DECEMBER 2021

CHAPTER 4: PROJECTS AND MANAGEMENT ACTIONS

SISKIYOU COUNTY FLOOD CONTROL & WATER CONSERVATION DISTRICT

Shasta Valley Groundwater Sustainability Plan

FINAL DRAFT REPORT

Siskiyou County Flood Control and Water Conservation District Groundwater Sustainability Agency Shasta Valley Groundwater Sustainability Plan

Suggested Citation: Siskiyou County Flood Control and Water District Groundwater Sustainability Agency, Shasta Valley Groundwater Sustainability Plan (Public Draft), December 2021, https://www.co.siskiyou.ca.us/naturalresources/page/sustainable-groundwater-management-act-sgma

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4.1 INTRODUCTION AND OVERVIEW

To achieve this Plan's sustainability goal by 2042 and avoid undesirable results as required by SGMA regulations, multiple projects and management actions (PMAs) have been designed for implementation by the GSA. This section provides a description of PMAs necessary to achieve and maintain the Basin sustainability goal and to respond to changing conditions in the Basin. PMAs are described in accordance with §354.42 and §354.44 of the SGMA regulations. Projects generally refer to infrastructure features and other capital investments, their planning, and their implementation, whereas management actions are typically programs or policies that do not require capital investments, but are geared toward engagement, education, outreach, changing groundwater use behavior, adoption of land use practices, etc. PMAs discussed in this section will help achieve and maintain the sustainability goals and measurable objectives, and avoid the undesirable results identified for the Basin in Chapter 3. These efforts will be periodically assessed during the implementation period, at minimum every five years.

In developing PMAs, priorities for consideration include effectiveness toward maintaining the sustainability of the Basin, minimizing impacts to the Basin's economy, seeking cost-effective solutions for external funding and prioritizing voluntary and incentive-based programs over mandatory programs. As the planned or proposed PMAs are at varying stages of development, complete information on construction requirements, operations, permitting requirements, overall costs, and other details are not uniformly available.

A description of the operation of PMAs as part of the overall GSP implementation is provided in Chapter 5. After GSP adoption, the GSA will prioritize certain PMAs for feasibility reviews and preliminary engineering studies. Based on review and study results, PMAs may move forward to implementation.

In Shasta Valley, the PMAs are designed to achieve two major objectives related to the SMCs presented in Chapter 3:

- to achieve the thresholds and objectives for the interconnected surface water sustainability indicator (Section 3.4.5);
- to prevent lowering of groundwater levels to protect wells from outages; and
- to preserve ground-water dependent ecosystems and avoid additional stresses on interconnected surface water and their habitat.

The identified PMAs reflect a range of options to achieve the goals of the GSP and will be completed through an integrative and collaborative approach with other agencies, organizations, landowners, beneficial users and stakeholders. Few PMAs will be implemented by the GSA alone. The GSA considers itself to be one of multiple parties collaborating on achieving overlapping, complementary, multi-benefit goals across the integrated water and land use management nexus in the Basin. Particularly PMAs related to water quality, interconnected surface waters, and groundwater-dependent ecosystems will be most successful if implemented to meet multiple objectives with co-operating or collaborating partners. For many of the PMAs, the GSA will therefore enter informal or formal partnerships with other agencies, NGOs, or individuals. These partnerships may be in various formats, from GSA participation in informal technical or information exchange meetings, to collaborating on third-party proposals, projects, and management actions, to leading proposals and subsequently implementing PMAs.

The GSA and individual GSA partners will have varying but clearly identified responsibilities with respect to permitting and other specific implementation oversight which will be defined at the beginning of any collaboration or partnership. These responsibilities may vary from PMA to PMA or even within individual phases of a PMA. Inclusion in this GSP does not forego any obligations under local, state, or federal regulatory programs. Inclusion in this GSP also does not assume any specific project governance or role for the GSA. While the GSA does have an obligation to oversee progress towards groundwater sustainability, it is not the primary regulator of land use, water quality, or environmental project compliance. It is the responsibility of the respective implementing, lead agency to collaborate with appropriate regulatory agencies to ensure that the PMAs for which the lead agency is responsible are in compliance with all applicable laws. The GSA may choose to collaborate with regulatory agencies on specific overlapping interests such as water quality monitoring and oversight of projects developed within the Basin.

PMAs are classified under four categories: demand management for groundwater, surface water supply augmentation, stream habitat improvement, and groundwater recharge. Demand management projects reduce the demand for groundwater and can include projects such as irrigation efficiency improvements. Surface water supply augmentation projects contribute to increases in surface water in the Basin, an example of this type of project is instream flow leases. Habitat improvement projects can include restoration and upland management projects and groundwater recharge projects include managed aquifer recharge (MAR), in-lieu recharge (ILR). Examples of project types within these four categories are shown in Table 1. Further, PMAs are organized into three tiers reflective of the timeline for implementation:

1. **TIER I**: Existing PMAs that are currently being implemented and are anticipated to continue to be implemented.
2. **TIER II**: PMAs planned for near-term initiation and implementation (2022-2027) by individual member agencies.
3. **TIER III**: Additional PMAs that may be implemented in the future, as necessary (initiation and/or implementation 2027-2042).

A general description of existing and ongoing (Tier I) PMAs are provided in Section 4.2, Tier II PMAs in Section 4.3, and Tier III PMAs in Section 4.4. The process of identifying, screening, and finalizing PMAs is illustrated in Figure 1. Existing and planned projects were first identified through review of reports, documents, and websites. Planned and new projects also received stakeholder input in their identification. These projects were then categorized into the three categories: supply augmentation, demand management, stream habitat improvement, and groundwater recharge. In the next step, all projects were evaluated to identify those with the highest potential to be included in the GSP. Using the Shasta Watershed Groundwater Model (SWGM), the effectiveness of each project, or a combination of projects, was assessed to identify those projects that, if implemented, can most likely bring the basin to achieve sustainability. Monitoring will be a critical component in evaluating PMA benefits and measuring potential impacts from PMAs. More details on how projects will be evaluated and a road map to discuss feasibility and potential for success of each project (or a combination of projects) is presented in Chapter 5.

Funding is an important part of successfully implementing a PMA. The ability to secure funding is an important component in the viability of implementing a particular PMA. Funding sources may include grants or other fee structures (Appendix 5-C). Under the Sustainable Groundwater Management Implementation Grant Program Proposition 68, grants can be awarded for planning and for projects with a capital improvement component. As such, state funds for reimbursing landowners for implementation of PMAs, including land fallowing and well-shut offs, currently cannot be obtained under this program. Funding will also be sought from other local, state, federal, and private (NGO) sources.

The existing PMAs have been extracted from the following documents:

- Supply Enhancement (in Streams)
  - Siskiyou Land Trust (website)
- Demand Management (of Groundwater)
  - Permit required for groundwater extraction for use outside the basin from which it was extracted (Title 3, Chapter 13- Groundwater Management, Siskiyou County Code of Ordinances)
  - Siskiyou County Groundwater Use Ordinance (Title 3, Chapter 13, Article 7- Waste and Unreasonable Use, Siskiyou County Code of Ordinances)
  - Well Drilling Permits
    - Siskiyou County Well Drilling Permits (Standards for Wells, Title 5, Chapter 8 of Siskiyou County Code of Ordinances)
  - Scott Valley and Shasta Valley Watermaster District (website)
  - Shasta Valley Resource Conservation District
- Recharge
  - Existing reports, proposals
- Habitat Improvement
  - National Fish and Wildlife Foundation Grant Slates (website)
  - Shasta RCD (website)
  - Klamath National Forest (website)

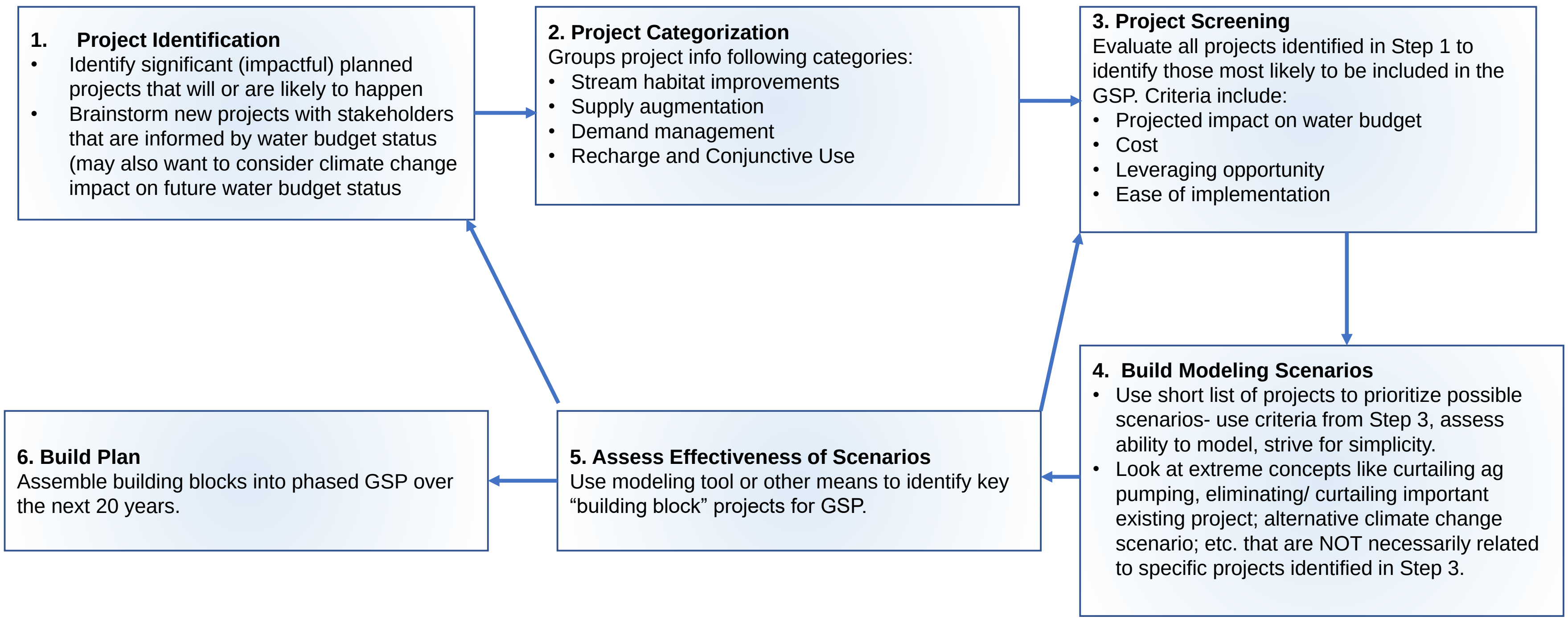

Figure 1: Process for identification and prioritization of PMAs. Further details, such as authority and finalized prioritization, are shown in Chapter 5.

Table 1: Projects and Management Actions Summary.

Tier	Title	Description	Lead Agency	Category	Status	Anticipated Timeframe	Targeted Sustainability Indicator(s) / Benefits
	Tier I PMAs						
I	Well Drilling Permits and County of Siskiyou Groundwater Use Restrictions	Siskiyou County Well Drilling Permits (Standards for Wells, Title 5, Chapter 8 of Siskiyou County Code of Ordinances).	County of Siskiyou	Demand Management	Existing/ Ongoing	Active	1. Groundwater levels
							2. Interconnected surface water.
I	Scott and Shasta Valley Watermaster District	Implements Shasta River Decree. Among other things, a watermaster assists in managing water leases under the authority of Shasta River Water Trust and 1707 dedications and transfers.	Scott Valley and Shasta Valley Water-master District	Demand Management	Existing/ Ongoing	N/A	Interconnected surface water
I	Shasta Watershed Groundwater Model (SWGM) Model Update and Isotope Results	Update the Shasta Watershed Groundwater Model and conduct a groundwater isotope study.	LWA / LLNL	GSA Implementation	Active	Active	GSA Implementation
I	Novy Rice Zenkus Fish Passage Improvement Project	Improve fish habitat on the Shasta River.	Regional Water Quality Control Board, Region 1 (North Coast)	Habitat Improvement			

Table 1: Projects and Management Actions Summary. *(continued)*

Tier	Title	Description	Lead Agency	Category	Status	Anticipated Timeframe	Targeted Sustainability Indicator(s) / Benefits
I	Montague-Grenada Weir Modification Project	Improve fish passage on the Shasta River.	Shasta Valley Resource Conservation District	Habitat Improvement	Active	2020-2021	Interconnected surface water
I	Piezometer Transect Study Project	Conduct piezometer transects at key reaches of primary surface water bodies in the Basin.	Shasta Valley Resource Conservation District	Demand Management	Active	2020	Groundwater levels
I	City of Yreka Water Demand	City water shortage contingency ordinance.	City of Yreka	Demand Management	Active	Active	Groundwater levels
I	Shasta River Safe Harbor Agreement	Improve fish habitat on the Shasta River.	CDFW	Habitat Improvement	Active	Active	Habitat Improvement
I	Enhancement of Survival Permits Authorizing Shasta River Template Safe Harbor Agreement and Associated Site Plans/ Recovery of Southern Oregon/Northern California Coast (SONCC) Coho Salmon	Habitat enhancement on private land.	NOAA Fisheries	Habitat Improvement	Active	Active	Interconnected surface water

Table 1: Projects and Management Actions Summary. *(continued)*

Tier	Title	Description	Lead Agency	Category	Status	Anticipated Timeframe	Targeted Sustainability Indicator(s) / Benefits
I	Shasta River Tailwater Reduction Plan	Reduce tailwater's negative impacts to water quality.	Shasta Valley Resource Conser-vation District	Conjunctive Use	Active	Active	Groundwater quality
I	Upland Management	Upland management includes removal of excess vegetation. This can occur on US Forest Service, Bureau of Land Management, or private land.	USFS	Supply Enhancement	Active	Active	1. Improved groundwater recharge
							2. Raise groundwater elevations
							3. Improved habitat
	Tier II PMAs						
II	(High Priority) Data Gaps and Data Collection	Series of high priority actions to address data gaps during GSP implementation to prepare for GSP updates in 2027.	GSA	GSA Implementation	Planning Phase	Implementation, applying for funding	GSA Implementation
II	Aquifer Charac-terization Analysis	Conduct aquifer characterization studies with large capacity wells.	GSA, TBD	Demand Management	Conceptual Phase	Conceptual Phase	1. Groundwater levels
							2. Interconnected surface water.

Table 1: Projects and Management Actions Summary. *(continued)*

Tier	Title	Description	Lead Agency	Category	Status	Anticipated Timeframe	Targeted Sustainability Indicator(s) / Benefits
II	Avoiding Significant Increase of Total Net Groundwater Use from the Basin	Avoid significant future increase of total net groundwater use above the most recent 20 year period (2000-2020) within the Basin through planning and coordination with land use zoning and well permitting agencies.	GSA, County of Siskiyou	Demand Management	Conceptual Phase	Conceptual Phase	1. Groundwater levels
							2. Interconnected surface water.
II	Conservation Easements	Conservation easements in Shasta Valley that enhance stream flow during the critical low flow period.	TBD	Supply Augmentation	Planning Phase	Development expected over the next five years	Interconnected surface water
II	Upslope Water Yield Projects	Building green infrastructure in the upper watershed to increase water yield. Green infrastructure includes fuel reduction, road improvements, canopy opening to manage snow shade and accumulation, and other large landscape projects that increase water storage within the upper watershed during wet periods and baseflow from the upper watershed during dry periods.	TBD	Supply Augmentation	Planning Phase	Planning Phase	Interconnected surface water
II	Habitat Improvement in Shasta Watershed	Improve wildlife habitat conditions in the Shasta watershed	GSA, TBD	Habitat Improvement	Planning Phase	Implementation	Interconnected surface water
II	Instream Flow Leases	Temporary transfer of a water right to protect instream flows	GSA, TBD	Supply Augmentation	Planning Phase	Planning Phase	Interconnected surface water

Table 1: Projects and Management Actions Summary. *(continued)*

Tier	Title	Description	Lead Agency	Category	Status	Anticipated Timeframe	Targeted Sustainability Indicator(s) / Benefits
II	Irrigation Efficiency Improvements	Increase irrigation efficiency (and in some cases, yields) through infrastructure or equipment improvements. Consider funding incentives through the NRCS EQIP program.	GSA, UCCE	Demand Management	Planning Phase	Planning Phase	1. Groundwater levels
							2. Interconnected surface water.
II	Juniper Removal	Remove juniper	GSA, USFS, TBD	Habitat Improvement	Conceptual Phase	Conceptual Phase	1. Groundwater levels
							2. Interconnected surface water.
II	Public Outreach	Public outreach and education for GSA stakeholders.	GSA	GSA Implementation	Planning Phase	Implementation	GSA Implementation
II	Reporting of Pump Volumes	Reporting of pump volumes for pumps above 500 gpm and commercial purposes.	GSA, TBD	Demand Management	Conceptual Phase	Conceptual Phase	Groundwater levels
II	Voluntary Managed Land Repurposing	Reduce water use through voluntary managed land repurposing activities including term contracts, crop rotation, irrigated margin reduction, conservation easements, and other uses	GSA, TBD	Demand Management	Conceptual Phase	Conceptual phase	1. Groundwater levels
							2. Interconnected surface water.
II	Well Inventory Program	Improve the GSA database of wells within the Basin.	GSA	GSA Implementation	Planning Phase	Planning Phase	GSA Implementation

Table 1: Projects and Management Actions Summary. *(continued)*

Tier	Title	Description	Lead Agency	Category	Status	Anticipated Timeframe	Targeted Sustainability Indicator(s) / Benefits
	Tier III PMAs						
III	Alternative, lower ET crops	Pilot programs on introducing alternative crops with lower ET but sufficient economic value. Incentivize and provide extension on long-term shift to lower ET crops.	GSA, UCCE, TBD	Demand Management	Conceptual Phase	Conceptual Phase	1. Groundwater levels
							2. Interconnected surface water.
III	MAR & ILR	Managed aquifer recharge and - during the irrigation season - in lieu recharge on irrigated agricultural land to increase baseflow during the critical summer and fall low flow period.	GSA	Recharge	Planning Phase	Planning Phase	1. Groundwater levels
							2. Interconnected surface water.
III	Shasta Recharge Pilot Project	Baseline study and pilot project in Grenada and Gazelle	GSA, TBD	Recharge	Conceptual Phase	Conceptual Phase	1. Groundwater levels
							2. Interconnected surface water.
III	Strategic Groundwater Pumping Restriction	Strategic timing of groundwater pumping restrictions. This management action would only be developed if Tier I and Tier II PMAs are insufficient. It would be an alternative tool for the GSA in support of the groundwater level SMC.	GSA	Demand Management	Conceptual Phase	Conceptual Phase	Groundwater levels

Table 1: Projects and Management Actions Summary. *(continued)*

Tier	Title	Description	Lead Agency	Category	Status	Anticipated Timeframe	Targeted Sustainability Indicator(s) / Benefits
III	Reservoirs	Feedback Needed					
III	Coordinated Shasta Valley Irrigation Management	Rotate diversions and other tools to maintain instream flows.	SSWD or RCD	Demand Management	Conceptual Phase	Conceptual Phase	1. Interconnected surface water.

4.2 TIER I: EXISTING OR ONGOING PROJECTS AND MANAGEMENT ACTIONS

As shown in Table 1 there are multiple existing and ongoing PMAs in the Basin (Tier I). The Basin has a range of existing PMAs in place to provide demand management, supply enhancement, and recharge.

Well Drilling Permits and County of Siskiyou Groundwater Use Restrictions

There are several existing regulations that are included in the demand management category of PMAs. These include the permitting requirements for new wells, as detailed in Title 5, Chapter 8 of the Siskiyou County Code of Ordinances. Siskiyou County also has ordinances that require permitting for extraction of groundwater underlying the Basin for use outside the Basin (per Title 3, Chapter 13) and a prohibition on wasting groundwater with underlying Siskiyou County for use cannabis cultivation (Article 7, Chapter 13, Title 3 of Siskiyou County Code of Ordinances). Providing demand management, these management actions benefit multiple sustainability indicators, including declining groundwater levels, groundwater storage, and depletion of interconnected surface waters.

Scott and Shasta Valley Watermaster District

Water master services currently exist for the Shasta River and its tributaries. Other than their primary duties of carrying out the Shasta River Decree, a water master may provide monitoring of water leases and Water Code 1707 dedications and transfers.

Shasta Watershed Groundwater Model (SWGM) Model Update and Isotope Results

A partnership between Larry Walker Associates (LWA) and Lawrence Livermore National Laboratory (LLNL) is updating the Shasta Watershed Groundwater Model (SWGM) for further evaluation of isotope data collected by LLNL by updating the model to the current date, refining the calibration, developing MODPATH simulations, and including isotope results. The current version of the SVIHM simulates the period from 1991-2018 because it was the period of data available at the time model development began. The project is adding three years (2019-2021) of new hydrologic data to the model inputs to extend the simulation period to near present day, water year 2021. The Shasta Valley PRMS simulation will use updated PRISM rainfall and evapotranspiration datasets and modeled surface water results from Paradigm to extend the modeled runoff, infiltration and streamflow that compose the major inputs to the groundwater model.

The current version of SWGM uses periodic groundwater elevation measurements (typically biannual) and streamflow data from a limited number of sites from 1991-2018 to compare simulated groundwater elevations and streamflows to observed data. The current calibration of the groundwater model is limited to biannual groundwater level measurements which allow adequate calibration of the hydraulic conductivity however, more continuous groundwater level data is needed in the calibration to improve estimates of the storage coefficients based on seasonal trends. Continuous groundwater and surface water data have been collected from 2019 to present that will allow the calibration period of the SVIHM to be extended and provide much more data both on groundwater storage dynamics and groundwater-surface water interaction dynamics.

MODPATH simulations will be developed using the groundwater flow vectors calculated by SWGM from the period 1991-2018 which will be used to forward and backward track the paths of particles. Forward flow tracking will be used initially to understand where water from different types of model recharge such as streams, soil infiltration and canals flows. Backward particle tracking will be used to identify the location of source water from observation wells that were sampled for isotope analysis and will indicate which recharge source it likely comes from. The MODPATH backward tracking simulation can be used to approximate the age of water by injecting many particles at the observation point and tracking the time it takes between the particle reached the well and was initially recharged.

The MODPATH backward tracking resulting in source area identification and approximate groundwater age will be compared to the isotope analysis of groundwater age and likely source. The isotope analyses will assist in validating MODPATH results and identifying areas where the model may need further refinement to improve the representation of recharge and groundwater flow dynamics.

Novy Ice Zenkus Fish Passage Improvement Project

The goal of the project is to improve habitat conditions, water quality, and fish passage on the main-stem Shasta River. The project includes irrigation dam improvements, fish screen relocation and improvements, and irrigation pipeline installation. Relocating the fish screen to the point of diversion will reduce fish entrainment in irrigation canals and eliminate the need for the existing fish return bypass channel, which results in warm water discharges to the Shasta River and potential fish stranding. Piping irrigation water will reduce ditch loss in the system and will result in a reduction of the quantity of water diverted.

Montague-Grenada Weir Modification Project

The purpose of this project is to improve fish passage for salmon species through all life stages while preserving the ability of the existing measuring weir to provide accurate flow measurements in the Shasta River. This project will also improve flow control at the pump station just downstream from this concrete structure.

Piezometer Transect Study Project

As part of the monitoring network, the SVRCD is conducting piezometer transect studies, herein referred to as “the Project,” at three discrete locations in the Shasta Valley groundwater basin. At each of the three locations the Project consists of installation of a stilling well to measure river stage within the channel, and up to four piezometers, or shallow monitoring wells, in a series spanning key reaches of primary surface water bodies within the basin. The piezometer transects will provide critical information about when a given reach is gaining water, loosing water, and increase understanding of interactions between surface water and groundwater through better representation of the gradient between river and aquifer and therefore model refinement. Details on the location of the transects are provided in Chapter 2 and in Appendix 2-H.

City of Yreka Water Demand

The City adopted a water shortage contingency ordinance in August 2015 and is found in Chapter 12.12 “Water Efficiency” of the Yreka Municipal Code.

Shasta River Safe Harbor Agreement

The Shasta River Safe Harbor Agreement supports recovery of federally threatened coho salmon while also supporting local farms and ranches. The voluntary agreement was signed in early 2021, between private landowners and the California Department of Fish and Wildlife. Other key partners include California Trout, The Nature Conservancy, and NOAA Fisheries. Private landowners agree to maintain or improve habitat for instream wildlife, specifically Coho salmon, in exchange for regulatory assurances that remove the risk of additional regulation and penalty under the Endangered Species Act (https://www.fisheries.noaa.gov/feature-story/shasta-river-safe-harbor-agreement-delivers-win-coho-salmon-and-landowners).

Enhancement of Survival Permits Authorizing Shasta River Template Safe Harbor Agreement and Associated Site Plans/ Recovery of Southern Oregon/Northern California Coast (SONCC) Coho Salmon

Safe Harbor agreements allow private landowners to implement habitat enhancement projects on their land in support of recovery of species protected under the ESA.

Shasta River Tailwater Reduction Plan

Watershed-wide planned and prioritized approach that guides efforts to reduce tailwaters’ negative impacts to water quality, mostly temperature. Temperature has not been the main focus of this GSP, but it will be considered in further developments.

Upland Management

Upland management includes removal of excess vegetation, which reduces evapotranspiration and increases rainfall percolation to groundwater. This can occur on US Forest Service, Bureau of Land Management, or private land. The US Forest Service regularly manages sections of US Forest Service land. Juniper removal can have a long-term effect on water levels. More details on future expanded upland management are provided under the “Upslope Water Yield Projects” described under Tier II.

4.3 TIER II: PLANNED PROJECTS AND MANAGEMENT ACTIONS

Tier II PMAs, planned for near-term initiation and implementation (2022-2027) by individual agencies, exist at varying stages in their development. Project descriptions are provided below for each of the identified Tier II PMAs. The level of detail provided for the eight PMAs described below depends on the status of the PMA; where possible the project descriptions include information relevant to §354.42 and §354.44 of the SGMA regulations.

- *High Priority PMAs - Data Gaps and Data Collection*
  - **Shasta Watershed Groundwater Model Update (High Priority)**
  - **Drought Year Analysis (High Priority)**
  - **Expand Monitoring Networks (High Priority)**
  - **General Data Gaps (High Priority)**
  - **Groundwater Dependent Ecosystem Data Gaps (High Priority)**
  - **Interconnected Surface Water Data Gaps (High Priority)**
- **i. Aquifer Characterization Analysis**
- **ii. Avoiding Significant Increase of Total Net Groundwater Use from the Basin**
- **iii. Conservation Easements**
- **iv. Upslope Water Yield Projects**
- **v. Habitat Improvement of Shasta Watershed**
- **vi. Instream Flow Leases**
- **vii. Irrigation Efficiency Improvements**
- **viii. Juniper Removal**
- **ix. Public Outreach**
- **x. Reporting of Pump Volumes**
- **xi. Voluntary Managed Land Repurposing**
- **xii. Well Inventory Program**

Shasta Watershed Groundwater Model Update (High Priority)

Project Description

Planned future updates to the Shasta Watershed Groundwater Model (SWGM) will build on the Tier I PMA “Shasta Watershed Groundwater Model (SWGM) Model Update and Isotope Results” and will include:

- after the PMA “Interconnected Surface Water Data Gaps” has been addressed, the GSA will update SWGM to include include an improved representation of surface water - groundwater interaction.
- update with more new data and extend the model to more recent years to capture additional climate and pumping patterns, particularly the last drought. Also the new continuous groundwater level data will aid the calibration of the SWGM by providing insight on seasonal groundwater level and storage fluctuations.

This PMA depends on expansion of current monitoring network and data collection, as outlined in other PMAs.

Drought Year Analysis (High Priority)

Project Description

The year 2021 was faced with an unprecedented drought that triggered a water right curtailment in the Shasta River Watershed (Order WR 2021-0082-DWR). The GSA will analyze all data collected within the 2021 water year to study how the Shasta groundwater basin responded to an exceptional drought year.

Expand Monitoring Networks (High Priority)

Project Description

The GSA will expand the current monitoring networks to address identified data gaps, as defined in Appendix 3-A with implementation details in Chapter 5. This includes:

- expansion of the groundwater level monitoring network to areas of interest, with an emphasis on continuous monitoring data. Monitoring wells near surface water and potential groundwater dependent ecosystems are needed. Additional monitoring of domestic wells is needed.
- expansion of the water quality monitoring network is needed to cover multiple needs such as:
  - coverage of all beneficial users such as domestic, agriculture, and environmental users.
  - improved spatial coverage of the Basin.
  - representation of all major water bearing formations in the Basin, such as shallow units that primarily supply domestic wells and deep units that supply agricultural and municipal wells.

Completion of this project during the implementation process will depend on funding availability and cooperation of partner agencies and stakeholders (See Chapter 5).

General Data Gaps (High Priority)

Project Description

The GSA will aim to fill all data gaps described in the GSP and Appendix 3-A. Data gaps regarding the monitoring networks, groundwater dependent ecosystems, and interconnected surface water are already addressed in separate PMAs. Additional data gaps that this PMA will address include:

- increasing the current frequency of water quality sampling.
- add continuous groundwater level monitoring to the groundwater level network.
- add snow and weather stations to the Shasta Valley watershed.

Completion of this project during the implementation process will depend on funding availability and cooperation of partner agencies and stakeholders (See Chapter 5).

Groundwater Dependent Ecosystem Data Gaps (High Priority)

Project Description

The GSA will work with the California Department of Fish and Wildlife (CDFW) and other interested stakeholders to address the data gaps related to groundwater dependent ecosystems (GDEs) in the Basin (Appendix 3-A). This includes:

- habitat maps of species that depend on GDEs based on local knowledge and surveys.
- ad-hoc committee review of species lists, habitat maps, and GDE maps.
- review species that depend on GDEs with a biologist or related expert.
- extend the groundwater level monitoring network to areas with potential GDEs.
- reanalyze potential GDEs after additional data is collected.
- develop a biological monitoring methodology to monitor GDEs for unreasonable impacts due to groundwater conditions, such as through satellite images.

Completion of this project during the implementation process will depend on funding availability and cooperation of partner agencies and stakeholders (See Chapter 5). Completion of this PMA would enable setting sustainable management criteria (SMCs) to protect GDEs in the next 5-year GSP update.

Interconnected Surface Water Data Gaps (High Priority)

Project Description

The GSA will work with the California Department of Fish and Wildlife (CDFW) and other interested stakeholders to address the data gaps related to interconnected surface water (ISWs) in the Basin (Appendix 3-A). This includes:

- establishing a monitoring station at Big Springs Creek (Water wheel) to collect data for the Big Spring Complex
- installing stream gages on Shasta River tributaries to record seasonal flow.
- extend the groundwater level monitoring network to areas near ISWs.
- conduct a pilot study of shallow monitoring wells or alternative options to analyze if surface water bodies are connected or disconnected to groundwater.
- collect surface water data for the numerical model such as surface water diversions, canal seepage, streamflow losses, and percolation from wetlands.

- reanalyze potential ISWs after additional data is collected and surface water has been incorporated into the numerical model.
- redevelop or create new SMCs as needed and define undesirable results for a future GSP update.

Completion of this project during the implementation process will depend on funding availability and cooperation of partner agencies and stakeholders (See Chapter 5).

Aquifer Characterization Analysis

Coordinate with parties that have large capacity wells to conducts aquifer characterization studies throughout the basin. Typically, these studies would include collection of one week of baseline data including static water level of the pumping well and static water level and water level trends of nearby wells, spring discharge measurements of any nearby springs, and an upstream and downstream flow measurements of any nearby streams. This data will be critical to better understand the geology and hydrogeology of the basin and will be used to:

1. Update the Shasta numerical model to better represent hydrogeologic conditions.
2. Evaluate groundwater-surface water interactions for specific springs, reaches, and areas.
3. Evaluate location specific project and management actions.

Robust aquifer characterization will have high upfront costs but information from these tests will be incorporated and used indefinitely in sustainable groundwater management in the Basin. Areas of interest include:

- Pluto's Cave area, located east, northeast, and southeast of the Big Springs Complex.
  - Area identified to increase understanding of potential flow paths of the Big Spring Complex.
- Big Springs Irrigation District service area.
  - Identified to understand groundwater-surface water interactions of the BSID area and flow in the Shasta River.
- Grenada and Gazelle areas
  - Areas identified as potential areas for Flood MAR. Timing and flow of recharge required to better evaluate climate impacts and potential management actions.
- Little Shasta River upper watershed
  - Poorly understood hydrogeologic area with multiple springs of different characteristics. Identified as a data gap in understanding how recharge and flow connects with the larger Shasta Basin.

Avoiding Significant Increase of Total Net Groundwater Use from the Basin

Project Description

The goal of this MA is to avoid water level declines and additional stream depletion in Shasta Valley that would result from significant expansion of net groundwater use relative to the practice over the past two decades. Net groundwater use is defined as the difference between groundwater pumping and groundwater recharge in the Basin. Under conditions of long-term stable recharge (from precipitation, irrigation, canal leakage, streams, floods) and long-term stable surface water supplies in the Basin, significant increases in long-term average ET (or other consumptive uses) in the Basin are indicative of significant increases in long-term average net groundwater use. While not leading to overdraft, such increase of net groundwater use would result in less groundwater discharge toward the Shasta River and, hence, lower dynamic equilibrium water levels in the Basin or portions of the Basin, possibly at levels lower than the minimum threshold (MT) for groundwater levels or for interconnected surface water, for significant periods of time (see Chapter 2.2.3.3). This MA helps to ensure that the sustainable yield of the basin is not exceeded (see Chapter 2.2.4) and that sustainable management criteria are met.

The MA sets a framework to develop a process for avoiding significant long-term increases in average net groundwater use in the Basin, while protecting current groundwater and surface water users, allowing Basin total groundwater extraction to remain at levels that have occurred over the most recent twenty-year period (2000-2020). By preventing future declining water levels, the MA will help the GSA achieve the measurable objectives of several sustainability indicators: groundwater levels, groundwater storage, subsidence, and interconnected surface water and GDEs.

Due to the direct relationship between net groundwater use and ET, implementation of the MA is measured by comparing the most recent five- and ten-year running averages of agricultural and urban ET over both the Basin and watershed, to the average value of Basin ET measured in the 2010-2020 period, within the limits of measurement uncertainty. Basin ET from anthropogenic activities in the Basin and surrounding watershed cannot increase significantly in the future without impacting sustainable yield.

This design is intended to achieve the following:

- To avoid disruption of existing urban and agricultural activities.
- To provide an efficient, effective, and transparent planning tool that allows for new urban, domestic, and agricultural groundwater extraction without increase of total net groundwater use. This can be achieved through exchanges, conservation easements, and other voluntary market mechanisms while also meeting current zoning restrictions for open space, agricultural conservation, etc (see chapter 2).
- To be flexible in adjusting the limit on total net groundwater extraction if and where additional groundwater resources become available due to additional recharge dedicated to later extraction. Critical tools of the MA will be monitoring and assessment of long-term changes in Basin and surrounding watershed hydrology (ET, precipitation, streamflow, groundwater levels, see chapter 3), outreach and communication with stakeholders, well permitting, collaboration with land use planning and zoning agencies, and limiting groundwater extraction to not exceed the sustainable yield.

Measurable Objectives Expected to Benefit

This MA directly benefits the measurable objectives of the following sustainability indicators:

- Groundwater levels – avoiding declining water levels below those corresponding to the most recent twenty-year period.
- Groundwater storage – avoiding declining water levels below those corresponding to the most recent twenty-year period.
- Depletion of Interconnected Surface Waters and Protection of Groundwater-Dependent Ecosystems – Avoiding depletion of interconnected surface waters with declining groundwater levels.

Circumstances for Implementation

Currently, there is no threat of chronically declining water levels in Shasta Valley. The Basin is not in a condition of overdraft. Future threats to groundwater levels fall into two categories, further explained below:

- Increased total net groundwater use in the Basin (total net groundwater use: difference between Basin landscape recharge and Basin pumping).
- Reduced recharge into and runoff from the watershed surrounding the Basin

This MA ensures that future declining water levels are not the result of any significant expansion of groundwater pumping in the Basin (first category), which would lead to new, lower equilibrium groundwater level conditions (see Chapter 2). While not constituting a condition of overdraft, these new dynamic equilibrium conditions may possibly exceed the MT for water level, also affecting the protection of GDEs and increase the depletion of interconnected surface water due to groundwater pumping at periods of critically low streamflow and spring flow conditions (summer and fall). Groundwater levels in the basin are fundamentally controlled by:

- The elevation and location of the Shasta River along the valley. The Shasta River is a net gaining stream, naturally draining the Basin. Segments of the river switch from gaining to loosing during the year, but on annual average the entire river is always a gaining system. Water budget analysis presented in Chapter 2 provides more details
- The amount of recharge from surface water feature in the upper part of the Basin, including Shasta River, Lake Shastina, and along westside creeks over their upper and middle alluvial fan sections; and the amount of recharge over the watershed to the south and east of the Basin and subsequent groundwater inflow from the upper watershed into the Basin.
- The amount of recharge from the Basin landscape due to precipitation, irrigation return flows, canal recharge, flooding, and MAR
- The amount of groundwater pumping for irrigation (the net consumptive groundwater use from domestic and public users is relatively small after accounting for return flows from septic systems and wastewater treatment plants to either groundwater or streams)

A dynamic equilibrium already exists between subsurface inflows, subsurface outflows, recharge across the Basin, groundwater pumping, and net discharge to the Shasta River. Water levels near the Shasta River vary within a relatively small range due to the interconnectedness of groundwater and surface water at the Shasta River. Water levels generally slope from the valley margins toward the Shasta River. Water levels fluctuate most near the valley margins: in the upper eastside gulches and near the western mountain front.

A significant future increase in net groundwater use within the Basin would lead to less groundwater discharge toward the Shasta River and, hence, a lowering of the water level gradient toward the Shasta River. A lower water level gradient means permanent lowering of the water table in the Basin or portions of the Basin. By preventing a significant long-term increase in total net groundwater use through proactive planning, the groundwater basin, which is not in overdraft conditions, remains at a dynamic equilibrium in water level conditions, above the MT, as long as natural recharge from streams flowing into the Basin remains stable. Other sources of recharge include canal leakage and percolation from excess irrigation.

Decreasing Recharge in or Runoff from the Surrounding Watershed

The Basin is part of the larger Shasta Valley watershed ("Watershed"). The Watershed has negligible groundwater inflows, but significant, if limited groundwater outflow along its northern boundary, which it shares with the northern Basin boundary. The Watershed's volcanic aquifer system is fully connected with the Basin's volcanic aquifer system. As a result, significant groundwater inflow to the Basin occurs on the southern and eastern Basin boundary, within the Watershed, as a result of recharge in the upper sections of the Watershed. Hence, groundwater pumping outside the Basin may significantly impact groundwater within the Basin.

Long-term climate changes cause changes in both precipitation amount and in snowmelt timing over the Watershed. This will affect the dynamics of groundwater flow from the upper Watershed, outside the Basin, into the Basin. On the westside of the Watershed, stream inflow dynamics at the Basin boundary may be affected as well and thus recharge into the alluvial aquifer portions of the Basin. Finally, the amount of surface water diversions may change, which in turn affects pumping in the Basin. The SWGM will be used throughout the implementation period to assess the impacts of these changes on sustainable yield. Preliminary scenarios of future climate change impacts evaluated using the parameters suggested by Department of Water Resources in its climate change guidelines are presented in Chapter 2.

Historic water levels indicated that there is no overdraft and no long-term decline in water levels. Where water levels have been observed since the 1960s, declines in dry year fall water levels occurred in the 1970s, relative to prior decades, but have been steady over the past 40 years. Average precipitation over the past 20 years (2000 - 2020) has been significantly lower than the average precipitation during the measured record in the 20th century (Figure 2, also see Chapter 2).

Based on current conditions in the Basin, this MA will be implemented immediately upon approval of the GSP by DWR and negotiation of partnerships with relevant agencies. During MA implementation, if groundwater levels stabilize at higher elevations due to GSA activities or climate change, total net groundwater use and the sustainable may be adjusted upward. The mechanism for off-ramping the MA is described in the implementation section below.

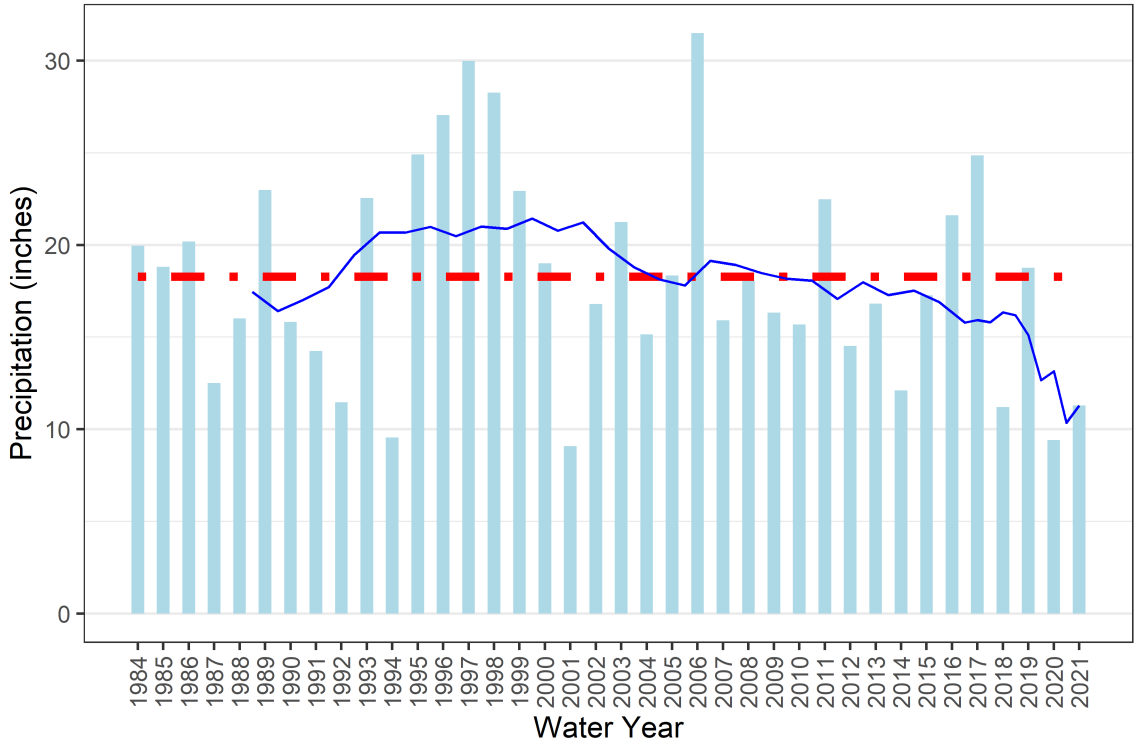

Figure 2: Annual precipitation over the 1982-2021 record as measured at Yreka CDEC station (YRK). The long term mean (18 in) shown as a red dashed line, and the 10 year rolling mean is the blue trendline.

Public Noticing

The GSA will implement the following education and outreach actions regarding the MA:

- Post and advertise the progress of MA implementation through the submittal of annual progress reports to DWR.

Implementation: Collaboration with Permitting and Regulatory Agencies

Implementation of the MA is focused on developing active coordination between the GSA with other planning, permitting, and regulatory entities within the Basin, including the Siskiyou County Department of Environmental Health and local land use zoning agencies (see below).

Siskiyou County Department of Environmental Health

The GSA will develop a formal partnership with the well construction permitting agency that operates within the Basin, the Siskiyou County Department of Environmental Health. The objective of the partnership is to develop a well permitting program for agricultural, urban, and large domestic wells that is supportive of and consistent with the GSA's goal not to expand total net groundwater use in the Shasta Valley Basin. The permitting program would ensure that construction of new extraction wells does not significantly expand current total net groundwater use in the Basin (to the degree that such expansion may cause the occurrence of undesirable results). This can be achieved through commensurate well retirements and through water market instruments.

Technical Example (Not a PMA)

Well replacement may not require that the new well has the same construction design as the old well, including well capacity. Here are two illustrative examples of an appropriate use of well replacement:

Example 1: Replacement of a 1,000-gpm agricultural well that will be properly decommissioned with a new 1,000-gpm agricultural well is permissible.

Example 2: Replacement of a 1,000-gpm agricultural well that will be properly decommissioned with a new 2,000-gpm capacity agricultural well is permissible with the explicit condition that the 10-year average total net groundwater extraction within the combined area serviced by the old and the new well does not exceed the average groundwater extraction over the most recent 10-years.

Land Use Zoning Agencies

The GSA will develop a partnership with all relevant land use zoning agencies in the watershed. Land use zoning agencies in the Basin include:

- Siskiyou County
- City of Montague
- City of Yreka
- City of Weed

The objective of the partnership is for those agencies to develop land use zoning and land use permitting programs that are supportive of and consistent with the GSA's goal not to expand total net groundwater use in the Basin. Developing close partnerships and timely transfer of information will best prevent an expansion of total anthropogenic consumptive water use in the Basin. Preventing an expansion of total net groundwater use in the Basin and surrounding areas still allows for both urban and agricultural growth.

Urban expansion is not currently planned to occur in Shasta Valley in the near future. If needed it would be by expansion into either agricultural or natural lands, within the constraints of land use planning objectives and zoning laws. Agriculture-to-urban land use conversion does not increase net groundwater use within the footprint of that conversion. Sometimes the net groundwater use may be lower after conversion (due to lower evapotranspiration). The total annual volume of net groundwater use reduction can be made available for net groundwater use increase elsewhere in the Basin through designing appropriate land use zoning and permitting processes, and after considering ecologic, public interest, and hydrologic or hydrogeologic constraints to such exchanges.

Agricultural expansion, where permissible under zoning regulations, is similarly made possible, e.g., by voluntary managed land repurposing of existing agricultural activities in the same location or elsewhere within the Basin and ensuring that there is no increase in net groundwater extraction between the expansion on one hand and land repurposing on the other. This may be achieved through land purchasing or trade of net groundwater extraction rights (water markets) or through contractual arrangements for land repurposing (e.g., conservation easements) to balance expansion and reduction of net groundwater use. If additional Basin total net groundwater extraction capacity becomes available (after a prolonged period of water level increase), the GSA will work with the land use zoning agencies to ensure land use zoning and permitting is adjusted accordingly, following a hydrologic assessment.

De minimis exceptions to net groundwater use expansion: domestic water use, up to 2 acre-feet per house-hold, contributes minimally to net groundwater extraction of a basin. Nearly all household water use other than irrigation is returned to groundwater via septic systems leachate, while irrigation contribute as deep percolation. Larger household water use, above *de minimis* levels, is typically due to irrigation of pasture or lawn and therefore, will be considered a net groundwater extraction.

If additional net groundwater extraction becomes available (after a prolonged period of water level increase), the partnership will ensure that well permitting is adjusted accordingly.

Technical Example (Not a PMA)

Market instruments encompass a wide range of management tools that rely on monetary transactions to efficiently and effectively trade water uses in ways that do not affect the overall water balance of a basin. The following are two hypothetical examples of water market transactions to illustrate how such instruments may be applied, if circumstances and zoning regulations are appropriate:

Example 1: Expansion of urban groundwater use into agricultural lands, where consistent with zoning and land use planning - Net groundwater use per acre of urban land is generally similar to or lower than under agricultural land use (this accounts for the fact that wastewater is recharged to groundwater and that the largest consumptive use in urban settings is ET from green landscapes). A hypothetical example: lets assume that urban net groundwater use is 1.5 acre-feet per acre, whereas it is 3 acre-feet per acre on agricultural land. Net water use is the difference between groundwater pumping and groundwater recharge over the area in question. Let's further assume that an urban expansion occurs into 500 acres of agricultural land. Prior to the land use conversion, net water use was 3 x 500 = 1,500 acre-feet. After the land use conversion, net water use is 1.5 x 500 = 750 acre-feet. The land use conversion makes 750 acre-feet available for additional annual groundwater pumping elsewhere in the Basin.

Example 2: Expansion of urban groundwater use into natural lands, where consistent with zoning and land use planning - Net groundwater use of urban land is generally larger than under natural land use. A hypothetical example: urban net groundwater use is 1.5 acre-feet per acre, whereas it is 0.5 acre-feet per acre prior to the land-use conversion. Let's again assume that the urban expansion is 500 acres. Prior to the land use conversion, water use on the 500 acres was 0.5 x 500 = 250 acre-feet. After land use conversion, the net water use is 1.5 * 500 = 750 acre-feet. The land use conversion therefore requires an additional 500 acre-feet of water.

If the city also purchases 500 acres of agricultural land for urban development, as in example 1, it already has a credit of 750 acre-feet, of which it may apply 500 acre-feet toward this additional 500 acre expansion into natural land.

Alternatively, the city would need to purchase a conservation easement on 200 acres of agricultural land elsewhere in the basin (net groundwater use: 3 acre-feet per acre, or 3 x 200 = 600 acre-feet) that converts that agricultural land to natural land (net groundwater use: 0.5 acre-feet per acre, or 0.5 x 200 = 100 acre-feet). The net groundwater use on the easement would be reduced from 600 acre-feet to 100 acre-feet, a 500 acre-feet gain to balance the city's development into natural lands, above. Costs for the easement may include costs for purchasing or leasing that land and the cost for maintaining the conservation easement. We note that conversion to natural land may require significant and habitat development and management as appropriate.

The above examples do not account for possible water rights issues that will also need to be considered. In California, urban groundwater rights are generally appropriative, while agricultural water rights are overlying, correlative rights.

Implementation: Monitoring

In a groundwater basin where agricultural pumping exceeds 95% of applied groundwater use in the basin, the total long-term change in the amount of net groundwater use (groundwater pumping minus irrigation return flows to groundwater) can be estimated by quantifying the long-term changes in the Basin's evapotranspiration (ET) from irrigated landscapes. This assumes that long-term trends in precipitation and applied surface water are sufficiently negligible such that only a significant increase in Basin ET leads to changes in the long-term groundwater balance or that their impacts are separately assessed using a model (Section 2.2.4). Monitoring of Basin ET, together with the monitoring programs outlined in chapter 3 and use of the Shasta Watershed Groundwater Model (SWGM) provide the basis for comprehensive monitoring of net groundwater use in the Basin. Furthermore, water level and groundwater storage monitoring (chapter 3) provide an instrument to continually assess the effectiveness of avoiding the expansion of total net groundwater use.

Legal Authority

The GSA only has authority for groundwater within the Shasta Valley Groundwater Basin. The GSA has no land use zoning authority. The GSA will collaboratively work with the County of Siskiyou, other land use zoning agencies, and stakeholders within the Shasta Valley Basin to implement this MA.

Schedule

The schedule for implementing the MA is as follows:

- The GSA will create partnerships within the first year of the GSP, by January 31, 2023.
- The partnerships will have the MA program in place no later than January 31, 2024.
- Benefits are to be seen immediately; that is, net groundwater use during the 2020-2030 decade will not exceed net groundwater use during the 2000-2020 baseline period.

Expected Benefits

Benefits generated by the MA will include:

- Security of groundwater pumping for existing groundwater users.
- Efficient, effective, and transparent planning tools available for new groundwater uses through voluntary market instruments.

Estimated Costs and Funding Plan

An economic analysis contractor will complete a description of the estimated cost for each project or management action and a description of how the Agency plans to meet those costs will be provided in the GSP update when the planning phase has been completed for a majority of projects and management actions.

Management of Groundwater Use and Recharge

Management of groundwater uses and recharge will be evaluated to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods. Assumptions that will be used to evaluate management of groundwater use and recharge include:

- There is currently no overdraft in the basin.
- The goal of this PMA is to avoid water level declines in Shasta River Valley that are due to further expansion of total net groundwater extraction in the Basin.
- The PMA sets a framework to develop a process for avoiding significant long-term increases in net groundwater extraction in the Shasta Valley.
- Total net groundwater use remains at levels that have occurred over the most recent twenty-year period (2000-2020).
- Monitoring: Compliance with the PMA is measured by determining whether the most recent ten-year running average basin sum of agricultural and urban ET remains at or below levels measured for the 2010-2020 period, within the limits of measurement uncertainty (about 10%).

Upslope Water Yield Projects

Project Description

The objective of these types of projects is to increase water yield from the upper watershed, through green infrastructure. Green infrastructure may include fuel reduction, road improvements, canopy opening to manage snow shade and accumulation, and other actions that reduce direct runoff to surface waters.

The project is currently in the feasibility and planning phase, and areas that would be suitable are being evaluated. Anticipated benefits from these types of projects include increased water storage in the upper watershed during the wet season, improved flows from the upper watershed during the dry season, and the support of desired instream flow conditions.

Changes in streamflow entering the Basin will be monitored and evaluated through existing and proposed new streamflow gauges on key tributaries and mostly on the main stem of the Shasta river (see Section 3.3) and through statistical analyses of these data.

Habitat Improvement in Shasta Watershed

The GSA will cooperate with a combination of agencies to improve habitat conditions within the Shasta watershed. This will include a combination of treatments including adding large woody debris along four miles of stream, modification of stream crossing structures, and meadow restoration. Other treatments include riparian fencing, tree planting, and bank enhancement. These treatments will add stream habitat structure and complexity, improve connectivity and aquatic organism passage. These improvements will not directly have an impact on groundwater conditions and/or on groundwater use, but they should be included as potential multi-benefit projects where the GSA can develop collaboration with other agencies and enhance opportunities for funding.

Instream Flow Leases

The GSA and will work with stakeholders to research developing a program of instream flow leases.

Irrigation Efficiency Improvements

Project Description

Achieving increases in irrigation efficiency through equipment improvements are anticipated to reduce irrigation pumping and diversions during the growing season, lessening the chance of river disconnection during critical periods. This is expected to support desired instream flows, fish migration, and aquatic habitat. However, improving irrigation efficiency may have both positive and negative impacts on surface flows, but because of differences in timing, the net effect during the dry season is expected to be positive. Higher irrigation efficiencies reduce the amount of surface water diversion and groundwater pumping during the irrigation season, benefitting stream flows. Higher irrigation efficiencies also reduce the amount of recharge to groundwater to the degree that ET is not significantly reduced. This will increase stream depletion. For pumping near streams, the effect of reduced pumping has a more immediate impact on surface water depletion, whereas the effect of reduced recharge on stream depletion may be delayed in time. This may provide short-term gains in stream depletion reversal, balanced by later increases in stream depletion (from lack of recharge), but outside of the summer baseflow season. More direct gains in stream depletion reversal come from reducing the amount of evaporation from irrigation spray, e.g., when converting to highly efficient LESA systems on center pivots.

Currently, this project is in the planning phase and funding options will be explored during the first five years of GSP implementation. This project involves an exploration of options to improve irrigation efficiency, assessment of irrigator willingness, outreach and extension activities, and development of funding options, primarily by cooperators, possibly in cooperation with NRCS. This PMA is likely to be accomplished through a voluntary, incentive-based program. This may also include incentives for switching to less water-intensive crops. Cost estimates have not yet been completed for this PMA.

Future benefits of actual implementation status to streamflow depletion reversal (and remaining streamflow depletion) will be evaluated and assessed with SWGM using the methodology described in Chapter 3.3 and using monitoring data describing the implementation of the irrigation efficiency improvement program.

Monitoring data in the irrigation efficiency improvement program include, but are not limited to:

- Total acreage with improved irrigation efficiency equipment
- Location of fields under improved irrigation efficiency equipment
- Assessment of the increase in irrigation efficiency, with particular emphasis on assessing the reduction or changes in consumptive water use (evaporation, evapotranspiration) based on equipment specification, scientific literature, or field experiments
- Cropping systems in fields with improved irrigation efficiency equipment
- Metering of water use

Juniper Removal

The GSA, USGS and other agencies and private stakeholders will remove excess juniper within the watershed to improve groundwater levels. While it is conceptually possible to increase water yield for some number of years following juniper removal, it is difficult to actually implement at a watershed scale and maintain it over time. Furthermore, juniper removal will not necessarily increase water yield in all climates, so local conditions will be evaluated (Niemeyer et al. 2017). This project will be considered within a holistic management framework that re-establishes historical fire regimes and does not focus solely on water yield. Maintenance would be needed because the benefits of one-time removal projects are likely to be short-lived (Fogarty et al. 2021).

Public Outreach

This general PMA emphasizes the GSA's goal for public outreach and education among stakeholders to implement the spirit of the PMA and achieve groundwater sustainability within the Shasta Valley groundwater basin. This includes outreach related to other PMAs and filling data gaps, as well as coordinated, widespread, voluntary conservation efforts and grassroots stewardship. The GSA will also work with municipal water agencies and other relevant organizations to coordinate residential, municipal, and small agricultural water conservation education, particularly in times of drought or critical times of the year. This outreach will help engage the public and create more meaningful opportunities for public interest representation within the GSA.

Reporting of Pump Volumes

Owners of groundwater wells meeting certain criteria would be responsible for implementing a reporting system of groundwater pumped over the next 5 years. Reporting over the next 5 years will be done on a volunteer basis The criteria for reporting pumping volume are:

- Pumps operated above a specific pumping volume with values will be provided by pump and by owner; or
- Pumps used for commercial purposes.

Reporting can be conducted one of three ways:

1. A flow meter or totalizer will be installed and read on a monthly basis.
2. Monthly electrical use from the pump can be reported in-lieu of pump volume (when possible). However, using power consumption does not work for variable frequency drives (VFDs).
3. Monthly report of acres of irrigated land, irrigation method, and crop type. Data will be used to better quantify groundwater extraction spatially and temporally throughout the Basin. Possible subsidies in installation of flow meters from Prop 68 Implementation funds.

Voluntary Managed Land Repurposing

Project Description

Voluntary managed land repurposing programs include a wide range of voluntary activities that make dedicated, managed changes to land use (including crop type) on specific parcels in an effort to reduce consumptive water use in the Basin to improve and increase groundwater levels and instream flow during the critical late spring recess, summer baseflow, and early fall flush flow period. The GSA will have ongoing outreach to encourage volunteers for these activities. These activities may include any of the following:

Term Contracts: In some circumstances, programs like the Conservation Reserve Program (CRP) could provide a means of limiting irrigation on a given area for a term of years. Because of low rates, the CRP has not been utilized much in California, but this could change in the future. In addition, other term agreements may be developed at the state or local level. The Shasta River Water Transactions Program is an example of such a term contract.

Crop Rotation: Landowners may agree to include a limited portion of their irrigated acreage in crops that require only early season irrigation. For example, a farmer may agree to include 10% of their land in grain crops that will not be irrigated after June 30.

Irrigated Margin Reduction: Farmers could be encouraged to reduce irrigated acreage by ceasing irrigation of field margins where the incentives are sufficient to offset production losses. For corners, irregular margins, and pivot end guns, this could include ceasing irrigation after a certain date or even ceasing irrigation entirely in some instances.

Crop Support: To support crop rotation, particularly for grain crops, access to crop support programs may be important to ensure that this option is economically viable. Some type of crop insurance and prevented planting payment programs could provide financial assurances to farmers interested in planting grain crops.

Other Uses: In some circumstances, portions of a farm that are currently irrigated may be well suited for other uses that do not consume water. For example, a corner of a field may be well suited for wildlife habitat or solar panel, subject to appropriate zoning requirements to avoid undesirable outcomes. Other voluntary managed land repurposing projects include conservation easements that reduce or eliminate surface water diversion for irrigation (streamflow augmentation). Such streamflow augmentations effectively offset an equivalent amount of (pre-existing) depletion of interconnected surface water due to groundwater pumping. Conservation easements or similar instruments may also include temporary, seasonal, or permanent restriction of groundwater, where the restriction may be defined either by an amount of groundwater pumping restriction or by the acreage not receiving irrigation from groundwater. Depending on the circumstances of an individual project, conservation easements may include habitat conservation easements, wetland reserve easements, or other easements that limit irrigation with surface water or groundwater on a certain area of land. It may be established that certain portions of a property may be suitable for an easement, while the rest of the property remains in irrigated agriculture. Many form of such temporary, seasonal, or permanent easements are possible. They may additionally specify restrictions or requirements on the repurposed use, e.g., to ensure appropriate habitat management.

Currently in the planning phase, this project type is to be developed throughout the next 5 years.

Implementation of this project type includes consideration of the following elements:

- Role of the GSA versus other agencies, local organizations, and NGOs
- Development of education and outreach programs in collaboration with local organizations
- Exploration of program structure.
- Contracting options.

- Exploration and securing of funding source(s).
- Identification of areas and options for easements or other contractual instruments.

Anticipated benefits from this type of project include improvement in instream flow conditions on the Shasta River and its tributaries during critical late spring recess, summer and fall baseflow, and fall flush flow periods.

Monitoring data collected in this voluntary managed land repurposing program include, but are not limited to:

- Total acreage and timing of land repurposing.
- Location of parcels with land repurposing.
- Assessment of the effective decrease in evapotranspiration (consumptive water use) and applied water use.
- Description of the alternative management on repurposed land with:
  - Quantification and timeline of surface water dedications to instream flow specified in the easement.
  - Quantification and timeline of groundwater pumping restrictions, including water year type or similar rule to be applied and specified in the easement.
- Annual Water Master certification of easement implementation, as appropriate.

Future benefits of implemented projects to streamflow depletion reversal (and remaining streamflow depletion) will be evaluated and assessed with SWGM using the methodology described in Chapter 3 and using the above monitoring data that describe the implementation of voluntary managed land repurposing programs.

Well Inventory Program

In feedback from DWR on other GSPs, a better inventory and definition of active wells was requested along with discussion of impacts to these wells in annual reports, as some shallow wells may be impacted if MTs are reached.

A detailed well inventory will improve the understanding of the Basin conditions and will be valuable for modeled results. A better inventory of domestic wells and other drinking water users will assist the GSA protect affected beneficial users in times of drought and other critical times. It will also help solve ongoing issues with evaluation of *de-minimus* users and their proper inclusion in SWGM.

Shasta Recharge Pilot Project

Project Description

The project will divert water from the Shasta River or its tributaries onto target land near Gazelle and Grenada for winter groundwater recharge when enough water is available in the river. Specific locations for the pilot recharge project will be proposed, and initial baseline studies will occur. Following results, long term and larger recharge projects will be designed and built.

The goal for this project is to provide a preliminary assessment of more large scale as in future recharge opportunities in the Basin. It will also provide a good opportunity to start exploring availability of water, based on year type and climate conditions in general. This project should be considered as a pilot explorative project that will enhance data collection and understanding of the Basin characteristics.

Measurable Objective

The purpose of this study is to evaluate the use of groundwater recharge to augment Shasta River flows during critical periods (i.e. late summer and fall). Key outcomes of this study include determination of when and where water that is recharged enters the Shasta River, the amount of water that recharges the groundwater system and potential water quality benefits associated with groundwater recharge.

Circumstances for Implementation

This project is included in the Tier II projects, as planned for implementation during the first 5 years after GSP acceptance. The MWCD Parks Creek Water Right depends on excess winter runoff to fill the reservoir. This project will need to occur below the Parks Creek diversion and those diversions above will need to be restricted to their current water rights.

Public Noticing

Public notice will be provided prior to the start of the project and outreach conducted to landowners. Outreach will continue to be conducted for additional recharge activities following project completion. Findings from this project will be made publicly available following project completion.

Permitting and Regulatory Process

A temporary Water Rights Permit (i.e., SWRCB Application for Temporary Permit filed pursuant to Water Code 1425 to Divert to Underground Storage During High Flow Events) is needed to allow diversion of water from the Shasta River during winter months. As permits can be issued for up to 180 days, this permit will be needed for every application year. California Department of Fish and Wildlife also requires a Lake and Streambed Alteration Agreement when a project may affect fish and wildlife resources and the appropriate coordination will be completed to secure these permits.

Schedule for Implementation

The first phase of this project will be initiated within 5 years of GSP implementation.

Implementation

Prior to implementation of this project, baseline conditions will be monitored at potential pilot sites, site selection will be conducted, water conveyance infrastructure will be added, if not already in place, and landowner permission and outreach will be conducted. Monitoring equipment installation will be completed, as necessary to ensure data collection according to the monitoring plan and the appropriate permitting for diversions in the winter will be obtained.

Expected Benefits

This study is expected to provide information on the amount and timing of groundwater recharge and evaluate the use of groundwater recharge to augment Shasta River flows during critical periods (i.e., late summer and fall).

Future benefits from actual implementation status on streamflow depletion reversal (and remaining streamflow depletion) will be evaluated and assessed with SWGM using the methodology described in Chapter 3.3 and using monitoring data describing the implementation of this managed aquifer recharge program.

Monitoring data collected in this managed aquifer recharge program include, but are not limited to:

- Total acreage used each winter for MAR
- Location of fields used for MAR
- Monthly total volume of MAR applied
- Groundwater level monitoring data, if any are collected as part of this project
- Scientific and technical reports

Legal Authority

This project would require appropriate permitting from the State Water Board. Permitting includes temporary Water Rights Permit which provides the authority to divert water from the Shasta River during winter months for groundwater recharge. Landowner permission and agreements are also required. The project would need to avoid infringement on any existing water rights, including the Montague Water Conservation District Parks Creek Water Right which depends on excess winter runoff to fill reservoir.

Estimated Costs and Funding Plan

Costs and funding for this project have not yet been explored. Potential funding sources will be explored during the first five years of GSP implementation.

4.3 TIER III: POTENTIAL FUTURE PROJECT AND MANAGEMENT ACTIONS

- **i. Alternative, Lower ET Crops**
- **ii. MAR and ILR**
- **iii. Strategic Groundwater Pumping Restriction**
- **iv. Reservoirs**
- **v. Coordinated Shasta Valley Irrigation Management**

Alternative, Lower ET Crops

Project Description

The “alternative, lower ET crop” PMA is a pilot program to develop and introduce alternative crops with lower ET but sufficient economic value to the Basin’s agricultural landscape. The implementation of such crop changes would occur as part of the Tier II Voluntary Managed Land Repurposing

PMA. The objective of this PMA is to develop capacity in the Basin to facilitate crop conversion in some of the agricultural landscape that would reduce total crop consumptive use (evapotranspiration) of water in the Basin, as needed. The management action is to develop a program to develop and implement pilot studies with alternative crops that have a lower net water consumption for ET, and to provide extension assistance and outreach to growers to facilitate and potentially incentivize the crop conversion process. This PMA will be implemented jointly with University of California Cooperative Extension, the Siskiyou County Farm Bureau, the Siskiyou County Resources Conservation District, and/or other partners. Currently in the conceptual phase, this project involves:

- Scoping of potential crops
- Pilot research and demonstrations
- Defining project plan
- Exploration of funding options
- Securing funding
- Development of an incentives program
- Implementation of education and outreach

Anticipated benefits from this project include introduction of lower consumptive water use crops and either an increase in recharge (on surface water irrigated crops) or a reduction in the amount of irrigation or both. As a result, water levels in the aquifer system will rise. This will also lead to an increase in instream flows and some reversal of streamflow depletion will occur. The potential benefits associated with transitioning to alternative, lower ET crops were investigated using the SWGM. Implementation of this project will include an assessment of the economic value of alternative, lower ET crops to growers.

Future benefits of actual implementation status to streamflow depletion reversal (and remaining streamflow depletion) will be evaluated and assessed with SWGM using the methodology described in Chapter 3.3 and using monitoring data describing the implementation of the alternative, lower evapotranspiration program.

Monitoring data in the alternative, lower evapotranspiration program include, but are not limited to:

- Total acreage with alternative, lower evapotranspiration crops
- Location of fields with alternative, lower evapotranspiration crops
- Assessment of the effective decrease in evapotranspiration Cropping systems used as alternative, lower evapotranspiration crops

MAR and ILR

Project Description

As already mentioned in the description of the Shasta pilot recharge project, Managed Aquifer Recharge (MAR) is the process of intentionally adding water to aquifers and In-Lieu Recharge (ILR) is storing or preserving groundwater through replacement of some or all of groundwater use with surface water. This project builds on findings obtained from the Shasta pilot recharge project and plans on extending the areas where MAR and ILR (during the irrigation season) can be used to recharge groundwater at a watershed scale. If winter water rights can be obtained. Winter recharge could help prevent recurrence of domestic well outages near these cities.

Measurable Objective

Use of MAR and ILR has been explored in the Basin and elsewhere in California as an option to increase groundwater recharge. The purpose of this PMA is to increase baseflow in Shasta River during the critical summer and fall low period and support the reversal of streamflow depletion presented in Chapter 3 as part of the discussion on sustainable management criteria for Interconnected Surface Water.

Public Noticing

Public noticing for this project will be conducted by the GSA prior to project implementation and will include submittal of the appropriate CEQA/NEPA or other environmental documentation, if required. Public notification is planned to be executed with significant project changes or additional project elements.

Permitting and Regulatory Process

A temporary Water Rights Permit (i.e., SWRCB Application for Temporary Permit filed pursuant to Water Code 1425 to Divert to Underground Storage During High Flow Events) is needed to allow diversion of water from the Shasta River during winter months. As permits can be issued for up to 180 days, this permit will be needed for every application year. California Department of Fish and Wildlife also requires a Lake and Streambed Alteration Agreement when a project may affect fish and wildlife resources and the appropriate coordination will be completed to secure these permits.

Schedule for Implementation

This PMA is in the planning and conceptualization stage. An exploration of funding sources, project location and project feasibility are planned within the first five years of GSP implementation.

Implementation

This PMA utilizes excess winter and spring flows for recharge to temporarily increase groundwater storage to augment streamflow's during critical periods (increased baseflow). The project includes:

- Finding landowners willing to participate
- Securing project funding
- Obtaining water rights and other permit requirements as necessary
- Constructing infrastructure and installing monitoring equipment as necessary to identify potential project impacts and quantify project benefits.

Expected Benefits

The primary benefit of MAR and ILR is to reverse streamflow depletion through augmenting baseflow in Shasta River during the critical summer and fall periods. This is expected to provide benefits to aquatic species, including anadromous fish (as discussed in Chapter 2.X), water quality and habitat.

Legal Authority

With the appropriate permitting, and without infringement on existing water rights, the GSA is authorized to divert surface water for use with MAR and ILR.

Estimated Costs and Funding Plan

Costs and funding for this project have not yet been explored. Potential funding sources will be explored during the first five years of GSP implementation.

Strategic Groundwater Pumping Restriction

In Shasta Valley, the current level of Basin pumping is determined to be sustainable provided the implementation of Tier I and Tier II PMAs will assist in maintaining sustainability and help ensure that pumping at current levels can continue. Through SGMA, the GSA has the ability to implement groundwater pumping restrictions within locations of the GSA's jurisdiction. Although the GSA has the ability to implement pumping restrictions, the development and implementation of Tier I, Tier II, and other Tier III PMA's are designed to maintain sustainability within the Basin, making pumping restrictions a last resort under this GSP.

Considerably more work, data collection and discussion would need to be done to define the policies and procedures for pumping restrictions, and the GSA would first determine, using the Shasta Watershed Groundwater Model (SWGM) and other hydrologic assessment tools, the amount of water that affected pumpers could take sustainably prior to determining what may need to be restricted. Restrictions may be temporary, seasonal, or permanent.

Reservoirs

The objective of this PMA is to capture and store runoff and excess stream flows to augment Shasta River flows during critical periods. This project is still in the conceptual phase; details on feasibility and most promising locations will be considered during a preliminary evaluation phase.

Anticipated benefits from this project include reversal of stream depletion to increase instream flows in Shasta River during critical periods. Quantification of potential benefits will be evaluated using the SWGM model to run scenarios. One or multiple reservoirs may be implemented to meet the interconnected surface water minimum threshold (as described in Chapter 3). Temperature consideration may limit direct discharge into streams or require management of discharge, i.e., as recharge near streams (to lower temperatures) or use for irrigation in lieu of groundwater pumping and (cold) surface water diversions.

Significant regulatory, policy, and funding challenges come with this PMA. A first step for the GSA would be to implement a feasibility and scoping study to develop a long-term strategy, if any, for determining feasibility, funding, design, and implementing of this PMA option.

Coordinated Shasta Valley Irrigation Management

A PMA proposed by the Scott Valley and Shasta Valley Watermaster District, a voluntary locally-led initiative amongst all water users to rotate diversions and employ other tools to keep more water instream and avoid additional regulations. Potentially led by SSWD or RCD.

4.4 Other Management Actions

Monitoring Activities

Chapter 3 and data gap appendix (Appendix 3-A) clearly describe the importance of establishing an extensive monitoring network which will be used to support future GSP updates. A summary of the proposed monitoring activities includes, but is not limited to:

- Development of new RMPs (Representative Monitoring Points) to support the groundwater quality SMC
- Development of new RMPs to support groundwater level SMC
- New stream gauges in both the mainstem of Shasta River and in key tributaries
- Use of satellite images, twice per year, to evaluate status of Groundwater Dependent Ecosystems
- Continue to ongoing effort from Lawrence Livermore National Laboratory to further understand groundwater flow and SW/GW interaction through the use of isotopes data.

Voluntary Well Metering

This project would facilitate the collection and reporting of groundwater extraction data. Accurate groundwater extraction data improves the quality of information used in modelling, and in decision-making. Additionally collection of pumping data is useful for tracking the effectiveness of the proposed demand reduction PMAs, including residential wells. Public outreach will be done to encourage participation.

Future of the Basin

This project would entail developing a study of the economic impacts of the projects and management actions included in the GSP. This would include an evaluation of how implementation of the project could affect the economic health of the region and on local agricultural industry. It would also consider the projected changes to the region's land uses and population and whether implementation of these projects would support projected and planned growth. While an agricultural economic analysis considering groundwater regulation has been completed (see Appendix 5-D) and provides a good starting point, additional work is needed.

Chapter 1

References

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