FINAL DRAFT

Antelope Subbasin

Sustainable Groundwater Management Act

Groundwater Sustainability Plan (Chapter 4 Projects and Management Actions)

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4 SUSTAINABLE GROUNDWATER MANAGEMENT: PROJECTS AND MANAGEMENT ACTIONS (§ 354.44)

4.1 Introduction

This chapter describes the projects and management actions (PMAs) that are planned or considered for implementation in the Antelope Subbasin (Subbasin). In accordance with 23 CCR §354.44, PMAs were developed to achieve and maintain 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 support sustainable groundwater management.

4.1.1 Development Approach

PMAs were developed and prioritized through a tiered approach, beginning with an initial exploration with stakeholders of various PMA concepts, and then refining those concepts to a specific set of PMAs developed for implementation in the Antelope Subbasin and conceptual PMAs for further development if monitoring indicates they are needed. The following sections describe the process used to evaluate possible future changes in Subbasin conditions, identify PMAs for implementation, and maintain sustainability through adaptive management. The adaptive management approach planned for the Subbasin involves ongoing monitoring of Subbasin conditions and addressing any challenges related to maintaining groundwater sustainability by scaling and implementing PMAs in a targeted and proportional manner in accordance with the needs of the Subbasin.

4.1.1.1 Evaluation of Future Subbasin Conditions

PMAs were formulated and evaluated for their potential to address possible future changes in Subbasin conditions that could cause undesirable results over the long term. The possible future changes in Subbasin conditions without PMAs were assessed through comparison of the historical water budget and the projected water budget with future land use and adjustment for 2070 central tendency (2070CT) climate change (see **Section 2.3**, Water Budget, for additional information). Water budget results from the Tehama Integrated Hydrologic Model (Tehama IHM) represent the best available data and science for describing projected future groundwater conditions in the Antelope Subbasin at the time of GSP development (consistent with 23 CCR §354.44(c)). Use of 2070CT climate change is regarded as a conservative approach for evaluating possible future changes in Subbasin conditions. While the 2070CT climate change adjustment assumes that the 2070CT effects are occurring every year in the projected water budget period; these effects will gradually occur over time with significant uncertainty in their magnitude and interannual variability.

Table 4-1 provides a comparison of key water budget parameters considered in formulation of the PMAs. Average water budget results are presented for three scenarios: the historical water budget scenario (1990-2018), the projected with current land use scenario (2022-2072, assuming 2019 land use occurs in all years), and the projected with future land use and 2070CT climate change scenario (2022-2072, assuming urban land increases slightly over the future period and that 2070CT climate change factors occur in all years). All scenarios represent conditions in the Subbasin without implementation of projects and management actions. All water budget quantities are expressed in average annual (by water year) volumes of acre-feet per year (af/yr) over the indicated model simulation period.

Without projects and management actions, groundwater storage in the projected future land use 2070CT scenario is expected to decline by -300 af/yr. In comparison to the historical water budget storage decline of -600 af/yr, the projected future land use 2070CT has a relative increase in storage from historical conditions by 300 af/yr on average (0.5 percent of total inflows to the groundwater system). However, it is worth noting that such small changes in storage and the differences in simulated change in storage between model runs is within the estimated uncertainty of the projected water budget results (described in **Section 2.3**). The average annual decrease in groundwater storage in all simulations is estimated to be 600 af/yr (0.03 feet per acre) or less, resulting in Subbasin conditions that are not expected to cause undesirable results over the GSP planning and implementation horizon.

These results indicate that, even without PMAs, ongoing operation of the Antelope Subbasin according to the best estimates of future conditions described in the projected water budget is expected to maintain the Subbasin sustainability through the end of the implementation period in 2042 and beyond though at least 2072. Even so, the GSA plans to continue monitoring sustainability indicators throughout GSP implementation and will initiate and scale PMAs as needed to ensure that the measurable objectives are met. Groundwater sustainability will be maintained through adaptive groundwater management, described below. Section 3, Monitoring Networks, and Section 2.1, Basin Setting, identify data gaps that will be addressed as part of GSP implementation (**Section 5**). Addressing data gaps will improve the modeled outputs, water budget parameters, and understanding of groundwater conditions in the Antelope Subbasin. Improvements in understanding of groundwater conditions will inform adaptive management of the Antelope Subbasin.

Table 4-1. Summary of Key Groundwater System Water Budget Parameters Influencing Formulation of Projects and Management Actions in the Antelope Subbasin (Average Annual Volumes in Acre-feet per year, Rounded).

GROUNDWATER SYSTEM WATER BUDGET PARAMETER[1]	HISTORICAL (1990-2018)	PROJECTED, CURRENT LAND USE (2022-2072)	PROJECTED, FUTURE LAND USE, 2070CT (2022-2072)	DIFFERENCE (PROJECTED, FUTURE LAND USE, 2070CT – HISTORICAL)	PERCENT DIFFERENCE[2]
Net Seepage	-49,200	-38,800	-23,100	26,100	-53%
Deep Percolation	11,700	11,400	11,300	-400	-3%
Subsurface Inflow from Uplands (Small Watersheds)	1,400	1,400	1,500	100	7%
Groundwater Pumping	-13,200	-15,000	-17,600	-4,400	33%
Root Water Uptake	-1,500	-1,200	-800	700	-47%
Net Subsurface Inflow from Adjacent Subbasins	50,200	41,900	28,400	-21,800	-43%
Total Inflows[1]	63,300	54,700	41,200	26,900	42%
Total Outflows[1]	-63,900	-55,000	-41,500	-26,600	42%
Average Annual Change in Groundwater Storage (Total Inflows – Total Outflows)					
Average Change in Storage (acre-feet per year)	**-600**	**-300**	**-300**	**300**	**0.5%**
Average Rate (acre-feet per acre per year)	**-0.032**	**-0.016**	**-0.016**	**0.016**	**--**

[1] Positive values indicate a net inflow to the groundwater system. Negative values indicate a net outflow from the groundwater system. Total inflows are the sum of all positive values, while total outflows are the sum of all negative values.

[2] Percent difference is calculated as the "Difference" column divided by the historical average volume for that parameter, except for the average annual change in groundwater storage, for which the percent difference is calculated relative to the historical average total inflows to the groundwater system.

4.1.1.2 PMAs Identified for Adaptive Groundwater Management

Recognizing the GSP data gaps and uncertainties in the basin setting (per 23 CCR §354.44(d)), PMA development and implementation in the Antelope Subbasin applies an adaptive approach informed by continued monitoring of groundwater conditions.

The adaptive management approach includes two categories of PMAs:

- **PMAs developed for implementation** that would help to maintain groundwater sustainability while supporting other local goals. This includes a proposed grower education program and a proposed multi-benefit groundwater recharge project that would supply groundwater recharge and provide habitat for migrating shorebirds.
- **A portfolio of other potential PMAs** that could be implemented, as needed, to achieve and maintain long-term sustainable groundwater management across the Antelope Subbasin. These potential PMAs would be further evaluated and selected for implementation as warranted by changing conditions in the Subbasin that threaten groundwater sustainability. Management actions include a potential demand management program that could be implemented as a backstop to other PMAs to ensure groundwater sustainability.

PMAs are presented in this chapter according to these two categories of implementation for adaptive management. In accordance with 23 CCR §354.44(a), PMAs developed for implementation are expected to support the GSA in achieving the Antelope Subbasin sustainability goal and avoid exceedance of MTs defined in this GSP under future, changing conditions. PMAs developed for implementation are described in greater detail in this GSP, in accordance with all the requirements in 23 CCR §354.44(b). The portfolio of other potential PMAs are described in lesser detail, reflecting their conceptual nature at the time of GSP development. It is anticipated that additional information will be provided in annual reports and periodic, five-year GSP updates, as these PMAs are needed, evaluated for feasibility, and selected for implementation.

Per 23 CCR § 354.44(b)(9), PMAs described in this GSP are expected to maintain the balance of groundwater extractions and recharge to ensure that lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage in other years. In particular, in-lieu and direct recharge benefits of the PMAs developed for implementation are expected to increase the use and recharge of available surface water supplies during wetter years, offsetting any potential increases in groundwater pumping during drought when surface water supplies are limited. The expected recharge benefits of these PMAs are described in Section 4.4. The GSA's extensive portfolio of other potential PMAs will also be informed by continued monitoring of groundwater conditions and implemented, as needed, to achieve and maintain long-term sustainable groundwater management.

The remaining sections of this chapter are organized as follows:

- Section 4.2 provides an overview of all PMAs described in this GSP.
- Section 4.3 introduces the various PMA concepts that were explored as part of GSP development.
- Sections 4.4 and 4.5 describe the specific PMAs developed for implementation and the portfolio of other potential PMAs that may be implemented through adaptive management of the Antelope Subbasin. Within each category, PMAs are further classified by type (project or management action).

A matrix summary of all developed and potential PMAs is also provided in **Appendix 4-A**.

4.2 Summary of Projects and Management Actions

- Summarizing PMAs developed for implementation (costs/benefits/etc.)

Status of each project and action including cost, funding, expected initiation and completion

4.2.1 Overview of All Proposed Projects and Management Actions

Table 4-2 summarizes all PMAs identified for the Antelope Subbasin GSP. Summary information includes the PMA name, type, proponent, and a brief description of activities that would be completed as part of the PMA. PMAs are grouped into subsections in the table according to their implementation category (PMAs developed for implementation, or other potential PMAs). As described above, PMAs developed for implementation are planned to be implemented before 2042 to maintain groundwater sustainability while supporting other local goals. Other potential PMAs could be implemented, as needed, to achieve and maintain long-term groundwater sustainability, depending on changing conditions in the Antelope Subbasin.

PMAs are described in this GSP according to the requirements of 23 CCR §354.44(b). PMAs developed for implementation are described in greater detail. Other potential PMAs are described concisely and more generally, reflecting the conceptual nature and need for future development of these PMAs as they are needed. Additional project development and description will occur as those projects are needed, evaluated for feasibility, and selected for implementation.

Table 4-3 summarizes the estimated groundwater recharge benefit and capital, operating, and maintenance costs of PMAs developed for implementation. Specific project benefit and cost information is limited for many other proposed projects because a detailed feasibility assessment has not been completed. If needed, GSAs may further develop projects during the GSP implementation period and after 2042 and refine estimated costs as projects are identified for implementation. Additional information about all PMAs is provided in a matrix format in **Appendix 4-A**.

As GSP implementation proceeds, the GSA will continue to consider additional PMAs proposed by agencies and stakeholders. A list of all proposed PMAs will be maintained on the GSP website. PMAs can be added to the matrix (**Appendix 4-A**) at any time and will be reviewed for inclusion in the GSP at the discretion of the GSA. Review of new projects and management actions will occur during the periodic, five-year GSP updates, and at other times at the discretion of the GSA.

Table 4-2. Summary of Projects and Management Actions Proposed for the Antelope Subbasin.

PROJECT/MANAGEMENT ACTION NAME	PROJECT/ MANAGEMENT ACTION TYPE	PROPONENT	BRIEF DESCRIPTION
Projects and Management Actions Developed for Implementation: Projects and Management Actions in this category are planned to be completed prior to 2042. These projects and management actions are expected to support the GSA in achieving the GSP sustainability goal and responding to changing conditions in the Subbasin.			
Multi-Benefit Recharge	Direct Groundwater Recharge (Project)	Multi-Agency/ Jurisdiction	The Nature Conservancy (TNC) has prepared guidance to assist GSAs in planning on-farm, multi-benefit groundwater recharge programs. A multi-benefit recharge program will provide groundwater recharge through normal farming operations while also providing critical wetland habitat for shorebirds migrating along the Pacific Flyway. Fields with soil and cropping conditions conducive to groundwater recharge will be flooded to benefit shorebirds. Water will be sourced from existing or new water rights, depending on availability. The GSA may also consider incentives for participants, offsetting field preparation, irrigation, and water costs.
Grower Education	Education/ Outreach (Management Action)	Multi-Agency/ Jurisdiction	A grower education and outreach program is proposed as a management action for all subbasins in Tehama County. 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. 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. The program would continue and expand the irrigation evaluation services currently in place through the Mobile Irrigation Lab (MIL), operated in Tehama County by the Tehama County Resource Conservation District since 2002.
Portfolio of Potential Projects and Management Actions: Projects and Management Actions in this category are proposed as potential options 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			

PROJECT/MANAGEMENT ACTION NAME	PROJECT/ MANAGEMENT ACTION TYPE	PROPONENT	BRIEF DESCRIPTION
Projects			
Direct Groundwater Recharge of Stormwater and Flood Water	Direct Groundwater Recharge		• Recharge groundwater with excess surface water in wet years for use in dry years. Recharge may be done in conveyances such as unlined canal and laterals, natural drainages such as creek beds, recharge basins, agricultural fields, and aquifer storage and recovery (ASR) wells. Areas identified for recharge should have suitable recharge surficial geology, low enough groundwater levels to provide storage for recharge, and access to surface water. • Divert flood water for off-stream temporary storage on private lands, providing direct recharge and potentially in-lieu recharge.
Stormwater Management Improvements	Direct Groundwater Recharge		• Improve stormwater management facilities to enhance groundwater recharge of stormwater. • Maintain stormwater pumps and ensure stormwater holding basins are of adequate size for retention. • Restore watersheds burned in wildfires and restore unused grazing land to reduce runoff and improve recharge.
Levee Setback and Stream Channel Restoration	Direct Groundwater Recharge		• Restore stream channel and levee setback to increase groundwater recharge, provide wildlife habitat, lower water temperatures in the Sacramento River, and improve the overall riparian ecosystem.
Rain-MAR	Direct Groundwater Recharge		• Capture rainfall through modification of on-field conditions and recharge water the aquifer
Recycled Water Projects	Direct Groundwater Recharge, In-Lieu Groundwater Recharge		• Facilitate use of recycled water of suitable quality (e.g., treated wastewater) for groundwater recharge and for urban or agricultural irrigation. • Enhance wastewater treatment facilities to supply tertiary-treated Title-22 effluent for use as irrigation water.

PROJECT/MANAGEMENT ACTION NAME	PROJECT/ MANAGEMENT ACTION TYPE	PROPONENT	BRIEF DESCRIPTION
			• Construct and operate wetlands as a discharge site for treated wastewater (e.g., the Rio Alto Water District Wastewater Treatment Plant & Constructed Wetlands Project). Creation of constructed wetlands would enhance the surrounding community by increasing natural habitat for waterfowl and wildlife, while offering educational and recreational opportunities for local schools and community residents through the development of walking trails and informational kiosks.
Invasive Plant Removal from Creeks and Irrigation Conveyance Canals	Groundwater Demand Reduction		• Remove invasive plants from creeks and irrigation conveyance canals (e.g., Arundo donax, tamarisk, Himalayan blackberry). Many small tributaries in the watersheds of Tehama County have decreased conveyance, elevated levels of siltation, and diminished flood-carrying capacity due to invasive vegetation overgrowth. Debris-clearing is a challenge due to environmental permitting restrictions. Plant removal would reduce conveyance issues, reduce evapotranspiration (ET), and allow for more water in the shallow groundwater area, restoring conditions for GDEs and native riparian species.

Inter-Basin Surface Water Transfers or Exchanges	In-Lieu Groundwater Recharge		• Promote inter-basin surface water transfers or exchanges and potentially subsidize surface water costs so that it is less expensive than groundwater.
			• Import underutilized surface water and other supplies from other subbasins in Tehama County and use for direct recharge or in lieu of groundwater pumping. Potential opportunities include:
			  ○ Treated wastewater from the City of Red Bluff
			  ○ Trout Unlimited Groundwater substitution transfers
			  ○ Groundwater substitution transfers.

PROJECT/MANAGEMENT ACTION NAME	PROJECT/ MANAGEMENT ACTION TYPE	PROPONENT	BRIEF DESCRIPTION
Water Supply Reservoir Construction, Renovation, or Conversion	Surface Water Supply Augmentation		• Construct, renovate, or convert flood control facilities to a water supply reservoir.
Enhanced Boundary Flow Measurement	In-Lieu Groundwater Recharge		• Enhance measurement of boundary outflows resulting from precipitation runoff and irrigation return flows, which are estimated to be a substantial component of the water budget. Improved understanding of boundary outflows, which vary substantially from year to year, can facilitate capture of and use of this water for in-lieu recharge.
Well Metering	In-Lieu Groundwater Recharge		• Meter larger agricultural wells to better assess the total volume of groundwater pumped in the Subbasin. Data will help to better manage continued sustainability of the Subbasin within its sustainable yield and improve management of pumping for in-lieu recharge benefits.
Management Actions			
Assistance and Incentives for On-Farm Irrigation Infrastructure Improvements	Education/ Outreach, In-Lieu Groundwater Recharge		• Assist growers with conversion to efficient and dual-source irrigation systems. Related efforts may include soil mapping to customize irrigation timing and duration and grower education to encourage soil management to improve moisture retention. • Improve surface water conveyance and irrigation infrastructure to allow growers to utilize both surface water and groundwater for drip irrigation of orchards. Typical components required for a dual-source system are 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. Improvements in the Subbasin may include installation of regulating reservoirs, filters or treatment, and pressurization equipment.

PROJECT/MANAGEMENT ACTION NAME	PROJECT/ MANAGEMENT ACTION TYPE	PROPONENT	BRIEF DESCRIPTION
			• Assist growers with capital improvements to irrigation infrastructure, from use of groundwater to use of surface water or dual-source systems.
Incentives for Residential and Municipal Water Use Efficiency Improvements	Groundwater Demand Reduction		• Offer incentives for urban, residential, and commercial projects that improve water use efficiency, such as high efficiency appliance rebates and incentives for lawn removal, low-water landscape installation, rain barrels, graywater reuse, etc. • Evaluate municipal water system operation and reduce losses to reduce municipal groundwater pumping demand.

Demand Management	Groundwater Demand Reduction		• Promote conversion of agricultural lands to less water intensive crops to reduce water use while continuing to promote agriculture land use. Would be considered if other planned PMAs are insufficient to maintain sustainability.
			• Considered if other planned PMAs are insufficient to maintain sustainability:
			  ○ Coordinate with county to restrict land use changes that increase water demand in the Subbasin. Management would primarily focus on development of new agricultural land, and to restrict growth in areas with no surface water supply.
			  ○ Implement tiered fee structure for groundwater extractions to incentivize reduced groundwater use.
			  ○ Curtail and/or restrict groundwater extractions through a groundwater extraction allocation program.
			  ○ Curtail and/or restrict groundwater extractions through a land fallowing program.
			  ○ Coordinate with county to develop policies that align with sustainable groundwater management goals. Possible ordinances include regulations and limits for groundwater use, export, and illegal diversion of surface water. County could

PROJECT/MANAGEMENT ACTION NAME	PROJECT/ MANAGEMENT ACTION TYPE	PROPONENT	BRIEF DESCRIPTION
			create additional guidelines during the well permitting process to reduce competition between nearby wells (i.e., well spacing or suggestions regarding total well depth, depth of well perforations, and location of a new well relation to existing wells). Efforts could be designed to be protective of domestic wells.
Incentives for Use of Available Surface Water and Recycled Water	In-Lieu Groundwater Recharge		• Incentivize use of surface water for irrigation when available to allow groundwater levels to recover in between drought years when surface water is not available. • Provide incentives for use of recycled water of suitable quality (e.g., treated wastewater) for groundwater recharge and for urban or agricultural irrigation to decrease groundwater demand.
Water Market for Surface Water and Groundwater Exchange	In-Lieu Groundwater Recharge		• Create a water market for exchanging surface water and groundwater, allowing for flexibility in water use to meet irrigation demands in the Subbasin while remaining within the overall sustainable yield.
Tehama County Domestic Well Tracking and Outreach Program	Monitoring to Fill Data Gaps, Programs to Support Wells		• Provide domestic well owners with resources and funding for well testing, inspection, and replacement. Target well owners in locations where domestic wells are known to go dry or have water quality impacts. • Create a county-wide system to track dry domestic wells. Information will allow Tehama County to better manage assistance to domestic well owners when water levels drop and wells go dry, identify if wells need to be replaced, and provide information on well replacement.
Well Deepening or Replacement Program	Programs to Support Wells		• Create a program to deepen or replace shallow wells and/or wells that go dry.
Review of County Well Permitting Ordinances	Well Permitting Ordinances		• Review existing ordinances and assess if additional well permitting requirements are warranted. Follow updated DWR well

PROJECT/MANAGEMENT ACTION NAME	PROJECT/ MANAGEMENT ACTION TYPE	PROPONENT	BRIEF DESCRIPTION
			construction recommendations (Bulletin 74), as needed. Improve the well permitting and installation program to help protect water quality, allow for better screening, and avoid interference or impacts on neighboring wells.
Other Activities (Studies, Monitoring, Modeling)			
Coordination and Development of Public Data Portals	Coordination and Data Sharing		• Continue coordination with member units and other water purveyors to develop shared public data portals. Coordination would determine the types of data and data formats available, and establish standard methods for receiving, storing, and sharing data with the public, DWR, other agencies. • Continue coordination and information sharing among agencies in Tehama County and with agencies in neighboring subbasins. Coordination would include holding regular public meetings, attending meetings in neighboring subbasins, coordination with land use planning entities, and fostering relationships with relevant agencies and organizations. • Continue and improve sharing of contaminant data across organizations, including data to track and monitor contaminant plumes.
Additional Studies of GDEs and Groundwater - Surface Water Interactions	Monitoring to Fill Data Gaps		• Analyze the relationship between groundwater levels and GDE health to improve the understanding of how GDEs are affected by conditions in the groundwater aquifer accessed by pumping. • Analyze the water supplies accessed by potential GDEs, potentially using a combination of surface water data, shallow groundwater level data, and remote sensing data related to vegetative cover. • Evaluate the need for additional studies or monitoring of groundwater-surface water interactions. Additional information would improve the understanding of how GDEs relate to the groundwater aquifer accessed by pumping, and may allow for

PROJECT/MANAGEMENT ACTION NAME	PROJECT/ MANAGEMENT ACTION TYPE	PROPONENT	BRIEF DESCRIPTION
			refinement of how GDEs and their water supply needs are monitored
Expanded Subbasin Monitoring and Aquifer Testing	Monitoring to Fill Data Gaps		• Aquifer testing will improve the understanding of aquifer conditions, particularly the level of confinement, connectivity between depths, connectivity with surface water bodies, and the understanding of hydraulic properties needed for simulation within the Tehama IHM and an improved estimate of recharge entering the Subbasin. • Collect LIDAR (Light Detection and Ranging) data across the Subbasin to support monitoring all sustainability indicators. • Identify locations in the Subbasin that are potentially vulnerable to damage from subsidence.
Install Additional Agroclimate Stations	Monitoring to Fill Data Gaps		• Install additional stations that monitor agriculture-related weather and climate parameters. Improved data will inform agricultural water use practices and potentially enhance water conservation. Data can also improve the accuracy of the Tehama Integrated Hydrologic Model (Tehama IHM).
Maintain and Expand Groundwater Level Monitoring Network	Monitoring to Fill Data Gaps		• Maintain existing monitoring network to improve the understanding of aquifer conditions and dynamics and to monitor groundwater conditions related to sustainable management criteria. • Maintain existing coordination with other monitoring entities to support the use of identified monitoring locations as part of the monitoring network and to share relevant collected data. • Identify existing wells that may be incorporated into the groundwater level monitoring network. Wells may be used to fill data gaps and improve understanding of aquifer conditions and dynamics, and groundwater conditions related to GDEs and surface water depletions.

PROJECT/MANAGEMENT ACTION NAME	PROJECT/ MANAGEMENT ACTION TYPE	PROPONENT	BRIEF DESCRIPTION
			• Identify new monitoring sites that may be added to the groundwater level monitoring network. Wells may be used to fill data gaps and improve understanding of aquifer conditions and dynamics, and groundwater conditions related to GDEs and surface water depletions.
One-Time Groundwater Quality Snapshot and Evaluation	Monitoring to Fill Data Gaps		• Conduct a one-time sampling of groundwater quality parameters over a wide range of wells in Tehama County. Data will improve understanding of groundwater quality conditions and provide a basis for refinement of monitoring networks. • Evaluate groundwater quality monitoring options, potentially informed by the one-time groundwater quality snapshot. Consider options to better characterize widespread groundwater quality conditions and address localized groundwater quality concerns.
Tehama County Well Inventory and Registration Program	Monitoring to Fill Data Gaps		• Create a county-wide well inventory to compile all available information on active wells in Tehama County and improve understanding of well distribution, construction, and hydrogeology. Inventory will be useful for filling monitoring data gaps. • Create a well registration program to collect well locations, screening information, and pumping data for use in GSP updates.

Table 4-3. Benefits and Costs of Projects and Management Actions Developed for Implementation.

PROJECT/ MANAGEMENT ACTION NAME	PROPONENT	FIRST YEAR OF IMPLEMENTATION	GROSS AVERAGE ANNUAL BENEFIT AT FULL IMPLEMENTATION (AF/YR)	ESTIMATED CAPITAL COST ($)	ESTIMATED ANNUAL COST AT FULL IMPLEMENTATIO N ($/YR)
Multi-Benefit Recharge	Multi-Agency / Jurisdictions	To Be Determined [1]	TBD	(reported as part of annual cost)	TBD
Grower Education	Multi-Agency / Jurisdictions	To Be Determined [1]	N/A [2]	N/A	$10,000

[1] Planned initiation of the project or management action will occur before 2042, though the precise year will be determined as GSP implementation and annual reporting proceeds. The timing of implementation will be informed by improved understanding of basin groundwater conditions over time and will be planned to manage changing hydrologic or groundwater conditions to achieve the GSP sustainability goal.

[2] Grower education does not have a specific annual volumetric benefit but is expected to generally improve use of existing surface water supplies and reduce net consumption of groundwater supplies, supporting groundwater sustainability efforts.

4.2.2 Sustainability Indicators Benefitted by Projects and Management Actions

The sustainability indicators expected to directly benefit from each type of project or management action are summarized in **Table 4-4**. All proposed projects and management actions are expected to benefit groundwater levels and groundwater storage, whether through direct or in-lieu groundwater recharge, or 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 surface water 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 4-4. Sustainability Indicators Expected to Benefit from Projects and Management Action Types Proposed for the Antelope Subbasin.

PROJECT/MANAGEMENT ACTION TYPE	SUSTAINABILITY INDICATORS EXPECTED TO DIRECTLY BENEFIT				
	GROUNDWATER LEVELS	GROUNDWATER STORAGE	WATER QUALITY	SURFACE WATER DEPLETION	LAND SUBSIDENCE
Coordination and Data Sharing	-[1]	-[1]	-[1]	-[1]	-[1]
Direct Groundwater Recharge	X	X		X	X
Education/Outreach	X	X	X	X	X
Groundwater Demand Reduction	X	X		X	X
In-Lieu Groundwater Recharge	X	X		X	X
Monitoring to Fill Data Gaps	-[1]	-[1]	-[1]	-[1]	-[1]
Programs to Support Wells[1]	-[2]	-[2]	-[2]	-[2]	
Surface Water Supply Augmentation	X	X		X	X
Well Permitting Ordinances	X	X	X	X	X

[1] Coordination, data sharing, and monitoring to fill data gaps 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] Programs designed to support wells (e.g., well tracking, well deepening or replacement) are beneficial for monitoring and addressing any potential impacts to those beneficial uses and users of groundwater during GSP implementation. However, there are no anticipated direct benefits to specific sustainability indicators.

4.2.3 Maintaining Sustainability

As described above, the evaluation of historical and projected groundwater conditions described in Chapter 2 and results from the Tehama IHM indicate the Antelope Subbasin is currently in a sustainable conditions and sustainability is expected to be maintained without undesirable results over the GSP planning and implementation horizon. These results consider the potential effects of climate change (2070CT scenario) and are without implementation of any PMAs.

Ongoing management of the Antelope Subbasin under this GSP is planned to maintain sustainability and respond to unforeseen future conditions that may impact sustainable operation of the Antelope Subbasin. The GSA plans to maintain sustainability through an adaptive management strategy: continuing to monitor sustainability indicators throughout GSP planning and implementation horizon and implement PMAs as needed to ensure that the sustainability goal is achieved and that undesirable results do not occur.

PMAs developed for implementation are expected to support ongoing sustainability. Grower education is planned to encourage on-farm practices that support direct and in-lieu recharge, and multi-benefit groundwater recharge is planned to supply direct recharge of available flood water to the Subbasin while also providing habitat to migratory shorebirds. Other potential PMAs would also be evaluated and selected for implementation if the GSA finds that established measurable objectives (MOs) cannot be maintained and/or if minimum thresholds (MTs) are being approached. This adaptive approach will be informed by continued monitoring of groundwater conditions, using the monitoring network and methods described in Chapter 3.

4.3 Overview of Concepts Explored

This section provides a brief overview of various concepts explored when proposing and identifying PMAs for the Antelope Subbasin. While not all concepts were proposed for implementation in the Antelope Subbasin, exploring these concepts is useful for identifying the types and scale of potential PMAs that could be explored and implemented in the future to maintain sustainability, depending on future changes in subbasin conditions.

4.3.1 Well Permit Revision

The need for and benefit from potential modifications to well regulations was considered as a mechanism to ensure that groundwater sustainability is maintained in the Subbasin. Well permitting regulations can help avoid adverse impacts on groundwater beneficial users by reducing potential for mutual well interference or streamflow depletion through limitations on well screen depths and well spacing and/or setbacks.

4.3.2 Demand Management

Demand management broadly refers to any water management activity that reduces the consumptive use of irrigation water. When considered as a management action to support sustainable groundwater management, demand management must result in a net reduction in groundwater pumping (pumping net of recharge). Activities that, for example, reduce canal seepage or reduce deep percolation to the groundwater system are generally ineffective at demand management. While they may decrease the quantity of water diverted or applied, they also reduce the quantity of recharge to usable groundwater, resulting in no (or little) net reduction in groundwater pumping.

Demand management activities considered as concepts for implementation in the Antelope Subbasin include:

- **Management and Restrictions of Land Use** Changes: Implementing county water use ordinances or other policies to restrict land use changes that would increase water demand in the Subbasin. Policies would generally restrict development of new agricultural land, restrict growth in areas with no surface water supply, and/or promote conversion of agricultural lands to less water intensive crops.
- **Pumping Fees:** Implementing tiered fee structures for groundwater extractions to incentivize reduced groundwater use.
- **Groundwater Extraction Allocation Program:** Creating groundwater extraction allocations to curtail or restrict the volume of groundwater extraction allowed. Could be implemented with pumping fees.
- **Land Fallowing Program:** Curtailing and/or restricting groundwater extractions by creating and enforcing, or incentivizing, a land fallowing program.

Demand management actions are scalable to suit the volume of groundwater reduction that is needed, both in the timing and the spatial extent of implementation. While long-term, wide-ranging demand management actions may be necessary to achieve and maintain sustainability in severely overdrafted areas, shorter-term and localized demand management actions are also possible to address localized groundwater concerns.

As described previously, the Antelope Subbasin is expected to be managed sustainably by 2042 and without undesirable results over the GSP planning and implementation horizon, even without implementation of PMAs. Demand management actions are thus considered only as conceptual, “backstop” measures that would be considered and implemented only if other planned PMAs are insufficient to maintain sustainability.

4.3.3 Multi-Benefit Recharge Project

Multi-benefit recharge projects have emerged as promising tools to maximize the benefits of recharge projects for numerous groundwater and environmental water uses and users. The multi-benefit recharge projects explored in Tehama County are specifically focused on strategic flooding of agricultural fields for managed aquifer recharge (MAR).

The main goals of these multi-benefit recharge projects are to simultaneously:

- recharge groundwater supplies using available surface water supplies, and
- create temporary habitat for migratory shorebirds along the Pacific Flyway

These multi-benefit recharge projects are distributed, operating through participating growers who voluntarily flood their fields during peak migratory periods to create temporary habitat for the shorebirds while also recharging the underlying aquifer. These projects can offer incentives to encourage grower participation and can also offer assistance for field preparation prior to flooding. The scale of implementation may vary depending on grower interest, which in turn may vary depending on water availability, water reliability, outreach, local interests, and compensation (if applicable).

Successful multi-benefit recharge projects will realize the greatest benefit from selecting sites with high groundwater recharge potential, flooding those sites at times when the environmental benefits to migratory shorebirds are highest, and implementing recharge with the greatest practicality. Ideal sites have soil and crop conditions favorable for flooding and recharge during peak migratory periods (generally July 15-October 1 and/or March 15-April 30). Practical sites have existing access to surface water and infrastructure that supports flooding.

Although the Antelope Subbasin is expected to continue to be managed sustainably through 2042 and beyond, without undesirable results over the GSP planning and implementation horizon, multi-benefit recharge is a concept of great interest to growers and stakeholders in the Subbasin. Thus, a multi-benefit recharge project has been developed for implementation in the Antelope Subbasin (see Section 4.4.1 for more information).

4.3.4 Flood Managed Aquifer Recharge (Flood-MAR)

Conceptually, projects that use flood water for on-farm managed aquifer recharge (i.e., Flood-MAR) are similar to the multi-benefit recharge projects described in the previous section, although the timing of Flood-MAR projects are confined to periods when flood water is available rather than the migratory periods of shorebirds. Flood-MAR projects operate through distributed, voluntary participation of growers, who divert and apply flood water to fields when it is available to supply groundwater recharge.

Implementation of Flood-MAR can occur at various scales, from individual landowners diverting flood water from creeks and streams using existing infrastructure, to larger facilities operated by one or more agencies to divert larger volumes of flood water to detention and recharge areas. Besides groundwater recharge, Flood-MAR can also provide benefits to flood risk reduction, ecosystem enhancement, water quality improvement, climate change adaptation, and recreation in the Antelope Subbasin. While no specific Flood-MAR project is specifically developed for implementation in the Antelope Subbasin at this time, Flood-MAR is proposed among other potential PMAs that could be implemented to support adaptive management of the Subbasin.

4.3.5 Rainfall Managed Aquifer Recharge (Rain-MAR) to Capture Runoff from Fields

Rainfall Managed Aquifer Recharge (Rain-MAR) projects considered in Tehama County would be designed to modify on-field conditions and infrastructure to capture and hold precipitation, taking water that would have otherwise drained from the field through runoff and instead supplying that to the groundwater system through on-field infiltration. Like the multi-benefit recharge and Flood-MAR projects described

above, Rain-MAR projects would provide distributed groundwater recharge throughout the Subbasin, operating through voluntary grower participation. Besides groundwater recharge, Rain-MAR can also provide benefits to flood risk reduction by decreasing runoff, and to ecosystem enhancement for birds and other wildlife.

Although the Antelope Subbasin is expected to be managed sustainably by 2042 and without undesirable results over the GSP planning and implementation horizon, a Rain-MAR project is a scalable and potentially low-cost option for addressing localized groundwater issues, or as a response to future climate change effects. While no specific Rain-MAR project is specifically developed for implementation in the Antelope Subbasin at this time, a Rain-MAR project is proposed among other potential PMAs that could be implemented to support adaptive management of the Subbasin.

4.3.6 Other Groundwater Management Strategies (Projects and Management Actions and Cost Feasibility)

Various other groundwater management strategies have also been discussed in the Subbasin. Strategies discussed include use of recycled water, incentivizing maximum use of all surface water available through existing or potential future water rights or allocations, and coordinated and cooperative management between key groundwater user groups (e.g., urban, agricultural, environmental), and groundwater ordinances. The feasibility of different management strategies in the Subbasin is closely tied to cost. Recognizing that the Subbasin is currently in a sustainable condition and is projected to maintain sustainability through the GSP implementation and planning horizon, cost makes certain groundwater management strategies difficult to implement, although these management strategies are available for consideration if needed in the future.

4.3.7 Ongoing Evaluation of Groundwater Management Efforts

In accordance with SGMA and GSP regulations, the Subbasin will conduct ongoing assessments of groundwater conditions, including annual GSP reporting and five-year GSP updates. Ongoing assessments will evaluate new information on changes in water use, changes in Subbasin and management area groundwater conditions, efficacy or benefits from management actions implemented, and consider additional management tools or actions needed to maintain Subbasin sustainability. These efforts will support adaptive management of the Subbasin groundwater resources and enable the Subbasin to respond to groundwater management needs if they arise.

4.4 Projects and Management Actions Developed for Implementation

This section describes the PMAs that were developed for implementation in the Antelope Subbasin. GSP analyses indicate that the Antelope Subbasin is expected to be sustainable through 2042 and beyond, without undesirable results over the GSP planning and implementation horizon, even without implementation of PMAs. Nevertheless, the GSA has identified and developed two PMAs for potential implementation to support ongoing sustainability and adapt to potential future changes in Subbasin conditions. The two PMAs include a multi-benefit recharge project and a grower education program related to on-farm practices to support ongoing sustainability. These PMAs are described below and could be scaled as needed to support adaptive management of the Subbasin.

4.4.1 Multi-Benefit Recharge Project

4.4.1.1 Overview

An on-farm, multi-benefit groundwater recharge program has been developed for potential implementation in the Antelope Subbasin based on guidelines provided by The Nature Conservancy (TNC). 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 habitat for shorebirds migrating along the Pacific Flyway.

The multi-benefit recharge project would be implemented through the coordinated actions of growers who volunteer to participate and flood their fields during the course of normal farming operations. During the migratory period, fields with soil and cropping conditions conducive to groundwater recharge would be flooded and maintained with shallow depths, recharging groundwater while also providing critical wetland habitat for migrating shorebirds. If an incentive structure is established, the program could provide financial compensation to growers, potentially paying 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 Antelope Subbasin.

4.4.1.2 Implementation

Implementation of a multi-benefit groundwater recharge program in the Antelope 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 Antelope Subbasin, with multiple benefits to groundwater recharge and temporary wetland habitat for migrating shorebirds. 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 would commence with selection of sites suitable for multi-benefit recharge, and initiation of any necessary permitting and environmental documentation. The GSA would use resources provided by TNC to identify fields with soil and cropping conditions conducive to groundwater recharge and temporary wetland habitat formation.[1] In later phases of project implementation, suitable fields would continue to be identified following similar criteria, with refinement according to lessons learned from early project implementation.

[1] TNC offers an online Multi-Benefit Recharge Suitability Tool for identifying areas potentially suitable for multi-benefit recharge: https://tnc.maps.arcgis.com/apps/webappviewer/index.html?id=b898ab568d374cc9baf89f762d9bb78c.

Suitable project sites would be selected by the following characteristics:

- Soil characteristics that are conducive to recharge, as indicated by:
    - Soil types
    - SAGBI rating relationship
- Crop types that are conducive to high-quality, open wetland habitat suitable for shorebird stopovers when flooded (i.e., not orchards)
- Crop types that are suitable for recharge (i.e., suitable for flooding in February through April, 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/).

The GSA would conduct or coordinate outreach to local growers to identify willing participants that irrigate fields where multi-benefit groundwater recharge can be implemented. Outreach would be conducted through existing communication pathways described in the GSP. Participant responses would 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

The GSA, with potential support from other proponents in the Subbasin, 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 would be prepared for flooding and monitoring. At that time, necessary monitoring equipment would 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" (generally February through April), 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.

4.4.1.2.1 Implementation Schedule

A typical annual timeline of project implementation is provided in **Table 4-5.** At this time, the multi-benefit groundwater recharge program has been developed and evaluated only at an investigative, planning level. This project would ultimately be selected for implementation according to the criteria identified in Section 4.4.1.2.5. At that time, the GSA would develop and implement the program annually following the general implementation schedule presented in **Table 4-5**.

Table 4-5. Potential Annual Implementation Timeline for the Antelope Subbasin Multi-Benefit Groundwater Recharge Project.

TIMELINE ACTIVITY	START	END
Participant Applications	December-January	March
Site Selection	January-February	March
Construction, Site Preparation (If Needed)	February	March
Operation (Field Flooding)	February	April
Financial Incentive Payment (If Applicable)	April	June

4.4.1.2.2 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.

4.4.1.2.3 Construction Activities and Requirements

This project may be configured and operated to utilize existing diversion and conveyance infrastructure available within the Subbasin or may require construction of new diversion and conveyance infrastructure. If existing infrastructure and facilities are available and used for this project, there would be no anticipated infrastructure construction activities and requirements. If new diversion and conveyance infrastructure must be constructed, it is anticipated that this project would require one or more diversion structures, each equipped with a pump, fish screen, and magnetic flow meter. Conveyance pipeline and metered turnout structures would also be required to supply water to participating fields, and to facilitate project monitoring and reporting. The precise configuration and capacity of necessary infrastructure would be refined during future project development.

The project may also require on-farm activities for participating growers to enhance field flooding and recharge on existing fields. The program is designed to work within existing field infrastructure and irrigation systems. Any on-farm water management modifications are expected to be modest to increase standing water on fields outside of the growing season to support both recharge and habitat. Prior to field flooding, the GSA should facilitate a survey of the fields and install pressure transducers and/or flow meters at inlets and outlets and in adjacent wells to facilitate measurement of applied water depths and changes in groundwater depth.

4.4.1.2.4 Water Source

Surface water used in this project is expected to be available from existing or new surface water rights contracts from waterways within or adjacent to the Subbasin. The availability and reliability of surface water for projects is described in Section 4.8. Existing or newly constructed diversions and conveyance infrastructure would be used to supply surface water to participating fields for multi-benefit groundwater recharge. Surface water would be delivered during a “flooding window,” generally from February through April.

4.4.1.2.5 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" (generally February through April), when wetland habitat for waterbirds migrating along the Pacific Flyway is 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 Antelope Subbasin. The GSA 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. The GSA 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 overall Subbasin sustainability goal.

4.4.1.2.6 Legal Authority, Permitting Processes, and Regulatory Control

The following agencies have potential permitting roles for the multi-benefit groundwater recharge project: County, the State Water Resources Control Board (SWRCB), and USBR (if using CVP contract supply). If necessary, the GSA will obtain land grading permits from the County. If necessary, the GSA 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 likely need a Negative Declaration or Mitigated Negative Declaration.

4.4.1.3 Operation and Monitoring

Following site selection, operation of the multi-benefit recharge project would begin with site preparation. Field preparation is completed prior to flooding 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 may also be installed in the fields, as needed, to facilitate project monitoring. Soil and water

samples could be collected to ascertain water quality prior to wetting, as desired. Wooden stakes should also be installed to support monitoring of water depths and bird presence.

After site preparation, multi-benefit groundwater recharge would be implemented through field flooding. During the implementation period (generally February through April), participants would spread water on their fields and maintain a shallow depth (four inches maximum) for four to six weeks. Participants would record any changes in water flow in an irrigation log. Meanwhile, the GSA would coordinate monitoring of field depth, bird presence, water delivery volume, and changes in groundwater depth.

4.4.1.4 Project Benefits and Costs

The expected benefits and costs of the multi-benefit recharge program are summarized in **Table 4-6**. Potential benefits to the groundwater system are estimated based on soil infiltration rates and analyses of potential recharge areas in the Antelope Subbasin (documented in Appendix 2-J, Tehama IHM Model Documentation). Habitat benefits are estimated to be equal to the participating area.

While actual participation in the program would vary from year to year, depending on grower interest, water availability, changes in cropping, and other factors, preliminary mapping was done to identify potential recharge areas that may be suitable for participation in the project. The total area potentially suitable for the multi-benefit recharge project was evaluated based on recharge potential and cropping, as described in **Appendix 2-J Tehama IHM Model Documentation**. Recharge potential was quantified based on the area-weighted soil agricultural groundwater banking index (SAGBI) rating of fields in the Subbasin, considering only fields with a SAGBI rating of “moderately good” or higher (UC Davis, 2021). Crop areas suitable for multi-benefit recharge were evaluated based on 2018 Land IQ spatial land use data, filtering land areas by crop type to exclude permanent crops, rice, crops with growing seasons unsuited to the flooding window, and non-agricultural areas. In total, approximately 80 acres in the Antelope Subbasin are potentially suitable for multi-benefit recharge according to these criteria. Additional information is described in Appendix 2-J. Of this total, it is estimated that an average of approximately 40 acres may participate in the multi-benefit recharge program in a given year (approximately 50 percent of the total potential recharge area).

Based on observed infiltration from a multi-benefit recharge pilot project conducted on fields with soil infiltration characteristics similar to potential recharge areas identified in the Antelope Subbasin[2], infiltration rates are expected to range between 0.2 and 1.2 inches per day for participating fields in the Antelope Subbasin. Assuming an average of 30 days of flooding per year, the average expected recharge benefit of the multi-benefit recharge program is approximately 70 AF per year (ranging from 20 to 120 AF per year, depending on actual field recharge rates). Analyses in Section 4.8 indicate that the potential water available for diversion from Antelope Creek each year is generally sufficient to supply at least several hundred acre-feet of water for this project. While changes in water availability may impact the extent of program participation from year to year, the program could operate in most years, providing both groundwater recharge and migratory bird habitat along the Pacific Flyway.

Typical program cost components are summarized in **Table 4-7**, 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.

Besides groundwater recharge and habitat, the multi-benefit recharge project can also provide benefits to flood risk reduction and climate change adaptation. Those potential benefits are not quantified at this time.

Typical program cost components are summarized in **Table 4-7**, on a per site basis. These costs include only on-farm equipment and direct costs and estimated program operation costs, and do not include costs for any new diversion and conveyance infrastructure that may be needed. The precise configuration and costs of any new diversion and conveyance infrastructure would be identified and refined during future project development.

Slightly higher on-farm and program 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.

[2] Observed infiltration rates for fields with a SAGBI rating of “moderately good” or higher for a 2020 pilot project conducted in Colusa County.

Table 4-6. Estimated Average Recharge Volume and Temporary Wetland Habitat Formation for the Multi-Benefit Groundwater Recharge Project.

PROJECT	ESTIMATED POTENTIAL RECHARGE AREA (ACRES)	ESTIMATED PARTICIPATING AREA (ACRES/ WATER-YEAR)	ESTIMATED AVERAGE ANNUAL RECHARGE (AF/YEAR)	ESTIMATED AVERAGE ANNUAL ON-FARM COST[2]	AVERAGE ANNUAL ON-FARM COST PER AF BENEFIT
Multi-Benefit Groundwater Recharge	80	40	70	$7,000	$100

[1] Average estimated benefit, assuming 40 acres flooded for 30 days each year, with an estimated recharge rate ranging from 0.2-1.2 inches/day (20 – 120 AF/year).

[2] Assumes that on average 50% of sites are new and 50% of sites are established in a given year, and that average participating field sizes are 20 acres. See Table 8-7 for unit costs per site. Costs do not include estimated costs for constructing any new diversion and conveyance infrastructure that may be needed.

Table 4-7. 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 ($)[1]	ESTIMATED AVERAGE ANNUAL COST AT ESTABLISHED SITES ($)
Capital Costs		
Equipment and Direct Cost	$2,000	$1,000
Operations and Maintenance Costs		
Labor, Coordination, Administration, Analysis	$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

4.4.2 Grower Education Relating to On-Farm Practices for Sustainable Groundwater Management

4.4.2.1 Overview

A grower education and outreach program is proposed as a management action for the Antelope 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 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. The program would continue and potentially expand the irrigation evaluation services currently in place through the Mobile Irrigation Lab (MIL), operated in Tehama County by the Tehama County Resource Conservation District since 2002.

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 both agricultural productivity and economic benefits along with sustainable groundwater management[3]. **Table 4-8** identifies the sustainability indicators 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 4C.**

Table 4-8. Sustainability indicators Benefitted by On-Farm Management Actions.

ON-FARM MANAGEMENT ACTION	SUSTAINABILITY INDICATORS 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

[3] In most cases, not all on-farm practices will be able to be implemented. Also, some practices will not work in tandem with one another.

4.4.2.1.1 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 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-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, 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 that have the potential to 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 promote groundwater sustainability.

4.4.2.1.2 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 result in increases in direct recharge and improving soil moisture storage may increase effective precipitation and slightly reduce the required volume and frequency of irrigation.

4.4.2.1.3 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.

4.4.2.1.3.1 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.

4.4.2.1.3.2 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 while having 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.

4.4.2.1.4 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.) and 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 or liberate these constituents that are present in the ground from historic practices. 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.

4.4.2.2 Implementation

The GSA 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. The program would continue and expand the irrigation evaluation services currently in place through the Mobile Irrigation Lab (MIL), operated in Tehama County by the Tehama County Resource Conservation District since 2002.

As the GSA begins to conceptualize and implement specific grower education programs and tools, it 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 that the GSA may consider partnering with are:

- University of California Cooperative Extension (UCCE)
- California State University, Chico (Chico State)
- University of California, Davis (UC 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.

4.4.2.2.1 Implementation Schedule

A general implementation schedule for the grower education program is presented in **Table 4-9**. 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 occur 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 4-9. 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

4.4.2.2.2 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 the GSP.

4.4.2.2.3 Construction Activities and Requirements

There are no anticipated construction activities that would affect the grower education program. The grower education program will primarily require development and distribution of technical and educational resources, which the GSA would prepare through the partnerships described above.

4.4.2.2.4 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.

4.4.2.2.5 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 Antelope Subbasin grows.

4.4.2.2.6 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.

4.4.2.3 Operation and Monitoring

The grower education program will be accomplished by the GSA through partnerships with agencies, as described under the implementation section, above. The GSA 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 sustainability indicators in the Antelope Subbasin will be evaluated through groundwater monitoring and water quality monitoring at nearby monitoring sites, identified in the GSP.

4.4.2.4 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 4-9**). 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 approximately $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.

4.5 Portfolio of Other Potential Projects and Management Actions

In addition to the PMAs developed for implementation, the GSA has identified a portfolio of other potential PMAs that could provide benefits with respect to one or more of the sustainability indicators. These PMAs are still under development and require additional information that would be determined through future monitoring and evaluation, and as the GSA continues to identify and fill data gaps. This section provides descriptions for these other potential PMAs that could be selected for future implementation in the Antelope Subbasin if needed to maintain sustainability.

While the Antelope Subbasin is expected to be managed sustainably by 2042, the GSA has planned an adaptive management strategy that will be informed by continued monitoring of groundwater conditions throughout GSP implementation. If monitoring indicates that established measurable objectives (MOs) cannot be maintained and/or that minimum thresholds (MTs) are being approached, one or more of these potential PMAs could be evaluated and selected for implementation to ensure that the sustainability goal is achieved and that undesirable results do not occur.

The portfolio of potential PMAs is summarized below, organized according to PMA type. “Projects” generally refer to structural features or activities that may require construction and related permitting activities (e.g., recharge basins, Flood-MAR). “Management actions” are typically non-structural programs, policies, or efforts that serve to change behaviors and practices around groundwater use designed to support sustainable groundwater management (e.g., education programs, well ordinances). Per 23 CCR §354.44(b)(2), the potential management actions include demand management efforts that could be rapidly implemented and scaled if the Antelope Subbasin is approaching minimum thresholds specified in the GSP. Projects and management actions are expected to benefit specific groundwater sustainability indicators through their implementation, for example improving groundwater levels, groundwater storage, or water quality. “Other” activities are also proposed that do not directly benefit specific groundwater sustainability indicators but are still beneficial for effectively implementing the GSP. Examples of other activities include studies, monitoring, and improvements in modeling to better understand groundwater conditions in the Subbasin.

Potential PMAs are described at a reconnaissance-level of detail relative to the PMAs described in Section 4.4, above. However, PMA information is still reported in accordance with 23 CCR §354.44(b). The required information is summarized in a table following a brief description of each potential PMA.

4.5.1 Potential Projects

This section describes potential projects that would be implemented if determined to be necessary, pending future conditions in the Antelope Subbasin. **Table 4-10** lists the potential projects described in the subsections that follow.

Table 4-10. List of Potential Projects Proposed for the Antelope Subbasin.

PROJECT	PRIMARY PROJECT TYPE(S)[1]
Direct Groundwater Recharge of Stormwater and Flood Water	Direct Groundwater Recharge
Stormwater Management Improvements	Direct Groundwater Recharge
Levee Setback and Stream Channel Restoration	Direct Groundwater Recharge
On-Farm Infiltration	Direct Groundwater Recharge
Recycled Water Projects	Direct Groundwater Recharge, In-Lieu Groundwater Recharge
Invasive Plant Removal from Creeks and Irrigation Conveyance Canals	Groundwater Demand Reduction
Inter-Basin Surface Water Transfers or Exchanges	Surface Water Supply Augmentation
Water Supply Reservoir Construction, Renovation, or Conversion	Surface Water Supply Augmentation
Enhanced Boundary Flow Measurement	Monitoring to Fill Data Gaps
Well Metering	Monitoring to Fill Data Gaps

[1]The primary function of the project as conceptualized, although during implementation projects may be used for multiple functions to support groundwater sustainability.

4.5.1.1 Direct Groundwater Recharge of Stormwater and Flood Water

This project would recharge groundwater using excess surface water available in wet years. Additional recharge during wet years provided by this project would offset increased demand for groundwater during drier years (23 CCR §354.44(b)(9)). It is anticipated that this project would primarily use flood water and stormwater, diverted directly from waterways, or delivered to recharge areas through existing conveyance infrastructure. Recharge may occur through conveyance such as unlined canal and laterals, natural drainages such as creek beds, recharge basins, and aquifer storage and recovery (ASR) wells. Recharge may also occur using flood water for on-farm managed aquifer recharge (Flood-MAR). Specific recharge areas are not yet identified but should have characteristics that are suitable for recharge (e.g., suitable surficial geology, low enough groundwater levels to provide storage for recharge, and access to surface water). A summary of the project is provided in **Table 4-11**

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Table 4-11. Direct Groundwater Recharge of Stormwater and Flood Water: Summary (23 CCR §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 areas of the Subbasin that have access to stormwater and/or flood water. The precise location 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 provide direct groundwater recharge to the aquifer. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Antelope 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 in all years when stormwater and flood water is available, potentially beginning the first year of project 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 project would use flood water and stormwater when available along creeks, streams, and channels in and adjacent to the Antelope Subbasin. See Section 4.8 for a description of the reliability of flood water and stormwater.
Legal Authority, Permitting Processes, and Regulatory Control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, 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 will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. 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 will be done with the Tehama IHM 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.

4.5.1.2 Stormwater Management Improvements

This project would improve stormwater management efforts to enhance groundwater recharge during periods when stormwater is available. Improvements to existing facilities may include maintenance and repairs of pumps and holding basins to ensure they have adequate capacity to manage and retain anticipated stormwater. Improvements to the watershed and landscape may include restoration of areas affected by wildfires and of unused grazing land to reduce runoff and improve recharge. A summary of the project is provided in **Table 4-12**.

Table 4-12. Stormwater Management Improvements: Summary (23 CCR §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 areas of the Subbasin with existing stormwater management infrastructure, and in wildfire-affected areas or unused grazing land that may contribute to undesirable stormwater runoff characteristics. 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 provide direct groundwater recharge to the aquifer by reducing runoff and by improving or increasing the recharge potential of stormwater detention facilities. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Antelope 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 in all years when stormwater flows occur, potentially beginning the first year of project 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 project would use stormwater when available along creeks, streams, and channels in and adjacent to the Antelope Subbasin. See Section 4.8 for a description of the reliability of stormwater.
Legal Authority, Permitting Processes, and Regulatory Control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, 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 will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water.

ITEM IN GSP REGULATIONS	DESCRIPTION
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 supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling will be done with the Tehama IHM 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.

4.5.1.3 Levee Setback and Stream Channel Restoration

This project would restore stream channels and levee setbacks in the Subbasin to increase groundwater recharge of surface water along waterways. The project is also expected to provide other benefits to environmental water users, providing wildlife habitat, lowering water temperatures in the Sacramento River system, and improving the overall riparian ecosystem. A summary of the project is provided in **Table 4-13**.

Table 4-13. Levee Setback and Stream Channel Restoration: Summary (23 CCR §354.44(b)).

ITEM IN GSP REGULATIONS	DESCRIPTION
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This project is proposed for implementation along stream channels in and surrounding the Subbasin boundaries. 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 provide direct groundwater recharge to the aquifer by restoring channel and levee characteristics, with additional benefits for environmental water users. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Antelope 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 in all years that stream flows occur, potentially beginning the first year of project 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

ITEM IN GSP REGULATIONS	DESCRIPTION
	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 conveyance of existing flows along stream channels in and surrounding the Antelope Subbasin. See Section 4.8 for a description of the reliability of existing water supplies.
Legal Authority, Permitting Processes, and Regulatory Control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, 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 will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	The sustainability Indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. 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 will be done with the Tehama IHM 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.

4.5.1.4 Rain-MAR

This project would modify on-field conditions and infrastructure to capture and hold precipitation, taking water that would have otherwise drained from the field through runoff and instead supplying that to the groundwater system through rainfall managed aquifer recharge (Rain-MAR). Rain-MAR would provide distributed groundwater recharge throughout the Subbasin, operating through voluntary grower participation. Besides groundwater recharge, Rain-MAR can also provide benefits to flood risk reduction by decreasing runoff, and to ecosystem enhancement for birds and other wildlife. A summary of the project is provided in **Table 4-14**.

Table 4-14. Rain-MAR: Summary (23 CCR §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 agricultural areas of the Subbasin, particularly those with soil and slope characteristics suitable for retaining runoff and supplying recharge to the aquifer. The precise location 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 provide direct groundwater recharge to the aquifer. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Antelope 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 in all years when precipitation and runoff occurs, potentially beginning the first year of project 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 project would capture precipitation on-field, preventing runoff and using that water to recharge the aquifer instead. Precipitation may be available in all years, with additional precipitation in wetter years. See Section 2.3 for the Subbasin water budget, including average annual precipitation over the projected water budget period. This project increases subbasin recharge only in wet years when precipitation volume is high, such that a portion of the precipitation flows out of the subbasin,
Legal Authority, Permitting Processes, and Regulatory Control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, 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 will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. 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,

ITEM IN GSP REGULATIONS	DESCRIPTION
	and others to be determined. Modeling will be done with the Tehama IHM 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.

4.5.1.5 Recycled Water Projects

Recycled water projects would identify and facilitate use of recycled water of suitable quality in the Subbasin. Recycled water could be used for groundwater recharge, urban or agricultural irrigation, or other purposes. Potential sources of recycled water include treated wastewater or treated process water from agricultural facilities. To generate additional supply, the projects may also explore enhancements to wastewater treatment facilities to supply tertiary-treated Title-22 effluent for irrigation. Projects may also explore construction of wetlands as a discharge site for treated wastewater, modeled after the Rio Alto Water District Wastewater Treatment Plant & Constructed Wetlands Project. Constructed wetlands may provide groundwater recharge benefits while also enhancing habitat for waterfowl and wildlife and providing other educational and recreational opportunities for the community. A summary of the projects is provided in **Table 4-15.**

Table 4-15. Recycled Water Projects: Summary (23 CCR §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 all areas of the Subbasin with access to recycled water of suitable quality. 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. Depending on how and where recycled water is used, the project could provide direct groundwater recharge (e.g., when used to create wetlands) and in-lieu groundwater recharge (e.g., when used for irrigation) benefits. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Antelope 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 in all years recycled water is available, potentially beginning the first year of project 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 project would use available recycled water supplies of suitable quality. See Section 4.8 for a description of the reliability of water supplies.
Legal Authority, Permitting Processes, and Regulatory Control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, 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 will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. 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 will be done with the Tehama IHM 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.

4.5.1.6 Invasive Plant Removal from Creeks and Irrigation Conveyance Canals

This project would remove invasive plants from creeks and irrigation conveyance canals (e.g., Arundo donax, tamarisk, Himalayan blackberry). Many small tributaries in the watersheds of Tehama County have decreased conveyance, elevated levels of siltation, and diminished flood-carrying capacity due to invasive vegetation overgrowth. Debris-clearing is a challenge due to environmental permitting restrictions. Removal of these plants would reduce conveyance issues, reduce non-beneficial consumptive use of shallow groundwater and surface water, and restore conditions for GDEs and native riparian species. A summary of the project is provided in **Table 4-16**.

Table 4-16. Invasive Plant Removal: Summary (23 CCR §354.44(b)).

ITEM IN GSP REGULATIONS	DESCRIPTION
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This project is proposed for implementation along stream channels and irrigation conveyance canals in the Subbasin. 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 reduce groundwater demand of those invasive species removed, with additional benefits for other environmental water users. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Antelope 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 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))	While there is no water source directly used by this project, removal of invasive plants species will reduce non-beneficial consumptive use of shallow groundwater and surface water, preserving an equal volume of water for other uses in the Subbasin.
Legal Authority, Permitting Processes, and Regulatory Control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, 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 will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water.

ITEM IN GSP REGULATIONS	DESCRIPTION
	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 will be done with the Tehama IHM 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.

4.5.1.7 Inter-Basin Surface Water Transfers or Exchanges

This project would promote inter-basin transfers or exchanges of underutilized surface water supplies from other subbasins in Tehama County. As part of this project, incentives for surface water use could also be explored to encourage in-lieu groundwater recharge. Potential opportunities for transfers and exchanges include, but are not limited to:

- Transfers of treated wastewater from the City of Red Bluff
- Trout Unlimited Groundwater substitution transfers, and
- Other Groundwater substitution transfers.

A summary of the project is provided in **Table 4-17**.

Table 4-17. Inter-Basin Surface Water Transfers or Exchanges: Summary (23 CCR §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 all areas of the Subbasin with access to surface water supplies, particularly along irrigation conveyance canals or channels that could be used to transfer water. 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 surface water supplies available to users in the Subbasin, which could be used for direct groundwater recharge and/or in-lieu groundwater recharge, depending on how and where the water is used. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Antelope 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 implementation, pending potential transfers or exchanges.
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 surface water supplies procured through potential transfers or exchanges from other agencies in Tehama County. See Section 4.8 for a description of the reliability of potential water supplies available through transfers or exchanges.
Legal Authority, Permitting Processes, and Regulatory Control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, 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 will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. 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 will be done with the Tehama IHM model used for GSP development.

ITEM IN GSP REGULATIONS	DESCRIPTION
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.

4.5.1.8 Water Supply Reservoir Construction, Renovation, or Conversion

This project would explore opportunities to construct, renovate, or convert flood control facilities to a water supply reservoir. Additional surface water storage would augment available surface water supplies for use in the Subbasin, with potential direct recharge or in-lieu recharge benefits depending on how or where the surface water is used. A summary of the project is provided in **Table 4-18**.

Table 4-18. Water Supply Reservoir Construction, Renovation, or Conversion: Summary (23 CCR §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 existing flood control facilities in the Subbasin, or potentially at other locations identified as suitable for construction of a new water supply reservoir. 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 surface water supplies available to users in the Subbasin, which could be used for direct groundwater recharge and/or in-lieu groundwater recharge, depending on how and where the water is used. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Antelope 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 begin following reservoir construction, renovation, or conversion. Benefits are expected to accrue in all years when stormwater flows occur, potentially 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 augment surface water supply resources by managing and storing flood flows along stream channels in and surrounding the Antelope Subbasin. See Section 4.8 for a description of the reliability of flood flows.

ITEM IN GSP REGULATIONS	DESCRIPTION
Legal Authority, Permitting Processes, and Regulatory Control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, 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 will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. 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 will be done with the Tehama IHM 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.

4.5.1.9 Enhanced Boundary Flow Measurement

This project would enhance measurement of boundary outflows from lands in the Subbasin. Outflows of interest include surface water outflows from canals and drains, and distributed outflows from irrigated lands, such as precipitation runoff and irrigation return flows. Distributed outflows, in particular, are estimated to be a substantial component of the water budget, but are largely unquantified at this time. Improved understanding of boundary outflows, which vary substantially from year to year, can facilitate capture of and use of this water for in-lieu recharge. A summary of the project is provided in **Table 4-19.**

Table 4-19. Enhanced Boundary Flow Measurement: Summary (23 CCR §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 locations where surface water outflows occur (e.g., measurement sites at the ends of canals and drains), or at locations where surface water outflows can be estimated more accurately (e.g., measurement sites at strategic locations along streams and creeks). 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 help to improve management of existing surface water supplies in the Subbasin, allowing this water to be captured and used for in-lieu recharge or other beneficial uses. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Antelope 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 Antelope Subbasin. See Section 4.8 for a description of the reliability of existing water supplies.
Legal Authority, Permitting Processes, and Regulatory Control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, 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 will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	While enhanced boundary flow measurement is beneficial to GSP implementation and supporting Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators 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 will be done with the Tehama IHM model used for GSP development.

ITEM IN GSP REGULATIONS	DESCRIPTION
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.

4.5.1.10 Well Metering

This project would enhance monitoring of groundwater extractions in the Subbasin by installing meters on larger agricultural wells. The data collected through this project would help the GSA to better manage continued sustainability of the Subbasin within its sustainable yield and improve management of pumping for in-lieu recharge benefits. A summary of the project is provided in **Table 4-20.**

Table 4-20. Well Metering: Summary (23 CCR §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 larger agricultural wells in the Subbasin. 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. Data collected through this project would help to manage continued operation of the Subbasin within its sustainable yield and allow better management of pumping for in-lieu recharge benefits. This project may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Antelope 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 groundwater supplies in the Antelope Subbasin within the sustainable yield of the Subbasin.
Legal Authority, Permitting Processes, and Regulatory Control (§354.44(b)(3); §354.44(b)(7))	The GSA, Districts, 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 will be initiated may include, but is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.

ITEM IN GSP REGULATIONS	DESCRIPTION
Benefits and Benefit evaluation Methodology (§354.44(b)(5))	While well metering is beneficial to GSP implementation and supporting Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators. 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 will be done with the Tehama IHM 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.

4.5.2 Potential Management Actions

This section describes potential management actions that would be implemented if determined to be necessary, pending future conditions in the Antelope Subbasin**. Table 4-21** lists the potential management actions described in the subsections that follow.

Table 4-21. List of Potential Management Actions Proposed for the Antelope Subbasin.

MANAGEMENT ACTION	MANAGEMENT ACTION TYPE(S)[1]
Assistance and Incentives for On-Farm Irrigation Infrastructure Improvements	Education/Outreach, In-Lieu Groundwater Recharge
Incentives for Residential and Municipal Water Use Efficiency Improvements	Groundwater Demand Reduction
Demand Management	Groundwater Demand Reduction
Incentives for Use of Available Surface Water and Recycled Water	In-Lieu Groundwater Recharge
Water Market for Surface Water and Groundwater Exchange	In-Lieu Groundwater Recharge
Tehama County Domestic Well Tracking and Outreach Program	Monitoring to Fill Data Gaps, Programs to Support Wells
Well Deepening or Replacement Program	Programs to Support Wells
Review of County Well Permitting Ordinances	Well Permitting Ordinances

[1]The primary function of the management action as conceptualized, although during implementation management actions may be used for multiple functions to support groundwater sustainability.

4.5.2.1 Assistance and Incentives for On-Farm Irrigation Infrastructure Improvements

This management action would provide growers assistance with on-farm irrigation infrastructure improvements, especially capital improvements that support groundwater sustainability and allow growers to convert to dual-source irrigation systems. Dual-source irrigation systems support in-lieu groundwater recharge by allowing growers to use both surface water and groundwater for drip irrigation of orchards and other crops. Typical components required for a dual-source system are 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. Other improvements to water conveyance infrastructure may also support on-farm irrigation using surface water, including installation of regulating reservoirs, filters or treatment, and pressurization equipment.

Implementation of this management action together with the planned grower education program (**Section 4.4.2**) would further encourage on-farm practices that support groundwater sustainability. A summary of the management action is provided in **Table 4-22.**

Table 4-22. Assistance and Incentives for On-Farm Irrigation Infrastructure Improvements: Summary (23 CCR §354.44(b)).

ITEM IN GSP REGULATIONS	DESCRIPTION
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This management action is proposed for implementation in irrigated areas of the Subbasin that have access to surface water supplies (e.g., surface water supplier service areas, areas with surface water rights adjacent to waterways). The precise location would be determined through further evaluation if/when the management action is selected for implementation. The management action would provide in-lieu groundwater recharge by encouraging and incentivizing use of surface water for irrigation when available. This management action may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Antelope Subbasin.
Timeline (§354.44(b)(4))	This management action is currently in the early planning stage. Thus, the start and completion dates for this management action 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 when surface water is available and used by participants in-lieu of groundwater, potentially 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 management action would use existing surface water supplies when available in the Antelope Subbasin. See Section 4.8 for a description of the reliability of existing water supplies.

ITEM IN GSP REGULATIONS	DESCRIPTION
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 management actions. 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 is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, depletion of interconnected surface water, and potentially water quality. This management action is currently in the early planning stage. Thus, the expected yield of this management action 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-action measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling will be done with the Tehama IHM model used for GSP development.
Costs (§354.44(b)(8))	This management action is currently in the early planning stage. Thus, the anticipated costs of this management action have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The proponent would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

4.5.2.2 Incentives for Residential and Municipal Water Use Efficiency Improvements

This management action would offer incentives for urban, residential, and commercial projects that improve water use efficiency. Residential and municipal water in the Subbasin is primarily supplied by groundwater. Improvements in residential and municipal water use efficiency thus support in-lieu groundwater recharge. Potential incentives and offers through this management action may include rebates for high efficiency appliances and incentives for lawn removal, low-water landscape installation, rain barrels, graywater reuse, or other activities that offset groundwater demand. Among these, only incentives for lawn removal and low-water landscape installation are expected to impact the Subbasin water budget, although all would offset a portion of the groundwater demand. This management action may also evaluate municipal water system operations and losses for other opportunities to reduce municipal water demand. A summary of the management action is provided in **Table 4-23.**

Table 4-23. Incentives for Residential and Municipal Water Use Efficiency Improvements: Summary (23 CCR §354.44(b)).

ITEM IN GSP REGULATIONS	DESCRIPTION
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This management action is proposed for implementation in residential areas and municipal service areas in the Subbasin. The precise location would be determined through further evaluation if/when the management action is selected for implementation. The management action would reduce groundwater demand and improve groundwater quality by reducing residential and urban water demands, which are mainly met by groundwater in the Subbasin. This management action may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Antelope Subbasin.
Timeline (§354.44(b)(4))	This management action is currently in the early planning stage. Thus, the start and completion dates for this management action 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 management action would not directly use water supplies but would improve management and utilization of groundwater supplies in the Antelope Subbasin.
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 management actions. 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 is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, ground water quality, and depletion of interconnected surface water. This management action is currently in the early planning stage. Thus, the expected yield of this management action 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-action measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling will be done with the Tehama IHM model used for GSP development.
Costs (§354.44(b)(8))	This management action is currently in the early planning stage. Thus, the anticipated costs of this management action have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The proponent would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

4.5.2.3 Demand Management

While demand management is not expected to be required in the Antelope Subbasin during GSP implementation, demand management has been identified as a backstop to other potential PMAs if those are insufficient to maintain sustainability over the GSP planning and implementation horizon.

If needed, this management action would implement any of various water management activities that reduce demand for groundwater, primarily by reducing the consumptive use of irrigation water and reducing net groundwater pumping (pumping net of recharge) in the Subbasin. The demand management activities proposed in this management action are configurable and scalable, allowing the GSA to implement only those activities needed to address localized groundwater concerns.

As described in **Section 4.3.2,** potential demand management activities that could be implemented in Tehama County include:

- **Management and Restrictions of Land Use Changes**: Implementing county water use ordinances or other policies to restrict land use changes that would increase water demand in the Subbasin. Policies would generally restrict development of new agricultural land, restrict growth in areas with no surface water supply, and/or promote conversion of agricultural lands to less water intensive crops.
- **Pumping Fees:** Implementing tiered fee structures for groundwater extractions to incentivize reduced groundwater use.
- **Groundwater Extraction Allocation Program:** Creating groundwater extraction allocations to curtail or restrict the volume of groundwater extraction allowed. Could be implemented with pumping fees.
- **Land Fallowing Program:** Curtailing and/or restricting groundwater extractions by creating and enforcing a land fallowing program.
- **Other County Ordinances**: The County may develop or review policies and ordinances that align with sustainable groundwater management goals. Possible ordinances include regulations and limits for groundwater use, export, and illegal diversion of surface water. The County could also create additional guidelines during the well permitting process to reduce nearby competition between wells (i.e., well spacing or suggestions regarding total well depth, depth of well perforations, and location of a new well in relation to existing wells). Efforts may be designed to be protective of domestic wells.

A summary of the management action is provided in **Table 4-24.**

Table 4-24. Demand Management: Summary (23 CCR §354.44(b)).

ITEM IN GSP REGULATIONS	DESCRIPTION
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	Demand management is proposed for scaled implementation in areas of the Subbasin where groundwater conditions may cause undesirable results. While demand management is not expected to be required in the Antelope Subbasin during GSP implementation, demand management has been identified as a backstop to other potential PMAs if those are insufficient to maintain sustainability. The precise location would be determined through further evaluation if/when the management action is selected for implementation. The management action would reduce groundwater demand by reducing pumping (through fees or allocations) and by reducing consumptive water requirements (through fallowing or policies to restrict land use changes). This management action may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Antelope Subbasin.
Timeline (§354.44(b)(4))	This management action is currently in the early planning stage. Thus, the start and completion dates for this management action 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 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 management action would reduce utilization of groundwater supplies in the Antelope Subbasin.
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 management actions. 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 is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. This management action is currently in the early planning stage. Thus, the expected yield of this management action 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-action measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling will be done with the Tehama IHM model used for GSP development.
Costs (§354.44(b)(8))	This management action is currently in the early planning stage. Thus, the anticipated costs of this management action have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The proponent would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

4.5.2.4 Incentives for Use of Available Surface Water and Recycled Water

This management action would incentivize the use of surface water and/or recycled water for irrigation whenever those water sources are available. Incentivized pricing structures and conveyance infrastructure improvements that enhance the utility of these water supply sources are expected to reduce groundwater demand among growers who irrigate with groundwater for reasons of cost and convenience. By offsetting groundwater demand with a like volume of surface water or recycled water, this management action is expected to provide in-lieu groundwater recharge benefits to the Subbasin. A summary of the management action is provided in **Table 4-25.**

Table 4-25. Incentives for Use of Available Surface Water and Recycled Water: Summary (23 CCR §354.44(b)).

ITEM IN GSP REGULATIONS	DESCRIPTION
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This management action is proposed for implementation in irrigated areas of the Subbasin that have access to surface water supplies (e.g., surface water supplier service areas) and/or areas adjacent to waterways and conveyance infrastructure that could be used to convey recycled water. The precise location would be determined through further evaluation if/when the management action is selected for implementation. The management action would provide in-lieu groundwater recharge by encouraging and incentivizing use of surface water and/or recycled water for irrigation when available. This management action may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Antelope Subbasin.
Timeline (§354.44(b)(4))	This management action is currently in the early planning stage. Thus, the start and completion dates for this management action 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, depending on availability of surface water and recycled water.
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 management action would use surface water supplies and available recycled water supplies of suitable quality. See Section 4.8 for a description of the reliability of 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 management actions. 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 is

ITEM IN GSP REGULATIONS	DESCRIPTION
	not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. This management action is currently in the early planning stage. Thus, the expected yield of this management action 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-action measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling will be done with the Tehama IHM model used for GSP development.
Costs (§354.44(b)(8))	This management action is currently in the early planning stage. Thus, the anticipated costs of this management action have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The proponent would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

4.5.2.5 Water Market for Surface Water and Groundwater Exchange

This management action would create a water market for growers and other water users in the Antelope Subbasin, allowing them to exchange surface water and groundwater. A surface water and groundwater exchange would allow for flexibility in water use to meet irrigation demands, while maintaining groundwater extraction within the overall sustainable yield of the Subbasin. A summary of the management action is provided in **Table 4-26**.

Table 4-26. Water Market for Surface Water and Groundwater Exchange: Summary (23 CCR §354.44(b)).

ITEM IN GSP REGULATIONS	DESCRIPTION
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This management action is proposed for implementation in irrigated areas of the Subbasin. The precise location would be determined through further evaluation if/when the management action is selected for implementation. The management action would provide flexibility to water users to manage the use of groundwater within the sustainable yield of the Subbasin. This management action may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Antelope Subbasin.
Timeline (§354.44(b)(4))	This management action is currently in the early planning stage. Thus, the start and completion dates for this management action 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, depending on participation and availability of surface water.

ITEM IN GSP REGULATIONS	DESCRIPTION
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 management action would use surface water supplies and manage use of groundwater supplies within the sustainable yield of the Subbasin. See Section 4.8 for a description of the reliability of 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 management actions. 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 is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	The sustainability indicators expected to benefit are groundwater levels, groundwater storage, and depletion of interconnected surface water. This management action is currently in the early planning stage. Thus, the expected yield of this management action 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-action measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling will be done with the Tehama IHM model used for GSP development.
Costs (§354.44(b)(8))	This management action is currently in the early planning stage. Thus, the anticipated costs of this management action have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The proponent would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

4.5.2.6 Tehama County Domestic Well Tracking and Outreach Program

This management action would create a system for tracking groundwater conditions at domestic wells across Tehama County. The centralized information in this system would allow the County to better manage and focus assistance and resources for domestic well owners in areas where monitoring indicates that groundwater levels have dropped, or in areas where wells are reported to have water quality impacts or have gone dry. This management action would also provide domestic well owners with resources and funding for well testing, inspection, and replacement, especially in areas where the tracking system indicates that wells have gone dry or that water quality concerns exist. Together, these actions will allow the County to be more proactive in supporting beneficial use of groundwater by domestic well users throughout GSP implementation. A summary of the management action is provided in **Table 4-27**.

Table 4-27. Tehama County Domestic Well Tracking and Outreach Program: Summary (23 CCR §354.44(b)).

ITEM IN GSP REGULATIONS	DESCRIPTION
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This management action is proposed for implementation throughout Tehama County. The management action would track dry domestic wells and offer outreach and assistance services to all domestic well users to support their ongoing beneficial use of groundwater. This management action may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Antelope Subbasin.
Timeline (§354.44(b)(4))	This management action is currently in the early planning stage. Thus, the start and completion dates for this management action 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, depending on participation.
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 management action would not directly use water supplies but would improve management and utilization of groundwater supplies in the Antelope Subbasin within the sustainable yield of the Subbasin.
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 management actions. 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 is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	While domestic well tracking and outreach are beneficial to GSP implementation and supporting Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators. This management action is currently in the early planning stage. Thus, the expected yield of this management action 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-action measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling will be done with the Tehama IHM model used for GSP development.
Costs (§354.44(b)(8))	This management action is currently in the early planning stage. Thus, the anticipated costs of this management action have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The proponent would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

4.5.2.7 Well Deepening or Replacement Program

This management action would create a program to deepen or replace shallow wells and/or wells that have gone dry in Tehama County. This program would complement the well tracking and outreach program described in the previous section. A summary of the management action is provided in **Table 4-28.**

Table 4-28. Well Deepening or Replacement Program: Summary (23 CCR §354.44(b)).

ITEM IN GSP REGULATIONS	DESCRIPTION
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This management action is proposed for implementation throughout Tehama County. The management action would create a program to deepen or replace shallow wells to support ongoing beneficial use of groundwater by those users. This management action may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Antelope Subbasin.
Timeline (§354.44(b)(4))	This management action is currently in the early planning stage. Thus, the start and completion dates for this management action 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, depending on participation.
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 management action would not directly use water supplies but would improve management and utilization of groundwater supplies in the Antelope Subbasin within the sustainable yield of the Subbasin.
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 management actions. 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 is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and benefit evaluation methodology (§354.44(b)(5))	While a well deepening and replacement program is beneficial to supporting beneficial uses and users of groundwater in the Subbasin, there are no anticipated direct benefits to specific sustainability indicators. This management action is currently in the early planning stage. Thus, the expected yield of this management action 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-action measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling will be done with the Tehama IHM model used for GSP development.

ITEM IN GSP REGULATIONS	DESCRIPTION
Costs (§354.44(b)(8))	This management action is currently in the early planning stage. Thus, the anticipated costs of this management action have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The proponent would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

4.5.2.8 Review of County Well Permitting Ordinances

Through this management action, Tehama County would review existing well permitting ordinances and assess whether additional well permitting requirements are warranted to maintain sustainable groundwater conditions in the Subbasin. As needed, county ordinances could be updated to follow the latest DWR-recommended well standards (described in DWR Bulletin 74). The management action may also improve the well permitting and installation program to help protect water quality, allow for better screening, and avoid interference or impacts of pumping on neighboring wells. A summary of the management action is provided in **Table 4-29.**

Table 4-29. Review of County Well Permitting Ordinances: Summary (23 CCR §354.44(b)).

ITEM IN GSP REGULATIONS	DESCRIPTION
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This management action is proposed for implementation throughout Tehama County. The management action would review existing County well permitting ordinances and assess whether additional well permitting requirements are warranted to support groundwater sustainability. This management action may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable levels are not reached following implementation of other PMAs. This will be done in the context of Sustainable Management Criteria to ensure sustainable operation of the Antelope Subbasin.
Timeline (§354.44(b)(4))	This management action is currently in the early planning stage. Thus, the start and completion dates for this management action 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 management action would not directly use water supplies but would improve management and utilization of groundwater supplies in the Antelope Subbasin within the sustainable yield of the Subbasin.
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 management actions. 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 is not limited to:

ITEM IN GSP REGULATIONS	DESCRIPTION
	DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	While reviewing and updating County well permitting ordinances may be beneficial to supporting ongoing operation of the Subbasin within its sustainable yield, there are no anticipated direct benefits to specific sustainability indicators. This management action is currently in the early planning stage. Thus, the expected yield of this management action 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-action measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling will be done with the Tehama IHM model used for GSP development.
Costs (§354.44(b)(8))	This management action is currently in the early planning stage. Thus, the anticipated costs of this management action have yet to be determined and will be reported in GSP annual reports and five-year updates when known. The proponent would identify funding sources to cover costs as part of development. These may include grants, fees, loans, and other assessments.

4.5.3 Potential Other Activities

This section describes other potential activities that could be implemented if determined to be necessary, pending future conditions in the Antelope Subbasin. These potential "other" activities are not expected to directly benefit specific groundwater sustainability indicators but are still beneficial for effectively implementing the GSP. Examples of other activities include studies, monitoring, and improvements in modeling to better understand groundwater conditions in the Subbasin

Table 4-30 lists the potential other activities described in the subsections that follow.

Table 4-30. List of Potential Other Activities Proposed for the Antelope Subbasin.

OTHER ACTIVITY	OTHER ACTIVITY TYPE(S)[1]
Coordination and Development of Public Data Portals	Coordination and Data Sharing
Additional Studies of GDEs and Groundwater - Surface Water Interactions	Monitoring to Fill Data Gaps
Expanded Subbasin Monitoring and Aquifer Testing	Monitoring to Fill Data Gaps
Install Additional Agroclimate Stations	Monitoring to Fill Data Gaps
Maintain and Expand Groundwater Level Monitoring Network	Monitoring to Fill Data Gaps
One-Time Groundwater Quality Snapshot and Evaluation	Monitoring to Fill Data Gaps
Tehama County Well Inventory and Registration Program	Monitoring to Fill Data Gaps

[1]The primary function of the activity as conceptualized, although during implementation actions may be used for multiple functions to support groundwater sustainability.

4.5.3.1 Coordination and Development of Public Data Portals

This activity would maintain ongoing coordination and information sharing among water purveyors and agencies in the Tehama County subbasins and neighboring subbasins. As part of this activity, agencies may develop shared public data portals to track and monitor groundwater sustainability indicators. Coordination would determine the types of data and data formats available, and establish standard methods for receiving, storing, and sharing data with the public, DWR, other agencies. Coordination would also foster relationships with neighboring subbasins, land use planning entities, and relevant local, state, and federal agencies and organizations. A summary of this activity is provided in **Table 4-31.**

Table 4-31. Coordination and Development of Public Data Portals: Summary (23 CCR §354.44(b)).

ITEM IN GSP REGULATIONS	DESCRIPTION
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would foster joint coordination and information sharing among agencies in the Tehama County subbasins and neighboring subbasins. Information sharing may include development of shared public data portals to track and monitor groundwater sustainability indicators. This activity may be initiated to support GSP implementation if determined to be necessary or useful for maintaining ongoing sustainability in the Antelope 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 Antelope 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 coordination and data sharing efforts. 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 is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	While coordination and data sharing are beneficial to GSP implementation and supporting Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators. This activity is currently in the early planning stage. Thus, the expected yield of this activity 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-

ITEM IN GSP REGULATIONS	DESCRIPTION
	and post-action measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling will be done with the Tehama IHM model used for GSP development.
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.

4.5.3.2 Additional Studies of GDEs and Groundwater - Surface Water Interactions

This activity would investigate the relationship between groundwater levels and access to surface water supplies on the health of groundwater dependent ecosystems (GDEs). Supporting analyses may consider a combination of surface water data, shallow groundwater level data, and remote sensing data related to vegetative cover to improve the understanding of how GDEs are affected by conditions in the groundwater aquifer accessed by pumping. Findings of these analyses may be used to refine how GDEs, and their water supply needs are monitored and protected during GSP implementation. This activity would also evaluate the need for additional studies or monitoring of groundwater-surface water interactions to address potential data gaps. A summary of this activity is provided in **Table 4-32**.

Table 4-32. Additional Studies of GDEs and Groundwater - Surface Water Interactions: Summary (23 CCR §354.44(b)).

ITEM IN GSP REGULATIONS	DESCRIPTION
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would analyze the water supplies used to support GDEs, and evaluate the need for additional studies or monitoring of groundwater-surface water interactions to improve overall understanding of GDEs and address potential data gaps. This activity may be initiated to support GSP implementation if determined to be necessary or useful for maintaining ongoing sustainability in the Antelope 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 Antelope 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 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 is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	While studies of GDEs and groundwater-surface water interactions are beneficial to GSP implementation and supporting Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators. This activity is currently in the early planning stage. Thus, the expected yield of this activity 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-action measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling will be done with the Tehama IHM model used for GSP development.
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.

4.5.3.3 Expanded Subbasin Monitoring and Aquifer Testing

This activity would expand monitoring efforts across the Subbasin to improve understanding of existing groundwater conditions, monitor changes in groundwater conditions throughout GSP implementation, and improve simulation of the Subbasin water budget within the Tehama IHM. Specific monitoring efforts may include:

- Aquifer testing to improve the understanding of aquifer conditions, particularly the level of confinement, connectivity between depths, connectivity with surface water bodies, and hydraulic properties.
- LIDAR (Light Detection and Ranging) data collection and analysis across the Subbasin to support monitoring of all sustainability indicators.
- Identification of locations in the Subbasin that are potentially vulnerable to damage from subsidence.

A summary of this activity is provided in **Table 4-33.**

Table 4-33. Expanded Subbasin Monitoring and Aquifer Testing: Summary (23 CCR §354.44(b)).

ITEM IN GSP REGULATIONS	DESCRIPTION
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would expand monitoring efforts across the Subbasin (e.g., aquifer testing, LIDAR data collection) to improve understanding and modeling of groundwater conditions and address potential data gaps. This activity may be initiated to support GSP implementation if determined to be necessary or useful for maintaining ongoing sustainability in the Antelope 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 Antelope 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 monitoring and data collection efforts. 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 is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	While Subbasin-wide monitoring and data collection efforts are beneficial to GSP implementation and supporting Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators. This activity is currently in the early planning stage. Thus, the expected yield of this activity 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-action measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling will be done with the Tehama IHM model used for GSP development.
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.

4.5.3.4 Install Additional Agroclimate Stations

This activity would install additional "agroclimate stations" that monitor agriculture-related weather and climate parameters. Data collected by these stations would help to inform agricultural water use practices and potentially enhance water conservation efforts through strategic irrigation scheduling. These data may also improve the accuracy of the Tehama IHM. A summary of this activity is provided in **Table 4-34.**

Table 4-34. Install Additional Agroclimate Stations: Summary (23 CCR §354.44(b)).

ITEM IN GSP REGULATIONS	DESCRIPTION
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would install additional stations that monitor agriculture-related weather and climate parameters to inform agricultural water use practices, improve modeling of groundwater conditions, and address potential data gaps. This activity may be initiated to support GSP implementation if determined to be necessary or useful for maintaining ongoing sustainability in the Antelope 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 Antelope 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 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 monitoring and data collection efforts. 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 is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	While monitoring and data collection efforts are beneficial to GSP implementation and supporting Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators. This activity is currently in the early planning stage. Thus, the expected yield of this activity 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-

ITEM IN GSP REGULATIONS	DESCRIPTION
	action measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling will be done with the Tehama IHM model used for GSP development.
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.

4.5.3.5 Maintain and Expand Groundwater Level Monitoring Network

This effort would encompass various activities to maintain and expand the groundwater level monitoring network in the Antelope Subbasin. Specific efforts proposed under this effort include:

- Maintenance of wells in the existing monitoring network
- Identification of existing wells in the Subbasin that may be incorporated into the groundwater level monitoring network
- Identification of new monitoring wells that may be added to the groundwater level monitoring network.
- Ongoing coordination with other monitoring entities to support the use of identified monitoring locations as part of the monitoring network and to share relevant collected data.

Maintaining and improving the monitoring network would improve the understanding of groundwater conditions in the Subbasin. Additional wells may be used to fill data gaps and improve understanding of aquifer conditions and dynamics, and groundwater conditions related to GDEs and surface water depletions. A summary of this activity is provided in **Table 4-35**.

Table 4-35. Maintain and Expand Groundwater Level Monitoring Network: Summary (23 CCR §354.44(b)).

ITEM IN GSP REGULATIONS	DESCRIPTION
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would maintain and expand the Subbasin groundwater level monitoring network to improve understanding of aquifer conditions and dynamics, and groundwater conditions related to GDEs and depletions of interconnected surface water. Monitoring will address potential data gaps and improve modeling of groundwater conditions throughout GSP implementation. This activity may be initiated to support GSP implementation if determined to be necessary or useful for maintaining ongoing sustainability in the Antelope 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 Antelope Subbasin.

ITEM IN GSP REGULATIONS	DESCRIPTION
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 monitoring and data collection efforts. 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 is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	While monitoring and data collection efforts are beneficial to GSP implementation and supporting Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators. This activity is currently in the early planning stage. Thus, the expected yield of this activity 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-action measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling will be done with the Tehama IHM model used for GSP development.
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.

4.5.3.6 One-Time Groundwater Quality Snapshot and Evaluation

This activity would conduct a one-time sampling of groundwater quality parameters over a wide range of wells in Tehama County, providing a "groundwater quality snapshot" in Tehama County. The data collected through this effort would improve understanding of groundwater quality conditions in the Subbasin and provide a basis for refinement of the groundwater quality monitoring network. Evaluation of these data can also inform the selection of groundwater quality monitoring options that better characterize both widespread groundwater quality conditions and localized groundwater quality concerns. A summary of this activity is provided in **Table 4-36.**

Table 4-36. One-Time Groundwater Quality Snapshot and Evaluation: Summary (23 CCR §354.44(b)).

ITEM IN GSP REGULATIONS	DESCRIPTION
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would conduct and evaluate a one-time sampling of groundwater quality parameters over a wide range of wells in Tehama County. The data collected in this study will improve understanding of groundwater quality conditions and provide a basis for refinement of the Subbasin monitoring network. This activity may be initiated to support GSP implementation if determined to be necessary or useful for maintaining ongoing sustainability in the Antelope 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 Antelope 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 following evaluation of data collected in the one-time groundwater quality snapshot.
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 monitoring and data collection efforts. 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 is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	While monitoring and data collection efforts are beneficial to GSP implementation and supporting Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators. This activity is currently in the early planning stage. Thus, the expected yield of this activity 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-action measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others

ITEM IN GSP REGULATIONS	DESCRIPTION
	to be determined. Modeling will be done with the Tehama IHM model used for GSP development.
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.

4.5.3.7 Tehama County Well Inventory and Registration Program

This activity would create a county-wide well inventory to compile all available information on active wells in Tehama County and improve understanding of well distribution, construction, and hydrogeologic characteristics. The inventory would be useful for identifying and filling monitoring data gaps. Complementary to the inventory, Tehama County could also create a well registration program to collect well locations, screening information, and pumping data for use in GSP updates. A summary of this activity is provided in **Table 4-37**.

Table 4-37. Tehama County Well Inventory and Registration Program: Summary (23 CCR §354.44(b)).

ITEM IN GSP REGULATIONS	DESCRIPTION
Implementation (§354.44(b)(1)(A); §354.44(b)(6))	This activity would create an inventory and registration program for all wells in Tehama County. Data collected through this program would improve understanding of well distribution, construction, and hydrogeology, and support ongoing Subbasin modeling and GSP implementation. This activity may be initiated to support GSP implementation if determined to be necessary or useful for maintaining ongoing sustainability in the Antelope 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 Antelope 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 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, Districts, and individual proponents have the authority to plan and implement monitoring and data collection efforts. 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 is not limited to: DWR, SWRCB, CDFW, Flood Board, Regional Water Boards, USFWS, NMFS, LAFCO, County of Tehama, and CARB.
Benefits and Benefit Evaluation Methodology (§354.44(b)(5))	While monitoring and data collection efforts are beneficial to GSP implementation and supporting Subbasin sustainability, there are no anticipated direct benefits to specific sustainability indicators. This activity is currently in the early planning stage. Thus, the expected yield of this activity 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-action measurements supported by modeling. Measured parameters will include surface water deliveries, groundwater levels, and others to be determined. Modeling will be done with the Tehama IHM model used for GSP development.
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.

4.6 Project Financing

The plan and content related to project financing is in development.

4.7 GSA Coordination

4.7.1 Goals, Policies, and Ordinances

The Tehama County Flood Control and Water Conservation District (District) GSA is the exclusive GSA for the Antelope Subbasin. As a county-wide agency, the District was established in 1957 by legislation to, among other functions, provide for the control and conservation of flood and storm waters; the protection of watercourses and watersheds; and for the acquisition, retention, conservation, and distribution of drainage, storm, flood, and other waters for beneficial uses in Tehama County. These goals are aligned with the goals of other agencies within the Subbasin, and with GSAs in neighboring subbasins in Tehama County, many of which are also exclusively managed by the District GSA.

The District Board of Directors is composed of members of the Tehama County Board of Supervisors, who are responsible for passing ordinances and policies related to well permitting, groundwater aquifer protection, and groundwater use in the Subbasin. This overlapping organizational structure facilitates direct coordination of policies and ordinances that are directly aligned with the subbasin sustainability goal established by the GSA and the PMAs described in this GSP.

Specific policies and ordinances that may be reviewed during GSP implementation include:

- Well permitting ordinances to align well construction recommendations with DWR Bulletin 74, as needed, and/or to help protect water quality, allow for better screening, and avoid interference or impacts of pumping on neighboring wells. Efforts could be designed to be protective of domestic wells.
- Ordinances to regulate or limit groundwater use, export, and illegal diversion of surface water (would be considered if other planned PMAs are insufficient to maintain sustainability)

4.7.2 Well Owner Outreach and Education

Education and outreach efforts to well owners about proper well protection, maintenance, and monitoring will benefit individual well owners and all groundwater beneficial users. Wellhead protection efforts can help protect groundwater quality from impacts from surface activities. Regular well maintenance and monitoring will maximize the life of a well and its pumping equipment. Monitoring of well performance and groundwater conditions in a well will keep well owners aware of well or groundwater conditions that may impact the reliability or quality of water produced by their well. Well monitoring and reporting of monitoring information by well owners can also greatly benefit the Subbasin in understanding groundwater conditions, including identification of any groundwater management-related concerns. Outreach and education efforts by the Subbasin can coordinate with well owner outreach content available through other agencies and programs including ILRP, SWRCB, DWR, USGS, and others.

4.7.3 Participation in Other Water Resources Management Programs

The GSA's and local stakeholders' continued role and participation in other water resources management efforts occurring with the Subbasin and at a more regional level are important to ensure coordination within and between groundwater subbasins in the area across different levels of water resources management. This involvement includes coordinating in development or updating of the Tehama County Groundwater Management Plan (GWMP), assisting with preparation and implementation of the North Sacramento Valley Integrated Regional Water Management Plan (IRWMP), and participation in other planning efforts involving salt and nutrient management plans, Irrigated Lands Regulatory Program (ILRP) and other groundwater quality related programs.

4.8 Subbasin Water Available for Projects

The Antelope Subbasin has two primary sources of surface water that could be a supply for groundwater recharge projects: the Sacramento River that is the western boundary of the subbasin and Antelope Creek, the eastern boundary of the subbasin. Salt Creek, a small creek that flows through the subbasin from the east before joining the Sacramento River is a third potential source. The information and analysis presented in this section focuses on Antelope Creek to illustrate the analysis that quantifies the potential water available for groundwater recharge projects.

4.8.1 Antelope Creek

Antelope Creek originates in the foothills of the Sierra Nevada mountains and flows west to join the Sacramento River. The watershed upstream of the Sacramento Valley is approximately 120 square miles. The USGS maintained a gage on Antelope Creek from 1940 to 1982. This gage was located about 3.75 miles east of the intersection of Highway 36 and Highway 99 near where Antelope Creek enters the

agricultural lands of the Sacramento Valley floor. The average annual runoff from Antelope Creek for the period of observed flows was about 109,000 acre-feet per year.

The gage record for Antelope Creek was extended through water year 2020 by finding the linear correlation between the observed gage record for Antelope Creek and Deer Creek. The linear correlation between the two gages is shown in **Figure 4-1**. The drainage area for Deer Creek is approximately 1.7 times the drainage area for Antelope Creek. The average annual runoff for the full period of analysis, water year 1941 through 2020, is approximately 107,000 acre-feet.

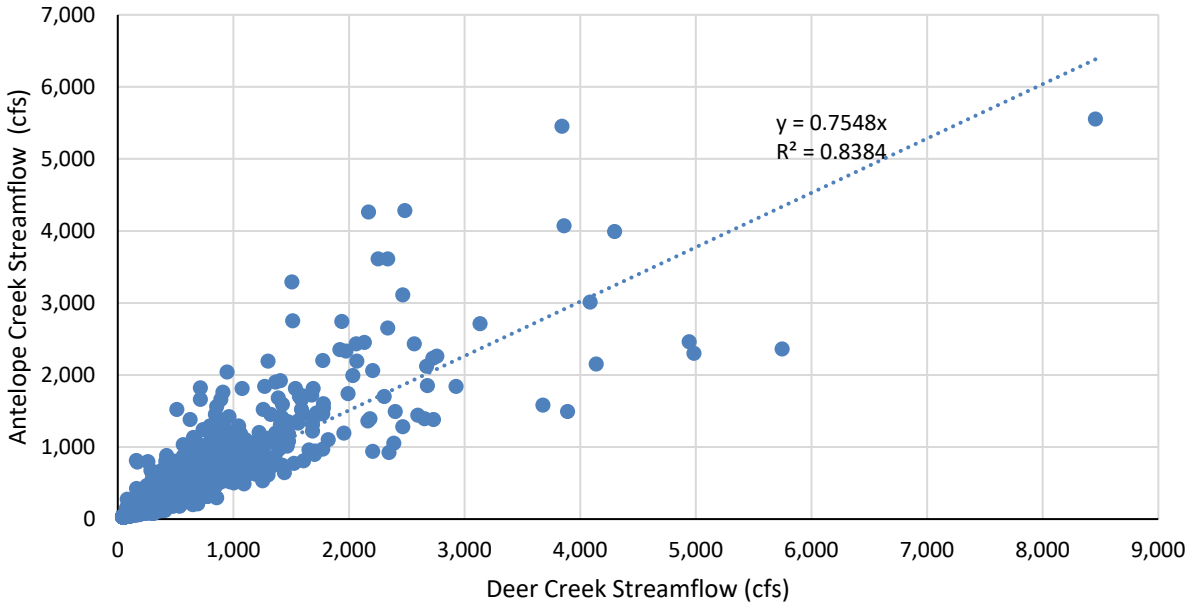


Figure 4-1. Linear Correlation between Deer Creek and Antelope Creek for the Common Gaged Period

The gaged and extended daily flows for the period of water year 1949 through 2020 were used as a common period for surface water availability for Tehama County subbasins. **Figure 4-2** shows the monthly flow volume in Antelope Creek averaged by water year type with the study period of 1949 -2020. The water year types shown in the figure are defined in the Sacramento Valley Water Year Hydrologic Classification (SWRCB Decision 1641) as shown in Table 8-38. The index is the Sacramento Valley unimpaired runoff for the water year.

Table 4-38. Water Year Classification Defined in Sacramento Valley Water Year Hydrologic Classification

CLASSIFICATION	ABBREVIATION	INDEX (MILLIONS OF ACRE-FEET)
Wet	W	>= 9.2
Above Normal	AN	7.8 – 9.2
Below Normal	BN	6.5 – 7.8
Dry	D	5.4 - 6.5
Critical	C	<= 5.4

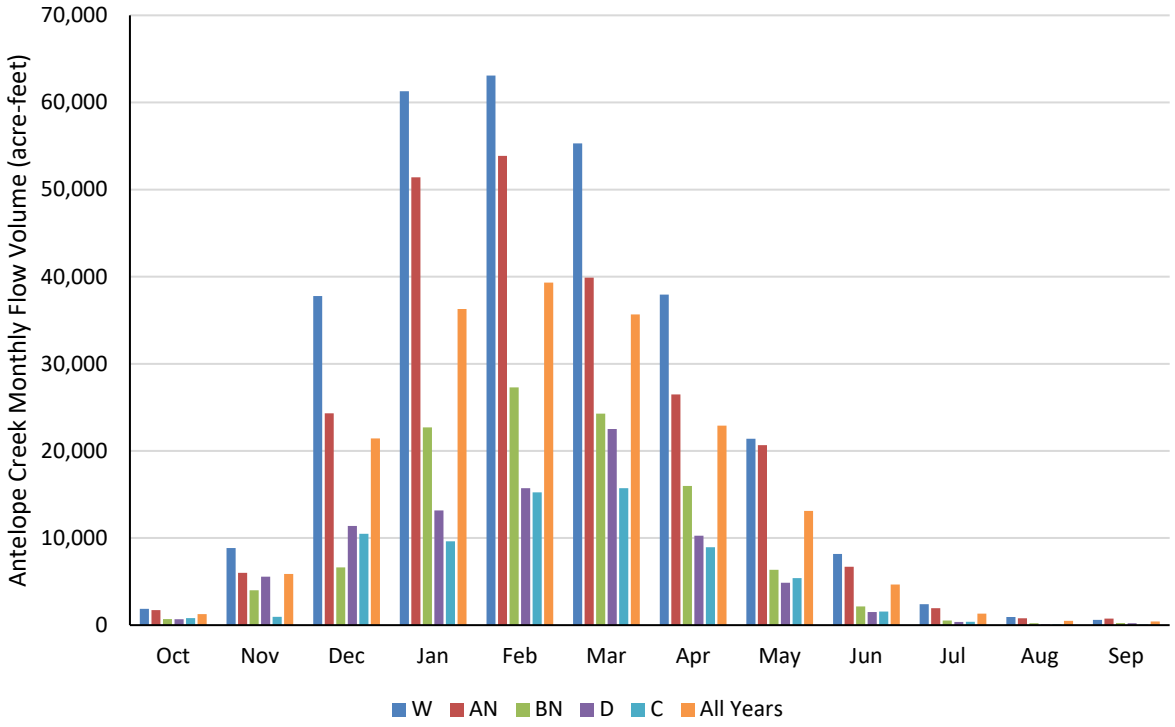


Figure 4-2. Antelope Creek Monthly Flow Volume by Water Year Classification

Figure 4-2 shows flow in Antelope Creek is higher in wetter years and lower in dry years with the highest monthly flows occurring in the months of January through March.

4.8.2 Water Right Permits

A water right or permit will be required to divert and store water from Antelope Creek for groundwater recharge and beneficial uses. The State Water Resources Control Board (SWRCB) issues and administers water rights in California. There are two categories of water right permits available through the SWRCB to divert water for groundwater recharge projects: standard permits and temporary permits. Both permits require an application be filed with the SWRCB. Temporary permits allow for short-term periods of diversion and storage, e.g., 180-days, but are not water rights. Temporary permits are a conditional approval to divert and use available water.

Standard permits are available through two different application processes: standard and streamlined. A standard water right application is typically more involved and may require significant effort and many years of review and processing by the SWRCB. The streamlined application process is relatively new and was designed to divert water during high flow events to recharge groundwater basins. The goal of the streamlined application process is to help GSAs address SGMA and reduce the impact of groundwater extractions. The GSA can also apply for a temporary permit and a streamlined permit at the same time, as it could take several years for the streamlined permit to get approved.

4.8.3 Potential Water Available from Antelope Creek for Groundwater Recharge

An analysis of Antelope Creek was performed based on the eligibility criteria for streamlined application processing of a standard permit. The following criteria were applied to the observed and extended Antelope Creek gage data to determine the water available for potential diversion:

- season of diversion of December 1 through March 31
- flow at the point of diversion is above the 90th percentile for the day based on the gage record
- the diversion rate is limited to no more than 20 percent of the total flow.

The 90th percentile flow for each day was calculated based on the gaged and extended record of flows. The observed daily flow was then compared to the 90th percentile flow for each day to determine when water could be diverted during the December 1 through March 31 period each year. The daily water available was limited to no more than 20 percent of total flow, and further limited based on an assumed diversion and groundwater recharge capacity of 100 cfs. A multi-benefit recharge project on Antelope Creek is at a preliminary planning level of development and the actual diversion capacity of existing or new facilities will need to be verified or designed. A recharge capacity of 100 cfs would require about 3,500 acres assuming a recharge rate of 0.7 inches/day. This recharge rate is the middle of the range of recently observed rates in Colusa County. **Figure 4-3** shows the potential diversion for flow when above the 90th percentile for the winter of 1998 as an example of the analysis for a wet year.

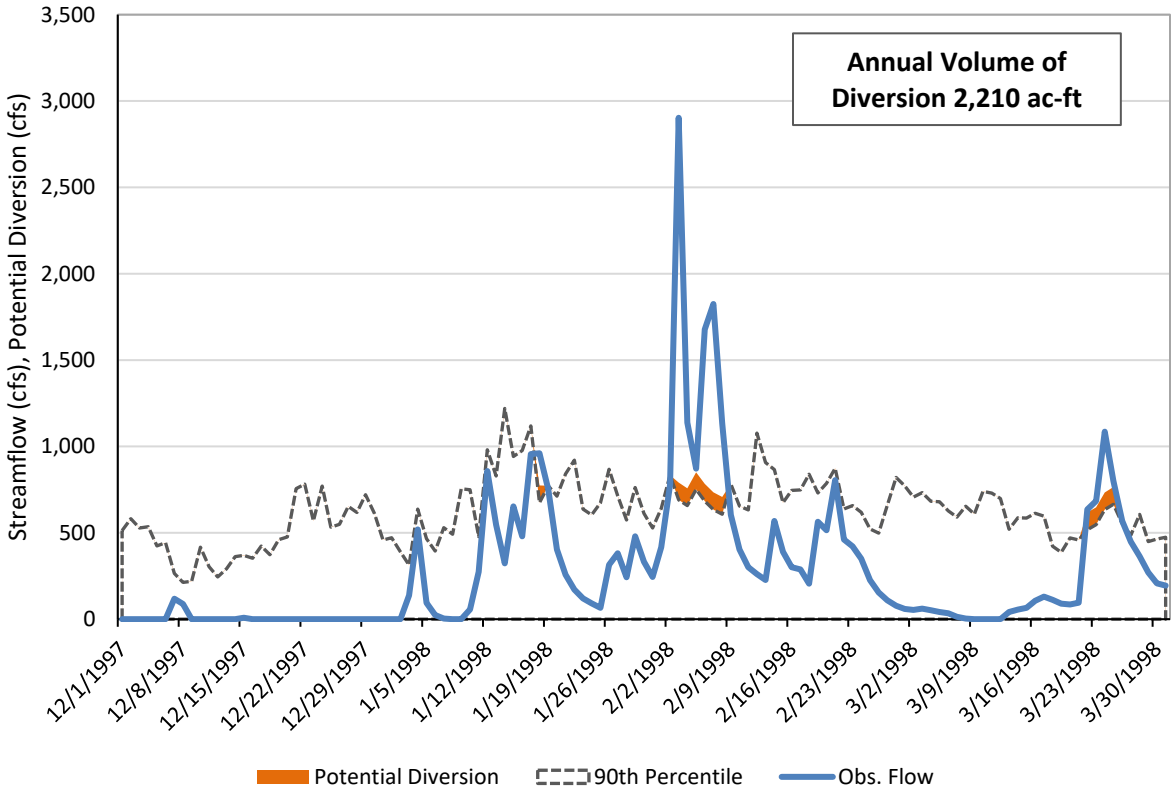


Figure 4-3. Potential Diversion for Example Wet Year: Winter 1998 under Streamlined Permit

In 1998 the estimated flow in Antelope Creek went above the 90th percentile for a brief period in January, and a more extended period in February and again near the end of March. During these periods, the orange shaded areas illustrate potential diversion of 100 cfs under the criteria for a streamlined water right permit. Figure 8-6 illustrates a few key considerations for the use of Antelope Creek as a source for groundwater recharge. The relatively "flashy" nature of rain-fed streams like Antelope Creek will need projects that can respond quickly to divert and recharge water when available. Additionally, the potential recharge available is dependent on the capacity to divert and recharge the water when it is available.

The analysis illustrated for a single year in **Figure 4-6** was performed for each of the 72 years in the period of analysis. **Figure 4-4** shows the average monthly potential diversion by water year type from Antelope Creek that could be used for groundwater recharge from December to March.

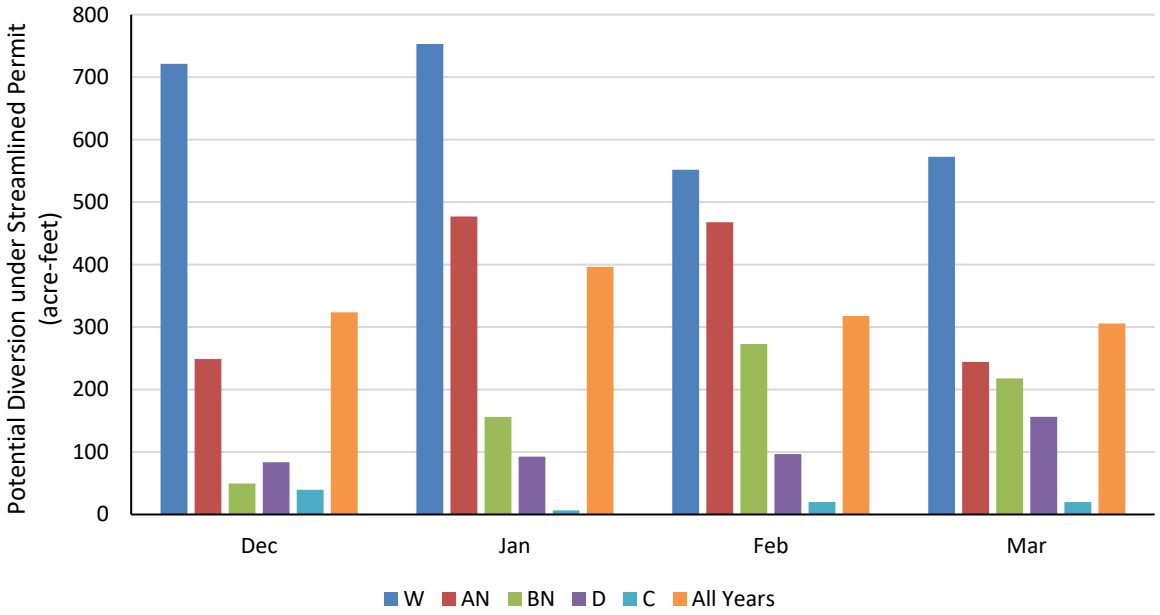


Figure 4-4. Potential Diversion under Streamlined Permit by Water Year Classification

Results summarized in **Figure 4-4** show potential diversions of several hundred acre-feet in most months in wet and above normal years and a limited amount of water available in critical years.

The potential water available for groundwater recharge varies depending on the rainfall each year, as shown in **Figure 4-5**. There would have been water available for recharge in 60 of the 72 years studied. The average yearly potential groundwater recharge from Antelope Creek is approximately 1,350 acre-feet/year, assuming a diversion and recharge capacity of 100 cfs.

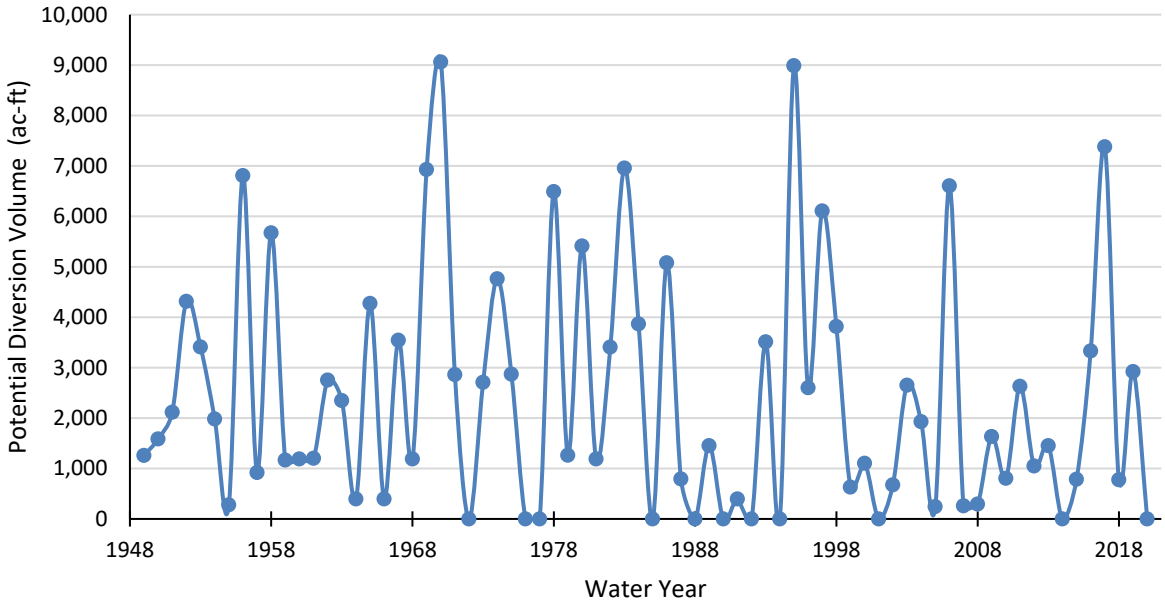


Figure 4-5. Potential Diversion Volume for Water Years 1948-2020

As described above, the water available for groundwater recharge from Antelope Creek is dependent on the assumption for the diversion and recharge capacity. A simple sensitivity analysis was performed to understand how the annual average water available for recharge varies based on the assumed diversion/recharge capacity. **Figure 4-6** illustrates the results of this analysis and indicates that a capacity of approximately 50 cfs could provide the recharge that would exceed the simulated average annual change in storage identified in the water budget summary for the Antelope Subbasin.

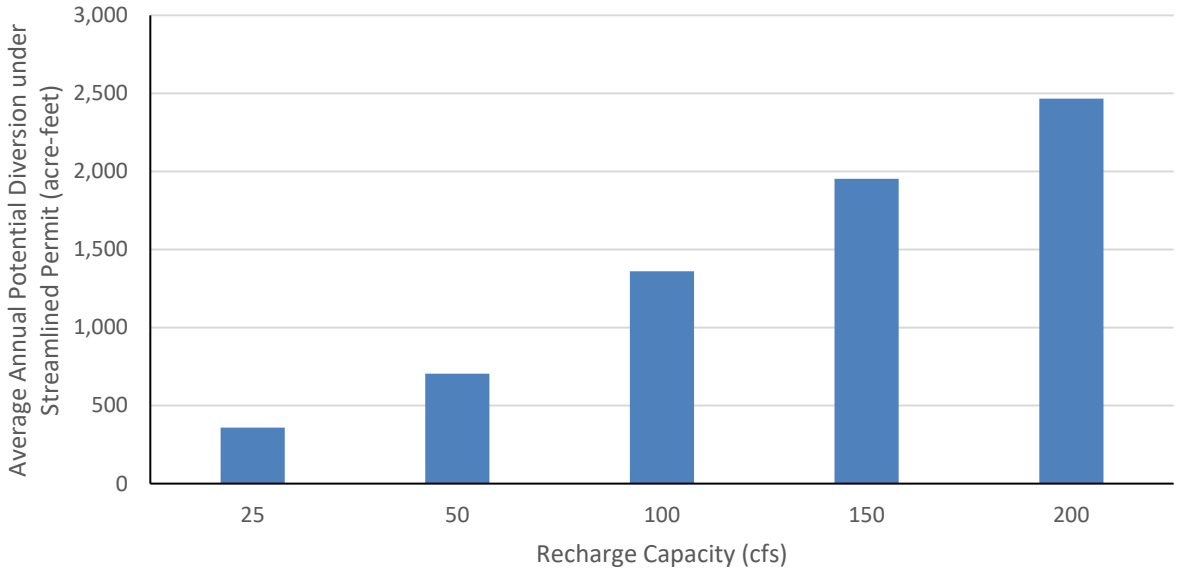


Figure 4-6. Average Annual Potential Diversion under Streamlined Permit with varying Recharge Capacity