association (NCWA). August 2014a. Feather River Regional Agricultural Water Management Plan, Volume II: Supplier Plan Contents – Butte Water District.

Northern California Water Association (NCWA). August 2014b. Feather River Regional Agricultural Water Management Plan, Volume II: Supplier Plan Contents – Sutter Extension Water District.

Rantz, S.E. and others. 1982a. United Sates Geological Survey (USGS) Water Supply Paper 2175, *Measurement and Computation of Streamflow: Volume 1. Measurement of Stage and Discharge*. https://pubs.usgs.gov/wsp/wsp2175/wsp2175.pdf. Accessed: August 16, 2021.

Rantz, S.E. and others. 1982b. United Sates Geological Survey (USGS) Water Supply Paper 2175, *Measurement and Computation of Streamflow: Volume 2. Computation of Discharge.* https://pubs.usgs.gov/wsp/wsp2175/wsp2175_vol2.pdf. Accessed: August 16, 2021.

Sanden, B., Prichard, T.L, and Fulton, A.E. *Improving Water Penetration*. In L. Ferguson and D.R. Haviland (Eds.), Pistachio Production Manual, Publication 3545. University of California Agriculture and Natural Resources (UCANR) Publications.

United States Department of Agriculture (USDA), National Resource Conservation Service (NRCS). 2009. *Part 650 Engineering Field Handbook, Chapter 1 Surveying*. https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=25276.wba. Accessed: August 16, 2021.

United States Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 2014. Soil Infiltration: Soil Health – Guides for Educators. May. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051576.pdf. Accessed: September 23, 2021.

University of California, Davis (UC Davis). 2021. Soil Agricultural Groundwater Banking Index (SAGBI) Web Application. California Soil Resource Lab, UC Davis, and UC Agriculture & Natural Resources. https://casoilresource.lawr.ucdavis.edu/sagbi/. Accessed: September 23, 2021.

Wood Rodgers. 2012. *Sutter County Groundwater Management Plan*. March.

C H A P T E R   E I G H T

Plan Implementation

This page intentionally left blank

8. PLAN IMPLEMENTATON

Implementation of the Sutter Subbasin Groundwater Sustainability Plan (GSP) includes:

- GSP implementation, administration, and management
- Implementation of the projects, management actions, and monitoring program as described in **Chapter 7** *Sustainability Implementation*
- Data collection, evaluation, and reporting, including preparation and submittal of annual reports and five-year assessment reports, also referred to as five-year updates
- Implementation of adaptive management strategies
- Development of long-term funding streams

This chapter describes the implementation schedule and financing of these activities, as well as the contents of both the annual reports and five-year assessment reports that must be provided to the California Department of Water Resources (DWR) as required by Sustainable Groundwater Management Act (SGMA) regulations.

8.1 Implementation Schedule

Implementation of much of the Sutter GSP will occur on an as-needed basis due to the sustainable condition of the Subbasin. Many portions of the Plan implementation are scheduled for completion at regular intervals or early in the implementation process.

Figure 8-1 illustrates the Sutter Subbasin GSP implementation schedule through 2042. Included in the Gantt chart are activities necessary for ongoing GSP monitoring and updates; additional details about activities included in the schedule are provided in the respective sections of this GSP. Adaptive management actions will only be executed if the GSP interim goals, as described in **Section 8.8**, are not being met or if triggering event occur. The schedules for implementing projects and management actions, as described in **Section 7.1**, will vary depending on the need, permitting and availability of financing.

This page intentionally left blank.

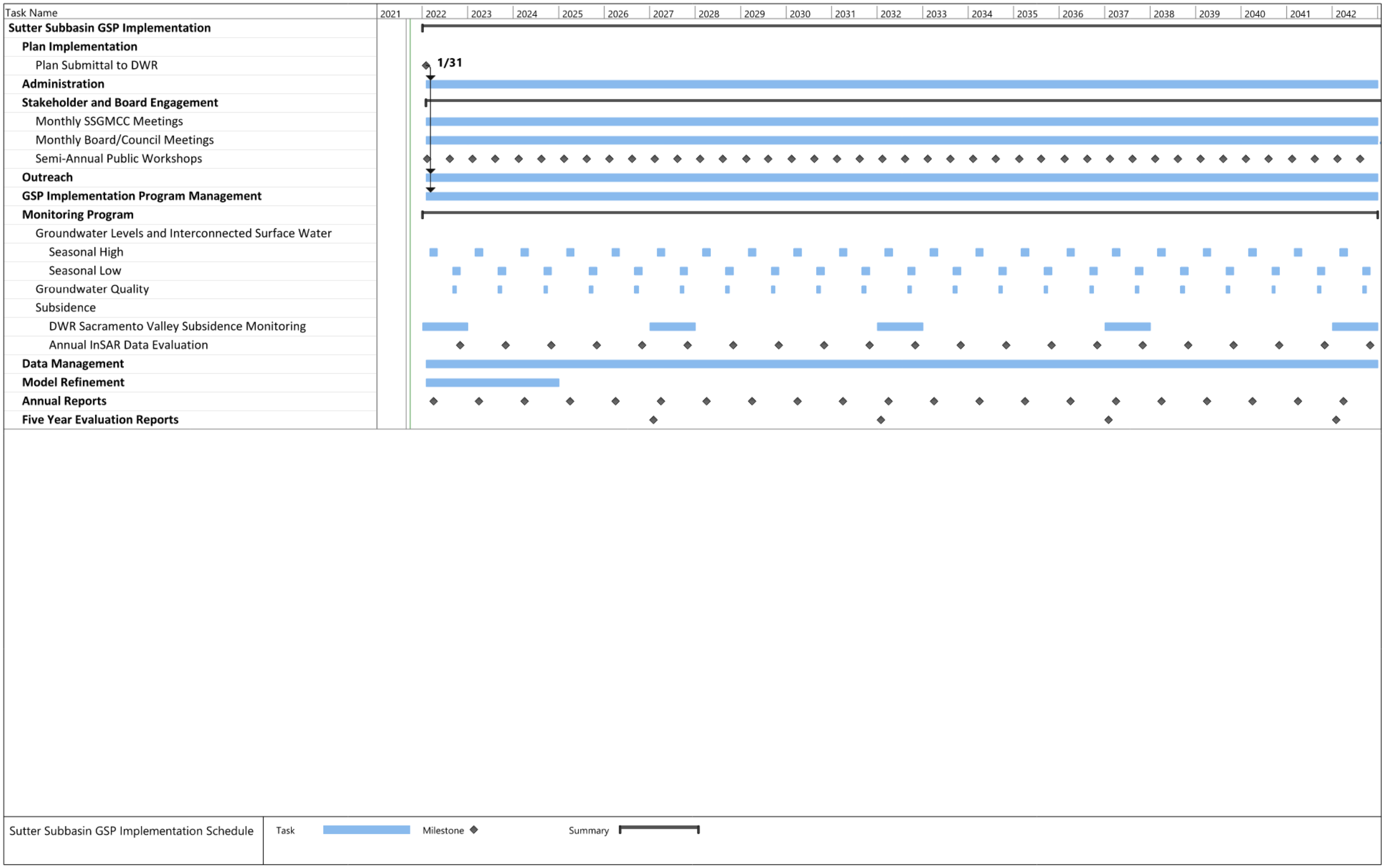


Figure 8-1. Implementation Schedule

This page intentionally left blank.

8.2 Financing

Operating the Sutter Subbasin GSAs, Sutter Subbasin Groundwater Management Coordination Committee (SSGMCC), and implementing the GSP will incur costs that will require funding by the individual entities comprising the GSAs. The five primary activities that will require financing include:

- Operation of the Sutter Subbasin GSAs and SSGMCC
- Implementation of the GSP (including monitoring, data management, and outreach)
- Development of annual reports, including data collection, analysis, and reporting
- Development of five-year assessment reports
- Implementation of the GSP-related projects and management actions

Table 8-1 summarizes the estimated costs of these activities. These estimates will be refined as implementation of the GSP progresses.

This page intentionally left blank.

Table 8-1. Estimated Implementation Costs

Activity	Estimated Cost	Assumptions
GSP Implementation and GSA Operations		
Administration	$200,000 to $400,000 annually	Overall program management, coordination activities, and legal services
Stakeholder and Board Engagement	$75,000 to $125,000 annually	Bi-monthly SSGMCC meetings, bi-monthly Board meetings, and semi-annual public workshops
Outreach	$30,000 to $60,000 annually	Email communications, newsletters, and website management
GSP Implementation Program Management	$75,000 to $150,000 annually	Program management and oversight of projects and management actions, coordination of GSA implementation, technical activities
Monitoring Program	$175,000 annually for first two years $50,000 annually for following years	Groundwater level and groundwater quality monitoring, collection of publicly available subsidence monitoring and stream gage data, and conduct quality control checks on monitoring data
Data Management	$30,000 to $50,000 for first year $20,000 annually for following years	On-going DMS management, including data uploads and system improvements
Model Refinement	$275,000 to $400,000 (one time)	On-going refinement of C2VSim-FG, including data calibration and scenario development
Annual Reporting	$75,000 annually	Includes data compilation, annual updates to C2VSim-FS-Sutter model, annual report development, and submittal of annual report materials to DWR

Activity	Estimated Cost	Assumptions
Five-Year Updates	$800,000 to $1,000,000 every five years (across two fiscal years)	Includes data compiling and reporting on progress for each relevant sustainability indicator, plan implementation progress and updates, monitoring network updates and progress in addressing data gaps, description of new information, amendments, and coordination.
Projects and Management Actions		
Project 1: System Modernization (BWD)	$16,681,000	Estimated costs for all phases (Phases 1-4) and levels (levels 1 and 2) of project implementation. All cost components calculated in July 2014 and reported in the 2014 FRRAWMP Volume II.4 (Appendix B) and the 2014 FRRAWMP Volume II.6 (Appendix C). Cost estimates were escalated to 2021 according to the U.S. Army Corps of Engineers Civil Works Construction Cost Composite Index.
Project 2: System Modernization (SEWD)	$15,073,000	Estimated costs for all phases (Phases 1-4) and levels (levels 1 and 2) of project implementation. All cost components calculated in July 2014 and reported in the 2014 FRRAWMP Volume II.4 (Appendix B) and the 2014 FRRAWMP Volume II.6 (Appendix C). Cost estimates were escalated to 2021 according to the U.S. Army Corps of Engineers Civil Works Construction Cost Composite Index.

Activity	Estimated Cost	Assumptions
Project 3: Boundary Flow and Primary Spill Measurement and Drainage Recovery Projects (BWD)	$1,184,000	Estimated costs for all phases (Phases 1-4) and levels (levels 1 and 2) of project implementation. All cost components calculated in July 2014 and reported in the 2014 FRRAWMP Volume II.4 (Appendix B) and the 2014 FRRAWMP Volume II.6 (Appendix C). Cost estimates were escalated to 2021 according to the U.S. Army Corps of Engineers Civil Works Construction Cost Composite Index.
Project 4: Boundary Flow and Primary Spill Measurement and Drainage Recovery Projects (SEWD)	$1,154,000	Estimated costs for all phases (Phases 1-4) and levels (levels 1 and 2) of project implementation. All cost components calculated in July 2014 and reported in the 2014 FRRAWMP Volume II.4 (Appendix B) and the 2014 FRRAWMP Volume II.6 (Appendix C). Cost estimates were escalated to 2021 according to the U.S. Army Corps of Engineers Civil Works Construction Cost Composite Index.
Project 5: Dual Source Irrigation Systems	N/A	Total costs are not available at this time
Project 6: Multi-Benefit Recharge	N/A	Total costs will vary depending on the configuration and scale of project implementation. Estimated average annual costs on a per-site basis are noted in the project descriptions in Section 7.1
Project 7: Grower Education	N/A	Total costs are not available at this time

Activity	Estimated Cost	Assumptions
Project 8: Installation of Additional Shallow Groundwater Monitoring Wells	$1,135,100	
TOTAL – during FY with no five-year updates or projects (2022-2025)	**$632,000 – $1,012,000**	**Average annual estimate**
TOTAL – during FY with five-year updates and no projects (2026-2027)	**$792,000 – $1,212,000**	**Average annual estimate**

8.2.1 Financing of GSP Implementation and Operations

Costs associated with implementing the Sutter GSP and operation of the Sutter Subbasin GSAs and SSGMCC include:

- **Administration**: Overall program management, coordination activities, and legal services
- **Stakeholder and Board Engagement**: Monthly SSGMCC meetings, monthly Board meetings, semi-annual public workshops
- **Outreach**: Email communications, newsletters, and website management
- **GSP Implementation Program Management**: Program management and oversight of project and management action implementation, including coordination among Board, staff, and stakeholders; coordination of GSA implementation technical activities; oversight and management of consultants, budget tracking, schedule management; and quality assurance/quality control of project implementation activities
- **Monitoring Program, Data Management, and Model Refinement**: Groundwater level and groundwater quality monitoring; collection of publicly available subsidence monitoring data and stream gage data; conducting quality control checks on and management of data; summarizing and/or estimating other data sets required for annual reporting; ongoing management of Data Management System (DMS), including data uploads and system improvements; ongoing refinement of the C2VSimFG-Sutter model, including data calibration and scenario development

Implementation of this GSP is projected to run between approximately $632,000 and $1,212,000 per year during the initial years of implementation, excluding implementation of projects and management actions. Costs associated with the implementation of identified projects and management actions will vary depending on the project type and stage of the project (e.g., planning or construction). Development of this GSP was partially funded through a Proposition 1 Sustainable Groundwater Planning Grant. Operations of the SSGMCC are funded by volunteer contributions (both directly and through in-kind services) from the GSAs. Although ongoing operation could include contributions from the Subbasin GSAs, which are ultimately funded through customer fees or other public funds, additional funding will likely be required to implement the GSP. Of the implementation activities described in this GSP, only project implementation is likely to be eligible for grant or loan funding, and funding through grants or loans have varying levels of certainty. As such, the Sutter Subbasin GSAs will develop a financing plan that may include one or more of the following financing approaches:

- **Assessments:** Assessments could be levied using a fee-based assessment on land area or irrigated acreage. Funding GSP implementation by assessing a fee for all acres in the Subbasin (approximately 285,819 acres) would result in assessments ranging between approximately $2 and $4 per acre per year, assuming the assessment would not distinguish between land use types. Funding by assessing a fee only on irrigated acres (approximately 170,000 acres during the current conditions water year [2013]) would result in fees ranging between $4 and $7 per acre per year. An assessment solely on irrigated acreage could affect agricultural operations and contribute to land use conversions, which could, in turn, affect the overall assessment amount.
- **Pumping Fees:** Pumping fees are typically a charge for pumping that would be used to fund GSP implementation activities. In the absence of other sources of funding (i.e., grants, loans, or combined with assessments), fees would range between $5 and $9 per acre-foot (AF) of water pumped per year (based on projected baseline pumping on an average annual basis from 2022 to 2027 and 2022 to 2072, respectively). To meet the funding needs of the GSP, a tiered approach may be used where fees would decrease when groundwater elevations are higher and increase when groundwater elevations are lower to encourage conservation, or a modified fee structure could be implemented based on the type of pumping (domestic vs agricultural vs municipal), including a potential waiver of pumping fees for *de minimis* groundwater pumping.
- **Combination of fees and assessments:** This approach would combine pumping fees and assessments to moderate the effects of either approach on the economy in the Sutter Subbasin. This approach would likely include an assessment that would apply to all acres within the Subbasin, rather than just to irrigated acreage (thereby accounting for a shared regulatory compliance cost), coupled with a pumping fee to account for those properties that extract more groundwater than others.

If the Sutter Subbasin GSAs secure grants or loans to help pay for project and/or management action implementation, the possible financing approaches may be adjusted to align with operating costs of ongoing GSP implementation activities. Potential funding sources that may be used for GSP implementation are summarized in **Table 8-2** with an assessment of the likelihood of each funding source being obtained.

Table 8-2. Potential Funding Sources for GSP Implementation

Funding Source	Certainty
Ratepayers (within Project Proponent service area or area of project benefit)	**High** – User rates pay for operation and maintenance (O&M) of a utility's system. Depends upon rate structure adopted by the project proponent and the Proposition 218 rate approval process, which is dependent upon the structure of the GSA and its authority to collect rates from users. Can be used for project implementation as well as project O&M.
General Funds or Capital Improvement Funds (of Project Proponents)	**High** – General or capital improvement funds are set aside by agencies to fund general operations and construction of facility improvements. Depends upon agency approval.
User fees, special taxes, and assessments (within Project Proponent service area or area of project benefit)	**High** – Monthly user fees, special taxes, and assessments can be assessed by some agencies should new facilities directly benefit existing customers. Depends upon the rate structure adopted by the project proponent and the Proposition 218 rate approval process, which is dependent upon the structure of the GSA and its authority to collect fees/taxes/assessments from users.
Sustainable Groundwater Management (SGM) Implementation Grant Program administered by DWR	**High** – Grant solicitation is expected to open in fall/winter 2022 and will make at least $204.5 million available for medium and high priority basins for Round 2 and future funding solicitations (subject to change based upon future appropriations approved by the California Legislature). Grant amounts range from $2 million to $8 million. Local cost share is not required. Eligible project types include filling data gaps in the GSP, project development activities, evaluation of groundwater management needs, annual reporting for GSPs, installation of and/or instrumentation for monitoring wells, and groundwater recharge projects.

Funding Source	Certainty
Water & Waste Disposal Loan & Grant Program in California administered by the United States Department of Agriculture (USDA), Rural Development	**High** – Long-term, low-interest loans and grants available to fund clean and reliable drinking water systems, sanitary sewage disposal, sanitary solid waste disposal, and storm water drainage to household and businesses in eligible rural areas (areas or towns with populations of 10,000 or less). Funds may be used to finance the acquisition, construction, or improvement of drinking water sourcing, treatment, storage, and distribution as well as storm water collection, transmission, and disposal, for example. Eligible applicants include most state and local governmental entities, private nonprofits, and federally-recognized tribes. Applications are accepted year-round.
Community Facilities Direct Loan & Grant Program in California administered by USDA, Rural Development	**High** – Low interest direct loans and grants available to provide affordable funding to develop essential community facilities in eligible rural areas (areas or towns with populations of 20,000 or less). An essential community facility is defined as a facility that provides an essential service to the local community for the orderly development of the community in a primarily rural area and does not include private, commercial, or business undertakings. Funding priorities include small communities with a population of 5,500 or less and low-income communities having a median household income below 80% of the state nonmetropolitan median household income.
Infrastructure State Revolving Fund Loan Program administered by the California Infrastructure and Economic Development Bank (I-Bank)	**High** – Low-interest loans are available from I-Bank for infrastructure projects (such as water distribution). Maximum loan amount is $25 million per applicant. Applications are accepted on a continuous basis.
Integrated Regional Water Management (IRWM) Implementation Grant Program administered by DWR	**Medium** – The Northern Sacramento IRWM Region, which overlaps the Sutter Subbasin, will pursue grant funding in the Sacramento River Funding Area, where approximately $1.7 million has been made available for Proposition 1, Round 2. Applications are expected to be due in March or September 2022.

Funding Source	Certainty
Drinking Water State Revolving Fund Loan Program administered by the SWRCB Division of Drinking Water	**Medium** – Approximately $150 to $250 million is available on an annual basis for drinking water projects. Low-interest loans are available for project proponents should they decide to seek financing. Funding has become more limited; however, applicants are encouraged to apply.
Clean Water State Revolving Fund (CWSRF) Loan Program administered by the California State Water Resources Control Board (SWRCB)	**Medium** – Approximately $200 to $700 million has been made available annually for low-interest loans (typically ½ of the General Obligation Bond Rate) in recent years for water recycling, wastewater treatment, and sewer collection projects. During recent years, available funding has become limited due to high demand. Success in securing a low-interest loan depends on demand of the CWSRF Program and available funding. Applications are accepted on a continuous basis. SWRCB prepares a fundable list for each fiscal year. In order to receive funding, a project must be on the fundable list. Full applications must be submitted by the end of the calendar year to be considered for inclusion on the following year's fundable list.
Water Recycling Funding Program (WRFP) – Planning and Construction Grants from SWRCB	**Medium** – WRFP grants are funded by Proposition 1, as well as the general CWSRF Program. Planning grants (for facilities planning) are available and can fund 50% of eligible costs, up to $150,000. Construction grants are available and can fund 35% of eligible costs, up to $5,000,000. While low-interest loans through the CWSRF program are also available, recycled water projects receive priority over wastewater projects (which are also eligible under CWSRF, the umbrella program for the WRFP).
Title XVI Water Recycling and Reclamation / Water Infrastructure Improvements for the Nation (WIIN) Program – Construction Grants administered by the United States Bureau of Reclamation (USBR)	**Medium** – Grants up to 25% of project costs or $20 million, whichever is less, are available from USBR for water recycling projects. A Title XVI Feasibility Study must be submitted to and approved by USBR to be eligible. USBR solicits grants annually.

Funding Source	Certainty
WaterSMART Grant Programs administered by USBR	**Medium** – During Fiscal Year 2021, $7.8 million was appropriated to WaterSMART grant programs. WaterSMART grant programs include Water and Energy Efficiency Grants, Water Marketing Strategy Grants, and Small-Scale Water Efficiency Projects. Grant programs can help fund projects such as canal lining/piping, municipal metering, and supervisory control and data acquisition (SCADA) systems.
Bonds	**Medium** – Revenue bonds can be issued to pay for capital costs of projects allowing for repayment of debt service over 20- to 30-year timeframe. Depends on the bond market and the existing debt of project proponents.
WaterSMART Title XVI Water Recycling and Reclamation Program – Feasibility Study Grants administered by USBR	**Low** – Grants up to $150,000 have been available in the past for preparation of Title XVI Feasibility Studies. It is possible future rounds may be administered.

8.2.2 Financing of Projects and Management Actions

Costs for projects and management actions are described in **Section 7.1** of this GSP. Financing of the projects and management actions would vary depending on the activity and timing. Potential financing for projects and management actions are provided in **Section 7.1**, though other financing may be pursued as opportunities arise or as appropriate.

8.3 Administration

Each of the Sutter Subbasin GSAs are administered independently and involve meetings and oversight of individual GSA projects and programs. GSA administration will include coordination meetings; regular email communications to update GSA members on on-going basin activities; coordination activities with the other GSAs, such as on projects or studies; administration of projects implemented by the GSA; and general oversight and coordination. SSGMCC meetings are assumed to occur bi-monthly, with other oversight and administration activities occurring as needed and on an on-going basis.

GSA administration is also expected to require additional effort during GSP updates and around the time of annual report and 5-year evaluation report development. Other administrative actions may involve tracking and evaluating GSP implementation and sustainability conditions, as well as assessing the benefit to the Subbasin. Annual costs for GSA administrative actions are estimated to range from $200,000 to $400,000 and includes estimates for annual legal, audit, and insurance expenses.

8.4 Public Outreach

During GSP development, the GSAs used multiple forms of outreach to communicate SGMA-related information and solicit input. The GSAs intend to continue public outreach and provide opportunities for engagement during GSP implementation, as described in **Chapter 4**. To continue to keep stakeholders informed about coordination and implementation efforts following GSP adoption, the GSAs will conduct the following outreach efforts during GSP implementation:

- Continuing to hold regular SSGMCC meetings during the GSP implementation phase. SSGMCC meetings between the GSAs and Funding Partners are assumed to occur monthly during GSP implementation, with other oversight and administrative activities occurring as needed and on an ongoing basis. The GSAs may also choose to establish a new advisory committee to hold standing outreach meetings specific to GSP implementation.
- Providing regular updates at GSA Board or City Council meetings through a standing SGMA agenda item.
- Maintaining the Sutter Subbasin GSP website and keeping it up to date with a regular posting of information.
- Performing local outreach at public meetings and events.
- Producing and distributing a quarterly newsletter to update interested parties on ongoing basin activities, such as on projects or studies.

Costs to support outreach are estimated to range from $105,000 to $185,000 annually.

8.5 Monitoring

The Sutter Subbasin GSAs will use the monitoring programs described in **Section 7.2** to track conditions for the applicable sustainability indicators discussed in **Chapter 6**. Monitoring network data will be collected, uploaded to the DMS, and used to determine whether undesirable results are occurring, whether minimum thresholds are being reached or exceeded, and to determine if adaptive management is necessary. The monitoring networks make use of existing monitoring programs and develop further monitoring to continue characterization of the system and support development of water budgets.

Key components involved in the implementation of the monitoring network activities for the GSP include:

- Semi-annual groundwater level monitoring at 63 wells for the chronic lowering of groundwater levels sustainability indicator and 23 wells for the depletions of interconnected surface water sustainability indicator.

- Semi-annual groundwater quality monitoring at 28 wells.
- Annual evaluation of publicly available Interferometric Synthetic Aperture Radar (InSAR) provided by DWR for land subsidence monitoring.
- Coordination between the new GSP monitoring program and other regulatory programs requiring monitoring and reporting (e.g., Irrigated Lands Regulatory Program).

8.6 Data Management System

As required under the GSP Emergency Regulations §352.6 Data Management System, each GSA is required to develop and maintain a DMS that is capable of storing and reporting information relevant to the development or implementation of the GSP(s). Additionally, per §354.4 Reporting Monitoring Data to the Department, all monitoring data is to be stored in a DMS with copies of the monitoring data included in the annual report and submitted electronically on forms provided by DWR. The Sutter Subbasin GSAs have coordinated to develop a single DMS for the Sutter Subbasin.

The Sutter Subbasin DMS is implemented using the Opti platform and serves as a data sharing portal to support sustainable groundwater management and transparent reporting of data and results relative to GSP implementation. The DMS is web-based and publicly accessible using common web browsers, including Google Chrome, Firefox, and Microsoft Edge. It is a flexible and open software platform that utilizes familiar Google maps and charting tools for analysis and visualization. The site may be accessed through https://opti.woodardcurran.com/sutter/.

The DMS can be configured for additional tools and functionality as needed to support the Sutter Subbasin GSAs and SSGMCC. Detailed instructions on the usage of the DMS can be found in the Opti Public User Guide (https://opti.woodardcurran.com/sutter/upload/OptiPublicDMS_Guide.pdf).

In order to facilitate data synthesis, monitoring data will be uploaded to the DMS as follows:

- **Groundwater elevations** – Twice per year, with seasonal high groundwater elevation data collected between March and April, and seasonal low groundwater elevation data collected between September and October. Additional water level data may be collected for those representative monitoring locations influenced by rice growing operations.
- **Interconnected surface water** – Twice per year in conjunction with groundwater level monitoring.
- **Groundwater quality** – Once per year in conjunction with groundwater quality monitoring in September.
- **Subsidence** – Publicly available subsidence data will be used along with locally-collected data.

The DMS will be maintained by Sutter County with a contract with the software vendor for hosting, maintenance, and future maintenance. DMS maintenance will be included in the costs for GSP administration.

8.7 Model Refinements

The C2VSimFG-Sutter model will be updated based on newly available data or additional information provided by GSAs. Areas of higher uncertainty, such as calibration in the Sutter Buttes area and other areas of the Subbasin with few wells and the need for better understanding of surface water-groundwater interactions, will be refined using additional information collected through GSP monitoring and projects to achieve better calibration. Once the model has been updated and recalibrated, new SGMA scenarios will be developed and evaluated, including the current, projected, and sustainable scenarios, as well as associated water budgets and the evaluation of sustainability indicators based on project implementation.

The C2VSimFG-Sutter model will be updated annually as part of the Annual Report preparation. The model will be refined and recalibrated by 2026 so that updated scenarios can be developed before the GSP five-year assessment is due in 2027. Model refinement costs are expected to be $275,000 to $400,000.

8.8 Adaptive Management Strategies

As part of the GSP implementation, adaptive management strategies would only be considered for implementation if designated trigger events for that strategy occur. Triggers for implementation of adaptive management allow for a variety of actions, ranging from coordination and monitoring to management of groundwater extractions and recharge. Triggering events for implementation are based on monitoring results, and data are set in relation to sustainable management criteria described in **Chapter 6**. The purpose of this adaptive management strategy is for the GSAs to take necessary action to investigate the cause of potential exceedances of the minimum threshold and provide a framework for responding to such exceedances.

If a single observation exceeding the minimum threshold at a representative monitoring site is recorded, the monitoring entity will report this exceedance to the GSA. The GSA would then, in turn, flag the representative monitoring site where the exceedance is observed and would bring the flagged monitoring site to the attention of the SSGMCC. The SSGMCC will consider the results of an assessment performed by the GSAs of the exceedance to determine if it is a locally-driven change in conditions or representative of a long-term, regional change in conditions. The SSGMCC will recommend a course of action that may include collecting additional data, conducting additional monitoring to confirm the impact, and/or working with water managers near the site to resolve the issue. The GSA would take action(s) deemed necessary, including corrective action, additional studies, or management modification, if any, in the area influencing the monitoring site.

Corrective action to better understand or mitigate the impact may include increased monitoring frequency, coordination and information sharing with overlying land use planning agencies or other water and wastewater management entities to determine the cause of exceedances, augmenting alternate water supplies for the area, providing additional recharge, and addressing changes in recharge in the area. In extreme cases, halting or reducing groundwater pumping in the depths and areas influenced by the representative well monitoring site may be considered until conditions recover. Alternative supplies for those in the affected area would be coordinated should groundwater pumping be halted. Given the current, historical, and projected sustainable nature of the Sutter Subbasin, and given the cost associated with developing detailed response plans, details of these adaptive management actions will be further developed only if conditions suggest a reasonable potential for implementation of such strategies.

The corrective action or information gathering would be deemed successful in returning Subbasin to sustainable conditions, following the implementation of corrective action or measures, once monitoring indicates that conditions are above the minimum threshold, or that the issue was a result of localized conditions.

8.9 Annual Reports

Annual reports must be submitted by April 1 of each year following GSP adoption, per the GSP Emergency Regulations §356.2 Annual Reports. Annual reports must include four key sections as follows:

- General Information
- Basin Conditions
- Plan Implementation Progress

A general outline of what information will be provided in each of these sections in the annual report is included below. In addition, a copy of the monitoring data stored in the DMS will be submitted electronically to DWR through the Monitoring Network Module or Annual Report Module, as appropriate, and would be completed in a manner and format consistent with §356.2 of the GSP Emergency Regulations and additional guidance provided by DWR. The Sutter Subbasin GSAs will also report, at a minimum, two static groundwater elevation readings per year, representing the seasonal low and seasonal high groundwater conditions in the basin, to DWR electronically by January 1 and July 1, respectively.

As annual reporting continues, it is anticipated that this outline will change to reflect current Subbasin conditions, priorities of the Sutter Subbasin GSAs, and applicable State requirements.

8.9.1 General Information

General information will include an executive summary that highlights the key content of the annual report. As part of the executive summary, this section will include a description of the sustainability goals, provide a description of GSP projects and their progress, as well as an annually-updated implementation schedule and map of the Subbasin.

8.9.2 Subbasin Conditions

Subbasin conditions will describe the current groundwater conditions and monitoring results. This section will evaluate how conditions have changed in the Subbasin over the previous year and compare groundwater data for the water year to historical groundwater data. Pumping data, effects of project implementation (e.g., recharge data, conservation, etc., if applicable), surface water flows, total water use, and groundwater storage will be included.

Key components, as required by the GSP Emergency Regulations, include:

- Groundwater elevation data from the monitoring network, including seasonal high and seasonal low contour maps
- Hydrographs of groundwater elevation data at representative monitoring locations
- Groundwater extraction data
- Surface water supply data by source
- Total water use data by sector and source
- Change in groundwater storage, including a map and graph

8.9.3 Plan Implementation Progress

Progress toward successful Plan implementation will be included in the annual report. This section of the annual report will describe the progress made toward achieving interim milestones as well as implementation of projects and management actions.

Key components, as required by GSP Emergency Regulations, include:

- Plan implementation progress, including interim milestones achieved and any proposed changes to the GSP
- Progress toward the Subbasin sustainability goal
- Implementation of projects or management actions

8.10 Five-Year Assessment Reports

SGMA requires evaluation of GSPs regarding their progress toward meeting approved sustainability goals at least every five years. SGMA also requires developing a written assessment and submitting this assessment to DWR. An evaluation must also be made whenever the GSP is amended. A description of the information that will be included in the five-year report is provided below and would be prepared in a manner consistent with §356.4 of the GSP Emergency Regulations.

8.10.1 Sustainability Evaluation

This section will contain a description of current groundwater conditions for each applicable sustainability indicator and will include a discussion of overall Subbasin sustainability. Progress toward achieving interim milestones and measurable objectives will be included, along with an evaluation of groundwater elevations (i.e., those being used as direct or proxy measures for the sustainability indicators) in relation to minimum thresholds. If any of the adaptative management triggers are found to be met during this evaluation, a plan for implementing adaptive management described in the GSP would be included.

8.10.2 Plan Implementation Progress

This section will describe the current status of project and management action implementation, and report on whether any adaptive management action triggers had been activated since the previous five-year report. Updated project implementation schedules will be included, along with any new projects that were developed to support the goals of the GSP, and a description of any projects that are no longer included in the GSP. The benefits of projects that have been implemented will be included, and updates on projects and management actions that are underway at the time of the five-year report will be reported.

8.10.3 Reconsideration of GSP Elements

Part of the five-year report will include a reconsideration of GSP elements. As additional monitoring data are collected during GSP implementation, land uses and community characteristics change over time, and GSP projects and management actions are implemented, it may become necessary to revise the GSP. This section of the five-year report will reconsider the Subbasin setting, management areas, undesirable results, minimum thresholds, and measurable objectives. If appropriate, the five-year report will recommend revisions to the GSP. Revisions would be informed by the outcomes of the monitoring network, and changes in the Subbasin, including changes to groundwater uses or supplies and outcomes of project implementation.

8.10.4 Monitoring Network Description

A description of the monitoring network will be provided in the five-year report. Data gaps or areas of the Subbasin that are not monitored in a manner commensurate with the requirements of §352.4 and §354.34(c) of the GSP Emergency Regulations will be identified. An assessment of the monitoring network's function will also be provided, along with an analysis of data collected to date. If data gaps are identified, the GSP will be revised to include a program for addressing these data gaps along with an implemented schedule for addressing gaps and how the Sutter Subbasin GSAs will incorporate updated data into the GSP.

8.10.5 New Information

New information that becomes available after the last five-year evaluation or GSP amendment would be described and evaluated. If the new information would warrant a change to the GSP, this would also be included, as described in **Section 8.10.3**.

8.10.6 Regulations or Ordinances

The five-year report will include a summary of the regulations or ordinances related to the GSP that have been implemented by DWR since the previous report and address how these may require updates to the GSP.

8.10.7 Legal or Enforcement Actions

Enforcement or legal actions taken by the Sutter Subbasin GSAs in relation to the GSP will be summarized in this section along with how such actions support sustainability in the Subbasin.

8.10.8 Plan Amendments

A description of amendments to the GSP will be provided in the five-year report, including adopted amendments, recommended amendments for future updates, and amendments that are underway during development of the five-year report.

8.10.9 Coordination

Ongoing coordination will be required by the Sutter Subbasin GSAs for plan implementation, in addition to coordination with neighboring subbasins and GSAs in neighboring subbasins. This section of the five-year report will describe coordination activities between these entities, such as meetings, joint projects, or data collection efforts. If additional neighboring GSAs have been formed, existing GSAs have been modified, or changes in neighboring basins have occurred since the previous report that result in a need for new or additional coordination within or outside the Subbasin, such coordination activities would also be included and discussed.

8.10.10 Reporting to Stakeholders and the Public

Any outreach activities associated with the GSP assessment and any resultant updates should be documented in this section of the five-year report.

This page intentionally left blank.

CHAPTER NINE

References and Technical Studies

This page intentionally left blank

9. REFERENCES AND TECHNICAL STUDIES

The following tables summarize the references and technical studies used in the development of the Sutter Subbasin Groundwater Sustainability Plan (GSP). References used in developing the various sections of the GSP are summarized at the end of each GSP chapter.

This page intentionally left blank.

Title	Author	Publish Date	Reference URL	Additional Data	GSP Chapter/Section
Water quality for agriculture	Ayers, R.S. and D.W. Westcot	12/31/1985	http://www.fao.org/docrep/003/T0234E/T0234E00.htm	Table 1 – Guidelines for Interpretations of Water Quality for Irrigation and Table 21 – Recommended Maximum Concentrations of Trace Elements in Irrigation Water. FAO Irrigation and Drainage Paper 29 Rev. 1	Chapter 5 - Basin Setting, Section 2: Groundwater Conditions
Contact relations of the Ione and Valley Springs Formations in the east-central Great Valley, California	Bartow, J.A.	12/31/1992	-	USGS, Open-File Report 92-588	Chapter 5 - Basin Setting, Section 1: Hydrogeologic Conceptual Model (HCM)
Dynamics of Fluids in Porous Media	Bear, J.	12/31/1972	-	Dover Publications, Inc. New York	Chapter 5 - Basin Setting, Section 1: HCM
Status of Groundwater Quality in the Southern, Middle, and Northern Sacramento Valley Study units, 2005-08: California GAMA Priority Basin Project	Bennett, G.L., M.S. Fram, and K. Belitz	12/31/2011	https://pubs.usgs.gov/sir/2011/5002/	U.S. Geological Survey Scientific Investigations Report 2011-5002, 120 p	Chapter 2 - Plan Area
Base of Fresh Ground-Water -- Approximately 3,000 micromhos -- in the Sacramento Valley and Sacramento-San Joaquin Delta, California	Berkstresser, C.F.	12/31/1973	-	U.S. Geological Survey Water-Resource Inv. 40-73	Chapter 5 - Basin Setting, Section 1: HCM
Cenozoic Fluvial-Facies Architecture and Aquifer Heterogeneity, Oroville, California, Superfund Site and Vicinity, in A.D. Miall and N. Tyler, eds., The Three-Dimensional Facies Architecture of Terrigenous Clastic Sediments and Its Implications for Hydrocarbon Discovery and Recovery, SEPM, Concepts in Sedimentology and Paleontology, Volume 3	Blair, T.C., Baker, F.G., and Turner, J.B.	12/31/1991	-		Chapter 5 - Basin Setting, Section 1: HCM; Chapter 7 - Sustainability Implementation, Section 1: Projects and Management Actions
Final Report, Lower Tuscan Aquifer, Monitoring, Recharge, and Data Management Project	Brown and Caldwell	5/21/2013	-		Chapter 5 - Basin Setting, Section 1: HCM
Geology and ground-water resources of Sacramento Valley, California	Bryan, K.	12/31/1923	https://pubs.er.usgs.gov/publication/wsp495	United States Geological Survey Water Supply Paper 495, xi, 285 p. xix pl	Chapter 5 - Basin Setting, Section 2: Groundwater Conditions
Late Cenozoic stratigraphy of the Feather and Yuba rivers area, California, with a section on soil development in mixed alluvium at Honcut Creek	Busacca, A.J., Singer, M.J., and Verosub, K.I.	12/31/1989	-	USGS Bulletin 1590-G, p. G!-G132	Chapter 5 - Basin Setting, Section 1: HCM
Refuge Water Supply Program Details	California Department of Fish and Wildlife	n.d.	https://wildlife.ca.gov/Conservation/Watersheds/Refuge-Water/Details		Chapter 2 Plan Area
Overview of the Surface Water Protection Program	California Department of Pesticide Regulation (CDPR)	n.d.	https://www.cdpr.ca.gov/docs/emon/surfwtr/overvw.htm		Chapter 2 - Plan Area

Title	Author	Publish Date	Reference URL	Additional Data	GSP Chapter/Section
Guidance Document for the Sustainable Management of Groundwater: Preparation Checklist for GSP Submittal	California Department of Water Resources	12/31/2016	https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Preparation-Checklist-for-GSP-Submittal.pdf		Chapter 1 - Introduction
5-021.62 Sacramento Valley - Sutter Basin Boundaries Description	California Department of Water Resources	12/31/2018	https://cadwr.app.box.com/s/rhqaflj4t5d063he9o314ojzz394idec/file/764121944134		Chapter 1 - Introduction
Chronologically Reconstructed Sacramento and San Joaquin Valley Water Year Hydrologic Classifications Indices	California Department of Water Resources	12/31/2021	https://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST		Chapter 5 - Basin Setting, Section 3: Water Budgets
DAC Mapping Tool	California Department of Water Resources	n.d.	https://gis.water.ca.gov/app/dacs/		Chapter 4 - Outreach & Communication
EDA Mapping Tool	California Department of Water Resources	n.d.	https://gis.water.ca.gov/app/edas/		Chapter 4 - Outreach & Communication
Groundwater Basins in California: Sacramento Valley	California Department of Water Resources (DWR)	1/31/1980	-	Bulletin 118-80	Chapter 5 - Basin Setting, Section 1: HCM
Water Well Standards: State of California, Bulletin 74-81	California Department of Water Resources (DWR)	12/31/1981	https://www.acwd.org/DocumentCenter/View/169/Bulletin-74-81-Water-Well-Standards---State-of-California?bidId=		Chapter 2 - Plan Area
California Well Standards, Bulletin 74-90	California Department of Water Resources (DWR)	12/31/1991	https://www.countyofglenn.net/sites/default/files/Environmental_Health/WP_DWR_Bulletin_74-90.pdf		Chapter 2 - Plan Area
Bulletin 118-2003: California's Groundwater	California Department of Water Resources (DWR)	12/31/2003	https://cawaterlibrary.net/document/bulletin-118-californias-groundwater-2003/		Chapter 2 - Plan Area
California's Groundwater, Bulletin 118 – Update 2003, Sutter Subbasin	California Department of Water Resources (DWR)	1/20/2006	-		Chapter 5 - Basin Setting, Section 1: HCM
Best Management Practices: Monitoring Networks and Identification of Data Gaps	California Department of Water Resources (DWR)	12/31/2016	https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-2-Monitoring-Networks-and-Identification-of-Data-Gaps_ay_19.pdf		Chapter 7 - Sustainability Implementation, Section 2: Monitoring

Title	Author	Publish Date	Reference URL	Additional Data	GSP Chapter/Section
Best Management Practices: Monitoring Protocols Standards and Sites	California Department of Water Resources (DWR)	12/31/2016	https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-1-Monitoring-Protocols-Standards-and-Sites_ay_19.pdf		Chapter 7 - Sustainability Implementation, Section 2: Monitoring
California Code of Regulations, Title 23 Waters, Division 2 Department of Water Resources, Chapter 1.5 Groundwater Management	California Department of Water Resources (DWR)	12/31/2016	https://govt.westlaw.com/calregs/Browse/Home/California/CaliforniaCodeofRegulations?guid=I74F39D13C76F497DB40E93C75FC716AA		Chapter 7 - Sustainability Implementation, Section 2: Monitoring
Water Districts shapefile	California Department of Water Resources (DWR)	12/31/2016	https://data.cnra.ca.gov/dataset/water-districts		Chapter 2 - Plan Area
Draft Best Management Practices for the Sustainable Management of Groundwater - Sustainable Management Criteria BMP	California Department of Water Resources (DWR)	12/31/2017	https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-6-Sustainable-Management-Criteria-DRAFT_ay_19.pdf		Chapter 6 - Sustainability Management Criteria
Natural Communities Commonly Associated with Groundwater (NCCAG) Dataset	California Department of Water Resources (DWR)	12/31/2018	https://gis.water.ca.gov/app/NCDatasetViewer/#		Chapter 5 - Basin Setting, Section 2: Groundwater Conditions
CA Bulletin 118 Groundwater Basins shapefile (updated 2018)	California Department of Water Resources (DWR)	12/31/2019	https://data.cnra.ca.gov/dataset/ca-bulletin-118-groundwater-basins		Chapter 2 - Plan Area
TRE Altamira InSAR Dataset	California Department of Water Resources (DWR)	12/31/2021	https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#landsub		Chapter 5 - Basin Setting, Section 2: Groundwater Conditions
California Data Exchange Center	California Department of Water Resources (DWR)	n.d.	https://cdec.water.ca.gov/misc/CDEC_Brochure.pdf		Chapter 2 - Plan Area
Groundwater Monitoring (CASGEM)	California Department of Water Resources (DWR)	n.d.	https://water.ca.gov/Programs/Groundwater-Management/Groundwater-Elevation-Monitoring--CASGEM		Chapter 2 - Plan Area
SGMA Data Viewer	California Department of Water Resources (DWR)	n.d.	https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#gwlevels		Chapter 2 - Plan Area
Well Completion Report Map Application	California Department of Water Resources (DWR)	n.d.	https://www.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37		Chapter 2 - Plan Area

Title	Author	Publish Date	Reference URL	Additional Data	GSP Chapter/Section
2008 DWR/USBR Sacramento Valley Subsidence Project – Project Report	California Department of Water Resources (DWR) and United States Bureau of Reclamation (USBR)	9/30/2008	https://www.yologroundwater.org/files/9d543426e/5%29+DWR-USBR+Sac+Valley+Subsidence+Report+2008.pdf		Chapter 2 - Plan Area
California Central Valley Groundwater-Surface Water Simulation Model - Fine Grid (C2VSimFG) Development and Calibration Version 1.0	California Department of Water Resources (DWR), Sustainable Groundwater Management Office (SGMO)	12/31/2020	https://data.cnra.ca.gov/dataset/c2vsimfg-version-1-0/resource/4f904e97-a47b-4138-81df-9b74bd952948		Chapter 5 - Basin Setting, Section 3: Water Budgets
Agreement on Diversion of Water from the Feather River	California Department of Water Resources and Joint Board	5/27/1969	-		Chapter 7 - Sustainability Implementation, Section 1: Projects and Management Actions
2017 GPS Survey of the Sacramento Valley Subsidence Network	California Department of Water Resources, Northern Region Office (DWR NRO)	12/31/2018	-		Chapter 2 - Plan Area; Chapter 5 - Basin Setting, Section 2: Groundwater Conditions; Chapter 6 - Sustainability Management Criteria
City of Live Oak GSA shapefile	California Department of Water Resources, SGMA Portal	2/28/2017	https://sgma.water.ca.gov/portal/gsa/print/136		Chapter 2 - Plan Area
Sutter Community Service District GSA shapefile	California Department of Water Resources, SGMA Portal	2/28/2017	https://sgma.water.ca.gov/portal/gsa/print/114		Chapter 2 - Plan Area
Sutter Extension Water District GSA shapefile	California Department of Water Resources, SGMA Portal	2/28/2017	https://sgma.water.ca.gov/portal/gsa/print/121		Chapter 2 - Plan Area
Reclamation District No. 1500 GSA shapefile	California Department of Water Resources, SGMA Portal	3/31/2017	https://sgma.water.ca.gov/portal/gsa/print/239		Chapter 2 - Plan Area
City of Yuba City GSA shapefile	California Department of Water Resources, SGMA Portal	4/30/2017	https://sgma.water.ca.gov/portal/gsa/print/264		Chapter 2 - Plan Area
Reclamation District No. 1660 GSA shapefile	California Department of Water Resources, SGMA Portal	6/30/2017	https://sgma.water.ca.gov/portal/gsa/print/321		Chapter 2 - Plan Area
Reclamation District No. 70 GSA shapefile	California Department of Water Resources, SGMA Portal	6/30/2017	https://sgma.water.ca.gov/portal/gsa/print/320		Chapter 2 - Plan Area
Butte Water District GSA – Sutter shapefile	California Department of Water Resources, SGMA Portal	7/31/2017	https://sgma.water.ca.gov/portal/gsa/print/119		Chapter 2 - Plan Area
County of Sutter GSA – Sutter shapefile	California Department of Water Resources, SGMA Portal	7/31/2017	https://sgma.water.ca.gov/portal/gsa/print/218		Chapter 2 - Plan Area

Title	Author	Publish Date	Reference URL	Additional Data	GSP Chapter/Section
2016 Statewide Crop Mapping GIS Map Service	California Natural Resources Agency	1/31/2020	https://data.cnra.ca.gov/dataset/statewide-crop-mapping/resource/653de2ff-d734-4a9a-b7a5-417c45ed83b5		Chapter 2 - Plan Area
Resolution 68-16 Statement of Policy with Respect to Maintaining High Quality of Waters in California	California State Water Resources Control Board (SWRCB)	12/31/1968	https://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/1968/rs68_016.pdf		Chapter 6 - Sustainability Management Criteria
Groundwater Information Sheet: Arsenic	California State Water Resources Control Board (SWRCB)	10/31/2017	https://www.waterboards.ca.gov/water_issues/programs/gama/docs/coc_arsenic.pdf		Chapter 5 - Basin Setting, Section 2: Groundwater Conditions
Groundwater Information Sheet: Nitrate	California State Water Resources Control Board (SWRCB)	11/30/2017	https://www.waterboards.ca.gov/water_issues/programs/gama/docs/coc_nitrate.pdf		Chapter 5 - Basin Setting, Section 2: Groundwater Conditions
Groundwater Information Sheet: Salinity	California State Water Resources Control Board (SWRCB)	11/30/2017	https://www.waterboards.ca.gov/water_issues/programs/gama/docs/coc_salinity.pdf		Chapter 5 - Basin Setting, Section 2: Groundwater Conditions
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	California State Water Resources Control Board (SWRCB)	5/31/2018	https://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/sacsjr_201805.pdf		Chapter 6 - Sustainability Management Criteria
2021 Aquifer Risk Assessment	California State Water Resources Control Board (SWRCB)	12/31/2021	https://gispublic.waterboards.ca.gov/portal/apps/webappviewer/index.html?id=17825b2b791d4004b547d316af7ac5cb		Chapter 4 - Outreach & Communication
Groundwater Ambient Monitoring and Assessment Program (GAMA) Groundwater Information System	California State Water Resources Control Board (SWRCB)	12/31/2021	https://gamagroundwater.waterboards.ca.gov/gama/datadownload.		Chapter 5 - Basin Setting, Section 2: Groundwater Conditions
GeoTracker – Download ESI Data by County	California State Water Resources Control Board (SWRCB)	n.d.	https://geotracker.waterboards.ca.gov/data_download_by_county		Chapter 2 - Plan Area
What is a Public Water System?	California State Water Resources Control Board (SWRCB)	n.d.	https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/waterpartnerships/what_is_a_public_water_sys.pdf		Chapter 2 - Plan Area
SWAMP Monitoring Plan – Sacramento Watershed Coordinated Monitoring Program	California Water Boards	2/28/2009	https://www.waterboards.ca.gov/water_issues/programs/swamp/docs/workplans/regionalworkplan2.pdf		Chapter 2 - Plan Area
SWAMP Achievements Report – Sacramento Watershed Coordinated Monitoring Program	California Water Boards	12/31/2009	https://www.waterboards.ca.gov/water_issues/programs/swamp/achievements/2009/monitoring/sac_coordmp.pdf		Chapter 2 - Plan Area
State Water Board 2016 Water Transfers	California Water Boards	12/31/2016	https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_transfers/docs/2016transfertable.pdf		Chapter 2 - Plan Area

Title	Author	Publish Date	Reference URL	Additional Data	GSP Chapter/Section
State Water Board 2018 Water Transfers	California Water Boards	12/31/2018	https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_transfers/docs/2018transfertable.pdf		Chapter 2 - Plan Area
SWAMP – Sacramento River Basin	California Water Boards	6/30/2019	https://www.waterboards.ca.gov/centralvalley/water_issues/swamp/sacramento_river_basin/		Chapter 2 - Plan Area
Storm Water Grant Program (SWGP) – Storm Water Resource Plans	California Water Boards	6/30/2020	https://www.waterboards.ca.gov/water_issues/programs/grants_loans/swrp/		Chapter 2 - Plan Area
GAMA – About	California Water Boards	7/31/2020	https://www.waterboards.ca.gov/water_issues/programs/gama/about.html		Chapter 2 - Plan Area
GAMA Online Tools	California Water Boards	12/31/2020	https://www.waterboards.ca.gov/water_issues/programs/gama/online_tools.html		Chapter 2 - Plan Area
State Water Board 2020 Water Transfers	California Water Boards	12/31/2020	https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_transfers/docs/2020transfertable.pdf		Chapter 2 - Plan Area
Surface Water Ambient Monitoring Program (SWAMP) – Statewide Monitoring Programs	California Water Boards	12/31/2020	https://www.waterboards.ca.gov/water_issues/programs/swamp/monitoring/statewide_monitoring_programs.html		Chapter 2 - Plan Area
State Water Board 2021 Water Transfers	California Water Boards	12/31/2021	https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_transfers/docs/2021transfertable_rev2.pdf		Chapter 2 - Plan Area
California Environmental Data Exchange Network	California Water Boards	n.d.	https://ceden.waterboards.ca.gov/AdvancedQueryTool		Chapter 2 - Plan Area
Aquifer Storage Recovery Feasibility Assessment Report Prepared for City of Yuba City, California	Carollo Engineers, Pueblo Water Resources, and ASR Systems	11/30/2010	-		Chapter 2 - Plan Area
Central Valley Region Salt and Nitrate Management Plan – Final Document for Central Valley Water Board Consideration	Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS)	12/31/2016	https://www.cvsalinity.org/docs/central-valley-snmp/final-snmp.html		Chapter 2 - Plan Area
Reclamation District No. 1500 Groundwater Management Plan	CH2M Hill	2/28/2012	-		Chapter 2 - Plan Area
Sacramento Valley Water Quality Coalition Groundwater Quality Assessment Report	CH2M Hill	12/31/2014	-		Chapter 5 - Basin Setting, Section 1: HCM
Sacramento Valley Water Quality Coalition Groundwater Quality Assessment Report	CH2M Hill	1/31/2016	-		Chapter 5 - Basin Setting, Section 1: HCM

Title	Author	Publish Date	Reference URL	Additional Data	GSP Chapter/Section
Groundwater Trend Monitoring Workplan and Data Gap Assessment Plan – Prepared for Central Valley Regional Water Quality Control Board On Behalf of California Rice Commission	CH2M Hill	3/31/2016	https://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/water_quality/coalitions_submittals/california_rice_commission/ground_water/2016_03_rice_gar.pdf		Chapter 2 - Plan Area
Sacramento River Settlement Contactors Drought Management Plan	CH2M Hill and MBK Engineers	10/31/2016	https://wuedata.water.ca.gov/public/awmp_attachments/6089756608/Drought%20Mgmt%20Plan.pdf		Chapter 2 - Plan Area
Water Balance Summary Prepared for Sacramento River Settlement Contractors	CH2M Hill and MBK Engineers	10/31/2016	https://wuedata.water.ca.gov/public/awmp_attachments/6360883414/Water%20Balance%20Summary_12.29.16.pdf		Chapter 2 - Plan Area
City of Live Oak 2030 General Plan	City of Live Oak	n.d.	https://www.liveoakcity.org/Home/ShowDocument?id=494		Chapter 2 - Plan Area
Yuba City General Plan	City of Yuba City	12/31/2004	https://www.yubacity.net/UserFiles/Servers/Server_239174/File/Development%20Services/Planning/Plans/General/YC-GPAC-APR-04-FINAL.pdf		Chapter 2 - Plan Area
Accuracy of Annual Volume from Current-Meter-Based Stage Discharges	Clemmens, A.J. and Wahlin, B.T.	10/31/2006	-		Chapter 7 - Sustainability Implementation, Section 1: Projects and Management Actions
Feather River Regional Agricultural Water Management Plan, Volume 1: Regional Plan Components	Davids Engineering, Inc	12/31/2014	-		Chapter 5 - Basin Setting, Section 1: HCM
Groundwater and Wells	Driscoll, F.G.	12/31/1986	https://www.nrc.gov/docs/ML1423/ML14237A631.pdf	2nd Edition, Johnson Division, St Paul, 1089	Chapter 5 - Basin Setting, Section 1: HCM
National Conservation Easement Database	Ducks Unlimited and The Trust for Public Land	12/31/2021	https://www.conservationeasement.us/interactivemap/		Chapter 2 - Plan Area
Conjunctive Water Management: What is it? Why consider it? What are the challenges?	Dudley, T. and Fulton, A.	n.d.	https://ucanr.edu/sites/Tehama/files/20596.pdf		Chapter 7 - Sustainability Implementation, Section 1: Projects and Management Actions
City of Live Oak Water Master Plan	EcoLogic	12/31/2009	-		Chapter 2 - Plan Area
Addressing Regional Surface Water Depletions in Caifornia: A Proposed Approach for Compliance with the Sustainable Groundwater Management Act	Environmental Defense Fund (EDF)	12/31/2018	https://www.edf.org/sites/default/files/documents/edf_california_sgma_surface_water.pdf		Chapter 7 - Sustainability Implementation, Section 1: Projects and Management Actions and Section 2: Monitoring
Reactive Transport of Nitrate in Northern California Groundwater basins: An Integrated Characterization and Modeling Approach	Esser, B., Moran, J., Hudson, G., Carle, S., McNab W., Tompson, A., Moore, K., Beller H., Kane, S., Eaton, G.	12/31/2003	-	AGU Fall Meeting Abstracts	Chapter 5 - Basin Setting, Section 1: HCM

Title	Author	Publish Date	Reference URL	Additional Data	GSP Chapter/Section
Geology and ground-water hydrology of the Mokelumne area, California	Gale, H.S., Piper, A.M., and Thomas, H.E.	12/31/1939	-	U.S. Geological Survey Water-Supply Paper 780, p. 14-101	Chapter 5 - Basin Setting, Section 1: HCM
Alternative Submittal to a Groundwater Sustainability Plan for Sutter Subbasin, Sutter County, California	GEI	12/19/2016	-		Chapter 2 - Plan Area; Chapter 5 - Basin Setting, Section 1: HCM and Section 2: Groundwater Conditions; Chapter 6 - Sustainability Management Criteria
California Protected Areas Database, Version 2020b	GreenInfo Network	12/31/2021	http://www.mapcollaborator.org/cpad/?base=map&y=37.50973&x=-123.94775&z=6&layers=mapcollab_cpadng_cpad_ownlevel%2Cnotes%2Cpolygons%2Cuploads&opacs=50%2C100%2C25%2C90		Chapter 2 - Plan Area
Late Cenozoic Tectonism of the Sacramento Valley, California	Harwood, D.S., and Helley, E.J.	12/31/1987	https://pubs.usgs.gov/pp/1359/report.pdf	U.S. Geological Survey Professional Paper 1359	Chapter 5 - Basin Setting, Section 1: HCM
Final, Feather River West Levee Project, Environmental Impact Report	ICF International	4/30/2013	http://sutterbutteflood.org/admin/upload/Feather%20River%20West%20Levee%20Project%20Final%20EIR.pdf		Chapter 5 - Basin Setting, Section 1: HCM
2020 Rice-Specific Groundwater Assessment Report Update – Prepared for Central Valley Regional Water Quality Control Board On Behalf of California Rice Commission	Jacobs and Montgomery & Associates	5/31/2020	-		Chapter 2 - Plan Area
Land Use Datasets: Statewide Crop Mapping 2018	Land IQ	12/31/2021	https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#waterbudget		Chapter 7 - Sustainability Implementation, Section 1: Projects and Management Actions
USGS, Sacramento Folio	Lindgren, W.	1894-12-31	https://ngmdb.usgs.gov/Prodesc/proddesc_358.htm	p.3	Chapter 5 - Basin Setting, Section 1: HCM
Groundwater Quality Trend Monitoring Workplan Addendum for the Sacramento Valley Water Quality Coalition	Luhdorff & Scalmanini Consulting Engineers (LSCE)	7/31/2018	https://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/water_quality/coalitions_submittals/sacramento_valley/ground_water/2018_0731_svwqc_gqtmp_add.pdf		Chapter 2 - Plan Area
Sutter Mutual Water Company SBx7-7 Water Measurement Compliance Program	MBK Engineers	10/31/2016	https://wuedata.water.ca.gov/public/awmp_attachments/3454450309/SMWC%20Water%20Measurement%20Program.pdf		Chapter 2 - Plan Area
Progress Report: Subsidence in California, March 2015 – September 2016	National Aeronautics and Space Administration (NASA)	2016-09-31	https://cawaterlibrary.net/document/progress-report-subsidence-in-california-march-2015-september-2016/		Chapter 5 - Basin Setting, Section 1: HCM
Sutter Extension Water District Groundwater Management Plan	No author	8/31/1995	-		Chapter 2 - Plan Area
Butte Water District Groundwater Management Plan	No author	5/31/1996	-		Chapter 2 - Plan Area

Title	Author	Publish Date	Reference URL	Additional Data	GSP Chapter/Section
Groundwater Management Plan of Feather Water District	No author	11/30/2005	-		Chapter 2 - Plan Area
2012 Sacramento Valley Regional Water Management Plan Annual Update	No author	12/31/2012	https://wuedata.water.ca.gov/public/awmp_attachments/8930585563/2012%20RWMP%20Annual%20Update%209.6.13.pdf		Chapter 2 - Plan Area
North American Stratigraphic Code, AAPG Bulletin, v. 89, no. 11	North American Commission on Stratigraphic Nomenclature (NACM)	11/30/2005	https://ngmdb.usgs.gov/Info/NACSN/Code2/code2.html	pp. 1547–1591	Chapter 5 - Basin Setting, Section 1: HCM
Feather River Regional Agricultural Water Management Plan, Volume II: Supplier Plan Contents - Butte Water District	Northern California Water Association (NCWA)	8/31/2014	-		Chapter 7 - Sustainability Implementation, Section 1: Projects and Management Actions
Feather River Regional Agricultural Water Management Plan, Volume II: Supplier Plan Contents - Sutter Extension Water District	Northern California Water Association (NCWA)	8/31/2014	-		Chapter 7 - Sustainability Implementation, Section 1: Projects and Management Actions
Feather River Regional Agricultural Water Management Plan – Volume II: Supplier Plan Components Biggs-West Gridley Water District	Northern California Water Association (NCWA)	12/31/2015	https://wuedata.water.ca.gov/public/awmp_attachments/5030301749/Biggs-West%20Gridley%20WD%202015%20AWMP.pdf		Chapter 2 - Plan Area
Feather River Regional Agricultural Water Management Plan – Volume II: Supplier Plan Components Butte Water District	Northern California Water Association (NCWA)	12/31/2016	https://wuedata.water.ca.gov/public/awmp_attachments/2549176871/Butte%20WD%202016%20AWMP.pdf		Chapter 2 - Plan Area
Re-managed Instream Flows in the Sacramento River Basin	Northern California Water Association (NCWA)	11/30/2019	https://norcalwater.org/wp-content/uploads/2012/01/Re-managed-Instream-Flows-in-the-Sac-River-Basin.pdf		Chapter 6 - Sustainability Management Criteria
Feather River Regional Agricultural Water Management Plan - Volume I: Regional Plan Components	Northern California Water Association (NCWA)	4/30/2021	https://static1.squarespace.com/static/56f3336d9f7266fac154ef8b/t/609c3443b381117ad8bd97d6/1620849749379/I.1-7+Regional+AWMP_final.pdf		Chapter 2 - Plan Area
Feather River Regional Agricultural Water Management Plan - Volume II: Supplier Plan Components Sutter Extension Water District	Northern California Water Association (NCWA)	2016-09-31	https://wuedata.water.ca.gov/public/awmp_attachments/8171979606/II.6.%20SEWD%20AWMP%20Final.pdf		Chapter 2 - Plan Area
2014 Northern California Sacramento Valley Integrated Regional Water Management Plan, Updated March 2020	Northern Sacramento Valley Integrated Regional Water Management Group	3/31/2020	https://nsvwaterplan.org/mdocuments-library/#		Chapter 2 - Plan Area
PRISM Climate Data	Oregon State University	12/31/2021	https://prism.oregonstate.edu/		Chapter 5 - Basin Setting, Section 3: Water Budgets

Title	Author	Publish Date	Reference URL	Additional Data	GSP Chapter/Section
Measurement and Computation of Streamflow: Volume 1. Measurement of State and Discharge	Rantz, S.E. and others	12/31/1982	https://pubs.usgs.gov/wsp/wsp2175/wsp2175.pdf		Chapter 7 - Sustainability Implementation, Section 2: Monitoring
Measurement and Computation of Streamflow: Volume 2. Computation of Discharge	Rantz, S.E. and others	12/31/1982	https://pubs.usgs.gov/wsp/wsp2175/wsp2175_vol2.pdf		Chapter 7 - Sustainability Implementation, Section 2: Monitoring
The Tertiary Princeton submarine valley system beneath the Sacramento Valley, California	Redwine, L.E.	12/31/1972	-	Univ. of California, Los Angeles, unpubl. Thesis (PhD): 480 p.	Chapter 5 - Basin Setting, Section 1: HCM
Groundwater and Stream Interaction in California's Central Valley: Insights for Sustainable Groundwater Management	RMC	2/28/2016	https://www.scienceforconservation.org/assets/downloads/GroundwaterStreamInteraction_2016.pdf		Chapter 5 - Basin Setting, Section 1: HCM
About the Sacramento River Coordinated Monitoring Program	Sacramento River Watershed Data Program	n.d.	https://data.sacriver.org/explore_data_custom/sacramento-river-watershed-cmp		Chapter 2 - Plan Area
Improving Water Penetration	Sanden, S., Prichard, T.L, and Fulton, A.E.	12/31/2016	-		Chapter 7 - Sustainability Implementation, Section 1: Projects and Management Actions
Framework for Drinking Water Well Impact Mitigation Program	Self-Help Enterprises, Leadership Counsel for Justice and Accountability, and the Community Water Center	n.d.	https://static1.squarespace.com/static/5e83c5f78f0db40cb837cfb5/t/5f3ca9389712b732279e5296/1597811008129/Well_Mitigation_English.pdf		Chapter 6 - Sustainability Management Criteria
Stratigraphic Analysis and Hydrogeologic Characterization Of Cenozoic Strata In The Sacramento Valley Near Sutter Buttes	Springhorn, S.T.	12/31/2008	https://www.csus.edu/indiv/h/hornert/Geologic%20maps%20and%20references/Springhorn_2008_Cenozoic_Strata_Sacramento_Valley_.pdf	Master Thesis, California State University Chico. Spring.	Chapter 5 - Basin Setting, Section 1: HCM
Sutter County General Plan – Policy Document	Sutter County	12/31/2011	https://www.suttercounty.org/assets/pdf/cs/ps/General_Plan_Policy_Document_Dec_2015_Amended_Sep2019.pdf		Chapter 2 - Plan Area
Sutter County Code of Ordinances, 700 – Health and Sanitation, Chapter 768 Water Wells	Sutter County	n.d.	https://library.municode.com/ca/sutter_county/codes/code_of_ordinances?nodeId=n700HESA_CH765WAWE		Chapter 2 - Plan Area
Water Well Permit Application	Sutter County Environmental Health Division (SCEHD)	7/31/2013	https://www.suttercounty.org/assets/pdf/cs/ehs/well_permit_application.pdf		Chapter 2 - Plan Area
ICONS: Interconnected Surface Water in California's Central Valley, Version 1.0.1	The Nature Conservancy (TNC)	12/31/2021	https://icons.codefornature.org/		Chapter 5 - Basin Setting, Section 2: Groundwater Conditions

Title	Author	Publish Date	Reference URL	Additional Data	GSP Chapter/Section
Identifying Environmental Surface Water Beneficial Users – Freshwater Species List For Each Groundwater Basin, Sacramento Valley – Sutter	The Nature Conservancy (TNC)	n.d.	https://groundwaterresourcehub.org/sgma-tools/environmental-surface-water-beneficiaries/		Chapter 5 - Basin Setting, Section 2: Groundwater Conditions
City of Yuba City 2020 Urban Water Management Plan	Tully & Young	7/20/2021	https://wuedata.water.ca.gov/public/uwmp_attachments/8303815543/Yuba%2020%20UWMP%20%28Final%29.pdf		Chapter 2 - Plan Area
Evaluation of Groundwater Potential for Incremental Level 4 Refuge Water Supply	United States Bureau of Reclamation (USBR)	7/31/2004	https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=92276&inline		Chapter 2 - Plan Area
Part 650 Engineering Field Handbook, Chapter 1 Surveying	United States Department of Agriculture (USDA), National Resource Conservation Service (NRCS)	12/31/2009	https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=25276.wba		Chapter 7 - Sustainability Implementation, Section 2: Monitoring
Soil Infiltration: Soil Health - Guides for Educators	United States Department of Agriculture (USDA), National Resource Conservation Service (NRCS)	5/31/2014	https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051576.pdf		Chapter 7 - Sustainability Implementation, Section 1: Projects and Management Actions
BLM National Surface Management Agency Area Polygons shapefiles	United States Department of the Interior, Bureau of Land Management	12/31/2018	https://catalog.data.gov/dataset/blm-national-surface-management-agency-area-polygons-national-geospatial-data-asset-ngda		Chapter 2 - Plan Area
Geochemistry of Groundwater in the Sacramento Valley, California	United States Geological Survey (USGS)	12/31/1984	https://pubs.usgs.gov/pp/1401b/report.pdf	Central Valley of California RASA Project, Geological Survey Professional Paper 1401-B	Chapter 5 - Basin Setting, Section 1: HCM
Ground-Water Quality in the Southeastern Sacramento Valley Aquifer, California	United States Geological Survey (USGS)	12/31/2001	-	U.S. Geological Survey Water-Resources Investigations Report 01-4125	Chapter 5 - Basin Setting, Section 1: HCM
Type Region of the Ione Formation (Eocene), Central California: Stratigraphy, Paleogeography, and Relation to Auriferous Gravels	United States Geological Survey (USGS)	12/31/2007	-		Chapter 5 - Basin Setting, Section 1: HCM
Groundwater Quality in the Southern Sacramento Valley, California. Fact Sheet 2011-3006	United States Geological Survey (USGS)	4/30/2011	-		Chapter 5 - Basin Setting, Section 1: HCM
National Water Information System: Web Interface	United States Geological Survey (USGS)	n.d.	https://waterdata.usgs.gov/nwis		Chapter 2 - Plan Area

Title	Author	Publish Date	Reference URL	Additional Data	GSP Chapter/Section
Soil Agricultural Groundwater Banking Index (SAGBI) Web Application	University of California, Davis	12/31/2021	https://casoilresource.lawr.ucdavis.edu/sagbi/	California Soil Resource Lab, UC Davis, and UC Agriculture & Natural Resources	Chapter 7 - Sustainability Implementation, Section 1: Projects and Management Actions
Elastic storage of aquifers	Verruijt, A.	12/31/1969	-	Flow Through Porous Media, edited by R.J.M. De Wiest, Academic Press, New York. pp. 331-376	Chapter 5 - Basin Setting, Section 1: HCM
Yuba City Basin Storm Water Resource Plan	West Yost Associates	12/31/2018	https://www.yubacity.net/UserFiles/Servers/Server_239174/File/Public%20Works/Engineering/Stormwater%20Management/SWRP/SWRP%20Final/Yuba%20City_FINAL%20Storm%20Water%20Resource%20Plan%20July%202018_reduced.pdf		Chapter 2 - Plan Area
City of Yuba City Water Treatment Plant and Distribution System Master Plan – Volume I	West Yost Associates	12/31/2019	https://www.yubacity.net/UserFiles/Servers/Server_239174/File/Public%20Works/Utilities/Water/City%20of%20Yuba%20City%20WMP_Vol%201.pdf		Chapter 2 - Plan Area
City of Yuba City Water Treatment Plant and Distribution System Master Plan – Volume II	West Yost Associates	12/31/2019	https://www.yubacity.net/UserFiles/Servers/Server_239174/File/Public%20Works/Utilities/Water/City%20of%20Yuba%20City%20WMP_Vol%202.pdf		Chapter 2 - Plan Area
Sutter County Groundwater Management Plan	Wood Rodgers	4/30/2012	https://www.suttercounty.org/contents/pdf/pw/wr/gmp/Sutter_County_Final_GMP_20120319.pdf		Chapter 2 - Plan Area; Chapter 5 - Basin Setting, Section 1: HCM and Section 2: Groundwater Conditions; Chapter 7 - Sustainability Implementation, Section 2: Monitoring

This page intentionally left blank

WOODARD
&CURRAN

801 T Street
Sacramento, CA 95811
916.999.8700
woodardcurran.com

In Association with

GeoSyntec
Consultants

DAVIDS
ENGINEERING, INC