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**.

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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

7.1.4.1.1 Projects 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

7.1.4.3.1 Systems 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

7.1.4.4.1 Projects 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.

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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.

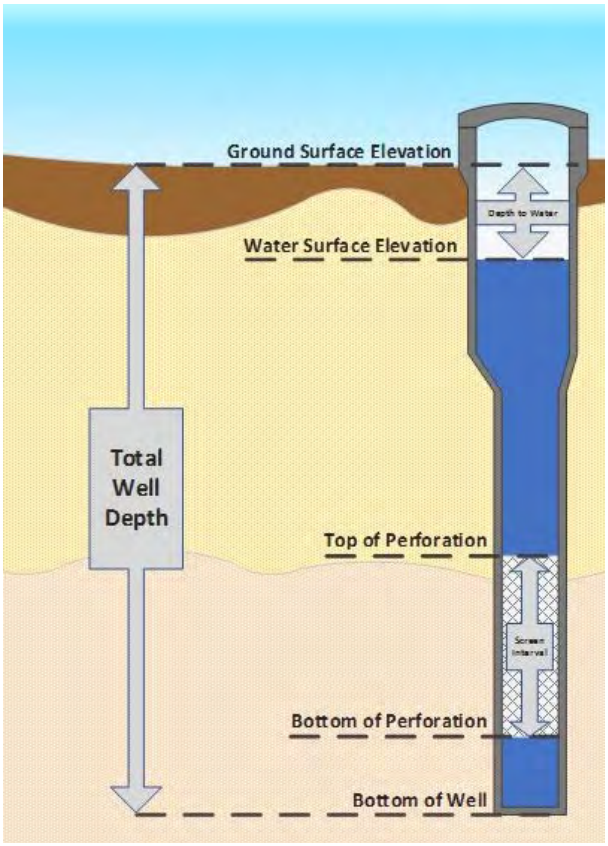

Figure 7-1. Diagram of Key Groundwater Monitoring Well Measurements

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** *Plan 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.

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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

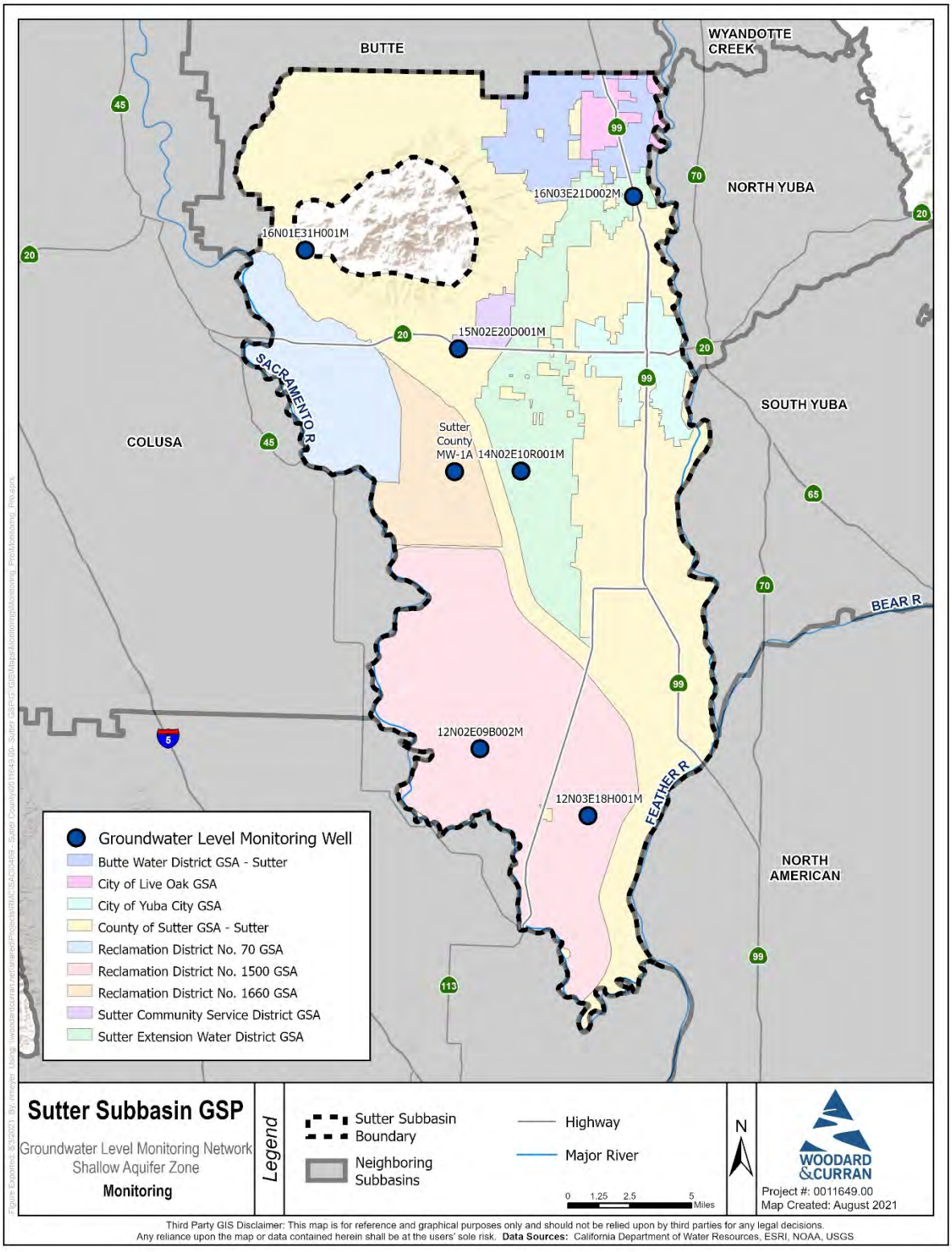

Figure 7-2. Groundwater Level Monitoring Network Wells, Shallow AZ

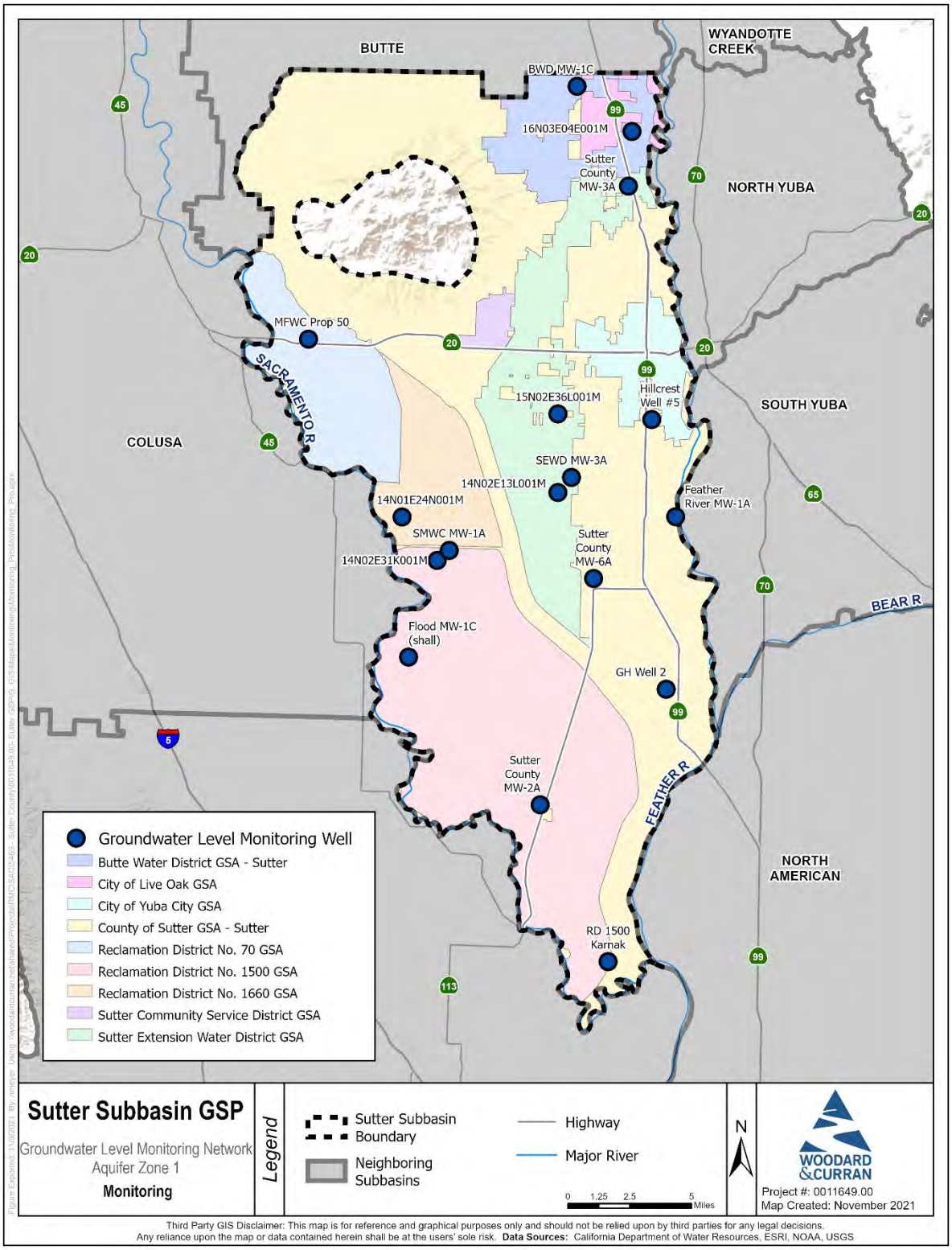

Figure 7-3. Groundwater Level Monitoring Network Wells, AZ-1

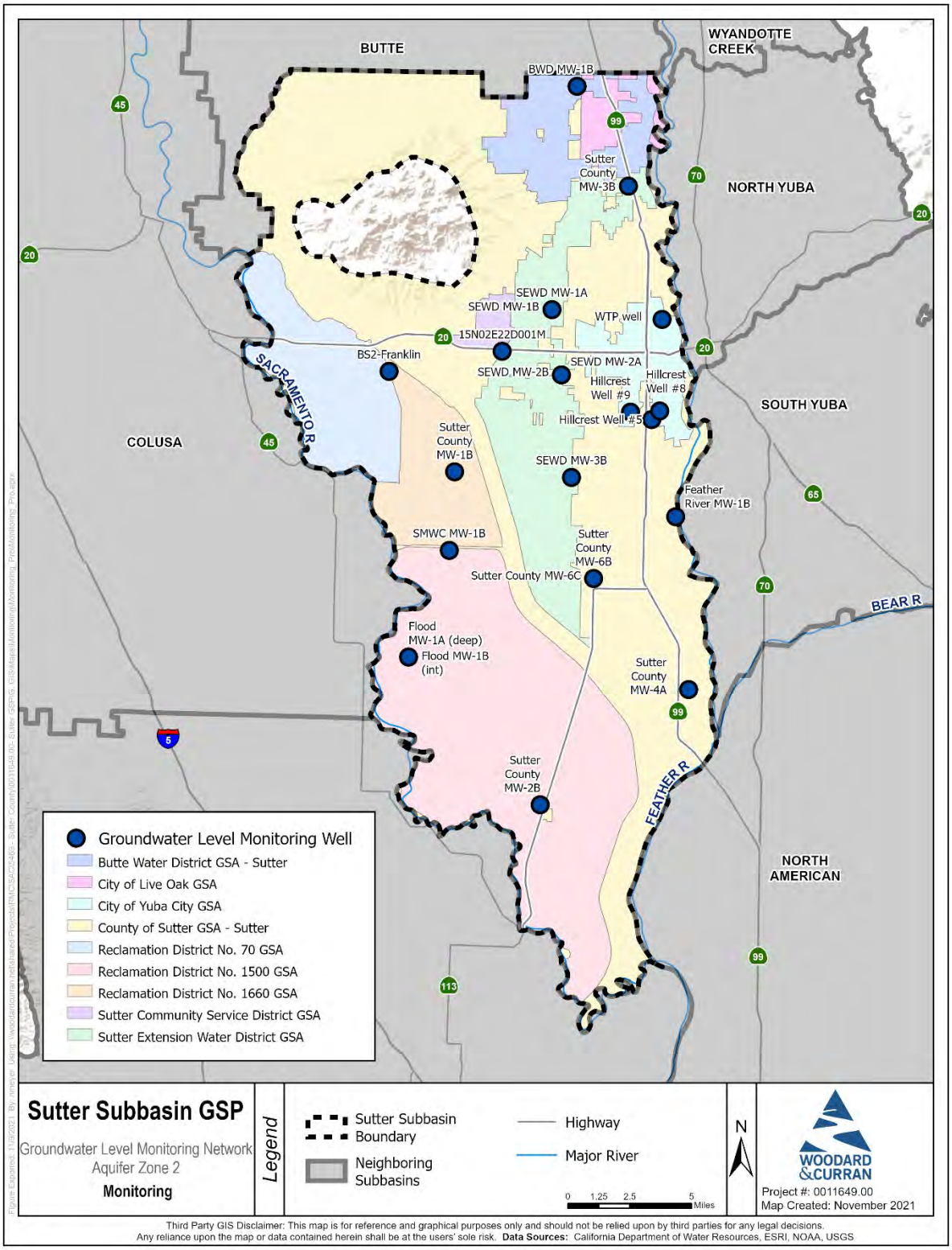

Figure 7-4. Groundwater Level Monitoring Network Wells, AZ-2

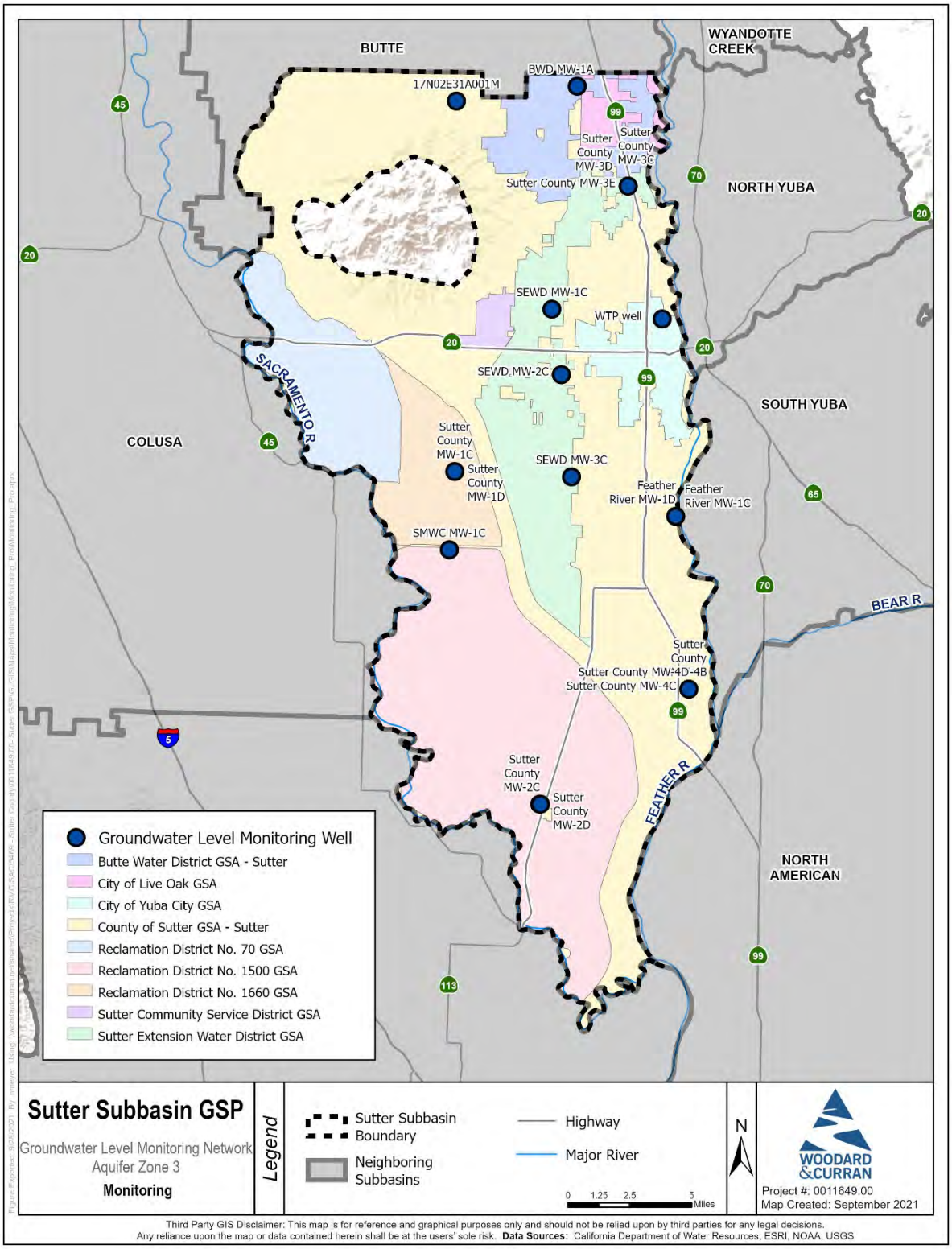

Figure 7-5. Groundwater Level Monitoring Network Wells, AZ-3

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.

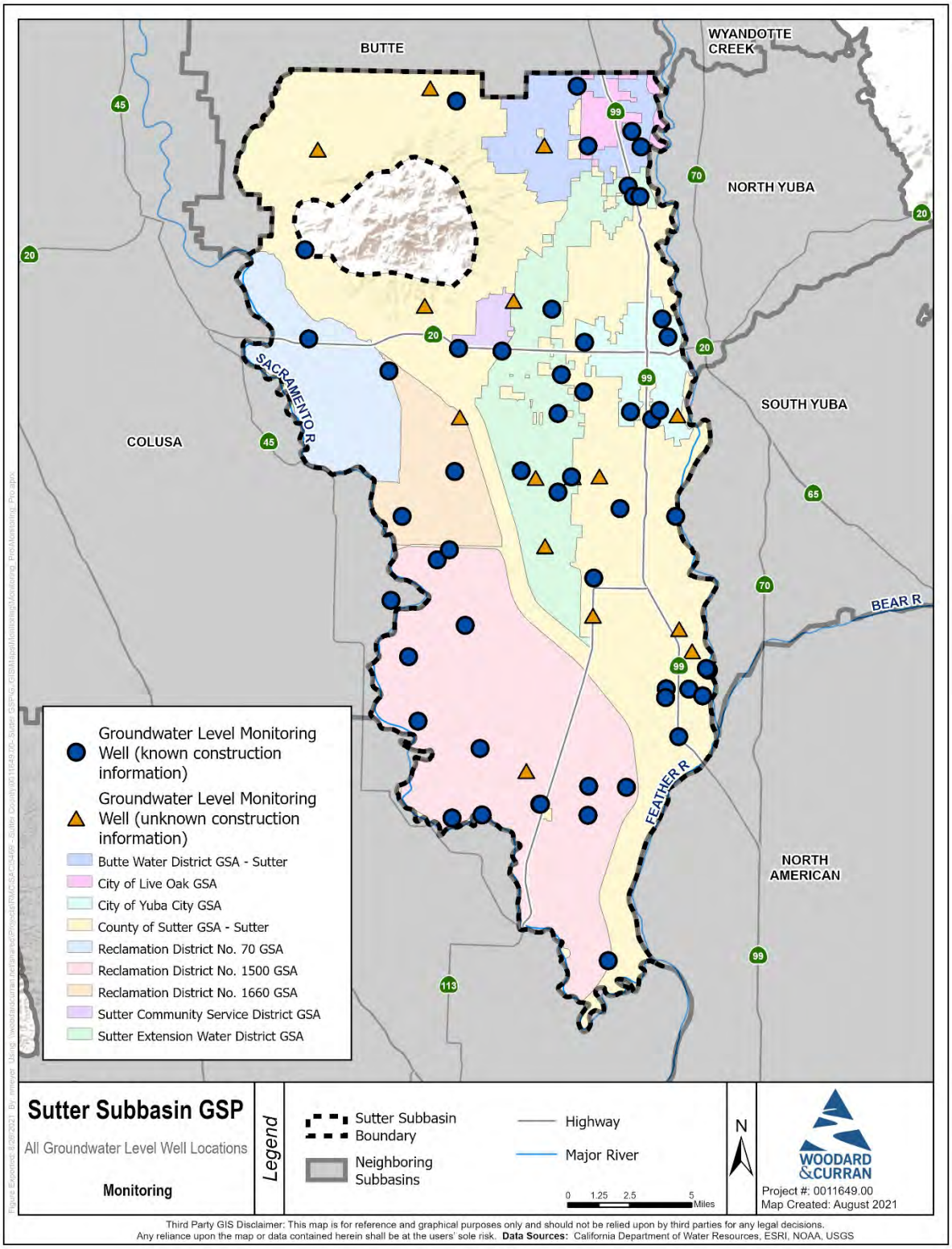

Figure 7-6. All Groundwater Level Wells in Sutter Subbasin

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	-	-	-	-	-	-

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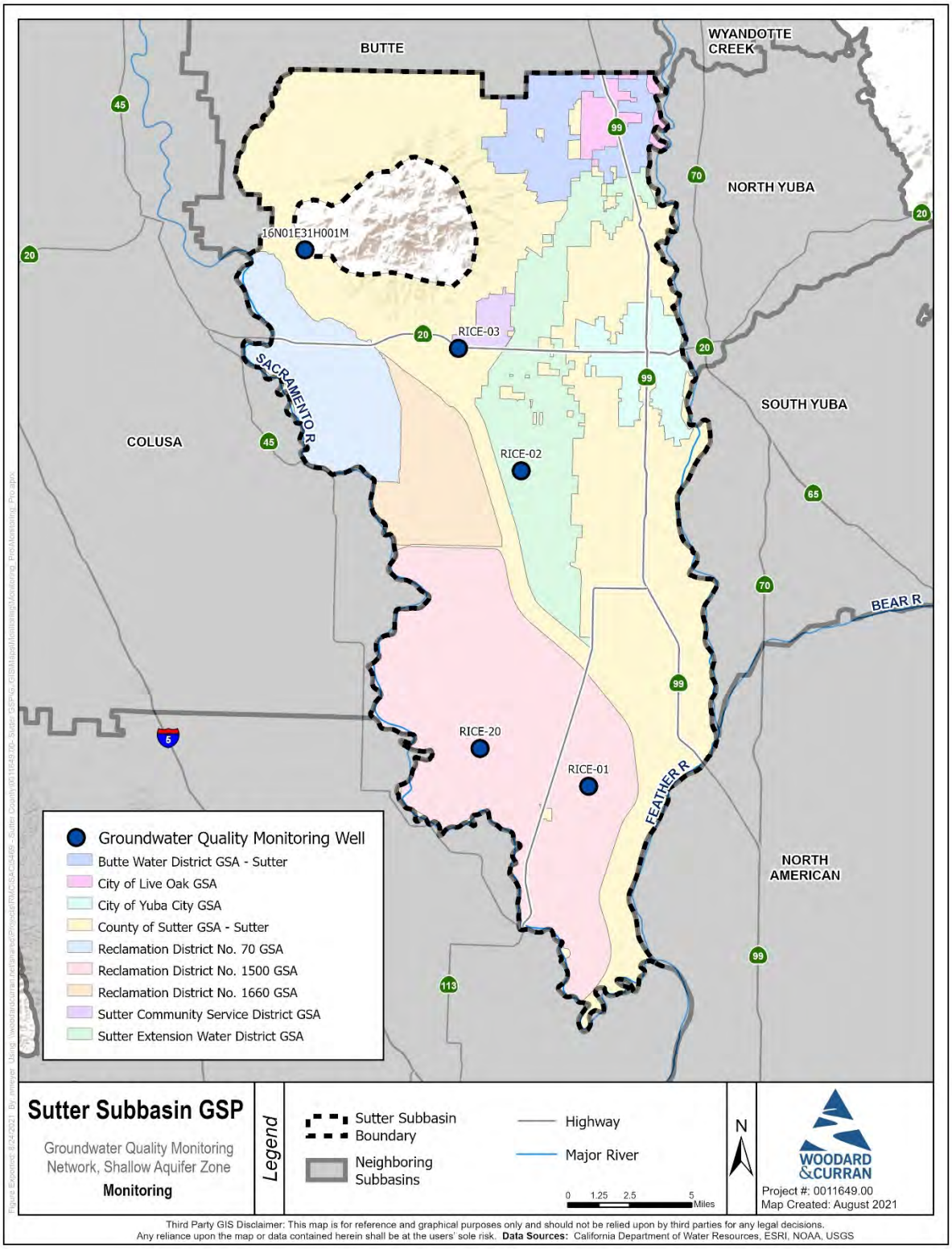

Figure 7-7. Groundwater Quality Monitoring Network Wells, Shallow AZ

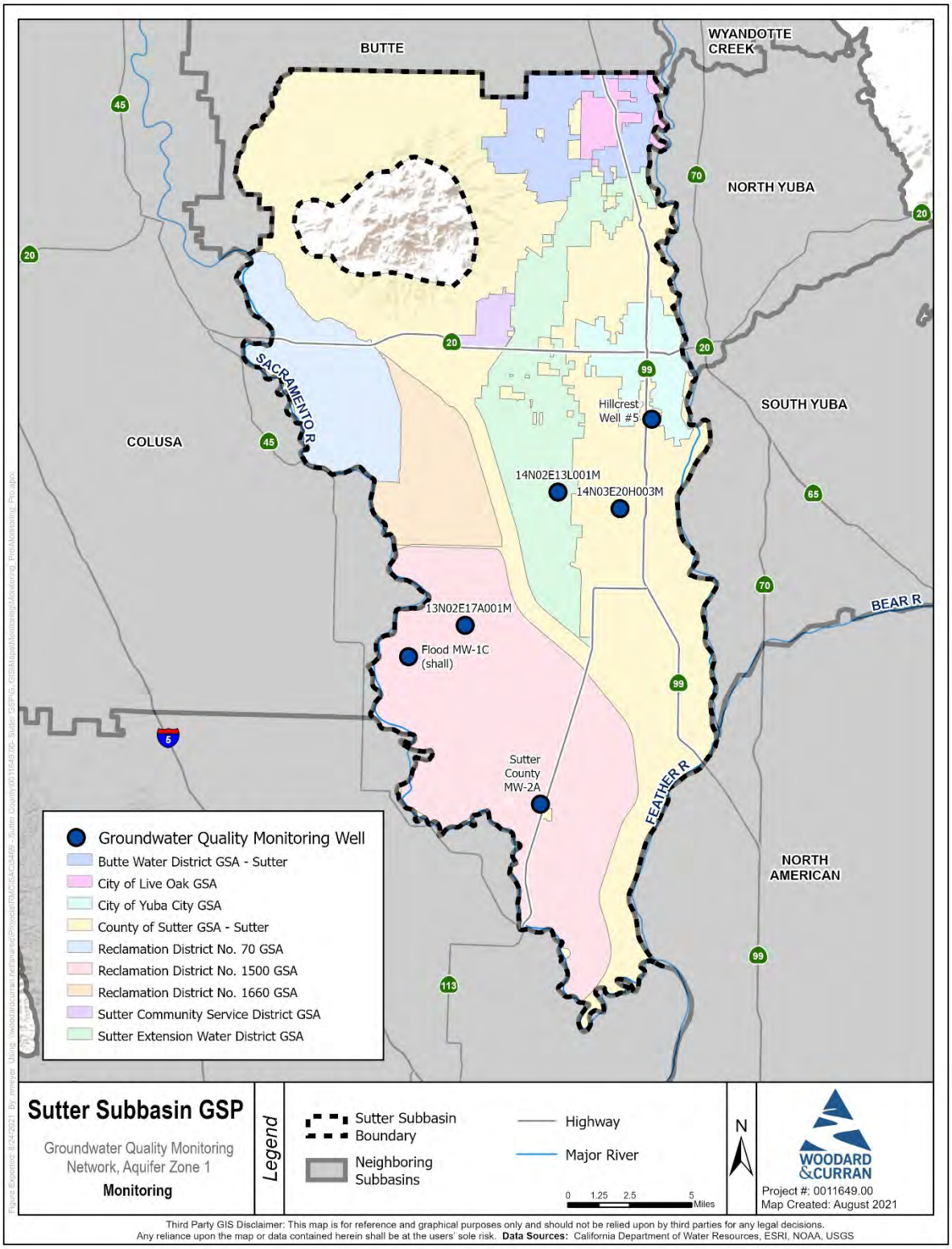

Figure 7-8. Groundwater Quality Monitoring Network Wells, AZ-1

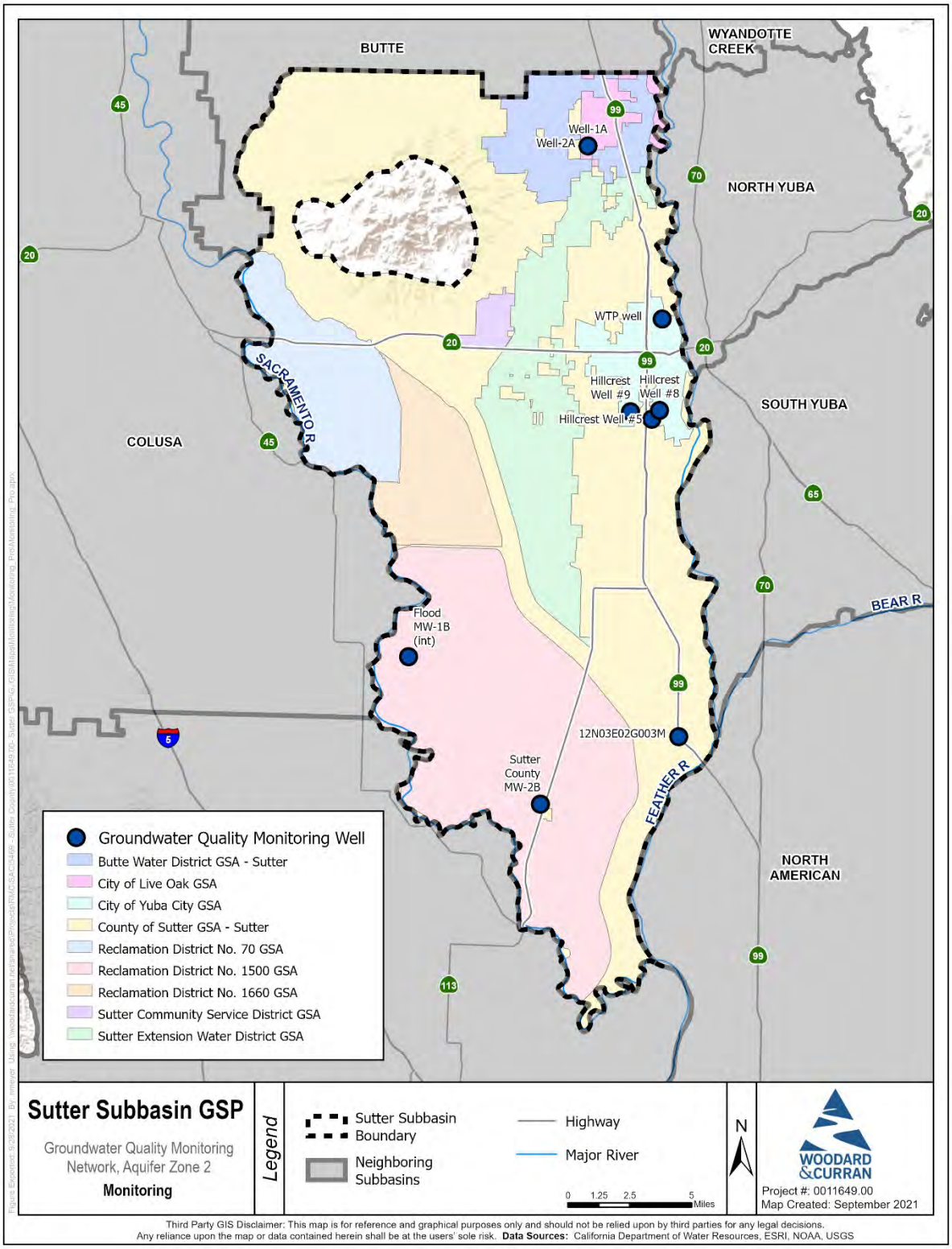

Figure 7-9. Groundwater Quality Monitoring Network Wells, AZ-2

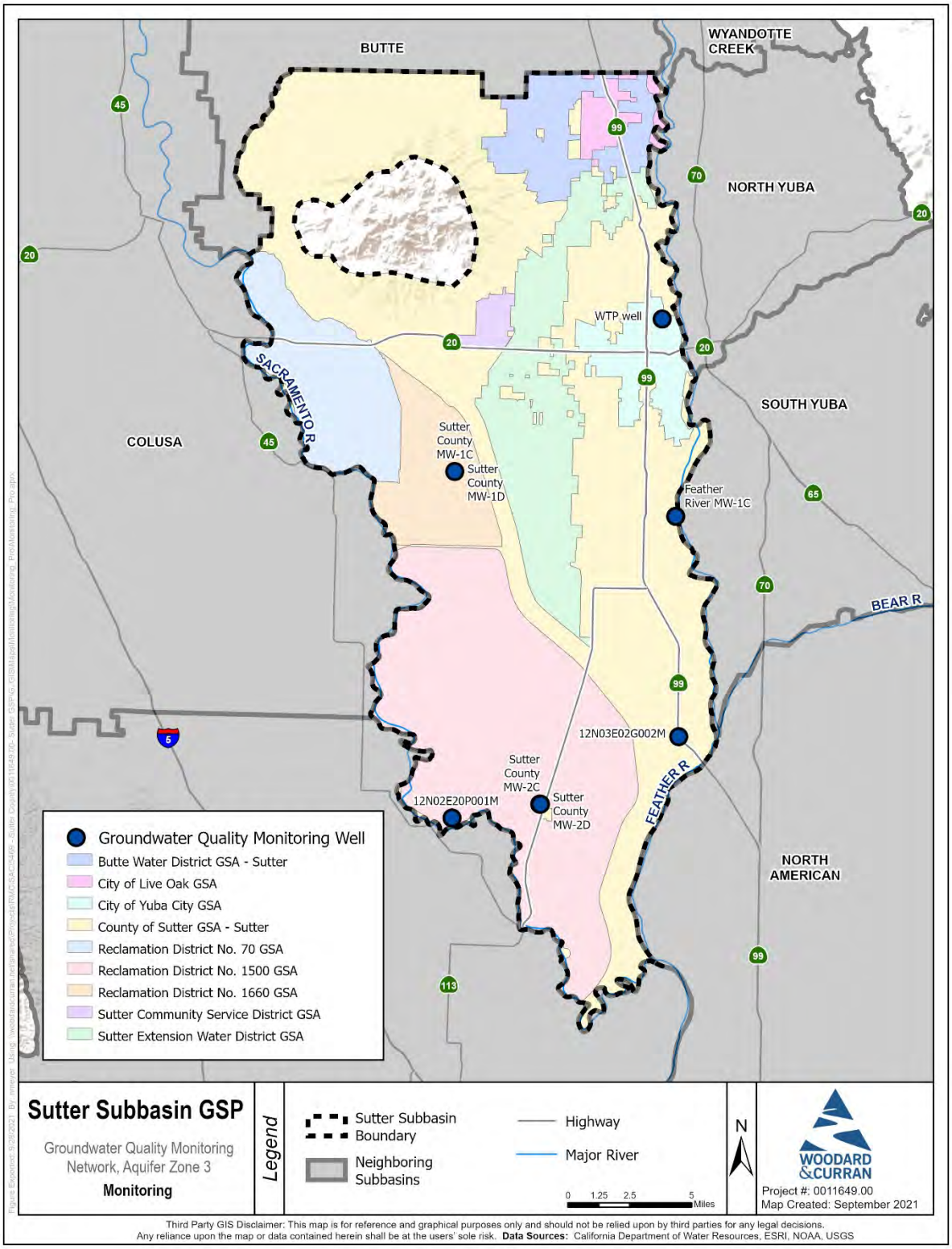

Figure 7-10. Groundwater Quality Monitoring Network Wells, AZ-3

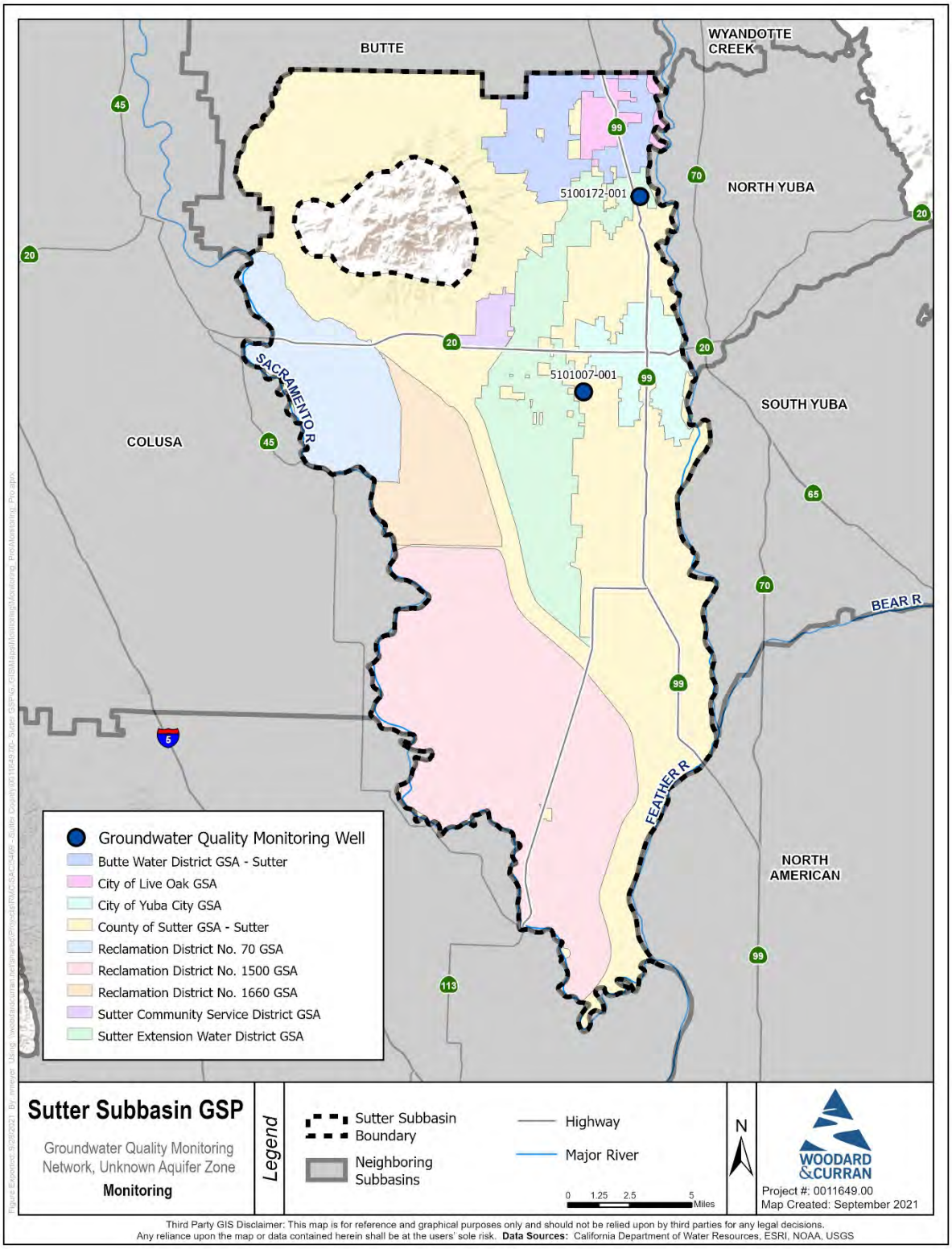

Figure 7-11. Groundwater Quality Monitoring Network Wells, Unknown AZ

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.

Sampling Water Quality Data

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**).

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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

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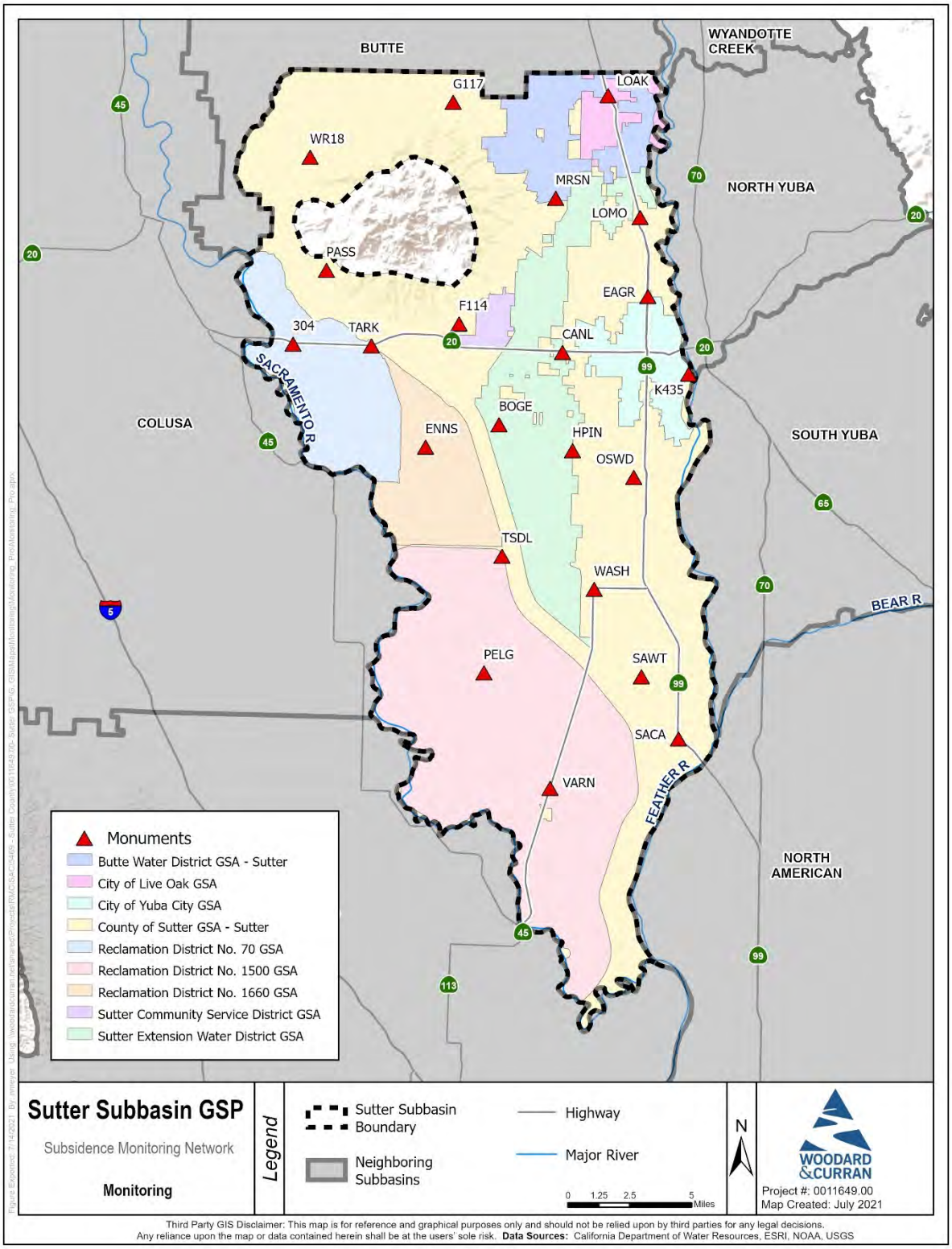

Figure 7-12. Subsidence Monitoring Network

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

Data Reduction, Validation, and Reporting

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.

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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

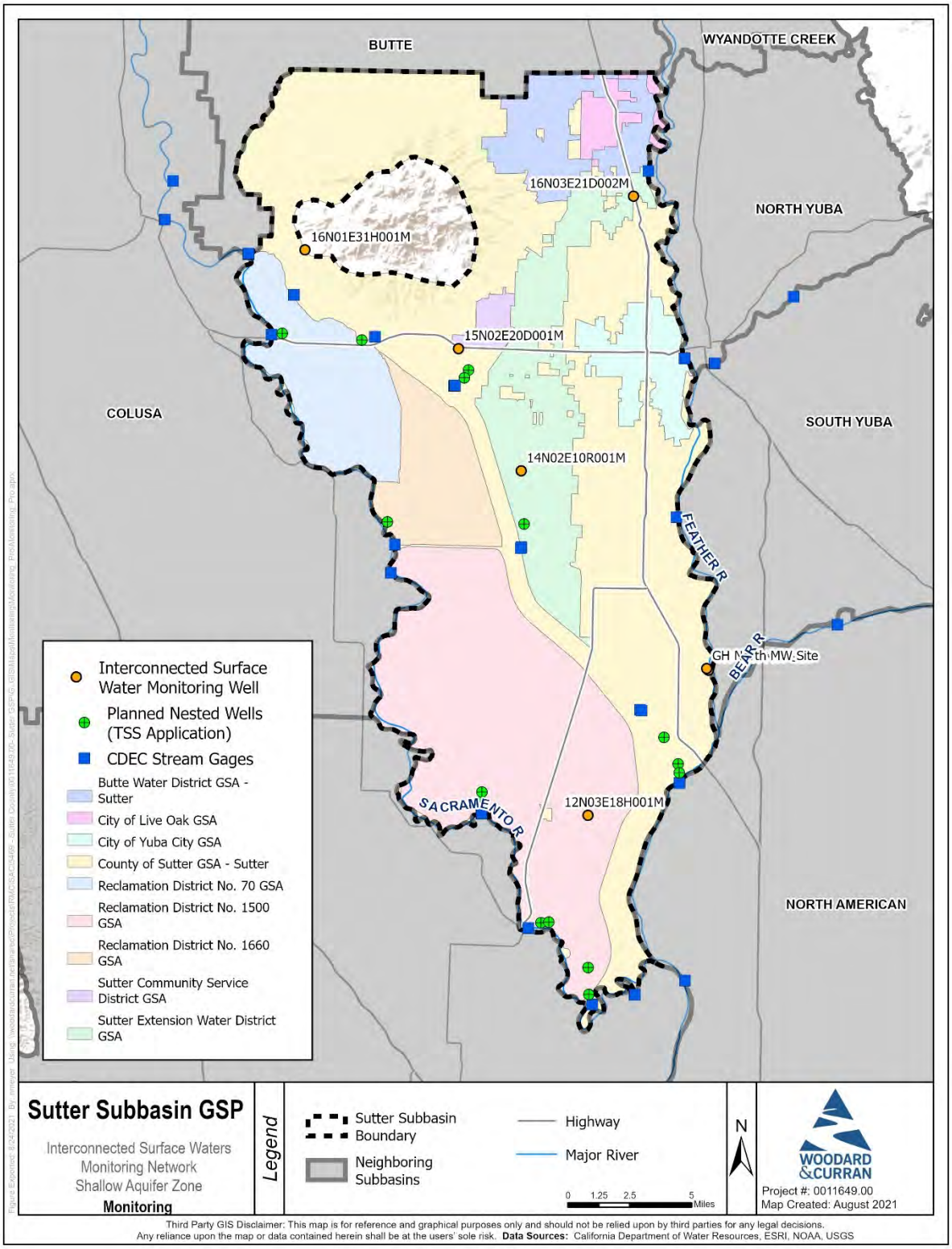

Figure 7-13. Interconnected Surface Water Monitoring Network Sites, Shallow AZ

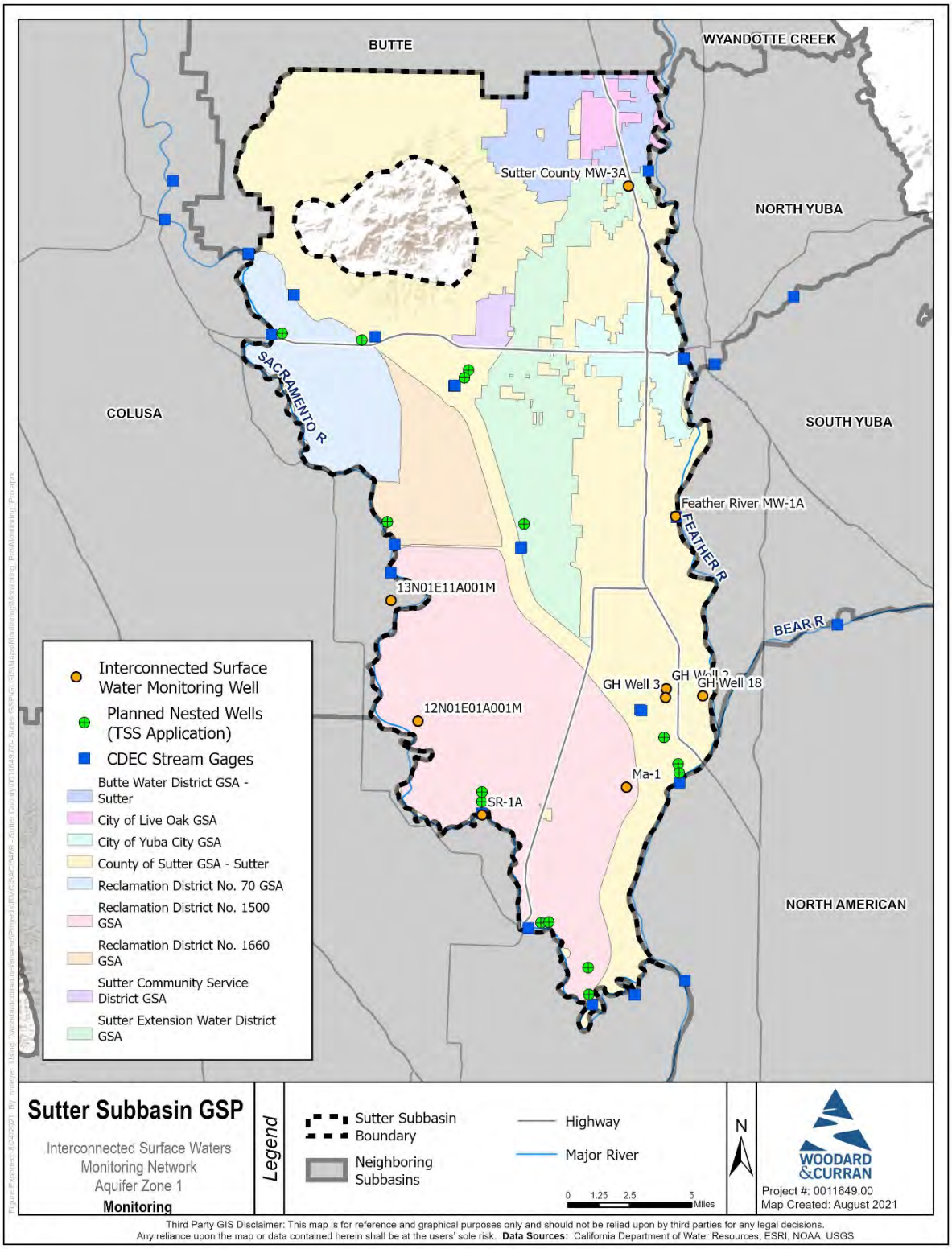

Figure 7-14. Interconnected Surface Water Monitoring Network Sites, AZ-1

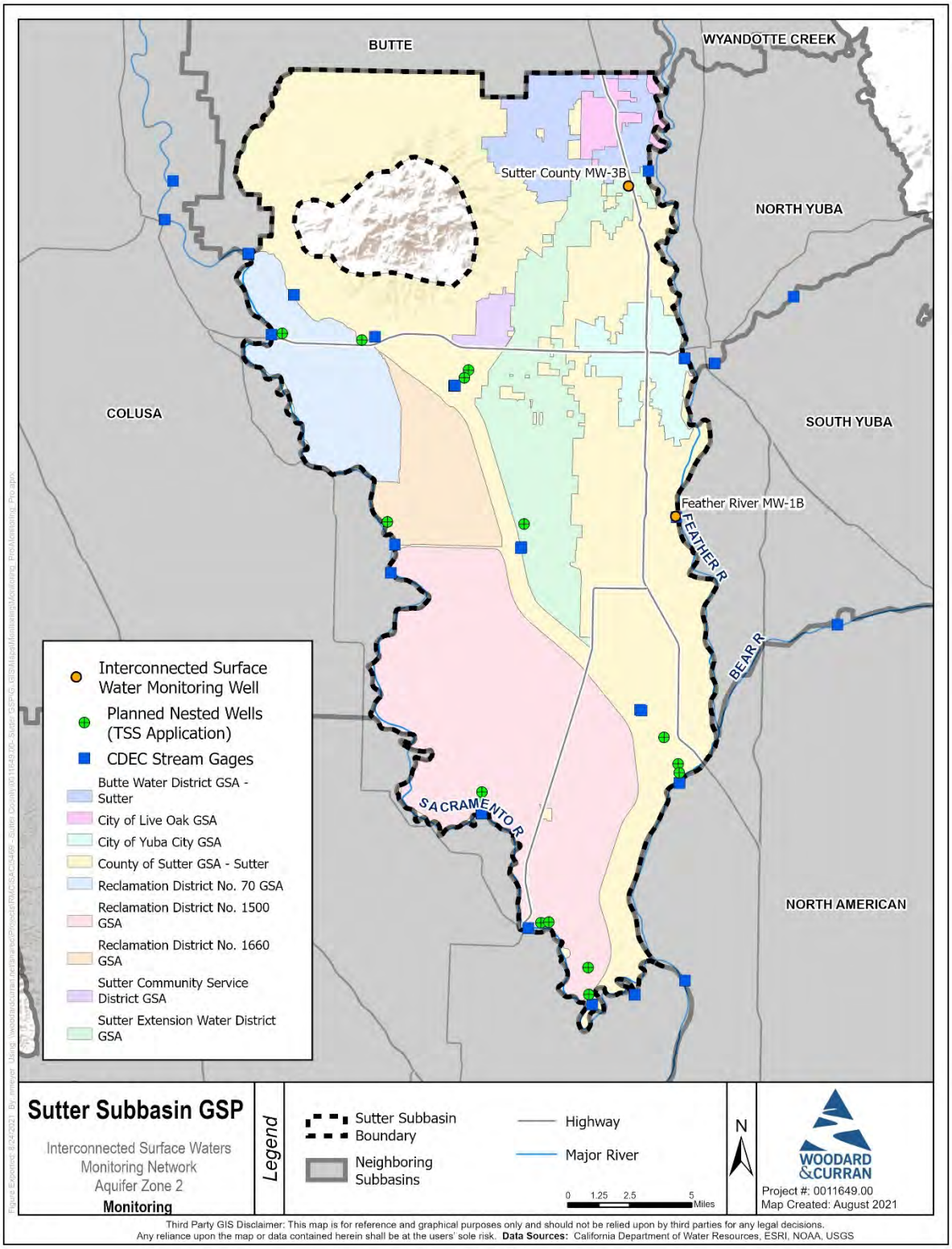

Figure 7-15. Interconnected Surface Water Monitoring Network Sites, AZ-2

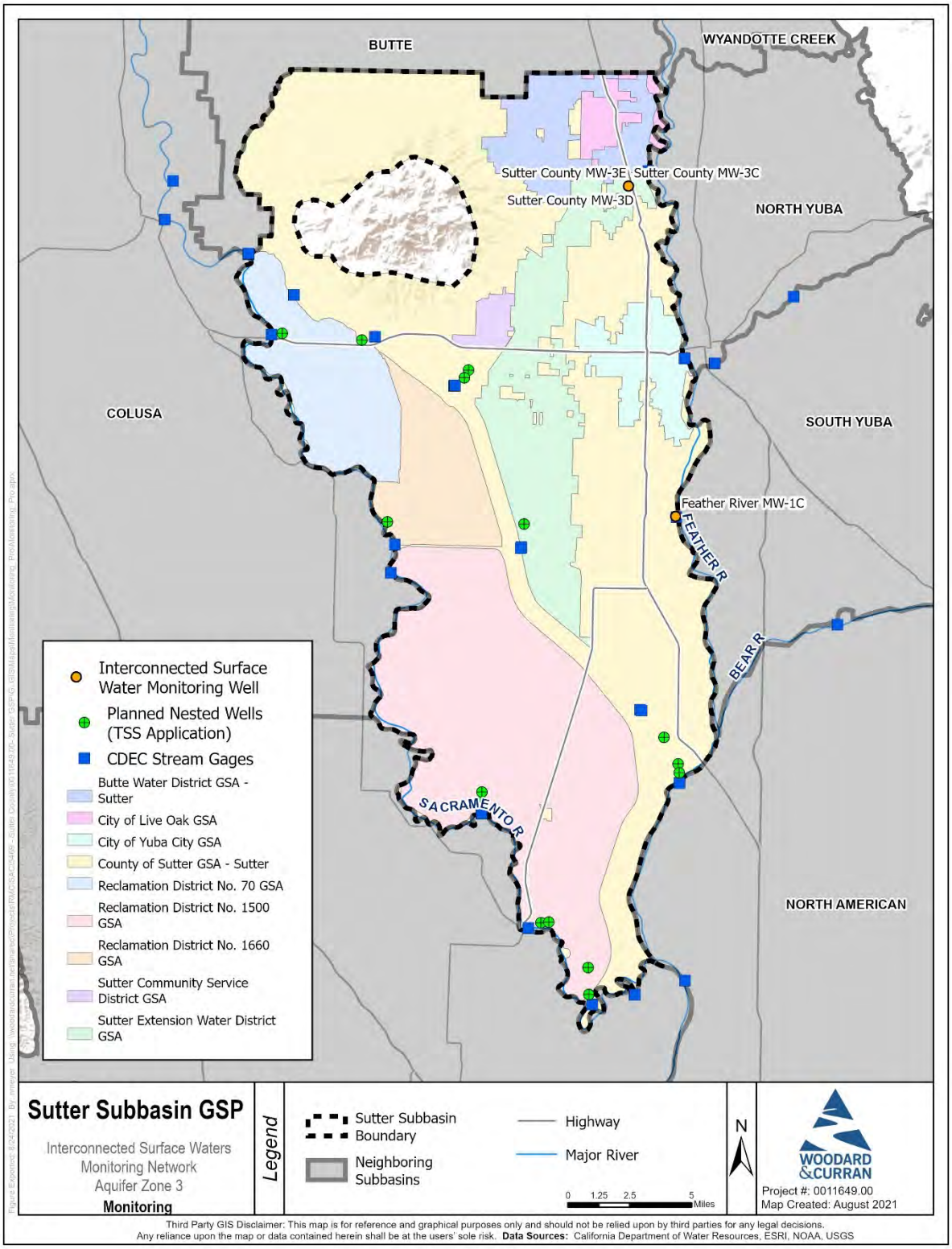

Figure 7-16. Interconnected Surface Water Monitoring Network Sites, AZ-3

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.

Protocols for Measuring Streamflow

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.

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CHAPTER EIGHT

Plan Implementation

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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.

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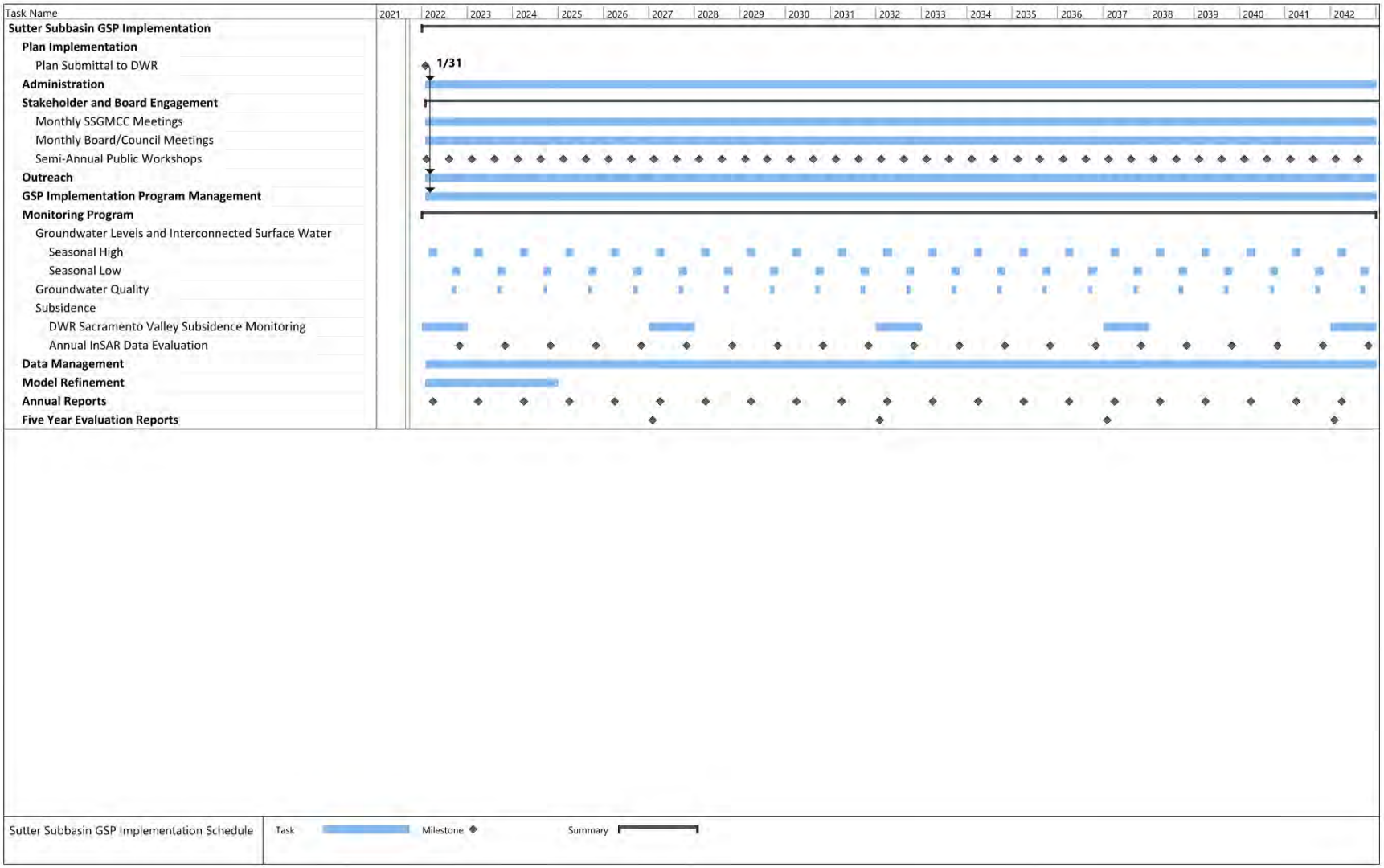

Figure 8-1. Implementation Schedule

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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.

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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.

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CHAPTER NINE

References and Technical Studies

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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.

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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

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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

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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

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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

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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

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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_ggtmp_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

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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

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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
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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

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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%202020%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

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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

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