GROUNDWATER SUSTAINABILITY PLAN SANTA ROSA PLAIN GROUNDWATER SUBBASIN



December 2021

Prepared by Sonoma Water

SANTA ROSA PLAIN GROUNDWATER SUSTAINABILITY AGENCY

Acknowledgments

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ES EXECUTIVE SUMMARY

California's historic Sustainable Groundwater Management Act (SGMA) became effective on January 1, 2015, at the height of the state's last drought. SGMA mandates that groundwater resources be sustainably managed to ensure that water will be available today and into the future for all beneficial users, including flora and fauna, municipal and domestic, agricultural, and business users. The Santa Rosa Plain Groundwater Sustainability Agency (Santa Rosa Plain GSA) was formed to develop and implement this Groundwater Sustainability Plan (GSP or Plan) for the Santa Rosa Plain Groundwater Subbasin (Subbasin) as required by SGMA (**Figure ES-1**).

This GSP lays out a management process for ensuring a sustainable groundwater supply in the future by improving the understanding of this hidden resource, measuring progress through metrics that will be monitored, actively implementing projects, adopting policies and management actions in response to groundwater conditions if they decline unacceptably, and developing the funding needed for long-term implementation. The GSP implementation process includes active engagement of local stakeholders, including disadvantaged communities (DACs), Tribes, residential well owners, farmers, businesses, and environmental representatives.

The Subbasin is classified by California Department of Water Resources (DWR) as a medium-priority basin. Based on the medium-priority designation, the GSA must submit the GSP to DWR by January 31, 2022. The Santa Rosa Plain GSA began work on the GSP in 2018, to identify and quantify existing problems and data gaps, define local goals for sustainable management of the Subbasin, and develop a GSP that achieves and maintains groundwater sustainability 50 years into the future.

Prior to the passage of SGMA, a U.S. Geological Survey (USGS) study was conducted in the Subbasin and surrounding watershed (contributing watershed area—provides water to the groundwater Subbasin), which was published in 2014 and included the development of an integrated surface water and groundwater computer model. Under the leadership of a diverse-stakeholder based Basin Advisory Panel, the voluntary Santa Rosa Plain Groundwater Management Plan (GMP) was developed and released in 2014. The GMP advanced the characterization and monitoring of groundwater conditions and initial study and planning of potential projects within the Subbasin.

This GSP presents detailed, technical information to build upon the work done in the GMP and to better understand groundwater in the Subbasin. The GSP uses quantifiable sustainable management criteria to define sustainability and includes projects, management actions, and an implementation plan necessary to achieve locally determined sustainability goals.

Because Santa Rosa Plain once again faces historic drought conditions, and with climate change projections showing that longer, more severe droughts are inevitable, the GSP lays out a path for long-term sustainability and resiliency, as defined by SGMA. While the current drought highlights water resource challenges, this GSP was not developed to address immediate short-term issues, but is focused on long-term, systemic groundwater issues.

Figure ES-1 Plan Area / Santa Rosa Plain Groundwater Subbasin

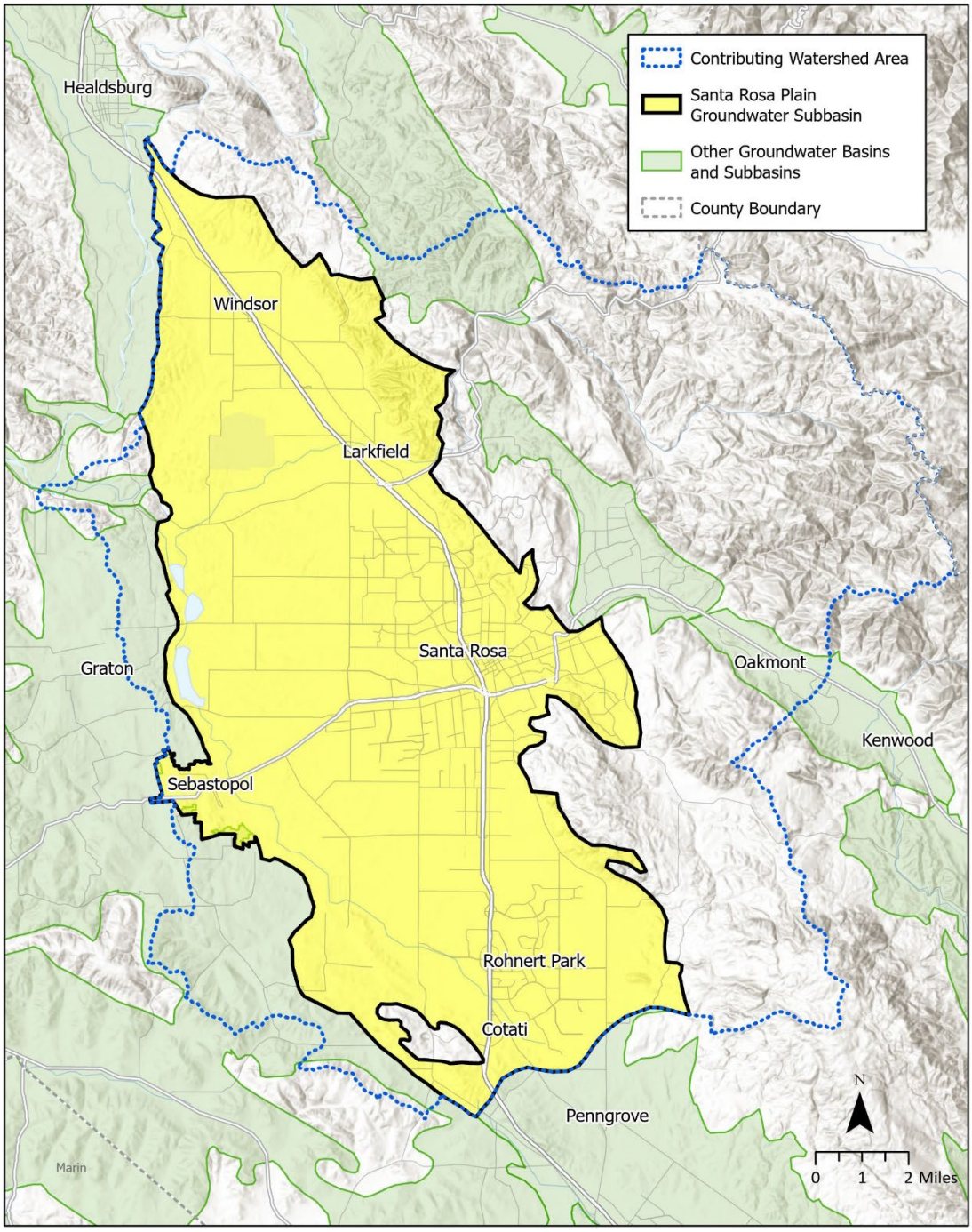


Figure ES-1. Santa Rosa Plain Groundwater Subbasin

For example, using a computerized model, described in **Section ES-3**, the GSP projects a 50-year climate future characterized by a few very dry years, followed by several wet or very wet years, and then a long drought. This scenario is representative of projected conditions in the North Bay, but is one of multiple options that could have been used. The climate scenario will be re-evaluated as more refined projections become available. This approach reflects a key component of this GSP, which is adaptive management. The document identifies areas of uncertainty and describes how new information will be incorporated into GSP implementation to make adjustments and to correct course as appropriate when necessary.

Adaptive Management
A key tenant of this GSP is adaptive management. Adaptive management is a structured, iterative process of robust decision-making in the face of uncertainty, with an aim to reducing uncertainty over time via monitoring and through the incorporation of new information as it becomes available.

This GSP and Executive Summary are organized following DWR's guidance documents (DWR 2016a):

- Executive Summary
- Section 1 Introduction
- Section 2 Description of the Plan Area
- Section 3 Basin Setting
- Section 4 Sustainable Management Criteria
- Section 5 Monitoring Networks
- Section 6 Projects and Management Actions to Achieve Sustainability
- Section 7 Implementation Plan
- Section 8 References and Technical Studies Used to Develop the GSP

ES.1 Introduction

The Santa Rosa Plain GSA was formed through a Joint Exercise of Powers Agreement (JPA) entered into by the cities of Cotati, Rohnert Park, and Santa Rosa; the Town of Windsor; Gold Ridge Resource Conservation District; Sonoma County (County); Sonoma County Water Agency (Sonoma Water); Sonoma Resource Conservation District; and an organized group of mutual water and Public Utilities Commission-regulated companies (Independent Water Systems), in accordance with the requirements of California Water Code Section 10723 for establishing GSAs under the SGMA.

In August 2019 following an adjustment of the Subbasin boundaries, the JPA was amended to include the City of Sebastopol. During this time, three mutual water companies neighboring Sebastopol joined the Independent Water Systems group.

In recognition of the importance of stakeholder input, the Board created an 18-member Advisory Committee to provide feedback and advice on all aspects of the GSP to the Board (**Figure ES-2**). The Advisory Committee consists of members appointed by each member agency, the Federated Indians of Graton Rancheria, and seven interest-based members appointed by the Santa Rosa Plain GSA Board. The seven interest-based members represent the following groups:

- Two from environmental organizations with a presence in the Subbasin
- Two from rural-residential well owners
- Two from the agricultural community
- One from the business community

The Advisory Committee meetings are open to the public, advertised through a monthly email update, and posted on the website santarosaplaingroundwater.org.

GSP development was a collaborative effort among the Board, Advisory Committee, and technical consultants and was further informed by input from member agencies, resource agencies, and the community, including representatives of DACs, residential well owners, Tribes, agriculture, business, and environmental interests. Key policy issues were vetted, discussed, and modified based on this open, public exchange.

ES.2 Plan Area

Section 2 of the GSP describes the Plan Area, including government jurisdictions, land use, water sources and uses, topography, surface water features, current monitoring and water management programs, and the well-permitting process.

The Plan Area for this GSP covers the entire 80,000-acre Subbasin, which lies within the Coast Ranges geomorphic province. The Subbasin is one of three coastal alluvial subbasins of the Santa Rosa Valley Groundwater Basin in the North Coast Hydrologic Region; Healdsburg Area and Rincon Valley are the other two subbasins. The Santa Rosa Plain Subbasin is generally bounded on the west by low-lying hills of the Mendocino Range and on the east by the Sonoma Mountains and Mayacamas Mountains. The Subbasin is approximately 22 miles long from north to south and the width from west to east varies from approximately 9 miles through the Santa Rosa area to 6 miles at the south end near the City of Cotati and narrows greatly at its northern end. The Subbasin includes the Town of Windsor; Cities of Cotati, Rohnert Park, Santa Rosa, and Sebastopol; and areas of unincorporated rural communities.

The major urban water suppliers in the Subbasin are the individual cities and towns and Cal-American Water Company's Larkfield system. Most of these water suppliers rely primarily on imported Russian River water supplied by Sonoma Water, but they also pump groundwater for supplemental supply, and during droughts and in emergencies. The City of Sebastopol relies entirely on groundwater pumped from the Subbasin. The urban communities account for about 36 percent of the land use. Residences outside of urban water supply systems rely on groundwater. The exact number of domestic wells is unknown but is estimated to be between 4,000 and 5,500. Agriculture, which accounts for 26 percent of land use—primarily wine grapes—depends on groundwater and recycled water, where available. . Native vegetation or water make up 35 percent of land use, and 3 percent of land is classified as vacant. In 2020, imported water accounted for 45 percent of water supply in the Subbasin, groundwater accounted for 35 percent, and recycled water accounted for about 20 percent (**Figure ES-3a**). **Figure ES-3b** shows the DACs in the Subbasin. These communities are generally (but not entirely) located in areas that receive water from municipal suppliers, which rely primarily on surface water supply.

Climate, groundwater, and streamflow conditions in the Subbasin are informed by robust monitoring networks. Multiple studies, programs, land use plans, and regulations affect, inform, and protect current and future water resources, water use, and water quality in the Subbasin. The County is responsible for administering well permits in both incorporated and unincorporated areas of the Subbasin.

ES.3 Basin Setting

Section 3 describes the Subbasin setting based on existing studies related to geology, climate, and historical groundwater conditions.

ES.3.1 Hydrogeologic Conceptual Model

The Hydrogeologic Conceptual Model (HCM) characterizes the physical components of the surface water and groundwater systems, regional hydrology, geology, water quality, and principal aquifers and aquitards.

The Subbasin is located within a region of geologic complexity caused by long periods of active tectonic deformation, volcanic activity, and sea-level changes. Faults in the Subbasin serve as major structural boundaries for geologic formations and groundwater movement.

Groundwater resources are highly variable throughout the Subbasin. The productive freshwater aquifers occur both at shallower depths, generally less than 200 feet where many residential wells are drilled, and at deeper depths, where many municipal, industrial, and agricultural wells are constructed. The Subbasin's deepest wells extend to approximately 1,500 feet and no known existing wells extend deeper than 2,000 feet.

In general, groundwater flows from the east and west highlands to the Laguna de Santa Rosa (**Figure ES-4**)**.** Faults along the Subbasin boundary may impede, enhance, or redirect groundwater flow and affect groundwater quality locally. Principal sources of groundwater recharge within the Santa Rosa Plain watershed are direct infiltration of precipitation and infiltration from streams. The shallow aquifer system receives most of this type of recharge every year. Recharge that reaches the deeper aquifer zones is less understood but is inferred to come from a combination of leakage from overlying shallow aquifers and mountain-front recharge along the margins of the valley. Deeper recharge may take decades or longer to reach the aquifers, due to long travel paths.

For the purpose of implementing SGMA, two principal aquifer systems are described in the GSP: the shallow and deep aquifer systems, which are commonly separated by layers of clay, forming aquitards. The properties and features that are the basis for grouping into shallow and deep aquifer systems include the degree of surface water connectivity, degree of confinement, and responses to hydraulic stresses such as recharge and pumping. Although the deep and shallow aquifer systems are grouped separately, the degree of connection between them is variable depending upon the local nature and thickness of the clay aquitards.

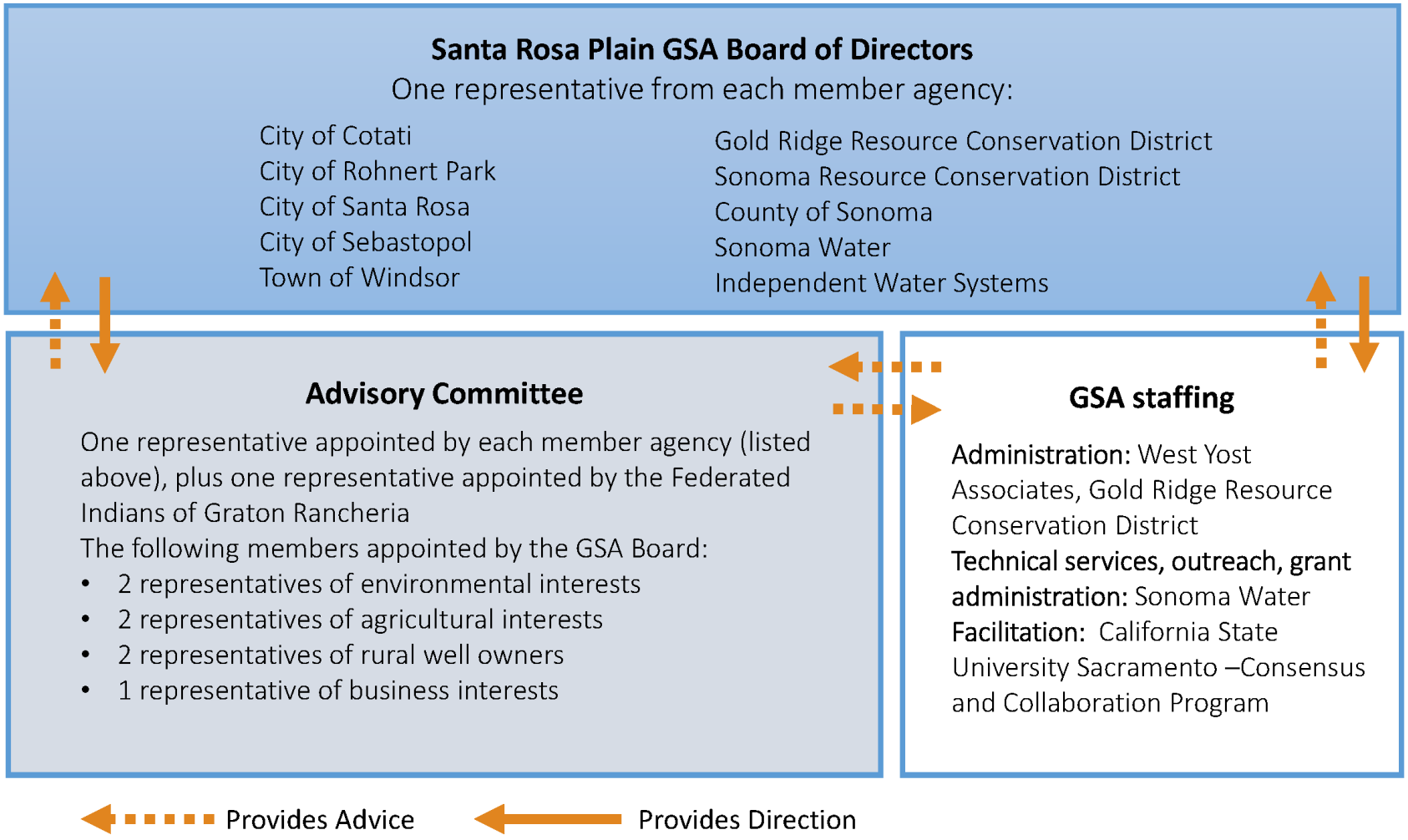


Figure ES-2. GSA Organizational Structure

Figure ES-3a Santa Rosa Plain Water Sector and Water Use Type

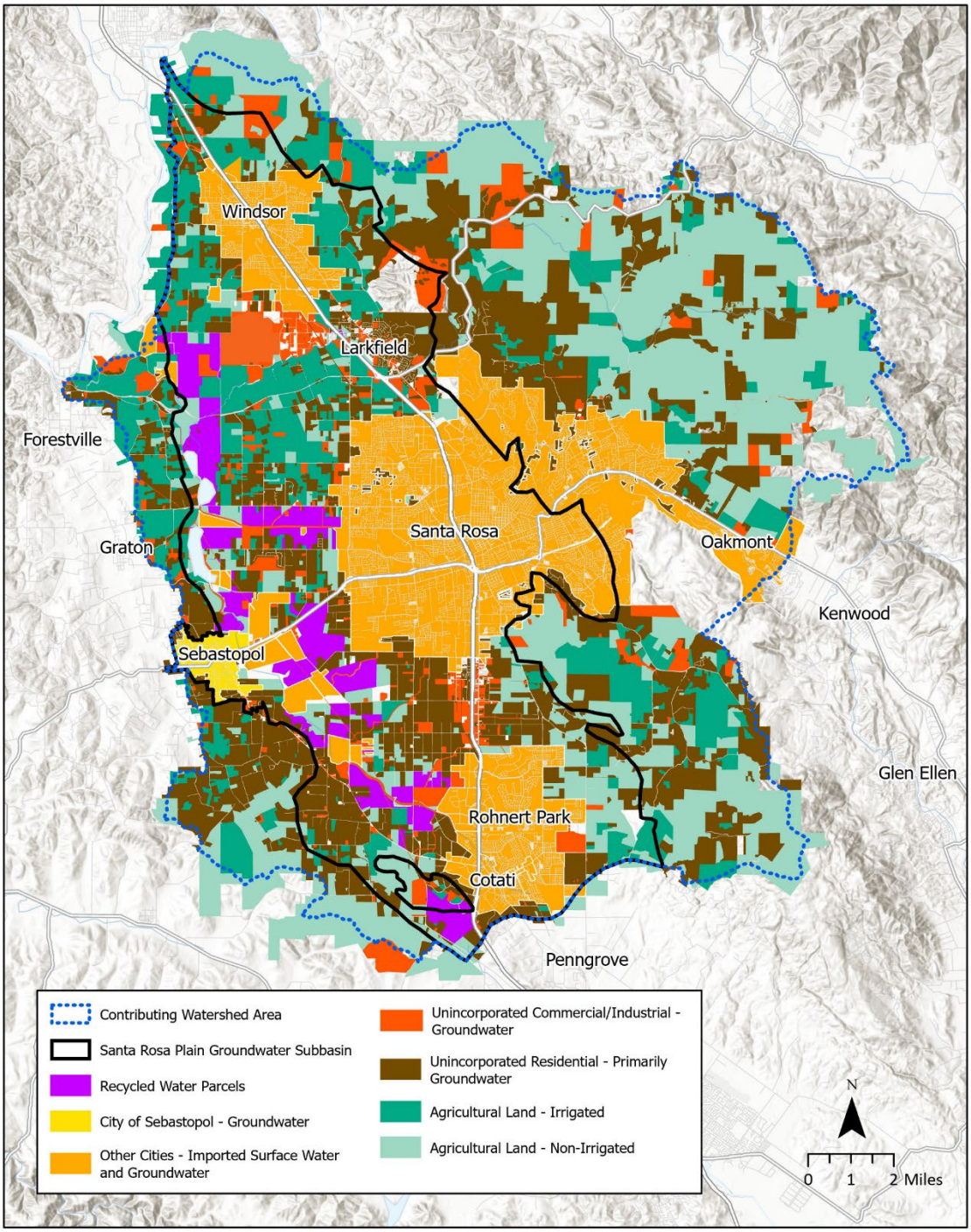


Figure ES-3a. Water Sector and Water Use

Figure ES-3b Santa Rosa Plain Disadvantaged Communities

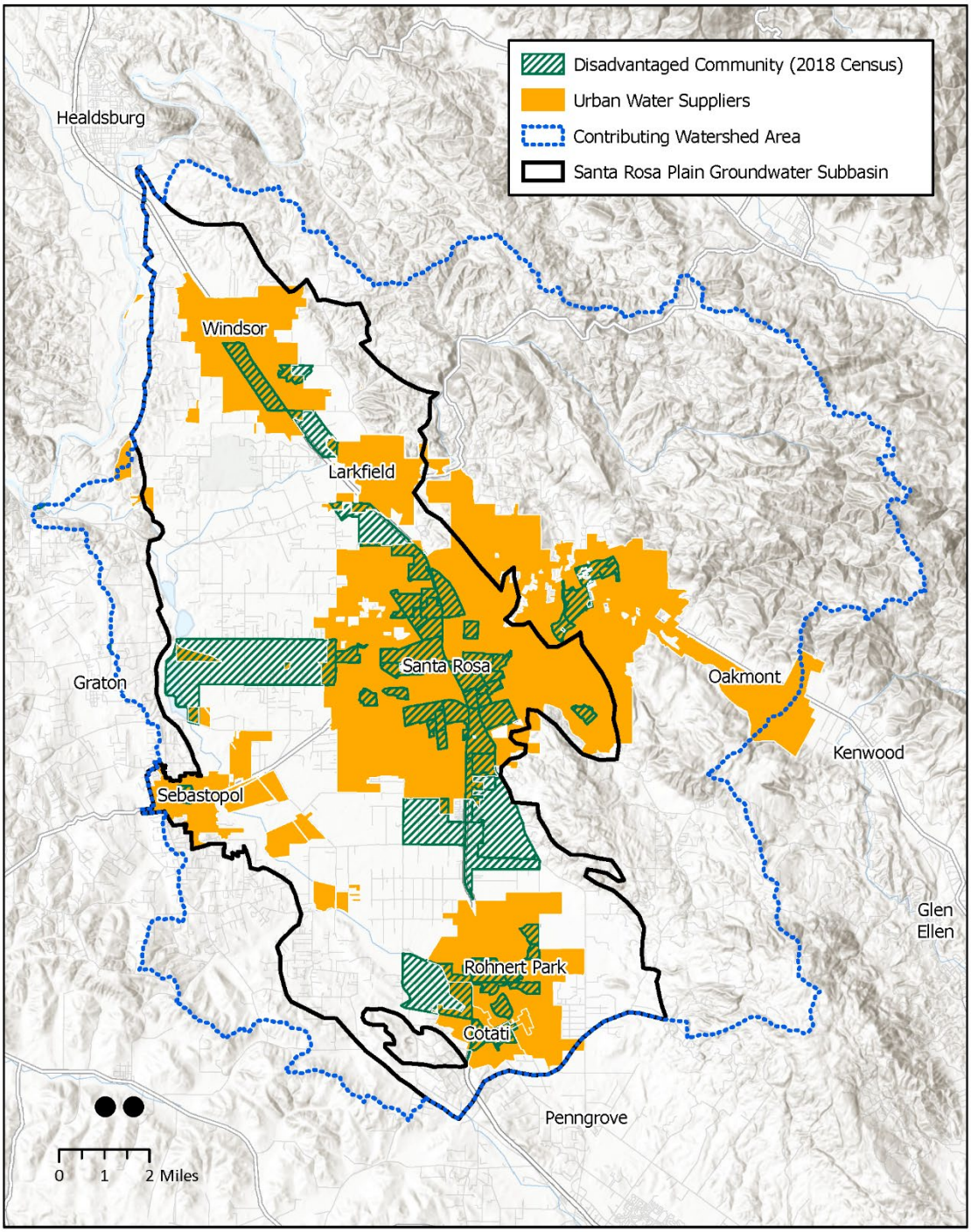


Figure ES-3b. Locations of Disadvantaged Communities

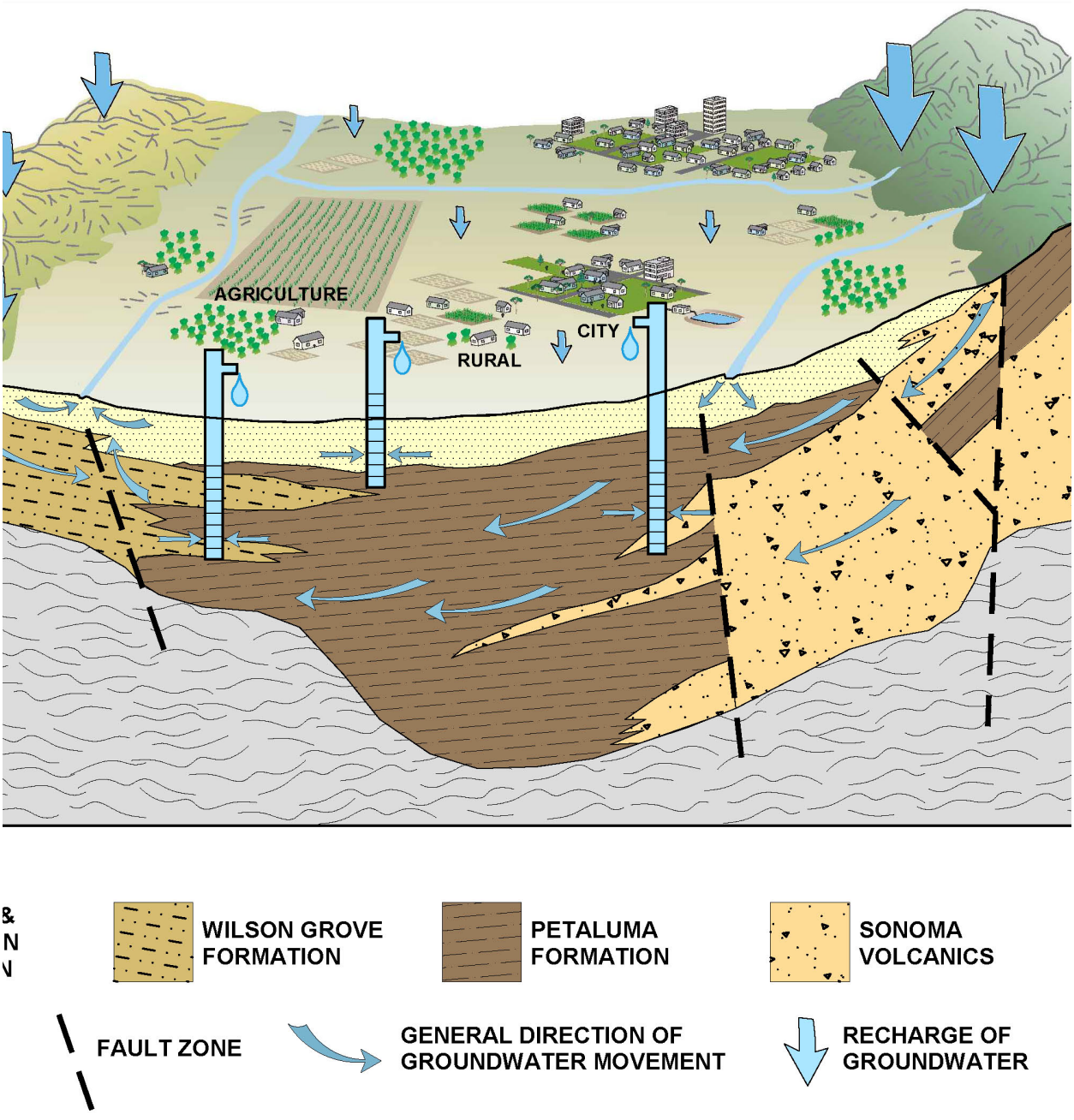


Figure ES-4. Fault Lines

The shallow aquifer system serves a number of different users and uses, with the primary extractions being from domestic water-supply wells and, in some areas, agricultural and public water-supply wells. In many areas the shallow aquifer system is locally and seasonally connected to creeks and streams and in some areas where groundwater levels are close to the ground surface, the shallow aquifer system provides water for vegetation communities in the Subbasin.

The deep aquifer system is generally confined to semi-confined and is not spatially connected with surface water (although hydraulic connections between the shallow and deep aquifers do provide for hydraulic connectivity between surface water and the deep aquifer). The deep aquifer system serves a combination of rural-residential properties with domestic water-supply wells in the unincorporated areas of the Subbasin, agricultural wells used for crop irrigation, industrial and commercial wells, and public water-supply wells for municipal and smaller public supply systems.

Primary data gaps in the HCM include the geometry and properties of aquifer and aquitards, how the faults in the Subbasin affect groundwater flow, and basin boundary characteristics. Additionally, more data are needed to better understand groundwater recharge and discharge mechanisms, including surface water-groundwater interactions, and the amount and locations of groundwater extractions.

ES.3.2 Current and Historical Groundwater Conditions

SGMA requires GSAs to evaluate groundwater conditions using six indicators of groundwater sustainability: groundwater levels, groundwater storage, groundwater quality, land subsidence, seawater intrusion, and interconnected surface water-groundwater. Because the Subbasin is not connected to or influenced by the ocean or bay, the seawater intrusion sustainability indicator is not applicable. In **Section 3**, previous studies, monitoring well data, and data from other monitoring networks are used to describe current and historical groundwater conditions for the remaining five sustainability indicators.

Groundwater Levels: Groundwater levels for 31 of the 37 shallow aquifer monitoring wells are generally stable and 6 of the wells exhibit increasing trends. More limited data from the deeper aquifer system finds that of the 24 wells, 7 exhibit relatively stable groundwater levels; 15 in the southern portions of the Subbasin and along the western boundary exhibit increasing trends and 2 wells, located east of and outside the Subbasin but within the contributing watershed area, have declining levels. Historically, groundwater-level declines exceeding 100 feet in the deep aquifer system occurred in the Rohnert Park-Cotati area associated with increases in municipal groundwater pumping due to population growth in the 1980s and 1990s. These declines have since recovered as the use of imported surface water and recycled water has increased and reduced municipal groundwater pumping in this area.

Groundwater Storage: The groundwater budget (described in Section ES-3.5) finds that the amount of groundwater stored in the shallow and deep aquifer systems is declining on average by about 2,100 acre-feet per year (AFY).

Land Surface Subsidence: Existing data from both Interferometric Synthetic-Aperture Radar (InSAR) and Global positioning system (GPS) stations currently do not indicate that inelastic (irrecoverable) land subsidence is occurring as a result of groundwater pumping.

Groundwater Quality: Groundwater quality monitoring performed throughout the Subbasin for numerous different studies and regulatory programs finds that groundwater quality is generally adequate to support existing beneficial uses. Groundwater quality is naturally poor in some local areas and there are some locally limited human-caused impacts on groundwater quality from land use activities, such as industrial, commercial, agriculture, septic systems, and urban activities.

Interconnected Surface Water and Groundwater: Multiple years of measuring streamflows at different locations combined with high-frequency groundwater monitoring provide evidence of the connection between groundwater and surface water in the Subbasin. In addition, an analysis of environmental beneficial users by a practitioners working group identified aquatic species and habitats that could be adversely affected by the depletion of interconnected surface water caused by groundwater pumping. More data are needed from monitoring wells near creeks and from stream gages to determine the specific impacts of groundwater pumping on surface water and on these groundwater dependent ecosystems (GDEs).

ES.3.3 Groundwater Flow Model

A computerized numerical groundwater flow model, the Santa Rosa Plain Hydrologic Model (SRPHM), developed by the USGS in 2014 and revised by Sonoma Water to incorporate more recent data, is used as a groundwater management tool and to calculate the combined groundwater flows into and out of the basin of both the shallow and deep aquifer**.** The model accounts for precipitation, surface water, and groundwater entering the Subbasin through runoff, streams, septic systems, and other sources; and surface water and groundwater leaving the basin through evapotranspiration, streams, pumping, diversions, and other means.

ES.3.4 Projected Future Basin Conditions, Land Use, and Climate Change

Sustainability in the Subbasin must be achieved and maintained even as conditions—including land use and climate—change. Assumptions for future projected land use changes and water demands were estimated for rural-residential groundwater pumping, agricultural land use footprint, and municipal demands. Two practitioner workgroups and surveys and input from the Advisory Committee helped develop the model data used to project future conditions.

The Santa Rosa Plain GSA chose a climate change scenario that provides for several very dry years through 2025; normal and wetter years through 2050; and then a long-term drought after the mid-twenty-first century. This climate scenario allows for a significant stress test for groundwater resources planning during the GSP implementation horizon. As part of its adaptive approach to groundwater management, the GSA anticipates revising and updating climate projections as part of the 5-year update.

ES.3.5 Water Budget

The water budget was developed using the surface water and groundwater computer model. The water budget provides an accounting and assessment of the total annual volume of surface water and groundwater entering and leaving the basin and the change of the volume of groundwater in storage under historical, current, and projected water budget conditions.

Figure ES-5 summarizes the major sources of groundwater inflows and outflows. Overall, groundwater outflows are larger than inflows, resulting in losses of groundwater in storage of about 2,100 AFY during the current modeled period (2012-2018).

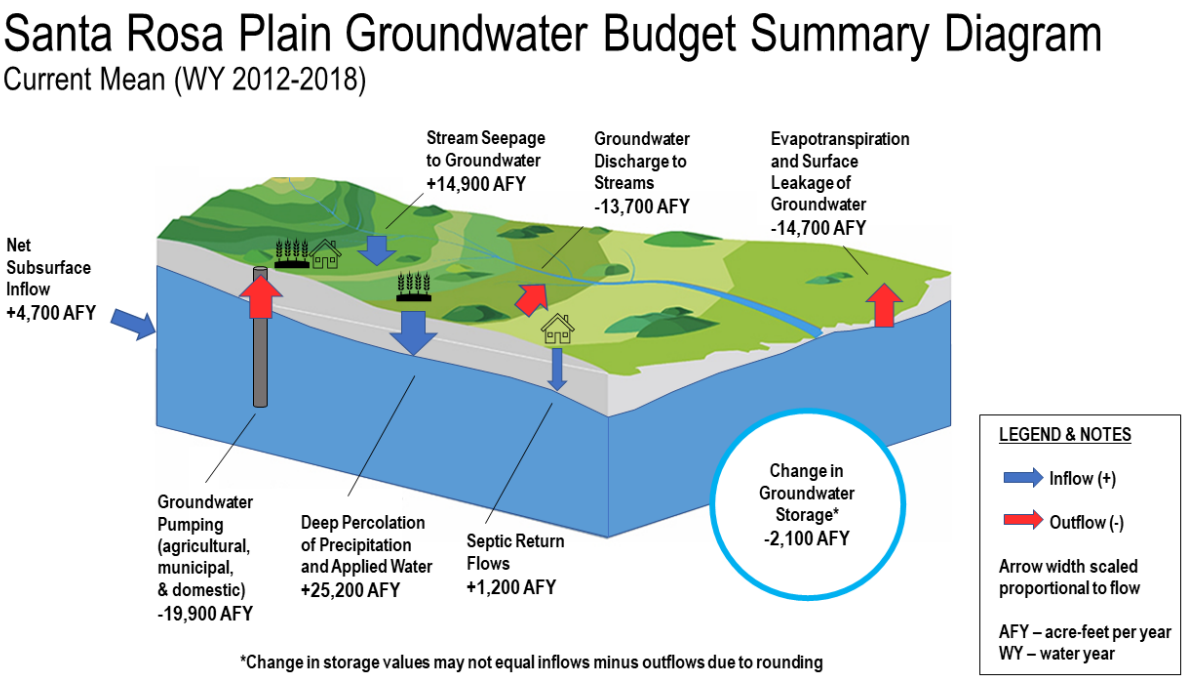


Figure ES-5. Current Water Budget

The projected water budget covers water years (WYs) 2021 to 2070. Storage change from the first year of the historical period in WY 1976 through to the end of the projected period in WY 2070 has a simulated cumulative loss of 97,200 acre-feet (AF). For the first part of the projected period, from WY 2021 to WY 2040, the simulated average loss of groundwater in storage is 200 AFY, reflecting the projected wet and very wet climate change scenario. For the full projected period from WY 2021 through WY 2070, that includes an extended drought beginning in 2050, the simulated average loss of groundwater in storage increases to 1,400 AFY for a total projected loss of 71,500 AF cumulatively over the 50-year period. **Table ES-1** summarizes the historical, current, and projected annual changes in groundwater storage for the Subbasin.

Figure ES-6 illustrates the changes in groundwater inflows, by source, in the historical, current, and future periods, while **Figure ES-7** illustrates the changes in groundwater outflows during the same time periods. The primary source of inflow, precipitation, is projected to increase

between 2021-2040, and then decline. Outflows are also projected to increase in the future, through outflows to streams and agricultural pumping.

Table ES-1. Summary Historical (WYs 1976-2018), Current (WYs 2012-2018), and Projected (WYs 2021-2070) Average Annual Change in Groundwater Storage (AFY)[a]

Water Budget Periods	
Average, Historical Period (1976-2018)	-600
Average, Current Period (2012-2018)	-2,100
Future Period	
Average (2021-2070)	**-1,400**

Note:

[a] Values rounded to nearest 100.

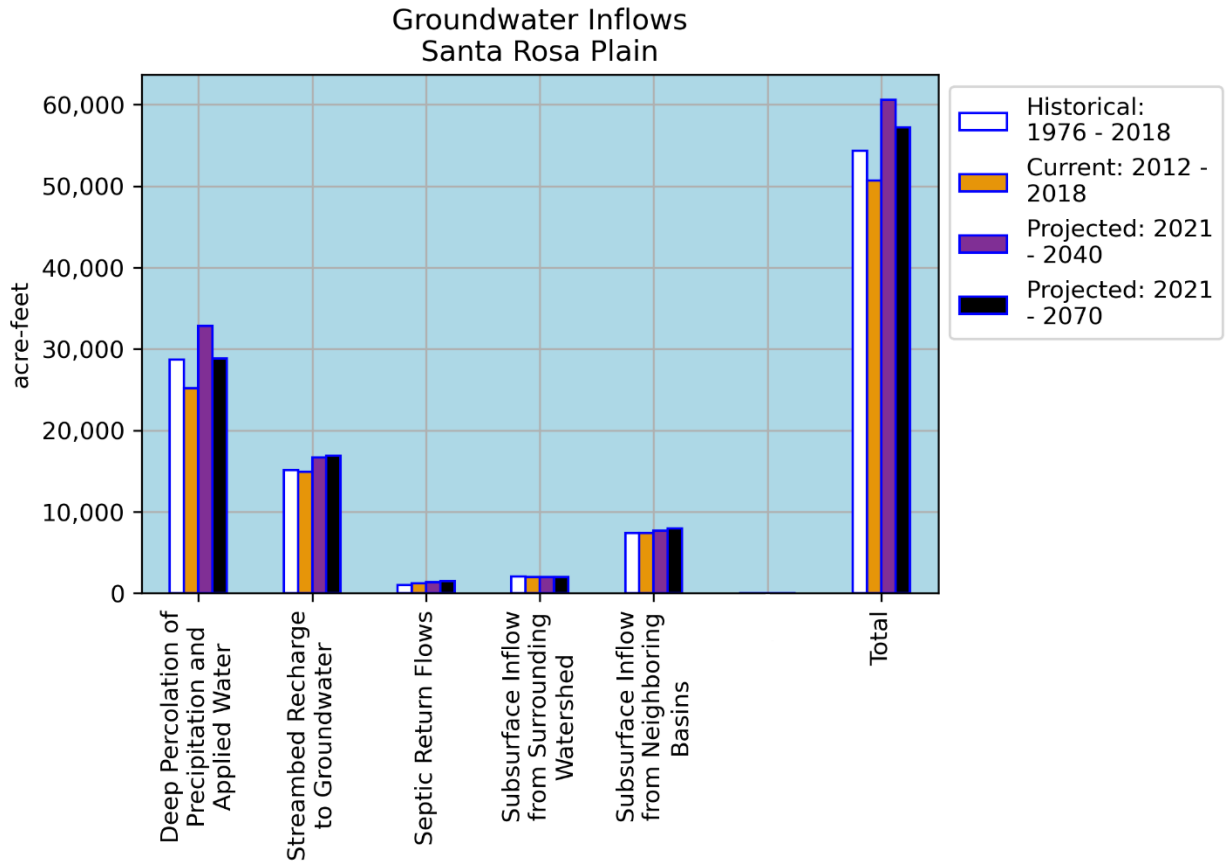


Figure ES-6. Historical, Current, and Future Groundwater Inflows

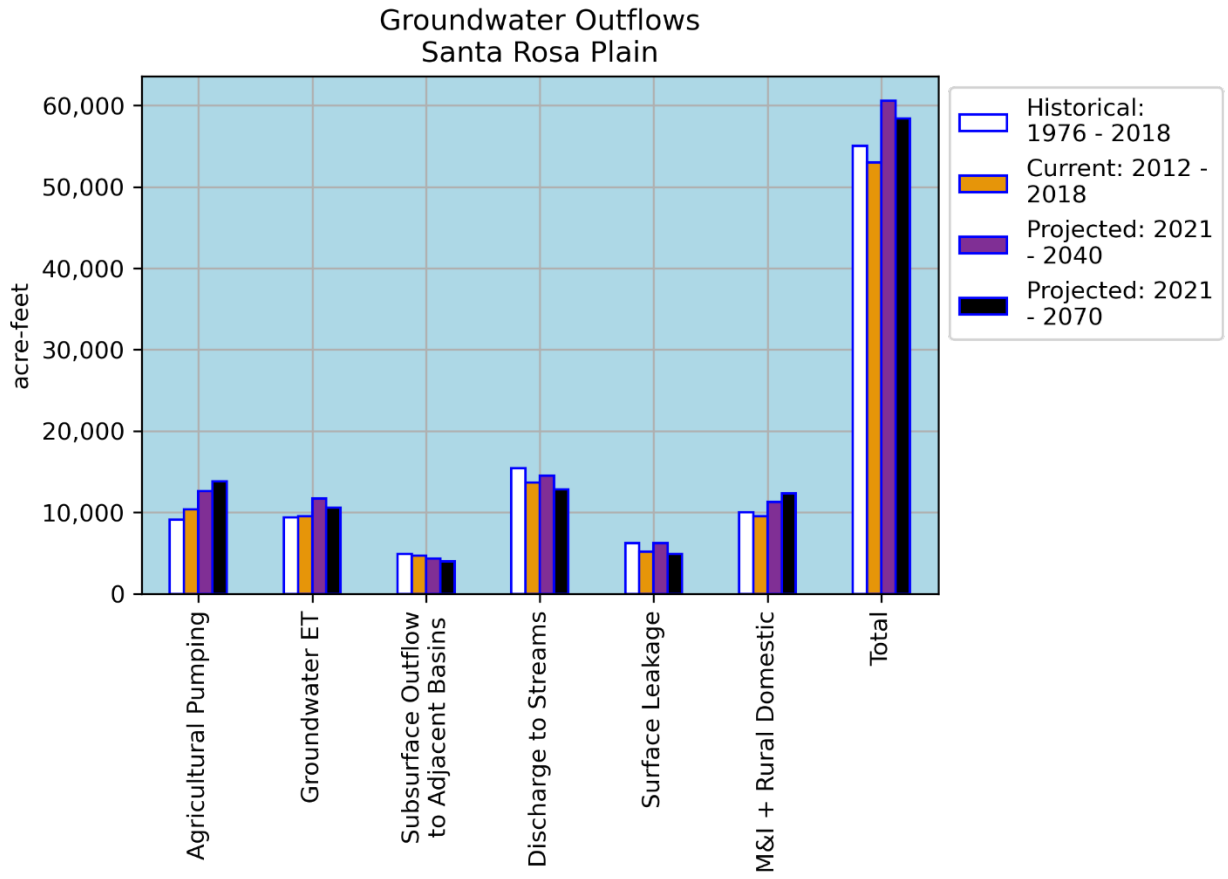


Figure ES-7. Historical, Current, and Future Groundwater Outflows

ES.3.6 Sustainable Yield

The sustainable yield of the Subbasin is an estimate of the quantity of groundwater that can be pumped on a long-term average annual basis without causing undesirable results. Basin-wide pumping within the sustainable yield estimate is neither a measure of, nor proof of, sustainability. However, estimates of sustainable yield using the current and projected simulations may prove useful in estimating the need for projects and management actions to help achieve sustainability.

The 20-year modeled period from WY 2021 to WY 2040 is used to determine the sustainable yield of the Subbasin. The average total annual groundwater pumping for this period is 23,900 AF, which is defined here as the sustainable yield. This value is 39 percent of the total groundwater inflows into the Subbasin, and is greater than the average total groundwater pumpage experienced during the current water budget period. However, the annual average projected pumping for the 50-year period from 2021 to 2070 of 26,100 AF exceeds the sustainable yield indicating that projects and management actions are needed to sustainably manage the Subbasin and avoid potential future undesirable results.

ES.4 Sustainable Management Criteria

SGMA provides specific language and criteria for establishing and maintaining sustainability, including the development of a sustainability goal, which Santa Rosa Plain GSA defines as follows:

The goal of this GSP is to adaptively and sustainably manage, protect, and enhance groundwater resources while allowing for reasonable and managed growth through:

- Careful monitoring of groundwater conditions
- Close coordination and collaboration with other entities and regulatory agencies that have a stake or role in groundwater management in the Subbasin
- A diverse portfolio of projects and management actions that ensure clean and plentiful groundwater for future uses and users in an environmentally sound and equitable manner

Central to SGMA is the development of sustainable management criteria (SMC) for the sustainability indicators, depicted on **Figure ES-8.** The Santa Rosa Plain GSA identified undesirable results, minimum thresholds (MTs), measurable objectives (MOs), and interim milestones for the sustainability indicators as discussed in **Sections 4.4** through **4.10** (refer to the breakout box for definitions). The five sustainability indicators applicable and relevant to the Subbasin are listed in the following paragraphs with a summary of what the GSA considers significant and unreasonable conditions for each indicator. **Table ES-2** provides the SMC for all sustainability indicators.

Chronic Lowering of Groundwater Levels: Chronic lowering of groundwater levels that significantly exceed historical levels or cause significant and unreasonable impacts to beneficial users.

Reduction in Groundwater Storage: Reduction of groundwater storage that causes significant and unreasonable impacts on the long-term sustainable beneficial use of groundwater in the basin, as caused by either:

- Long-term reductions in groundwater storage
- Pumping exceeding the sustainable yield

Degraded Groundwater Quality: Significant and unreasonable water quality conditions occur if an increase in the concentration of constituents of concern (arsenic, nitrates, and salinity) in groundwater leads to adverse impacts on beneficial users or uses of groundwater, due to either:

- Direct actions by Santa Rosa Plain GSP projects or management activities
- Undesirable results occurring for other sustainability indicators

Table ES-2. Santa Rosa Plain GSA Sustainable Management Criteria

Sustainability Indicator	Significant and Unreasonable Statement	Minimum Threshold	Measurement	Measurable Objective	Undesirable Result
Chronic lowering of groundwater levels	Chronic lowering of groundwater levels that significantly exceed historical levels or cause significant and unreasonable impacts on beneficial users.	**Stable Wells:** Maintain near historical observed ranges while accounting for future droughts and climate variability. Metric: Historical low elevations minus four-year drought assumption.	Monthly or monthly-averaged groundwater levels measured at representative monitoring point wells.	**Stable Wells:** Maintain within historical observed ranges. Metric: Historical median spring groundwater elevation	10% of RMPs (2 RMPs within the shallow or deep aquifer) exceed MT for 3 consecutive years
		Wells with Historical Declines and then recovery: Maintain above historical low elevations and protect at least 98% of nearby water supply wells. Metric: Shallower (more protective) of historical low elevations OR above the 98th percentile of nearby water supply well depths.		**Wells with Historical Declines and then recovery:** Maintain within recent (recovered or recovering) historical observed ranges. Metric: Recent (2010-2019) median spring groundwater elevation	
Reduction in groundwater storage	Reduction of groundwater storage that causes significant and unreasonable impacts on the long-term sustainable beneficial use of groundwater in the Subbasin, as caused by: • Long-term reductions in groundwater storage; or • Pumping exceeding the sustainable yield	Measured using groundwater elevations as a proxy. MT for groundwater storage is identical to the MT for chronic lowering of groundwater levels.	Annual groundwater storage will be calculated and reported by comparing changes in contoured groundwater elevations. However, monitoring for the chronic lowering of groundwater levels will be used to compare with MTs and MOs.	MO for groundwater storage is identical to the MO for chronic lowering of groundwater levels.	Undesirable result for groundwater storage is identical to the undesirable result for chronic lowering of groundwater levels.
Degraded water quality	Significant and unreasonable water quality conditions occur if an increase in the concentration of constituents of concern in groundwater leads to adverse impacts on beneficial users or uses of groundwater, due to: • Direct actions by Santa Rosa Plain GSP projects or management activities • Undesirable results occurring for other sustainability indicators.	The MT is based on two additional supply wells exceeding MCLs for (1) arsenic, (2) nitrate, or (3) salts (measured as TDS).	The number of public water supply wells with annual average concentrations of arsenic, nitrate, or TDS that exceed MCLs in groundwater quality data available through state data sources.	The MO is identical to the MT.	An undesirable result occurs if, during 2 consecutive years, a single groundwater quality MT is exceeded when computing annual averages at the same well, as a direct result of projects or management actions taken as part of GSP implementation.
Subsidence	Any rate of inelastic subsidence caused by groundwater pumping is a significant and unreasonable condition, everywhere in the Subbasin and regardless of the beneficial uses and users.	0.1 ft/year of inelastic subsidence (elastic and inelastic).	DWR-provided InSAR dataset average annual subsidence for each 100 meter by 100-meter grid cell.	The MO is identical to the MT (0.1 ft/year of subsidence)	Annual MT of 0.1 foot total subsidence is exceeded over a minimum 25-acre area **OR** Cumulative total subsidence of 0.2 foot is exceeded within 5-year period **AND** MT exceedance is determined to be correlated with: (1) groundwater pumping, (2) a MT exceedance of the Chronic Lowering of GWLs SMC (that is, groundwater levels have fallen below historical lows)
Depletion of interconnected surface water	Significant and unreasonable depletion of surface water from interconnected streams occurs when surface water depletion, caused by groundwater pumping within the Subbasin, exceeds historical depletion or adversely impacts the viability of GDEs or other beneficial users of surface water.	Maintain estimated streamflow depletions below historical maximum amounts. Metric: Shallow groundwater elevations are used as a proxy for stream depletion. The MT is the equivalent groundwater level, representing the 3 years (2014-2016) during which the most surface water depletion due to groundwater pumping was estimated between 2004-2018.	Monthly-averaged groundwater levels measured in representative monitoring points (shallow monitoring wells near interconnected surface water).	The MO is to maintain groundwater levels within historical observed ranges. Metric: Mean groundwater level for available dry-season observations between 2004 and 2020.	When MTs are exceeded at 40 percent of RMP wells during drought years and 10 percent of RMP wells during non-drought years.

GWL = groundwater levels

RMP = representative monitoring point



Figure ES-8. Sustainability Indicators

Land Surface Subsidence: Any rate of inelastic land subsidence caused by groundwater pumping is a significant and unreasonable condition, everywhere in the Subbasin and regardless of beneficial uses and users.

Depletion of Interconnected Surface Water: Significant and unreasonable depletion of surface water from interconnected streams occurs when surface water depletion, caused by groundwater pumping within the Subbasin, exceeds historical depletion or adversely impacts the viability of GDEs or other beneficial users of surface water.

SGMA requires the use of monitoring networks to quantitatively measure Subbasin health and the GSA's progress in meeting or maintaining sustainability. The monitoring network is described in **Section 5**. Because the Santa Rosa Plain GSA lacks detailed information needed to measure changes for several of the sustainability indicators, groundwater-level monitoring will initially be used as proxy for monitoring Subbasin health for reductions in groundwater storage and depletion of interconnected surface water. Additionally, an assessment of how other sustainability indicators could be influenced by groundwater-level MTs indicates that if groundwater level undesirable results are avoided, undesirable results for other sustainability indicators (reduction in groundwater storage, land subsidence, and degraded water quality caused by groundwater pumping) are not

Components of Sustainable Management Criteria

Sustainability Goal: A succinct statement of the GSA's objectives and desired conditions and how the basin will achieve these conditions.

Significant and Unreasonable Condition: A qualitative statement regarding conditions that should be avoided.

Undesirable Results: A quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the Basin or Subbasin.

Minimum Thresholds: The quantitative values that reflect what is significant and unreasonable at every measuring site. This value is what you want to try to avoid, and take action if reached.

Measurable Objectives: Specific, quantifiable goals at each representative monitoring site to maintain or improve groundwater conditions in order to maintain or achieve the sustainability goal for the basin. This value is what you want to achieve in the future, where you want to be.

Interim Milestone: The quantitative values that are set to reach at 5-year increments.

Representative Monitoring Sites: These are typical monitoring sites within the broader network of sites that reliably provide high quality data that characterize groundwater conditions in the basin.

expected to occur. For these reasons, groundwater levels are a main focus of sustainability monitoring.

ES.5 Monitoring Networks

SGMA requires monitoring networks to quantitatively measure Subbasin health and the GSA's progress in meeting or maintaining sustainability. **Section 5** describes the monitoring networks that are planned in the Subbasin and in the contributing watershed area. The section also discusses how the existing monitoring networks described in **Section 2** were evaluated and refined.

Consideration of Public Trust Resources

While SGMA does not require the Plan to address California's public trust doctrine, a 2018 California Court of Appeal ruling found that groundwater pumping that reduces the flow or volume of water in a navigable stream (and tributaries that supply navigable streams) may violate the public trust in certain fact-specific circumstances (Environmental Law Foundation et al. v. State Water Resources Control Board [2018] 26 Cal.App.5th 844). This Plan recognizes the importance of considering and protecting public trust resources to the extent feasible, including fish and wildlife and recreation, in the Subbasin's streams that are interconnected with groundwater. Working groups that included state and federal resource agencies and environmental non-profits and non-governmental organizations were created and facilitated to help develop the SMC for Interconnected Surface Water and to identify plants and animals that could be affected by surface water depletion due to groundwater pumping. The GSA developed a plan that considers public trust resources.

The purpose of the monitoring networks is to demonstrate progress toward achieving MOs, monitor impacts on groundwater users and uses, monitor changing groundwater conditions, and quantify changes in the water budget.

Representative monitoring point (RMP) networks are a subset of the larger monitoring network and are described in detail in **Section 5** (**Table ES-3**). Representative monitoring points within the RMP network are wells where sustainability indicators are monitored. **Figures ES-9** and **ES-10** illustrate the location of RMPs for chronic lowering of groundwater levels. As shown in **Table ES-3**, **Section 5** includes a monitoring plan for groundwater levels outside the Subbasin but within and along the boundaries of the contributing watershed. These wells are included to provide information on possible changes near the Subbasin boundaries.

Table ES-3. Monitoring Networks and Initial Representative Monitoring Point Networks

Sustainability Indicator	Monitoring Network	Initial Representative Monitoring Point Network
Chronic Lowering of Groundwater levels	96 wells within the contributing watershed area (including 85 wells in the Subbasin) • 61 wells are in the shallow aquifer • 35 wells in the deep aquifer	14 wells screened within the shallow aquifer 12 wells screened primarily within the deep aquifer
Subbasin Boundary Groundwater-level Monitoring Network: This network provides information on boundary conditions, but is not used for RMPs	16 wells outside boundaries but within contributing watershed, including: 8 wells – Wilson Grove Formation Highlands Basin 1 well – Petaluma Valley Basin 3 wells – Rincon Valley Subbasin 1 well – Alexander Valley Subbasin 2 wells – outside of defined basins	
Reduction in Groundwater Storage	96 wells within the contributing watershed area (including 85 wells in the Subbasin) • 61 wells are in the shallow aquifer • 35 wells in the deep aquifer	13 wells screened within the shallow aquifer 10 wells screened primarily within the deep aquifer
Degraded Water Quality	Existing supply well groundwater quality monitoring programs, as follows: Arsenic: 104 wells Nitrate: 122 wells Salts: 92 wells	Existing supply well groundwater quality monitoring programs, as follows: Arsenic: 104 wells Nitrate: 122 wells Salts: 92 wells
Land Surface Subsidence	3 GPS locations; InSAR satellite in most of the Subbasin	InSAR dataset
Interconnected Surface Water	18 stream gages; 10 shallow monitoring wells adjacent to streams	7 shallow monitoring wells adjacent to streams

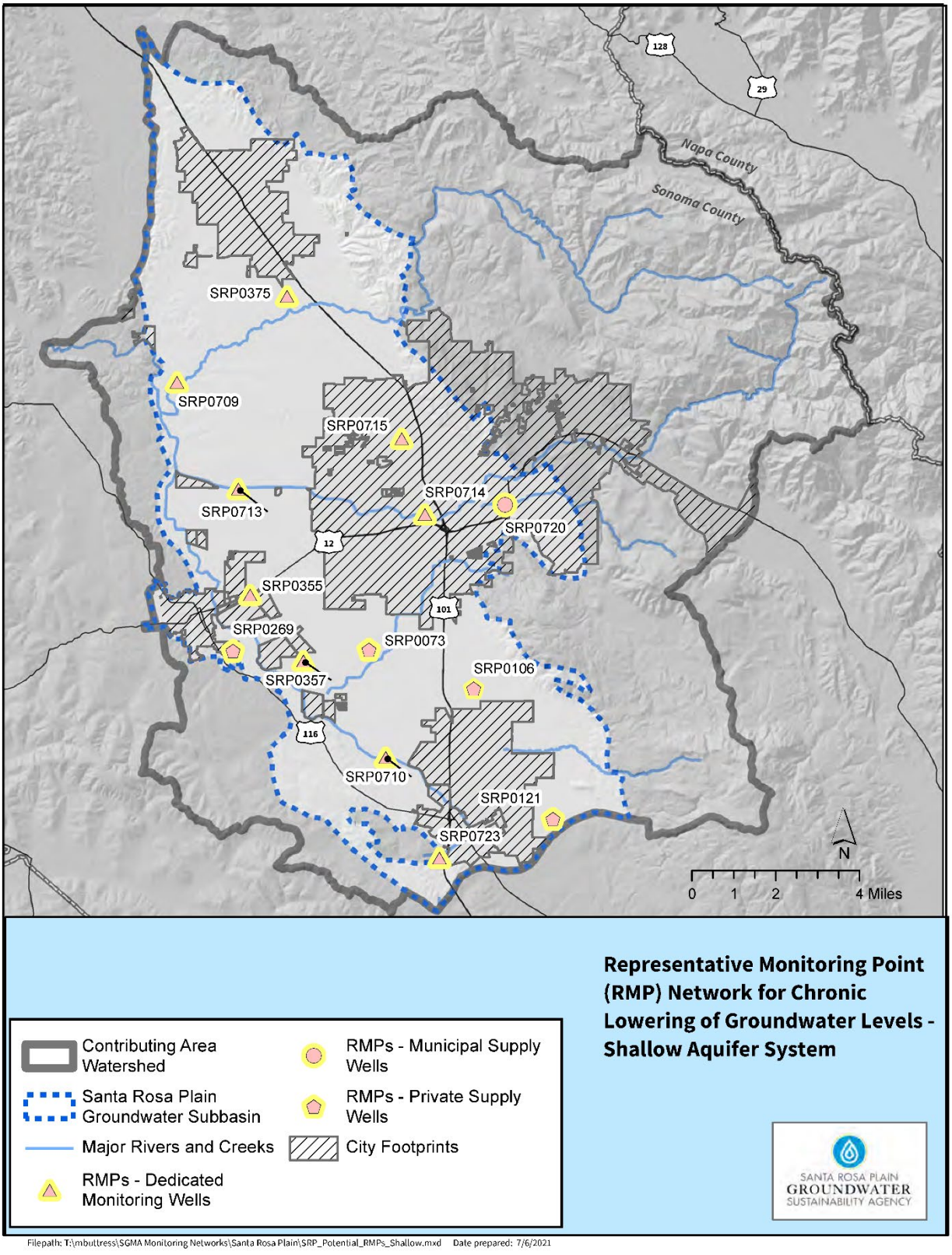


Figure ES-9. Representative Monitoring Point Network for Chronic Lowering of Groundwater Levels, Shallow Aquifer System

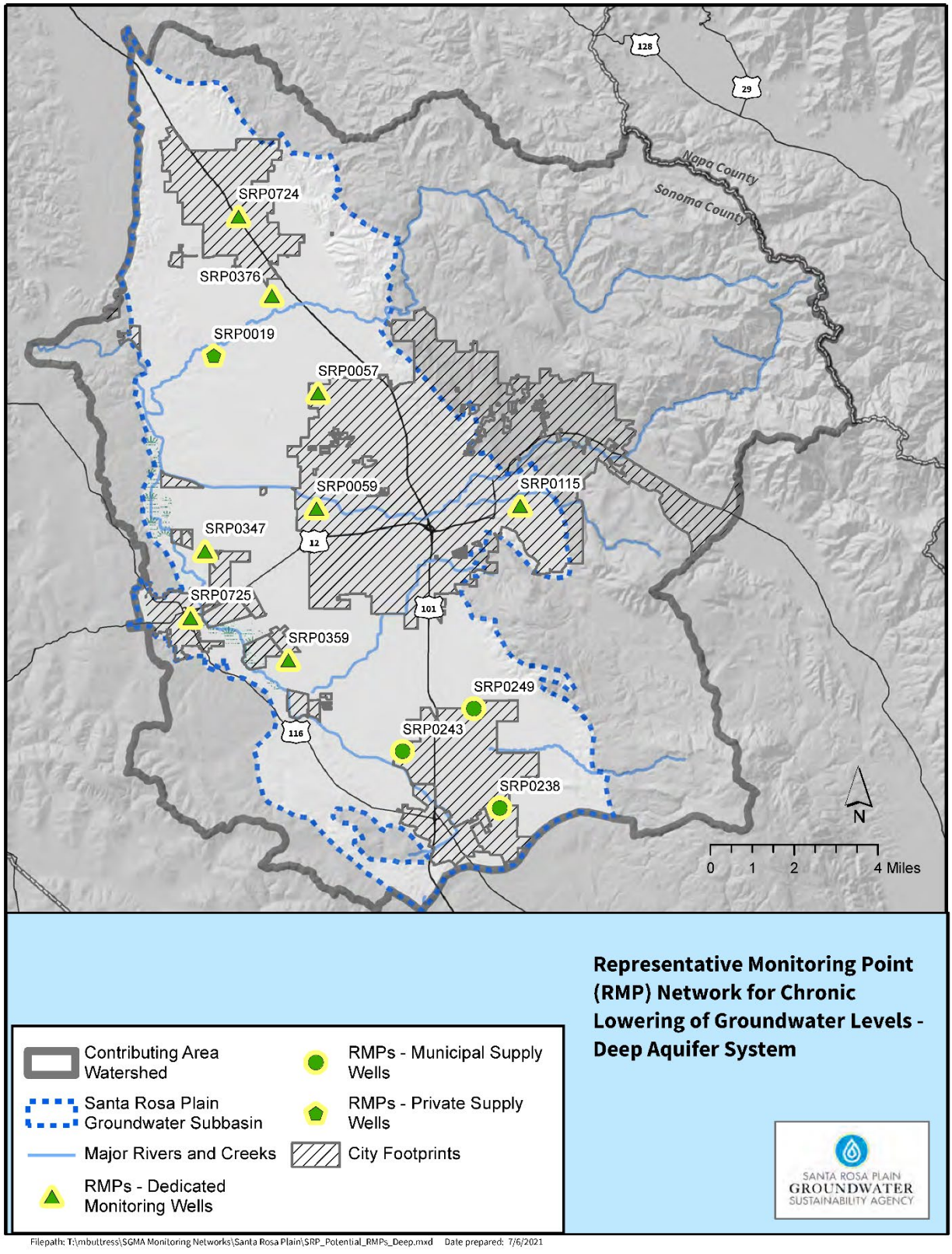


Figure ES-10. Representative Monitoring Point Network for Chronic Lowering of Groundwater Levels, Deep Aquifer System

Section 5 also identifies the data gaps that exist in the monitoring networks, and describes how these gaps will be filled during GSP implementation. The early years of GSP implementation will specifically focus on filling additional data needs to better monitor interconnected surface water, basin boundary conditions, and specific groundwater levels.

ES.6 Projects and Management Actions

GSPs are intended to help communities achieve groundwater sustainability as defined by the SMC and based on current and projected future groundwater conditions. **Section 6** of the GSP identifies conceptual projects and management actions that avoid undesirable results and unsustainable groundwater conditions described in **Section 4**. These projects and management actions attempt to balance groundwater pumping reductions with projects that maximize the use of supplemental sources of water.

Projects and management actions are grouped into three categories. The groupings are as follows:

Group 1

- Voluntary reductions in groundwater use through water conservation tools (such as appliance rebates and replacement, smart irrigation controllers, and water use audits), onsite rainwater capture, and greywater use.
    - The programs and education offered to domestic, commercial, and industrial groundwater users will mirror programs offered to regional municipal water users, which have led to a 37 percent reduction in per capita water use since 2010.
    - The programs and education offered to agricultural users would be focused on leveraging existing best management practices and working with farmers who have not had access to or the resources available to reduce water use.
    - For the purposes of simulating these projects using the model, it was assumed that these tools would result in a 20 percent reduction in rural domestic groundwater use and a 10 percent reduction in agricultural groundwater use.

Group 2

- Stormwater capture and recharge, such as floodplain inundation along and near streams. The focus of this project is to temporarily capture local stormwater during high flow events in detention basins or by spreading on farmlands during the dormant season, letting it slowly sink into the ground to recharge the shallow aquifer and provide baseflow to streams near critical coho salmon streams.

Group 3

- Aquifer storage and recovery of treated Russian River drinking water into existing or new deep water supply wells. This project entails using dedicated groundwater wells in reverse during the rainy season to store treated Russian River water when it is plentiful. A feasibility study found that even during drought years, there are periods when river flows are high enough to store water in aquifers for use during the summer, in droughts, or during emergencies.

The project groups were modeled incrementally to assess their effect on Subbasin groundwater resources. Model scenario results indicate that these projects result in raising groundwater levels and improving discharge to streams relative to the projected baseline without projects. The projects were also simulated to help mitigate potential declines in groundwater storage during future extreme droughts.

Considering current uncertainties due to modeling and project information, these project scenarios provide a pathway for reaching sustainability and preparing for future changed conditions in the Subbasin to meet GSP requirements and help address future extreme droughts. Additional data collection and project conceptualization during early phases of GSP implementation will help refine these scenarios and allow for consideration of additional scenarios, including mandatory restrictions on groundwater extractions, if necessary, to achieve sustainability.

ES.6.1 Management Actions

In addition to the projects previously described above, the GSA will initiate the following management actions in the first year of GSP implementation.

Study of and Prioritization of Potential Policy Options: This management action involves a collaboration between the GSA Board, local land use agencies, GSA member agencies, other Sonoma County GSAs, and stakeholders to assess and prioritize future policy options that may be appropriate for the GSA to consider adopting or recommending for adoption by other agencies. This study will prepare a prioritized list of potential policy options for the GSA Board to consider. Based on input from the Advisory Committee and GSA Board, the following initial list of policy options has been developed for potential inclusion in the assessment:

- Water conservation plan requirements for new development
- Discretionary review of well permits for any special areas identified in GSP
- Expand low impact development or water efficient landscape plan requirements
- Modifications to the County well ordinance to improve monitoring of groundwater conditions

- Well construction and permitting recommendations (for example, water quality sampling/reporting for contaminants of concern, requirement for water-level measurement access, and procedures for preventing cross-screening of multiple aquifers)
- Well metering program for non-residential wells
- Domestic well mitigation program
- Study of water markets
- Permitting and accounting of water hauling

Coordination of Farm Plans with GSP Implementation: This management action involves a collaboration between the three Sonoma County GSAs and interested members of the agricultural community to evaluate the feasibility of developing a program that coordinates farm plans, developed at individual farm sites, with the implementation of the basin-wide GSP.

ES.7 Plan Implementation

Section 7 describes the timing, process, and estimated costs of implementing the projects and management actions described in **Section 5** and the monitoring described in **Section 6**. The section describes the following implementation components:

- GSA Administration
- Communication and Engagement
- Routine Monitoring, Data Evaluation, and Annual Reporting
- Addressing Data Gaps
- Maintaining, Updating, and Improvements to Model
- Refining, Study, and Implementation of Potential Projects and Actions
- 5-Year Update to GSP

ES.7.1 Estimated Implementation Costs

Section 7 provides a high-level budget for the estimated cost over the initial 5 years of GSP implementation. Costs are based on the best estimates available and reflect Santa Rosa Plain GSA's understanding of the effort necessary for effective management and to comply with SGMA requirement for monitoring and reporting.

Costs are divided into the following categories: administration and operations (including legal and grants); communication and stakeholder engagement; routine monitoring, data evaluation, and reporting; addressing data gaps; model maintenance, updates, and improvements; conceptual projects and planning design; and 5-year GSP update. Percentage allocations of costs are shown on **Figure ES-11**.

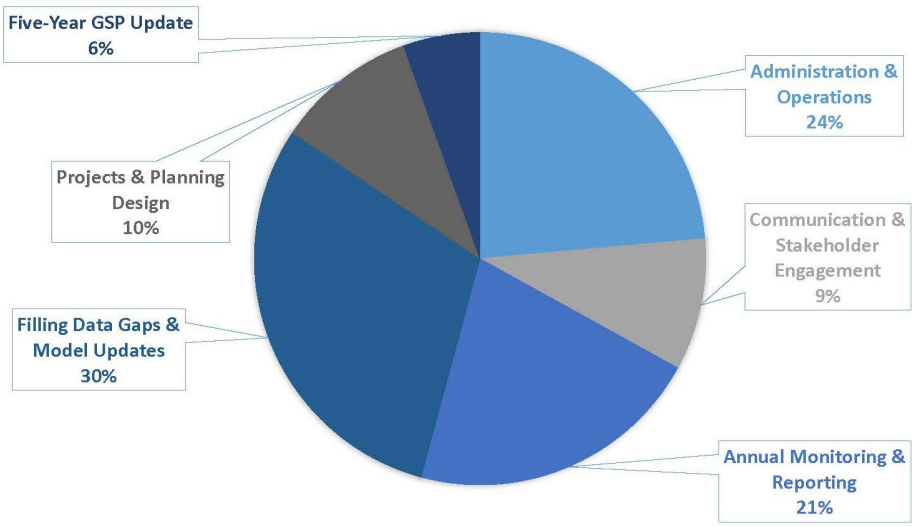


Figure ES-11. Percentage Breakdown of Cost Categories for 5-year GSP Implementation

The mid-range budget projections for the first 5 years total about $5.9 million, averaging about $1.2 million annually, as summarized in **Table ES-4**.

Table ES-4. Mid-range 5-year Total Budget Estimates

GSP Implementation Item	Year 1 2022 to 2023	Year 2 2023 to 2024	Year 3 2024 to 2025	Year 4 2025 to 2026	Year 5 2026 to 2027
GSA Administration and Operations	$285,000	$255,000	$250,000	$240,000	$255,000
Communication and Stakeholder Engagement[a]	$120,000	$95,000	$95,000	$95,000	$110,000
Annual Monitoring, Evaluation, and Reporting	$275,000	$220,000	$220,000	$220,000	$220,000
Data Gap Filling[a]	$100,000	$355,000	$551,000	$290,000	$0
Conceptual Projects and Planning Design[a]	$80,000	$165,000	$265,000	$20,000	$20,000
Model Updates[a]	$50,000	$150,000	$75,000	$50,000	$25,000
5-year GSP Updates[a]	$0	$0	$0	$100,000	$200,000
Subtotal	$910,000	$1,240,000	$1,456,000	$1,015,000	$830,000
10% Contingency - rounded to nearest $5,000	$90,000	$125,000	$145,000	$100,000	$85,000
Total	**$ 1,001,000**	**$ 1,364,000**	**$ 1,601,600**	**$ 1,116,500**	**$ 913,000**
Preliminary average annual costs equal approximately $1.2 million					

Note:

[a] Potential for bond funding/technical services support

ES.7.2 Funding Sources and Mechanisms

Currently, the GSA funds operations, outreach, and GSP development through a groundwater user fee. Municipal water suppliers pay an annual fee based on average annual groundwater extraction, as determined in 2019 when the fee was implemented. The County and Sonoma Water contribute funds to the Santa Rosa Plain GSA in lieu of the fee being collected from residential, agricultural, industrial, commercial, and other groundwater pumpers. The in lieu contribution will end on June 30, 2022, and all groundwater pumpers will be subject to the fee.

The Santa Rosa Plain GSA has successfully applied for and received more than $2 million in state grant funding for GSP development and to help address data gaps. Grant funding through Proposition 68 and future state bond measures continue to be a critical source of revenue, particularly for closing data gaps and for project planning and implementation. In addition, Santa Rosa Plain GSA has initiated a funding study to review its current fee and to identify alternative local financing options moving forward.

ES.7.3 Implementation Schedule

Group 1 projects and management actions are scheduled to be implemented by Santa Rosa Plain GSA and partner agencies by 2025. Group 2 and Group 3 projects have a longer planning horizon, and are anticipated to be implemented by 2028, as shown on **Figure ES-12**. However, some of the projects and management actions may be implemented sooner by other agencies and entities within the Subbasin in response to the 2021 drought conditions.

ES.8 References and Technical Studies

The final section of the GSP includes a complete list of references and technical studies that supported the development of this GSP.

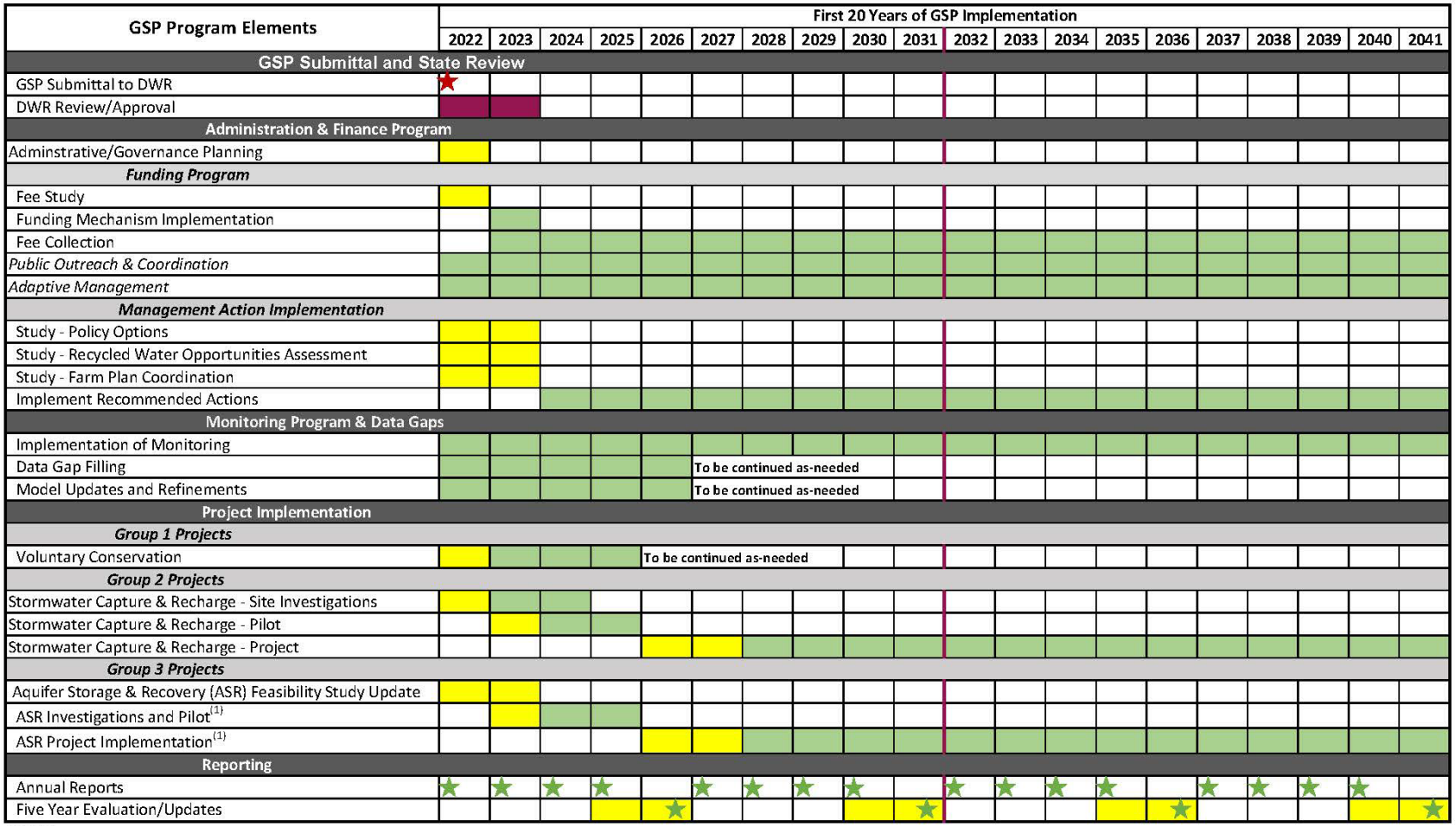


Figure ES-12. Santa Rosa Plain GSP Implementation Schedule

Groundwater Sustainability Plan for Santa Rosa Plain Groundwater Subbasin

Table of Contents

1 INTRODUCTION 1-1

1.1 Purpose of Groundwater Sustainability Plan 1-1

1.2 Guide to the Groundwater Sustainability Plan 1-3

1.3 Groundwater Sustainability Agency Authorities and Administrative Information 1-11

1.3.1 Santa Rosa Plain Groundwater Sustainability Agency 1-11

1.3.2 Santa Rosa Plain Groundwater Sustainability Agency Board and Advisory Committee 1-12

1.3.3 Groundwater Sustainability Agency Coordination 1-13

1.4 Stakeholder Engagement and Communication 1-13

1.4.1 Beneficial Uses and Users of Groundwater 1-14

1.4.2 Implementation of the Sustainable Groundwater Management Act – Phases of Work 1-14

2 DESCRIPTION OF PLAN AREA (23 CCR 354.8 b) 2-1

2.1 General Setting and Jurisdictional Areas (23 CCR 354.8 b) 2-1

2.2 General Land Use Characteristics (23 CCR 354.8 b) 2-6

2.3 Water Source Types and Water Use Sectors (23 CCR 354.8 b) 2-6

2.3.1 Groundwater 2-11

2.3.2 Imported Surface Water 2-12

2.3.3 Local Surface Water 2-12

2.3.4 Recycled Water 2-12

2.4 Existing Monitoring Programs and Networks (23 CCR 354.8 c, d, e) 2-12

2.4.1 Groundwater-level Monitoring 2-12

2.4.2 Groundwater Quality Monitoring 2-18

2.4.3 Climate Monitoring 2-19

2.4.4 Surface Water Monitoring 2-19

2.4.5 Land Surface Subsidence Monitoring 2-22

2.5 Existing Management Programs and Studies (23 CCR 354.8 c, d, e) 2-22

2.5.1 Santa Rosa Plain Groundwater Management Program 2-22

2.5.2 Urban Water Management Planning....2-23
2.5.3 North Coast Resource Partnership....2-25
2.5.4 Climate Change Studies and Planning....2-25
2.5.5 Groundwater Banking Feasibility Study....2-26
2.5.6 Water Conservation....2-26
2.5.7 Stormwater Management....2-29
2.6 General Plan and Related Plan Land Use Categories....2-31
2.6.1 General Plans....2-32
2.6.2 Specific Area Plans....2-37
2.6.3 Sonoma County Local Agency Formation Commission....2-37
2.7 Well Permitting Policies and Procedures....2-38
3 BASIN SETTING....3-1
3.1 Hydrogeologic Conceptual Model....3-1
3.1.1 Topography and Geography....3-2
3.1.2 Surface Water and Drainage Features....3-4
3.1.3 Soil Characteristics....3-6
3.1.4 Regional Geologic Setting....3-9
3.1.5 Principal Aquifer Systems and Aquitards....3-15
3.1.6 Effects of Faults on Groundwater....3-22
3.1.7 Groundwater Recharge and Discharge....3-23
3.1.8 Data Gaps and Uncertainty....3-25
3.2 Current and Historical Groundwater Conditions....3-26
3.2.1 Climatic Conditions and Trends....3-28
3.2.2 Groundwater Elevations and Trends....3-31
3.2.3 Estimated Changes in Groundwater Storage....3-58
3.2.4 Land-surface Subsidence....3-58
3.2.5 Groundwater Quality Conditions and Trends....3-64
3.2.6 Surface Water Conditions and Surface Water and Groundwater Connectivity....3-79
3.3 Water Budget....3-91
3.3.1 Overview of Water Budget Development....3-91
3.3.2 Overview of Model Assumptions for Water Budget Development....3-99
3.3.3 Historical and Current Water Budgets....3-102

3.3.4 Subbasin Water Supply Reliability 3-120
3.3.5 Uncertainties in Water Budget Calculations 3-120
3.3.6 Projected Water Budgets 3-121
3.3.7 Sustainable Yield 3-147
3.4 Management Areas 3-148
4 SUSTAINABLE MANAGEMENT CRITERIA 4-1
4.1 Definitions 4-2
4.2 Sustainability Goal 4-4
4.3 General Process for Establishing Sustainable Management Criteria 4-5
4.4 Sustainable Management Criteria Summary 4-6
4.5 Chronic Lowering of Groundwater Levels Sustainable Management Criteria 4-11
4.5.1 Locally Defined Significant and Unreasonable Conditions 4-11
4.5.2 Minimum Thresholds 4-12
4.5.3 Measurable Objectives 4-27
4.5.4 Undesirable Results 4-28
4.6 Reduction in Groundwater Storage Sustainable Management Criteria 4-29
4.6.1 Locally Defined Significant and Unreasonable Conditions 4-30
4.6.2 Minimum Thresholds 4-30
4.6.3 Measurable Objectives 4-32
4.6.4 Undesirable Results 4-32
4.7 Seawater Intrusion Sustainable Management Criteria 4-33
4.8 Degraded Water Quality Sustainable Management Criteria 4-33
4.8.1 Locally Defined Significant and Unreasonable Conditions 4-33
4.8.2 Minimum Thresholds 4-34
4.8.3 Measurable Objectives 4-43
4.8.4 Undesirable Results 4-44
4.9 Subsidence Sustainable Management Criteria 4-45
4.9.1 Locally Defined Significant and Unreasonable Conditions 4-47
4.9.2 Minimum Thresholds 4-47
4.9.3 Measurable Objectives 4-50
4.9.4 Undesirable Results 4-50
4.10 Depletion of Interconnected Surface Water Sustainable Management Criteria 4-52
4.10.1 Locally Defined Significant and Unreasonable Conditions 4-53

4.10.2 Minimum Thresholds....4-53
4.10.3 Measurable Objectives....4-59
4.10.4 Undesirable Results....4-59
4.10.5 Consideration of Public Trust Resources....4-61
5 MONITORING NETWORKS....5-1
5.1 Monitoring Network Objectives....5-1
5.2 Description of Monitoring Networks for Groundwater Sustainability Plan Implementation....5-1
5.2.1 Groundwater-level Monitoring Network....5-1
5.2.2 Groundwater Quality Monitoring Network....5-4
5.2.3 Surface Water Monitoring Network....5-14
5.2.4 Land Surface Elevation Monitoring Network....5-17
5.3 Representative Monitoring Point Networks....5-17
5.3.1 Representative Monitoring Point Network for Chronic Lowering of Groundwater Levels....5-17
5.3.2 Representative Monitoring Point Network for Degraded Water Quality....5-18
5.3.3 Representative Monitoring Point Network for Depletion of Interconnected Surface Water....5-24
5.3.4 Representative Monitoring Point Network for Land Subsidence....5-24
5.4 Assessment and Improvement of Monitoring Networks....5-24
5.4.1 Assessment and Identification of Data Gaps – Groundwater-level Monitoring Network....5-27
5.4.2 Assessment and Identification of Data Gaps – Surface Water Monitoring Network....5-33
6 PROJECTS AND MANAGEMENT ACTIONS....6-1
6.1 Identification of Projects and Management Actions....6-1
6.2 Project Descriptions....6-2
6.2.1 Water-Use Efficiency and Alternate Water Source Projects (Group 1)....6-3
6.2.2 Stormwater Capture and Recharge (Group 2)....6-6
6.2.3 Aquifer Storage and Recovery (Group 3)....6-8
6.3 Evaluation of Projects Through Scenario Modeling....6-12
6.4 Management Actions and Projects Requiring Additional Assessment....6-15
6.4.1 Coordination of Farm Plans with Groundwater Sustainability Plan Implementation....6-16

6.4.2 Assessment of Additional Recycled Water Opportunities 6-17
6.4.3 Assessment of Potential Policy Options for Groundwater Sustainability Agency Consideration 6-18
7 IMPLEMENTATION PLAN 7-1
7.1 Governance Structure and Planned Administrative Approach 7-1
7.2 Groundwater Sustainability Plan Implementation Components and Estimated Costs 7-2
7.2.1 Administration and Finance 7-2
7.2.2 Communication and Stakeholder Engagement 7-2
7.2.3 Annual Monitoring, Data Evaluation, and Reporting 7-3
7.2.3.1 Monitoring and Data Evaluation 7-3
7.2.3.2 Annual Reports 7-5
7.2.4 Addressing Data Gaps 7-7
7.2.4.1 Studies and Information Gathering 7-9
7.2.4.2 Monitoring Network Improvements 7-10
7.2.5 Maintaining, Updating, and Improvements to Model 7-11
7.2.6 Study and Implementation of Projects and Actions 7-12
7.2.7 5-year Update to Groundwater Sustainability Plan 7-15
7.2.8 Estimated 5-year Implementation Costs 7-16
7.3 Funding 7-17
7.3.1 Fees, Grants, and Other Funding Sources 7-18
7.4 Schedule 7-18
8 REFERENCES 8-2
8.1 Works Cited 8-2
8.2 Santa Rosa Plain GIS Data Sources 8-12

Appendices

Appendix 1-A. Comments Received on Santa Rosa Plain Groundwater Sustainability Plan
Appendix 1-B. Resolution of the Board of Directors of the Santa Rosa Plain Groundwater Sustainability Agency Forming a Groundwater Sustainability Agency for the Santa Rosa Plain
Appendix 1-C. Santa Rosa Plain Groundwater Sustainability Agency Board and Advisory Committee Members
Appendix 1-D. Santa Rosa Plain Groundwater Sustainability Agency Advisory Committee Charter
Appendix 1-E. Santa Rosa Plain Groundwater Sustainability Agency Advisory Committee Meetings 2017-2021

Appendix 1-F. Community Engagement Plan for Development and Adoption of a Groundwater Sustainability Plan Santa Rosa Plain Groundwater Sustainability Agency
Appendix 1-G. Stakeholder Assessment Report: Findings and Recommendations on Implementing the Sustainable Groundwater Management Act in Sonoma County
Appendix 3-A. Water Year Type Classification for Petaluma Valley, Santa Rosa Plain, and Sonoma Valley
Appendix 3-B. Groundwater Monitoring Well Hydrographs
Appendix 3-C. Santa Rosa Plain Hydrologic Model (SRPHM) Updates
Appendix 3-D. Future Groundwater Demands and Land Use Changes
Appendix 3-E. Selection of Global Circulation Model for Climate Change Projections
Appendix 4-A. Hydrographs of Representative Monitoring Points
Appendix 4-B. Definition of Drought for Sonoma County Groundwater Sustainability Plans
Appendix 4-C. Key Themes and Outcomes from Interconnected Surface water Practitioners Work Group
Appendix 4-D. Development of Sustainable Management Criteria of Interconnected Surface Water – Santa Rosa Plain
Appendix 5-A. Monitoring Protocols
Appendix 5-B. Comparative Hydrographs – Chronic Lowering of Groundwater Levels Representative Monitoring Points
Appendix 6-A. Simulation of Projects and Management Actions for the Santa Rosa Plain Groundwater Sustainability Plan
Appendix 6-B. Simulated Waterlevel Hydrographs from the Simulation of Projects and Management Actions
Appendix 7-A. Model Maintenance and Improvements for the Santa Rosa Plain Groundwater Sustainability Plan

Acronyms and Abbreviations

µg/L	microgram(s) per liter
AB	Assembly Bill
AF	acre-feet
AFY	acre-feet per year
AG	agricultural
ASR	aquifer storage and recovery
AWIA	America's Water Infrastructure Act
Basin	Petaluma groundwater basin
bls	below land surface
BMP	best management practice
Boundary Network	Subbasin Boundary Groundwater-Level Monitoring Network
CASGEM	California Statewide Groundwater Elevation Monitoring
CBI	Consensus Building Institute
CCR	California Code of Regulations
CCTAG	Climate Change Technical Advisory Group
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CII	commercial, industrial, and institutional
COC	constituent of concern
CoCoRaHS	Community Collaborative Rain, Hail and Snow Network
County	Sonoma County
CWC	California Water Code
DAC	Disadvantaged Community
DDW	Division of Drinking Water
DHS	Department of Health Services
DTW	depth-to-groundwater
DWR	California Department of Water Resources
EC	electrical conductivity

ET	evapotranspiration
ft/d	foot(feet) per day
ft/yr	foot(feet) per year
GAMA	Groundwater Ambient Monitoring and Assessment Program
GCM	general circulation model
GDE	groundwater dependent ecosystem
GHB	General Head Boundary
GHG	greenhouse gas
GMP	Groundwater Management Plan
GMWL	global meteoric water line
gpm	gallon(s) per minute
GPS	global positioning system
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GWL	groundwater level
HCM	hydrogeologic conceptual model
HUC	Hydrologic Unit Code
InSAR	Interferometric Synthetic Aperture Radar
IRWMP	Integrated Regional Water Management Program
ISW	interconnected surface water
JPA	Joint Exercise of Powers Agreement
km	kilometer(s)
LAFCO	Local Agency Formation Commission
LiDAR	Light Detection and Ranging
M&I	municipal and industrial
MCL	maximum contaminant level
mg/L	milligram(s) per liter
MO	measurable objective
MRP	Monitoring and Reporting Program
MS4	Municipal Separate Storm Sewer System

msl	mean sea level
MT	minimum threshold
MWELO	Model Water Efficient Landscape Ordinance
NA	not applicable
NAVD88	North American Vertical Datum of 1988
NCRP	North Coast Resource Partnership
NCRWQCB	North Coast Regional Water Quality Control Board
NGVD29	National Geodetic Vertical Datum of 1929
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resources Conservation Service
NWIS	National Water Information System
PBO	Plate Boundary Observatory
PRISM	Parameter-elevation Regressions on Independent Slopes Model
PRMS	Precipitation Runoff Modeling System
RCD	Resource Conservation District
RCP	Representative Concentration Pathway
Regional Boards	Regional Water Quality Control Boards
RMP	representative monitoring point
SC	specific conductance
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SGMA	Sustainable Groundwater Management Act
SMC	sustainable management criteria
SMCL	secondary maximum contaminant level
SNMP	Salt and Nutrient Management Plan
SRPGMP	Santa Rosa Plain Groundwater Management Program
SRPHM	Santa Rosa Plain Hydrologic Model
SSURGO	Soil Survey Geographic Database
SWRCB	State Water Resources Control Board
SWRP	Stormwater Resources Plan

TDS	total dissolved solids
TNC	The Nature Conservancy
TSS	Technical Support Services (a DWR program)
UNAVCO	University NAVSTAR Consortium
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
UWMP	Urban Water Management Plan
WRE	water resource element
WY	water year

GLOSSARY

* indicates definition from SGMA definitions.

Abandoned well — A well that has not been used for 1 year, unless the owner demonstrates intention to use the well again in accordance with the provisions of Section 115700 of the California Health and Safety Code.

Acre-foot (af) — Equivalent to the volume of water which will cover 1 acre of land to a depth of 1 foot; an acre-foot of water equals 43,560 cubic feet or 325,851 gallons.

Advanced wastewater treatment — Any physical, chemical or biological treatment process used to accomplish a degree of treatment greater than that achieved by secondary treatment.

Advanced water purification — Results in high-quality drinking water using advanced treatment processes available, including, but not limited to microfiltration, reverse osmosis, and high intensity ultraviolet light/advanced oxidation.

Agency* — Refers to a groundwater sustainability agency as defined in the Sustainable Groundwater Management Act.

Agricultural water management plan* — Refers to a plan adopted pursuant to the Agricultural Water Management Planning Act as described in Part 2.8 of Division 6 of the Water Code, commencing with Section 10800 et seq.

Alternative Plan* — Refers to an alternative to a Plan described in Water Code Section 10733.6.

Alluvium — A general geologic term describing stratified unconsolidated beds of sand, gravel, silt and clay deposited by flowing water.

Annual report — The report that transmits monitoring and progress towards meeting sustainable management criteria on the Plan, required on annual basis by Water Code Section 10728.

Appropriator — A party that diverts or extracts surplus water for use on nonriparian or nonoverlying land or for nonriparian or nonoverlying uses. Most public entities holding water rights are appropriators.

Aquiclude — A relatively impermeable rock formation that typically overlies or underlies an aquifer, confining its water under pressure. It usually has the capacity to absorb water, but is not sufficiently porous to conduct water quickly enough to supply a spring or a well. Generally replaced by the term aquitard.

Aquifer — A body of rock that is sufficiently permeable to conduct groundwater and to yield economically significant quantities of water to wells and springs.

Aquifer storage and recovery (ASR) — Injection of water into a well for storage in the aquifer and subsequent recovery from the same well.

Aquifer storage transfer and recovery (ASTR) - Injection of water into a well for storage In the aquifer and recovery from a different well, generally to provide additional water treatment.

Aquifer test — Commonly misnamed a pump test, it consists of pumping one well and recording both the drawdown in that well and may include measuring the drawdown caused by this pumping in other nearby observation wells. The data can be analyzed to show the hydraulic characteristics of the aquifer.

Aquitard — A confining bed or rock formation that retards the movement of water either to or from adjacent beds. Aquitards do not prevent the flow of water but may serve to store groundwater, although they are not effective as sources for wells or springs.

Area of origin* — In an interbasin transfer, the region exporting water.

GLOSSARY

* indicates definition from SGMA definitions.

Arid — A climate or region in which precipitation is so deficient in quantity or occurs so infrequently that intensive agricultural production is not possible without irrigation. Less than 25 cm of annual rainfall or a higher evaporation rate than precipitation rate.

Artesian — A reference to groundwater that is confined under pressure resulting in a condition in which the static water level stands above the top of the aquifer. The groundwater will rise above the overlying confining beds if provided the opportunity to escape upward via a well.

Artesian aquifer — A rock formation containing groundwater under more than hydrostatic pressure.

Artesian well — A well tapping a confined aquifer in which the static water level stands above the top of the aquifer. A flowing artesian well is one in which the tapped water flows out at the land surface. The term artesian well can be applied to a well in which pumping is required for the confined water to reach the surface.

ASR well — Dual purpose well to inject, store and recover source water in an aquifer for subsequent beneficial use.

Bank filtration — Extraction of groundwater from a well or caisson near or under a river or lake that induces infiltration from the surface water body, thereby improving and making more consistent the quality of water recovered.

Baseline* — Historic information used to project future conditions for hydrology, water demand, and availability of surface water and to evaluate potential sustainable management practices of a basin. Also baseline conditions.

Basin* — Groundwater basin or subbasin identified and defined in Bulletin 118 or as modified pursuant to Water Code 10722 et seq.

Basin setting* — The information about the physical setting, characteristics, and current conditions of the basin as described by the Agency in the hydrogeologic conceptual model, the groundwater conditions, and the water budget, pursuant to Subarticle 2 of Article 5.

Beneficial use — The use of water for some domestic, agricultural, industrial, social, recreational or instream use. The SWRCB lists 23 types of beneficial uses with water quality criteria for those uses established by the RWQCBs. Water rights holders must demonstrate that the use if both reasonable and beneficial.

Best available science* — The use of sufficient and credible information and data, specific to the decision being made and the time frame available for making that decision, that is consistent with scientific and engineering professional standards of practice.

Best management practice* — A practice, or combination of practices, that are designed to achieve sustainable groundwater management and have been determined to be technologically and economically effective, practicable, and based on best available science.

Board* — The State Water Resources Control Board.

Brackish water — Water containing dissolved minerals in amounts that exceed normally acceptable standards for municipal, domestic and irrigation uses. Considerably less saline than sea water.

California Department of Fish and Game (DFG) — DFG administers and enforces the California Fish and Game Code, and the regulations promulgated by the Fish and Game Commission.

California Department of Toxic Substances Control (DTSC) — The primary regulatory authority under both state and federal law for hazardous waste disposal within California.

GLOSSARY

* indicates definition from SGMA definitions.

California Department of Water Resources (DWR) — oversees the State Water Project (SWP) and has the ability to implement, promote and encourage statewide water conservation. The DWR also has the responsibility for investigating groundwater conditions, SGMA implementation, and recommending protective actions and the safety of non-federal dams. Updates the State Water Plan every 5 years.

Capillary fringe — The zone immediately above and continuous with the water table in which all or some of the soil or rock interstices are filled with water under less than atmospheric pressure.

CASGEM* — The California Statewide Groundwater Elevation Monitoring Program developed by the Department pursuant to Water Code Section 10920 et seq., or as amended.

Chloride — A compound of chlorine and a positive radical of one or more elements. Useful in recognition of seawater in groundwater, chloride is the dominant anion of ocean water and normally occurs in only small amounts in groundwater.

Closed basin — A basin whose topography prevents surface outflow of water. It is considered to be hydrologically closed if neither surface nor underground outflow of water can occur under average hydrologic conditions.

Community water system — A public water system that serves at least 15 service connections used by yearlong residents or regularly serves at least 25-year-long residents.

Cone of depression — The conical-shaped area around a well, produced in a water table or potentiometric surface by pumping.

Confined aquifer — A water-bearing subsurface stratum that is bounded above and below by formations of impermeable, or relatively impermeable, soil or rock.

Confined groundwater — Groundwater that is under pressure greater than that of the atmosphere so that, if provided an upward escape route, it will rise above the interface between the top of the aquifer and the impermeable bed which confines it.

Confining bed — A body of impermeable or distinctly less permeable material stratigraphically above one or more aquifers.

Conjunctive use — Also conjunctive operation, the operation of a groundwater basin in combination with a surface water storage and conveyance system to maximize water supply. Water is stored in the groundwater basin for later use by intentionally recharging a basin when a water supply is available.

Connate water — Water entrapped in the interstices of sedimentary rock at the time it was deposited. It may have been derived from ocean or fresh water sources and, typically, is highly mineralized.

Consumptive use — Use of water in a manner that makes it unavailable for use by others, generally because of absorption, evaporation, transpiration or incorporation in a manufactured product.

Contamination — The impairment of water quality as a result of the introduction of pathogens, chemical or industrial wastes, sewage or other pollutants in such concentrations that the water may eventually become unfit for its intended use or constitutes a public health hazard.

Contour line — An imaginary line that connects points of equal value (for example, land surface elevations) above or below a reference value or datum (for example, sea level). Contour lines may also demonstrate variations in other quantifiable properties such as sediment characteristics, porosity or the texture of deposits.

GLOSSARY

* indicates definition from SGMA definitions.

Cumulative departure plot — A graph of the departure from mean for a set of values, typically hydrologic data such as annual rainfall or annual streamflow. The difference between the annual value and the mean value for the full period of the data set is calculated for each data point, and each difference is added cumulatively from the beginning of the period to the end of the period. When portions of the graph have a positive slope, hydrologic values are greater than average (such as in a wet cycle); a negative slope occurs when hydrologic values are less than average (such as in a drought cycle).

Cycle testing — The systematic process in determining the operational recharge and backwashing routine for an ASR well.

Data gap* — A lack of information that significantly affects the understanding of the basin setting or evaluation of the efficacy of Plan implementation, and could limit the ability to assess whether a basin is being sustainably managed.

Deep percolation — Precipitation that moves downward below the root zone towards storage in subsurface strata.

De minimis well — A domestic well that extracts less than 2 acre-feet of groundwater annually. De minimis users cannot be required to report annual pumpage, but can be required to pay a fee if the GSA regulates them.

Depletion — The continued withdrawal of water from a reservoir or groundwater supply faster than its rate of replenishment.

Desalination — A process that converts sea water or brackish water to fresh water or an otherwise more usable condition through removal of dissolved solids. Also called desalting.

Destroyed well — A well that is no longer useful and that has been completely filled in accordance with the procedures described in Section ?B of the California Well Standards, DWR Bulletin 74-81 and Bulletin 74-90 (supplement to Bulletin 74-81).

Developed water — Water either imported into a groundwater basin or salvaged, reclaimed, or process for augmenting local surface water supplies that would not occur under natural conditions.

Domestic well — A water well used to supply water for the domestic needs of an individual residence or systems of four or fewer serviced connections.

Drawdown — The distance by which the potentiometric surface of a groundwater body is lowered by the withdrawal of water through pumping. Drawdown can be described as (1) the lowering of the potentiometric surface or water table as a result of groundwater withdrawal; (2) the difference between the height of a water table before pumping and the height of the water in a well during pumping; (3) diminished pressure in an aquifer as a result of groundwater withdrawal.

Drilling rig — The derrick, mast or standing equipment used to drill a well, together with the motive power, cable and tools used in drilling.

Drought — A prolonged period of dry weather characterized by an absence or a deficiency in rainfall. There is no measure for determining a drought, but qualitatively it usually causes a partial crop failure, a hydrologic imbalance or an interference with the ability to meet established water demands.

Dry well — A well that is constructed in the unsaturated zone of an aquifer and designed to optimize infiltration of water.

GLOSSARY

* indicates definition from SGMA definitions.

Effective porosity — The volume of interconnected openings available for transmission of fluids, frequently expressed as a percentage representing the ratio between volume of available openings and total volume of openings.

Electric well logging — The geophysical process of recording the formations traversed by a drill hole, based upon the measurements of two basic observable parameters: spontaneous potential and the resistivity of the formations to the flow of electric currents. Also geophysical well logging.

Emerging contaminant — A variety of synthetic chemicals, as well as some natural constituents, typically newly discovered in the environment due to improved analytical technological and heightened awareness, and not expected to be present in aquatic systems. For the most part, emerging contaminants are not new chemicals, and not new to the environment, but may suddenly become an issue due to new analytical technology and ability to quantify the constituent, change in regulatory standard, widespread or focused occurrence, heightened public awareness, new toxicological evidence, new chemical or increase in use, or a new legal issue.

Environmental water — Water serving environmental purposes, including instream fishery flow needs, wild and scenic river flows, water needs of freshwater wetlands, and Bay-Delta requirements.

Evaporation — The vaporization of a liquid from a free surface at a temperature below the boiling point; a process that occurs whenever water in a liquid state comes into contact with the unsaturated atmosphere.

Evapotranspiration — That portion of the precipitation returned to the air through direct evaporation or by transpiration of vegetation, no attempt being made to distinguish between the two, or consumptive use by vegetation.

Extraction — The process of withdrawing groundwater from storage by pumping or other controlled means.

Fault — A break or fracture zone in the Earth's crust along which movement of the rock mass adjacent to the fracture has occurred, on at least one side of the break. As a result, the strata of a previously continuous formation are separated relative to one another, with the displacement ranging from inches to thou-sands of feet or hundreds of miles. A fault frequently acts as a barrier to the movement of groundwater.

Field capacity — The amount of water held in a soil by capillary action after gravitational water has percolated downward and drained away; expressed as the ratio of the weight of water retained to the weight of dry soil.

Flowing well — A well yielding water at the land surface without pumping or the aid of any lifting device, but through artesian pressure.

Gravel pack — Artificially placed gravel filter or envelope surrounding a well screen. A gravel pack in a properly developed well serves to stabilize the aquifer, prevents sand from entering the well, permits the use of a large screen slot with a maximum open area, and provides an or annular zone of high permeability, which increases the effective radius and yield of the well.

Groundwater — Subsurface water occurring in the zone of saturation.

Groundwater basin — A groundwater reservoir, defined on the basis of geological and hydrological conditions and possibly consideration of political boundary lines. Often described as a basin or trough-shaped structure that is filled with porous or permeable material that stores and transmits water.

GLOSSARY

* indicates definition from SGMA definitions.

Groundwater budget — A numerical accounting of the recharge, discharge and changes in storage of a geographically defined groundwater system.

Groundwater capture — Increase in the productivity of an aquifer by increasing the recharge rate or by reducing the rate of unused discharge.

Groundwater dependent ecosystem* - Ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface.

Groundwater flow* — The volume and direction of groundwater movement into, out of, or throughout a basin.

Groundwater management — The planned and coordinated management of a geographically defined groundwater system with the overall goal of long-term sustainability of the resource.

Groundwater management plan — A comprehensive written document developed for the purpose of groundwater management and adopted by an agency having appropriate legal or statutory authority.

Groundwater storage coefficient — The volume of water released from storage or taken into aquifer storage per unit of surface area of the aquifer per unit of change in the pressure or the head.

Groundwater table — The surface between the zone of saturation and the zone of aeration or the level at which the hydraulic pressure of a body of unconfined groundwater is equal to atmospheric pressure. No water table exists if the upper surface of the zone of saturation is in contact with an overlying confining layer.

Hardness — The content of metallic ions which react with sodium soaps to produce solid soaps or scummy residue and which react with negative ions. Hardness is normally expressed as the total concentration of Ca^{+2} and Mg^{+2} as milligrams per liter equivalent to $CaCO_3$.

Head or static head — Water-level elevation in a well or elevation to which the water of a flowing artesian well will rise in a pipe extended high enough to stop the flow.

Hydraulic conductivity (permeability coefficient) — The degree of permeability of a porous or water-bearing stratum, expressed as the rate of flow of water in gallons/day through a cross section of I square foot at a unit hydraulic gradient at either the prevailing temperature in the field or at a temperature adjusted to 60 degrees Fahrenheit or 15.6 degrees Centigrade. The conductivity can also be expressed in ft/day, cm/s or m/day.

Hydraulic gradient — The slope or gradient of the water table or piezometric or potentiometric surface in the direction of greatest change. A gradient may be expressed as a ratio (vertical to horizontal), a fraction (feet per mile, meters/kilometer), percentage (vertical distance as a percentage of horizontal distance) or as an angle (degrees).

Hydraulic head gradient — In an aquifer or surface watercourse, the change in total head per unit distance of flow in a given direction from a given point, usually in the direction of greatest rate of change.

Hydrogeology — The science that deals with subsurface waters, subsurface water quality and related geologic aspects of surface waters.

Hydrograph — A time record of groundwater level or stream discharge at a given cross section or stream surface elevation, and at a given point. Stream hydrographs generally indicate rate of flow and represent stage, flow, velocity or other characteristics, while groundwater hydrographs represent water level or head.

GLOSSARY

* indicates definition from SGMA definitions.

Hydrologic budget; balance — An accounting of the inflow, outflow, storage and evaporation of water from a hydrologic unit, such as a drainage basin, aquifer, soil zone, lake or reservoir, and expressed by the hydrologic equation as the relationship between inflow and outflow including evaporation, precipitation, runoff and water storage within a hydrologic unit over a specified period of time.

Hydrologic cycle — The process involving the continuous circulation of water from the oceans and the land surface of the Earth to the atmosphere through transpiration and evaporation, and its eventual return to the Earth's surface through various forms of precipitation.

Hydrologic equation — Inflow minus Outflow = +/- Change in Storage. Also called the Law of Mass Conservation, water budget, water balance, hydrologic equation.

Hydrologic region — A study area, consisting of one more planning subareas.

Hydrology — The study of the origin, distribution and circulation of water of the Earth including precipitation, streamflow, infiltration, groundwater storage and evaporation.

Hyporheic zone — Located in the beds and banks of a stream where water and solutes can exchange through the pores spaces and surface water and groundwater mix, linking aquatic and terrestrial systems. The hyporheic zone can be several feet to hundreds of feet deep and wide, depending upon geology and stream channel morphology.

Impermeable — A textural condition of rock, sediment or soil that makes it incapable of transmitting fluid under pressure. The cause is generally low porosity or the presence of small individual pores that lack connectivity.

Imported water — Water transported into a watershed from a different watershed. Native water is water that occurs naturally within a watershed.

Infiltration — (1) The flow of a fluid, such as water, into a solid substance through pores or small interstices, and particularly referring to the movement of water into soil or porous rock; (2) the absorption by soil of water either from precipitation or streamflow; (3) the amount of groundwater that enters pipes through breaks, joints or porous walls.

Infiltration galleries — Buried trenches (often containing slotted pipes or other structural components for water storage space) in permeable soils that allow infiltration through the unsaturated zone to an unconfined aquifer.

Infiltration rate — Rate at which a soil under specified conditions can absorb falling rain or melting snow; in recharge, the rate at which water drains into the ground when a recharge basin is flooded, expressed as quantity of water per unit time.

Injection well — A well through which water is injected to recharge an aquifer, either by pumping or by gravity flow.

In lieu recharge — Groundwater recharge by substituting surface water for groundwater, and accounting for the groundwater saved/stored for future beneficial use.

Interested parties* — Persons and entities on the list of interested persons established by the Agency pursuant to Water Code Section 10723.4.

Interim milestone* — A target value representing measurable groundwater conditions, in increments of five years, set by an Agency as part of a Plan.

Irrigation — Distribution of water to land through artificial means to enhance crop production, either where natural water sources are so deficient as to make crop production impossible or

where it is advantageous to supplement the natural water supply at certain critical stages in the development of crops.

Irrigation return flow — Applied water that is not transpired, evaporated or deep percolated into a groundwater basin, but returns to a surface water.

Joint powers agreement (JPA) — An agreement entered into by two or more public agencies that allows them to jointly utilize any power common to the two contracting parties. The JPA is defined in Chapter 5, Division 7 of Title I of the California Government Code, commencing with Section 6500.

Land retirement — Taking land out of agricultural production by leaving it fallow or letting it return to a natural state.

Land subsidence — The lowering of a natural land surface in response to: Earth movements; lowering of fluid pressure (or lowering of groundwater level); removal of underlying supporting materials by mining or solution of solids, either artificially or from natural causes; compaction caused by wetting (hydrocompaction); oxidation of organic matter in soils; added load on the land surface; by tectonic activity; or by lithification.

Leaching — The flushing of salts from the soil by the downward percolation of surface water.

Leaching requirement — The theoretical amount of irrigation water that must pass (leach) through the soil beyond the root zone to keep soil salinity in the root zone within acceptable levels for sustained productive crop growth.

Level of development — In a planning study, the practice of holding constant the population, irrigated acreage, industry and wildlife so that hydrologic variability can be studied to determine adequacy of supplies.

Lithology — The description of rocks, especially in hand specimen and outcrop, on the basis of such characteristics as mineralogy, grain size and color.

Managed aquifer recharge (MAR) — Addition of surface water to a groundwater reservoir by human activity, such as putting surface water into spreading basins or injecting water through wells. Also artificial recharge (older term).

Management area — An area within a basin for which the Plan may identify different minimum thresholds, measurable objectives, monitoring, or projects and management actions based on differences in water use sector, water source type, geology, aquifer characteristics, or other factors.

Maximum contaminant level (MCL) — The highest concentration of a constituent in drinking water permitted under federal and state Safe Drinking Water Act regulations.

Measurable objectives* — Specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin.

Milligrams per liter (mg/L) — The weight in milligrams of any substance dissolved in one liter of liquid; nearly the same as parts per million.

Mineralization — The process whereby concentrations of minerals, such as salts, increase in water, a natural process resulting from water dissolving minerals found in rocks and soils through which it flows.

Minimum threshold* — A numeric value for each sustainability indicator used to define undesirable results.

GLOSSARY

* indicates definition from SGMA definitions.

Mining — Withdrawal of water from a groundwater resource at a rate that exceeds the rate of replenishment so that the supply is threatened or its economic usefulness is endangered. Refer to overdraft.

MOU — Memorandum of Understanding.

NAD83* — North American Datum of 1983 computed by the National Geodetic Survey, or as modified.

NAVD88* — North American Vertical Datum of 1988 computed by the National Geodetic Survey, or as modified.

National Pollutant Discharge Elimination System (NPDES) — A provision of Section 402 of the federal Clean Water Act of 1972 that established a permitting system for discharges of waste materials to water courses. The program is administered in California by the Regional Water Quality Control Boards.

Nitrate — A salt of nitric acid, a compound containing the radical (NO_3). Dissolved nitrogen in the form of nitrate is the most common contaminant identified in groundwater. Used colloquially to denote all forms of nitrogen.

Nonpoint source — wastewater or contaminant discharge other than from point sources. Also, refer to point source. An example is the regional contamination of groundwater by the overapplication of fertilizers in an agricultural region.

Outflow — The water that is discharged from a drainage basin or from a stream, lake, reservoir or aquifer system.

Overdraft — The intentional or inadvertent withdrawal of water from an aquifer in excess of the amount of water that recharges the basin over a period of years, during which if continued over time could eventually cause the underground supply to be exhausted, cause seawater intrusion, cause subsidence, cause the water table to drop below economically feasible pumping lifts, or cause a detrimental change in water quality. Synonym: groundwater mining.

Overdraft, critical conditions of — A groundwater basin in which the continuation of present practices would probably result in significant adverse overdraft-related environmental, social or economic impacts. There are 21 SGMA priority basins that DWR has defined as critically overdrafted.

Overlying land — Property, a portion of which overlies the water-bearing portion of a groundwater basin. If a portion of the property overlies the water bearing formation, the entire parcel located within the drainage area of the basin is overlying.

Parts per million (ppm) — A measure, by weight and not by volume, of the concentration of a foreign substance in a solution.

Pathogens — Any viruses, bacteria, protozoa or fungi that cause disease.

Perched groundwater — Unconfined groundwater separated from an underlying main body of groundwater by an unsaturated zone.

Percolation — The movement of water through small openings within a porous material.

Permeability — The capability of soil or other geologic formation to transmit water.

Permeable — Porous or fissured so that water easily soaks in or passes through.

Pesticide — Any organic or inorganic substance used to kill or inhibit plant or animal life, including any insecticide, herbicide, rodenticide, algicide, miticide, nematicide or fungicide.

GLOSSARY

* indicates definition from SGMA definitions.

Phreatic zone — The zone beneath the water table in which the pore space is filled with water. Also referred to as the saturated zone.

Piezometer — The basic field device for the measurement of hydraulic head. A pipe sealed along its length, open to water flow at the bottom and open to the atmosphere at the top.

Piezometric surface (potentiometric surface) — An imaginary surface representing the level to which groundwater will rise in a well as a result of the pressure under which it is confined in an aquifer.

Plain language* — Language that the intended audience can readily understand and use because that language is concise, well-organized, uses simple vocabulary, avoids excessive acronyms and technical language, and follows other best practices of plain language writing.

Plan* — A groundwater sustainability plan (GSP) as defined in SGMA.

Plan implementation* — An Agency's exercise of the powers and authorities described in the Act, which commences after an Agency adopts and submits a Plan or Alternative to the Department and begins exercising such powers and authorities.

Plan manager* — An employee or authorized representative of an Agency, or Agencies, appointed through a coordination agreement or other agreement, who has been delegated management authority for submitting the Plan and serving as the point of contact between the Agency and the Department.

Point source — A specific site from which waste or polluted water is discharged into a water body, the source of which can be identified and measured.

Pollution — Contamination or other change in the physical, chemical or biological properties of a substance, especially water (including change in temperature, taste, color or odor) that may eventually impair its quality for use by ecosystem organisms or create a nuisance or make the substance detrimental to public health, safety or welfare. Refer to contamination.

Porosity — Voids or open spaces in alluvium and rocks that can be filled with water, frequently expressed ratio of the volume of open space to the total rock volume, expressed as a percentage.

Potentiometric surface — Refer to piezometric surface.

Precipitation — The discharge of water, in either liquid or solid form, from the atmosphere to the surface of the Earth, including rain, drizzle, sleet, snow, snow pellets, snow grains, ice crystals, ice pellets, hail, dew and frost, usually measured in inches, hundredths of inches or millimeters of equivalent depth in water.

Prescriptive rights — The rights acquired over a period of years by parties who use water adverse to the rights of the lawful owner of a property.

Principal aquifers* — Aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems.

Public water system — A system for the provision of water for human consumption though pipes or other constructed conveyances that has 15 or more service connections or regularly serves at least 25 individuals daily at least 6o days a year.

Public Utilities Commission (PUC) — The successor to the California Railroad Commission. The PUC regulates the affairs of private investor owned utilities. It does not possess regulatory authority over public entities.

Pumping lift — The distance water must be lifted in a well from the well pumping level to ground surface. pumping level — the position of the groundwater surface in a well during pumping.

GLOSSARY

* indicates definition from SGMA definitions.

Pump tax — Also groundwater charge, extraction fee, production assessment, replenishment assessment, replenishment fee, or basin assessment fee. Assessments levied by public agencies on the amount of groundwater pumped for use in conducting groundwater management activities such as purchasing imported water to replenish groundwater extracted in excess of the perennial yield, building recharge facilities.

Radius of influence — The distance from the center of a well to the limit of the cone of depression.

Rainwater harvesting — Roof runoff is diverted into a tank, well, sump, or caisson where it is allowed to percolate to the water table where it is collected by pumping from a well, or stored for later use.

Reasonable use — Required by the California Constitution, Article X, Section 2, but a term which is not subject to a standard definition; one of the requirements that must be satisfied by any party asserting a water right in California. Primarily thought to refer to the method, manner, or means of use.

Receiving water — Groundwater that will receive the source water recharged.

Recharge — Flow to groundwater storage from precipitation, infiltration from streams, irrigation, spreading basins, injection well and other sources of water.

Recharge area or zone — Surface area or zone in which water infiltrates into the ground, reaches the zone of saturation, recharging the underlying aquifer.

Recharge basin — A surface facility, often a large pond or other similar artificial basin used to increase the percolation of surface water into a groundwater basin thereby replenishing a groundwater supply. Also infiltration basin.

Recharge well — Well that is used to recharge water directly to an aquifer.

Recovery efficiency — Calculated as the cumulative volume of water recovered from storage in an ASR well divided by the cumulative volume previously stored during the same operating cycle, usually expressed as a percentage.

Recycled water — Previously used domestic or municipal water (wastewater) that has been treated for reuse for potable or non-potable beneficial uses, and can serve as source water for recharge. Used synonymously with reclaimed water.

Reference point* — A permanent, stationary and readily identifiable mark or point on a well, such as the top of casing, from which groundwater level measurements are taken, or other monitoring site.

Regional Water Quality Control Boards (RWQCBs) — The primary state agencies that regulate water quality and which are operated pursuant to policies adopted or approved by the State Water Resources Control Board. The RWQCBs have authority to compel cleanup and abatement of groundwater pollution under the Porter-Cologne Water Quality Control Act.

Representative monitoring* — A monitoring site within a broader network of sites that typifies one or more conditions within the basin or an area of the basin.

Residence time — Average amount of time a fluid spends during transport through a volume of subsurface or a laboratory vessel.

Return flow — The portion of withdrawn water not consumed by evapotranspiration or system losses which returns to its source or to another body of water.

Reuse — The additional use of previously used water.

GLOSSARY

* indicates definition from SGMA definitions.

Reverse osmosis — Treatment method for removing salts from water by forcing water through a membrane.

Riparian land — Land that adjoins or abuts a natural watercourse.

Runoff — The surface flow of water from an area; the total volume of surface flow from an area during a specified time.

Safe yield — Refer to sustainable yield.

Saline — Consisting of or containing salts the most common of which are potassium, sodium or magnesium in combination with chloride, nitrate or carbonate.

Salinity — Generally, the concentration of mineral salts dissolved in water. Salinity may be measured by weight (total dissolved solids), electrical conductivity or osmotic pressure. Where sea water is known to be the major sources of salt, salinity is often used to refer to the concentration of chlorides in the water. Refer to total dissolved solids.

Salinity intrusion — The movement of salt water into a body of fresh water. It can occur in either surface water or groundwater bodies. There are six types of salinity intrusion, one of which is sea water intrusion.

Saltwater barrier — A physical facility or method of operating which is designed to prevent the intrusion of salt water into a body of fresh water.

Saltwater intrusion — The phenomenon occurring when a body of salt water, because of its greater density, invades a body of fresh water. It can occur either in surface or groundwater bodies. When groundwater is pumped from aquifers that are in hydraulic connection with the sea, the gradients that are set up may induce a flow of salt water from the sea toward the well.

Saturated zone — The area below the water table in which the soil is completely saturated with groundwater. Also zone of saturation.

Seasonal high* — The highest annual static groundwater elevation that is typically measured in the Spring and associated with stable aquifer conditions following a period of lowest annual groundwater demand.

Seasonal low* — The lowest annual static groundwater elevation that is typically measured in the Summer or Fall, and associated with a period of stable aquifer conditions following a period of highest annual groundwater demand.

Seawater intrusion* — The advancement of seawater into a groundwater supply that results in degradation of water quality in the basin, and includes seawater from any source.

Sediment — Soil or mineral material transported by water and deposited in streams and channels. Sediments constitute the major aquifers in California.

Seepage — The gradual movement of a fluid into, through or from a porous medium.

Sewage — The liquid waste from domestic, commercial and industrial establishments.

Soluble minerals — Naturally occurring substances capable of being dissolved.

Source water — Referred to as the water that will be recharged in a managed aquifer recharge project.

Specific capacity — The volume of water pumped from a well in gallons per minute per foot of drawdown.

Specific retention — As applied to a rock or soil it is the ratio of : 1) the volume of water which, after being saturated, it will retain against the pull of gravity to; 2) its own volume. It is stated as a percentage.

GLOSSARY

* indicates definition from SGMA definitions.

Specific yield — The ratio of the volume of water that a given mass of saturated rock or soil will yield by gravity to the volume of that mass.

Spreading water — Discharging native or imported water to a permeable area for the purpose of allowing it to percolate to the zone of saturation.

Spring — A place where groundwater naturally flows from rock or soil onto the land surface or into a water body. The occurrence of a spring is dependent upon the location of permeable and impermeable rock layers, the level of the water table and on the local topography.

State Water Resources Control Board (SWRCB) — Administrative agency with the primary responsibility for regulating and determining rights to surface water and subterranean stream flow. In addition, the SWRCB has primary responsibility for enforcing the constitutional reasonable use requirement.

Static groundwater level — The water level in a well that is not flowing or being pumped; generally the level immediately before pumping is started after being stopped for a period of time.

Statutory deadline* — The date by which an Agency must be managing a basin pursuant to an adopted Plan, as described in Water Code Sections 10720.7 or 10722.4.

Storativity — The volume of water released from storage in an aquifer in a vertical column of 1 ft^2 when the water table of potentiometric surface declines 1 foot. In an unconfined aquifer it is approximately equal to specific yield.

Supply augmentation alternatives — Water management programs (such as conjunctive use, water banking or water project facility expansion) that increase supply.

Surface spreading — Recharging water at the surface through recharge basins, ponds, pits, trenches, constructed wetlands, or other systems.

Surface supply — Water in reservoirs, lakes or streams; expressed either in terms of rate of flow or volume.

Sustainability indicator* — Any of the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, cause undesirable results, as described in Water Code Section 10721(x).

Sustainable yield* — The maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result.

Tertiary treatment — The treatment of wastewater beyond the secondary or biological stage. The term normally implies the removal of nutrients, such as phosphorus and nitrogen, and of a high percentage of suspended solids.

Total dissolved solids (TDS) — The quantity of minerals (salts) in solution in water, usually expressed in milligrams per liter or parts per million.

Transmissivity — The capacity of rock to transmit groundwater under pressure, expressed as a quantity of water, at the prevailing temperature, transmitted horizontally in a given period of time through a vertical strip of a given width of the fully saturated thickness of the aquifer, under a hydraulic gradient of one.

Uncertainty* — A lack of understanding of the basin setting that significantly affects an Agency's ability to develop sustainable management criteria and appropriate projects and management actions in a Plan, or to evaluate the efficacy of Plan implementation, and therefore may limit the ability to assess whether a basin is being sustainably managed.

GLOSSARY

* indicates definition from SGMA definitions.

Unconfined groundwater — Groundwater that has a free water table at atmospheric pressure. It is not confined under pressure beneath relatively impermeable rocks or soil.

Underground injection control (UIC) — the UIC Program under the Safe Drinking Water Act, found in Title 40 of the US Federal Code of Regulations, which provides minimum requirements for injection of fluids through wells into the subsurface, including ASR wells.

Unsaturated zone — A subsurface soil zone, also called the vadose zone or the zone of aeration that lies above the zone of saturation (the water table). The interstitial water tends to move under gravity despite being held by molecular capillary forces. This zone of aeration is divided into the belt of soil water, the intermediate belt and the capillary fringe which is just above the zone of saturation.

Urban water management plan* — A plan adopted pursuant to the Urban Water Management Planning Act as described in Part 2.6 of Division 6 of the Water Code, commencing with Section 10610 et seq.

Usable storage capacity — The quantity of groundwater of acceptable quality that can be economically withdrawn from storage.

U.S. Endangered Species Act (ESA) — Federal legislation which provides a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, and which provides a program for the conservation of such threatened and endangered species.

U.S. Environmental Protection Agency (EPA) — The agency was created to permit coordinated and effective governmental action on behalf of the environment. The EPA endeavors to abate and control pollution systematically, by proper integration of a variety of research, monitoring, standard setting and enforcement activities.

Vadose water — Water below the surface of the earth and above the water table, either held by the soil or percolating downward toward the water table through the vadose zone (unsaturated zone).

Waste — Loss of a resource such as water without substantial benefit or beneficial use.

Water banking — A water conservation and use optimization system whereby water is allocated for current use or stored in surface water reservoirs or in aquifers for later use. Water banking is a means of handling surplus water resources during wet years.

Water conservation — Reduction in applied water due to more efficient water use such as implementation of Urban Best Management Practices or Agricultural Efficient Water Management Practices. The extent to which these actions actually create savings in a water supply depends on how they affect total water use and depletion.

Water marketing — The selling or leasing of water rights in an open market.

Water quality — Used to describe the chemical, physical and biological characteristics of water, usually in regard to its suitability for a particular purpose or use.

Water reclamation — As used in this report. Includes water recycling, sea water desalting, groundwater reclamation and desalting agricultural brackish water.

Water recycling — The treatment of urban wastewater to a level rendering it suitable for a specific, direct, beneficial use.

Water source type* — Represents the source from which water is derived to meet the applied beneficial uses, including groundwater, recycled water, reused water, and surface water sources

identified as Central Valley Project, the State Water Project, the Colorado River Project, local supplies, and local imported supplies.

Water table — Refer to groundwater table.

Water transfer — Conveyance of groundwater or surface water from one area to another that involves crossing a political or hydrologic boundary. A voluntary change in a point of diversion, place of use, or purpose of use that may involve a change in water rights. A long-term transfer shall be for any period in excess of one year (California Water Code Section 1735.)

Water use sector* — Categories of water demand based on the general land uses to which the water is applied, including urban, industrial, agricultural, managed wetlands, managed recharge, and native vegetation.

Water year — A continuous 12-month period for which hydrologic records are compiled and summarized. In California, it begins on October 1 and ends September 30 of the following year. Water year 2003 ended Sept 30, 2003.

Water year type* — The classification assess the amount of annual precipitation in a basin.

Well, water well, "Water supply wells" or "supply wells" — Any artificial excavation constructed by any method for the purpose of extracting water from, or injecting water into, the underground. For purposes of this GSP, water supply wells includes all types of wells that provide water for beneficial uses, inclusive of private domestic wells, irrigation wells, industrial wells, commercial wells, and public supply wells. This does not include: (a) oil and gas wells, or geothermal wells constructed under the jurisdiction of the Department of Conservation, except those wells converted to use as water wells; or (b) wells used for the purpose of (1) dewatering during construction, or (2) stabilizing hillsides or earth embankments (Water Code Division 7, Chapter 10, Article 2, Section 13710).

Well casing — Serves as a lining to maintain an open hole from ground surface to the aquifer. It seals out surface water and any undesirable groundwater and also provides structural support against caving materials outside the well. Materials commonly employed for well casing are iron, steel and PVC.

Well completion report — California Water Code Section 13751 requires that anyone who constructs, alters, or destroys a water well, cathodic protection well, groundwater monitoring well, or geothermal heat exchange well must file with the Department of Water Resources a report of completion within 60 days of the completion of the work. Drillers submit their well completion reports with the Online System of Well Completion Reports (OSWCR, say ,Oscar,). OSWCR users create an account based on their C-57 license that DWR will validate. Upon approval users will be able to submit Well Completion Reports.

Well construction — The procedures necessary, using the proper materials and equipment to build a well for a specific purpose.

Well destruction — The procedures necessary using the proper materials and equipment, to ensure the boring is no longer a conduit for contamination of groundwater.

Well log — A graphic record of a well, generally a lithologic and/or stratigraphic record of the units traversed by a borehole.

Section 1: Introduction

Groundwater Sustainability Plan for Santa Rosa Plain Groundwater Subbasin

Table of Contents

1 INTRODUCTION 1-1

1.1 Purpose of Groundwater Sustainability Plan 1-1

1.2 Guide to the Groundwater Sustainability Plan 1-3

1.3 Groundwater Sustainability Agency Authorities and Administrative Information 1-11

1.3.1 Santa Rosa Plain Groundwater Sustainability Agency 1-11

1.3.2 Santa Rosa Plain Groundwater Sustainability Agency Board and Advisory Committee 1-12

1.3.3 Groundwater Sustainability Agency Coordination 1-13

1.4 Stakeholder Engagement and Communication 1-13

1.4.1 Beneficial Uses and Users of Groundwater 1-14

1.4.2 Implementation of the Sustainable Groundwater Management Act – Phases of Work 1-14

Tables

Table 1-1. Cross-reference of GSP Regulations and Associated GSP Sections 1-5

Table 1-2. Cross-reference of SGMA Statute related to GSP Requirements and GSP Section Numbers 1-8

Figure

Figure 1-1. Plan Area/Santa Rosa Plain Groundwater Subbasin 1-2

Appendices

Appendix 1-A. Comments Received on Santa Rosa Plain Groundwater Sustainability Plan

Appendix 1-B. Resolution of the Board of Directors of the Santa Rosa Plain Groundwater Sustainability Agency Forming a Groundwater Sustainability Agency for the Santa Rosa Plain

Appendix 1-C. Santa Rosa Plain Groundwater Sustainability Agency Board and Advisory Committee Members

Appendix 1-D. Santa Rosa Plain Groundwater Sustainability Agency Advisory Committee Charter

Appendix 1-E. Santa Rosa Plain Groundwater Sustainability Agency Advisory Committee Meetings 2017-2021

Appendix 1-F. Community Engagement Plan for Development and Adoption of a Groundwater Sustainability Plan Santa Rosa Plain Groundwater Sustainability Agency
Appendix 1-G. Stakeholder Assessment Report: Findings and Recommendations on Implementing the Sustainable Groundwater Management Act in Sonoma County

1 INTRODUCTION

In 2014, the State of California enacted the Sustainable Groundwater Management Act (SGMA), which substantially changes the way groundwater is managed in California. This law requires that groundwater basins and subbasins in California designated as medium- or high-priority by the California Department of Water Resources (DWR) under SGMA be managed sustainably.[1] Satisfying the requirements of SGMA generally involves four basic activities that must be completed by local agencies:

1. Forming one or more Groundwater Sustainability Agencies (GSAs) to fully cover the high- or medium-priority basin/subbasin.

2. Developing one or multiple Groundwater Sustainability Plans (GSPs) that fully cover the SGMA high- or medium-priority basin/subbasin.

3. Implementing the GSP and managing to achieve quantifiable objectives and sustainability within 20 years of GSP adoption.

4. Regularly reporting data and GSP progress to the DWR.

The Santa Rosa Plain Groundwater Subbasin (Subbasin), designated as basin number 1-55.01 in DWR's Bulletin No. 118 (DWR 2016a), and shown on **Figure 1-1**, is categorized as a medium-/high-priority basin by DWR (DWR 2020) and is, therefore, required to comply with SGMA.

1.1 Purpose of Groundwater Sustainability Plan

The purpose of this document is to fulfill the GSP requirement and present a path for sustaining groundwater resources in the Subbasin pursuant to the provisions of SGMA. Primary objectives addressed by this GSP are to:

- Meet the requirements of SGMA and DWR's GSP Emergency Regulations (GSP Regulations) by establishing criteria and management actions that will achieve and maintain sustainable groundwater management in the Subbasin within 20 years of GSP adoption.

- Incorporate the best available scientific and technical information by building on the strong technical foundation established through previous technical studies and voluntary groundwater management activities in the Santa Rosa Plain.

[1] DWR prioritizes groundwater basins as critically overdrafted, high-, medium-, low-, and very low-priority based on a variety of technical factors. Refer to https://water.ca.gov/Programs/Groundwater-Management/Basin-Prioritization.

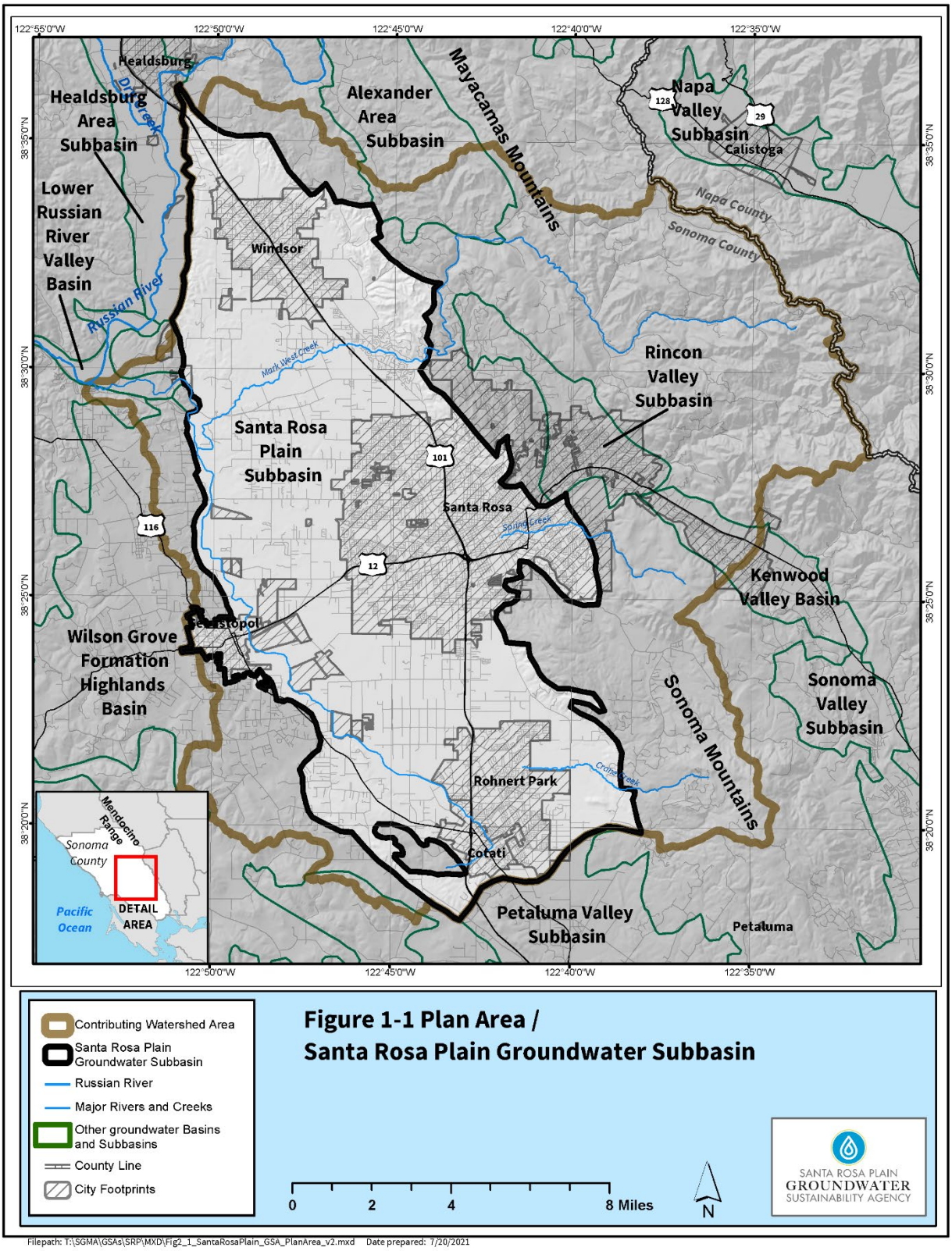


Figure 1-1. Plan Area/Santa Rosa Plain Groundwater Subbasin

- Integrate the perspectives and interests of the many diverse users and uses of groundwater resources within the basin through a process that provides opportunity for significant public and community engagement. Hundreds of comments were received and considered during multiple phases of revising the GSP (**Appendix 1-A**).

- Leverage the limited available funding and local resources through continued regional coordination and information sharing with other local entities and GSAs.

The development of this GSP benefits from a recent history of collaborative groundwater management and water-resource planning by local stakeholders, which had focused on addressing groundwater sustainability issues in the Subbasin prior to the passage of SGMA.

The purpose of the GSP is not to tackle water supply risk and resilience issues or prepare emergency response plans for community drinking water systems. The America's Water Infrastructure Act (AWIA) of 2018 requires community drinking water systems to develop or update risk assessments and emergency response plans to identify vulnerabilities, including malevolent acts and natural disasters, such as floods and droughts, that may potentially threaten the ability of community water systems to deliver safe drinking water.

The Santa Rosa Plain GSA, in collaboration with Sonoma Water, other Sonoma County GSAs, and local water suppliers, has and will continue to provide information to the local community on the severe multi-year drought occurring during the preparation of this GSP and other droughts in the future, including, but not limited to:

- News releases on the status of historically low surface water reservoir supplies

- Messaging to encourage communities to change everyday habits and adapt to eliminate water waste, and to conserve and reduce water usage by 20 percent

- Participation in public workshops on drought conditions and what the community can do to help address this issue

The GSAs do have the authority to mandate conservation and manage extractions but ultimately cannot affect water rights under SGMA. While California's Human Right to Water (California Water Code 106.3) does not apply to the Santa Rosa Plain GSA (which does not provide drinking water and is not a state agency), the GSP is developed to be protective of both groundwater levels and groundwater quality for all beneficial users including residential well owners and disadvantaged communities (DACs). By addressing all beneficial uses and users, the GSP has addressed California's Human Right to Water.

1.2 Guide to the Groundwater Sustainability Plan

The Santa Rosa Plain GSP is organized sequentially, starting with a high-level overview of the Subbasin (**Section 2**), and drilling into more details on hydrology, geology, and the current and projected groundwater conditions (**Section 3**). A discussion of what sustainability means locally is provided in **Section 4**, and **Section 5** details how sustainability will be monitored over time.

Sections 6 (Projects and Management Actions) and **7** (Implementation Plan) describe how sustainability will be achieved. Each section builds on the prior section and contributes to the reader's understanding of the issues facing the Subbasin and the proposed solutions.

This document is composed of the following sections:

- **Front Matter** – This includes a table of contents that can help readers locate specific plan components, and a list of acronyms and abbreviations that can help readers navigate arcane water lingo.
- **Executive Summary** – A brief overview of the GSP, providing high-level information about the Subbasin, sustainability goals, and how the GSP will be implemented.
- **Section 1, Introduction** – Basic administrative information about the GSA, its composition and authorities, and how it communicates with and engages stakeholders.
- **Section 2, Plan Area** – A description of the Subbasin, including jurisdictions, land uses, water uses, and well permitting.
- **Section 3, Basin Setting** – A detailed overview of the Subbasin, including its physical setting, climate, the hydrogeologic conceptual model (which includes the factors that describe and effect its hydrology, such as geologic features, aquifer, and aquitards), current and historical groundwater conditions, the current and projected water budget, and management areas.
- **Section 4, Sustainable Management Criteria** – This section describes proposed management criteria for each of SGMA's six sustainability indicators: groundwater levels, groundwater storage, water quality, land subsidence, seawater intrusion, and surface water depletion.
- **Section 5, Proposed Monitoring Plan** – The Sustainable Management Criteria (SMC) described in Section 4 are quantifiable and are measured over time. This section describes the current monitoring network and proposed enhancements needed to accurately monitor data into the future.
- **Section 6, Projects and Management Actions** – This section describes and ranks projects and actions that could be used to achieve or maintain sustainability by 2042.
- **Section 7, Implementation Plan** – This section describes how the GSP will be implemented over time, including a draft, high-level budget and potential funding sources.
- **Section 8, References** – This section provides a list of all documents cited in this GSP.
- **Appendices** – The appendices to this report provide a wealth of additional information.

Tables 1-1 and **1-2** provide a detailed list of the DWR-required GSP components from the GSP Regulations and SGMA statutes, respectively.

Table 1-1. Cross-reference of GSP Regulations and Associated GSP Sections

Sub-article	Section	Paragraph	Requirement	GSP Section
1. Administrative Information	354.4. General Information	(a)	Executive summary	00
		(b)	List of references and links to technical studies	Appendices
	354.6. Agency Information	-	Agency information pursuant to CWC Section 10723.8 (notification of GSA formation to DWR), along with:	1.2 and Appendices
		(a)	Agency name and mailing address	1.2
		(b)	Agency organization and management structure, persons with management authority for GSP implementation	1.2
		(c)	GSP manager name and contact information	1.2
		(d)	Legal authority of agency	1.2
		(c)	Estimate of GSP implementation costs and description of how agency plans to meet costs	7
	354.8. Description of Plan Area	(a)	Maps of GSP area	Figure 2-1
		(b)	Written description of GSP area	2.1
		(c)-(d)	Identification of existing water-resource monitoring and management programs, and description of any such planned programs	2.4 and 2.5
		(c)	Description of conjunctive use programs	2.5
		(f)	Description of the land use elements or topic categories	2.6
		(g)	Description of additional GSP elements (CWC Section 10727.4)	2.7 and 2.8
	354.10. Notice and Communication	(a)	Description of the beneficial uses and users of groundwater in the subbasin	1.3
		(b)	List of public meetings	1.3
		(c)	Comments and responses regarding the GSP	Appendices
		(d)	Description of communication procedures	1.3
2. Basin Setting	354.12. Introduction to Basin Setting	-	Information about the basin setting (physical setting, characteristics, current conditions, data gaps, uncertainty)	3
	354.14. Hydrogeologic Conceptual Model	(a)	Description of the subbasin hydrogeologic conceptual model	3.1
		(b)	Summary of regional geologic and structural setting, subbasin boundaries, geologic features, principal aquifers, and aquitards	3.1
		(c)	Cross sections depicting major stratigraphic and structural features	Figure 3-5
		(d)	Maps of subbasin physical characteristics	Figures 3-1 through 3-10

Sub-article	Section	Paragraph	Requirement	GSP Section
	354.16. Groundwater Conditions	(a)-(g)	Description of current and historical groundwater conditions including: 1. Groundwater elevation 2. Change in storage 3. Seawater intrusion 4. Groundwater quality issues 5. Land subsidence 6. Interconnected surface water systems 7. Groundwater-dependent ecosystems	3.2
	354.17. Water Budget	(a)	Water budget providing total annual volume of groundwater and surface water entering and leaving the subbasin, including historical, current, and projected water budget conditions, and change in storage	3.3
		(b)-(f)	Development of a numerical groundwater and surface water model to quantify current, historical, and projected: 1. Total surface water entering and leaving by water source type 2. Inflow to the groundwater system by water source type 3. Outflows from the groundwater system by water use sector 4. Change in groundwater storage 5. Overdraft over base period 6. Annual supply, demand, and change in storage by water year type. 7. Estimated sustainable yield	3.3 and Appendix
	354.20. Management Areas	(a)	Description of management areas	3.4
		(b)	Describe purpose, minimum thresholds, measurable objectives, monitoring, analysis	NA
		(c)	Maps and supplemental information	NA
3. Sustainable Management Criteria	354.22. Introduction to Sustainable Management Criteria	-	Criteria by which an agency defines conditions that constitute sustainable groundwater management for the subbasin	4
	354.24. Sustainability Goal	-	Description of subbasin sustainability goal, including basin setting information used to establish the goal, sustainability indicators, discussion of measures to ensure the subbasin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved and maintained	4

Sub-article	Section	Paragraph	Requirement	GSP Section
	354.26. Undesirable Results	(a)	Processes and criteria used to define undesirable results applicable to the subbasin	4
		(b)-(c)	Description of undesirable results, including cause of groundwater conditions and potential effects on beneficial uses and users of groundwater	4
	354.28. Minimum Thresholds	(a)	Establish minimum thresholds to quantify groundwater conditions for each applicable sustainability indicator	4
		(b)-(d)	Describe information and criteria to select, establish, justify, and quantitatively measure minimum thresholds	4
	354.30. Measurable Objectives	(a)-(g)	Establish measurable objectives, including interim milestones in increments of 5 years, to achieve and maintain the subbasin sustainability goal	4
4. Monitoring Networks	354.32. Introduction to Monitoring Networks	-	Description of monitoring network, monitoring objectives, monitoring protocols, and data reporting	5
	354.34. Monitoring Network	(a), (e)-(g)	Development of monitoring network to yield representative information about groundwater conditions	5
		(b)-(d)	Monitoring network objectives	5
		(h)	Maps and tables of monitoring sites	5
		(i)	Monitoring protocols	Appendices
	354.36. Representative Monitoring	(a)-(c)	Designation of representative monitoring sites	5
	354.38. Assessment and Improvement of Monitoring Network	(a)-(d)	Evaluation of monitoring network, including uncertainty, data gaps, and efforts to fill data gaps	5
		(e)	Adjustment of monitoring frequency and density to assess management action effectiveness	5
	354.40. Reporting Monitoring Data to the Department	(f)	Copy of monitoring data from data management system	Digital Submittal
5. Projects and Management Actions	354.44. Projects and Management Actions	(a)-(c)	Description of projects and management actions to achieve and maintain the subbasin sustainability goal	6

Notes:

CWC = California Water Code

NA = not applicable

Table 1-2. Cross-reference of SGMA Statute related to GSP Requirements and GSP Section Numbers

Requirement	GSP Section
Chapter 5 Powers And Authorities	
10726.9. REQUIREMENT OF PLAN TO TAKE INTO ACCOUNT GENERAL PLAN ASSUMPTIONS	
A groundwater sustainability plan shall take into account the most recent planning assumptions stated in local general plans of jurisdictions overlying the basin.	2.6
Chapter 6. Groundwater Sustainability Plans	
10727. REQUIREMENT TO DEVELOP GROUNDWATER SUSTAINABILITY PLAN FOR MEDIUM- AND HIGH-PRIORITY BASINS; FORM OF PLAN	
(a) A groundwater sustainability plan shall be developed and implemented for each medium- or high-priority basin by a GSA to meet the sustainability goal established pursuant to this part. The groundwater sustainability plan may incorporate, extend, or be based on a plan adopted pursuant to Part 2.75 (commencing with Section 10750).	1.0
10727.2. REQUIRED PLAN ELEMENTS A groundwater sustainability plan shall include all of the following:	
(a) A description of the physical setting and characteristics of the aquifer system underlying the basin that includes:	3.0
(1) Historical data, to the extent available.	3.2, 3.3
(2) Groundwater levels, groundwater quality, subsidence, and groundwater-surface water interaction.	3.2
(3) A general discussion of historical and projected water demands and supplies.	3.2, 3.3
(4) A map that details the area of the basin and the boundaries of the GSAs that overlie the basin that have or are developing GSPs.	Figure 3-1
(5) A map identifying existing and potential recharge areas for the basin. The map or maps shall identify the existing recharge areas that substantially contribute to the replenishment of the groundwater basin. The map or maps shall be provided to the appropriate local planning agencies after adoption of the GSP.	Figures 3-8a and 3-8b
(b) (1) Measurable objectives, as well as interim milestones in increments of 5 years, to achieve the sustainability goal in the basin within 20 years of the implementation of the plan.	4.0
(2) A description of how the plan helps meet each objective and how each objective is intended to achieve the sustainability goal for the basin for long-term beneficial uses of groundwater.	4.0
(3) (A) Notwithstanding paragraph (1), at the request of the groundwater sustainability agency, the department may grant an extension of up to 5 years beyond the 20-year sustainability timeframe upon a showing of good cause. The department may grant a second extension of up to 5 years upon a showing of good cause if the GSA has begun implementation of the work plan described in clause (iii) of subparagraph (B). (B) The department may grant an extension pursuant to this paragraph if the groundwater sustainability agency does all of the following: (i) Demonstrates a need for an extension. (ii) Has made progress toward meeting the sustainability goal as demonstrated by its progress at achieving the milestones identified in its GSP. (iii) Adopts a feasible work plan for meeting the sustainability goal during the extension period.	NA
(4) The plan may, but is not required to, address undesirable results that occurred before, and have not been corrected by, January 1, 2015. Notwithstanding paragraphs (1) to (3), inclusive, a	4

Requirement	GSP Section
groundwater sustainability agency has discretion as to whether to set measurable objectives and the timeframes for achieving any objectives for undesirable results that occurred before, and have not been corrected by, January 1, 2015.	
(c) A planning and implementation horizon.	3.4.1.2
(d) Components relating to the following, as applicable to the basin: (1) The monitoring and management of groundwater levels within the basin.	4.0, 5.0, 6.0
(2) The monitoring and management of groundwater quality, groundwater quality degradation, inelastic land surface subsidence, and changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin.	4.0, 5.0, 6.0
(3) Mitigation of overdraft.	4.0, 5.0, 6.0
(4) How recharge areas identified in the plan substantially contribute to the replenishment of the basin.	3.1.7
(5) A description of surface water supply used or available for use for groundwater recharge or in-lieu use.	2.3.2
(e) A summary of the type of monitoring sites, type of measurements, and the frequency of monitoring for each location monitoring groundwater levels, groundwater quality, subsidence, streamflow, precipitation, evaporation, and tidal influence. The plan shall include a summary of monitoring information such as well depth, screened intervals, and aquifer zones monitored, and a summary of the type of well relied on for the information, including public, irrigation, domestic, industrial, and monitoring wells.	5.0
(f) Monitoring protocols that are designed to detect changes in groundwater levels, groundwater quality, inelastic surface subsidence for basins for which subsidence has been identified as a potential problem, and flow and quality of surface water that directly affect groundwater levels or quality or are caused by groundwater extraction in the basin. The monitoring protocols shall be designed to generate information that promotes efficient and effective groundwater management.	Appendix
(g) A description of the consideration given to the applicable county and city general plans and a description of the various adopted water resources-related plans and programs within the basin and an assessment of how the groundwater sustainability plan may affect those plans.	2.4, 2.5
10727.4. ADDITIONAL PLAN ELEMENTS In addition to the requirements of Section 10727.2, a GSP shall include, where appropriate and in collaboration with the appropriate local agencies, all of the following:	
(a) Control of saline water intrusion.	
(b) Wellhead protection areas and recharge areas.	3.1.7
(c) Migration of contaminated groundwater.	2.1
(d) A well abandonment and well destruction program.	2.7
(e) Replenishment of groundwater extractions.	6.0
(f) Activities implementing, opportunities for, and removing impediments to, conjunctive use or underground storage.	2.1
(h) Measures addressing groundwater contamination cleanup, groundwater recharge, in-lieu use, diversions to storage, conservation, water recycling, conveyance, and extraction projects.	2.5, 6.0
(i) Efficient water management practices, as defined in Section 10902, for the delivery of water and water conservation methods to improve the efficiency of water use.	2.5.4
(j) Efforts to develop relationships with state and federal regulatory agencies.	7

Requirement	GSP Section
(k) Processes to review land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity.	7
(l) Impacts on groundwater-dependent ecosystems.	4
10727.8. PUBLIC NOTIFICATION AND PARTICIPATION; ADVISORY COMMITTEE (a) Prior to initiating the development of a GSP, the GSA shall make available to the public and the department a written statement describing the manner in which interested parties may participate in the development and implementation of the GSP. The GSA shall provide the written statement to the legislative body of any city, county, or city and county located within the geographic area to be covered by the GSP. The GSA may appoint and consult with an advisory committee consisting of interested parties for the purposes of developing and implementing a GSP. The GSA shall encourage the active involvement of diverse social, cultural, and economic elements of the population within the groundwater basin prior to and during the development and implementation of the GSP.	1.2, 1.3, Appendix
(b) For purposes of this section, interested parties include entities listed in Section 10927 that are monitoring and reporting groundwater elevations in all or a part of a groundwater basin managed by the GSA.	NA
10728. ANNUAL REPORTING BY GROUNDWATER SUSTAINABILITY AGENCY TO DEPARTMENT On the April 1 following the adoption of a GSP, and annually thereafter, a GSA shall submit a report to the department containing the following information about the basin managed in the GSP: (a) Groundwater elevation data (b) Annual aggregated data identifying groundwater extraction for the preceding water year (c) Surface water supply used for or available for use for groundwater recharge or in-lieu use (d) Total water use (e) Change in groundwater storage	7.0
10728.2. PERIODIC REVIEW AND ASSESSMENT A GSA shall periodically evaluate its GSP, assess changing conditions in the basin that may warrant modification of the plan or management objectives, and may adjust components in the GSP. An evaluation shall focus on determining whether the actions under the GSP are meeting the plan's management objectives and whether those objectives are meeting the sustainability goal in the basin.	7.0
10728.4. ADOPTION OR AMENDMENT OF PLAN FOLLOWING PUBLIC HEARING A GSA may adopt or amend a GSP after a public hearing, held at least 90 days after providing notice to a city or county within the area of the proposed plan or amendment. The GSA shall review and consider comments from any city or county that receives notice pursuant to this section and shall consult with a city or county that requests consultation within 30 days of receipt of the notice. Nothing in this section is intended to preclude an agency and a city or county from otherwise consulting or commenting regarding the adoption or amendment of a plan.	1.3, 7.0
10728.6. CEQA NOT APPLICABLE TO PLAN PREPARATION AND ADOPTION Division 13 (commencing with Section 21000) of the Public Resources Code does not apply to the preparation and adoption of plans pursuant to this chapter. Nothing in this part shall be interpreted as exempting from Division 13 (commencing with Section 21000) of the Public Resources Code a project that would implement actions taken pursuant to a plan adopted pursuant to this chapter.	5

Note:

CEQA = California Environmental Quality Act

1.3 Groundwater Sustainability Agency Authorities and Administrative Information

1.3.1 Santa Rosa Plain Groundwater Sustainability Agency

SGMA requires GSAs to be formed to cover basins/subbasins designated by DWR as high- or medium-priority (based on a variety of technical factors). Any local agency that has water supply, water management, or land use responsibility in a groundwater basin is eligible to form a GSA. The legislative intent of SGMA is to encourage GSA-eligible agencies to form one GSA that covers an entire SGMA basin/subbasin and prepare one GSP; however, SGMA offers local agencies the flexibility of forming multiple GSAs and preparing multiple GSPs in a basin/subbasin. SGMA empowers GSAs with new management tools and authorities to, among other things:

- Register groundwater wells
- Collect data/conduct studies
- Measure extractions (with the exception of de minimis wells that pump less than 2 acre-feet per year [AFY])
- Require reporting
- Manage extractions
- Assess fees

The Santa Rosa Plain GSA was formed to meet SGMA requirements in June 2017, and is one of three GSAs established in Sonoma County (the other two are Petaluma Valley and Sonoma Valley). The jurisdictional area of the Santa Rosa Plain GSA is the entire Santa Rosa Plain Subbasin, and no other GSAs have jurisdiction within the Subbasin. The Santa Rosa Plain GSA was formed through a Joint Exercise of Powers Agreement (JPA) entered into by the cities of Cotati, Rohnert Park, and Santa Rosa; the Town of Windsor; Gold Ridge Resource Conservation District; Sonoma County; Sonoma County Water Agency (Sonoma Water); Sonoma Resource Conservation District (RCD); and an organized group of Mutual Water and Public Utilities Commission-Regulated Companies (Independent Water Systems), in accordance with requirements of CWC Section 10723 for establishing GSAs under the SGMA.

In August 2019, the JPA was amended to include the City of Sebastopol and three neighboring mutual water companies (Fircrest, Belmont Terrace, and Kelly), following an adjustment of the Subbasin boundaries. The boundary change was a result of DWR's proposed 2018 reprioritization of the neighboring Wilson Grove Formation Highlands Basin (Wilson Grove) from very low-priority to medium-priority. Entities within Wilson Grove were concerned about their ability to comply with SGMA, and the cities of Sebastopol and Petaluma, the three mutual water districts, and the County of Marin made jurisdictional requests to DWR to change the basin boundaries. DWR authorized the boundary changes. As a result, Sebastopol and the water companies are now solely within the Santa Rosa Plain Subbasin. (Petaluma and a portion of Marin County are now within the Petaluma Valley Basin.)

A copy of the resolution forming the JPA and the resolution revising the JPA is included in **Appendix 1-B**.

1.3.2 Santa Rosa Plain Groundwater Sustainability Agency Board and Advisory Committee

The Santa Rosa Plain GSA is governed by 10 Board members and alternates from the member organizations, which each appoint one member and one alternate member (Board members are listed in **Appendix 1-C**). The Santa Rosa Plain GSA Board (GSA Board) members are elected or appointed members of their governing bodies who serve at the pleasure of the member organization appointing them. GSA Board members annually elect the officers of the Board for 1-year terms, which may be extended to multiple consecutive terms. The GSA Board role in the GSP development process is to provide guidance and direction on key components of the GSP and consider recommendations from the Santa Rosa Plain GSA Advisory Committee (Advisory Committee) and input from the public. The GSA Board is responsible for adopting the GSP and authorizing its submission to DWR for evaluation, assessment, and approval.

The Santa Rosa Plain GSA formed an Advisory Committee of 18 members in October 2017 consisting of members appointed by each of the original 9 member agencies, the City of Sebastopol and the Federated Indians of Graton Rancheria, and 7 interest-based members appointed by the Santa Rosa Plain GSA Board. The seven interest-based members are composed of the following groups:

- Environmental (from organizations with a presence in the Basin) (two members)
- Rural residential well owners (two members)
- Business community (one member)
- Agricultural (two members)

As described in **Section 2.1**, the DACs in the Subbasin are generally (although not entirely) located in areas that receive water from municipal-water suppliers, which rely primarily on surface water (not groundwater). However, the Sonoma Water appointee to the Advisory Committee was chosen to represent the DACs and participates from that perspective. As described in **Section 1.4.2.1**, government-to-government outreach was conducted from the County to Tribes when the Santa Rosa Plain GSA was formed. The Federated Indians of Graton Rancheria chose to participate on the Advisory Committee. During the implementation phase of the GSP, federally and non-federally recognized Tribal governments will be contacted to reassess their interest in participating in GSA activities.

The role of the Advisory Committee during the GSP development process is to work toward a consensus and incorporate community and stakeholder interests into recommendations to the GSA Board on GSP development and SGMA implementation. Advisory Committee members also report to, and seek input from, their larger constituency groups on key components and proposals related to GSP development.

The Advisory Committee meets 6 to 10 times annually, and the meetings are open to the public. The Advisory Committee makes recommendations to the GSA Board that reflect the outcome

of committee discussions. To ensure that all viewpoints are heard and considered by the Board, the Advisory Committee reports to the GSA Board regularly, identifying areas of agreement and disagreement among the Advisory Committee members. The names of GSA Board and Advisory Committee members can be found in **Appendix 1-C**, and the Advisory Committee Charter is provided in **Appendix 1-D**.

1.3.3 Groundwater Sustainability Agency Coordination

Implementation of SGMA in the Subbasin is closely coordinated with neighboring GSAs in Petaluma Valley and Sonoma Valley, as well as local agencies with land use responsibilities, including the cities of Cotati, Rohnert Park, Santa Rosa, Sebastopol, Town of Windsor, and the County of Sonoma. In addition to close coordination when managing and monitoring along shared Subbasin boundaries, resources are leveraged and shared by the three existing GSAs in Sonoma County to maximize efficiencies, including shared templates and methodologies for certain GSP components, outreach resources, grant opportunities, and the development of data management system tools and technologies.

The Santa Rosa Plain GSA has a service agreement with Sonoma Water for technical support, public outreach and community engagement, and grant writing and management. The GSA also has service agreements with outside firms for administrative support, legal advice, financial decision making, and facilitation services for Advisory Committee meetings.

Contact information for the Santa Rosa Plain GSA is:

Santa Rosa Plain Groundwater Sustainability Agency
2235 Mercury Way #105, Santa Rosa California 95407
www.santarosaplaingroundwater.org (707) 243-8555

GSA Administrator: Andy Rodgers, West Yost Associates, Inc.

GSA Plan Manager: Jay Jasperse, Chief Engineer and Director of Groundwater Management, Sonoma County Water Agency

1.4 Stakeholder Engagement and Communication

SGMA requires that GSAs consider the beneficial uses and users of groundwater. As a result, GSP development included robust outreach and stakeholder engagement through a variety of methods and tools, which are described in detail in **Sections 1.4.2.1** through **1.4.2.3**.

As described in **Section 1.3**, the Santa Rosa Plain GSA is governed by a local board, which receives and considers recommendations from an Advisory Committee representing multiple stakeholder interests. Both the GSA Board and Advisory Committee hold regular public meetings in compliance with California's laws governing public meetings (commonly known as the Brown Act). A list of meetings is provided in **Appendix 1-E**.

All phases of SGMA compliance in the Santa Rosa Plain Groundwater Subbasin have been, and will continue to be, characterized by an open collaborative process with strong stakeholder

engagement, providing stakeholders and the public with opportunities to provide input and to influence the process. Information is available on the website, https://santarosaplaingroundwater.org, where all meeting materials and notifications are posted.

1.4.1 Beneficial Uses and Users of Groundwater

SGMA requires GSAs to identify and consult with people and agencies who represent the "beneficial uses and users of groundwater in the basin, including the land uses and property interest potentially affected by the use of groundwater in the basin" (California Code of Regulations [CCR] Section 354.10). **Appendix 1-F**, The *Community Engagement Plan for Development and Adoption of a Groundwater Sustainability Plan* (Santa Rosa Plain GSA 2018), identifies beneficial users and uses as "interested parties" that include water suppliers, agricultural users, business and commercial uses, rural residential well owners, DACs, state and local landowners, and environmental users.

As described in **Section 1.3**, many of these beneficial users and those engaged in beneficial uses are included on the GSA Board or the Advisory Committee. Specific information regarding consultation with representatives of beneficial users and uses is described in the following sections.

1.4.2 Implementation of the Sustainable Groundwater Management Act – Phases of Work

Outreach for SGMA is associated with the following four work phases:

- Phase 1: GSA Formation and Coordination – The formation of the Santa Rosa Plain GSA began in 2015, with an initial stakeholder assessment conducted by the Consensus Building Institute (CBI), followed by negotiations between GSA-eligible entities in the Subbasin. This phase was completed in June 2017, when the GSA was created by a JPA (described in **Section 1.2**).

- Phase 2: GSP Preparation and Submission – This phase of work began in 2018 and will be completed in January 2022. During this phase, outreach was largely guided by a Community Engagement Plan (Santa Rosa Plain GSA 2018) (**Appendix 1-F**). Pre-submission, the final draft GSP was released for public comments and review.

- Phase 3: GSP Review and Evaluation – This phase began in 2019, with the majority of the review taking place in 2021. This phase will continue through 2022, when the GSP is submitted and DWR provides additional opportunity for additional public review and comments.

- Phase 4: Implementation and Reporting – Following the submission of the GSP to DWR, the Santa Rosa Plain GSA will begin implementing projects and programs to reach sustainability in the Subbasin. This will be an ongoing phase, with 5-year updates that will include public input and feedback, as the GSA strives for sustainability by 2042.

1.4.2.1 Phase 1: Groundwater Sustainability Agency Formation and Coordination

From 2015 through 2017, local agencies worked with the CBI to facilitate the formation of the Santa Rosa Plain GSA. CBI began by conducting a stakeholder assessment in the three Sonoma County basins and subbasins (Santa Rosa Plain Subbasin, Petaluma Valley Basin, and Sonoma Valley Subbasin) that were immediately subject to SGMA implementation. Assessment results were described in *Findings and Recommendations on Implementing the Sustainable Groundwater Management Act in Sonoma County* (**Appendix 1-F**).

The assessment included interviews with and surveys of representatives of key stakeholder groups. During the assessment phase, the County of Sonoma sent government-to-government letters to federally recognized Tribes within the three basins and subbasins, and the Federated Indians of Graton Rancheria chose to participate on the Santa Rosa Plain Advisory Committee. The stakeholder assessment resulted in recommendations for a transparent and inclusive process for local implementation of SGMA and also recommended that separate GSAs be created for each of the three basins/subbasins to reflect the local basin characteristics and stakeholder concerns. Other findings include the following:

- There is an overall commitment to long-term sustainable groundwater management and the importance of groundwater-surface water interaction, conjunctive use, and integrated water-resources management.

- Respondents respect local knowledge and control for water management and expressed concern about (1) needing to participate in management decisions for other basins and (2) having agencies or stakeholders from external jurisdictions making decisions about local groundwater. At the same time, some recognize a need for a regional perspective on water resources and land use; those with this perspective feel confident that regional considerations can blend with local decisions.

- Agencies expressed concerns about costs and funding SGMA implementation.

- Stakeholders demonstrated a high level of expectation for public outreach and stakeholder involvement. Respondents urged expansive outreach to rural residential well owners and those seeking guidance and input from basin advisory panels and the public on forming the GSA.

The assessment prescribed a process for input and decision making which involved representatives of the GSA-eligible entities in the Subbasin. The process was implemented, and included community forums that were held in 2016 to receive and consider input from the public on GSA formation.

Some areas of the Subbasin are classified as DACs by the DWR (DWR 2021a), the Sonoma County Transportation Authority (SCTA 2017), and Sonoma County Department of Health Services (2014). Representatives of DAC stakeholders were included in the assessment survey, or were separately interviewed by staff during the GSA formation process.

The beneficial uses and users of the Subbasin, as defined by SGMA (CWC Section 10723.2), are represented in the structure of the GSA Board and the Advisory Committee. GSP beneficiaries include private domestic well owners, agriculture, businesses, municipal public water systems, DACs, and environmental users.

Stakeholders on the GSA Board and Advisory Committee include representatives from municipal-water suppliers, agriculture, environmental organizations, businesses, rural well owners, and at-large community members. Refer to **Section 1.2** for additional information about GSA Board and Advisory Committee composition.

1.4.2.2 Phase 2: Preparation and Submission

The GSA Board and Advisory Committee were actively engaged in the development of the GSP, including:

- Reviewing and commenting on GSP sections as they were prepared
- Providing feedback and suggestions for SMC (discussed in **Section 4** of this GSP)
- Actively engaging and soliciting feedback from the stakeholders they represent

All meetings were publicly advertised and conducted in accordance with California's Ralph M. Brown Act and other public meeting laws (beginning at Government Code 54950). Meetings held during the pandemic were advertised and conducted in accordance with Governor Newsom's Executive Orders N-25-20 issued on March 3, 2020 and N-29-20, issued on March 4, 2020. Public comment was included on every item, and meeting minutes were taken and are available via the website.

Broader public input was determined to be a critical component of GSP development, and was guided by the *Community Engagement Plan for Development and Adoption of a Groundwater Sustainability Plan Santa Rosa Plain Groundwater Sustainability Agency* (Santa Rosa Plain GSA 2018) (**Appendix 1-F**), which was adopted by the Board in January 2018. To encourage stakeholder engagement, key outreach tools included:

- Development of an Interested Parties List through both meeting attendance and by soliciting the public to sign-up via the website
- Monthly informational emails to the Interested Parties list that provided information regarding SGMA implementation, GSP planning, and groundwater management
- Development of a website with meeting information and GSP materials, including a location for public comments as draft GSP sections were released
- Public forums on the SGMA implementation process, subbasin conditions, SMC development, draft SMCs, and the draft GSP
- Forums coordinated with the other Sonoma County GSAs on cross-cutting issues, including climate change modeling (as discussed in **Appendix 3-E**) and groundwater recharge

- Presentations to and discussions with key stakeholder groups in the Subbasin, including the Sonoma Water Coalition (a countywide coalition of environmental groups), environmental stakeholder groups, cannabis growers, the Sonoma County Farm Bureau's water committee, the Sebastopol Grange, and organizations serving DACs, including California Human Development, Latino Service Providers, and Los Cien

- A survey mailed to all domestic well owners in the basin, in both English and Spanish, assessing their priorities regarding groundwater sustainability and identifying key issues related to groundwater resources

- Focus groups, including a basin-wide group, a DAC group that included representatives from the other Sonoma County basins, and an agricultural focus group

- A campaign targeted to informing domestic well owners, including a website revision, social media messaging, newspaper ads, and lawn signs

- Participation in 2021 Drought-Drop-By events, where groundwater users were provided with information about the GSP along with a water-saving toolkit

During the pandemic, outreach continued through these activities. Regular GSA Board and Advisory Committee meetings, and two community meetings, were held virtually.

1.4.2.3 Phase 3: Groundwater Sustainability Plan Review and Evaluation

Phase 3 began in 2019, with the majority of the review occurring in 2021. During this phase, sections of the draft GSP were released sequentially to the GSA Board, Advisory Committee, and public for comments. In addition, the draft GSP was posted on the website and made available at regional libraries and all city and town halls in the Subbasin. During the 30-day review period, 20 comments were received from 15 individuals or organizations. All comments submitted through the various Advisory Committee, GSA Board, and public reviews are available in **Appendix 1-A**. During the public comment period, a community workshop attended by approximately 45 people provided an overview of GSP content. In addition, a Board meeting held during the comment period allowed the public the opportunity to provide verbal comments and feedback.

Public comments were incorporated into the GSP as appropriate, and the final GSP will be considered by the GSA Board in early December.

Following submittal to DWR, there will be a 75-day comment period through DWR's SGMA portal at http://sgma.water.ca.gov/portal/. Comments will be posted to the DWR website prior to the state agency's evaluation, assessment, and approval.

1.4.2.4 Phase 4: Implementation and Reporting

Phase 4 will continue through the duration of the 50-year planning window to ensure that sustainability is achieved and maintained, and that the activities, programs, and policies of the GSA are transparent and inclusive. Both the GSA Board and Advisory Committee will continue

to meet, and the Advisory Committee's scope and purpose will be refined to focus on GSP implementation. Tribal governments will be contacted to reassess their interest in participation in the GSA and in the implementation process.

Section 2: Description of Plan Area
Groundwater Sustainability Plan for Santa Rosa Plain Groundwater Subbasin

Table of Contents

2 DESCRIPTION OF PLAN AREA (23 CCR 354.8 b) 2-1

2.1 General Setting and Jurisdictional Areas (23 CCR 354.8 b) 2-1

2.2 General Land Use Characteristics (23 CCR 354.8 b) 2-6

2.3 Water Source Types and Water Use Sectors (23 CCR 354.8 b) 2-6

2.3.1 Groundwater 2-11

2.3.2 Imported Surface Water 2-12

2.3.3 Local Surface Water 2-12

2.3.4 Recycled Water 2-12

2.4 Existing Monitoring Programs and Networks (23 CCR 354.8 c, d, e) 2-12

2.4.1 Groundwater-level Monitoring 2-12

2.4.2 Groundwater Quality Monitoring 2-18

2.4.3 Climate Monitoring 2-19

2.4.4 Surface Water Monitoring 2-19

2.4.5 Land Surface Subsidence Monitoring 2-22

2.5 Existing Management Programs and Studies (23 CCR 354.8 c, d, e) 2-22

2.5.1 Santa Rosa Plain Groundwater Management Program 2-22

2.5.2 Urban Water Management Planning 2-23

2.5.3 North Coast Resource Partnership 2-25

2.5.4 Climate Change Studies and Planning 2-25

2.5.5 Groundwater Banking Feasibility Study 2-26

2.5.6 Water Conservation 2-26

2.5.7 Stormwater Management 2-29

2.6 General Plan and Related Plan Land Use Categories 2-31

2.6.1 General Plans 2-32

2.6.2 Specific Area Plans 2-37

2.6.3 Sonoma County Local Agency Formation Commission 2-37
2.7 Well Permitting Policies and Procedures 2-38

Tables

Table 2-1. Summary of Municipal General Plan Policies Specific to Groundwater 2-35

Figures

Figure 2-1. Plan Area 2-2
Figure 2-2. Elevation and Surface Water Features 2-3
Figure 2-3. Jurisdictional and Protected Areas 2-5
Figure 2-4a. Land Use (1999) 2-7
Figure 2-4b. Land Use (2012) 2-8
Figure 2-4c. Land Use, Crops, and Vegetation (2013) 2-9
Figure 2-5. Water Sector and Water Use 2-10
Figure 2-6a. Water Wells 2-13
Figure 2-6b. Water Well Depth Distribution 2-14
Figure 2-7a. Santa Rosa Plain Groundwater-level Monitoring Network – Shallow Wells (< 200 feet) 2-16
Figure 2-7b. Santa Rosa Plain Groundwater-level Monitoring Network – Deep Wells (> 200 feet) 2-17
Figure 2-7c. Climate Stations 2-20
Figure 2-7d. Streamflow Monitoring Network 2-21
Figure 2-8. General Plan Land Use Zoning 2-34
Figure 2-9. County of Sonoma Groundwater Availability Classifications 2-39

2 DESCRIPTION OF PLAN AREA (23 CCR 354.8 B)

This section provides a description of the area covered by the GSP (Plan Area), including the Santa Rosa Plain Groundwater Subbasin's (Subbasin) general physical setting and jurisdictional areas; topography and surface water features; land use characteristics; water source types and uses; existing monitoring and management programs; applicable land use plans; and the well permitting process. The numbers in parentheses in each subheading indicate the applicable SGMA regulation.

2.1 General Setting and Jurisdictional Areas (23 CCR 354.8 b)

The Plan Area for this GSP is the entire 80,000-acre Subbasin, which lies within the Coast Ranges geomorphic province and is one of three coastal alluvial subbasins of the Santa Rosa Valley Groundwater Basin (that is, Santa Rosa Plain, Healdsburg Area, and Rincon Valley) in the North Coast Hydrologic Region (**Figure 2-1)**. It is generally bounded on the west by low-lying hills of the Mendocino Range and on the east by the Sonoma Mountains and Mayacamas Mountains. The Subbasin is approximately 22 miles long and the width varies from approximately 9 miles through the Santa Rosa area to 6 miles at the south end of the valley near the City of Cotati and narrows greatly at its northern end. The Subbasin includes the Town of Windsor, Cities of Cotati, Rohnert Park, Santa Rosa, and Sebastopol, and areas of unincorporated rural communities. Outside city limits, the Subbasin is characterized by native vegetation, rural properties, and agriculture – primarily vineyards but also nurseries, dairies, and row crops. The principal streams in the Subbasin are Mark West Creek, Santa Rosa Creek, and Laguna de Santa Rosa **(Figure 2-2)**, which drain a combined watershed area of approximately 251 square miles.

Adjacent groundwater basins and subbasins are also shown on **Figure 2-1** and include the very low-priority Healdsburg Area Subbasin (designated as basin 1-55.02 by DWR) to the north, the very low-priority Wilson Grove Formation Highlands Basin (designated as basin 1-059 by DWR) to the west, and the medium-priority Petaluma Valley Basin (designated as basin 2-001 by DWR) to the south. The very low-priority Alexander Area Subbasin (designated as basin 1-054.01 by DWR) and the very low-priority Rincon Valley Subbasin (designated as basin 1-054.03 by DWR) both abut a small eastern segment of the Subbasin boundary. The only adjacent GSA is the Petaluma Valley GSA, which formed in June 2017 and is responsible for implementing SGMA in the Petaluma Valley Basin. As very low-priority groundwater basins/subbasins, the Healdsburg Area, Wilson Grove Formation Highlands, Alexander Valley, and Rincon Valley are not required to form GSAs or develop GSPs; only high- and medium-priority basins are required to meet SGMA mandates.

Available technical information related to the hydrologic connection between the Santa Rosa Plain Subbasin and adjacent basins and subbasins is included in **Section 3** (Basin Setting) and provisions for coordinating with applicable GSAs and other local agencies within neighboring basins and subbasins are described in **Section 7** (Implementation Plan).

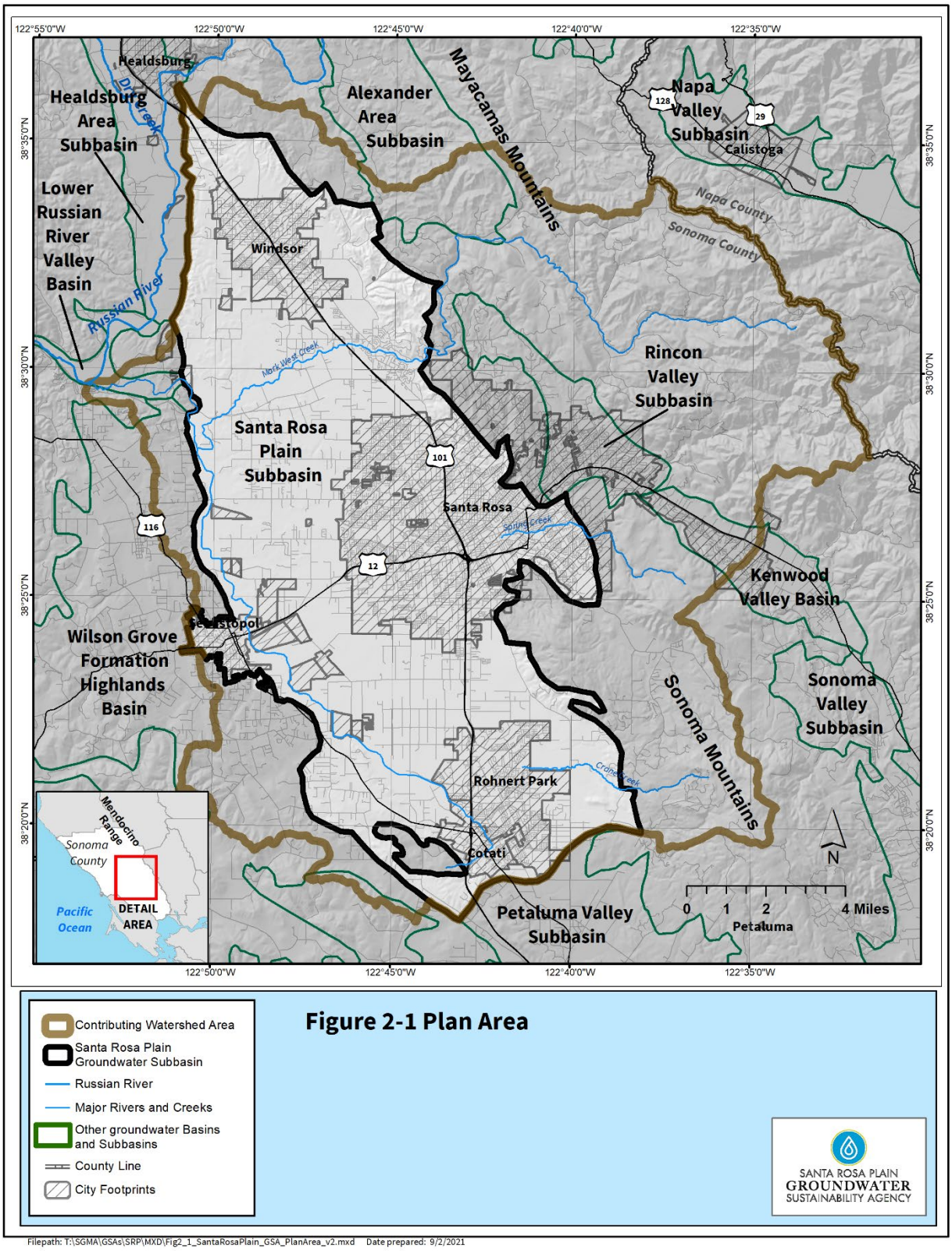


Figure 2-1. Plan Area

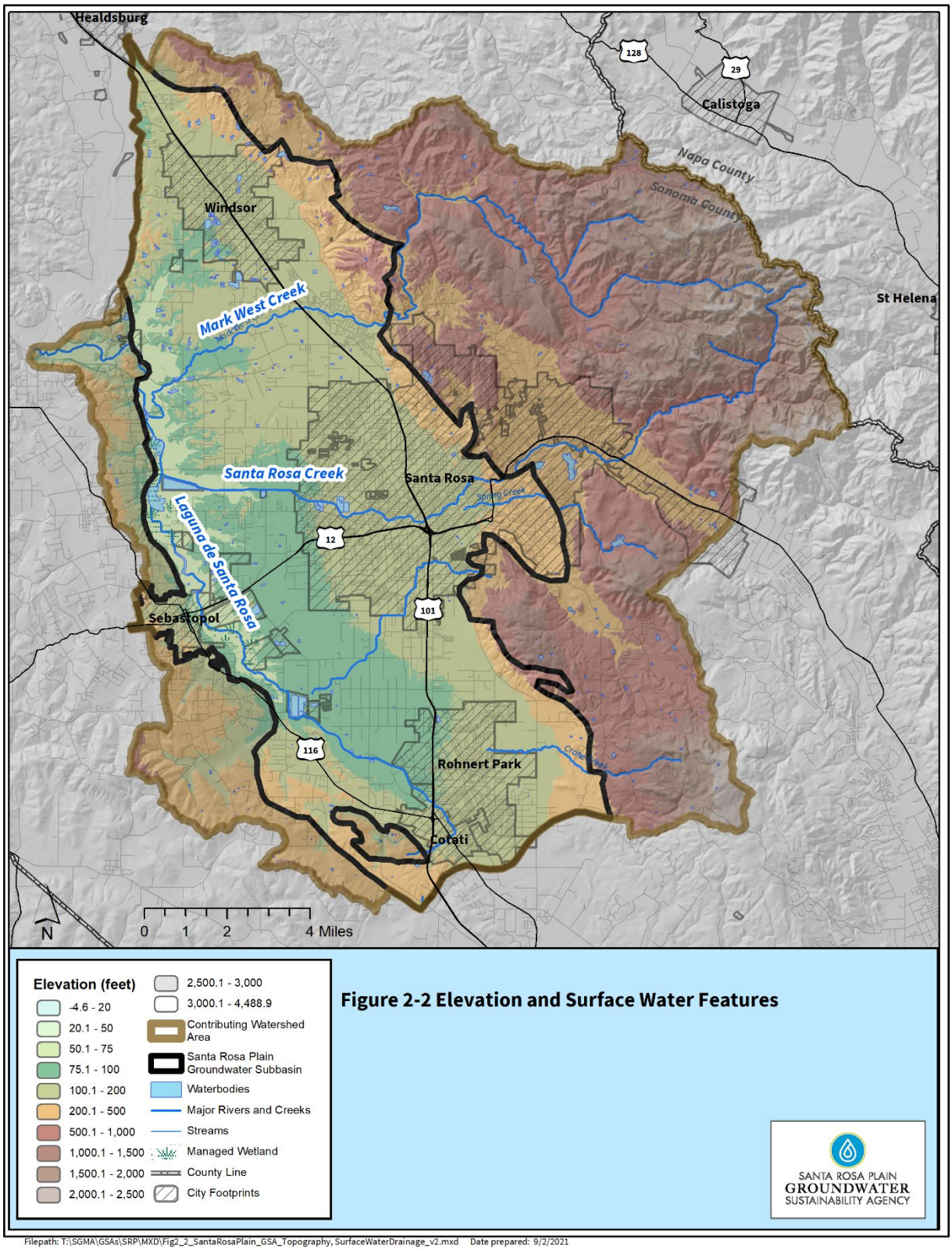


Figure 2-2. Elevation and Surface Water Features

While the Plan Area and jurisdiction of the Santa Rosa Plain GSA is limited to the Santa Rosa Plain Subbasin as defined by SGMA basin prioritization (DWR 2020) and DWR's Bulletin 118 (DWR 2003), technical studies (including monitoring and groundwater-flow modeling) indicate that contributing watershed areas outside of the Subbasin are hydrologically connected and represent important sources of inflow (both in the form of surface streamflows and subsurface inflows) to the Subbasin. In recognition of the hydrologic connection with the contributing watershed areas, available data and information from these areas are also included in this GSP. The contributing watershed area is also shown on **Figure 2-1** and is a modified version of the Laguna-Mark West Watershed that extends slightly outside of the watershed to encompass the entire Bulletin 118 Santa Rosa Plain Subbasin at the northernmost boundary and a portion of the western boundary around the City of Sebastopol. Distinctions between metrics and features associated with the Bulletin 118 Santa Rosa Plain Subbasin jurisdictional area of the GSA and contributing watershed areas are clearly indicated or displayed in relevant sections and figures.

Local agencies with jurisdiction within the Subbasin include the Santa Rosa Plain GSA; Cities of Cotati, Rohnert Park, Santa Rosa, and Sebastopol; Town of Windsor; Gold Ridge RCD, Sonoma RCD; Sonoma Water; and County of Sonoma. **Figure 2-3** shows the jurisdictional boundaries of these local agencies, state, federal and tribal lands, and protected lands within the Subbasin. State lands include Sonoma State University within the Subbasin and several state parks and preserves located within the contributing watershed area. Tribal lands include lands owned by the Federated Indians of Graton Rancheria (west of Rohnert Park) and by the Lytton Band of Pomo Indians (west of Windsor). Protected lands shown on **Figure 2-3** include city parks and fields, county regional parks and preserves, special district properties and preserves, state parks and preserves, and nonprofit preserves. There are no federally owned lands within the Subbasin or contributing watershed.

Figure 2-3 shows the DACs in the Subbasin. These communities generally are located in areas that receive water from municipal suppliers, which rely primarily on surface water supply, as described in **Section 2.3**.

The California Legislature assigned primary responsibility for protecting and enhancing California's surface water and groundwater quality to the State Water Resources Control Board (SWRCB), and the nine regional water quality control boards (Regional Boards). The SWRCB provides state-level coordination for the water quality control program and regulatory monitoring by establishing statewide policies and plans for implementing state and federal laws and regulations. The Regional Boards adopt and implement water quality control plans (basin plans), recognizing the unique characteristics of each region's natural surface water and groundwater quality, actual and potential beneficial uses, and surface water and groundwater quality problems. Article 3 of Chapter 4 of the Porter-Cologne Act directs the Regional Boards to adopt, review, and revise basin plans, and provides specific guidance on factors that must be considered in adopting surface water and groundwater quality objectives and implementation measures.

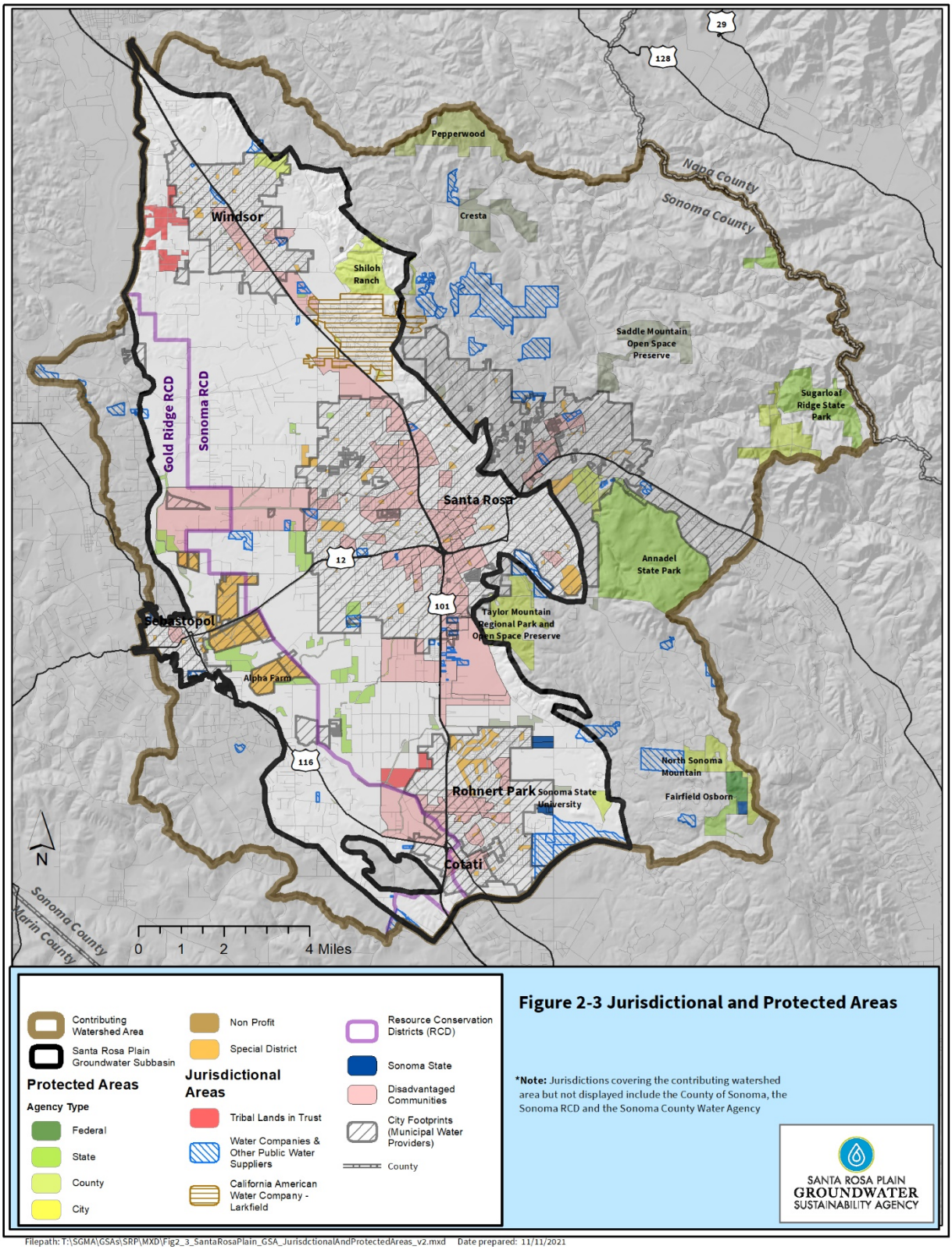


Figure 2-3. Jurisdictional and Protected Areas

The North Coast Regional Water Quality Control Board (NCRWQCB) implements water quality regulations in the watershed, including establishing Total Maximum Daily Loads for water quality impairments within the Laguna de Santa Rosa watershed, adopting General Waste Discharge Requirements for agricultural lands, dairies, recycled water, and for stormwater and wastewater discharges. The NCRWQCB and the California Department of Toxic Substances Control (DTSC) are responsible for regulating the cleanup of contaminant sites and contaminated groundwater; the GSA has no authority to regulate groundwater contaminant site cleanups or the migration of plumes.

2.2 General Land Use Characteristics (23 CCR 354.8 b)

Land use maps for 1999, 2012, and 2013 within the Subbasin are shown on **Figures 2-4a, 2-4b,** and **2-4c**, respectively. Land use mapping over the past several decades provides a measure of growth and land use changes in the Subbasin, which includes increases in residential and commercial land uses and irrigated agriculture and a resulting decrease in native vegetation or water (**Figures 2-4a** and **2-4b**). **Figure 2-4c** presents more detailed classification of vegetation types within the Subbasin and contributing watershed areas from the Sonoma County Light Detection and Ranging (LiDAR) and Vegetation Mapping Program.

Existing land use conditions correlate most closely with the 2012 land use survey (DWR 2012) (**Figure 2-4b**), which indicates the Subbasin is primarily comprised of urban, residential, commercial, and industrial land uses (36 percent), and native vegetation or water (35 percent) with irrigated and non-irrigated agriculture making up approximately 26 percent of the land uses. The major urban and residential areas in the Subbasin include the Cities of Cotati, Rohnert Park, Santa Rosa, and Sebastopol, the Town of Windsor, several unincorporated communities, and areas of rural and semirural residential development.

2.3 Water Source Types and Water Use Sectors (23 CCR 354.8 b)

This GSP recognizes that the efficient use and conjunctive management of the various available water sources is integral to achieving sustainable groundwater management in the Subbasin. The Subbasin has four primary water sources: groundwater, imported surface water, local surface water, and recycled water. An overview of the spatial distribution of the reliance on the four primary water source types by primary water use sectors in the Subbasin is shown on **Figure 2-5** and provided in **Sections 2.4.1** through **2.4.4**. Additional details on water uses associated with the Subbasin water budget are described in **Section 3** (Basin Setting) and additional information on the availability and feasibility for future uses is included in **Section 6** (Projects and Actions).

Initially, communities in the Santa Rosa Plain relied completely on abundant springs and surface water during its settlement and early growth period. Census information for Sonoma County indicates relatively flat population growth from 1890 to 1940, then growth increased until about 2000. Since then, growth has slowed and has remained relatively constant. Local surface water supply accounted for approximately 3 percent of the water supply in the Subbasin in 2020.

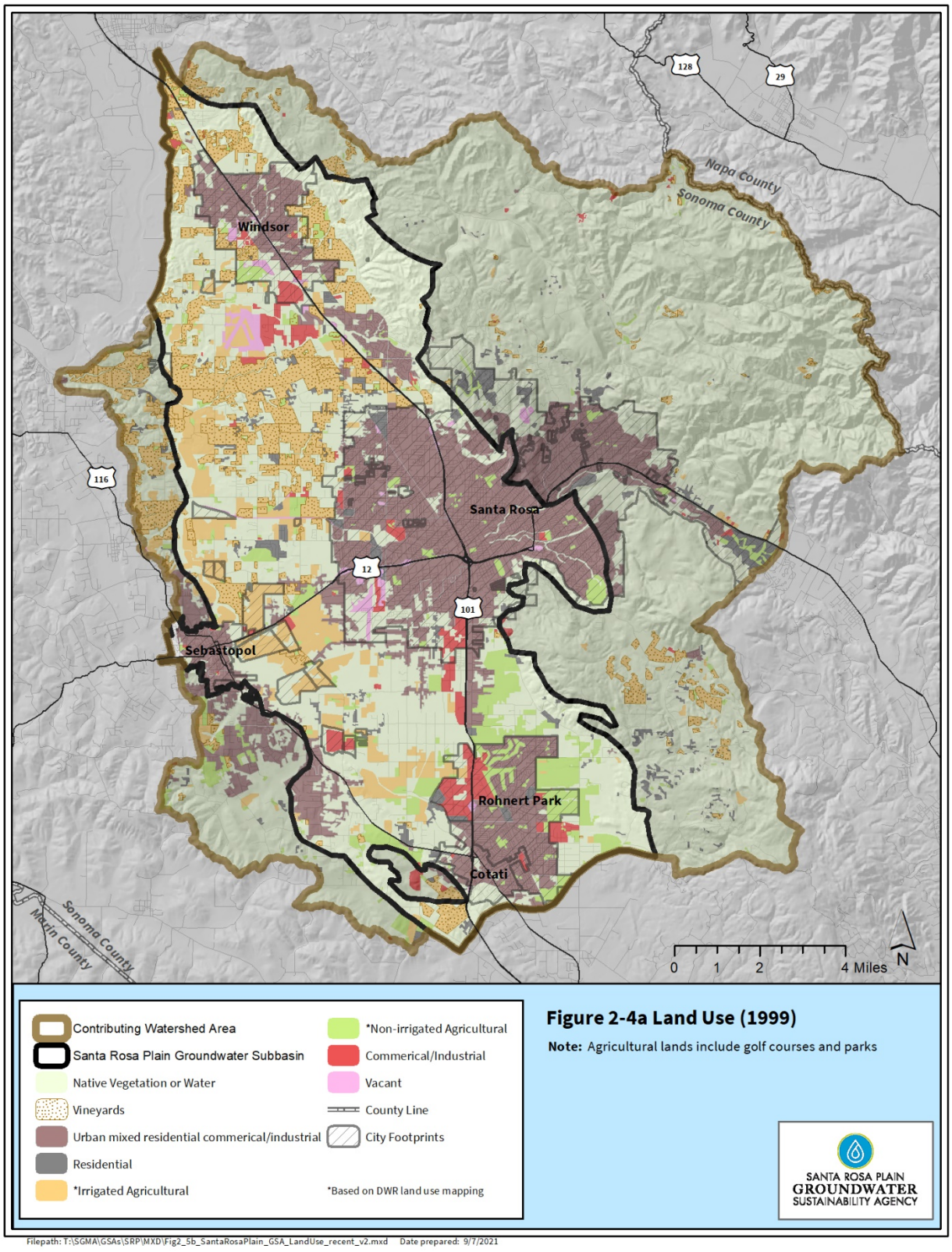


Figure 2-4a. Land Use (1999)

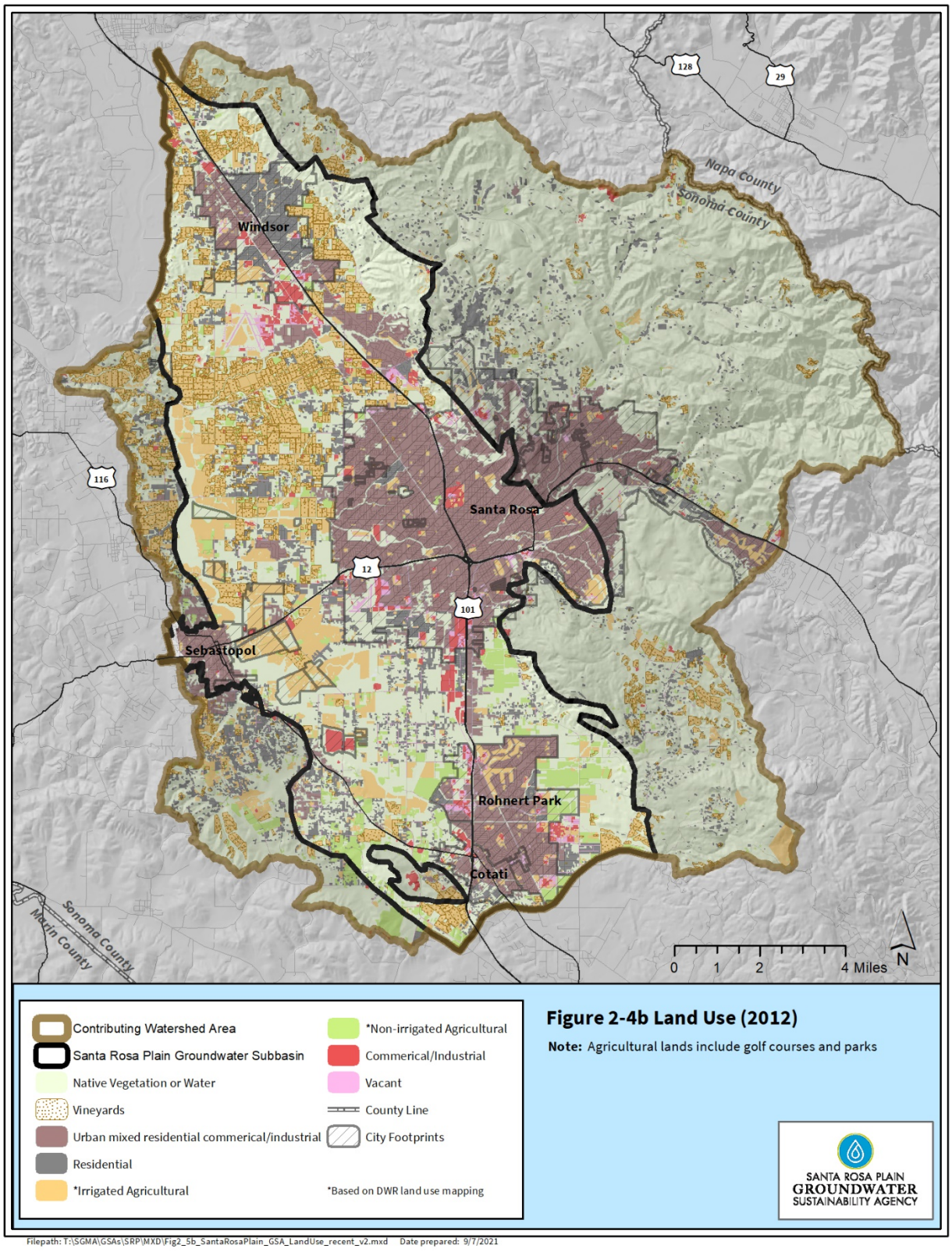


Figure 2-4b. Land Use (2012)

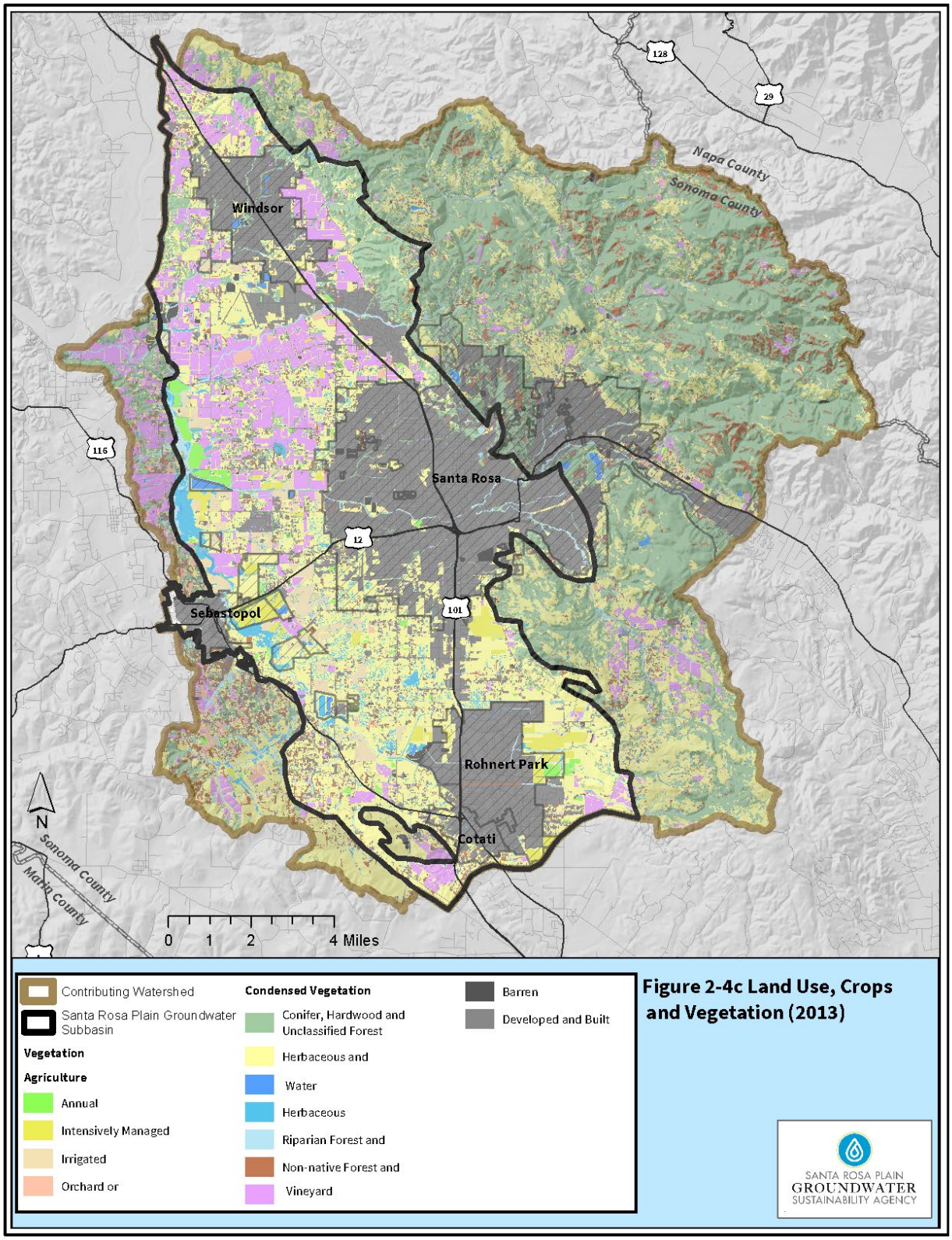


Figure 2-4c. Land Use, Crops, and Vegetation (2013)

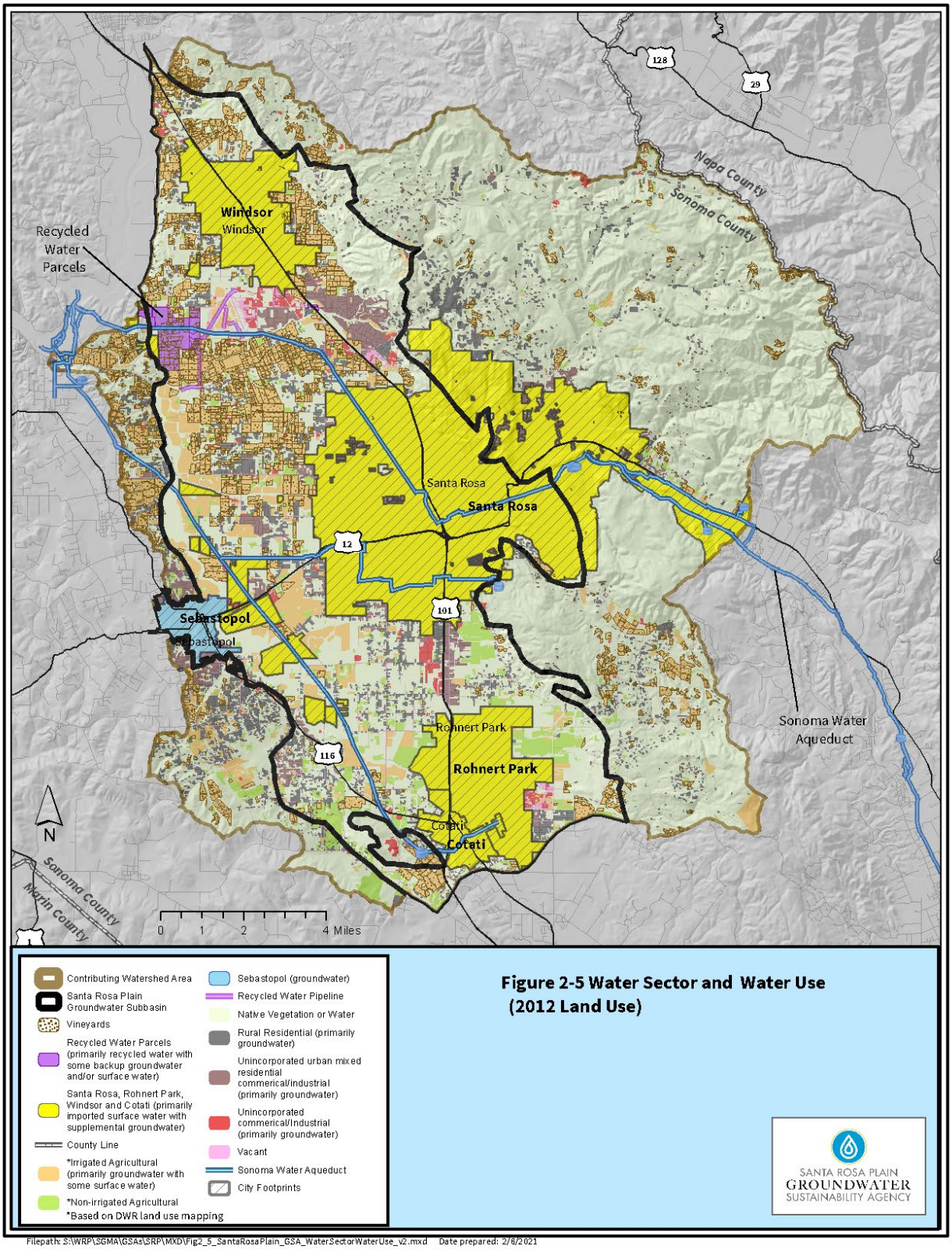


Figure 2-5. Water Sector and Water Use

Historically, the Santa Rosa Plain relied completely on its local groundwater and surface water resources until 1959 with the completion of the Santa Rosa Aqueduct and initiation of Russian River-imported surface water deliveries resulting in a mix of imported surface water and groundwater to meet water-supply demands. Deliveries to the City of Santa Rosa have been between 5,000 and 6,000 AFY over the past 25 years. With the completion of the Russian River-Cotati Intertie pipeline in 1975, deliveries of Russian River-imported surface water began flowing to Cotati and the City of Rohnert Park. Deliveries to City of Rohnert Park ranged between 2,600 and 2,900 AFY between 1996 and 2003, a period of localized groundwater declines, increased to more than 4,000 AFY for a number of years, and has ranged between 2,200 and 3,000 AFY in more recent times. Deliveries to City of Cotati have ranged between roughly 400 and 800 AFY, and for the Town of Windsor ranged between 500 and 700 AFY over the same time period. Russian River-imported water supply accounts for about 45 percent of the Subbasin water supply today.

Growth in the wine industry and increasing vineyards in the Santa Rosa Plain accounts for most of the agricultural demand expansion, from about 2,500 acres of vineyards in 1974 to about 9,700 acres of vineyards in the Subbasin in 2016. Groundwater pumping for irrigated crops in the Subbasin was estimated through the groundwater model, ranging from 5,700 AFY to 13,900 AFY with a median of 9,000 AFY. Urban and private systems groundwater demands did not begin to ramp up until later due in part to the Santa Rosa Aqueduct imported water supplements beginning in the 1960s, followed by the Russian River-Cotati Intertie. Urban and small system groundwater pumping has ranged from 4,800 AFY to 11,100 AFY with a median of 8,000 AFY. Rural residential well pumping has ranged from 2,000 AFY to 2,900 AFY with a median of 2,600 AFY. Because of incomplete well permit information, the exact number of domestic wells is unknown but is estimated to be between 4,000 and 5,500. Over time, the recently launched Groundwater Users Information Data Exchange will lead to more accurate information on the number of residential wells. Today, groundwater accounts for approximately 35 percent of the overall Subbasin water supply.

Deliveries of recycled water commenced in 1990 and is used for landscape and agricultural irrigation. An estimated 10,200 AFY has been used for the irrigation of vineyards, replacing groundwater pumping. Recycled water accounts for about 20 percent of the water supply in the Subbasin.

2.3.1 Groundwater

Groundwater is the primary water supply for irrigated agriculture (where access to recycled water is not available), rural residential properties (including many mutual water companies), commercial and industrial users in unincorporated areas, and the City of Sebastopol. Groundwater is also the primary source of supply for California American Water Company's Larkfield District, which also utilizes imported surface water as a source of secondary supply. Groundwater is also an important supplemental or backup source of supply for many of the municipal water purveyors, including Sonoma Water; the Cities of Santa Rosa, Rohnert Park, and Cotati, all of which operate municipal wellfields within the Subbasin and contributing watershed areas. **Figure 2-6a** shows the approximate location and density of water wells within

the Subbasin and contributing watershed areas based on available data from DWR. **Figure 2-6b** illustrates the depth of groundwater wells in the Subbasin and watershed.

2.3.2 Imported Surface Water

Imported water consists of Russian River water sourced from Sonoma Water's production facilities located outside of the Subbasin that is delivered via aqueduct to the cities within the Subbasin. Imported surface water represents the primary source of water for urban residents and businesses that are served by the Cities of Cotati, Rohnert Park, and Santa Rosa, and the Town of Windsor.

2.3.3 Local Surface Water

Local surface water from Mark West Creek, Santa Rosa Creek, and Laguna de Santa Rosa (**Figure 2-2**) and their tributaries represents an important source of supply for some water users. Information on the approximate amounts of surface water is available through reported surface water diversions filed with the California SWRCB (2018).

2.3.4 Recycled Water

Recycled water is treated to tertiary standards by wastewater treatment plants operated by the Town of Windsor, the City of Santa Rosa, and Airport Larkfield (**Figure 2-1**), which is used for crop and landscape irrigation in lieu of using groundwater or imported water. Recycled water produced from the City of Santa Rosa's Laguna Treatment Plant (serving Santa Rosa, Cotati, Rohnert Park, and Sebastopol) and the Town of Windsor's Wastewater Treatment Facility is also delivered for energy generation to the Geysers Geothermal Steamfield located in the Mayacamas Mountains outside of the contributing watershed.

2.4 Existing Monitoring Programs and Networks (23 CCR 354.8 c, d, e)

Existing monitoring programs and networks within the Subbasin have been developed and implemented by many agencies, organizations, and volunteers for a variety of purposes. This section provides a description of the existing monitoring programs and networks. An assessment of the existing monitoring networks and programs for their suitability to comply with DWR's GSP Regulations, including identification of data gaps, is described in **Section 5** (Monitoring Plan).

2.4.1 Groundwater-level Monitoring

Numerous organizations within the Subbasin and contributing watershed areas collect groundwater-level measurements, including DWR; Sonoma Water; the Sonoma and Gold Ridge RCDs; the Cities of Cotati, Rohnert Park, and Santa Rosa; the Town of Windsor; Sonoma State University; and many operators of small mutual water systems. Permit Sonoma administers the Use Permit Groundwater Monitoring Program, which requires the measurement and reporting of groundwater levels on a quarterly or monthly basis for commercial and industrial projects requiring a use permit and using more than 0.5 AFY of water. Groundwater levels are measured from a combination of private wells, dedicated monitoring wells, and inactive and active public water-supply wells.

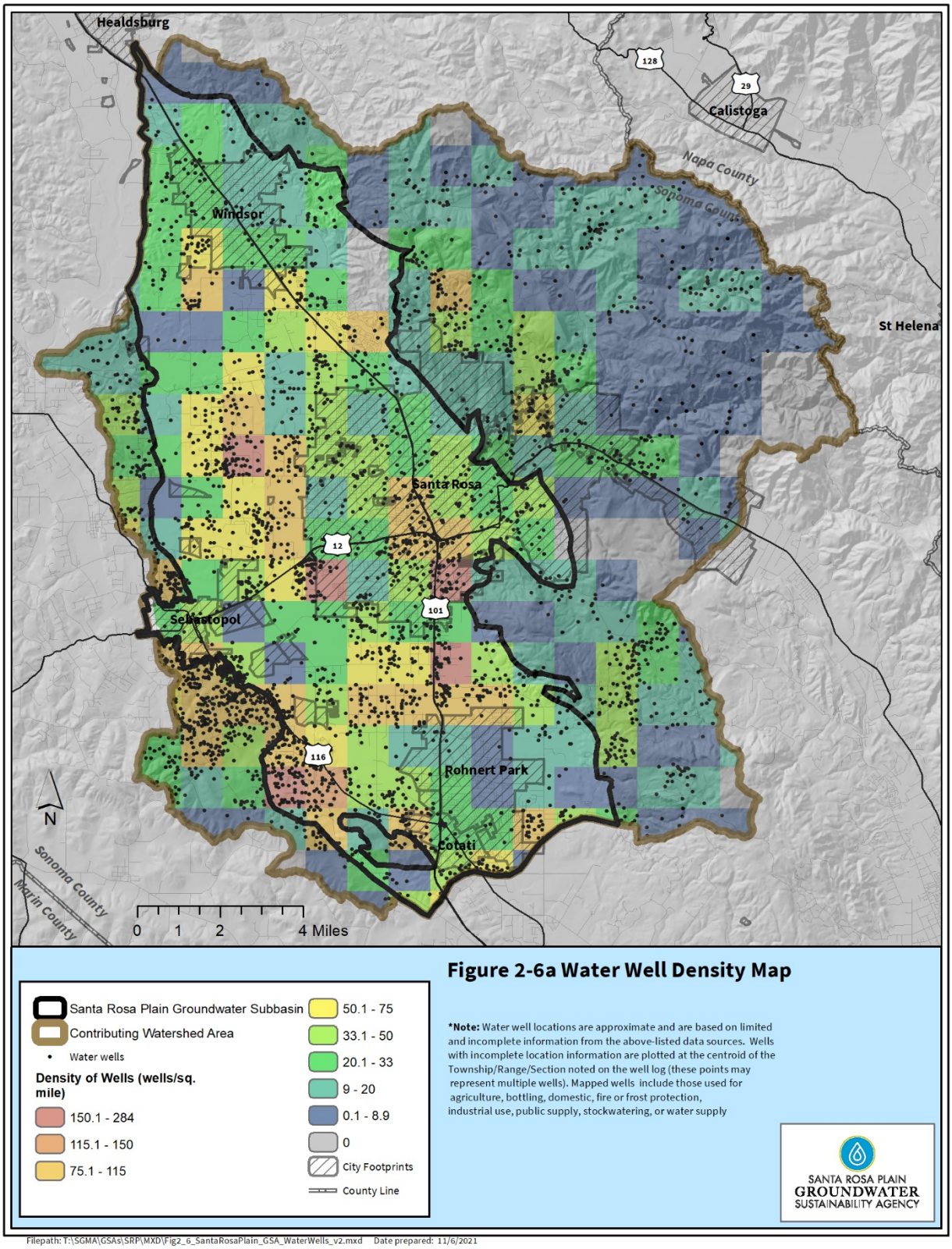


Figure 2-6a. Water Wells

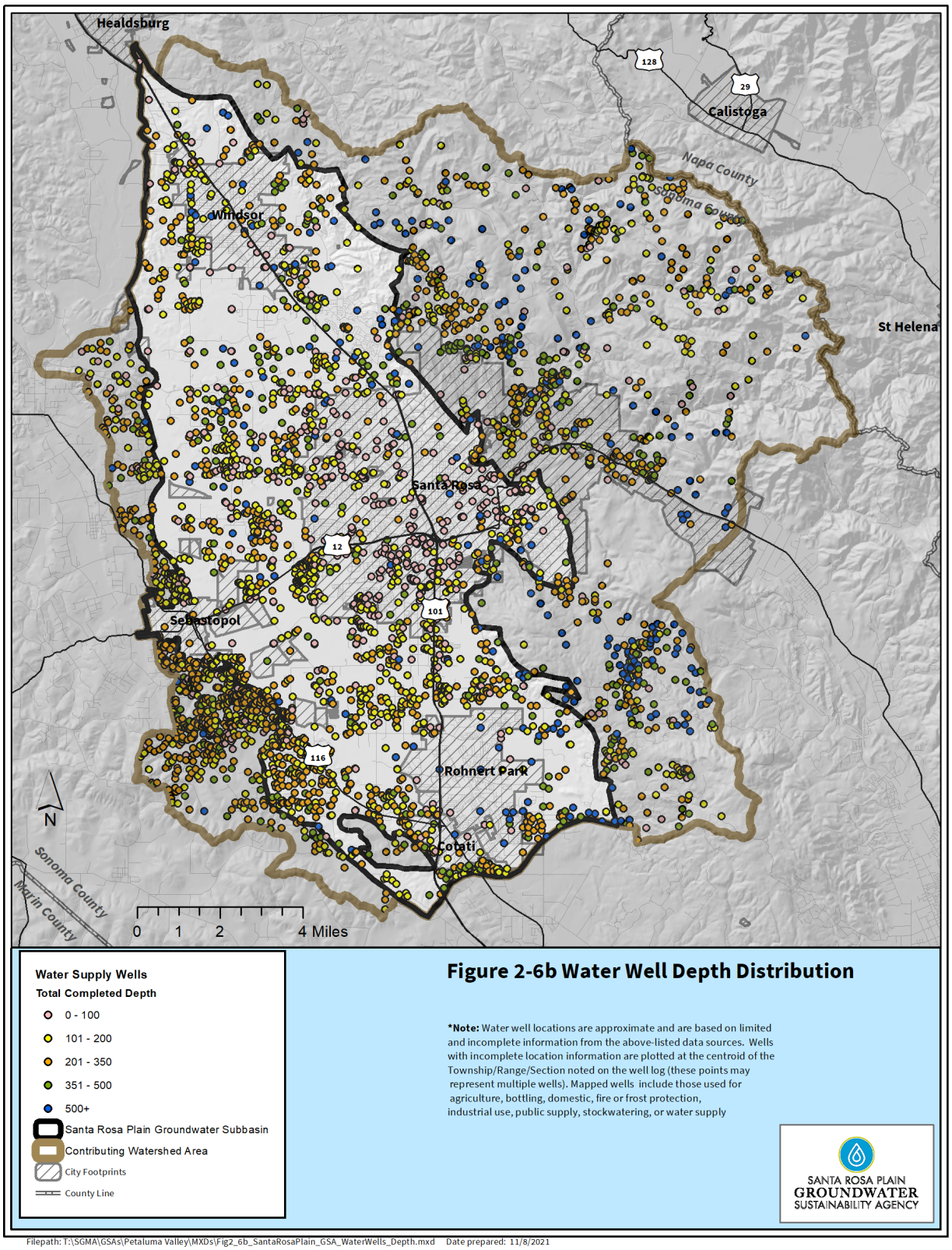


Figure 2-6b. Water Well Depth Distribution

The Groundwater-level Monitoring Network expanded significantly under the voluntary Santa Rosa Plain Groundwater Management Program (SRPGMP 2016) through public outreach and education to private well owners who volunteered to have their wells monitored. The majority of wells monitored in the program are voluntary private domestic and agricultural wells, with a smaller but significant portion of publicly owned water-supply wells and dedicated monitoring wells.

Groundwater-level monitoring is generally conducted twice a year, in the spring and fall, at 134 groundwater-level monitoring program wells within the watershed, as shown on **Figures 2-7a** and **2-7b**. A subset of the wells is monitored on a more frequent basis, including continuous monitoring using pressure transducers. The 134 wells in the existing monitoring program were subdivided according to their well-screen depth or total depth, where known, into the following categories:

- Less than 200 feet deep
- 200 to 500 feet deep
- Greater than 500 feet deep
- Unknown well-screen and depth

DWR has measured groundwater levels in a network of wells within the Subbasin for decades. Most of these wells were incorporated into DWR's monitoring network between the mid-1950s and 1981. Measurements are generally collected from these wells semiannually in the spring and fall, although a subset of wells are monitored monthly.

Groundwater-level data are available to the public from DWR, SWRCB, and the U.S. Geological Survey (USGS). The DWR California statewide Groundwater Elevation Monitoring (CASGEM) Program is a state program to compile groundwater-level monitoring data statewide from local monitoring programs. A subset of the Subbasin groundwater-level monitoring data is reported by Sonoma Water to the CASGEM program. The SWRCB GeoTracker program provides groundwater-level monitoring data on a number of soil and groundwater cleanup sites in the Subbasin. The USGS operates the National Water Information System (NWIS; https://waterdata.usgs.gov/nwis), which is a database of surface water and groundwater data.

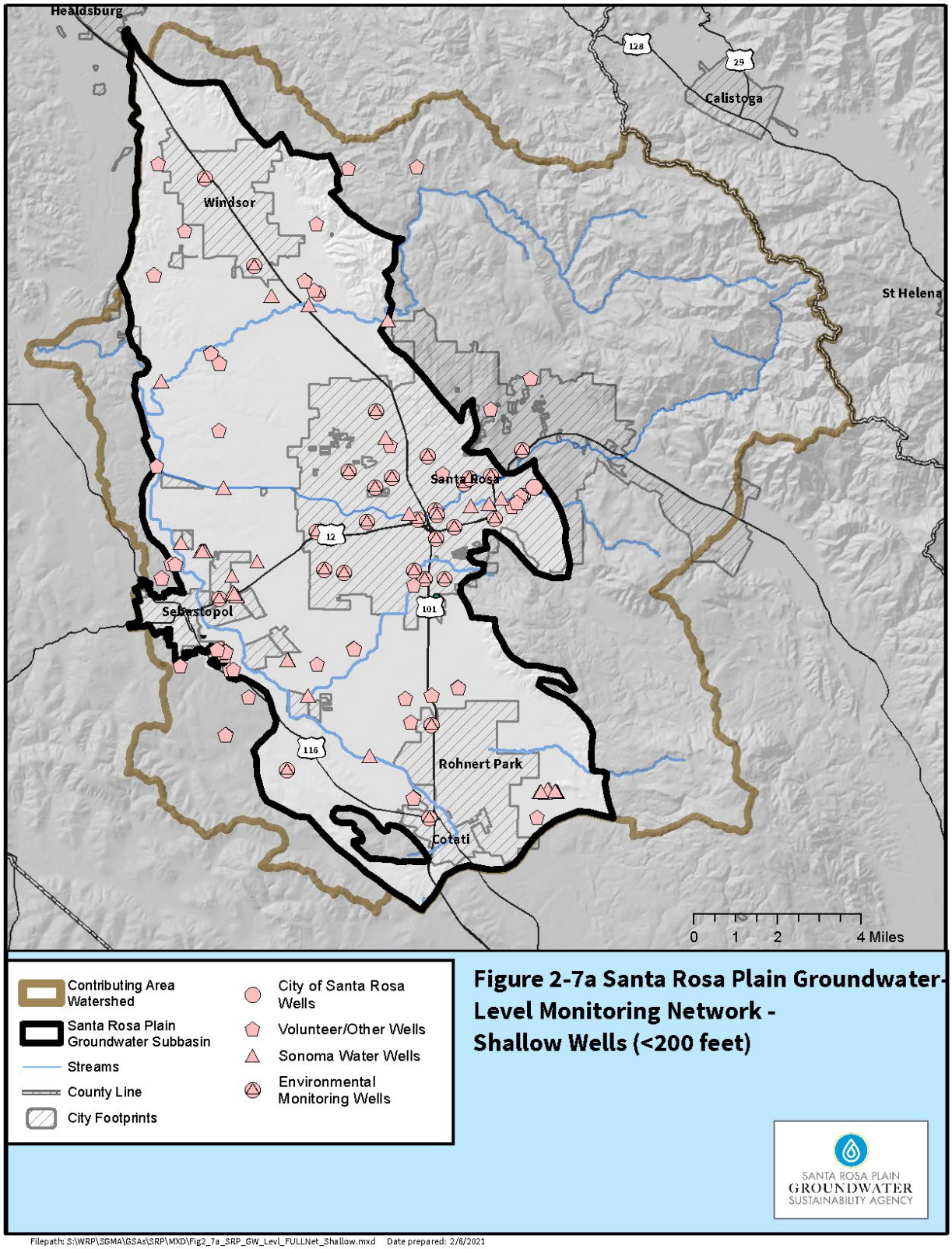


Figure 2-7a. Santa Rosa Plain Groundwater-level Monitoring Network – Shallow Wells (< 200 feet)

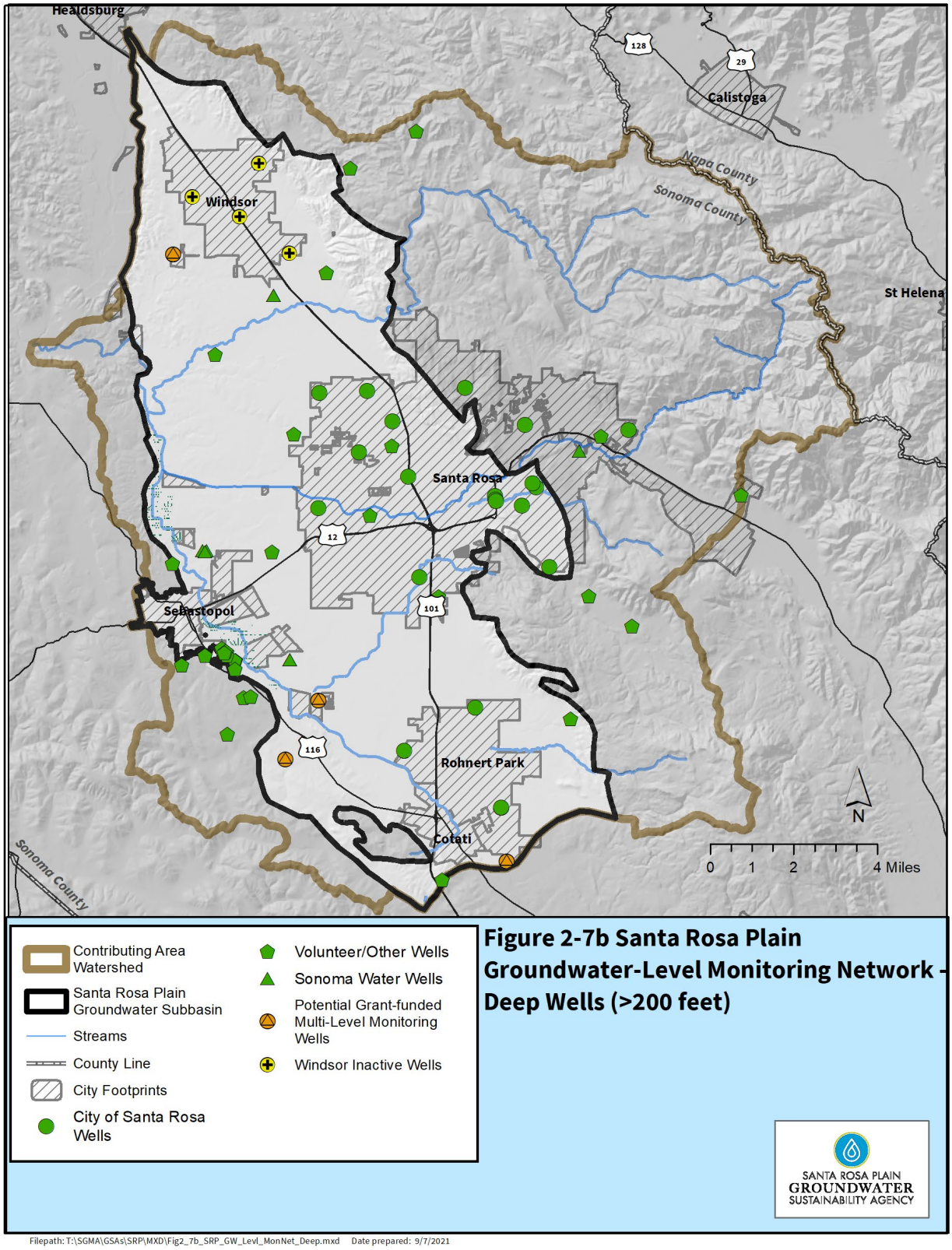


Figure 2-7b. Santa Rosa Plain Groundwater-level Monitoring Network – Deep Wells (> 200 feet)

2.4.2 Groundwater Quality Monitoring

Groundwater quality data has been collected through many different programs and initiatives described in **Sections 2.5.2.1** through **2.5.2.5**. The synthesis and evaluation of results from the below-water quality monitoring programs are described in **Section 3** (Basin Setting).

2.4.2.1 Public Water-Supply Well Monitoring

The SWRCB's Division of Drinking Water (DDW) monitors public water system wells for compliance with CCR Title 22 requirements for drinking water standards. Title 22 includes standards relative to levels of organic and inorganic compounds such as metals, microbial compounds, and radiological analytes. Data are available for active and inactive drinking water sources, for water systems that serve the public, and wells defined as serving 15 or more connections, or more than 25 people per day. In the Subbasin, DDW wells were monitored for Title 22 requirements.

2.4.2.2 State Water Resources Control Board Groundwater Ambient Monitoring and Assessment Program

Established in 2000, the Groundwater Ambient Monitoring and Assessment (GAMA) Program monitors groundwater quality throughout the State of California. GAMA is intended to create a comprehensive groundwater monitoring program and increase public access to groundwater quality and contamination information. GAMA receives data from a variety of monitoring entities, including DWR, USGS, and the SWRCB.

2.4.2.3 Water Data Library

DWR monitors groundwater quality data and reports the results through the Water Data Library. Samples are collected from a variety of well types including irrigation, stock, domestic, and some public-supply wells. Wells are not sampled regularly, and most wells have only 1 or 2 days' worth of sampling measurements and large temporal gaps between the results. Constituents most frequently monitored include chloride, sodium, calcium, boron, magnesium, and sulfate. Measurements taken include conductance, pH, total alkalinity, and hardness. Additional dissolved nutrients, metals, and total dissolved solids (TDS) are also sampled but have fewer sample results available.

2.4.2.4 Santa Rosa Plain Salt and Nutrient Management Plan

The Santa Rosa Plain Salt and Nutrient Management Plan (SNMP) was prepared in 2013 (City of Santa Rosa 2013a) in accordance with California's Recycled Water Policy of 2009 (as amended in 2013 and 2018, SWRCB 2018) by the City of Santa Rosa in collaboration with partner agencies (Cities of Cotati, Sebastopol, Rohnert Park; Town of Windsor; and Sonoma Water). Santa Rosa submitted the final SNMP in 2013 and the NCRWQCB approved the SNMP in a letter dated September 1, 2015. The SNMP proposed a conceptual monitoring framework and implementation plan that the NCRWQCB approved as part of the SNMP review and approval process. A Revised Monitoring and Reporting Program (MRP) was submitted to the NCRWQCB in August 2021 and is currently being reviewed by the NCRWQCB (City of Santa Rosa 2021). Developed to comply with the SNMP, the MRP is proposed to include monitoring of TDS and

nitrate using laboratory methods and pH, temperature, and electrical conductivity (EC) using field methods from six monitoring wells in an area of high recycled water application with higher potential risk to water quality in the central portions of the Subbasin. Upon the implementation of the MRP, monitoring efforts will be coordinated and, where possible, combined with the monitoring program described in **Section 5** (Proposed Monitoring Program).

2.4.2.5 U.S. Geological Survey

Special studies conducted by the USGS within the Santa Rosa Plain Subbasin have included the collection and analysis of groundwater quality data. Water quality analyses have included major ions, trace elements, nutrients, stable isotopes (oxygen-18 and deuterium), tritium, the radioactive isotope of carbon (carbon-14), and the stable isotope of carbon (carbon-13). Data collected by the USGS through these studies are available on the NWIS database (USGS 2021).

2.4.3 Climate Monitoring

Climate-monitoring stations in the watershed provide part of the information necessary for forecasting weather conditions, flood preparedness, drought preparedness, water-supply planning, and for determining the Subbasin water budget. Climate-monitoring stations may include sensors to collect data on rainfall, air temperature, relative humidity, wind speed and direction, solar radiation, soil temperature, and moisture. Climate data (**Figure 2-7c**) in the Subbasin are collected by several stakeholders, agencies, and tools, including:

- Western Weather Group (http://www.westernwx.com/sonoma)
- Community Collaborative Rain, Hail and Snow Network (CoCoRaHS 2021)
- Sonoma Water, OneRain program (https://sonoma.onerain.com/home.php)
- California Irrigation Management Information System (CIMIS; DWR 2021c)
- National Weather Service's MesoWest gages
- Pepperwood Preserve
- National Oceanic and Atmospheric Administration's (NOAA's) National Climate Data Center

The primary weather station in the Subbasin, which has been used to calculate mean annual rainfall, is Climate Station Sonoma County Airport (National Climatic Data Center #7965). The station is located at the Charles M. Schulz Sonoma County Airport. Data are available from 1903 to the present at this station; however, the station dataset does not contain a complete record of daily rainfall.

2.4.4 Surface Water Monitoring

Existing continuous surface water monitoring in the watershed includes nine stream gaging stations operated by the USGS, seven gages operated by Sonoma Water, and one stream gage operated by the Pepperwood Preserve (**Figure 2-7d**). Most streamflow records within the Plan Area date back to Water Year (WY) 1999 through the present. Data collection by Sonoma Water began in 2018.

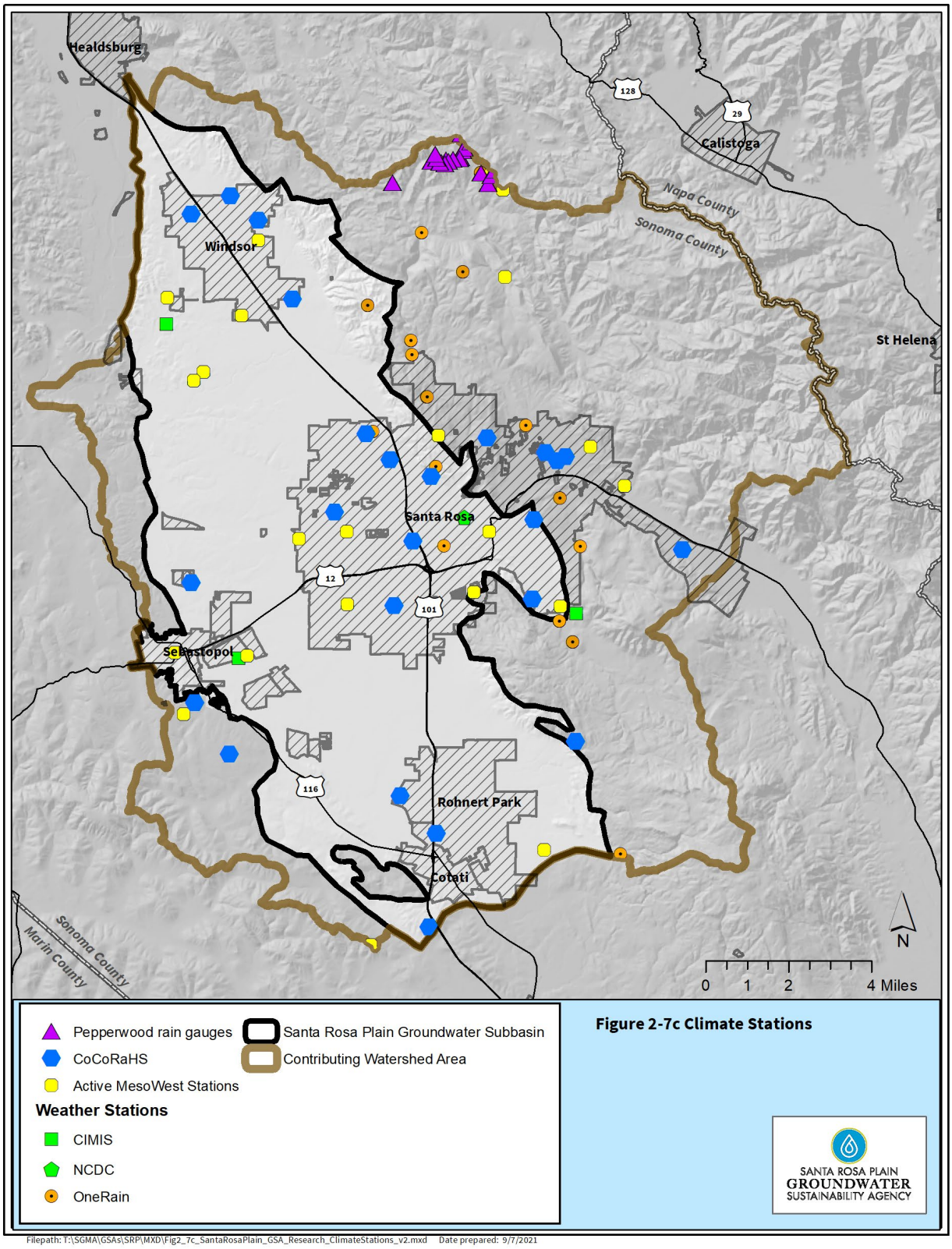


Figure 2-7c. Climate Stations

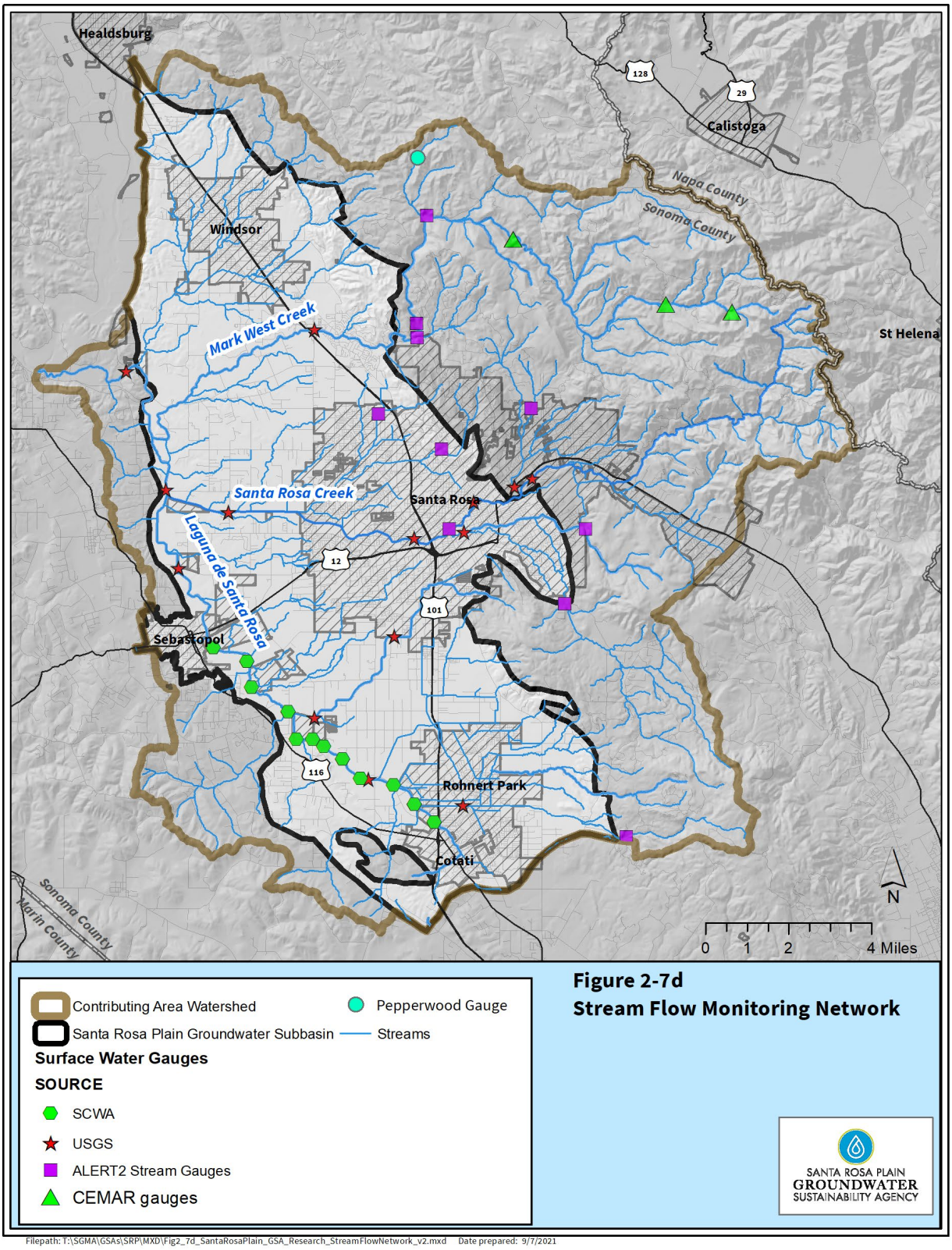


Figure 2-7d. Streamflow Monitoring Network

2.4.5 Land Surface Subsidence Monitoring

There are two primary systems for monitoring land surface subsidence in the Subbasin, described as follows:

- To support the implementation of SGMA, subsidence is currently estimated every month by DWR using Interferometric Synthetic-Aperture Radar (InSAR) data. The InSAR data are spatially extensive (covering nearly the entire Subbasin) with data available monthly going back to 2015.

- In the Subbasin, global positioning system (GPS) stations monitored by the University NAVSTAR Consortium's (UNAVCO) Plate Boundary Observatory (PBO) program are currently used as an indicator of subsidence. There are currently no regularly scheduled theodolite or total station surveys and no extensometers in the Subbasin. The UNAVCO PBO network consists of a network of about 1,100 continuous GPS and meteorology stations in the western United States used to monitor multiple pieces of information, including subsidence. There is one station in the Subbasin and two in the contributing watershed: (1) P197, located on Highway 12 at Fulton Road; (2) P196, located along Meacham Road southeast of Cotati, and (3) P201, located on the ridgetop just north of Mark West Quarry.

2.5 Existing Management Programs and Studies (23 CCR 354.8 c, d, e)

There are many existing and previous water management programs, studies, and initiatives covering the Subbasin that have been developed for a variety of purposes by multiple agencies and organizations. This section summarizes those deemed most relevant to groundwater management planning and indicates the type of information from these plans that is incorporated into subsequent sections of this GSP.

2.5.1 Santa Rosa Plain Groundwater Management Program

The USGS completed two groundwater studies of the Santa Rosa Plain Watershed in collaboration with Sonoma Water; the Cities of Cotati, Rohnert Park, Santa Rosa, and Sebastopol; the Town of Windsor; Sonoma County; and the California American Water Company (Nishikawa 2013; Woolfenden and Nishikawa 2014).

These studies formed the basis of the 2014 Santa Rosa Plain Watershed Groundwater Monitoring Plan, developed for the Santa Rosa Plain Watershed under the leadership of a Basin Advisory Panel, composed of a diverse group of local stakeholders. The Groundwater Monitoring Plan was prepared under the authority of the Groundwater Management Act, California Water Code (Water Code) Section 10750 et seq., originally enacted as Assembly Bill (AB) 3030 in 1992 to encourage voluntary, nonregulatory groundwater management at the local level.

The Groundwater Monitoring Plan goal was to locally and voluntarily manage, protect, and enhance groundwater resources for all beneficial uses in a sustainable, environmentally sound, economical, and equitable manner for generations to come. This plan identified a range of voluntary water management actions, including groundwater recharge, groundwater banking,

increased water-use efficiency, and greater use of recycled water to reduce demand for groundwater. Key information, tools, and outcomes from these previous groundwater management planning activities include the following:

- Technical information on the Subbasin hydrology, hydrogeologic framework, water chemistry and source, surface water and groundwater interaction monitoring, and records of groundwater levels.
- Significant expansion of monitoring activities.
- Initiation of studies for groundwater banking and stormwater recharge.
- Initial scoping of projects and actions to sustain groundwater resources in the Santa Rosa Plain.
- Engagement of local stakeholders in local groundwater planning and management.

Concurrently, the USGS and Sonoma Water entered into a cooperative agreement for the development of an integrated computer model (GSFLOW) of surface water and groundwater systems in the Subbasin and contributing watershed area.

In 2017, as the Santa Rosa Plain GSA was forming and beginning to assume management responsibilities for the Subbasin under SGMA, the Basin Advisory Panel and Technical Advisory Committee dissolved.

2.5.2 Urban Water Management Planning

Municipalities and other urban water providers regularly assess future water supplies, through both mandated Urban Water Management Plans (UWMPs) and other documents or processes.

UWMPs are prepared every 5 years by California's urban water suppliers to support long-term resource planning and ensure adequate water supplies are available to meet existing and future water demands. Every urban water supplier that either provides more than 3,000 AFY of water or serves more than 3,000 customers is required to assess the reliability of its water sources over a 20-year planning horizon considering normal, dry, and multiple dry years. The plans are submitted to DWR, which then reviews the submitted plans to ensure they have completed the requirements identified in the Urban Water Management Planning Act (Division 6 Part 2.6 of the Water Code Sections 10610–10656).

Within the Subbasin, UWMPs are prepared by Sonoma Water (as a wholesaler) and the Cities of Cotati, Rohnert Park, and Santa Rosa, and the Town of Windsor (as water retailers). The City of Sebastopol currently serves fewer than 3,000 customers and supplies less than 3,000 AFY and is, therefore, not required to prepare an UWMP. California American Water Company’s Larkfield District has not historically prepared a UWMP because it serves fewer than 3,000 customers, but is preparing one in 2021. The UWMPs discuss and describe the following:

- Existing water supplies and infrastructure
- Projected water demands over the next 20 years, based on population growth projections, land use designations and growth policies in city and county general plans
- Projected water supplies available over the next 20 years, the reliability of that supply, and general plans for water-supply projects
- Current and planned water conservation activities, targets, and compliance
- A water shortage contingency analysis
- A comparison of water supply and water demand over the next 20 years under different hydrological assumptions (normal year, single dry year, and four consecutive dry years)

Because local groundwater makes up a portion of the water supply for urban purveyors within the Subbasin, the UWMPs also discuss and describe groundwater production facilities, historical and projected groundwater use, and the conditions of the groundwater basin. Thus, UWMPs serve as a routine mechanism for local urban water providers to coordinate and plan for future urban groundwater use. The most recent projections for future urban groundwater use are incorporated into the projected water budget described in **Section 3** (Basin Setting). However, it is noted that UWMPs do not consider rural residential, agricultural and small municipal/mutual water systems.

In addition to the state-required UWMPs, many local urban water providers perform other water-supply planning activities related to groundwater, including the development of water master plans, preparation of water-supply assessments for larger proposed developments (more than 500 dwelling units or equivalent), updates of city and county general plans as described previously, and other activities. Information regarding some of these activities is summarized as follows:

- The Cities of Cotati (Cotati 2011), Santa Rosa (City of Santa Rosa 2014), Sebastopol (City of Sebastopol 2005), and the Town of Windsor (Town of Windsor 2011) have developed Water Master Plans, which assess water-supply needs and describe planned projects.
- The City of Santa Rosa adopted a Groundwater Master Plan (City of Santa Rosa 2013c) to provide strategic direction for managing the groundwater resources within the urban growth boundary of the city. The master plan integrates groundwater and surface water protection and management with water conservation and reuse to increase groundwater reliability and sustainability. The master plan includes the following:
    - Recommendations for an emergency groundwater supply plan
    - Development of a key well monitoring network
    - Conceptual evaluation of aquifer storage and recovery (ASR)

  - Recommended groundwater policies designed to guide the future role of groundwater and promote balanced use and sustainability for the groundwater resources available to the city

  - Identification of specific groundwater projects and programs based on these recommended policies

- Sonoma Water has developed a *Water Supply Strategies Action Plan* in coordination with its water contractors to increase water-supply system reliability, resiliency, and efficiency in the face of limited resources, regulatory constraints, and climate change uncertainties (Sonoma Water 2018).

- Beginning with passage of SB 610 in 2002, water-supply assessments must be furnished to local governments for inclusion in any environmental documentation for certain projects that are subject to California Environmental Quality Act (CEQA) (as defined in Water Code 10912[a]). The water-supply assessments are required to determine water-supply sufficiency for a 20-year projection in addition to the demand of existing and other planned future uses.

2.5.3 North Coast Resource Partnership

In 2002, the California State Legislature approved the Integrated Regional Water Management Planning Act (SB 1672). The implementation of the Act facilitates regional cooperation in water resources planning, and along with the passage of Propositions 50, 84, 1E, and 1, has provided grant funding for projects identified in a regional plan, referred to as an Integrated Regional Water Management Plan (IRWMP).

The North Coast IRWMP was formed in 2004 as a voluntary, nonregulatory, stakeholder-driven planning meant to emphasize shared priorities and local autonomy, authority, knowledge, and approaches to achieving tribal, state, regional, and local priorities related to North Coast water infrastructure, watersheds, public health, and economic vitality. The North Coast IRWMP changed its name in early 2013 to the North Coast Resource Partnership (NCRP). The NCRP continues to focus on areas of common interest and concern to North Coast stakeholders, and on attracting funding to the North Coast Region, and recognizes unique local solutions in different parts of the region (https://northcoastresourcepartnership.org).

The NCRP serves as a comprehensive planning tool that links other water resources management plans and programs through collaborative processes, coordination, and communication.

2.5.4 Climate Change Studies and Planning

Projected changes in climate include increased variability in precipitation and rises in air temperature, resulting in a shorter wet season, longer dry season, more droughts, and more extreme high flows. To face these potential changes in climate, local organizations are working with federal and state partners, including the USGS, DWR, NOAA, and the U.S. Army Corps of Engineers to advance the science in our region in an effort to plan for and adapt to predicted

changes. Local agencies have also partnered to form the Sonoma County Regional Climate Protection Authority and developed a regional Climate Action Plan (Sonoma County Regional Climate Protection Authority 2016). Findings and results from these efforts are described in **Section 3** (Basin Setting) and incorporated into future model projections in this GSP. In addition, the City of Santa Rosa has prepared two Climate Action Plans: the communitywide *Climate Action Plan* (City of Santa Rosa 2012) and the *Municipal Operations Climate Action Plan* (City of Santa Rosa 2013b).

2.5.5 Groundwater Banking Feasibility Study

Because of uncertainties in the reliability of regional future water supplies (both surface water and groundwater), Sonoma Water; the Cities of Rohnert Park, Cotati, and Sonoma; Valley of the Moon Water District; and the Town of Windsor conducted the Groundwater Banking Feasibility Study for a regional groundwater banking program to investigate the viability of enhancing the conjunctive management of surface water and groundwater resources (GEI et al. 2013).

Conceptually, the groundwater banking program would involve the diversion and transmission of surplus Russian River water produced at existing drinking water production facilities during wet weather conditions (that is, the winter and spring seasons) for storage in the Santa Rosa Plain Groundwater Subbasin and/or Sonoma Valley Groundwater Subbasin. The stored water would then be available for subsequent recovery and use during dry weather conditions (that is, the summer and fall seasons) or emergency situations. The Groundwater Banking Feasibility Study provided an evaluation of the regional needs and benefits, source water availability and quality, regional hydrogeologic conditions, and alternatives for groundwater banking.

Based on the findings from the study, which found that area aquifers are generally suitable for ASR, pilot studies to further assess the technical feasibility were recommended and currently are being pursued in the City of Sonoma, where a pilot project was completed in fall of 2018. The pilot project resulted in the empirical verification of specific hydrogeologic and water quality factors. The next steps are a technical and economic viability assessment of ASR technology in the region. If deemed feasible, the pilot project results could be used to complete environmental documentation and design for a full-scale or permanent ASR project in the region. Results from the pilot project also provided information on the technical feasibility for ASR in Sonoma Valley to other local agencies.

2.5.6 Water Conservation

Numerous regional and local water conservation programs are operational in the Plan Area including the Sonoma-Marin Saving Water Partnership, the LandSmart Program, and the Sustainable Winegrowing Program.

These programs are described in **Sections 2.6.6.1**, **2.6.6.5**, and **2.6.6.6**, respectively, however, it is anticipated that changes will likely occur as a result of sweeping legislation approved in 2018: AB 1668 (Friedman) and SB 606 (Hertzberg), which lay out a new long-term water conservation framework for California. The framework addresses both the urban and agricultural sectors, with goals to establish long-term improvements in water conservation and drought planning

that recognize the need to adapt to climate change and the resulting longer and more intense droughts in California. The development of programs and initiatives is organized around four primary goals as follows:

1. Use water more wisely
2. Eliminate water waste
3. Strengthen local drought resilience
4. Improve agricultural water-use efficiency and drought planning

To fully plan, develop, and implement the new framework, DWR and the SWRCB are working together in collaboration with stakeholders to develop new standards for the following:

- Indoor residential water use
- Outdoor residential water use
- Commercial, industrial, and institutional (CII) water use for landscape irrigation with dedicated meters
- Water loss

Based on these standards, urban water suppliers will be required to stay within annual water budgets for their service areas. In addition, water suppliers will need to report on implementation of new performance measures for CII water use.

The legislation also made important changes to existing urban and agricultural water management planning, and enhanced drought preparedness and water shortage contingency planning for both urban water suppliers and small water systems and rural communities. Currently, state agencies are conducting needed studies and investigations, and developing standards and performance measures, web-based tools and calculators, data and data platforms, reports, and recommendations for adoption of new regulations.

2.5.6.1 Sonoma-Marin Water Saving Partnership

The Sonoma-Marin Saving Water Partnership represents 10 water utilities in Sonoma and Marin counties that are signatories to the California Water Efficiency Partnership and have joined to create a regional approach to water-use efficiency. Within the Subbasin, these utilities include the Cities of Cotati, Rohnert Park, and Santa Rosa; the Town of Windsor; California American Water Company's Larkfield District and Sonoma Water. Water conservation and water-use efficiency program elements specific to the Sonoma-Marin Saving Water Partnership include the following:

- Establishing a conservation coordinator and water waste prohibition, assistance, and water loss control programs (audits, leak detection, and repair).
- Metering urban water and conservation pricing (tiered structure).

- Developing and maintaining public information and school education programs on water and conservation.
- Increasing conservation through specific urban residential programs for increasing indoor (high-efficiency toilets, fixtures, and washers) and outdoor (landscaping assistance, surveys, and retrofits) conservation.
- Increasing conservation through specific industrial and large-landscape assistance, surveys, and retrofits.
- Initiating rebate programs for high-efficiency appliances and fixtures.
- Training for qualified water efficient landscapers that provides education on proper plant selection for local climates, irrigation-system design and maintenance, and irrigation-system programming and operation.
- Offering an online water wise gardening website that offers a Mediterranean and native plant list, design and garden installation tips, and irrigation-system design and maintenance information.
- Providing a green business program that provides businesses with water and energy conservation information and incentives, to reduce waste and prevent pollution.

In addition to the partnership, its member agencies and the City of Sebastopol have water conservation programs to assist their communities in improving water-use efficiency to reduce water waste.

2.5.6.2 Windsor Pay as You Save

Windsor Efficiency “pay as you save” is a mechanism to provide efficiency upgrades for Town of Windsor home and apartment occupants. Examples of water efficiency measures eligible under the program are high-efficiency showerheads, toilets, faucet aerators, drought-resistant landscaping, and high-efficiency clothes washers.

2.5.6.3 Model Water Efficient Landscape Ordinances

Governor Brown’s Drought Executive Order of April 1, 2015 (EO B-29-15) directed DWR to update the state’s Model Water Efficient Landscape Ordinance (MWELO) through expedited regulation. Local agencies must adopt the MWELO or adopt a local ordinance that must be at least as effective in conserving water as MWELO by December 1, 2015. Executive Order B-29-15 and the revised ordinance require that local agencies report on the implementation and enforcement of their single agency Local Ordinances to DWR by December 31, 2015. Reporting for all agencies is due by January 31 of each year thereafter.

The county and cities have all developed individual water efficient landscape ordinances. The new water efficient landscape ordinances require a landscape plan check for certain projects, as

described in each ordinance. It includes requirements for landscape water budgets, landscape and irrigation design, and irrigation scheduling.

2.5.6.4 Rural Landowner Programs

There are also resources for implementing water conservation practices for rural landowners not connected to city water utilities or who are ineligible for urban water conservation program rebates. These include the following:

- A water conservation and stormwater management guide for all types of landowners is called *Slow it. Spread it. Sink it. Store It!* produced by the Sonoma RCD (2015). This homeowner's and landowner's guide offers many ideas and tips on practices that can help to protect and replenish groundwater resources, reduce erosion and pollution, prevent flooding, and increase water conservation and stormwater management.

- A guide focusing on rainwater catchment systems called *Roof Water Harvesting for a Low Impact Water Supply, Featuring the Brazilian Ball Pre-Filter System: A Case Study* produced by the Occidental Arts and Ecology Center's WATER Institute (2008).

2.5.6.5 LandSmart Program

The Sonoma RCD, Napa RCD, and the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service developed the LandSmart Program to promote productive lands and thriving streams through planning and on-the-ground implementation of beneficial management practices, including efficient irrigation. LandSmart Plans are developed by the agricultural producer, who can also seek certification from the RCD's certification team once plans are complete. Plan templates and guidance materials are designed to assess current practices and identify recommendations for other practices that would benefit natural resources such as water quantity and quality. Practices are prioritized and tracked over time. Information on the LandSmart Program is available at www.LandSmart.org.

2.5.6.6 Sustainable Winegrowing

Members of Wine Institute and the California Association of Winegrape Growers introduced the Code of Sustainable Winegrowing Practices Self-Assessment Workbook in 2002 (updated in 2006, 2013, and 2020) to promote environmental stewardship and social responsibility in the California wine industry (California Sustainable Winegrowing Alliance 2020). The workbook addresses a number of criteria for measuring performance, including Vineyard Water Management and Winery Water Conservation and Quality. More information on sustainable winegrowing practices is available at http://www.sustainablewinegrowing.org/. Additionally, the Sonoma County Winegrowers have developed a Sustainability Certification Program for vineyards, which includes water conservation assessments.

2.5.7 Stormwater Management

The need for integrating appropriate stormwater management practices while protecting and preserving groundwater resources is increasingly recognized by decision makers and such practices have been integrated into several initiatives and planning efforts.

2.5.7.1 Storm Water Resources Plans

Storm Water Resources Plans (SWRPs) are required by Senate Bill 985 (Pavley 2014) to be eligible to seek funding from any future state bond measures for stormwater projects. A SWRP is a nonregulatory, watershed-based, and stakeholder-driven plan that builds on local stormwater management objectives and identifies and prioritizes projects that capture, treat, or reuse stormwater and dry weather runoff. The *Russian River Storm Water Resource Plan* was developed by the Russian River Watershed Association for the Russian River Watershed (which includes the Subbasin) with support from local agencies and partners to identify and prioritize stormwater management projects (Russian River Watershed Association 2018). These projects must provide at least two benefits, which may include environmental enhancement, flood protection, groundwater recharge, water quality improvement, and/or recreational opportunities. The Russian River SWRP provides a framework for submitting, quantifying, scoring, and ranking future projects in an objective and data-driven format.

2.5.7.2 Stormwater Management-Groundwater Recharge

Sonoma Water conducted scoping studies in three of its flood zones to identify opportunities to alleviate flooding, while possibly recharging groundwater aquifers or providing other benefits. The *Stormwater Management-Groundwater Recharge* study (Sonoma Water 2012) assessed the feasibility of projects in Laguna-Mark West watershed (subwatershed of the Santa Rosa Plain Watershed), which informed the development of the Russian River SWRP.

Local growers have also been investigating the feasibility of performing on-farm recharge projects within the Subbasin through the performance of pilot studies and field investigations.

2.5.7.3 Municipal Stormwater Permit Program

Pursuant to the Federal Water Pollution Control Act (Clean Water Act) Section 402(p), California's Phase I Municipal Separate Storm Sewer System (MS4) Permit Program regulates stormwater discharges from an MS4 serving a population of 100,000 or more through the National Pollution Discharge Elimination System (NPDES). Sonoma Water is a co-permittee with the City of Santa Rosa and the County of Sonoma inside the Phase I MS4 permit boundary, incorporating most of the Subbasin. In 2013, municipalities serving a population of less than 100,000 were designated in the Phase II Permit Program and were provided an option to align with the Phase I MS4 program in an effort to foster watershed-wide consistency and collaboration.

Within the Santa Rosa Plain Subbasin, the Cities of Cotati, Rohnert Park, and Sebastopol, and the Town of Windsor, and the Phase II-designated portions of the County of Sonoma elected to participate in the 2015 Phase I permit program as co-permittees. Each co-permittee in the Subbasin has developed a draft Non-Stormwater Best Management Practices (BMP) Plan (BMP Plan) to eliminate or minimize the discharge of pollutants to the MS4 related to select types of discharges and conduct seasonal water quality monitoring and annual reporting.

To comply with the MS4 permit, the City of Santa Rosa and County of Sonoma developed a Low Impact Development Technical Design Manual (2011), which provides technical guidance for

project designs that require the implementation of permanent stormwater BMPs. Low-impact development, as it relates to stormwater, aims for a design to mimic the hydraulic function of an undeveloped site by capturing, treating, and infiltrating stormwater as close to the source as possible, and locating small scale landscape-based features throughout the project site. Each co-permittee is responsible for applying these permit requirements in conformance with this manual, at a minimum, to new development, retrofit projects, and applicable infrastructure improvement projects within their jurisdiction.

2.5.7.4 Water Smart Development Guidebook

Sonoma Water developed the *Water Smart Development Guidebook* (2013) to provide Sonoma County land developers; city and county planning officials; and environmental-regulatory agencies with a reference guide that can help them avoid and minimize potential adverse impacts on water resources from development projects. The guidebook provides guidance for planning and designing water resource-related project elements for residential and commercial developments. The three core guidebook sections focus on ways to increase water conservation and water reuse and reduce stormwater impacts.

2.6 General Plan and Related Plan Land Use Categories

Existing city and county planning activities that are directly or indirectly linked with water supply and groundwater management include general plans, and specific plans, which are described in **Section 2.2.1** through **2.2.2**. and UWMPs. Under SGMA, cities and counties retain their land use authorities; however, in recognizing the linkages between land use and water management, SGMA does require increased coordination between land use planners and GSAs. Cities and counties must now refer proposed general plan changes to GSAs, and similarly GSPs must consider “the most recent planning assumptions stated in local general plans of jurisdictions overlying the basin” (CWC Section 10726.9). In addition, Government Code Section 65350.5 stipulates that before general plans are adopted other GSPs must be reviewed and considered.

Future land use planning and associated growth projections are incorporated into the analysis of the projected water budget, over the planning and implementation horizon (**Section 3** [Basin Setting]).

The Cities of Cotati, Rohnert Park, Santa Rosa, and Sebastopol, the Town of Windsor, and Sonoma County general plans and specific plans provide growth estimates that are used in the UWMPs and in this GSP to project future water demands. These growth estimates are incorporated into the sustainable management criteria and metrics, including measurable objectives and interim milestones, the sustainability goal, proposed projects, and management actions. Projections of future groundwater availability and planned projects and actions needed for sustaining groundwater resources in the Subbasin will be shared with city and county planners for incorporation into their respective land use planning and decision-making.

In addition to coordinating on activities within the Subbasin, coordination and information sharing between the GSA and land use planning agencies will be needed for the contributing

watershed areas located outside of the GSA's jurisdiction, as described in **Section 7** (Implementation Plan). These areas primarily fall within the purview of the Sonoma County General Plan.

2.6.1 General Plans

Counties and cities are required to develop and adopt comprehensive general plans to guide future local physical development, as required in California State Government Code Title 7, Division 1, Article 5, Section 65300 et seq. Each general plan must contain a statement of policies, including maps or diagrams and text, setting forth objectives, principles, standards, and plan proposals. City general plans are focused on providing guidance on growth and development in the urban setting, while the county general plan focuses on the unincorporated areas of the county. Developing and updating general plans involves significant community involvement through workshops, hearings, and public review of draft plans and policies.

General plans include eight mandatory elements, including land use, circulation, housing, conservation, open space, noise, safety, and environmental justice. Optional elements can also be included; as described herein, the County of Sonoma has included an optional water resource element in its general plan.

Land use elements must reflect the content of the other general plan elements and must account for "rivers, creeks, streams, flood corridors, riparian habitats, and land that may accommodate floodwater for purposes of groundwater recharge and stormwater management…" as identified in the conservation element (Government Code Section 65302[d][3]). Land use elements must designate the type and density of land uses within the jurisdictional boundaries of the General Plan. The housing elements must be updated on an 8-year cycle to correspond with state regional housing needs allocations (Government Code Section 65584[b]).

The Subbasin includes areas covered by the Sonoma County General Plan and the general plans of the Cities of Cotati, Rohnert Park, Santa Rosa, Sebastopol, and the Town of Windsor. Government Code Section 65350.5 stipulates that before general plans are adopted, they must review and consider GSPs.

2.6.1.1 Sonoma County General Plan 2020

In recognition of the importance of water resources within unincorporated areas of the county, an optional new water resource element (WRE) was developed and included in the Sonoma County General Plan 2020 (Sonoma County 2008). The main purpose of the WRE is to ensure that Sonoma County's water resources are sustained and protected. To achieve this main purpose, the WRE states that water resource management should consider the amount of quality water that can be used without exceeding the replenishment rates over time or causing long-term declines or degradation in available surface water or groundwater resources.

The WRE includes goals, objectives, and policies for water quality; groundwater; public water systems; conservation and reuse; importing and exporting; and watershed management. These

goals, objectives, and policies include supporting local groundwater studies and management programs, and encouraging activities that protect natural groundwater recharge areas. The WRE for the Sonoma County General Plan 2020 can be reviewed at https://sonomacounty.ca.gov/PRMD/Long-Range-Plans/General-Plan/Water-Resources/.

Specific WRE goals related to groundwater include the following:

- Protect, restore, and enhance the quality of surface and groundwater resources to meet the needs of all reasonable beneficial uses.
- Manage groundwater as a valuable and limited shared resource.
- Assure that new proposals for surface and groundwater imports and exports are consistent with Sonoma County's ability to sustain an adequate supply of high-quality water for all its water uses and dependent natural resources.
- Improve understanding, valuation, and sound management of the water resources in Sonoma County's diverse watersheds.

Other water-related topics incorporated in the Sonoma County General Plan 2020 include water availability as a factor in land use map densities addressed in the Land Use Element. Land use designations based on Sonoma County's General Plan 2020 are shown on **Figure 2-8**. The open space and resource conservation element addresses riparian corridors, wetlands, wildlife protection, tree protection, fishery resources and other biotic resources, water-oriented recreation, soil erosion, forestry, and mineral resources. The public facilities and services element addresses connections to public water systems. The public safety element addresses flood hazards, fire suppression, and hazardous materials. The county's General Plan 2020 also includes a policy for the designation of community separators, which are rural open space and agricultural and resource lands that separate cities and other communities, prevent sprawl, protect natural resources, and provide city and community identity by providing visual relief from continuous urbanization.

It is anticipated that the next Sonoma County General Plan update will begin in 2022 and conclude in 2028.

2.6.1.2 Municipal General Plans

City general plans guide growth and development in the urban community, and typically involve an urban growth boundary. The UWMPs and general plans are clearly linked: UWMPs calculate future water demand based on growth and development projected in the general plan. The status of municipal general plans is as follows:

- City of Cotati – General Plan Update 2015 (City of Cotati 2015).
- City of Rohnert Park – General Plan Update 2000 – (City of Rohnert Park 2000) update in process.

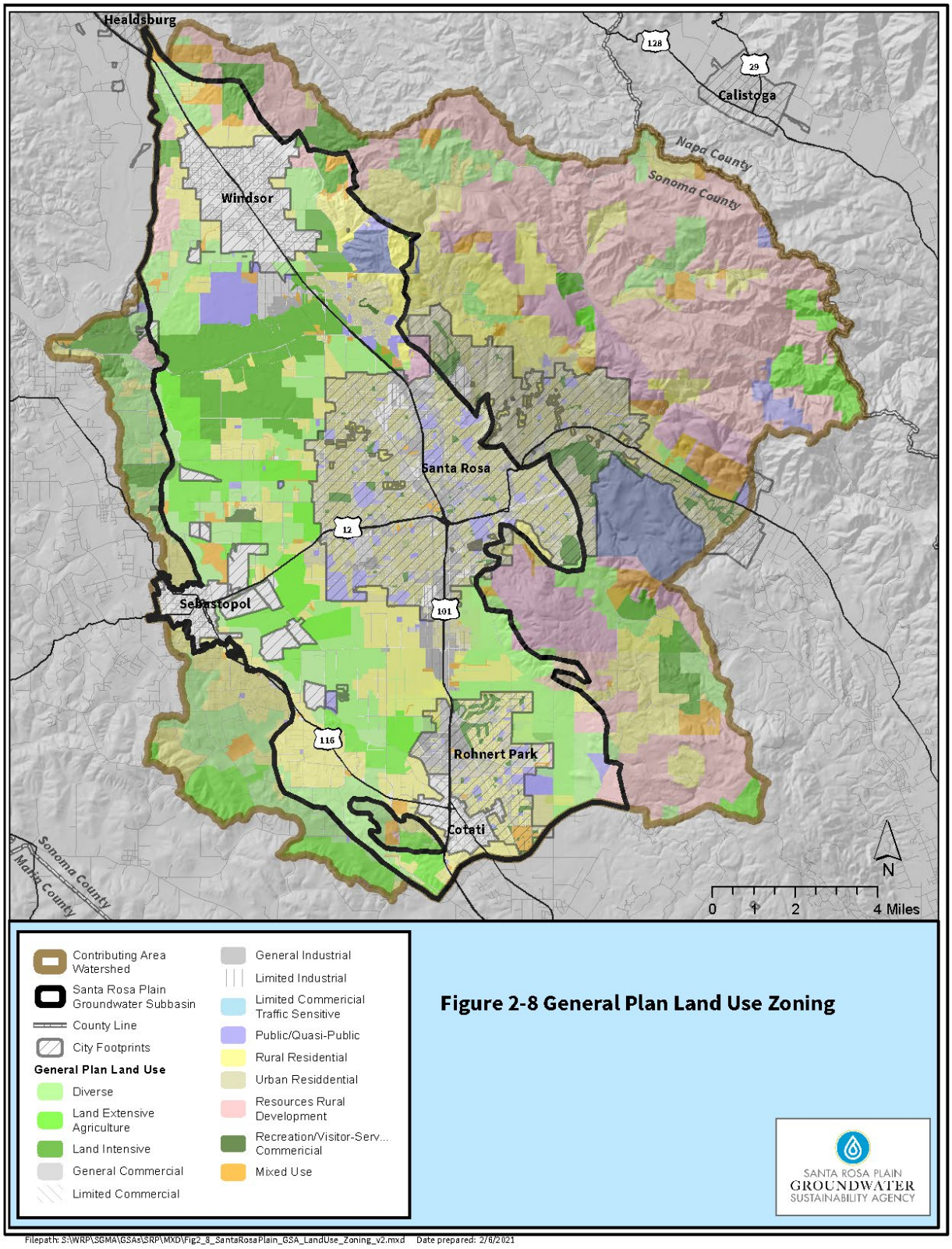


Figure 2-8. General Plan Land Use Zoning

- City of Santa Rosa – General Plan 2035 Update 2009 (City of Santa Rosa 2009). The city's General Plan 2050 is in development and slated for final review in fall 2022.
- Town of Windsor – General Plan 2040 (Town of Windsor 2018).
- City of Sebastopol – General Plan Update 2016 (City of Sebastopol 2016).

The Cities of Cotati, Rohnert Park, Santa Rosa, Sebastopol, and the Town of Windsor general plan documents contain Community Development, Environmental Resources, Local Economy, Circulation, Public Safety, Noise and Housing Elements. Each element contains goals, policies, and implementation measures that set a course for future land use in the city. Goals summarize how development and future growth should be directed to achieve the general plan vision by identifying physical, economic, and/or social ends that the community wishes to achieve.

In addition, municipal general plans include specific goals and policies related to groundwater, as shown in **Table 2-1**.

Table 2-1. Summary of Municipal General Plan Policies Specific to Groundwater

Municipality	General Plan Goals or Policies Specific to Groundwater
Cotati	• Support conjunctive groundwater use • Coordinate with and participate in planning efforts for the Santa Rosa Plain Groundwater Management Plan • Protect groundwater quality through appropriate design of septic and sewer systems • Encourage the use of flood and/or stormwater retention facilities for groundwater recharge
Rohnert Park	• Utilize purchased water supplies and reduce reliance on groundwater drawn from municipal wells, except for emergency use. • Ensure that groundwater withdrawal does not exceed safe yield. • Monitor the operation of the municipal well field on a monthly basis to ensure that production does not exceed the recharge rates quantified in the study so as to result in a substantial lowering of groundwater levels in the vicinity of the Urban Growth Boundary (Policy PF-11). • Develop a monthly municipal wellfield monitoring program that (i) identifies points of compliance; (ii) establishes the factors to be considered in determining when production which exceeds the recharge rates will result in a substantial lowering of groundwater levels ("thresholds"); and (iii) includes any information necessary to implement PF-11. • In the event that the monthly municipal wellfield monitoring program concludes that a substantial lowering of groundwater levels in the vicinity of the Urban Growth Boundary will occur because development proposed in the area outside the existing City limits as of July 1, 2000 requires production that exceeds the appropriate recharge rates, the City shall either disapprove such development or deny such development connection to the water system until such time that the program concludes that the City is in compliance with the standard established in PF-11. • Continue to collect and analyze monthly groundwater-level data to assist in management and operation of Rohnert Park's municipal wellfield. Coordinate with other agencies on regional drawdown impacts.

Municipality	General Plan Goals or Policies Specific to Groundwater
Santa Rosa	• Consider development of additional sources of water supply, possibly including utilization of the city's groundwater resources. • Protect groundwater recharge areas, particularly creeks and riparian corridors. Identify and protect other potential groundwater recharge areas. • Require provision of open space areas for storm water retention and infiltration and opportunities for groundwater recharge. • Adhere to all state, federal and regional laws and regulations to avoid groundwater contamination. • Require remediation and cleanup, and evaluate risk prior to reuse, in identified areas where hazardous materials and petroleum products have impacted soil or groundwater.
Sebastopol	• Groundwater should be managed as part of a broader integrated approach that includes surface water, conservation, water quality, reuse, environmental stewardship, and other water management strategies. • Operate the City's well system in such a manner as to not exceed the sustainable yield of the local groundwater aquifer. • Encourage new groundwater recharge opportunities and protect existing groundwater recharge areas throughout the Sebastopol Planning Area. • Promote the use of permeable surface materials and provide for ample areas of open space and naturalized land in order to decrease surface runoff and promote groundwater recharge. • Seek opportunities to expand the groundwater recharge capacity of City-owned parcels throughout Sebastopol. • Implement water conservation measures as a key strategy in sustainably managing local groundwater supplies. • Implement greenhouse gas reduction measures and participate in regional efforts to study the effects of climate change on precipitation levels as a key strategy in sustainably managing local groundwater supplies. • Continue to encourage and support federal, state, and local research on and monitoring of local groundwater conditions, aquifer recharge, watersheds and streams where needed to assess groundwater quantity and quality. • Protect the water quality obtained from City wells. • Reduce agricultural and pharmaceutical contamination of potable water supplies in the local aquifer.

Municipality	General Plan Goals or Policies Specific to Groundwater
Windsor	• Protect, manage, and improve natural creek habitats and the quality of the Town's surface water and groundwater resources. • The Town should actively support Federal and State laws pertaining to the Clean Water Act, Porter-Cologne Water Quality Control Act, and Sustainable Groundwater Management Act in attainment of water quality standards and management of surface water and groundwater. • The Town shall continue to properly abandon municipal wells that are no longer serving backup or monitoring roles and shall continue to cooperate with Sonoma County on the proper abandonment of private wells by private property owners in order to eliminate a potential pathway to contaminate the groundwater. • The Town shall operate its wells in compliance with the Sustainable Groundwater Management Act. • The Town shall determine and review alternative groundwater sources that can adequately supply the town with water during an ongoing drought. • The Town shall strive to ensure that important groundwater recharge areas are maintained as open space. • The Town has prepared a Local Hazard Mitigation Plan that contains a climate vulnerability assessment and strategies to address climate change adaptation. • The Town shall encourage the development of groundwater recharge projects of all scales to increase groundwater supplies. • The Town shall encourage rainwater harvesting design options in new development and retrofitting in existing development. • The Town shall encourage the use of low-impact development techniques for both public and private sites to aid in groundwater retention and infiltration.

2.6.2 Specific Area Plans

Specific area plans are planning documents that guide the development of a particular geographic area within the county. Any new developments or subdivisions within the defined area must be consistent with the general plan and specific plan.

2.6.3 Sonoma County Local Agency Formation Commission

The Sonoma County Local Agency Formation Commission (LAFCO) is a state-created regulatory agency that approves or disapproves proposals to expand municipal water and wastewater services outside of existing service areas. Through this power, the LAFCO is an important agency in proposals to offset groundwater use with urban water for both new and existing development in the county.

LAFCO has responsibility in four areas affecting local government in Sonoma County as follows:

1. To review and approve or disapprove proposals for changes in the boundaries and organization of the 9 cities and 54 special districts within Sonoma County, including incorporations of new cities, formation of new special districts and mergers, consolidations or dissolutions of existing cities, and special districts

2. To conduct studies, including municipal service reviews, of existing local government services with the goal of improving the efficiency of providing services

3. To establish spheres of influence, which are plans for the probable physical boundaries of each local agency, for cities and special districts within the county and to review and update those spheres of influence every 5 years

4. To assist the public and other government agencies concerning changes in local government boundaries and organization

2.7 Well Permitting Policies and Procedures

The GSA is not responsible for well permitting or groundwater pumping permits. Permit Sonoma is the Sonoma County agency responsible for administering permits for wells within the Subbasin. The Sonoma County Department of Health Services administers permits for environmental drilling and wells generally associated with contaminated sites. The purpose of the county's well-construction policies is to provide for the location, construction, repair, reconstruction, destruction, and addressing of the abandonment of all wells to protect the groundwater resource of the county because contamination may cause serious public health, safety, or economic problems.

The Sonoma County Well Ordinance contains regulations and requirements for constructing wells to prevent groundwater contamination from the surface, and between multiple water bearing zones in (Ordinance 25B).

Permit Sonoma reviews all development proposals within unincorporated areas that will rely on wells for water supply. Permit Sonoma has developed a four-tier classification system, based on geologic information and water yields, to designate general areas of groundwater availability (**Figure 2-9**). Class 1 areas are Major Groundwater Basins, Class 2 areas are Major Natural Recharge Areas, Class 3 areas are Marginal Groundwater Availability Areas, and Class 4 areas are Areas with Low or Highly Variable Water Yield (Permit Sonoma 2016).

Permit Sonoma uses this groundwater classification system in reviewing certain development and building permit applications. For example, dry season well yield tests are required in Class 4 areas prior to residential development. In addition, discretionary applications in Class 3 and 4 areas and in SGMA medium- and high-priority basins are required to include hydrogeologic reports to establish that groundwater quality and quantity are adequate and will not be adversely impacted by the cumulative developments and uses allowed in the area. The aim is to avoid causing or exacerbating an overdraft condition in a groundwater basin or subbasin.

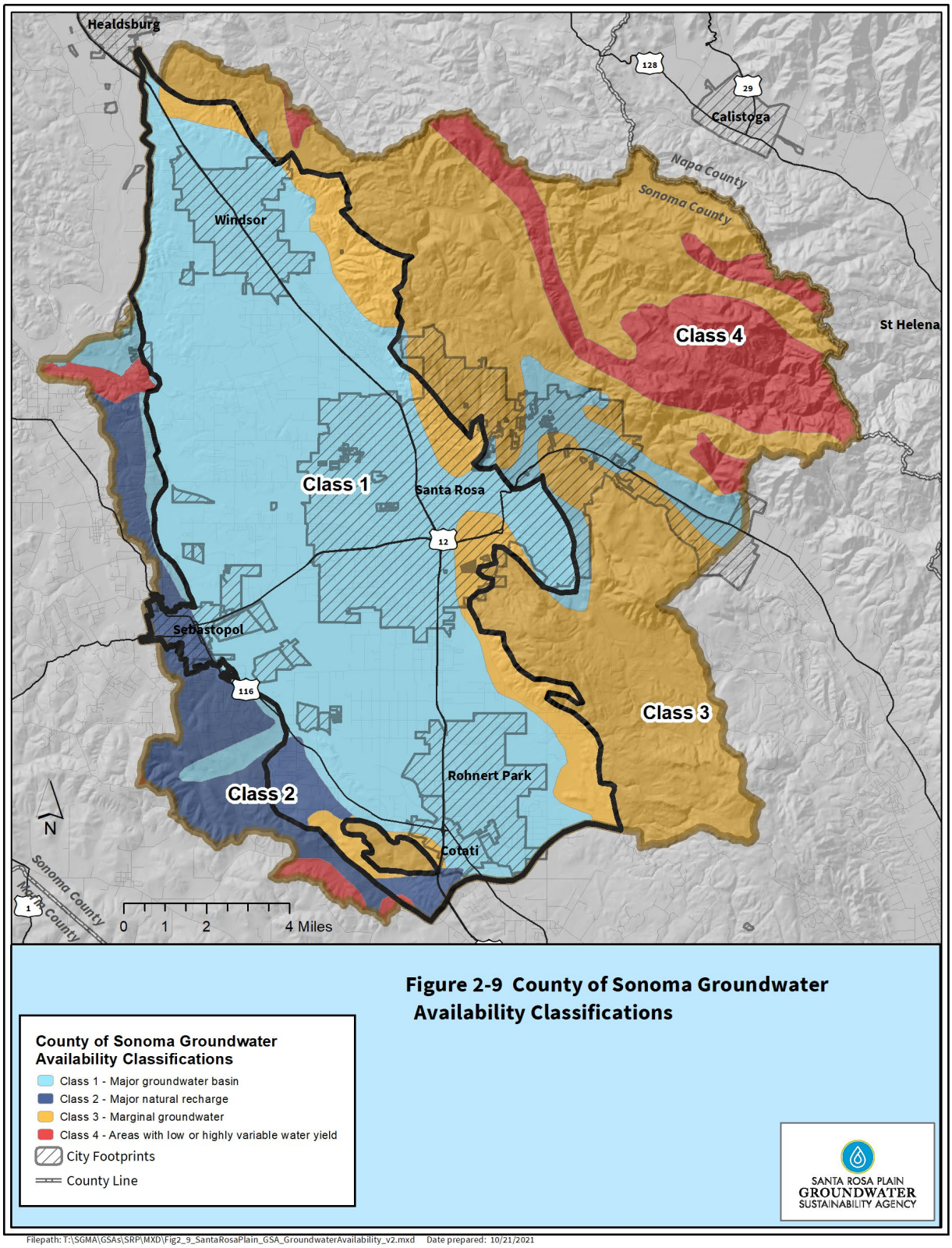


Figure 2-9. County of Sonoma Groundwater Availability Classifications

Section 3: Basin Setting
Groundwater Sustainability Plan for Santa Rosa Plain Groundwater Subbasin

Table of Contents

3 BASIN SETTING 3-1
3.1 Hydrogeologic Conceptual Model 3-1
3.1.1 Topography and Geography 3-2
3.1.2 Surface Water and Drainage Features 3-4
3.1.3 Soil Characteristics 3-6
3.1.4 Regional Geologic Setting 3-9
3.1.5 Principal Aquifer Systems and Aquitards 3-15
3.1.6 Effects of Faults on Groundwater 3-22
3.1.7 Groundwater Recharge and Discharge 3-23
3.1.8 Data Gaps and Uncertainty 3-25
3.2 Current and Historical Groundwater Conditions 3-26
3.2.1 Climatic Conditions and Trends 3-28
3.2.2 Groundwater Elevations and Trends 3-31
3.2.3 Estimated Changes in Groundwater Storage 3-58
3.2.4 Land-surface Subsidence 3-58
3.2.5 Groundwater Quality Conditions and Trends 3-64
3.2.6 Surface Water Conditions and Surface Water and Groundwater Connectivity 3-79
3.3 Water Budget 3-91
3.3.1 Overview of Water Budget Development 3-91
3.3.2 Overview of Model Assumptions for Water Budget Development 3-99
3.3.3 Historical and Current Water Budgets 3-102
3.3.4 Subbasin Water Supply Reliability 3-120
3.3.5 Uncertainties in Water Budget Calculations 3-120
3.3.6 Projected Water Budgets 3-121
3.3.7 Sustainable Yield 3-147
3.4 Management Areas 3-148

Tables

Table 3-1. Climate Station Santa Rosa Yearly Average Rainfall 3-30
Table 3-2. Summary of Historical and Current Water Budget Time Periods.....3-98
Table 3-3. Santa Rosa Plain Hydrologic Model - Summary of Water Budget Component Data Sources 3-100
Table 3-4. Number of Stream Inflow and Outflow Locations for Each HUC 12 Area and Major Stream[a] 3-103
Table 3-5. Historical (WY 1976 to WY 2018) Surface Water Budget Summary (AFY)[a] 3-105
Table 3-6. Current (WY 2012 to WY 2018) Surface Water Budget Summary (AFY)[a] 3-105
Table 3-7. Historical (WY 1976 to WY 2018) Groundwater Inflows Budget Summary (AFY)[a].....3-110
Table 3-8. Current (WY 2012 to WY 2018) Groundwater Inflows Budget Summary (AFY)[a] ..3-110
Table 3-9. Historical (WY 1976 to WY 2018) Groundwater Outflows Budget Summary (AFY)[a].....3-111
Table 3-10. Current (WY 2012 to WY 2018) Groundwater Outflows Budget Summary (AFY)[a].....3-111
Table 3-11. Average Annual Change of Groundwater in Storage (AFY)[a].....3-112
Table 3-12. Historical (WY 1976 to WY 2018) Groundwater Pumpage by Water-use Sector (AFY)[a].....3-113
Table 3-13. Current (WY 2012 to WY 2018) Groundwater Pumpage by Water-use Sector (AFY)[a].....3-113
Table 3-14. Historical (WY 1976 to WY 2018) Subbasin Boundary Flows (AFY)[a].....3-114
Table 3-15. Current (WY 2012 to WY 2018) Subbasin Boundary Flows (AFY)[a].....3-114
Table 3-16. Historical (WY 1976 to WY 2018) Budget for Watershed Areas Outside Subbasin and Major Soil-zone Fluxes[a] 3-116
Table 3-17. Historical (WY 1976 to WY 2018) Budget for Watershed Areas Outside Subbasin, and Subsurface and Surface Inflows (AFY)[a] 3-117
Table 3-18. Current (WY 2012 to WY 2018) Watershed Budget for Watershed Areas Outside Subbasin and Major Soil-zone Fluxes[a].....3-117
Table 3-19. Current (WY 2012 to WY 2018) Watershed Budget for Watershed Areas Outside Subbasin, Subsurface Flows to Santa Rosa Plain Subbasin, and Surface Flows to the Subbasin[a] 3-117
Table 3-20. Historical (WY 1976 to WY 2018) Budget for the Subbasin Soil Zone[a] 3-118
Table 3-21. Current (WY 2012 to WY 2018) Budget for the Subbasin Soil Zone[a].....3-119
Table 3-22. Projected (WY 2021 to WY 2040) Surface Water Budget Summary (AFY)[a] 3-127
Table 3-23. Projected (WY 2021 to WY 2070) Surface Water Budget Summary (AFY)[a] 3-128
Table 3-24. Projected (WY 2021 to WY 2040) Groundwater Inflows Budget Summary (AFY)[a].....3-133
Table 3-25. Projected (WY 2021 to WY 2070) Groundwater Inflows Budget Summary (AFY)[a].....3-134
Table 3-26. Projected (WY 2021 to WY 2040) Groundwater Outflows Budget Summary (AFY)[a].....3-136

Table 3-27. Projected (WY 2021 to WY 2070) Groundwater Outflows Budget Summary (AFY)[a] 3-136
Table 3-28. Average Annual Change of Groundwater in Storage (AFY)[a] 3-137
Table 3-29. Projected (WY 2021 to WY 2040) Groundwater Pumpage by Water-use Sector (AFY)[a] 3-139
Table 3-30. Projected (WY 2021 to WY 2070) Groundwater Pumpage by Water-use Sector (AFY)[a] 3-140
Table 3-31. Projected (WY 2021 to WY 2040) Subbasin Boundary Flows (AFY)[a] 3-141
Table 3-32. Projected (WY 2021 to WY 2070) Subbasin Boundary Flows (AFY)[a] 3-141
Table 3-33. Projected (WY 2021 to WY 2040) Budget for Watershed Areas Outside Subbasin and Major Soil-zone Fluxes[a] 3-142
Table 3-34. Projected (WY 2021 to WY 2040) Budget for Watershed Areas Outside Subbasin, Subsurface, and Surface Flows into Subbasin (AFY)[a] 3-143
Table 3-35. Projected (WY 2021 to WY 2070) Watershed Budget for Watershed Areas Outside Subbasin and Major Soil-zone Fluxes[a] 3-143
Table 3-36. Projected (WY 2021 to WY 2070) Watershed Budget for Watershed Areas Outside Subbasin, Subsurface Flows to Subbasin, and Surface Flows to the Subbasin[a] 3-143
Table 3-37. Projected (WY 2021 to WY 2040) Budget for the Subbasin Soil Zone[a] 3-144
Table 3-38. Projected (WY 2021 to WY 2070) Budget for Subbasin Soil Zone[a] 3-145

Figures

Figure 3-1. Elevation and Surface Water Features 3-3
Figure 3-2. Santa Rosa Plain Groundwater Subbasin – Subwatersheds 3-5
Figure 3-3a. Santa Rosa Plain Groundwater Subbasin – Soil Textures 3-7
Figure 3-3b. Saturated Hydraulic Conductivity of Soils 3-8
Figure 3-4b. Geology of Santa Rosa Plain Groundwater Subbasin and Contributing Watershed 3-11
Figure 3-5. Schematic West-East Geologic Cross Sections 3-12
Figure 3-6. Natural Relative Recharge Potential 3-24
Figure 3-7. Natural Discharge 3-27
Figure 3-8. Average Annual Precipitation (1981-2010) 3-29
Figure 3-9a. Groundwater-level Contours 1951, 1990, and 2007 Plan Area 3-32
Figure 3-9b. Total Annual Pumping, Southern SRP, Surface Water Deliveries, and Groundwater Levels, 1968-2008 3-33
Figures 3-10a. Shallow Groundwater Elevation, Fall 2015 3-34
Figures 3-10b. Deep Groundwater Elevation, Fall 2015 3-35
Figures 3-10c. Shallow Groundwater Elevation, Spring 2015 3-36
Figures 3-10d. Deep Groundwater Elevation, Spring 2015 3-37
Figures 3-10e. Shallow Groundwater Elevation, Fall 2018 3-38
Figures 3-10f. Deep Groundwater Elevation, Fall 2018 3-39
Figures 3-10g. Shallow Groundwater Elevation, Spring 2018 3-40
Figures 3-10h. Deep Groundwater Elevation, Spring 2018 3-41
Figure 3-11a. Selected Hydrographs Cotati-Rohnert Park Area 3-43

Figure 3-11b. Selected Hydrographs Sebastopol Area 3-44
Figure 3-11c. Selected Hydrographs Santa Rosa, Bennett Valley, and Rincon Valley 3-45
Figure 3-11d. Selected Hydrographs Windsor Area 3-46
Figure 3-12a. Shallow Aquifer Wells Groundwater-level Trends 3-48
Figure 3-12b. Deep Aquifer Wells Groundwater-level Trends 3-49
Figure 3-13a. High-frequency Groundwater-level Monitoring Station Locations 3-50
Figure 3-13b. Groundwater-level Hydrographs – City of Rohnert Park Wells 3-51
Figure 3-13c. Groundwater-level Hydrographs – City of Santa Rosa Municipal Production Wells 3-52
Figure 3-13d. Groundwater-level Hydrographs – City of Santa Rosa Shallow Monitoring Wells 3-53
Figure 3-13e. Groundwater-level Hydrographs – City of Santa Rosa Deep Wells (<500 feet) ..3-54
Figure 3-13f. Groundwater-level Hydrographs – City of Santa Rosa Deep Wells (>500 feet) ...3-55
Figure 3-13g. Groundwater-level Hydrographs – SCWA Shallow Monitoring Wells 3-56
Figure 3-13h. Groundwater-level Hydrographs – SCWA Deep Monitoring Wells 3-57
Figure 3-13i. Groundwater-level Hydrographs – SCWA Copeland Creek Monitoring Wells 3-58
Figure 3-14a. Regional UNAVCO GPS Stations 3-60
Figure 3.14b. Vertical GPS Observations of Regional UNAVCO Stations Normalized to 2015 ..3-61
Figure 3-14c. PS-InSAR Data Interpretation for 1992-2001 3-61
Figure 3-14d. Map Pattern of Surface Deformation Velocities 3-62
Figure 3-14e. InSAR Vertical Displacement, June 2015 to June 2018 3-63
Figure 3-15a. Groundwater Quality – Arsenic 3-68
Figure 3-15b. Groundwater Quality – Chloride 3-70
Figure 3-15c. Groundwater Quality – Total Dissolved Solids 3-71
Figure 3-15d. Groundwater Quality Trends – Chloride North 3-72
Figure 3-15e. Groundwater Quality Trends – Chloride South 3-73
Figure 3-15f. Groundwater Quality Trends – Total Dissolved Solids North 3-74
Figure 3-15g. Groundwater Quality Trends – Total Dissolved Solids South 3-75
Figure 3-15h. Groundwater Quality – Nitrate 3-77
Figure 3-16. GeoTracker Cleanup Sites in Santa Rosa Plain Subbasin 3-78
Figure 3-17. Total Annual Gaged Surface Water Flow (Water Years 1999 through 2021) 3-79
Figure 3-18a. Depth-to-Water Along Stream Channels, Spring 2015 3-82
Figure 3-18b. Percent of Time Stream is Gaining, from 2000 to 2010 3-83
Figure 3-18c. Median Flow, from 2000 to 2010 3-85
Figure 3-18d. Surface Leakage, 2006 3-86
Figure 3-18e. Interconnected Surface Water Groundwater Combined Scores 3-87
Figure 3-19. Groundwater Dependent Ecosystems 3-90
Figure 3-20. Schematic Hydrologic Cycle 3-92
Figure 3-21. Zones and Boundary Conditions for the Santa Rosa Plain Hydrologic Model 3-93
Figure 3-22. Surface Water inflow and Outflow: Subregion and Stream Names 3-95
Figure 3-23. Climate and Precipitation for Historical and Current Water Budget Time Periods 3-98
Figure 3-24. Overview of the SRPHM Modules 3-100
Figure 3-25. Historical and Current Surface Water Budget 3-104

Figure 3-26. Net Boundary Inflows and Outflows by HUC 12 Subregion and Stream Name ..3-105
Figure 3-27. Inflows by HUC 12 Subregion and Stream Name[] 3-106
Figure 3-28. Monthly Surface Water Fluxes for a Wet Water Year and Normal Water Year..3-107
Figure 3-29. Average Monthly Surface Water Fluxes the Historical and Current Periods 3-108
Figure 3-30. Inflows to the Groundwater System 3-110
Figure 3-31. Outflows from the Groundwater System 3-111
Figure 3-32. Historical and Current Groundwater Budget.....3-112
Figure 3-33. Groundwater Pumpage by Water-use Sector[] 3-113
Figure 3-34. Inflows and Outflows from Watershed Areas and Neighboring Basins/ Subbasins 3-114
Figure 3-35. Historical and Current Budget for Watershed Areas Outside Subbasin.....3-116
Figure 3-36. Historical and Current Soil-zone Budget for the Subbasin.....3-118
Figure 3-37. Water Year Types for Santa Rosa Plain Future Projected Water Budget.....3-125
Figure 3-38. Historical, Current, and Future Temperature Projections for Windsor (Station No. 1) and Santa Rosa (Station No. 2) Weather Stations 3-126
Figure 3-39. Projected Surface Water Budget 3-127
Figure 3-40. Average Surface Water Inflows and Outflows.....3-128
Figure 3-41. Net Boundary Inflows and Outflows by HUC 12 Subregion and Stream Name ..3-129
Figure 3-42. Inflows by HUC 12 Subregion and Stream Name[] 3-130
Figure 3-43. Monthly Surface Water Fluxes for a Wet Water Year and Normal Water Year..3-131
Figure 3-44. Average Monthly Surface Water Fluxes in the Projected Period.....3-132
Figure 3-45. Groundwater Inflows to the Groundwater System: Historic, Current, and Projected Periods.....3-133
Figure 3-46. Groundwater Inflows by Water Budget Period 3-134
Figure 3-47. Groundwater Outflows from the Groundwater System: Historic, Current, and Projected Periods.....3-135
Figure 3-48. Groundwater Outflows by Water Budget Period 3-136
Figure 3-49. Inflows, Outflows, and Change in Groundwater Storage 3-137
Figure 3-50. Groundwater Pumpage by Water-use Sector 3-139
Figure 3-51. Historical, Current, and Projected Inflows and Outflows from Watershed Areas and Neighboring Basins/Subbasins 3-140
Figure 3-52. Projected Budget for Watershed Areas Outside Subbasin 3-142
Figure 3-53. Projected Soil-zone Budget for the Subbasin 3-144
Figure 3-54. Sustainable Yield: Total Groundwater Pumpage and Change in Groundwater Storage.....3-148

Appendices

Appendix 3-A. Water Year Type Classification for Petaluma Valley, Santa Rosa Plain, and Sonoma Valley
Appendix 3-B. Groundwater Monitoring Well Hydrographs
Appendix 3-C. Santa Rosa Plain Hydrologic Model (SRPHM) Updates
Appendix 3-D. Future Groundwater Demands and Land Use Changes
Appendix 3-E. Selection of Global Circulation Model for Climate Change Projections

3 BASIN SETTING

This section provides information about the physical setting, characteristics, and current conditions of the Subbasin setting, including the identification of data gaps and levels of uncertainty. The information included within this section represents the current understanding of the Subbasin based on available data and information and serves as the basis for defining and assessing sustainable management criteria, potential projects, and management actions. This section contains four primary subsections:

- Hydrogeologic Conceptual Model (**Section 3.1**)
- Current and Historical Groundwater Conditions (**Section 3.2**)
- Water Budget (**Section 3.3**)
- Management Areas (**Section 3.4**)

This section draws upon previously published studies and reports including the following primary data sources that document the conditions of the Santa Rosa Plain Subbasin and contributing watershed areas:

- *Santa Rosa Plain Watershed Groundwater Management Plan* (Santa Rosa Plain Basin Advisory Panel 2014)
- *Simulation of Groundwater and Surface-Water Resources of the Santa Rosa Plain Watershed, Sonoma County, California* (Woolfenden and Nishikawa 2014)
- *Hydrologic and Geochemical Characterization of the Santa Rosa Plain Watershed, Sonoma County, California* (Nishikawa 2013)
- *Status and Understanding of Groundwater Quality in the North San Francisco Bay Groundwater Basins, 2004: California GAMA Priority Basin Project* (Kulongoski et al. 2010)
- *Santa Rosa Plain Ground Water Model* (Kadir and McGuire 1987)
- *Evaluation of Ground Water Resources, Sonoma County, Volume 2: Santa Rosa Plain* (Herbst et al. 1982)
- *Geology and Ground Water in the Santa Rosa and Petaluma Areas, Sonoma County, California* (Cardwell 1958)

3.1 Hydrogeologic Conceptual Model

This subsection describes the hydrogeologic conceptual model (HCM), which characterizes the physical components of the surface water and groundwater systems in the basin. As defined in the GSP Regulations, the HCM should provide the following:

- General physical characteristics related to regional hydrology, geology, geologic structure, water quality, principal aquifers, and principal aquitards of the basin setting

- Contextual information necessary to develop water budgets, mathematical (analytical or numerical) models, and monitoring networks

- A tool for stakeholder outreach and communication

As such, this subsection includes a description of the topography, geography, surface water features, soil characteristics, geologic setting and formations, principal aquifers and aquitards, role of faults, groundwater recharge and discharge area, and data gaps and uncertainties. This information is integrated into the water budget and numerical model described in **Section 3.3** (Water Budget) and monitoring networks described in **Section 5** (Monitoring Program). Additionally, figures and diagrams developed for the HCM are incorporated into community and stakeholder outreach materials.

3.1.1 Topography and Geography

The Subbasin lies generally within the Santa Rosa Plain watershed (SRP watershed or contributing watershed), defined by Nishikawa (2013) as a modified form of the Mark West Creek watershed. The Subbasin is one of six groundwater basins or portions of groundwater basins contained within the SRP watershed (Nishikawa et al. 2013a).

The Subbasin is located in the northwest trending mountains and valleys of the North Coast Ranges geomorphic province of California and is one of three coastal alluvial subbasins of the Santa Rosa Valley Groundwater Basin. The Subbasin generally occupies a relatively flat northwest trending structural depression between low-lying hills of the Mendocino Range to the west and the Sonoma Mountains and Mayacamas Mountains to the east (**Figure 3-1**).

The Subbasin lies mostly between elevations of about 50 and 150 feet above sea level (asl). The north-northwest trending axis of the valley extends for about 20 miles, from Meacham Hill on the south to near the Russian River on the north; the valley width ranges mostly from 4 to 7 miles. The Subbasin and contributing watershed surface consists of a low uneven topography, developed on alluvial flood plains, terraces, and fans eroded by west-flowing intermittent streams (Sowers et al. 1998).

The highlands surrounding the Subbasin have modest changes in elevation, with peaks generally lower than 2,500 feet asl, and most ridge lines between 500 and 1,500 feet asl. The Mendocino Range in this area is made up of mostly low, rounded hills that generally range from 200 to 300 feet asl. The Sonoma Mountains rise from near sea level to elevations of 1,000 to 2,500 feet asl southeast of Santa Rosa (**Figure 3-1**). The Mayacamas Mountains are less steep and elevations mostly vary between 500 and 2,500 feet asl. The maximum elevation of highland surrounding the Subbasin is 2,730 feet asl, at the summit of Mt. Hood in the Mayacamas Mountains.

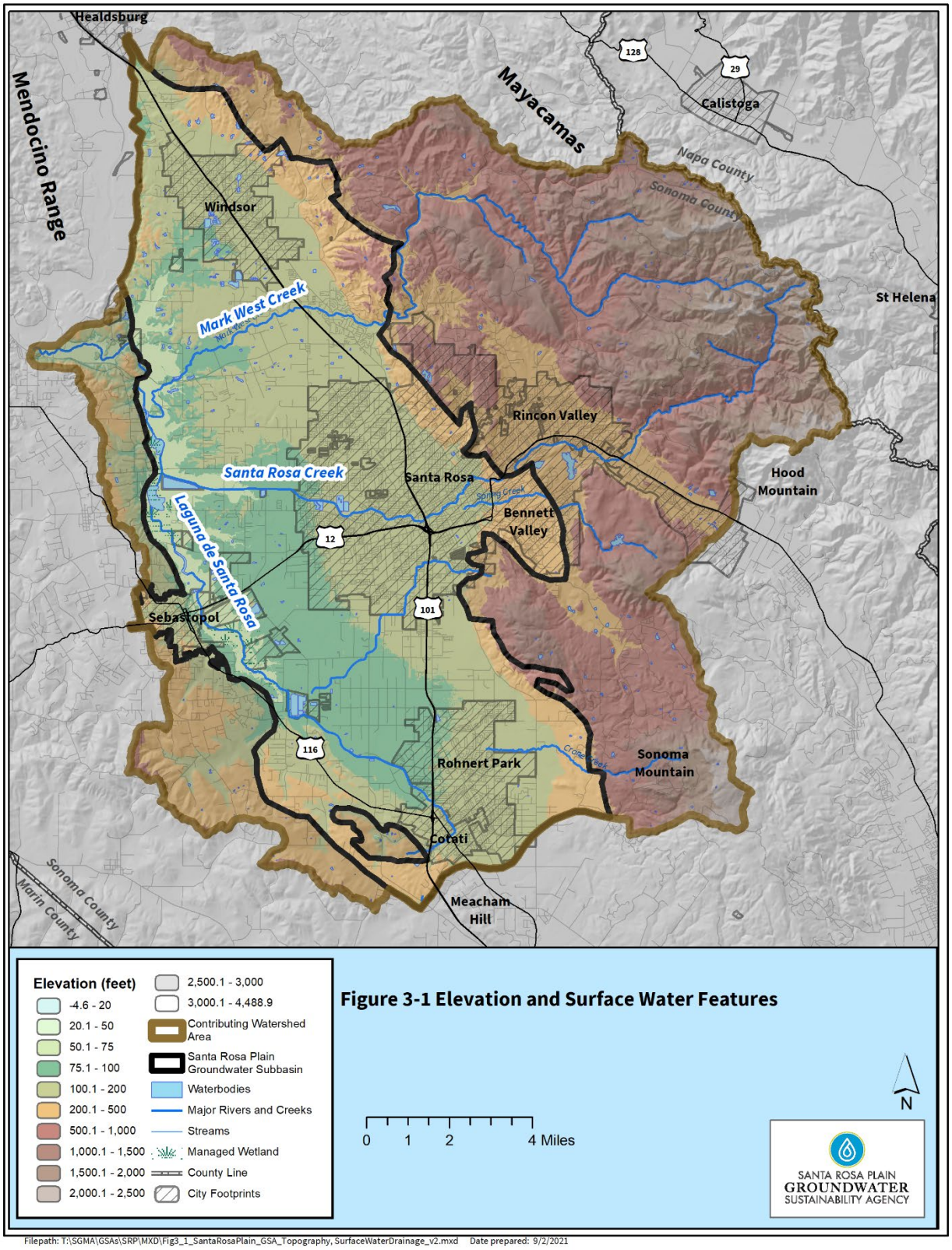


Figure 3-1. Elevation and Surface Water Features

3.1.2 Surface Water and Drainage Features

The SRP watershed is mostly within the middle Russian River watershed and includes three main drainage areas based on the National Hydrography Dataset (USGS 2006), which collectively drain an area of 262 square miles (Nishikawa 2013). These three main drainages are named for the main streams in each area: Mark West Creek, Santa Rosa Creek, and Laguna de Santa Rosa (**Figure 3-2**) (Simley and Carswell 2009). The Subbasin also contains numerous natural and artificial surface water bodies, including small lakes, ponds, and wetland areas. The following sections describe these drainage subbasins, as well as other significant surface water features.

3.1.2.1 Mark West Creek

The Mark West Creek drainage covers 86 square miles in the northern part of the SRP watershed. Mark West Creek (**Figure 3-2**), has a 29.9-mile-long channel originating at an elevation of 1,922 feet asl in the Mayacamas Mountains.

The main channel of Mark West Creek is perennial throughout much of its length (Simley and Carswell 2009), having summer flows maintained by numerous springs near the headwaters. Most of the main channel is in its natural state and much of the riparian vegetation adjacent to the Mark West Creek channel, as well as the creek bed, is undeveloped and characteristic of natural channel conditions. Some tributaries of Mark West Creek are perennial, but most are either ephemeral or intermittent and become dry during late spring to early fall (CEMAR 2014).

3.1.2.2 Santa Rosa Creek

The Santa Rosa Creek drainage subwatershed is a 77-square-mile drainage area in the central and eastern parts of the SRP watershed (**Figure 3-2**). Santa Rosa Creek is a 22-mile-long channel flowing in a westerly direction from drainage divides in the Mayacamas and Sonoma Mountains, to its confluence with the Laguna de Santa Rosa drainage channel. The source of Santa Rosa Creek is at an elevation of 1,940 feet asl near the summit of Mt. Hood.

Santa Rosa Creek originates in steep terrain of the Mayacamas Mountains, an area of mostly natural vegetative cover. The middle part of the Santa Rosa Creek drainage crosses the City of Santa Rosa and adjacent agricultural lands, while the lower part of the Santa Rosa Creek drainage mainly traverses agricultural land. Through the urbanized city landscape, Santa Rosa Creek flows in an engineered channel with concrete or earthen embankments. The upper Santa Rosa Creek and its tributary, Matanzas Creek, are perennial streams that carry diminished flows in late summer and fall (Simley and Carswell 2009). Other Santa Rosa Creek tributaries generally have engineered channels and flows are intermittent (Simley and Carswell 2009).

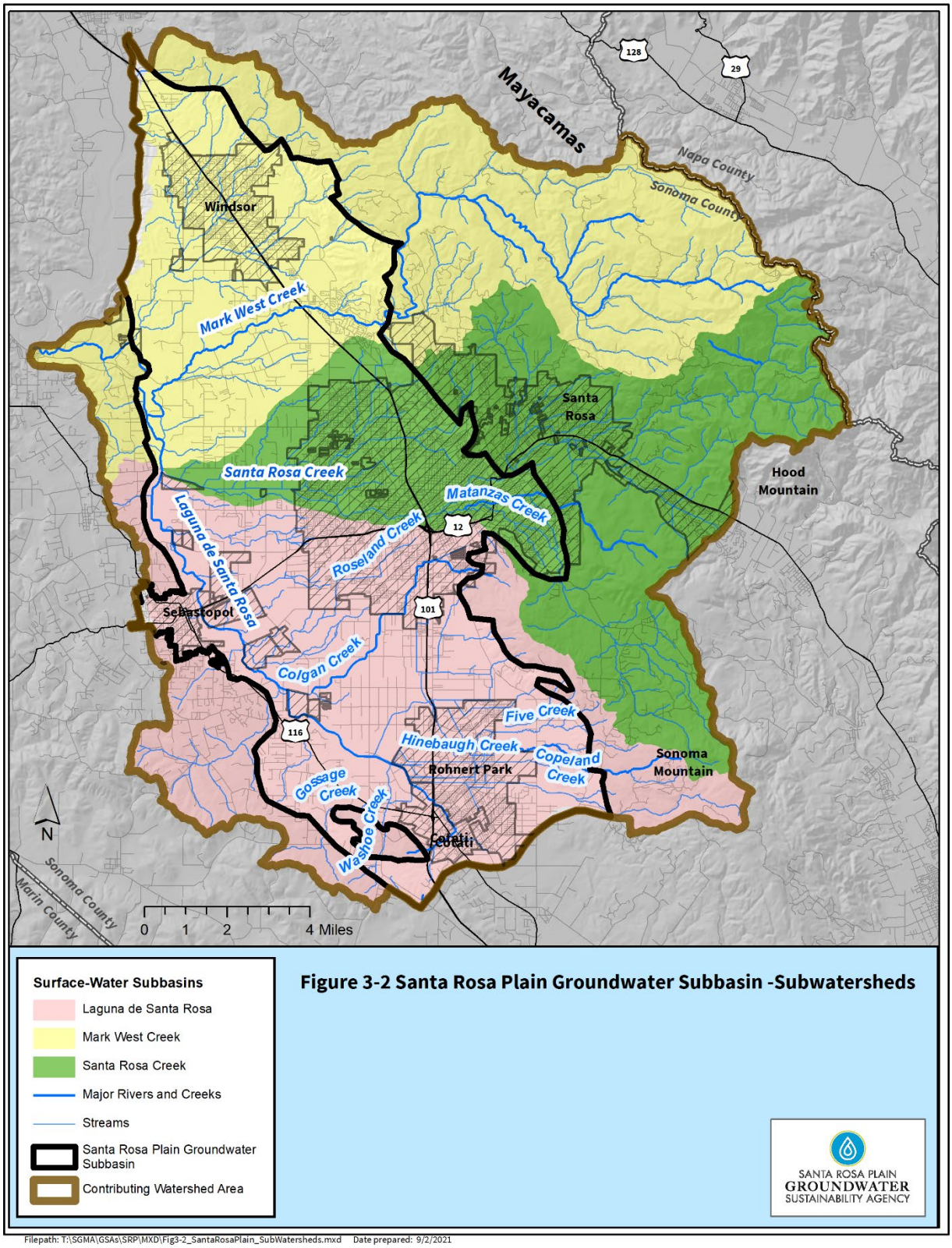


Figure 3-2. Santa Rosa Plain Groundwater Subbasin – Subwatersheds

3.1.2.3 Laguna de Santa Rosa, Peripheral Streams, and Drainages

The 22-mile-long Laguna de Santa Rosa channel and associated 88-square-mile drainage subwatershed collects and funnels precipitation and stormflows from the southern and southwestern areas of the SRP watershed upstream of the Santa Rosa Creek tributary, emptying to the north into Mark West Creek (**Figure 3-2**). The "Laguna de Santa Rosa" also refers to the general area of wetlands, ponds, and vernal pools within the area of the 100-year floodplain surrounding the main Laguna de Santa Rosa channel. The Laguna de Santa Rosa channel and floodplain together form a natural overflow subwatershed connecting Santa Rosa Creek, Mark West Creek, and the smaller creeks in the SRP watershed with the Russian River.

The Laguna de Santa Rosa channel originates at an elevation of 260 feet asl, west of Cotati and close to the southern boundary of the Subbasin (**Figure 3-2**). Much of the Laguna de Santa Rosa upstream of the Mark West Creek juncture is below an elevation of 50 feet. Important Laguna de Santa Rosa tributaries include Santa Rosa Creek, Copeland Creek, Crane Creek, Hinebaugh Creek, Five Creek, Colgan Creek, Gossage Creek, Washoe Creek, and Roseland Creek. Copeland Creek and Crane Creek have short perennial reaches (Simley and Carswell 2009) draining the Sonoma Mountains in the southeastern part of the Subbasin. Copeland Creek is perennial in its upper sections, becomes intermittent as it flows westward across the alluvial fan east of Rohnert Park, and is mostly channelized as it continues flowing westward through Rohnert Park and Cotati before joining the Laguna de Santa Rosa. Downstream of the junctions with the tributaries listed herein, the Laguna de Santa Rosa is a very low gradient drainage network defined by straight and engineered channels, canals, and drainage ditches through urbanized and agriculturally developed lands. The Laguna de Santa Rosa main channel is perennial, although summer flows can be quite small.

3.1.3 Soil Characteristics

Soil types and characteristics in the Subbasin have been mapped by USDA Natural Resources Conservation Service (NRCS), which developed a spatial database of soils for the entire United States (the Soil Survey Geographic Database or SSURGO) (USDA 2007). The SSURGO database defines 17 different soil textures (excluding variable and unknown textures) present in the Subbasin and contributing watershed, which are shown on **Figure 3-3a**. The majority of the Subbasin surface is characterized by clayey soils and loams with gravelly and cobbly loams and are more prevalent along alluvial fans and hilly areas. The southern portions of the Subbasin are characterized by more clay-rich soils. Gravelly and sandy soils are primarily limited to the low hills in the southwestern portions of the Subbasin and the western portions of the contributing watershed outside the Subbasin and along narrow stream channels within the Subbasin.

The SSURGO database also assigns saturated hydraulic-conductivity values to soil groups (**Figure 3-3b**). Saturated hydraulic conductivity is a measurement of the representative or average water-transmitting properties of soils and is a good indicator of the soil's infiltration potential. As indicated on **Figure 3-3b**, the loams and clayey loam soils that predominate the floor of the Subbasin exhibit relatively low hydraulic conductivities (slow to moderate), on the order of 0.1 to 4 feet per day.

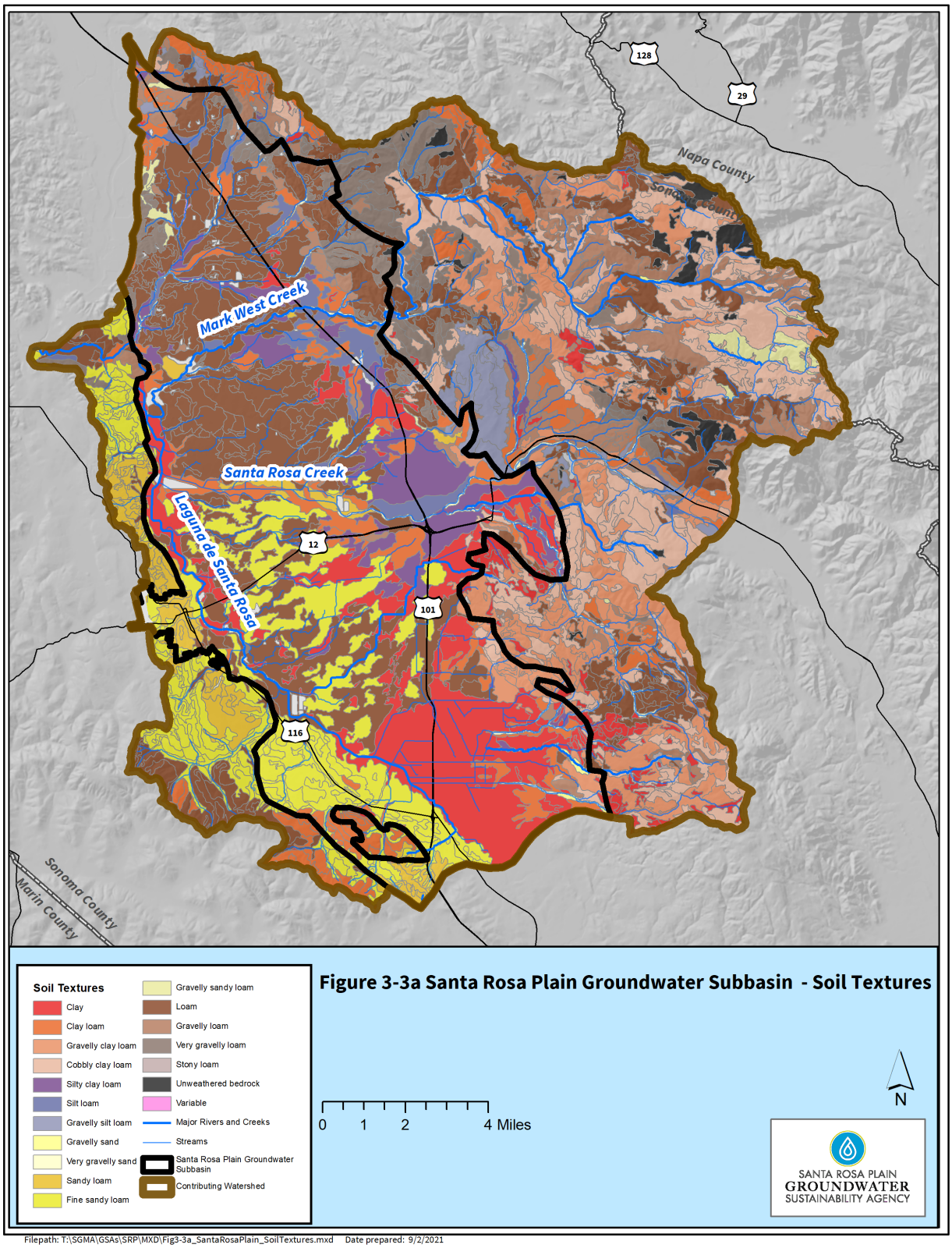


Figure 3-3a. Santa Rosa Plain Groundwater Subbasin – Soil Textures

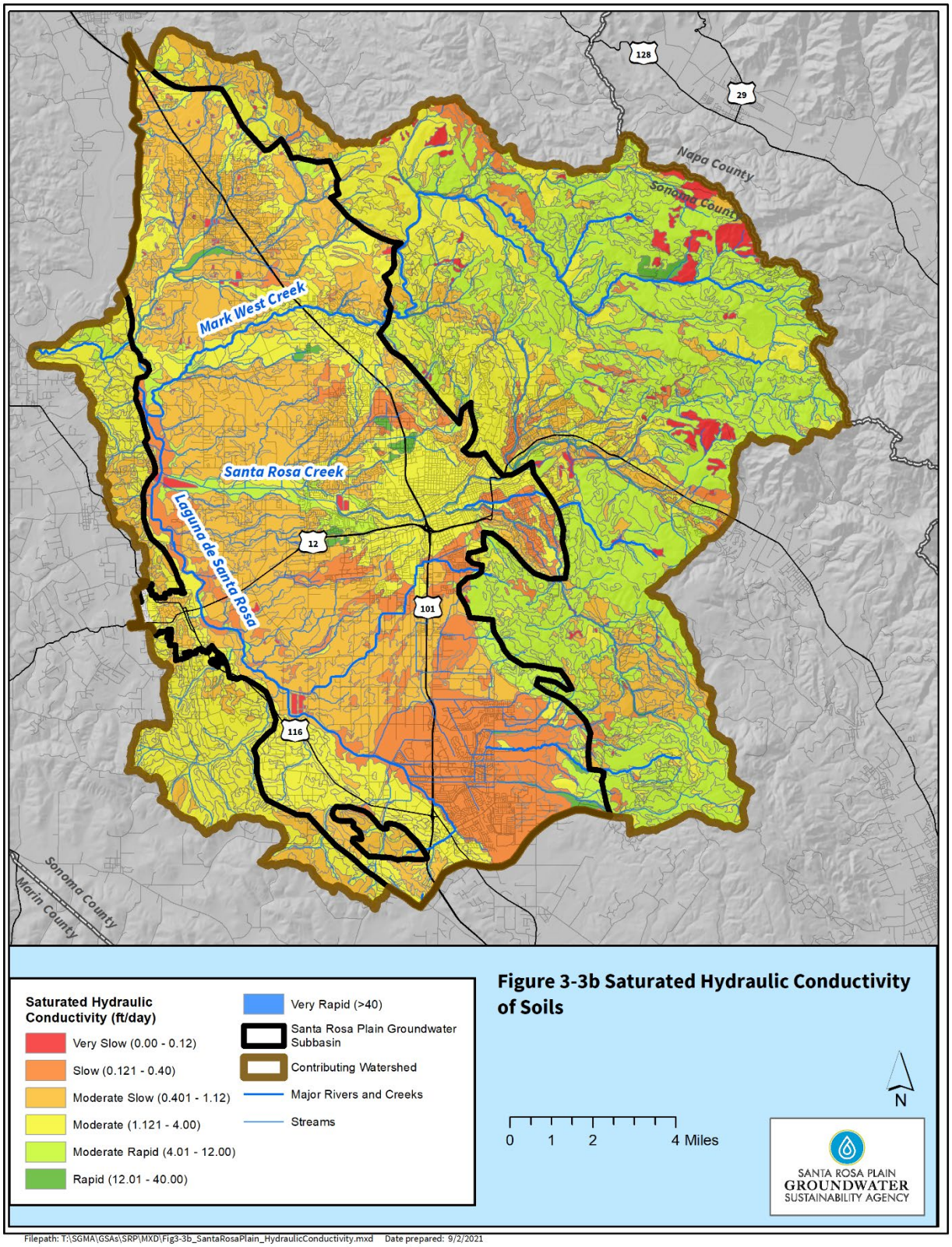


Figure 3-3b. Saturated Hydraulic Conductivity of Soils

Coarser-grained soils present in and around the Subbasin, which exhibit higher hydraulic-conductivity values (moderate rapid) on the order of 4 to 12 feet per day are predominately in the hilly areas in the southwest portions of the Subbasin, along the southeastern margins of the Subbasin, and along the lower portions of Santa Rosa Creek, Mark West Creek, and Windsor Creek. The highest saturated hydraulic conductivities (rapid to very rapid), on the order of 12 to 40 feet per day, primarily occur along and near streambed channels. At locations where subsurface storage space is available and the underlying geologic formations have sufficient permeability, these more permeable soils (moderate rapid to rapid) could be favorable for managed aquifer recharge.

3.1.4 Regional Geologic Setting

The regional geologic setting is a synopsis of work by Sweetkind et al. (2013) and Wagner and Gutierrez (2017). The Subbasin is located within a region of geologic complexity caused by long periods of active tectonic deformation, volcanic activity, and sea level changes. **Figure 3-4a** displays the regional geology of the northern Coast Ranges, including generalized geologic units and primary faults that influence the geometry of the Subbasin and the distribution of adjoining groundwater basins and upland areas. **Figure 3-4b** presents a geologic map of the watershed showing the surficial distribution of geologic units within the Subbasin and surrounding watershed areas. Geologic formations within the Subbasin are grouped into two broad categories (Mesozoic Era basement rocks and younger Cenozoic Era volcanic and sedimentary units) based on the age, degree of consolidation, and amount of deformation (such as folding, faulting, and fracturing). The Subbasin is underlain at varying depths by Mesozoic Era (more than 66 million years old) basement rocks consisting of metamorphic, igneous, and metasedimentary rocks of the Jurassic/Cretaceous-aged Franciscan Complex, Coast Range Ophiolite, and Great Valley Sequence. A mixture of younger (Tertiary and Quaternary-aged) volcanic and sedimentary rocks and unconsolidated sediments of the Cenozoic Era (less than 66 million years old) overlies these basement rocks (Sweetkind et al. 2013; Wagner and Gutierrez 2017). The inferred subsurface distribution of the geologic units is displayed on the hydrogeologic cross sections shown on **Figure 3-5.**

3.1.4.1 Geologic Structure

The Subbasin is located in the northern Coast Ranges, which are mountains with geologic structure dominated by the northwest trending San Andreas right-lateral transform fault system that includes the San Andreas fault zone to the west, and the Rodgers Creek, the Mayacama, and the Bennett Valley fault zones right-lateral strike-slip faults within or adjacent to the Subbasin. The Rodgers Creek Fault zone is approximately 0.6 mile wide and consists of a southern Rodgers Creek Fault segment that is interpreted to join with the Hayward fault to the south under San Pablo Bay (Watt et al. 2016) and a northern Healdsburg fault segment, separated by the Santa Rosa Creek floodplain. The Bennett Valley fault zone is a narrow, steeply dipping right-lateral fault. On the west side of the Subbasin, the Sebastopol Fault is a curved zone of east-side-down normal faults at the break in slope between the westside hills and valley floor. The Sebastopol Fault generally coincides with the lowest Subbasin elevations, forming the contact between Quaternary sediments and the underlying Wilson Grove Formation. An unnamed fault east of the Sebastopol Fault may be a branch from the Sebastopol, and is important for deep groundwater flow and quality (Nishikawa et al. 2013a). All of these faults have sufficient offset to juxtapose different geologic units against one another and serve as the main boundaries for the sedimentary basins beneath the Subbasin.

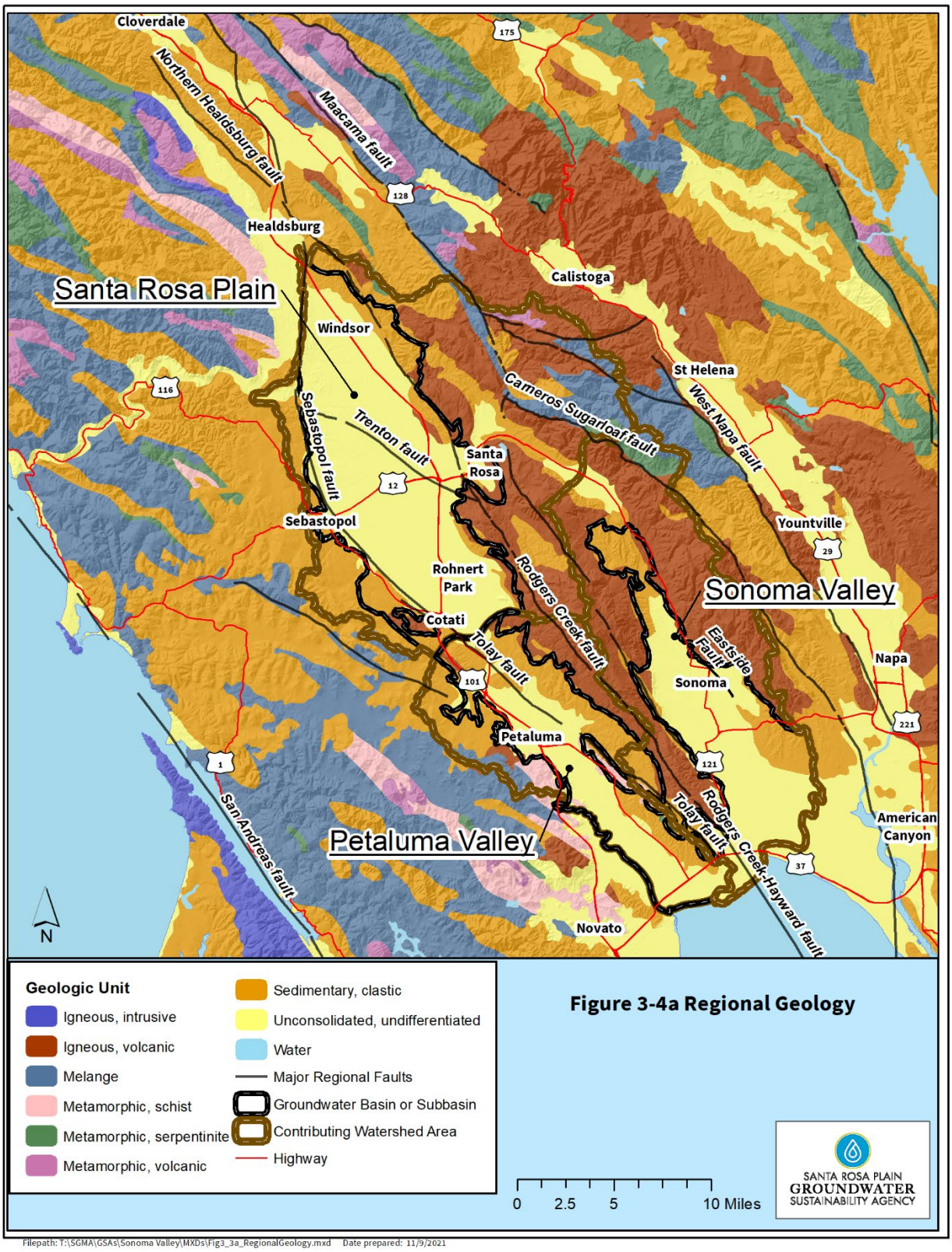


Figure 3-4a. Regional Geology

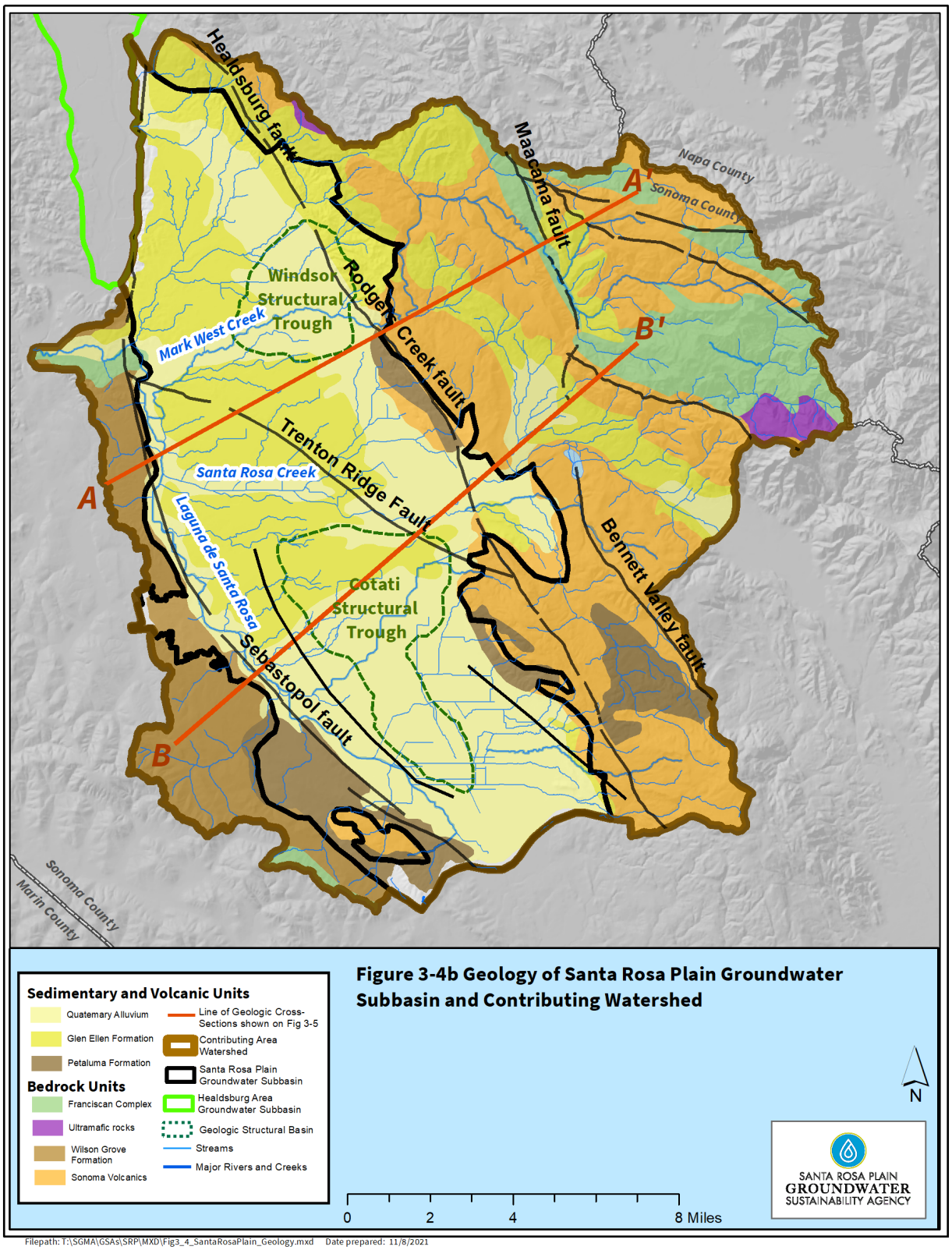


Figure 3-4b. Geology of Santa Rosa Plain Groundwater Subbasin and Contributing Watershed

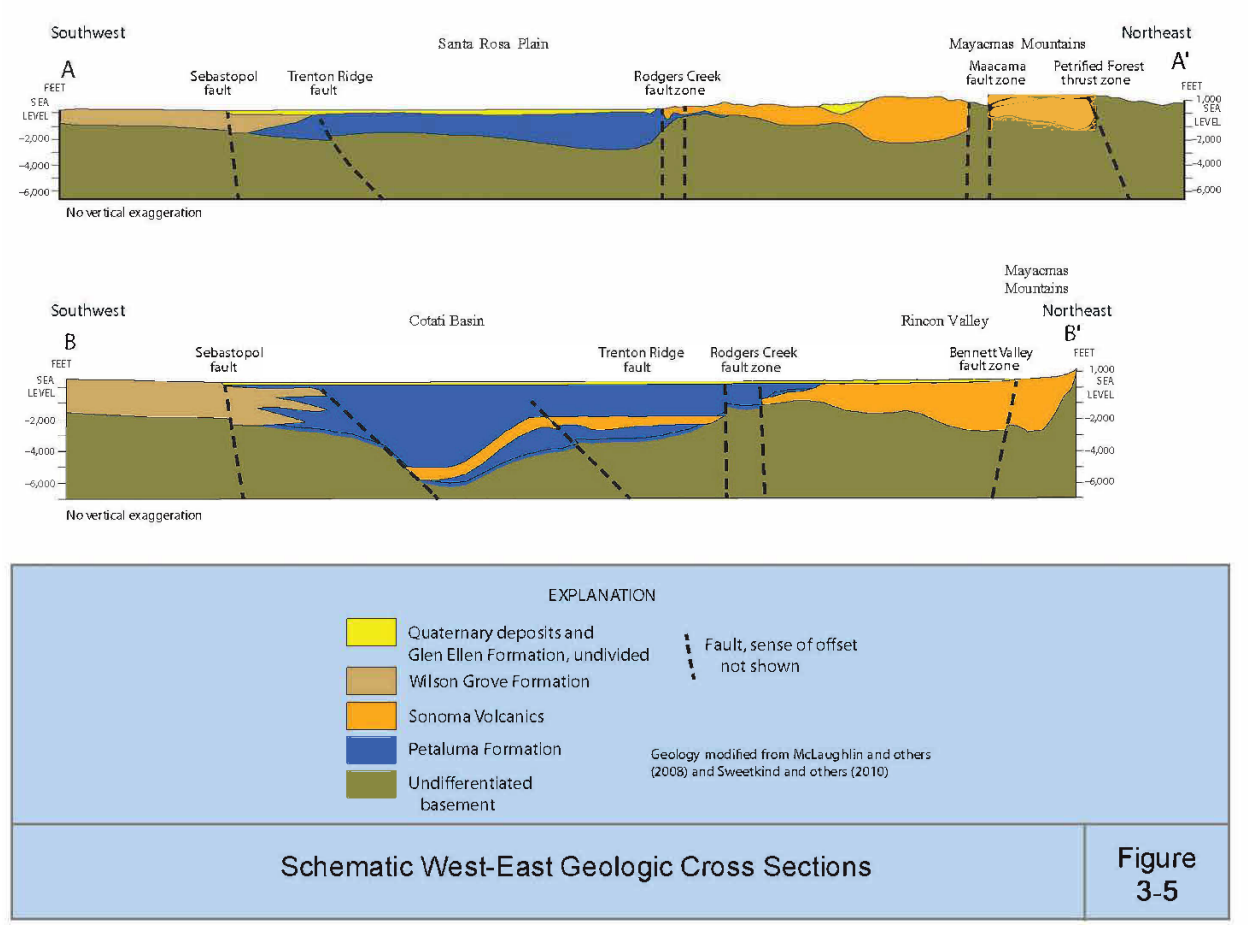


Figure 3-5. Schematic West-East Geologic Cross Sections

Analysis of gravity data reveals two steep-sided sedimentary structural troughs beneath the Subbasin: the Windsor structural trough beneath the northern portion of the Subbasin and the Cotati structural trough beneath the southern portion. These two structural troughs are modeled to range up to 10,000 feet deep and are separated by northwest to west-northwest trending, northeast dipping Trenton Ridge thrust fault, which forms a bedrock high between the structural troughs possibly as shallow as 1,000 feet below land surface (bls) (Langenheim et al. 2006, 2010; McPhee et al. 2007; Nishikawa et al. 2013a).

Available information on the effects of faults on groundwater movement and groundwater quality in the Subbasin is described in **Section 3.1.6**.

3.1.4.2 Mesozoic Era Basement Rocks

The Subbasin sits on a bedrock basement of deformed and faulted Mesozoic age rocks of the Franciscan Complex, Great Valley Sequence, and Coast Range ophiolite. The Mesozoic basement rocks are only exposed outside of the Subbasin at the northern boundary and within the east-central portion of the contributing watershed where rocks of the Franciscan Complex and Coast Range Ophiolite occur (Sweetkind et al. 2013).

Mesozoic Era basement rocks generally yield very little water, as their porosity is primarily attributed to fractures that are commonly limited in extent and water-transmitting capacity. Wells completed in the basement rocks generally produce relatively small amounts of water suitable for domestic supply. Successful domestic wells commonly produce 5 gallons per minute (gpm) or less from basement rocks in the hills and mountains within the contributing watershed area. While the basement rocks locally provide a viable, sole source supply for many households, they are not considered a significant water-supply source in the Subbasin (Santa Rosa Plain Basin Advisory Panel 2014).

3.1.4.3 Cenozoic Era Volcanic and Sedimentary Units

Groundwater resources within the Subbasin are primarily located within the Cenozoic volcanic and sedimentary units deposited over the Mesozoic basement rocks. The thick sedimentary layers and some of the volcanic rocks that overlie the Mesozoic bedrock in the Subbasin are capable of storing and yielding large quantities of groundwater. The water-bearing properties of the geologic units vary considerably as a result of changes in rock type within units and interfingering between units. This variability determines how much water can be obtained from wells in different parts of the watershed. Geologic units that are of greatest importance for groundwater resources within Santa Rosa Plain Subbasin (Sweetkind et al. 2013) are described in subsequent text in general order of decreasing age (older to younger) and include both Tertiary-aged (between 66 and 2.5 million years old) and Quaternary-aged (younger than 2.5 million years old) units.

Tertiary Volcanic Units

The Sonoma Volcanics of Miocene to Pliocene age (approximately 8 to 2.5 million years old) are a thick and highly variable sequence of volcanic rocks interbedded with volcaniclastic sedimentary deposits (sediments derived from volcanic rocks). The unit consists of thick deposits of volcanic lava flows with some interbedded volcanic ash flows, mud flows, tuffs, and volcaniclastic sedimentary deposits of tuffaceous sands and volcanic gravels. The Sonoma Volcanics cover an area of approximately 1,200 square miles in Sonoma and Napa counties and have been grouped into western, eastern, and northern groups based on their age (Sweetkind et al. 2013). The western age group occurs within the Santa Rosa Plain and contributing watershed areas and includes the Sonoma Mountain assemblage, which includes rhyolite; rhyodacite breccia interbedded with Petaluma Formation sediments; mafic andesitic and basalt flows; tuffs; and volcaniclastic sediments (Wagner et al. 2011).

The Sonoma Volcanics are exposed throughout the Mayacamas and Sonoma Mountains and along the margins of the Subbasin and extend beneath the valley floor where they are buried beneath younger geologic units. The Sonoma Volcanics are highly variable in lithology and their subsurface distribution is often difficult to discern from well drillers logs. Additionally, the upper part of the Sonoma Volcanics interfingers with sedimentary units of the Glen Ellen and Petaluma Formations in places further complicating subsurface mapping of volcanic units. The total thickness of the volcanic units is highly variable and has been estimated to be up to 3,000 feet thick (Sweetkind et al. 2013).

Tertiary Sedimentary Units

Petaluma Formation

The Petaluma Formation is a Pliocene-aged (approximately 5 million years old) sedimentary unit that was deposited in transitional continental and shallow marine environments. The unit is dominated by more or less consolidated silt or clay-rich mudstone, with local beds and lenses of poorly sorted sandstone and minor conglomerate beds and has been subdivided into an upper, middle, and lower member (Allen 2003; Holland et al. 2009). The lower member is up to 750 feet thick and is predominantly dense beds of mudstone that have the lowest hydraulic conductivity within the formation. The formation coarsens in the 3,500-foot thick middle and upper parts, in which beds of poorly sorted sands and gravels result in increased hydraulic conductivity. In general, the beds of coarser materials are thin and not of great lateral extent (Sweetkind et al. 2013).

Wilson Grove Formation

The late Miocene to late Pliocene sandstone-dominated Wilson Grove Formation is exposed in the low hills west of the Subbasin and is also continuous in the subsurface to the east for some distance, where it interfingers with the Petaluma Formation beneath Quaternary alluvial deposits and, in the northern Subbasin, with the Glen Ellen Formation. The Wilson Grove Formation is relatively thick (300 feet to greater than 1,000 feet thick), and mostly composed of weakly cemented marine-deposited sandstone, with volcanic ash intervals. The predominance of relatively clean sand and the low degree of cementation in the Wilson Grove Formation result in moderate to high hydraulic conductivity (Powell and Holland 2004).

Glen Ellen Formation

The Glen Ellen Formation is also Pliocene- to Pleistocene-aged (approximately 3 to 3.5 million years old) fluvial sedimentary unit deposited as alluvial fans and adjoining flood plains. The unit consists primarily of clay-rich stratified stream deposits of poorly sorted sand, silt, and gravel. Beds of these sediments vary from coarse- to fine-grained, commonly over distances of a few tens to hundreds of feet, both laterally and vertically, with low to moderate hydraulic conductivity (Cardwell 1958).

Quaternary Sedimentary Deposits

Quaternary alluvial deposits cover much of the flat eastern and southern valley floor and include Holocene (younger than 12,000 years) (Geological Society of America 2018) to modern stream channel and stream terrace deposits (loose alluvial sand, gravel, and silt) and surrounding late Pleistocene to Holocene undissected stream terrace deposits, older alluvium, and alluvial fan deposits. The Quaternary alluvial deposits consist of sedimentary deposits that are widespread throughout the SRP watershed, generally in proximity to and comprising minor aquifers of limited extent along modern streams and beneath alluvial fans. These deposits are dominated by alluvial fan and floodplain deposits eroded from rock exposed in the flanking hills. The deposits generally consist of mixed poorly to well-sorted sand, silt, clay, gravel, cobbles, and boulders, as interfingering, variably thin or thick beds of limited lateral extent (tens to hundreds of feet), and range from low to high hydraulic conductivity. Layers in the

older alluvium add up to a thickness of about 400 feet and younger alluvium layers are generally less than 150 feet thick (Sweetkind et al. 2013).

3.1.4.4 Lateral and Vertical Extent of Subbasin

The structural setting and distribution of geologic units described in the previous section influence the Subbasin extents, which are defined by DWR, as documented in Bulletin 118 (DWR 2016a). The lateral extent and boundaries of the Subbasin are defined as follows:

- The southern boundary of Subbasin coincides with a surface watershed divide between the Laguna de Santa Rosa drainage subbasin and the Petaluma River Watershed. The boundary is also the approximate location of a groundwater-flow divide; however, no known structural or geologic features restrict flow between the two areas.

- The contact shown on **Figure 3-4b** between the topographically higher Sonoma Volcanics and the Petaluma Formation and overlying Quaternary alluvial deposits generally defines the eastern boundary of the Subbasin, with the exception of a small segment where the Rincon Valley Subbasin adjoins the Subbasin (**Figure 2-1**).

- The northwestern boundary of the Subbasin generally follows the contact between the Glen Ellen Formation and Quaternary alluvial deposits of the Russian River Valley within the Healdsburg Area Subbasin (**Figure 3-4b**).

- The remaining western boundary generally follows the contact between the Wilson Grove Formation and either the Quaternary alluvial deposits or the Petaluma Formation, with the exception of the City of Sebastopol, where the boundary follows the jurisdictional boundary of the city and extends into a portion of the Wilson Grove Formation (**Figure 3-4b**).

The base of the Subbasin is not defined based on a transition in geologic materials, such as the Mesozoic basement rocks that occur at depths exceeding 10,000 feet in some areas. Rather, the vertical extent of the Subbasin is defined based on the approximate depth at which viable water-supply aquifers are no longer present. The productive freshwater aquifers generally occur at shallower depths with the deepest wells within the Subbasin extending to approximately 1,500 feet and no existing known water wells extending deeper than 2,000 feet. At depths exceeding approximately 2,000 feet, aquifers are likely not usable for water supply due to a combination of: (1) lower well yields related to increased consolidation and cementation of aquifer materials at these depths and (2) poor-quality water related, in part, to the presence of brackish connate water and geothermally affected waters (Nishikawa et al. 2013b).

3.1.5 Principal Aquifer Systems and Aquitards

The GSP Regulations require the identification of principal aquifers and aquitards within groundwater basins. Principal aquifers are defined in 23 CCR 351 as “aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems.” These aquifers have unique and important requirements defined in 23 CCR 354, requiring the following for each principal aquifer:

- Characterization of physical properties, structural barriers, water-quality conditions, and primary uses
- Groundwater-elevation contour maps
- Hydrographs
- Change in storage estimates
- Minimum thresholds and measurable objectives
- Sufficient monitoring network, including groundwater levels and water quality

The Cenozoic volcanic and sedimentary units described in **Section 3.1.4** form a heterogeneous and continuous body of saturated materials below the water table, where groundwater occurs in pore spaces of the Quaternary alluvial deposits, Glen Ellen, Wilson Grove, and Petaluma Formations, and the Sonoma Volcanics (Sweetkind et al. 2013). The distribution, subsurface extent, and interfingering of these five primary aquifer units reflect the Subbasin's complex geologic history of tectonic deformation concomitant with volcanic activity and sediment deposition in alluvial, lake, and estuarine settings.

To characterize the aquifer systems within the Santa Rosa Plain for the purpose of implementing SGMA, two principal aquifer systems have been identified based on available data and information: the shallow and deep aquifer systems. This aquifer system characterization is consistent with grouping used for existing monitoring programs (Santa Rosa Plain Basin Advisory Panel 2014; City of Santa Rosa 2013a) and supported by findings from the USGS studies within the Subbasin (Nishikawa et al. 2013a; Woolfenden and Nishikawa 2014). Properties and features considered in grouping the shallow and deep aquifer systems into separate aquifer systems include the degree of surface water connectivity, degree of confinement, and responses to hydraulic stresses such as recharge and pumping. Although the deep and shallow aquifer systems are grouped separately, the boundary between the shallow and deep aquifer systems is not intended to represent a distinct boundary to groundwater flow. The degree of hydraulic separation between the two is variable throughout the Subbasin with some areas, such as where clay aquitard materials between the two aquifer systems are thinner or absent, exhibiting stronger hydraulic communication. The identification of the boundary between the two aquifer systems is further complicated by the complex stratigraphic relationships and high degree of heterogeneity associated with the aquifer units. The appropriateness of the principal aquifer system designation within the Subbasin will continue to be evaluated and considered as more data and information are developed during implementation of the GSP regarding the lateral and vertical characteristics and hydraulic connections between the different aquifer units.

The shallow aquifer system generally extends from the water table to depths ranging from 150 to 200 feet bls. The shallow aquifer system is present over the entire lateral extent of the Subbasin and primarily occurs within Quaternary alluvial deposits and Glen Ellen Formation.

However, in a few limited areas where these units are absent or thin near the margins of the Subbasin, the shallow aquifer system locally occurs within sedimentary units of the Wilson Grove and Petaluma Formations. The shallow aquifer system is generally present under unconfined or semiconfined conditions with semiconfined conditions generally occurring in areas of the shallow aquifer system that exhibit higher proportions of clay and silt units. In some localized and limited areas, very shallow and seasonally perched aquifers are present where infiltrating water can accumulate on very shallow lenses of clay: these are not considered to be part of the shallow aquifer system because they are not continuous in extent, not tapped for water supply, and likely do not contribute to the baseflow of streams.

Aquifer units beneath the shallow aquifer system are characterized collectively as the deep aquifer system and occur under confined or semiconfined conditions within the Wilson Grove Formation, Petaluma Formation. and Sonoma Volcanics. The deep aquifer is generally present beneath approximately 200 feet bls (that is, below the shallow aquifer system), and the thickness of individual permeable aquifer zones within the deep aquifer system is highly variable and can range from several feet to hundreds of feet in thickness (Allen 2003; Cardwell 1958; Powell and Holland 2004). In areas where multiple permeable zones occur within the deep aquifer system, these different zones can sometimes exhibit distinct features (for example, distinct water-quality signature or appreciable differences in hydraulic head) and can generally be further subdivided into upper and lower aquifers. However, the continuity of these distinct upper and lower portions is not well constrained nor correlative across the Subbasin due, in part, to the limited number of wells and lithologic information for the deep aquifer system, and the heterogeneous and discontinuous nature of the sediments.

Attributes of the shallow and deep aquifer systems, which generally correlate throughout the Subbasin and facilitate distinguishing between the two include the following:

- The shallow aquifer system generally is separated from the underlying deep aquifer system by sequences of clay, which form discontinuous aquitards that predominantly occur in either the lower portions of the Glen Ellen Formation or upper portions of the Petaluma Formation, as evidenced by noted differences in water quality (Martin et al. 2013) and estimated hydraulic properties, such as vertical hydraulic conductivity (Woolfenden and Nishikawa 2014). Generally, hydraulic conductivity is typically significantly lower in the vertical direction compared with the horizontal direction due to anisotropic flow conditions typical of layered sedimentary aquifer systems (Heath 1984). These anisotropic conditions inhibit groundwater flow vertically and cause increasing confinement of groundwater with increasing depth. The separation caused by clay aquitards in the Subbasin is likely less prevalent along the western boundary, where the sand-rich Wilson Grove Formation dominates the subsurface (Nishikawa et al. 2013).

- The shallow aquifer system is generally present under unconfined to semiconfined conditions, while the deep aquifer system is commonly present under semiconfined or confined conditions (Sweetkind et al. 2013).

- The shallow aquifer system generally exhibits stable long-term groundwater levels, while deeper aquifer system wells have exhibited appreciable periods of declining groundwater levels in certain areas of the Subbasin (Santa Rosa Plain Basin Advisory Panel 2014; Sonoma Water 2017).

- While seasonal fluctuations in groundwater levels are observed in both the shallow and deep aquifer systems, rapid increases and decreases in groundwater levels within the deep aquifer system appear to correlate closely with groundwater pumping events, whereas responses within the shallow aquifer system appear more muted or delayed (Sweetkind et al. 2013).

- In many areas within the Subbasin the shallow aquifer system is locally and seasonally connected to streams and surface waters, while the deep aquifer system is not physically connected with surface waters of the Subbasin and hydraulic communication between the deep aquifer system and surface waters is expected to exhibit a muted and delayed response.

- Differences in groundwater quality between the shallow and deep aquifer zones are common (Martin et al. 2013), as indicated in **Section 3.1.5.2**.

Characteristics of the shallow and deep aquifer systems, including individual aquifer unit materials and properties, general water quality and primary uses based on available data and limitations are further described in the following subsections.

3.1.5.1 Materials and Properties of Primary Aquifer Systems

Aquifer properties include aquifer storage properties (specific yield for unconfined aquifers and storativity or specific storage for confined aquifers) and aquifer transmission properties (hydraulic conductivity and transmissivity). While these properties can be estimated using lithologic texture descriptions from well drillers' logs, they are most accurately determined by conducting aquifer tests consisting of pumping a well at a known and controlled rate for a sufficient period of time (typically several days) and observing the groundwater-level response in the pumped well and neighboring observation wells. Available aquifer test data are limited within the Subbasin (Sweetkind et al. 2013); therefore, the values for these properties are a source of uncertainty.

Shallow Aquifer System Materials and Properties

Materials and properties of the two geologic units that predominantly comprise the shallow aquifer system are described in the following paragraphs.

Quaternary Alluvium

Quaternary alluvial deposits, which blanket much of the Subbasin predominantly include alluvial fan deposits, stream channel deposits, older alluvium, and basin deposits (Wagner and Gutierrez 2017). The generally coarse-grained alluvial fan and stream channel deposits, and their proximity to modern streams, allow for rapid recharge of precipitation and runoff to the

groundwater system and exchanges between groundwater and surface water. The composition of the older alluvium is variable, consisting of a mixture of fine- and coarse-grained sediments. The basin deposits, which primarily occur within the southern portions of the Subbasin are finer-grained and exhibit low permeability. Groundwater is unconfined in most places within the alluvial deposits, but semiconfined conditions exist in areas with higher proportions of clay or silt (Sweetkind et al. 2013).

The Quaternary alluvial deposits provide some water to shallow wells and contribute part of the water to deeper wells that also draw from underlying formations. Yields from wells that are completed only in alluvial deposits ranged from 1 to 650 gpm. The highest well yields are in the northern Subbasin near Mark West Creek (Sweetkind et al. 2013). The alluvial deposits are generally poorly sorted and, locally, contain large fractions of clay resulting in a range of specific yields (the amount of water a saturated aquifer will yield by gravity – or what is available to wells) between 8 and 17 percent. Hydraulic-conductivity values from two available aquifer tests range from 2 to about 51 feet per day (ft/d), and storativity values range from about 0.0013 to 0.19. The large range of hydraulic properties is consistent with the lithologic heterogeneity and varying degree of confinement of the alluvial deposits (Sweetkind et al. 2013; Santa Rosa Plain Basin Advisory Panel 2014).

Glen Ellen Formation

The relatively high content of clay-sized material, degree of compaction, and cementation tend to limit the permeability of the Glen Ellen Formation. Within the Subbasin, the Glen Ellen Formation ranges from tens of feet to several hundred feet thick (Sweetkind et al. 2013). Where sufficiently thick, the Glen Ellen Formation includes some beds of moderately to well-sorted, coarse-grained materials that have high permeability and yield appreciable amounts of water to wells.

Most wells in which the Glen Ellen Formation is the principal water-bearing unit will produce between 15 and 30 gpm (Ford 1975). The specific yield and hydraulic conductivity of the Glen Ellen Formation has been estimated to range from 3 to 7 percent (Herbst et al. 1982) and 13 to 23 ft/d (Cardwell 1958), respectively.

Deep Aquifer System Materials and Properties

Materials and properties of the three geologic units that comprise the predominantly deep aquifer system are described in the following paragraphs.

Wilson Grove Formation

Most wells screened partially or totally in the Wilson Grove Formation are within the upper stratigraphic horizons, which are coarser-grained and more permeable than deep deposits to the west. Domestic wells drilled into the Wilson Grove Formation yield on average about 20 gpm (DWR 1979). Large capacity and municipal wells can yield up to 1,000 gpm or more (Sweetkind et al. 2013). Wells drawing from the Wilson Grove Formation have estimated specific yields in the range of 10 to 20 percent (Herbst et al. 1982), higher than any of the other rocks or sediments in the Subbasin. Estimates of hydraulic conductivity and storativity from

aquifer tests conducted in 11 wells in the western portions of the Subbasin range from 3 to 65 ft/d and 0.00095 to 0.08, respectively (Sweetkind et al. 2013).

Petaluma Formation

The productivity of wells drilled in the Petaluma Formation depends mostly on the total thickness of the thin, poorly sorted beds of sand and gravel perforated by the well. In general, the upper member of the Petaluma Formation is the most productive. The Petaluma Formation is at least 3,000 feet thick in places within the Subbasin. Domestic wells drilled into the Petaluma Formation yield an average of about 20 gpm and range from 10 to 50 gpm (DWR 1979). Even though the formation is dominated by clay, areas of thin, moderately to poorly sorted beds of sands and gravels can provide yields greater than 100 gpm from wells in areas of coarser-grained materials providing higher yields (Sweetkind et al. 2013). For example, in the Rohnert Park area municipal wells drawing predominantly from the Petaluma Formation have produced as much as 500 gpm.

Specific yields are typically low in the Petaluma Formation, ranging from 3 to 7 percent (Cardwell 1958; DWR 2003). Estimates of transmissivity based on specific capacities of Rohnert Park municipal wells range from 130 to 1,600 square feet per day (ft^2/d) (City of Rohnert Park 2007); however, some of the wells are perforated in interbeds of Wilson Grove Formation, Sonoma Volcanics, or both (DWR 1979).

Sonoma Volcanics

The Sonoma Volcanics exhibit a large variation in water-bearing properties, with a mixture of fractured lava beds, unwelded tuffs, and interbedded volcaniclastic sedimentary deposits generally providing the best aquifer materials (Wagner et al. 2005; McLaughlin et al 2008). Lava beds have extremely low primary permeability and only fractures, or the tops and bottoms of individual flows yield significant water. Unwelded tuffs can yield water similar to high porosity, high permeability alluvial sediments. This formation has the highest variability in water-bearing properties in the Santa Rosa Plain.

Water production from wells drilled into thick air-fall pumice units can exceed a few hundred gpm, but wells drilled into unfractured lavas or welded tuffs can produce less than 10 gpm, and dry holes are sometimes encountered. For wells penetrating the Sonoma Volcanics, previous studies suggest a range of well yields between 10 and 50 gpm (Ford 1975); however, some of the wells penetrate more than one formation, and the relative contributions are unknown. The specific yield of the Sonoma Volcanics has been reported to be in the range of 0 to 15 percent (Herbst et al. 1982) and transmissivity has been estimated to range from 0.8 to 5,300 ft^2/d. (Sweetkind et al. 2013; Santa Rosa Plain Basin Advisory Panel 2014).

3.1.5.2 General Water-Quality Characteristics

Groundwater quality is highly variable throughout the study area and is generally acceptable for beneficial uses, although constituents of potential concern pose challenges on a localized basis. Specific conductance, chloride, TDS, nitrate, and arsenic are considered water-quality constituents of potential concern in the Subbasin because some samples from wells exceeded

state- or federal-recommended or mandatory regulatory standards for drinking water. In general, groundwater within the Subbasin is of mixed cation-bicarbonate-type with median dissolved solids concentrations of approximately 350 milligrams per liter (mg/L). Some distinctions between shallow and deeper aquifer system water quality include the following:

- Water samples from wells completed within the shallow aquifer system generally exhibit greater proportions of calcium and magnesium, while samples collected from the deep aquifer system exhibit greater proportions of sodium and potassium, which is consistent with increasing mineralization and ion exchange between clays and groundwater with increasing distance and depth from recharge sources (Martin et al. 2013). Typically, isotopically heavier constituents, such as nitrate and tritium, are more commonly found in the shallow aquifer system in comparison to the deep aquifer system.

- As determined by carbon-14 dating or the presence of tritium, the shallow and deep aquifers exhibit different groundwater ages, with the deep well samples all exhibiting water ages of 4,000 years or older and the shallow aquifer generally containing waters recharged within the last 50 years (Martin et al. 2013).

Further data and discussion of groundwater quality conditions and trends are included in **Section 3.2**.

3.1.5.3 Aquifer System Primary Uses

The shallow aquifer system serves a number of different users and uses with the primary extractions being from domestic water-supply wells, which provide water to rural-residential properties in the unincorporated areas of the Subbasin. In some areas, agricultural and public water-supply wells are also completed, either completely or partially, within the shallow aquifer system. The shallow aquifer system is a primary source of recharge to the deep aquifer system. It is also the source of baseflow to streams within the Subbasin, thereby providing ecosystem benefits in the Subbasin. Additionally, in some areas where groundwater levels are close to the ground surface, such as near streams and in the Laguna de Santa Rosa areas, the shallow aquifer system provides water for vegetation communities in the Subbasin.

The deep aquifer system serves a number of different users and uses. Users include a combination of rural-residential properties with domestic water-supply wells in the unincorporated areas of the Subbasin, agricultural irrigation wells used for crop irrigation, industrial, and commercial use and public water-supply wells for municipal and smaller public supply systems.

3.1.5.4 Aquitards

Generally discontinuous aquitards composed of clay deposits commonly provide some degree of hydraulic separation between the shallow and deep aquifer systems and serve to locally confine the deeper aquifer system to varying degrees of semiconfined or confined conditions. Clay aquitards are common within some portions of the Quaternary alluvial deposits, such as the basin deposits within the southern portions of the Subbasin, the Glen Ellen Formation, and

clay-dominated portions of the older Petaluma Formation. These aquitards may contribute to semi-confined or confined conditions of the more permeable sand and gravel aquifer zones within the Wilson Grove and Petaluma Formations of the deep aquifer system. Due to the overall complexity of the Subbasin hydrogeology and complicated interfingering stratigraphic relations of the Petaluma Formation with the Wilson Grove Formation and Sonoma Volcanics, some wells can pass from one formation into another more than once. The interfingering of the three formations can also place relatively impermeable lavas or clay beds above more permeable sand or gravel beds, producing confined groundwater conditions (Sweetkind et al. 2013). Wells spanning unconfined and confined layers, however, can provide pathways for groundwater to flow between layers and can affect both the hydraulics and water quality of these areas.

3.1.6 Effects of Faults on Groundwater

Faults can affect water flow and well production because groundwater movement may be inhibited or preferentially increased across or within faults and fault zones. Faulting can break even very strong rocks, producing fracture zones that tend to increase permeability, and may provide preferential paths for groundwater flow. Conversely, some faults can form groundwater barriers if the faulting grinds the broken rock into fine-grained fault gouge with low permeability, or where chemical weathering and cementation over time have reduced permeability. The hydraulic characteristics of materials in a fault zone, and the width of the zone, can vary considerably so that a fault may be a barrier along part of its length but elsewhere allow or even enhance groundwater flow across it. Faults also may displace rocks or sediments so that geologic units with very different hydraulic properties are contiguous, which can affect localized groundwater flow regimes.

Faults in the Subbasin serve as major structural boundaries for geologic formations and groundwater movement. Faults have also played a major role in the geometry of the basin with the formation of the Windsor and Cotati structural troughs separated by the Trenton Ridge Fault (**Figures 3-4a**, **3-4b**, and **3-5**). Major faults, which are present along or near the boundaries of the Subbasin include the Rodgers Creek-Healdsburg Fault Zone along the eastern boundary and the Sebastopol Fault along the western boundary. The Trenton Ridge Fault and two unnamed faults present in the southern portions of the Subbasin are the main mapped faults located within the interior of the Subbasin (**Figures 3-4a** and **3-4b**). The Rodgers Creek Fault appears to act as a barrier to groundwater flow and also creates groundwater upflow or mixing along part of its length (**Figure 3-5**). The Sebastopol Fault appears to limit the lateral groundwater movement to the east. To the east of the Sebastopol Fault, an unnamed fault is at least a partial barrier to groundwater flow and appears to create upflow or mixing along part of its length (Martin et al. 2013).

The alignments of thermal springs and wells (that is, wells affected by volcanic heat sources), along and near valley-bounding faults, indicate that some faults enable deep waters to move upward to the surface or into shallow formations. West of the Rodgers Creek Fault, and directly downgradient (in the groundwater flow direction), groundwater compositions change from characteristics typical of recent rainfall replenishment to those of hydrothermal or connate

water (water included during accumulation of the rock or sediment materials). These changes suggest that the fault orientation and activity may be directing groundwater downward and causing deep mixing of older and more recently replenished waters, or may be evidence of groundwater upwelling. The Sebastopol Fault may be acting as a barrier to shallow flow, but does not appear to impede flow at greater depths.

3.1.7 Groundwater Recharge and Discharge

3.1.7.1 Groundwater Recharge

The principal sources of recharge to groundwater systems within the SRP watershed are direct infiltration of precipitation and infiltration from streams (Sweetkind et al. 2013). Minor sources of recharge include infiltration from septic tanks, leaking water-supply pipes, leaking storm drainpipes, irrigation water in excess of crop requirements, and crop frost-protection applications. The shallow aquifer system receives most of this recharge. Recharge that reaches the deeper aquifer zones is less well-defined and appears to come from a combination of leakage from overlying shallow aquifers and mountain-front recharge along the margins of the valley. The amount of groundwater recharge and discharge is estimated a number of ways through direct measurement, approximation incorporating some literature-based variables, and with the use of the groundwater model.

Previous estimates of groundwater recharge in the Santa Rosa Plain have primarily included qualitative assessments. Natural recharge potential mapping of the Subbasin and contributing watershed was conducted that incorporates soil permeability, slope, and shallow geologic unit permeability (0 to 50 feet bls) (Todd Engineers 2012). The weighting of each parameter—slope (20 percent), soil (30 percent), and geology (50 percent)—is generally based on other similar studies and guidance (Sesser et al. 2011; DWR 1982; Muir and Johnson 1979) and sensitivity analysis. The natural recharge potential map developed by Todd Engineers (**Figure 3-6**) ranks the very high to very low relative potential for natural groundwater recharge from rainfall infiltration. The term recharge potential is used because the actual recharge rate also depends on other factors such as the distribution, intensity and duration of precipitation, the locations of streams and other surface-water bodies, and the connection to deeper aquifers (which were not incorporated into that study). Areas showing a higher recharge potential using this desktop approach are generally located within the flatter areas of the Glen Ellen Formation and the areas underlain by the Wilson Grove Formation. Potential constraints or limitations that are not directly incorporated into the analysis include the presence of shallow or perched groundwater, natural springs, and existing groundwater quality.

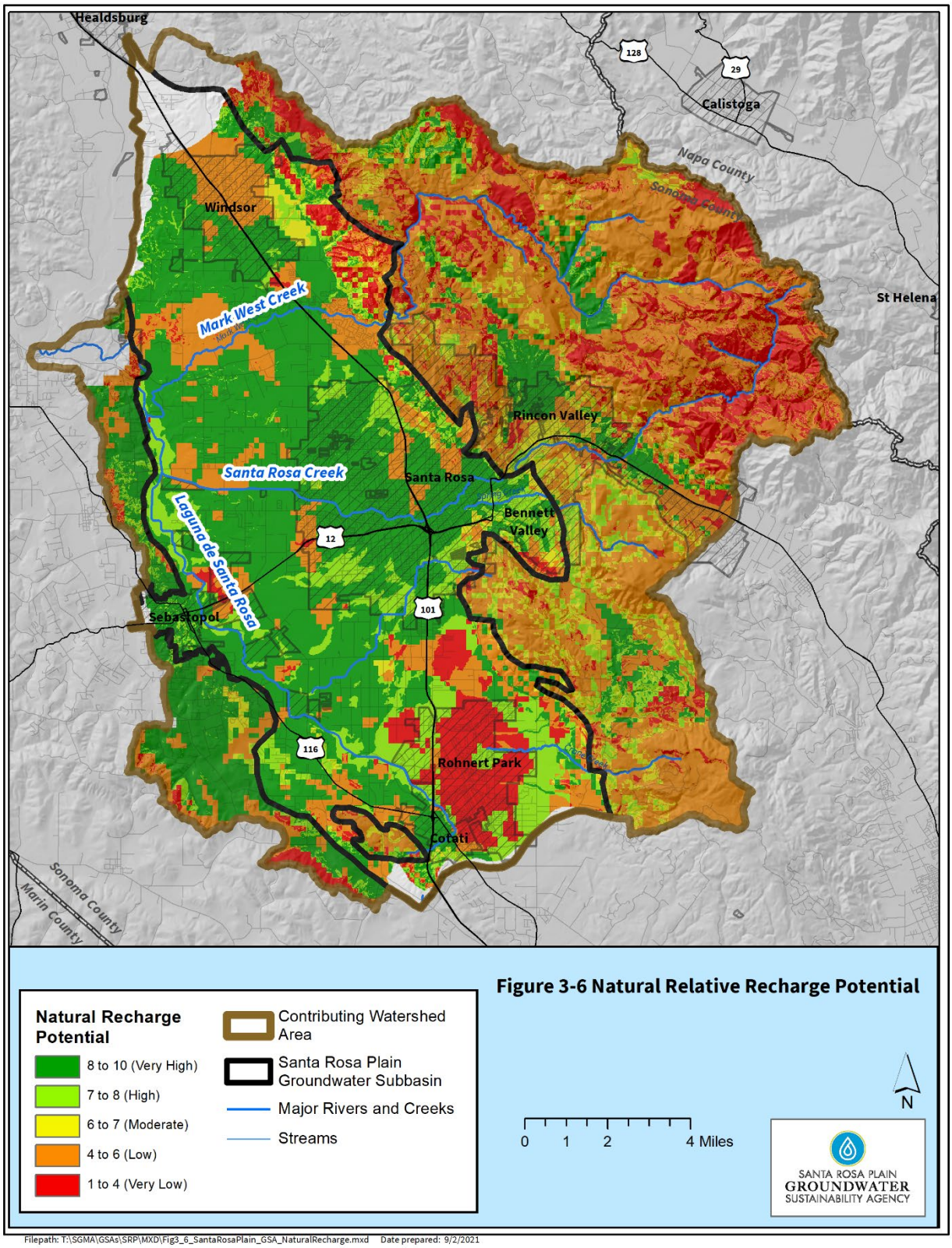


Figure 3-6. Natural Relative Recharge Potential

3.1.7.2 Groundwater Discharge

Groundwater discharge occurs in the Subbasin as stream baseflow (gaining streams), discharge at springs and seeps, underflow to neighboring groundwater basins, and discharge at interconnected wetlands. Groundwater also discharges through evapotranspiration (ET) from phreatophytes and groundwater pumping. These two components of groundwater discharge are described in **Section 3.3** (Water Budget).

Based on USGS' National Hydrography Dataset and NWIS, there are 17 mapped springs and seeps in the contributing watershed (**Figure 3-7**). On the west side of the Subbasin, groundwater discharges from the Wilson Grove Formation through springs and seeps, and on the east side springs are relatively common discharging from the Sonoma Volcanics and Glen Ellen Formation (Sweetkind et al. 2013).

3.1.8 Data Gaps and Uncertainty

While the information and data presented in this HCM incorporates the best available information and datasets, it is recognized that all HCMs will contain varying degrees of uncertainty that can be improved through additional data collection and analysis. Addressing the following primary identified data gaps would improve and reduce uncertainty of the HCM for the Subbasin and will be considered and prioritized in **Section 6** (Projects and Actions) and **Section 7** (Implementation Plan).

3.1.8.1 Aquifer and Aquitard Continuity and Properties and Role of Fault Zones

As described in preceding sections, the geologic complexities of the Subbasin and limited high quality subsurface lithologic data limit the understanding of the lateral and vertical continuity and properties of aquifers and aquitards in the Subbasin. Developing the following information would improve our understanding of aquifers and aquitards:

- Improving estimates of the annual volume of groundwater recharge and discharge, including pumping.

- Filling three-dimensional data gaps in the monitoring network for each primary aquifer in the Subbasin. Depth-dependent water-level and water-quality data are needed to improve understanding of the hydrogeology and aquifer systems, which could be improved through construction of dedicated nested monitoring wells in key areas.

- Gaining a better understanding of the role of faults within and along the boundaries of the Subbasin, with a focus on the role of the Sebastopol Fault, Trenton Ridge Fault, and Unnamed Fault. Potential methods for addressing this data gap could include the performance of aquifer tests and geophysical surveys, geochemical sampling, and analyses in the vicinity of these faults.

- Developing better information on basin boundary characteristics, such as the direction and magnitude of fluxes across Subbasin boundaries, including boundaries between the Subbasin and adjoining groundwater basins and boundaries between the Subbasin and the

upper contributing watershed areas outside of the Bulletin 118 basins. Potential methods for addressing this data gap could include the construction of dedicated nested monitoring wells and/or performance of aquifer tests and geophysical surveys in the vicinity of the boundaries.

3.1.8.2 Recharge and Discharge Areas and Mechanisms and Surface Water/Groundwater Interaction

Improved understanding of recharge and discharge mechanisms within the Subbasin for both the shallow and deep aquifer systems will support the appropriate selection of projects and actions needed for the Subbasin, this includes:

- Gaining an improved understanding of the interconnection of streams to the shallow aquifer system, including seasonal variability and how groundwater pumping can affect streamflow. Additional shallow monitoring wells near stream courses paired with stream gages and meteorological stations can help advance this understanding.
- Conducting geochemical or tracer studies, which can help better understand both recharge and discharge mechanisms to both the shallow and deep aquifer systems, as well as surface water/groundwater interaction within the Subbasin.

3.2 Current and Historical Groundwater Conditions

This subsection describes the current and historical groundwater conditions within the Subbasin and contributing watershed areas. As described in the GSP Regulations, “Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes the following”:

- Groundwater-elevation Data: Contour maps, hydrographs
- Change in Storage Estimates: Annual and cumulative changes, including groundwater use and water year (WY) type
- Seawater Intrusion: Maps and cross sections for each principal aquifer
- Groundwater Quality: Issues that may affect supply and beneficial uses, map of contaminant sites and plumes
- Land Subsidence: Extent and annual rate
- Interconnected Surface Water: Timing of depletions, map of Groundwater Dependent Ecosystems (GDE)

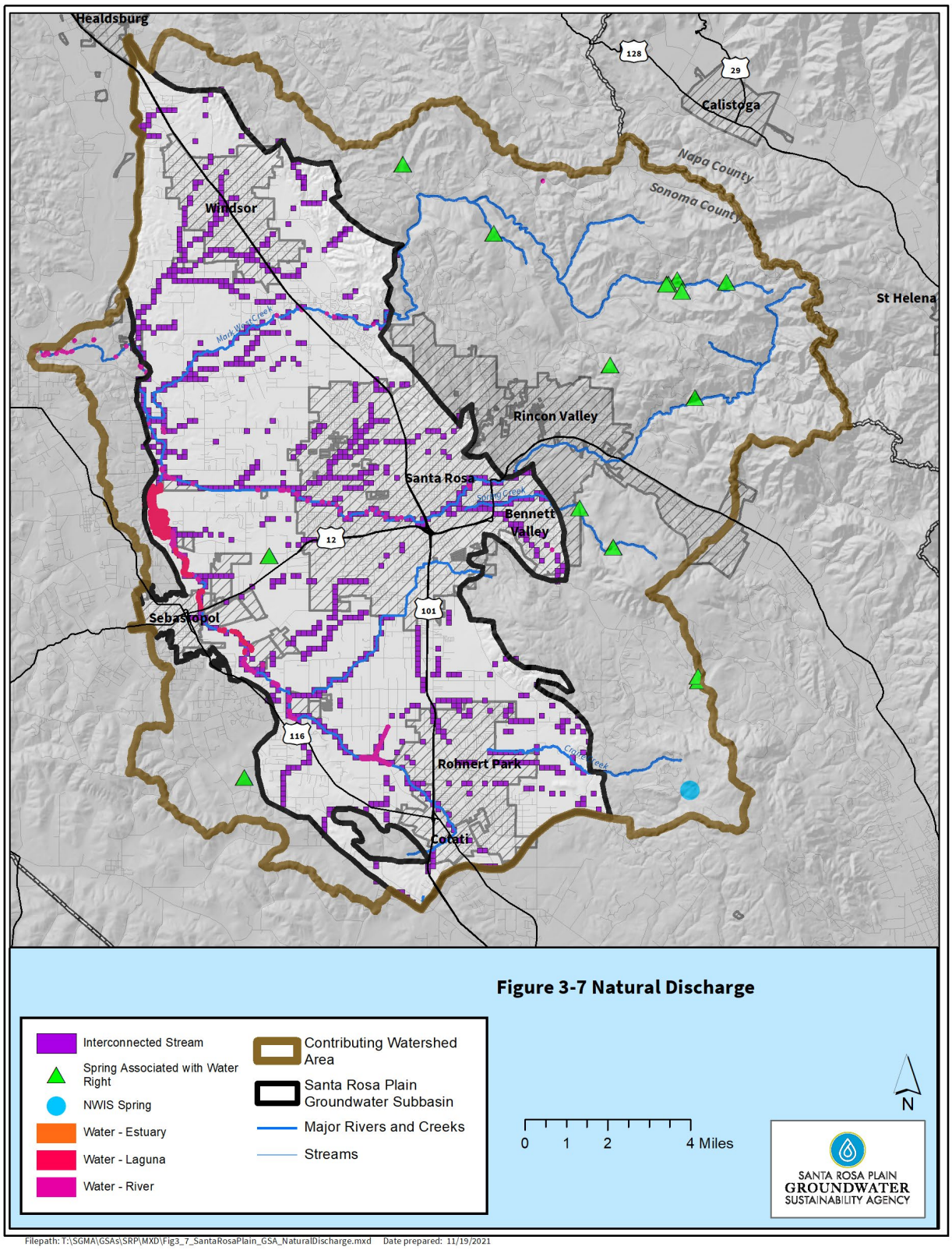


Figure 3-7. Natural Discharge

To assess and evaluate the listed conditions for the Subbasin and contributing watershed areas, this subsection includes a description of the following conditions based on available information and data:

- Climate conditions and trends
- Groundwater-elevation data and trends
- Estimates of storage changes
- Groundwater quality data and trends
- Land-surface subsidence data and trends
- Surface water conditions and trends
- Assessment of interconnected surface water and GDE

3.2.1 Climatic Conditions and Trends

Regional climate patterns in the Northern California region encompassing the SRP watershed are characterized by Mediterranean conditions with cool, wet winters; warm, dry summers; and a strong coastal influence on climate that moderates temperature extremes (Sloop et al. 2009). Distributions of temperature and rainfall display high spatial and temporal variability due to the combination of coastal and inland weather systems. The intersection of these variable weather patterns with the rugged topography of the Coast Ranges results in a broad variety of microclimates.

The Mediterranean climate in the SRP watershed influences water demands by separating the year into wet and dry seasons. During the dry season outdoor irrigation demands, particularly for agriculture, are not met by precipitation. Approximately 93 percent of the annual precipitation normally falls during the wet season (October to May), with a large percentage of the rainfall typically occurring during three or four major winter storms. Precipitation is highly affected by atmospheric rivers, which concentrate rainfall and runoff along narrow bands in the atmosphere. Nearly 50 percent of precipitation in the Sonoma County area is due to atmospheric rivers (Dettinger et al. 2011). The quantity of rainfall over the contributing watershed increases with elevation, with the greatest precipitation over the highest ridges, reaching nearly 50 inches per year in the Mayacamas and Sonoma Mountains (**Figure 3-8**).

Mean annual precipitation in the Santa Rosa Plain has been assessed using both observed data from Climate Station Santa Rosa (USC00047965), which is located in downtown Santa Rosa at an elevation of 109 feet (National Geodetic Vertical Datum of 1929 [NGVD 29]), as well as annual averages calculated using the Parameter-elevation Regressions on Independent Slopes Model (PRISM) for the SRP watershed. The Santa Rosa station has operated from 1903 to present, with periods of missing and incomplete records. The yearly average precipitation measured from this station from WY 1903 through WY 2020 is 29.81 inches (**Table 3-1**), compared with 33.3 inches, as calculated by PRISM. This calculation is based on the annual WY standard nomenclature, which begins on October 1 and ends the following calendar year on September 30.

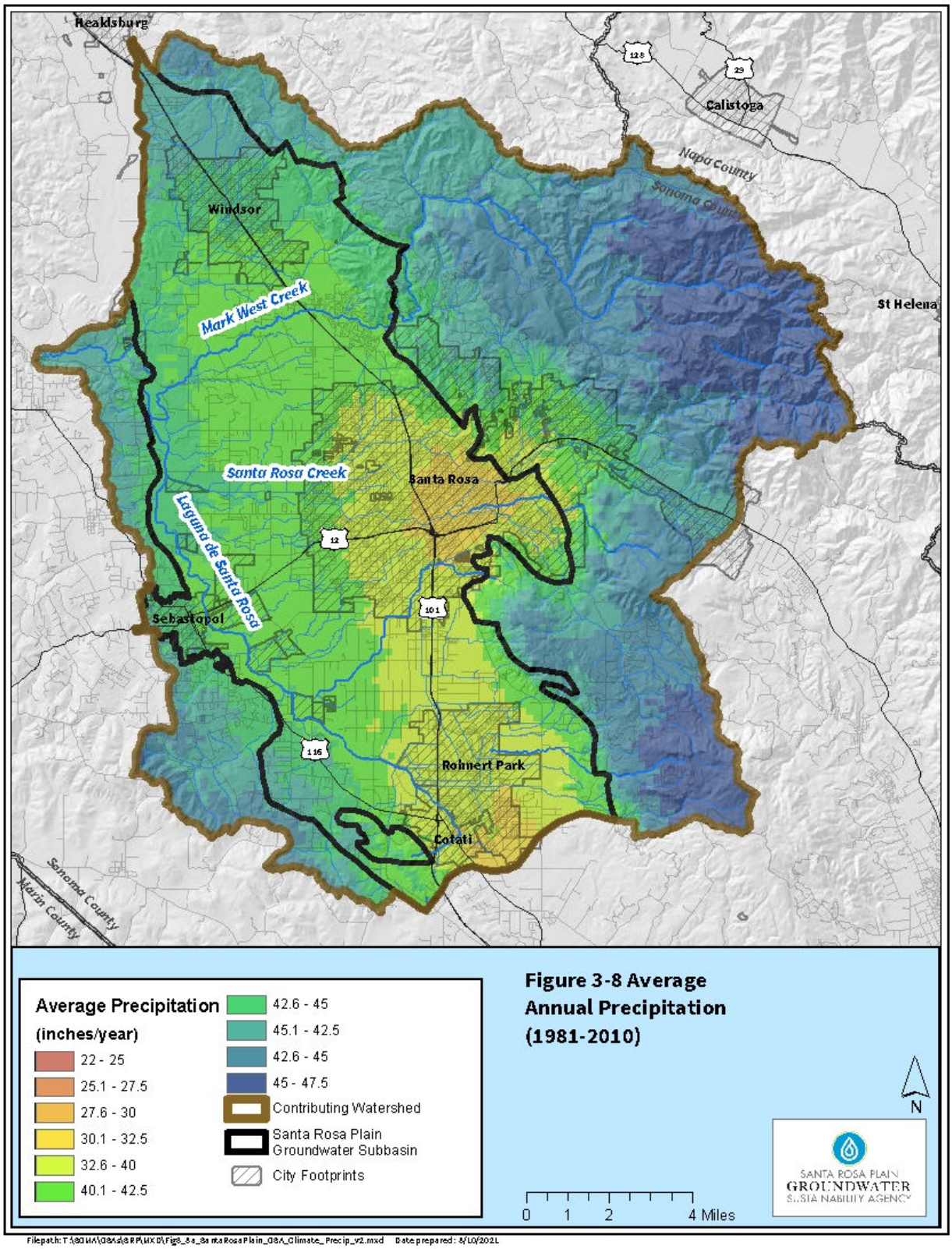


Figure 3-8. Average Annual Precipitation (1981-2010)

Table 3-1. Climate Station Santa Rosa Yearly Average Rainfall

Water Year	Annual Rainfall (Inches)	Completeness of data
WY-1903	28.78	85.8%
WY-1904	48.54	100.0%
WY-1905	31.62	100.0%
WY-1906	25.42	77.0%
WY-1907	33.90	94.5%
WY-1908	17.84	82.2%
WY-1909	39.31	95.1%
WY-1910	26.58	86.3%
WY-1911	29.49	94.5%
WY-1912	21.45	100.0%
WY-1913	21.11	100.0%
WY-1914	31.85	52.9%
WY-1915	42.53	75.1%
WY-1916	30.24	75.7%
WY-1917	19.18	52.3%
WY-1918	20.45	60.5%
WY-1919	25.26	38.4%
WY-1920	12.84	25.7%
WY-1921	38.97	32.6%
WY-1922	23.69	33.7%
WY-1923	29.94	51.2%
WY-1924	13.96	93.7%
WY-1925	42.13	89.3%
WY-1926	31.30	100.0%
WY-1927	42.54	98.4%
WY-1928	28.47	94.5%
WY-1929	17.38	86.6%
WY-1930	26.95	100.0%
WY-1931	13.27	98.6%
WY-1932	24.22	100.0%
WY-1933	20.95	100.0%
WY-1934	20.91	100.0%
WY-1935	35.35	100.0%
WY-1936	29.93	99.7%
WY-1937	26.39	100.0%
WY-1938	39.32	99.7%
WY-1939	15.29	100.0%
WY-1940	38.59	100.0%
WY-1941	51.82	100.0%
WY-1942	40.63	100.0%
WY-1943	32.43	100.0%
WY-1944	23.27	100.0%
WY-1945	28.18	100.0%
WY-1946	25.86	100.0%
WY-1947	20.24	100.0%
WY-1948	28.45	100.0%
WY-1949	19.89	100.0%
WY-1950	25.06	99.5%
WY-1951	32.09	100.0%
WY-1952	37.56	100.0%
WY-1953	32.62	99.5%
WY-1954	28.40	97.3%
WY-1955	20.58	100.0%
WY-1956	43.99	99.5%
WY-1957	23.31	100.0%
WY-1958	43.49	100.0%
WY-1959	21.58	100.0%
WY-1960	24.39	99.7%
WY-1961	24.77	98.9%
WY-1962	21.41	98.4%
WY-1963	35.34	100.0%
WY-1964	20.31	100.0%
WY-1965	31.49	91.8%
WY-1966	25.12	100.0%
WY-1967	41.96	100.0%
WY-1968	26.66	100.0%
WY-1969	41.19	100.0%
WY-1970	38.46	100.0%
WY-1971	31.28	100.0%
WY-1972	17.63	100.0%
WY-1973	42.95	100.0%
WY-1974	42.25	100.0%
WY-1975	28.05	100.0%
WY-1976	16.92	100.0%
WY-1977	12.13	99.5%
WY-1978	27.98	100.0%
WY-1979	4.99	50.4%
WY-1980	37.76	100.0%
WY-1981	22.60	99.7%
WY-1982	48.48	100.0%
WY-1983	55.74	99.7%
WY-1984	30.82	92.9%
WY-1985	26.90	92.9%
WY-1986	42.57	100.0%
WY-1987	19.00	99.7%
WY-1988	21.70	99.5%
WY-1989	26.67	99.7%
WY-1990	21.43	100.0%
WY-1991	22.72	100.0%
WY-1992	24.32	100.0%
WY-1993	37.95	100.0%
WY-1994	21.43	100.0%
WY-1995	47.78	100.0%
WY-1996	38.43	100.0%
WY-1997	33.91	100.0%
WY-1998	53.01	100.0%
WY-1999	32.72	100.0%
WY-2000	30.68	100.0%
WY-2001	21.91	100.0%
WY-2002	35.17	100.0%
WY-2003	34.92	100.0%
WY-2004	29.38	100.0%
WY-2005	37.77	100.0%
WY-2006	45.72	100.0%
WY-2007	20.85	100.0%
WY-2008	24.14	100.0%
WY-2009	22.62	100.0%
WY-2010	32.05	100.0%
WY-2011	39.14	100.0%
WY-2012	23.22	100.0%
WY-2013	29.36	100.0%
WY-2014	14.90	100.0%
WY-2015	24.05	100.0%
WY-2016	32.17	100.0%
WY-2017	60.32	100.0%
WY-2018	25.12	100.0%
WY-2019	48.12	100.0%
WY-2020	19.23	100.0%

Average Rainfall (1903WY-2020WY) : **29.81**

Note: Rainfall totals derived from daily precipitation measurements recorded at National Climatic Data Center station #7965, currently located at the Sonoma County Airport (Lat. 38.503, Long. -122.810). Some years do not contain a complete record, which is described in the "Completeness of data" column.

For the purposes of comparing and classifying WY types for the GSP, data from PRISM and historical data were used from Sonoma Valley, Santa Rosa Plain, and Petaluma Valley to develop an aggregated WY classification for all three basins. The methodology and results are provided in **Appendix 3-A**.

Future climate change projections are described in **Section 3.3** (Water Budget).

3.2.2 Groundwater Elevations and Trends

Changing patterns of land use, surface water use, groundwater pumping, and climate changes can cause changes in groundwater levels and movement directions. This subsection describes historical and current groundwater-elevation conditions and trends based on available data from the monitoring programs described in **Section 2.4**. While records for some wells extend back to the 1950s, the majority of available groundwater-level data are from the last 10 to 15 years. Data presented and evaluated as part of this section include the following:

- Historical groundwater-level contour maps (**Figures 3-9a** and **3-9b**)
- Recent groundwater-level contour maps for each principal aquifer (**Figures 3-10a** through **3-10h**)
- Long-term groundwater-level hydrographs (**Figures 3-11a** through **3-11d**)
- Groundwater-level trend maps (**Figure 3-12a** and **3-12b**)
- Short-term groundwater-level hydrographs (**Figures 3-13b** through **3-13i**)

3.2.2.1 Groundwater-level Contour Maps

Historical groundwater-elevation contour maps of groundwater levels in the Subbasin (**Figure 3-9a**) show overall groundwater spring flow directions and trends for 1951 through 2007. The contours presented on these maps, which are provided to present overall patterns, do not distinguish between wells completed in the shallow and deep aquifer systems and are considered composites of both principal aquifer systems. The dominant direction of groundwater flow in the spring of 1951 was from the east toward the west (**Figure 3-9a**). The influence of Mark West and Santa Rosa Creeks also appear as upstream deflections in the contours, indicating segments of these watercourses were likely being fed from groundwater discharge (gaining stream condition) at that time.

Groundwater-elevation contours for spring 1990 (**Figure 3-9a**) show substantial groundwater-level declines from 1951 conditions. There were groundwater-level declines exceeding 100 feet in the Rohnert Park-Cotati area and approximately 20 feet of groundwater-level decline west of the City of Santa Rosa (**Figure 3-9a**). The declines in the southern portions of the Subbasin are primarily attributed to increases in municipal groundwater pumpage associated with population growth through the 1980s and 1990s, exacerbated also by the droughts in 1976-77 and 1987-92 (**Figure 3-9b**).

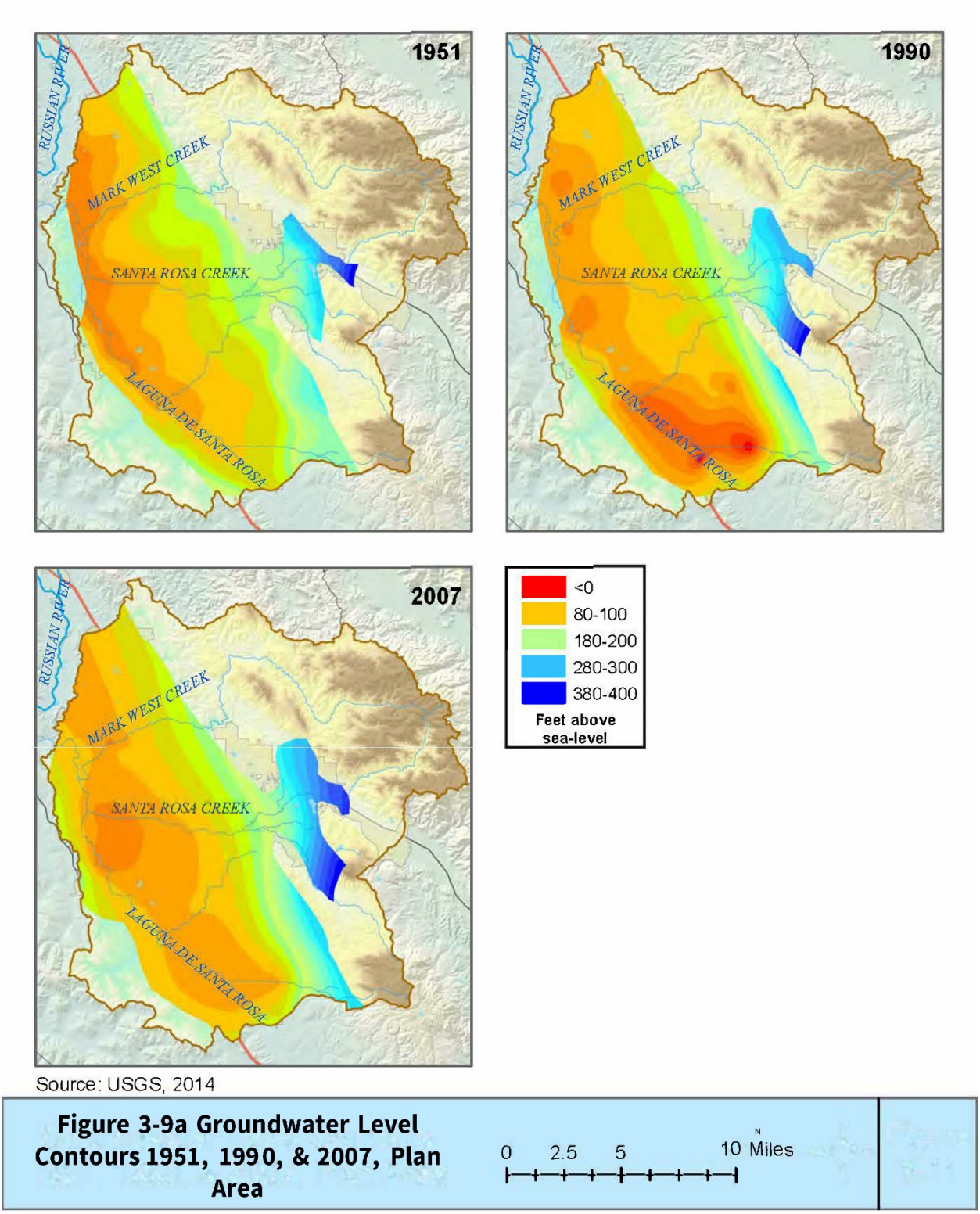


Figure 3-9a. Groundwater-level Contours 1951, 1990, and 2007 Plan Area

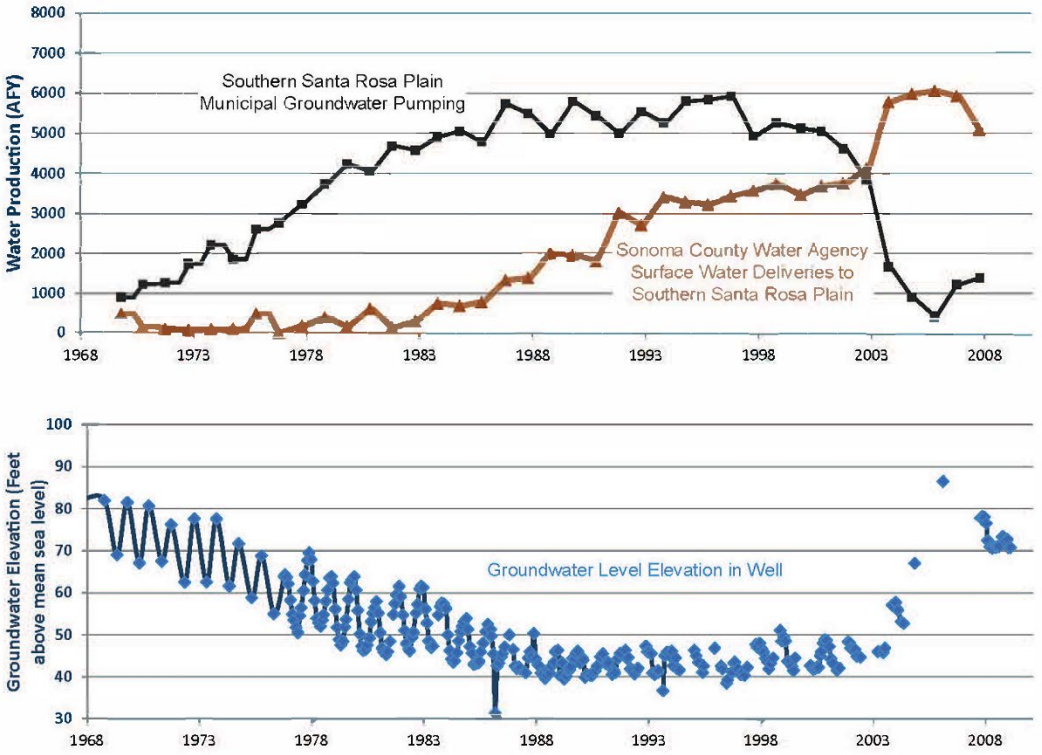
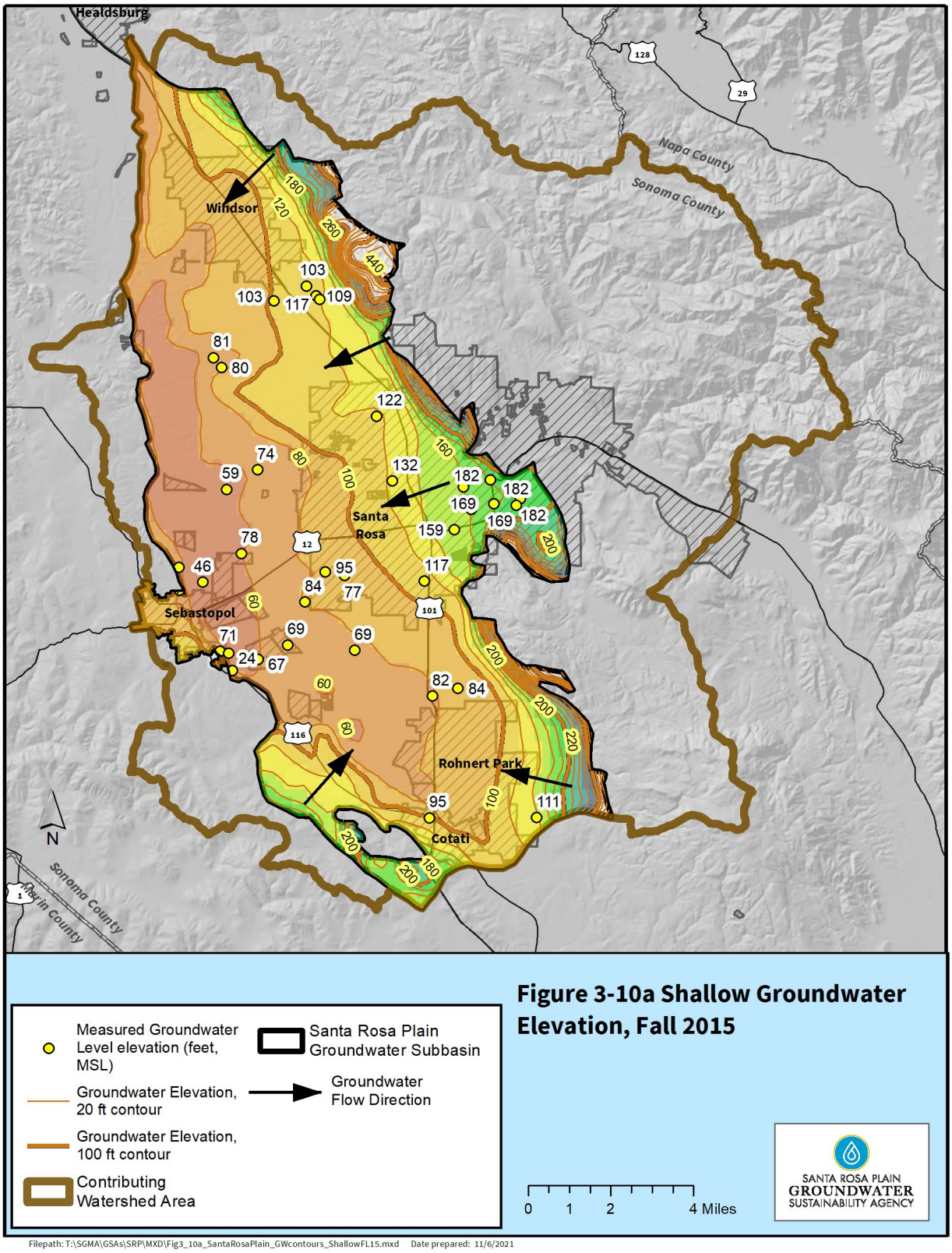


Figure 3-9b Total Annual Pumping, Southern SRP, Surface Water Deliveries, and Groundwater Levels, 1968-2008

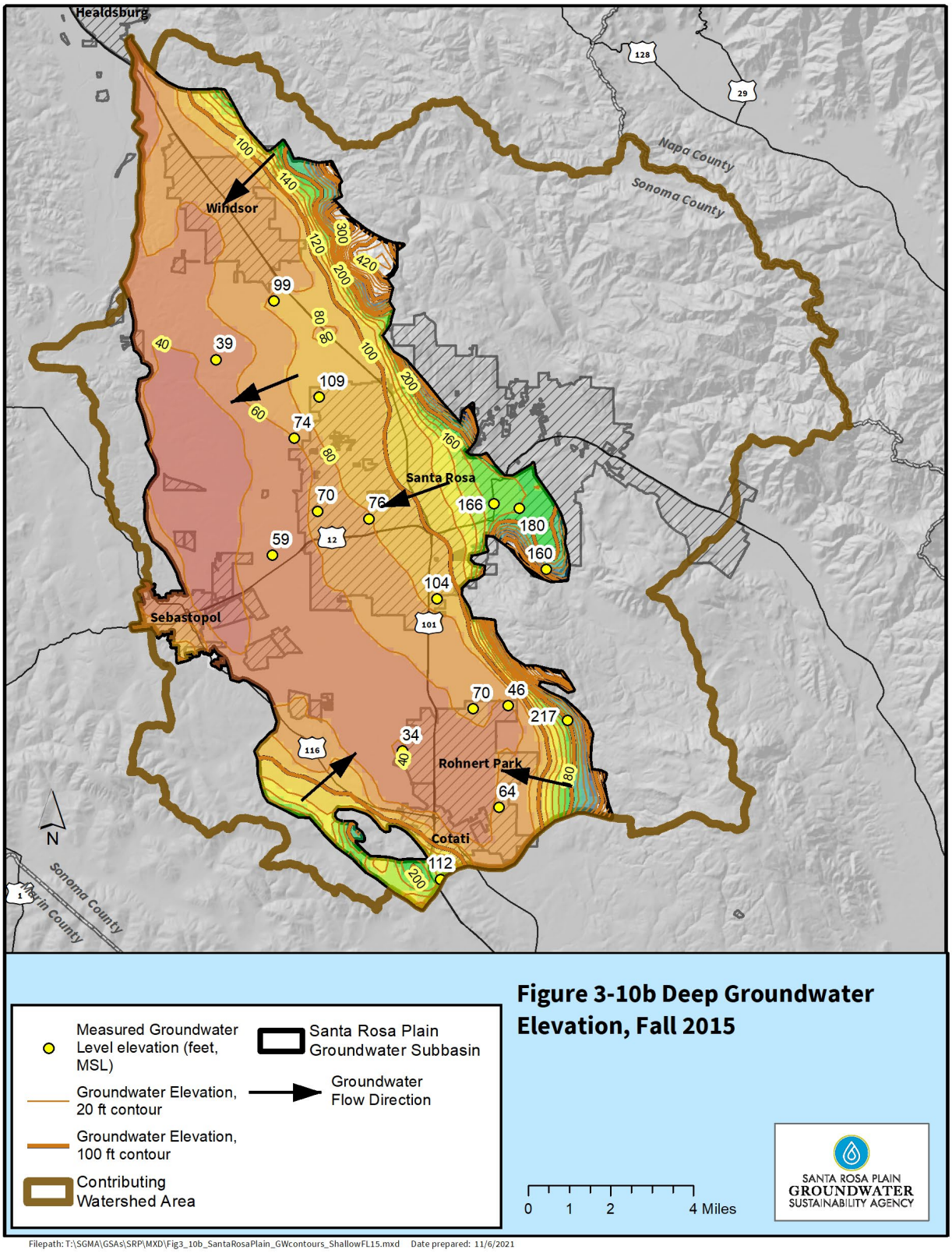
Figure 3-9b. Total Annual Pumping, Southern SRP, Surface Water Deliveries, and Groundwater Levels, 1968-2008

Groundwater-elevation contours for spring 2007 (**Figure 3-9a**) show higher water levels in the Rohnert Park-Cotati area, which coincided with a substantial pumpage reduction at City of Rohnert Park wells, primarily due to increased imports of Russian River water provided by the Sonoma Water, as well as increased conservation and recycled water use. The reduction of the 1990s groundwater depression suggests that reduced pumping in the Rohnert Park-Cotati area allowed groundwater levels to recover to elevations typical of the early 1970s.

More recent groundwater-elevation maps prepared for the Groundwater Management Plan and for this GSP contour the shallow aquifer system and deeper aquifer system separately based on water-level data from the shallow and deep aquifer system wells, respectively. Groundwater-elevation contour maps for the shallow and deep aquifers for the fall and spring seasons of 2015 and 2018 are shown on **Figures 3-10a** through **3-10h**.



Figures 3-10a. Shallow Groundwater Elevation, Fall 2015



Figures 3-10b. Deep Groundwater Elevation, Fall 2015

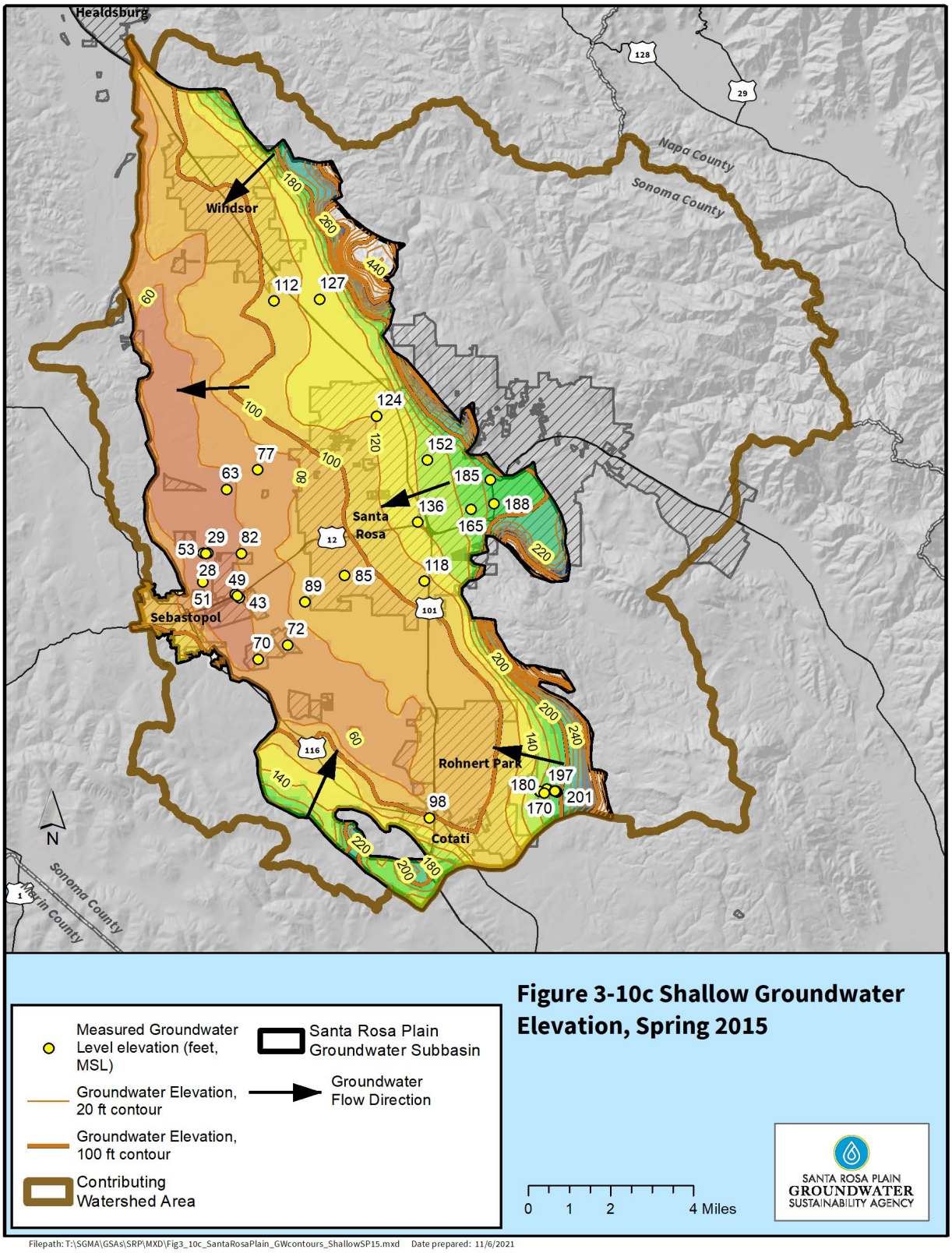
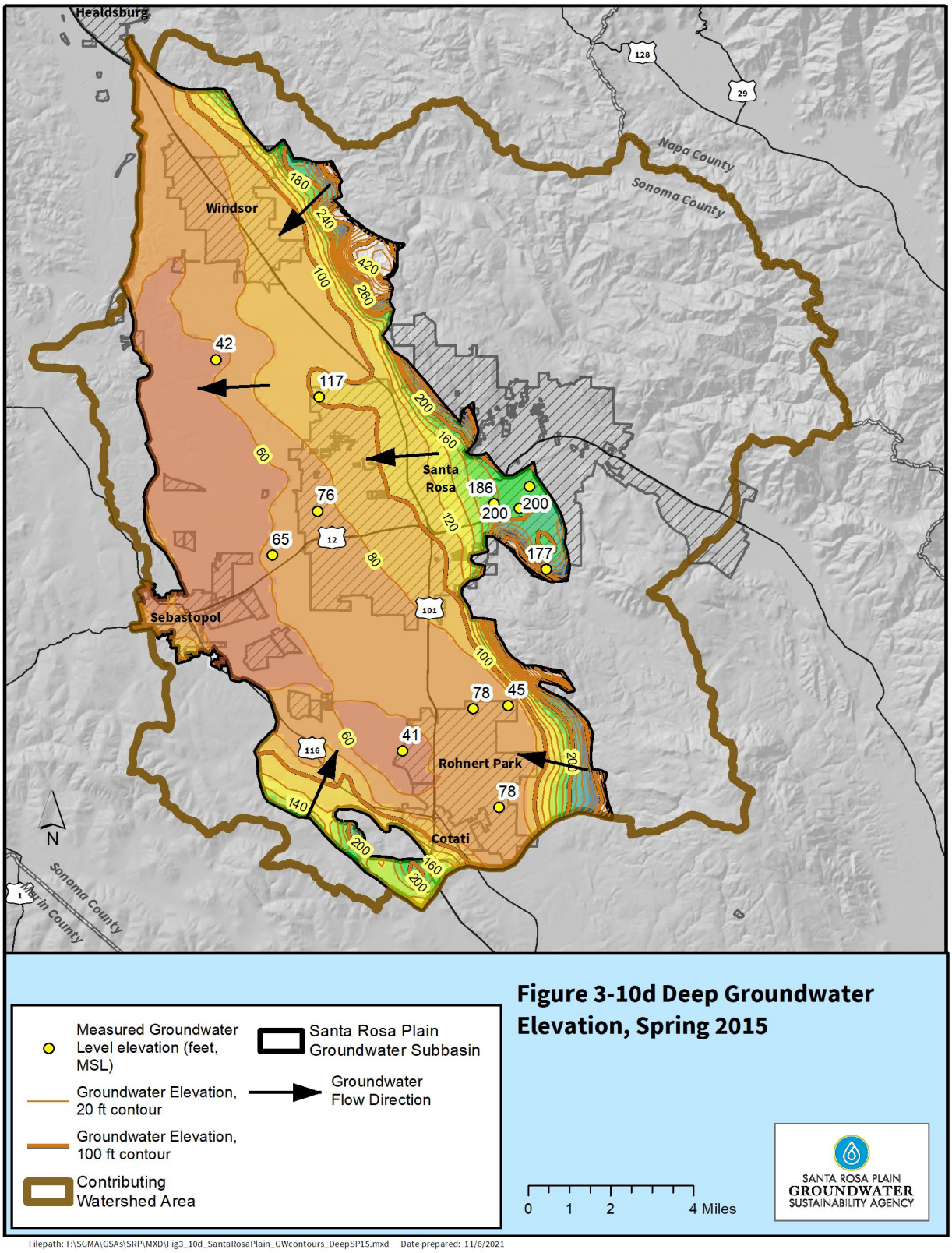
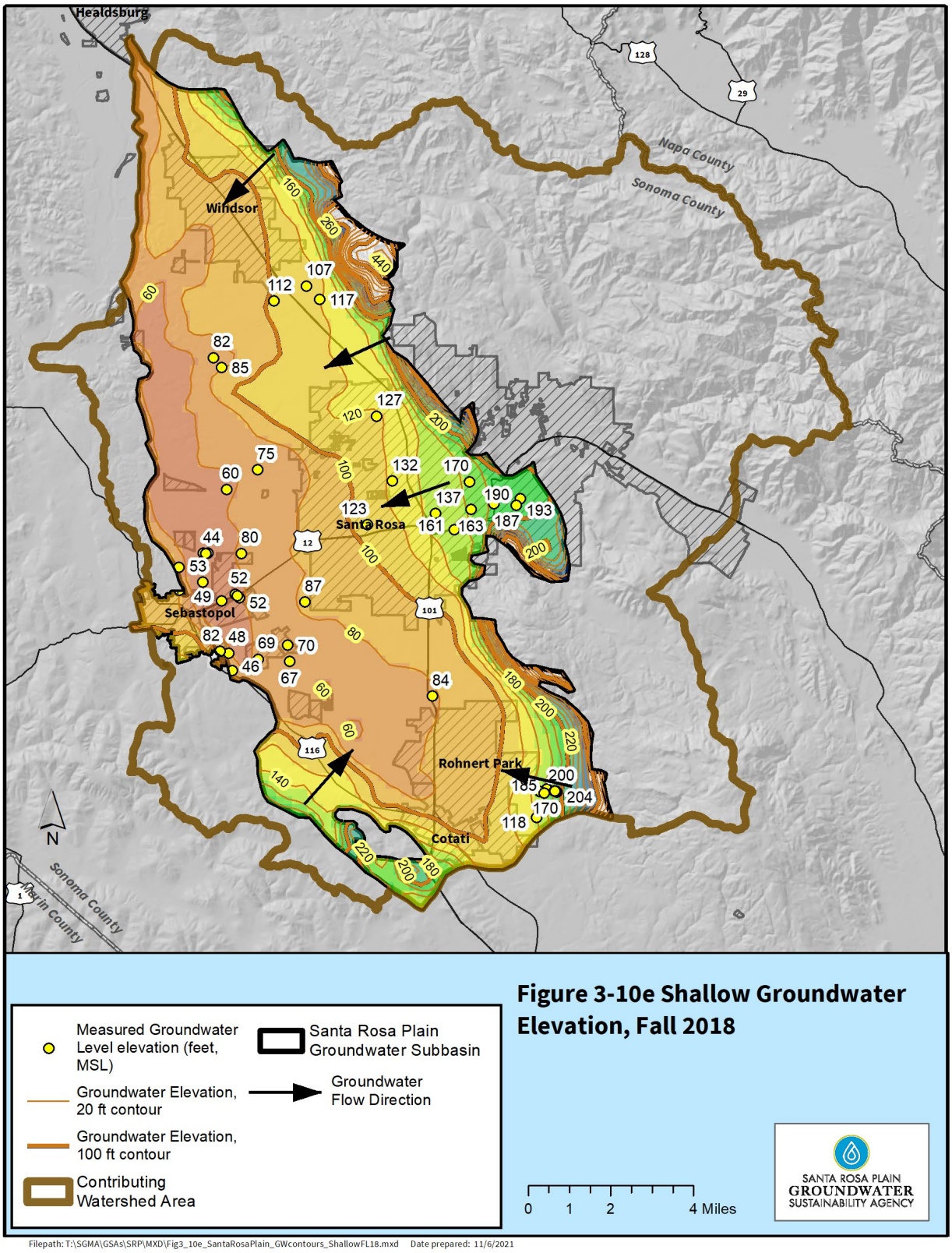


Figure 3-10c Shallow Groundwater Elevation, Spring 2015

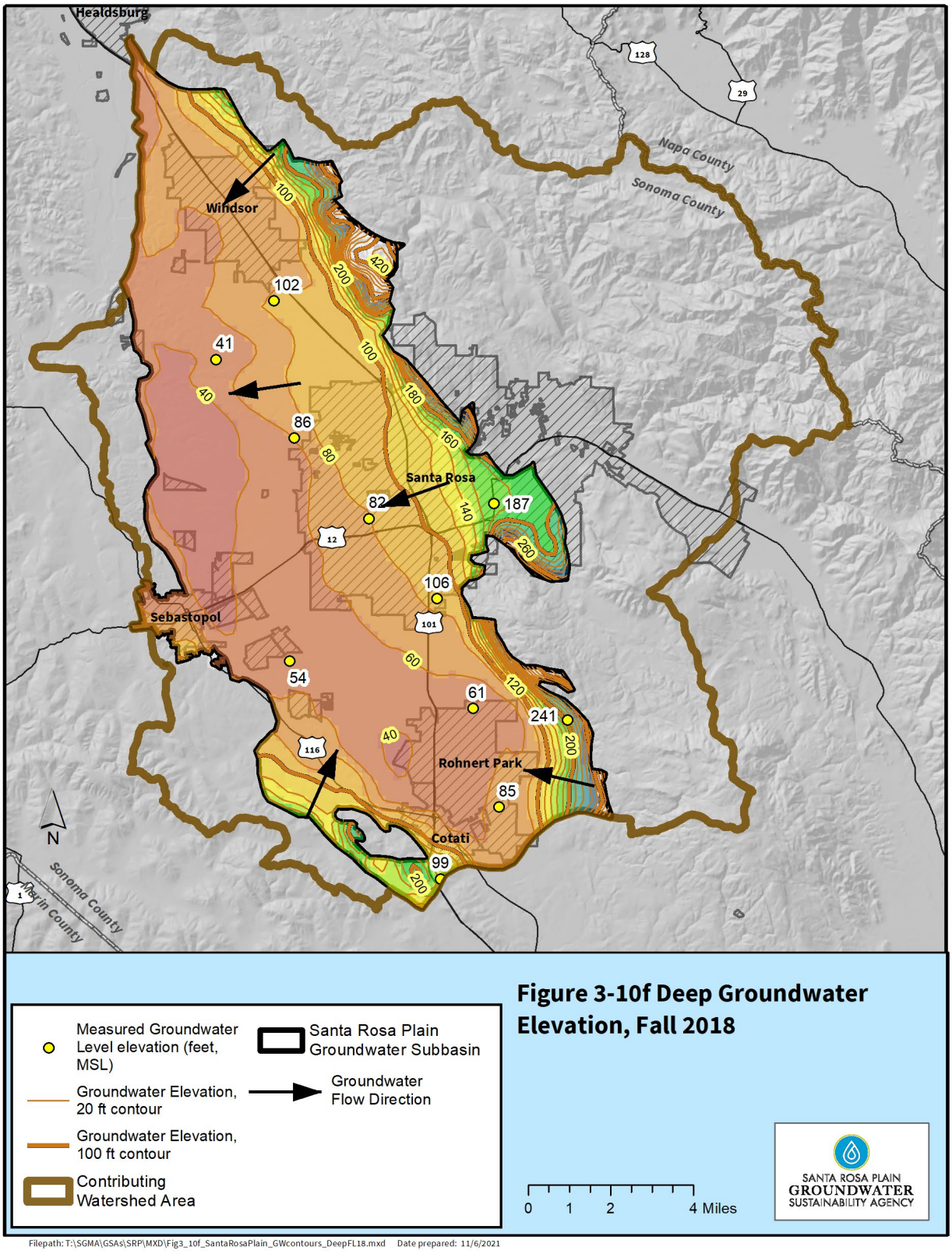
Figures 3-10c. Shallow Groundwater Elevation, Spring 2015



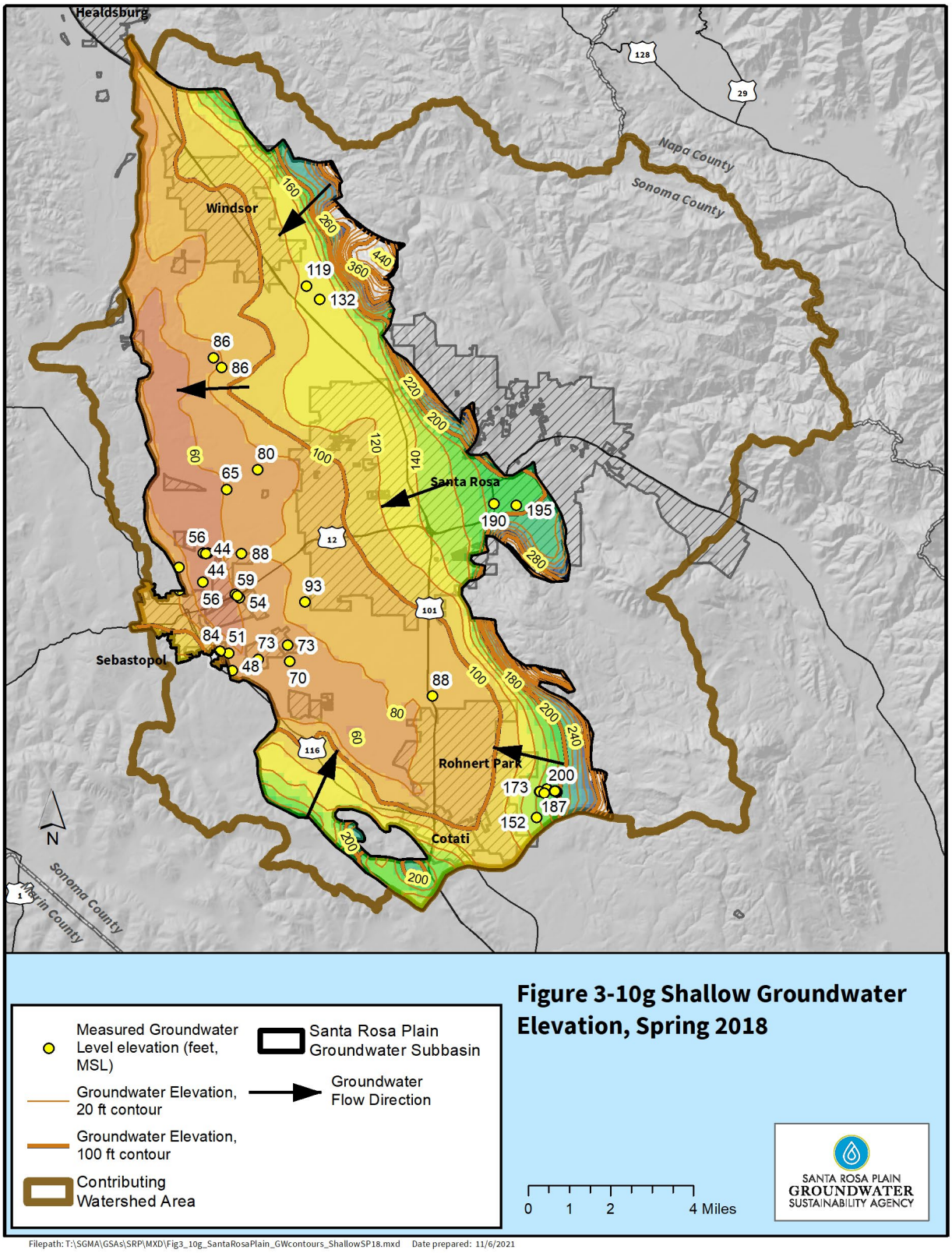
Figures 3-10d. Deep Groundwater Elevation, Spring 2015



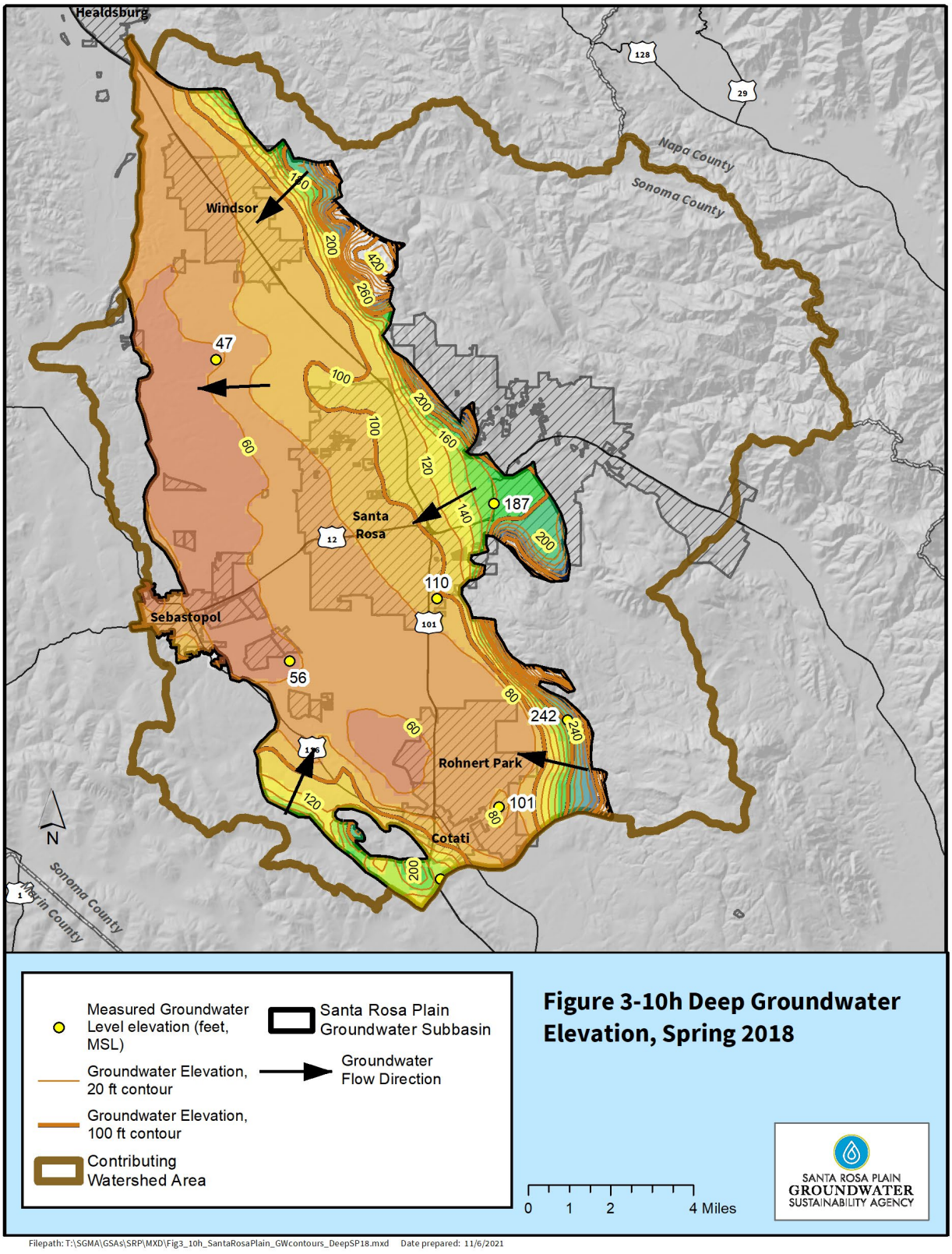
Figures 3-10e. Shallow Groundwater Elevation, Fall 2018



Figures 3-10f. Deep Groundwater Elevation, Fall 2018



Figures 3-10g. Shallow Groundwater Elevation, Spring 2018



Figures 3-10h. Deep Groundwater Elevation, Spring 2018

Groundwater-elevation contour maps for the shallow aquifer indicate that groundwater in the Subbasin generally flows westward from recharge areas in the Sonoma and Mayacamas Mountains, toward the Laguna de Santa Rosa, the primary discharge area (**Figures 3-10a**, **c**, **e**, and **g**). From the south end and west side of the valley, groundwater flows northwesterly and east, respectively toward the Laguna de Santa Rosa. The spring water levels are slightly higher in the WY 2018 (**Figure 3-10c**), which follows the wet WY 2017, compared to the shallow water levels in 2015, which occurs in the midst of a below-average period of precipitation (**Figure 3-10g**). The deep aquifer generally mirrors that of the shallow aquifer, but with smoother changes in groundwater elevation (**Figures 3-10b**, **d**, **f**, and **h**). Comparison between the shallow and deep aquifer system groundwater-elevation contour maps indicates that groundwater elevations in the deeper zone aquifers are approximately 10 to 40 feet lower than groundwater elevations in the shallow aquifer system in the Subbasin (**Figures 3-10b**, **d**, **f**, and **h**). Such vertical differences induce a downward flow from the shallow to the deeper aquifer. Comparing these recent measurements with the historical contour maps described previously suggest two groundwater pumping depressions in the southern and western portions of the Santa Rosa Plain have continued to exhibit recovery of groundwater levels.

It is important to note that groundwater elevations measured in nearby wells can be highly variable due to differences in well design (that is, the depth and length of well-screen intervals) and the spatial variations in aquifer materials (which can vary abruptly due to the complex geologic conditions and numerous fault zones present in the Subbasin). Therefore, the associated groundwater-level contour maps represent generalized groundwater flow patterns and should not be used to interpret more localized or site-specific conditions.

3.2.2.2 Groundwater-level Trends

Temporal changes in groundwater levels were evaluated for both long-term (wells with 10 or more years of data) trends and short-term (for example, seasonal) trends using data collected from the monitoring program. In general, longer-term trends were evaluated using data collected on a monthly to semiannual basis and short-term trends were evaluated using data collected on a more frequent basis (for example, monthly to hourly or less) using data from wells instrumented with pressure transducers.

Long-term Trends

Representative hydrographs for selected wells distributed throughout the Subbasin are shown on **Figures 3-11a** through **3-11d**. Additionally, hydrographs for all wells included in the groundwater-level monitoring program are provided in **Appendix 3-B**. These hydrographs present the change in groundwater elevation (vertical axis in feet) over time (horizontal axis in years).

As indicated on **Figures 3-11a** through **3-11d**, nearly all of the hydrographs indicate relatively stable groundwater-level conditions over time or increasing trends with the exception of wells within the southern portion of the Subbasin. A few hydrographs in the Cotati area show a decline in groundwater levels for the late 1970s and 1980s, which reached an historic low in the early 1990s, followed by recovery in the early 2000s (**Figure 3-11a**).

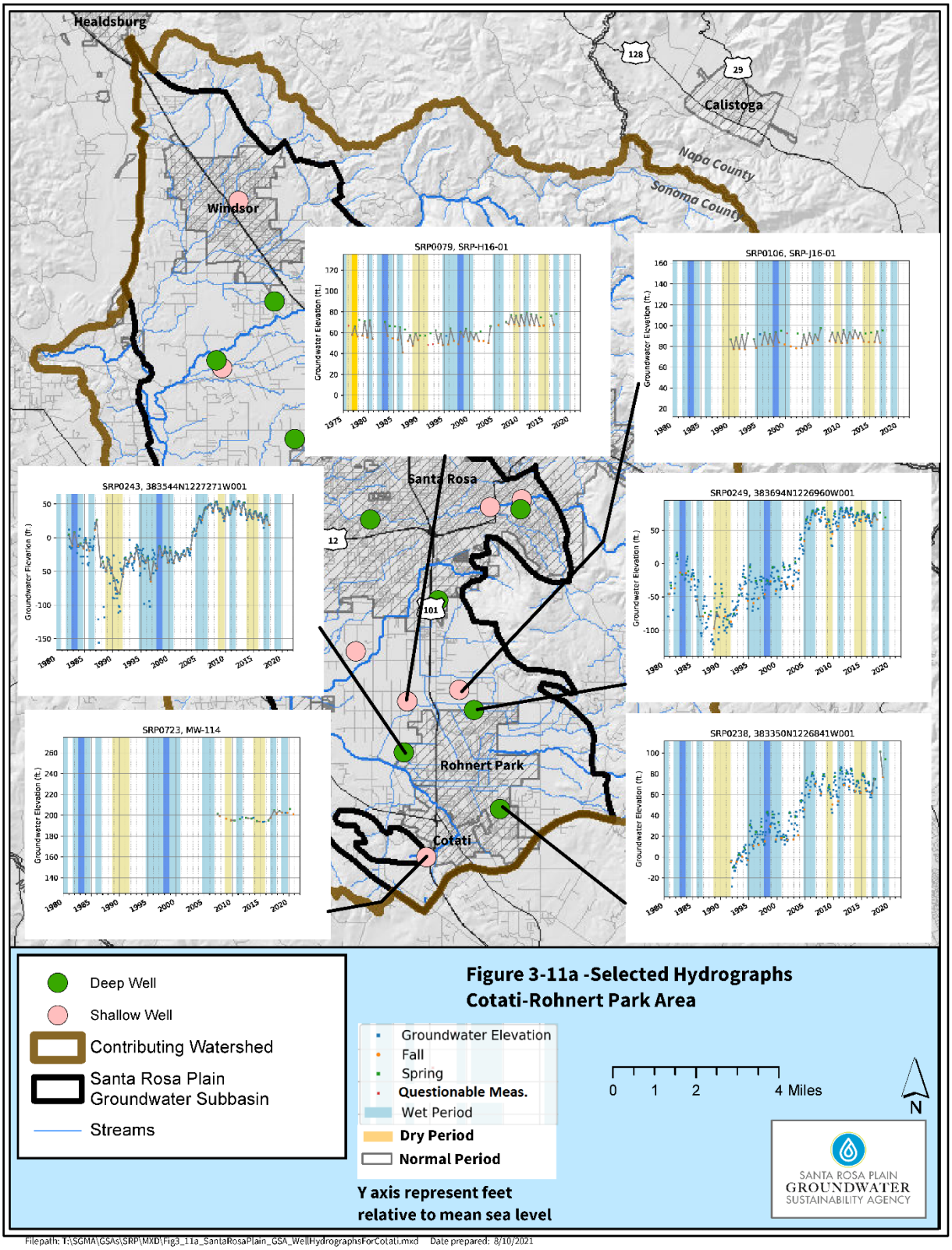


Figure 3-11a. Selected Hydrographs Cotati-Rohnert Park Area

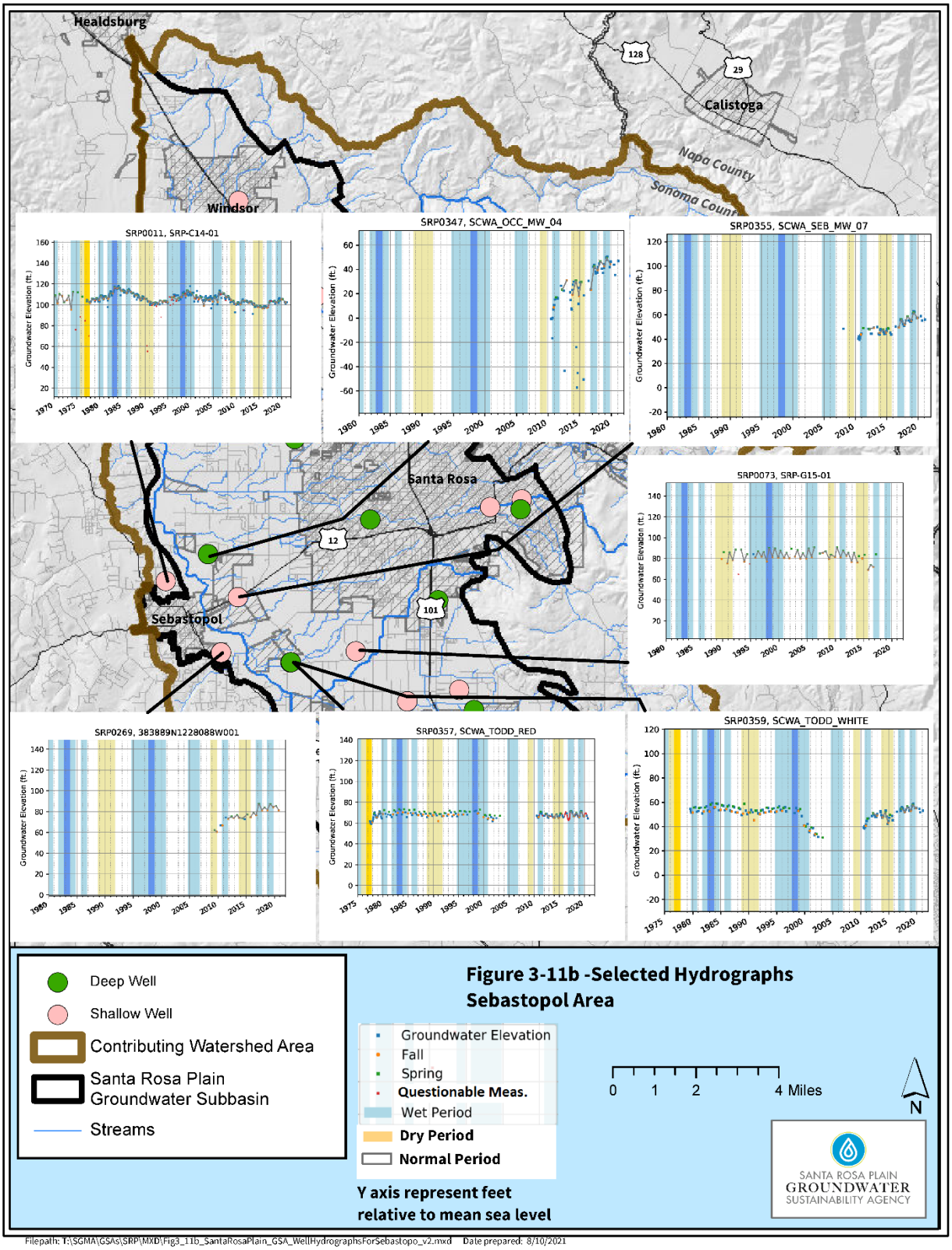


Figure 3-11b. Selected Hydrographs Sebastopol Area

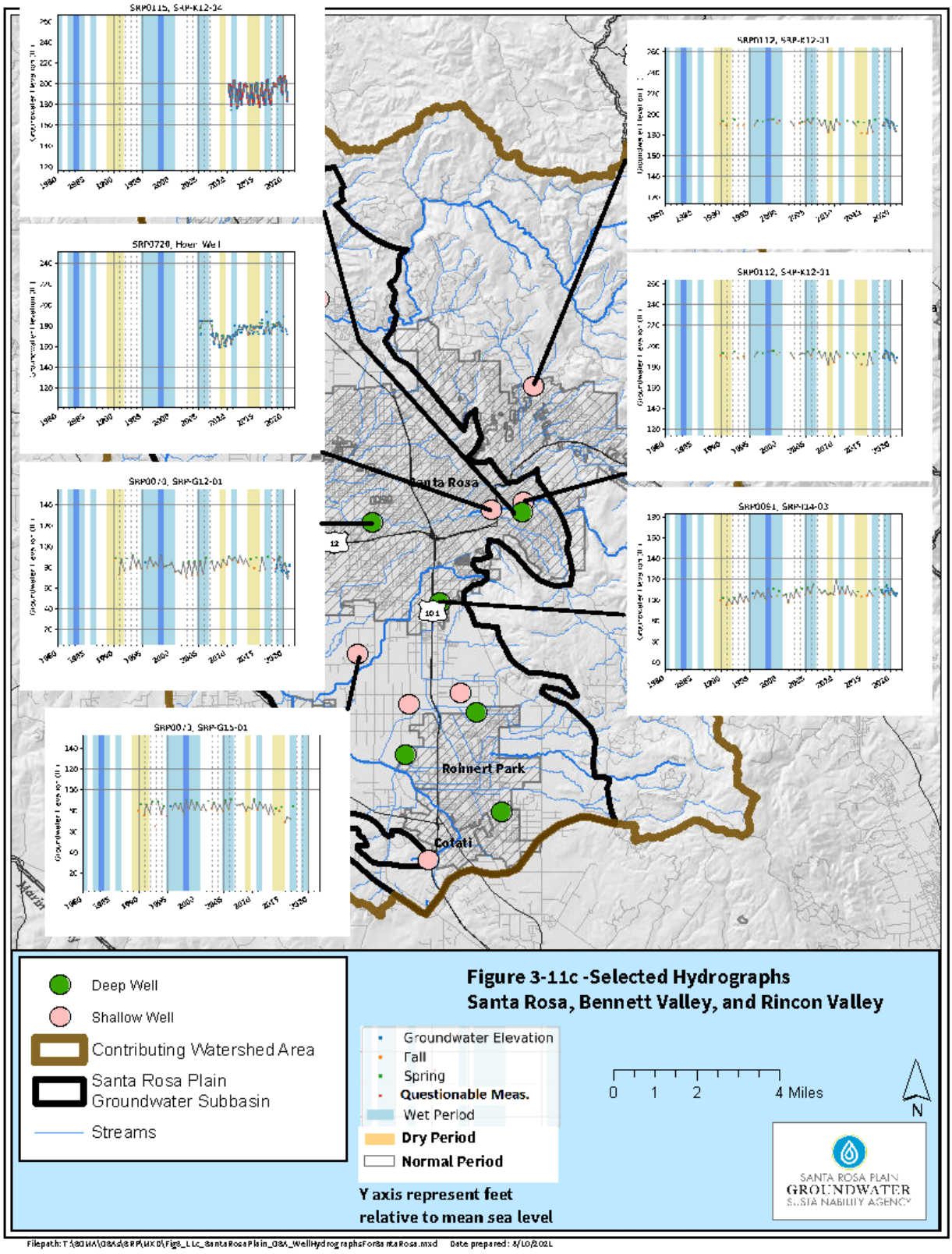


Figure 3-11c -Selected Hydrographs Santa Rosa, Bennett Valley, and Rincon Valley

Figure 3-11c. Selected Hydrographs Santa Rosa, Bennett Valley, and Rincon Valley

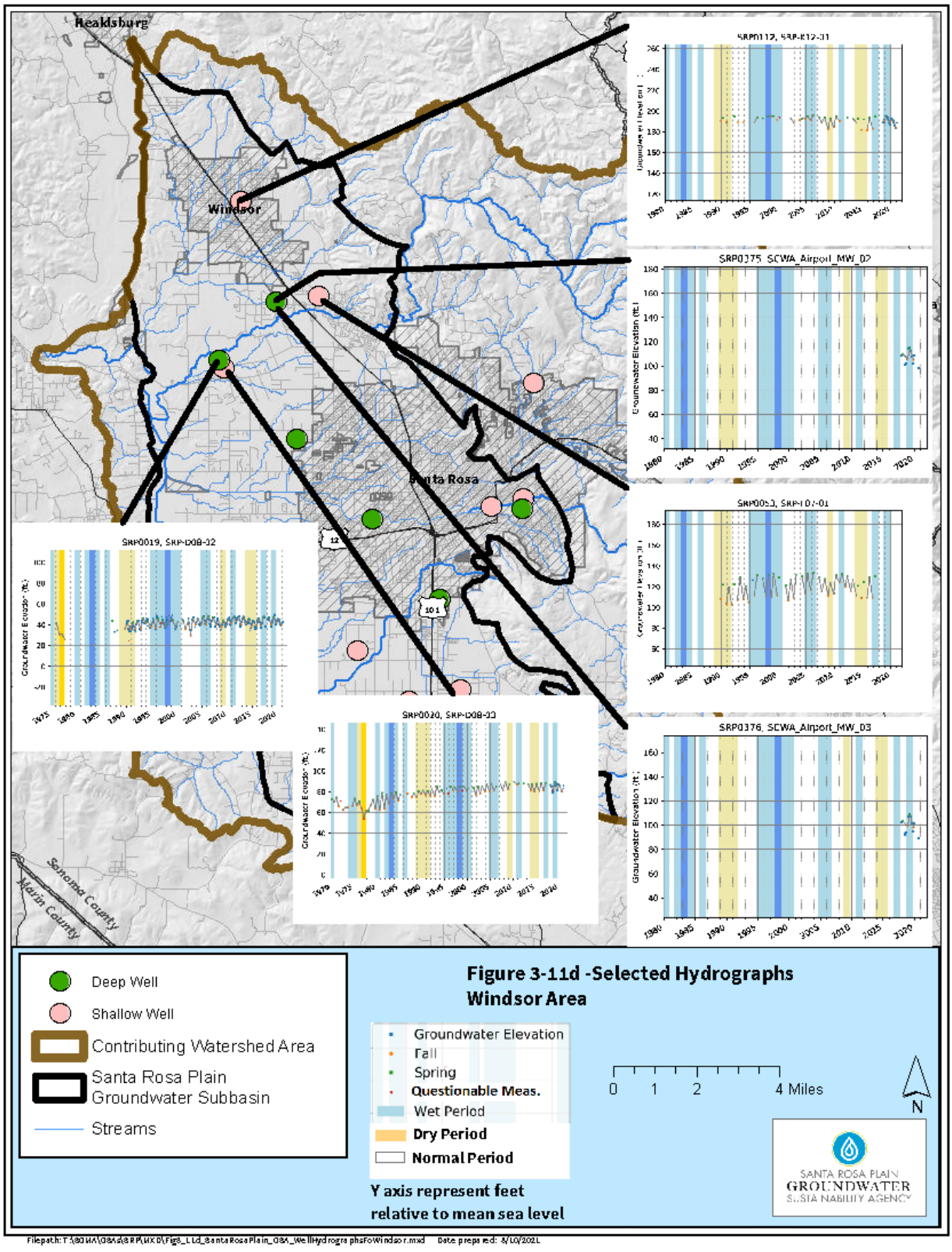


Figure 3-11d. Selected Hydrographs Windsor Area

As described previously the historical groundwater declines in this area are primarily associated with increases in municipal groundwater pumping related to population growth through the 1990s coupled with droughts in 1976-77 and 1987-92, and the recovered groundwater levels coincide with the aforementioned reduced pumping in this area since the early 2000s.

To further evaluate trends for wells that have a minimum of 10 years of recent groundwater-level data, 10-year trend lines (based on the span of available data between 2010 and 2020) were applied to spring groundwater levels on the hydrographs to depict overall trends for these time periods. The slope of the trend lines was computed using the method of ordinary least squares linear regression to estimate the change in groundwater level in feet per year (ft/yr). These computed groundwater-level changes are provided on **Figures 3-12a** and **3-12b** for the shallow and deep aquifer systems, respectively, to display the average groundwater-level change per year at all wells with data spanning the most recent 10 years.

As illustrated on **Figure 3-12a**, most of the shallow aquifer zone wells (31 of 37 wells) exhibit relatively stable groundwater-level trends (change of less than +/- 1 ft/yr) and six wells exhibit increasing trends with the majority of those wells located along the western Subbasin boundary.

Figure 3-12b shows that groundwater-level trend data are more limited in the deeper zone wells (a total of 24 wells are included in the trend analysis). Seven of the 24 wells exhibit relatively stable groundwater-level trends (change of less than +/- 1 ft/yr) and 15 wells located in the southern portions of the Subbasin and along the western boundary exhibit increasing trends with several exhibiting increases of more than 3 ft/yr. The only wells exhibiting decreasing trends are located east and outside of the Subbasin within the contributing watershed area.

Seasonal and Short-term Trends

A number of production and monitoring wells within the Subbasin have been outfitted with pressure transducer dataloggers to assess short-term groundwater-level trends. These include monitoring wells in the vicinity of Sonoma Water production wells along the western edge of the Subbasin, a series of shallow monitoring wells along Copeland Creek in the southeastern corner of the Subbasin, City of Santa Rosa production wells (active and inactive), test wells and monitoring wells located throughout and adjacent to the Subbasin, and several inactive City of Rohnert Park production wells (**Figure 3-13a**).

City of Rohnert Park Wells

Four City of Rohnert Park inactive deep aquifer system production wells (Wells 17, 24, 26, and 38) are currently monitored using pressure transducer dataloggers (**Figure 3-13b**). Prior to 2006, groundwater-level elevations measured in the Rohnert Park wells were significantly lower than they are today.

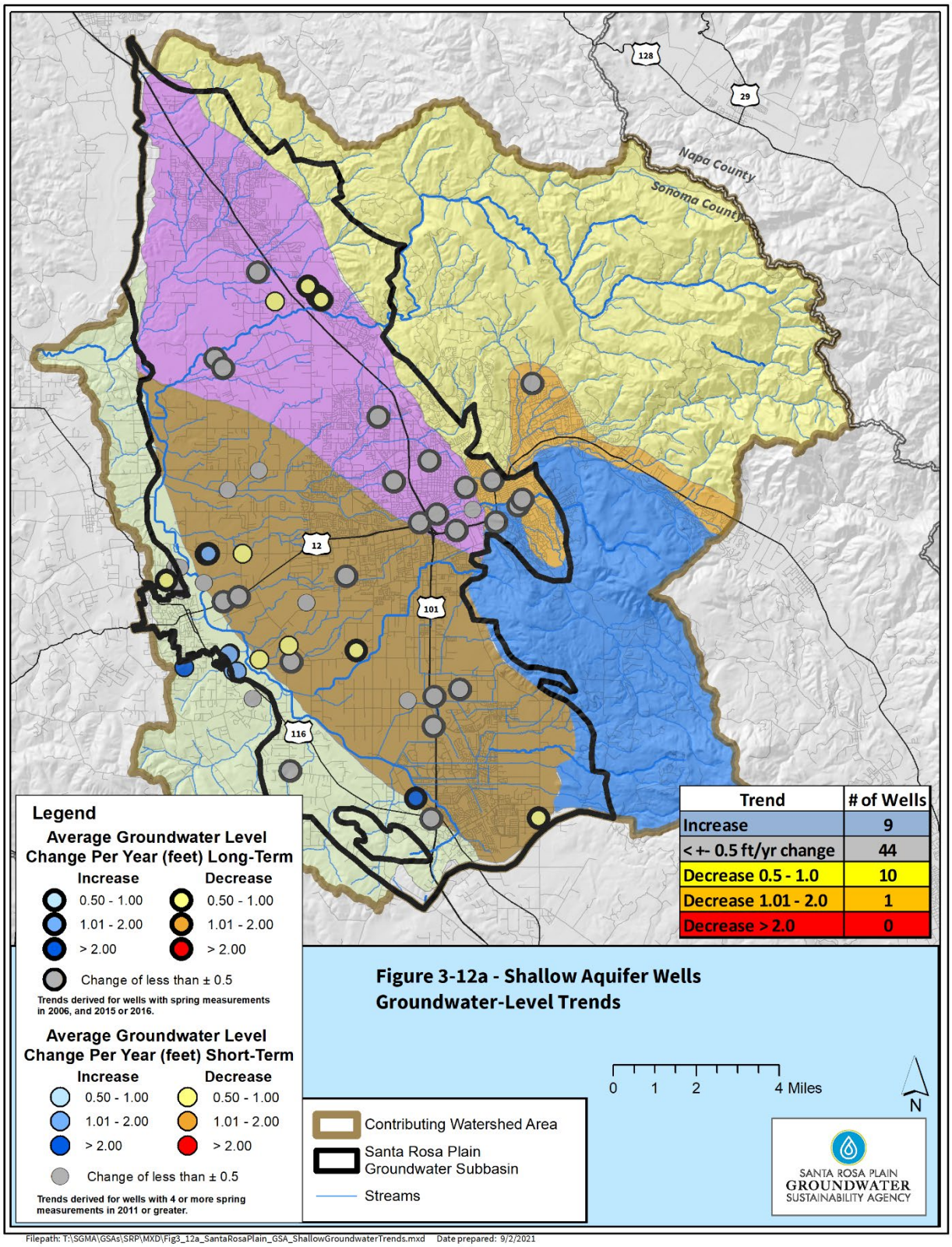


Figure 3-12a. Shallow Aquifer Wells Groundwater-level Trends

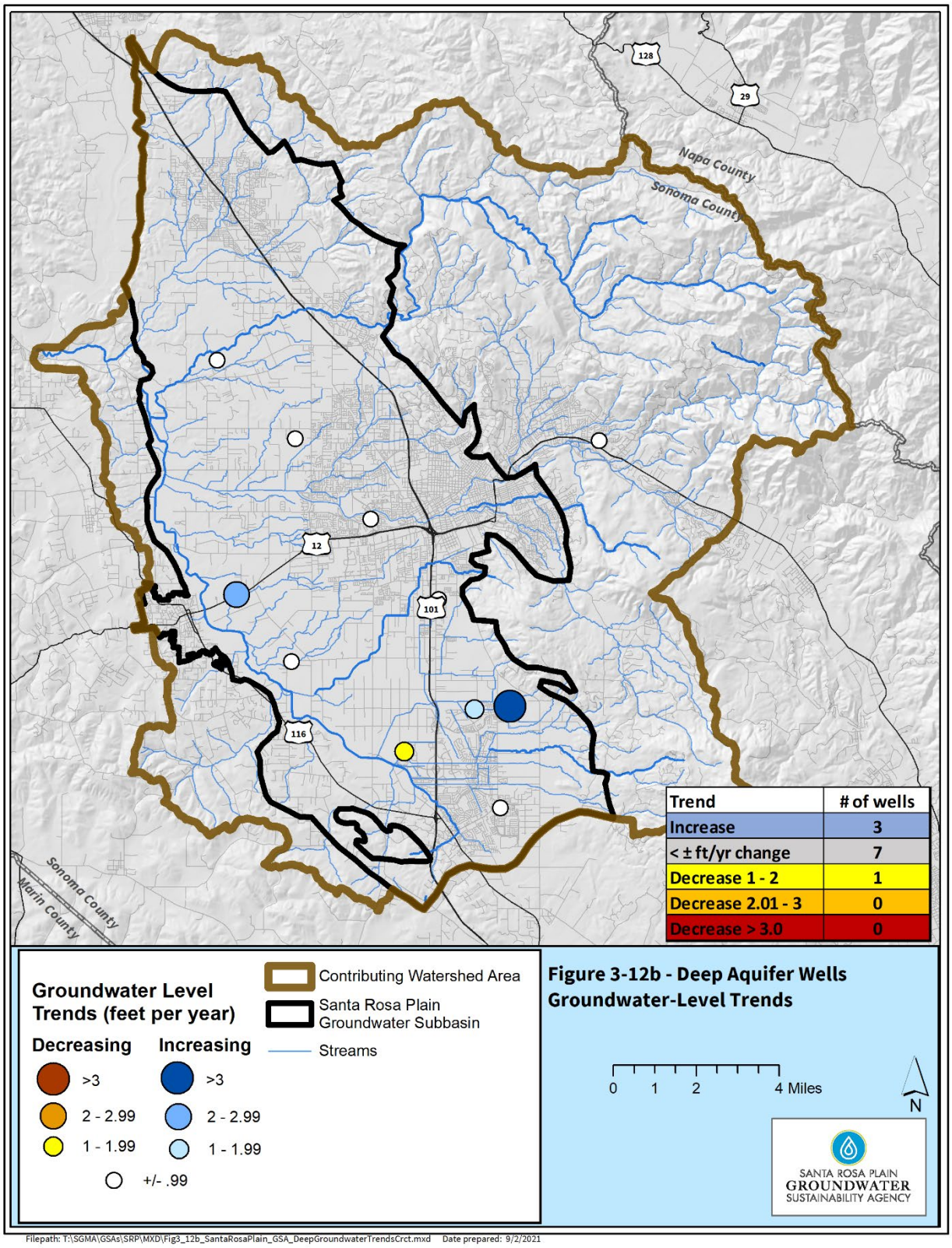


Figure 3-12b. Deep Aquifer Wells Groundwater-level Trends

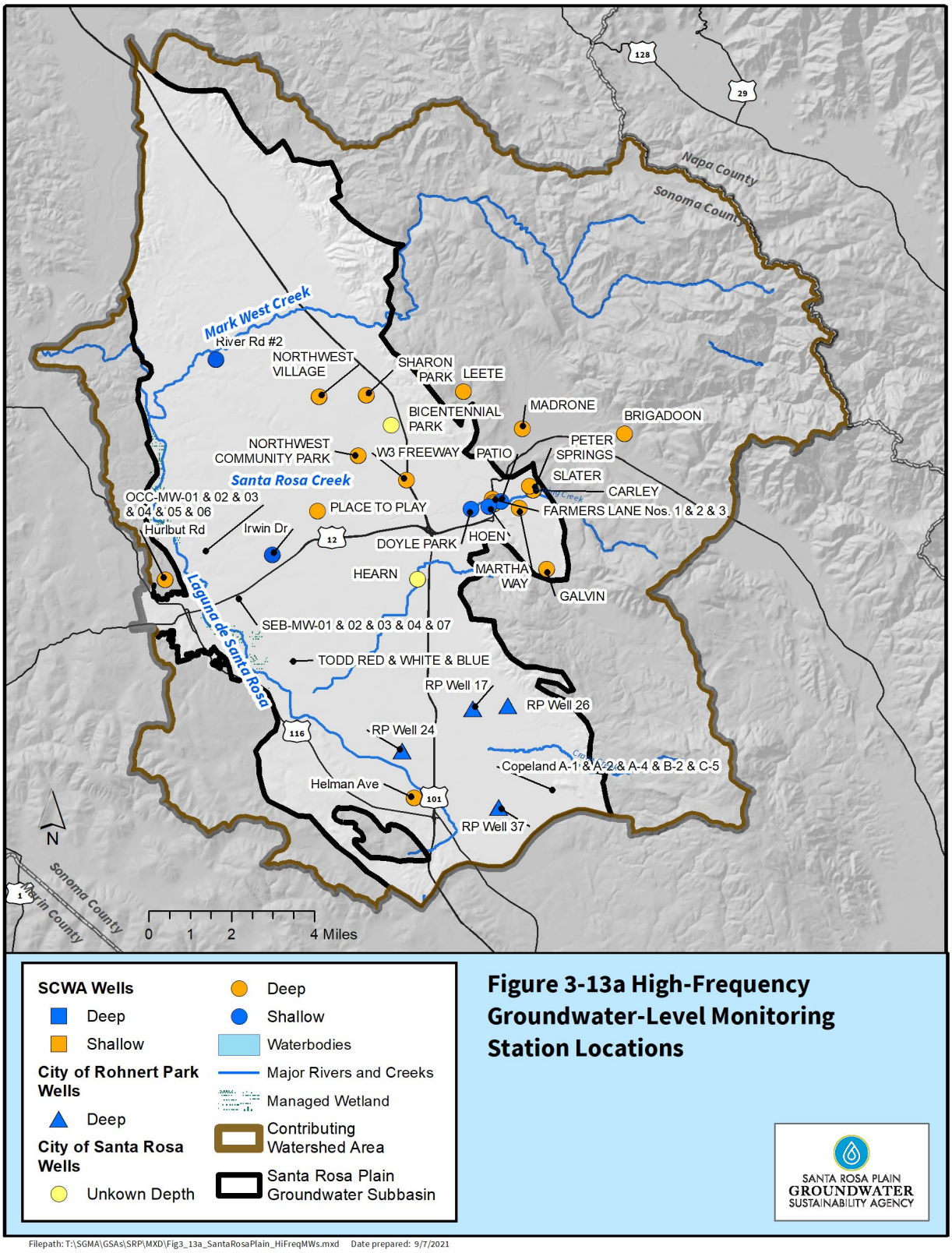


Figure 3-13a. High-frequency Groundwater-level Monitoring Station Locations

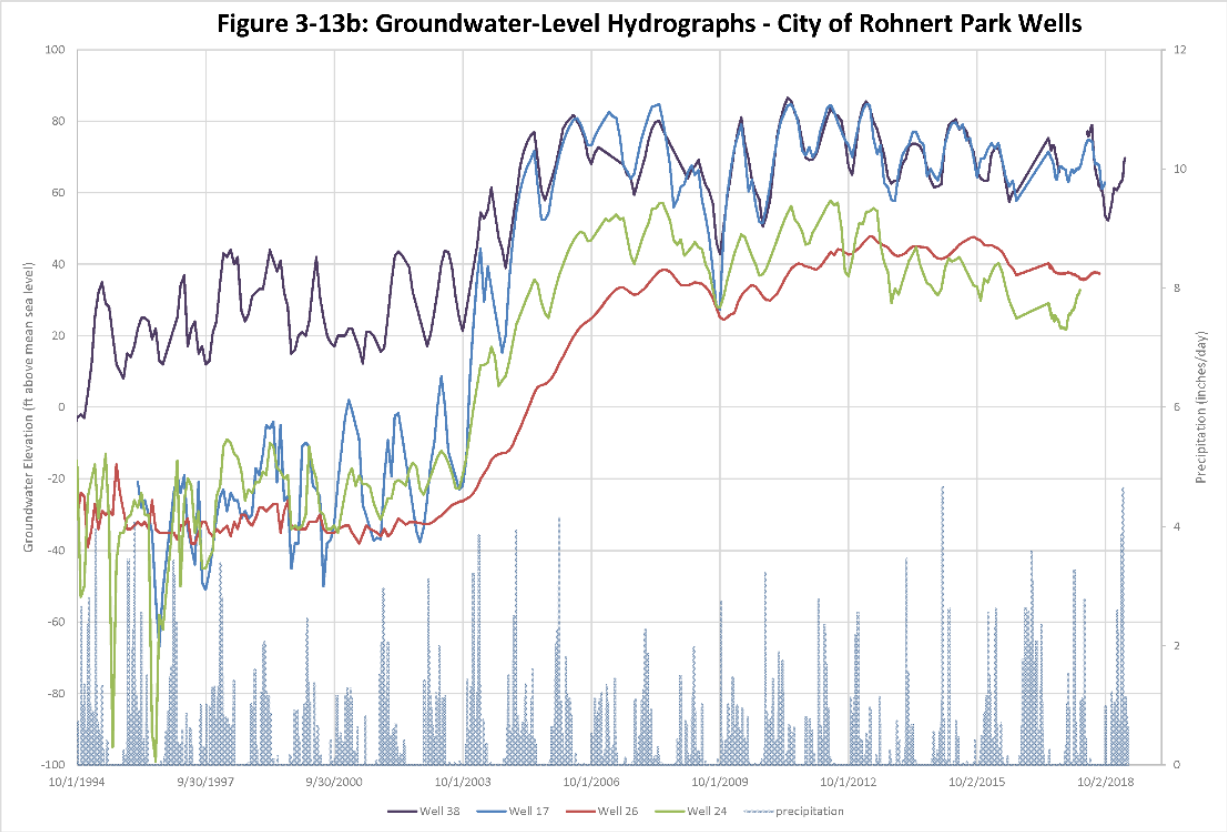


Figure 3-13b. Groundwater-level Hydrographs – City of Rohnert Park Wells

From 2006 to present, groundwater-level elevations have been relatively stable in the Rohnert Park wells, with exception of a decline of approximately 20 feet in Well 24 since approximately 2013. Since WY 2006, seasonal groundwater-level fluctuations range from approximately 5 to 30 feet and are most pronounced in Wells 17 and 38, and least pronounced in Well 26. Seasonal high groundwater levels are typically observed in March to June and seasonal low groundwater levels are typically observed in September to November in these wells.

City of Santa Rosa Wells

The City of Santa Rosa has monitored 23 high-frequency groundwater-level monitoring points with the frequency of water-level data collection ranging from monthly to once every 6 hours. This network includes the following:

- Six active or emergency/standby municipal production wells (five of these are completed within the deep aquifer system and one is completed within the shallow aquifer system)
- Five shallow aquifer system private wells monitored by the city
- Twelve deep aquifer system test wells and inactive former production wells that have been converted to monitoring wells (for data presentation and discussion purposes these deep

aquifer system wells are grouped into wells between 200 and 500 feet deep and wells that are deeper than 500 feet)

Groundwater-level hydrographs for the six active or emergency/standby municipal production wells (Farmers Lane No. 1, Farmers Lane No. 2, Farmers Lane No. 3, Leete Well, Carley Well, and Peter Springs Well) are shown on **Figure 3-13c**. All of these wells are more than 200 feet deep with the exception of the Peter Springs Well, which is 160 feet deep. Farmers Lane No. 1 and Farmers Lane No. 2 are both more than 1,000 feet deep. As shown on **Figure 3-13a**, these wells are all located along the eastern edge of the Subbasin (east of the Rodgers Creek Fault Zone), with the Leete Well located outside of the Subbasin, but within the contributing watershed area. In general, nonpumping groundwater levels are very stable in these wells with artesian conditions present in the Farmers Lane No. 1, Farmers Lane No. 2, and Leete wells. Seasonal groundwater-level fluctuations range from approximately 20 to 30 feet in the Farmers Lane No. 3, Carley, and Peter Springs Wells. Drawdown related to seasonal pumping of Farmers Lane Nos. 1 and 2 are also evident in the hydrographs for those two wells, in addition to the nearby Farmers Lane No. 3.

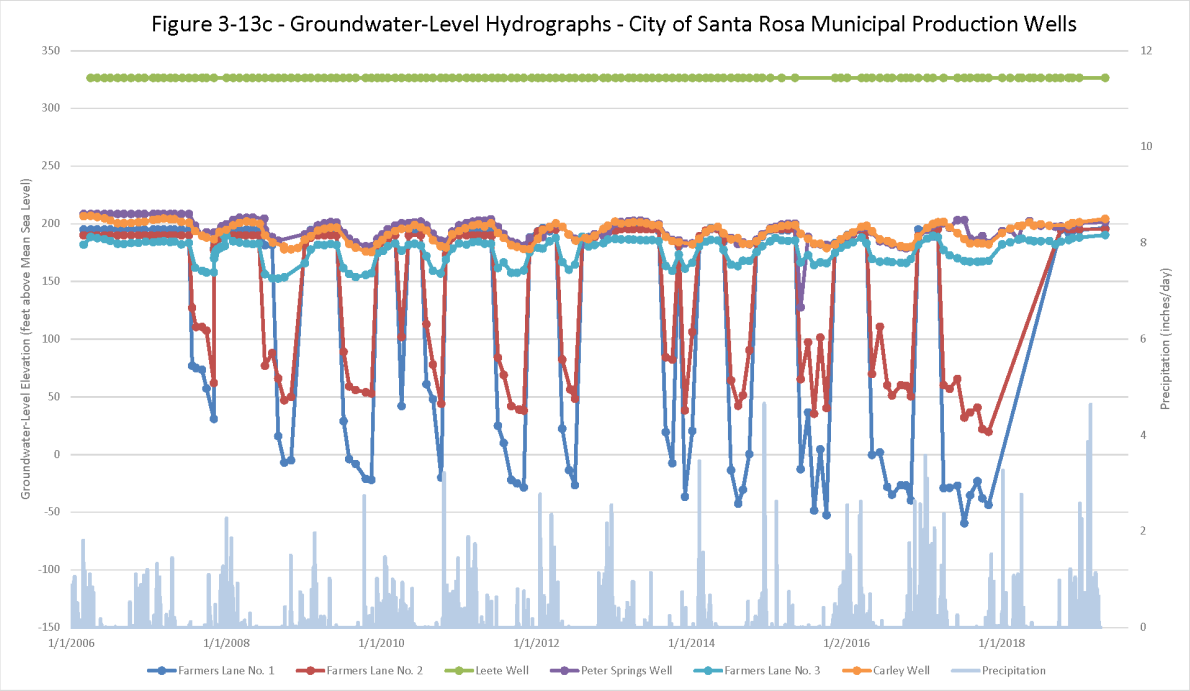


Figure 3-13c. Groundwater-level Hydrographs – City of Santa Rosa Municipal Production Wells

Groundwater-level hydrographs for five City of Santa Rosa shallow aquifer system (total depths ranging from 82 to 200 feet) high-frequency groundwater-level monitoring points are shown on **Figure 3-13d**. The locations of these wells are shown on **Figure 3-13a**. The Patio, Doyle, and Hoen Wells are all in the vicinity of the Farmers Lane production wells on the eastern edge of the Subbasin. These wells exhibit seasonal groundwater-level fluctuations ranging from approximately 5 to 25 feet, which are most pronounced in the Patio Well and least pronounced

in the Doyle Well. Two of the wells (Helman Avenue Well and Hurlbut Road Well), which have subsequently been discontinued from monitoring, are located outside of the City of Santa Rosa (**Figure 3-13a**). Groundwater-level data from these wells do not exhibit pronounced seasonal fluctuations or responses to precipitation events. Occasional short-term declines, likely associated with local groundwater pumping, followed by subsequent recovery to relatively stable conditions are observed in both of these wells.

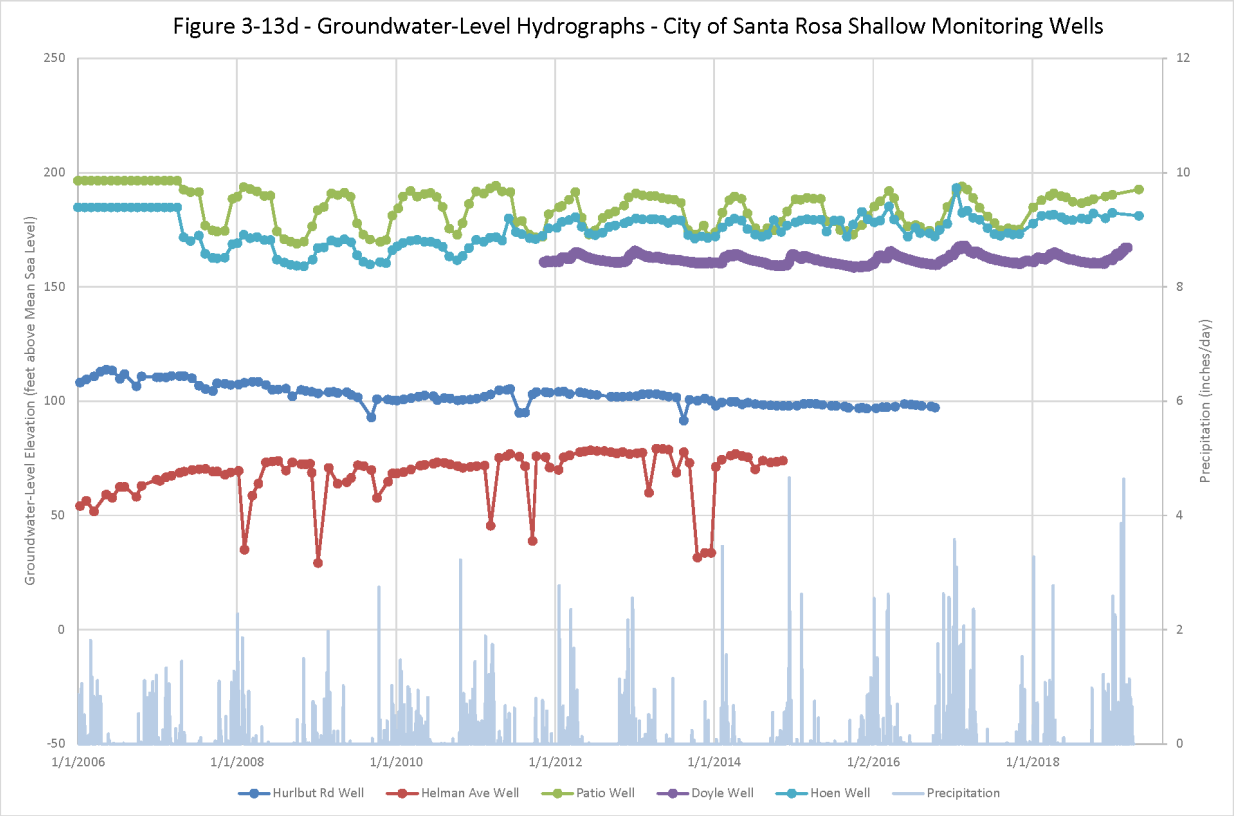


Figure 3-13d. Groundwater-level Hydrographs – City of Santa Rosa Shallow Monitoring Wells

Groundwater-level hydrographs for six City of Santa Rosa deep aquifer system (between 200 and 500 feet deep) high-frequency groundwater-level monitoring points are shown on **Figure 3-13e**. The locations of these wells are shown on **Figure 3-13a**. The Northwest Village and Sharon Park test wells exhibit similar hydrographs with stable groundwater-level elevations and seasonal fluctuations of approximately 10 feet. The Madrone and Brigadoon test wells are located outside of the Subbasin and within the contributing watershed area, in eastern Santa Rosa and exhibit similar hydrographs with seasonal groundwater-level fluctuations ranging from approximately 5 to 20 feet. The Galvin test well exhibits larger seasonal groundwater-level fluctuations up to approximately 50 feet. The Irwin Drive well exhibits seasonal groundwater-level declines, possibly related to local groundwater pumping, of up to 45 feet. The overall groundwater-level elevation trends for all of these wells during their respective observation periods appear to be very stable or increasing.

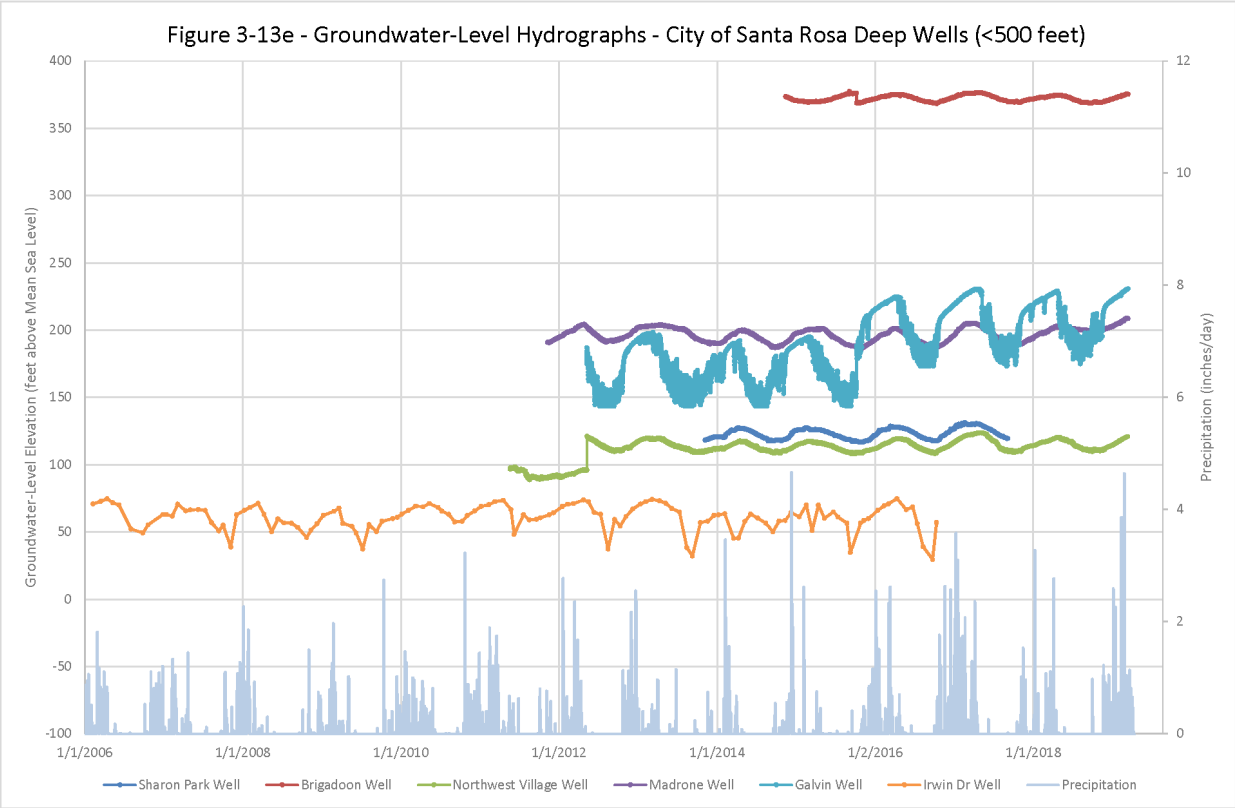


Figure 3-13e. Groundwater-level Hydrographs – City of Santa Rosa Deep Wells (<500 feet)

Groundwater-level hydrographs for six City of Santa Rosa deep aquifer system (greater than 500 feet deep) high-frequency groundwater-level monitoring points are shown on **Figure 3-13f**. The locations of these wells are shown on **Figure 3-13a**. The hydrographs for the Slater and Martha Way wells are nearly identical and depict seasonal groundwater-level fluctuations of approximately 20 to 25 feet. Seasonal groundwater-level fluctuations in the Freeway, Northwest Community Park, and Place 2 Play wells range from approximately 5 to 15 feet, and are most pronounced in the Freeway and Northwest Community Park wells and least pronounced in the Place 2 Play well. The hydrographs for these wells illustrate how seasonal fluctuations in the deep aquifer system are likely less pronounced and occur later (seasonal high groundwater levels are typically observed in April in the Freeway Well and in May in the Place 2 Play Well) toward the center of the Subbasin versus toward the eastern edge. The groundwater-level hydrograph for the River Road No. 2 well exhibits seasonal fluctuations ranging from approximately 5 to 10 feet with seasonal high elevations typically observed in April to June and seasonal low elevations typically observed in August to September. The overall groundwater-level elevation trends for all of these wells during their respective observation periods appear to be very stable.

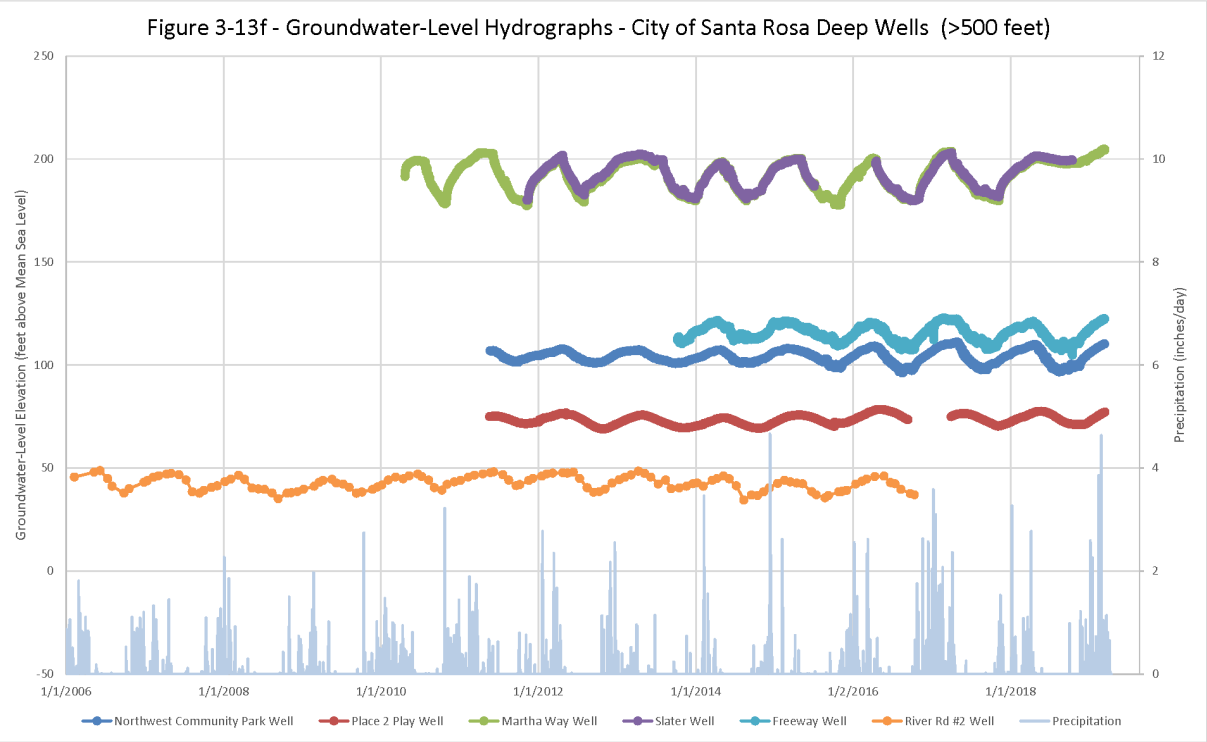


Figure 3-13f. Groundwater-level Hydrographs – City of Santa Rosa Deep Wells (>500 feet)

Sonoma Water Monitoring Wells

Sonoma Water conducts a high-frequency groundwater-level monitoring program in 14 dedicated monitoring wells in the vicinity of its Occidental Road, Todd Road, and Sebastopol water-supply wells (**Figure 3-13a**). Groundwater-level hydrographs for shallow and deep aquifer system monitoring wells in the vicinity of the Sonoma Water's supply wells are presented on **Figures 3-13g** and **3-13h**, respectively. In general, the data collected as part of the Sonoma Water's groundwater-level monitoring program indicate the following:

- Seasonal fluctuations in groundwater levels in the shallow aquifer wells on the order of 5 to 15 feet
- No discernable short-term responses to pumping cycles within shallower monitoring wells
- General stability of shallow zone groundwater levels, with the exception of shallow zone monitoring wells (OCC-MW-2, OCC-MW-3, and OCC-MW-5) located near the Occidental Road supply well, which exhibited declines ranging between 15 to 30 feet between approximately 2000 and 2009 followed by subsequent recovery or stabilization of groundwater levels from 2009 to present (**Figure 3-13g**)
- Rapid drawdown and recovery in response to pumping cycles within the deep aquifer monitoring wells perforated across the same horizon as the groundwater- supply wells (**Figure 3-13h**)

- An overall trend of lowering of deeper zone groundwater levels between approximately 2000 and 2009 when the groundwater-supply wells were operating relatively continuously, followed by subsequent recovery of groundwater levels from 2009 to present

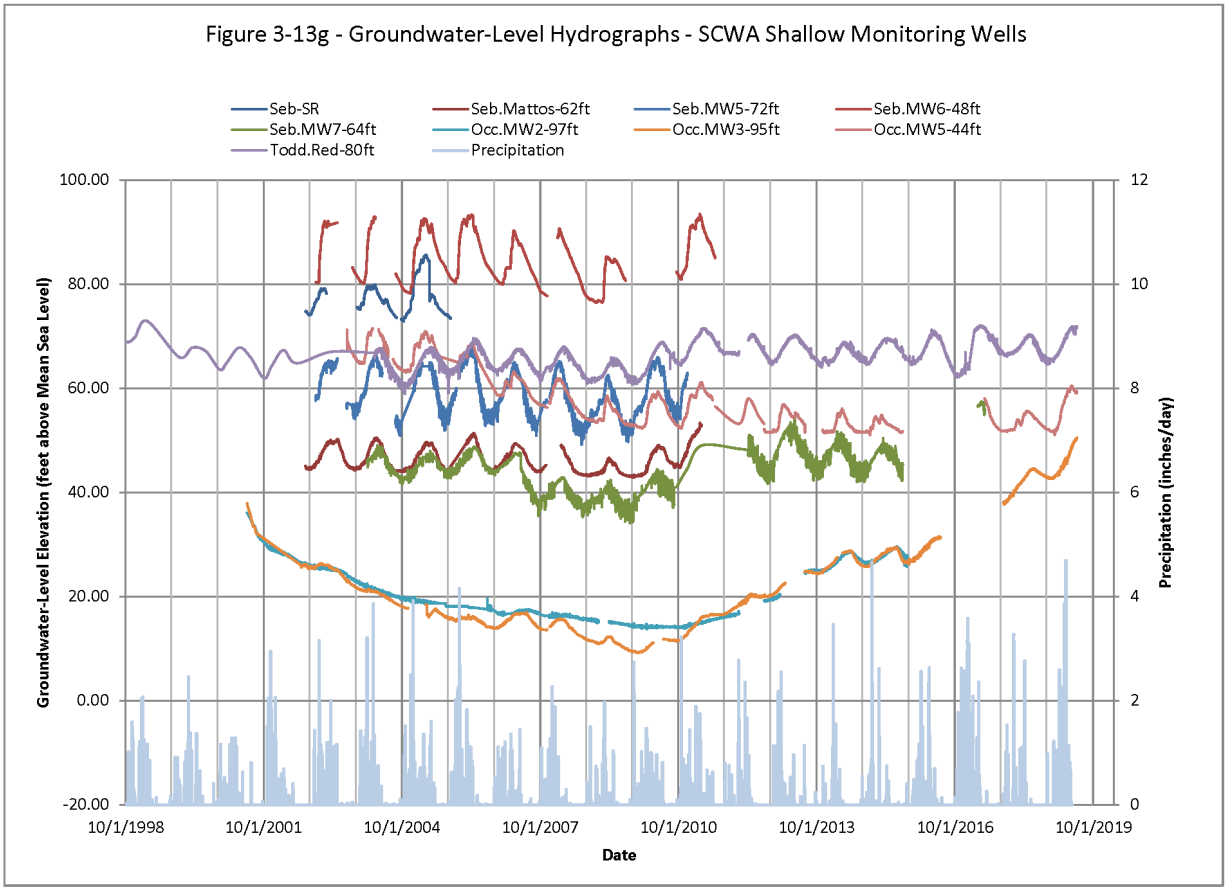


Figure 3-13g. Groundwater-level Hydrographs – SCWA Shallow Monitoring Wells

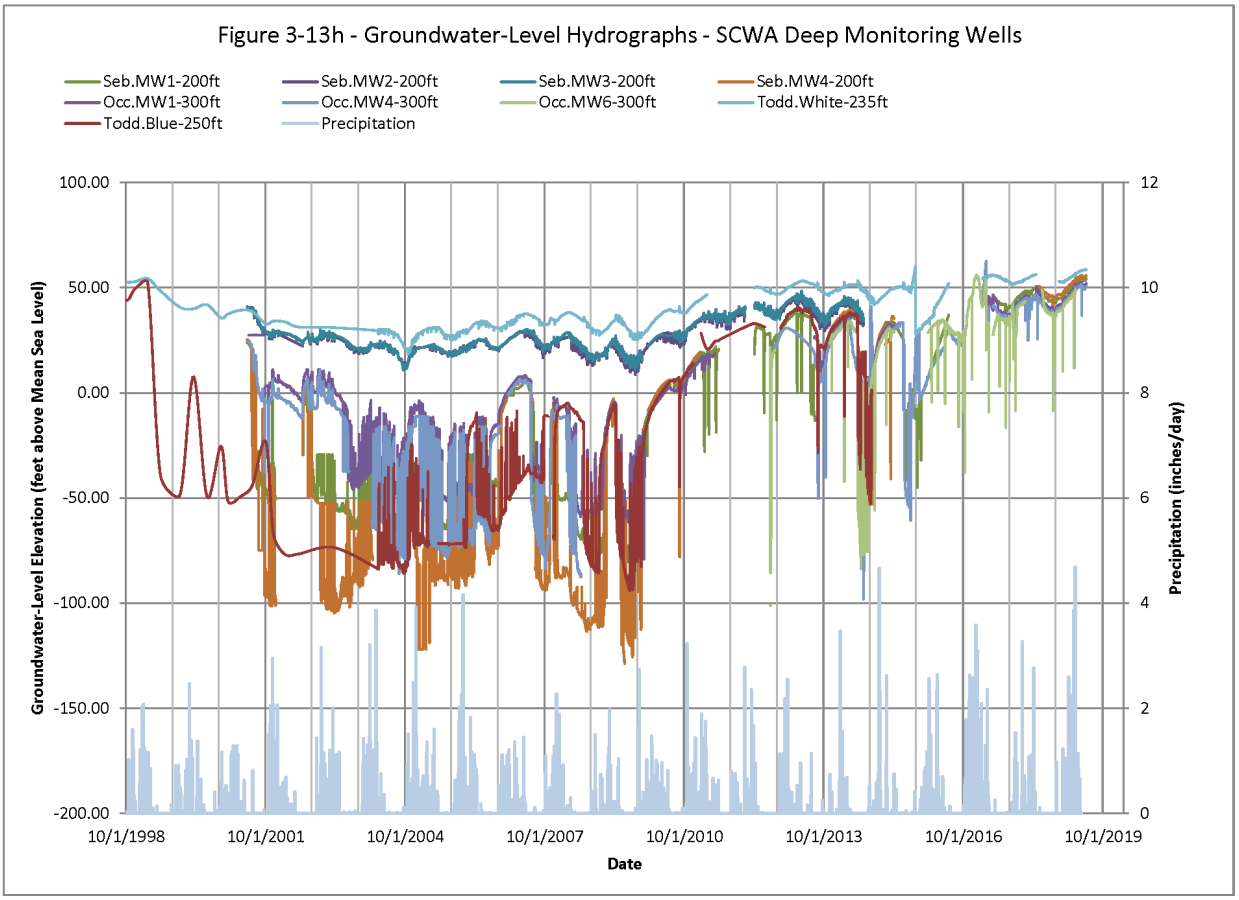


Figure 3-13h. Groundwater-level Hydrographs – SCWA Deep Monitoring Wells

Copeland Creek Monitoring Wells

Sonoma Water conducts a high-frequency groundwater-level monitoring program in a series of shallow monitoring wells in the vicinity of Copeland Creek, in the southeast corner of the Subbasin (**Figure 3-13a**). Groundwater-level hydrographs for select monitoring wells in this area are shown on **Figure 3-13i**. Monitoring wells A-1, A-2, A-4, B-2, and C-5 range in total depth from 24 to 35 feet. Data collected from these wells from 2014 to present indicate the following:

- Seasonal fluctuations in the Copeland Creek shallow monitoring wells range from approximately 10 to 25 feet.
- Groundwater levels in the monitoring wells respond rapidly to precipitation events.
- Timing of seasonal high and seasonal low groundwater levels is highly variable with seasonal high levels observed from December to April, and seasonal low levels observed from August to December.

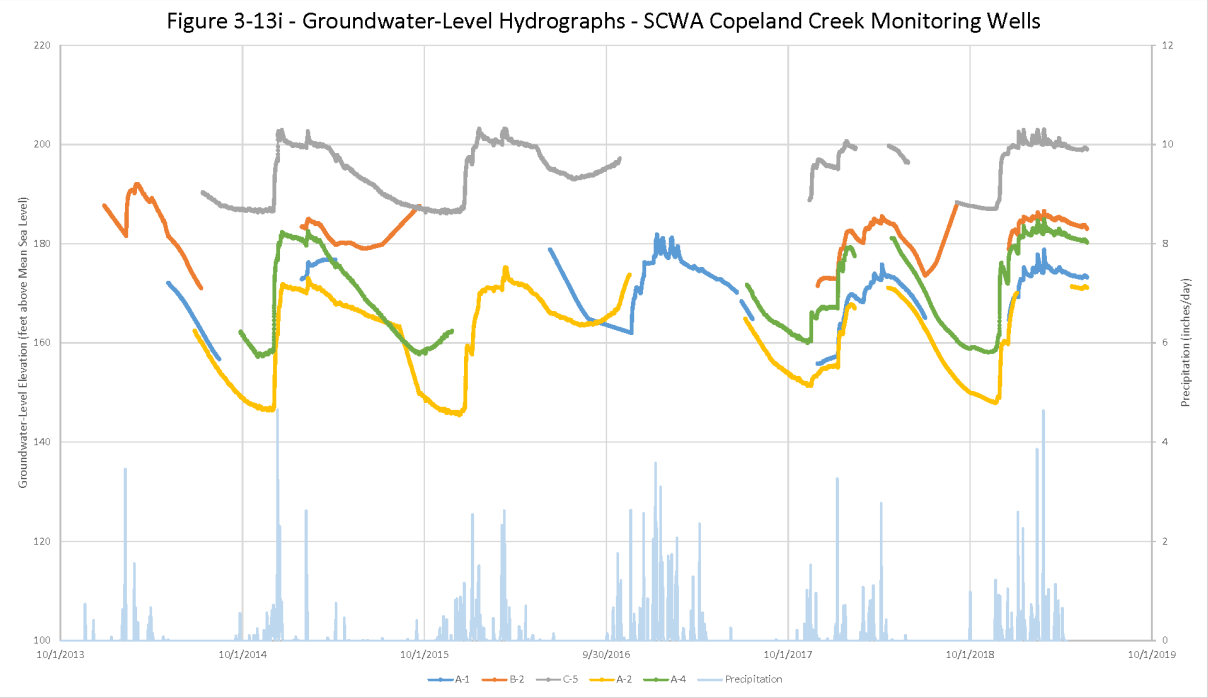


Figure 3-13i. Groundwater-level Hydrographs – SCWA Copeland Creek Monitoring Wells

3.2.3 Estimated Changes in Groundwater Storage

The change in groundwater estimated to be stored in the basin is equal to the total inflow into the Subbasin minus the total outflow. A negative change in groundwater storage indicates groundwater-storage depletion while a positive value indicates groundwater-storage accretion. The groundwater budget finds that storage declined during the historical (1976-2018) and current (2012-2018) budget periods, with a larger magnitude negative change in groundwater storage during the current period, which includes the recent drought. **Table 3-11** (**Section 3.3.3.2**) shows on average, that groundwater storage in the historical period declined by 600 AFY, while it declined by 2,100 AFY in the current period. The average annual results indicate that about 3 percent of pumpage in the basin is supplied by groundwater-storage depletion.

The increased rate of groundwater-storage depletion during the recent period appears to be more a result of a drier climate than increased groundwater pumping during that period. **Section 3.3.3.2** shows groundwater pumpage by water-use sector, along with the 5-year moving average of pumpage for the historical period. The peak of the 5-year moving average of the current period (21,000 AFY) is exceeded during 5 years in the 2000 to 2011 period, indicating that total groundwater pumpage for the current period is not greater than the previous 12-year period.

3.2.4 Land-surface Subsidence

Changes in land-surface elevation may be caused by tectonic processes, hydrologic isostatic-loading, increases in effective stress caused by excessive groundwater pumping, and other

processes. In locations where multiple processes impact land-surface elevations, it may be difficult to determine the cause of changes. The North Bay region is located in the tectonically active Pacific margin, characterized by numerous active faults and geologically recent volcanic activity. In addition to the effects of tectonics, water stored on earth's surface and subsurface exerts a downward pull on the earth's crust. Increases in stored water increase this downward force, whereas declines in storage release this downward force. This hydrologic isostatic-loading is important in California, occurs in 100- to 1,000-kilometer (km) scales, and explains much of the land surface changes in areas without significant groundwater pumping or tectonic processes (Borsa et al. 2014). In areas of intensive water use, groundwater pumping can cause subsidence by reducing hydrostatic pressure. When water is removed, hydrostatic pressure decreases, which in turn increases the weight that the skeletal structure of the aquifer must support (effective stress). Aquifer materials rich in clays may collapse under this weight thus causing a lowering of the ground surface and a potentially unrecoverable loss in aquifer storage.

Existing data related to the potential for land subsidence in the Santa Rosa Plain is limited to GPS data collected as part of a plate boundary study and a focused study of the Rodgers Creek Fault zone. GPS data are being collected as part of a PBO network to monitor tectonic earth movements in North America. The project is led and managed by University Navigation Signal Timing and Ranging Global Positioning System Consortium, a university-governed consortium. PBO's network of 1,100 permanent continually operating GPS stations spans the Pacific/North American plate boundary in the western United States and Alaska, with additional stations on the stable continental interior. One PBO GPS station is located within the Santa Rosa Plain Subbasin (**Figure 3-14a**). This station (SRP0496; P197) has been actively monitored since 2006 and results are shown on **Figure 3-14b**.

From late 2005 to 2019 the GPS station in the Santa Rosa Plain has shown a total vertical change of +0.1 inch (**Figure 3-14b**). From 2015 to 2019 the total vertical change for the station is 0.01 inch, with annual changes of +0.003 inch. The positive ground height changes observed in Santa Rosa stand in contrast to other nearby stations. The other stations in Bodega Bay, Marin, Napa, and in the Russian River areas exhibit long-term declines in ground height. Regional interannual variation in hydrologic isostatic-loading is likely the best explanation for the observed regional trends. As described in **Section 3.2.2**, reductions in municipal groundwater pumping beginning in 2002 have resulted in significant recovery of groundwater levels in the Rohnert Park-Cotati area and is likely the cause of the rebound in ground-heights observed in SRP0496 GPS data.

Two focused studies conducted to assess the Rodgers Creek Fault for evidence of creep have revealed potential evidence of land-surface subsidence and subsequent uplift in the southern portions of the Subbasin related to groundwater pumping patterns (Funning et al. 2007; Jin and Funning 2017). The studies used Permanent Scattering Interferometric Synthetic Aperture Radar (PS-InSAR) technique from satellite data from 1992 to 2001 and from 2003 to 2010 to analyze the area for land-surface deformation related to fault movements (**Figures 3-14c** and **3-13d**, respectively).

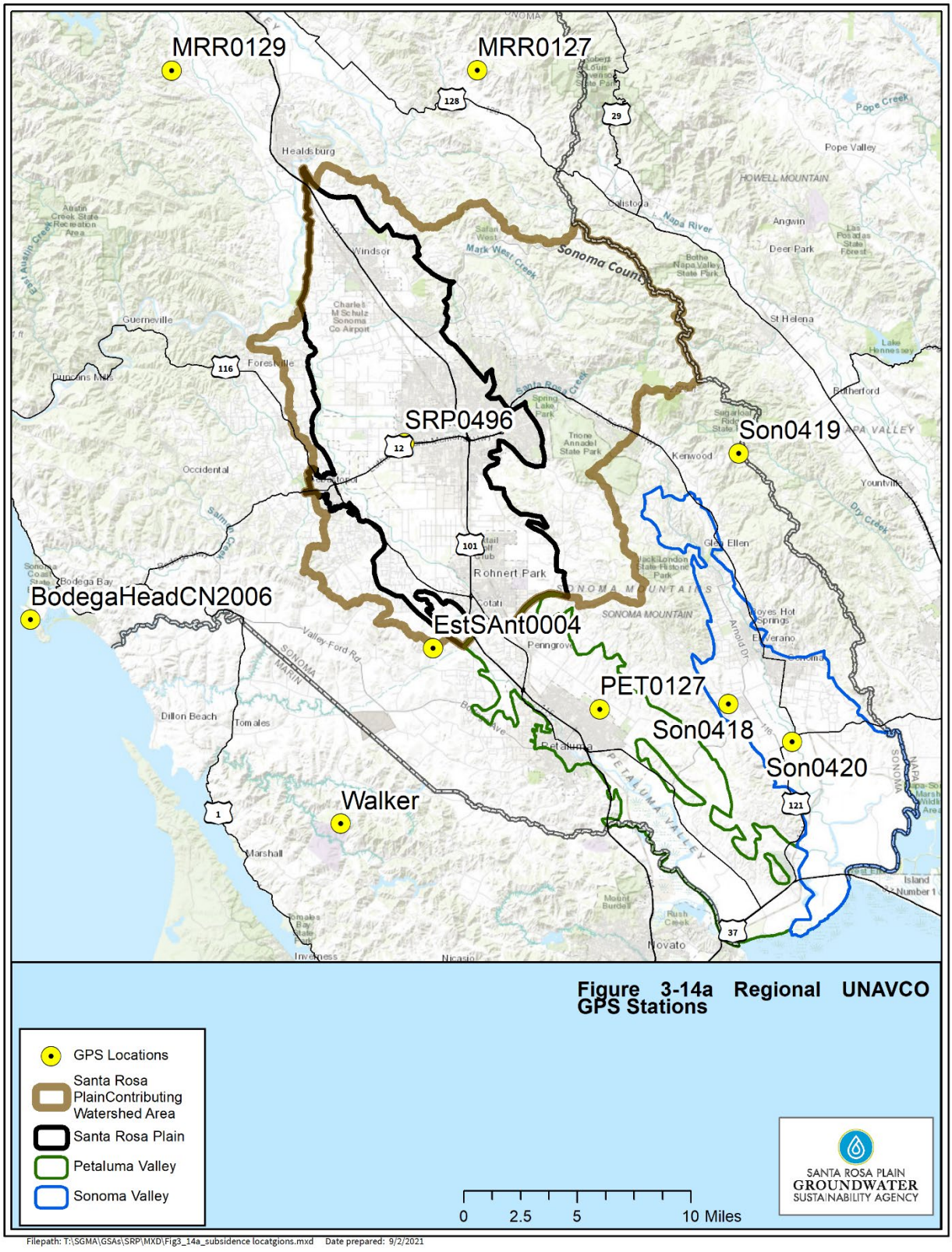


Figure 3-14a. Regional UNAVCO GPS Stations

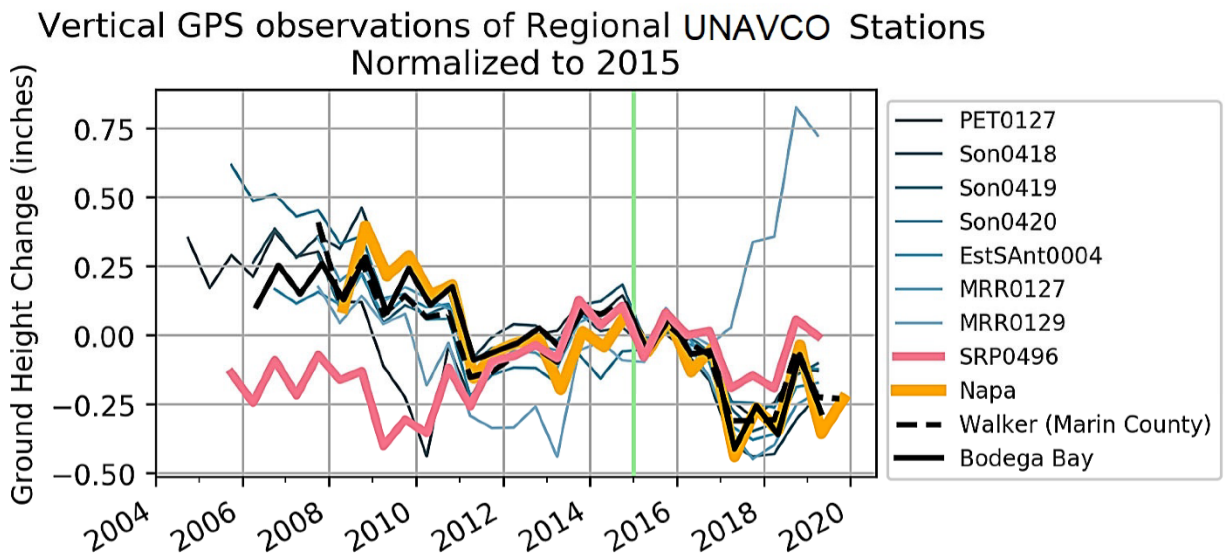


Figure 3.14b. Vertical GPS Observations of Regional UNAVCO Stations Normalized to 2015

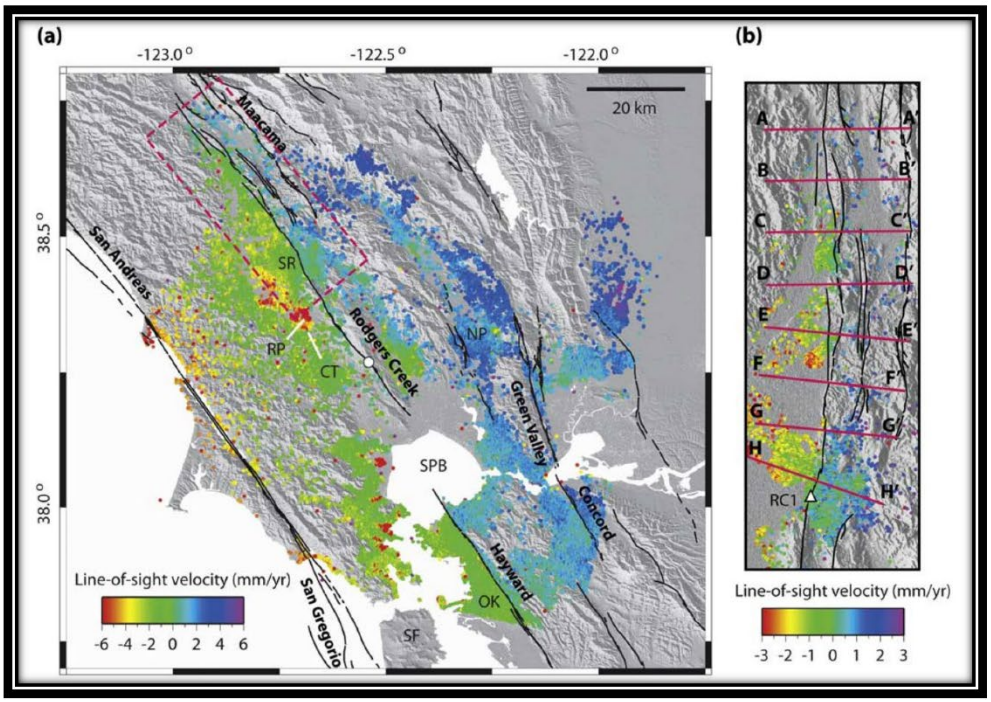


Figure 3-14c. PS-InSAR Data Interpretation for 1992-2001

While not specifically designed to investigate potential land-surface subsidence due to groundwater pumping, the fault studies identified an area in the southern portions of the Subbasin where the land surface subsided and subsequently rebounded coinciding with an area of groundwater-level declines and subsequent recovery. As shown on **Figure 3-14c**, during the 1992 to 2001 timeframe, land-surface elevations declined at a rate of about 6 millimeters

(0.2 inch) per year over the 10-year study period in the vicinity of Rohnert Park and Cotati (Funning et al. 2007). This timeframe coincides with the previously described period of increased municipal groundwater pumping and groundwater-level declines in the same area (**Figures 3-9b** and **3-11a**). During the subsequent study period of 2003 to 2010, the land-surface elevations in the same area exhibited an uplift (or rebound) of approximately 6 millimeters (0.2 inch) per year over the 8 years, as shown on **Figure 3-14d** (Jin and Funning 2017), coinciding with the period of reduced municipal groundwater pumping and increasing groundwater levels. The subsequent rebound of the land surface following the reduction in groundwater pumping and recovery of groundwater levels provides evidence that the relatively minor historical land-surface subsidence in this area represents elastic land-surface subsidence, which has not caused permanent (or inelastic) collapse of fine-grained units within the aquifer system.

Figure 3-14d

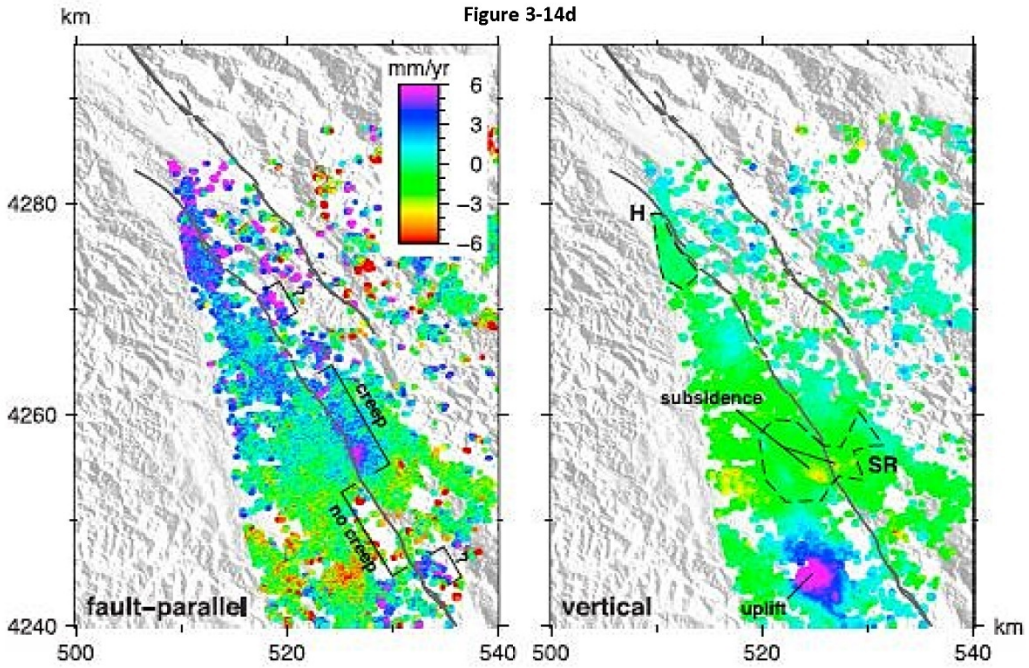


Figure 6. Map pattern of surface deformation velocities, decomposed into (left) fault-parallel and (right) vertical components. Fault-parallel velocities are horizontal velocities with an azimuth of 135°, i.e., positive fault-parallel velocities indicate movement to the southeast. An abrupt increase in velocity from west to east across the Rodgers Creek fault is consistent with right-lateral creep, such as a ~10 km zone extending northwest along strike from Santa Rosa, and also possibly in two other localized zones (indicated by question marks). In contrast, there is no evidence for creep immediately southeast of Santa Rosa. In the vertical deformation map, positive deformation rates indicate uplift; the most prominent feature is an uplift feature with an amplitude of 6 mm/yr in the southern part of the image, which we interpret as a recharging aquifer. We can also identify localized subsidence features across the area, such as a pair of subsiding areas either side of the Rodgers Creek fault in Santa Rosa. (Black dashed lines indicate locations of cities. SR: Santa Rosa, H: Healdsburg.)

Figure 3-14d. Map Pattern of Surface Deformation Velocities

Recent spatial variation of ground surface change (albeit with a lower level of vertical resolution) within the Subbasin is shown on **Figure 3-14e**. This dataset has been provided by DWR and represents changes from June 2015 to 2018 measured by InSAR. The maximum vertical changes are within the +0.25- to -0.25-foot range for the entire basin, with a majority of the basin within the 0.0- to -0.25-foot range over the 3-year period.

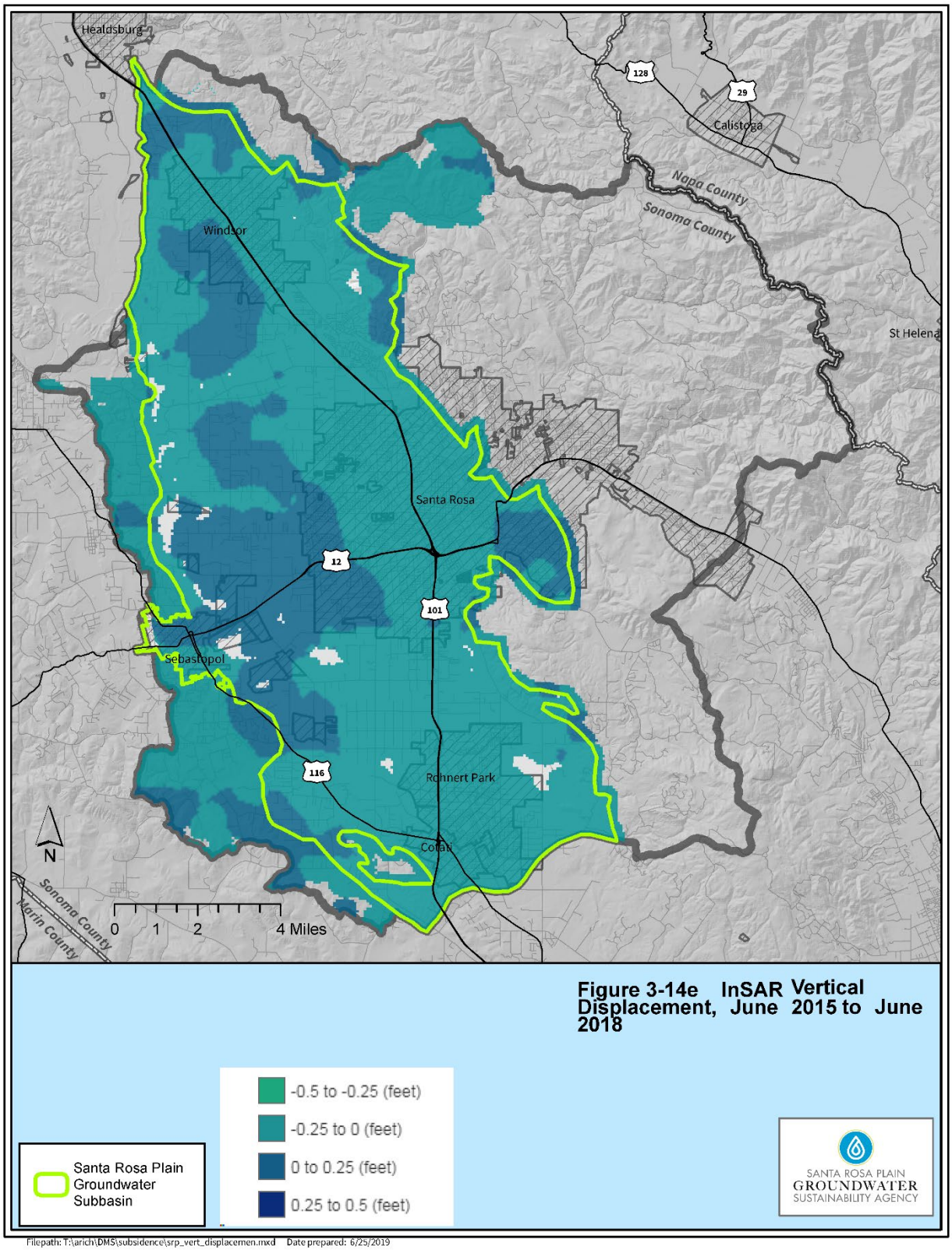


Figure 3-14e. InSAR Vertical Displacement, June 2015 to June 2018

3.2.5 Groundwater Quality Conditions and Trends

Groundwater quality sampling has been performed throughout the Subbasin for a number of different studies and regulatory programs. This section provides a summary of groundwater quality conditions and trends from these various studies and regulatory programs, which include the following:

- DWR periodic sampling of private wells (1950s to 2010)
- GAMA studies of public water-supply wells (Kulongoski et al. 2006) and private domestic wells (Bennett et al. 2014)
- USGS 2013 study (Martin et al. 2013)
- 2013 SNMP (City of Santa Rosa 2013a)
- Data from regulated public water-supply system sampling
- Regulated contaminant sites

Groundwater quality is highly variable throughout the Subbasin and contributing watershed area and is generally acceptable for beneficial uses, although some constituents pose challenges on a localized basis within the study area. Localized areas of poor groundwater quality within the Subbasin and contributing watershed areas are primarily related to the following potential sources of impairment: (1) anthropogenic inputs associated with certain land use activities (for example industrial, agricultural, or urban land uses), (2) deep connate waters associated with ancient seawater entrapped during deposition of Tertiary Era sedimentary units, and (3) hydrothermal fluids associated with portions of the Sonoma Volcanics and/or fault zones.

The following sections describe general groundwater quality characteristics and the occurrence and distribution of naturally occurring and anthropogenic constituents of interest. This section also includes a discussion of special focus parameters, including stable isotopes and trace elements used for age-dating and tracers to provide insights on groundwater movement. Summary results are provided for general minerals major-ion data, TDS, and specific conductance, and arsenic, nitrate, and chloride, which are constituents that have been identified as constituents of interest in previous studies within the Subbasin and/or serve as indicators for thermal or deep connate groundwater. All these constituents of interest occur naturally in groundwater systems, although nitrate also tends to be strongly associated with land use practices. Other anthropogenic constituents associated with land use practices, such as releases of fuel hydrocarbons and solvents, also occur in localized areas.

Much of the data summarized in **Section 3.2.5.1** are from public drinking water systems that provide treatment to remove these and other constituents of potential concern to levels below applicable regulatory standards. The concentrations presented for these wells are prior to such treatment, so as to allow for a characterization of native (or ambient) groundwater quality

conditions. Additionally, since much of the data come from public supply wells that typically are completed in deeper aquifer zones, the data largely represent deeper aquifer zones. Therefore, the data may not adequately represent the water quality of the shallower aquifers being accessed by most domestic wells.

3.2.5.1 General Groundwater Quality Characteristics

Major-ion concentrations and stable isotopes were used to help classify and characterize the groundwater quality within the Subbasin and contributing watershed areas.

Major-ion Concentrations

Major-ion concentrations are assessed by evaluating relative proportions of common ions and anions and are used to group and classify by a water type. These data can help indicate groundwater flow paths and interconnection with surface water. The major-ion composition of groundwater is controlled by the natural chemistry of the recharge water, geochemical reactions in the subsurface, and anthropogenic factors. As groundwater flows through the subsurface, it assumes a characteristic chemical composition as a result of interaction with the aquifer matrix (solid) materials and length of time in the subsurface. Typically, the longer the groundwater flows along a pathway following the hydraulic gradient (groundwater flow path) in contact with and flowing through the aquifer matric materials, the higher the dissolved solids concentrations and major constituent concentrations. This helps explain why it is common to find higher dissolved solids concentrations in groundwater with depth. Most groundwater in the Subbasin is bicarbonate-type water and ranges from sodium-potassium-type water to calcium-magnesium-type water.

General groundwater characteristics have been classified on the basis of groundwater quality data analyses by groundwater storage units (Sweetkind et al. 2013; Martin et al. 2013). The following summarizes the general groundwater classification of the five groundwater storage units as defined by Sweetkind et al. (2013):

Subbasin storage units:

Windsor Basin (north of Trenton Fault and between Mayacamas Mountain foothills and Sebastopol Fault)

- Dominantly a mixed cation-bicarbonate- and sodium-bicarbonate-type water
- Median dissolved solids concentration of 321 mg/L

Cotati Basin (south of the Trenton Fault)

- Mixed cation-bicarbonate- or sodium-bicarbonate-type water
- Median dissolved solids concentration of 362 mg/L

Contributing watershed areas storage units:

Uplands (generally upland areas east of the Rodgers Creek Fault)

- Mixed cation-bicarbonate- or calcium/magnesium bicarbonate-type water

- Median dissolved solids concentration of 330 mg/L

Valley (Rincon/Bennett Valley areas east of the Rodgers Creek Fault)

- Mixed cation-bicarbonate-type water with relatively higher sodium
- Median dissolved solids concentration of 392 mg/L

Wilson Grove (generally areas west of the Sebastopol Fault)

- Calcium-bicarbonate- or mixed cation-bicarbonate-type water
- Median dissolved solids concentration of 233 mg/L

Additionally, water samples from wells completed within the shallow aquifer system generally exhibit greater proportions of calcium and magnesium, while deep aquifer samples exhibit greater proportions of sodium and potassium, which is consistent with increasing mineralization and ion exchange between clays and groundwater with increasing distance and depth from recharge sources (Martin et al. 2013).

Stable Isotopes and Age-dating

Stable environmental isotopes are measured as the ratio of the two most abundant isotope types of a given element, and in hydrologic studies, oxygen and hydrogen are commonly used. For oxygen, it is the ratio of Oxygen-18 (^{18}O) to Oxygen-16 (^{16}O), and for hydrogen, it is the ratio of deuterium (^{2}H or D) to hydrogen (^{1}H). These data provide information on the potential source, evaporative history, and movement of water. Water that condensed at cooler temperatures (precipitation that condenses at higher altitudes, cooler climatic regimes, or higher latitudes) tends to be isotopically lighter than precipitation that condenses at higher temperatures (precipitation that condenses at lower altitudes, warmer climatic regimes, and lower latitudes) (Muir and Coplen 1981). Because the source of much of the precipitation globally is derived from the evaporation of seawater, the ^{18}O and D compositions of precipitation near coasts throughout the globe cluster along a line known as the global meteoric water line (GMWL) (Craig 1961). Water that has been partially evaporated is enriched in the heavier (less negative) isotopes; these values plot to the right of the GMWL, along a line known as the evaporative-trend line. Results from the stable isotope analyses suggest that groundwater recharge in the Subbasin is primarily from infiltration of precipitation and the infiltration of seepage from water courses (Martin et al. 2013).

Isotopic values of groundwater samples collected within the Subbasin generally plotted slightly below the GMWL, indicating that the samples could have been subject to some evaporation, been mixed with evaporated surface water, or been derived from recharge source areas with somewhat different meteoric water lines because of differing altitudes. Within the Subbasin, the heavier isotopic values, which only deviated slightly from the GMWL, indicated that at least some of the recharge to the Subbasin originates as precipitation directly falling on the lower elevations of the Subbasin. In general, the isotopic values of samples east of the Rodgers Creek Fault grouped together and were in the lighter range of all measured isotopic values. The isotopic values for well samples from the western margins of the SRP watershed also grouped

together but fell within the heavier range of all isotopic values from wells in the study area (Martin et al. 2013).

Measured carbon-14 ages in groundwater samples collected from the SRP watershed indicate groundwater ages of 1,000 to 34,000 years before present (Martin et al. 2013). As determined by carbon-14 dating or the presence of tritium, the shallow and deep aquifers exhibit different groundwater ages, with the deep well samples all exhibiting water ages of 4,000 years or older and the shallow aquifer generally containing waters recharged within the last 50 years (Martin et al. 2013). The tritium and carbon-14 data indicate that the vertical migration of recharge in the Santa Rosa Plain is probably retarded by the presence of low-permeability clay deposits in the Glen Ellen and Petaluma Formations (Martin et al. 2013).

3.2.5.2 Naturally Occurring Constituents of Interest

Arsenic, boron, TDS, and chloride have been identified as naturally occurring constituents of interest through previous studies within the Subbasin.

Arsenic

Arsenic is a relatively common element that occurs naturally in the environment. Arsenic is considered a carcinogen, and the maximum contaminant level (MCL) for arsenic has been set at 10 micrograms per liter (µg/L). Arsenic solubility increases with increasing water temperature, and also tends to desorb from aquifer matrix materials under alkaline conditions (pH greater than 8.0) (USGS 2014). Due to its increased solubility with increased temperature, arsenic is commonly elevated in groundwater that is affected by hydrothermal fluids.

Water-sample analyses for arsenic were available from 89 wells within the SRP watershed between 2010 and 2019. The occurrence and distribution of arsenic in groundwater is displayed on **Figure 3-15a**. Groundwater samples from 15 of the 89 wells (17 percent) exceeded the MCL of 10 µg/L for arsenic. Areas of elevated arsenic concentrations are most notable in the northeastern portions of the Subbasin, immediately south of the City of Santa Rosa, in the vicinity of the City of Sebastopol and along the Trenton Fault near Mark West Creek. Many areas of higher arsenic concentrations appear to be associated with known or inferred faults.

Chloride and Total Dissolved Solids

Chlorides are widely distributed in nature as salts of sodium, potassium, and calcium. Chlorides are leached from various rocks into soil and water by weathering and can also be an indicator for seawater intrusion or the presence of older connate water. Anthropogenic sources of chloride commonly include manufacturing, power generation, landfill leachate, and wastewater. Chloride has a secondary MCL of 250 mg/L based on taste (salty).

TDS refers to the amount of minerals, salts, metals, cations, and anions dissolved in water. Pure water such as distilled water will have a very low TDS and sea water, brackish water, older connate water, and mineralized thermal waters exhibit high TDS concentrations.

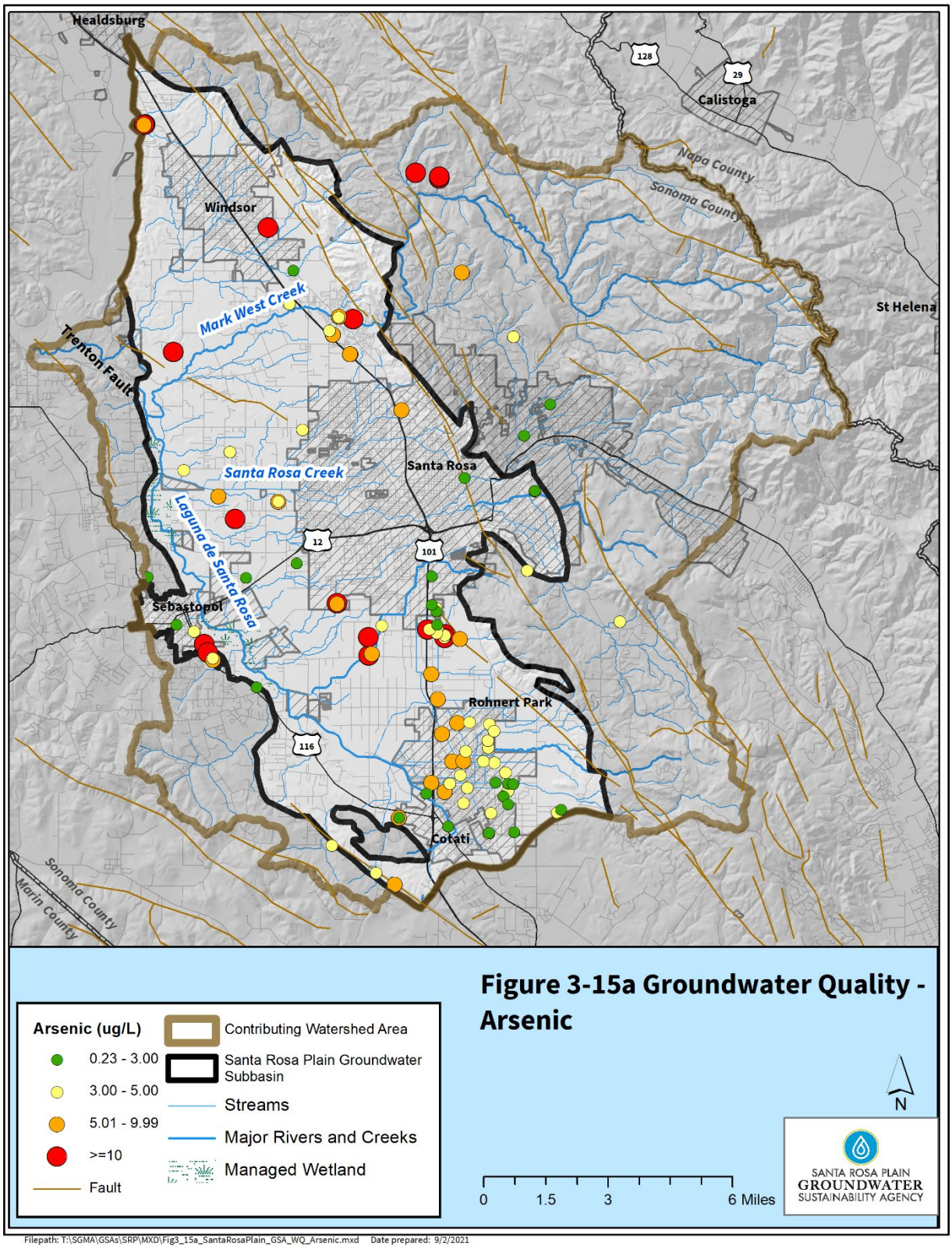


Figure 3-15a. Groundwater Quality – Arsenic

TDS has a secondary MCL of 500 mg/L based on hardness deposits, colored water, staining, and salty taste. Specific conductance (SC - also called electrical conductivity [EC]) is the measure of the liquid capacity to conduct an electrical charge, which is dependent on the amount of dissolved minerals, salts, metals, cations, anions, and temperature of water, and correlates with TDS measurements. SC is easily and inexpensively measured via portable water-quality sensor in the well or in water samples on site from a well, whereas TDS is generally analyzed in the laboratory at a greater expense.

Water-sample analyses for chloride were available from 95 wells within the SRP watershed between 2010 and 2019. The occurrence and distribution of chloride in groundwater is displayed on **Figure 3-15b**. No groundwater samples exceeded 100 mg/L chloride.

Water-sample analyses for TDS (and SC as a surrogate for TDS) were available from 97 wells within the Subbasin and contributing watershed areas between 2010 and 2019 (18 within the shallow aquifer system and 121 within the deep aquifer system). The occurrence and distribution of TDS in groundwater is displayed on **Figure 3-15c**. Groundwater samples from three of the wells exceeded the secondary MCL.

Martin et al. (2013) reported that while concentrations of chloride and SC are predominantly well below secondary drinking water standards, concentrations of these two constituents appear to be increasing with time in the Subbasin. Chloride concentrations increased similarly in about two-thirds of the wells, and just more than half increased by more than 10 percent. Not all wells had increases; a more than 10 percent decrease in concentration was measured in 15 percent of the wells for SC and 30 percent for chloride. The greatest increases in concentrations of SC, chloride or both were in wells located in the vicinity of the Cities of Rohnert Park and Cotati. Possible causes of the increased SC and chloride include groundwater underflow of high dissolved solids concentration groundwater present along the Rodgers Creek Fault zone, historic irrigation return flow, septic tank effluent, or leaky sewer pipes (Martin et al. 2013). Depth-dependent hydrologic, chemical, and isotopic data are needed to better understand the cause of the increased SC and chloride concentrations.

Figures 3-15d through **3-15g** display more recent time-concentration plots of chloride and TDS, respectively, for wells with the longest periods of records based on available historical data. As indicated on the time-concentration plots, the majority of wells exhibit relatively stable concentrations of chloride and TDS over time. The absence of increasing trends in this more recent data may be related to samples from different wells than the USGS study or indicate that concentrations have stabilized since the USGS study. It is important to note that many of the time-concentration plots do not include very complete records over time (sampling for several of the wells, which were sampled in the 1950s through 1970s were discontinued and many of the wells with more complete recent data do not have data extending back over time). Additionally, spatial data gaps occur in both the shallow and deep aquifer system.

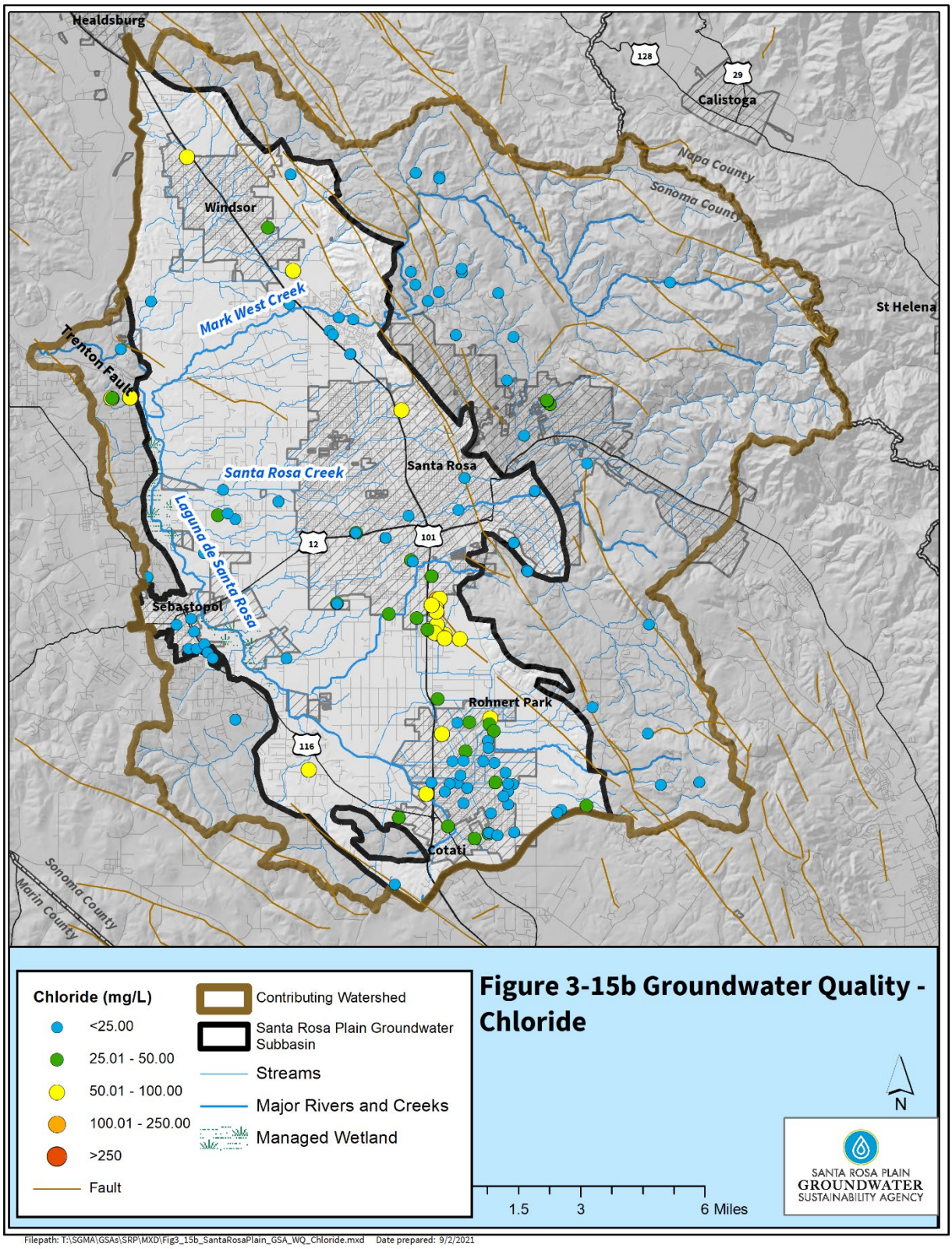


Figure 3-15b. Groundwater Quality – Chloride

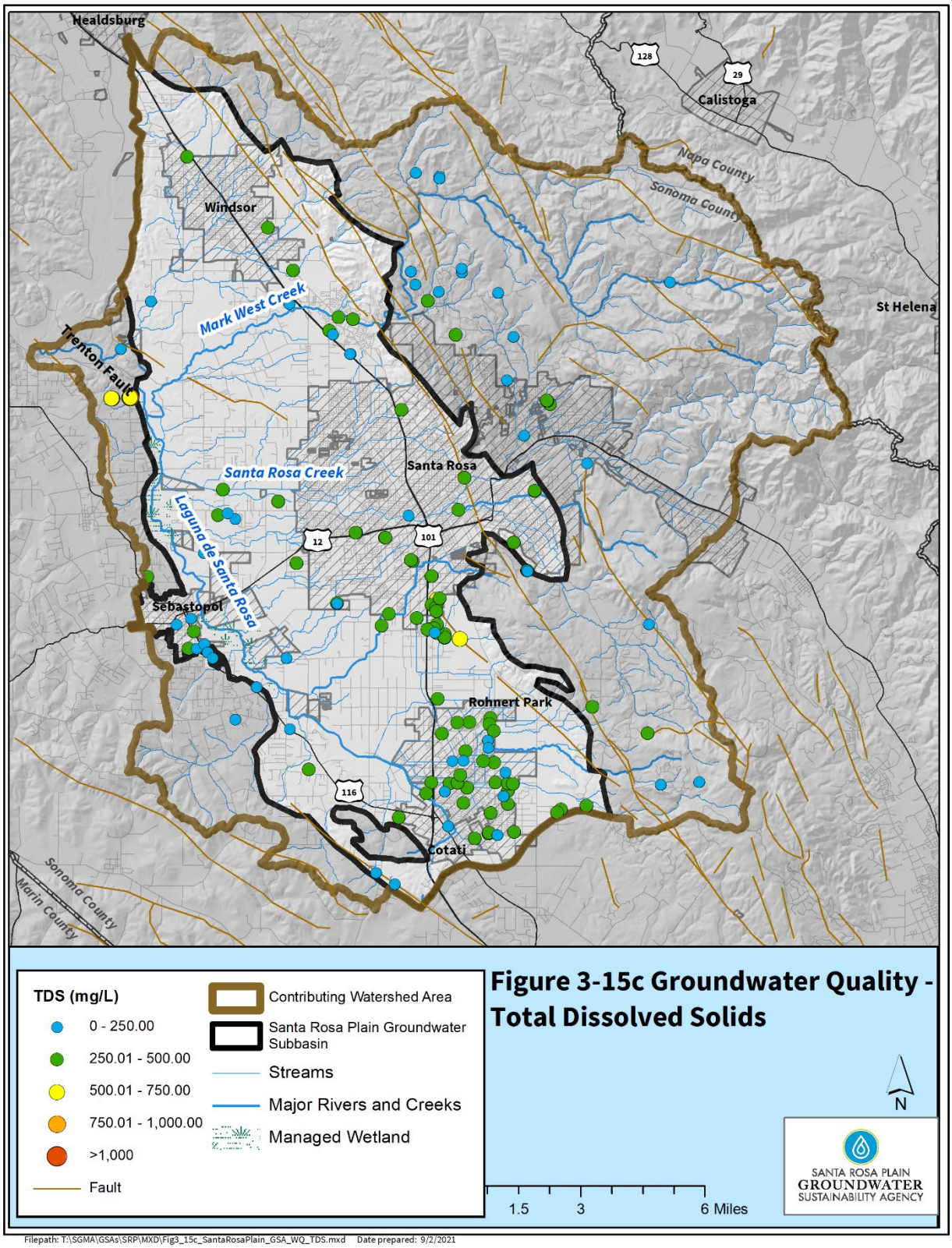


Figure 3-15c. Groundwater Quality – Total Dissolved Solids

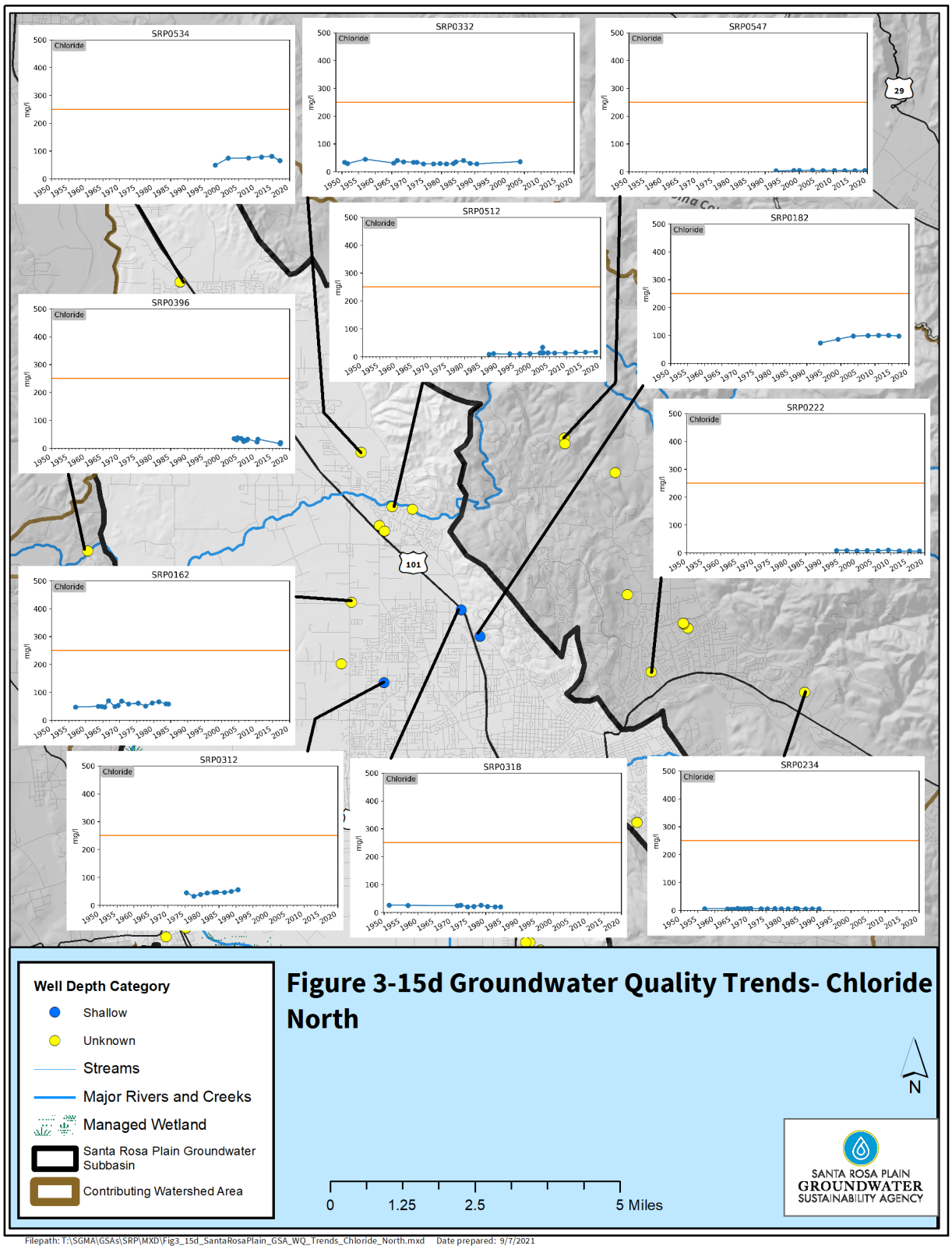


Figure 3-15d. Groundwater Quality Trends – Chloride North

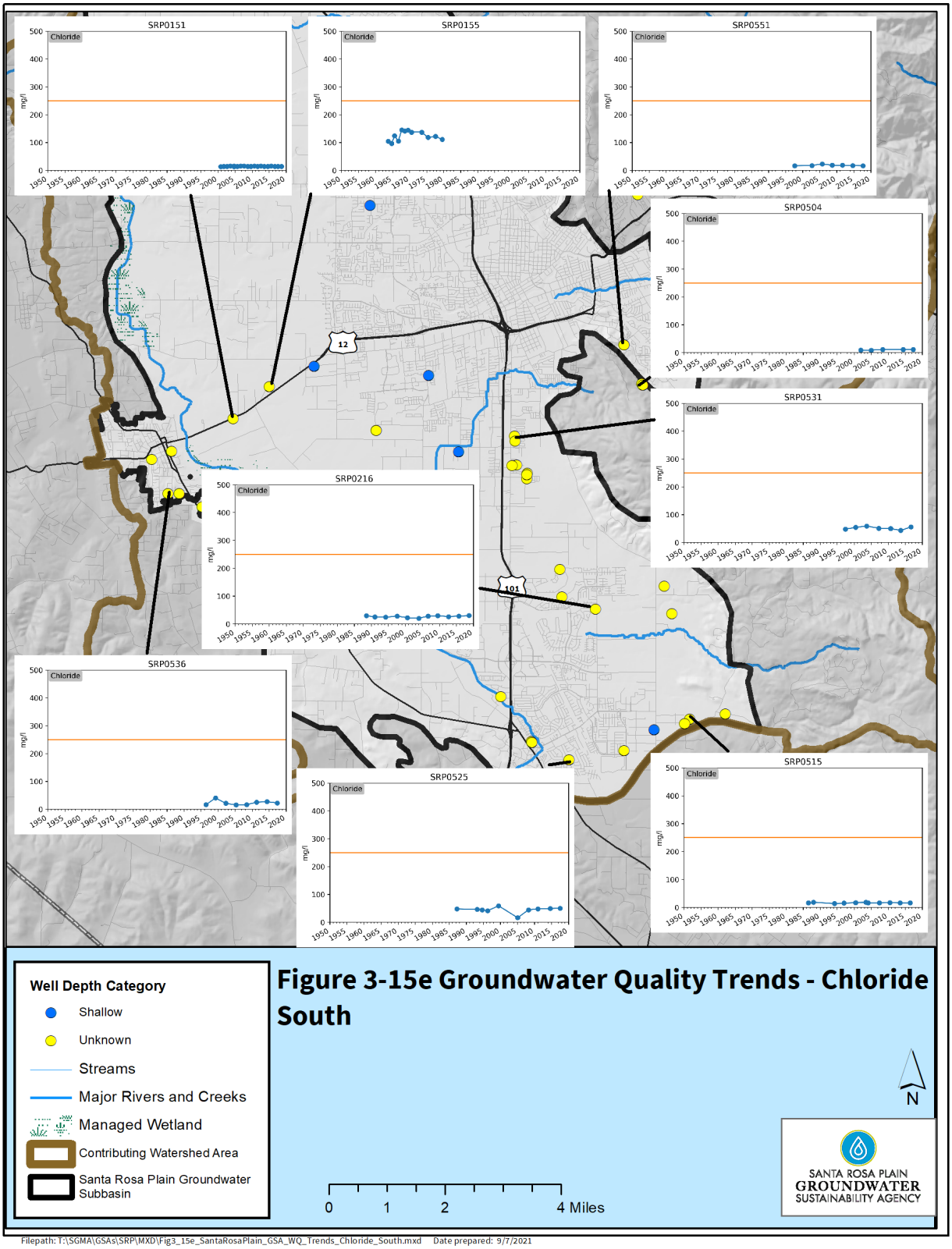


Figure 3-15e. Groundwater Quality Trends – Chloride South

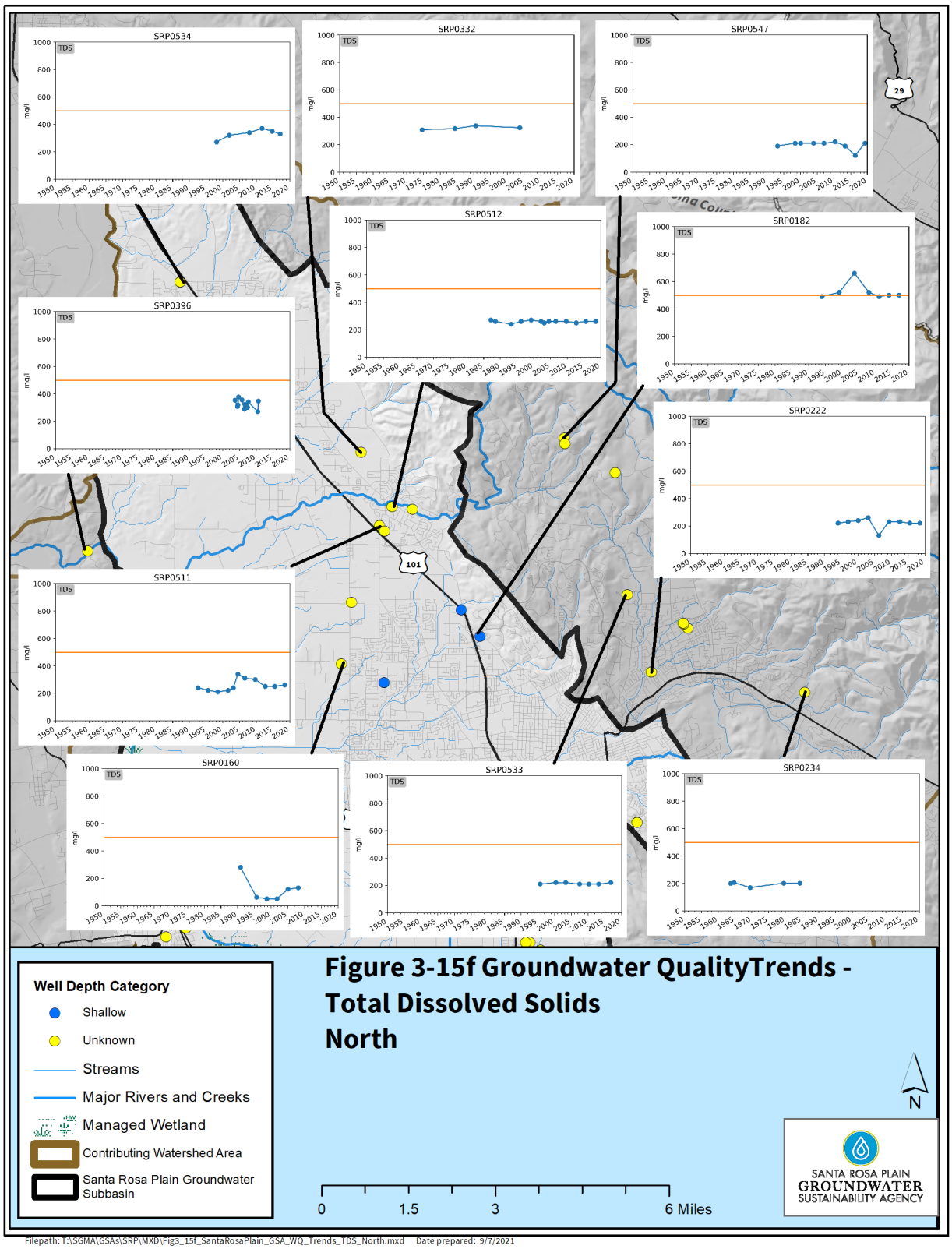


Figure 3-15f. Groundwater Quality Trends – Total Dissolved Solids North

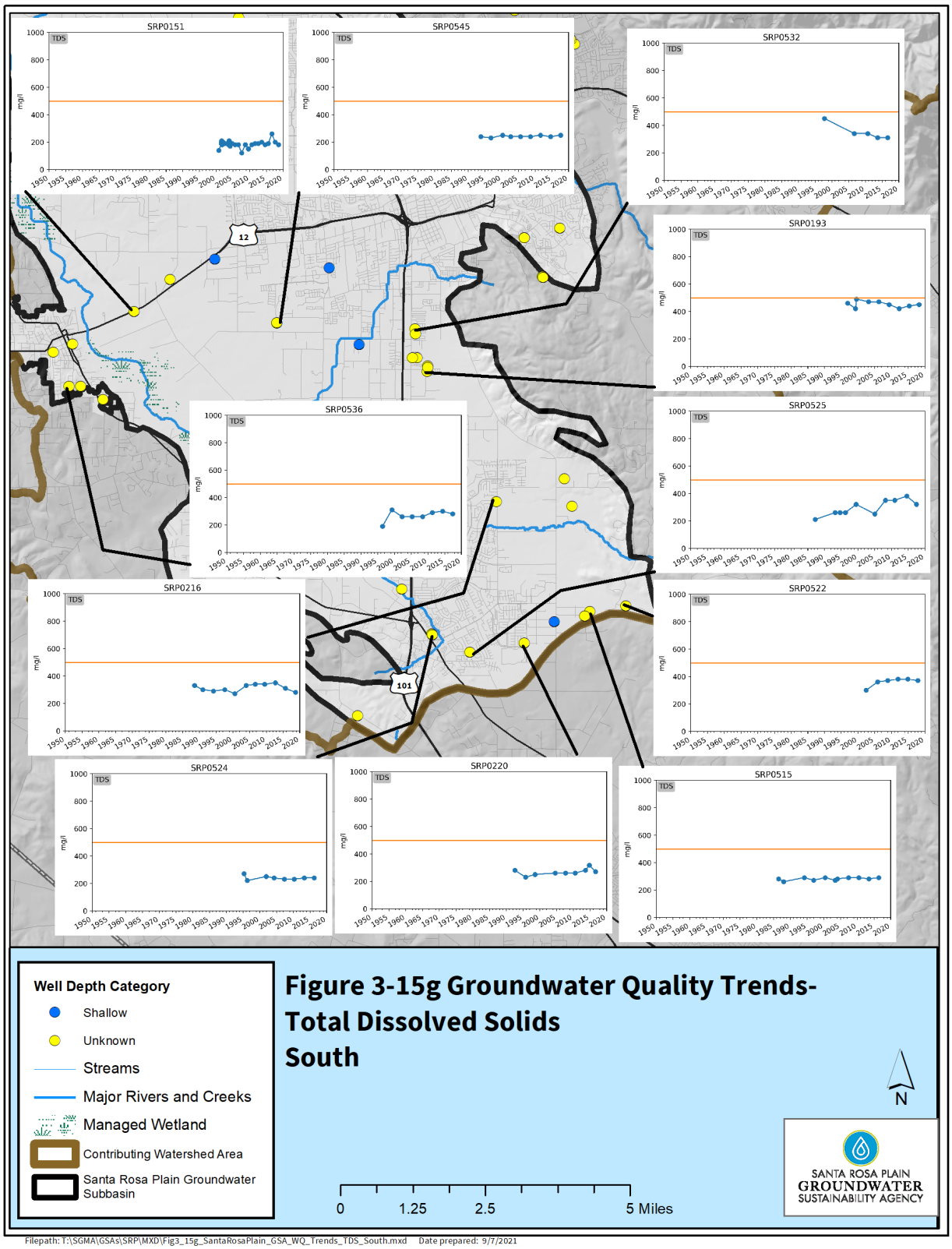


Figure 3-15g. Groundwater Quality Trends – Total Dissolved Solids South

3.2.5.3 Anthropogenic Constituents of Interest

Nitrate

Nitrate is a widespread contaminant and its occurrence in groundwater systems is commonly associated with agricultural activities, septic systems, confined animal facilities, landscape fertilization, and wastewater treatment facility discharges. Elevated levels of nitrate in drinking water are considered to be especially unhealthy for infants and pregnant women (SWRCB 2012) and the MCL for nitrate as N is 10 mg/L.

Only 2 of the 92 groundwater samples analyzed for nitrate as nitrogen exceeded or equaled the nitrate MCL of 10 mg/L, as shown on **Figure 3-15h**. The median concentration of nitrate in shallow wells was 0.9 mg/L in the Windsor structural trough and 4.4 mg/L in the Cotati structural trough (Martin et al. 2013). Median concentrations for deeper wells were 0.2 mg/L in the Windsor structural trough and 1.0 mg/L in the Cotati structural trough (Martin et al. 2013).

Regulated Groundwater Contamination Sites

The SRP watershed contains a number of currently regulated contaminant release sites (**Figure 3-16**), many of which are under an active cleanup order by the SWRCB (SWRCB 2021). These include leaking underground tanks from gasoline and solvent storage, land disposal, and military facilities. These releases, which include petroleum and chlorinated solvent contaminants and metals, are generally of limited areal extent, although impacts to water-supply wells from a number of sites have occurred within the study area. These releases and sites are regulated through programs administered by other agencies, including the North Coast Regional Water Quality Control Board, DTSC, and County of Sonoma Environmental Health.

The SWRCB GAMA Priority Basin Project study of the North San Francisco Bay Groundwater Basins has included two studies by the USGS, which evaluated inorganic and organic constituents in groundwater, and which includes constituents associated with regulated contaminant release sites. The first study conducted in 2004 included samples from 18 public water-supply wells in the Subbasin and contributing watershed areas. The second study conducted in 2012 included samples from seven private domestic wells in the Subbasin and contributing watershed areas. These samples were analyzed for up to 270 constituents and water-quality indicators including volatile organic compounds, pesticides, nutrients, major and minor ions, trace elements, radioactivity, microbial indicators, dissolved noble gases, and naturally occurring isotopes (Kulongoski et al. 2010; Bennett et al. 2014). A small number of the public and private wells sampled as part of the GAMA program had very low-level detections of volatile organic compounds and/or pesticides, but all detections were significantly below the contaminant's respective MCLs (Kulongoski et al. 2010; Bennett et al. 2014).

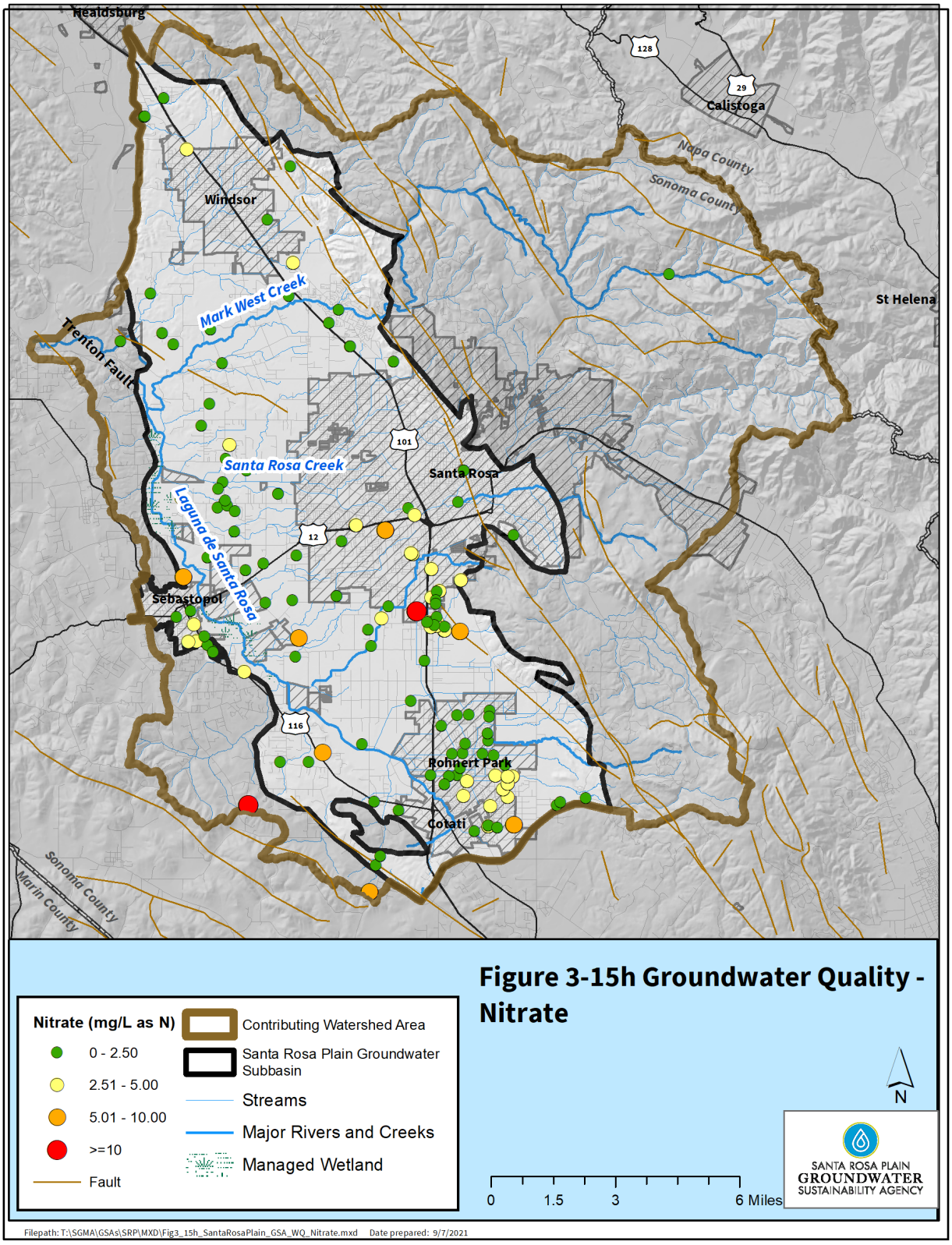


Figure 3-15h. Groundwater Quality – Nitrate

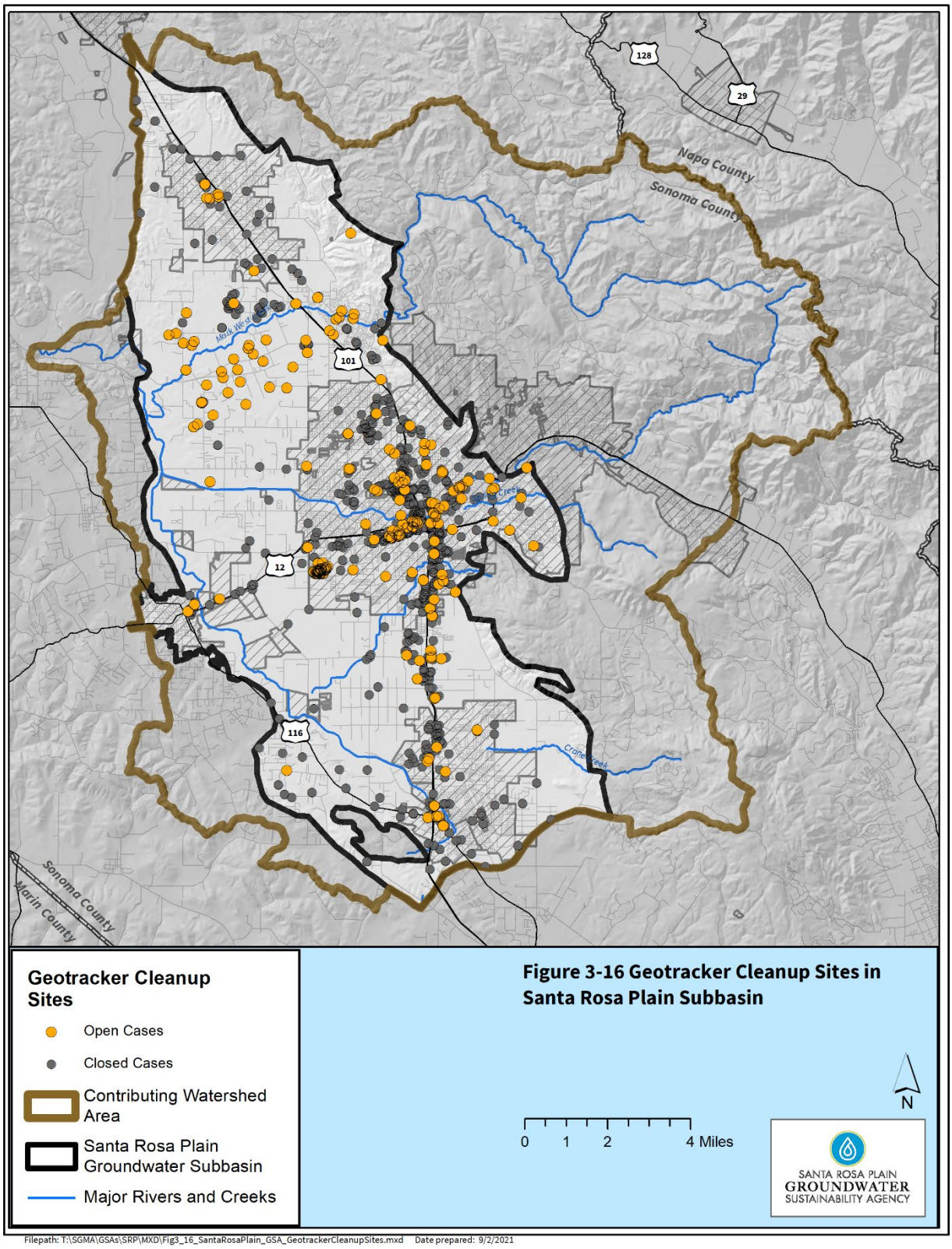


Figure 3-16. GeoTracker Cleanup Sites in Santa Rosa Plain Subbasin

3.2.6 Surface Water Conditions and Surface Water and Groundwater Connectivity

SGMA requires the GSP include a HCM that provides a qualitative and quantitative understanding of the Subbasin's physical characteristics and how the aquifers react to hydrologic stresses over time, and interaction of the surface water and groundwater systems in the basin, to include quantitative information on surface water inflows and outflows in the water budget. Also required are the development of sustainable management criteria for surface water depletion from groundwater pumping.

3.2.6.1 Surface Water Conditions

Streamflow information in the Subbasin and contributing watershed is based on data gathered from stream gages and previous studies. Historical streamflow records are available at 15 USGS gaging stations and at the time of GSP preparation, 9 stream gaging stations were operated by the USGS, 7 gages were operated by Sonoma Water, and 1 stream gage was operated by the Pepperwood Preserve (**Figure 2-7d**). Most streamflow records within the Subbasin are relatively recent and date to WY 1998 or more recent. **Figure 3-17** shows total annual gaged surface water flow at the nine active USGS gages for WY 2000 through 2020 and historical data for one inactive USGS stream gage (Brush Creek).

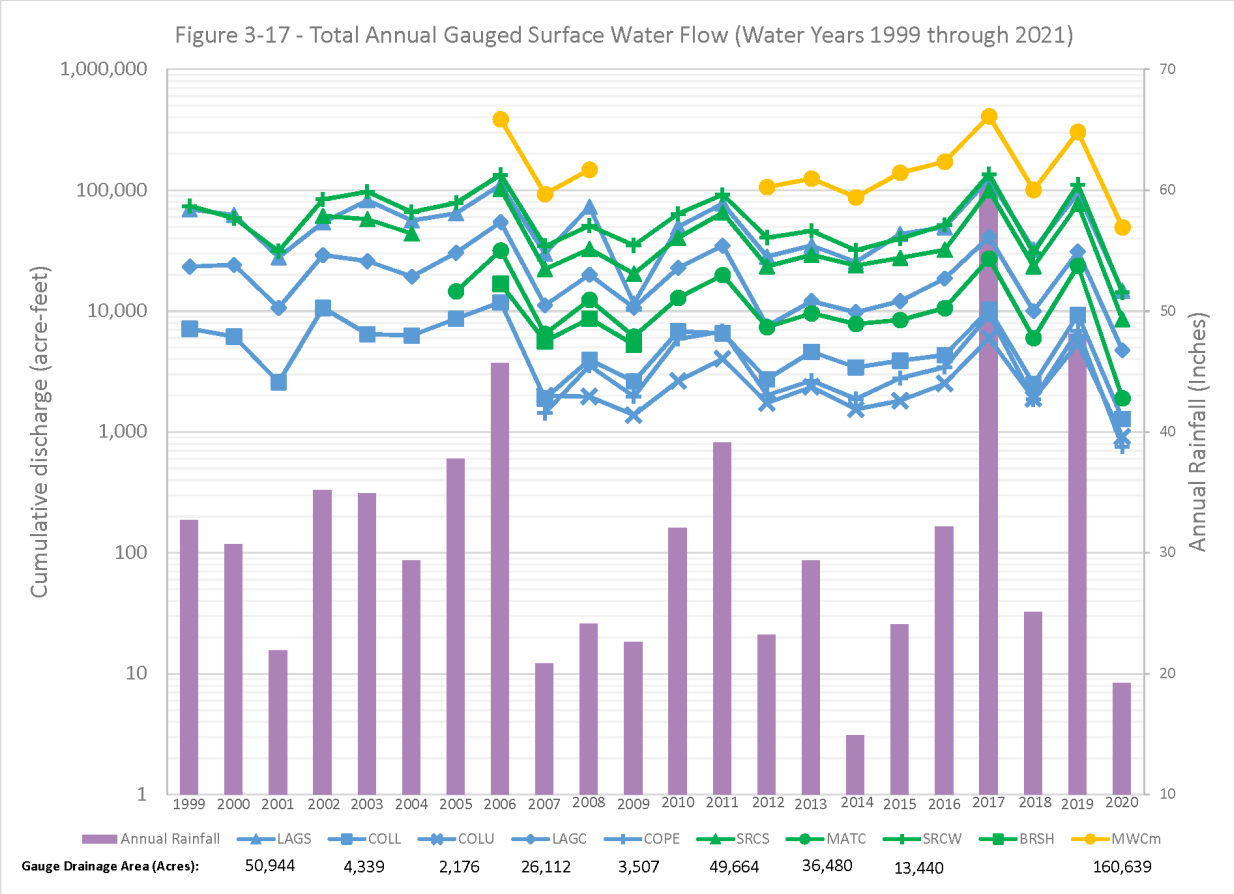


Figure 3-17. Total Annual Gaged Surface Water Flow (Water Years 1999 through 2021)

The Subbasin and contributing watershed experience extremes, from very high flows and flooding during wetter than normal winters, to periods of much lower flows during drought years. High Russian River flows, and rapid, high-volume inflow to the Laguna de Santa Rosa from tributary drainages, can slow and even reverse streamflow in the Laguna de Santa Rosa drainage channel, and in the lower channels of Mark West Creek and Santa Rosa Creek due to backwater effects in the Laguna de Santa Rosa floodplain. These conditions arise only from larger storms, during wetter than normal winters. The largest floods within the Subbasin are caused by the combined effects of runoff from within the Subbasin and contributing watershed areas and inflows from the Russian River into the Laguna de Santa Rosa floodplain. When the Russian River rises above flood stage, the Laguna de Santa Rosa Plain acts as a natural flood retention basin for the Russian River by capturing and storing flood water, thus dampening the peak flows in the Russian River downstream of the Mark West Creek tributary.

During summer, low-flow conditions occur throughout the Subbasin and contributing watershed, with most of the streamflow consisting of baseflow (the component of the streamflow that persists without precipitation, generally spring-fed or groundwater-fed), and in some cases irrigation runoff. Perennial streamflow may characterize sections of Matanzas Creek, Spring Creek, and upper Santa Rosa Creek.

3.2.6.2 Interconnected Surface Water

Interconnected surface waters are defined in the GSP Regulations as “surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.” A stream segment is interconnected where (and when) variations in groundwater hydraulic head influence the rate of exchange between the groundwater and surface water systems (Brunner et al 2011; Sophocleous 2002). Below this depth, changes in groundwater elevation do not influence streambed infiltration. The direction and magnitude of the flux between surface waters and the groundwater system depends upon the difference between the surface water level or stage and adjacent groundwater elevations, and the hydraulic conductivity of aquifer and streambed, channel morphology, and other factors. During gaining conditions, the groundwater elevation is above the surface water stage and during losing conditions the groundwater elevation is below the stream stage. Because groundwater elevations and stream stage are not constant, this interaction may change in magnitude and direction seasonally or year-to-year, and along the length of a stream reach. The degree of interaction can be impacted by changes in climate and groundwater pumping, upstream diversions, and land use, amongst other factors (Winters et al. 1999).

Direct measurements of the flux between surface water and groundwater are difficult to make. As such, indicators of interconnected surface waters were assimilated with direct measurements to assess where interconnected surface waters in the Subbasin likely exist. The types of evidence used are the following:

1. Measured groundwater-level and streambed elevation differences
    a. Depth-to-groundwater along stream channels, spring 2015

2. Modeled output derived from Woolfenden and Nishikawa (2014)
    b. Percent of time stream is gaining, from 2000 to 2010
    c. Median stream flow, from 2000 to 2010
    d. Surface leakage, 2006

The two types of data are combined into a scoring system to determine where interconnected surface waters likely occur. The points are aggregated for model cells that were used in the GSFLOW model for the Santa Rosa Plain. The rationale for this approach is that it allows for direct use of output from model simulation and size of the cells are appropriate (660 feet by 660 feet) for assessing local variability.

The first data source used in the scoring system is the estimated depth-to-groundwater derived from a groundwater-level contour map derived for the shallow aquifer system of the Subbasin. This map was derived by interpolation between groundwater levels measured in shallow aquifer system wells from spring 2015 and converting these to elevations. These elevations were intersected with the stream bottom elevation for each grid cell. Where the shallow groundwater elevation is greater than the stream bottom elevation interconnected surface, water conditions are inferred to occur. Stream bottom elevations were extracted from 2013 Vegmap LiDAR (Sonoma Vegmap 2013). Where shallow groundwater elevations are lower than the stream bottom, then the stream is inferred to be disconnected from the groundwater system. This analysis does not consider the impact of varying stream stage and assumes that the stream bottom is a reasonable surrogate for stream stage. Points for this category were assigned to give the full 5 points for reaches inferred to be interconnected using this method (negative values) and decreasing to 0 points where groundwater elevations are 10 feet below the stream bottom. To provide a conservative approach and account for the inherent uncertainties within the datasets, reaches where the groundwater elevation is estimated to be within 10 feet of the streambed were assigned either one or two points depending upon the depth. If the substrates below the streams were understood to be homogenous and had high hydraulic conductivities, a deeper value would be selected. However, with the likely existence of a heterogeneous alluvium beneath the streams, the low-permeability lenses characteristic of these deposits inhibit hydraulic connections at greater depths (Peterson and Wilson, 1988). **Figure 3-18a** shows the depth-to-water for all of the stream reaches.

The second data source used for the scoring system relates to the amount of time there is a direct groundwater connection with the stream cell and the stream is simulated as gaining. This data was derived from the GSFLOW simulation. The values represent the amount of time from 2000 to 2010 that simulated hydraulic head in stream flow cells were greater than the simulated stream stage. The values range from 0 to 100 percent, where 0 percent indicates that the stream stage is always greater than the groundwater elevation, whereas 30 percent value indicates that a reach is gaining 30 percent of the time. The points awarded for the different percent time gaining range from 0 points for stream reaches that are never gaining to 5 points for stream reaches that are gaining more than 60 percent of the time. The simulated percent time that streams are gaining is shown on **Figure 3-18b**.

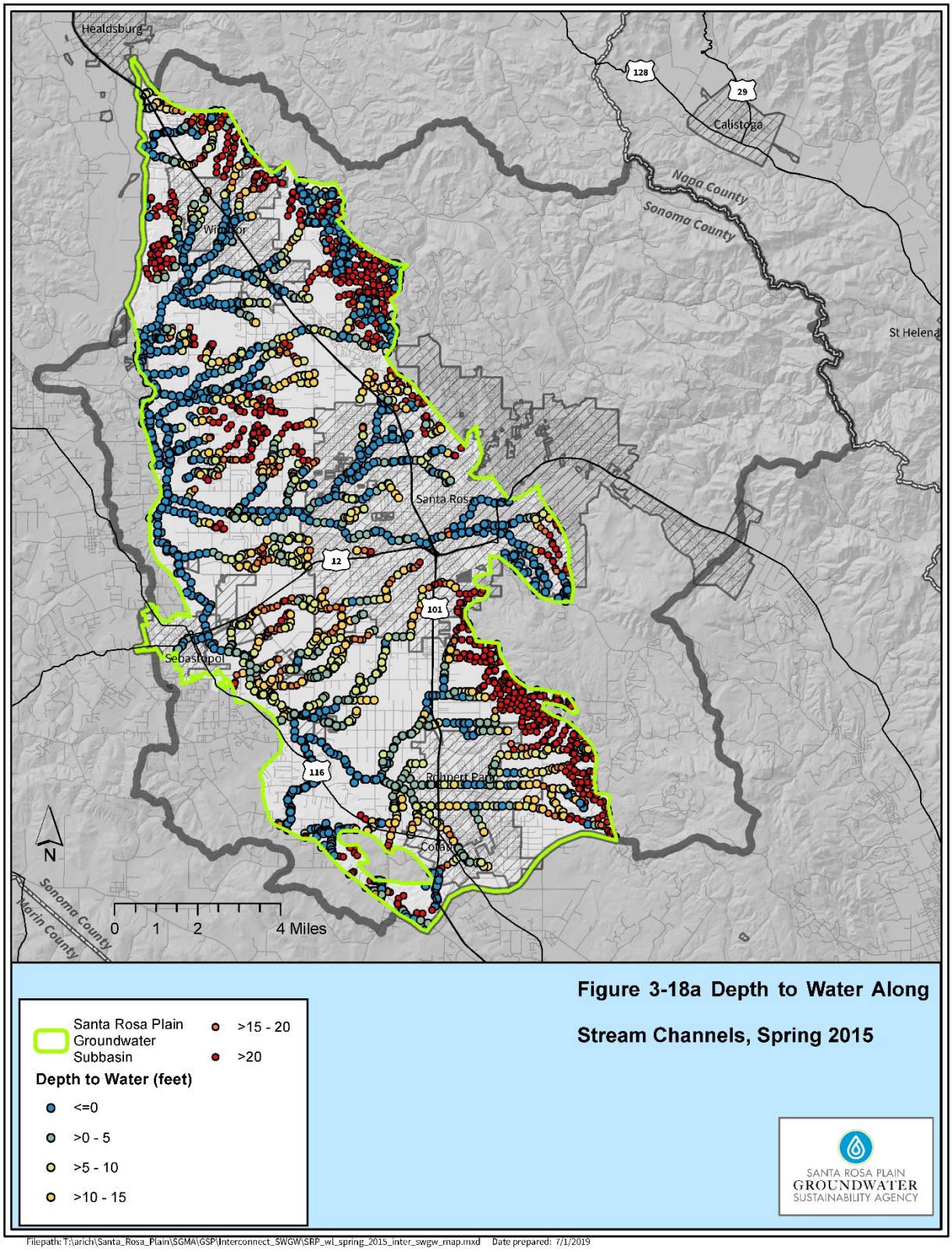


Figure 3-18a. Depth-to-Water Along Stream Channels, Spring 2015

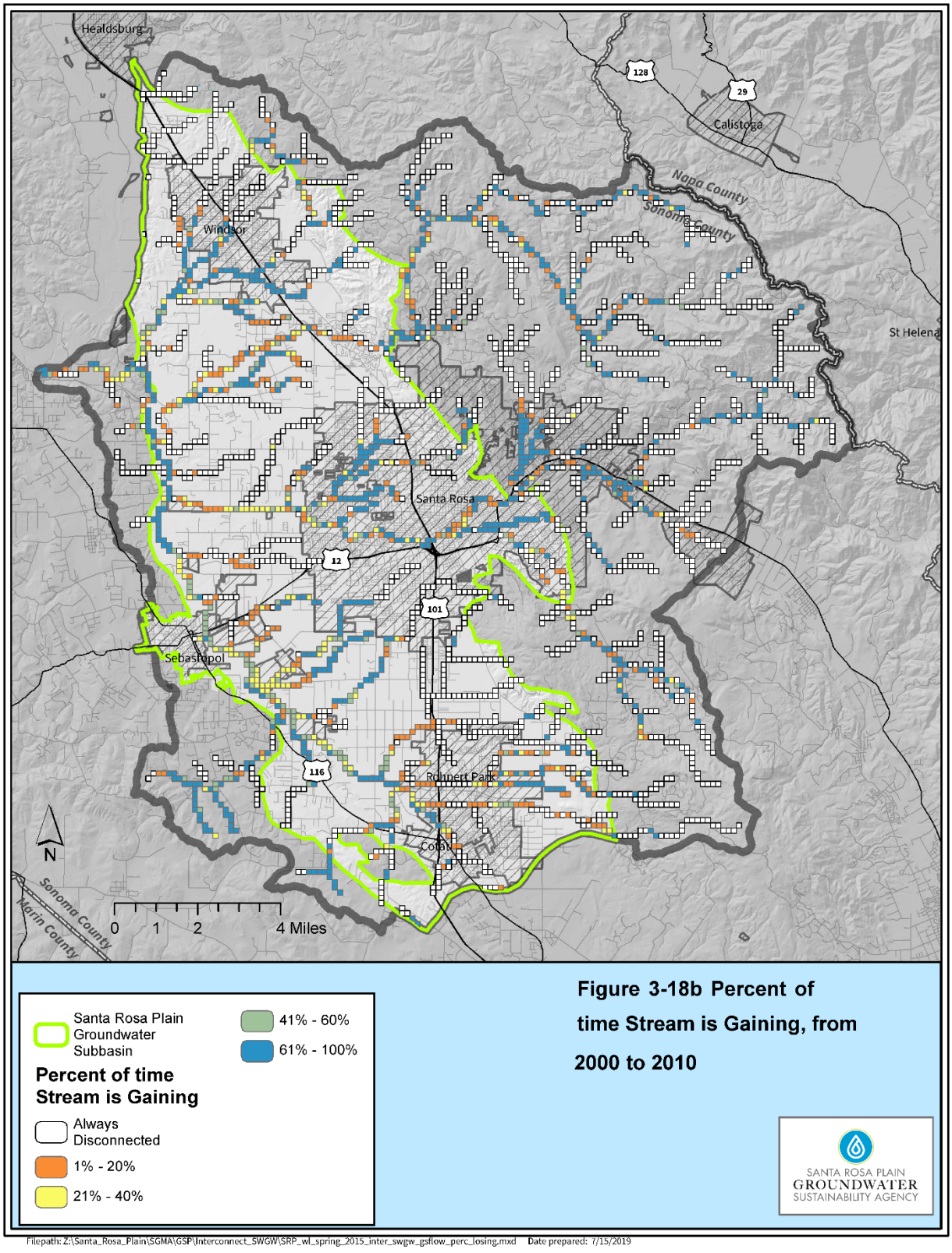


Figure 3-18b. Percent of Time Stream is Gaining, from 2000 to 2010

The simulated median stream flow was extracted from the GSFLOW output as the third criteria for the scoring system. The purpose of including this dataset was to account for stream reaches that are frequently dry. For stream reaches that are dry more than 50 percent of the time 0 points were assigned, whereas reaches with median nonzero discharges receive 2 points. A large majority of stream reaches are not frequently dry and receive 2 points, as shown on **Figure 3-18c**).

The simulated surface leakage was included as the fourth criteria to account for areas outside of stream reaches where interconnected surface water conditions might occur. Surface leakage occurs in GSFLOW where simulated groundwater heads are greater than the altitude of cell top. When surface leakage occurs, it would indicate wetland-like conditions. Model cells with simulated surface leakage are shown on **Figure 3-18d** and receive 2 points. Many of these cells are located in areas of the Subbasin that receive recycled water from the City of Santa Rosa.

Classifying Reaches as Interconnected Surface Waters

The point values from **Figures 3-18b** through **Figure 3-18d** were summed for each cell. The resulting values range from 1 to 14. A cutoff value is chosen to select stream reaches classified as interconnected surface waters based on a multiple lines of evidence approach. A value of 7 points was chosen based on the following reasoning. Stream reaches below a value of seven have either only one high-scoring metric (for example, 5 points) and a low-scoring metric (2 points or fewer), or multiple low-scoring metrics. These reaches therefore do not have multiple lines of strong evidence indicating they are interconnected. On the other hand, reaches with 7 or more points have at least one high-scoring and one medium-scoring metric, or multiple medium-scoring metrics. These reaches are therefore characterized by multiple lines of evidence as having interconnections to the groundwater system. The second line of reasoning that supports the chosen point value cutoff is its distinction between small and large streams. It is expected that small streams go dry during summer months and during drier periods. As presented on **Figure 3-18e**, some smaller streams are included in the interconnected reaches, but the interconnected reaches are predominantly the higher order stream reaches. Groundwater elevations from 10 recently constructed shallow monitoring wells equipped with dedicated pressure transducers, at 9 locations near streams in the Santa Rosa Plain, were used to further assess and corroborate the mapping of interconnected surface water in the Subbasin. The nine locations are all along streams mapped as interconnected using the scoring methodology. Streambed elevations near each monitoring well were obtained from LiDAR datasets to compare with groundwater elevations and assess interconnectedness, as only a few shallow wells have stream-surface water measurements near enough to assess the presence of gaining or losing conditions. While the period of record from these datasets only begins in November 2019, the limited available data indicate that at eight of the nine locations, groundwater levels occur above the estimated streambed at least part of the time and at the remaining location (SRP 0710 located along the Laguna de Santa Rosa at Stony Point Road), groundwater levels are within 10 feet of the streambed elevation. While limited, this additional dataset supports the mapping of interconnected streams shown on **Figure 3-18e**.

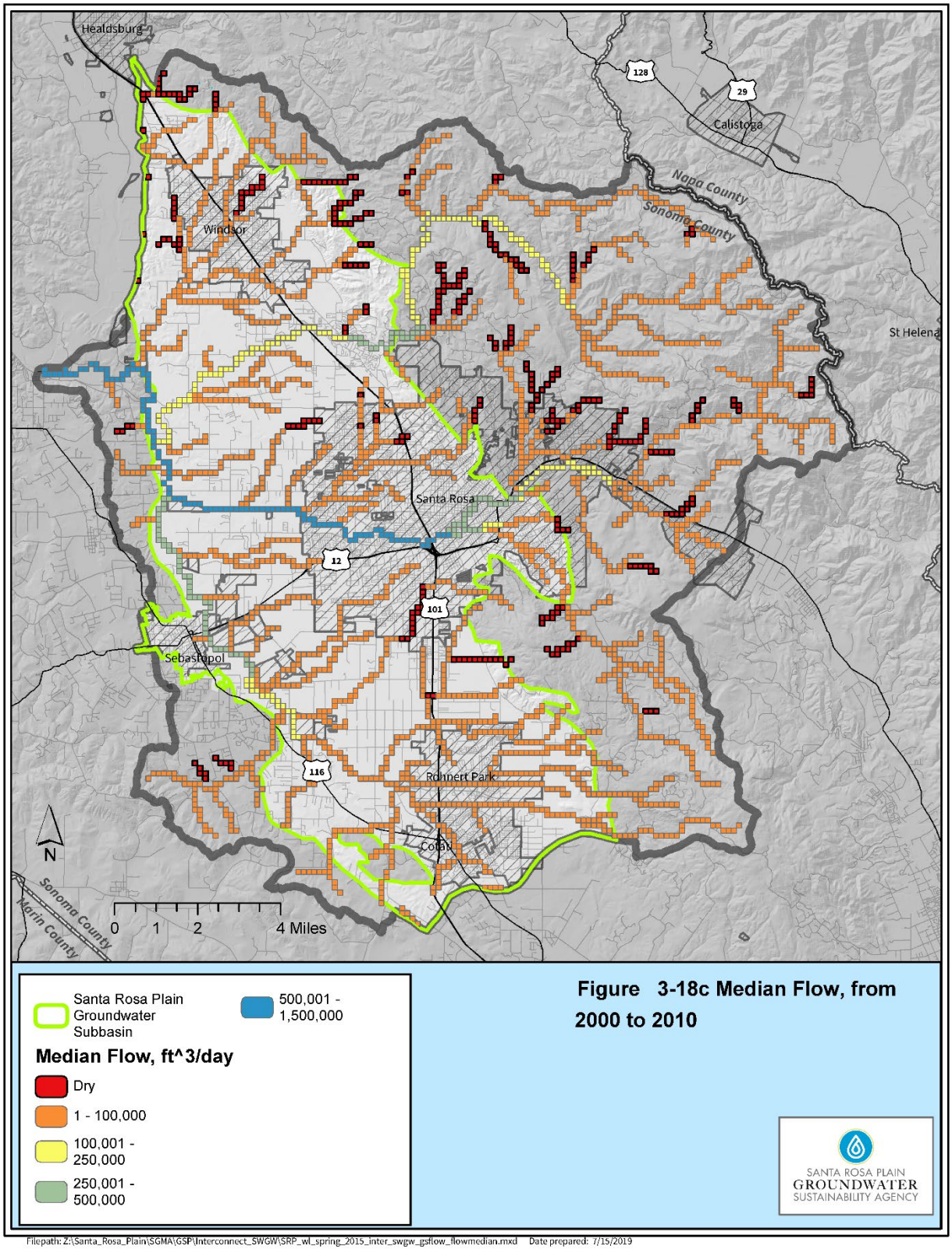


Figure 3-18c. Median Flow, from 2000 to 2010

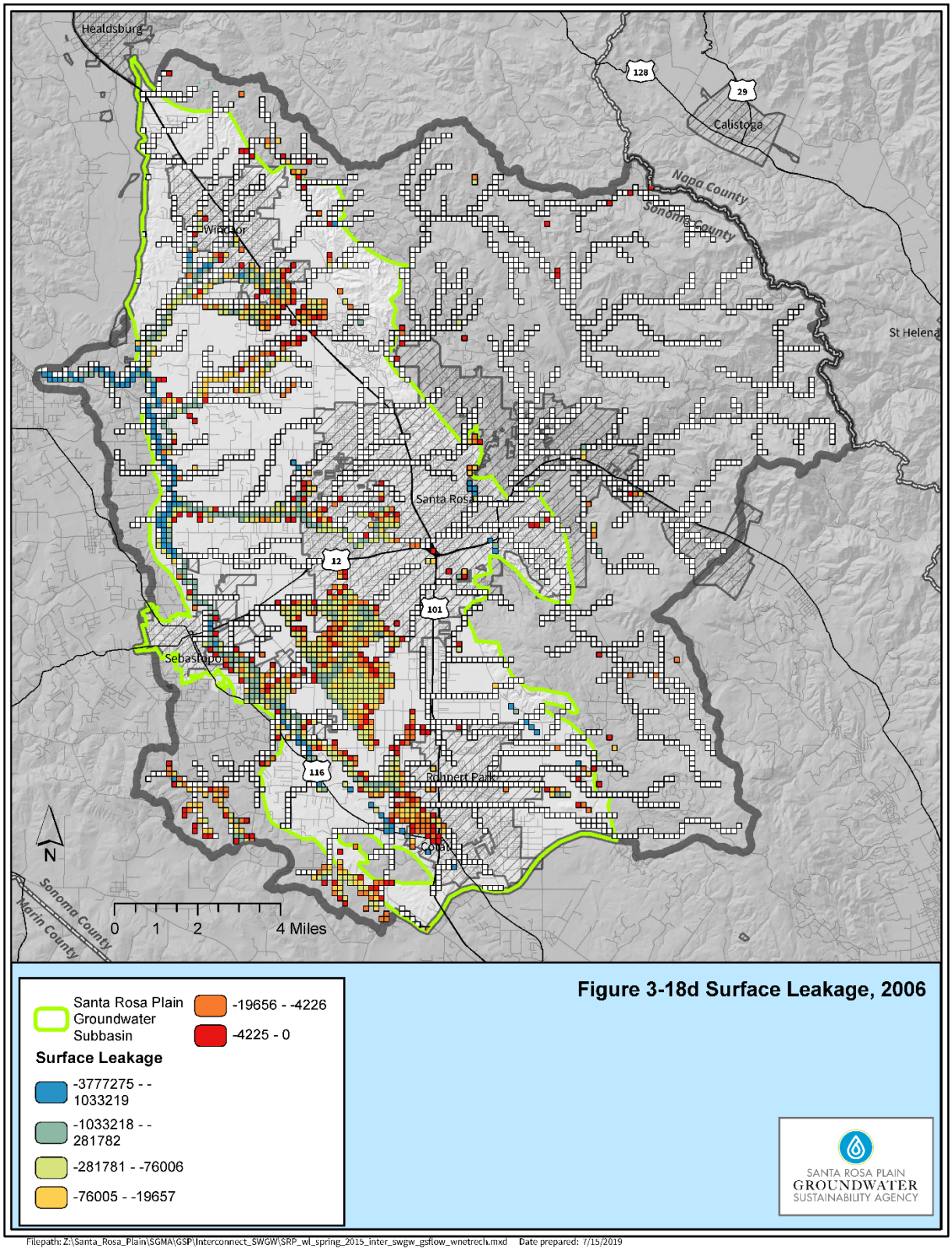


Figure 3-18d. Surface Leakage, 2006

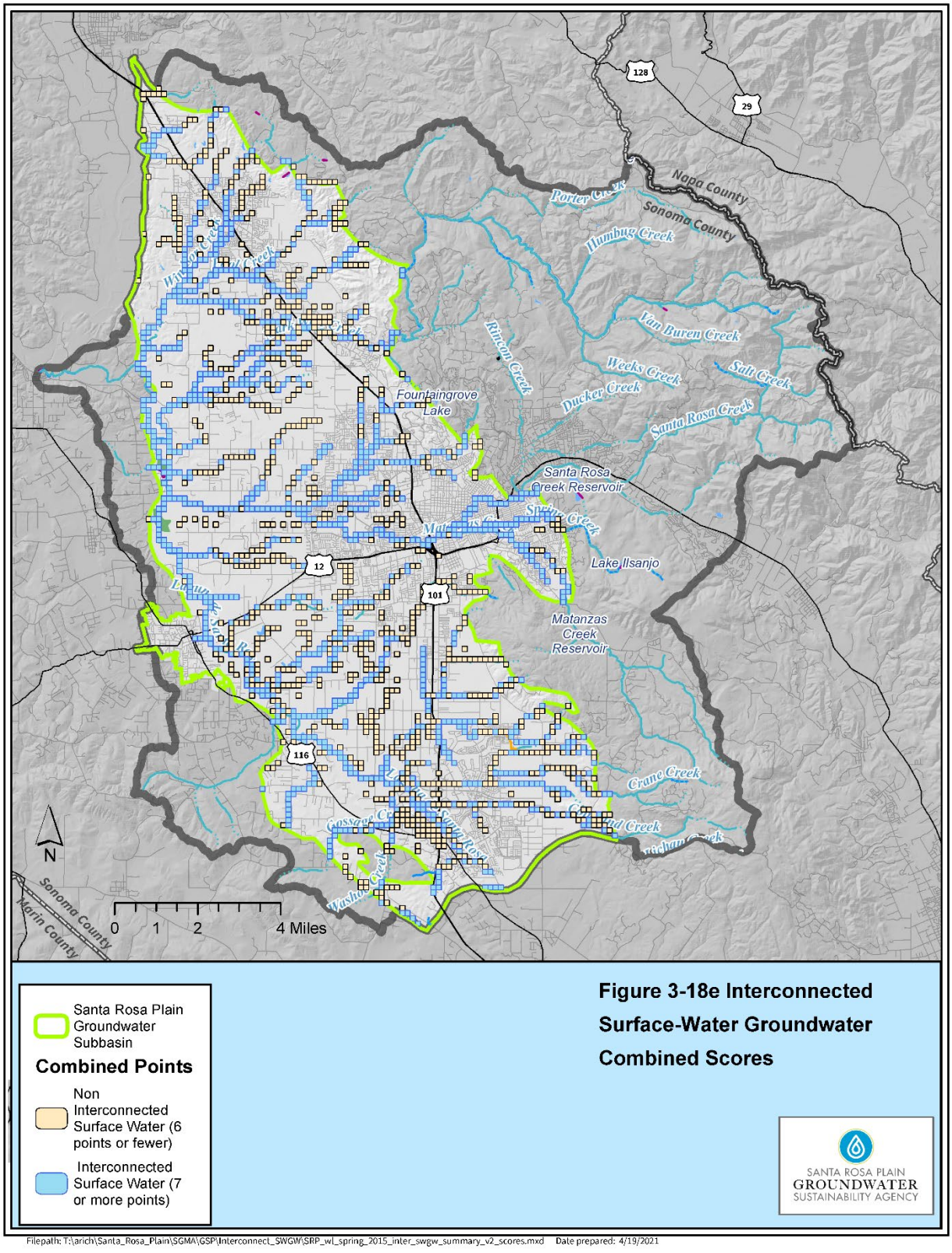


Figure 3-18e. Interconnected Surface Water Groundwater Combined Scores

The characterization of interconnected reaches of streams will continue to be evaluated and refined as additional data and information are gathered during implementation of the GSP.

3.2.6.3 Groundwater Dependent Ecosystems

SGMA defines an undesirable result as "depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water" (CA Water Code Section 10721 [w][6]). To help characterize environmental beneficial users, it is necessary to identify the aquatic species and habitats that could be adversely affected by lowered groundwater levels in principle aquifers and interconnected surface water depletion. The GSA partnered with the Petaluma Valley and Sonoma Valley GSAs to form a practitioner's work group to provide expert advice and perspectives. This group met three times between July and November 2020. Meeting summaries and meeting materials are included in **Appendix 4-C**. The GDE Work Group included staff, expert biologists from Sonoma Water, and representatives from the following groups:

- San Francisco Estuary Institute
- County of Sonoma Ag and Open Space Preservation District
- Sonoma Ecology Center
- California Department of Fish and Wildlife
- Permit Sonoma
- The Nature Conservancy
- National Marine Fisheries Service
- Laguna Foundation

SGMA defines GDEs as "ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface," which generally includes plant and animal communities that rely on shallow groundwater levels or interconnected surface water to meet all or some of their needs. The GDE Work Group focused on mapping aquatic species GDEs and vegetation GDEs that can be affected by groundwater conditions and management and are within the jurisdiction of the GSA. The methodology for mapping potential GDEs used information and guidance developed by The Nature Conservancy (TNC 2018) and the Groundwater Resource Hub (https://groundwaterresourcehub.org/).

3.2.6.4 Aquatic Species Groundwater Dependent Ecosystems

For mapping aquatic species GDEs, species listed in Critical Species LookBook (Rohde et al. 2019) were identified and include steelhead, Chinook salmon, coho salmon, California red-legged frog, and California tiger salamander. The Critical Species LookBook is a compendium of 84 state- and federally listed species that are likely to be affected by groundwater management and merit consideration by GSAs under the SGMA. Also, the federal- and state-endangered California freshwater shrimp was added at the request of resource agency staff. California tiger salamander was excluded because this species has "no known reliance on groundwater" (Rohde et al. 2019). The distribution of target species (species or groups of species specifically chosen for long-term monitoring) is based on frameworks developed for evaluating historically suitable coho salmon habitat (Leidy et al. 2005) and the salmonid sample frame developed for

coastal monitoring plan in the Russian River watershed (Sonoma Water and University of California Cooperative Extension/California Sea Grant 2014).

In the Santa Rosa Plain, a total of eight streams were identified as habitat for at least one target species. Steelhead was the most widespread species occurring in each of the eight streams. The distribution of Chinook salmon and coho salmon within Mark West Creek coincides with the distribution of steelhead. For this reason, steelhead are essentially used as a priority indicator species to cover all aquatic GDEs in the Subbasin. To provide a conservative assessment whether any segment of a stream has been identified as habitat for steelhead (priority indicator species for sensitive aquatic species), the entire stream reach downstream of any interconnected reaches is included as sensitive aquatic species GDE.

Vegetation Groundwater Dependent Ecosystems

For mapping vegetation GDEs high-resolution local mapping available from the Sonoma County Veg Map was used (Sonoma Veg Map 2013). Classifications considered to have a potential reliance on groundwater included the following general classifications:

- Riparian Woodland
- Oak Woodland
- Freshwater Marsh and Aquatic

To identify where these vegetation classes are likely to have some connection with groundwater conditions within the Subbasin, the rooting depths of common tree species were compared to available depth-to-groundwater (DTW) mapping.

Following guidance from TNC, potential vegetation GDEs were mapped for areas with DTW of 30 feet or less to incorporate the potential rooting depths of oak trees (TNC 2018). The DTW mapping utilized available contoured springtime datasets for the shallow aquifer system (from 2015 and 2016) and high-resolution LiDAR data. The resulting high-resolution DTW maps used to assess potential rooting depths are included with other GDE Work Group meeting materials and meeting summaries in **Appendix 4-C**. To address Work Group member concerns that groundwater levels were generally at lower levels in 2015 and 2016 due to dry conditions, minor adjustments in some areas were made to incorporate the shallowest depth-to-water on record for each well based on review of all available data from 2005 to 2020. Additionally, all riparian woodland and oak woodland habitat within 100 feet of mapped interconnected surface waters were included as potential vegetation GDEs.

Integrated Potential Groundwater Dependent Ecosystem Map

The potential aquatic species GDEs and the potential vegetation GDEs were then integrated into a single potential GDE map presented on **Figure 3-19**.

As further described in **Section 4** and **Section 7**, additional studies and data gathering are recommended during the implementation of the GSP to better define the mapping and relationship of GDEs to groundwater conditions within the Subbasin.

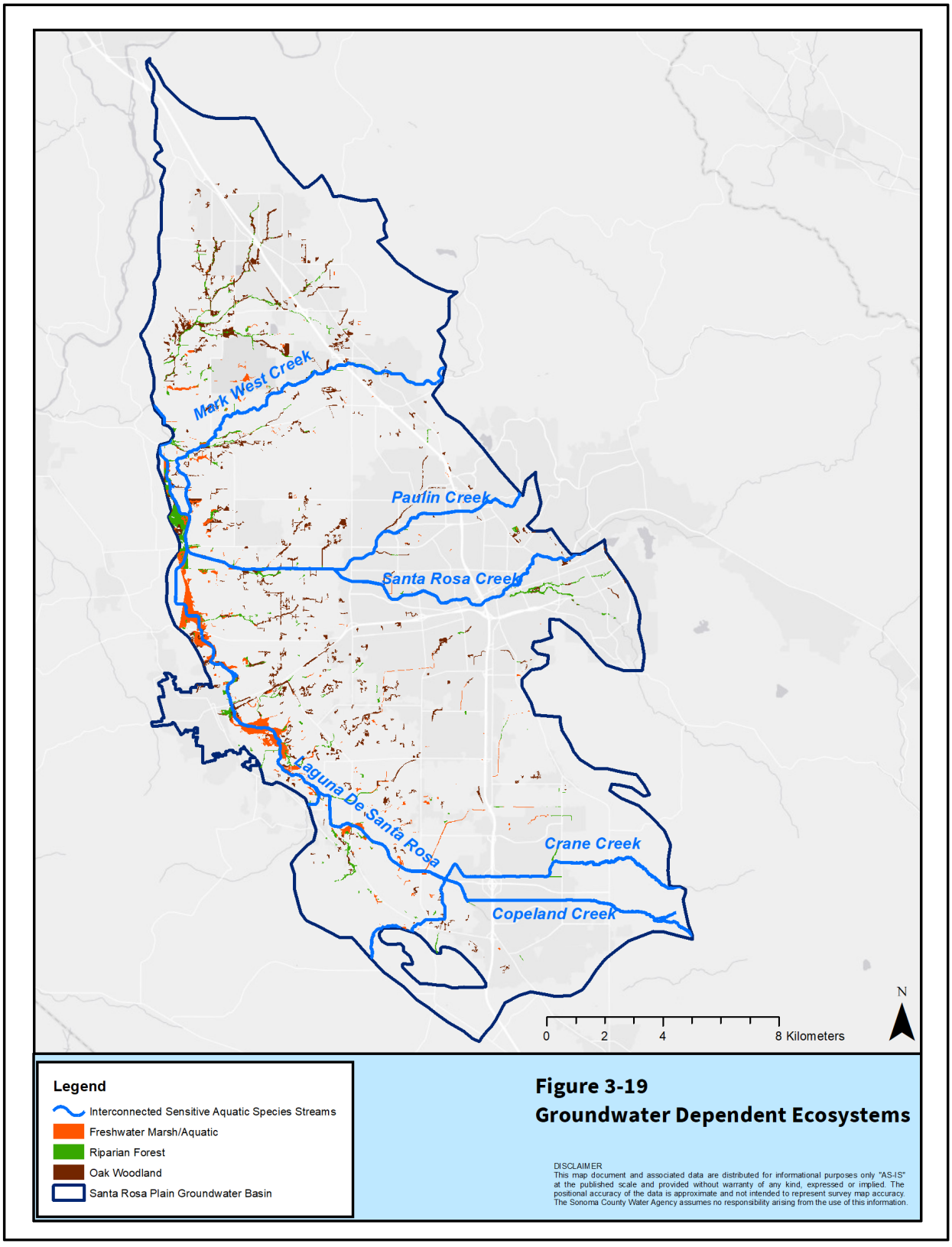


Figure 3-19. Groundwater Dependent Ecosystems

3.3 Water Budget

This section summarizes the estimated water budgets for the Subbasin, including information required by the SGMA Regulations and information that is important for developing an effective plan to achieve sustainability. In accordance with the GSP Regulations Section 354.18, this water budget provides an accounting and assessment of the total annual volume of surface water and groundwater entering and leaving the basin, including historical, current, and projected water budget conditions, and the change in the volume of groundwater in storage. Water budgets are reported in graphical and tabular formats, where applicable.

3.3.1 Overview of Water Budget Development

This section is subdivided into three subsections: (1) historical water budgets, (2) current water budgets, and (3) future water budgets. Within each of these subsections, a surface water budget and groundwater budget are presented. Water budgets were developed using the Santa Rosa Plain Hydrologic Model (SRPHM), originally developed by the USGS (Woolfenden and Nishikawa 2014), and revised by Sonoma Water for purposes of developing more accurate water budgets in the Subbasin. An overview of the model constructions and revisions made for this GSP are provided in **Appendix 3-C**. A detailed description of the construction and calibration of the original SRPHM can be found in the report by Woolfenden and Nishikawa (2014).

Before presenting the water budgets, a brief overview of the inflows and outflows pertaining to the Santa Rosa Plain Subbasin is provided.

In accordance with Section 354.18 of the GSP Regulations, one integrated groundwater budget was developed for the combined inflows and outflows for the two principal aquifers for each water budget period. Groundwater is pumped from both principal aquifers for beneficial use.

3.3.1.1 Water Budget Components

The water budget is an inventory of surface water and groundwater inflows and outflows from the Subbasin. A few components of the water budget can be measured, such as groundwater pumping from a metered well. Other components of the water budget are estimated, such as septic return flows and unmetered domestic groundwater pumping. Additional components of the water budget are simulated by SRPHM, such as unmetered agricultural pumping, recharge from precipitation and irrigation return flows, and change of groundwater in storage.

Figure 3-20 presents the general schematic diagram of the hydrologic cycle (DWR 2016d).

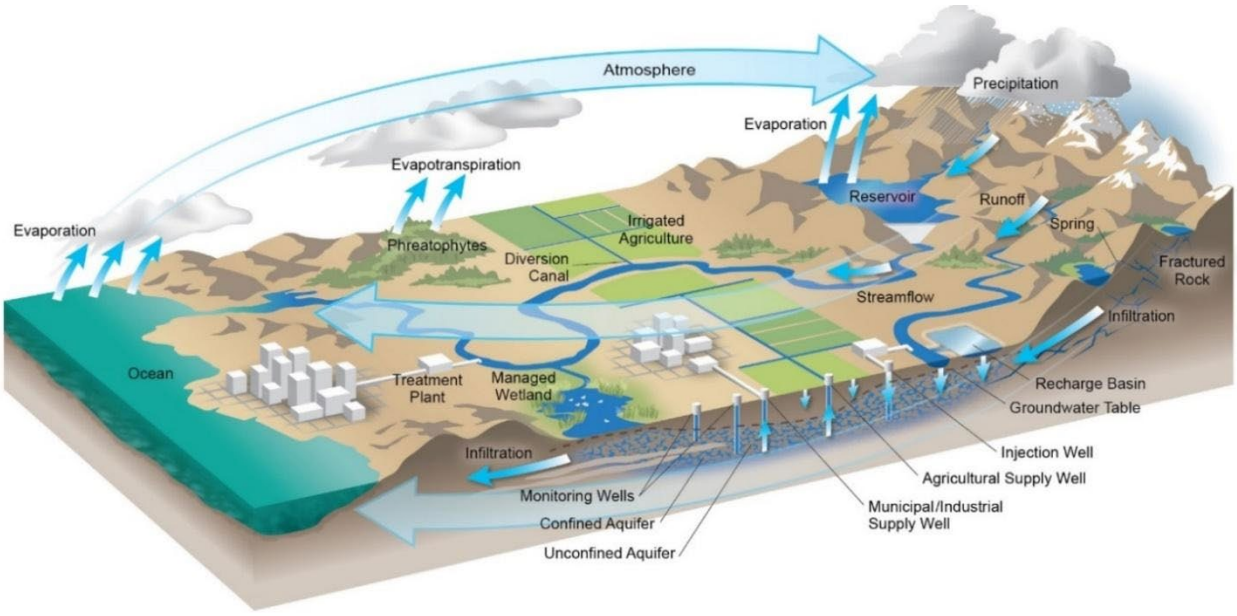


Figure 3-20. Schematic Hydrologic Cycle
Source: DWR 2016d

The water budgets for the Subbasin are calculated within the following boundaries:

- Lateral boundaries: The perimeter of the Santa Rosa Plain Subbasin as shown on **Figure 3-21.**
- Bottom: Base of the groundwater subbasin is approximately 2,000 feet, which is the depth below which groundwater is generally not considered usable. The water budget is not sensitive to the exact definition of this base elevation because it is defined as a depth below where there is not significant inflow, outflow, or change in storage.
- Top: Above the ground surface, such that surface water is included in the water budget.

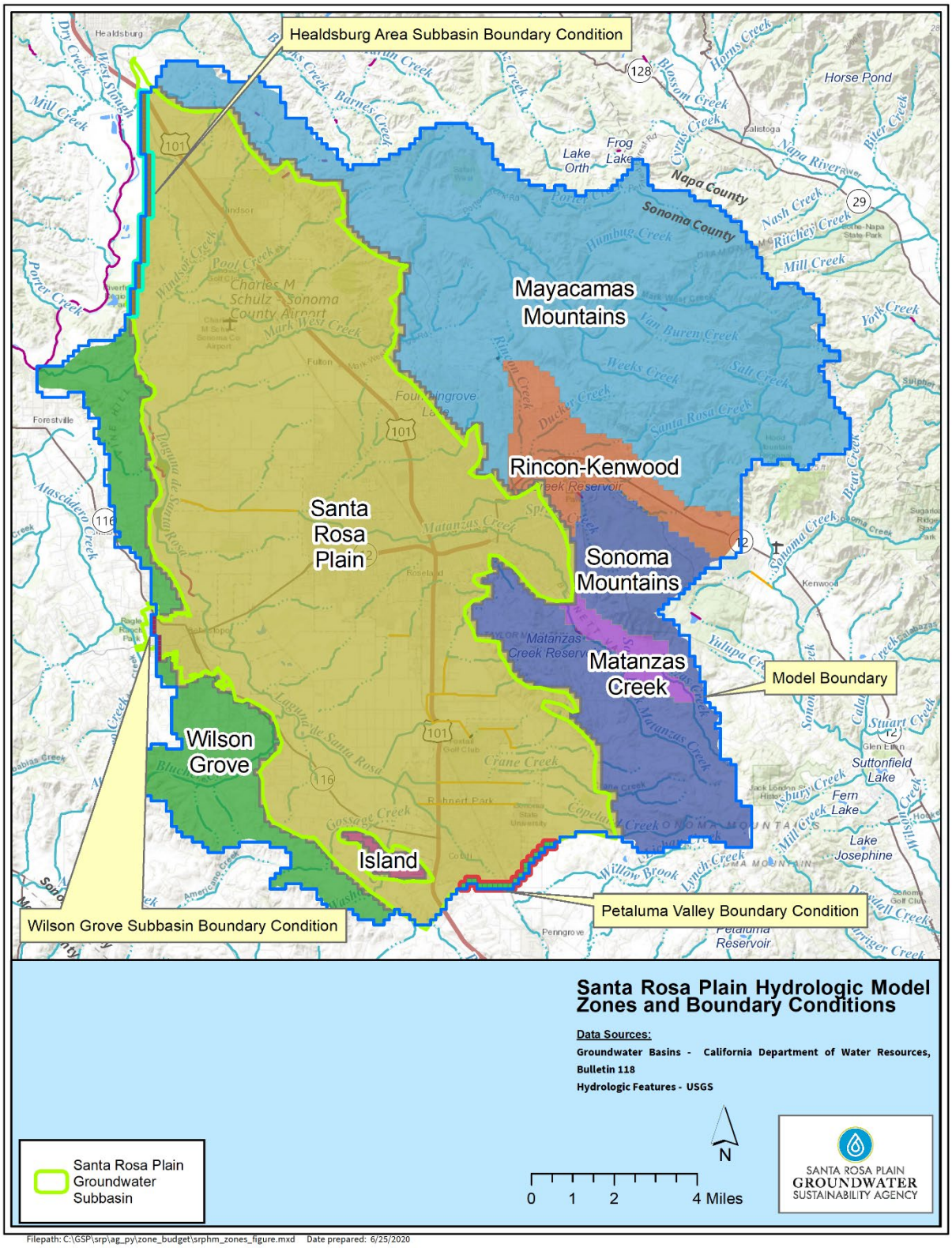


Figure 3-21. Zones and Boundary Conditions for the Santa Rosa Plain Hydrologic Model

The Santa Rosa Plain Subbasin includes the following inflows and outflows:

Surface Water Inflows:

- Runoff of precipitation (overland flow)
- Surface water inflows from creeks that enter the Subbasin: Mark West Creek, Santa Rosa Creek, Laguna de Santa Rosa, Blucher Creek, Windsor Creek, Copeland Creek, and other smaller streams
- Groundwater discharge to streams

Surface Water Outflows:

- Streambed recharge to groundwater
- Outflow to neighboring subbasins
    - Outflow of Mark West Creek and Windsor Creek
    - Outflow to Petaluma River and Estero de Santa Antonio to the Petaluma Valley Basin
    - Outflow of combination of other smaller streams
- Evaporation (assumed to be negligible compared to other surface water outflows)
- Direct diversions are not currently simulated in the model for lack of data accuracy; however, estimates are provided through summaries of eWRIMS data

The inflow and outflow locations are shown on **Figure 3-22**, along with the Hydrologic Unit Code (HUC) 12 (USGS 2006) boundaries that define the subregions used to aggregate inflows and outflows into the Subbasin.

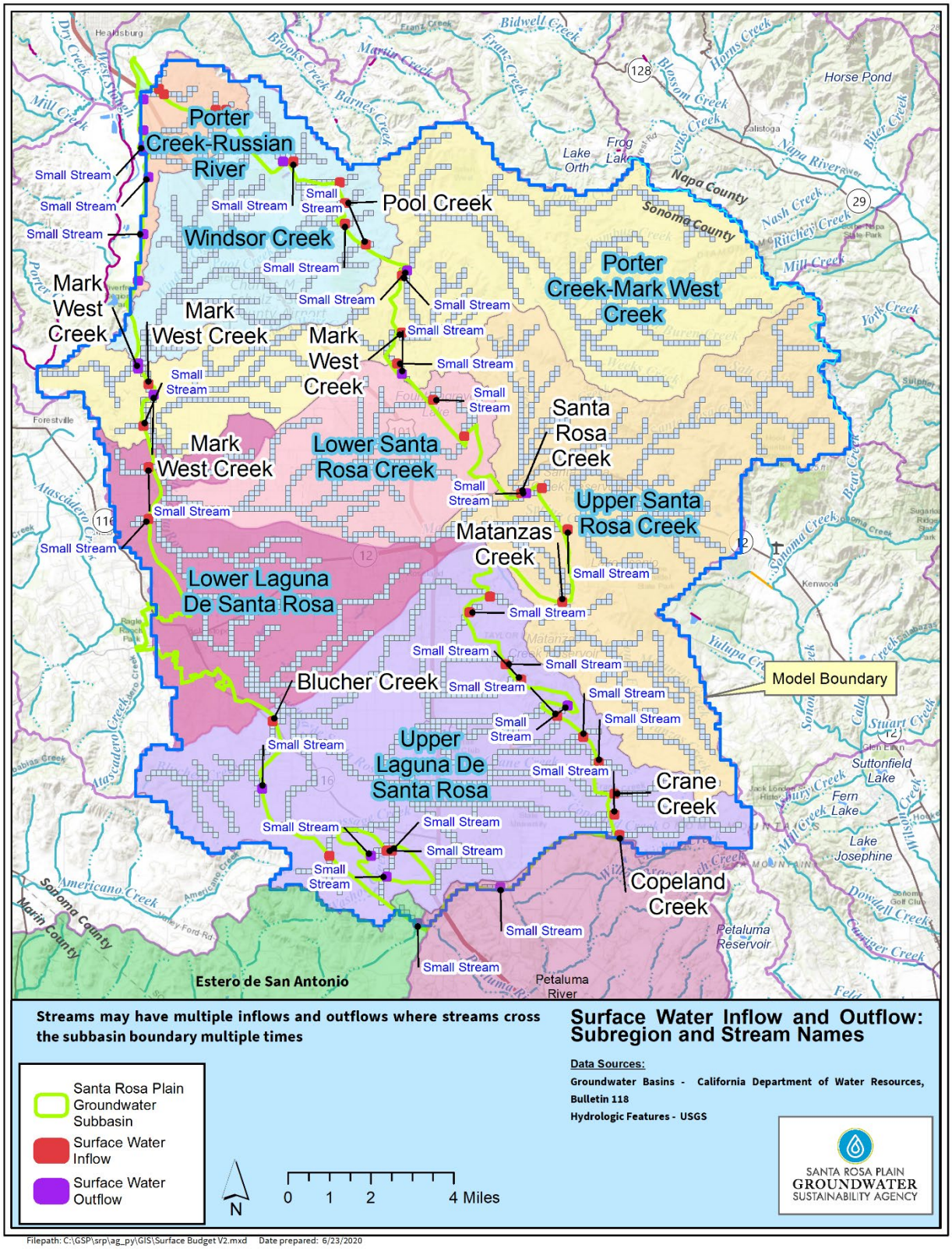


Figure 3-22. Surface Water inflow and Outflow: Subregion and Stream Names

Groundwater Inflows:

- Deep percolation from precipitation and applied irrigation water
- Septic return flows
- Streambed recharge to groundwater
- Subsurface inflows:
    - Inflow from Wilson Grove Formation Highlands Subbasin (Wilson Grove Subbasin and Wilson Grove Subbasin Boundary Condition on **Figure 3-22**)
    - Inflow from Healdsburg Area Subbasin (Healdsburg Area Subbasin Boundary Condition on **Figure 3-22**)
    - Inflow from Petaluma Valley Basin (Petaluma Valley Subbasin Boundary Condition on **Figure 3-22**)
    - Inflow from Rincon-Kenwood Subbasin
- Subsurface inflow from the surrounding watershed that are not other DWR subbasins, or mountain-front recharge (including the "island" just west of Cotati [**Figure 3-22**])

Groundwater Outflows:

- Crop, native vegetation and riparian ET
- Groundwater pumping (including municipal and industrial, rural domestic, and agricultural)
- Groundwater discharge to streams
- Subsurface outflows:
    - Outflow to Wilson Grove Formation Highlands Subbasin (Wilson Grove Subbasin and Wilson Grove Subbasin Boundary Condition on **Figure 3-22**)
    - Outflow to Healdsburg Area Subbasin (Healdsburg Area Subbasin Boundary Condition on **Figure 3-22**)
    - Outflow to Petaluma Valley Subbasin (Petaluma Valley Basin Boundary Condition on **Figure 3-22**)
    - Outflow to Rincon-Kenwood Subbasin
- Surface leakage, which is groundwater discharge to soil zone (rejected recharge to the surface in shallow groundwater areas)

Water infiltrates into the soil zone through a few processes, including infiltration of precipitation and applied agricultural irrigation water. Once in the soil storage reservoirs, it may end up as recharge but there is no way to distinguish different fates between the two. Because of this, deep percolation from precipitation and applied irrigation water are combined as one groundwater inflow term. However, precipitation is a far greater source of recharge than applied irrigation water over a yearly time period.

The difference between groundwater inflows and outflows is equal to the change of groundwater in storage.

3.3.1.2 Water Budget Time Frames

In estimating the Subbasin water budget, a time period for the budget needs to be specified. The GSP Regulations require water budgets for three different timeframes, representing historical conditions, current conditions, and projected conditions, as follows:

- The historical water budget is intended to evaluate how past water supply availability has affected aquifer conditions and the ability of groundwater users to operate within the sustainable yield. GSP Regulations require that the historical water budget includes at least the most recent 10 years of water budget information. DWR's Water Budget BMP document (DWR 2016d) further states that the historical water budget should help develop an understanding of how historical conditions concerning hydrology, water demand, and surface water supply availability or reliability have impacted the ability to operate the basin within the sustainable yield. Accordingly, historical conditions should go back to the most reliable historical data that are available for GSP development and water budgets calculations.

- The current water budget is intended to allow the GSA and DWR to understand the existing supply, demand, and change in storage under the most recent population, land use, and hydrologic conditions. Current conditions are generally the "most recent conditions" for which adequate data are available and that represent recent climatic and hydrologic conditions. Current conditions are not well-defined by DWR but can include an average over a few recent years with various climatic and hydrologic conditions (for example, centered around the most recent drought in 2015, which is also the effective date of SGMA).

- The projected water budget is intended to quantify the estimated future baseline conditions both with and without implementation of potential GSP projects and management actions. The projected water budget is based on information from the historical budget and includes an assessment of uncertainty. The projected water budget estimates the future baseline conditions concerning hydrology, water demand, and surface water supply over a 50-year planning and implementation horizon. It is based on historical trends in hydrologic conditions, which are used to project forward 50 years while considering projected climate change and sea level rise (if applicable).

Although there is a significant seasonal variation between wet and dry seasons, the GSP does not consider seasonal water budgets for the groundwater budget. All water budgets are developed for complete WY(s). Though not required, a monthly water budget is shown for the surface water budget because of the importance of seasonal flow regimes for GDEs. Selected time periods for the historical and current water budgets are summarized in **Table 3-2** and on **Figure 3-23,** and described in **Sections 3.3.3.1** and **3.3.3.2**.

Table 3-2. Summary of Historical and Current Water Budget Time Periods

Time Period	Proposed Date Range	WY Types Represented in Time Period	Rationale
Historical	WYs 1976 to 2018	Very dry: 1 Dry: 7 Normal: 20 Wet: 13 Very wet: 2	Based on entire model timeframe (after a 1-year model spin-up period). Provides insights on water budget response to a wide range of variations in climate and groundwater use over an extensive period of record.
Current	WYs 2012 to 2018	Very dry: 0 Dry: 2 Normal: 4 Wet: 1 Very wet: 0	Best reflection of current land use and water-use conditions with a range of recent climate variability.

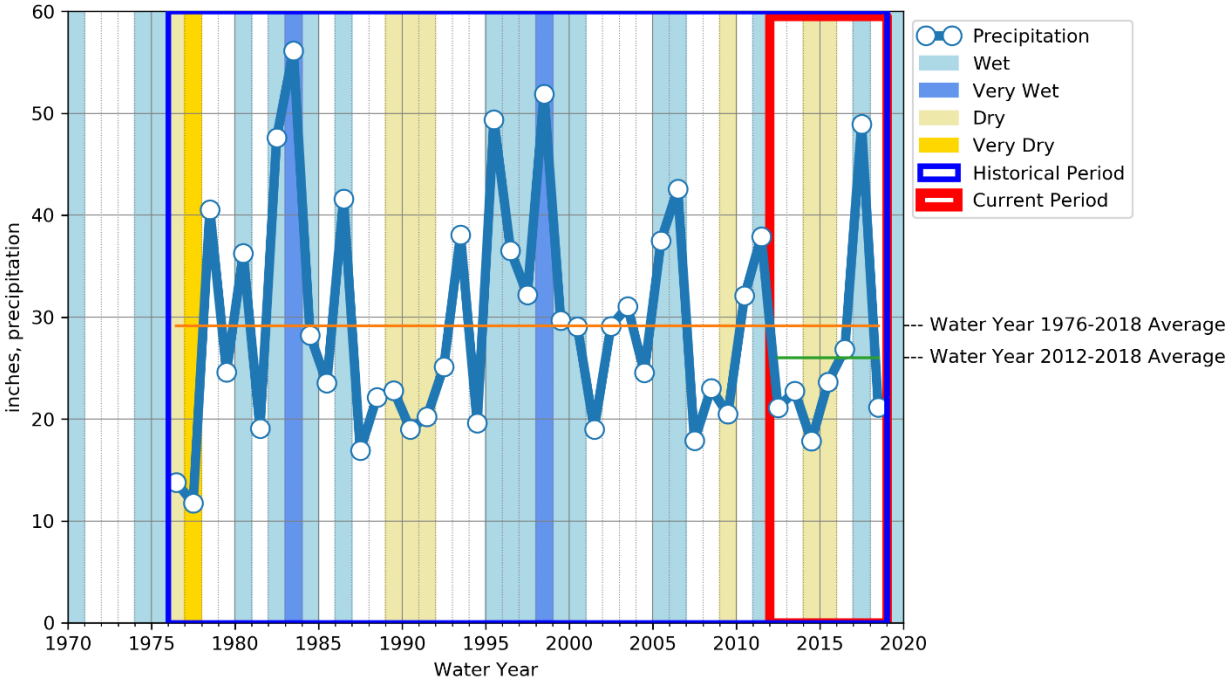


Figure 3-23. Climate and Precipitation for Historical and Current Water Budget Time Periods
Years with no color are "normal" water year type.

Historical Water Budgets Time Period

The only specific GSP guideline requirement is that the historical water budget be at least 10 years.

From Section 354.18. Water Budget: A quantitative assessment of the historical water budget, starting with the most recently available information and extending back a minimum of 10

years, or as is sufficient to calibrate and reduce the uncertainty of the tools and methods used to estimate and project future water budget information and future aquifer response to proposed sustainable groundwater management practices over the planning and implementation horizon.

The water budget is computed using the revised SRPHM, which simulates the time period from October 1974 to December 2018 encompassing the period of best available science and information for the Subbasin. It is recommended that the first year of the model simulation is used as a "spin-up" period to account for possible boundary effects influences of initial conditions; in other words, so that the model equilibrates with the initial conditions. The SRPHM fully covers WYs 1975 to 2018, and therefore, the historical period is selected to encompass WYs 1976 to 2018 (a 43-year period).

Current Water Budgets Time Period

The current water budget time period is also computed using the revised SRPHM and is based on the average of conditions between WYs 2012 through 2018 (a 7-year period). This time period includes 2 years classified as dry, 1 year classified as wet, and 4 years classified as normal, providing both pre-and post-drought WYs so that a variety of WY types are covered in the current average. This time period is also most reflective of current and recent patterns of groundwater use and imported surface water deliveries.

Future Projected Water Budgets Time Period

Future projected conditions are based on model simulations using the revised SRPHM numerical flow model and using projected land use changes, population growth estimates, and a projected climate change scenario. Projected climate based on the selected general circulation model (GCM) will represent WY 2020 through 2071.

3.3.2 Overview of Model Assumptions for Water Budget Development

All groundwater models contain assumptions and some level of uncertainty, particularly when predicting future conditions. Model uncertainty stems from heterogeneity in Subbasin and the surrounding watershed geology, hydrology, and climate, in addition to assumptions regarding unmetered groundwater pumping. However, inputs to the SRPHM are carefully selected using best available data, resulting in a model well suited to simulate Subbasin hydrogeologic conditions. As GSP implementation proceeds, the SRPHM will be updated and recalibrated with new data to better inform model simulations of current and projected water budgets.

The USGS report discusses model assumptions and uncertainty. Some of the more significant model limitations identified by the USGS include uncertainties in the following:

- Estimates and spatial distribution of agricultural and rural domestic pumpage
- Amount and spatial distribution of precipitation
- Long-term streamflow discharge
- Vertical distribution of hydraulic head in deeper aquifer zones

Figure 3-24 depicts the SRPHM modules that contribute to the various water budget components. **Table 3-3** provides the detailed water budget components and model assumptions and limitations for each.

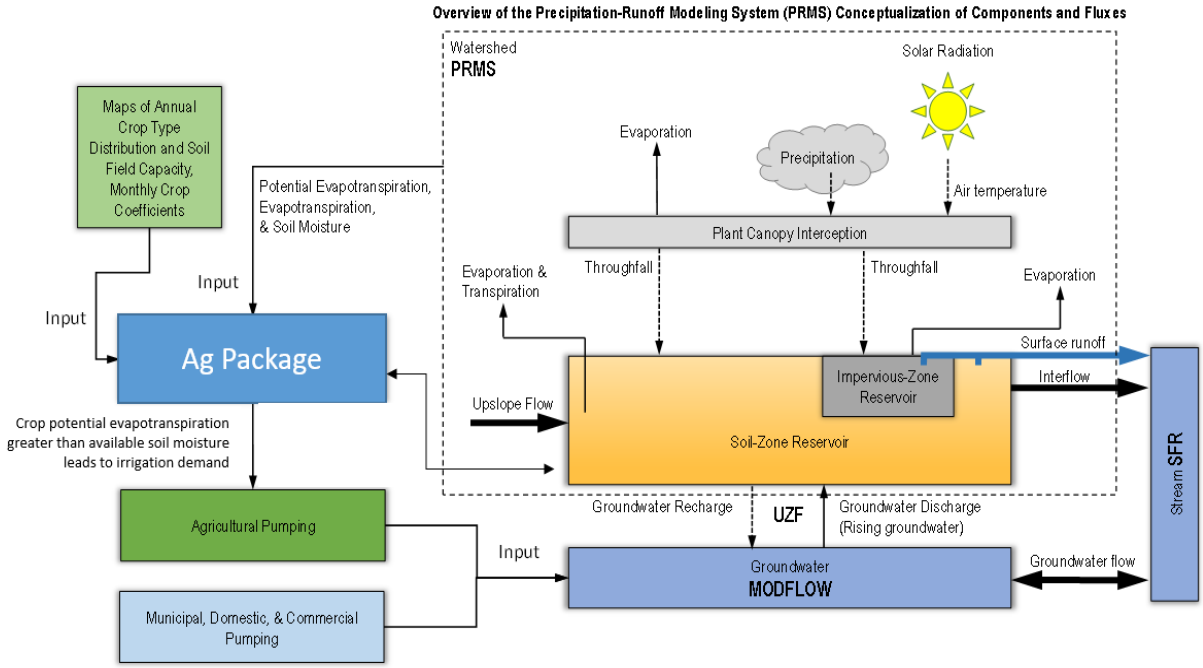


Figure 3-24. Overview of the SRPHM Modules

Table 3-3. Santa Rosa Plain Hydrologic Model - Summary of Water Budget Component Data Sources

Water Budget Component	Source of Model Input Data	Limitations
Precipitation	Measured precipitation at two stations within the Subbasin; spatially distributed for historical simulations.	Spatial distribution of precipitation may change with changing climate.
ET from Soil Zone	Measured and estimated temperature spatially distributed for historical simulations from two climate stations; future climate temperature uses same spatial distribution as historical simulations. Simulated from calibration to potential ET.	Not simulated from surface water bodies or riparian vegetation.
Soil Moisture	Simulated from calibrated model.	Not measured but based on calibration of streamflow to available data from gaged creeks.
Surface Water Inflows		
Inflow from Streams Entering Basin	Simulated from calibrated model for all creeks.	Not all creeks are gaged.
Groundwater Discharge to Streams	Simulated from calibrated model.	Based on calibration of streamflow to available data from gaged creeks.

Water Budget Component	Source of Model Input Data	Limitations
Overland Runoff	Simulated from calibrated model.	Based on calibration of streamflow to available data from gaged creeks.
Surface Water Outflows		
Streambed Recharge to Groundwater	Simulated from calibrated model.	Based on calibration of streamflow to available data from gaged creeks.
Diversions	Not modeled.	Diversions known to exist, but are currently limited in number and small in magnitude.
Streambed Recharge to Groundwater	Simulated from calibrated model.	Based on calibration of streamflow to available data from gaged creeks.
Groundwater Inflows		
Deep Percolation of Precipitation	Measured precipitation spatially distributed for historical simulations and percolation simulated by watershed component of calibrated model.	Based on calibration of streamflow to available data from gaged creeks. Simulated model output combined with irrigation return flows.
Streambed Recharge to Groundwater	Simulated from calibrated model.	Based on calibration of streamflow to available data from gaged creeks.
Irrigation Return Flows	Simulated from demands based on crop, acreage, temperature, and soil-zone processes.	Based on land use datasets of 8 years to represent historical period and regional crop coefficient values. Simulated model output combined with deep percolation of precipitation. These years are 1976, 1979, 1986, 1999, 2008, 2012, 2014, and 2016.
Septic System Return Flows	Estimated based on percentage of indoor water use for non-sewered parcels.	Based on uniform estimates indoor use and estimate of return flow from indoor use.
Subsurface Inflow from Neighboring Basins	Simulated from calibrated model.	Limited groundwater calibration data in adjacent basins.
Subsurface Inflow from Surrounding Watershed Other than Neighboring Basins	Simulated from calibrated model.	Limited data for calibration.
Groundwater Outflows		
Groundwater Pumping	Metered for historical municipal pumping and some small water systems.	Nonmunicipal domestic pumping based on uniform estimate of indoor use per parcel and uniform irrigation depth. Simulated agricultural irrigation based on land use datasets of 8 years to represent historical period and regional crop coefficient values.
	Estimated for nonmunicipal domestic pumping.	
	Simulated from model for agricultural and large-scale turf irrigation.	
Groundwater Discharge to Streams	Simulated from calibrated model.	Based on calibration of streamflow to available data from gaged creeks.

Water Budget Component	Source of Model Input Data	Limitations
Subsurface Outflow to Adjacent Basins	Simulated from calibrated model.	Limited calibration data in adjacent boundaries.
Riparian ET	Simulated from calibrated model.	Based on uniform extinction depth.
Surface Leakage (Flow to Soil Zone)	Simulated from calibrated model.	Based on calibration of streamflow to available data from gaged creeks.

3.3.3 Historical and Current Water Budgets

Water budgets for the historical (WYs 1976–2018) and current (WYs 2012–2018) are presented in 3.3.3.1 and 3.3.3.2. The surface water budgets are presented first, then the groundwater budgets are presented. Watershed budgets are also presented to show how precipitation provides water supply to the surface water and groundwater budgets, as well as a soil-zone budget of the Subbasin. The detailed surface water, watershed, and soil-zone water budgets are not required components of the GSP but are presented to provide insight into the hydrologic cycle in the Subbasin.

3.3.3.1 Surface Water Budget

The surface water budget shows the inflows and outflows for the streams within the Santa Rosa Plain Subbasin. This includes streamflows of tributaries that enter and exit the Subbasin as well as flows into and out of streams within the Subbasin. The number of stream inflow and outflows locations for each HUC 12 and stream are presented in **Table 3-4**. Flows within the Subbasin include overland runoff to streams and stream-aquifer interactions (net streambed exchange). The model does not simulate diversions from the streams. Stream-aquifer interactions within the Subbasin, including recharge to groundwater and discharge from groundwater, are also part of the groundwater budget. The net streambed exchange is not equal to the net stream leakage in the groundwater budget because there may be flow out of streams to the unsaturated zone.

Figure 3-25 shows the surface water budget for the historical period, which also includes the current period. **Table 3-5** and **Table 3-6** show summary statistics of surface water budget for the historical and current periods, respectively. Positive values are inflows into the stream system, and negative values are outflows from the stream system. A positive net streambed exchange indicates more groundwater discharge to streams than stream seepage to groundwater. Boundary inflows and outflows dominate the surface water budget. **Figure 3-26** indicates that streamflows exiting the Subbasin are generally double the streamflows entering the Subbasin, which is primarily due to overland runoff that occurs within the Subbasin. On average, groundwater discharge to streams exceeds streambed losses, resulting in a net streambed exchange into streams of approximately 300 AFY. The value of the net streambed exchange depends less on year-to-year variability in precipitation, and more on 5- to 10-year (climatic) variability in precipitation. WY 2017 is one of the top 3 wettest years in the historical period but still experiences a negative streambed exchange. This is because WYs 2012 to 2016 were all dry or normal precipitation years. Consequently, in the current period there is a negative net streambed exchange of -1,300 AFY. **Figure 3-26** shows net stream inflows and

outflows at the Subbasin boundaries by HUC 12 subregion. Subregions with negative flows are those where the streamflow is greater at its outflow than at its inflows at Subbasin boundaries, and those with positive values have greater inflows than outflows (**Figure 3-26**). Not all subregions have both inflows and outflows that cross the Subbasin boundary. **Table 3-4** lists the number of inflow and outflow locations by HUC region and stream name. Mark West Creek, for example, crosses the Subbasin boundary at the eastern and the western boundary before finally discharging from the basin near Trenton. The largest net streamflows entering the Subbasin are from Upper Santa Rosa Creek and Upper Laguna de Santa Rosa. The largest net streamflows exiting the Subbasin are from Porter Creek-Mark West Creek and Windsor Creek (**Figure 3-26**). The net combined surface water outflow from the Subbasin ranges from 47,000 to 1,165,000 AFY. **Figure 3-27** displays only stream inflows entering the Subbasin, as well as removing intermediate inflows and outflows. Intermediate flows are inflows and outflows where stream segments leave and re-enter the basin. The largest inflows into the Subbasin are from Porter Creek-Mark West Creek and Upper Santa Rosa Creek.

Figure 3-28 shows the surface water budget components as hydrographs for a wet WY and a normal WY. WY 1999 is the fifth of 5 consecutive wet WYs, whereas WY 2016 is a normal WY that follows 2 previous dry WYs in 2014 and 2015. In WY 1999 stream inflows at the Subbasin boundary and overland runoff are the main contributors to flows from December to May. From December to March net streambed recharge averages roughly zero, then becomes consistently positive from April until the end of the WY. The stream budget is distinctly different in the normal WY of 2016. Early in the WY of 2016, from October to February, net streambed exchange is entirely into the groundwater system from the streambed, generating about 2,000 acre-feet of recharge in both January and February. In the summer, the groundwater system provides baseflow in May and June, but this tapers off by July when the surface water system returns to losing water to the groundwater system.

Average monthly budget components for the surface water system are shown on **Figure 3-29** for the historical and current budget periods. The historical period receives greater surface water inflows at the boundaries than does the current period for the first half of the calendar year. For the second half of the calendar year the current period has greater stream inflows and outflows at the Subbasin boundary. The historic period net stream recharge is either more positive than, or less negative than, the current period net stream recharge from March through December. This likely reflects the impacts of a drier current period than the historical period and the cumulative impacts of groundwater pumpage.

Table 3-4. Number of Stream Inflow and Outflow Locations for Each HUC 12 Area and Major Stream[a]

HUC 12 Region Name	Stream Name	Number of Stream Inflow Segments	Number of Stream Outflow Segments
Lower Laguna De Santa Rosa	Small Stream	2	0
Lower Santa Rosa Creek	Small Stream	2	0
Petaluma River-Estero de San Antonio	Small Stream	0	2
Porter Creek-Mark West Creek	Mark West Creek	2	2
Porter Creek-Mark West Creek	Small Stream	3	2

HUC 12 Region Name	Stream Name	Number of Stream Inflow Segments	Number of Stream Outflow Segments
Porter Creek-Russian River	Small Stream	4	7
Upper Laguna de Santa Rosa	Blucher Creek	1	0
Upper Laguna de Santa Rosa	Colgan Creek	1	0
Upper Laguna de Santa Rosa	Copeland Creek	1	0
Upper Laguna de Santa Rosa	Crane Creek	1	0
Upper Laguna de Santa Rosa	Gossage Creek	1	0
Upper Laguna de Santa Rosa	Small Stream	12	4
Upper Santa Rosa Creek	Matanzas Creek	1	0
Upper Santa Rosa Creek	Santa Rosa Creek	1	0
Upper Santa Rosa Creek	Small Stream	2	1
Windsor Creek	Pool Creek	1	0
Windsor Creek	Small Stream	3	1
Windsor Creek	Windsor Creek	1	1
Windsor Creek	Wright Creek	1	0

[a] Refer to **Figure 3-22** for HUC 12 Regions and Streams.

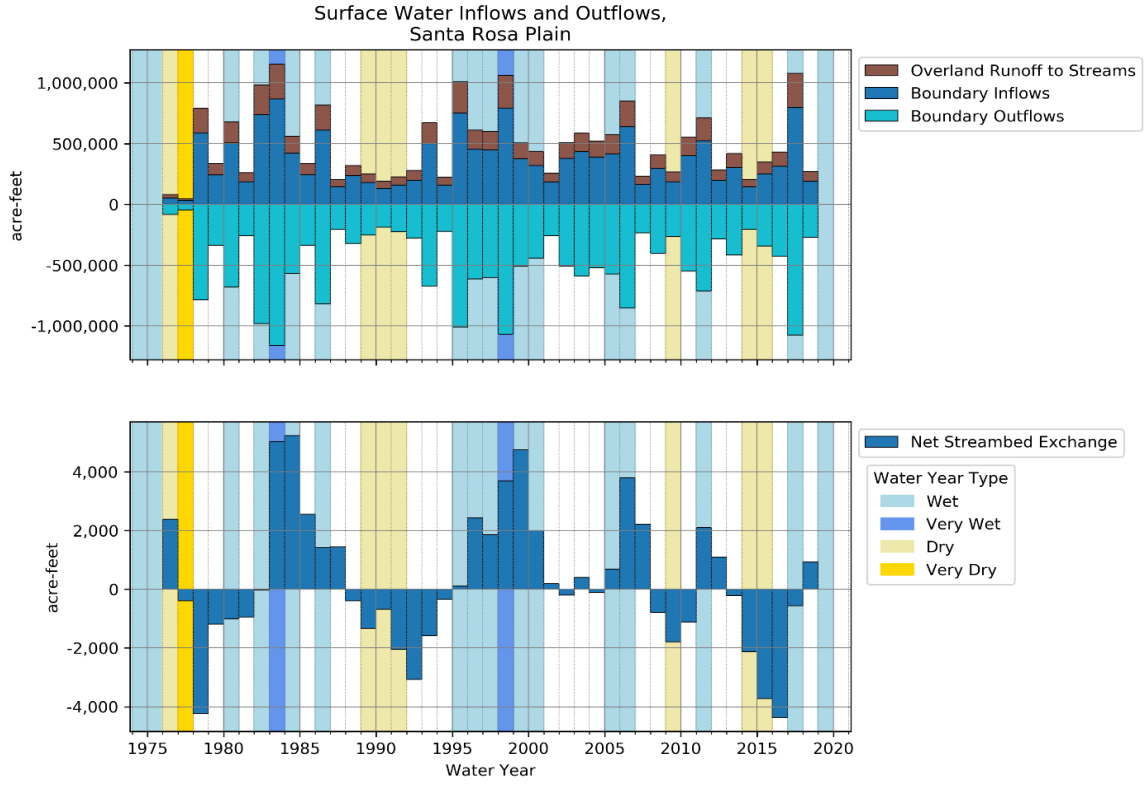


Figure 3-25. Historical and Current Surface Water Budget

Table 3-5. Historical (WY 1976 to WY 2018) Surface Water Budget Summary (AFY)[a]

	Net Streambed Exchange	Overland Runoff to Streams	Boundary Outflows	Boundary Inflows
Mean	300	130,200	-492,200	362,000
Minimum	-4,400	15,700	-1,161,600	31,200
Maximum	5,200	288,900	-46,600	868,500
Median	-100	118,600	-427,600	312,300

[a] Values are rounded to the nearest 100 acre-feet.

Table 3-6. Current (WY 2012 to WY 2018) Surface Water Budget Summary (AFY)[a]

	Net Streambed Exchange	Overland Runoff to Streams	Boundary Outflows	Boundary Inflows
Mean	-1,300	119,900	-432,200	313,700
Minimum	-4,400	64,000	-1,077,900	142,600
Maximum	1,100	282,100	-204,500	797,000
Median	-600	95,300	-342,900	251,300

[a] Values are rounded to the nearest 100 acre-feet.

Net boundary inflows and outflows by subregion and stream name

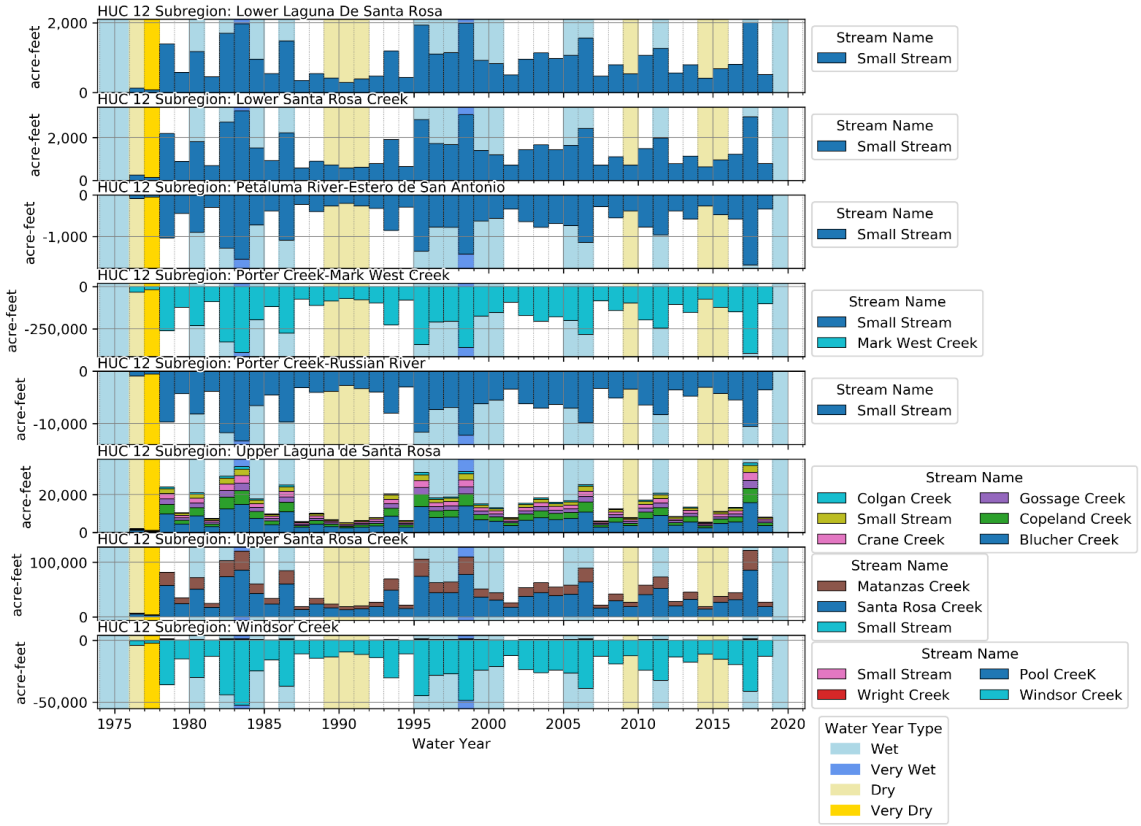


Figure 3-26. Net Boundary Inflows and Outflows by HUC 12 Subregion and Stream Name

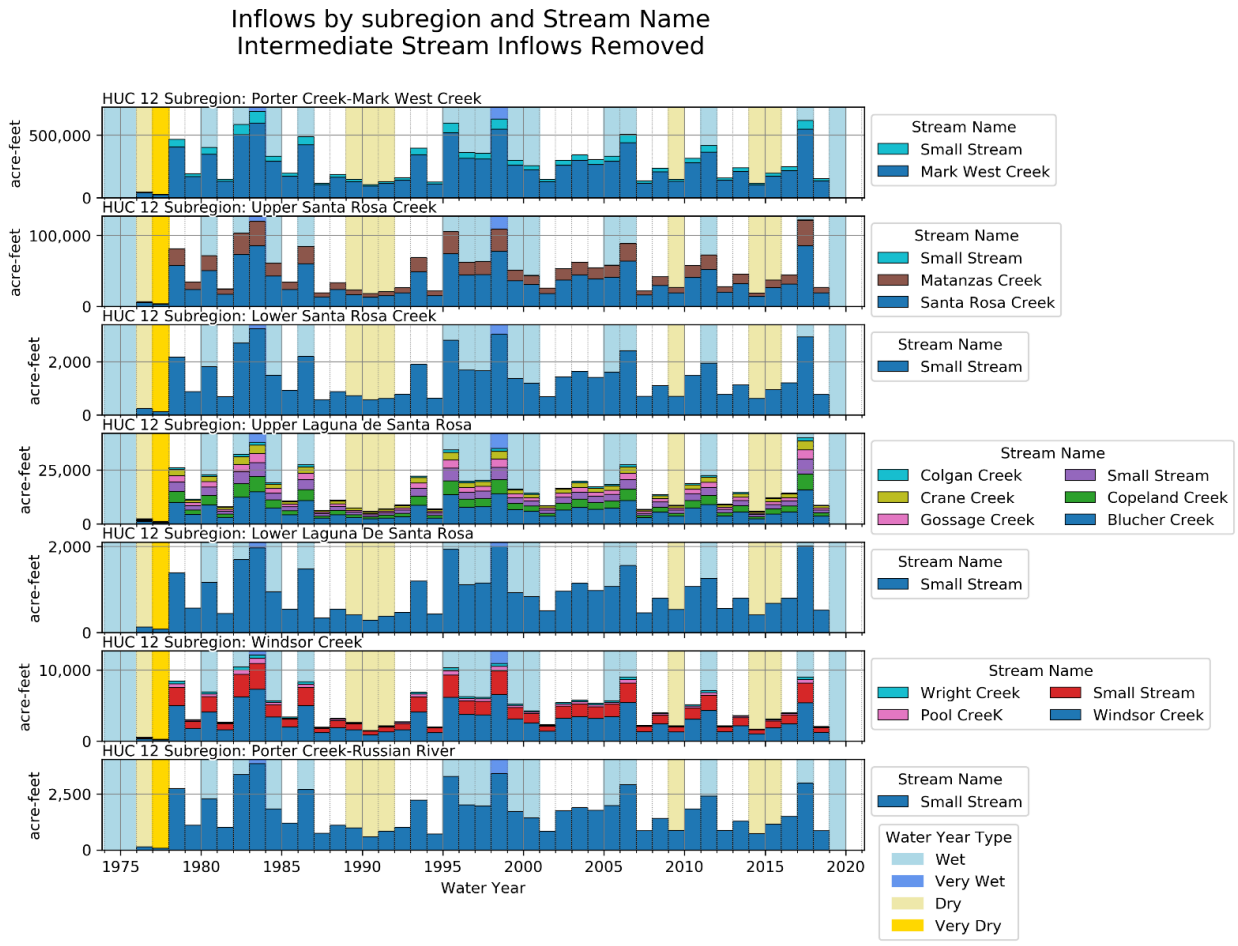


Figure 3-27. Inflows by HUC 12 Subregion and Stream Name[1]

[1] Intermediate inflows removed; values intended to represent surface inflows at headwaters where streams cross the boundary the first time. Some streams cross the Subbasin boundary multiple times, but only the inflows from the initial inflow location are shown here.

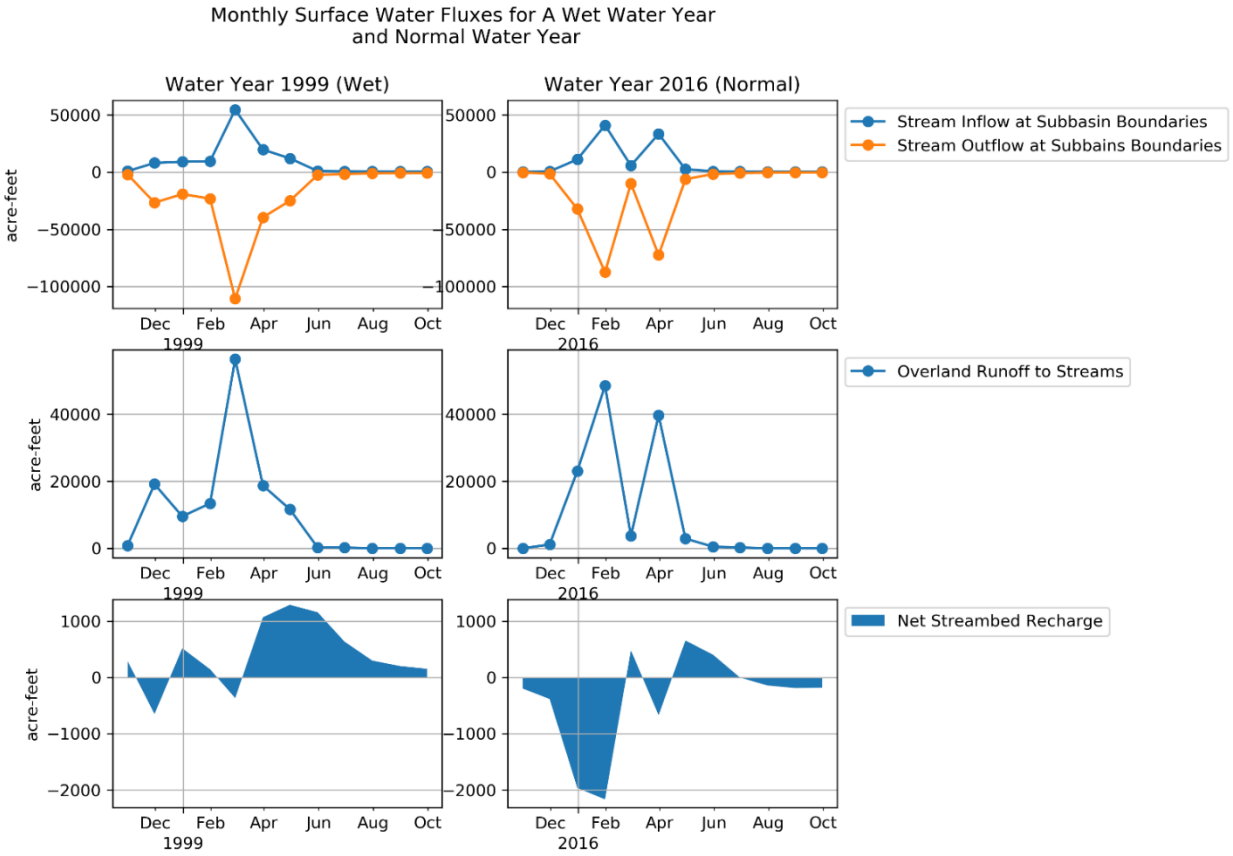


Figure 3-28. Monthly Surface Water Fluxes for a Wet Water Year and Normal Water Year

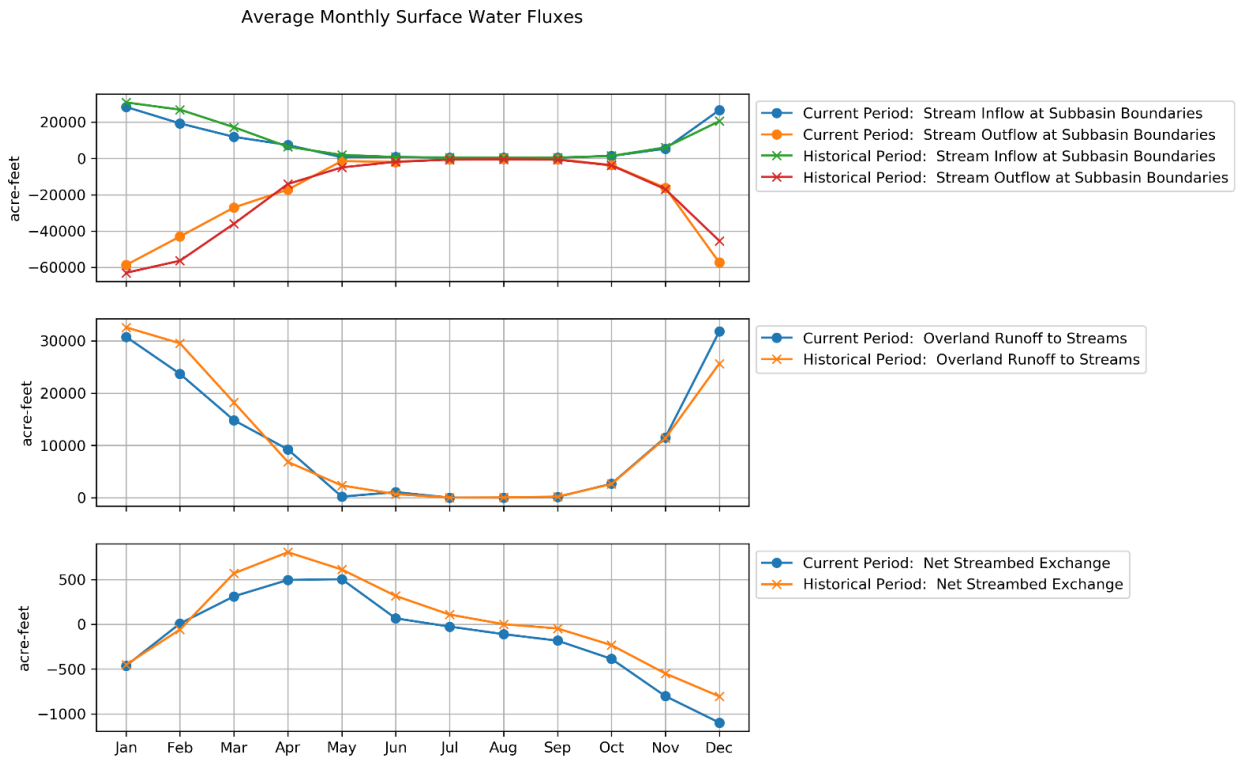


Figure 3-29. Average Monthly Surface Water Fluxes the Historical and Current Periods

3.3.3.2 Groundwater Budget

The groundwater budget shows the inflows and outflows for the saturated aquifer system of the Santa Rosa Plain Subbasin. This includes inflows and outflows of groundwater at the Subbasin boundaries, recharge, pumping, and flows of groundwater to and from streams, the surface, and the ET.

Figure 3-30 shows inflows to the groundwater system for the historical and current time periods. The majority of groundwater inflow into the Subbasin are: (1) the percolation of precipitation and applied agricultural irrigation water (53 percent of total), (2) streambed recharge (28 percent of total), and (3) subsurface inflow from neighboring DWR groundwater basins and subbasins (14 percent of total).

Table 3-7 and **Table 3-8** provide summary statistics for groundwater inflows for the historical and current period, respectively. The largest inflow is deep percolation of precipitation and applied irrigation water and the next largest inflow is inflows stream recharge for the historical and current time periods. In general, the historical and current inflows are similar; however, the current deep percolation is about 88 percent of the historical average value, reflecting the lower average precipitation in the current period.

Figure 3-31 shows outflows from the groundwater system for the historical and current time periods. **Table 3-9** and **Table 3-10** provide summary statistics for groundwater outflows of the historical and current period, respectively. Groundwater pumping is the biggest stress

(municipal and industrial [M&I] and rural domestic users and agricultural) followed by discharge to streams for the historical and current time periods. ET from groundwater and groundwater leakage to the surface soil zone are also substantial outflows. Total groundwater pumpage during the historical and current time periods was fairly constant.

Figure 3-32 shows the entire groundwater water budget and includes the annual change in groundwater storage. Change in groundwater storage is equal to total inflow minus total outflow in the groundwater budget. A negative change in groundwater storage indicates groundwater-storage depletion while a positive value indicates groundwater-storage accretion. Cumulative groundwater storage represents the total change in storage over a given period. The maximum (positive) cumulative storage change occurred in the wet period in WY 1983 and the lowest cumulative storage change occurred in WY 1992 following a period of dry and normal years, and concurrent municipal groundwater pumping.

Table 3-11 shows the annual change in groundwater storage for the historical and current budget periods. On average, the historical period shows a negative change in groundwater storage with a larger magnitude negative change in groundwater storage during the current period, which includes the recent drought. The increased rate of groundwater-storage depletion during the recent period appears to be more a result of a drier climate than increased groundwater pumping during that period. This is supported by **Figure 3-33**, showing groundwater pumpage by water-use sector, along with the 5-year moving average for the historical period. The peak of the 5-year moving average of the current period (21,000 AFY) is exceeded 5 years of the 2000 to 2011 period, indicating that total groundwater pumpage for the current period is not greater than the previous 12-year period. (**Table 3-12** and **Table 3-13** shows the historical and current groundwater pumpage by sector.) The continued decline in groundwater storage reflects a Subbasin that has not yet reached a dynamic equilibrium between the inflows and outflows. If the Subbasin is to reach dynamic equilibrium (that is, zero groundwater storage decline over a multiyear period) with the same average groundwater pumpage and a climate that is comparable to the current period, rates of depletion of surface water depletion will continue to increase (Barlow and Leake 2012). In this case, surface water depletion refers to the pumping-induced decline in surface water flows caused by decreased aquifer discharge to streams or groundwater ET, or by increased discharge to groundwater from streams. If surface water depletion does not increase, pumpage remains the same, and a similar climate persists, the Subbasin will experience continued declines in groundwater storage. The average annual results indicate that about 3 percent of pumpage was supplied by groundwater-storage depletion.

Figure 3-34 and **Table 3-14** and **Table 3-15** show net subsurface flows entering and exiting the Subbasin by watershed and neighboring subbasin. The Subbasin is a net recipient of inflows from surrounding groundwater basins and watershed areas. Subsurface inflows from adjacent basins exceed subsurface outflows by approximately a factor of 5. The largest subsurface inflows are from the Rincon-Kenwood and Wilson Grove Subbasins. The largest subsurface outflows are to the Healdsburg Area Subbasin.

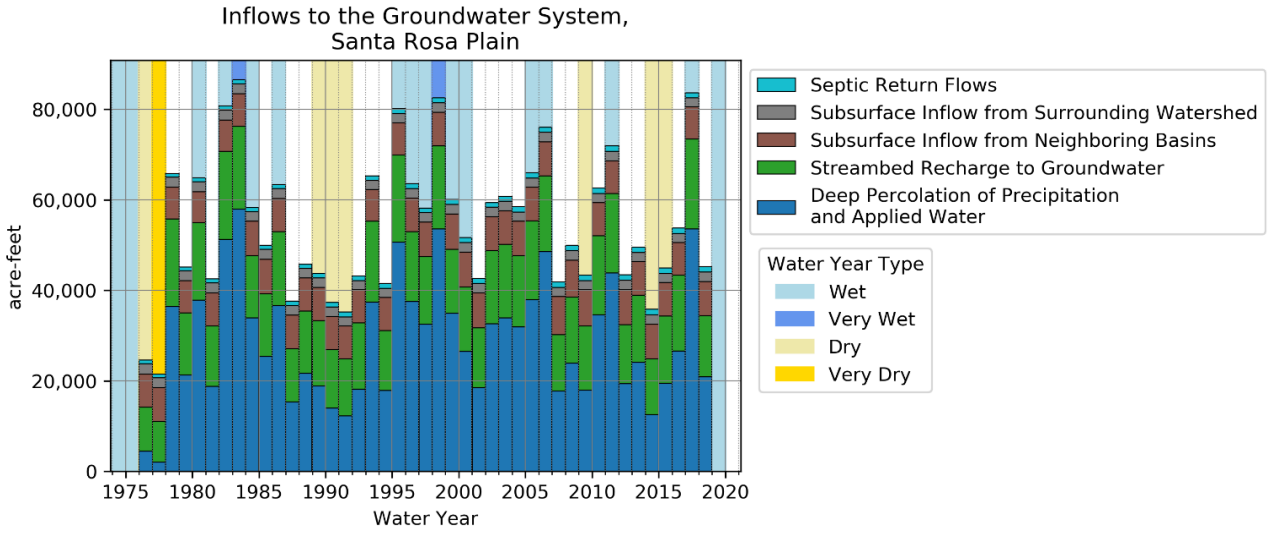


Figure 3-30. Inflows to the Groundwater System

Table 3-7. Historical (WY 1976 to WY 2018) Groundwater Inflows Budget Summary (AFY)[a]

	Deep Percolation of Precipitation and Applied Water	Streambed Recharge to Groundwater	Septic Return Flows	Subsurface Inflow from Surrounding Watershed	Subsurface Inflow from Neighboring Basins
Mean	28,700	15,100	1,000	2,100	7,400
Minimum	2,000	9,100	800	2,000	6,900
Maximum	58,100	19,700	1,200	2,300	8,400
Median	26,500	14,700	1,100	2,100	7,400

[a] Values are rounded to the nearest 100 acre-feet.

Table 3-8. Current (WY 2012 to WY 2018) Groundwater Inflows Budget Summary (AFY)[a]

	Deep Percolation of Precipitation and Applied Water	Streambed Recharge to Groundwater	Septic Return Flows	Subsurface Inflow from Surrounding Watershed	Subsurface Inflow from Neighboring Basins
Mean	25,200	14,900	1,200	2,000	7,400
Minimum	12,600	12,300	1,200	2,000	7,100
Maximum	53,400	19,700	1,200	2,100	7,700
Median	20,800	14,700	1,200	2,000	7,400

[a] Values are rounded to the nearest 100 acre-feet.

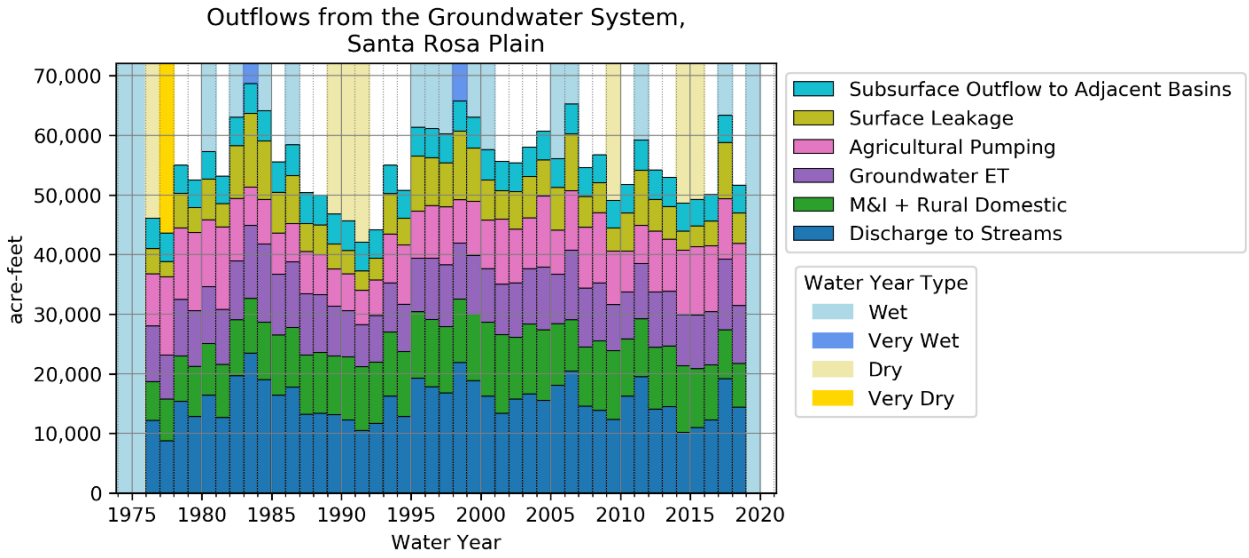


Figure 3-31. Outflows from the Groundwater System

Table 3-9. Historical (WY 1976 to WY 2018) Groundwater Outflows Budget Summary (AFY)[a]

	Agricultural Pumping	Groundwater ET	Subsurface Outflow to Adjacent Basins	Discharge to Streams	Surface Leakage	M&I + Rural Domestic
Mean	9,100	9,400	4,900	15,400	6,200	10,000
Minimum	5,700	7,100	4,500	8,700	2,500	6,500
Maximum	13,900	13,100	5,200	23,400	12,300	13,200
Median	9,000	9,300	4,900	15,400	5,800	10,100

[a] Values are rounded to the nearest 100 acre-feet.

Table 3-10. Current (WY 2012 to WY 2018) Groundwater Outflows Budget Summary (AFY)[a]

	Agricultural Pumping	Groundwater ET	Subsurface Outflow to Adjacent Basins	Discharge to Streams	Surface Leakage	M&I + Rural Domestic
Mean	10,400	9,500	4,700	13,700	5,200	9,500
Minimum	8,700	8,600	4,500	10,200	3,200	7,300
Maximum	11,400	11,800	5,000	19,200	9,500	11,200
Median	10,400	9,200	4,700	14,100	5,100	9,900

[a] Values are rounded to the nearest 100 acre-feet.

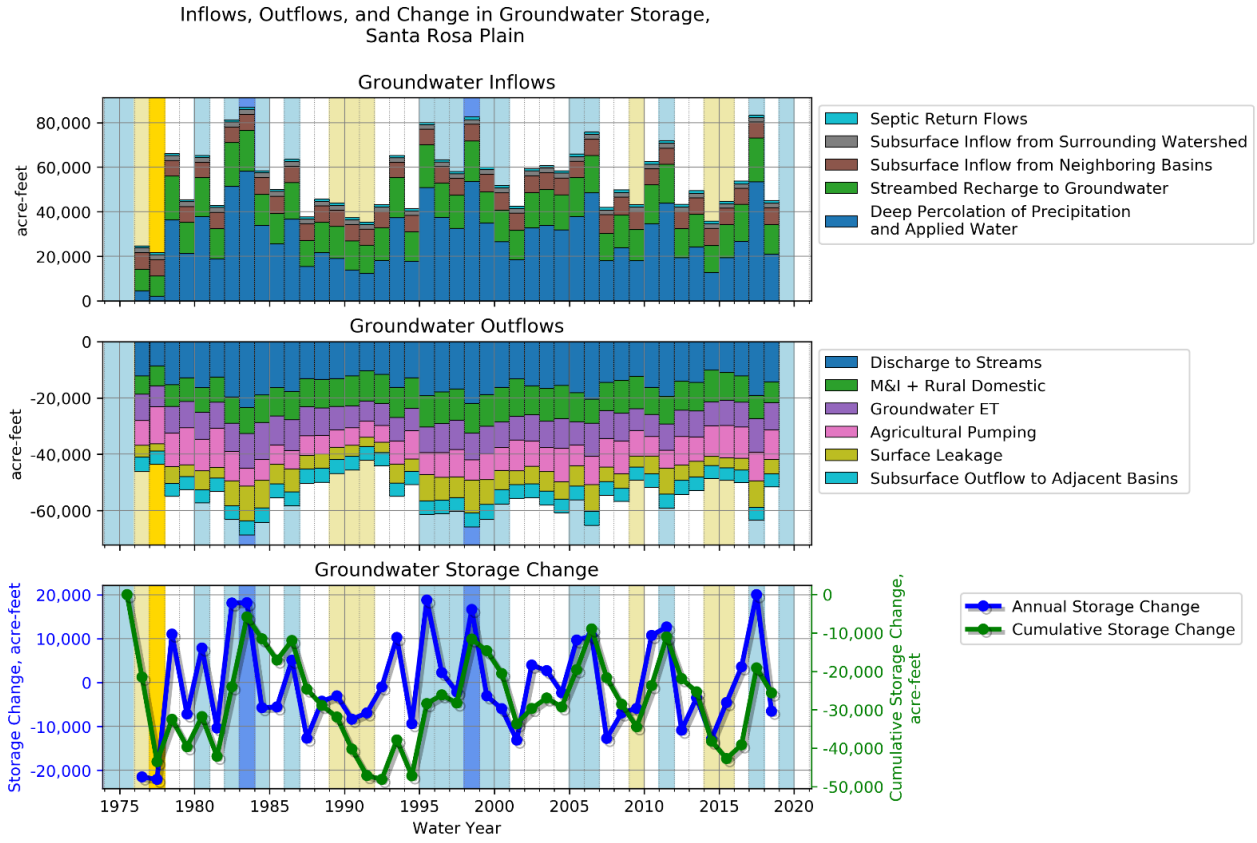


Figure 3-32. Historical and Current Groundwater Budget

Table 3-11. Average Annual Change of Groundwater in Storage (AFY)[a]

	Historical[a] (WY 1976 to WY 2018)	Current (WY 2012 to WY 2018)
Mean	-600	-2,100
Minimum	-22,000	-12,900
Maximum	20,000	20,000
Median	-3,000	-4,500

[a] Values may not equal inflows minus outflows due to rounding.

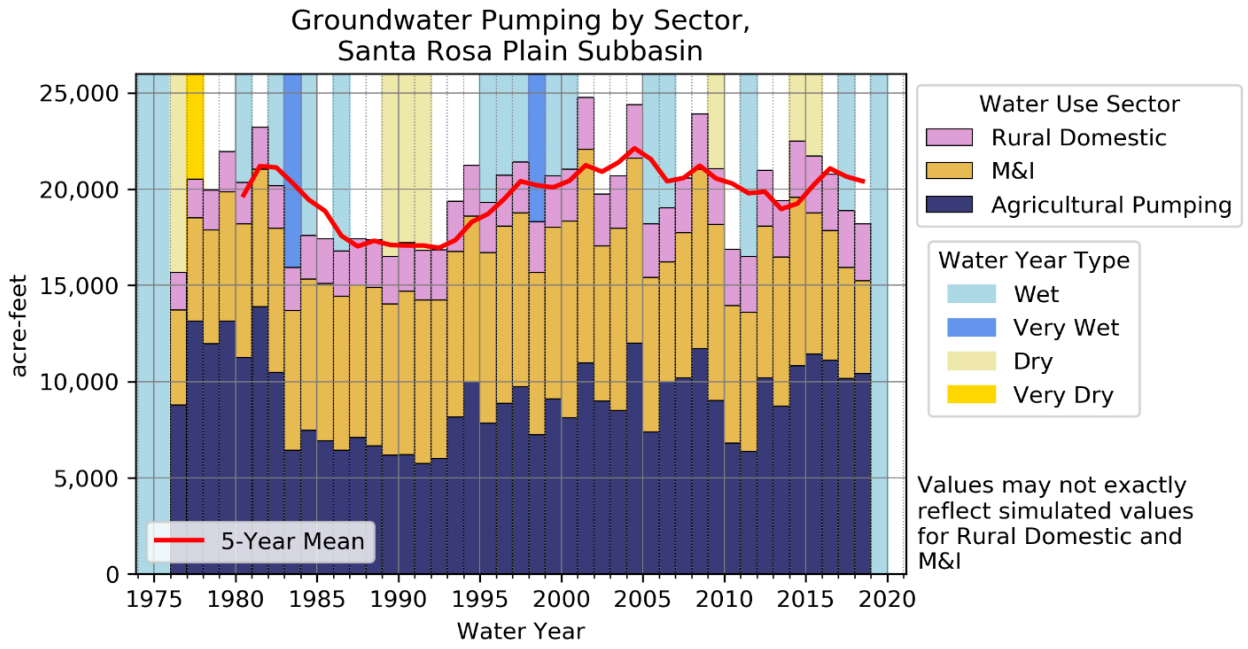


Figure 3-33. Groundwater Pumpage by Water-use Sector[2]

Table 3-12. Historical (WY 1976 to WY 2018) Groundwater Pumpage by Water-use Sector (AFY)[a]

	M&I	Rural Domestic	Agricultural Pumping
Mean	7,900	2,600	9,100
Minimum	4,800	2,000	5,700
Maximum	11,100	2,900	13,900
Median	8,000	2,600	9,000

[a] Values are rounded to the nearest 100 acre-feet.

Table 3-13. Current (WY 2012 to WY 2018) Groundwater Pumpage by Water-use Sector (AFY)[a]

	M&I	Rural Domestic	Agricultural Pumping
Mean	7,000	2,900	10,400
Minimum	4,800	2,900	8,700
Maximum	8,800	2,900	11,400
Median	7,300	2,900	10,400

[a] Values are rounded to the nearest 100 acre-feet.

[2] The values shown for M&I and rural-domestic are not equal to the combined outflows on **Figure 3-31** because of the manner in which boundary conditions (pumping) are treated by the model.

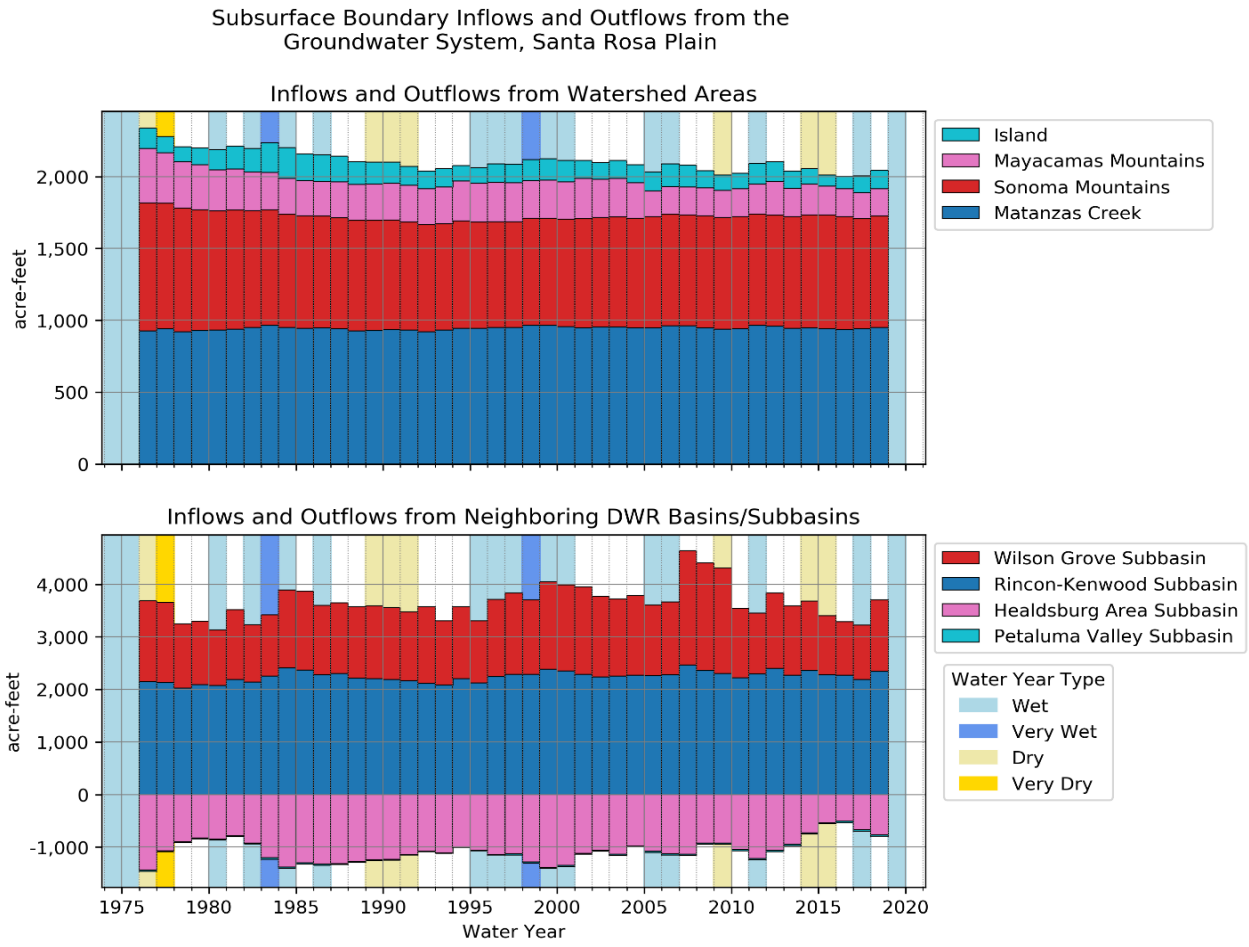


Figure 3-34. Inflows and Outflows from Watershed Areas and Neighboring Basins/Subbasins

Table 3-14. Historical (WY 1976 to WY 2018) Subbasin Boundary Flows (AFY)[a]

	Petaluma Valley Basin	Rincon-Kenwood Subbasin	Healdsburg Area Subbasin	Wilson Grove Subbasin
Mean	-20	2,200	-1,100	1,400
Minimum	-30	2,000	-1,400	1,000
Maximum	-10	2,500	-500	2,200
Median	-20	2,300	-1,100	1,400

[a] Values are rounded to the nearest 100 acre-feet.

Table 3-15. Current (WY 2012 to WY 2018) Subbasin Boundary Flows (AFY)[a]

	Petaluma Valley Basin	Rincon-Kenwood Subbasin	Healdsburg Area Subbasin	Wilson Grove Subbasin
Mean	-20	2,300	-700	1,200
Minimum	-30	2,200	-1,100	1,000
Maximum	-20	2,400	-500	1,400
Median	-20	2,300	-700	1,300

[a] Values are rounded to the nearest 100 acre-feet.

3.3.3.3 Watershed and Soil-zone Budget

Watershed budgets show how precipitation and applied water are apportioned to surface water and the soil zone. In this case, "watershed" includes the watershed areas (Mayacamas Mountains, Sonoma Mountains, and Matanzas Creek) and portions of neighboring basins (Petaluma Valley) and subbasins (Healdsburg Area, Rincon-Kenwood, and Wilson Grove). **Figure 3-35** shows the watershed water budget for watershed areas outside the Subbasin for the historical and current period. **Table 3-16** and **Table 3-17** show the historical soil-zone fluxes and subsurface inflows, respectively, and **Table 3-18** and **Table 3-19** show current summary statistics for the soil-zone fluxes and subsurface inflows, respectively. In Precipitation Runoff Modeling System (PRMS), precipitation is first routed through vegetation, where it may be intercepted and transpired, then onto the surface where it may cause runoff depending on imperviousness, soil hydraulic conductivity, and surface storage. After these and other processes it will enter the soil zone as infiltration where it will get partitioned into the capillary and gravity reservoir. ET of soil moisture is the largest outflow of water within the soil zone. In drier years ET is significantly greater than the combined outflows of recharge and runoff from Dunnian runoff and interflow. Dunnian flow is surface flow that results from saturation excess in the soil zone, and interflow is water that infiltrates the soil zone and then flows laterally within that zone to a stream (Nishikawa et al. 2013a). In wetter periods recharge and runoff exceed total soil ET. This is because ET is limited by total soil moisture storage and potential ET. The soil-water storage responds to interannual variation in precipitation, whereas the boundary inflows into the Subbasin from the watershed areas do not fluctuate as readily. Surface flows into the Subbasin are orders of magnitude greater than subsurface inflows, though the fate of the surface water inflows depends on groundwater levels within the basin.

Figure 3-36 shows the soil-zone water budget for watershed areas within the Subbasin for the historical period. Compared to the watershed soil-zone fluxes, Dunnian flow is a significantly greater contributor to runoff than is interflow, indicating that soils are typically saturated during wet months when precipitation is rejected by the soil zone. Agricultural irrigation is relatively small compared to precipitation totals, at about 1/100th of average precipitation. Soil moisture storage responds quickly to interannual variability in precipitation; after the very dry WY of 1977, when the total soil moisture storage reached its minimum for the historical period, it recovered after 1 year of above average precipitation. **Tables 3-20** and **3-21** show summary statistics for the Subbasin soil-zone budget for the historical period and current period, respectively.

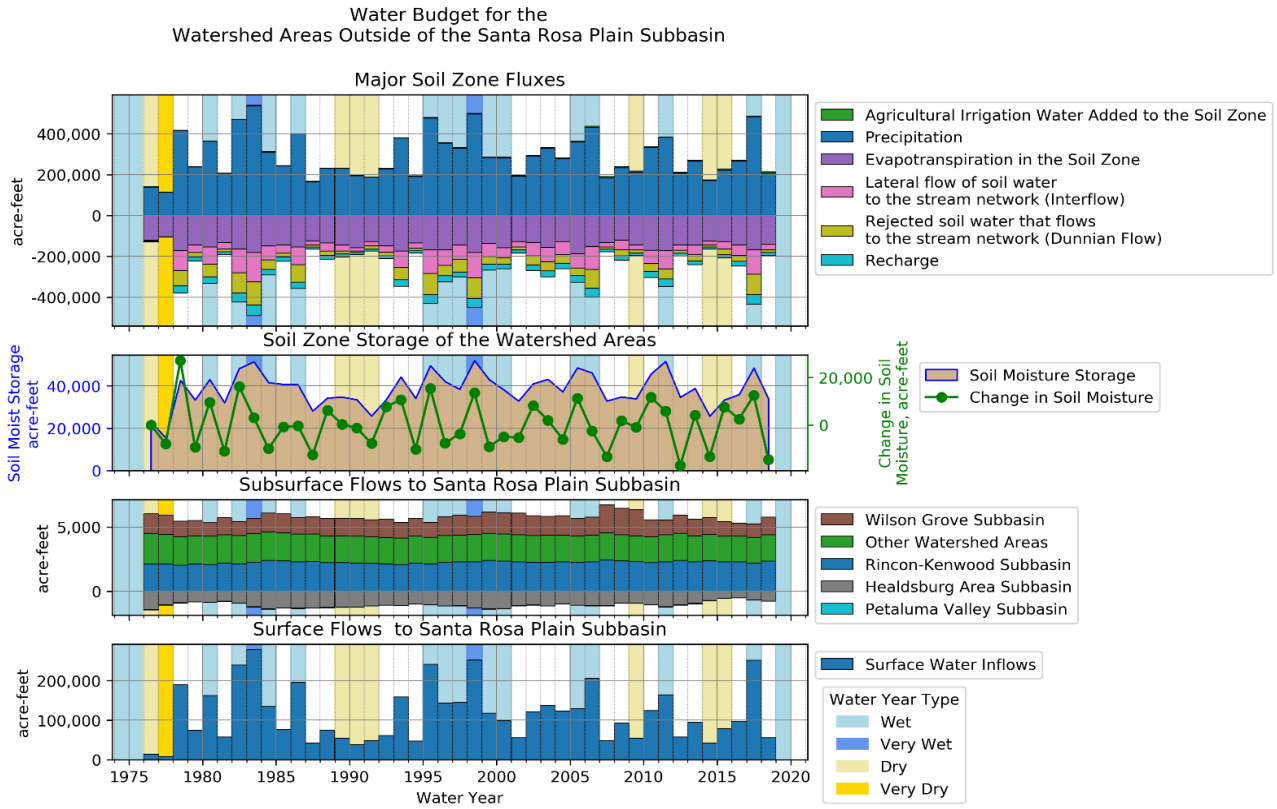


Figure 3-35. Historical and Current Budget for Watershed Areas Outside Subbasin

Table 3-16. Historical (WY 1976 to WY 2018) Budget for Watershed Areas Outside Subbasin and Major Soil-zone Fluxes[a]

	Precipitation (AFY)	Agricultural Irrigation Water Added to the Soil Zone (AFY)	ET in the Soil Zone (AFY)	Soil-zone Recharge (AFY)	Rejected soil water that flows to the stream network (Dunnian Flow; AFY)	Lateral flow of soil water to the stream network (Interflow; AFY)	Soil Moisture (acre-feet)	Change in Soil Moisture (AFY)
Mean	290,400	3,100	-147,600	-23,700	-40,100	-57,100	38,200	200
Minimum	112,500	1,000	-186,500	-51,600	-112,900	-143,100	15,400	-16,900
Maximum	536,800	6,100	-103,500	-900	-900	-900	52,000	27,200
Median	266,100	3,000	-144,800	-21,000	-31,600	-50,400	38,200	-200

[a] Values are rounded to the nearest 100 acre-feet.

Table 3-17. Historical (WY 1976 to WY 2018) Budget for Watershed Areas Outside Subbasin, and Subsurface and Surface Inflows (AFY)[a]

	Other Watershed Areas	Surface Water Inflows
Mean	2,100	114,200
Minimum	2,000	8,400
Maximum	2,300	278,900
Median	2,100	98,000

[a] Values are rounded to the nearest 100 acre-feet.

Table 3-18. Current (WY 2012 to WY 2018) Watershed Budget for Watershed Areas Outside Subbasin and Major Soil-zone Fluxes[a]

	Precipitation (AFY)	Agricultural Irrigation Water Added to the Soil Zone (AFY)	ET in the Soil Zone (AFY)	Soil-zone Recharge (AFY)	Rejected soil water that flows to the stream network (Dunnian Flow; AFY)	Lateral flow of soil water to the stream network (Interflow; AFY)	Soil Moisture (acre-feet)	Change in Soil Moisture (AFY)
Mean	260,300	4,300	-142,700	-20,200	-32,700	-45,900	35,900	-2,500
Minimum	169,700	3,300	-166,300	-47,100	-101,100	-120,800	25,700	-16,900
Maximum	482,800	4,700	-126,400	-8,700	-10,500	-17,600	48,400	12,500
Median	221,000	4,500	-144,400	-15,600	-27,900	-35,800	34,700	2,600

[a] Values are rounded to the nearest 100 acre-feet.

Table 3-19. Current (WY 2012 to WY 2018) Watershed Budget for Watershed Areas Outside Subbasin, Subsurface Flows to Santa Rosa Plain Subbasin, and Surface Flows to the Subbasin[a]

	Other Watershed Areas	Surface Water Inflows
Mean	2,000	97,300
Minimum	2,000	41,900
Maximum	2,100	252,400
Median	2,000	79,600

[a] Values are rounded to the nearest 100 acre-feet.

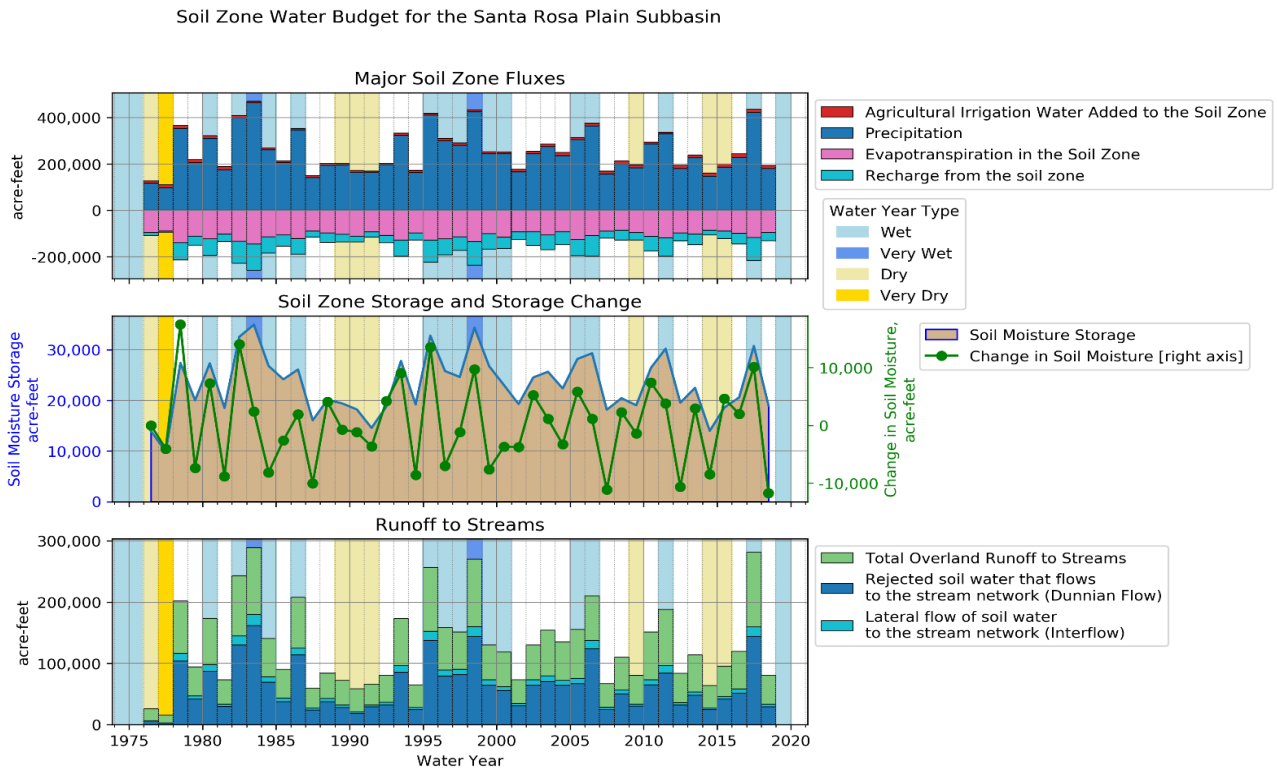


Figure 3-36. Historical and Current Soil-zone Budget for the Subbasin

Table 3-20. Historical (WY 1976 to WY 2018) Budget for the Subbasin Soil Zone[a]

	Precipitation (AFY)	Agricultural Irrigation Water Added to the Soil Zone (AFY)	ET in the Soil Zone (AFY)	Soil-zone Recharge (AFY)	Rejected soil water that flows to the stream network (Dunnian Flow; AFY)	Lateral flow of soil water to the stream network (Interflow; AFY)	Soil Moisture (acre-feet)
Mean	248,800	10,600	-107,300	-53,000	62,200	7,400	23,100
Minimum	96,200	6,700	-145,800	-111,900	2,800	300	9,900
Maximum	463,000	15,100	-84,900	-5,400	161,900	18,000	35,000
Median	229,500	10,800	-105,400	-48,900	51,500	6,500	22,500

[a] Values are rounded to the nearest 100 acre-feet.

Table 3-21. Current (WY 2012 to WY 2018) Budget for the Subbasin Soil Zone[a]

	Precipitation (AFY)	Agricultural Irrigation Water Added to the Soil Zone (AFY)	ET in the Soil Zone (AFY)	Soil-zone Recharge (AFY)	Rejected soil water that flows to the stream network (Dunnian Flow; AFY)	Lateral flow of soil water to the stream network (Interflow; AFY)	Soil Moisture (acre-feet)
Mean	224,800	13,200	-97,600	-45,100	53,000	6,000	20,700
Minimum	147,500	10,800	-116,900	-98,500	24,500	2,500	14,000
Maximum	422,900	14,400	-85,100	-21,600	144,200	15,000	30,800
Median	186,100	13,400	-97,000	-35,200	41,500	4,600	19,600

[a] Values are rounded to the nearest 100 acre-feet.

3.3.3.4 Water Budget Summary

The main groundwater inflows into the Subbasin are: (1) the percolation of precipitation and applied agricultural irrigation water (53 percent of total), (2) streambed recharge (28 percent of total), and (3) subsurface inflow from neighboring DWR groundwater basins and subbasins (14 percent of total). Together these inflows contribute 95 percent of total groundwater inflows. Subsurface inflows from surrounding watershed areas and septic return flows are smaller inflows compared to the others. Discharge to streams, total pumpage, and groundwater ET comprise about 80 percent of groundwater outflows. The smaller outflow terms are surface leakage and subsurface outflow to adjacent basins.

Overall groundwater outflows are greater than inflows into the groundwater system, resulting in an estimated decline in groundwater storage in both the historical and current water budget periods. The historical (WYs 1976-2018) annual change in storage is -600 AFY, whereas the current (WYs 2012-2018) annual change in groundwater storage is -2,100 AFY. Historically, storage depletion comprised about 3 percent of the average groundwater pumpage. If groundwater pumping, climate, and net streambed recharge and groundwater ET remain similar as that of the current period, the Subbasin will continue to experience declines in groundwater storage. If groundwater pumping and climate remain similar to the current period, and if groundwater storage declines were to stabilize, losses from the streambed will become greater and groundwater ET will decrease until inflows equal outflows from the groundwater system.

The Healdsburg subarea (containing the middle reach of the Russian River) receives the greatest boundary outflow from the Subbasin, whereas the Rincon-Kenwood and Wilson Grove Formation Highlands subbasins are greatest contributors of boundary inflow to the Subbasin. Interflow and Dunnian flow are important soil-zone processes that generate runoff into streams. Hortonian overland flow, which occurs when precipitation rates exceed soil hydraulic conductivity, is another important source of runoff. Stream discharge into the basin is much greater than subsurface boundary inflows into the Subbasin.

A comparison of the historical water budget and current water budget shows greater stress on the Subbasin in the current period than historically on average. Conditions are drier in the current periods with approximately 10 percent less precipitation. This results in approximately 12 percent less deep percolation to groundwater in the Subbasin. Meanwhile, pumping increased 5 percent in the current period compared to the historical period, mostly due to a greater than 14 percent increase in agricultural pumping.

Subbasin boundary inflows and outflows dominate the surface water budget by total volume. Overland flows to streams are the greatest contributor to discharge within the basin, compared to the net groundwater discharge to streams. Mark West Creek is the main drainage within the Subbasin by volume discharged. Surface water-groundwater interactions (net streambed exchange) is controlled more by 5- to 10-year variations in precipitation than by interannual variability in precipitation. During wet years there is a net groundwater discharge to streams whereas normal precipitation years may experience net seepage to groundwater, especially when following a dry period. One result of the increased stress in the current water budget is that net streambed exchange changes from net discharge of groundwater to streams to net recharge to groundwater from streams. Net streambed exchange was 300 AFY during the historical period and the rate for the current period was -1,300 AFY. This reflects a wetter climate during the historical period, and the cumulative impacts of groundwater pumping on streamflows during the current period. Groundwater discharge to streams in the historical period is nearly equal to or greater for all months than the current period.

3.3.4 Subbasin Water Supply Reliability

Based on analysis conducted for Sonoma Water's 2020 UWMP (Sonoma Water 2021), Sonoma Water has adequate water supply to deliver imported surface water through the 2045 planning horizon analyzed in the 2020 UWMP. The exception are single-dry years, starting after 2025. For single-dry years, model simulations predict that storage levels in Lake Sonoma will drop below 100,000 AF prior to July 15th, thus requiring demand curtailments by Sonoma Water customers per SWRCB Decision 1610 (SWRCB 1986) for some portion of the year. In these circumstances, Sonoma Water will work with its customers to reduce demands on the imported surface water. Based on efforts over the last 5 years during dry conditions, Sonoma Water does not anticipate any difficulty in maintaining an adequate supply of imported surface water during the single-dry year. The magnitude of these single-dry year potential shortfalls is estimated to be about 19 percent of average annual demand by 2045. This condition is accounted for in the baseline projected water budget developed for this GSP by assuming higher levels of groundwater demands from Sonoma Water contractors during dry conditions.

3.3.5 Uncertainties in Water Budget Calculations

The level of accuracy and certainty is highly variable between water budget components. A few water budget components are directly measured, but most water budget components are estimated as input to the model or simulated by the model. Both estimated and simulated values are based on assumptions and there is additional model uncertainty for simulated results. Model uncertainty stems from an imperfect representation of natural condition and is reflected in model calibration error. However, inputs to the model are carefully selected using

best available data, the model's calculations represent established science for groundwater flow, and the model calibration error is within acceptable bounds. Therefore, the model is the best available tool for estimating water budgets.

Simulated components based on calibrated model have the most uncertainty because those simulated results encompass uncertainty of other water budget components used in the model in addition to model calibration error. The following lists groups of water budget components in descending order of uncertainty:

- Measured: metered municipal and some small water system pumping
- Estimated: nonmunicipal domestic pumpage and septic system return flow, including depth and location
- Simulated primarily based on climate data: precipitation, ET, irrigation pumpage, including depth and location
- Simulated based on calibrated model: all other water budget components

3.3.6 Projected Water Budgets

SGMA Legislation and GSP Regulation requirements for projected water budgets are as follows:

- Simulate projected groundwater conditions 50 years into the future
- Incorporate projections of land use change, climate change, and other changes in groundwater demands (such as population increase)

The results of the projected conditions simulation will be used to assess how the sustainability indicators respond to the changing climate and groundwater demands in the future. If undesirable results are simulated to occur, the GSP will need to plan for projects and management actions that respond to the undesirable results.

Projected water budgets will be useful for showing that sustainability will be achieved in the 20-year implementation period and maintained over the 50-year planning and implementation horizon.

The projected water budget is developed using a predictive simulation from the SRPHM that incorporates a climate change scenario.

3.3.6.1 Method and Assumptions Used to Develop Projected Water Budgets

Future projected conditions are based on model simulations using the updated SRPHM numerical flow model and using estimates of the following:

- Projected land use changes
- Projected population growth
- Projected climate change

Future Projected Land Use Change and Water Demand Assumptions

Assumptions for future projected land use changes and water demands were estimated for rural-residential groundwater pumping, agricultural land use footprint, and municipal demands. Several workgroups and surveys helped develop the data used in the projected model. Assumptions for each set of data are described and projections are provided in **Appendix 3-D**.

Municipal purveyors provided ranges of projected demands based on combination of historical and potential future use. The projections included higher-end ranges for GSP planning that are generally higher in comparison with planning projections for UWMPs. Nonpotable groundwater demands were included where applicable for GSP modeling (City of Santa Rosa).

To capture these ranges and incorporate potential climate variability in the model, the following steps were taken:

- For purveyors with both surface water and groundwater sources, varied annual future pumping based on projected future climate year classifications (very dry, dry, normal, wet, very wet) using calculated standard deviation from historical pumping records
- Applied patterns of seasonality of groundwater production based on historical wellfield operations

Projected Climate Change Simulation Approach

SGMA requires the incorporation of climate change into projected future simulation scenarios for purposes of assessing impact of climate change on groundwater conditions, demands, and availability, and identifying uncertainties in future conditions when including projects and management actions and identifying SMC. For the GSP, after review of DWR Climate Change Guidance and recommendations, the GSA decided to choose one potential climate change scenario representative of regional conditions to limit the number of simulations and provide better comparability between various potential projects and actions. During the 5-year GSP update, the status of climate change science will be assessed and the use of different climate futures will be considered, as appropriate.

Projections of future climate conditions are generally performed through GCMs forced with specific global greenhouse gas (GHG) emissions scenarios (IPCC 2013). **Appendix 3-E** provides a description of GCM selection.

The overall approach for selecting and simulating projected climate change can be summarized as follows:

1. Choose projected climate future by selecting regionally representative GCM and then selecting a specific GHG emissions scenario.
    a. Review DWR-recommended GCMs and choose one GCM and emissions scenario that best represents projected median conditions in Russian River Watershed area (including groundwater basins)

2. Update model inputs for the following:
   a. Precipitation
   b. Temperature/ET
3. Use climate data as follows:
   a. Define precipitation and calculate potential ET and actual evaporation and transpiration
   b. Calculate projected irrigation water demands and groundwater pumping

Selection of Regional Representative General Circulation Model

The projections reviewed for purposes of developing this GSP relied upon available climate projections using the models and emissions scenarios included in the Coupled Model Intercomparison Project 5 (CMIP5). Twenty individual downscaled GCM projections were reviewed using 10 different GCMs and 2 different Representative Concentration Pathways (RCPs), RCP4.5 and RCP8.5 for each model (**Appendix 3-E**). The 10 GCMs were chosen by the DWR Climate Change Technical Advisory Group (CCTAG) based on a regional evaluation of climate model ability to reproduce a range of historical climate conditions (CCTAG 2015) and are contained in the California Fourth Climate Change Assessment (He et al. 2018).

For GSP planning purposes, it is desirable to identify projected climate scenarios that more specifically represent the climate and hydrologic conditions within the Russian River watershed and Sonoma County. To identify the model that was most representative of the Russian River watershed, a technical analysis was conducted to compare how well each model performed relative to historical data for objective metrics (for example, river flow and reservoir storage). The evaluation identified the HadGEM2-ES GCM as best representing the middle of the ensemble for mean climate and hydrologic metrics for the Russian River watershed and did not stray to any of the extremes for other metric rankings.

Greenhouse Gas Emissions Scenario

Upon selection of the HadGEM2-ES model, the next step focused on selection of an emissions scenario. Emissions scenarios are possible pathways that society might take in the emission of GHGs in the future. Each are categorized as a RCP. DWR has recommended the use of two potential RCPs: RCP 4.5 and RCP 8.5.[3] RCP 4.5 is sometimes considered “most likely” based on current projections of GHG emissions, and RCP 8.5 is often known as “worst-case scenario.” Experts and scientists contacted by GSA staff have differing views on which emissions scenario is more likely, although many acknowledge that selection of an emissions scenario is not a technical or scientific issue but rather a societal issue.. Accordingly, the process to select which emissions scenario to use was based on several Advisory Committee and GSA Board meetings in addition to a focused workshop for the three Sonoma County SGMA basins and subbasins. As part of this effort, the model results for both RCP 4.5 and RCP 8.5 for the Santa Rosa Plain Subbasin were presented and discussed. In general, the model results indicated that RCP 8.5 was the worst-case scenario (relative to RCP 4.5) in terms of groundwater storage, groundwater recharge, groundwater discharge to streams, and pumping. RCP 8.5 provided a stiffer stress test

[3] RCP 4.5 refers to the additional 4.5 watts per meter squared energy above a baseline that will enter into the atmosphere, and the amount of GHGs necessary to accomplish such an increase.

for groundwater resources due to a forecasted sustained period of several dry years after the mid-21st century and the increased temperature associated with this higher emissions scenario (increased pumping and ET). Based on this review of groundwater model results from simulating the combination of each RCP with the chosen HadGEM2-ES GCM (**Appendix 3-E**), the majority of Advisory Committee members supported RCP 8.5 and the GSA Board affirmed that recommendation.

Projected climate based on the selected GCM and emissions scenario represent WY 2021 through 2070.

3.3.6.2 Modifications to Modeling Platform to Simulate Future Projected Conditions

Where possible, all model inputs used the same assumptions that were made in the historic water budget simulation.

Projected climate input assumptions and modifications

The climate portion of the inputs was incorporated into the model via the PRMS component of GSFLOW. The projected values are defined as daily precipitation, and minimum and maximum temperatures over the projected simulation period. The changing land use patterns and associated water uses were simulated in two distinct manners. The agricultural (AG) package was used to simulate the projected growth and contraction of agriculture, and the associated groundwater demand. As with the historical model, the AG package uses the locations of crops to determine the potential ET not met by soil moisture. The AG package applies water pumped from an associated well to satisfy this demand. These simulations account for changing climate patterns, including potential ET and precipitation, soil moisture, and other factors. The AG package input was modified with the changing land use patterns described in **Appendix 3-D**.

Projected groundwater pumping assumptions and modifications

Municipal, rural domestic, and industrial projected water uses are simulated using the USGS Well Package. These uses are defined on a monthly basis and incorporate the projected population growth and associated groundwater demands. As with the historical model, the groundwater use of the rural domestic parcels was estimated based on parcel size. Parcel groundwater use is aggregated by groundwater model cell for each stress period.

Other projected boundary conditions assumptions and modifications

The projected model starts in October 2020 (beginning of WY 2021). The initial groundwater heads for each layer were extracted from the ending conditions of the historical model. The intervening period from October 2018 to October 2020 was not simulated, nor does the model reflect any changes between those two periods.

The general head boundary conditions that represent the model interface with the Petaluma Valley Basin, Wilson Grove, and the Healdsburg Area Subbasins require values of boundary head for the simulation period. The values used in the historic model were carried forward into the projected simulation. Therefore, the model does not account for changing hydrologic conditions at those boundaries and assumes they remain constant into the future. Additionally,

the model does not account for changes in impervious surface area as this is not readily available for use in the model. The projected impervious values incorporated in the model reflect values as of 2016.

3.3.6.3 Climate of the Projected Water Budget Simulation Period

The first 20 years of the projected simulation period are relatively wet compared to the historical precipitation. The first 2 years of the projection are very dry, but are then followed by a total of 6 wet, 1 very wet, 1 dry, and 10 normal years. In this period, the average precipitation is 35.6 inches per year, which is 20 percent greater than the historical average. After WY 2041 there is an 11-year period with 3 wet years, 1 dry year, and the rest normal. In the final 20 years, the conditions become drier when compared to the prior simulation period; there are no wet WY types, and 13 dry WYs (**Figure 3-37**). Both minimum and maximum daily temperatures increase in the projected simulations as calculated by the HadGEM2-ES RCP 8.5 scenario (**Figure 3-38**).

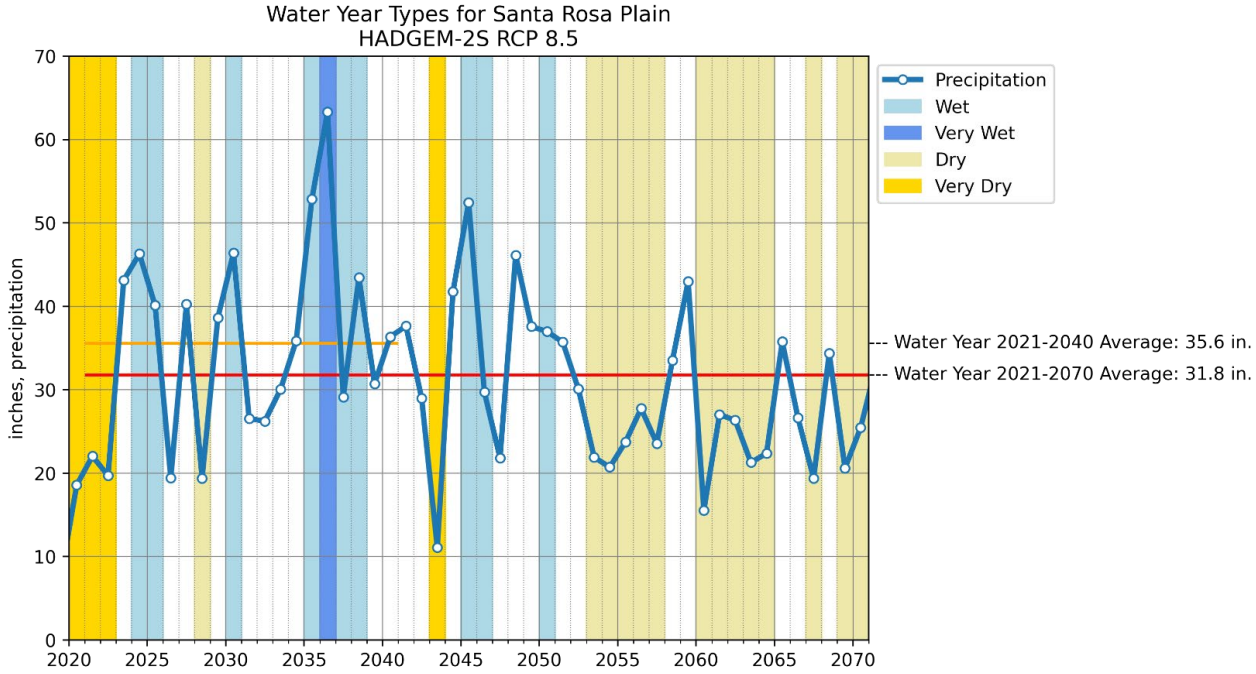


Figure 3-37. Water Year Types for Santa Rosa Plain Future Projected Water Budget

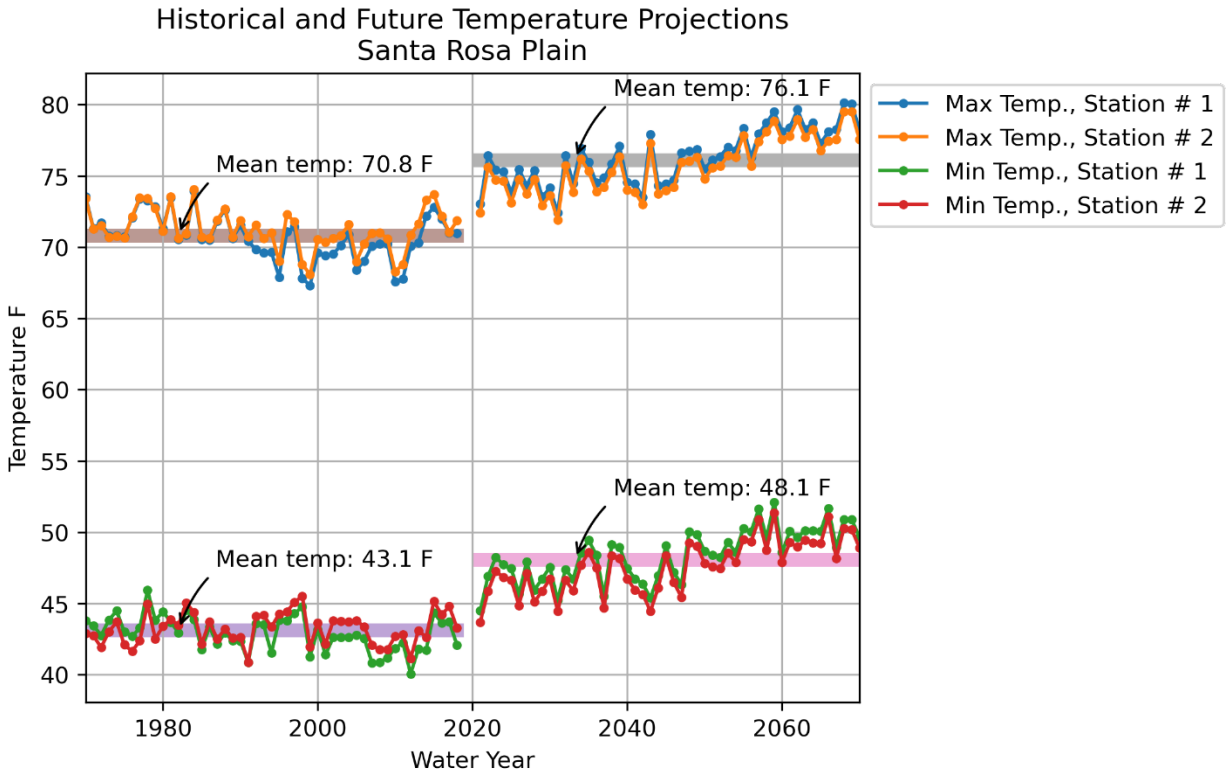


Figure 3-38. Historical, Current, and Future Temperature Projections for Windsor (Station No. 1) and Santa Rosa (Station No. 2) Weather Stations

3.3.6.4 Projected Surface Water Budget

Surface water inflows and outflows at the Subbasin margins increase in the WY 2021-2040 period (**Figure 3-39**). In the historical period the average inflow was 362,000 AFY, and in the WY 2021-2040 period it is 468,500 AFY (**Table 3-22**), representing a 29 percent increase. Streamflow generated by overland runoff increases similarly in the projected period, with a 33 percent increase from 130,200 AFY to 172,700 AFY. The WY 2021 to 2040 period exhibits higher minimum flows than the historical minimum, and also greater maximum inflows. The trend in net streambed exchange contrasts that of the surface water inflows. Despite the wetter conditions in the WY 2021 to 2040 period, the net streambed exchange transitions from an average gaining conditions of the historical period to a relatively consistently losing stream system (**Table 3-22**). A gaining system discharges more groundwater to the streams than stream seepage to the groundwater system. The rates of net streambed exchange are +500, -1,300, and -2,200 for the historical, current and WY 2021 to 2040 periods, respectively. Only 3 years of the first 20 years exhibit positive net streambed exchange, whereas 20 years of the historical record are positive (**Figure 3-39**).

Following the trend of Subbasin precipitation, surface water inflows are lower in the latter 30 years of the projected period, especially after WY 2050 (**Figure 3-39**). During the entire WY 2021 to 2070 period the mean boundary inflows, outflows, and overland runoff to streams is 376,000, 514,900, and 143,200 AFY, respectively (**Table 3-23**). A summary of the average fluxes

for the historical, current, and projected water budget periods is shown on **Figure 3-40**. The magnitude of these values is greater than the corresponding values for the historical period. On the other hand, net streambed exchange shows nearly monotonic declines after WY 2050 (**Figure 3-39**). The net groundwater exchange averages -4,100 AFY for the entire future projected period. The decline in net groundwater exchange rates is driven by a decline in groundwater discharge (baseflows) to streams, rather than an increase in stream seepage to groundwater. In contrast to groundwater discharge to streams, stream discharge to groundwater remains nearly unchanged in the projected simulation.

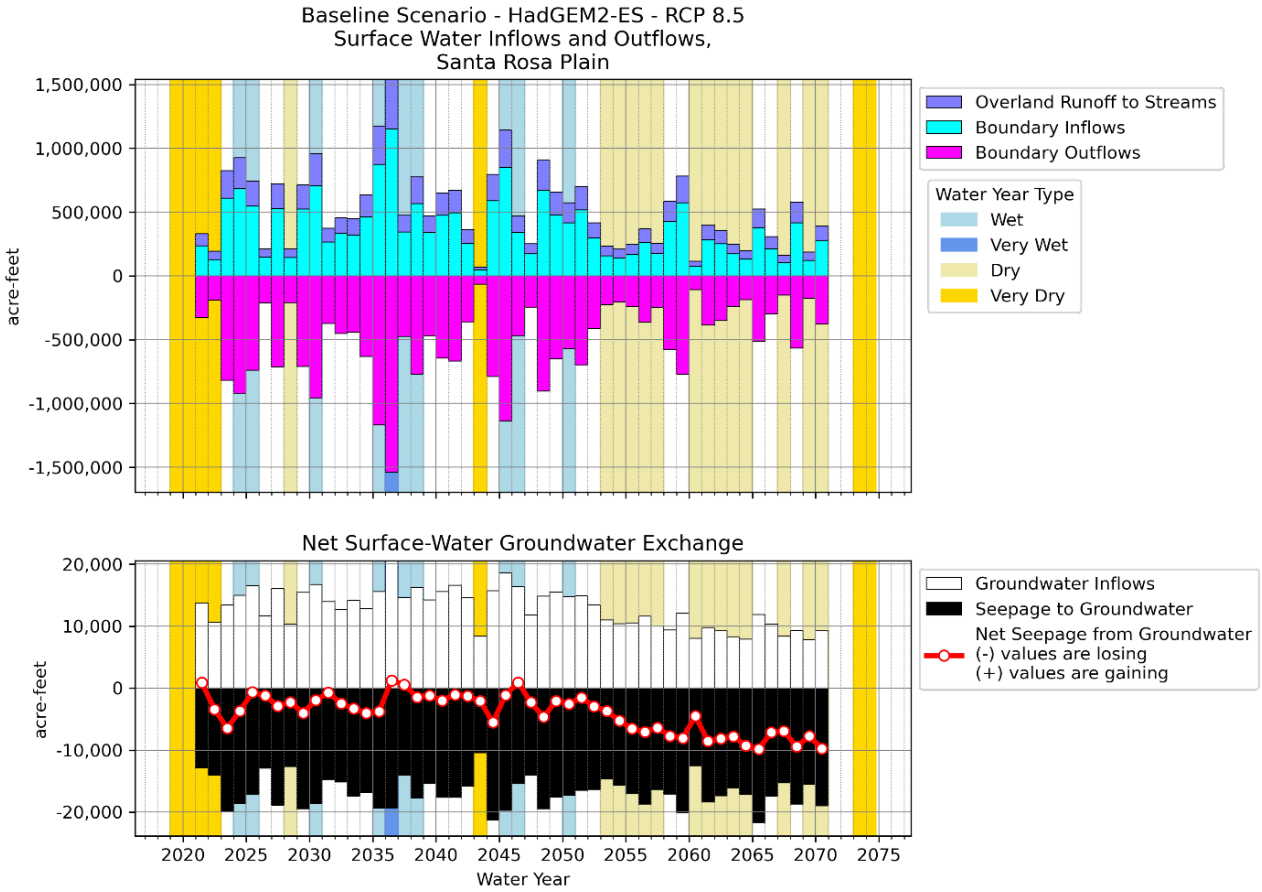


Figure 3-39. Projected Surface Water Budget

Table 3-22. Projected (WY 2021 to WY 2040) Surface Water Budget Summary (AFY)[a]

	Net Streambed Exchange	Overland Runoff to Streams	Boundary Outflows	Boundary Inflows
Mean	-2,200	172,700	-638,800	468,500
Minimum	-6,500	65,500	-1,540,900	128,400
Maximum	1,300	389,100	-190,500	1,151,600
Median	-2,100	174,300	-637,800	466,800

[a] Values are rounded to the nearest 100 acre-feet.

Table 3-23. Projected (WY 2021 to WY 2070) Surface Water Budget Summary (AFY)[a]

	Net Streambed Exchange	Overland Runoff to Streams	Boundary Outflows	Boundary Inflows
Mean	-4,100	143,200	-514,900	376,000
Minimum	-9,800	23,800	-1,540,900	44,500
Maximum	1,300	389,100	-66,300	1,151,600
Median	-3,600	127,600	-460,000	335,200

[a] Values are rounded to the nearest 100 acre-feet.

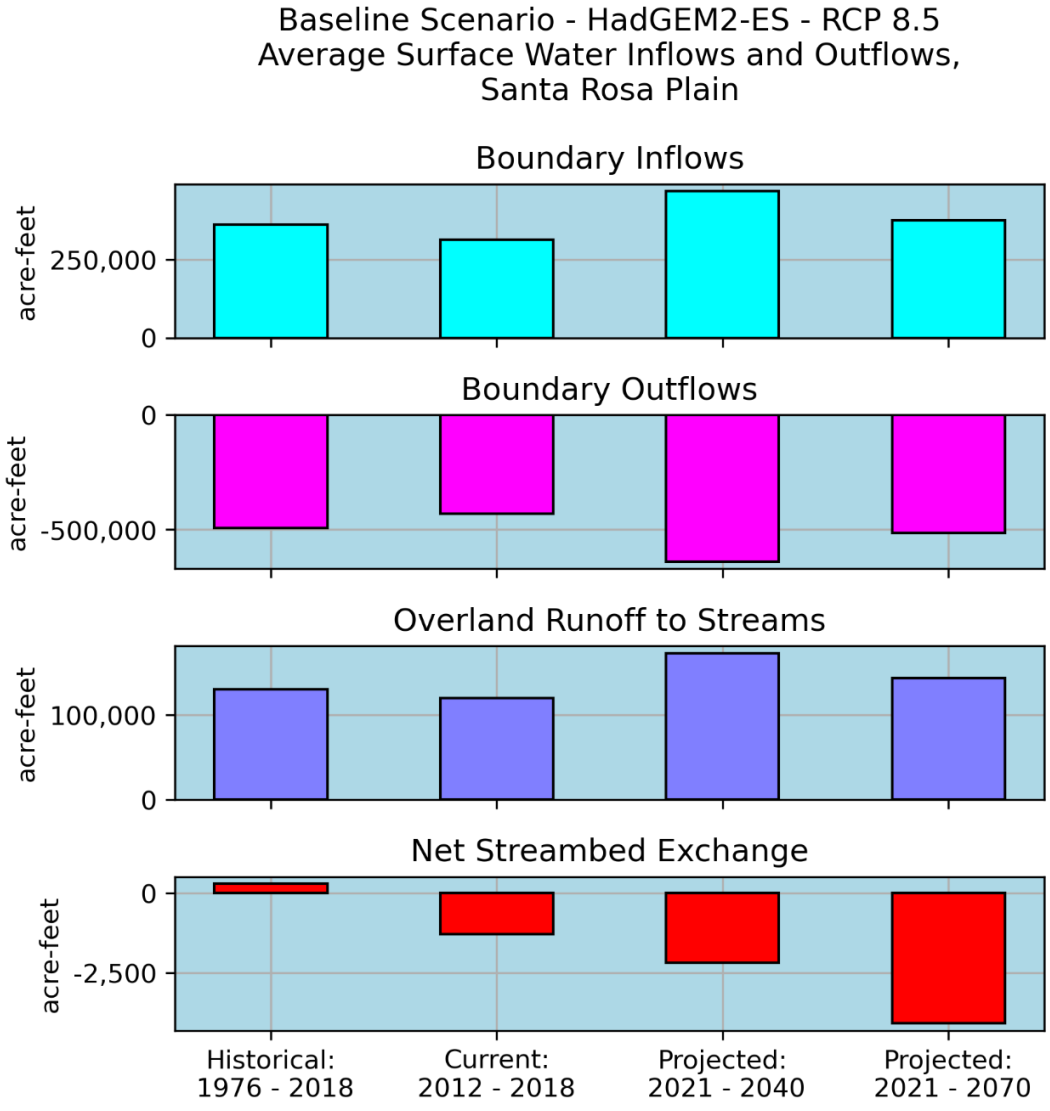


Figure 3-40. Average Surface Water Inflows and Outflows

Figure 3-41 and **Figure 3-42** illustrate the net boundary inflows and outflows for each of the HUC 12 watershed subregions, and the streams that drain them. The locations and extents of the watersheds is shown on **Figure 3-22**. The relative discharges in the projected conditions from each watershed are similar to those of the historical values (**Figure 3-25**). For example, in both the projected and historical conditions, the discharge from Windsor Creek is equal to about 50 percent of the inflows from Upper Santa Rosa Creek. However, as previously discussed, yearly discharge values for the projected conditions are greater principally as a result of the projected increase in precipitation in the WY 2021 – 2050 period.

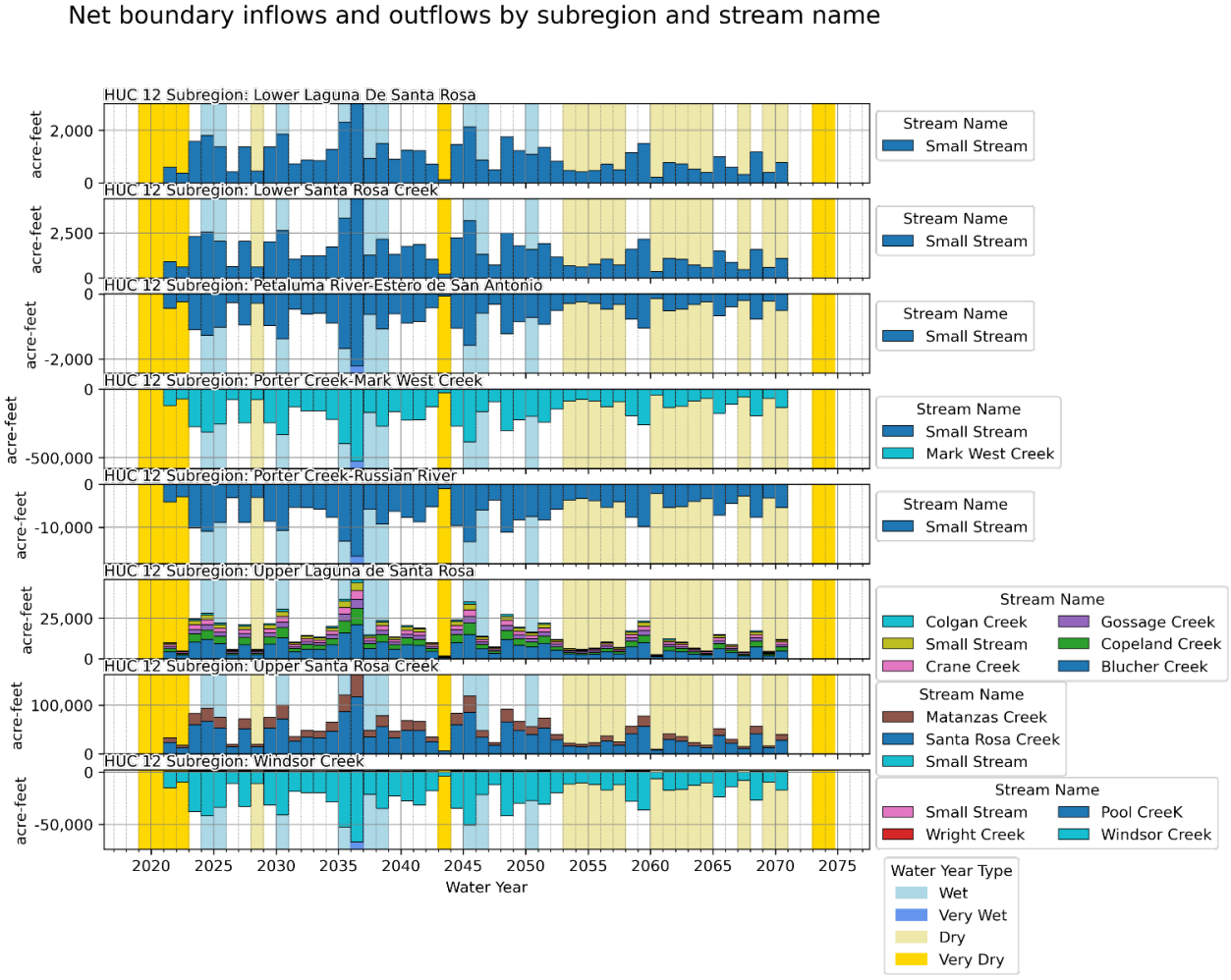


Figure 3-41. Net Boundary Inflows and Outflows by HUC 12 Subregion and Stream Name

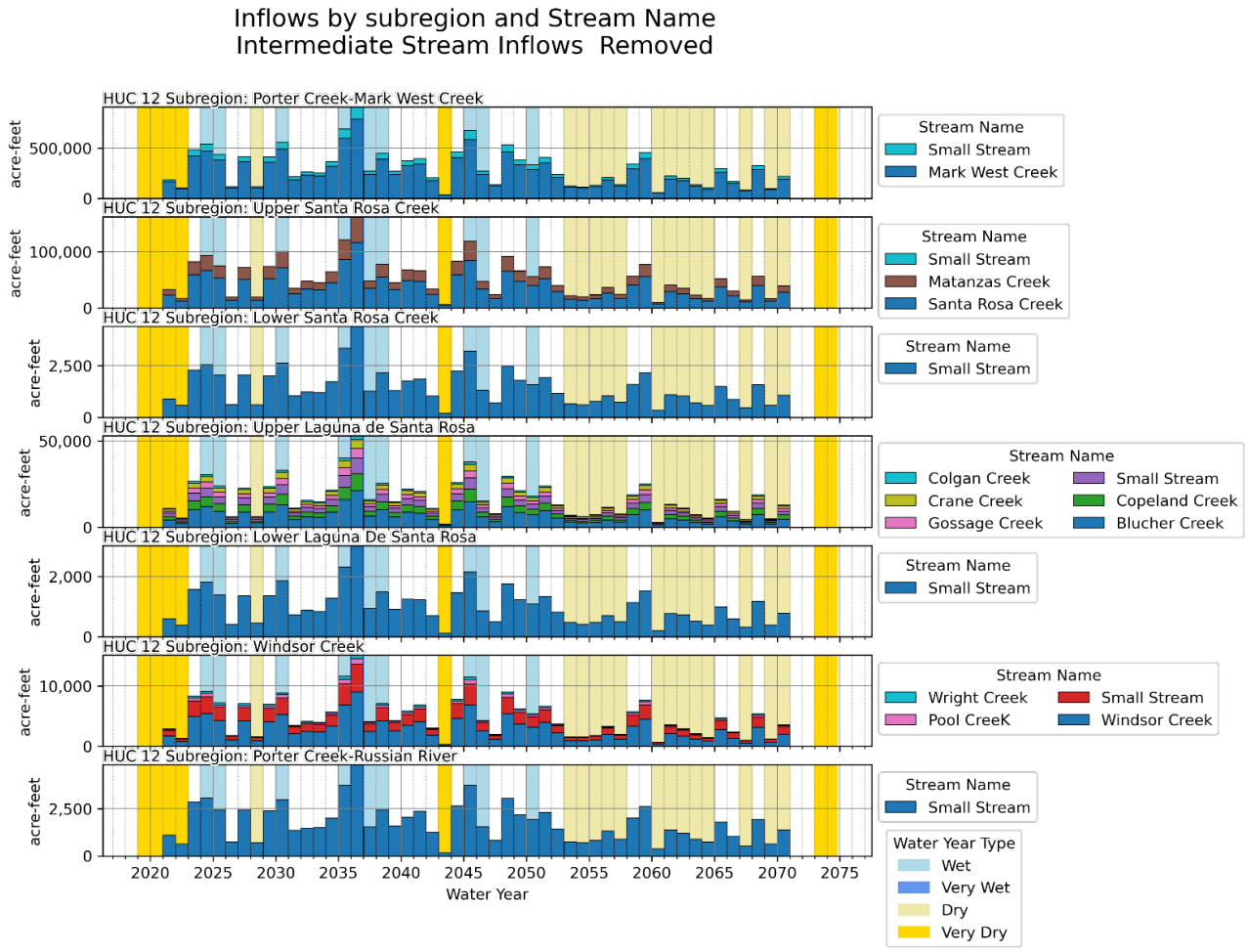


Figure 3-42. Inflows by HUC 12 Subregion and Stream Name[4]

On **Figure 3-43** fluxes for the surface water system are displayed for a wet (WY 2026) and normal (WY 2057) WY. WY 2026 occurs after 3 consecutive years of wet or normal conditions whereas WY 2057 is preceded by 4 dry WYs. Likely because of these precedent conditions, the net groundwater exchange dynamics are markedly different. During the WY 2026, the net groundwater exchange ranges from -1,000 acre-feet to +500 acre-feet. In this WY, there is a significant portion of the year in which baseflows are sustaining streamflows. The WY 2057 has negative values (losing conditions) for all but 1 month, and generally ranges from -1,500 AFY to -250 AFY. In this year there is little to no net baseflow discharge to streams in the Subbasin. Overland runoff to streams generates similar total volumes in these 2 years.

[4] Intermediate inflows removed; values intended to represent surface inflows at headwaters where streams cross the boundary the first time. Some streams cross the Subbasin boundary multiple times, but only the inflows from the initial inflow location are shown here.

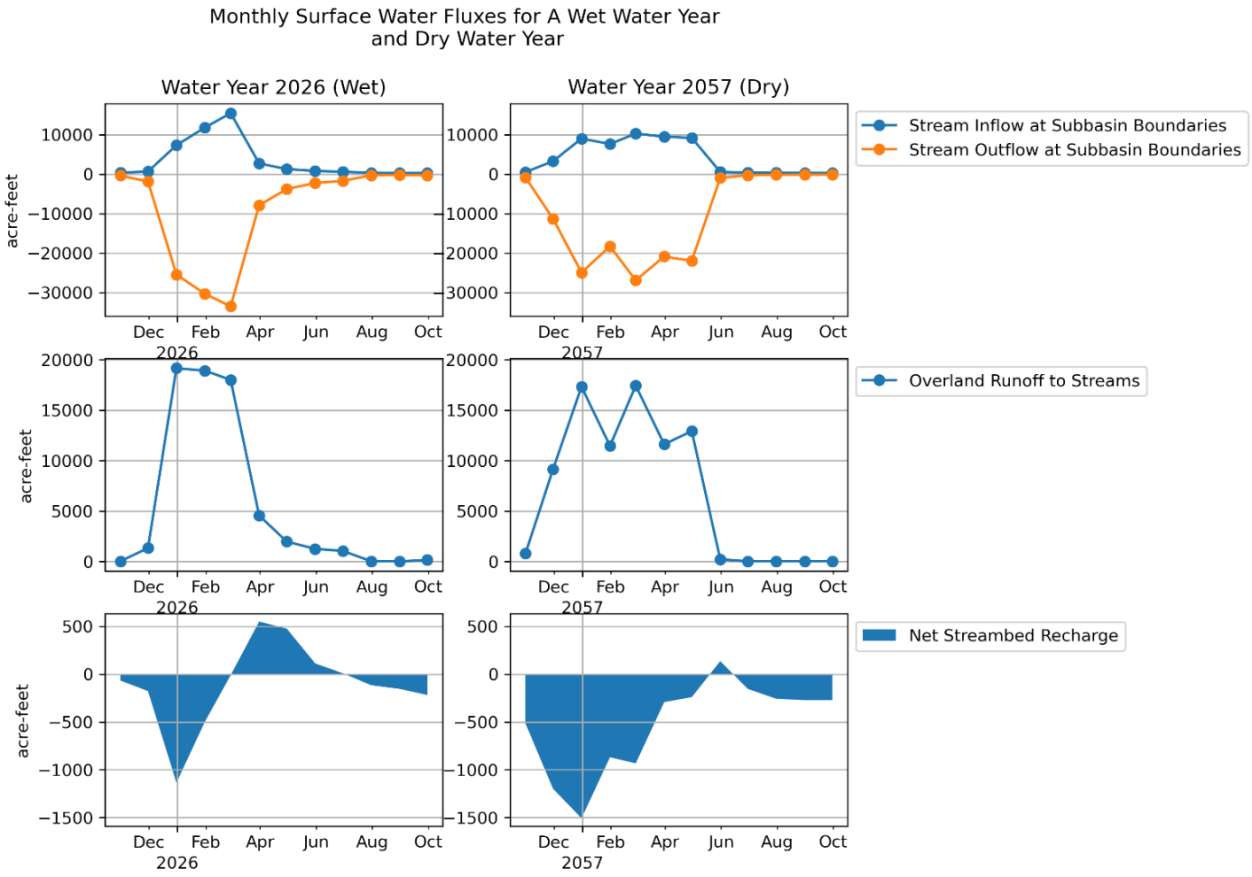


Figure 3-43. Monthly Surface Water Fluxes for a Wet Water Year and Normal Water Year

On **Figure 3-44** the average monthly surface water fluxes are shown for the WY 2021 to 2040 and the WY 2021 to 2070 periods. In the projected conditions the net streambed exchange is less than zero from July to January. The historical period, by comparison, is below zero for October through January. The net streambed exchange is -500 acre-feet for October in the projected conditions, but is half that value in the historical conditions.

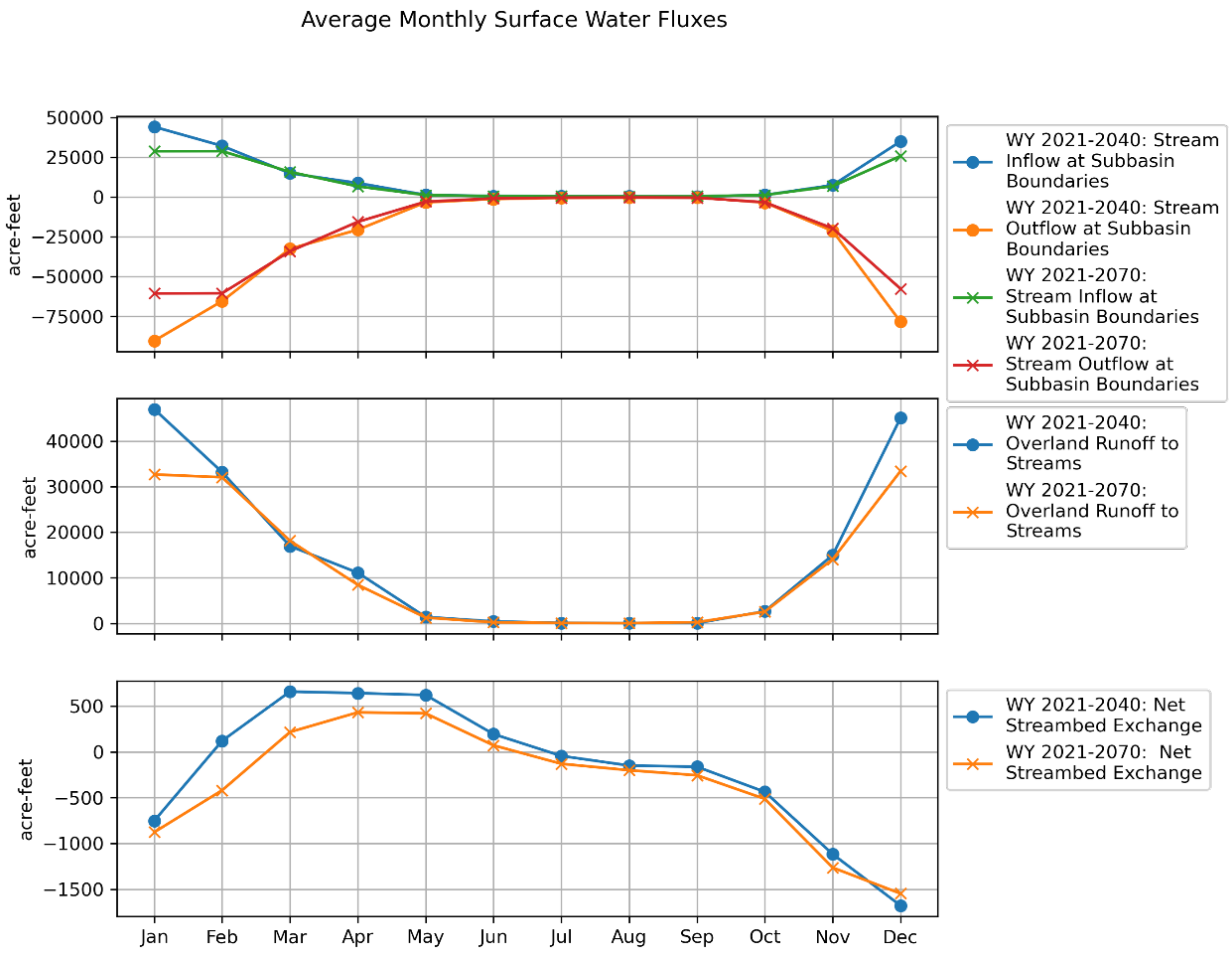


Figure 3-44. Average Monthly Surface Water Fluxes in the Projected Period

3.3.6.5 Projected Groundwater Budget

During the projected WY 2021 to 2040 period the increased precipitation impacts groundwater inflows in different ways (**Figure 3-45** and **Table 3-24**). Compared to the historical water budget, the deep percolation of precipitation and streambed recharge increase the most with increases of 4,100 AFY and 1,600 AFY of the mean values, respectively, whereas subsurface inflow from neighboring watersheds and basins changes -100 AFY and 300 AFY, respectively. For the entire projection from WY 2021 to 2070 (**Table 3-25**), deep percolation of precipitation and applied water values are nearly equal to the historical values (**Figure 3-46** and **Figure 3-47**). Streambed recharge increased from an average of 15,100 AFY in the historical period to a mean of 16,900 AFY in the WY 2021 to 2070 period, representing an increase of 12 percent. Septic return flows increased by 50 percent between the two periods, resulting in a mean of 1,500 AFY in the WY 2021 to 2070 period. The average combined total inflows for the entire projection period is 57,200 AFY, representing a 5 percent increase from the historical value of 54,300 AFY. This increase is predominantly caused by the greater deep percolation of precipitation and applied water that occur in the WY 2021 to 2040 period rather than the following 30 years.

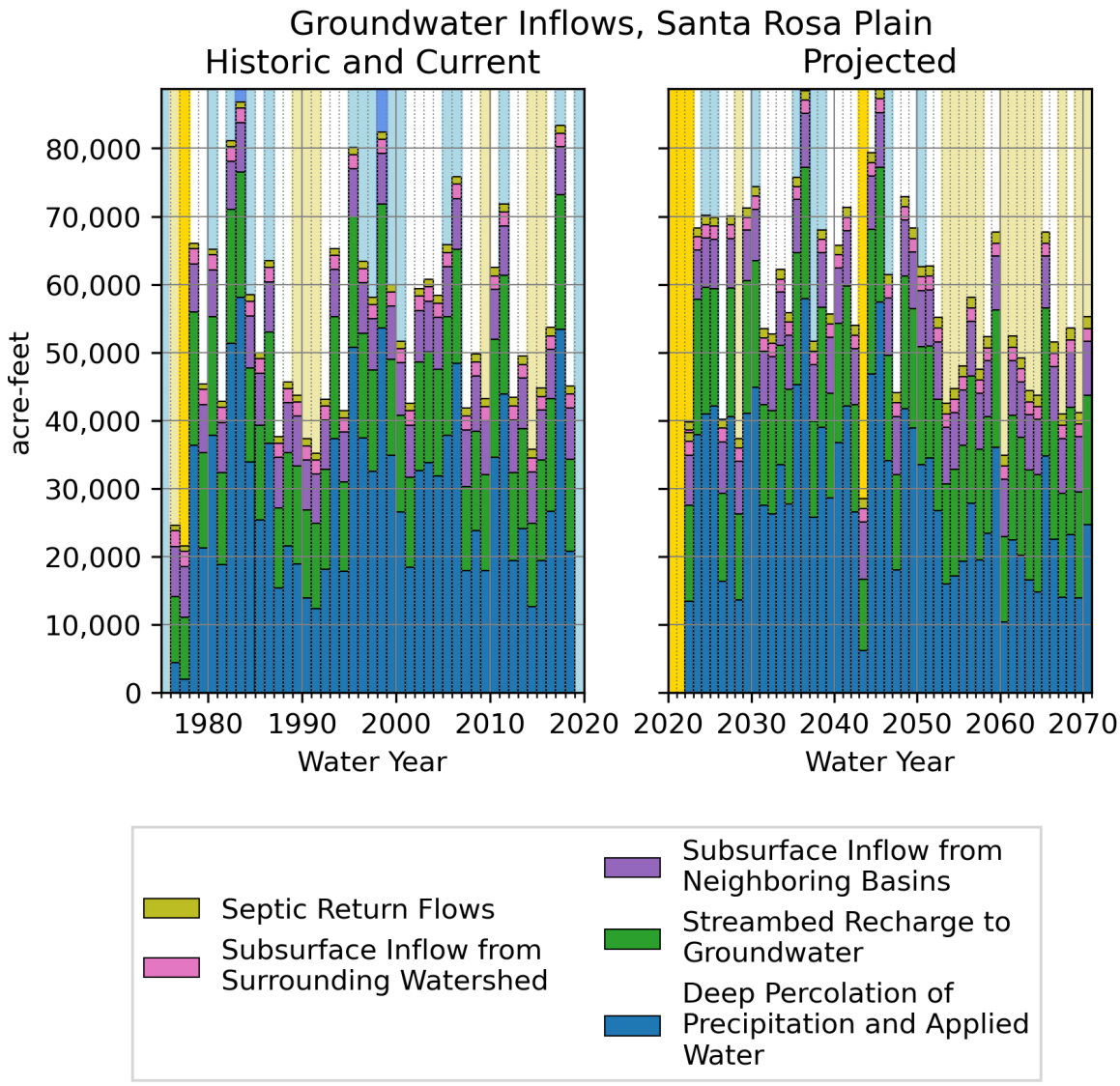


Figure 3-45. Groundwater Inflows to the Groundwater System: Historic, Current, and Projected Periods

Table 3-24. Projected (WY 2021 to WY 2040) Groundwater Inflows Budget Summary (AFY)[a]

	Deep Percolation of Precipitation and Applied Water	Streambed Recharge to Groundwater	Septic Return Flows	Subsurface Inflow from Surrounding Watershed	Subsurface Inflow from Neighboring Basins
Mean	32,800	16,700	1,400	2,000	7,700
Minimum	13,400	12,600	1,200	1,900	7,200
Maximum	57,900	19,900	1,400	2,200	8,400
Median	35,100	17,300	1,300	2,000	7,700

[a] Values are rounded to the nearest 100 acre-feet.

Table 3-25. Projected (WY 2021 to WY 2070) Groundwater Inflows Budget Summary (AFY)[a]

	Deep Percolation of Precipitation and Applied Water	Streambed Recharge to Groundwater	Septic Return Flows	Subsurface Inflow from Surrounding Watershed	Subsurface Inflow from Neighboring Basins
Mean	28,800	16,900	1,500	2,000	8,000
Minimum	6,200	10,500	1,200	1,900	7,200
Maximum	57,900	21,700	1,700	2,200	8,500
Median	27,200	17,200	1,500	2,000	8,100

[a] Values are rounded to the nearest 100 acre-feet.

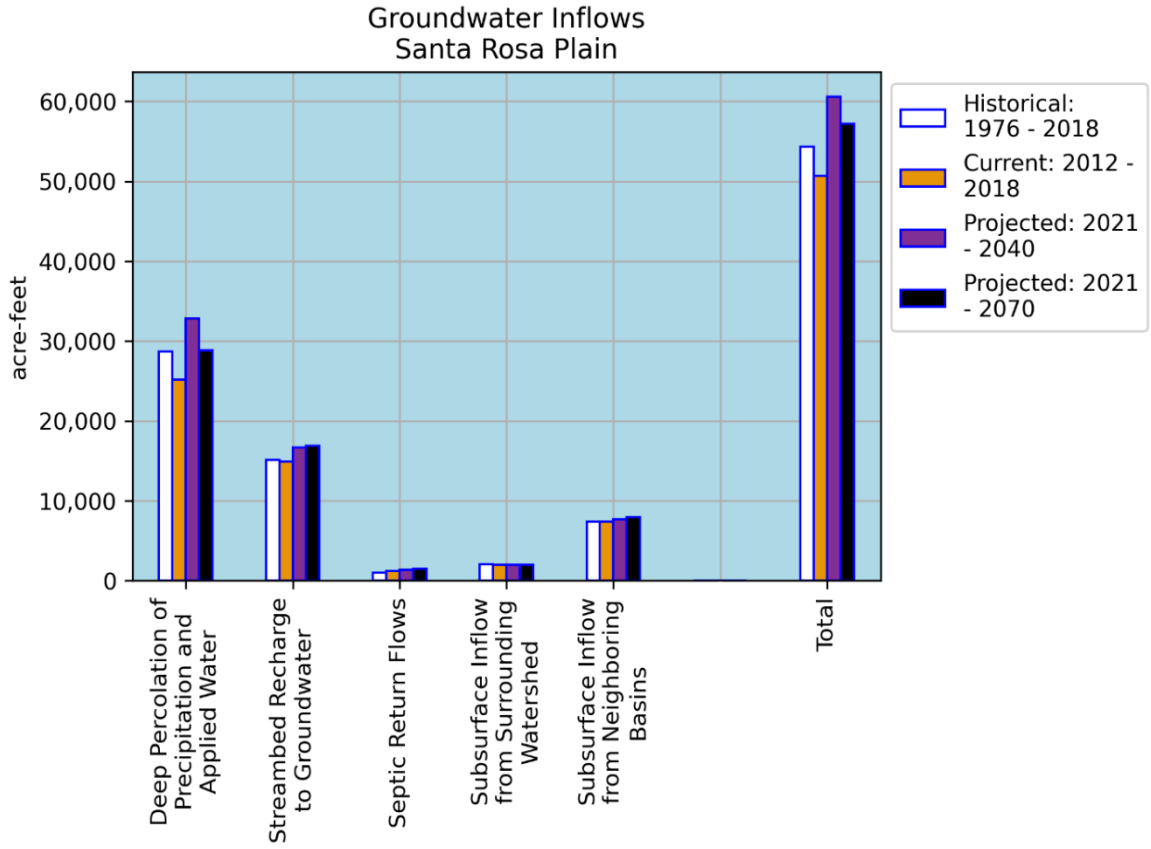


Figure 3-46. Groundwater Inflows by Water Budget Period

Figure 3-47, **Table 3-26**, and **Table 3-27** show groundwater outflows for the projected period. Groundwater outflows generally mirror groundwater inflows, with greater total outflows in the first 30 years during the wetter period, followed by declining total outflows for the last 20 years. This overall pattern is reflected in some of the fluxes, but is absent in others. Surface leakage, groundwater discharge to streams, and groundwater ET reach their peaks between WY 2035 and WY 2045 and decline steadily in the final 30 years of the simulation such that they average 79 percent, 88 percent, and 90 percent, respectively, of their WY 2021 to 2040 averages. The average surface leakage, groundwater discharge to streams, and groundwater ET for the WY 2021 to 2040 period are 6,200 AFY, 14,500 AFY, and 11,700 AFY. In contrast to

leakage, ET, and discharge to streams, two of the outflow terms–groundwater pumpage by municipal, and the combined rural domestic and agriculture users–actually increase from their WY 2021 to 2040 means. Agricultural pumpage increases by 10 percent, and the combined municipal and rural domestic pumpage increases by 9 percent, compared to the WY 2021 to 2040 period. Compared to the historical period, agricultural pumpage experienced the largest increase in the groundwater outflows, followed by groundwater ET (**Figure 3-48**). Subsurface outflows to adjacent basins, discharge to streams, and surface leakage decreased over the same two periods.

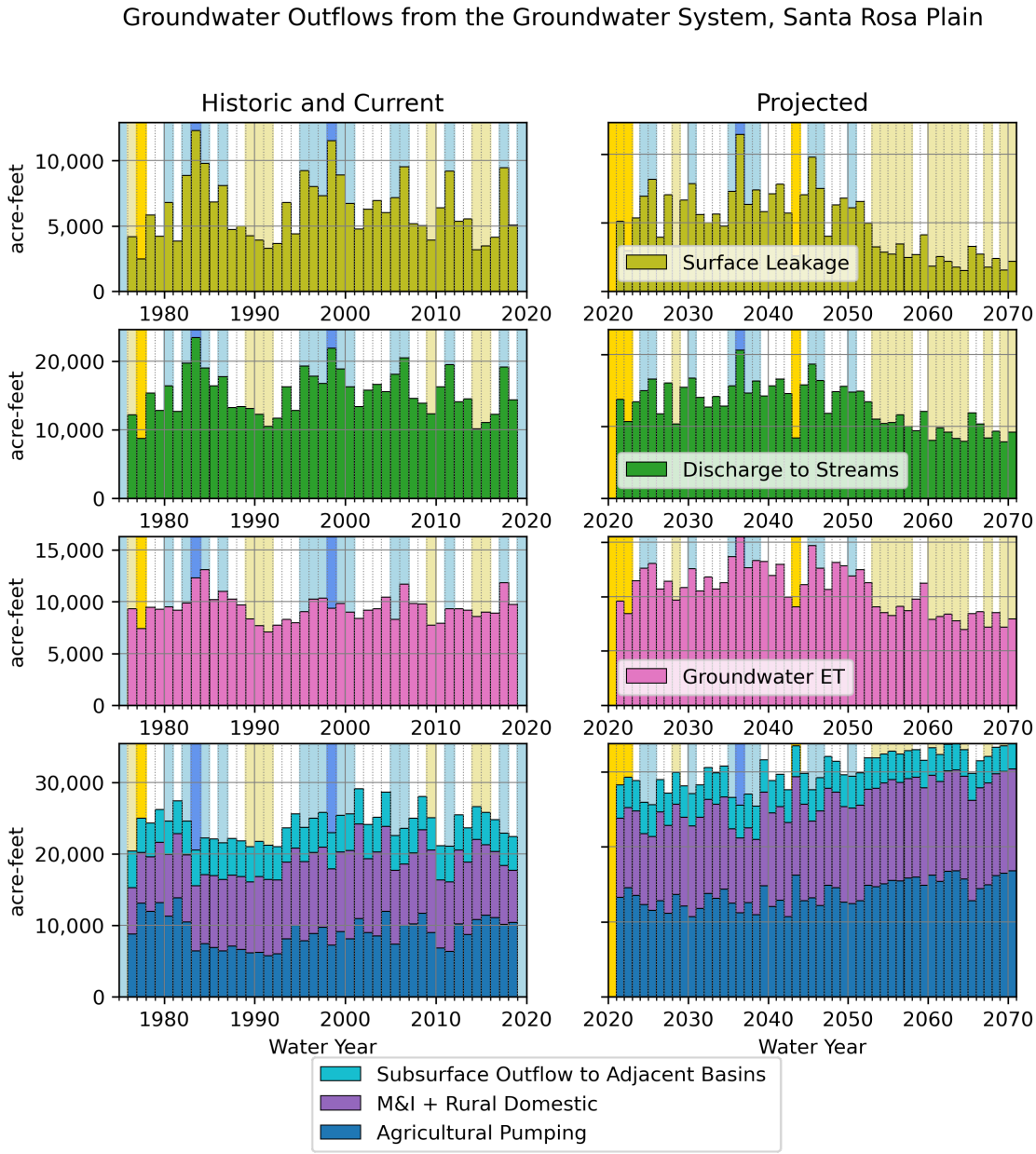


Figure 3-47. Groundwater Outflows from the Groundwater System: Historic, Current, and Projected Periods

Table 3-26. Projected (WY 2021 to WY 2040) Groundwater Outflows Budget Summary (AFY)[a]

	Agricultural Pumping	Groundwater ET	Subsurface Outflow to Adjacent Basins	Discharge to Streams	Surface Leakage	M&I + Rural Domestic
Mean	12,600	11,700	4,300	14,500	6,200	11,300
Minimum	10,700	8,400	4,000	10,400	3,000	9,500
Maximum	14,800	15,500	4,500	20,600	11,400	12,500
Median	12,500	11,600	4,300	14,400	6,100	11,800

[a] Values are rounded to the nearest 100 acre-feet.

Table 3-27. Projected (WY 2021 to WY 2070) Groundwater Outflows Budget Summary (AFY)[a]

	Agricultural Pumping	Groundwater ET	Subsurface Outflow to Adjacent Basins	Discharge to Streams	Surface Leakage	M&I + Rural Domestic
Mean	13,800	10,600	4,000	12,800	4,900	12,300
Minimum	10,700	6,900	3,400	7,800	1,500	9,500
Maximum	16,800	15,500	4,500	20,600	11,400	13,700
Median	13,700	10,700	4,100	13,100	5,000	12,700

[a] Values are rounded to the nearest 100 acre-feet.

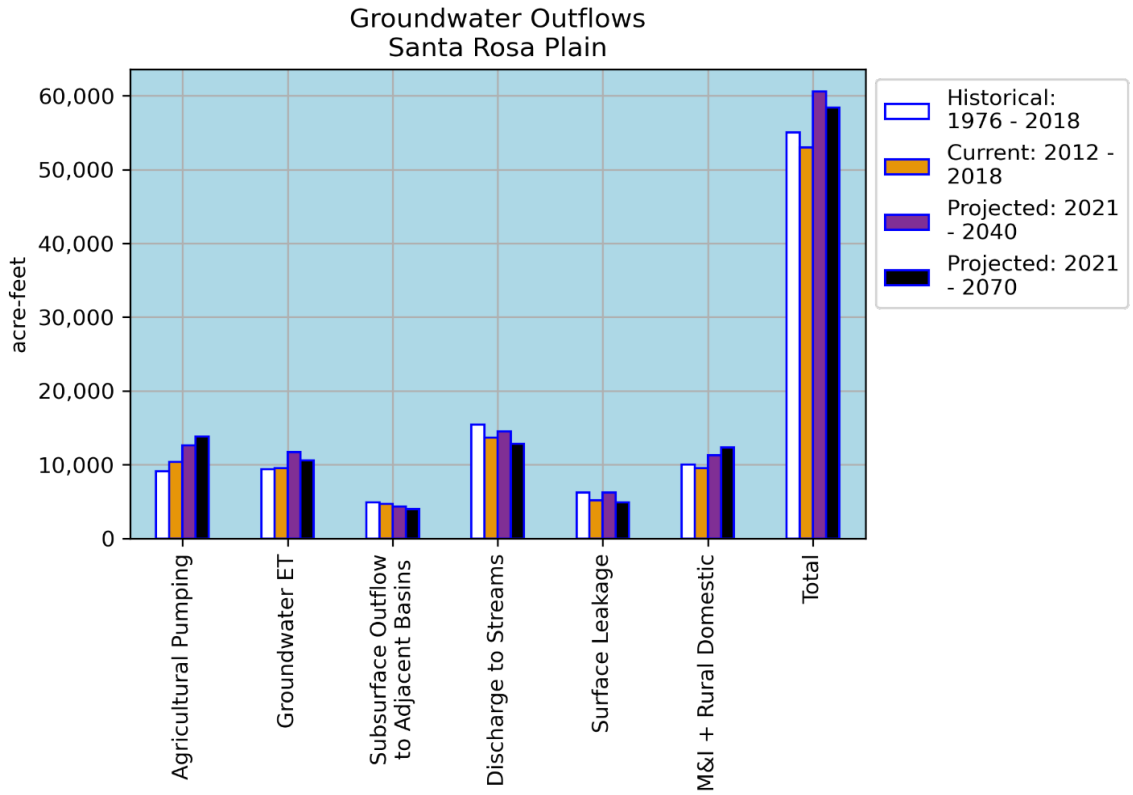


Figure 3-48. Groundwater Outflows by Water Budget Period

The change in groundwater storage is equal to the sum of groundwater inflows and the sum of groundwater outflows. Groundwater inflows and outflows are depicted on **Figure 3-49** in the first two rows of plots, and the change in groundwater storage is shown in the third row. The cumulative storage change from the initiation of the historic model in WY 1976 to the conclusion of the projected conditions in WY 2070 is a total decline of -97,200 acre-feet. By the end of WY 2040, the cumulative storage change from the initiation of the historic model is -28,900 acre-feet. For the 20-year period, from WY 2021 to 2040, the average change in groundwater storage is -200 AFY (-3,300 acre-feet total), whereas for the WY 2021 to 2070, the average change in groundwater storage is -1,400 AFY (-71,500 acre-feet total; **Table 3-28**). Groundwater storage in the Subbasin experiences a moderate increase in the first 25 years of the projected period, followed by a more rapid decline from WY 2046 to 2070 at a rate of -3,100 AFY.

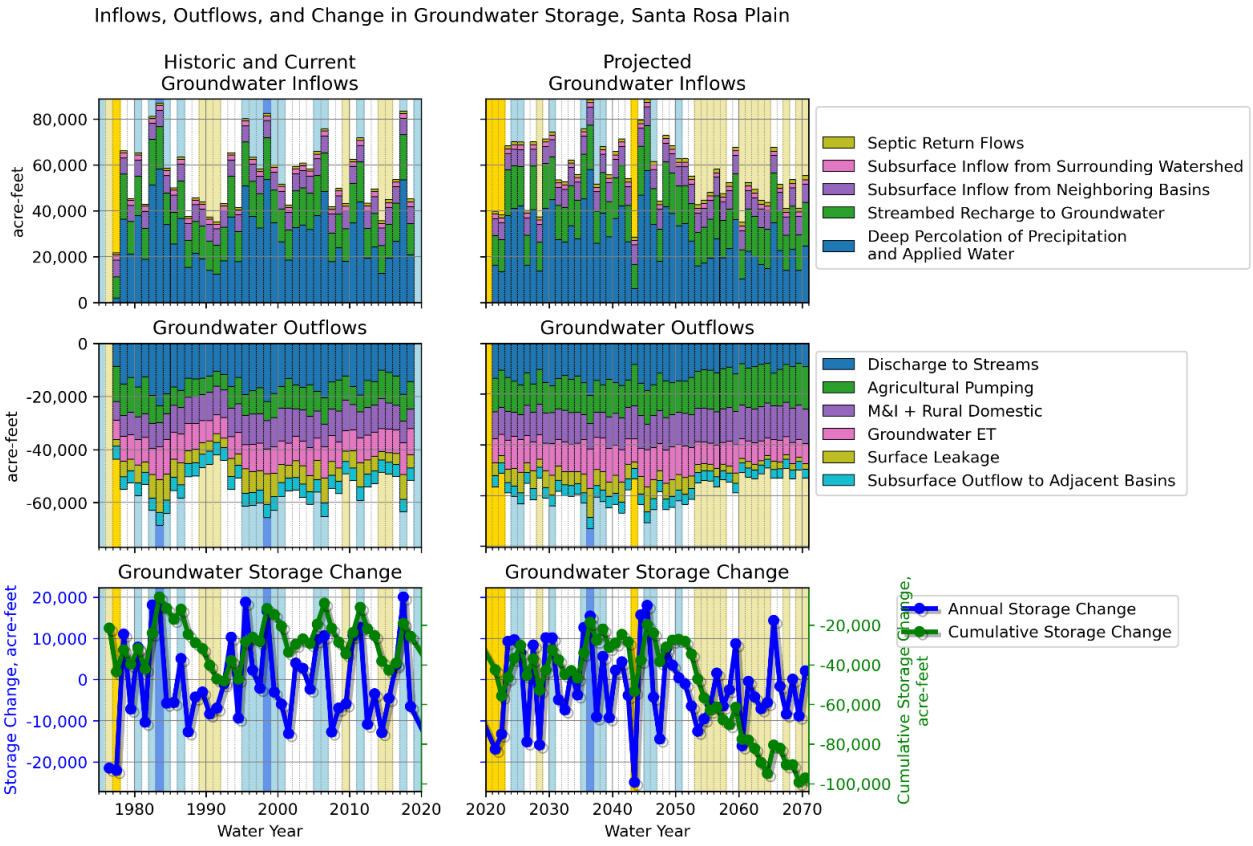


Figure 3-49. Inflows, Outflows, and Change in Groundwater Storage

Table 3-28. Average Annual Change of Groundwater in Storage (AFY)[a]

	Projected (WY 2021 to WY 2070)	Projected (WY 2021 to WY 2040)
Mean	-1,400	-200
Minimum	-24,900	-16,900
Maximum	18,000	15,400
Median	-2,000	2,100

[a] Values are rounded to the nearest 100 acre-feet.

Figure 3-50 shows the groundwater pumpage by water-use sector. For the WY 2021 to 2040 period, rural domestic pumpage is similar to the current period. Rural domestic pumpage is projected to increase over the 50-year simulation period, however. Municipal pumpage increases by 1,400 AFY for WY 2021 to 2040 period, and agriculture pumpage increases by 2,200 AFY, compared to the current period. Together these changes combine to increase the total groundwater pumpage by 3,600 AFY, which represents an 18 percent increase in pumpage for the WY 2021 to 2040 period, compared to the current period (**Table 3-29**). The increase in agricultural pumpage is caused by crop expansion in the Subbasin and by the projected warming climate. Increases in both minimum and maximum temperatures cause an increase in potential ET, which thus increases agricultural irrigation demands. These effects become more important by the end of the simulation. Near WY 2070 agricultural pumpage reaches its peak. The total increase in groundwater pumpage for agriculture is 33 percent for the WY 2021 to 2070 period, compared to the current water budget period. Municipal water uses increase 31 percent (2,200 AFY) for the same periods, and rural domestic uses increase by 10 percent (300 AFY). Overall total groundwater pumpage increases by 29 percent or 5,900 AFY for the WY 2021 to 2070 simulation (**Table 3-30**).

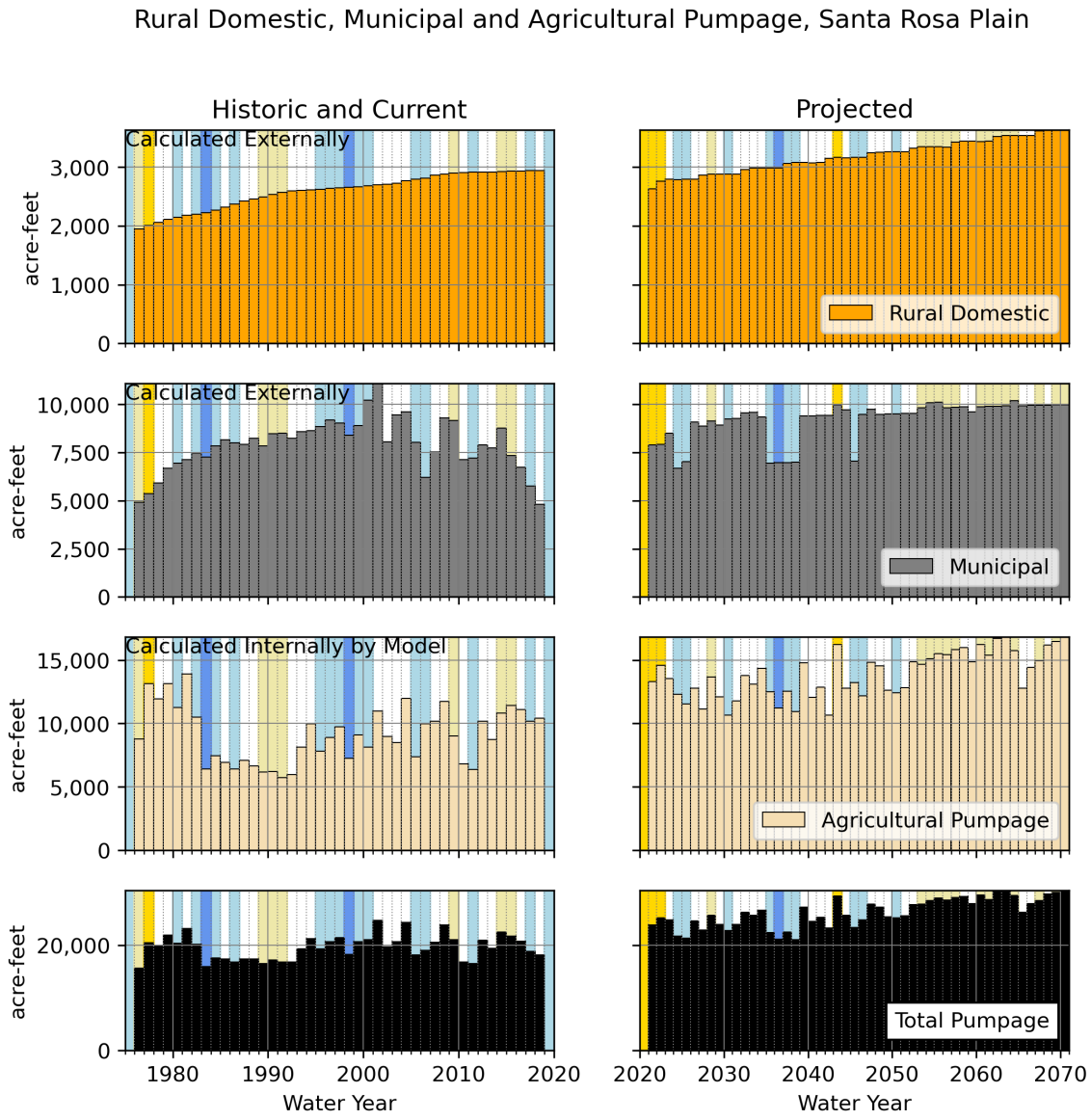


Figure 3-50. Groundwater Pumpage by Water-use Sector

Table 3-29. Projected (WY 2021 to WY 2040) Groundwater Pumpage by Water-use Sector (AFY)[a]

	M&I	Rural Domestic	Agricultural Pumping
Mean	8,400	2,900	12,600
Minimum	6,700	2,600	10,700
Maximum	9,600	3,100	14,800
Median	8,900	2,900	12,500

[a] Values are rounded to the nearest 100 acre-feet.

Table 3-30. Projected (WY 2021 to WY 2070) Groundwater Pumpage by Water-use Sector (AFY)[a]

	M&I	Rural Domestic	Agricultural Pumping
Mean	9,200	3,200	13,800
Minimum	6,700	2,600	10,700
Maximum	10,200	3,600	16,800
Median	9,500	3,200	13,700

[a] Values are rounded to the nearest 100 acre-feet.

Figure 3-51 shows the historical, current, and projected groundwater inflows from neighboring watershed areas and neighboring groundwater subbasins. Groundwater inflows from neighboring watershed areas are projected to continue to decline to the end of the simulation period at WY 2070. Groundwater inflows from Rincon-Kenwood Subbasin inflows increase by 200 AFY for both the WY 2021 to 2040 (**Table 3-31**) and WY 2021 to 2070 periods (**Table 3-32**) compared to the historic budget, which is a 9 percent change. The Wilson Grove inflows decrease by 300 AFY for both projected simulation budget periods, which is a -21 percent change compared to historic values. Finally, the groundwater inflows from the Healdsburg Area Subbasin change the most significantly compared to the other inflows. Because of lowered groundwater levels in the Subbasin after WY 2050, the Healdsburg Area switches from its previous outflow conditions to one in which groundwater flow is predominantly moving into the Subbasin from the Healdsburg Area Subbasin. In the historic period this boundary received 1,100 AFY from the Subbasin, but during the entire future budget period the flow into the basin is +400 AFY.

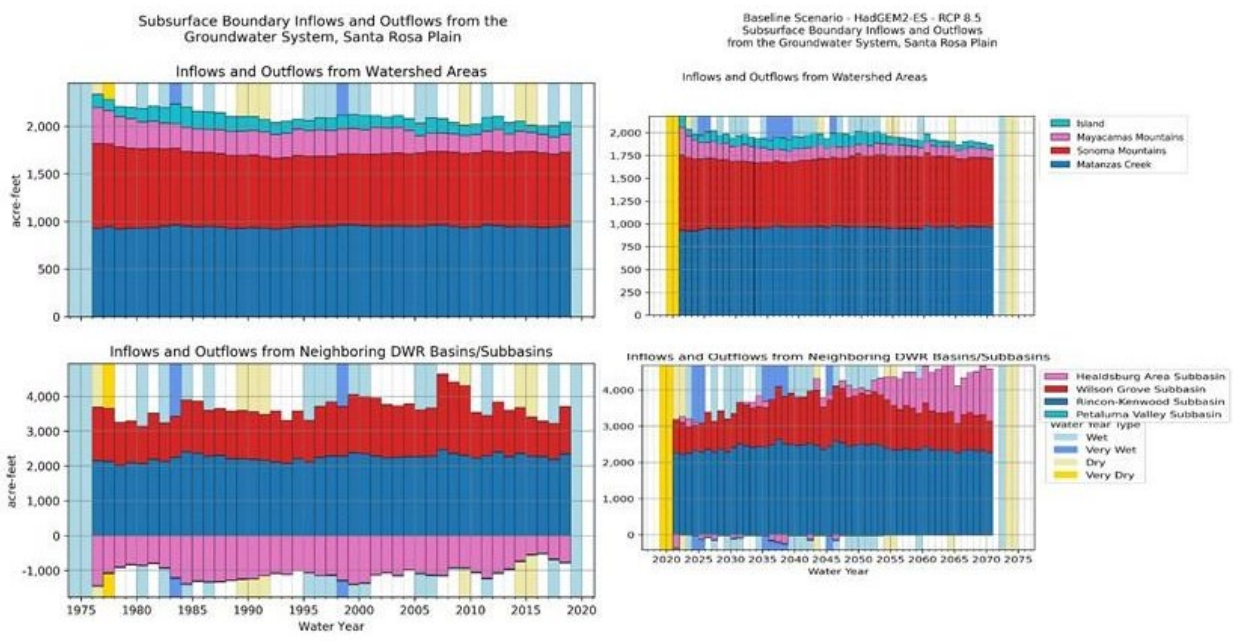


Figure 3-51. Historical, Current, and Projected Inflows and Outflows from Watershed Areas and Neighboring Basins/Subbasins

Table 3-31. Projected (WY 2021 to WY 2040) Subbasin Boundary Flows (AFY)[a]

	Petaluma Valley Basin	Rincon-Kenwood Subbasin	Healdsburg Area Subbasin	Wilson Grove Subbasin
Mean	-0	2,400	-0	1,100
Minimum	-0	2,200	-400	700
Maximum	-0	2,600	300	1,500
Median	-0	2,400	0	1,100

[a] Values are rounded to the nearest 100 acre-feet.

Table 3-32. Projected (WY 2021 to WY 2070) Subbasin Boundary Flows (AFY)[a]

	Petaluma Valley Basin	Rincon-Kenwood Subbasin	Healdsburg Area Subbasin	Wilson Grove Subbasin
Mean	-0	2,400	400	1,100
Minimum	-0	2,200	-400	700
Maximum	-0	2,600	1,400	1,600
Median	-0	2,400	200	1,100

[a] Values are rounded to the nearest 100 acre-feet.

3.3.6.6 Projected Watershed and Soil-zone Budgets

The projected watershed and soil-zone budgets are shown on **Figure 3-52**, and are summarized in **Table 3-33**, **Table 3-34**, **Table 3-35**, and **Table 3-36**. In the WY 2021 to 2040 period, soil-zone recharge increases 15 percent, similar to the change in precipitation, compared to the historical period. Precipitation increases 19 percent for the same period. The historical mean precipitation is 290,400 AFY and the WY2021-2040 mean precipitation is 346,100 AFY. Likely as a result of the increased precipitation and some very wet years in that period, the mean Dunnian flow and interflow increase 38 percent and 22 percent, respectively, compared to their historic values, changing from -40,100 AFY to -55,500 AFY, and -57,100 AFY to -69,800 AFY, respectively. Soil moisture remains similar to the historic period, while total soil ET increased by 13 percent.

For the projected period from WY 2021 to 2070, overall soil moisture decreases by 6 percent, from an average of 38,200 AF in the historic to 36,000 AF in the WY 2021 to 2070 period (**Table 3-35**, and **Table 3-36**). Dunnian flow and interflow showed deviations of 3 percent and -1 percent, respectively, from their historic averages. Aside from agricultural water applied to the soil zone, which experienced a 2,900 AFY increase in the projected period, ET in the soil zone showed the biggest change. It increased by 12 percent from its historical value of -147,600 AFY to 165,700 AFY in the WY 2021-2070 period likely due to the increased potential ET in the warmer projected climate.

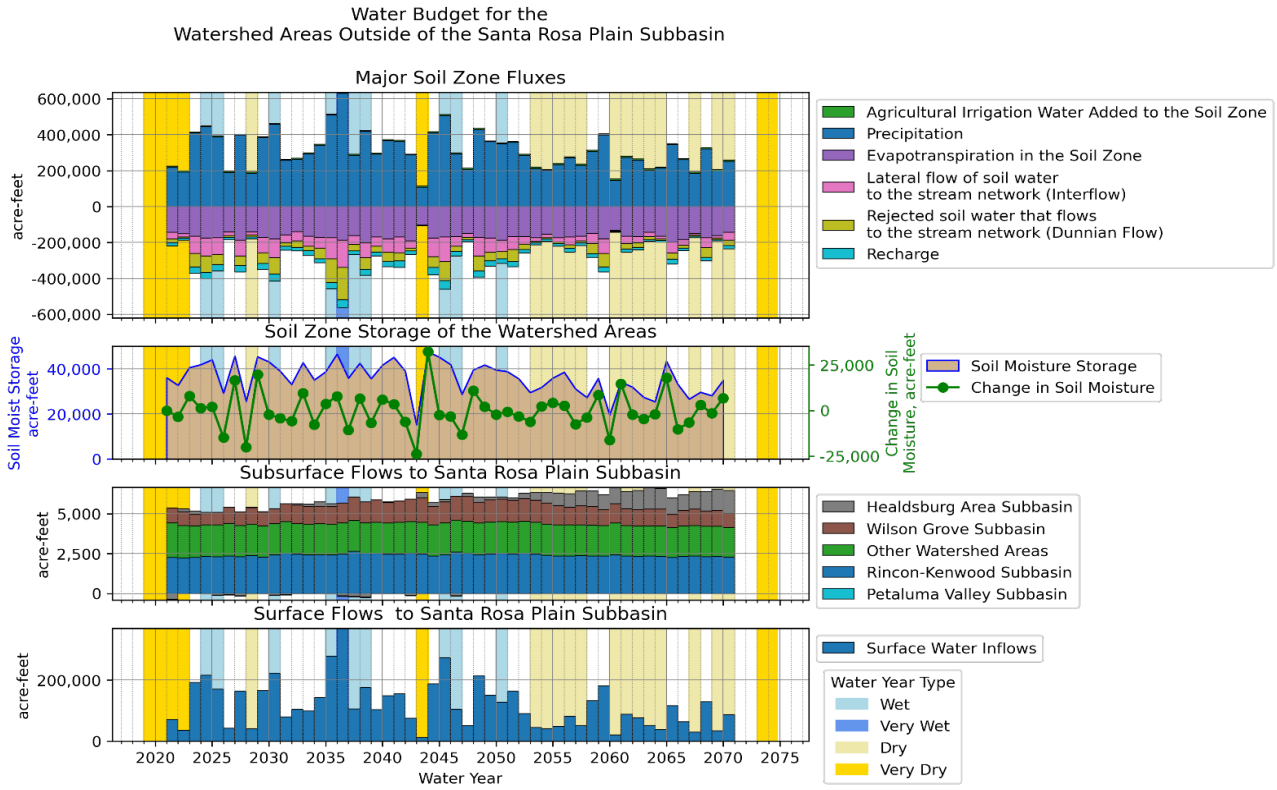


Figure 3-52. Projected Budget for Watershed Areas Outside Subbasin

Table 3-33. Projected (WY 2021 to WY 2040) Budget for Watershed Areas Outside Subbasin and Major Soil-zone Fluxes[a]

	Precipitation (AFY)	Agricultural Irrigation Water Added to the Soil Zone (AFY)	ET in the Soil Zone (AFY)	Soil-zone Recharge (AFY)	Rejected Soil Water that Flows to the Stream Network (Dunnian Flow; AFY)	Lateral flow of Soil Water to the Stream Network (Interflow; AFY)	Soil Moisture (acre-feet)	Change in Soil Moisture (AFY)
Mean	346,100	5,400	-167,200	-27,100	-55,500	-69,800	38,800	300
Minimum	185,100	4,400	-201,400	-46,600	-179,200	-151,100	25,700	-20,100
Maximum	630,600	6,800	-139,600	-8,600	-7,100	-16,500	46,600	19,800
Median	353,600	5,300	-170,500	-28,400	-52,200	-67,400	39,800	600

[a] Values are rounded to the nearest 100 acre-feet.

Table 3-34. Projected (WY 2021 to WY 2040) Budget for Watershed Areas Outside Subbasin, Subsurface, and Surface Flows into Subbasin (AFY)[a]

	Other Watershed Areas	Surface Water Inflows
Mean	2,000	146,300
Minimum	1,900	35,300
Maximum	2,200	369,000
Median	2,000	145,500

[a] Values are rounded to the nearest 100 acre-feet.

Table 3-35. Projected (WY 2021 to WY 2070) Watershed Budget for Watershed Areas Outside Subbasin and Major Soil-zone Fluxes[a]

	Precipitation (AFY)	Agricultural Irrigation Water Added to the Soil Zone (AFY)	ET in the Soil Zone (AFY)	Soil-zone Recharge (AFY)	Rejected Soil Water that Flows to the Stream Network (Dunnian Flow; AFY)	Lateral Flow of Soil Water to the Stream Network (Interflow; AFY)	Soil Moisture (acre-feet)	Change in Soil Moisture (AFY)
Mean	307,600	6,000	-165,700	-22,900	-41,300	-56,300	36,000	-0
Minimum	107,200	4,400	-201,400	-49,800	-179,200	-151,100	15,200	-23,800
Maximum	630,600	7,800	-104,300	-1,300	-1,400	-1,300	47,700	32,400
Median	289,000	6,000	-168,600	-20,900	-31,200	-51,100	36,000	-1,800

[a] Values are rounded to the nearest 100 acre-feet.

Table 3-36. Projected (WY 2021 to WY 2070) Watershed Budget for Watershed Areas Outside Subbasin, Subsurface Flows to Subbasin, and Surface Flows to the Subbasin[a]

	Other Watershed Areas	Surface Water Inflows
Mean	2,000	116,800
Minimum	1,900	12,300
Maximum	2,200	369,000
Median	2,000	103,600

[a] Values are rounded to the nearest 100 acre-feet.

The soil-zone water budget for the Subbasin is shown on **Figure 3-53** and is summarized in **Table 3-37** and **Table 3-38**. The biggest change in soil-zone fluxes is ET with a change of -48,400 AFY in the WY 2021 to 2040, and -51,100 AFY in the WY 2021 to 2070 period, compared to the historic period. The historical value is -107,300 AFY and the values are -155,700 AFY and -158,400 AFY for the WY 2021-2040 and WY 2021-2070 periods, respectively (**Table 3-37** and **Table 3-38)**. Given that the longer period has a greater magnitude of ET than the WY 2021 to 2040 period, the increased rate of ET is more likely due to an increase in temperatures than an increased availability of water. The future maximum temperatures are 5.3 F greater than the

historical period, and the minimum temperatures are 5.0 F greater (**Figure 3-38**). In addition, the soil moisture storage of the entire projection period is 8 percent lower than the historic period despite the prolonged period of increased precipitation. Again, given the relative similarity of average precipitation in the projected period compared to the historic, this decrease in soil moisture storage is likely due to the increased soil ET.

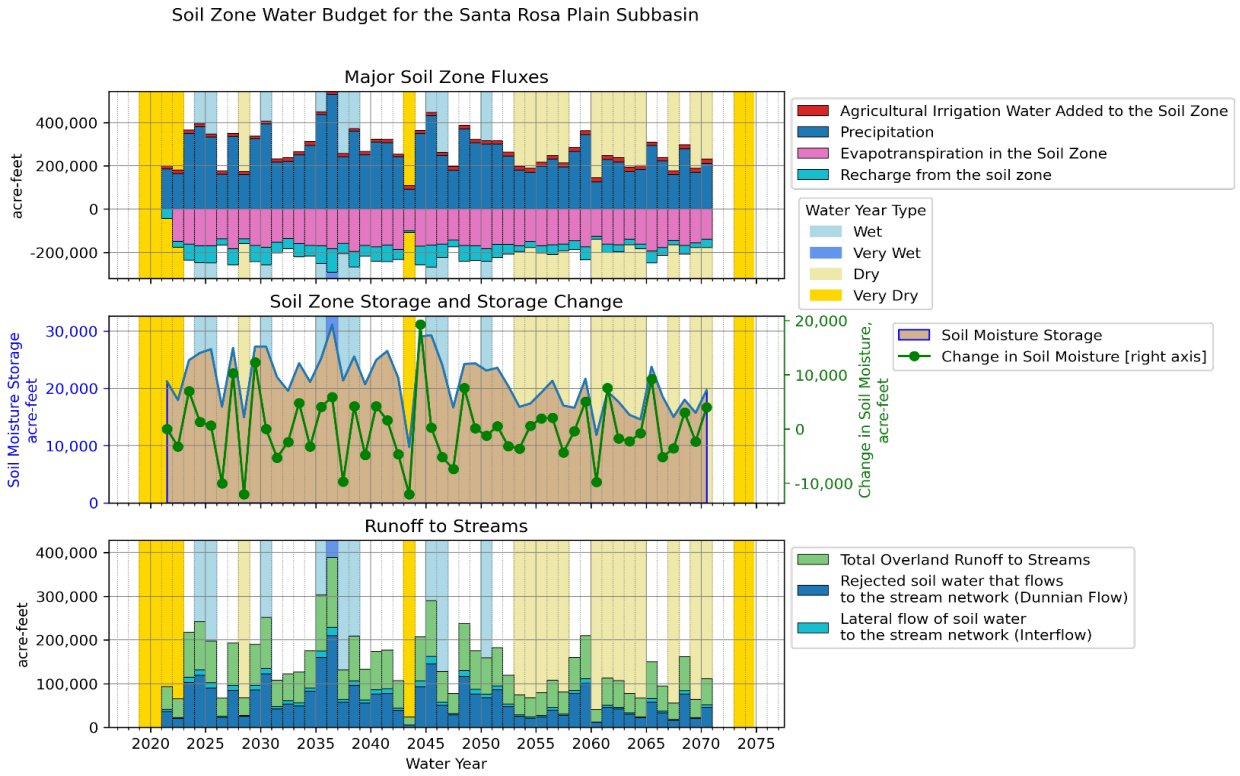


Figure 3-53. Projected Soil-zone Budget for the Subbasin

Table 3-37. Projected (WY 2021 to WY 2040) Budget for the Subbasin Soil Zone[a]

	Precipitation (AFY)	Agricultural Irrigation Water Added to the Soil Zone (AFY)	ET in the Soil Zone (AFY)	Soil-zone Recharge (AFY)	Rejected Soil Water that Flows to the Stream Network (Dunnian Flow; AFY)	Lateral Flow of Soil Water to the Stream Network (Interflow; AFY)	Soil Moisture (acre-feet)
Mean	294,900	14,500	-155,700	-60,700	79,500	8,900	23,300
Minimum	159,200	12,200	-196,100	-109,300	20,000	2,500	15,000
Maximum	530,500	17,000	-0	-23,400	210,000	18,800	31,100
Median	302,200	14,400	-167,200	-63,200	79,500	8,500	24,600

[a] Values are rounded to the nearest 100 acre-feet.

Table 3-38. Projected (WY 2021 to WY 2070) Budget for Subbasin Soil Zone[a]

	Precipitation (AFY)	Agricultural Irrigation Water Added to the Soil Zone (AFY)	ET in the Soil Zone (AFY)	Soil-zone Recharge (AFY)	Rejected Soil Water that Flows to the Stream Network (Dunnian Flow; AFY)	Lateral Flow of Soil Water to the Stream Network (Interflow; AFY)	Soil Moisture (acre-feet)
Mean	262,600	15,900	-158,400	-50,800	62,800	7,200	21,200
Minimum	91,300	12,200	-196,100	-109,300	5,400	500	9,800
Maximum	530,500	19,200	-0	-8,100	210,000	18,800	31,100
Median	246,900	15,700	-164,200	-46,900	52,100	6,600	21,300

[a] Values are rounded to the nearest 100 acre-feet.

3.3.6.7 Projected Water Budget Summary

The projected water budget is characterized by an elevated average precipitation in the first 30 years of the 50-year simulation. This period is followed by an increasingly warm and dry climate for the last 20 years of the simulation period. Mean annual minimum and maximum temperatures are greater for the future simulation period, averaging 5.0°F and 5.3°F greater, respectively, than the historical period.

In the initial wetter 30-year period, the groundwater storage experiences a net positive increase as groundwater inflows respond via increased recharge from precipitation and streamflow recharge. Starting around WY 2050, surface leakage, groundwater discharge to streams, and groundwater ET begin to decline steadily, while groundwater storage begins a notable decline. From WY 2046 to 2070 the average rate of groundwater storage change is -3,100 AFY. The average rate of groundwater storage change is -200 AFY for the WY 2021 to 2040 period. Though most of storage loss occurred in the last 20 years, the WY 2021 to 2070 change in groundwater storage is -1,400 AFY.

During the implementation period from WY 2021 to 2040, total inflows increase by 11 percent whereas outflows increase by 10 percent, compared to the historical mean values. The largest absolute gains to inflows is observed in deep percolation of precipitation and applied waters (4,100 AFY increase or 14 percent), and streambed recharge to groundwater (1,600 AFY increase or 11 percent increase). The increases in groundwater outflows result from a 25 percent increase in groundwater pumpage (4,800 AFY) and a 25 percent increase in groundwater ET (2,300 AFY). Similar to the increases in groundwater ET, the increased temperatures also cause greater soil-zone ET to occur in both the watershed and Subbasin areas. The total soil-zone ET increases 48 percent from the historic period to the WY 2021- 2040 period, for areas within the Subbasin. Despite the large increases in soil ET, mean values of soil moisture decrease by only -8 percent in the Subbasin from the historic to the WY 2021-2070 period.

Total groundwater pumpage for the entire WY 2021-2070 simulation period increases from its current period mean annual value by 5,900 AFY (from 20,300 AFY). Agricultural pumpage experiences the largest growth of the water-use sectors. For the WY 2021-2070 period, agricultural pumpage increase 3,400 AFY from the current period mean value of 10,400 AFY. Along with the increased temperatures and a drying climate, the projected growth in agricultural crop acreage is a driver of the increased agricultural groundwater pumpage demands.

During the historic period groundwater typically flowed from the Subbasin into the Healdsburg Area Subbasin. But due to lowered groundwater levels, the groundwater flow direction reverses direction, changing the Healdsburg Area into a continuous net contributor of groundwater into the Subbasin by the end of the simulation period.

3.3.6.8 Uncertainties in Projected Water Budget Simulations

The uncertainty of the projected water budget components is similar to those of the historical budget, but there are additional uncertainties due to the incorporation of long-term projections. The projected budget incorporates uncertain projections of land use changes for agriculture, changes in groundwater demands for municipal users, and modeled estimates of rural domestic groundwater demands. These projections are based on the simplification of complex socioeconomic, cultural and political forces, amongst many other drivers of change that will impact how groundwater usage changes in the future. The incorporation of a climate change scenario creates additional uncertainty. Like the projections of groundwater demand and land use changes, there are numerous factors that prohibit accurate and reliable climate change conditions. Despite these challenges, it should be emphasized that the projections of climate change and groundwater demands are within the bounds of reasonableness for such projections, and do provide a useful tool for understanding future groundwater conditions. Other model boundary conditions are also characterized by increased uncertainty in the projected simulation. General head boundaries (GHBs) simulate subsurface groundwater inflow and outflow from neighboring areas, such as the Wilson Grove, Petaluma Valley Basin, and the Healdsburg Area Subbasin. For the historical simulation, the boundary head defined for these interfaces was derived from observed data nearby the boundaries. For the projected simulation there exist no observed data that can be used to establish the boundary heads. Because of this, the historical boundary heads were used for the projected boundary heads. The overall impact of this approach should be limited given the relative magnitude of the net subsurface inflow from neighboring basins compared to the other sources of inflow. The net groundwater inflow simulated by the GHBs is 1/20th the magnitude of the remaining groundwater inflow components.

There does exist inescapable uncertainty in the projected simulation water budget. Despite these limitations, the model and its conclusions should be regarded as a useful tool and source of information for the planning and implementation of the GSP.

3.3.7 Sustainable Yield

The sustainable yield of the Subbasin is an estimate of the quantity of groundwater that can be pumped on a long-term average annual basis without causing undesirable results. Basinwide pumping within the sustainable yield estimate is neither a measure of, nor proof of, sustainability. Sustainability under SGMA is only demonstrated by avoiding undesirable results for the five applicable sustainability indicators. However, estimates of sustainable yield using the current and projected simulations may prove useful in estimating the need for projects and management actions to help achieve sustainability.

The role of sustainable yield estimates in SGMA, as described in the SMC BMP (DWR 2017), are as follows:

> "In general, the sustainable yield of a basin is the amount of groundwater that can be withdrawn annually without causing undesirable results. Sustainable yield is referenced in SGMA as part of the estimated basinwide water budget and as the outcome of avoiding undesirable results.
>
> Sustainable yield estimates are part of SGMA's required basinwide water budget. Section 354.18(b)(7) of the GSP Regulations requires that an estimate of the basin's sustainable yield be provided in the GSP (or in the coordination agreement for basins with multiple GSPs). A single value of sustainable yield must be calculated basinwide. This sustainable yield estimate can be helpful for estimating the projects and programs needed to achieve sustainability."

The 20-year period from WY 2021 to 2040 is used to determine the sustainable yield of the Subbasin. This period is selected based on the following factors:

- Representative of long-term conditions: Mix of 6 wet years, 1 very wet year, 1 dry year, 2 very dry years and 10 normal years.
- The simulated net groundwater storage change during this period is near zero (**Figure 3-54**).
- There are no simulated undesirable results related to chronic lowering of groundwater during this period.
- The sustainable yield is derived from Projected Baseline conditions that include climate change.

The average total groundwater pumpage for this period is 23,900 AFY, which is defined here as the sustainable yield (**Figure 3-54**). This value is 39 percent of the total groundwater inflows into the Subbasin, and is greater than the average total groundwater pumpage experienced during the current water budget period.

The sustainable yield is dependent on the anticipated reasonable climate conditions (Loaiciga 2016) and is not predicated on implementation of projects and actions. If future climate

conditions are better represented by the hotter and drier conditions observed in the WY 2050-2070 period of the projected scenario rather than the wetter WY 2021-2040 period, then the sustainable yield will need to be reduced, or projects and management actions will need to occur to allow for the Subbasin to avoid undesirable results.

Minimum thresholds for depletion of interconnected surface water will be further refined during the five-year GSP update. As such the sustainable yield does not fully account for the impact of basinwide pumpage on surface water depletion.

The sustainable yield pertains to a basinwide pumping value. Changes in the location of pumping may induce greater depletion of surface waters or movement of waters of poor water quality, for example, which may lead to undesirable results. As described in **Section 7**, the water budget and estimated sustainable yield will continue to be evaluated with new information and alternative climate scenarios during the five-year GSP updates.

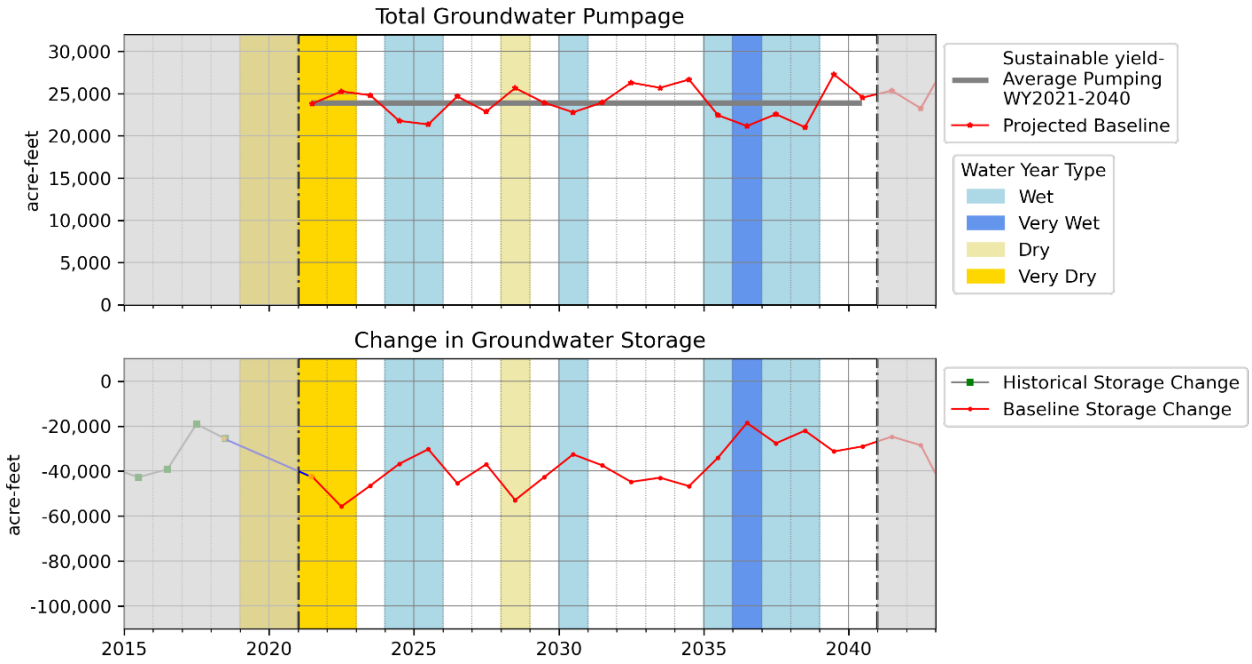


Figure 3-54. Sustainable Yield: Total Groundwater Pumpage and Change in Groundwater Storage

3.4 Management Areas

SGMA provides GSAs with the ability to define one or more management areas within a basin if the GSA determines that the creation of management areas will facilitate implementation of the GSP. Management areas can be used to define different minimum thresholds and be operated to different measurable objectives than the basin at large, provided that undesirable results are defined consistently throughout the basin (23 CCR 354.20).

Management areas were not defined for the Subbasin. Management areas may be considered in the future if the GSA finds that doing so will facilitate implementation of the GSP.

Section 4: Sustainable Management Criteria
Groundwater Sustainability Plan
Santa Rosa Plain Groundwater Subbasin

Table of Contents

4 SUSTAINABLE MANAGEMENT CRITERIA 4-1
4.1 Definitions 4-2
4.2 Sustainability Goal 4-4
4.3 General Process for Establishing Sustainable Management Criteria 4-5
4.4 Sustainable Management Criteria Summary 4-6
4.5 Chronic Lowering of Groundwater Levels Sustainable Management Criteria 4-11
4.5.1 Locally Defined Significant and Unreasonable Conditions 4-11
4.5.2 Minimum Thresholds 4-12
4.5.3 Measurable Objectives 4-27
4.5.4 Undesirable Results 4-28
4.6 Reduction in Groundwater Storage Sustainable Management Criteria 4-29
4.6.1 Locally Defined Significant and Unreasonable Conditions 4-30
4.6.2 Minimum Thresholds 4-30
4.6.3 Measurable Objectives 4-32
4.6.4 Undesirable Results 4-32
4.7 Seawater Intrusion Sustainable Management Criteria 4-33
4.8 Degraded Water Quality Sustainable Management Criteria 4-33
4.8.1 Locally Defined Significant and Unreasonable Conditions 4-33
4.8.2 Minimum Thresholds 4-34
4.8.3 Measurable Objectives 4-43
4.8.4 Undesirable Results 4-44
4.9 Subsidence Sustainable Management Criteria 4-45
4.9.1 Locally Defined Significant and Unreasonable Conditions 4-47
4.9.2 Minimum Thresholds 4-47
4.9.3 Measurable Objectives 4-50
4.9.4 Undesirable Results 4-50

4.10 Depletion of Interconnected Surface Water Sustainable Management Criteria 4-52
4.10.1 Locally Defined Significant and Unreasonable Conditions 4-53
4.10.2 Minimum Thresholds 4-53
4.10.3 Measurable Objectives 4-59
4.10.4 Undesirable Results 4-59
4.10.5 Consideration of Public Trust Resources 4-61

Tables

Table 4-1. Sustainable Management Criteria Summary 4-7
Table 4-2. Summary of Calculations for Minimum Thresholds and Measurable Objectives 4-19
Table 4-3. Santa Rosa Plain Subbasin Monitoring Networks 4-36
Table 4-4. Future Monitoring Networks for Project-Specific Monitoring 4-36
Table 4-5. Summary of Constituents Monitored at Each Well Network 4-36
Table 4-6. Groundwater Quality Minimum Thresholds Basis 4-37
Table 4-7. Minimum Thresholds for Degradation of Groundwater Quality for the Public Supply Wells Under the Current Monitoring Network 4-37
Table 4-8. Minimum Thresholds and Measurable Objectives for Depletion of Interconnected Surface Water 4-55

Figures

Figure 4-1. Proposed Representative Monitoring Point Network for Chronic Lowering of Groundwater Levels – Shallow Aquifer System 4-14
Figure 4-2. Proposed Representative Monitoring Point Network for Chronic Lowering of Groundwater Levels – Deep Aquifer System 4-15
Figure 4-3. Calculated 98th Percentile Well Depths and Saturated Thickness Factor 4-17
Figure 4-4. Application of Well Impact Depth and Drought Buffer to Minimum Thresholds 4-18
Figure 4-5 Baseline Groundwater Quality Arsenic 2015-2019 4-38
Figure 4-6. Baseline Groundwater Quality Nitrate 2015-2019 4-39
Figure 4-7. Baseline Groundwater Quality TDS 2015-2019 4-40

Appendices

Appendix 4-A. Hydrographs of Representative Monitoring Points
Appendix 4-B. Definition of Drought for Sonoma County Groundwater Sustainability Plans
Appendix 4-C. Key Themes and Outcomes from Interconnected Surface water Practitioners Work Group
Appendix 4-D. Development of Sustainable Management Criteria of Interconnected Surface Water – Santa Rosa Plain

4 SUSTAINABLE MANAGEMENT CRITERIA

This section identifies the sustainability goal, defines the conditions that constitute sustainable groundwater management, discusses the process by which the GSA will characterize undesirable results, and establishes minimum thresholds (MTs) and measurable objectives (MOs) for each applicable sustainability indicator.

The MOs, MTs, and undesirable results detailed in this section define the Subbasin's future desired conditions and inform the selection, prioritization, and planning for projects and management actions to achieve these conditions. Defining these sustainable management criteria (SMC) included both a significant level of technical analysis utilizing currently available data and information and best available science and substantial input from stakeholders. This section includes a description of how SMC were developed and how they influence all beneficial uses and users. Uncertainty caused by data gaps in the hydrogeologic conceptual model and existing monitoring networks was considered when developing the SMC. Due to this uncertainty, these SMC are considered initial criteria and will be re-evaluated and potentially modified in the future as new data become available.

SMC are provided for each of the following sustainability indicators:

- Chronic lowering of groundwater levels
- Reduction in groundwater storage
- Degraded water quality
- Land subsidence
- Depletion of interconnected surface water

Seawater intrusion is not applicable to the Subbasin and therefore no SMC are defined for this sustainability indicator.

Each sustainability indicator subsection follows a consistent format that contains the information required by Section 354.22 et. seq of the GSP Regulations and outlined in the SMC BMP (DWR 2017). The subsection for each sustainability indicator includes a description of:

- How locally defined significant and unreasonable conditions were developed
- How MTs were developed, including:
  - The information and methodology used to develop MTs, Section 354.28 (b)(1)
  - The relationship between MTs for other sustainability indicators, Section 354.28 (b)(2)
  - Potential effects of MTs on neighboring basins, Section 354.28 (b)(3)
  - Potential effects of MTs on beneficial uses and users, Section 354.28 (b)(4)
  - Relationship of MTs to relevant federal, state, or local standards, Section 354.28 (b)(5)
  - The method for quantitatively measuring MTs, Section 354.28 (b)(6)

- How MOs were developed, including:
  - The methodology for setting MOs, Section 354.30
  - Interim milestones, where applicable, Sections 354.30 (a), 354.30 (e), 354.34 (g)(3)

- How undesirable results were developed, including:
  - The criteria for defining undesirable results, Section 354.26 (b)(2)
  - Potential causes of undesirable results, Section 354.26 (b)(1)
  - Potential effects of these undesirable results on the beneficial users and uses, Section 354.26 (b)(3)

4.1 Definitions

The SGMA legislation and GSP Regulations contain terms relevant to the SMC. These terms are defined as follows using the definitions included in the GSP Regulations, and explanatory text is provided where appropriate. This explanatory text is not part of the official definitions of these terms but provides useful clarifications.

Interconnected surface water refers to surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted. Interconnected surface waters are sections of streams, lakes, or wetlands where the groundwater table is at or near the ground surface or surface water body/stream channel bottom. Interconnection between surface water and groundwater may be seasonal.

Interim milestone refers to a target value representing measurable groundwater conditions, in increments of 5 years. Interim milestones are targets such as groundwater elevations that should be achieved every 5 years to demonstrate progress towards sustainability.

Measurable objectives refer to specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted plan to achieve the sustainability goal for the basin. MOs are goals that the GSP is designed to achieve.

Minimum threshold refers to a numeric value for each sustainability indicator used to define undesirable results. MTs are indicators of an unreasonable condition. For example, groundwater levels that maintain operational capacity for water wells may be a MT because groundwater levels dropping below levels that significantly impact well production capacities or dewater wells would be an unreasonable condition.

Representative monitoring sites refers to a monitoring site within a broader network of sites that typifies one or more conditions within the basin or an area of the basin.

Significant and unreasonable conditions

> "Significant and unreasonable conditions" is a phrase used to identify conditions that lead to undesirable results but is not specifically defined in the definitions section of the GSP Regulations (Section 351). This expression is often confused with, or used interchangeably with, undesirable results. This GSP defines significant and unreasonable conditions as a narrative description of physical conditions to be avoided; an undesirable result is a

quantitative assessment based on MTs. Defining significant and unreasonable conditions early in the process of developing SMC for each sustainability indicator helps set the framework by which the quantitative SMC metrics are determined.

Sustainability indicator refers to any of the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, cause undesirable results, as described in Water Code Section 10721(x). The five sustainability indicators relevant to this Subbasin include chronic lowering of groundwater levels; reduction of groundwater storage; degraded water quality; land subsidence; and depletion of interconnected surface waters. Seawater intrusion is not applicable to the Subbasin.

Uncertainty refers to a lack of understanding of the basin setting that significantly affects an Agency's ability to develop SMC and appropriate projects and management actions in a plan, or to evaluate the efficacy of plan implementation, and therefore may limit the ability to assess whether a basin is being sustainably managed.

Undesirable Result means one or more of the following effects caused by groundwater conditions occurring throughout the basin, as described in Water Code Section 10721(x):

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.

- Significant and unreasonable reduction of groundwater storage.

- Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.

- Significant and unreasonable land subsidence that substantially interferes with surface land uses.

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

Undesirable Result is not defined in the definitions section of the GSP Regulations (Section 351). However, the Regulations' description of undesirable result states that it should be a quantitative description of the combination of MT exceedances that cause significant and unreasonable effects in the Subbasin. Undesirable results should not be confused with significant and unreasonable conditions.

4.2 Sustainability Goal

Per Section 354.24 of the GSP Regulations, the sustainability goal for the Subbasin has three parts:

- A description of the sustainability goal
- A discussion of the measures that will be implemented to ensure the Subbasin will be operated within sustainable yield
- An explanation of how the sustainability goal is likely to be achieved

Description of Sustainability Goal:

The goal of this GSP is to adaptively and sustainably manage, protect, and enhance groundwater resources while allowing for reasonable and managed growth through:

- Careful monitoring of groundwater conditions
- Close coordination and collaboration with other entities and regulatory agencies that have a stake or role in groundwater management in the Subbasin
- A diverse portfolio of projects and management actions that ensure clean and plentiful groundwater for future uses and users in an environmentally sound and equitable manner

Measures to Achieve Sustainability Goal:

Projects and actions that the GSA has identified as potential measures to be implemented to ensure sustainability are included in **Sections 6** and **7** of this GSP. These measures include actions proposed to fill data gaps and reduce uncertainty to inform future refinement and possible modification of the initial SMC described herein. While all of the identified measures may not be implemented, some combination of these measures will be implemented to ensure the Subbasin is operated within its sustainable yield and achieves sustainability. The measures to achieve sustainability are centered on advancing the following four projects within the Subbasin while also developing and prioritizing demand management policy options for the GSA Board to consider in the early stages of GSP implementation:

- Implementation and assessment of voluntary conservation and groundwater-use efficiency projects
- Planning and implementation of ASR projects
- Planning and implementation of stormwater capture and recharge projects

Section 6 also describes the following management actions to supplement the previously described projects:

- Assessment and prioritization of potential policy options, including demand management measures, for future GSA consideration
- Coordination with agricultural groundwater users within the Subbasin to integrate measures that support sustainable groundwater management with farm plans that are developed at individual farm sites
- Assessment of additional opportunities to expand and/or maximize efficiencies of recycled water supplies

The projects and management actions will be implemented using an adaptive management strategy, which will allow the GSA to react to the progress and outcomes of projects and management actions implemented in the Subbasin and to make management decisions to redirect efforts in the Subbasin as necessary to effectively achieve the sustainability goal. **Section 7** of this GSP describes the initial prioritization and sequencing of measures that are considered likely to be implemented in the early stages of GSP implementation.

4.3 General Process for Establishing Sustainable Management Criteria

The SMC presented in this section were developed using technical analysis of publicly available information, meetings with GSA and member agency staff, Advisory Committee members, GSA Board, practitioner work groups, discussions with regulatory agencies, and feedback gathered during public meetings. The general process included:

- Identification of technical data sources in the Subbasin and review of information developed for the Santa Rosa Plain GMP.
- Discussions with GSA technical staff to develop initial overarching methodologies to developing SMC, and specific approaches for each sustainability indicator.
- Public meeting presentations to the Advisory Committee outlining the approach to developing SMC and discussing initial SMC ideas. The public was provided opportunity to comment during these presentations. The Advisory Committee provided feedback and suggestions for the development of initial SMC.
- Discussions and meetings with staff from other regulatory agencies and local organizations that have shared interests or responsibilities for components of some sustainability indicators, including practitioner work groups convened to inform and support development of SMC for depletion of interconnected surface water.
- Public meeting presentations to the GSA Board on the SMC requirements, proposed methodology for establishing MTs and MOs, options for establishing undesirable results and SMC implications.

- Modifying MTs, MOs, and undesirable results, where appropriate, based on technical analyses, input from GSA and member agency staff, Advisory Committee members, GSA Board members, and the public.

This general process resulted in the SMC presented in this section.

4.4 Sustainable Management Criteria Summary

Table 4-1 provides a succinct summary of the SMC for each of the five applicable sustainability indicators. Further discussion of the SMC, including the rationale and background for developing these criteria are described in detail in the following subsections.

Table 4-1. Sustainable Management Criteria Summary

Sustainability Indicator	Significant and Unreasonable Statement	Minimum Threshold	Measurement	Measurable Objective	Undesirable Result	Interim Milestones
Chronic lowering of groundwater levels	Chronic lowering of groundwater levels that significantly exceed historical levels or cause significant and unreasonable impacts on beneficial users.	**Stable Wells:** Maintain near historical observed ranges while accounting for future droughts and climate variability and protect at least 98 percent of nearby water supply wells. Metric: Shallower (more protective) of historical low elevations minus 4-year drought assumption or above the 98th percentile of nearby water supply well depths.	Monthly or monthly-averaged groundwater levels measured at RMP wells.	**Stable Wells:** Maintain within historical observed ranges. Metric*:* Historical median spring groundwater elevation	10 percent of RMPs (2 RMPs within the shallow or deep aquifer) exceed MT for 3 consecutive years	The MO is based on recent conditions therefore interim milestones are identical to the MO.
		Wells with Historical Declines and then recovery: Maintain above historical low elevations and protect at least 98 percent of nearby water supply wells. Metric: Shallower (more protective) of historical low elevations OR above the 98th percentile of nearby water supply well depths.		**Wells with Historical Declines and then recovery:** Maintain within recent (recovered or recovering) historical observed ranges. Metric: Recent (2010-2019 for recovered wells and 2015-2019 for recovering wells) median spring groundwater elevation		

Sustainability Indicator	Significant and Unreasonable Statement	Minimum Threshold	Measurement	Measurable Objective	Undesirable Result	Interim Milestones
Reduction in groundwater storage	Reduction of groundwater storage that causes significant and unreasonable impacts on the long-term sustainable beneficial use of groundwater in the Subbasin, as caused by either: • Long-term reductions in groundwater storage • Pumping exceeding the sustainable yield	Measured using groundwater elevations as a proxy. MT for groundwater storage is identical to the MT for chronic lowering of groundwater levels.	Annual groundwater storage will be calculated and reported by comparing changes in contoured groundwater elevations. However, monitoring for the chronic lowering of groundwater levels will be used to compare with MTs and MOs.	MO for groundwater storage is identical to the MO for chronic lowering of groundwater levels.	Undesirable result for groundwater storage is identical to the undesirable result for chronic lowering of groundwater levels.	Interim milestones for groundwater storage are identical to the interim milestones for chronic lowering of groundwater levels.
Degraded water quality	Significant and unreasonable water quality conditions occur if an increase in the concentration of COCs in groundwater leads to adverse impacts on beneficial users or uses of groundwater, due to either: • Direct actions by Santa Rosa Plain GSP projects or management activities • Undesirable results occurring for other sustainability indicators	The MT is based on two additional supply wells exceeding MCLs for (1) arsenic, (2) nitrate, or (3) salts (measured as TDS).	The number of public supply wells with annual average concentrations of arsenic, nitrate, or TDS that exceed MCLs in groundwater quality data available through state data sources.	The MO is based on zero additional supply wells exceeding the applicable maximum contaminant level for (1) arsenic, (2) nitrate, or (3) salts (measured as TDS).	An undesirable result occurs if, during 2 consecutive years, a single groundwater quality MT is exceeded when computing annual averages at the same well, as a direct result of projects or management actions taken as part of GSP implementation.	The MO is based on current conditions; therefore, interim milestones are identical to the MO.

Sustainability Indicator	Significant and Unreasonable Statement	Minimum Threshold	Measurement	Measurable Objective	Undesirable Result	Interim Milestones
Subsidence	Any rate of inelastic subsidence caused by groundwater pumping is a significant and unreasonable condition, everywhere in the Subbasin and regardless of the beneficial uses and users.	0.1 ft/yr of inelastic subsidence (elastic and inelastic).	DWR-provided InSAR dataset average annual subsidence for each 100-meter-by-100-meter grid cell.	The MO is identical to the MT (0.1 ft/yr of subsidence)	Annual MT of 0.1 foot total subsidence is exceeded over a minimum 25-acre area or cumulative total subsidence of 0.2 foot is exceeded over a geographic area of 35 acres within 5-year period and MT exceedance is determined to be correlated with: (1) groundwater pumping, (2) a MT exceedance of the chronic lowering of GWLs SMC (that is, groundwater levels have fallen below historical lows)	The MO is set at current conditions; therefore, interim milestones are also identical to current conditions.

Sustainability Indicator	Significant and Unreasonable Statement	Minimum Threshold	Measurement	Measurable Objective	Undesirable Result	Interim Milestones
Depletion of interconnected surface water	Significant and unreasonable depletion of surface water from interconnected streams occurs when surface water depletion, caused by groundwater pumping within the Subbasin, exceeds historical depletion or adversely impacts the viability of GDEs or other beneficial users of surface water.	Maintain estimated streamflow depletions below historical maximum amounts. Metric: Shallow groundwater elevations are used as a proxy for stream depletion. The MT is the equivalent groundwater level, representing the 3 years (2014-2016) during which the most surface water depletion due to groundwater pumping was estimated between 2004-2018.	Monthly-averaged groundwater levels measured in RMPs (shallow monitoring wells near interconnected surface water).	The MO is to maintain groundwater levels within historical observed ranges. Metric: Mean groundwater level for available dry-season observations between 2004 and 2020.	When MTs are exceeded at 40 percent of RMP wells during drought years and 10 percent of RMP wells during non-drought years and are entirely or partially attributable to groundwater pumping under the jurisdiction of the GSA.	The MO is based on current conditions; therefore, interim milestones are identical to current conditions.

Notes:

COC = constituent of concern

GWL = groundwater levels

RMP = representative monitoring point

4.5 Chronic Lowering of Groundwater Levels Sustainable Management Criteria

Chronic lowering of groundwater levels was the first sustainability indicator addressed in the SMC process described in **Section 4.3**, as it contains the most readily available and robust datasets and is directly related to most of the other indicators. Additionally, SGMA allows for use of groundwater levels as proxy for other sustainability indicators if a significant correlation is established between groundwater levels and the other metrics. In this GSP, groundwater levels are used as a proxy for two other sustainability indicators (reduction of groundwater storage and depletion of interconnected surface water). This is further described in **Sections 4.6** and **4.10**, respectively.

For the chronic lowering of groundwater-level SMC, the following SGMA definition of an undesirable result assisted in characterizing significant and unreasonable conditions for the Subbasin and establishing the SMC described as follows:

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon.

- Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.

As described in **Section 3.2.2**, recent groundwater-level trends exhibit relatively stable groundwater-level conditions or recovering trends. The recovering trends generally occur within the southern and western portions of the Subbasin and are associated with higher levels of municipal pumping that historically occurred through the late 1970s and early 2000s that has since been reduced.

Taking these conditions and stakeholder input into account, the following overall approach guided development of the SMC for chronic lowering of groundwater levels:

1. For areas with stable groundwater-level trends, maintain groundwater levels within or near historical conditions while accounting for future droughts and climate variability.

2. For areas with historical declining trends and subsequent recovery and wells with increasing trends, maintain groundwater levels near current elevations and above the historical lows.

4.5.1 Locally Defined Significant and Unreasonable Conditions

Locally defined significant and unreasonable conditions were determined based on public meetings, and discussions with GSA staff, Advisory Committee members, and GSA Board.

Significant and unreasonable chronic lowering of groundwater levels in the Subbasin was defined as follows:

Chronic lowering of groundwater levels that significantly exceed historical levels or cause significant and unreasonable impacts on beneficial users, such as the following.

- Declining groundwater levels that limit the ability of domestic, agricultural, and municipal well owners to access groundwater for beneficial uses (for example, falling groundwater levels below pumping depths of water supply wells), causing significant and unreasonable economic burden on those who rely on basin groundwater
- Groundwater levels falling near basin boundaries that indicate impacts on or from neighboring basins
- Falling groundwater levels that cause impacts on groundwater-dependent vegetation (shallow aquifer only)

4.5.2 Minimum Thresholds

Section 354.28 (c)(1) of the GSP Regulations states that "The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results." The GSP Regulations further specify that MTs for chronic lowering of groundwater levels are to be supported by information on the rate of groundwater elevation decline based on historical trends, WY type, projected water use in the basin, and potential effects on other sustainability indicators.

The process for developing the MTs for the chronic lowering of groundwater levels involved development of numerous alternatives for stakeholder consideration, which include (1) the above GSP Regulations, (2) the approach for considering differing patterns of historical groundwater-level trends, and (3) the significant and unreasonable statement. The alternatives were developed on behalf of the GSA by technical staff and subconsultants based on the evaluation of historical groundwater elevations over the available period of record (including consideration of average water levels over various time periods, long-term trends, and response to the recent drought), well construction data, and input from stakeholders. The following sections provide details on the development of MTs.

4.5.2.1 Information and Methodology Used to Establish Chronic Lowering of Groundwater Levels Minimum Thresholds

The information used for establishing the MTs for the chronic lowering of groundwater levels sustainability indicator included:

- Historical groundwater elevation data
- Depths and locations of existing wells

- Maps of current and historical groundwater elevation data
- Input from member agency staff, Advisory Committee members, GSA Board members, and the public regarding significant and unreasonable conditions and desired current and future groundwater elevations communicated during public meetings
- Results of modeling of future groundwater-level conditions

As described in this section and in **Section 3.2.2**, different patterns of historical groundwater-level trends are observed within the Subbasin, with areas exhibiting long-term stable groundwater-level trends and areas with historical declining trends that have exhibit recovered or recovering groundwater levels. To account for the distinct patterns of historical groundwater-level trends observed within the Subbasin, different methodologies were applied to the following two categories of RMPs based on observed patterns in historical and recent groundwater-level trends:

- RMPs with relatively stable long-term groundwater levels, defined as less than 0.5 ft/yr of decline during dry years and measurable recovery following wet years
- RMPs that have exhibited recovering, or recovered, trends following historical declines in groundwater levels (includes RMPs with historical recovery and less than 0.5 ft/yr decline within the last 10 years and RMPs with ongoing or recent recovery trends within the last 10 years)

These two different patterns were distinguished based on visual inspection and evaluation of trend lines calculated by linear regression of observed groundwater levels at each RMP (or from a similarly constructed nearby monitoring well where historical records are limited). **Figures 4-1** and **4-2** present which RMPs are associated with each pattern and hydrographs for each RMP with historical groundwater-level data are included in **Appendix 4-A**. Some RMPs on **Figures 4-1** and **4-2** have no trend, and SMC are set for these wells following the same methodology that was used for RMPs with stable trends.

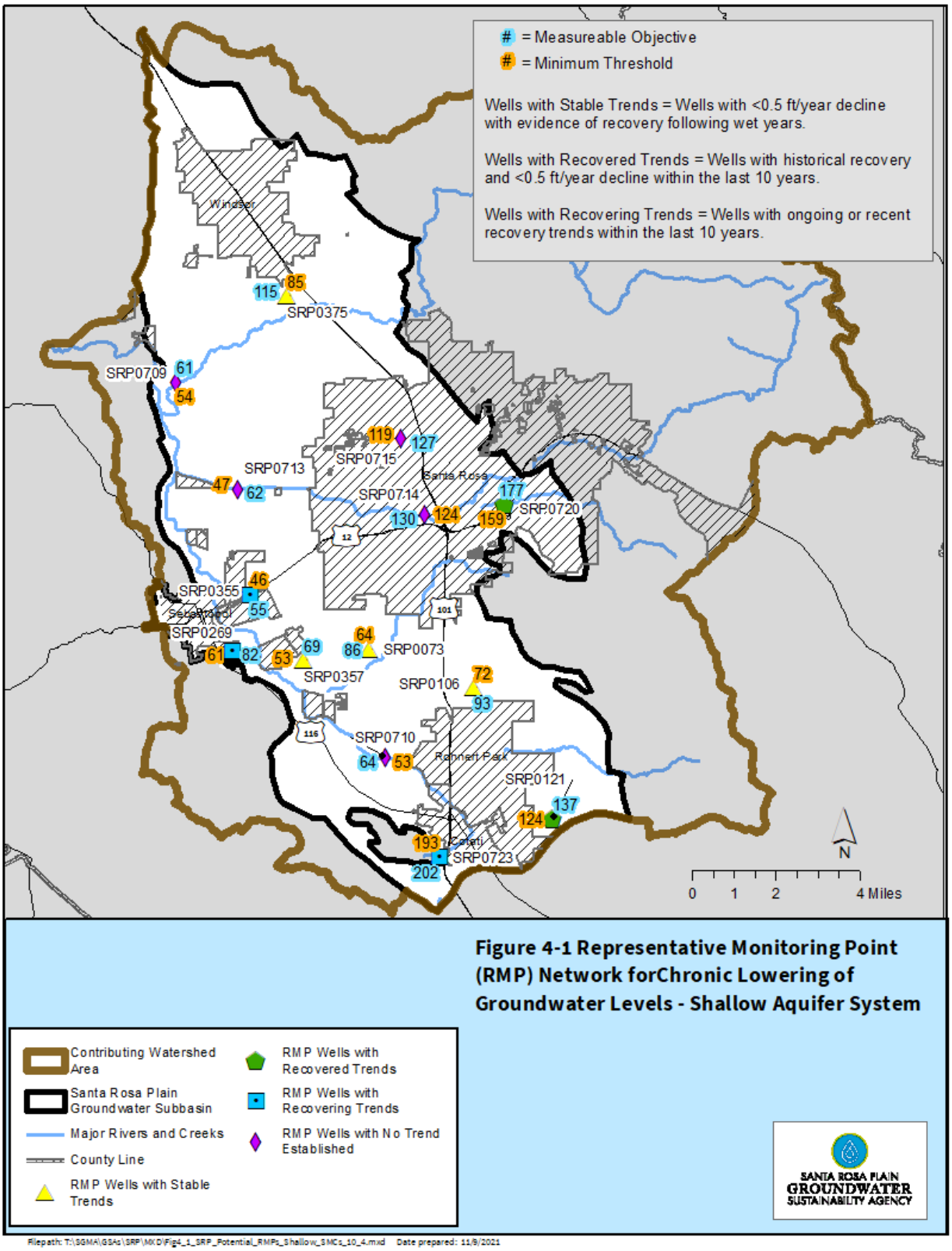


Figure 4-1. Proposed Representative Monitoring Point Network for Chronic Lowering of Groundwater Levels – Shallow Aquifer System

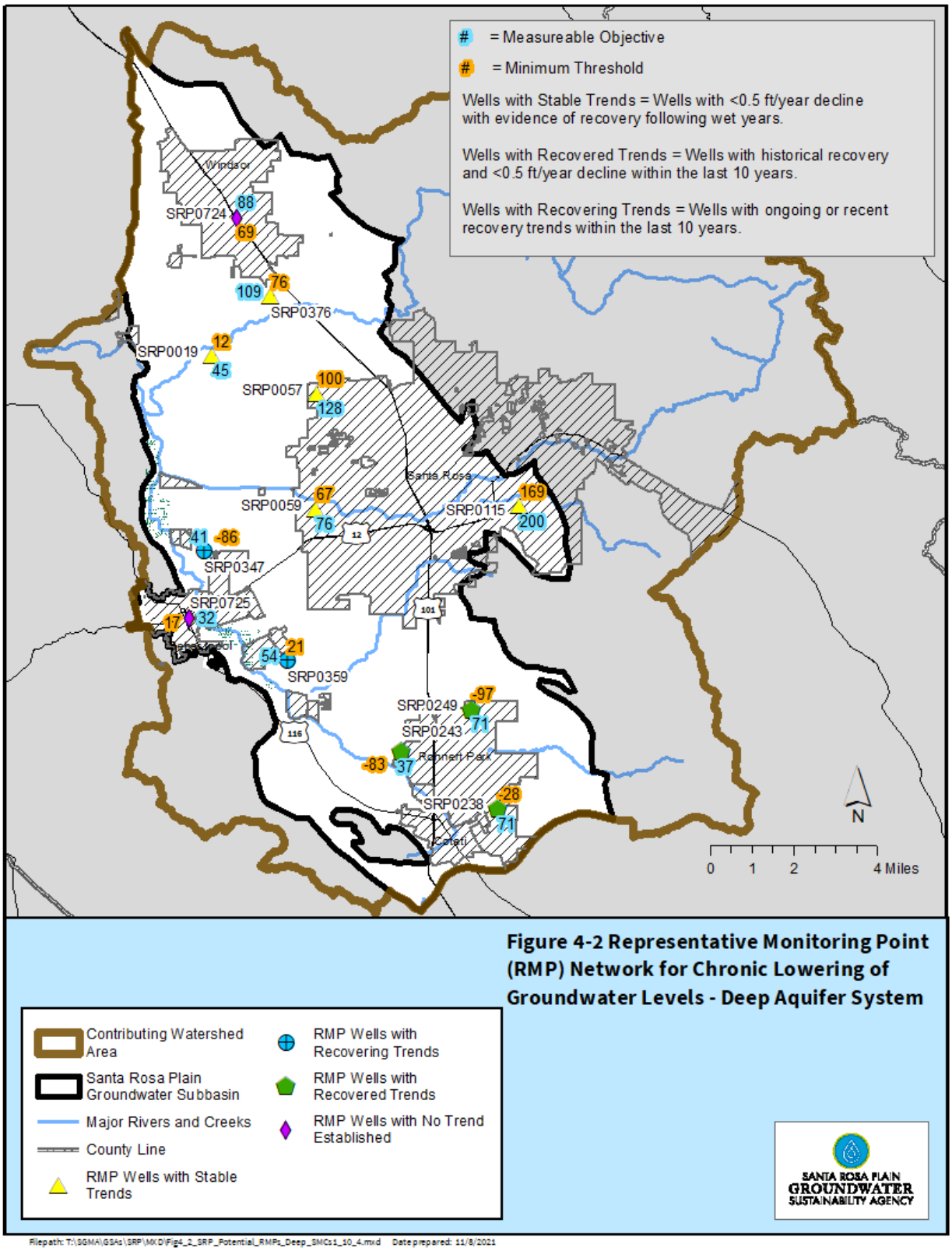


Figure 4-2. Proposed Representative Monitoring Point Network for Chronic Lowering of Groundwater Levels – Deep Aquifer System

The MTs were set at each RMP based on the three following primary factors:

1. Review of groundwater-level data and hydrographs to identify the lowest historical groundwater elevation at each RMP after removing any measurements flagged as "questionable measurements" or otherwise anomalous measurements from the datasets.

2. Calculation of "well impact depths" in the vicinity of each RMP to identify depths at which lowering of groundwater levels may impact well users, including domestic, agricultural, public supply, and industrial wells.

3. Calculation of a "drought factor" at each RMP exhibiting relatively stable historical groundwater levels and each RMP with sufficient historical data to determine trends to account for reasonably foreseeable future droughts.

Calculation of Well Impact Depths

The methodology for incorporating the potential impact on existing well users involved the statistical evaluation of known completion information for water supply wells located within the vicinity of each potential RMP. These statistics were calculated by drawing polygons for each potential RMP area and querying Sonoma Water's Water Well Database (sourced from DWR's Online System for Well Completion Reports, Permit Sonoma, and the USGS). Generally, the Subbasin boundary and midpoints between potential RMPs were used to draw the vicinity areas. In some cases, physical features that appear to have a direct influence on groundwater movement were used as boundaries to the vicinity areas. For each vicinity area polygon, the total number of supply wells, shallowest supply well total depth, 98th percentile shallowest supply well total depth, and the average supply well depth were calculated (these statistics, along with maps showing the vicinity area polygons, are provided in **Appendix 5-B**). For each RMP, the analysis included all types of supply wells contained within the datasets (domestic wells, irrigation wells, public supply wells, and industrial wells) with the listed total depth occurring in the same aquifer system as the RMP.

To ensure that the analysis accounts for a reasonable level of drawdown due to production from existing wells, the calculated well impact depths incorporate "saturated thickness factors," which are added to the 98th percentile shallowest supply well depths. The saturated thickness factors for each principal aquifer system are described as follows:

Shallow aquifer system wells (wells with total depth greater than 40 feet and less than 200 feet):

Wells shallower than 40 feet were filtered out from database to remove records for non-supply wells for example, monitoring wells) and some older (greater than 50-year-old wells) that have likely been replaced.

- A saturated thickness factor of 10 feet was added to the 98th percentile shallowest supply well total depths.

Deep aquifer system wells (wells with total depth greater than 200 feet and more than half of screened interval below 200 feet below ground surface):

A saturated thickness factor of 50 feet was added to the total depth to compensate for increased drawdown responses within confined aquifer systems (Alley et al. 1999) and the typical higher production rates of deeper wells.

Figure 4-3 provides a conceptual illustration of this methodology. The figure presents a series of wells, with the well on the farthest right representing the 98th percentile shallowest well depth and showing how the saturated thickness factor would be applied.

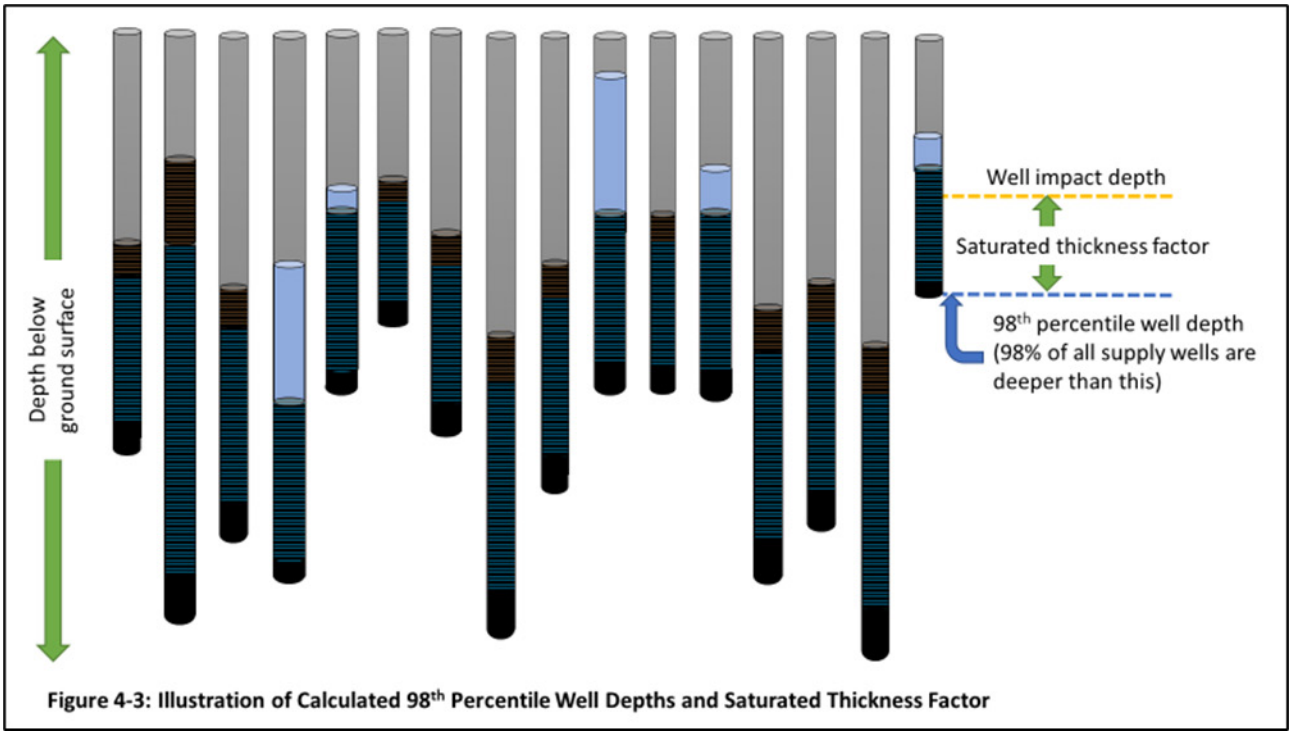


Figure 4-3. Calculated 98th Percentile Well Depths and Saturated Thickness Factor

Factoring for Future Drought Conditions

A factor to account for reasonably foreseeable future droughts was calculated at each RMP that exhibits stable trends or has insufficient historical data available to establish a trend. The calculations were made using the following methodology:

- For wells with 10 or more years of historical data, the largest consecutive 4-year decline during historical dry periods was used
- For wells with less than 10 years of historical data, the drought factor is based on either the future simulated largest consecutive 4-year decline or extrapolation of observed declines during the 2020/2021 drought

As the degree of groundwater-level responses to yearly climate conditions varies based on localized hydrogeologic condition, calculating a factor specific to each RMP incorporates observed groundwater-level responses specific to each RMP vicinity area into the MTs. The declines associated with these drought factors are consistent with levels of observed declines within the Subbasin during historical droughts, which then recovered during subsequent normal and/or wet WYs. For wells with 10 or more years of historical data, the calculated drought factors range from 5 to 14 feet within the shallow aquifer system RMPs and 2 to 17 feet within the deep aquifer system RMPs, which are generally representative of confined conditions. The range of projected drought factors for five shallow RMPs and three deep RMPs with insufficient historical data is 3 to 12 feet.

As presented on **Figure 4-4** (Case 1), the historical lows or historical lows minus the drought factor (for wells exhibiting stable historical conditions) were applied as the MT to RMPs where these levels are above the well impact depth. For RMPs where the well impact depth is shallower than the historical lows or historical lows minus the drought buffer, the well impact depth was applied as the MT, as presented on **Figure 4-4** (Case 2). **Table 4-2** provides a summary of these metrics and presents the final criteria used for calculating the MT at each of the 26 existing RMPs. As indicated in **Table 4-2**, MTs for 5 (Son0073, Son0355, Son0347, Son0243, and Son0249) of the 26 existing RMPs represent the calculated well impact depths (that is, at these locations the well impact depth is shallower than the historical low with the drought factor and is considered more protective of beneficial users (including domestic well users) (**Figure 4-4**). At the remaining 21 RMPs with the MTs calculated using the historical low elevations, the drought factors were determined to be above (protective of) the calculated well impact depths (Case 1 [**Figure 4-4**]).

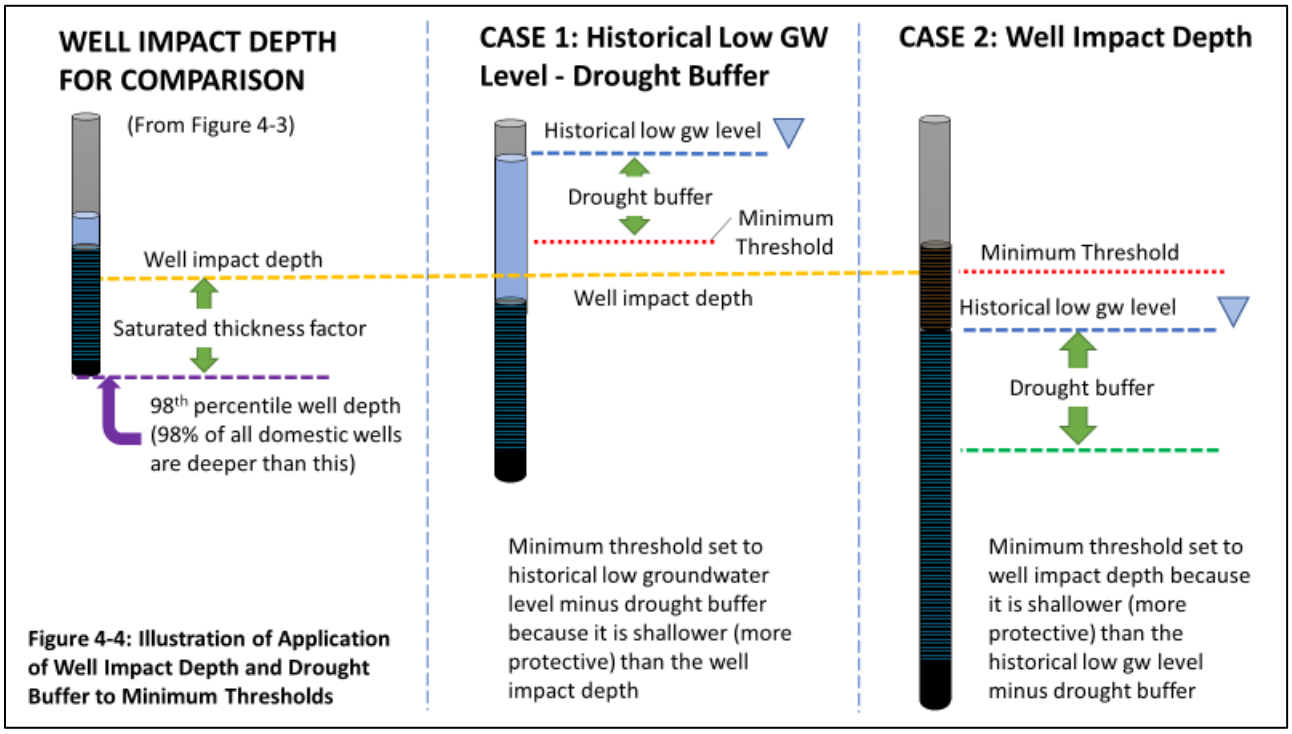


Figure 4-4. Application of Well Impact Depth and Drought Buffer to Minimum Thresholds

Table 4-2. Summary of Calculations for Minimum Thresholds and Measurable Objectives

Shallow Aquifer System (stable or no trend)							**MT**	**MO**
Well ID	**Observed Historical Low (feet msl)**	**Year of Observed Historical Low**	**Calculated Drought Factor (feet)**	**Drought Factor Years**	**Historic Low minus Drought Factor (feet msl)[a]**	**Well Impact Depths (feet msl)[a] 98th percentile plus 10 feet**	**Shallower of Historical Low minus 4-year Drought or Well Impact Depth**	**Historical Spring Median (entire)**
SRP0073	64.8	1992	-13.6	2011-2015	51	**64**	64	86
SRP0106	77.4	1992	-5.3	1998-2002	**72**	64	72	93
SRP0357	59.1	1977	-5.6	1986-1990	**53**	49	53	69
SRP0375	98.2	2020	-13.2	2016-2020	**85**	82	85	115
SRP0709	57.2	2020	-3.0	Projected	**54**	28	54	61
SRP0710	61.2	2020	-8.0	Projected	**53**	43	53	64
SRP0713	56.7	2020	-10.0	Projected	**47**	33	47	62
SRP0714	127.9	2020	-4.0	Projected	**124**	118	124	130
SRP0715	123.2	2020	-4.0	Projected	**119**	106	119	127
Shallow Aquifer System (recovered)							**MT**	**MO**
Well ID	**Observed Historical Low (feet msl)**	**Year of Observed Historical Low**	**Calculated Drought Factor (feet)**	**Drought Factor Years**	**Historic Low minus Drought Factor (feet msl)[a]**	**Well Impact Depths (feet msl)[a] 98th percentile plus 10 feet**	**Shallower of Historical Low or Well Impact Depth**	**Historical Spring Median (2010-current)**
SRP0121	**75.1**	1994	NA	NA	NA	23	75	137
SRP0720	**159.1**	2008	NA	NA	NA	157	159	177
Shallow Aquifer System (recovering)							**MT**	**MO**

Well ID	Observed Historical Low (feet msl)	Year of Observed Historical Low	Calculated Drought Factor (feet)	Drought Factor Years	Historic Low minus Drought Factor (feet msl)[a]	Well Impact Depths (feet msl)[a] 98th percentile plus 10 feet	Shallower of Historical Low or Well Impact Depth	Historical Spring Median (2015-current)
SRP0269	**60.6**	2009	NA	NA	NA	49	61	82
SRP0355	34.9	2009	NA	NA	35	**46**	46	55
SRP0723	**193.4**	2015	NA	NA	NA	189	193	202
Deep Aquifer System (stable or no trend)							**MT**	**MO**
Well ID	**Observed Historical Low (feet msl)**	**Year of Observed Historical Low**	**Calculated Drought Factor (feet)**	**Drought Factor Years**	**Historic Low minus Drought Factor (feet msl)**	**Well Impact Depths (feet msl)[a] 98th percentile plus 50 feet**	**Shallower of Historical Low minus 4-year Drought or Well Impact Depth**	**Historical Spring Median (entire)**
SRP0019	29.4	2002	-17.3	1998-2002	**12**	-91	12	45
SRP0059	68.9	2012	-1.9	2016-2020	**67**	-62	67	76
SRP0057	110.0	2016	10.0	Projected	**100**	-58	100	128
SRP0115	177.4	2011	-9.2	2012-2016	**169**	26	169	200
SRP0376	89.1	2020	-13	2011-2015	**76**	-37	76	109
SRP0724	81.0	2020	-12.0	Projected	**69**	-47	69	88
SRP0725	25.0	2020	-8.0	Projected	**17**	-85	17	32
Deep Aquifer System (recovering)							**MT**	**MO**
Well ID	**Observed Historical Low (feet msl)**	**Year of Observed Historical Low**	**Calculated Drought Factor (feet)**	**Drought Factor Years**	**Historic Low minus Drought Factor (feet msl)**	**Well Impact Depths (feet msl)[a] 98th percentile plus 50 feet**	**Shallower of Historical Low or Well Impact Depth**	**Historical Spring Median (2015-current)**
SRP0347	-95.5	2009	NA	NA	NA	**-86**	-86 (-54[b])	41
SRP0359	**20.9**	2004	NA	NA	NA	-123	21	54

Deep Aquifer System (recovered)							**MT**	**MO**
Well ID	**Observed Historical Low**	**Year of Observed Historical Low**	**Calculated Drought Factor**	**Drought Factor Years**	**Historic Low minus Drought Factor**	**Well Impact Depths (feet msl)[a] 98th percentile plus 50 feet**	**Historical Low or 98th Percentile Well Depth plus 50 Feet**	**Historical Spring Median (2010-current)**
SRP0238	**-28.0**	1992	NA	NA	NA	-52	-28(25[b])	71
SRP0243	-153.0	1987	NA	NA	NA	**-83**	-83(-24[b])	37
SRP0249	-128.0	1988	NA	NA	NA	**-97**	-97(-30[b])	71

[a] Bold values indicate criteria used for final MT value.

[b] At these RMPs a "warning-level" threshold has also been developed to address uncertainties associated with potential impacts on beneficial users of groundwater.

Note: There are NA entries because drought factors are not applied to RMPs with recovered or recovering historical trends.

NA = not applicable

Warning-level Thresholds for Representative Monitoring Points with Significant Historical Declines

Based on concerns raised by Advisory Committee members during development of the SMC, for wells with historical declines exceeding 100 feet, a shallower "warning-level" threshold has been developed and included in the hydrographs in **Table 4-2** and **Appendix 4-A**, which would initiate an investigation into potential causes of any future declines. The RMPs that have a "warning-level" threshold include three wells around the City of Rohnert Park (SRP0238, SRP0243, and SRP0249), where higher amounts of municipal pumping occurred between the 1980s and early 2000s, and one RMP (SRP0347) located in the vicinity of Sonoma Water's production wells, where higher amounts of municipal pumping occurred between approximately 1998 and 2009. The "warning-level" thresholds were developed due to (1) uncertainties associated with well depth datasets, (2) uncertainties as to whether historical lows could cause undesirable results, and (3) in the case of the RMPs near the City of Rohnert Park, the presence of other pumpers that do not have existing policy limitations on groundwater production in the area. For the RMPs near the City of Rohnert Park, the "warning-level" thresholds were calculated using the mean historical seasonal lows for 1998 to 2004, which represents a time period after significant late 1980s/early 1990s drought years and prior to full recovery when groundwater levels were relatively stable. For the RMP in the vicinity of Sonoma Water's production wells, the "warning-level" thresholds were calculated using the mean historical seasonal lows for 2014 and 2015, which represents a time period when Sonoma Water's wells were activated to address drought conditions but were pumped at lower volumes and for much shorter continuous durations than during the 1998 to 2009 time period.

Adaptive Management to Address Data Gaps and Improve/Refine Sustainable Management Criteria

There is appreciable uncertainty regarding the SMC developed for the chronic lowering of groundwater levels sustainability indicator. In addition to developing the previously described warning-level thresholds to account for this uncertainty, specific planned data collection activities that will reduce uncertainty and inform future adjustments or refinements to the chronic lowering of groundwater-level SMC are described in **Section 5** and include:

- Refine information on depths of nearby water wells from well log databases and information obtained through future GUIDE program implementation
- Improve mapping and correlation of well depth data with stratigraphic data
- Assess and develop plans to fill data gaps in monitoring networks through targeted additional dedicated monitoring wells and suitable volunteered private wells based on:
    - Hydrogeologic properties and geologic features
    - Areas of boundary inflows and outflows
    - Distribution of pumping
    - Location of sensitive beneficial users, such as shallow domestic well users or GDEs

4.5.2.2 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

Section 354.28 of the GSP Regulations requires that the description of all MTs include a discussion of the relationship between the MTs for each sustainability indicator. In the SMC BMPs (DWR 2017), DWR clarified that the GSP must describe the relationship between each sustainability indicator's MT by describing why or how a water level MT set at a particular RMP is similar to or different to water level thresholds in a nearby RMP. Additionally, the GSP must describe the relationship between the selected MTs and MTs for other sustainability indicators.

Groundwater elevation MTs are derived from examination of the historical record reflected in hydrographs at each individual RMP and depths of nearby water wells, including domestic well users. Therefore, the MTs are unique at every well, but when combined represent reasonable and achievable groundwater conditions and flow paths.

Assessment of how other sustainability indicators could be influenced by the chronic lowering of groundwater levels MT indicates the following:

- **Reduction in groundwater storage**. Changes in groundwater elevations are directly correlated to changes in the amount of groundwater in storage and groundwater levels are used as a proxy for the reduction in groundwater storage sustainability indicator. The groundwater elevation MTs are set to establish a minimum elevation that will not lead to undesirable conditions, and that is acceptable to the stakeholders in the area. Therefore, if the groundwater elevation MTs are met (that is, groundwater levels remain stable and above historical lows), they will not result in long-term significant or unreasonable changes in groundwater storage.

- **Degraded water quality**. A significant and unreasonable condition for degraded water quality would occur if an increase in the concentration of COCs in groundwater leads to adverse impacts on beneficial users or uses of groundwater, due to direct actions by Santa Rosa Plain GSP projects or management activities or undesirable results occurring for other sustainability indicators. If future declines in groundwater levels occur, that could potentially impact water quality by inducing poor-quality water into areas not previously impacted by water quality degradation. However, since MTs are set to avoid significant declines of groundwater levels below historically observed levels, this is not expected to occur.

- **Subsidence**. A significant and unreasonable condition for subsidence is the occurrence of inelastic subsidence caused by groundwater pumping. Since MTs are set to avoid significant declines of groundwater levels below historically observed levels, inelastic land subsidence is not expected to occur.

- **Depletion of interconnected surface water**. MTs for chronic lowering of groundwater levels do not promote additional pumping or lower groundwater elevations adjacent to interconnected surface water than has historically occurred. Therefore, the chronic

lowering of groundwater elevations MTs will not result in a significant or unreasonable depletion of interconnected surface water.

4.5.2.3 Effect of Minimum Thresholds on Neighboring Basins and Subbasins

The Santa Rosa Plain Subbasin has one neighboring subbasin that is categorized as medium-priority and is also subject to SGMA: the Petaluma Valley Basin, to the south.

The Santa Rosa Plain Subbasin is also adjacent to the very low-priority Healdsburg Area Subbasin to the northwest, and the Wilson Grove Formation Highlands Basin to the west, both of which are not required to develop GSPs under SGMA.

The boundary between the Santa Rosa Plain Subbasin and the Petaluma Valley Basin coincides with a surface watershed divide between the Laguna de Santa Rosa drainage subbasin and the Petaluma River Watershed. The boundary is also the approximate location of a groundwater flow divide; however, no known structural or geologic features restrict flow between the two areas and groundwater-level changes on one side of the boundary have the potential to influence groundwater levels on the other side. During the historical groundwater-level declines that occurred in the southern portions of the Santa Rosa Plain Subbasin through the early 2000s, no impacts on wells located within the adjacent areas of the Petaluma Valley Basin are known to have occurred. Since the MTs for chronic lowering of groundwater aim to maintain groundwater levels above historical lows within the Santa Rosa Plain Subbasin, the potential for any negative effects to occur within the Petaluma Valley Basin related to the MTs for chronic lowering of groundwater levels is limited.

The boundary between the Santa Rosa Plain Subbasin and the Wilson Grove Formation Highlands Basin generally follows the contact between the Quaternary alluvial deposits and the Wilson Grove Formation, with the exception of the City of Sebastopol, where the boundary follows the jurisdictional boundary of the city and three neighboring mutual water system service areas and extends into a portion of the Wilson Grove Formation. The boundary also roughly coincides with the mapped trace of the Sebastopol Fault and uncertainty regarding the hydrogeologic connection between the two areas, including any potential boundary effects of the Sebastopol Fault, has been identified as an important data gap to be addressed during GSP implementation, as described in **Section 7**. Available groundwater-level data along the boundary and information from the simulated water budget do indicate that the basins are connected with groundwater from the Wilson Grove Formation Highlands Basin representing an important source of inflow to the Santa Rosa Plain Subbasin. Therefore, groundwater-level changes on one side of the boundary have the potential to influence groundwater levels on the other side. Since the MTs for chronic lowering of groundwater aim to maintain groundwater levels above historical lows within the Santa Rosa Plain Subbasin, the potential for any negative effects to occur within the Wilson Grove Formation Highlands Basin related to the MTs for chronic lowering of groundwater levels is limited.

The northwestern boundary of the Subbasin generally follows the contact between the Glen Ellen Formation and Quaternary alluvial deposits of the Russian River Valley within the

Healdsburg Area Subbasin. Available groundwater-level data along the boundary and information from the simulated water budget do indicate that the basins are connected with groundwater from the Santa Rosa Plain Subbasin flowing into the Healdsburg Area Subbasin. Therefore, groundwater-level changes on one side of the boundary have the potential to influence groundwater levels on the other side. Since the MTs for chronic lowering of groundwater aim to maintain groundwater levels above historical lows within the Santa Rosa Plain Subbasin, the potential for any negative effects to occur within the Healdsburg Area Subbasin related to the MTs for chronic lowering of groundwater levels is limited.

While not required to be evaluated by SGMA, the potential effect of the chronic lowering of groundwater levels MTs are also very unlikely to influence groundwater levels in other adjoining areas that are not classified as groundwater basins or subbasins by DWR. Groundwater use in these upland areas that flank the eastern and western boundaries of the Subbasin primarily occurs within the Sonoma Volcanics upgradient of the Subbasin.

The potential for impacts to occur along all of the above-described boundaries will be evaluated as part of the GSA's routine MRP, which includes both RMP wells and other wells monitored for groundwater levels in the Santa Rosa Plain Subbasin and within the neighboring areas near these boundaries (including the Petaluma Valley Basin, Wilson Grove Formation Highlands Basin, and contributing watershed areas). **Section 5.3** describes (1) the specific wells currently incorporated into this boundary monitoring program; (2) identified data gaps in these areas; and (3) plans to address the data gaps.

Additionally, the Santa Rosa Plain GSA will continue to closely coordinate with the Petaluma Valley GSA and the County (for areas that are not under a GSA's jurisdiction) should any future issues arise.

4.5.2.4 Effect on Beneficial Uses and Users

MTs for chronic lowering of groundwater levels are set at the more protective of historical low conditions with allowances for future droughts and the depths at which existing water supply wells could be impacted by lowering of groundwater levels. The MTs are generally advantageous to beneficial users and land uses in the Subbasin:

- **Agricultural land uses and users**. The chronic lowering of groundwater-level MTs protects existing agricultural users' ability to meet typical demands by maintaining groundwater levels near current conditions. However, the chronic lowering of groundwater-level MTs places a practical limit on the acceptable lowering of groundwater levels in the Subbasin, thus conceptually restricting future levels of agriculture in the Subbasin beyond what is projected in the 50-year baseline scenario without projects to supplement water supplies, or management actions to limit future pumping increases. The potential for this to occur will be addressed through considering the implementation of the projects and management actions discussed in **Section 6**.

- **Urban land uses and users.** The chronic lowering of groundwater-level MTs protects existing municipal and industrial groundwater users' ability to meet typical demands by maintaining groundwater levels near current conditions. However, the chronic lowering of groundwater-level MTs places a practical limit on the acceptable lowering of groundwater levels in the Subbasin, thus conceptually restricting future levels of municipal and industrial groundwater pumping in the Subbasin beyond what is projected in the 50-year baseline scenario without projects to supplement water supplies, or management actions to limit future pumping increases. The potential for this to occur will be addressed through considering the implementation of the projects and management actions discussed in **Section 6**.

- **Domestic land uses and users**. The chronic lowering of groundwater levels MTs are established to protect as many rural residential domestic wells as possible. Therefore, the MTs will likely have an overall beneficial effect on existing domestic land uses by protecting the ability to pump from domestic wells within the Subbasin.

- **Ecological land uses and users**. Maintaining groundwater near or above historical levels will help maintain the interconnected nature of groundwater and surface water in the Subbasin. This will protect GDE habitat and generally benefit environmental land uses and users.

4.5.2.5 Relation to State, Federal, or Local Standards

No federal, state, or local standards exist that are specific to chronic lowering of groundwater levels.

4.5.2.6 Method for Quantitative Measurement of Minimum Thresholds

Depth to groundwater will be directly measured at the RMPs identified in **Section 5.3.1** for comparison to MTs. The RMP network includes 14 existing shallow aquifer wells and 12 existing deep aquifer wells, resulting in a total of 26 wells. Additionally, between two and four new multi-level monitoring wells, which will monitor both the shallow and deep aquifer system at each location, are planned for construction by the GSA in 2022. It is anticipated that these wells will be incorporated into the RMP network following their construction and development of SMC for each. The groundwater-level data will be collected in accordance with the monitoring protocols outlined in **Section 5.3.1** and converted to groundwater elevation by subtracting the measured depth to water from the reference point elevation used to take the depth to water measurement.

Available groundwater-level data, including historical data used for calculation of the MTs and MOs, contains a variety of measurement frequencies ranging from hourly to semiannually. Groundwater-level measurement frequency for the 26 existing wells in the RMP monitoring networks include the following:

- 18 measured more than once per day
- 4 measured monthly
- 4 measured semiannually

As indicated in **Section 5.3.1**, the goals for groundwater-level measurement frequency will be to: (1) measure groundwater levels at least monthly for all RMPs during GSP implementation; and (2) use pressure transducers where feasible to provide a higher level of quality control, as potential short-term or residual pumping influences can be identified and flagged. Consistent with the monitoring protocols, only static groundwater levels will be compared to MTs.

For reporting seasonal highs and lows for future comparison with MTs, all measurements collected at a higher frequency than monthly will be reported as monthly averages to better align with the measurement frequency within historical datasets used to calculate the MTs. During GSP implementation, individual groundwater-level measurements collected manually and by data loggers will be reviewed for quality control and analyzed for MT exceedances during compilation of GSP annual and 5-year update reports.

Staff has identified data gaps in some areas of the Subbasin in the monitoring networks discussion (**Section 5**). The GSP includes a plan to expand the monitoring network as described in the implementation discussion (**Section 7**).

4.5.3 Measurable Objectives

MOs for chronic lowering of groundwater levels represent target groundwater elevations for 2042, considering realistic project implementation and allowing for operational flexibility over a range of climate and hydrologic variability.

4.5.3.1 Method for Setting Measurable Objectives

Similar to the approach and methodology used for setting MTs, MOs are reflective of the distinct patterns of historical groundwater-level trends observed within the Subbasin.

For RMPs exhibiting relatively stable long-term groundwater-level trends, the MO is calculated as the historical median spring groundwater elevation, given that the aim of the MO is to maintain groundwater levels within historical ranges for these areas.

For RMPs that have exhibited recovering trends following historical declines, the MO is calculated as the median spring groundwater elevation of the most recent 5 or 10 years (for wells with increasing trends and wells with historical declines and subsequent recovery, respectively), because the aim of the MO is to maintain groundwater levels within recent (recovered or recovering) historical observed ranges.

MOs for each RMP are listed in **Table 4-2**.

4.5.3.2 Interim Milestones

For all RMPs, the MO is essentially set at recent conditions (that is, the aim of the MO is to maintain groundwater levels within historical and recent ranges), therefore interim milestones are essentially equivalent to the MO throughout the GSP implementation period.

4.5.4 Undesirable Results

4.5.4.1 Criteria for Defining Undesirable Results

The chronic lowering of groundwater levels undesirable result is a quantitative combination of groundwater elevation MT exceedances. For the Subbasin the specific groundwater conditions that constitute an undesirable result is: Groundwater levels in 10 percent of the RMPs in either the shallow or deep aquifer systems exceed their MTs for three consecutive fall measurements.

Consistent with DWR guidance, if MT exceedances are caused by emergency operational issues or droughts that extend for longer than the 4-year drought factor incorporated into the MTs (as described in **Section 4.6.2.1**), it is not considered an undesirable result unless the groundwater levels do not rebound to above the thresholds during future normal and wet years following long-term droughts.[1]

Exceedances of MTs at a single well will require investigation to determine if any actions should be considered to avoid potential future onset of undesirable results, as described in **Section 4.6.4.2**.

The 3 consecutive years of MT exceedances was selected by the GSA Board to: (1) balance protection of beneficial users with costs related to response actions and (2) limit the potential for shorter-duration MT exceedances that may not be chronic in nature to trigger undesirable results.

4.5.4.2 Potential Causes of Undesirable Results

The potential causes of undesirable results for chronic lowering of groundwater levels include:

- Increased groundwater pumping in the Subbasin leading to chronic groundwater-level declines
- A significant reduction in natural recharge as a result of climate change, reduced groundwater and surface water interaction, or other land surface processes

If the location and volumes of groundwater pumping change as a result of unforeseen rural residential, agricultural, and urban growth that depend on groundwater as a water supply without supplemental supplies, these increased demands might lower groundwater to undesirable levels. Reduction in recharge or changes in rainfall patterns could also lead to more prolonged periods of lowered groundwater levels than have occurred historically.

[1] The draft SMC BMP (DWR 2017) provides information on how droughts may affect the groundwater-level SMC: "Undesirable results are one or more of the following effects: Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods."

As described in **Section 6**, projects and actions are being considered for implementation to augment recharge and reduce groundwater pumping to mitigate the potential for these conditions to occur.

Additionally, to respond to these potential conditions prior to the onset of an undesirable result, the following actions would be implemented if an MT is exceeded at a single RMP that does not trigger an undesirable result:

- Review available data from full monitoring network (that is, non-RMP monitoring wells) to assess the potential scale of areas exhibiting declines.
- Assess whether exceedance is climate-related.
- Review any known or potential changes in groundwater pumping patterns, as needed (for example, new wells brought online, changes in land/water use).
- Consider whether additional RMPs are needed.
- Share information with nearby well owners, as appropriate.
- Consider planning or implementing projects/actions, as appropriate (for example, begin with lower cost and/or voluntary projects/actions).

The approach is a proactive means for avoiding exceedance of undesirable results when warning signs are available. Not all actions would be implemented for each individual exceedance of a MT. These tasks would generally be performed sequentially based on potential severity of the occurrence.

4.5.4.3 Effects on Beneficial Users and Land Use

The potential effects of undesirable results for chronic lowering of groundwater levels on beneficial users and land use could be the inability of a significant number of private, agricultural, and municipal and industrial production wells from supplying groundwater to meet their water demands. The beneficial users that could be impacted by undesirable results from chronic lowering of groundwater levels include domestic well users, irrigation well users, and public water supply well users (inclusive of DACs that obtain water from these user categories). Lowered groundwater levels reduce the saturated thickness of aquifers from which wells can pump, which could lead to increased pumping costs, reduced pumping capacity, or the need to drill new deeper wells. This would effectively increase the cost of using groundwater as a water source for all users. Avoiding undesirable results for the chronic lowering of groundwater levels will limit the potential for these conditions to occur in the future.

4.6 Reduction in Groundwater Storage Sustainable Management Criteria

The reduction in groundwater storage SMC will be evaluated using groundwater levels as a proxy based on well-established hydrogeologic principles that the volume of groundwater in

storage is directly proportional to groundwater elevations (Alley et al. 1999). The groundwater elevations MTs and MOs are established to maintain adequate groundwater supplies for all beneficial uses and users. Therefore, preventing groundwater elevations from dropping below MTs, by definition, maintains adequate amount of water in storage. Maintaining groundwater elevations within the operational range between MTs and MOs is equivalent to no long-term change in storage.

4.6.1 Locally Defined Significant and Unreasonable Conditions

Locally defined significant and unreasonable conditions were determined based on public meetings, and discussions with GSA staff, Advisory Committee members, and the GSA Board. Significant and unreasonable reduction in groundwater storage in the Subbasin is defined as: Reduction of groundwater storage that causes significant and unreasonable impacts on the long-term sustainable beneficial use of groundwater in the basin, as caused by long-term reductions in groundwater storage; or pumping exceeding the sustainable yield.

4.6.2 Minimum Thresholds

Section 354.28(c)(2) of the GSP Regulations states that "The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, WY type, and projected water use in the basin."

This GSP will monitor changes in groundwater levels at the RMPs as a proxy for the change in groundwater storage metric. As allowed in Section 354.36(b)(1) of the GSP Regulations, groundwater elevation data at the RMPs will be reported annually as a proxy to track changes in the amount of groundwater in storage.

Based on well-established hydrogeologic principles, stable groundwater elevations maintained above the MTs will indicate that groundwater storage is not being depleted (Alley, et al. 1999). Therefore, using groundwater elevations as a proxy, the MT for groundwater storage will be met if MTs for the chronic lowering of groundwater levels are not exceeded.

4.6.2.1 Information and Methodology Used to Establish Groundwater Storage Minimum Thresholds

Similar to the chronic lowering of groundwater-levels SMC, the information used for establishing the MTs for the groundwater storage sustainability indicator included:

- Historical groundwater elevation data
- Depths and locations of existing wells
- Maps of current and historical groundwater elevation data

- Input from stakeholders regarding significant and unreasonable conditions and desired current and future groundwater elevations communicated during public meetings
- Results of modeling of future groundwater-level conditions

4.6.2.2 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

The MTs for reduction in groundwater storage are the same as those used for the chronic lowering of groundwater levels. Because groundwater elevations will be used as a proxy for estimating changes in groundwater storage, the reduction in groundwater storage sustainability indicator cannot cause undesirable results for the chronic lowering of groundwater levels sustainability indicator.

The relationship between the groundwater storage sustainability indicator and other sustainability indicators is the same as the relationship between chronic lowering of groundwater levels and other sustainability indicators, as described in **Section 4.5.2.2**.

4.6.2.3 Effect of Minimum Thresholds on Neighboring Basins and Subbasins

The potential effect of the groundwater storage MT on neighboring basins, subbasins and other adjoining areas is the same as the relationship described for chronic lowering of groundwater levels in **Section 4.5.2.3**.

4.6.2.4 Effect on Beneficial Uses and Users

The MT for reduction in groundwater storage will maintain stable average groundwater elevations and encourages minimal long-term net change in groundwater elevations and storage.

The potential effects of the groundwater storage MT on beneficial uses and users are the same as the potential effects described for chronic lowering of groundwater levels in **Section 4.5.2.4**.

4.6.2.5 Relation to State, Federal, or Local Standards

No federal, state, or local standards exist that are specific to groundwater storage.

4.6.2.6 Method for Quantitative Measurement of Minimum Thresholds

Storage MTs will be measured by collecting groundwater-level measurements at the RMP sites in the monitoring network, as described in **Sections 4.5.2.6** and **5.3.1**. This data will be used to monitor groundwater elevations and compare with MTs.

Annual groundwater storage will also be calculated and reported by comparing changes in contoured groundwater elevations to assess changes in groundwater storage.

4.6.3 Measurable Objectives

The change in storage sustainability indicator was defined using groundwater levels as a proxy for the change in storage MO. The same MTs and MOs are used as are defined in the chronic lowering of groundwater-level indicator to protect against significant and unreasonable reduction in groundwater storage.

Additionally, even though groundwater levels are being used as a proxy in lieu of using the total volume of groundwater pumped, the achievement of MOs for chronic lowering of groundwater levels will require that groundwater levels either increase or are maintained at their current levels. Therefore, the MOs will necessitate pumping within the sustainable yield calculated for the Subbasin in order to have no long-term change in storage once sustainability is reached.

4.6.3.1 Method for Setting Measurable Objectives

The methods for setting the MO for groundwater storage incorporates the same methods for setting the MO for chronic lowering of groundwater levels described in **Section 4.5.3.1**.

4.6.3.2 Interim Milestones

Interim milestones for groundwater storage are the same as those established for chronic lowering of groundwater levels. Achieving the chronic lowering of groundwater levels interim milestones will prevent long-term reductions in groundwater in storage.

4.6.4 Undesirable Results

4.6.4.1 Criteria for Defining Undesirable Results

Assessment of groundwater in storage will be evaluated with the same MTs and MOs as the chronic lowering of groundwater levels sustainability criteria.

Therefore, for the purposes of this GSP, the definition of undesirable conditions for the reduction of groundwater storage is the same as following definition for the chronic lowering of groundwater levels: Groundwater levels in 10 percent of the RMPs in either principal aquifer system exceed their MTs for three consecutive fall measurements.

4.6.4.2 Potential Causes of Undesirable Results

The potential causes of undesirable results for reduction of groundwater storage are the same as those identified for chronic lowering of groundwater levels in **Section 4.5.4.2**:

- Increased groundwater pumping in the Subbasin leading to chronic groundwater-level declines
- A significant reduction in natural recharge as a result of climate change or other processes

4.6.4.3 Effects on Beneficial Users and Land Use

The potential effects of undesirable results for groundwater storage on beneficial users and land use are the same as those identified for the chronic lowering of groundwater levels, as described in **Section 4.5.4.3**, which could include the inability of a significant number of private, agricultural, and municipal and industrial production wells from supplying groundwater to meet their water demands. Lowered groundwater levels reduce the thickness of saturated aquifer from which wells can pump, which could lead to increased pumping costs or the need to drill new deeper wells. This would effectively increase the cost of using groundwater as a water source for all users. Avoiding undesirable results for the reduction in groundwater storage will limit the potential for these conditions to occur in the future.

4.7 Seawater Intrusion Sustainable Management Criteria

The Subbasin does not border the Pacific Ocean, bays, deltas, or inlets and therefore seawater intrusion is not an applicable sustainability indicator and is not further discussed in this GSP.

4.8 Degraded Water Quality Sustainable Management Criteria

Unlike most other sustainability indicators, degraded water quality is the subject of robust federal, state, and local regulatory regimes carried out by a number of different entities and is not regulated by SGMA. The GSA is not responsible for enforcing existing water quality standards or collecting data to support existing water quality programs, nor is the GSA responsible for natural changes in groundwater quality or groundwater degradation caused by others. However, potential groundwater quality degradation needs to be considered during GSP development to ensure that activities associated with implementing the GSP, such as GSP projects and actions, do not degrade current water quality conditions.

One of the primary challenges in implementing the degraded water quality SMC will be to assess in the future if any degradation to groundwater quality is due to GSA actions.

4.8.1 Locally Defined Significant and Unreasonable Conditions

Locally defined significant and unreasonable conditions were determined based on public meetings, and discussions with GSA staff, Advisory Committee members, and GSA Board.

Significant and unreasonable water quality conditions occur if an increase in the concentration of COCs in groundwater leads to adverse impacts on beneficial users or uses of groundwater due to either:

1. Direct actions by Santa Rosa Plain GSP projects or management activities
2. Undesirable results occurring for other sustainability indicators

Examples of potential adverse impact are in **Sections 4.8.2.7** and **4.8.4.3**.

As noted in the GSP Regulations, MTs are based on a degradation of water quality, not an improvement of water quality (CCR Title 23. Section 354.28). Therefore, this GSP is designed to

avoid taking any action that may inadvertently move groundwater constituents that have already been identified in the Subbasin in such a way that the constituents have a significant and unreasonable impact that would not otherwise occur. COCs were identified based on three criteria:

1. They have an established level of concern such as an MCL or secondary maximum contaminant level (SMCL), or a level that reduces crop production

2. They have been found in the Subbasin at levels above the level of concern and are routinely analyzed and reported through existing regulatory monitoring programs

3. The occurrence of the COC is extensive throughout the Subbasin

Based on the review of groundwater quality in **Section 3.2.5**, three COCs were identified that may affect groundwater supply in the Subbasin. The COCs include:

- Arsenic
- Nitrate
- Salinity (measured as TDS)

There are other point source contaminants found sporadically in the Subbasin, but these are not regional in extent, are monitored through various other regulatory programs, and consequently SMC are not established in the GSP. New or additional water quality constituents may be identified as potential COCs applicable to the GSP implementation activities through routine consultation and information sharing with other regulatory agencies. The GSA would then consider adding potential COCs and assigning SMC during the 5-year GSP updates.

Future GSP implementation projects or actions that require their own site-specific monitoring network would take into consideration any localized COCs and regulatory requirements.

4.8.2 Minimum Thresholds

The GSP Regulations allow three options for setting degraded water quality MTs: “The minimum threshold shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin” (CCR Title 23. Section 354.28). In this Subbasin, MTs are based on a number of supply wells that exceed concentrations of constituents determined to be of concern for the Subbasin.

The currently available supply wells for monitoring COCs that have an MCL or SMCL are public supply wells. Should domestic wells or agricultural irrigation wells be incorporated into future monitoring programs established by the GSA or other entities, they could also be included in monitoring COCs during future GSP updates.

4.8.2.1 Existing Water Quality Monitoring Programs and Networks

The SMC are based on a number of supply wells, and the GSA identified sets of supply wells that are currently monitored (or are proposed to be monitored in the future) for various groundwater constituents and supply uses such as drinking water and irrigation water. Because these supply wells are monitored under different programs and may have different required sampling schedules (even under the same program), no one set of constituents will be sampled in all wells.

The goal is to use existing monitoring programs for supply well water quality assessment and not create new water quality monitoring networks that the GSA would be responsible for sampling. Initially, it is anticipated that RMPs will come from public supply wells that are already monitored. The only additional sampling the GSA would perform is on a project as-needed basis to specifically identify potential impacts on supply wells due to the development of a project related to GSP implementation.

Existing monitoring programs identified in this Subbasin include:

- Public supply wells, regulated by the SWRCB DDW. Public drinking water supply wells are included in the water quality monitoring network because they are routinely sampled to meet CCR Title 22 water quality reporting requirements as regulated by the SWRCB DDW. Title 22 analyses include arsenic, nitrate, and TDS, which are the Subbasin COCs. This dataset can be obtained from the SWRCB through the GAMA online portal.

- Monitoring wells, agricultural irrigation supply, and public drinking water supply wells are included in the water quality network in the Santa Rosa Plain SNMP (City of Santa Rosa 2013a). The Revised SNMP MRP was submitted to the NCRWQCB in August 2021 and is currently being reviewed by the NCRWQCB, regulated by the NCRWQCB, requires annual sampling and analysis of water quality constituents in a network of wells (City of Santa Rosa 2021). The monitoring network is initially proposed to include six monitoring wells in the central portions of the Subbasin. Per the MRP, each of the wells is required to be sampled annually and analyzed for nitrate and TDS. The analytical datasets from the MRP wells will be available from the SWRCB through the GAMA online portal.

Existing and future water quality monitoring programs may be used to help collect data during GSP implementation and establish consistency with other programs. This includes the North Coast Water Board's dairy program that started in 2020 but has yet to upload groundwater quality data to publicly available databases. Additional information on each of the existing monitoring programs is provided in **Table 4-3**. **Table 4-4** provides information on future monitoring networks to be used specifically for monitoring projects and management actions for GSP implementation.

Table 4-3. Santa Rosa Plain Subbasin Monitoring Networks

Monitoring Network	Responsible Party	Type of Wells	Constituents Sampled	Sampling Frequency	Purpose of Network
Salt and Nutrient Management Plan	City of Santa Rosa	Public Supply; Irrigation; Monitoring	EC, TDS, Nitrate, pH, temperature	Varies	Abide by SNMP requirements
DDW Public Supply Wells	Cities and small water systems	Public Supply	Subset of Title 22 constituents	Varies	Protect drinking water beneficials users
North Coast Water Board's Dairy Program	Dairies under DWR	Irrigation and domestic wells	Nitrate, TDS	This monitoring program started in 2020 and data will be made available on the GeoTracker site	Includes monitoring of wells in the vicinity of dairy operations

Table 4-4. Future Monitoring Networks for Project-Specific Monitoring

Future As-needed Monitoring Network	Responsible Party	Type of Wells	Constituents Sampled	Sampling Frequency	Purpose of Network
Future Project Implementation Monitoring Network	GSA	To be determined (public and private wells)	COCs identified as part of the GSP – and to the constituents as required by the project permitting	To be determined	Identify water quality impacts related to site-specific project and action implementation

Each of these well networks are monitored for different purposes and overseen by different entities; therefore, sampling frequency and analytical suites vary. Water quality MTs for each well are selected based on which constituents are analyzed in water samples per existing programs, summarized in **Table 4-5**.

Table 4-5. Summary of Constituents Monitored at Each Well Network

Constituent	Public Supply	SNMP
Arsenic	✓	
Nitrate	✓	✓
TDS	✓	✓

4.8.2.2 Level of Concern for each Constituent of Concern

Each COC has an associated level of concern for each category of beneficial user. For the drinking water supply well category, the level of concern is represented by the MCL, or SMCL, as applicable.

The NCRWQCB Basin Plan (Basin Plan) designates a municipal water quality management objective for the Subbasin (that is the Russian River watershed). The municipal designation aims to maintain water quality for public supplies below the California MCL and SMCL drinking water standards (NCRWQCB 2017). There are no specific numeric thresholds for agricultural water quality for groundwater in the Subbasin.

The basis for establishing MTs for each COC in the Subbasin are summarized in **Table 4-6**. This table does not identify the total number of supply wells that may exceed the level of concern, but rather identifies how many additional wells will be allowed to exceed the level of concern. Wells that already exceed this level are not counted against the MTs.

Table 4-6. Groundwater Quality Minimum Thresholds Basis

Constituent of Concern	Minimum Threshold Based on Number of Wells
Arsenic	Two additional supply wells exceed the arsenic MCL of 0.010 mg/L.
Nitrate	Two additional supply wells exceed the nitrate measured as nitrogen MCL of 10 mg/L.
TDS	Two additional supply wells exceed the TDS recommended SMCL of 500 mg/L.

4.8.2.3 Development of Minimum Thresholds at Supply Wells

The MTs for degraded water quality for the supply wells are based on the number of additional exceedances of any MCL or SMCL in existing supply wells presented in **Table 4-6**. Establishing the MT as the number of additional exceedances accounts for supply wells with previous exceedances, assuming these exceedances will likely continue into the future. The GSA Board selected two as the number of additional supply wells with exceedances to represent the MT. The MT for the number of allowed exceedances is therefore equal to the baseline number of exceedances (calculated as the number of supply wells with any MCL or SMCL exceedance between 2015 and 2019) plus two additional supply wells with an exceedance. Based on the number of supply wells in the existing water quality monitoring network, the number of existing exceedances since 2015 for each constituent is tabulated in **Table 4-7** and the distribution of exceedances are on **Figures 4-5** through **4-7**, along with all of the other supply wells included in the initial RMP network.

Table 4-7. Minimum Thresholds for Degradation of Groundwater Quality for the Public Supply Wells Under the Current Monitoring Network

Constituent of Concern	Regulatory Exceedance Standard	Standard Units	Number of Sampled Wells in Monitoring Network (2015-2019)	Total Number of Exceedances (2015-2019)	Number of Wells Exceeding Regulatory Standard (2015-2019)	Minimum Threshold
Arsenic	10	µg/L	104	778	21	23
Nitrate	10	mg/L	122	12	2	4
TDS	500	mg/L	94	2	2	4

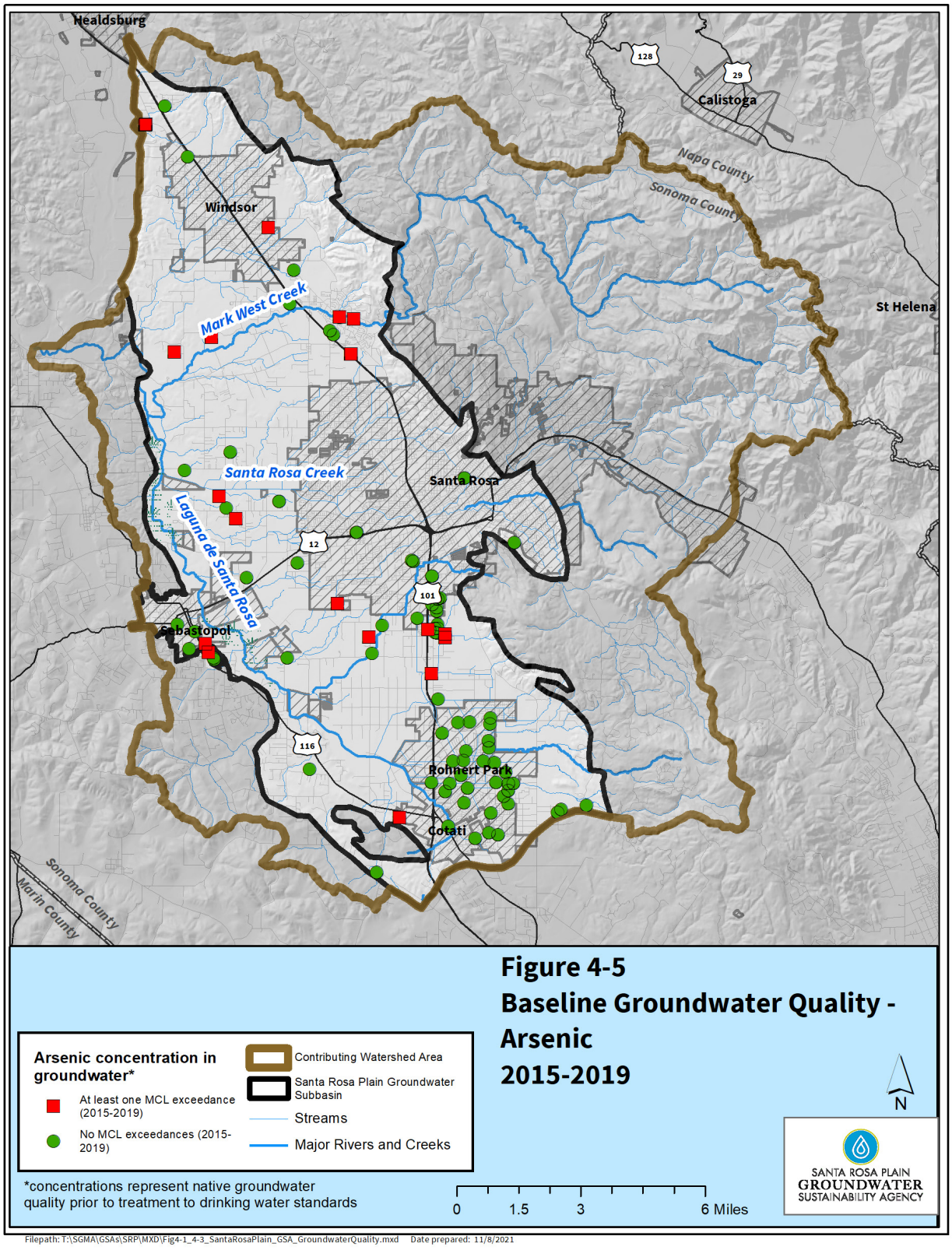


Figure 4-5 Baseline Groundwater Quality Arsenic 2015-2019

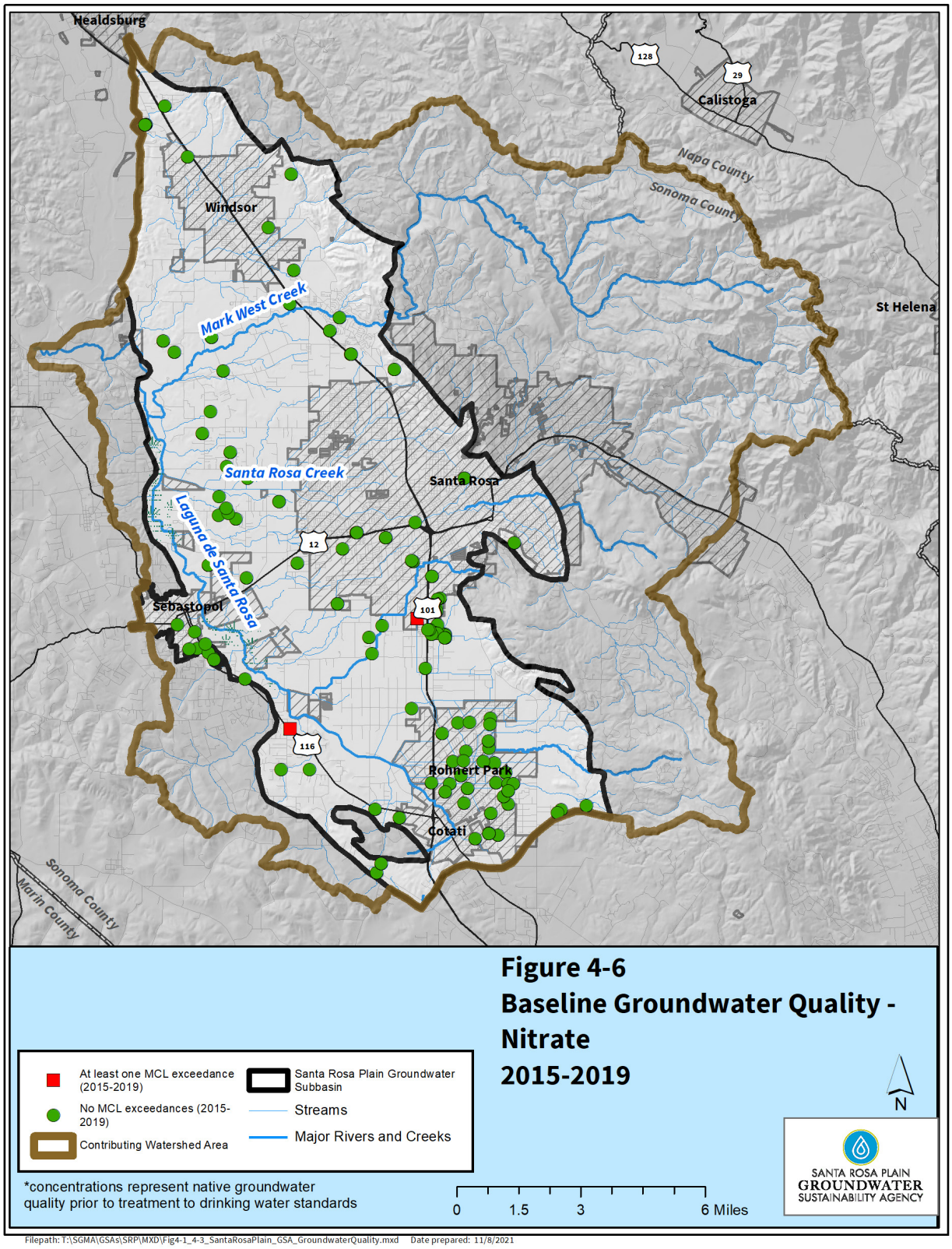


Figure 4-6. Baseline Groundwater Quality Nitrate 2015-2019

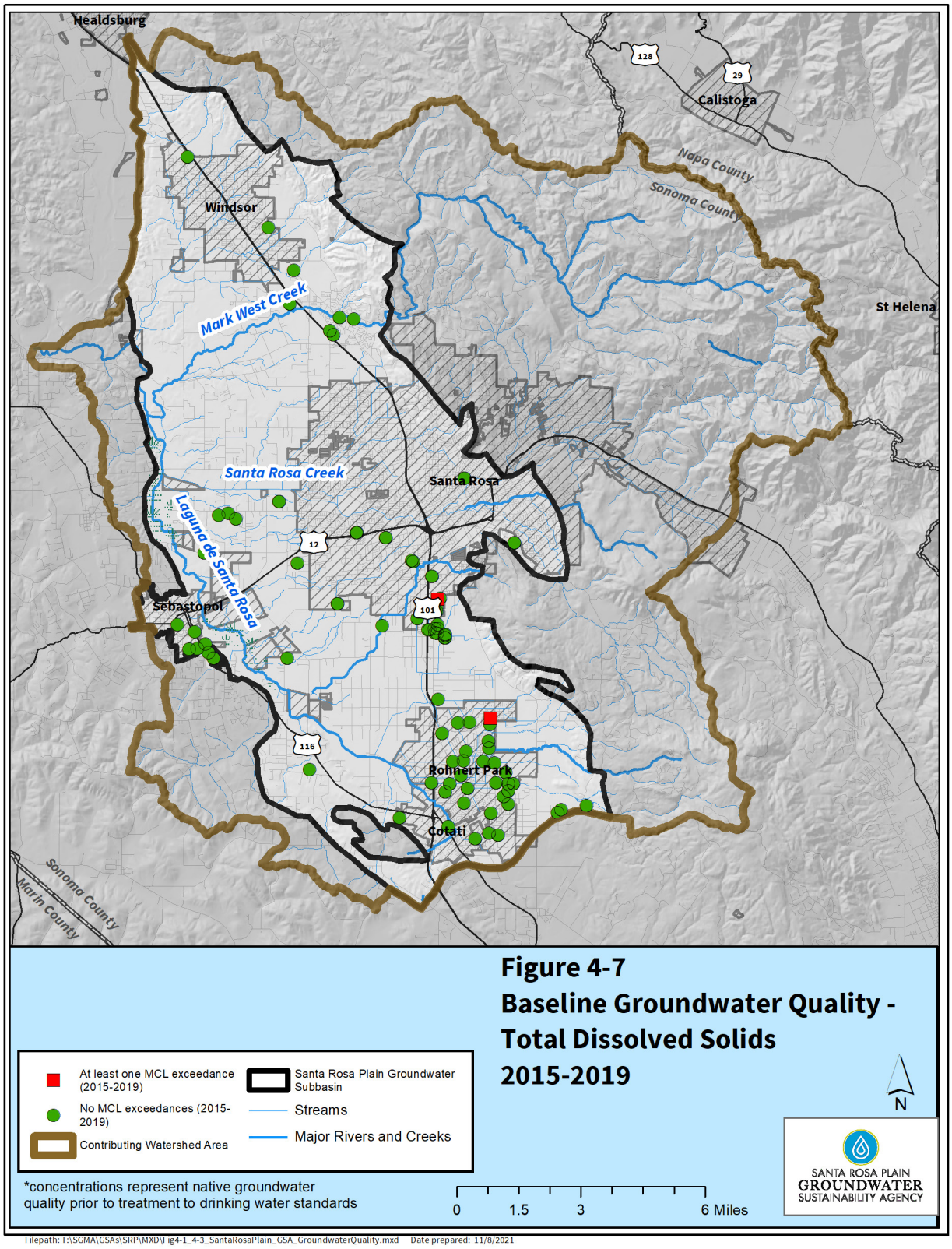


Figure 4-7. Baseline Groundwater Quality TDS 2015-2019

MT exceedances are based on existing supply wells only. According to the GSP Regulations, the MTs are based on the same number of supply wells to have exceedances, not necessarily the same wells. The well networks will be re-assessed every 5 years to identify any new supply wells that could be added to the monitoring networks. The MT will be increased by one for each new supply well added to the monitoring network with an initial measured concentration exceeding the MCL or SMCL. Additionally, if the MCL or SMCL changes for a GSP-identified COC, the specific MT should be examined and updated as appropriate.

If new exceedances of MTs are observed that are not due to GSP implementation, those new levels may be used to modify the MT accordingly to better reflect Subbasin conditions regardless of the GSP implementation actions.

4.8.2.4 Information and Methodology Used to Establish Water Quality Minimum Thresholds and Measurable Objectives

The exceedances in **Table 4-7** were based on a review of recent datasets. The information used for establishing the degradation of groundwater quality MTs includes:

- Historical groundwater quality data from public supply in the Subbasin
- Federal and state drinking water quality standards
- Feedback from GSA staff members and Advisory Committee members

The historical groundwater quality data used to establish groundwater quality MTs are presented in **Section 3.2.5**. Based on the reviews of historical and current groundwater quality data, federal and state drinking water standards, these standards are appropriate to define groundwater quality MTs.

4.8.2.5 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

Because SGMA does not require projects or actions to improve groundwater quality, there will be no direct actions under the GSP associated with the groundwater quality MTs. Therefore, there are no actions that directly influence other sustainability indicators. However, preventing migration of poor groundwater quality may limit activities needed to achieve MTs for other sustainability indicators.

- **Chronic lowering of groundwater levels**. Groundwater quality MTs could influence groundwater elevation MTs by limiting the types of water that can be used for recharge to raise groundwater elevations. Water used for recharge cannot result in exceedances of any of the groundwater quality MTs. In addition, a change in groundwater elevations may cause a change in groundwater flow direction which in turn could cause poor water quality to migrate into areas of good water quality.

- **Change in groundwater storage**. Nothing in the groundwater quality MTs promotes pumping in excess of the sustainable yield. Therefore, the groundwater quality MTs will not result in an exceedance of the groundwater storage MT.

- **Subsidence**. Nothing in the groundwater quality MTs promotes additional pumping that could cause subsidence. Therefore, the groundwater quality MTs will not result in an exceedance of the subsidence MT.

- **Depletion of interconnected surface waters**. Nothing in the groundwater quality MTs promotes additional pumping or lower groundwater elevations adjacent to interconnected surface waters. Therefore, the groundwater quality MTs will not result in a significant or unreasonable depletion of interconnected surface waters.

4.8.2.6 Effect of Minimum Thresholds on Neighboring Basins and Subbasins

The anticipated effect of the degraded water quality MTs on each of the neighboring subbasins is addressed in this section.

The Santa Rosa Plain Subbasin has one neighboring subbasin that is categorized as medium-priority and is also subject to SGMA: the Petaluma Valley Subbasin, to the south.

The Santa Rosa Plain Subbasin is also adjacent to the very low-priority Healdsburg Area Subbasin to the North, and the Wilson Grove Formation Highlands Basin to the west, both of which are not subject to SGMA.

Because the MTs in the Santa Rosa Plain Subbasin are to prevent migration of poor-quality water, it is likely that the MTs will not prevent the Petaluma Valley Subbasin from achieving and maintaining sustainability. The MTs are also not likely to negatively impact the Healdsburg Area Subbasin or the Wilson Grove Formation Highlands Basin. The Santa Rosa Plain GSA will coordinate closely with the Petaluma Valley GSA as they both set MTs to ensure that the subbasins do not prevent each other from achieving sustainability.

4.8.2.7 Effect on Beneficial Uses and Users

Agricultural land uses and users. The degradation of groundwater quality MTs is designed to avoid negative effects to groundwater quality associated with implementation of the GSP. Avoiding degradation of groundwater quality for the identified COCs, including salts which can impact agricultural irrigation, helps maintain groundwater quality providing positive benefits to the Subbasin's agricultural water users.

Urban land uses and users. The degradation of groundwater quality MTs is designed to avoid negative effects to groundwater quality associated with implementation of the GSP. Avoiding degradation of groundwater quality from the identified COCs helps maintain municipal drinking water quality providing positive benefits to the Subbasin's urban water users.

Domestic land uses and users. The degradation of groundwater quality MTs is designed to avoid negative effects to groundwater quality associated with implementation of the GSP. Avoiding degradation of groundwater quality from the identified COCs helps maintain drinking water quality providing benefits for domestic well users.

Ecological land uses and users. Although the groundwater quality MTs are not designed to directly benefit ecological uses, it can be inferred that the degradation of groundwater quality MTs provide generally positive benefits to the Subbasin's ecological water uses by helping maintain groundwater quality.

4.8.2.8 Relation to State, Federal, or Local Standards

The degradation of groundwater quality MTs specifically incorporate state and federal standards for drinking water.

4.8.2.9 Method for Quantitative Measurement of Minimum Thresholds

Degradation of groundwater quality MTs will be measured directly using analysis of samples collected from public drinking water supply wells reported through SWRCB DDW. An average concentration of water quality samples will be used for wells that are sampled more than once a year. If any other routine monitoring of supply wells is initiated in the Subbasin at a later date, these wells, will also be considered for inclusion in the water quality monitoring network. The data review will focus on exceedances of MTs, or MCLs and SMCLs for the COCs identified for this GSP. However, if during review of the water quality data, additional constituents appear to frequently exceed MCLs and SMCLs, MTs and MOs will be considered for these additional constituents during GSP 5-year updates.

4.8.3 Measurable Objectives

The MOs for degradation of groundwater quality represent target groundwater quality distributions in the Subbasin. SGMA does not mandate the improvement of groundwater quality. Therefore, the GSA has set the MO for each COC to the number of existing supply wells that exceeded the MCL or SMCL from 2015 to 2019 (**Table 4-7**). In other words, the MO is to have zero additional supply wells exceeding the applicable MCL or SMCL for any of the COCs.

4.8.3.1 Method for Setting Measurable Objectives

MOs are established using a similar method to the MTs detailed in **Section 4.8.2**, except the target number of additional MCL or SMCL exceedances will be zero.

4.8.3.2 Interim Milestones

The MOs for degradation of groundwater quality are set at current conditions; there is no anticipated degradation of groundwater quality during GSP implementation that results from the implementation of projects and actions as described in **Section 6**. Therefore, the expected interim milestones are identical to current conditions.

4.8.4 Undesirable Results

4.8.4.1 Criteria for Defining Undesirable Results

By regulation, the degradation of groundwater quality undesirable result is a quantitative combination of groundwater quality MT exceedances. Some groundwater quality changes are expected to occur independent of SGMA activities; because these changes are not related to SGMA activities they do not constitute an undesirable result. The degradation of groundwater quality undesirable result occurs if, during 2 consecutive years, a single groundwater quality MT is exceeded when computing annual averages at the same well, as a direct result of projects or management actions taken as part of GSP implementation.

4.8.4.2 Potential Causes of Undesirable Results

Conditions that may lead to an undesirable result include the following:

- If the location and rates of groundwater pumping change as a result of projects implemented under the GSP, these changes could alter hydraulic gradients and associated flow directions, and cause movement of one of the COCs towards a supply well at concentrations that exceed relevant standards.

- Active recharge of imported water or captured runoff could modify groundwater gradients or alter local geochemical conditions and move one of the COCs towards a supply well in concentrations that exceed relevant limits.

- Recharging the Subbasin with water that exceeds an MCL, SMCL, or level that reduces crop production may lead to an undesirable result.

- The exceedance of an undesirable results for another sustainability indicator may lead to an undesirable result for degraded water quality.

Prior to determining whether an undesirable result has occurred based on MT exceedances, an investigation of the cause for the exceedance(s) will be conducted by the GSA. Such investigation would likely include the following steps, as needed:

1. Is a project or action by the GSA located in the vicinity and can be reasonably linked to the exceedance?

2. Are undesirable results occurring for any other sustainability indicators that could impact water quality?

If the answer to either question above is yes, then the following additional steps would be taken:

- Evaluate monitoring data from any projects and actions in the vicinity of the exceedance and correlate to the data from the well that had an exceedance

- Review of any other available groundwater quality data in the vicinity of the exceedance
- A detailed review of available laboratory analytical data and laboratory quality assurance/quality control measures
- Resampling of wells with the exceedances if it is established that the GSA projects or actions may be the cause of the exceedance

For any projects and actions implemented under the GSP, additional groundwater quality monitoring in the vicinity of the project or actions sites may be implemented to determine the possibility of causing undesirable results. Any needed mitigation measures to avoid the negative conditions will be included.

4.8.4.3 Effects on Beneficial Users and Land Use

The undesirable result for degradation of groundwater quality is adverse impacts on beneficial uses and users in the Subbasin from groundwater degradation due to actions directly resulting from GSP implementation. Adverse impacts include diminished supply due to water quality impacts that cause non-compliance with drinking water standards or undue costs for mitigating impacts through wellhead treatment or well replacement. Beneficial users that could be impacted by undesirable results from groundwater quality degradation include domestic well users, irrigation well users, and public water supply well users (inclusive of DACs that obtain water from these user categories). If water quality degradation due to GSP implementation activities is avoided, there will be no impact on the use of groundwater and there will be no negative effect on the beneficial users and uses of groundwater. If projects and actions are shown to cause the degradation of localized groundwater quality, however, the GSA will develop mitigation actions.

This undesirable result only applies to groundwater quality changes directly caused by projects or management actions implemented as part of this GSP. This undesirable result does not apply to groundwater quality changes that occur due to other causes.

4.9 Subsidence Sustainable Management Criteria

Land surface subsidence is the change in land surface elevation caused by an increase in effective stress due to groundwater overdraft, tectonics, or other natural processes such as hydrologic isostatic loading. Land surface subsidence may be elastic or inelastic. Elastic subsidence is recoverable as groundwater conditions change. Inelastic subsidence is unrecoverable and is primarily due to irreversible compaction of clay-rich sediments. Per the GSP Regulations, the GSAs are only responsible for managing inelastic land subsidence caused by lowered groundwater elevations. They are not responsible for managing elastic subsidence or subsidence conditions caused by something other than groundwater pumping, such as tectonic activity.

Available land surface subsidence datasets for the Subbasin do not indicate the occurrence of inelastic subsidence due to groundwater pumping. Subsidence measurements have been

collected in the Subbasin at one discrete GPS location since 2005 and by InSAR satellite in most of the Subbasin since 2015. Two detailed studies were also performed to map and assess the Rodgers Creek Fault for evidence of creep from 1992 to 2001 and from 2003 to 2010. The available datasets and studies were summarized in the Basin Setting section of this GSP (**Section 3.2.4**).

Recent land surface elevation measured by GPS and InSAR indicate that land surface elevation is relatively stable in the Subbasin with some areas demonstrating slight increasing land surface elevation and others demonstrating slight land surface elevation decrease. Land surface elevation measured by GPS surveys at one discrete location between Santa Rosa and Sebastopol slightly increased by about 0.1 inch (or 0.008 foot) since 2005. Similarly, land surface elevation measured throughout the Subbasin by InSAR satellite since 2015 was less than 0.25-inch (or 0.021 foot) with some areas of land surface elevation increase up to 0.25 inch.

The Rodgers Creek Fault studies between 1992 and 2010 identified slight land surface elevation increase to the east of the fault and slight subsidence west of the fault, which follows a north-northwest trending plane through the City of Santa Rosa. While not specifically designed to investigate potential land surface subsidence due to groundwater pumping, the fault studies identified an area in the southern portions of the Subbasin near Rohnert Park and Cotati where the ground surface subsided between 1992 and 2001 at a rate of about 0.2 inch (0.017 foot) per year and subsequently rebounded between 2003 and 2010 at the same rate. This location generally coincided with an area of groundwater-level declines and subsequent recovery over similar timeframes as discussed in **Section 3.2.2**. The subsequent rebound of the land surface following the reduction in groundwater pumping and recovery of groundwater levels provides evidence that the relatively minor historical land surface subsidence in this area likely represents elastic land surface subsidence, which has not caused permanent (or inelastic) collapse of fine-grained units within the aquifer system.

Together, the subsidence datasets indicated that the land surface elevation is relatively stable throughout the Subbasin and where land surface movement is occurring, it appears to be related to fault movement rather than groundwater pumping. Areas to the east of the Rodgers Creek Fault appear to have slight upward movement and areas to the west of the fault appear to have slight downward movement. The overall land displacement trends in other portions of the Subbasin beyond the fault zone are generally stable with similar land surface elevation fluctuations in areas both with and without groundwater pumping. It is not known if the historical subsidence was elastic or inelastic; however, since the subsidence was found to be regionally consistent with the active fault location, it is not likely attributed to groundwater pumping and more likely due to natural causes such as tectonics or hydrostatic loading. Consequently, it appears that no significant inelastic subsidence has occurred within the Subbasin due to groundwater pumping.

4.9.1 Locally Defined Significant and Unreasonable Conditions

As described above and in **Section 3.2.3**, available Subbasin-wide datasets (while limited to recent time periods) do not indicate the occurrence of inelastic land surface subsidence due to groundwater pumping within the Subbasin. There have been no problems reported by Subbasin stakeholders related to historical inelastic subsidence (for example, damage to infrastructure or modified drainage patterns). However, the risk of future inelastic land surface subsidence and consolidation of the clay-rich portions of the Subbasin's aquifer system exists if there are chronic declines of groundwater levels.

Locally defined significant and unreasonable conditions were determined based on public meetings, and discussions with GSA staff, Advisory Committee members, and GSA Board. Significant and unreasonable land subsidence in the Subbasin was defined as any rate of future inelastic subsidence caused by groundwater pumping everywhere in the Subbasin regardless of the beneficial uses and users.

4.9.2 Minimum Thresholds

Section 354.28(c)(5) of the GSP Regulations states that "The minimum threshold for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results" CCR Title 23. Section 354.28. As such, the defined metric from the GSP Regulations for measuring total subsidence includes the rate of change in land surface elevation. This can be measured with extensometers, continuous GPS stations, levelling surveys, or by satellite with InSAR. It is difficult to assess a-priori whether subsidence interferes with surface land uses to address the second portion of the GSP regulation; therefore, the GSA has selected a single protective MT for subsidence for the entire Subbasin. While zero inelastic subsidence due to pumping is the desire to avoid significant and unreasonable conditions, there is an inherent 0.1-foot potential error in the InSAR technology. The following MT was developed for the Subbasin to account for this potential measurement error of the data collection method:

The MT for subsidence in the Subbasin is 0.1 feet per year of inelastic subsidence measured by InSAR for each of the 100 square meter, or approximately 2.5 acre, grids or pixels in the Subbasin.

4.9.2.1 Information and Methodology Used to Establish Subsidence Minimum Thresholds and Measurable Objectives

The subsidence MT and MO allow for no measurable additional inelastic subsidence in the Subbasin due to groundwater pumping. The MT allowance of 0.1 ft/yr of subsidence was developed based on the inherent measurement error of InSAR technology described above.

The InSAR pixels serve as the RMPs. The reported total subsidence value is an average of many individual measurements within each InSAR pixel. InSAR is the method used for establishing MTs and MOs given the spatial coverage, accuracy, and availability at no cost to the GSA (state funded program for SGMA). Disadvantages of InSAR are that it measures total subsidence rather than inelastic subsidence and the available data record only extends to 2015.

4.9.2.2 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

Subsidence MTs have little or no impact on other MTs, detailed as follows:

- Chronic lowering of groundwater levels. Nothing in the subsidence MT promotes additional pumping that could cause chronic lowering of groundwater levels. Therefore, the subsidence MT will not result in an exceedance of the groundwater storage MT.
- Change in groundwater storage. Nothing in the subsidence MT promotes pumping in excess of the sustainable yield. Therefore, the subsidence MT will not result in an exceedance of the groundwater storage MT.
- Degraded water quality. Nothing in the subsidence MT promotes additional pumping that could cause degradation of groundwater quality. Therefore, the subsidence MT will not result in an exceedance of the groundwater quality MT.
- Depletion of interconnected surface waters. Nothing in the subsidence MT promotes additional pumping or lower groundwater elevations adjacent to interconnected surface waters. Therefore, the subsidence MT will not result in a significant or unreasonable depletion of interconnected surface waters.

4.9.2.3 Effect of Minimum Thresholds on Neighboring Basins and Subbasins

The anticipated effect of the subsidence MT on each of the neighboring subbasins is addressed in this section.

The Santa Rosa Plain Subbasin has one neighboring subbasin that is categorized as medium-priority and is also subject to SGMA: the Petaluma Valley Basin, to the south. The Santa Rosa Plain Subbasin is also adjacent to the very low-priority Healdsburg Area Subbasin to the North, and the Wilson Grove Formation Highlands Basin to the west, both of which are not subject to SGMA.

Because the MTs in the Santa Rosa Plain Subbasin is intended to prevent any measurable inelastic subsidence due to groundwater pumping, it is likely that the MTs will not prevent the Petaluma Valley GSA from achieving and maintaining sustainability. The Santa Rosa Plain GSA will coordinate closely with the Petaluma Valley GSA as they both set MTs to ensure that the subbasins do not prevent each other from achieving sustainability.

4.9.2.4 Effect on Beneficial Uses and Users

Agricultural land uses and users. The subsidence MT is designed to avoid negative effects to infrastructure associated with implementation of the GSP. Avoiding land subsidence helps protect wells and water conveyance infrastructure that are critical to the Subbasin's agricultural water users.

Urban land uses and users. The subsidence MT is designed to avoid negative effects to infrastructure associated with implementation of the GSP. Avoiding land subsidence helps protect buildings, roads, utilities, wells, and other infrastructure. This provides positive benefits to the Subbasin's urban water users.

Domestic land uses and users. The subsidence MT is designed to avoid negative effects to infrastructure associated with implementation of the GSP. Avoiding land subsidence helps protect buildings, roads, utilities, wells and other infrastructure. This provides positive benefits to the Subbasin's domestic water users.

Ecological land uses and users. The subsidence MT is not designed to directly benefit ecological uses. Preventing future subsidence in the Subbasin will not harm or benefit ecological water users.

4.9.2.5 Relation to State, Federal, or Local Standards

There are no federal, state, or local regulations related to land subsidence.

4.9.2.6 Method for Quantitative Measurement of Minimum Thresholds

There are two existing subsidence monitoring networks in the Subbasin, InSAR and one continuous GPS monitoring location. The continuous GPS data are temporally extensive, but spatially limited. Therefore, the GSA intends to use the InSAR method for assessment of subsidence SMC. Statewide subsidence data is currently estimated every month by satellite using InSAR methodology. DWR maintains a database of InSAR data and makes it publicly available for use in GSPs.

Quantitative measurements for InSAR data are provided on a monthly timestep by DWR. The DWR database and webmap reports an average total subsidence value of many individual measurements within a single 100 square meter, or approximately 2.5 acres pixel. The average for each pixel will be used for the subsidence MT. DWR has stated that, on a statewide level, for the total vertical displacement measurements between June 2015 and June 2019, the errors are as follows:

1. The error between InSAR data and continuous GPS data is 16 mm (0.052 foot) with a 95 percent confidence level (DWR 2021b).

2. The measurement accuracy when converting from the raw InSAR data to the maps provided by DWR is 0.048 foot with 95 percent confidence level.

For the purposes of this GSP, the cumulative errors for InSAR data are considered the sum of errors 1 and 2, for a combined total error of 0.1 foot.

The InSAR data provided by DWR reflects both elastic and inelastic subsidence. While it is difficult to compensate for elastic subsidence, visual inspection of monthly changes in ground elevations suggest that elastic subsidence is largely seasonal. Due to the seasonal elastic

fluctuations, annual subsidence will be calculated by comparing InSAR datasets at the same time each year to reduce the effect of any seasonal elastic fluctuations of elevation on observed data.

4.9.3 Measurable Objectives

The MO is the aspirational goal to achieve optimal protection of groundwater conditions. The recommended MO is the same as the MT given that zero subsidence related to groundwater pumping is the significant and unreasonable condition. In other words, there is not a more stringent condition for land subsidence than the MT. Similar to the MT, the subsidence MO allows for 0.1 foot of measurement error per year.

4.9.3.1 Method for Setting Measurable Objectives

MOs are set to be identical to the MTs and therefore follow the same method as detailed in **Section 4.9.2**.

4.9.3.2 Interim Milestones

The MOs for subsidence are set at current conditions and there is no anticipated additional subsidence during GSP implementation that results from groundwater pumping; therefore, the expected interim milestones are identical to current conditions, MTs, and MOs.

4.9.4 Undesirable Results

By regulation, the subsidence undesirable result is a quantitative combination of subsidence MT exceedances. For the Subbasin, any inelastic subsidence as a direct result of groundwater pumping is considered unacceptable. Since the GSP Regulations allow for elastic and inelastic subsidence due to natural conditions such as plate tectonics and hydrostatic loading, any subsidence resulting from these phenomena are not included in the definition of undesirable results.

A land subsidence undesirable result will occur in the Subbasin if:

1. The land subsidence MT of 0.1 feet of total subsidence is exceeded over a geographic area of 25 acres in a single year.

2. Cumulative total subsidence of 0.2 feet is exceeded over a geographic area of 25 acres within a 5-year period.

3. The MT exceedance is determined to be correlated with (1) groundwater pumping, and (2) a MT exceedance of the chronic lowering of groundwater-levels SMC.

The geographic area of 25 acres was selected to reduce the likelihood that a very small area or a single data point anomaly within a single 2.5-acre grid could result in Subbasin-wide undesirable results. The cumulative cap of 0.2 foot within a 5-year period was selected to account for the risk of cumulative small amounts of annual total subsidence less than 0.1 foot

adding up to a more significant level of subsidence. The 0.2-foot cumulative total represents an estimated minimum limit for elastic subsidence during groundwater-level decline and subsequent recover related to changes in groundwater pumping near Rohnert Park and Cotati discussed in **Section 4.9**. Maintaining 0.2 foot or less of cumulative subsidence allows for elastic land surface deformation from groundwater-level decline and subsequent recovery, while maintaining protections to avoid the potential for future inelastic subsidence. The undesirable result is tied to groundwater pumping and an exceedance of the chronic lowering of groundwater-levels SMC to isolate subsidence caused by groundwater pumping from other causes such as plate tectonics and hydrostatic loading.

4.9.4.1 Criteria for Defining Undesirable Results

An important aspect of the recommended SMC is the determination of whether total subsidence measured by InSAR is correlated to groundwater-level declines caused by pumping.

Activities that the GSAs will conduct if future MT exceedances occur to evaluate if inelastic land subsidence occurred due to groundwater pumping include the following:

- Review of land surface elevation data from InSAR, continuous GPS stations, or other measurement devices in the Subbasin
- Review of groundwater elevation measurements and trends in RMPs (established as part of the declining groundwater-level SMC) and other nearby wells being monitored, including an assessment as to whether groundwater levels are below historical lows or exceeding MTs
- Evaluation of time series plots of groundwater levels from nearby monitoring wells
- Review of seismic related data and records that might explain land subsidence observations
- Evaluation of known or estimated groundwater pumping patterns within the vicinity of any observed potential land subsidence
- Assessment of whether data gaps hamper the ability to determine the cause of MT exceedances

4.9.4.2 The number of the actions implemented for each individual exceedance of an MT would depend upon the severity and extent of the MT exceedances. Potential Causes of Undesirable Results

Conditions that may lead to an undesirable result for land subsidence include the following:

- Continued decline of groundwater levels due to groundwater pumping within the Subbasin could trigger inelastic subsidence in areas with clay-rich sediments.
- If the location and rates of groundwater pumping change as a result of projects implemented under the GSP, subsidence may occur.

- Shifting a significant amount of pumping to an area that is susceptible to subsidence could trigger subsidence that has not been observed before.

- The exceedance of an undesirable result for another sustainability indicator may lead to an undesirable result for subsidence.

4.9.4.3 Effects on Beneficial Users and Land Use

The undesirable result for subsidence does not allow any inelastic subsidence to occur in the Subbasin. Therefore, there is no negative effect on any beneficial uses and users.

4.10 Depletion of Interconnected Surface Water Sustainable Management Criteria

The SMC for depletion of interconnected surface water are more technically complex to develop and requires robust modeling tools, historical records of streamflow and groundwater levels near streams, and identification of potential impacts from streamflow depletion. To develop these SMC, staff convened two practitioner work groups to provide expert input on: (1) mapping of groundwater- dependent ecosystems; and (2) development of the SMC for depletion of interconnected surface water. Collectively, these work groups met seven times between July 2020 and March 2021. The work group focused on the development of the SMC for depletion of interconnected surface water included the following participants:

- Rick Rogers, National Marine Fisheries Service
- Jessie Maxfield, California Department of Fish and Wildlife
- Natalie Stork, State Water Resources Control Board
- Val Zimmer, State Water Resources Control Board
- Sam Boland-Brien, State Water Resources Control Board
- Maurice Hall, Environmental Defense Fund
- Melissa Rohde, The Nature Conservancy
- Andrew Renshaw, California Department of Water Resources

Key themes and outcomes from work group members that assisted in developing the SMC for interconnected surface water are documented in **Appendix 4-B**. As described in **Appendix 4-B**, the SMC for depletion of interconnected surface water are unique in that information in the historical record linking surface water depletion directly to groundwater usage under the jurisdiction of the GSAs is very limited. Variable levels of correlation between simulated streamflow depletion and groundwater levels, a lack of existing instream flow targets, and limited data for assessing the presence of any historically significant and unreasonable conditions complicate the development of this SMC.[2] An additional complication is that depletions of surface water can be caused by diversions under surface water rights (for

[2] While it is recognized that low summer baseflows in certain years can impact aquatic species, until we know how much water they need to survive and thrive (for example, via instream flow targets), an MT is difficult to determine. The current approach requires using historical data and avoiding conditions lower than historical surface water depletion amounts.

example, direct surface water diversions or wells pumping under appropriative or riparian rights) that are outside the jurisdiction of SGMA and the GSAs. Therefore, the cause of the depletion must be evaluated to assess if such depletions are caused by pumping under the jurisdiction of the GSA.

Empirical data are not currently available within the Subbasin on potential causes and effects of surface water depletion due to groundwater pumping to adequately determine when it "adversely impacts the viability of GDEs or other beneficial users of surface water." For this reason, this GSP includes:

- A detailed adaptive management plan for developing new information and data to refine the SMC during initial years of GSP implementation
- Initial SMC focused on not exceeding historical levels of depletion based on available data and modeling tools

4.10.1 Locally Defined Significant and Unreasonable Conditions

Locally defined significant and unreasonable conditions were determined based on public meetings, and discussions with GSA staff, Work Group members, Advisory Committee members, and GSA Board. Significant and unreasonable depletion of interconnected surface water in the Subbasin was defined as:

> Significant and unreasonable depletion of surface water from interconnected streams occurs when surface water depletion, caused by groundwater pumping within the Subbasin, exceeds historical depletion or adversely impacts the viability of groundwater dependent ecosystems (GDEs) or other beneficial users of surface water.[3]

4.10.2 Minimum Thresholds

Section 354.28(c)(6) of the GSP Regulations states that "The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results."

Available data are currently insufficient to directly calculate the rate or volume of surface water depletions from streamflow measurements or reliably estimate depletions from a surface water budget. Quantifying surface water depletion due to pumping is a challenge because: (1) it

[3] Important definitions related to the significant and unreasonable statement include:

- "Groundwater pumping" excludes any diversions by surface water rights holders
- "Historical depletion" estimated as simulated surface water depletion caused by groundwater pumping as informed by available historical measured data (2004-2018)
- "Groundwater dependent ecosystems" includes aquatic species and vegetation, as defined in **Section 3**
- "Other beneficial users of surface water" include surface water rights holders and recreational uses (where applicable)

cannot be measured directly; and (2) the influence of surface water depletion by pumping is often obscured by other factors, such as precipitation and runoff, surface water diversions, ET, and natural groundwater/surface water interactions. Therefore, groundwater levels are used as a proxy for the rate or volume of surface water depletion for these initial SMC. The use of groundwater levels as a proxy metric for the depletion of interconnected surface water sustainability indicator is considered the best available criteria because:

- The depletion of interconnected surface water is driven by the gradient between water surface elevation in the surface water body and groundwater elevations in the connected, shallow aquifer system.
- Groundwater levels are also one of the controlling factors in supporting rooting depths for vegetation-based GDEs.
- Groundwater levels represent criterion that the GSA has direct authority to manage within the Subbasin (for example, compared with streamflows that can be strongly influenced by the factors described above, as well as inflows from upland areas outside of the Subbasin).

4.10.2.1 Information and Methodology Used to Establish Depletion of Interconnected Surface Water Minimum Thresholds

The information used for establishing the MTs and MOs for the depletion of interconnected surface water sustainability indicator included:

Frequency of observed or measured streamflow:

- Comparison of interpolated groundwater levels within the shallow aquifer system and streambed elevations
- High frequency groundwater-level observations from shallow monitoring wells located near streams
- Map of interconnected surface water reaches within the Subbasin
- Map of the distribution of GDEs within the Subbasin
- Input from the practitioner work group for interconnected surface water

Appendix 4-C provides a description of the specific methodology used for developing the SMC for the depletion of interconnected surface water sustainability indicator, including: (1) the selection of appropriate RMPs for depletion of interconnected surface water, (2) methodology for demonstrating correlation between groundwater levels and interconnected surface water depletion, and (3) methodology for determining MTs and MOs for depletion of interconnected surface water at the RMPs.

As detailed in **Appendix 4-C**, the initial SMC for depletion of interconnected surface water were developed based on simulated data and the best available historical information. The SMC will be refined, as needed, with observed data during the implementation phase. The general procedure for developing the initial SMC involves:

1. Use of groundwater levels measured at shallow monitoring wells near streams (RMPs) as a proxy for surface water depletion

2. Use model to estimate the 3 years with highest levels of simulated streamflow depletion between 2004 and 2018

3. Calculate percentile ranking of simulated dry-season groundwater levels associated with these years

4. Set initial MTs at this percentile ranking using available datasets for wells measured near RMPs

5. Set initial MO as mean of dry season measured groundwater levels from historical record

The MTs developed using this methodology are provided in **Table 4-8** and represent: The equivalent groundwater level, representing the 3 years (2014–2016) during which the most surface water depletion due to groundwater pumping was estimated between 2004 and 2018.

The goal of the MTs is to maintain estimated rates and volume of streamflow depletion below historical levels, using groundwater-level measurements as a proxy.

Table 4-8. Minimum Thresholds and Measurable Objectives for Depletion of Interconnected Surface Water

RMP Well	Proposed MT (feet above msl)	Proposed MO (feet above msl)
SRP0707	111.4	118.1
SRP0709	56.0	58.2
SRP0711	63.3	63.7
SRP0712	45.2	46.3
SRP0713	57.9	58.4
SRP0714	126.2	128.2
SRP0716	124.4	125.2

msl = mean sea level

Adaptive Management to Address Data Gaps and Improve/Refine Sustainable Management Criteria

In recognition of the significant information and data limitations and the importance of interconnected surface water to beneficial users within the Subbasin, potential future studies and activities have been identified and prioritized in coordination with the work group according to relative importance and potential costs. These studies and activities listed in two groups are described more thoroughly in **Section 7** of this GSP for implementation in the early implementation phase of the GSP. Initial identification of monitoring network data gaps, which consider the distribution of currently mapped GDEs within the Subbasin, is also provided in **Section 5**. Additionally, at this time, none of the streams in the Subbasin have instream flow criteria established by the state. If and when the state agencies conduct habitat and other studies to establish instream flow criteria, the GSA will use this information to evaluate surface water depletions to ensure compliance with SGMA.

Group 1

This group will focus on improved characterization of causes and effects of depletion, lower cost studies, and outside funding or leveraged funding opportunities with partners:

- Improve data/information on existing water wells and stream diversions
- Model improvements – focused calibration of surface water and groundwater interaction
- Improve GDE mapping/remote sensing for vegetation health (for example, use of Normalized Difference Vegetation Index, GDE pulse)
- Compile and evaluate existing and relevant habitat field surveys
- Evaluate future airborne geophysical data

Group 2

This group will focus on monitoring network improvements, higher cost studies, and related tasks:

- Additional shallow monitoring wells and stream gages
- Focused geophysical studies
- Geomorphic and streambed conductivity assessments
- Additional focused habitat field mapping in partnership with other agencies, as needed

4.10.2.2 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

Assessment of how other sustainability indicators could be influenced by the depletion of interconnected surface water MT indicates the following:

- **Chronic lowering of groundwater levels**. Groundwater levels are used as a proxy for monitoring the depletion of interconnected surface water MTs. Because the MTs for the depletion of interconnected surface water are generally set within close proximity to streambed elevations within the Subbasin, they are shallower (more protective) than MTs set for nearby RMPs for the chronic lowering of groundwater levels. Therefore, an exceedance of the depletion of interconnected surface water MTs will not result in exceedances for chronic lowering of groundwater-level MTs.

- **Reduction in groundwater storage**. Because the chronic lowering of groundwater levels MTs will be used as a proxy for estimating groundwater pumping and changes in groundwater storage, an exceedance of the depletion of interconnected surface water MTs will not result in an exceedance of the groundwater storage MTs, for the same reasons described for the chronic lowering of groundwater levels sustainability indicator.

- **Degraded water quality**. MTs for depletion of interconnected surface water are intended to maintain groundwater levels near streams above historical levels, which is not anticipated to lead to degradation of water quality.

- **Subsidence**. MTs for depletion of interconnected surface water are intended to maintain groundwater levels near streams above historical levels, which is not anticipated to lead to subsidence.

4.10.2.3 Effect of Minimum Thresholds on Neighboring Basins and Subbasins

The Santa Rosa Plain Subbasin has one neighboring subbasin that is categorized as medium-priority and is also subject to SGMA: the Petaluma Valley Basin, to the south.

The Santa Rosa Plain Subbasin is also adjacent to the very low-priority Healdsburg Area Subbasin to the northwest, and the Wilson Grove Formation Highlands Basin to the west, both of which are not required to develop GSPs under SGMA.

The reaches of interconnected streams within the Subbasin that are subject to the MTs for depletion of interconnected surface water are separated by surface water divides from the Petaluma Valley Basin, and do not flow into the Healdsburg Area Subbasin or the Wilson Grove Formation Highlands Basin. Therefore, the MTs for depletion of interconnected surface water depletion will not have an effect on these neighboring basins and subbasins.

Additionally, the Santa Rosa Plain GSA will continue to closely coordinate with the Petaluma Valley GSA and the County (for areas that are not under a GSA's jurisdiction) should any future issues arise.

4.10.2.4 Effect on Beneficial Uses and Users

The MTs for depletion of interconnected surface water measured using groundwater levels as a proxy assumes that maintaining groundwater levels at or above historical low levels in the Subbasin will avoid surface water depletion that exceeds historical levels. Avoiding surface water depletion at levels greater than historical conditions will provide a benefit to beneficial users and land uses that rely on interconnected surface water. The following specifically describes how MTs will benefit land and beneficial water use in the Subbasin:

- **Agricultural land uses and users**. Maintaining the historical levels of surface water depletion should not impact agricultural land uses or irrigation water supplies.

- **Urban land uses and users.** Municipal groundwater pumpers are not anticipated to be affected if surface water depletion from groundwater pumping remains similar to historical levels.

- **Domestic land uses and users**. Maintaining rates of surface waters depletion from groundwater pumping at or above historical levels will protect residential beneficial users of groundwater by keeping groundwater levels at or above historical low levels.

- **Ecological land uses and users**. The main benefit of the surface water depletion MTs is to GDEs (primarily aquatic species and riparian vegetation). Maintaining shallow groundwater levels near streams at or above historical low levels helps maintain interconnected conditions and historical levels of baseflow. Better understanding the causal effects of interconnected surface water depletion due to groundwater pumping on GDEs and habitat is a primary focus of the early stages of GSP implementation and will be used to further evaluate potential effects on GDEs and refine the MTs in future GSP updates, as appropriate.

4.10.2.5 Relation to State, Federal, or Local Standards

No federal, state, or local standards exist that are specifically address depletion of interconnected surface water, however state and federal endangered species provisions call for the protection and restoration of conditions necessary for steelhead and coho salmon. These provisions were considered in development of the surface water depletion MTs.

If and when new standards, such as instream flow targets, are developed by other agencies they will be evaluated and incorporated into any potential future refinements to the MTs for depletion of interconnected surface water.

4.10.2.6 Method for Quantitative Measurement of Minimum Thresholds

Groundwater elevations will be measured in seven RMPs used to monitor surface water depletion as a proxy. Groundwater-level monitoring will be conducted in accordance with the monitoring protocol outlined in **Section 5.3.3**. For reporting seasonal highs and lows for future comparison with MTs, all measurements collected more frequently than monthly will be reported as monthly averages in order to better align with the measurement frequency within

historical datasets used to calculate the MTs. During GSP implementation, individual groundwater-level measurements collected manually and by data loggers will be reviewed for quality control and analyzed for MT exceedances during compilation of GSP annual and 5-year update reports. As described in **Section 4.10.2.1** and in **Sections 5** and **7**, additional work to fill data gaps and implement monitoring network improvements are identified as high-priority actions during GSP implementation.

4.10.3 Measurable Objectives

MOs for depletion of interconnected surface water represent achievable target groundwater elevations near streams that allow for operational flexibility over a range of climate and hydrologic variability. Based on input from the work group, the Advisory Committee, and GSA Board, it was decided that MO values at RMP locations should maintain the observed average dry-season surface water depletion from pumping that occurred during the years with available observations during 2004-2020. This time period is considered representative of average conditions, because it contains 8 normal years, 5 wet years, and 1 dry year. **Table 4-8** lists the MOs for each RMP.

4.10.3.1 Method for Setting Measurable Objectives

A description of the specific methodology used for developing the MOs for the depletion of interconnected surface water sustainability indicator is provided in **Appendix 4-C**.

4.10.3.2 Interim Milestones

Interim milestones are intended to show how MOs will be achieved during the initial 20-year implementation period of the GSP. As the MOs are set at the average groundwater elevations during recent years (average of 2004–2020), interim milestones are identical to the groundwater levels associated with the MOs.

4.10.4 Undesirable Results

4.10.4.1 Criteria for Defining Undesirable Results

The depletion of interconnected surface water undesirable result is defined using groundwater levels as a proxy. Per the GSP Regulations, the description of undesirable results is based on a quantitative description of the combination of MT exceedances that cause significant and unreasonable effects in the Subbasin. For the Subbasin the specific groundwater conditions that constitute an undesirable result is:

Undesirable result occurs if MTs are exceeded at 40 percent of RMP wells during drought years and 10 percent of RMP wells during non-drought years and are entirely or partially attributable to groundwater pumping under the jurisdiction of the GSA.

The different percentages associated with drought years versus non-drought years were selected to help address the concerns expressed by some work group and Advisory Committee members that setting MTs at levels experienced during significant droughts could be

detrimental to aquatic species and associated habitat if allowed during future normal and wet years. Placing the different weights on drought and non-drought years helps address the expressed concern by ensuring that during normal/wet years the higher levels of estimated streamflow depletion from 2014-2016 are avoided.

Exceedances of MTs at a single RMP will require investigation to determine if any actions should be considered to avoid potential future onset of undesirable results, as in **Section 4.10.4.2**.

4.10.4.2 Potential Causes of Undesirable Results

Many factors influence surface water flows and interconnected surface water depletion which are outside the control of the GSA. For undesirable results to occur, the cause of surface water depletion must be related to the extraction of groundwater or other project and management actions implemented for groundwater sustainability, and not due to lack of precipitation during periods of prolonged drought or surface water diversions under the jurisdiction of the SWRCB.

Undesirable results may occur in the future to GDEs if groundwater-level declines near creeks are caused by groundwater pumping or if there is reduced recharge in the shallow aquifer system.

Prior to determining if undesirable results are occurring based on MT exceedances, the GSA would need to assess whether potential causes of exceedances are related to depletions associated with groundwater pumping or other activities not under the jurisdiction of the GSA. Staff is currently working with staff of the SWRCB to develop a description of a coordination process with SWRCB to address this. The goal of the coordination process is to assess whether potential causes of exceedances are related to depletions (entirely or in part) associated with groundwater conditions under the jurisdiction of the GSA or other activities not under the jurisdiction of the GSA and will include (1) information and data sharing; (2) conferring on potential causes of exceedances; and (3) improving the SMC as needed based on outcomes and new information.

Additionally, in order to respond prior to the onset of undesirable results the following actions would be implemented if a MT is exceeded at a single RMP that does not trigger an undesirable result:

- Review available data from full monitoring network (that is, non-RMP monitoring wells) to assess potential scale of areas exhibiting declines
- Assess whether exceedance is climate-related
- Review of any known or potential changes in groundwater pumping patterns for example, new wells brought online, changes in land/water use)
- Consider whether additional RMPs are needed
- Information sharing with other stakeholder, as appropriate

4.10.4.3 Effects on Beneficial Users and Land Use

If depletions of interconnected surface water were to reach undesirable results, adverse effects could include the reduced ability of the streamflows to meet instream flow requirements for local fisheries and critical habitat, including GDEs, in the Subbasin. Reduction of streamflow directly reduces the amount of suitable rearing habitat for fisheries by reducing the amount of wetted area, stream depth, flow velocity, cover, and dissolved oxygen. Reduced flow can also result in increased water temperature. In extreme conditions, dewatering of stream reaches eliminates the ability of fish to move to more suitable areas and can cause mortality. Reduced surface flows can also negatively affect permitted surface water diversions. Riparian vegetation GDEs can also be impacted by lowered groundwater levels in the vicinity of interconnected surface water within the Subbasin. Consideration of these effects was included as part of SMC development.

4.10.5 Consideration of Public Trust Resources

While SGMA does not require the plan to address California's public trust doctrine, a 2018 California Court of Appeal ruling found that groundwater pumping that directly reduces the flow or volume of water in a navigable waterway (and tributaries that are known to supply those navigable waters) may violate the public trust doctrine under certain fact-specific circumstances where public trust resources are adversely affected. The public trust doctrine does not apply to groundwater itself. Rather, the public trust doctrine may apply if extraction of groundwater adversely impacts a navigable waterway or tributary to a navigable waterway to which the public trust doctrine does apply (Environmental Law Foundation et al. v. State Water Resources Control Board [2018], 26 Cal.App.5th 844). As described elsewhere in this plan, to the extent that tributaries in the Subbasin flow into the Russian River, the plan analyzes potential impacts on interconnected surface water (ISW), GDEs, and public trust resources.

The public trust doctrine is the principle that the government holds in trust designated resources for the benefit of the people. Public trust uses can include commerce, recreation, and fishing in navigable waters, as well as wildlife habitat and recreation. It is a balancing doctrine that protects these resources to the extent feasible and includes a reasonable consideration of public trust resources in specific governmental decision-making processes. Here, the plan reasonably considers and incorporates public trust resources protection to the extent feasible; the plan accomplishes this by using an inclusive public process and using the best data and best available science.

The various beneficial uses and users of surface waters (including known water rights holders, ecological surface water users and uses, and recreational surface water users) were addressed when setting the ISW depletion SMC. This is a reasonable review of all uses and users in an attempt to balance all interests that must be considered. GSAs under SGMA are "charged with procedural and substantive obligations designed to balance the needs of the various stakeholders in groundwater in an effort to preserve [groundwater], and replenish [it] to the extent possible" (Environmental Law Foundation et al. v. State Water Resources Control Board, citing CWC Sections 10721[u], [v, [x][6]; 10723.2; 10725.2; 10725.4; 10726.2; 10726.4;

10726.5). This is not an assessment about what constitutes a reasonable and beneficial use under Article X, Section 2 of the California Constitution. The SMC for depletion of ISW are developed as described in **Section 4.10** and in **Appendix 4-D**, including public information about critical habitat, locations of ISW derived from best available data, and available information about known water rights holders.

This plan specifically recognizes the importance of protecting environmental public trust resources. As described in the introduction of **Section 4.10**, the GSA sought expert advice regarding the best available science and applied for and received grant funding through Proposition 68 to convene and facilitate a Practitioners Working Group. The purpose of this working group, as described in **Section 4.10**, was to help develop the SMC for the consideration of ISW to avoid or reduce potential depletion. This process involved the reasonable analysis and consideration of public trust resources.

Another example of the GSA's efforts to consider public trust resources is a second Practitioners Working Group that was convened to assist in identifying the GDEs, including fish and wildlife that use streamflows that could be affected by the potential depletion of ISW as applicable in some parts of the Subbasin. This working group included representatives from National Marine Fisheries Service, California Department of Fish and Wildlife, TNC, San Francisco Estuary Institute, Permit Sonoma, Sonoma County Agricultural Preservation and Open Space District, Sonoma Ecology Center, and The Laguna de Santa Rosa Foundation.

As described in **Section 3.2.6**, available information to map ISW is limited in the Subbasin, and is further complicated by challenges in quantifying surface water depletion due to pumping (described in **Section 4.10**). The current monitoring network for ISW does include some data gaps, which are described in **Section 5.4.2**. The plan proposes an aggressive adaptive management plan and methodology, described in **Appendix 4-D**, which uses existing information to avoid adverse effects on public trust resources and makes adjustments as new information and data become available. The implementation plan (**Sections 7.2.4.1** and **7.2.4.2**) describes how these data gaps will be filled and how the monitoring network and mapping will be improved within the first 5 years of implementation. This shows that the GSA has a proactive approach to fully understanding and taking steps to identify and avoid adverse effects on public trust resources. The GSA has taken steps to make use of the best available science, and additionally taken steps to make additional information and data available to update the best available science as soon as is feasible. Specifically, as it has in the past, the GSA will apply to DWR for the next round of available funding to support GSP implementation, including funding to further analyze and address data gaps, ISW, and public trust resources.

Section 5: Monitoring Networks
Groundwater Sustainability Plan for Santa Rosa Plain Groundwater Subbasin

Table of Contents

5 MONITORING NETWORKS 5-1

5.1 Monitoring Network Objectives 5-1

5.2 Description of Monitoring Networks for Groundwater Sustainability Plan Implementation 5-1

5.2.1 Groundwater-level Monitoring Network 5-1

5.2.2 Groundwater Quality Monitoring Network 5-4

5.2.3 Surface Water Monitoring Network 5-14

5.2.4 Land Surface Elevation Monitoring Network 5-17

5.3 Representative Monitoring Point Networks 5-17

5.3.1 Representative Monitoring Point Network for Chronic Lowering of Groundwater Levels 5-17

5.3.2 Representative Monitoring Point Network for Degraded Water Quality 5-18

5.3.3 Representative Monitoring Point Network for Depletion of Interconnected Surface Water 5-24

5.3.4 Representative Monitoring Point Network for Land Subsidence 5-24

5.4 Assessment and Improvement of Monitoring Networks 5-24

5.4.1 Assessment and Identification of Data Gaps – Groundwater-level Monitoring Network 5-27

5.4.2 Assessment and Identification of Data Gaps – Surface Water Monitoring Network 5-33

Tables

Table 5-1a. Groundwater-level Monitoring Network for GSP Implementation – Shallow Aquifer System 5-8

Table 5-1b. Groundwater-level Monitoring Network for GSP Implementation – Deep Aquifer System 5-12

Table 5-2. Surface Water Monitoring Network 5-15

Table 5-3a. Representative Monitoring Point Network for Chronic Lowering of Groundwater Levels - Shallow Aquifer System 5-21
Table 5-3b. Representative Monitoring Point Network for Chronic Lowering of Groundwater Levels - Deep Aquifer System 5-22
Table 5-4. Representative Monitoring Point Network for Depletion of Interconnected Surface Water 5-26

Figures

Figure 5-1a. Groundwater-level Monitoring Network for Groundwater Sustainability Plan Implementation – Shallow Aquifer System 5-5
Figure 5-1b. Groundwater-level Monitoring Network for Groundwater Sustainability Plan Implementation – Deep Aquifer System 5-6
Figure 5-1c. Subbasin Boundary Groundwater-level Monitoring Network 5-7
Figure 5-2. Surface Water Monitoring Network 5-16
Figure 5-3a. Representative Monitoring Point Network for Chronic Lowering of Groundwater Levels – Shallow Aquifer System 5-19
Figure 5-3b. Representative Monitoring Point Network for Chronic Lowering of Groundwater Levels – Deep Aquifer System 5-20
Figure 5-4. Representative Monitoring Point Network for Degraded Water Quality 5-23
Figure 5-5. Representative Monitoring Point Network for Depletion of Interconnected Surface Water 5-25
Figure 5-6a. Preliminary Data Gap Assessment Groundwater-level Monitoring Network – Shallow Aquifer System 5-28
Figure 5-6b. Preliminary Data Gap Assessment Groundwater-level Monitoring Network – Deep Aquifer System 5-29
Figure 5-6c. Preliminary Data Gap Assessment – Subbasin Boundary Groundwater-level Monitoring Network 5-31
Figure 5-7. Preliminary Data Gap Assessment – Surface Water Monitoring Network 5-34
Figure 5-8. Shallow Groundwater-level and Surface Water Monitoring Networks and Groundwater Dependent Ecosystems 5-35

Appendices

Appendix 5-A. Monitoring Protocols

Appendix 5-B. Comparative Hydrographs – Chronic Lowering of Groundwater Levels Representative Monitoring Points

5 MONITORING NETWORKS

This section describes the monitoring networks that are planned in the Subbasin and contributing watershed areas for implementation of the GSP and how the existing monitoring networks described in **Section 2.5** were evaluated and refined. RMPs, for which SMC are set, are identified in this section and the processes used to select suitable RMPs, along with monitoring objectives, are described. This section also presents an assessment of the monitoring networks identified for GSP implementation, including identification of data gaps and improvements to the monitoring networks.

5.1 Monitoring Network Objectives

SGMA regulations require monitoring networks be developed to promote the collection of data of sufficient quality, frequency, and spatial distribution to characterize groundwater and related surface water conditions in the Subbasin, and to evaluate changing conditions that occur during implementation of the GSP. Monitoring networks should accomplish the following:

- Demonstrate progress toward achieving MOs described in the GSP.
- Monitor impacts on the beneficial uses and users of groundwater.
- Monitor changes in groundwater conditions relative to MOs and MTs.
- Quantify annual changes in water-budget components.

Specific objectives for each monitoring network in the Subbasin are described in **Sections 5.2 through 5.4**. To ensure the quality and consistency of the data collected, monitoring protocols have been established and are presented in **Appendix 5-A**.

5.2 Description of Monitoring Networks for Groundwater Sustainability Plan Implementation

The monitoring networks included in this section are based on existing monitoring networks described generally in **Section 2.5** (Existing Monitoring Programs and Networks). To relate monitoring stations to sustainability indicators, monitoring networks are described in **Sections 5.2.1** through **5.2.4** for each of the information types that are needed to evaluate the sustainability indicators described in **Section 4**.

5.2.1 Groundwater-level Monitoring Network

The existing groundwater-level monitoring network described in **Section 2.5** was evaluated in accordance with SGMA regulations and guidelines, with the monitoring network objectives in mind, and refined into the Groundwater-level Monitoring Network for GSP Implementation (GSP Implementation Network).

SGMA requirements and guidance for monitoring are described in the GSP Regulations and DWR's BMPs for Monitoring Protocols, Standards, and Sites (DWR 2016b) and Monitoring

Networks and Identification of Data Gaps (DWR 2016c). These include the following data and reporting standards and guidance related to groundwater levels:

- Well location, accurate to within 30 feet
- Elevation of the ground surface and reference point, accurate to within 0.5 foot
- Field measurements measured and reported to accuracy of 0.1 foot
- Description of the well type (for example, public supply, irrigation, domestic, monitoring, or other type of well) and whether the well is active or inactive
- Construction information (casing perforations, borehole depth, and total well depth)
- Well completion reports, if available, from which the names of private owners have been redacted
- Identification of principal aquifers monitored
- Selection of aquifer-specific wells and avoidance of wells that are screened across more than one aquifer
- Active water supply wells (for example, agricultural or municipal wells) that can be used temporarily until either dedicated monitoring wells can be installed or an existing well can be identified that meets the required criteria
- Any active water supply wells used for monitoring, screened across a single water-bearing unit, and care must be taken to ensure that pumping drawdown has sufficiently recovered before collecting data from a well

Specific objectives for the Groundwater-level Monitoring Network are to provide a sufficient number of monitoring sites with adequate spatial distribution, monitoring frequency, and data quality to achieve the following:

- Produce seasonal maps of potentiometric surfaces for the shallow and deep aquifer systems throughout the Subbasin that clearly identify changes in groundwater-flow direction and gradient.
- Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features.
- Demonstrate groundwater occurrence, flow directions, and hydraulic gradients across basin boundaries, when combined with data from adjacent basins.
- Identify short-term and long-term trends and seasonal fluctuations when combined with historical data.

- Track water levels relative to MTs and MOs.

- Support water-budget calculations and calibration of the groundwater model for the Subbasin.

5.2.1.1 Rationale for Selection of Groundwater Sustainability Plan Implementation Groundwater-level Monitoring Network Sites

The following criteria were used for assessment and initial screening of the entire existing Groundwater-level Monitoring Network to identify which wells are suitable for inclusion into the GSP Implementation Network:

- Well Construction: Wells with known complete construction information (that is, total depth, casing diameter, depth of screened interval[s]) are preferred and wells to be included in the GSP Implementation Network should be screened within a single aquifer system. For wells selected for inclusion into the GSP Implementation Network that have incomplete construction information, attempts will be made to ascertain the information through records searches of applicable databases or records requests directly to the well owner, or applying for video-logging services through the DWR's Technical Support Services (TSS) program.

- Historical Data Record: Wells with complete data records of 10 years or longer that are part of a current monitoring program are preferred. In some cases, for wells where monitoring has been discontinued in the past few years (2017 or later), efforts are being made to reinstate monitoring as a part of GSP implementation.

- Well Type: Dedicated monitoring wells are preferred. Secondary preference is given to inactive supply wells and the lowest preference is given to active supply wells (that is, domestic, irrigation, or municipal). For active supply wells included in the GSP Implementation Network, special precautions will be taken to ensure representative measurements are collected as described in **Appendix 5-A**, **Monitoring Protocols**. Environmental monitoring wells were not considered for the GSP Implementation Network because they are typically privately owned and somewhat temporary in nature.

- Spatial Coverage: Monitoring sites were selected to maximize horizontal and vertical coverage of the entire Subbasin. Special considerations were given to areas near streams and areas of uncertainty such as near faults or basin boundaries. Where available, wells outside of the Subbasin, but within the contributing watershed areas, are included in the GSP Implementation Network.

- Well Ownership: Wells owned by a GSA member agency are preferred. Privately owned wells are also included in the GSP Implementation Network to maximize spatial coverage of the Subbasin.

5.2.1.2 Description of Refined Groundwater-level Monitoring Network for Groundwater Sustainability Plan Implementation

The GSP Implementation Network consists of a total of 96 wells within the contributing watershed areas, including 85 wells within the Subbasin itself (**Figures 5-1a** and **5-1b**). For the shallow aquifer system there are a total of 61 wells within the contributing watershed areas, including 57 wells within the Subbasin itself. Of the 61 shallow (less than 200 feet deep) wells in the GSP Implementation Network, 41 are dedicated monitoring wells (including municipal test wells), 2 are municipal supply wells, and 18 are private supply wells.

For the deep aquifer system there are a total of 35 wells within the contributing watershed areas, including 28 wells within the Subbasin itself. Of the 35 deep (greater than 200 feet deep) wells in the GSP Implementation Network, 15 are dedicated monitoring wells (including municipal test wells), 9 are municipal supply wells, and 11 are private supply wells. Details for wells in the GSP Implementation Network, including well construction, well use, and length of monitoring record are presented in **Tables 5-1a** and **5-1b**.

Monitoring frequencies for wells in the GSP Implementation Network are shown in **Tables 5-1a** and **5-1b**. Of the 96 wells in the GSP Implementation Network, 43 are high-frequency monitoring points with water-level data collected at least daily. Of the 43 high-frequency monitoring points, 22 are part of the shallow aquifer system monitoring network and 21 are part of the deep aquifer system monitoring network. The remaining 53 wells are monitored semiannually, with a subset of the wells monitored monthly.

5.2.1.3 Subbasin Boundary Groundwater-level Monitoring Network

To monitor boundary conditions, a Subbasin Boundary Groundwater-Level Monitoring Network (Boundary Network) has been developed. The Boundary Network includes wells that are outside of the Subbasin but within the contributing watershed areas included in the GSP Implementation Network and additional wells outside of the contributing watershed areas in adjacent groundwater basins and subbasins (**Figure 5-1c**). This network consists of 16 wells, including 8 wells in the Wilson Grove Formation Highlands Basin, 1 well in the Petaluma Valley Basin, 3 wells in the Rincon Valley Subbasin, 1 well in the Healdsburg Area Subbasin, 1 well in the Alexander Area Subbasin, and 2 wells outside of the defined basin/subbasin areas. Details for wells in the Boundary Network, including well construction, well use, monitoring frequency, and length of monitoring record are presented in **Tables 5-1a** and **5-1b**.

5.2.2 Groundwater Quality Monitoring Network

As described in **Section 4.8.2.1**, the Groundwater Quality Monitoring Network for the Subbasin is based on existing supply well monitoring programs. The GSA has identified sets of supply wells that are currently monitored (or are proposed to be monitored in the future) for various groundwater constituents and supply uses such as drinking water and irrigation water. Because these supply wells are monitored under different programs and may have different required sampling schedules (even under the same program), no one set of constituents will be sampled in all wells.

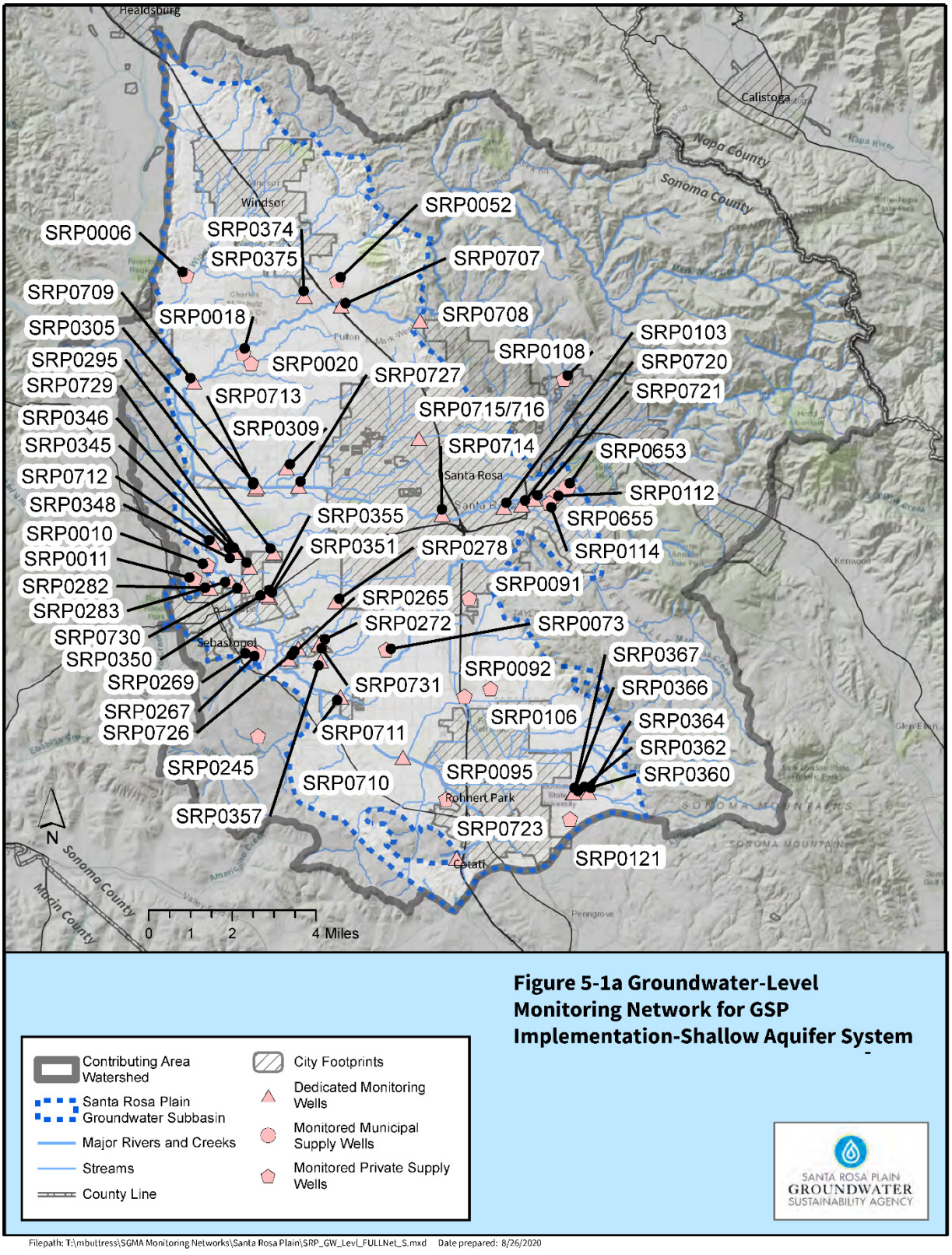


Figure 5-1a. Groundwater-level Monitoring Network for Groundwater Sustainability Plan Implementation – Shallow Aquifer System

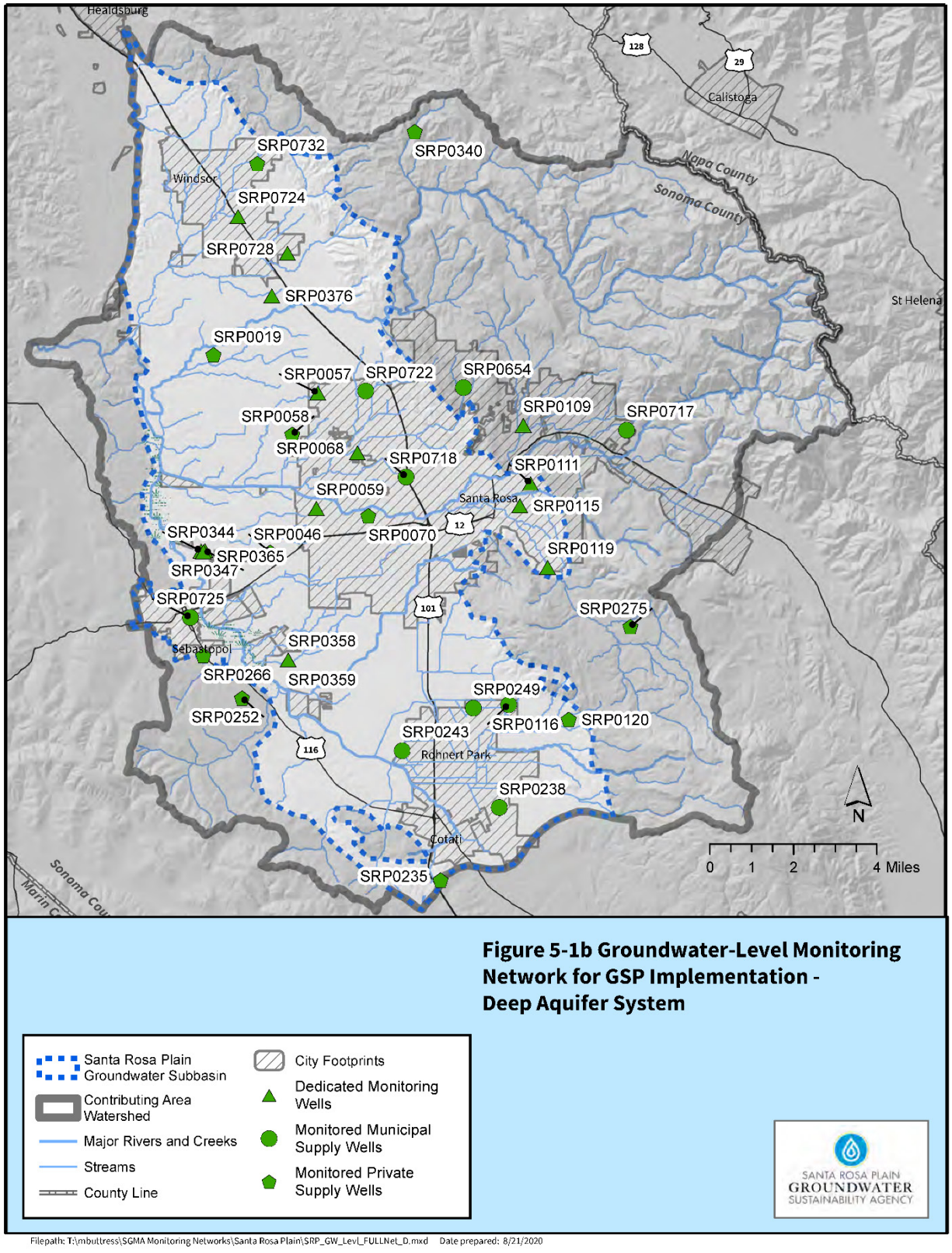


Figure 5-1b. Groundwater-level Monitoring Network for Groundwater Sustainability Plan Implementation – Deep Aquifer System

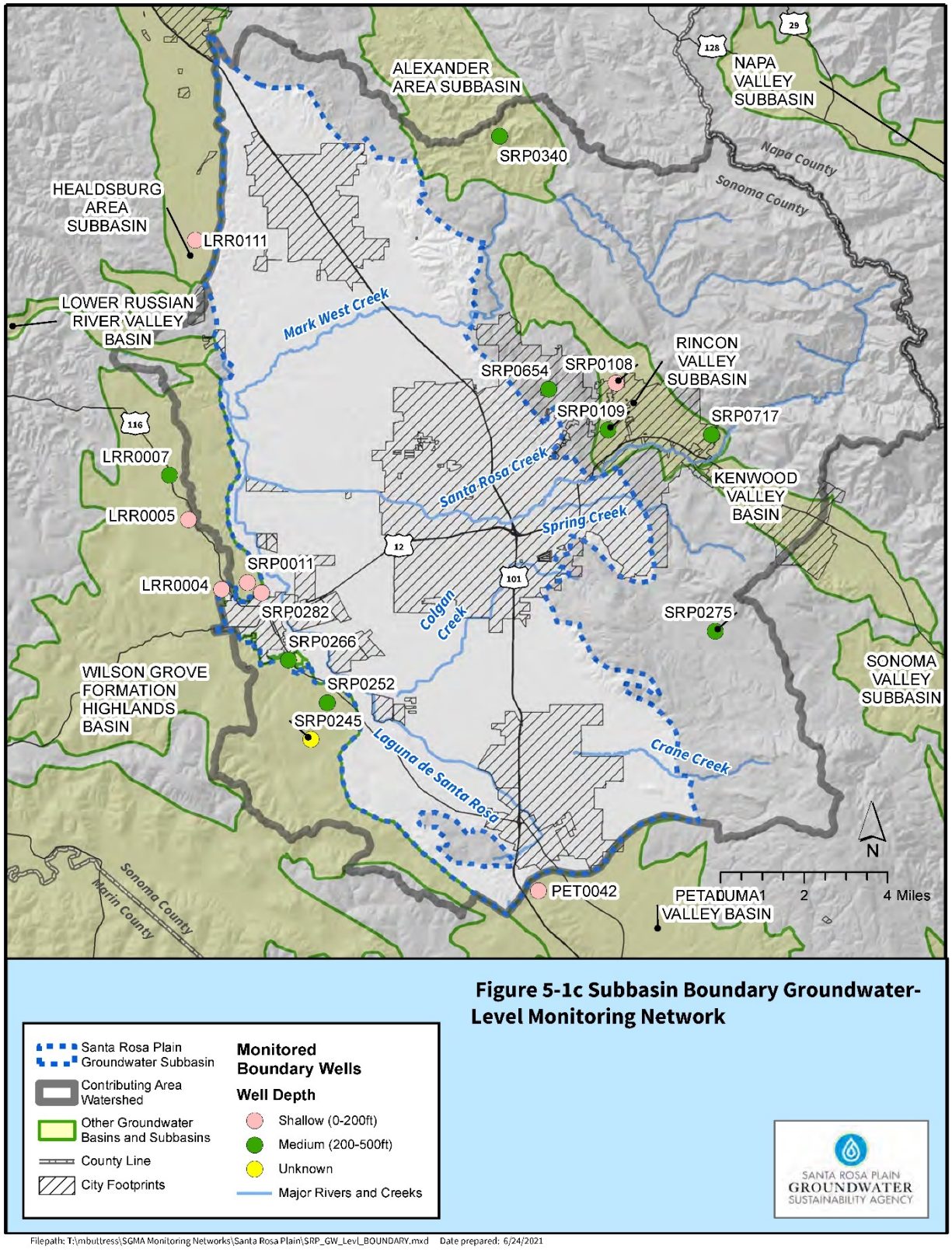


Figure 5-1c. Subbasin Boundary Groundwater-level Monitoring Network

Table 5-1a. Groundwater-level Monitoring Network for GSP Implementation - Shallow Aquifer System

Data Management System ID	Data Management System ID					Data Record	Data Record		
Station Name	Station Number	Type of Well	Well Depth[a] (feet)	Well Depth Category	Screened Interval(s)[a] (feet)	Data From	Data Until	Monitoring Frequency	Additional ID Information
Monitored Wells Inside the Santa Rosa Plain Groundwater Subbasin									
Sonoma Water Wells									
SRP0345	SCWA_OCC_MW_02	Observation	97	Shallow (0-200 feet)	60-80	3/27/2009	Present	Sub-Daily	
SRP0346	SCWA_OCC_MW_03	Observation	95	Shallow (0-200 feet)	67-87	7/16/2008	Present	Sub-Daily	
SRP0348	SCWA_OCC_MW_05	Observation	44	Shallow (0-200 feet)	30-50	6/28/2010	Present	Sub-Daily	
SRP0350	SCWA_SEB_MW_02	Observation	200	Shallow (0-200 feet)	170-190	6/28/2010	Present	Sub-Daily	
SRP0351	SCWA_SEB_MW_03	Observation	200	Shallow (0-200 feet)	164-190	6/1/2010	Present	Sub-Daily	
SRP0355	SCWA_SEB_MW_07	Observation	90	Shallow (0-200 feet)	70-90	2/14/2008	Present	Sub-Daily	
SRP0357	SCWA_TODD_RED	Observation	80	Shallow (0-200 feet)	60-80	6/1/1977	Present	Sub-Daily	
SRP0360	SCWA_Copeland_A-1	Observation	25	Shallow (0-200 feet)	19.88-24.88	5/5/2014	Present	Sub-Daily	
SRP0362	SCWA_Copeland_B-2	Observation	24	Shallow (0-200 feet)	17.56-22.56	12/27/2013	Present	Sub-Daily	
SRP0364	SCWA_Copeland_C-5	Observation	26	Shallow (0-200 feet)	11.4-26.4	5/5/2014	Present	Sub-Daily	
SRP0366	SCWA_Copeland_A-2	Observation	37	Shallow (0-200 feet)	20-35	5/15/2014	Present	Sub-Daily	
SRP0367	SCWA_Copeland_A-3	Observation	122	Shallow (0-200 feet)	105-120	5/15/2014	Present	Sub-Daily	
SRP0374	SCWA_Airport_MW_01	Observation	60	Shallow (0-200 feet)	40-60	4/25/2011	Present	Sub-Daily	383882N1228050W002, SRP-E07-01
SRP0375	SCWA_Airport_MW_02	Observation	140	Shallow (0-200 feet)	120-140	4/29/2011	Present	Sub-Daily	385117N1227863W001, SRP-E07-02
SRP0707	SRP-F07-04_Fulton	Observation	50.5	Shallow (0-200 feet)	30-50	11/21/2019	Present	Sub-Daily	Mark West Creek at Fulton Road
SRP0708	SRP-H07-01_Mark West	Observation	25.5	Shallow (0-200 feet)	15-25	11/21/2019	Present	Sub-Daily	Mark West Creek at Mark West Springs Road
SRP0709	SRP-C09-01_River Road	Observation	33.5	Shallow (0-200 feet)	23-33	11/25/2019	Present	Sub-Daily	Mark West Creek at River Road
SRP0710	SRP-H18-02_Stony	Observation	45.5	Shallow (0-200 feet)	35-45	11/21/2019	Present	Sub-Daily	Laguna de Santa Rosa at Stony Point Road

Data Management System ID	Data Management System ID					Data Record	Data Record		
Station Name	Station Number	Type of Well	Well Depth[a] (feet)	Well Depth Category	Screened Interval(s)[a] (feet)	Data From	Data Until	Monitoring Frequency	Additional ID Information
SRP0711	SRP-F16-01_Llano	Observation	45.5	Shallow (0-200 feet)	35-45	11/25/2019	Present	Sub-Daily	Colgan Creek at Llano Road
SRP0712	SRP-C13-03_Sanford	Observation	48.5	Shallow (0-200 feet)	28-48	11/25/2019	Present	Sub-Daily	Laguna de Santa Rosa at Occidental Road
SRP0713	SRP-D11-02_Willow	Observation	45.5	Shallow (0-200 feet)	25-45	11/25/2019	Present	Sub-Daily	Santa Rosa Creek at Willowside Road
SRP0714	SRP-H12-01_Pierson	Observation	51.5	Shallow (0-200 feet)	41-51	11/25/2019	Present	Sub-Daily	Santa Rosa Creek at Pierson St.
SRP0715	SRP-H10-04_Hardies	Observation	40.5	Shallow (0-200 feet)	30-40	11/25/2019	Present	Sub-Daily	Paulin Creek at Hardies Ln.
SRP0716	SRP-H10-04s_Hardies	Observation	20.5	Shallow (0-200 feet)	15-20	11/25/2019	Present	Sub-Daily	Paulin Creek at Hardies Ln - Shallow
City of Santa Rosa Wells									
SRP0103	SRP-J12-02	Observation	200	Shallow (0-200 feet)	130-180	11/9/2011	Present	Sub-Daily	DOYLE PARK
SRP0265	383862N1227919W001	Observation	35	Shallow (0-200 feet)	10-34	5/23/2007	10/10/2019	Semiannually	SRP-05, RECMW101
SRP0272	383913N1227789W001	Observation	40	Shallow (0-200 feet)	?	5/23/2007	10/10/2019	Semiannually	SRP-13, RECMW103
SRP0278	384064N1227713W001	Observation	32	Shallow (0-200 feet)	8-30	5/23/2007	10/14/2019	Semiannually	SRP-06, RECMW104
SRP0283	384130N1228169W001	Observation	42	Shallow (0-200 feet)	10-40	5/29/2007	10/14/2019	Semiannually	SRP-08, RECMW108
SRP0295	384232N1227996W001	Observation	45	Shallow (0-200 feet)	11-45	5/24/2007	10/11/2019	Semiannually	SRP-07, RECMW105
SRP0305	384456N1228066W001	Observation	42	Shallow (0-200 feet)	10-40	5/24/2007	10/14/2019	Semiannually	SRP-10, RECMW110
SRP0309	384525N1227929W001	Observation	42	Shallow (0-200 feet)	10-40	5/24/2007	10/7/2019	Semiannually	SRP-11, RECMW111
SRP0653		Municipal	160	Shallow (0-200 feet)	?	10/12/1949	11/8/2019	Monthly	PETER SPRING WELL
SRP0655		Municipal	208	Shallow (0-200 feet)	50-190	10/1/1948	11/8/2019	Monthly	CARLEY WELL
SRP0720		Observation	115	Shallow (0-200 feet)	?	4/1/2005	11/8/2019	Monthly	HOEN
SRP0721		Observation	150	Shallow (0-200 feet)	?	4/1/2005	11/8/2019	Monthly	PATIO
SRP0723	RECMW114	Observation	37.5	Shallow (0-200 feet)	?	5/30/2007	10/10/2019	Semiannually	RECMW114
SRP0726	RECMW102	Observation	36.3	Shallow (0-200 feet)	?	5/23/2007	10/10/2019	Semiannually	RECMW102

Data Management System ID	Data Management System ID					Data Record	Data Record		
Station Name	Station Number	Type of Well	Well Depth[a] (feet)	Well Depth Category	Screened Interval(s)[a] (feet)	Data From	Data Until	Monitoring Frequency	Additional ID Information
SRP0727	RECMW112	Observation	27.9	Shallow (0-200 feet)	?	5/29/2007	10/11/2019	Semiannually	RECMW112
SRP0729	RECMW106	Observation	47	Shallow (0-200 feet)	?	5/24/2007	10/7/2019	Semiannually	RECMW106
SRP0730	RECMW107	Observation	29.1	Shallow (0-200 feet)	?	5/30/2012	10/11/2019	Semiannually	RECMW107
SRP0731	RECMW115	Observation	90.3	Shallow (0-200 feet)	?	5/23/2007	10/10/2019	Semiannually	RECMW115
Volunteer/Other Wells									
SRP0006	SRP-B06-02	Unknown	145	Shallow (0-200 feet)	?	11/1/1989	3/22/2017	Semiannually	08N09W22R001M
SRP0010	SRP-C13-02	Unknown	110	Shallow (0-200 feet)	?	4/26/2012	12/19/2019	Semiannually	07N09W26P001M
SRP0018	SRP-D08-01	Unknown	89	Shallow (0-200 feet)	?	3/16/1976	12/9/2019	Semiannually	08N09W36N001M
SRP0020	SRP-D08-03	Unknown	110	Shallow (0-200 feet)	?	3/26/1970	12/9/2019	Semiannually	07N09W01C001M
SRP0052	SRP-F06-01	Unknown	95	Shallow (0-200 feet)	?	11/8/1989	12/9/2019	Semiannually	08N08W29C003M
SRP0073	SRP-G15-01	Unknown	80	Shallow (0-200 feet)	?	11/3/1989	3/21/2017	Semiannually	06N08W04Q001M
SRP0091	SRP-I14-03	Unknown	205	Shallow (0-200 feet)	?	11/9/1989	12/19/2019	Semiannually	07N08W35K001M
SRP0092	SRP-I16-01	Unknown	120	Shallow (0-200 feet)	?	11/9/1989	12/19/2019	Monthly	06N08W11P001M
SRP0095	SRP-I19-01	Unknown	82	Shallow (0-200 feet)	?	11/3/1989	3/20/2017	Semiannually	06N08W27H001M
SRP0106	SRP-J16-01	Unknown	90	Shallow (0-200 feet)	?	10/3/1989	3/11/2020	Semiannually	06N08W12M001M
SRP0112	SRP-K12-01	Unknown	85	Shallow (0-200 feet)	?	11/8/1989	12/19/2019	Semiannually	07N07W19B001M
SRP0114	SRP-K12-03	Unknown	68	Shallow (0-200 feet)	?	11/8/1989	12/19/2019	Semiannually	07N07W19F002M
SRP0121	SRP-L19-01	Unknown	150	Shallow (0-200 feet)	?	11/9/1989	11/26/2019	Monthly	06N07W30R001M
SRP0267	383882N1228050W001	Municipal	205	Shallow (0-200 feet)	113-193	10/24/2009	10/13/2019	Semiannually	SRP-14
SRP0269	383889N1228088W001	Unknown	160	Shallow (0-200 feet)	100-160	5/23/2009	10/13/2019	Semiannually	WGFH-08

Data Management System ID	Data Management System ID					Data Record	Data Record		
Station Name	Station Number	Type of Well	Well Depth[a] (feet)	Well Depth Category	Screened Interval(s)[a] (feet)	Data From	Data Until	Monitoring Frequency	Additional ID Information
Monitored Wells Outside of the Subbasin but Within the Contributing Watershed Area									
City of Santa Rosa Wells									
SRP0282	384101N1228271W001	Observation	61	Shallow (0-200 feet)	26-60	5/31/2012	10/14/2019	Semiannually	SRP-09, RECMW109
Volunteer/Other Wells									
SRP0011	SRP-C14-01	Unknown	167	Shallow (0-200 feet)	?	3/25/1970	12/19/2019	Semiannually	07N09W35D002M
SRP0108	SRP-K09-01	Unknown	100	Shallow (0-200 feet)	?	11/8/1989	12/19/2019	Semiannually	07N07W06H002M
SRP0245	383594N1228048W001	Unknown	?	Unknown	?	11/7/2011	10/15/2019	Semiannually	WGFH-01
Additional Boundary Wells Outside of the Contributing Watershed Area									
LRR0004	384111N1228448W001	Unknown	76	Shallow (0-200 feet)	?	4/26/2012	2/8/2021	Monthly	07N09W34F001M
LRR0005	384351N1228597W001	Unknown	160	Shallow (0-200 feet)	?	11/7/2011	10/28/2020	Semiannually	WGFH-06
LRR0111	SCWA_MW_02B	Observation	195	Shallow (0-200 feet)	175-195	9/13/2013	Present	Hourly	
PET0042	383076N1227041W001	Unknown	155	Shallow (0-200 feet)	30-150	2/3/1976	2/9/2021	Monthly	05N08W02H001M

[a] Well depth and screened interval(s) reported in feet below top-of-casing

Table 5-1b. Groundwater-level Monitoring Network for GSP Implementation - Deep Aquifer System

Data Management System ID / Station Name	Data Management System ID / Station Number	Type of Well	Well Depth[a] (feet)	Well Depth Category	Screened Interval(s)[a] (feet)	Data Record / Data From	Data Record / Data Until	Monitoring Frequency	Additional ID Information
Monitored Wells Inside the Santa Rosa Plain Groundwater Subbasin									
Sonoma Water Wells									
SRP0344	SCWA_OCC_MW_01	Observation	300	Medium (200-500 feet)	?	6/28/2010	Present	Sub-Daily	
SRP0347	SCWA_OCC_MW_04	Observation	300	Medium (200-500 feet)	?	6/28/2010	Present	Sub-Daily	
SRP0358	SCWA_TODD_BLUE	Observation	250	Medium (200-500 feet)	?	6/1/1977	Present	Sub-Daily	
SRP0359	SCWA_TODD_WHITE	Observation	257	Medium (200-500 feet)	237-257	8/2/1979	Present	Sub-Daily	
SRP0376	SCWA_Airport_MW_03	Observation	360	Medium (200-500 feet)	340-360	4/25/2011	Present	Sub-Daily	385117N1227863W002, SRP-E07-03
SRP0365	SCWA_OCC_MW_06	Observation		Unknown	?	9/14/2012	Present	Sub-Daily	
City of Santa Rosa Wells									
SRP0057	SRP-F09-02	Observation	360	Medium (200-500 feet)	200-350	5/20/2011	Present	Sub-Daily	NORTHWEST VILLAGE
SRP0059	SRP-F12-01	Observation	694	Medium (200-500 feet)	199-684	5/20/2011	Present	Sub-Daily	PLACE TO PLAY
SRP0119	SRP-L13-01	Observation	380	Medium (200-500 feet)	350-370	5/8/2012	Present	Sub-Daily	GALVIN
SRP0722		Municipal	275	Medium (200-500 feet)	?	11/6/2013	Present	Sub-Daily	W6 SHARON PARK
SRP0111	SRP-K11-01	Observation	660	Deep (>500 feet)	600-650	11/9/2011	Present	Sub-Daily	SLATER
SRP0115	SRP-K12-04	Observation	870	Deep (>500 feet)	500-860	4/22/2010	Present	Sub-Daily	MARTHA WAY
SRP0718		Municipal	817	Deep (>500 feet)	107-817	10/7/2013	Present	Sub-Daily	W3 FREEWAY
SRP0068	SRP-G11-01	Observation	694	Unknown	156-684	5/23/2011	Present	Sub-Daily	NORTHWEST COMMUNITY PARK
City of Rohnert Park Wells									
SRP0117	SRP-K19-01	Municipal	380	Medium (200-500 feet)	130-380	11/1/1991	3/14/2019	Daily	CASGEM ID: 383350N1226841W001, RP Well 37
SRP0107	SRP-J17-01	Municipal	462	Medium (200-500 feet)	302-462	9/1/1980	3/14/2019	Daily	CASGEM ID: 383694N1226960W001, RP Well 17
SRP0081	SRP-H18-01	Municipal	582	Deep (>500 feet)	258-582	3/1/1982	10/1/2017	Daily	CASGEM ID: 383544N1227271W001, RP Well 24
SRP0116	SRP-K17-01	Municipal	540	Deep (>500 feet)	297-540	12/1/1985	10/1/2017	Daily	CASGEM ID: 383706N1226803W001, RP Well 26
City of Sebastopol Wells									
SRP0725	Sebastopol Well #5	Municipal	528	Deep (>500 feet)	138-528	2/1/2007	Present	Sub-Daily	Sebastopol Well #5
Town of Windsor Wells									
SRP0724	Bluebird_Windsor	Observation	765	Deep (>500 feet)	695-745	6/16/2020	6/16/2020	Semiannually	BLUEBIRD WELL
SRP0728	Esposti_Windsor	Observation	670	Deep (>500 feet)	380-655	NM	NM	Semiannually	ESPOSTI PARK WELL
Volunteer/Other Wells									
SRP0019	SRP-D08-02	Unknown	1048	Deep (>500 feet)	?	3/16/1976	12/9/2019	Semiannually	08N09W36P001M
SRP0046	SRP-E13-01	Unknown	290	Medium (200-500 feet)	?	1/17/2012	9/21/2017	Semiannually	07N08W30K001M
SRP0058	SRP-F10-01	Unknown	220	Medium (200-500 feet)	?	11/1/1989	12/9/2019	Semiannually	07N08W08M001M

Data Management System ID Station Name	Data Management System ID Station Number	Type of Well	Well Depth[a] (feet)	Well Depth Category	Screened Interval(s)[a] (feet)	Data Record Data From	Data Record Data Until	Monitoring Frequency	Additional ID Information
SRP0070	SRP-G12-01	Unknown	360	Medium (200-500 feet)	?	12/20/1989	12/19/2019	Semiannually	07N08W21J001M
SRP0120	SRP-L17-01	Unknown	370	Medium (200-500 feet)	?	11/9/1989	12/19/2019	Semiannually	06N07W17G001M
SRP0235	383096N1227098W001	Domestic	419	Medium (200-500 feet)	118-418	6/12/2015	10/22/2019	Semiannually	St. John
SRP0732	Foothills_Windsor	Irrigation	350	Medium (200-500 feet)	160-350	6/16/2020	6/16/2020	Semiannually	Foothills of Windsor Well
Monitored Wells Outside of the Subbasin but Within the Contributing Watershed Area									
City of Santa Rosa Wells									
SRP0109	SRP-K10-01	Observation	470	Medium (200-500 feet)	390-460	11/9/2011	Present	Sub-Daily	MADRONE
SRP0654		Municipal	323	Medium (200-500 feet)	?	4/2/1997	11/8/2019	Monthly	LEETE WELL
SRP0717		Municipal	316	Medium (200-500 feet)	?	11/1/2014	Present	Sub-Daily	BRIGADOON
Volunteer/Other Wells									
SRP0252	383722N1227978W001	Unknown	220	Medium (200-500 feet)	?	5/23/2009	10/13/2019	Semiannually	WGFH-10
SRP0266	383868N1228151W001	Unknown	260	Medium (200-500 feet)	130-250	5/23/2009	10/13/2019	Semiannually	WGFH-11
SRP0275	383980N1226270W001	Unknown	254	Medium (200-500 feet)	234-254	11/9/1989	12/19/2019	Semiannually	
SRP0340	385690N1227238W001	Unknown	440	Medium (200-500 feet)	100-120, 260-440	5/17/2010	10/23/2019	Semiannually	AVAA-03
Additional Boundary Wells Outside the Contributing Watershed Area									
LRR0007	384505N1228683W001	Unknown	225	Medium (200-500 feet)	?	4/26/2012	2/4/2021	Monthly	07N09W16M001M

[a] Well depth and screened interval(s) reported in feet below top-of-casing

The following existing monitoring programs are included in the Groundwater Quality Monitoring Network:

- Public supply wells, regulated by the SWRCB DDW. Public drinking water supply wells are included in the Groundwater Quality Monitoring Network because they are routinely sampled to meet CCR Title 22 water quality reporting requirements as regulated by the SWRCB DDW. Title 22 analyses include arsenic, nitrate, and TDS, which are the Subbasin COCs. This dataset can be obtained from the SWRCB through the GAMA online portal.

- Monitoring wells, agricultural irrigation supply, and public drinking water supply wells are included in the water quality network in the SNMP (City of Santa Rosa 2013a). The MRP, regulated by the SWRCB, requires annual sampling and analysis of water quality constituents in a network of wells (Woodard & Curran 2020). The monitoring network includes two monitoring wells, three irrigation wells, and six public supply wells. The six public supply wells proposed for the MRP are already included in the DDW dataset described previously. Per the MRP, each of the wells is required to be sampled annually and analyzed for nitrate and TDS. The analytical datasets from the MRP wells will be available from the SWRCB through the GAMA online portal.

Existing and future water quality monitoring programs may be used to help collect data during GSP implementation and establish consistency with other programs. This includes the North Coast Water Board's dairy program that started in 2020 but has yet to upload groundwater quality data to publicly available databases. There are not currently any identified data gaps in the Groundwater Quality Monitoring Network. Additional water quality monitoring networks will be developed specifically for monitoring projects and management actions during GSP implementation.

5.2.3 Surface Water Monitoring Network

The surface water monitoring network in the Subbasin has been developed with the following objectives:

- Quantify inflow and outflow of surface water to and from the Subbasin
- Characterize spatial and temporal exchanges between surface water and groundwater
- Calibrate the tools and methods necessary to calculate depletions of surface water caused by groundwater extraction

There are nine active stream gages operated by the USGS and partner agencies located in the Subbasin and contributing watershed areas. The USGS gages provide a well-distributed stream monitoring network with data records extending back to between 1998 and 2006. Additional surface water monitoring stations include nine OneRain gages operated by Sonoma Water. Details for the stream gages including parameters measured and length of data record are included in **Table 5-2**. The locations of the stream gages are shown on **Figure 5-2**.

Table 5-2. Surface Water Monitoring Network

USGS ID	Location Description	Parameters Measured	Data Record From	Data Record Until	Continuous/ Seasonal[a]	Adjacent Shallow Monitoring Well
11466320	Santa Rosa Creek at Willowside Road near Santa Rosa, CA	Discharge, Stream Stage	12/10/1998	Present	Continuous	SRP0713
11466200	Santa Rosa Creek at Santa Rosa, CA	Discharge, Stream Stage	12/1/2001	Present	Seasonal	SRP0714
11466170	Matanzas Creek at Santa Rosa, CA	Discharge, Stream Stage	10/1/2004	Present	Seasonal	
11465660	Copeland Creek at Rohnert Park, CA	Discharge, Stream Stage	10/20/2006	Present	Seasonal	
11465680	Laguna de Santa Rosa at Stony Point Road near Cotati, CA	Discharge, Stream Stage	11/7/1998	Present	Continuous	SRP0710
11465690	Colgan Creek near Santa Rosa, CA	Discharge, Stream Stage	10/1/2006	Present	Seasonal	
11465700	Colgan Creek near Sebastopol, CA	Discharge, Stream Stage	11/8/1998	Present	Continuous	SRP0711
11465750	Laguna de Santa Rosa near Sebastopol, CA	Discharge, Stream Stage	11/19/1998	Present	Continuous	SRP0712
11466800	Mark West Creek near Mirabel Heights, CA	Discharge, Stream Stage	12/10/2005	Present	Continuous	
	Brush Creek at Badger Road	Stream Stage, Precipitation	2018	Present	Continuous	
	Brush Creek at Middle Fork Dam	Stream Stage, Water Temperature, Precipitation	2018	Present	Continuous	
	Linda Creek at Mark West Springs Road	Stream Stage	2018	Present	Continuous	
	Mark West Creek at Michele Way	Discharge, Stream Stage, Precipitation	2018	Present	Continuous	
	Piner Creek at Hopper Avenue	Stream Stage, Precipitation	2018	Present	Continuous	
	Spring Lake	Lake Stage, Water Temperature, Precipitation	2018	Present	Continuous	
	Spring Creek at Diversion	Stream Stage, Precipitation	2018	Present	Continuous	
	Matanzas Creek at Bennett Valley	Stream Stage, Precipitation	2018	Present	Continuous	
	Matanzas Reservoir	Lake Stage, Water Temperature, Precipitation	2018	Present	Continuous	
	Upper Copeland Creek	Stream Stage, Precipitation	2018	Present	Continuous	
	Mark West Creek at Porter Creek Road	Stream Stage, Precipitation	2018	Present	Continuous	

[a] Seasonal gages operate from October through April each water year

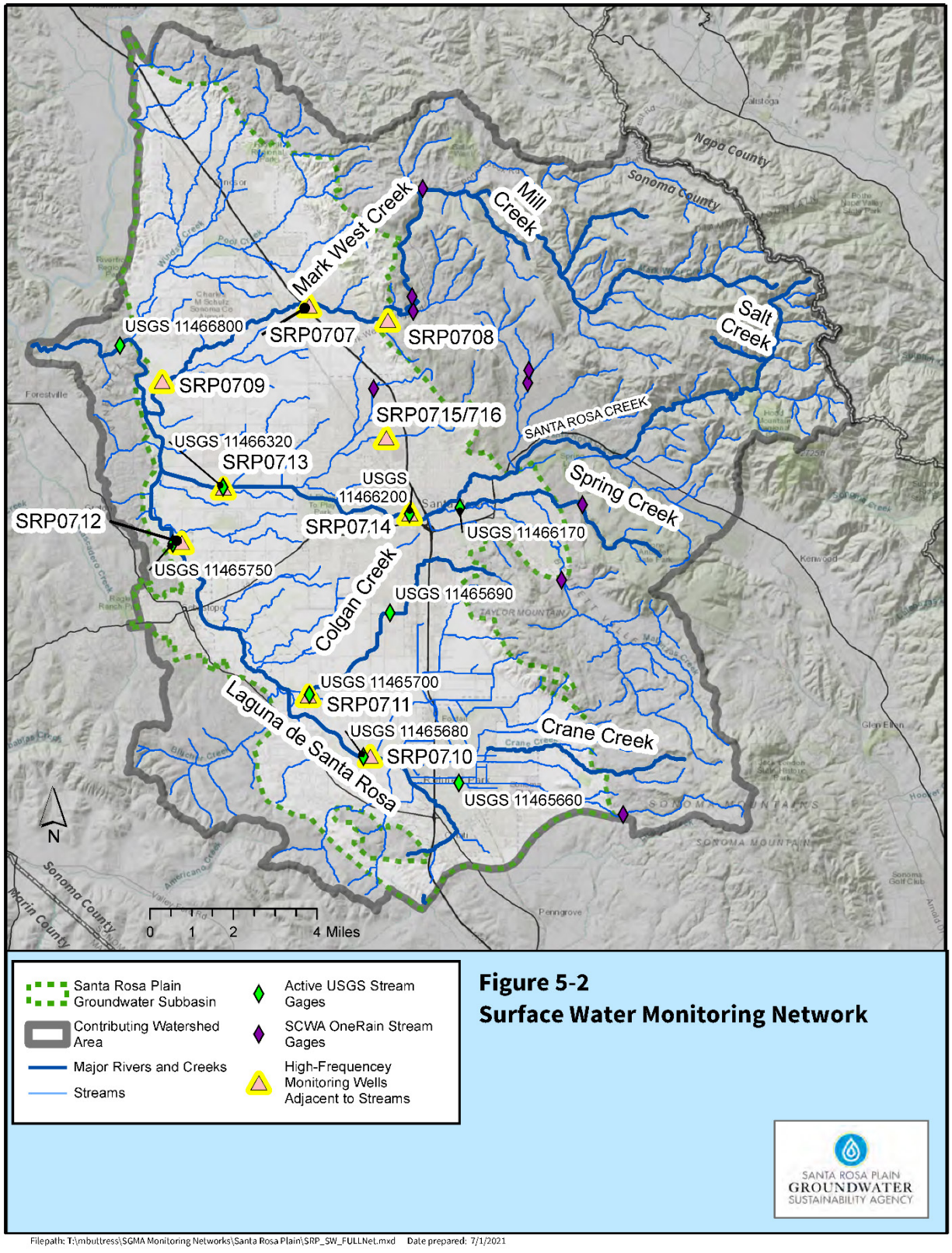


Figure 5-2. Surface Water Monitoring Network

In 2019, the GSA partnered with DWR's TSS program to install 10 shallow groundwater monitoring wells at 9 locations (one location has a cluster of two wells) adjacent to streams in the Subbasin to further the understanding of groundwater-surface water interaction. Five of these shallow monitoring wells were installed adjacent to active USGS gages (**Table 5-2; Figure 5-2)**. Details for the stream-adjacent shallow monitoring wells are shown in **Table 5-1a**.

5.2.4 Land Surface Elevation Monitoring Network

Available land surface elevation datasets for the Subbasin include measurements collected at one discrete GPS location since 2005 and InSAR satellite in most of the Subbasin since 2015. There are two additional GPS stations within the contributing watershed areas to the Subbasin. The GPS stations are monitored by the UNAVCO's PBO program and are identified as follows: P197, located on Highway 12 at Fulton Road; P196, located along Meacham Road south of Cotati; and P201, located on the ridgetop just north of Mark West Quarry.

5.3 Representative Monitoring Point Networks

As stated in the GSP Regulations, "Representative monitoring sites may be designated by an Agency as the point at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim milestones are defined" (23 CCR 354.36).

5.3.1 Representative Monitoring Point Network for Chronic Lowering of Groundwater Levels

The same data and reporting standards and guidance related to groundwater levels described for the Groundwater-level Monitoring Network for GSP Implementation in **Section 5.2.1** apply to the RMP Network for the Chronic Lowering of Groundwater Levels (Groundwater-level RMP Network). In addition, the following SGMA requirements and guidance from the GSP Regulations and DWR's BMPs for Monitoring Protocols, Standards and Sites and Monitoring Networks (DWR 2016b) and Identification of Data Gaps (DWR 2016c) apply to the selection of RMPs:

- "The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area" (23 CCR 354.36).
- "If RMPs are used to represent groundwater elevations from a number of surrounding monitoring wells, the GSP should demonstrate that each RMP's historical measured groundwater elevations, groundwater elevation trends, and seasonal fluctuations are similar to the historical measurements in the surrounding monitoring wells" (DWR 2016b).

Rationale for Selection of RMP Network for Chronic Lowering of Groundwater Levels Sites

Potential groundwater-level RMPs were assessed using the same criteria used for the selection of GSP Implementation Network sites, as described in **Section 5.2.1**. These criteria include well

type, well construction, well ownership, historical data record, and spatial coverage. In addition, the following criteria was used to assess potential groundwater-level RMPs:

- **Hydrograph Comparability:** Once potential RMPs were identified using the criteria listed above, groundwater-level hydrographs were plotted for the potential RMPs along with hydrographs for nearby wells with available data. Linear regression trend lines were plotted for spring groundwater levels. Potential RMPs were further evaluated by comparing overall trends and the magnitude of seasonal variations in groundwater levels with nearby wells to determine if the potential RMP could be considered representative of a given region. The comparative hydrographs for the potential RMPs and other nearby monitored wells are included in **Appendix 5-B** (**Figures 5-B-1** through **5-B-23**).

In some cases, newer wells (including new wells constructed specifically for SGMA compliance) with limited historical data records were selected as groundwater-level RMPs because they have favorable well type, well construction, well location, and/or well ownership attributes. For these wells, available historical data for nearby wells screened within the same aquifer system are plotted on the RMP comparative hydrographs (**Appendix 5-B**, **Figures 5-B-8**, **5-B-9**, **5-B-10**, **5-B-11**, **5-B-12**, and **5-B-17**) to help assess historical groundwater levels and trends in the vicinity of the newer RMP well.

Description of RMP Network for Chronic Lowering of Groundwater Levels

The Groundwater-level RMP Network for the shallow and deep aquifer systems is shown on **Figures 5-3a** and **5-3b**, respectively. This network consists of 14 wells screened within the shallow aquifer system and 12 wells screened primarily within the deep aquifer system. All of the RMP wells are located within the Subbasin. For the shallow aquifer system, 10 of the groundwater-level RMPs are dedicated monitoring wells (including municipal test wells) and 4 are private domestic wells. For the deep aquifer system, seven of the groundwater-level RMPs are dedicated monitoring wells (including municipal test wells), four are public supply wells, and one is a private domestic well. Details for wells in the Groundwater-level RMP Network including well construction, well use, and length of monitoring record are presented in **Tables 5-3a** and **5-3b.**

Monitoring frequencies for wells in the Groundwater-level RMP Network are shown in **Tables 5-3a** and **5-3b**. A total of 18 of the 26 Groundwater-level RMP wells are equipped with pressure transducers for subdaily water-level data collection, four of the RMP wells are monitored monthly, and the remaining four are monitored semiannually.

5.3.2 Representative Monitoring Point Network for Degraded Water Quality

All the public supply wells in the existing monitoring programs described in **Section 5.2.2** that have been sampled for COCs between 2015 and 2019 are initial RMPs for Degraded Water Quality (**Figure 5-4)**. This includes 104 wells sampled for arsenic, 122 wells sampled for nitrate, and 92 wells sampled for TDS.

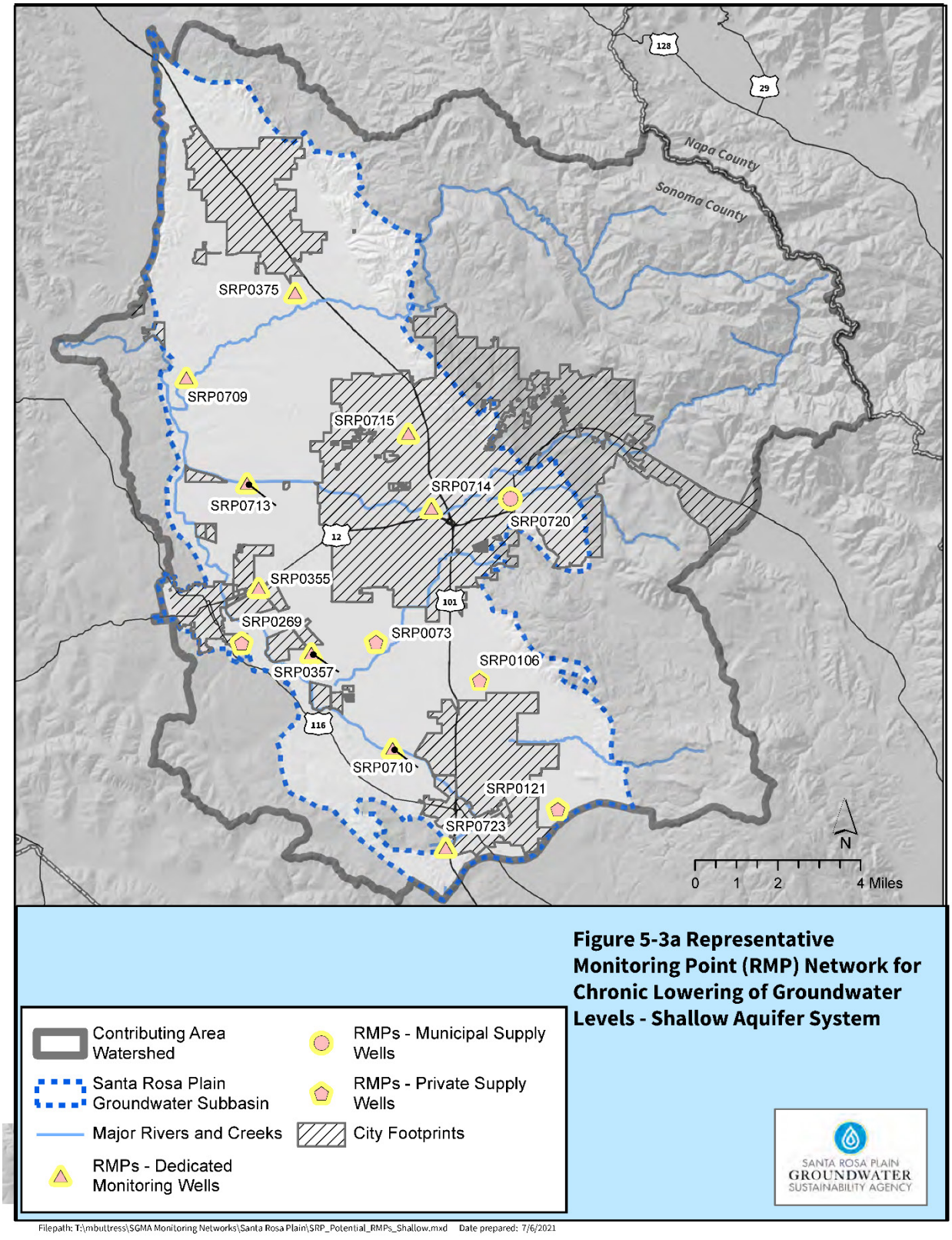


Figure 5-3a. Representative Monitoring Point Network for Chronic Lowering of Groundwater Levels – Shallow Aquifer System

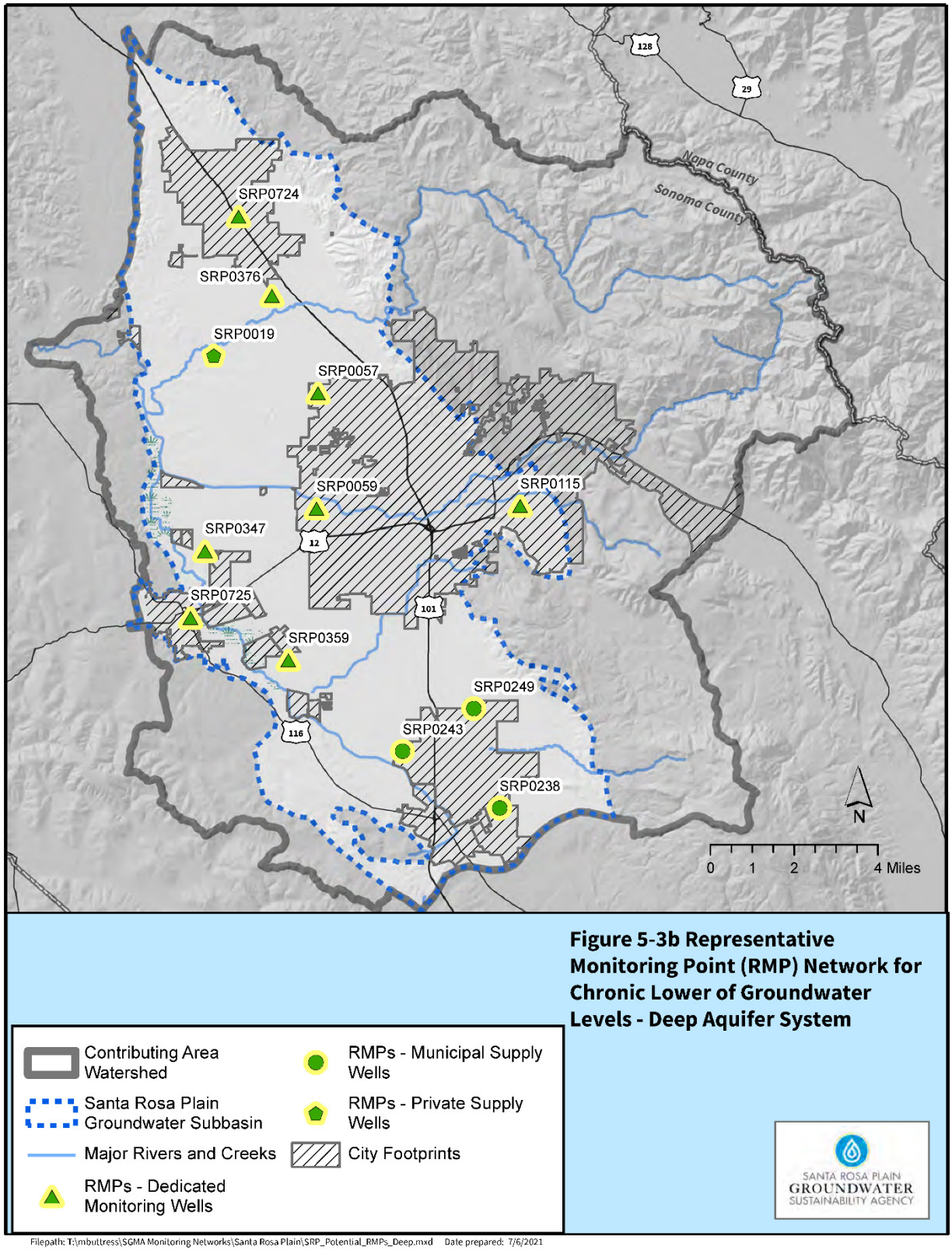


Figure 5-3b. Representative Monitoring Point Network for Chronic Lowering of Groundwater Levels – Deep Aquifer System

Table 5-3a. Representative Monitoring Point Network for Chronic Lowering of Groundwater Levels - Shallow Aquifer System

Data Management System ID	Data Management System ID					Data Record	Data Record		
Station Name	Station Number	Type of Well	Well Depth[a] (feet)	Screened Interval(s)[a] (feet)	Current Monitoring Frequency	From	Until	Additional Information	Well Owner
SRP0710	SRP-H18-02_Stony	Observation	45.5	35-45	Hourly	11/21/2019	Present	Laguna de Santa Rosa at Stony Point Road	Santa Rosa Plain Groundwater Sustainability Agency
SRP0709	SRP-C09-01_River Rd	Observation	33.5	23-33	Hourly	11/25/2019	Present	Mark West Creek at River Road	Santa Rosa Plain Groundwater Sustainability Agency
SRP0713	SRP-D11-02_Willow	Observation	45.5	25-45	Hourly	11/25/2019	Present	Santa Rosa Creek at Willowside Road	Santa Rosa Plain Groundwater Sustainability Agency
SRP0714	SRP-H12-01_Pierson	Observation	51.5	41-51	Hourly	11/25/2019	Present	Santa Rosa Creek at Pierson St.	Santa Rosa Plain Groundwater Sustainability Agency
SRP0715	SRP-H10-04_Hardies	Observation	40.5	30-40	Hourly	11/25/2019	Present	Paulin Creek at Hardies Ln.	Santa Rosa Plain Groundwater Sustainability Agency
SRP0355	SCWA_SEB_MW_07	Observation	90	70-90	Hourly	2/14/2008	Present		Sonoma County Water Agency
SRP0357	SCWA_TODD_RED	Observation	80	60-80	Hourly	6/1/1977	Present		Sonoma County Water Agency
SRP0375	SCWA_Airport_MW_02	Observation	140	120-140	Hourly	4/29/2011	Present	385117N1227863W001, SRP-E07-02	Sonoma County Water Agency
SRP0720	Hoen Well	Observation	115	?	Monthly	4/1/2005	11/8/2019		City of Santa Rosa
SRP0723	MW-114	Observation	?	?	Semiannually	5/30/2007	10/10/2019		City of Santa Rosa
SRP0073	SRP-G15-01	Unknown	80	?	Semiannually	11/3/1989	3/21/2017	06N08W04Q001M	Private
SRP0106	SRP-J16-01	Unknown	90	?	Monthly	10/3/1989	2/9/2021	06N08W12M001M	Private
SRP0121	SRP-L19-01	Unknown	150	?	Monthly	11/9/1989	2/13/2020	06N07W30R001M	Private
SRP0269	WGFH-08	Unknown	160	100-160	Semiannually	5/23/2009	10/13/2019	383889N1228088W001	Private

[a] Well depth and screened interval(s) reported in feet below top-of-casing

Table 5-3b. Representative Monitoring Point Network for Chronic Lowering of Groundwater Levels - Deep Aquifer System

Data Management System ID	Data Management System ID					Data Record			
Station Name	Station Number	Type of Well	Well Depth[a] (feet)	Screened Interval(s)[a] (feet)	Monitoring Frequency	From	Until	Additional Information	Well Owner
SRP0359	SCWA_TODD_WHITE	Observation	257	237-257	Hourly	8/2/1979	Present		Sonoma County Water Agency
SRP0347	SCWA_OCC_MW_04	Observation	740	660-740	Hourly	6/28/2010	Present		Sonoma County Water Agency
SRP0376	SCWA_Airport_MW_03	Observation	360	340-360	Hourly	4/25/2011	Present	CASGEM ID: 385117N1227863W002, SRP-E07-03	Sonoma County Water Agency
SRP0115	SRP-K12-04	Observation	870	500-860	Sub-Daily	4/22/2010	Present	MARTHA WAY	City of Santa Rosa
SRP0057	SRP-F09-02	Observation	360	200-350	Sub-Daily	5/20/2011	Present	NORTHWEST VILLAGE	City of Santa Rosa
SRP0059	SRP-F12-01	Observation	694	199-684	Sub-Daily	5/20/2011	Present	PLACE TO PLAY	City of Santa Rosa
SRP0238	SRP-K19-01	Municipal	380	130-380	Sub-Daily	11/1/1991	Present	CASGEM ID: 383350N1226841W001, RP Well 37	City of Rohnert Park
SRP0249	SRP-J17-01	Municipal	462	302-462	Sub-Daily	9/1/1980	Present	CASGEM ID: 383694N1226960W001, RP Well 17	City of Rohnert Park
SRP0243	SRP-H18-01	Municipal	582	258-582	Sub-Daily	3/1/1982	Present	CASGEM ID: 383544N1227271W001, RP Well 24	City of Rohnert Park
SRP0724	Windsor_Bluebird	Observation	765	695-745	Semiannually	6/16/2020	3/22/2021	BLUEBIRD WELL	Town of Windsor
SRP0725	Sebastopol Well #5	Municipal	528	138-528	Sub-Daily	2/1/2007	Present		City of Sebastopol
SRP0019	SRP-D08-02	Unknown	1048	?	Monthly	3/16/1976	2/5/2020	08N09W36P001M	Private

[a] Well depth and screened interval(s) reported in feet below top-of-casing

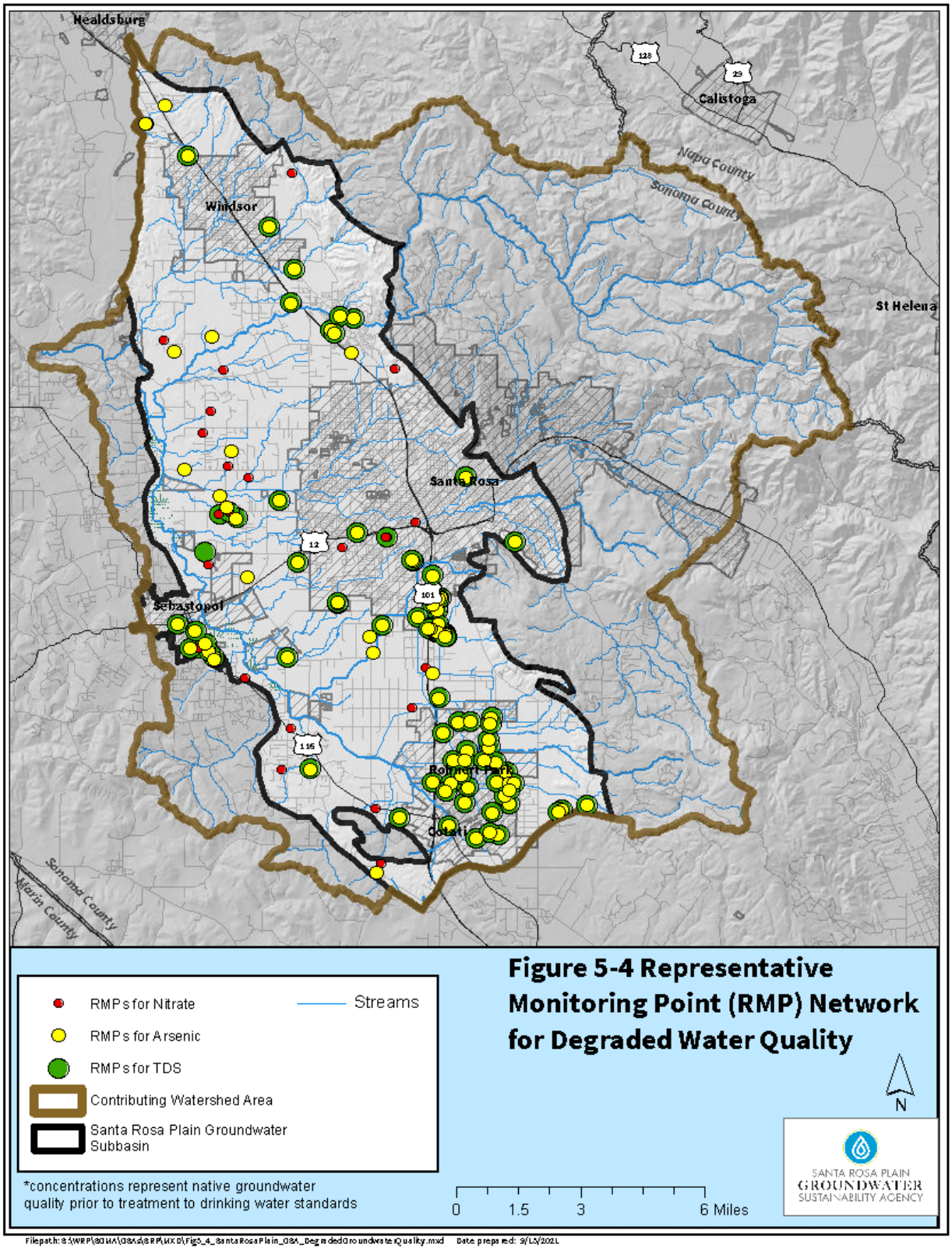


Figure 5-4. Representative Monitoring Point Network for Degraded Water Quality

5.3.3 Representative Monitoring Point Network for Depletion of Interconnected Surface Water

The 10 dedicated stream-adjacent groundwater monitoring wells were evaluated as potential RMPs for depletion of interconnected surface water (**Figure 5-2)**. The monitoring wells were surveyed and instrumented with pressure transducers for collection of hourly groundwater-level and temperature data. After the first year of data collection (WY 2020), the groundwater-level data were compared with streambed elevation data at each location to assess groundwater-surface water interconnection. Hydrographs showing groundwater-level data for the shallow stream-adjacent monitoring wells alongside streambed elevation data and stream stage data, where available, are presented in **Appendix 4-C**. Based on the assessment of interconnection, 7 of the 10 shallow stream-adjacent monitoring wells were initially selected as RMPs for depletion of interconnected surface water. The RMPs include one well adjacent to the Laguna de Santa Rosa, two wells adjacent to Mark West Creek (one near the confluence with the Laguna de Santa Rosa), two locations adjacent to Santa Rosa Creek, one location adjacent to Paulin Creek, and one location adjacent to Colgan Creek (near the confluence with the Laguna de Santa Rosa) (**Figure 5-5**). Details of the RMPs, including well construction and monitoring frequency, are presented in **Table 5-4**.

5.3.4 Representative Monitoring Point Network for Land Subsidence

As described in **Section 4.9**, each 100-square-meter InSAR pixel is considered an RMP for land subsidence. The InSAR dataset covers virtually the entire Subbasin with no significant data gaps (**Figures 5-1a** and **5-1b**).

5.4 Assessment and Improvement of Monitoring Networks

The GSP Regulations require a plan to include a review and evaluation of each monitoring network. As stated in the Regulations, “Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or uses monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency” (23 CCR 354.38).

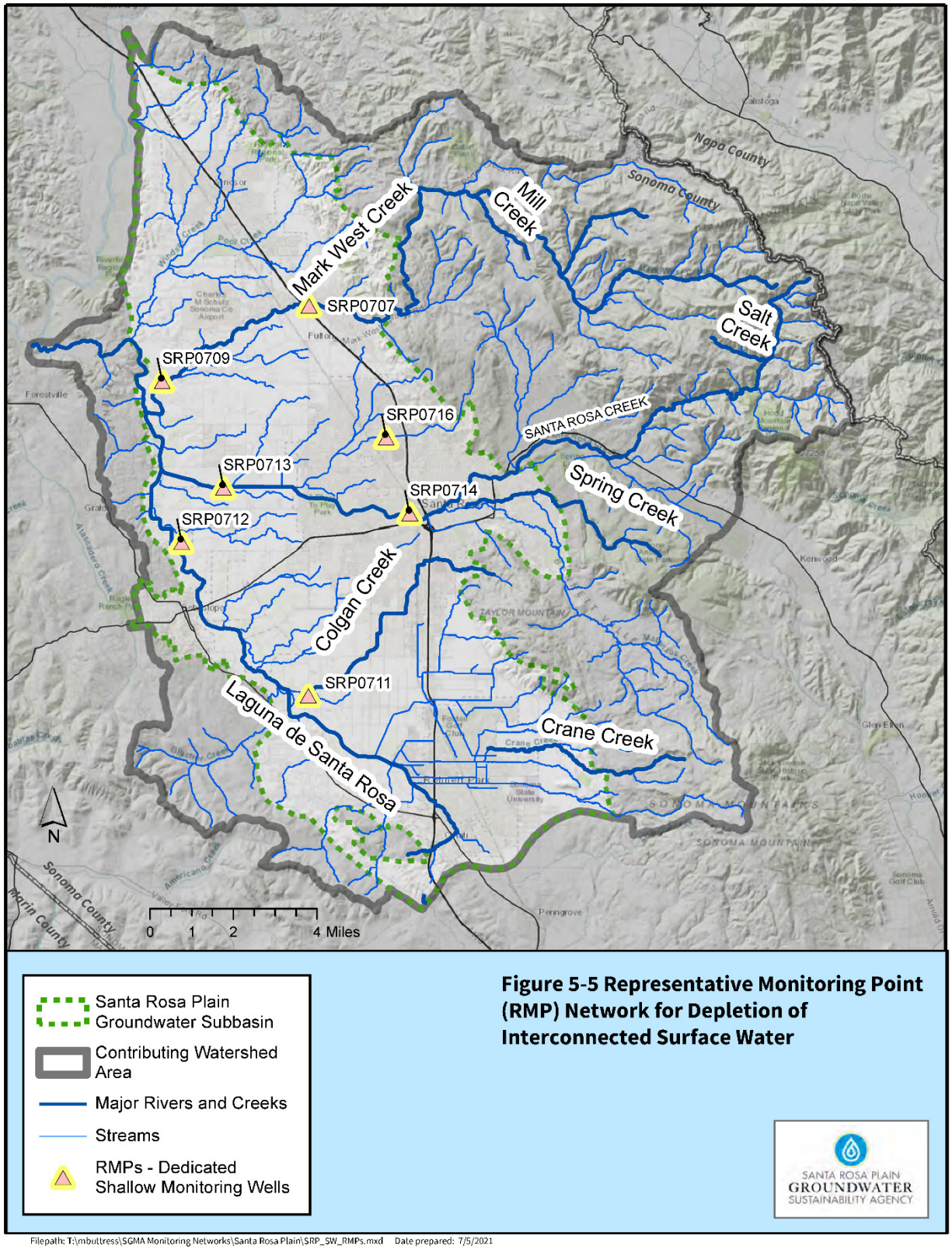


Figure 5-5. Representative Monitoring Point Network for Depletion of Interconnected Surface Water

Table 5-4. Representative Monitoring Point Network for Depletion of Interconnected Surface Water

Data Management System ID	Data Management System ID					Data Record	Data Record		
Station Name	Station Number	Type of Well	Well Depth[a] (feet)	Well Depth Category	Screened Interval(s)[a] (feet)	Data From	Data Until	Monitoring Frequency	Additional ID Information
SRP0707	SRP-F07-04_Fulton	Observation	50.5	Shallow (0-200 feet)	30-50	11/21/2019	Present	Sub-Daily	Mark West Creek at Fulton Road
SRP0709	SRP-C09-01_River Rd	Observation	33.5	Shallow (0-200 feet)	23-33	11/25/2019	Present	Sub-Daily	Mark West Creek at River Road
SRP0711	SRP-F16-01_Llano	Observation	45.5	Shallow (0-200 feet)	35-45	11/25/2019	Present	Sub-Daily	Colgan Creek at Llano Road
SRP0712	SRP-C13-03_Sanford	Observation	48.5	Shallow (0-200 feet)	28-48	11/25/2019	Present	Sub-Daily	Laguna de Santa Rosa at Occidental Road
SRP0713	SRP-D11-02_Willow	Observation	45.5	Shallow (0-200 feet)	25-45	11/25/2019	Present	Sub-Daily	Santa Rosa Creek at Willowside Road
SRP0714	SRP-H12-01_Pierson	Observation	51.5	Shallow (0-200 feet)	41-51	11/25/2019	Present	Sub-Daily	Santa Rosa Creek at Pierson Street
SRP0716	SRP-H10-04s_Hardies	Observation	20.5	Shallow (0-200 feet)	15-20	11/25/2019	Present	Sub-Daily	Paulin Creek at Hardies Lane - Shallow

[a] Well depth and screened interval(s) reported in feet below top-of-casing

5.4.1 Assessment and Identification of Data Gaps – Groundwater-level Monitoring Network

With 61 monitored wells in the shallow aquifer system and 35 monitored wells in the deep aquifer system, the Groundwater-level Monitoring Network for GSP Implementation contains sufficient monitoring sites to meet the monitoring objectives for the Subbasin. In the deep aquifer system, monitoring sites are well distributed throughout the Subbasin. In the shallow aquifer system, monitoring sites are well distributed throughout the Subbasin, with some clustered around streams and major creeks, and in the vicinity of natural discharge areas, which is appropriate and consistent with monitoring objectives.

5.4.1.1 Spatial Distribution Data Gap Assessment

A preliminary assessment of spatial coverage data gaps in the GSP Implementation Network is presented on **Figures 5-6a** and **5-6b** for the shallow and deep aquifer systems, respectively. This assessment was conducted during the GSP preparation process and used to inform monitoring network improvement projects, particularly the installation of up to four multilevel monitoring wells under a Proposition 68 grant planned for 2022.

The initial assessment for the shallow aquifer system identified data gaps in the northern tip of the Subbasin near the Town of Windsor and in the southwestern corner of the Subbasin, west of the Sebastopol Fault (**Figure 5-6a**). Additionally, the need for a multi-depth monitoring well along the southern boundary of the Subbasin was identified to improve the understanding of subsurface interaction with the adjacent Petaluma Valley Groundwater Basin. The shallow aquifer system Groundwater-level Monitoring Network for GSP Implementation was compared with the well density map presented in the Description of Plan Area section (**Figure 2-6**). This comparison indicated that all areas within the Subbasin with relatively high densities of water supply wells have shallow monitoring sites within a reasonably close vicinity, with the exception of the southwestern corner data gap area. Monitoring well sites have been identified in the northern tip and southern boundary data gap areas, and multilevel monitoring wells have been designed and will be installed when funding allows. A suitable location for a dedicated monitoring well has not been identified in the southwestern corner data gap area. The GSA will attempt to incorporate additional existing wells into the monitoring network in this area. Several previously identified data gaps in the shallow aquifer system Groundwater-level Monitoring Network were addressed through the installation of 10 shallow monitoring wells completed through DWR's TSS program in 2019.

The initial assessment for the deep aquifer system identified data gaps in the northern tip of the Subbasin near the Town of Windsor, in the northwestern portion of the Subbasin southwest of the Town of Windsor, along the western edge of the Subbasin north of the City of Sebastopol, in the eastern-central portion of the Subbasin near southwestern Santa Rosa, and in the southwestern corner of the Subbasin, west of the Sebastopol Fault (**Figure 5-6b**). Although several City of Rohnert Park municipal supply wells included in the deep aquifer system Groundwater-level Monitoring Network provide coverage in the southern portion of the Subbasin, it was determined that an additional dedicated monitoring well is needed to monitor groundwater conditions near the southern boundary of the Subbasin with the Petaluma Valley

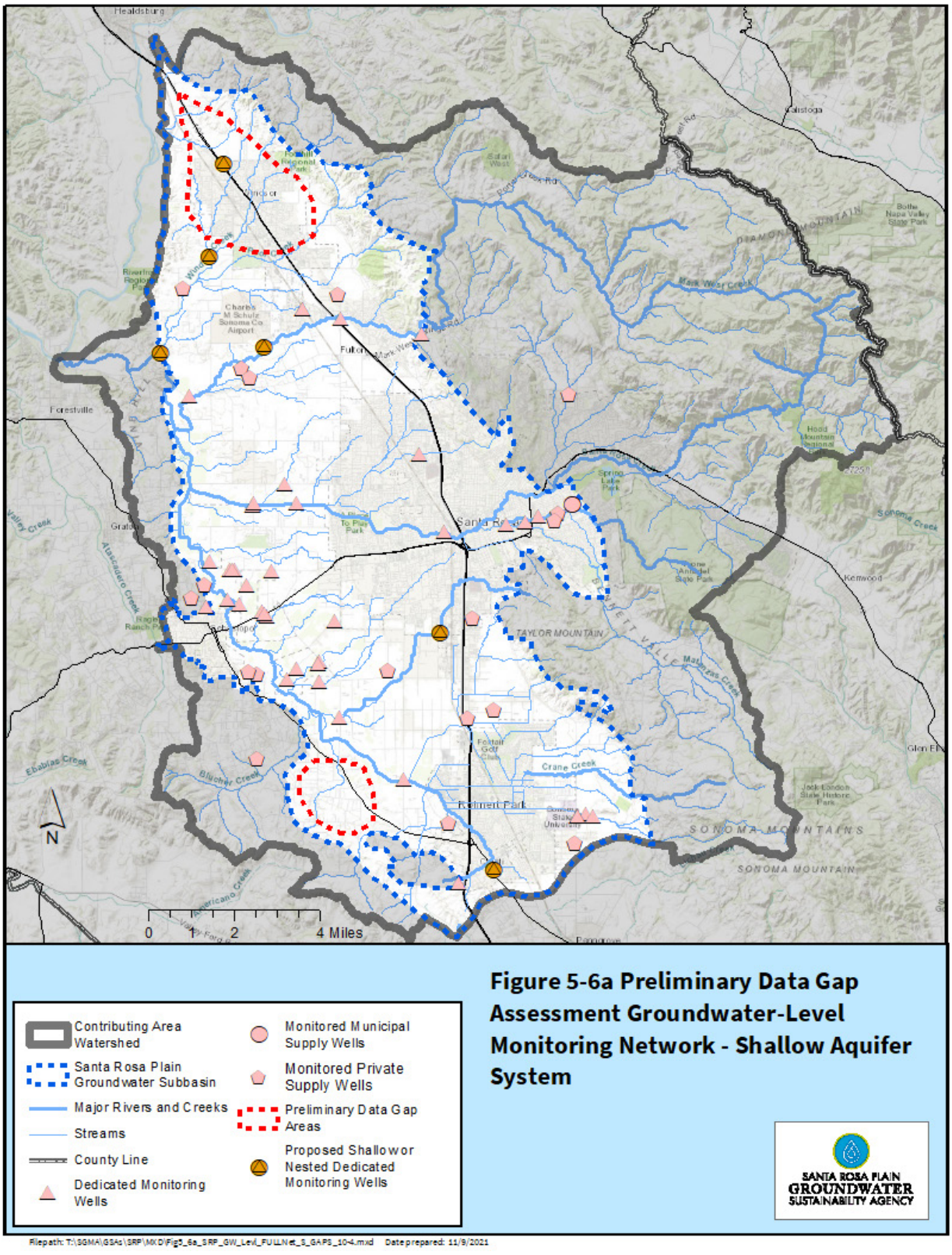


Figure 5-6a. Preliminary Data Gap Assessment Groundwater-level Monitoring Network – Shallow Aquifer System

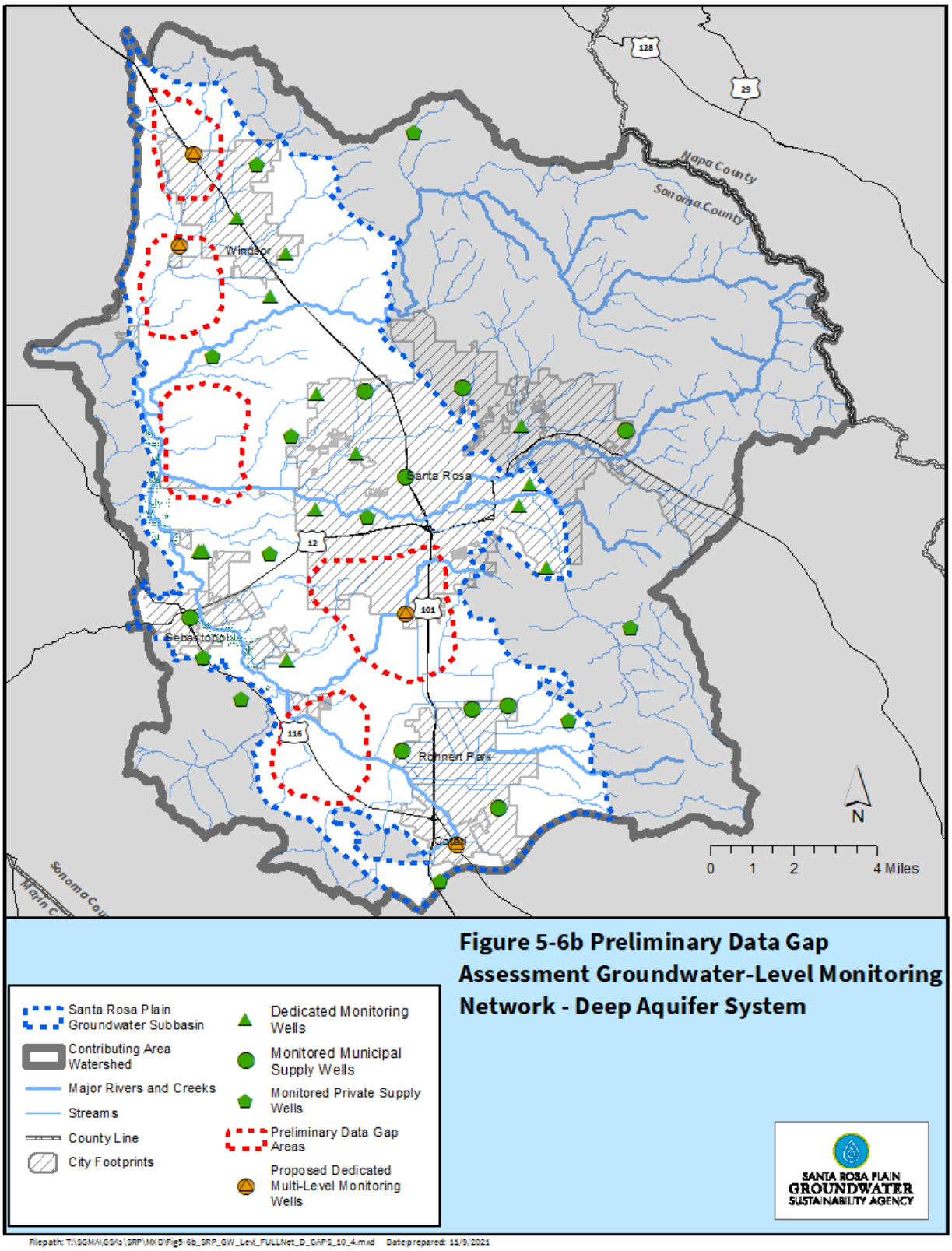


Figure 5-6b. Preliminary Data Gap Assessment Groundwater-level Monitoring Network – Deep Aquifer System

Groundwater Basin. The deep aquifer system GSP Implementation Network was compared with the well density map presented in the Description of Plan Area section (**Figure 2-6**). This comparison indicated that all areas within the Subbasin with relatively high densities of water supply wells have deep monitoring sites within a reasonably close vicinity with the exception of the southwestern corner and eastern-central data gap areas and, to a lesser extent, the northwestern and western edge data gap areas. The northwestern and eastern-central data gap areas will be addressed through the installation of Proposition 68-funded multilevel monitoring wells planned for 2022. Monitoring well sites have been identified in the northern tip and southern boundary data gap areas, and multilevel monitoring wells have been designed and will be installed when funding allows. For the remaining data gap areas along the western edge of the Subbasin north of the City of Sebastopol and in the southwestern corner of the Subbasin, the GSA will look for opportunities to incorporate existing wells into the monitoring network. The GSA intends to conduct outreach and expand the voluntary Groundwater-level Monitoring Program in the Subbasin during GSP implementation.

Figure 5-6c presents the identified spatial data gaps in the Boundary Network. The majority of the monitored wells in the Boundary Network (8 out of 16 wells) are in the Wilson Grove Formation Highlands Groundwater Basin to the west of the Subbasin. This is appropriate as much of the Wilson Grove Formation Highlands Basin is classified as a major natural recharge area (**Figure 2-9**) providing subsurface inflow to the Santa Rosa Plain Subbasin. The monitored wells in the Wilson Grove Formation Highlands basin range in total depth from 61 feet to 260 feet with four shallow wells (less than 200 feet deep), three deep wells (greater than 200 feet deep), and one well with unknown construction details. This network is sufficient for monitoring groundwater-level trends in the eastern portion of the Wilson Grove Formation Highlands Basin that could affect subsurface inflow to the Santa Rosa Plain Subbasin. Two data gap areas are shown in the Wilson Grove Formation Highlands Basin (**Figure 5-6c)** (adjacent to the southwestern corner of the Subbasin and to the west of the City of Sebastopol). Because well SRP0245's construction details are unknown and the surrounding area has a relatively high density of water supply wells (**Figure 2-6**), the GSA will attempt to incorporate additional existing wells into the Boundary Network in these areas. The remaining eight monitored wells in the Boundary Network are in the Healdsburg Area Subbasin, the Alexander Area Subbasin, the Rincon Valley Subbasin, the Petaluma Valley Basin, and areas outside of the defined basins but within the contributing watershed areas to the Santa Rosa Plain Subbasin. Additional Boundary Network data gap areas are identified in the Healdsburg Area Subbasin and the northern portion of the Petaluma Valley Basin (**Figure 5-6c**). The GSA will attempt to identify existing wells to incorporate into the Boundary Network in the Healdsburg Area Subbasin. Installation of a multilevel dedicated monitoring well is planned for 2022 in the northern Petaluma data gap area.

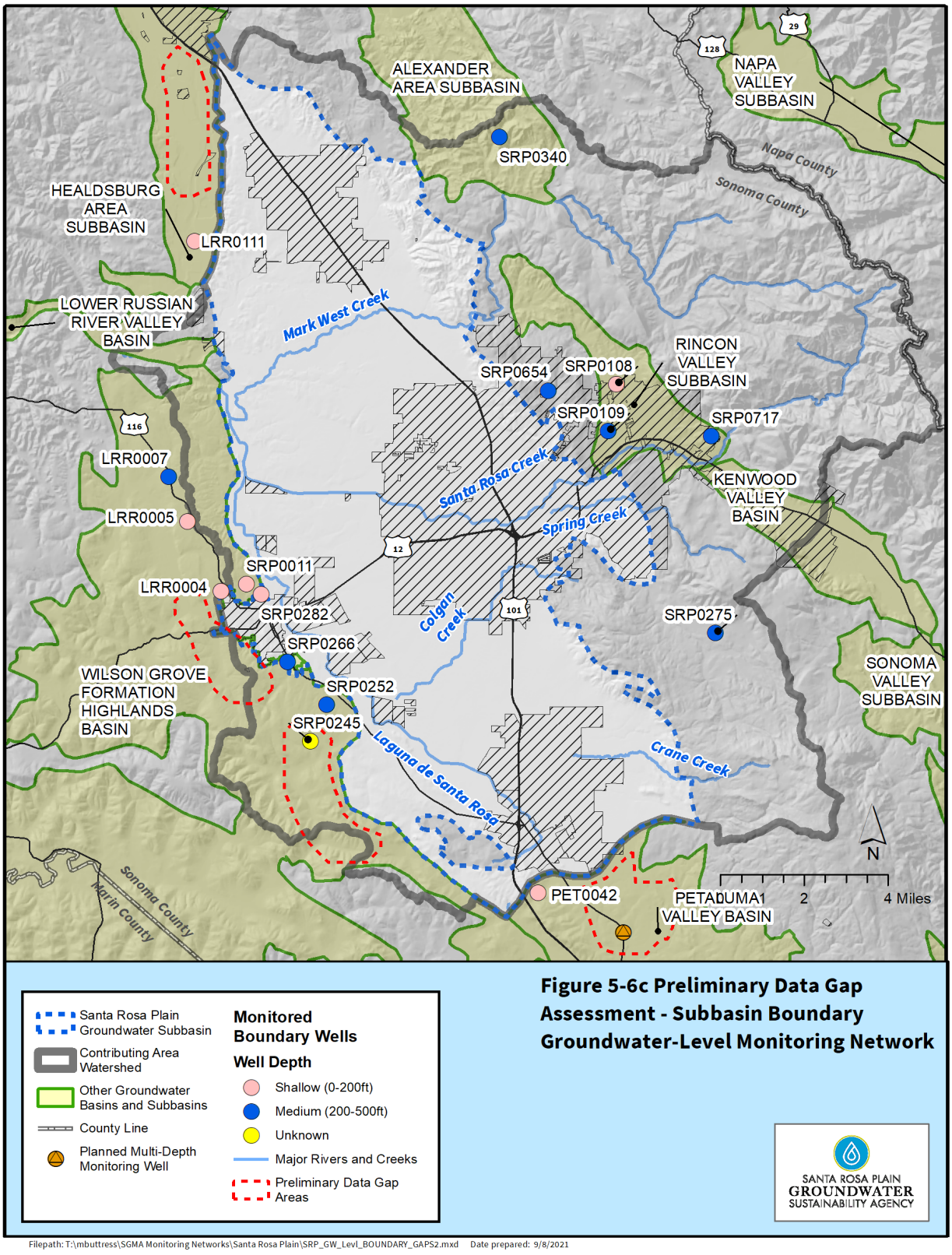


Figure 5-6c. Preliminary Data Gap Assessment – Subbasin Boundary Groundwater-level Monitoring Network

5.4.1.2 Monitoring Frequency Data Gap Assessment

Water-level data is collected at least daily (typically hourly) using pressure transducers from 43 (high-frequency monitoring wells) of the 96 wells in the GSP Implementation Network. Manual water-level measurements are collected at least semiannually for all wells in the network. Included in the High-Frequency Monitoring Wells are 10 shallow monitoring wells installed adjacent to streams and major creeks in 2019 with the intended purpose of monitoring shallow groundwater levels relative to nearby surface water levels. A total of 18 of the 26 wells in the RMP network for chronic lowering of groundwater levels are equipped with pressure transducers for subdaily water-level data collection. Four of the RMP wells are monitored monthly and the remaining four are monitored semiannually. The monitoring frequencies described above are sufficient to meet the monitoring objectives for the Subbasin. Increased monitoring frequencies are recommended for the four RMP wells that are currently monitored semiannually (SRP0073, SRP0269, SRP0723, and SRP0724). The GSA will contact well owners to request permission to increase monitoring frequency to quarterly or monthly. The GSA will explore the possibility of installing remote monitoring equipment such as pressure transducers for subdaily data collection in the eight RMP wells that are not currently high-frequency monitoring wells, dependent on funding availability, well owner willingness, and well compatibility.

5.4.1.3 Data Quality Assessment

An initial assessment of data gaps related to the ability of groundwater-level monitoring sites to satisfy applicable SGMA standards was conducted during GSP preparation. This subsection presents the initial assessment of data quality and identifies data gaps to be addressed during the GSP implementation phase. Specific SGMA standards or guidance for which data gaps were identified are as follows:

- “Reference point elevations shall be measured and reported in feet to an accuracy of at least 0.5 feet, or the best available information, relative to NAVD88 [North American Vertical Datum of 1988], or another national standard that is convertible to NAVD88, and the method of measurement described” (23 CCR 352.4).

- For wells used to monitor groundwater conditions, the GSA will provide the following information: casing perforations, borehole depth, and total well depth.

- Wells that are part of the monitoring program should be dedicated groundwater monitoring wells with known construction information. The selection of wells should be aquifer specific and wells that are screened across more than one aquifer should be avoided where possible.

The initial assessment of the groundwater-level monitoring networks indicated the following:

- Forty-one of the 96 wells in the Groundwater-level Monitoring Network for GSP Implementation lack sufficient reference point vertical survey data (that is, top-of-casing elevation). This includes 9 of the 26 wells in the RMP network for chronic lowering of groundwater levels.

- Thirty-nine of the 96 wells in the Groundwater-level Monitoring Network for GSP Implementation lack complete construction information (that is, missing screened intervals and/or total depth information). This includes 7 of the 26 wells in the RMP network for chronic lowering of groundwater levels.

- Eight of the 35 wells in the deep aquifer system Groundwater-level Monitoring Network for GSP Implementation have screened intervals that extend into the shallow aquifer system. This includes 2 of the 12 deep aquifer system wells in the RMP network for chronic lowering of groundwater levels.

The GSA will work to improve data quality in groundwater-level monitoring networks by a combination of the following activities:

- Performing survey activities for wells that lack sufficient reference point vertical survey data, as funding becomes available

- Obtaining well construction information from well owners or by conducting investigations (for example, video logging) as funding or technical assistance becomes available

- Replacing wells in the monitoring network that have data quality issues with dedicated monitoring wells, as funding becomes available

5.4.2 Assessment and Identification of Data Gaps – Surface Water Monitoring Network

The nine active USGS stream gages and nine OneRain gages operated by Sonoma Water provide a robust, well-distributed surface water monitoring network in the Subbasin and contributing watershed areas. Ten stream-adjacent shallow groundwater monitoring wells, combined with the surface water monitoring network, monitor groundwater-surface water interaction throughout the Subbasin. Data gaps in the understanding of interconnected surface water in the Subbasin are illustrated on **Figure 5-7**. Additional stream-adjacent shallow groundwater monitoring wells are needed adjacent to the active USGS stream gages on Mark West Creek near Mirabel Heights and Colgan Creek near Santa Rosa. The GSA is planning to work with DWR's TSS program to install a shallow monitoring well near Mark West Creek near the Mirabel Heights gage and is planning to install a multilevel monitoring well (including a shallow stream-adjacent well) near Colgan Creek near the Santa Rosa gage in 2022 using Proposition 68 grant funds. Another data gap area is along Windsor Creek in the northern portion of the Subbasin (**Figure 5-7)**. A multilevel groundwater monitoring well is planned for installation adjacent to Windsor Creek using Proposition 68 grant funds in 2022. The GSA also plans to install a stilling well with a pressure transducer at this location for comparing shallow groundwater-level and surface water elevations. Lastly, the GSA plans to install a stilling well and pressure transducer on Mark West Creek at Fulton Road adjacent to monitoring well SRP0707 for comparison of shallow groundwater-level and surface water elevations.

Figure 5-8 illustrates the shallow aquifer groundwater-level and surface water monitoring network, data gaps and mapped groundwater dependent ecosystems, as described in **Section 3.2.6.3**.

Section 6: Projects and Management Actions

Groundwater Sustainability Plan
Santa Rosa Plain Groundwater Subbasin

Table of Contents

6 PROJECTS AND MANAGEMENT ACTIONS 6-1
6.1 Identification of Projects and Management Actions 6-1
6.2 Project Descriptions 6-2
6.2.1 Water-Use Efficiency and Alternate Water Source Projects (Group 1) 6-3
6.2.2 Stormwater Capture and Recharge (Group 2) 6-6
6.2.3 Aquifer Storage and Recovery (Group 3) 6-8
6.3 Evaluation of Projects Through Scenario Modeling 6-12
6.4 Management Actions and Projects Requiring Additional Assessment 6-15
6.4.1 Coordination of Farm Plans with Groundwater Sustainability Plan Implementation 6-16
6.4.2 Assessment of Additional Recycled Water Opportunities 6-17
6.4.3 Assessment of Potential Policy Options for Groundwater Sustainability Agency Consideration 6-18

Table

Table 6-1. Summary of Project Groupings and Yields 6-12

Figures

Figure 6-1. Locations of Simulated Stormwater Capture and Recharge Projects 6-13
Figure 6-2. Locations of Simulated Aquifer Storage and Recovery Projects 6-14

Appendices

Appendix 6-A. Simulation of Projects and Management Actions for the Santa Rosa Plain Groundwater Sustainability Plan
Appendix 6-B. Simulated Waterlevel Hydrographs from the Simulation of Projects and Management Actions

6 PROJECTS AND MANAGEMENT ACTIONS

This section satisfies Sections 354.42 and 354.44 of the SGMA regulations, which require that GSPs include descriptions of projects and possible management actions that the GSA has determined will help achieve the sustainability goal as well as to respond to changing conditions in the basin over the 50-year planning horizon. Additionally, the GSP is required to include:

1. Which MO will benefit from a specific project or management action
2. Criteria and circumstances that would trigger implementation and future termination
3. The process by which the GSA will determine a project or management action is necessary to execute

Projects and management actions can be used to attain the MOs, meet interim milestones, and avoid MT exceedances and undesirable results.

The management actions and projects covered in this chapter outline a framework for achieving sustainability; however, many details must be negotiated before many of the projects and management actions can be implemented. The costs for management actions and project implementation are additional to the funding required to sustain the operation of the GSA, and the funding needed for monitoring and reporting. The collection of projects and management actions discussed in this section demonstrate that sufficient options exist to reach and maintain sustainability. Not all projects and actions have to be implemented to attain sustainability. Therefore, the projects and management actions included herein should be considered a list of options that will be refined during GSP implementation.

6.1 Identification of Projects and Management Actions

The identification of projects and management actions was an iterative process which included significant Advisory Committee and GSA Board input, and a substantial amount of staff work. Input received from the Advisory Committee and GSA Board helped refine and categorize the selection of projects and management actions into those that could be initially evaluated as part of this GSP, and those that require further assessment or study prior to implementation. For example, based on limitations and uncertainty related to the potential for future expansion of recycled water supplies, additional expansion of recycled water deliveries for irrigation supplies is not included with the projects evaluated using scenario modeling described in **Section 6.3**. Future opportunities for expansion and optimization of recycled water supplies with recycled water purveyors within the Subbasin will be evaluated as a management action during the first 5 years of GSP implementation. Additionally, other ideas for projects and actions raised by Advisory Committee and community members would need to be further developed and planned to evaluate with model scenarios. For example, recharge net-metering programs, water markets, and net-zero water use requirements for new development need further refinement. Management actions the GSA has under its authority, such as mandatory

conservation or pumping reductions, will also be studied and considered during the first 5 years of GSP implementation, as described in **Section 6.4**.

The projects and management actions considered for implementation and further planning build upon the successful historical groundwater management activities conducted within the Subbasin are listed below:

- Use of imported surface water by various municipalities (Sonoma Water's water contractors) in lieu of local groundwater supplies
- Development and use of recycled water supplies for meeting agricultural and landscape irrigation demands
- Implementation of water-use efficiency and conservation programs within the urban water-use sector
- Studies and implementation of water-use efficiency measures within the agricultural sector
- Studies and initial planning for managed aquifer recharge, including:
    - Feasibility study and initial planning for ASR
    - Studies, data collection, and pilot testing for stormwater recharge projects

While some of these initiatives and activities have historically been developed and planned specifically to address groundwater conditions within the Subbasin, many have been developed and implemented to achieve other benefits, objectives, and purposes. Inclusion and further assessment of these initiatives and activities during implementation of the GSP will facilitate coordination and optimization of these initiatives and activities to support sustainable groundwater management. **Sections 6.2.** through **6.4** describe the identified projects, summarize initial assessment of projects using scenario modeling, and describe identified management actions.

6.2 Project Descriptions

To prevent potential undesirable results and to achieve MOs, a portfolio of projects has been developed and evaluated with the goal of addressing relevant sustainability indicators during GSP implementation. The GSA plans to immediately begin implementation of selected projects. In some cases, initial implementation steps include performing studies or analyses to refine the concepts into actionable projects. **Sections 6.2.1** through **6.2.4** provide descriptions of the projects, including information required by Section 354.44 of the GSP Regulations. Where applicable, a CEQA analysis will be performed for projects. A CEQA analysis includes an assessment of water supply impacts, GHG emissions, and impacts on tribal cultural resources.

The projects described in this section were assembled into different groups for the purposes of performing an initial assessment of benefits using model scenarios:

- Group 1:
    - Water-Use Efficiency and Alternate Water Source Projects
- Group 2:
    - Stormwater Capture and Recharge
- Group 3:
    - ASR (existing municipal wells)

Applicable results from the model scenarios related to expected project benefits are included in project descriptions in **Section 6.2**, summary results are included **Section 6.3**, and details of the methodology and results of model scenarios are included as **Appendix 6-A**. The evaluation of projects and management actions incorporate the future climate change and growth assumptions described in **Section 3.3.6.1.**

6.2.1 Water-Use Efficiency and Alternate Water Source Projects (Group 1)

The water-use efficiency and alternate water source projects include smaller-scale dispersed land-owner projects, such as turf removal, rainwater harvesting, and stormwater capture/reuse. These projects are initially planned as voluntary, incentive-based projects focused on groundwater users, primarily rural, residential, agricultural, and commercial/industrial groundwater users. The programs and education offered to rural domestic and commercial groundwater users will mirror programs offered to regional municipal water users, which have led to a 37 percent reduction in per capita water use since 2010. It is assumed that existing water-use efficiency by municipal groundwater users will continue through the Sonoma-Marin Saving Water Partnership. In addition to the Sonoma-Marin Saving Water Partnership, as described in **Section 2.6**, numerous regional and local water conservation programs are operational in the Plan Area including the LandSmart Program and the Sustainable Winegrowing Program. Many grape growers already use drip irrigation and rely on new technologies to determine when and how much to irrigate vines. This program would be focused on leveraging existing tools and BMPs and working with farmers who have not had either access to or the resources available to reduce water use. Examples of the tools and BMPs included in these programs are:

- Indoor (high-efficiency toilets, fixtures, and washers) and outdoor (landscaping assistance, surveys, and retrofits) water-use efficiency
- Conservation rebate programs for high-efficiency appliances and fixtures, landscape water budgets, landscape and irrigation design, and irrigation scheduling

- Stormwater management through low-impact development practices
- Rainwater harvesting
- BMPs for conserving water use in commercial processing, including wineries
- Soil moisture monitoring and efficient irrigation scheduling

During the first year of GSP implementation, this project will include an assessment of the exact types of water-use efficiency tools and alternate water source projects that are expected to be most effective and feasible for Subbasin stakeholders, including groundwater-use characteristics, existing levels of conservation and water-use efficiency, and recommendations on preferred tools and strategies for implementation (such as incentive options). While implementation of these projects is initially planned to be on a voluntary basis, the assessment will also identify specific metrics for evaluating the benefits of the projects and assess Subbasin conditions that may lead to consideration of mandatory implementation of demand management actions.

6.2.1.1 Objectives, Circumstances and Timetable for Implementation

Implementation of the water use efficiency and alternate water source projects will help achieve MOs and avoid undesirable results for the chronic lowering of groundwater levels sustainability indicator. Achieving MOs and avoiding undesirable results for the chronic lowering of groundwater levels sustainability indicator is also expected to benefit the groundwater storage and land subsidence sustainability indicators. Additionally, depending upon the locations within the Subbasin where Group 1 projects are implemented, benefits to the MOs for the depletion of interconnected surface water sustainability indicator may also be realized.

After a short planning period, it is assumed that water use efficiency and alternate water source project implementation will begin in 2023, while project benefits are assumed to begin in 2025 for the model scenarios. As described above, initial implementation will include an assessment of the exact types of water-use efficiency tools and alternate water source projects that are expected to be most effective and feasible for Subbasin stakeholders. The assessment will also evaluate specific metrics for evaluating the benefits of the projects and assess Subbasin conditions that may lead to mandatory implementation of demand management projects.

6.2.1.2 Expected Benefits

Initial evaluation of potential benefits of the water use efficiency and alternate water source projects were simulated under the Group 1 model scenario. For the purposes of estimating potential benefits of these projects, it was assumed that the Group 1 scenario simulates the impacts of a 20 percent reduction in all rural domestic use and a 10 percent reduction in consumptive use for all vineyards, both beginning in 2025. This assumption was considered to represent a reasonable level of groundwater use reduction based on the outcomes from existing BMPs and other water-use efficiency programs. Other groundwater-use sectors would

be included in the project, including commercial, industrial, and other agricultural crops. However, for the purposes of conducting the scenario modeling, only reductions in rural domestic and vineyard groundwater use were applied, as these components were most readily able to be incorporated in the model.

Based on these assumptions and others further described in **Appendix 6-A**, benefits simulated include reduction in the number of potential future MT exceedances and elimination of potential undesirable results for the chronic lowering of groundwater levels, as well as decreasing the decline in groundwater storage. Benefits simulated by the model relative to the baseline scenario for the Group 1 scenario are summarized as follows:

- Simulated project yield: total of 1,800 AFY (1,200 AFY from reduction in agricultural consumptive use, 600 AFY reduction in rural domestic groundwater use)
- Simulated increase in groundwater levels: 5- to 15-foot increases, primarily in the deep aquifer system in the northern portions of the Subbasin
- Simulated increase in groundwater storage: 200 AFY
- Simulated net reduction in surface water depletion: 700 AFY

The planned initial assessment of water use efficiency and alternate water source projects will include recommendations for evaluating specific metrics for the actual benefits of the projects during implementation.

6.2.1.3 Public Noticing, Permitting and Regulatory Process

Public notice and outreach communications will be a critical component to the success of implementing water use efficiency and alternate water source projects, as these actions are initially planned as voluntary and will rely on Subbasin stakeholders clearly understanding their importance and benefits. Activities described in **Section 7.2.2** will include outreach to DACs, tribal, rural residential, commercial, industrial, and agricultural stakeholders focused on highlighting the benefits of participation.

Some of the water use efficiency and alternate water source projects do not have any permitting or regulatory requirements. Any projects that may include permit or regulatory requirements, such as graywater systems, would need to comply with local requirements and ordinances.

6.2.1.4 Estimated Costs and Funding Plan

A total of $90,000 is included in the initial 5-year budget provided in **Section 7.2** to perform the assessment of water use efficiency and alternate water source projects and to fund initial rollout of voluntary measures. To continue and/or expand implementation of water use efficiency and alternate water source projects, the GSA will seek grant funding. The GSA is also considering applying for funding of high-efficiency toilet replacement and agricultural BMP

implementation through the State's 2021 Drought Relief Program or other applicable grant opportunities.

6.2.1.5 Legal Authority

No legal authority is anticipated to be needed to voluntarily implement the water use efficiency and alternate water source projects.

6.2.2 Stormwater Capture and Recharge (Group 2)

As described in **Section 2.6**, planning for stormwater capture and recharge efforts, including site investigations and pilot studies, has been initiated by local agencies and growers within the Subbasin. Stormwater capture and recharge projects are intended to cover two general types of stormwater capture activities that have been identified in the Russian River Regional Storm Water Resource Plan (Russian River Watershed Association 2018). The first stormwater capture activity involves retaining and recharging onsite runoff. Examples of this type of activity include low-impact development and on-farm recharge of local runoff. The second stormwater capture activity involves recharge of unallocated storm flows, which could include multi-benefit projects such as managed floodplain inundation. These actions require temporary diversions of storm flows from streams, and conveyance of those flows to recharge locations. State programs and grants (such as FLOOD-MAR, Proposition 68) and local entities (such as RCDs) can be used as resources to move forward on stormwater capture and recharge efforts.

Prior to implementing long-term stormwater capture and recharge programs, site-specific field investigations and assessments will be needed to identify suitable locations. Therefore, early stages of implementing stormwater capture and recharge projects are anticipated to include site-specific investigations and pilot studies of on-farm and other dispersed recharge opportunities that consider and include the following:

- Water available for recharge
- Areas with permeable near-surface soils
- Optimal methods and techniques
- Outreach to interested landowners with locations that could help sustain baseflows to streams and support GDEs

6.2.2.1 Objectives, Circumstances and Timetable for Implementation

Implementation of the stormwater capture and recharge projects are primarily anticipated to help achieve MOs and avoid undesirable results for the depletion of interconnected surface water sustainability indicator. Depending upon the location of stormwater capture and recharge projects, and hydraulic connection between surficial recharge locations and the shallow aquifer system, there may be benefits to the chronic lowering of groundwater levels, groundwater storage and land subsidence sustainability indicators.

Stormwater capture and recharge projects require permitting, environmental analysis, and engineering design, which would begin in 2022. Depending upon results of pilot studies,

planned to be initiated in 2024, full-scale implementation of stormwater capture and recharge projects is anticipated to begin in 2028. However, implementation of smaller-scale low-impact development type projects may proceed sooner, as permitting requirements are anticipated to be much less involved that projects that involve recharging diverted streamflows. The timing of projects is based on best estimates and may shift as GSP implementation proceeds, depending upon project needs at the time, permitting timelines, and resources available.

6.2.2.2 Expected Benefits

Expected benefits from implementation of stormwater capture and recharge projects are described in **Appendix 6-A**. Initial evaluation of potential benefits of the stormwater capture and recharge source projects were simulated under the Group 2 model scenario. For the purposes of estimating potential benefits of these projects, the following assumptions were made:

- The Group 2 scenario simulates the effects of stormwater capture and recharge on agricultural lands (On-Farm Recharge) along Mark West Creek, which was selected for initial modeling assessment based on generally favorable soil conditions and presence of GDEs, including critical species.
- The recharge locations were selected based on identifying simulated irrigated agricultural model cells principally downslope of the diversion location selected. There are 184 model cells, or 1,840 acres, that receive equal amounts of diverted water. This initial assessment of Mark West Creek will inform identification of other locations for stormwater capture and recharge projects within the Subbasin during implementation of this project.

The benefits simulated by the model relative to the baseline scenario for the Group 2 scenario are summarized as follows:

- Simulated project yield: 240 AFY of stormwater diverted and recharged
- Simulated increase in groundwater levels: only localized increases in the shallow aquifer system near the recharge areas
- Simulated increase in groundwater storage: 100 AFY
- Simulated net reduction in surface water depletion: 300 AFY, including a 10 percent increase in summertime flows along lower Mark West Creek

Benefits from stormwater capture and recharge projects would primarily be evaluated using changes in measured groundwater levels and surface water flows near and downstream of project locations.

6.2.2.3 Public Noticing, Permitting and Regulatory Process

Public outreach would be conducted to identify landowners interested in participating in stormwater capture and recharge projects. The degree of public noticing will vary depending upon the scale and type of recharge project.

Recharge of stormwater by retaining and recharging onsite runoff does not require permits. Recharge of unallocated storm flows is currently subject to the SWRCB's streamlined permit program for groundwater recharge by capturing high flow events. Recharge of unallocated storm flows will be subject to the terms of these 5-year permits. Stormwater capture may also be subject to CEQA permitting. Additionally, stormwater management projects will need to comply and coordinate with existing NPDES and MS4 permits for regional municipal stormwater systems. Future GSP implementation projects or actions that require their own site-specific monitoring network, such as some stormwater capture and recharge projects, would take into consideration any localized COCs and regulatory requirements to avoid potential impacts on beneficial users, including domestic well users and DACs.

6.2.2.4 Estimated Costs and Funding Plan

A total of $160,000 is included in the initial 5-year budget provided in **Section 7.2** to perform site-specific investigations and fund a pilot study. To continue and expand implementation of stormwater capture and recharge projects, the GSA will coordinate with other project proponents who may be pursing multi-benefit projects, consider providing additional funding in future years, and seek opportunities for grant funding.

6.2.2.5 Legal Authority

In addition to acquiring required permits and the right to divert stormwater, other legal authorities required to implement stormwater capture and recharge will depend upon the lead implementing agency for the projects. CWC Section 10726.2 provides GSAs the authority to purchase, among other things, land, water rights, and privileges.

6.2.3 Aquifer Storage and Recovery (Group 3)

As described in **Section 2.6**, regional planning for ASR and well-specific assessments have been performed by local agencies within the Subbasin (GEI et al. 2013 and City of Santa Rosa 2013c). Conceptually, an ASR program would involve the diversion and transmission of surplus Russian River water produced at existing drinking water production facilities during wet weather conditions (that is, the winter and spring seasons) for storage in the deep aquifer system of the Subbasin. The stored water would then be available for subsequent recovery and use during dry weather conditions (that is, the summer and fall seasons) or emergency situations. The Groundwater Banking Feasibility Study (GEI et al. 2013) provided an evaluation of the regional needs and benefits, source water availability and quality, regional hydrogeologic conditions, and alternatives for groundwater banking. Based on the findings from the study, pilot studies to further assess the technical feasibility of ASR as a method for groundwater banking were

recommended and in 2018 a pilot project was completed in the nearby Sonoma Valley Subbasin (GEI et al. 2020).

The feasibility study also found that adequate water for a hypothetical 5,000 AFY groundwater recharge program would be available for diversion from Sonoma Water's diversion facilities along the Russian River more than 90 percent of the time. This divertible flow was calculated by simulating the river system operations to meet Sonoma Water demands, simulating Sonoma Water diversions, and then subtracting minimum flows needed to meet the Biological Opinion and other instream requirements. In general, water is expected to be available for groundwater recharge in most years during the months of December through May. Because of the high-flow rates in these winter and spring months (with 100 cfs or more divertible flow expected 90 percent of the time), this pattern of availability is expected to be present under higher future levels of demand. Some water would also be available for diversion to groundwater storage during June through November, though less frequently (GEI et al. 2013). An updated assessment of water available for recharge will be performed during the early stages of GSP implementation.

Prior to implementing long-term ASR programs in the Santa Rosa Plain Subbasin, pilot studies are recommended to verify location specific feasibility, including aquifer capacity for recharge and recovery operations and geochemical compatibility. Pilot testing involves injecting potable drinking water into the Subbasin's aquifers and recovering it to assess injection and recovery capacities and monitor potential water quality impacts to native groundwater resources. Information generated by pilot test evaluations will help inform the degree to which ASR is a feasible strategy to improve the reliability water supply, along with helping to evaluate whether or not an ASR project can be developed and operated in a manner that will achieve both supply reliability and groundwater sustainability benefits. Therefore, early stages of implementing ASR projects are anticipated to include both site-specific investigations and pilot studies. Additionally, it is recommended that the 2013 Groundwater Banking Feasibility Study be updated to address current source water (Russian River) availability and transmission system capacity assumptions, perform an assessment of locations and operations that specifically benefit GSP implementation, and design and implement pilot studies for favorable areas.

It is also recognized that other water purveyors are pursuing initiation of ASR in the Subbasin on a more expedited timeframe in response to the 2020/2021 drought and associated funding opportunities. Specifically, Sonoma Water is developing plans to implement ASR at two of its production wells within the Santa Rosa Plain as part of its Santa Rosa Plain Drought Resiliency Project. The GSA will coordinate and provide support for planning and implementation of ASR projects that may be developed and implemented by Sonoma Water and other project proponents in response to current drought conditions.

6.2.3.1 Objectives, Circumstances and Timetable for Implementation

Implementation of ASR projects will help achieve MOs and avoid undesirable results for the chronic lowering of groundwater levels sustainability indicator. Achieving MOs and avoiding undesirable results for the chronic lowering of groundwater levels sustainability indicator is also

expected to benefit the groundwater storage and land subsidence sustainability indicators. Additionally, depending upon the locations within the Subbasin where ASR projects are implemented, benefits to the MOs for the depletion of interconnected surface water sustainability indicator may also be realized.

ASR projects require permitting, environmental analysis, and engineering design, which would begin in 2022. Depending upon results of pilot studies, planned to be initiated in 2024, full-scale implementation of ASR projects is anticipated to begin in 2028. The timing of projects is based on best estimates and may shift as GSP implementation proceeds based upon the needs at the time. As noted earlier, this timeframe may be further accelerated in response to the 2021/2022 drought.

6.2.3.2 Expected Benefits

Expected benefits from implementation of ASR projects include:

- Limiting the potential for chronic lowering of groundwater levels and undesirable results for other associated sustainability indicators.
- Enhanced reliability of the regional water supply during droughts, natural hazard events (such as, earthquakes), and periods of peak seasonal water demands.

For the purposes of assessing the effects, ASR was simulated in wells owned by Sonoma Water, City of Cotati, City of Rohnert Park, City of Santa Rosa, and Town of Windsor that have been initially assessed and deemed potentially feasible for ASR operations in previous studies (GEI et al. 2013 and City of Santa Rosa 2013c) Potential benefits from implementation of ASR projects based on the scenario modeling are described in **Appendix 6-A**. Based on the assumptions described in **Appendix 6-A**, benefits simulated include reduction in the number of potential future MT exceedances for the chronic lowering of groundwater levels, as well as decreasing the decline in groundwater storage. The following summarizes benefits simulated by the model relative to the baseline scenario for the Group 3 scenario:

- Simulated project yield: 940 AFY of stormwater diverted and recharged
- Simulated increase in groundwater levels: 5- to 10-foot increases over large areas of northern and southern portions of the Subbasin
- Simulated increase in groundwater storage: less than 100 AFY
- Simulated net reduction in surface water depletion: 300 AFY

Benefits from ASR projects would primarily be evaluated using changes in measured groundwater levels and improvements to groundwater storage changes.

6.2.3.3 Public Noticing, Permitting and Regulatory Process

Public notice for aspects of the ASR pilot projects will be carried out by the lead agency for each project. For ASR projects where the GSA is not the lead agency, the GSA will provide support for outreach activities to nearby well owners and the local community. For the full-scale ASR project, public notice is anticipated to occur through compliance with CEQA for any facilities or plans associated with the project. This includes the development of an underground storage supplement to permit the storage of water in the Subbasin that is required by the SWRCB, and through publicly noticed discussions of the proposed project at public meetings. CEQA analysis includes an assessment of water supply impacts, GHG emissions, and impacts on tribal cultural resources.

The SWRCB has recognized that it in the best interest of the state to develop a comprehensive regulatory approach for ASR projects, and has adopted general waste discharge requirements for ASR projects that inject drinking water into groundwater (Order No. 2012-0010-DWQ or ASR General Order). The ASR General Order provides a consistent statewide regulatory framework for authorizing both pilot ASR testing and permanent ASR projects. Pilot tests and any future permanent ASR facility will be permitted under the ASR General Order. Oversight of these regulations is done through the RWQCBs and will require project proponents to comply with the monitoring and reporting requirements of the ASR General Order. Any additional permits required for the construction and operation of an ASR facility will be obtained by the lead agency for each ASR project as needed. Future GSP implementation projects or actions that require their own site-specific monitoring network, such as ASR, would take into consideration any localized COCs and regulatory requirements to avoid potential impacts on beneficial users, including domestic well users and DACs.

6.2.3.4 Estimated Costs and Funding Plan

Preliminary cost estimates to test, permit and construct project facilities for ASR is estimated to range from about $300,000 to $3,600,000 depending upon the complexity of each project with the lower cost estimates representing the use of existing wells that have the necessary monitoring infrastructure (GEI et al. 2013). The range of the costs also varies dependent upon whether existing facilities could be retrofitted or new facilities would need to be constructed. Preliminary costs will need to be further refined and provided upon completion of site-specific evaluation and pilot testing. The current plan for developing ASR in the Subbasin would utilize to the greatest extent possible existing infrastructure, meaning that new infrastructure would be greatly limited, thus allowing for earlier onset of both incremental drought supply and groundwater sustainability benefits.

A total of $150,000 is included in the initial 5-year budget provided in **Section 7.2** to contribute to an updated regional ASR feasibility study and to complete site-specific investigations of favorable areas. To continue and expand implementation of ASR projects, the GSA will coordinate with other project proponents who may be pursuing ASR projects, consider providing additional funding in future years, and will seek opportunities for grant funding.

6.2.3.5 Legal Authority

Local water supply agencies and the GSA have the authority to develop water supply projects, such as ASR for both water supply benefits and to provide groundwater sustainability benefits.

6.3 Evaluation of Projects Through Scenario Modeling

For the purposes of conducting initial evaluation of projects for this GSP, staff assembled conceptual projects and actions that are likely to be initiated within the first 5 years of implementation into two general categories:

- Those that have identified potential funding sources, or are voluntary or incentive-based with lower-costs (Group 1 projects). The Group 1 projects represent voluntary, incentive-based water-use efficiency and alternate water source projects focused on non-municipal groundwater users. Examples include smaller-scale dispersed land-owner projects, such as turf removal, rainwater harvesting, and irrigation efficiency practices. The exact types of these dispersed projects are not distinguished for the purposes of evaluating potential benefits using model scenarios.
- New or significantly expanded projects and actions that would require further studies and planning for implementation (Group 2 and 3 projects). Both Group 2 and Group 3 projects represent managed aquifer recharge projects that aim to maintain or raise groundwater levels and improve summer and fall streamflows. The Group 2 projects represent stormwater capture and recharge projects that could specifically benefit streamflows within the Subbasin and help comply with the SMC for depletion of interconnected surface water. Group 3 projects represent ASR projects that can reduce municipal pumping of native groundwater, help address many sustainability indicators, primarily the chronic lowering of groundwater levels, and build drought-resiliency.

These two general categories formed the basis for model scenarios of potential projects. The model scenarios were performed as an initial evaluation of benefits of the Group 1-3 projects relative to the baseline 50-year projected scenario and incorporate the future climate change and growth assumptions described in **Section 3.3.6.1**. **Table 6-1** summarizes the simulated yields expected for each group.

Table 6-1. Summary of Project Groupings and Yields

Project	Group 1	Group 2	Group 3
Reduce Crop Consumptive Use	Averages 1,200 AFY less agricultural pumping than baseline simulation	Same as Group 1	Same as Group 1
Reduce Rural Domestic Pumping	Averages 600 AFY less agricultural pumping than the baseline simulation	Same as Group 1	Same as Group 1
Stormwater Managed Aquifer Recharge	None	Average deliveries of 240 AFY	Same as Group 2
Aquifer Storage and Recovery	None	None	940 AFY

Approximate locations of the Group 2 and Group 3 projects are shown on **Figures 6-1** and **6-2**, respectively. The locations for Group 1 projects are distributed across the Subbasin. The methodology and results of the scenario modeling are described in **Appendix 6-A** and summary results of potential benefits are provided after the figures.

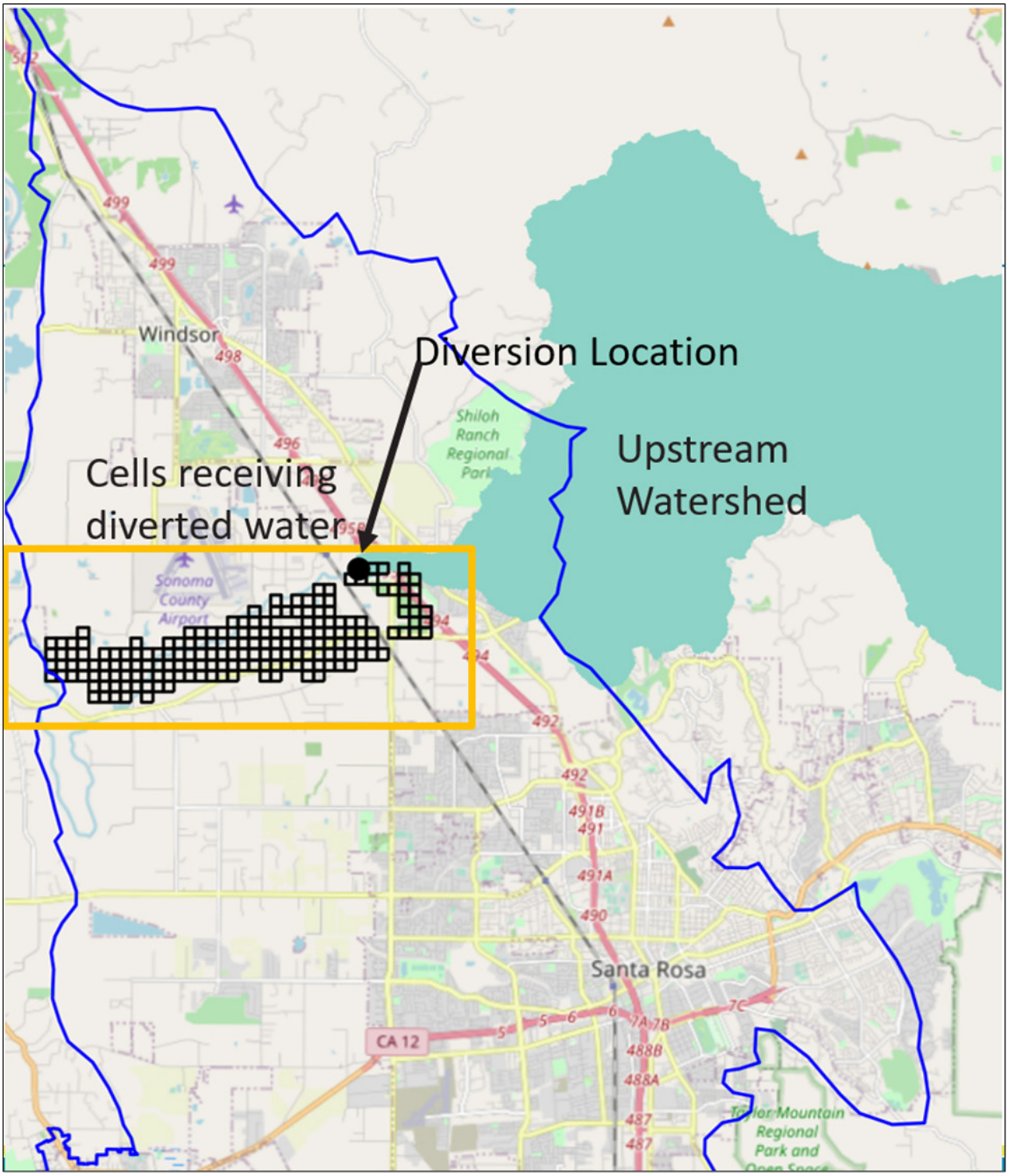


Figure 6-1. Locations of Simulated Stormwater Capture and Recharge Projects

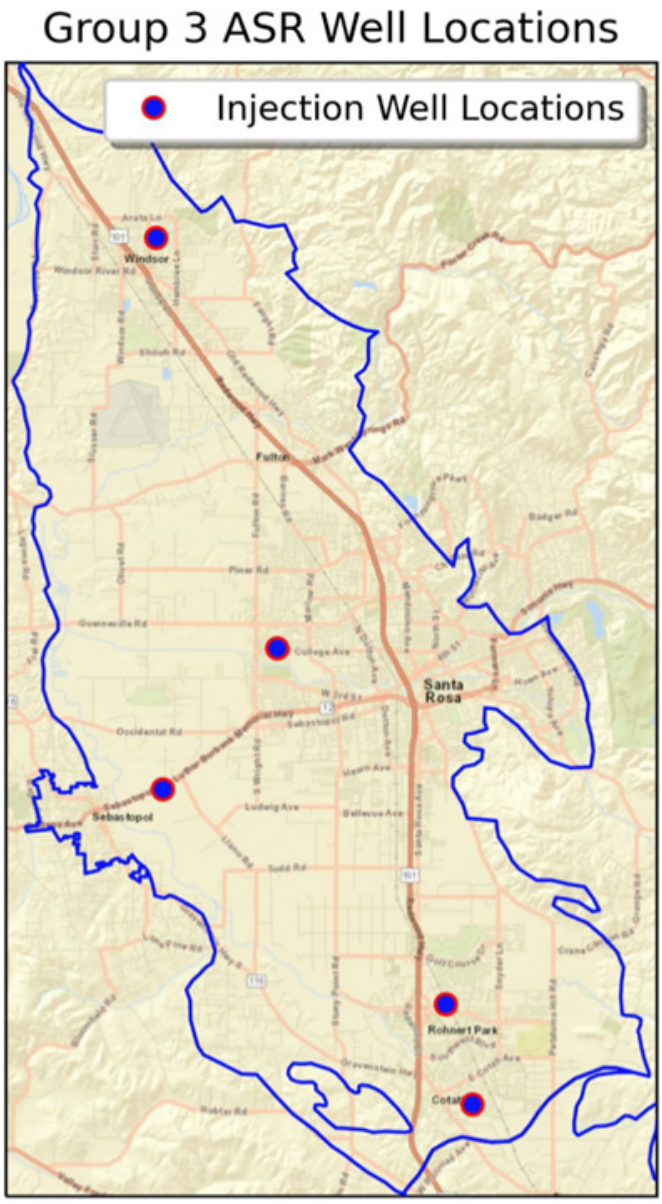


Figure 6-2. Locations of Simulated Aquifer Storage and Recovery Projects

General findings from the model scenarios indicate the following:

- **Groundwater Levels**: In the baseline scenario, groundwater levels in the shallow and deep aquifers remain above MTs for the first 20-year period. Groundwater levels generally fall below MTs in the last 11 years of the 50-year projected baseline water budget, primarily in RMPs in the deeper aquifer, potentially leading to undesirable results. The cumulative projects remove all occurrences of undesirable results by decreasing MT exceedances in RMP wells from 66 to 18. Implementation of Group 1 results in greatest decline in MT exceedances in RMP wells and eliminates potential undesirable results that are simulated to occur during the baseline 50-year projection.

- **Groundwater storage:** Groundwater in storage under a baseline scenario without projects is estimated to decline by an average of 200 AFY between 2021 and 2040 and 1,400 AFY over the entire 50-year projection period that includes a simulated extreme 20-year drought between 2050 and 2070. Cumulative projects are simulated to increase the amount of groundwater in storage by 400 AFY between 2021 and 2040 (resulting in an average 200 AFY storage increase) and reduce the average decline by 300 AFY over the entire 50-year projection (resulting in an average 1,100 AFY storage decline).

- **Stream-Aquifer Interaction:** Higher groundwater levels near streams can better support streamflow, particularly in the summer and fall months. The addition of the Group 2 projects increases simulated summer streamflow by 10 percent in Mark West Creek.

Project scenarios help limit groundwater declines during the latter portion of the projected period (affected by the major drought). Although MT exceedances are not completely avoided during this more extreme dry period under these scenarios, the exceedances during severe droughts are not representative of undesirable results unless groundwater levels do not recover during subsequent wetter time periods.

Considering current uncertainties due to modeling, data gaps, and project information, these project scenarios provide a pathway for reaching sustainability and preparing for future changed conditions in the Subbasin to meet GSP requirements. Additional data collection and project conceptualization during early phases of GSP implementation will help refine these scenarios and allow for consideration of additional scenarios, including additional demand management actions, if necessary to achieve sustainability. The projects will also be supplemented by the following planned management actions, which include an assessment and prioritization of policy options that include demand management actions for the GSA Board to consider.

6.4 Management Actions and Projects Requiring Additional Assessment

In addition to initiating the projects described above, the GSA will further assess the following management actions and potential future projects that require additional assessment and planning:

- Coordination of Farm Plans with GSP implementation
- Assessment of additional recycled water opportunities
- Assessment and prioritization of potential policy options

Additionally, as provided by SGMA, should the above-described projects and management actions not be sufficient to eliminate undesirable results during implementation of the GSP, the GSA has authorities to limit groundwater pumping. **Section 6.4.3** further describes these authorities and potential situations where they may be considered.

6.4.1 Coordination of Farm Plans with Groundwater Sustainability Plan Implementation

Farm Plans are voluntary plans developed by third party organizations in collaboration with individual landowners that identify best management practices and provide site-specific actions to mitigate issues like sediment runoff or to improve water quality. In some areas of California, regulatory fees are reduced for landowners with Farm Plans that are certified by agreed-upon third parties. Currently, most Farm Plans do not include aspects of groundwater management that would directly support the GSA's efforts to comply with the requirements of the SGMA.

This management action involves a collaboration between the three Sonoma County GSA's and interested members of the agricultural community to evaluate the feasibility of developing a program that coordinates Farm Plans, developed at individual farm sites, with the implementation of the basin-wide GSP. This effort will identify areas of mutual interest (for example, improved water use efficiency, increased groundwater recharge, increased monitoring and data collection, coordinated information sharing, and reporting) in addition to challenges that need to be addressed (for example, data confidentiality, data quality requirements, verification of Farm Plan performance).

6.4.1.1 Objectives, Circumstances and Timetable for Implementation

Objectives of the management action include:

- Strengthening partnerships and coordination between the GSA and growers
- Identifying requirements or standards that need to be met to demonstrate that the implementation of the Farm Plan contributes to compliance with SGMA
- Developing metrics that will be measured and verified during implementation of the Farm Plan
- Considering options for Farm Plan sites to receive a form of credit for the contributions of the subject farm to the compliance with SGMA.

Coordination activities will begin in the first year of GSP implementation and it is anticipated that within 1 year of funding approval, staff would submit a report to the GSA Board with recommendations on the viability of such a program and next steps, as appropriate.

6.4.1.2 Expected Benefits

Expected benefits would include information sharing and coordination between the GSA and growers within the Subbasin. Other benefits will depend upon the outcome of the coordination activities and identification of mutual areas of interest to incorporate into Farm Plans. Potential areas of benefit include improvements to the GSAs monitoring network, filling key data gap areas, and advancing projects (such as water-use efficiency or recharge projects) that support the sustainability goal and avoid undesirable results to sustainability indicators.

6.4.1.3 Public Noticing, Permitting and Regulatory Process

Public notice of actions and outcomes from the coordination process would be provided at the GSA's regular Board and Advisory Committee meetings. The permitting and regulatory process would depend upon the outcome of the coordination and identification of mutual areas of interest to include within the Farm Plans.

6.4.1.4 Estimated Costs and Funding Plan

A total of $40,000 is included in the initial 5-year budget provided in **Section 7.2** for developing and beginning implementation of the work plan. It is assumed that costs for portions of the study will be shared with the Petaluma Valley and Sonoma Valley GSAs.

6.4.1.5 Legal Authority

Any needed legal authorities would depend upon the outcome of the coordination and identification of mutual areas of interest to include within the Farm Plans.

6.4.2 Assessment of Additional Recycled Water Opportunities

The use of recycled water for agricultural and landscape irrigation within the Subbasin has provided substantial benefits to groundwater conditions. During the current water budget period, it is estimated that approximately 10,000 AFY of recycled water is delivered within the Subbasin for agricultural and landscape irrigation, significantly reducing the need for use of groundwater and other potable water supplies. As described in **Section 6.1**, based on limitations and uncertainty related to the potential for future expansion of recycled water supplies, additional expansion of recycled water deliveries for irrigation supplies was not included with the projects evaluated using scenario modeling.

This project involves a collaboration between the GSA and City of Santa Rosa and participating cities for the Santa Rosa Water Reuse System, Town of Windsor, and Sonoma Water for the Airport/Larkfield/Wikiup Sanitation Zone to perform an assessment of additional recycled water opportunities. It is anticipated that the assessment will include:

- Evaluation of existing and future availability, delivery commitments, and constraints
- Assessment of options to optimize existing and projected future supplies
- Analysis of preliminary costs and benefits for future options

6.4.2.1 Objectives, Circumstances and Timetable for Implementation

Objectives for expanding recycled water deliveries are to help achieve MOs and avoid undesirable results for the chronic lowering of groundwater levels sustainability indicator. Achieving MOs and avoiding undesirable results for the chronic lowering of groundwater levels sustainability indicator is also expected to benefit the groundwater storage and land subsidence sustainability indicators. Additionally, depending upon the locations within the Subbasin where recycled water projects are expanded, benefits to the MOs for the depletion of interconnected surface water sustainability indicator may also be realized.

It is assumed that the assessment will begin within the first 2 years of GSP implementation.

6.4.2.2 Expected Benefits

Potential benefits from implementation of expanding and maximizing the efficiency of recycled use is anticipated to include a reduction in groundwater pumping and localized increases in groundwater levels. Benefits from recycled water projects would primarily be evaluated using changes in measured groundwater levels and improvements to groundwater storage changes through implementation of the monitoring activities described in **Section 5**.

6.4.2.3 Public Noticing, Permitting and Regulatory Process

Public notice of actions and outcomes from the assessment would be provided at the GSA's regular Board and Advisory Committee meetings. While the permitting and regulatory process would depend upon the outcome of the assessment, each of the water recyclers within the Subbasin currently complies with all applicable permitting and regulatory requirements associated with recycled water use.

6.4.2.4 Estimated Costs and Funding Plan

A total of $30,000 is included in the initial 5-year budget provided in **Section 7.2** for the GSA to coordinate with recycled water purveyors to perform the necessary assessment.

6.4.2.5 Legal Authority

Each individual water recycler within the Subbasin owns its recycled water and has the legal authority to sell its recycled water in alignment with its policies. CWC Section 10726.2 provides GSAs the authority to purchase, among other things, land, water rights, and privileges.

6.4.3 Assessment of Potential Policy Options for Groundwater Sustainability Agency Consideration

SGMA provides several authorities to GSAs, which can be used to achieve groundwater sustainability and requires coordination between GSAs and land use agencies. This management action involves a collaboration between the GSA Board, local land use agencies, GSA member agencies, and stakeholders to assess future policy options that may be appropriate for the GSA to consider adopting or recommending for adoption by other agencies. This study will prepare a prioritized list of potential policy options, including stronger demand management actions that may need to be adopted should the projects described above not be implementable or successful. Based on input from the Advisory Committee, GSA Board, and the public, the following initial list of policy options has been developed for potential inclusion in the assessment:

- Water conservation plan requirements for new development.
- Discretionary review of well permits for any special areas identified in GSP

- GSA review of discretionary projects that impact groundwater resources
- Low-impact development or water efficient landscape plan requirements expansion
- Well construction and permitting recommendations (for example, water quality sampling and reporting for COCs, requirement for water-level measurement access, and procedures for preventing cross-screening of multiple aquifers)
- Well metering program
- Development of a drinking water well mitigation program
- Study of water markets
- Permitting and accounting of water hauling

This list represents initial ideas for policy options, which will be informed through the continued stakeholder engagement and outreach described in **Section 7**. As required by SGMA, it is expected that the GSA will participate with the County in the development of future General Plan amendments and updates. During this process, additional policy options may be developed and considered.

6.4.3.1 Objectives, Circumstances and Timetable for Implementation

The objectives for this management action are to develop, prioritize, and vet potential policy options that may be needed to supplement or replace the projects. As the timeframe for conducting the community outreach, studies, and procedural requirements for adopting policy options can be lengthy, the assessment and prioritization will be initiated in the first year of GSP implementation. The circumstances and timetable for adopting and implementing any of the recommended policy options will be based on ongoing monitoring of groundwater conditions and progress of project implementation. Policy options that focus on demand management would be applied in the case of a situation where planned projects and management actions are determined to be insufficient to reach and/or maintain sustainability and undesirable results are occurring and are not projected to be eliminated by 2042 using other available projects and management actions.

6.4.3.2 Expected Benefits

Specific expected benefits for this management action will depend upon the type and scope of any policy options that are recommended and adopted by the GSA Board and/or partner agencies. However, the types of policy options considered and recommended will be those that focus on avoiding undesirable results and achieving the sustainability goal.

6.4.3.3 Public Noticing, Permitting and Regulatory Process

Public noticing will be a key aspect of implementing this management action, as considerable engagement with stakeholders will be needed to assess potential benefits and impacts to

current and future groundwater users. Any policy options that result in limitations or curtailments of groundwater users would be conducted in an open and transparent process. The permitting and regulatory process associated with this management option will also depend upon the type of policy options under consideration.

6.4.3.4 Estimated Costs and Funding Plan

A total of $75,000 is included in the initial 5-year budget provided in **Section 7.2** for the GSA to perform the assessment and initiate implementing recommendations. The total cost associated with implementing the management action will depend upon the type and scope of any policy actions considered for implementation.

6.4.3.5 Legal Authority

The legal authorities required for implementing any policy options will depend upon the type of policy options being considered. For policy options that include mandatory reductions or limitations on groundwater use, CWC Section 10726.4(a)(2) provides GSAs with the authority to control groundwater extractions by regulating, limiting, or suspending extractions from individual groundwater wells or extractions from groundwater wells in the aggregate. Legal authorities for policy options that involve land use policy changes are retained by the County and City of Sonoma. Similarly, for any policy options related to well permitting, the legal authorities reside with the County.

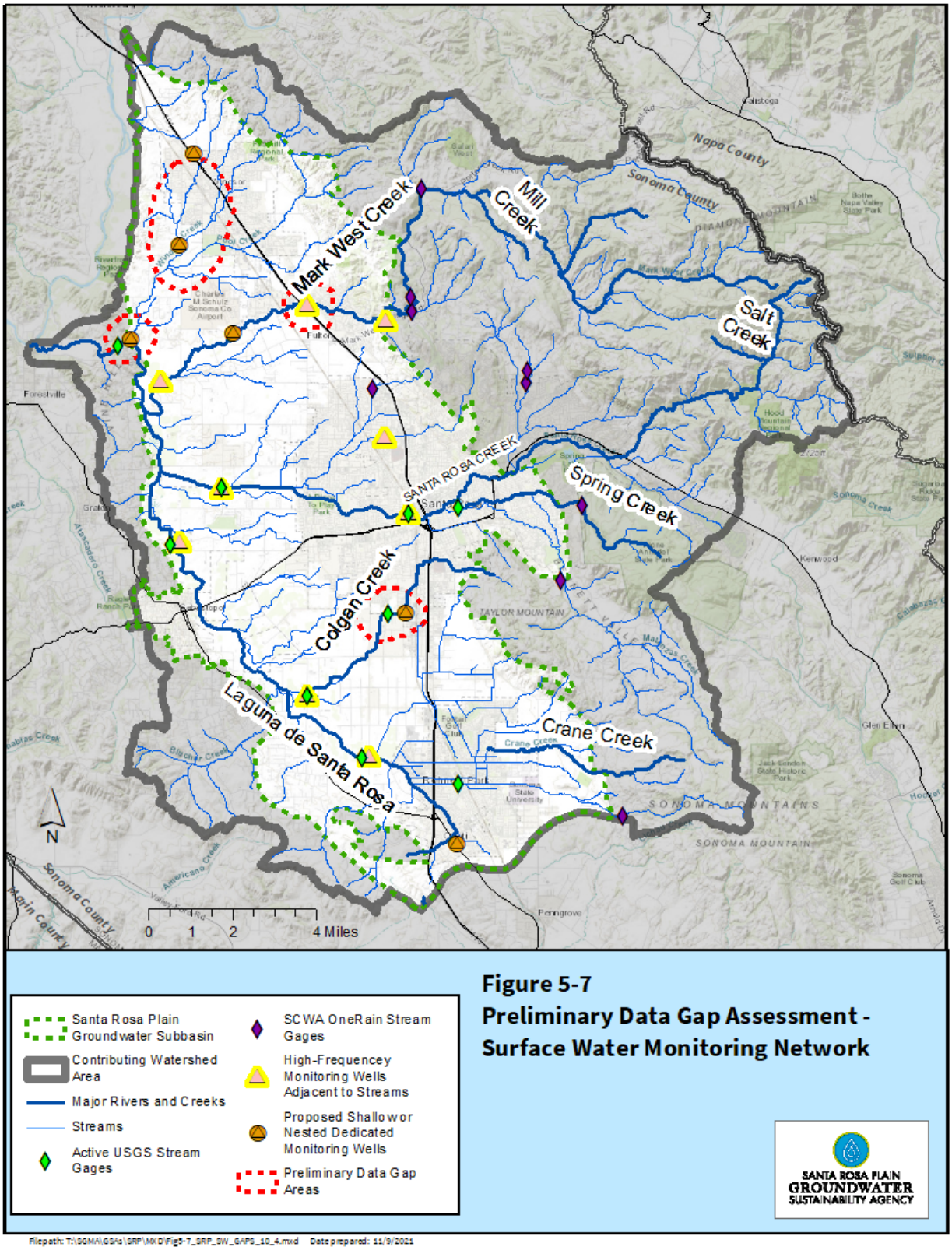


Figure 5-7. Preliminary Data Gap Assessment – Surface Water Monitoring Network

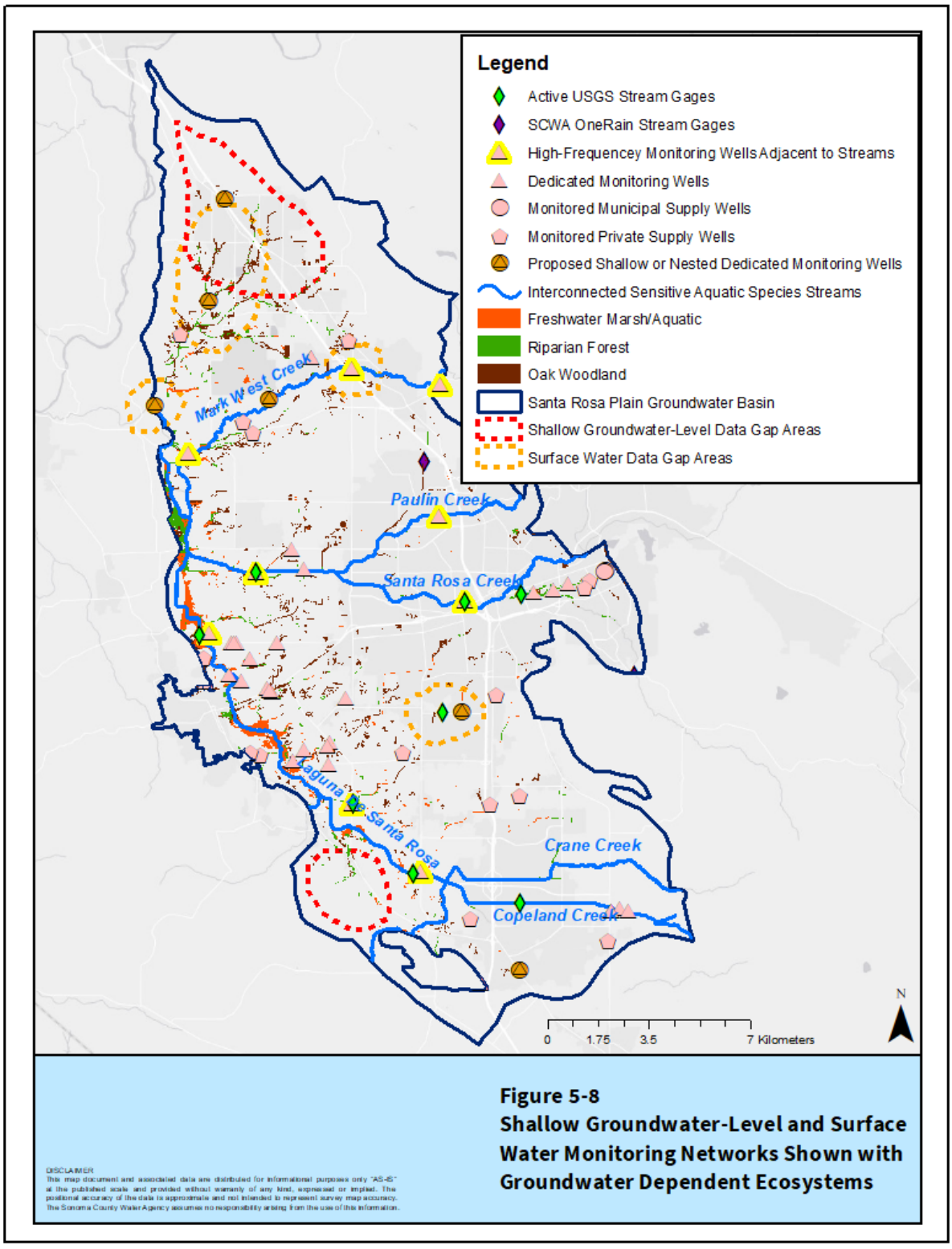


Figure 5-8. Shallow Groundwater-level and Surface Water Monitoring Networks and Groundwater Dependent Ecosystems

Section 7: Implementation Plan
Groundwater Sustainability Plan for Santa Rosa Plain Groundwater Subbasin

Table of Contents

7 IMPLEMENTATION PLAN 7-1
7.1 Governance Structure and Planned Administrative Approach 7-1
7.2 Groundwater Sustainability Plan Implementation Components and Estimated Costs 7-2
7.2.1 Administration and Finance 7-2
7.2.2 Communication and Stakeholder Engagement 7-2
7.2.3 Annual Monitoring, Data Evaluation, and Reporting 7-3
7.2.3.1 Monitoring and Data Evaluation 7-3
7.2.3.2 Annual Reports 7-5
7.2.4 Addressing Data Gaps 7-7
7.2.4.1 Studies and Information Gathering 7-9
7.2.4.2 Monitoring Network Improvements 7-10
7.2.5 Maintaining, Updating, and Improvements to Model 7-11
7.2.6 Study and Implementation of Projects and Actions 7-12
7.2.7 5-year Update to Groundwater Sustainability Plan 7-15
7.2.8 Estimated 5-year Implementation Costs 7-16
7.3 Funding 7-17
7.3.1 Fees, Grants, and Other Funding Sources 7-18
7.4 Schedule 7-18

Tables

Table 7-1. Monitoring Networks and Initial Representative Monitoring Point Networks 7-5
Table 7-2. Summary of Estimated 5-year Costs for Projects and Management Actions, Excluding Capital Project Costs 7-14
Table 7-3. Total Estimated 5-year Implementation Costs 7-17

Figures

Figure 7-1. Implementation Schedule 7-8

Appendix

7-A. Model Maintenance and Improvements for the Santa Rosa Plain Groundwater Sustainability Plan

7 IMPLEMENTATION PLAN

This implementation plan serves as an initial roadmap for addressing GSP implementation activities between 2022 and 2042 with a primary focus on implementation activities within the initial 5 years (2022 through 2026). This section describes the plans for implementing the activities and actions identified in **Sections 4** through **6** in this GSP, including the following:

- The GSA's governance structure and planned administrative approach
- The main implementation components and estimated costs for the initial 5 years of implementation
- The initial approach to funding
- A schedule

This implementation plan is based on the current understanding of Subbasin conditions, identified data gaps, monitoring needs and projects, and management actions. To successfully implement the GSP, the implementation plan will adapt over time based on new information and data, model development, and input from Subbasin stakeholders.

7.1 Governance Structure and Planned Administrative Approach

The GSA anticipates that the current governance and general administrative structure will remain in place through the implementation period. As described in **Section 1.3.2**, the 10 member agencies currently plan to continue operating under the Joint Powers Authority agreement that created the GSA. The Board will continue serving as the governing body, making decisions regarding implementation of projects and management actions; closing data gaps; contracts; administration; funding; and other governance issues. A stakeholder-based Advisory Committee representing multiple stakeholder interests will continue providing guidance and recommendations to the Board and GSA staff. Both the GSA Board and Advisory Committee will continue to hold regular public meetings in compliance with California's laws governing public meetings (commonly known as the Brown Act).

Currently, the GSA contracts with Sonoma Water for technical, outreach, grant administration, and GSA management services and contracts with other consultants for legal, facilitation, and some monitoring services. As the GSA transitions from GSP development to implementation starting in 2022, staffing needs will be evaluated to determine the most efficient and effective move forward. To reduce costs and for consistency for groundwater users within Sonoma County, it is possible that the GSA will coordinate management and other services with the Petaluma Valley and Sonoma Valley GSAs.

7.2 Groundwater Sustainability Plan Implementation Components and Estimated Costs

This section describes details of each of the main implementation components, assumptions, and estimated costs for the initial 5 years.

7.2.1 Administration and Finance

Administration and finance costs include day-to-day management of the agency, as-needed legal costs, costs associated with applying for and administering grants, tasks associated with implementation of a fee, auditing and accounting services, administration of the well registration program, facility fees, and office supplies. Annual administration costs are estimated to range from $250,000 to $300,000 annually.

7.2.2 Communication and Stakeholder Engagement

To meet the requirements of SGMA, the GSA will continue the activities described in **Section 1**, including the following:

- Holding regular meetings of a diverse, stakeholder-based Advisory Committee to receive feedback on implementation efforts and to solicit outreach ideas and assistance
- Informing, educating, and soliciting feedback from stakeholders on the progress of implementing projects and management actions and on Subbasin conditions through social media, the GSA website, periodic community/town hall meetings, focused stakeholder briefings, and paid and free media
- Approaching and engaging a diverse set of stakeholders and groundwater users by continuing to reach out to and meet with organizations that represent DACs (including Spanish-language engagement), farmers, environmental interests, rural landowners, and business interests
- Conducting government-to-government communication with federally and non-federally recognized Tribal governments to reassess interest in participating in GSA activities

The GSA will maintain and improve two products currently under development: The Groundwater User Information Data Exchange program, which allows well owners to review and correct well and groundwater-use information, and the Groundwater Data Dashboard, which will provide groundwater data in a visual, user-friendly format.

The GSA will conduct, in cooperation with other agencies or organizations, outreach and education programs on specific topics relevant to groundwater users within the Subbasin, such as the importance of well maintenance, management, and best practices with the goal of empowering well owners to understand well construction, pump and storage practices, water quality considerations and treatment options, and well abandonment.

In addition, the GSA will continue to engage and coordinate with local, state, and regional agencies (including GSA member agencies, other GSAs, Permit Sonoma, Agricultural Commissioner, Sonoma County Ag + Open Space District, DWR, SWRCB-DDW and Water Rights

Division, and NCRWQCB) to fill data gaps and implement projects and actions. This coordination will include discussions of partnering opportunities for funding implementation components that are mutually beneficial.

A focused area of engagement in the early stages of GSP implementation is anticipated to be continued coordination and information sharing with agencies that have land use responsibilities and authorities, including Permit Sonoma, city planning departments, and county and city planning commissions. This coordination will build on ongoing coordination that has occurred through development of the GSP and activities that Permit Sonoma has initiated using Proposition 68 grant funding. Coordination will include sharing of information, including tracking land use changes, the number of new well permits, and new agricultural permits (including cannabis projects) within the Subbasin/contributing watershed and surrounding areas. In addition, as required by SGMA, the GSA will engage in and review General Plan amendments, other local policies and issues related to groundwater resources in the Subbasin.

An important component of this engagement will be ongoing coordination with agencies responsible for regulating groundwater quality. The GSA will regularly coordinate with NCRWQCB, SWRCB-DDW, and others to understand and develop a process for determining if groundwater management is resulting in degraded water quality and to assess whether any additional COCs should be considered in the future.

Annual outreach and communication are estimated to range in cost from approximately $95,000 to $120,000 per year.

7.2.3 Annual Monitoring, Data Evaluation, and Reporting

Monitoring of the five applicable sustainability indicators is a key component for successful implementation of the GSP. Most monitoring relies on existing monitoring programs, some of which will be enhanced or expanded as described in **Section 5** and **Section 7.2.4.2**. Data from the monitoring programs will be routinely evaluated to ensure progress is being made toward sustainability, or to identify whether undesirable results are occurring, and assess and investigate conditions that may lead to undesirable results. Data will be maintained in the Data Management System and will be used by the GSA to guide decisions on projects and management actions and to prepare annual reports to Subbasin stakeholders and DWR.

7.2.3.1 Monitoring and Data Evaluation

Specific planned monitoring activities are summarized herein and in **Table 7-1** and are more fully described in **Section 5**.

Groundwater-level monitoring activities will include the collection of groundwater-level data at the 26 existing RMPs and new planned RMPs identified in **Section 5.3.1** for comparison to MTs and MOs. The groundwater-level monitoring will also include the coordination and evaluation of measurements from 80 additional wells within the Subbasin and contributing watershed areas, as well as outside of the contributing watershed areas along basin boundaries, as described in **Section 5.2.1**, to continue tracking trends in these wells with historical data, assess changes in groundwater elevations near boundaries, and support the development of groundwater-level contour maps and storage change estimates. The groundwater-level data

will be collected in accordance with the monitoring protocols outlined in **Section 5.3.1**. Monitoring network data gaps identified in **Section 5.4.1** will be addressed through the activities described in **Section 7.2.4**. Groundwater elevation data will be uploaded to the DWR data portal semiannually, before January 1 and July 1 of each year.

- Water quality monitoring activities will include the compilation and evaluation of water quality data reported from existing public water supply wells and compared with the MTs and MOs for the water quality sustainability indicator.

    - For the water quality sustainability indicator, the data review will focus on exceedances of MTs, or MCLs and SMCLs for the three COCs (arsenic, nitrate, and TDS) identified for this GSP. However, if during review of the water quality data additional constituents appear to frequently exceed MCLs and SMCLs, MTs and MOs will be considered for these additional constituents during GSP 5-year updates. The number of public water supply wells routinely monitored for each COC is in **Table 7-1**. If any other routine monitoring of supply wells is initiated in the Subbasin at a later date, these wells will also be considered for inclusion in the water quality monitoring network.

- Monitoring for land surface subsidence will be measured using satellite InSAR data provided by DWR. InSAR data will be downloaded from the DWR website annually, checked and verified for completeness and reasonableness, and used to develop annual change in elevation maps. The average value for each 100 square meter pixel and elevation change maps will be used to compare with MTs and MOs for the land surface subsidence sustainability indicator.

- Monitoring for surface water and groundwater interaction will include the following monitoring activities:

    - Compilation and evaluation of surface water data from 18 active stream gages within the Subbasin and contributing watershed area.

    - Measurement and evaluation of groundwater elevations from the seven RMPs used to monitor surface water depletion as a proxy. For reporting seasonal highs and lows for future comparison with MTs, all measurements collected more frequently than monthly will be reported as monthly averages to better align with the measurement frequency within historical datasets used to calculate the MTs.

    - Assessment and improvement of the monitoring network for surface water and groundwater interaction as described in **Section 7.2.4.1**.

Table 7-1. Monitoring Networks and Initial Representative Monitoring Point Networks

Sustainability Indicator	Monitoring Network	Initial Representative Monitoring Point Network
Chronic Lowering of Groundwater Levels	96 wells within the contributing watershed area (including 85 wells in the Subbasin) 61 wells are inferred to primarily monitor the shallow aquifer 35 wells inferred to primarily monitor the deep aquifer	14 existing and 4 new shallow aquifer system wells 12 existing and 4 new deep aquifer system wells
Subbasin Boundary Groundwater-level Monitoring Network (this network provides information on boundary conditions, but is not used for RMPs)	16 wells outside boundaries but within contributing watershed, including: 8 wells: Wilson Grove Formation Highlands Basin 1 well: Petaluma Valley Basin 3 wells: Rincon Valley Subbasin 1 well: Alexander Valley Subbasin 2 wells: outside of defined basins	
Reduction in Groundwater Storage	Same as monitoring network for Chronic Lowering of Groundwater Levels	Same as monitoring network for Chronic Lowering of Groundwater Levels
Degraded Water Quality	Existing supply well groundwater quality monitoring programs, as follows: Arsenic: 104 wells Nitrate: 122 wells Salts: 92 wells	Existing supply well groundwater quality monitoring programs, as follows: Arsenic: 104 wells Nitrate: 122 wells Salts: 92 wells
Land Surface Subsidence	Three GPS locations; InSAR satellite in most of the Subbasin	InSAR dataset
Interconnected Surface Water	18 stream gages; 10 shallow monitoring wells adjacent to streams	Seven shallow monitoring wells adjacent to streams

7.2.3.2 Annual Reports

Annual reports will be developed to present data, information, and the implementation status for each WY and meet SGMA requirements. As defined by DWR, annual reports must be submitted for DWR review by April 1st of each year following the GSP adoption, except in years when 5-year or periodic assessments are submitted. Annual reports are anticipated to include three key sections: General Information, Subbasin Conditions (including SMC status and progress towards achieving measurable objectives), and Implementation Actions and Activities.

General Information

The General Information section will include an executive summary that highlights the key content of the annual report. This section will include a map of the Subbasin, a description of the sustainability goal, a description of GSP projects and their progress, and an annual update to the GSP implementation schedule.

Subbasin Conditions

The Subbasin Conditions section will describe the current groundwater conditions and monitoring results. This section will also include an evaluation of how conditions have changed over the previous year and will compare groundwater data for the WY to historical groundwater data. Estimated pumping data, effects of project implementation (if applicable), surface water deliveries, total water use, and groundwater storage data will be included. Key required components include the following:

- Groundwater-level data from the monitoring network, including contour maps of seasonal high and seasonal low water-level maps
- Hydrographs of groundwater elevation data at RMPs
- Groundwater extraction data and estimates by water-use sector
- Groundwater quality at RMPs
- Surface water supply availability and use data by water-use sector and source
- Streamflow data
- Total water-use data
- Change in groundwater in storage
- Subsidence rates and associated data

As part of the monitoring program reporting, status of SMC will also be reported, including MT and MO status for RMPs. Additionally, information on land use changes and additional permitting of wells and projects that use groundwater will be tracked and reported in the annual reports.

Groundwater Sustainability Plan Implementation Progress

Progress toward GSP implementation will be included in the annual reports. This section of the annual report will describe the progress made toward achieving interim milestones as well as implementation of projects and management actions. Key required components include the following:

- GSP implementation progress, to be measured by whether the GSA is achieving the milestones provided on the Implementation Schedule (**Figure 7-1**)
- Progress toward achieving the Subbasin sustainability goals
- Any changes that may be considered necessary for successful GSP implementation

Development of an annual report will begin following the end of the WY, September 30, and will include an assessment of the previous WY. The annual report will be submitted to DWR before April 1 of the following year. The 2022 annual report covering WY 2021 will be

submitted by the GSA by April 1, 2022. Four annual reports for the Subbasin will be submitted to DWR each April between 2022 and 2025, prior to the first 5-year update of this GSP, which will be prepared in 2026 and submitted to DWR in January 2027.

The estimated annual cost of performing annual monitoring, data evaluation, and reporting ranges from $225,000 to $275,000, with a cumulative 5-year cost ranging from $1,125,000 to $1,375,000.

7.2.4 Addressing Data Gaps

Through development of this GSP, a number of key data gaps have been identified in **Sections 3** through **5**. These data gaps were shared and discussed with Subbasin stakeholders to prioritize activities and actions needed to address the following data gaps:

- Amounts, locations, and depths of groundwater pumping (rural residential, agricultural, public water systems, commercial, and industrial)
- Role of faults within and along the boundaries of the Subbasin, particularly the Sebastopol Fault
- Interconnection of streams to the shallow aquifer system, including seasonal variability and how groundwater pumping and surface water diversions affect streamflow
- Basin boundary characteristics, such as the direction and magnitude of groundwater fluxes across Subbasin boundaries
- Aquifer hydraulic properties, recharge and discharge mechanisms, and volumes for both the shallow and deep aquifer systems
- Three-dimensional data gaps in the monitoring network for each primary aquifer

Studies and activities planned to address these identified data gaps within the initial 5 years of GSP implementation are identified in the following sections and categorized as either studies and information gathering or monitoring network improvements.

GSP Program Elements	First 20 Years of GSP Implementation																			
	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
GSP Submittal and State Review																				
GSP Submittal to DWR	★																			
DWR Review/Approval																				
Administration & Finance Program																				
Adminstrative/Governance Planning																				
Funding Program																				
Fee Study																				
Funding Mechanism Implementation																				
Fee Collection																				
Public Outreach & Coordination																				
Adaptive Management																				
Management Action Implementation																				
Study - Policy Options																				
Study - Recycled Water Opportunities Assessment																				
Study - Farm Plan Coordination																				
Implement Recommended Actions																				
Monitoring Program & Data Gaps																				
Implementation of Monitoring																				
Data Gap Filling						To be continued as-needed														
Model Updates and Refinements						To be continued as-needed														
Project Implementation																				
Group 1 Projects																				
Voluntary Conservation					To be continued as-needed															
Group 2 Projects																				
Stormwater Capture & Recharge - Site Investigations																				
Stormwater Capture & Recharge - Pilot																				
Stormwater Capture & Recharge - Project																				
Group 3 Projects																				
Aquifer Storage & Recovery (ASR) Feasibility Study Update																				
ASR Investigations and Pilot[(1)]																				
ASR Project Implementation[(1)]																				
Reporting																				
Annual Reports	★	★	★	★		★	★	★	★		★	★	★	★		★	★	★	★	
Five Year Evaluation/Updates					★					★					★					★

Notes:

DWR Review

Milestone/Document Submittal

Planning, Desiign,Contruction Activity

Implementation Activity

1 Some projects, such as ASR, may be pursued on a more rapid pace by other entities involved with drought response.

7.2.4.1 Studies and Information Gathering

Planned studies and information gathering include the following activities.

Improve information on existing water wells and groundwater extraction. The objective of this task is to better assess the locations, depths, volumes, and timing of groundwater pumping from water-use sectors that have not historically measured and reported water use, such as rural residential, agricultural, commercial, and industrial. This will improve the assessment of potential impacts from groundwater pumping to beneficial users and uses within the Subbasin, including existing residential and other water wells and GDEs. The task will include the following activities, which will be performed within the initial 2 years of GSP implementation:

- Integration of parcel-specific information obtained through the planned well registration program with existing well log databases
- Assessment of available remote sensing data on actual ET to help constrain the estimates of groundwater demands for irrigation supplies

Aquifer system properties assessment: The objective of this task is to improve the understanding of the aquifer system hydrogeologic framework, distribution, and potential effects of faults on groundwater flow and basin boundary characteristics. Completion of this task will also improve the GSA's ability to assess potential impacts from groundwater pumping to beneficial users and uses within and along the boundaries of the Subbasin, including existing residential and other water wells and GDEs. As part of this task, the GSA will evaluate the airborne electromagnetic survey results (data collection and compilation funded by DWR) and incorporate them into the existing HCM. DWR is planning to collect geophysical data from the Subbasin through its airborne electromagnetic survey program in 2021 or 2022. Additional focused geophysical surveys to refine information in key areas (for example, areas identified for potential managed aquifer recharge projects) will also be considered.

Based on the data collection and evaluation described in this section, aquifer testing will be performed and evaluated at up to three locations. It is anticipated that the aquifer testing will be completed within the initial 3 years of GSP implementation. Wells for testing will be identified using the following criteria:

- Wells are owned by willing cooperators
- Wells have known well completion information
- Wellheads are completed such that water elevations in wells can be monitored with data loggers
- Wells are equipped with accurate flowmeters
- Wells have area or system for discharge of test water
- Preferred wells will have nearby wells that can be monitored during the test and will be located near key data gap areas, such as near interconnected surface water with nearby

shallow monitoring wells and along Subbasin boundaries (particularly the western and southern boundaries)

Interconnected surface water and GDE studies: As indicated in **Section 4.10.2.1**, in recognition of the significant information and data limitations and the importance of interconnected surface water to beneficial users within the Subbasin, the following studies and activities are planned:

- Develop improved information on the locations and amounts of surface water diversions under the jurisdiction of the SWRCB, including both direct diversions from streams and diversions that may occur from water wells near streams under riparian water rights. This information will be developed through the coordination process established between the GSA and SWRCB related to depletions of interconnected surface water.

- Perform studies that determine the impact of groundwater pumping on surface water depletion through a combination of differential stream gaging, tracer experiments, temperature profiling, and other methods.

- Assess the influence of groundwater pumping and groundwater levels on GDE health using available remote sensing tools and datasets. The GDE Pulse web app developed by TNC provides data on long-term temporal trends of vegetation metrics. This information will be integrated with available groundwater-level data and information to assess the relationship between groundwater conditions and GDEs. Conduct field visits as needed to verify the findings of the remote sensing assessment regarding GDE locations and health. The potential GDEs identified in this GSP will be field-verified to ensure that groundwater-dependent communities exist, and that the shallow groundwater is connected to regional aquifers that will be managed as part of this GSP.

- Compile and evaluate existing and relevant habitat field surveys that aid in understanding potential impacts of groundwater pumping on habitat associated with interconnected surface water.

To help prioritize and schedule these activities, the GSA will develop ongoing consultation with interested members of the GDE and ISW practitioner work groups to address these important data gaps within the Subbasin. It is anticipated that this consultation will be scheduled within the first 6 months of implementation.

7.2.4.2 Monitoring Network Improvements

Based on the assessment of data gaps in **Section 5**, the following activities for improving the monitoring networks are planned.

Refinement of Groundwater-level Monitoring Network: As described in **Section 5**, many of the identified data gaps in the Groundwater-level Monitoring Network are being addressed through new wells being constructed under the Proposition 68 grant. For remaining data gap areas, the GSA will evaluate both use of existing voluntary wells and construction of new dedicated monitoring wells. For the purposes of estimating costs, it is assumed that two new dedicated multi-level monitoring wells would be constructed for the Groundwater-level Monitoring

Network. The GSA intends to conduct outreach and expand the voluntary groundwater-level monitoring program in the Subbasin during GSP implementation.

Additionally, the GSA will work to improve data quality in groundwater-level monitoring networks by a combination of the following activities:

- Performing survey activities for wells that lack sufficient Reference Point vertical survey data, as funding becomes available
- Obtaining well construction information from well owners or by conducting investigations (that is, video logging) as funding or technical assistance becomes available
- Replacing wells in the monitoring network that have data quality issues with dedicated monitoring wells, as funding becomes available

Refinement of interconnected surface water monitoring network: Following completion of the interconnected surface water and GDE studies and information gathering as described, improvements to the interconnected surface water monitoring network will be developed. For the purposes of estimating costs, it is assumed that two new dedicated shallow aquifer system monitoring wells would be constructed for the interconnected surface water monitoring network between years 2 and 4 of GSP implementation. Additionally, it is assumed that remote sensing assessments of vegetation health will continue to be performed and reported at key intervals such as the 5-year GSP updates.

The 5-year costs of addressing data gaps are estimated to be from $750,000 to $1,250,000.

7.2.5 Maintaining, Updating, and Improvements to Model

The Subbasin groundwater model (SRPHM) informs the project and management activities and ongoing performance assessment of the SMC. Periodic updates to the groundwater model will be required to continue to refine and improve its capabilities and maintain ongoing functionality. This includes incorporating new model tools and features, updates to HCM, incorporating new monitoring data, and related work to support ongoing simulations of projects and management actions. Improvements will be focused on the initial 3 years of implementation to facilitate reassessing preliminary SMC, as appropriate, considering the appropriateness basin boundary representation in the model, and planning for any projects and actions. Model updates and refinements will be informed by data and information collected during early stages of implementation, including the planned activities for assessing data gaps described in **Section 7.2.4**. A detailed plan for model improvements and updates is provided in **Appendix 7-A**. The preliminary areas of focus identified for model updates and improvements include the following:

- Focused calibration of surface water and groundwater interaction
- Assessment of aquifer properties using data from planned airborne electromagnetic surveys, aquifer testing, and model testing

- Assessment of model boundary conditions, including locations and representation of simulated model boundaries with a focus on the western boundary where some of the larger areas of uncertainty currently exist

- Improvement of model estimates of groundwater pumping, including response to changing climate, impact of surface water diversions, and recycled water

- Update model predictive simulations to reflect new information on alternative future climate scenarios

The 5-year costs of performing updates and improvements to the model are estimated to be from $250,000 to $400,000.

7.2.6 Study and Implementation of Projects and Actions

To prevent potential undesirable results and to achieve MOs, projects and management actions are planned as part of GSP implementation. As described in **Section 6**, a portfolio of projects and management actions has been developed with the goal of addressing relevant sustainability indicators, including the circumstances under which they may be implemented.

The GSA plans to immediately begin implementation of selected projects and management actions. In some cases, initial implementation steps include performing studies or analyses to refine the concepts into actionable projects. Therefore, the initial activities for project implementation will include both initiation of Group 1 projects, and refining and planning for other projects and actions identified in **Section 6**. Studies and work efforts may include, but are not limited to, CEQA studies and documentation and engineering feasibility studies and preliminary design reports.

After necessary initial studies are completed, projects and management actions will undergo, as necessary, final engineering design (in the case of infrastructure projects) and public noticing and outreach, after which construction projects can occur followed by ongoing operations and maintenance.

The following activities related to projects and actions are planned during the first 5 years of implementation.

<u>Implementation of Group 1 Projects</u>:

- Assessment and implementation of conservation and groundwater-use efficiency opportunities. This project would include an assessment of groundwater-use characteristics, existing levels of water-use efficiency, and recommendations on preferred tools and strategies for implementation. While implementation of these projects is initially planned to be on a voluntary basis, the assessment will also identify specific metrics for evaluating the benefits of the projects and assess Subbasin conditions that may lead to mandatory implementation of demand management actions.

Planning and Potential Implementation of Group 2 Projects:

- Site-specific investigations and pilot study of On-Farm and other dispersed recharge opportunities, which will consider and include the following:
    - Water available for recharge
    - Areas with permeable near-surface deposits
    - Optimal methods and techniques
    - Outreach to interested landowners with locations that could help sustain baseflows/support GDEs for recharge

Planning and Potential Implementation of Group 3 Projects:

- Update 2013 Groundwater Banking Feasibility Study for other ASR opportunities including the following:
    - Update source water (Russian River) availability and transmission system capacity assumptions
    - Assess locations/operations that benefit GSP implementation (that is, areas of depletion)
    - Design and implement pilot studies for favorable areas
- Coordination and support for planning and implementation of ASR projects that may be developed and implemented by other project proponents on an accelerated timeframe in response to current drought conditions.

Management Actions:

- Coordination of Farm Plans developed at individual farm sites, with implementation of the basinwide GSP as follows:
    - Identify areas of mutual interest (for example, improved water-use efficiency, increased groundwater recharge, increased monitoring and data collection, coordinated information sharing, and reporting) in addition to challenges that need to be addressed (for example, data confidentiality, data quality requirements, verification of Farm Plan performance)
    - Identify requirements or standards to demonstrate benefits to GSP implementation, develop metrics that would be measured and verified, and consider options to incentivize actions of mutual benefit
- Assessment of additional recycled water opportunities including the following:
    - Optimization of existing and projected future available supplies
    - Cost/benefit analysis for future alignment options
    - Identification of optimal locations for future storage

- Study of potential policy options for future GSA consideration or recommendation. This study will prepare a prioritized list of potential policy options, including stronger demand management actions that may need to be adopted should the projects previously described in this section not be implementable or successful. The following initial list of potential policy options has been developed for potential inclusion in the assessment:
    - Water conservation plan requirements for new development
    - Discretionary review of well permits for any special areas identified in GSP
    - GSA review of discretionary projects that impact groundwater resources
    - Expansion of low-impact development or water efficient landscape plan requirements
    - Well construction and permitting recommendations (for example, water quality sampling/reporting for COCs, requirement for water-level measurement access, prevent cross-screening multiple aquifers)
    - Metering program
    - Development of a drinking water well mitigation program
    - Permitting and accounting of water hauling

This list represents initial ideas for policy options, which will be informed through continued stakeholder engagement and outreach. In particular, it is expected that as the GSA participates in future General Plan amendments and updates with the County, as required by SGMA, additional policy options may be developed and considered.

The estimated costs of refining and implementing these projects and actions are estimated to be from $320,000 to $790,000, as summarized in **Table 7-2**.

It is anticipated that the capital project costs within the initial 5 years will be paid for by some combination of individual project proponents/beneficiaries and grant funding. Specific details regarding roles of project proponents and the cost share mechanisms are anticipated to be determined as the projects are further defined and scoped. Therefore, costs associated with implementation of capital projects are not included in the GSP implementation budget estimate in **Table 7-2**.

Table 7-2. Summary of Estimated 5-year Costs for Projects and Management Actions, Excluding Capital Project Costs

Project/Action	Project Scenario Group	Estimated 5-year Costs	Other Potential Funding Sources	Assumptions
Conservation/Water-Use Efficiency/Alternate Water Sources	1	$75,000 to $110,000	Other GSAs	Some assessment costs shared by other GSAs
Stormwater Capture and Recharge	2	$80,000 to $230,000		

Project/Action	Project Scenario Group	Estimated 5-year Costs	Other Potential Funding Sources	Assumptions
Aquifer Storage and Recovery	3	$100,000 to $200,000	Other GSAs, Sonoma Water/Water Contractors	Other GSAs and Sonoma Water/Water Contractors will also contribute funding
Farm Plan Coordination		$20,000 to $60,000	Other GSAs	Other GSAs will also contribute funding
Recycled Water Assessment		$20,000 to $40,000	Water recyclers	
Policy Options		$25,000 to $120,000	Other GSAs/County	Other GSAs will also contribute funding for assessment of options
		$320,000 to $790,000 $550,000	Total Range Midrange	

It is also anticipated that each implemented project and management action will have its own set of monitoring objectives and data collection requirements to allow for evaluation and confirmation assessments, and, if necessary, modifications to improve effectiveness of the projects and management actions. The costs of specific projects that are not covered by beneficiaries/project proponents will include assumptions about financing the projects over time.

7.2.7 5-year Update to Groundwater Sustainability Plan

As required by SGMA regulations, an evaluation of the GSP and the progress toward meeting the approved SMC and the sustainability goal will occur at least every 5 years and with every amendment to the GSP. A written 5-year evaluation report (or periodic evaluation report) will be prepared and submitted to DWR. The information to be included in the evaluation reports is summarized as follows:

- A sustainability evaluation that contains a description of current groundwater conditions for each applicable sustainability indicator and that includes a discussion of overall sustainability in the Subbasin. Progress toward achieving interim milestones and MOs will be included, along with an evaluation of status relative to MTs. If interim milestones are not being achieved, the evaluation will identify obstacles to achieving the interim milestones. The evaluation will include a plan for overcoming those obstacles and provide a new assessment of interim milestones that achieve sustainability by 2042.

- An implementation plan progress section that describes the current status of project and management action implementation and whether any adaptive management actions have been implemented since the previous report. An updated project implementation schedule will be included, along with any new projects identified that support the sustainability goals of the GSP and a description of any projects that are no longer included in the GSP. Benefits of implemented projects and management actions will be described and updates on projects and management actions that are underway at the time of the report will be documented.

- GSP elements will be reconsidered as additional monitoring data are collected, land uses and community characteristics change, and GSP projects and management actions are implemented. It may become necessary to reconsider elements of this GSP and revise the GSP as appropriate. GSP elements to be reassessed may include basin setting, management areas, undesirable results, MTs, and MOs. If appropriate, a revised GSP, completed at the end of the 5-year evaluation period, will include revisions informed by findings from the monitoring program and changes in the Subbasin, including changes to groundwater uses, demands, or supplies, and results of project and management action implementation.

- A description of the monitoring network will be provided. An assessment of the monitoring network's function will be included, along with an analysis of data collected to date. If data gaps are identified, the GSP will be revised to include a method for addressing these data gaps, along with an implementation schedule for addressing gaps and a description of how the GSA will incorporate updated data into the GSP.

- New information available since the GSP adoption, last 5-year evaluation, or GSP amendment will be described and evaluated. New information warranting a change to the GSP will be included in the update.

- A summary of the regulations or ordinances related to the GSP that have been implemented by DWR or others since the previous report will be provided. The report will include a discussion of any required updates to the GSP.

- Legal or enforcement actions taken by the GSA in relation to the GSP will be summarized, including an explanation of how such actions support sustainability in the Subbasin.

- A description of amendments to the GSP will be provided in the 5-year evaluation report, including adopted amendments, recommended amendments for future updates, and amendments that are underway.

- Ongoing coordination will be required among the GSA; members of the Advisory Committee; other local, state, and federal partners; and the public. The 5-year evaluation report will describe coordination activities between these entities such as meetings, joint projects, data collection and sharing, and groundwater modeling efforts.

- Outreach activities associated with the GSP implementation, assessment, and GSP updates will be documented in the 5-year evaluation report.

The initial 5-year GSP evaluation is due to be submitted to DWR in 2027. The estimated cost of preparing the initial 5-year GSP update is estimated to be from $200,000 to $300,000.

7.2.8 Estimated 5-year Implementation Costs

The cost of the items described in **Sections 7.1.1** through **7.1.7** will vary from year to year but the average cost of implementation is approximately $1.2 million annually for the first 5 years (fiscal year 2022-2023 through fiscal year 2027-2028) for total costs of approximately $5.9 million, excluding the construction costs of specific capital projects, as summarized in **Table 7-3**.

To enhance efficiencies and provide similar benefits to nearby groundwater users in Sonoma Valley and Petaluma Valley GSAs, it is assumed that the development costs of common projects and actions will be shared among the three GSAs. In addition, the budget assumes that costs will be shared for the development of projects and actions conducted in cooperation with local, regional, and state partners (such as recycled water purveyors, water suppliers, RCDs, and others).

Table 7-3. Total Estimated 5-year Implementation Costs

	Year 1	Year 2	Year 3	Year 4	Year 5
GSP Implementation Item	**2022 to 2023**	**2023 to 2024**	**2024 to 2025**	**2025 to 2026**	**2026 to 2027**
GSA Administration & Operations	$285,000	$255,000	$250,000	$240,000	$255,000
Communication & Stakeholder Engagement[a]	$120,000	$95,000	$95,000	$95,000	$110,000
Annual Monitoring, Evaluation & Reporting	$275,000	$220,000	$220,000	$220,000	$220,000
Data Gap Filling[a]	$100,000	$355,000	$551,000	$290,000	$0
Conceptual Projects & Planning Design[a]	$80,000	$165,000	$265,000	$20,000	$20,000
Model Updates[a]	$50,000	$150,000	$75,000	$50,000	$25,000
5-year GSP Updates[a]	$0	$0	$0	$100,000	$200,000
Subtotal	$910,000	$1,240,000	$1,456,000	$1,015,000	$830,000
10 percent Contingency - rounded to nearest $5,000	$90,000	$125,000	$145,000	$100,000	$85,000
Total	$1,001,000	$1,364,000	$1,601,600	$1,116,500	$913,000

[a] Potential for bond funding/technical services support

Notes:

Preliminary average annual costs are equal to approximately $1.2 million.

Estimates of future implementation costs (Years 6 through 10) will be provided in the 5-year GSP update.

7.3 Funding

Development of this GSP was partially funded through grants from DWR through the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1) and the California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access for All Act of 2018 (Proposition 68). Additional support was provided through DWR Technical Support Services program, which included the drilling of 12 shallow monitoring wells. GSA member agencies, as described in **Section 1.3.1**, funded the remainder of the GSP development and GSA administration through a fee based on groundwater pumping and/or member-agency contributions. The grant funding ends after submittal of this GSP. The current fee will be reassessed and member-agency funding commitments will end on June 30, 2022. Therefore, additional funding streams are needed for GSP implementation.

GSP implementation will partially be funded by an implementation fee that is the current subject of an ongoing fee study. Other potential funding sources include grants through DWR, SWRCB, and federal and local entities; DWR technical support; and partnerships with member

agencies, other GSAs and entities interested in leveraging mutually beneficial programs, projects, and studies.

7.3.1 Fees, Grants, and Other Funding Sources

SGMA provides GSAs the authority to impose certain fees, including groundwater pumping fees. In September 2021, the GSA engaged a consultant, SCI Consulting, to conduct a fee study to evaluate and provide recommendations for GSP implementation funding. The study will build on the work done in a previous fee study adopted by the GSA Board in 2019. The new study will include outreach and education to inform and solicit feedback from groundwater users and other stakeholders. Any imposition of a fee, tax, or charge will comply with California law and all applicable Constitutional requirements, based on the nature of the fee.

The fee will be designed to pay for the costs of implementing the GSP that will not be covered by grants, low-interest financing, project beneficiaries and project partners. An implementation budget provided in **Table 7-3** provides a high-level overview of costs, and indicates items that could be eligible for grant funding. Administrative and operational costs are generally not eligible for grants or loans, but the remainder of the items listed in the budget (with the exception of contingency funds) may be partially or fully eligible for grant funding, depending on the grant source and availability. The GSA has successfully applied for and received more than $2.2 million in grant funding and technical support services, and will continue to pursue grants and low-interest financing to offset the costs of monitoring, filling data gaps, and for planning and implementing projects and actions.

In addition, funding could be provided by project partners (such as other agencies) or project beneficiaries (such as farmers, businesses, and nearby groundwater users) who directly benefit from project implementation.

A more detailed budget will be developed as part of the fee study process and will be available in Winter 2022. The GSA Board will consider adoption of the implementation fee in Spring 2022, and fee collection is anticipated to begin in December 2022.

7.4 Schedule

The implementation schedule is on **Figure 7-1.** The final GSP will be submitted to DWR no later than January 31, 2022. While DWR has 2 years to review the GSP, the schedule on **Figure 7-1** assumes that implementation begins immediately, and provides an overview of the preliminary schedule for agency administration and finance, monitoring, project implementation, and reporting. Many of these categories consist of ongoing tasks and efforts that will continue throughout GSP implementation.

Administration and finance presented on **Figure 7-1** includes completion and implementation of the fee study and outreach and communication. The task also includes studies and implementation of management actions, including Farm Plan Coordination, assessment of additional recycled water opportunities, and development of the policy options (described in **Section 7.2.6**).

The monitoring program and data gap task includes collecting and analyzing data from existing and future RMPs, and planning for new monitoring sites to fill the data gaps discussed in **Section 5**.

The project implementation schedule includes the development and implementation of Group 1, Group 2, and Group 3 projects, as described in **Section 6**. After a short planning period, it is assumed that Group 1 project implementation will begin in 2023. Group 2 and 3 projects require permitting, environmental analysis, and engineering design, which would begin in 2022. Depending upon results of pilot studies, planned to be initiated in 2024, full-scale implementation of Group 2 and 3 projects is anticipated to begin in 2028. The timing of projects is based on best estimates and may shift as GSP implementation proceeds based upon the needs at the time. Additionally, some projects, such as ASR, may be pursued on a more rapid pace by other entities involved with drought response.

The implementation of the management actions (coordination of Farm Plans with GSP implementation, assessment of recycled water opportunities, assessment and prioritization of potential policy options) and will be initiated in the first year of implementation with the goal of having initial recommendations on scope and prioritization for the GSA Board to consider within the first 2 years of implementation.

GSP reporting will occur on an annual and a 5-year basis as required under SGMA. Annual reports will be submitted to DWR by April 1 of each year. Periodic reports (every 5 years or following substantial GSP amendments) will be submitted to DWR by April 1 at least every 5 years (2027, 2032, 2037, and 2042). The contents of annual and periodic reports are described in **Section 7.2**.

Section 8: References

Groundwater Sustainability Plan for Santa Rosa Plain Groundwater Subbasin

Table of Contents

8 REFERENCES 8-2
8.1 Works Cited 8-2
8.2 Santa Rosa Plain GIS Data Sources 8-12

8 REFERENCES

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8.2 Santa Rosa Plain GIS Data Sources

Bureau of Indian Affairs - California Department Forestry and Fire Protection Land Ownership

California American Water Company - County of Sonoma GIS Central

City Footprints - Permit and Resource Management Department (PRMD), County of Sonoma, 2006

City of Rohnert Park Land Use - City of Rohnert Park General Plan, 2018

Climate Station Locations - MesoWest, CoCoRaHS and UC Davis, Sonoma Water

County Line - County of Sonoma GIS Central

Elevation - Sonoma County Vegetation Mapping and LiDAR Program, North American Vertical Datum 1988 (NAVD88)

General Plan Land Use - Sonoma County Permit Resource Management Department, 2020 General Plan

GSP Study Area Watershed - Sonoma Water

Groundwater Availability - Sonoma County Permit and Resource Management Department (Permit Sonoma)

Groundwater Basins - California Department of Water Resources, Bulletin 118

Land Use Survey - Department of Water Resources, 2012 land use survey

Major Rivers and Creeks - Department of Water Resource, National Hydrography dataset

Managed Wetlands - Department of Water Resources, 2014 Crop Mapping

Protected Areas - California Protected Areas Database, 2017 holdings

Resource Conservation District (RCD) - County of Sonoma GIS Central

Sonoma State - County of Sonoma GIS Central

Vegetation and Agriculture classes - Sonoma County LiDAR and Vegetation Mapping Program and Sonoma Water

Water Companies & Other Public Water Suppliers - County of Sonoma GIS Central

Water Infrastructure - Sonoma Water

Water Wells and Well Density - by Sonoma County Water Agency with source data courtesy of California Department of Water Resources Online System for Well Completion Reports (OSWCR - https://data.cnra.ca.gov/dataset/well-completion-reports), Permit Sonoma, and the USGS Well Density and Known well Locations – U.S. Geological Survey dataset developed for Hydrologic and Geochemical Characterization of the Santa Rosa Plain Watershed, Sonoma County, California (https://pubs.usgs.gov/sir/2013/5118/)

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Appendix 1-A
Comments Received on Santa Rosa Plain Groundwater Sustainability Plan

SANTA ROSA PLAIN GSP COMMENTS: EXECUTIVE SUMMARY			
Date Received	**Commentor**	**Comment**	**Responses to Comments**
COMMENTS RECEIVED OCTOBER 1-31, 2021			
10/2/2021	Aaron Prysock	Hello, I began to look over the plan, and I must say that it is quite extensive and intimidating for the layperson. Are you able to put out a more concise version for regular everyday joes like me to understand without the need for a dictionary and thesaurus? Thanks, Aaron Prysock	The Executive Summary provides a concise description of the plan and its findings. The abbreviations and acronyms and glossary include definitions of frequently used technical terms and acronyms.
10/31/2021	Bob Anderson	When looking at the 3 draft GSPs – there are many similarities as to analysis and work product. One item stands out given there is also a slight variation on the dates – sometimes the 20-year period runs to 2041 and sometimes it is 2042 or the 50-year period is 2070 or sometimes 2072. It would be good to have the 3 all have a single version "Readers Digest" – to allow for assessing what is the same, what is different between each of them.	Comment noted.
COMMENTS RECEIVED AUGUST 2021 VERSION			
8/31/2021	Bob Anderson	P. 2: Kenwood Basin, Wilson Grove Basin, I think it is also Petaluma Valley Basin (not subbasin)	Noted - text corrected
		p. 3: Is this goal accomplished? "develop a Plan that achieves and maintains groundwater sustainability 50 years into the future."	Comment noted
		p. 3: "This GSP presents detailed, technical information to build upon the work of done in the GMP and to better understand groundwater in the Subbasin."	Noted - text corrected
		p. 6: Figure ES-3: Along right side of gray area, "Sonoma W" need correction	Noted - text corrected
		p. 9: Deeper recharge takes decades or longer to reach the aquifers, due to long travel paths. ? how this works with Projects and Actions showing improvement in Deep aquifer from Group projects?	Added 'may' take decades or longer...Improvements come through reductions in pumping from the deep aquifer system associated with conservation projects and from ASR, which directly reaches deep aquifer
		P. 10: needs a closer look. First sentence is 'shallow' then 24 are deep, then 15? Deep or shallow? "Groundwater levels: Groundwater levels for the majority of shallow-aquifer wells are generally stable. More limited data from the deeper aquifer system finds 7 of 24 wells exhibit relatively stable groundwater levels, 15 of the wells in the southern portions of the Subbasin and along the western boundary exhibit increasing trends, and only 2 wells, located east of and outside the Subbasin but within the contributing watershed area, have declining levels.	Noted - text corrected and clarifications added
		Groundwater storage decline = Groundwater storage: The groundwater budget (described below) finds that the amount of groundwater stored in the shallow and deep aquifer systems is declining on average by about 2,100 acre-feet per year (AFY).	Comment noted

Date Received	Commentor	Comment	Responses to Comments
		P. 13: The 20-year modeled period from WY 2021 to 2040 is used to determine the sustainable yield of the Subbasin. The average total annual groundwater pumping for this period is 23,900 AF, which is defined here as the sustainable yield. This value is 39% of the average total annual groundwater inflows into the Subbasin and is greater than average total annual groundwater pumping over the current budget period. It should be emphasized that the sustainable yield is dependent on the simulated climate conditions and assumed future pumping during this period and is not predicated on implementation of projects and actions, **i.e., no projects or actions are included in the model simulation to estimate the sustainable yield.**	Comment noted
		P. 14: wording switched from 'results' to 'conditions': Central to SGMA is the development of sustainable management criteria (SMC) for the sustainability indicators. The Santa Rosa Plain GSA identified undesirable results, minimum thresholds, measurable objectives, and interim milestones for the sustainability indicators as discussed in Sections 4.4 through 4.10. The five sustainability indicators applicable and relevant to the Subbasin are listed below with a summary of what the GSA considers significant and undesirable conditions for each indicator. Table ES-2 provides the Sustainable Management Criteria for all sustainability indicators.	Noted - text corrected
		P. 16: definitions show terms separately for Conditions and Results: Significant and Unreasonable Condition: A qualitative statement regarding conditions that should be avoided. Undesirable Results: A quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the Basin.	Comment noted
		P. 19: extra period after '50-year projection." Check on wording of whole phrase: The projects in all three groups are simulated to reduce the average decline by 400 AFY between 2021-2040 and 300 AFY over the entire 50-year projection.is estimated to decline by an average of 1,400 AFY between 2021- 2070.	Text revised based on addtional modeling
		Additions to Executive Summary – two figures presenting the story for all scenarios 1976-2070. From page 88 of 109 in Section 3 Fig 3-46. Groundwater Inflows by Water Budget Period – Historical, Current and Future) and on P. 91 of Section 3, Fig. 3-48. Groundwater Outflows by Water Budget period.	Comment noted
9/10/2021	Wayne Haydon	Figure ES-1 Plan Area: Line weight for "Other groundwater Basins and Subbasins" in explanation does not match line weight on map.	Noted - Figure to be corrected
		Figure ES-3: Line weight for "Contributing Watershed Area" in explanation does not match line weight on map.	Noted - Figure to be corrected
		Page 12. "The projected water budget covers the years 2021 – 2070." Can we add a chart for the water budget from 2021-2070, like Figure ES-6. Could use Figure 1-30, right side.	Changed to Water Years 2021-2070
		Page 19. "Groundwater storage: Groundwater in storage under a baseline scenario without projects is estimated to decline by an average of 200 AF between 2021-2040 and 1,400 AFY over the entire 50-year projection period that includes a simulated extreme 20-year drought between 2050 and 2070. The projects in all three groups are simulated to reduce the average decline by 400 AFY between 2021-2040 and 300 AFY over the entire 50-year projection.is estimated to decline by an average of 1,400 AFY between 2021-2070." Last sentence "is estimated…" needs a beginning.	
9/7/2021	Robert Pennington	General comment - I recommend shortening this section where possible. A few suggestions of sections that could be shortened include: a. Discussion of pre-SGMA GMP; b. History related to basin boundary; c. Geology section (paragraph 2 of HCM). d. Water Budget. Perhaps methods, description of climate scenarios and other details could be reserved for the main body of the report.	Text revised and shortened

Date Received	Commentor	Comment	Responses to Comments
		Page 9 - “The deep aquifer system is generally confined to semi-confined and is not physically connected with surface water”. COMMENT: It is unclear what is meant by “physically connected”. Spatially or hydraulically? Though spatially disconnected, it should be made clear that there is expected to be hydraulic connection between the deep aquifer and shallow aquifer, which therefore results in hydraulic connectivity between the deep aquifer and surface water.	The deep aquifer system is generally confined to semi-confined and is not spatially connected with surface water (although hydraulic connections between the shallow and deep aquifers result in hydraulic connectivity between surface water and the deep aquifer).

SANTA ROSA PLAIN GSP COMMENTS: SECTION 1 INTRODUCTION			
Date Received	**Commentor**	**Comment**	Responses to Comments
COMMENTS RECEIVED ON AUGUST 2021 DRAFT			
10-31-2021	Coalition including: The Nature Conservancy, Audubon California, Local Govt Commission, Union of Concerned Scientists, Clean Water Action/Clean Water Fund (Coalition)	Stakeholder engagement during GSP development is insufficient. SGMA's requirement for public notice and engagement of stakeholders is not fully met by the description in the Community Engagement Plan (Appendix 1-E). The GSP states that the GSA Advisory Committee includes representatives from the tribal and environmental stakeholder community, and that the Advisory Committee will continue to meet during GSP implementation. However, we note the following deficiencies with the overall stakeholder engagement process:	Specific stakeholder engagement during various phases of GSP development and implementation is described in Sections 1.4.2.
		The GSP documents opportunities for public involvement and engagement through monthly informational emails, the GSA website, public forums, presentations to stakeholder groups within the subbasin, a rural community engagement program, and GSA Board, Advisory Committee and community meetings. There is no explicit identification of a DAC representative on the Advisory Committee or other outreach targeted to DACs and drinking water users.	Language added describing DAC representation on the Advisory Committee and on specific outreach to drinking water users (rural residential well owners).
		Other than representation on the Advisory Committee, outreach to tribes and environmental stakeholders is described in general terms. The role that the Advisory Committee plays during the GSP implementation process is unclear.	Language added to Section 1.4 regarding outreach to tribes , environmental and other stakeholders, and in Section 1.4.2.4 regarding the ongoing role of the Advisory Committee.
		RECOMMENDATIONS: 1. In the Community Engagement Plan, describe active and targeted outreach to engage DACs and domestic well owners throughout the GSP development and implementation phases. Refer to Attachment B for specific recommendations on how to actively engage stakeholders during all phases of the GSP process. 2. Provide more information on the role of the Advisory Committee during the GSP implementation process. 3. Utilize DWR's tribal engagement guidance to comprehensively address all tribes and tribal interests in the subbasin within the GSP.	Langauge added to Section 1.4. The community engagement plan will be updated during the GSP implementation process. Language added. Comment noted. Language added regarding post-GSP tribal engagement.
10/31/2021	Russian River Keeper	p. 2: To help increase the representation of underrepresented communities, we would encourage the SRBGSA to broaden outreach to local community groups that are directly involved in water quality and environmental justice issues throughout the region. Coordinating with a broader range of community groups on education and implementation will be beneficial and necessary to the long-term success of the GSP.	Comment noted.

Date Received	Commentor	Comment	Responses to Comments
		p. 3 There also needs to be a section or appendix that defines how terms are being used within this GSP specifically. This will not only help with consistency in use of terms, but it will also help the lay person understand what is being said throughout this GSP.	Glossary will be provided in final GSP.
COMMENTS RECEIVED ON AUGUST 2021 DRAFT			
8/31/2021	Bob Anderson	P. 3, paragraph 3, correct from "Sonoma Valley" to Santa Rosa Plain p. 14, Phase 2, changes from Sonoma Valley to Santa Rosa plain p. 16, Appendix reference to Sonoma Valley; change to Santa Rosa Plain p. 17, references Sonoma Valley community engagement plan p. 22, Not sure why chair and vice-chair start at August 2017 and everyone else at Oct 2017 P. 33, update the * for final draft	Noted - text corrected Noted - text corrected Noted - text corrected Noted - text corrected Comment noted Comment noted
COMMENTS RECEIVED ON JANUARY 2021 DRAFT			
2/8/2021	Elizabeth Cargay	Easy to read and complete except no appendices list was listed in the TOC. It would have been more helpful to do a full review. This review form is easy to use. Can we save our comments to come back to later, or to have all of our comments from one agency submit at once? Figure 1-1	Comment noted
2/7/2021	Beth Lamb	Well organized	Comment noted
2/7/2021	Peter Martin	Multiple small edits; in multiple locations, a word appears to be missing after SGMA ("implementation"?)	Noted -- text corrected
2/7/2021	Rue M Furch	Three suggestions: 1) add a map showing the basin and how it fits in the watershed. 2) Mention the COVID years and adaptations made to continue outreach. 3) Community Engagement should include radio ... and possibly text or other media used more commonly by DAC. Section 1, Lines 28, 32 & 48 ... "designated medium or high priority" ... for a citizen - "medium or high" what? water table? at risk? what? Line 68: insert link to map MAPS WILL BE INSERTED INTO FINAL DOCUMENT Line 110: grammar Line 165 "was" or "will be" released? Line 247: are monthly notices being sent? (to which list?) Line 256: is this happening?	Figures added that show basin within watershed. Added language regarding COVID adjustments. Comment noted regarding engagement. Added clarifying text. Maps inserted in subsequent versions. Corrected grammar and made other edits. Montly updates are sent to email list of about 1500 stakeholders.
	Holly Roberson	In multiple locations: Change to state agency's evaluation, assessment, and approval of the GSP.	Noted -- text corrected
2/6/2021	Holly Roberson	This is a strong introduction; it clearly shows that extensive work and public outreach has gone into the development of the Santa Rosa Plain GSP.	Comment noted
2/3/2021	David Long	Well written and presented	Comment noted

Date Received	Commentor	Comment	Responses to Comments
2/2/2021	John Rosenblum	1. The comments page is very limiting and impossible to complete both "general" and "specific" comments in a single effort (therefore, I'm putting everything in a single "general" box). 2. Omits that the 2019 boundary adjustment included not only the City of Sebastopol, but also the jurisdictions of (1) Belmont Terrace Mutual Water Company, (2) Kelly Mutual Water Company, and (3) Fircrest Mutual Water Company. 3. All 3 Sebastopol-area mutual water companies are active in and represented by IWS. They are therefore members of the GSA. They are omitted in the listing of active IWS members in this document. 4. There are communication obligations for board members, advisory committee members and the public - but none for GSA/Sonoma Water staff. For Sebastopol-area members and representatives this has resulted in deflections, omissions, and lack of substance in exchanges about our recharge area in the Wilson Grove Highlands. 5. Omitted from the introduction is any mention that Sebastopol-area boundary adjustments were made (along with Petaluma and Marin) to reduce DWR's designation of Wilson Grove Highlands from "medium" to "low" - and subsequent release of Sonoma County from preparing a costly separate GSA. (A staff presentation showed how weightings relative to population in DWR's EXCEL spreadsheet were the main factor).	1. Acknowledged. Will change for future comments. 2. Added language. 3. Listed these water companies 4. Comment acknowledged 5. Language added.
2/2/2021	John Rosenblum	Too "happy"	Comment acknowledged
2/1/2021	Craig Scott	Line 41 - remove \high\" as basin is designated as a medium priority basin." Additional small edits.	Text revised
2/1/2021	Mark Grismer	Good overview, seems complete and readily understood.	Comment acknowledged
1/28/2021	Joe Gaffney	No comments. Good job!	
1/26/2021	Bob Anderson	Needs work. Line 132: Should phone number be updated to be the same as number used in GUIDE? Add title for Appendix 1-A. Make consistent capitalization for Interested Parties List. Include links on lines 286-296 (if using links elsewhere). Appendix 1-D has an "Appendix A and B and Attachment A (parts of 1-D but adds element of confusion). Page numbering should be consistent (between Section text and appendices)	Comments acknowledged. Title added. Punctuation and grammar revised. Page numbering revised.
1/25/2021	Bob Likins	Maps are good as long as they can be made clear.	Comment acknowleged.
1/25/2021	Bob Likins	I am hopeful that each section can also be prefaced by a shortened section with key points summarized ,,,,, like a one or two page version of this eight page introduction. The length of the final report will discourage some interested readers from attempting to read and understand what you will want to tell them if there is no shorter version. ..... Bob	Executive summary provided in subsequent versions.
1/24/2021	Wayne Haydon	73 District (RCD); and an organized group of Mutual Water and Public Utilities Commission- 74 Regulated Companies (Independent Water Systems) WDH comments Where listed? Where Board members and AC members listed? 110 reports to the GSA Board identifying areas 172 Phase 4: Implementation and Reporting -- Following the submission of the GSP to DWR, the 173 Santa Rosa Plain GSA will begin implementation of projects and programs? 211-215 DAC are also a state designation.	Revisions and corrections made to address comments; added appendix listing Board and Advisory Committee members.

Date Received	Commentor	Comment	Responses to Comments
Comments from 2018 Introduction & Plan Area Section (prior to separating the Introduction & Plan Area into separate sections)			
Date Received	**Commentor**	**Comments**	Responses to comments
11/26/2018	Jennifer Burke & Colin Close	Gold Ridge Resource Conservation District	Text revised
		The Santa Rosa Plain GSA formed an Advisory Committee of 18 members in October 2017 consisting of appointment of members appointed by from each of the nine-member agencies, the City of Sebastopol and the Federated Indians of Graton Rancheria, and nine seven interest based members appointed by the Santa Rosa Plain GSA Board: 2 - Environmental (from organizations with a presence in the Basin) • 2- Rural residential well owner • 1 - Business community • 2 - Agricultural • 1 - Federated Indians of Graton Rancheria • 1 – City of Sebastopol	Text revised
		both abut a small eastern segments segment of the Santa Rosa Plain Subbasin boundary.	Text revised
		Area Subbasin, Alexander Area Subbasin, and Wilson Grove Formation Highlands Basin.	Text revised
		In 2014, the State of California enacted the Sustainable Groundwater Management Act, which includes requirements that must be addressed in the Santa Rosa Plain, as this area is considered a medium priority groundwater basin.	Text revised
		Rosa, Sebastopol, Town of Windsor, several unincorporated communities, and areas of rural	
		Recycled water is treated to tertiary standards and provided by the Town of Windsor's, and the City of Santa Rosa's Laguna Treatment Plant, and the Airport Larkfield's Wwastewater Ttreatment Pplants and is used for crop and landscape irrigation in lieu of using groundwater or imported water.	Text revised
		Recycled water is ~~relied upon for agricultural purposes~~ used to irrigate vineyards, dairies, and pasturelands, as well as landscaped parks, commercial properties, schools and golf courses. *Suggest we add information regarding how much acreage is irrigated by recycled water/how much water is used for irrigation purposes in all these service areas.*	Text revised
		Suggest deleting the following sentence – it's not entirely correct as recycled water from both Santa Rosa and Windsor goes to the Geyers and not sure it's relevant as we should be indicating how much acreage is irrigated/how much water is used to offset gw/imported water in the basin ~~: A significant portion of the total recycled water produced from Laguna Treatment Plant is delivered for energy generation to the Geysers Geothermal Steamfield located in the Mayacamas Mountains outside of the Subbasin and contributing water shed areas.~~	Text revised
		Suggest spelling out acronym afy – it's the first time used in this document.	Text revised
		Suggest spelling out acronym CASGEM - it's the first time used in this document.	Text revised
		The City of Santa Rosa ~~adopted~~ submitted the final SNMP in 2013 and the NCRWQCB approved the SNMP in a letter dated September 1, 2015.	Text revised

Date Received	Commentor	Comment	Responses to Comments
		Suggest including info about CIMIS (California Irrigation Management Information System) to this section. There are multiple stations in the basin. See listing of stations here (sort by County for easy identification of local stations) : https://cimis.water.ca.gov/Stations.aspx)	Text revised
		Rosa ~~Plan~~ **Plain**	Text revised
		Formatting problem – sentence appears to not be justified correctly	Formatting corrected
		The Water Supply Strategies Action Plan **(Action Plan)** was…	
		There are many "plans" referred to in this chapter. Where possible, use different acronyms	Text revised
		Immediate actions identified within the **Action P**lan that are specific to groundwater include:	Text revised
		Add a sentence regarding the City of Santa Rosa's climate plan efforts – although we are part of the RCPA, we have separate Climate Action Plans that the regional plan refers to. Suggest inserting the following sentence: In addition, the City of Santa Rosa has prepared two Climate Action Plans – the Community-wide Climate Actin Plan and the Municipal Climate Action Plan which complement the Regional Climate Action Plan (https://srcity.org/1634/Climate-Action-Planning)	Text revised
		CUWCC is now called California Water Efficiency Partnership (CalWEP)	Text revised
		Each of these member utilities, in addition to the City of Sebastopol and California American Water Company, have water conservation programs to assist their communities in **improving water use efficiency** and reducing water waste ~~**use**~~.	Text revised
		Specific urban residential programs for **increasing** indoor (high efficiency toilets, fixtures, and washers) and outdoor (landscaping assistance, surveys and retrofits) ~~for increasing~~ conservation.	Text revised
		The MWELO was most recently updated in 2015 and all entities were required to comply. This section needs to be updated accordingly.	Text revised
		landowners ~~is~~ **called** ~~the~~ "Slow it. Spread it. Sink it. Store it!" ~~publication~~ produced by the Sonoma RCD.	Text revised
		A guide focusing on rainwater catchment systems ~~is~~ **called** ~~the~~ "Roof Water Harvesting for a Low Impact Water Supply" ~~booklet~~ produced by the…	Text revised
		The ~~resulting plan~~ **Russian River Regional SWRP** provides a framework for submitting, quantifying, scoring, and ranking future projects in an objective and data driven format.	Text revised
		The description for this section needs to be updated - In early 2013, jurisdictions that had been designated as Phase II municipalities within the Russian River Watershed were provided an option to align with the Phase I program in an effort for watershed-wide consistency and collaboration. The cities of Cloverdale, Cotati, Rohnert Park, Healdsburg, Sebastopol, Ukiah, and the Town of Windsor, and the Phase II designated portions of the County of Sonoma elected to participate in the Phase I program as Co-Permittees. *Also suggest including link to the LID manual*	Text revised
		~~The Water Agency~~ **Sonoma Water**	Text revised
		local agency responsible for administering permits for wells within the Subbasin. *(Missing a period at end of sentence)*	Text revised
		Figure 2-9 – add classification numbers to the key, so Class 1-4 areas are numbered according to the discussion in lines 931-933 and 937.	Figure revised

Date Received	Commentor	Comment	Responses to Comments
11/29/2018	Wayne Haydon	North Coast Resource Partnership ~~Integrated regional water Management Plan~~ The North Coast Integrated Regional Water Management Plan (NCIRWMP) was formed in 2004 as a voluntary, non-regulatory, stakeholder-driven planning framework meant to emphasize shared priorities and local autonomy, authority, knowledge, and approaches to achieving Tribal, state, regional, and local priorities related to North Coast water infrastructure, watersheds, public health, and economic vitality. The NCIRWMP changed it's name in early 2013 to the North Coast Resources Partnership (NCRP) to distinguish the partnering entities and cooperative process comprising the NCRP, and to recognize and emphasize that the NCRP is embarking upon a more well-rounded planning effort in order to meet all of the social, economic, and environmental challenges facing the North Coast, not only those directly related to water. The NCRP continues to focuses on areas of common interest and concern to North Coast stakeholders and on attracting funding to the North Coast Region, and recognizes unique local solutions in different parts of the Region(https://northcoastresourcepartnership.org/). ~~is a stakeholder driven colaboration among local goverment, watershed groups, tribes and interested partners in the North Coast region of California (http://www.northcoastirwmp.net)~~ The North Coast comprises seven counties, multiple major watersheds, and a planning area of 19,390 square miles, representing 12% of California's landscape, including the Plan Area. It is a "source region" – for clean water, carbon sequestration, and biological diversity and provides these benefits to other parts of California and the world. The NCRP's focus areas include restoring salmonid populations, enhancing the beneficial water uses, promoting energy independence, reducing greenhouse gas emissions, addressing climate change, supporting local autonomy and intra-regional cooperation, and enhancing public health and economic vitality in the region's economically disadvantaged communities. The NCRP~~IRWMP~~ serves as a comprehensive planning tool that links other water resources management plans and programs through collaborative processes, coordination and communication.	Text revised Section revised Section revised; it was very long compared to other sections, and was edited to be consistent in length and format. Text revised
1/14/2019	Advisory Committee	Change logo The two are confusing because irrigated ag could be assumed to be GW. The next map is recycled water and shows all purple. Should include recycled water on 2.4b. Highway 12 needs to be a line. Currently it looks like the basin boundary. How we represent knowledge of wells and quantity? Do we need to represent this as documented water wells (not estimated or inferred)? Need to clarify that data set is what is documented and not necessarily what is there. Locating wells from databases is very difficult. Is this map of wells from the state's database? Should note if it's a hybrid of different things Should include a disclaimer that the figure is simplified, since it has to be so general.	Revised Figure revised Figure revised Figure revised Figure revised Figure revised Figure revised

SANTA ROSA PLAIN GSP COMMENTS: SECTION 2 PLAN AREA			
Date Received	**Commentor**	**Comment**	**Responses to Comments**
COMMENTS RECEIVED FROM OCTOBER 1-31			
10/11/2021	Jim Mangels	Fig. 2-6. I was disappointed with this figure. Why have a figure if the data is incomplete "information is based on limited and incomplete information". Not knowing the location and density of water wells in inappropriate. Should that information be available from user permits? Does this mean that permits and water meters are not employed universally? How can water usage from water wells be known without this information. We need to know how much ground water is being used and from what wells, and these customers need to pay their fair share.	Comment noted. Information is based on best available records from well logs, many of which are incomplete or not digitized. The Santa Rosa Plain Groundwater User Information Data Exchange program was developed to improve the database.
10-31-2021	Coalition	RECOMMENDATIONS: Provide a map of DACs and more information about the population of each identified DAC. 1. Identify the sources of drinking water for DAC members, including an estimate of how many people rely on groundwater (e.g., domestic wells, state small water systems, and public water systems). 2. Include a domestic well density map for the subbasin. 3) Include a map showing domestic well locations and average well depth across the subbasin.	Figure 2-3 modified to show DACs and tribal lands in trust and text was added to Section 2 to describe main sources of drinking water for DACs. Regarding the well density map, there is not a requirement that well density for each use type is prepared. The well density map required by the GSP regulations in included as Figure 2-6a shows density of all known water suppl wells in the Subbasin. Figure 2-6b added to display the approximate known depths of water wells and language added regarding estimated number of domestic wells. Current information regarding specific well types are inadequate to reliably display the densities of all different well types, including domestic wells. In general, the
COMMENTS RECEIVED ON AUGUST 2021 VERSION			
8/31/2021	Bob Anderson	P. 4: appears to be from another GSA's GSP: The San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) implements water quality regulations in the watershed, including establishing Total Maximum Daily Loads for pathogens and sediment in Sonoma Creek, adopting General Waste Discharge Requirements (WDRs) for vineyard discharges, and for stormwater and wastewater discharges. The WDRs for vineyard discharges require development of a farm plan, which outlines best management practices (BMPs) implemented to reduce sediment and stormwater runoff and monitoring and reporting. P. 6: this may be generally the case but Sonoma County's GP has a Water Resources Element. General plans include seven mandatory elements, and the conservation element of the general plan is typically where water resources are addressed, although other water-related topics may also be addressed in other elements	Noted - text corrected Noted - text corrected

Date Received	Commentor	Comment	Responses to Comments
		See: 2.2.2 Sonoma County General Plan 2020 In recognition of the importance of water resources within unincorporated areas of the county, an optional new water resource element (WRE) was developed and included in the Sonoma County General Plan 2020 (Sonoma County 2008). P. 5: through Section 2.3? 2.2 General Plan and Related Plan Land Use Categories Existing city and county planning activities that are directly or indirectly linked with water supply and groundwater management include general plans, specific plans, and Urban Water Management Plans (UWMPs), which are described in Section 2.2.1 through 2.4.1. P. 9: An overview of the spatial distribution of the reliance on the four primary water source types by primary water use sectors in the Subbasin is shown on Figure 2-5 and provided in Sections 2.4.1 through 2.4.4 (2.4.1 Groundwater – begins on page 10 of 42) P. 10: not Regional: 2.4.4 Recycled water produced from the City of Santa Rosa Regional Water Treatment System (serving Santa Rosa, Cotati, Rohnert Park, and Sebastopol). From https://srcity.org/ArchiveCenter/ViewFile/Item/4272 Santa Rosa Water operates the Laguna Subregional Water Reclamation System which serves the residents in Santa Rosa, Rohnert Park, Cotati, Sebastopol, and unincorporated areas of Sonoma County. The hub of the Subregional Water Reclamation System is the Laguna Treatment Plant, P. 13: may need to clarify use of "for years" – this wording makes it sound like a big data gap. The station is located at the Charles M. Schulz Sonoma County Airport. Data are available from 1903 to the present at this station; however, the station dataset does not contain a complete record of daily rainfall for years P. 14: SRP. There is one station in the Sonoma Valley Basin and two in the contributing watershed: (1) P197, located on Highway 12 at Fulton Road; P. 25: be good to add a link to the two USGS reports: (1) Nishikawa, T., ed. 2013. Hydrologic and geochemical characterization of the Santa Rosa Plain watershed, Sonoma County, California. U.S. Geological Survey Scientific Investigations Report 2013-5118, 178 p. and (2) Woolfenden, L.R. and Nishikawa, T., eds. 2014. Simulation of groundwater and surface-water resources of the Santa Rosa Plain watershed, Sonoma County, California. U.S. Geological Survey Scientific Investigations Report 2014-5052, 258 p.	Noted - text corrected Noted - text corrected Noted - text corrected Noted - text corrected Noted - text corrected Noted - text corrected Links have been removed from main body text, but are included with references (Appendix 8) if part of citation.
9/2/2021	Elizabeth Cargay	Fig. 2-7b: The Windsor well shown in the very northeast part of Town is not a Windsor inactive well. It is a volunteer well. It does not belong to the Town, it belongs to an HOA. Please change.	Figure revised
9/7/2021	Robert Pennington	3. Page 8 - "Groundwater is also an important supplemental **or backup source** of supply for many of the municipal water purveyors, including Sonoma Water; the Cities of Santa Rosa, Rohnert Park, and Cotati; and California American Water Company's Larkfield District, all of which operate municipal wellfields within the Subbasin and contributing watershed areas" COMMENT: I believe groundwater is the primary source for Cal-Am, and Russian River water is secondary/backup.	Noted - text corrected

Date Received	Commentor	Comment	Responses to Comments
		4. Page 17 - The Sonoma-Marin Saving Water Partnership represents 10 water utilities in Sonoma and Marin counties that are signatories to the California Water Efficiency Partnership and have joined to create a regional approach to water-use efficiency. Within the Subbasin, these utilities include the Cities of Cotati, Rohnert Park, and Santa Rosa; the Town of Windsor; and Sonoma Water. COMMENT: I believe Sebastopol is now a member	Sebastopol is not a current member, but Cal-American Water - Larkfield is. Added Cal-am.
COMMENTS MADE ON FEBRUARY 2021 RELEASE OF SECTION 2			
3/8/2021	Beth Lamb	This whole document need a tech editor to go over formatting. So many inconsistencies makes the document look sloppy. I assume that much of this section was cut and paste from other documents and therefore uses lots of different styles were used. Table of contents needs to be revised formatting issues. Minor items: 1) Need an abbreviations list/table. 2) Are you doing penultimate common or not choose one and stick to it. 3) For lists some times there are bullets, other times numbers and then some times nothing. Be consistent. 4) Note to reader format different one time it is a new paragraph that is in italics (see page 7) then is is at the end of a sentence in parentheses (see page 8) Be consistent! 5) "In Lieu" should be italicized as a foreign word or use another word. (page 8 paragraph 5) suggest using "instead of" Specific comments: Page 3 Paragraph 2 - The Subbasin includes the Town of Windsor; cities of Cotati, Rohnert Park, Santa Rosa, and Sebastopol; and areas of unincorporated rural communities and agricultural cultivation. Very confusing punctuation then and agricultural cultivation doesn't fit. It is apples and oranges. If you include cultivation then shouldn't you includes dairies and breweries and vineyards and parks and forest and open space, Page 3 paragraph2 "Neighboring groundwater basins and subbasins are also shown on Figure 2-1 and include the very low-priority Healdsburg Area Subbasin (designated as basin 1-55.02 by DWR) to the north, the very low-priority Wilson Grove Formation Highlands Basin (designated as basin 1-059 by DWR) to the west, and the medium-priority Petaluma Valley Subbasin (designated as basin 2- 001 by DWR) to the south. The very low-priority Alexander Area Subbasin (designated as basin 1-054.01 by DWR) and the very low-priority Rincon Valley Subbasin (designated as basin 1- 054.03 by DWR) both abut a small eastern segment of the Subbasin boundary. The only neighboring GSA is the Petaluma Valley GSA, which formed in June 2017 and is responsible for implementing SGMA in the Petaluma Valley Basin.	Comment acknowledged. Tech editor engaged. Text revised Comment acknowledged Comment acknowledged Comment acknowledged Comment acknowledged Text revised

Date Received	Commentor	Comment	Responses to Comments
		What about 1) the Sonoma GSA , 2)The lower RR valley basin, 3) the Kenwood valley basin. If you don't mention these basin then you need a topic sentence her like these are the basins the are adjacent to is neighboring=adjacent? If they are on the map they should be discussed in this paragraph.	Text revised
		Page 4 Paragraph 3 - Existing city and county planning activities that are directly or indirectly linked with water supply and groundwater management include general plans,specific plans, and Urban Water Management Plans (UWMPs), which are described below. needs a space between plan, specific	Text revised
3/7/2021	Bob Anderson	Very thorough.	Comment ackwnowledged
		A couple of minor points:	
		page 8 of 24:	
		re Recycled Water: Rohnert Park also uses recycled water on its parks and golf course.	Landscape' irrigation encompasses parks and golf courses
		"city of Santa Rosa's Laguna Treatment Plant" is the "Subregional" serving SR, RP, Cotati and Sebastopol	Text revised
		page 13 of 24 -	
		be good to also include a link for the two USGS studies	Links included in references, not in main body text.
		page 15 of 24	
		Is there a date for Sebastopol's?	Added
		Water Master Plans have been developed by the cities of Cotati (Cotati, 2011), Santa Rosa (Santa Rosa, 2014), Sebastopol and Town of Windsor (Windsor, 2011),	
		page 20 of 24 - new term (Laguna-Mark West) / different than 'subbasin'?	Text added to clarify
		The Stormwater Management Groundwater Recharge study assessed the feasibility of projects in Laguna-Mark West watershed (subwatershed of the Santa Rosa Plain watershed), which informed the development of the Russian River Regional SWRP.	
		On Figures several legends have extra white lines or overlays. Figure 2-5 has Hwy 1 on lower left and aqueduct not on legend.	Figures revised
3/5/2021	Peter Martin	Overall comment - SGMA Reg. § 354.14 requires a description of the Hydrogeologic Conceptual Model (HCM), it is unclear if that is part of the descriptions included in this chapter? If so, it needs to be called out. If that is to be included elsewhere that needs to be called out. It makes sense that it would be at the beginning of Chapter 2.	HCM described in Section 3
		Section 2.1, Page 4 - Inflow from outside the boundary is references. Is there a reason why there is no reference to the outflow?	Described in more detail in Section 3
		Section 2.2, Page 4-5 - Should reference Government Code 65350.5 that stipulates before General Plans are adopted they must review and consider GSPs. That is an important linkage...	Text revised
		Section 2.2, Page 6 - City of Santa Rosa General Plan: General Plan 2050 is in development, slated for final review in Fall 2022. Contact is Andy Gustavson - AGustavson@srcity.org	Text revised

Date Received	Commentor	Comment	Responses to Comments
		Urban Water Planning, Page 14 - DWR UWMP guidelines only require planning on 20 year horizon. Check that all participants are planning UWMPs with 25 year projections. Urban Water Planning, Page 14 - UWMPs also include reporting on water conservation activities, targets and compliance	Text corrected Text revised
3/3/2021	Marlene Soiland	No comments	Comment acknowledged
3/3/2021	Mark Grismer	The section appears to be complete and was easy to read and sort through. Appreciated the links to outside resources within the text and the inclusion of the many agency or County programs affecting water planning or conservation within the Basin.	Comment acknowledged
3/3/2021	Wayne Haydon	Page 13. North Coast Resource Partnership Replace first paragraph with the following In 2002, the California Legislature approved the Integrated Regional Water Management Planning Act (SB 1672). The implementation of the Act facilitates regional cooperation in water-resources planning, and along with the passage of Propositions 50, 84, 1E and 1, has providing grant funding for projects identified in a regional plan, referred to as an Integrated Regional Water Management Plan (IRWMP). Page 11. Climate Monitoring Data are available from 1903 to the present at this station; however, the station dataset does not contain a complete record of daily rainfall for years. Are we listing years without data here. Page 16. Groundwater Banking Feasibility Study The report states, “Based on the findings…” 1. Can we summarize the conclusions of the study? 2. Did the study find GW banking and ASR to be feasible and where and how much?	Text revised Text revised No Text revised Study referenced if readers want additional information.
2/16/2021	John Rosenblum	1. The general problem with this GSP chapter is that it needs clarify that GSA boundaries for modelling and analysis were set to surface watershed topography, rather than groundwater hydrogeology. I recommend adding the following to Section 2.1: a. Even if the political fragility of SGMA at the State level and political constraints on budget at the local level is understandable, the scientific limitations of Bulletin 118 boundaries – and GSA modelling – should be discussed. b. Even though this chapter is a technical description, setting the boundary should have been a policy/political GSA board decision (e.g. an early 2019 GSA board decision reserved funds for a scientific justification of boundary adjustments into the Wilson Grove Highlands (WGH) – rather than jurisdictional – if required by DWR). c. Applying hydrogeological boundaries is critical for GSA members in the Sebastopol area; adequate analysis of GSA members’ recharge is required by SGMA.	Addressed in Section 3 Addressed in Section 1 Comment acknowledged

Date Received	Commentor	Comment	Responses to Comments
		d. Fig 2-3: need to explain that the jurisdictional boundary of Gold Ridge RCD extends far West of the Contributing Watershed Area. Also that the RCD's "Green Valley" section covers Wilson Grove Highlands recharge area for Sebastopol members' wells.	Comment acknowledged
		2. Section 2.3 General Land Use Characteristics, Fig 2-4a, Fig 2-4b, Fig 2-4c,and Fig 2-5 need to explain that Ag and residential land use does not stop West of Bulletin 118 - and GSA's modelling – boundaries (while a much larger area East of the Bulletin 118 boundary is included in modelling).	Comment acknowledged; figures only show watershed boundaries.
		3. Section 2.4, Water Source Types and Water Use Sectors This chapter should reference the March 2016 report released by O'Connor Environmental, Inc. (https://eb314f72-46be-4adb-874f-ce4ecf88f20d.filesusr.com/ugd/128aec_6782b34297cf4c9494d25d958bcd2814.pdf) about conditions and trends in the Wilson Grove Highlands (WGH). A summary of the report's relevance should be included in the GSP:	Included reference to report in Section 3
		a. Local and State data about land use, groundwater, and Ag & domestic wells in the WGH have long been available.	Comment acknowledged
		b. A specific area of continuous and thick Wilson Grove Formation in the WGH groundwater recharge area for Sebastopol-area wells was identified (smaller than DWR's proposed GSA for WGH partially shown in Fig 2.1).	Comment acknowledged
		c. Groundwater levels decreased from 2009 to 2014 in the WGH recharge area for Sebastopol GSA members' wells.	Comment acknowledged
		d. Potential groundwater extraction impacts on streamflows and dependent ecosystems/fisheries were identified.	See Section 4
		4. Section 2.4 Groundwater, Fig 2-6: need to explain that wells and groundwater flow do not stop West of the Bulletin 118 - and GSA's modelling – boundaries.	Comment acknowledged; figures only show watershed boundaries.
		5. Section 2.4 Local Surface Water: need to explain that, as noted in the March 2016 report by O'Connor Environmental, Inc, "… it is believed that the vast majority of diversions associated with Riparian Water Rights (formalized by a Statement of Use) are not reported…" (to the California State Water Resources Control Board's eWRIMS program). The report states that other data and field observations can make up for the uncertainty, which means that GSP monitoring programs must be designed to reduce the uncertainty – particularly for Sebastopol members' wells' WGH recharge.	Included reference to report in Section 3
		6. Section 2.5, Groundwater Level Monitoring:	
		a. Sebastopol GSA members' WGH recharge area must be included in monitoring. The March 2016 report by O'Connor Environmental, Inc relied on long available groundwater level data from many domestic wells from CASGEM, and Ag wells from the Sonoma Ag Commissioner's office.	Monitoring network described in Section 5
		b. Fig 2-7a and Fig 2-7b: labelling could mislead the reader to assume that GSA members' recharge from WGH is adequately included in modelling and analysis.	Comment acknowledged

Date Received	Commentor	Comment	Responses to Comments
		7. Section 2.5 Santa Rosa Plain Salt and Nutrient Management Plan: The December 31, 2020 salination risk analysis has been published for public response (Staff Report for North Coast Hydrologic Region Salt and Nutrient Management Planning Groundwater Basin Evaluation and Prioritization). The draft proposes: a. Critical risk for the Santa Rosa Plain b. High risk for Rincon Valley and Healdsburg c. Medium risk for Wilson Grove Highlands. 8. Section 2.6, Groundwater Banking Feasibility Study: The 2013 feasibility study needs to be updated for the SGMA-required 50-year climate analysis, including: a. Increased frequency and duration of consecutive dry years b. Reduced volume of bankable winter streamflows c. Increased frequency and intensity of winter storms, with high sediment loads d. Legal/regulatory limitations due to upstream demands and surface water treatment	Text updated to include information about August 2021 report and review Comment acknowledged.

SANTA ROSA PLAIN GSP COMMENTS: SECTION 3 BASIN SETTING			
Date Received	**Commentor**	**Comment**	**Responses to Comments**
COMMENTS RECEIVED OCTOBER 1-31			
11/2/2021	Rick Savel	Below is an excerpt from a report (see SAVEL PV SRP_11022021 comment) I compiled and submitted to PRMD regarding Penngrove area Community Separator recommendations. #3) involves the shifting of the southern basin boundary divide separating the Laguna Santa Rosa and Petaluma groundwater basins in the vicinity of the surface watershed divide boundaries and hydraulic inter-connection “flow reversal” of sub-surface groundwater recharge. (CWD Cardwell,1951). My question is: **#1) will this unresolved "sub-surface" divide condition be taken into consideration when determining the basin boundaries for further analysis and evaluation of existing and future conditions and #2) as the EIR data and analysis pointed out, this involves drafting recharge from Lichau Creek which is identified as Steelhead bearing creek.** According to the State Fish & Game Lichau Creek Survey Report (See Savel_Attchmnt1_PetalumaR_LichauCr_Willowbrook), conducted summer 2007, completed March 2008, Lichau Creek should be managed as an anadromous, natural production stream. **What impact is this hydraulic inter- connection “flow reversal” of sub-surface groundwater recharge having on Lichau Creek recharge flows on Penngrove wells and fish habitat?**	Obtaining improved information on the subsurface nature and hydraulic communication accross Subbasin boundaries (including potential changes in the direction and magnitude of groundwater gradients) is identified as a primary data gap in Section 3.1.8. Planned studies and information gathering to address this data gap are described in Section 7.2.4 and include evaluation of geophysical data collected across boundaries, performance and analysis of aquifer tests, and evaluation of future groundwater-level monitoring data. It is noted, that subsequent to the conditions described by the commentor, groundwater levels within the southern portions of the Santa Rosa Plain Subbasin have recovered, reducing the potential for any future 'flow reversals' across the boundary.
10/31/2021	Bob Anderson	Page 143 of 152- to repeat a point made in earlier comments: “not able to follow this logic”: For the WY 2021 to 2040 period, rural domestic pumpage is similar to the current period. Rural domestic pumpage is projected to increase, however.	The GSP narrative has been modified for clarity
10/31/2021	Coalition	The identification of Interconnected surface water is insufficient. The GSP uses a multiple-lines-of-evidence approach to assign point values to stream segments based on the following four criteria: (a) depth-to-groundwater along stream channels, spring 2015 (b) percent of time stream is gaining, from 2000 to 2010 (c) median stream flow, from 2000 to 2010 (d) surface leakage, 2006. There are several problems with this approach. The points assigned for each criteria are arbitrary, as is the total point value that determines whether a reach is interconnected or not. Other issues include the following: · The GSP gives more points to areas of streams where groundwater elevation is higher than the stream bottom elevation. This procedure is completed for one point in time only, spring 2015. Using seasonal groundwater elevation data over multiple water year types is an essential component of identifying ISWs. The use of one date does not reflect the temporal (seasonal and interannual) variability inherent in California’s climate.	The relative values of the points are not arbitrary but rather reflect the level of confidence and significance of the various lines of evidence. Comment noted. To help address the uncertainty associated with this analysis, points were also assigned to stream reaches where the groundwater level is inferred to be below, but within 10 feet of the streambed bottom. Additionally, other lines of evidence used to map interconnected surface water does incorporate seasonal groundwater elevation data over multiple water year types.

Date Received	Commentor	Comment	Responses to Comments
		· The GSP gives more points to segments of stream that are gaining throughout the year. Losing streams are not considered in this assessment. This is problematic because stream segments that are interconnected (losing or gaining) for any percentage of time should be considered an ISW.	Losing interconnected reaches are more difficult to constrain using the model. For this reason multiple lines of evidence were used map interconnected surface water, including interpolated groundwate levels beneath stream segments and evaluation of high frequency groundwater level data near streams. This will be further assessed during GSP implementation.
		· The GSP gives more points to streams with flow more than 50% of the time. However, even short durations of flow can indicate interconnected conditions. Note the regulations [23 CCR §351(o)] define ISW as "surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted". "At any point" has both a spatial and temporal component. Even short durations of interconnections of groundwater and surface water can be crucial for surface water flow and supporting environmental users of groundwater and surface water.	Comment noted.
		RECOMMENDATIONS: 1. Consider stream reaches with connection for any percentage of time as interconnected. On the map of streams in the subbasin, clearly labeled reaches as interconnected (gaining/losing) or disconnected. Consider any segments with data gaps as potential ISWs and clearly mark them as such on maps provided in the GSP.	One motivation to use the 'multiple-lines-of-evidence' approach was to account for the uncertainty in the available data. This approach allowed us to make stronger inferences from the data. With multiple sources of evidence capable of indicating interconnected surface-water/groundwater, locations and times in which only one line of evidence indicates interconnection and reasonably be removed. This approach reasonably accounts for scientific uncertainty in the data.
		2. Provide depth-to-groundwater contour maps using the best practices presented in Attachment D, to aid in the determination of ISWs. Specifically, ensure that the first step is contouring groundwater elevations, and then subtracting this layer from land surface elevations from a digital elevation model (DEM) to estimate depth to groundwater contours across the landscape. This will provide accurate contours of depth-to-groundwater along streams and other land surface depressions where GDEs are commonly found.	This procedure was used in mapping depth interconnected surface water. The depth to water maps shared with the practitioners work group have been added to Appendix 4-C.
		3. Use seasonal data over multiple water year types to capture the variability in environmental conditions inherent in California's climate, when mapping ISWs. We recommend the 10-year pre-SGMA baseline period of 2005 to 2015.	The multiple lines of evidence approach integrates information from different datasets spanning different time periods, including 2000-2010, 2015 and 2019.
		4. Reconcile ISW data gaps with specific measures (shallow monitoring wells, stream gauges, and nested/clustere wells) along surface water features in the Monitoring Network section of the GSP.	Data gap areas for Interconnected Surface Water monitoring are depicted on Figure 5-7. Shallow or multi-level monitoring wells and/or stilling wells are proposed in 4 out of the 4 identified data gap areas. Additional stream-adjacent shallow monitoring well sites will be identified as-needed during GSP implementation.

Date Received	Commentor	Comment	Responses to Comments
		The identification of Groundwater Dependent ecosystems is incomplete. The GSP maps GDEs using the Sonoma County Veg Map, which we agree is the best available data for the subbasin. To identify where the potential GDEs are likely to have connection with groundwater, the rooting depths of common tree species were compared to available depth-to-groundwater data. The GSP states (p. 3-88): "The DTW mapping used available contoured springtime datasets for the shallow aquifer system (from 2015 and 2016) and high-resolution LiDAR data. To address GDE Work Group member concerns that groundwater levels were generally at lower levels in 2015 and 2016 due to dry conditions, minor adjustments in some areas were made to incorporate the shallowest depth-to-water on record for each well based on review of all available data from 2005 to 2020." However, no further details on the available data from 2005 to 2020 was provided.	Hydrographs of monitoring wells are provided in Appendix 3-B.
		The GSP states (p. 3-88): "Following guidance from TNC, potential vegetation GDEs were mapped for areas with DTW of 30 feet or less to incorporate the potential rooting depths of oak trees (TNC 2018)." If Valley Oaks exist in the subbasin, we recommend instead that an 80-foot depth-to-groundwater threshold be used when inferring whether Valley Oak polygons in the Veg Map derived potential GDE map are likely reliant on groundwater. This recommendation is based on a recent correction in TNC's rooting depth database,2 after finding a typo in the max rooting depth units for Valley Oak. This resulted in a specific change in the max rooting depth of Valley Oak from 24 feet to 24 meters (80 feet). For all other phreatophytes, we continue to recommend that a 30-foot depth-to-groundwater threshold be used when inferring whether all other vegetation polygons are likely reliant on groundwater.	The citation provided in comment refers to Valley Oaks inhabiting "fractured and jointed metamorphic rock". Vegetation inhabiting such geologic conditions are not relevant to the GSP as these conditions are not found within the boundary of the Subbasin. (Lewis DC Burgy RH (1964) The relationship between oak tree roots and groundwater in fractured rock as determined by tritium tracing. J. Geophys. Res. 69(12):2579-2588.)
		RECOMMENDATIONS: 1. Discuss available shallow groundwater data. Use depth-to-groundwater data from multiple seasons and water year types (e.g., wet, dry, average, drought) to determine the range of depth to groundwater around Veg Map derived potential GDE polygons. We recommend that a baseline period (10 years from 2005 to 2015) be established to characterize groundwater conditions over multiple water year types. Refer to Attachment D of this letter for best practices for using local groundwater data to verify whether polygons in the Veg Map derived potential GDE map are supported by groundwater in an aquifer.	Comment noted. This analysis will continue with additional surface water and groundwater data collection in the future during GSP implementation.
		2. Refer to Attachment B for more information on TNC's plant rooting depth database. Deeper thresholds are necessary for plants that have reported maximum root depths that exceed the averaged 30-ft threshold, such as Valley Oak (Quercus lobata). We recommend that the reported max rooting depth for these deeper-rooted plants be used if these species are present in the subbasin. For example, a depth-to-groundwater threshold of 80 feet should be used instead of the 30-ft threshold, when verifying whether Valley Oak polygons are connected to groundwater.	The citation provided in comment refers to Valley Oaks inhabiting "fractured and jointed metamorphic rock". Vegetation inhabiting such geologic conditions are not relevant to the GSP as these conditions are not found within the boundary of the Subbasin. (Lewis DC Burgy RH (1964) The relationship between oak tree roots and groundwater in fractured rock as determined by tritium tracing. J. Geophys. Res. 69(12):2579-2588.)

Date Received	Commentor	Comment	Responses to Comments
		3. Further discuss data gaps for GDEs, including specific plans and locations for additional shallow monitoring wells.	See section 7 for information on how GSP will address data gaps in the GDE's.
		Native vegetation and Managed Wetlands: Native vegetation and managed wetlands are required to be included in the water budget. The integration of native vegetation into the water budget is insufficient. The water budget includes a separate item for evapotranspiration, but combines crop, native vegetation, and riparian Evapotranspiration into one term. The omission of explicit water demands for native vegetation is problematic because key environmental uses of groundwater are not being accounted for as water supply decisions are made using this budget, nor will they likely be considered in project and management actions. Managed wetlands are not mentioned in the GSP, so it is not known whether or not they are present in the subbasin.	See below responses to recommendations.
		RECOMMENDATIONS: 1. Quantify and present all water use sector demands in the historical, current, and projected water budgets with individual line items for each water use sector, including native vegetation.	This will be incorporated in future updates to the GSP.
		2. State whether or not there are managed wetlands in the subbasin. If there are, ensure that their groundwater demands are included as separate line items in the historical, current, and projected water budgets.	It is assumed that managed wetlands shown on Figure 2-3 within the Subbasin do not rely on groundwater. However, this is an area of uncertainty that will be evaluated during GSP implementation.
		RECOMMENDATIONS (Water model and climate change):	
		1. Consider other GCM projections to account for uncertainty beyond median statistics.	The median statistics were generally used to compare various GCM's and their appropriateness for the Sonoma County GSP's. The downscaled, transient GCM output for the Santa Rosa Plain Subbasin was used for the projected simulation model, not the median statistic. The chosen model includes an extremely dry and hot period near the last 20-years of the simulation period.
		2. Integrate climate change, including extreme climate scenarios, into all elements of the projected water budget to form the basis for development of sustainable management criteria and projects and management actions.	The chosen model includes an extremely dry and hot period near the last 20-years of the simulation period.
		3. Incorporate climate change into surface water flow inputs, including imported water, for the projected water budget.	This was performed for the GSP. See appendix 3-D, section 3.5, which shows that the Russian River is capable of meeting demands for all climate scenarios.
		4. Incorporate climate change scenarios into projects and management actions.	This was performed for the GSP.

Date Received	Commentor	Comment	Responses to Comments
10/31/2021	Russian Riverkeeper	Today, groundwater accounts for approximately 35 percent of the overall sub-basin water supply, however as dry periods increase and surface waters are reduced this percent will likely increase significantly. Because this GSP does not adequately consider future dry years and climate change induced extremes, there is no way to adequately determine future risks and management actions to the necessary degree so that long-term sustainability is achieved. Further, the SRBGSA should look beyond existing plans and studies when making determinations about future water supply and demand as many existing plans also fail to consider future impacts of climate change or pre-date the last significant drought in 2014. Reliance on such plans will only lead to the expansion of future supply gaps that could have been mitigated if climate change had been properly considered in the here and now. p. 13: The (climate change) scenario chosen for this GSP is not representative of our region's future conditions despite there being a fair consensus on this point. The choice to use a wetter model is a risky move when a more conservative and proactive acceptance of our climate future could have only benefited our region long-term. At what point will the GSA accept these changes and reevaluate this GSP? There is no timeline provided other than when "more refined projections become available"—what does that mean though? P. 14: Besides the fact that expectations of future drought scenarios have changed since DWR first published guidance in 2018, the guidance itself encourages groundwater sustainability agencies to analyze the more extreme Dry-Extreme Warming and Wet-Moderate Warming scenarios. This did not happen here and there is no reasonable basis for not following DWR's guidance. Choosing not to consider these scenarios constitutes a failure to consider the best available science and information as required by SGMA.	The GSP accounts for increased dry periods and declining surface waters in a number of ways. First, the the projected baseline scenario accounts for projected climate directly into the groundwater simulation (Appendix 3-E). Municipal demands also account for the projected climate by adjusting (Appendix 3-D) groundwater demands based on yearly precipitation. And finally, surface water reliability under projected climate is accounted for in Section 3 of the GSP and Appendix 3-E. The GSP is a living document, and along with the groundwater model wil be updated a minimum of every five years. Data collected along with sustainable management criteria will be evaluated and transmitted annualy in a report to the state as required by law, and as a result, the GSA will be tracking the direct measurements with the climate projections over time.
10/12/2021	Marshall Behling	We are told by scientists and politicians that we're in a "new normal" when it comes to drought and wildland fires. We can't use the "old normal" to predict the new normal. Please specifically analyze, discuss, and justify your assumptions on rainfall. Failure to do so will cause the public to lose faith in your efforts. Thanks, MB	Please see appendix 3-E. It details the selection process of choosing the global circulation model that projects climate. We did not assume anything about rainfall. The rainfall used in future simulations came directly from these scientifically-sound, sophisticated global circulation models that are internationally recognized and legitimized.

Date Received	Commentor	Comment	Responses to Comments
		The basis for policies and actions in this GSP stem from a 50 year predictive model of 30 years of “normal” rainfall followed by 20 years of severe drought. Such a model is not supported by current Climate Change science, but rather opts for a highly optimistic near-term environment, and a future stress run without consideration of compounding factors. Future conditions are far more likely to be non-linear. That is, precipitation patterns will not reflect historic periods, but rather shift back and forth violently, just as we have seen with this year's severe drying followed by sudden flooding deluge (13” of rainfall total last year, and then10” in the last 48 hours). The basis for such volatility can be found in the increasing loss of temperature differential between the Arctic and temperate North American continent. As this differential diminishes, the dominant jet stream band breaks down to a greater and greater degree, leading to incipient high pressure off the California coast, heat domes, and monsoon precipitation events. It is possible to predict the breakdown of the jet stream by looking at modeling for the loss of Arctic sea ice, which is now expected by the end of this decade. This implies that an assumption of 30 years of “normal” wet years moving forward is wildly optimistic, and misleading as a basis for planning.	There is no assumption that '30 years of normal rainfall' will occur. See appendix 3-E for source of data used in projected model simulations.
		Predictions for groundwater pumping rates for land owners during prolonged drought assume household “efficiencies” comparable to urban residents, and, if need be, mandated monitoring and restrictions on extraction. However, this fails to take into account the larger system impacts such a severe, prolonged drought would have on the residents of Sonoma County. When (not if) we enter a cycle of prolonged drought and heat, agriculture in the Central Valley will also be experiencing equal or greater stress. The precautionary principle must assume not just a local water availability issue, but a collapse in California's water-intensive agricultural sector. In response to diminished supply and increased cost for food, land owners in Sonoma County will be compelled to plant crops or fodder on scale. Intensive food production in our dry-summer climate is extremely water demanding, even with modern technology, and a shift to cropping would result in groundwater pumping far exceeding the models employed in this GSP. Attempts by local government agencies to limit pumping at the cost of a communities ability to feed themselves would lead to rampant social crisis.	Comment noted.

Date Received	Commentor	Comment	Responses to Comments
10/12/2021	Deborah Eppstein	Thank you for all your work on these GSAs. Although I not am a water expert, I am a scientist. As a scientist, I am very concerned that the climate model chosen, predicting wetter weather for the next 20 years, does not reflect best current knowledge concerning hotter drier climate, with significantly more water loss to evaporation-transpiration. Even with a slightly wetter model, predictions are for precipitation to come in shorter, more intense periods during the winter, with much less during the former shoulder periods of spring and fall. Even if greater total precipitation, this pattern causes more runoff and less ground water recharge. Also climate predictions include more intervening years of severe drought which further cause ground water levels to lower, even if they are followed by wetter years. Using only a model that predicts more than average rainfall for the next 20 years is ignoring the science. At very least I recommend that you use a range of options, and prepare for the worst scenario. If updates are made every 5 years, we could be left high and dry (literally) in 5 years if we base our current planning on a wetter next 20 years, but that does not materialize. I have not down an exhaustive search, but for example, see article below by McEvoy et al (2020): Earths Future Vol 8, issue 11 Nov 2020; Projected Changes in Reference Evapotranspiration in California and Nevada: Implications for Drought and Wildland Fire Danger. Daniel J. McEvoy, David W. Pierce, Julie F. Kalansky, Daniel R. Cayan, John T. Abatzoglou. First published: 29 October 2020. https://doi.org/10.1029/2020EF001736 Also, what analysis is being done for all the unincorporated areas that are not within the three GSAs? Both agriculture and cannabis as well as homes use ground and surface water in these areas, and this usage may increase significantly if there is not a solid water availability analysis to guide future permitting. Even the state Department of Cannabis Control has asked the county (through Permit Sonoma) to perform analyses of cumulative impacts of water usage across the entire county, for all water uses, surface and groundwater. NOAA has also requested such. I hope you will commit to revise these GSA's before they need to be submitted, to include additional climate prediction models encompassing less precipitation, greater water loss due to evapotranspiration, and periodic years fo extended drought. ~~This may be the new normal. Thank you for your consideration~~	The concern that the chosen model "does not reflect best current knowledge" is illogical (see appendix 3-E). The best current knowledge is actually derived, in part, from the chosen model. The chosen model (HadGEM2-ES RCP8.5) is one of the Climate Model Intercomparison Project version 5 (CMIP5) models that was used in the McEvoy et al (2020) listed by the commentor. As such the chosen model is well-founded and defensible. Secondly, the increased evaporative demand referenced by the comment is very well accounted for by the groundwater flow model. The GSFLOW model uses a sophisticated set of computations to account for the impact of increased temperatures on evaporative demand. Similarly the changed hydrologic patterns mentioned by the comment will be well accounted for by the model. Groundwater use outside of the Subassin area have been accounted for in the groundwater model. This includes current and projected ag, rural, and municipal groundwater users.

Date Received	Commentor	Comment	Responses to Comments
10/12/2021	Craig Harrison	I want to provide brief comments on the draft Santa Rosa Plain groundwater sustainability plan. I understand that it contains an assumption that rainfall will be “above average” during the next 20 or so years. Any such assumption must be justified by science. I suspect it is purely an assumption, because so far as I know there are few if any credible projections for decades in the future. As Yogi Berra famously said, “It's tough to make predictions, especially about the future.” f I were projecting rainfall over the coming decade, I would be much more inclined to use the rainfall during the past decade rather than the rainfall during the 1970s, 1980, 1990s, or any other prior time. We are told by scientists and politicians that we’re in a “new normal” when it comes to drought and wildland fires. Why assume the “old normal” is still the current norm? This element of the plan seems likely to drive most results and policies that will be based on the plans. Unless your assumed rainfall can be justified, I suggest that you do the following. Perform all analyses based on three different scenarios/assumptions: 1. Average rainfall over a designated period. 2. Above average rainfall by a certain percentage over a designated period. 3. Under average rainfall by the same percentage over a designated period. This allows a sensitivity analysis for your results and conclusions. The public and decision makers can readily ascertain the degree to which this assumption drives the results. For results that are the same or nearly the same under all three scenarios/assumptions, you will have confidence that you can made sound policy judgments based on those results. Where the results are different, you will have a clear warning that you do not have a sound scientific basis for policy decisions based on these results. In that event, I suggest that you employ the precautionary principle and take actions to preserve options in the event any optimistic assumptions turn out to be wrong. I ask that your report specifically analyze, discuss, and justify your assumptions on rainfall. Failure to do so will cause the public to lose faith in your efforts. It might be contrary to law. Thank you for your work on this important issue.	See appendix 3-E for details on methodology on future climate used in the GSP. There were no assumptions that climate would be wetter or drier than historical. The output of the global circulations models are basis of future projected model scenarios.
COMMENTS RECEIVED ON AUGUST 2021 VERSION			
9/9/2021	Beth Lamb	There is a lot of good information that is very technical in this section. I found that the color figures were very helpful to explain some very technical information. Seems like this section will need to be updated substantially as new data becomes available especially in the water balance section. Section 3.2.5.2 There is starting to be evidence that CrVI is naturally occuring in shallow groundwater in the Santa Rosa Plain	Comment noted Comment noted - if there is documentation please provide to the SRP GSA.

Date Received	Commentor	Comment	Responses to Comments
9/7/2021	Robert Pennington	Page 3 - "The main channel of Mark West Creek is perennial throughout much of its length (Simley and Carswell 2009), having summer flows maintained by numerous springs near the headwaters. Most of the main channel is in its natural state and much of the riparian vegetation adjacent to the Mark West Creek channel, as well as the creek bed, is undeveloped and characteristic of natural channel conditions." Is this true of Mark West Creek within the SRP? I thought there had been dredging and straightening, especially in areas near the confluence with the Laguna.	Comment noted Not dredging and channeling but diversions - "most" of the main channel is in natural state - In the mid-19th century, lower Mark West Creek flowed northwest across the Santa Rosa Plain to its confluence with the Laguna de Santa Rosa. Between the late-19th century and the mid-20th century, a series of diversions (possibly combined with natural course shifts) caused the channel to move progressively further to the south. Today, the Laguna-Mark West Creek confluence is located approximately two miles south of the historical confluence. (San Francisco Bay Institute)
		It would be useful to identify streams that are listed as critical habitat for threatened and endangered aquatic species.	Comment noted
		7. Page 10 - "However, the continuity of these distinct upper and lower portions is not well constrained nor correlative across the Subbasin ~~due, in part, to the limited number of wells and lithologic information for the deep aquifer system~~." I recommend deleting, as above. More likely, the sedimentary structure is highly heterogeneous, and laterally continuous aquitards simply do not exist. It is unlikely that more well logs could adequately define the 3 dimensional discontinuous layer cake of sands, silts and clays to a resolution needed to define the "shallow" from the "deep" aquifer. Sweetkind (2010) made a great effort to use well logs to characterize the subsurface, additional well logs are unlikely to provide much more information that is of value at the basin scale.	Comments incorporated in part.
		8. Page 10 - "The shallow aquifer system generally is separated from the underlying deep aquifer system by sequences of clay, which form aquitards ~~that predominantly occur in either the lower portions of the Glen Ellen Formation or upper portions of the Petaluma Formation~~, as SECTION 3 — BASIN SETTING Santa Rosa Plain Subbasin GSP Santa Rosa Plain GSP Working Draft 3-11 08162021 evidenced by noted differences in water quality (Martin et al. 2013) and estimated hydraulic properties, such as vertical hydraulic conductivity (Woolfenden and Nishikawa 2014). Generally, hydraulic conductivity is typically 10 to 10000 times lower in the vertical direction compared with the horizontal direction due to anisotropic flow conditions typical of layered sedimentary aquifer systems (Heath. 1983)."	

Date Received	Commentor	Comment	Responses to Comments
		See strike out above. I don't think documented hydro-stratigraphy (Sweetkind et al 2010) support this description, and this appears inconsistent with the Geologic Descriptions and Aquifer System Materials and Properties sub-sections included in the Basin Setting. I don't think there is much evidence for the clay rich layers in lower Glen Ellen or Upper Petaluma. Certainly this could be true in specific areas of the basin, but I don't think a general statement is appropriate. There are clay layers throughout both units. Confinement generally increases with depth as more and more low permeability layers (of varying thickness) are crossed. However, I don't think there is any particular laterally continuous aquitard at 150 to 200 feet.	
		Check the groundwater model for the range of Kh to Kv, I think it is up to 10000, but am not certain.	Comment noted
		Page 15 – "~~Aquitards composed of clay deposits commonly separate the shallow and deep aquifer systems and serve to locally confine the deeper aquifer system to varying degrees causing semiconfined and confined conditions.~~ Clay aquitards are common within some portions of the Quaternary alluvial deposits, such as the basin deposits within the southern portions of the Subbasin, the Glen Ellen Formation, and clay-dominated portions of the older Petaluma Formation, ~~which serve to confine more permeable sand and gravel aquifer zones within the Wilson Grove and Petaluma Formations of the deep aquifer system.~~"	Comment incorporated in part
		I think this section should be redrafted. Confined conditions are often gradational through the shallow aquifer through the deep aquifer. This may result from one confining layer or numerous low permeability layers. Rarely is there evidence for a productive upper aquifer, followed by a discrete confining layer, followed by a productive deep aquifer. More discussion of the complexity and range of potential configurations should be added.	Comment noted - as more data is collected, the GSP can be updated with this information
		Discussion and a map identifying areas where there is low, intermediate and strong evidence for confined deep aquifer conditions would be useful.	Comment noted.
		Page 35 - "Interconnected surface waters are defined in the GSP Regulations as "surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted." ~~A stream segment is interconnected where (and when) the groundwater water table elevation equals or exceeds the streambed elevation."~~	Alternate definition is incorporated.
		See strike out above. This statement is inconsistent with the preceding definition interconnected surface water, and inconsistent with text lower down in the same paragraph. If groundwater levels must be at or above the stream, then interconnected-losing streams would not be considered interconnected.	The text does not say gaining/neutral streams are an exclusive type of interconnected streams.

Date Received	Commentor	Comment	Responses to Comments
		Page 36 - “Where the shallow groundwater elevation is greater than the stream bottom elevation interconnected surface, water conditions are inferred to occur. Stream bottom elevations were extracted from 2013 Vegmap LiDAR (Vegmap 2013). Where shallow groundwater elevations are lower than the stream bottom, then the stream is inferred to be disconnected from the groundwater system. This analysis does not consider the impact of varying stream stage and assumes that the stream bottom is a reasonable surrogate for stream stage. Points for this category were assigned to give the full 5 points for reaches inferred to be interconnected using this method (negative values) and decreasing to 0 points where groundwater elevations are 10 feet below the stream bottom. **To provide a conservative approach and account for the inherent uncertainties within the datasets, reaches where the groundwater elevation is estimated to be within 10 feet of the streambed were assigned either one or two points depending upon the depth. Figure 3-18a shows the depth-to-water for all of the stream reaches.”**	There exists some critical depth at which point changes in local groundwater elevation does not impact sw/gw exchange. Our scientific basis is that occurs at 10 feet. The sentence implies that if groundwater elevation is 10 feet below streambed, then the stream is disconnected. This may in certain locations be incorrect, but without more data cannot be ruled out as correct/conservative. See sophocleous 2002 for good review.
		The sentence in bold seems to imply that if groundwater elevations were definitively known to be below the streambed, then the stream would be disconnected, which is incorrect.	
		Points based methods 1 and 2 give points to reaches that are “gaining”, and the methods appear to assume that reaches that are “losing” are disconnected. I find the method problematic for reaches where there is a gaining reach upstream, yet the reach itself is considered disconnected. These reaches are quite likely to be interconnected-losing. One example, evident on Figure 3-18e, is the main stem of Mark West Creek near HWY 101. I understand this reach to have perennial flow, and it is likely interconnected, but has been designated as “Non Interconnected”. I recommend all reaches downstream of a reach identified as “interconnected” be designated as interconnected as well.	Identifying losing-interconnected reaches is difficult. Assuming that all reaches below gaining section are interconnected stretches plauisibility due to limited upstream flow to supply cumulative downstream losses. Some streams go dry, especially smaller streams in this region.
		Page 69 - “Although the interannual estimate of groundwater storage both increases and decreases with the most recent cumulative net positive storage occurring in WY 2017, overall the outflows are greater than inflows into the groundwater system, resulting in an estimated decline in groundwater storage in both the historical and current water budget periods. The historical (WYs 1976–2018) annual change in storage is -600 AFY, whereas the current (WYs 2012–2018) annual change in groundwater storage is -2,100 AFY.”	First half of statement was removed for lack of clarity
		I suspect there are useful statistics on time series data that could be applied here. That current storage is well within the range of historic storage levels, this seems like a worthwhile point to emphasize. When considering the historic period, it does not appear that there is a significant downward storage trend.	Comment noted

Date Received	Commentor	Comment	Responses to Comments
		Page 70 - "The magnitude of these single-dry year potential shortfalls is estimated to be about 19 percent of average annual demand by 2045. This condition is accounted for in the baseline projected water budget developed for this GSP by assuming higher levels of groundwater demands from Sonoma Water contractors during dry conditions." This could use a little more description. What is meant by "accounted for"? Does this mean groundwater pumping is increased to offset 19% of the average annual demand during a severe dry year?	This has been addressed in text.
8/18/2021	Wayne Haydon	3.1.2 Surface Water and Drainage Features: Reference Simsley and Carswell, 2009 seems incorrect. Could use a reference for the channel condition. 3.1.3 Soil Characteristics: Text and Figure 3-3a: Not sure what is meant by "variable and unknown textures)". Most of light pink colored areas on map are Wright Loam WhA. Statement "At locations…recharge." Should be in another section on Recharge. Quaternary Sedimentary Deposits: Holocene is younger than 11,700 year. 3.1.5 Principal Aquifer Systems and Aquitards: "However, in a few limited areas where these units (shallow aquifer system) are absent or thin near the margins of the Subbasin, the shallow aquifer system locally occurs within sedimentary units of the Wilson Grove and Petaluma Formations." I think it would be better if we said the shallow aquifer is not present (not exposed) in these limited areas in the Shallow Aquifer discussion, and that the Deep Aquifer is exposed at the surface in these limited areas, but this should be stated in the Deep aquifer discussion. Otherwise, we are saying the Wilson Grove and Petaluma Formations could be either the shallow or the deep aquifer. 3.2.4 Land-Surface Subsidence: "Increases and decreases in stored water cause opposite land surface effects in bedrock versus alluvial areas. Increases in stored water increase this downward force resulting in elastic subsidence in bedrock areas and uplift in alluvial areas, whereas declines in storage release this downward force resulting in elastic land surface uplift in bedrock areas and subsidence in alluvial areas." My additions and edits are optional and could rewritten better. Could move to line 1136.	Noted - reference corrected Descriptors are directly transcribed from USDA source dataset Comment noted - soil permeability is mentioned in the Groundwater Recharge section and this is a soil characteristic Comment incorporated. "younger than 12,000 years" (Reference: Walker, J.D., Geissman, J.W., Bowring, S.A., and Babcock, L.E., compilers, 2018, Geologic Time Scale v. 5.0: Geological Society of America, https://doi.org/10.1130/2018.CTS005R3C. ©2018 The Geological Society of America) Comment noted. Comment noted. The report referenced (Argus et. al, 2017) is focused on the Sierra Nevada and Central Valley, not the Coast Ranges and coastal basins. Additionally, Figure 1 of the referenced report displays zero meters equivalent water thickness change in the Coast Ranges in the Sonoma County area for the mean seasonal water gain for the period 2006-2016, suggests that there would be zero uplift or

Date Received	Commentor	Comment	Responses to Comments
		Add reference: Argus, D. F., Landerer, F. W., Wiese, D. N., Martens, H. R., Fu, Y., Famiglietti, J. S., … Watkins, M. M. (2017). Sustained water loss in California's mountain ranges during severe drought from 2012 to 2015 inferred from GPS. Journal of Geophysical Research: Solid Earth, 122, 10,559–10,585. Last three sentences of first paragraph: Flesh out the three sentences, reverse order to reflect that aquitard compaction (not collapse) is the greater subsidence cause, aquifer compaction much less cause.	subsidence effect on bedrock, unlike the Sierra Nevada with 0.5-0.75 meters equivalent water thickness change.
		Figure 3-18d needs values in Explanation. Explain why negative numbers. Vegetation GDEs: How did you get "…the following general classifications." I don't find this in the Sonoma County Veg Map. 3.3 Water Budget: General comment: Quite an impressive body of work and a very useful tool for future predictions of conditions and interactions. Question: has the model been run backwards in time to compare simulated conditions versus observed conditions? What verification of the model has been completed. Page 3-51: Figure 3-26 On the "Water Year Type" are the white or clear color bars normal water years? Need to add to Explanation. "The value of the net streambed exchange depends less on year-to-year variability in precipitation, and more on 5- to 10-year (climatic) variability in precipitation." While I don't doubt this statement, Explain how this was calculated, at a glance Water Year Type appears to control inflow/outflow magnitude. Page 3-52: "Figure 3-26 shows net stream inflows and…" This sentence seems out of place and could be an introduction of Figure 3-26. Maybe move to page 3-51 before, "Figure 3-26 indicates that streamflows exiting the Subbasin are…" To Fig 3-26, might add description of what negative and positive values mean. "These dynamics are likely climatically driven, rather than a result of increasing imperviousness." While I don't doubt this statement, Explain analysis that reaches that conclusion. Page 3-65: Explain "Dunnian runoff and interflow" Page 3-69: "If groundwater pumping and climate remain similar to the current period, and groundwater storage declines stabilize, losses from the streambed will become greater and groundwater ET will decrease until inflows equal outflows from the groundwater system." Are we saying in order for groundwater storage declines to stabilize, losses from the streambed must become greater and groundwater ET must decrease? Otherwise, I'm not sure what we are saying.	Comment incorporated The Nature Conservancy GDE vegetation mapping Comment noted Yes, the model has been compared against observed data. overall the model does a good job at simulating groundwater heads and observed streamflows. these results are presented in the model update appendix. Noted in Figure 3-23. Subsequent sentences in text were intended to support the statement. Comment noted. Subsequent sentences in text were intended to support the statement. Comment incorporated - now defined. Correct - text clarified.

Date Received	Commentor	Comment	Responses to Comments
		"The lateral flow of soil water (interflow) and rejected soil water (Dunnian flow) are important soil-zone processes that generate runoff into streams. Hortonian overland flow, which occurs when precipitation rates exceed soil hydraulic conductivity, is another important source of runoff that is not detailed here." Sentence appears out of place, should appear earlier.	Comment incorporated.
		Page 3-70: "A comparison of the historical water budget and current water budget shows greater stress…agricultural pumping." And " Subbasin boundary inflows and outflows…" Provide reference to graph and tables that show this conclusion.	As part of the summary it seems unnecessary to add references to each table and figure.
		"Surface water-groundwater interactions (net streambed exchange) is controlled more by 5 to 10-year variations in precipitation…" While I don't doubt this statement, Explain analysis that reaches that conclusion, at a glance Water Year Type appears to control inflow/outflow magnitude.	Explanation of analysis for this is presented in 3.3.3.1.
		3.3.4 Subbasin Water Supply Reliability: Page 3-70: "For single-dry years, model simulations…" Who's model, the UWMP or GSA?	The SRPHM.
		3.3.5: consider moving these to a more introductory position, perhaps after 3.3.2	Comment noted.
		3.3.6 Projected Water Budgets: Page 3-77 "A summary of the average fluxes for the historical, current, and projected water budget periods is shown on Figure 3-39." Only shows projected.	The text should reference figure 8-40 - this has been incorporated.
		3.3.6.3 Climate of the Projected Water Budget Simulation Period: Page 3-74: "The first 20 years of the projected simulation period are relatively wet compared to the historical precipitation. The first 2 years of the projection are dry, but are then followed by a total of 8 wet and 6 very wet years." And 4 normal years?	Comment incorporated.
		But 3.3.6.7 Projected Water Budget Summary: Page 3-95: "The projected water budget is characterized by an increased average precipitation in the first 30 years of the 50-year simulation." Dp these say the same thing?	Changed to 'elevated' average precipitation.
		3.3.7 Sustainable Yield: Page 3-97: "The 20-year period from WY 2021 to 2040 is used to determine the sustainable yield of the Subbasin. This period is selected based on the following factors: • Representative of long-term conditions: Mix of 6 wet years, 1 very wet year, 1 dry year, 2 very dry years and 10 normal years • The simulated net groundwater storage change during this period is near zero". Questions: 1. how does point one above this compare to what was said in 3.3.6.3 on page 3-74, copied above, about number of wet/dry years? 2. Reference which graph depicts "simulated net groundwater storage change during this period is near zero." Fig. 3-49? Did the model simulate the future (2020-2070) groundwater elevation for the shallow and deep aquifers? If so, where is that data presented?	Comments incorporated - corrections made. Data is presented in Appendix 6-A.
8/23/2021	Joe Gaffney	Appendix 3-D: Under "Municipal Demand Water projections," the document should be amended to read: "City of Sebastopol, which is entirely reliant on groundwater pumped from the Santa Rosa Plain Subbasin and the Wilson Grove Formation."	Comment noted. The narrative is focused on wells in the subbasin and not the geological formation.

Date Received	Commentor	Comment	Responses to Comments
8/31/2021	Bob Anderson	P. 13: this is an important statement – needs to be presented more definitively: To characterize the aquifer systems within the Santa Rosa Plain for the purpose of implementing SGMA, two principal aquifer systems have been identified based on available data and information: the shallow and deep aquifer systems	Comment noted. The aquifer systems are presented more definitively in susbequent subsections.
		P.15: this may need to be qualified – assume it refers to Rohnert Park's wells – now changed. The shallow aquifer system generally exhibits stable long-term groundwater levels, while deeper aquifer system wells have exhibited appreciable periods of declining groundwater levels in certain areas of the Subbasin (Santa Rosa Plain Basin Advisory Panel 2014; Sonoma Water 2017).	Comment noted. See Figure 3-9b.
		P. 18: Over what years is the data trends? Figures 3-12a and 3-12b	Comment incorporated into figures.
		P. 20: likely important detail re faults and impact on aquifers: The Rodgers Creek Fault appears to act as a barrier to groundwater flow and also creates groundwater upflow or mixing along part of its length (Figure 3-5). The Sebastopol Fault appears to limit the lateral groundwater movement to the east. To the east of the Sebastopol Fault, an unnamed fault is at least a partial barrier to groundwater flow and appears to create upflow or mixing along part of its length (Martin et al. 2013)…. These changes suggest that the fault orientation and activity may be directing groundwater downward and causing deep mixing of older and more recently replenished waters, or may be evidence of groundwater upwelling. The Sebastopol Fault may be acting as a barrier to shallow flow, but does not appear to impede flow at greater depths. Recharge that reaches the deeper aquifer zones is less well-defined and appears to come from a combination of leakage from overlying shallow aquifers and mountain-front recharge along the margins of the valley	Comment noted.
		P. 20: Was this study used for Group 2 Projects? The natural recharge potential map developed by Todd Engineers (Figure 3-6) ranks the very high to very low relative potential for natural groundwater recharge from rainfall infiltration	Yes.
		P. 22: does any of this need to be updated now both Sections 6 & 7 are written? 3.1.8.2 Recharge and Discharge Areas and Mechanisms and Surface Water/Groundwater Interaction Improved understanding of recharge and discharge mechanisms within the Subbasin for both the shallow and deep aquifer systems will support the appropriate selection of projects and actions needed for the Subbasin, this includes: • Gaining an improved understanding of the interconnection of streams to the shallow aquifer system, including seasonal variability and how groundwater pumping can affect streamflow. Additional shallow monitoring wells near stream courses paired with stream gages and meteorological stations can help advance this understanding. • Conducting geochemical or tracer studies, which can help better understand both recharge and discharge mechanisms to both the shallow and deep aquifer systems, as well as surface water/groundwater interaction within the Subbasin.	No.

Date Received	Commentor	Comment	Responses to Comments
		P. 23: which number is one used in the GSP? The yearly average precipitation measured from this station from WY 1903 through WY 2018 is 29.3 inches (Table 3-1), compared with 33.3 inches, as calculated by PRISM.	Both are used (referenced) in the GSP as is explained in the susbequent paragraph. Note this text has been updated to include the updated Table 3-1 data extending to 2020.
		P. 24: Average rainfall = 29.81	
		P. 25: Out of sequence – coming after Figures 3-10 a.b. • Historical groundwater-level contour maps (Figures 3-9a and 3-9b)	Comment incorporated. Narrative has been adjusted for sequence of historical then current.
		P. 26: check the wording: More recent groundwater-elevation contour maps prepared for the GMP and for this GSP separate shallow aquifer system and deeper aquifer system wells to contour the two principal aquifer systems separately. Comparison between the shallow and deep aquifer system groundwater-elevation contour maps indicates that groundwater elevations in the deeper zone aquifers are approximately 10 to 40 feet lower than groundwater elevations in the shallow aquifer system in the Subbasin.	Comment incorporated into revised narrative text.
		P. 30: important detail appears in this – but the charts come at pages 66-67 of 109. 3.2.3 Estimated Changes in Groundwater Storage -- Table 3-11 (Section 3.3.3.2) shows on average, that groundwater storage in the historical period declined by 600 AFY, while it declined by 2,100 AFY in the current period. The average annual results indicate that about 3 percent of pumpage in the basin is supplied by groundwater-storage depletion. The increased rate of groundwater-storage depletion during the recent period appears to be more a result of a drier climate than increased groundwater pumping during that period.	Comment incorporated by standard convention of moving Table 3-11 and Figure 3-33 up to this section and renumbering tables and figures.
		Figure 3-33 (Section 3.3.3.2) shows groundwater pumpage by water-use sector, along with the 5-year moving average of pumpage for the historical period. The peak of the 5-year moving average of the current period (21,000 AFY) is exceeded during 5 years in the 2000 to 2011 period, indicating that total groundwater pumpage for the current period is not greater than the previous 12-year period.	Comment noted
		P. 31: looks as if the Hwy 12 sign is covering the white dot for SRPO496: One PBO GPS station is located within the Santa Rosa Plain Subbasin (Figure 3-14a). This station (SRP0496; P197) has been actively monitored since 2006 and results are shown on Figure 3-14b.	Comment incorporated - monitoring location symbol to be move on top of highway symbol.
		P. 47: Estero de Santa Antonio - should be Estero de San Antonio	Comment incorporated.
		P. 47: Petaluma Valley Subbasin	Comment incorporated.
		P. 49: text says “Subsurface inflows” – Fig 3-22 says “surface”	Both are correct - the Figure 3-22 reference in the text is to geographic location and not type of inflow.
		P. 52: Is it 2071 or 2070? Projected climate based on the selected global circulation model (GCM) will represent WY 2020 through 2071.	WY 2021 through 2070 - text has been corrected.

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		P. 55: what is change in groundwater levels? On average, groundwater discharge to streams exceeds streambed losses, resulting in a net streambed exchange into streams of approximately 300 AFY. WY 2017 is one of the top 3 wettest years in the historical period but still experiences a negative streambed exchange. This is because WYs 2012 to 2016 were all dry or normal precipitation years. Consequently, in the current period there is a negative net streambed exchange of -1,300 AFY. The net combined surface-water outflow from the Subbasin ranges from 47,000 to 1,165,000 AFY	Groundwater level changes are presented in appendix 6A.
		P. 58: Not sure -- appears an explanation is missing for Table 3-6+ (maybe Current?)	Comment incorporated - unlabeled Table labeled Table 3-7.
		P. 78: what was the number used for population growth for Municipal? Projected groundwater pumping assumptions and modifications Municipal, rural domestic, and industrial projected water uses are simulated using the WEL package. These uses are defined on a monthly basis and incorporate the projected population growth and associated groundwater demands.	Not a simple population growth projection as different municipalities used different assumptions to estimate demands over time, which were then extraploated out to 50 years - see Appendix 3D.
		P. 78: what was the annual precipitation after 2040? Climate of the Projected Water Budget Simulation Period. The first 20 years of the projected simulation period are relatively wet compared to the historical precipitation. The first 2 years of the projection are dry, but are then followed by a total of 8 wet and 6 very wet years. In this period, the average precipitation is 35.6 inches per year, which is 20 percent greater than the historical average. Average 2021-2070 = 31.8 in.	Please refer to Figure 3-37.
		P. 82: this says Figure 1-1 – believe it may instead be Figure 3-22. Surface Water inflow and Outflow: Subregion and Stream Names on page 48 of 109. Figure 3-41 and Figure 3-42 illustrate the net boundary inflows and outflows for each of the HUC 12 watershed areas, and the streams that drain them. The locations and extents of the watersheds is shown on Figure 1-1.	Comment incorporated - reference to watersheds changed to subregions.
		p. 82-83: Text cites to “subsurface inflows – except Figure 3-22 = Surface Water inflow and Outflow: Subregion and Stream Names – page 48 of 109	This is actually surface inflows.
		P. 86: typo - For the entire projection from WY 2021 to 2070 (Table 3-233),	Typo corrected.
		P. 87: what is ASR – gets a color but not included in Figure 3-45?	Correct.
		P. 100: Petaluma Valley Subbasin	Text corrected.
		P. 101: The average total groundwater pumpage for this period is 23,900 AFY, which is defined here as the sustainable yield (Figure 3-54). This value is 39 percent of the total groundwater inflows into the subbasin, and is greater than the average total groundwater pumpage experienced during the current water budget period…. Minimum thresholds for depletion of interconnected surface water will be further refined during the five-year GSP update. As such the sustainable yield does not fully account for the impact of basin-wide pumpage on surface-water depletion	Comment noted.
		P. 109: APPENDIX : http://santarosaplaingroundwater.org/wp-content/uploads/SRPGSP-SMC_SECTION-4_08192021_Final.pdf	Comments noted and text revised.

Date Received	Commentor	Comment	Responses to Comments
		P. 5: Note to Readers: The following information on Sustainability Goal will be reviewed updated when the GSP is completed Note: The list of projects and actions will be included here once finalized. Description of how the sustainability goal will be achieved: Note to Reader: The effects of the projects and actions will be included here in final version of Draft GSP.	
COMMENTS RECEIVED ON APRIL 2021 VERSION			
5/10/2021	Susan Harvey	Thanks for the opportunity to read this section of the plan. A lot of it is very technical, but I thought a lot of effort was made to bridge the gap for the lay person, like me. There were a few things that I had questions about. I tried to copy the text and list the lines.	Comment noted.
		lines 1019 – 1021: Six active or emergency/standby municipal production wells (five of these are completed within the shallow aquifer system and one is completed within the shallow aquifer system	Comment incorporated. Six active or emergency/standby municipal production wells (five of these are completed within the deep aquifer system and one is completed within the shallow aquifer system).
		Both of the five and the one say "within the shallow aquifer system". Should one of these say something different?	No. the first bullet referes to City of Santa Rosa muncipal wells, and the second bullet refers to shallow private wells for monitoring.
		lines 1350 – 1352: Areas of elevated arsenic concentrations are most notable in the northeaster portions of the Subbasin, immediately south of the city of Santa Rosa, in the vicinity of the city of Sebastopol and along the Trenton Fault near Mark West Creek.	Text corrected to say "northeastern." The sentence refers to four different geographic areas, and the northeastern part of the basin is one the four areas.
		First, should that be "northeastern"? Second, I was confused since it said northeastern and then talked about south and kinda west of Santa Rosa	
		lines 1589 – 1590: and the following representatives from the following groups: This spoke to following representative, as in the names of the folks from these groups, but no names were listed. I was thinking if there was no intent to list the names, maybe it should say "and representatives from the following groups"	Comment incorporated.
5/6/2021	Mark Grismer	Have reviewed the chapter 3 info and found no substantial issues – these will arise I suspect more so as we try to set thresholds and propose projects that may involve reductions in GW use	Comment noted.
5/24/2021	Matt O'Connor	3-10a & 3-10b & pg 23: Groundwater elevations shown for shallow and deep aquifers appear to be similar. In east Rohnert Park, shallow aquifer elevations are considerably lower than deep aquifer elevations. This convergence of groundwater elevations should be discussed; at face value it may call into question whether these aquifers are distinct from one another. The discussion of these figures on page 23 says the deep aquifer elevations are approximately 10-40 ft lower...	Hydrogeologic data and hydrographs are more suitable for separating out hydrogeologic differences and the deep and shallow hydrographs show clearly different response patterns suggesting hydrostratigraphic separation.

Date Received	Commentor	Comment	Responses to Comments
		P. 25, line 1019-1021 two subgroups of wells both identified as shallow aquifer	Comment addressed - this was a typo.
		P. 35 Surface water conditions in upper Mark West Creek (above Quietwater Road) have been simulated for a 10-year period (2010-2019) and calibrated at stream gages, notably the Michele Way gage operated by Sonoma Water) by O'Connor Environmental Inc study of Mark West Creek. OEI developed rating curve for Michele Way 2018-2019. These are the only streamflow data for upper Mark West Creek that are available and given the limited data available of this type, it seems worth at least some mention.	Comment noted. Comparison of assumptions, input datasets and output from OEI modeling in upper Mark West Creek watershed will be compared with data and assumptions from the SRPHM during GSP implementation.
		Fig. 3-18b: OEI modeling for Upper Mark West Creek can be compared with respect to gaining stream conditions	Comment noted. Comparison of assumptions, input datasets and output from OEI modeling in upper Mark West Creek watershed will be compared with data and assumptions from the SRPHM during GSP implementation.
		Fig. 3-18c: units of cubic ft per day may not be best choice; data for upper Mark West Creek can be directly compared to OEI modeling	Comment noted. Comparison of assumptions, input datasets and output from OEI modeling in upper Mark West Creek watershed will be compared with data and assumptions from the SRPHM during GSP implementation.
		Fig. 3-6: Relative recharge potential map; a similar but finer scale hydrogeologic model prepared for the upper Mark West Cr watershed found substantially different spatial distribution of predicted groundwater recharge. The model prepared by O'Connor Environmental Inc. for Coast Range Watershed Institute and Sonoma RCD, funded by State Wildlife Conservation Board grant, is focused entirely upstream of the SRP groundwater basin, so it isn't clear whether a different representation of groundwater recharge in the upper watershed would have much effect on recharge of the SRP basin by Mark West Creek. The OEI model also predicts surface water discharge from upper Mark West watershed to the SRP sub-basin, and that data might be the most important for a comparison of the two models.	Comment noted. Comparison of assumptions, input datasets and output from OEI modeling in upper Mark West Creek watershed will be compared with data and assumptions from the SRPHM during GSP implementation.
		P. 18: Sec 3.1.7 discusses a qualitative ranking of groundwater recharge potential in the sub-basin based on a study by Todd Engineers 2012. How does Todd's study relate to groundwater recharge calculated by the USGS GSFLOW model? Doesn't the model provide estimates of groundwater recharge? This section is written to describe the principal aquifers per SGMA requirements, so this treatment of the topic might seem reasonable, but it seems inconsistent with the fundamentals of the model-driven estimates of recharge. It is misleading in that way.	Comment noted. Comparison of assumptions, input datasets and output from OEI modeling in upper Mark West Creek watershed will be compared with data and assumptions from the SRPHM during GSP implementation.

Date Received	Commentor	Comment	Responses to Comments
		p. 19: Sec 3.1.8 regarding uncertainty references a "hydrogeologic conceptual model" that up this point in the chapter hasn't been a focus. I don't dispute that this section is about a conceptual model in some sense, but at this point I thought it was describing the aquifer descriptions for shallow and deep per SGMA requirements	The section 3.1 HCM covers all the components of the HCM as required in the SGMA GSP Regulations § 354.14
		p. 19: Sec 3.1.8 regarding uncertainty and data gaps. I think additional items not noted in this list that would be appropriate include 1. aquifer parameters whether shallow v deep or by aquifer material type; a wide range of aquifer materials are present with a wide range of T & S estimates and this high variability is somehow integrated in the conceptual model for shallow and deep aquifers, 2. groundwater recharge rates are primarily estimated; reference to other modeling efforts in the region that develop estimates of groundwater recharge rates could help characterize uncertainty 3. uncertainty regarding boundary inflows from other groundwater basins is acknowledged, this is an opportunity for the report to implicitly or explicitly identify particular discussions about the western basin boundary with the Wilson Grove Formation; there is both monitoring data from the Sebastopol area and groundwater model estimates from another regional model by O'Connor Environmental Inc. prepared for Gold Ridge RCD and funded by State Fisheries Restoration Grant Program. 4. Groundwater use is estimated by appropriate methods, but is nevertheless uncertain and it should be acknowledged so that there may be ongoing	Section 7.2.4 of the GSP identifies these as additional data gaps and identifies studies, information gathering and additional monitoring planned to address the data gaps.
		pps. 4&5: description of the subject basin in 3.1.1 is confused by apparently inconsistent reference to sub-basins referenced in Nishikawa 2013.	Comment addressed with consistent terminology.
		p. 6: sec 3.1.3 references "Soil Survey Staff, 2021". What was the new information brought forth in the past 4 months and how does it relate to the hydrologic model parameters?	This reference has been removed.
		p. 7: sec 3.1.4 more subbasin references...seems like this is describing the SRP basin study area as a sub-basin.	The Santa Rosa Plain is a "subbasin" as legally defined by DWR in Bulletin 118.
		p. 13: sec 3.1.5 I think it should be acknowledged that distinctive hydrogeologic characteristics of different geologic formations could be expected to be an alternative and possibly superior approach to defining aquifers simply as shallow and deep. The selection of shallow and deep aquifers to represent aquifers is justifiable owing to the limited available data to describe aquifers based on geologic materials (i.e. aquifer hydraulic parameters) and owing to the complex and novel requirements of SGMA. There is a substantial component of fundamental practicality and simplification that motivates the conceptualization of shallow & deep aquifers.	Comment noted.

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5/19/2021	Bob Likins	Here in Section 3 you talk about Water Budgets ..... I recall that at the early public meetings a year or two ago a lot of people were upset at the prospect of being charged for their water wells. My strong recommendation is that throughout this entire report you change your terminology and when you are talking about water usage or water allocation you use terms like that and not use the term "budget" until you get to the place where you are talking about money. And be very clear throughout the report to differentiate between the water use and the GSA administration budget/cost of administering the water use program being developed. Additionally, the clarity in terminology will be helpful when you talk about water usage and water recharge ..... that is taking water away from the general supply and adding water to the general supply. And when you talk about any dollar charges to users for using the supply and dollar credit to users for owning, caring for and paying taxes on land which is not covered with impervious surface and thereby adds to the general supply. It may have been mentioned once that it is tough to give recharge credit, but despite that, it is very important that it be done, understanding that it will involve many assumptions and approximations. Additionally, some may think that the length of time it takes surface water to get to the aquifer is an issue but it is not. W whether a rainfall benefits users tomorrow or in 50 or 100 years it still benefits them thanks to current land owners who provide surfaces of land that can absorb rainfall	Comment noted. The terminology 'Water budget' is required by law - see SGMA GSP Regulations §354.18. Water Budget
5/19/2021	Wayne Haydon	Line 178-179: Reference Simsley and Carswell, 2009 seems incorrect. Could use a reference for the channel condition. Line 198-199: Reference Simsley and Carswell, 2009 seems incorrect. Line 217-218: Reference Simsley and Carswell, 2009 seems incorrect. Line 232 and Figure 3-3a: Not sure what is meant by “variable and unknown textures)”. Most of light pink colored areas on map are Wright Loam WhA. Line 251-253: Statement “At locations…recharge.” Should be in another section on Recharge. Line 339-340: Reference Sweetkind et al. 2011 or 2013? Line 375: permeability or hydraulic conductivity? Line 377-382: no discussion of permeability or hydraulic conductivity. Line 387: Holocene is younger than 11,700 year. Line 430: could use a reference.	Comment incorporated. "Simley and Carswell, 2009" Comment incorporated. "Simley and Carswell, 2009" Comment incorporated. "Simley and Carswell, 2009" Source is USDA soils dataset. Comment noted - soil permeability is mentioned in the Groundwater Recharge section and this is a soil characteristic. Comment incorporated - 2013. Sweetkind references clarified. Comment noted. Comment incorporated. "younger than 12,000 years" (Reference: Walker, J.D., Geissman, J.W., Bowring, S.A., and Babcock, L.E., compilers, 2018, Geologic Time Scale v. 5.0: Geological Society of America, https://doi.org/10.1130/2018.CTS005R3C. ©2018 The Geological Society of America) Comment incorporated. (Nishikawa et. al, 2013)

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		Line 478-480: "However, in a few limited areas where these units (shallow aquifer system) are absent or thin near the margins of the Subbasin, the shallow aquifer system locally occurs within sedimentary units of the Wilson Grove and Petaluma Formations." I think it would be better if we said the shallow aquifer is not present (not exposed) in these limited areas in the Shallow Aquifer discussion, and that the Deep Aquifer is exposed at the surface in these limited areas, but this should be stated in the Deep aquifer discussion. Otherwise, we are saying the Wilson Grove and Petaluma Formations could be either the shallow or the deep aquifer.	Comment noted.
		Line 509-511: "Hydraulic conductivity…" start sentence with "In general". Otherwise, is reads like we are talking specifically about these geologic units	Comment noted.
		General comment: We state the formations properties, like thickness, lithology, confinement, etc. in several places. Could we reduce the repetition?	Comment noted.
		Line 640: Boron has been a COC	Comment noted.
		Line 684-688: Reads like we are grouping together the QAD and GEF as basin deposits. How about, "Clay aquitards are common within some portions of the Quaternary alluvial deposits, such as in the southern portions of the Subbasin and in the Glen Ellen Formation…"	Comment noted and text modified.
		Line 717-719: Figure 3-5 does not depict that "The Rodgers Creek Fault…" just the faults location. How about adding a previous sentence, "Fig 3.5 depicts fault locations in the subsurface."?	Comment noted and text modified.
		Line 728-730: or might suggest upflow of water from deep aquifers. Is there evidence either way?	Comment noted and text modified. Currently this is a data gap.
		Line 739-742: "Recharge that reaches the deeper aquifer zones… mountain-front recharge along the margins of the valley." Are we discussing where the shallow and deep aquifers are connected without sufficient separating aquitards? And/Or where the deep aquifer is exposed at the surface i.e., Wilson Grove or Petaluma formations? Like in the Block Diagram "Understanding Recharge and Our Groundwater Basins " Explain.	
		Line 771: Figure 3-7, don't see all the springs mentioned in text, where are NHD Springs. Also, there is a lot of information on this figure, but not discussed in this section. Should we make this a figure without Interconnected Streams and Water, include Springs only? Possibly make another Figure with Interconnected Streams and Water to be presented in a later section.	
		Line 981-992 and Figure 3-12a and b: In Explanation can we leave out parenthesis around numbers? Box in Map, does "<+- ft/yr change" depict "+/- .99" in Explanation? If so, should have consistent naming and fill coloring (probably white, grey would be lost in grey map background).	

Date Received	Commentor	Comment	Responses to Comments
		Line 1002-1121: We should state consistently they are depicted on Figure 3-13a, and state consistently Figures for Hydrographs. In reference to GWL cycles, we repeatedly say, "…responses to pumping cycles…" and "…wells were operating relatively continuously…" Do we show pumping cycle dates/time somewhere, what data was used to determine GWL are, "…responses to pumping cycles…", example Line 1093?	Comment noted and text modified. Pumping cycles and data are not included; rapid groundwater level changes in monitoring wells are considered responses to a nearby pumping well; other possible causes are equipment maintenance, earthquakes, or precipitation events in shallow wells along streams.
		Line 1116: "…monitoring wells respond rapidly to precipitation events and changes in streamflow in…." Do we present streamflow data to confirm this conclusion?	Yes -
		Line 1132: "**Increases and decreases in stored water cause opposite land surface effects in bedrock versus alluvial areas**. Increases in stored water increase this downward force resulting in **elastic subsidence in bedrock areas and uplift in alluvial areas,** whereas declines in storage release this downward force **resulting in elastic land surface uplift in bedrock areas and subsidence in alluvial areas.**" My additions and edits are optional and could rewritten better. Could move to line 1136. Add reference: Argus, D. F., Landerer, F. W., Wiese, D. N., Martens, H. R., Fu, Y., Famiglietti, J. S., … Watkins, M. M. (2017). Sustained water loss in California's mountain ranges during severe drought from 2012 to 2015 inferred from GPS. Journal of Geophysical Research: Solid Earth, 122, 10,559–10,585. https://doi.org/10.1002/2017JB014424	Comment noted. The report referenced (Argus et. al, 2017) is focused on the Sierra Nevada and Central Valley, not the Coast Ranges and coastal basins. Additionally, Figure 1 of the referenced report displays zero meters equivalent water thickness change in the Coast Ranges in the Sonoma County area for the mean seasonal water gain for the period 2006-2016, which suggests that there would be zero uplift or subsidence effect on bedrock, unlike the Sierra Nevada with 0.5-0.75 meters equivalent water thickness change.
		Line 1136-1140: Flesh out the two sentences, reverse order to reflect that aquitard compaction is greater subsidence cause, aquifer compaction much less cause.	Comment noted.
		Line 1179: Figure 3-14d?	Comment incorporated.
		Line 1183: Figure 3-14d and e?	Comment incorporated.
		Line 1191: Figure 3-14c?	Comment incorporated.
		Figure 3-15a thru c, and h, Fault mapping only extends north to Mark West Creek.	Comment incorporated.
		Line 1307-1323: Explain meteoric water line and have figure with described data.	Comment incorporated.
		Line 1372: where "SC" described?	Comment incorporated.
		Line 1448: Can we add why we are addressing Surface water.	Comment incorporated.
		Line 1470: Need reference for 80,000 acre feet.	Comment incorporated.
		Line 1473-1474: "…the component of the hydrograph that persists without precipitation…" Can we change "hydrograph that persist" to "streamflow". Easier to understand.	Comment incorporated.
		Line 1486-1488: explain gain-losing refers to stream flow.	Comment incorporated.
		Line 1499: Include stream flow elevation or stream stage. Line 1519-1520: Why ignore stream flow elevation (stage) over time? Not enough stream flow/elevation data? If so, say this. See Line 1532-1533. Streamflow discharge and elevation is being simulated as described in Line 1537.	Need to add more explanation and rationale for not using stream stage - not just line 1519-20 "This analysis does not consider the impact of varying stream stage and assumes that the stream bottom is a reasonable surrogate for stream stage" - explain why

Date Received	Commentor	Comment	Responses to Comments
		Line 1493: Need to add "Winters, et al, 1998" to references.	Comment incorporated.
		Line 1505: flesh out rationale for "scoring system."	Comment incorporated.
		Line 1531: "2000 to 2010" why these years? GWL is for 2015. Also, "…simulated **groundwater** head…"	2000 to 2010 was selected to represent the most recent simulated conditions by the model at the time the analysis was performed in order to incorporate multiple water year types in the analysis.
		Line 1532-1533: "The values range from 0 – 100%, where 0% indicates that the stream **stage** is always greater than the groundwater elevation…" Stage or stream bed elevation? See comment above for Line 1499.	Stream stage is what was used in order to assess gaining vs losing stream conditions.
		Line 1537: …median discharge… Figure 3-18c says Median Flow. We should be consistent. Both should say "stream", I prefer discharge.	Comment noted. Changed text to be consistent with figure
		Line 1545: what is "…cell top…"? describe. Is this elevation.	The elevation of the cell top does correspond to a specific elevation within the model.
		Figure 3-18d needs values in Explanation. Explain why negative numbers.	The more negative the values shown on the figure correspond to higher rates of surface leakage
		Tables not included to be reviewed.	Comment incorporated.
		Line 1617-1619: add this to references.	Comment incorporated.
		Line 1624: "In Sonoma Valley…"??	Comment incorporated.
		Line 1628-1633: Is "Sonoma County Veg Map" really "Watershed Sciences Inc., 2016"?? How did you get "…the following general classifications." I don't find this in the Sonoma County Veg Map.	Work group presentation materials added to Appendix 4-C address this question.
5-19-2021	Bob Anderson	Page 6 line 213: Santa Rosa Creek, which is not included in the Laguna de Santa Rosa drainage subbasin, is the largest tributary to the Laguna de Santa Rosa.	Comment incorporated.
		Page 6 line 228 – mixing Subbasin / SRP watershed: Soil types and characteristics in the **Subbasin** and surrounding watershed have been mapped by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), which developed a spatial database of soils for the entire United States (the Soil Survey Geographic Database or SSURGO) (U.S. Department of Agriculture, 2007). The SSURGO database defines 17 different soil textures (excluding variable and unknown textures) present in the SRP **watershed** (Soil Survey Staff, 2021), which are shown on Figure 3-3a.	Comment incorporated.
		Line 233: The majority of the **valley floor** is characterized by clayey soils and loams with gravelly and cobbly loams and more prevalent along alluvial fans and hilly areas. The southern portions of the **Subbasin** are characterized by much more clayrich soils. Gravelly and sandy soils are primarily limited to the low hills in the southwestern portions of the Subbasin and the western portions of the SRP watershed outside the Subbasin and along narrow stream channels within the Subbasin.	Comment incorporated.

Date Received	Commentor	Comment	Responses to Comments
		Page 11 line 412 – don't see Healdsburg Area Subbasin on Figure 3-4: The northwestern boundary of the Subbasin generally follows the contact between the Glen Ellen Formation and Quaternary alluvial deposits of the Russian River Valley within the Healdsburg Area Subbasin (Figure 3-4).	Comment incorporated.
		Page 12 line 493: In areas where multiple permeable zones occur within the deep aquifer system, these different zones can sometimes exhibit distinct features (e.g., distinct water quality signature or appreciable differences in hydraulic head) and can generally be further subdivided into upper and lower aquifers. However, the continuity of these distinct upper and lower portions is not well constrained nor correlative across the Subbasin due, in part, to the limited number of wells and lithologic information for the deep aquifer system. In areas where data is available, distinctions between the upper and lower portions of the deep aquifer system are discussed in this GSP	Comment incorporated.
		Page 14 Line 567: Within the SRPW, yields from wells that are completed only in alluvial deposits ranged from 1 to 650 gpm. The highest well yields are in the northern Subbasin near Mark West Creek (Sweetkind et al., 2013).	Comment incorporated.
		Page 15 line 594: Within the SRP watershed, most wells screened partially or totally in the Wilson Grove Formation are within the upper stratigraphic horizons, which are coarser grained and more permeable than deep deposits to the west. Domestic wells drilled into the Wilson Grove Formation yield on average about 20 gpm (California Department of Water Resources, 1979). Large capacity and municipal wells can yield up to 1,000 gpm or more (Sweetkind et al., 2013). Wells drawing from the Wilson Grove Formation have estimated specific yields in the range of 10 to 20 percent (Herbst et al., 1982), higher than any of the other rocks or sediments in the Subbasin.	Comment incorporated.
		Page 16 line 643: Specific conductance, chloride, total dissolved solids, nitrate, and arsenic are considered waterquality constituents of potential concern in the **SRP watershed** because some samples from wells exceeded state or federal recommended or mandatory regulatory standards for drinking water. In general, groundwater within the **Subbasin** is of mixed cation-bicarbonate type	Comment incorporated.
		Page 16 line 673: in the tidal marshland areas,	Comment incorporated.
		page 17 line 710: Faults in the **SRP watershed** serve as major structural boundaries for geologic formations, the **Subbasin** and groundwater movement.	Comment incorporated.
		Page 19 line 770: Based on USGS' National Hydrography Dataset and National Water Information System, there are 28 mapped springs and seeps in the SRP watershed, (Figure 3-7).	Comment noted.

Date Received	Commentor	Comment	Responses to Comments
		Page 20 line 808: Improved understanding **OF** recharge and discharge mechanisms within the Subbasin for both the shallow and deep aquifer systems will support the appropriate selection of projects and actions needed for the Subbasin. ● Gaining an improved understanding of the interconnection of streams to the shallow aquifer system, including seasonal variability and how groundwater pumping can affect streamflow. Additional shallow monitoring wells near stream courses paired with stream gages and meteorological stations can help advance this understanding. ● Conducting geochemical or tracer studies, which can help better understand both recharge and discharge mechanisms to both the shallow and deep aquifer systems, as well as surface water/groundwater interaction within the Subbasin	Comment incorporated.
		Page 21 line 873: The yearly **averaged** precipitation measured from this station from water years 1903 through water year 2018 is 29.3 inches, compared with 33.3 inches, as calculated by the PRISM model, as shown indicated in Appendix 3-A.	Comment noted.
		Page 22 line 894: Historical groundwater-level contour maps (Figure 3-9a-b) – **missing**	Comment noted - to be provided in subsequent draft for AC review.
		Page 23 line 931: From the south end of the valley, groundwater flows northwesterly from the Mendocino Range toward the Laguna de Santa Rosa.	Comment incorporated.
		Page 25 line 1019: Six active or emergency/standby municipal production wells (five of these are completed within the shallow aquifer system and one is completed within the shallow aquifer system);	Comment incorporated.
		All these wells are over 200 feet deep with the exception of the Peter Springs Well which is 160 feet deep	Comment incorporated.
		Page 38 line 1580: 3.2.6.3 Groundwater Dependent Ecosystems SGMA defines an undesirable result as "depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water." To help characterize environmental beneficial users, it is necessary to identify the aquatic species and habitats that could be adversely affected by lowered groundwater levels in principal aquifers and interconnected surface water depletion. The GSA partnered with the **Santa Rosa Plain and Petaluma Valley GSAs** to form a practitioners' work group to provide expert advice and perspectives,	Comment noted.
		In Sonoma Valley, a total of 19 streams were identified as habitat for at least one target species. Steelhead was the most widespread species occurring in each of the 19 streams. The distribution of Chinook salmon, coho salmon, and California freshwater shrimp overlap entirely with steelhead streams. For this reason, steelhead are essentially used as a priority indicator species to cover all aquatic GDEs in the Subbasin.	Comment incorporated - text revised.
		COMMENTS BELOW REGARDING APPENDIX WB 3-A: Updating the Santa Rosa Plain Hydrologic Model for Use in Development of the Groundwater Sustainability Plan for the Santa Rosa Plain Groundwater Subbasin pp 52	All comments below noted and staff communicated directly with Mr. Anderson.

Date Received	Commentor	Comment	Responses to Comments
		Overall, I find the document would benefit from some additional background / introductory guidance. The reader (DWR) most cares about the Bulletin 118 area. The model has a history from USGS. It also has been revised. And, the data shown for the Subbasin has been mostly extracted from the larger whole. But, at day's end, it is the Subbasin that matters. Best to focus on that alone and pare down the rest. Would be good to have a special place for listing of key data points. Such as from 1.2.1.2: A total of 11,943 parcels are included within the entire model domain and 7,482 parcels are within the Subbasin, of which 1,282 wells are urban users in the Subbasin (Table 1). Though again, it is the Subbasin that matters. P. 12 from WORKING DRAFT Water Budget – reference differ between documents: The water budget is computed using the revised SRPHM, which simulates the time period from October 1974 to December 2018 encompassing the period of best available science and information for the Subbasin. Then on P. 9, revised SRPHM 1.0+ is several times lower than estimates from the original SRPHM. P. 4: this is first and only mention of two aquifers: In accordance with Section 354.18 of the GSP Regulations, one integrated groundwater budget was developed for the combined inflows and outflows for the two principal aquifers for each water budget period. P. 11: be good to cite to a place in document for # amount of recycled water: Recycled water is indirectly incorporated through the external link file that acts to apply the recycled water directly into the soil zone. This water should act to limit groundwater pumping where it is applied by satisfying the potential evapotranspiration before irrigation is required. P. 11: different years? The datasets included the crop land use datasets for 1974, 1986, 1999 and 2008. Newly available land use datasets from DWR for 2012, 2014 and 2016 were used to update the agricultural land use to 2018. On page 15: These years are 1976, 1979, 1986,1999, 2008, 2012, 2014 and 2016 P. 11: in the text, which is 'the above list?' and only cells in the above list are included	

Date Received	Commentor	Comment	Responses to Comments
		p. 12: be good to flag this issue of pasture acreage/ water source for “future work needed”. Pastures are prevalent within the Subbasin and can can be a water intensive crop. In the 2019 Rate Study (Raftelis, 2019) it was assumed that pastures in the subbasin were not irrigated, whereas the 2012 DWR land use map by DWR indicates an irrigated land use for pasture areas. In order to assess whether pastures are irrigated, we mapped irrigated pastures identified in DWR’s land use dataset with the remote sensing-based normalized difference vegetation index (NDVI). NDVI is a common tool to assess vegetation health (Anderson et al, 2012), with values ranging from -1 to 1. Greater NDVI values indicate the increasing presence of chlorophyll content in plant matter, and thus a healthier non-stressed crop which is interpreted to be an indicator of irrigated agriculture. Figure 5 shows the irrigated pasture locations from DWR 2012 as input into the groundwater model with the 2012 Fall NDVI average values. The pastures identified in the model occur in areas with high NDVI values indicating vigorous growth late in the season, and therefore a high likelihood that these pastures are irrigated. // For water year 2012, 74% of the simulated pasture model cells in the subbasin received recycled water. // The pasture land use crop inputs derived from the DRAFT 2012 dataset were applied for the 1986 to 2018 period because of the reliance on data only available within the 2012 dataset P. 11-12: in one place 2012 Pasture acreage is 3,420 – in another 2012 Pasture acreage is 890: Table 2 Comparison of Acres of Crops in the DWR 2012 Land Use dataset and the VEGMAP dataset. These are not the same values used in the AG package as some crops were removed depending on irrigation source or non-irrigation. Only crops with comparable classifications are shown. On P. 16 – Table 4, shows pasture as 890. p. 22 – why end in 1990? How do these #s change with recycled water? Table 7 Average simulated irrigation depth by crop, pre-recycled water deliveries from 1975 to 1990 P. 19 – how much can this number (2 in.) change with soil type or management? All crops were assigned a value of 2 inches for the water holding capacity of the soil zone as defined by soil_moist_max and sat_threshold….Maximum available water holding capacity of capillary reservoir p. 20: Pastures were the dominant use of irrigation until 1983, after which vineyard irrigation has been the largest total use of groundwater irrigation in the sSubbasin. P. 23: does this mean the 1272 urban outdoor wells are not included? “Other sources of groundwater extraction, such as pumping for urban landscape irrigation are not included in the model”	

Date Received	Commentor	Comment	Responses to Comments
		P. 23 – was the original a daily model and revised is now monthly? "The representation of climate stresses in the model has been changed from the original approach of the SRPHM 1.0 of using daily grids of precipitation and minimum and maximum temperature, to an approach based on time series input for individual weather stations which are then interpolated spatially onto the model grid by PRMS subroutines." P. 24: or it seems daily at the two stations – hard to sort through: "On this basis, the updated time series for the two station locations are based on interpolation to the station locations directly from daily PRISM gridded data…l. The PRISM daily data sets only extend to January 1, 1981; therefore, the original USGS SRPHM v1.0 time series values are used for 1974-1980" P. 39: When considering all of the streamflow gage records, the updated SRPHM 1.0+ is generally well suited at simulating the monthly flow duration curves and the monthly average flow rates for summer and fall discharge. Figures 16-19 show little variation P. 29 - hard to sort through: Recycled water use has now been separated and is represented by adding recycled water volumes to the soil zone through a new input file using the PRMS Water Use Input Module. The use of this module also accounts for irrigation with recycled water when estimating rural pumpage with the Ag Package. For the most part, land irrigated with recycled water was within the Laguna de Santa Rosa 100-year flood-plain area, and is used for both landscape and agricultural irrigation (as seen on Figure 21 of USGS, 2013). (not sure about that statement) **COMMENTS BELOW REGARDING APPENDIX 3-2 (1-B): Future Groundwater Demands and Land Use Change** Municipal Water Demand Projections: Page 71: "While the ranges of future pumping estimates are generally inclusive of projections currently being developed for 2020 Urban Water Management Plans (UWMP) by each purveyor, in order to account for the significant uncertainty in the future projections and provide for a conservative estimate for the GSP projections, the maximum estimates generally assume higher levels of pumping in comparison with the UWMP projections." Comment: Looking at City of Santa Rosa's number from UWMP = 2,500 afy is mid-range. UWMP says peak is 2300 afy at Farmers wells. Sonoma Water's 1272 afy tracks peak use from 2000 but is half of the 2,300 afy per adopted UWMP. Will these numbers change with UWMP's adoption? Question: How does the model apply min /max numbers? Is it pre-determined (knowing in advance that Year 39 will be Dry) or as make-up after a Dry year? Or a function of ET during the irrigation season? http://santarosaplaingroundwater.org/wp-content/uploads/SRPGSP_Section-3_WBAppendix-1-B_042521_ADA.pdf	

Date Received	Commentor	Comment	Responses to Comments
		Page 60: 5.2.2.2 Sonoma Water Groundwater Facilities, Historical Groundwater Production, and Monitoring: Sonoma Water's three groundwater supply wells are located along Sonoma Water's aqueduct in the Santa Rosa Plain at Occidental Road, Sebastopol Road, and Todd Road. The wells were initially constructed in 1977, as emergency supply wells in response to the 1976-1977 drought. Two of the wells (Occidental and Sebastopol) were replaced in 1998. The three production wells range in depth from 794 to 1,060 feet with pumping capacities ranging from 1,300 to 2,200 gallons per minute (gpm). The locations of the wells are depicted on Figure 3-1 and their operational history is described below. Relatively continuous operations of the Todd, Sebastopol, and Occidental Road water supply wells began in April 1999, June 2001, and July 2003, respectively, and continued through 2008. The annual groundwater quantities pumped by Sonoma Water between 2006 and 2010 ranged from a high of 3,922 ac-ft in 2008 to a low of 52 ac-ft in 2010 and averaged 2,514 ac-ft/yr. Beginning in 2009, the use of the wells was shifted to a seasonal and as-needed basis to better balance the conjunctive management of Russian River and groundwater supplies (during years when sufficient supplies are available from the Russian River, use of the groundwater wells are is limited). Annual production from the three wells has ranged from 172 to 1,271 ac-ft from 2011 to 2015, averaging 643 ac-ft/yr and has declined further for the most recent five years (2016-2020) to an average of 20 ac-ft/yr. page 73 of 196 https://www.sonomawater.org/media/PDF/Water%20Resources/Sonoma%20Water%202020%20UWMP_Public%20Review%20Draft-ADA.pdf page 457 of 570 https://srcity.org/DocumentCenter/View/32225/1-UWMP---Complete-document-PDF?bidId= 2.2.1 Sources of Water Supply. Purchased Water: Sonoma Water also has three groundwater wells that provide water supply. They are located near the Laguna de Santa Rosa and feed directly into Sonoma Water's Russian River-Cotati Intertie Pipeline. Sonoma Water estimates the future production capacity of these wells at 2,300 AFY. Groundwater:	

Date Received	Commentor	Comment	Responses to Comments
		Prior to 1960, the City relied primarily on groundwater from this sub-basin for its water supply, plus a small amount of surface water from Lake Ralphine. In June 1959, Sonoma Water began supplying surface water to the City and other Water Contractors. By the 1980s and until 2007, the City relied solely on purchased water deliveries from Sonoma Water to meet its water demands. In July 2005, the City received permission from California Department of Public Health (now Division of Drinking Water, or DDW) to use two groundwater wells (Farmers Lane Wells), formerly permitted as standby emergency wells, for full-time, active potable water supply. The Farmers Lane wells are located in the Santa Rosa Plain Sub-Basin. Groundwater trend data from the existing monitoring wells located throughout the Sub-basin indicate that water levels within the main portion of the Sub-basin have generally remained constant or have slightly increased over time, indicating that the Sub-basin is in balance and is not suffering from overdraft. This supply source is permitted for regular production of potable water. The Farmers Lane wells can provide up to 2,300 AFY.	

SANTA ROSA PLAIN GSP COMMENTS: SECTION 4 SUSTAINABLE MANAGEMENT CRITERIA			
Date Received	**Commentor**	**Comment**	Response to Comments
COMMENTS RECEIVED FROM OCTOBER 1-OCTOBER 31			
10/11/2021	Jim Mangels	We need to think out of the box to increase our ground water storage capacity. For example, if we have a seasonal high rain storm and the Russian River is overflowing, how about trying to capture some of the run-off more fully for storm water management. If property close to the Russian River was obtained for storage/banking the basins could recharge our ground water capacity. Purchase some vineyard property adjacent to the river--for the good of Sonoma County and build basins to capture some of the runoff.	Section 6, Projects and Management Actions, includes a description of groundwater banking projects to be implemented, including Aquifer Storage and Recovery and managed aquifer recovery.
10/31/2021	Community Alliance with Family Farmers	Sustainable Management Criteria. We are concerned that the metric for wells with historical declines then recovery uses 2010-2019, which include drought years when a number of local wells went dry and other significant impacts occurred. Setting these relatively low water levels as a base standard could allow for far greater impacts during future droughts.	As described in Section 4.5.3.1, the aim of the measurable objectives for RMPs which have exhibited recovering trends following historical declines is to maintain groundwater levels within recent observed ranges. This approach allows for setting the measurable objectives at more protective levels (shallower) than those observed during the historical declines. Including the drought years in calculating the average for 2010-2019 is also conistent with the GSP regulations which state that measurable objectives "...shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought..."
		Regarding Depletion of Interconnected Surface Water – Setting a minimum threshold at 40 percent of representative monitoring point wells during drought years would allow for significant impact to riparian habitat including vegetation, aquatic species and all related ecosystems. Sustainable agriculture depends on healthy, diverse surrounding ecosystems that support populations of beneficial birds, insects and other creatures, and could have a significant impact on the potential loss of recharge opportunities.	As described in Section 4.10.4.1, these percentages for the number of minimum thresholds exceedances that cause undesirable results were selected based on input from the Interconnected Surface Water Practitioners Work Group (Appendix 4-C). Recognizing that sources of depletion are varied, and likely include lack of precipitation during drought years, placing the different weights on drought and non-drought years helps address concerns expressed by some Work Group and Advisory Committee members by ensuring that during normal/wet years the higher levels of estimated streamflow depletion from 2014-2016 are avoided. Additional details on potential effects of beneficial users related to undesirable results were added to Section 4.10.4.3. These potential effects will be further assessed through the studies and information gathering described in Section 7.2.4.
10/30/2021	Milo Baker Chapter of the California Native Plant Society	These comments were created after reviewing Section 4 of the Draft Groundwater Sustainability Plan (DGSP) for the Santa Rosa Plain Ground Water Subbasin; however, these comments are general enough that they can be applied to all three subbasins in Sonoma County.	Comment noted

Date Received	Commentor	Comment	Response to Comments
		The DGSP for the Santa Rosa Plain Groundwater Subbasin states that shallow aquifer is between 40 feet and 200 feet and a deep aquifer is 200 feet or more. We understand that it takes millennia for groundwater to percolate into the bedrock and up to centuries for water to percolate into the various formations. The surface flows from rain feed the watercourses. How is the DGWSP proposing to slow and recharge the aquafers and basins along the various creeks that run east to west to the Laguna? The Laguna is currently acting as a large recharge area but many of the creeks in the sub basin have been channelized. Are there any plans to improve our creeks through retention basins, flood plains and increasing canopy cover?	Section 6, Projects and Management Actions, includes a description of on- or near stream stormwater capture and recharge projects and managed aquifer recharge projects.
		The DGSP identifies various tools for evalua:ng the groundwater, from remote sensing to stream gauges and weather monitoring instrumentation, but this is monitoring, and the report does not discuss how they will apply this information. We are concerned that this is relying too much on deeper ground water resources and ignoring the shallower resources that are sustaining our native plants and vegetation communities. An additional cross check could be to use tree health, not only along riparian corridors but also in the plains. For example, valley oaks and their regeneration could be used for monitoring sub- surface waters levels. It has been documented that the best growth is attained when water tables are about 33 feet (10 m) below the surface and the trees are inundated every 5 years (Howard 1992). Ofen associated with seaonal wetlands, this species could be used to show the health of near surface water storage.	Section 5 of the GSP includes detailed monitoring plans, with information about monitoring the shallow aquifer. Comment noted on monitoring using tree health.
		One of the sustainability indicators of the DGSP (Table 4-1) is depletion of interconnected surface water, but the emphasis on streamflows ignores the seasonal wetlands and seeps that are also direct indicators and can be evaluated and mapped on Google Earth based on size. We are concerned that depletion of water levels below 40 feet will likely change the native vegetation within the Santa Rosa basin, especially wetland endemics that are some of the more rare and endangered plants in the County.	Seasonal wetlands and seeps that are considered groundwater-dependent are also included within the freshwater marsh/aquatic classification that is incorporated within the GDE map (Figure 3-19). As described in Sections 4.10.2.1 numerous and significant information and data gaps limit the GSA's ability to characterize the potential effects of groundwater conditions on biological response impacts to GDEs. Section 7.2.4 describes plans to fill these data and information gaps during the initial years fo GSP implementation, which would be used to consider future refinements of the SMC for chronic lowering of groundwater levels.

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		The DGSP identifies surface and groundwater budgets and estimates groundwater overdraft but how can that be known if you don't have a baseline. There are two periods identified, historical (1976-2018) and current (2012 – 2018). According to ca.water.usgs.gov drought years in the "historical period" occurred between 1976-1977 (2 year of drought), 1987-1992 (6 years), 2001-2002 (2 year), 2007-2009 (3 years), with normal or above normal rainfall in between years. In the "current year" drought years occurred between 2012-2016 (5 years) with only barely normal rainfall. Since 2000, the longest duration of drought in California lasted 376 weeks (December 27, 2011 – March 5, 2019) (7 years) (ca.water.usgs.gov) and that has been classified as a severe to extreme drought (ncdc.noaa.gov). NOAA also states that the 1980s and 1990s were characterized by unusual wetness with short periods of droughts of extensive droughts, while the first two decades of the 2000s saw extensive drought and extensive wetness. What will the baseline be after a 3-year extreme drought (2019-2021) that is classified as intense with higher evapotranspiration rates (due to higher air temperatures)?	The impact of climate (including the current drought) on groundwater conditions will be monitored and evaluated during GSP implementation. Data and information obtained through this monitoring will be incorporated into future 5-year updates to the GSP.
10-31-2021	Coalition	The consideration of beneficial uses and users when establishing sustainable management criteria (SMC) is insufficient. The consideration of potential impacts on all beneficial users of groundwater in the basin are required when defining undesirable results and establishing minimum thresholds. **RECOMMENDATIONS:** 1. Chronic Lowering of Groundwater Level. Describe direct and indirect impacts on DACs, drinking water users and tribes when describing undesirable results and defining minimum thresholds for chronic lowering of groundwater levels.	DACs in the GSP are grouped into beneficial user types based on their source of water supply, which is primarily municipal water or water from private domestic wells. The effects of minimum thresholds and undesirable results for chronic lowering of groundwater levels on all beneficial users, including DACs, drinking water users and tribes, are described in Sections 4.5.2.4 and 4.5.4.3, respectively. Additional language has been added to Section 4.5.4.3 to clarify that these specific beneficial users are considered. The methodology for establishing minimum thresholds for chronic lowering of groundwater levels incorporates the statistical evaluation of known completion information for water supply wells located within the vicinity of each potential RMP, to avoid potential impacts on existing well users, including DACs, drinking water users and tribes.

Date Received	Commentor	Comment	Response to Comments
		2. Degraded Water Quality. Describe direct and indirect impacts on DACs, drinking water users and tribes when defining undesirable results for degraded water quality. For specific guidance on how to consider these users, refer to “Guide to Protecting Water Quality Under the Sustainable Groundwater Management Act.”	DACs in the GSP are grouped into beneficial user types based on their source of water supply, which is primarily municipal water or water from private domestic wells. The effects of minimum thresholds and undesirable results for degraded water quality on all beneficial users, including DACs, drinking water users and tribes, are described in Sections 4.8.2.7 an 4.8.4.3, respectively. As described in Section 4.8.2.7, the minimum thresholds are designed to avoid negative effects to groundwater quality associated with implementation of the GSP. Avoiding degradation of groundwater quality from the identified COCs helps maintain drinking water quality providing benefits for domestic well users. Additional language has been added to Section 4.8.4.3 to clarify that these specific beneficial users are considered.
		3. Evaluate the cumulative or indirect impacts of proposed minimum thresholds for degraded water quality on DACs, drinking water users and tribes.	As described in Section 4.8.2.7, the minimum thresholds are designed to avoid negative effects to groundwater quality associated with implementation of the GSP. Avoiding degradation of groundwater quality from the identified COCs helps maintain drinking water quality providing benefits to DACs, drinking water users and tribes.
		4. Set minimum thresholds and measurable objectives for all water quality constituents within the subbasin that are impacted by groundwater use and/or management. Ensure they align with drinking water standards	As described in Section 4.8.1, the GSP identified COCs based on three criteria: 1. They have an established level of concern such as an MCL or secondary maximum contaminant level (SMCL), or a level that reduces crop production 2. They have been found in the Subbasin at levels above the level of concern and are routinely analyzed and reported through existing regulatory monitoring programs 3. The occurrence of the COC is extensive throughout the Subbasin New or additional water quality constituents may be identified as potential COCs applicable to the GSP implementation activities through the planned routine consultation and information sharing with other regulatory agencies described in Section 7.2.2. The GSA would then consider adding potential COCs and assigning SMC during the 5-year GSP updates.
		Groundwater Dependent Ecosystems and Interconnected Surface Waters **RECOMMENDATIONS:**	

Date Received	Commentor	Comment	Response to Comments
		When defining undesirable results for chronic lowering of groundwater levels, provide specifics on what biological responses (e.g., extent of habitat, growth, recruitment rates) would best characterize a significant and unreasonable impact to GDEs. Undesirable results to environmental users occur when 'significant and unreasonable' effects on beneficial users are caused by one of the sustainability indicators (i.e., chronic lowering of groundwater levels, degraded water quality, or depletion of interconnected surface water). Thus, potential impacts on environmental beneficial uses and users need to be considered when defining undesirable results in the subbasin. Defining undesirable results is the crucial first step before the minimum thresholds can be determined.	As described in Sections 4.10.2.1 numerous and significant information and data gaps limit the GSA's ability to characterize the potential effects of groundwater conditions on biological response impacts to GDEs. Section 7.2.4 describes plans to fill these data and information gaps during the initial years fo GSP implementation, which would be used to consider future refinements of the SMC for chronic lowering of groundwater levels.
		When defining undesirable results for depletion of interconnected surface water, include a description of potential impacts on instream habitats within ISWs when minimum thresholds in the subbasin are reached.15 The GSP should confirm that minimum thresholds for ISWs avoid adverse impacts to environmental beneficial users of interconnected surface waters as these environmental users could be left unprotected by the GSP. These recommendations apply especially to environmental beneficial users that are already protected under pre-existing state or federal law.	As described in Sections 4.10.2.1 numerous and significant information and data gaps limit the GSA's ability to characterize the potential effects of groundwater conditions on biological response impacts to GDEs. Section 7.2.4 describes plans to fill these data and information gaps during the initial years fo GSP implementation, which would be used to consider future refinements of the SMC for chronic lowering of groundwater levels.
		When establishing SMC for the subbasin, consider that the SGMA statute [Water Code §10727.4(l)] specifically calls out that GSPs shall include "impacts on groundwater dependent ecosystems".	GDEs are identified as beneficial users within the GSP and potential impacts on GDEs are specifically addressed with other ecological land uses and users in Section 4 for each sustainability indicator.

Date Received	Commentor	Comment	Response to Comments
10/28/2021	California Dept of Fish and Wildlife	**Sustainable Management Criteria (SMC) for Depletion of Interconnected Surface Waters (ISWs)** **Comment:** The GSA has established the following Minimum Threshold (MT) for the SMC for Depletion of ISWs sustainability criteria: "Maintain estimated streamflow depletions below historical maximum amounts. Metric: Shallow groundwater elevations are used as a proxy for stream depletion. The MT is the equivalent groundwater level, representing the 3 years (2014-2016) during which the most surface water depletion due to groundwater pumping was estimated between 2004-2018." Minimum Thresholds should ensure regional groundwater extractions do not lead to significant and adverse impacts on fish or wildlife resources by meeting plant and animal species temporal/spatial water needs including water availability especially for Threatened and Endangered species and Species of Special Concern. They should be designed to account for climatic/water year type variability. Where specific data are lacking, MTs should be conservative with respect to preserving fish and wildlife beneficial users of groundwater from undesirable results. Furthermore, the GSP states "undesirable result occurs if MTs are exceeded at 40 percent of RMP wells during drought years and 10 percent of RMP wells during non-drought years". It is unclear how these percentages relate to ecological impacts. The GSP should identify monitoring metrics for GDEs that will enable the GSA to characterize GDE vulnerability to groundwater depletion and associated undesirable results, and to undertake management intervention accordingly. The Department understands the need to use "placeholder" Sustainable Management Criteria and Minimum Thresholds due to the current lack of groundwater and stream discharge data throughout the planning area. However, numerous times during the Work Group meetings resource agency representatives commented that using a threshold that maintains estimated streamflow depletions at historically low levels is not appropriate for protecting ESA-listed salmonids. Setting Minimum Thresholds and measurable objectives using data from years with historically low rainfall (i.e., 2014-2016) would likely create historically high streamflow depletion rates and potentially negatively impact GDEs and their critical habitat.	**RESPONSE:** Thank you for the recommendation. As outlined in Section 4.10.4.2, groundwater pumping is one of several factors that can contribute to depletion of interconnected surface water (ISW), including factors outside of GSA jurisdiction, like surface water diversions, lack of precipitation, and evapotranspiration by riparian vegetation. Because depletion of ISW by groundwater pumping cannot be measured directly, determining the proportion of depletion due to pumping is challenging. Recognizing the significant information and data limitations, as well as the importance of ISW to beneficial users in the basin, the depletion of ISW by pumping SMC is set using an adaptive approach. The current Minimum Thresholds for each RMP were chosen to approximate the average amount of depletion during the 3 years with the highest levels of simulated streamflow depletion between 2004 and 2018. Mathematically, this 3-year average value over the 15-year evaluation period roughly corresponds with the 10th percentile of historical streamflow depletion at that location, by year, during 2004–2018. Undesirable results would occur if MT exceedances occurred at 40% or 10% of RMPs during drought and non-drought years, respectively. As described in Section 4.10.4.1, these percentages were selected based on input from the Interconnected Surface Water Practitioners Work Group (Appendix 4-C). Recognizing that sources of depletion are varied, and likely include lack of precipitation during drought years, placing the different

Date Received	Commentor	Comment	Response to Comments
		<u>Recommendation: The Department recommends reconsidering this Minimum Threshold and revising the GSP to address and describe:</u> · How Minimum Threshold prevents undesirable results; · The effect the Minimum Threshold will have on environmental beneficial uses and users of groundwater, and what impact it will have on fish and wildlife · How the Minimum Threshold accounts for climatic/water year type variability **Groundwater Elevations as a Proxy for Depletion of Interconnected Surface Water Minimum Thresholds**	weights on drought and non-drought years helps address concerns expressed by some Work Group and Advisory Committee members by ensuring that during normal/wet years the higher levels of estimated streamflow depletion from 2014-2016 are avoided. **RESPONSE:** Thank you for the recommendation. As stated in Section 4.10, it is recognized that low summer baseflow in certain years can impact aquatic species, but until the amount of summer baseflow needed for these species is quantified (e.g., via instream flow targets), the specific impacts of the MT on beneficial uses and users of groundwater remain difficult to quantify. The current approach leverages historical data to avoid conditions lower than historical surface water depletion amounts. **RESPONSE:** Thank you for the recommendation. As described in Section 4.10.4.1, undesirable results would occur if MT exceedances occurred at 40% or 10% of RMPs during drought and non-drought years, respectively. These percentages were selected based on input from the Interconnected Surface Water Practitioners Work Group (Appendix 4-C). Recognizing that sources of depletion are varied, and likely include lack of precipitation during drought years, placing the different weights on drought and non-drought years helps address concerns expressed by some Work Group and Advisory Committee members by ensuring that during normal/wet years the higher levels of estimated streamflow depletion from 2014-2016 are avoided.

Date Received	Commentor	Comment	Response to Comments
		Comment: While the GSP relied on a 15-year simulation to evaluate the correlation between surface water depletion from groundwater pumping and shallow groundwater levels at RMP locations, Appendix 4C states “Two RMP locations (SON0342, SON0552; Figs. 18, 20) showed poor simulated correlation between surface water depletion from groundwater pumping and shallow groundwater levels (R-squared values less than 0.60). Groundwater level proxy SMC values were still set for these RMP locations because poor correlation at these sites was attributed to poor process representation in the model at these RMP locations rather than insufficient hydrologic connection between surface water and shallow groundwater levels.” This highlights the simulation’s inability to capture areas where actual data shows a connection between surface and groundwater and calls into question the overall results of the simulation. In order for the GSA to use groundwater elevations as a proxy for depletion of interconnected surface water, the GSP should identify a significant correlation between groundwater elevations and interconnected surface water depletions as required by Title 23 CCR section 354.36(b)(1).The GSP currently attempts to correlate groundwater elevations with streamflow by modeling results; however, a specific rate or volume of surface water depletions caused by groundwater should be developed to correlate groundwater levels with streamflow depletions. If a significant correlation is not determined, groundwater elevations used as a proxy for surface water depletions may misinform groundwater management activities and poorly predict instream habitat conditions for fish and wildlife species. The current proposed approach to maintain shallow groundwater gradients at current/historic levels may serve as an interim management approach but should be revisited to include an improved understanding of the relationship between surface water-groundwater connectivity. **Recommendation:** The GSP should include discussion on what additional data will be collected to better inform the model and more details on when the simulation will be revisited and updated using this information.	

Date Received	Commentor	Comment	Response to Comments
			RESPONSE: Thank you for the recommendation. The Santa Rosa Plain Hydrologic Model (SRPHM) is a sophisticated GSFLOW model used to simulate inflows, outflows, exchanges, and stores of water in the surface-water and groundwater system. It is a thoroughly developed, documented, and tested tool that was originally developed by the US Geological Survey (Wolfenden and Nishikawa, 2014[1]) and revised by Sonoma Water for the purposes of developing more accurate water budgets for SGMA. The model leverages the best available data and science to accurately simulate key hydrologic processes. Where data are limited, the uncertainty of simulated hydrologic processes increases. The GSP notes that—like for nearly all GSAs—data are particularly limited for characterizing groundwater/surface-water interactions and surface water depletion due to pumping, resulting in greater uncertainty of these simulated processes. Appendix 4-C emphasizes that "[q]uantifying surface water depletion due to pumping is a challenge because (1) it cannot be measured directly and (2) the influence of surface water depletion by pumping is often obscured by other factors, such as precipitation and runoff, diversions, evapotranspiration, and natural groundwater/surface-water interactions."As noted in the comment, the GSP shows that two of seven RMP locations show poor correlations between simulated surface water depletion and simulated groundwater levels. The remaining five RMP locations show good correlation. Rather than "call[ing] into question the overall results of the simulation", these results highlight select RMP locations where additional data should be collected and the model should be adjusted to improve representation of these processes according to the adaptive management strategy outlined in Section 4.10. Additionally, Section 7.2, Section 5.4, and Appendix 7-A outline specific steps to implement additional studies and data gathering and improve model simulation of these processes during the implementation phase. As noted in Section 4.10 and Appendix 4-C, these improvements may inform the determination of appropriate revised SMCs for depletion of interconnected surface water. [1] Nishikawa, Tracy, ed., 2013, Hydrologic and geochemical characterization of the Santa Rosa Plain watershed, Sonoma County, California: U.S. Geological Survey Scientific Investigations Report 2013–5118, 178 p.

Date Received	Commentor	Comment	Response to Comments
10/31/2021	Russian Riverkeeper	p. 7: For the development of the SMC for streamflow depletions cause by groundwater pumping, we generally support the need to develop and use interim criteria until more appropriate and precise criteria, informed by studies relating groundwater levels, streamflow depletion rates, and instream habitat effects, can be developed. However, we do not agree with the decision to rely on historical maximum amounts for an interim minimum threshold until those studies are completed. This decision fails to give proper protection to public trust resources and listed species, especially during our increasingly dry years. For instance, simulated instream flow within Sonoma Creek during 2014, 2015, and 2016 was diminished by approximately 90 percent due to groundwater pumping. Thus, we concur with NMFS in their recommendation that while data is collected to inform that analysis, the GSA follow guidance by the California Department of Fish and Wildlife that recommends conservative sustainability management criteria be established to ensure groundwater dependent ecosystem protection.	Minimum thresholds represent the groundwater elevation below which significant and unreasonable depletions of streamflow occur and represents a condition the GSA seeks to avoid, not "maintain". The objective of SGMA is not to maintain levels at minimum thresholds but rather to be at the more aspirational measurable objectives by 2042, or even higher. A description of how public trust resources are incorporated into the SMC for interconnected surface water depletion has been added to Section 4.10.5.
		p. 9 : The GSP must set forth concrete steps that will be taken to establish legally sufficient SMCs, including impacts to Public Trust resources. SGMA requires corresponding projects and management actions, sufficient to support the determination by the SRBGSA that the sustainability goal will be met, be included in the GSP, and then implemented. The SRBGSA must separately demonstrate that it has fulfilled its duties under the Reasonable Use and Public Trust doctrines. Indeed, an attempt to avoid or minimize the harm to public trust uses is the second step required by the Public Trust Doctrine.	A description of how public trust resources are incorporated into the SMC for interconnected surface water depletion has been added to Section 4.10.5.
		p. 15: Groundwater plans should consider potential impacts to and appropriate protections for interconnected surface waters and their tributaries, and interconnected surface waters that support fisheries, including the level of groundwater contribution to those waters. In the context of SGMA statutes and regulations, and Public Trust Doctrine considerations, GSA groundwater planning must carefully consider and protect environmental beneficial uses and users of groundwater including fish and wildlife and their habitats: groundwater dependent ecosystems and interconnected surface waters. Public Trust resources have not been given due consideration throughout this GSP and analysis must be done to fully do so now and in the future.	A description of how public trust resources are incorporated into the SMC for interconnected surface water depletion has been added to Section 4.10.5.

Date Received	Commentor	Comment	Response to Comments
10/29/2021	Sebastian Bertsch	Table 4-1: "The MO is to maintain groundwater levels within historical observed ranges." This does not ensure protection of interconnected surface waters. There is not provided evidence that the current groundwater levels, let alone their historic lows, are sufficient to protect surface waters. Furthermore, the drought loophole allows further groundwater depletions beyond historic lows with no consideration for their impact on surface water.	As described in Appendix 4-B, information in the historical record linking surface water depletion and any related impacts to beneficial users directly to groundwater usage under the jurisdiction of the GSAs is very limited. For this reason, for this reason additional data collection focused on improving the understanding of surface water depletion is prioritized in the implementation plan. As additional information and data is collected during GSP implementation and potential impacts to benefical users, including GDEs, the measurable objectives will be further evaluated and refined as needed.
		Table 4-1: "The number of public supply wells with annual average concentrations of arsenic, nitrate, or TDS that exceed MCLs in groundwater quality data available through state data sources." According to this, the GSA will permit an unlimited number of private wells to become contaminated. The three MCLs also ignore other possible contaminates. Well owners who face contamination from pesticides, organic compounds or heavy metals will not be protected.	As described in Section 4.8.2.7, the minimum thresholds are designed to avoid negative effects to groundwater quality associated with implementation of the GSP. Avoiding degradation of groundwater quality from the identified COCs helps maintain drinking water quality providing benefits for domestic well users. As described in Section 4.8.1, the GSP identified COCs based on three criteria: 1. They have an established level of concern such as an MCL or secondary maximum contaminant level (SMCL), or a level that reduces crop production 2. They have been found in the Subbasin at levels above the level of concern and are routinely analyzed and reported through existing regulatory monitoring programs 3. The occurrence of the COC is extensive throughout the Subbasin There are other point source contaminants found sporadically in the Subbasin, but these are not regional in extent, are monitored through various other regulatory programs, and consequently SMC are not established in the GSP. New or additional water quality constituents may be identified as potential COCs applicable to the GSP implementation activities through the planned routine consultation and information sharing with other regulatory agencies described in Section 7.2.2. The GSA would then consider adding potential COCs and assigning SMC during the 5-year GSP updates.

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		Table 4-1: "Historical low elevations minus 4-year drought assumption. " This is a surprisingly low standard to set at the minimum. This doesn't take into account historic depletions, or have any consideration for ho these lower levels impact local ecologies and surface water. It is disappointing that the GSA's goal is to merely maintain water levels at the "worst they have ever been". The drought loophole also makes this standard effectively meaningless. If wells are allowed to be depleted beyond historic minimums, there is effectively no protection or performance standard.	Minimum thresholds represent the groundwater elevation below which significant and unreasonable conditions are likely to occur and represents a condition the GSA seeks to avoid, not "maintain". The objective of SGMA is not to maintain levels at minimum thresholds but rather to be at the more aspirational measurable objectives by 2042. Maintaining levels at minimum thresholds could certainly cause undesirable results and that is not the intention of SGMA nor this GSP. Historical depletions are taken into account and where there is uncertainty related to any known impacts to beneficial users from wells with more significant historical declines (greater than 100 feet), a warning-level threshold is established which would trigger investigation into potential causes and impacts prior to minimum thresholds being exceeded. Additionaly, the implementation plan includes the development of improved information on well depths and locations and GDEs to better inform potential impacts to beneficial users related to the minimum thresholds. This information and data collected during GSP implementation will help determine whether future modifications to the minimum thresholds are needed.
COMMENTS RECEIVED ON AUGUST 2021 VERSION			
8/27/2021	National Marine Fisheries Service	**Comment re: Minimum Thresholds:** To develop sustainable management criteria for the depletion of interconnected surface water, the GSAs of the Sonoma County subbasins convened a “Sonoma Sustainable Management Criteria for Depletion of Interconnected Surface Water Practitioner Work Group”, which met several times in early 2021. NMFS was a participant in this group, and generally agrees with the sequential approach being proposed within the Sonoma County subbasins for developing sustainable management criteria addressing streamflow depletion caused by groundwater pumping. Essentially, the approach is to develop and use interim criteria until more appropriate and precise criteria, informed by studies relating groundwater levels, streamflow depletion rates, and instream habitat effects, can be developed.	Comment noted

Date Received	Commentor	Comment	Response to Comments
		We understand the need to use "placeholder" sustainable management criteria due to the current lack of groundwater and stream discharge data throughout the County. Gathering this data during the first few years of GSP implementation and updating the sustainable management criteria accordingly is a sound plan. However, as raised numerous times during the Work Group meetings, we do not feel an interim minimum threshold that maintains estimated streamflow depletions at historical maximum amounts, as is currently proposed for the Santa Rosa Plain and Sonoma Valley subbasins, is appropriately protective when dealing with ESA-listed salmonids. Basic hydraulic principles dictate that groundwater flow is proportional to the difference between groundwater elevations at different locations along a flow path. Using this basic principle, groundwater flow to a stream, or conversely seepage from a stream to the underlying aquifer, is proportional to the difference between water elevation in the stream and groundwater elevations at locations away from the stream.	Minimum thresholds represent the groundwater elevation below which significant and unreasonable depletions of streamflow occur and represents a condition the GSA seeks to avoid, not "maintain". The objective of SGMA is not to maintain levels at minimum thresholds but rather to be at the more aspirational measurable objectives by 2042, or even higher. Maintaining levels at minimum thresholds could certainly cause undesirable results and that is not the intention of SGMA nor this GSP.
		Minimum thresholds and measurable objectives consistent with the lowest groundwater elevations on record would likely create historically high streamflow depletion rates that, when combined with low surface flow input, would be very likely to adversely affect ESA-listed salmonids and their critical habitat. Analysis within the draft Sonoma Valley subbasin Sustainable Management Criteria chapter confirms the significant impact to instream flow volume that would likely occur under the proposed minimum criteria – simulated instream flow within Sonoma Creek during 2014, 2015, and 2016 was diminished by approximately 90 percent due to groundwater pumping (Figure 23).	Measurable objectives have been established to represent the average dry-season groundwater levels between 2004 and 2020 and are not "consistent with the lowest groundwater elevation on record".
		Recommendation: NMFS is committed to working with GSAs, CDFW, and other stakeholders in determining what streamflow depletion level avoids significant and unreasonable impacts to beneficial uses of surface water, as those beneficial uses relate to ESA-listed salmon and steelhead survival and recovery. However, while data is collected to inform that analysis, we suggest the GSA follow guidance by the California Department of Fish and Wildlife that recommends conservative sustainability management criteria be established to ensure groundwater dependent ecosystem protection (CDFW 2019).	Comment noted

Date Received	Commentor	Comment	Response to Comments
		Comments re: Measurable Objective: The stated measurable objective (i.e., "maintain groundwater levels within historical observed ranges") is likewise inappropriate when considering streamflow depletion impacts on ESA-listed salmon and steelhead. According to DWR (2017), "measurable objectives are quantitative goals that reflect the basin's desired groundwater conditions and allow the GSA to achieve the sustainability goal within 20 years." Within groundwater subbasins where past streamflow depletion likely impacted ESA-listed salmonids and their habitat (e.g., near 90 percent depletion during 2014-16), maintaining groundwater levels within historical ranges is unlikely to result in sustainable groundwater management (i.e., avoiding all undesirable results) as required by SGMA regulation. **Recommendation:** We recommend the GSA craft measurable objectives that avoid potential streamflow depletion impacts on beneficial uses of surface water.	Measurable objectives have been established to represent the average dry-season groundwater levels between 2004 and 2020 and are not "consistent with the lowest groundwater elevation on record". In addition to the description of measurable objectives the commentor provides, DWR (2017) also states that measurable objectives shall "...take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty". As additional information and data is collected during GSP implementation and potential impacts to benefical users, including ESA-listed salmon and steelhead, the measurable objectives will be further evaluated and refined as needed. Comment noted
9/9/2021	Beth Lamb	P. 1: This section identifies the sustainability goal, defines the conditions that constitute sustainable groundwater management, discusses the process by which the GSA will characterize undesirable results, and establishes MTs (MTs) and measurable objectives (MOs) for each applicable sustainability indicator. Comment: Spell out Minimum Thresholds (MTs) first use in this section P. 1: Defining these SMC included both a significant level of technical analysis utilizing currently available data and information and best available science and substantial input from stakeholders. Comment: Spell out Sustainable Management Criteria (SMC) first use in this section Tble 4-1: Comment This was a good way to try and simplify very conceptually complicated material Page 14 A saturated thickness factor of 10 feet was added to the 98th percentile shallowest supply well total depths. Comment - I don't understand the point of adding 10 feet to these well depths. Did I miss something? Page 17 Adaptive Management to Address Data Gaps and Improve/Refine Sustainable Management Criteria: Comment This is so important! General Comment this need a tech editor too many run on sentence and jargon language. Also too much use of acronyms. A tech editor should be able to clean these things up.	Comment incorporated - correction made. Comment incorporated - correction made. Comment noted. The "Calculation of Well Impact Depths" section describes the rationale for adding that 10 feet to well depths. Additional text has been added to clarify this rationale. Comment noted. Comment noted.

Date Received	Commentor	Comment	Response to Comments
9/7/2021	Robert Pennington	Chronic Lowering of Groundwater Levels define MTs and MOs for wells with two patterns: (1) Stable (2) Historical Declines and then recovery; Figure 4-1 and 4-2 has four patterns (1) stable, (2) decline and recovering, (3) decline and recovered, (4) No Trend. COMMENT: Are "No Trend" considered "stable"? Are "recovered" and "recovering" the same?	Text has been added to state that wells with recovering or recovered trends are treated the same. Text has been added to state that some wells have no trend, and SMCs are not set for these wells
		I suggest modifying the MT and MO to be inclusive of trends identified in Figure 4-1, AND other hypothetical trends such as "declining" or "decline then stable". I recommend this because new RMP may be added sometime in the future and they may have trends that do not fit into the defined categories of this draft.	Comment noted.
		MTs and MOs reference "historical" or "recent". It appears that "historical" for the MOs and MTs is not being used consistently with the model periods from the Basin Setting section. It also appears that different data ranges are used for RMPs with different trends. It could be confusing 20 or 50 years to know what date ranges should be compared against. This could be particularly problematic for RMP with "No Trend" or no data within the "historic" range, it may be useful to develop alternative MOs and MTs for these.	Definitions have been added to the Glossary.
		I suggest creating a table that specifies the date ranges or definitions of "recent" and "historic" for RMPs with various trends.	Text has been added to state that some wells have no trend, and SMCs are not set for these wells
		Table 4-2 does not have rows for many RMPs from Figures 4-1 and 4-2 that have "No Trend". Is that because these RMPs have not been established? Or are these "missing RMPs" not included because they are for streamflow depletion, not chronic lowering?	Comment noted
8/26/2021	Matt O'Conner	4.10.2.1 Information and Methodology: Table 4.8 would be improved by including the range of streambed elevation where flow depletion is of concern that would be indicated by each RMP well along with relevant information from the model regarding how the stream elevation is represented in the model (i.e. what is the reference elevation used by the model for the stream reach of interest). This is important for interpretation because the scale of the GSFLOW model creates stream reaches of substantial length over which bed elevation changes. This is a form of sensitivity analysis that should also be considered in adaptive management.	Comment noted

Date Received	Commentor	Comment	Response to Comments
		4.10: Depletion of Interconnected Surface Water: Limitations of historical data are understood; did the GSA staff and/or practitioner group consider whether or not data from the California Environmental Flow Framework beneficially informs regarding the spatial and temporal distribution of flow depletion? If not, GSA staff should consider evaluation of this tool.	Comment noted
8/19/2021	Peter Martin	p.1. ""Seawater intrusion is not applicable to the Subbasin and therefore no SMC are defined for this sustainability indicator."" Are there other GSPs that take this approach of not addressing this as an SMC? I fully understand the approach but sometimes try to do my best to ""think like a regulator"	SGMA regulations (354.24) state that SMCs must be devloped for "...each applicable sustainability indicator." SMCs are not required for sustainability indicators that are not applicable.
		p.2. "Representative monitoring sites" - Is this the same as RMPs referenced later?	Yes, additional text has been added to clarify that these are the same as representative monitoring points (RMPs).
		"p.4. ""A discussion of the measures that will be implemented to ensure the Subbasin will be operated within sustainable yield • An explanation of how the sustainability goal is likely to be achieved. Note to Readers: The following information on Sustainability Goal will be reviewed updated when the GSP is completed.Description of Sustainability Goal: "Recommend we add a note that we are not only ""ensuring"" sustainability with these criteria, but will be providing description in the following of how we'll demonstrate that we're achieving sustainability.Should make sure we are responsive to the SGMA regs § 354.24. Sustainability Goal. portion ""including information from the basin setting used to establish the sustainability goal"" Recommend that we could have some overarching statement about how measures are currently stable with regard to groundwater levels about how we are targeting no additional decline in groundwater levels during the planning horizon. ""SMC"" change to ""SMCs""."	Comment noted
		p.5. "Sonoma Valley Basin Management Plan" - Not familiar with this plan being referenced?	Reference deleted
		p.10. p.5. "Sonoma Valley Basin Management Plan" - Not familiar with this plan being referenced?	Reference deleted
		p.10. "vegetation" - Should we say ecosystems?	Comment noted. SMCs based on locations of vegetation that indicate GDEs.
		p.5. "five applicable sustainability indicators" - text highlighted	Comment noted.
		p.22. "principal aquifer system" - Recommend spelling out shallow and deep here rather than reference principal aquifer system.	Change made

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		"p.24. ""These tasks would generally be performed sequentially based on potential severity of the occurrence."" - Do we need to speak to timelines on this? i.e. annual or quarterly data reviews? Perhaps this is covered in later chapters."	Comment noted. A timeline is likely not necessary at this point.
		p.24."Lowered groundwater levels reduce the saturated thickness of aquifers from which wells can pump, which could lead to increased pumping costs or the need to drill new deeper wells." - Also decreased pumping capacity?	Text added
		p.24. "Maintaining groundwater elevations within the operational range between MTs and MOs is equivalent to no long-term change in storage." should we swap out "change" with "decline"?	Comment noted. Text not changed
		p.24. "yield" missing period here	Text fixed
		p.25. "sustainability" - Should be SMC	Comment noted. Text not changed
		p.25. "sustainability" - Sustainability indicator or criteria?	Comment noted
		p.30. "SNMP" I don't believe this acronym was defined	Acronym now defined
		p.37. "which can impact agricultural irrigation, helps maintain groundwater quality providing positive benefits to the Subbasin's agricultural water users." We may want to highlight (how) degraded water quality could impact these users like in earlier sections.	Comment noted
		p.41. "Any" - lowercase	Text fixed
		p.46. "conducted" - how often?	Comment noted
9/1/2021	Bob Anderson	P. 3: Format: Some have bullets, some do not.	Comment noted
		P. 16 of Exec Summary, definitiions show terms separately for conditions and results, while page 4 of Sect 4: Undesirable Result is not defined in the definitions section of the GSP Regulations (Section 351). However, the Regulations' description of undesirable result states that it should be a quantitative description of the combination of MT exceedances that cause significant and unreasonable effects in the Subbasin. Undesirable results should not be confused with significant and unreasonable conditions, as described above.	The executive summary no longer contains definitions.

Date Received	Commentor	Comment	Response to Comments
		implemented; actions proposed to fill data gaps and reduce uncertainty; inform future refinement and possible modification; the identified measures may not be implemented; some combination of these measures will be implemented; Subbasin is operated within its sustainable yield and achieves sustainability; sequencing of measures that are considered likely to be implemented; there are significant uncertainties related to this approach – page 35 of 78; a substantial simplification that (1) does not differentiate between wells; and (2) simulates conditions outside of the calibrated range of the model; additional uncertainties compound the uncertainties and simplifications inherent to the calibrated model; analysis is especially useful for evaluating the relative magnitudes of surface water depletion; outline a framework for achieving sustainability page 2 of 14; many details must be negotiated before many of the projects and management actions can be implemented; demonstrate that sufficient options exist to reach sustainability; should be considered a list of options that will be refined; Inclusion and further assessment of these initiatives and activities during implementation of the GSP will facilitate coordination and optimization of these initiatives and activities to support sustainable groundwater management.; based on limitations and uncertainty related to the potential for future expansion of recycled water supplies, additional expansion of recycled water deliveries for irrigation supplies is not included; other ideas for projects and actions raised by Advisory Committee members would need to be further developed and planned in order to evaluate with model scenarios; recommendations on preferred tools and strategies for implementing, including options for incentivizing; initial implementation steps include performing studies or analyses to refine the concepts into actionable projects; the planned initial assessment of Group 1 projects will include recommendations for evaluating specific metrics related to Group 1 implementation; focused outreach to rural residential and agricultural stakeholders on benefits of participating; first stormwater capture activity involves retaining and recharging onsite runoff; timing of projects is based on best estimates and may shift P. 6: Identification of technical data sources in the Subbasin and review of information developed for the Sonoma Valley Basin Management Plan. p. 10: “assisted”? SGMA definition of an undesirable result assisted in characterizing significant and unreasonable conditions	Comment noted Text corrected

Date Received	Commentor	Comment	Response to Comments
		P. 10: important but not clearly stated. The recovering trends generally occur within the southern and western portions of the Subbasin and are associated with higher levels of municipal pumping that historically occurred through the late 1970s and early 2000s that has since been reduced.	Comment noted
		P. 44: Petaluma Valley Subbasin	Text corrected
		P. 46: check the wording: Since the GSP Regulations allow for elastic and inelastic subsidence due to natural conditions such as plate tectonics and hydrostatic loading, these phenomena are considered with definition of undesirable results.	
		p. 47: Is land subsidence to be measured at nearby wells? Or only groundwater levels? Evaluation of time series plots of groundwater levels and land subsidence from nearby monitoring wells	Comment noted. Text edited.
		p. 47: Any change? Less / more pumping? • If the location and rates of groundwater pumping change as a result of projects implemented under the GSP, subsidence may occur.	Comment noted. Text edited.
		P. 53: Petaluma Valley Basin,!	Text corrected
		P. 54: maybe check the wording: Effect on Beneficial Uses and Users The minimum thresholds for depletion of interconnected surface water measured using groundwater levels as a proxy assumes that maintaining groundwater levels at or above historical low levels in the Subbasin, will avoid surface water depletion that exceeds historical levels. Avoiding surface water depletion at levels greater than historical conditions will provide a benefit to beneficial users and land uses that rely on interconnected surface water	Comment noted
		P. 55: it was decided that MO values at RMP locations should maintain the observed average dry-season surface water depletion from pumping that occurred during the years with available observations during 2004–2020	Minimum thresholds are based on the years 2004 to 2018. Measurable objectives are based on data from years between 2004 and 2020. The language is now consistent in the GSP.
		P. 51: The MTs developed using this methodology are provided in Table 4-8 and represent: The equivalent groundwater-level, representing the three years (2014–2016) during which the most surface water depletion due to groundwater pumping was estimated between 2004–2018. Use model to estimate the 3 years with highest levels of simulated streamflow depletion between 2004 and 2018	Minimum thresholds are based on the years 2004 to 2018. Measurable objectives are based on data from years between 2004 and 2020. The language is now consistent in the GSP.
		P. 55: see page 51 of 57: As the MOs are set at the average groundwater elevations during recent years (average of 2004–2020), interim milestones are identical to the groundwater levels associated with the MOs.	Minimum thresholds are based on the years 2004 to 2018. Measurable objectives are based on data from years between 2004 and 2020. The language is now consistent in the GSP.
		COMMENTS BELOW RELATED TO APPENDIX 4-C	

Date Received	Commentor	Comment	Response to Comments
		P. 35: not finding Figs 4-10: Simulated differences in streamflow for pumping and no-pumping scenarios are shown for all RMPs in Figs. 4–10. p. 37: using available observed historical dry-season low groundwater levels during 2004–2020…with available observations during 2004–2020. Accordingly, MO values at each RMP are set to reflect average dry-season observed groundwater levels during the years with available observations during 2004–2020. MO values for each RMP are summarized in Table 1 and are shown in Figs. 20–36. P. 38: Since the dedicated shallow monitoring wells at RMP locations were installed in fall 2019, there is limited data to directly estimate the average dry-season groundwater levels during 2004–2015	Text is modified to clarify this means figures 4 through 10 Minimum thresholds are based on the years 2004 to 2018. Measurable objectives are based on data from years between 2004 and 2020. The language is now consistent in the GSP. Comment noted
COMMENTS RECEIVED ON JUNE 2021 VERSION			
7/14/2021	Bob Anderson	Page 6 of 112: Seawater not applicable – but then seawater is included The five sustainability indicators relevant to this Subbasin include: chronic lowering of groundwater levels; reduction of groundwater storage; degraded water quality; land subsidence; and depletion of interconnected surface waters. Seawater intrusion is not applicable to the Subbasin. Undesirable Result means one or more of the following effects caused by groundwater conditions occurring throughout the basin, as described in Water Code Section 10721(x): o Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods. o Significant and unreasonable reduction of groundwater storage. o Significant and unreasonable seawater intrusion. P 5-6: Definitions need work – to be a narrative but “storage reduction” suggests a number plus “significant and unreasonable” appears in definition for Undesirable Result. Undesirable results should not be confused with significant and unreasonable conditions, as described (below):.	Text revised Text revised Text revised

Date Received	Commentor	Comment	Response to Comments
		"Significant and unreasonable conditions" is a phrase used to identify conditions that lead to undesirable results but is not specifically defined in the GSP Regulations. This expression is often confused with, or used interchangeably with, undesirable results. However, significant and unreasonable conditions, are a narrative description of physical conditions to be avoided; an undesirable result is a quantitative assessment based on minimum thresholds. Defining significant and unreasonable conditions early in the process of developing SMC for each sustainability indicator helps set the framework by which the quantitative SMC metrics are determined. Undesirable Result means <u>Significant and unreasonable reduction of groundwater storage</u> 4.2 Sustainability Goal: Note: The following information will be updated when the GSP is completed. Note noted – but critical piece is missing. When will it be available? These measures will achieve sustainability within 20 years by the following means: Note: The effects of the projects and actions will be included here once finalized. p. 8: Table 4-4-1 provides a summary of the SMCs for each of the six sustainability indicators. Table 4-4-1 contains 5 indicators. As noted previously on page 6 of 112 ¬- Seawater intrusion is not applicable to the Subbasin. p. 24: 4.5.2.4 Effect on Beneficial Uses and Users Minimum thresholds for chronic lowering of groundwater levels are set at the more protective of historical low conditions with allowances for future droughts and the depths at which existing wells could be impacted by lowering of groundwater levels. [Seems maybe "trying a bit too hard" to address existing wells] [Also: "and the depths at which" is not very precise.] p. 25: Historical and current measurement frequency for the 26 existing wells in the RMP monitoring networks include the following: • 18 measured sub-daily • 4 measured monthly • 4 measured semi-annually = Totals 24	Text revised Text revised Text revised Text added Text added Text revised This is a summary of the approach used, which is explained in more detail in Section 4.5.2.1. 18 + 4 +4 = 26

Date Received	Commentor	Comment	Response to Comments
		Staff has identified data gaps in some areas of the basin, and the GSP would include a plan to expand the monitoring network. Where is this located? For each group below – "existing" appears – Doesn't the Baseline 50-year looks to add future component to each group? Agricultural land uses and users. The chronic lowering of groundwater level minimum thresholds protects existing agricultural users' ability to meet typical demands by maintaining groundwater levels near current conditions. Urban land uses and users. The chronic lowering of groundwater level minimum thresholds protects existing municipal groundwater users' ability to meet typical demands by maintaining groundwater levels near current conditions. Domestic land uses and users. The chronic lowering of groundwater levels minimum thresholds are established to protect as many domestic wells as possible. Therefore, the minimum thresholds will likely have an overall beneficial effect on existing domestic land uses by protecting the ability to pump from domestic wells within the Subbasin. Page 25 of 112: Isn't this a rather bold declaration re GDE "the very connected" when elsewhere it is stated we need more data to understand "nature of groundwater and surface water?" *Ecological land uses and users. Maintaining groundwater near or above historical levels will help maintain the very connected nature of groundwater and surface water in the Subbasin.*	Section 5 The future baseline already includes new projected pumping. The analysis of effect on beneficial users is not addressed for each individual user. These effects are generalized based on anticipated future conditions. Text revised

Date Received	Commentor	Comment	Response to Comments
		Page 25 of 112: Is this the method used in Table 4-5-1 Observed Historical Low (ft msl)? 4.5.2.6 Method for Quantitative Measurement of Minimum Thresholds Depth to groundwater will be directly measured at the RMPs identified in Section 5.3.1 for comparison to minimum thresholds. The RMP network includes 14 existing shallow aquifer wells and 12 existing deep aquifer wells, plus four planned multi-level monitoring wells. The groundwater level data will be collected in accordance with the monitoring protocols outlined in Section 5.3.1 and converted to groundwater elevation by subtracting the measured depth to water from the reference point elevation used to take the depth to water measurement. Will this be updated and cite to Implementation once that Section is completed? Staff has identified data gaps in some areas of the basin, and the GSP would include a plan to expand the monitoring network. Page 26 of 112: For RMPs hat have exhibited recovering -- that Measurable objectives for each RMP are listed on Table 4-5-1. However, Table 4-5-1 (on page 20 of 112) includes only 19 wells – 26 in the list of RMPs (page 21 of 112: of the 26 existing RMPs) From page 28 of 112 This looks like a To-Do list that has the potential for high cost in terms of effort and expense? 34 RMPs Trigger within this is MT, not URs. Additionally, in order to respond to these potential conditions prior to the onset of an undesirable result the following actions would be implemented if an MT is exceeded at a single RMP that does not trigger an undesirable result: •Review available data from full monitoring network (i.e., non-RMP monitoring wells) to assess potential scale of areas exhibiting declines	Yes. This is the method used. Gaps identified in Section 5. Table revised The approach is a proactive means for avoiding exceedance of undesirable results when warning signs are available. Not all actions would be implemented for each individual exceedance of a minimum threshold. The tasks described above would generally be performed sequentially based on potential severity of the occurrence.

Date Received	Commentor	Comment	Response to Comments
		• Assess whether exceedance is climate-related • Review of any known or potential changes in groundwater pumping patterns (eg, new wells brought on-line, changes in land/water use, etc.) • Consider whether additional RMPs are needed • Information-sharing with nearby well owners as appropriate • Consider planning or implementing projects/actions, as appropriate (eg, begin with lower cost and/or voluntary projects/actions)	
		Page 29: It would be good to have the "sustainable yield" discussion in Section 3 to compare to its use here: [pumping 'exceeding' sustainable yield is potentially a big factor and is unknowable to this reader at this point in time]	Sustainable yield discussion will be added in Sect 3 and 4 in the nect draft for public review.
		Reduction of groundwater storage that causes significant and unreasonable impacts to the long-term sustainable beneficial use of groundwater in the basin, as caused by: • Long-term reductions in groundwater storage; or • Pumping exceeding the sustainable yield	
		Do we really "achieve" minimum thresholds? Therefore, using groundwater elevations as a proxy, the minimum threshold for groundwater storage will be met if minimum thresholds for the chronic lowering of groundwater levels are achieved.	Text revised
		Page 30 of 112: This is 4.6.2.2 – circular reference (See below). And, this text is unclear: the reduction in groundwater storage sustainability indicator would not cause undesirable results for the chronic lowering of groundwater levels sustainability indicator.	Text revised for clarity; subsection numbering changed.
		4.6.2.2 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators The minimum thresholds for reduction in groundwater storage are the same as those used for the chronic lowering of groundwater sustainability. Because groundwater elevations will be used as a proxy for estimating groundwater pumping and changes in groundwater storage, the reduction in groundwater storage sustainability indicator would not cause undesirable results for the chronic lowering of groundwater levels sustainability indicator.	

Date Received	Commentor	Comment	Response to Comments
		The relationship between the groundwater storage sustainability and other sustainability indicators is the same as the relationship between chronic lowering of groundwater levels and other sustainability indicators, as described in Section 4.6.2.2. 4.6.2.4 Effect on Beneficial Uses and Users The minimum threshold for reduction in groundwater storage will maintain stable average groundwater elevations and encourages minimal long-term net change in groundwater elevations and storage. The potential effects of the groundwater storage minimum threshold on beneficial uses and users are the same as the potential effects described for chronic lowering of groundwater levels in Section 4.6.2.4. circular reference 4.6.3.1 Method for Setting Measurable Objectives The methods for setting the measurable objective for groundwater storage incorporates the same methods for setting the measurable objective for chronic lowering of groundwater levels described in Section 4.6.3.1. circular reference 4.6.4.2 Potential Causes of Undesirable Results The potential causes of undesirable results for reduction of groundwater storage are the same as those identified for chronic lowering of groundwater levels in Section 4.6.4.2:	Subsection numbering changed Subsection numbering changed

Date Received	Commentor	Comment	Response to Comments
		4.6.4.2 Potential Causes of Undesirable Results The potential causes of undesirable results for reduction of groundwater storage are the same as those identified for chronic lowering of groundwater levels in Section 4.6.4.2: • increased groundwater pumping in the Subbasin leading to chronic groundwater level declines; or • a significant reduction in natural recharge as a result of climate change. 4.6.4.3 Effects on Beneficial Users and Land Use The potential effects of undesirable results for groundwater storage on beneficial users and land use are the same as those identified for the chronic lowering of groundwater levels, as described in Section 4.6.4.2, ??? that section is groundwater storage Page 33 of 112 Are we implementing water Quality SMC that is 'degraded?' One of the primary challenges in implementing the degraded water quality SMC will be to assess in the future if any degradation to groundwater quality is due to SGMA activities, and specific projects and management actions may include focused groundwater quality monitoring as appropriate. And on page 42 becomes degradation of groundwater quality Page 37: Two paragraphs – bounce between "existing wells" and "public water supply wells" and introduces "new" 4.8.2.3 Development of Minimum Thresholds at Supply Wells	Subsection numbering changed We are implementing SMC. Text revised for consistency Text revised for consistency

Date Received	Commentor	Comment	Response to Comments
		The minimum thresholds for degraded water quality for the supply wells are based on the number of additional exceedances of any MCL or SMCL in existing wells shown in Table 4-8-5. Establishing the minimum threshold as the number of additional exceedances accounts for wells with previous exceedances, assuming these exceedances will likely continue into the future. The GSA Board selected two as the number of additional wells with exceedances to represent the minimum threshold. The minimum threshold for the number of allowed exceedances is therefore equal to the baseline number of exceedances (calculated as the number of public water supply wells with any MCL or SMCL exceedance between 2015 and 2020) plus two additional public supply wells with an exceedance. Based on the number of public supply wells in the existing water quality monitoring network, the number of existing exceedances since 2015 for each constituent is tabulated in Table 4-8-6 and the distribution of exceedances are shown on Figures 4-8-1 through 4-8-3, along with all of the other public water supply wells included in the initial RMP network. Minimum threshold exceedances are based on existing wells only. According to the GSP Regulations, the minimum thresholds are based on the same number of wells to have exceedances, not necessarily the same wells. The well networks will be re-assessed every 5 years to identify any new wells that could be added to the monitoring networks. The minimum threshold will be increased by one for each new well added to the monitoring network with an initial measured concentration exceeding the MCL or SMCL. Additionally, if the MCL or SMCL changes for a GSP-identified COC, the specific minimum threshold should be examined and updated as appropriate. Page 44: Here the wells become “supply wells” – these are different than “public supply wells” in 4.8.2.3 Therefore, the GSA has set the measurable objective for each COC to the number of existing supply wells that exceeded the MCL or SMCL from 2015 to 2019 as shown in Table 4-8-6. In other words, the measurable objective is to have zero additional supply wells exceeding the applicable MCL or SMCL for any of the COCs.	Text revised for consistency

Date Received	Commentor	Comment	Response to Comments
		Page 56: Confusing text – the “initial SMC” was “developed” and will be “refined” and “historical” updated As detailed in Appendix 4-10-2, the initial SMC for depletion of interconnected surface water was developed based on simulated data and the best available historical information that will be updated and, where appropriate, refined with actual observed data during the implementation phase.	
		Page 58: Confusing text -- Assessment of how other sustainability indicators could be influenced by the depletion of interconnected surface water minimum threshold indicates the following: • Chronic lowering of groundwater levels. Groundwater levels are used as a proxy for monitoring the depletion of interconnected surface water minimum thresholds. Because the minimum thresholds for the depletion of interconnected surface water are generally set within close proximity to streambed elevations within the Subbasin, they are shallower (more protective) than minimum thresholds set for nearby RMPs for the chronic lowering of groundwater levels If groundwater levels. Therefore, the depletion of interconnected surface water depletion will not result in exceedances for chronic lowering of groundwater level minimum thresholds. • Reduction in groundwater storage. Minimum thresholds for depletion of interconnected surface water do not promote pumping in excess of the sustainable yield that is needed to ensure change of groundwater in storage does not cause undesirable results. Therefore, the minimum threshold for depletion of interconnected surface water minimum thresholds will not result in an exceedance of the groundwater storage minimum threshold. Seawater Intrusion. Minimum thresholds for depletion of interconnected surface water are intended to maintain groundwater levels near streams above historical levels which is not anticipated to lead to seawater intrusion.	Text revised
		Pages 6 and 32: 4.7 Seawater Intrusion SMC The Subbasin does not border the Pacific Ocean, bays, deltas, or inlets and therefore seawater intrusion is not an applicable sustainability indicator and is not further discussed in this GSP.	Text revised Corrected

Date Received	Commentor	Comment	Response to Comments
		Page 58:From Basin Setting – streams do flow into Healdsburg Subbasin The reaches of interconnected streams within the Subbasin that are subject to the minimum thresholds for depletion of interconnected surface water are separated by surface water divides from the Petaluma Valley Basin and do not flow into the Healdsburg Area Subbasin or the Wilson Grove Formation Highlands Basin. See page 9 of 67 - Water Budget Groundwater Outflows: • Crop, native vegetation and riparian evapotranspiration (ET) • Groundwater pumping (including municipal and industrial, rural-domestic, and agricultural) • Groundwater discharge to streams • Subsurface outflows: o Outflow to Wilson Grove Formation Highlands Subbasin (Wilson Grove Subbasin and Wilson Grove Subbasin Boundary Condition in Figure 1-2) o Outflow to Healdsburg Area Subbasin (Healdsburg Area Subbasin Boundary Condition in Figure 1-2) Page 59: 4.10.2.4 Effect on Beneficial Uses and Users The minimum thresholds for depletion of interconnected surface water measured using groundwater levels as a proxy assumes that maintaining groundwater levels at or above historical low levels in the Subbasin, Becomes… Agricultural land uses and users. Maintaining the interconnection of surface water and groundwater at historical levels should not impact agricultural land uses or irrigation water supplies. Urban land uses and users. Municipal groundwater pumpers are not anticipated to be affected if surface water interconnection with groundwater remains similar to historical levels. Domestic land uses and users. Maintaining surface water interconnection with groundwater at or above historical levels will protect residential beneficial users of groundwater by keeping groundwater levels at or above historical low levels.	Refrred text from water budget diisucssed groundwater outflow, not surface water outflow. Comment noted

Date Received	Commentor	Comment	Response to Comments
		Page 54: for interconnected surface water are documented in Appendix 4-10-1. As described in Appendix 4-10-1, the SMC for depletion of interconnected surface water is unique in that information in the historical record linking surface water depletion directly to groundwater usage under the jurisdiction of the GSAs is very limited. Page 60: 4.10.3.1 Method for Setting Measurable Objectives A description of the specific methodology used for developing the measurable objectives for the depletion of interconnected surface water sustainability indicator is provided in Appendix 4-10-1. Page 68: This is number for citation above to Appendix: Appendix 4-10-2 Development of Sustainable Management Criteria for Depletion of Interconnected Surface Water—Santa Rosa Plain GSP Years begin 2004-2018 but then shift to 2004-2020: Page 60:Based on input from the work group, as well as from the Advisory Committee and GSA Board, it was determined that MO values at RMP locations should maintain the observed average dry-season surface water depletion from pumping that occurred during the years with available observations during 2004–2018. The measurable objectives for the depletion of interconnected surface water are the average dry-season observed groundwater levels at each RMP during the years with available observations during 2004–2018. Page 69: 2.2 Demonstrating Correlation between Groundwater Levels and Surface Water Depletion at RMP Locations : To evaluate the correlation between surface water depletion from groundwater pumping and shallow groundwater levels at RMP locations, this methodology focused on a 15-year simulation period from 2004–2018 Page 71: To set the groundwater-level proxy MT value at each RMP location, the method relies on evaluating the resultant percentile ranking for each RMP (Table 1) using available observed historical dry-season low groundwater levels during 2004–2020. 3.2 Methodology for Determining Groundwater-Level Measurable Objectives at RMP Locations	Corrected Corrected to 2004-2020. 2020. These portions of the text will be corrected. 2004-2020 was used as the time period for MOs because unlike the percentile approach with the model used for the MTs, which only simulates to 2018, the MO is based on the average of measured dry-season GWLs, some of which extend beyond 2018 to 2020. Corrected to 2004-2020 Correct

Date Received	Commentor	Comment	Response to Comments
		Based on input from the Depletion of Interconnected Surface Water Work Group, as well as from the SRP Advisory Committee and Board, it was determined that MO values at RMP locations should maintain the observed average dry-season surface water depletion from pumping that occurred during the years with available observations during 2004–2020. Accordingly, MO values at each RMP are set to reflect average dry-season observed groundwater levels during the years with available observations during 2004–2020. MO values for each RMP are summarized in Table 1 and are shown in Figs. 20–36. 3.2.1 Transferring Groundwater-Level Measurable Objective Percentile Ranking Value from Adjacent Wells Since the dedicated shallow monitoring wells at RMP locations were installed in fall 2019, there is limited data to directly estimate the average dry-season groundwater levels during 2004–2015 at these dedicated wells.	Correct
July 12, 2021	John Rosenblum	p.7 regarding Sustainability Goals, there are 2 bullet points “careful monitoring of groundwater conditions” and ”close coordination with other entities...” Neither have been followed regarding existing reports about Wilson Grove Highlands that will potentially impact 4 GSA members in the Sebastopol area. p.23 regarding regarding the boundary with Wilson Grove Highlands, the conclusion that there will limited effect within the Santa Rosa Plain Subbasin might be correct – but besides the point for the 4 GSA members in the Sebastopol area. Since the staff modelling and analysis is blind to land use and well extractions west of Sebastopol, the GSP provides no protection/warning of developing trends in our recharge area. At the very most, GSA action might be considered after 2032 – long after significant chronic reductions in our wells’ groundwater levels have been identified. p.27 regarding Potential Causes of Undesirable Results has 2 bullets revealing a dichotomy of GSA staff consideration. The first again limits concern only to increased groundwater pumping within the GSA boundaries, i.e. missing the impact of increased pumping outside the Bulletin 118 boundary. The second bullet regarding natural recharge impacts from climate-change might give feeble hope to those of us on the western boundary. However, I anticipate “clever” word-smithing to dash any hope.	Comment noted The comment is correct that extractions west of Sebastopol, which are not in the Santa Rosa Plain Subbasin, are not addressed in this GSP. The comment is correct that the GSA has no authority to control pumping outside the subbasin

Date Received	Commentor	Comment	Response to Comments
		I eagerly wait for Section 6 to see if any measures are proposed to mitigate my concerns. I have commented on initial modeling of measure, but staff steadfastly refused substantive comments – or any at all. I expect this to change now that this email is “correctly” addressed.	Comment noted
	Wayne Haydon	Page 5, Significant and unreasonable conditions I find this phrase confusing, “…but is not specifically defined in the GSP Regulations.” I think we mean DWR does not define the specific conditions, but could use additional verbiage to make clear. I like the definition used on a slide, “A S&U provides the overall goal for the sustainability indicator in terms of conditions which must be avoided to achieve sustainability.” Although, I like the phrase, “…are a narrative description of physical conditions to be avoided…”	Text revised
		Page 6, Undesirable Result “…an undesirable result is a quantitative assessment based on minimum thresholds.” Move to here. Then the examples from the Water Code that all refer to SU makes more sense. Again, “…is not defined in the GSP Regulations.” is confusing. Frankly, I would leave out the perceived confusion between SU and UR. Recommend, “However, the description of undesirable result states that it should be a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the Subbasin.”	Text revised
		Figure on page 16 and 17, In the explanation the description for the green and blue wells reads the same.	One is recovering, the other is recovered. The distinction is explained in the blue text box to top right
		Page 18, Define somewhere. “98th percentile shallowest supply well total depth,” and “saturated thickness factors”	98th percentile seem clear. Revised text regarding saturated thickness factors.
		Page 28, Recommend, “Lowered groundwater levels reduce the saturated thickness of the shallowsaturated aquifer…”	Comment noted. Using "shallow” as suggested may confuse readers; also affects the deep aquifer
		Page 48, “Areas to the east of the Rodgers Creek Fault appear to have slight upward movement and areas to the west of the fault appear to have slight downward movement.” I don’t see this on slides 28-29 of September 2020 meeting material. Could add text stating small vertical land surface movements may be caused by expansive soils.	Added text. Both the Rodgers Creek Fault data and the point about expansive soils being a potential contribution to subsidence are discussed/addressed in basin setting section.

Date Received	Commentor	Comment	Response to Comments
		Section 4.9.1, Recommend; "However, the risk of future inelastic land surface subsidence and consolidation of the clay-rich portions of the Subbasin's aquifer system exists if there are chronic declines of groundwater levels." Make it clear what we don't want to happen, first-land surface subsidence, second-compaction of aquifers and resulting loss of storage, and third-consolidation of aquitards.	Text revised.
		Page 53, Recommend "Continued decline of groundwater levels due to groundwater pumping within the Subbasin could trigger inelastic subsidence in areas with clay-rich aquitard materials."	Text revised
		Page 53, "The SMC for depletion of interconnected surface water is one of the more technically complex to develop and requires robust modeling tools, historical records of stream flow and groundwater levels near streams, and identification of potential impacts from streamflow depletion."	Text revised
		Page 54, Recommend "Therefore, the cause of the depletion must be evaluated to assess if such depletions are caused by groundwater pumping under the jurisdiction of the GSA."	Text revised
		Page 55, Where is the definition of and results of seepage runs? Appendix 4-10-2?	Reference deleted; not applicable to this subbasin
		Page 58, why address Seawater Intrusion? Not addressed before.	Reference deleted; not applicable to this subbasin
		Page 60, Recommended, "Based on input from the work group, the Advisory Committee and GSA Board, it was decided that MO values at RMP locations should maintain the observed average dry-season surface water depletion from pumping that occurred during the years with available observations during 2004–2018. The measurable objectives for the depletion of interconnected surface water are the average dry-season observed groundwater levels at each RMP during the years with available observations during 2004–2018." These 2 sentences repeat.	Text revised
		Page 63-67, Seems out of place. Should this be in the Section text or be part of Appendix 4-10-2?	Comment noted

SANTA ROSA PLAIN GSP COMMENTS: SECTION 5 MONITORING NETWORK			
Date Received	**Commentor**	**Comment**	**Responses to Comments**
COMMENTS RECEIVED FROM OCTOBER 1-OCTOBER 31			
10/31/2021	Coalition	The consideration of beneficial users when establishing monitoring networks is insufficient, due to lack of specific plans to increase the Representative Monitoring Points (RMPs) in the monitoring network that represent water quality conditions around DACs and domestic wells in the subbasin Figure 5-3a (Representative Monitoring Point Network for Chronic Lowering of Groundwater Levels – Shallow Aquifer System) and Figure 5-4 (Representative Monitoring Point Network for Degraded Water Quality) shows sufficient representation of DACs and drinking water users for water quality monitoring. These beneficial users may remain unprotected by the GSP without adequate monitoring and identification of data gap fails to meet SGMA's requirements for the monitoring network. **RECOMMENDATIONS** 1. Provide maps that overlay current and proposed monitoring well locations (specifying whether they are shallow or deep wells) with the locations of DACs, domestic wells, GDEs, and ISWs to clearly identify monitored areas. 2. Increase the number of RMPs in the shallow aquifer across the subbasin as needed to adequately monitor all groundwater condition indicators across the subbasin and at appropriate depths for all beneficial users. Prioritize proximity to DACs, domestic wells, and GDEs when identifying new RMPs. 3. Ensure groundwater elevation and water quality RMPs are monitoring groundwater conditions spatially and at the correct depth for all beneficial users - especially DACs, domestic wells, and GDEs.	Comment noted. The locations of DACs and areas with high concentrations of domestic wells were considered for current efforts to expand monitoring networks and will be considered when monitoring networks are expanded further during GSP implmentation. Comment noted. Monitoring networks were developed to monitor conditions throughout the Subbasin to the greatest extent possible. Data gap areas are acknowledged in the GSP. Monitoring networks will be expanded during GSP Implementation. Comment noted. A new figure (Figure 5-8) has been developed showing the proposed shallow aquifer system and interconnected surface water monitoring networks overlain with GDEs, which includes interconnected surface water. The distribution and depths of domestic wells have been incorporated into the proposed RMP networks and identification of data gaps using information from Figure 2-6, which includes the distribution of domestic wells. Comment noted. Monitoring networks will be expanded during GSP implementation Comment noted. Monitoring networks will be expanded during GSP implementation

Date Received	Commentor	Comment	Responses to Comments
10/28/2021	California Dept of Fish & Wildlife	**Planned Monitoring to Address Data Gaps: Comment:** The GSP acknowledges that more data are needed to better understand groundwater recharge and discharge mechanisms in the Subbasin, including surface water-groundwater interactions and the amount and location of groundwater extractions. In Section 5 pf te draft GSP, Figure 5-5 shows the RMP Nrtowrk for Depletion of Interconne te Surface Waters but does not include where surface water monitoring will be taking place. Also, the Norhtern and Southern portions of the subbasin seem t lack inclusion in the RMP Networks coverage. **Recommendation:** The Department recommends expanding the RMP to be better representative of the entire GSP area and establishing RMPs in the northern part of the basin (near Windsor) and in the southern basin (near Rphnert Park). This expansion of the RNP netowrk will likely help with better understanding and characterizing interconnected surface waters throughtout the GSP area.	Thank you for the recommendation. The GSA recognizes the importance of ISW monitoring. **Figure 5-5** shows the Representative Monitoring Point (RMP) Network for Depletion of Interconnected Surface Waters. Additional details are provided in Appendix 4-C, which includes Figures describing current ISW RMP locations, including shallow wells and stream gages, as well as additional high-frequency monitoring wells and planned shallow/multi-level dedicated monitoring wells adjacent to ISW (Figures 1-2). **Section 7.2.4.2** outlines future refinements for the ISW monitoring network. Specific locations for additional ISW monitoring locations will be identified following future ISW and GDE studies and information gathering.
10/31/2021	Russian Riverkeeper	p. 9-10: Section 5 contains no mention of groundwater demand and that must be identified as requires addressing in a timely manner. ....It is reasonable to take a short period of time, as is the plan in this GSP, to determine the best way to implement such monitoring be it either through amendments to PRMD's permitting process or through direct GSA action. However, the timetable for implementation of policy changes related to monitoring and data capture for groundwater demand cannot be delayed until other planned projects and managements actions are "determined to be insufficient." Demand data is a monitoring gap now and must be addressed in a timely manner. p. 10 (WQ monitoring) Thus we recommend choosing a variety of existing programs that span different program ages, different activities, and are spread across the sub-basin so as to try and reduce the impact of skewed data. We would also recommend that the GSA coordinate with various regulatory agencies on new permit programs and permit program renewals, so that the necessary types of data needs are getting incorporated into these other programs. Working with other agencies to improve programs where monitoring is already required will help lead to more consistent data and help ensure the data collected is more multi-use across the agencies.	Comment noted. Comment noted.
COMMENTS RECEIVED ON AUGUST 2021 VERSION			

Date Received	Commentor	Comment	Responses to Comments
9/9/2021	Beth Lamb	Seems comprehensive and clearly written	Comment noted
9/1/2021	Bob Anderson	Special studies conducted by the USGS within the Santa Rosa Plain Subbasin have included the collection and analysis of groundwater-quality data. Water-quality analyses have included major ions, trace elements, nutrients, stable isotopes (oxygen-18 and deuterium), tritium, the radioactive isotope of carbon (carbon-14), and the stable isotope of carbon (carbon-13). Data collected by the USGS through these studies are available on the NWIS database (USGS 2021). 2.5.2.5 U.S. Geological Survey -does this include any of the work by Flints 2019 – in another forum have seen a reference to same, supposedly done countywide – any info ??? Page 9 of 58 – check reference to Figures: The locations of the initial RMPs for each COC are shown in Section 4, and on Figures 4-8-1, 4-8-2, and 4-8-3; Figure 4-3. Baseline Groundwater Quality Arsenic 2015–2019 page 34 of 57; Figure 4-4. Baseline Groundwater Quality Nitrate 2015–2019 page 35 of 57; Figure 4-5. Baseline Groundwater Quality TDS 2015–2019 page 36 of 57	No. Changed to combined Figure 5-4
9/10/2021	David Noren	I support the analysis of groundwater elevation and water quality data gaps in Chapter 5. The representative well network should concentrate efforts of monitoring and further assessment in boundary areas, especially in areas of recharge to the Plain that are outside of the basin boundary. This issue has been raised many times in the technical advisory discussion as it pertains to the Wilson Grove Formation that borders the western side of the Santa Rosa Plain. The Wilson Grove plays a significant part in subsurface recharge to the Santa Rosa Plain and additional monitoring networks should be considered as this area that includes a significant number of private wells, wells operated by the the City of Sebastopol, agricultural wells and three large emergency backup wells on the western side of the Laguna de Santa Rosa. There is also the presence of the Sebastopol which private well monitoring conducted to date suggests represents a hydrologic barrier for shallow groundwater flow towards the Santa Rosa Plain from the Wilson Grove. The data gathering schedule for water level monitoring appears appropriate with the use of pressure transducers in many wells and other monitoring points being measured monthly and at a minimum semi-annually. A question is how will data be presented to the public and other stakeholders? It has been my experience that the dissemination of information to private well owners is key to building consensus, participation and willingness to make changes to water use and individual behavior for the collective good of managing the resource.	Comment noted Comment noted. In process of developing GW data dashboard to present data to the public
9/10/2021	Peter Martin	No comments on Chapter 5, great job covering the data gaps discussion. A few minimal comments on Section 6 are attached.	Comment noted

Date Received	Commentor	Comment	Responses to Comments
9/7/2021	Robert Pennington	Page 7 – The Representative Monitoring Point Network for Degraded Water Quality is a bit confusing. It is unclear if there are different sets of RMPs for different COCs, or if between 2015 and 2019 only some wells were sampled for various COCs. I recommend removing reference to how many wells were sampled for various COCs between 2015 and 2019 if that information is superfluous. It is also unclear if RMPs will be added automatically as new public supply wells or public water supply systems are developed.	New combined Figure 5-4 should help to clarify this
		Table 5-2 describes the gauge at Mark West Creek at Michelle Way as being monitored for Discharge. I understand that OEI developed a rating curve for this site, but that ongoing discharge measurements and rating curve calibration is not planned. I think this gauge site is very useful and recommend that discharge and rating curve calibration be conducted, especially during the dry season. This could be very useful for monitoring/validating groundwater surface water interaction in Mark West Creek.	Comment noted
		There is no stream gauge on Mark West Creek on the west side of the basin upstream from the confluence with the Laguna. I consider this a data gap and recommend pairing a stream gauge with SRP0709. Mark West Creek is arguably the stream of greatest habitat value within the SRP. Effort should be made to measure groundwater/surface water exchange along Mark West Creek. To do so, I recommend maintenance of a gauge and regular streamflow measurements through the dry season at Michelle Way or a site near SRP0707 and at a downstream gauge site near SRP0709.	Comment noted
		Figure 5-2 – Remove labels for “Mill Creek”, “Salt Creek” and “Spring Creek”, these are small tributaries and the labels clutter the map.	Comment incorproated - labels removed
COMMENTS RECEIVED ON JULY 2021 VERSION			
8/1/2021	John Rosenblum	On p.3 of the PDF (5.1 Monitoring Network Objectives): “ Monitor impacts to beneficial uses and users of groundwater” (my emphasis) should apply to the City of Sebastopol and the three mutual water companies. To me, this would mean monitoring – there are plenty of willing volunteers with historical well level data and CASGEM data - in the WGH.	Comment noted.
		On p.4 of the PDF (5.1 Monitoring Network Objectives): “Active supply wells… can be used temporarily…” covers existing data that should have been included in the GSA’s model/analysis right from the beginning of the process (i.e. as proposed long before the boundary adjustment in 2019).	Comment noted.
		On p.5 of the PDF (5.1 Monitoring Network Objectives): “… wells outside of the Subbasin, but within the contributing watershed are included in the GSP Implementation Network”. This is a false statement that is based solely on the inadequate and extremely narrow western boundary of the GSA model/analysis.	Comment noted.
		On p.9 of the PDF (5.3.1 Representative Monitoring Point Network for Chronic Lowering of Groudwter Levels – Hydrograph Comparability):	

Date Received	Commentor	Comment	Responses to Comments
		Ø Analyzing only spring levels is deceptive, since the critical reductions occur in summer/fall, with spring recovery heavily dependent on the winter precipitation. After the 3rd drought year, spring recovery has not been full, and a single point "trend" cannot reveal causation. However, the SMC has been conceived as a 3-year average to mask the potential impacts of slower cumulative reductions over time.	Comment noted.
		Ø On the western boundary, the omission of wells farther to the west in Sebastopol's WGH recharge area cannot be "representative". On p.12 of the PDF (5.4.1 Spatial Distribution Data Gap Assesment): "Fig 5-6 presents the data gaps… (8 out of 16 wells) are in the Wilson Grove Highlands Groundwater Basin to the west of the Subbasin. This is appropriate… providing subsurface inflow to the Santa Rosa Plain Subbasin… the GSA will attempt to incorporate existing wells into the Boundary Network…"	Comment noted.
		Ø All the words are factual, but the meaning is deceptive. The issue for the GSA members in the Sebastopol area is to monitor wells far to the west of the Boundary Network.	Comment noted.
		Ø The 2016 analysis (O'Connor Environmental, Inc) of the WGH recharge area existed long before starting the GSA modelling/analysis effort, and should have - at the very least – been the hydrogeological basis for extending the boundary westwards to include the clearly defined area of unfragmented Wilson Grove Formation.	Comment noted.
		On p.13-14 of the PDF (Data Quality Assesment): All the recommendations are good, but do not include expanding the GSA modelling/analysis boundary westwards into the clearly defined area of unfragmented Wilson Grove Formation. Much historical monitoring data could have already been incorporated during development of the GSP. Finally, it is unacceptable that known hydrogeological evidence was ignored by limiting the western boundary to the topographical surface watershed.	Comment noted.
7/28/2021	Bob Anderson	p. 3 This section describes the monitoring networks that are planned in the Subbasin and contributing watershed areas for implementation of the GSP and how the existing monitoring networks **described in Section 2.5,**	Text revised for consistency
		5.2 Description of Monitoring Networks: The monitoring networks included in this subsection are based on existing monitoring networks described generally in Subsection 2.5:	Text revised for consistency
		p. 4: 5.2.1 Groundwater-Level Monitoring Network: The existing groundwater-level monitoring network described in Subsection 2.5	Text revised for consistency

Date Received	Commentor	Comment	Responses to Comments
		p. 6 Maybe create a chart or text box for the following (lots of important detail gets lost/hard to compare or assess): This network consists of a total of 96 wells within the contributing watershed areas, including 85 wells within the Subbasin itself. For the shallow aquifer system there are a total of 61 wells within the contributing watershed areas, including 57 wells within the Subbasin itself. Of the 61 shallow (less than 200 feet deep) wells in the GSP Implementation Network, 41 are dedicated monitoring wells (including municipal test wells), 2 are municipal supply wells, and 18 are private supply wells. For the deep aquifer system there are a total of 35 wells within the contributing watershed areas, including 28 wells within the Subbasin itself. Of the 35 deep (greater than 200 feet deep) wells in the GSP Implementation Network, 15 are dedicated monitoring wells (including municipal test wells), 9 are municipal supply wells, and 11 are private supply wells. p. 7 This sentence is within a paragraph above 5.2.3 – is an important conclusion – best highlighted: There are not currently any identified data gaps in the Groundwater Quality Monitoring Network. p. 9 Figures 5-3h, 5-3i, 5-3j, 5-3k, 5-3l, and 5-3q) are included – data is missing in Figures p. 9 Another candidate for chart or text box: This network consists of 14 wells screened within the shallow aquifer system and 12 wells screened primarily within the deep aquifer system. All of the RMP wells are located within the Subbasin. For the shallow aquifer system, 10 of the Groundwater-Level RMPs are dedicated monitoring wells (including municipal test wells) and 4 are private domestic wells. For the deep aquifer system, 7 of the groundwater-level RMPs are dedicated monitoring wells (including municipal test wells), 4 are public supply wells, and 1 is a private domestic well p. 10 In sentence below, change period after collection to ; or comma , transducers for sub-daily water-level data **collection.** 4 of the RMP wells are monitored on a monthly basis and the remaining 4 are monitored semi-annually. p. 15 Check the wording in sentence below re “should be installed” ? ? ? Will be / in the plan: Lastly, a stilling well and pressure transducer should be installed on Mark West Creek at Fulton Rd adjacent to monitoring well SRP0707 for comparison of shallow groundwater-level and surface water elevations.	Comment noted Text revised. Figures revised Comment noted Text revised Text revised
7/31/2021	Wayne Haydon	Page 4, “Construction information (Casing perforations, borehole depth, **gravel pack interval** and total well depth)” Wells GWLs reflect, and wells produce water from all aquifers exposed in well bore within the gravel pack interval.	Text revised

Date Received	Commentor	Comment	Responses to Comments
		p. 7 Define "DDW" p. 9 “This network consists of 14 wells screened within the shallow aquifer system and 12 wells screened **primarily** within the deep aquifer system.” Explain primarily. p. 10 …the InSAR dataset covers virtually the entire Subbasin with no significant data gaps.” Explain virtually. p. 14 Section 5.4.2 Assessment and Identification of Data Gaps – Surface Water Monitoring Network Explain how measure surface water and adjacent GWL at same time; install staff gauge in creeks and read when monitor? How often surface water levels monitored? Don’t recall hearing about stilling wells, page 15.	Style for document is to define once at first use in GSP and then acronym throughout. Acronyms included in front matter Table 5-3a provides information on well screening and depth. Coverage described in Section 3 and illustrated in Figure 3-14c Protocols explained in Appendix 5-A
7/22/2021	Mark Grismer	p. 6 I understand the challenge of regular semi-continuous monitoring, but semi-annual information is hardly worth the effort and should be increased to at least monthly p. 7 Re. "There are not currently any identified gaps in the GW quality monitoring network": This is hard to believe given the very limited amount of ground WQ data available both in time and across constituents. i realize that for the Title 22 and related drinking water issues the primary monitoring wells provide a basic signature, but I'd think data gaps would include rates of salinity & nitrate contamination of the shallow aquifer at the basic level and then uncertainty about contamination rates associated with more exotic herbicide, pesticide, PCPs and other pharmaceuticals...	Monitoring frequency is discussed in Section 5.4.1.2 as a data gap. The GSA's responsibilities for GW quality monitoring are discussed in Section 4. In the context of those responsibilities, there are not currently any identified data gaps that the GSA needs to address.
		p. 10 5.3.2 RMPs for degraded WQ: see previous comment about semi-annual monitoring being inadequate p. 10 5.3.3, regarding RMPs for ISW: This is a good start on shallow GW monitoring adjacent to key stream across the basin, but expect more will be required. Have placed 20 such wells along 6 mile reach of Putah Creek in Solano county on behalf of GSA there and their GWLs show markedly different behavior p. 11 Data gaps: Would be really cool to possibly crowd-source GWL info from the 1000s of domestic wells if we could offer a simple method and incentive to do so; might get folks more invested in the whole GW mgmt process as a shared endeavor. Of course, there are some who would not want to do so... p. 13 Re. monitoring frequency data gaps: Great, this addresses my previous comments p. 14 Re. IWS monitoring data gaps: Great - this will help to improve info on the ISW connection while better informing possible policies, or future plans	Monitoring frequency is discussed in Section 5.4.1.2 as a data gap. Comment noted Comment noted Comment noted Comment noted

SANTA ROSA PLAIN GSP COMMENTS: SECTION 6 PROJECTS AND MANAGEMENT ACTIONS			
Date Received	**Commentor**	**Comment**	Responses to Comments
COMMENTS RECEIVED OCTOBER 1-21, 2021			
10/25/2021	Roy Smith	The core focus should be on capture and recharge, as articulated in section 6.2.4. High-energy weather patterns may result in “normal” annual rates (30+inches) of measured precipitation, but very low levels of “functional” rainfall. “Functional” precipitation is that which is reasonably absorbed into soils and aquifers. This last storm of October 24th/25th had a great deal of measured rainfall, but a very low level of absorbed rainfall (the vast majority flowing to the Bay within a few hours). Methods such as stream flow diversion or Aquifer Storage and Recovery are ingenious, but are either disruptive or demand high energy inputs. ASR may work technically, but to take river water and filter, pump-down, pump-up, and filter again is a strategy based on massive amounts of low-cost energy; this is not the future we can expect by 2042	In regards to comments about ASR and energy use - Sonoma Water currently provides its wholesale water entirely with carbon-free energy. Such considerations will be important in the future, but continuing to provide carbon-free water will likely remain possible.
10/11/2021	Jim Mangels	I thought the project that Healdsburg did this year using residential recycled water was a clever idea to help customers with their water needs. This way it encouraged users to use recycled water on some of their plants instead of tap water as a water savings technique. This system should roll out to other cities perhaps next year to help customers with their water needs. Let's think about a similar program for a start date in Spring 2022 during the Winter of 2021.	Comment noted. Recycled water availability in Santa Rosa Plain is subject to contract demands and supply availability. Also, City of Santa Rosa has already been doing a similar project.
10/31/2021	Community Alliance with Family Farmers	Clear guidance for implementing sustainable groundwater management in land use policy, including prioritization of water for local food production. Land use is inextricably tied to groundwater use and its sustainable management. The Plan needs to address not just water use of current activities and sectors, but of the expansion of water use and water-intensive activities, such as housing development, winery development and expansion, land conversion to new vineyards, and cannabis projects. Land use should be tied to meaningful measurements and projections of long-term water availability and be considered cumulatively, for the protection of all beneficial uses. Specifically, the plan should include Accounting and permitting of water hauling guidelines for the allowance of water hauling for food production, in particular ranches, should be developed. Permitting should be streamlined and cost-effective for defined emergency drought use.	Comment noted. Appendix 3-D describes the projections of future water demands associated with future growth and land use changes that have been incorporated into the GSP. These projections will be revisted during 5-year GSP updates. Consideration of permitting guidelines for water hauling is a policy options that has been included in the initial list of policy options that will be considered and prioritized by the GSA Board within the initial years of GSP implementation.
		Regarding policy options, all policy options listed in the Santa Rosa Plain GSP ES.6.1 should be prioritized and expedited. Collaboration between the GSA Boards, local land use agencies, GSA member agencies, other Sonoma County GSAs, land use authorities and stakeholders is critical to achieving desired goals so must begin promptly. Several of these policies should be strengthened:	Comment noted.
		· Mandatory water conservation plans for all sites which use groundwater as well as new development must be required. A good example is recent legislation in Nevada which prohibits decorative turf. Plans should include mandatory conservation within jurisdictions. Plans also must create water conservation requirements for new development, as well as education for existing well owners, which has historically resulted in significant water savings.	Comment noted. Specifics regarding conservation plans for new development will be developed as part of the management action for assessing potential policy options.

Date Received	Commentor	Comment	Responses to Comments
		· Every county Use Permit must require monitoring of wells associated with the project at least bi- annually (spring and fall) with annual reporting that is compiled to produce trend lines for groundwater levels. Permit Sonoma has data for projects that required monitoring so that data must be “mined” to determine impacts. There should also be required assessment of cumulative impacts of well uses when a new well is permitted.	Comment noted. Data provided to Permit Sonoma has been incorporated into the GSP and will continue to be included in monitoring conditions during GSP implementation. Specifics regarding well permitting recomendations will be developed as part of the management action for assessing potential policy options. As the GSA does not have authority over well permitting, any policy options related to well permitting would be recommendations to the County, which has authorities regarding well permitting.
		· Well permits must be required to show explicit proof of sustained availability and to demonstrate NO cumulative impacts	As the GSA does not have authority over well permitting, any policy options related to well permitting would be recommendations to the County, which has authorities regarding well permitting.
		· Well construction and permitting must have requirements, not just recommendations, that comply with GSA goals. · Accounting and permitting of water hauling guidelines for the allowance of water hauling for food production, in particular ranches, should be developed. Permitting should be streamlined and cost-effective for defined emergency drought use. Sonoma County’s Chapter of CAFF requests to be included in these upcoming GSP activities: stakeholder input on the fee schedule to be levied on agricultural users; Farm Plan assessments; and any additional agricultural stakeholder meetings. Although agricultural stakeholder meetings have previously been held in the planning process, CAFF-- which represents the many small farms and ranches which supply our farmers markets, grocery stores, CSA boxes and some restaurants-- was noted in the focused working group.	Specifics regarding water hauling recomendations will be developed as part of the management action for assessing potential policy options. Comment noted. CAFF representatives will be contacted to participate in the listed GSP activities.
10-31-2021	Coalition	The consideration of beneficial users when developing projects and management actions is insufficient, due to the failure to completely identify benefits or impacts of identified projects and management actions, including water quality impacts, to key beneficial users of groundwater such as GDEs, aquatic habitats, surface water users, DACs, and drinking water users. Therefore, potential project and management actions may not protect these beneficial users. Groundwater sustainability under SGMA is defined not just by sustainable yield, but by the avoidance of undesirable results for all beneficial users.	Comment noted. A major focus of the initial five years of implementation will be to gather information and data in many key areas to improve the understanding of potential impacts associated with groundwater conditions to sensitive beneficial users, primarily shallower domestic well users (including DACs) and GDEs. This information and data will inform consideration of future refinements to SMC and appropriate response actions (projects and management actions) protective of these sensitive beneficial users.

Date Received	Commentor	Comment	Responses to Comments
		The management actions described in Section 6.4.3 (Assessment of Potential Policy Options for GSA Consideration) and Section 6.4.1 (Coordination of Farm Plans with GSP Implementation) describe improvement to water quality through sediment runoff mitigation and water quality sampling. The GSP specifically describes projects with benefits to GDEs, including the Stormwater Capture and Recharge Project described in Section 6.2.2. However, the plan fails to identify or describe projects or management action with explicit benefits to DACs or drinking water users, including a domestic well mitigation program.	Projects and management actions with explicit benefits to DACs and drinking water users include any of the projects that are anticipated to raise groundwater levels. These primarily include water-use efficiency and alternate water source projects and aquifer storage and recovery.
		RECOMMENDATIONS: 1. For DACs and domestic well owners, include a drinking water well impact mitigation program to proactively monitor and protect drinking water wells through GSP implementation. Refer to Attachment B for specific recommendations on how to implement a drinking water well mitigation program. 2. For DACs and domestic well owners, include a discussion of whether potential impacts to water quality from projects and management actions could occur and how the GSA plans to mitigate such impacts. 3. Recharge ponds, reservoirs, and facilities for managed stormwater recharge can be designed as multiple-benefit projects to include elements that act functionally as wetlands and provide a benefit for wildlife and aquatic species. For guidance on how to integrate multi-benefit recharge projects into your GSP, refer to the “Multi-Benefit Recharge Project Methodology Guidance Document”. 4. Develop management actions that incorporate climate and water delivery uncertainties to address future water demand and prevent future undesirable results.	While a drinking water well impact mitigation program is not considered to be needed in the near-term based on current conditions, consideration of a well impact mitigation program has been added to the list of potential policy options for the GSA to consider in Section 6.4.3 of the GSP. The following language was added to the description of projects that could potentially impact water quality: "Future GSP implementation projects or actions that require their own site-specific monitoring network would take into consideration any localized COCs and regulatory requirements to avoid potential impacts to beneficial users, including domestic well users and DACs." Comment noted. This was performed for GSP. See Section 6 and Appendix 3-G
10/28/2021	California Dept of Fish & Wildlife	**Comment:** Management actions should include specifics on how and on what timeline adverse impacts will be reversed, if observed. The GSP should specify adaptive management strategies to account for ‘lag’ impacts wherein groundwater responses to changes in management regimes are delayed due to aquifer characteristics. Projects and management actions should seek to maximize multiple-benefit solutions, including habitat improvements.	Comment noted. Adaptive management strategies are being developed through the assessment of potential policy options, including demand management measures, that could be utilized to address potential "lag" in projects and management action implementation and results.

Date Received	Commentor	Comment	Responses to Comments
		Recommendation: The Department encourages the GSA to consider implementing recharge projects that facilitate floodplain inundation. These projects offer multiple benefits including downstream flood attenuation, groundwater recharge, and ecosystem restoration. Managed floodplain inundation can recharge floodplain aquifers, which in turn slowly release stored water back to the stream during summer months. These projects also reconnect the stream channel with floodplain habitat, which can benefit juvenile salmonids by creating off-channel habitat characterized by slow water velocities, ample cover in the form of submerged vegetation, and high food availability. Additionally, these types of multi-benefit projects likely have more diverse grant funding opportunities that can lower their cost as compared to traditional off-channel recharge projects.	Comment noted. Flood-MAR is one of the projects included in the Projects and Management Actions section.
10/31/2021	Russian Riverkeeper	p. 4: Real time well-metering must be put in place to get a better understanding of this use so that the GSA can make informed decisions about recharge needs and establish use models to mitigate potential for future draw-down. Wells must be sampled regularly so as to help grow the water data library and ensure improved modeling can occur over time. As is, the GSP appears to omit this gap in water use and potential impact of leaving that factor unknown. p. 5: The GSP currently puts a heavy emphasis on surface water supply augmentation as opposed to demand reduction. ...Due to the increasing issues surrounding future supply replenishment, it is vital that demand reductions be fully considered and given a higher priority throughout this GSP. To date, groundwater pumping has been allowed to continue unimpeded such that the GSA does not know how much water is pumped, how that amount changes across the seasons, or where all the wells are even located. Without any of this data it is impossible for the GSP to tackle the demand side of things and it is a necessary and vital component to achieving lasting sustainability. Monitoring and reporting data to obtain this key information must be given priority—in both time and funding. p. 6: Demand reduction methods that need to be considered include the feasibility of land fallowing, increased urban conservation, pumping restrictions through local government policies, fees for groundwater pumping, and irrigation reductions. The timeline for implementing such measures may not need to be immediate, but the GSP needs to properly allocate time and funding to determine the feasibility and beneficial impacts of demand reduction in order for the Santa Rosa Basin to actually obtain long-term sustainability. Without demand reduction and knowledge of how groundwater is used, the Santa Rosa Basin cannot obtain long-term sustainability.	Well metering/monitoring is included in the list of policy options to be considered in collaboration with the County and other agencies. The Group 1 project consists solely of conservation by rural domestic and agricultural groundwater users. The 'surface water supply' projects are of lower priority. Regarding the monitoring of well data, well metering/monitoring is included in the list of policy options to be considered in collaboration with the County and other agencies. The GSA does not have land use authority, so it cannot require prescription of land fallowing. Regarding the other recommendations in the comment, some of them fall under the Group 1 projects and policy options described in Section 6 and 7.

Date Received	Commentor	Comment	Responses to Comments
		p. 8 Groundwater extraction has the potential to harm endangered salmon instream habitat, and must be given more attention in the form of specific details on addressing data gaps, timeline on obtaining necessary data, and funding allocated to closing this data gap. The GSP must give further detail in how this interchange is going to be impacted by climate change and present a timeline for closing any existing data gaps. Funding for collecting this information must be made a priority and a detailed timeline should be provided. Details also need to be provided on mitigation measures and what conditions will trigger those measures, especially during dry periods with severely reduced precipitation—for instance pumping restrictions and moratoriums on new groundwater wells near interconnected surface waters when certain thresholds are exceeded in extended dry periods. There also needs to be analysis and consideration for how groundwater pumping may impact water rights in light of this surface- groundwater interchange.	Interconnected surface waters are identified as a key data-gap in Sections 4 and 7. Section 7 details how the data-gaps will be addressed.
		p. 10 Thus we recommend that policy changes be implemented within the first year of GSP implementation such that a standardized well-metering program is put in place so the GSA has access to real-time continuous pumping and water demand data. Similar to surface water management practices, an accurate and current use baseline must be established to gauge project responses. To provide public assurance in health and safety of aquifer, this data should also be made publicly available.	Well metering/monitoring is included in the list of policy options to be considered in collaboration with the County and other agencies.
		p. 10 In order to ensure best available information about impacts to beneficial users reliant on shallow groundwater, we also recommend the GSA improve local information about the location and condition of both active and abandoned groundwater wells. Local investigations would improve accuracy regarding well location, condition and water quality. We are also concerned that because well abandonment data is largely unavailable, there is potential for migration of surface contaminants to groundwater from improperly closed wells. We recommend the GSA coordinate with other local agencies to identify inactive and abandoned wells to ensure that they have been properly retired	Comment noted. Improving information on the locations and depths of existing water wells and volumes and timing of groundwater extraction is identified as a study that will be initiated during implementation of the GSP. Gaining information on inactive and abandoned wells will also be incorporated into this study.
		P. 11: p. 11: Voluntary measures are not sufficient and the GSA must fully utilize its powers to impose stronger actions on groundwater users for both agricultural and domestic users. If the GSA would prefer, they could implement an incentive program for the initial few years to try and increase conservation based habits.	Comment noted
		p. 12: Recharge projects that do not occur on government land must be done equitably. Ownership of any waters used for recharge and deposited into the aquifer directly below private property must be clear before projects are implemented. Recharge projects done at community costs must benefit the entire community, and must not be allowed to become a solely private supply for participating property owners. Recharge projects must happen throughout the sub-basin so that all well users can benefit. Prioritizing areas with more domestic well concentrations is also recommended as they are for human health needs and are more likely to be negatively impacted by excessive agricultural pumping.	Comment noted.

Date Received	Commentor	Comment	Responses to Comments
		p. 12: The determination that there will be an excess 5000 AFY in the Russian River more than 90% of the time to help facilitate recharge projects needs reconsidered. It is highly unlikely that there will be an additional 5000 AFY 90% of the time that can be diverted for recharge projects. The GSP notes that water availability will be updated during the early stages of implementation, but there is no timeline provided on what early means. A fundamental reliance on water that may not be there in future years is not setting the sub-basin up to achieve its goals p. 12: An alternative method of obtaining this 5000 AFY goal with more reliability would be through the use and injection of recycled water for recharge projects. However, the GSP chose not to include recycled water projects in their modeling scenarios due to cost limitations and other unidentified uncertainties. The GSP also appears to have only focused on the use of recycled water to augment supply for irrigation with smaller scale recharge happening as a by-product. However, recycled water has additional potential that should be considered for the region in terms of direct injection. p. 12: The GSA should utilize its power to purchase lands to restore them to a natural floodplain where multiple benefits including downstream flood attenuation and ecosystem restoration can occur. The GSA can also use its powers to create special management areas where lands of environmental significance or ideal recharge conditions have been identified so that pumping impacts in those areas is further reduced and recharge efforts are more robust.	The availability of Russian River water for groundwater recharge is estimated to occur 90% of the time during winter and spring months. These estimates are based on the best available data as of 2013. These values will be refined, based on newly available climate forecasts, during GSP implementation. Due to contractual obligations there is limited recycled water available for the foreseeable future in the plan area. The GSA likely does not have the capacity to purchase lands, nor does the GSA does have have authority over land use practices. Additionally downstream flood attenuation is not under the scope of the GSA.
10/31/2021	Bob Anderson	Appendix 6A:	

Date Received	Commentor	Comment	Responses to Comments
		Page 4 of 12 – three different but same explanations pages 4, 6, 11 The Group 1 scenario was implemented by changing the following model inputs: Rural Domestic Pumping: For Group 1, rural domestic pumping reductions were simulated by rescaling specified pumping rates for rural domestic wells in the MODFLOW WEL file. From WY 2025 until the end of the simulation, the rural domestic pumping rates were reduced by 20% from the baseline scenario. Vineyard Consumptive Use: For Group 1, vineyard consumptive use reductions were simulated by reducing crop coefficients (Kc) by 10% during the growing season from what was used for the baseline scenario, beginning in water year 2025. Crop coefficients in the PVIHM were specified as part of the inputs to the MODFLOW-OWHM Farm Process (FMP) Page 6 of 54 2.1.1 Group 1 The Group 1 project scenario builds upon the future baseline scenario by adding reductions in water use for rural domestic water users and reductions in vineyard consumptive use. The Group 1 scenario simulates the impacts of a 20% reduction in all rural domestic use and a 10% reduction in consumptive use for all vineyards, both beginning in 2025. Page 11 of 54 2.2 Implementation of Projects in Model In each PMA scenario, each type of project is implemented in the model in the same way. Crop Consumptive Use: Crop consumptive use reductions are simulated by reducing crop coefficients (Kc) by 10% during the growing season, beginning in water year 2025. This has the effect of lowering the potential evapotranspiration. As a result, the AG package calculates lower groundwater pumping to meet crop demand. Rural Domestic Pumping: Rural domestic pumping reductions are simulated by rescaling specified pumping rates. From WY 2025 until the end of the simulation, the rural domestic pumping rates are reduced by 20%. These declines in water use are assumed to occur via reductions in outdoor water use only. Because indoor water does not decline, septic return flows are assumed to remain the same as those of the Projected Baseline simulation.	Comment noted.
		Page 13 of 54 – ag use cited in both boxes under Group 1	Table now fixed.
		page 14 of 54 – here Group 1 appears to start well past start date in the text	Results shown on graph on graph reflect the time lag of the impact of the projects on groundwater conditions. This is not unexpected or indicative of a modeling error.

Date Received	Commentor	Comment	Responses to Comments
		Page 143 of 152- to repeat a point made in earlier comments: “not able to follow this logic”. For the WY 2021 to 2040 period, rural domestic pumpage is similar to the current period. Rural domestic pumpage is projected to increase, however. Section 6: (See slide for reference) In each of the slide decks for the Community meetings for the Public Review Draft, the text for ‘future policy options’ was presented using wording not contained in the three documents. The slides did variations instead and acknowledged the fact that the County of Sonoma is the entity that reviews well permits. The GSP wording should be changed and track the slides.	text clarified Clarifications of text has been added to Section 6.
COMMENTS RECEIVED ON AUGUST 2021 VERSION			
8/27/2021	National Marine Fisheries Service	· We suspect that groundwater recharge projects are likely to be an important action implemented as part of the effort to achieve groundwater sustainability in Sonoma County. NMFS encourages the GSA to consider implementing recharge projects that facilitate floodplain inundation, offering multiple benefits including downstream flood attenuation, groundwater recharge, and ecosystem restoration. · Managed floodplain inundation can recharge floodplain aquifers, which in turn slowly release stored water back to the stream during summer months. These projects also reconnect the stream channel with floodplain habitat, which can benefit juvenile salmon, steelhead, and sturgeon by creating off-channel habitat characterized by slow water velocities, ample cover in the form of submerged vegetation, and high food availability. · As an added bonus, these types of multi-benefit projects likely have more diverse grant funding streams that can lower their cost as compared to traditional off-channel recharge projects. NMFS stands ready to work with any GSA interested in designing and implementing floodplain recharge projects.	Comment noted. The stormwater capture and recharge projects could include multi-benefit floodplain inundation. Comment noted. The stormwater capture and recharge projects could include multi-benefit floodplain inundation. Comment noted. The stormwater capture and recharge projects could include multi-benefit floodplain inundation.
8/19/2021	John Rosenblum	6.1.2 Evaluation of Projects Through Scenario Modeling: For the purposes of conducting initial evaluation of projects for this GSP, staff assembled conceptual projects and actions that are likely to be initiated within the first five years of implementation into two general categories. **COMMENT: “Implementation” means after the 20-year grace period?** 1. Those that have identified potential funding sources or are voluntary or incentive-based and are lower-cost (Gro	Implementation overall begins in WY 2021 - the actual project start dates depend on complexity of projects. Mandatory State orders are outside the purview of the GSP.

Date Received	Commentor	Comment	Responses to Comments
		2. New or significantly expanded projects/actions that would require further studies and planning for implementation (Group 2 and 3 projects). Both Group 2 and Group 3 projects represent managed aquifer recharge projects that aim to maintain or raise groundwater levels and improve summer and fall streamflows. The Group 2 projects represent stormwater capture and recharge projects that could specifically benefit streamflows within the Subbasin and help comply with the SMC for depletion of interconnected surface water. Group 3 projects represent aquifer storage and recovery (ASR) projects that can reduce municipal pumping of native groundwater, help address many sustainability indicators, primarily the chronic lowering of groundwater levels, and build drought-resiliency. **COMMENT: As storms increase in severity and flooding is more frequent?**	As storms increase in severity, there will be greater opportunites for stormwater recharge projects.
		• Groundwater Levels: In the baseline scenario, groundwater levels in the shallow and deep aquifers remain above minimum thresholds for the first 20-year period. Groundwater levels generally fall below minimum thresholds in the last 11 years of the 50-year projected baseline water budget, primarily in RMPs in the deeper aquifer, leading to undesirable results. The cumulative projects decrease minimum threshold exceedances from 66 to 18 and remove all occurrences of undesirable results. CMMENT: 20-year grace period – "threshold" defined by depth and by the number of wells impacted. 18 is still undesirable. Removing undesirable results assumes recovery	Undesirable results are defined by number of different RMP's with minimum threshold exceedances. Such exceedances are not met here, so no undesirable results occur, as simulated.
		Groundwater storage: Groundwater in storage under a baseline scenario without projects is estimated to decline by an average of 200 AFY between 2021-2040 and 1,400 AFY over the entire 50-year projection period that includes a simulated extreme 20-year drought between 2050 and 2070. Cumulative projects are simulated to reduce the average decline by 400 AFY between 2021 -2040 and 300 AFY over the entire 50-year projection. **COMMENT Unclear: 200x19=3,800AF loss up to 2040; 1,400x50=70,000 AF loss up to 2071. "by" = "to"?**	Text corrected
		Project scenarios help limit groundwater declines during the latter portion of the projected period (affected by the major drought). Although minimum threshold exceedances are not completely avoided during this more extreme dry period under these scenarios, the exceedances during severe droughts are not representative of undesirable results unless groundwater levels do not recover during subsequent wetter time periods. **COMMENT: "Get out of jail"?** **The major issue is whether there will be recovery between "severe droughts"**	Undesirable results are defined by number of different RMP's with minimum threshold exceedances. Such exceedances are not met here, so no undesirable results occur, as simulated.
		Considering current uncertainties due to modeling and project information, these project scenarios show reasonable efforts towards reaching sustainability in the Subbasin to meet GSP requirements. Additional data collection and project conceptualization during early phases of GSP implementation will help refine these scenarios and allow for consideration of additional scenarios.	Comment noted.
8/23/2021	Bob Anderson	Page 4 of 14 - key sentence but ends up it is stuck in middle, "remove all" that's big: The cumulative projects decrease minimum threshold exceedances from 66 to 18 and remove all occurrences of undesirable results.	Comment noted.

Date Received	Commentor	Comment	Responses to Comments
		Page 4 of 14 – 200 AFY decline is then simulated to reduce the average decline by 400 AFY? Groundwater storage: Groundwater in storage under a baseline scenario without projects is estimated to decline by an average of 200 AFY between 2021-2040 and 1,400 AFY over the entire 50-year projection period that includes a simulated extreme 20-year drought between 2050 and 2070. Cumulative projects are simulated to reduce the average decline by 400 AFY between 2021 -2040 and 300 AFY over the entire 50-year projection	Text revised
		Page 4 of 14 – hardly very convincing: Considering current uncertainties due to modeling and project information, these project scenarios show reasonable efforts towards reaching sustainability in the Subbasin to meet GSP requirements.	Text revised
		Page 5 of 14 – PMAs? Used in text here but not defined: To prevent potential undesirable results and to achieve measurable objectives, PMAs are planned as part of GSP implementation. As described above, a portfolio of PMAs has been developed and evaluated with the goal of addressing relevant sustainability indicators. The GSA plans to immediately begin implementation of selected PMAs	Text revised
		Page 5 of 14 – typo add Section before 354.44 as done on page 2 of 14 “This section satisfies Sections 354.42 and 354.44 of the SGMA regulations” The following sections provide descriptions of the Group 1, 2 and 3 projects, including information required by 354.44.	Correction made
		Page 7 of 14 – cited - needs reference: Russian River Regional Storm Water Resource Plan	Reference added
		Page 8 of 14: In order to continue and/or expand implementation of Group 2 projects, the GSA coordinate with other project proponents who may be pursing multi-benefit projects, consider providing additional funding in future years and will seek opportunities for grant funding.	
		P. 12: Only one of these “A total of $30,000 is included in the initial five-year budget”:	
		6.3.2 Assessment of Additional Recycled Water Opportunities The use of recycled water for agricultural and landscape irrigation within the Subbasin has provided substantial benefits to groundwater conditions. During the current water budget period, it is estimated that approximately 10,000 AFY of recycled water is delivered within the Subbasin for agricultural and landscape irrigation, significantly reducing the need for use of groundwater and other potable water supplies.	Revised
		6.3.3 Assessment of Potential Policy Options for GSA Consideration The use of recycled water for agricultural and landscape irrigation within the Subbasin has provided substantial benefits to groundwater conditions. During the current water budget period, it is estimated that approximately 10,000 AFY of recycled water is delivered within the Subbasin for agricultural and landscape irrigation, significantly reducing the need for use of groundwater and other potable water supplies	Revised

Date Received	Commentor	Comment	Responses to Comments
		Page 13 of 14 – hidden but attention worthy: Under a curtailment scenario, the GSA would need to determine the amount of water that affected pumpers could take sustainably, and the pumpers would be required to reduce their groundwater extraction to that allocation. Under such a scenario, all pumpers subject to allocations and restriction would be required to be metered. In the event of a need to restrict pumping, pumping restrictions could also be placed on new wells.	Text revised
		Page 14 of 14: restrictions on permits in specific areas could be considered if additional localized pumping could drive one or more sustainability indicators below the minimum threshold. (URs?) not very limiting (or very limiting potentially) - "limit": Limits could also be placed on which aquifers could be drawn from if there was a potential adverse impact in a particular zone that might affect certain sustainability indicators.	Text revised
		COMMENTS ON APPENDIX 6-A: SIMULATION OF PROJECTS AND MANAGEMENT ACTIONS	
		Page 10 of 53 – typo. In the Group 2 scenario, MAR of stormwater is simulated by adding water to the soil zone. The stormwater is recharged to the soil zone by adding it to the external water source option in the in the Precipitation and Runoff Module System component of GSFLOW.	Noted and addressed
		Page 11 of 53 – typo in Rural domestic pumping box Group 1 column	Noted and addressed
		Page 12 of 53: Despite the injection of 940 AFY in Group 3, there is only minor benefit to groundwater storage in this scenario. This occurs because **a number fluxes offset** the increased inflows	Noted and addressed
		Page 4 of 53: The Group 1 scenario simulates the impacts of a 20% reduction in all rural domestic use and a 10% reduction in consumptive use for all vineyards, both beginning in 2025.	
		Page 12 of 53 – here the Group 1 projects appear to be added in ~2034, AND on Page 17 of 19 – here it is 2023: The project implementation schedule includes the development and implementation of Group 1, Group 2 and Group 3 projects, as described in Section 6. After a short planning period, it is assumed that Group 1 project implementation will begin in 2023.	One cannot directly observe beginning of implementation through these graphs. There are lags between the projects and their impacts.
		Page 13 of 53 – isn't it more important to show impact 2021-2040? 2021 – 2070	noted
		Page 19 of 53 – typo – need period after period. Maybe not after Table 7 (or drop name of the Table): These values are summarized in Table 7. Summary of Waterlevel exceedances by depth and period	comment is unclear
		Page 22 of 53 – check the colors – bit confusing between shallow & deep and WY type	Noted and addressed
8/23/2021	Mark Grismer	Well done. See comments below.	Comment noted
		p. 2, para 2: These seem to be reasonable caveats, but may want to add the possibility of water use restrictions. I realize that these are under GSA and SWRCB, but thought they should at least be mentioned up front as a means of possible GW mgmt., as they are considered in the final section 6.3.4.	Discussed under management actions
		p. 3, Evaluation of Projects through Scenario Modeling: OK, this sort of addresses my previous comment	Comment noted

Date Received	Commentor	Comment	Responses to Comments
		p. 4, last para: Considering current uncertainties due to modeling and project information, these project scenarios show reasonable efforts towards reaching sustainability in the Subbasin to meet GSP requirements. COMMENT: 'Progress' instead of 'efforts' p. 5: 6.2.1.1 Objectives, Circumstances and Timetable for Implementation ~~Objectives for implementing the~~ Group 1 projects are to help achieve measurable objectives and avoid undesirable results for the chronic lowering of groundwater levels sustainability indicator. p. 7: 6.2.2.1 Objectives, Circumstances and Timetable for Implementation ~~Objectives for implementing~~ the Group 2 projects are primarily anticipated to help achieve measurable objectives and avoid undesirable results for the depletion of interconnected surface water sustainability indicator. p. 9: 6.2.3.1 Objectives, Circumstances and Timetable for Implementation ~~Objectives for implementing~~ ASR projects are to help achieve measurable objectives and avoid undesirable results for the chronic lowering of groundwater levels sustainability indicator.	Text revised Text revised Text revised Text revised
9/10/2021	Peter Martin	P.3. "and they have not yet all been sufficiently developed or agreed upon by stakeholders." Not sure if this note is necessary.	Text revised
9/10/2021	David Noren	Section 6 contemplates future actions that can be implemented as projects and management actions. The GSP should include a commitment of building incentives for all project levels. This should include agricultural property owners that are both users of recycled water in the Santa Rosa Plain and also represent the land base in which larger scale projects can be implemented. The connection of the GSA efforts to Farm Plans and other regulatory and non-regulatory projects is a smart strategy for combining efforts and goals. The GSA should also consider working with the update of the Sonoma County General Plan Resource Elements to require metering for all new wells and include provisions that allow for a standardized approach for data gathering for private and agricultural wells. The cost and construction of these items can be lessened if installed during the installation of new wells. Minimal standardized water quality testing may also be considered as a reporting requirement for newly installed wells to establish baseline conditions.	Comment noted Text revised to refer to general plan specifically under policy options discussion.
9/7/2021	Robert Pennington	Page 8 – Estimated cost for Group 1 and 2 Projects seem low. Additional seasonal use of Russian River Water in place of groundwater use could be cost effective. I recommend a future assessment (similar to the proposed evaluation of recycled water) be specified. In particular, Cal American may have significant potential to use more Russian River water during the winter months.	Cost estimates are based on costs of prior studies. Costs will continue to be refined through upcoming fee study budget. Suggestion can be addressed in future GSP implementation period.

SANTA ROSA PLAIN GSP COMMENTS: SECTION 7 IMPLEMENTATION PLAN			
Date Received	**Commentor**	**Comment**	Responses to Comments
10/1/2021	Tim Carlson	I am curious about how the proposed fees will be applied? as a residential non-commercial well owner I am solely responsible for the maintenance, repairs and energy costs related to pumping water out of the ground for our home use. Current costs to drill a new well are over $75 per foot. There are no avenues for financial aid for us. Supervisor Rabbit told me he is proposing that the fees be spread across all water consumers in Petaluma but he could not speak for the Santa Rosa plain proposal. Is the going to be the case in the Santa Rosa plain plan as well?	Consideration of fees for funding GSP implementation will be addressed through a fee study that was initiated in 2021 and will continue through mid-2022.
10/22/2021	Jennifer LaPorta	I skimmed thru Sect 7, thinking I'd get the info I was seeking but did not. I don't have time to read thru this entire report. Please just tell me: what fee are you thinking of charging rural residential well owners like me? Also, are you planning to put meters on our wells? if so, I sure as hell hope they won't be wireless devices, because we are electro-magnetic sensitive here. NO wireless devices!!!	Consideration of fees for funding GSP implementation will be addressed through a fee study that was initiated in 2021 and will continue through mid-2022. Well metering is a policy option that will be studied during implementation of the GSP. Wells used for single-family homes and landscaping (no commercial use and that pump less than 1,785 gallons a day) are considered deminimis users by SGMA and can't be required to meter their wells.
10/25/2021	Roy Smith	The greatest scale of recharge at the lowest cost can be gained by engaging all land owners with parcels of 1+ acres. Simple and durable land alterations can be employed to slow and sink available precipitation. However, land owners are not currently incentivized in this direction as the cost of implementation is born directly by them individually, but the benefit is conveyed to the public at large through the “commons”. It may be best to pursue County-wide groundwater recharge through education, credit schemes, easily replicable designs, and funding or grant schemes coordinated through other local, State, and Federal agencies.	Comment noted
10/29/2021	Sebastian Bertsch	Section 7.3.1: This section should highlight some takeaways from the initial fee study completed in 2019. It should also highlight SGMA guidelines which state domestic de-minimis users are subject to less oversite, and cannot be forced to meter. It should also summarize the feedback from public comment that stated a clear opinion that fee structures should respect the distinction in SGMA to place more of the oversite and cost burden on commercial users of groundwater.	Comment acknowledged. The fee study that is currently underway will include consideration of the intial fee study and will also address issues regarding fair-share distribution of the fee.
10/31/2021	Community Alliance with Family Farmers	We believe the following components should be included in every Groundwater Sustainability Plan (GSP):	

Date Received	Commentor	Comment	Responses to Comments
		Clear guidance for implementing sustainable groundwater management in land use policy, including prioritization of water for local food production. Land use is inextricably tied to groundwater use and its sustainable management. The Plan needs to address not just water use of current activities and sectors, but of the expansion of water use and water-intensive activities, such as housing development, winery development and expansion, land conversion to new vineyards, and cannabis projects. Land use should be tied to meaningful measurements and projections of long-term water availability and be considered cumulatively, for the protection of all beneficial uses. Specifically, the Plan should include: 1. Coordination of water management and land use planning. In line with the objective of "close coordination and collaboration with other entities and regulatory agencies that have a stake or role in groundwater management in the Subbasin," the GSP should provide clear mandates and guidelines to be incorporated by Permit Sonoma into Use Permits, and by other jurisdictions into their land use policies and permits. Permitting must not be in conflict with the GSP and should support achieving sustainability goals. 2. Prioritization of water for food farming (fruit, vegetables, herbs, and livestock). As supply chain disruptions continue due to climate change and other impacts, we will increasingly rely on local food production, especially during emergencies. Given that local food security is likely to become an even more significant issue over the 50-year planning horizon, the Plan must distinguish agricultural water use by food vs. non-food crops. It may be argued that wine grapes are essential to our economy, but they can be dry farmed—whereas most fruits and vegetables, and all livestock, require water. According to annual Crop Reports there has been a glut of wine grapes on the market since 2018, yet more vineyards continue to be developed across the county. CAFF has been involved with providing resources and training on irrigation efficiency and assisting with vineyard transition to dry farming.	Additional text had been added to Section 7.2.2 regarding coordination with land use agencies. Recommendations on policy options will addressed through the policy options management action. Comment noted.

Date Received	Commentor	Comment	Responses to Comments
		3. Preparation for large-scale, emergency groundwater reliance/ usage. Staff have explained that “long-term sustainability” and “adaptive management” are central to groundwater sustainability planning, and that short-term shortages and drought are not intended to be included in this phase. Assuming that groundwater levels begin to significantly decline, it will be possible to create and implement necessary management actions in the future. We find this approach to be highly irresponsible and inadequate. Plans should contain proactive preparation for worst-case scenario groundwater extraction, such as if sudden or drastic shortages and/or disruptions to surface water supplies were to occur. Local agencies and municipalities should use this information to create or update contingency plans, which should also include equitable prioritization of uses. “Worst case scenario” planning provides necessary time to change course in advance of irreversible decline or degradation. We are concerned that the climate model showing “normal” and wetter than normal conditions for 2025-2050 could lead to severe water shortages - the opposite of sustainability.	Comment noted. Many of the implementation activities and planned projects and actions will build resiliency for groundwater users within the Subbasin.
		Sonoma County’s Chapter of CAFF requests to be included in these upcoming GSP activities: stakeholder input on the fee schedule to be levied on agricultural users; Farm Plan assessments; and any additional agricultural stakeholder meetings. Although agricultural stakeholder meetings have previously been held in the planning process, CAFF-- which represents the many small farms and ranches which supply our farmers markets, grocery stores, CSA boxes and some restaurants-- was not included in the focused working group.	Comment noted. CAFF representatives will be contacted to participate in the listed GSP activities.
10/31/2021	Santa Rosa Metro Chamber of Commerce	A reliable supply of water is a critical resource that underlies our ability to live in an area on a long-term basis. The droughts we have experienced in California over the past decade – and the especially severe drought of the past two years – have emphasized that our water infrastructure and water management practices must be up to the job of ensuring that our residents and businesses have at least a minimally adequate supply of water even during the worst droughts.	Comment noted
		We have been following the development of the Groundwater Sustainability Plan by the Agency over the past few years pursuant California’s 2014 Sustainable Groundwater Management Act. The draft Plan follows the requirements of the Act and its preparation by the Agency and will ensure that the region will retain control over the management of its groundwater rather than having the state manage it for us. The Plan lays out the information basis, the decision-making criteria, and the process and timetable for developing actions in future years to achieve sustainability while allowing for flexibility in selecting specific policies and actions to accommodate future basin conditions.	Comment noted

Date Received	Commentor	Comment	Responses to Comments
		We support the adoption of the Plan by the Agency and we look forward to working with the Agency as it assesses and prioritizes policy options to achieve the goals of the Plan in the first year following its approval by the State.	Comment noted
10/31/2021	Russian Riverkeeper	p. 13: Every single policy option presented on the initial list for GSA consideration must be implemented in a timely manner. A timely study to determine the best route for impleentation is reasonable, but these policy options cannot be delayed beyond this determination…There is no excuse to not getting these policy options into place within the next 2 to 4 years, and there is no justifiable reason to delay any ofthese actions until other "projects and management actions are determined to be insufficient."	Comment noted
		p. 15: The SRBGSA must provide concrete triggers and timelines for projects within its control, including pumping restrictions, to demonstrate a likelihood of avoiding undesirable results and meeting the ustainability goal as required under SGMA. Management actions that will have an immediate, quantifiable impact, including limiting new wells and taking the necessary steps to initiate pumping restrictions must be included in the GSP because they provide certainty and therefore are reasonably likely to help meet sustainability goals for the region as SGMA requires.	Comment noted. Initial timelines for projects are included in the schedule and will be refined as information is developed during GSP implementation. Triggers and timelines for specific management actions considered and prioritized by the GSA Board will be developed as part of the planned policy options study.
		p. 15: Establishing an ongoing fee program and pay rate for groundwater will be essential to ensuring that the GSA will be able to fulfill its SGMA duties. One thing to consider during this transition to a fee program and/or pay rate would be the use of monetary incentives (e.g. rate discounts) in exchange for real-time well-metering and reporting, fallowing of land for recharge, conservation achievements, or other multi-benefit action done to help the GSA achieve long-term sustainability in the sub-basin.	Comment noted

Date Received	Commentor	Comment	Responses to Comments
10/28/2021	California Dept of Fish & Wildlife	**Comment:** Management actions should include specifics on how and on what timeline adverse impacts will be reversed, if observed. The GSP should specify adaptive management strategies to account for 'lag' impacts wherein groundwater responses to changes in management regimes are delayed due to aquifer characteristics. Projects and management actions should seek to maximize multiple-benefit solutions, including habitat improvements. **Recommendation:** The Department encourages the GSA to consider implementing recharge projects that facilitate floodplain inundation. These projects offer multiple benefits including downstream flood attenuation, groundwater recharge, and ecosystem restoration. Managed floodplain inundation can recharge floodplain aquifers, which in turn slowly release stored water back to the stream during summer months. These projects also reconnect the stream channel with floodplain habitat, which can benefit juvenile salmonids by creating off-channel habitat characterized by slow water velocities, ample cover in the form of submerged vegetation, and high food availability. Additionally, these types of multi-benefit projects likely have more diverse grant funding opportunities that can lower their cost as compared to traditional off-channel recharge projects.	Thank you for the recommendation. The GSA recognizes the importance of implementing recharge projects, and has outlined Projects and Management Actions to facilitate stormwater capture and recharge (Section 6.2.2).
COMMENTS RECEIVED ON AUGUST 2021 VERSION			
9/1/2021	Bob Anderson	page 3 of 19 – typo ten not nine. As described in Section 1.3.2, the nine member agencies currently plan to continue operating under the Joint Powers Authority Page 4 of 19 – typo – no Section 7.1.4. 7.2.3 Annual Monitoring, Data Evaluation and Reporting Monitoring of the five applicable sustainability indicators is a key component for successful implementation of the GSP. Most monitoring relies on existing monitoring programs, some of which will be enhanced or expanded as described in Section 5 and Section 7.1.4.	Corrected. Corrected.
9/9/2021	Beth Lamb	Table 7-3: Total Estimated Five-Year Implementation Costs No 5 year total 5.7 Millionish?	Added total costs
8/23/2021	Mark Grismer	P. 6: "Interconnection of streams to the shallow aquifer system, including seasonal variability and how groundwater pumping and surface water diversions ~~can~~ affect streamflow: COMMENT: and stream recharge to shallow and deeper groundwater systems P. 7: ~~well owners~~ Cooperators instead	Noted - text corrected Noted - text corrected

Date Received	Commentor	Comment	Responses to Comments
		p. 7: This information will be integrated with available groundwater level data and information to assess the relationship between groundwater levels and GDEs. Conduct field visits as-needed to verify findings from remote sensing assessment. COMMENT: and consider the addition of shallow (<50' bgs) groundwater monitoring wells adjacent to streams of within relevant riparian areas as identified above.	Comment noted
		P. 8: Seen note above: The phrase may better fit here: "and consider the addition of shallow (<50' bgs) groundwater monitoring wells adjacent to streams of within relevant riparian areas as identified above." at this location: Additionally, it is assumed that remote sensing assessments of vegetation health will continue to be performed and reported at key intervals such as the 5-year GSP updates.	Comment noted
		p. 11: A sustainability evaluation ~~will contain~~ a description of current groundwater conditions for each applicable sustainability indicator and ~~will include~~ a discussion of overall sustainability in the Subbasin. COMMENT: "that contains" and "and includes."	Noted - text corrected
		p. 12, first para: Not sure why these are all in the future tense as that was already indicated at the top. Would simply clarify as edited in first paragraph above	Noted - text corrected
9/10/2021	Peter Martin	I won't review section 7 further. I read through quickly late last month and the presentation of budget, reporting, funding etc. to the AC didn't cause me any concern. I'm done reviewing – sorry for waiting till the last minute.	Comment noted
9/10/2021	David Noren	In Section 7 - I strongly support the communication and outreach process. Private well owners should have many opportunities and forums to get information and updates that are geared to lay people that distills information in a format that is not a long technical report. The reporting to the public stakeholders and private well owners should be conducted annually along with the reporting to DWR. Consider using all elements of social networking, news media and other forums to communicate goals and outcomes. Annual town hall type meetings would also be of benefit. This ties into the process of fees to provide a service of information to well owners and stakeholders of data, management actions, outcomes, fiscal and budget requirements and statement and update of goals to a community that to this point has not been regulated or had a requirement for fees for the use of water.	Comment noted
9/10/2021	Wayne Haydon	P. 7, second point: Interconnected surface water and GDE studies: "The GDE Pulse web app developed by the Nature Conservancy provides data on long term temporal trends of vegetation metrics, including." Need to finish sentence.	Noted - text corrected

Date Received	Commentor	Comment	Responses to Comments
		p. 15: Should we name the consultant hires in August 2021, and discuss/summarize the previous Raftelis fee study, and how the new study will differ from the Raftelis study?	Noted - section corrected
9/7/2021	Robert Pennington	p. 24: 24. I do not see discussion of the GSA reviewing and responding to: a. General Plan amendments; b. Other local policies related to groundwater resources; c. Other public and private projects subject to CEQA . Review and response to GP amendments is required per 65352.5(d). The report on anticipated effect could take a fair bit of GSA staff time, and it may be worth noting as a future task or administrative task. If the GSA wants to take an active role in reviewing private projects and requesting specific conditions of approval or mitigation measures, this would also take staff time and resources. Per the current CEQA checklist includes the following "Conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan?" Lead agencies will look to the GSA staff to help answer this question, and determine suitable mitigation measures. Mitigation fees could also be a source of funding for GSA supported projects.	Coments noted - added language regarding the points made
9/12/2021	John Rosenblum	The imprecise use of the terms "implementation" and "implementation period" means that it could take 20 years (SGMA REQUIRED PLAN ELEMENTS 10727.2. (b) (1) Measurable objectives, as well as interim milestones in increments of five years, to achieve the sustainability goal in the basin within 20 years of the implementation of the plan) Section 7-A refers to GSP updates in 5 years' time, but the detailed descriptions reveal only that the modelers will consider inclusion of new information that they deem relevant. Time is not on our side to slowly develop formal communication procedures, install separate fully-automated monitoring wells, and run a few test scenarios. The GSP overall lacks any sense of urgency, while there are ample volunteers who would gladly provide access to wells and data about their well – particularly in the West County/Wilson Grove Highlands. Without purposeful outreach to volunteers, and incorporation of existing data and evaluations (e.g. O'Connor 2016) – and given the County's lack of enforcement of reporting from Ag wells and surface diversions – it is unlikely that new groundwater information/data will be available to update the hydraulic model.	Implementation will begin in 2022. Comment noted. Outreach to obtain information volunteered by groundwater users is a key component of the implementation plan.

Date Received	Commentor	Comment	Responses to Comments
		As a specific example of proposed considerations is “Perform sensitivity analyses of existing model to determine sensitivity of boundary flux”. From a scientific perspective, of course this should be done (one of the gaps pointed by O’Connor 2016). However, such an effort requires verification with groundwater data from the Wilson Grove Highlands – especially since the downstream Laguna impacts will be negligible compared to all the other factors (already pointed out in the older USGS reports). So, rather than invest effort in creative statistical analyses of spotty historical data, there would be far less uncertainty from obtaining data outside the existing model boundary – at the very least from the points utilized by O’Connor for the 2009-2014 trend. In lay terms, relying on boundary flux is like waiting until a crisis occurs before telling us that it is confirmed by the model – instead of tracking developing trends in time to make plans.	Evaluation of the basin boundary's representation in the model will include available data and information from areas outside of the Subbasin, including data from O'Connor, 2016.

Date Received	Commentor	Comment	Responses to Comments
		For climate scenarios, there is the same lack of urgency (e.g. “As part of the five year update to the GSP, the latest available projected climate science and data will be reviewed and considered for incorporation into the scenarios for the Water Year 2026 through 2072 projected period.”). In addition, the phrasing still means that there would be no change in modeling the RCP 8.5 pathway to extinction. Again, as with the hydraulic model, the implication is to wait until the formal IPCC reports tell us all is lost (diplomatic managers of COP prevent dire warnings from becoming policy). Although consideration of the “Paris Accords” (RCP 2.6) requires an effort far beyond the State’s mandates, it would demonstrate that sustainable groundwater planning is not only a local, or even a California issue. A comparison with RCP 8.5 would show how much smaller the groundwater impact might be if achievable climate-adaptation did become the guideline for sustainability planning (calling extinction “adaptive” is in much line with George Orwell’s predictions from the 1930’s).	The selection of the RCP 8.5 scenario of the HadGEM2-ES model was based on extensive input from the three stakeholder advisory committees (ACs) and Board of Directors (Boards). These discussions occurred as part of an all-basin workshop and several AC and Board meetings. In addition to the technical information provided in Appendix 3-E, additional information included a summary of input from climate scientists regarding RCP 4.5 vs. 8.5 and a comparison of model output from both futures for the Santa Rosa Plain. The input from climate scientists was mixed with some indicating RCP 4.5 was more realistic while others indicated RCP 8.5 (known as business as usual – worst case) would be more appropriate. Many also indicated that the selection of an RCP emission scenario is really not a technical or scientific decision but rather a philosophical view of whether global mitigation efforts would reduce emissions closer to a RCP 4.5 or whether the “business as usual” RCP 8.5 would occur. In regards to the modeled comparison between the RCP 4.5 and 8.5, the results (attached to this document) clearly show the RCP 8.5 provides a worse case for groundwater storage, groundwater pumping, groundwater discharge to streams, and groundwater recharge. This is because the RCP 8.5 exhibits increased temperatures (increase evapotranspiration and pumping) and increased variability of precipitation by severe droughts (stress tests) relative to the RCP 4.5 scenario. Based on the above process, the majorities of each of the stakeholder Advisory Committees and the GSA Boards decided to use the more conservative (worst case) RCP 8.5. There were some who favored the RCP 4.5 and at least one who felt the RCP 2.6 (Paris Accords) should be used. Again, this review will be re-evaluated in the next plan update.

Date Received	Commentor	Comment	Responses to Comments
		The 3 mutual water companies in Sebastopol recommend explicit commitments in Section 7 to include: a. Expand the hydraulic model to include all the unfragmented Wilson Grove Formation before the next 5-year GSP update (incorporating O'Connor's 2016 data and methodology) b. Immediate outreach to well-owners to volunteer access and/or groundwater levels, including monthly measurements with measuring tape and/or pressure transducers (possibly purchased and maintained by Sonoma Water) c. Complete enforcement of Ag well and surface diversion reporting by the County Ag Commissioner and PRMD (the boards of the GSA, Sonoma Water, and County are largely overlapping) d. Add RCP 2.6 ("Paris Accords") to the climate modeling	a.) The need and appropriateness of expanding the model boundary will be evaluated within the first few years of GSP implementation, as described in Appendix 7-a. b) Outreach for a voluntary groundwater level measurement program is included 7.2.4.2 c) The GSA does not have authority to enforce reporting of surface water diversions. d) Additional climate scenarios will be evaluated and considered for future model scenarios during GSP updates.

Appendix 1-B
Resolution of the Board of Directors of the Santa Rosa Plain Groundwater Sustainability Agency Forming a Groundwater Sustainability Agency for the Santa Rosa Plain

Santa Rosa Plain Groundwater Sustainability Agency

Resolution No. SRP-17-001

RESOLUTION OF THE BOARD OF DIRECTORS OF THE SANTA ROSA PLAIN GROUNDWATER SUSTAINABILITY AGENCY
FORMING A GROUNDWATER SUSTAINABILITY AGENCY FOR THE SANTA ROSA PLAIN

WHEREAS, the comprehensive groundwater legislation collectively enacted and referred to as the "Sustainable Groundwater Management Act" at California Water Code Section 10720 *et seq.* ("SGMA") initially became effective on January 1, 2015; and

WHEREAS, the stated purpose of SGMA, as set forth in California Water Code section 10720.1, is to provide for the sustainable management of groundwater basins at a local level by providing local groundwater agencies with the authority and technical and financial assistance necessary to sustainably manage groundwater; and

WHEREAS, SGMA requires the designation of Groundwater Sustainability Agencies ("GSAs") for the purpose of achieving groundwater sustainability through the adoption and implementation of Groundwater Sustainability Plans ("GSPs") for all medium and high priority basins as designated by the California Department of Water Resources; and

WHEREAS, SGMA authorizes a combination of local agencies, as defined by SGMA, to form a GSA by entering into a joint powers agreement; and

WHEREAS, the Santa Rosa Plain Groundwater Sustainability Agency ("Agency") was formed pursuant to a Joint Exercise of Powers Agreement entered into by the City of Cotati, City of Rohnert Park, City of Santa Rosa, County of Sonoma, Gold Ridge Resource Conservation District, Sonoma County Water Agency, Sonoma Resource Conservation District, and Town of Windsor, each of which is a local agency as defined by SGMA, within the Santa Rosa Plain ("Basin") which is designated basin number 1-55.01 in Department of Water Resources Bulletin No. 118 and which is designated as a medium priority basin; and

WHEREAS, the Agency's jurisdiction covers the full geographical area of the Basin; and

WHEREAS, the purpose of the Agency is to serve as the GSA for the Santa Rosa Plain to comply with SGMA; and

WHEREAS, SGMA requires that the Basin have a designated GSA by no later than June 30, 2017; and

WHEREAS, the Agency is committed to sustainable management of the Basin's groundwater resources; and

WHEREAS, notice of a public hearing on the Agency's decision to become a GSA for the Basin has been published in in the Santa Rosa Press Democrat (on May 17, 24, and 28, 2017) as required by Water Code section 10723 and Government Code section 6066; and

WHEREAS, on this day, the Agency held a public hearing to receive public comment and consider the decision to become the GSA for the Basin in accordance with Water Code section 10723; and

WHEREAS, it would be in the best interest of the Basin for the Agency to become the GSA for the Basin, and to begin the process of preparing a GSP for the Basin; and

WHEREAS, the Agency's process to develop the GSP for the Basin will include stakeholder outreach and input and will provide multiple opportunities for public involvement;

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of the SANTA ROSA PLAIN GROUNDWATER SUSTAINABILITY AGENCY, as follows:

1. All recitals are true and correct.

2. The Agency hereby elects to be the GSA for the Basin.

3. The Agency's Interim Administrator is directed file the GSA Formation Notification, along with required supporting documentation, with the California Department of Water Resources, no later than June 30, 2017.

PASSED, APPROVED AND ADOPTED this day, June 1, 2017, by the following vote:

DIRECTORS:

Dutton: _____ Harvey: _____ Hopkins: _____ Millan: _____ Ryan: _____

Schwedhelm: _____ Stafford: _____ Zane: _____

VOTES:

Ayes: ____ Noes: ____ Absent: ____ Abstain: ____

By:

Chairperson Santa Rosa Plain Groundwater Sustainability Agency	Brittany Jensen Date: Interim Administrator

WHEREAS, notice of a public hearing on the Agency's decision to become a GSA for the Basin has been published in in the Santa Rosa Press Democrat (on May 17, 24, and 28, 2017) as required by Water Code section 10723 and Government Code section 6066; and

WHEREAS, on this day, the Agency held a public hearing to receive public comment and consider the decision to become the GSA for the Basin in accordance with Water Code section 10723; and

WHEREAS, it would be in the best interest of the Basin for the Agency to become the GSA for the Basin, and to begin the process of preparing a GSP for the Basin; and

WHEREAS, the Agency's process to develop the GSP for the Basin will include stakeholder outreach and input and will provide multiple opportunities for public involvement;

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of the SANTA ROSA PLAIN GROUNDWATER SUSTAINABILITY AGENCY, as follows:

1. All recitals are true and correct.

2. The Agency hereby elects to be the GSA for the Basin.

3. The Agency's Interim Administrator is directed file the GSA Formation Notification, along with required supporting documentation, with the California Department of Water Resources, no later than June 30, 2017.

PASSED, APPROVED AND ADOPTED this day, June 1, 2017, by the following vote:

DIRECTORS:

Dutton: _____ Harvey: _____ Hopkins: _____ Millan: _____ Ryan: _____

Schwedhelm: _____ Stafford: _____ Zane: _____

VOTES:

Ayes: 8 Noes: 0 Absent: 0 Abstain: 0

By:

Chairperson Santa Rosa Plain Groundwater Sustainability Agency	Brittany Jensen Date: Interim Administrator

Appendix 1-C
Santa Rosa Plain Groundwater Sustainability Agency
Board and Advisory Committee Members

Appendix 1-B

Santa Rosa Plain GSA Board and Advisory Committee Members

Santa Rosa Plain Board Members		
Name	**Represents**	**Time Served**
Tom Schwedhelm, Chair	City of Santa Rosa	June 2017-Current
Susan Harvey, Vice-Chair	City of Cotati	June 2017-Current
Joe Dutton	Gold Ridge Resource Conservation District	June 2017-Current
Lynda Hopkins	Sonoma County Water Agency	June 2017-Current
Evan Jacobs	Independent Water Systems	Nov 2017-Current
Sam Salmon	Town of Windsor	January 2021-Current
John Nagle	Sonoma Resource Conservation District	Feb 2018-Current*
Pam Stafford	City of Rohnert Park	June 2017-Current*
Patrick Slayter	City of Sebastopol	December 2020-Current
Chris Coursey	County of Sonoma	January 2021-Current
Past Board Members		
Gina Belforte	City of Rohnert Park	June 2017-June 2018
Michael Carnacchi	City of Sebastopol	Aug 2019-Dec 2020
Debora Fudge	Town of Windsor	Jan 2019-Dec 2020
Mark Millan	Town of Windsor	June 2017-Dec 2018
Walt Ryan	Sonoma Resource Conservation District	June 2017-Aug 2021
Shirlee Zane	County of Sonoma	June 2017-Dec 2020

*The Rohnert Park and Sonoma RCD appointees served as Board members or alternates.

Santa Rosa Plain GSA Advisory Committee Members		
Name	**Represents**	**Time Served**
Bob Anderson, Chair	Agricultural Interests	Oct 2017-Current
Rue Furch, Vice-Chair	Environmental Interests	Oct 2017-Current
Elizabeth Cargay	Town of Windsor	March 2021- Current
Carolyn Dixon	Sonoma County Water Agency	Oct 2017-Current
Joe Gaffney	City of Sebastopol	June 2021-Current
Maureen Geary	Graton Rancheria	Oct 2017-Current
Mark Grismer	County of Sonoma	Oct 2017-Current
Wayne Haydon	Sonoma Resource Conservation District	Oct 2017-Current
Beth Lamb	Environmental Interests	February 2020-Current
David Long	Agricultural Interests	Oct 2017 -Current
Peter Martin	City of Santa Rosa	March 2020-Current
David Noren	Rural Residential Well Owners	April 2020-Current
Matt O'Conner	Gold Ridge Resource Conservation District	Oct 2017-Current
Mary Grace Pawson	City of Rohnert Park	Oct 2017-Current
John Rosenblum	Independent Water Systems	Jan 2019-Current
Craig Scott	City of Cotati	Oct 2017-Current
Marlene Soiland	Rural Residential Well Owners	Oct 2017-Current

Past Advisory Committee Members		
Chris Bates	Independent Water Systems	Oct 2017-Dec 2018
Jennifer Burke	City of Santa Rosa	Oct 2017-Jan 2019
Sebastian Bertsch	Environmental Interests	Oct 2017-Dec 2019
Colin Close	City of Santa Rosa	Oct 2017-Jan 2019
Doug Berretta	Agricultural representative	Oct 2017-Dec 2019
Joe Gaffney	Business Interests	Oct 2017-June 2021
Henry Mikus	City of Sebastopol	Oct 2017-Nov 2020
Sandi Potter	Town of Windsor	Oct 2017-Feb2021

Appendix 1-D
Santa Rosa Plain Groundwater Sustainability Agency
Advisory Committee Charter

Santa Rosa Plain Groundwater Sustainability Agency
Advisory Committee Charter

Adopted by consensus – January 8, 2018
Amended by consensus – May 7, 2018

The purpose of the Advisory Committee is to advise the Santa Rosa Plain Groundwater Sustainability Agency ("SRPGSA" or "Agency") Board of Directors ("Board") on groundwater sustainability plan development and implementation, and on Agency policies. The intent of the Committee is to provide community perspective and participation to the Agency. The Committee will make recommendations that the SRPGSA Board will consider in its decision-making.

The Advisory Committee may review or provide recommendations to the Board on groundwater-related issues:

- Development, adoption, or amendment of the groundwater sustainability plan
- Sustainability goals and objectives
- Technical and reporting standards, including best management practices, data management and reporting
- Monitoring programs
- Annual work plans and reports (including mandatory 5-year milestone reports)
- Modeling scenarios
- Inter-basin coordination activities
- Project and management actions to achieve sustainability
- Grant funding proposals
- Community outreach
- Local regulations to implement SGMA
- Fee proposals
- General advisory in response to Board inquiries

The Advisory Committee will not be involved in Agency budgets or day-to-day operations, such as personnel staffing or contracting.

Brown Act, Open Process, and Conflicts of Interest

All meetings of the Advisory Committee are open to the public. The Agency will announce Committee meetings on its web site and through its regular communication channels.

Advisory Committee meetings are subject to the Brown Act. The Advisory Committee shall adopt a schedule and location for regular meetings, and meeting agendas shall be posted in accordance with the Brown Act.

All Advisory Committee meetings shall provide for public comment in accordance with the Brown Act, including non-agenda public comment and public comment on individual agenda items. Speakers will generally be limited to 2 minutes, but time may be adjusted based upon meeting circumstances. As needed, time limits may be placed on public comments to ensure the Advisory Committee is reasonably able to address all agenda items during the course of the meeting. Special and emergency meetings need not provide for non-agenda public comment,

but such comment may be allowed in the Advisory Committee's discretion. Members of the Advisory Committee are subject to all applicable conflict of interest laws including Government Code section 1090 and the California Political Reform Act. The Board shall adopt a conflict of interest code for the Advisory Committee.

Roles and Responsibilities

Advisory Committee

The role and responsibility of the Advisory Committee is to solicit and incorporate community and stakeholder interests into recommendations on SGMA implementation in the Santa Rosa Plain Groundwater Basin for the Board to consider in its decision-making process. The Advisory Committee will also, to the best of its ability, integrate

in the Santa Rosa Plain.

Advisory Committee members ("members") reflect the diverse interests of local public agencies and groundwater users. The criteria for Advisory Committee members are to:

- Serve as a strong, effective advocate for the interest group represented
- Work collaboratively with each other
- Commit time needed for ongoing discussions
- Collectively reflect diversity of interests

As part of membership, members agree to:

- Arrive at each meeting fully prepared to discuss the issues on the agenda. Preparation may include reviewing meeting summaries, technical information, and draft documents distributed in advance of each meeting.
- Present their constituent members' views on the issues being discussed and be willing to engage in respectful, constructive dialogue with other members of the group.
- Develop a problem-solving approach in which they consider the interests and viewpoints of all group members, in addition to their own.
- Keep their constituencies informed about the deliberations and actively seek their constituents' input.

Chair

The Advisory Committee will appoint a chair and vice-chair. The chair for the Advisory Committee agrees to:

- Work with the Agency Administrator and facilitator to develop the agenda for all Advisory Committee meetings.
- Assist in framing issues so members are able to have a productive conversation and develop recommendations.
- Brief the Board on the nature and progress of the committee at key milestones, and on recommendations from the Advisory Committee.
- Serve as the Advisory Committee media spokesperson in cooperation with the Agency communications lead.

Administrator

- Maintain a current roster of Advisory Committee members.
- Work with GSA Board to fill Advisory Committee vacancies, as needed.
- In coordination with the facilitator and Advisory Committee chair, prepare agendas for

Advisory Committee meetings.
- Notice all meetings in accordance with the Brown Act.
- Staff all meetings, record minutes and develop and distribute meeting summaries.
- Work with the committee and GSA Board to develop annual workplan and schedule for Advisory Committee meetings.
- Facilitate the process of incorporating Advisory Committee recommendations into Board packets.
- Provide options and ensure records for AC 1234 Ethics Training and Brown Act Training for Advisory Committee members.

Facilitator

As resources allow, a third-party facilitator may provide impartial facilitation services for Advisory Committee meetings. The facilitator's primary responsibility is to ensure an open process where all member interests are heard and thoughtfully considered. To this end, the facilitator works on behalf of the process and the members contributing to Advisory Committee efforts. Specific responsibilities include:

- Support the Agency Administrator and Advisory Committee Chair and/or Vice Chair in developing and distributing Advisory Committee agendas and relevant materials.
- Advocate for a fair, effective, and credible process, but remain impartial with respect to the outcome of the deliberations.
- Apply collaborative, interest-based negotiation methods that foster openness and identify areas of preliminary and final consensus agreement for advice and recommendations to the Board.
- In the absence of consensus, help identify areas of agreement and disagreement.
- Check in with members as needed to ensure all issues are identified and explored.
- Coordinate with the Agency Administrator and Chair or Vice Chair to ensure accurate, impartial documentation of meetings and agreements (i.e. meeting summaries and recommendation reports).
- Ensure all members uphold the tenets of the charter.

Decision-Making

To inform SRPGSA Board decision-making, the Advisory Committee will provide written recommendations in reports that reflect the outcome of Advisory Committee recommendations or decisions. The recommendation reports will reflect all of the opinions of committee members, and will identify areas of agreement and disagreement. The Committee may request that one or more Advisory Committee members present its recommendations to the Board, including areas of agreement and disagreement, consistent with Advisory Committee deliberations. The SRPGSA Board will consider Advisory Committee recommendations when making decisions. If the Board does not agree with the recommendations of the Advisory Committee, the Board shall state the reasons for its final decision.

The Advisory Committee will strive for consensus (agreement among all members) in all of its decision-making. Working toward consensus is a fundamental principle. Consensus means that all Advisory Committee members either fully support or can live with a recommendation. In reaching consensus, some Advisory Committee members may strongly endorse a particular proposal while others may accept it as "workable." Others may be only able to "live with it." Still others may choose to "stand aside" by verbally noting a disagreement, yet allowing all other

members of the group to reach a consensus without them if the recommendation does not affect them or compromise their interests. Any of these actions constitutes consensus.

Any Advisory Committee member or members that disagree with a recommendation must provide an alternative that attempts to meet his/her interests while also meeting the interests of other members. The Advisory Committee will strive for consensus, but shall not limit itself to strict consensus if 100% agreement among all participants cannot be reached after all interests and options have been thoroughly identified, explored, and discussed. Less-than-consensus recommendation-making shall not be undertaken lightly. When unable to reach consensus on advice or recommendations, the Committee will outline the areas in which it does not agree, providing some explanation of both majority and minority viewpoints in its recommendation reports that inform Board decision-making. When outlining areas in which the Advisory Committee does not agree, numbers of votes on any items will also be clearly recorded and presented to the Board.

In order to hold a meeting and conduct business (e.g. make and advance a recommendation to the Board), a quorum of the Advisory Committee must be present. A simple majority of the total number of filled Advisory Committee member seats constitutes a quorum.

From time to time, members may be unable to attend Advisory Committee meetings. In order to continue to run efficient meetings and make recommendations or decisions timely, each member may choose to submit a proxy to weigh in on recommendations or decisions that are noticed on the agenda. Members must submit proxies to the Agency Administrator, but may designate either the Agency Administrator or another committee member to carry the proxy. Proxies carried by other members may allow the member carrying the proxy the latitude to weigh in for the absent member (i.e. the absent member fully supports, can live with or does not support, or is willing to stand aside) on recommendations or decisions should the substance of said recommendations or decisions change during the course of the meeting. All proxies shall be in writing and must be received by the Agency Administrator before the start of the meeting; this includes noting in writing when a committee member holding a proxy of another member has the latitude to weigh in for that member on recommendations or decisions that change during the course of the meeting. Any submitted proxies will be announced the outset of the meeting.

Subcommittees

The Advisory Committee can form ad hoc subcommittees or workgroups to assist with its charge advising the SRPGSA Board on groundwater sustainability plan development and implementation, and on Agency policies. Subcommittee or workgroup composition should be representative of diverse groundwater interests.

On an as needed basis, and in coordination with GSA staff, the facilitator, and Advisory Committee members, the chair will call for, solicit interested committee member participation, and affirm establishment of ad hoc workgroups. The number of members on any ad hoc workgroup will generally be limited to five to ensure manageable group size and efficiency of work effort. If strong interest is expressed by committee members, the maximum number will be eight. Upon establishment, the chair will generally define the scope and expected duration of any ad hoc workgroup. As needed, the chair may adjust the scope and extend the duration of

any workgroup. GSA staff, facilitators and technical experts will provide assistance to ad hoc workgroups as needed. A simple summary will be prepared for any ad hoc workgroup meeting that takes place. The summary will memorialize the date of the meeting, who attended, and topics discussed. Ad hoc workgroups will not provide advice or recommendations directly to the SRPGSA Board. Rather, ad hoc workgroup products will be presented to the full Advisory Committee for consideration. Ad hoc workgroups will abide by the Advisory Committee's ground rules.

Membership

Composition of the Advisory Committee is intended to reflect the beneficial uses and users of groundwater in the Santa Rosa Plain. Established by the Board, the Advisory Committee consists of eighteen members that represent the following member agency designations and interest groups:

- Nine at-large members, one appointed by each SRPGSA member agency.
- Two at-large members from SRPGSA member agencies that have chosen not to participate on the Board
- Seven interest-based appointees appointed by the SRPGSA Board:
    - Two environmental representatives
    - Two rural residential well owners
    - One business community representative
    - Two agricultural interests (surface water or groundwater user)

Advisory Committee members may not serve concurrently on the SRPGSA governing board.

Members must live or work within or represent an organization with a presence in the Santa Rosa Plain Groundwater Basin, identified by the Department of Water Resources current Bulletin 118. The Board will determine if alternates are necessary, and if so, the appointment process.

Advisory Committee members serve without compensation.

Selection and Appointment Process

The Board maintains an interested parties list, develops and oversees an application process, and make appointments to the Advisory Committee following member terms outlined below.

At-Large Seats

Each SRPGSA member agency's governing body will appoint its at-large seat. Member agencies will notify the Administrator in writing in the event the agency needs to change its appointed member.

Interest-Based Seats

Interested individuals from the community or local organizations may apply to the Board, designating in the application the seat that the applicant would intend to fill. The SRPGSA Board encourages interest groups to work together to recommend a single candidate to fill that interest's seat. The Board will give strong consideration to appointing candidates that have the backing of multiple organizations or individuals within that interest group and familiarity with

groundwater and its management. The Board will also give preference to applicants with experience working with diverse community-based groups.

For the interest-based community representatives, the Board will give strong preference to representatives who live or work within a Disadvantaged Community (as defined in SGMA) and will in any case give preference to appointees that can represent the interests of disadvantaged populations or interests that are otherwise under-represented on the Advisory Committee.

The Board may modify by supermajority vote the composition and number of Advisory Committee members. The Board can remove an interest-based committee member by majority vote if the member is not performing his or her responsibilities.

Terms
The initial Advisory Committee appointments will include seven seats with three-year terms (interest-based categories) ending in December 2020 and 11 two-year terms (at-large) ending in December 2019. Following initial Committee appointment, all terms will be two years and end in December. Appointees are not term-limited; however, members must apply for each term. If a vacancy occurs for an interest-based seat before the end of the term, the Board will appoint a new individual to complete the term. The appointing Member shall fill at-large vacancies.

To ensure continuity and broad participation at Advisory Committee meetings, members may, but are not required to, use alternates on an as-needed basis. Alternates serve the same role as members when members are absent, including serving as a proxy for members during committee deliberations. Any member who cannot attend a meeting must ensure that his/her alternate is adequately briefed on relevant issues and prepared to participate, offer advice and make any recommendations on his/her behalf. Alternates are expected to be fully prepared to discuss agenda items and participate in committee decisions and recommendations. No items addressed at previous meetings will be revisited to accommodate an alternate. Only the member participates at a given meeting if both the member and the alternate are present.

Alternates (Note: Use of alternates is still pending Board approval)
Selection of alternates will align with the Board's prior process for selecting and appointing advisory committee members (described above). Each member agency will self-select its primary member and alternate. For interest-based members, the Board will open a solicitation process for alternates. Any interest-based members who wish to use an alternate will inform the GSA Administrator of such interest, and, further, notify the Administrator when a prospective alternate has been identified. In alignment with the Board appointment process, prospective interest-based alternates, like the member him/herself, will apply and be subject to appointment by the Board. The prospective alternate will designate in the application the seat and specific individual member for which the person will serve as an alternate. Any alternate application will include a letter of support from the primary member for which the individual will serve as an alternate.

The Board will give strong consideration to appointing alternates that have the backing of multiple organizations or individuals within an interest group, and familiarity with groundwater and its management. The Board will also give preference to applicants with experience working with diverse community-based groups, or applicants that can represent the interests of Disadvantaged Communities (as defined by SGMA). Like the advisory committee members,

alternates must live, work or represent an organization with a presence in the basin. One alternate may live outside the basin and within the watershed.

Process Agreements and Ground Rules

To conduct a successful collaborative process, the facilitator and all Advisory Committee members will work together to create a constructive, problem solving environment. To this end, all members agree to the following process agreements which the Committee will use, and to ground rules which will guide individual and group behavior.

Process Agreements

- ✓ **Everyone agrees to negotiate in good faith.** All participants agree to participate in decision making, to act in good faith in all aspects of this effort and to communicate their interests during meetings. Good faith also requires that members not make commitments they do not intend to follow through with, and that members act consistently in the meetings and in other forums where the issues under discussion in these meetings are also being discussed.

- ✓ **Everyone agrees to address the issues and concerns of the participants.** Everyone who is joining in the Advisory Committee is doing so because s/he has a stake in the issue at hand. For the process to be successful, all the members agree to validate the issues and concerns of the other members and strive to reach an agreement that takes all the issues under consideration. Disagreements will be viewed as problems to be solved, rather than battles to be won.

- ✓ **Everyone agrees to inform and seek input from their constituents about the outcome of the facilitated discussions.** To the extent possible, scheduling will allow for members to inform and seek input from their constituents, scientific advisors, and others about discussions.

- ✓ **Everyone agrees that members can meet with other organizational or interest group members.** Advisory Committee members may find it helpful to meet with other organizations or interest group members and to consult with constituents outside of the meeting so the member is better able to communicate community concerns on the issues at hand.

- ✓ **Everyone agrees to attend all the meetings to the extent possible.** Continuity of the conversations and building trust are critical to the success of the Advisory Committee. Members are encouraged to turn off cell phones and focus on the issue at hand. Agency staff or the facilitator will coordinate the meeting schedule.

Ground Rules

Use Common Conversational Courtesy

Treat each other with mutual respect as you discuss and deliberate groundwater issues.

All Ideas and Points of View Have Value

All ideas have value in this setting. We are looking for innovative ideas. The goal is to achieve understanding. Simply listen, you do not have to agree. If you hear something

you do not agree with or you think is "silly" or "wrong," please remember that the purpose of the forum is to share ideas.

Be Honest, Fair, and as Candid as Possible
Put your interests forward, help others understand you and listen actively in order to understand others.

Avoid Editorials
It will be tempting to analyze the motives of others or offer editorial comments. Please talk about *your own* ideas and thoughts. Avoid commenting on why you believe another participant thinks something.

Honor Time, Be Concise and Share the Air
Help ensure an inclusive discussion by being cognizant of time constraints, stating your views clearly and concisely, and sharing the air so others can participate as well.

Think Innovatively and Welcome New Ideas
Creative thinking and problem solving are essential to success. “Climb out of the box” and attempt to think about the problem in a new way.

Invite Humor and Good Will
Don’t hesitate to bring levity and humor to the process when warranted, as this often helps collaborative discussions.

Be Comfortable
Please feel help yourself to refreshments or take personal breaks. If you have other needs please inform the facilitator.

Be Engaged
Please turn off (or place on vibrate mode) your cell phones and other mobile devices. If you must take a call or check emails, please take a personal break outside.

Communication

Media
Members are asked to speak only for their organization or themselves when asked by external parties, including the media, about the Advisory Committee’s progress, unless there has been a formal adoption of a statement, concepts, or recommendations by the Advisory Committee. Members will refer media inquiries to the Agency communications lead and reserve freedom to express their own opinions to media representatives. Members should be careful to present only their own views and not those of other participants. The temptation to discuss someone else’s statements or position should be avoided. The Agency communications lead may refer media to the Advisory Committee Chair to speak on behalf of the Advisory Committee as needed.

Amendments

The Advisory Committee can recommend and adopt future changes to the charter. Suggested changes may be put forward by the Committee members, the facilitator or the Administrator. The Advisory Committee will utilize its decision-making procedure to adopt changes to the charter. In the absence of consensus on suggested changes to the charter amendments, majority and minority views will be communicated to the Board, and the Board will have final decision making authority on charter content.

Appendix 1-E
Santa Rosa Plain Groundwater Sustainability Agency
Advisory Committee Meetings 2017-2021

Santa Rosa Plain Groundwater Sustainability Agency Meetings 2017-2021

https://santarosaplaingroundwater.org/meetings/

SANTA ROSA PLAIN BOARD	SANTA ROSA PLAIN ADVISORY COMMITTEE
June 1, 2017	October 30, 2017
August 10, 2017	December 4, 2017
November 20, 2017	January 8, 2018
February 8, 2018	February 12, 2018
April 12, 2018	April 9, 2018
June 14, 2018	May 7, 2018
August 9, 2018	June 11, 2018
October 11, 2018	September 10, 2018
December 13, 2018	November 5, 2018
March 14, 2019	January 14, 2019
April 11, 2018	March 11, 2019
June 13, 2019	May 13, 2019
August 8, 2019	July 8, 2019
October 10 – Cancelled, due to power shut down	September 9, 2019
December 12, 2019	November 18, 2019
February 13, 2020	January 13, 2020
April 9, 2020	March 9, 2020
June 11, 2020	May 11, 2020
August 13, 2020	June 22, 2020
October 8, 2020	July 13, 2020
October 29, 2020	September 14, 2020
December 10, 2020	October 19, 2020
January 28, 2021	November 9, 2020
February 11, 2021	January 11, 2021
March 11, 2021	February 8, 2021
April 8, 2021	March 8, 2021
June 10, 2021	March 29, 2021
August 12, 2021	May 10, 2021
September 30, 2021	July 12, 2021
October 14, 2021*	September 13, 2021
December 9, 2021*	November 8, 2021*

**Calendared*

Appendix 1-F
Community Engagement Plan for Development and Adoption of a Groundwater Sustainability Plan
Santa Rosa Plain Groundwater Sustainability Agency

Community Engagement Plan

for Development and Adoption of a Groundwater Sustainability Plan
Santa Rosa Plain Groundwater Sustainability Agency

January 2018

Purpose, Outcomes & Goals

The purpose of the Sustainable Groundwater Management Act (SGMA), signed by Governor Brown in 2014, is to ensure local sustainable groundwater management in medium- and high-priority groundwater basins statewide. **California's Department of Water Resources has determined that Sonoma County has three medium priority basins that are subject to SGMA Implementation:**

- Petaluma Valley basin
- Santa Rosa Plain subbasin
- Sonoma Valley subbasin

This draft Community Engagement Plan applies only to the Santa Rosa Plain Groundwater Sustainability Agency, although many outreach activities will be coordinated with the other basins.

SGMA Milestones: The Santa Rosa Plain basin achieved the first milestone in SGMA by creating a Groundwater Sustainability Agency (GSA) by June 30, 2017. The second major milestone in the SGMA is the adoption of a Groundwater Sustainability Plan (GSP) by January 30, 2022. The GSP is prescribed by SGMA and contains required elements. The third milestone is achieving sustainability by 2042.

Several key steps must be taken to ensure that the Groundwater Sustainability Plan is adopted, including:

- Adoption and implementation of a financing plan that will allow the Santa Rosa Plain GSA to be financially independent;
- Development, drafting and vetting of specific elements within the GSP;
- Compilation, vetting and final drafting of the GSP as a whole.

Outcomes: The desired outcome for this communication and outreach plan is to achieve adoption of the GSP with input from and in consideration of Sonoma County's diverse people, economy and ecosystems. As the GSA gets closer to completion of the GSP, a new community engagement plan will be developed to address implementation issues.

Plan Goals: SGMA requires the GSA to consider the interests of all beneficial uses and users of groundwater, and encourage involvement of diverse social, cultural, and economic elements of the population within the Basin during GSP preparation and implementation. The goals of the Community Engagement Plan are to:

- Enhance understanding and inform the public about water and groundwater resources in the Santa Rosa Plain, the purpose and need for sustainable groundwater

management, the benefits of sustainable groundwater management and the need for a GSP.
- Engage a diverse group of interested parties and stakeholders and promote informed feedback from stakeholders, the community and groundwater-dependent users throughout the GSP preparation and implementation process.
- Reach out to and engage disadvantaged communities throughout the rate/fee study and GSP preparation process.
- Coordinate communication and involvement between the GSA (Board, Advisory Committee and staff), and other local agencies (including other GSAs), elected and appointed officials, and the general public.
- Utilize the GSA Advisory Committee to facilitate a comprehensive public engagement process.
- Employ a variety of outreach methods that make public participation easy and accessible. Hold meetings at times and venues that encourage broad participation.
- Respond to public concerns and provide accurate and up-to-date information.
- Manage the community engagement program in a manner that provides maximum value to the public and an efficient use of GSA and local agency resources.

Time Period: The Plan is intended to cover communication and outreach for January 2018-January 2022, when the GSP is due to be submitted to California Department of Water Resources. Because this is a multi-year project and plan, the key activities needed to achieve these goals will be broken down into annual work plans, and may be amended in response to community needs.

Interested Parties and other stakeholders: SGMA lists interested parties who the GSA must consider when developing and implementing the GSP, including:
- Agricultural users of water
- Domestic well owners
- Municipal well operators
- Public water systems
- Land use planning agencies
- Environmental users of groundwater
- Surface water users
- The federal government
- California Native American tribes
- Disadvantaged communities (including those served by private domestic wells or small community water systems).

See Appendix A for a list of the interested parties in Santa Rosa Plain. Representatives of most of the interested parties are included on the GSA Board or Advisory Committee.

Other stakeholders can also be impacted by decisions made by the GSA, including businesses, schools, land stewardship organizations, and state government agencies. **See Appendix B** for a listing of additional stakeholders that will be considered and solicited for feedback during development of the GSP.

Outreach Roles

The **GSA Board**, which is comprised of elected and appointed officials, will make the ultimate decisions on financing options and on the GSP. As required by the Joint Powers Authority agreement that created the GSA, the Board will consider the recommendations of the Advisory Committee.

In regard to outreach, the Board is responsible for:

- Adopting and overseeing implementation of the Community Engagement Plan;
- Receiving public comments made verbally and in writing;
- Considering the recommendations of the Advisory Committee.

In addition, the Board may choose to play a more active role in outreach through communication with the public, stakeholder groups, and the entities it represents.

The **Advisory Committee,** which is comprised of members appointed by the GSA Board, , representatives of entities that comprise the GSA, and representatives of eligible entities not part of the GSA, will become familiar with financing options and issues related to the GSP. The Advisory Committee is charged with actively engaging with the public for input and feedback. This charge will be carried out through various mediums and a variety of activities, but generally includes:

- Advising staff in the drafting of the Community Engagement Plan;
- Actively seeking input from the represented stakeholder groups on issues before the GSA;
- Sharing input and feedback with the full Advisory Committee meeting; and
- Making recommendations to the Board.

The Santa Rosa Plain GSA Board, the Santa Rosa Plain GSA Advisory Committee, and staff are committed to keeping the **public informed**, providing the public with **balanced and objective information** to assist the public in understanding SGMA, available options and recommendations, and **creating an open process** for public input on the development and implementation of the GSP.

When evaluating the options and making decisions, the Board, Advisory Committee and staff will **solicit public input** through a variety of methods, including public workshops, written and verbal comments, meetings with stakeholder organizations and community events (see Attachment A for Year One examples). Input can be made during public comment periods at Advisory Committee and Board meetings, and in writing. Comments made in writing can be submitted to Brittany@goldridgercd.org.

True engagement requires policymakers and the public to not only talk, but to also listen. The Santa Rosa Plain GSA asks all participants – whatever their role – to follow these rules of engagement:

- Be a good listener. Listen to what is being said; find out why it is being said.
- Be respectful to all participants.

Community Engagement Plan

To truly engage the public in development of a GSP that is science-based, complex, technical, and includes achievable outcomes, the GSA will strive to meet these overall objectives:

- Educate the public in compelling ways. Communicate what may often be complex concepts in simple and compelling ways with graphics and examples.
- Manage expectations. Avoid "anything goes" meetings that might pursue unrealistic and unpractical approaches.
- Show how the input received has been incorporated into the plan or process. Demonstrating to the public how their ideas have been reflected in the plan or planning process is an important piece to the puzzle.
- Remain focused on results. Understand objectives of each public meeting and facilitate the achievement of those objectives.

The Community Engagement Plan is comprised of two categories of activities a: Ongoing and project- or program-specific.

Ongoing activities are the "housekeeping" tasks of the GSA outreach, including website maintenance and updates, monthly blogs to the interested parties list, expansion and maintenance of the interested parties list, updating fact sheets and FAQs, posting Board and Advisory Committee meetings and materials and issuing press releases about meetings.

Project or program-specific engagement activities are developed to meet the outreach goals of each project or program.

In Year One (July 1, 2017- June 30, 2018), the GSA Board must hire legal counsel (completed); hire rate/fee consultants (completed); apply for Proposition 1 GSP funding grant (underway); adopt various documents including bylaws and a Community Engagement Plan; initiate the first steps in developing the GSP; determine whether to request basin boundary modifications; and determine a short-term mechanism for funding the GSA. The initiation of the GSP and the rate/fee study are projects that require robust community engagement, using the tools described in the Communication Forums and Tools section, below. Attachment A provides a detailed table of Year One engagement activities, including timeframes and key roles.

In Years Two through Five (July 1, 2018-January 31, 2022), program specific engagement activities will be focused on development of GSP plan elements. The GSP will be prepared iteratively and in a logical progression, building on previously developed technical and policy information. Throughout the process of preparing the GSP, background materials along with draft text, figures and tables for each section will be provided to the GSA member agency staff, Advisory Committee, the GSA Board and the public in advance of meetings for input and comment. The Advisory Committee, public and Board will have opportunities to comment on each element, before the element is ultimately adopted by the Board.

It is anticipated that the GSP will be developed in six phases:

1. Preparation and submittal of initial notification of GSP preparation (Year One)
2. Definition of plan area and basin setting (Year Two)

3. Development of sustainable management criteria, including the sustainability goal, undesirable results, minimum thresholds, measurable objectives and interim milestones. (Years Two and Three)
4. Design of monitoring program and data management system. (Year Three)
5. Identification and evaluation of proposed projects and management actions (Years Four and Five)
6. Development of GSP implementation costs, detailed schedule, and reporting Year Five)

Each phase requires robust outreach with the goal of educating and engaging the general public, stakeholders, the Advisory Committee and Board on the technical and policy aspects of the GSP plan elements. Each phase will include a mix of communication tools, to be used in a variety of forums. Public hearings will be held at the end of each phase.

Every March, staff will work with the Advisory Committee to develop an Activities Plan for the upcoming fiscal year (beginning on July 1), incorporating tools and techniques that worked well in previous years and modifying or eliminating tools that failed to engage people.

Communication Forums & Tools

Governance Agencies Briefings
Board members may brief their councils or boards regularly on GSA activities and may work with GSA staff to provide additional briefings on sensitive or important topics.

In Year One, the goal is to brief member agencies about the initiation of the GSP and the rate/fee study in January and about proposed rate/fee options in April. The purpose of the briefings is to inform boards and councils about the purpose of the GSP and the rate/fee study; the necessity and timing of the rate/fee study; and to get feedback on proposed rate/fee options.

Stakeholder Briefings
Advisory Committee members will meet with and communicate regularly with organizations comprised of the stakeholder groups they represent. To avoid overlap and mixed messages, all briefings will be coordinated with outreach staff. Many stakeholder groups were interviewed in 2015, during SGMA initial stakeholder outreach. The Stakeholder Assessment can be found online at www.sonomacountygroundwater.org.

Disadvantaged Community Engagement – Community Events & Using Existing Venues
Disadvantaged Communities (DACs) are specifically called out in SGMA as an interested party. Thirty-six percent of the area in the Santa Rosa Plain Basin is designated an Economically Distressed Area, and 24 percent of the area in the basin is categorized as a DAC. A large percent of the people living in the DAC areas are relatively recent immigrants from Spanish-speaking and Asian countries.

Previous assessments of engaging Sonoma County's Spanish speaking community recommend using "food, faith and festivals" as opportunities to educate and interact with

people on critical issues. Connecting with communities through existing organizations and through community events, churches and schools, provides an opportunity share information and solicit feedback on rate/fee options and GSP elements

Public Meetings/Hearing

Public meetings or hearings are formal opportunities for people to provide official comments on programs, plans and proposals. SGMA requires that a public meeting be held prior to the adoption of a fee and that public hearings are held for the adoption of GSP elements and the final GSP plan. There are also constitutional requirements for public hearings for some fee/rate options. Public meetings and hearings are an important forum for people to share viewpoints and concerns, but often occur at the end of a process, when only one option is under consideration. The GSA will hold required public meetings and hearings, but will also use less formal public workshops (described below) to solicit feedback and information early in the process.

Public Workshops

Public educational workshops provide less formal opportunities for people to learn about groundwater, SGMA, financing options, and GSP elements. Workshops can be organized in a variety of ways, including open houses, "stations" where people can ask questions one-on-one, world cafes and traditional presentations with facilitated question and answer sessions. In order to solicit feedback from people who may not be comfortable speaking in public, workshops can include small group breakout discussions, "dot" voting, comment cards and other techniques. Whatever format is used, workshops will be designed to maximize opportunities for public input.

A workshop will be held in the spring of Year One (2018) to describe and solicit feedback on fee/rate options. Workshops will also be held as GSP elements are being developed.

Public Notices

In addition to the public notice required for fee adoption, SGMA requires that prior to initiating the development of a GSP, the GSA must provide a written statement describing the manner in which interested parties may participate in the development and implementation of the GSP. The statement must be provided to all the cities within the basin and to the County of Sonoma.

As outlined in this Community Engagement Plan, there will be a variety of opportunities for people to participate in the development and implementation of the GSP, including workshops, public hearings, providing comments at Board and Advisory Committee meetings and through written comments. In early 2018, staff and legal counsel will develop a written statement for public participation.

Specific tools will be used to inform and engage people, including:

Interested Persons List

SGMA mandates the creation of an interested persons list. SGMA does not specify the type of list (email versus hard copy). The first preference is an email list, to get information out quickly and to reduce costs. A secondary list will be developed for people who don't use email. Board members (and the agencies they represent), Advisory Committee members and

staff can contribute names of organizations, agencies, and individuals to the list. Whenever new inquiries are made the people making the inquiry will be added to the list. The Santa Rosa Plain Groundwater Basin Advisory Panel lists will also be utilized.

The list is broad and includes anyone who would like to stay informed about SGMA activities and anyone the Board and Advisory Committee thinks should be informed about GSP process and the outcome of the planning effort. Outreach staff will send out monthly updates to the Interested Persons list. This list will also be used for dissemination of information on public workshops, public meetings, etc.

Informational Materials
Developing a variety of informational materials is critical to successful education and necessary to circulate consistent, accurate information. Outreach staff, with the input of the administrator, plan manager and the Advisory Committee, will develop a range of materials, including at least the following:

Periodic Updates
- **Talking Points:** Clear, concise messages to be used by Board and Advisory Committee members and staff when communicating with media, organizations and stakeholders.
- **Milestone Fact Sheets:** For initiating the GSP, the rate/fee study and completion of elements of the GSP.
- **Newsletter Articles:** A short paragraph (50-100 words) that Advisory Committee members can insert into organizational newsletters. These brief articles can also be published in the Sonoma County Water Agency's e-newsletter, which has a broad distribution.
- **Newspaper editorials:** Authored by Outreach staff and Board or Advisory Committee (after review and approval of the full Advisory Committee) members for submittal to local news sources.
- **Briefing Packets:** For milestone briefings to the public and stakeholders. Packets will include standard talking points, PowerPoint presentations, and other materials to assist in educational outreach and for soliciting feedback.

Background/Baseline Information
- **General Fact Sheet**: A general Fact Sheet describing the GSA governance structure.
- **Basin Conditions:** Very brief description of the Santa Rosa Plain basin (one page, two sides).
- **GSP Goals and Requirements:** A Fact Sheet describing the goals and requirements for the Groundwater Sustainability Plan.
- **Existing Educational Materials:** Such as the Santa Rosa Plain Groundwater fact sheets and primers.

Website: The project website, www.sonomacountygroundwater.org, will be a tool for distributing and archiving meeting and communication materials as well as a repository for any studies. Outreach staff anticipates updating the website monthly, and more often if needed. The website includes the following information:
- Home page: summary and "what's new" information
- Groundwater basics
- Santa Rosa Plain Information:

- Board members, meeting schedule, agendas, and meeting materials.
- Advisory Committee members, meeting schedule, agendas, and meeting materials

Social Media: Existing Facebook, Twitter, Next Door and other emerging social media technologies will be leveraged to provide updates on milestone progress to interested parties.

Surveys: Online tools, such as Survey Monkey, will be used periodically to gather stakeholder ideas and to provide feedback on key issues.

Media Plan: Outreach staff will work with the administrator to develop press releases and Public Service Announcements (if appropriate) at each milestone and for meetings. The press releases will be distributed to local and regional media and Legislative and Congressional representatives.

Appendix A:* Consideration of Interests, as required by SGMA[1]

*This list is not exhaustive or exclusive.

Cities, Town, County

- Cotati
- Rohnert Park
- Santa Rosa
- Sebastopol
- Windsor
- County of Sonoma

Tribes

- Federated Indians of Graton Rancheria
- Lytton Band of Pomo Indians

Federal Government

- National Oceanic & Atmospheric Administration/NMFS
- US Army Corps of Engineers
- Natural Resource Conservation Service
- USFWS
- EPA

Public Water Systems

(Note: Many of the mutual and PUC-regulated water companies listed below have joined together and hold one seat on the GSA Board and one seat on the GSA Advisory Committee. The other water companies have been contacted but are not currently interested in participating in the GSA.)

- Sonoma County Water Agency
- Cal-American, Larkfield
- Penngrove Water Company
- Athena Terrace Mutual Water Company
- Branger Mutual Water Company, Inc.
- Hawkins Water Co-Cal Water Service
- Holland Heights Mutual Water Company
- Madrone Mutual Water Company
- Mount Weske Estates Mutual Water Company
- Park Royal Mutual Water
- Wendell Water Company
- Willowside Mutual Water Company

Agriculture

- Sonoma County Farm Bureau
- United Winegrowers
- Community Alliance of Family Farmers/Farmer's Guild
- Western United Dairymen's Association
- Sonoma County Winegrape Commission
- Sonoma County Vintners
- BRONC
- North Bay Agricultural Alliance

[1] Water Code §10723.2

- Santa Rosa Plain Vintners and Growers
- Gold Ridge Resource Conservation District
- Sonoma Resource Conservation District
- Sonoma County Growers Alliance

Organizations that Represent Environmental Uses of Groundwater

- Sonoma County Water Coalition
- Sonoma County Conservation Action
- Fairfield Osborn Preserve
- Pepperwood Preserve
- Sebastopol Water Information Group (SWIG)

Disadvantaged Communities (and organizations that represent disadvantaged communities)[2]

- Roseland, Southwest Santa Rosa, Southeast Santa Rosa, Northwest Santa Rosa, Kawana Springs, Apple Valley
- Social Advocates for Youth
- Boys and Girls Club
- Los Cien
- Community Action Partnership
- Burbank Housing
- Catholic Charities
- Immigration advocacy groups

Well Owners (including domestic well owners)

[2] As identified by the County of Sonoma

Appendix B:* Other Interested Parties[3]

***** While not required to be engaged under SGMA, these stakeholders will be including in the outreach program. This list is not exhaustive or exclusive.

- Sonoma County Agricultural Preservation & Open Space District
- Sonoma County Planning Commission
- City/Town Planning Commissions
- Russian River Watershed Association
- Santa Rosa Plain school districts
- Sonoma State University
- Santa Rosa Junior College
- Memorial Hospital
- Sutter Hospital
- Kaiser Hospital

State Government

- Regional Water Quality Control Board
- California Department of Fish and Wildlife

Business / Developers

- Sonoma County Alliance
- Construction Coalition
- North Bay Association of Realtors
- Economic Development Board
- Chambers of Commerce

Citizens & Community Organizations

- League of Women Voters
- Democratic and Republican Club
- Rotaries
- Kiwanis
- SIRS
- Sonoma County Community Foundation
- Sonoma Land Trust
- Accountable Development Coalition
- Concerned Citizens for Santa Rosa
- Sierra Club

[3] Appendix B includes parties and organizations that may be interested in groundwater management, but are not specifically identified as an interest that must be considered under Water Code §10723.2.

Attachment A: SANTA ROSA PLAIN GSA -- YEAR ONE OUTREACH					
Activity	**Description**	**SGMA or Brown Act?**	**Shared across basins?**	**Time Frame**	**Who**
Ongoing Outreach					
Monthly Updates	Blog to Interested Party List		X	Emailed by 15th of each month	WA Staff, with review by administrator
Website	Postings, updates, edits		X	15th of each month	WA staff, with review by administrator
Fact Sheets	GSA description Basin Description GSP FAQ			December December March	WA staff, with review by administrator and AC (GSP FAQ)
Media contacts	Inquiries from reporters		X	As needed	WA staff takes inquiries, directs reporter to administrator, Plan Manager, AC Chair or Board Chair
Notifications	Post Board & AC agendas	X		72 hours before meeting	WA staff. Materials provided by administrator
Free media	Issue press releases for Board & AC meetings		X	2 weeks before meeting	WA staff, with review by administrator
Additional Outreach for Initiation of GSP					
Public Notice		X		January	WA staff, with review by administrator and plan manager
Paid, free & social media	Press releases, ads and social media.		X	January	Staff, with AC input. Use existing social media channels of AC and Board organizations/agencies.
Additional Outreach for Rate & Fee Study					
Talking Points	In English and Spanish		X	v1 December v2 February v3 April/May	WA staff, with input and review by administrator & AC
Fact Sheets/FAQs	English and Spanish		X	V1 December V2 March	WA staff, with input and review by administrator & AC
Workshop			X	March	WA staff, with input and review by administrator & ACs
Paid, free & social media	Press releases, ads and social media. Purpose is to publicize workshops, Public Hearings.		X	March, May	Staff, with ACs input. Use existing social media channels of AC and Board organizations/agencies. Spanish language outreach via radio.

Additional Outreach for Rate & Fee Study (cont.)					
Activity	**Description**	**SGMA or Brown Act?**	**Shared across basins?**	**Time Frame**	**Who**
Agency Briefings	Brief member agencies on study and options			January, April	WA staff works with Board members to coordinate
Stakeholder Briefings	Speak at existing meetings			December-May	ACs , Board members, staff
DAC outreach	Use existing venues (church, school, community events)			December - May	WA staff works with AC members to identify opportunities and to attend events
Public Meeting or Hearing	Public meeting required by SGMA; hearing may be needed	X		May	Raftelis, with staff support

Appendix 1-G
Stakeholder Assessment Report: Findings and Recommendations on Implementing the Sustainable Groundwater Management Act in Sonoma County

Consensus Building Institute

Stakeholder Assessment Report

Findings and Recommendations on Implementing the Sustainable Groundwater Management Act in Sonoma County

Developed by Senior Mediator Gina Bartlett, Consensus Building Institute, Inc.
September 15, 2015

Overview

The State of California passed the Sustainable Groundwater Management Act in 2014. The State has designated three groundwater basins in Sonoma County as medium priority: the Petaluma Valley, Santa Rosa Plain, and Sonoma Valley. The Act requires that medium and high priority basins form a groundwater sustainability agency by June 2017, develop a groundwater sustainability plan by 2022, and achieve sustainability by 2042. Under the Act, local agencies with water supply, water management or land use responsibilities are eligible to form a groundwater sustainability agency. To develop an effective process for groundwater sustainability agency formation in these three basins, the Sonoma County Water Agency contracted with the Consensus Building Institute to conduct a stakeholder assessment and make recommendations on a process for forming groundwater sustainability agencies in compliance with the Act. This report summarizes the interview findings and process recommendations.

CBI conducted interviews with representatives of each GSA-eligible local agency and key organizations and interest groups. CBI also met with both the Santa Rosa Plain and the Sonoma Valley basin advisory panels in person to discuss panel members' perspectives on implementing the Act. CBI also conducted an online survey related to these issues and received 36 confidential responses. For the survey, CBI invited basin advisory panel members from both the Sonoma Valley and Santa Rosa Plain, stakeholders interested in water issues, federal and state agencies with jurisdiction in the region, and Public Utilities Commission-regulated water companies to participate.

During this assessment, CBI met periodically with the County-Water Agency Working Group made up of staff from the County Administrator's Office, Permit & Resource Management Department, County Counsel and the Sonoma County Water Agency to discuss preliminary insights and findings and identify subsequent steps in the assessment process. After completing most of the interviews and receiving the majority of survey respondents, CBI met with staff of the GSA-eligible entities to discuss the assessment's preliminary findings and begin developing a process that would consider the responsibilities of the governing boards of the eligible entities and the many stakeholders in the county that are interested in groundwater issues. Process recommendations in this report reflect the outcome of those deliberations.

Existing Groundwater Management Programs

Both the Sonoma Valley and the Santa Rosa Plain have groundwater management programs with monitoring programs, stakeholder involvement, and other components to manage groundwater in

different stages of implementation. The Sonoma County Water Agency is the lead agency for implementing these programs. Both have a Basin Advisory Panel that develops consensus-based recommendations to implement the groundwater programs effectively. The Petaluma Valley is in the early stages of assessing its groundwater resources.

Assessment Findings

The following summarizes findings from interviews and surveys of the Consensus Building Institute.

Understanding SGMA and Water Stakeholders

Generally, interviewees are trying to understand and think about the best way to implement the law in the designated basins in the county. It is important to note that most respondents, both staff and stakeholders, articulate commitment to long-term sustainable groundwater management and the importance of groundwater-surface water interaction, conjunctive use, and integrated water resources management. One interviewee emphasized that cooperation across all the entities (water districts, cities and county) is essential for implementing SGMA successfully.

Governance and Representation

Respondents discussed a range of issues that they would recommend for consideration in forming one or more groundwater sustainability agencies. Key themes were keeping decisions local within the basin, and making sure that different users' interests are somehow balanced in groundwater management. Respondents respect local knowledge and control for water management and expressed concern about needing to participate in management decisions for other basins and about agencies or stakeholders from external jurisdictions making decisions about local groundwater. At the same time, some recognize a need for a regional perspective on water resources and land use; those with this perspective feel confident that regional considerations can blend with local decisions. Everyone acknowledges that the county government has an important role to represent the unincorporated areas of the County, in particular domestic well owners. Participants offer the following considerations for the voting structure and representation.

Potential Voting Structure and Representation in a GSA

- Balance agriculture, urban, city, and rural residential interests
- Provide for local control
- Consider that Sebastopol (100% reliance) and Rohnert Park rely more heavily on groundwater supply than other cities
- Protect groundwater supply interests of cities' that use groundwater as supplemental supply (peak and emergency)
- Consider that SCWA has pumping facilities in the Santa Rosa Plain groundwater basin only, not in Petaluma Valley or Sonoma Valley
- Avoid using the quantity of water use for representation since conserving water use is key
- Consider population in representation
- Allow for governing boards to appoint representatives (so representative could be elected official or an appointee). Each entity to decide who represents it.
- GSA Board should not mix staff and elected officials. Interviewees prefer that GSA board consist of elected or appointees of electeds. People cite the Water Advisory Committee / Technical Advisory Committee model as effective with policy arm for limits and potential fees.
- Consider rural domestic well owners: representation and participation, the large number of wells, and significant groundwater use.

- Some would like opportunity for agriculture and private water companies (like Cal American Water) to have a role in governance.
- Concern exists that agricultural interests, if involved in GSA, might overwhelm cities' interests.

Examples
Multiple interviewees suggested the Sonoma County Transportation Authority and the Sonoma County Water Agency's Water Advisory Committee / Technical Advisory Committee as successful models to examine and possibly emulate. One person suggested the North Bay Watershed Association. Interviewees repeatedly cited the Waste Management Agency as an example to avoid.

Costs
Interviewees from the agencies are concerned about costs and funding SGMA implementation. While SGMA authorizes the groundwater sustainability agency to levy fees, the agency is still subject to Proposition 218, potentially limiting the ability to raise funds. Entities that purchase water from the Sonoma County Water Agency to supply their customer base (water contractors) expressed concern about paying for groundwater planning more than once – through water purchases that fund SCWA and through cost sharing agreements for groundwater planning. The cities express commitment to continuing to fund groundwater planning, but would like other groundwater users (specifically in unincorporated areas) to contribute since substantial groundwater use occurs outside of city boundaries, and some cities only use groundwater for emergency and peak supply – it is a small part of their water budget.

County of Sonoma Role
Since the County is default agency under SGMA[1], many interviewees believe that the County should take the lead in organizing SGMA implementation and seeking public input. The County has a stated commitment to sustainability and view groundwater as an element. The Board of Supervisors has the responsibility of representing both agriculture and domestic well owners in the unincorporated areas as well as city residents under SGMA. Some interviewees express concern about the County's ability to represent agricultural interests in the unincorporated areas. Most interviewees support the County representing rural residential well owners. The relationship between the Cities and the County is complex. As agencies, the Cities and County work together on a number of issues, and due to differing interests, some efforts have created tensions. These unrelated tensions sometimes affect attitudes about the role that the County should play in implementing SGMA.

Basin Advisory Panels and Public Input
Everyone recognizes the value that the existing basin advisory panels play in an advising on groundwater management. Interviewees express openness to relying on the basin advisory panels into the future in some capacity. Some interviewees strongly advocate that basin advisory panels continue because the panels have played a critical role for discussing and resolving groundwater management issues, reducing conflict in the groundwater basins. Some interviewees articulate concerns about challenges within the Santa Rosa Plain Basin Advisory Panel and limitations this places on effective collaboration.

[1] Under SGMA, the County can opt out of GSA formation. If no agency in a basin steps forward to form the GSA, the state would intervene.

Stakeholders demonstrate a high level of expectation for public outreach and stakeholder involvement. Respondents urge expansive outreach to rural residential well owners and seeking guidance and input from basin advisory panels and the public on forming the groundwater sustainability agency.

Governance Options

As part of the assessment, the facilitator and interviewees discussed possible configurations for the groundwater sustainability agency(s) within basins and across the three basins. Stakeholders articulated pros and cons of different options based on their understanding at the time.

One GSA per Basin or 3 GSAs

Pros
+ Provides for decision making at local level, reflects each unique basin

Cons
GSAs might compete against one another for external funding
Spreading resources too thin

Models: Existing BAP Structure

Hybrid: One GSA per Basin (or 3 GSAs) that Coordinate or Share Staff and Resources

This option was very popular among interviewees.

Pros
+ Provides for decision making at local level
+ Shares resources across basins
+ Allows for regional consideration on management issues

Cons
GSAs might compete against one another for external funding

Models: Metropolitan Transportation Commission

Centralized: 1 GSA in County for all three Basins

Pros
+ Like simplicity and ease of setting up
+ Shares decision making across agencies with possibility of designating seats for particular agencies or interests groups
+ Shares resources and costs

Cons
Governing board too big. Agency too big.
Prefer decision-making at local level. Might miss the nuances of the local detail
Concerned about GSA board representing all groundwater users' interests

Models: LAFCO

Multiple GSAs/Basin

No one expressed interest in having multiple GSAs within a basin

Important Qualities for a Groundwater Sustainability Agency

In response to the facilitator's question, respondents articulated the following qualities for the agency:

- Political and technical credibility
- Strong technical capacity
- Track record of conducting similar activities
- Fairly represent local interests
- Willingness to leverage existing work (USGS studies and existing Groundwater Management Programs)
- Link responsibility between countywide surface water supply and basin groundwater supplies
- Equal representation
- Ratepayer considerations
- Efficiencies
- Cost effective

Other Evaluative Elements

Interviewees recommend comparing costs, potential fees that structures and options would require.

Interviewees recommend creating a structure that can manage future basin designations as medium or high priority in the county

Consistent with SGMA, participants would like to evaluate the ability of the governance structure to protect groundwater supply interests for all beneficial uses / users.

Interviewees noted that SCWA has the technical and scientific capacity to develop the groundwater sustainability plan. SCWA is involved in groundwater management and conjunctive use. SCWA also provides regional perspective across basins and has been able to solicit funding from the state to assist existing groundwater programs.

Interviewees recommended repeatedly to keep the structure as simple as possible and to avoid cumbersome, costly bureaucracy while allowing more complex structures to evolve if needed in the future. Concern exists that establishing structure could be lengthy or difficult. Some worry that creating a joint powers authority would be very difficult to organize / agree to and cumbersome in implementation.

Some local agencies also express concern about the possibility of the groundwater sustainability agency usurping the control of local jurisdictions in decision-making.

Recommendations

The Consensus Building Institute has developed these process recommendations through a participatory evaluation process, sharing preliminary interview findings with staff of the GSA-eligible agencies to then design a recommended process. The goal of the proposed process is to form groundwater sustainability agencies in the basins that have widespread support of the eligible agencies, stakeholders, and the general public.

Anticipated Discussion Topics for Decision-Making on GSA Formation

Based on the interviews, surveys and discussions, the parties will need to discuss the following topics to reach a successful conclusion on GSA formation.

- *Decision-making framework*: Agree on how decisions will be made at a staff level and sequencing for governing board consideration and final approvals.
- *Principles for developing governance options*: Serve as a tool to demonstrate intent and help others understand how the GSA-eligible agencies will work together.
- *GSA authorities and responsibilities*: Clarify the authorities and responsibilities that the law establishes.
- *Governance structures and options*: Explore the governance structure options and necessary legal agreements necessary to support successful formation and implementation.
- *Criteria for evaluating options:* Use to evaluate, weigh and compare options using eligible entity and stakeholder interests as basis of criteria.
- *Legal documents for GSA formation*: Craft the legal documentation of all agreements.
- *Communication and outreach*: Develop an outreach strategy to inform all beneficial users of groundwater and the public at large.
- *Costs*: Consider the costs of forming and operating the groundwater sustainability agency and developing a funding and finance plan and associated policies.
- *Timeframe for GSA formation*: Monitor and comply with state-mandated deadlines.

Process Overview

The diagram outlines the recommended process for GSA(s) formation in Sonoma County. In summer 2015, staff of the GSA-eligible agencies began meeting to understand and explore options to comply with SGMA. In the summer and fall of 2015, staff would work together to develop governance options that might be appropriate for the basins, given the existing groundwater programs and based on the interests of the agencies and stakeholders in the basins. During fall 2015, the County and the Sonoma County Water Agency, in cooperation with the other GSA-eligible entities, would host public workshops to increase the public's understanding of SGMA and share information about potential options for complying with SGMA in the basins. Additional outreach activities would also occur, including informational materials and a web site. Also some GSA-eligible agencies would likely provide briefings to governing boards during regularly scheduled meetings, all of which are open to the public and would serve as another outreach vehicle.

While outreach was occurring, the GSA-eligible entities would continue discussing the details of GSA governance options, exploring options in more depth over time. These discussions would benefit from the outreach process yielding new insights and potential concerns that staff can then incorporate into discussions.

The California Department of Water Resources used its Bulletin 118 to establish the basin boundaries. If a basin wishes to change its boundary, the responsible entity must submit an application to the Department of Water Resources between January and March 2016. To that end, the GSA-eligible entities would decide on this issue by December 2015 to ready the application.

Proposed Process Overview

Anticipated Discussion Topics for Decision-Making on GSA Formation

Decision-making framework

Principles for developing governance options

GSA authorities and responsibilities

Governance structures and options

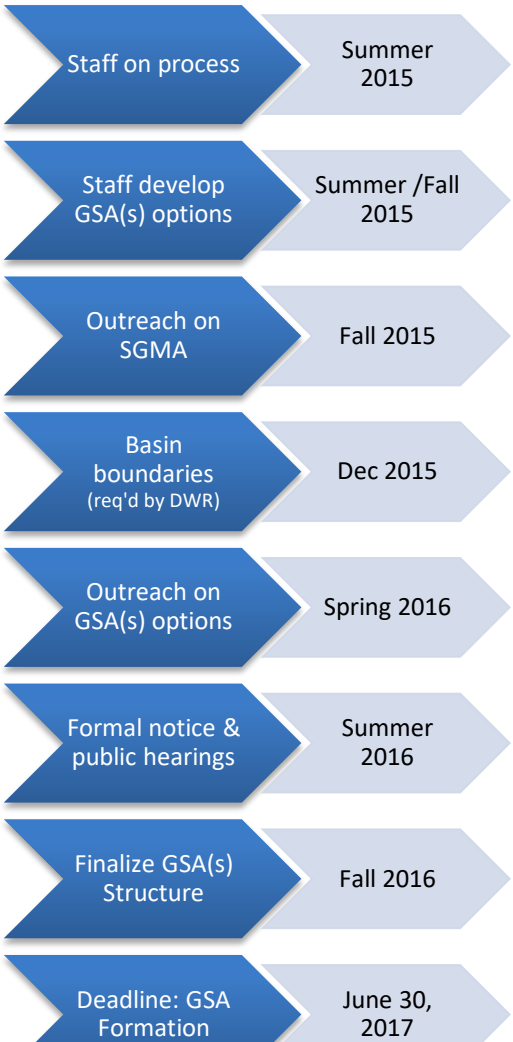
Criteria for evaluating options

Legal documents for GSA formation

Communication and outreach

Costs

Timeframe for GSA formation



By spring 2016, the goal would be for staff to have recommendations on the GSA(s). A robust outreach program on the recommendations would occur during the spring. Assuming no major challenges at that point, the responsible agency(s) would issue one or more formal notices (one per GSA), as SGMA requires, and hold the necessary public hearing. Contingent on the outcome of the public hearing, the governing boards would then direct staff to finalize the GSA structure(s) and notify the State of California of its formation.

Other Important Considerations

Government-to-government contact with the Lytton Rancheria and Graton Rancheria: The County of Sonoma is the appropriate body to initiate formal contact with the tribes in the basins to discuss SGMA. Initial outreach to the tribes has already occurred.

Dry Creek Tribe Land Ownership in Petaluma Valley Basin: The Dry Creek Tribe owns land in the Petaluma Valley groundwater basin; however, the land is not currently in trust.

Disadvantaged Communities: One stakeholder suggested to investigate water quality issues on wells in Southwest Santa Rosa - part of it is Roseland and North of Hearn, south of Highway 12, east of Wright Road and west of Highway 101.

Outreach Strategy: The GSA-eligible entities are putting together an outreach strategy, including briefing governing boards at public meetings, holding public workshops, communicating with the Basin Advisory Panels, and general information on a web site.

Interviews Completed and Survey Information

GSA-eligible Entities
Valley of the Moon Water District
City of Cotati
City of Petaluma
City of Rohnert Park
City of Santa Rosa
City of Sebastopol
City of Sonoma
Town of Windsor
North Bay Water District
Sonoma County Water Agency
County of Sonoma / PRMD

Also Interviewed
Cal American Water Company
Russian River Keeper – Don McEnhill
Sonoma County Farm Bureau – Tito Sasaki
Sonoma County Water Coalition Members: Rue Furch, Stephen Fuller-Rowell & Jane Nielson
Sonoma Resource Conservation District – Kara Heckert
United Winegrowers – Group interview

Group Discussion
Santa Rosa Plain Basin Advisory Panel
Sonoma Valley Basin Advisory Panel

36 Surveys Submitted
Basin Advisory Panel members, state and federal agencies, and non-governmental organization representatives invited to participate in survey.

About the Consensus Building Institute and Gina Bartlett

Founded in 1993, the Consensus Building Institute improves the way that community and organizational leaders collaborate to make decisions, achieve agreements, and manage multi-party conflicts and planning efforts. A nationally and internationally recognized not-for-profit organization, CBI provides collaborative problem solving, mediation and high-skilled facilitation for state and federal agencies, non-profits, communities, and international development agencies around the world. CBI senior staff are affiliated with the MIT-Harvard Public Disputes Program and the MIT Department of Urban Studies and Planning. Learn more about CBI at: www.cbuilding.org

Gina Bartlett is a senior mediator at CBI. She has mediated many complex policy issues related to water resources, land use and natural resources over the last 20 years. She is on the national roster of the U.S. Institute for Environmental Conflict Resolution and has a Master's degree in Conflict Analysis & Resolution. Ms. Bartlett previously conducted an assessment and facilitated development of the Sonoma Valley and Santa Rosa Plain groundwater management plans. You can learn more about Gina at: http://www.cbuilding.org/about/bio/gina-bartlett (Email: gina@cbuilding.org and Tel: 415.271.0049)

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Appendix 3-A
Water Year Type Classification for Petaluma Valley, Santa Rosa Plain, and Sonoma Valley

Water Year Type Classification for Petaluma Valley, Santa Rosa Plain, and Sonoma Valley

Monthly PRISM precipitation records from each basin were combined to create a single precipitation record. The 3 locations are

PRISM Location	Groundwater Basin	Representative Station
38.5068,-122.8029	Santa Rosa Plain	Santa Rosa Airport
38.2473,-122.6250	Petaluma Valley	Petaluma Airport
38.2992,-122.4553	Sonoma Valley	Vallejo House

These three records were first averaged for each water year. These are shown in Figure 1 for the period from 1895 to January 2020. The precipitation records for the 3 basins are highly correlated (Figure 2). This means aggregation of the 3 records will not introduce biases into the synthesized record. It also means that a single site could also be used as a surrogate for all 3. This approach does not account for the original biases that exist within the original datasets. These biases may exist because PRISM monthly estimates do not match actual recorded values for a given station.

A rolling weighted average was applied to the combined yearly precipitation record. This is done because groundwater recharge has a latency to precipitation, infiltration and other processes. We used a 3 year rolling window. Figure 3 shows the filtered signal using the same filter that is applied to the water year records. The filter applies weights so that the current year has the most effect on the moving average, and the two previous have lesser effects.

To classify water years in to hydrologic types, the following percentile classifications were applied. These values are based on the percentiles of the entire record and were used to classify the 3-year rolling average values (Table 1).

Table 2 Shows the number of water types based on this classification. The combined precipitation record, water year types, and rolling average is shown if Figure 4.

Percentile of Entire Record	Water Year Type	Lower Bound (inches)	Upper Bound (inches)
0 - 20%	Very Dry	11.2	18.5
20- 40%	Dry	18.5	22.7
40-60%	Normal	22.7	32.3
60-80%	Wet	32.3	41.5
80-100%	Very Wet	41.5	56.1

Percentile of Entire Record	Water Year Type	Number of Water Year Types
0 - 10%	Very Dry	4
10- 30%	Dry	20
30-70%	Normal	65
70-90%	Wet	34
90-100%	Very Wet	2

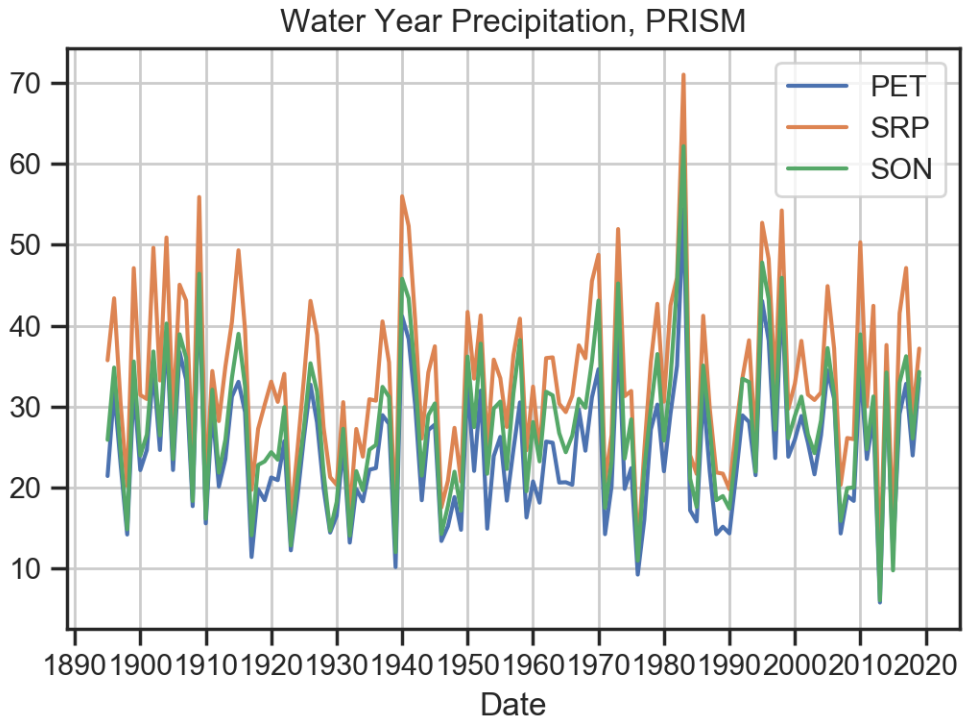

Figure 1 Water year precipitation for each basin

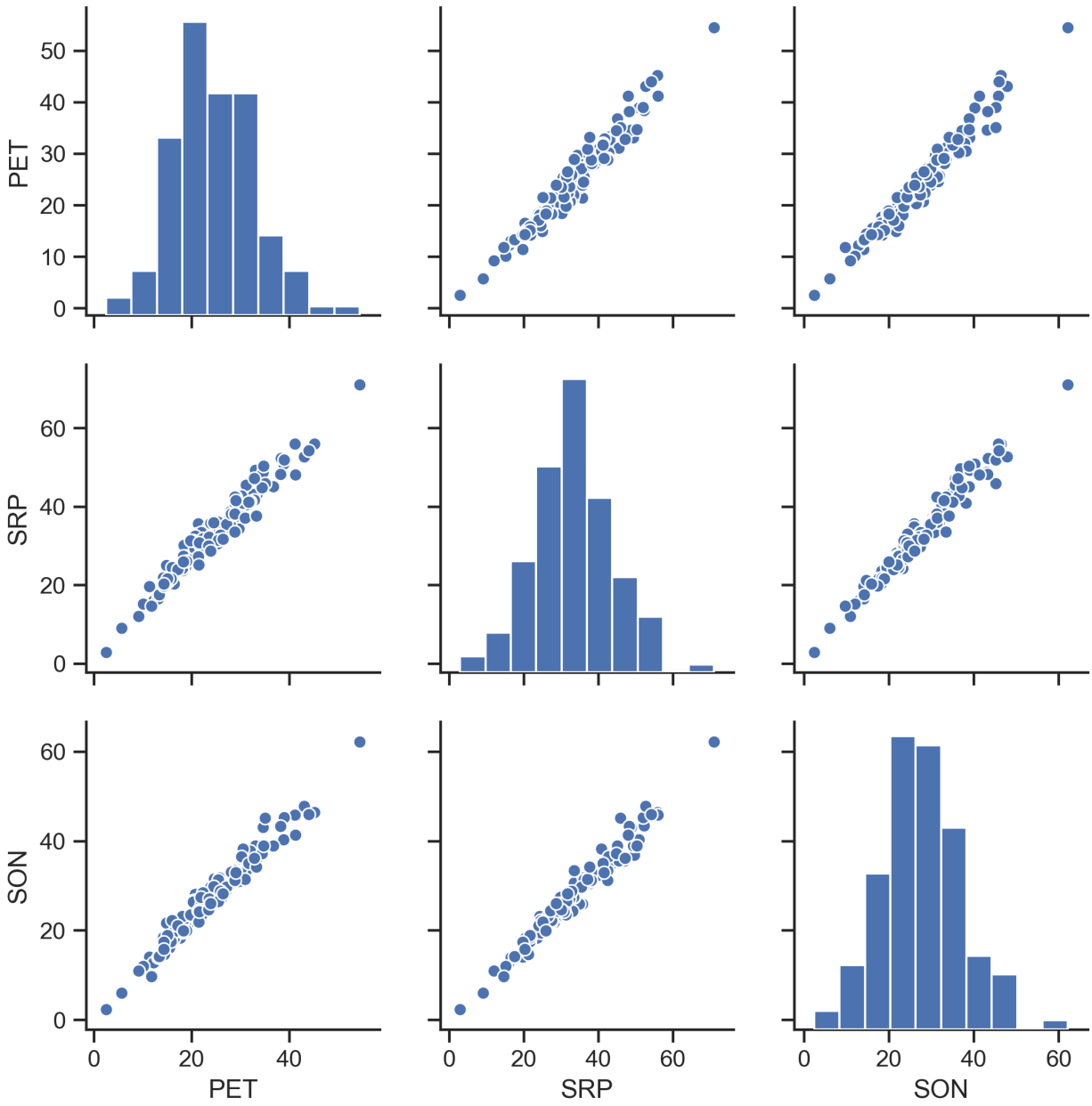

Figure 2 pairwise relationships for the 3 subbasin records

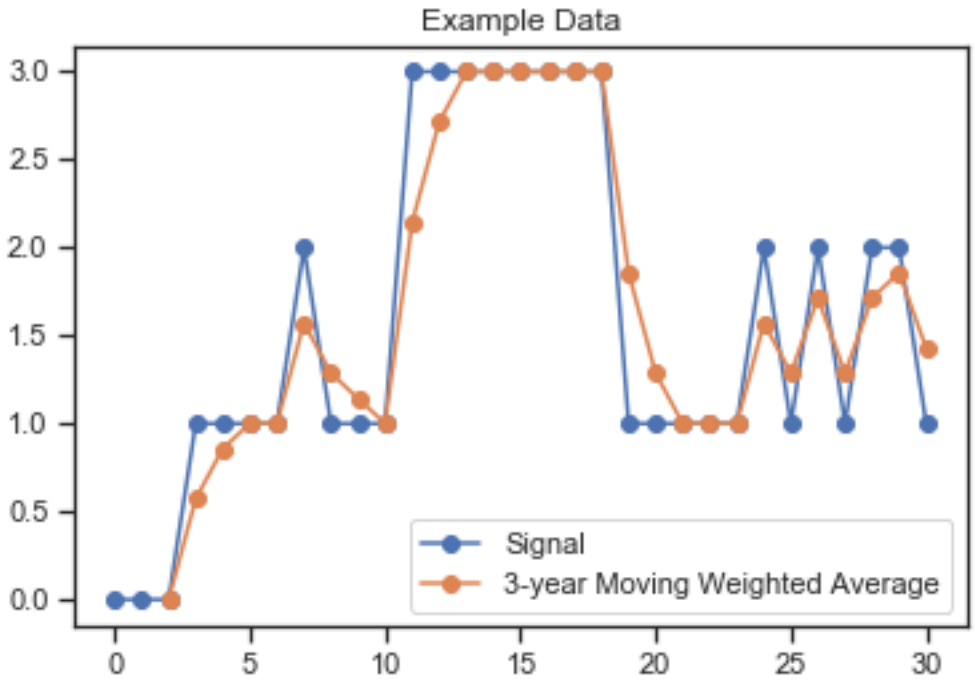

Figure 3 Example data showing signal and filtered response timeseries

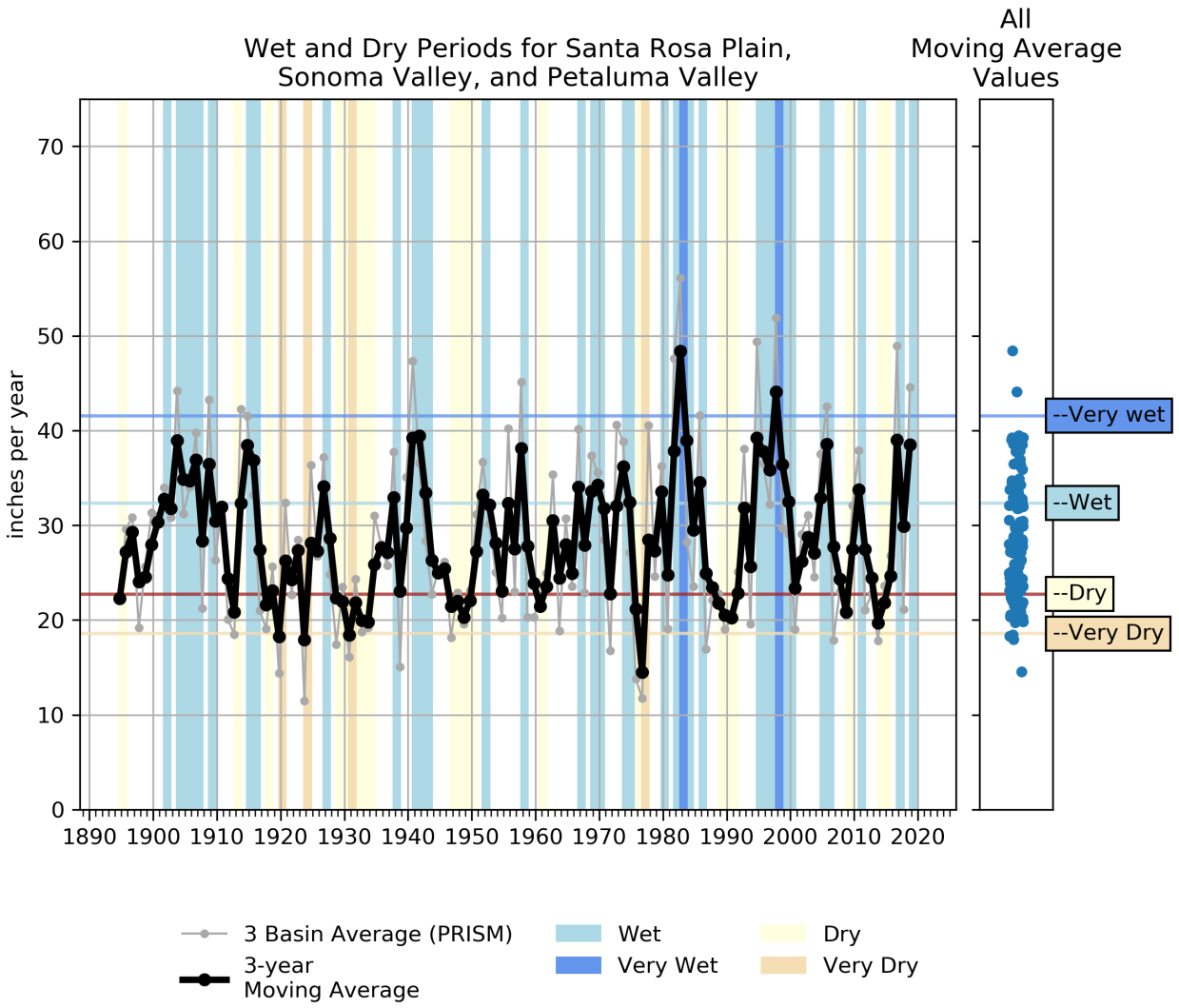

Figure 4 Water Classifications for Santa Rosa Plain, Sonoma Valley, and Petaluma Valley

Appendix 3-B
Groundwater Monitoring Well Hydrographs

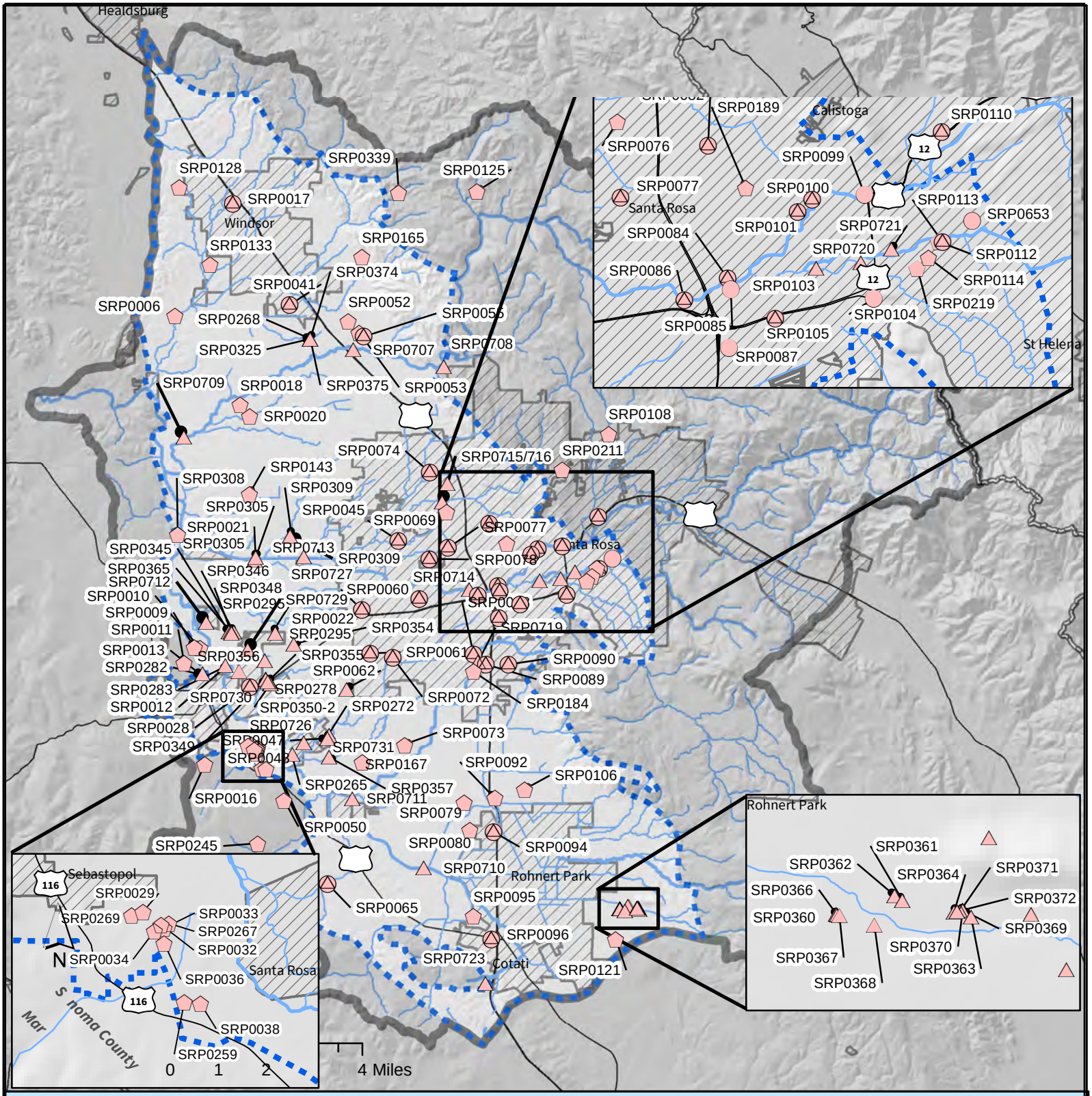

Figure 5-1a Existing Groundwater-Level Monitoring Network - Shallow Aquifer System

- Contributing Area Watershed
- Santa Rosa Plain Groundwater Subbasin
- Major Rivers and Creeks
- Streams
- City Footprints
- Dedicated Monitoring Wells
- Monitored Municipal Supply Wells
- Volunteer/Other Wells
- Environmental Monitoring Wells

Data Sources:

Groundwater Basins - California Department of Water Resources, Bulletin 118
Major Rivers and Creeks - Department of Water Resources
Streams - Sonoma County Central GIS and Sonoma Water

DRAFT

SANTA ROSA PLAIN GROUNDWATER SUSTAINABILITY AGENCY

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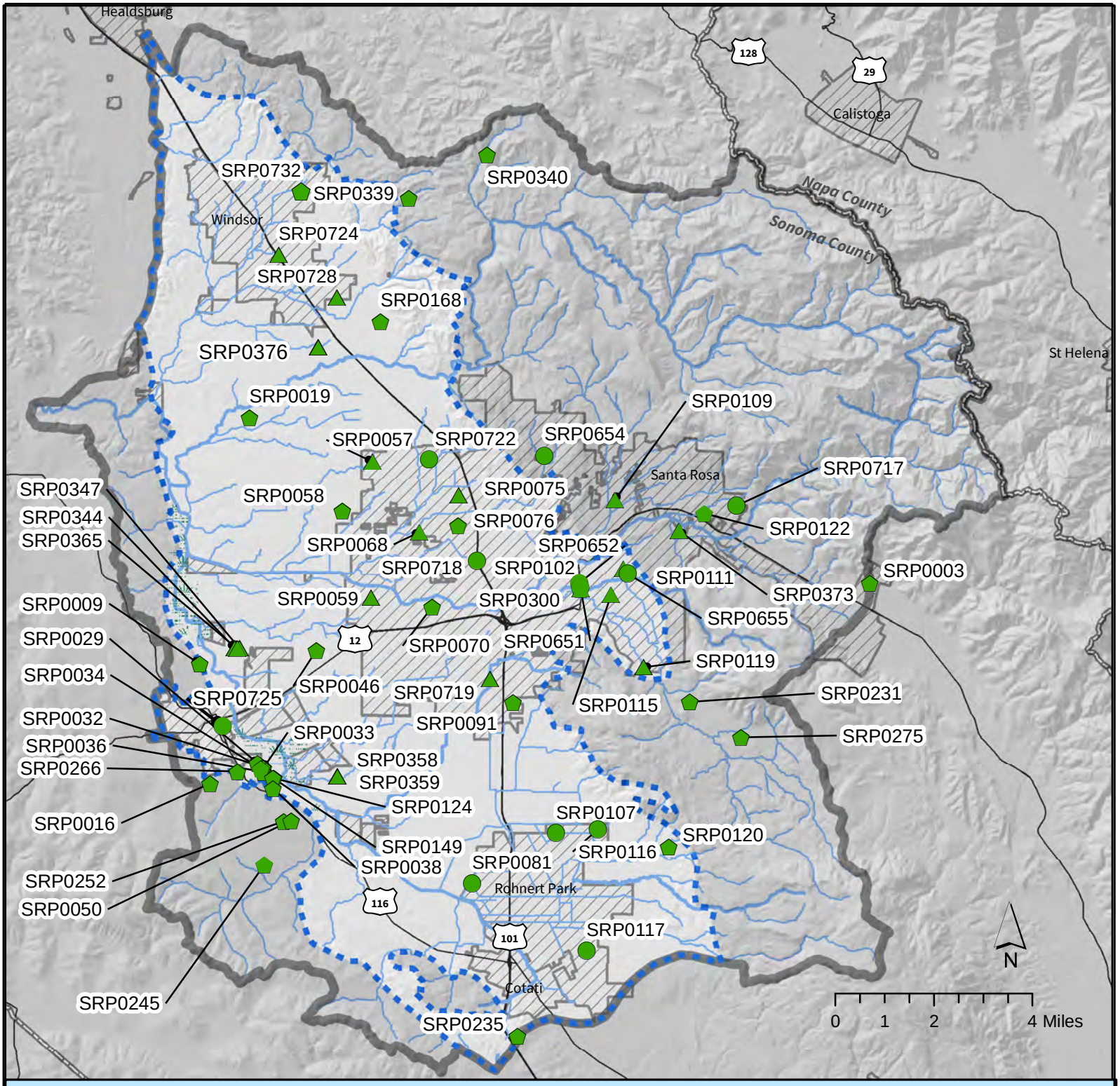

Figure 5-1b Existing Groundwater-Level Monitoring Network - Deep Aquifer System

- Contributing Area Watershed
- Santa Rosa Plain Groundwater Subbasin
- Major Rivers and Creeks
- Streams
- City Footprints
- Dedicated Monitoring Wells
- Monitored Municipal Supply Wells
- Volunteer/Other Wells

Data Sources:

Groundwater Basins - California Department of Water Resources, Bulletin 118
Major Rivers and Creeks - Department of Water Resources
Streams - Sonoma County Central GIS and Sonoma Water

DRAFT

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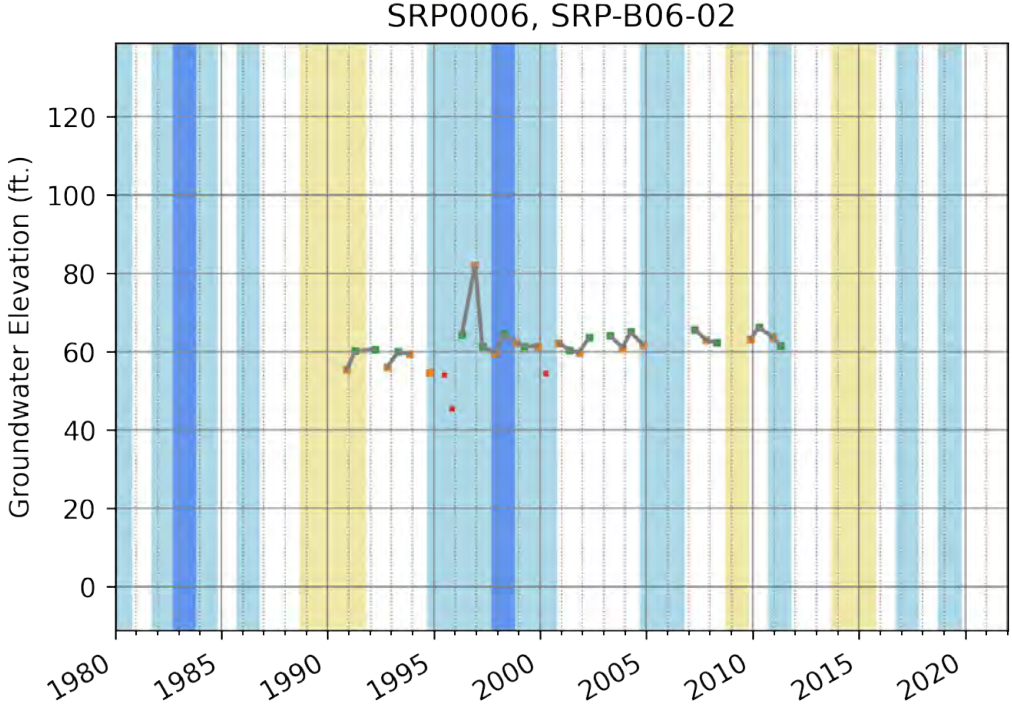
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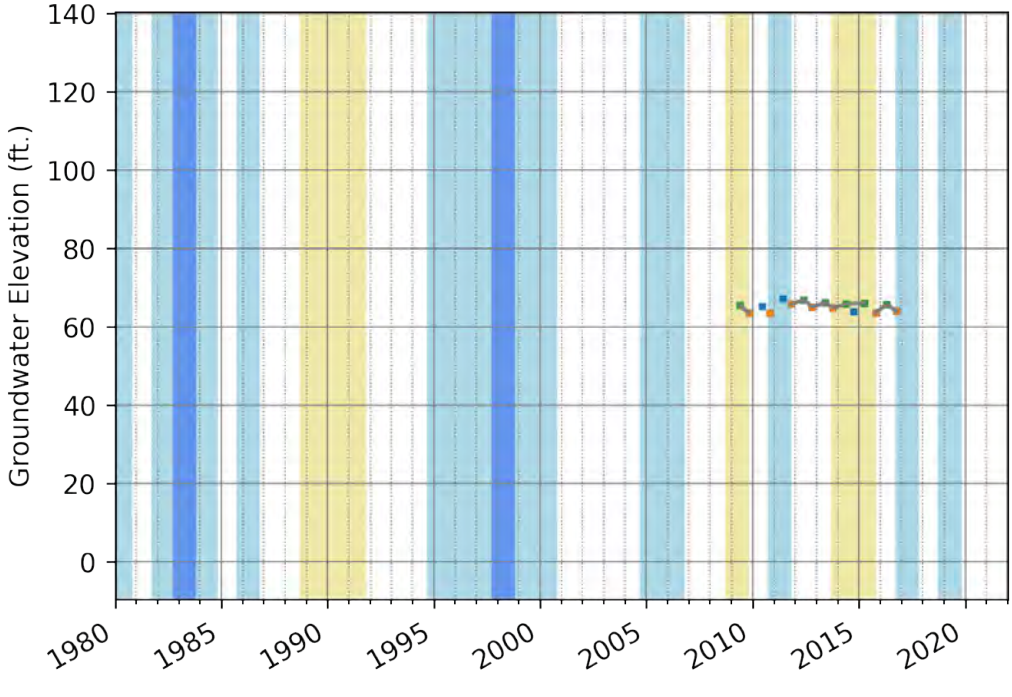
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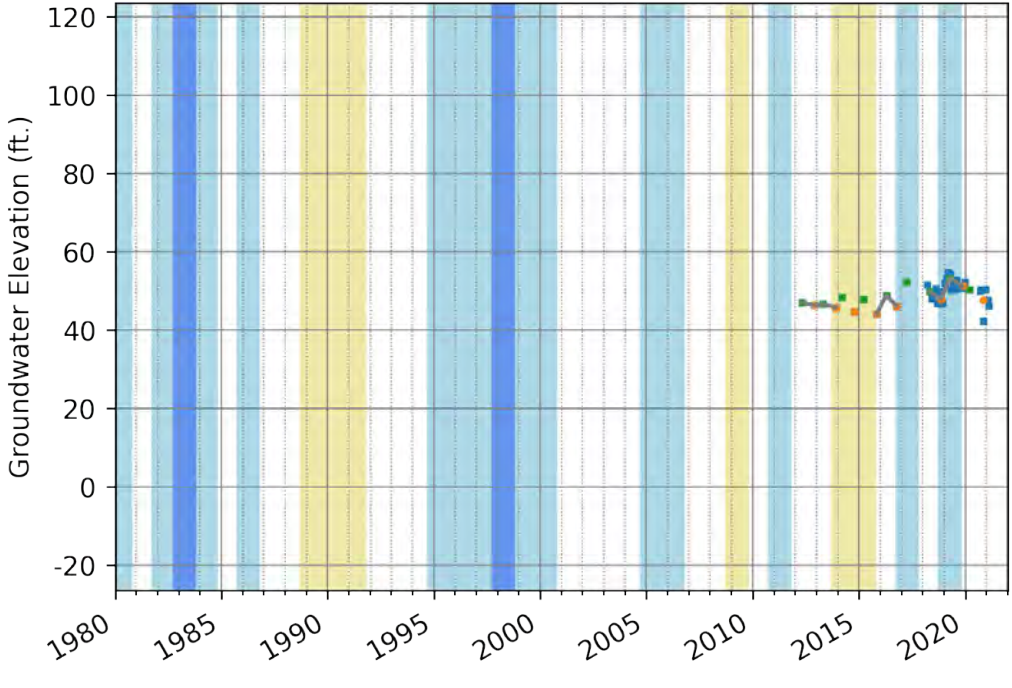
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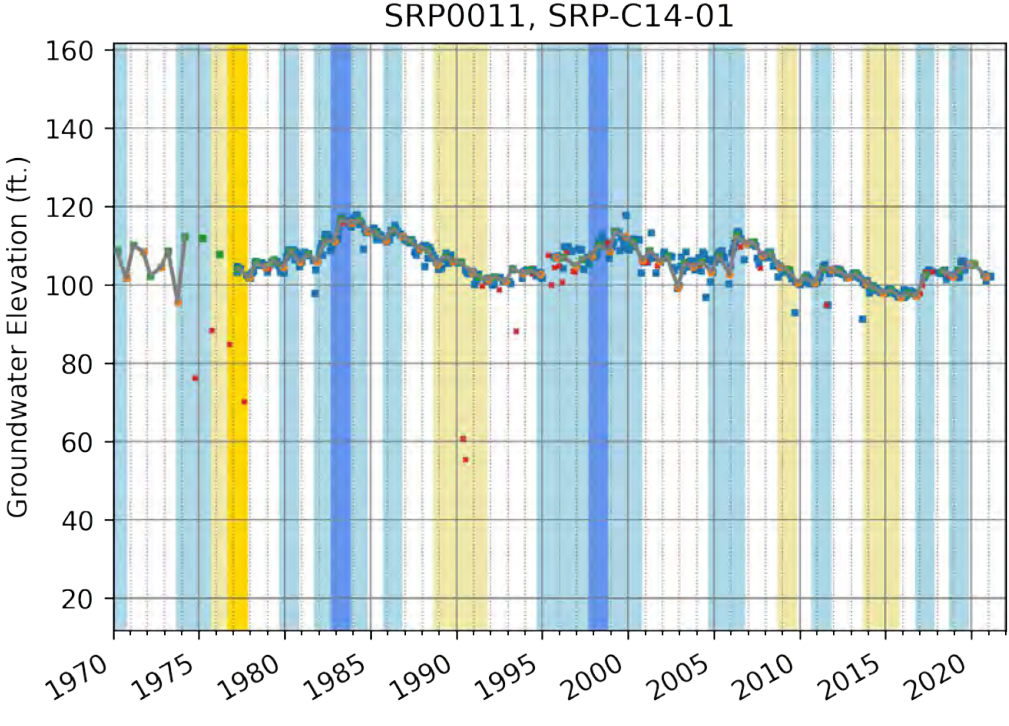
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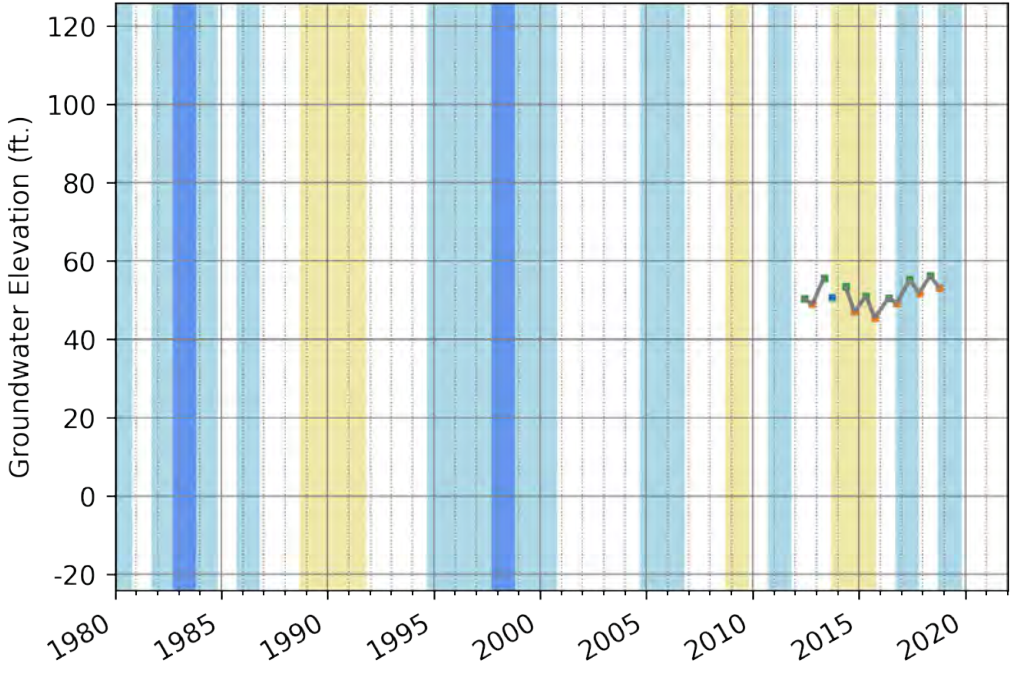
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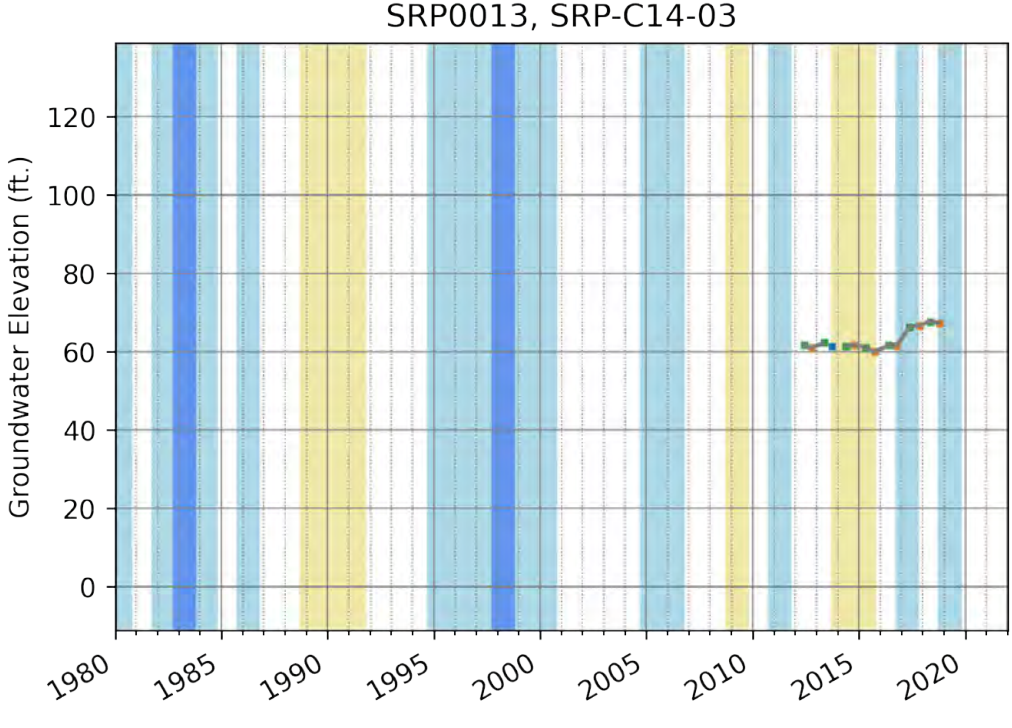
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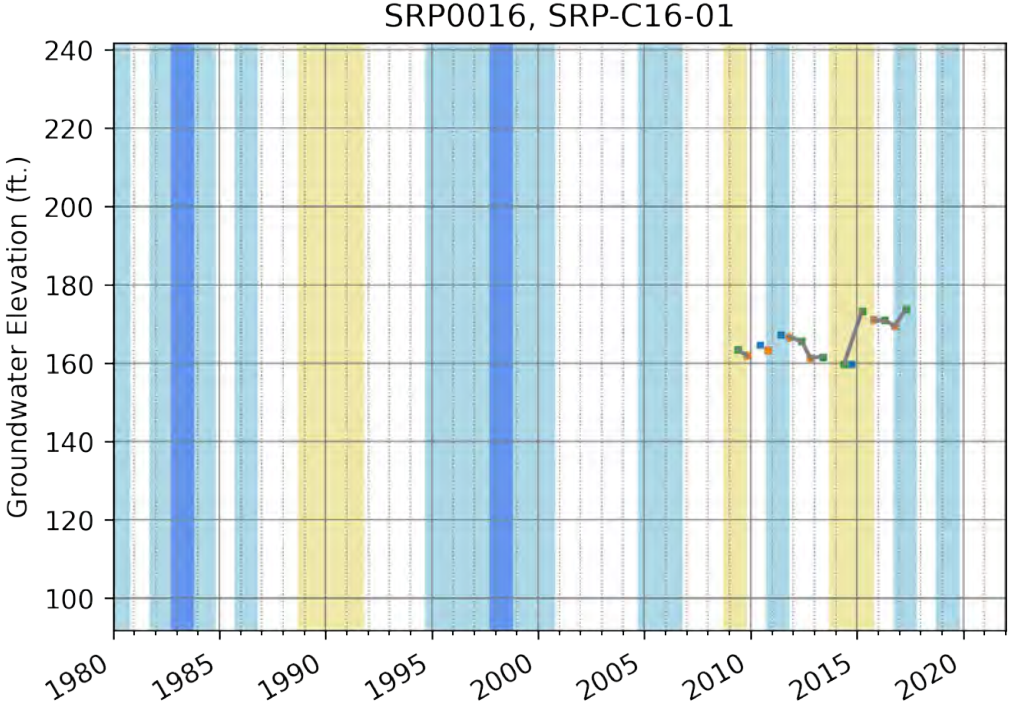
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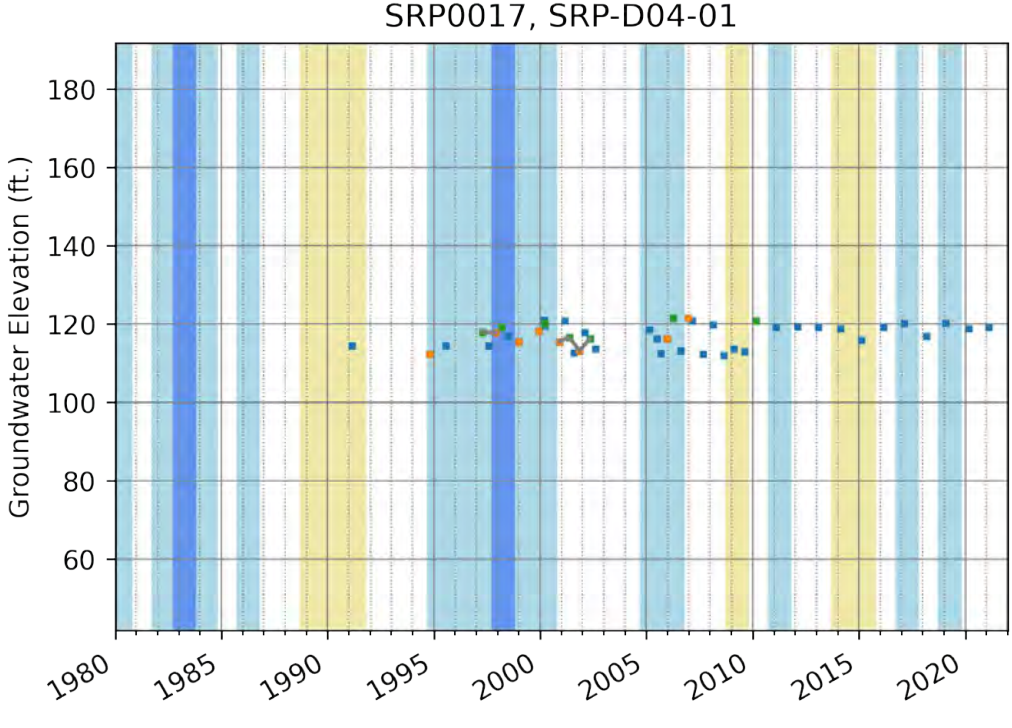
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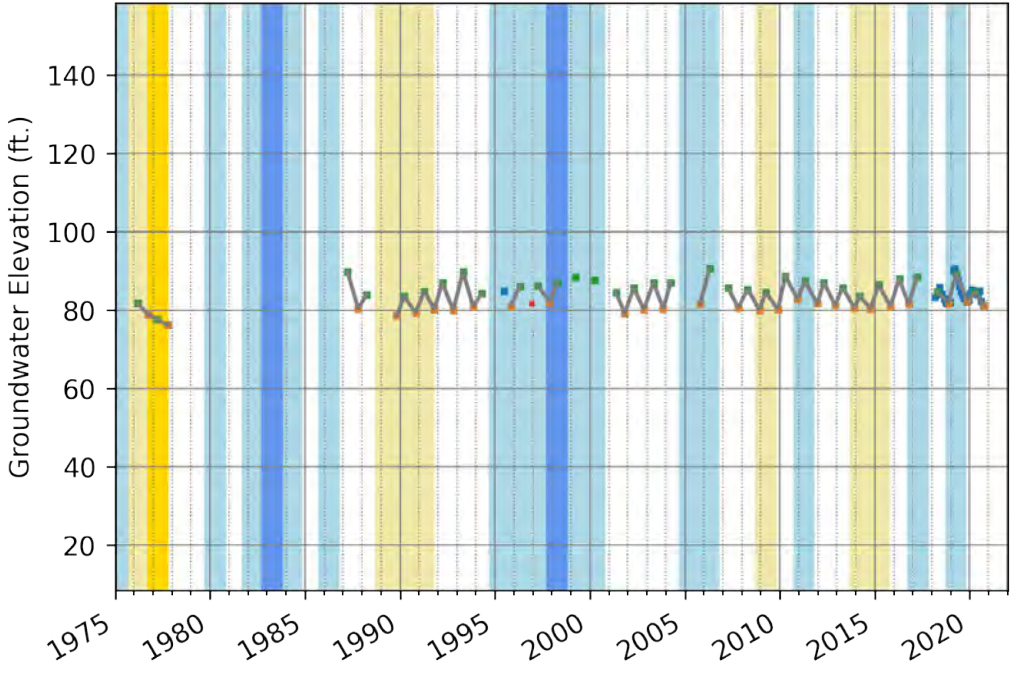
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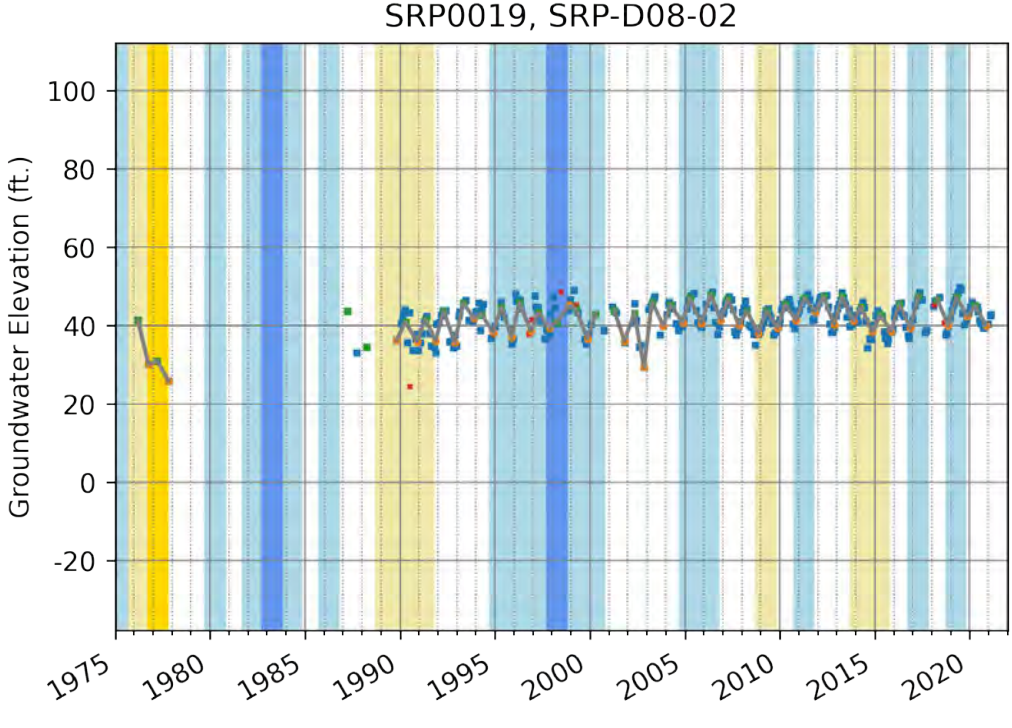
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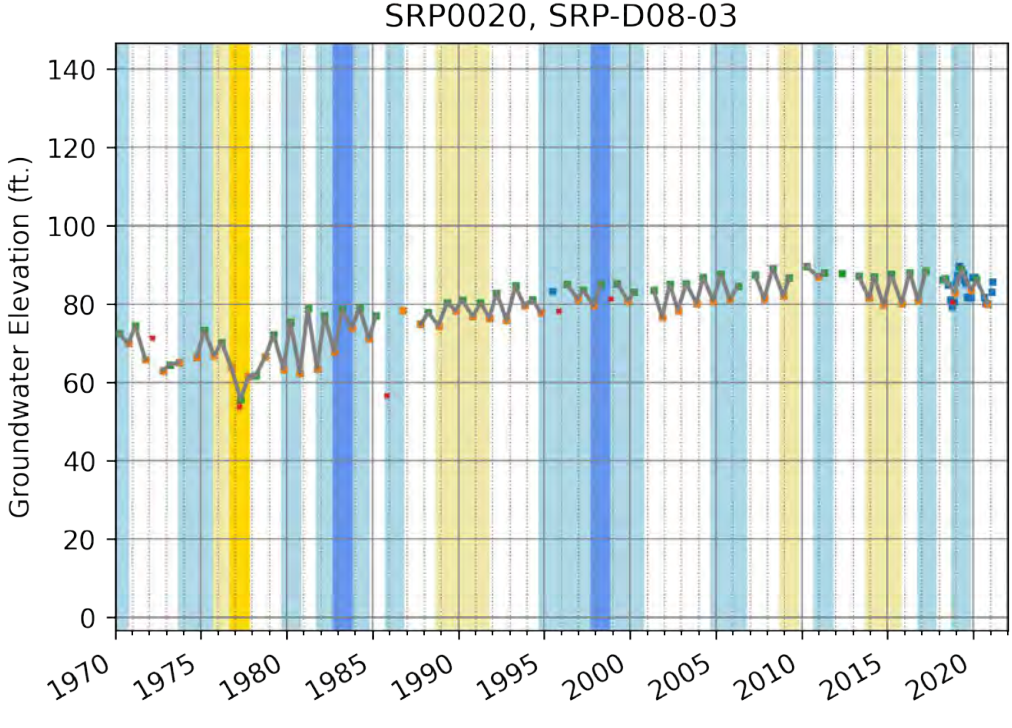
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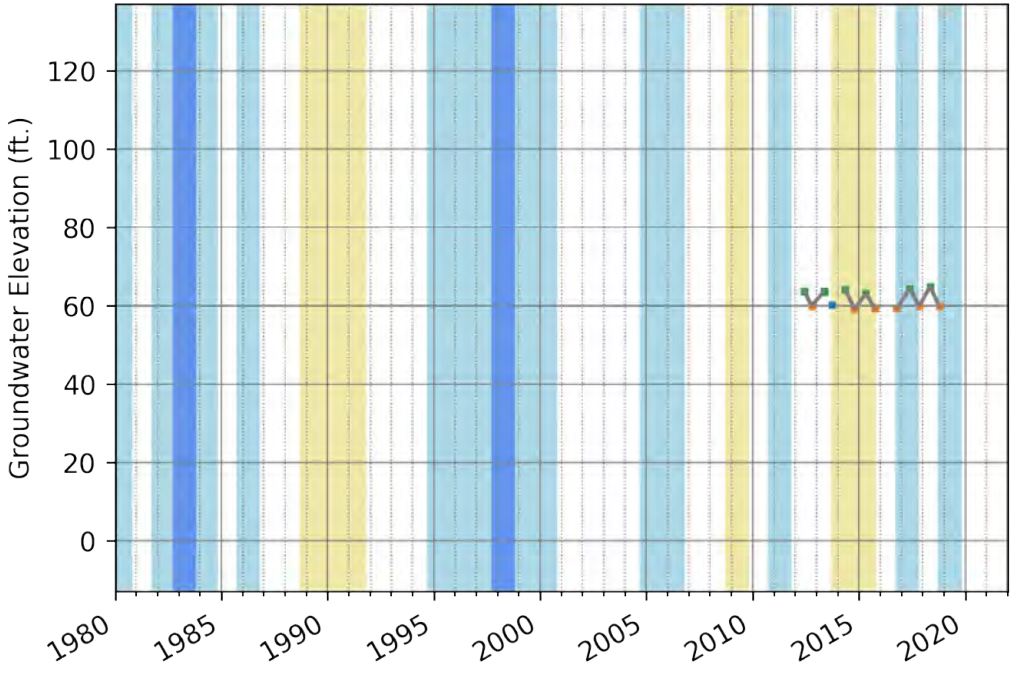
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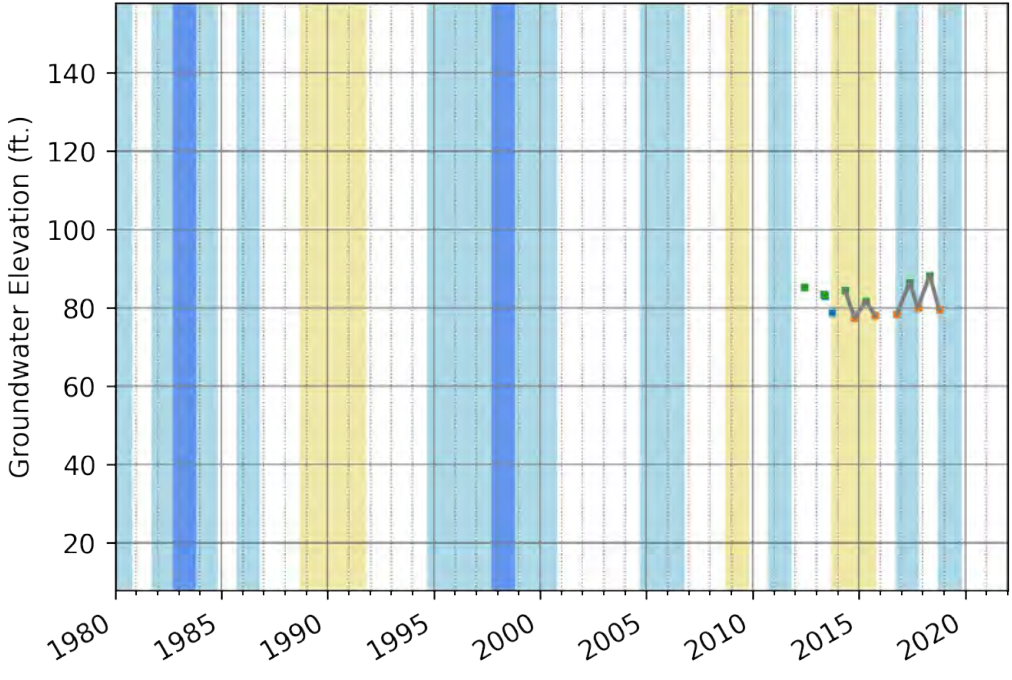
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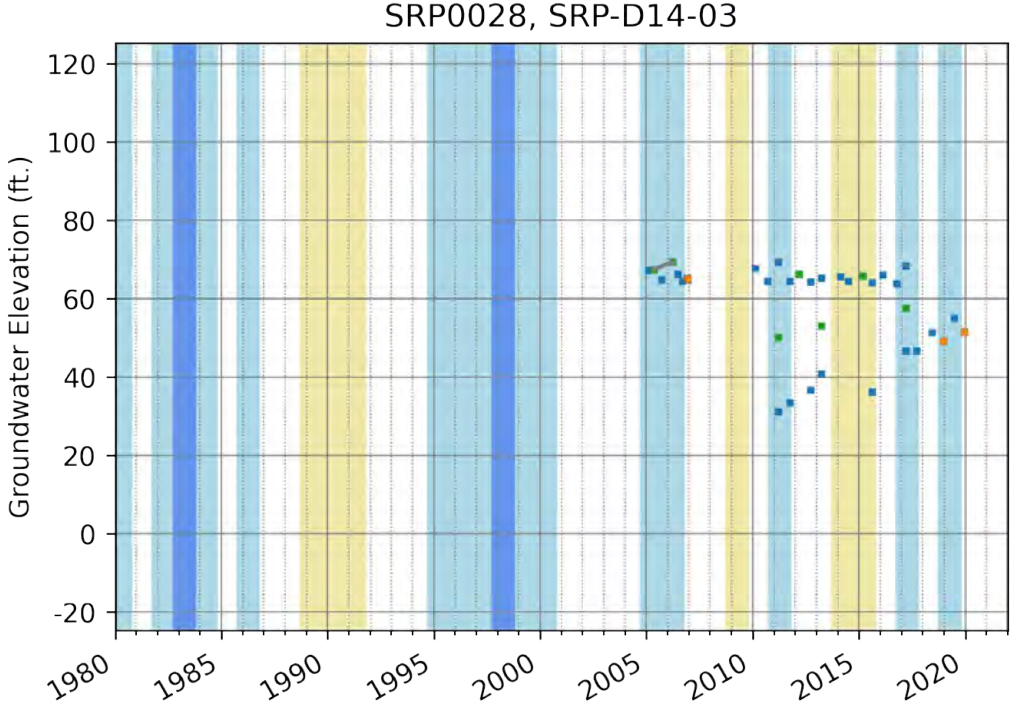
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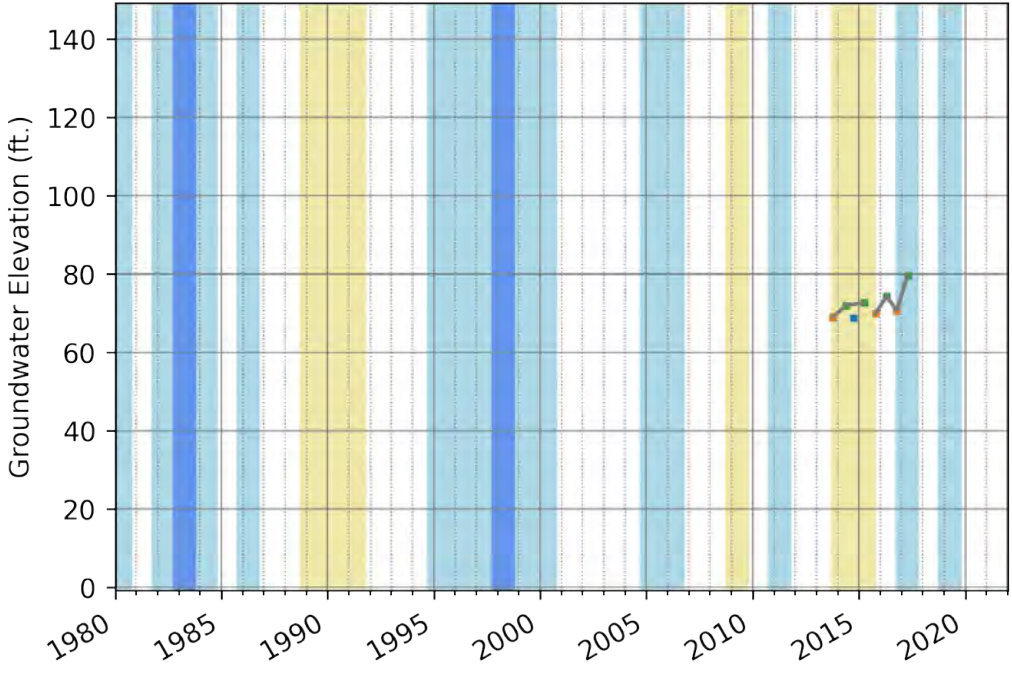
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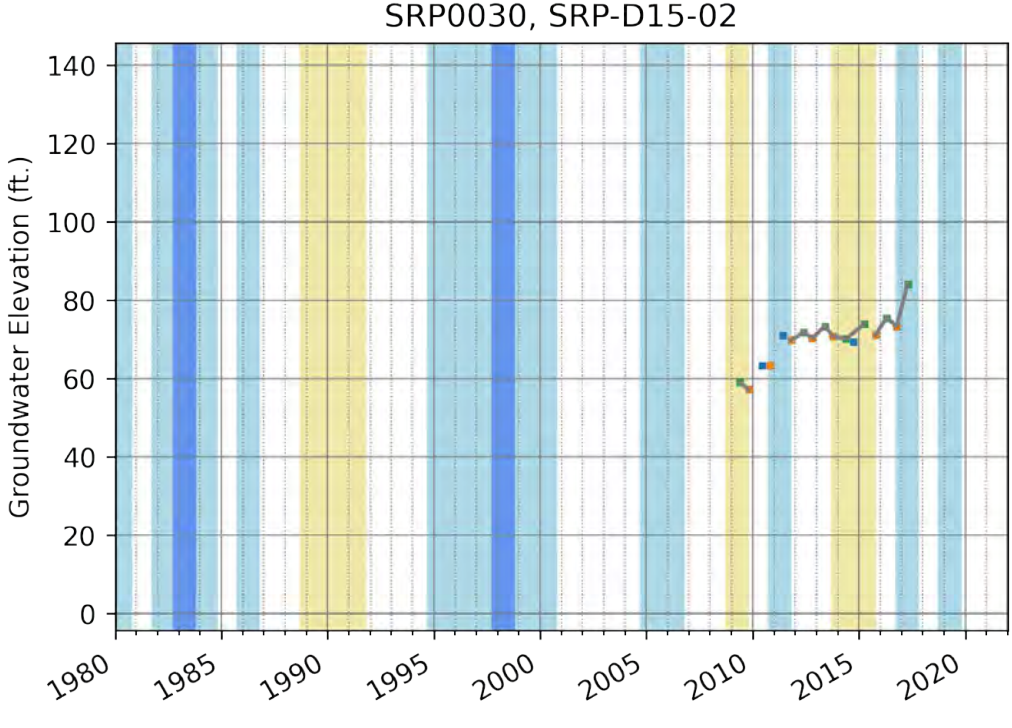
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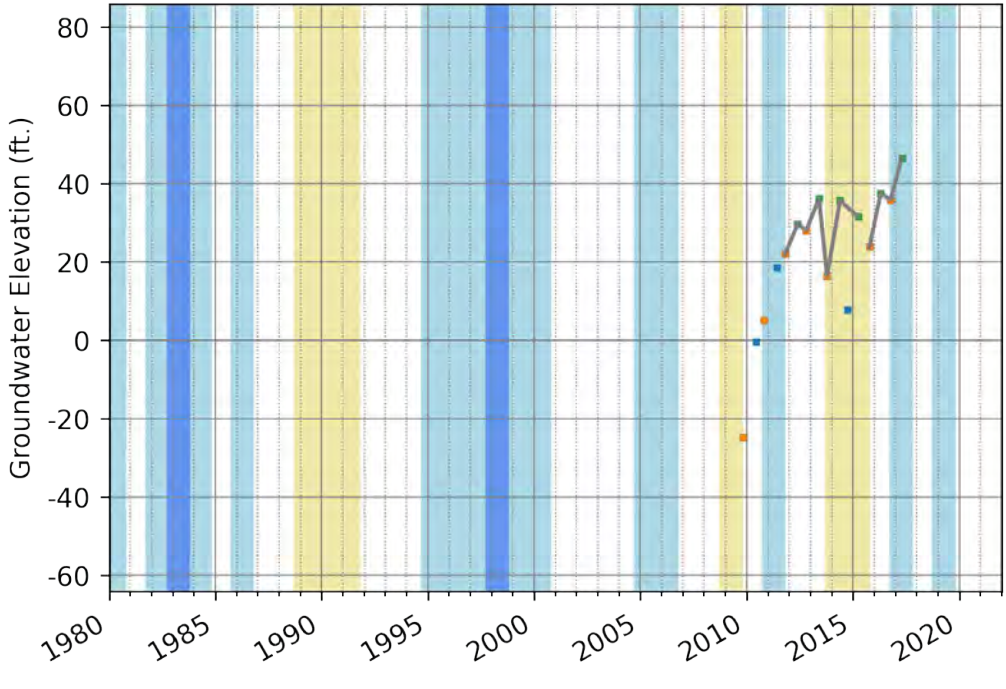
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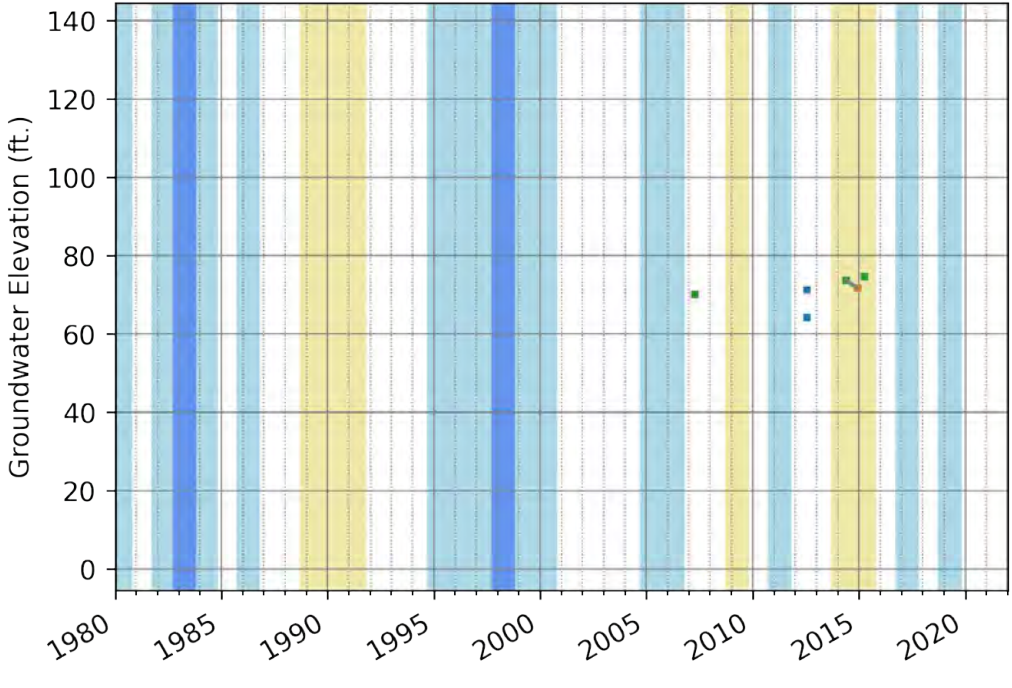
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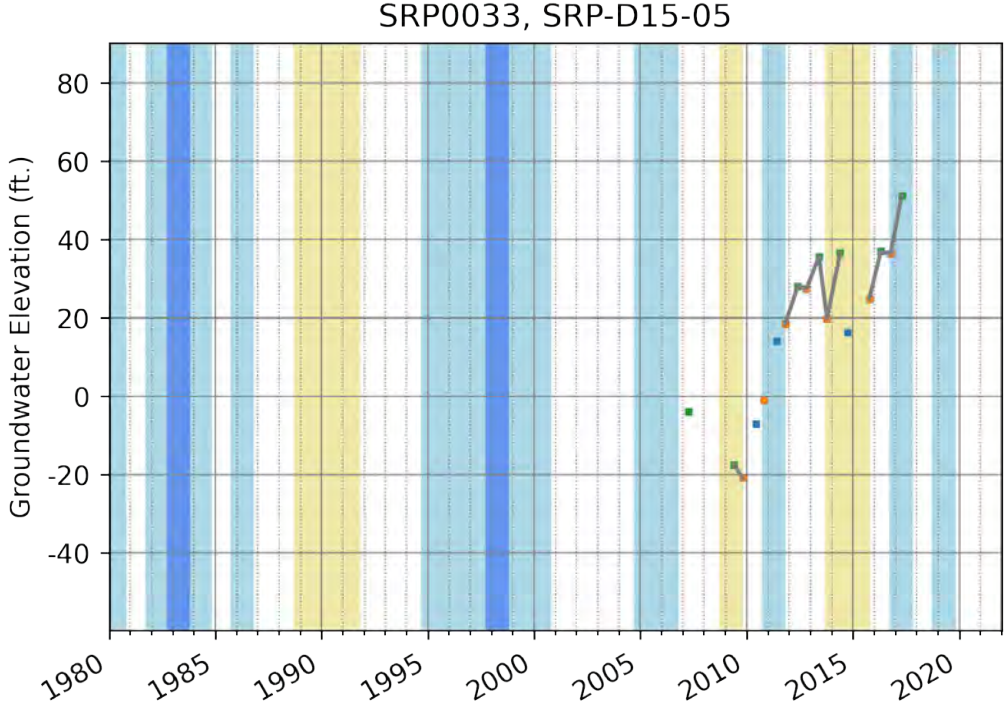
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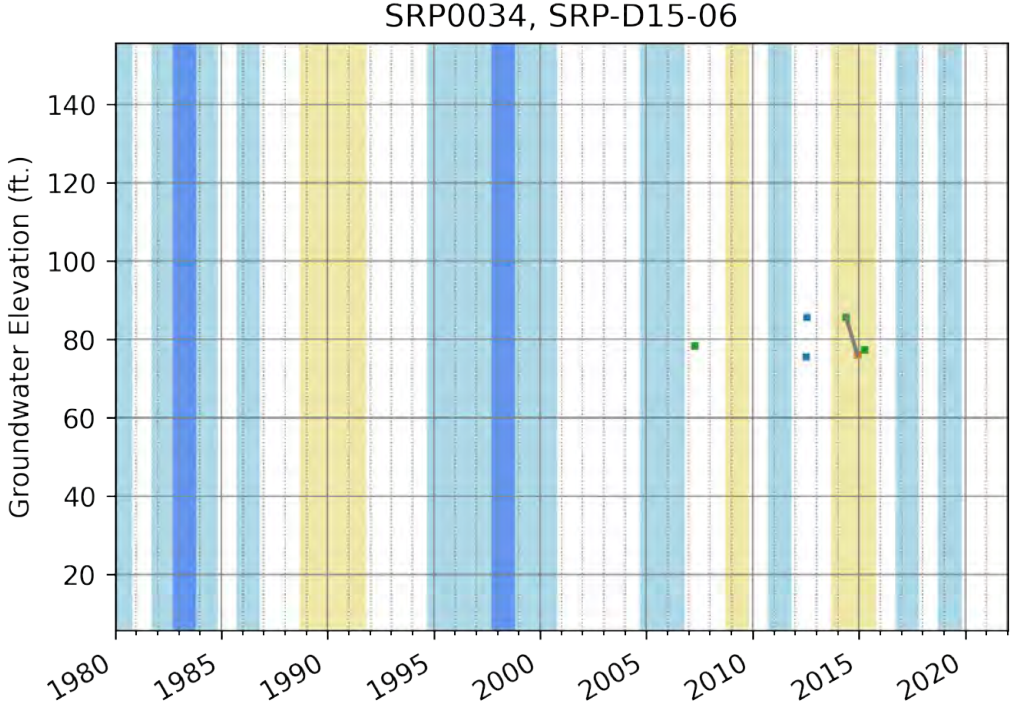
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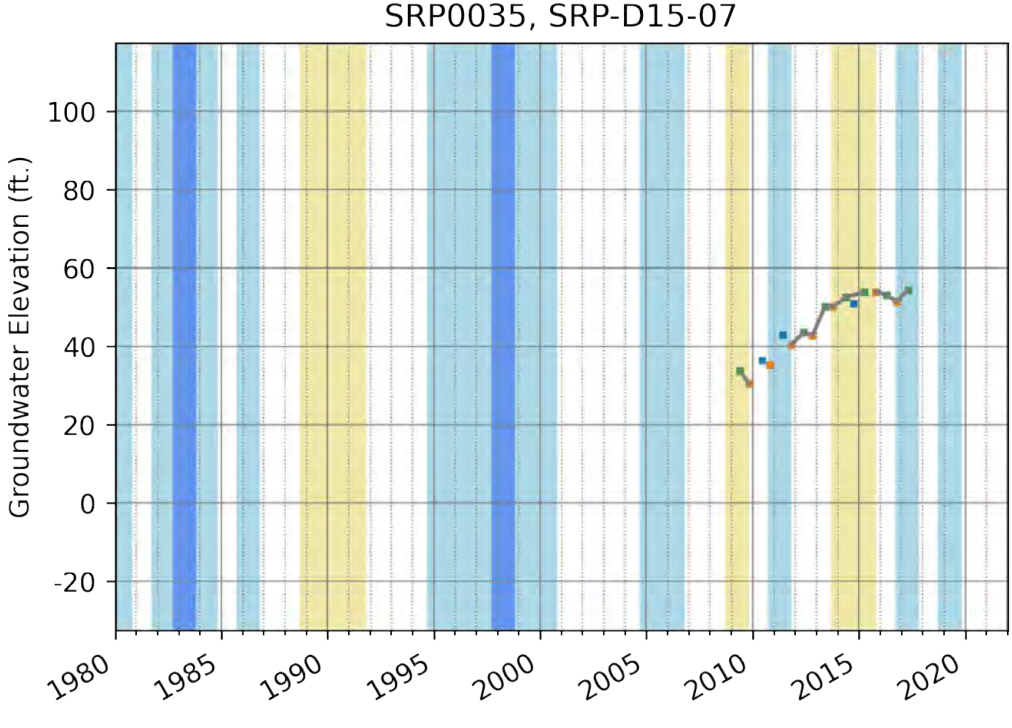
2015
2020


SRP0035, SRP-D15-07
Groundwater Elevation (ft.)
100
80
60
40
20
0
-20
1980
1985
1990
1995
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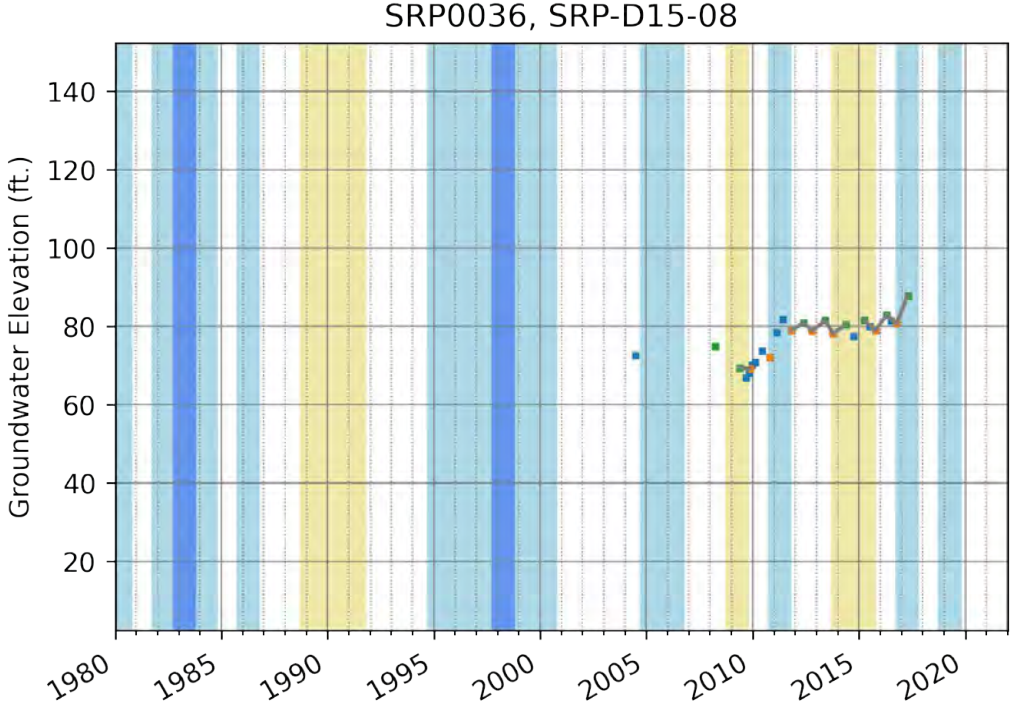
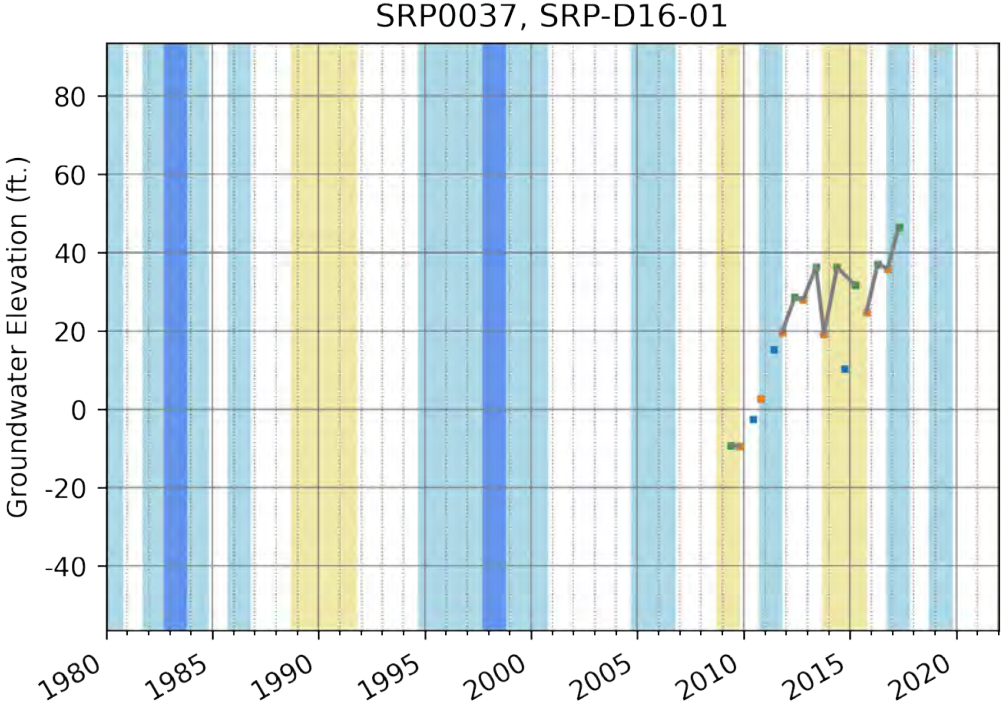
2005
2010
2015
2020


SRP0036, SRP-D15-08
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0037, SRP-D16-01
Groundwater Elevation (ft.)
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60
40
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-20
-40
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1985
1990
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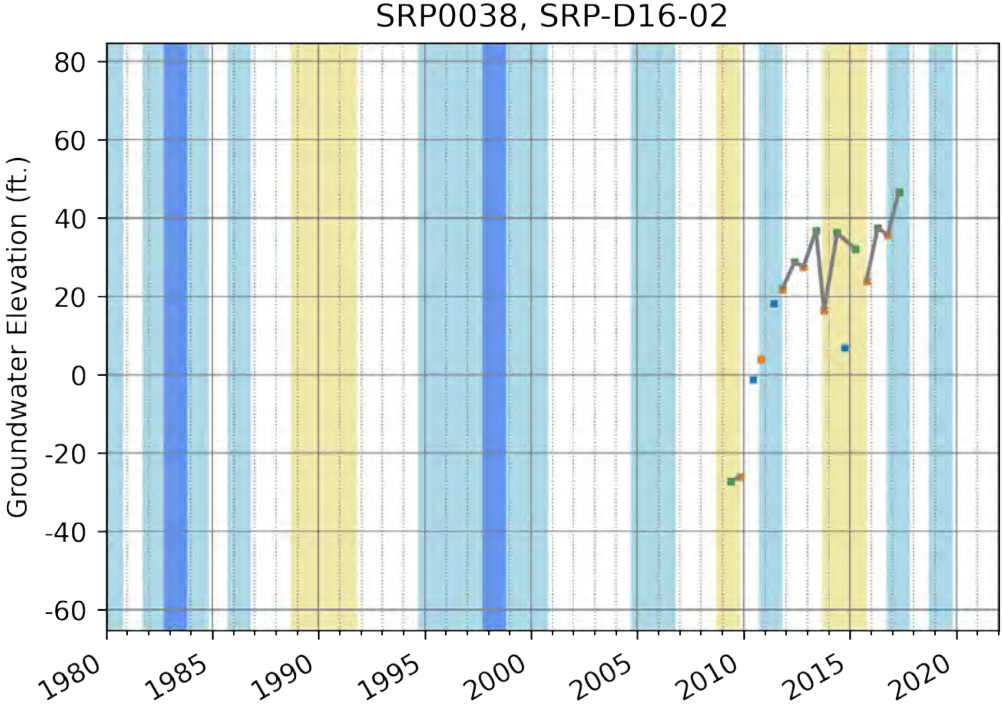
2005
2010
2015
2020


SRP0038, SRP-D16-02
Groundwater Elevation (ft.)
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60
40
20
0
-20
-40
-60
1980
1985
1990
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2015
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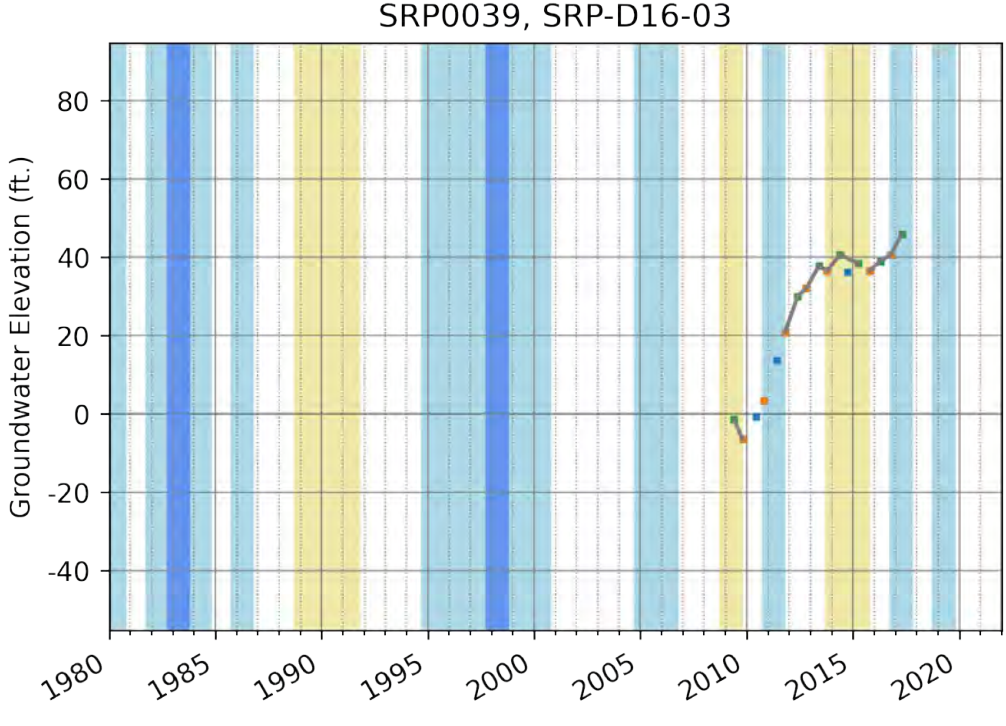
SRP0039, SRP-D16-03
Groundwater Elevation (ft.)
80
60
40
20
0
-20
-40
1980
1985
1990
1995
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2005
2010
2015
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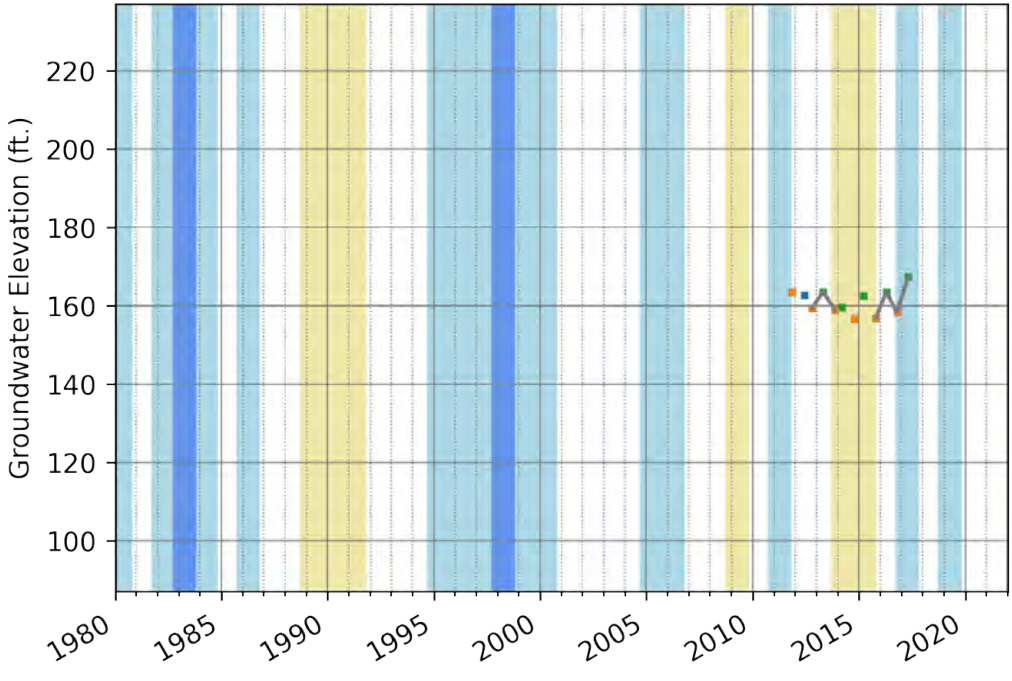
SRP0040, SRP-D17-01
Groundwater Elevation (ft.)
220
200
180
160
140
120
100
1980
1985
1990
1995
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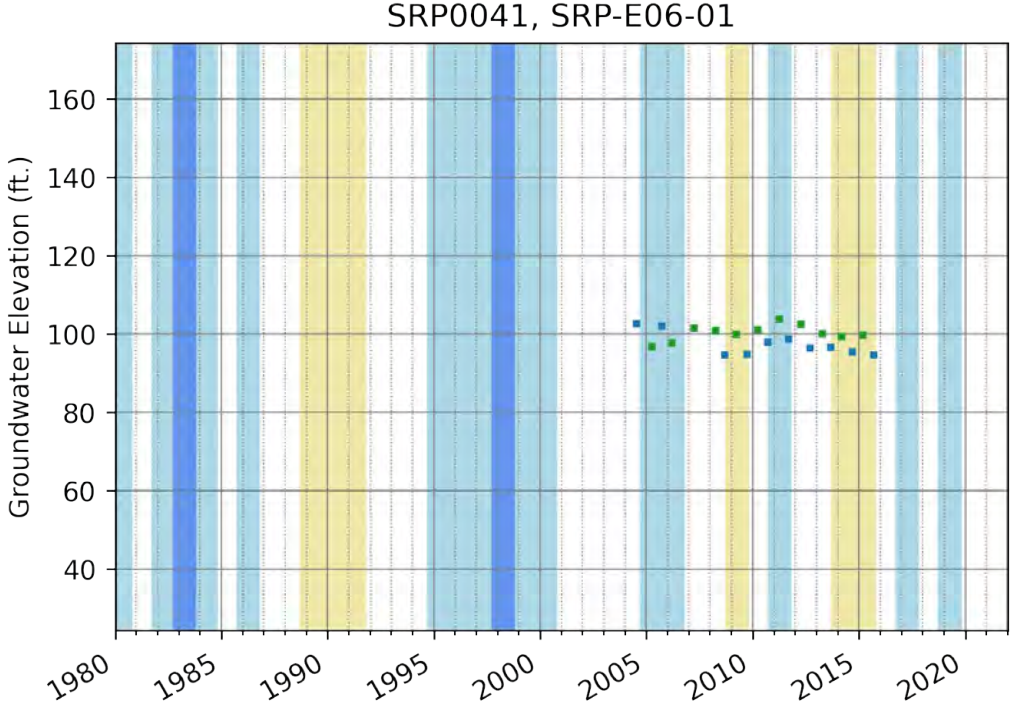
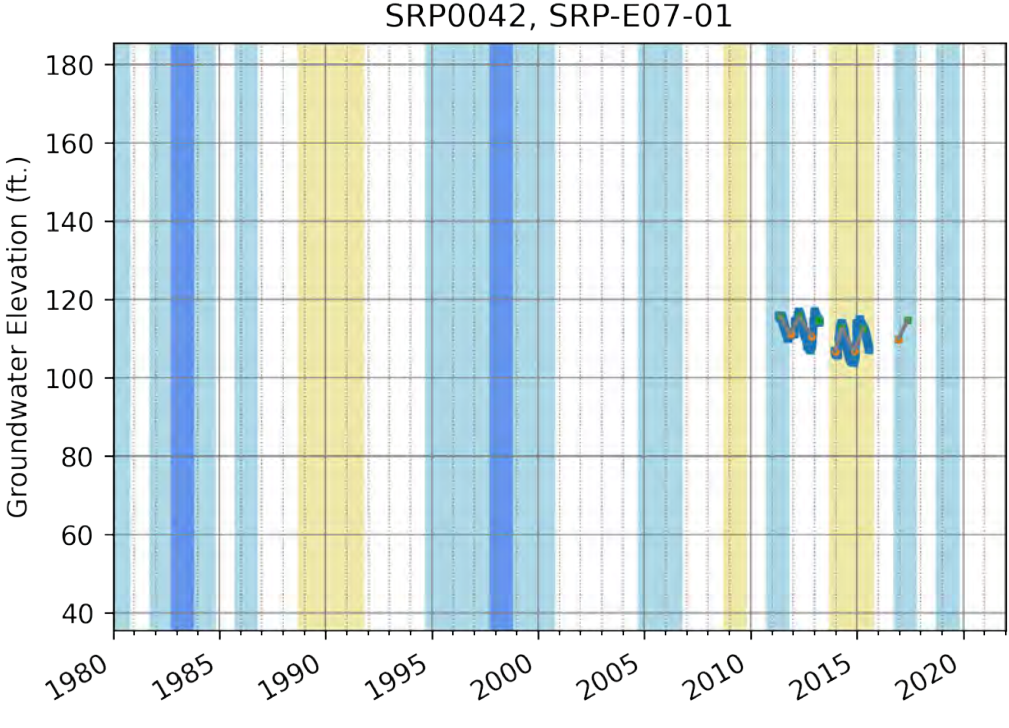
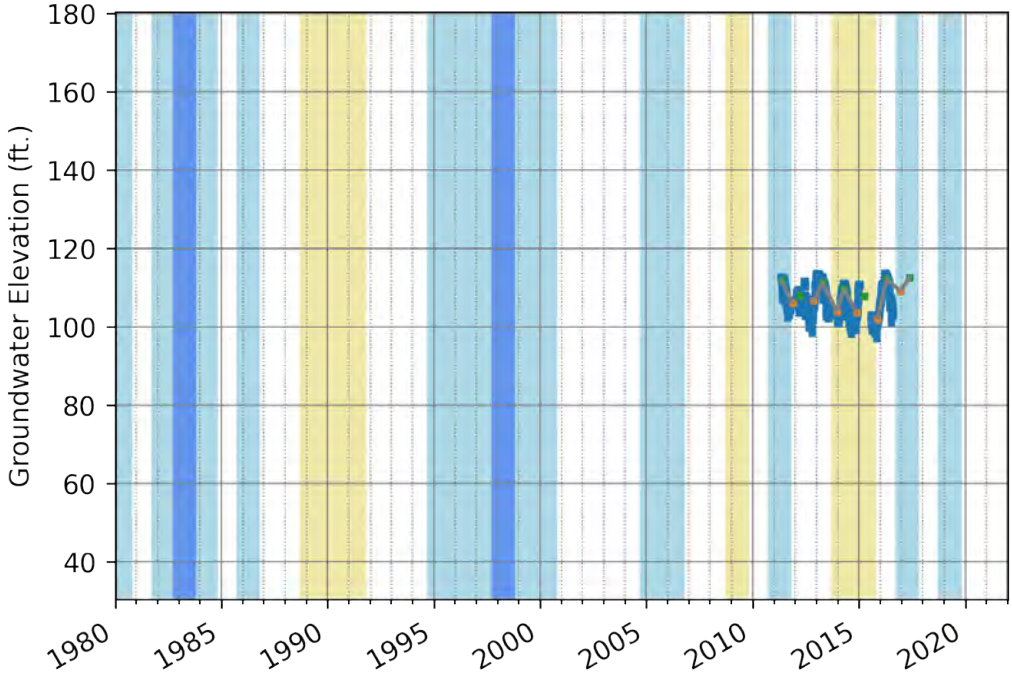
2005
2010
2015
2020


SRP0041, SRP-E06-01
Groundwater Elevation (ft.)
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0042, SRP-E07-01
Groundwater Elevation (ft.)
180
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0043, SRP-E07-02
Groundwater Elevation (ft.)
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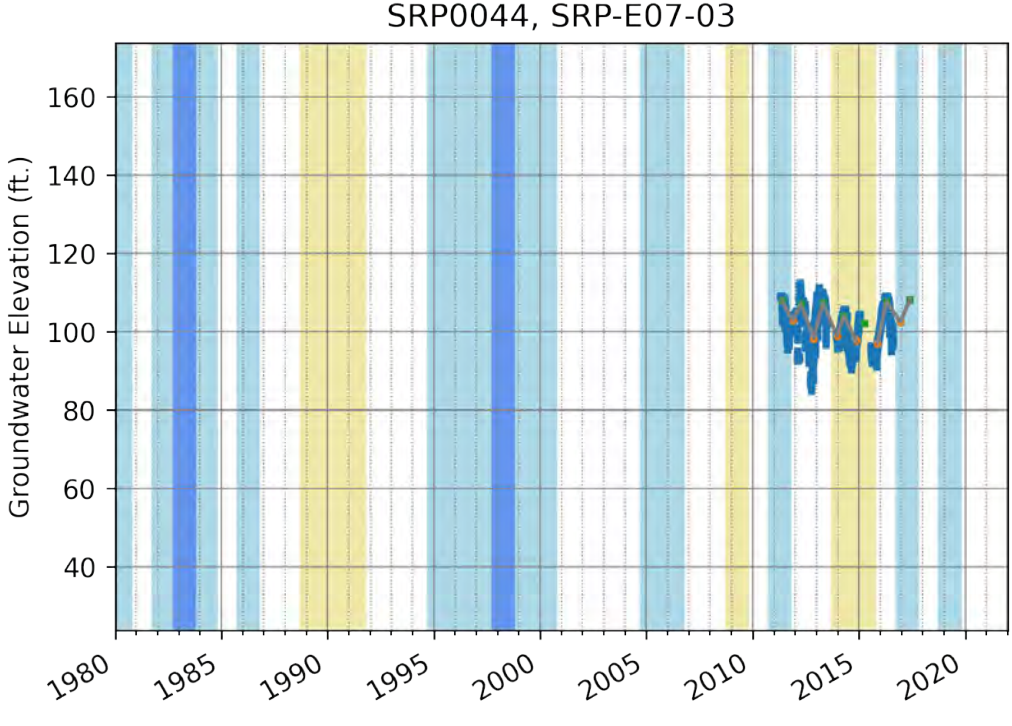
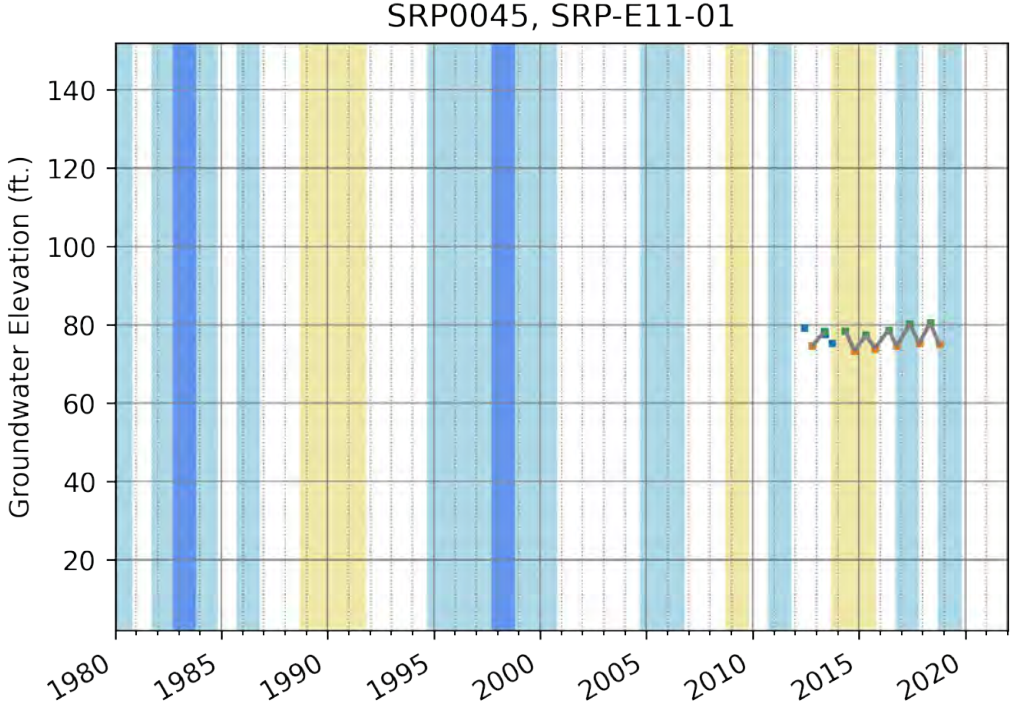
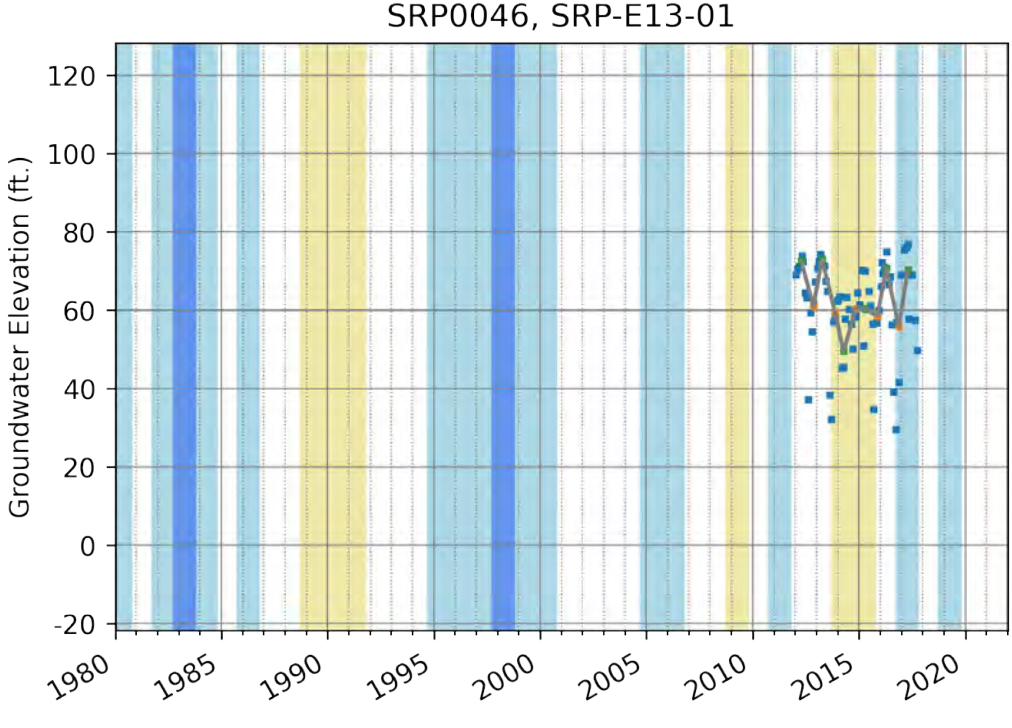
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0044, SRP-E07-03
Groundwater Elevation (ft.)
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0045, SRP-E11-01
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0046, SRP-E13-01
Groundwater Elevation (ft.)
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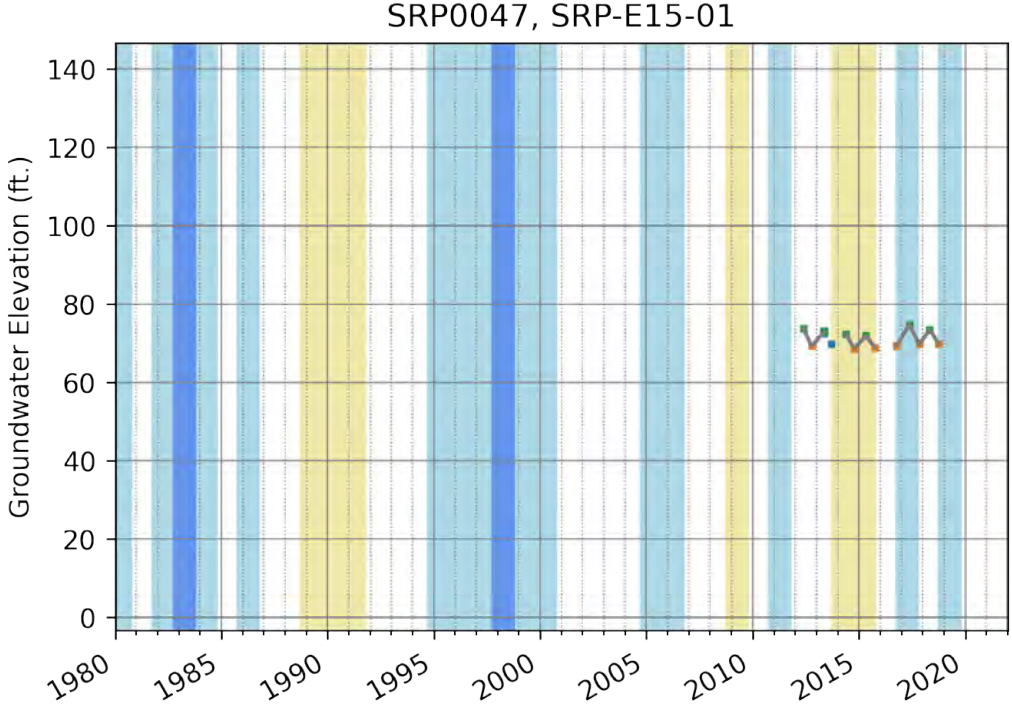
100
80
60
40
20
0
-20
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0047, SRP-E15-01
Groundwater Elevation (ft.)
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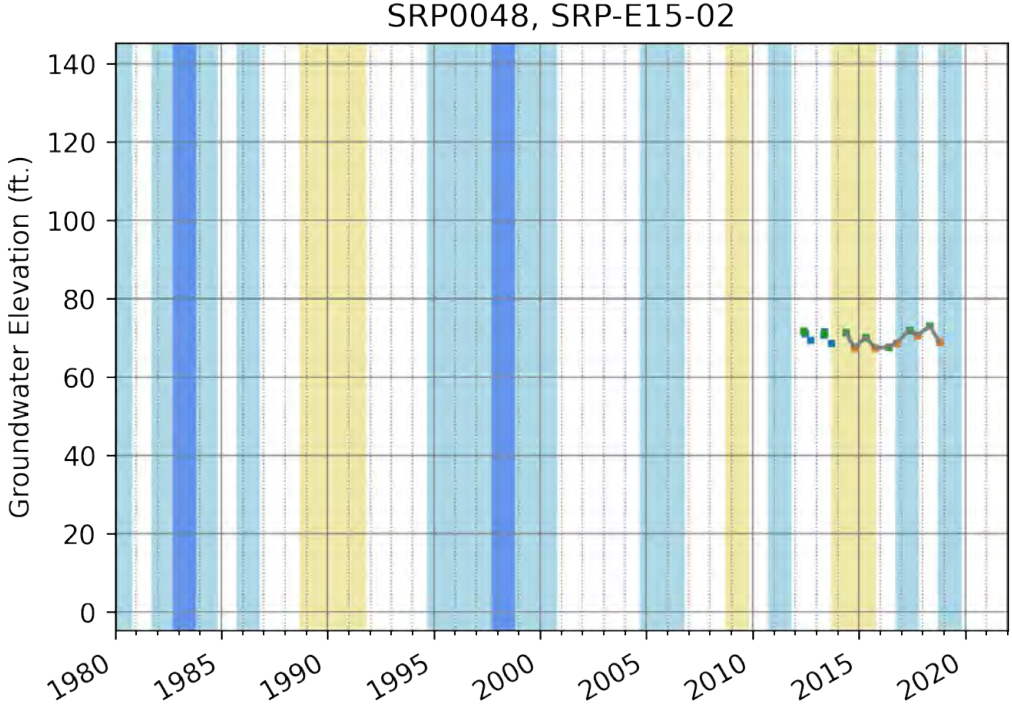
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0048, SRP-E15-02
Groundwater Elevation (ft.)
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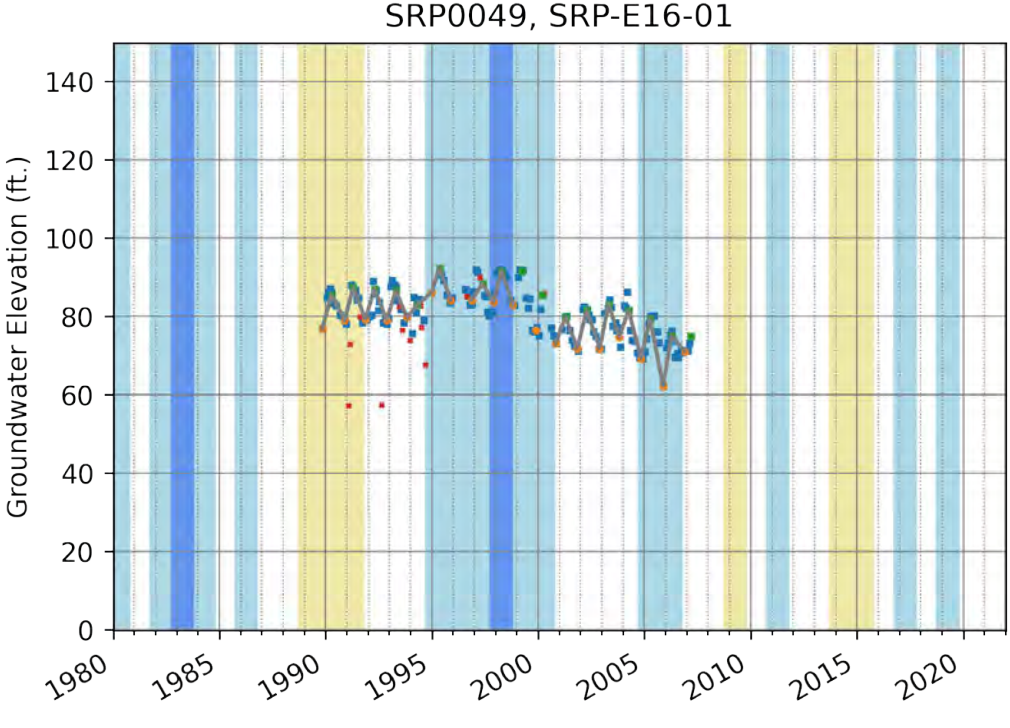
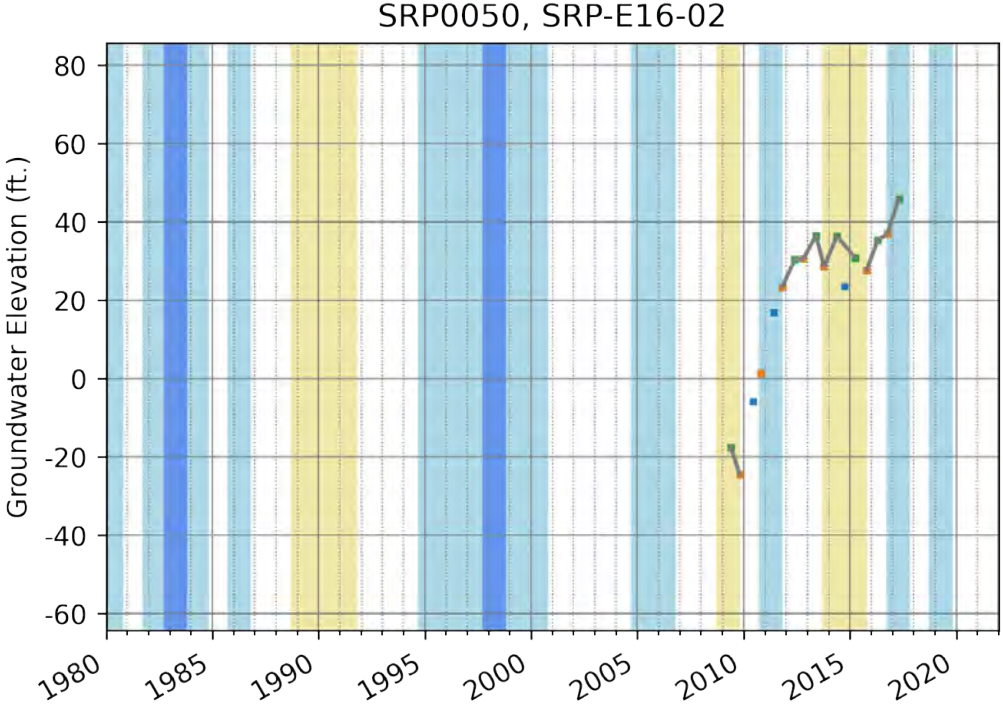
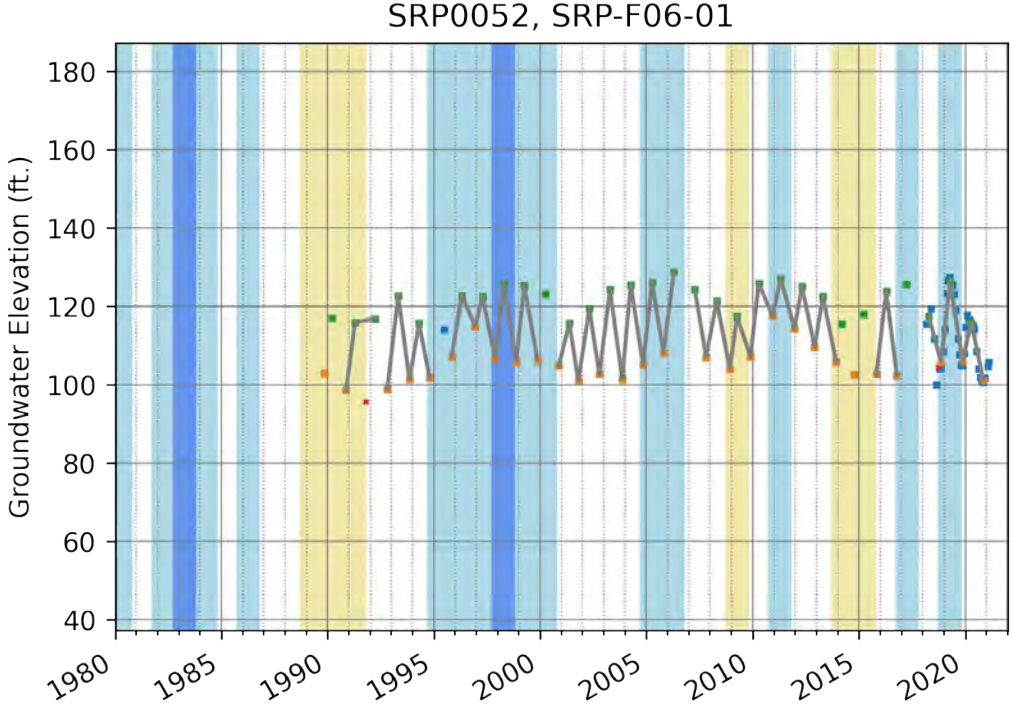
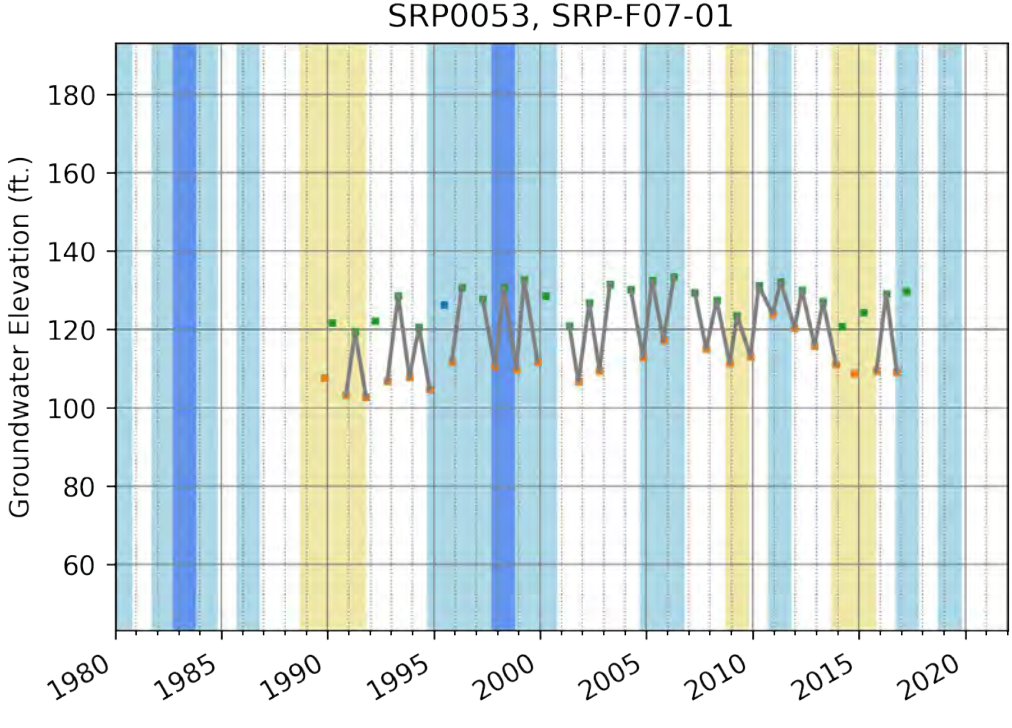
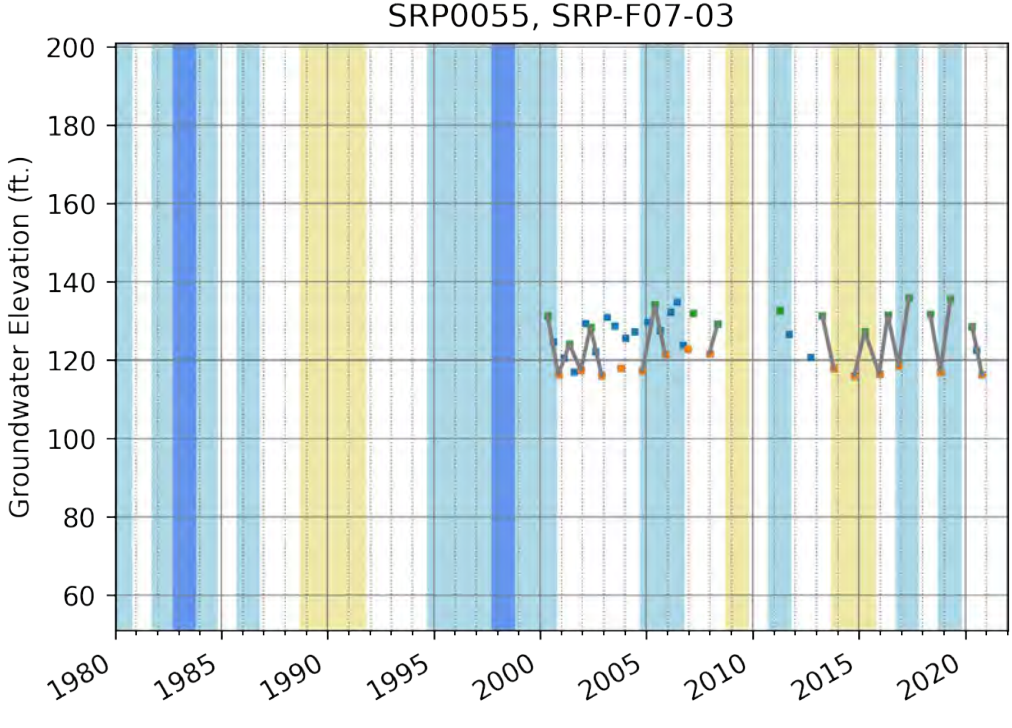
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020

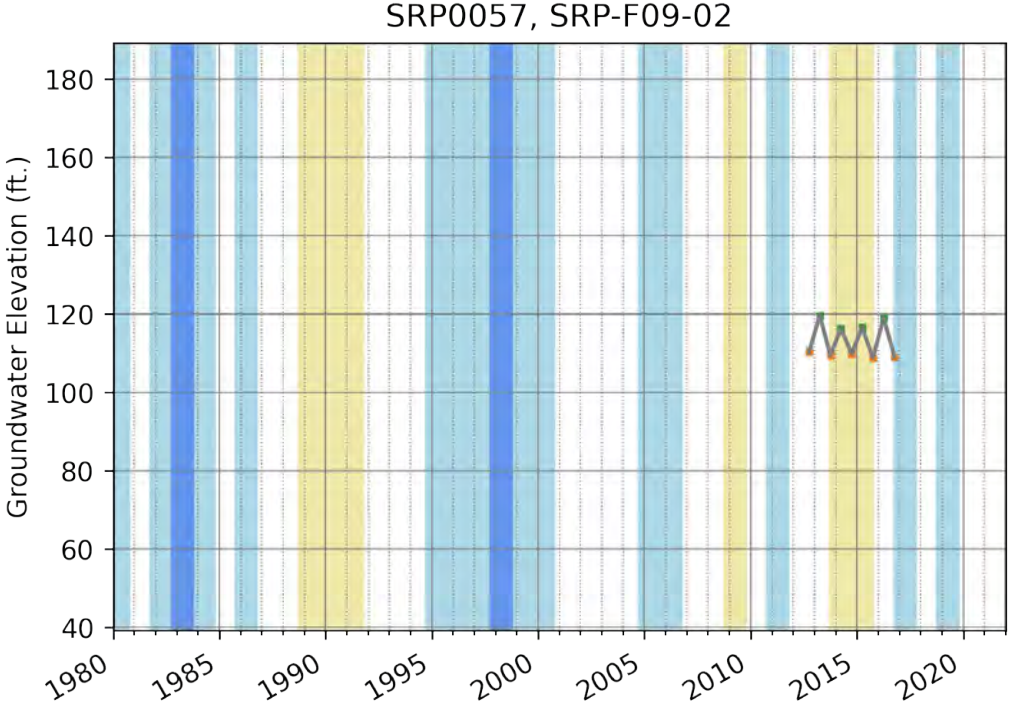

SRP0049, SRP-E16-01
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0050, SRP-E16-02
Groundwater Elevation (ft.)
80
60
40
20
0
-20
-40
-60
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0052, SRP-F06-01
Groundwater Elevation (ft.)
180
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0053, SRP-F07-01
Groundwater Elevation (ft.)
180
160
140
120
100
80
60
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0055, SRP-F07-03
Groundwater Elevation (ft.)
200
180
160
140
120
100
80
60
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0057, SRP-F09-02
Groundwater Elevation (ft.)
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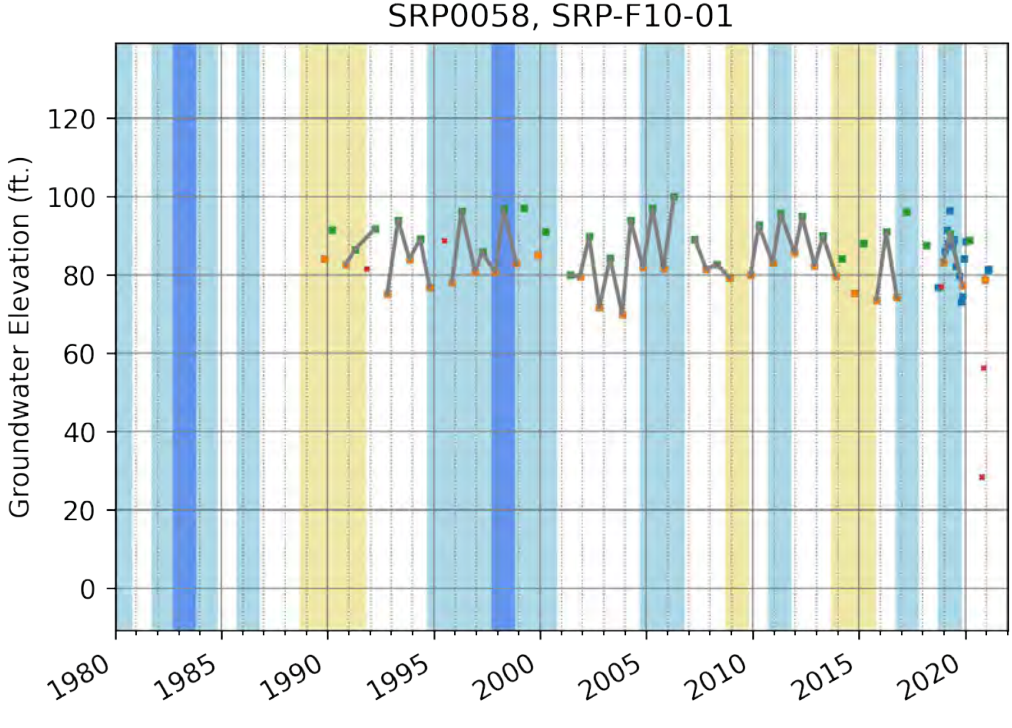
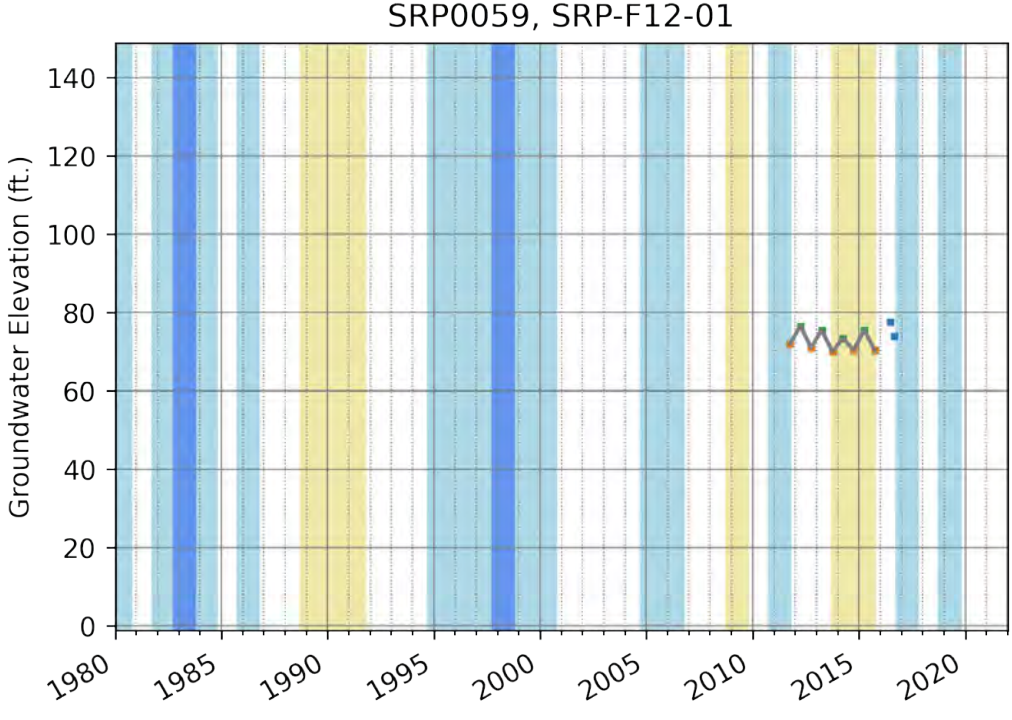
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0058, SRP-F10-01
Groundwater Elevation (ft.)
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0059, SRP-F12-01
Groundwater Elevation (ft.)
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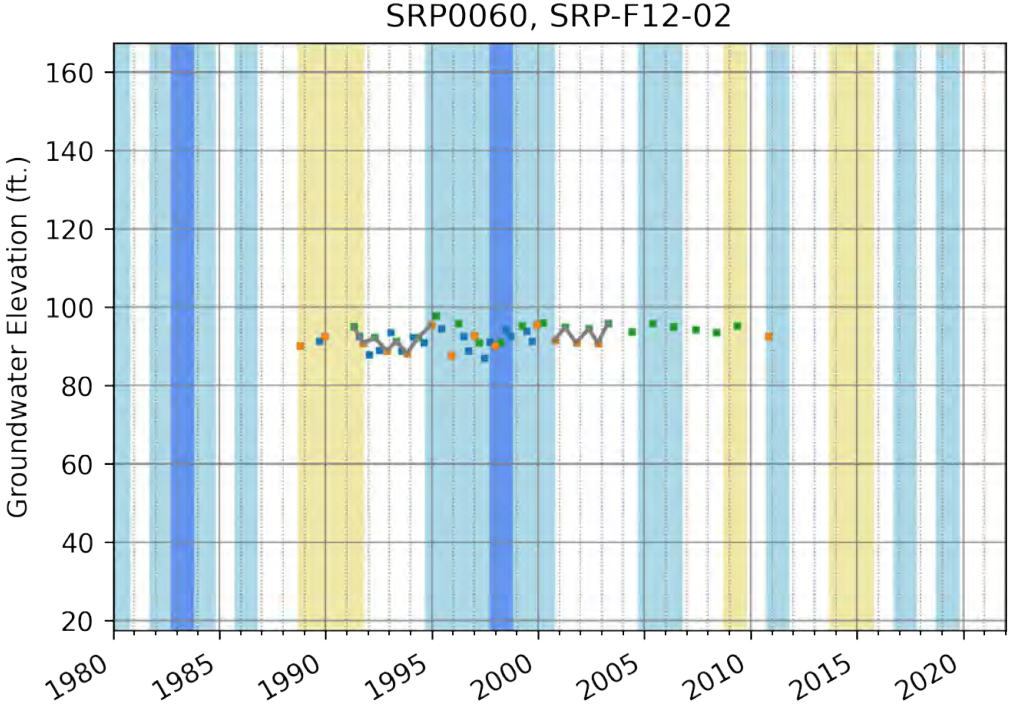
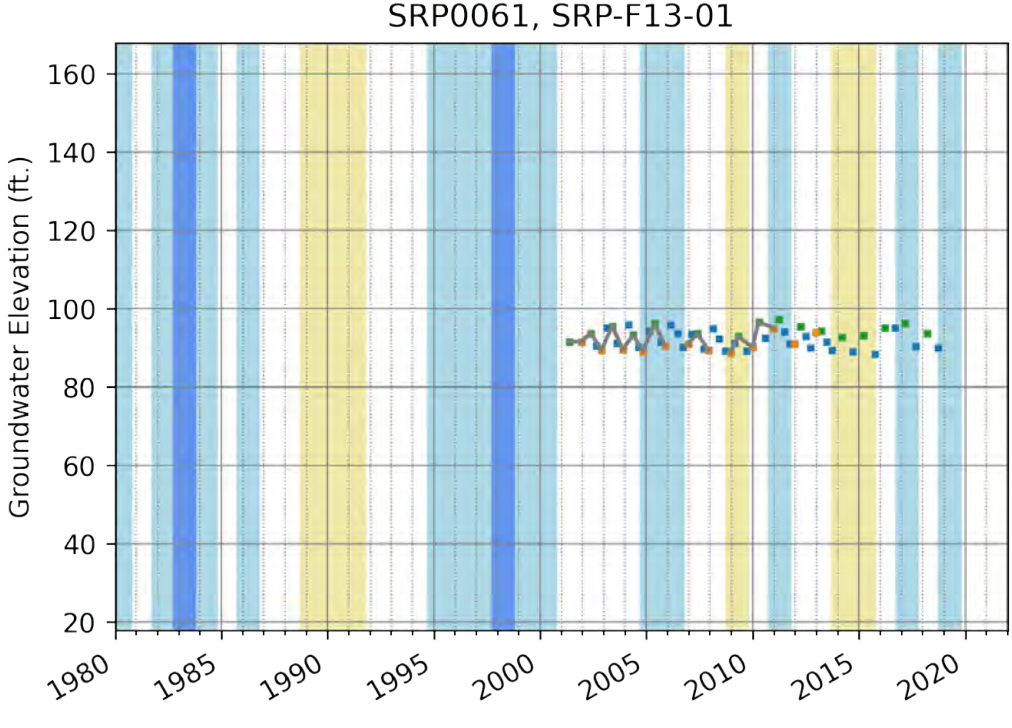
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0060, SRP-F12-02
Groundwater Elevation (ft.)
160
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0061, SRP-F13-01
Groundwater Elevation (ft.)
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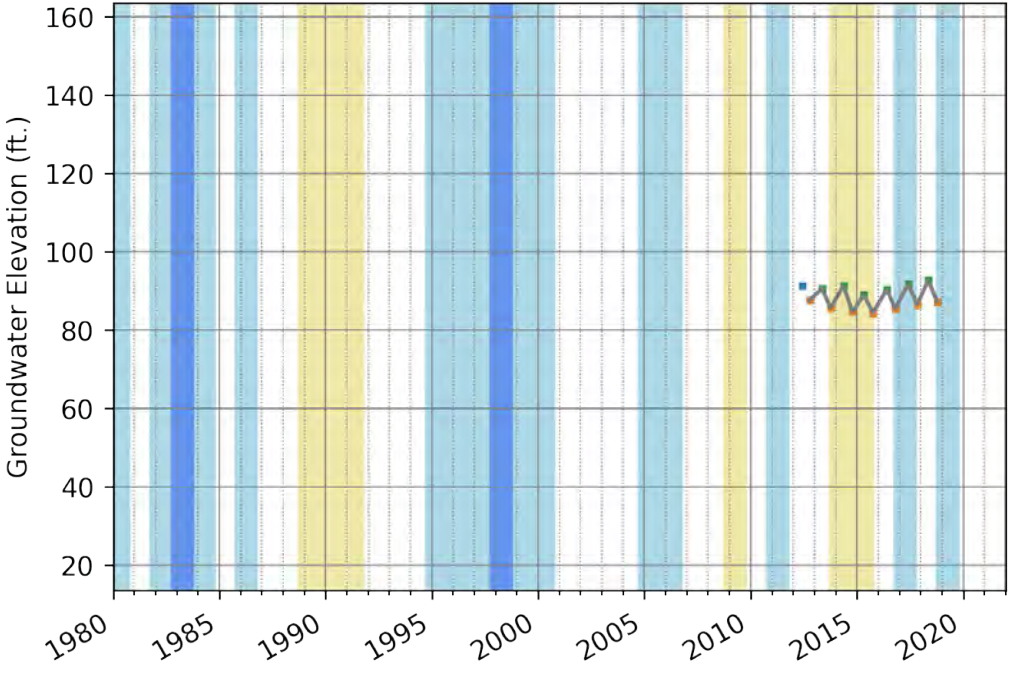
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0062, SRP-F14-01
Groundwater Elevation (ft.)
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140
120
100
80
60
40
20
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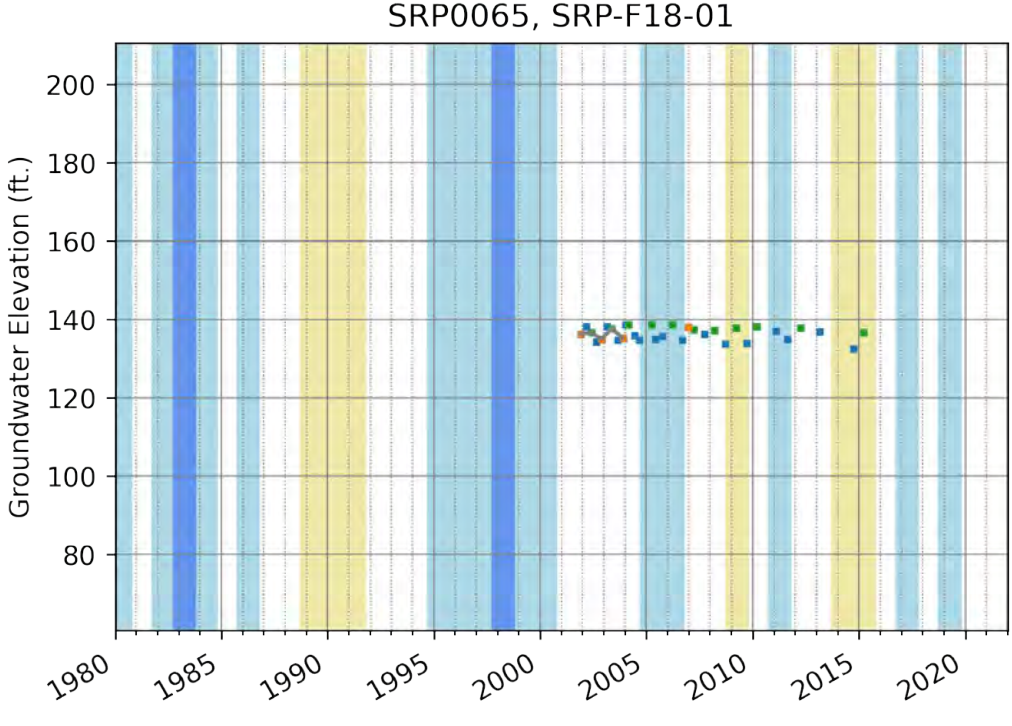
1985
1990
1995
2000
2005
2010
2015
2020


SRP0065, SRP-F18-01
Groundwater Elevation (ft.)
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180
160
140
120
100
80
1980
1985
1990
1995
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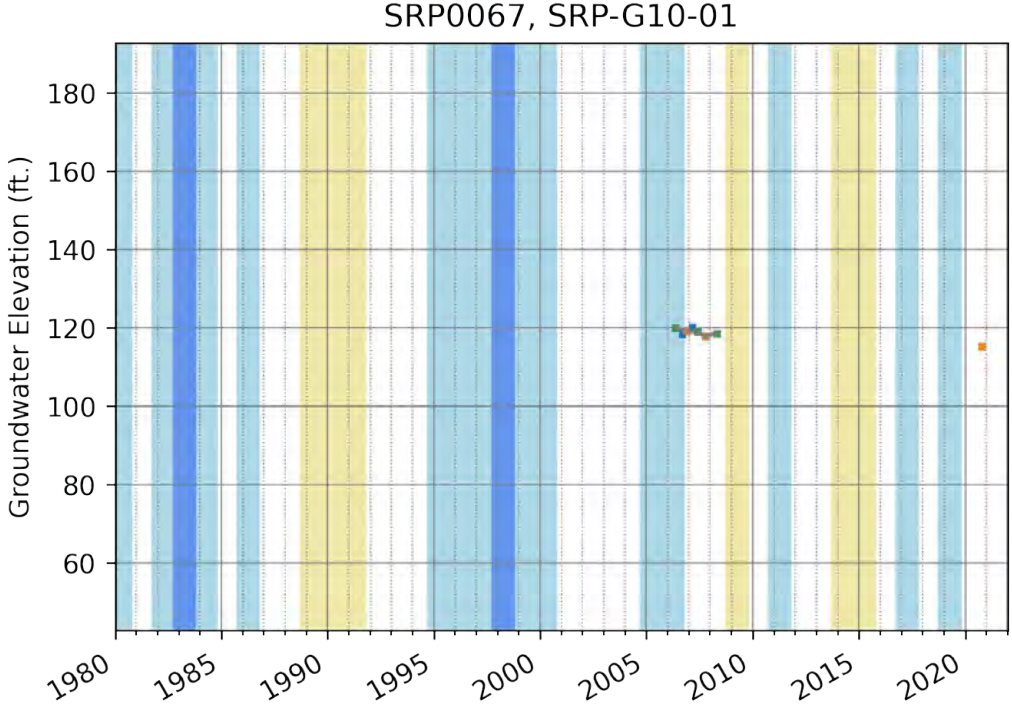
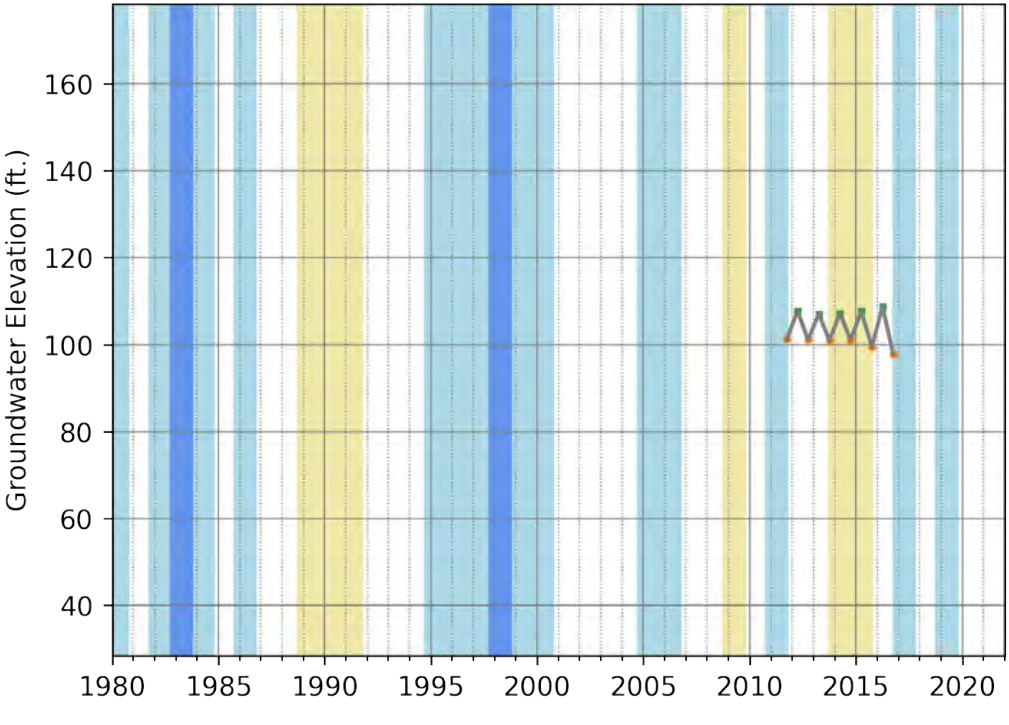
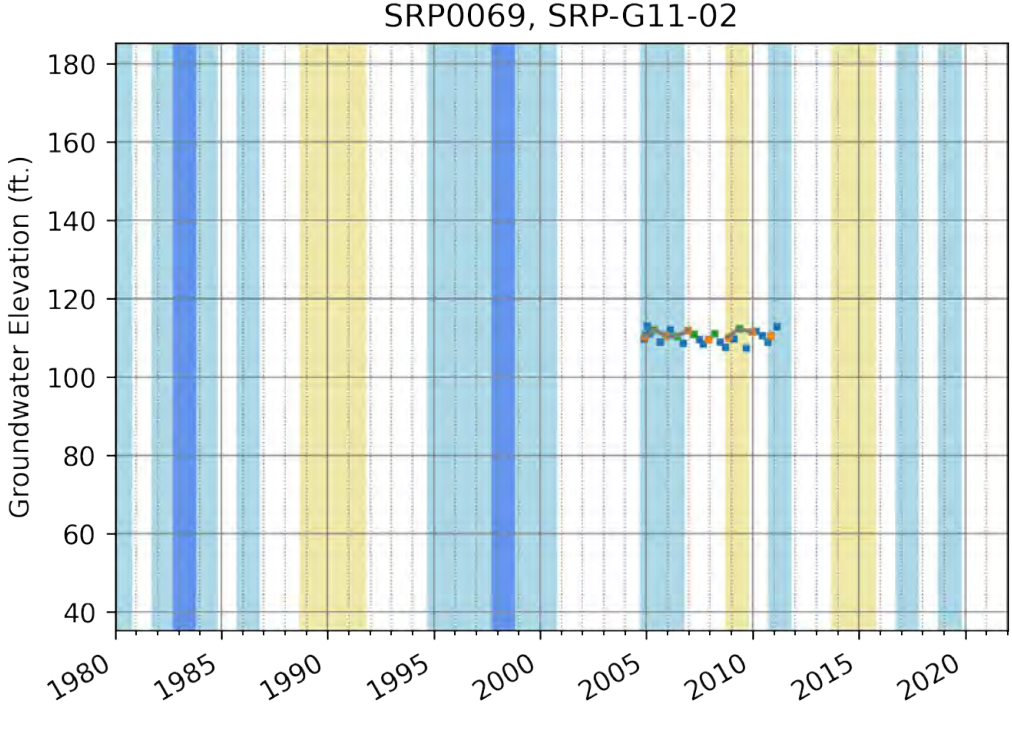
2005
2010
2015
2020


SRP0067, SRP-G10-01
Groundwater Elevation (ft.)
180
160
140
120
100
80
60
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0068, SRP-G11-01
Groundwater Elevation (ft.)
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0069, SRP-G11-02
Groundwater Elevation (ft.)
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160
140
120
100
80
60
40
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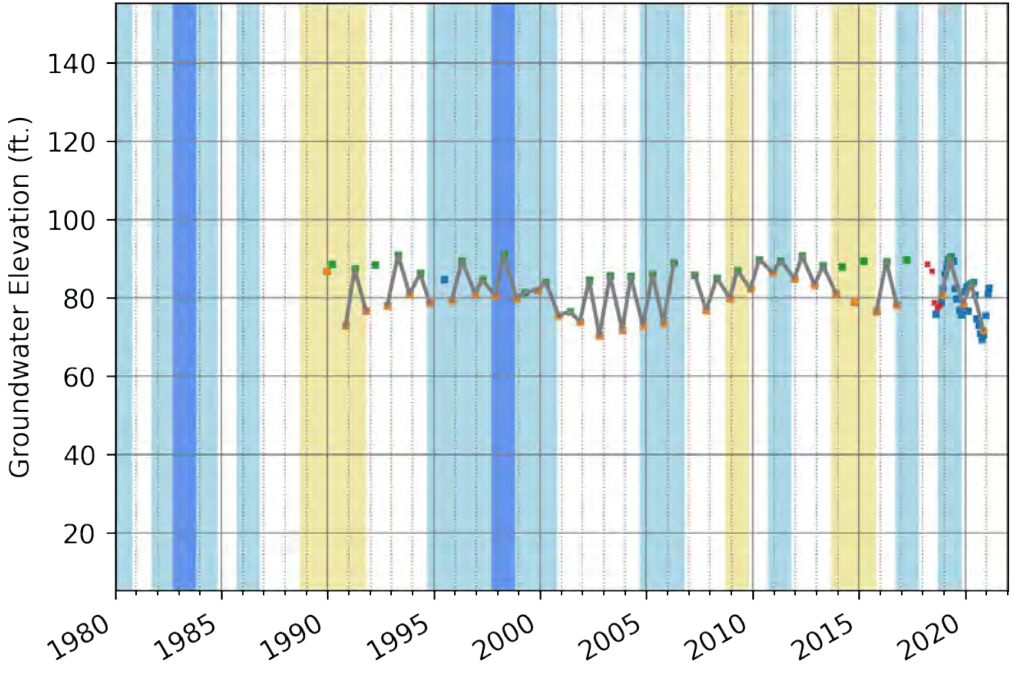
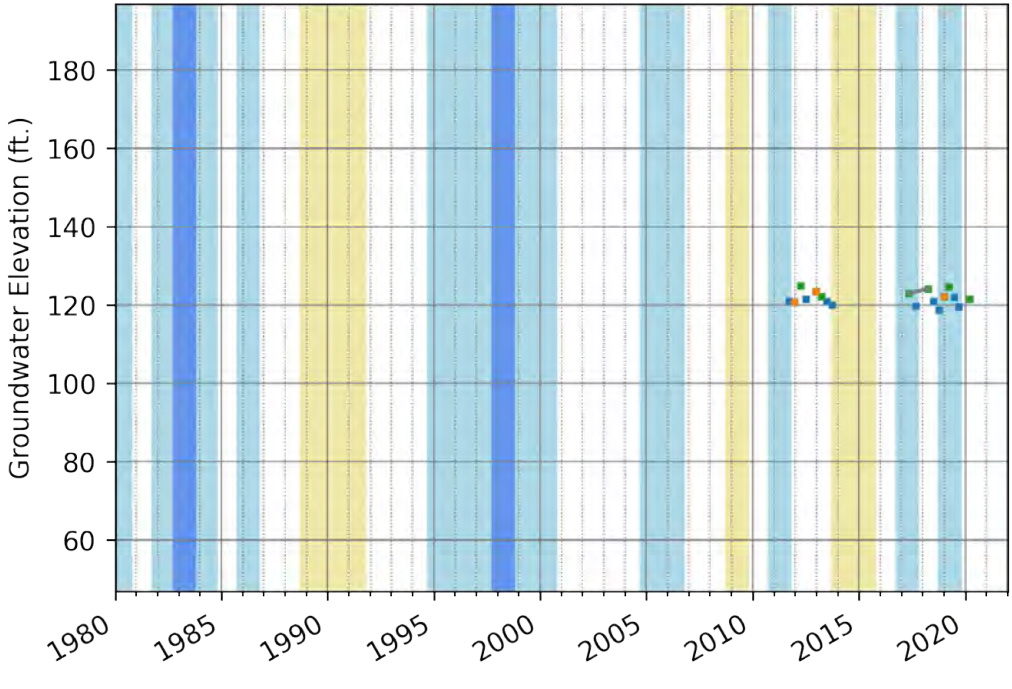
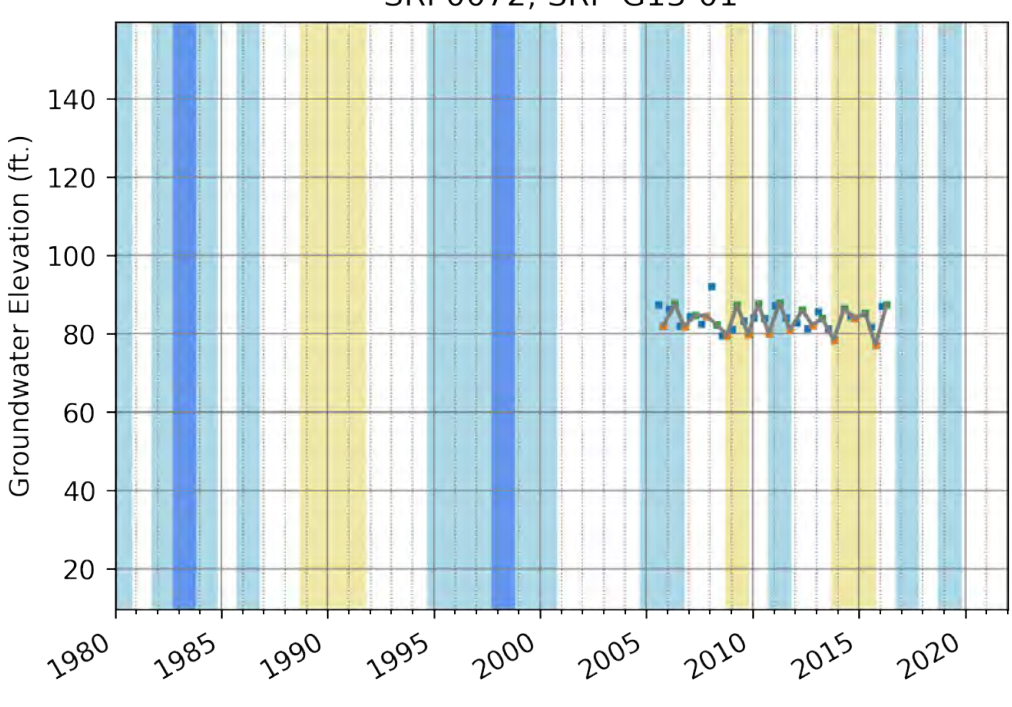
1985
1990
1995
2000
2005
2010
2015
2020


SRP0070, SRP-G12-01
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0071, SRP-G12-02
Groundwater Elevation (ft.)
180
160
140
120
100
80
60
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0072, SRP-G13-01
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1980
1985
1990
1995
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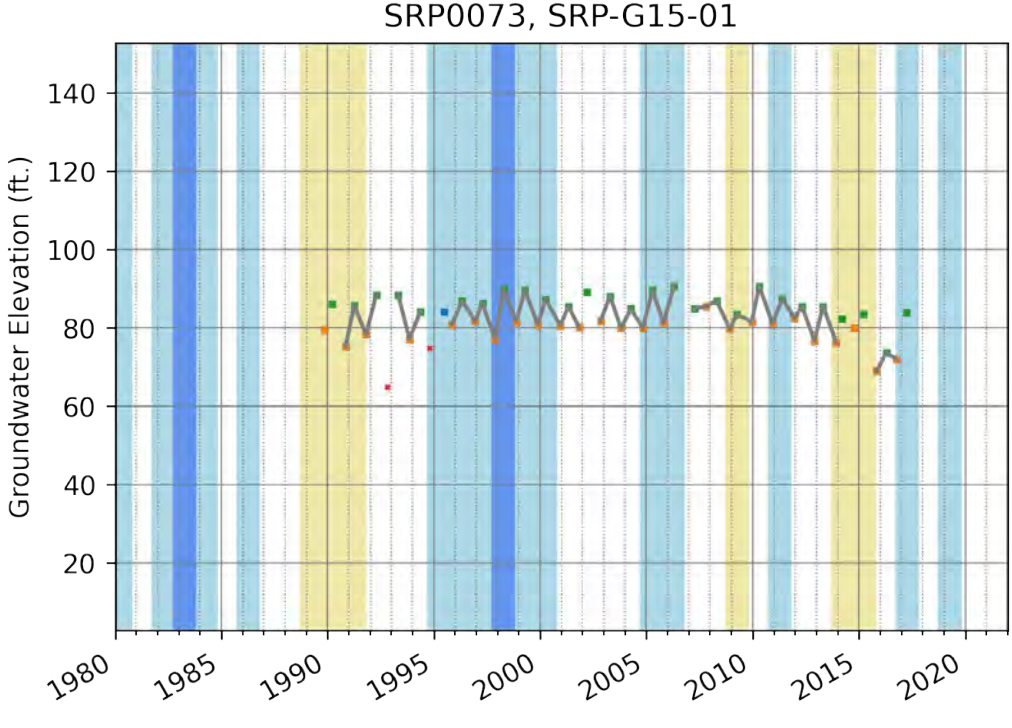
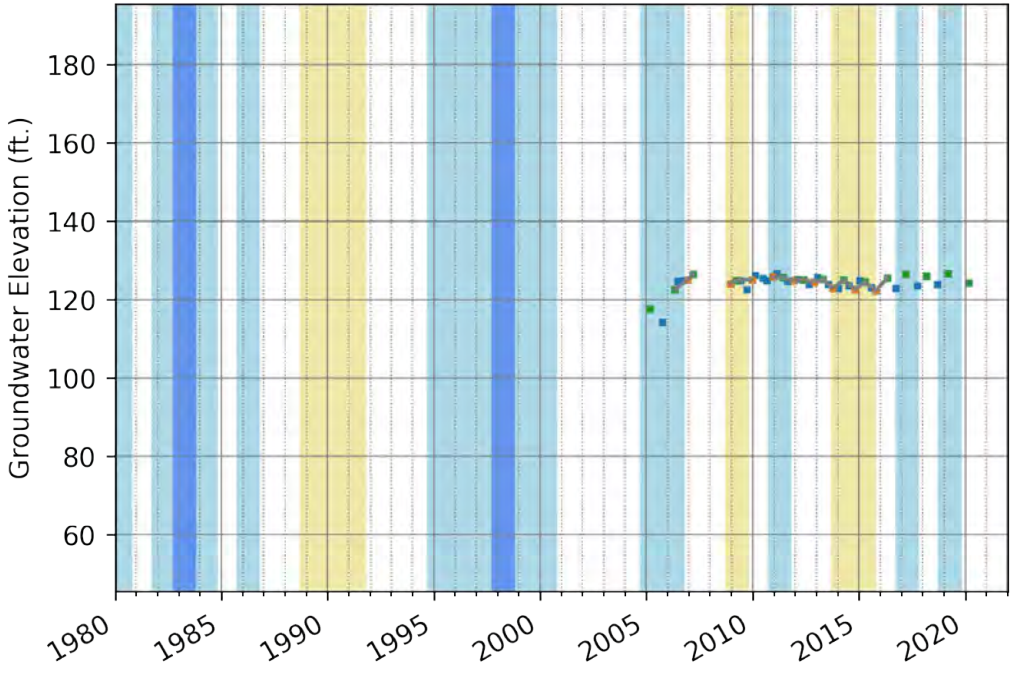
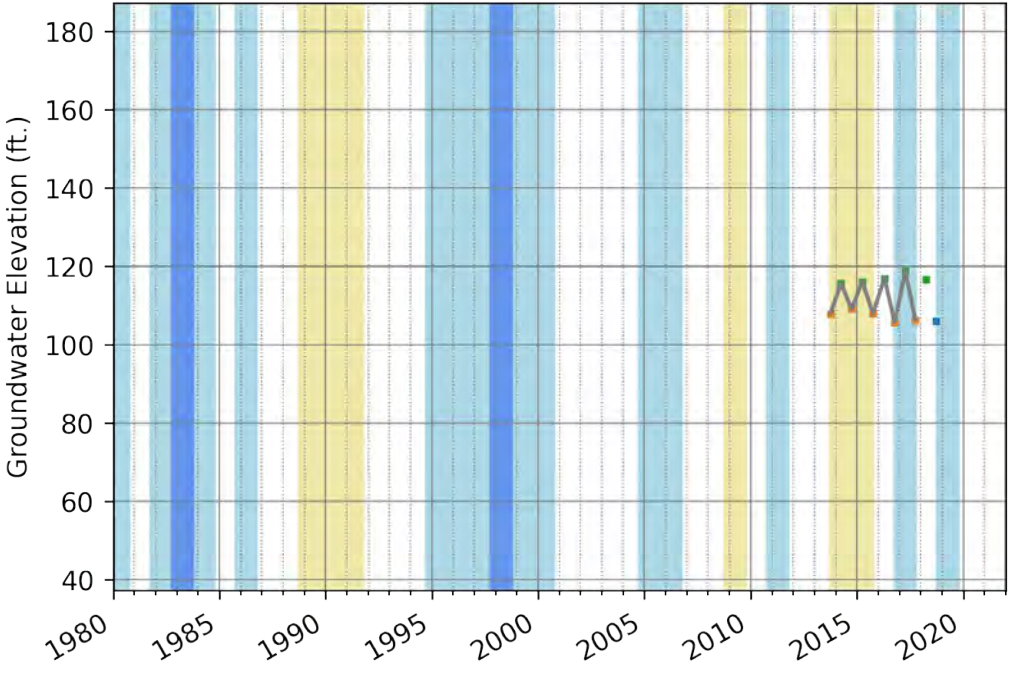
2005
2010
2015
2020


SRP0073, SRP-G15-01
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0074, SRP-H10-01
Groundwater Elevation (ft.)
180
160
140
120
100
80
60
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0075, SRP-H10-02
Groundwater Elevation (ft.)
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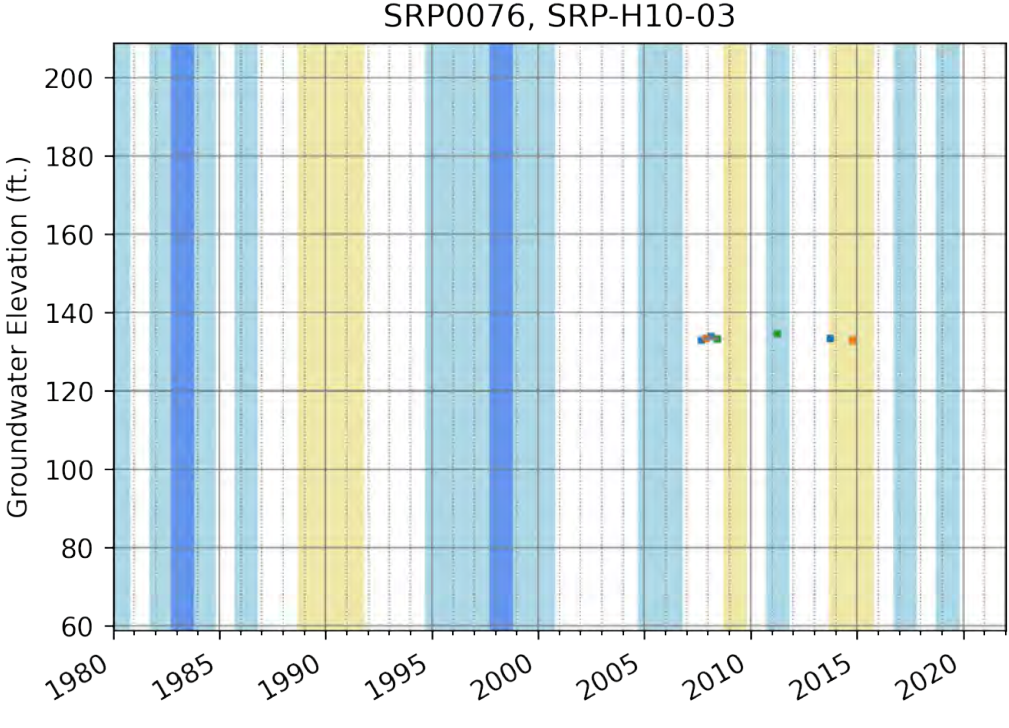
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0076, SRP-H10-03
Groundwater Elevation (ft.)
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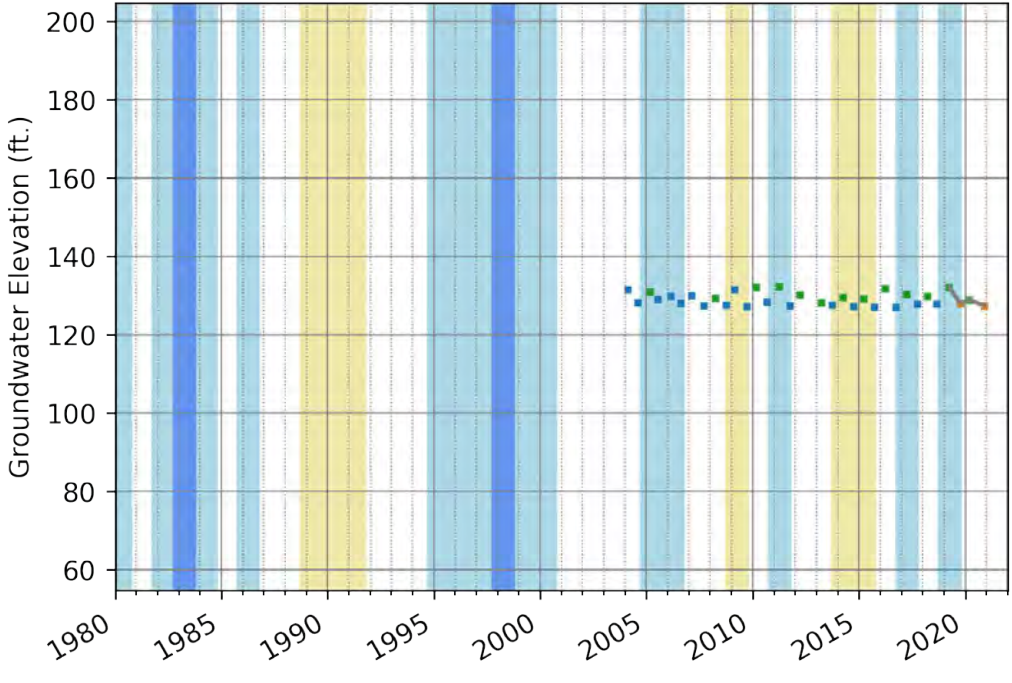
180
160
140
120
100
80
60
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0077, SRP-H11-01
Groundwater Elevation (ft.)
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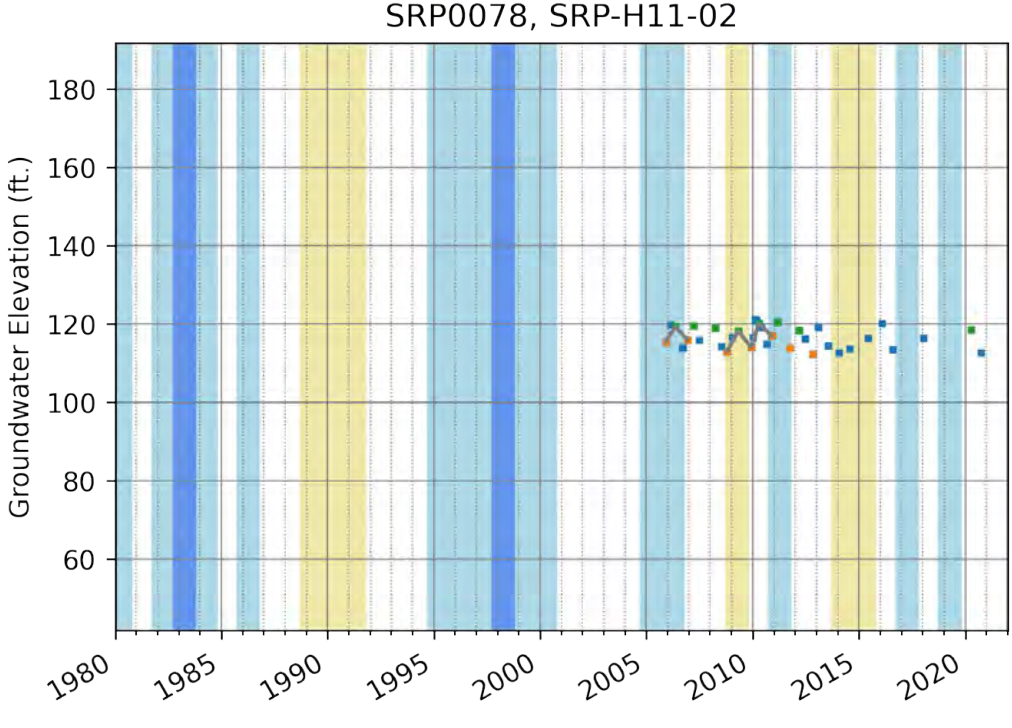
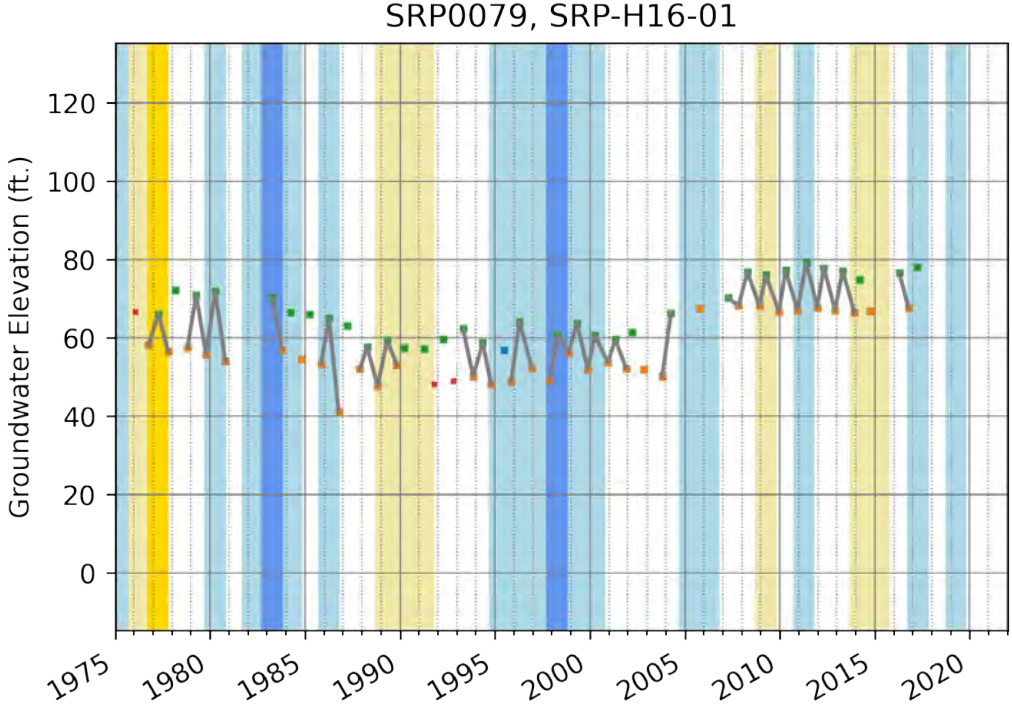
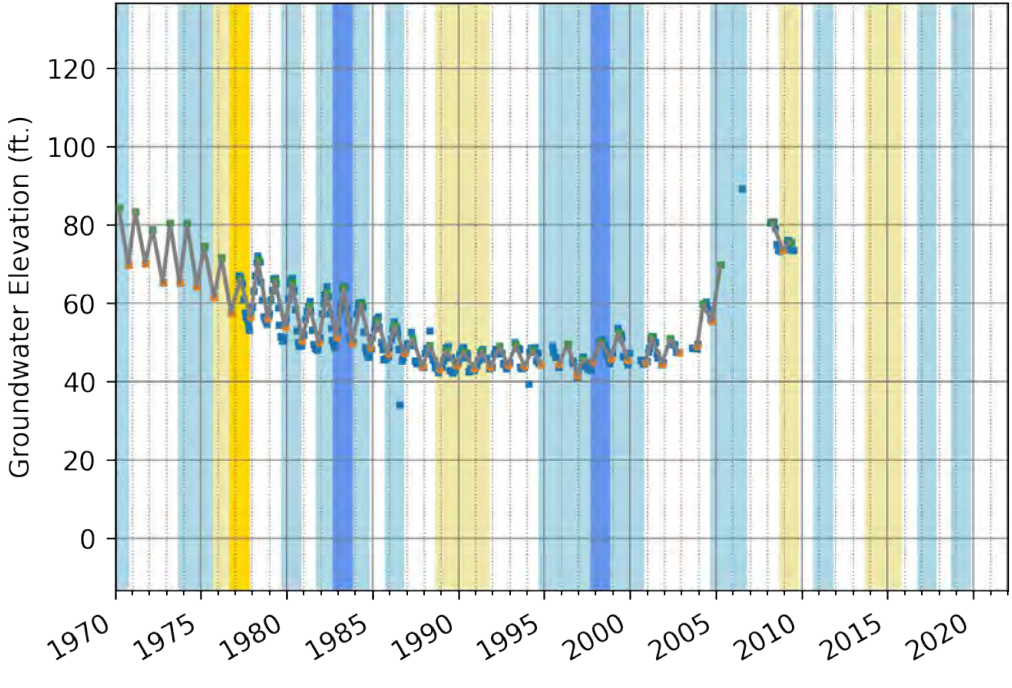
180
160
140
120
100
80
60
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0078, SRP-H11-02
Groundwater Elevation (ft.)
180
160
140
120
100
80
60
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0079, SRP-H16-01
Groundwater Elevation (ft.)
120
100
80
60
40
20
0
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0080, SRP-H17-01
Groundwater Elevation (ft.)
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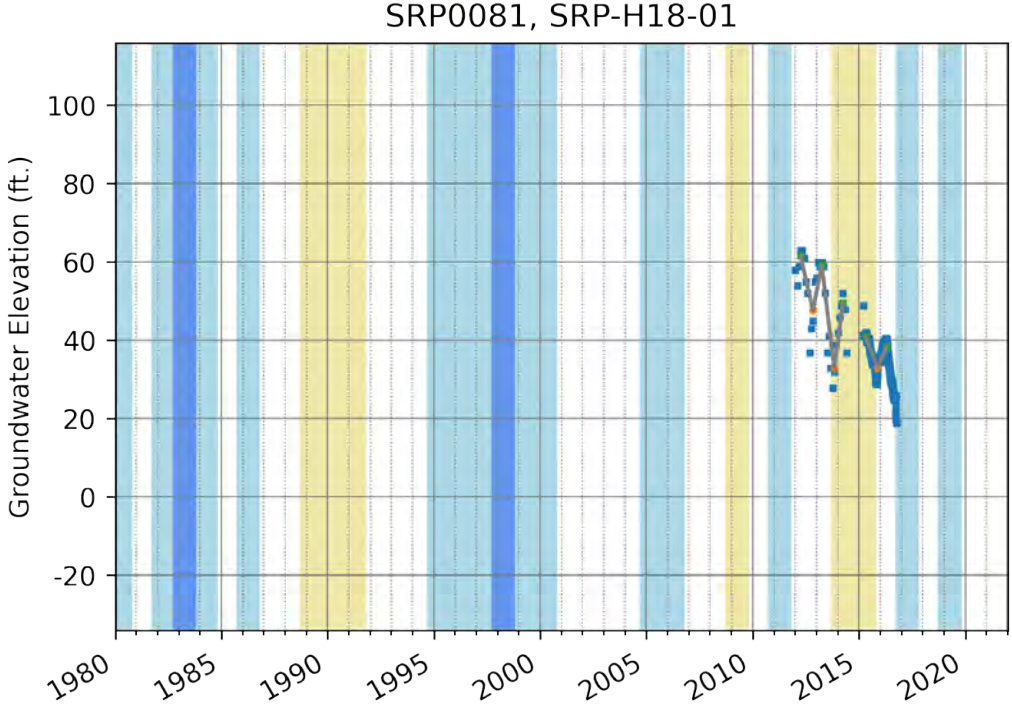
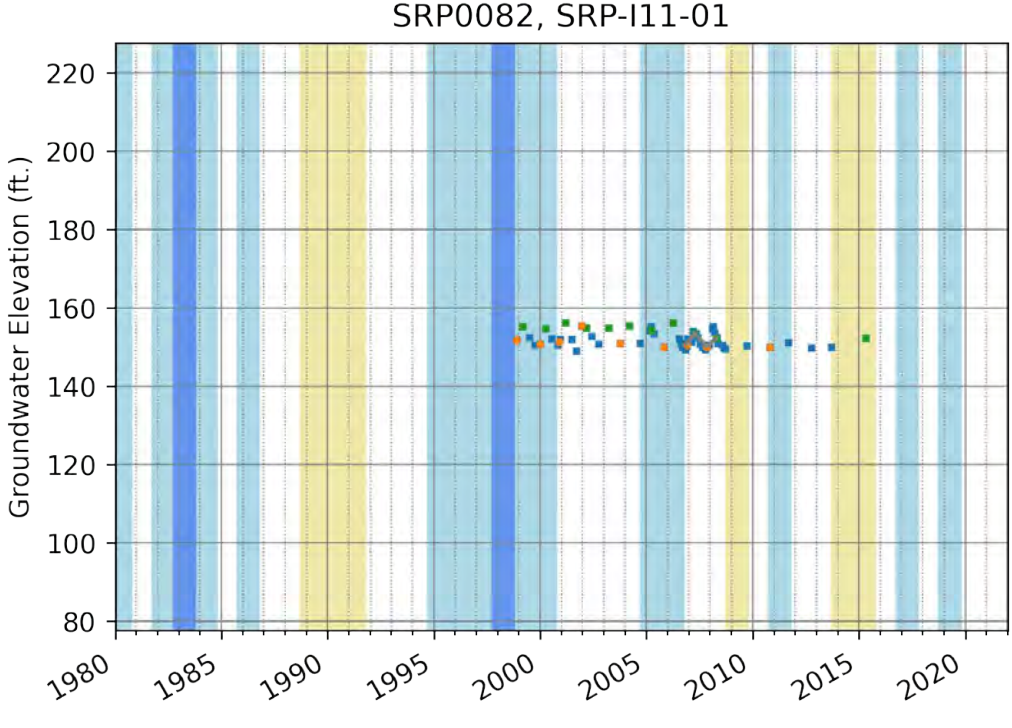
100
80
60
40
20
0
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0081, SRP-H18-01
Groundwater Elevation (ft.)
100
80
60
40
20
0
-20
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0082, SRP-I11-01
Groundwater Elevation (ft.)
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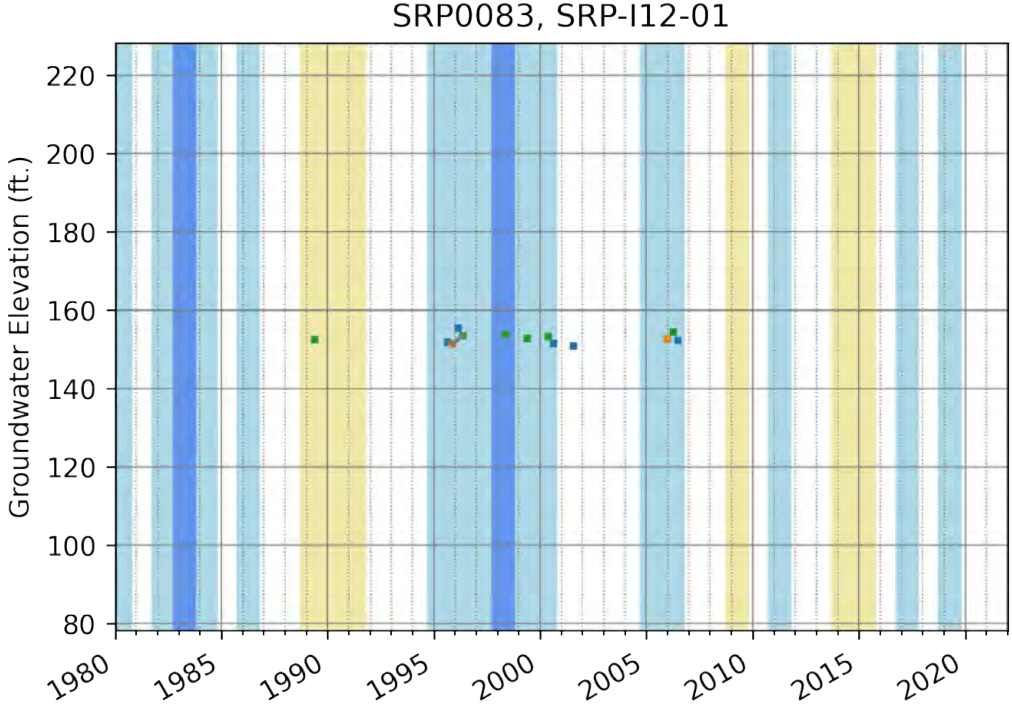
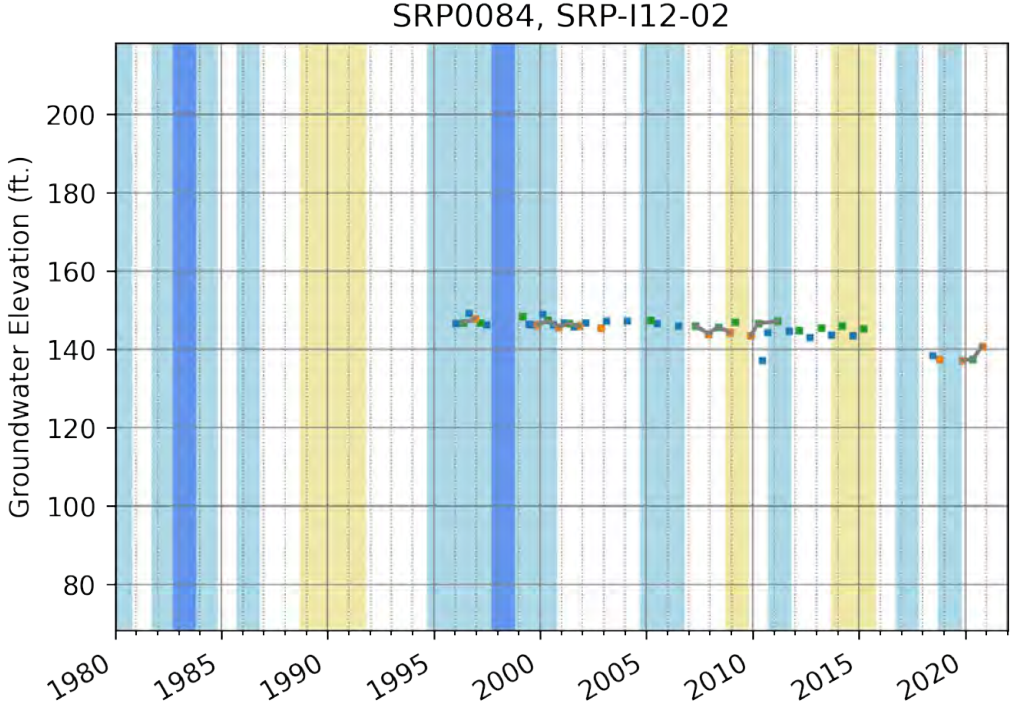
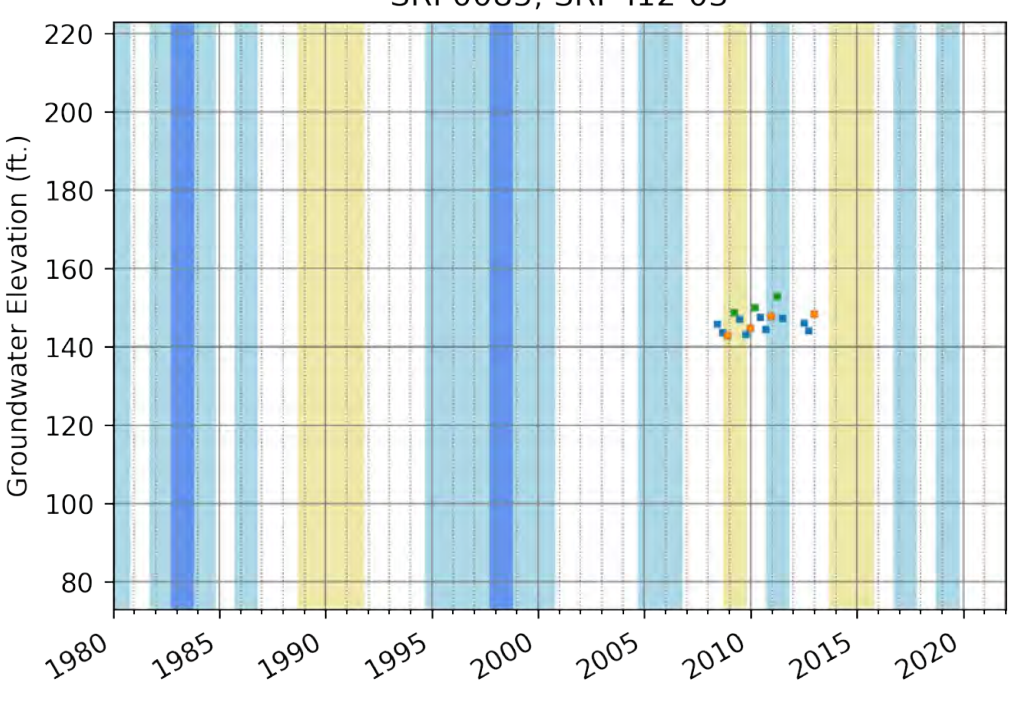
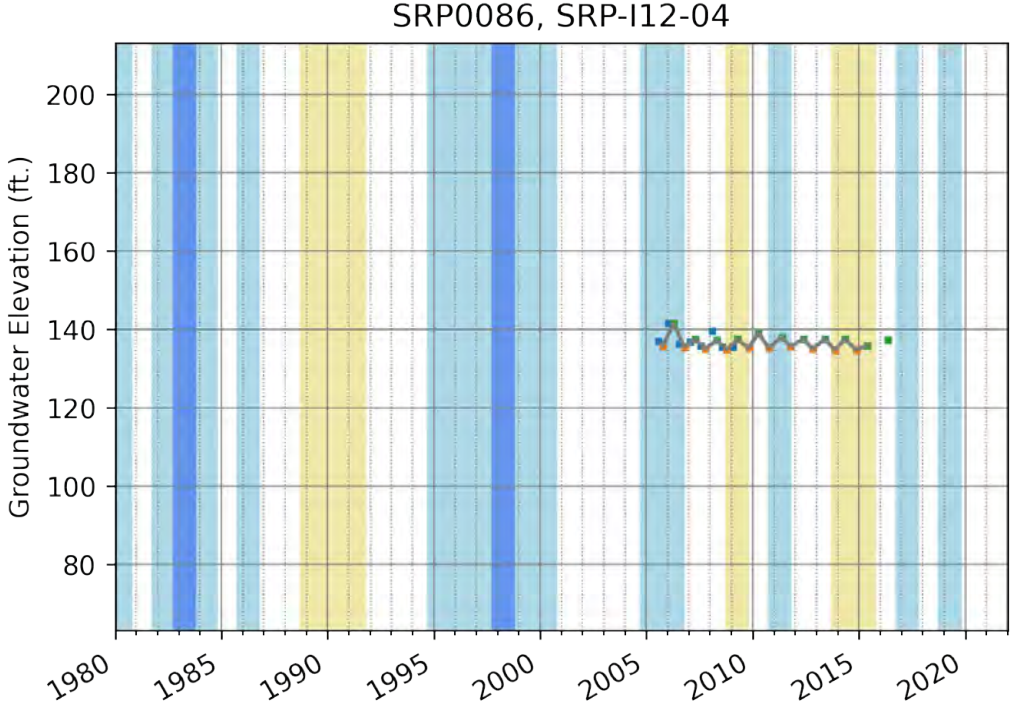
200
180
160
140
120
100
80
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0083, SRP-I12-01
Groundwater Elevation (ft.)
220
200
180
160
140
120
100
80
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0084, SRP-I12-02
Groundwater Elevation (ft.)
200
180
160
140
120
100
80
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0085, SRP-I12-03
Groundwater Elevation (ft.)
220
200
180
160
140
120
100
80
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0086, SRP-I12-04
Groundwater Elevation (ft.)
200
180
160
140
120
100
80
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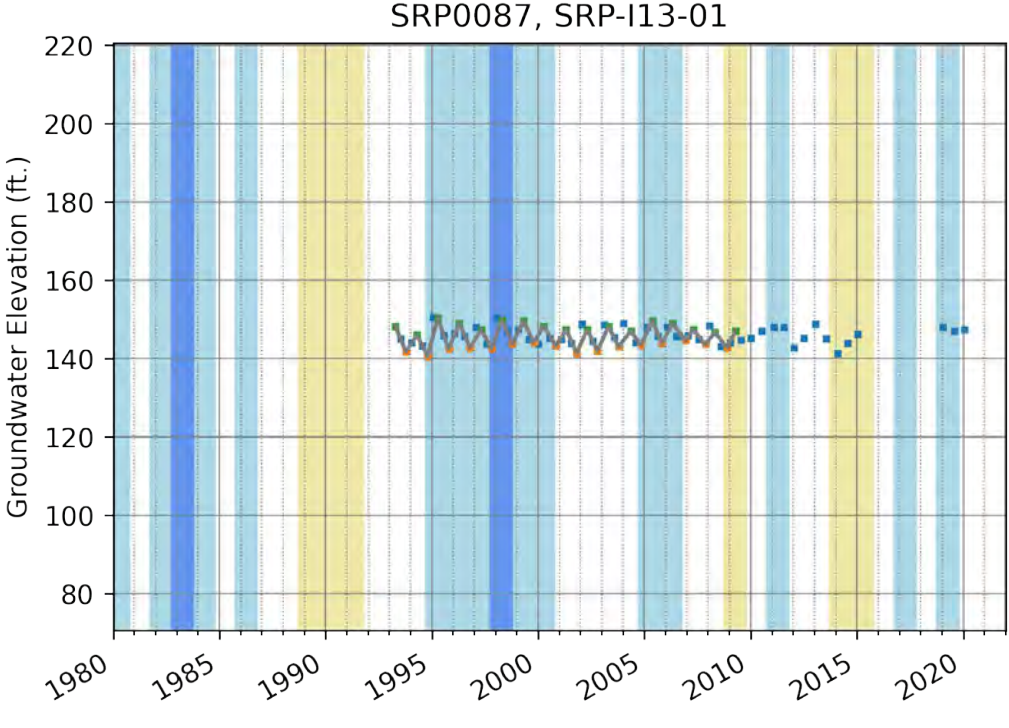
1985
1990
1995
2000
2005
2010
2015
2020


SRP0087, SRP-I13-01
Groundwater Elevation (ft.)
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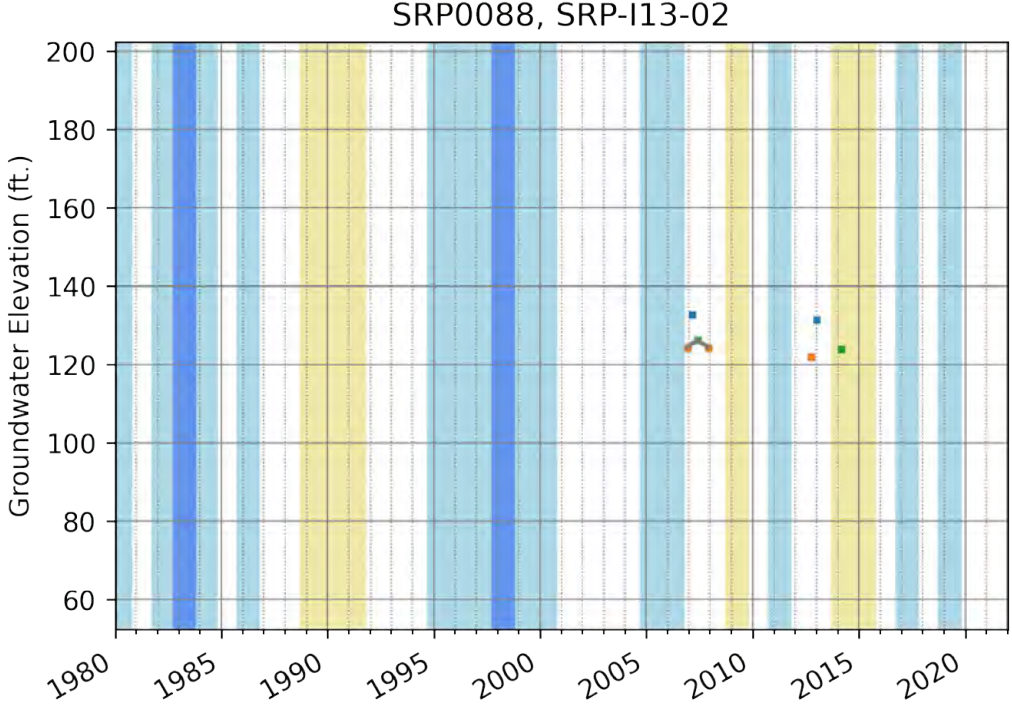
200
180
160
140
120
100
80
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0088, SRP-I13-02
Groundwater Elevation (ft.)
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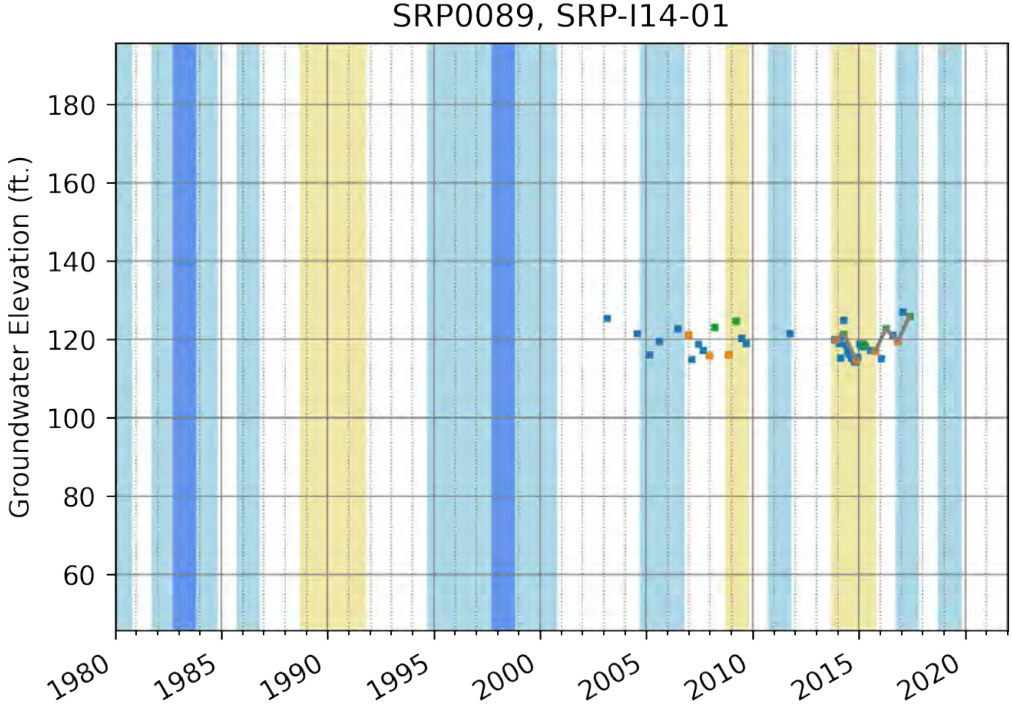
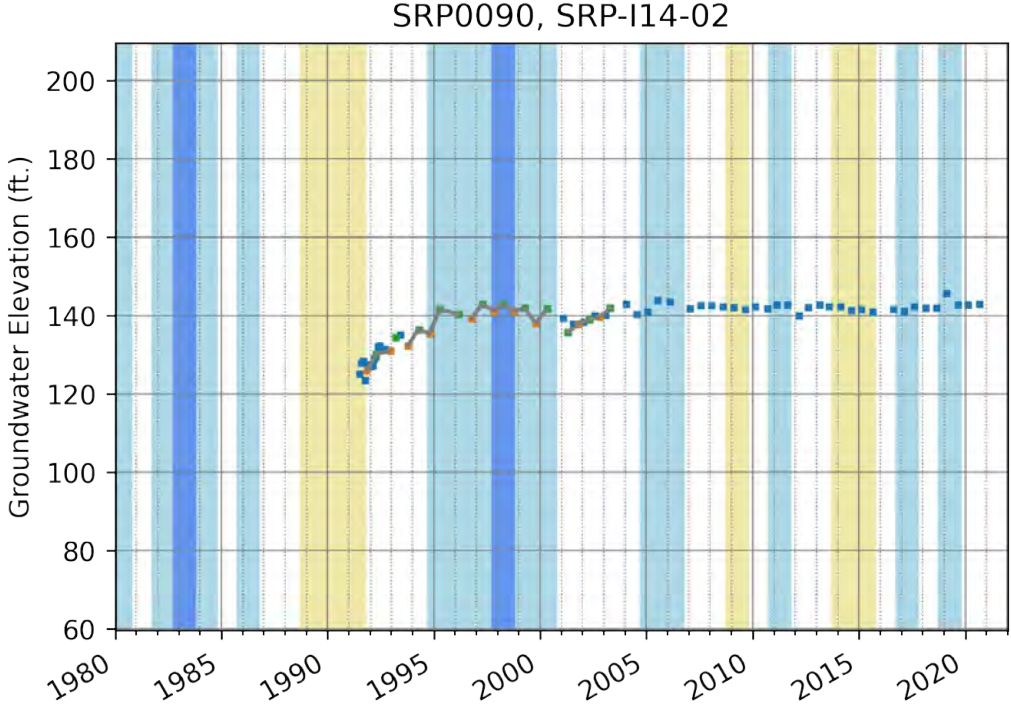
180
160
140
120
100
80
60
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0089, SRP-I14-01
Groundwater Elevation (ft.)
180
160
140
120
100
80
60
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0090, SRP-I14-02
Groundwater Elevation (ft.)
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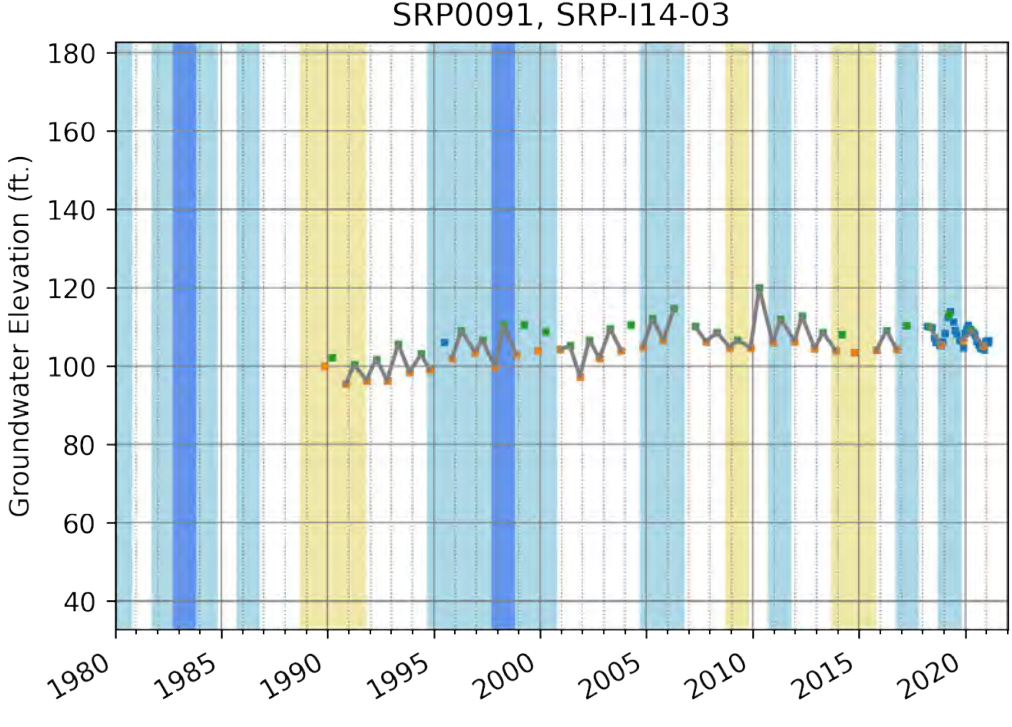
180
160
140
120
100
80
60
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0091, SRP-I14-03
Groundwater Elevation (ft.)
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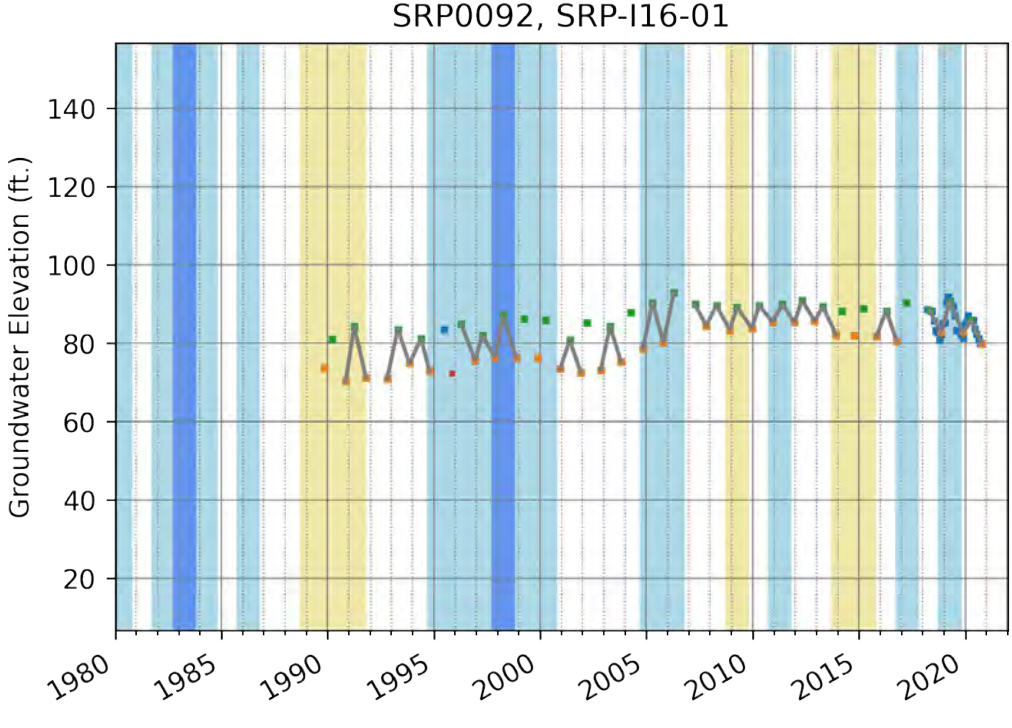
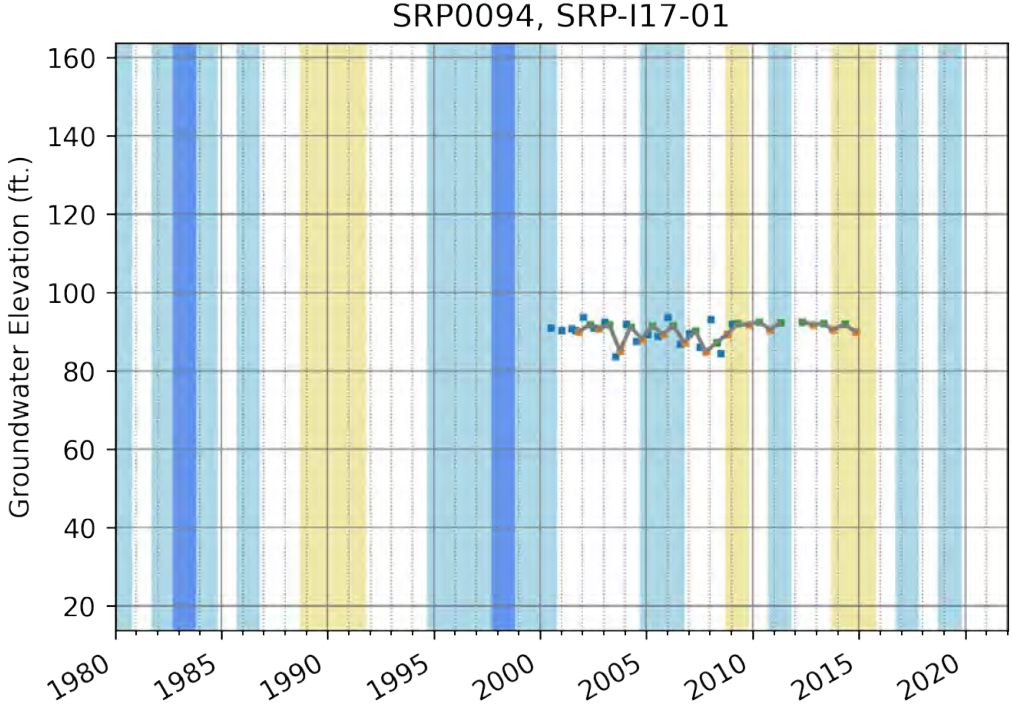
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0092, SRP-I16-01
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0094, SRP-I17-01
Groundwater Elevation (ft.)
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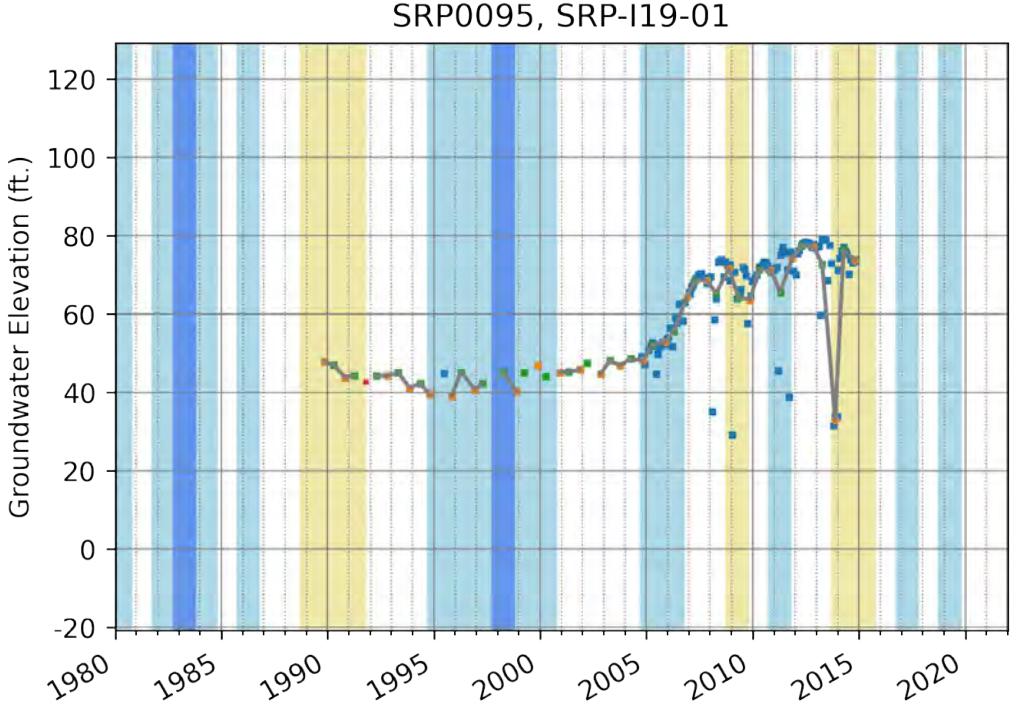
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0095, SRP-I19-01
Groundwater Elevation (ft.)
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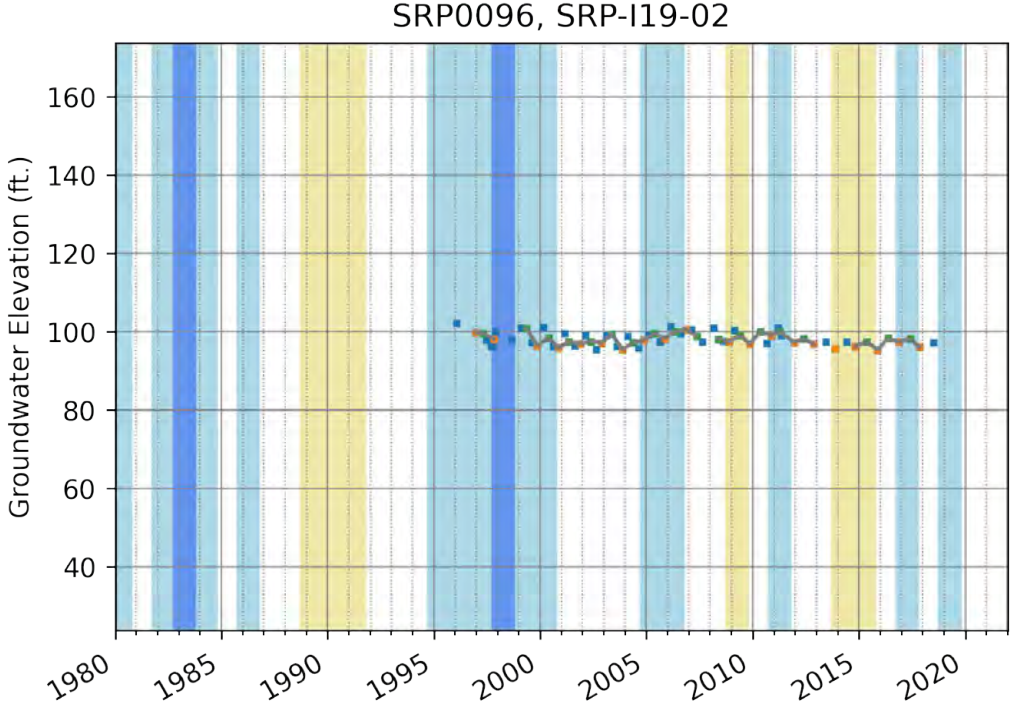
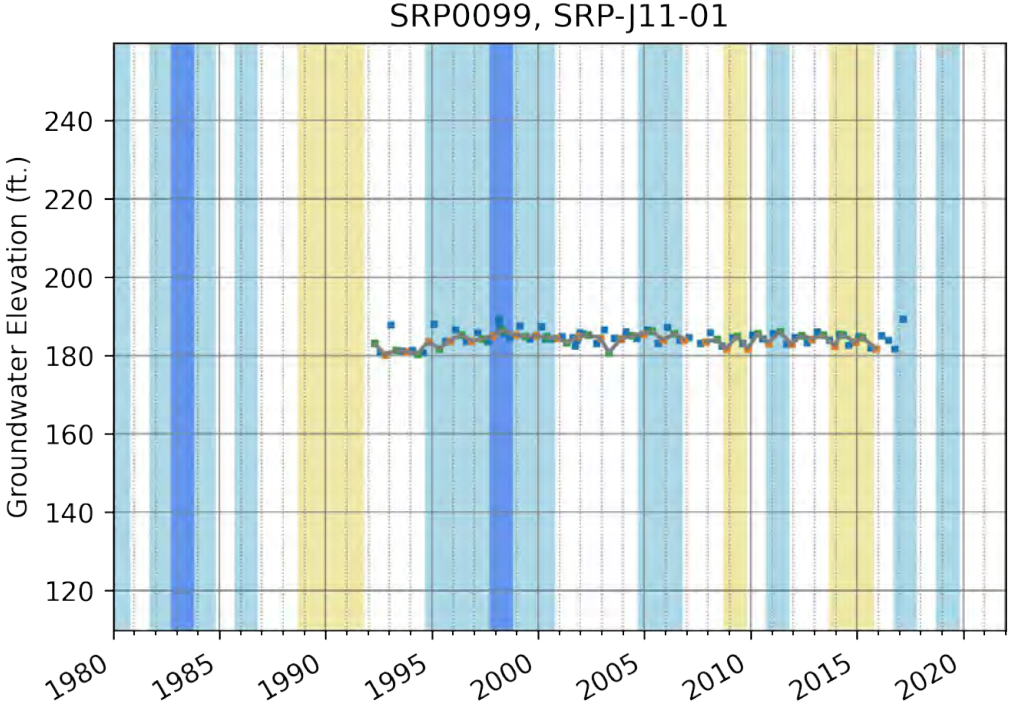
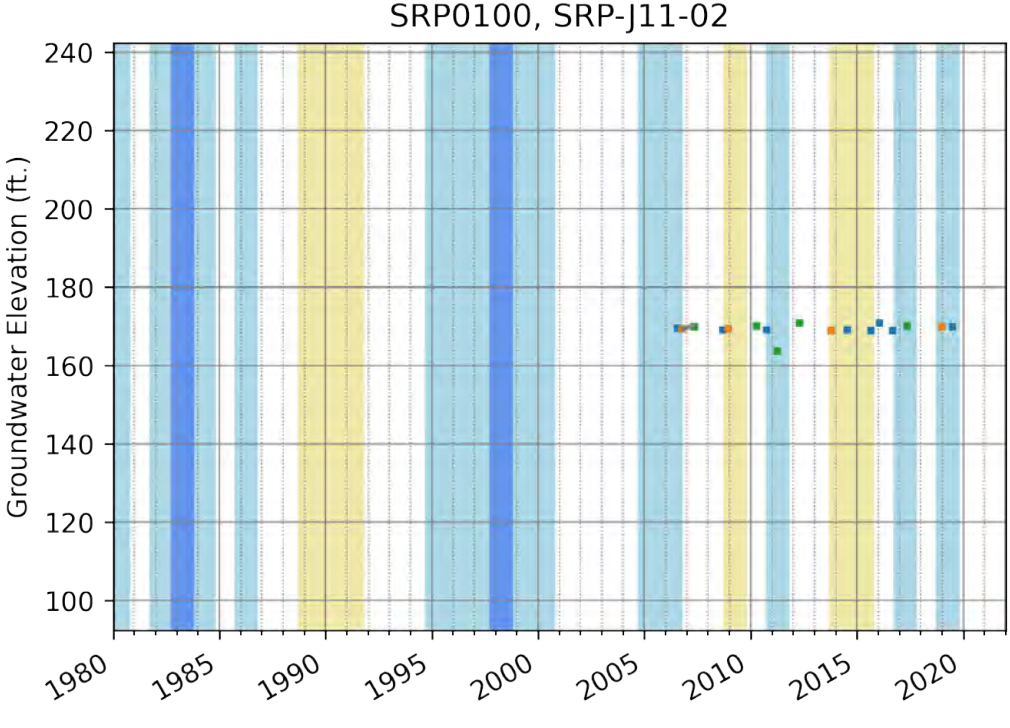
100
80
60
40
20
0
-20
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0096, SRP-I19-02
Groundwater Elevation (ft.)
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0099, SRP-J11-01
Groundwater Elevation (ft.)
240
220
200
180
160
140
120
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0100, SRP-J11-02
Groundwater Elevation (ft.)
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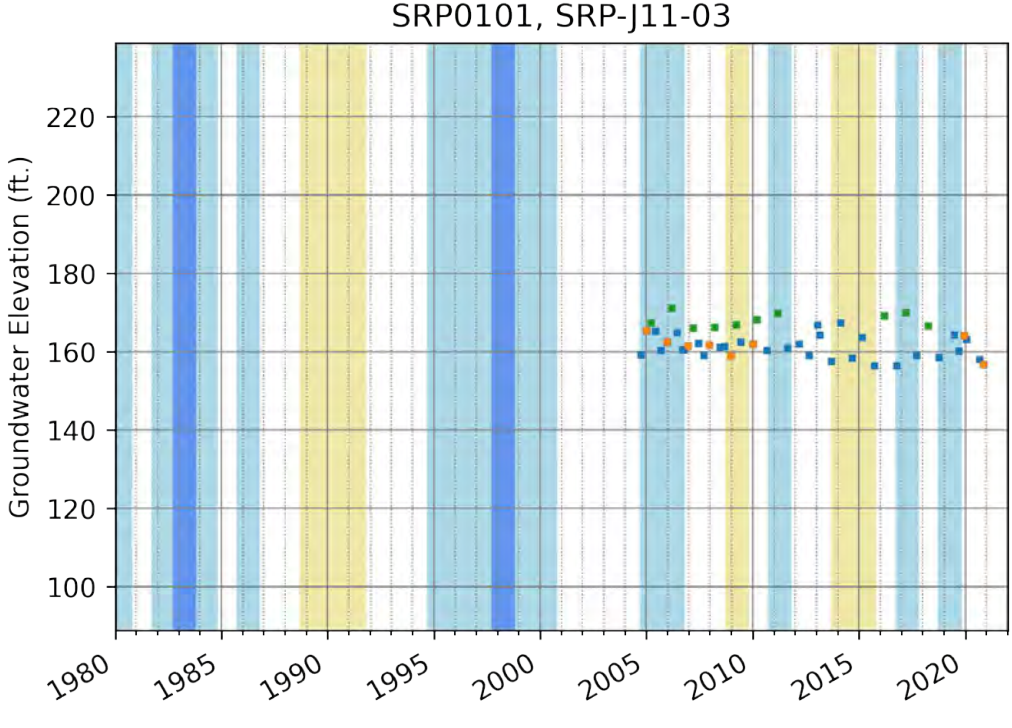
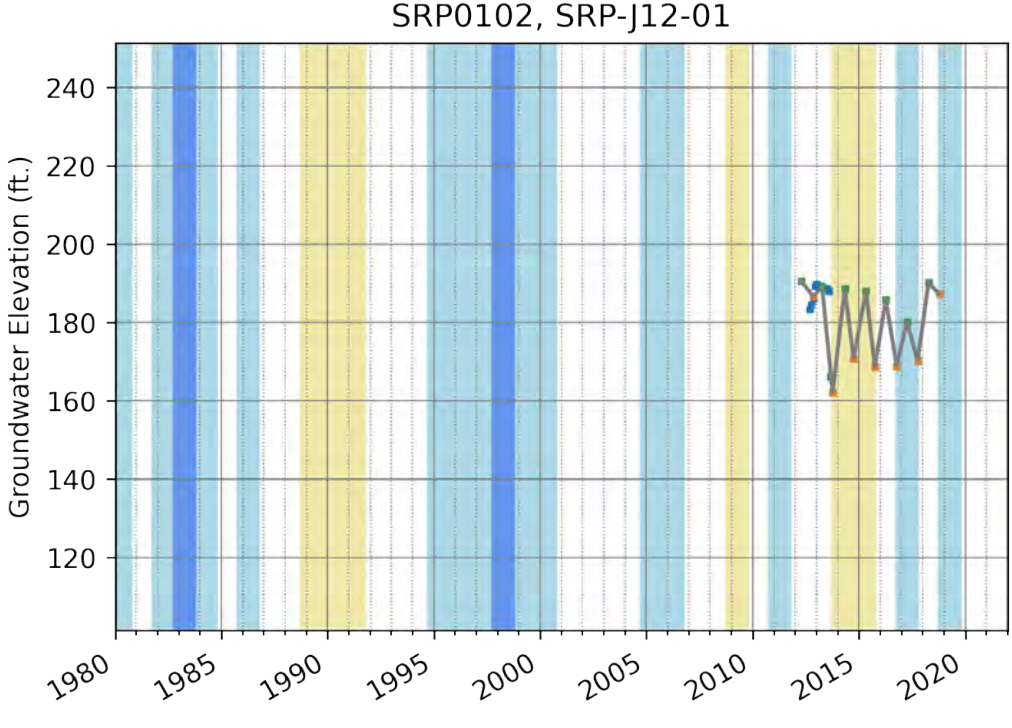
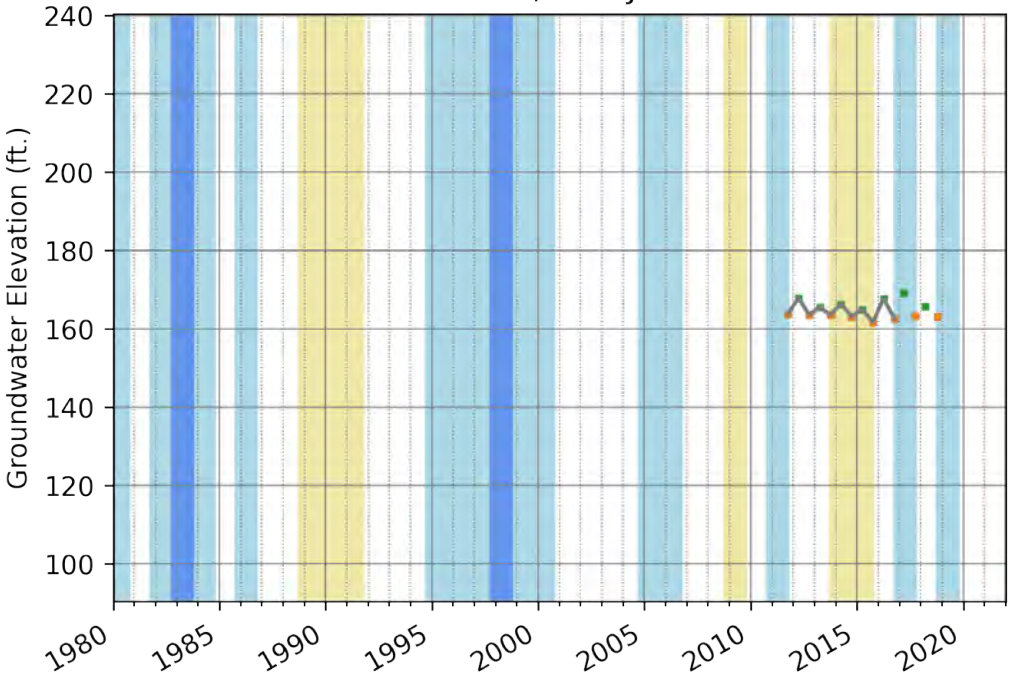
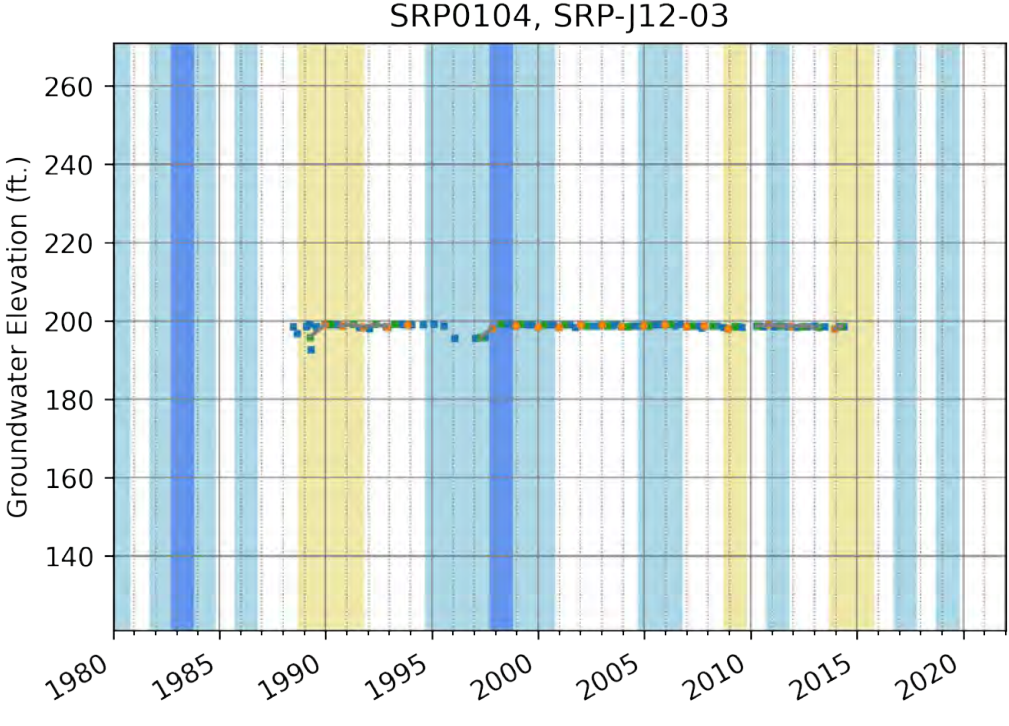
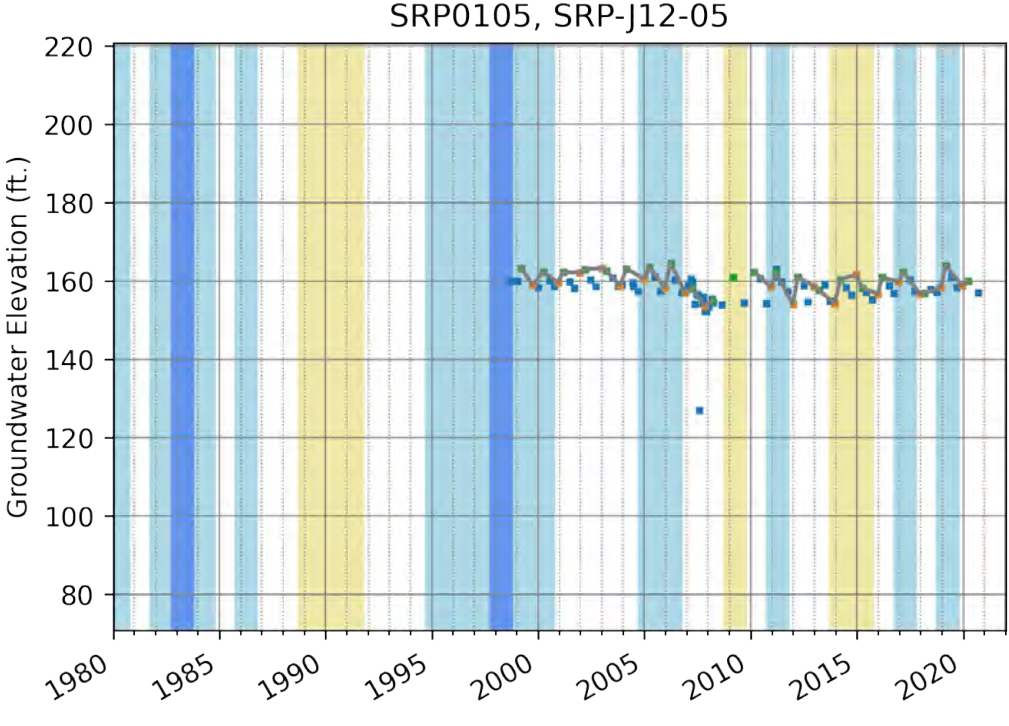
220
200
180
160
140
120
100
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0101, SRP-J11-03
Groundwater Elevation (ft.)
220
200
180
160
140
120
100
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0102, SRP-J12-01
Groundwater Elevation (ft.)
240
220
200
180
160
140
120
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0103, SRP-J12-02
Groundwater Elevation (ft.)
240
220
200
180
160
140
120
100
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0104, SRP-J12-03
Groundwater Elevation (ft.)
260
240
220
200
180
160
140
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0105, SRP-J12-05
Groundwater Elevation (ft.)
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200
180
160
140
120
100
80
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1985
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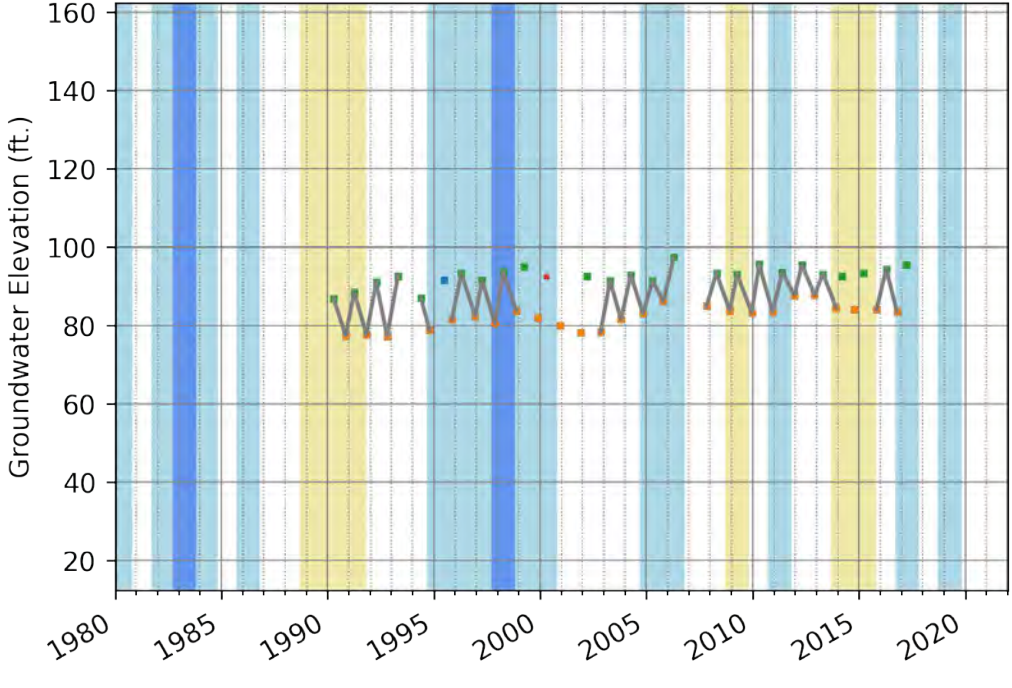
1995
2000
2005
2010
2015
2020


SRP0106, SRP-J16-01
Groundwater Elevation (ft.)
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140
120
100
80
60
40
20
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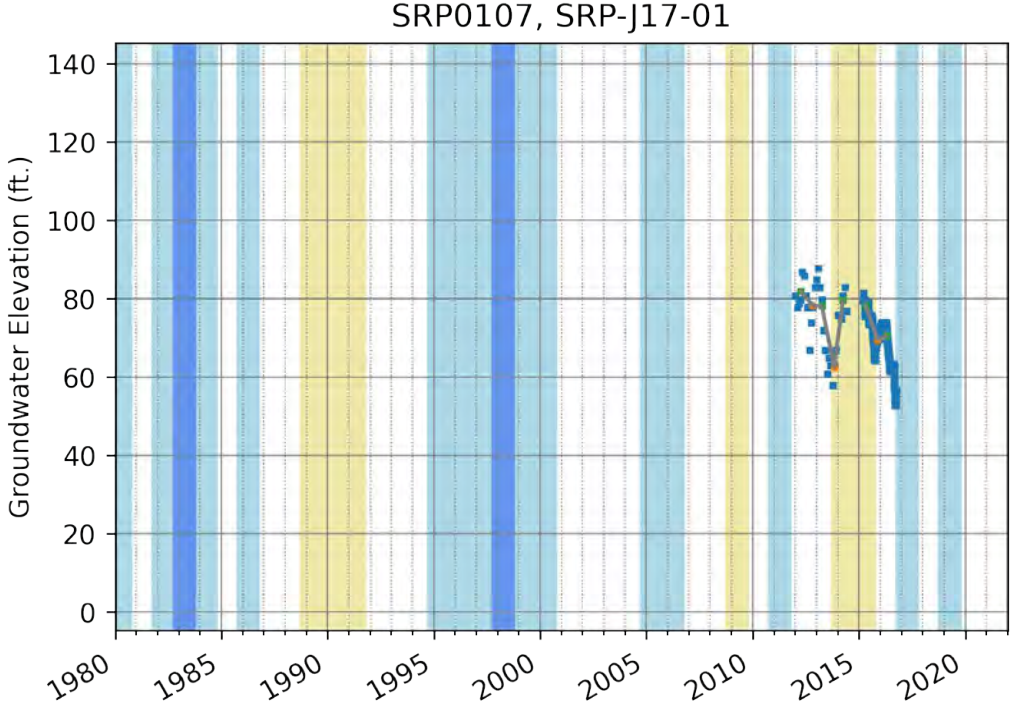
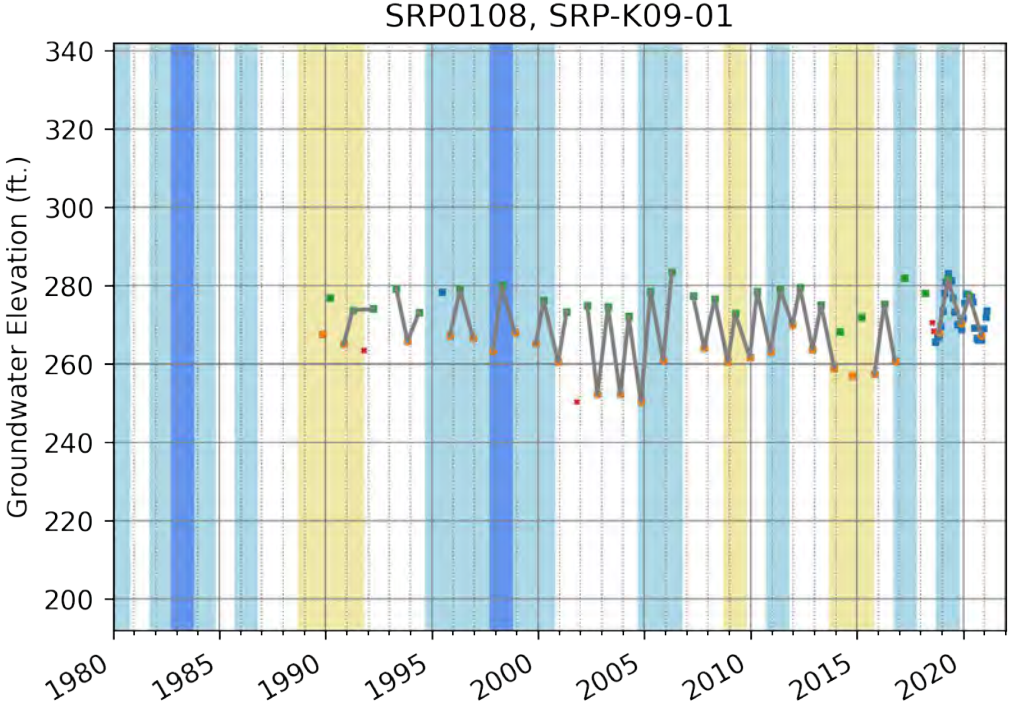
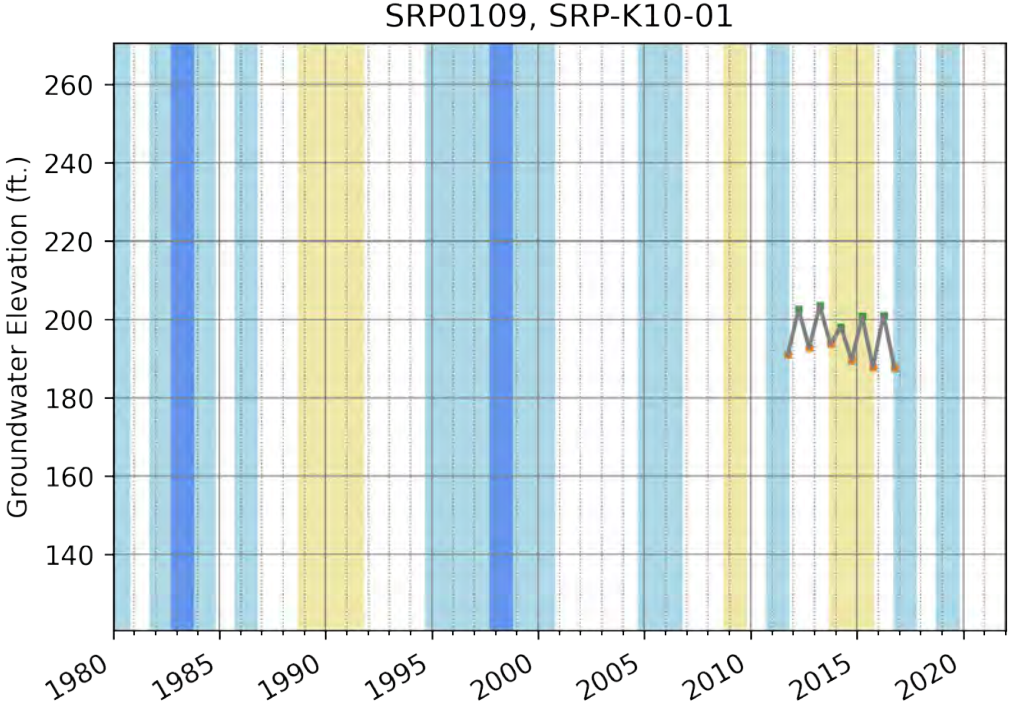
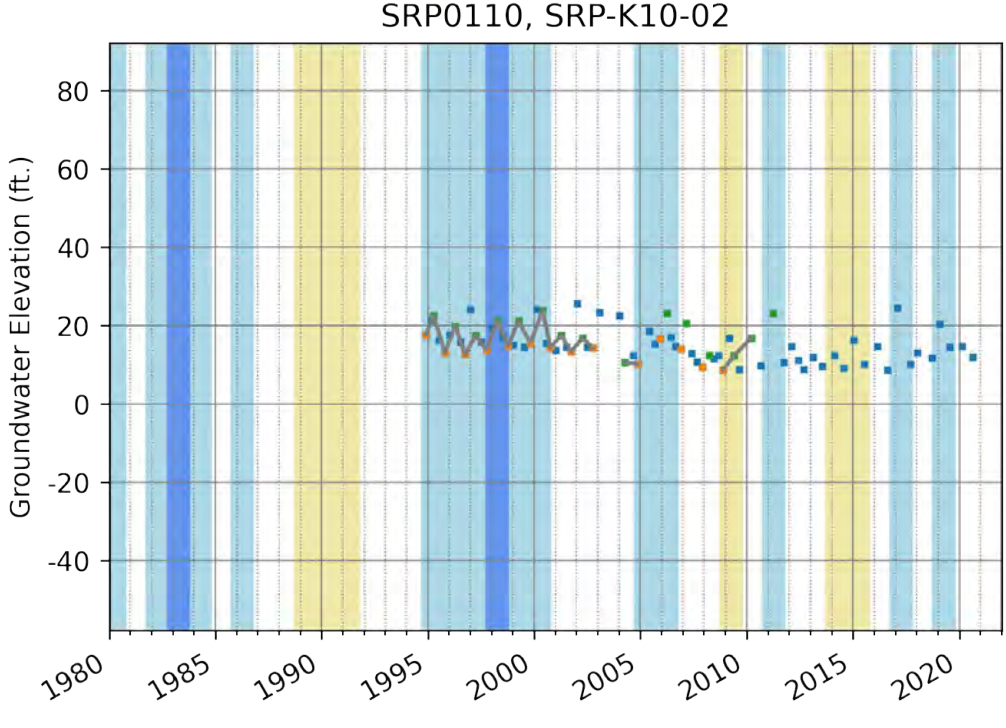
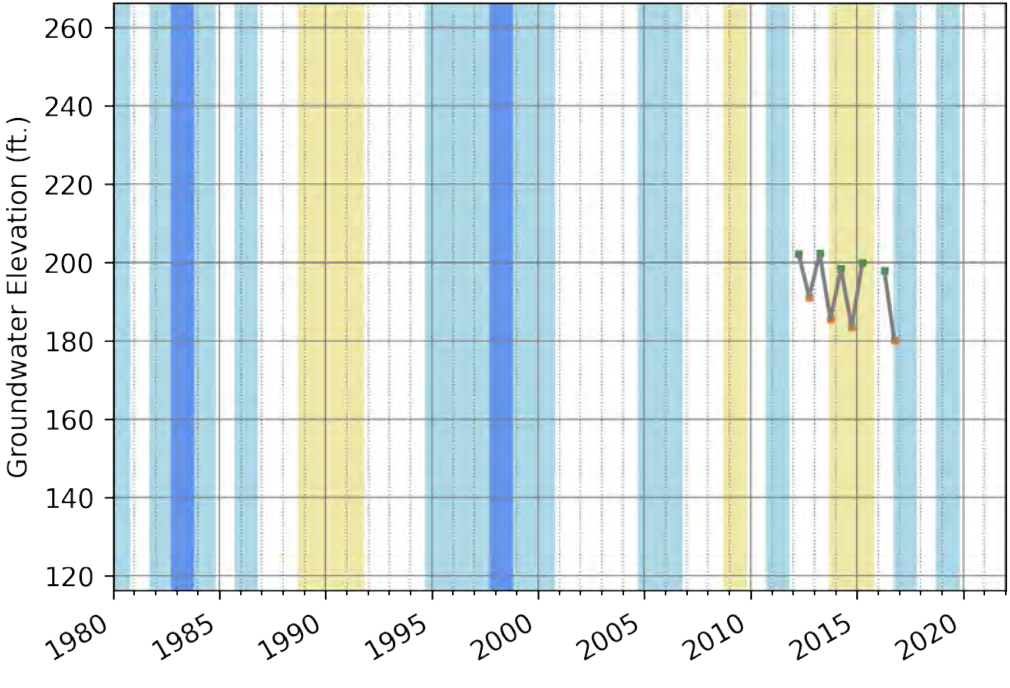
1985
1990
1995
2000
2005
2010
2015
2020

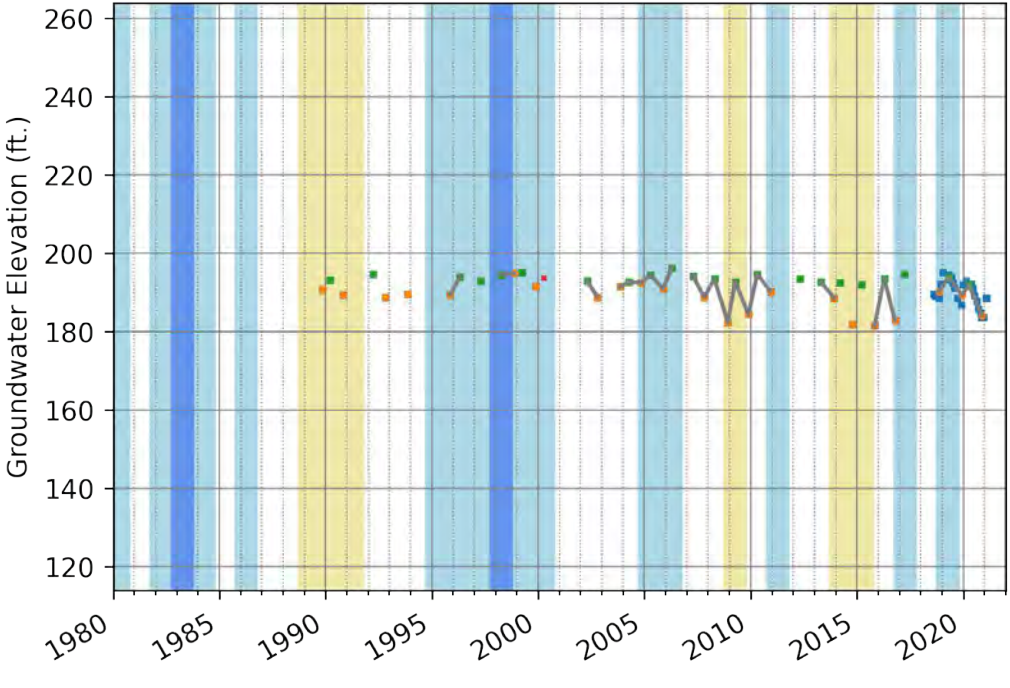

SRP0107, SRP-J17-01
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020

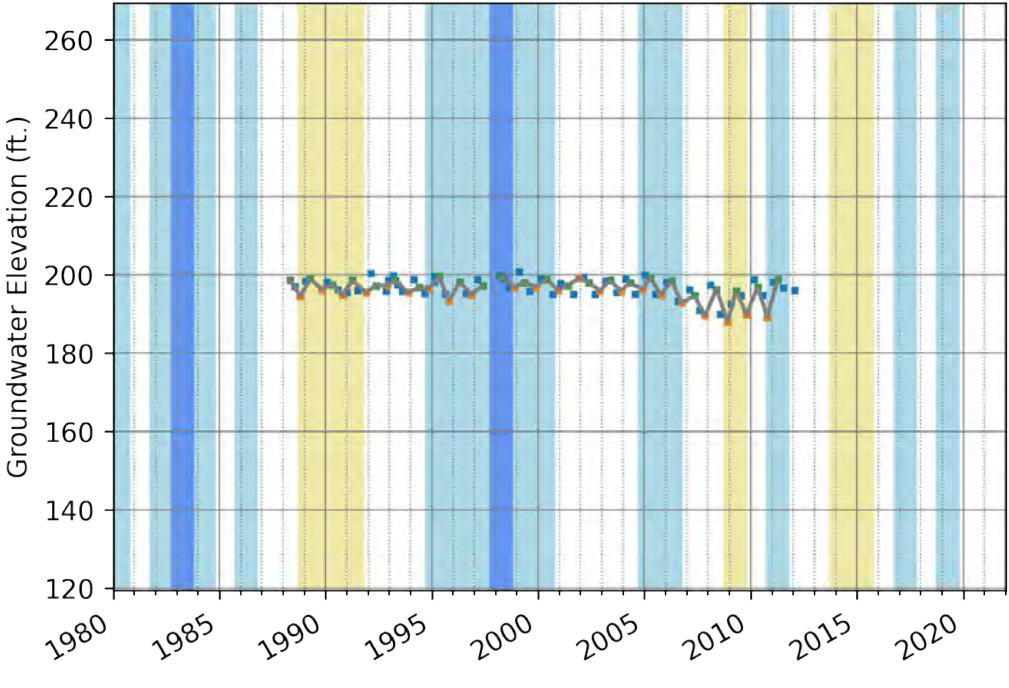

SRP0108, SRP-K09-01
Groundwater Elevation (ft.)
340
320
300
280
260
240
220
200
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0109, SRP-K10-01
Groundwater Elevation (ft.)
260
240
220
200
180
160
140
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0110, SRP-K10-02
Groundwater Elevation (ft.)
80
60
40
20
0
-20
-40
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0111, SRP-K11-01
Groundwater Elevation (ft.)
260
240
220
200
180
160
140
120
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0112, SRP-K12-01
Groundwater Elevation (ft.)
260
240
220
200
180
160
140
120
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0113, SRP-K12-02
Groundwater Elevation (ft.)
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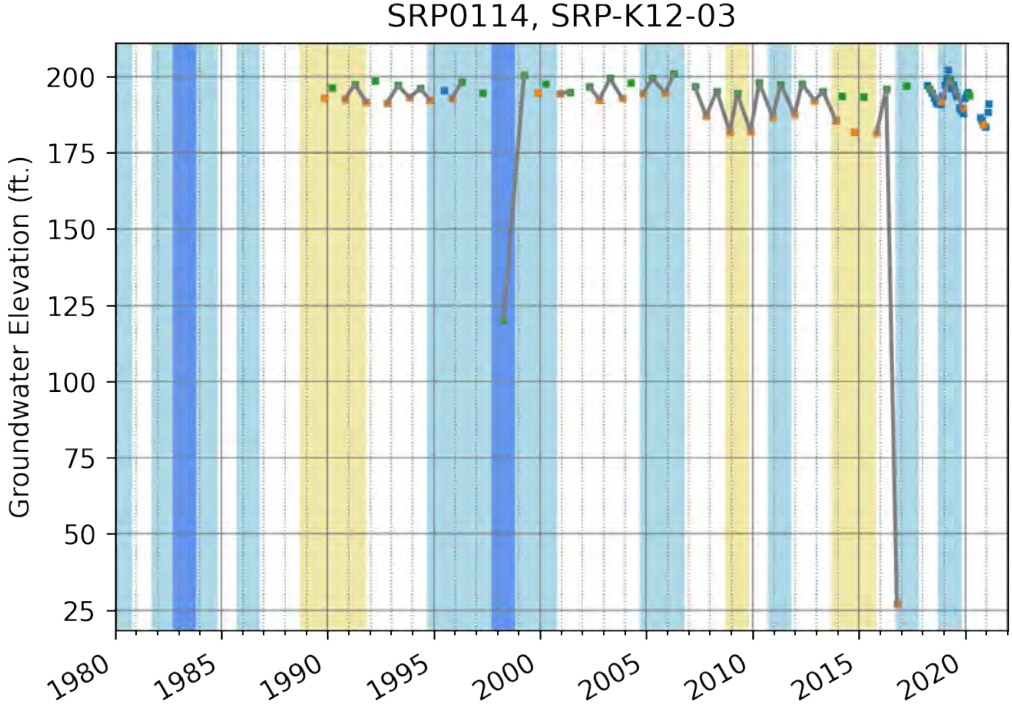
240
220
200
180
160
140
120
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0114, SRP-K12-03
Groundwater Elevation (ft.)
200
175
150
125
100
75
50
25
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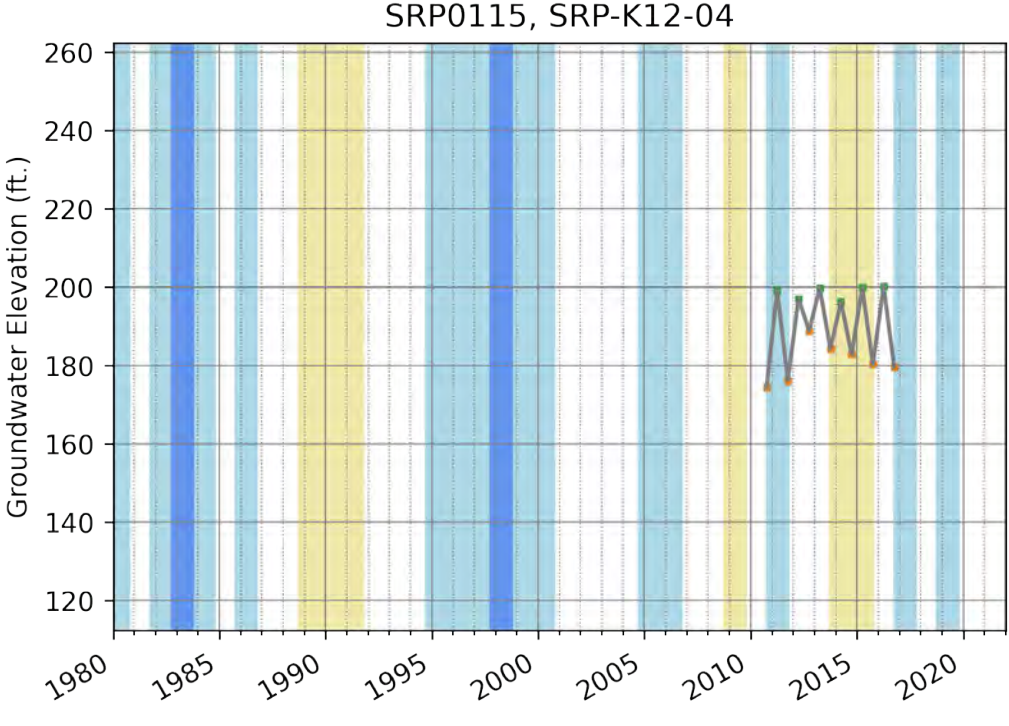
1985
1990
1995
2000
2005
2010
2015
2020


SRP0115, SRP-K12-04
Groundwater Elevation (ft.)
260
240
220
200
180
160
140
120
1980
1985
1990
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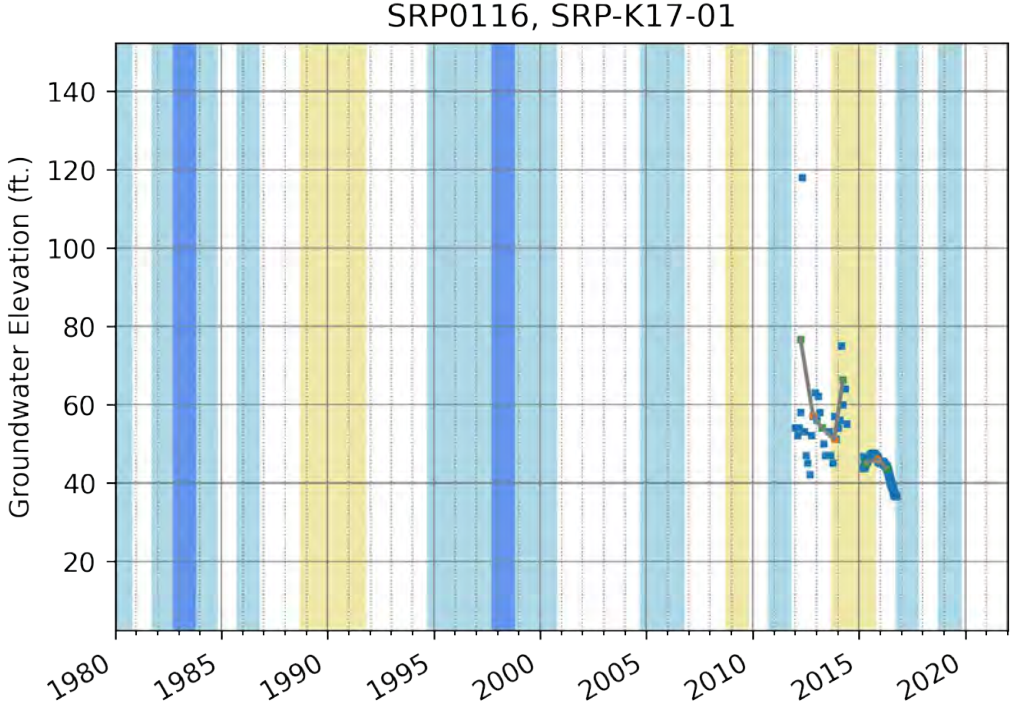
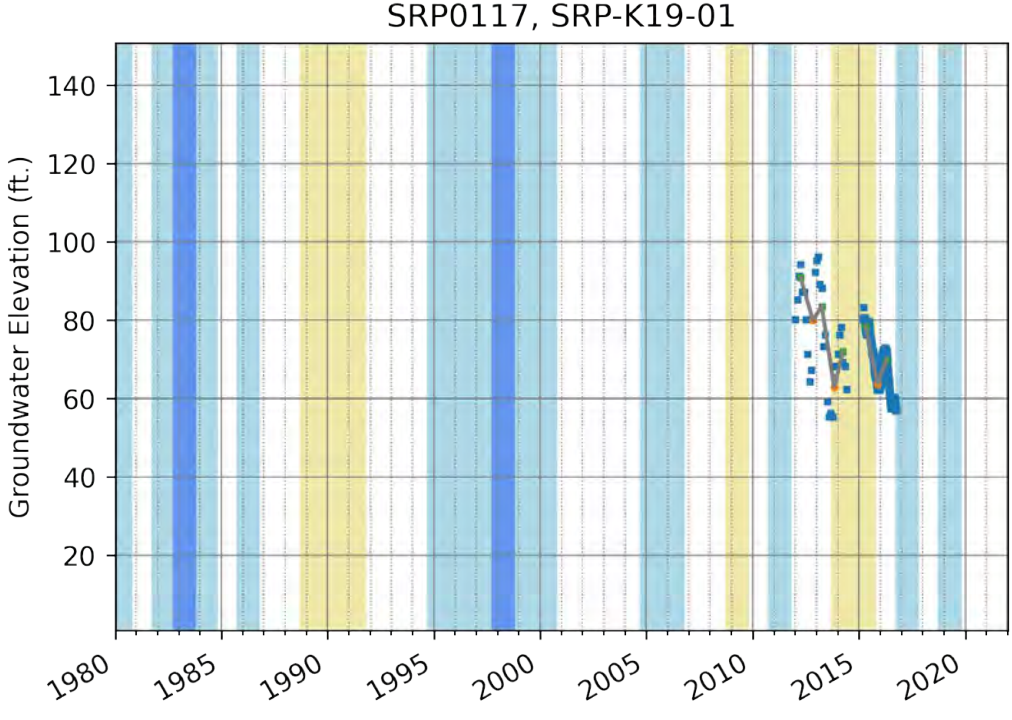
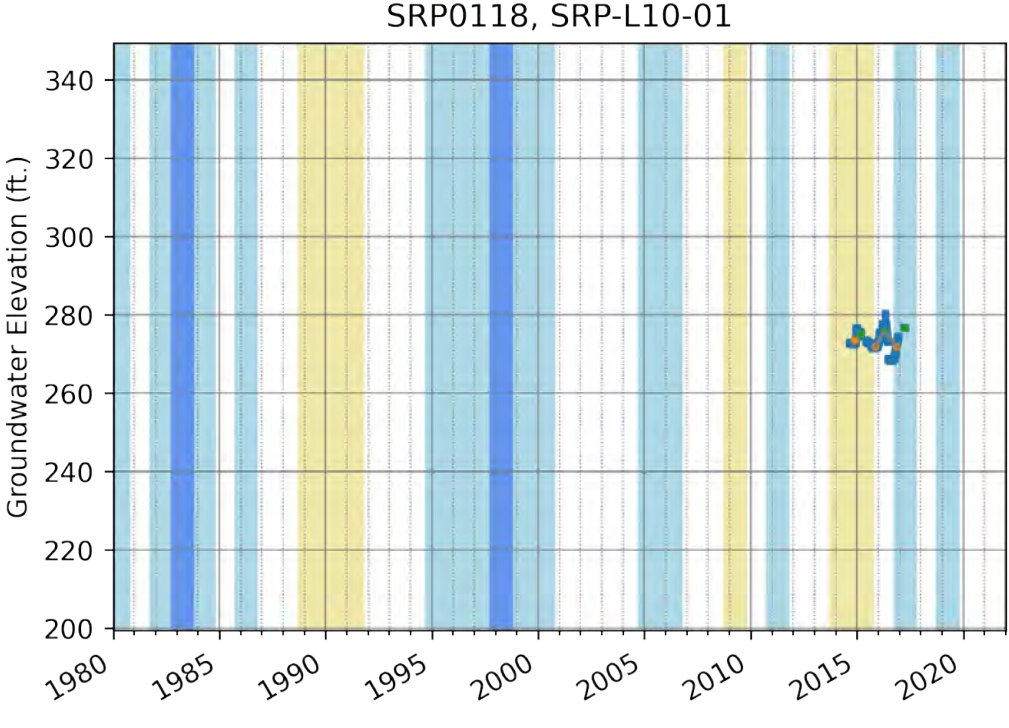
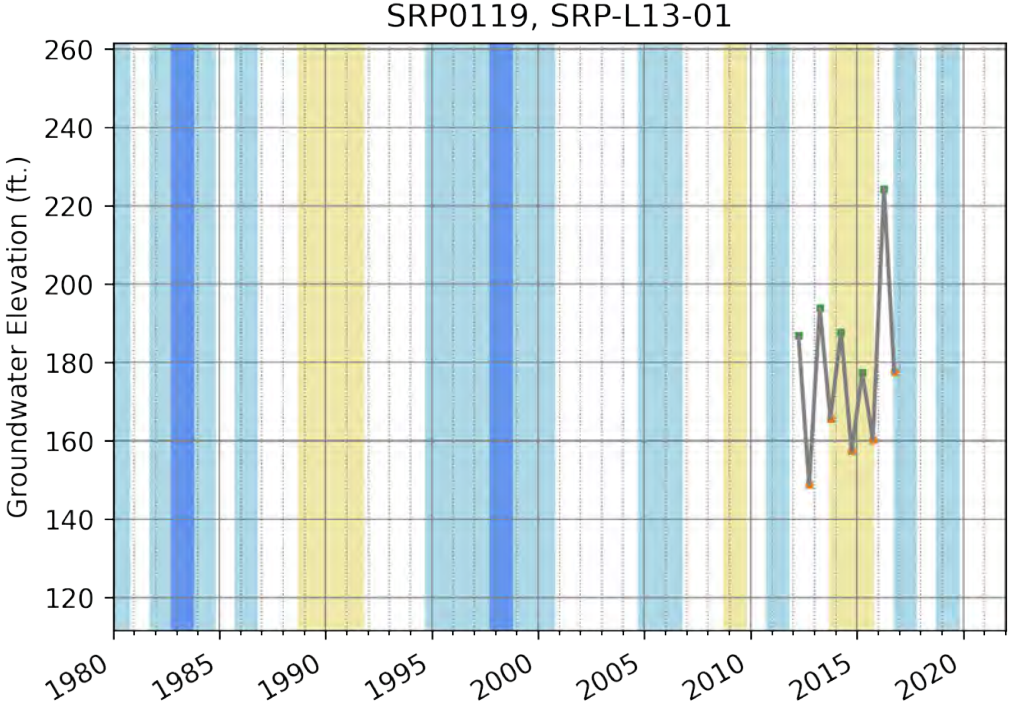
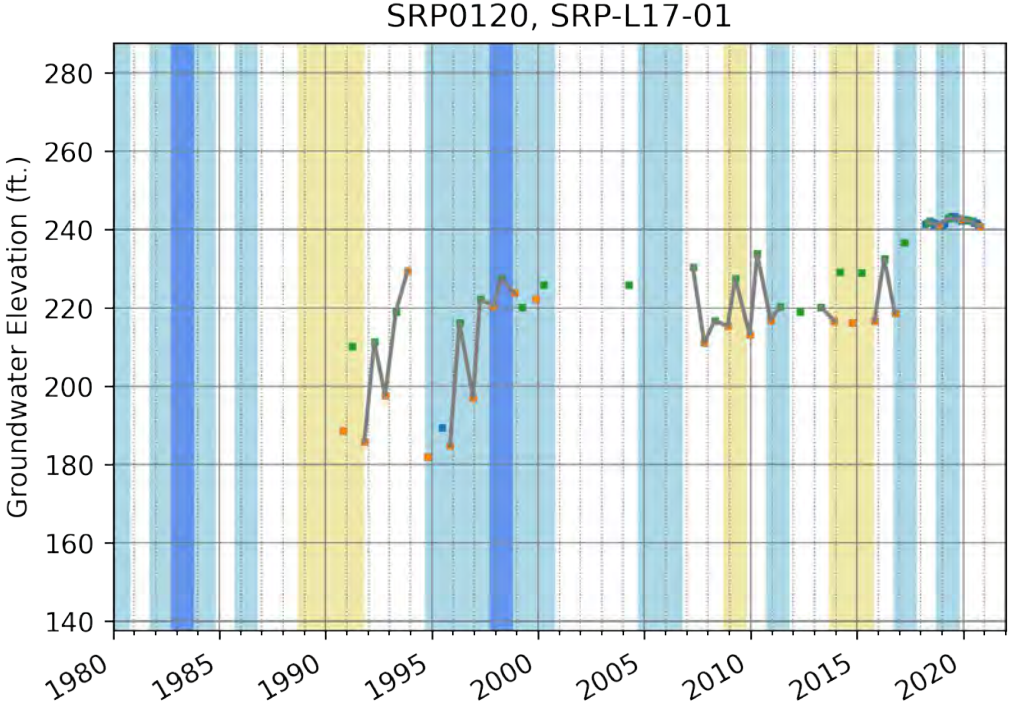
2000
2005
2010
2015
2020

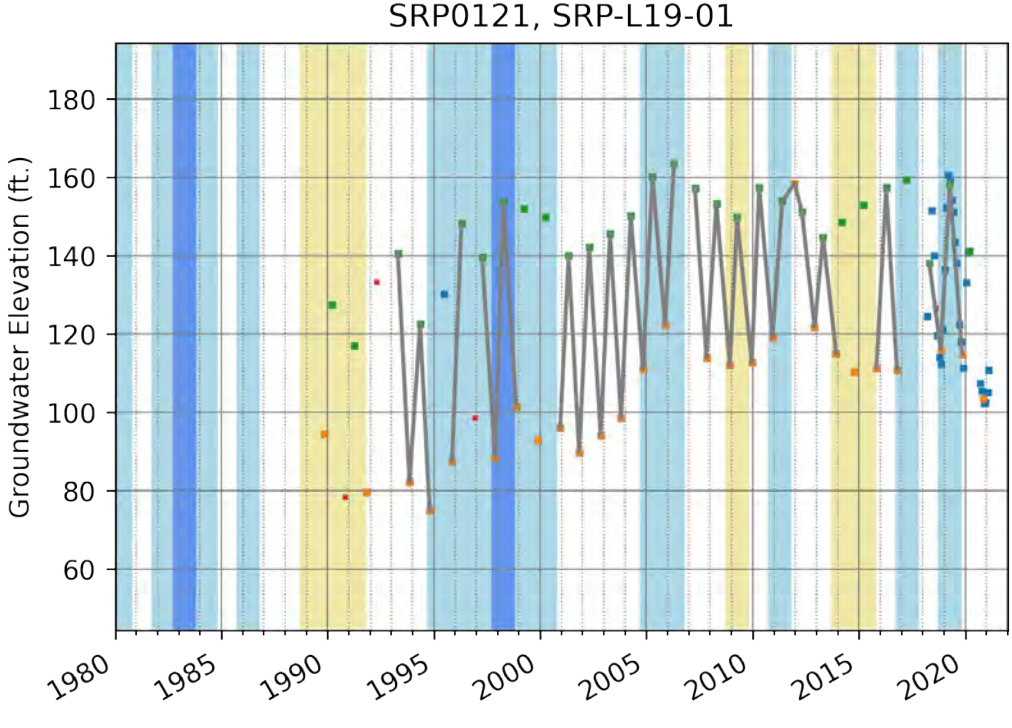

SRP0116, SRP-K17-01
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020

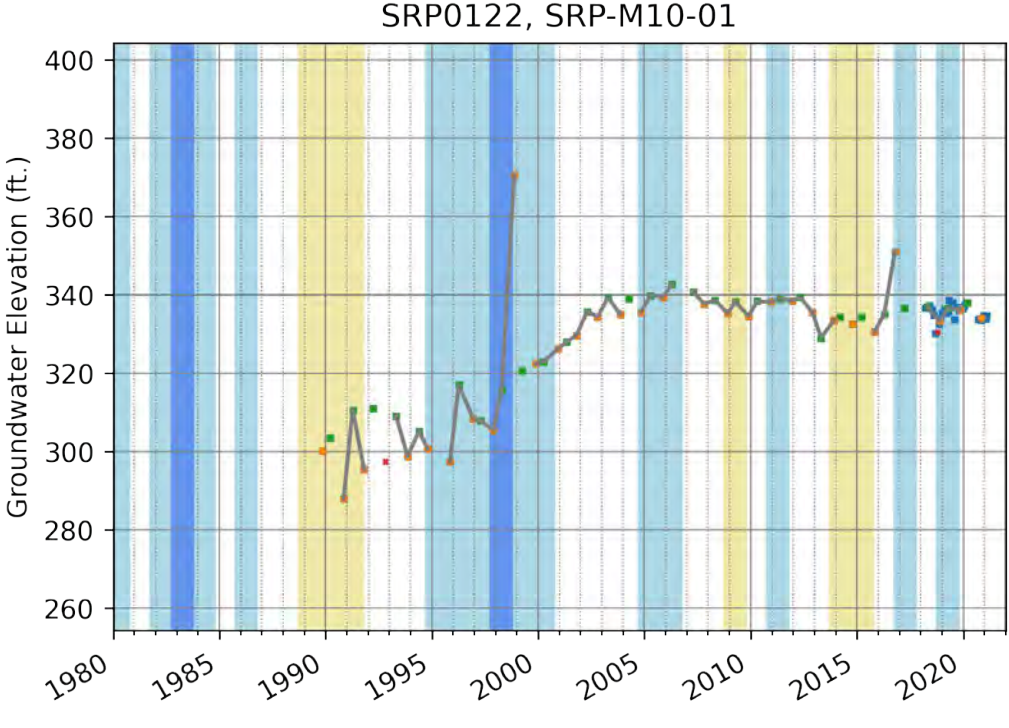

SRP0117, SRP-K19-01
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020

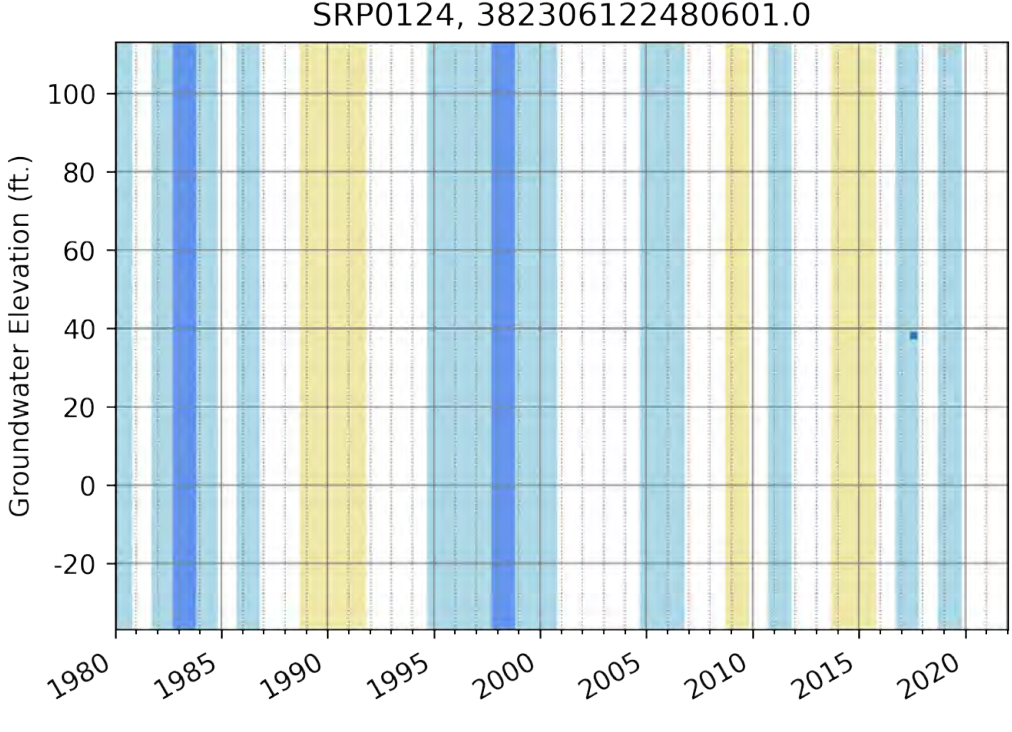

SRP0118, SRP-L10-01
Groundwater Elevation (ft.)
340
320
300
280
260
240
220
200
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0119, SRP-L13-01
Groundwater Elevation (ft.)
260
240
220
200
180
160
140
120
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0120, SRP-L17-01
Groundwater Elevation (ft.)
280
260
240
220
200
180
160
140
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0121, SRP-L19-01
Groundwater Elevation (ft.)
180
160
140
120
100
80
60
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0122, SRP-M10-01
Groundwater Elevation (ft.)
400
380
360
340
320
300
280
260
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0124, 382306122480601.0
Groundwater Elevation (ft.)
100
80
60
40
20
0
-20
1980
1985
1990
1995
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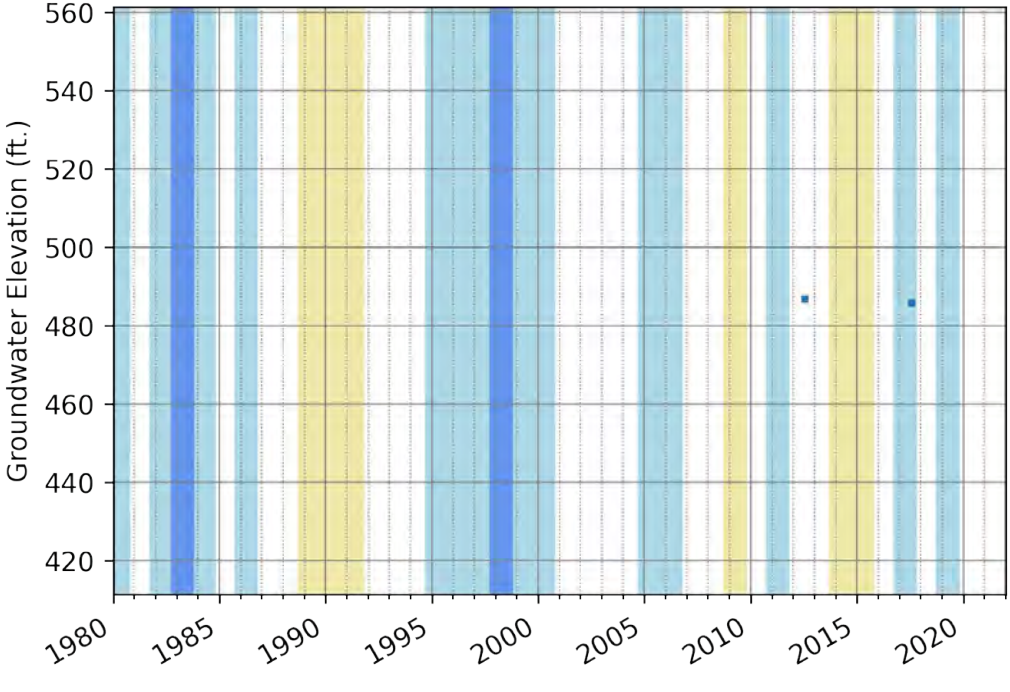
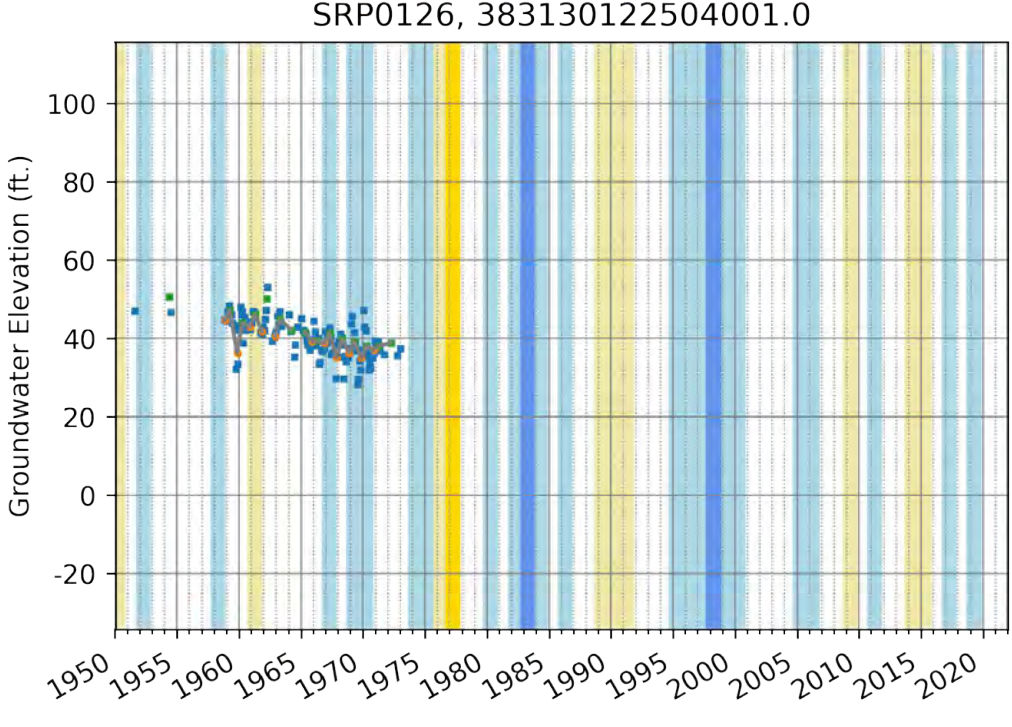
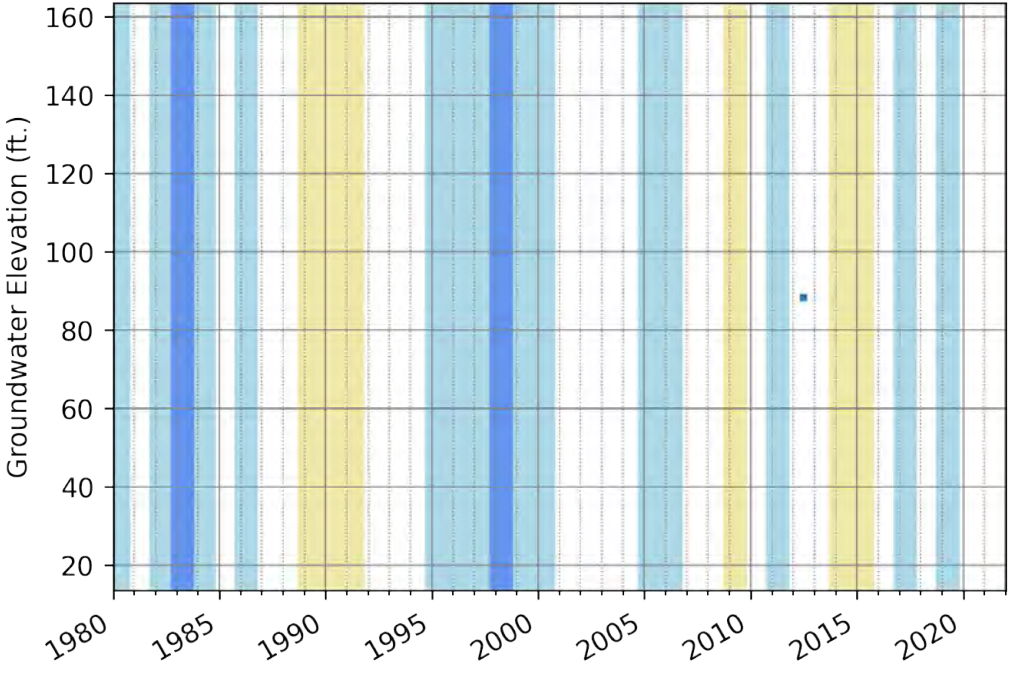
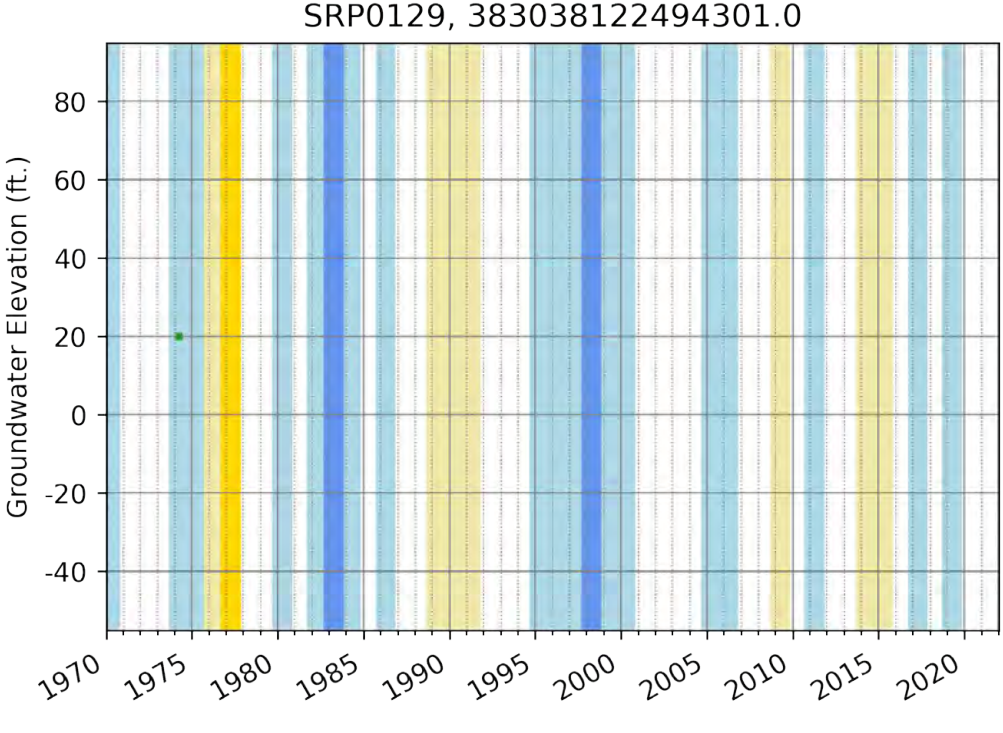
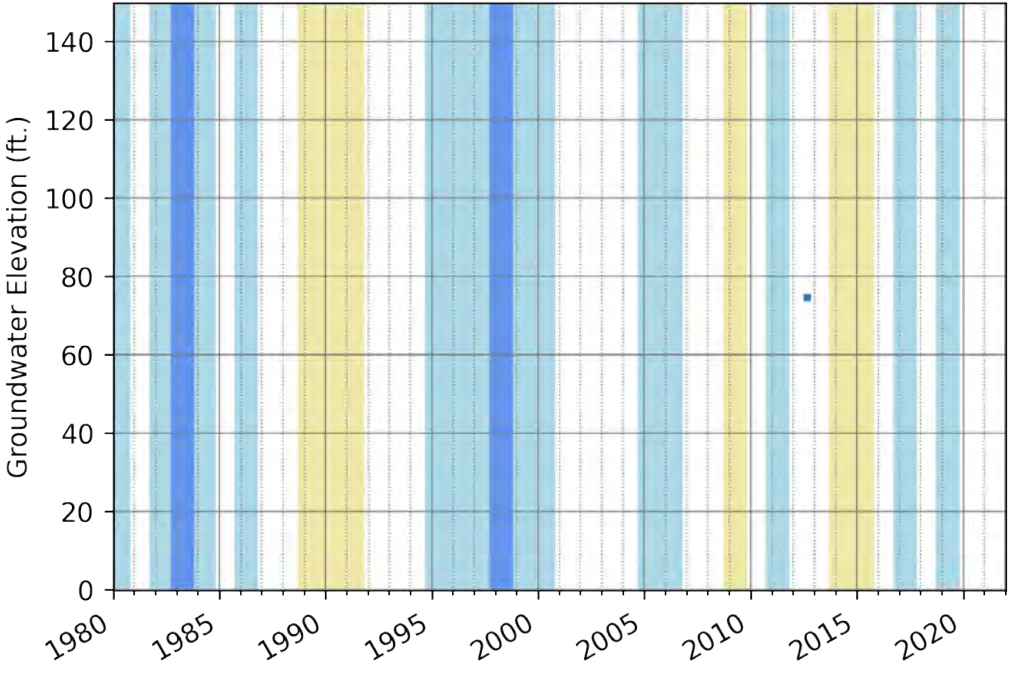
2005
2010
2015
2020

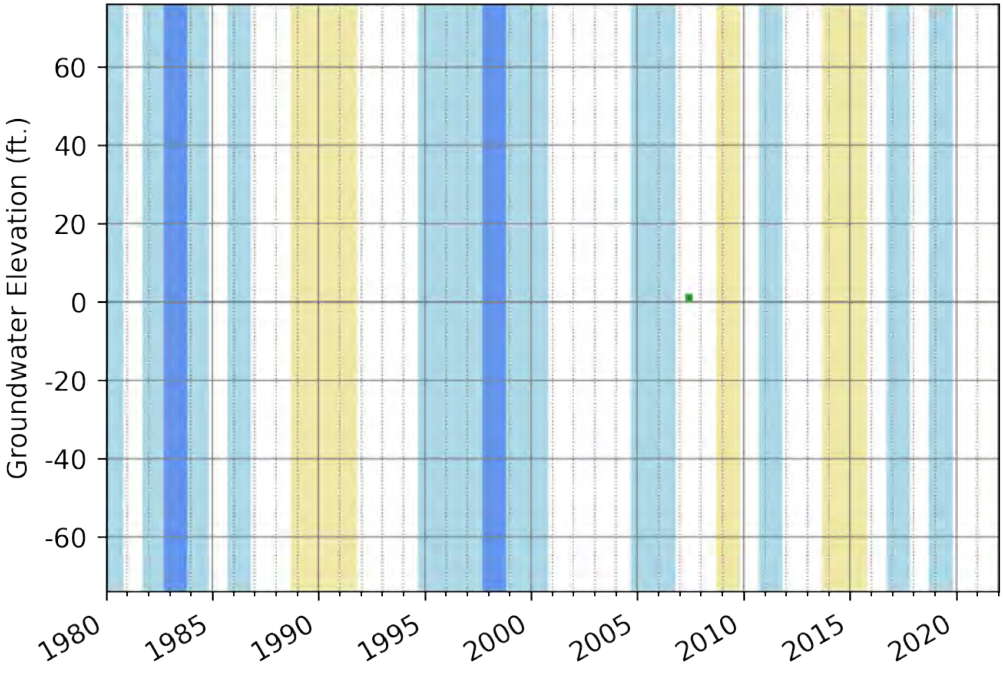

SRP0125, 383323122432101.0
Groundwater Elevation (ft.)
560
540
520
500
480
460
440
420
1980
1985
1990
1995
2000
2005
2010
2015
2020

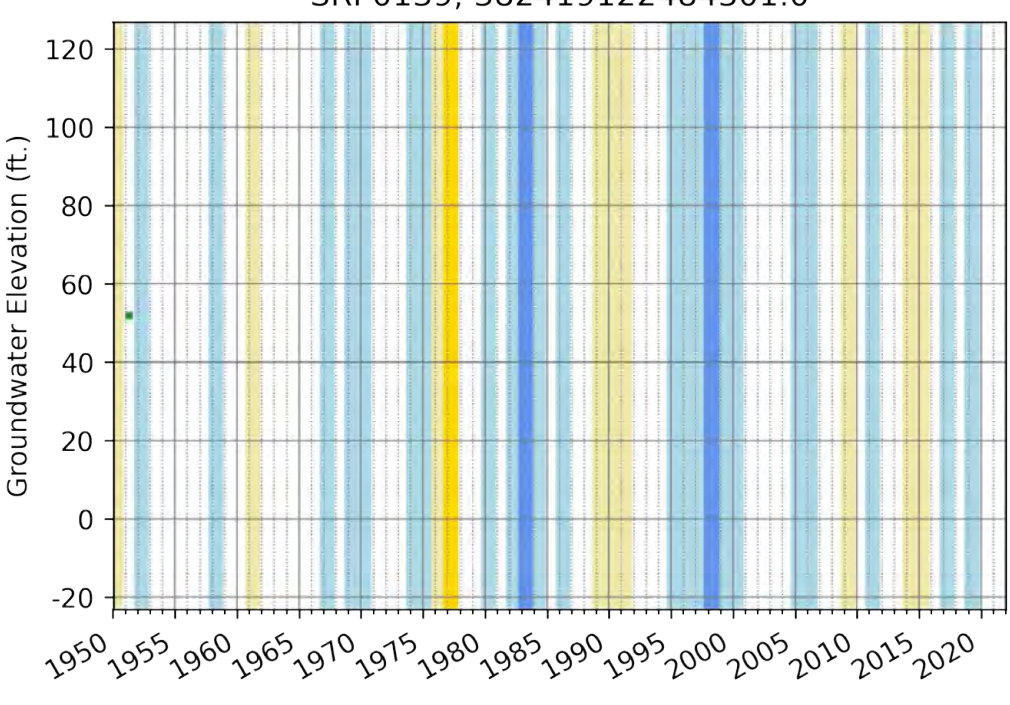

SRP0126, 383130122504001.0
Groundwater Elevation (ft.)
100
80
60
40
20
0
-20
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

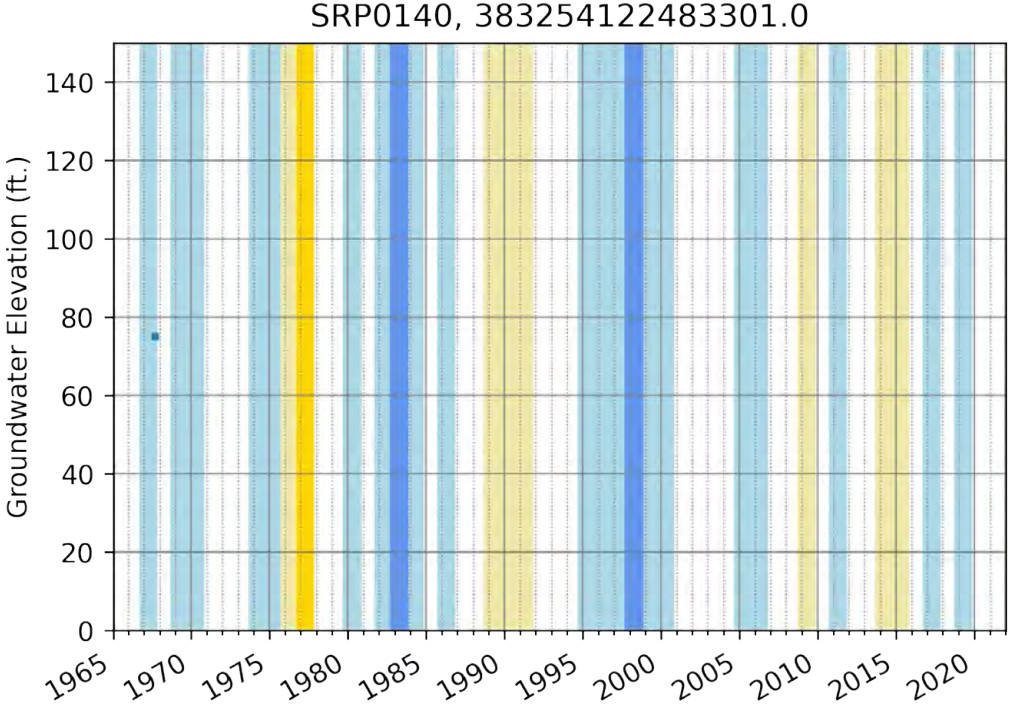

SRP0128, 383325122501301.0
Groundwater Elevation (ft.)
160
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020

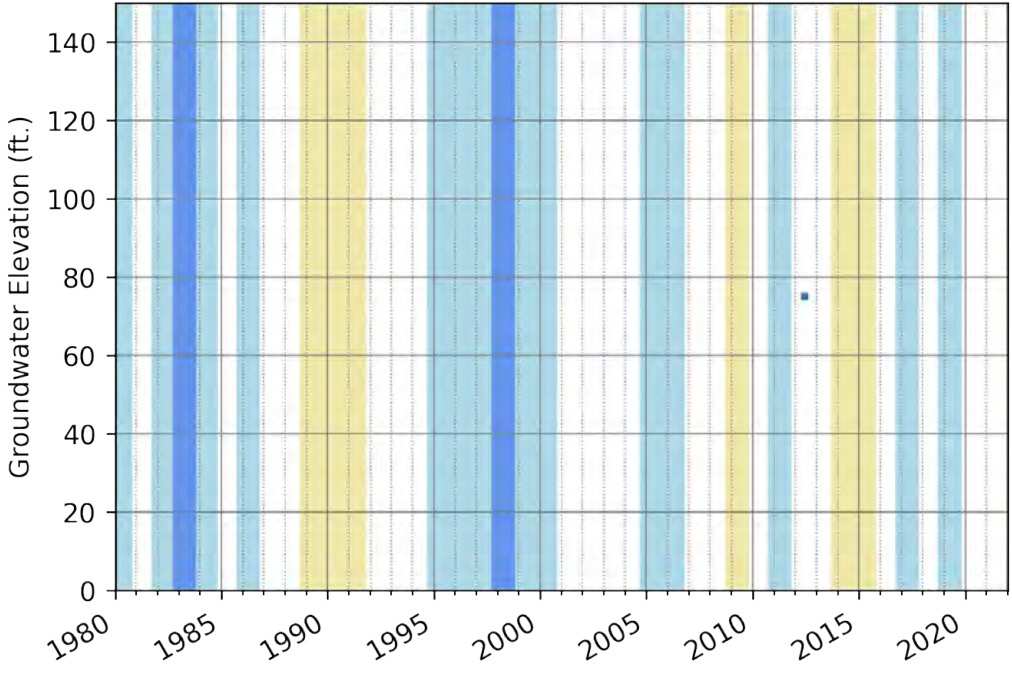

SRP0129, 383038122494301.0
Groundwater Elevation (ft.)
80
60
40
20
0
-20
-40
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

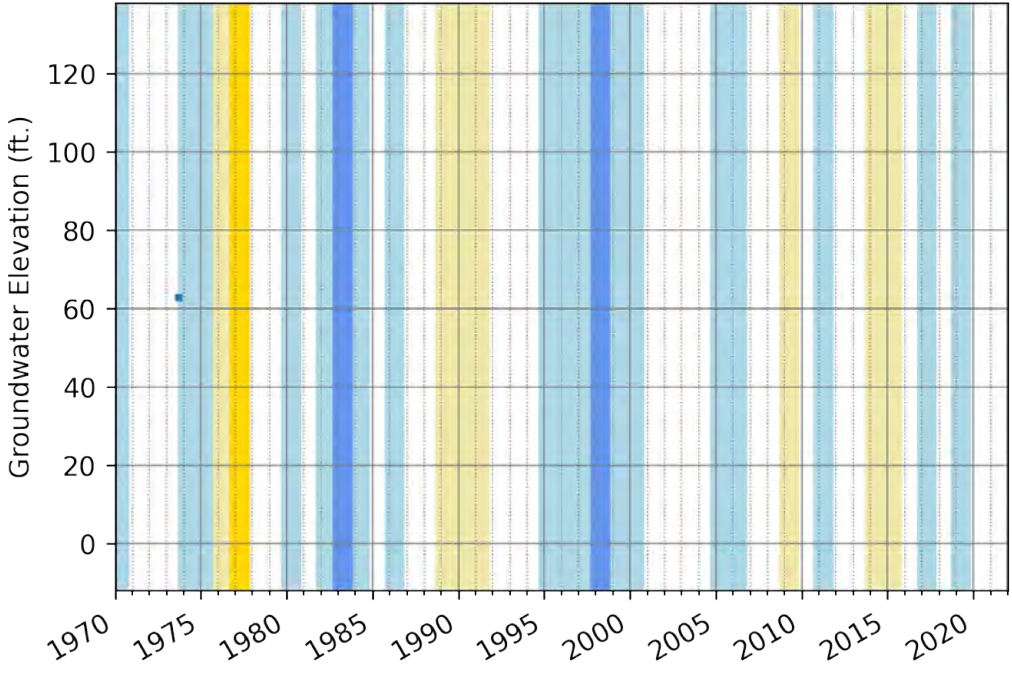

SRP0133, 383201122493001.0
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0138, 382522122485601.0
Groundwater Elevation (ft.)
60
40
20
0
-20
-40
-60
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0139, 382419122484301.0
Groundwater Elevation (ft.)
120
100
80
60
40
20
0
-20
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0140, 383254122483301.0
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
0
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0143, 382753122483201.0
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0148, 383243122480501.0
Groundwater Elevation (ft.)
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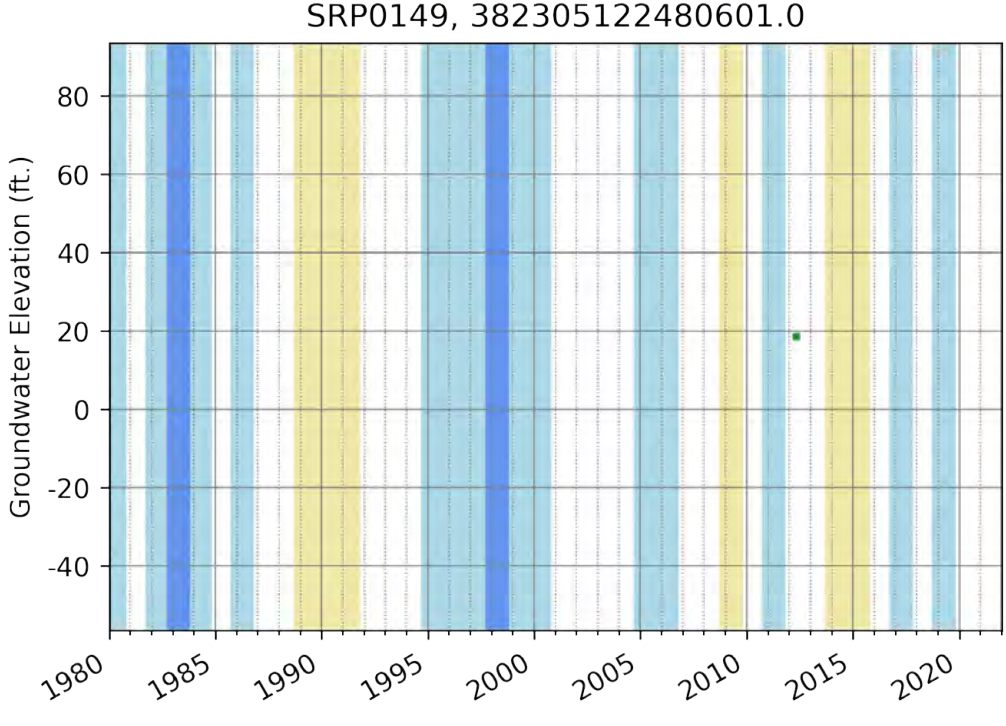
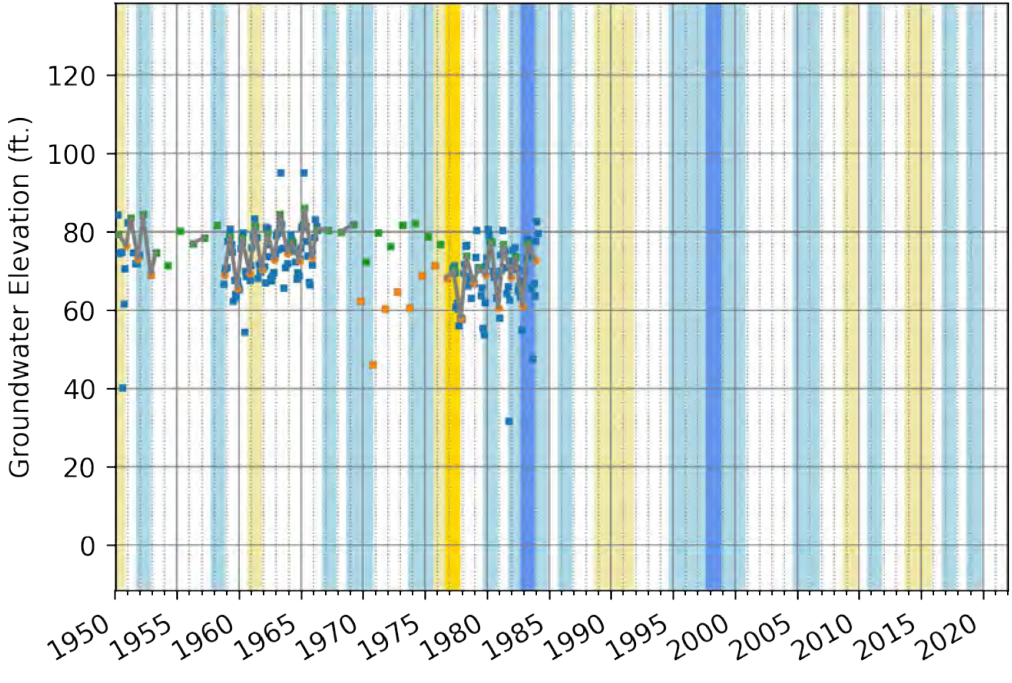
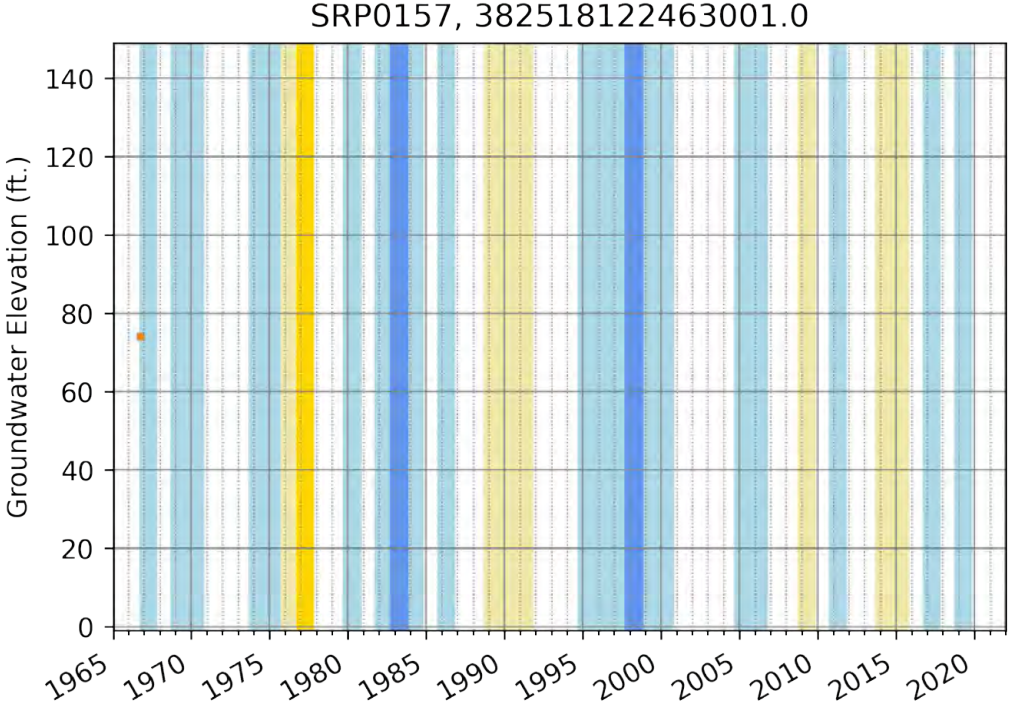
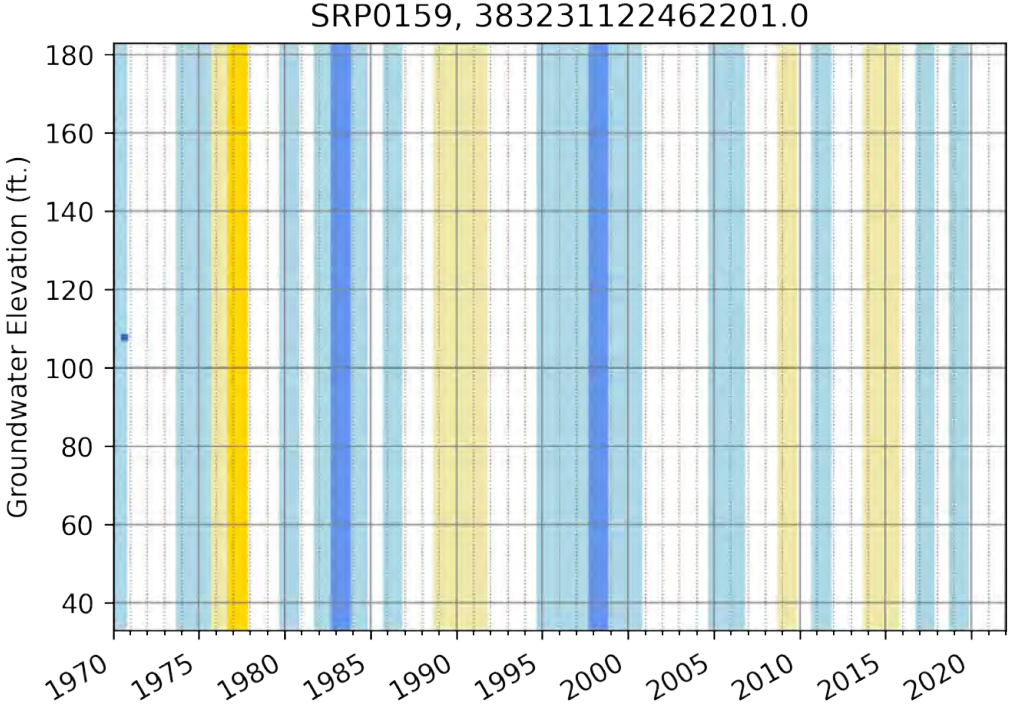
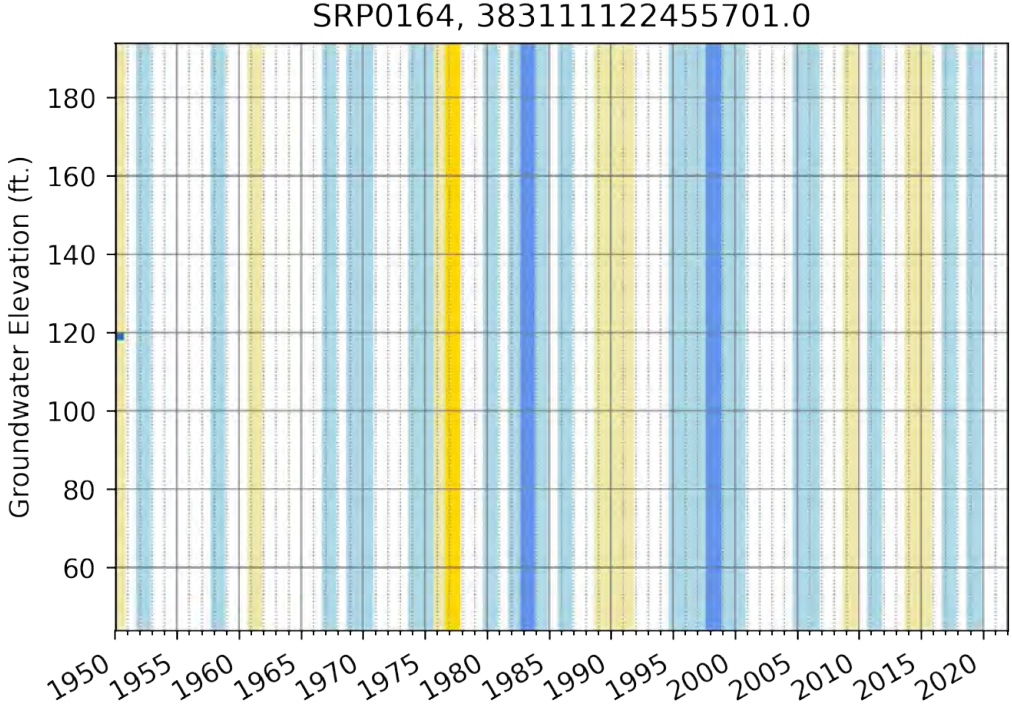
100
80
60
40
20
0
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

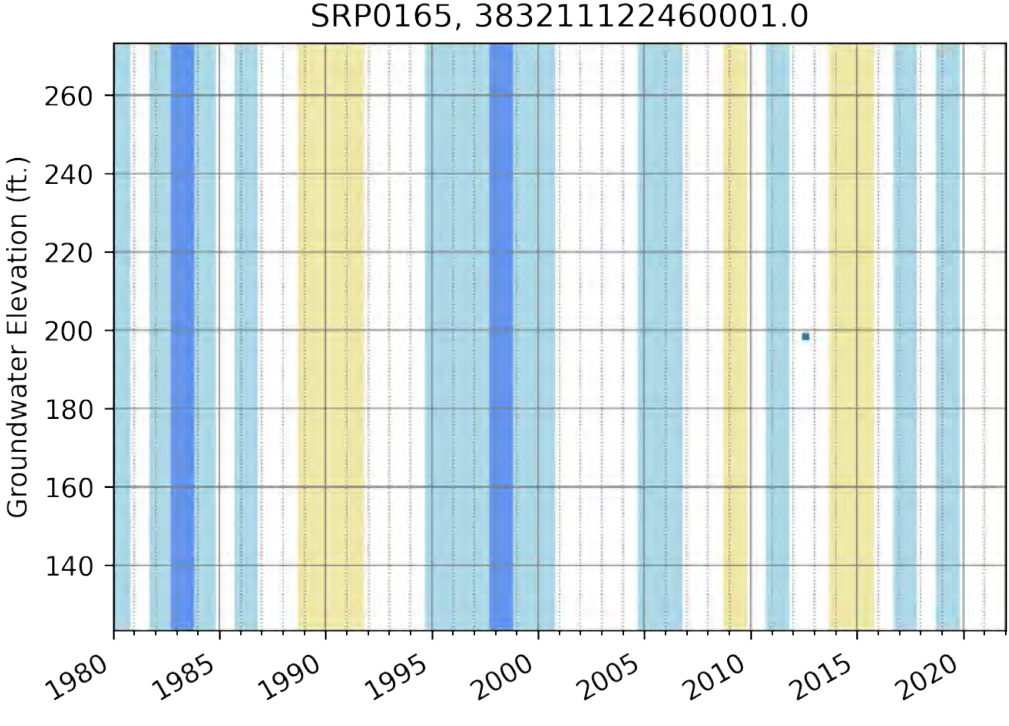

SRP0149, 382305122480601.0
Groundwater Elevation (ft.)
80
60
40
20
0
-20
-40
1980
1985
1990
1995
2000
2005
2010
2015
2020

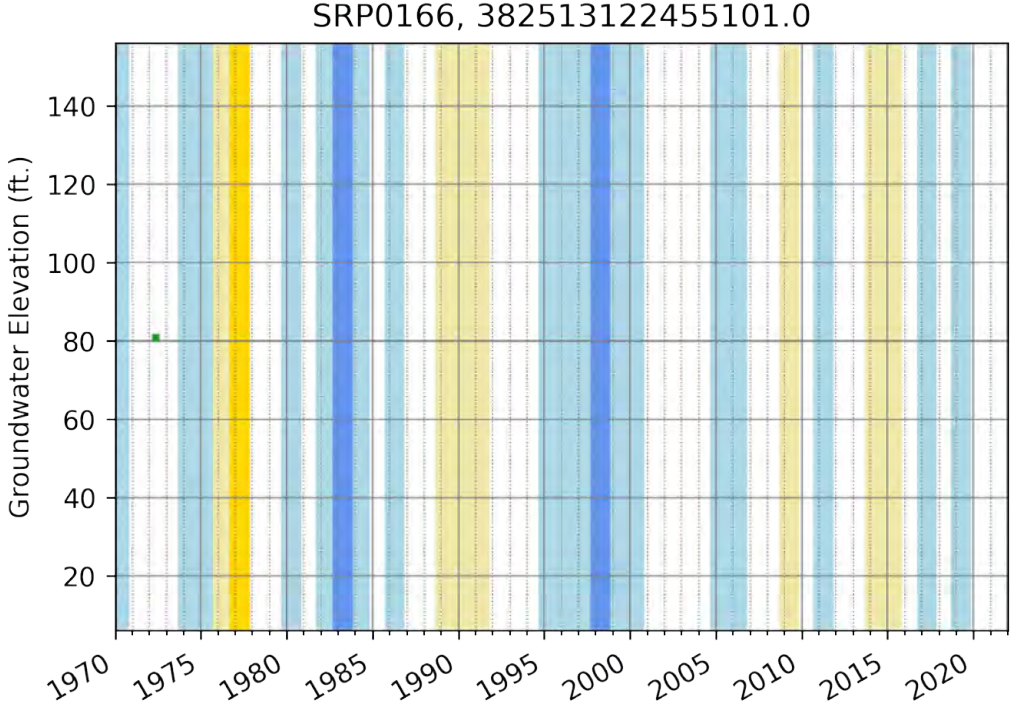

SRP0154, 382229122473101.0
Groundwater Elevation (ft.)
120
100
80
60
40
20
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

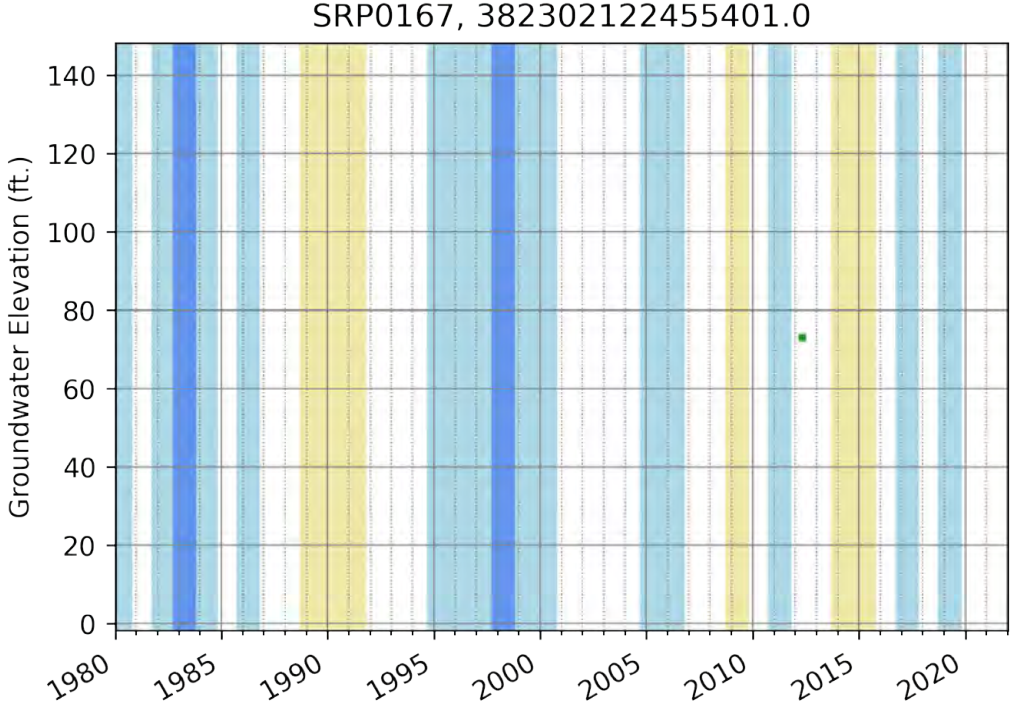

SRP0157, 382518122463001.0
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
0
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

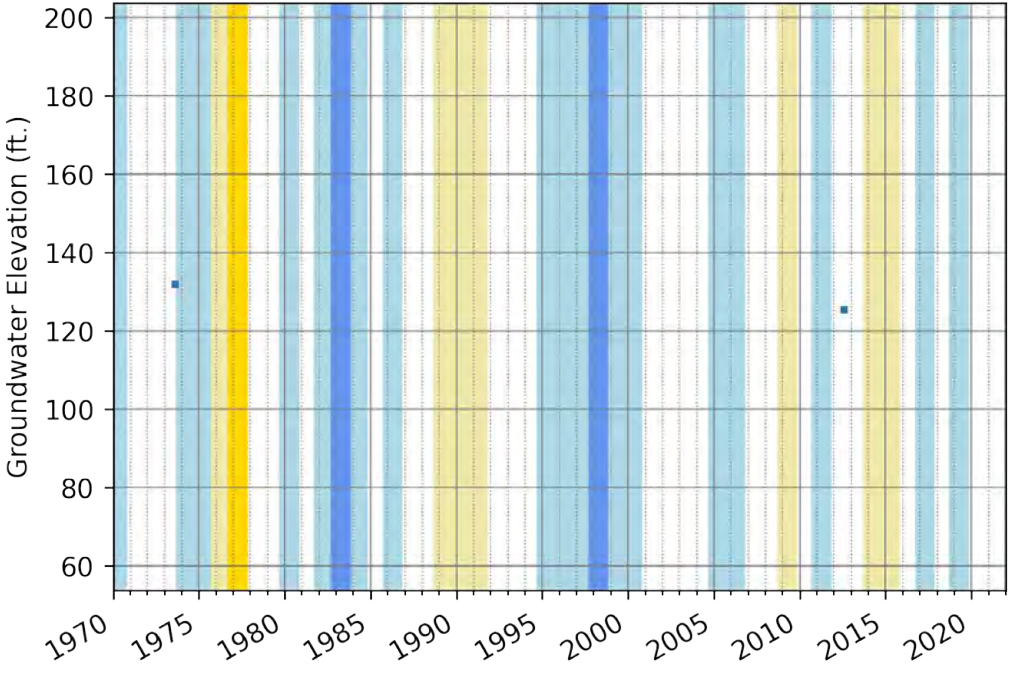

SRP0159, 383231122462201.0
Groundwater Elevation (ft.)
180
160
140
120
100
80
60
40
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0164, 383111122455701.0
Groundwater Elevation (ft.)
180
160
140
120
100
80
60
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0165, 383211122460001.0
Groundwater Elevation (ft.)
260
240
220
200
180
160
140
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0166, 382513122455101.0
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0167, 382302122455401.0
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0168, 383111122454301.0
Groundwater Elevation (ft.)
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180
160
140
120
100
80
60
1970
1975
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1985
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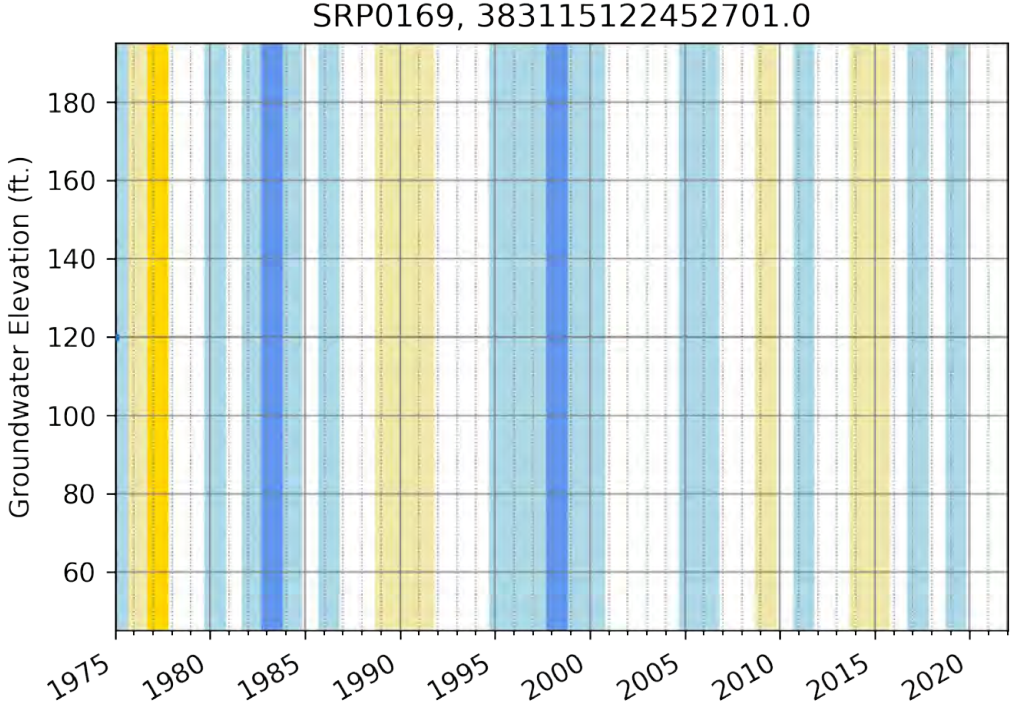
2005
2010
2015
2020


SRP0169, 383115122452701.0
Groundwater Elevation (ft.)
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160
140
120
100
80
60
1975
1980
1985
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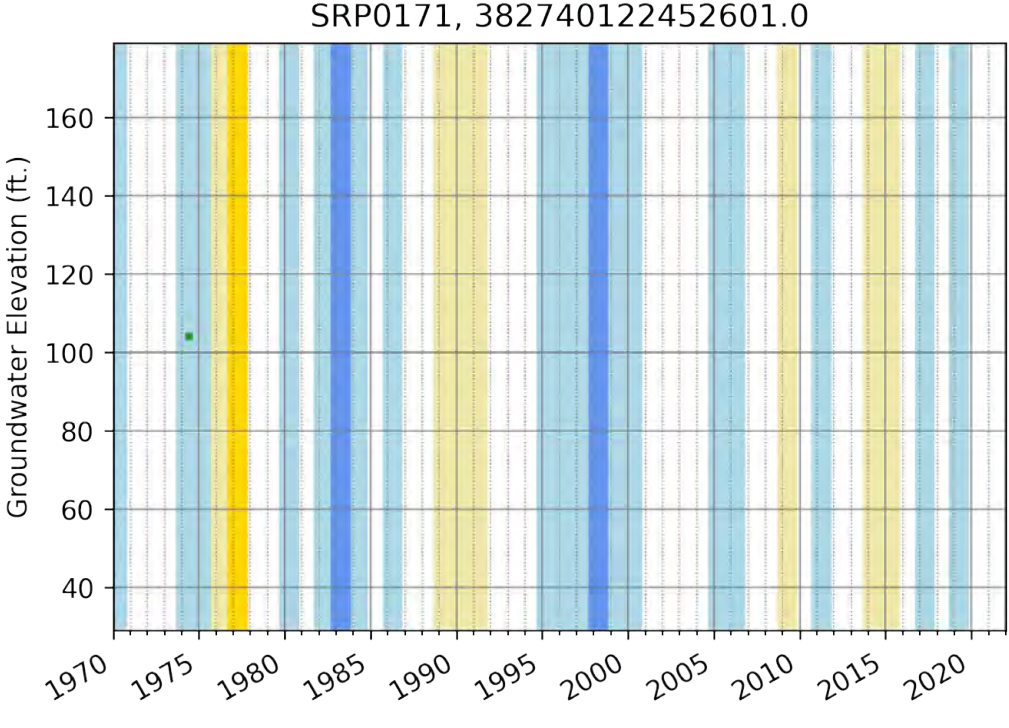
1995
2000
2005
2010
2015
2020


SRP0171, 382740122452601.0
Groundwater Elevation (ft.)
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140
120
100
80
60
40
1970
1975
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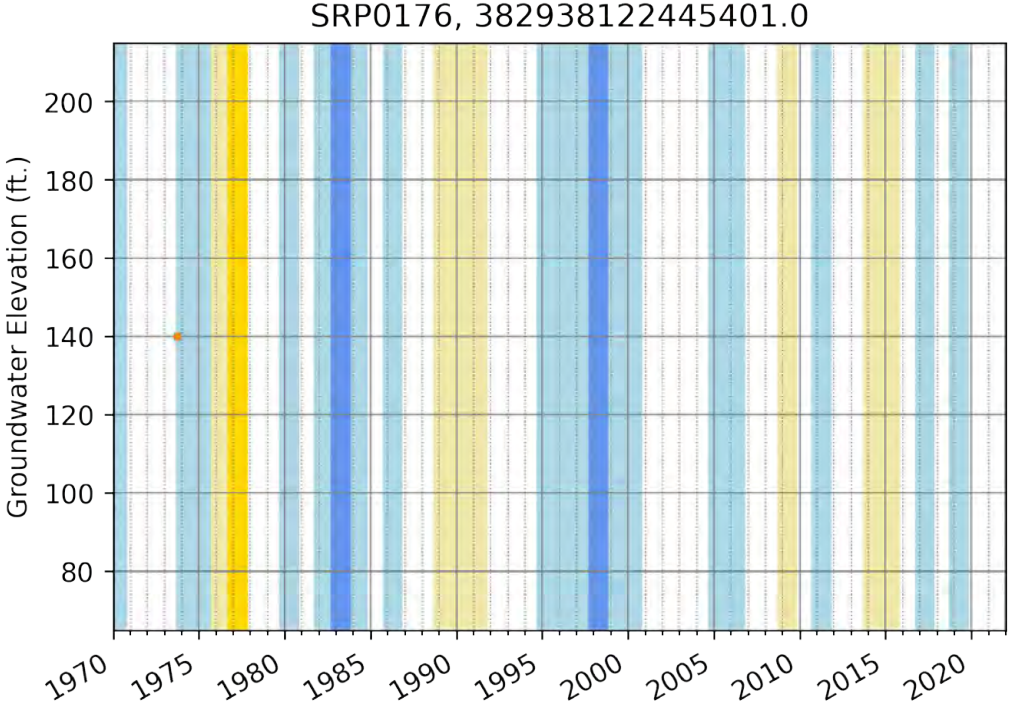
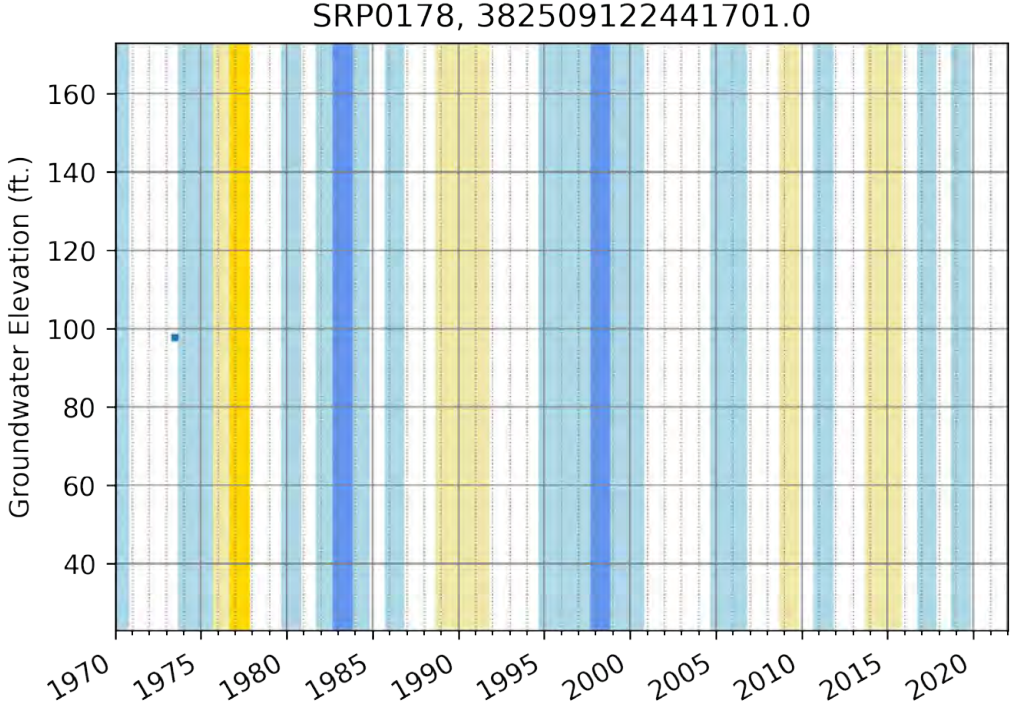
1990
1995
2000
2005
2010
2015
2020


SRP0176, 382938122445401.0
Groundwater Elevation (ft.)
200
180
160
140
120
100
80
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0178, 382509122441701.0
Groundwater Elevation (ft.)
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140
120
100
80
60
40
1970
1975
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1985
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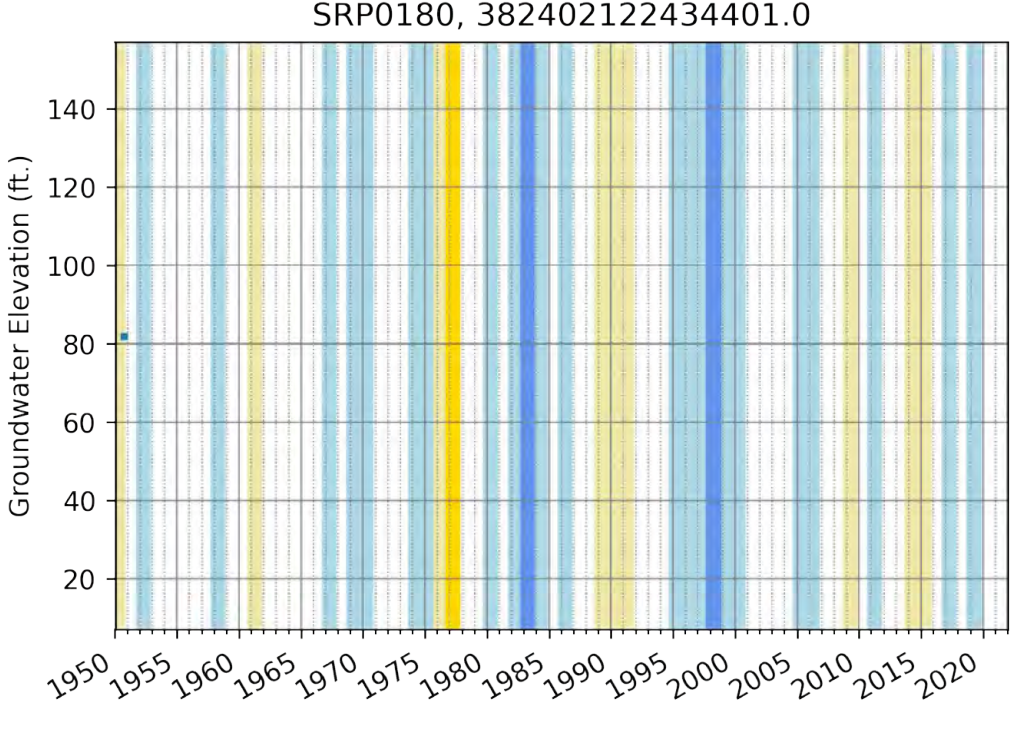
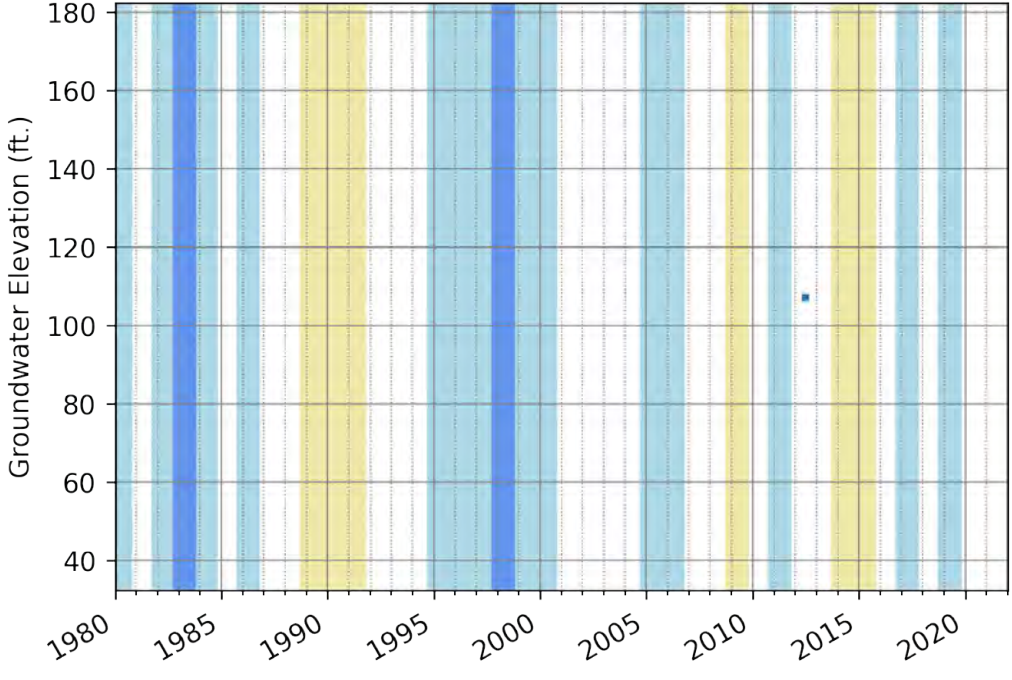
2005
2010
2015
2020


SRP0180, 382402122434401.0
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0184, 382442122432101.0
Groundwater Elevation (ft.)
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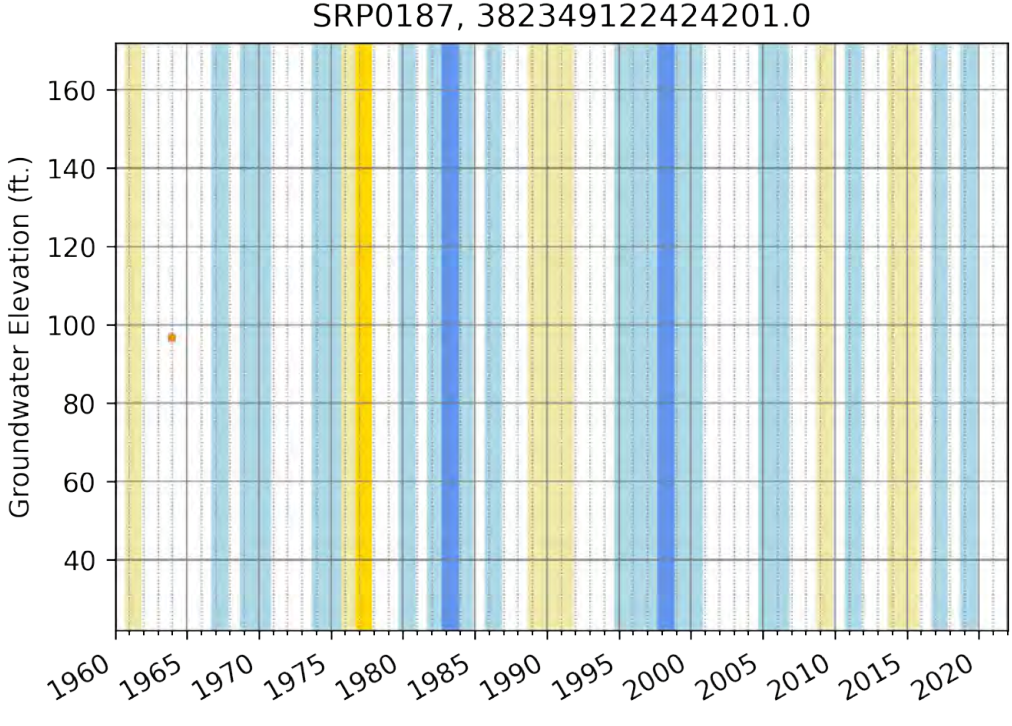
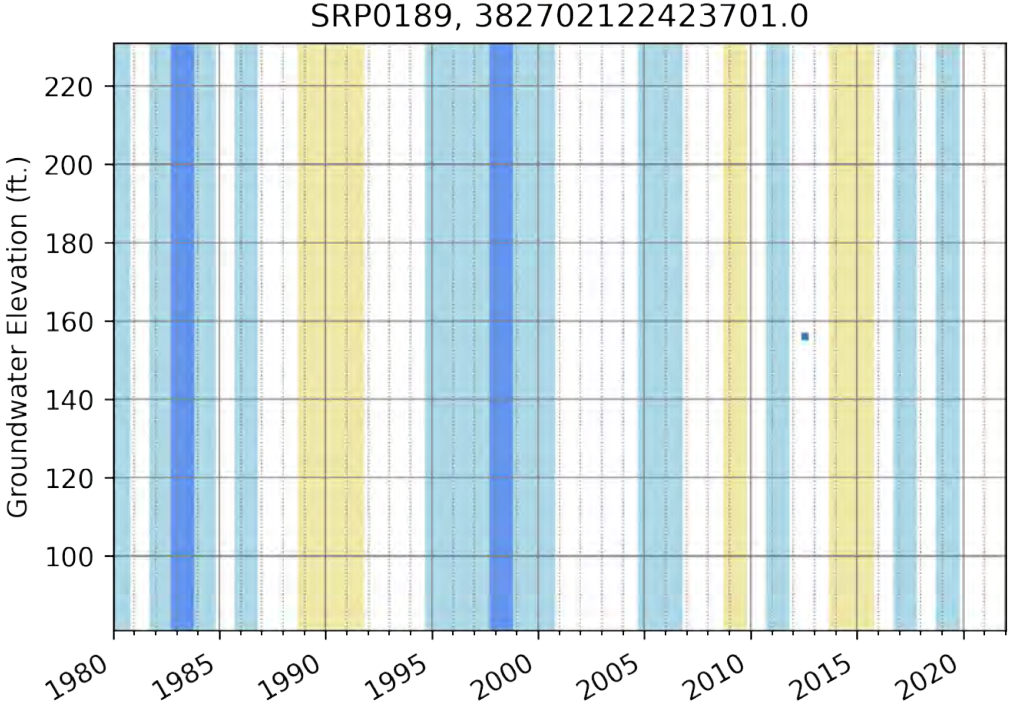
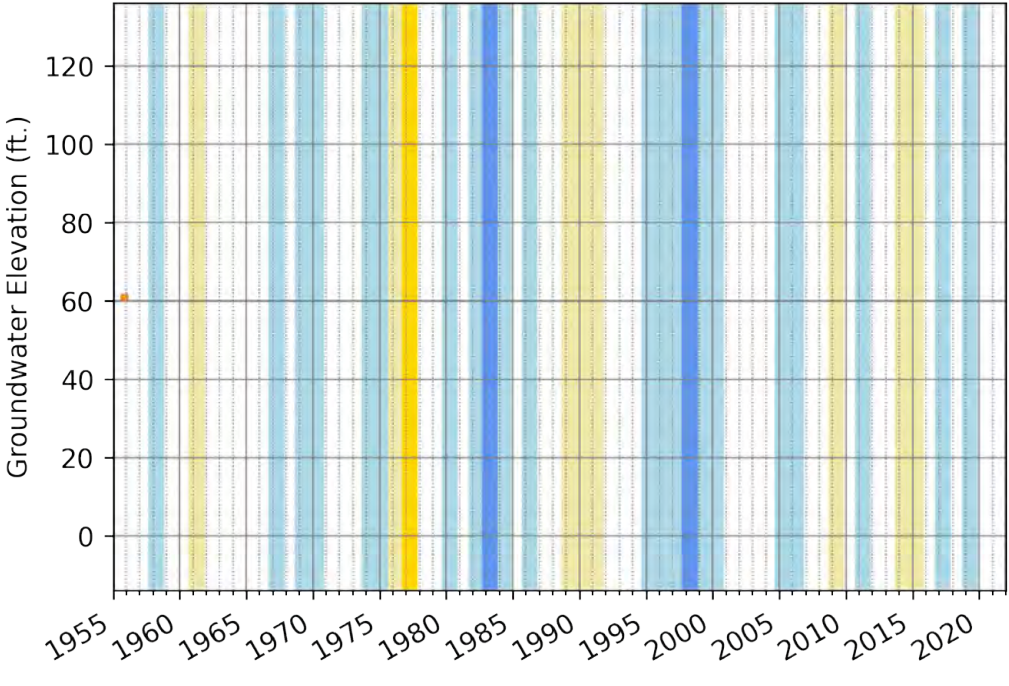
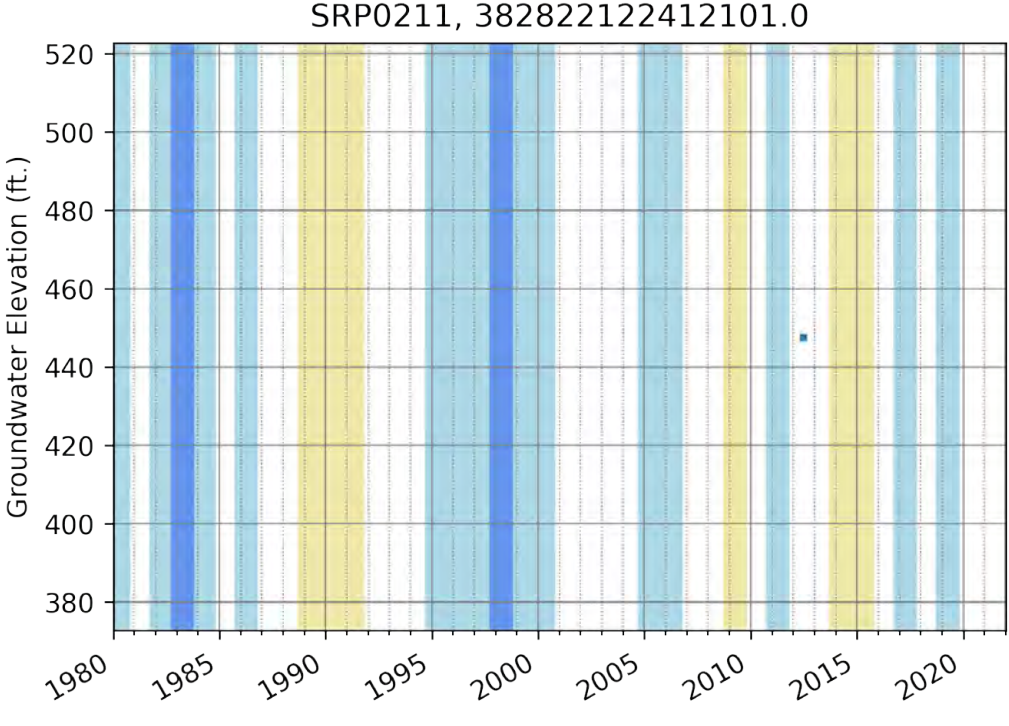
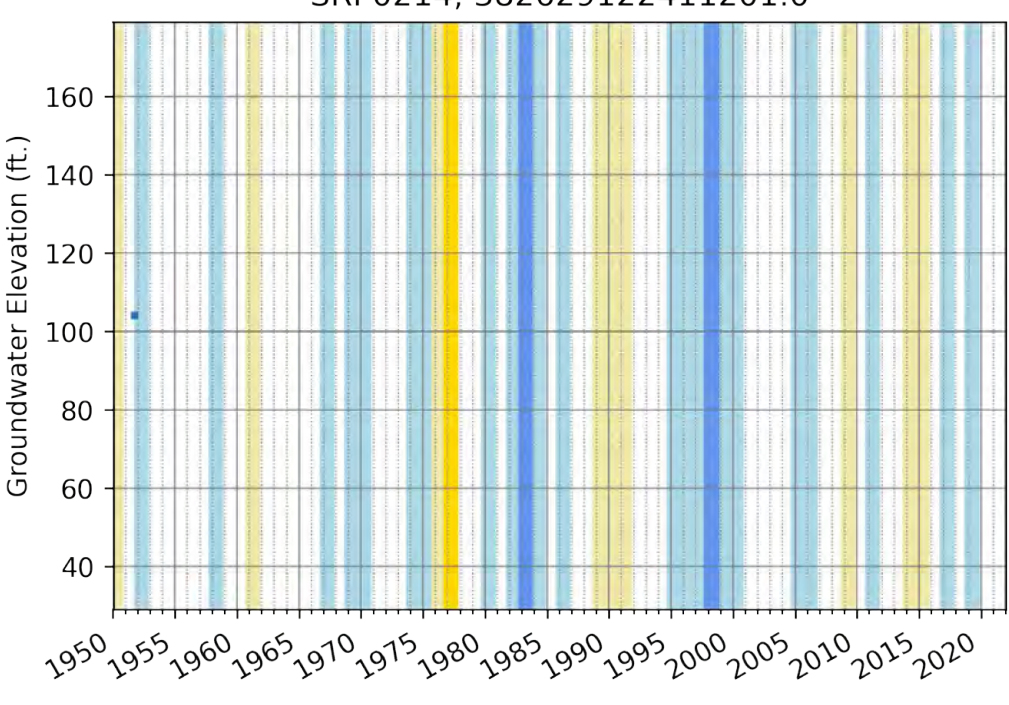
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0187, 382349122424201.0
Groundwater Elevation (ft.)
160
140
120
100
80
60
40
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0189, 382702122423701.0
Groundwater Elevation (ft.)
220
200
180
160
140
120
100
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0197, 382049122420401.0
Groundwater Elevation (ft.)
120
100
80
60
40
20
0
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0211, 382822122412101.0
Groundwater Elevation (ft.)
520
500
480
460
440
420
400
380
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0214, 382629122411201.0
Groundwater Elevation (ft.)
160
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40
1950
1955
1960
1965
1970
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1985
1990
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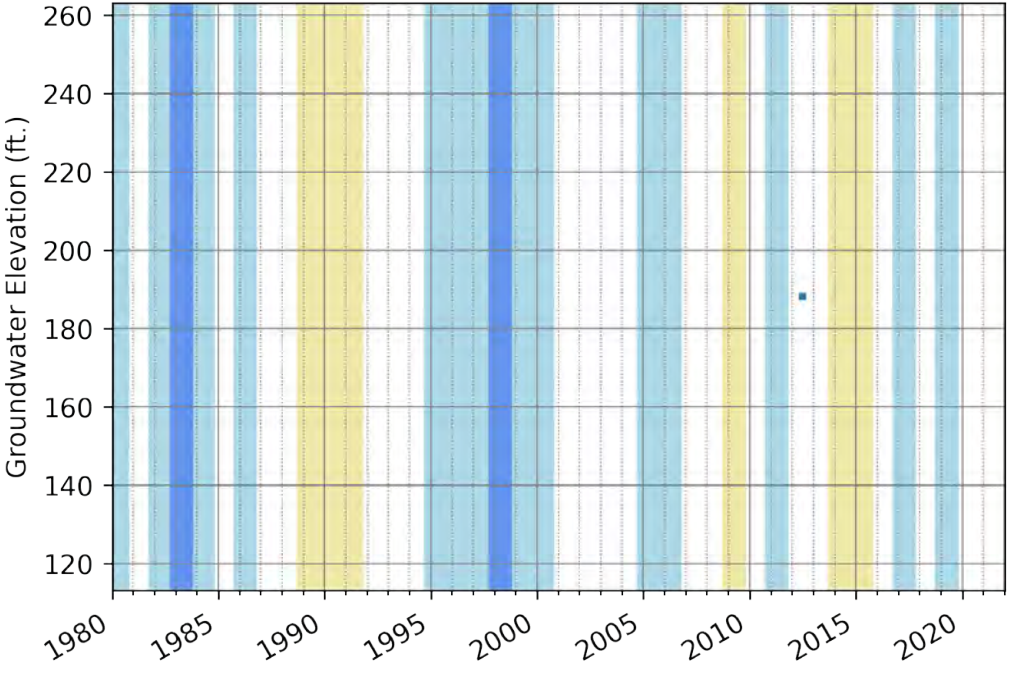
2000
2005
2010
2015
2020


SRP0219, 382622122404601.0
Groundwater Elevation (ft.)
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240
220
200
180
160
140
120
1980
1985
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1995
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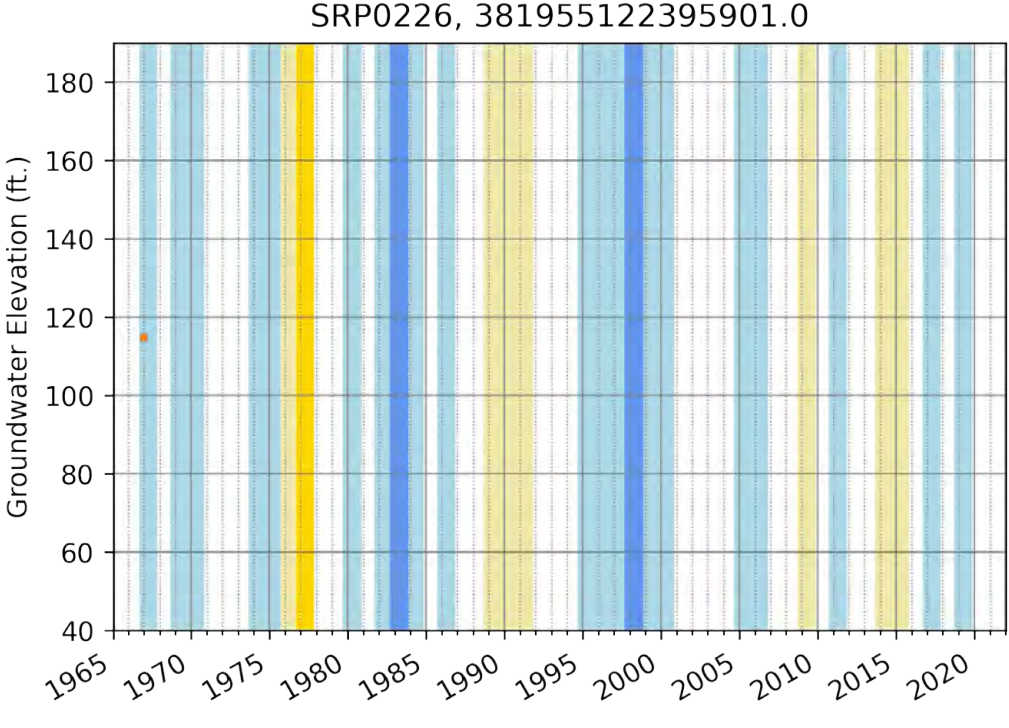
2005
2010
2015
2020


SRP0226, 381955122395901.0
Groundwater Elevation (ft.)
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120
100
80
60
40
1965
1970
1975
1980
1985
1990
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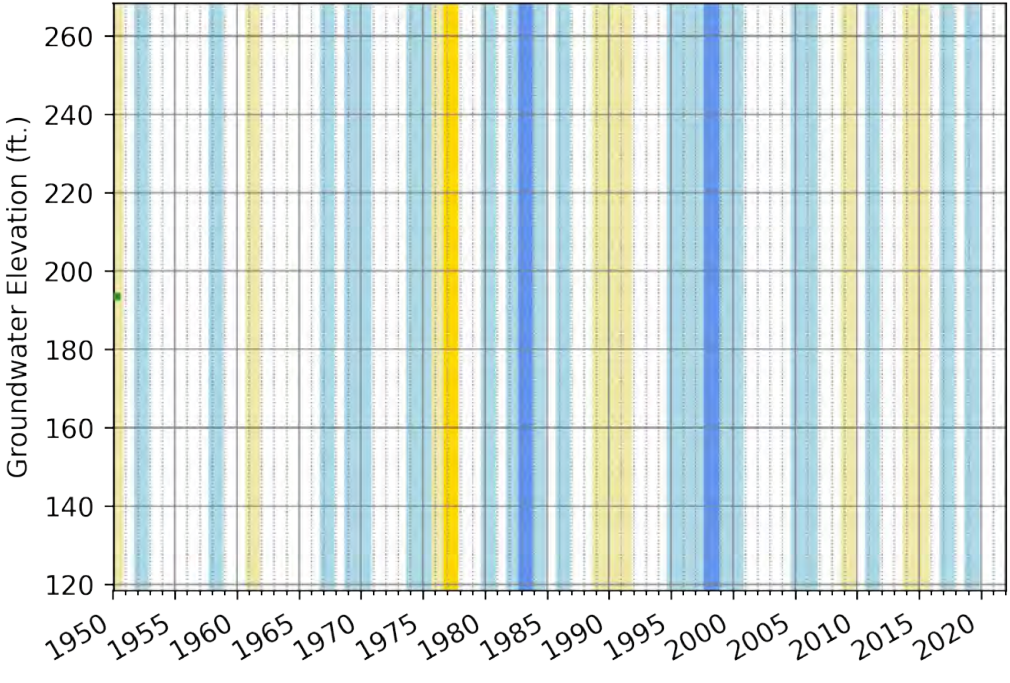
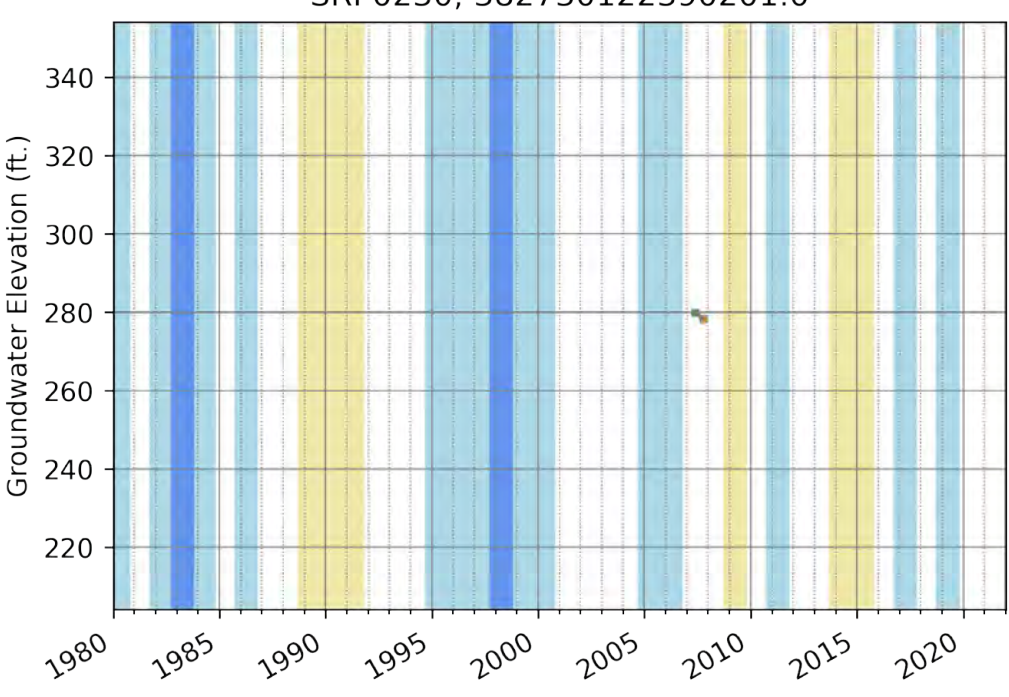
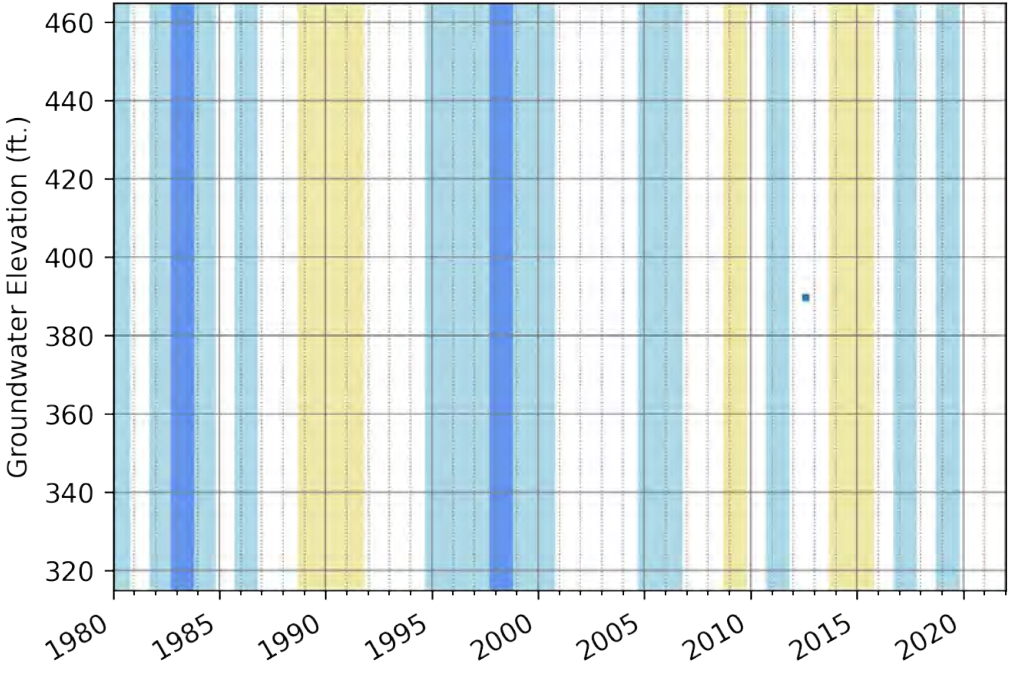
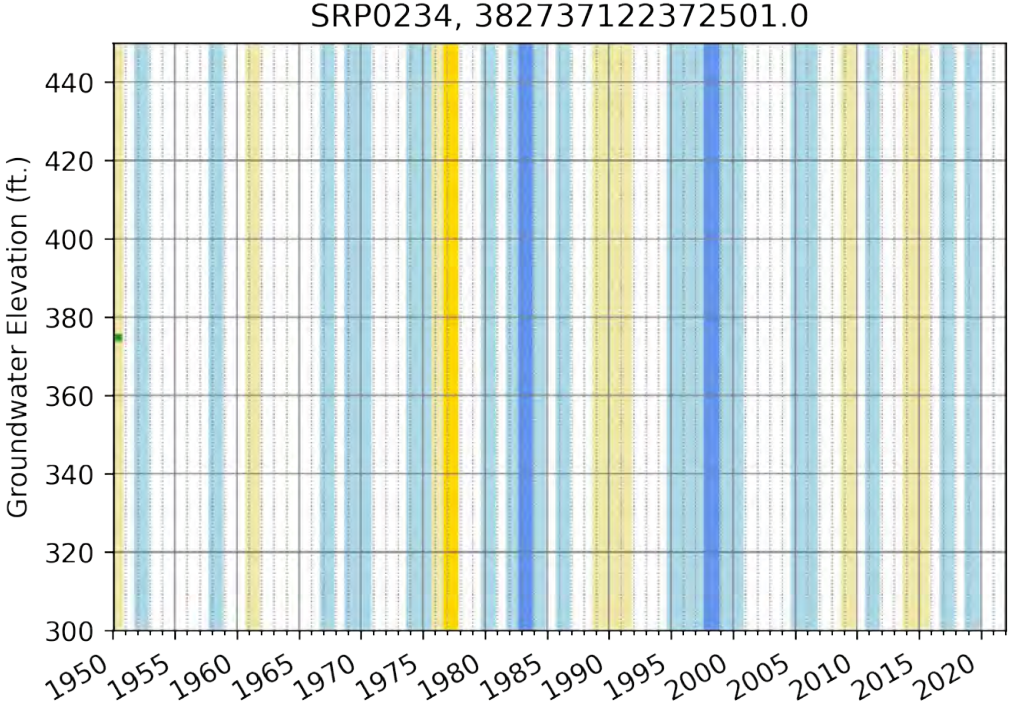
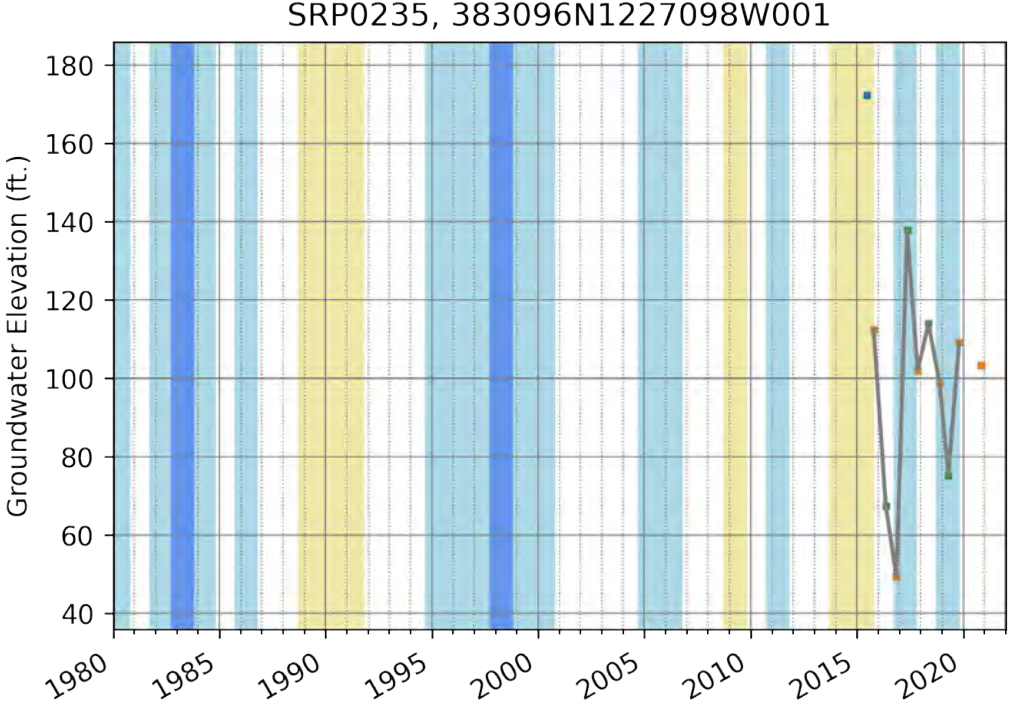
2005
2010
2015
2020

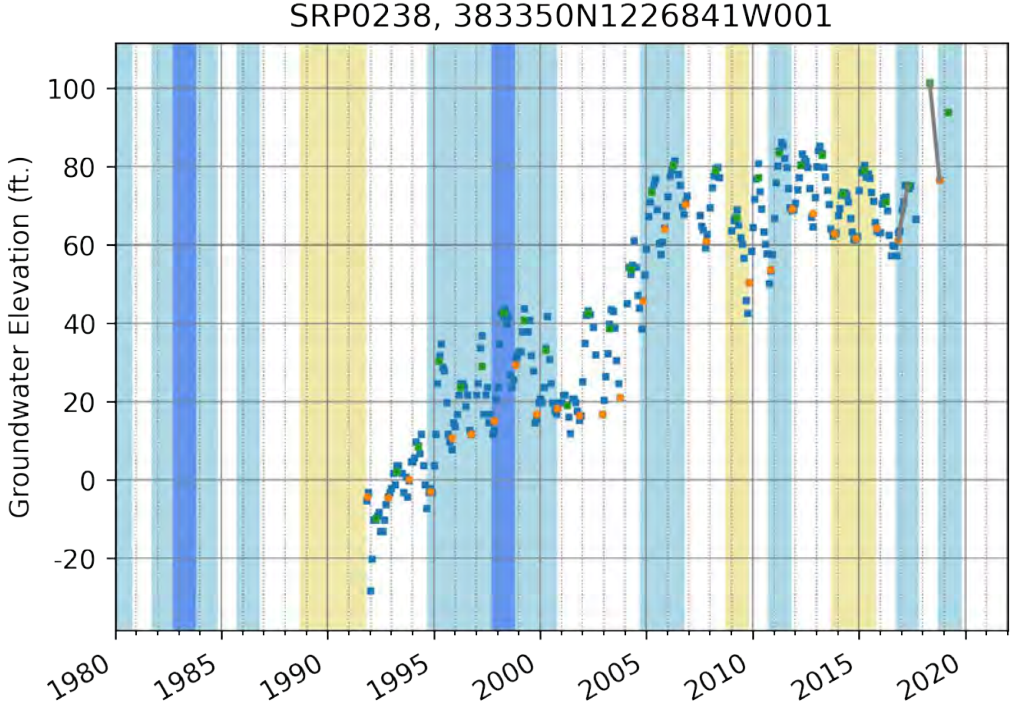

SRP0227, 382548122395501.0
Groundwater Elevation (ft.)
260
240
220
200
180
160
140
120
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

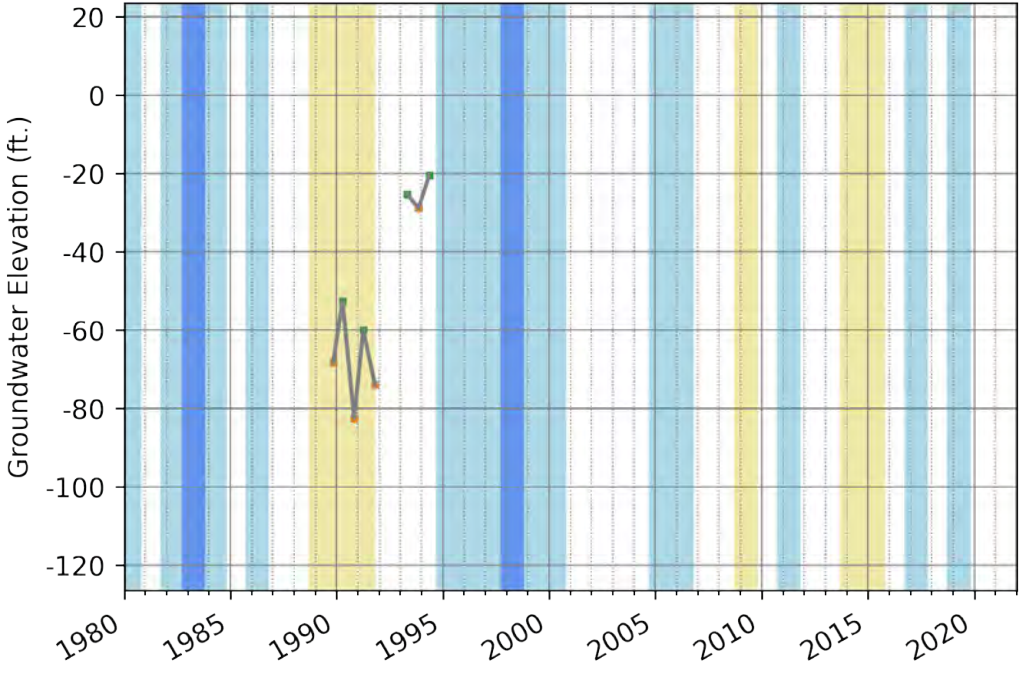

SRP0230, 382730122390201.0
Groundwater Elevation (ft.)
340
320
300
280
260
240
220
1980
1985
1990
1995
2000
2005
2010
2015
2020

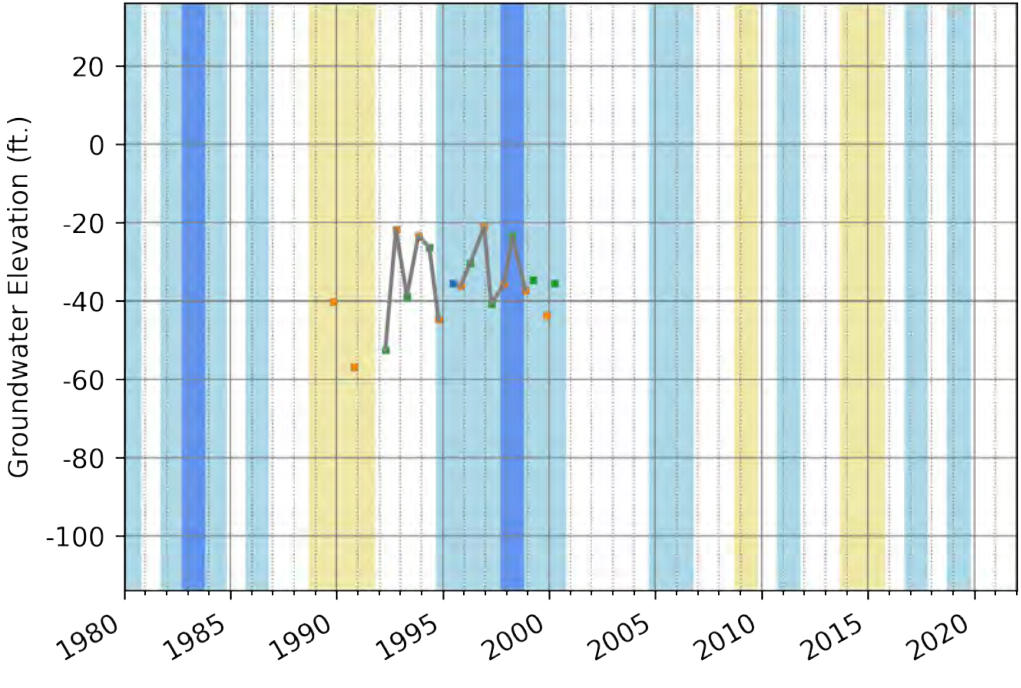

SRP0231, 382429122384601.0
Groundwater Elevation (ft.)
460
440
420
400
380
360
340
320
1980
1985
1990
1995
2000
2005
2010
2015
2020

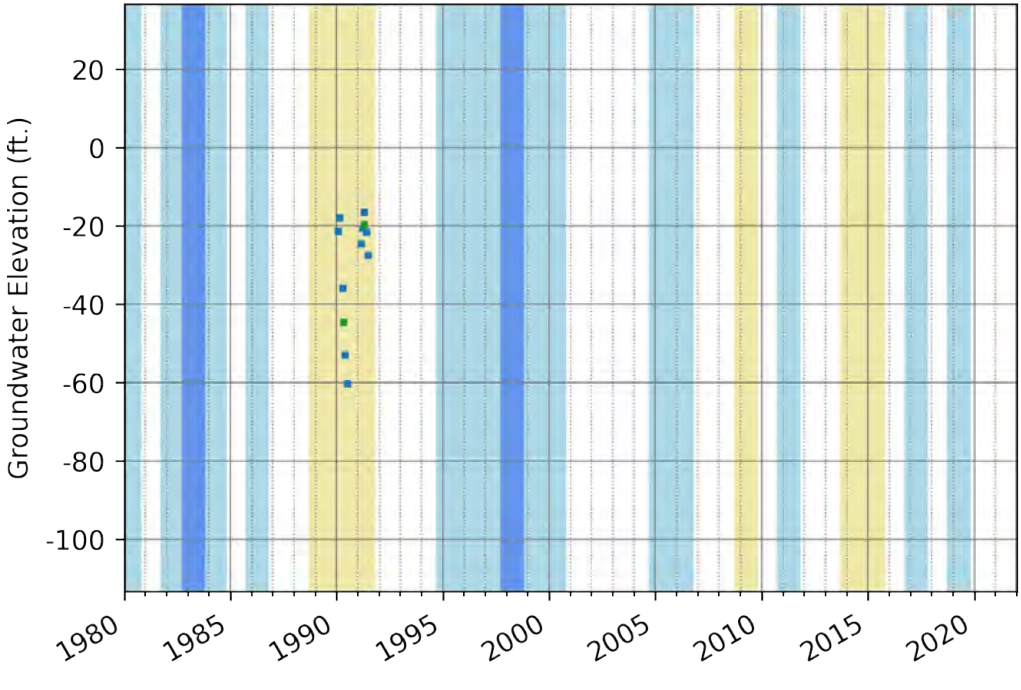

SRP0234, 382737122372501.0
Groundwater Elevation (ft.)
440
420
400
380
360
340
320
300
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

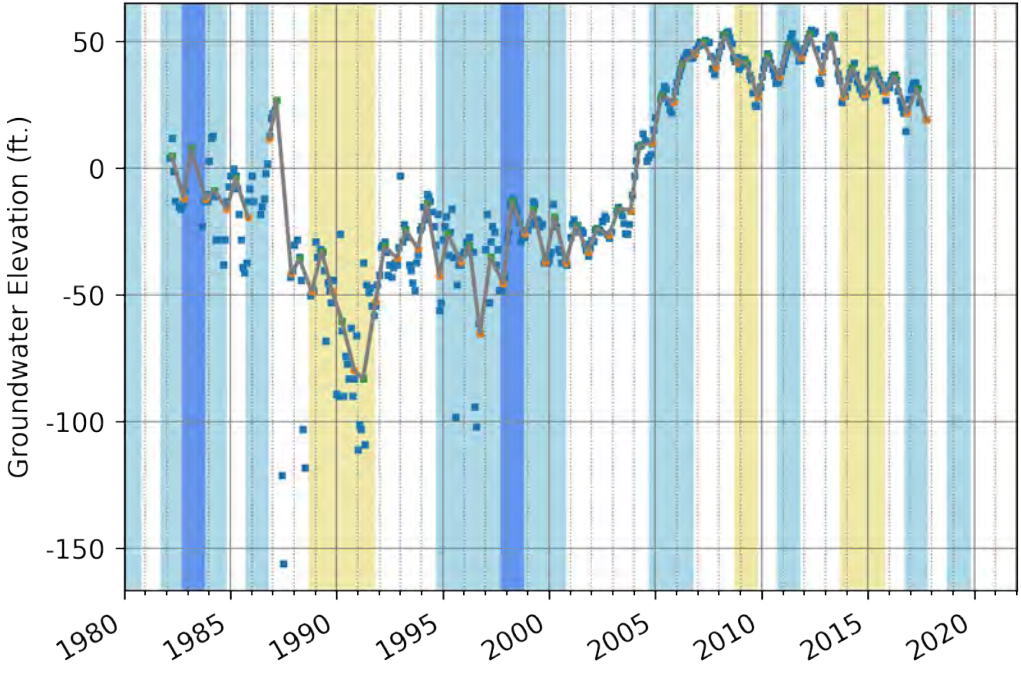

SRP0235, 383096N1227098W001
Groundwater Elevation (ft.)
180
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020

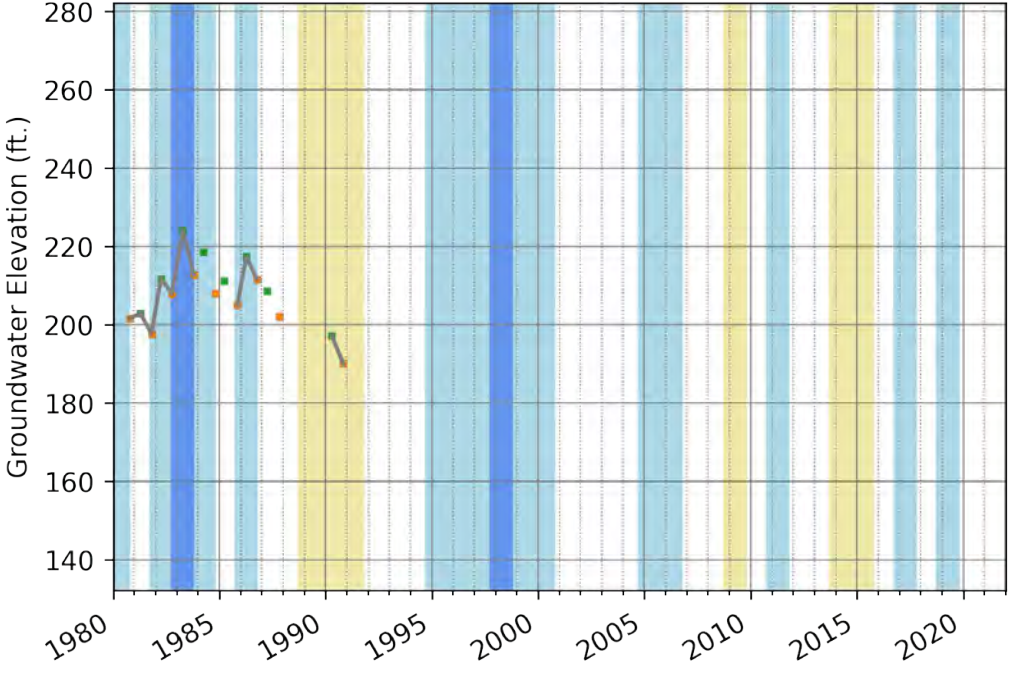

SRP0238, 383350N1226841W001
Groundwater Elevation (ft.)
100
80
60
40
20
0
-20
1980
1985
1990
1995
2000
2005
2010
2015
2020

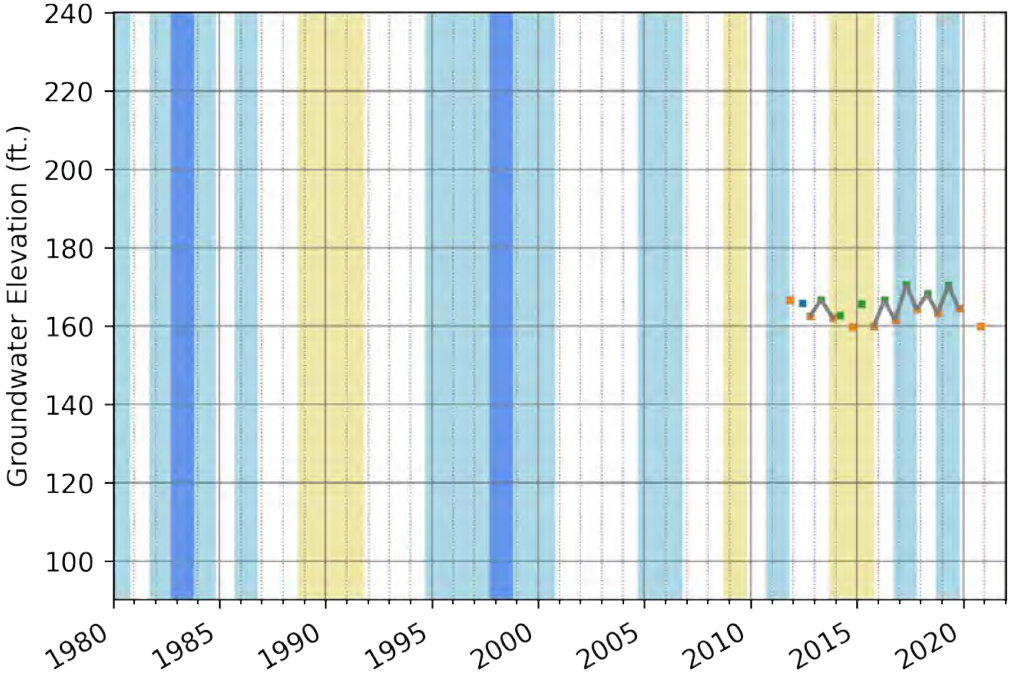

SRP0239, 383360N1227192W001
Groundwater Elevation (ft.)
20
0
-20
-40
-60
-80
-100
-120
1980
1985
1990
1995
2000
2005
2010
2015
2020

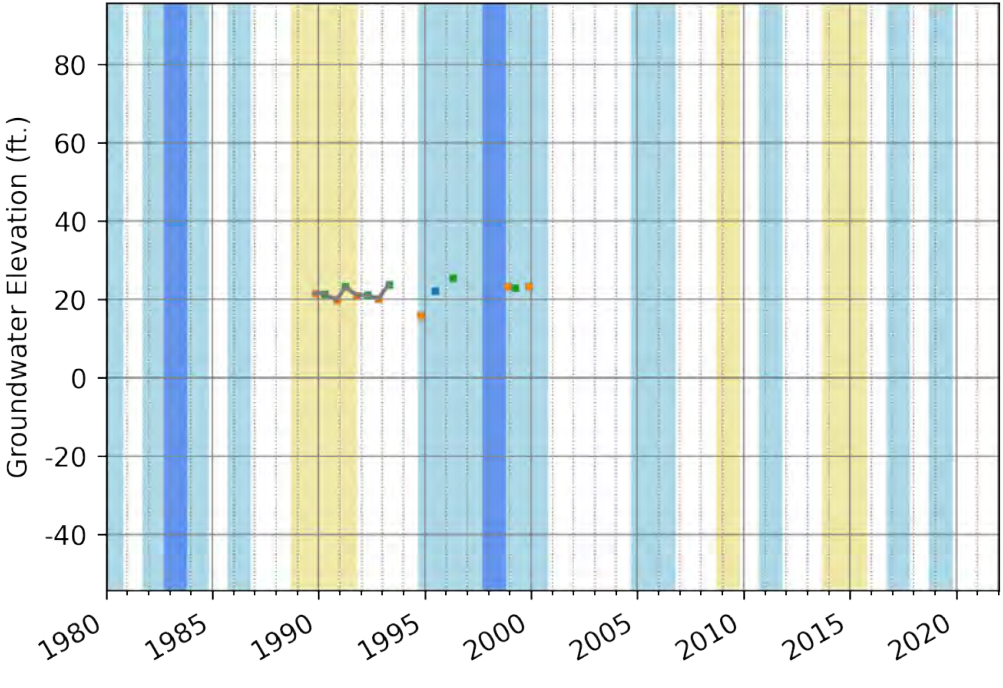

SRP0241, 383465N1227261W001
Groundwater Elevation (ft.)
20
0
-20
-40
-60
-80
-100
1980
1985
1990
1995
2000
2005
2010
2015
2020

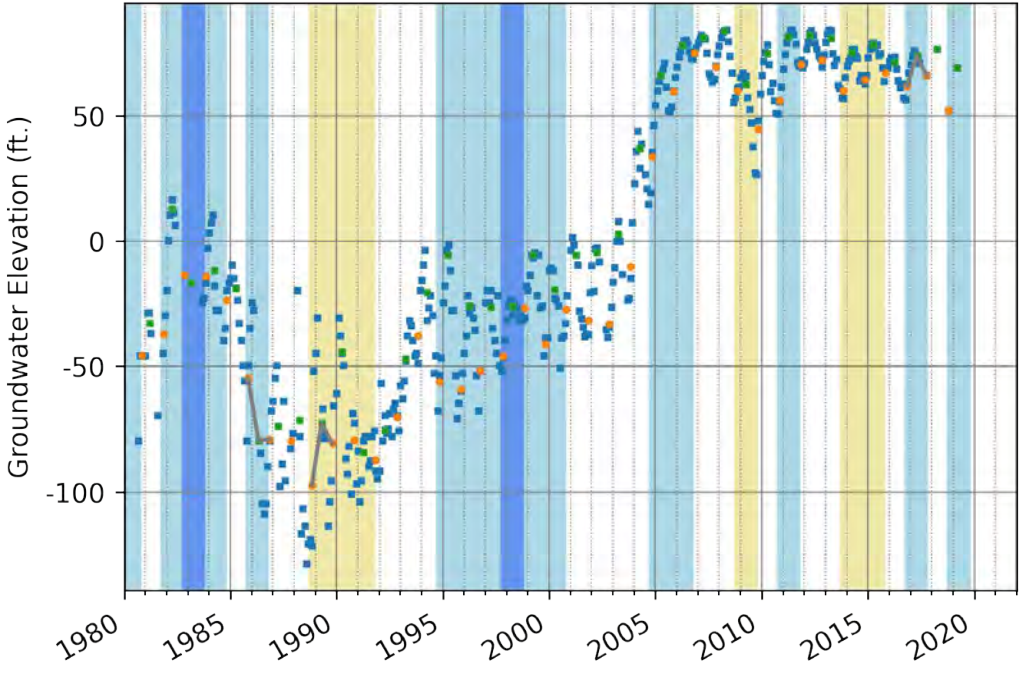

SRP0242, 383513N1226845W001
Groundwater Elevation (ft.)
20
0
-20
-40
-60
-80
-100
1980
1985
1990
1995
2000
2005
2010
2015
2020

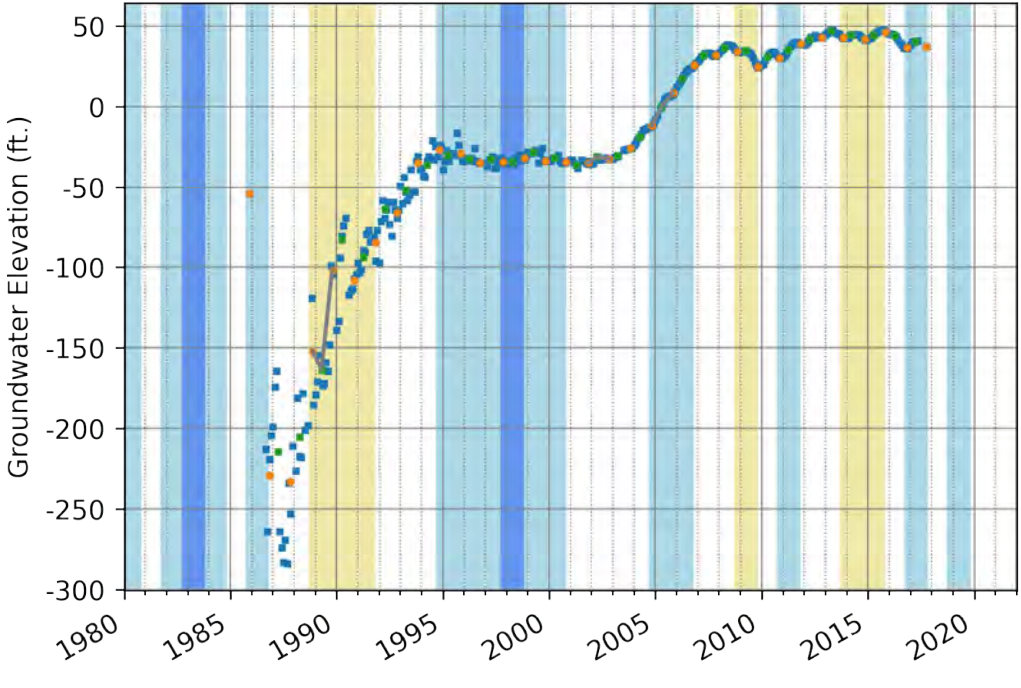

SRP0243, 383544N1227271W001
Groundwater Elevation (ft.)
50
0
-50
-100
-150
1980
1985
1990
1995
2000
2005
2010
2015
2020

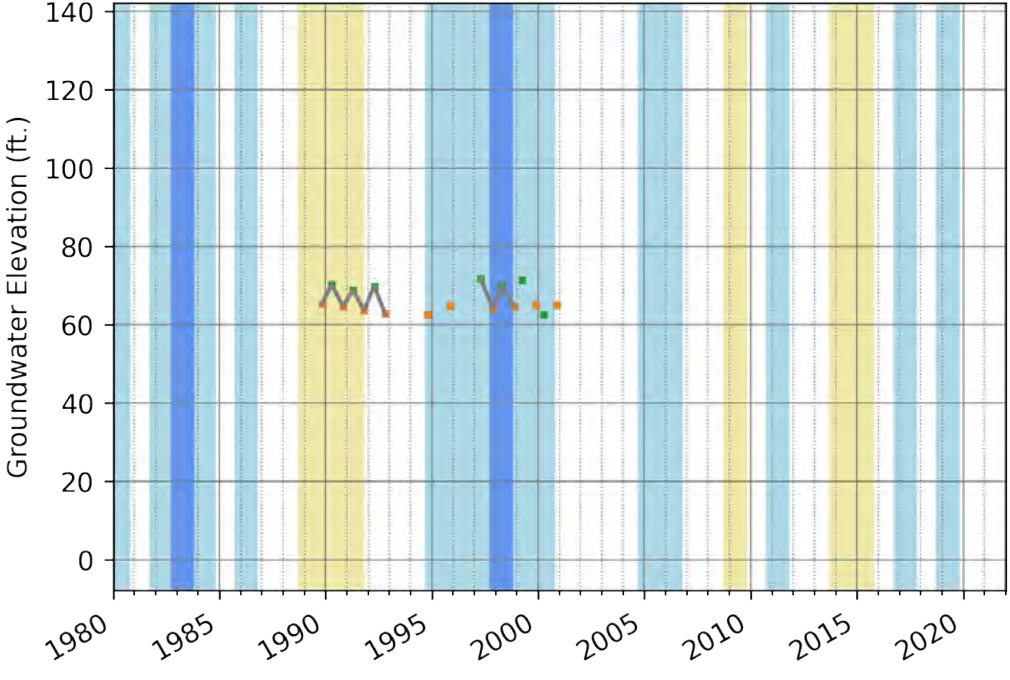

SRP0244, 383578N1228146W001
Groundwater Elevation (ft.)
280
260
240
220
200
180
160
140
1980
1985
1990
1995
2000
2005
2010
2015
2020

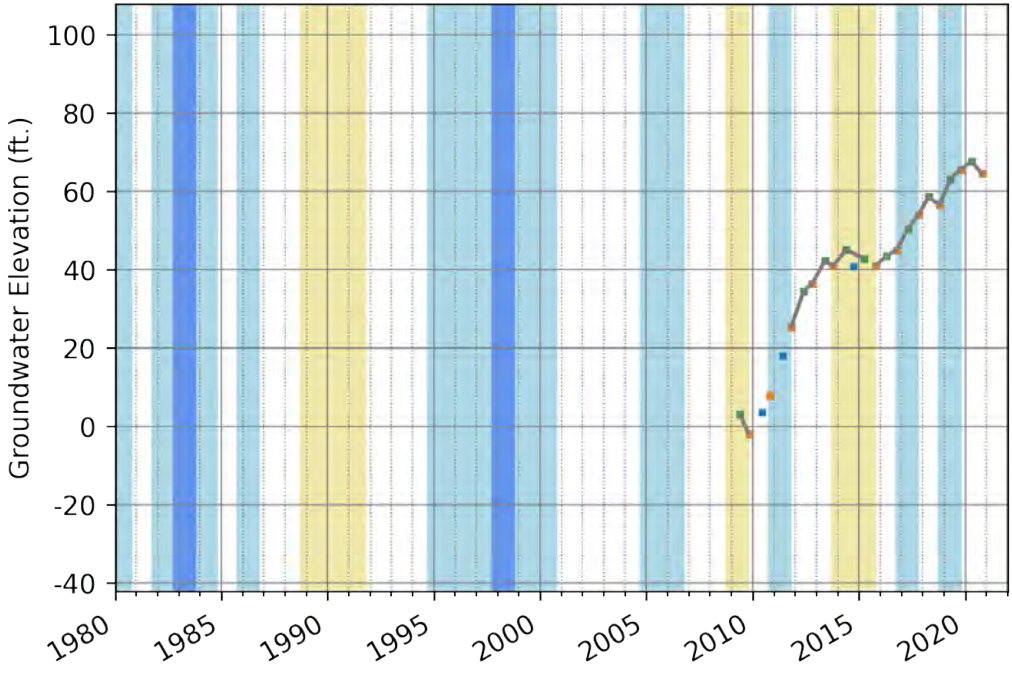

SRP0245, 383594N1228048W001
Groundwater Elevation (ft.)
240
220
200
180
160
140
120
100
1980
1985
1990
1995
2000
2005
2010
2015
2020

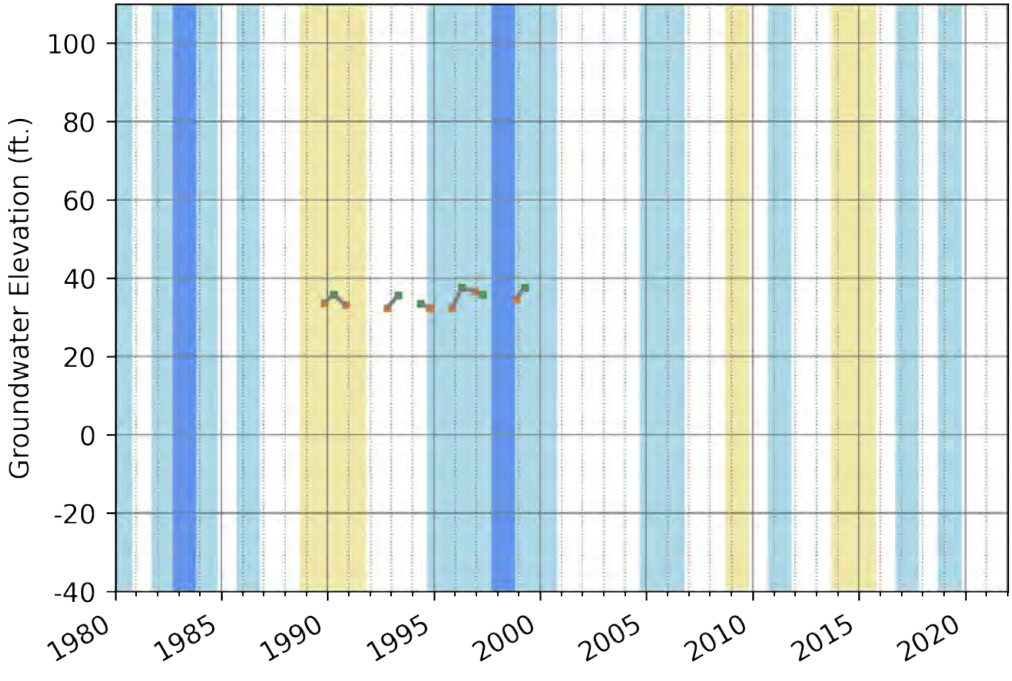

SRP0246, 383628N1227494W001
Groundwater Elevation (ft.)
80
60
40
20
0
-20
-40
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0249, 383694N1226960W001
Groundwater Elevation (ft.)
50
0
-50
-100
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0250, 383706N1226803W001
Groundwater Elevation (ft.)
50
0
-50
-100
-150
-200
-250
-300
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0251, 383708N1227894W001
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0252, 383722N1227978W001
Groundwater Elevation (ft.)
100
80
60
40
20
0
-20
-40
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0256, 383742N1227631W001
Groundwater Elevation (ft.)
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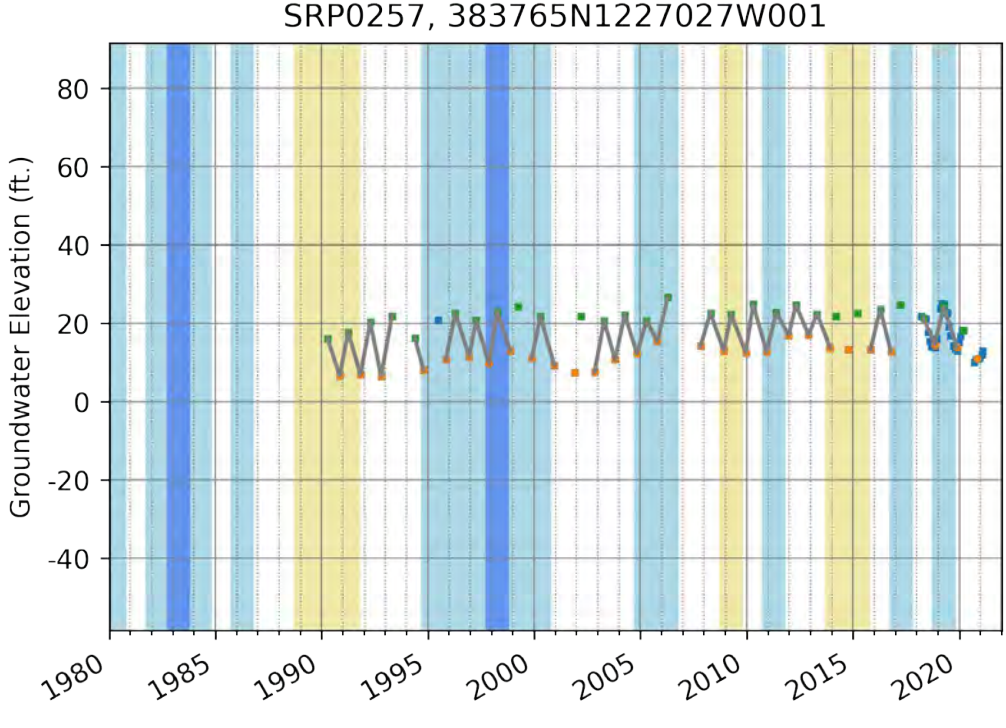
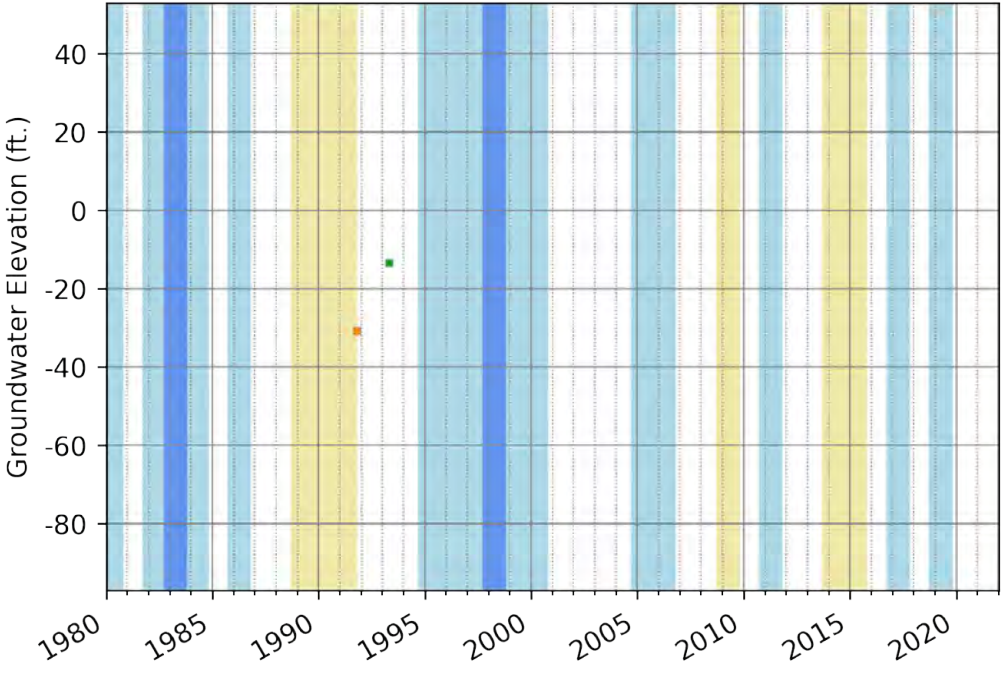
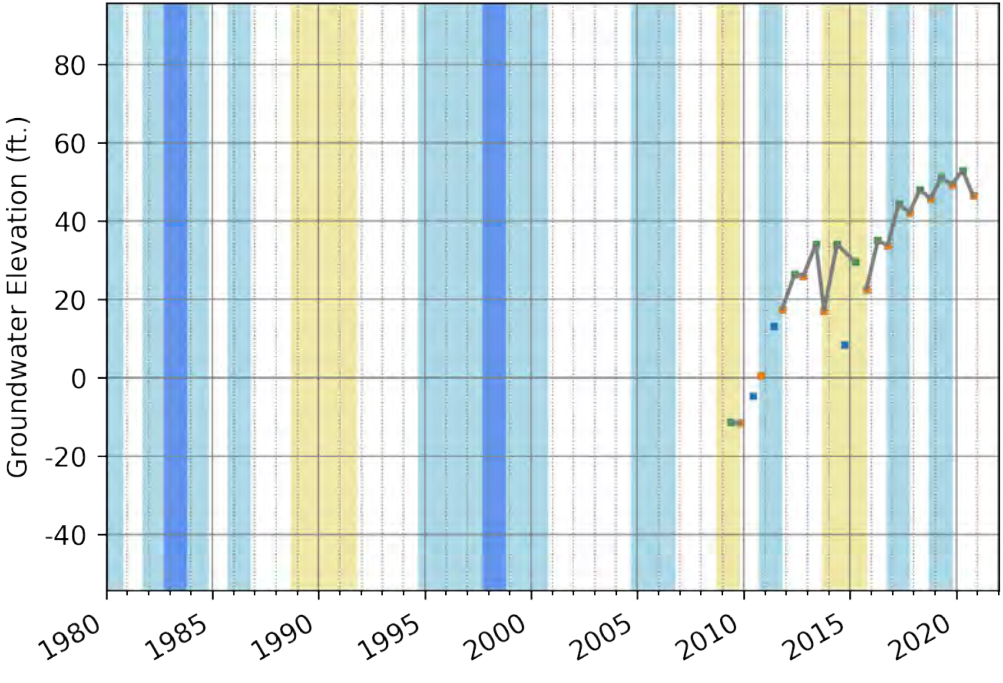
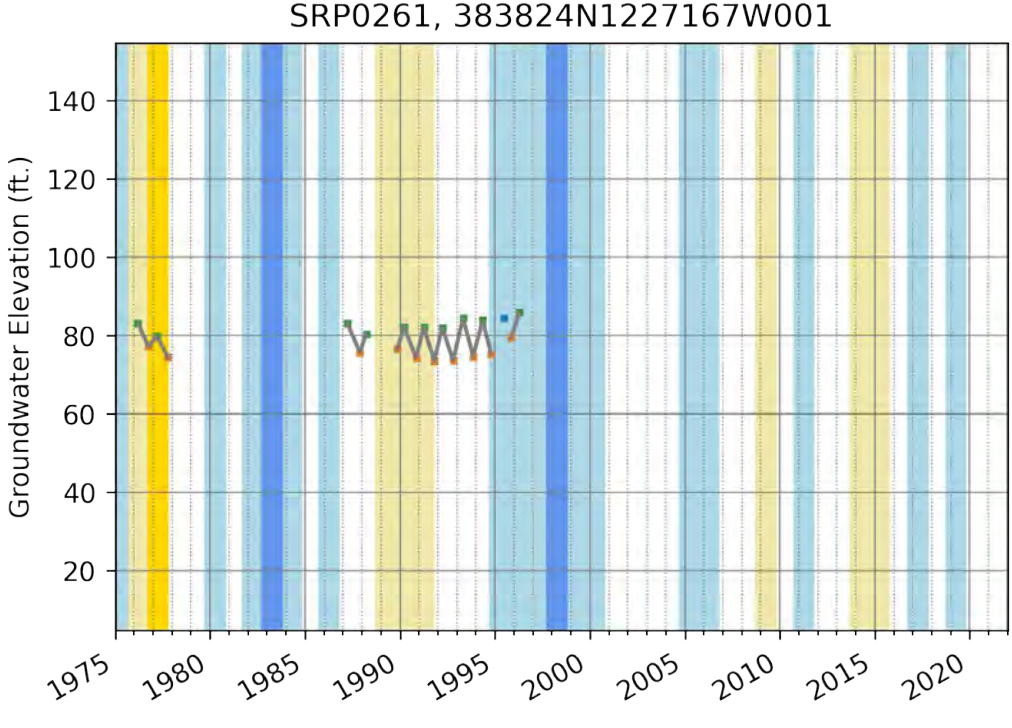
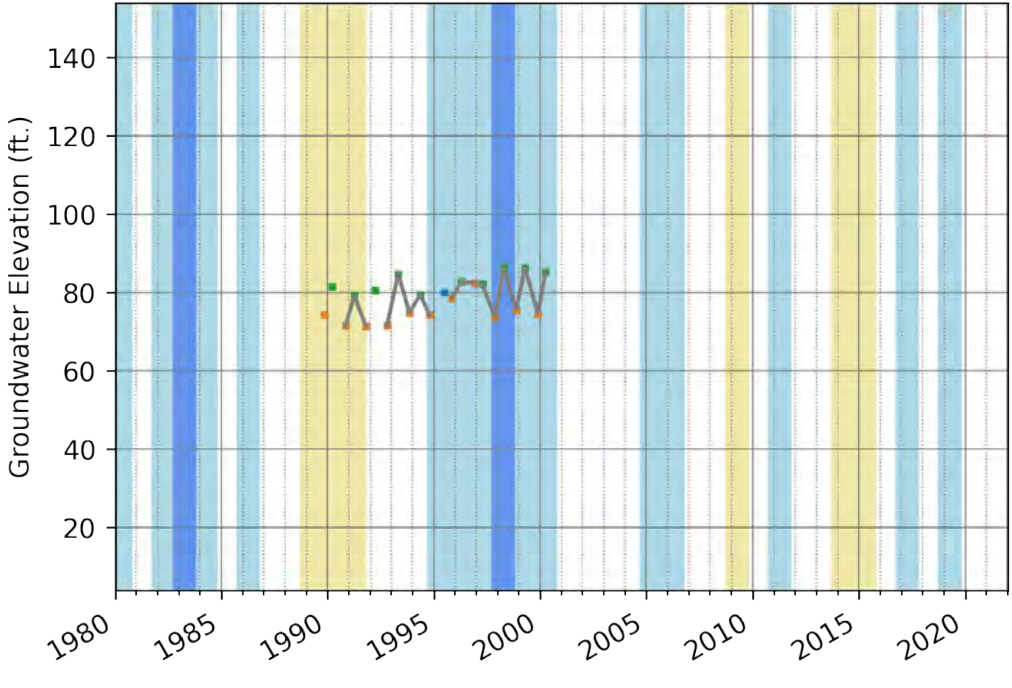
80
60
40
20
0
-20
-40
1980
1985
1990
1995
2000
2005
2010
2015
2020

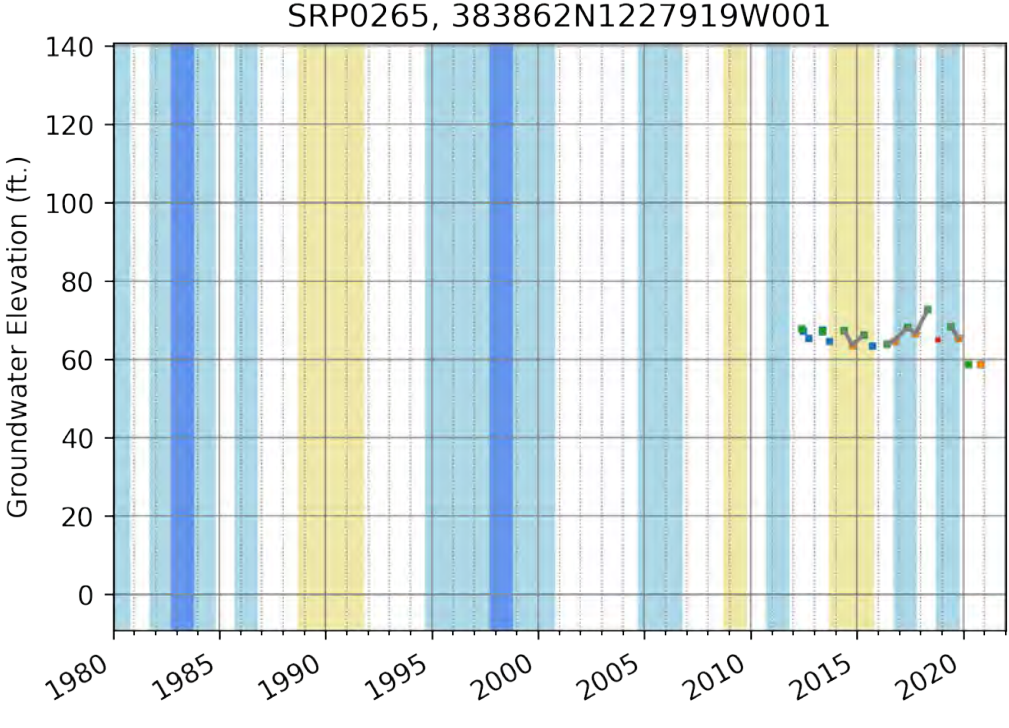

SRP0257, 383765N1227027W001
Groundwater Elevation (ft.)
80
60
40
20
0
-20
-40
1980
1985
1990
1995
2000
2005
2010
2015
2020

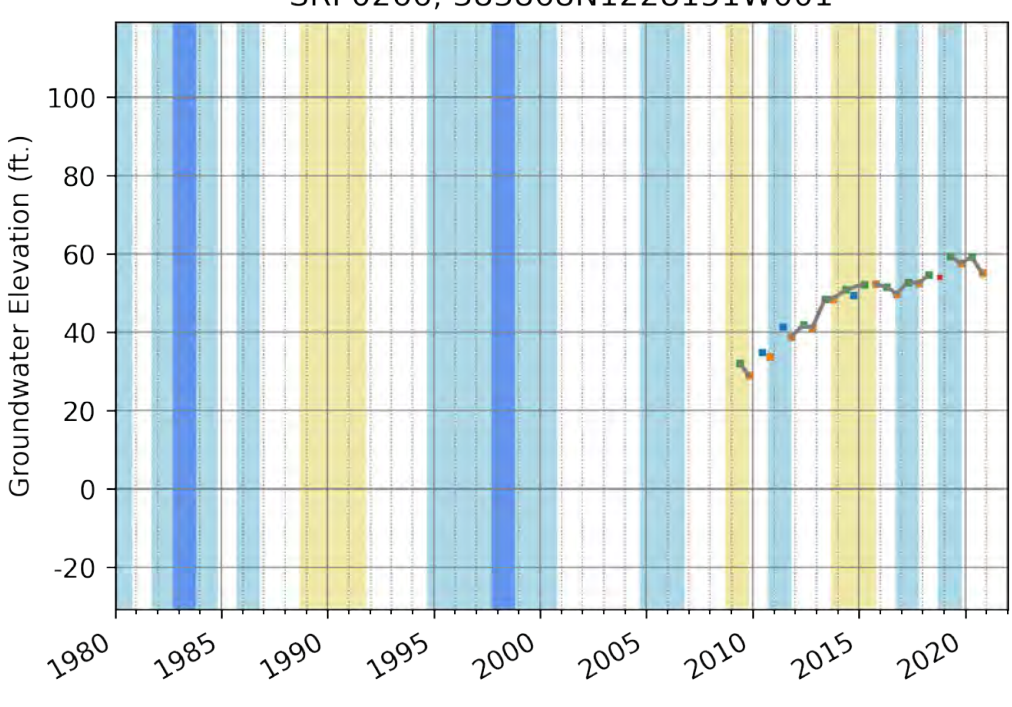

SRP0258, 383796N1227452W001
Groundwater Elevation (ft.)
40
20
0
-20
-40
-60
-80
1980
1985
1990
1995
2000
2005
2010
2015
2020

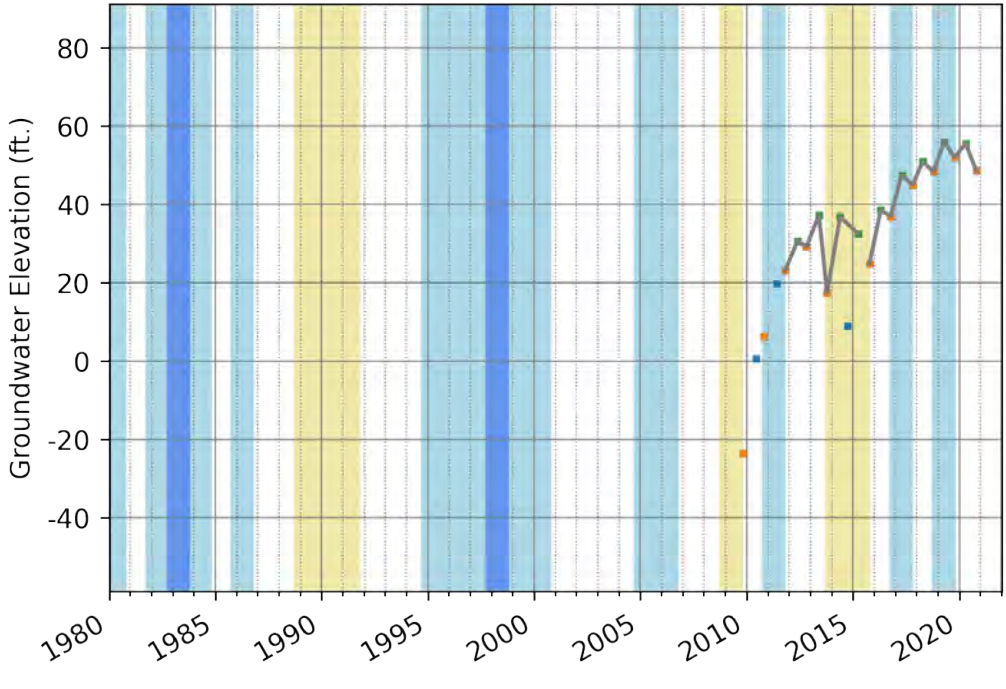

SRP0259, 383821N1228034W001
Groundwater Elevation (ft.)
80
60
40
20
0
-20
-40
1980
1985
1990
1995
2000
2005
2010
2015
2020

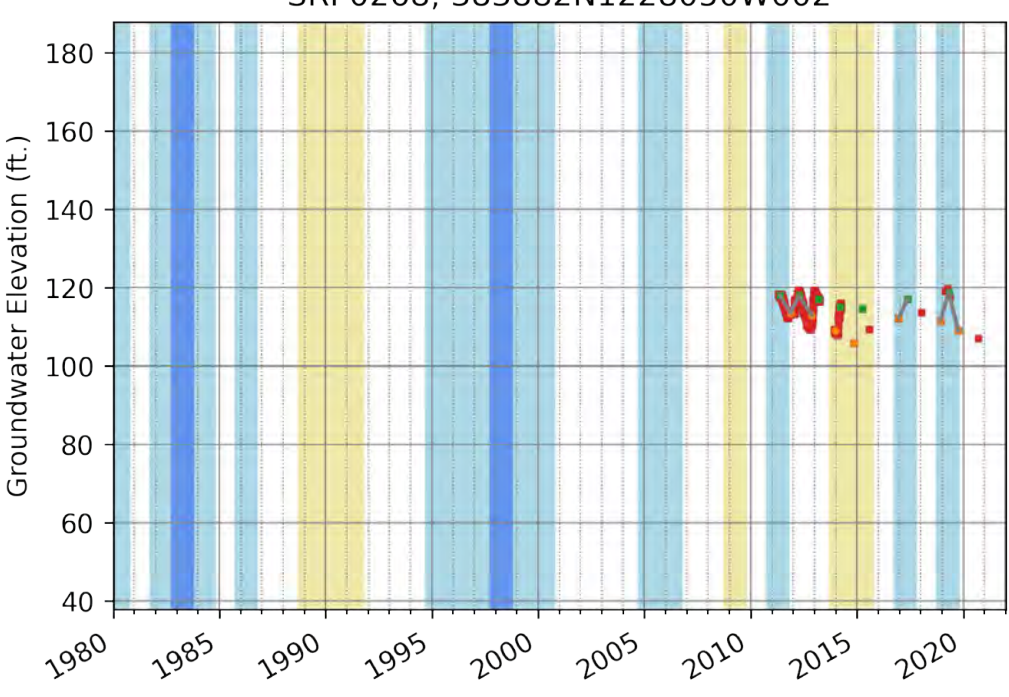

SRP0261, 383824N1227167W001
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

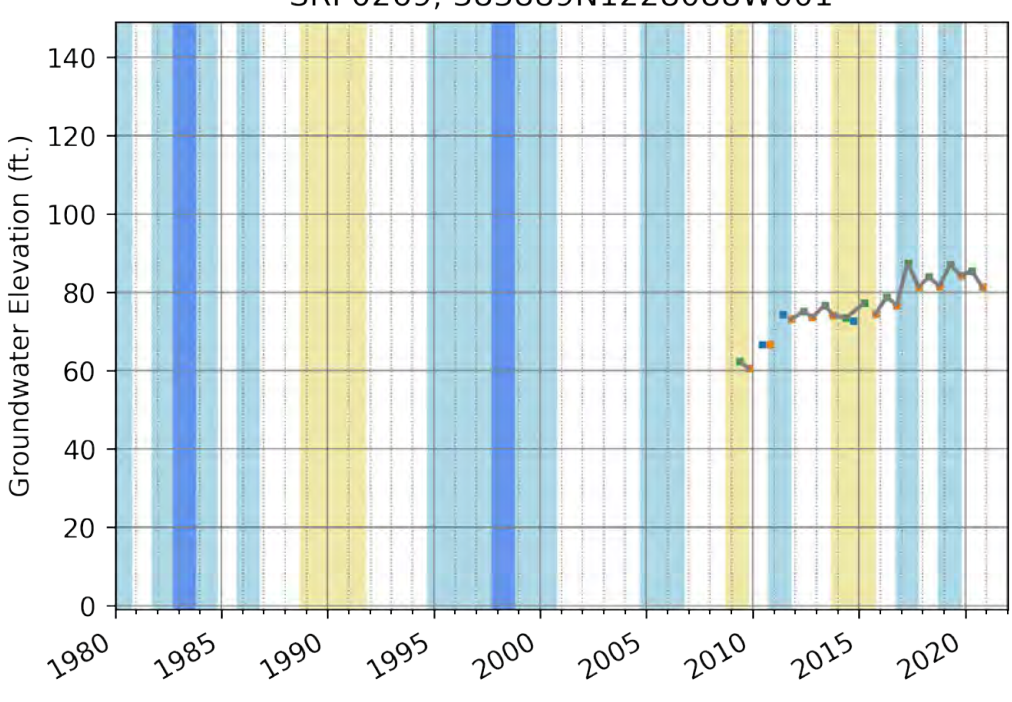

SRP0262, 383844N1227215W001
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020

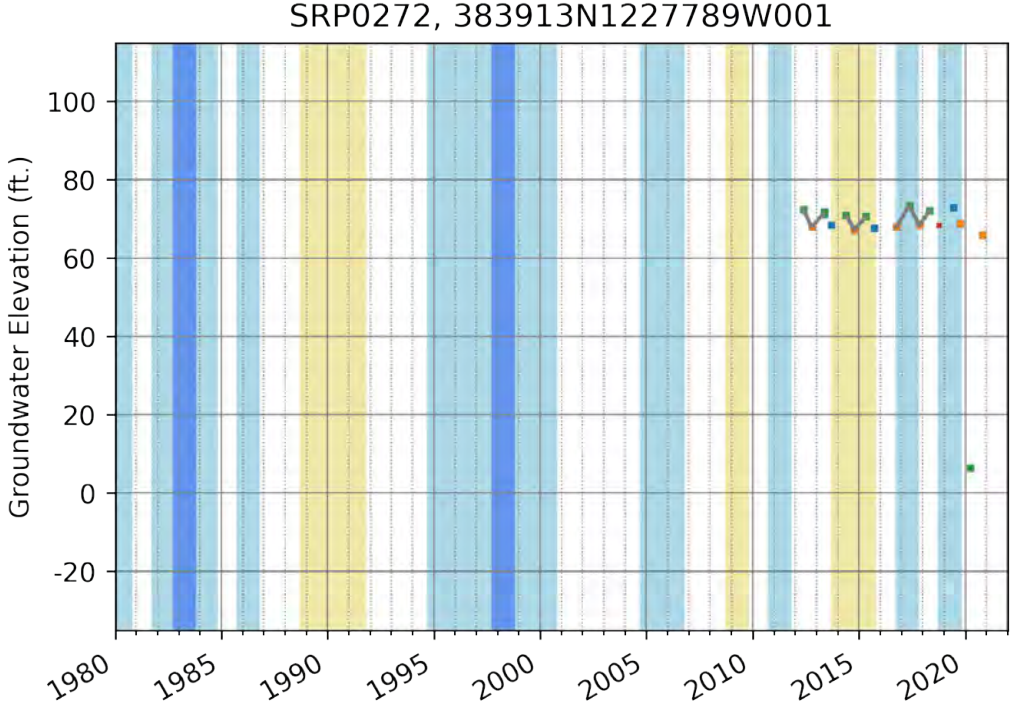

SRP0265, 383862N1227919W001
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020

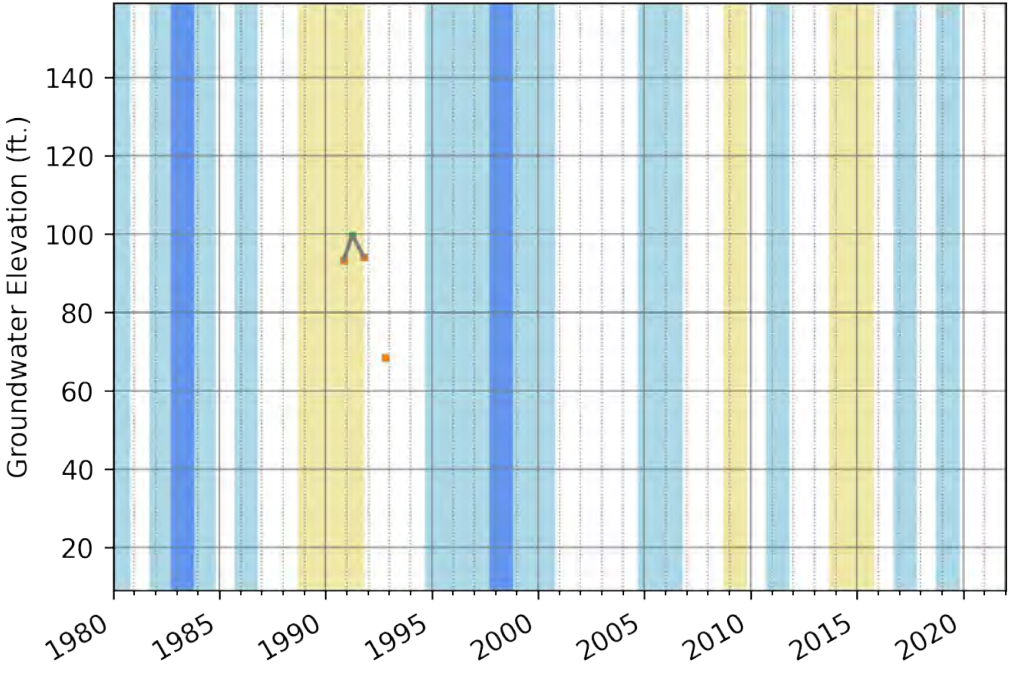

SRP0266, 383868N1228151W001
Groundwater Elevation (ft.)
100
80
60
40
20
0
-20
1980
1985
1990
1995
2000
2005
2010
2015
2020

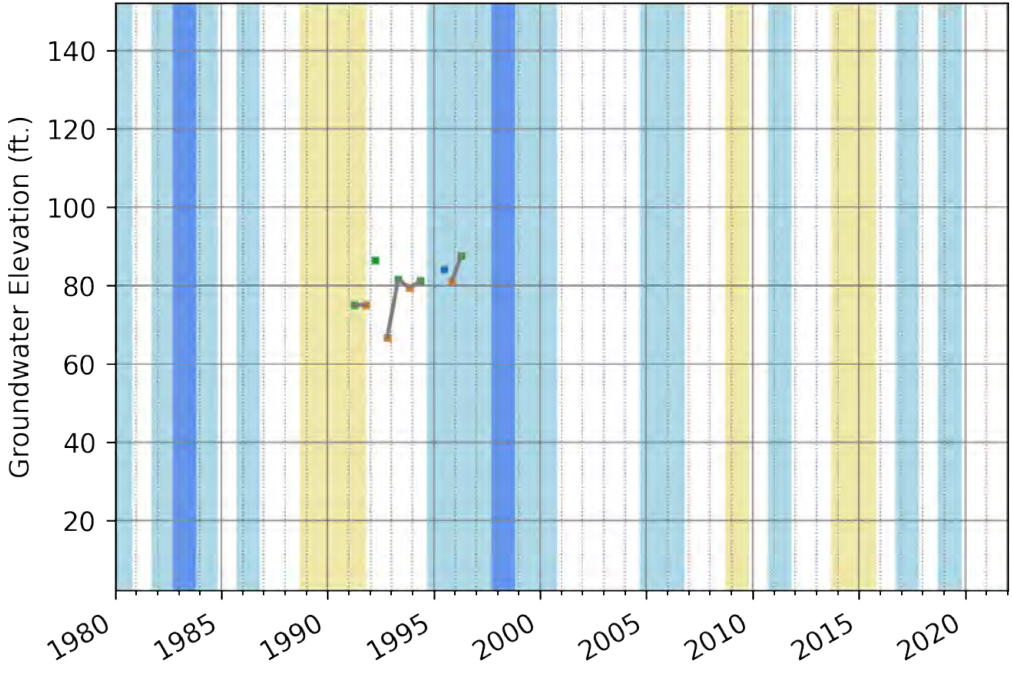

SRP0267, 383882N1228050W001
Groundwater Elevation (ft.)
80
60
40
20
0
-20
-40
1980
1985
1990
1995
2000
2005
2010
2015
2020

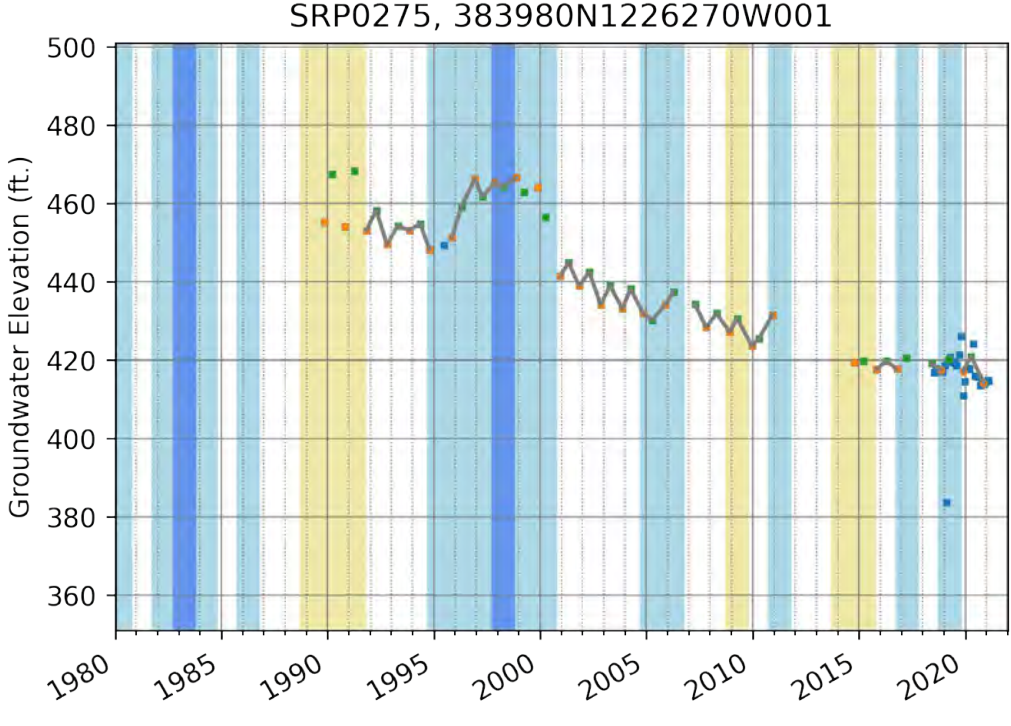

SRP0268, 383882N1228050W002
Groundwater Elevation (ft.)
180
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020

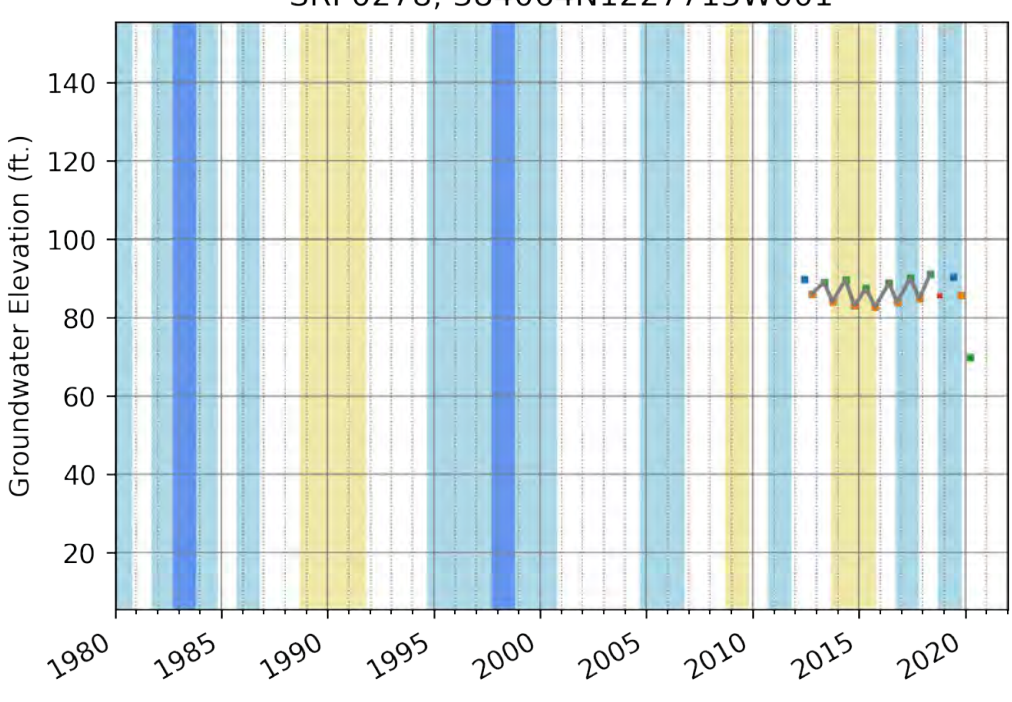

SRP0269, 383889N1228088W001
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020

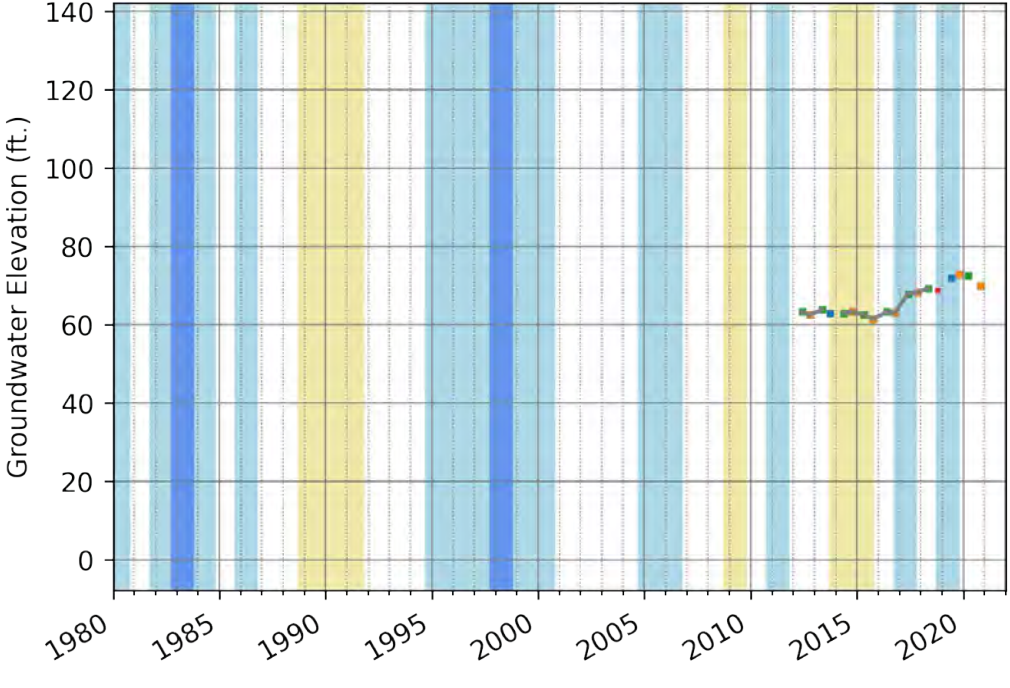

SRP0272, 383913N1227789W001
Groundwater Elevation (ft.)
100
80
60
40
20
0
-20
1980
1985
1990
1995
2000
2005
2010
2015
2020

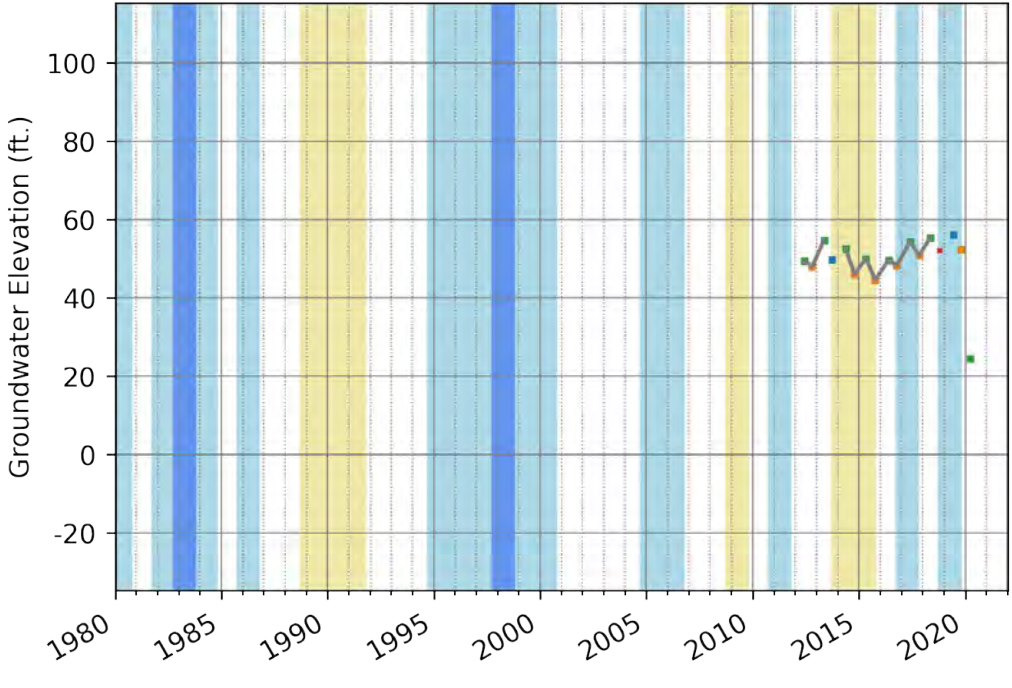

SRP0273, 383969N1227204W001
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020

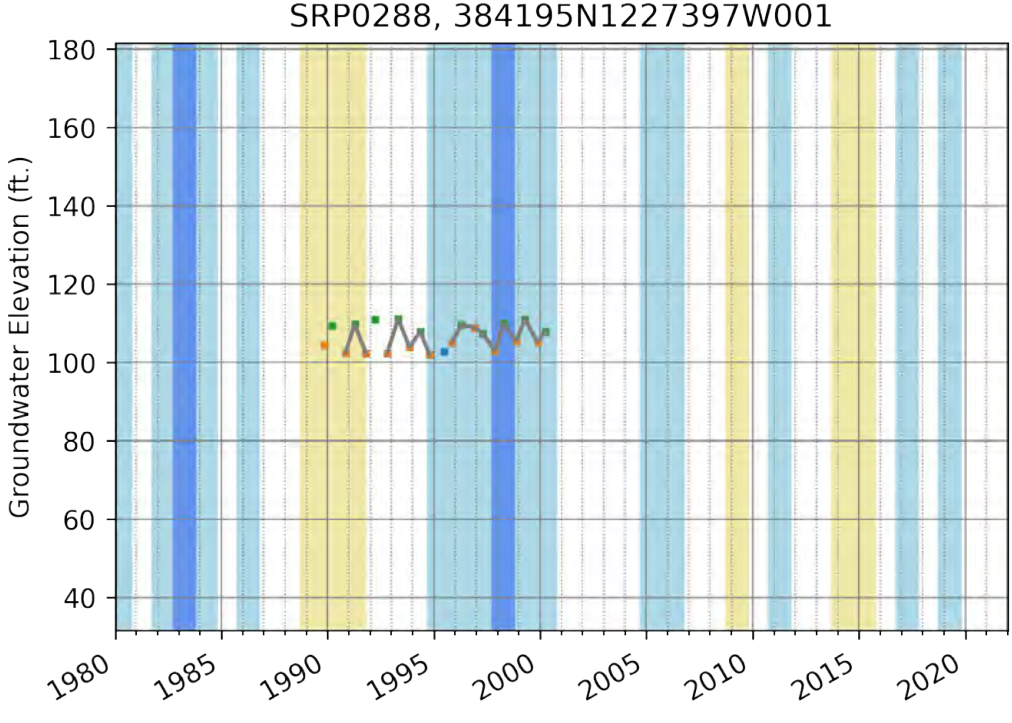

SRP0274, 383970N1227178W001
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020

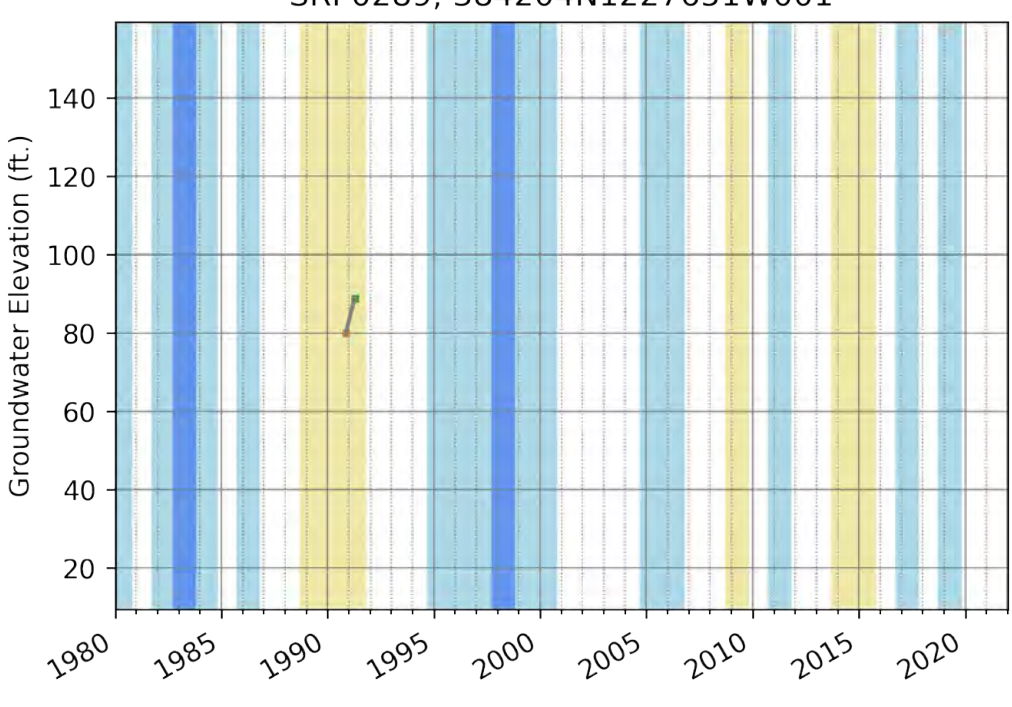

SRP0275, 383980N1226270W001
Groundwater Elevation (ft.)
500
480
460
440
420
400
380
360
1980
1985
1990
1995
2000
2005
2010
2015
2020

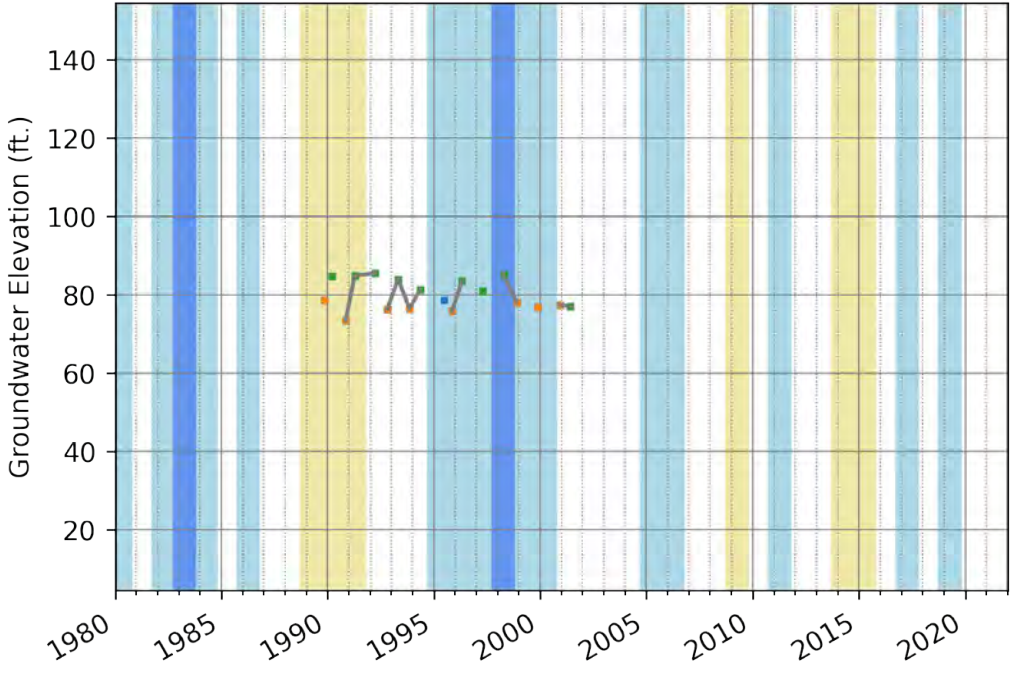

SRP0278, 384064N1227713W001
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020

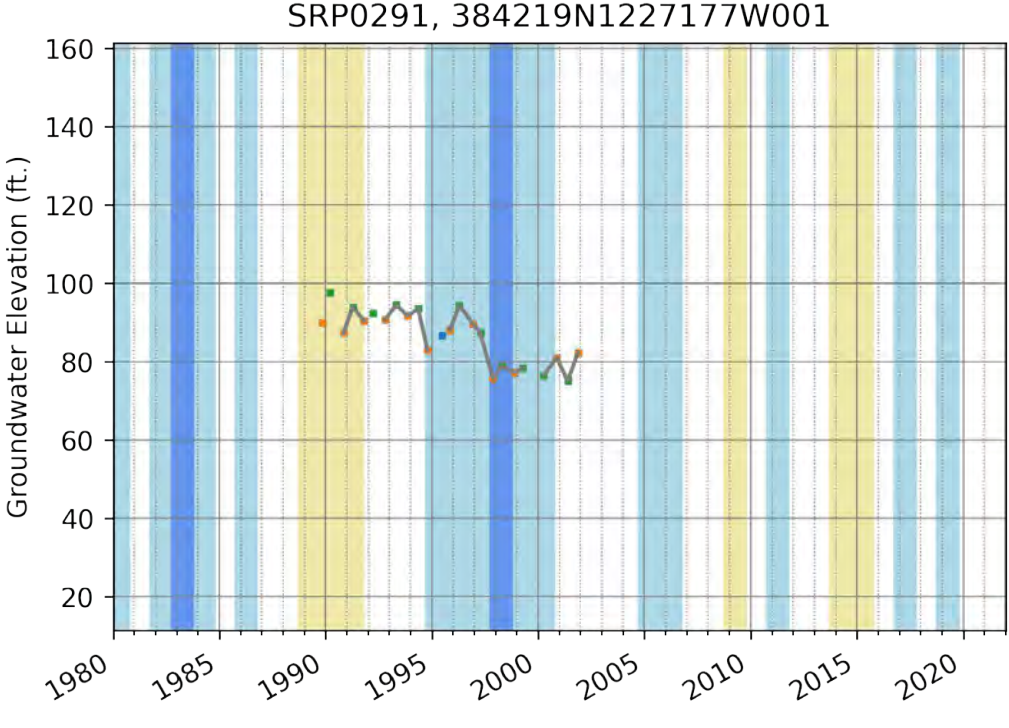

SRP0282, 384101N1228271W001
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020

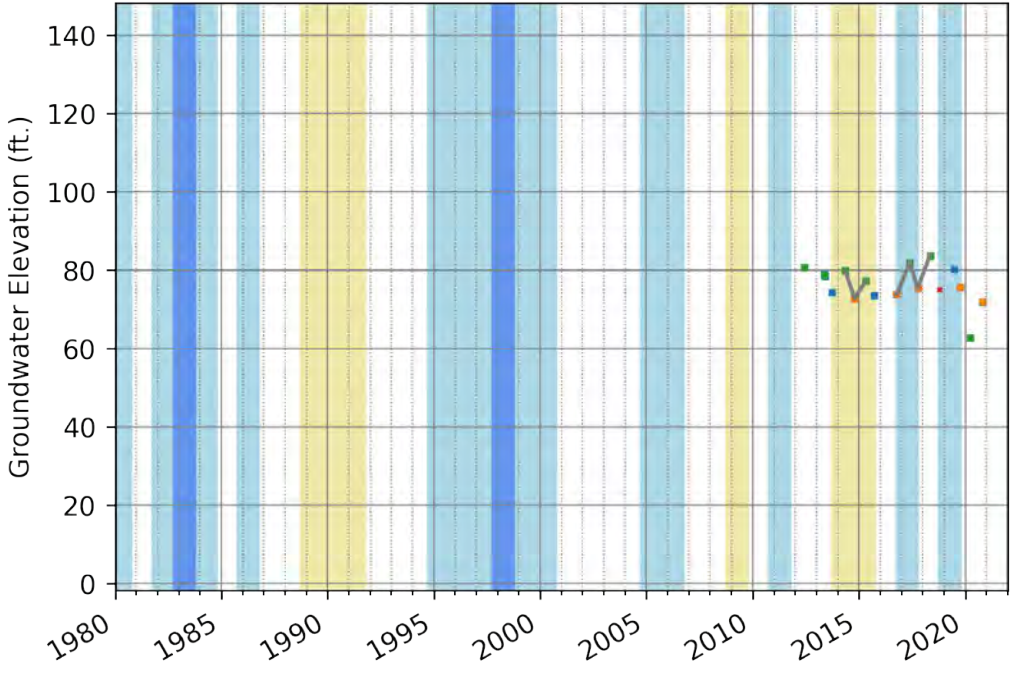

SRP0283, 384130N1228169W001
Groundwater Elevation (ft.)
100
80
60
40
20
0
-20
1980
1985
1990
1995
2000
2005
2010
2015
2020

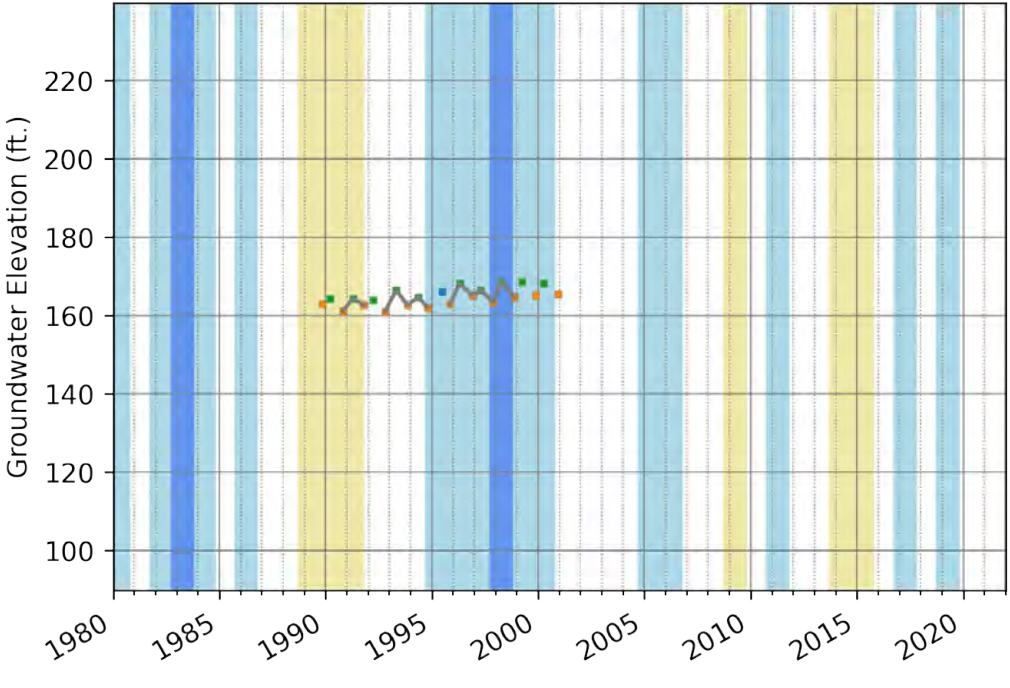

SRP0288, 384195N1227397W001
Groundwater Elevation (ft.)
180
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020

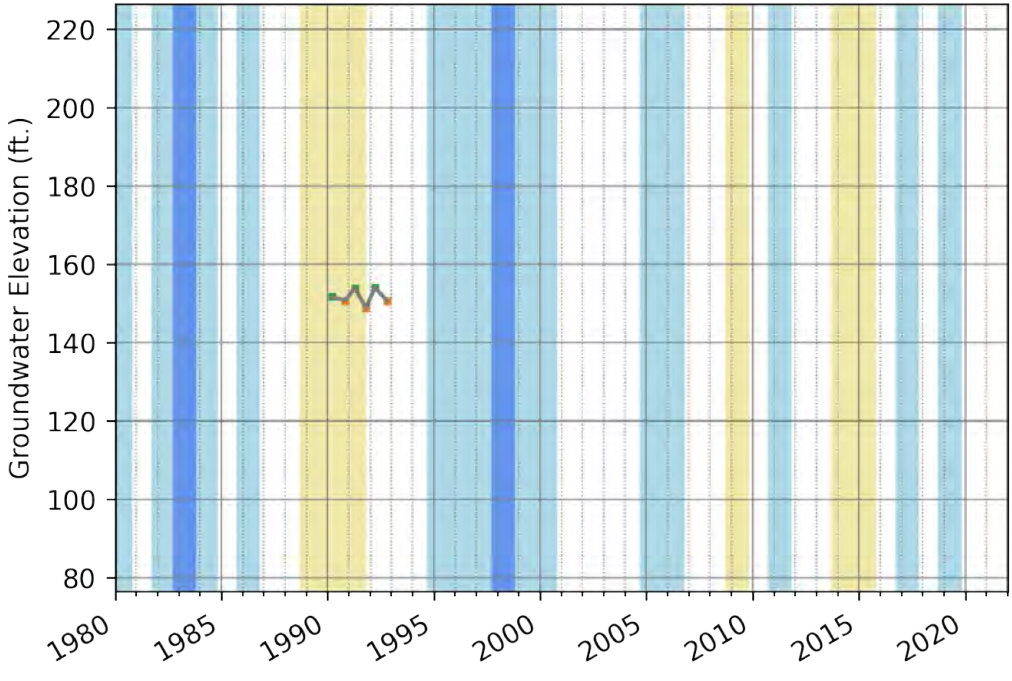

SRP0289, 384204N1227651W001
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020

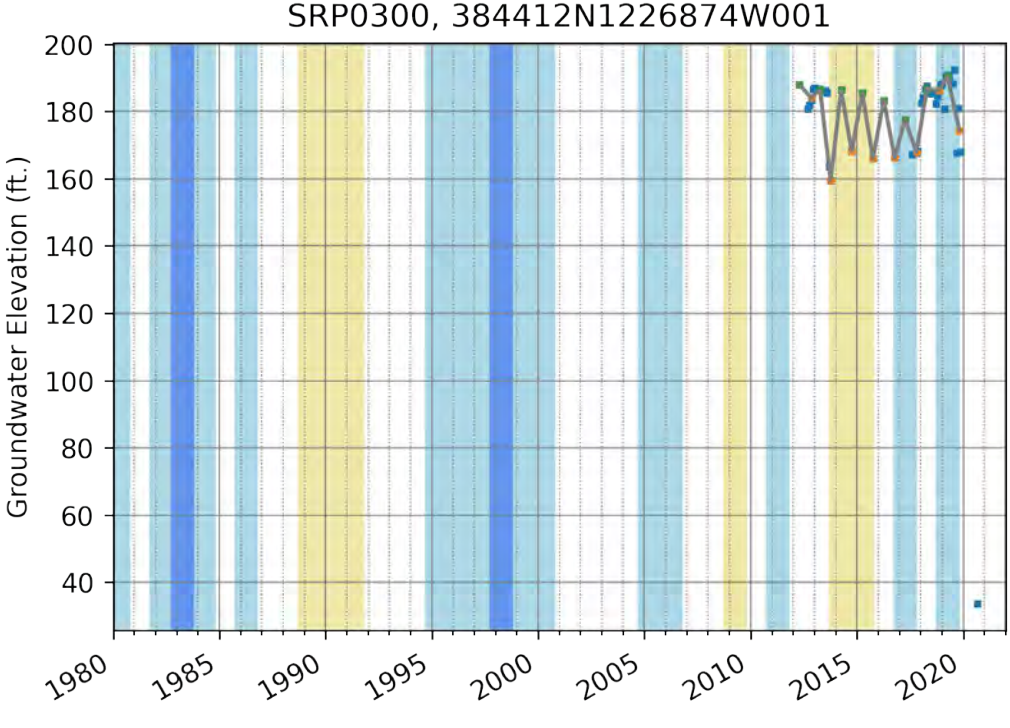

SRP0290, 384215N1227760W001
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020

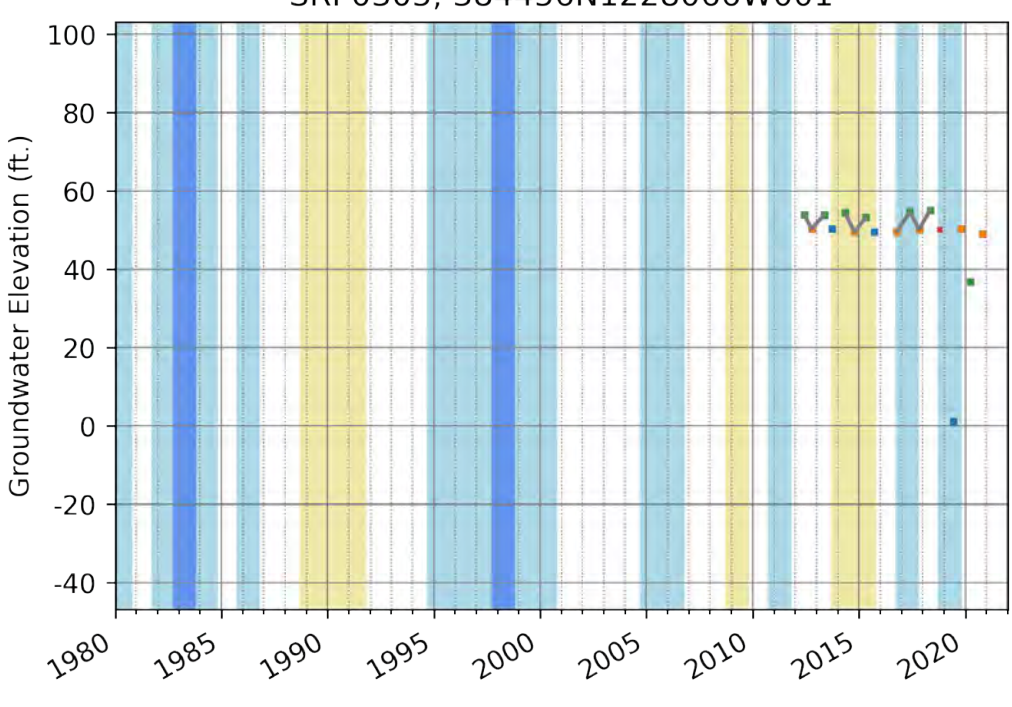

SRP0291, 384219N1227177W001
Groundwater Elevation (ft.)
160
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020

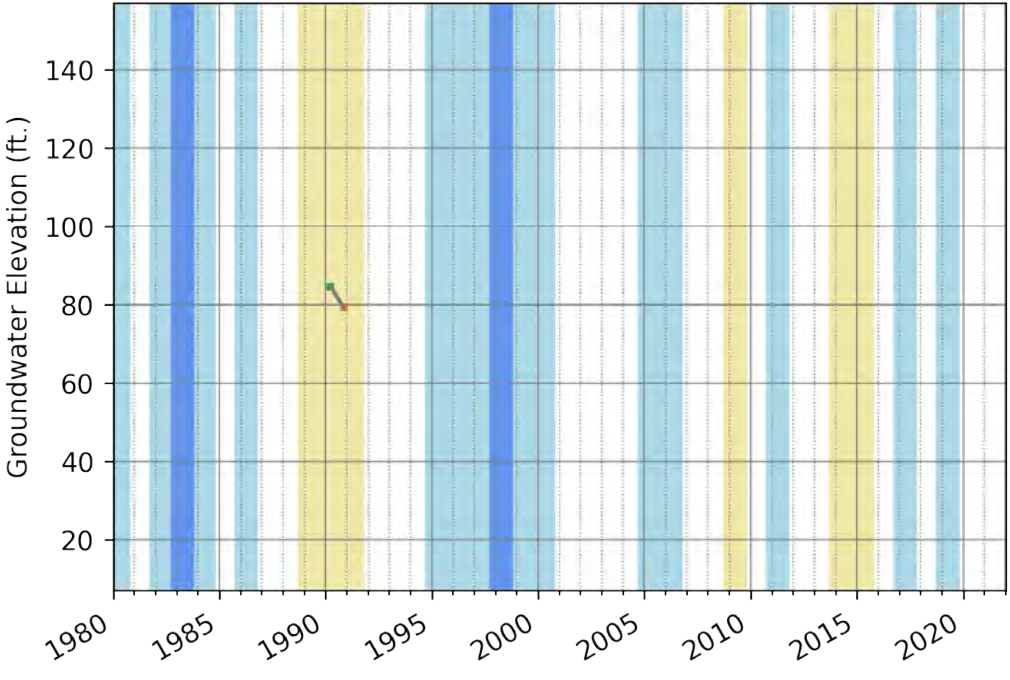

SRP0295, 384232N1227996W001
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020

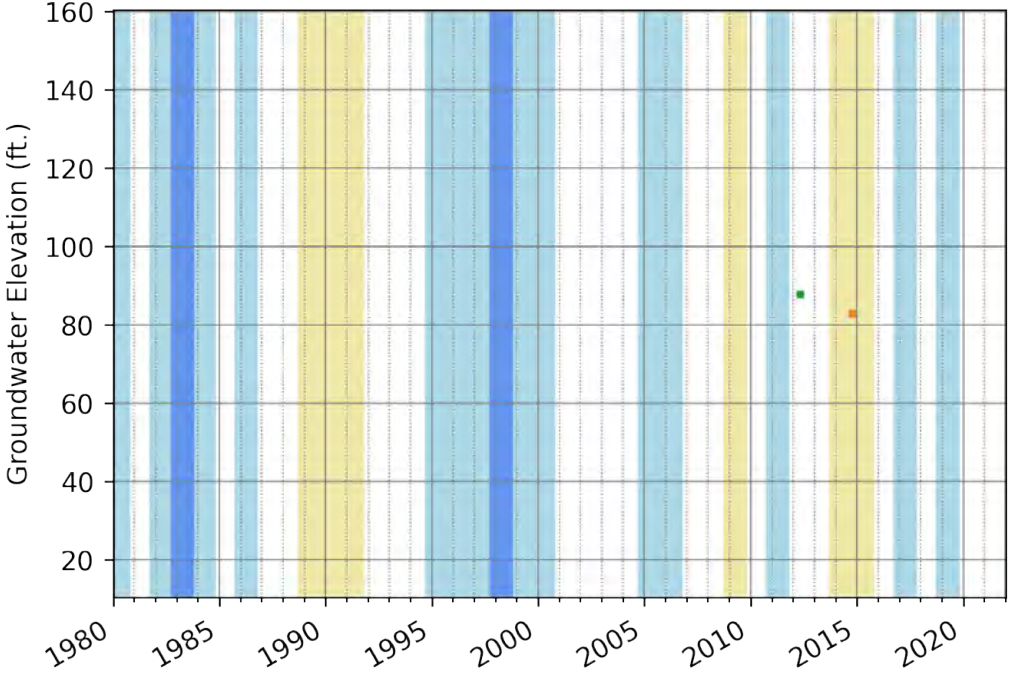

SRP0297, 384359N1226954W001
Groundwater Elevation (ft.)
220
200
180
160
140
120
100
1980
1985
1990
1995
2000
2005
2010
2015
2020

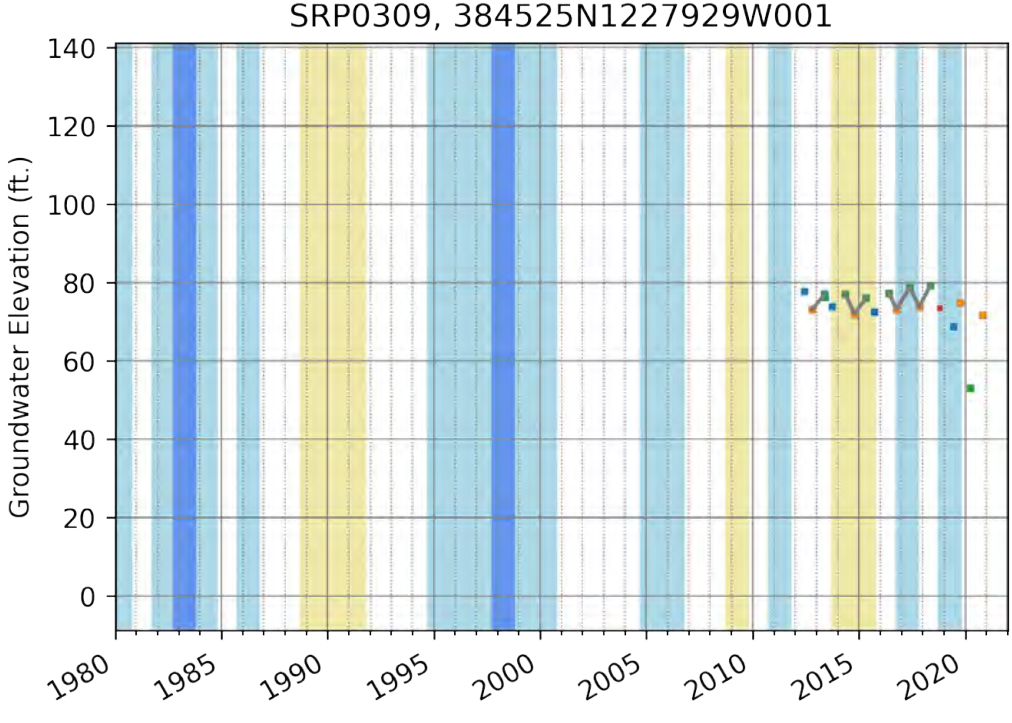

SRP0298, 384388N1227063W001
Groundwater Elevation (ft.)
220
200
180
160
140
120
100
80
1980
1985
1990
1995
2000
2005
2010
2015
2020

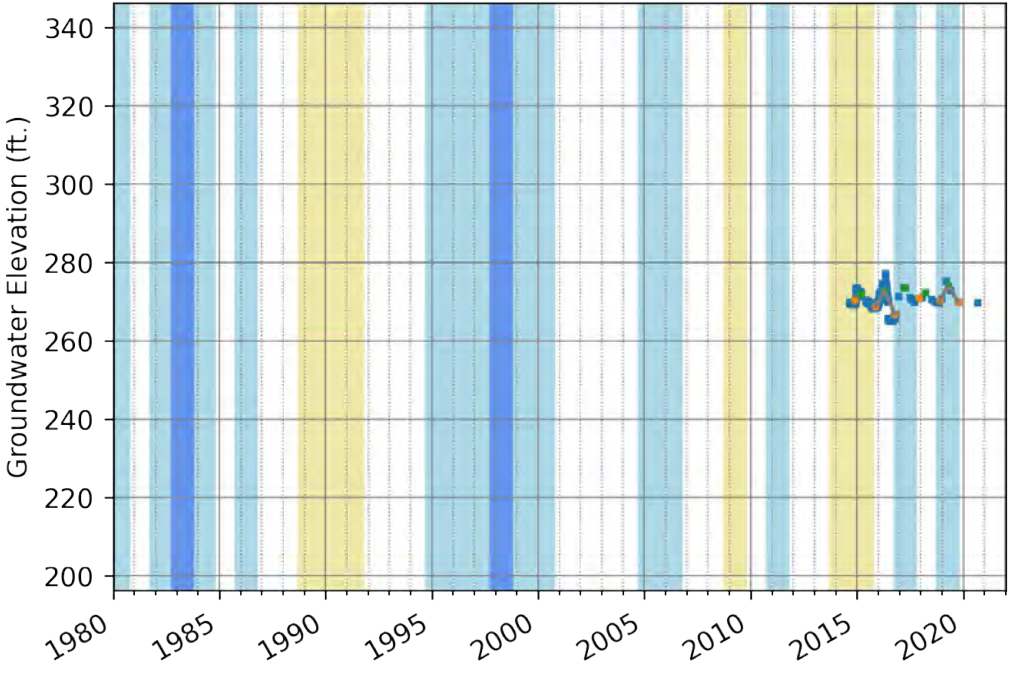

SRP0300, 384412N1226874W001
Groundwater Elevation (ft.)
200
180
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020

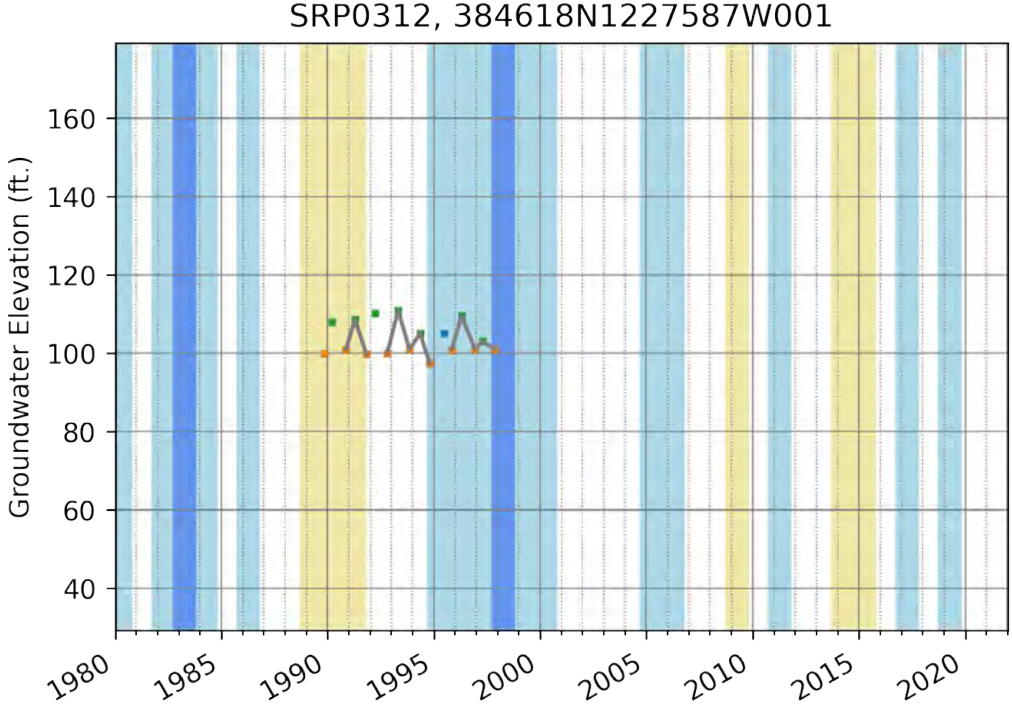

SRP0305, 384456N1228066W001
Groundwater Elevation (ft.)
100
80
60
40
20
0
-20
-40
1980
1985
1990
1995
2000
2005
2010
2015
2020

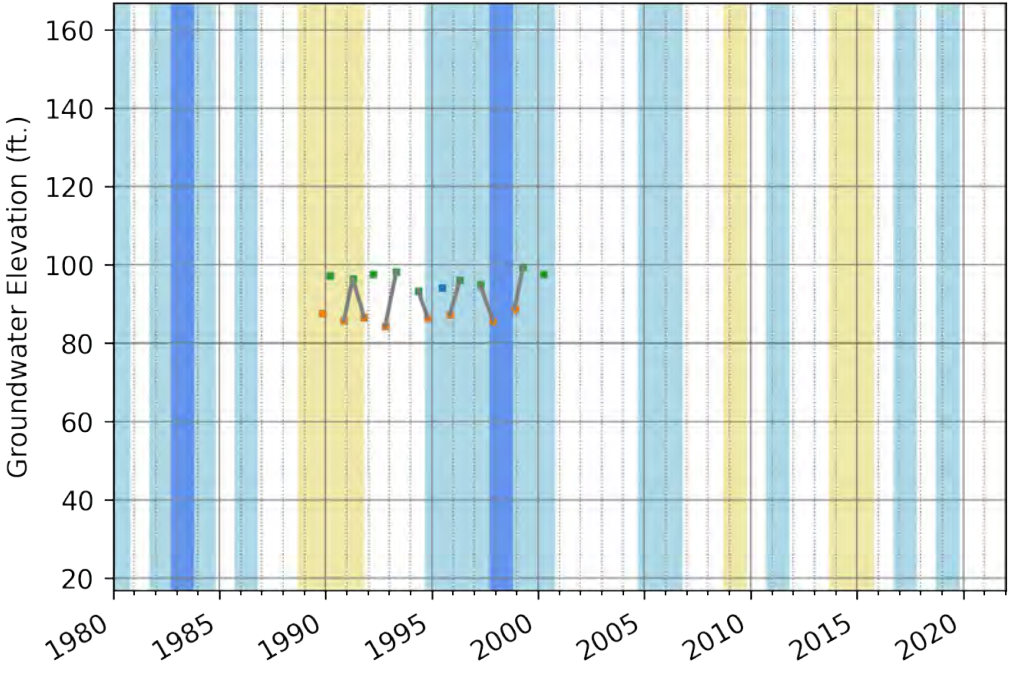

SRP0306, 384501N1227690W001
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020

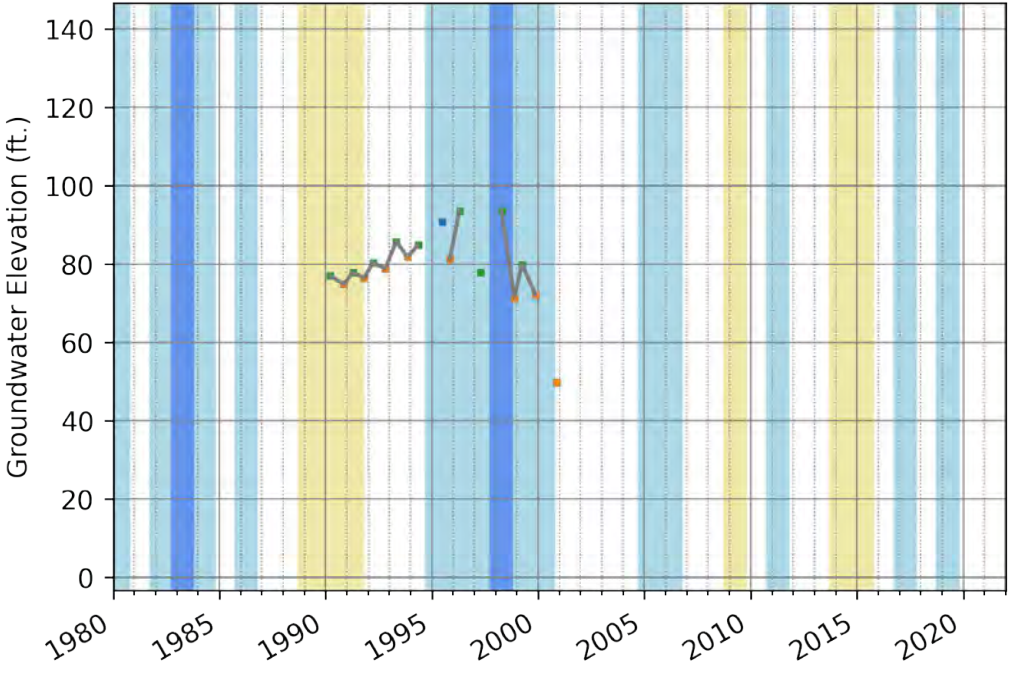

SRP0308, 384522N1228365W001
Groundwater Elevation (ft.)
160
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0309, 384525N1227929W001
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0311, 384587N1226512W001
Groundwater Elevation (ft.)
340
320
300
280
260
240
220
200
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0312, 384618N1227587W001
Groundwater Elevation (ft.)
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0313, 384620N1227860W001
Groundwater Elevation (ft.)
160
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0316, 384706N1227943W001
Groundwater Elevation (ft.)
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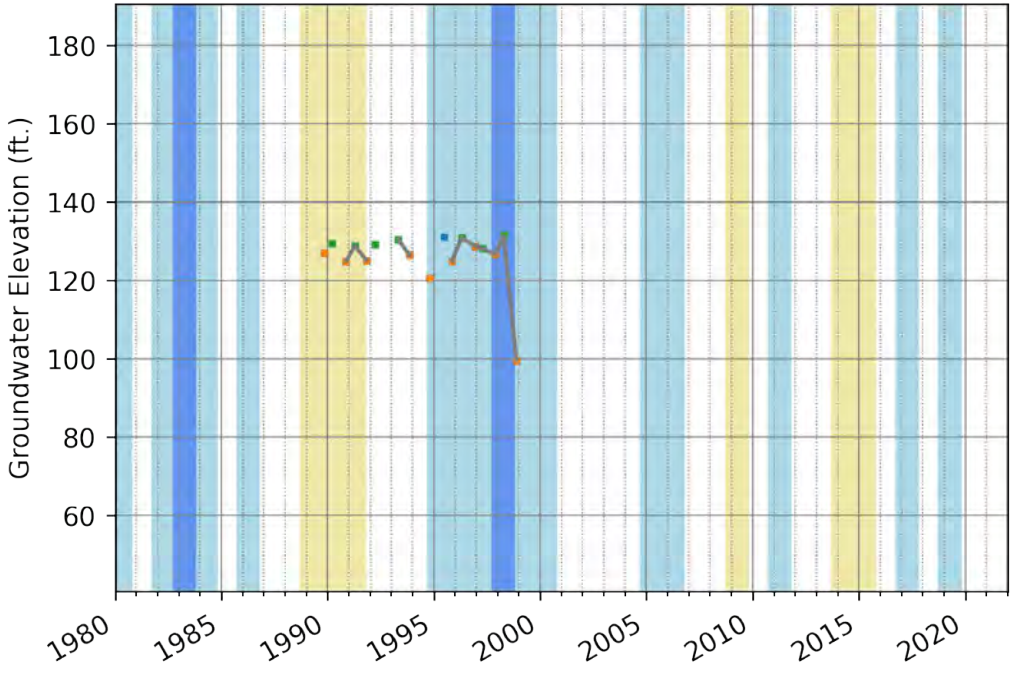
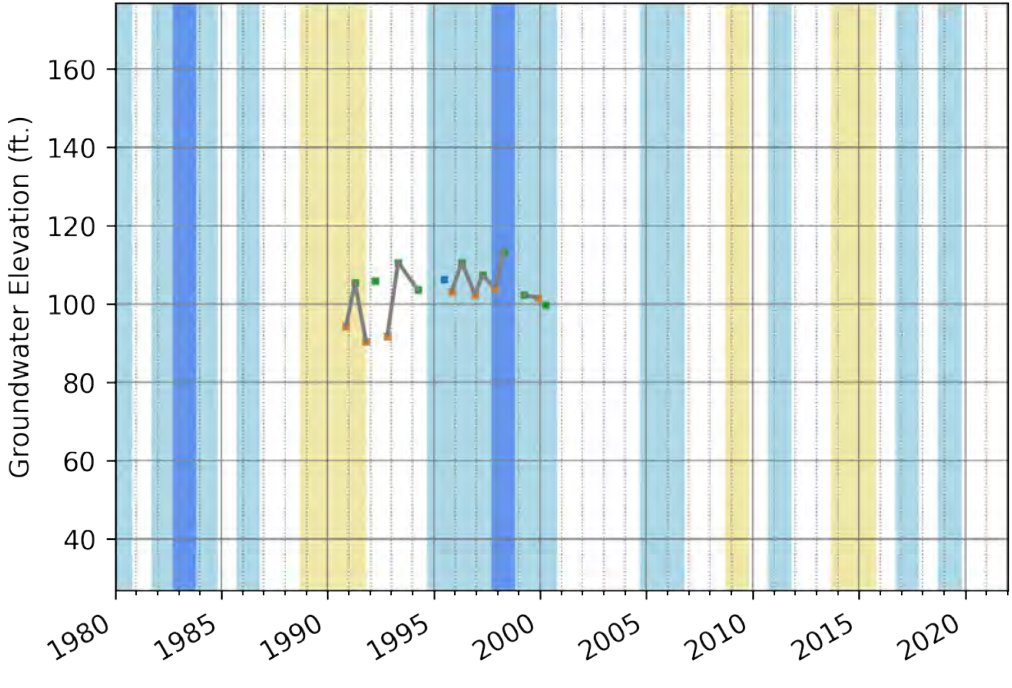
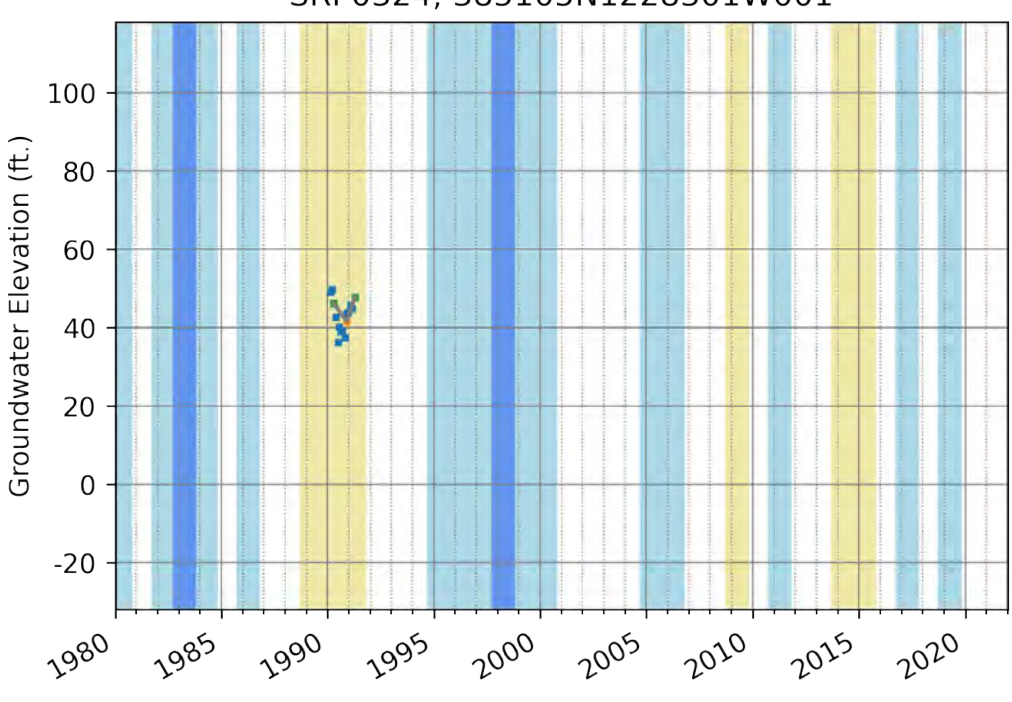
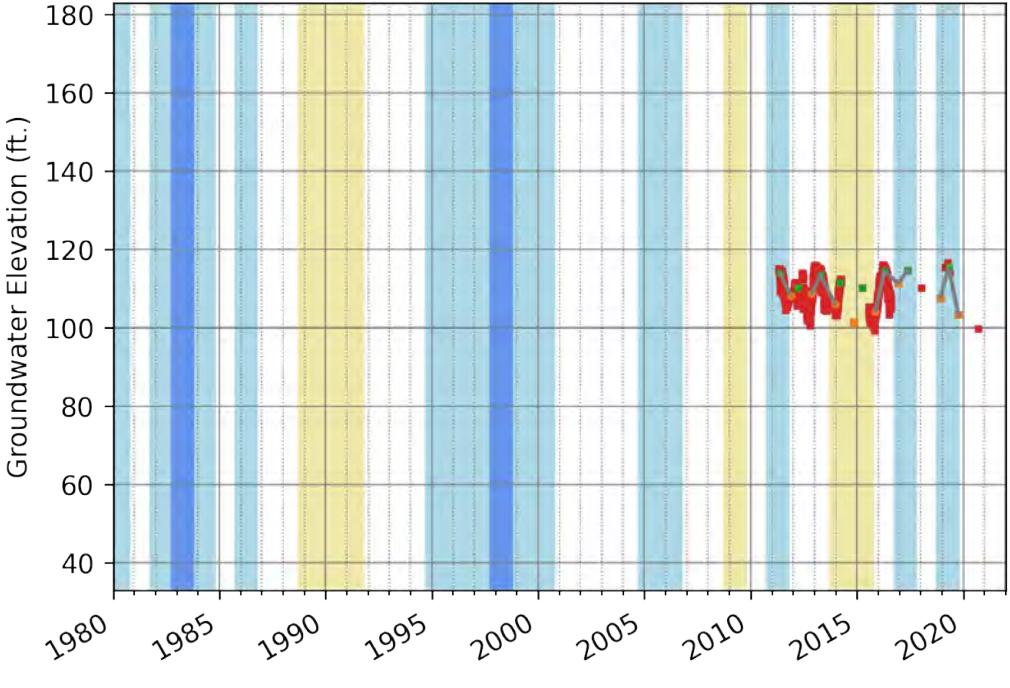
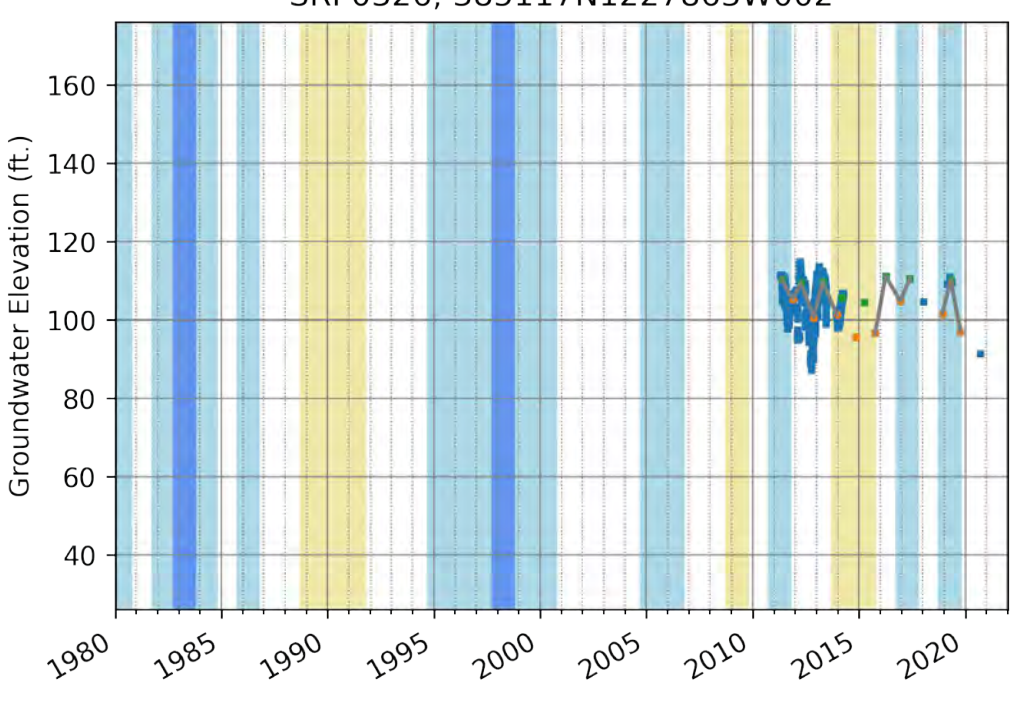
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020

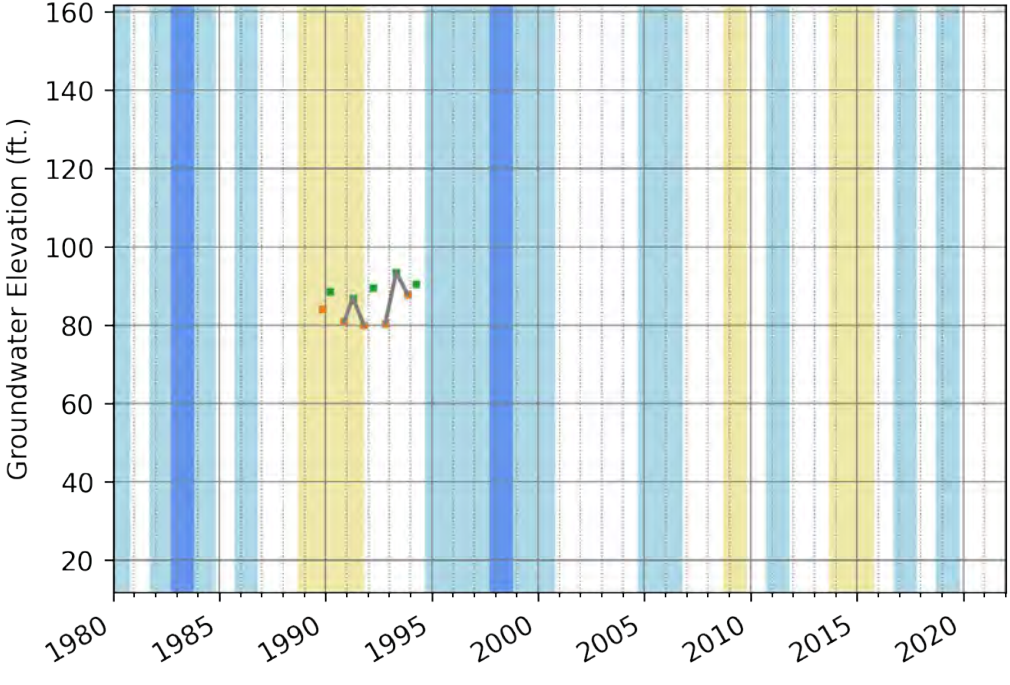

SRP0318, 384802N1227343W001
Groundwater Elevation (ft.)
180
160
140
120
100
80
60
1980
1985
1990
1995
2000
2005
2010
2015
2020

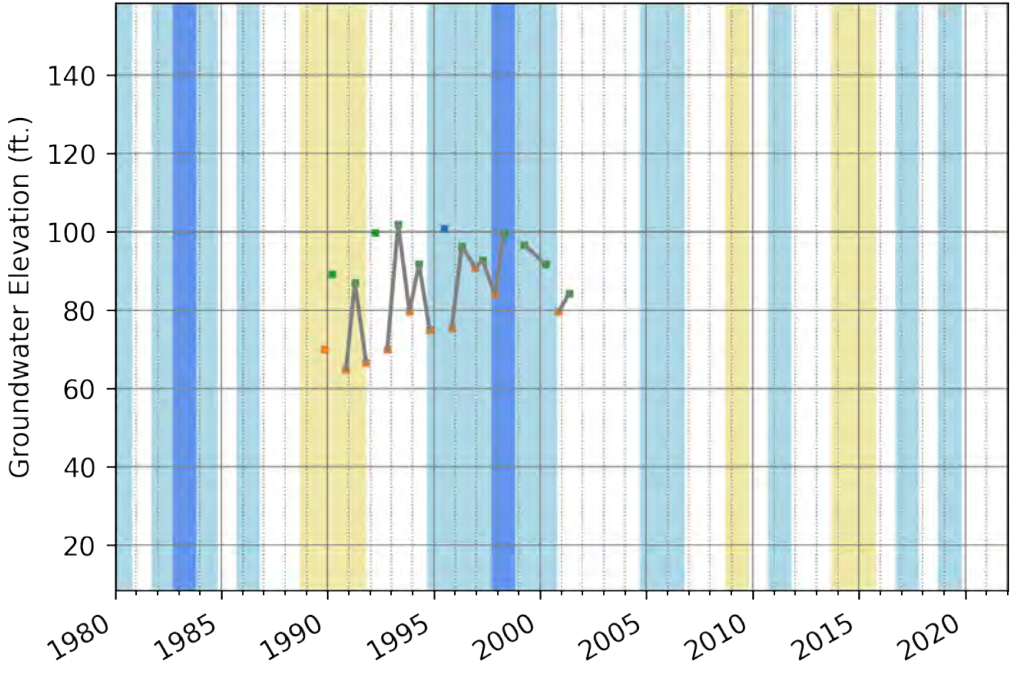

SRP0323, 384940N1227747W001
Groundwater Elevation (ft.)
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020

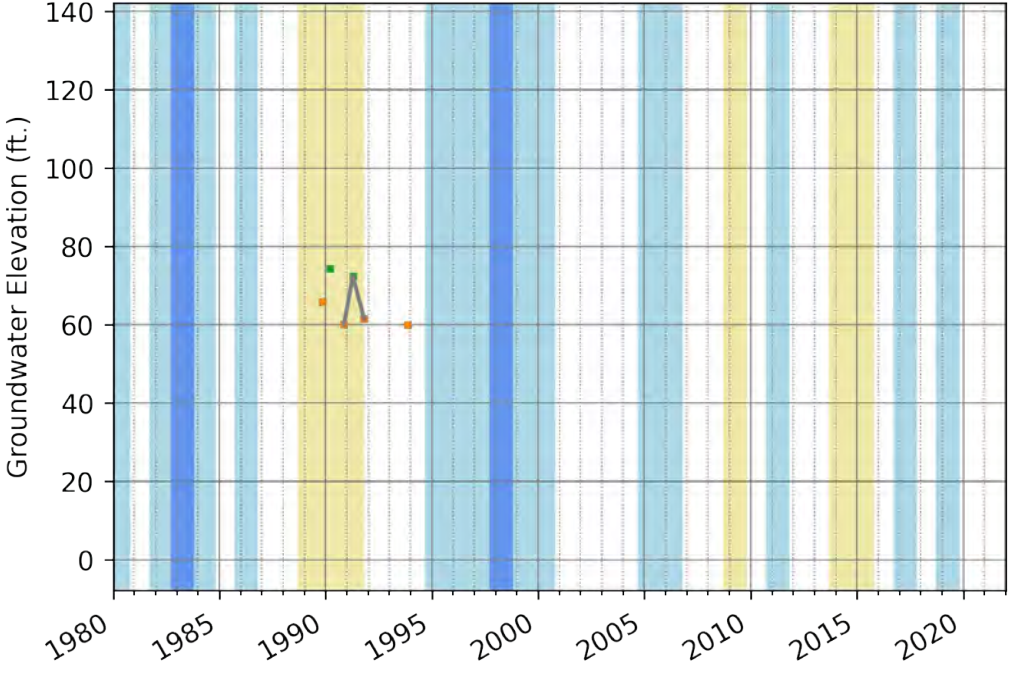

SRP0324, 385105N1228301W001
Groundwater Elevation (ft.)
100
80
60
40
20
0
-20
1980
1985
1990
1995
2000
2005
2010
2015
2020

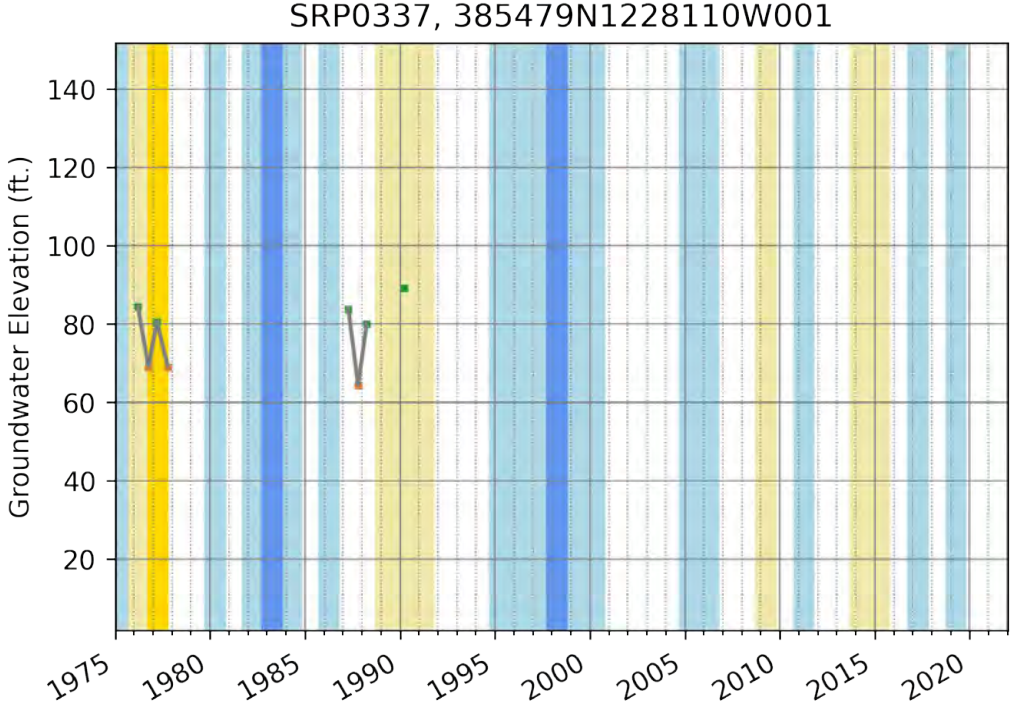

SRP0325, 385117N1227863W001
Groundwater Elevation (ft.)
180
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020

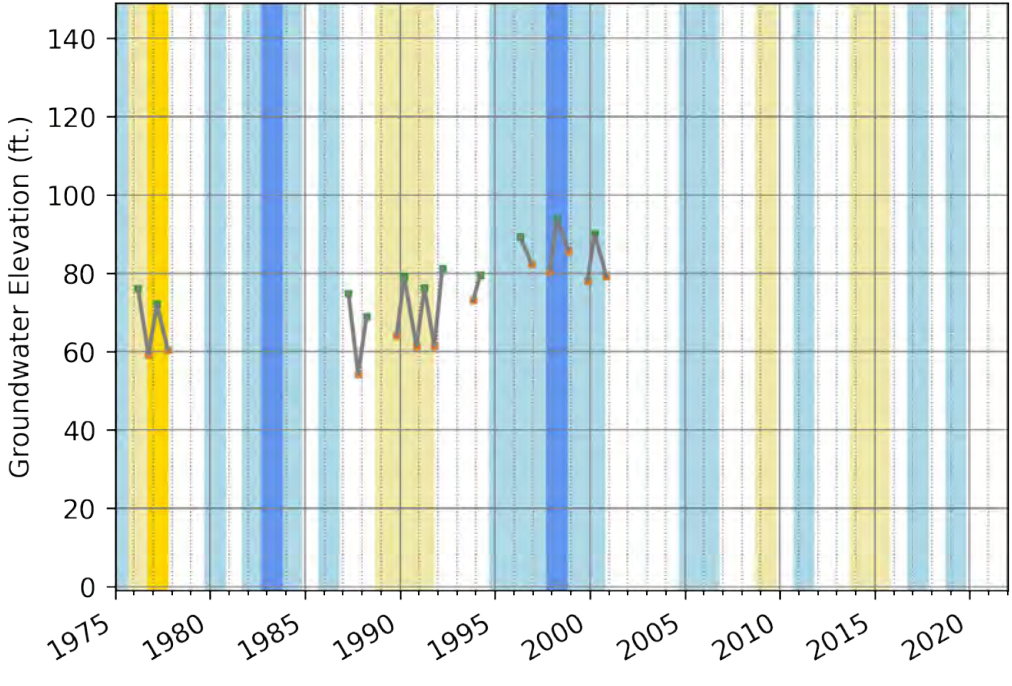

SRP0326, 385117N1227863W002
Groundwater Elevation (ft.)
160
140
120
100
80
60
40
1980
1985
1990
1995
2000
2005
2010
2015
2020

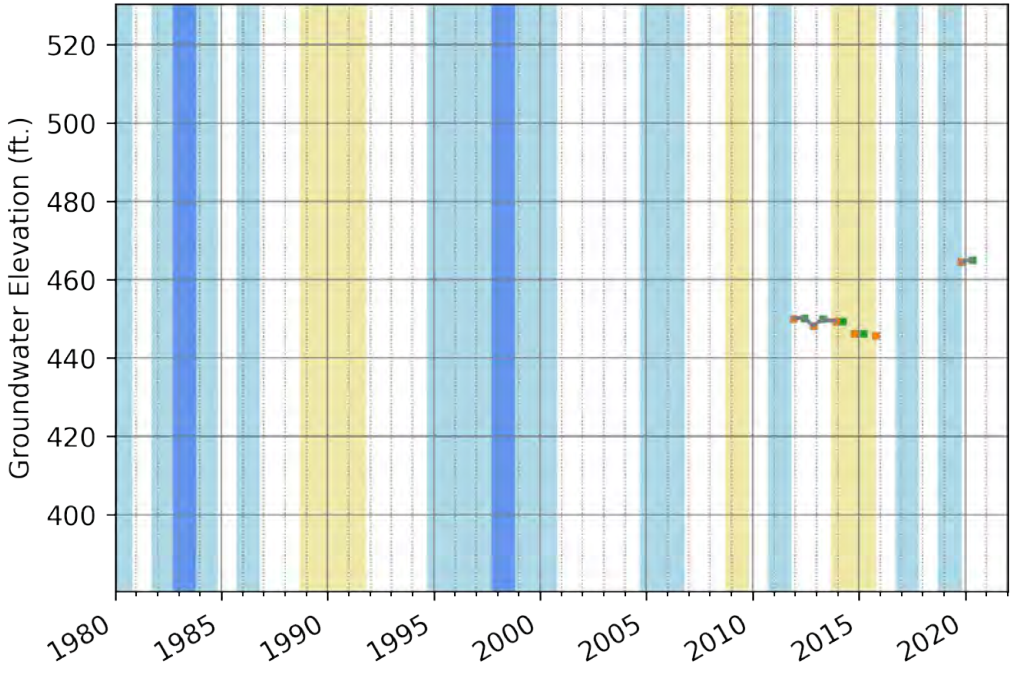

SRP0333, 385385N1228288W001
Groundwater Elevation (ft.)
160
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020

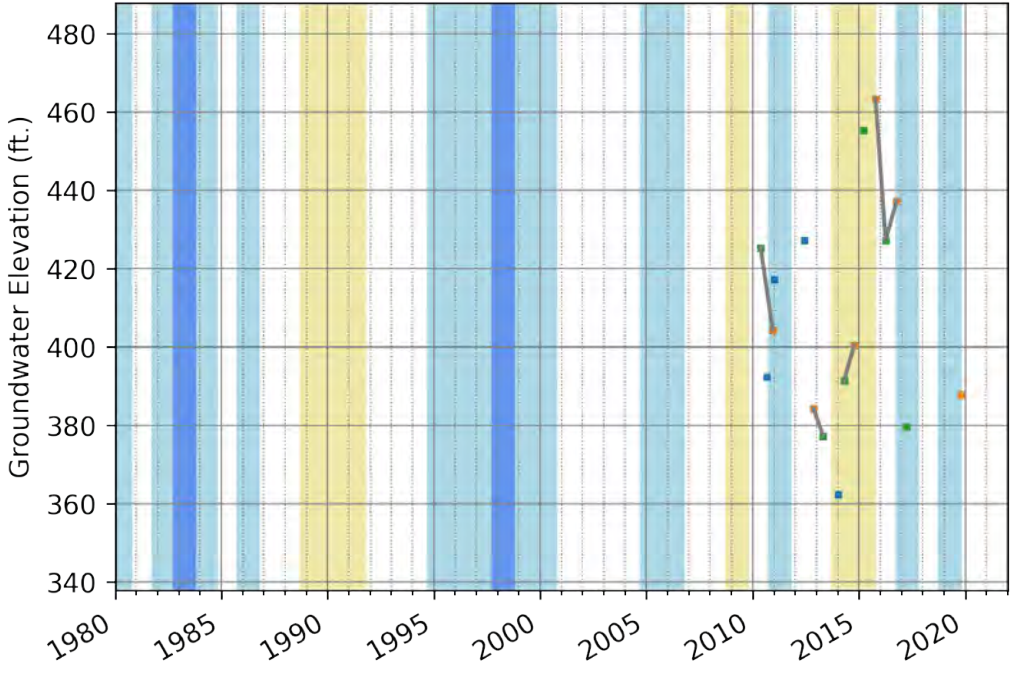

SRP0334, 385459N1227993W001
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020

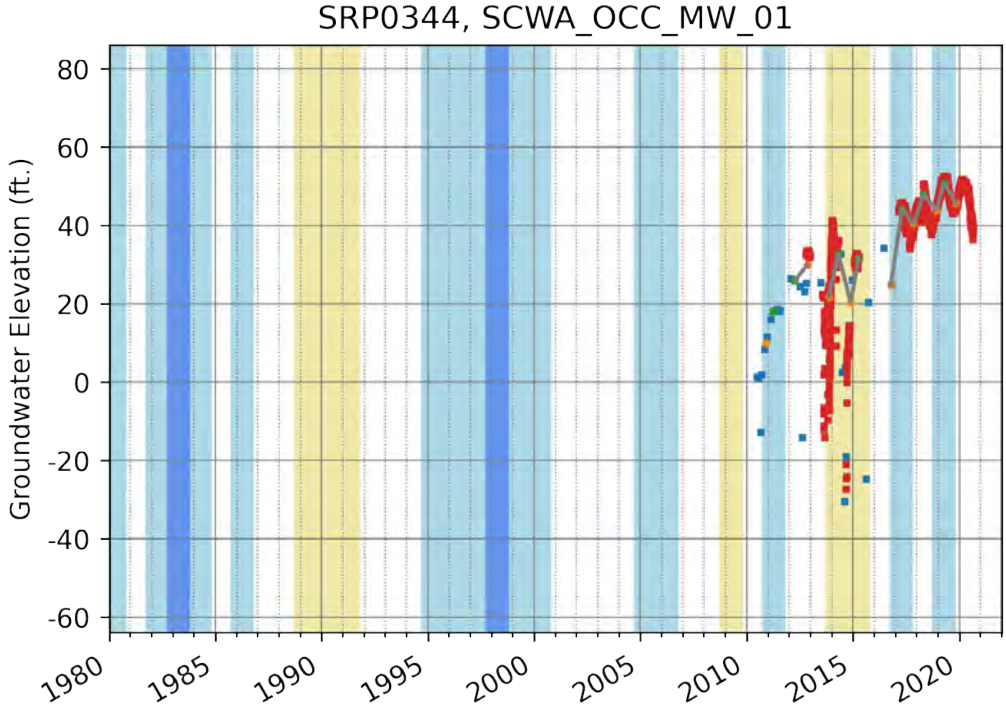

SRP0336, 385473N1228398W001
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020

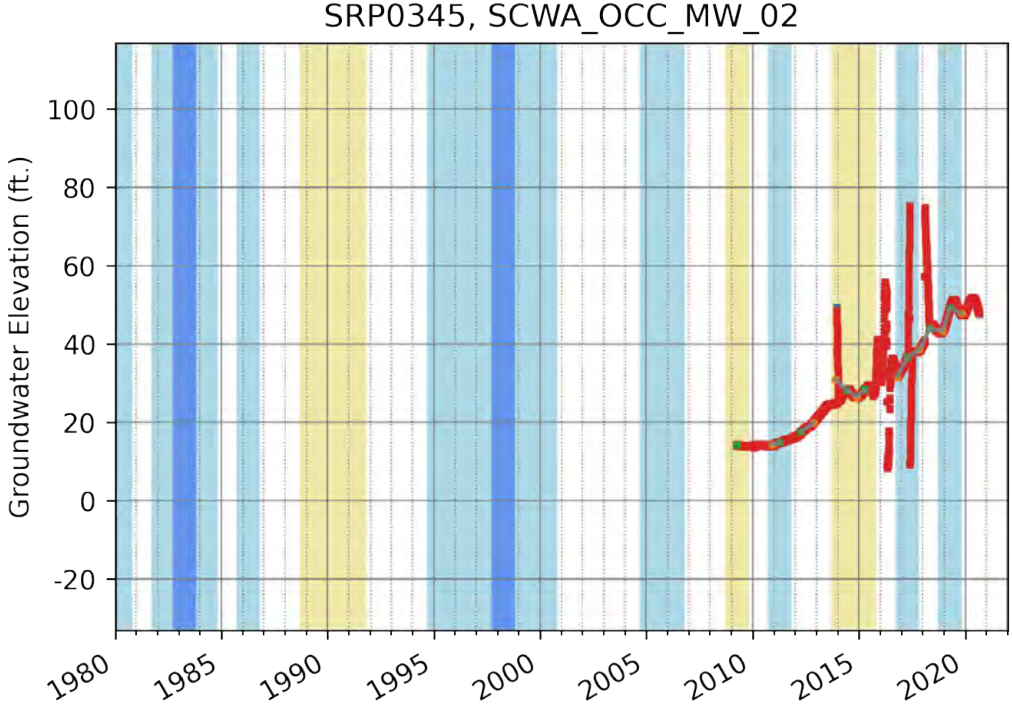

SRP0337, 385479N1228110W001
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

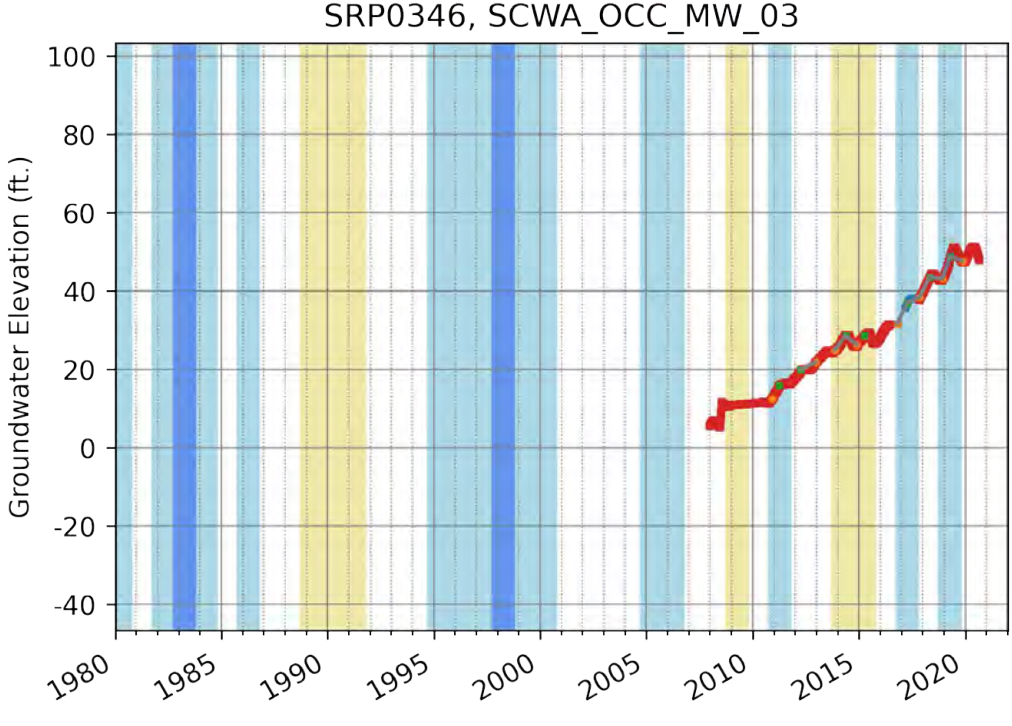

SRP0338, 385492N1228107W001
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
0
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0339, 385560N1227528W001
Groundwater Elevation (ft.)
520
500
480
460
440
420
400
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0340, 385690N1227238W001
Groundwater Elevation (ft.)
480
460
440
420
400
380
360
340
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0344, SCWA_OCC_MW_01
Groundwater Elevation (ft.)
80
60
40
20
0
-20
-40
-60
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0345, SCWA_OCC_MW_02
Groundwater Elevation (ft.)
100
80
60
40
20
0
-20
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0346, SCWA_OCC_MW_03
Groundwater Elevation (ft.)
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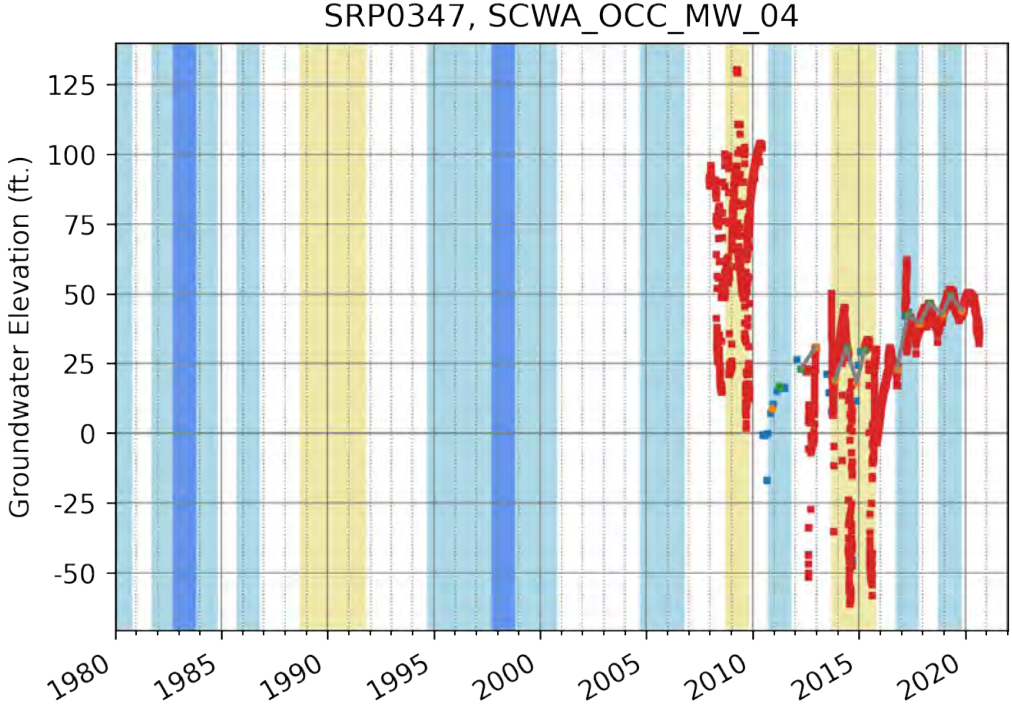
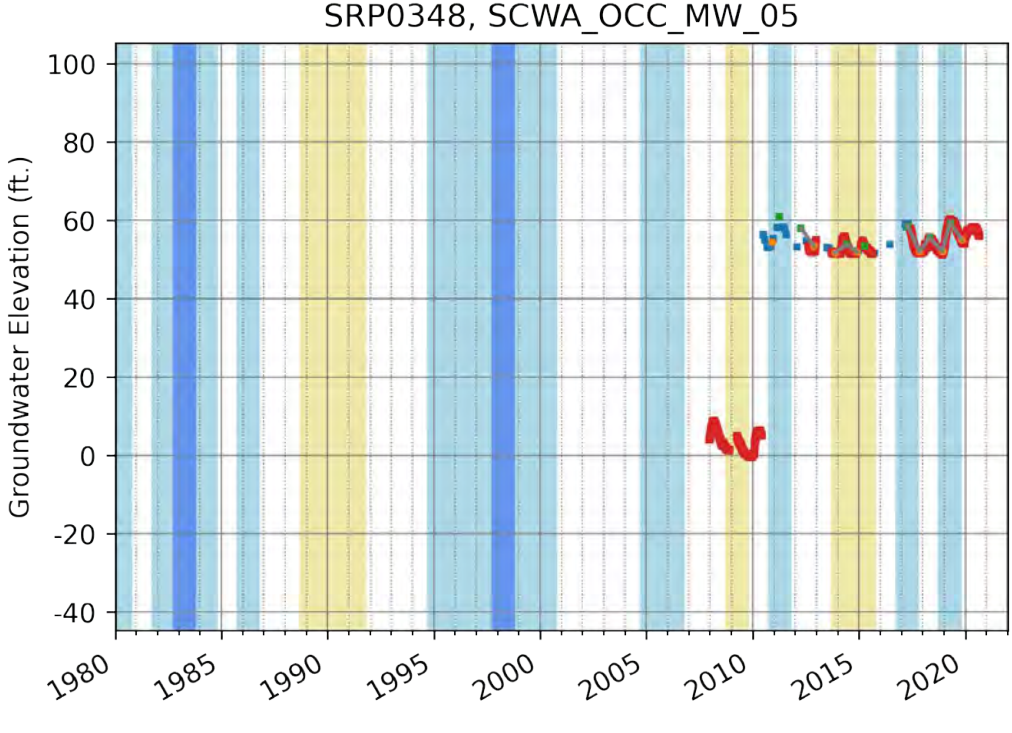
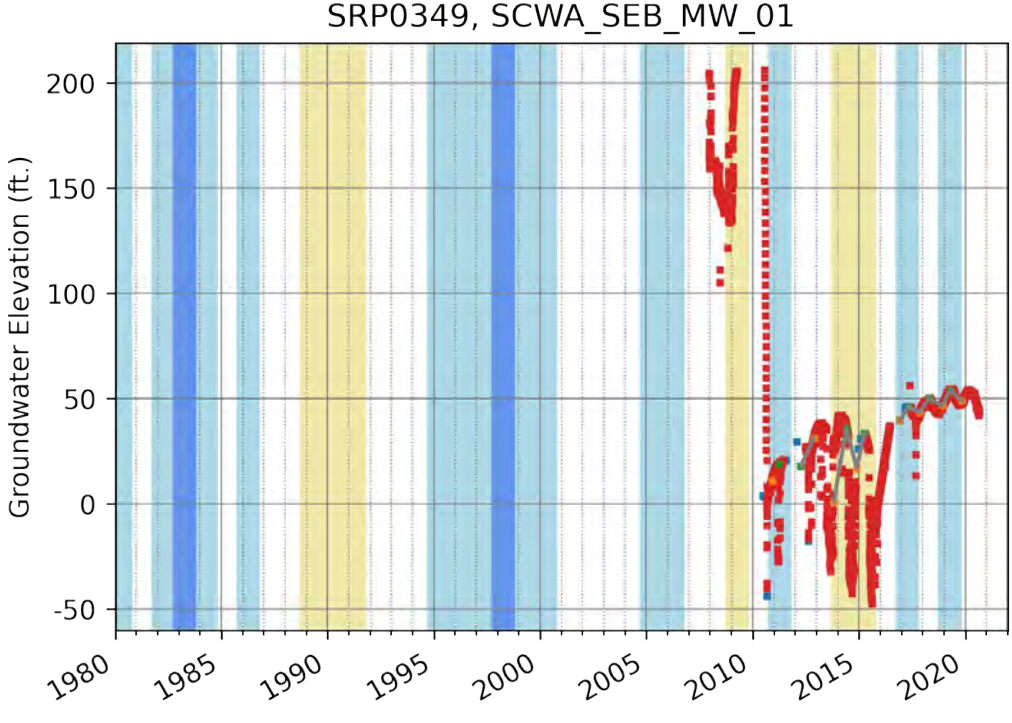
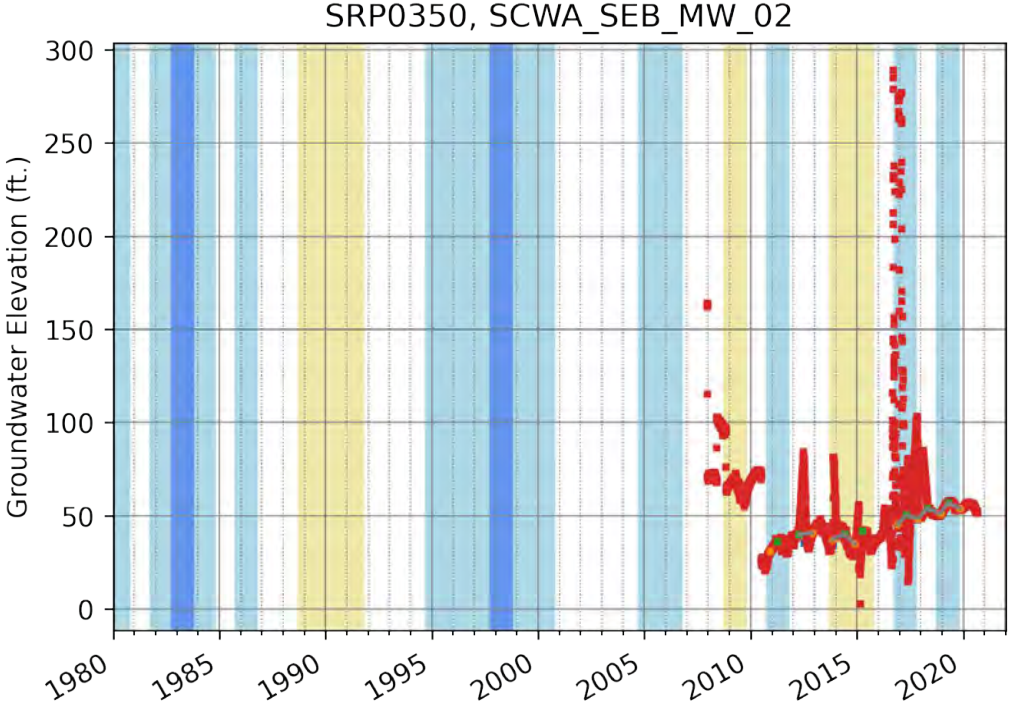
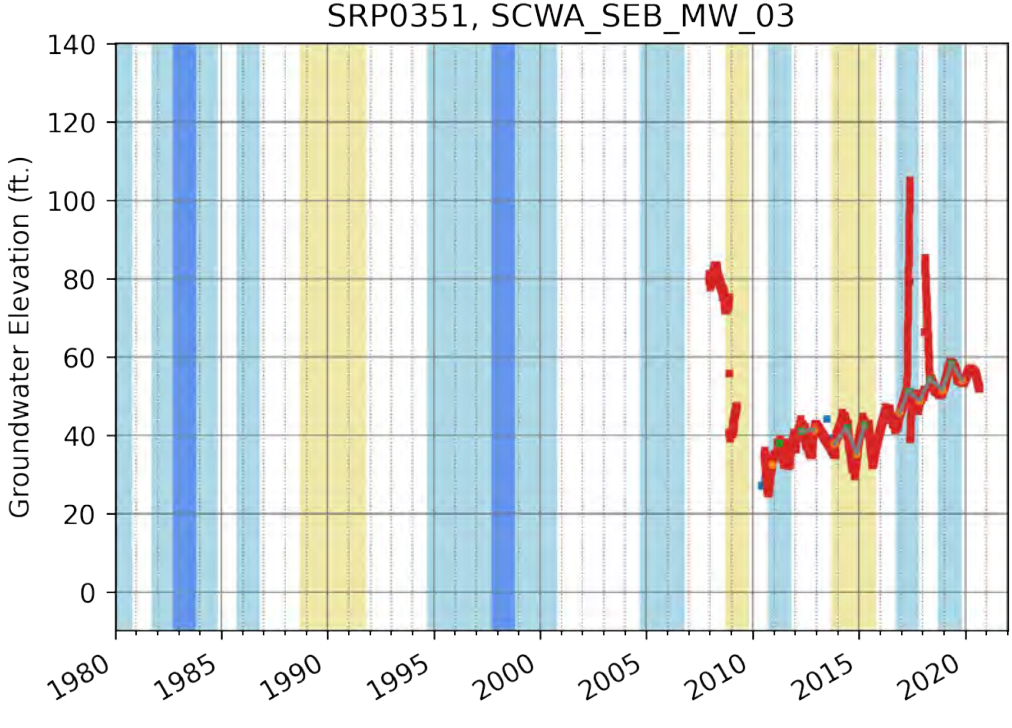
80
60
40
20
0
-20
-40
1980
1985
1990
1995
2000
2005
2010
2015
2020

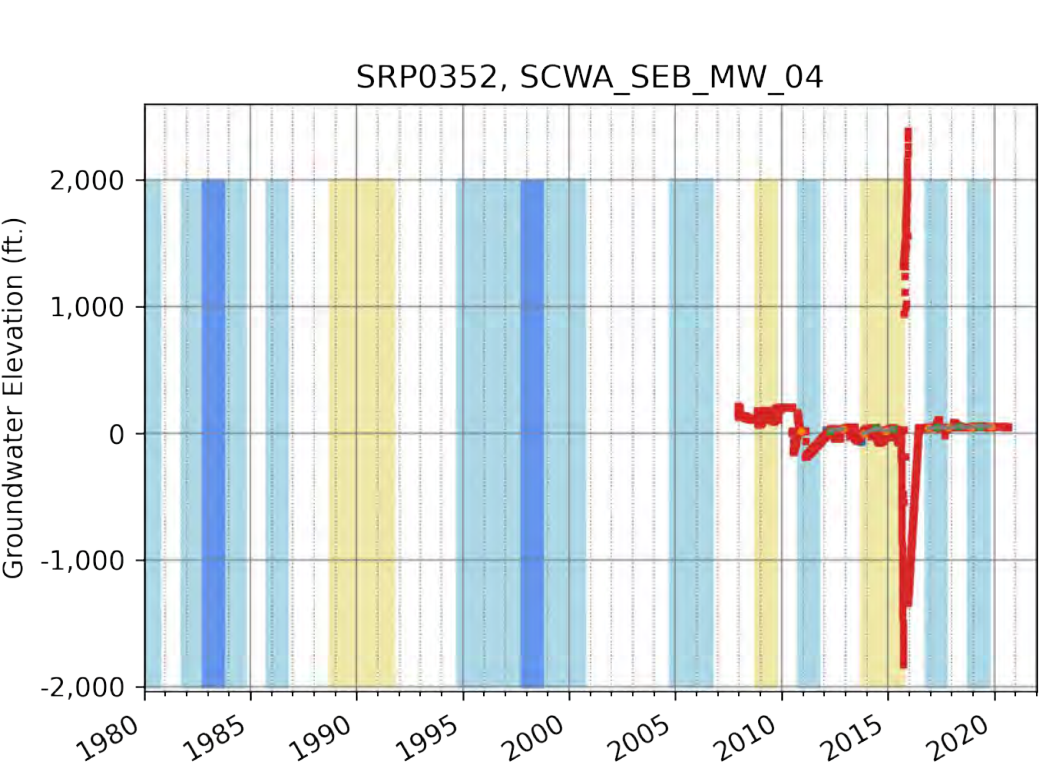

SRP0347, SCWA_OCC_MW_04
Groundwater Elevation (ft.)
125
100
75
50
25
0
-25
-50
1980
1985
1990
1995
2000
2005
2010
2015
2020

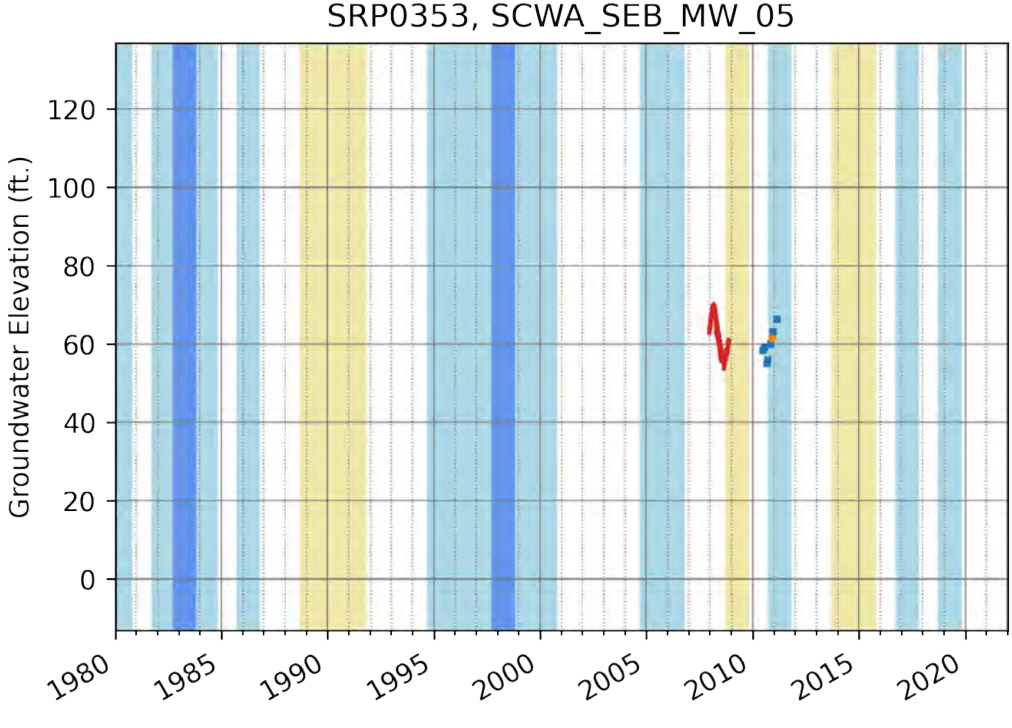

SRP0348, SCWA_OCC_MW_05
Groundwater Elevation (ft.)
100
80
60
40
20
0
-20
-40
1980
1985
1990
1995
2000
2005
2010
2015
2020

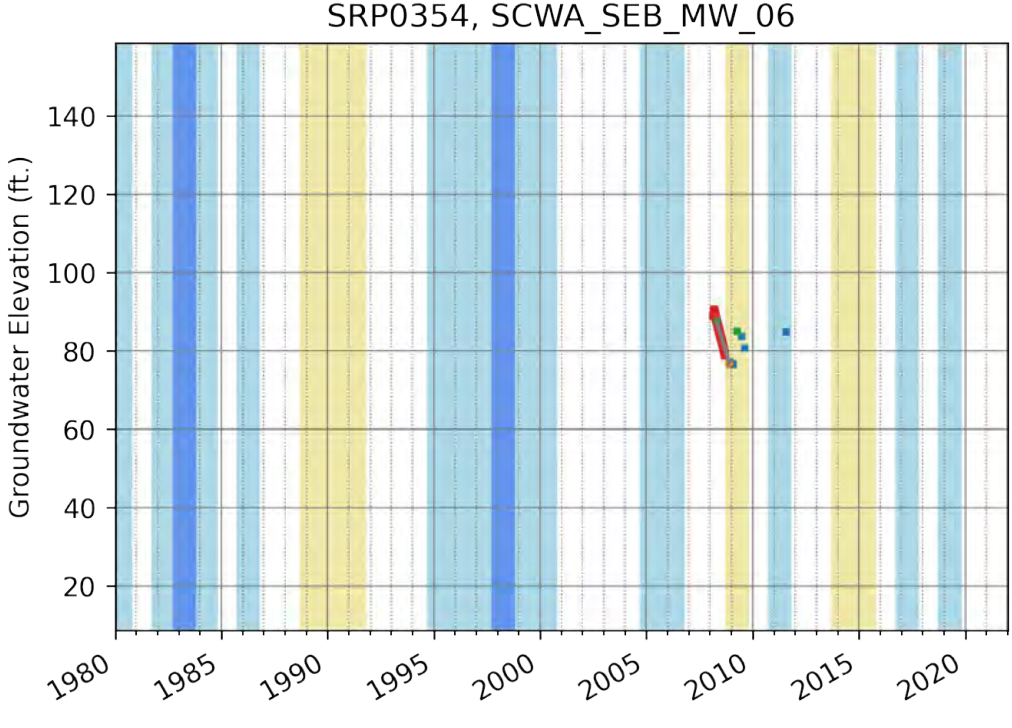

SRP0349, SCWA_SEB_MW_01
Groundwater Elevation (ft.)
200
150
100
50
0
-50
1980
1985
1990
1995
2000
2005
2010
2015
2020

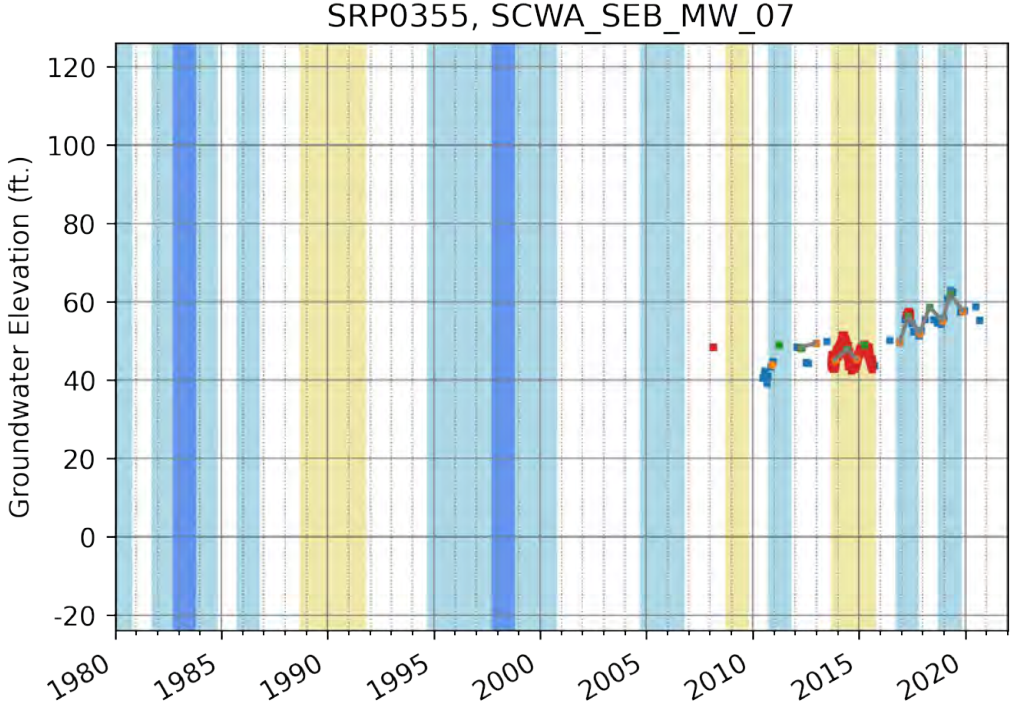

SRP0350, SCWA_SEB_MW_02
Groundwater Elevation (ft.)
300
250
200
150
100
50
0
1980
1985
1990
1995
2000
2005
2010
2015
2020

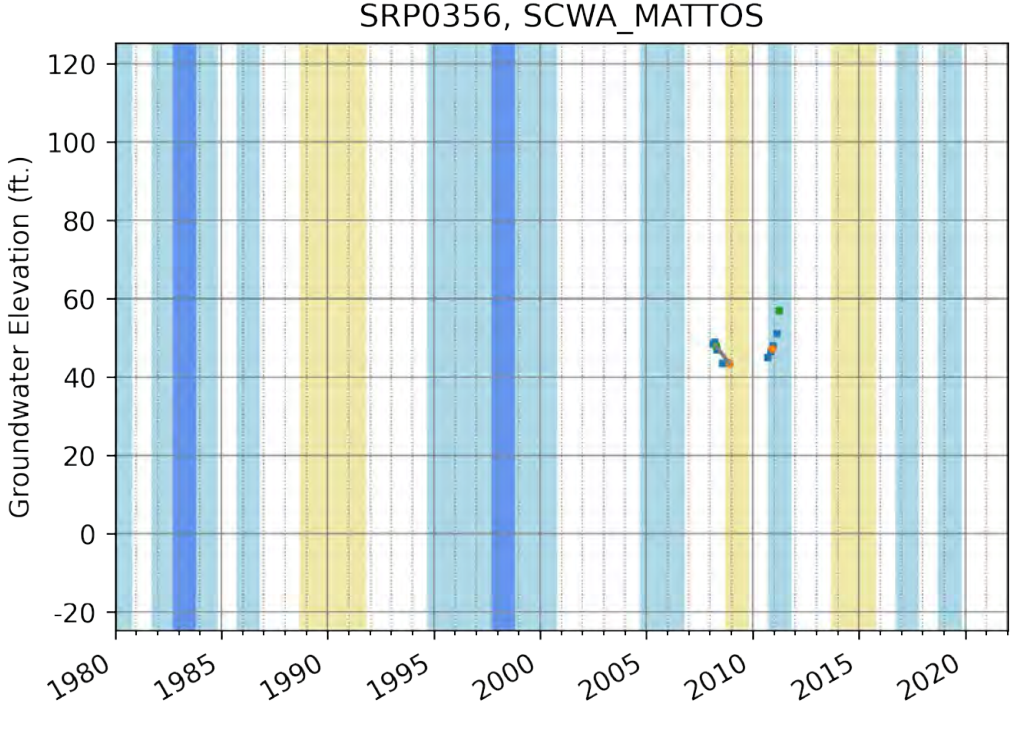

SRP0351, SCWA_SEB_MW_03
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020

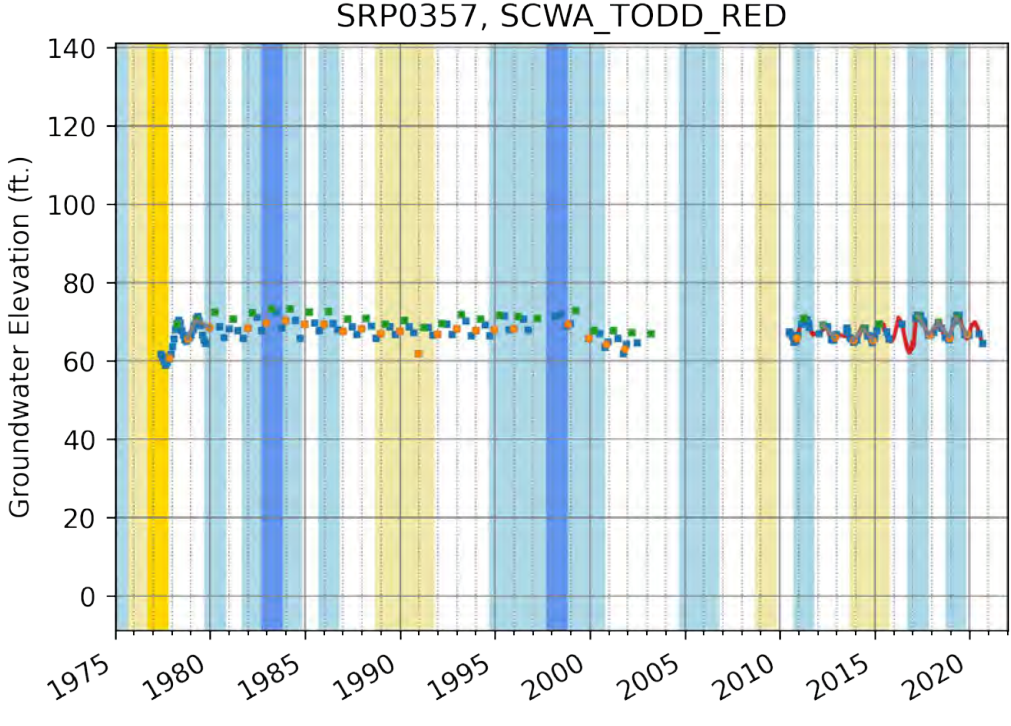

SRP0352, SCWA_SEB_MW_04
Groundwater Elevation (ft.)
2,000
1,000
0
-1,000
-2,000
1980
1985
1990
1995
2000
2005
2010
2015
2020

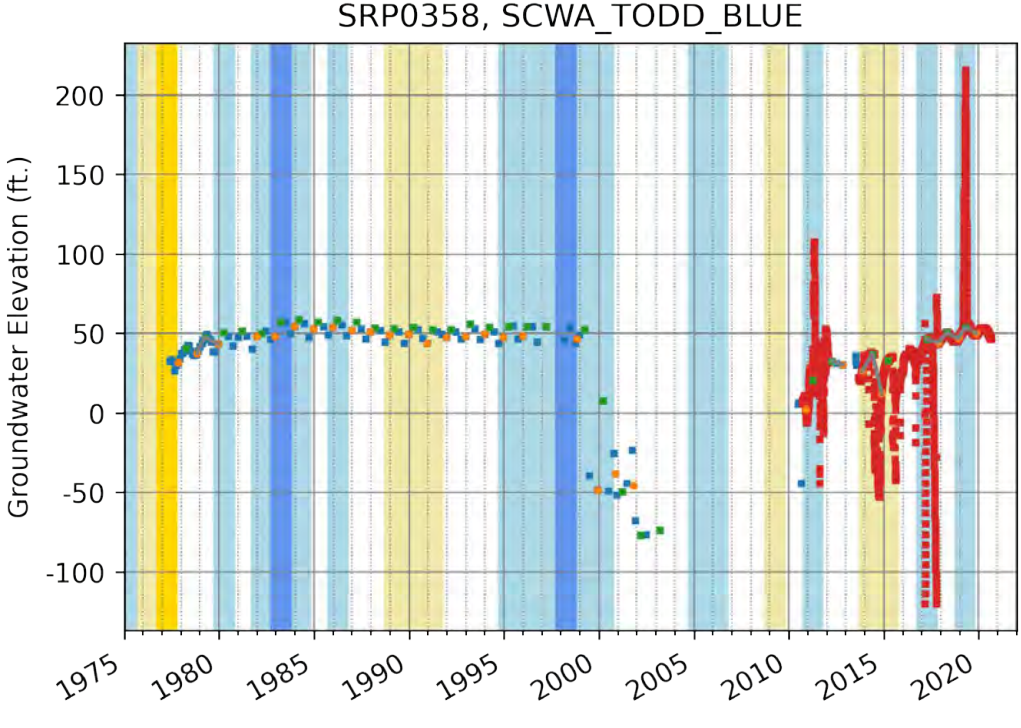

SRP0353, SCWA_SEB_MW_05
Groundwater Elevation (ft.)
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0354, SCWA_SEB_MW_06
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0355, SCWA_SEB_MW_07
Groundwater Elevation (ft.)
120
100
80
60
40
20
0
-20
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0356, SCWA_MATTOS
Groundwater Elevation (ft.)
120
100
80
60
40
20
0
-20
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0357, SCWA_TODD_RED
Groundwater Elevation (ft.)
140
120
100
80
60
40
20
0
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0358, SCWA_TODD_BLUE
Groundwater Elevation (ft.)
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100
50
0
-50
-100
1975
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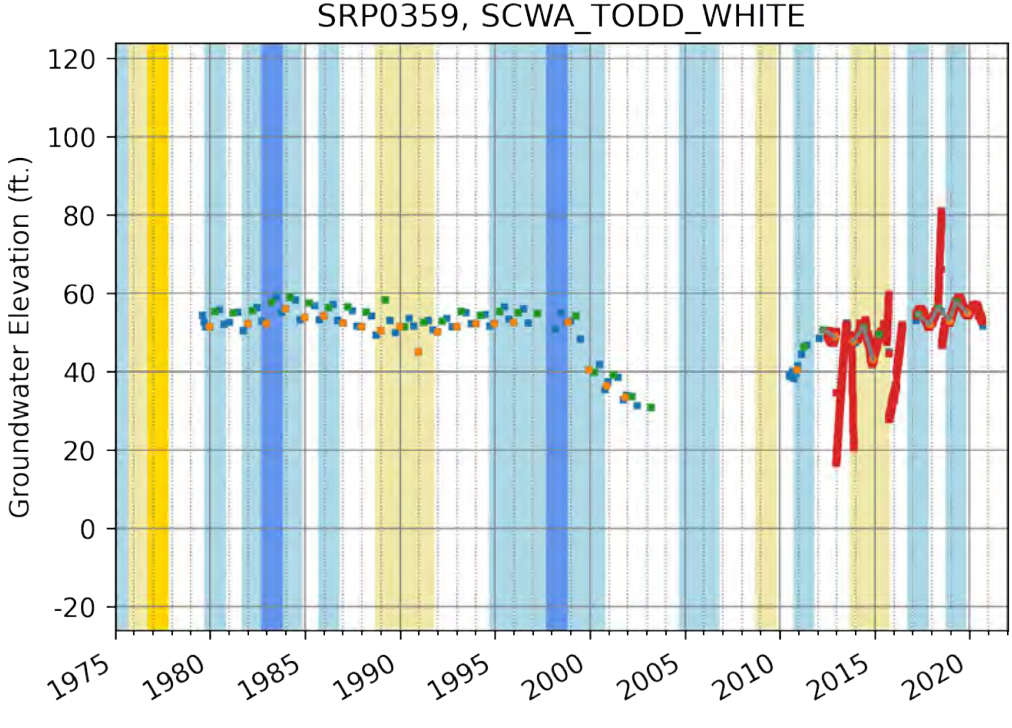
1985
1990
1995
2000
2005
2010
2015
2020


SRP0359, SCWA_TODD_WHITE
Groundwater Elevation (ft.)
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60
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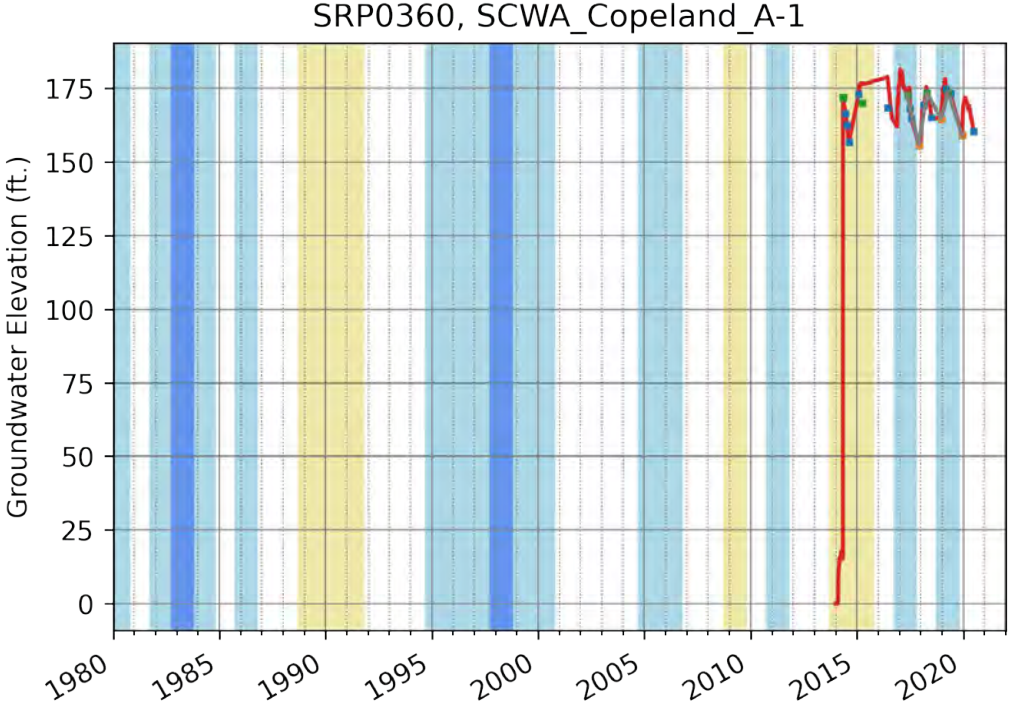
2005
2010
2015
2020


SRP0360, SCWA_Copeland_A-1
Groundwater Elevation (ft.)
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100
75
50
25
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1995
2000
2005
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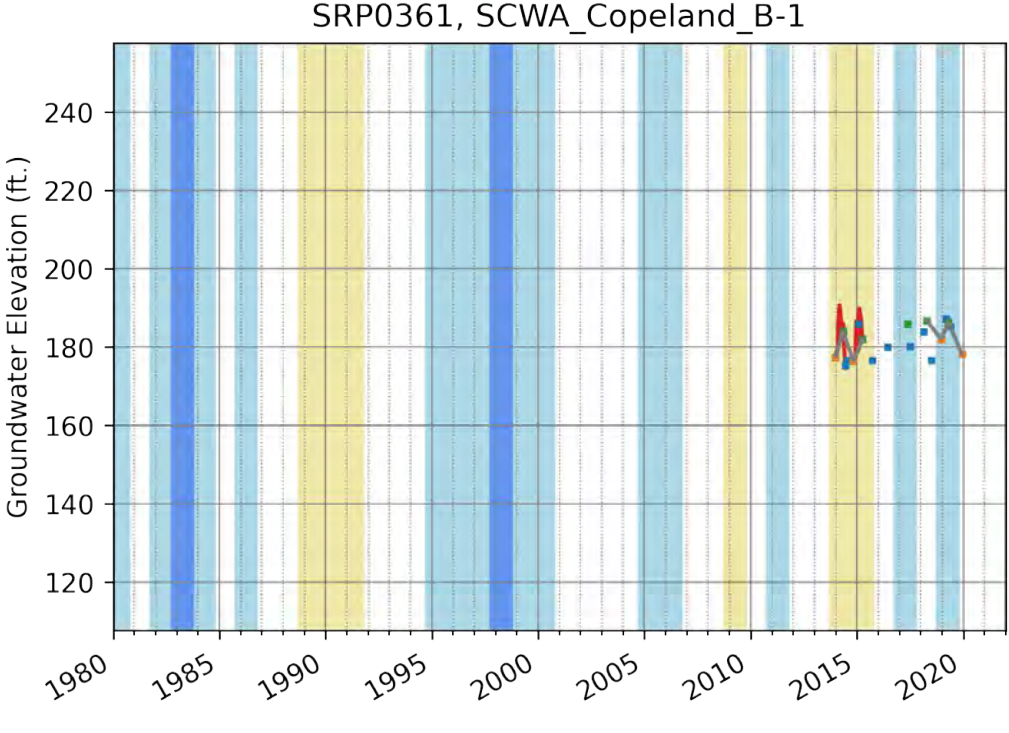
2015
2020


SRP0361, SCWA_Copeland_B-1
Groundwater Elevation (ft.)
240
220
200
180
160
140
120
1980
1985
1990
1995
2000
2005
2010
2015
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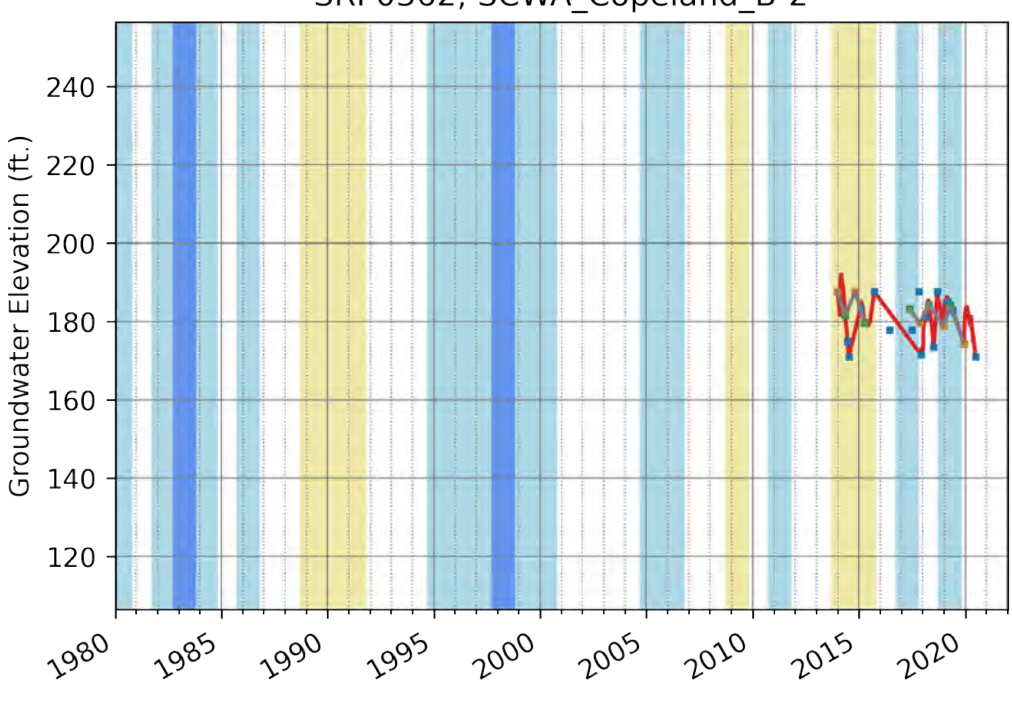
SRP0362, SCWA_Copeland_B-2
Groundwater Elevation (ft.)
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220
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2010
2015
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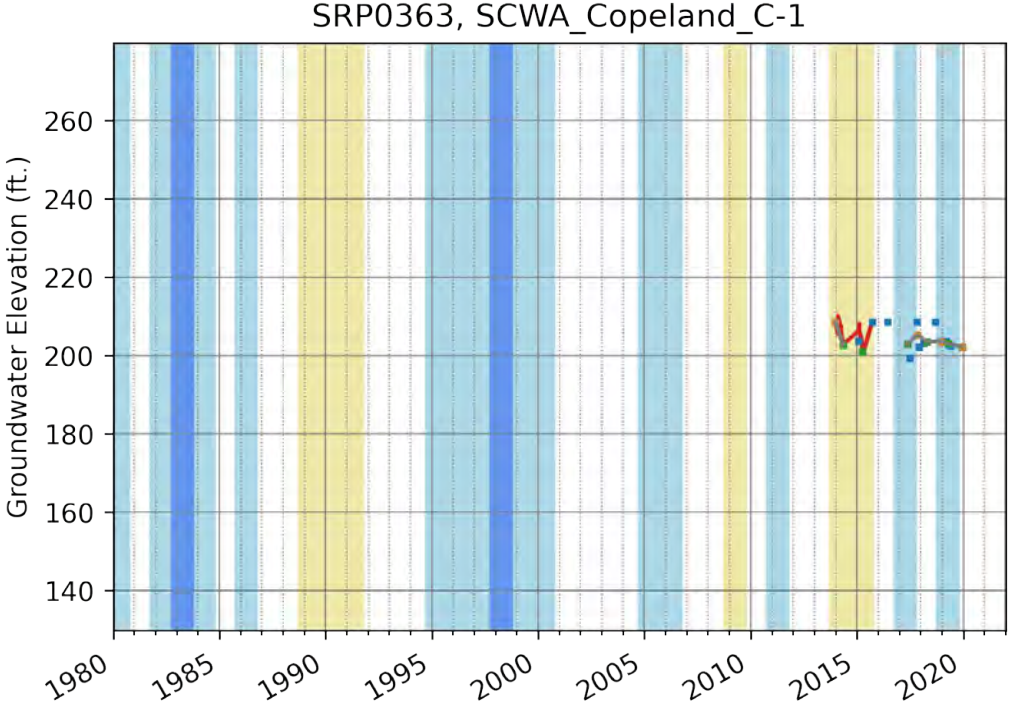
SRP0363, SCWA_Copeland_C-1
Groundwater Elevation (ft.)
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240
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200
180
160
140
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2015
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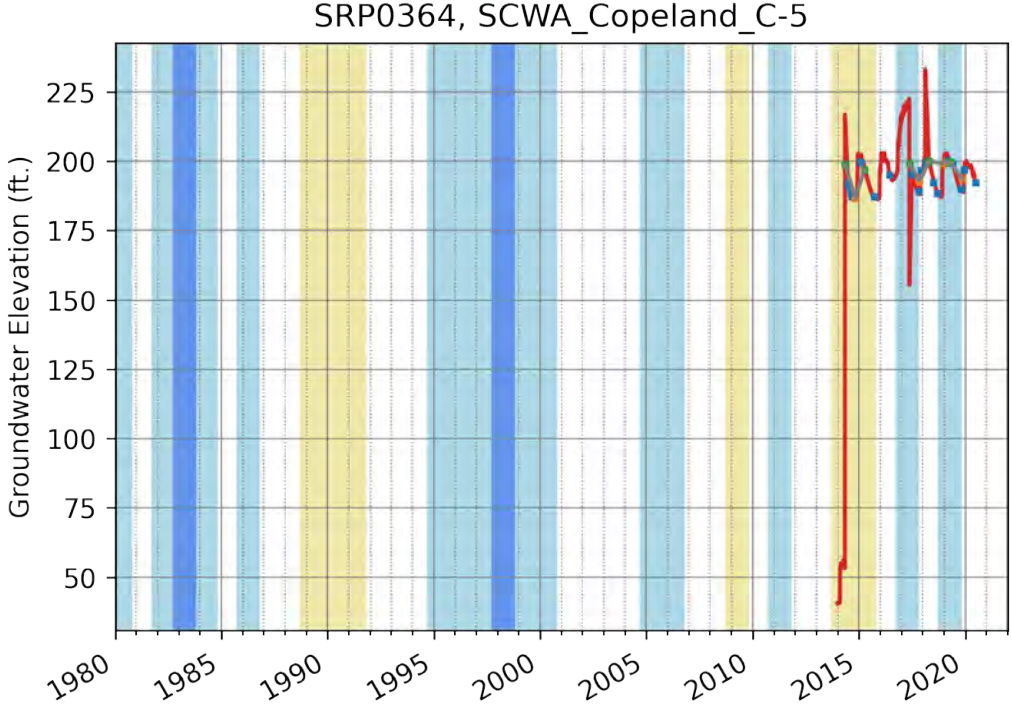
SRP0364, SCWA_Copeland_C-5
Groundwater Elevation (ft.)
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150
125
100
75
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1995
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2005
2010
2015
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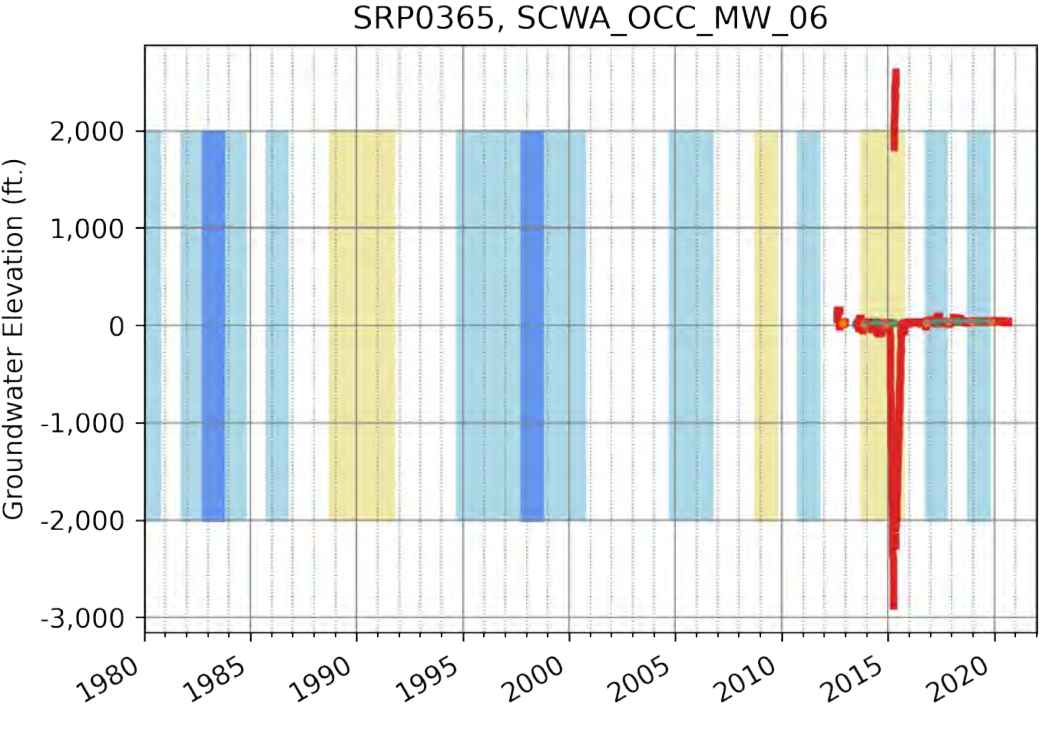
SRP0365, SCWA_OCC_MW_06
Groundwater Elevation (ft.)
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-1,000
-2,000
-3,000
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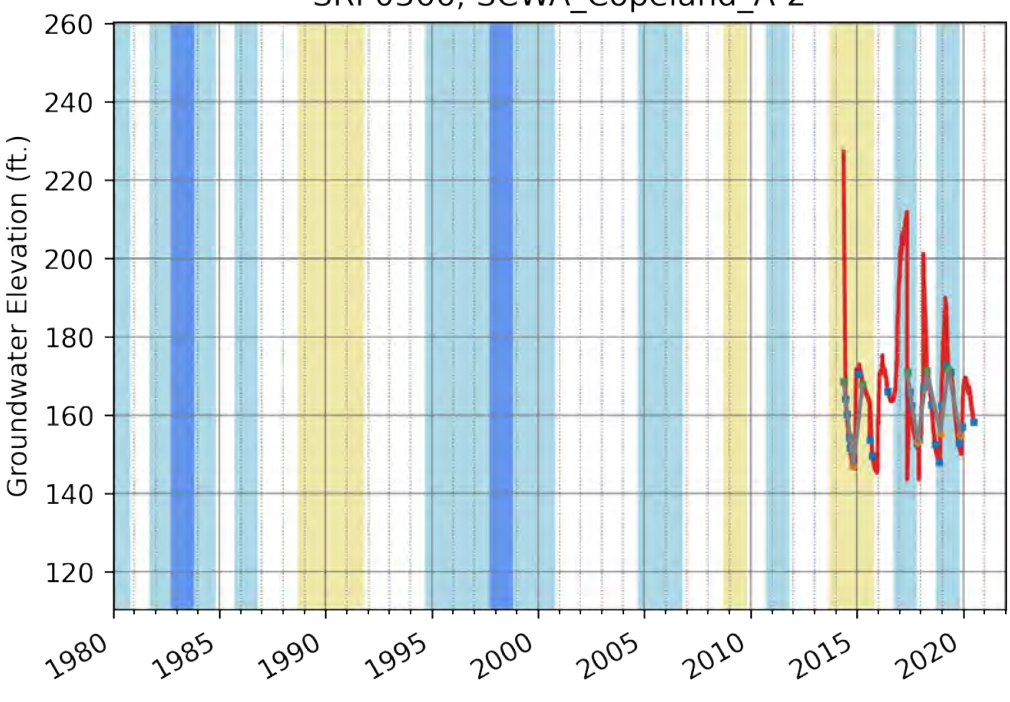
1990
1995
2000
2005
2010
2015
2020


SRP0366, SCWA_Copeland_A-2
Groundwater Elevation (ft.)
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180
160
140
120
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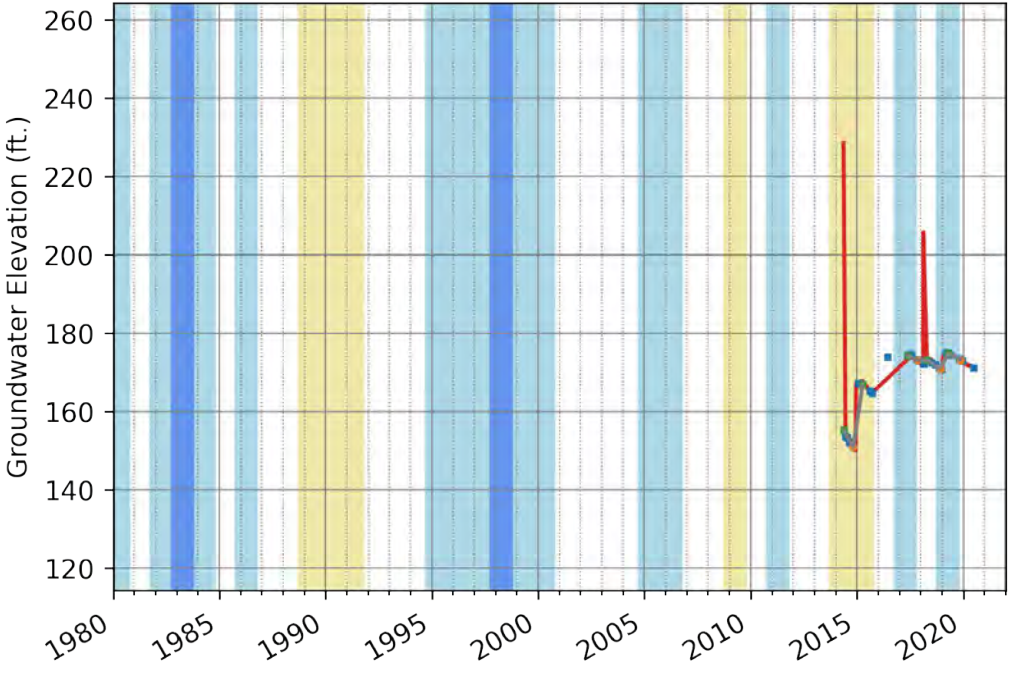
1985
1990
1995
2000
2005
2010
2015
2020


SRP0367, SCWA_Copeland_A-3
Groundwater Elevation (ft.)
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240
220
200
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160
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1985
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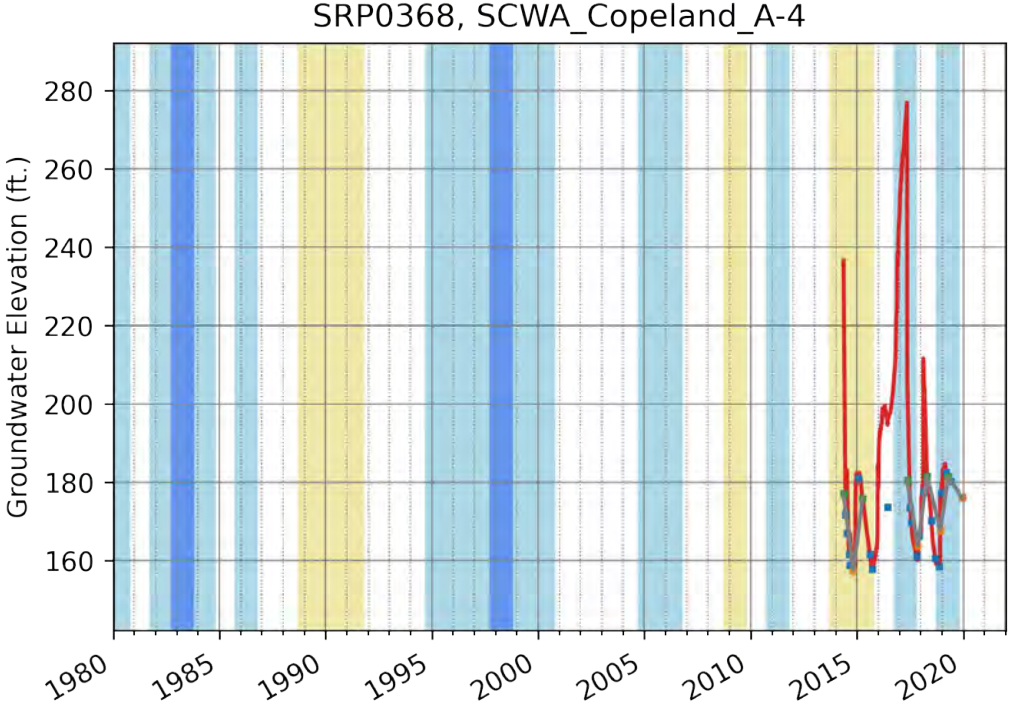
2015
2020


SRP0368, SCWA_Copeland_A-4
Groundwater Elevation (ft.)
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240
220
200
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160
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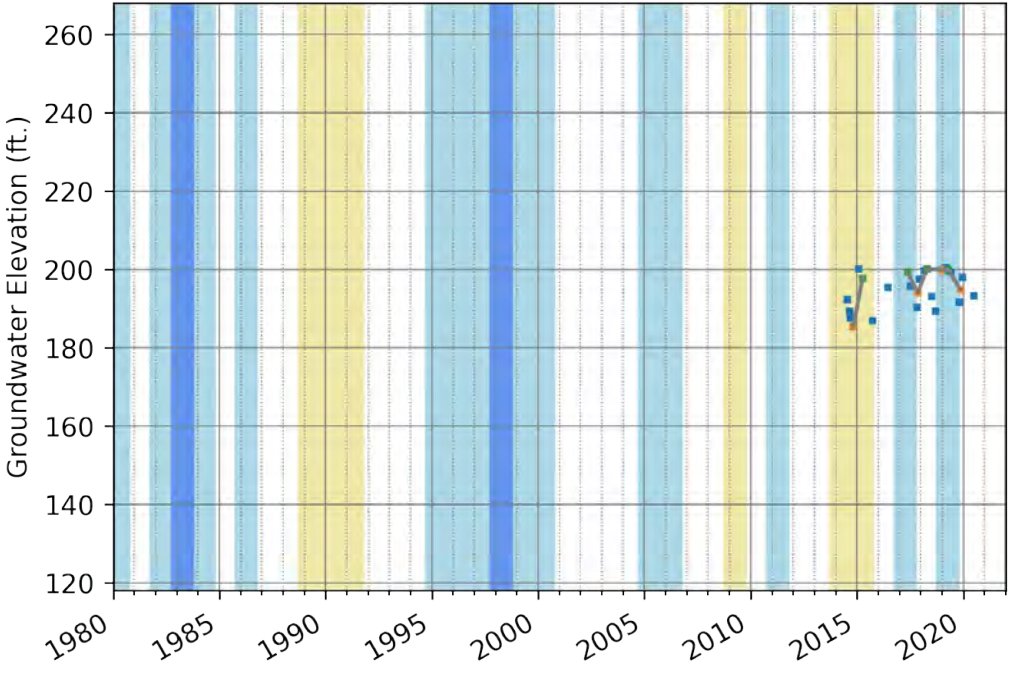
2015
2020


SRP0369, SCWA_Copeland_C-2A
Groundwater Elevation (ft.)
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220
200
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160
140
120
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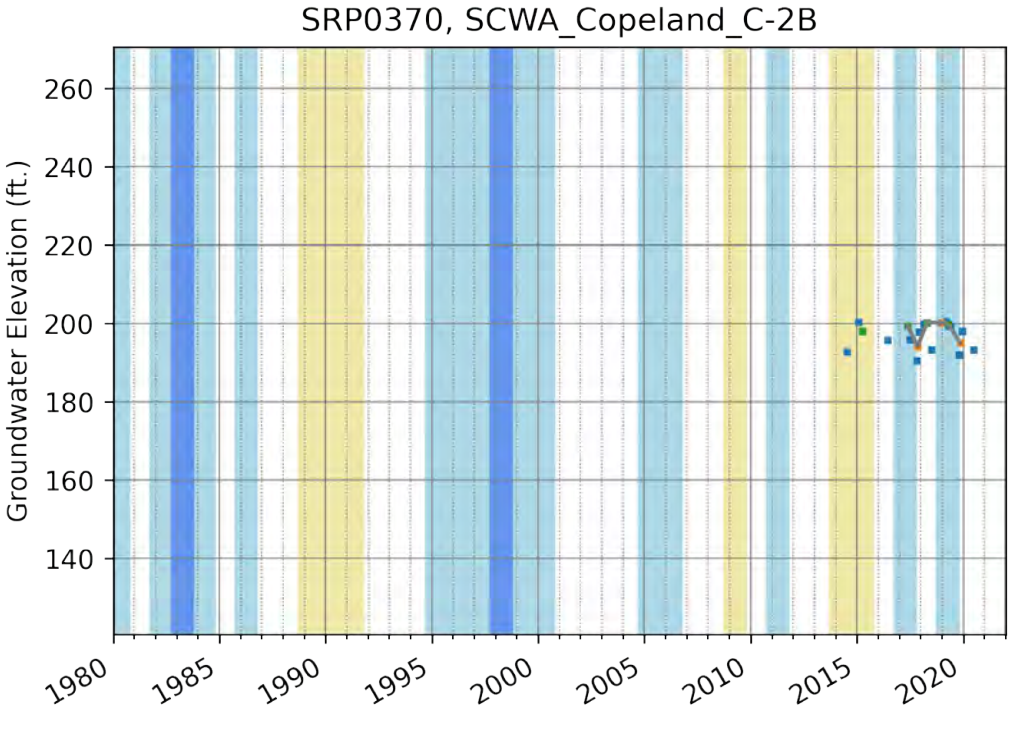
1985
1990
1995
2000
2005
2010
2015
2020


SRP0370, SCWA_Copeland_C-2B
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200
180
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140
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1990
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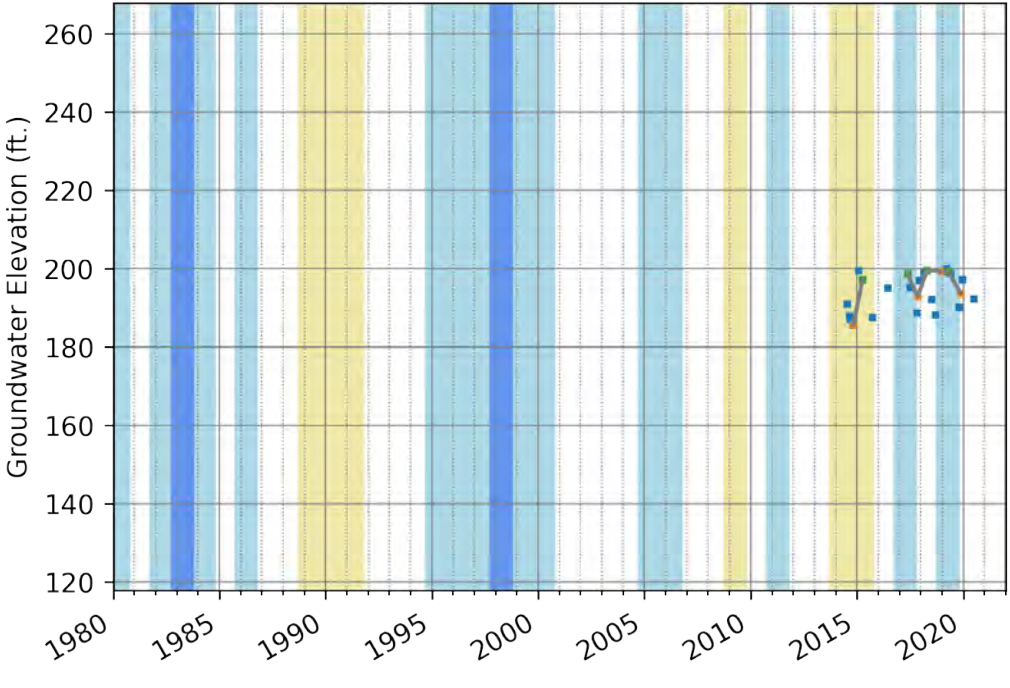
2000
2005
2010
2015
2020


SRP0371, SCWA_Copeland_C-3
Groundwater Elevation (ft.)
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240
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200
180
160
140
120
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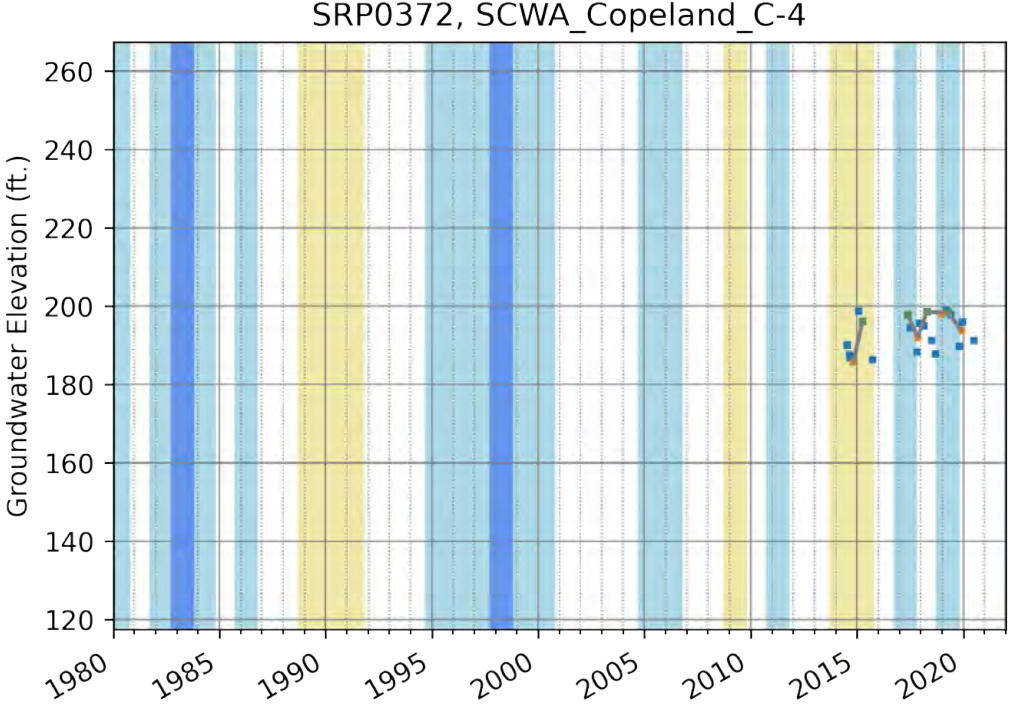
1985
1990
1995
2000
2005
2010
2015
2020


SRP0372, SCWA_Copeland_C-4
Groundwater Elevation (ft.)
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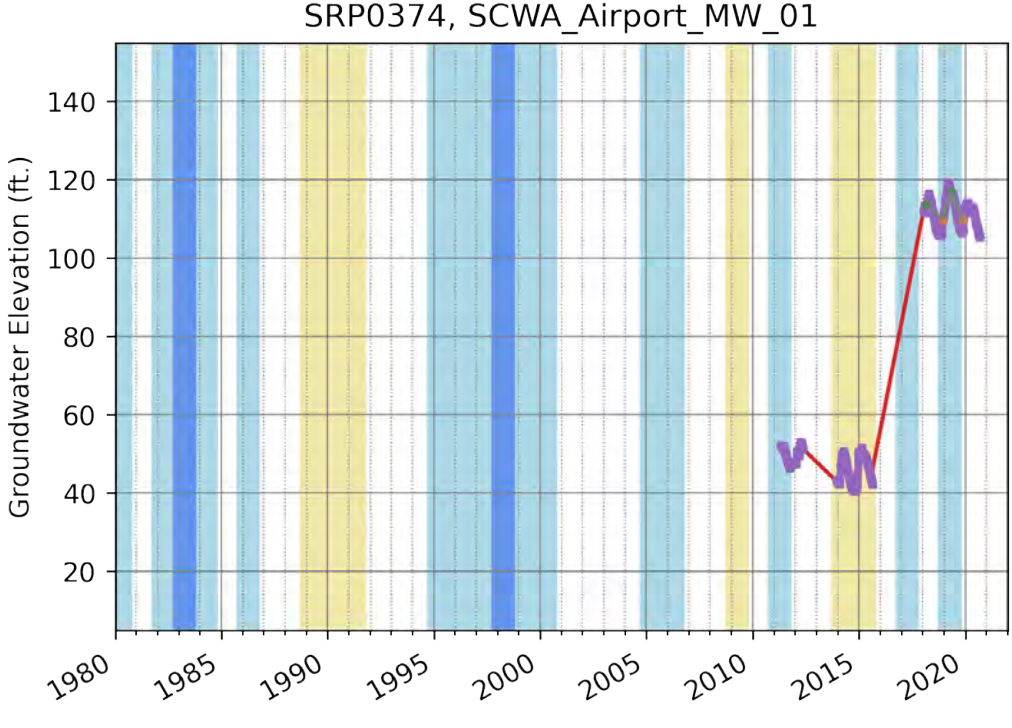
240
220
200
180
160
140
120
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0374, SCWA_Airport_MW_01
Groundwater Elevation (ft.)
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120
100
80
60
40
20
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1985
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1995
2000
2005
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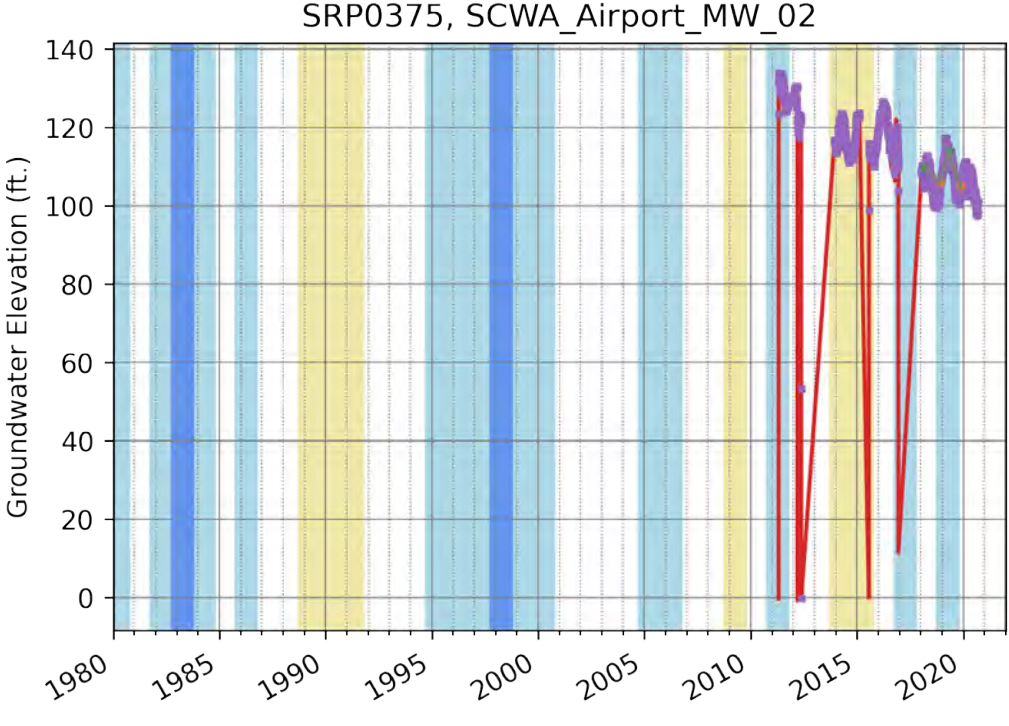
2015
2020


SRP0375, SCWA_Airport_MW_02
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60
40
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1985
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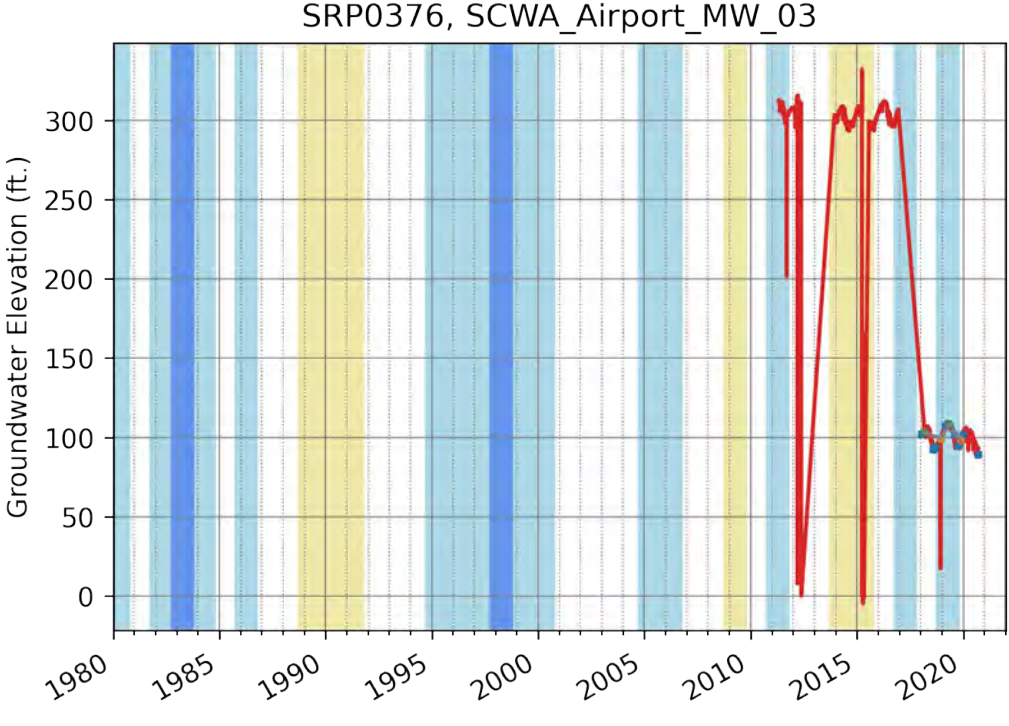
SRP0376, SCWA_Airport_MW_03
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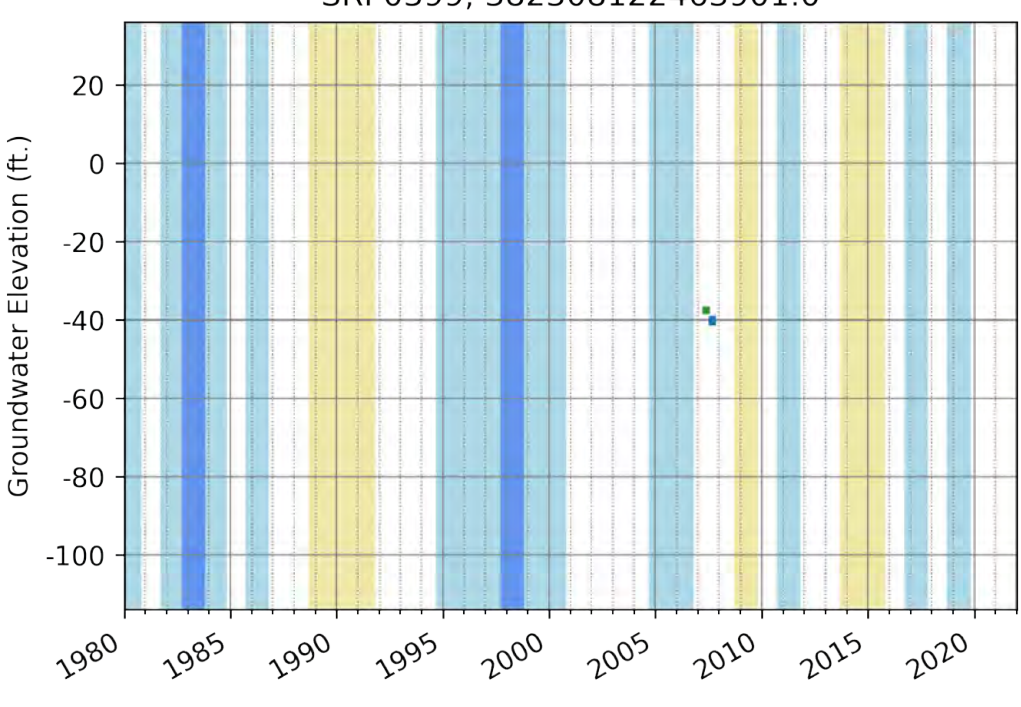
2015
2020


SRP0399, 382308122463901.0
Groundwater Elevation (ft.)
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-20
-40
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1980
1985
1990
1995
2000
2005
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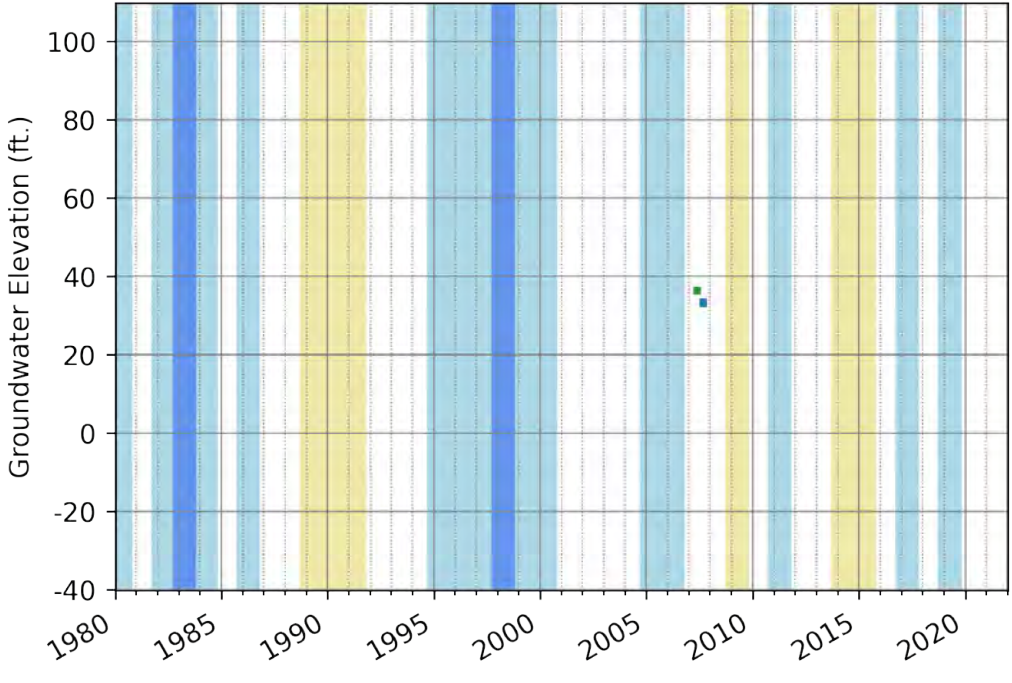
2015
2020


SRP0400, 382308122463902.0
Groundwater Elevation (ft.)
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-20
-40
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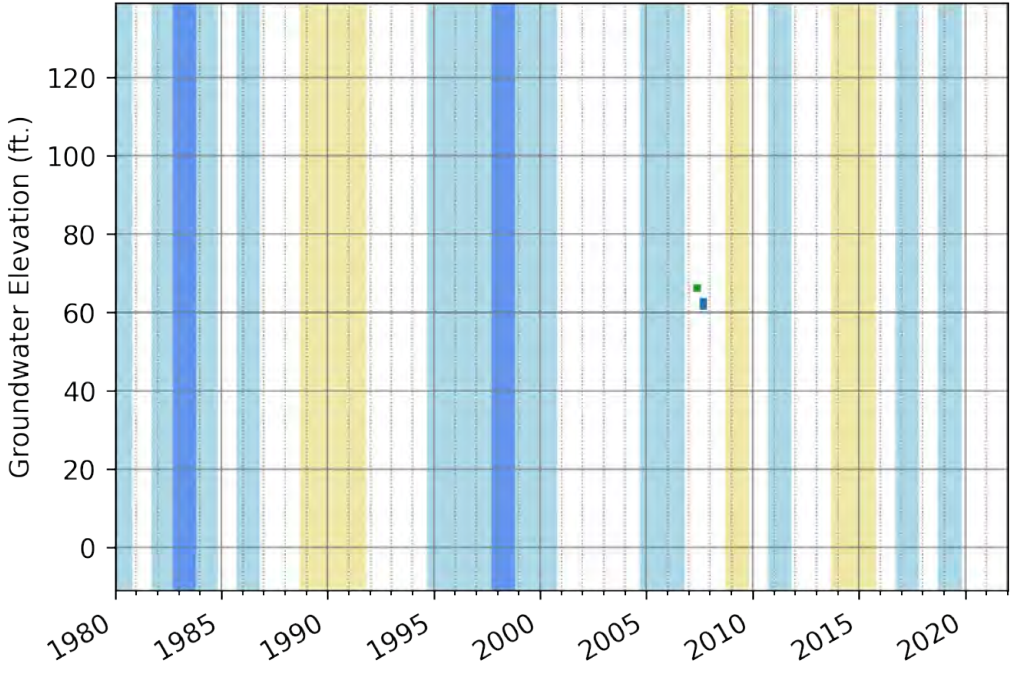
1985
1990
1995
2000
2005
2010
2015
2020


SRP0401, 382308122463903.0
Groundwater Elevation (ft.)
120
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80
60
40
20
0
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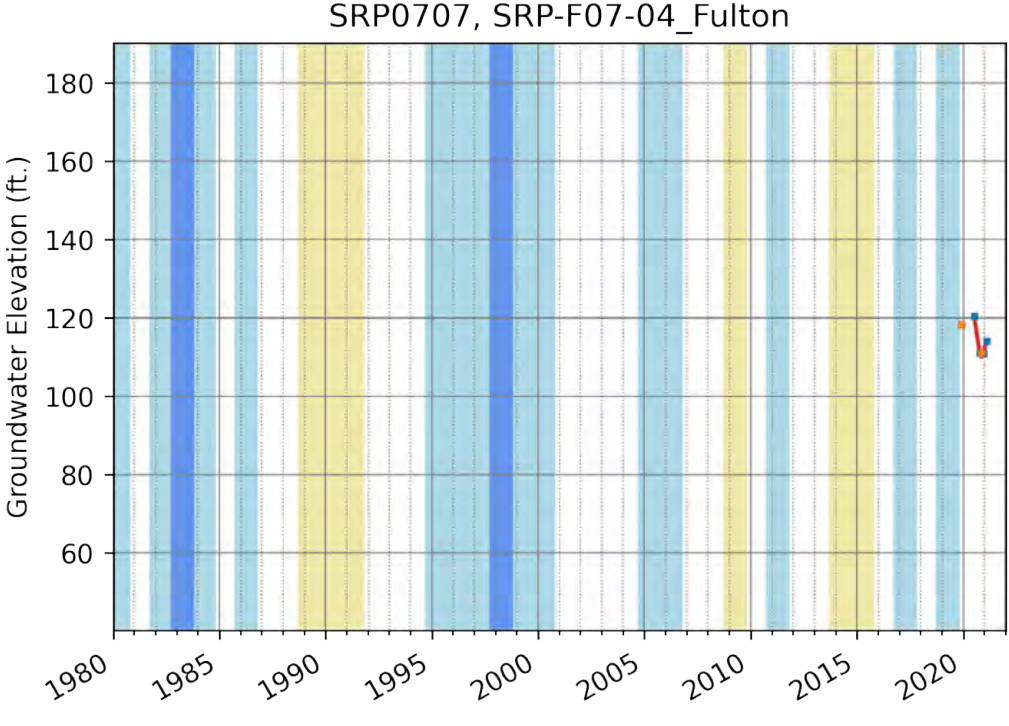
1990
1995
2000
2005
2010
2015
2020


SRP0707, SRP-F07-04_Fulton
Groundwater Elevation (ft.)
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160
140
120
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80
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1990
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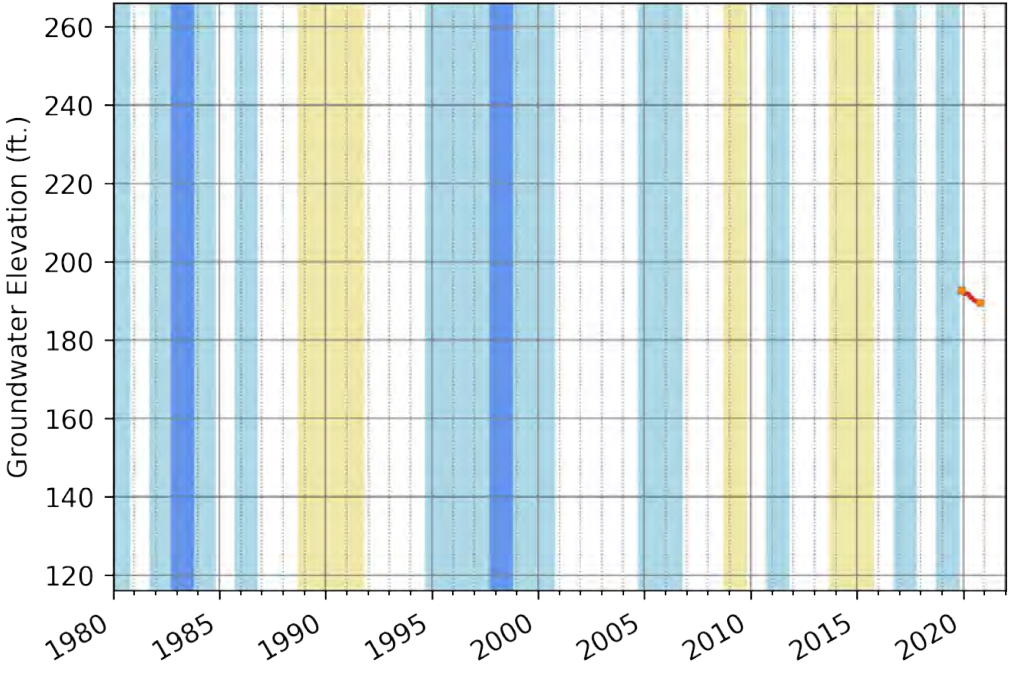
2010
2015
2020


SRP0708, SRP-H07-01_Mark_West
Groundwater Elevation (ft.)
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240
220
200
180
160
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120
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1985
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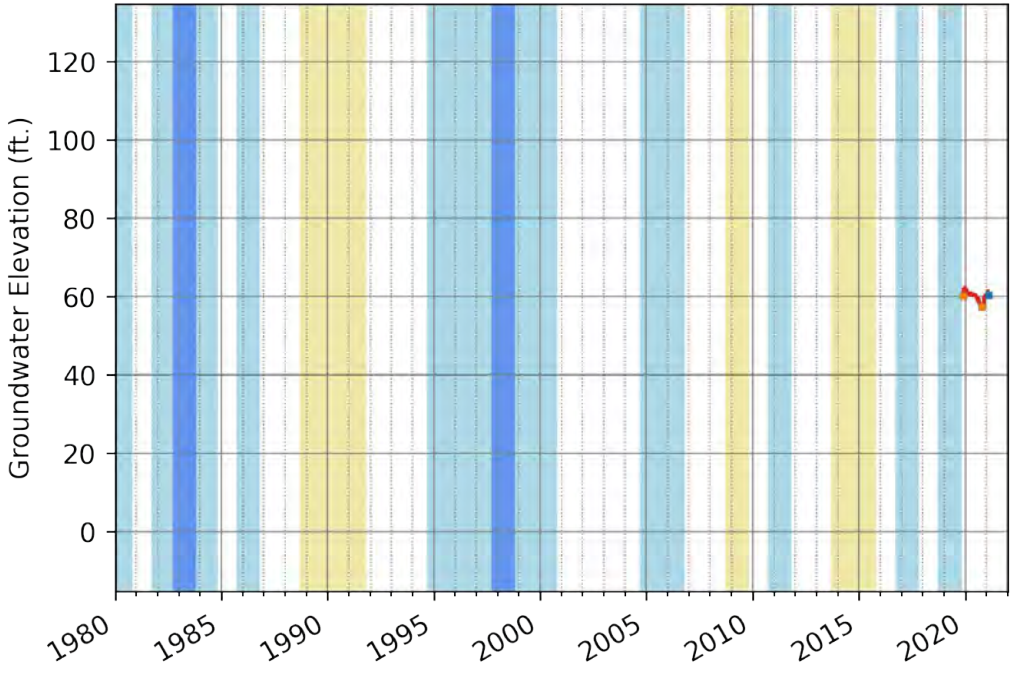
2010
2015
2020


SRP0709, SRP-C09-01_River_Rd
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40
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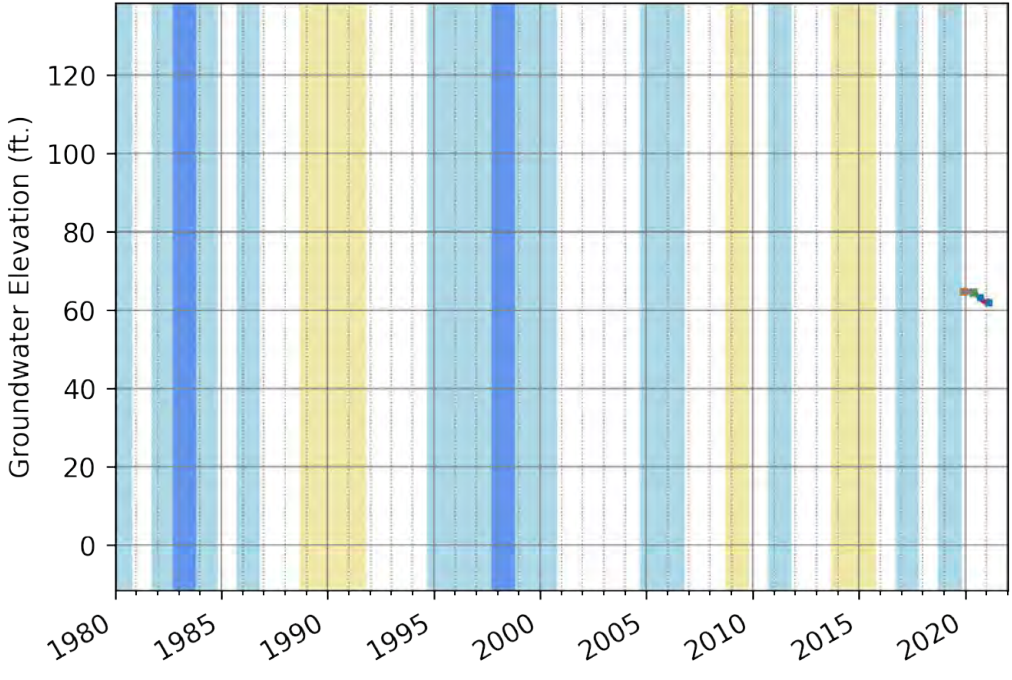
2005
2010
2015
2020


SRP0710, SRP-H18-02_Stony
Groundwater Elevation (ft.)
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60
40
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2015
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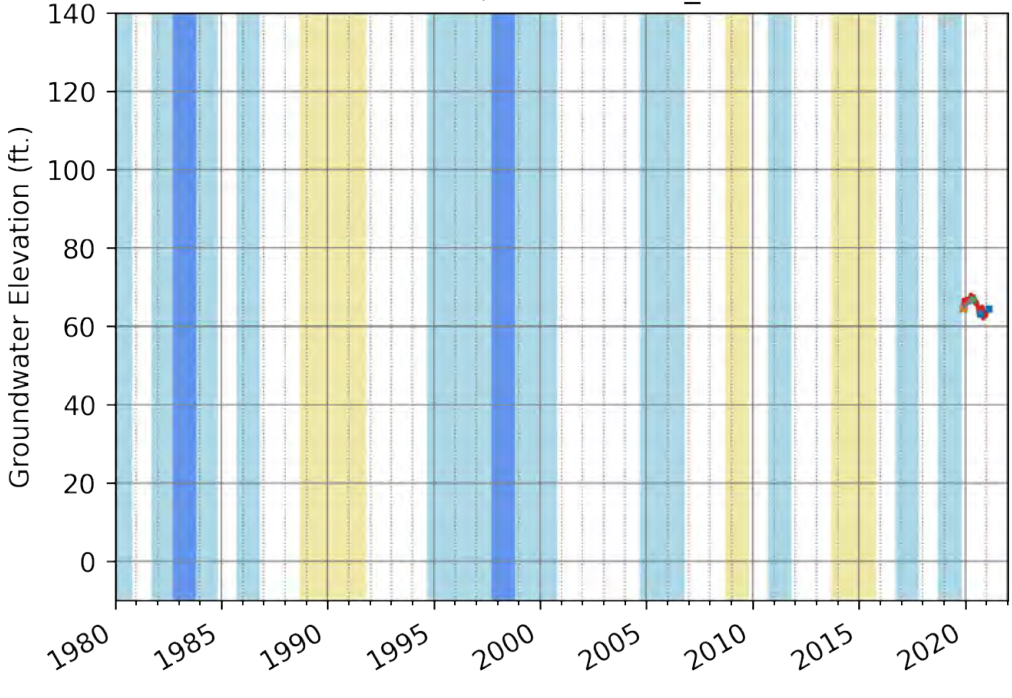
SRP0711, SRP-F16-01_Llano
Groundwater Elevation (ft.)
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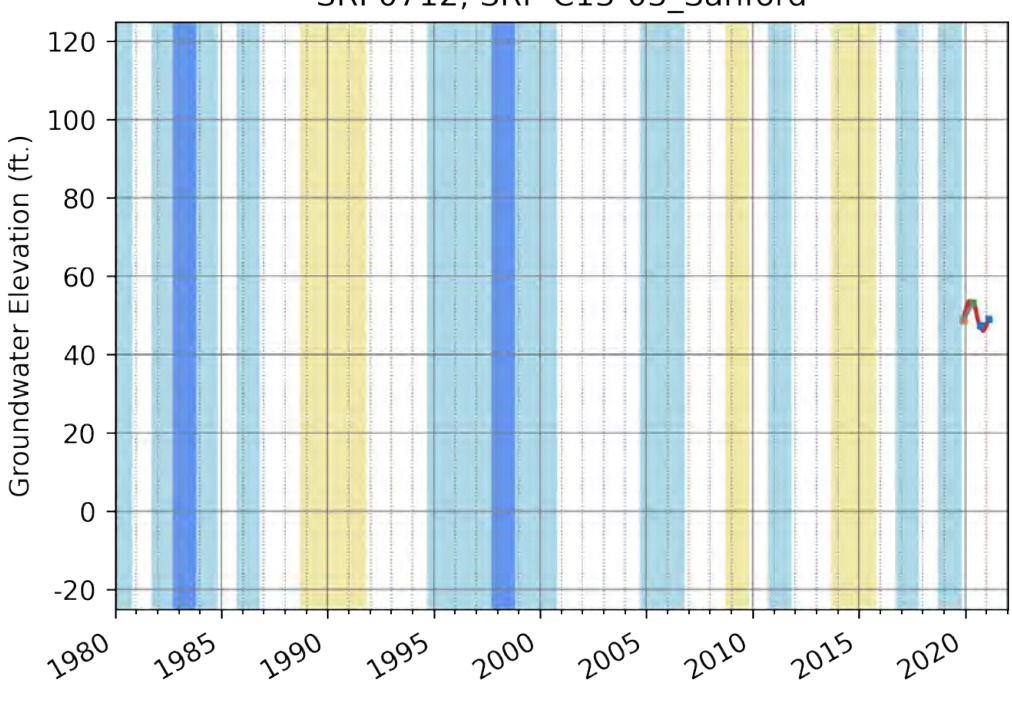
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0712, SRP-C13-03_Sanford
Groundwater Elevation (ft.)
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100
80
60
40
20
0
-20
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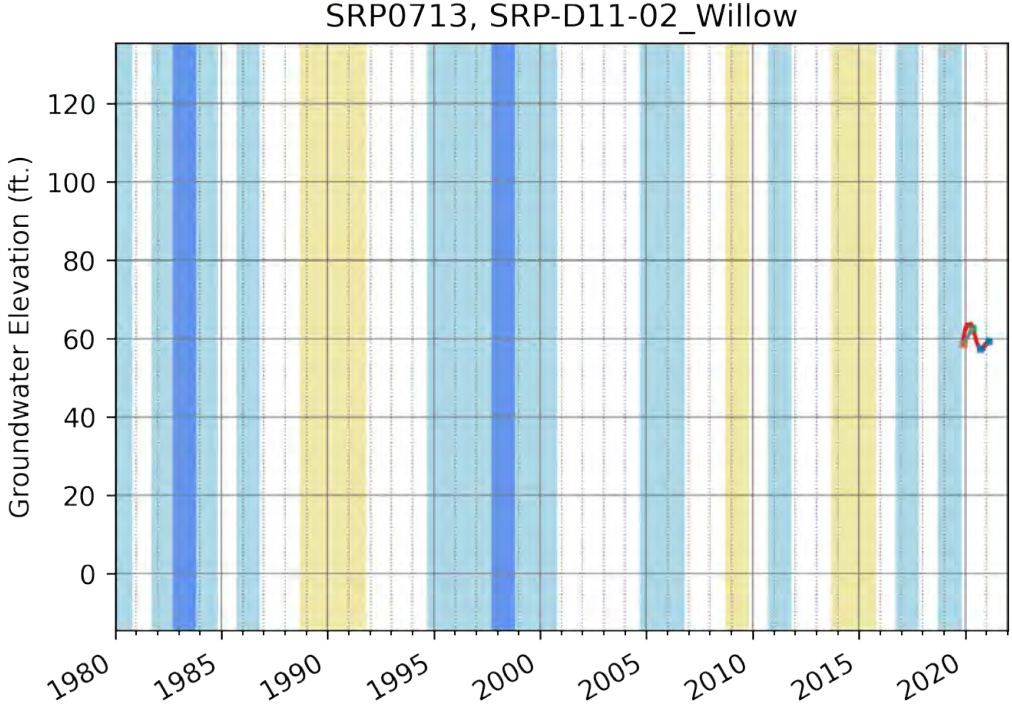
1985
1990
1995
2000
2005
2010
2015
2020


SRP0713, SRP-D11-02_Willow
Groundwater Elevation (ft.)
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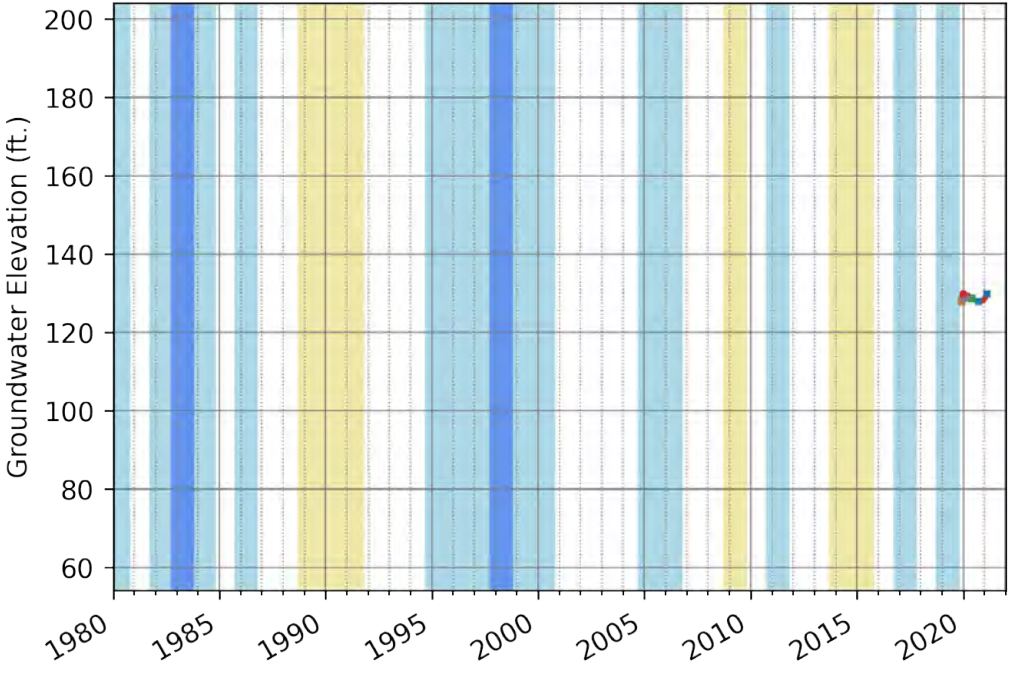
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0714, SRP-H12-01_Pierson
Groundwater Elevation (ft.)
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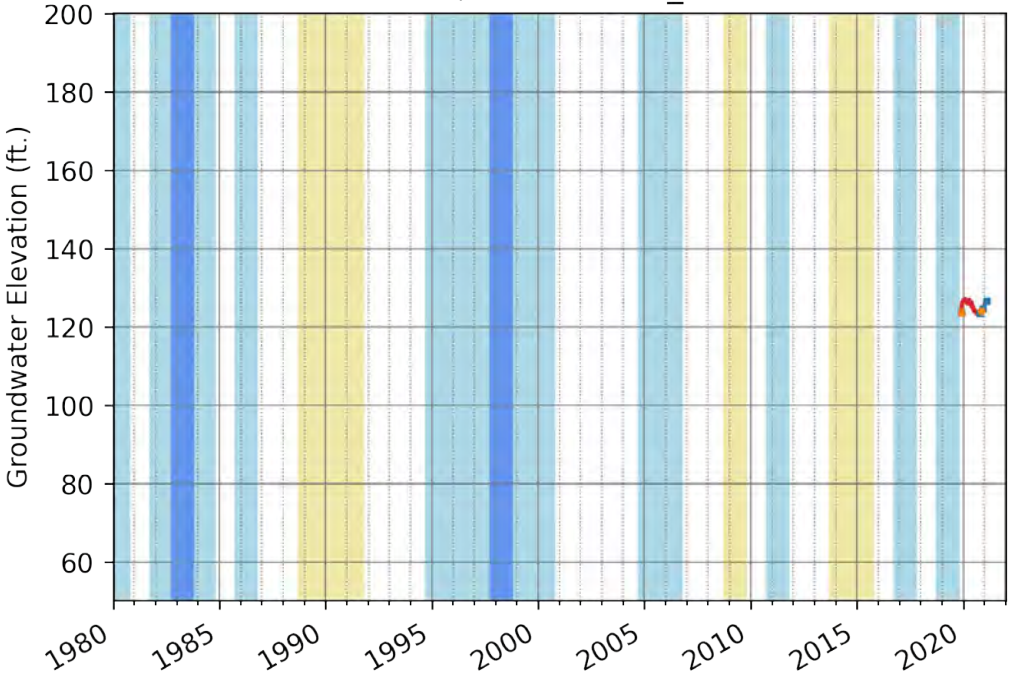
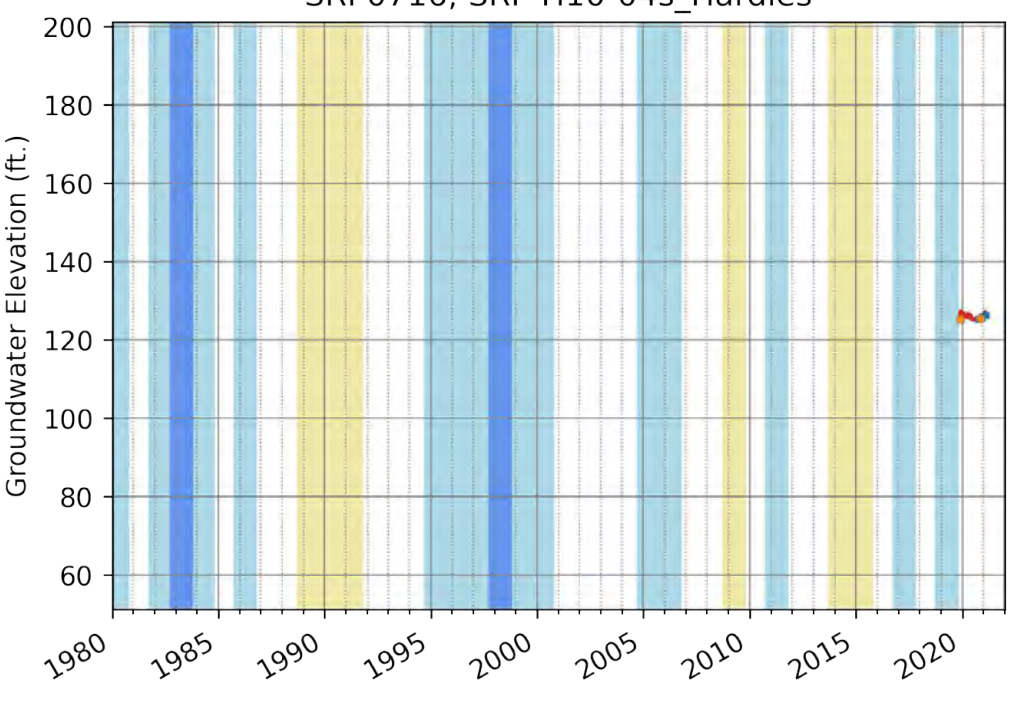
180
160
140
120
100
80
60
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0715, SRP-H10-04_Hardies
Groundwater Elevation (ft.)
200
180
160
140
120
100
80
60
1980
1985
1990
1995
2000
2005
2010
2015
2020


SRP0716, SRP-H10-04s_Hardies
Groundwater Elevation (ft.)
200
180
160
140
120
100
80
60
1980
1985
1990
1995
2000
2005
2010
2015
2020

.

Appendix 3-C
Santa Rosa Plain Hydrologic Model (SRPHM) Updates

Figures

Figure 1. Santa Rosa Plain Hydrologic Model (SRPHM) Area (modified from USGS, 2013) 5
Figure 2. SRPHM conceptual model of interactions between Ag Package, PRMS, and MODFLOW 6
Figure 3. Domestic groundwater users in the SRPHM 8
Figure 4. Rural domestic pumping in the Santa Rosa Plain Hydrologic Model for the entire model area. SRPHM 1.0+ refers to this update and SRPHM1.0 is the original USGS model. 10
Figure 5. Pastures in the Santa Rosa Plain: Normalized Difference Vegetation Index 13
Figure 6. Pastures in the Santa Rosa Plain: DWR Pastures and Water Source 14
Figure 7. Total Crop Area for the Entire SRPHM Area. Orange stars at base of graph indicate years where land use data was available to create crop input dataset. Years without recorded data were assigned by the nearest year with available data. 15
Figure 8. Active Crop Area withn the Santa Rosa Plain Subbasin. Orange stars at base of graph indicate years where land use data was available to create crop input dataset. Years without recorded data were assigned by the nearest year with available data. 16
Figure 9. Ag package Crop, 2012 17
Figure 10. Monthly Crop Coefficients 18
Figure 11. Monthly irrigation schedules 19
Figure 12. Simulated groundwater pumpage by crop for the Subbasin 21
Figure 13. Model Results: Average monthly irrigation depth per crop 22
Figure 14. Total Monthly Pumpage by Munipical and Industrial water service providers for the Santa Rosa Plain Subbasin with Top 10 Users labeled 23
Figure 15. Updated Climate Inputs for the SRPHM v1.0+ 25
Figure 16. Water Year 2015 Precipitation for the SRPHM 1.0+ 26
Figure 17. Water Year 2016 Precipitation for the SRPHM 1.0+ 27
Figure 18. Water Year 2017 Precipitation for the SRPHM 1.0+ 28
Figure 19. Water Year 2018 Precipitation for the SRPHM 1.0+ 29
Figure 20. Groundwater level hydrograph simulated by SRPHM 1.0 and SRPHM 1.0+, and observed waterlevels for SRP0357, Representative Monitoring Point 31
Figure 21. Groundwater level hydrograph simulated by SRPHM 1.0 and SRPHM 1.0+, and observed waterlevels for SRP0359, Representative Monitoring Point 32
Figure 22. Groundwater level hydrograph simulated by SRPHM 1.0 and SRPHM 1.0+, and observed waterlevels for SRP0117, Representative Monitoring Point 33
Figure 23. Groundwater level hydrograph simulated by SRPHM 1.0 and SRPHM 1.0+, and observed waterlevels for State Well ID 07N08W35K1 , Key Well 34
Figure 24. Observed versus simulated groundwater levels for the SRPHM 1.0 and SRPHM 1.0+ 35
Figure 25. SRPHM 1.0+ Mean Waterlevel Residuals, 1974 to 2018 37
Figure 26. Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Brush Creek at Santa Rosa 41
Figure 27. Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Colgan Creek near Santa Rosa 42

Figure 28. Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Colgan Creek near Sebastopol43
Figure 29. Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Copeland Creek at Rohnert Park 44
Figure 30. Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Laguna de Santa Rosa at Stony Point Road Near Cotati 45
Figure 31. Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Laguna de Santa Rosa Creek Near Sebastopol 46
Figure 32. Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Mark West Creek Near Mirabel Heights 47
Figure 33. Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Mark West Creek Near Windsor 48
Figure 34. Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Mayacamas Creek at Santa Rosa 49
Figure 35. Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Santa Rosa Creek at Willowside Road Near Santa Rosa 50

Tables

Table 1. Number of Domestic Wells Inside and Outside Subbasin, and by Domestic Use-Type 9
Table 2. Comparison of Acres of Crops in the DWR 2012 Land Use dataset and the VEGMAP dataset. These are not the same values used in the AG package as some crops were removed depending on irrigation source or non-irrigation. Only crops with comparable classifications are shown. 11
Table 3. Number of Acres per Crop for the Entire SRPHM Area. These values were determined from the land use datasets and were used to assign intervening years not listed. 15
Table 4. Number of Acres per Crop for the Subbasin. These values were determined from the land use datasets and were used to assign intervening years not listed. 16
Table 5. Changes to PRMS parameters in SRPHM 1.0+ 20
Table 6. Groundwater pumpage per crop for the Subbasin from Water 2012 to 2018 21
Table 7. Average simulated irrigation depth by crop, pre-recycled water deliveries from 1975 to 1990 22
Table 8. CIMIS Climate Stations in SRPHM 25

1. Introduction

The Groundwater Sustainability Plan (GSP) development includes the use of a groundwater flow model to compute a basin wide groundwater and surface water budget, to support sustainable management criteria (SMC) development, and to assess the effects of proposed projects and management actions on overall basin sustainability.
The U.S. Geological Survey (USGS) has developed an integrated surface water/groundwater flow model that encompasses the Santa Rosa Plain watershed and the groundwater basin. The Santa Rosa Plain Hydrologic Model (SRPHM) was released in 2014 and included a simulation period from 1975 through 2010. The USGS performed further revisions to the model in 2019 that were provided to the GSP model team. These revisions included a temporal update through 2015 and modification of input file structure (SRPHM 1.0). Further revisions to the model made by the GSP model team are documented herein as version SRPHM 1.0+. These revisions include:

- further temporal extension of the model through December, 2018;
- changes to agricultural pumping estimates;
- changes to rural domestic pumping estimates;
- updates to public water supply well pumping
- revisions to the representation of climate and recycled water; and
- incorporation of septic return flows

1.1 General Description of Model

The SRPHM is an integrated groundwater-surface water hydrologic and watershed model of the Santa Rosa Plain Watershed (262 square miles), inclusive of the entire Santa Rosa Plain[1] and Rincon Valley groundwater subbasins, and portions of the Kenwood Valley, Wilson Grove Formations Highlands, Healdsburg area, and Alexander area groundwater subbasins. The watershed, groundwater basin, and model domain boundary are show in Figure 1. SRPHM was developed using the USGS groundwater and surface water model, GSFLOW (McLaughlin et al., 2008), which consists of two integrated model components: (1) a watershed hydrology model based on the Precipitation Runoff Modeling System (PRMS) (Leavesly et al, 1983, 2005) and (2) a groundwater-surface water model developed using MODFLOW-NWT (MF-NWT) (Niswonger et al., 2011). Additionally, a decoupled soil-moisture balance model, the Crop Water Demand Model (CWDM), was used with the original USGS model to estimate crop irrigation pumping demands; this has been replaced with the recently developed Ag Package (Niswonger, 2020), as further described in Section 1.2.2 below. Figure 2 shows a schematic representation of the interaction between the different model components for the current updated version of the model (SRPHM 1.0+). For a detailed description of the conceptualization, parameterization, calibration and development of the original USGS model, the reader is referred to USGS Scientific Investigation Report 2014-5052 (Wolfenden and Nishikawa, 2014).

[1] Two slivers of the recently modified (expanded) DWR Bulletin 118 Santa Rosa Plain basin boundary are not covered by the model domain (154 acres near Sebastopol and 113 acres south of Healdsburg). Combined, these excluded slivers make up only 0.3% of the total Subbasin area of 81,284 acres.

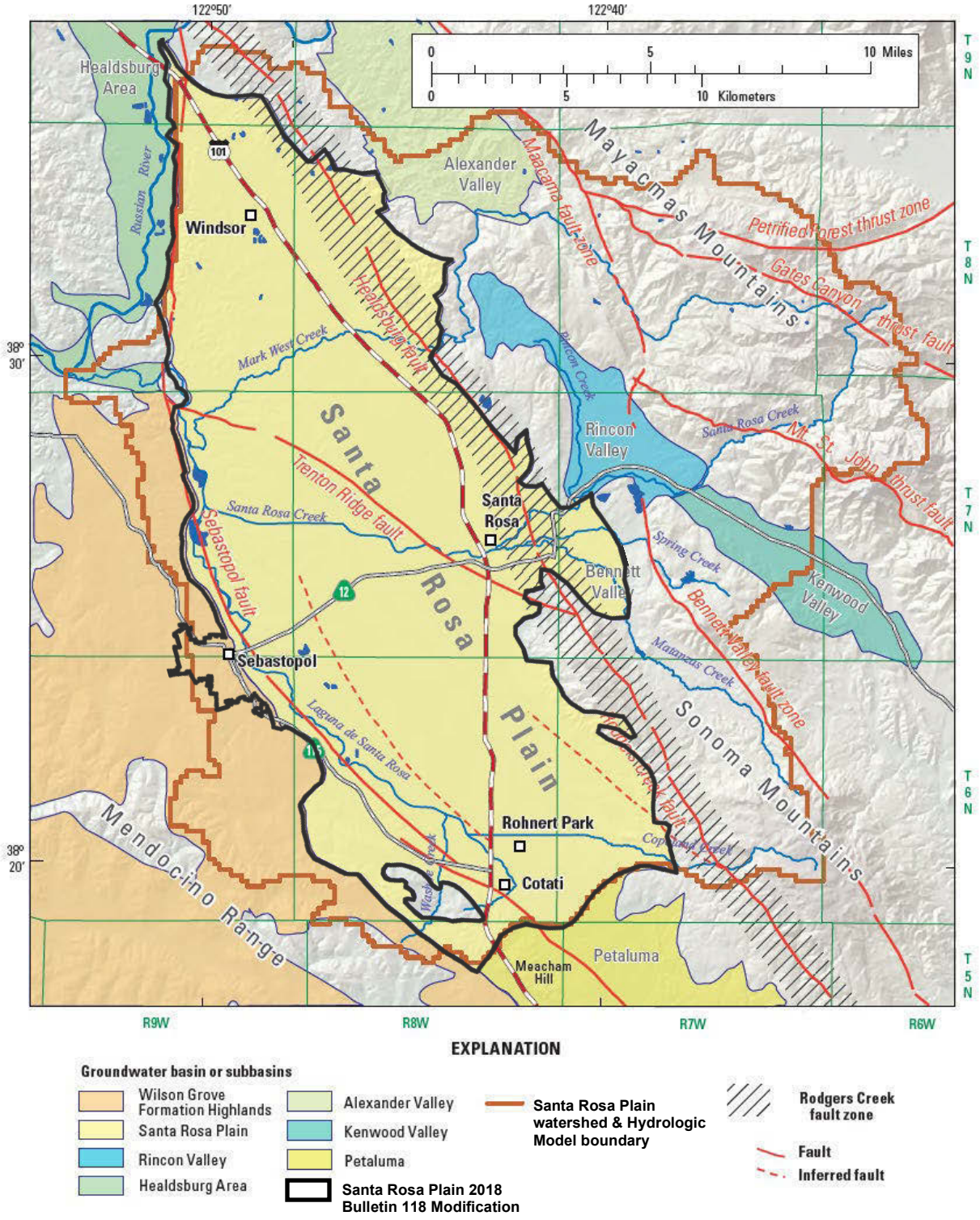


Figure 1. Santa Rosa Plain Hydrologic Model (SRPHM) Area (modified from USGS, 2013)

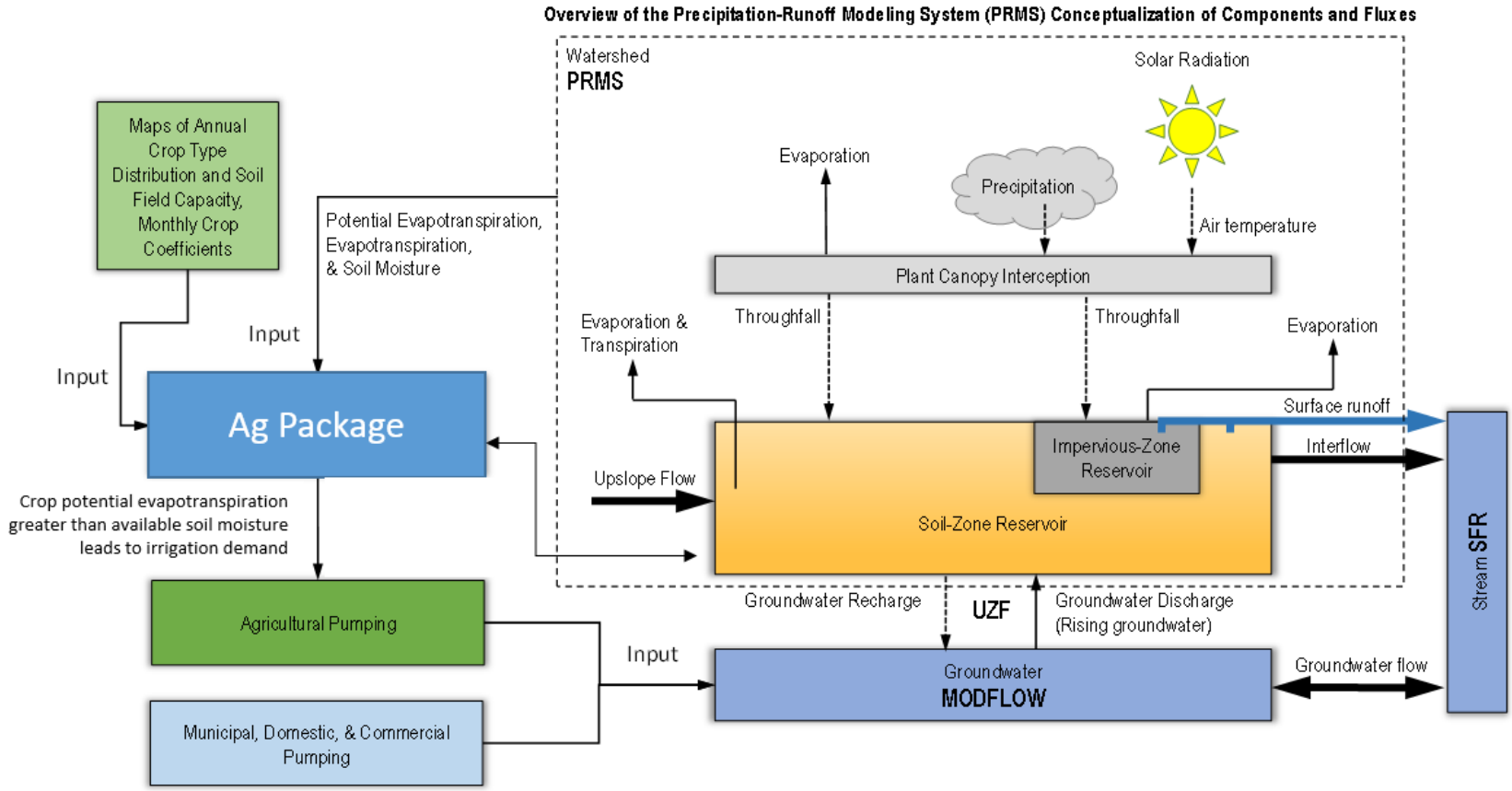


Figure 2. SRPHM conceptual model of interactions between Ag Package, PRMS, and MODFLOW

1.2 Rural Pumping Updates

The groundwater demand for rural pumping (rural pumpage) consists of the combined total of pumping to meet rural residential supply and unmet agricultural irrigation demand. As neither rural residential or agricultural pumping are commonly measured or reported, the USGS estimated these groundwater demands on the basis of estimates of rural population density and an average per-capita water usage, and by using the CWDM soil moisture balance model to estimate crop-specific irrigation demand.

1.2.1 Rural Residential Water Demand

1.2.1.1 Original USGS approach

The model assumed that rural residents outside the city limits of Santa Rosa, Rohnert Park, Cotati, Sebastopol, California American Water Company, and Town of Windsor rely entirely on groundwater. Census tract polygons and population density data were used to estimate the areas and population not serviced by public supply wells. By definition, the census tracts report a single population number which results in an assumption of homogeneous spatial population density within each tract. This caused an overestimate of the population density at the interface of the urban and rural areas within a census tract, which would result in an overestimation of pumping. An annual water demand of 0.19 acre-feet per capita per year (170 gallons per capita per day, gpcd) was assumed. The source of this value was referenced as being based on data from the 1994 California Water Plan Update (DWR, 1994).

1.2.1.2 Updated approach

Rural residential parcels identified in the Rate Study were used to locate parcels in the Santa Rosa Plain utilizing groundwater for domestic purposes (Raftelis, 2019). These include some parcels within city limits identified by their respective water service providers. The Sonoma County parcel database was filtered to locate rural residential parcels outside of the groundwater basin but within the groundwater model domain. The locations of parcels incorporated into the model are shown in Figure 3, as well as the indoor and outdoor water use by parcel. A total of 11,943 parcels are included within the entire model domain and 7,482 parcels are within the Subbasin, of which 1,282 wells are urban users in the Subbasin (Table 1). The 2019 Rate Study (Raftelis, 2019) cited a lower number of total residential groundwater users of 6,627 parcels. The discrepancy appears to be due to the Rate Study database being updated following the publication of the report to account for urban well users.

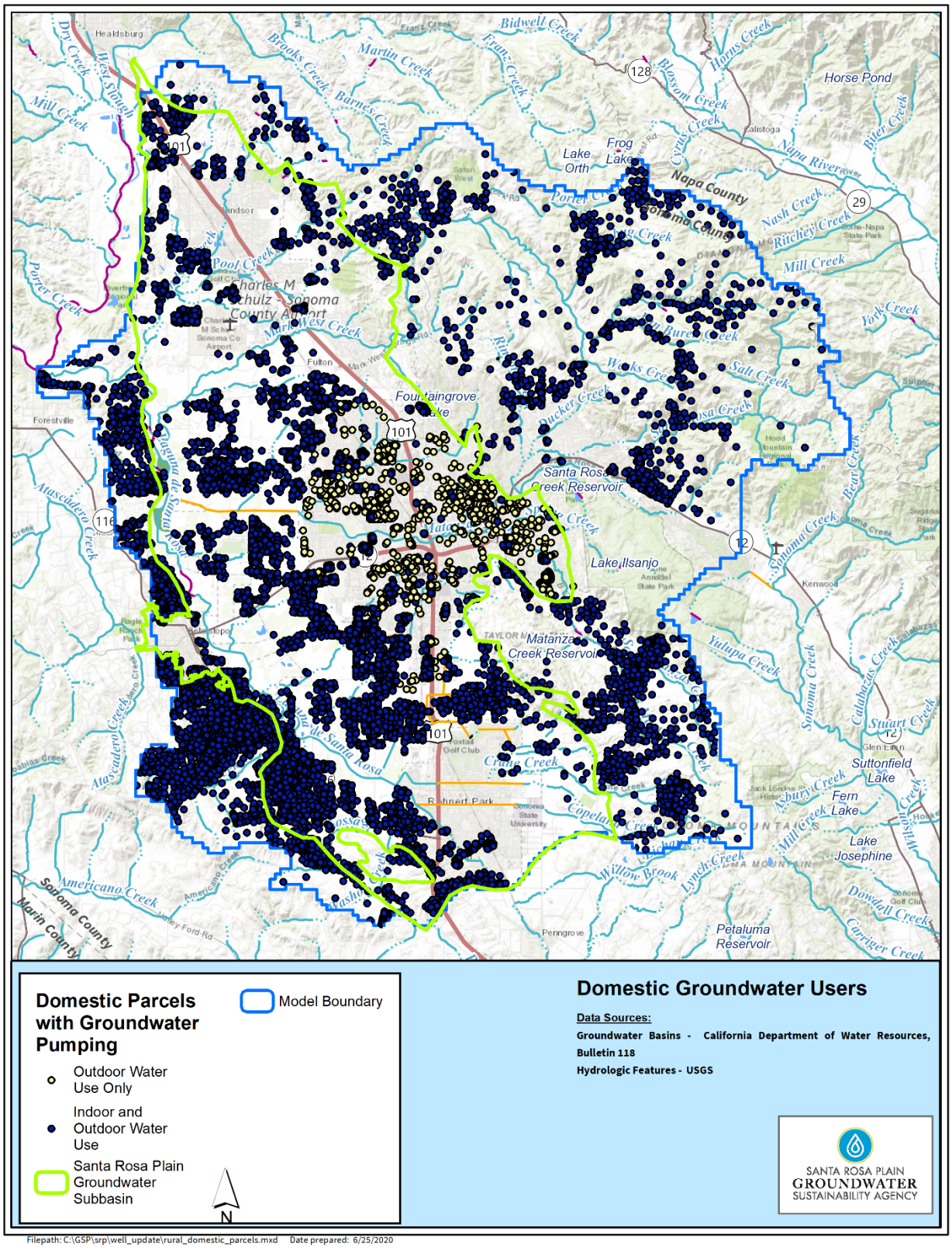


Figure 3 Domestic groundwater users in the SRPHM

The yearly groundwater usage applied to each parcel was determined by the size of the parcel and the parcel type. The groundwater demand was estimated by:

$$Q_{parcel} = Q_{indoor} + \%\ Irrigated \times I_d \times P_{av(i)}$$

% Irrigated = 2.80%

I_d = 2.9 ft/year; Turf Irrigation Depth

$P_{av(i)}$= Parcel area (acres)

Q_{indoor} (In home use) = 0.24 AF/year

Parcel zoning use codes were used to determine if a parcel uses groundwater for indoor and outdoor, indoor only, or outdoor only. Parcels with outdoor and indoor uses are typically common residences, whereas indoor only parcels are those with a mixed residential and agricultural zoning use code description. The assumption is that the agricultural demands will be satisfied by Ag Package (see below) for that parcel. Parcels with outdoor only use were identified in the rate study and the information was provided by the water service providers. These parcels are assumed to only use groundwater pumping for outdoor use only.

Table 1 Number of Domestic Wells Inside and Outside Subbasin, and by Domestic Use-Type

Demand Type	Inside Subbasin	Outside Subbasin	Total
Outdoor and Indoor	6,185	4,102	10,287
Indoor Only	15	353	368
Outdoor Only	1,282	6	1,288
Total	7,482	4,461	11,943

The start of pumping for a given parcel was determined from the year that the parcel database indicated the parcel was developed. The updated timeseries of rural domestic groundwater pumping applied in the entire model domain is shown in Figure 4. As indicated by Figure 4, the rural domestic pumping incorporated into the revised SRPHM 1.0+ is several times lower than estimates from the original SRPHM and reflect a smoother transition over time. The smoother transition is due to the use of the development dates from the parcel database rather than the use of periodic census surveys, which cause the more abrupt changes in the original SRPHM. The lower overall estimates of rural domestic pumping are also more consistent with estimates from the Rate Study. For the Subbasin, total pumping by rural domestic users totaled 3,664 acre-feet per year in the Rate Study whereas the total estimate derived by SRPHM 1.0+ is 2,900 acre-feet per year. The difference is due to the use of separate indoor and outdoor water use in the SRPHM 1.0+, which required independent water-use estimates. The Rate Study identified a group of estimates and chose a central representative value of 0.5 acre-feet per year per parcel,

whereas, the average per parcel water use calculated by SRPHM 1.0+, excluding urban water users, is 0.42 acre-feet per year. The Rate Study also accounted for secondary units on domestic parcels which were not accounted for in the SRPHM 1.0+.

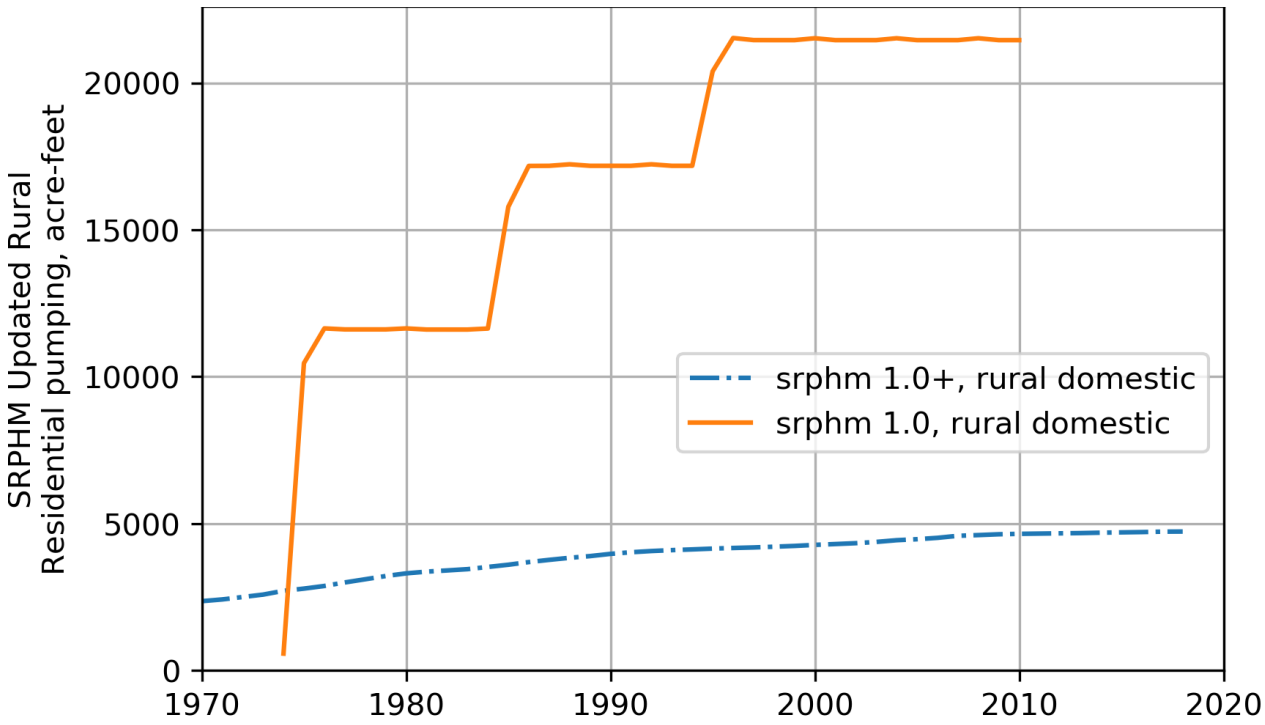


Figure 4 Rural domestic pumping in the Santa Rosa Plain Hydrologic Model for the entire model area. SRPHM 1.0+ refers to this update and SRPHM1.0 is the original USGS model.

Parcels are aggregated spatially by model cell for every stress period. The layers from which the parcels pump groundwater is determined from the reported domestic well depths. The reported well depths are provided by DWR's Well Completion Report Map which describes the number, maximum, minimum and average depths for wells by township, range, and section. The layer assigned to a given parcel was selected based on the minimum, maximum and mean defined in the DWR dataset for that well's township, range and section

1.2.2 Agricultural Irrigation Pumping

1.2.2.1 Original USGS approach

There is no comprehensive metering on agricultural pumping in the Subbasin, and therefore, agricultural groundwater pumping demands must be estimated through other means. Agricultural irrigation demand was estimated by the USGS for Water Year 1975-2015 using the daily Crop Water Demand Model (CWDM) in conjunction with the calibrated watershed model used in PRMS-only mode. The CWDM is decoupled from the calibrated watershed model. This means the CWDM uses information from the calibrated watershed model to calculate irrigation

demand and simulate pumping in the SRHM but does not apply the water to the watershed in the SRHM.

1.2.2.2 Updated approach

Due to limitations of the CWDM, a new but conceptually similar approach was taken in the model update to estimate agricultural pumping. The Ag Package is coupled with GSFLOW and dynamically computes crop water demand and irrigation pumping and irrigation return flows. Irrigation demands are calculated as the potential evapotranspiration that remains after evaporation and transpiration utilize all available water in the soil zone (Niswonger, 2020). The Ag Package performs this calculation through PRMS and, therefore, processes such as Hortonian overland flow, Dunnian runoff, and a suite of other soil moisture processes are incorporated into the calculation of applied irrigation. Recycled water is indirectly incorporated through the external link file that acts to apply the recycled water directly into the soil zone. This water should act to limit groundwater pumping where it is applied by satisfying the potential evapotranspiration before irrigation is required.

1.2.2.3 Land Use Processing and Ag Package Inputs

Many of the original USGS model input files used to run the CWDM were used as inputs for the Ag Package. The datasets included the crop land use datasets for 1974, 1986, 1999 and 2008. Newly available land use datasets from DWR for 2012, 2014 and 2016 were used to update the agricultural land use to 2018. The Sonoma County Vegmap dataset was assessed for use in the crop updates; however, because its land use classifications are inconsistent with DWR's, the DWR datasets were chosen. As seen in Table 2, the total acreage of vineyards mapped by the VEGMAP is only 100 acres (1%) greater than that mapped in the DWR 2012 land use dataset. Pastures and grains show the greatest variance between the two datasets, though this is potentially because of the classifications used in VEGMAP are different than the DWR classifications. The DWR 2012 land use dataset contains an array of information on crop type, water source, irrigation types, and other information, whereas the 2014 and 2016 datasets only map the crop type identified through aerial imagery. The crop types used in the original CWDM model were retained in SRPHM 1.0+, and include: Field Crop, Grains, Orchard, Pasture, Truck Crop, Turf Grass, and Vineyard. The land use type that makes up the majority area of a cell is assigned to those model cells and only cells in the above list are included in the Ag Package. A majority of model cells are not simulated by the Ag Package because they do not have active crops. Additionally, crops indicated as non-irrigated were not included in the Ag Package inputs.

Table 2 Comparison of Acres of Crops in the DWR 2012 Land Use dataset and the VEGMAP dataset. These are not the same values used in the AG package as some crops were removed depending on irrigation source or non-irrigation. Only crops with comparable classifications are shown.

Crop Type	DWR 2012	VEGMAP 2014
Field Crop	490	810
Grains	3350	1830
Orchard	260	220
Pasture	3420	2360
Vineyard	9960	10060

Pastures are prevalent within the Subbasin and can can be a water intensive crop. In the 2019 Rate Study (Raftelis, 2019) it was assumed that pastures in the subbasin were not irrigated, whereas the 2012 DWR land use map by DWR indicates an irrigated land use for pasture areas. In order to assess whether pastures are irrigated, we mapped irrigated pastures identified in DWR's land use dataset with the remote sensing-based normalized difference vegetation index (NDVI). NDVI is a common tool to assess vegetation health (Anderson et al, 2012), with values ranging from -1 to 1. Greater NDVI values indicate the increasing presence of chlorophyll content in plant matter, and thus a healthier non-stressed crop which is interpreted to be an indicator of irrigated agriculture. Figure 5 shows the irrigated pasture locations from DWR 2012 as input into the groundwater model with the 2012 Fall NDVI average values. The pastures identified in the model occur in areas with high NDVI values indicating vigorous growth late in the season, and therefore a high likelihood that these pastures are irrigated.

The DWR 2012 land use datasets are based off field-level reconnaissance mapping and aerial photo interpretation and are regarded as high-quality data. The DWR 2012 land use map indicates the source of irrigation for all fields, including pastures. It is assumed that if groundwater is the listed source of water for a pasture, then that field would be included as a pasture. Data from the recycled water providers indicates that many of the pastures that have groundwater as their irrigation source (as determined by DWR (2012)) also receive recycled water. For water year 2012, 74% of the simulated pasture model cells in the subbasin received recycled water. Pastures were not included in the simulation where sworn affidavits attesting to no groundwater use exist. There are 28 such parcels with sworn affidavits. The locations of simulated pastures, simulated pastures that receive recycled water, water source, and parcels with affidavits are show in Figure 6. For those model cells that receive it, recycled water is applied to the soil zone by PRMS, and if there is unmet evapotranspiration for that cell, then groundwater is pumped and applied to the soil zone.

The land use derived crop datasets for 1974, 1986, 1999, 2008, 2012, and 2018 were used to define the crops for the model simulation from 1974 to 2018. For every AG Package model cell, the crop type for a given year was defined by the crop map nearest in time for that cell. For example, to define the crops for 1995, the crop map from 1999 was used, whereas the crop map from 1986 was used for the model simulation year of 1990. Figure 7 and Table 3 show the area simulated by the AG Package within the entire model domain, and Figure 8 and Table 4 shows the crops within the Subbasin only. The pasture land use crop inputs derived from the

2012 dataset were applied for the 1986 to 2018 period because of the reliance on data only available within the 2012 dataset. Figure 9 depicts the spatial distribution of crops for calendar Year 2012.

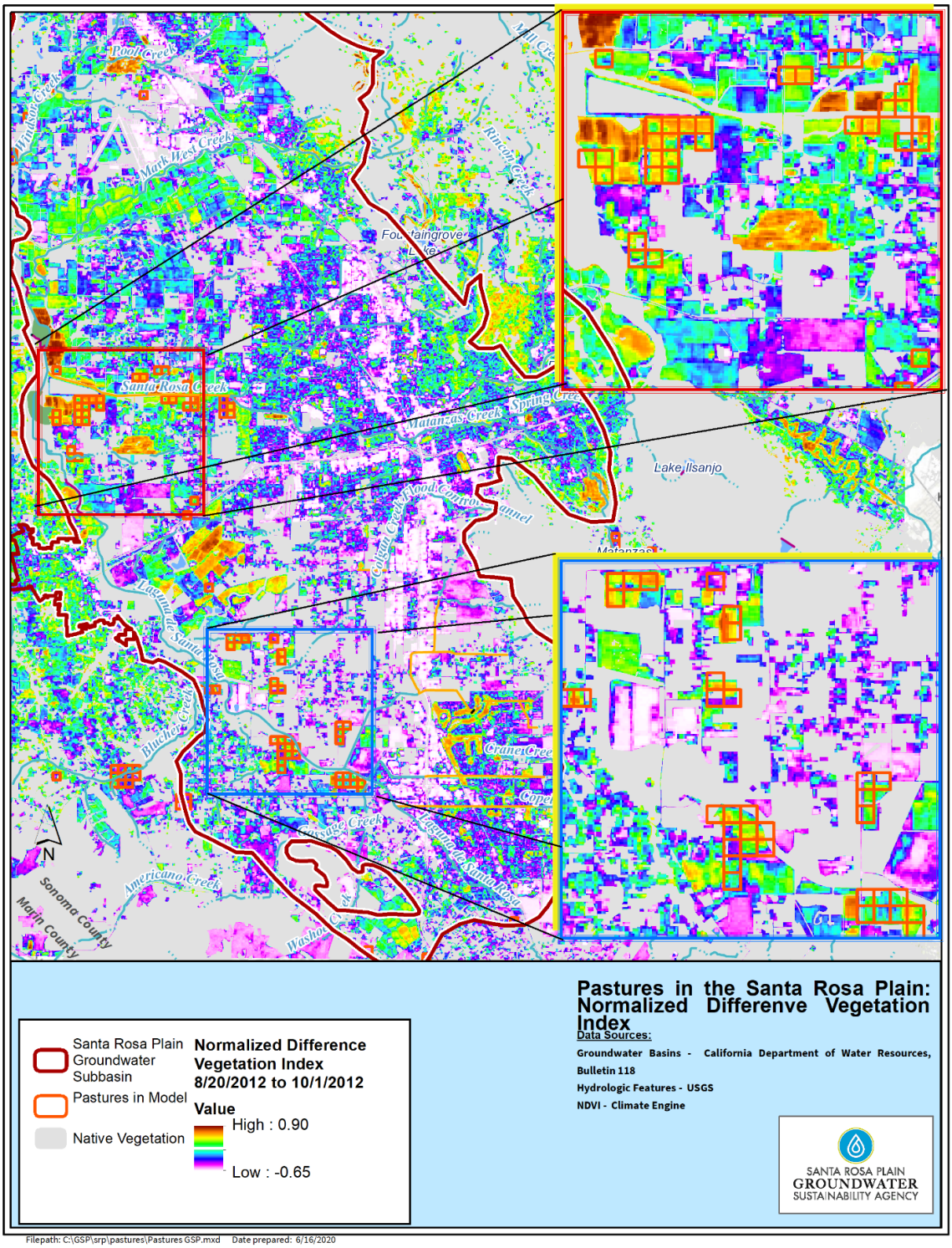


Figure 5 Pastures in the Santa Rosa Plain: Normalized Difference Vegetation Index

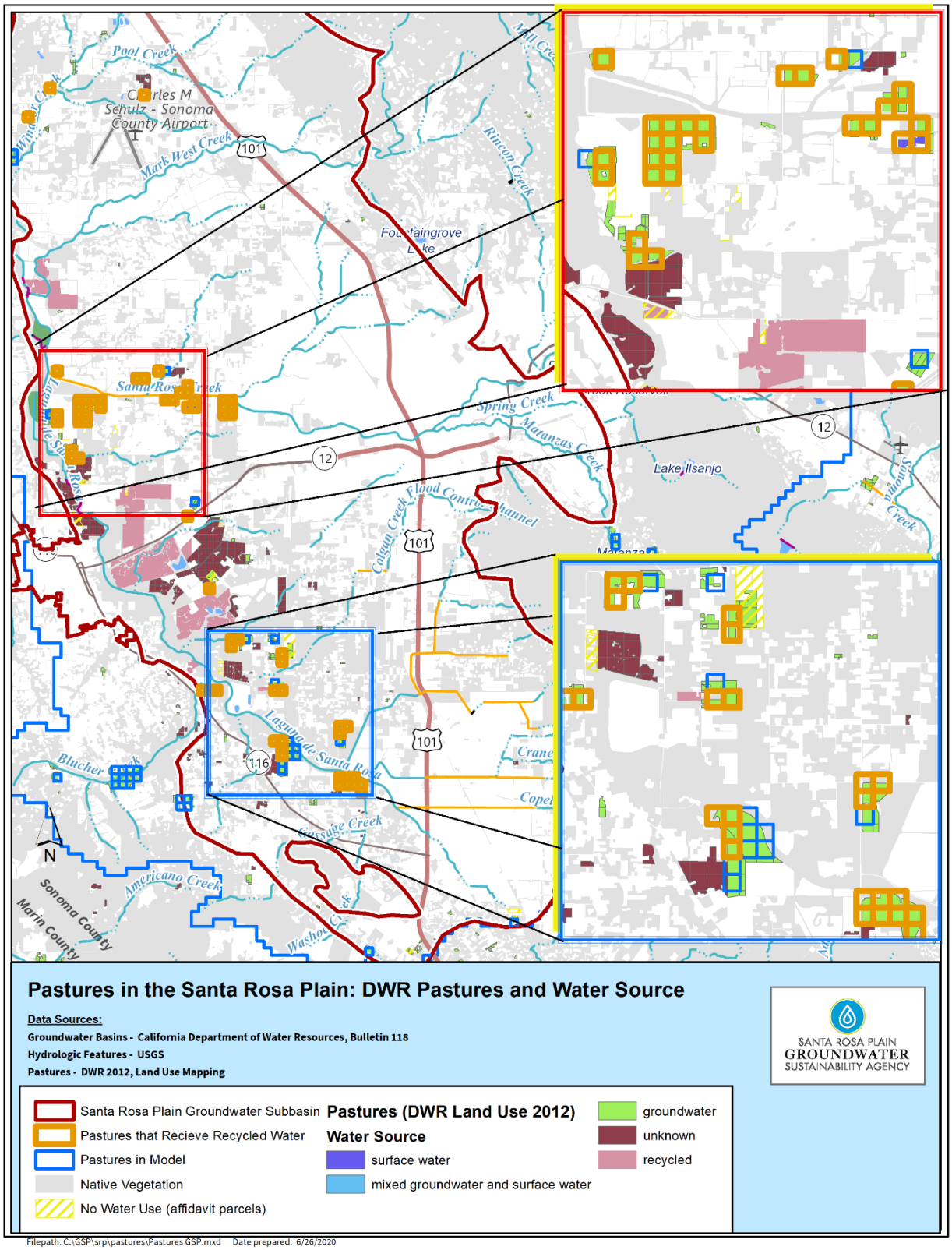


Figure 6 Pastures in the Santa Rosa Plain: DWR Pastures and Water Source

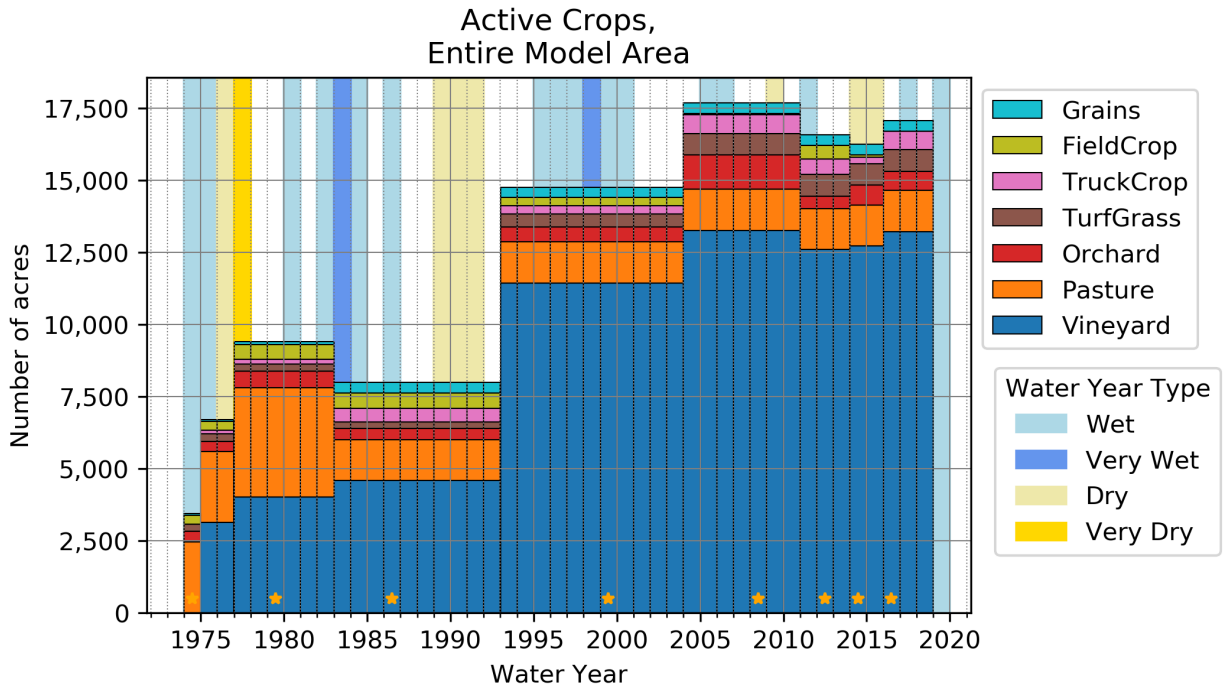


Figure 7 Total Crop Area for the Entire SRPHM Area. Orange stars at base of graph indicate years where land use data was available to create crop input dataset. Years without recorded data were assigned by the nearest year with available data.

Table 3 Number of Acres per Crop for the Entire SRPHM Area. These values were determined from the land use datasets and were used to assign intervening years not listed.

Year	Field Crop	Grains	Orchard	Pasture	Truck Crop	Turf Grass	Vineyard
1974	310	60	350	2,470	120	260	3,130
1979	520	100	560	3,790	160	260	4,020
1986	550	360	390	1,420	460	220	4,590
1999	280	360	510	1,420	290	450	11,440
2008	50	360	1,190	1,420	640	750	13,260
2012	480	360	440	1,420	530	750	12,590
2014	80	360	680	1,420	230	750	12,720
2016	10	360	670	1,420	630	750	13,220

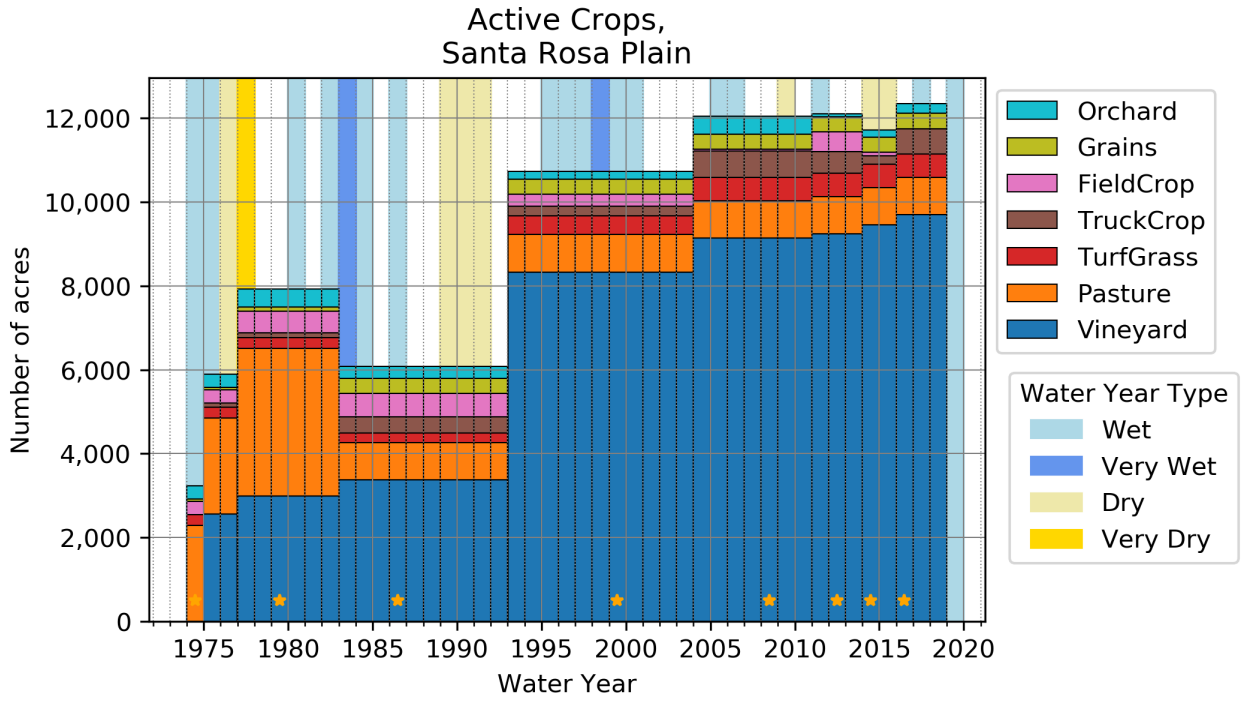


Figure 8 Active Crop Area within the Santa Rosa Plain Subbasin. Orange stars at base of graph indicate years where land use data was available to create crop input dataset. Years without recorded data were assigned by the nearest year with available data.

Table 4 Number of Acres per Crop for the Subbasin. These values were determined from the land use datasets and were used to assign intervening years not listed.

Year	Field Crop	Grains	Orchard	Pasture	Truck Crop	Turf Grass	Vineyard
1974	310	60	320	2,290	100	260	2,560
1979	510	100	430	3,520	110	260	2,990
1986	550	360	290	890	390	220	3,380
1999	280	360	190	890	230	450	8,330
2008	50	360	420	890	620	560	9,140
2012	470	360	70	890	510	560	9,240
2014	80	360	180	890	200	560	9,450
2016	10	360	230	890	590	560	9,700

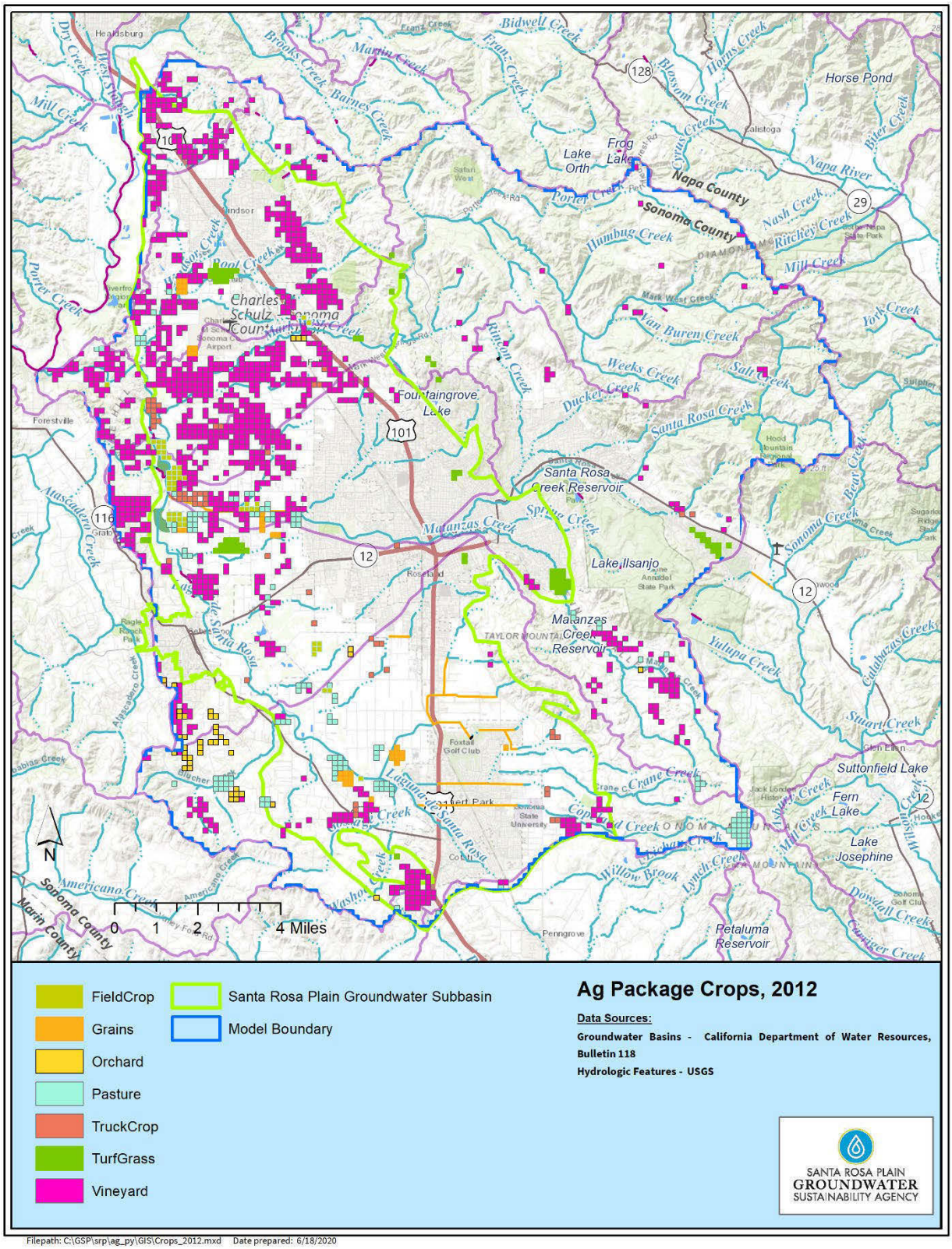


Figure 9 Ag package Crop, 2012

Crop coefficients are used to simulate the variation in crop evapotranspiration demands as a function of potential evapotranspiration. Potential evapotranspiration is calculated by PRMS using the Jensen-Haise formulation. Crop specific crop coefficients and monthly crop-irrigation schedules are shown in Figure 10 and Figure 11. The crop coefficients for vineyards are based on values derived for the Russian River region (Davids Engineering, 2013). The other crop coefficients are from Allen et al (1998), Gibeault et al (1989), Snyder et al (1987a, 1987b), and Brush et al (2004).

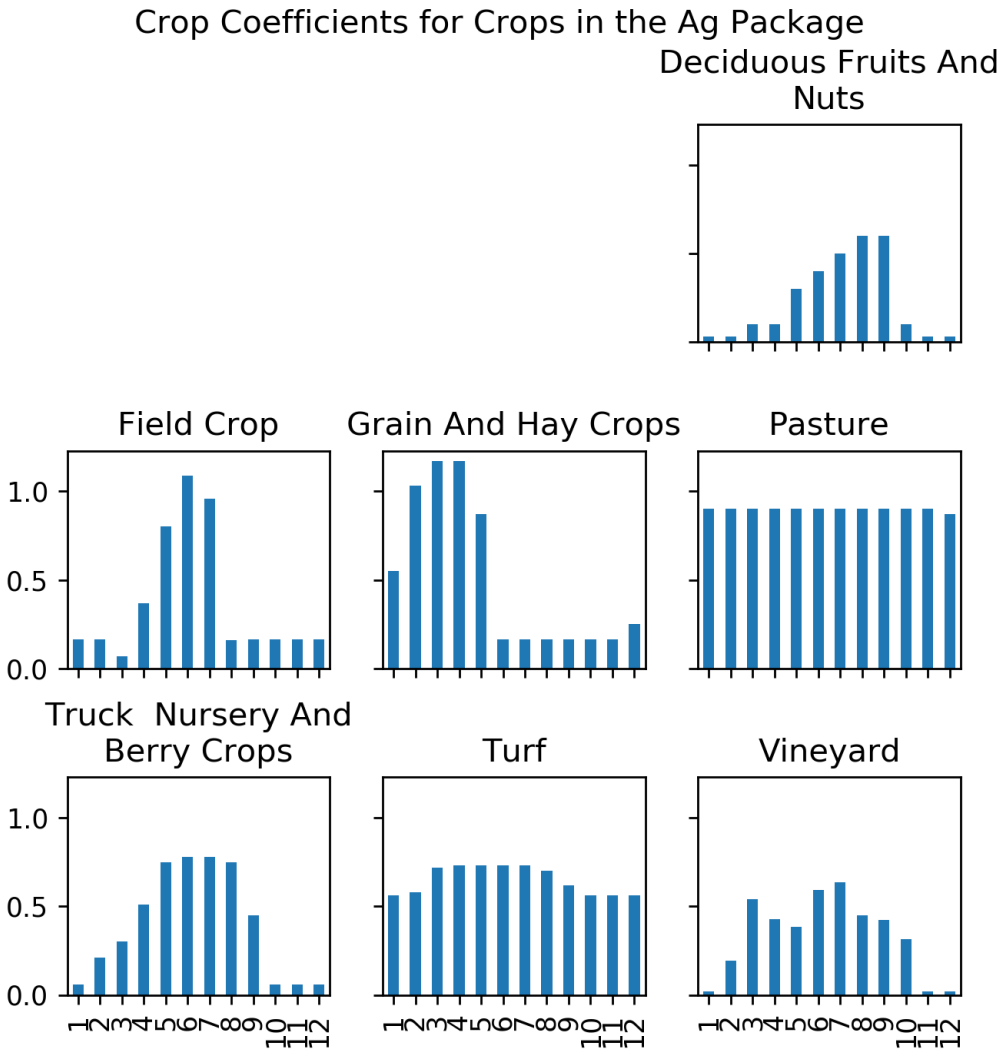


Figure 10 Monthly Crop Coefficients

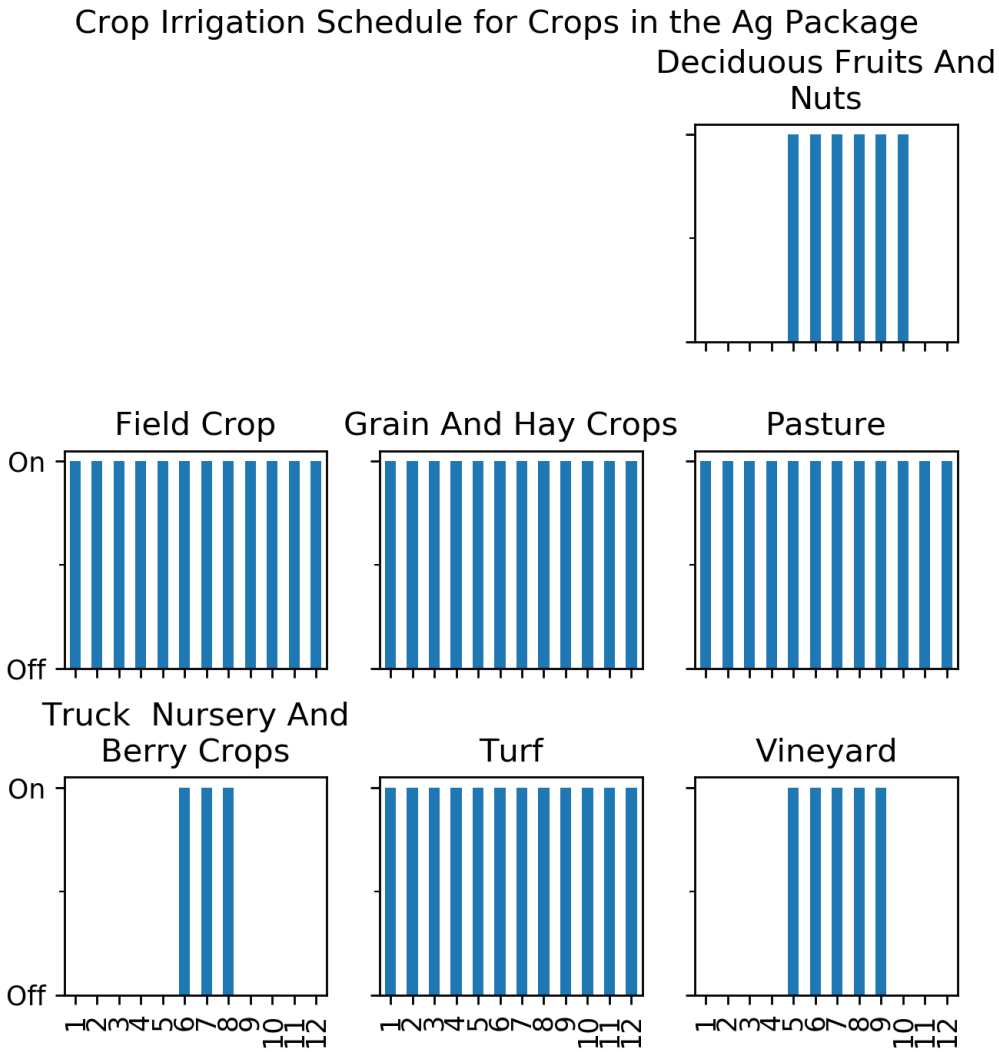


Figure 11 Monthly irrigation schedules

Adjustments were made to the PRMS soil parameters in order to incorporate agricultural practices such as drip irrigation for vineyards. For vineyard cells the impervious area was set to 30% to incorporate bare soils (Table 5), and summer rain interception value (srain_intcp) was set to zero so that no irrigation is intercepted by vegetation in order to simulate drip irrigation. soil2gw_max was also set to zero so that no water directly recharges from soil capillary zone to groundwater in order to simulate high efficiency irrigation for vineyards. All crops were assigned a value of 2 inches for the water holding capacity of the soil zone as defined by soil_moist_max and sat_threshold.

Table 5 Changes to PRMS parameters in SRPHM 1.0+

PRMS Parameter	PRMS Parameter Description	Crop Type	Updated Parameter	Rationale
srain_intcp	Summer rain interception	Vineyard	0%	drip irrigation
imperviousness	Percent of cell causing runoff	Vineyard	30%	estimate of bare soils and area where no ET occurs
soil2gw_max	Maximum amount of gravity reservoir that flows to groundwater	Vineyard	0 inch	used to simulate high efficiency irrigation
soil_moist_max	Maximum available water holding capacity of capillary reservoir	Vineyard	2 inch	calibrated value
sat_threshold	Water holding capacity of the gravity and preferential-flow reservoirs	Vineyard	2 inch	calibrated value
srain_intcp	Summer rain interception	All other Crops Besides Vineyards	Unchanged from original	NA
imperviousness	Percent of cell causing runoff	All other Crops Besides Vineyards	Unchanged from original	NA
soil2gw_max	Maximum amount of gravity reservoir that flows to groundwater	All other Crops Besides Vineyards	Unchanged from original	NA
soil_moist_max	Maximum available water holding capacity of capillary reservoir	All other Crops Besides Vineyards	2 inch	calibrated value
sat_threshold	Water holding capacity of the gravity and preferential-flow reservoirs	All other Crops Besides Vineyards	2 inch	calibrated value

The simulated pumpage per crop for the Santa Rosa Plain Subbasin is shown in Figure 12 and a summary of groundwater pumpage per crop for the period from water year 2012 to 2018 is shown in Table 6. Pastures were the dominant use of irrigation until 1983, after which vineyard irrigation has been the largest total use of groundwater irrigation in the subbasin. The total yearly average irrigation depth in feet per crop is shown in Table 7 and monthly average irrigation depth for all crops is shown in Figure 13. Pastures have the highest irrigation depth per crop and vineyards are the lowest irrigation depth on average. Most irrigation occurs in the summer months, although pastures and turfgrass have simulated irrigation periods that extend into the spring and fall.

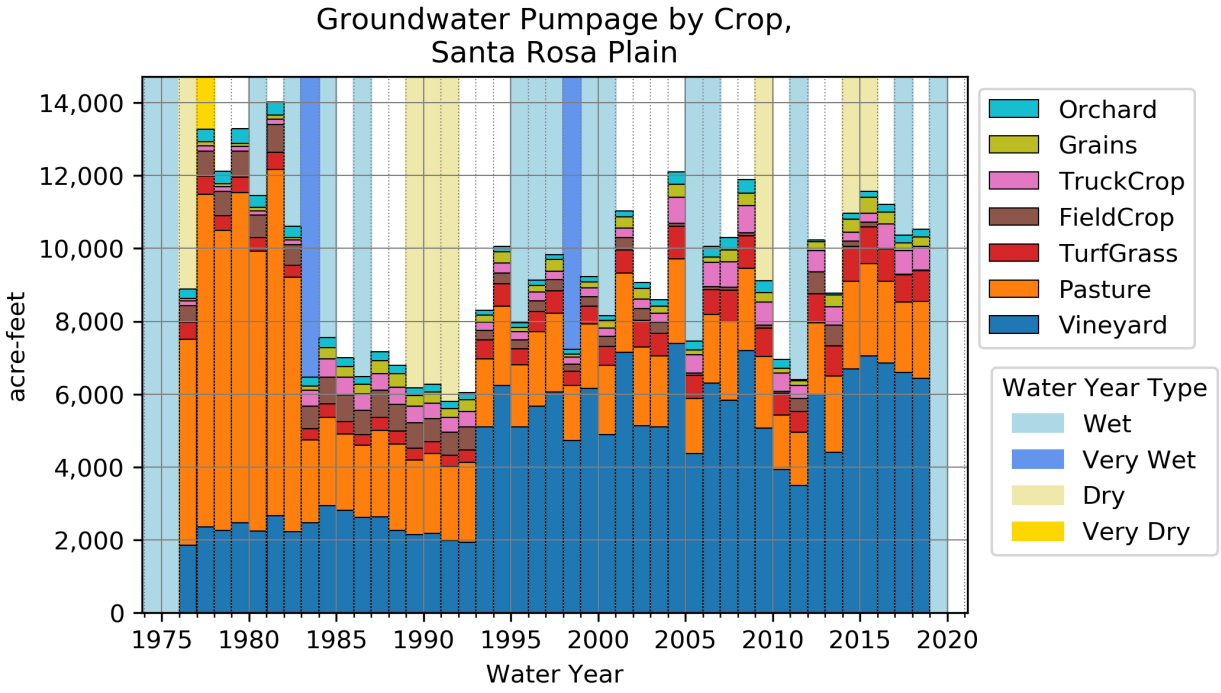


Figure 12 Simulated groundwater pumpage by crop for the Subbasin

Table 6 Groundwater pumpage per crop for the Subbasin from Water 2012 to 2018

	Field Crop	Grains	Orchard	Pasture	Truck Crop	Turf Grass	Vineyard
Mean	200	300	100	2,200	500	900	6,300
Minimum	0	200	0	1,900	200	800	4,400
Maximum	600	400	200	2,500	700	1,000	7,000
Median	100	300	200	2,100	600	800	6,600

Table 7 Average simulated irrigation depth by crop, pre-recycled water deliveries from 1975 to 1990

Crop Type	Irrigation depth (feet)
Vineyards	0.76
Orchard	0.78
Truck Nursery	1.25
Pastures	2.25
Grain	0.86
Turf Grass	1.55
Field Crop	1.29

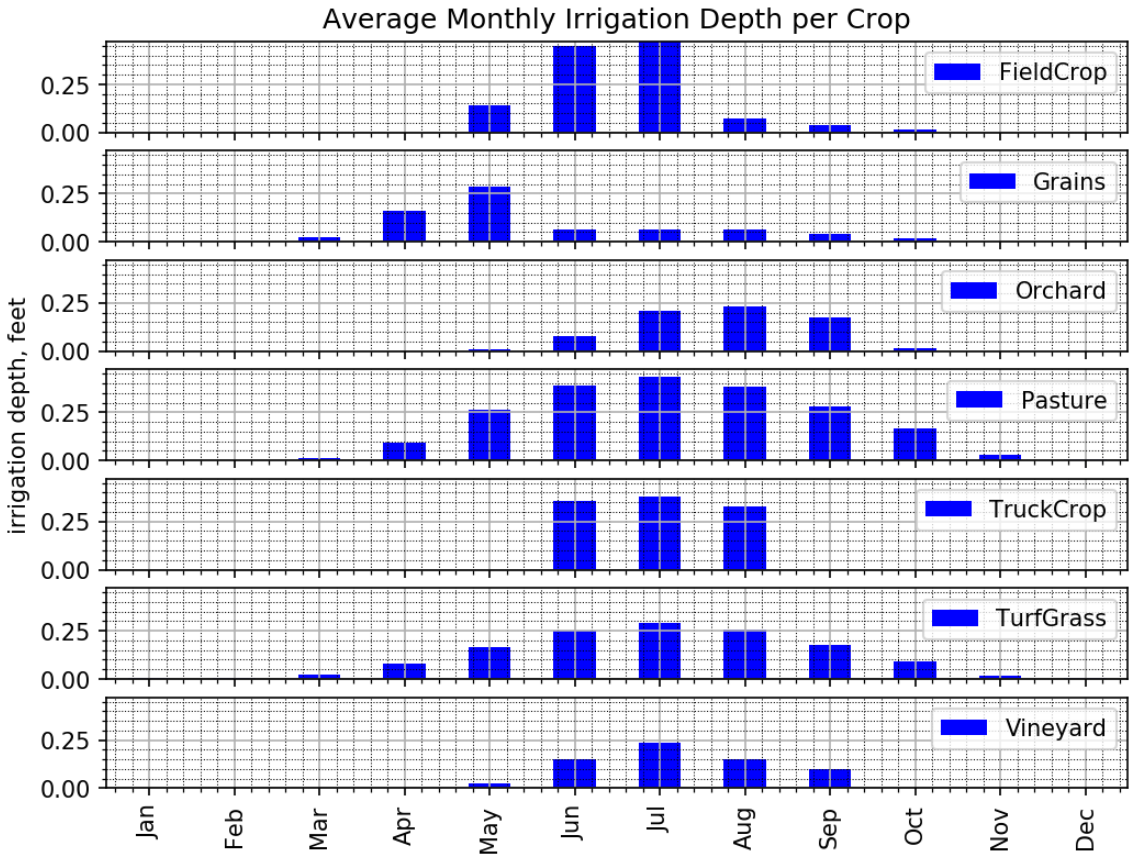


Figure 13 Model Results: Average monthly irrigation depth per crop

1.2.3 Public Water Supply Pumping

Large and small water service providers pump groundwater to serve to their customers. Large water suppliers include Cotati, Rohnert Park, Santa Rosa, Sebastopol, Windsor, Sonoma Water, Sonoma State University, and California-American Larkfield. Small water suppliers include Canon Manor Water System, Cloverleaf Ranch Summer Camp and many others including wineries, schools, mutual water companies, RV parks, restaurants, and parks. Other sources of

groundwater extraction, such as pumping for urban landscape irrigation are not included in the model. Pumpage data from the large and small water suppliers were included in the original USGS model and have been updated here. The large water suppliers generally provided pumpage records for each of their extraction wells. These pumpage records were summed by month and then used to extend the pumping records to December 2018 (shown annually in Figure 14). Pumpage data for small water suppliers were provided by CA DWR Division of Drinking Water (DDW). If monthly data were not available for certain periods, then they were estimated based on data from previous years[2]. If total pumpage was given for a supplier, then it was divided among all active wells managed by that supplier.

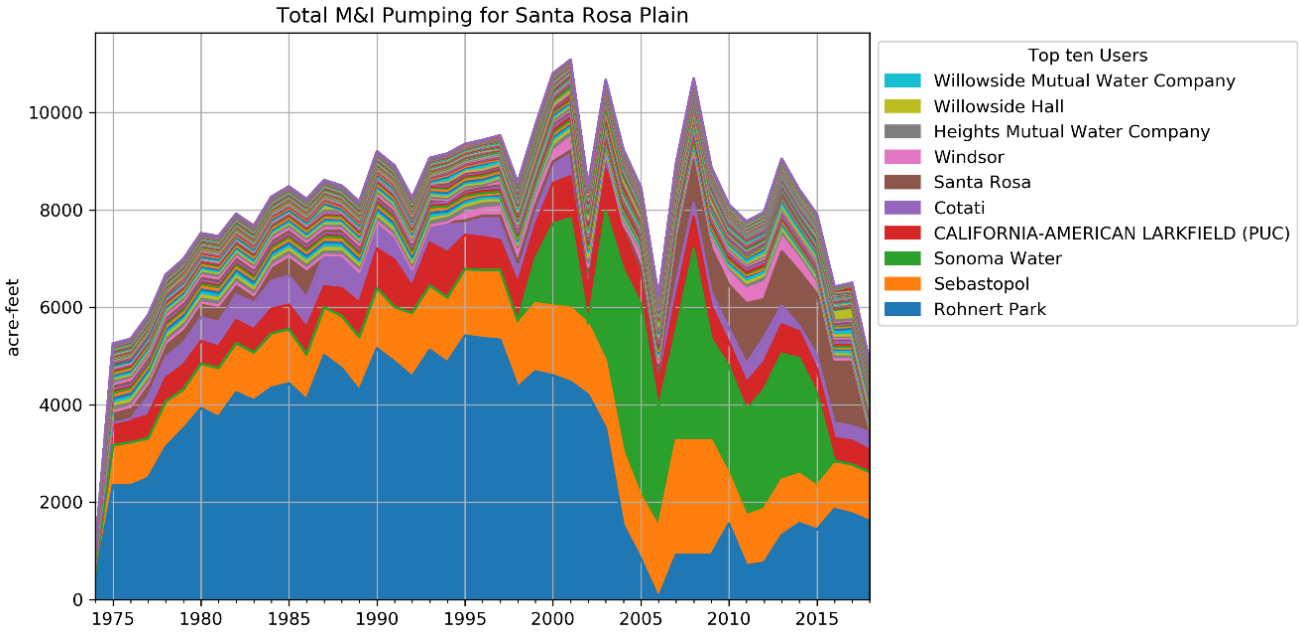


Figure 14 Total Monthly Pumpage by Munipical and Industrial water service providers for the Santa Rosa Plain Subbasin with Top 10 Users labeled

1.3 Additional Completed Model Updates

1.3.1 Climate Representation

The representation of climate stresses in the model has been changed from the original approach of the SRPHM 1.0 of using daily grids of precipitation and minimum and maximum temperature, to an approach based on time series input for individual weather stations which are then interpolated spatially onto the model grid by PRMS subroutines. This change resulted in a reduction in model input file size, although not a reduction in model run time. The updated

[2] Exceptions to this were for small water suppliers located in areas affected by 2017 Tubbs fire that were missing data for 2017 and 2018 because they were not operational after the fire.

model climate input files for 1975-2015 are currently only available in the new climate station format.

The PRMS watershed model requires input of daily precipitation and minimum and maximum daily air temperatures. The original SRPHM v1.0 used a gridded climate data set of daily precipitation and daily minimum and maximum air temperatures as input to GSFLOW. The gridded daily climate data set was developed externally to SRPHM as part of the model development by pre-processing and integration of climate data from a combination of monthly Parameter-elevation Regressions on Independent Slopes Model (PRISM) gridded data (monthly normal; Daly et al, 2002; PRISM Climate Group., 2016) and daily data from 109 climate stations centered on the watershed. The PRISM data were used to develop a spatial interpolation model that allowed for filling in many data gaps both spatially and temporally. This method was used to develop daily climate data for water years 1948-2010.

In contrast, the new USGS SRPHM v1.0 (which extended the model period through end of 2015) uses a station based climate input approach, where daily precipitation and minimum and maximum air temperature are provided at the locations of two climate stations within the basin, and then a spatial interpolation model is applied to these inputs directly within PRMS to define daily climate inputs at each model cell. The two station locations are at the Santa Rosa and Windsor California Irrigation Management Information System (CIMIS) stations (Table 8).

Although SRPHM v1.0+ uses station data time series as its input, the version of the updated input time series that the USGS extended through 2015 were actually derived from an extended gridded daily climate set developed in the same manner as for the SRPHM 1.0 model. Interpolated time series for these two station locations were extracted from this extended gridded data set. To update the climate input through 2018 (or for future updates) with this approach requires acquiring updated data through 2018 for all 109 climate stations used by the USGS and performing the data-processing steps to generate the full gridded daily data set. This would have been time consuming for a short period of the model update; therefore, a more simplified approach was implemented. The USGS SRPHM 1.0 input data time series for the two stations were compared with time series derived from the gridded PRISM daily data (interpolated to the coordinates of each station) for the 2010-2015 time period and showed good agreement. On this basis, the updated time series for the two station locations are based on interpolation to the station locations directly from daily PRISM gridded data. Though the 109 stations are not explicitly used as climate inputs here, observed climate data within and around the model domain are incorporated into the development of the PRISM model. The PRISM daily data sets only extend to January 1, 1981; therefore, the original USGS SRPHM v1.0 time series values are used for 1974-1980. The updated climate inputs used in the model update are shown in Figure 15, with the resulting water year 2015 to 2018 precipitation updated for SRPHM 1.0+ shown in Figure 16, Figure 17, Figure 18, and Figure 19.

Table 8 CIMIS Climate Stations in SRPHM

CIMIS Station #	DWR Regional Office	Station Name	County	Latitude	Longitude	Elev (ft)	Status	Connect Date	Disconnect Date
83	NCRO	Santa Rosa	Sonoma	38.40355	-122.799931	80	Active	1/1/1990	Active
103	NCRO	Windsor	Sonoma	38.526822	-122.813886	90	Active	12/14/1990	Active

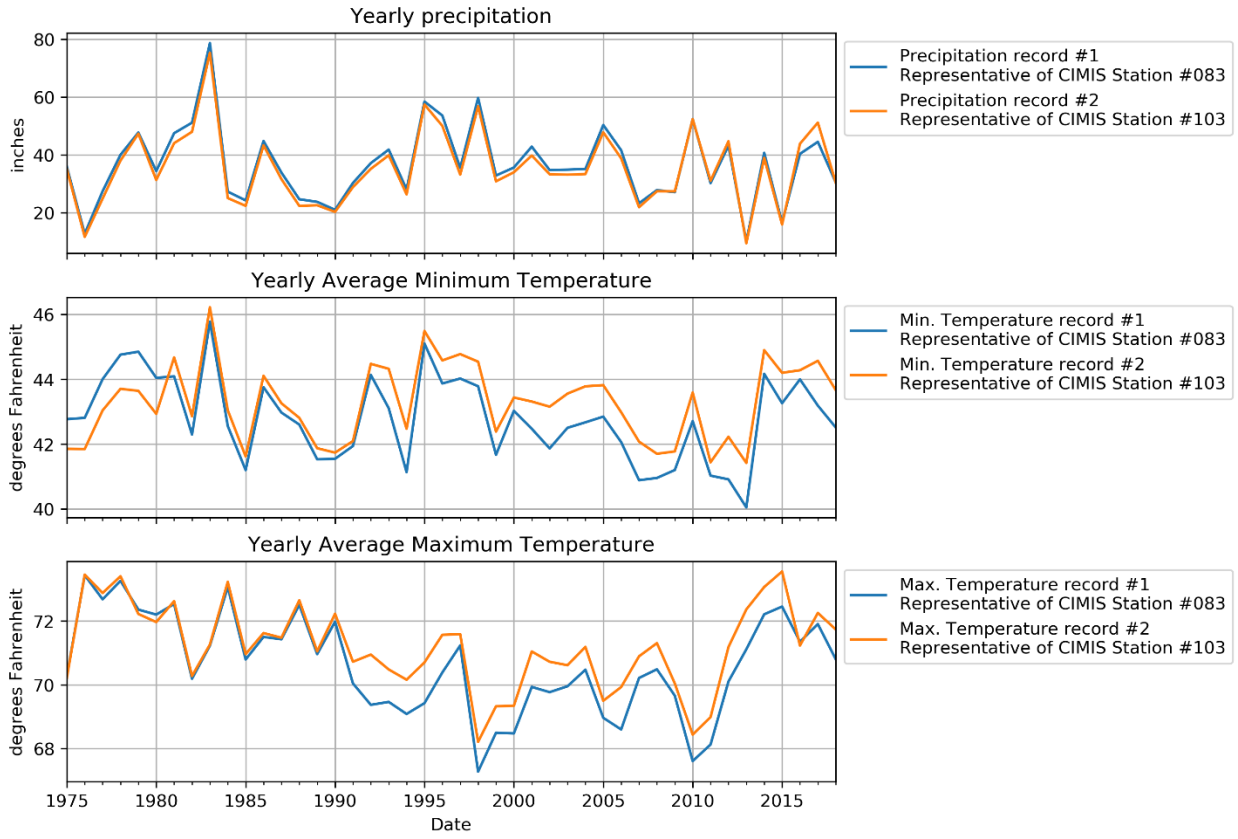


Figure 15 Updated Climate Inputs for the SRPHM v1.0+

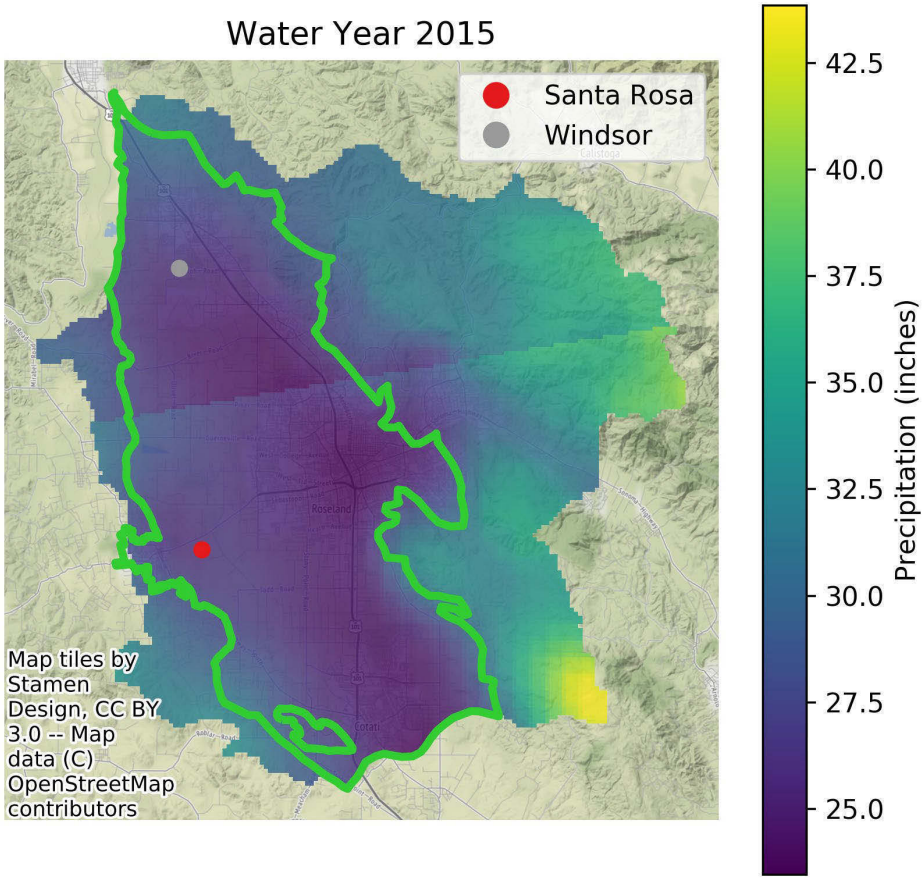


Figure 16 Water Year 2015 Precipitation for the SRPHM 1.0+

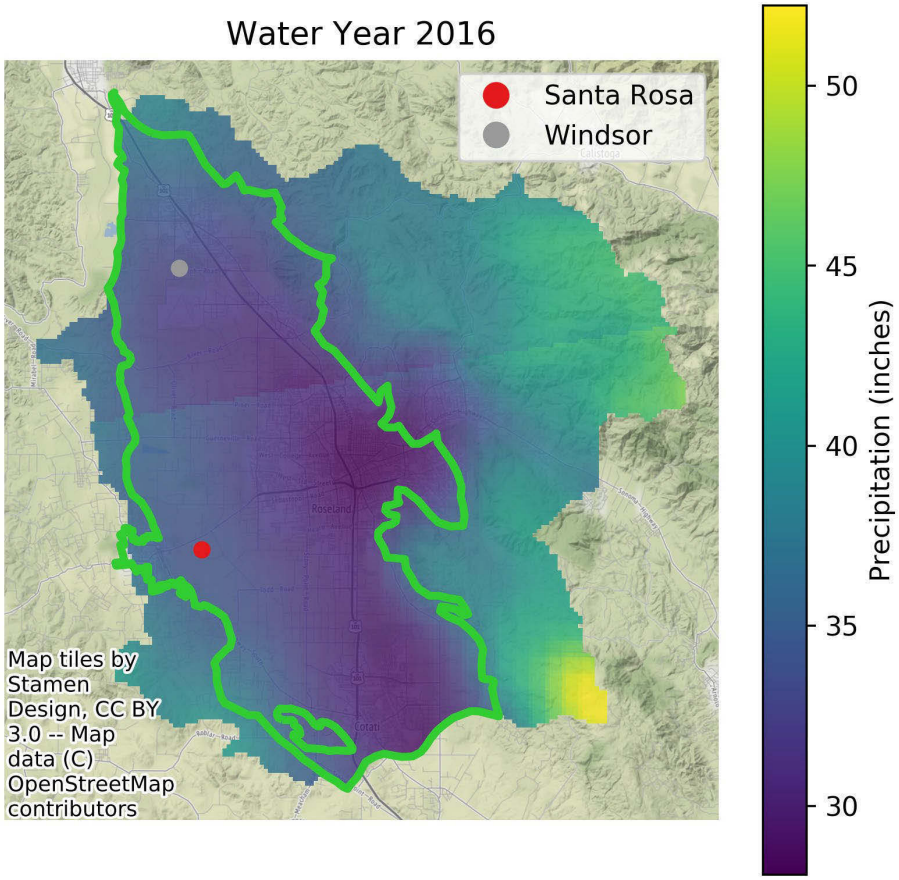


Figure 17 Water Year 2016 Precipitation for the SRPHM 1.0+

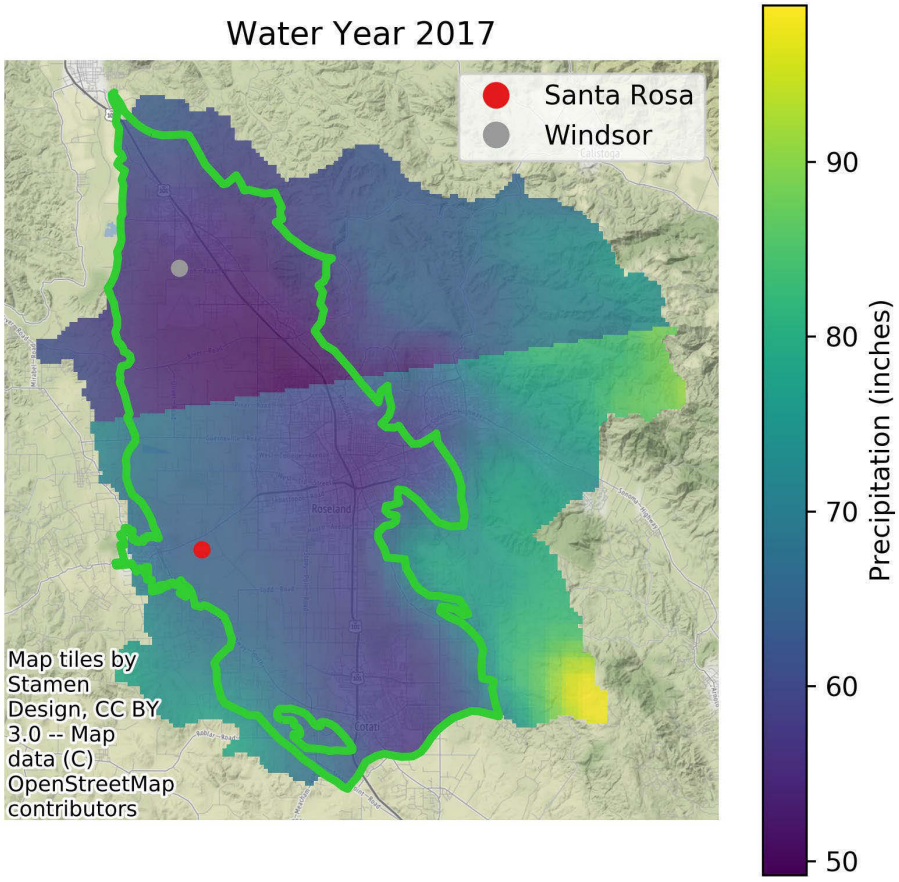


Figure 18 Water Year 2017 Precipitation for the SRPHM 1.0+

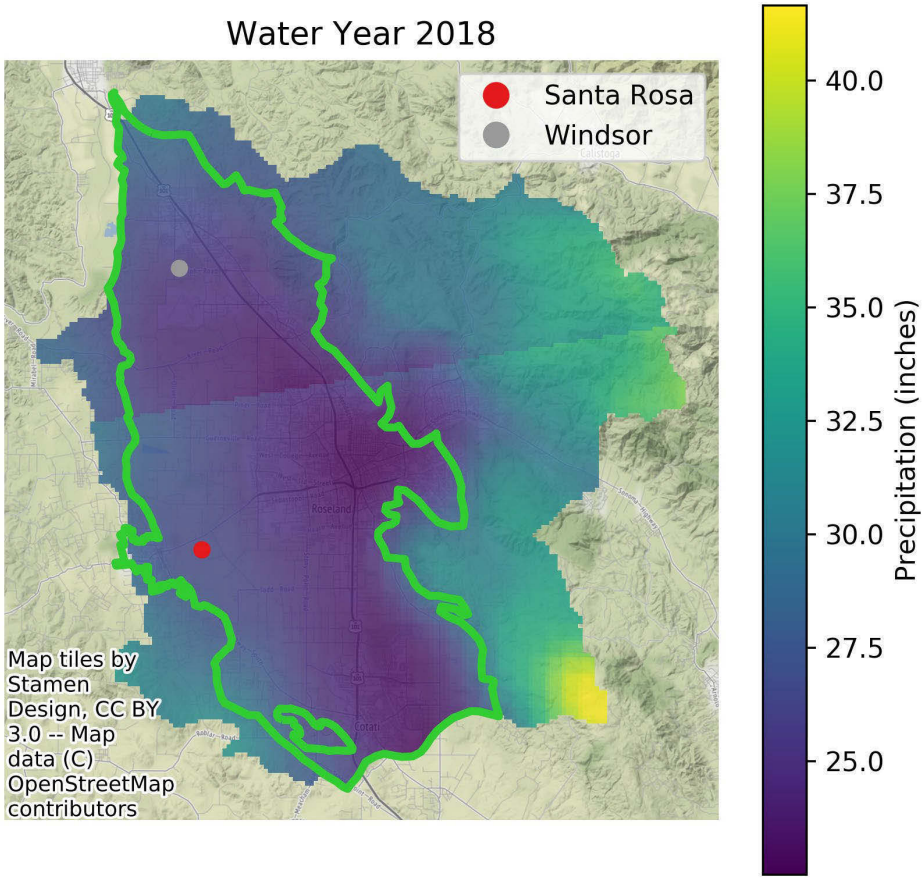


Figure 19 Water Year 2018 Precipitation for the SRPHM 1.0+

1.3.2 Recycled Water Deliveries

Recycled water deliveries applied as irrigation were previously simulated in SRPHM v1.0 by adding the delivered water to the daily precipitation grids. Recycled water use has now been separated and is represented by adding recycled water volumes to the soil zone through a new input file using the PRMS Water Use Input Module. The use of this module also accounts for irrigation with recycled water when estimating rural pumpage with the Ag Package.
Monthly records on the application of treated wastewater from the Town of Windsor and the city of Santa Rosa used for irrigation, also referred to as recycled or reclaimed water, were compiled by the USGS for water-years 1990 through 2017 for use in the SRPHM 1.0. Data for 2018 were estimated based on using monthly averages of the data from the previous three years. The SRPHM 1.0 data do not include recycled water deliveries from the Airport-Larkfield-

Wikiup Sanitation Zone and these were not updated in SRPHM 1.0+. For the most part, land irrigated with recycled water was within the Laguna de Santa Rosa 100-year flood-plain area, and is used for both landscape and agricultural irrigation (as seen on Figure 21 of USGS, 2013). The annual volume of recycled water used for irrigation averaged about 10,200 acre-ft.

1.3.3 Septic Return Flows

The original USGS SRPHM does not include septic return flows. The model was updated here to include septic return flows by recharging 80% of indoor water use to the first model layer (O'Conner Environmental, Inc. 2018) using the Flow and Head Boundary (FHB) package. The FHB package assumes that recharge occurs immediately and by utilizing this approach the delay of infiltrated septic water as it moves through the unsaturated zone is not simulated. This delay could be important for when a parcel is newly developed and there is a delay as the infiltrated water moves through the unsaturated zone. After a period of time, likely a year or less, depending on the rate of flow and the hydraulic conductivity of the unsaturated zone, recharge from septic infiltration becomes nearly continuous. The growth, locations and timing of the septic return flows mimic indoor rural domestic groundwater use described earlier. See Figure 3 for locations where groundwater pumping supplies water for indoor water use.

Calibration Results

After changing groundwater pumping, PRMS parameters, and other properties mentioned in this report, it is expected that the model will have different simulated results than SRPHM 1.0. Simulated groundwater levels are compared with observed groundwater levels to determine if the model remains relatively well-calibrated, or if model properties need to be adjusted to improve simulation capabilities. The two types of calibration observations are groundwater levels and streamflows. There are 111 groundwater wells for which the model simulates groundwater levels, and here we emphasize a subset of the key observation wells identified by Wolfenden and Nishikawa (2014) and the representative monitoring points used in the GSP. The key wells along with the other groundwater level hydrographs were updated in SRPHM 1.0+ through 2018.

Groundwater level hydrographs

The shallow groundwater level hydrograph in Figure 20 (SRP0357) near the town of Sebastopol shows a reasonable representation of the shallow groundwater levels. This well was not part of the original USGS study and therefore is a good representation of the updated model's ability to simulate groundwater levels in areas where it was not part of the calibration assessment. Figure 21 shows the hydrograph for SRP0359 and is located within the same borehole as SRP0357 as part of a nested well. This well is a medium depth well and also indicates that the model is capable of simulating groundwater levels in a location for which the model was not originally assessed for calibration. Because the shallow and deeper groundwater levels at this location are both reasonably simulated, the hydraulic gradient between these depths should be

well represented in the model. Groundwater movement is controlled by gradients, so this is an important consideration and a favorable model result.

Figure 22 displays the groundwater level hydrograph for a well located southeast of Rohnert Park. Both the observed and simulated hydrographs display a groundwater level rebound following the decrease in groundwater pumping in the area. The rebound in groundwater levels is very well represented by the simulated hydrograph, as well as the seasonal variations that occur in addition to the long-term changes.

Finally, Figure 23 depicts a model bias for well SRP0117 located in southeastern Santa Rosa. Here groundwater levels are about 25 feet too low, compared to the observed data for that location.

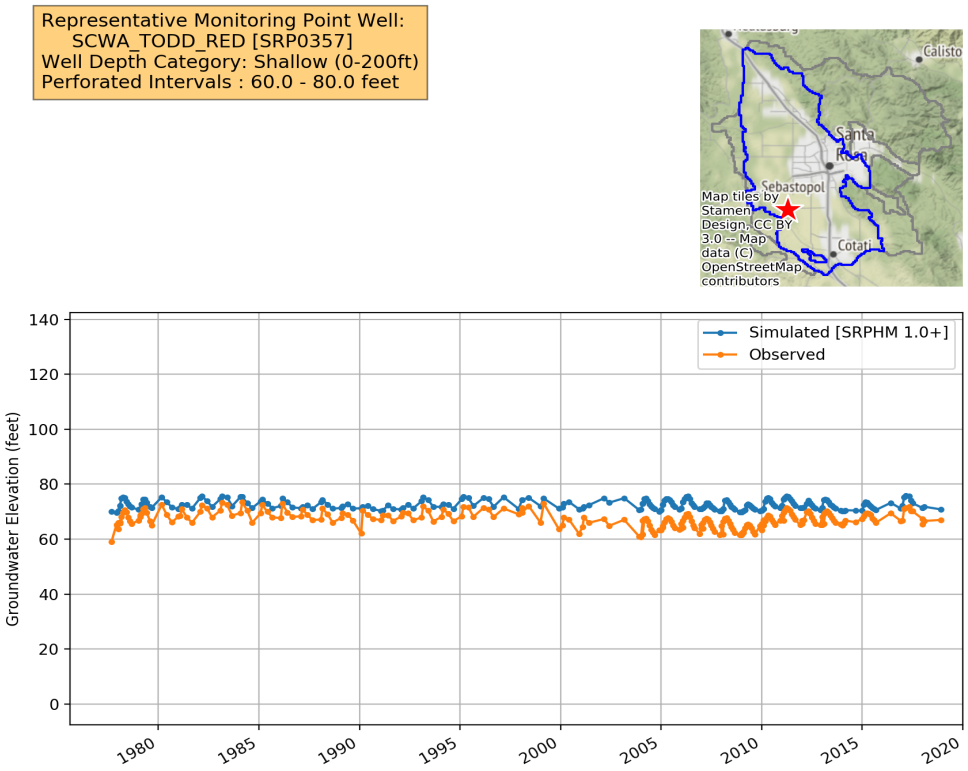


Figure 20 Groundwater level hydrograph simulated by SRPHM 1.0 and SRPHM 1.0+, and observed groundwater levels for SRP0357, Representative Monitoring Point

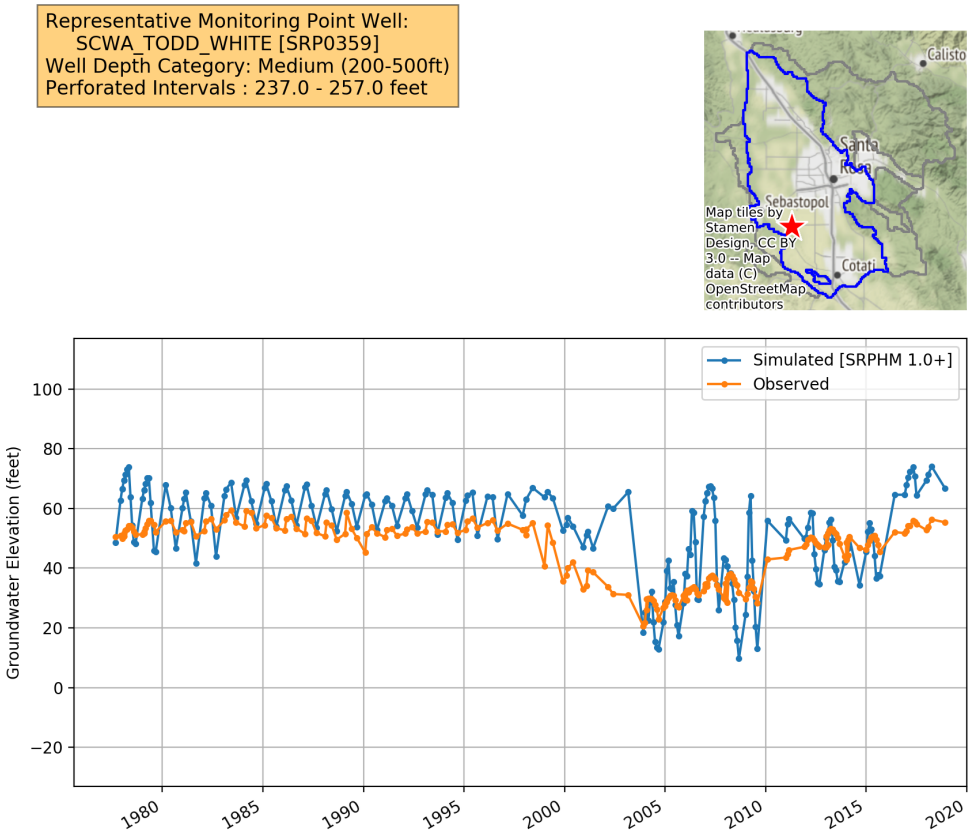


Figure 21 Groundwater level hydrograph simulated by SRPHM 1.0 and SRPHM 1.0+, and observed groundwater levels for SRP0359, Representative Monitoring Point

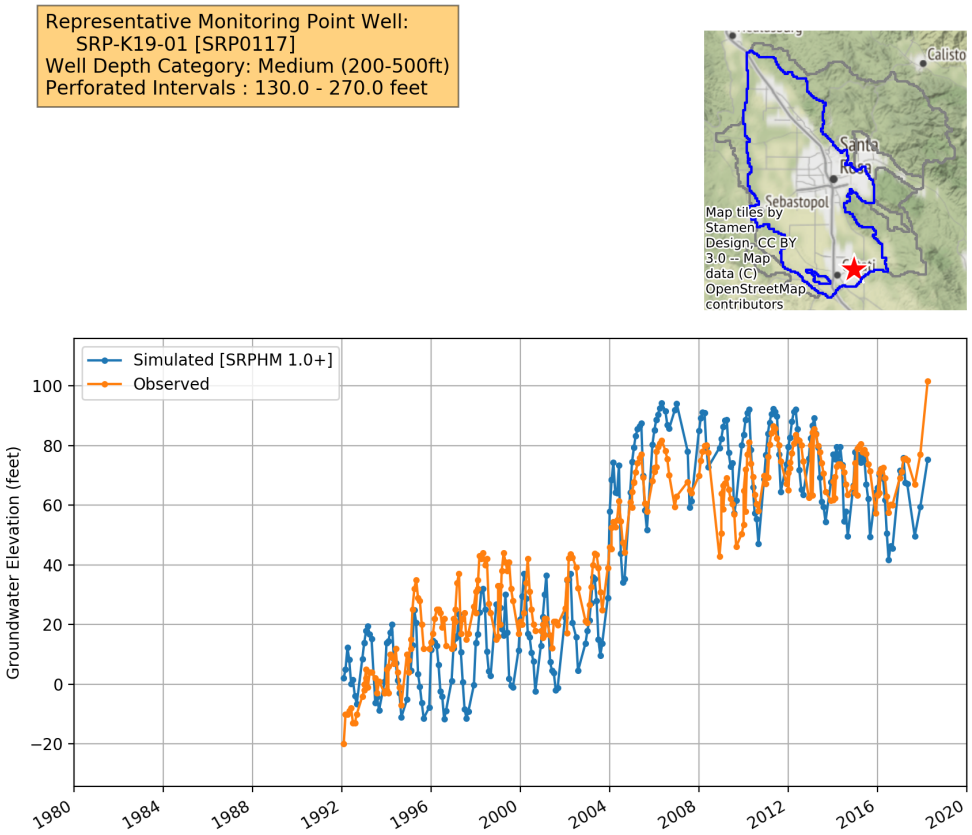


Figure 22 Groundwater level hydrograph simulated by SRPHM 1.0 and SRPHM 1.0+, and observed groundwater levels for SRP0117, Representative Monitoring Point

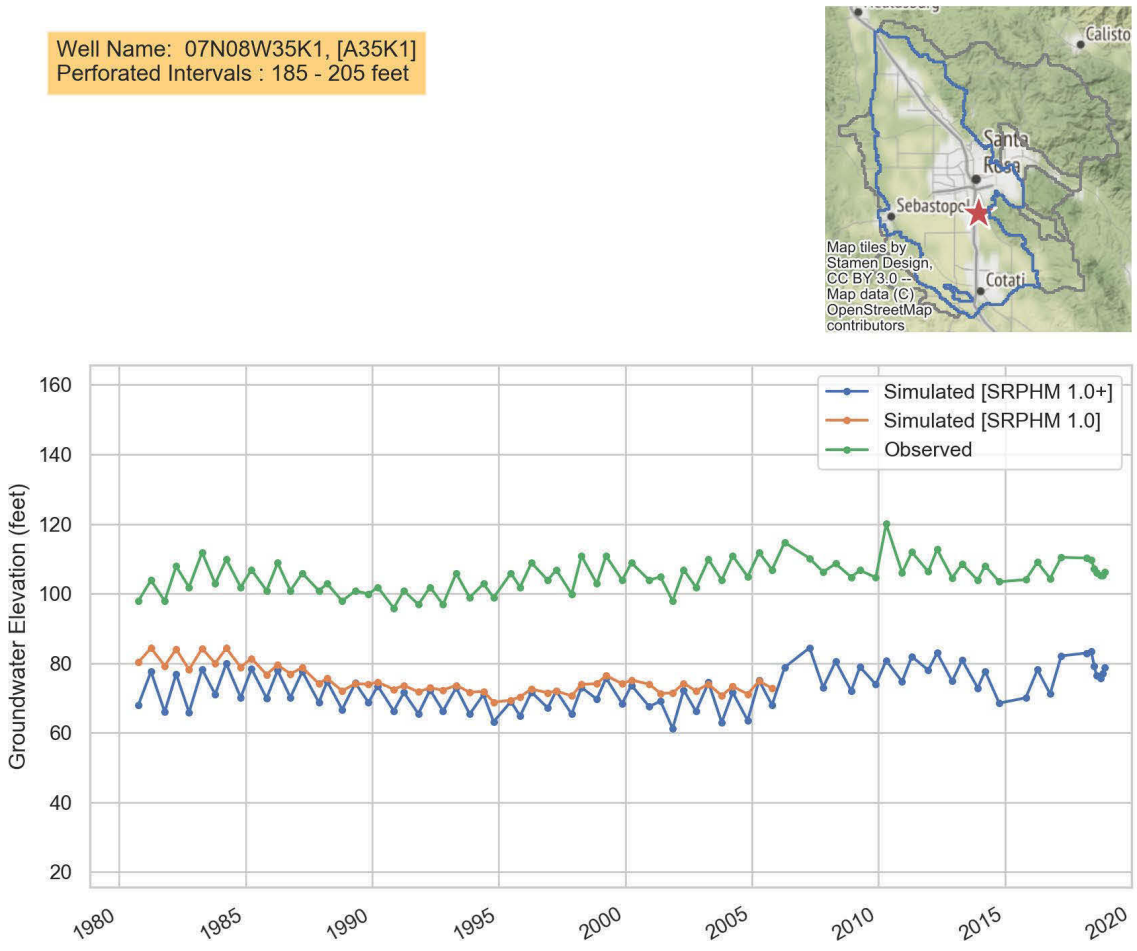


Figure 23 Groundwater level hydrograph simulated by SRPHM 1.0 and SRPHM 1.0+, and observed groundwater levels for State Well ID 07N08W35K1 , Key Well

One way to display groundwater level results is to plot the observed versus the simulated groundwater levels. If an observed groundwater level matches its simulated value, then the point will plot on the 1:1 line, whereas simulated values that are too high will plot above the 1:1 line, and simulated values that are too low will plot below the 1:1 line. Overall the errors should be distributed symmetrically about the 1:1 line reflecting a lack of bias in the simulation results. Figure 24 depicts the observed versus simulated groundwater levels for wells located within the Subbasin along with the 1:1 line in red. Additionally the figure shows that the Root Mean Square error for these results increased from 20.91 feet in SRPHM 1.0 to 21.84 ft in SRPHM 1.0+. The median residual did not change between SRPHM 1.0 to SRPHM 1.0+, though the average residual became slightly more negative. These results are reflected in Figure 24 which shows little difference between the density of residuals about the 1:1 line, reflecting a model that has a small but reasonable bias in overestimating groundwater levels. The small increase in the bias is likely a result of the decreased groundwater pumping from SRPHM 1.0 and SRPHM 1.0+, which would cause groundwater levels to increase.

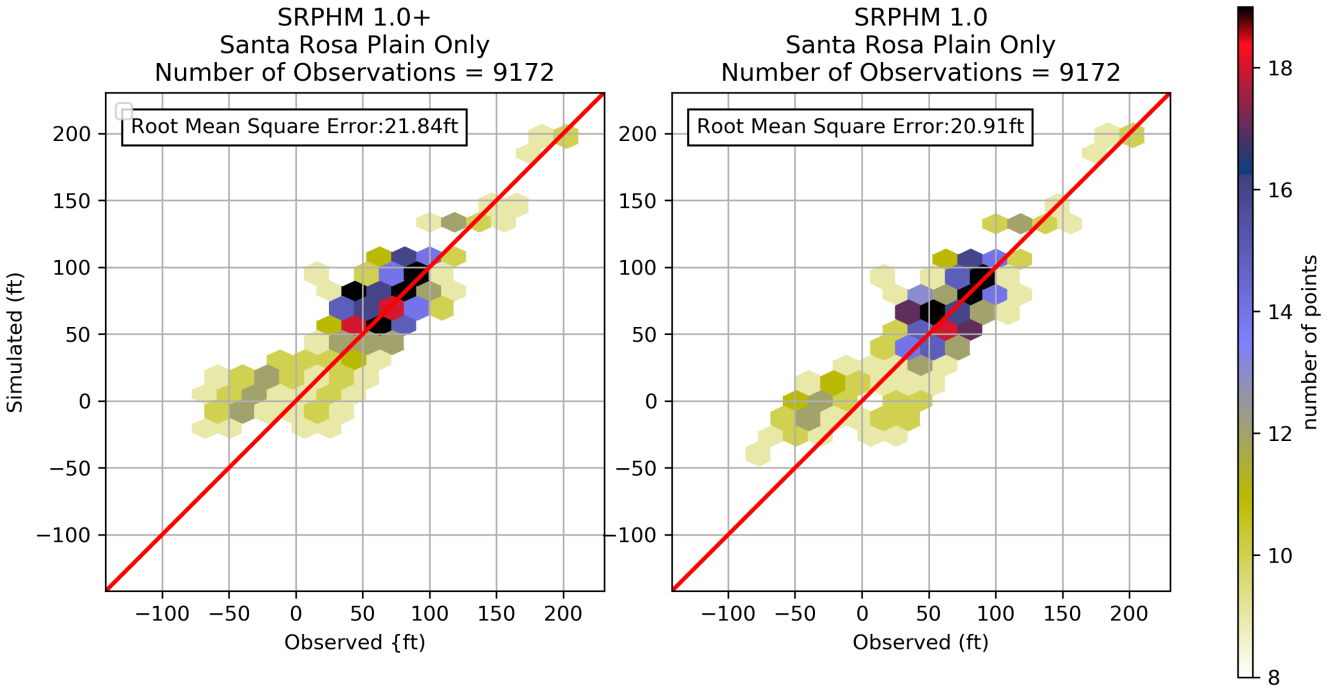


Figure 24 Observed versus simulated groundwater levels for the SRPHM 1.0 and SRPHM 1.0+

The difference between a simulated and observed value is known as the residual. The average residuals for all wells is shown in Figure 25, with the key calibration wells emphasized with grey boxes. A perfect simulation would have small residuals for all wells, and if any residuals were large, they would be randomly spatially distributed and not clustered in zones. At 18 of 38 of the key well locations the absolute groundwater level residual is less than 10 feet. As seen in the map, there are not any clusters of wells with correlated biases that cover large areas of the Subbasin model domain, indicating there is not significant spatial bias in the model. There is

one small cluster in the southern area west of Rohnert Park and another cluster of three wells east of the Santa Rosa Airport. These clusters are small and could potentially reflect too much pumping in the Airport area (positive residual) and too little pumping west of Rohnert Park (negative residual).

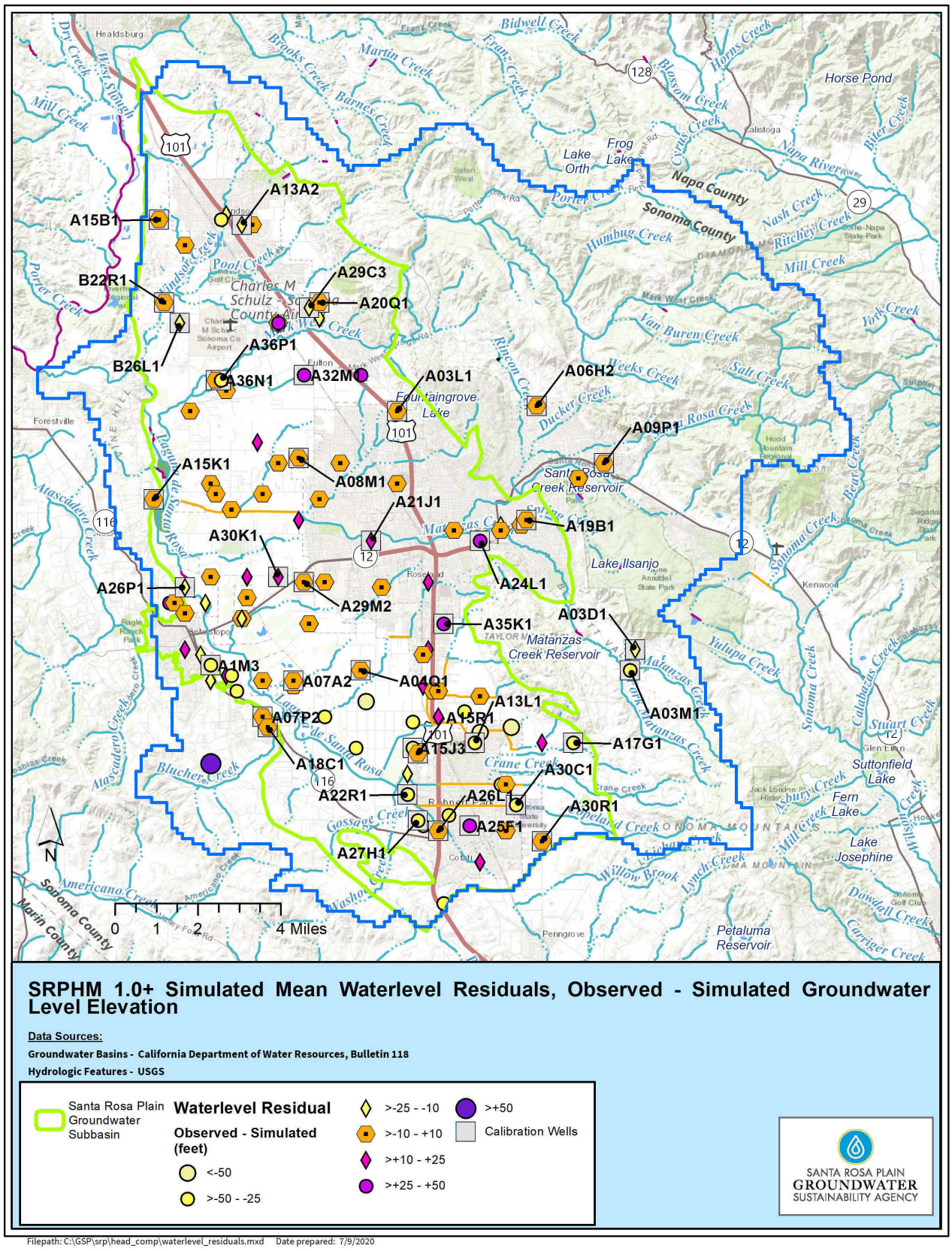


Figure 25 SRPHM 1.0+ Mean Groundwater level Residuals, 1974 to 2018

Stream Calibration

Streamflow is an important component for the GSP. It is also an important calibration metric because it incorporates a number of hydrologic processes that the model must simulate. Streamflow integrates precipitation volumes and distribution, actual evapotranspiration, aquifer hydraulic properties, and groundwater pumpage, amongst other processes. Fortunately for the Subbassin there are a large number of USGS stream gages that are, or have historically, operated within or just outside of the Subbasin. A map of the stream gage locations is shown on Figure 26. The calibration assessments for each of the gages is shown on Figure 26, Figure 28, Figure 28, Figure 29, Figure 30, Figure 31, Figure 32, Figure 33, Figure 34, Figure 35, for Brush Creek At Santa Rosa (11466065), Colgan Creek Near Santa Rosa (11465690), Colgan Creek Sebastopol (11465700), Copeland Creek at Rohnert Park (11465660), Laguna de Santa Rosa at Stony Point Roadd Nearr Cotati (11465680), Laguna de Santa Rosa Creek Near Sebastopol (11465750), Mark West Creek Near Mirabel Heights (11466800), Mark West Creek Near Windsor (11465500), Matanzas Creek at Santa Rosa (11466170), and Santa Rosa Creek at Willowside Road Near Santa Rosa (11466320), respectively. Brush Creek discharge reflects inflows from outside of the subbasin, and as seen in Figure 27, the simulated discharge data matches the observed very well, including the flow duration curve, the observed versus simulated, and the monthly flows. Colgan Creek near Santa Rosa, Colgan Creek near Sebastopol, and Copeland Creek near Rohnert Park all simulate both the low flows and high flows very well, with only the Colgan Creek near Sebastopol displaying a small divergence of flows at low flows around the 90% flow exceedance value. At that location the SRPHM 1.0+ performs better than the SRPHM 1.0. At the Laguna de Santa Rosa near Cotati both the SRPHM 1.0 and SRPHM 1.0+ display discharge values greater than the observed for the top 30% of flow exceedance, though they display similar trends for much of the remaining curves. Importantly, at both Laguna de Santa Rosa gages, the SRPHM 1.0+ displays comparable discharges in the June through September period when groundwater dependent ecosystems are likely heavily reliant on groundwater discharge to streams.

The Mark West Creek and the Matanzas Creek gages do not record summer low flows and therefore their calibrations are not as important here as other gages that do. Nonetheless, for the one year when the gages recorded summer flows, there is good agreement between the observed and simulated for those periods. The Santa Rosa Creek at Willowside Road near Santa Rosa streamgage record is very well reproduced at all but the lowest of flows. At flows below the 70% exceedance, the SRPHM 1.0+ has very similar exceedance, whereas at flows below 10 cfs (90% exceedance) there is some divergence. This divergence is either a result of too high of groundwater discharge to streams during the summer within the groundwater basin, or too high of discharge from the upstream locations outside of the Subbasin.

When considering all of the streamflow gage records, the updated SRPHM 1.0+ is generally well suited at simulating the monthly flow duration curves and the monthly average flow rates for summer and fall discharge. There is a slight tendency to over simulate pumping during these low flow periods, and bias may need to be accounted for when using the SRPHM for assessments of surface water depletion and other surface water processes.

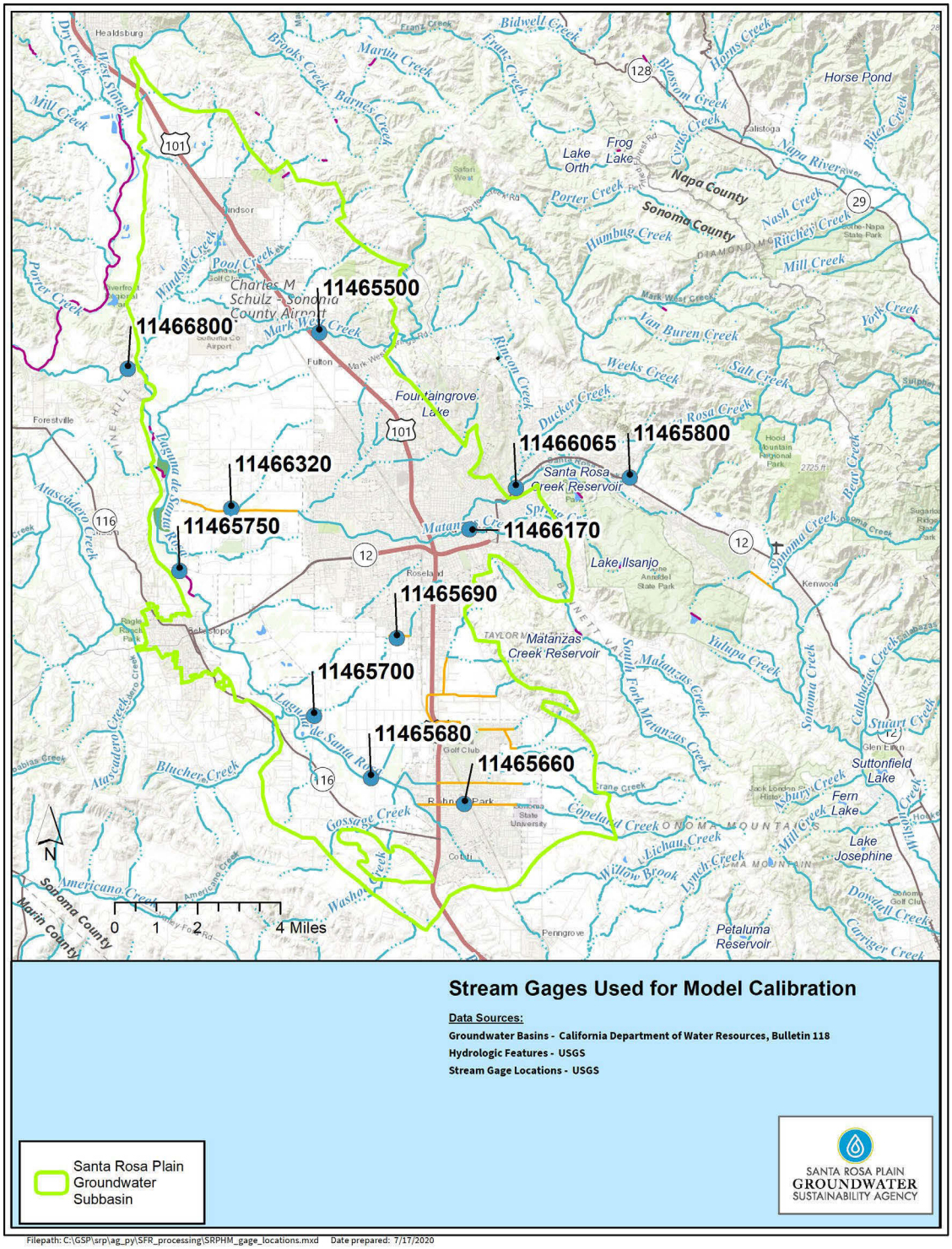


Figure 26 USGS stream gage locations and their site identifiers

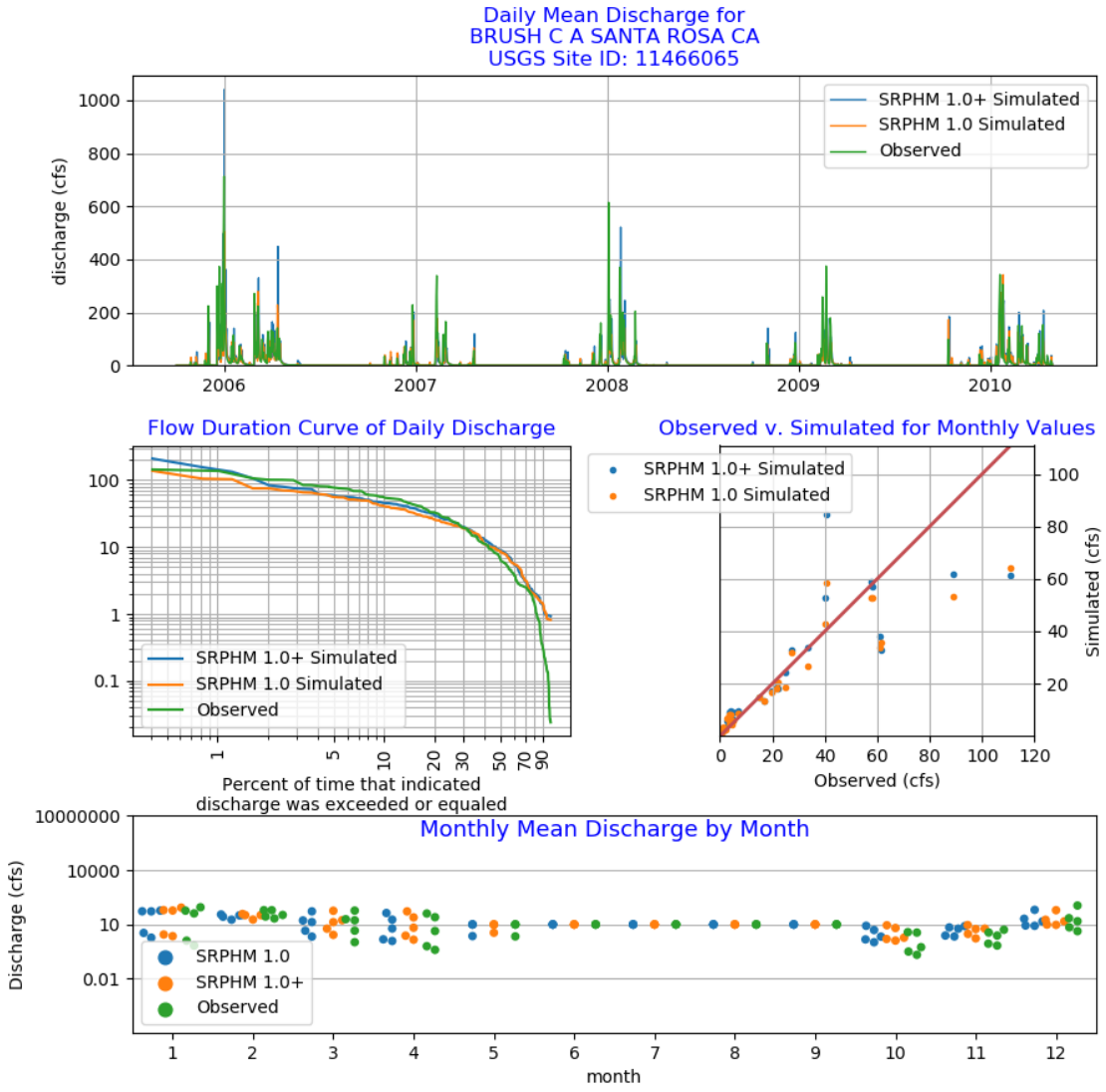


Figure 27 Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Brush Creek at Santa Rosa

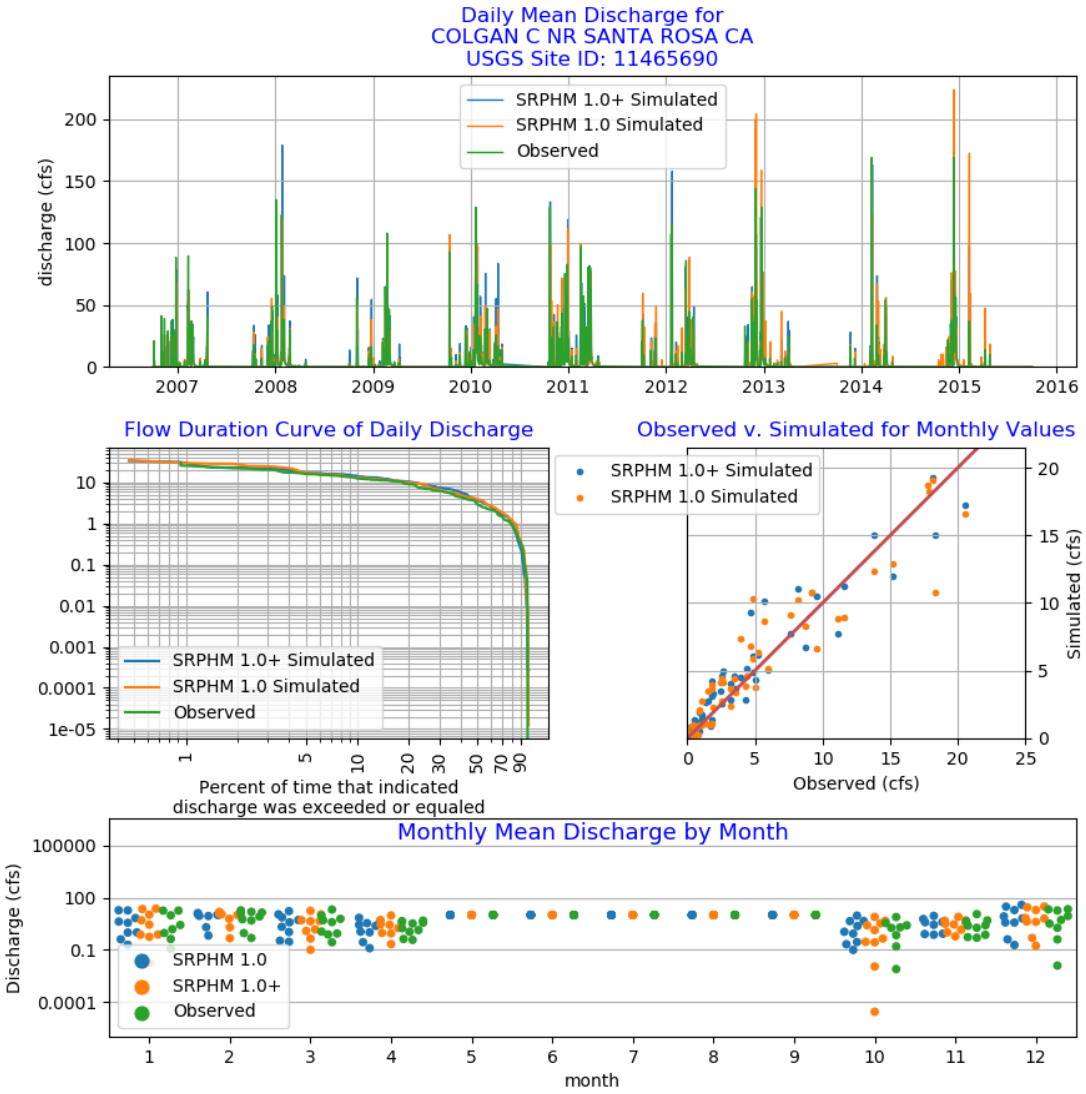


Figure 28 Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Colgan Creek near Santa Rosa

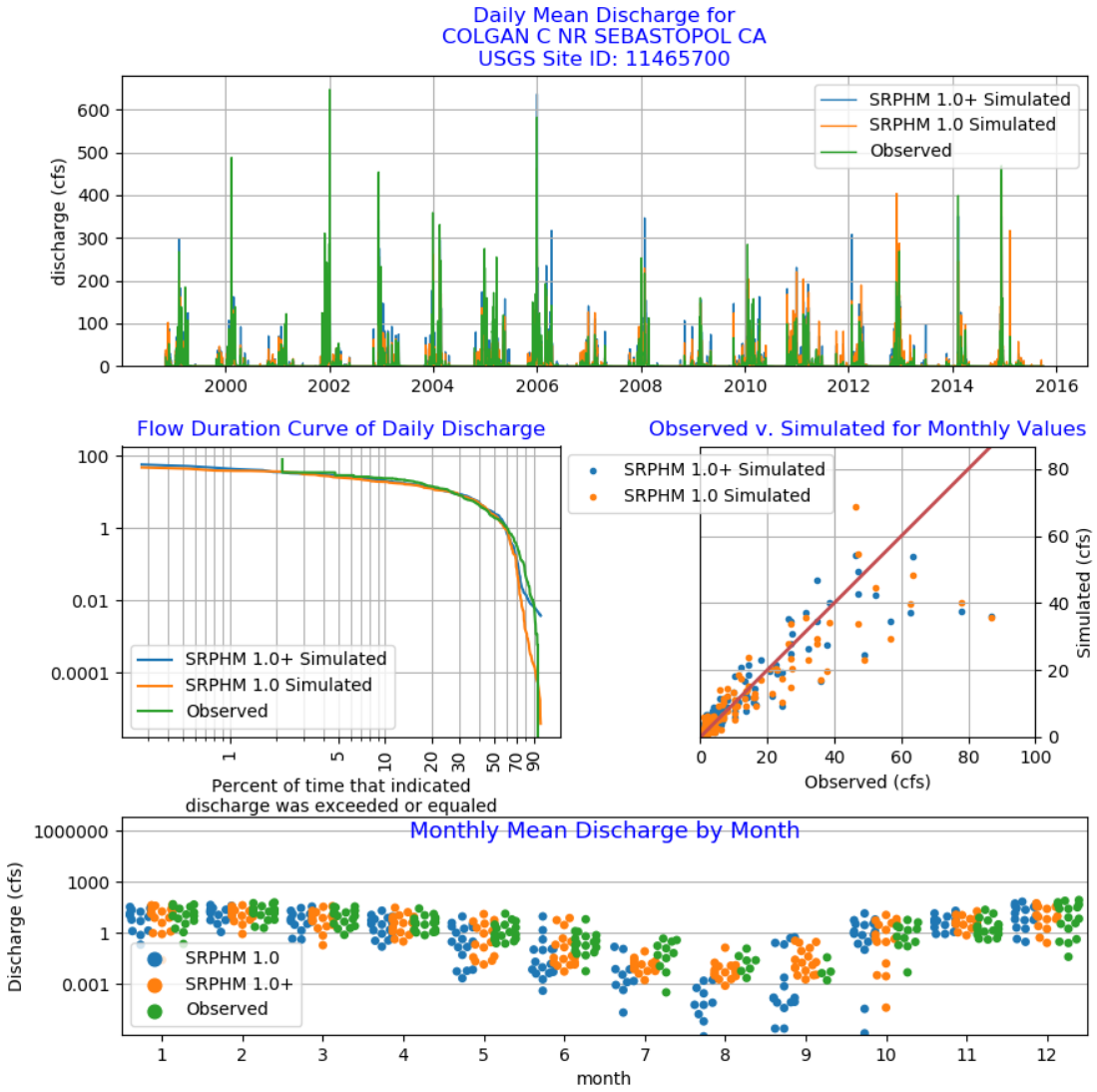


Figure 29 Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Colgan Creek near Sebastopol

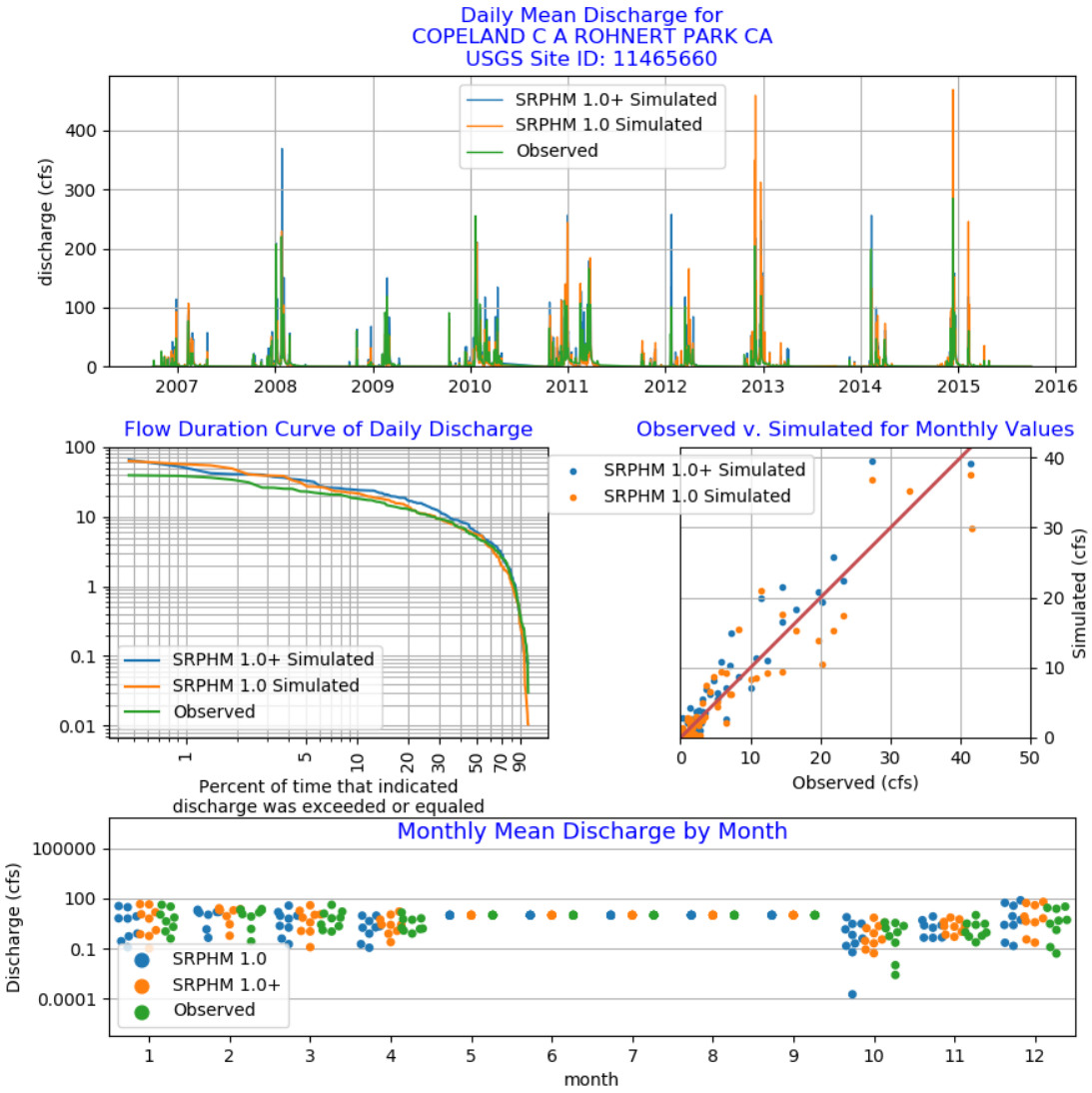


Figure 30 Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Copeland Creek at Rohnert Park

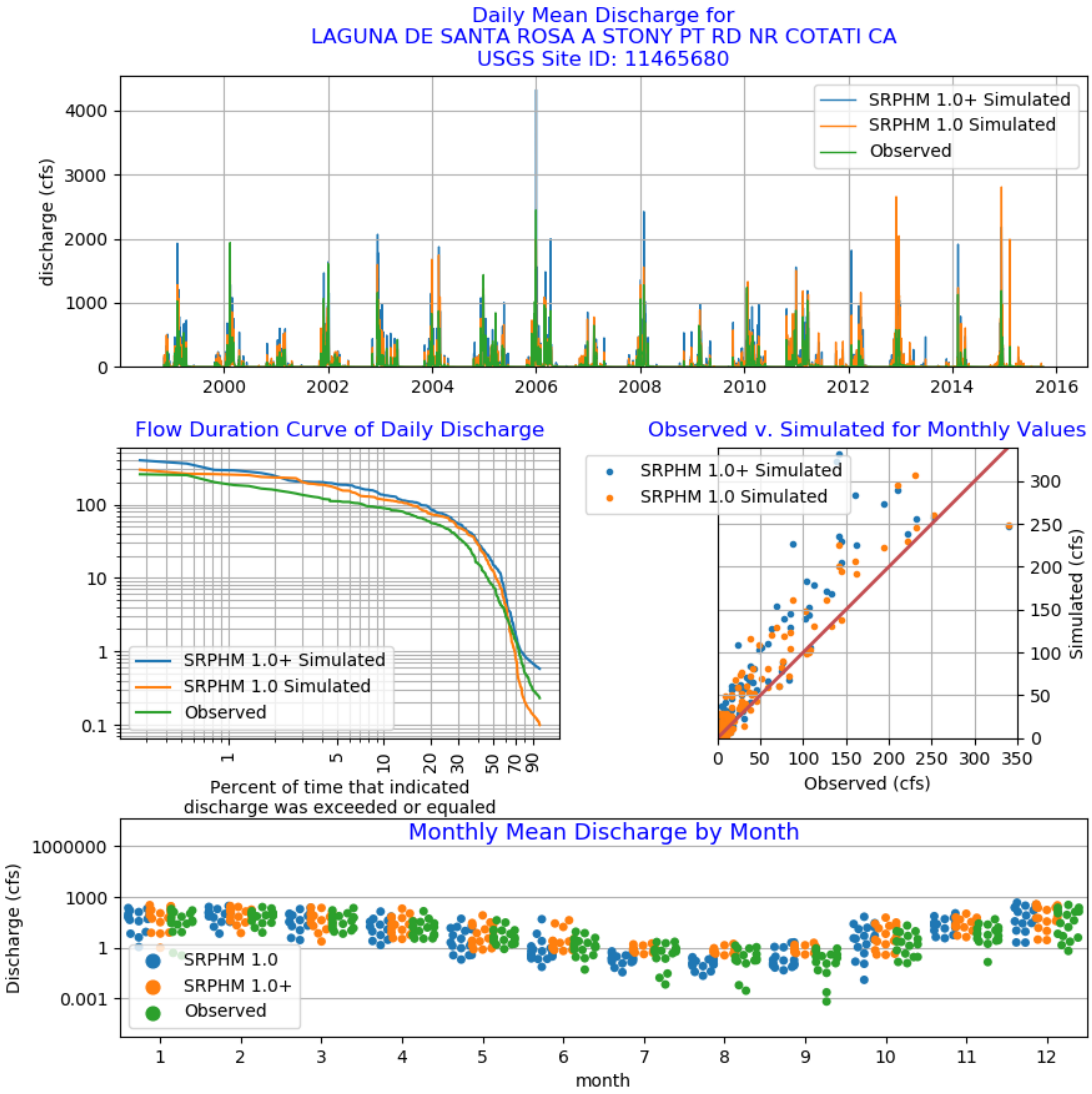


Figure 31 Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Laguna de Santa Rosa at Stony Point Road Near Cotati

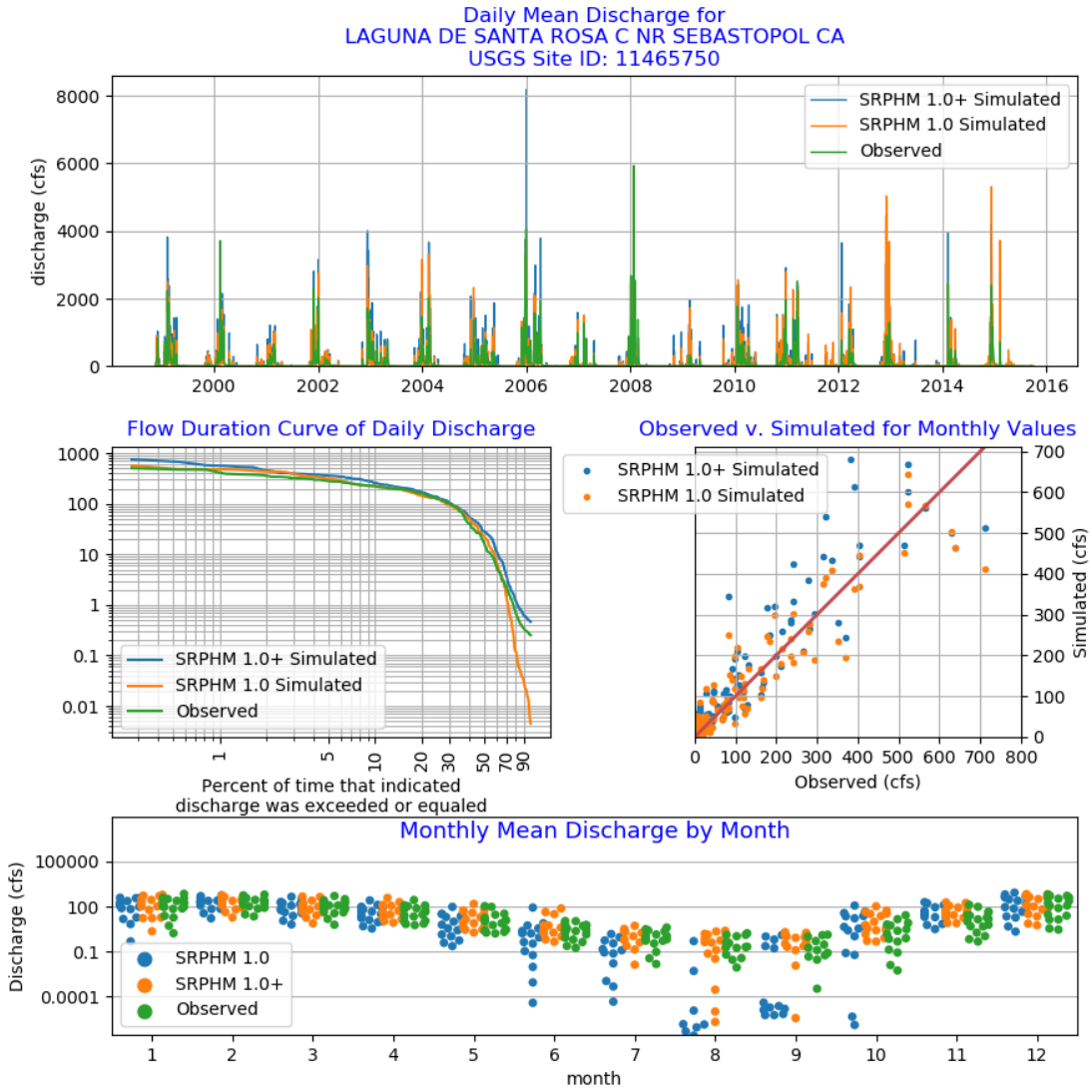


Figure 32 Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Laguna de Santa Rosa Creek Near Sebastopol

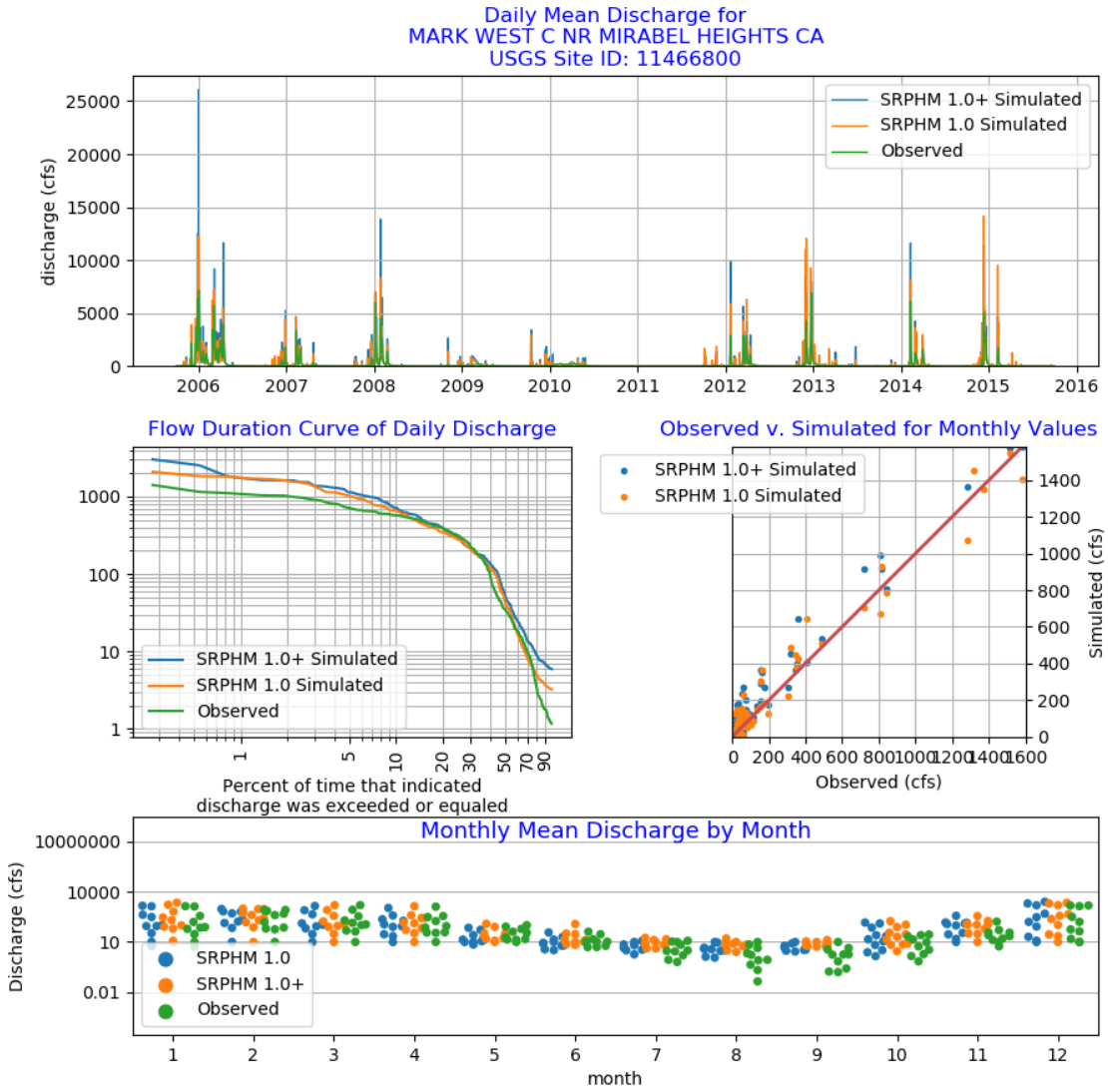


Figure 33 Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Mark West Creek Near Mirabel Heights

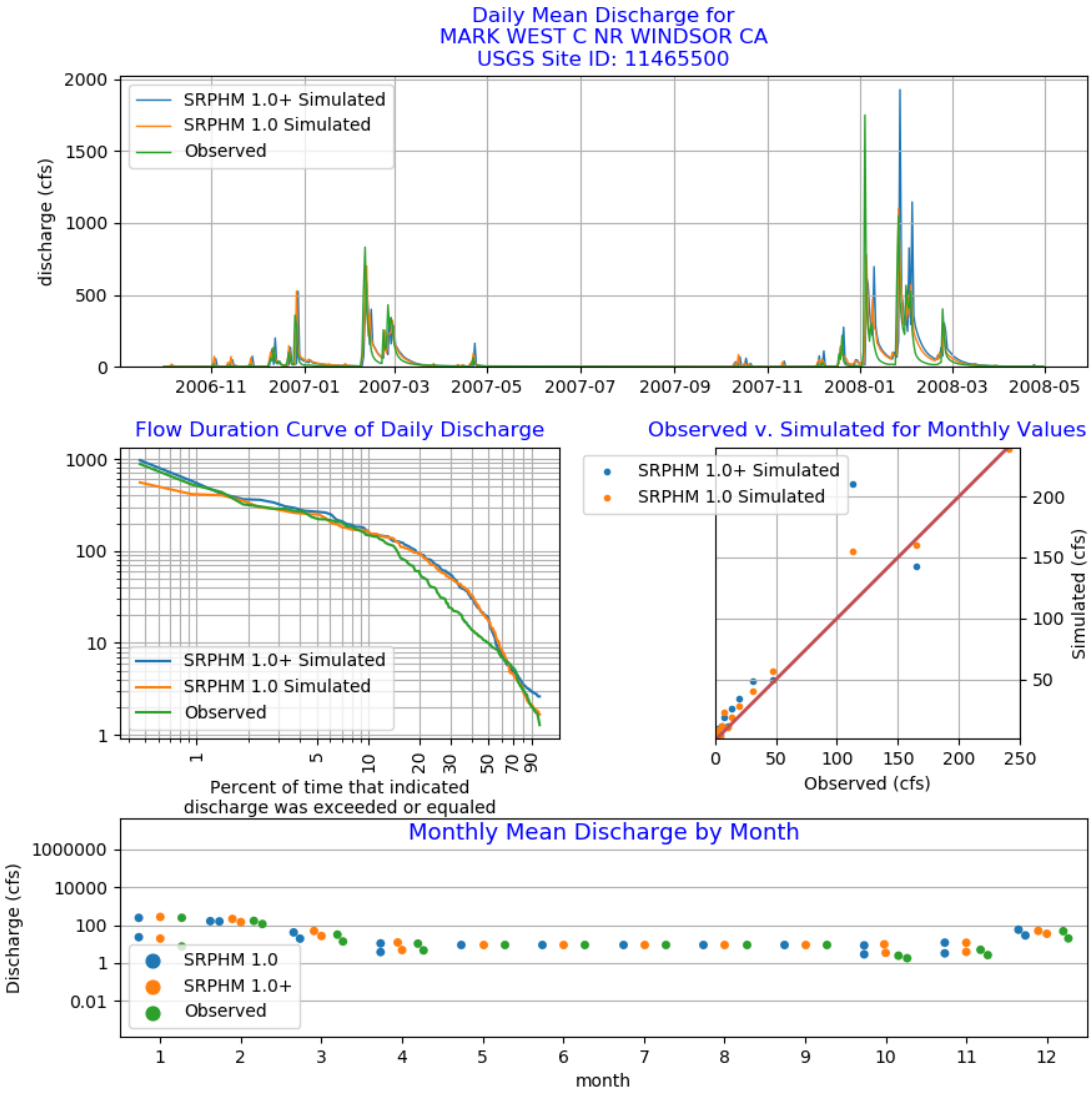


Figure 34 Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Mark West Creek Near Windsor

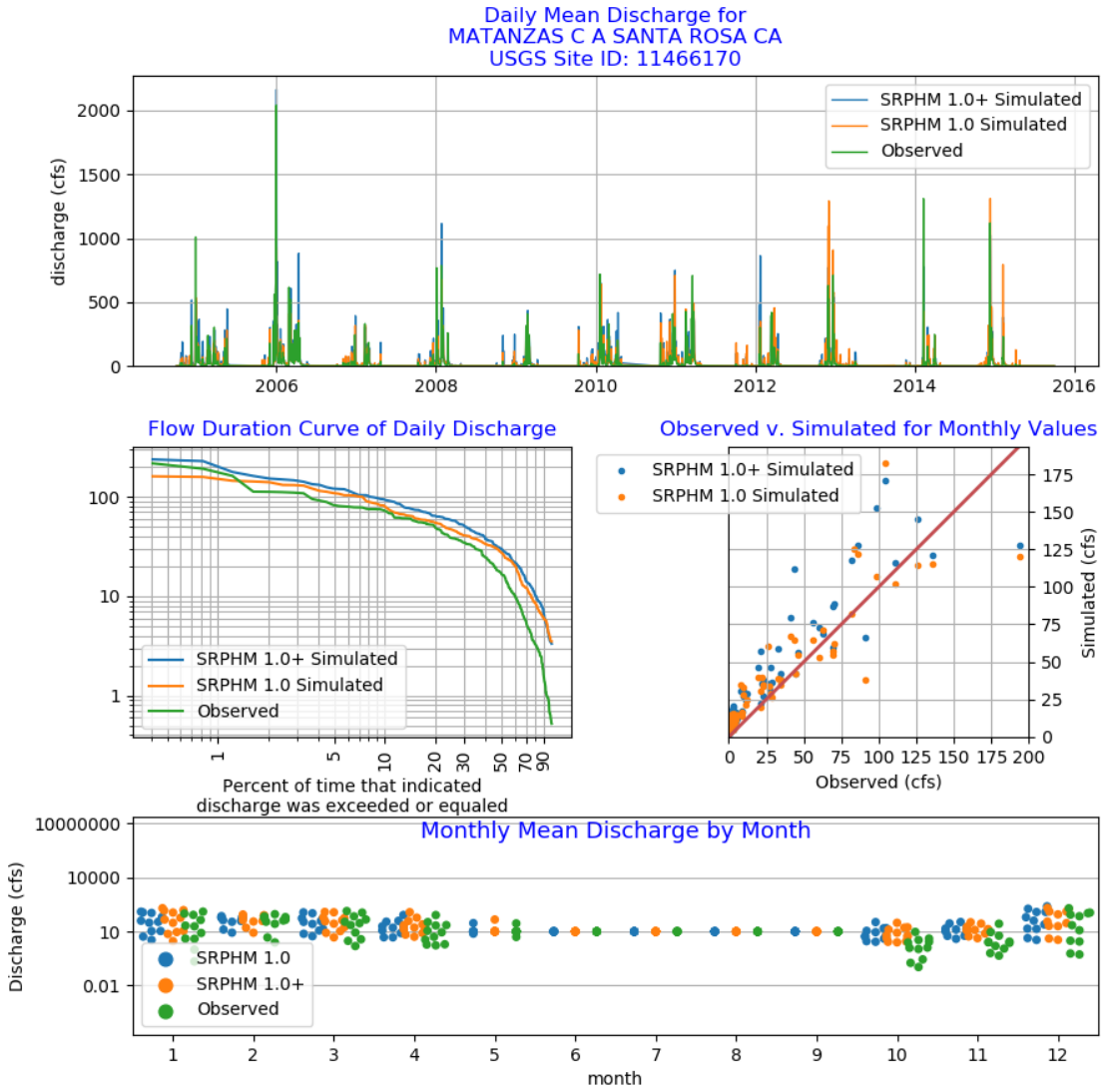


Figure 35 Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Mayacamas Creek at Santa Rosa

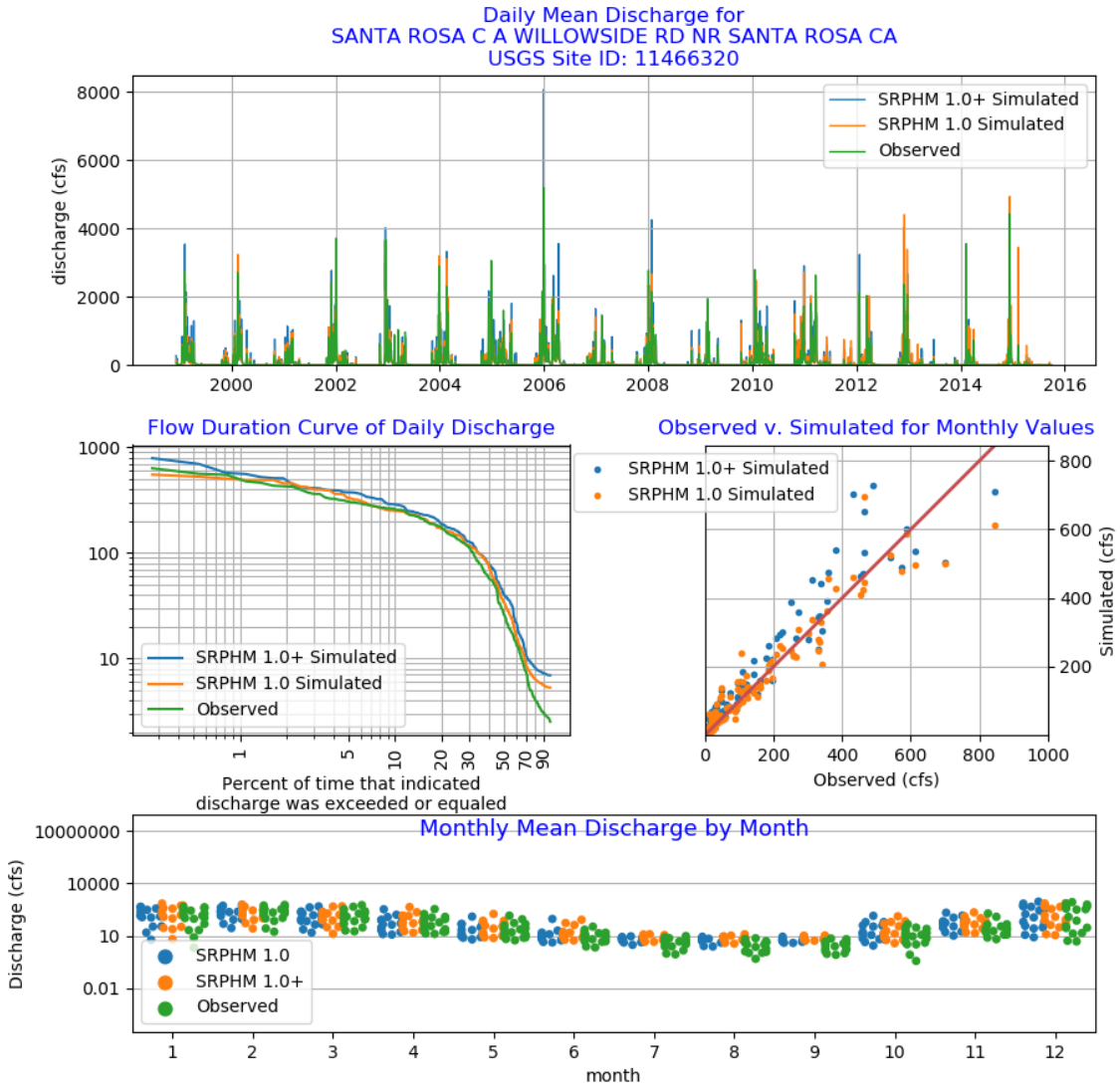


Figure 36 Simulated SRPHM 1.0, SRPHM 1.0+ and observed daily discharge, flow duration, observed versus simulated discharge, and monthly mean discharge for Santa Rosa Creek at Willowside Road Near Santa Rosa

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Appendix 3-D
Future Groundwater Demands and Land Use Changes

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Projection of Future Water Demands for Rural Residential and Municipal Water Users, and Changes in Agricultural Land Use for the Groundwater Sustainability Plans of the Santa Rosa Plain, Sonoma Valley, and the Petaluma Valley Subbasin

Future Groundwater Demands and Land Use Change

Santa Rosa Plain GSA, Sonoma Valley GSA, and Petaluma Valley GSA

The Petaluma Valley, Santa Rosa Plain, and the Sonoma Valley Groundwater Sustainability Agencies are required to incorporate projections of future groundwater use as part of their groundwater sustainability plan (GSP) development. This document details the methods and data used to make such projections. The documents contained herein were presented to the Advisory Committee for each GSA during the development of the GSP. The documents detail the projected changes in 1) land use for agriculture, 2) new housing units requiring groundwater for supply, and 3) municipal groundwater demand projections. The outputs from these projections are incorporated into the groundwater model for each groundwater subbasin,. The simulations cover the time period from October 2020 to September 2071.

Agricultural Water Demand Projections

Agricultural Water Demand Projections

Land-Use Surveys

This memo provides an overview of *preliminary* outcomes from the Agricultural Water Demand workgroup to date. The outcomes described below do not represent final work products; they are intended to offer an update for discussion purpose during October 2020 Advisory Committee meetings for the Sonoma Valley, Petaluma Valley, and Santa Rosa Plain subbasins. A complete summary of all practitioner work group outcomes will be provided to all Advisory Committees at the conclusion of discussions in the fall of 2020.

The primary focus of the Ag Demands work group has been providing estimates of agricultural contraction or expansion over the 50-year planning horizon of the GSP for major crop types in the three subbasins, including:

- Vineyards
- Irrigated pasture
- Dairies
- Grain and hay crops
- Truck, nursery, or berry crops (including row vegetables and field crops such as hops)
- Orchards/deciduous fruits and nuts
- Cannabis/hemp

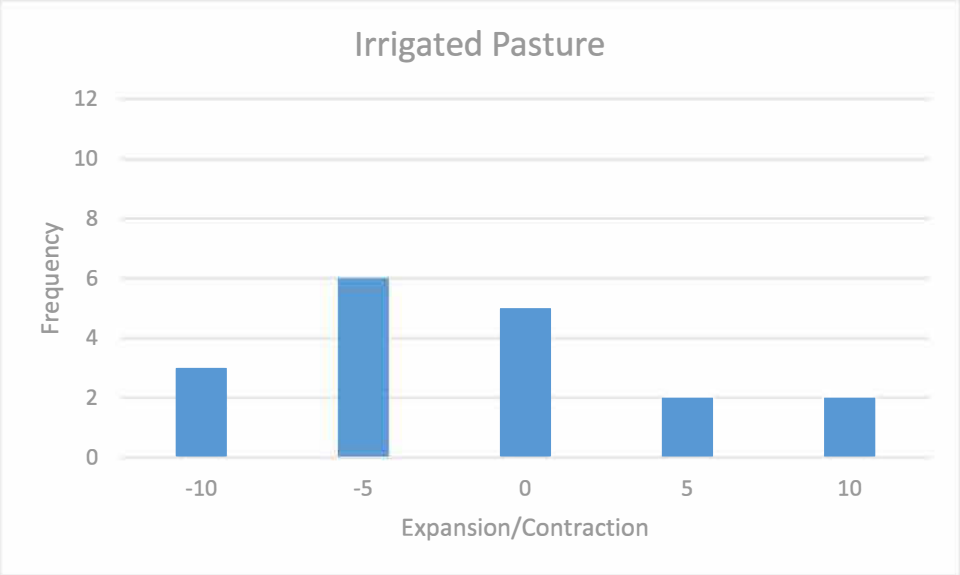
At the June 23rd meeting, work group members estimated that for all crop during the GSP planning horizon, the three subbasins can expect a general reduction of farmed acreage crop types with the exception of vineyards and cannabis/hemp. Work group members did concede that at least in the near term (5-10 years) vineyard production is also likely to contract, primarily due to market forces and an oversupply of grapes. Water supply availability, population growth/land conversion for residential use, and land prices in general were cited as the primary causes for contraction of other agricultural uses.

To further evaluate these assumptions, staff developed survey forms, which were sent to the Agricultural Water Demands Practitioner Work Group (7 respondents) and to agricultural land users in the SRP, SV, and PV (28 respondents). The surveys were distributed in late July and early August of 2020. Both surveys asked respondents about expected expansion or contraction of the following agricultural land uses: vineyards; irrigated pasture; grain and hay; truck, nursery, or berry crops (truck crops); orchards/deciduous fruits and nuts; cannabis/hemp; and other. Note that no respondent described “other”; therefore, this land use will not be addressed here.

There were differences in the surveys. The agricultural land users were asked about short term (10 years) and long term (50 years) changes in agricultural land use, while the practitioners were asked about only short-term changes. The agricultural land users were asked about dairies while the practitioners were not. The agricultural land users were asked if their answers were specific to one of the three groundwater basins and a plurality (13/28) indicated the SRP. It should be noted that some of the practitioners indicated that preserving Tiger Salamander habitat in the SRP will be a constraint to agricultural expansion in that basin.

Figures 1 and 2 show the survey results for expected short-term and long-term agricultural land-use changes, respectively. The short-term results combine the practitioner and land user responses with the exception of dairies, which only reflect the land-user responses. The long-term results only reflect the land-user responses. The X-axis shows the expected expansion or contraction, where -10, -5, 0, 5 and 10 are the percentage change in land use; where a negative value indicates contraction, zero indicates no change, and a positive value indicates expansion. The Y-axis shows the total count or frequency for each land-use change category.


Vineyard
12
10
8
6
4
2
0
Frequency
-10
-5
0
5
10
Expansion/Contraction


Irrigated Pasture
12
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Frequency
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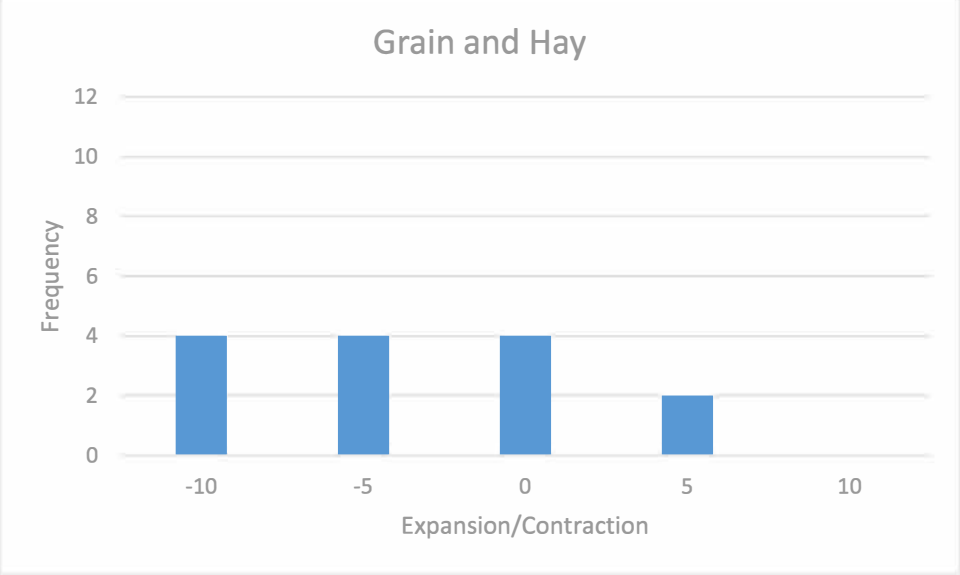
10
Expansion/Contraction


Grain and Hay
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Frequency
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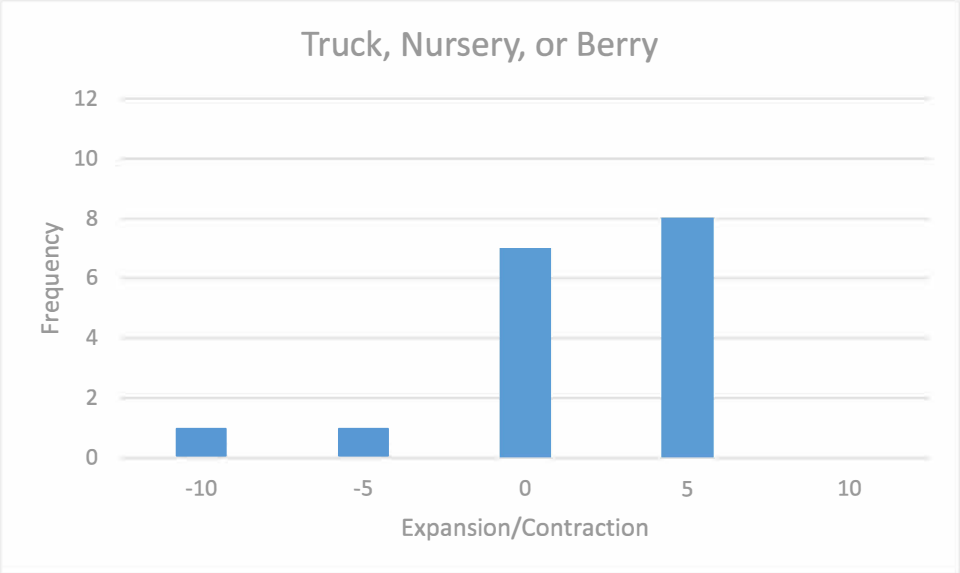
Expansion/Contraction


Truck, Nursery, or Berry
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Frequency
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-5
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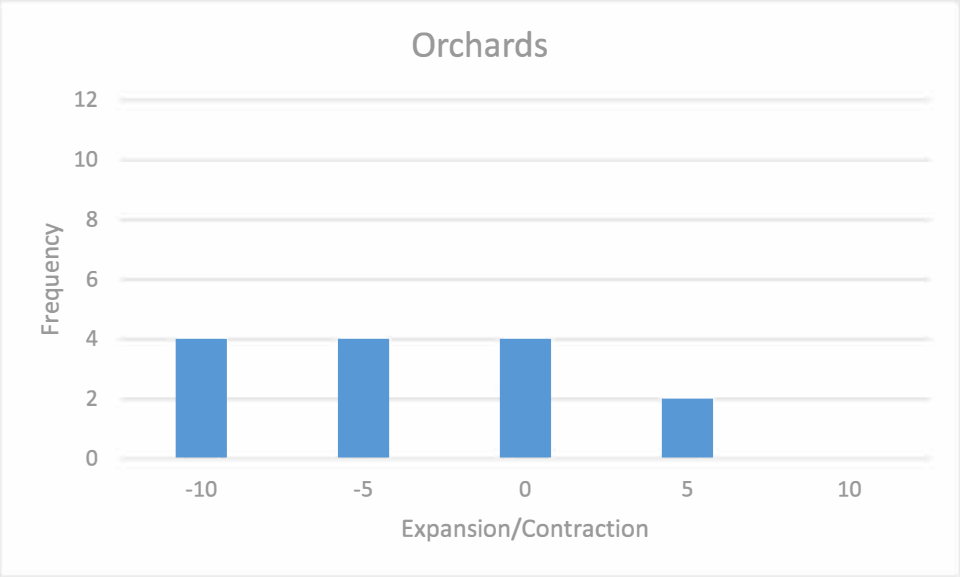
10
Expansion/Contraction


Orchards
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Frequency
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10
Expansion/Contraction

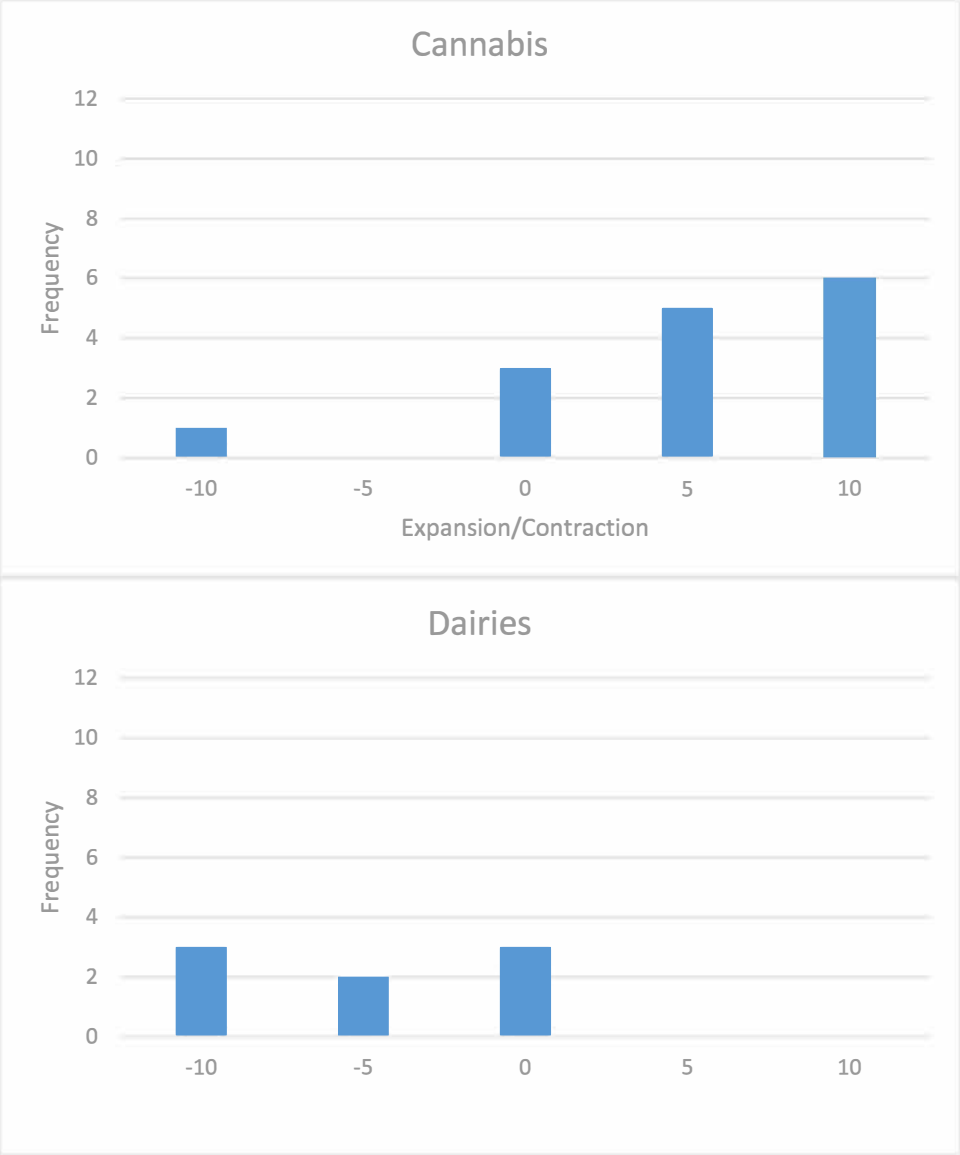
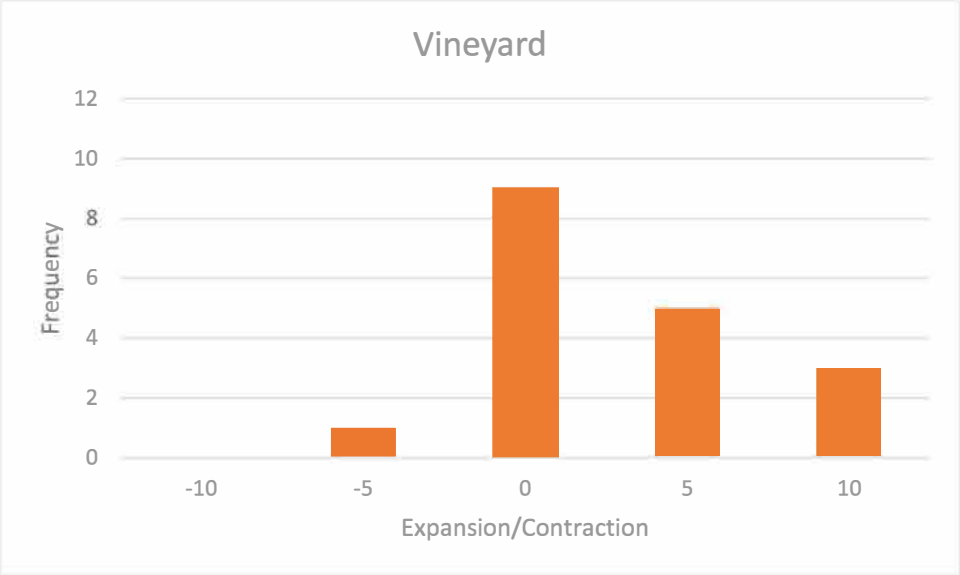


Figure 1. Short-term agricultural land-use changes in the Santa Rosa Plain, Sonoma Valley, and Petaluma Valley.

Consider the expected short-term land-use changes (fig. 1). Vineyards, truck crops, and cannabis/hemp are expected to expand (0-5%, 0-5%, and 5-10%, respectively). The other land uses are expected to contract as much as 10% (dairies).


Vineyard
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Frequency
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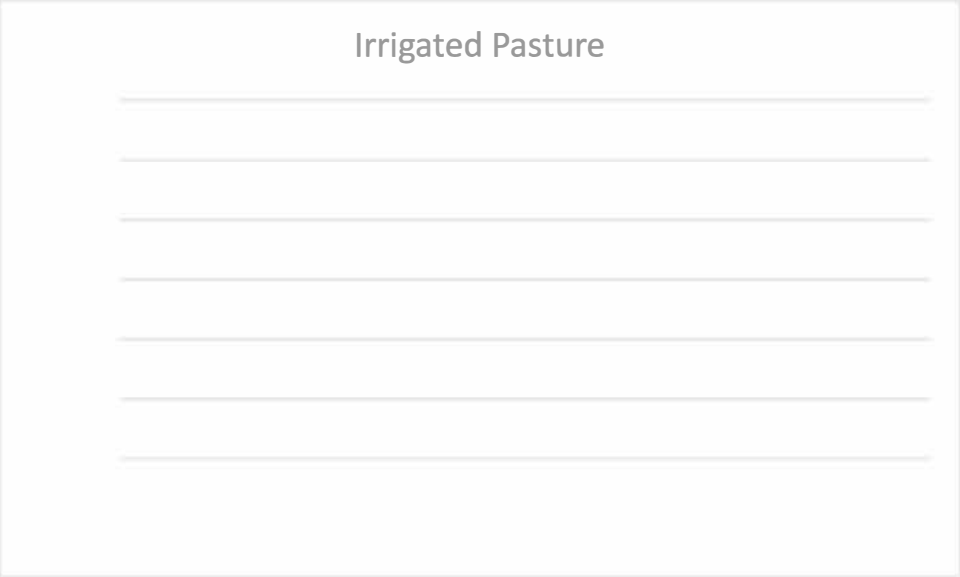
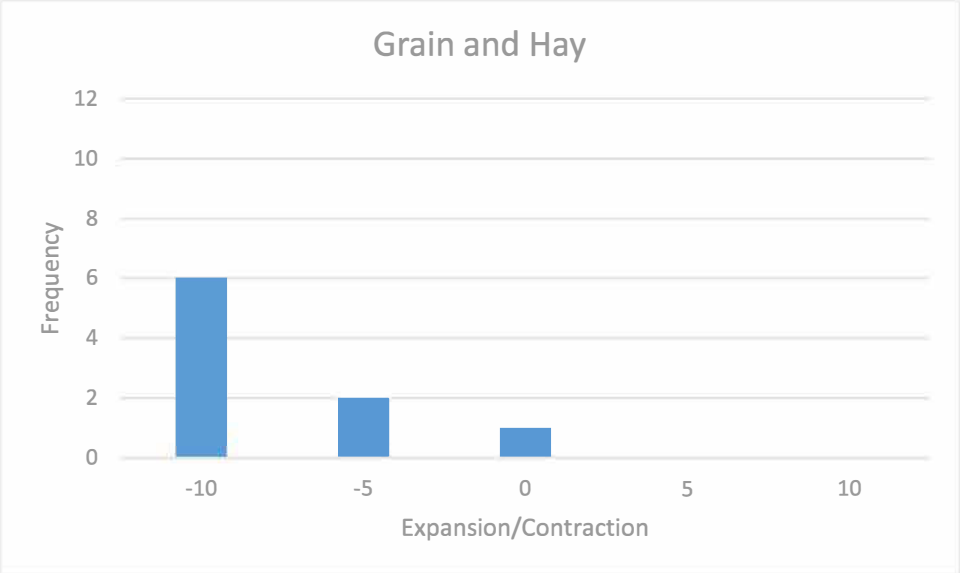
Expansion/Contraction


Irrigated Pasture


Grain and Hay
12
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Frequency
-10
-5
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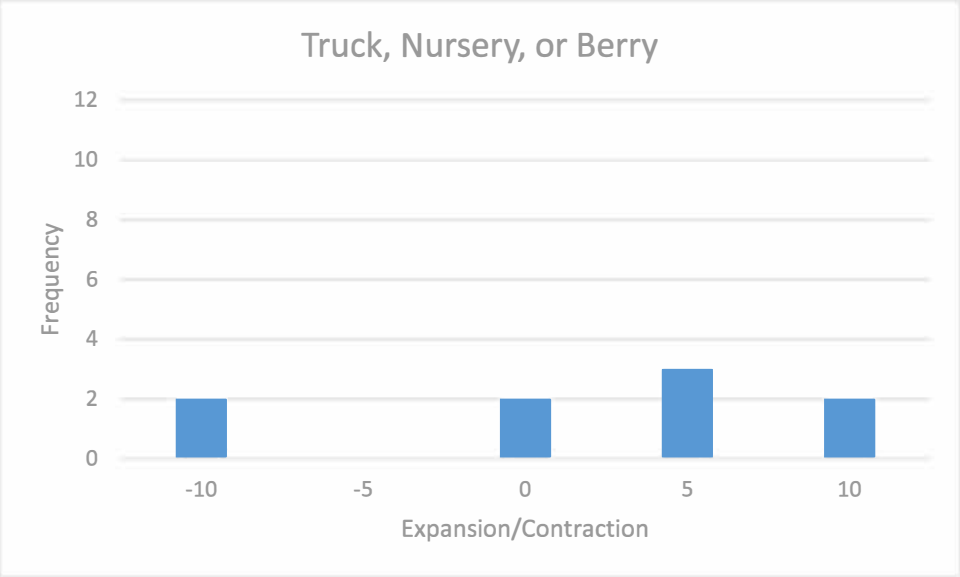
10
Expansion/Contraction


Truck, Nursery, or Berry
12
10
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6
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2
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Frequency
-10
-5
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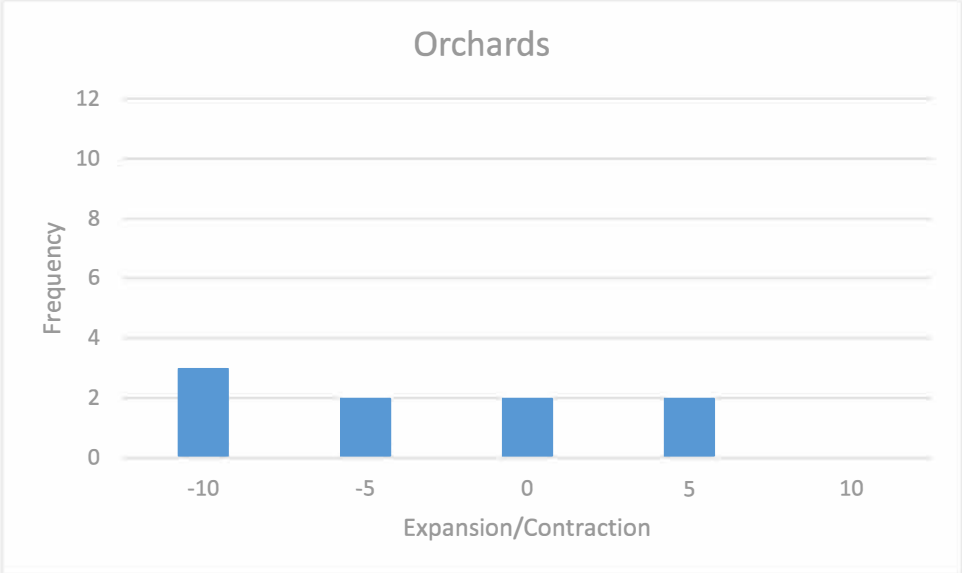
5
10
Expansion/Contraction


Orchards
12
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Frequency
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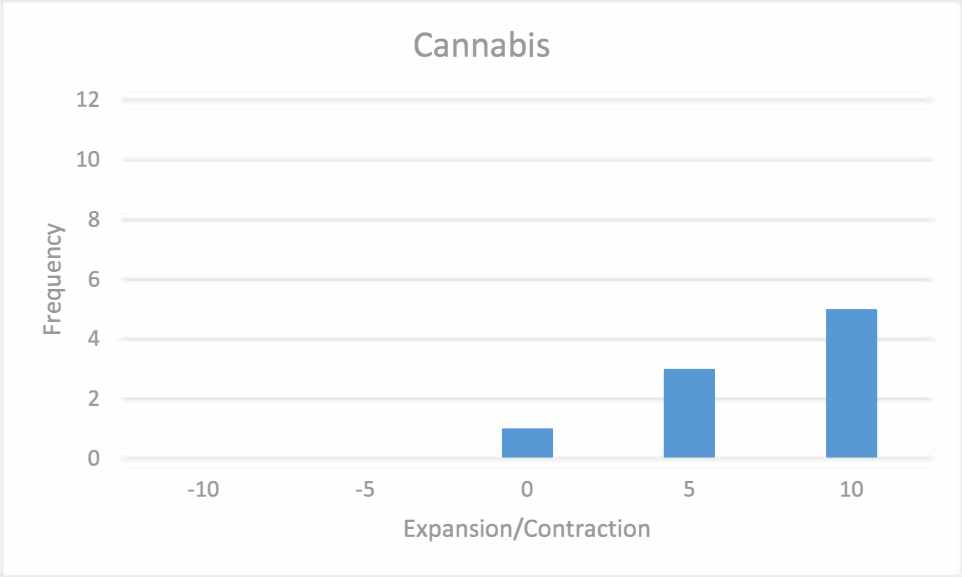
Expansion/Contraction


Cannabis
12
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2
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Frequency
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10
Expansion/Contraction

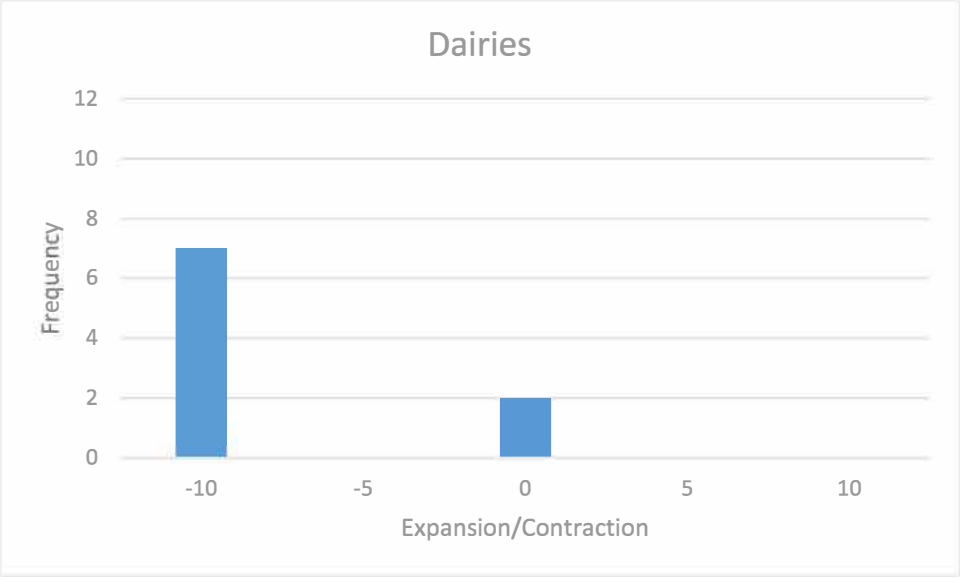


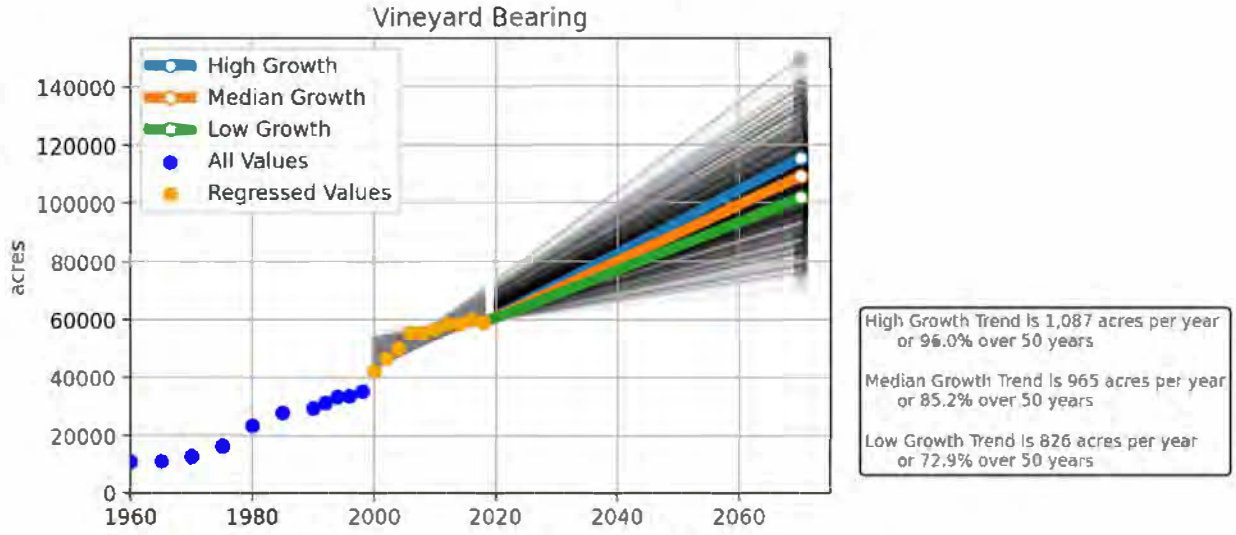
Figure 2. Long-term agricultural land-use changes in the Santa Rosa Plain, Sonoma Valley, and Petaluma Valley.

Consider the expected long-term land-use changes (fig. 2). Vineyards, truck crops, and cannabis/hemp again are expected to expand (0-10%, 0-10%, and 5-10%, respectively); however, a fairly large number of respondents expected truck crops to contract 10%. All the other land uses are expected to contract as much as 10%.

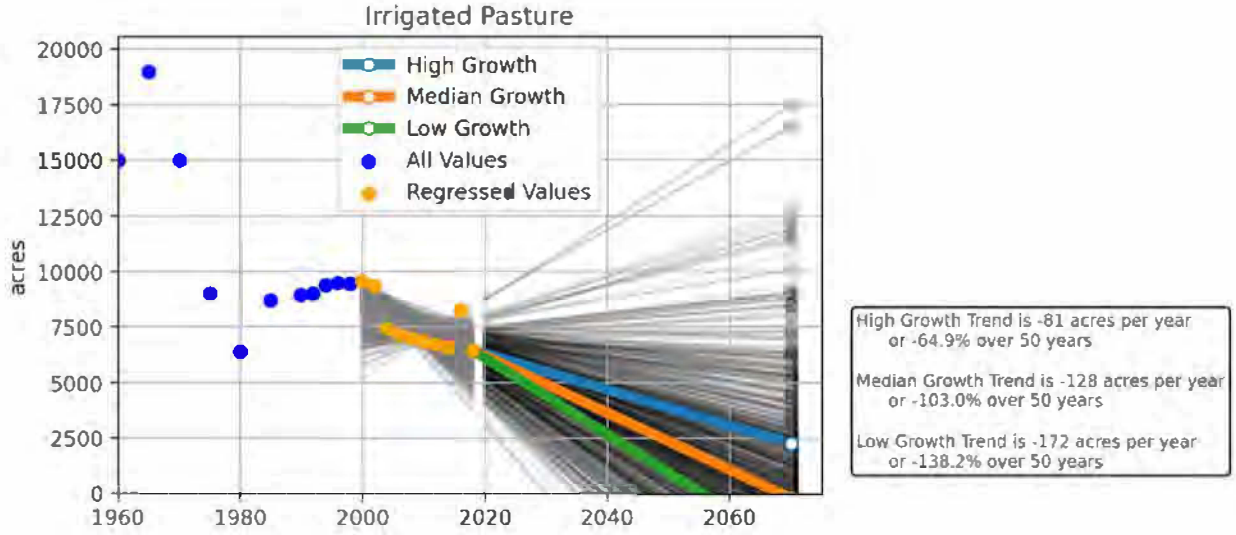
Reported Land-Use Data

In order to provide a comparison of survey results with historical changes in cropping patterns, land-use data from 1960 to 2018 (every 5 years until 1990, then every 2 years thereafter) for vineyards; irrigated pasture; grain and hay; truck crops; and orchards/deciduous fruits and nuts were compiled using Sonoma County crop reports (https://sonomacounty.ca.gov/Agriculture-Weights-and-Measures/Crop-Reports/) and are shown in figure 3. Note that the data compiled from the crop reports and displayed here represent all of Sonoma County. The crop reports reported bearing, nonbearing, and total acreage for vineyards and occasionally for orchards/deciduous fruits and nuts. In addition, the reports reported harvested acreage for the other land uses; it was assumed that harvested acreage was equivalent to bearing acreage. Therefore, bearing acreage is shown in figure 3.

Crop Acreage for All Sonoma County
from Sonoma County Departmept of Agriculture, Weights & Measures
Crop Reports

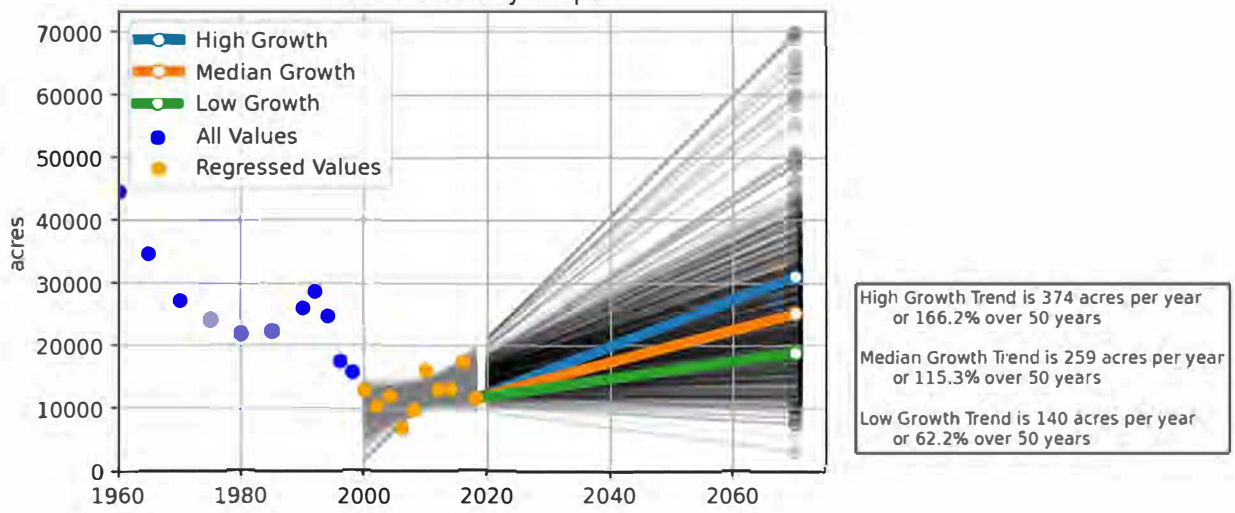


Crop Acreage for All Sonoma County
from Sonoma County Departmept of Agriculture, Weights & Measures
Crop Reports



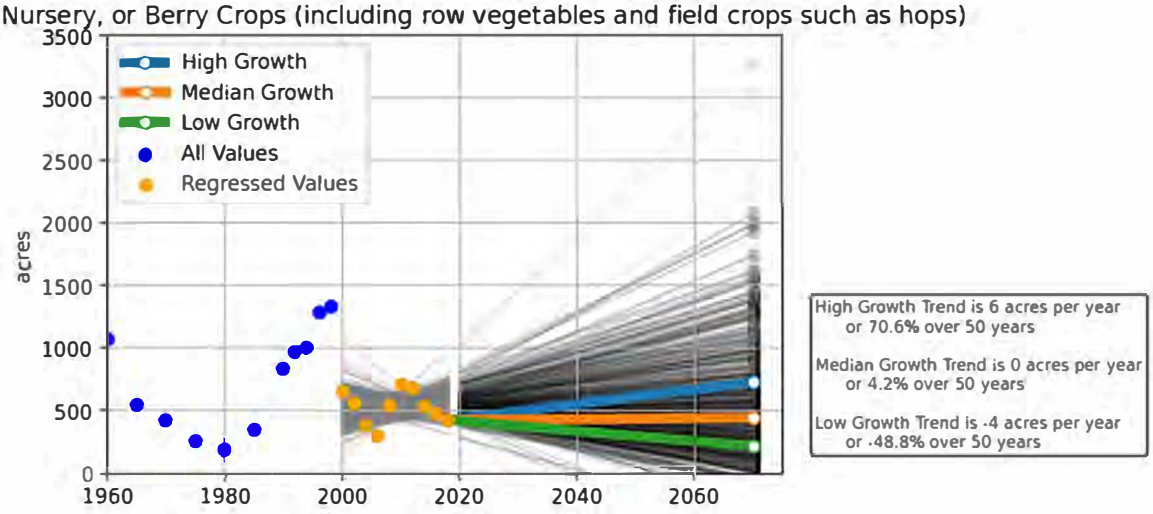
Crop Acreage for All Sonoma County
from Sonoma County Departmept of Agriculture, Weights & Measures
Crop Reports

Grain and Hay Crops



Crop Acreage for All Sonoma County
from Sonoma County Departmept of Agriculture, Weights & Measures
Crop Reports

Truck, Nursery, or Berry Crops (including row vegetables and field crops such as hops)



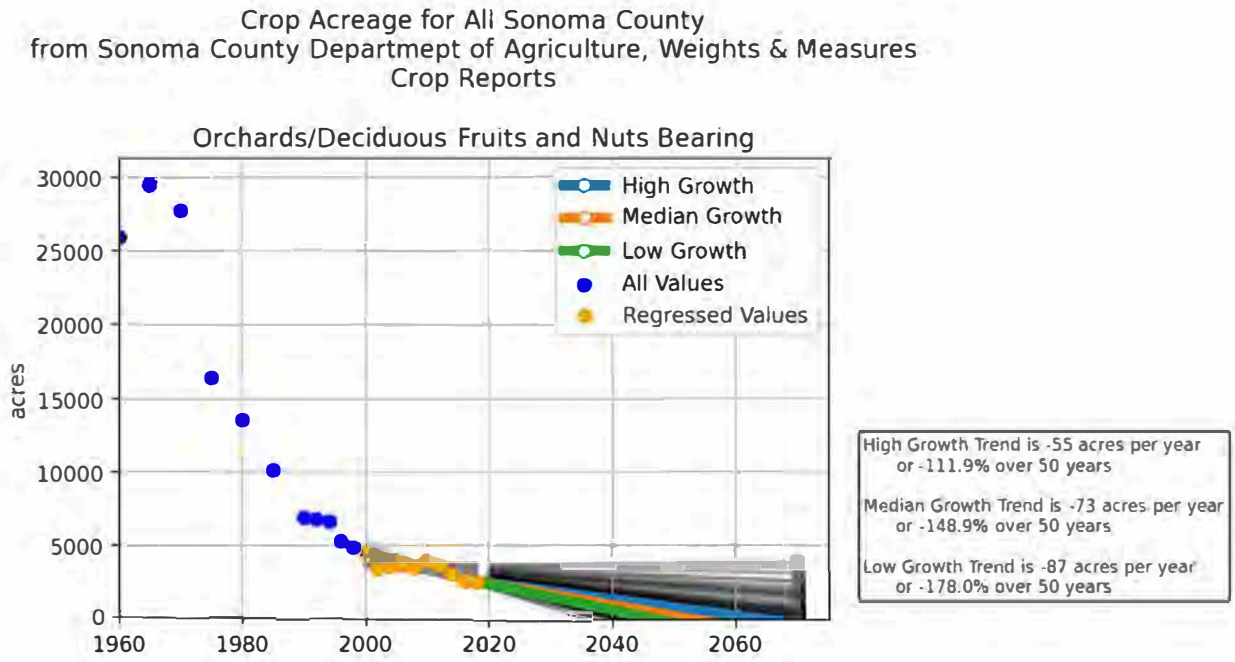


Figure 3: Agricultural land use for vineyards; irrigated pasture; grain and hay; truck crops; and orchards/deciduous fruits and nuts, 1960-2018. Future land use contraction or expansion based on 2000-2018 data.

In addition to the historic land use, the data were extrapolated from 2020 to 2070 based on regressions of the 2000 - 2018 data (fig. 3). An additional regression of the 2008-2018 data was performed for vineyards, as the growth pattern exhibited a more moderate rate during this more recent time period (fig. 4). The regressions include high, median, and low growth trends. Qualitatively, the results indicate that vineyards; grain and hay; and truck crops may expand while irrigated pastures and orchards contract (fig. 3). With the exception of grain and hay, these results generally agree with the survey results. However, the scale of expansion/contraction differ. For example, the regression indicates that vineyard acreage may expand 20% in 10 years and almost 100% in 50 years based on the 2000-2018 data and 10% in 10 years and 48% in 50 years based on the 2008-2018 data (figs. 3 and 4). On the other hand, the regression indicates that irrigated pastures may contract 50% in 10 years and almost 140% in 50 years (fig. 3). The survey results indicated an expected 0-10% expansion of vineyards and an expected 5-10% contraction of irrigated pastures within 50 years (fig. 2).

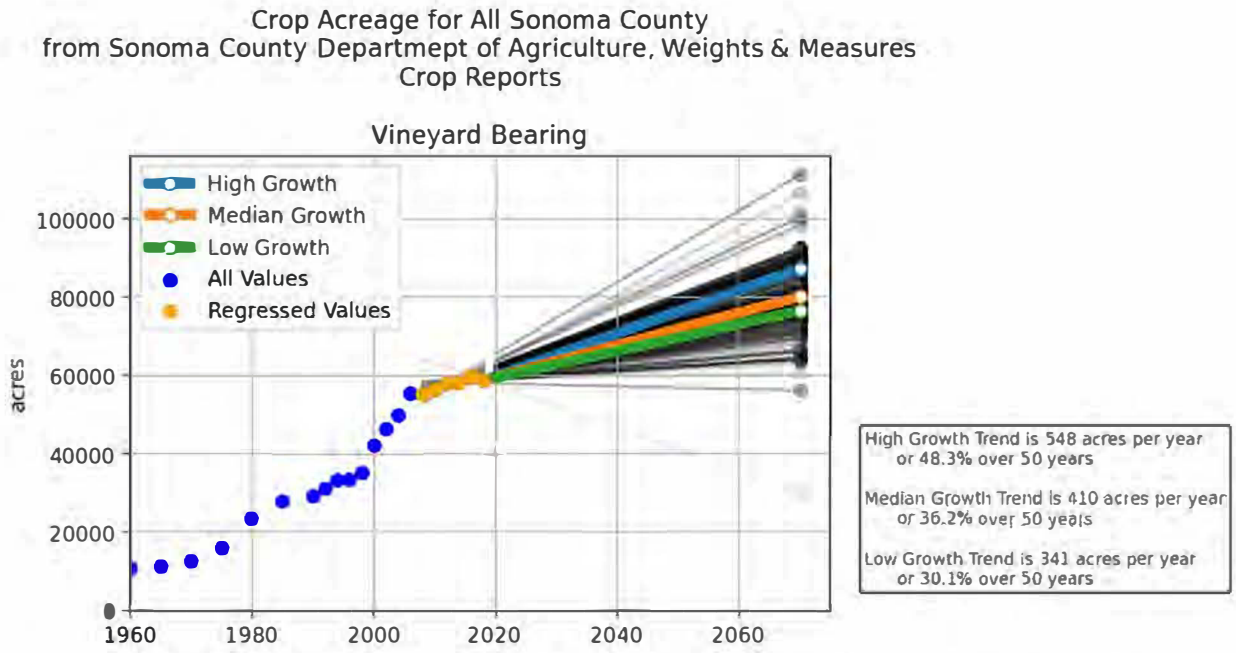


Figure 4. : Agricultural land use for vineyards, 1960-2018. Future land use contraction or expansion

Simulating Land-Use Change

The survey results must be incorporated into quantitative land-use projections for use in the GSPs. Sonoma Water, as part of its efforts to develop a groundwater-flow model of the Sonoma Valley, has developed an algorithm to estimate the change in vineyard acreage in the Sonoma Valley (Andrew Rich, Sonoma Water, personal communication, 2020). The algorithm uses changes in vineyard acreage between 1999 and 2012 to estimate growth rates and the probability that a parcel will be converted to a vineyard based on physical characteristics (e.g. slope, elevation, aspect, soil type, etc.), as well as possible constraints, such as conservation easements, and zoning of the parcel. The algorithm will be modified to address additional crops and the conversion of crops expected to contract in the area to crops expected to expand.

Specifically, the algorithm will be modified to include truck crops and, possibly, grain and hay. Although cannabis is expected to expand in the short and long term, the current acreage is so small (e.g., currently about 40 acres in the SRP) that even a 10% increase in acreage will result in a small total area (and relatively small projected water use at the basin-wide scale); therefore, cannabis will not be addressed here. Additionally, although the potential for future projected development of hemp as a crop in the basin was raised by several practitioners and land-user responders, hemp crops are not being simulated for the initial GSPs due to uncertainties related to any potential future cultivation of hemp and associated farming practices. Should cultivation of hemp occur at a significant scale during the early stages of GSP implementation, hemp can be included when updating future projections during 5-year GSP updates.

The projected growth rates can be defined by the survey or regression results. Staff will discuss options for simulating the growth rates at the practitioner workgroup's next meeting on October 15, 2020. The conversion probabilities will be modified to address vineyards and truck crops (and possibly grain and hay) and the physical characteristics of available, unused land as well as land being cultivated by crops expected to contract will be addressed. The land will assumed to be converted based on the conversion probabilities with the lands with the highest probabilities being converted first.

Agricultural Water Demands Practitioner Work Group; Summary Report/Update to Sonoma County GSA Advisory Committees

Agricultural Water Demands Practitioner Work Group

Summary Report/Update to Sonoma County GSA Advisory Committees

January 4, 2021

Work Group Overview

The Agricultural Water Demand Projections Practitioner Work Group was assembled to help develop estimates of future changes in crop acreage to inform water demand projections in three Sonoma County groundwater basins/subbasins (Sonoma Valley, Petaluma Valley, and Santa Rosa Plain) over the 50-year planning horizon for Groundwater Sustainability Plans (GSPs). Specifically, work group members were asked to consider whether acreage for the following major crop types are likely to contract, stay the same, or expand over the 50-year planning horizon:

- Vineyards
- Irrigated pasture
- Dairies
- Grain and hay crops
- Truck, nursery, or berry crops (including row vegetables and field crops such as hops)
- Orchards/deciduous fruits and nuts
- Cannabis/hemp

The work group met on June 23rd, August 6th, and October 15th; members include:

- Keith Abeles, Sonoma County Resources Conservation District
- Andy Casarez, Sonoma County Agricultural Commissioner
- Nick Frey, representing vineyard interests
- Brittany Heck, representing non-vineyard agriculture
- Rhonda Smith, UC Cooperative Extension
- Tawny Tesconi, Sonoma County Farm Bureau

At the June 23rd meeting, work group members estimated that for all crops during the GSP planning horizon, the three subbasins can expect a general reduction of farmed acreage crop types with the exception of vineyards and cannabis/hemp. Many work group members further indicated that in the near term (5-10 years) vineyard production could contract, primarily due to market forces and an oversupply of grapes. Water supply availability, population growth/land conversion for residential use, and land prices in general were cited as the primary causes for contraction of other agricultural uses.

To further vet these assumptions, staff developed a survey for work group consideration in advance of the August 6th work group meeting. In responding to the survey, a majority of work group participants said that a significant contraction of farmed acreage (defined as at least 5% of total acreage per year) should be expected for the following crop types:

- Dairies
- Grain and hay crops
- Orchards/deciduous fruits and nuts

- Irrigated pasture

Likewise, a majority of work group participants felt that the following crops types would experience either a continuation of existing farmed acreage or expansion:

- Vineyards
- Truck, nursery, or berry crops (including row vegetables and field crops such as hops)
- Cannabis/hemp

During the August 6th meeting, work group members generally confirmed these results, but noted that projections are highly uncertain due to a number of unforeseeable factors. That said, they agreed that common assumptions such as rising land value and cost of production will be determinative factors in overall agricultural production (and the corresponding water usage by crop type). They requested a similar survey be distributed to a larger group of growers in the subbasins to confirm these assumptions. Sonoma Farm Bureau offered to distribute the survey to its members, the Community Alliance with Family Farmers (CAFF), and the California Winegrape Commission on August 18th.

Public Survey Results

As noted, a survey was developed to poll agricultural practitioners in the three subbasins. 43 practitioners provided response; geographic distribution of respondents is provided in figure 1 below. Additionally, 19 or 43 respondents owned or operated vineyards, 7 indicated non-vineyard, unspecified agricultural operations, and the remaining 17 declined to state their business or organization.

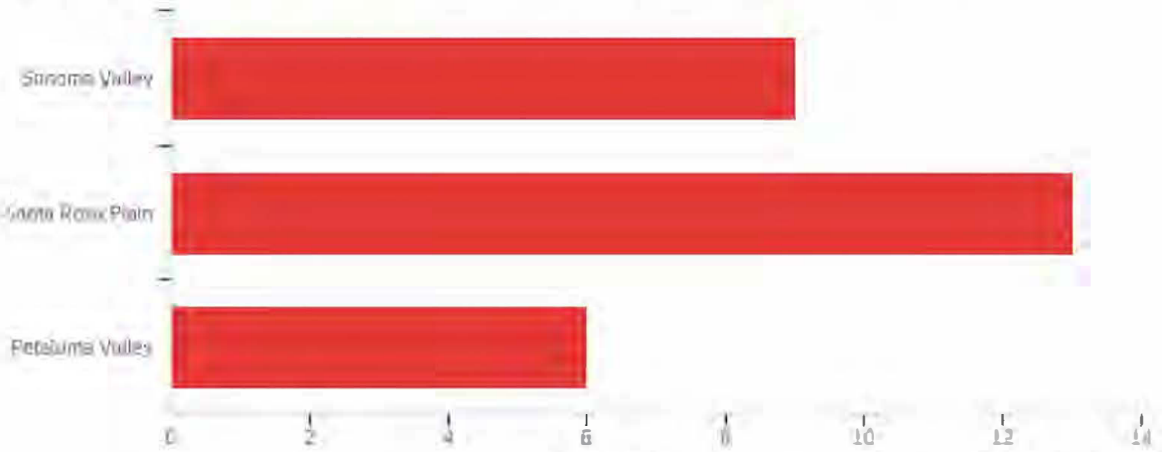


Figure 1: Geographic distribution of survey respondents

Public survey responses were generally in line with feedback received from work group members, and included the following key takeaways:

- General continuation or reduction of farmed acreage for all crop types except truck, nursery, or berry crops and cannabis/hemp.
- Water supply availability, population growth, land conversion and prices and market forces were cited as the primary reasons for the agricultural contractions.
- Responses on vineyard acreage ranged from substantial contraction to moderate expansion.

Extrapolated Historical Crop Data

In order to place the survey results within the frame of reference of historical changes in cropping patterns, land-use data from 1960 to 2018 (every 5 years until 1990, then every 2 years thereafter) for vineyards; irrigated pasture; grain and hay; truck crops; and orchards/deciduous fruits and nuts were compiled using Sonoma County crop reports (https://sonomacounty.ca.gov/Agriculture-Weights-and-Measures/Crop-Reports/).

The historical trends for each crop group were then extrapolated from 2020 to 2070 based on statistical regressions of the 2000 - 2018 county-wide crop report data. The regressions include high, median, and low growth trends correlating with the 75%, 50% and 25% percentiles. **Attachment 1** includes a memorandum with all survey results and analysis of trends in historical crop acreage, which was provided to work group members, Advisory Committee and Boards at their October meetings.

During the October 15th meeting, work group members noted that the relatively high historical growth trends for vineyards from 2000 – 2018 are likely not indicative of future trends. One work group member suggested further evaluating potential changes to vineyards by researching available market information from industry information sources, such as the Wine Market Council; Wine Institute; Turrentine, Gomberg & Frederickson; and Ciatti Global Wine and Grape Market reports. Research into available information from these sources, which are primarily focused on near-term markets for bulk wine and grapes, generally indicated that the underlying driver for wine demand--alcohol consumption generally and wine specifically--has been flat, and wineries & wine marketing organizations are working to grow that demand (with many sources noting the substantial uncertainty surrounding the future). However, no quantified future projections were identified through this additional research.

In order to help account for this information and work group member input, the historical cropping trends for vineyard projections were scaled downward by utilizing only the more recent (2008-2018) historical crop trends. Evaluation of the historical growth pattern for vineyards indicates this time period exhibits a more moderate increase in acreage in comparison with the longer-range 2000-2018 time period used for other crops and better reflects more recent trends for this crop (fig. 4 of Attachment 1).

Proposed Approach

At the October 15th work group meeting, staff provided a suggested approach for 50-year crop projections, consisting of:

- Calculating a range of projections for each crop type based on survey results and historical land use with data extrapolated through 2070;
- Utilizing the calculated mid-range of these high/low projections for the 50-year projected water budget.

Staff then used a combination of the survey results and historical extrapolated data to develop the proposed cumulative projection ranges for each crop type across all three basins. The higher (more positive/less negative) of the growth rates from the opinion polls and the historical extrapolated data is used for the high growth projections and the lower (less positive/more negative) is used for the low growth projections. In order to balance and help reconcile the practitioners input on projected cropping changes with the historical extrapolated data, the following procedure was followed:

- Where the most frequent survey responses indicated expansion (positive growth), the high historical extrapolated trend was used for the ranges;
- Where the most frequent survey responses indicated no or negligible growth, the median historical extrapolated trend was used for the ranges;
- Where the most frequent survey responses indicated contraction (negative growth), the low historical extrapolated trend was used for the ranges.

. The calculated proposed high, mid-range, and low growth trends, are as follows:[1]

Vineyards

- High growth: 36% increase over 50 years or 199 acres per year (based on the median historical extrapolated trend)
- Low growth: 0% over 50 years or 0 acres per year (most frequent survey response)

Proposed 50-year GSP projections (mid-range): increase of 100 acres per year or a 18% increase over 50 years (total 4,978 acre increase over 50-years across the three basins/subbasins)

Irrigated pasture

- High growth: 10% decrease over 50 years or -9 acres per year (based on most frequent survey response)
- Low growth: 138% decrease over 50 years or -122 acres per year (based on the low historical extrapolated trend)

Proposed 50-year GSP projections (mid-range): decrease of 57 acres per year or a 65% decrease over 50 years (total 2,872 acre decrease over 50-years across the three basins/subbasins)

Grain and hay crops

- High growth: 62% increase over 50 years or 31 acres per year (based on the low historical extrapolated trend)
- Low growth: 10% decrease over 50 years or -5 acres per year (most frequent survey response)

Proposed 50-year GSP projections (mid-range): increase of 13 acres per year or a 26% increase over 50 years (total 654 acre increase over 50-years across the three basins/subbasins)

Truck, nursery, or berry crops (including row vegetables and field crops such as hops)

- High growth: 70% increase over 50 years or 23 acres per year (based on the high historical extrapolated trend)
- Low growth: 5% over 50 years or 2 acres per year (most frequent survey response)

Proposed 50-year GSP projections (mid-range): increase of 12 acres per year or a 38% increase over 50 years (total 611 acre increase over 50-years across the three basins/subbasins)

[1] Cannabis and hemp projections were not included at this time, as total farmed acreage is currently negligible and limited historical data is available to extrapolate projections. Staff will re-evaluate inclusion of cannabis/hemp projections in the 5-year update to the GSP.

Orchards, deciduous fruits and nuts

- High growth: 10% decrease over 50 years or -2 acres per year (based on most frequent survey response)
- Low growth: 178% decrease over 50 years or -34 acres per year (based on the median historical extrapolated trend)

  Proposed 50-year GSP projections (mid-range): decrease of 18 acres per year or a 94% decrease over 50 years (total 893 acre decrease over 50-years across the three basins/subbasins)

Application of Projections into 50-Year Water Budgets

Based on the proposed projections above and subsequent input from the Advisory Committees in all three subbasins and work group members, staff will develop the projected 50-year water budgets using the mid-range growth trends for each crop. The procedures for geographically distributing the changes in cropping patterns for the 50-year model simulations are described in the following section, titled Converting Agricultural Projections to Spatial Projections Using the Agricultural Expansion and Contraction Model. The projections take into account physical characteristics (e.g. slope, elevation, aspect, soil type, etc.), as well as possible constraints, such as conservation easements, and parcel zoning. The projected land use changes detailed in the report will then be used as input datasets for each groundwater flow model which calculate the associated groundwater demands for each crop after taking into account available information on irrigation practices and availability of recycled water or surface water sources.

Rural Residential Housing Unit Projections

TO: **Sonoma County Groundwater Sustainability Agencies**

FROM: **Pete Parkinson, AICP**

DATE: **December 22, 2020**

SUBJECT: **Rural Residential Housing Unit Projections**

This memo summarizes the methodology used to develop a range of rural residential housing unit projections for use with the required projected water budgets for the three Groundwater Sustainability Plans (GSPs). These projections include rural residential growth anticipated to rely on groundwater in the three basins, including water from individual domestic wells and from independent water systems that rely on groundwater (e.g., mutual water companies and similar entities). The projections do not include development where water is provided by a large public water system[1]. The projections cover the entire 50-year planning horizon in the GSPs (2022 to 2072) and are summarized in the attachment.

Public agencies typically do not generate 50-year projections, mainly because of the considerable uncertainty associated with future land use and economic conditions. The starting point for most projections is the local general plan, in this case Sonoma County's *General Plan 2020*. However, the projections in General Plan 2020 only extend to the Plan's horizon year of 2020, so another source for data and projections is needed. It is noted that the California Department of Finance projects a 15 percent decline in Sonoma County's population by 2060, but this projection is not useful for estimating the rural residential subset of Sonoma County's land use future.[2]

Despite the lack of projections beyond the General Plan horizon year, this analysis assumes that the foundational planning policies adopted by the County and the incorporated cities will remain in place for the duration of the GSP. These adopted planning policies focus most residential growth into the cities and designated unincorporated urban service areas. All nine cities in Sonoma County have voter-adopted urban growth boundaries, which are assumed to remain in effect throughout the GSP planning period. As a result of these policies, residential growth in the rural areas has historically been low and is expected to remain that way into the foreseeable future.

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[1] For analysis purposes, large public water systems include municipal purveyors and other public water systems serving over 500 connections. Most of these large public water system service areas are included in water demand projections through 2045 that are currently under development for 2020 Urban Water Management Plans (UWMPs). These UWMP projections will help inform the development of future groundwater projections in service areas for large public water systems.

[2] California Department of Finance. Demographic Research Unit. Report P-2A: Total Population Projections, California Counties, 2010-2060 (Baseline 2019 Population Projections; Vintage 2019 Release). Sacramento: California. January 2020.

While the local land use plan does not provide useful projections, the Sonoma County Transportation Authority (SCTA) develops and maintains a countywide transportation model as part of the Comprehensive Transportation Plan (CTP) to forecast future traffic volumes and patterns. The current CTP has a horizon year of 2040. The transportation model includes projections of land use changes (residential and non-residential) in approximately 900 Traffic Analysis Zones (TAZs) throughout the County. These land use projections at the TAZ level are based on the projections in PlanBayArea 2040,[3] supplemented with a finer-grained analysis of local development activity and consideration of general plan buildout capacity, based on input from local planning agencies. In addition to the 2040 land use projections, the SCTA model has the added advantage of providing a geographic distribution of the projected housing unit growth.

Using SCTA's TAZ data, we have developed rural residential growth projections for three scenarios that provide a high, medium, and low range of growth rates, as shown in the attachment. The "low" scenario corresponds to general plan buildout, which is low mainly because of the short time horizon for the current general plan but relies on the geographic distribution from the SCTA model. The "medium" scenario is based on PlanBayArea 2040 and the "high" scenario is 25 percent above PlanBayArea 2040. Separate projections were made for areas within each groundwater basin and for areas in the contributing watershed for each basin which are also included in the domains of the models which will be used to estimate the projected water budgets. These are shown as "in-basin" and "watershed," respectively, on the attachment. The geographic distribution of future growth is the same for each scenario and is based on the land use projections in SCTA's model.

The following paragraphs describe how these projections were developed to ensure that we are only looking at rural residential growth that affects groundwater demand.

- The analysis excludes any portion of a TAZ that is either outside the basin or watershed (as the case may be), or within a large public water system.[4] Areas within a large public water system service boundary will be accounted for in the groundwater model by taking into account data projections from 2020 UWMPs or other water system projections currently being developed. GIS data was used to calculate the percentage of land area in each TAZ that is relevant to this analysis (i.e., within a basin but outside a municipal boundary). That percentage was then applied to the SCTA model's housing

[3] The regional planning agency for the Bay Area, ABAG/MTC, develops population and housing projections for each city and county in the region as part of the Regional Transportation Plan and Sustainable Communities Strategy. The current version of this plan, PlanBayArea 2040, includes projections to the year 2040.
[4] Large public water systems include the Town of Windsor; Cal-Am (California-American Larkfield PUC service area); the cities of Santa Rosa, Rohnert Park, Cotati, Petaluma, Sonoma and Sebastopol; Penngrove (used geographic extent of Penngrove detailed in the US Census TIGER database); and the Valley of the Moon Water district.

unit projections to arrive at an adjusted projection for each TAZ. The resulting data and projections were further analyzed for anomalous situations.

- Most anomalies occurred where a TAZ straddles a municipal boundary, but the projected housing unit growth will occur within the municipality, not in the rural portion of the TAZ. Since growth in the rural areas is expected to be relatively low, these anomalies were identified by scanning for TAZs that showed a high growth rate (e.g., more than a 25% increase over 25 years). These TAZs were then checked on a map to determine whether growth would likely occur within the municipal boundary or in the rural area. In nearly every situation where this was checked, the likely growth was determined to be within the municipal boundary, not in the rural area, so the projections for that TAZ were adjusted downward.

- In the community of Penngrove (part of the Petaluma Valley Subbasin), domestic water is provided by the privately owned Penngrove Water Company. Within this portion of its service area, the PWC uses water from the Sonoma Water aqueduct rather than groundwater, so this usage should not be included in groundwater demand projections. However, the PWC service area map does not correspond to the location of actual connections (actual connections are in a much smaller area). Considering this, the Penngrove area defined by the TIGER Census database was used as the service area instead of the published service area as it reflects the likely extent of the service area. The portion of the PWC service area outside of Penngrove relies on groundwater (most notably the Canon Manor West area in the Santa Rosa Plain Basin) and is included in the rural residential projections.

- The numerous mutual water companies in the three basins create an additional issue because geographically dispersed rural residential parcels draw water from a single shared well (or well field). For these areas, the projected growth will be distributed throughout the relevant TAZs as described above, but the current baseline groundwater pumping for the mutual water company will be assigned to the known location of the water company well(s), where data is available. Projections of housing unit growth in TAZs encompassing mutual water companies should not be interpreted as projections for those water providers; no attempt was made to project housing unit growth or future water demand for mutual water companies but additional housing unit development is accounted for at the TAZ level. It is noted that the areas served by most mutual water companies are largely built out and substantial additional residential development is not anticipated.

- Since the low-growth TAZ level projections based on SCTA's model only went to 2040, these figures were extrapolated out to 2072. This was a straight-line extrapolation based on the growth rates calculated in each TAZ from 2015 to 2040 (the period covered in SCTA's model). Consideration was given to decreasing the growth rate after 2040 as the County's rural areas approach buildout, but a straight-line extrapolation was

chosen due to the considerable uncertainty with long-range projections. The projected growth was divided evenly into 5-year increments to correspond to the time frames in the groundwater model.

- The figures in the attachment do not include Accessory Dwelling Unit (ADU) development in the rural areas. However, ADUs will be accounted for in the groundwater model by including a water use factor based on new ADUs as a percentage of new dwelling units. Data from 2014 to 2018 shows that, on average, the number of new ADUs was 25 percent of the number of new dwellings (with a low of 15% and a high of 35% per year). The water use factor assumes that ADUs do not result in additional outdoor water use, so the per-unit water use factor for new ADUs is a fraction of that used for new dwellings.

- While these projections were in development, the ABAG and MTC were (and remain) in the process of updating PlanBayArea to a 2050 horizon year. A key feature of this regional planning process is the Regional Housing Needs Allocation process, or RHNA. The RHNA process provides the number of new housing units that each city and county must plan for over the next eight-year planning period (2022-2030). Although the RHNA process is not finalized, preliminary information indicates jurisdictions throughout the Bay Area are likely to receive a substantially larger housing allocation in this upcoming cycle. Substantial uncertainty remains about the final RHNA numbers. The RHNA process and the planning necessary to distribute these additional housing units at the jurisdictional level will not be completed in time to be integrated into the initial GSPs. Given this timing and the substantial uncertainty surrounding the RHNA numbers themselves, no attempt was made in this analysis to forecast future housing based on new RHNA numbers.

As shown in the attachment, the growth rates in the three groundwater basins are projected to be quite low under the low, medium, and high growth scenarios. Even the “high” growth scenario shows less than 1 percent growth annually. As discussed above, this is to be expected in the rural areas of the County. Nonetheless, the three scenarios provide a reasonable range of projected rural residential housing unit growth.

These projections will be revisited and updated for each 5-year update of the GSP. The projections contained in the SCTA traffic model will remain a useful tool for medium-term projections (i.e., 20 years) and the TAZs will remain useful for projecting the geographic distribution of rural residential growth. In the first 5-year GSP interval, the upcoming round of RHNA allocations will be finalized and local planning agencies will complete the planning necessary to distribute those additional housing units throughout their respective communities. In addition, the County will likely make substantial progress and perhaps even complete its General Plan update, which will provide useful insights and updated population and housing forecasts.

In addition to using the adopted planning documents for each update of rural residential growth, it is recommended that permitting activity be tracked in each basin and watershed, at the TAZ level if possible. This will help validate the results obtained using the SCTA model data and improve the accuracy of projections over time as implementation of the GSPs occurs.

Attachments:

Figure 1 Petaluma Valley Rural Residential Growth Projections **7**
Figure 2 Santa Rosa Plain Rural Residential Growth Projections **8**
Figure 3 Sonoma Valley Rural Residential Growth Projections **9**

Table 1 Rural Residential Housing Projections **6**

Table 1 Rural Residential Housing Projections

		Low		Medium		High	
	2015 Baseline Housing Units	Annual Rate	Total New Housing Units	Annual Rate	Total New Housing Units	Annual Rate	
Sonoma Valley, In Basin	2987	**0.2%**	**340**	**0.6%**	**986**		
Sonoma Valley, Watershed	2843	**0.1%**	**98**	**0.4%**	**630**		
Petaluma Valley, In Basin	1021	**0.1%**	**67**	**0.5%**	**286**		
Petaluma Valley, Watershed	1399	**0.1%**	**44**	**0.1%**	**101**		
SRP, In Basin	7116	**0.2%**	**612**	**0.5%**	**2077**		
SRP, Watershed	5649						**2170**

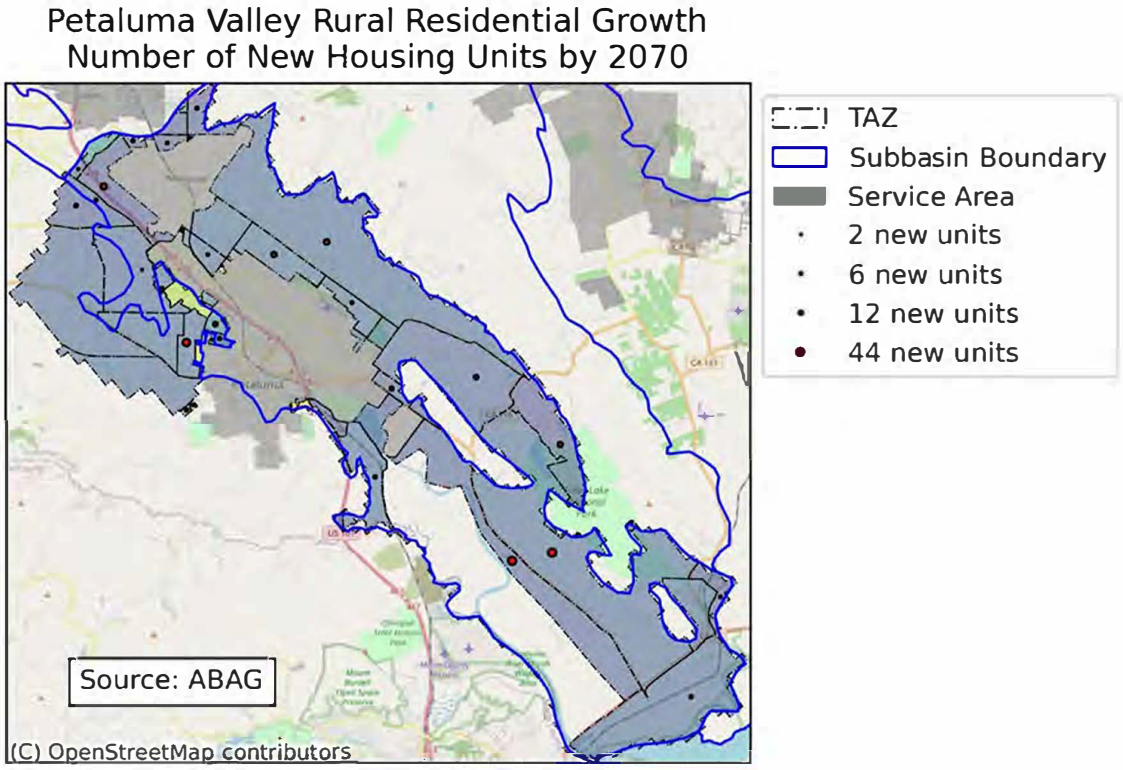

Figure 1 Petaluma Valley Rural Residential Growth Projections

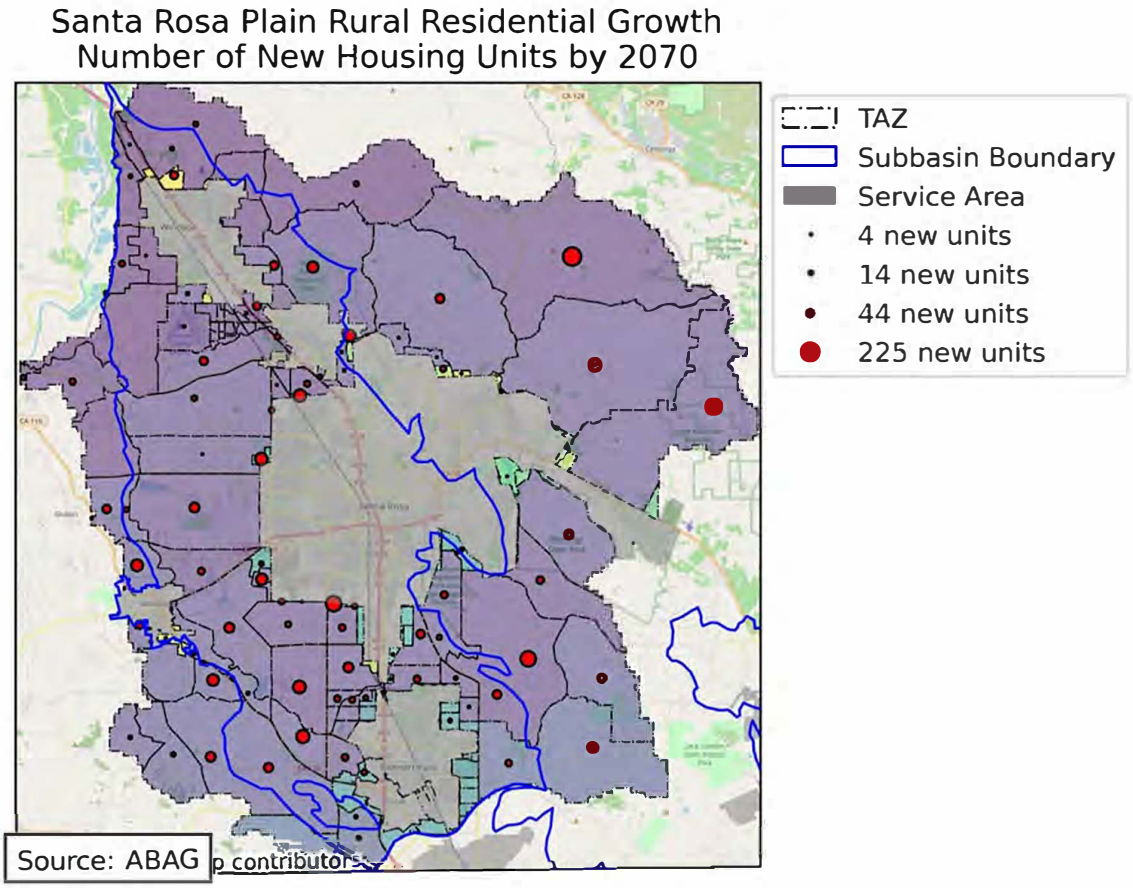

Figure 2 Santa Rosa Plain Rural Residential Growth Projections

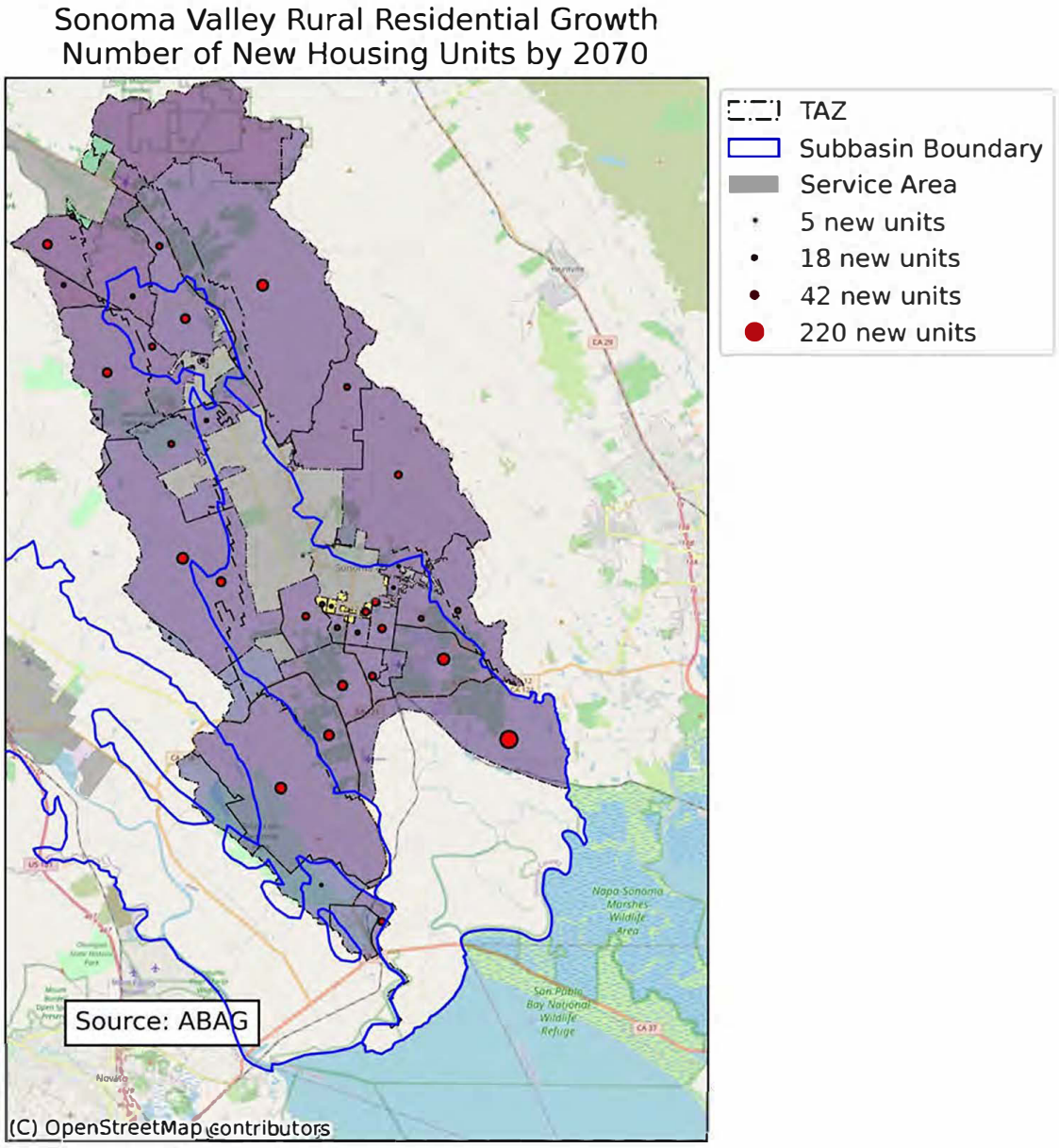

Figure 3 Sonoma Valley Rural Residential Growth Projections

Converting Agricultural Projections to Spatial Projections Using the Agricultural Expansion and Contraction Model (AECM)

Sonoma Water

Andrew Rich

April 13, 2021

Figure 1 Locations used for AECM 5
Figure 2 Land Use 6
Figure 3 Elevation for AECM 7
Figure 4 Slope for AECM 8
Figure 5 Precipitation for AECM 9
Figure 6 Temperature for AECM 10
Figure 7 Bedrock Depth for AECM 11
Figure 8 Hydrologic Soil Group 12
Figure 9 Converting Raw Expansion Values to Model Cell Crop Expansion Rankings 13
Figure 10 Model Cells Used for AECM predictions, Petaluma Valley Subbasin 14
Figure 11 Model Cells Used for AECM predictions, Santa Rosa Plain Subbasin 14
Figure 12 Model Cells Used for AECM predictions, Sonoma Valley Subbasin 15
Figure 13 Top 20% Ranked AECM Values for Orchards 16
Figure 14 Top 20% Ranked AECM Values for Field Crops 17
Figure 15 Top 20% Ranked AECM Values for Truck Crops 18
Figure 16 Top 20% Ranked AECM Values for Grains 19
Figure 17 Top 20% Ranked AECM Values for Pasture 20
Figure 18 Top 20% Ranked AECM Values for Vineyards 21
Figure 19 Crop Changes from 2020 to 2075 25
Figure 20 Projected Crops for 2020 26
Figure 21 Projected Crops for 2030 27
Figure 22 Projected Crops for 2040 28
Figure 23 Projected Crops for 2050 29
Figure 24 Projected Crops for 2060 30
Figure 25 Projected Crops for 2070 31
Figure 25 Projected Crops for 2070 for Petaluma Valley 32
Figure 25 Projected Crops for 2070 for Santa Rosa Plain 33
Figure 25 Projected Crops for 2070 for Sonoma Valley 34

Table 1 Independent AECM parameters 3

Introduction

This report summarizes the methods used to develop the spatial datasets of future agricultural land uses in the three Sonoma County groundwater subbasins/basins required to comply with the Sustainable Groundwater Management Act (SGMA). For these subbasins/basins projected 50-year future groundwater budgets are required as part of their groundwater sustainability plans (GSPs). The agricultural land use projections detailed here will serve as inputs into the groundwater flow models that were developed for each subbasin/basin. The groundwater flow models will then calculate groundwater demands based on the climate, crop types and other factors. For the Santa Rosa Plain, the AG Package (Niswonger, 2020) uses the outputs from the outputs developed here to calculate projected groundwater demands. The Sonoma Valley and Petaluma Valley models use MODFLOW-One Water Hydrologic Model (OWHM; Hanson et al, 2014, Boyce et al, 2020).

Projections of future agricultural land use expansion and contractions developed through the Agricultural Water Demand Projections Practitioner Work Group (work group) serve as the basis for this work. These projections detail the rate of growth or contraction in acres per year for vineyards, field crops, truck crops, orchards, grains and hay, and pastures. Some of the crops exhibit contractions whereas others are nearly stable or show expansion. The AECM developed here is used to spatially project the desired changes in land use based upon a statistical representation of the affinity for each crop for physiographic (eg topography, slope) properties. The work by Heaton and Merenlander (2000) demonstrated that a logistical regression model is suitable for predicting the conversion to vineyards in Sonoma County. The authors used a number of parameters such as slope, aspect, distance to streams, and others to predict locations more likely to be converted to vineyards in Sonoma County. Here we are adapting and generalizing the methods to be used for the 8 crops listed above.

Methods

For each crop a logistical regression model is fitted with the observed independent and observed dependent variables. A logistical regression is a statistical expression of the probability of a binary output conditioned on the independent variables. The locations for which all of the independent and dependent variables are extracted is shown in Figure 1. There are 17,407 points used in developing the AECM models for each crop. The dependent variable for each crop is the presence or absence of that crop. The presence or absence of a crop is extracted from the mapped land use as of 2012, shown in Figure 2. The independent variables for all crops are shown in Table 1. The maps for each of the independent variables are shown in Figure 3, Figure 4, Figure 5, Figure 6, Figure 7, and Figure 8.

Table 1 Independent AECM parameters

	Variable name	Type	Source
1	ppt	Average Precipitation	PRISM
2	tmean	Average Temperate	PRISM
3	slope	Slope	DEM

4	elev	Slope	DEM
5	asp	Aspect	DEM
6	BdrkDep	Bedrock Depth	NRCS Soil Data
7	HydSol	Hydrologic Soil Group	NRCS Soil Data

Summary of the Methods for Applying the Agricultural Expansion and Contraction Model

- *Use mapped crop distribution of the crop types [dependent variables]*
- *Create GIS datasets of soils, climate, and topographic properties expected to impact distribution of crops [independent variables]*
- *For each crop type create fit model that expresses ranking of a site based on independent variables*
- *Use fit model to assign ranking to all cells for each crop based on average ranking for cell*
- *Apply growth/contraction on 5-year intervals using crop rankings and GIS of areas where growth may occur*

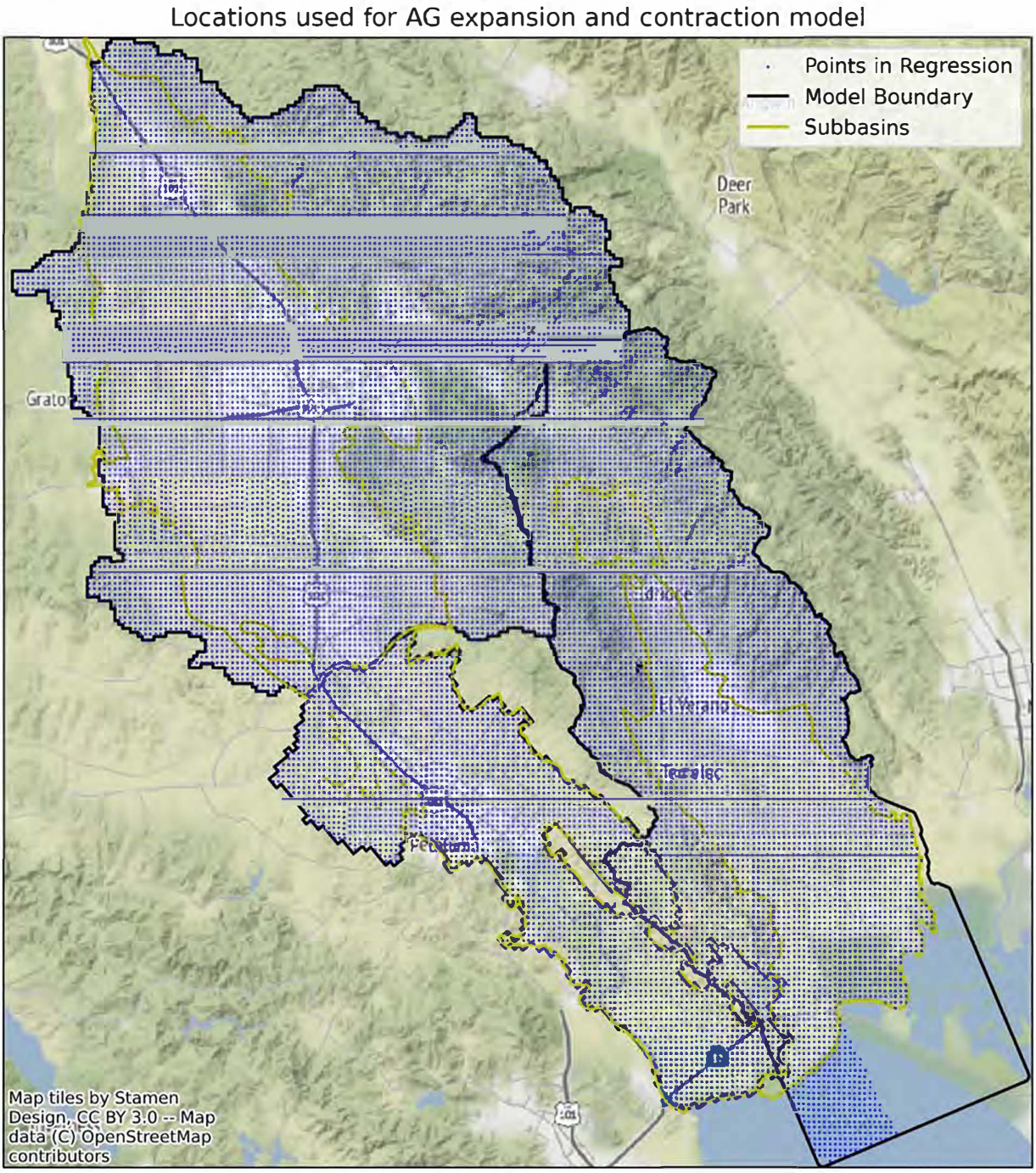

Figure 1 Locations used for AECM

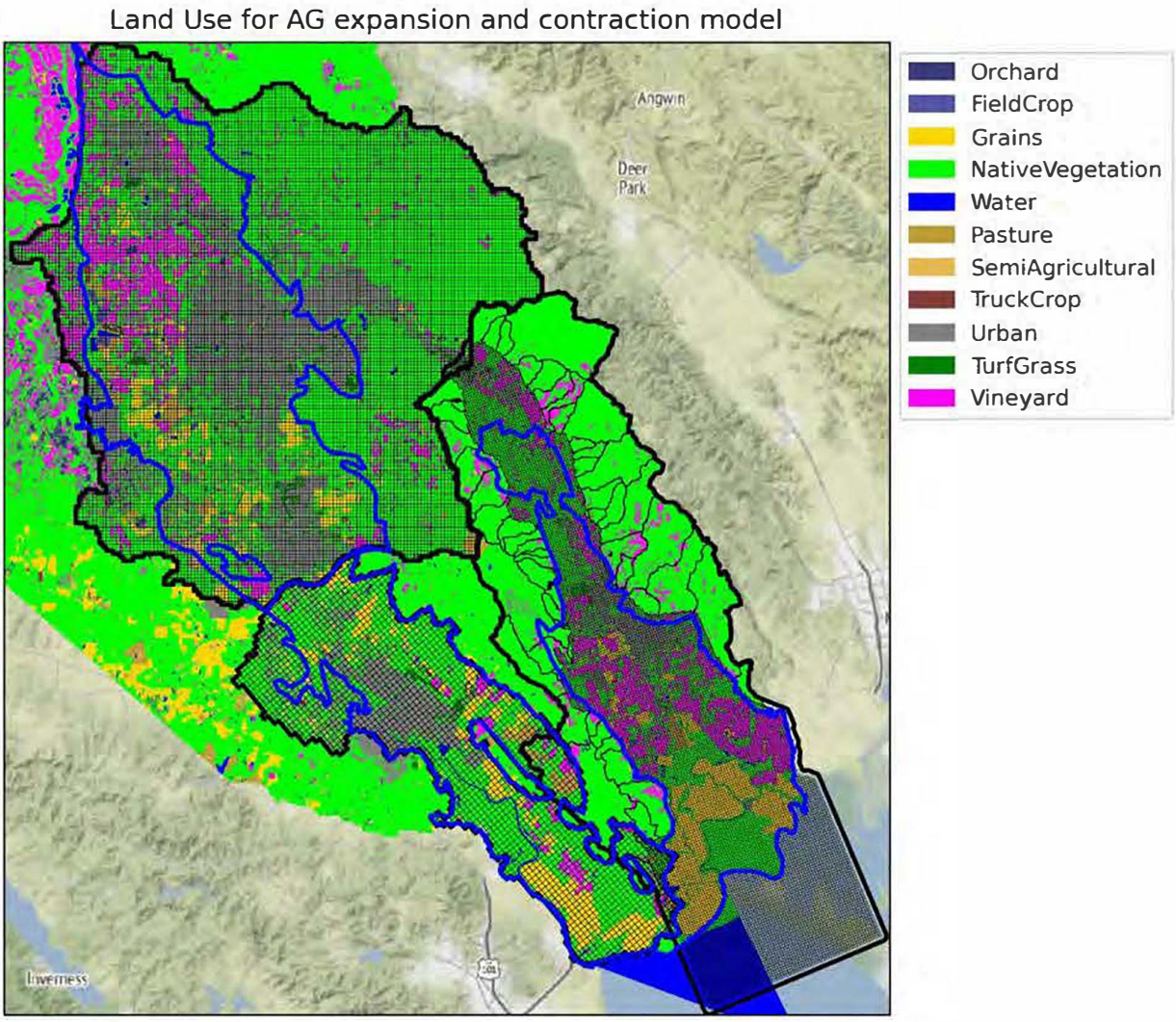

Figure 2 Land Use

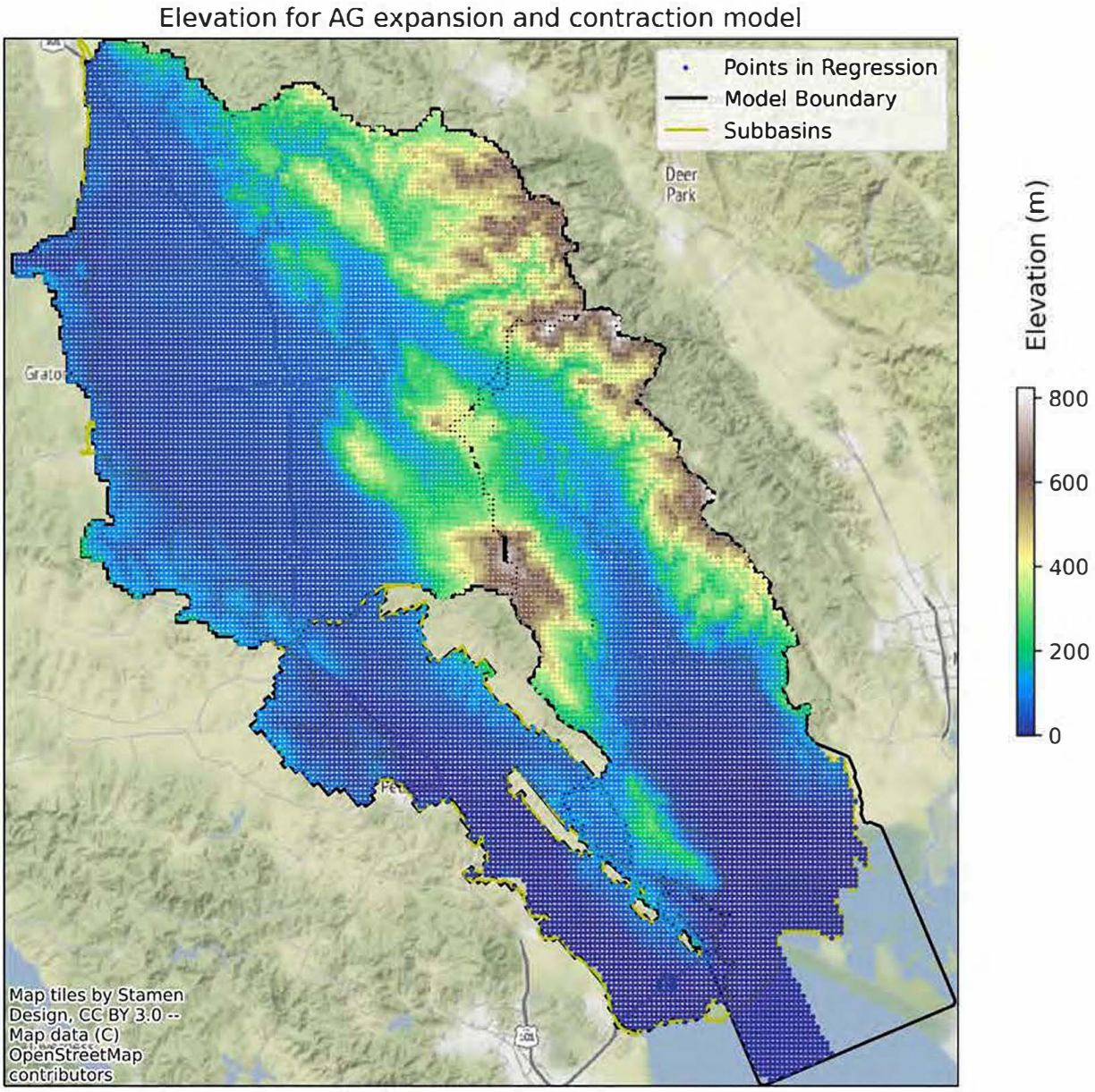

Figure 3 Elevation for AECM

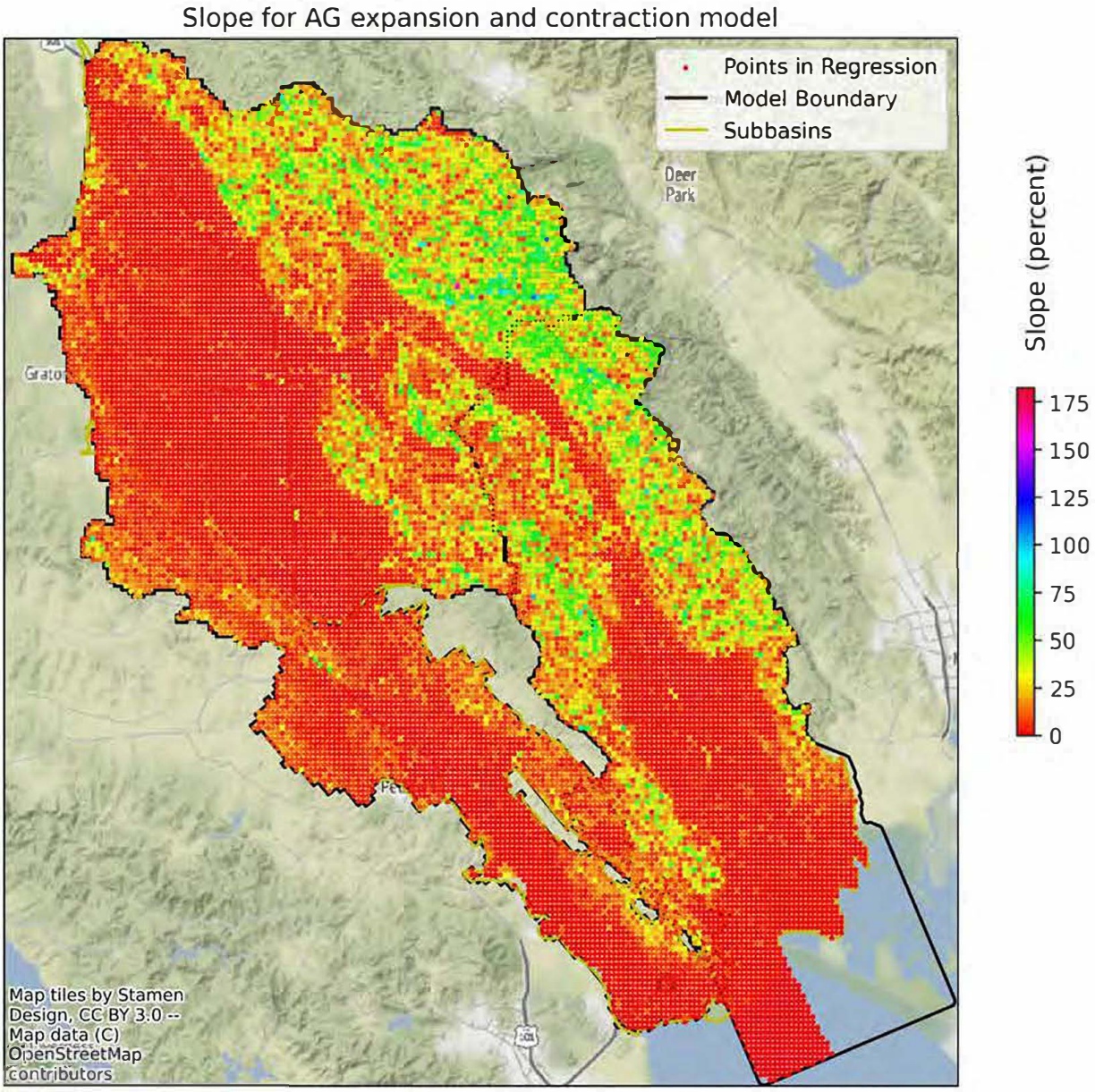

Figure 4 Slope for AECM

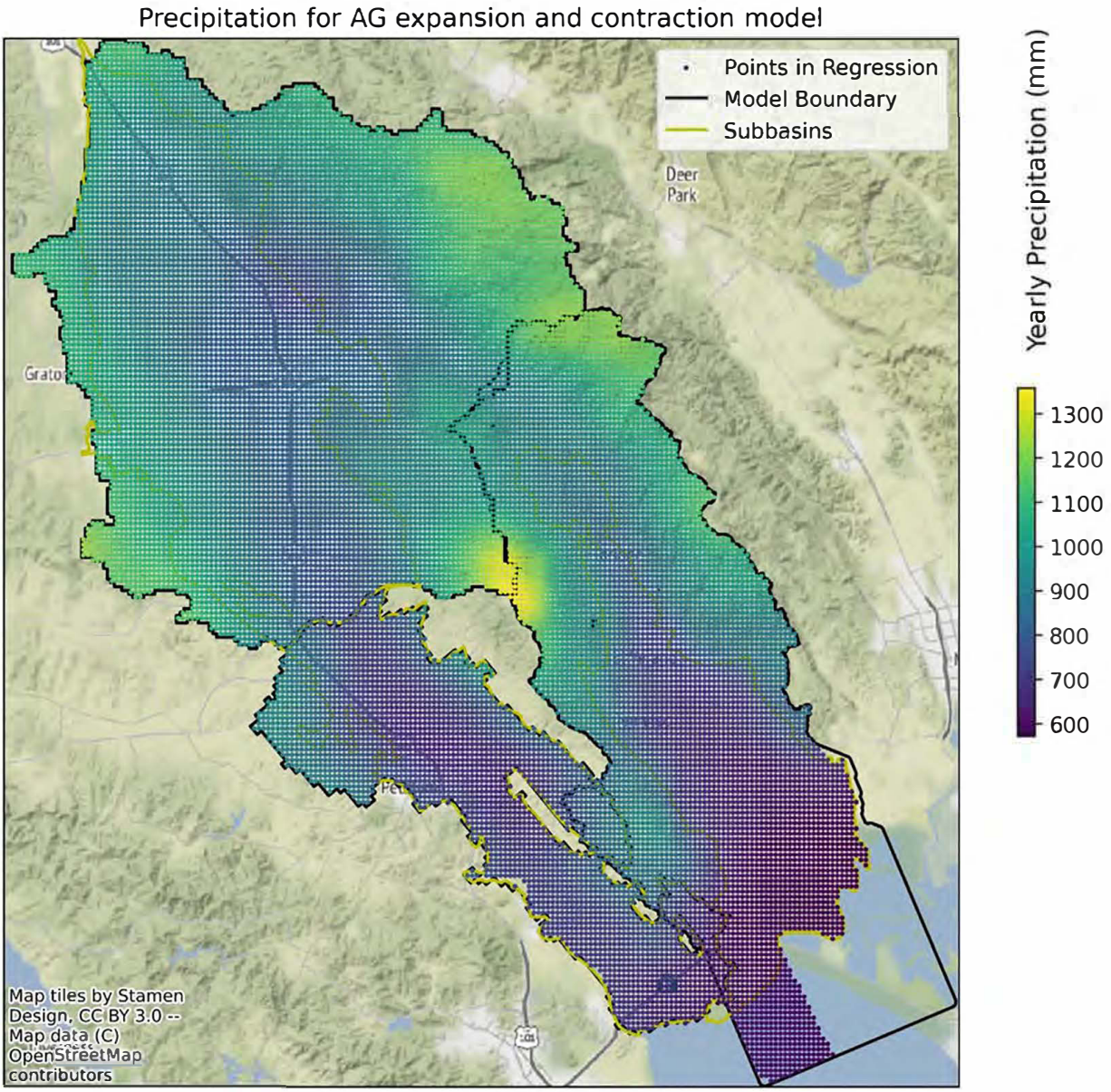

Figure 5 Precipitation for AECM

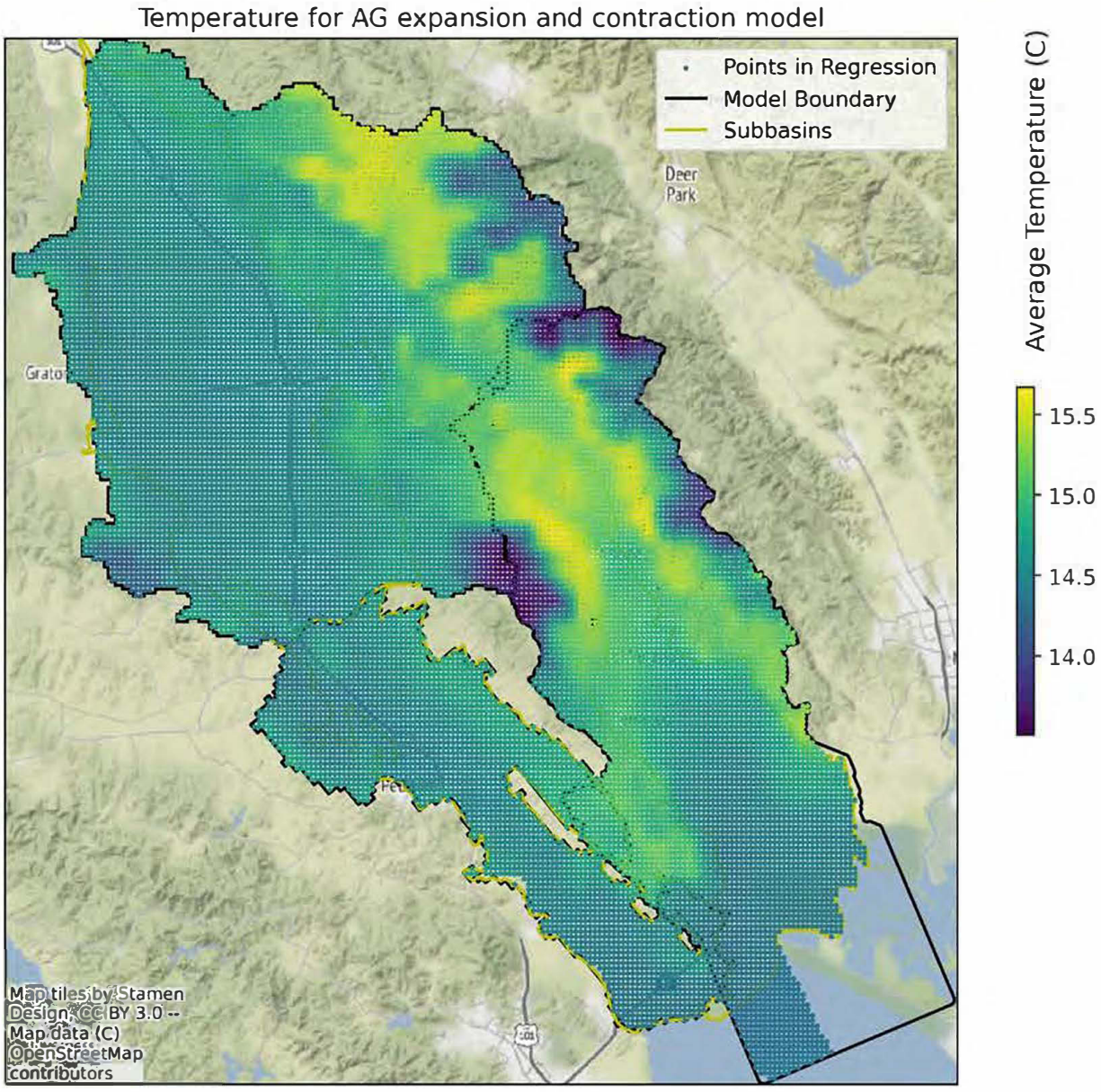

Figure 6 Temperature for AECM

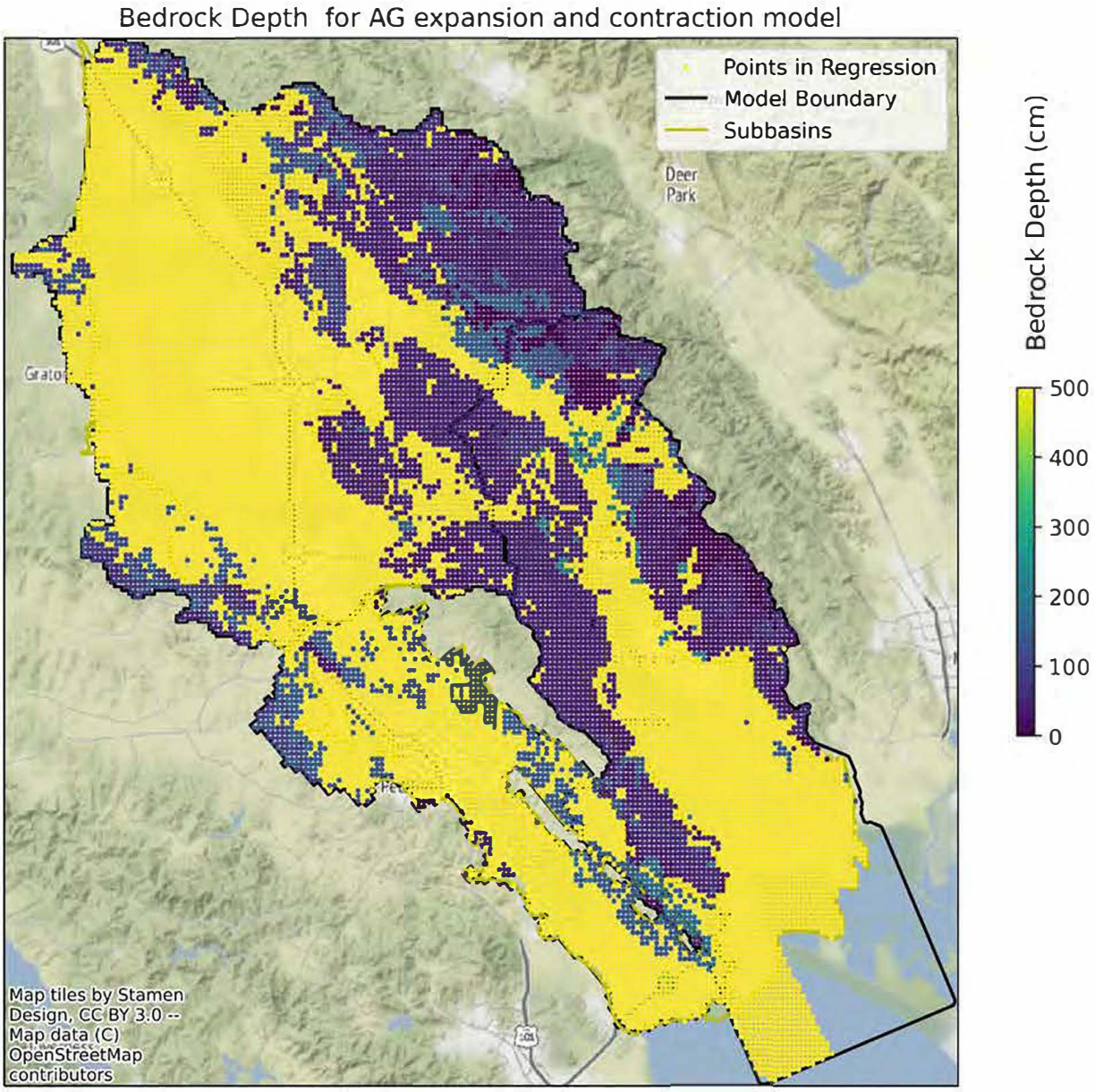

Figure 7 Bedrock Depth for AECM

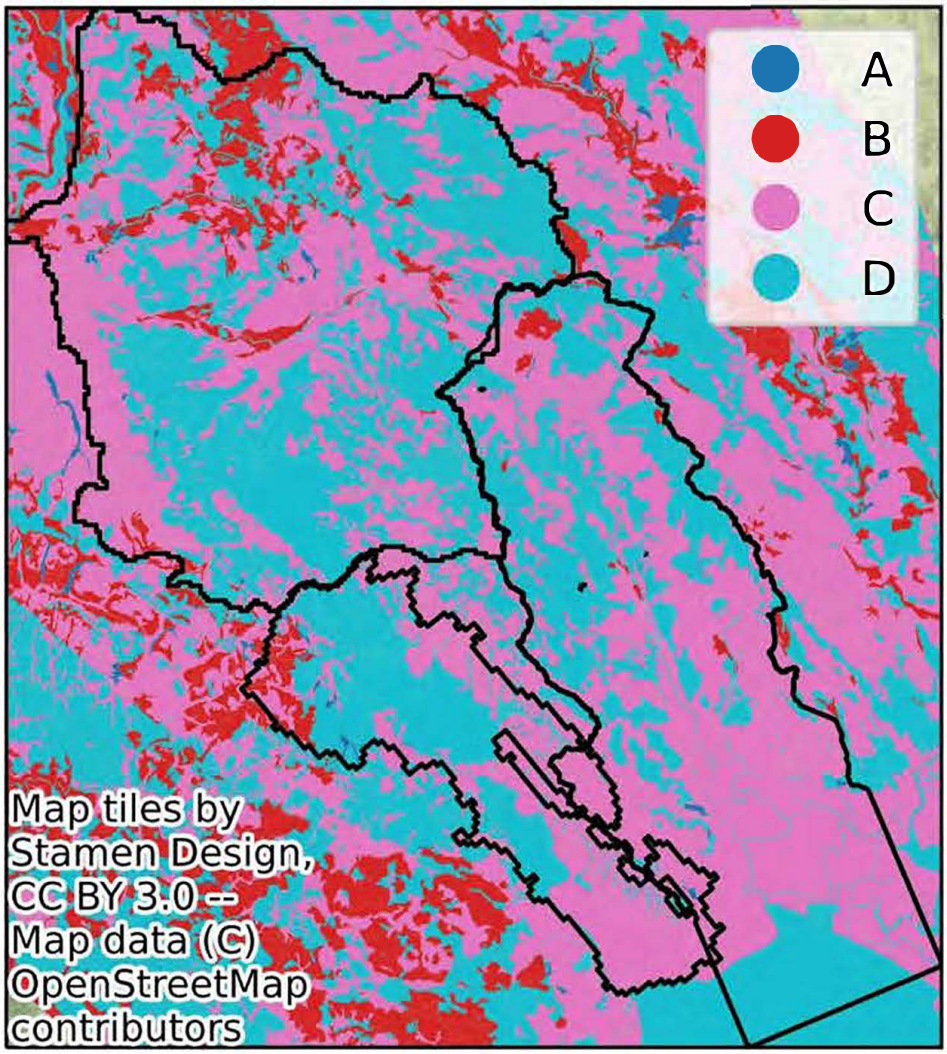

Figure 8 Hydrologic Soil Group

Logistical Regression Values to Crop Expansion Rankings

After developing the logistical regression statistical models for each crop, they are now used to estimate the ranking for all locations. To do so, five points were added to each model cell. Then for each point the fitted crop expansion regression probability was calculated and the mean value was assigned to each cell. These steps are shown in Figure 8. The model cells for which the five points were extracted and averaged are shown in Figure 9, Figure 10, and Figure 11.

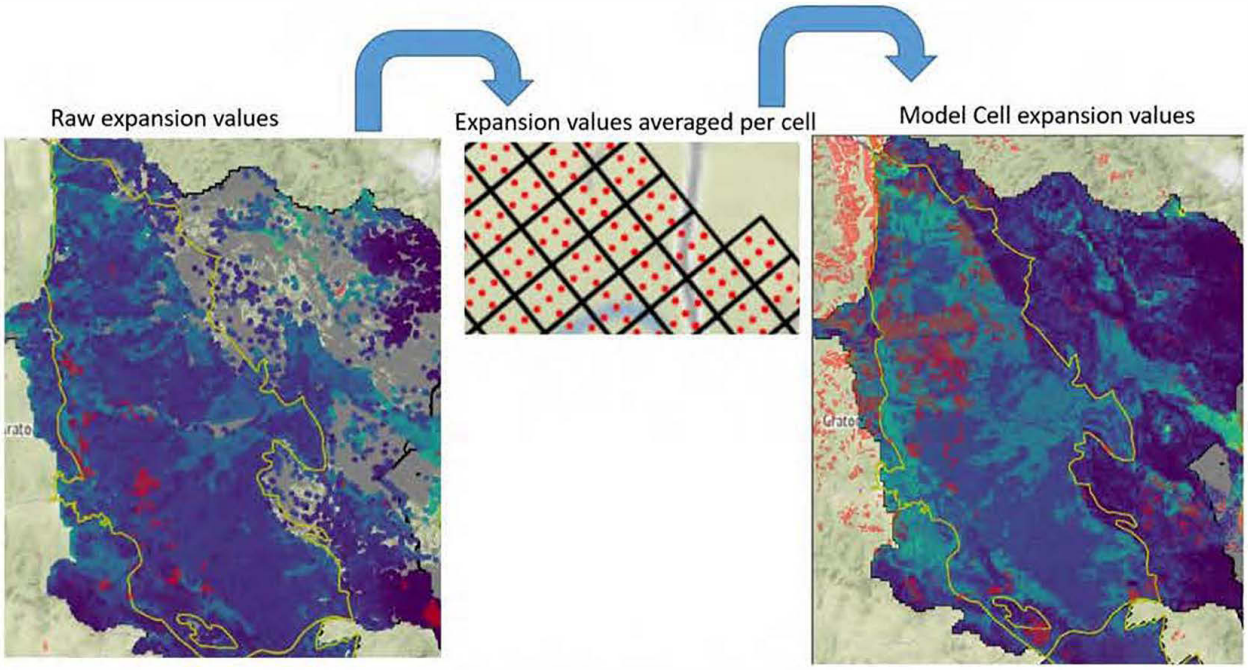

Figure 9 Converting Raw Expansion Values to Model Cell Crop Expansion Rankings

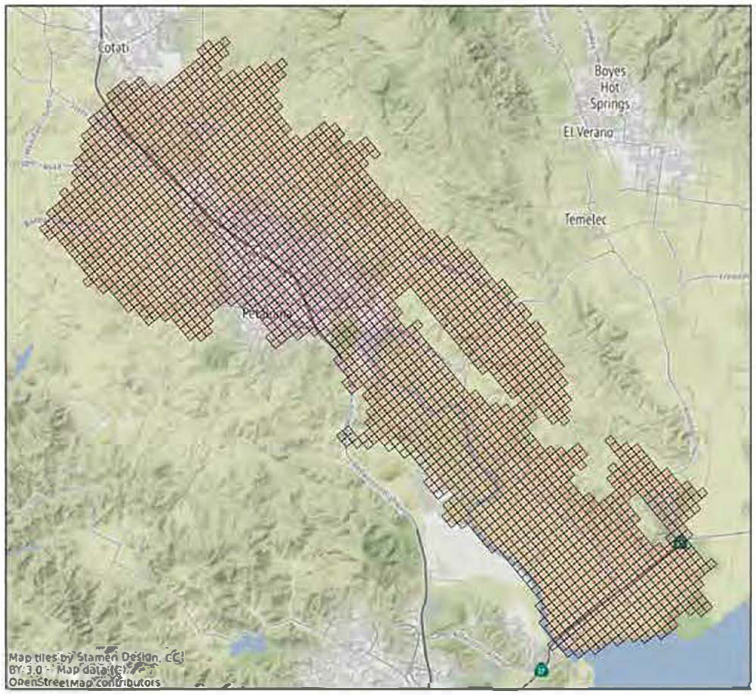

Figure 10 Model Cells Used for AECM predictions, Petaluma Valley Subbasin

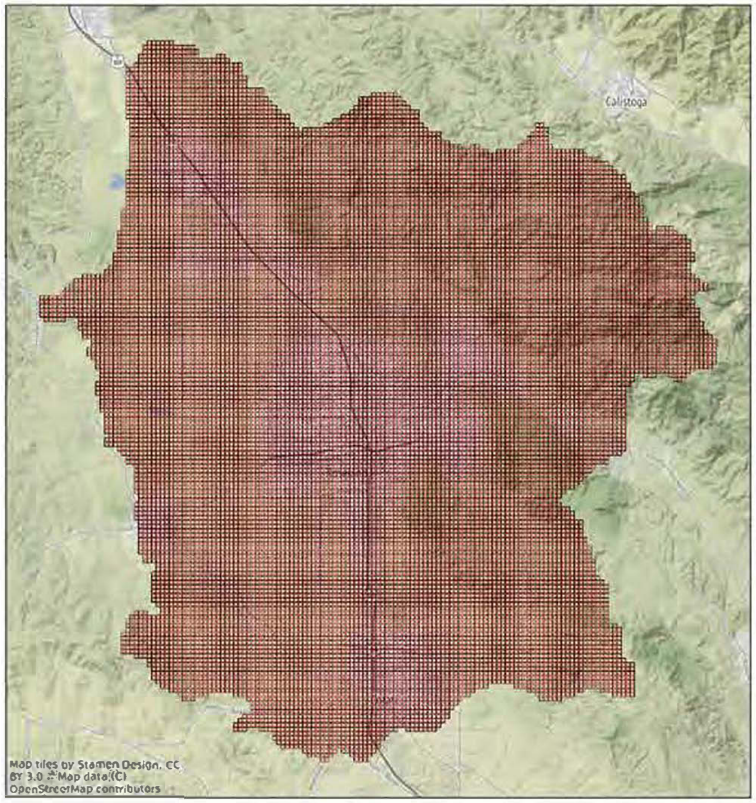

Figure 11 Model Cells Used for AECM predictions, Santa Rosa Plain Subbasin

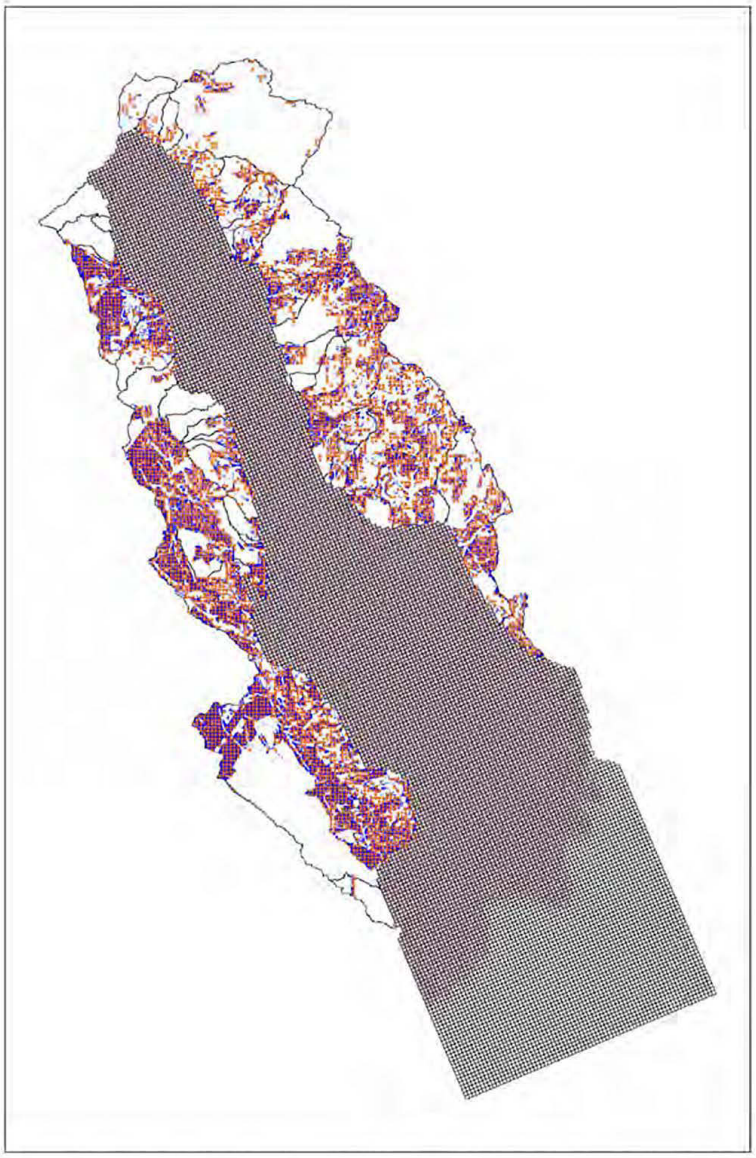

Figure 12 Model Cells Used for AECM predictions, Sonoma Valley Subbasin

Agricultural Expansion Model Values for Each Crop

The final AECM values for each crop are shown in Figure 12, Figure 13, Figure 14, Figure 15, Figure 16, Figure 17 for orchards, field crops, truck crops, grains and hay, pastures, and vineyards, respectively. The figures show the top 20% of locations (based on model cells) after removing locations that cannot be converted to a vineyard. The prohibited areas dataset consists of locations that cannot be developed due to zoning restrictions, public ownership, agricultural exclusion areas such as VESCO or stream buffers, and other datasets.

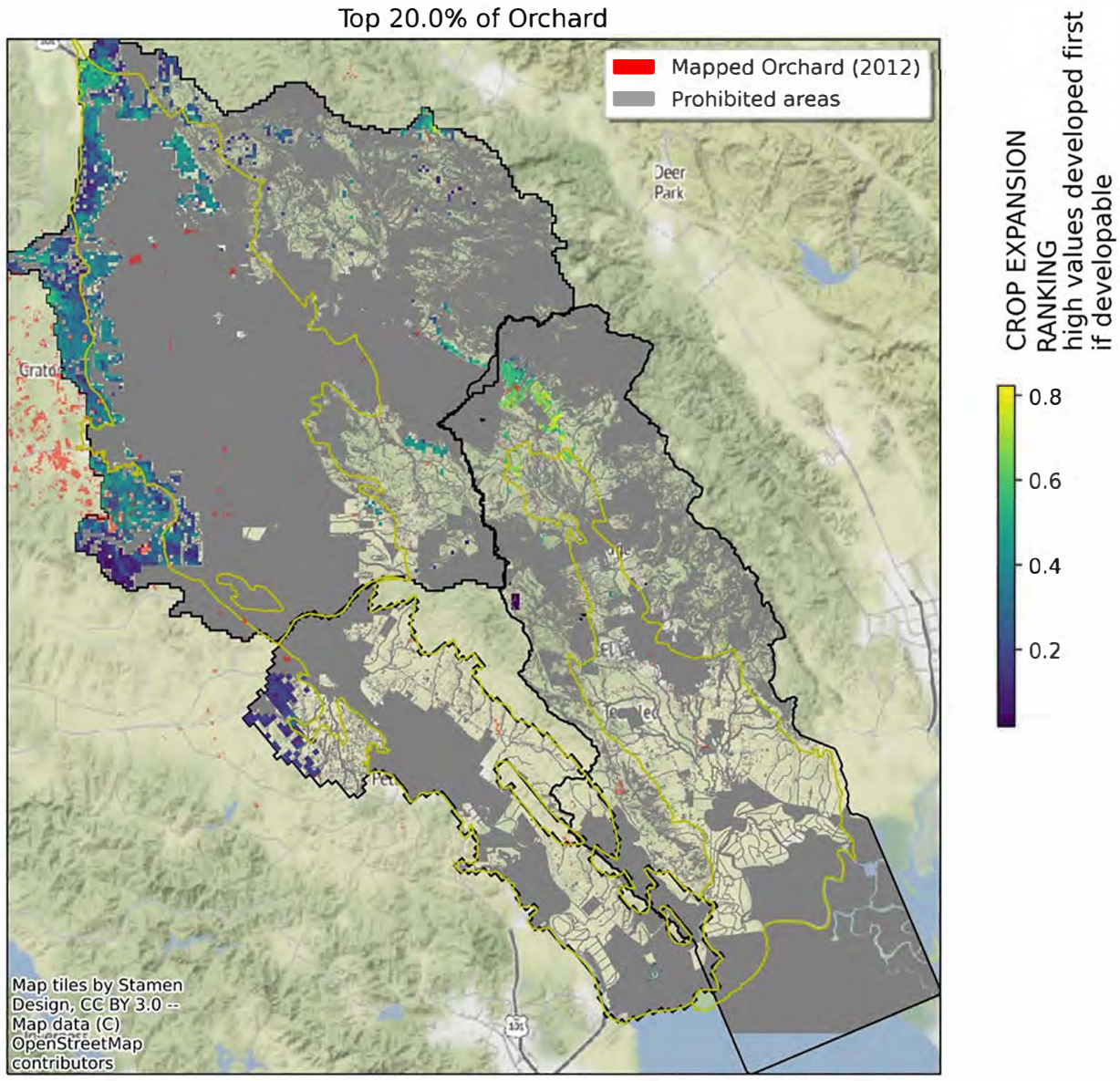

Figure 13 Top 20% Ranked AECM Values for Orchards

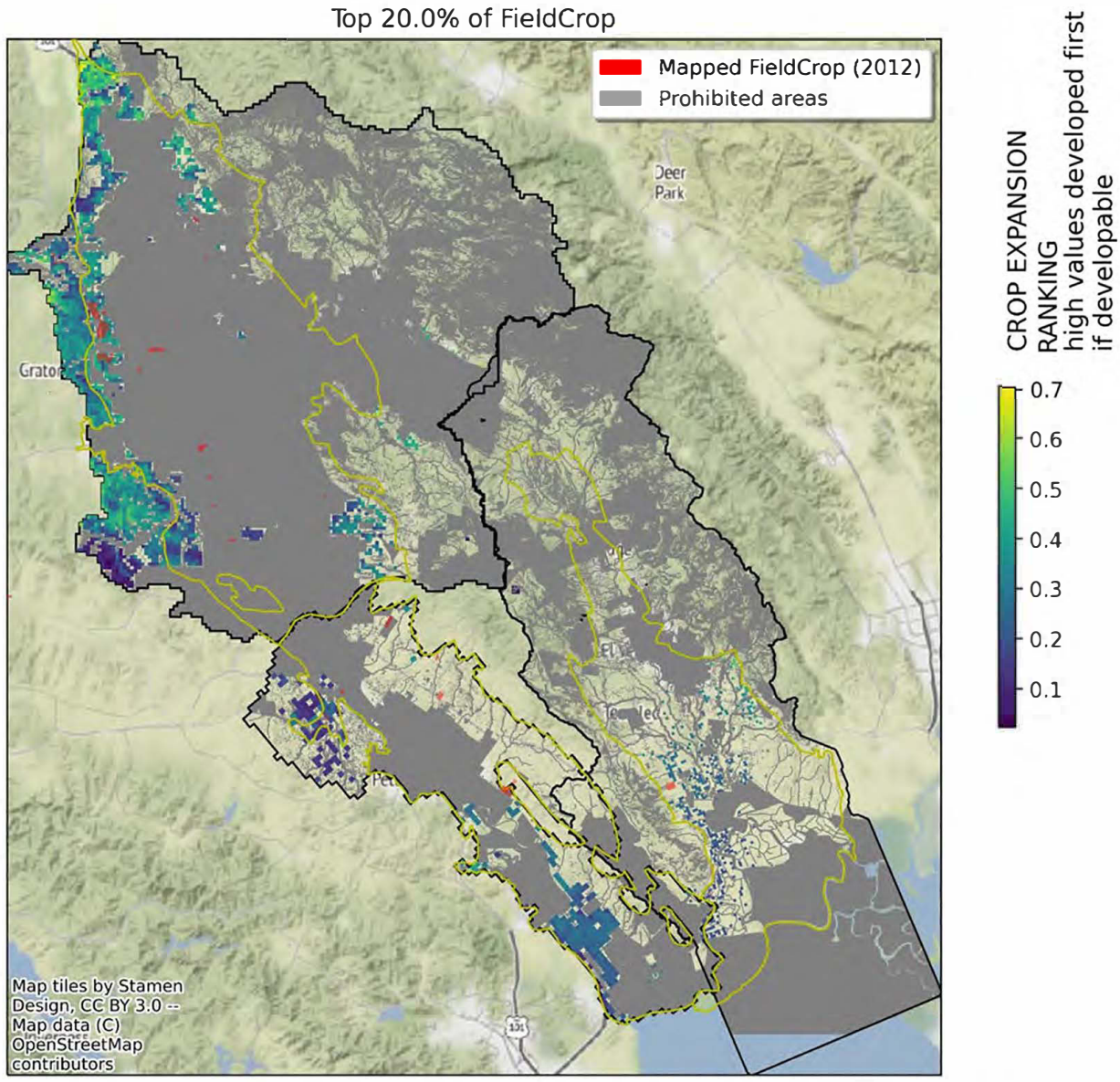

Figure 14 Top 20% Ranked AECM Values for Field Crops

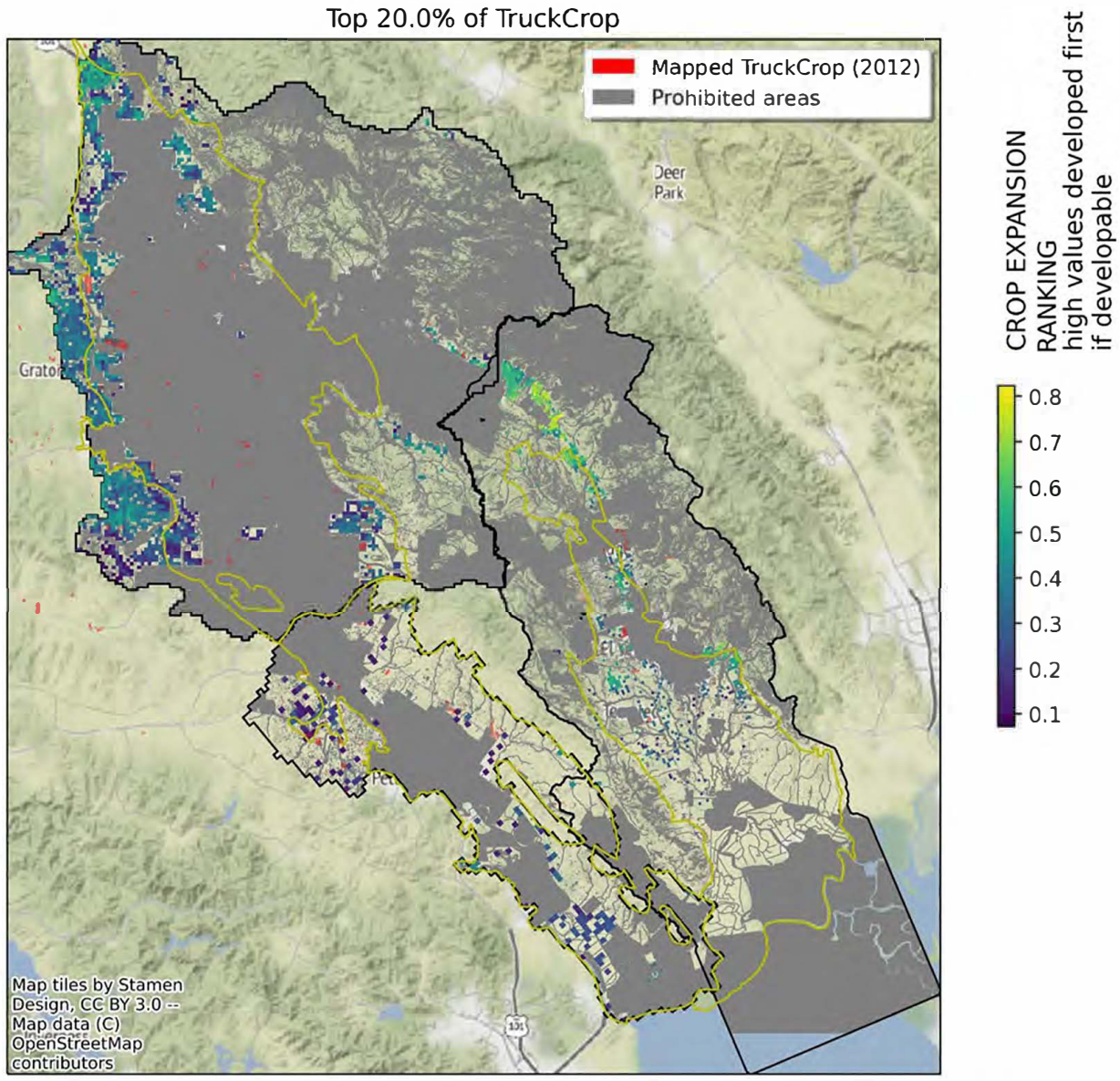

Figure 15 Top 20% Ranked AECM Values for Truck Crops

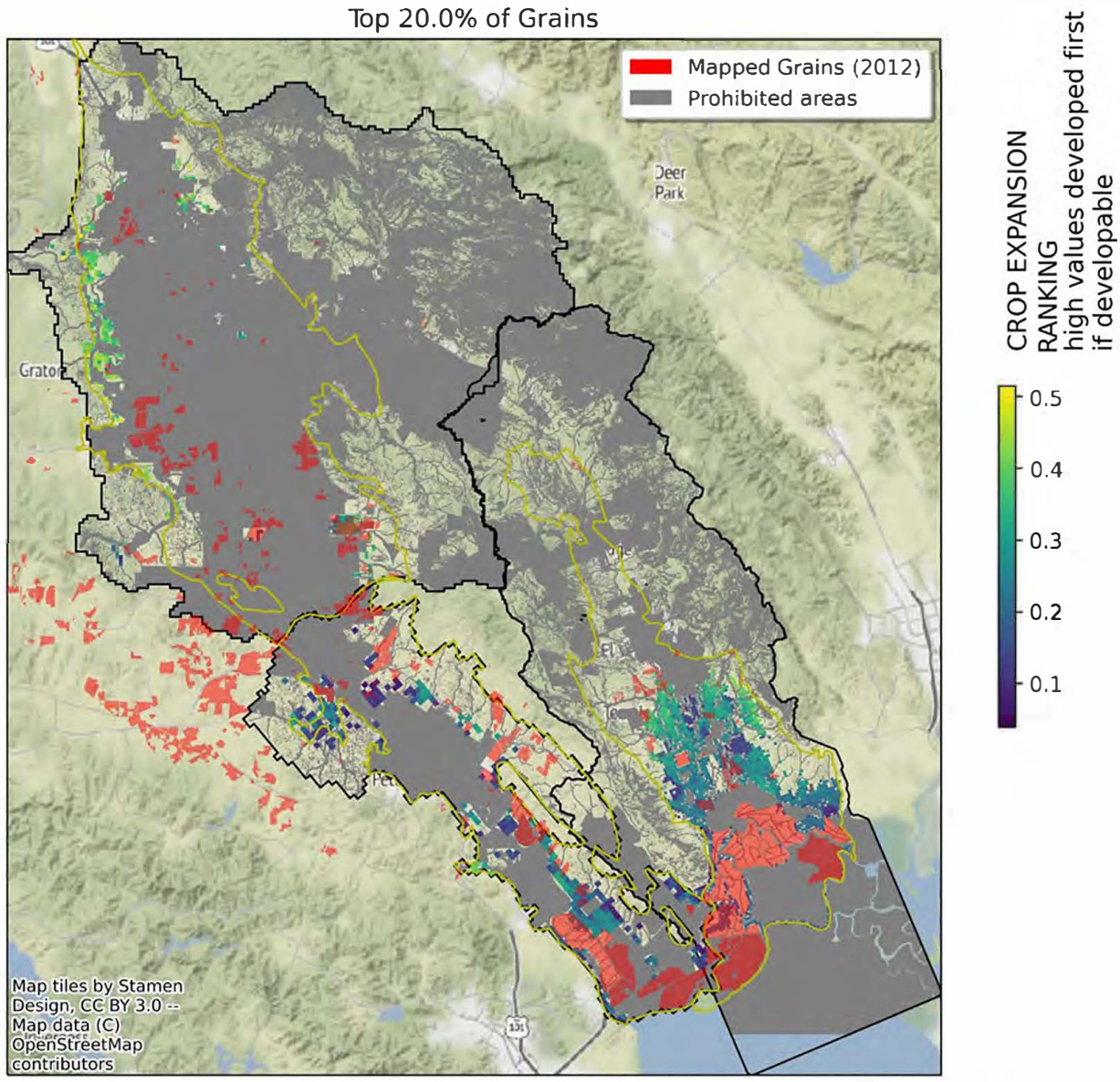

Figure 16 Top 20% Ranked AECM Values for Grains

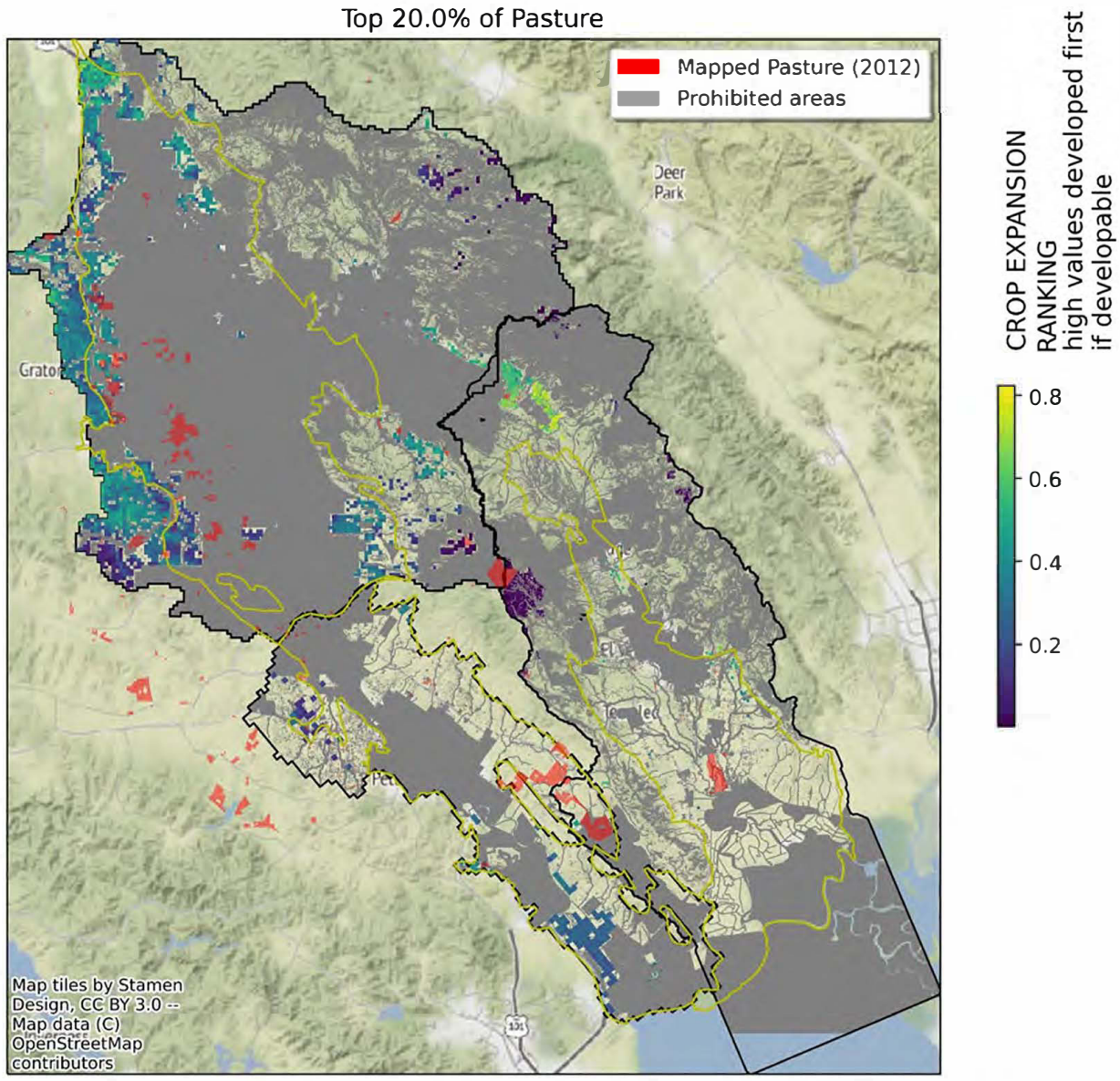

Figure 17 Top 20% Ranked AECM Values for Pasture

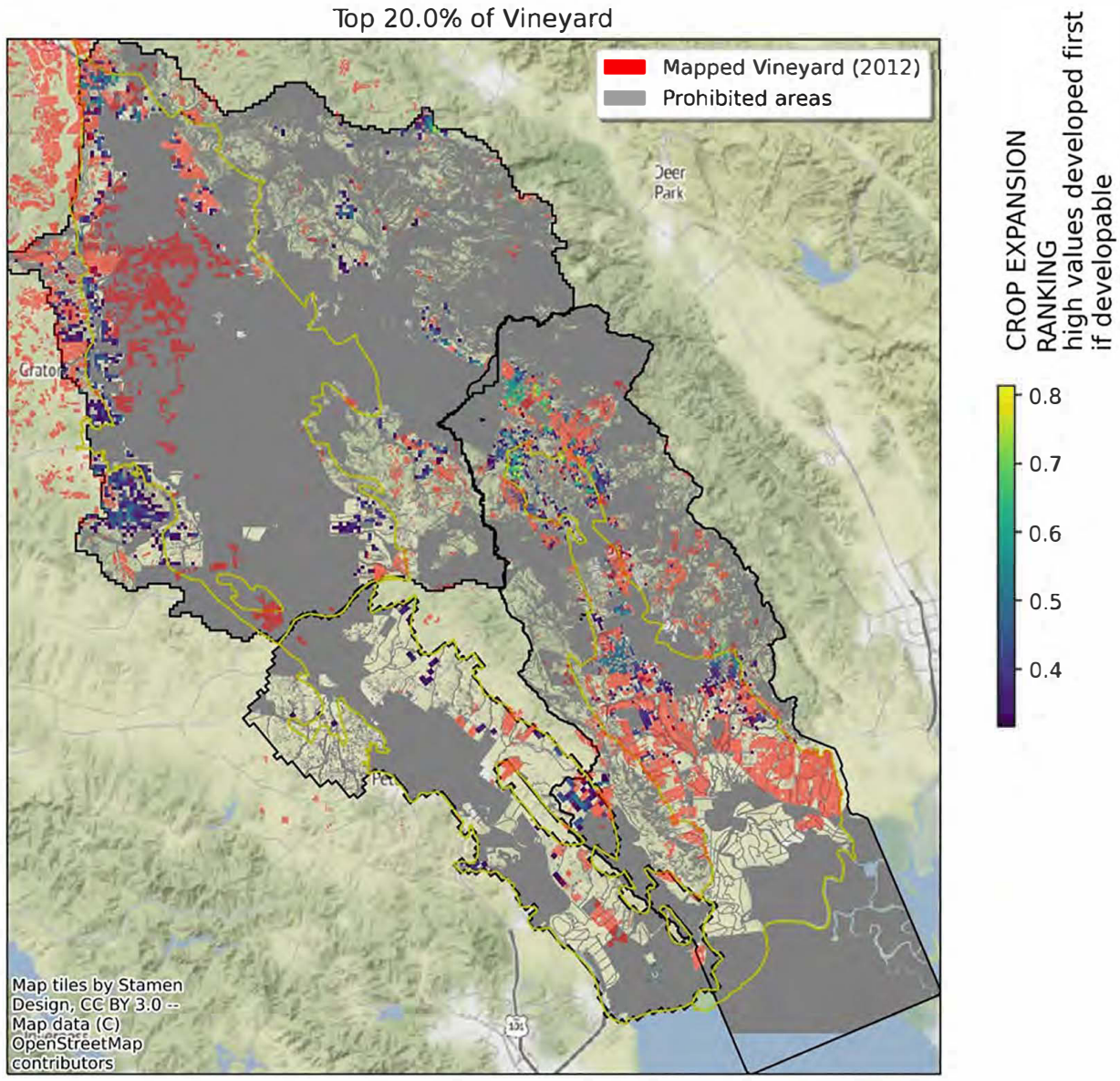

Figure 18 Top 20% Ranked AECM Values for Vineyards

Converting the Model Cell AECM Rankings to Spatial Forecast

With the crop expansion rates and the model cell AECM values now defined, the forecasted spatial locations of the new and removed crops can be assigned. Note that all three basins are treated equally, and if for example, one basin does not have suitable crop areas for a given crop, it may not experience any growth in that subbasin. For each forecast period, the following algorithm is applied on 5-year intervals. The algorithm accounts for growth of crops as well as the contraction of crop areas. When contraction occurs for a crop it is converted to native vegetation, which can then be converted to another crop.

Algorithm steps: loop through all crops, performing steps listed below on each, then proceed to next year

For negative growth:

1. *If no area is remaining for crop, then skip to next crop*
2. *Remove acreage ranked by areas with lowest AECM expansion value. Convert to native vegetation. These areas can be re-developed for other crops.*

For positive growth:

1. *Filter areas that are not developable based on zoning, riparian buffers, etc,*
2. *Filter crops and land uses that cannot be developed (eg vineyards, pastures, etc)*
3. *From remaining areas select cell nodes with highest AECM values until growth is satisfied*

The results of the crop expansion forecasts is summarized in Figure 19. This figure shows only locations that have changed crop type from 2020 to 2075 and does not represent the actual crop types. The figure shows the final crop type at 2075. Figure 20, Figure 21, Figure 22, Figure 23, Figure 24, and Figure 25 display the projected crop distributions from the period from 2020 to 2070.

Table 2 Projected Agricultural Areas for the Petaluma Valley Integrated Hydrologic Model Area

	Field Crop	Grains	Orchard	Pasture	Truck Crop	Vineyard
2020	0	4,563	0	2,203	0	2,025
2025	0	4,563	0	1,914	0	2,025
2030	0	4,563	0	1,692	0	2,048
2035	0	4,563	0	1,469	0	2,070
2040	0	4,585	0	1,246	0	2,070
2045	0	4,607	0	1,002	0	2,070
2050	0	4,630	0	712	0	2,226
2055	0	4,630	0	490	0	2,293
2060	0	4,630	0	267	0	2,315
2065	0	4,674	0	67	0	2,359
2070	0	4,696	0	22	0	2,404

Table 3 Projected Agricultural Areas for the Santa Rosa Plain Hydrologic Model area

	Field Crop	Grains	Orchard	Pasture	Truck Crop	Vineyard
2020	40	360	660	1,420	670	13,270
2025	70	360	570	1,410	710	13,360
2030	100	360	490	1,370	750	13,580
2035	130	360	400	1,360	790	13,780
2040	160	360	310	1,340	830	14,020

2045	190	360	220	1,330	870	14,340
2050	220	360	130	1,320	910	14,550
2055	250	360	40	1,250	950	14,850
2060	280	360	0	1,190	990	15,150
2065	310	360	0	1,110	1,030	15,390
2070	340	360	0	870	1,070	15,700

Table 4 Projected Agricultural Areas for the Sonoma Valley Integrated Hydrologic Model area

	Field Crop	Grains	Orchard	Pasture	Truck Crop	Vineyard
2020	947	7,587	11	195	23	14,426
2025	947	7,656	11	189	23	14,844
2030	947	7,725	0	166	23	15,102
2035	947	7,794	0	109	23	15,385
2040	947	7,840	0	63	23	15,650
2045	947	7,897	0	23	23	15,831
2050	947	7,943	0	23	23	15,973
2055	947	8,010	0	23	23	16,111
2060	947	8,079	0	11	23	16,294
2065	947	8,113	0	6	23	16,516
2070	947	8,177	0	0	23	16,664

Table 5 Projected Agricultural Areas for Areas Inside and Outside Subbasin, Petaluma Valley Integrated Hydrologic Flow Model

	Crop Area, Initial Conditions of Future Projections			Crop Area, End of Future Projections		
	Petaluma Valley	**Wilson Grove**	**Total**	**Petaluma Valley**	**Wilson Grove**	**Total**
Grains	4559	0	4559	4692	0	4692
Orchard	66	0	66	0	0	0
Pasture	2090	400	2490	0	22	22
Semi Agricultural	7516	489	8006	7339	489	7828
Urban	10385	3602	13988	10385	3602	13988
Vineyard	2023	0	2023	2401	0	2401

Table 6 Projected Agricultural Areas for Areas Inside and Outside Subbasin, Santa Rosa Plain Integrated Hydrologic Model

	Crop Area, Initial Conditions of Future Projections			Crop Area, End of Future Projections		
	Outside Basin	**Inside Basin**	**Total**	**Outside Basin**	**Inside Basin**	**Total**

Field Crop	0	10	10	190	150	340
Grains	0	360	360	0	360	360
Orchard	440	230	670	0	0	0
Pasture	530	890	1420	430	440	870
Truck Crop	40	590	630	160	910	1070
Turf Grass	190	560	750	190	560	750
Vineyard	3520	9700	13220	4920	10780	15700

Table 7 Projected Agricultural Areas for Areas Inside and Outside Subbasin, Sonoma Valley Integrated Hydrologic Model

	Crop Area, Initial Conditions of Future Projections			Crop Area, End of Future Projections		
	Outside Basin	**Inside Basin**	**Total**	**Outside Basin**	**Inside Basin**	**Total**
Vineyard	5,301	8,672	13,973	6,632	10,032	16,664
Field Crop	0	947	947	0	947	947
Truck Crop	0	23	23	0	23	23
Orchard	11	17	29	0	0	0
Grains	75	7,444	7,518	136	8,041	8,177
Pasture	23	172	195	0	0	0

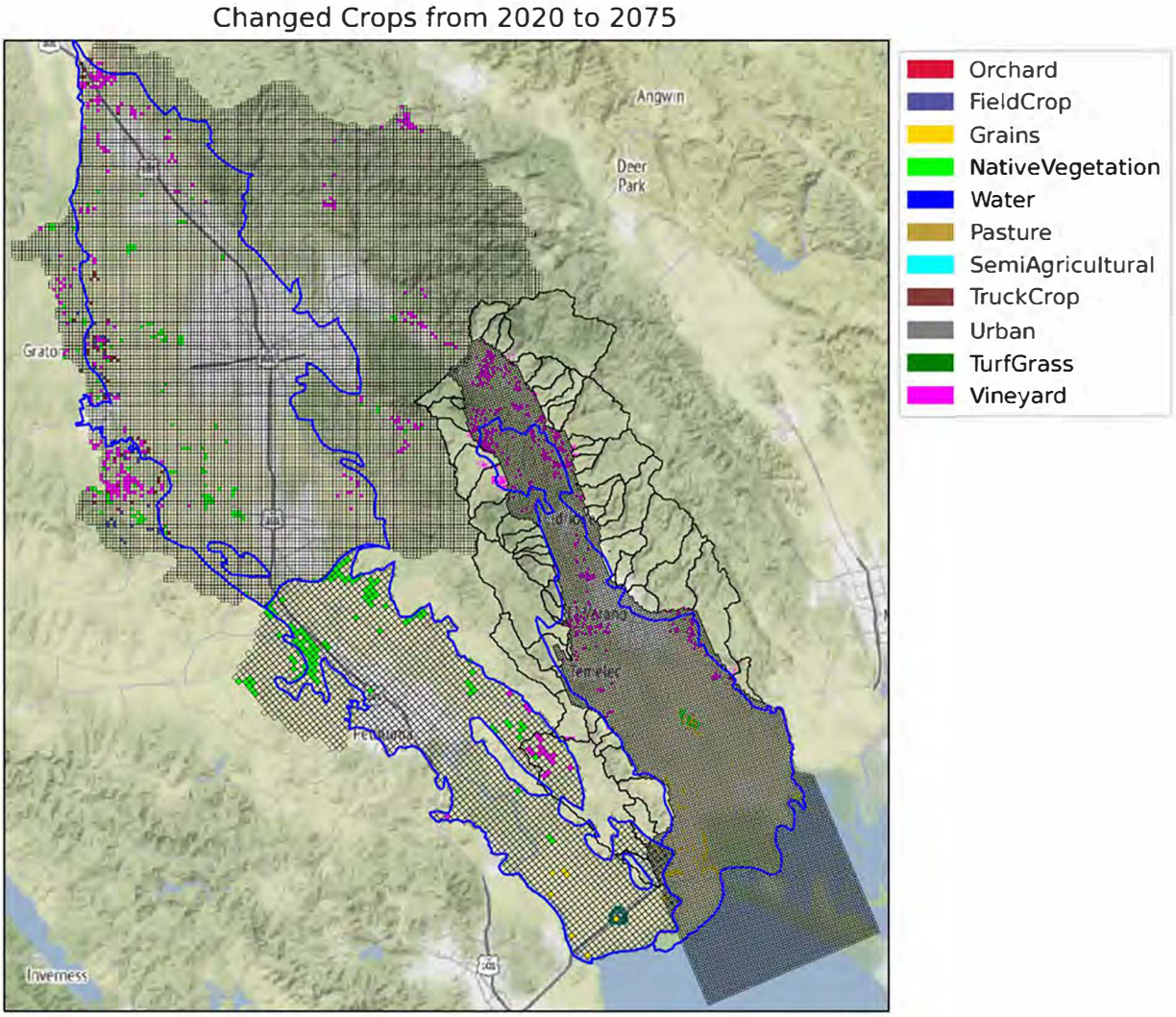

Figure 19 Crop Changes from 2020 to 2075

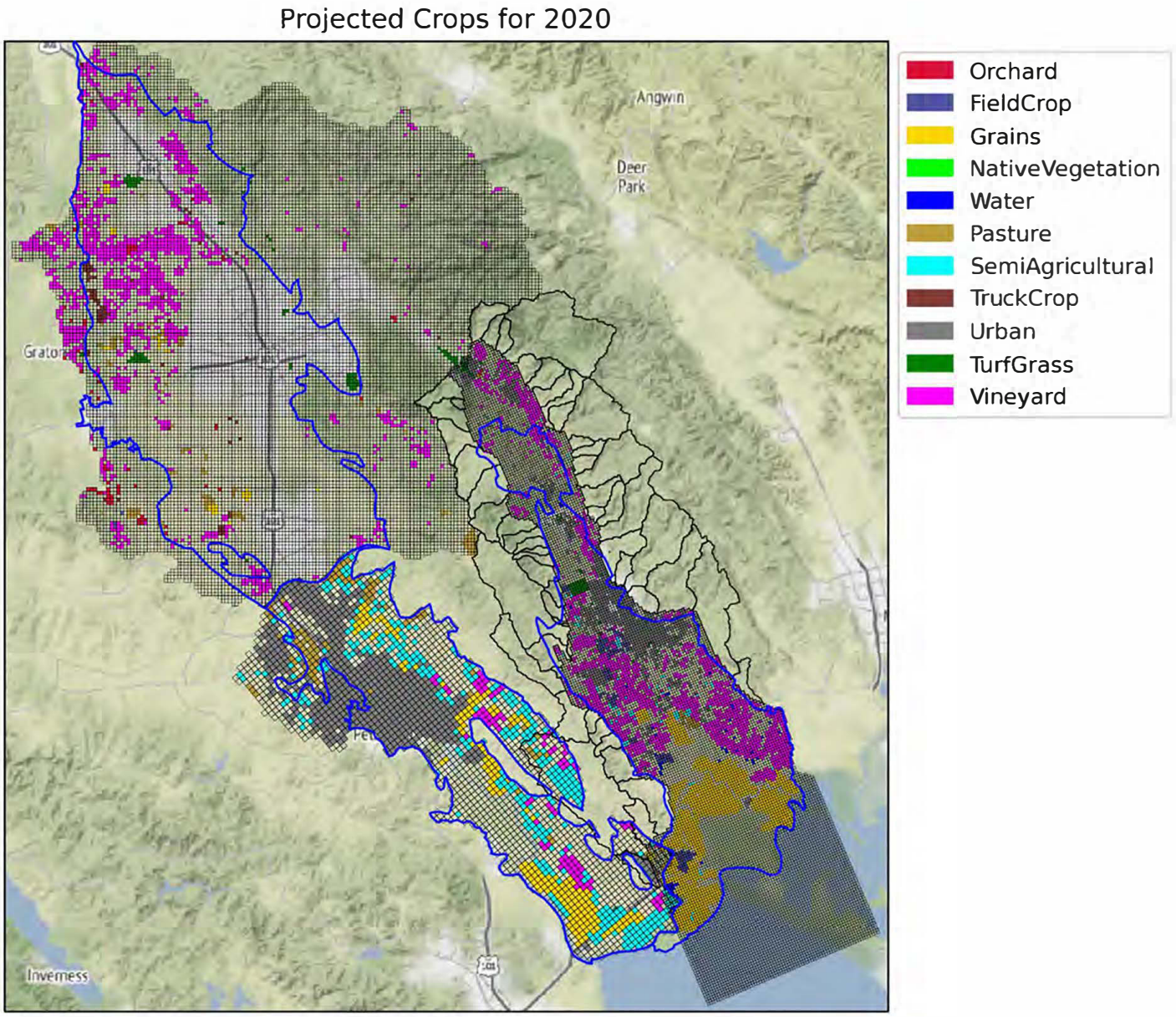

Figure 20 Projected Crops for 2020

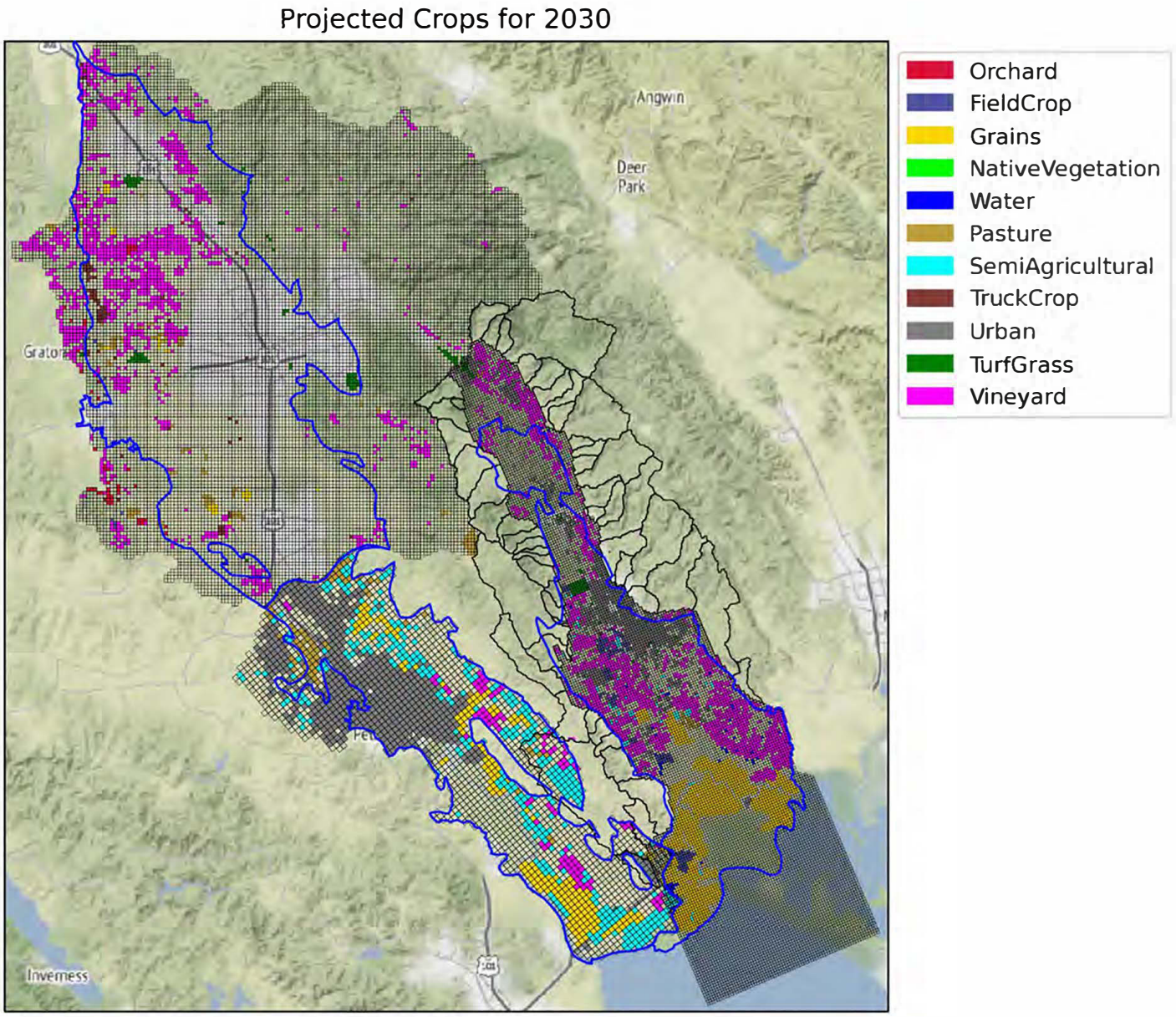

Figure 21 Projected Crops for 2030

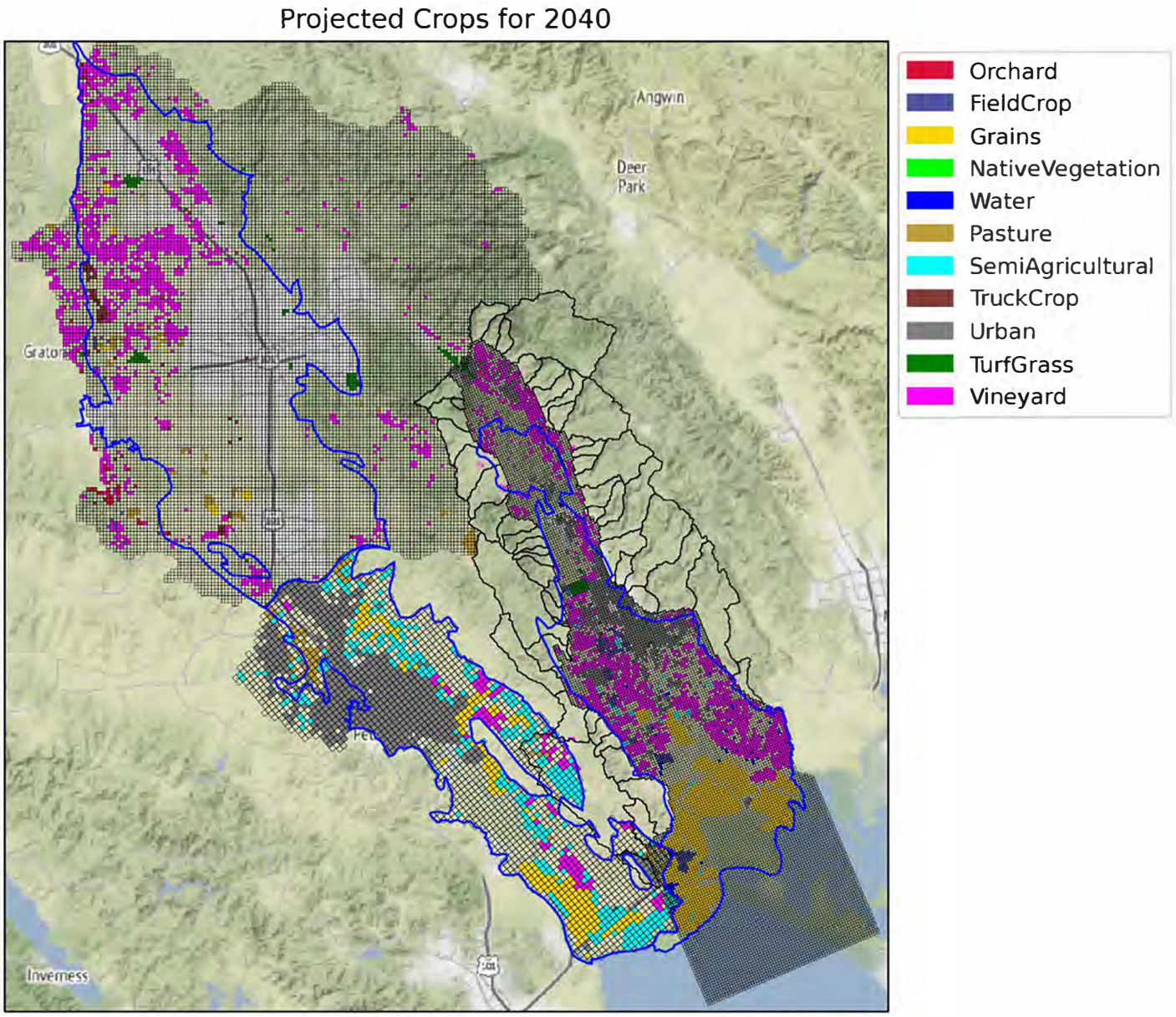

Figure 22 Projected Crops for 2040

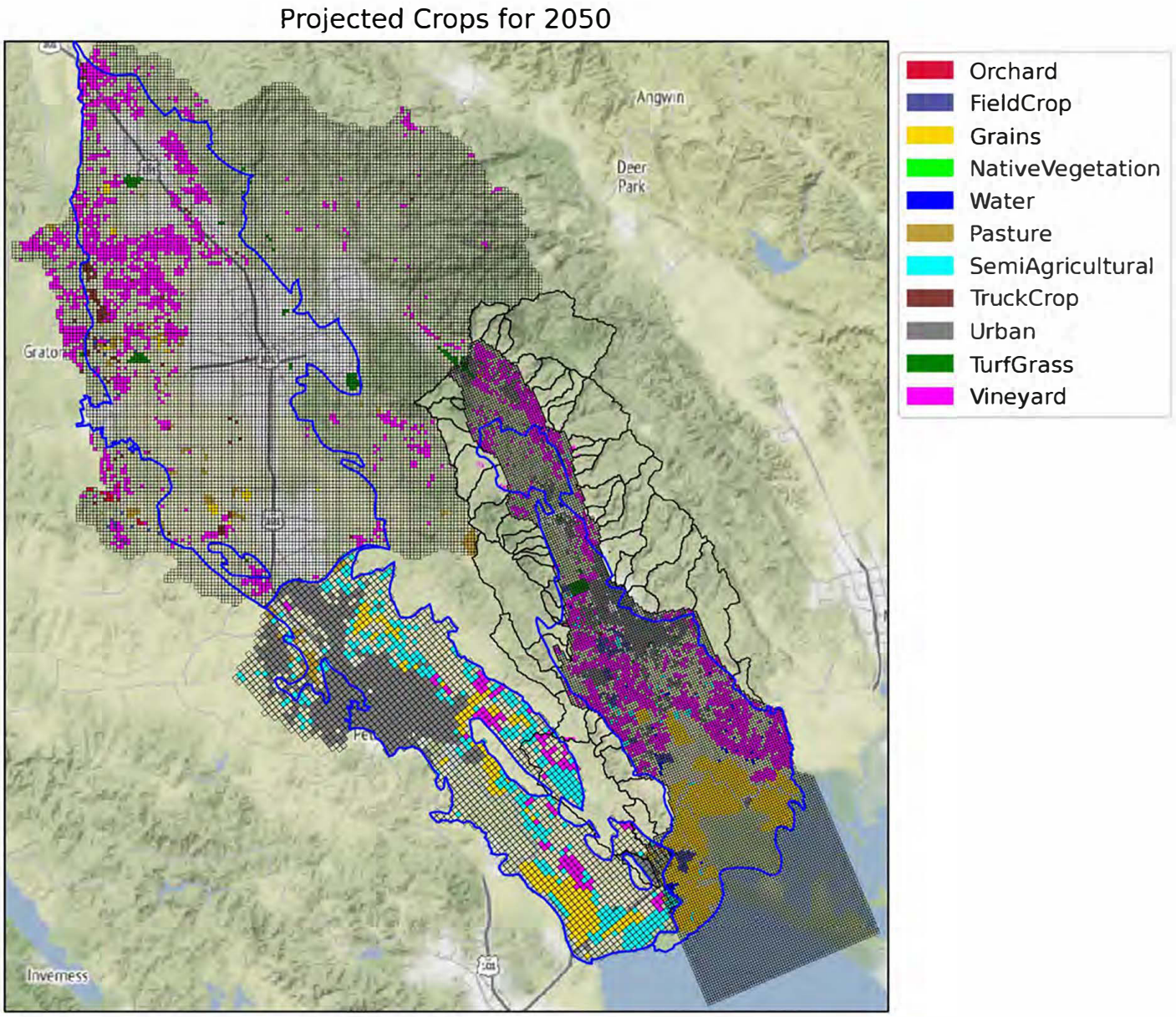

Figure 23 Projected Crops for 2050

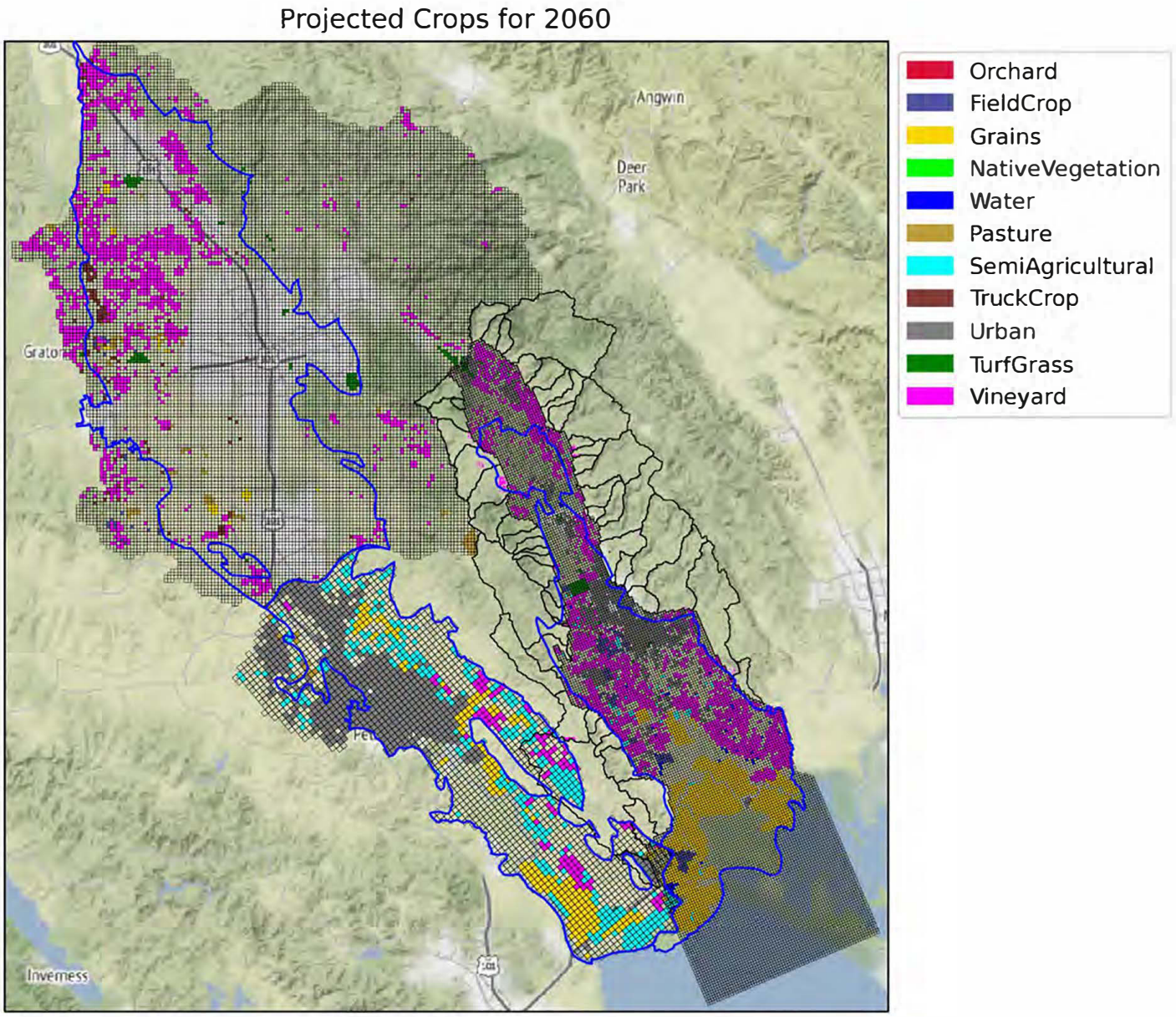

Figure 24 Projected Crops for 2060

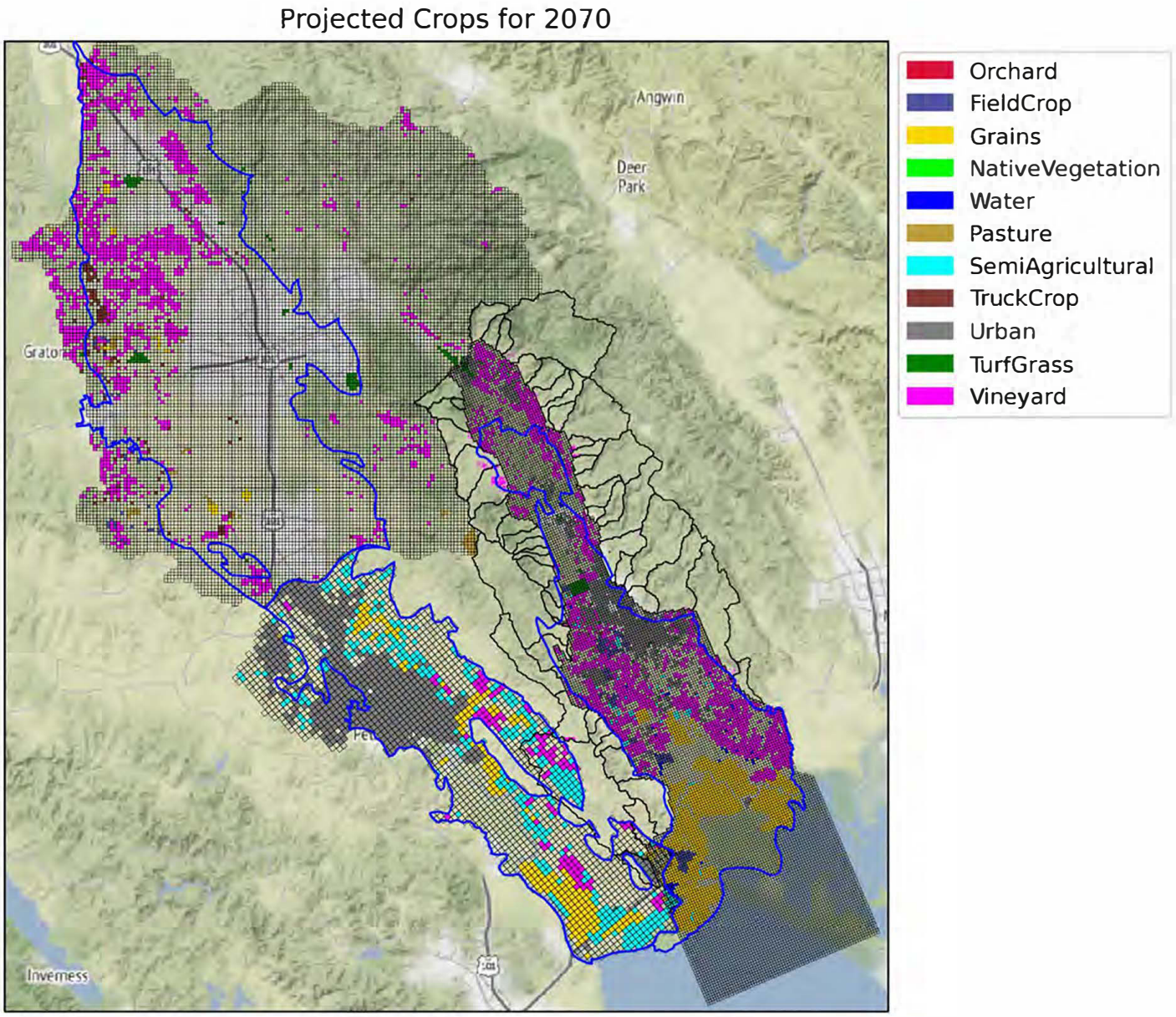

Figure 25 Projected Crops for 2070

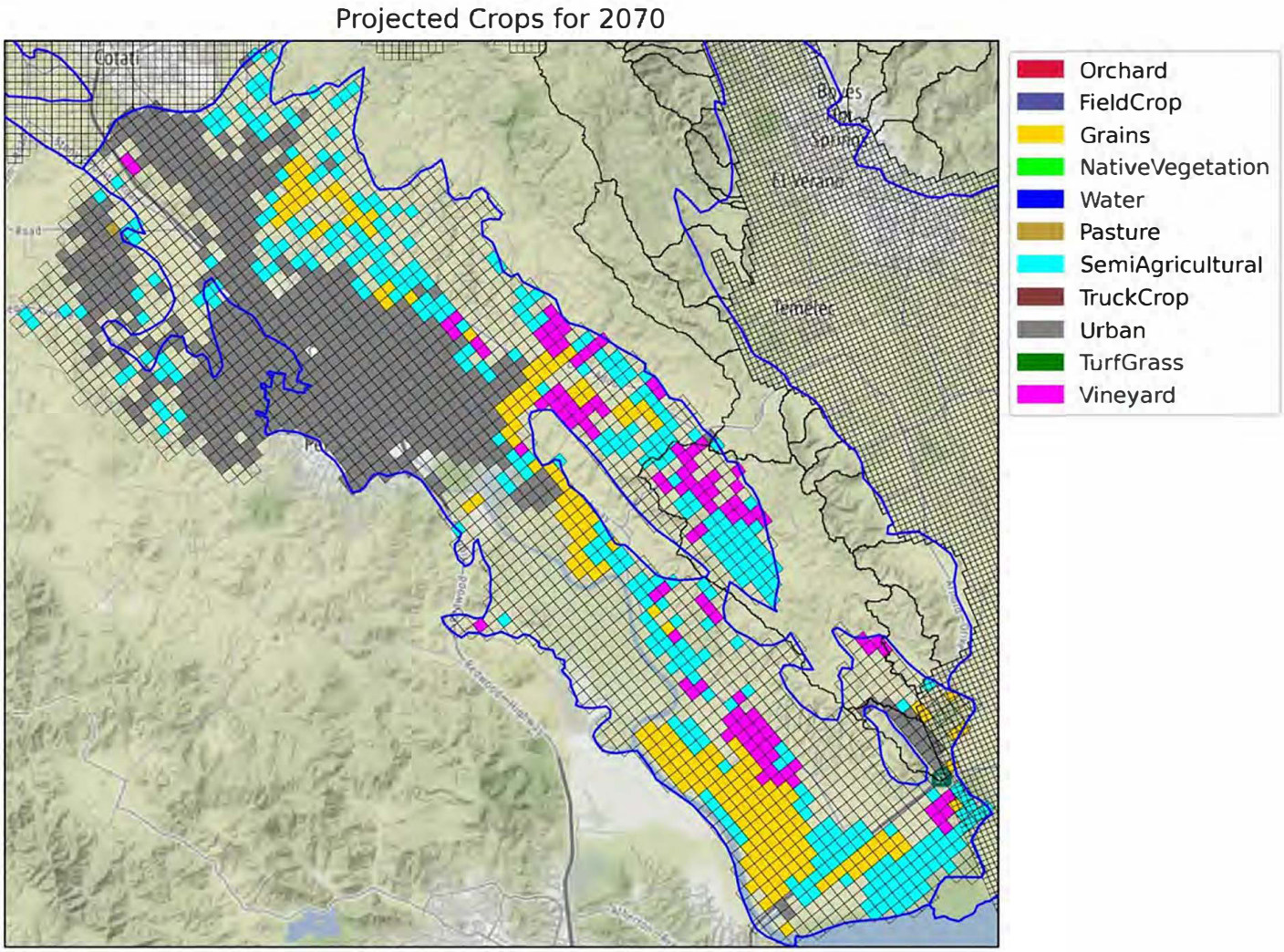

Figure 26 Projected Crops for 2070 for Petaluma Valley

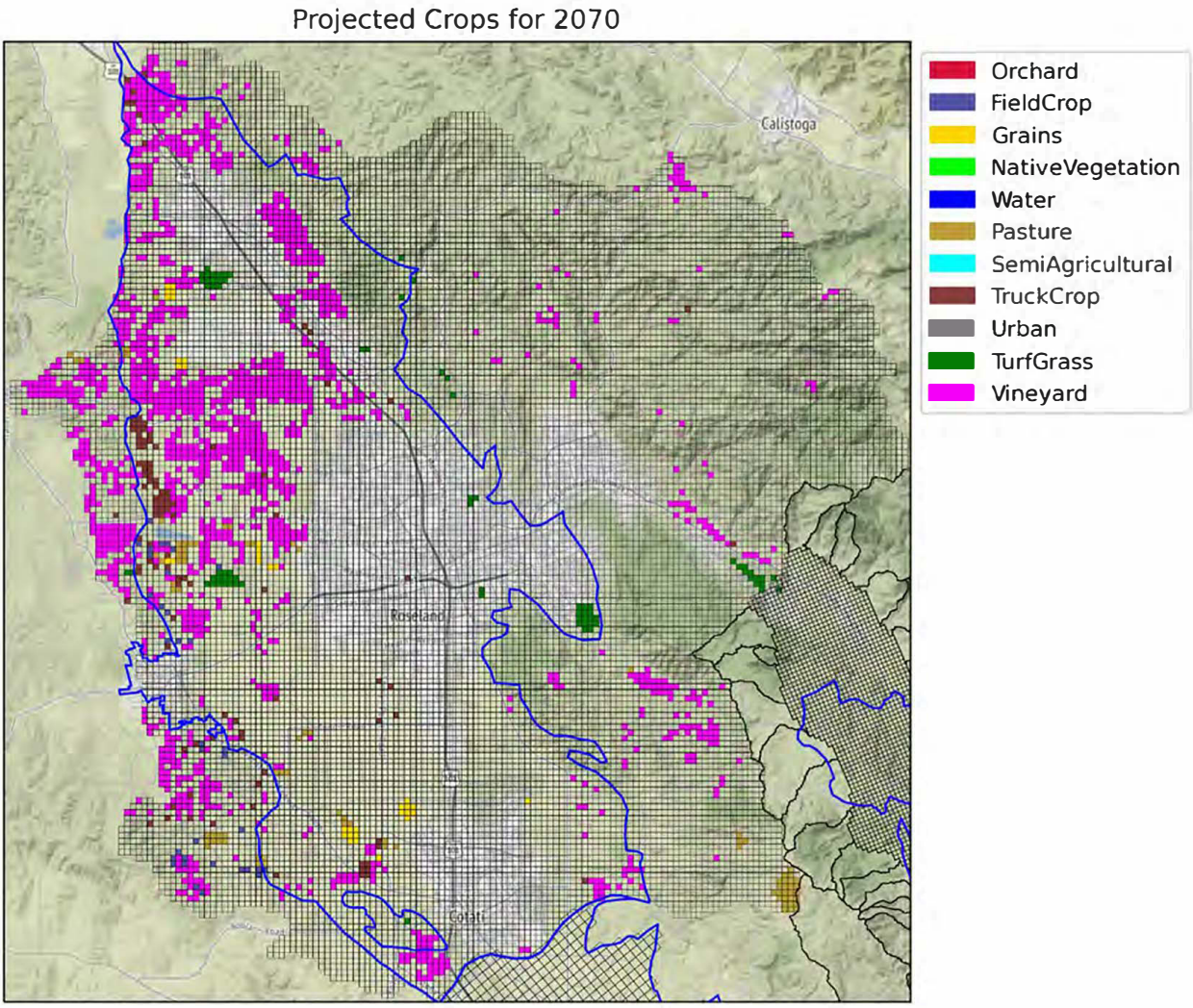

Figure 27 Projected Crops for 2070 for Santa Rosa Plain

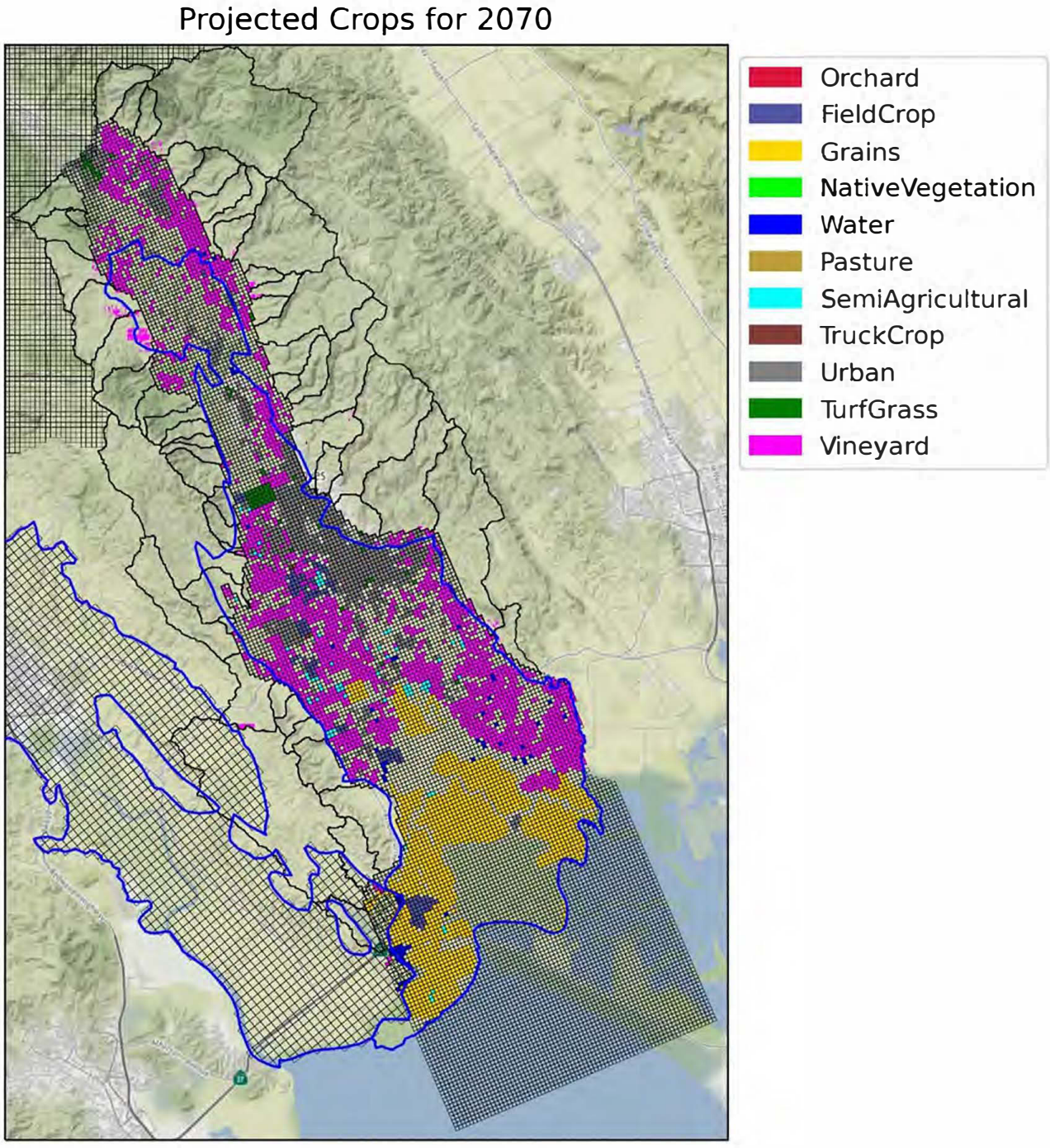

Figure 28 Projected Crops for 2070 for Sonoma Valley

Citations

Boyce, S.E., Hanson, R.T., Ferguson, I., Henson, W., Schmid, W., Reimann, T., Mehl, S.M., 2020, One-Water Hydrologic Flow Model: A MODFLOW Based Conjunctive Use and Integrated Hydrologic Flow Model: U.S. Geological Survey Techniques and Methods 6–A60, v.p.

Hanson, R.T., Boyce, S.E., Schmid, Wolfgang, Hughes, J.D., Mehl, S.M., Leake, S.A., Maddock, Thomas, III, and Niswonger, R.G., 2014, One-Water Hydrologic Flow Model (MODFLOW-OWHM): U.S. Geological Survey Techniques and Methods 6–A51, 120 p., http://dx.doi.org/10.3133/tm6A51.

Heaton E, Merenlender A. 2000. Modeling vineyard expansion, potential habitat fragmentation. Calif Agr 54(3):12-19. https://doi.org/10.3733/ca.v054n03p12.

Niswonger RG (2020) An agricultural water use package for MODFLOW and GSFLOW. Environ Model Softw, 104617

Municipal Water Demand Projections

This memo summarizes the methodology used to develop municipal pumpage projections for use with the required projected water budgets for the three Groundwater Sustainability Plans (GSPs) being developed in Sonoma County. The projections cover the entire 50-year planning horizon in the GSPs (2022 to 2072) and are summarized in the attachment. The municipal pumpers include the following categories:

- Water contractors to Sonoma Water with wells located in the Santa Rosa Plain Subbasin (city of Santa Rosa, Town of Windsor, city of Rohnert Park, city of Cotati), Petaluma Valley Basin (city of Petaluma) and Sonoma Valley Subbasin (city of Sonoma and Valley of the Moon Water District). These water contractors all use groundwater to varying degrees to supplement water deliveries from Sonoma Water (sourced primarily from the Russian River system);
- Sonoma Water which uses groundwater sourced from the Santa Rosa Plain Subbasin as a backup and supplement to its primary source of water from the Russian River system;
- California-American Water – Larkfield Wikiup District (Cal-am) which primarily uses groundwater sourced from the Santa Rosa Plain Subbasin and supplements with water deliveries from Sonoma Water; and
- City of Sebastopol, which is entirely reliant on groundwater pumped from the Santa Rosa Plain Subbasin.

Public agencies typically do not generate 50-year projections, mainly because of the considerable uncertainty associated with future land use and economic conditions. The starting point for the projections were maximum and minimum pumpage estimates for 2022-2072 that were supplied by Sonoma Water and its water contractors. While the ranges of future pumping estimates are generally inclusive of projections currently being developed for 2020 Urban Water Management Plans (UWMP) by each purveyor, in order to account for the significant uncertainty in the future projections and provide for a conservative estimate for the GSP projections, the maximum estimates generally assume higher levels of pumping in comparison with the UWMP projections. In addition, historical pumpage data (2003-19) supplied by municipal pumpers and future climate definitions generated by Sonoma Water were used to develop the projections for Sonoma Water and its water contractors which utilize groundwater as a supplemental or backup source of supply.

For Sonoma Water and its water contractors, the municipal pumpage projections were developed using the following steps:

1. Compile:
    a. historical monthly pumpage for water years (WY) 2003-2019;
    b. estimated future maximum and minimum annual pumpage estimates from Sonoma Water and its contractors for WY2022-2072 (table 1);

   c. and future climate definitions (table 2) developed by Sonoma Water. The future climate definitions are: very wet, wet, normal, dry, and very dry.
2. Calculate:
   a. statistics of historical pumpage including standard deviation (table 3)
   b. and median of future maximum and minimum annual pumpage.
3. Assign future annual pumpage based on future projected climate conditions and water year types with the maximum and minimum estimates from table 1 generally applied to very dry and very wet future periods, respectively. For dry, normal and wet periods, vary the annual pumping within the estimated maximum and minimum ranges using variations of the calculated standard deviations for each purveyor shown on table 3 to reflect higher pumping in drier periods and lower levels of pumping in wetter periods.

There were exceptions to the algorithm as applied to Santa Rosa, Rohnert Park, Cotati, and Sonoma Water. Santa Rosa did not pump groundwater in calendar year (CY) 2018 resulting in the pumpage in WY2018 and 2019 being low. Therefore, the data for WY2018 and 2019 were not used to calculate the standard deviation for the Santa Rosa pumpage data.

Rohnert Park reported that the city would pump 2,577 acre-ft/yr from WY2022-72. In order to apply the algorithm to Rohnert Park, the historical data were used for the maximum, minimum, median, and standard deviation. In addition, Rohnert Park pumped larger volume of groundwater in WY2003 (4,155 acre-ft), which is not representative of the city's more recent annual pumpage; therefore, data for WY2004-19 were used.

Cotati reported a maximum estimated pumpage of 322 acre-ft/yr. This rate is much less than the WY2003-19 maximum rate of 513 acre-ft/yr; therefore, a maximum rate of 513 acre-ft/yr was assigned.

Sonoma Water's strategy in use of groundwater has changed beginning in Water Year 2010 when its wells in the Subbasin were shifted to serve as supplemental and backup supplies resulting in significantly lower groundwater pumping during the current water budget period of 2012 through 2018 in comparison with the previous time period. Therefore, data for WY2012-18 were used for Sonoma Water.

City	Year	Minimum (afy)	Maximum (afy)
Santa Rosa	2020-2025	1300	3500
Windsor	2020-2025	25	400
	2026-2072	50	750
Rohnert Park*	2022-2072	340	2330
Cotati**	2022-2072	90	513
Petaluma	2020-2025	0	300
	2026-2072	0	600
Sonoma	2022-2072	50	238
Valley of the Moon	2020-2032	100	500
	2033-2052	100	750
	2053-2072	100	1000
Sonoma Water	2022-2072	0	1272

Table 1. Estimated future minimum and maximum projected pumpage rates, except where noted.
(* based on 2003-19 Rohnert Park pumpage and **used historic maximum rate)

Water year	Very Dry	Dry	Normal	Wet	Very Wet
2019	1	0	0	0	0
2020	1	0	0	0	0
2021	1	0	0	0	0
2022	1	0	0	0	0
2023	0	0	1	0	0
2024	0	0	0	1	0
2025	0	0	0	1	0
2026	0	0	1	0	0
2027	0	0	1	0	0
2028	0	1	0	0	0
2029	0	0	1	0	0
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2060	0	1	0	0	0
2061	0	1	0	0	0
2062	0	1	0	0	0
2063	0	1	0	0	0
2064	0	1	0	0	0
2065	0	0	1	0	0
2066	0	0	1	0	0
2067	0	1	0	0	0
2068	0	0	1	0	0
2069	0	1	0	0	0
2070	0	1	0	0	0
2071	0	0	1	0	0
2072	0	0	1	0	0
2073	1	0	0	0	0

Table 2. Future climate definitions as defined by Sonoma Water.

City	Mean	Standard Deviation	Minimum	25% quartile	Median	75% quartile	Maximum
Santa Rosa*	827.26	588.53	0.00	234.65	1125.76	1252.43	1638.29
Windsor**	89.29	70.82	29.92	45.33	68.95	112.91	189.34
Rohnert Park***	1356.68	557.99	338.88	880.94	1314.40	1764.26	2327.27
Cotati	285.93	121.66	53.42	258.06	298.53	363.86	513.08
Petaluma	290.27	346.55	0.00	0.00	156.12	383.99	1137.70
Sonoma	116.91	69.56	21.90	70.00	86.59	164.30	247.81
Valley of the Moon	480.59	88.35	343.86	410.95	480.84	534.40	668.74
Sonoma Water	453	499.0	2	27.15	208.00	829.13	1272

Table 3. Statistics of historic WY2003-19 pumpage data by city except where noted. (*used WY2003-17 data for Santa Rosa, **used WY2003-06 data for Windsor, ***used WY2004-19 data for Rohnert Park, ****used 2012-2018 data for Sonoma Water)

Future groundwater pumpage for CalAm and Sebastopol were assumed to increase annually without variations based on projected water year types, as both pumpers use groundwater as a primary source of supply and have less flexibility to conjunctively use both surface water and groundwater for water supply, (i.e., future groundwater demand is anticipated to be more influenced by future growth).

CalAm pumpage was assumed to increase 0.5% annually from the WY2019 pumpage of 637 acre-ft based on consultation with CalAm staff. The value of 0.5% was selected based on the medium range estimate of future growth developed for the rural residential projections. The growth was assumed as a straight-line increase in demand for the 5-year period, resulting in a 2072 projected pumpage of 826 acre-feet.

For the city of Sebastopol, the following methodology was developed in consultation with city of Sebastopol planning department staff:

1. For 2035, the stated assumptions on page 3.14-15 of the City of Sebastopol Draft EIR for its General Plan Update for buildout within the City limits were used:
    a. 1,324 acre-feet per year (AFY) based on projected 2035 population of 9,165 x 129 gallons per capita per day (gpcd)x 365 days
    b. Assume a straight-line increase from the City's average recent baseline pumping of 1,000 AFY in 2020 to 1,320 in 2035
2. For 2035 – 2072, given far greater uncertainty in growth during this period an annual projected growth of 0.5% (medium value assumed for rural residential growth projections) was applied and yielded:
    a. A 2072 projected population of ~10,860 (increase of 1,695 over the 37-year period between 2035 and 2072)
    b. A 2072 demand of 1,570 AFY by applying the same 129 gpcd assumptions as above

Sebastopol pumpage was assumed to increase linearly between WY2019 and 2035 and between WY2035 and 2073.

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Appendix 3-E
Selection of Global Circulation Model for Climate Change Projections

JACOBS

Sonoma Water Climate Scenario Assessment for Groundwater Sustainability Planning

Technical Assessment of Climate Scenarios for Sonoma Water Groundwater Sustainability Planning

February 24, 2020

Sonoma Water

Contents

1. Introduction 3
2. Approach and Methods 4
3. Results 6
3.1 Projected Changes in Precipitation and Temperature 6
3.2 Projected Changes in Annual Streamflow 9
3.3 Projected Changes in 3-Year Annual Streamflow 10
3.4 Projected Changes in Lake Sonoma Storage 12
3.5 Projected Changes in Sonoma Water Diversion Capability 15
4. Scenario Rankings 17
5. Summary and Recommendations 18
6. References 19

Comparison of Select Water Budget Components for Representative Concentration Pathways 4.5 and 8.5……20

Appendix A. Recommendations for Defining Water Year Types for Groundwater Sustainability Planning

1. Introduction

Sonoma Water is utilizing climate information for a number of regional water planning, sustainability, and resiliency efforts. As part of regional efforts to develop Groundwater Sustainability Plans (GSPs), future climate information is required to assess the sustainability of groundwater management over conditions that may be different than historical climate. This technical memorandum provides information on an evaluation of twenty individual climate model projections of simulated key metrics related to regional climate and hydrology that can be used to support identification of a subset of scenarios for use in water planning efforts. Figure 1 shows Russian River watershed and the 3 Groundwater sub-basins.

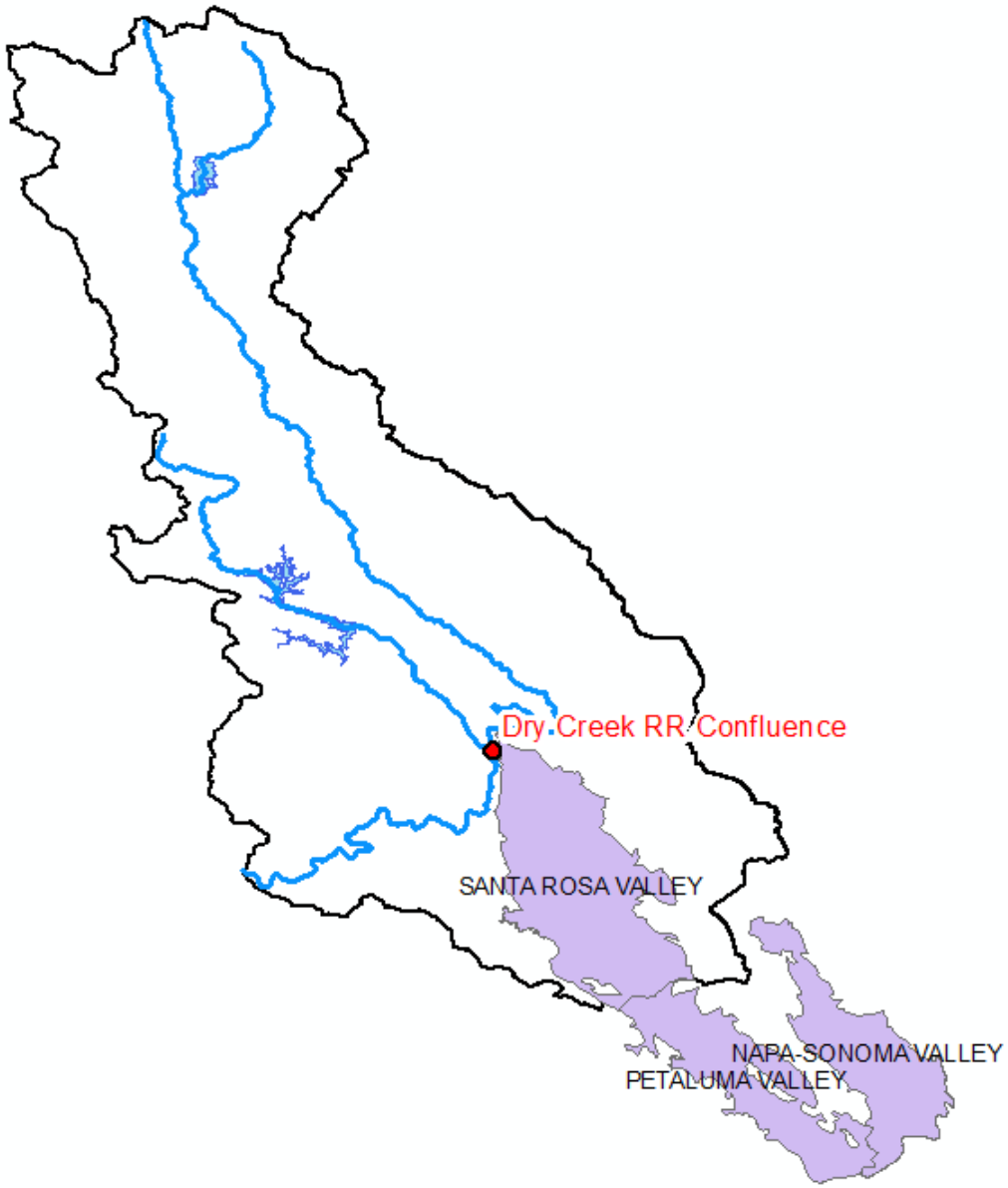


Figure 1. Russian River Hydrologic Basin and Santa Rosa Valley, Petaluma Valley, and Napa-Sonoma Groundwater Sub-Basins

2. Approach and Methods

Over the past several decades, air temperatures have increased globally and throughout the western United States, including California. While the Sonoma County region is complex with several microclimates, historical patterns of warming have occurred in near all monitoring stations in the region (Erkstrom and Moser 2012). Precipitation over most of California, including the Sonoma County region, is dominated by extreme variability, both seasonally, annually, and over decadal time scales.

Projections of future climate conditions are generally performed through general circulation models (GCMs) forced with specific global greenhouse gas (GHG) emission scenarios (IPCC 2013). The projections included in this summary rely upon available climate projections using the models and emissions scenarios included in the Coupled Model Intercomparison Project 5 (CMIP5). Twenty individual downscaled GCM projections were selected from ten different GCMs and two different Representative Concentration Pathways (RCPs), RCP4.5 and RCP8.5. The ten GCMs were chosen by the DWR Climate Change Technical Advisory Group (CCTAG) based on a regional evaluation of climate model ability to reproduce a range of historical climate conditions (DWR CCTAG, 2015). The 20 climate projections were downscaled using a statistical downscaling method called LOCA at 1/16th degree (~6 km) (~3.75 miles) spatial resolution by Scripps Institution of Oceanography (Pierce et al., 2014) and subsequently further downscaled to a 270-meter resolution by the USGS as part of the Basin Characterization Model (BCM) data set. These data form the basis for this assessment.

As part of California's Fourth Climate Change Assessment, four of the GCMs were identified as "cool/wet", "middle", "warm/dry", and "diversity" based on an evaluation of climate metrics for northern California coast region (Pierce et al. 2018). The individual GCMs, RCPs, and Fourth Climate Change Assessment identifiers are shown in Table 1.

Table 1. GCMs Selected by DWR CCTAG and Used in this Assessment

GCM	RCP 4.5	RCP 8.5	CA Fourth Climate Change Assessment "Northern CA Coast" Identifier
ACCESS1-0	X	X	
CCSM4	X	X	
CESM1-BGC	X	X	
HadGEM2-CC	X	X	
CMCC-CMS	X	X	
CNRM-CM5	X	X	Cool/Wet
CanESM2	X	X	Middle
GFDL-CM3	X	X	
HadGEM2-ES	X	X	Warm/Dry
MIROC5	X	X	Diversity

Since modeling efforts for the Sonoma GSPs may not be able to support the characterization of groundwater basin outcomes based on all 20 projections, a subset of climate projections may be needed to provide a representation of the future climate conditions. Two possible approaches are recommended: (1) selection of an individual climate projection such as HadGEM2-ES to represent a scenario of future climate or (2) use of a sub-ensemble of projections to map projected changes in temperature and precipitation to an underlying historical time series. The individual projection approach has advantages in that it will present one outcome of the climate model projections and will contain internally-consistent variability and change. Dry and wet periods (seasonal, annual, and inter-annual) of differing durations and severity can be explored. The second approach is termed an

ensemble-informed process and adjusts historical time series to reflect the projected changes associated with the sub-ensemble. The ensemble-informed process is included in the climate change data documented in Guidance Document for the Sustainable Management of Groundwater by California Department of Water Resources (CA DWR, 2018). This process provides a stable depiction of the central tendency of the ensemble of climate models and is capable of capturing seasonal and annual changes, but significant changes in interannual variability are not captured due to its reliance on an underlying historical time series. This technical report focuses on the evaluation of individual climate projections.

In addition, for GSP planning purposes, it is desirable to identify projected climate scenarios that more specifically represent the climate and hydrologic conditions within the Russian River watershed and Sonoma County. Based on the discussions with regional water managers, we have identified five major climate, hydrologic, and water supply metrics that could support assessment of specific climate scenarios. These metrics are listed below:

- Mean change in annual temperature and precipitation
- Mean annual Russian River streamflow
- 1- and 3-yr Russian River streamflow variability
- Lake Sonoma annual minimum reservoir storage conditions
- Sonoma Water delivery capability

For each future climate projection, each of the resulting metrics was assessed. Climate information was averaged for the Russian River watershed area. Naturalized streamflow was derived from BCM simulations and subsequently corrected for historical biases. Reservoir and water delivery outcomes were derived from HEC-ResSim simulations using the future climate and naturalized streamflow inputs.

Climate projection outcomes were assessed for two future periods. In order to capture variability in precipitation and streamflow a period of sufficient length was required. For this assessment, the mid-century period is defined as the period of 2006-2060 and late century is the period of 2045-2099 and results are compared to the historical period of 1951-2005. Each of these periods includes 55-years of variability, and the historical period represents the same period for which BCM streamflow results were bias-corrected. For climate information (temperature and precipitation change), we also present changes for shorter 30-year periods in addition to the longer 55-year periods for comparison. These additional periods are 2035-2065 for mid-century and 2070-2099 for late century compared to the historical period of 1976-2005 and are those presented in Pierce et al. (2018), a report prepared for the California Fourth Climate Change Assessment.

3. Results

The sections that follow present the results for projected changes in precipitation, temperature, streamflow, storage, and Sonoma Water diversion for mid-century conditions.

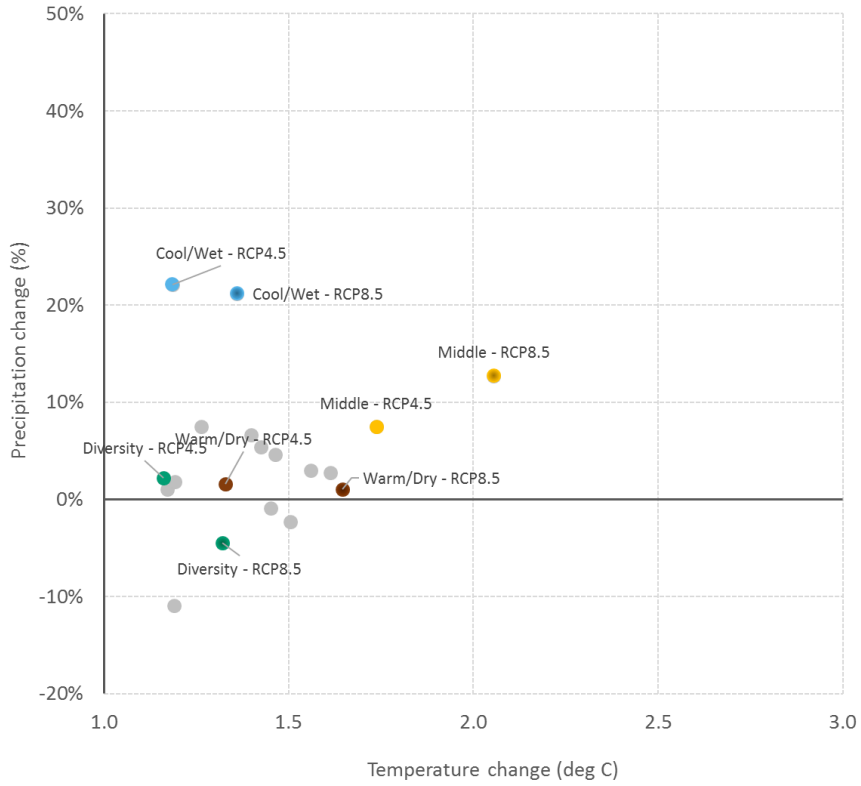
3.1 Projected Changes in Precipitation and Temperature

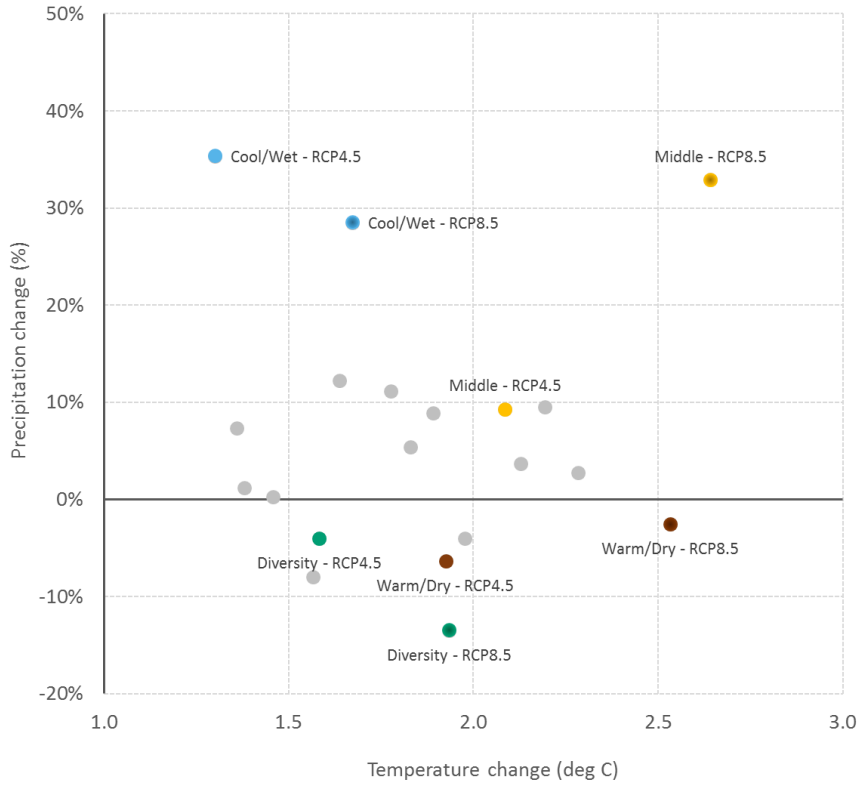
Figure 2 shows the temperature and precipitation changes projected by ten different GCMs for both RCP 4.5 and 8.5 scenarios for mid-century. The GCMs with a “Northern CA Coast” identifiers are colored and labeled with other GCMs shown in grey. The top panel shows the changes using the 55-year period of 2006-2060, while the bottom panel shows the changes for the 30-year period of 2035-2065. All models project temperature to increase between 1.2 and 2.6 degree Celsius. HadGEM2-ES (Warm/Dry model) and CanESM2 (Middle model) project the highest temperature increase, while CNRM-CM5 (Cool/Wet model) projects the lowest increase with about 1.2 degree Celsius among all model projections. In addition, most of the model projections (16 out of 20) suggest a slightly wetter future for the region. CNRM-CM5 and CanESM2 show the largest increases among all model projections. On the other hand, MIROC5 (Diversity model) suggests reduction in precipitation by mid-century.

Figure 3 shows the same information for late century. The top panel shows the changes using the 55-year period of 2045-2099, while the bottom panel shows the changes for the 30-year period of 2070-2099. All models project temperature to increase between 1.4 and 4.7 degree Celsius. HadGEM2-ES (Warm/Dry model) and CanESM2 (Middle model) project the highest temperature increase, while CNRM-CM5 (Cool/Wet model) projects the lowest increase. In addition, most of the model projections suggest a wetter future for the region. CNRM-CM5 and CanESM2 show larger increases among all model projections. On the other hand, MIROC5 (Diversity model) suggests reductions in precipitation starting in mid-century and becoming more pronounced by late-century.

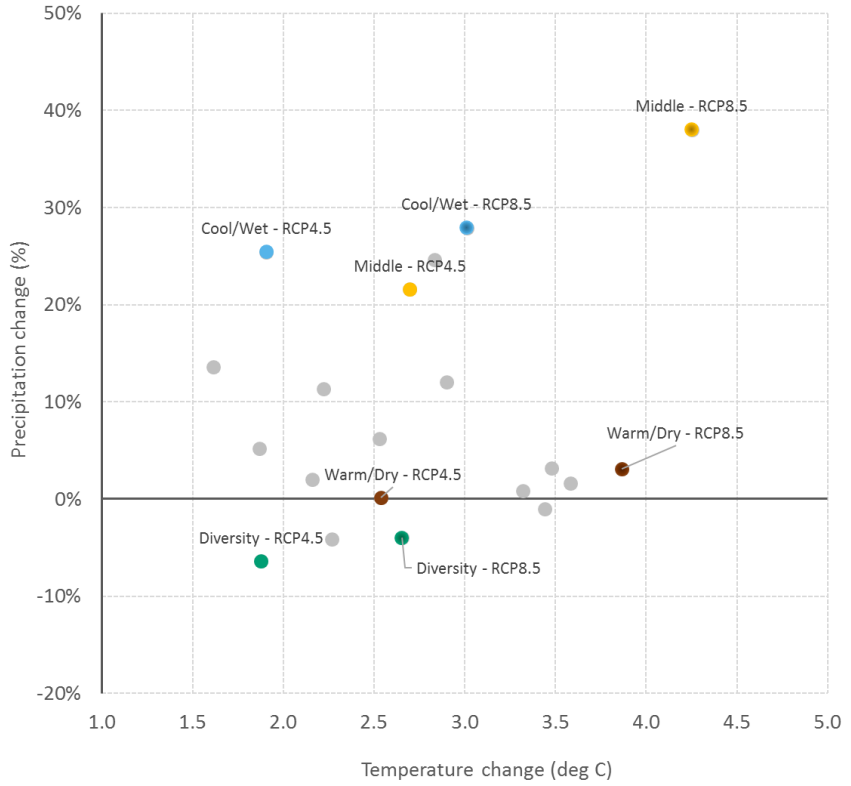
Based on this assessment, the CanESM2 model, which was labeled as “middle” in DWR’s Fourth Climate Change Assessment, can only be considered as “warm/wet” for the Russian River domain. The “warm/dry” HadGEM2-ES model tends more to the middle, and the “diversity” MIROC5 continues to be the driest model. The CNRM-CM5 model appears consistent with “cool/wet” identifier.

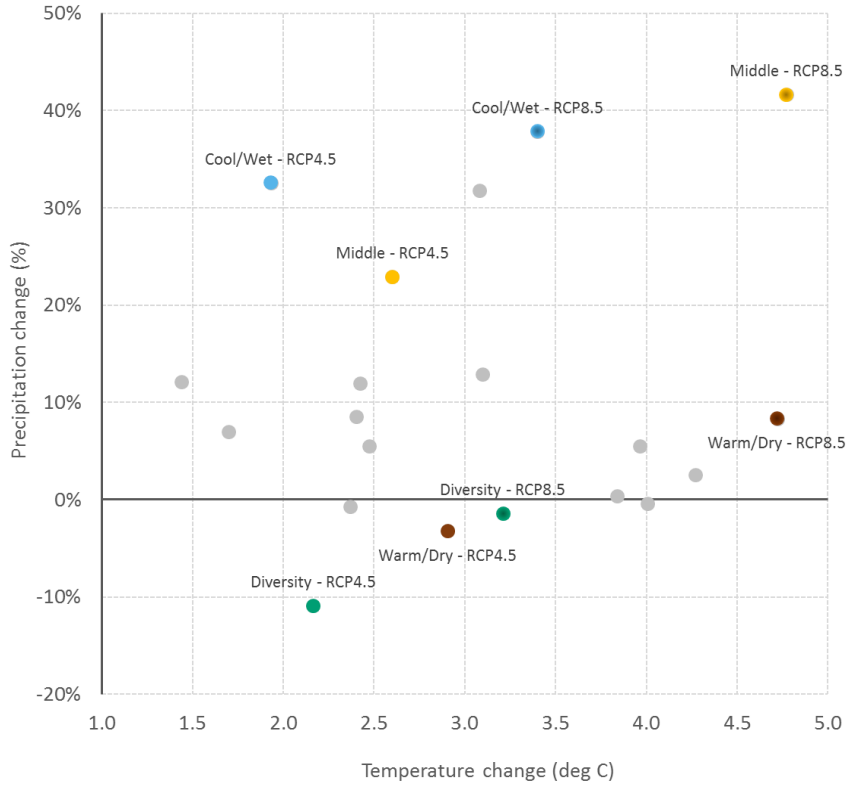
Figure 2. Projected Changes in Mean Annual Temperature and Precipitation (top panel: 2006-2060 and lower panel: 2035-2065)





igure 3. Projected Changes in Mean Annual Temperature and Precipitation (top panel: 2045-2099 and lower panel: 2070-2099)





3.2 Projected Changes in Annual Streamflow

Figure 4 shows the annual natural streamflow exceedance probability curves for historical and future scenarios at the Russian River downstream of the Dry Creek confluence for the period of 2006-2060. The results indicate the potential for streamflow reductions, particularly during the drier years (lower percentiles) and potential increases during wetter years (higher percentiles). The “cool/wet” and “middle” projections show much higher increases in streamflow increases than the “diversity” and “warm/dry” projections. It appears that the so-called “warm/dry” projections fall more towards the center of the ensemble of results and produce wetter wet years and drier dry years as compared to the historical distribution.

Figure 5 shows the annual natural streamflow exceedance probability curves for historical and future scenarios at the Russian River downstream of the Dry Creek confluence for the period of 2045-2099. Under this later future period, the differences between scenarios is magnified but shows similar relative ordering as the earlier period. The so-called “middle” projections exhibit the greatest change in streamflow, while the “warm/dry” once again tends toward the actual middle of the distribution.

Figure 4. Projected Changes in Annual Russian River Streamflow for Period of 2006-2060.

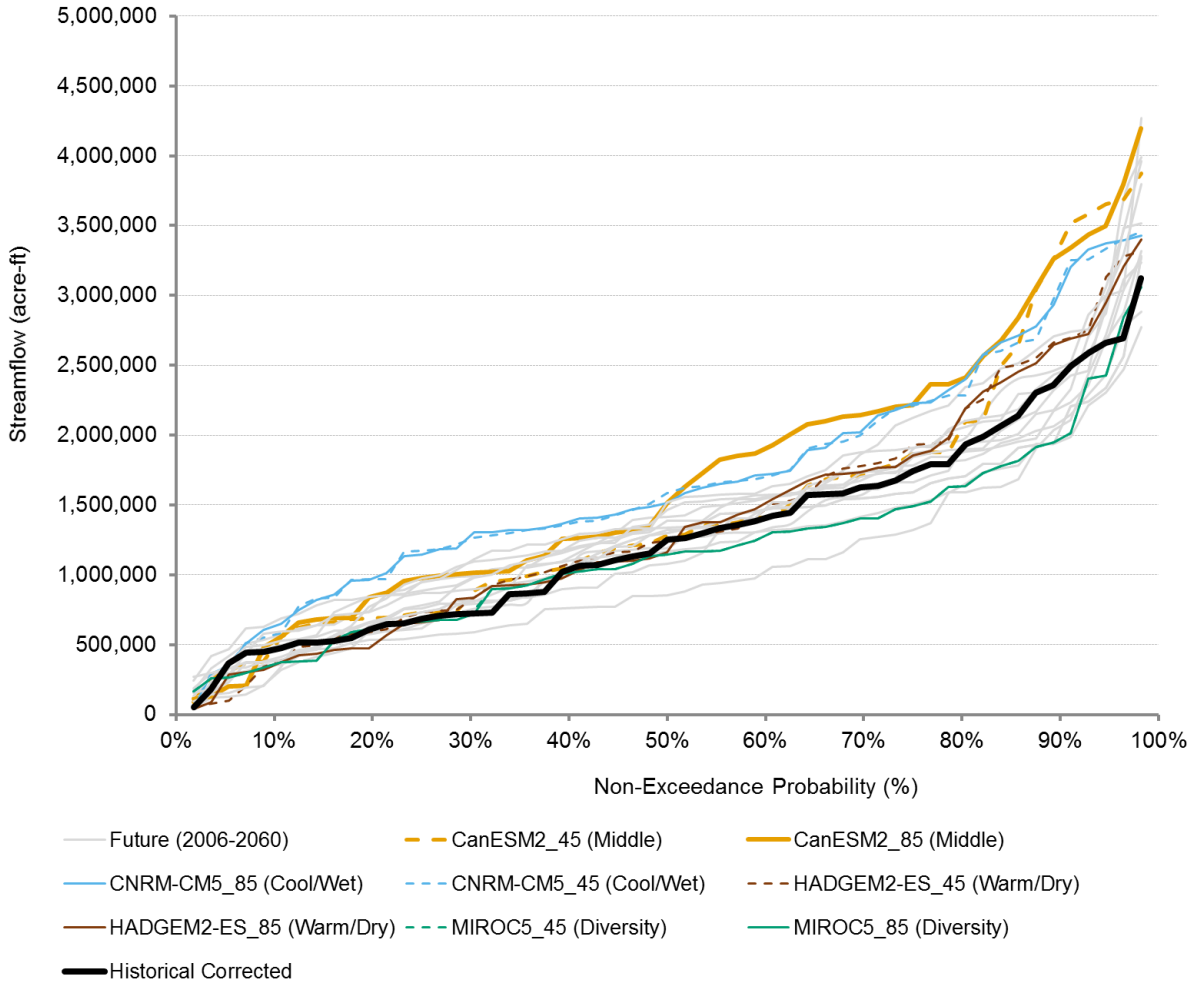
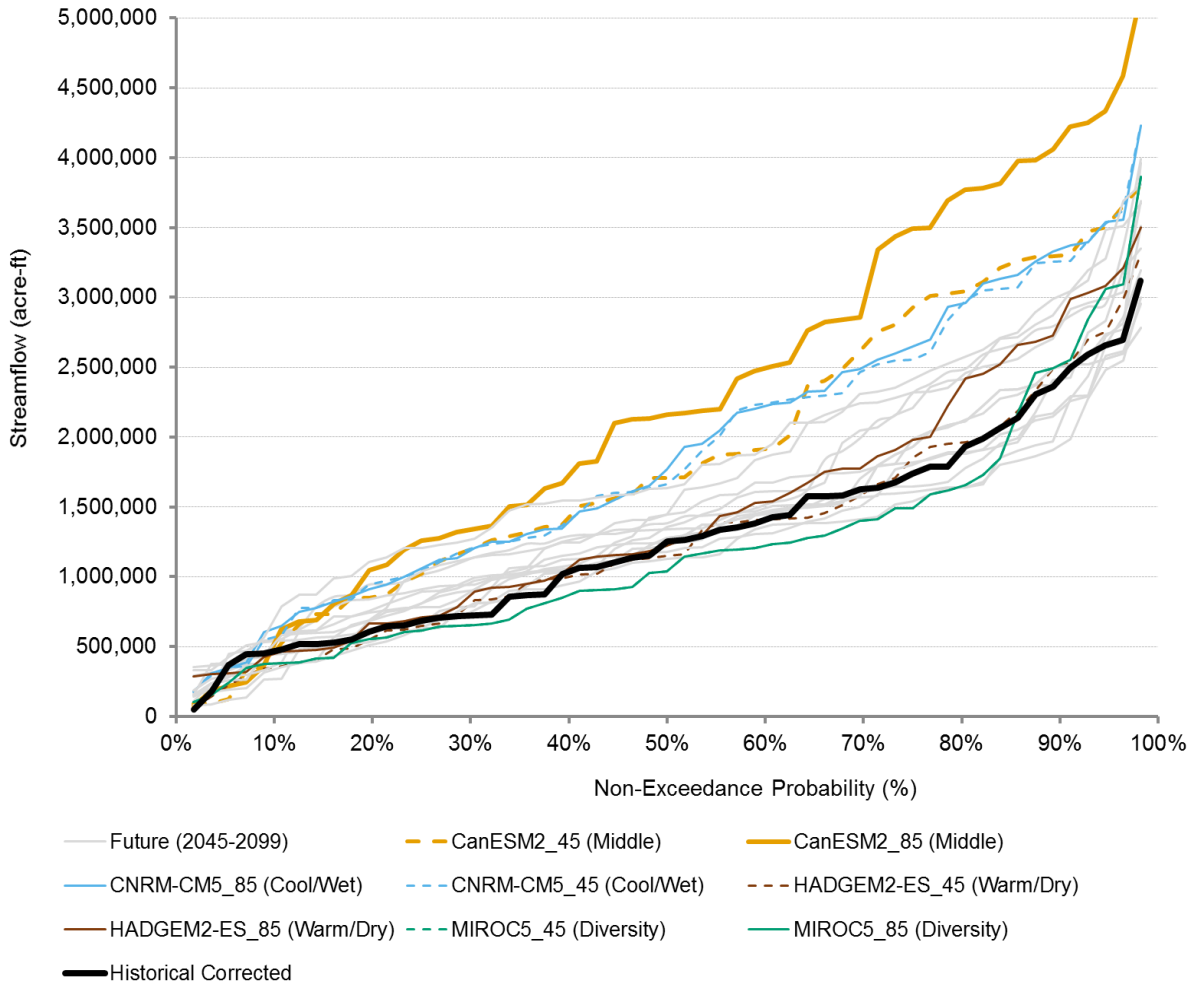


Figure 5. Projected Changes in Annual Russian River Streamflow for Period of 2045-2099.



3.3 Projected Changes in 3-Year Annual Streamflow

Figure 6 shows the 3-year annual natural streamflow exceedance probability curves for historical and future scenarios at the Russian River downstream of the Dry Creek confluence for the period of 2006-2060. The results indicate an expansion in variability for the moderate to wet periods but only modest changes in variability for the driest periods. The “cool/wet” and “middle” projections show the largest increases in 3-year streamflow, while the “diversity” and “warm/dry” projections indicate the greatest reductions in 3-year streamflow. Similar to annual streamflow, the so-called “warm/dry” projections fall more towards the center of the ensemble of results and produce wetter wet years and some drier dry years as compared to the historical distribution. The “diversity” projection continues to exhibit the lowest 3-year annual streamflow.

Figure 7 shows the 3-year annual natural streamflow exceedance probability curves for historical and future scenarios at the Russian River downstream of the Dry Creek confluence for the period of 2045-2099. Under this later future period, the differences between scenarios is magnified but shows similar relative ordering as the

earlier period. The so-called “middle” projections exhibit the greatest change in streamflow, while the “warm/dry” once again tends toward the actual middle of the distribution.

Figure 6. Projected Changes in 3-Year Annual Russian River Streamflow for Period of 2006-2060.

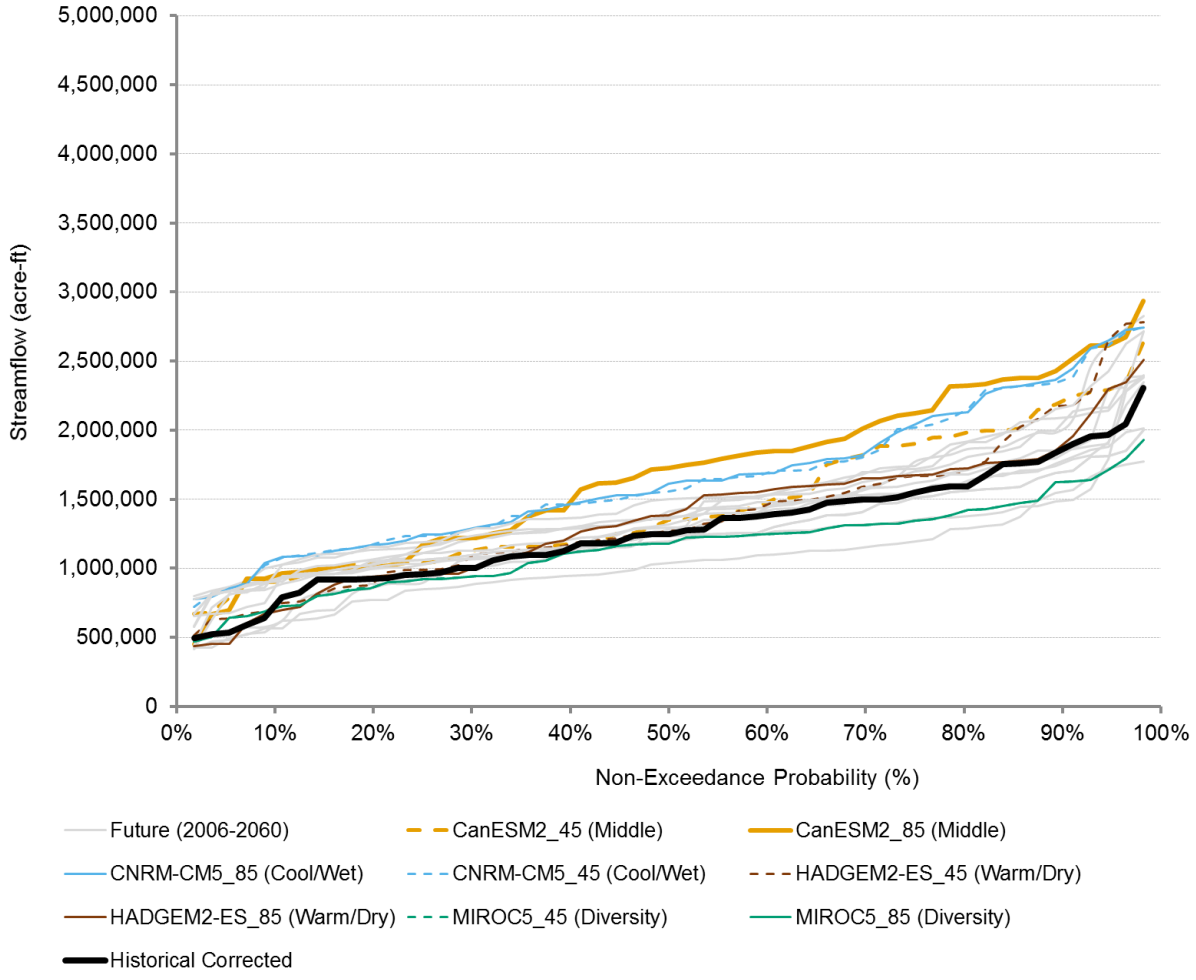
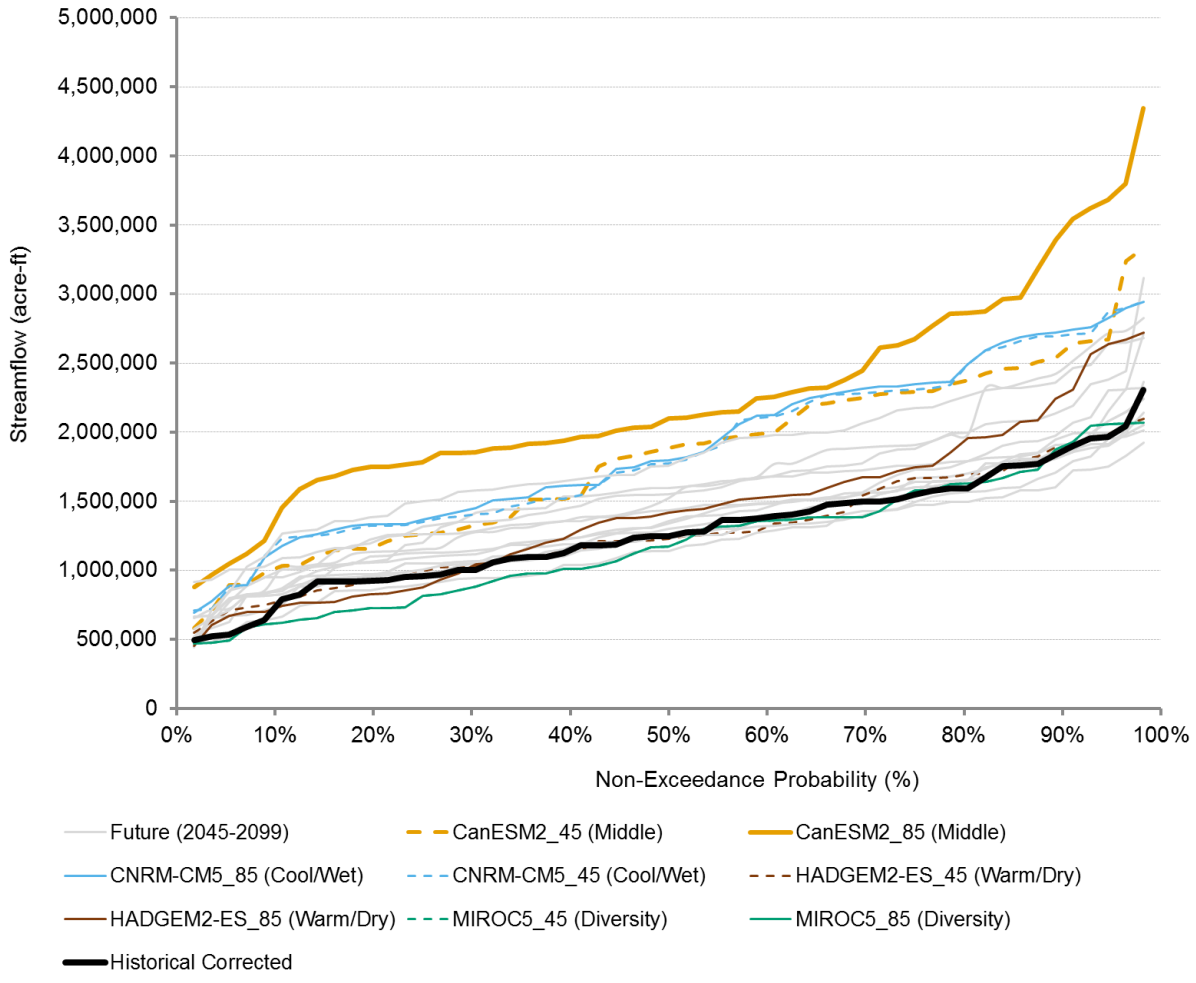


Figure 7. Projected Changes in 3-Year Annual Russian River Streamflow for Period of 2045-2099.



3.4 Projected Changes in Lake Sonoma Storage

Figure 8 shows the end of September storage exceedance probability curves for baseline and future scenarios at Lake Sonoma for the period of 2006-2060. Most future projections project decreases in storage across all exceedance values due to the projected increase in water demand in the basin and by Sonoma Water contractors. Note that the historical projections and “current operations” assume historical water demands. The range of outcomes for the lowest 30-40% of years is driven by the climate projections. Some projections suggest lower storage conditions than that projected under historical operations and indicate a few extreme challenging years.

Figure 9 shows the end of September storage exceedance probability curves for baseline and future scenarios at Lake Sonoma for the period of 2045-2099. Most future projections show decreases in storage across all exceedance values due to the projected increase in water demand in the basin and by Sonoma Water contractors. During this period, most of the projections suggest lower storage conditions than that projected under historical operations and indicate at least 10% of years lower than historical low levels.

Figure 8. Projected End of September Lake Sonoma Storage for Period of 2006-2060.

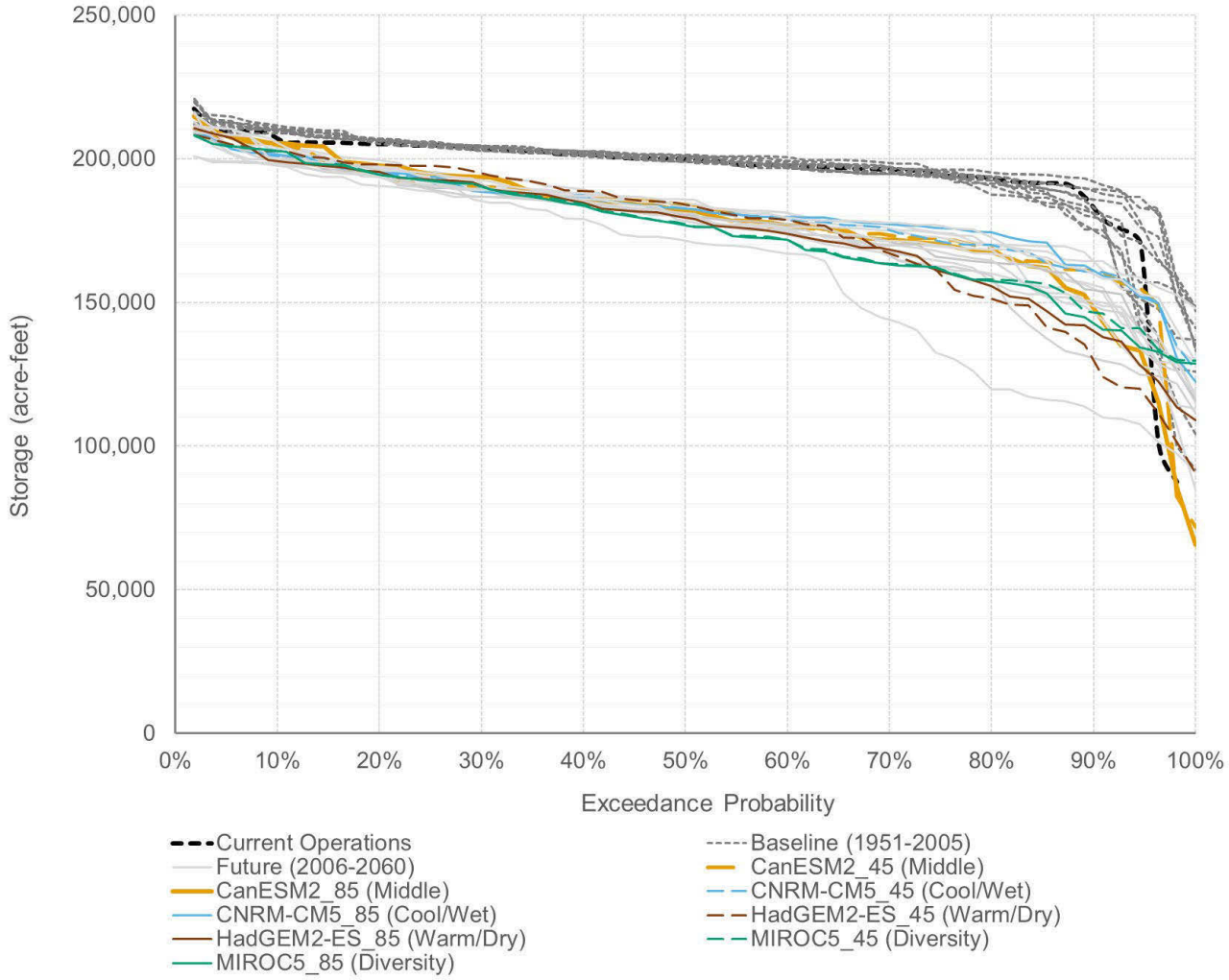
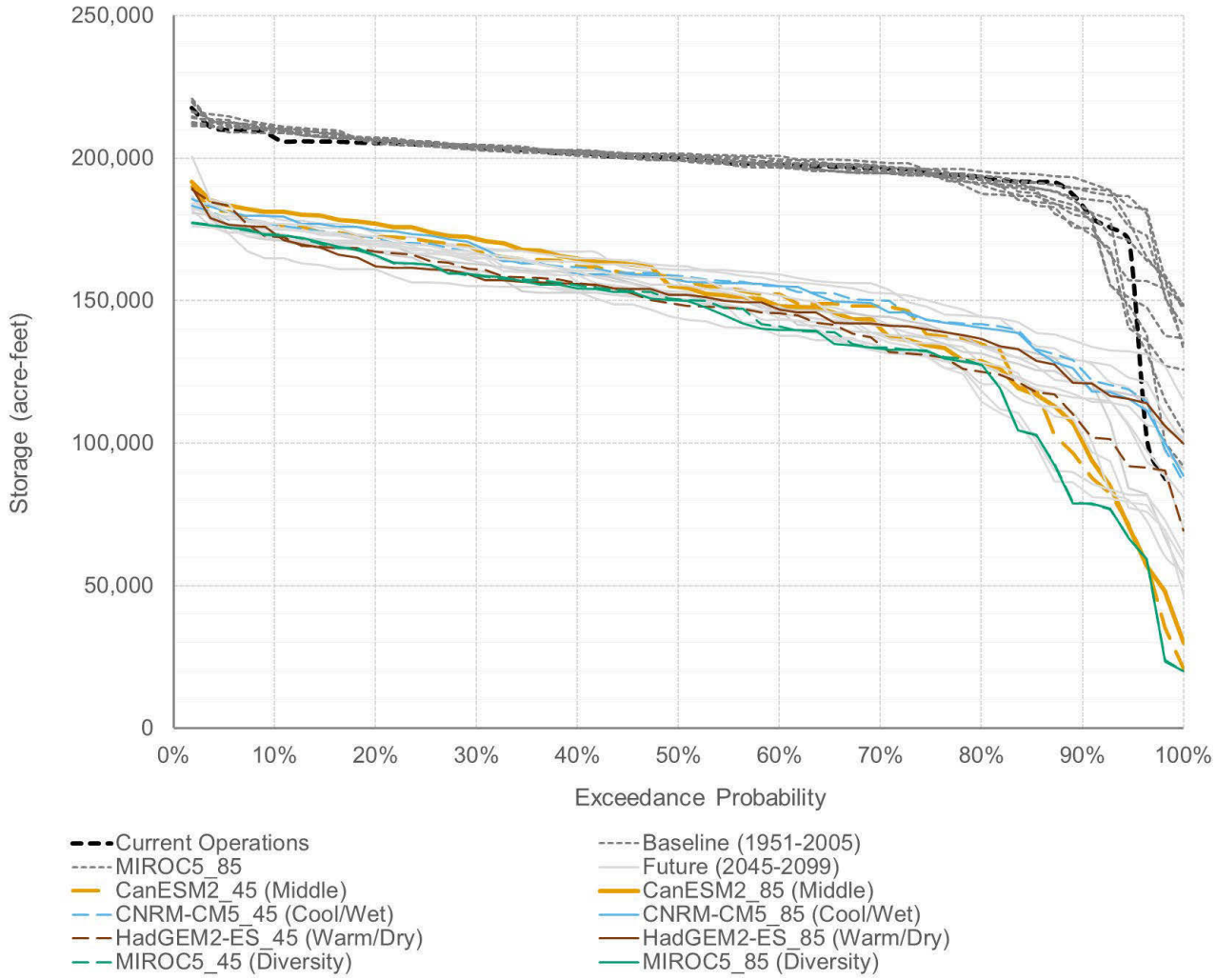


Figure 9. Projected End of September Lake Sonoma Storage for Period of 2045-2099.



3.5 Projected Changes in Sonoma Water Diversion Capability

Figures 10 and 11 show the exceedance probability curves for annual Sonoma Water diversion (acre-feet) under both baseline and future conditions. Due to increase in water demand, the Sonoma Water diversion is increased in all simulations. In general, HEC-ResSim simulations suggest nearly identical results for all GCM model projections which indicates similar delivery capability. The Sonoma Water system appears to be able to adapt to the climate and hydrologic changes projected in the scenarios.

Figure 10. Projected Sonoma Water Annual Diversion Capability for Period of 2006-2060.

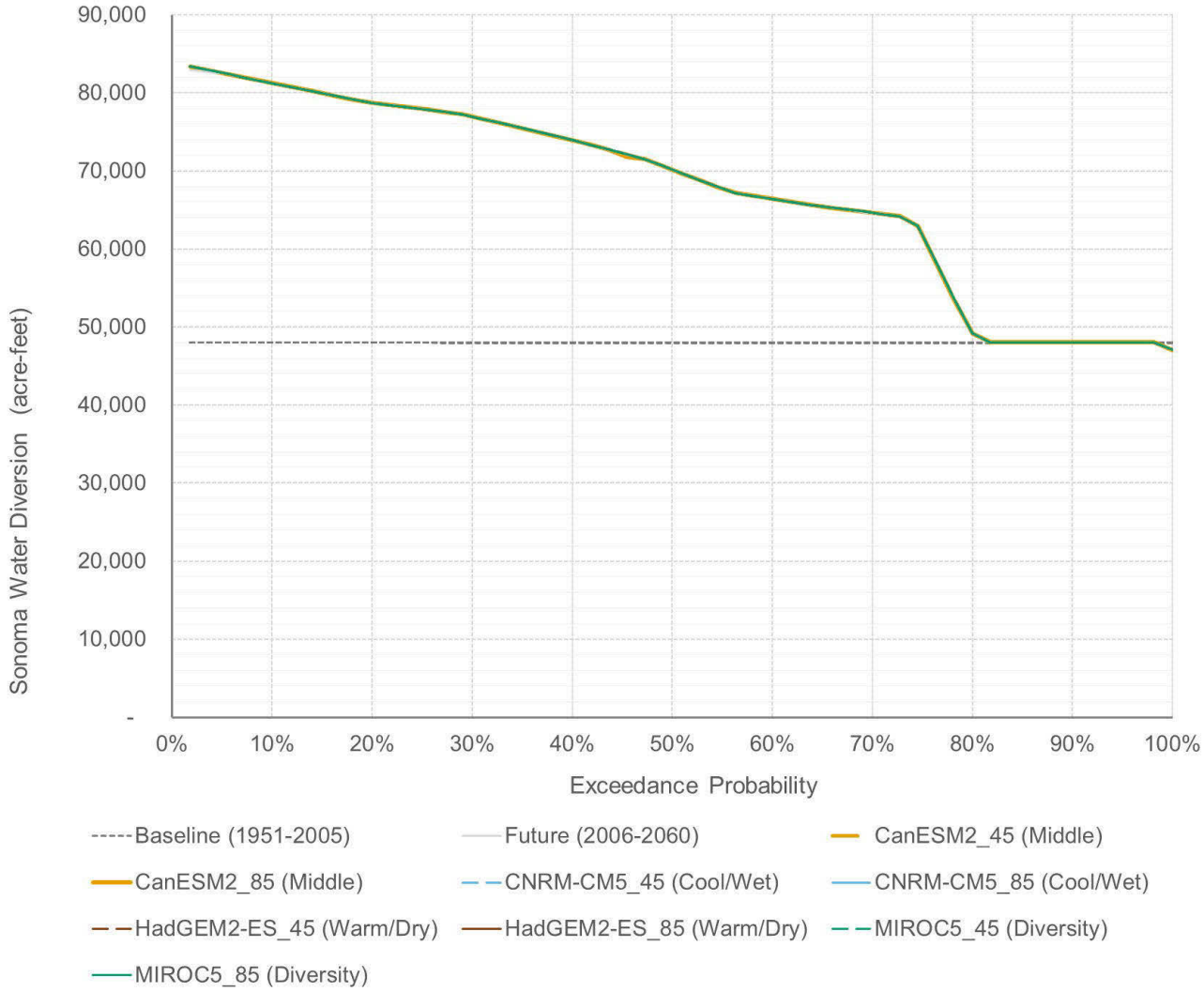
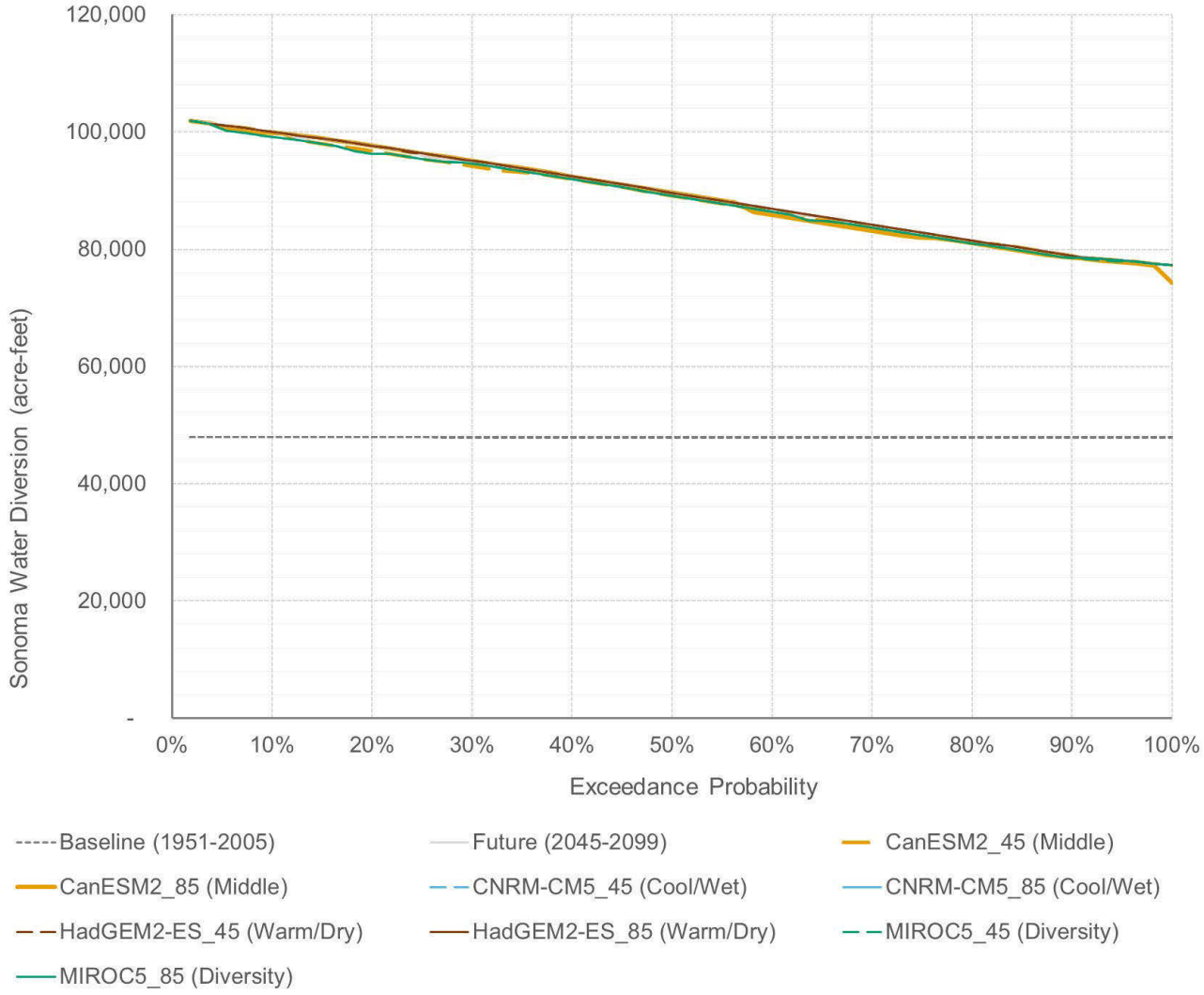


Figure 11. Projected Sonoma Water Annual Diversion Capability for Period of 2045-2099.



4. Scenario Rankings

For each of the climate, hydrologic, and water supply metrics, the model projection rank was determined by ordering the resulting metric values for the 2006-2060 period. A projection that had the largest increase amongst the 20 projections would indicate rank equal to 1, while the largest decrease/smallest increase projection would indicate rank equal to 20. The middle-most projections would indicate rank equal to 9, 10, or 11.

Table 2 shows the resulting rank of each GCM for each metric. Since each GCM includes simulations for both RCP 4.5 and 8.5, two rank values are shown.

The CanESM2 model, indicated by the CA Fourth Climate Change Assessment as "middle", ranks among the warmest, wettest, and highest annual streamflow projections. Similarly, the CNRM-CM5 model ranks among the wettest with high annual streamflow projections compared to the ensemble. Conversely, the CMCC-CMS, HadGEM2-CC, and MIROC5 models rank among the driest of the models when comparing streamflow. The CCSM4, GFDL-CM3, and HadGEM2-ES models rank closest to the middle when comparing the mean climate and hydrologic metrics.

Streamflow variability and storage metrics did not present substantial differentiation between scenarios, and since water diversion was essentially the same for all projections, no rank was assigned for this metric.

Table 2. Rank of GCM (RCP 4.5/8.5) for Metrics Used in this Assessment Based on 2006-2060 Period

GCM	T	P	Q mean (average streamflow)	Q var 1-yr (coefficient of variation of annual streamflow)	Q var 3-yr (coefficient of variation of 3-year annual streamflow)	Lake Sonoma Storage	Sonoma Water Diversion
ACCESS1-0	18/7	14/8	14/5	3/8	1/7	2/9	N/A
CCSM4	15/5	12/9	10/13	1/11	2/9	20/12	N/A
CESM1-BGC	10/14	6/5	6/7	12/17	14/16	1/6	N/A
HadGEM2-CC	20/8	19/16	15/16	15/14	19/18	13/11	N/A
CMCC-CMS	16/6	20/17	20/17	6/13	8/17	18/8	N/A
CNRM-CM5 (Cool/Wet)	17/11	1/2	3/1	19/18	11/10	5/4	N/A
CanESM2 (Middle)	2/1	4/3	4/2	2/7	6/5	7/10	N/A
GFDL-CM3	9/4	7/10	9/11	20/17	20/15	3/19	N/A
HadGEM2-ES (Warm/Dry)	12/3	13/15	15/12	5/4	3/4	16/17	N/A
MIROC5 (Diversity)	19/13	11/18	18/19	10/9	13/12	14/15	N/A

5. Summary and Recommendations

This assessment of projected climate scenarios reviewed important climatic, hydrologic, and water supply metrics that would be used to evaluate the relative performance of individual GCM projections within the Russian River watershed. For basin-wide planning projects and programs, such as the GSPs, for which the use of dozens of individual climate scenarios is not practical, this assessment was intended to inform which scenarios may be used to represent the 20-scenario ensemble and provide realistic climate change evaluations for (groundwater) planning purposes.

Through this assessment, we found that the CanESM2 model, indicated by the CA Fourth Climate Change Assessment as “middle” for the North Coast, ranks among the warmest, wettest, and highest streamflow projections for the Russian River watershed area. Use of this projection to represent the middle of the ensemble is not recommended for the Sonoma County GSPs. The CNRM-CM5 model also ranks among the wettest with high streamflow projections compared to the ensemble.

Conversely, the CMCC-CMS, HadGEM2-CC, and MIROC5 models rank among the driest of the models when comparing streamflow. The MIROC5 model was identified as a “diversity” model in the CA Fourth Climate Change Assessment, and we concur that this GCM includes projections that will likely test water supply and water management the most. This GCM could be considered for providing a “stress test” for Sonoma Water and regional water resource systems.

The CCSM4, GFDL-CM3, and HadGEM2-ES models rank closest to the middle of the ensemble when comparing the mean climate and hydrologic metrics. While the HadGEM2-ES model was identified as a “warm/dry” model in the CA Fourth Climate Change Assessment report, it likely best represents the middle of the ensemble for mean climate and hydrologic metrics for the Russian River watershed. While somewhat arbitrary to select this model from the other middle models, the HadGEM2-ES model did not stray to any of the extremes for other metric rankings. For example, the CCSM4 indicated the highest annual coefficient of variation for streamflow, while the GFDL-CM3 indicated the lowest. The HadGEM2-ES results may suggest that it was “more in the middle” than others, and thus may be appropriate for use in Sonoma County GSP development.

6. References

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Comparison of Select Water Budget Components for Representative Concentration Pathways 4.5 and 8.5

Document No.

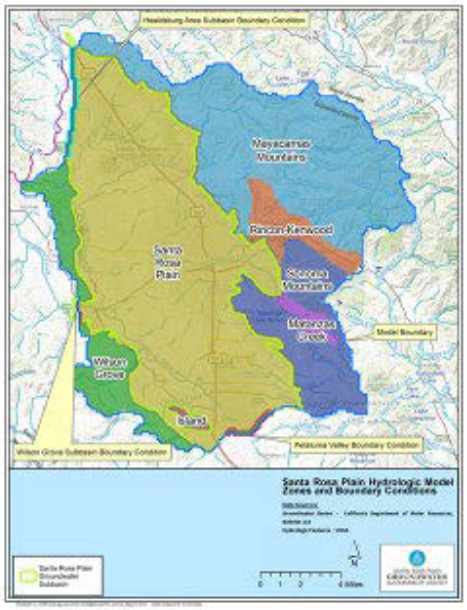
The following graphs compare simulated groundwater budget components for the Santa Rosa Plain subbasin using the representative concentration pathways (RCP) of 4.5 and 8.5. The simulations were performed with the Santa Rosa Plain Hydrologic Model using the same model inputs from the historical model, except for precipitation, temperature, and initial groundwater heads. Precipitation and temperature inputs are provided by the HadGEM2-ES global circulation model using outputs of the RCP 4.5 and 8.5.

Output from Santa Rosa Plain Hydrologic Model – Comparing RCP 4.5 and 8.5 Using HadGEM-ES

Model simulation with historical assumptions except for:

- Precipitation
- Temperature
- 2018 Initial Heads

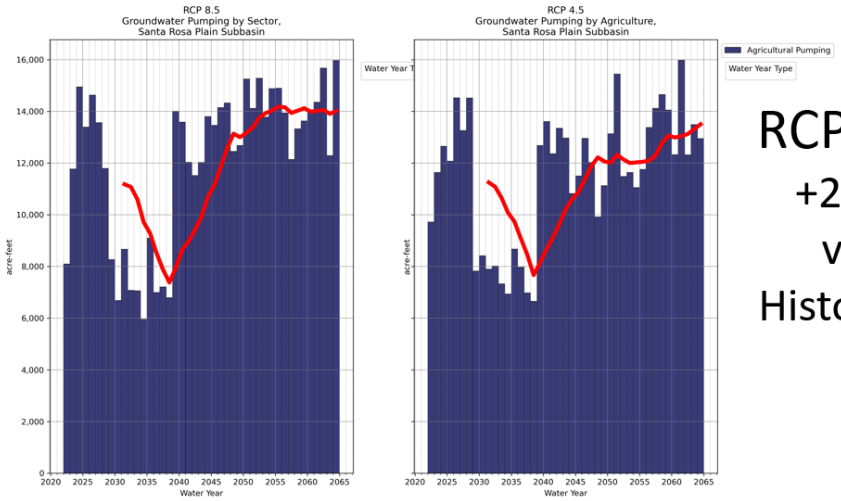
10/27/2021



28

Agricultural Pumping

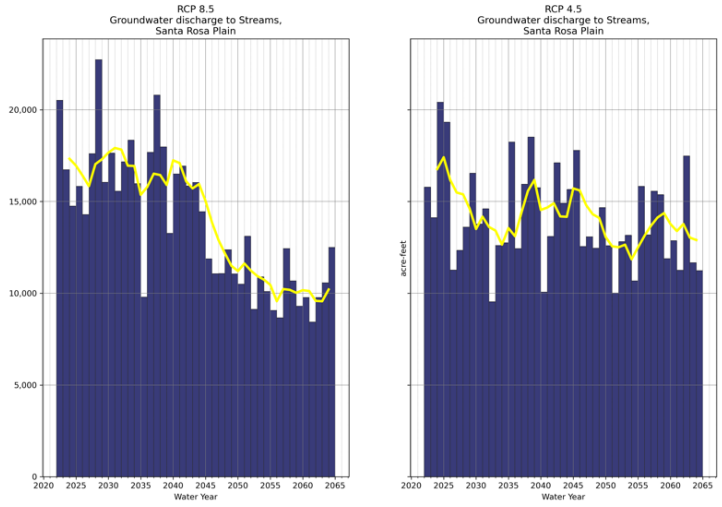
RCP 8.5
+33%
vs.
Historical



RCP 4.5
+26%
vs.
Historical

Groundwater Discharge to Streams

RCP 8.5
-10%
vs.
Historical



RCP 4.5
-8%
vs.
Historical

Document No.

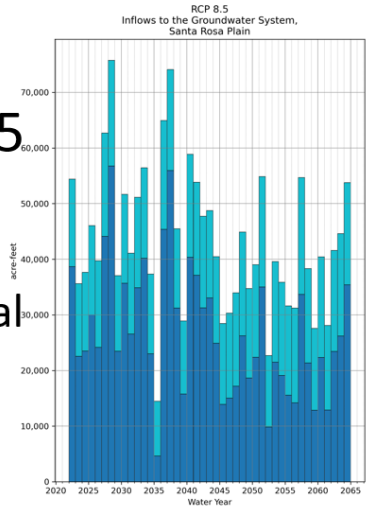
Groundwater Recharge

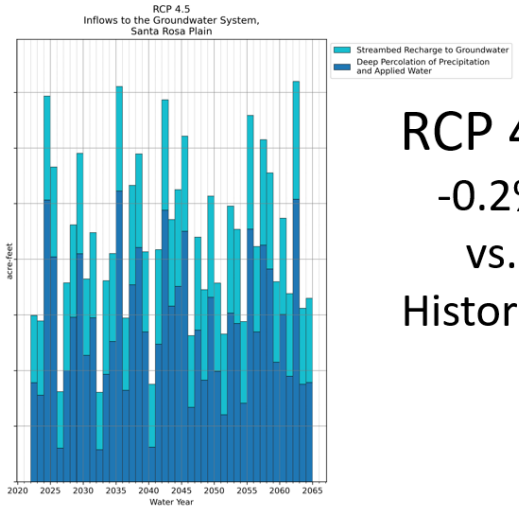
RCP 8.5

-1%

vs.

Historical





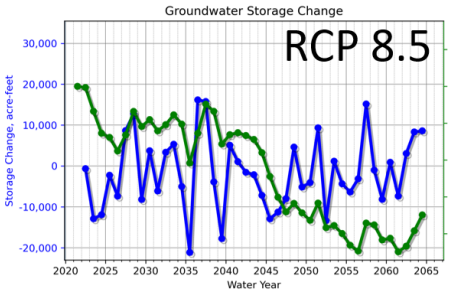
RCP 4.5

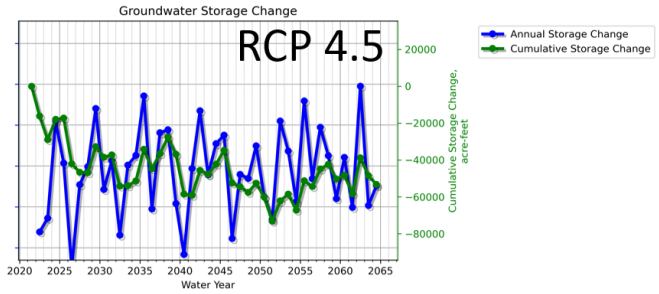
-0.2%

vs.

Historical

Change of Groundwater in Storage





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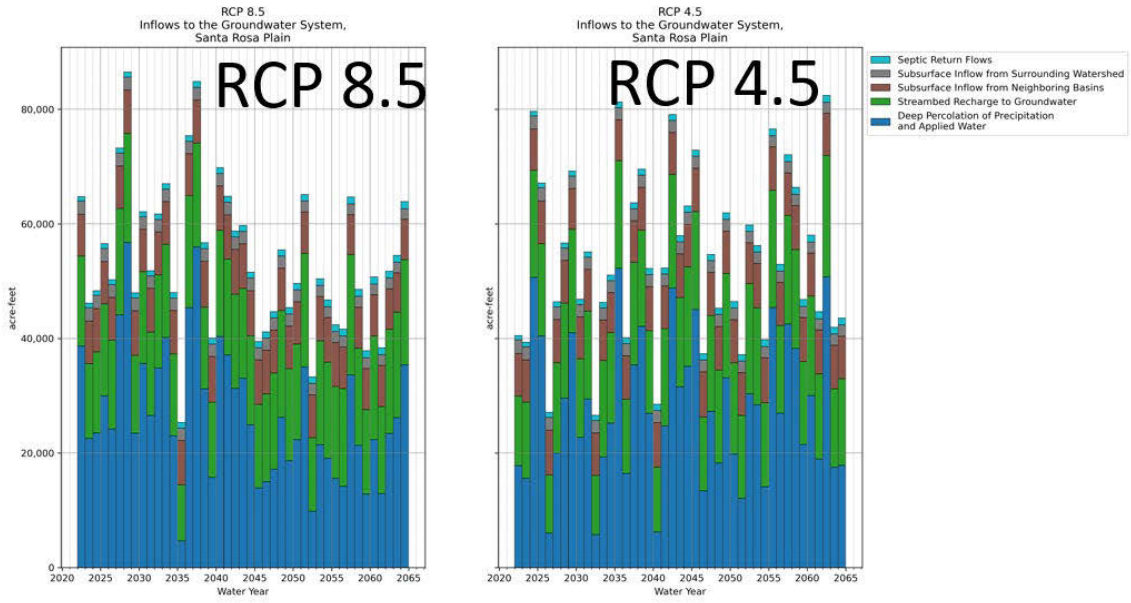
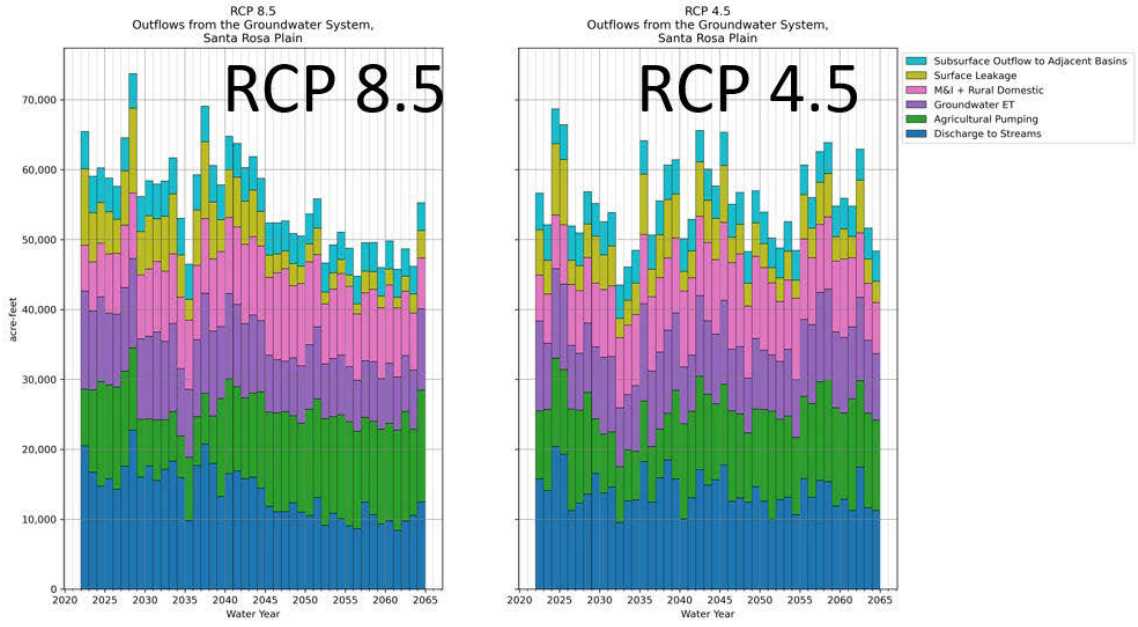
Groundwater Inflows



Groundwater Outflows



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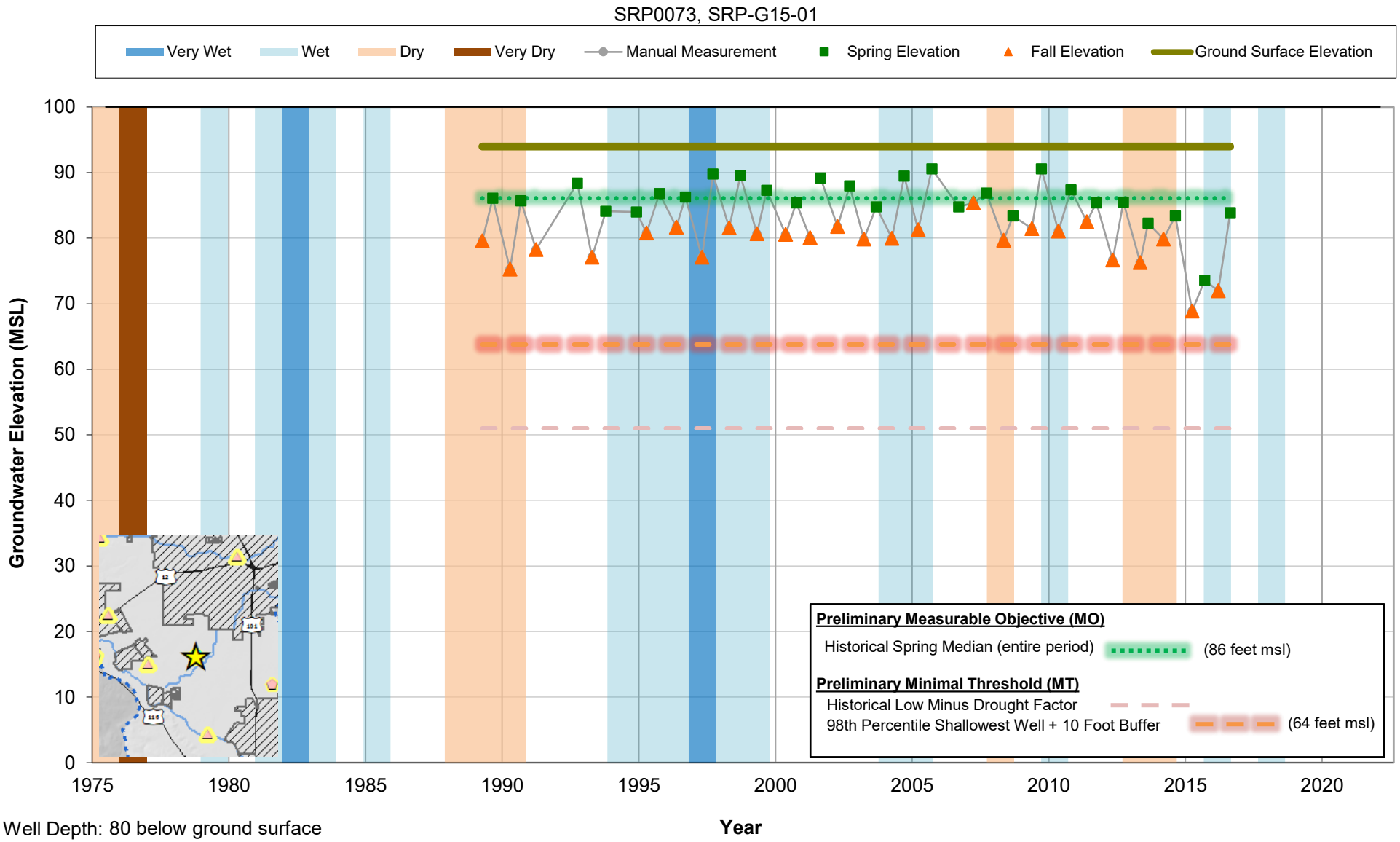
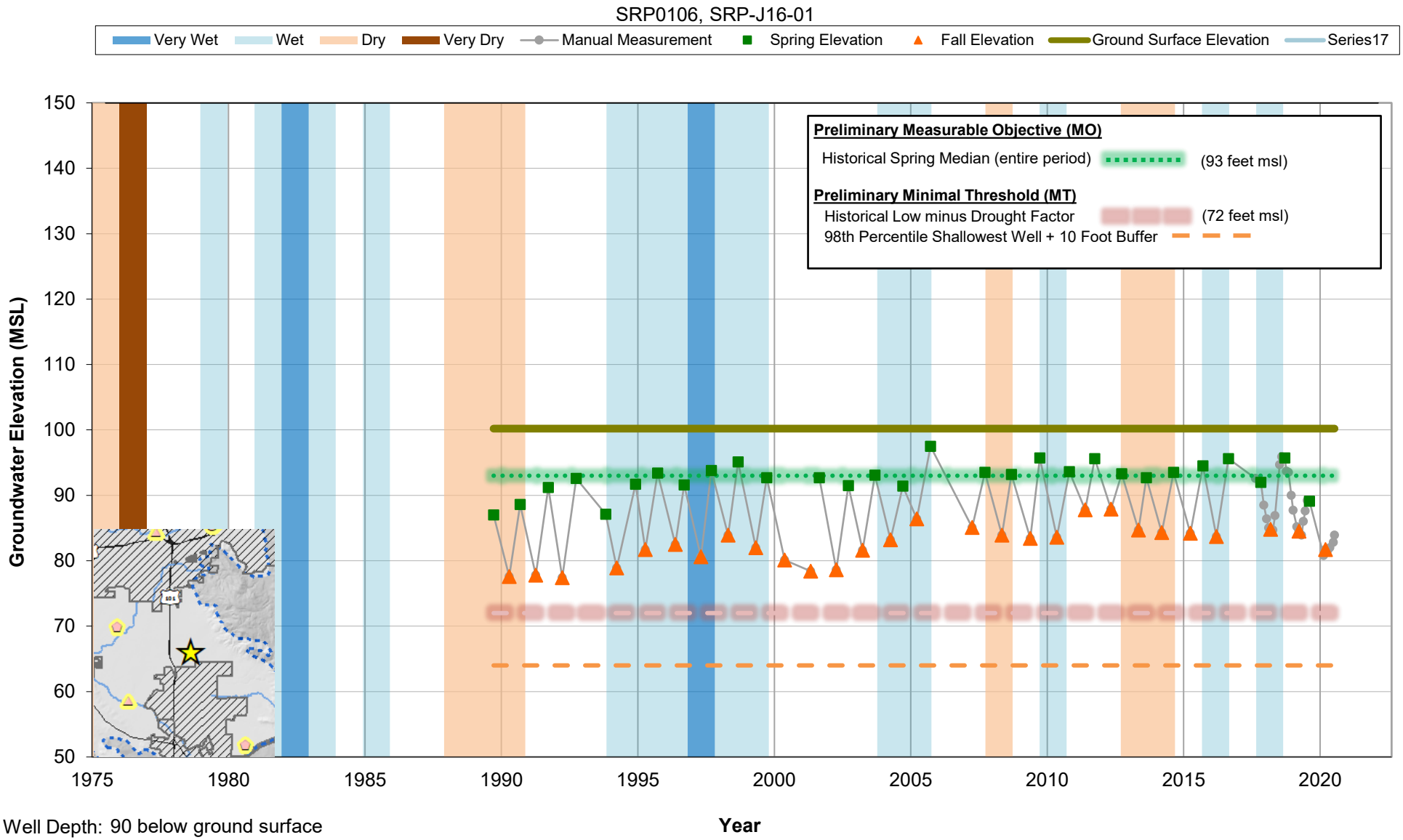
Appendix 4-A
Hydrographs of Representative Monitoring Points

Shallow Aquifer System (stable)



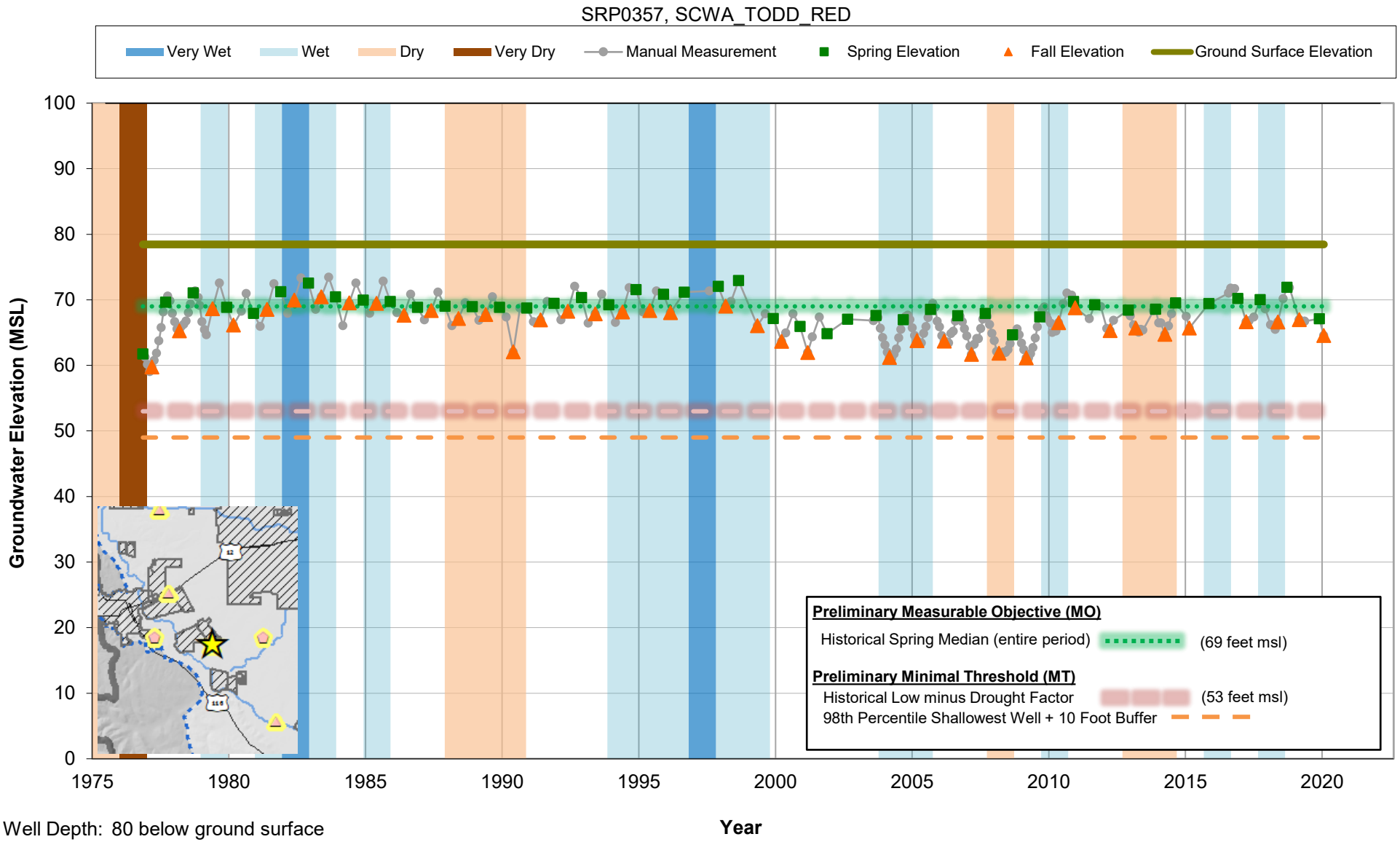
Well Depth: 80 below ground surface
Screened Intervals: Unknown
Type of Well: Unknown
Ground Surface Elevation: 94 feet msl

Working Draft



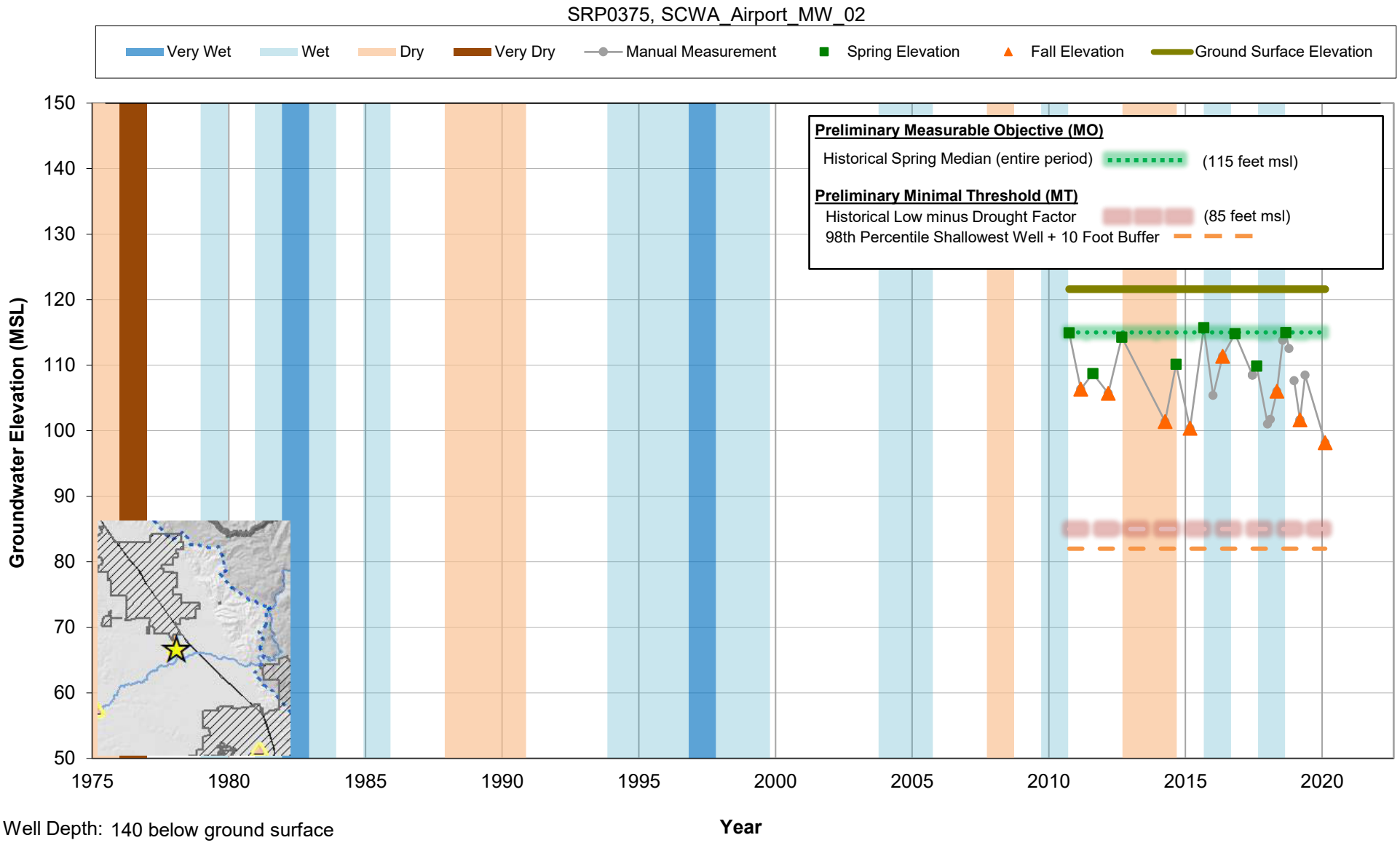
Well Depth: 90 below ground surface
Screened Intervals: Unknown
Type of Well: Unknown
Ground Surface Elevation: 100 feet msl

Working Draft



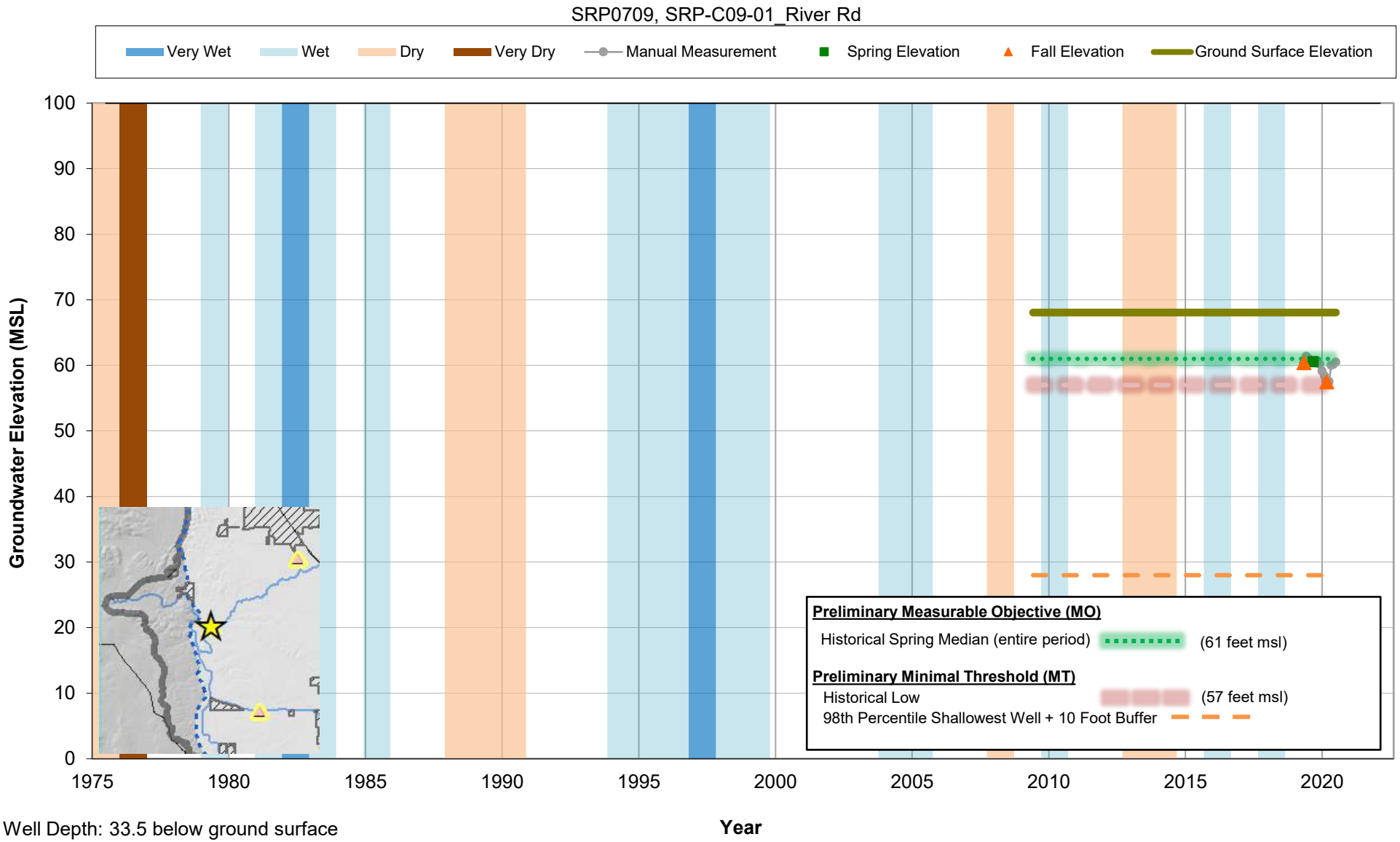
Well Depth: 80 below ground surface
Screened Intervals: 60-80 below ground surface
Type of Well: Observation
Ground Surface Elevation: 78 feet msl

Working Draft



Well Depth: 140 below ground surface
Screened Intervals: 120-140 below ground surface
Type of Well: Observation
Ground Surface Elevation: 122 feet msl

Working Draft



Well Depth: 33.5 below ground surface
Screened Intervals: 23-33 below ground surface
Type of Well: Observation
Ground Surface Elevation: 68 feet msl

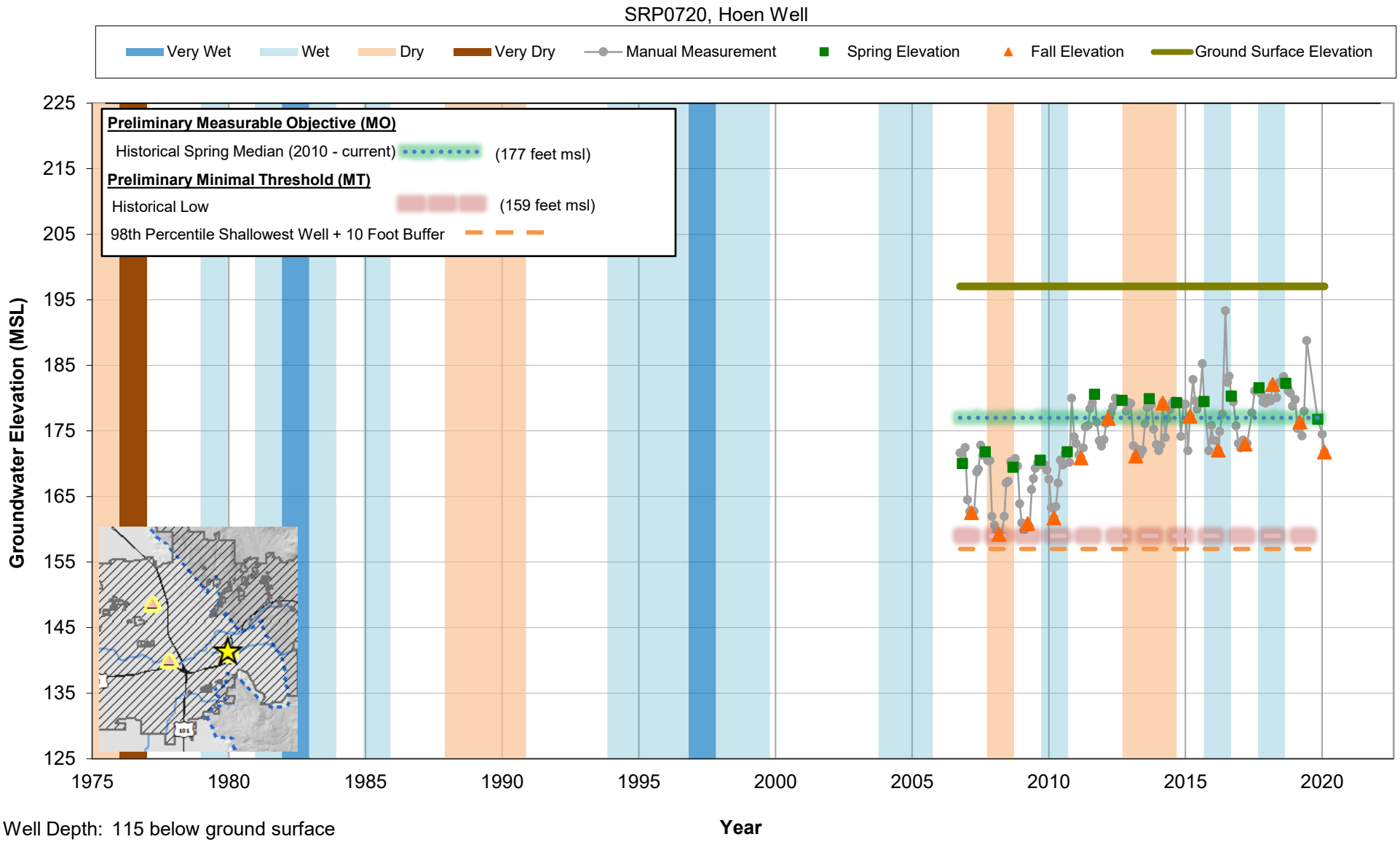
Working Draft

Shallow Aquifer System (recovered)



Well Depth: 150 below ground surface
Screened Intervals: Unknown
Type of Well: Unknown
Ground Surface Elevation: 178 feet msl

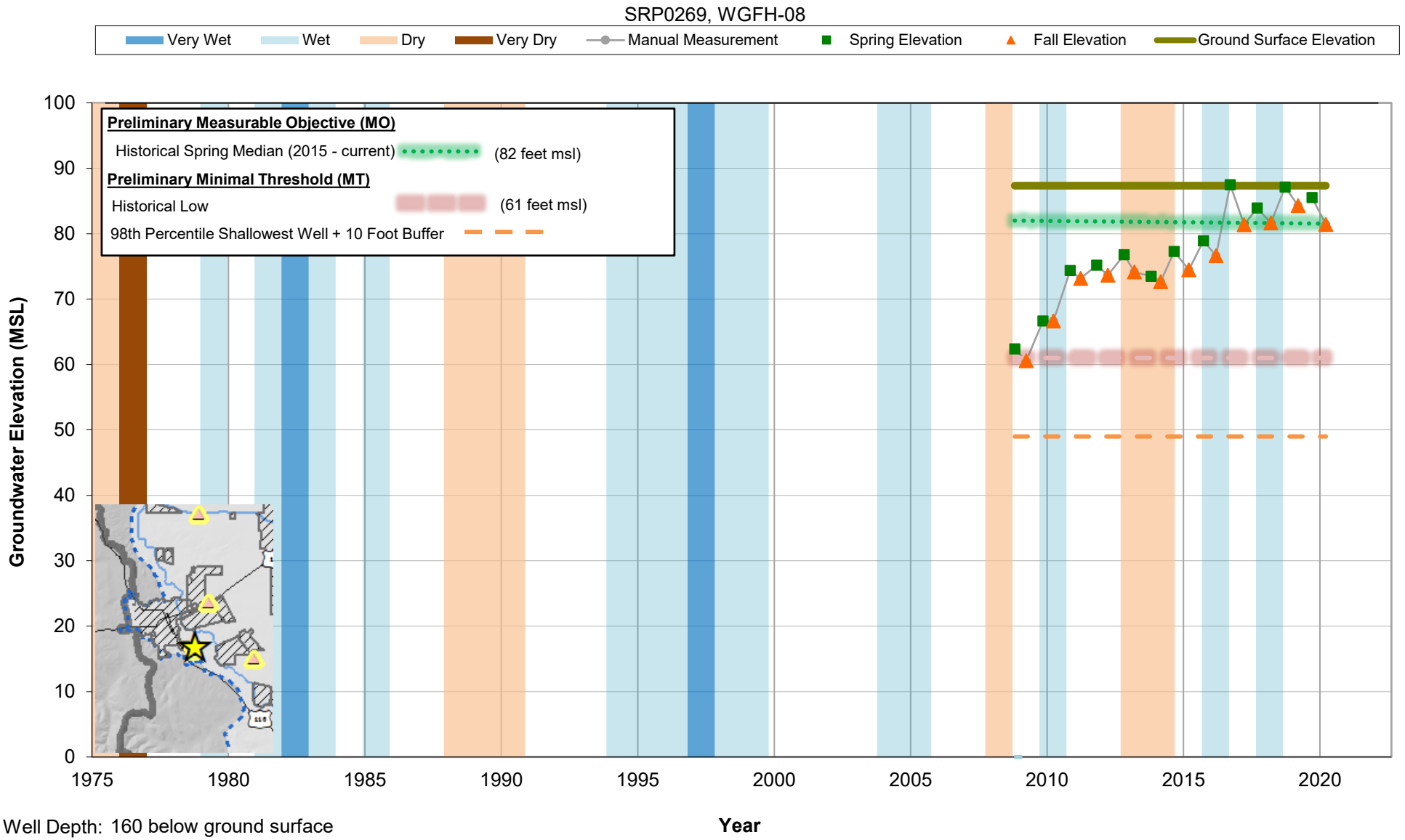
Working Draft



Well Depth: 115 below ground surface
Screened Intervals: Unknown
Type of Well: Municipal
Ground Surface Elevation: 197 feet msl

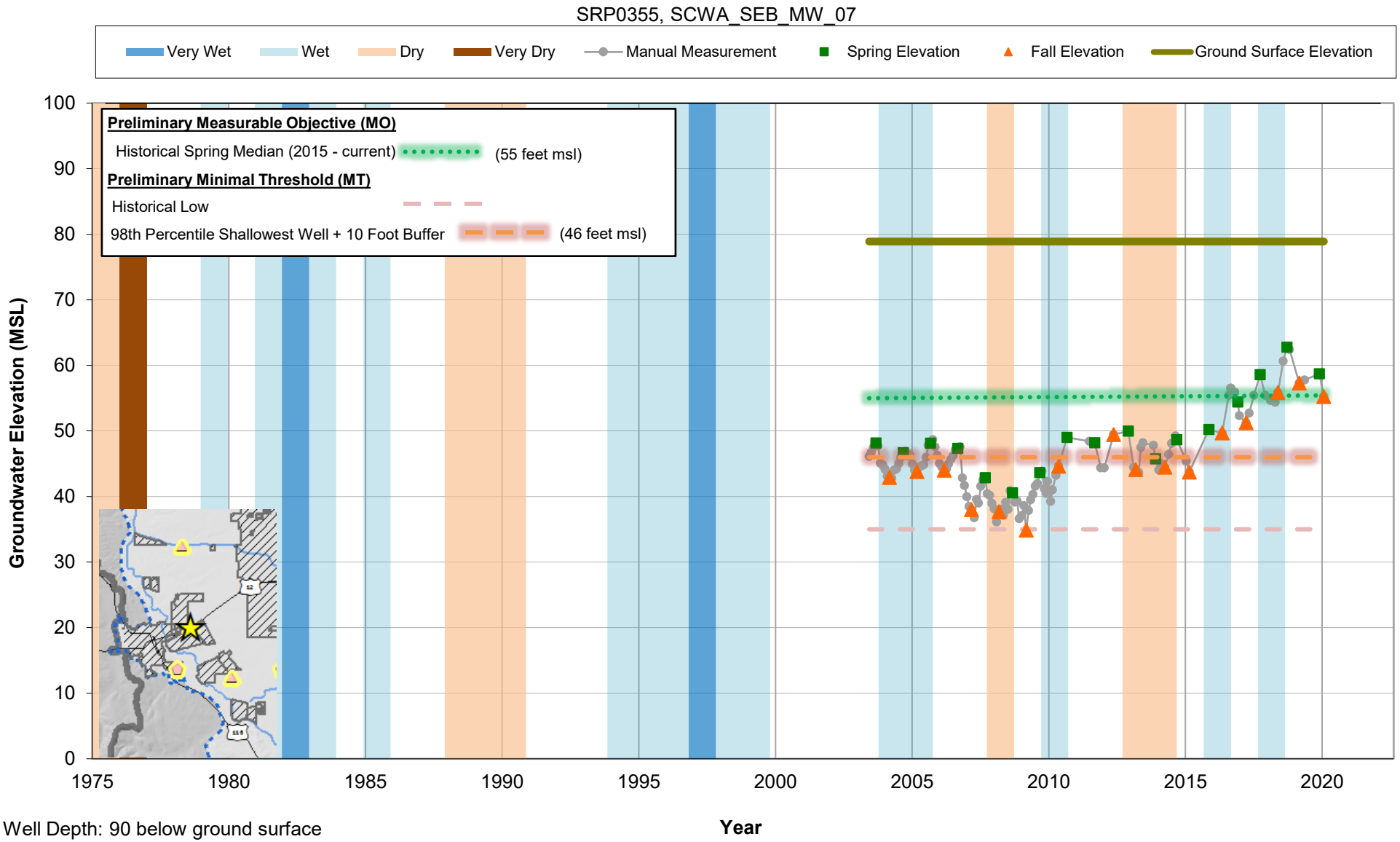
Working Draft

Shallow Aquifer System (recovering)



Well Depth: 160 below ground surface
Screened Intervals: 100-160 below ground surface
Type of Well: Unknown
Ground Surface Elevation: 87 feet msl

Working Draft



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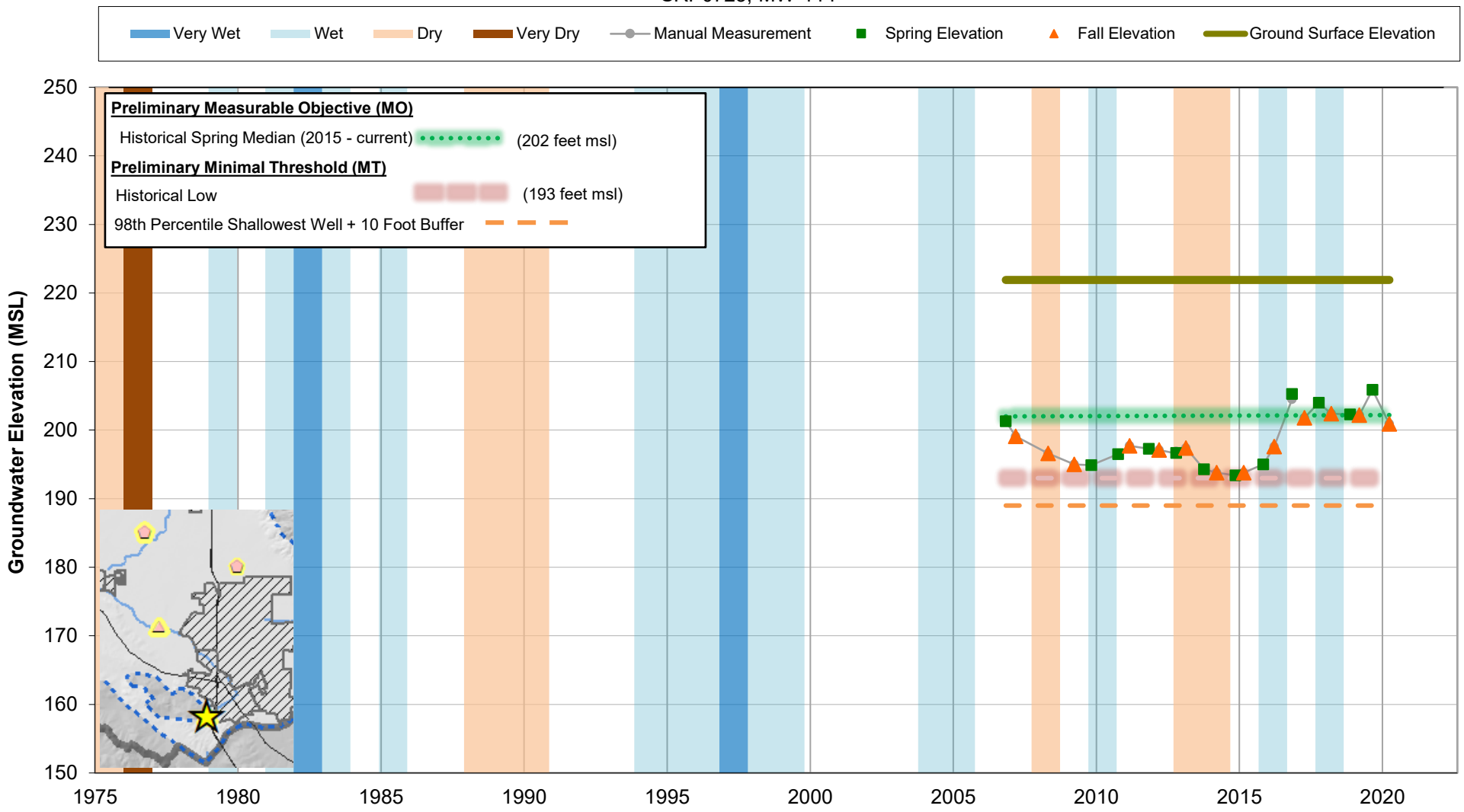
Type of Well: Observation
Ground Surface Elevation: 79 feet msl

Working Draft

SRP0723, MW-114

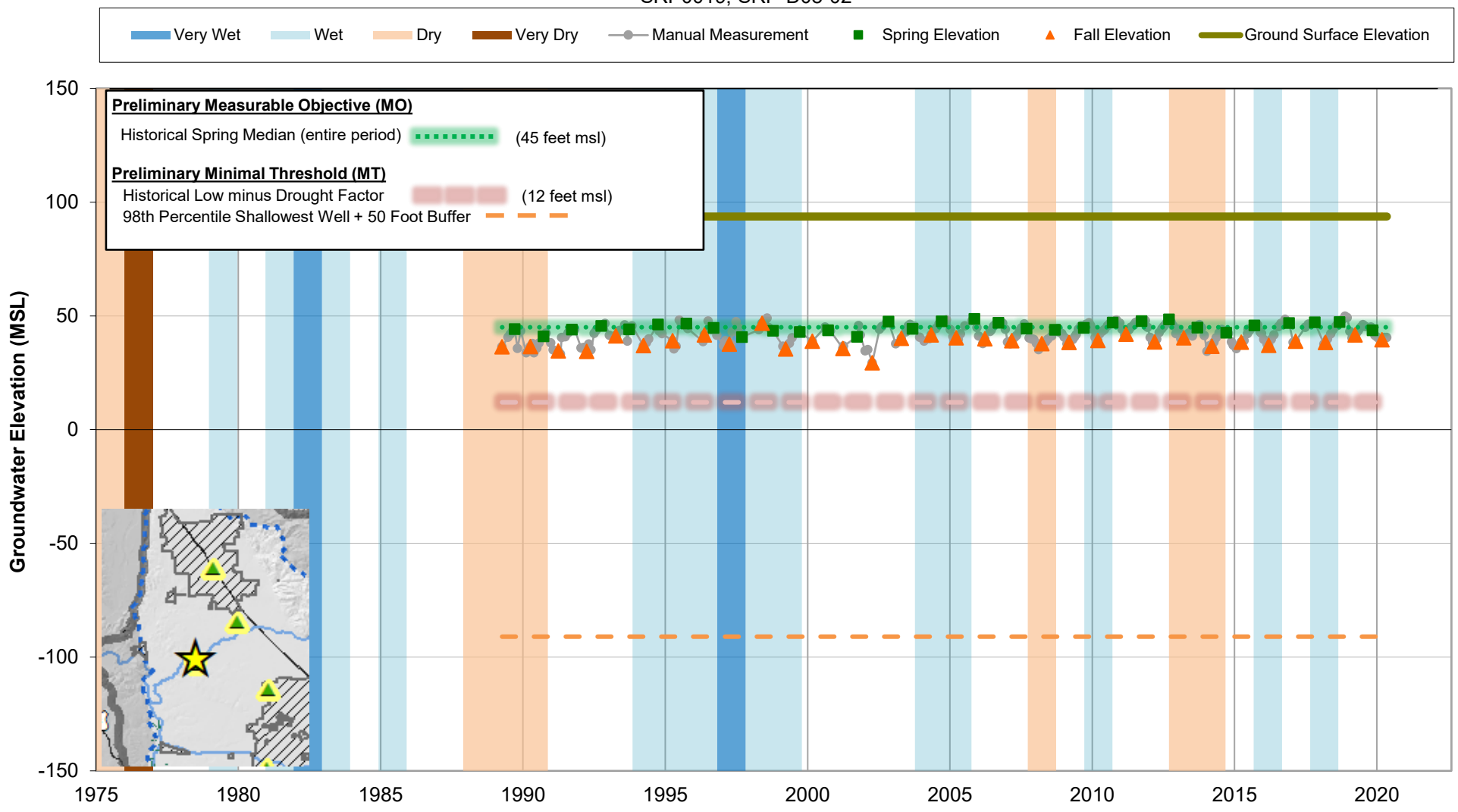


Well Depth: Unknown
Screened Intervals: Unknown
Type of Well: Observation
Ground Surface Elevation: 222 feet msl

Working Draft

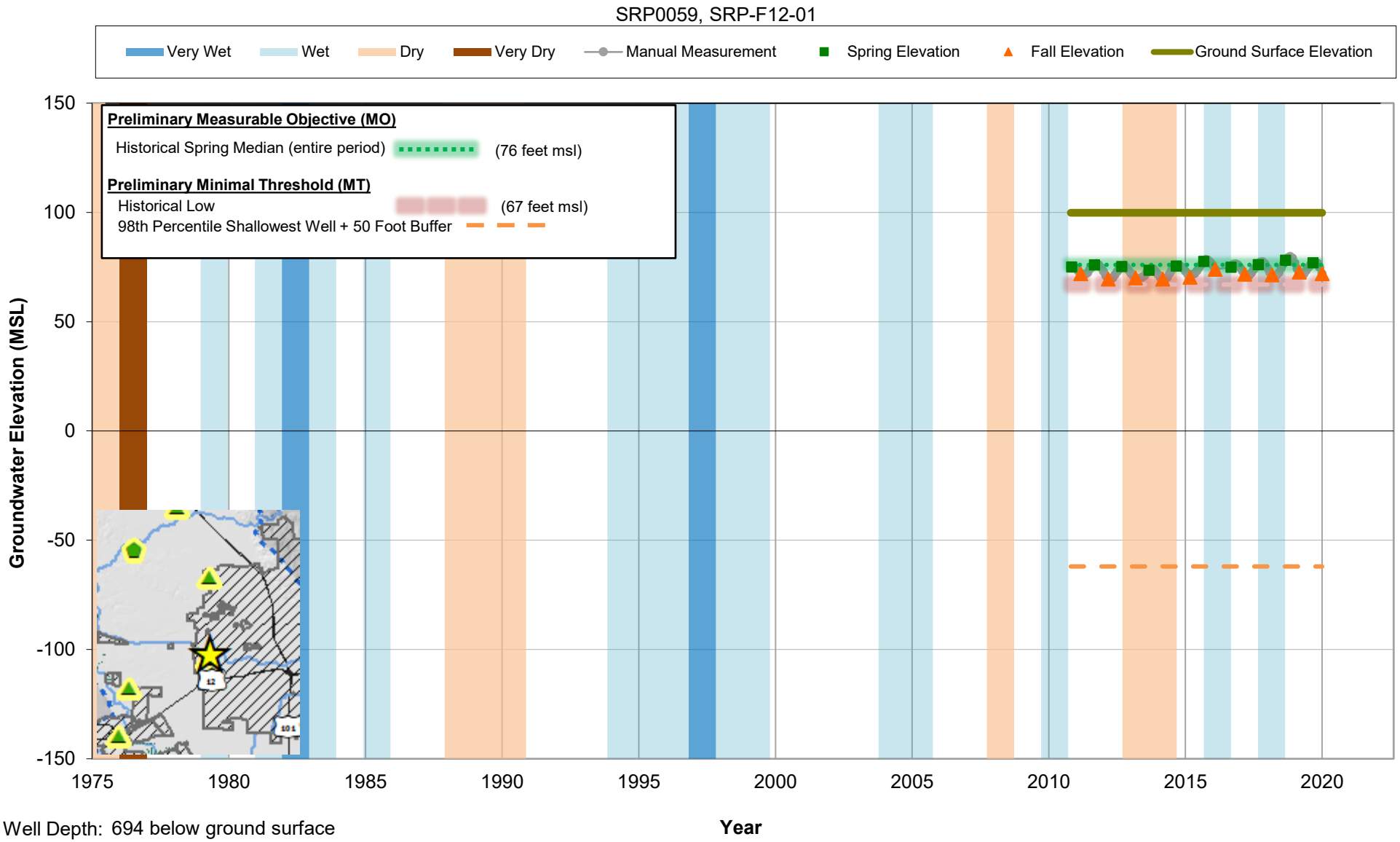
Deep Aquifer System (stable)

SRP0019, SRP-D08-02



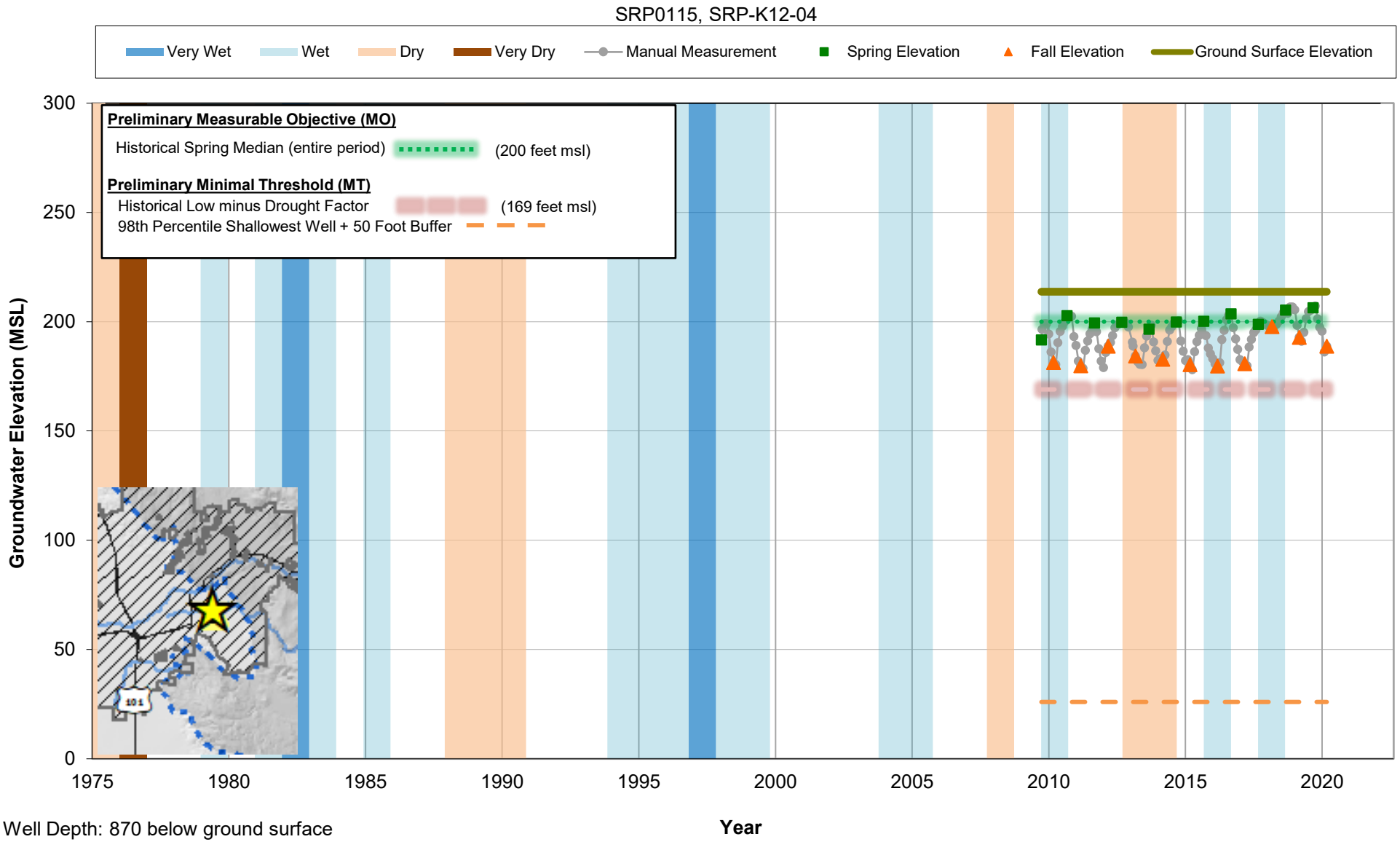
Well Depth: 1048 below ground surface
Screened Intervals: Unknown
Type of Well: Unknown
Ground Surface Elevation: 94 feet msl

Working Draft



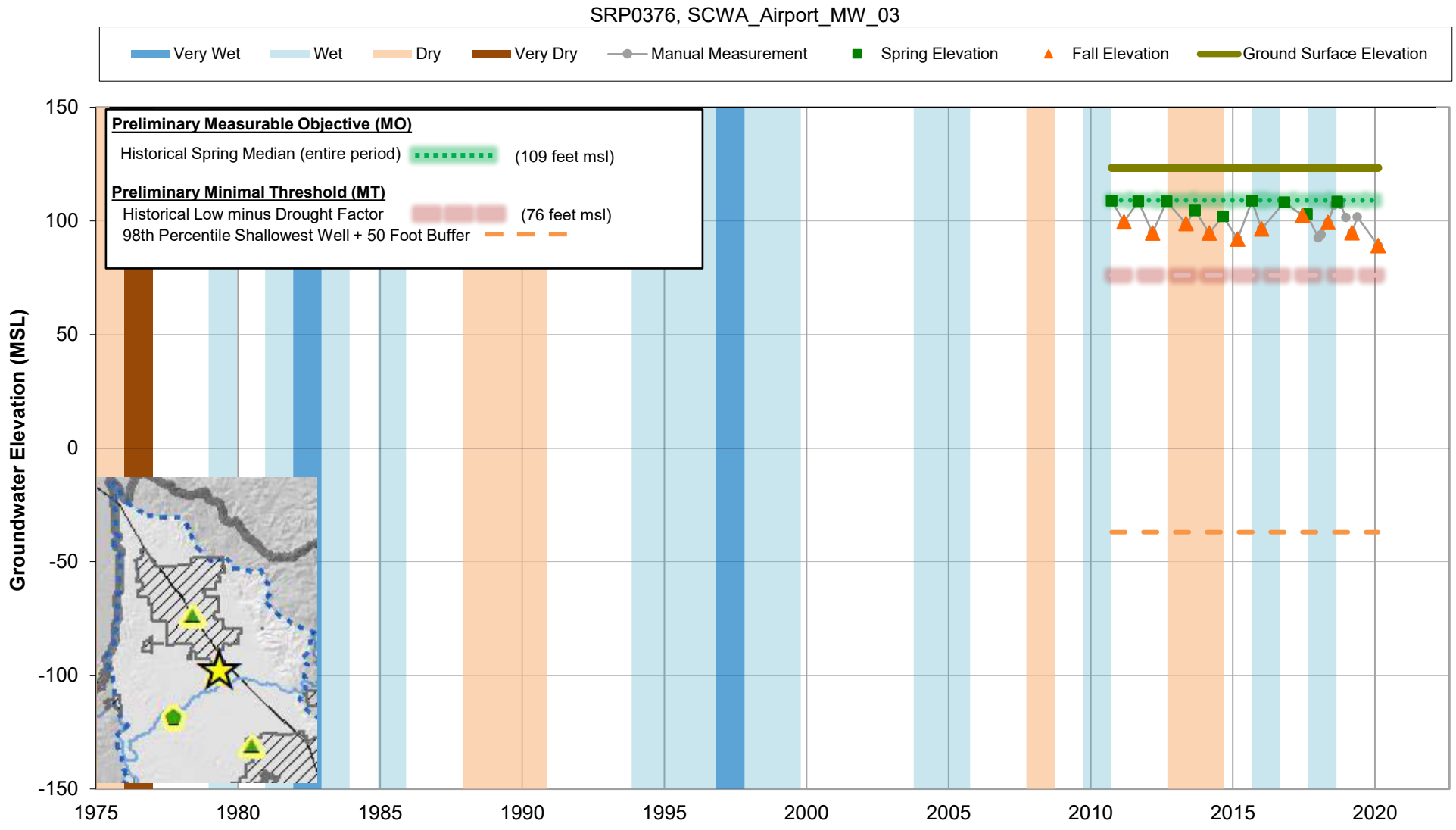
Well Depth: 694 below ground surface
Screened Intervals: 199-684 below ground surface
Type of Well: Observation
Ground Surface Elevation: 100 feet msl

Working Draft



Well Depth: 870 below ground surface
Screened Intervals: 500-860 below ground surface
Type of Well: Observation
Ground Surface Elevation: 214 feet msl

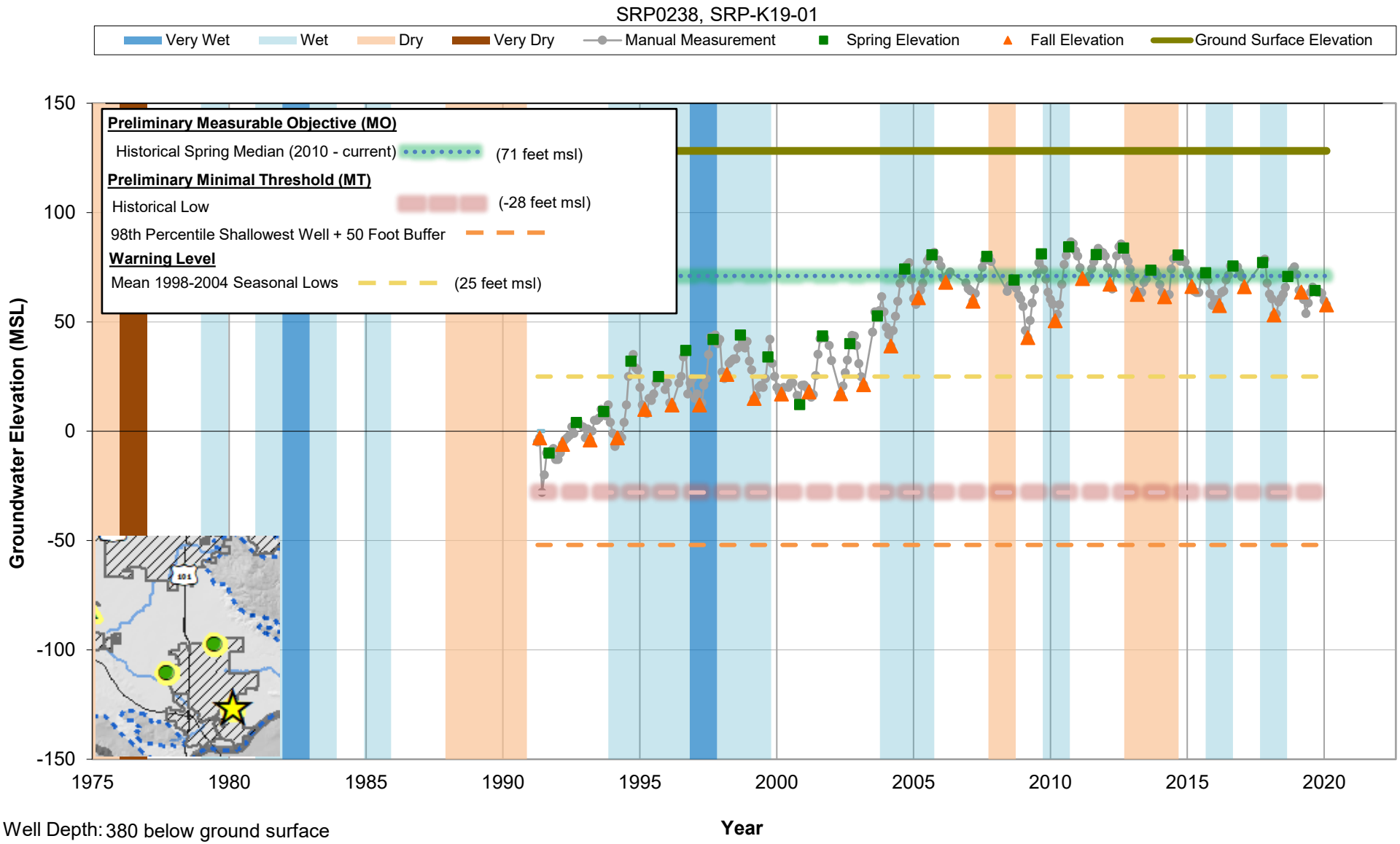
Working Draft



Well Depth: 360 below ground surface
Screened Intervals: 340-360 below ground surface
Type of Well: Observation
Ground Surface Elevation: 123 feet msl

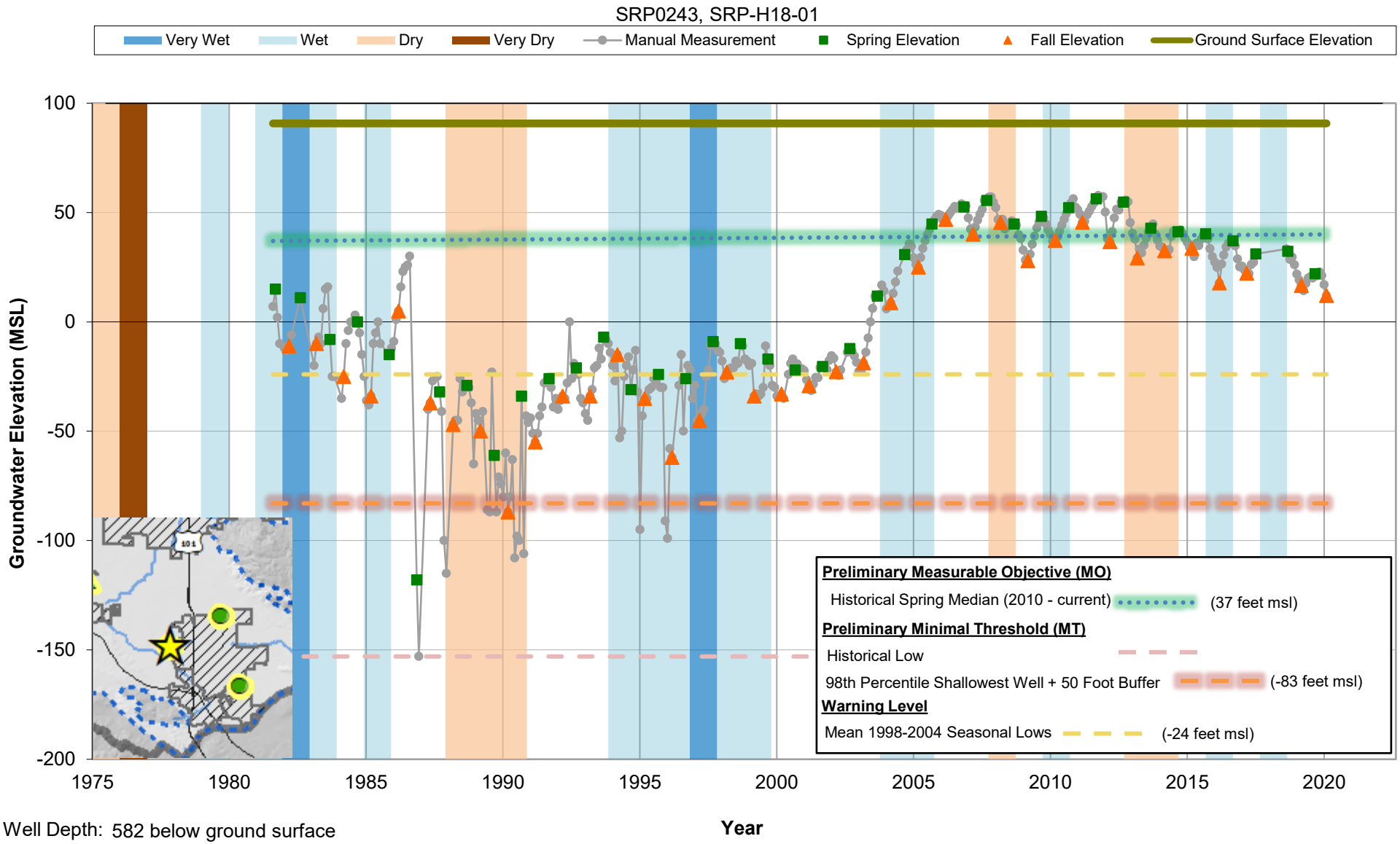
Working Draft

Deep Aquifer System (recovered)



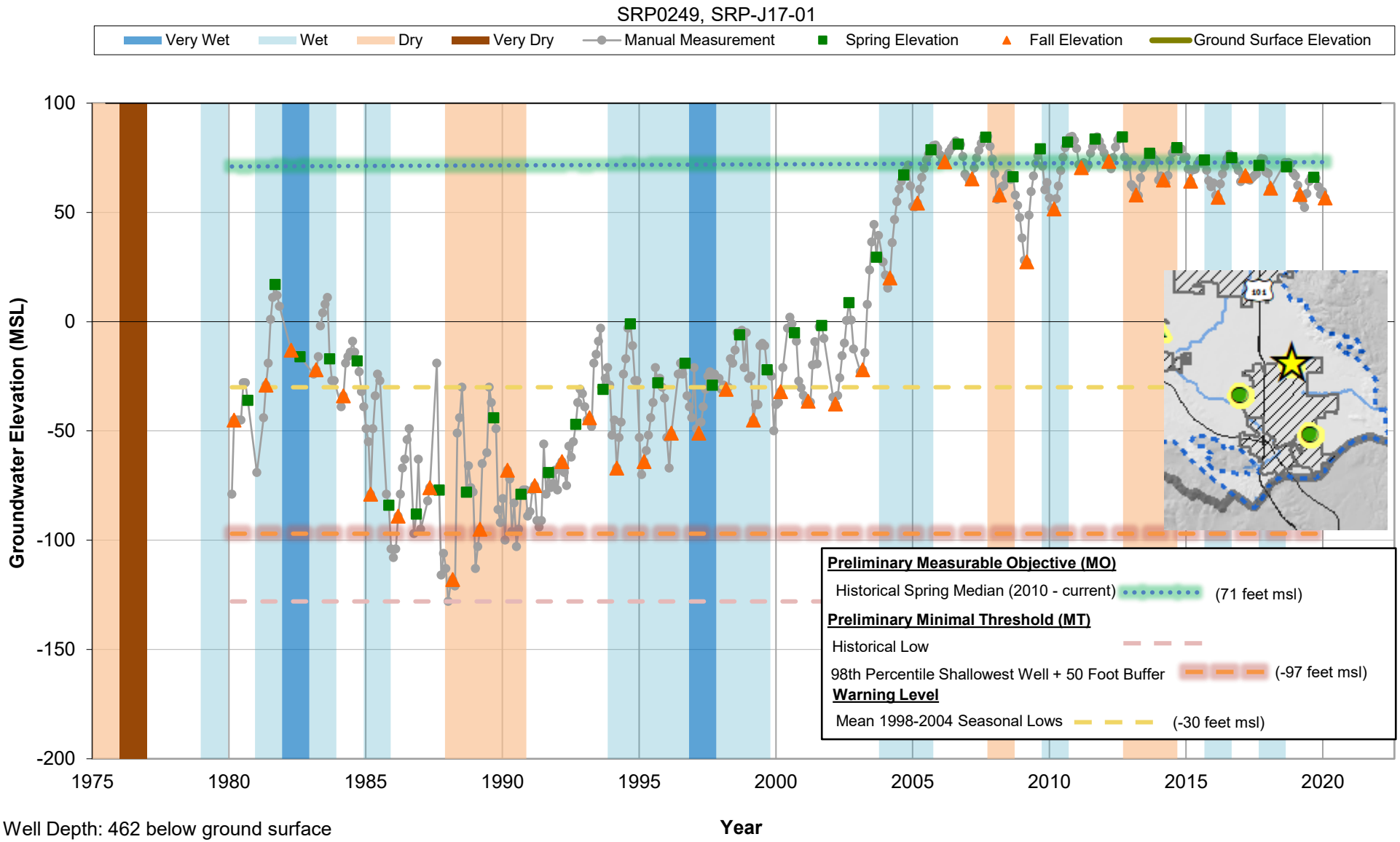
Well Depth: 380 below ground surface
Screened Intervals: 130-380 below ground surface
Type of Well: Municipal
Ground Surface Elevation: 128 feet msl

Working Draft



Well Depth: 582 below ground surface
Screened Intervals: 258-582 below ground surface
Type of Well: Municipal
Ground Surface Elevation: 91 feet msl

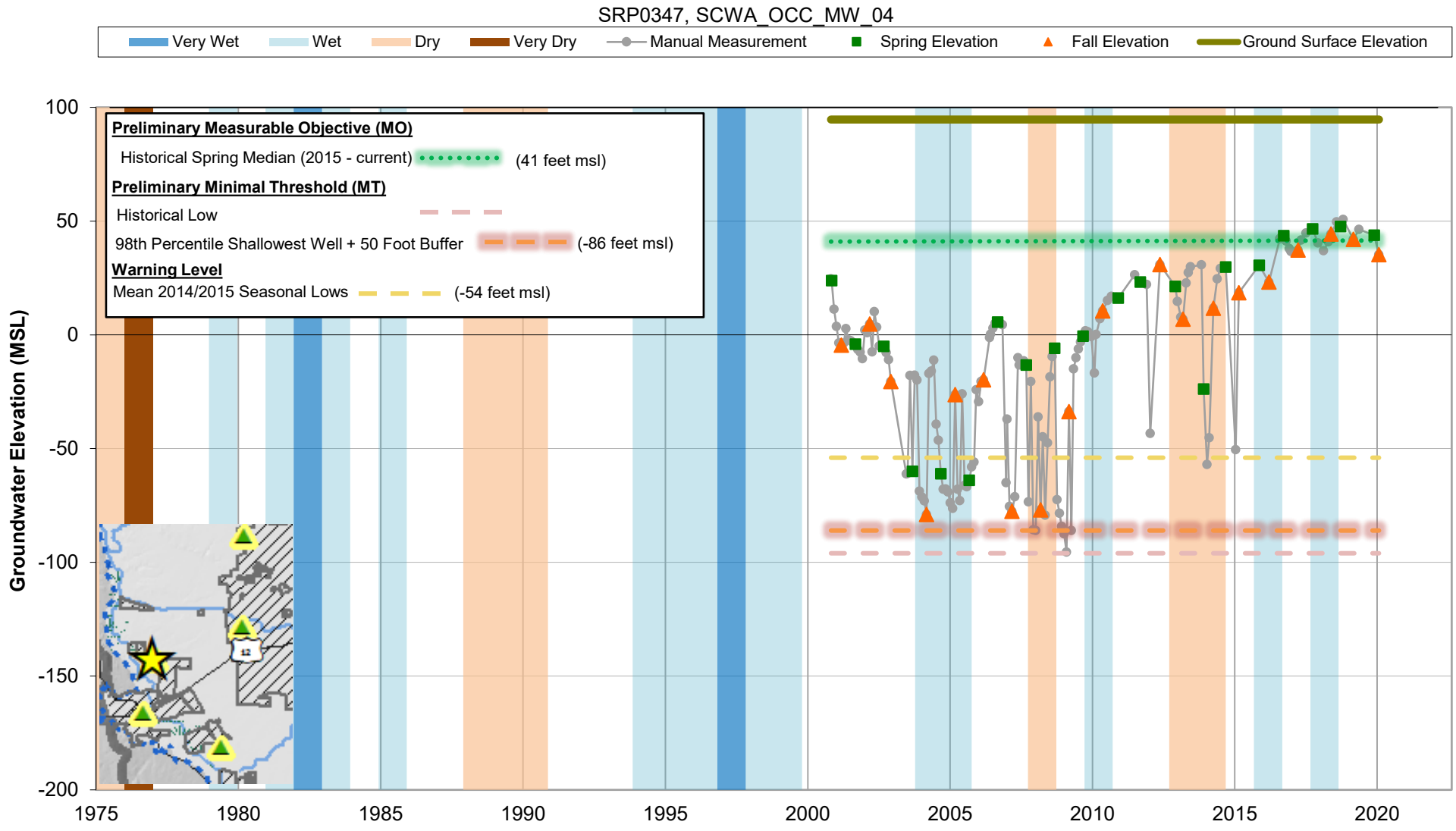
Working Draft



Well Depth: 462 below ground surface
Screened Intervals: 302-462 below ground surface
Type of Well: Municipal
Ground Surface Elevation: 103 feet msl

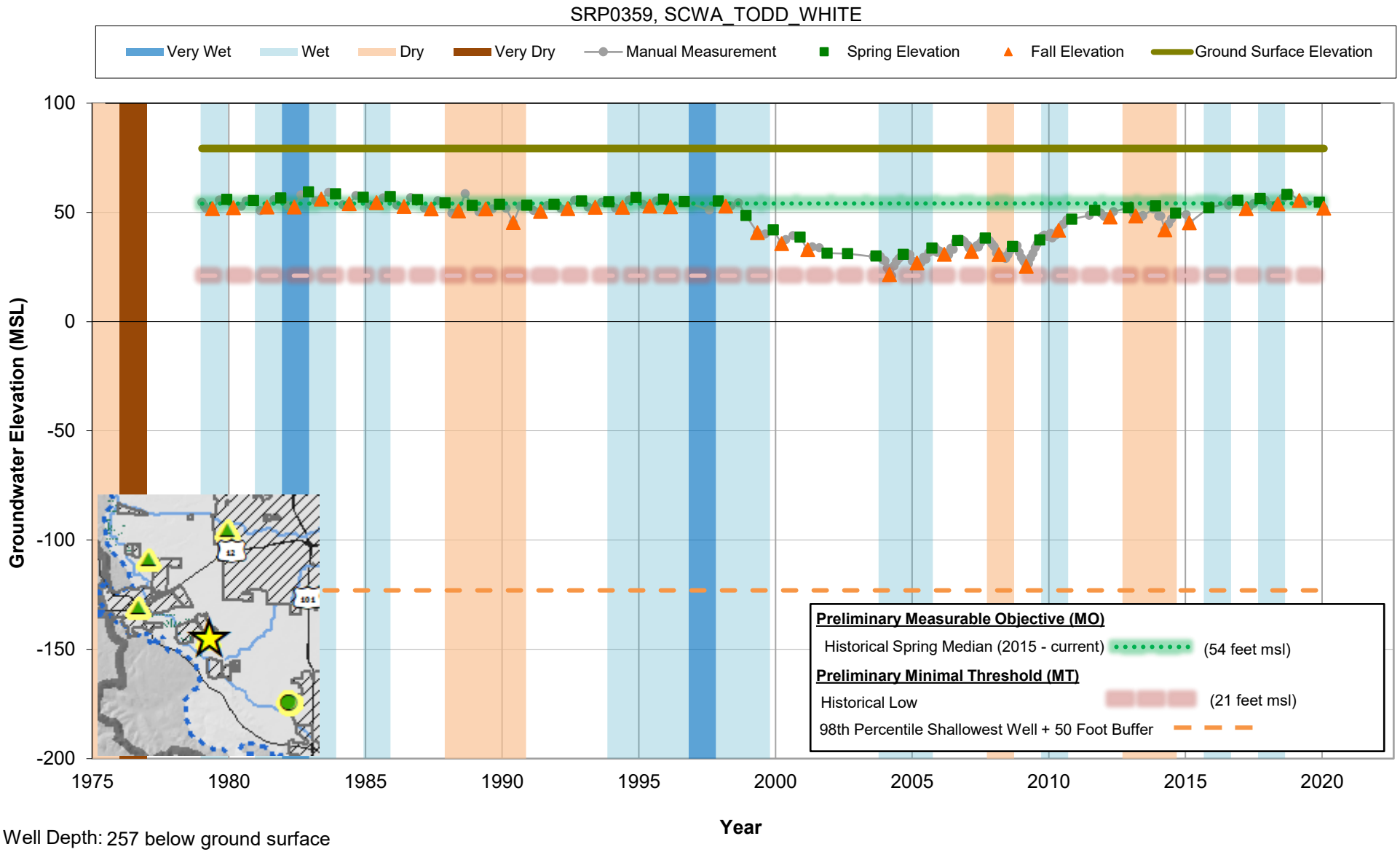
Working Draft

Deep Aquifer System (recovering)



Well Depth: 840 below ground surface
Screened Intervals: 660-740 below ground surface
Type of Well: Observation
Ground Surface Elevation: 95 feet msl

Working Draft



Well Depth: 257 below ground surface
Screened Intervals: 237-257 below ground surface
Type of Well: Observation
Ground Surface Elevation: 79 feet msl

Working Draft

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Appendix 4-B
Definition of Drought for Sonoma County Groundwater Sustainability Plans

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Definition of Drought for Sonoma County Groundwater Sustainability Plans

Summary

During the planning and implementation phases of the Groundwater Sustainability Plan (GSP) it will be necessary to make the determination if a water year qualifies as a droughtor does not. For the groundwater level sustainability indicator the occurrence of a drought may allow for overdraft to occur without qualifying as undesirable results. The Drought Monitor Long Term Drought Indicator Blend (LTDIB) will be used to assess for drought conditions. A drought is considered to occur when the LTDIB water-year averaged value meets or exceeds that of the D1, or moderate, drought.

Background

During periods of drought, the groundwater sustainability plans allow for minimum threshold exceedances that under normal conditions would constitute undesirable results. For the groundwater level sustainability indicator, if minimum threshold exceedances are caused by droughts that extend for longer than the 4-year drought factor already incorporated into the calculated minimum thresholds, it is not considered an undesirable result unless the groundwater levels do not rebound to above the thresholds during future normal and wet years following long-term droughts. This is consistent with GSP regulations which state that, “overdraft during a period of drought is not sufficient to establish a chronic lower of groundwater levels” (California Water Code 10721). Additionally, for the interconnected surface water sustainability indicator the percentage of minimum threshold exceedances that constitute undesirable results is higher during drought years and lower during non-drought years. Here the definition of a drought is detailed for use in the planning and implementation phases of the Sonoma County GSPs.

The US Drought Monitor is a map of drought conditions in the United States that is developed and updated by experts of National Drought Mitigation Center (NDMC) at the University of Nebraska-Lincoln, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Department of Agriculture (USDA). The map is updated every week and incorporates a number of meteorological, hydrologic, and agricultural inputs to assess conditions. Drought conditions are described by severity through the use of the following codes: abnormally dry (D0), showing areas that may be going into or are coming out of drought, and four levels of drought: moderate (D1), severe (D2), extreme (D3) and exceptional (D4). The effects of each drought category on California are shown in Table 1 and Figure 1 shows a snapshot view of the LTDIB values for April 2021 for the continental US.

A variety of maps are developed by the Drought Monitor. For the SGMA subbasins the Long-Term Drought Indicator Blend (LTDIB) will be used as the metric for establishing drought and non-drought conditions. This is an objective metric that utilizes a scoring system with inputs from the Palmer Drought Severity Index (PDSI), the Z-index, CPC soil moisture storage, and a 180 day, 1-year, 2-year, and 5-year observations of the Standardized Precipitation Index (Guttman, 1998). The PDSI is a standardized index

that uses both precipitation and evapotranspiration in a hydrologic accounting system (Palmer, 1965). The Z-index measures short-term drought on a monthly scale. The Climate Prediction Center Soil moisture storage[1] is a mechanistic model that simulates soil storage for the continental US. The SPI is a meteorological index that calculates the precipitation deficit for a given period, with respect to the observed precipitation variance. A limitation of the SPI is that it does not account for the effect evapotranspiration has on the presence or severity of drought. Under warming climate conditions this effect will become more important. The PDSI, Z-index, and CPC soils moisture storage do account for the effect of increased temperatures and should counteract the limitations of the SPI indices.

Table 1 Impacts on California By Drought Category[2]

Category	Historically observed impacts
D0 – Abnormally Dry	Soil is dry; irrigation delivery begins early
	Dryland crop germination is stunted
	Active fire season begins
	Winter resort visitation is low; snowpack is minimal
D1 – Moderate Drought	Dryland pasture growth is stunted; producers give supplemental feed to cattle
	Landscaping and gardens need irrigation earlier; wildlife patterns begin to change
	Stock ponds and creeks are lower than usual
D2 – Severe Drought	Grazing land is inadequate
	Producers increase water efficiency methods and drought-resistant crops
	Fire season is longer, with high burn intensity, dry fuels, and large fire spatial extent; more fire crews are on staff
	Wine country tourism increases; lake- and river-based tourism declines; boat ramps close
	Trees are stressed; plants increase reproductive mechanisms; wildlife diseases increase
	Water temperature increases; programs to divert water to protect fish begin

[1] https://www.cpc.ncep.noaa.gov/soilmst/w.shtml
[2] https://droughtmonitor.unl.edu/About/AbouttheData/DroughtClassification.aspx

	River flows decrease; reservoir levels are low and banks are exposed
D3 – Extreme Drought	Livestock need expensive supplemental feed, cattle and horses are sold; little pasture remains, producers find it difficult to maintain organic meat requirements
	Fruit trees bud early; producers begin irrigating in the winter
	Federal water is not adequate to meet irrigation contracts; extracting supplemental groundwater is expensive
	Dairy operations close
	Fire season lasts year-round; fires occur in typically wet parts of state; burn bans are implemented
	Ski and rafting business ar low, mountain communities suffer
	Orchard removal and well drilling company business increase; panning for gold increases
	Low river levels impede fish migration and cause lower survival rates
	Wildlife encroaches on developed areas; little native food and water is available for bears, which hibernate less
	Water sanitation is a concern, reservoir levels drop significantly, surface water is nearly dry, flows are very low; water theft occurs
	Wells and aquifer levels decrease; homeowners drill new wells
	Water conservation rebate programs increase; water use restrictions are implemented; water transfers increase
	Water is inadequate for agriculture, wildlife, and urban needs; reservoirs are extremely low; hydropower is restricted
	Fields are left fallow; orchards are removed; vegetable yields are low; honey harvest is small

D4 – Exceptional Drought	Fire season is very costly; number of fires and area burned are extensive
	Many recreational activities are affected
	Fish rescue and relocation begins; pine beetle infestation occurs; forest mortality is high; wetlands dry up; survival of native plants and animals is low; fewer wildflowers bloom; wildlife death is widespread; algae blooms appear
	Policy change; agriculture unemployment is high, food aid is needed
	Poor air quality affects health; greenhouse gas emissions increase as hydropower production decreases; West Nile Virus outbreaks rise
	Water shortages are widespread; surface water is depleted; federal irrigation water deliveries are extremely low; junior water rights are curtailed; water prices are extremely high; wells are dry, more and deeper wells are drilled; water quality is poor;

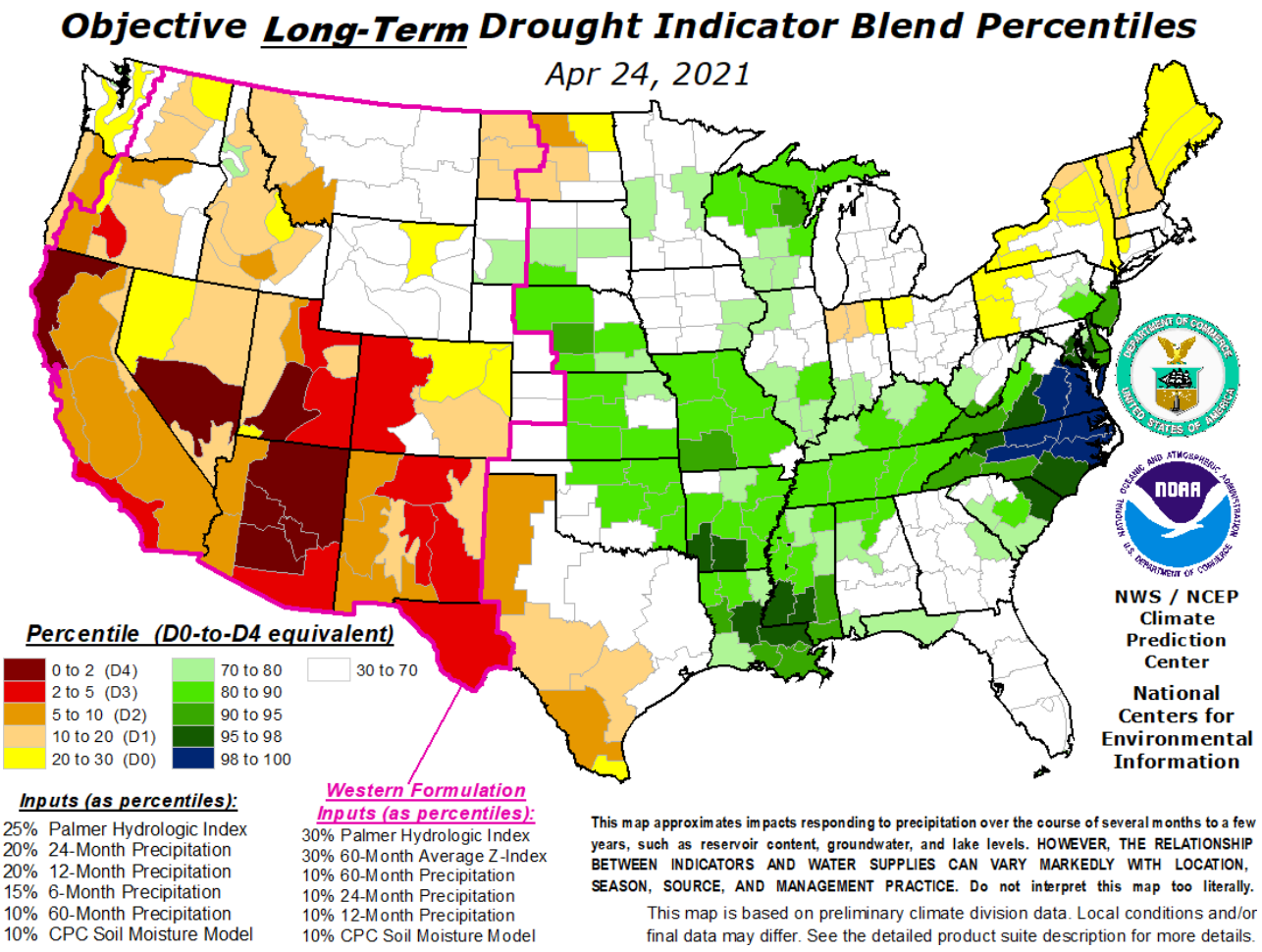


Figure 1 Snapshot of the Objective Long-Term Drought Indicator Blend for April 24, 2021

Approach for Future Drought Conditions

The LTDIB for all of Sonoma County is shown in Figure 2. The values represent the spatially averaged value for the entire county averaged for the entire water year. It should be emphasized that this value is averaged over the entire water year, so that, for example, water year 2021 ends in a D4 drought, but the water year is categorized only as D3 due to yearly averaging. The Water Year types for the three subbasins are also shown for comparison on Figure 2. Years classified as Moderate Drought (D1) will be used as the definition of Drought for the Subbasins. Given this definition there are nine years in the period spanning Water Year 1984 to the end of Water Year 2021 that qualify as drought conditions. In the same period there are 7 years classified as dry or very dry based on the water year type classifications developed by the GSA's. Four of these years are categorized as D1 drought conditions, one of the dry years is classified as D2, and water year 2021 is classified as an extreme dry year. There is good correspondence between the GSA water year type classifications and the LTDIB classifications. It should be noted that these years have not officially been classified as drought or non-drought years by the Drought Monitor.

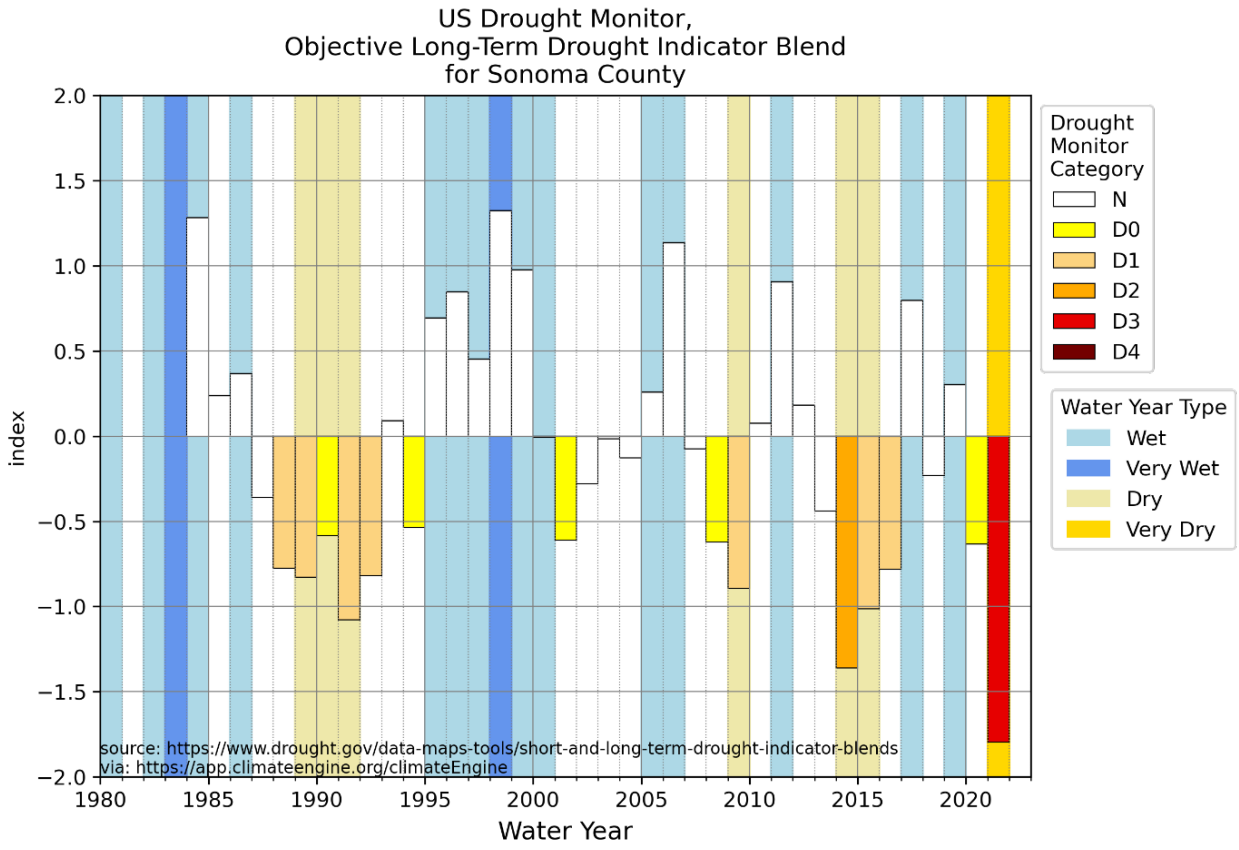


Figure 2 US Drought Monitor, Objective Long-Term Drought Indicator Blend for Sonoma County

Method of Calculation

The Earth Engine website (https://app.climateengine.org/climateEngine) stores the raw data and also calculates the LTDIB values. The sub-weekly values are averaged over the water year and then categorized based on the LTDIB value. The cutoffs for each classification are detailed in Table 2.

Table 2 Drought categories by LTDIB value

Range	Category
(-2.5, -2.0]	D4
(-2.0, -1.5]	D3
(-1.5, -1.2]	D2
(-1.2, -0.7]	D1
(-0.7, -0.5]	D0
(-0.5, 10.0]	N

Appendix 4-C
Key Themes and Outcomes from Interconnected Surface Water Practitioners Work Group

Sustainable Management Criteria (SMC) for the Depletion of Interconnected Surface Water (ISW)

Background, Proposed Adaptive Approach, and Key Themes and Outcomes from March 22 Practitioner Work Group Meeting

March 23, 2021

ISW SMC Background

Groundwater Sustainability Agency (GSA) Administrators for the Santa Rosa Plain, Petaluma Valley, and Sonoma Valley Subbasins convened a practitioner work group of experts to assist in the development of the ISW SMC. This document provides a brief overview of ISW SMC components and a recap of key outcomes from the work group's final meeting held on March 22, 2021.

As with other SMCs for Groundwater Sustainability Plans (GSPs) in the three subbasins discussed above, the ISW SMC consists of four *primary* components:

- A Significant and Unreasonable Conditions Statement (S&U) for the Subbasin, which provides the overall goal for the sustainability indicator in terms of conditions which must be avoided to achieve sustainability.
- Minimum Thresholds (MT) at each representative monitoring point which provide numerical targets for unreasonable conditions .
- Measurable Objectives (MO) at each representative monitoring point which provide numerical targets for the desirable conditions to be achieved with implementation of the GSP.
- Undesirable Results (UR), which provide a quantitative description of the combination of MT exceedances that cause significant and unreasonable effects in each subbasin. Avoiding URs is how sustainability is achieved in a subbasin.

Combined, these four components define how groundwater sustainability is achieved in relation to surface water depletion. However, the ISW SMC is unique in that information in the historical record linking surface water depletion directly to groundwater usage under the jurisdiction of the GSAs is very limited. In fact, at a majority of representative monitoring points in the subbasins, only one year of groundwater level data is available. Variable levels of correlation between simulated streamflow depletion and groundwater levels, a lack of existing instream flow targets, and limited data for assessing the presence of any *historically* significant and unreasonable conditions complicate the development of this SMC.[1] To address these data gaps, the GSA technical team propose a tiered adaptive management approach that will provide the information needed to update the SMC during the implementation phase of each of the GSPs, as summarized below.

[1] While it is recognized that low summer baseflows in certain years can impact aquatic species, until we know how much water they need to survive and thrive (via instream flow targets), a MT is difficult to determine. The current approach requires using historical data and avoiding conditions lower than historical surface water depletion amounts.

ISW SMC Proposed Adaptive Approach

In recognition of the significant information and data limitations and the importance of interconnected surface water to beneficial users within the Subbasin, potential future studies and activities have been identified and prioritized in coordination with the work group according to relative importance and potential costs. These studies and activities will be further developed and considered for the early implementation phase of the GSP based on available funding sources and future funding and partnership opportunities.

Group 1 (Improves characterization of causes and effects of depletion, lower cost studies, outside funding or leveraged funding opportunities with partners):

- Improve data/information on existing water wells and stream diversions
- Model improvements – focused calibration of surface water and groundwater interaction
- Improve GDE mapping/remote sensing for vegetation health (e.g., NVDI, GDE pulse, etc.)
- Compile and evaluate existing and relevant habitat field surveys
- Evaluate future airborne geophysical data (DWR funded)

Group 2 (Monitoring network improvements, higher cost studies, etc.):

- Additional shallow monitoring wells and stream gauges
- Focused geophysical studies
- Geomorphic and streambed conductivity assessments
- Additional focused habitat field mapping, as needed

In the meantime, an initial SMC must be developed and include the components above based on simulated data and the best available historical information that will be updated and, where appropriate, refined with actual observed data during the implementation phase. The general procedure for developing the initial SMC involves:

1. Use of groundwater-levels measured at shallow monitoring wells near streams (representative monitoring points [RMPS]) as a proxy for surface water depletion[2]
2. Use model to estimate years with highest levels of simulated streamflow depletion (20th percentile) between 2004 and 2018
3. Calculate percentile ranking of simulated dry-season groundwater levels associated with these years
4. Set initial MTs at this percentile ranking using available datasets for wells measured near RMPs
5. Set initial MO as mean of dry season measured groundwater-levels from historical record

The initial proposed S&U, MT, MO, and UR are as follows and will be refined through discussions with Advisory Committees in each of the three subbasins:

[2] Use of groundwater-levels as a proxy for surface water depletion focuses the SMC on conditions the GSA has authority to manage (i.e., groundwater conditions within the Subbasin)

- S&U Statement[3]: Significant and unreasonable depletion of surface water from interconnected streams occurs when surface water depletion, caused by groundwater pumping within the Basin/Subbasin, exceeds historical depletion or adversely impacts the viability of groundwater dependent ecosystems (GDEs) or other beneficial users of surface water.
- MT: The equivalent groundwater-level, representing the three years (2014-2016) during which the most surface water depletion due to groundwater pumping was estimated between 2004-2018. This is the number that serves as an indicator for the potential presence of undesirable results.
- MO: The mean groundwater level for any available dry-season observations during 2004–2020.
- UR: Options for consideration in determining undesirable results include:
    - 25% of RMPs (2 wells)
    - 25% of RMPs (2 wells) for 2 consecutive years
    - 25% of RMPs (2 wells) during drought years and 10% of RMPs (1 well) during non-drought years
    - 40% of RMPs (3 wells) during drought years and 10% of RMPs (1 well) during non-drought years

Prior to determining if undesirable results are occurring based on MT exceedances, the GSA would need to assess whether potential causes of exceedances are related to depletions associated with groundwater pumping or other activities not under the jurisdiction of the GSA

[3] Important definitions related to the S&U statement include:

- "groundwater pumping" excludes any diversions by surface water rights holders
- "historical depletion" estimated as simulated surface water depletion caused by groundwater pumping as informed by available historical measured data (2004-2018 for the Santa Rosa Plain)
- "groundwater dependent ecosystems" includes aquatic species and vegetation, as defined in Basin Setting
- "other beneficial users of surface water" include surface water rights holders and recreational uses (where applicable)

Key Themes and Outcomes from March 22 Work Group Meeting

Practitioner Work Group Members:

- Sam Boland-Brien, State Water Resources Control Board (SWRCB)
- Maurice Hall, Environmental Defense Fund (EDF)
- Jessie Maxfield, CA Department of Fish and Wildlife (CDFW)
- Andrew Renshaw, CA Department of Water Resources (DWR)
- Rick Rogers, National Marine Fisheries Service (NMFS)
- Melissa Rohde, The Nature Conservancy (TNC)
- Natalie Stork, SWRCB
- Val Zimmer, SWRCB

Data Gaps and Adaptive Management Approach (from March 22 Work Group meeting):

- Staff acknowledge a range of data gaps for the ISW SMC and recommend an adaptive management approach based on further study and increased monitoring during the implementation phase of GSPs for the Santa Rosa Plain, Petaluma Valley, and Sonoma Valley Subbasins.
- Practitioner Work Group members were highly supportive of the proposed adaptive management approach and recognized the significant data gaps due to a short period of record for RMPs in the Subbasins. Multiple participants acknowledged Sonoma Water is at the forefront of developing science around the ISW SMC.
- Suggested opportunities for future studies and partnerships to fill data gaps include:
    - CDFW Fisheries Restoration and Habitat Restoration Grant Programs may provide opportunities for future monitoring or studies.
    - GSAs will not be able to fund all necessary studies during the first 5 year update to the GSPs. Developing more information and monitoring on wells and surface water diversions should be the first priority.
    - Partnership with local academia, neighboring GSAs, and groups such as the Association of California Water Agencies (ACWA) could provide additional resources for studies, projects, and increased monitoring.
    - CDFW recommends increased analysis on the potential impact of cannabis cultivation for surface and groundwater levels as part of the Sonoma County Cannabis Land Use Ordinance Update and General Plan Amendment (Update). Partnership opportunities with CDFW and local jurisdictions may be available in relation to the Update.

Comments on approach and setting of MTs, MO, and URs (from March 22 Work Group meeting):

- Staff presented proposed MT/MO and UR options for consideration.
- Practitioner Work Group members generally agreed with the approach for developing the SMC, based on a thorough modeling analysis.
- Two primary suggestions were provided by Work Group members:
    - Using water years from 2014-2016 to set MTs could be problematic as these occurred during a historic drought. MTs based on these water years may not be protective of beneficial uses, most notably the health of aquatic species.

- For additional context on general streamflows, staff could consider providing the actual magnitude (in cfs) of flows *in addition* to the current relative percentages of depletion. Additionally, URs could be linked to the severity of MT exceedances to provide a sliding scale [for project/action implementation]

Materials from Practitioner Working Group Meetings for Interconnected Surface Water and Groundwater Dependent Ecosystems

SMC for Depletion of Interconnected Surface Water

Wednesday, October 7, 2020

Meeting Notes

Contact: Sam Magill, Practitioner Work Group Facilitator

Welcome and Work Group Purpose

Jay Jasperse, Sonoma Water welcomed the attendees and thanked them for their time and willingness to participate in the work group. Jasperse provided a brief overview of the work group structure.

Agenda Review and Work Group Introductions

Sam Magill, Work Group Facilitator walked through the agenda and meeting protocol before suggesting a round of introductions.

Work Group Background

Jay Jasperse presented the focus of the workgroup meetings. This group will assess options for developing Sustainable Management Criteria (SMC) for depletion of interconnected surface water due to groundwater pumping. The GSA technical staff will use the input from this subgroup to develop a recommended SMC methodology. Jasperse then provided a quick overview of Sustainable Management Criteria including the six indicators and key terms, followed by the role of the workgroup, Advisory Committee and Board. He covered key challenges (technical complexities, data and information limitations, surface water rights) for surface water depletion Sustainable Management Criteria.

Marcus Trotta, Sonoma Water gave an overview of the basin setting and groundwater conditions in the three basins followed by and integrated model overview for each basin.

Questions/Comments

Maurice Hall (chat) – Are there any areas where issues have or are arising from groundwater levels that are too high, e.g. flooding basements, saturated soils, etc.?

> Trotta – I am not aware of reported serious problems with shallow groundwater conditions. I know there are areas of shallow groundwater that can cause problems for construction. There are reports of agricultural drains in some of the basins, but we don't have good mapping/documentation of where they are in the basins.

Sam Boland-Brien – I am wondering – at the GSA Board level, what is their appetite for this topic and their interest level, and where does it fit in their priorities?

> Jasperse – It is a mixed bag. The three GSA Boards are made up of different interests and there are a variety of perspectives. We haven't discussed this topic too much with the Board yet so there hasn't been a great opportunity to provide detailed comments yet.

This SMC overlaps a lot of different interests. I know some of the Board members will be very interested in this.

Initial Work Group Feedback on Information Needs and Data Gaps

Sam Magill mentioned main points heard from meeting attendees before the meeting:

- Concern about selection of 2015 as baseline year
- Need to connect groundwater levels to interconnected surface water impacts
- Their organizations have already put together approaches on this SMC; staff has received the documents and will look at them.

Overview of Interconnected Surface Water (ISW) and Groundwater Dependent Ecosystem (GCE) Mapping Efforts

Andy Rich, Sonoma Water presented the mapping of interconnected surface waters in Sonoma Valley and Santa Rosa Plain; there is limited data available for Petaluma Valley. Interconnected surface water is defined in the GSP regulations as surface water that is hydraulically connected at any point by a continuous saturated zone to the underlaying aquifer and overlying surface water is not completely depleted. A surface water body may be connected to groundwater during some periods and disconnected during other periods.

Questions/Comments

Rick Rogers – For the Sonoma Valley Basin, what specifically informed the determination of "interconnected surface water", i.e. the blue lined map?

Rich – Basically, a combination of different factors which allowed us to decide at various times and various times of the year. We didn't choose any one line of evidence, it required self-corroborating lines of evidence to allow us to choose.

Rogers – In Sonoma Valley it sounds like you are going to have a USGS groundwater surface model, are you planning on incorporating that into your determination of interconnected reaches, or have you already?

Rich – For Sonoma Valley, we already have a groundwater flow model, but we are opting to work with actual observations of groundwater exchange/seepage runs.

Rogers – So with the seepage runs, it looks like one run was done in May, are they done at different times of the year and is the data variability factored in?

Rich – The seepage runs generally are done on semi-annual basis and the major reaches perform the seepage runs monthly. 2010 and 2013 are the earliest time periods we had the seepage runs performed. Starting in 2016, we started to more aggressively do seepage runs as described.

Rogers – When looking at and factoring in seepage runs, was there any consideration of current groundwater impacts in a reach impacting seepage runs? Seems there is a gap of no seepage below Glen Ellen for a distance. Is it due to a geologic phenomenon, or is it a result of excessive unsustainable groundwater pumping in the area?

Rich – I think it is more of a presentation issue. Or maybe during this seepage run that area wasn't measured or included. Generally, seepage runs are being performed along most reaches of Sonoma Creek

Rogers – In other areas, was there consideration for current groundwater pumping impacts and how they are affecting seepage rate?
Rich – No.

Boland-Brien – Some streams are losing in March 2017 and some are gaining in March 2017. I wonder, shouldn't there be some consistency in such a wet year?
Rich – The real hydrologic process going on where maybe the stage increase exceeded the groundwater level increase causing the stream loss or just the basic issue with an error in stream gage measurements. We try to account for error in the calculations.
Boland-Brien – What is the total flows that this delta is based on?
Rich – It is labeled on there so net seepage is the delta CFS.
Boland-Brien – That is the delta, what are the absolute values?
Rich – It varies from 1 to 1000 CFS in a couple years.

Val Zimmer – Is the baseline analysis high resolution enough to analyze no flow actions such as restoration to ameliorate stream incision or groundwater recharge projects? Seems groundwater pumping may be impacted at certain times of the year (ag). If someone were to initiate a small- or large- scale recharge project would this baseline be sufficient to analyze the success of either of those kinds of projects?
Rich – Are you asking about how we address the SMC or a general question?
Zimmer – I am brainstorming a little bit.
Rich – The datasets would be useful to understand the various projects or actions, but I don't know about the resolution.

Boland-Brien (chat) – I t would be helpful to think about SMC in the context of what might be done to manage those SMC.

Rogers – As far as the protocol you are using and results being generated, will they be put in a draft chapter or memo so we can comment?
Rich – I have a write-up we can share.

Maurice Hall – The process you described so far is a process by which you have used to define where there is interconnected surface water? Would be helpful to access documentation to help digest the material.
Rich – Yes.

Marcus Trotta followed with an update on Groundwater Dependent Eco-systems in the three basins and presented staff's proposed approach for GDE mapping and next steps.

Questions/Comments

Rogers – What time of year was the "30 feet depth to groundwater" measured?
Trotta – Those maps were based on springtime water levels.
Melissa Rohde – Which year?
Trotta – It varies by basin, either 2015 or 2016, I can follow up and let you know.

Possible Approaches for Developing SMC

Marcus Trotta shared existing data and said the objective was to identify opportunities for using shallow groundwater wells as a proxy for setting minimum thresholds for depletion of surface water. We feel incorporating groundwater data into this SMC is very important. Trotta introduced Stephen Maples, a recent hire at Sonoma Water, experienced with groundwater-surface water interaction.

Stephen Maples walked through his presentation with a look at how we can leverage measurements and models to characterize groundwater/surface water interactions and surface water depletion.

Outstanding Questions and Next Steps:

1. Are (1) simulated/observed heads in good enough agreement and (2) the regression relation robust enough to perform this assessment?
2. Can a regression be developed to assess other metrics, like duration of interconnection?
3. Are different regression relations needed for different periods within a year (i.e. wet/dry periods)? Or for different water year types?
4. What is the best approach for assessing the contribution from groundwater pumping? Differencing multiple simulations?

Questions/Comments

Rohde – I like the approach in terms of characterizing hydrologic variability, how do you bring it back to defining what an Undesirable Result is? With SGMA we are supposed to ensure groundwater pumping isn't affecting beneficial uses of groundwater. How do we integrate that into the assessment to ensure we aren't causing significant and unreasonable impacts?

> Maples – A lot of the choice or Minimum Thresholds and Measurable Objectives comes down to the Advisory Committees and Boards. It is a question we have too.
>
> Trotta – It comes to identifying what are significant and unreasonable conditions. Varying opinions would be helpful to hear from you on the specific insights on significant and unreasonable conditions that may have occurred in the past or what things you want to avoid in terms of surface water depletion due to groundwater pumping impacts to beneficial users.
>
> Rohde – Cautionary advice, if we don't measure potential impacts on groundwater use to the Board, they aren't going to be able to make a decision. At this point, we should clarify what the cause and effect relationships could be and what measures we could use to assess if groundwater conditions are adversely impacting various beneficial users.
>
> Trotta – Thank you, that is helpful.

Boland-Brien – I would probably say it stronger than "caution". I got very lost in the last few slides of the presentation as to *why* it is being done. It is missing the *why*. Maybe we are jumping too fast from local to regional, what are the impacts you are trying to consider? I would like to hear from the others what is undesirable and what is reasonable and insignificant.

> Maples – I think the reason why we are looking at pairing local data is using groundwater levels as a proxy. Groundwater-surface water interactions are difficult to measure explicitly. They are being measured in Sonoma Valley by doing differential gaging to look

at the actual loss from one location to the next location or gain of water. Other than doing that, you can't really measure the process directly. By developing the relationship between the groundwater head – we have historical data and a quite robust monitoring network that includes it, you need to develop a relationship between and actual measurement and a response we are trying to get out of it. Thank you for the comment.
Boland-Brien – It makes sense. It may be easier to say there is a choke point in the system from migration and needs to be preserved, put the monitoring there, and that is how we are protecting the reach. It might be simpler.
Maples – Good way to think about it.

Rogers – I want to relay my agency's thoughts on using groundwater. It is a common first stab at trying to solve this problem. Concern we have with using groundwater, is that when you look at the Undesirable Results of the streamflow it's significant and unreasonable impacts of beneficial uses of surface water. When it comes to steelhead, migration, etc. variables are informed by what the habitat is in the creek that supports the habitat. If you use groundwater as a correlation there needs to be some linkage between the groundwater level threshold and what that means to the streamflow level in the creek and how that stream flow levels protect habitat. Without the linkage, there needs to be significant correlation. What could be potential habitat condition thresholds, e.g. fish rearing habitat, we have a lot of studies in Sonoma County on low summer flows. If you disconnect stream reaches and de-water ripples, that is a threshold condition for juvenile salmonae. That is the kind of threshold that needs to be worked into whatever proxy you are using as a threshold level.

Maples – Thank you for that comment. It is the question we have for all of you. Looking at how much of the contribution comes from groundwater and looking at the change in contributions, especially if paired with additional analyses performed on certain reaches, it would help further inform decision making around measurable objectives.
Rogers – I think everybody understands whatever the level within the creek needed to avoid Undesirable Results that is a level impacted by groundwater pumping and surface flow diversion. The purpose is to identify it. SGMA is looking at impacts of groundwater pumping. What we can do is identify the component that SGMA is responsible for and look at other avenues that surface water diverters are having.
Trotta – Identifying the component that is surface water depletion is due to groundwater pumping, we recognize that as an important component for us to characterize. To the extent you can point us to any data points that would be helpful for us to identify habitat conditions that should be considered, would be very helpful.
Jasperse – This isn't really about sorting out the impacts of surface water and groundwater pumping. Groundwater wells can have surface water rights too and leads to complexity of sorting out the obligations of the GSA. It may change and needs to be considered.

Georgina King – I want to ask Rick Rogers if he can point us to a place where studies have been done where groundwater contribution is calculated. In lieu of any measured data we have, if you can respond to if there are any known studies that can throw out the groundwater contribution.

Rogers – I was speaking mainly of studies of habitat and flow levels. As far as trying to figure out how much groundwater is depleting surface water, I have never done that. I

think the groundwater-surface water model is trying to do that. A lot of the GSAs haven't been collecting this data. I think we will have to use the groundwater-surface water model; we will be hamstrung for the first few years. By the end of the 20-year period, we will have gathered more data and have a much better idea of what is going on. We won't have the answers at the get-go.

Hall – The analysis does a great job describing the connection of groundwater levels and stream flow. One would envision if you can maintain the groundwater level at the purple line, if the same things happens in the future, the groundwater wouldn't affect the stream flow any more than it was negatively affecting it when you first establish a negative issue. It fills in some of what some of my work colleagues call the multiple lines of evidence. My compliments to the analysis. It is another signal to me that Sonoma County has done a lot of work in this realm, sets a good bar and is a good educational tool. I am supportive of the analysis you have done.

Natalie Stork – A lot of good work has been done. It is great to have these analyses and to see what you are proposing. How does it relate to actual conditions in the basin? The concept of the 2015 baseline - the statute doesn't require GSAs to address conditions prior to January 2015. It might be something to consider when trying to relate impacts in the basin back to beneficial users. There were some great water level maps showing 2016 conditions. Is there anything for 2014 or 2015, have you had a look at those to see if depletions can be managed?

Trotta – We have data that spans across the 2015 baseline conditions. Much of the data is integrated into the models so it could be looked at as you suggest. I appreciate your comment.

Lisa Porta – A lot of discussion was focused on how you related this technical analysis to the conditions in the basin. It is always going back to the unreasonable condition and maybe that is where we can try to circle back to the significant unreasonable conditions we want to avoid before diving too much on Minimum Thresholds and Undesirable Results.

Boland-Brien – I agree with what Lisa Porta said. Generally, for the SMC, you might explore how flexible you might be. I think there are areas of flexibility, take advantage of that.

Jessie Maxfield (chat) – This may have come up at the GDE workgroup meeting, but the Department feels using 2015 as a baseline is not appropriate. This was the fourth year of a historic drought so stream depletion was already an issue and using 2015 as a baseline may not be protective of fish and wildlife.

Trotta – Thank you for all the different insights and perspectives. Bringing it back to significant and unreasonable is a critical step for us. Any input you have on that will be helpful to us. During the 2015 timeframe, I pose the question back to you – are there conditions that occurred that year that would be considered significant and you can point to?

Hall – Thank you for all the materials and good introduction. I look forward to further dialogue. Happy to respond to further inquiries by email until the next meeting.

Rohde – In addition, 2015 is only one year. We need multiple years of data to characterize groundwater conditions here in California's Mediterranean climate.

Maxfield – The baseline should not be a point in time but based on habitat conditions.

Rogers – Re the 2015 baseline, the way we look at it, we are urging caution to use it as a baseline – it was during the height of the drought and it likely represented poor conditions for stream flow and instream habitat. When you are implementing your plan and need a federal permit, we are going to have to do a separate consultation and the plan. Our analysis of the plan is going to come in. If it is based on 2015 impacts on streams, it is likely to be a concern. Whether it leads to a jeopardy situation or adverse pond determination, it is a possibility. I am not making a pre-determination; I am just saying people should be aware of it.

David Manning, Sonoma Water – I am not hearing we have the ability for the model tell us the ripple effects related to groundwater pumping. Are we trending away what could be a likely impact on stream flows but not determining what that level is?

> Maples – The groundwater models developed and resolution they are at, they can't resolve specific ripples and disconnecting - they can tell us the regional response.
> Rogers – I think I get the gist of what you are explaining, I think we are on the same page. I realize that in the startup of the GSP for the first few years, we won't have all the answers. I would like to see a plan in the GSP to acquire the data so we can refine the model and have what we need at the end of the 20-year period.
> Manning – That makes sense. Linking the mod should be part of the plan.
> Stork – A lot of the data can be used to manage the SMCs. I think there is a lot in the model that can be used especially after a few more model runs. Folks are bringing up good points about using the models for specific ripples, but a lot can be done to get started.

Initial Discussion of Monitoring Methodologies and Approach

Marcus Trotta put this item on the agenda to get meeting participants thinking about it. We are initially thinking about using shallow wells as a proxy for specific SMCs. Initially we are hoping we can rely on some of the shallow monitoring wells as a proxy for the specific SMC. It is a good subject for the next work group meeting. If you have any ideas for monitoring methodologies and approaches, send them to staff.

Questions/Comments

Manning – The remote sensing concept is fantastic. Great to see how the conditions exist for species at a critical time of year.

Zimmer – If you are looking at additional monitoring or locations for groundwater monitoring or stream gaging, it might be good to think about areas that are critical for species and targets for restoration that reduce impacts for groundwater pumpers; either high value or target areas to improve streamflow conditions.

> Trotta – That is helpful. In terms of GSP projects, they will be developed in the next six months as we wrap up the sustainable management criteria development.

Review Meeting Action Items and Discuss Scheduling

Marcus Trotta thanked the folks for attending and for the helpful input. We are looking at wrapping up some of the other work groups and will bring back information to you. We will take the input we received today and will put together a more built-out approach for establishing Minimum Thresholds and Measurable Objectives and how to characterize significant and unreasonable conditions for our next meeting.

Jay Jasperse said he appreciated the input and discussion. I agree putting our technical approach around the statement of significant and unreasonable conditions is essential. I am interested as we dive into more of the technical methodologies, one of the SMCs, seawater intrusion, don't have enough data, so we are going with an initial placeholder. I will be interested to see how this process works out as we examine data quality. I look forward to future discussions.

Sam Magill said an email would be sent out on next steps and to schedule a next meeting date. Today's slides are available at https://gcc02.safelinks.protection.outlook.com/ap/p-59584e83/?url=https%3A%2F%2Fmysacstate-my.sharepoint.com%2F%3Ap%3A%2Fg%2Fpersonal%2Fs_magill_csus_edu%2FEQ1pXkf1CXxLm6B3omBC_p8B1gM_LDl2V9ZVdeb9DApC_g%3Fe%3DRBT3p2&data=02%7C01%7CSimone.Peters%40scwa.ca.gov%7C93a0761f57ae45bc3fac08d86edec512%7Cc93b7179f57841648fe1c2704c730887%7C0%7C0%7C637381250356972267&sdata=ilRigCKbextB8Ziy092%2BBJqJ7%2F0yl53LmlX2bf26KQY%3D&reserved=0

Attendees

Jessie Maxfield, CA Department of Fish and Wildlife
Natalie Stork, State Water Resources Control Board
Val Zimmer, State Water Resources Control Board
Sam Boland-Brien, State Water Resources Control Board
Maurice Hall, Environmental Defense Fund
Melissa Rohde, The Nature Conservancy
Rick Rogers, National Marine Fisheries Service
Lisa Porta, Montgomery & Associates
Georgina King, Montgomery & Associates
Jay Jasperse, Sonoma Water
Marcus Trotta, Sonoma Water
Andy Rich, Sonoma Water
Stephen Maples, Sonoma Water
David Manning, Sonoma Water
Sam Magill, Work Group Facilitator
Simone Peters, Sonoma Water (recorder of meeting notes)

SANTA ROSA PLAIN • PETALUMA VALLEY • SONOMA VALLEY

GROUNDWATER SUSTAINABILITY AGENCIES

SUSTAINABLE MANAGEMENT CRITERIA FOR DEPLETION OF INTERCONNECTED SURFACE WATER

Time	Agenda Item	Materials
9:00	Welcome and Work Group Purpose Jay Jasperse, Sonoma Water	N/A
9:05	Agenda Review and Work Group Introductions Sam Magill , Work Group Facilitator All Work Group Participants	Agenda
9:15	Work Group Background • SGMA/SMC requirements and GSA role • GSP status and schedules Jay Jasperse, Sonoma Water Marcus Trotta, Sonoma Water	PPT presentation
9:25	Initial Work Group Feedback on Information Needs and Data Gaps Sam Magill , Work Group Facilitator	
9:35	Overview of Interconnected Surface Water (ISW) and Groundwater Dependent Ecosystem (GDE) Mapping Efforts • GDE Practitioner Work Group Overview and initial Outcomes • ISW mapping products and status • GDE mapping products and status Andy Rich, Sonoma Water Marcus Trotta, Sonoma Water	PPT presentation

Time	Agenda Item	Materials
10:05	Possible approaches for developing SMC • Prioritization of areas/stream reaches for establishing SMCs and monitoring o Beneficial users and uses of surface water o Impact of groundwater pumping on streamflows o *Purpose: Begin identifying relationship of pumping to shallow GW and then to streamflow* • Concepts for establishing Minimum Thresholds (MTs) and Measurable Objectives (Mos) o Role of model o Correlation with groundwater levels/groundwater pumping • Initial thoughts on Data gaps Groundwater Sustainability Plan (GSP) Staff All Work Group Participants	
11:35	Initial discussion of monitoring methodologies and approach GSP Staff All Work Group Participants	
11:55	Review Meeting Action Items and Discuss Scheduling	
11:00	Meeting Adjourns	

Workgroup Background – Jay Jasperse

Focus of Workgroup Meetings

Scope: This subgroup will be comprised of subject matter experts and representatives from agencies that have jurisdictional interests in stream flow, water use, and riparian ecosystems.

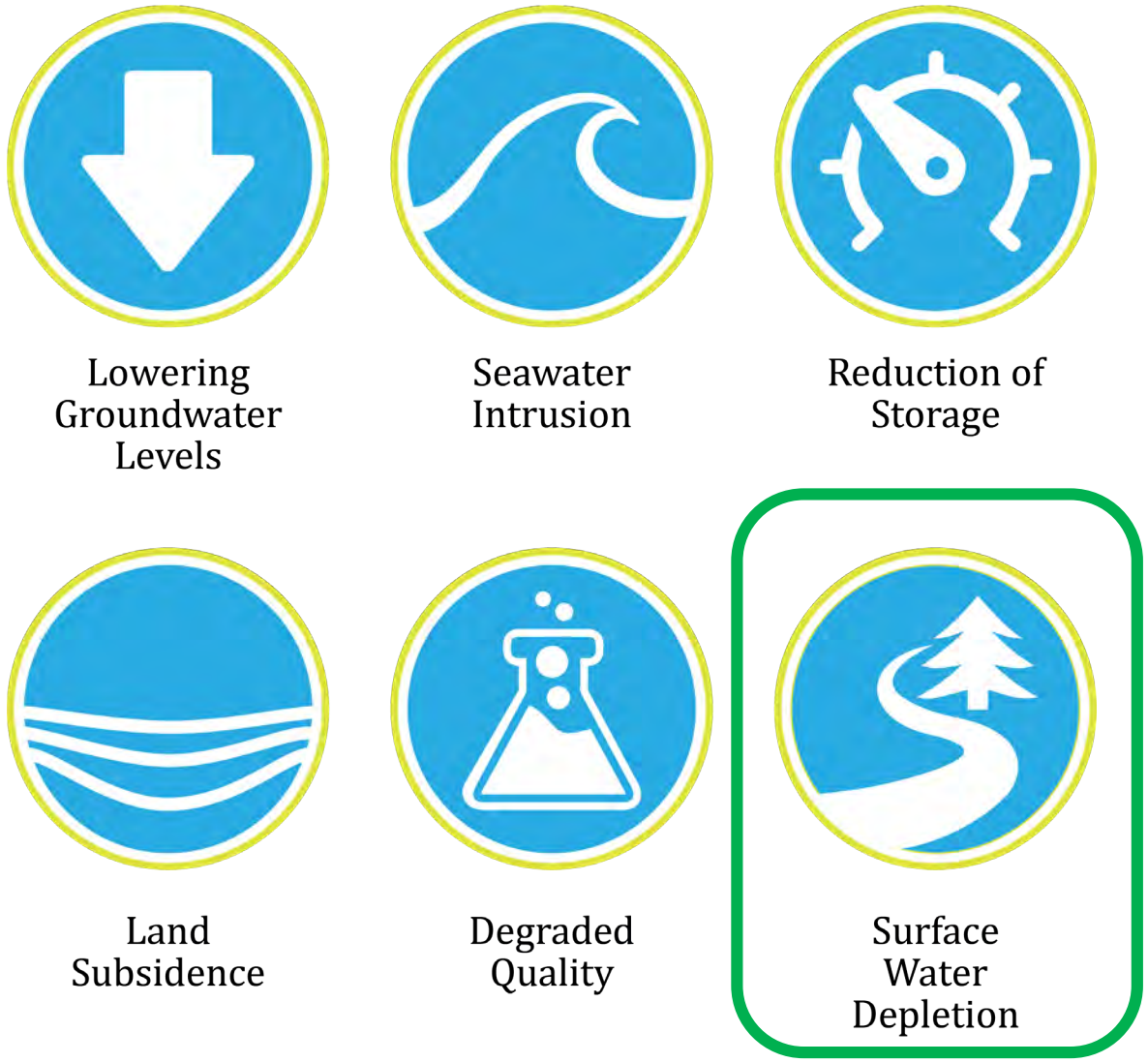
Utilize the results of the GDE subgroup, and other available information, in assessing options for developing SMCs for depletion of interconnected surface water due to groundwater pumping. The GSA technical staff will use the input from this subgroup to develop a recommended SMC methodology.

Sustainable Management Criteria

Sustainable Management Criteria (SMCs) are defined locally based on ***basin conditions*** to avoid *significant and unreasonable* ***Undesirable Results*** for SGMA ***Sustainability Indicators***.

Iterative Process which will involve significant stakeholder engagement, modeling of future climate, growth, and projects and actions

Sustainability Indicators



Sustainable Management Criteria Key Terms

- Undesirable Results
- Minimum Thresholds

Together these two terms **define what is <u>unacceptable</u>** within the basin and **determine whether the basin is being managed sustainably**

- Measurable Objectives

This term defines what is **<u>desirable</u>** within the basin and the conditions which the **GSA must strive to achieve**

Role of Workgroup, Advisory Committee and Board

Workgroup Role

- Recommended methodology for establishing and monitoring for Minimum Thresholds and Measurable Objectives
- Review preliminary MT and MO proposals
- Ideas for developing options for determining Undesirable Results
- Initial assessment of Data Gaps

Advisory Committee Role

- Review recommended methodology and preliminary MT and MO proposals
- Recommend options for determination of Undesirable Results
- Initial recommendations on prioritization of Data Gaps

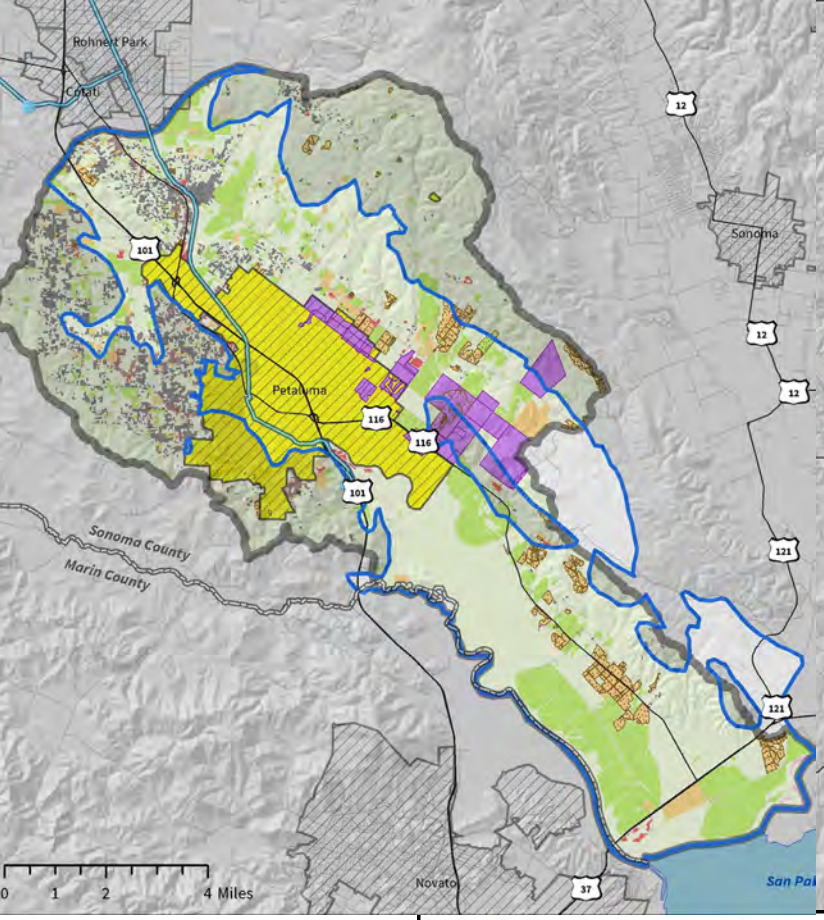
GSA Board Role

- Consider recommended methodology and preliminary MT and MO proposals
- Consider and select an option for determination of Undesirable Results
- Consider recommendations on prioritization of Data Gaps for GSP Implementation Program

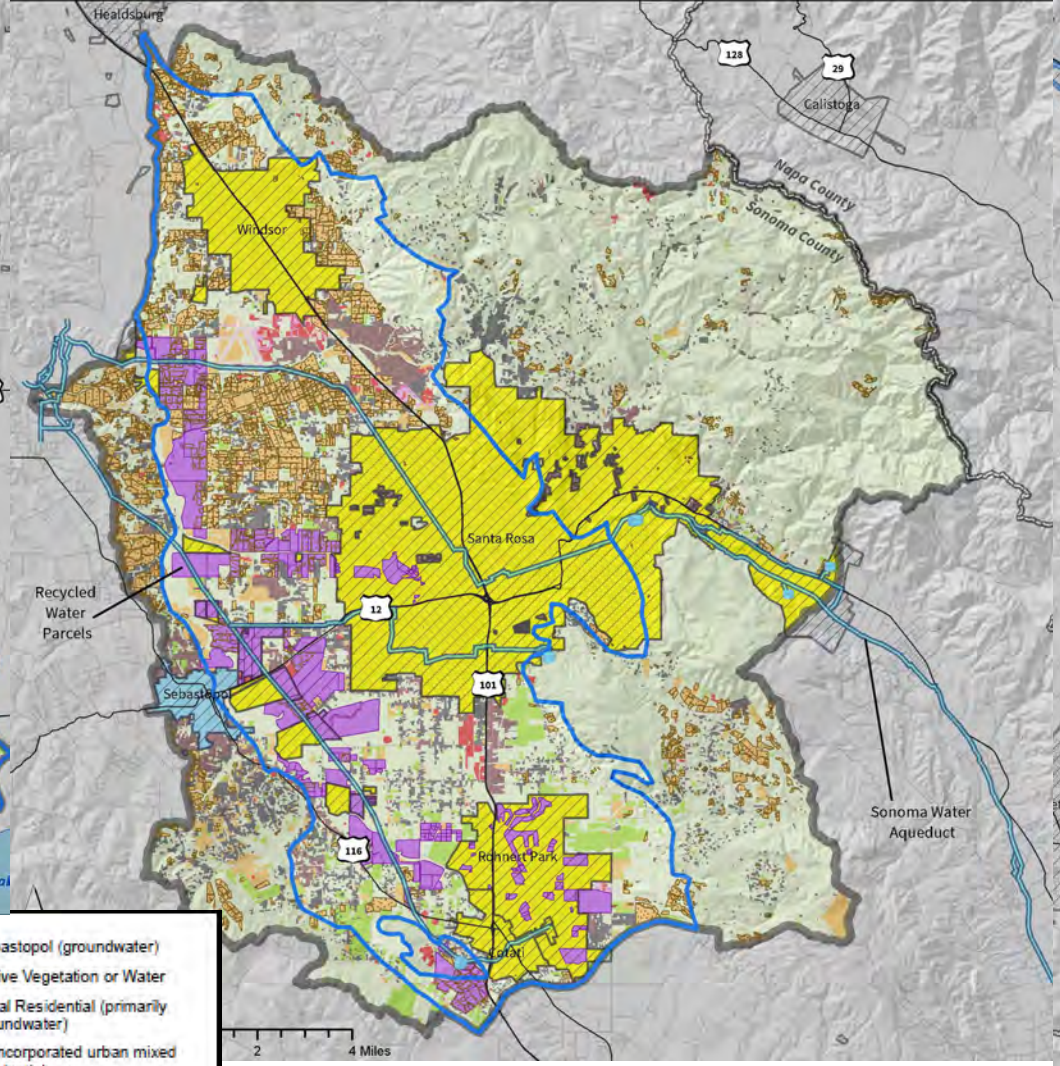
Key Challenges for Surface Water Depletion SMC

- Technical complexities in identifying fraction of surface water depletion caused by groundwater pumping (spatial and temporal variations)
  - Once estimated, how much of that depletion caused by groundwater pumping should be considered "significant and unreasonable"?
- Data and Information Limitations
  - Monitoring infrastructure for assessing degree of surface water and groundwater interaction (eg, streamflow gauges and shallow monitoring wells)
  - Locations, depths and timing of groundwater pumping from water wells
- Surface Water Rights
  - Limited information on type, location, timing and amounts of permitted surface water diversions
  - Regulatory complications

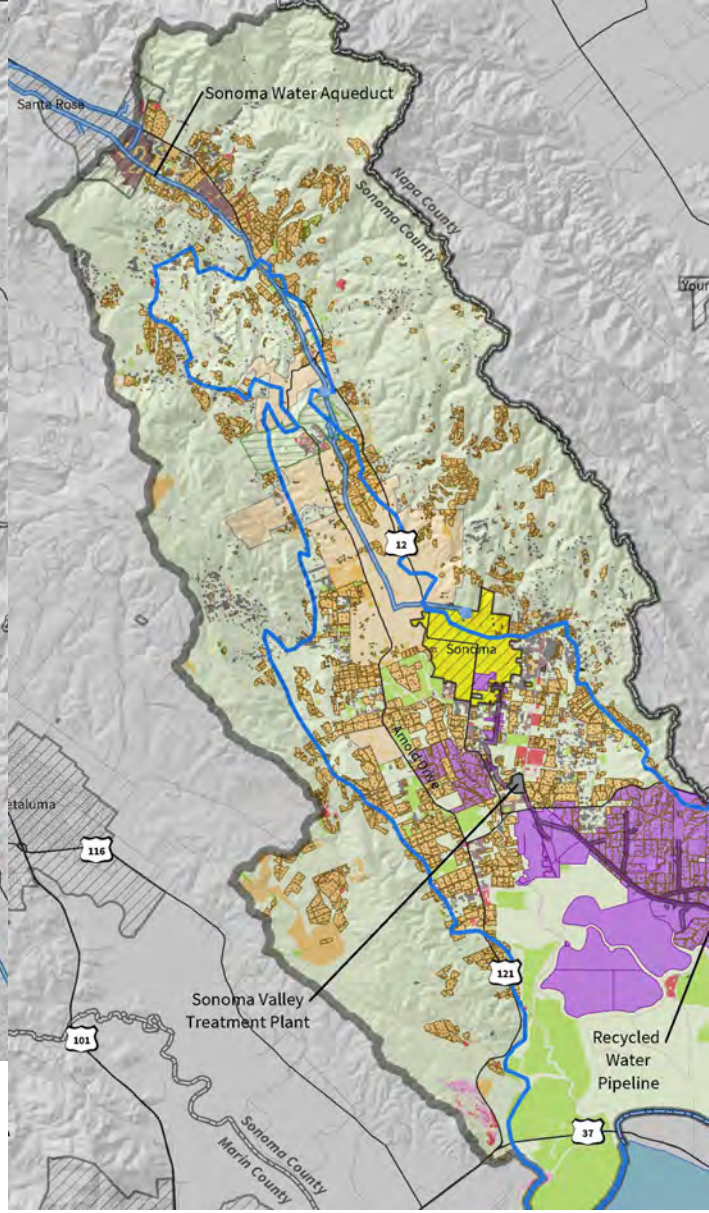
Basin Setting/Conditions Overview – Marcus Trotta



Petaluma Valley



Santa Rosa Plain



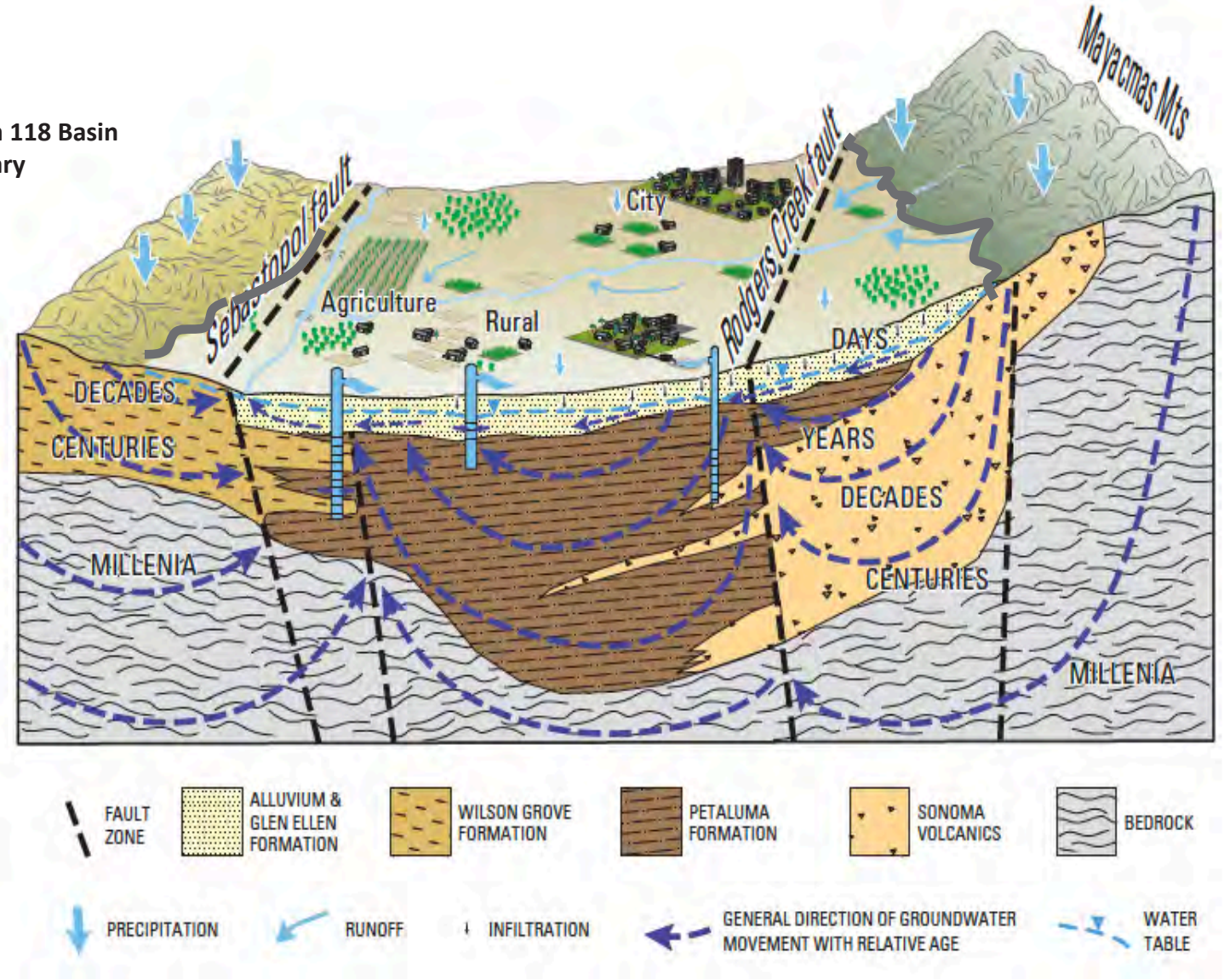
Sonoma Valley

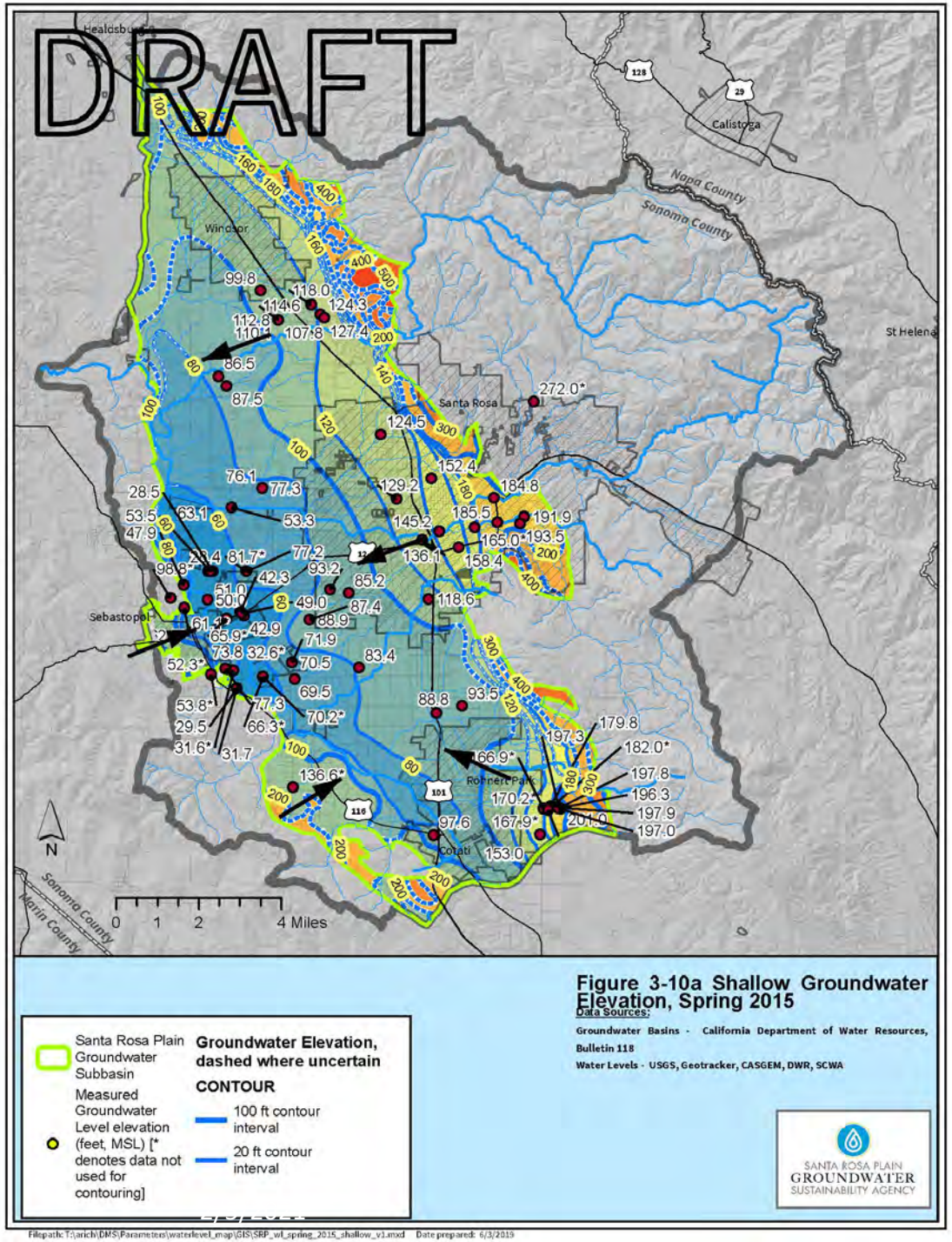
- Santa Rosa Plain Groundwater Subbasin
- Contributing Watershed Area
- Vineyards
- Recycled Water Parcels (primarily recycled water with some backup groundwater and/or surface water)
- Santa Rosa, Rohnert Park, Windsor and Cotati (primarily imported surface water with supplemental groundwater)
- *Irrigated Agricultural (primarily groundwater with some surface water)
- *Non-irrigated Agricultural
- Sebastopol (groundwater)
- Native Vegetation or Water
- Rural Residential (primarily groundwater)
- Unincorporated urban mixed residential commerical/industrial (primarily groundwater)
- Unincorporated commerical/Industrial (primarily groundwater)
- Vacant
- Sonoma Water Aqueduct
- City Footprints
- County Line

*Based on DWR land use mapping

Conceptual Model Diagram

Bulletin 118 Basin Boundary




DRAFT
Healdsburg
Windsor
Santa Rosa
Calistoga
St Helena
Napa County
Sonoma County
Sebastopol
Rohnert Park
Cotati
Sonoma County
Marin County
0 1 2 4 Miles
N
Santa Rosa Plain Groundwater Subbasin
Measured Groundwater Level elevation (feet, MSL) [* denotes data not used for contouring]
Groundwater Elevation, dashed where uncertain
CONTOUR
100 ft contour interval
20 ft contour interval
Figure 3-10a Shallow Groundwater Elevation, Spring 2015
Data Sources:
Groundwater Basins - California Department of Water Resources, Bulletin 118
Water Levels - USGS, Geotracker, CASGEM, DWR, SCWA
SANTA ROSA PLAIN GROUNDWATER SUSTAINABILITY AGENCY
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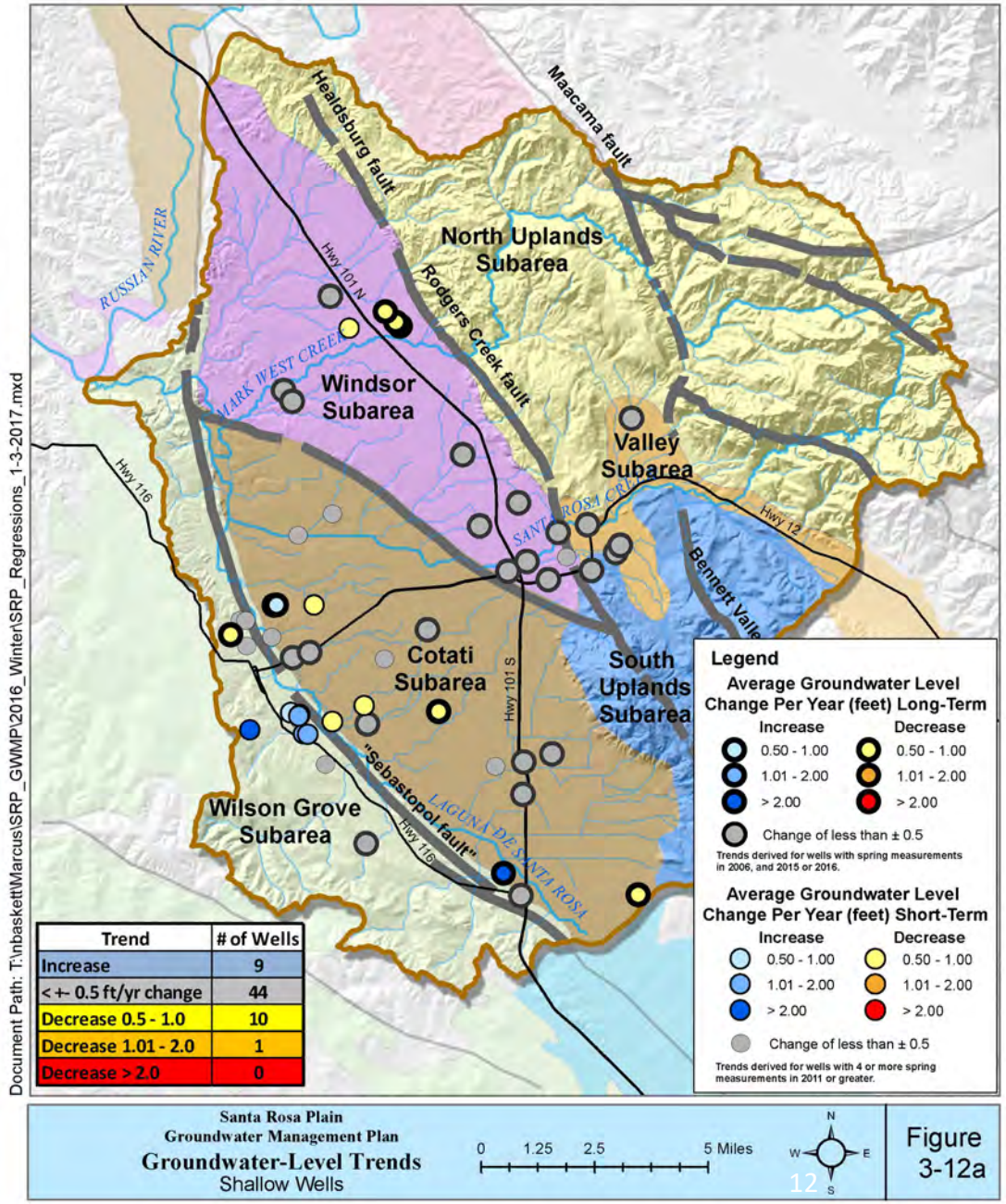
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Healdsburg fault
Maacama fault
Rodgers Creek fault
Hwy 101 N
Hwy 116
Hwy 101 S
Hwy 12
RUSSIAN RIVER
MARK WEST CREEK
SANTA ROSA CREEK
LAGUNA DE SANTA ROSA
Bennett Valley
"Sebastopol fault"
North Uplands Subarea
Windsor Subarea
Valley Subarea
Cotati Subarea
South Uplands Subarea
Wilson Grove Subarea
Trend | # of Wells
Increase | 9
< +- 0.5 ft/yr change | 44
Decrease 0.5 - 1.0 | 10
Decrease 1.01 - 2.0 | 1
Decrease > 2.0 | 0
Legend
Average Groundwater Level Change Per Year (feet) Long-Term
Increase
Decrease
0.50 - 1.00
1.01 - 2.00
> 2.00
Change of less than ± 0.5
Trends derived for wells with spring measurements in 2006, and 2015 or 2016.
Average Groundwater Level Change Per Year (feet) Short-Term
Increase
Decrease
0.50 - 1.00
1.01 - 2.00
> 2.00
Change of less than ± 0.5
Trends derived for wells with 4 or more spring measurements in 2011 or greater.
Santa Rosa Plain
Groundwater Management Plan
Groundwater-Level Trends
Shallow Wells
0 1.25 2.5 5 Miles
N
W
E
S
Figure 3-12a

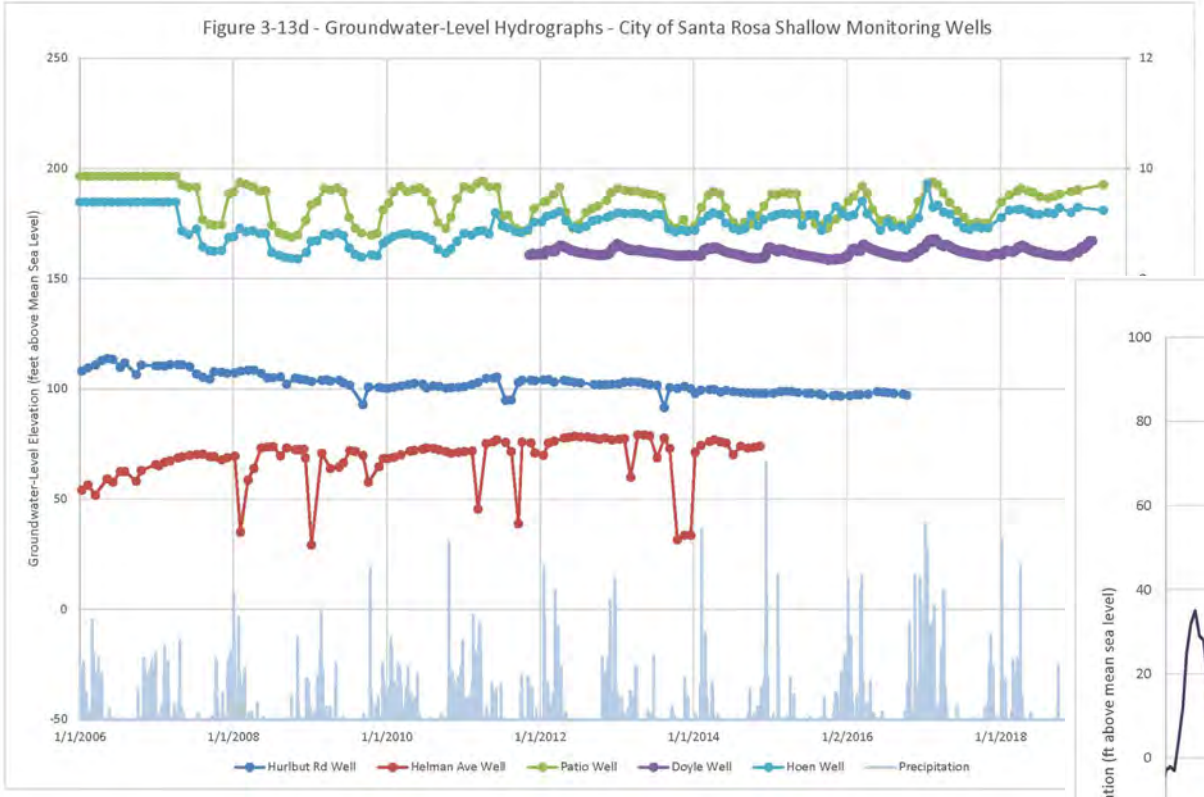


Figure 3-13d - Groundwater-Level Hydrographs - City of Santa Rosa Shallow Monitoring Wells
Groundwater-Level Elevation (feet above Mean Sea Level)
250
200
150
100
50
0
-50
12
10
1/1/2006
1/1/2008
1/1/2010
1/1/2012
1/1/2014
1/2/2016
1/1/2018
Hurlbut Rd Well
Helman Ave Well
Patio Well
Doyle Well
Hoen Well
Precipitation

.

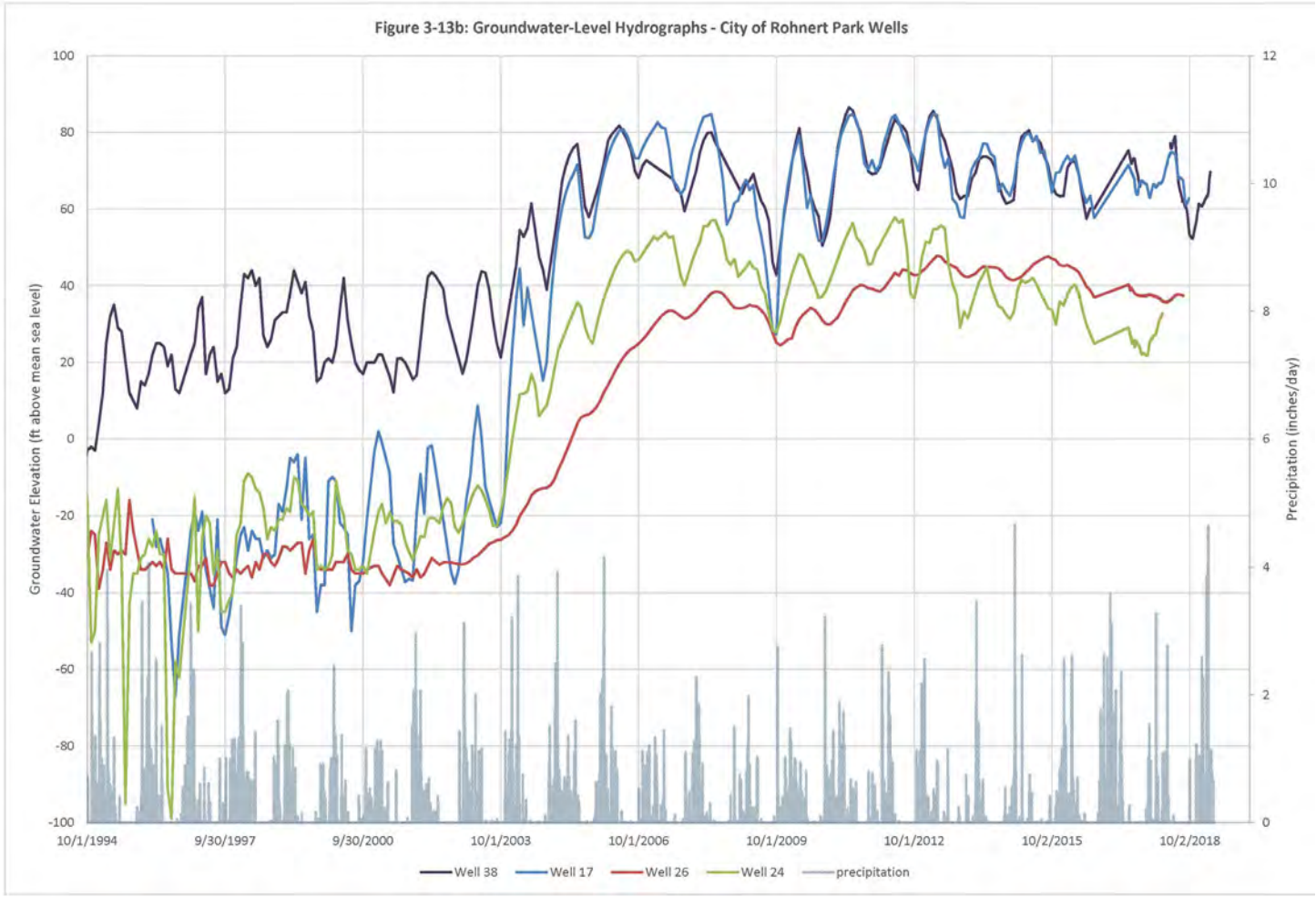
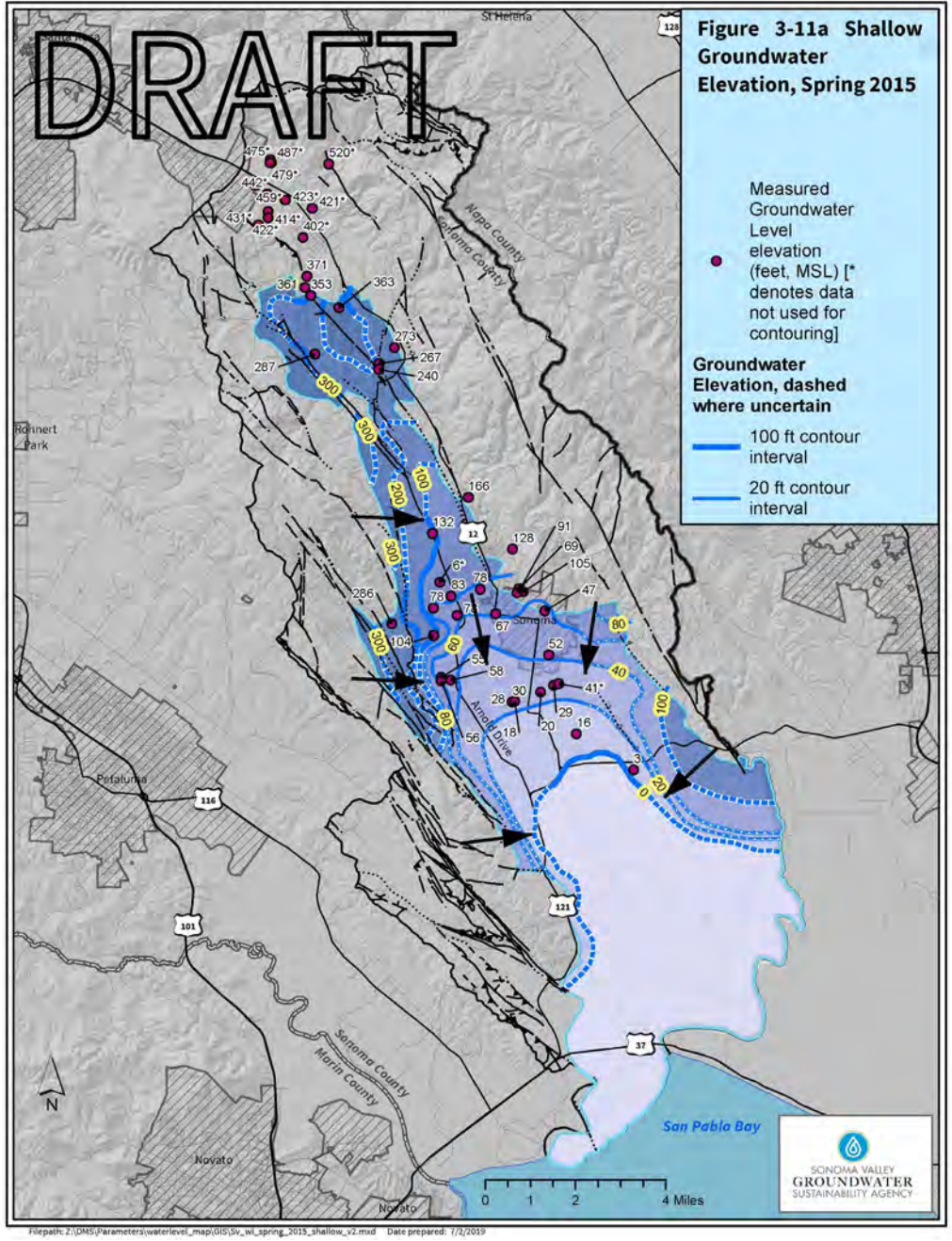
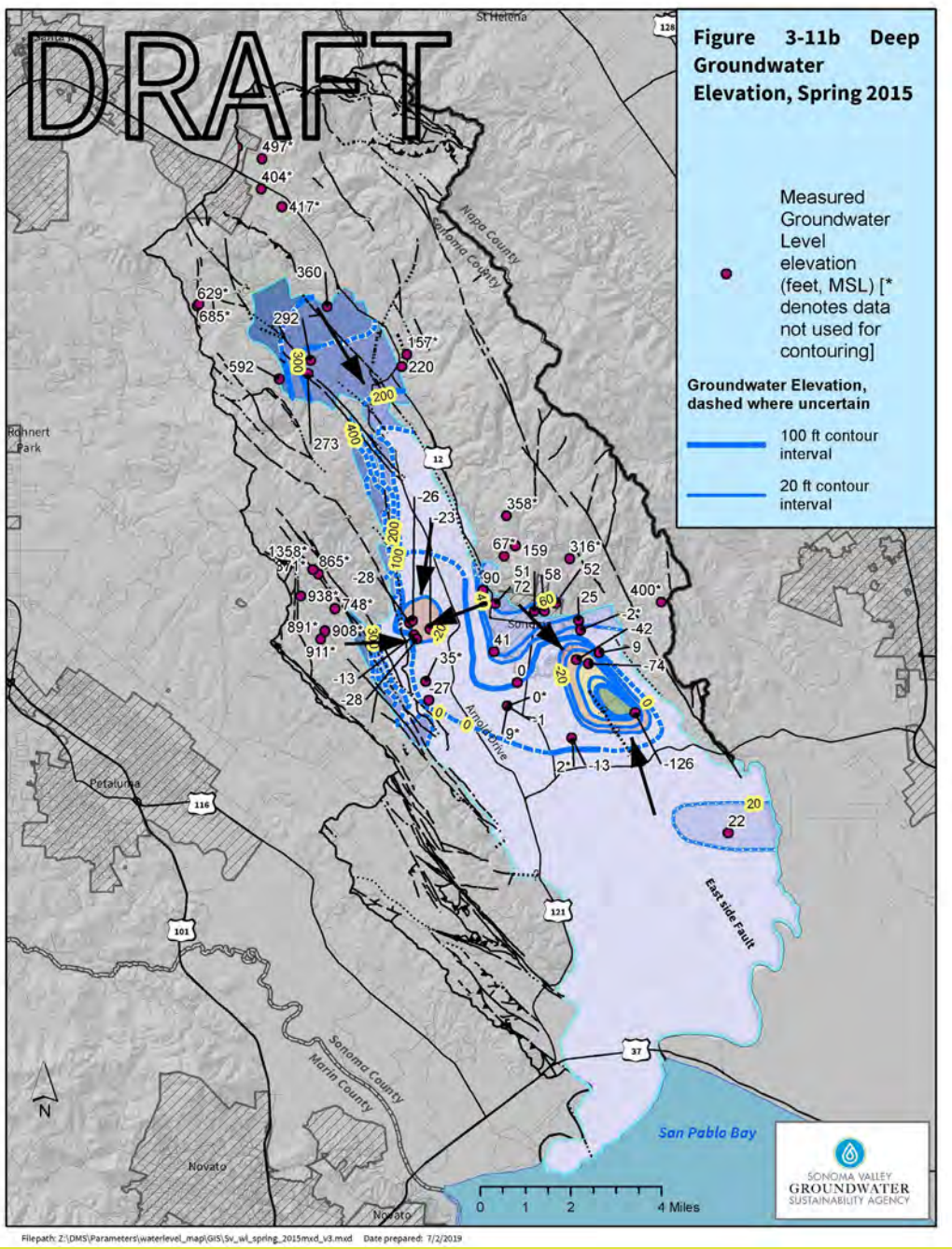


Figure 3-13b: Groundwater-Level Hydrographs - City of Rohnert Park Wells
Groundwater Elevation (ft above mean sea level)
100
80
60
40
20
0
-20
-40
-60
-80
-100
12
10
8
6
4
2
0
Precipitation (inches/day)
10/1/1994
9/30/1997
9/30/2000
10/1/2003
10/1/2006
10/1/2009
10/1/2012
10/2/2015
10/2/2018
Well 38
Well 17
Well 26
Well 24
precipitation


DRAFT
Figure 3-11a Shallow Groundwater Elevation, Spring 2015
Measured Groundwater Level elevation (feet, MSL) [* denotes data not used for contouring]
Groundwater Elevation, dashed where uncertain
100 ft contour interval
20 ft contour interval
St Helena
Napa County
Sonoma County
Rohnert Park
Petaluma
Sonoma
Arnold Drive
Sonoma County
Marin County
Novato
San Pablo Bay
0 1 2 4 Miles
N
SONOMA VALLEY GROUNDWATER SUSTAINABILITY AGENCY
Filepath: Z:\DMS\Parameters\waterlevel_map\GIS\Sv_wl_spring_2015_shallow_v2.mxd Date prepared: 7/2/2019


DRAFT
Figure 3-11b Deep Groundwater Elevation, Spring 2015
Measured Groundwater Level elevation (feet, MSL) [* denotes data not used for contouring]
Groundwater Elevation, dashed where uncertain
100 ft contour interval
20 ft contour interval
St Helena
Napa County
Sonoma County
Rohnert Park
Petaluma
Sonoma
Arnold Drive
East side Fault
Sonoma County
Marin County
Novato
San Pablo Bay
0 1 2 4 Miles
N
SONOMA VALLEY GROUNDWATER SUSTAINABILITY AGENCY
Filepath: Z:\DMS\Parameters\waterlevel_map\GIS\Sv_wl_spring_2015mxd_v3.mxd Date prepared: 7/2/2019

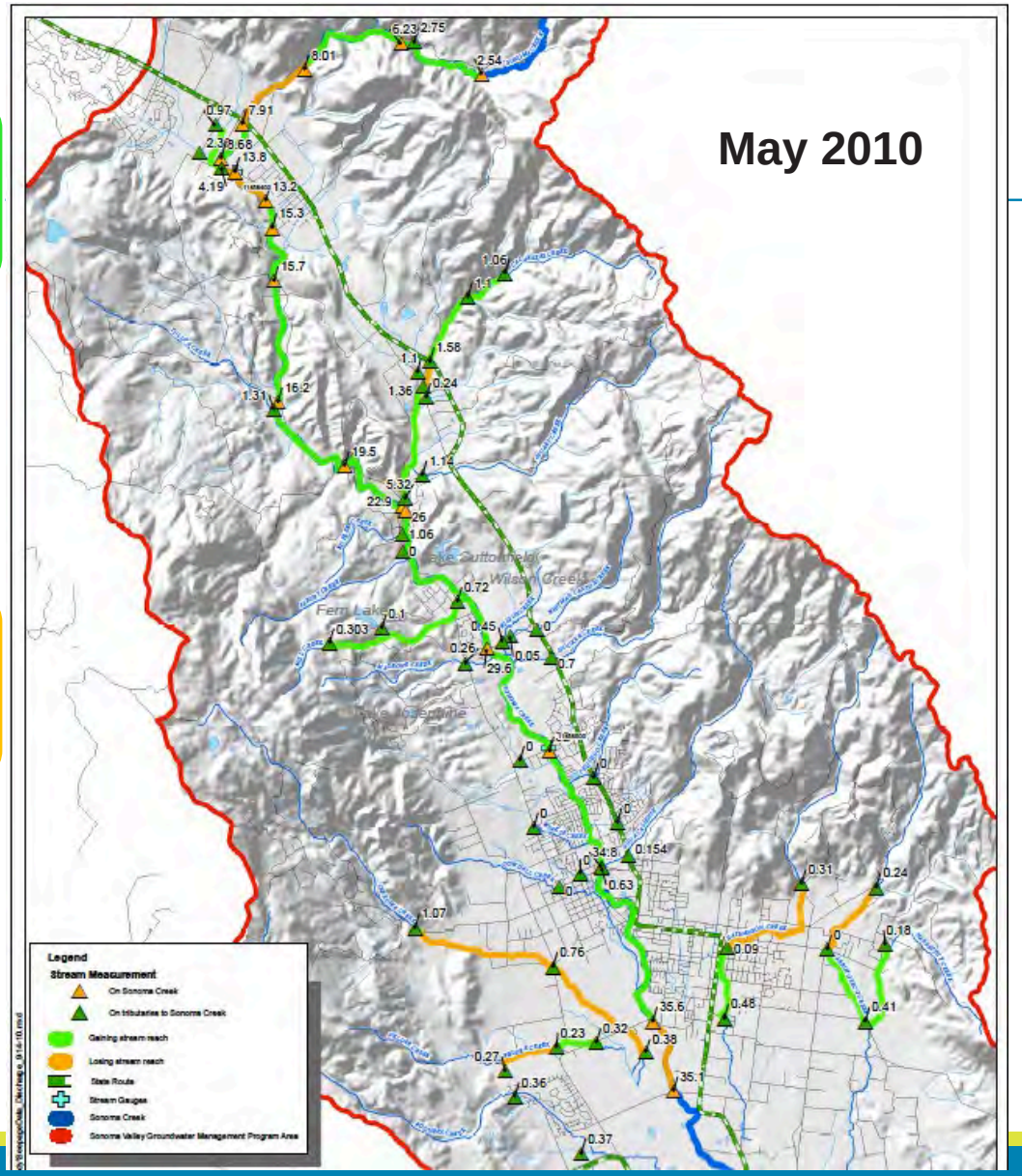
Sonoma Valley: Seepage Runs

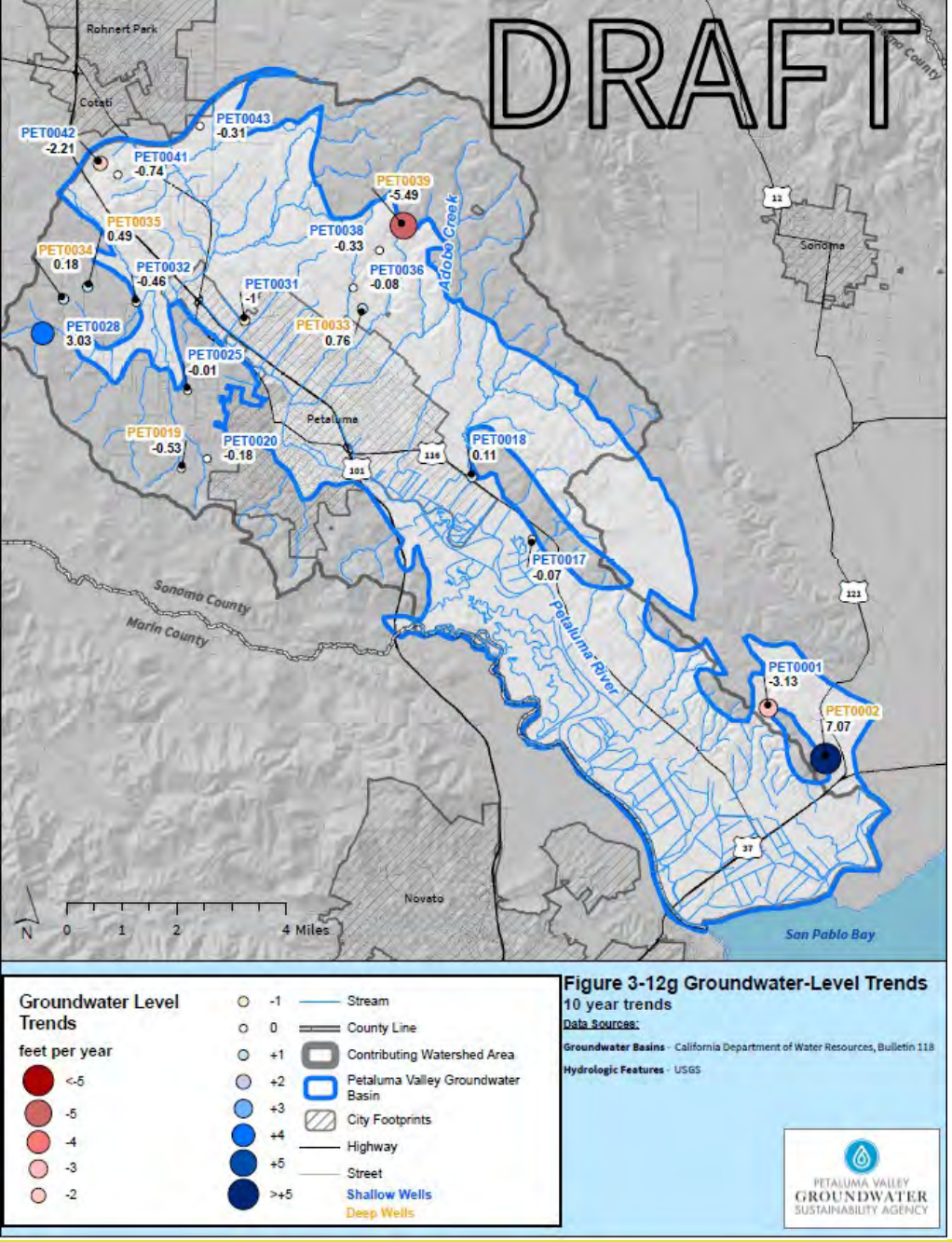
Discharge Segments
(Groundwater flows into Stream)

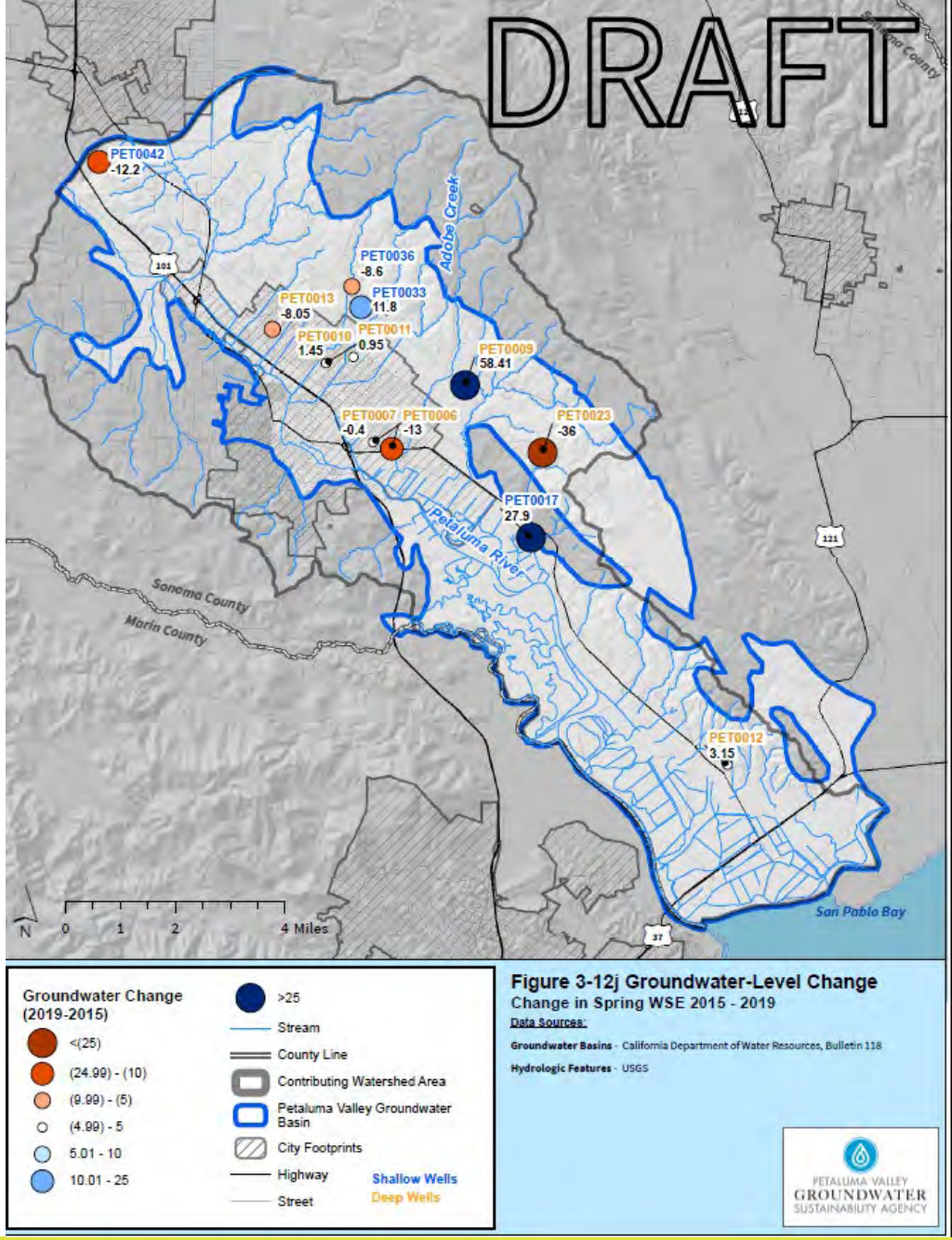
- **Most of Sonoma Creek**
- **Most of Calabazas**
- **Lower reaches of Fryer and Nathanson**

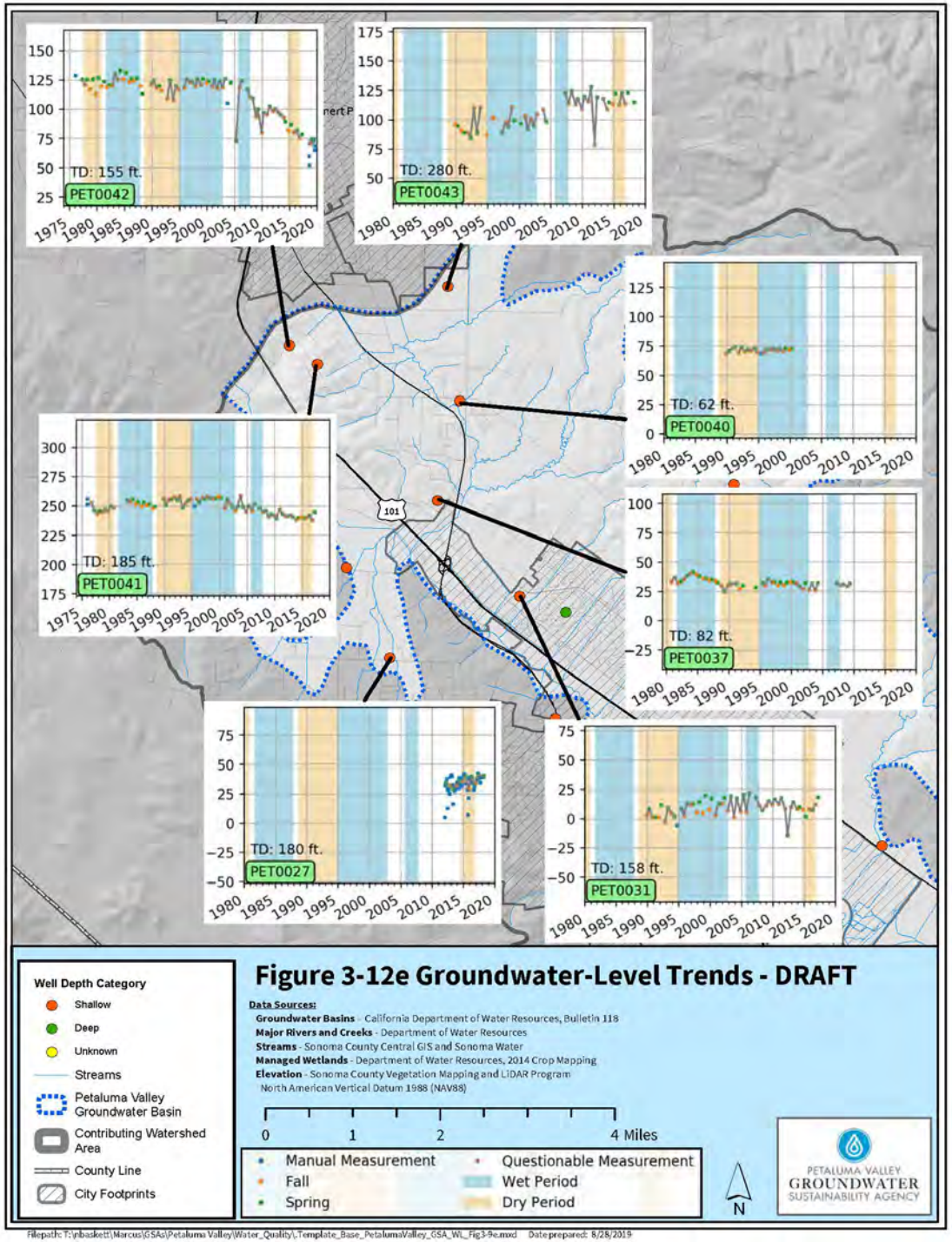
Recharge Segments
(Stream recharges Groundwater)

- **Sonoma Creek near Kenwood**
- **Carriger**
- **Upper reaches of Fryer and Nathanson**
- **Portion of Felder Creek**




DRAFT
Rohnert Park
Cotati
Sonoma
Petaluma
Novato
Sonoma County
Marin County
Adobe Creek
Petaluma River
San Pablo Bay
PET0042 -2.21
PET0043 -0.31
PET0041 -0.74
PET0039 -5.49
PET0035 0.49
PET0038 -0.33
PET0034 0.18
PET0032 -0.46
PET0031 -1
PET0036 -0.08
PET0028 3.03
PET0033 0.76
PET0025 -0.01
PET0019 -0.53
PET0020 -0.18
PET0018 0.11
PET0017 -0.07
PET0001 -3.13
PET0002 7.07
N 0 1 2 4 Miles
Groundwater Level Trends
feet per year
<-5
-5
-4
-3
-2
-1
0
+1
+2
+3
+4
+5
>+5
Stream
County Line
Contributing Watershed Area
Petaluma Valley Groundwater Basin
City Footprints
Highway
Street
Shallow Wells
Deep Wells
Figure 3-12g Groundwater-Level Trends
10 year trends
Data Sources:
Groundwater Basins - California Department of Water Resources, Bulletin 118
Hydrologic Features - USGS
PETALUMA VALLEY GROUNDWATER SUSTAINABILITY AGENCY


DRAFT
Sonoma County
Marin County
Adobe Creek
Petaluma River
San Pablo Bay
PET0042 -12.2
PET0036 -8.6
PET0033 11.8
PET0013 -8.05
PET0010 1.45
PET0011 0.95
PET0009 58.41
PET0007 -0.4
PET0006 -13
PET0023 -36
PET0017 27.9
PET0012 3.15
N 0 1 2 4 Miles
Groundwater Change (2019-2015)
<(25)
(24.99) - (10)
(9.99) - (5)
(4.99) - 5
5.01 - 10
10.01 - 25
>25
Stream
County Line
Contributing Watershed Area
Petaluma Valley Groundwater Basin
City Footprints
Highway
Street
Shallow Wells
Deep Wells
Figure 3-12j Groundwater-Level Change
Change in Spring WSE 2015 - 2019
Data Sources:
Groundwater Basins - California Department of Water Resources, Bulletin 118
Hydrologic Features - USGS
PETALUMA VALLEY GROUNDWATER SUSTAINABILITY AGENCY



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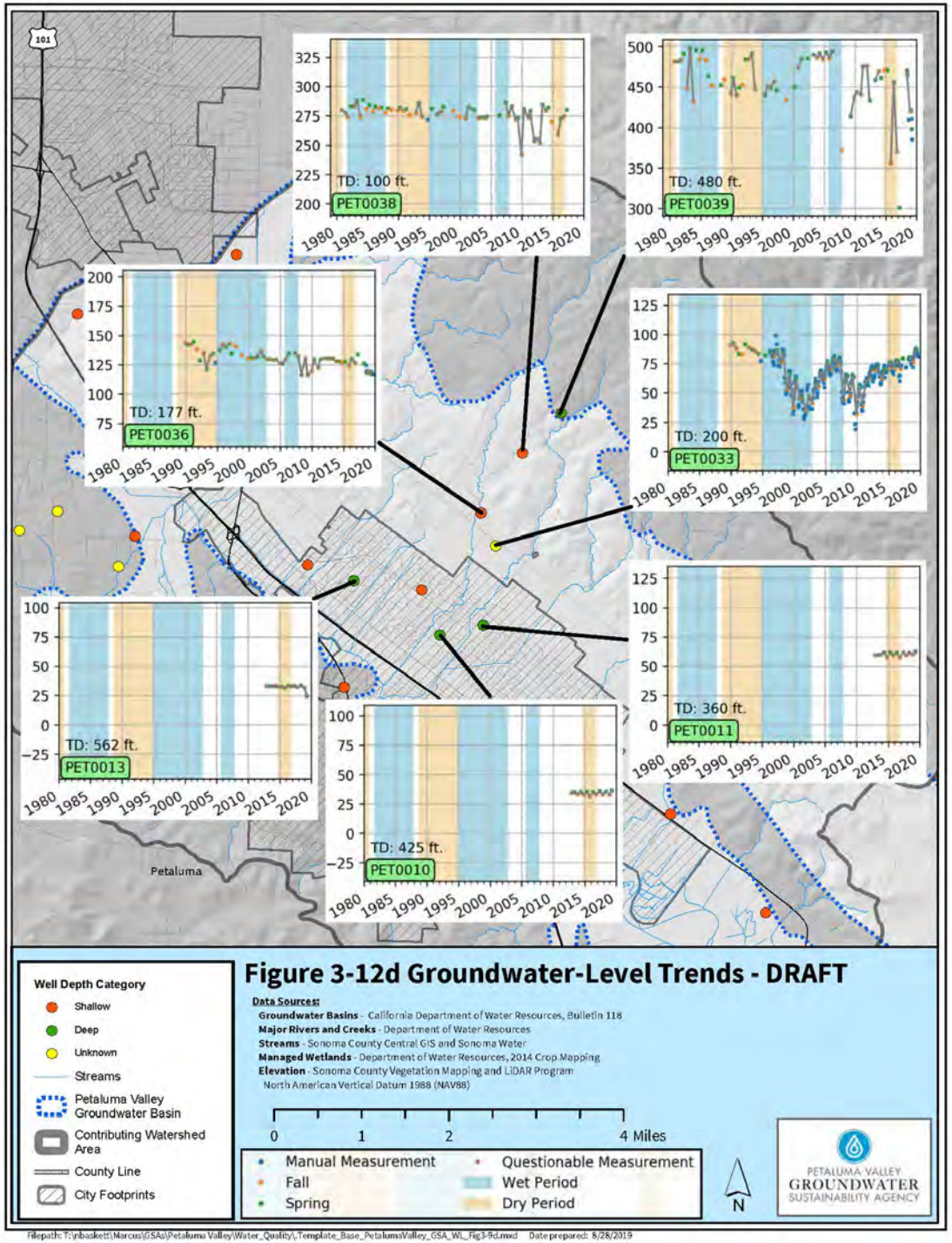

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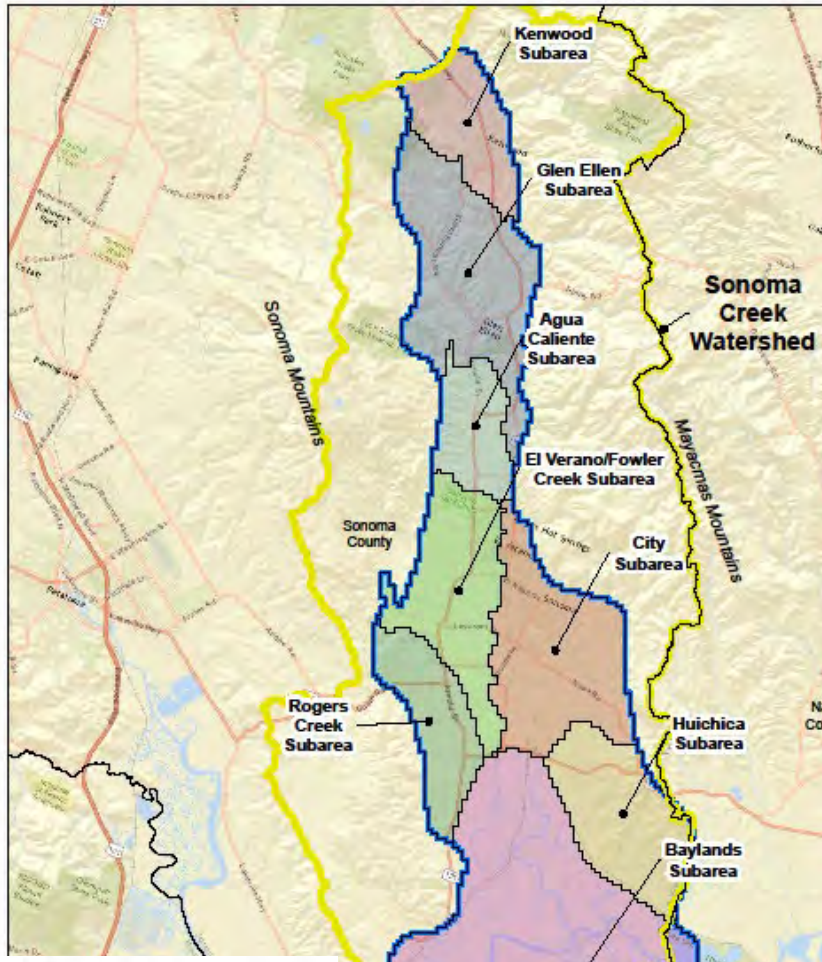
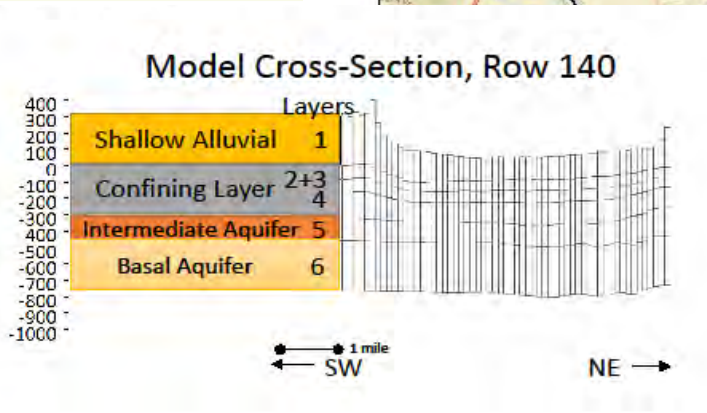
Sonoma Valley Integrated Model Overview

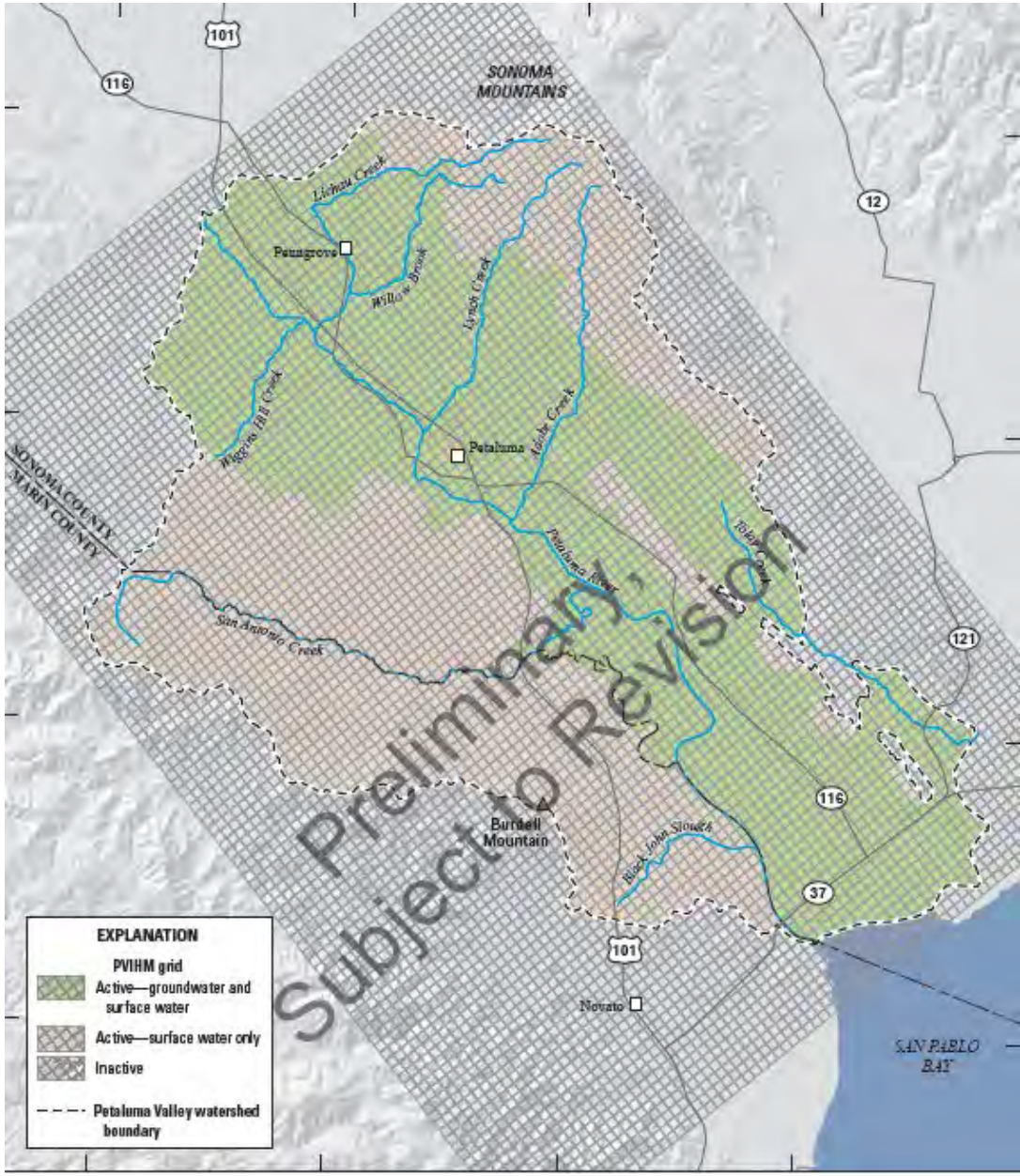
Sonoma Valley Subbasin	
Model Code/Developer	**USGS MODFLOW-OWHM/Sonoma Water**
Simulated Timeframe	**December 1969 to September 2018 (~49 yrs)**
Model Framework	**6 Layers with 500 by 500 foot grid cells**
Major Surface Water Features	**Sonoma Creek and tidal marshlands near San Pablo Bay**
Potentially Applicable Undesirable Results	**Groundwater level declines, storage declines, surface water/groundwater interaction (related to GDEs), saline water intrusion from San Pablo Bay**





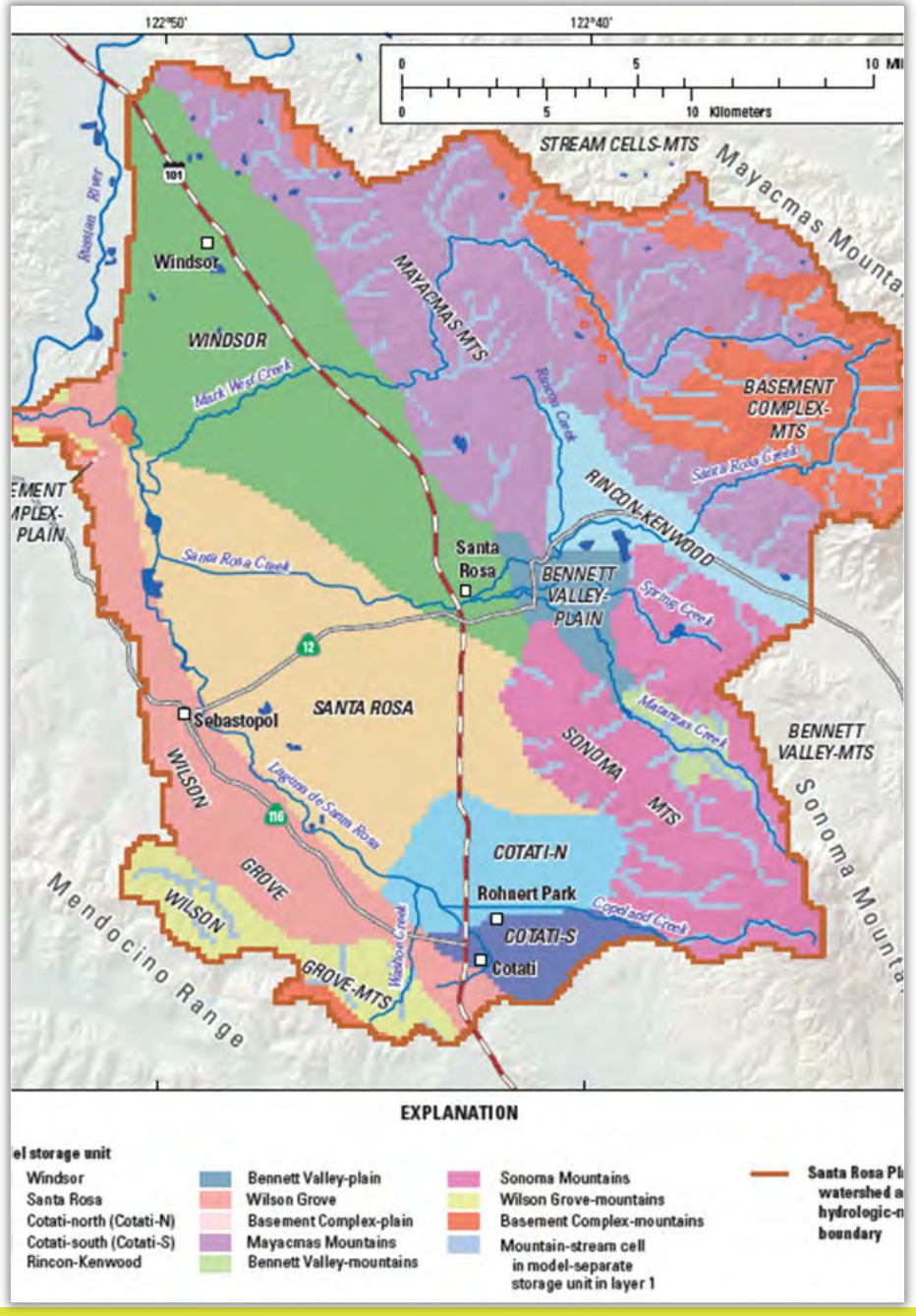
Petaluma Valley Integrated Model Overview

Petaluma Valley Basin	
Model Code/Developer	USGS MODFLOW-OWHM/USGS (In progress – anticipated late 2019)
Simulated Timeframe	October 1959 to September 2015 with monthly stress periods (planning to update to 2018 for GSP)
Model Framework	5 Layers with 984 by 984 foot grid cells
Major Surface Water Features	Petaluma River and tidal marshlands near San Pablo Bay
Potential Undesirable Results	Groundwater level declines, storage declines, surface water/groundwater interaction (related to GDEs), saltwater intrusion from San Pablo Bay

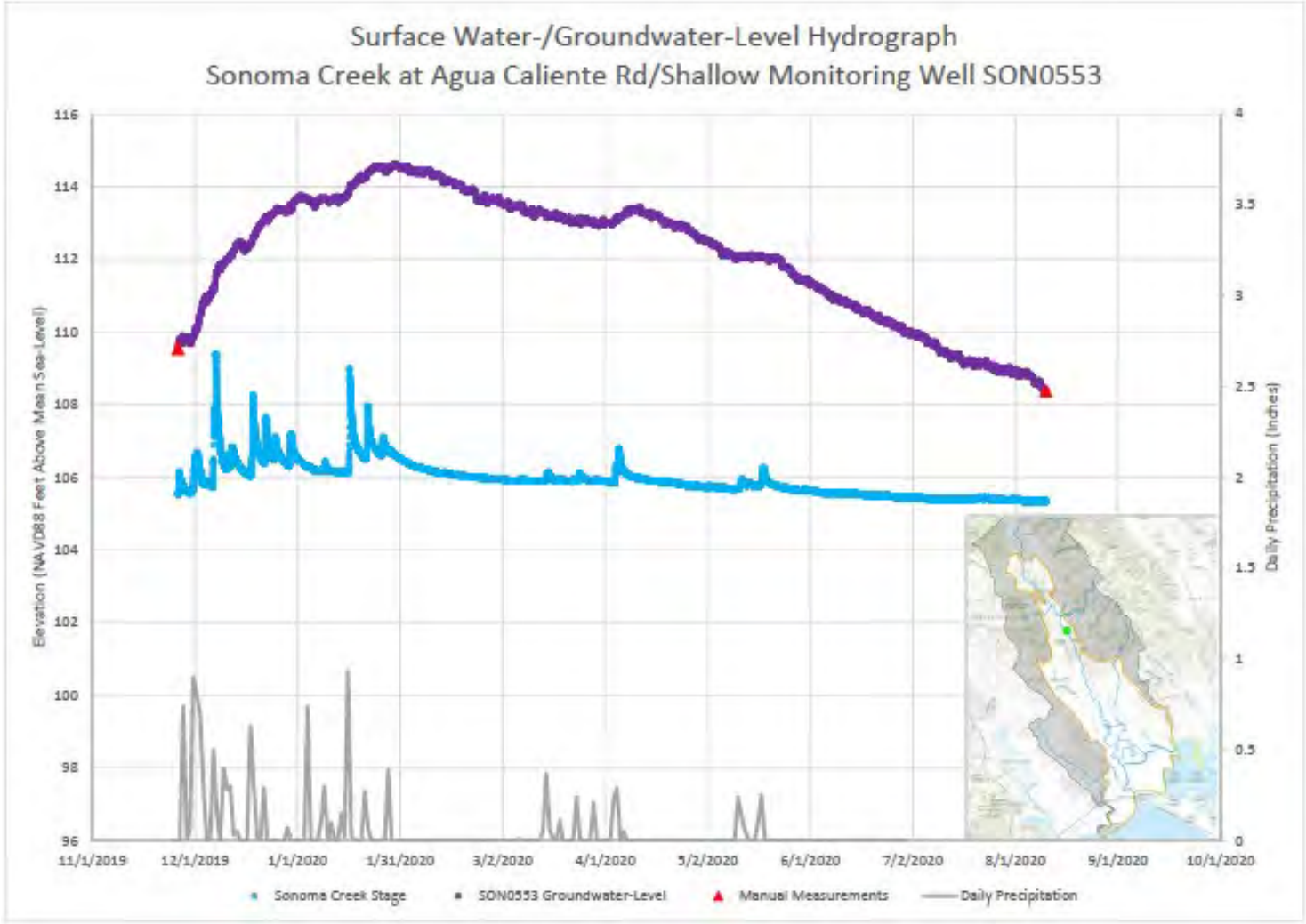


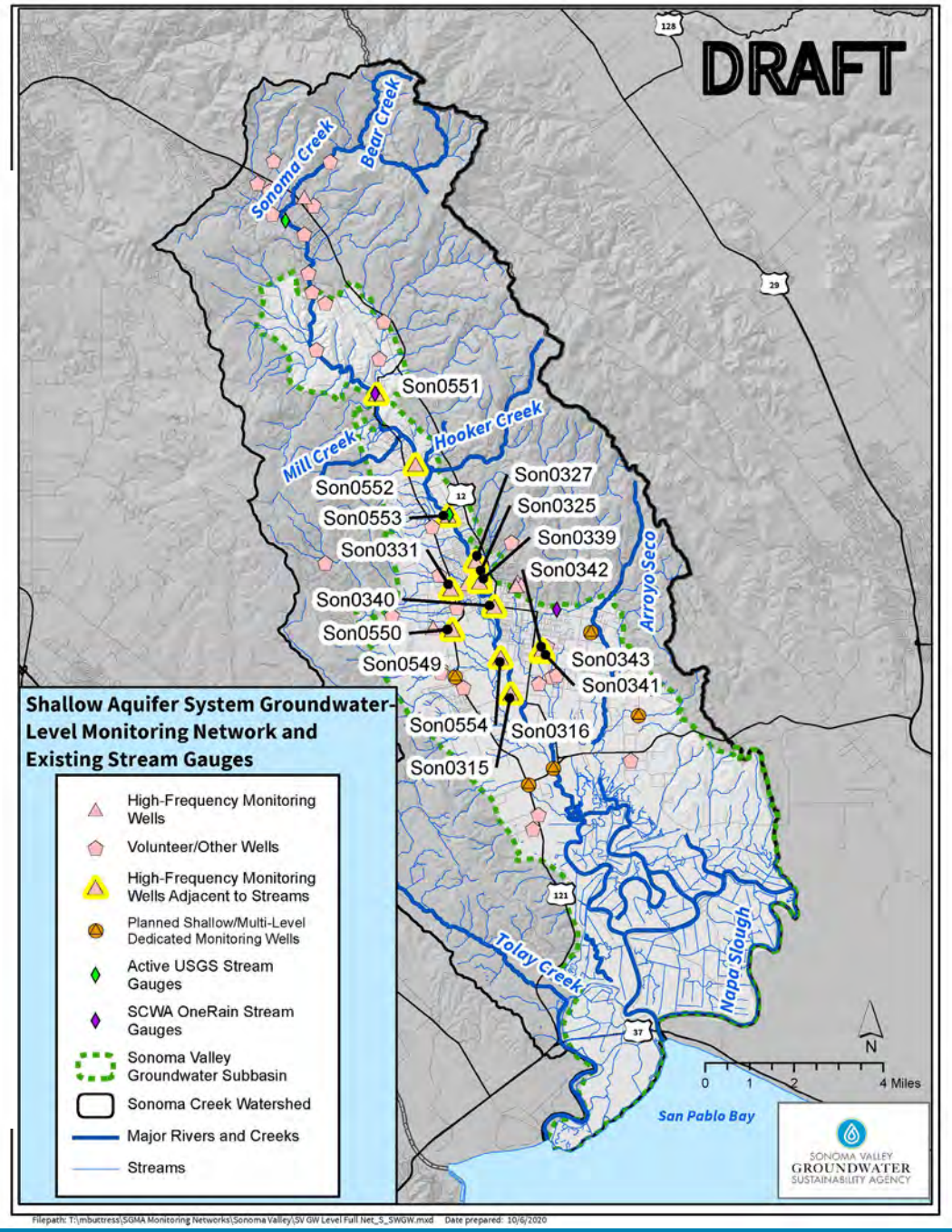
Santa Rosa Plain Integrated Model Overview

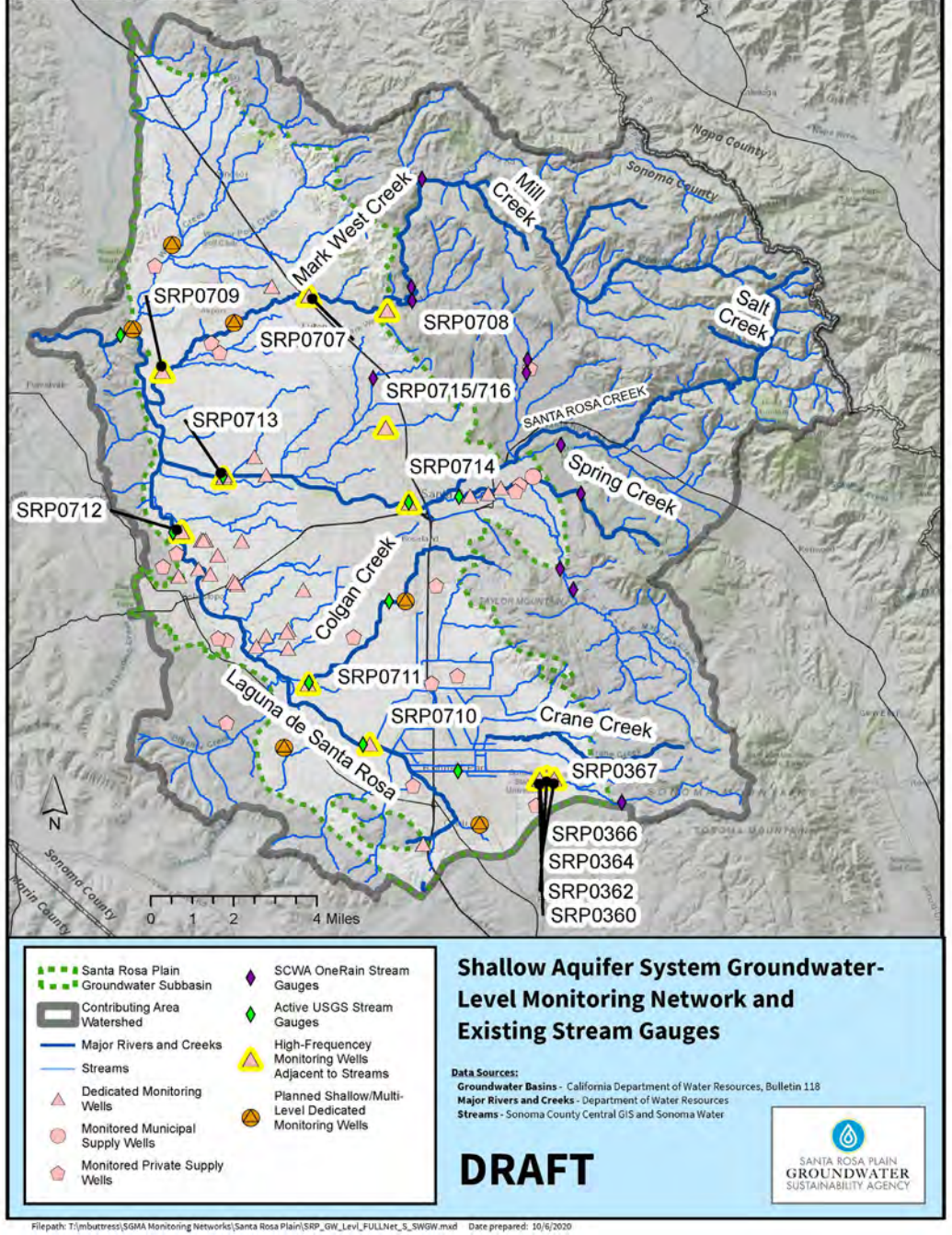
Santa Rosa Plain Subbasin	
Model Code/Developer	USGS GSFLOW/USGS
Simulated Timeframe	Calibration timeframe: water years 1975–2018 (43 years)
Model Framework	8 Layers with 660 by 660 foot grid cells
Major Surface Water Features	Santa Rosa Creek, Laguna de Santa Rosa, Mark West Creek (a tributary to the Russian River)
Potential Undesirable Results Model Could Assess	Groundwater level declines, storage declines, surface water/groundwater interaction (related to GDEs)



Additional Data Sources: Paired Shallow Monitoring Wells with Stream Gauges






Mark West Creek
Mill Creek
Salt Creek
SRP0709
SRP0707
SRP0708
SRP0715/716
SANTA ROSA CREEK
SRP0713
SRP0714
Spring Creek
SRP0712
Colgan Creek
SRP0711
Laguna de Santa Rosa
SRP0710
Crane Creek
SRP0367
SRP0366
SRP0364
SRP0362
SRP0360
Napa County
Sonoma County
Marin County
N
0 1 2 4 Miles
Santa Rosa Plain Groundwater Subbasin
Contributing Area Watershed
Major Rivers and Creeks
Streams
Dedicated Monitoring Wells
Monitored Municipal Supply Wells
Monitored Private Supply Wells
SCWA OneRain Stream Gauges
Active USGS Stream Gauges
High-Frequency Monitoring Wells Adjacent to Streams
Planned Shallow/Multi-Level Dedicated Monitoring Wells
Shallow Aquifer System Groundwater-Level Monitoring Network and Existing Stream Gauges
Data Sources:
Groundwater Basins - California Department of Water Resources, Bulletin 118
Major Rivers and Creeks - Department of Water Resources
Streams - Sonoma County Central GIS and Sonoma Water
DRAFT
SANTA ROSA PLAIN GROUNDWATER SUSTAINABILITY AGENCY
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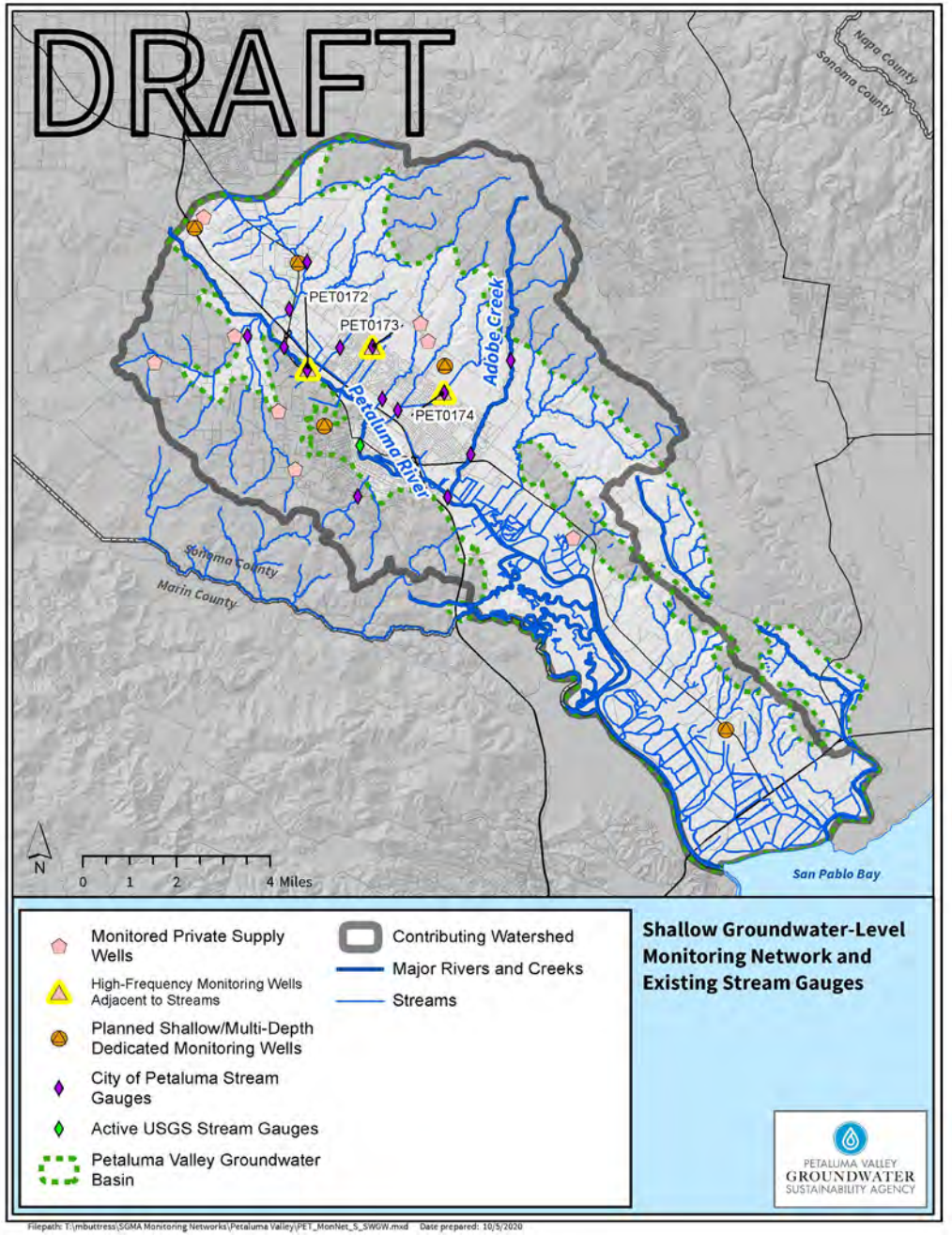

DRAFT
Napa County
Sonoma County
PET0172
PET0173
PET0174
Adobe Creek
Petaluma River
Sonoma County
Marin County
San Pablo Bay
N
0 1 2 4 Miles
Monitored Private Supply Wells
High-Frequency Monitoring Wells Adjacent to Streams
Planned Shallow/Multi-Depth Dedicated Monitoring Wells
City of Petaluma Stream Gauges
Active USGS Stream Gauges
Petaluma Valley Groundwater Basin
Contributing Watershed
Major Rivers and Creeks
Streams
Shallow Groundwater-Level Monitoring Network and Existing Stream Gauges
PETALUMA VALLEY GROUNDWATER SUSTAINABILITY AGENCY
Filepath: T:\mbuttress\SGMA Monitoring Networks\Petaluma Valley\PET_MonNet_S_SWGW.mxd Date prepared: 10/5/2020

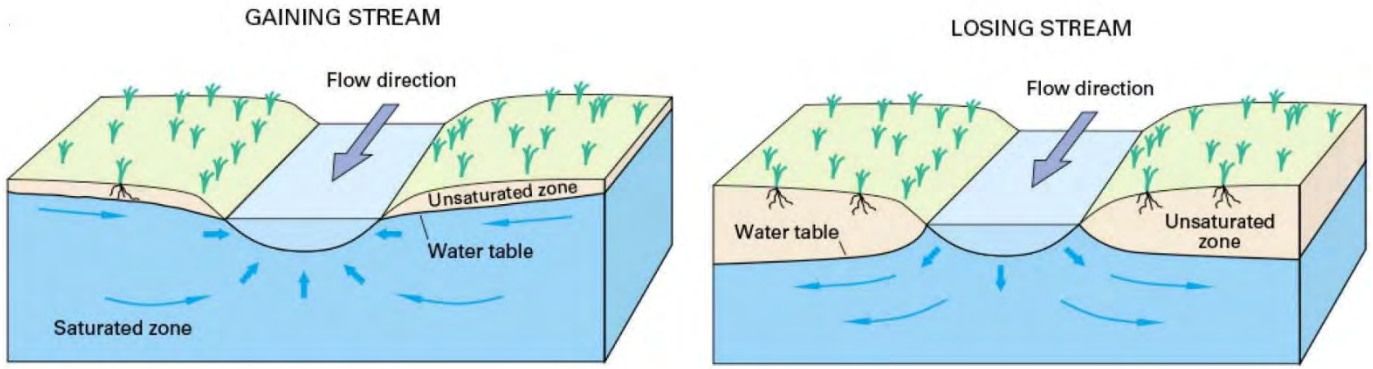
Interconnected Surface Water Mapping– Andy Rich

What is Interconnected Surface Water?

- “Interconnected surface water refers to surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.” (23 CCR § 351)

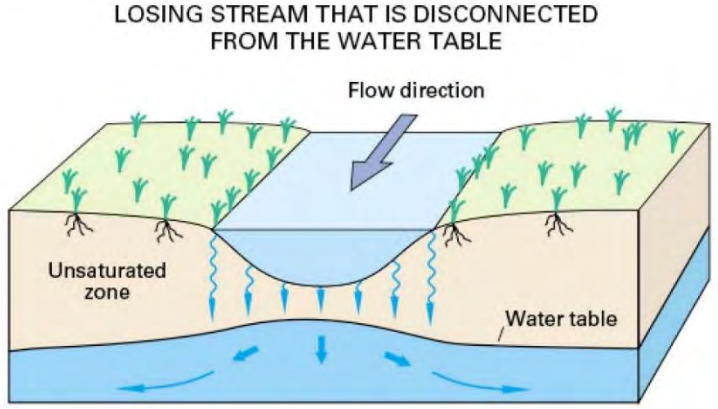
What is Interconnected Surface Water?

Many surface water bodies are ***interconnected with groundwater*** and exchange water between each reservoir.



Some surface water systems can be completely ***disconnected from groundwater***.

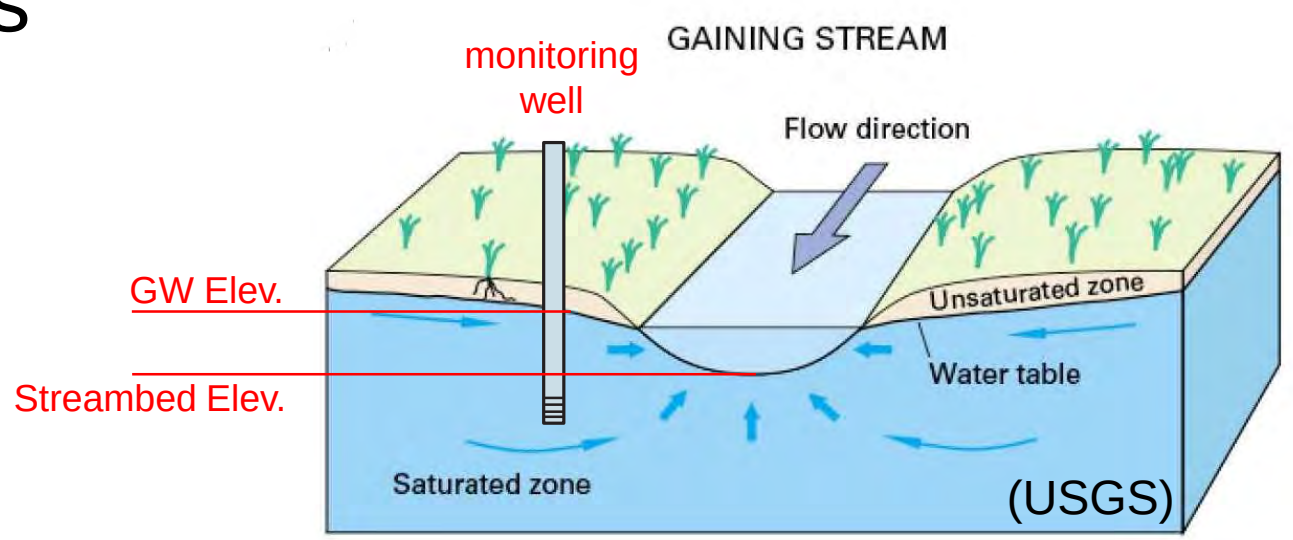
A surface water body may be connected to groundwater during some periods and disconnected during other periods.

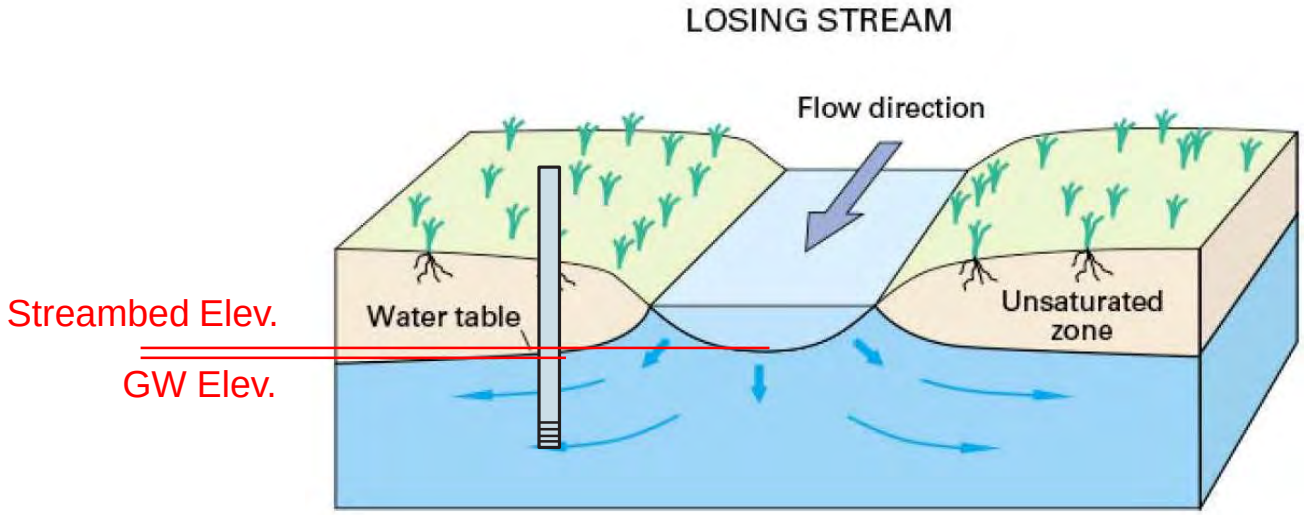


(USGS)

Shallow GW monitoring wells can help characterize ***local*** gaining/losing conditions

Interconnected surface water is either ***gaining*** or ***losing*** water from groundwater, depending on the gradient, as measured by shallow monitoring wells.





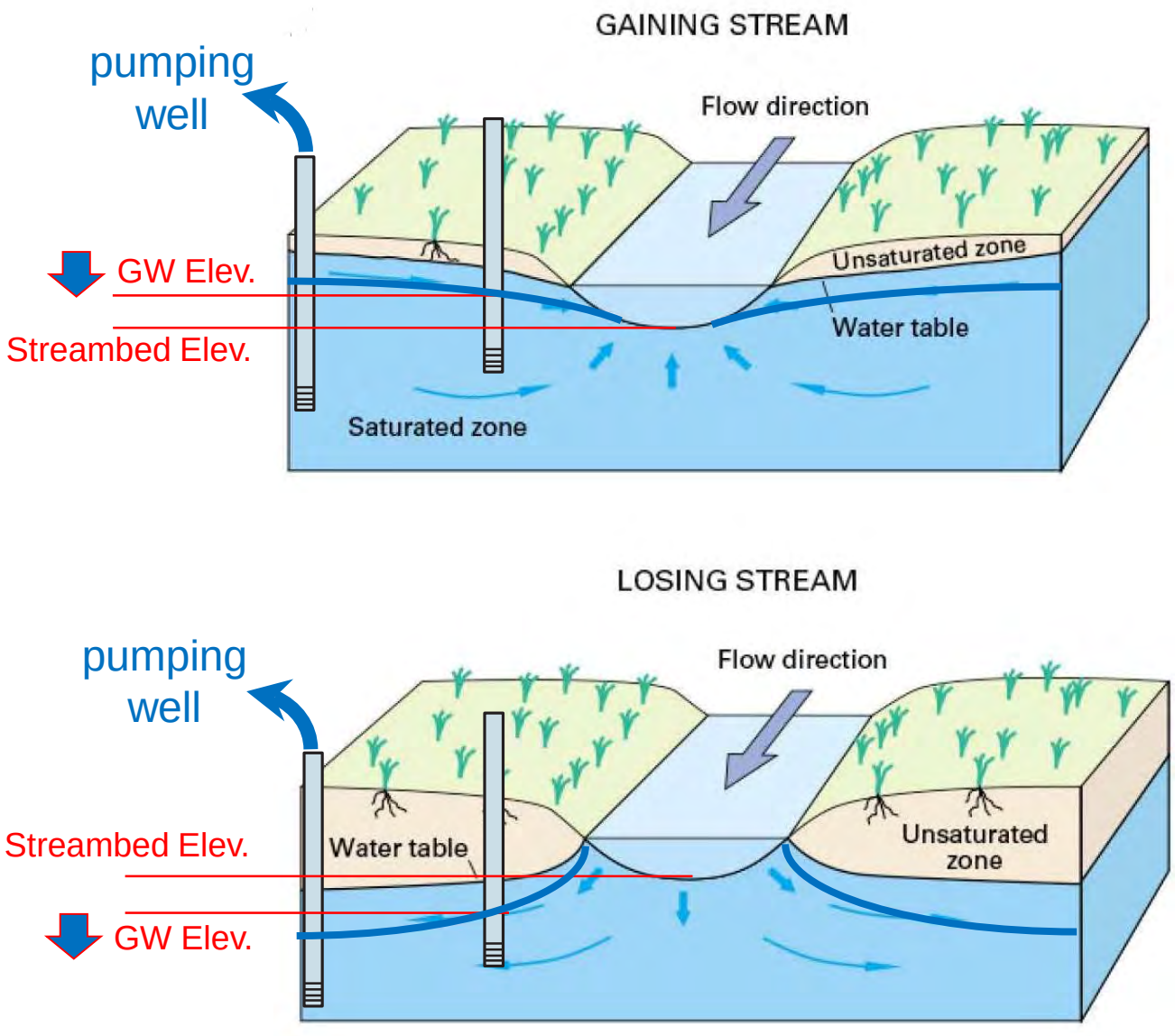
How can pumping at a well impact streamflow?

Pumping can ***decrease groundwater gains*** to surface water, or ***increase surface water losses*** to groundwater …

… phenomenon known as "Surface Water Depletion"

Depletion is a function of multiple factors:

- proximity to the river
- pumping rate
- climatology
- local geology
- geomorphology



Interconnected Surface Water – Requirements and Approach

Defined in the GSP Regulations as ***surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted*** (DWR, 2016).

Define with available data/existing tools using multiple lines of evidence (tools and datasets vary for each basin)

Sonoma Valley Approach

(1) results of seepage run monitoring;

(2) frequency of observed or measured streamflow;

(3) comparison of interpolated groundwater levels within the shallow aquifer system and streambed elevations; and

(4) high frequency groundwater level observations from shallow monitoring wells located near streams.

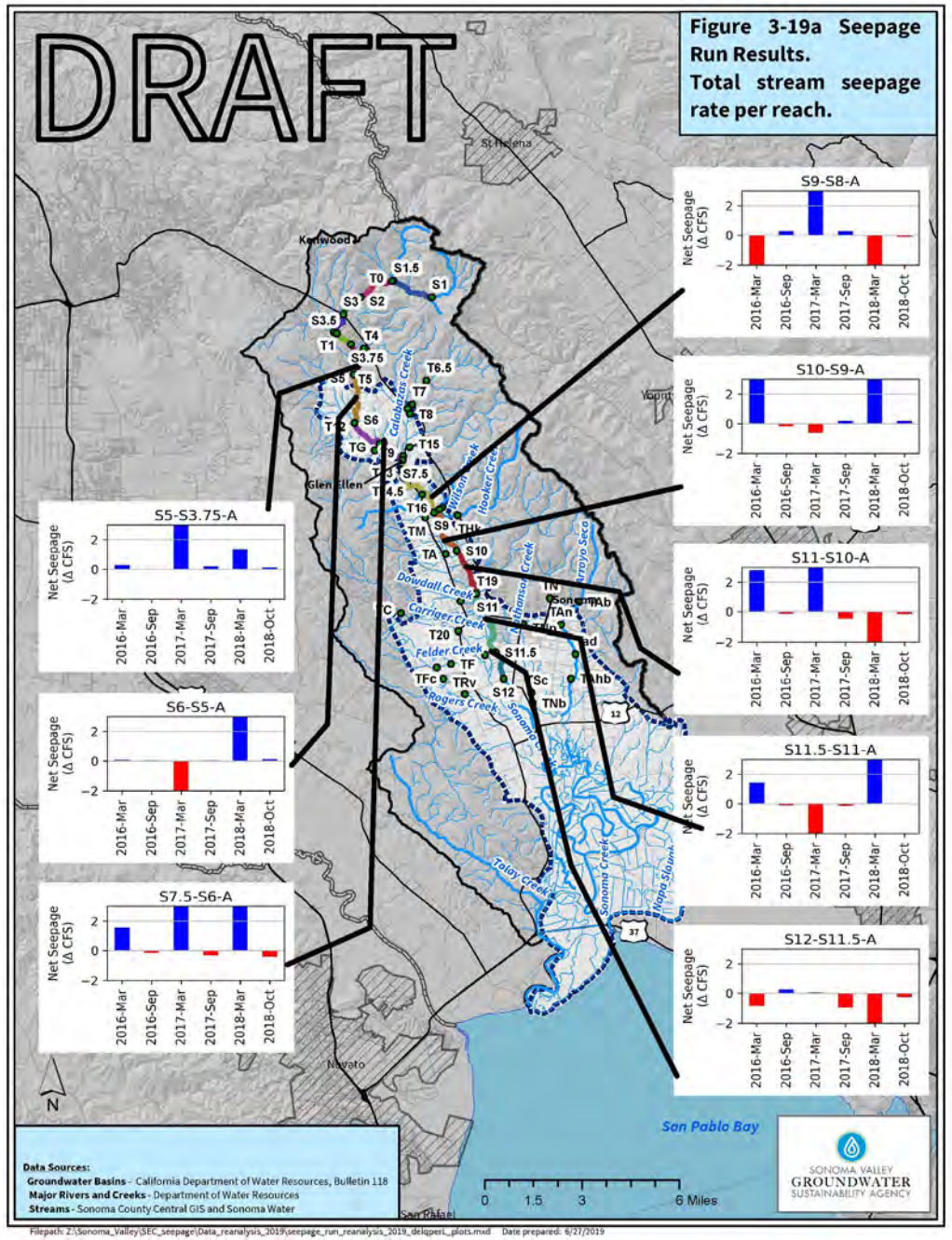
Did not use modeled interactions

Santa Rosa Plain Approach

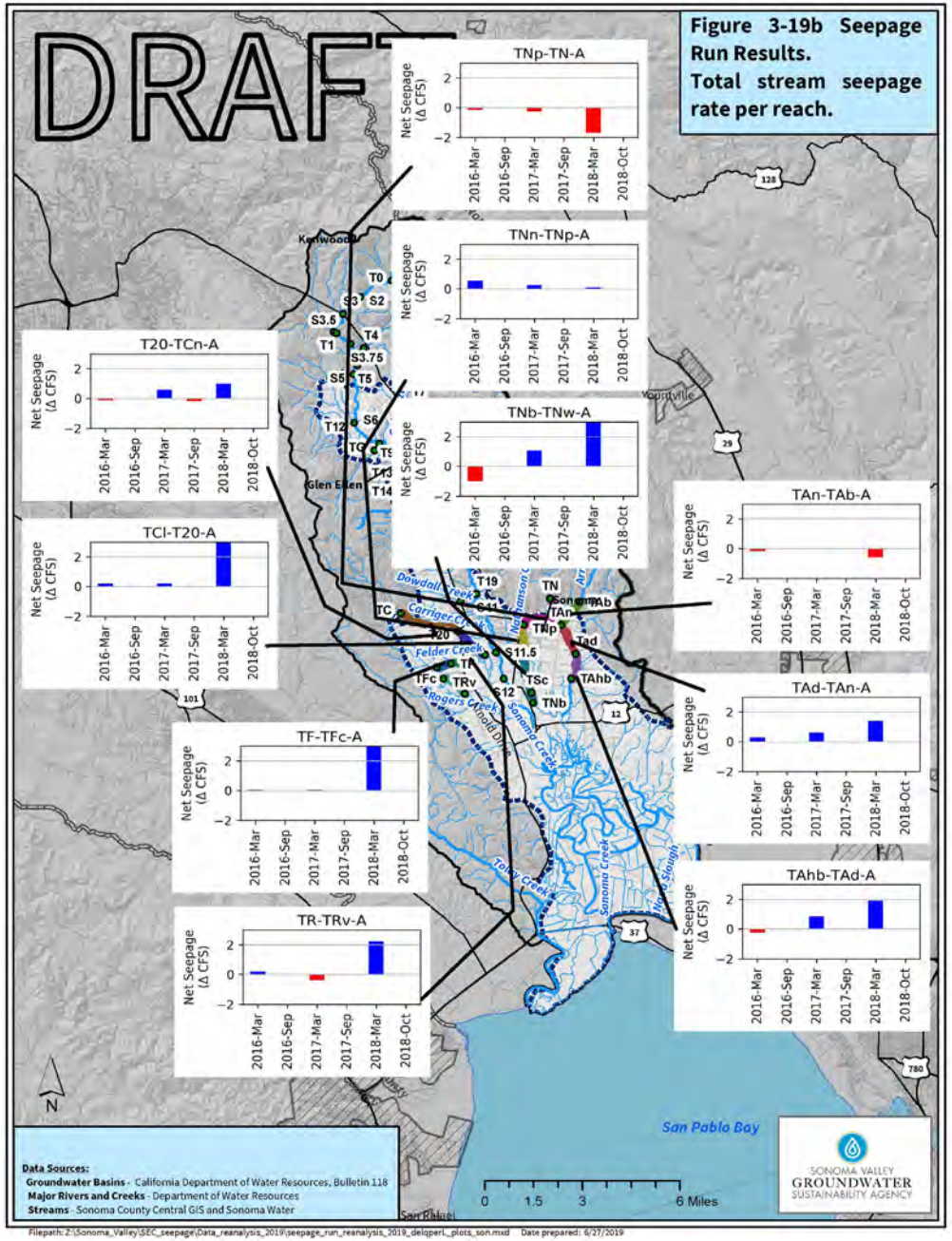
1) measured groundwater level and streambed elevation differences
2) modeled output derived from Wolfenden et al (2014)
    - Percent of time stream is gaining
    - Median streamflow
    - Surface leakage

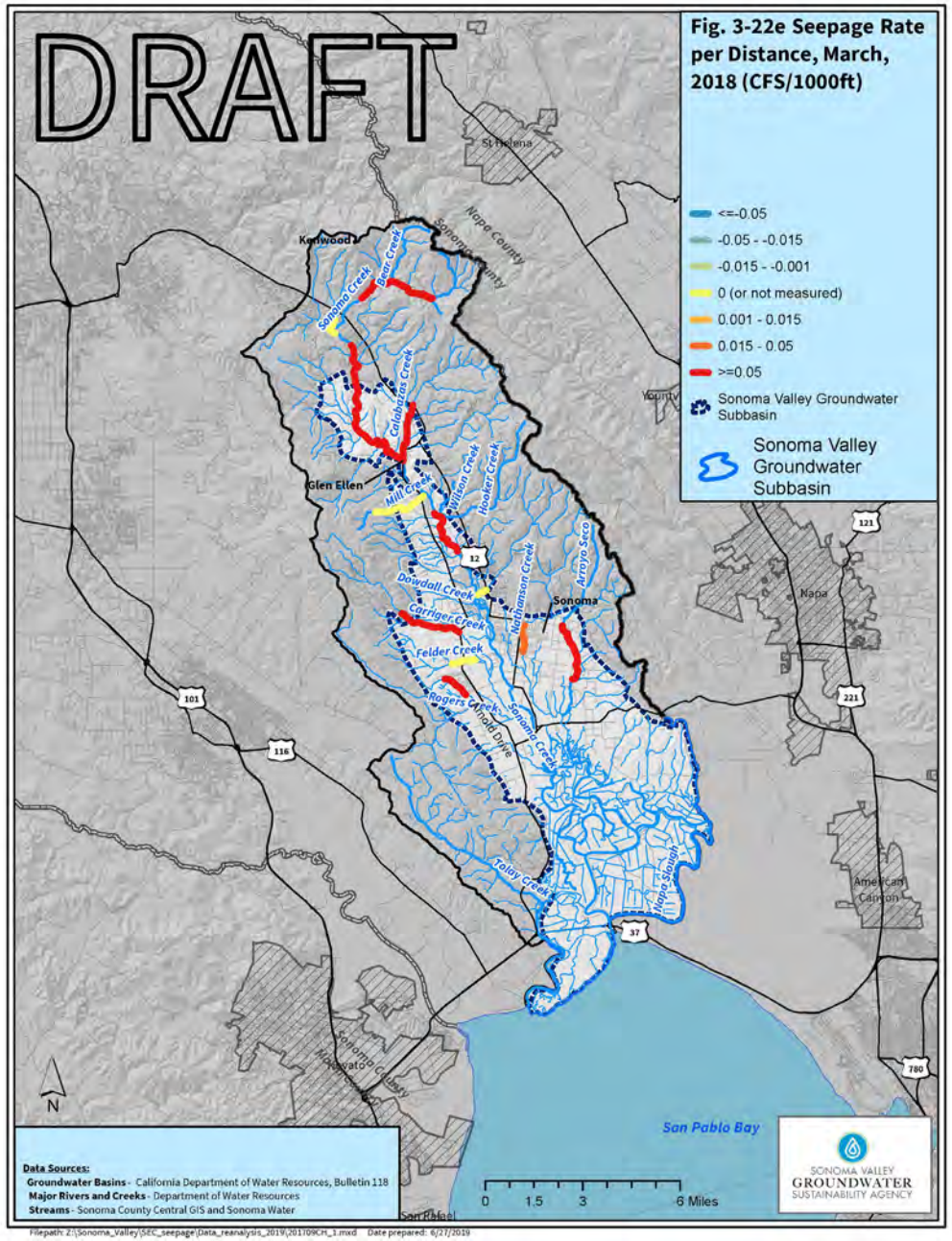
Additional information used in the assessment:

- streamflow seepage exchange through differential gaging
- baseflow separation of observed streamflow records

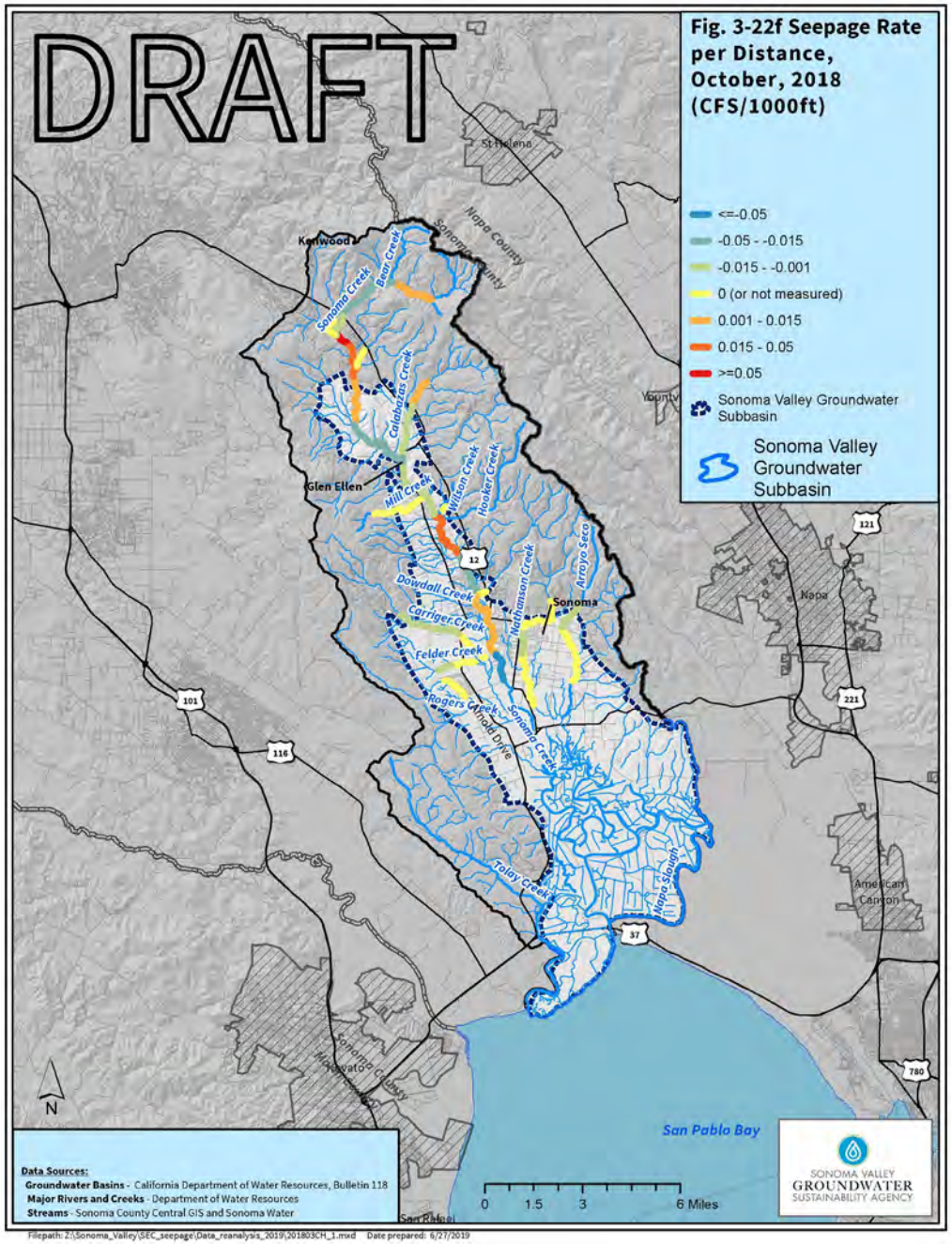


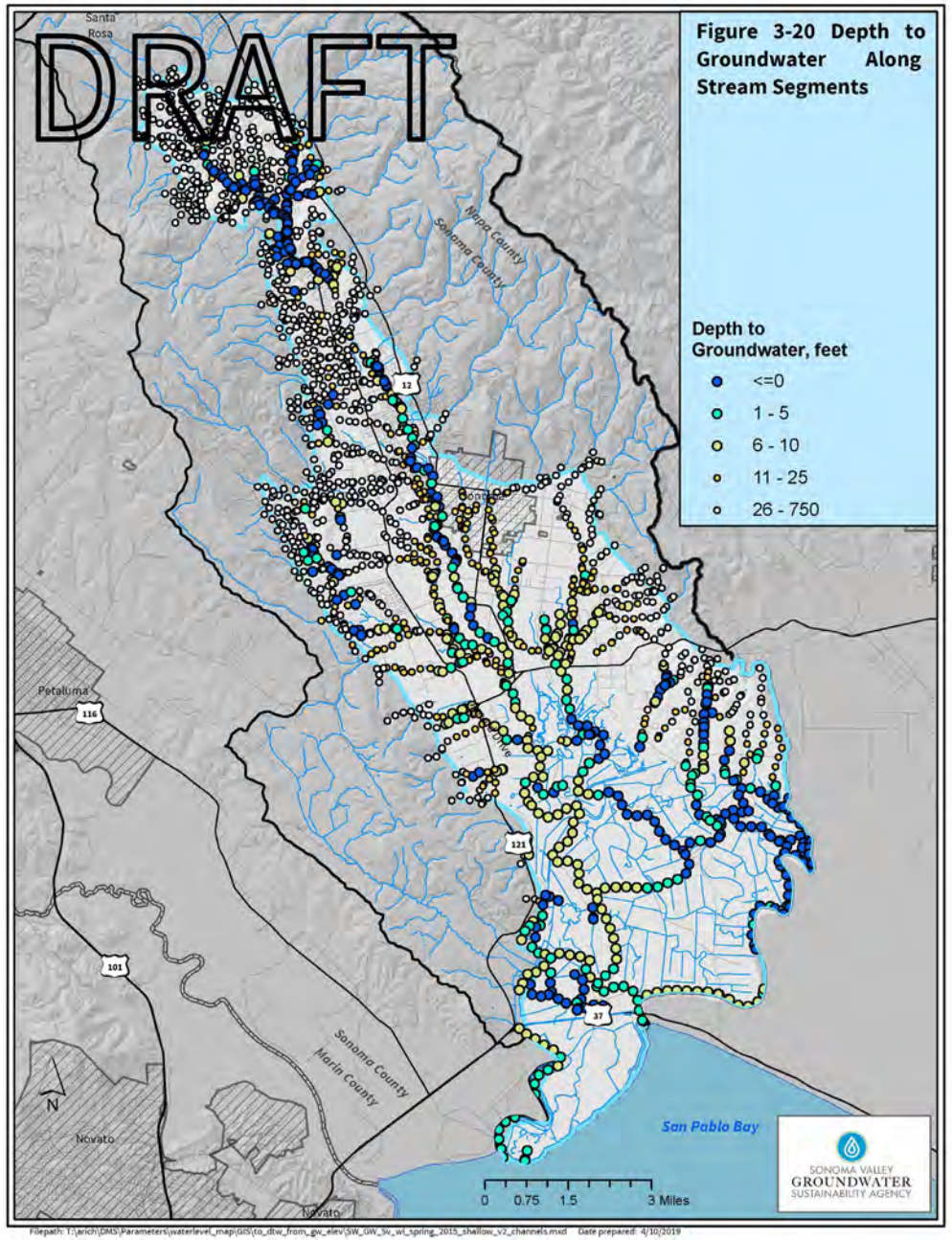
Sonoma Valley Seepage Runs: Total Seepage Rate per Reach



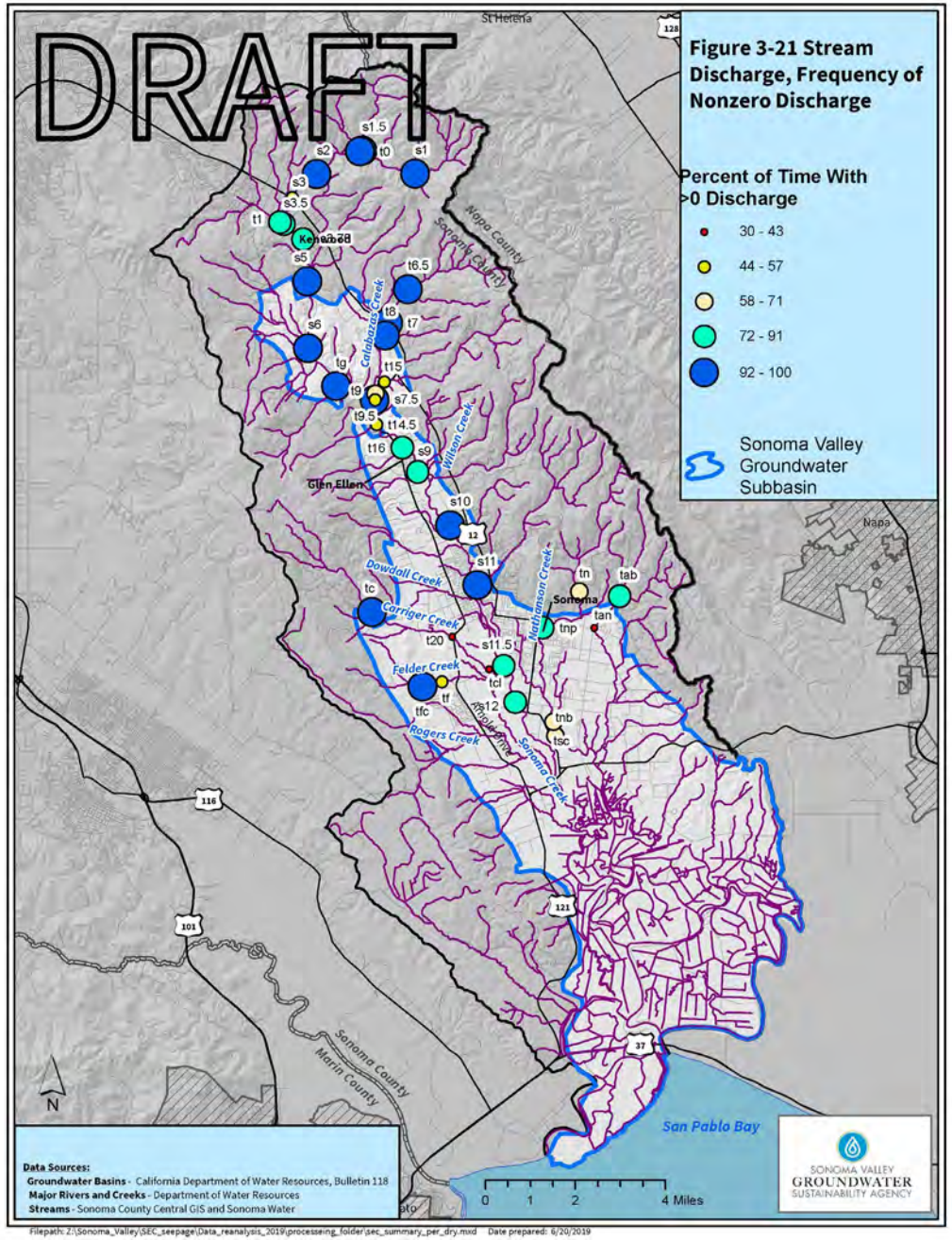


Sonoma Valley Seepage Runs: Total Seepage Rate Distance





Sonoma Valley Depth to Groundwater along Stream Segments & Frequency of Nonzero Discharge



Sonoma Valley Interconnected Surface Water Map

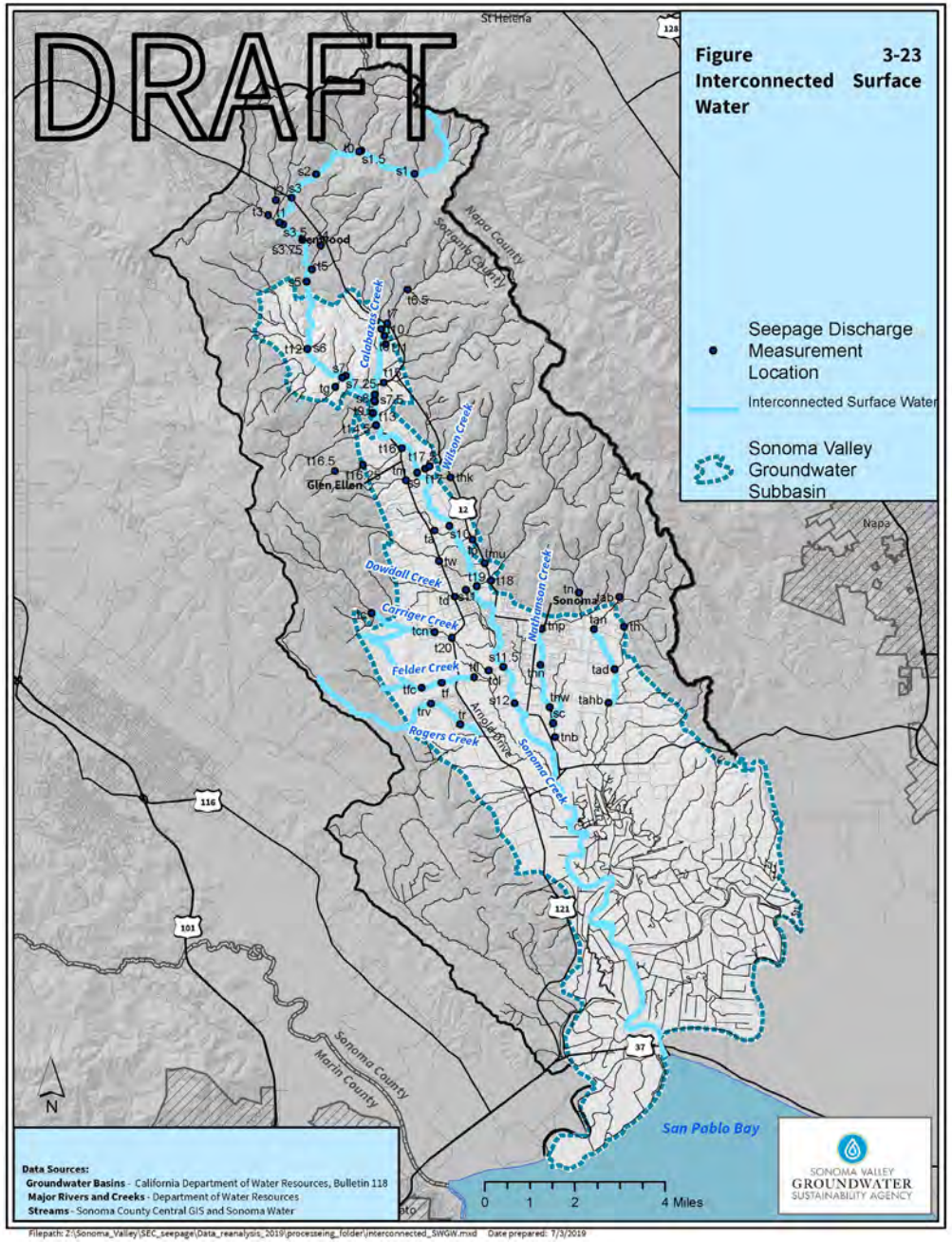


Figure 3-18b Percent of time Stream is Gaining, from 2000 to 2010

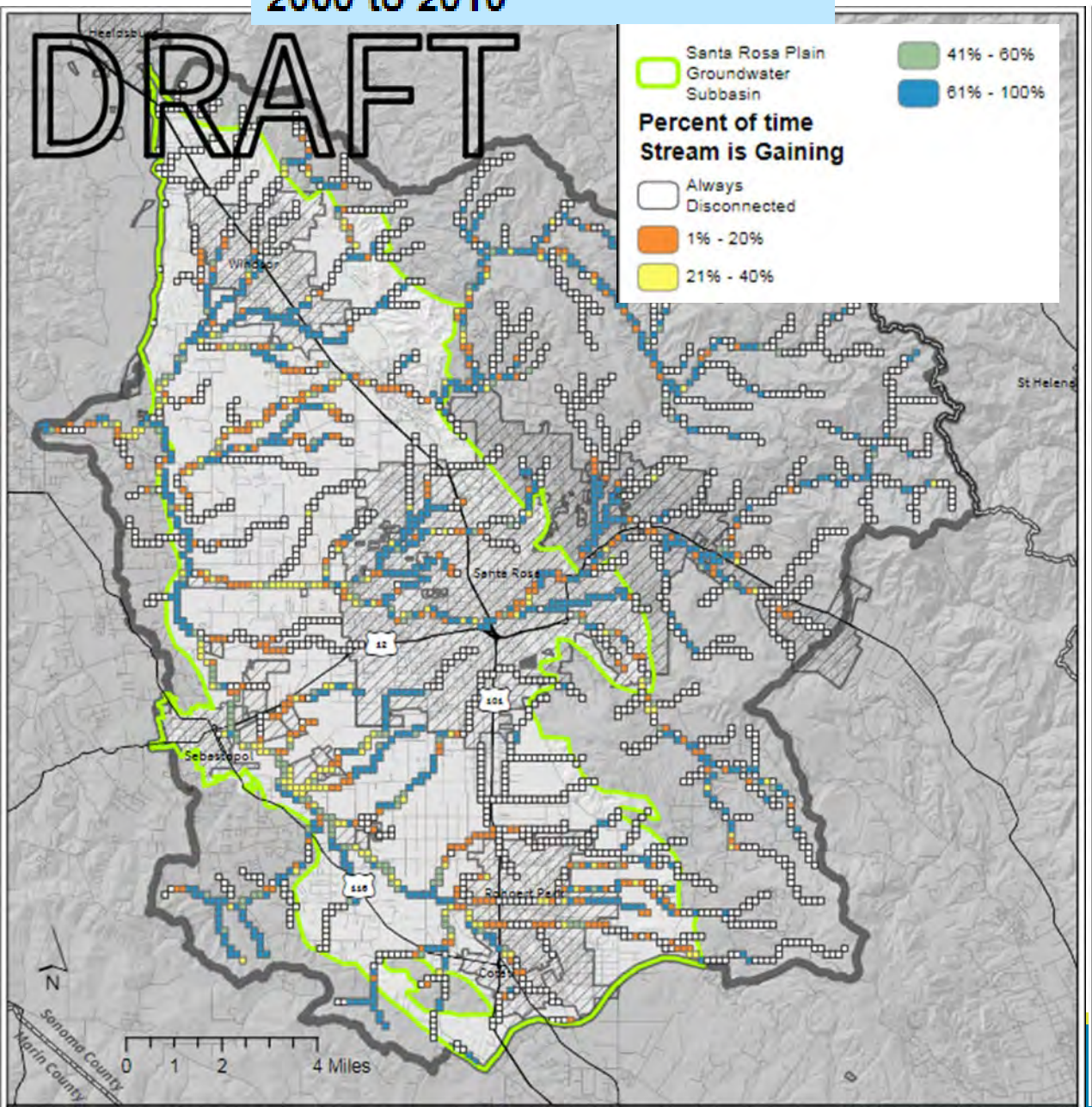


Figure 3-18a Depth to Water Along Stream Channels, Spring 2015

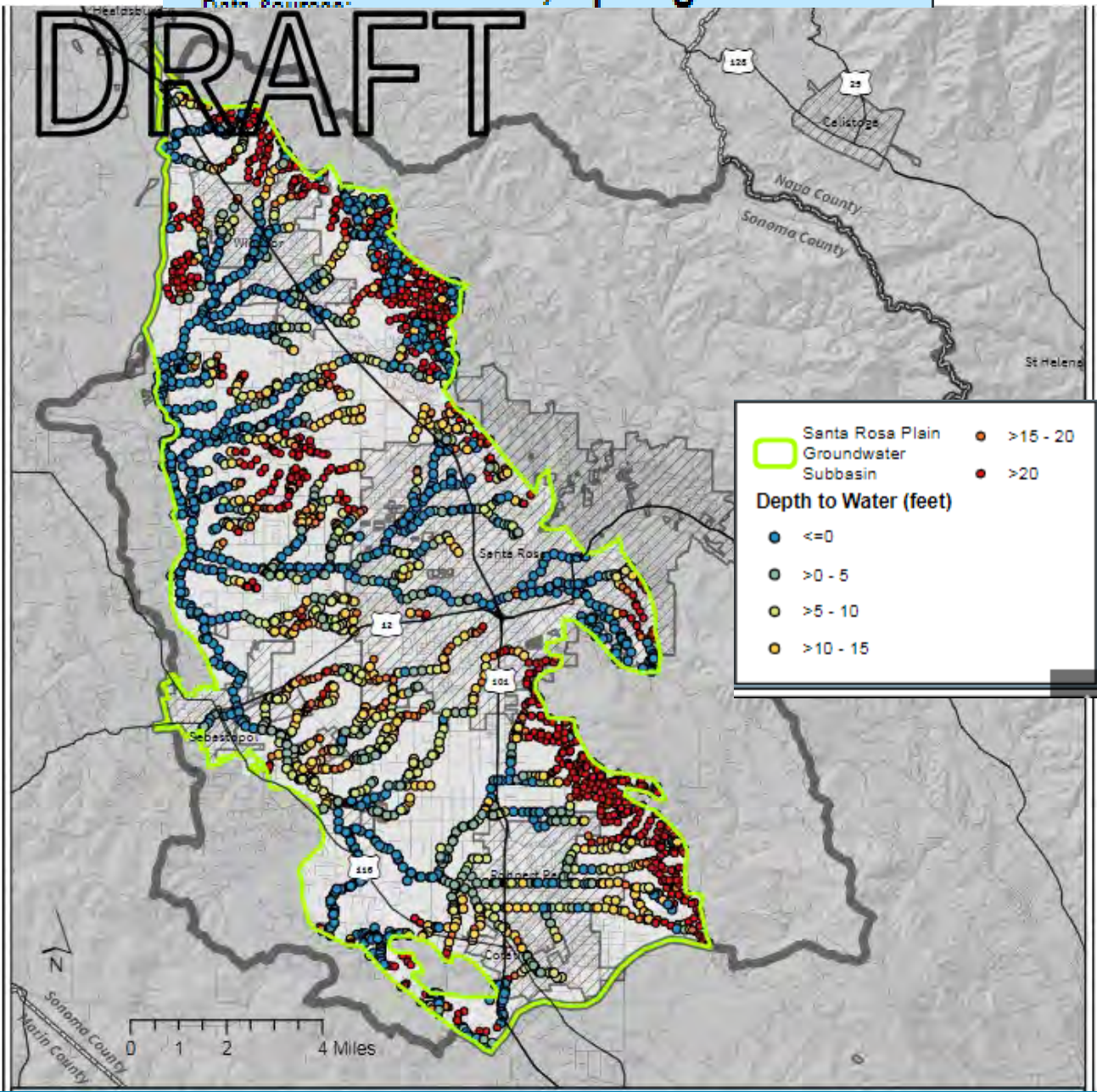


Figure 3-18d Surface Leakage, 2006

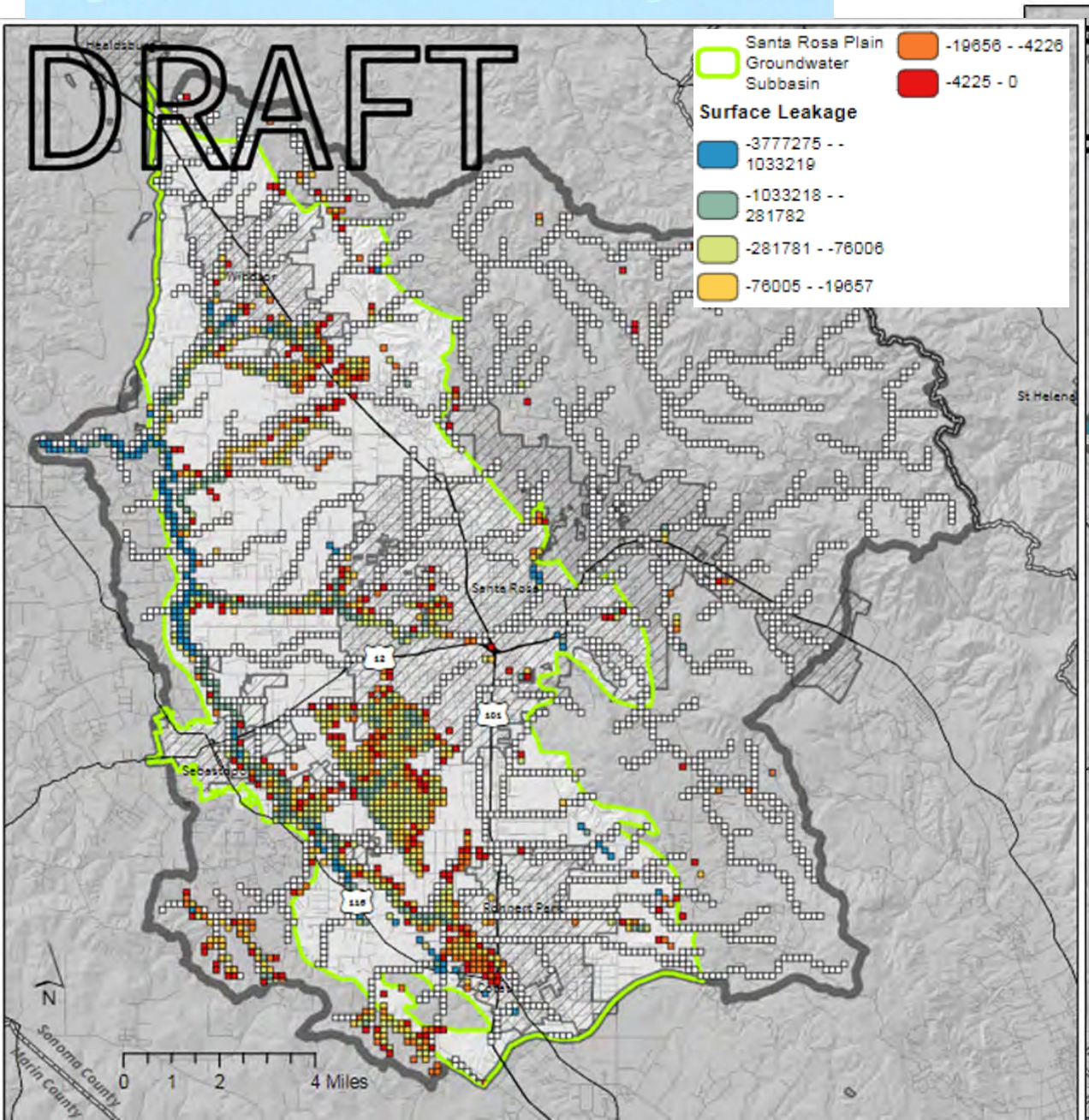
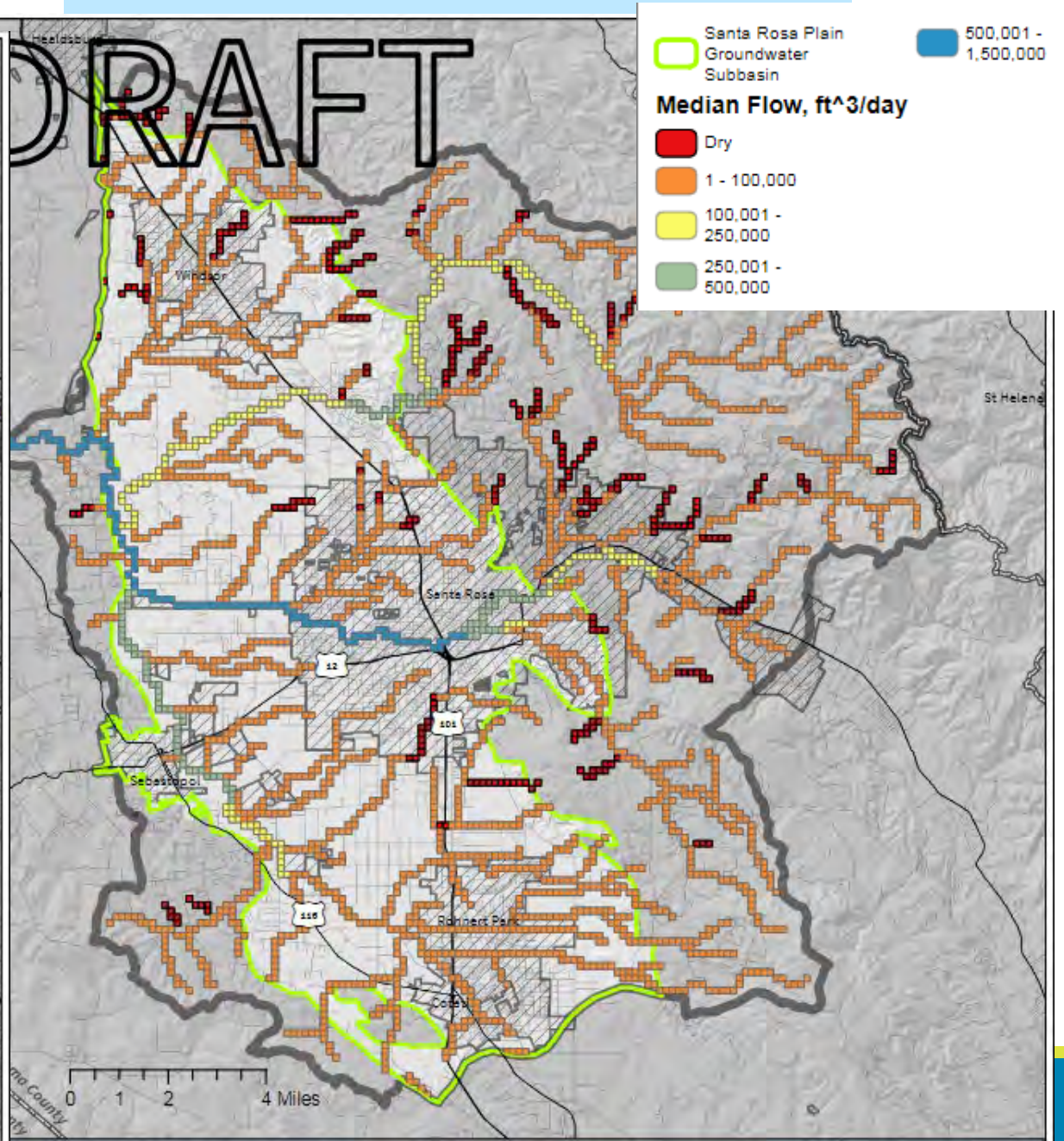


Figure 3-18c Median Flow, from 2000 to 2010



Santa Rosa Plain Interconnected Surface Water Mapping:

- Initial selection of Interconnected Surface Water based on Stream Reaches with 7 or more points (orange –colored cells

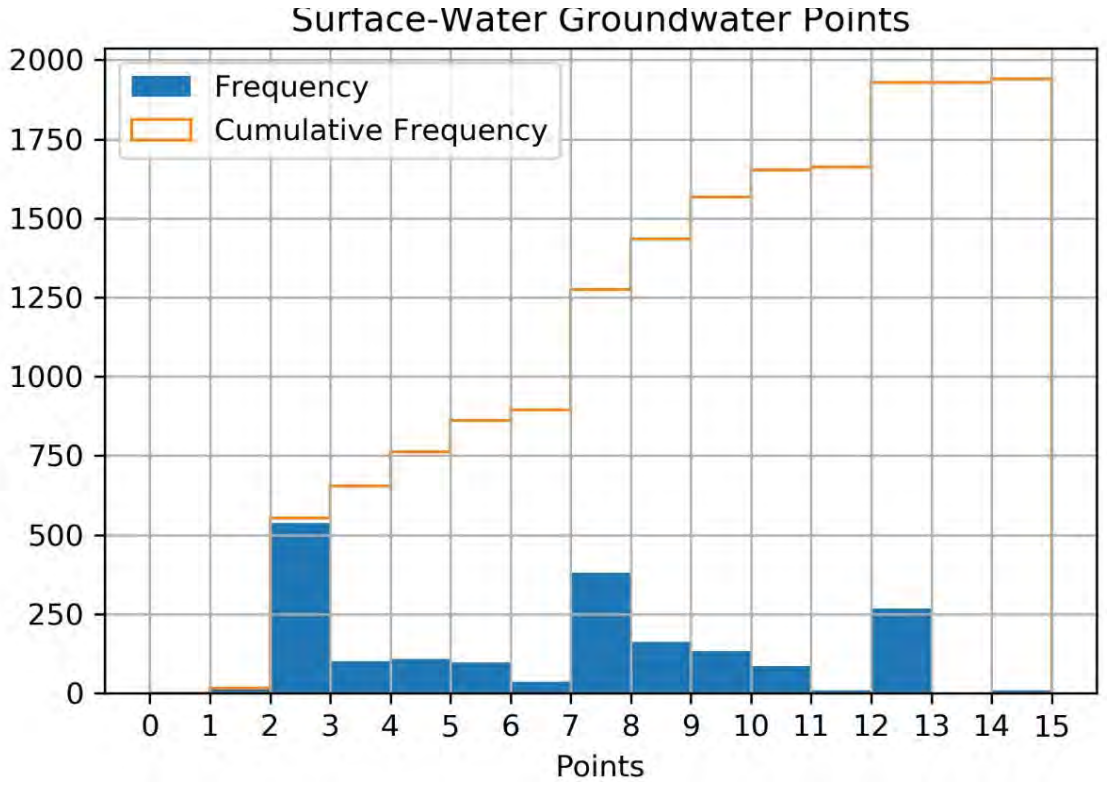
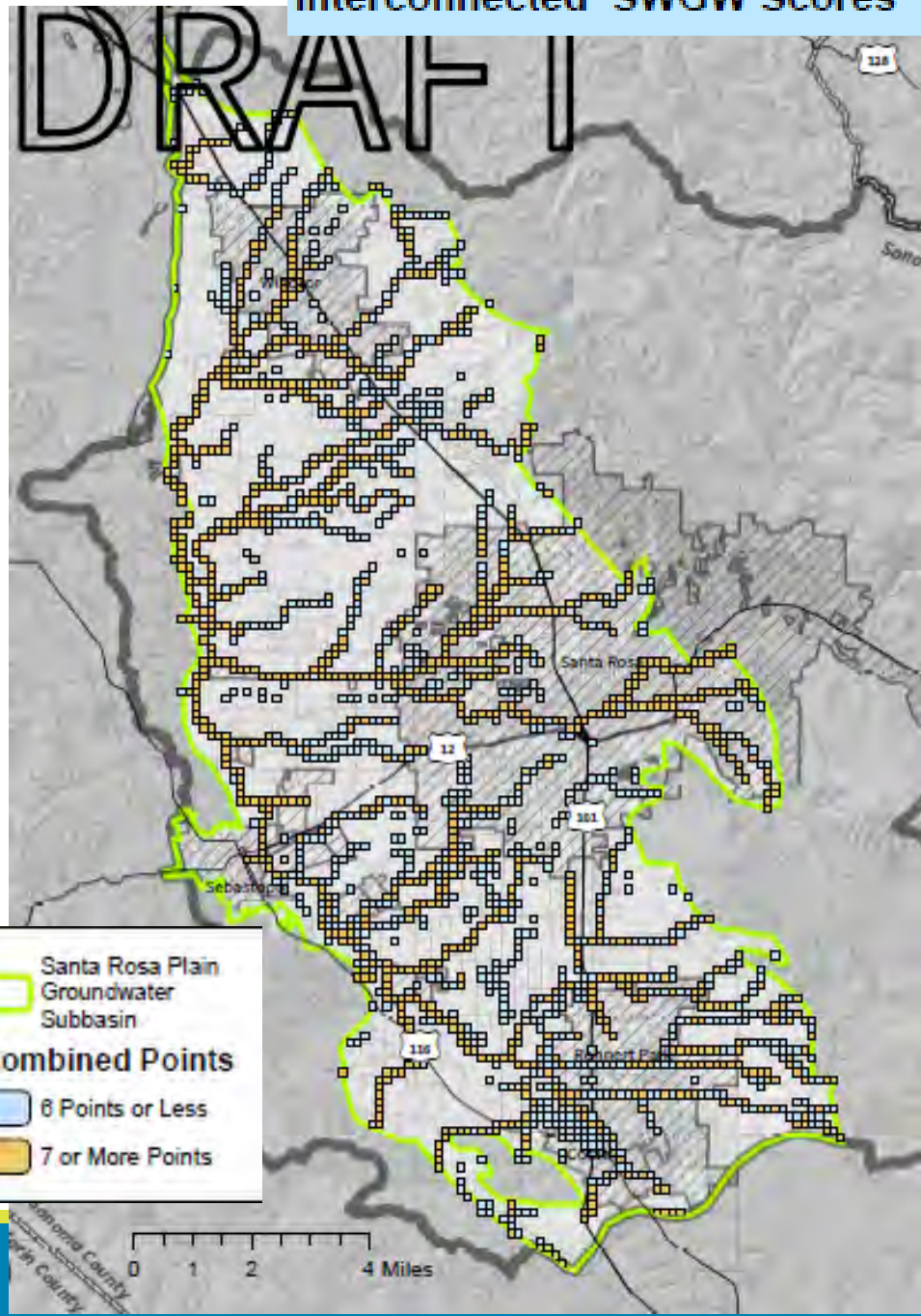


Figure 3-18f Combined Interconnected SWGW Scores

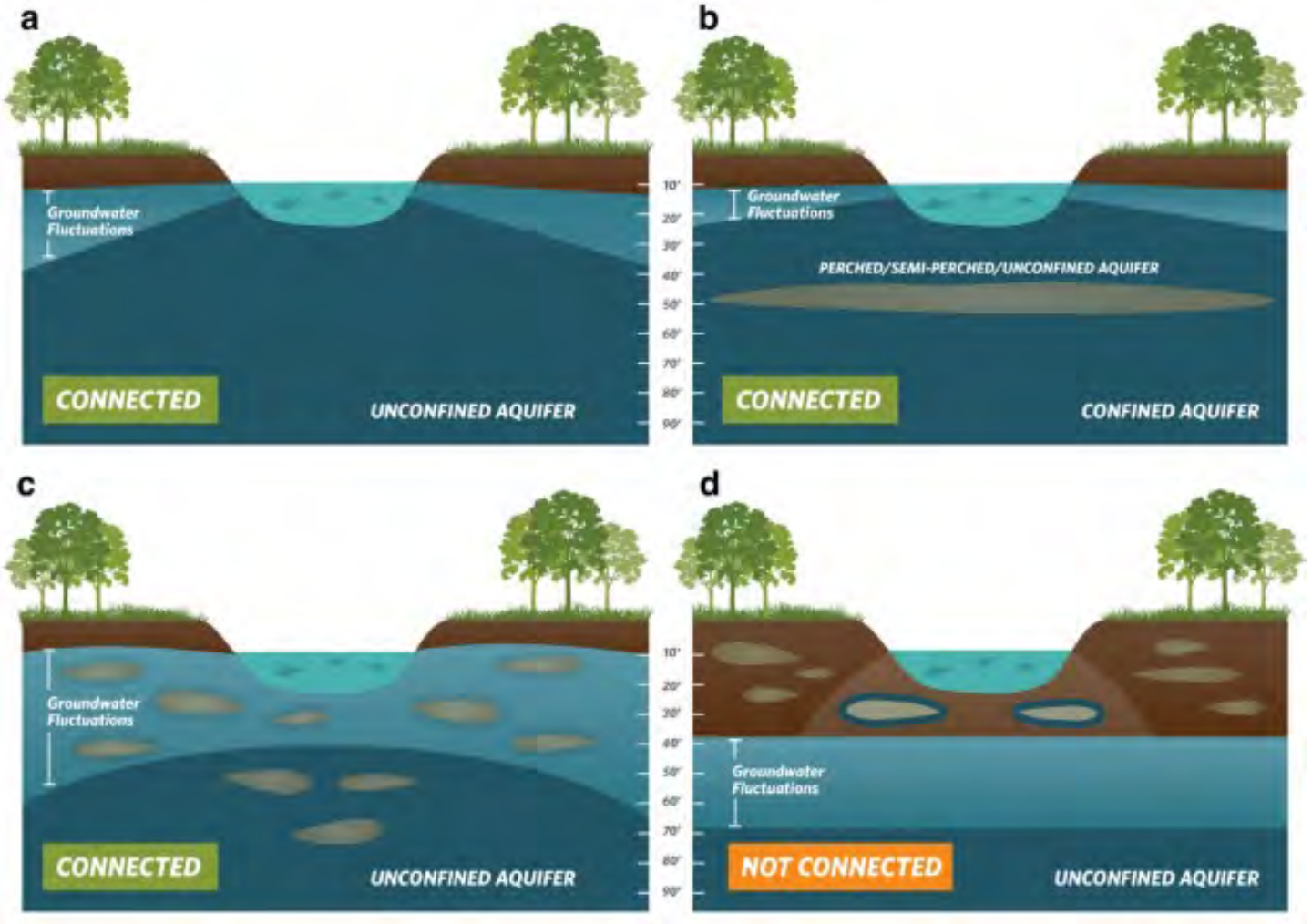


Questions/Discussion

Update on GDE Mapping – Marcus Trotta

Proposed Approach for GDE Mapping

- Focus on ecosystems that can be affected by groundwater conditions and management and are within jurisdiction of GSAs
- Utilize available statewide and local datasets to develop best available information
- Consider using “indicator” species and/or grouping of GDEs with similar characteristics/habitat needs
- Prioritize GDEs for consideration in developing SMCs for Surface Water Depletion (separate workgroup)



https://groundwaterresourcehub.org/

Source: The Nature Conservancy, Identifying GDEs Under SGMA Best Practices for using the NC Dataset, 2019

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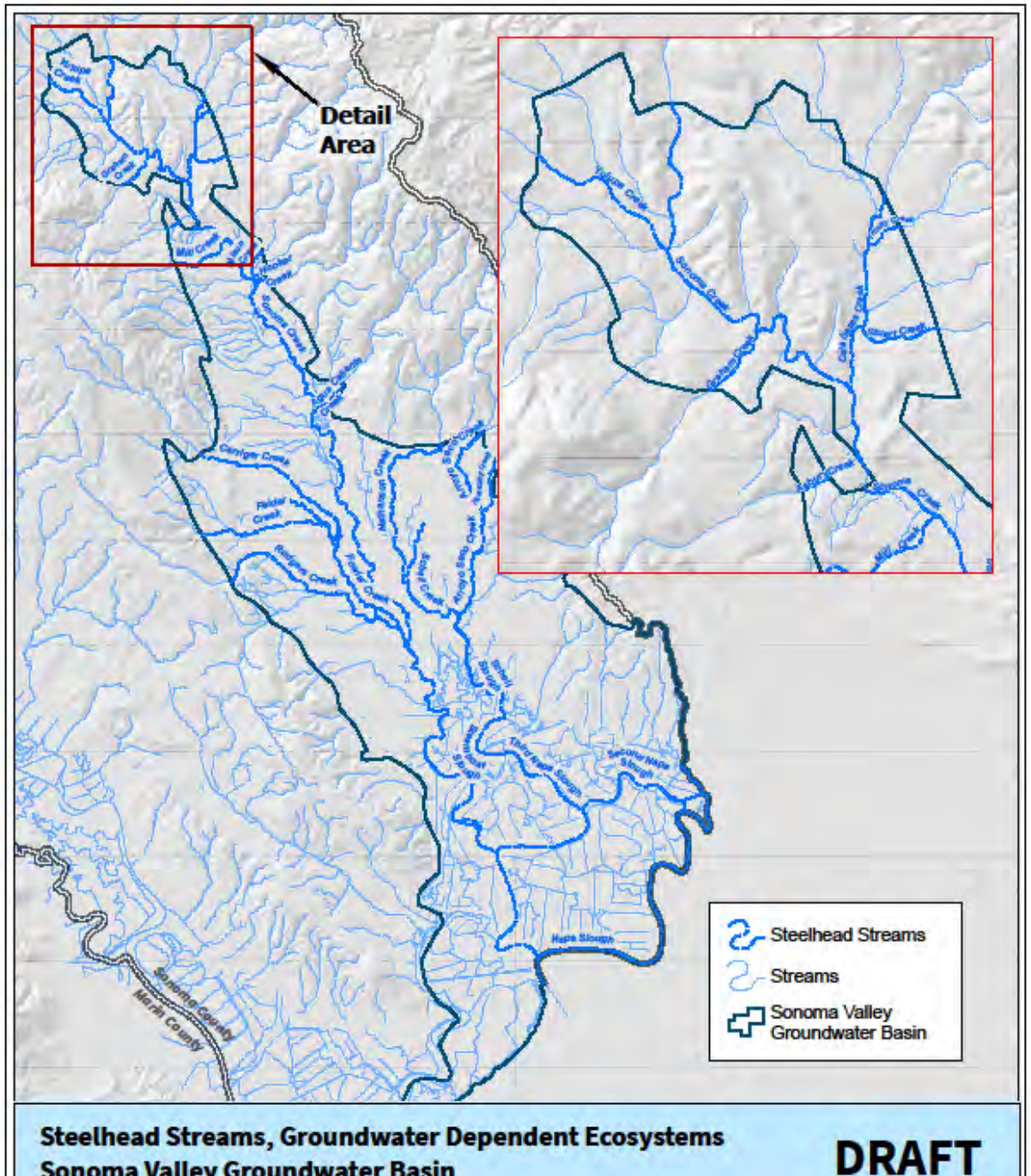
Preliminary Aquatic Groundwater Dependent Species Update

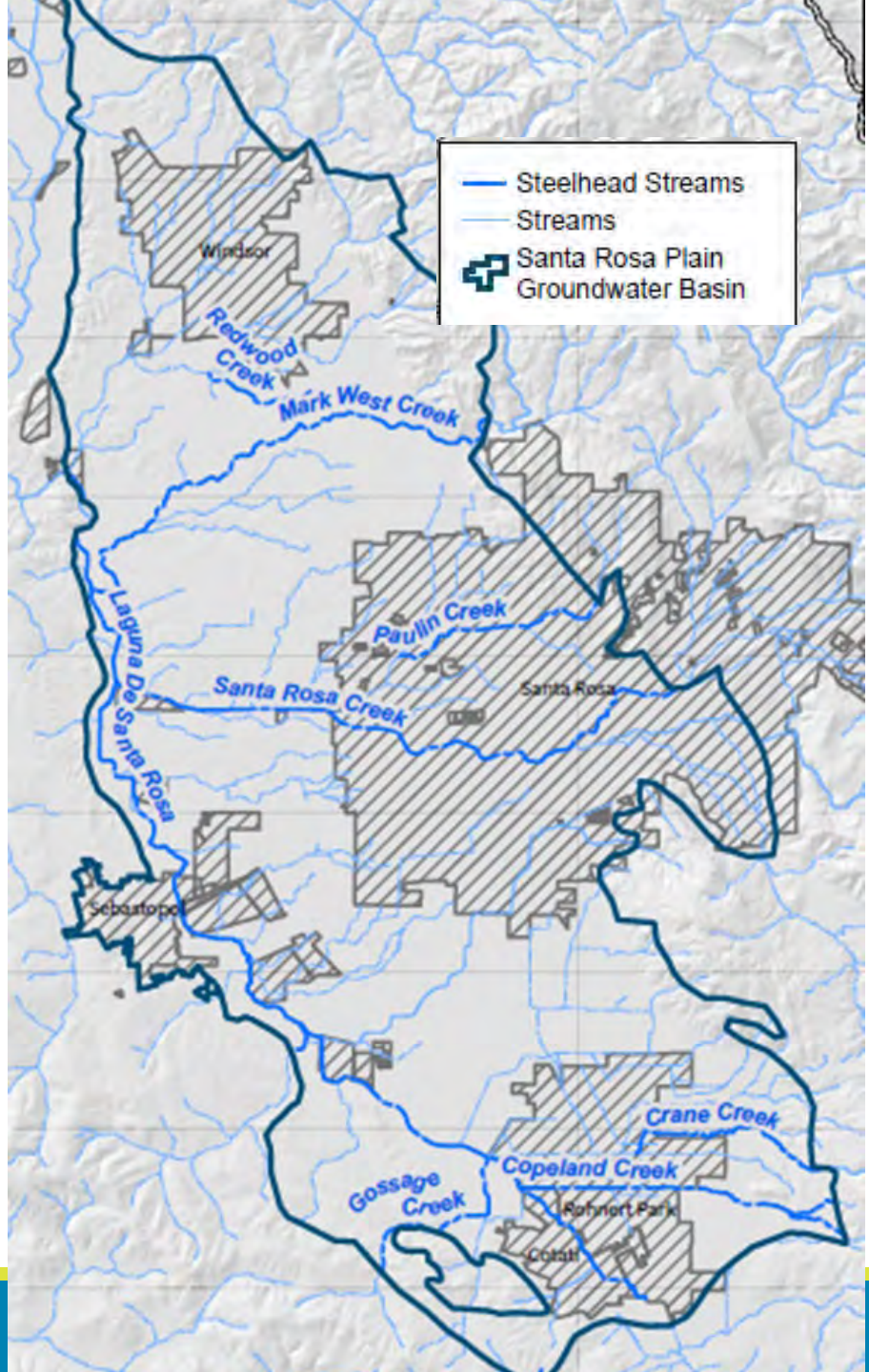
- Animals considered are listed in Critical Species LookBook (Rohde et al. 2019)
  - steelhead, Chinook salmon, coho salmon, California red-legged frog, and California tiger salamander.
  - Also, endangered California freshwater shrimp considered at the request of resource agency staff.
  - California tiger salamander excluded because species has “no known reliance on groundwater” (Rohde et al. 2019).
- Distribution of target species is based on:
  - Leidy et al. (2005), Salmonid Sample Frame Development for Coastal Monitoring Plan Implementation in the Russian River Watershed.
  - California Natural Diversity Data Base.

Preliminary Aquatic Groundwater Dependent Species (continued)

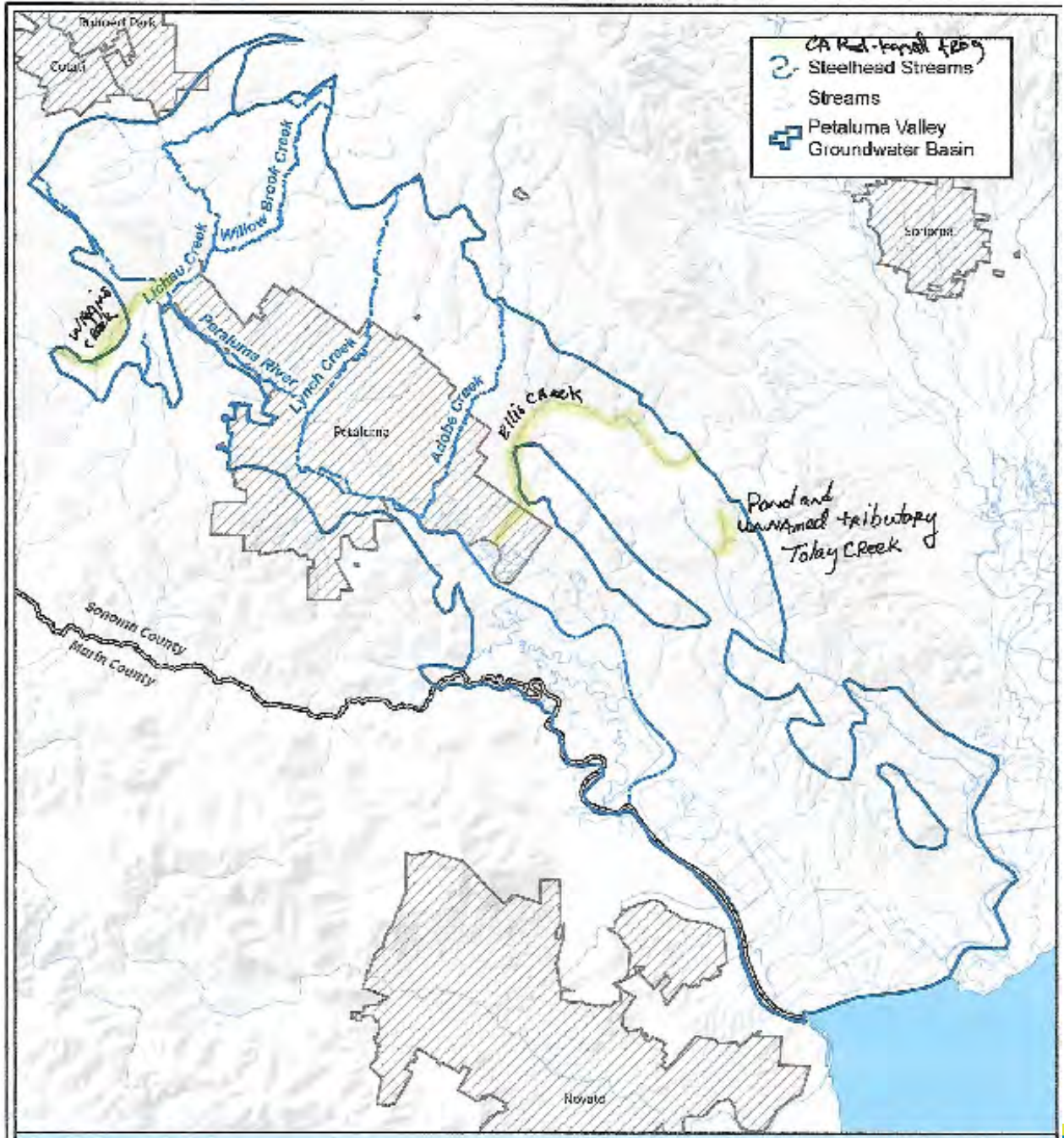
- A total of 35 streams were identified as habitat for at least one target species.
- Steelhead was the most wide spread species occurring in 32 (91%) of all streams.
- In Petaluma Valley, California red-legged frog occur in three streams not identified as a steelhead stream.
  - Wiggins Creek and Ellis Creek
  - Pond on unnamed tributary of Tolay Creek (recommend removal)
- Distribution of Chinook salmon, coho salmon, and California freshwater shrimp overlap entirely with steelhead streams.

Preliminary Aquatic Groundwater Dependent Species





Preliminary Aquatic Groundwater Dependent Species: Petaluma Valley



Vegetation Mapping Update

Summary of Methodology

- Map classes used in initial draft maps removed from consideration as GDEs (e.g. vernal pools).

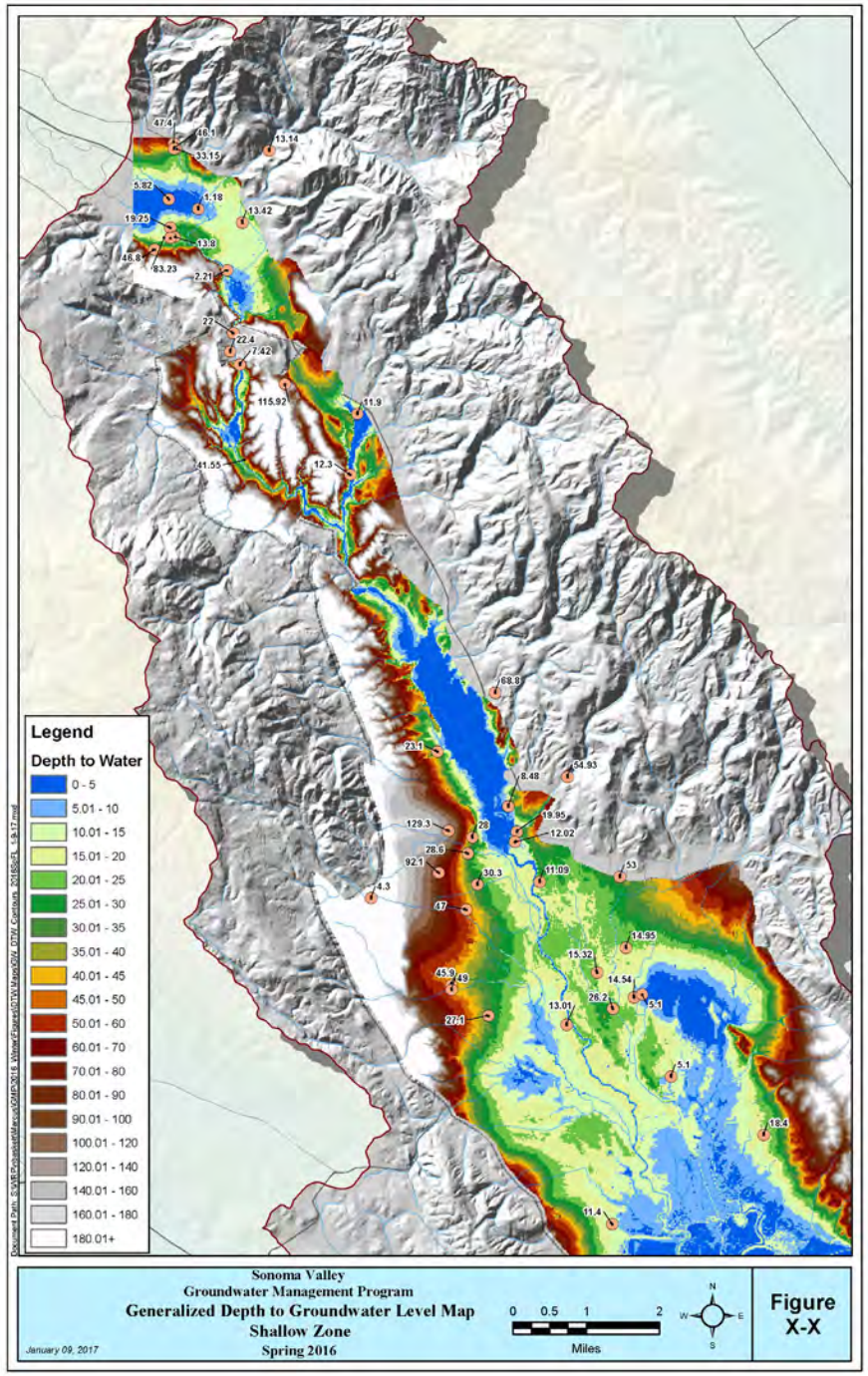
- Incorporate root depths of common tree species as available and compare to depth-to-groundwater (DTW) mapping.

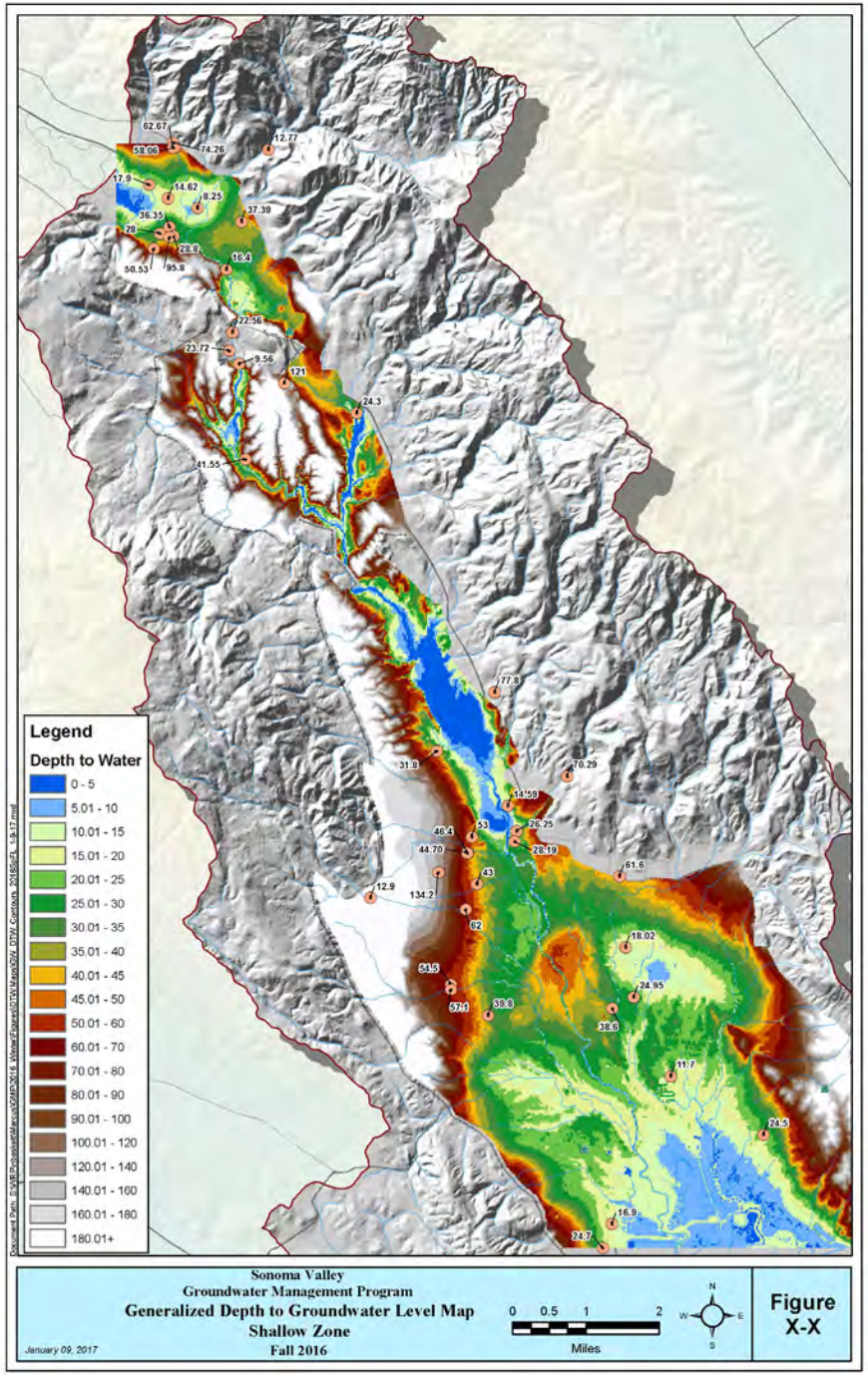
    -Minimal information of rooting depth of riparian tree species
    -Presumably riparian species have relatively shallow root systems
    -*Q. agrifolia* and *Q. lobata* are phreatophytes and common in riparian areas throughout Sonoma County.

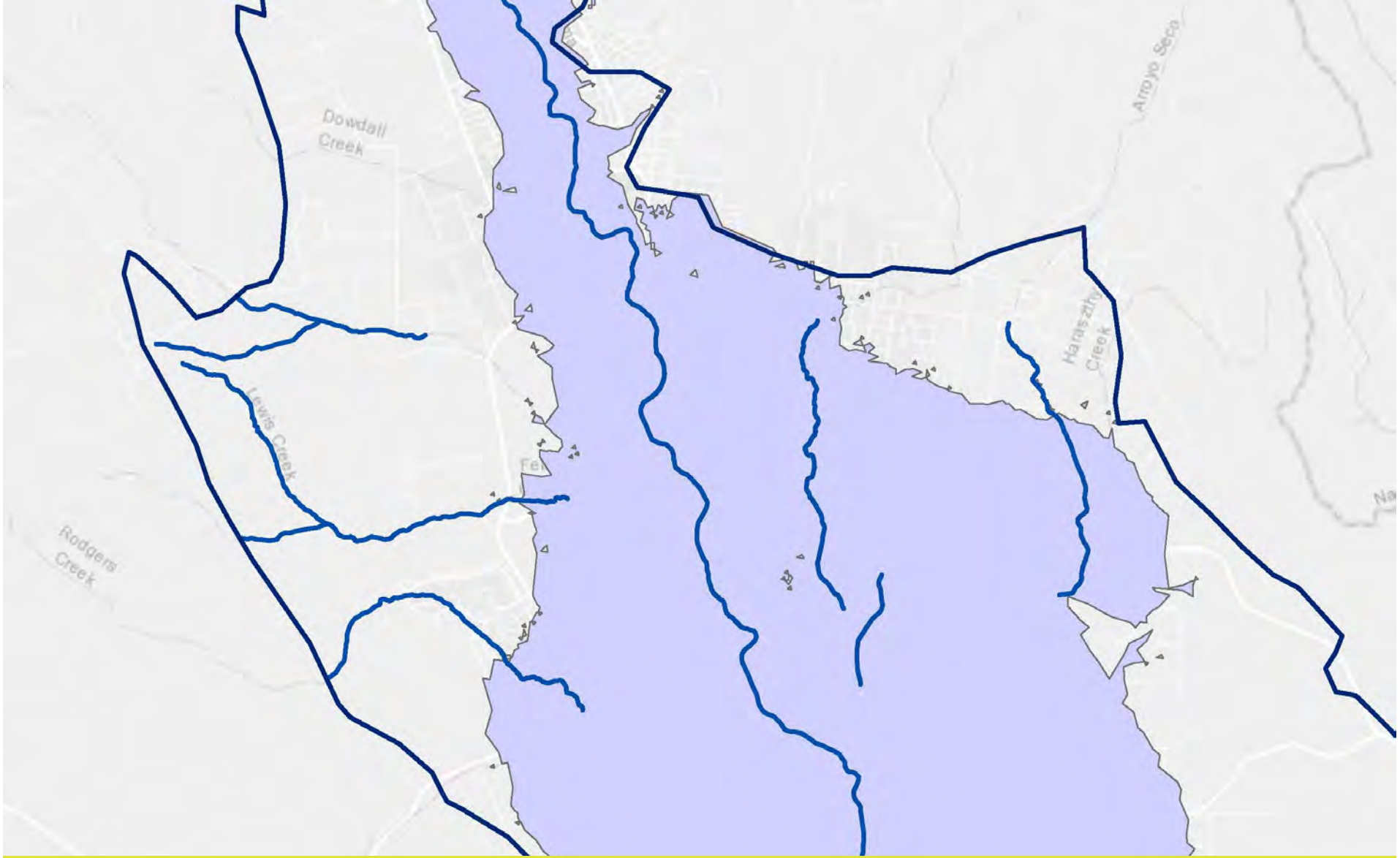
- Selected potential GDEs from areas mapped with depth to groundwater of 30 feet or less.

- Included Riparian Woodland and Oak Woodland habitat within 100 feet of mapped interconnected surface waters.

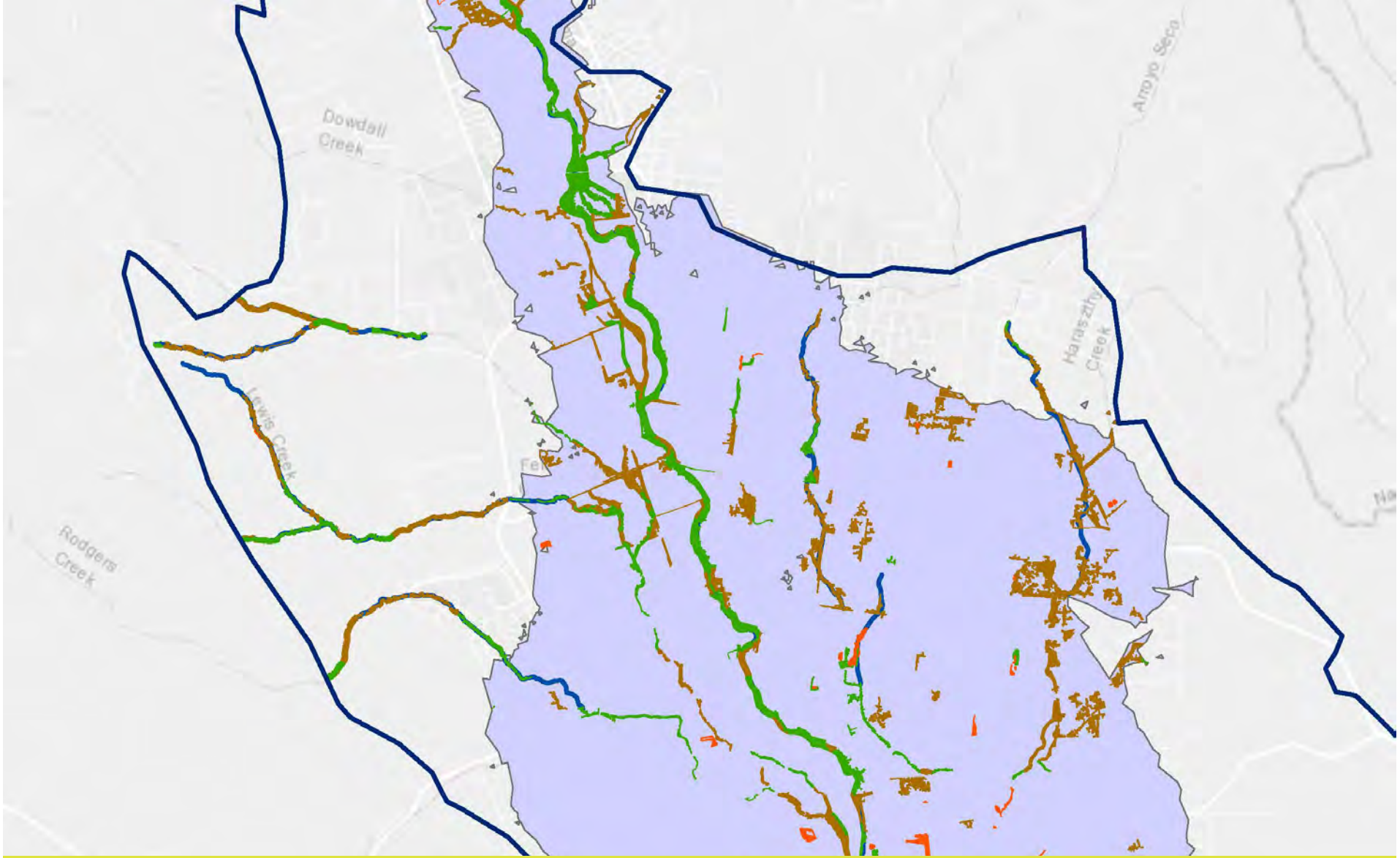
Depth-to-Groundwater Maps for Shallow Unconfined Aquifer System: Sonoma Valley – Spring and Fall 2016



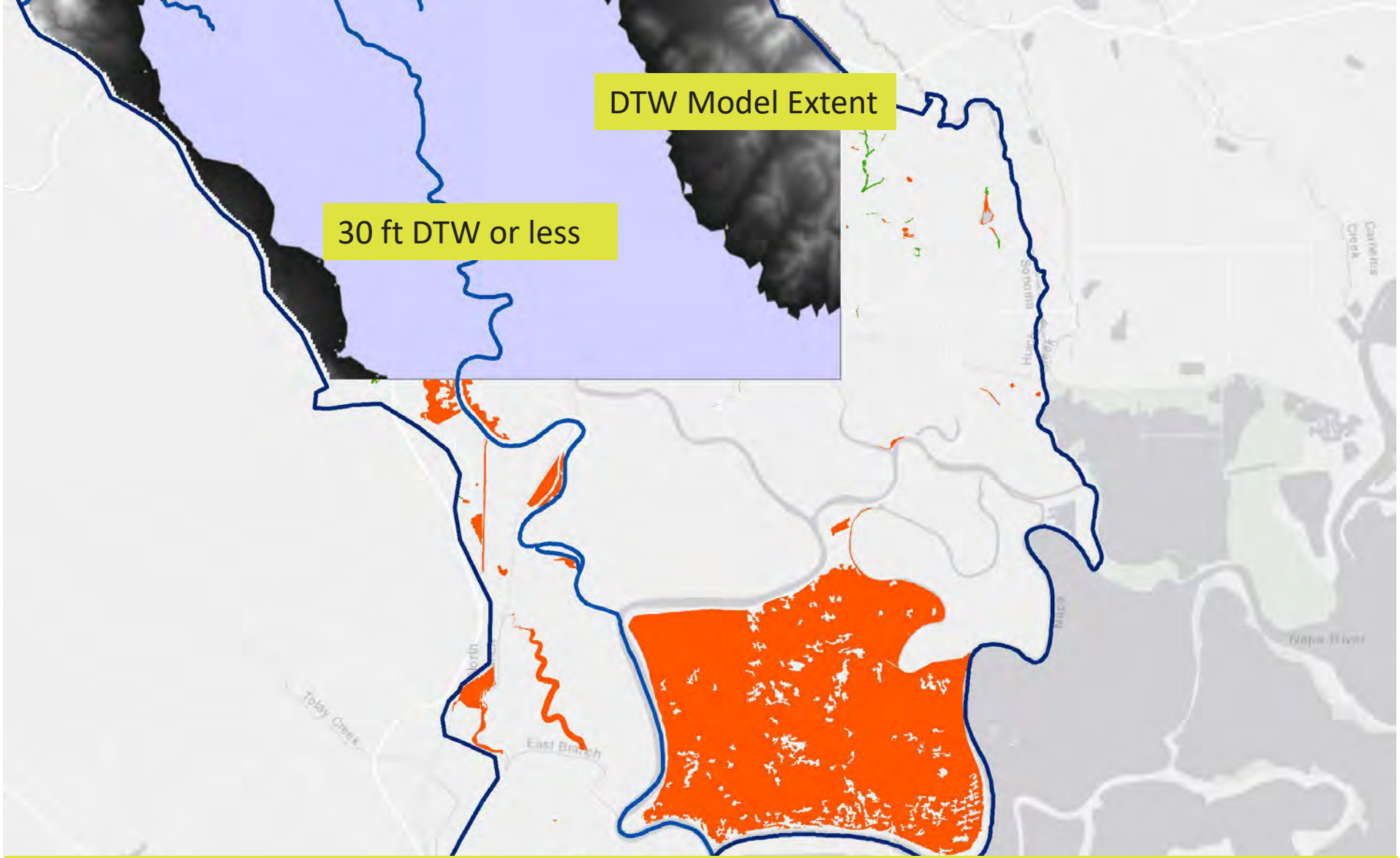




Interconnected surface waters and areas with depth to groundwater 30 feet or less (shaded blue).

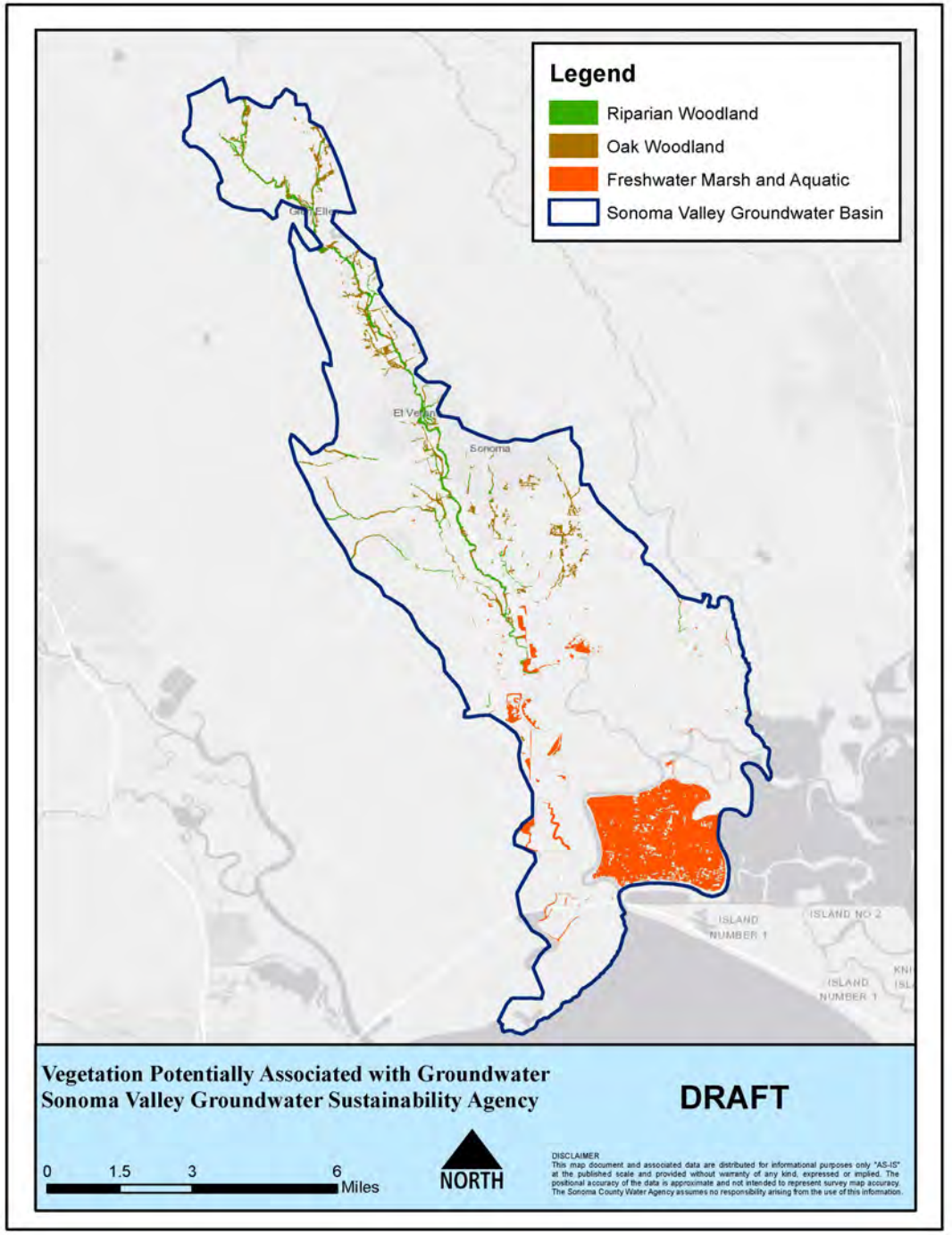


Vegetative Classes within interconnected surface waters (100ft buffer) and areas with depth to groundwater 30 feet or less (shaded blue).



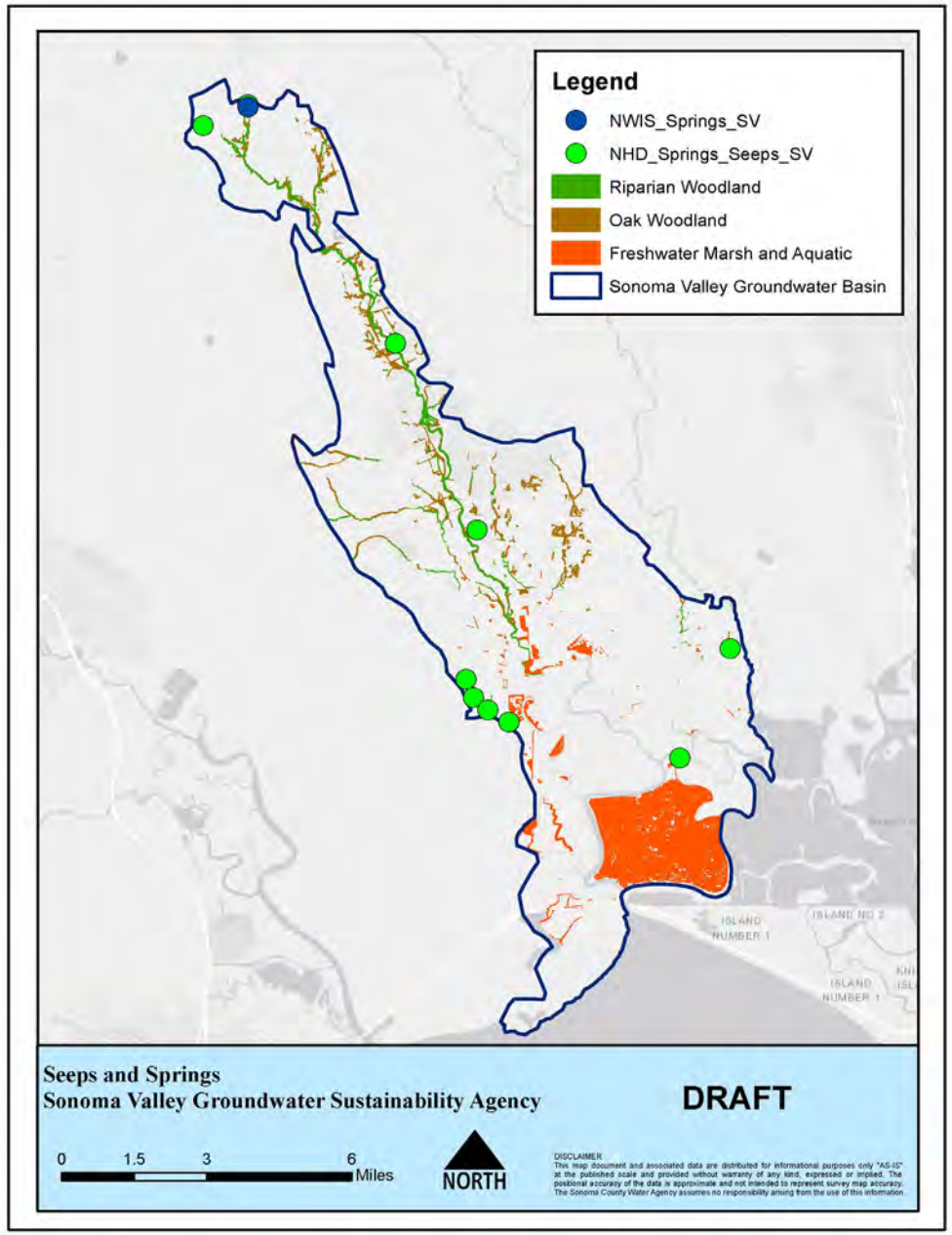
All Riparian Woodlands, Oak Woodlands, and Freshwater Marsh and Aquatic habitat were included in areas lacking depth to groundwater models were included in the draft map.

Results


Legend
Riparian Woodland
Oak Woodland
Freshwater Marsh and Aquatic
Sonoma Valley Groundwater Basin
Sonoma
ISLAND NUMBER 1
ISLAND NO 2
Vegetation Potentially Associated with Groundwater
Sonoma Valley Groundwater Sustainability Agency
DRAFT
0 1.5 3 6 Miles
NORTH
DISCLAIMER
This map document and associated data are distributed for informational purposes only "AS-IS" at the published scale and provided without warranty of any kind, expressed or implied. The positional accuracy of the data is approximate and not intended to represent survey map accuracy. The Sonoma County Water Agency assumes no responsibility arising from the use of this information.

Seeps and Springs

- Not particularly informative using NWIS and NHD data.
- A few were located within potential GDEs, others located in developed areas.
- Ground-truthing would be necessary to determine if there are GDEs associated with springs and seeps.



Next Steps in GDE Mapping

- Complete vegetation mapping for Santa Rosa Plain and Petaluma Valley
- Integrated maps with proposed vegetation and aquatic species GDEs
- Comparison mapping with TNC datasets
- Consideration of grouping GDEs based on habitat needs (timing, proximity to known and estimated groundwater pumping, etc.)
- Initial draft narrative describing process and how mapping will be used in GSP
- Share maps and approach with Surface Water Depletion SMC Workgroup

- What additional data collection is recommended for implementation phase of GSP?

Possible Approaches to Developing SMC
– Marcus Trotta & Stephen Maples

Motivation

Objective: Identify opportunities for using shallow GW wells as a proxy for GW/SW interactions

Approach:

1. Characterize GW/SW interactions using paired shallow GW and gage data
2. Develop regression relations between data and larger-scale stream-aquifer responses from the calibrated model.
3. Use regression relation to infer stream-aquifer responses in near-real-time with an indicator well (i.e., GW levels as a proxy).

How can we leverage measurements and models to characterize GW/SW interactions and SW depletion?

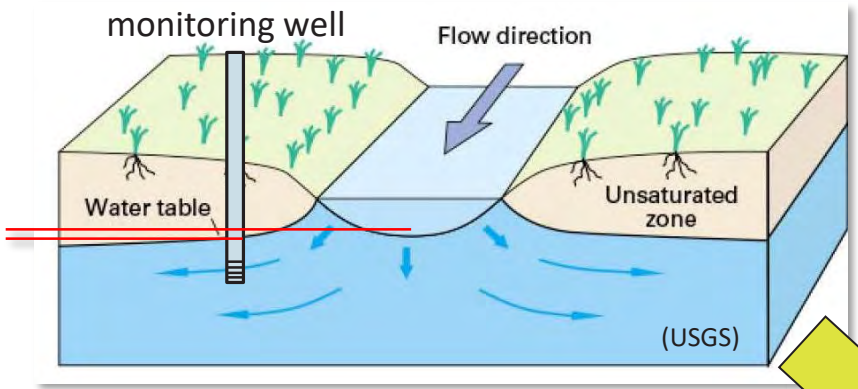
SGMA requires …

1. An understanding of the exchanges of groundwater and surface water within the basin (i.e., groundwater/surface-water interactions).
2. An assessment of the impact of groundwater management on groundwater/surface-water interactions.

Interactions of groundwater and surface water are typically …

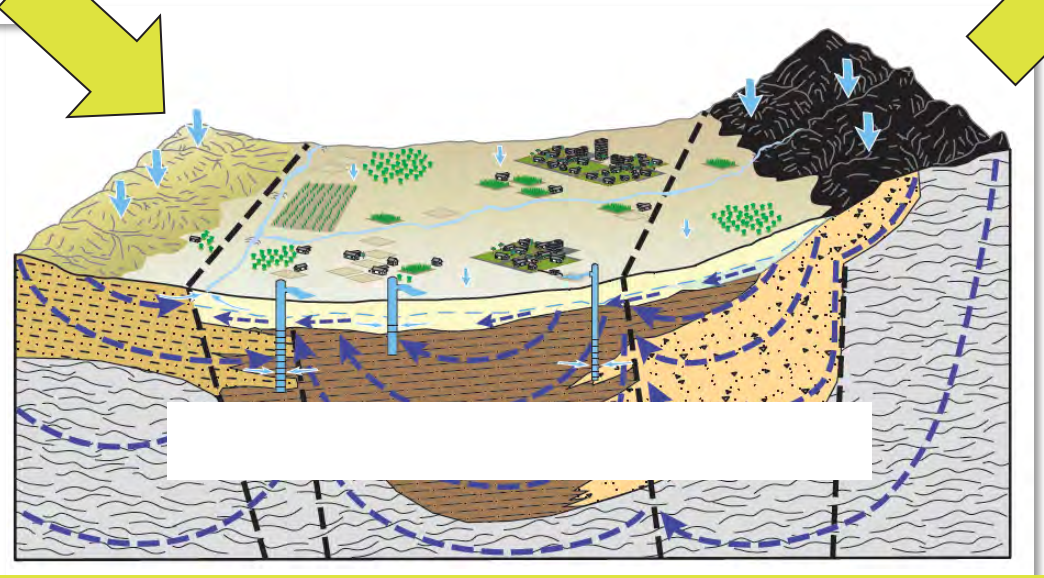
1. Highly variable in space and time.
2. Typically characterized directly at only a few locations.
3. Challenging to simulate with models, resulting in significant uncertainty.

How can we leverage measurements and models to characterize GW/SW interactions and SW depletion?

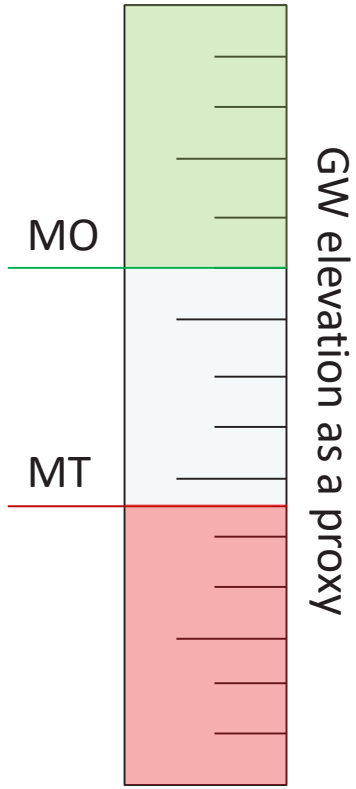


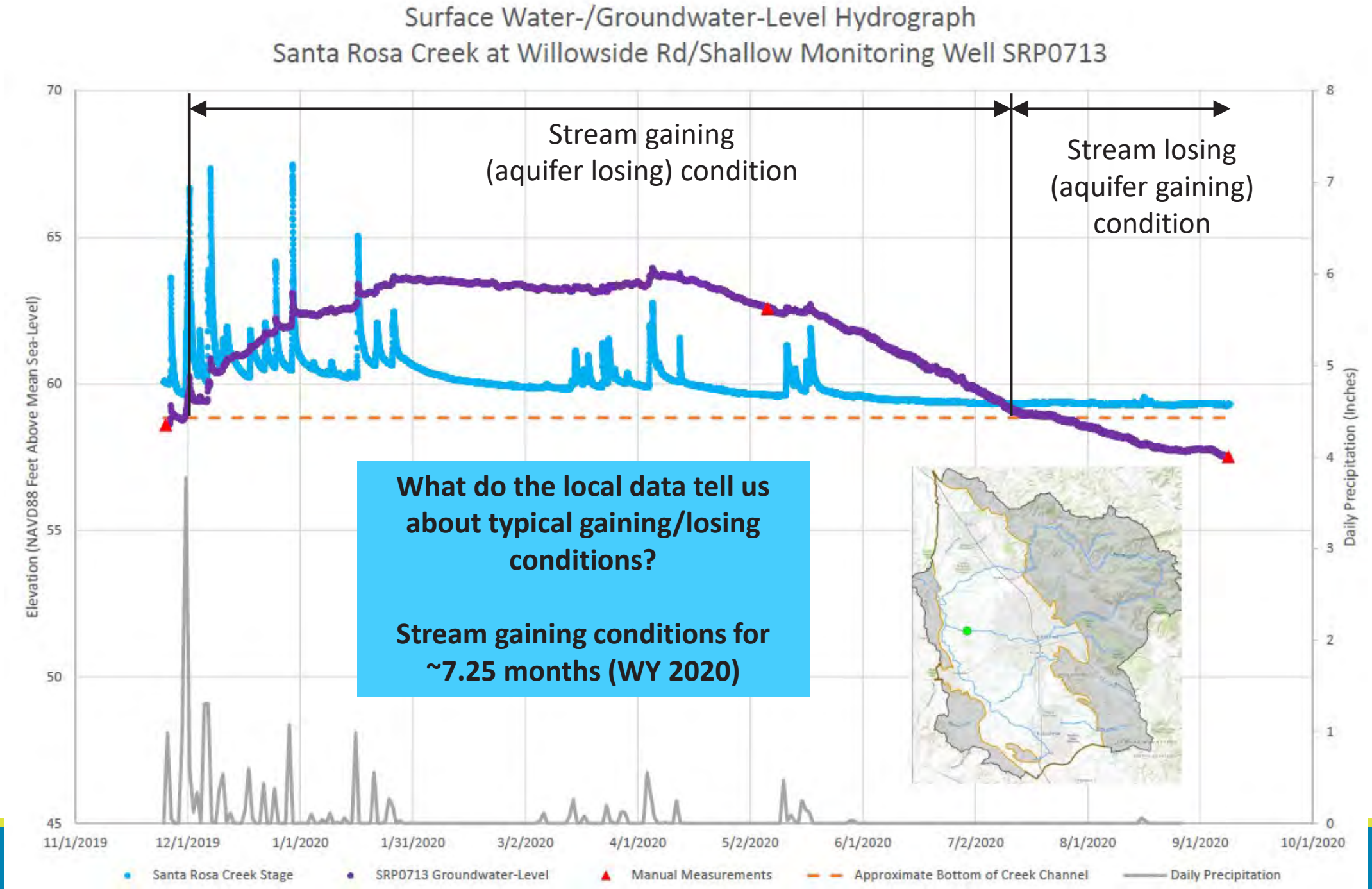
Local **GW/SW interaction characterization (measured)**

Regional **GW/SW interaction characterization (simulated)**



SMCs are tied to GW elevations and informed by simulation results





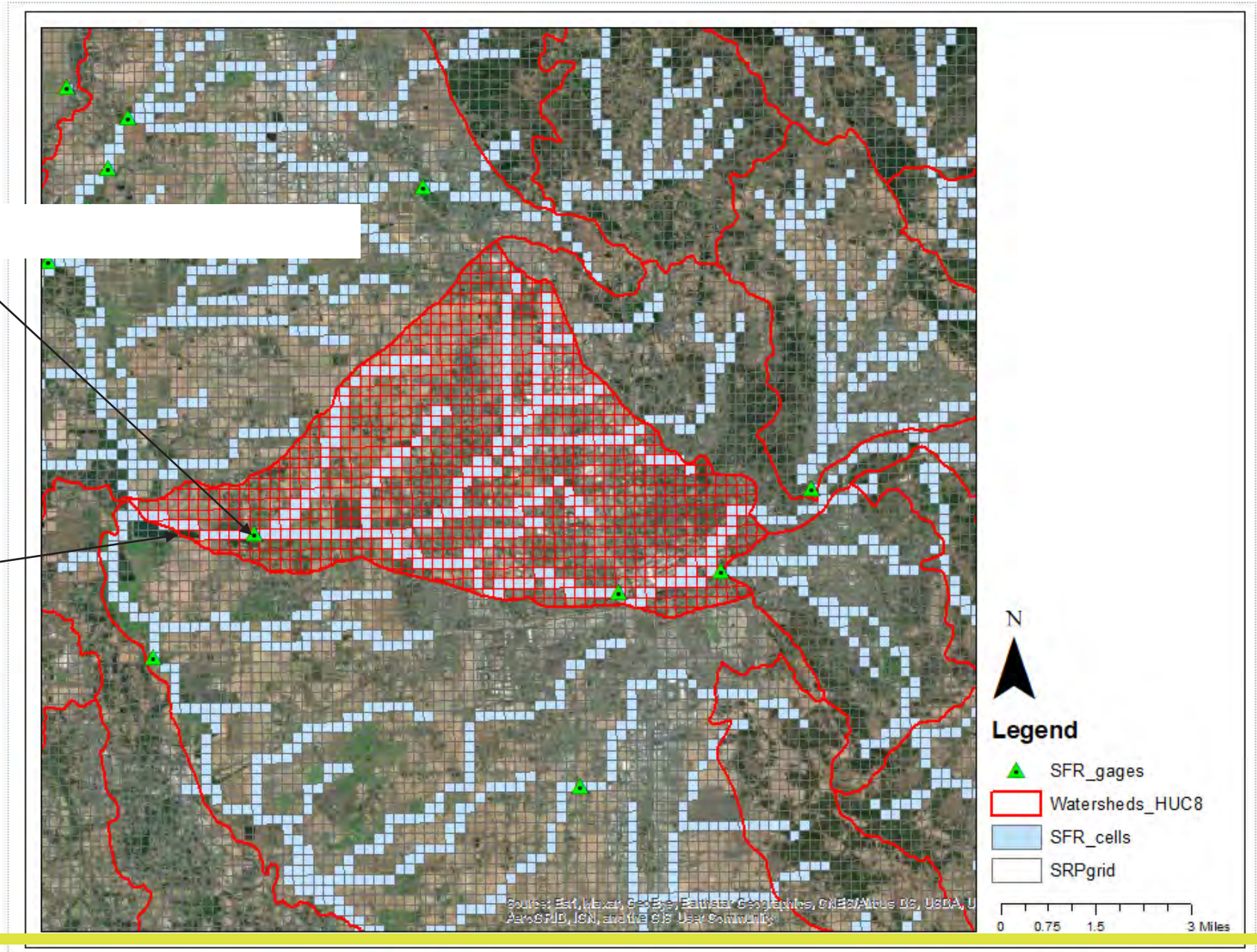
What do the local data tell us about typical gaining/losing conditions?

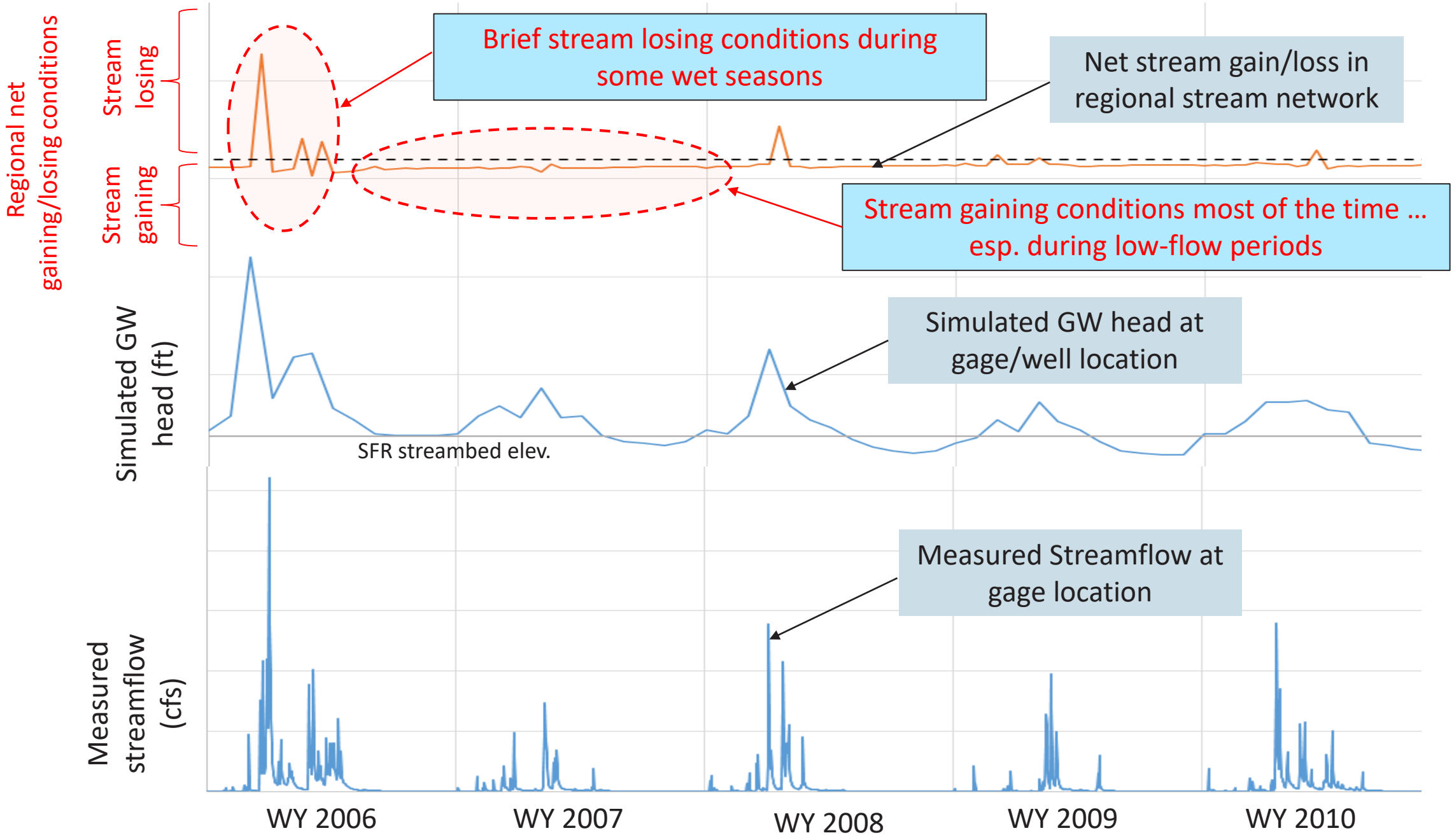
Stream gaining conditions for ~7.25 months (WY 2020)

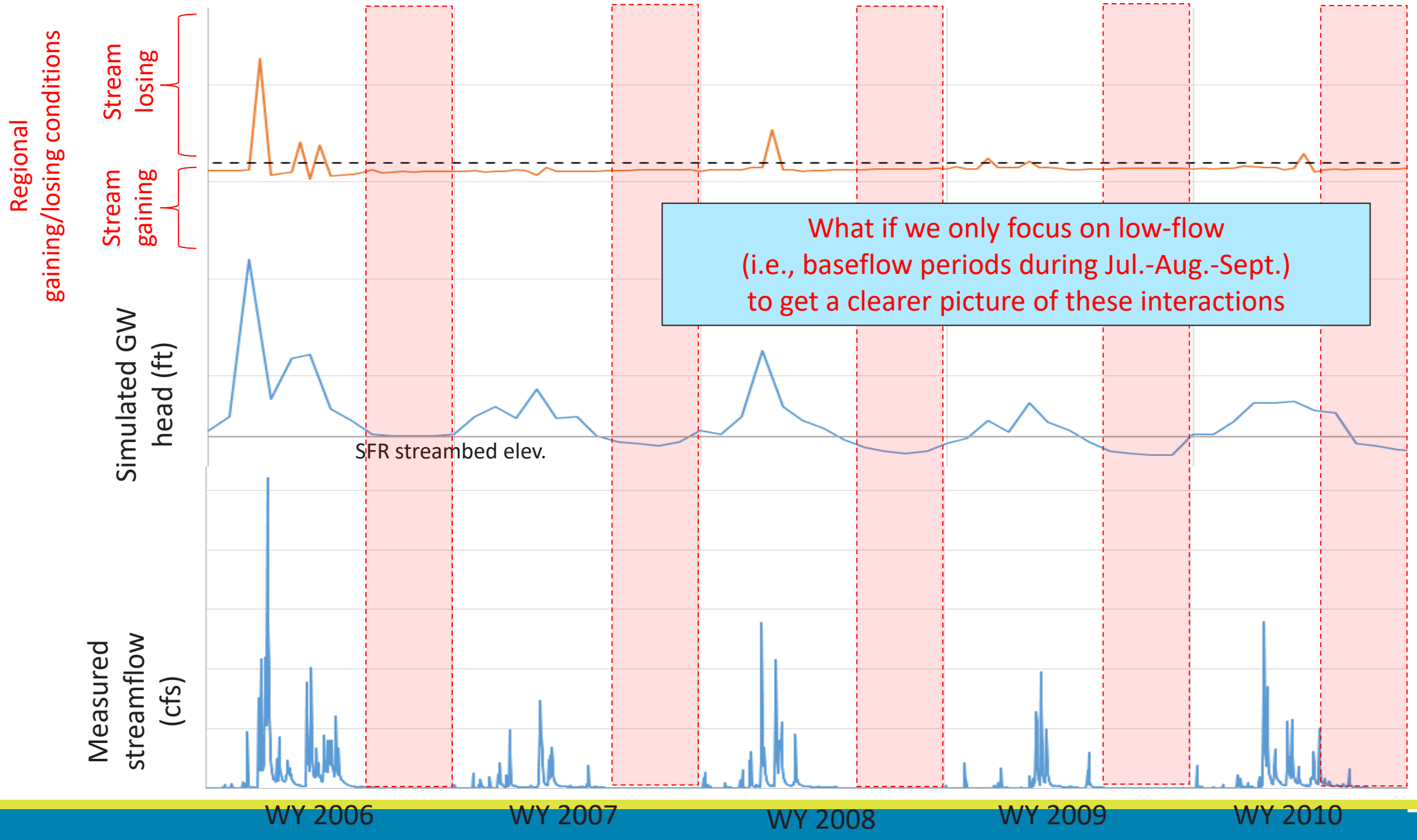
What does the model tell us about gaining/losing conditions over the greater region?

Paired gage/shallow GW well at Santa Rosa Cr. and Willowside Rd.

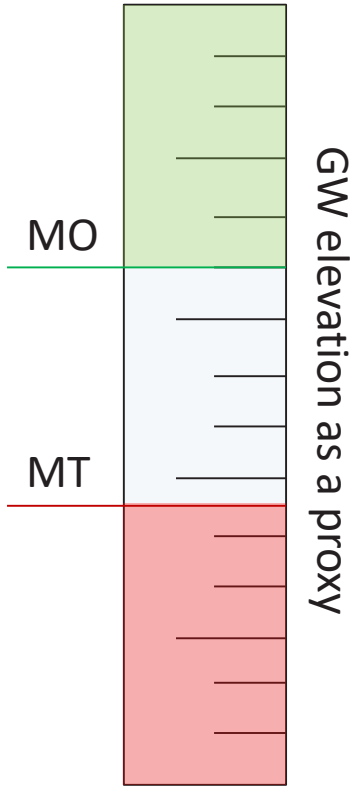
MODFLOW/SFR cells included within greater HUC8 boundary



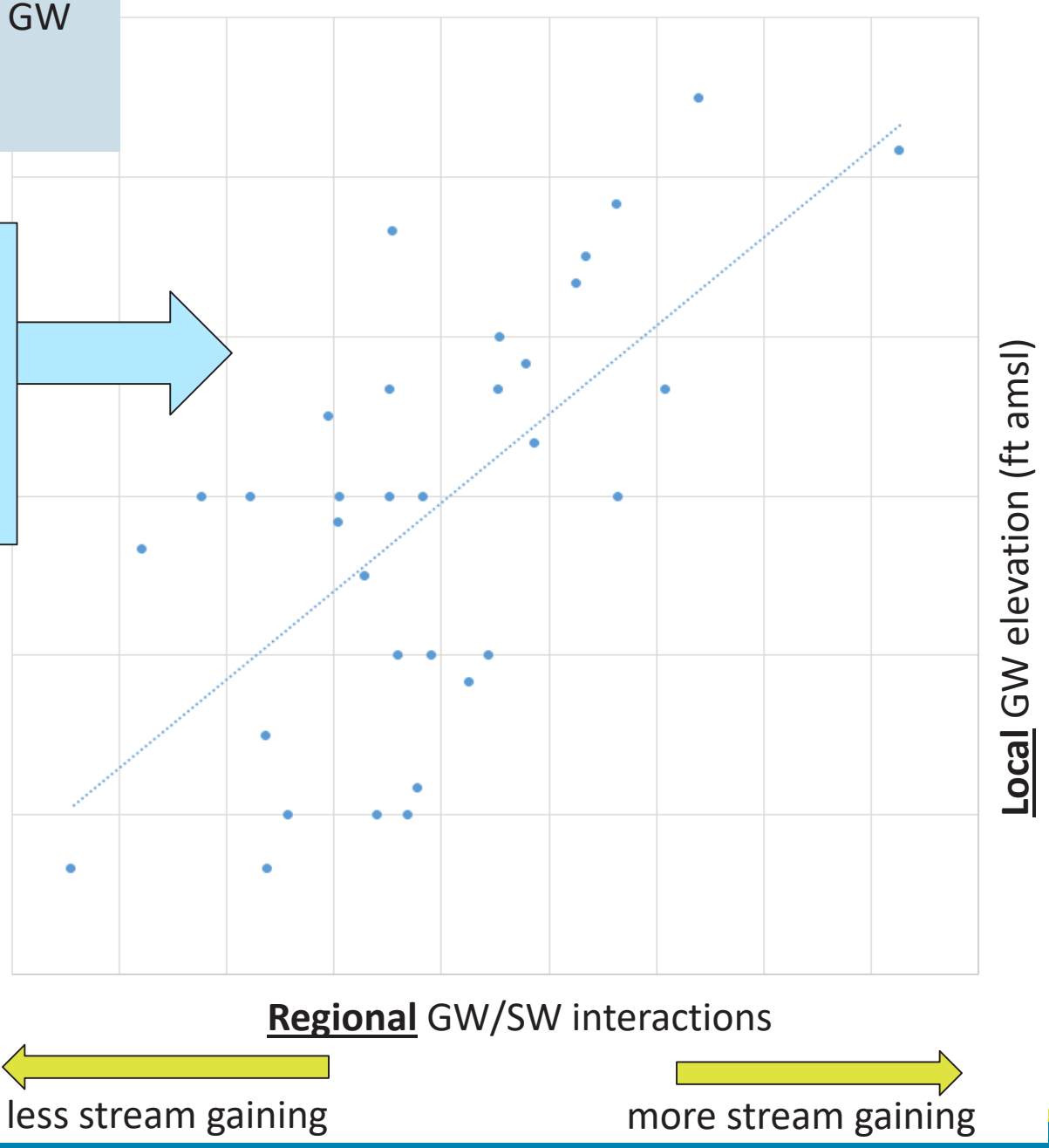

Regional net gaining/losing conditions
Stream losing
Stream gaining
Brief stream losing conditions during some wet seasons
Net stream gain/loss in regional stream network
Stream gaining conditions most of the time … esp. during low-flow periods
Simulated GW head (ft)
Simulated GW head at gage/well location
SFR streambed elev.
Measured streamflow (cfs)
Measured Streamflow at gage location
WY 2006
WY 2007
WY 2008
WY 2009
WY 2010


Regional gaining/losing conditions
Stream losing
Stream gaining
Simulated GW head (ft)
SFR streambed elev.
Measured streamflow (cfs)
What if we only focus on low-flow
(i.e., baseflow periods during Jul.-Aug.-Sept.)
to get a clearer picture of these interactions
WY 2006
WY 2007
WY 2008
WY 2009
WY 2010

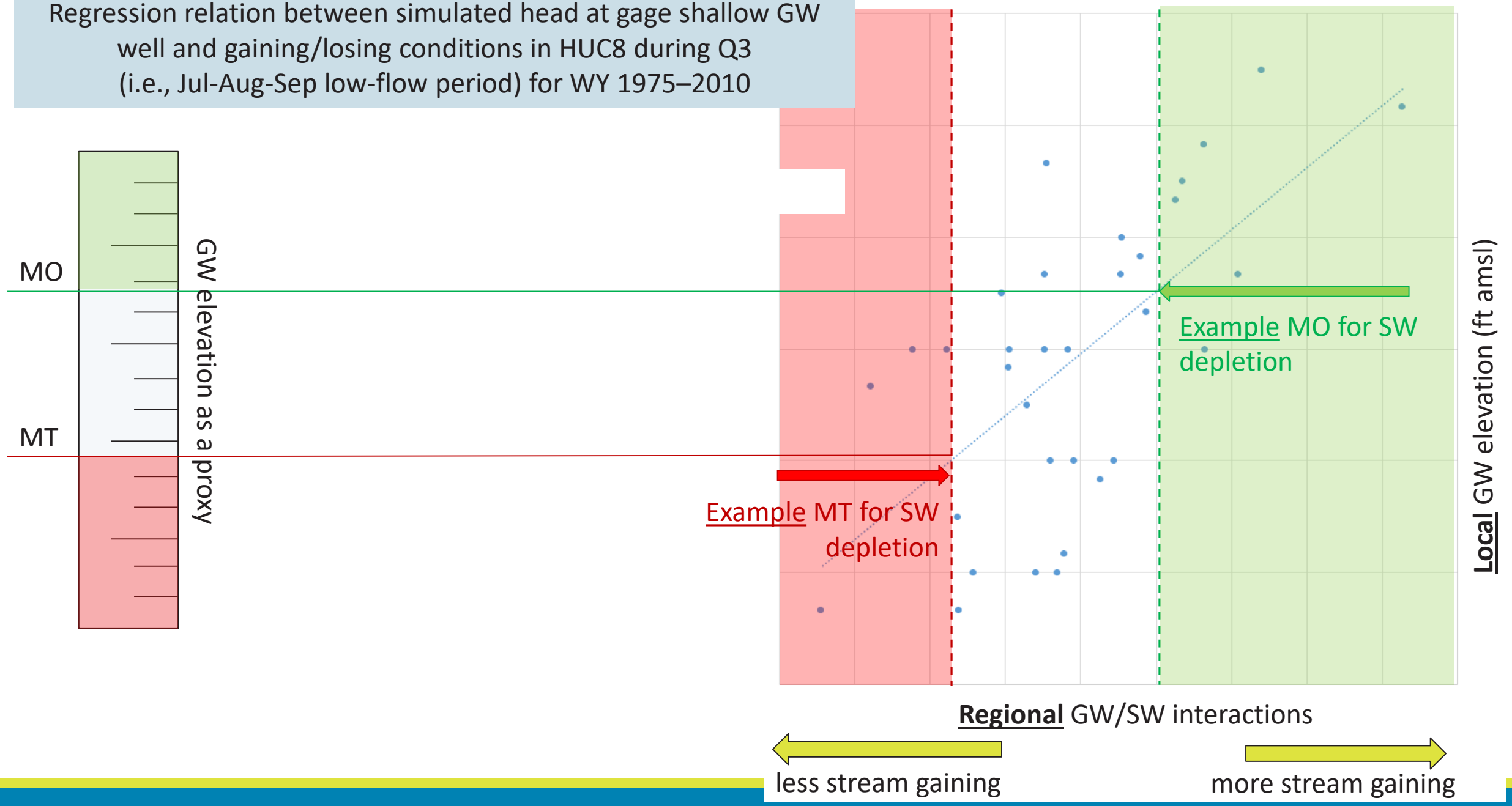
Regression relation between simulated head at gage shallow GW well and gaining/losing conditions in HUC8 during Q3 (i.e., Jul-Aug-Sep low-flow period) for WY 1975–2010



Example regression relation between local GW heads and simulated regional GW/SW interactions be used to inform SMCs



Regression relation between simulated head at gage shallow GW well and gaining/losing conditions in HUC8 during Q3 (i.e., Jul-Aug-Sep low-flow period) for WY 1975–2010



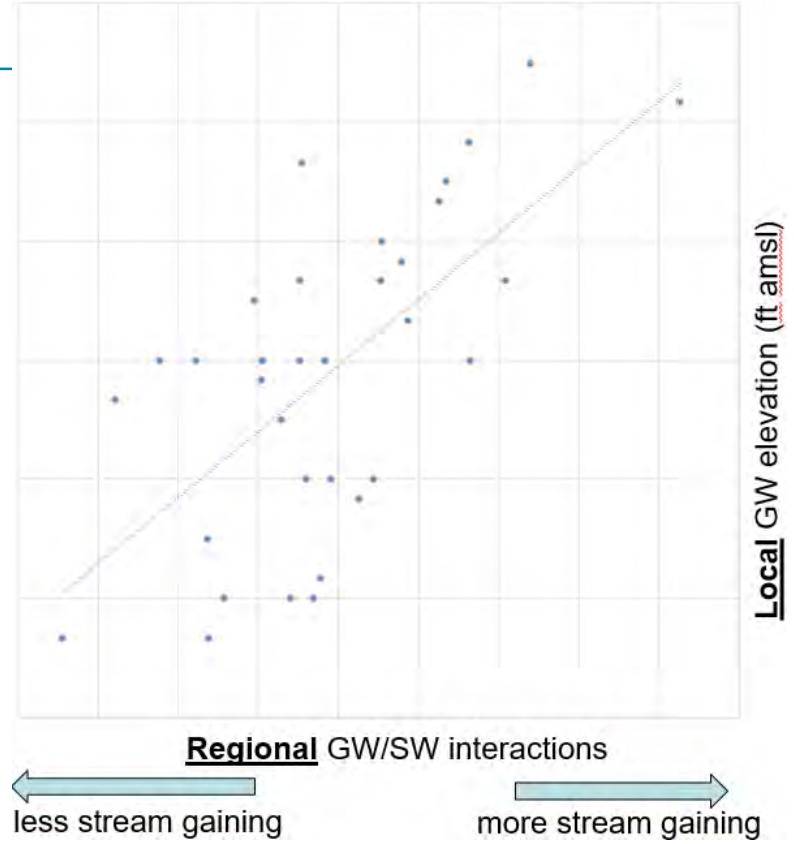
Outstanding Questions & Next Steps …

1. Are (1) simulated/observed heads in good enough agreement and (2) the regression relation robust enough to perform this assessment?

2. Can a regression be developed to assess other metrics, like for the GW/SW gradient? Or duration of interconnection?

3. Are different regression relations needed for different periods within a year (i.e., wet/dry periods)? Or for differing water year types?

4. What is the best approach for assessing the contribution from GW pumping? Differencing multiple simulations?



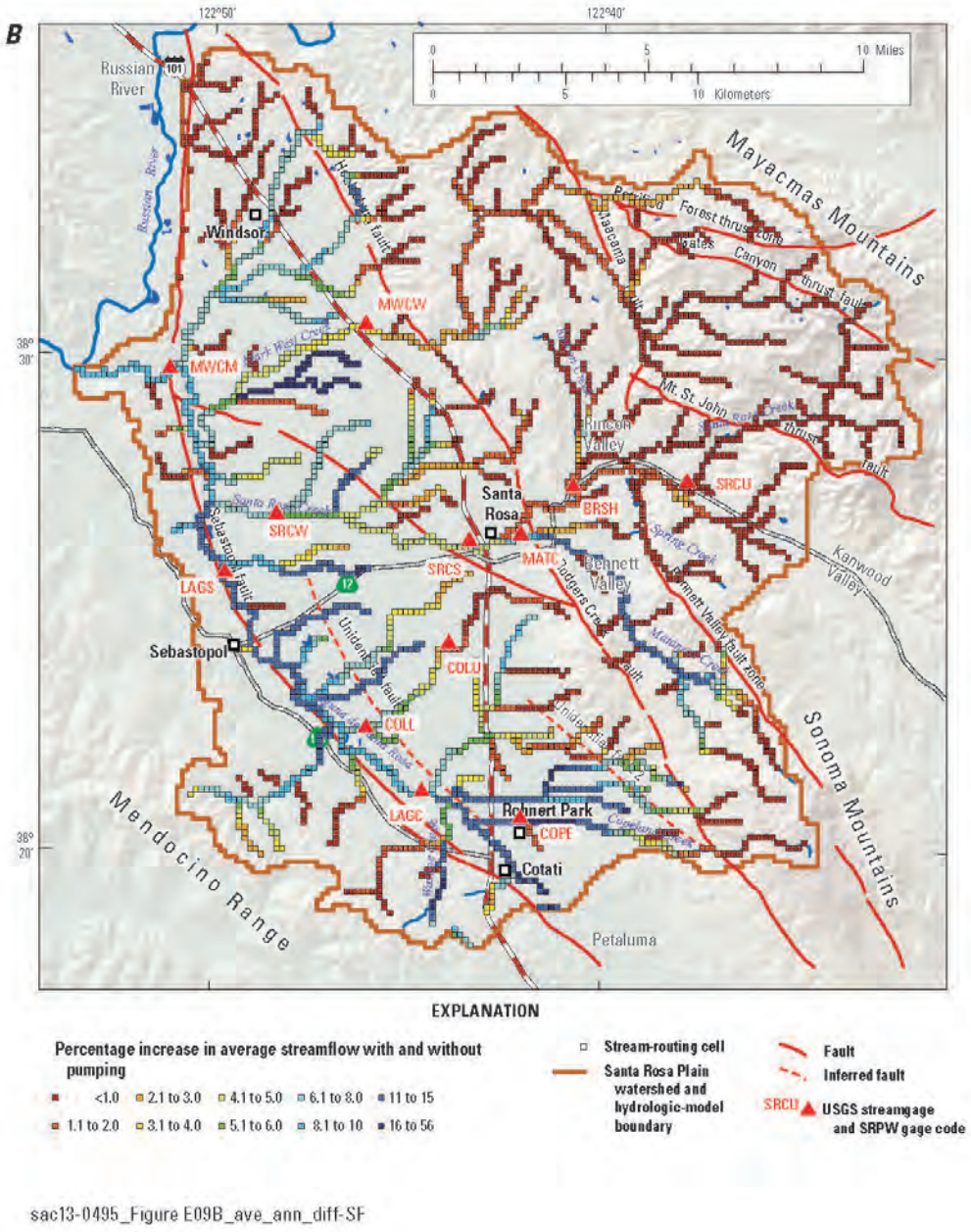
Questions/Discussion

Initial Discussion of Data Gaps

1. Are there other existing data sources that should be included for GSP?
2. What additional data collection is recommended for implementation phase of GSP?

Simulated Change in Streamflow With and Without Groundwater Pumping (USGS, 2014)

- Average 8% change in total simulated streamflow (35 year simulation)



sac13-0495_Figure E09B_ave_ann_diff-SF

SMC for Depletion of Interconnected Surface Water

Friday, December 11, 2020

Meeting Notes

Contact: Sam Magill, Practitioner Work Group Facilitator

Agenda Review and Work Group Introductions

Jay Jasperse welcomed the group and expressed his appreciation for the participants taking time out of their busy schedules to join the meeting.

Sam Magill, Work Group Facilitator walked through the agenda and meeting protocol then suggested a round of introductions.

Summary of ISW SMC Work Group Input to Date

Sam Magill provided a summary of initial work group input from the October 7 meeting.

Review and Discuss Draft Significant and Unreasonable Conditions Statement

A statement of **Significant & Unreasonable** is a qualitative statement describing groundwater conditions unacceptable to beneficial uses and users of water in the basin. These describe what conditions are to be avoided and serve as an initial framework around which the quantitative SMC are developed. Marcus Trotta provided example statements from other Groundwater Sustainability Plans and initial Advisory Committee input.

Questions/Comments

Jessie Maxfield (chat) – I am curious what "biological flows" are from the Salinas example.

> Lisa Porta – The point for that agency is that they need to manage the flows on the river so the biological flows wouldn't be impacted.
> Maxfield – In terms of biology are you looking at fish?
> Porta – Yes, related to their specific biological opinion on fish on the river.

Sam Magill said that all input from the group, Advisory Committees, and ongoing staff work were put together to develop the current proposed Strawman Significant and Unreasonable statement:

"Significant and unreasonable depletion of surface water from interconnected streams, occurs when groundwater pumping within the Basin/Subbasin depletes stream flows below historical levels and adversely impacts the viability of GDEs or to other beneficial surface water users."

Marcus Trotta said he was hoping for feedback from the group on the statement.

Rick Rogers (chat) – The inclusion of "below historical levels" should be removed.
It seems like including that wording leaves the door open for a pre SGMA baseline approach which has nothing to do with trying to prevent impacts or Undesirable Results, especially ones that impact beneficial uses of surface water. Putting the two together doesn't work for me.

Maxfeld (chat) – I second Rick's comment. It could read instead ".....depletes stream flows to levels that adversely impacts the viability of GDEs or other beneficial surface water users."

Trotta – We added the language to have something to work to as we develop our technical methodology for what could be considered significant and unreasonable. We haven't received information from the basins on levels or flow requirements that would help us define adverse impacts on the viability of the GDEs or surface water users. I understand the comments.

Sam Boland – If you remove the "below historical levels" the statement still works as a good strawman proposal because you still need to figure out how to define what adversely impacts these things and how they can be quantified in a measurable way. The challenge is equally difficult with or without the "historical levels".

Maurice Hall – If you remove "below historical levels", it seems like you are saying that pumping significant and unreasonable depletion of stream water from interconnected streams occurs when groundwater pumping occurs. I think some reference to historical levels is appropriate given the way SGMA is written. The depletion of stream flows below historical levels of streamflow – It seems to be linking groundwater pumping to stream flow when many other things affect stream flow. My recommendation would be to tie it to historical groundwater depletions of stream flows.

Val Zimmer – I think of something like surface water such as wetlands that may or may not be connected to groundwater or stream flows year-round, you might have OK streamflow but if you drying out wetland that is adjacent to it, it might be a different thing even though it is near it. I wonder if the language around stream flow needs to be adjusted.

Trotta – Both those points are helpful. Maybe something like "results in more depletion of surface water than has occurred historically" rather than reference the flows.

Georgina King – The indicator is surface water, so it does cover both, wetlands and stream flow. A lot of the metrics you propose to use is stream flow as an indicator, it is hard to do with a surface water body. In general, if it is groundwater affecting stream flow that is connected directly to the stream, a wetland is often separate from the stream. If it is separate from the stream it would come under "Groundwater Level".

Zimmer – I think speaking to an expert on wetlands would be useful.

Rogers (chat) - The problem is that in these med/high basins, streamflow depletion is likely impacting beneficial uses (and ESA-listed species) currently. Managing to a historical point in time does not ensure you are avoiding these impacts but would likely lead to a situation where the current impacts are continued or worsened (most proposed pre-SGMA baselines are chosen during our recent drought).
He added verbally – In most of these basins that are undergoing SMGA right now in where stream flow depletion has an impact, that impact is occurring right now and should be addressed. Using a point in time in the past as a management point, doesn't do anything to deal with the potential impact especially if the point in time chosen is during our past drought.

Rogers – I would suggest a different way of looking at this. What are some of the beneficial uses of surface water that would be significant and unreasonable? It seems it would be much more consistent with the definition within the regulations as to how you would solve the problem.

Boland - I agree with Rick, just replacing significant and unreasonable with adverse impacts, it doesn't take you much further than the original statements. The other suggestion is it seems the viability of GDEs and beneficial uses of surface water are synonymous here. GDEs that aren't in the surface water body – I

am not sure they are in scope for this Undesirable Result like they would be addressed by water level considerations.

Trotta – I think some of the details are things we thought about. Rather than including all GDEs, it sounds like focus on GDE fish and other animals within the surface water itself rather than riparian vegetation outside.

Boland – Yes, I meant GDEs in this context is a subset of beneficial uses.

Maxfield – The Dept. supports not using historic levels or conditions but using stream flows appropriate for the different life stages rather than looking at historic levels or a certain point in time.

Rohde – I am trying to see this statement as a goal statement. This statement is more like an "I want to get fit" statement and not very helpful for guiding what Minimum Thresholds and Measurable Objectives should be. It should be a little more explicit about what would constitute that.

King – Melissa – your analogy – isn't that more the Undesirable Result? The Significant and Unreasonable is supposed to be general.

Melissa – I thought in Santa Cruz County we were more specific in the process. Maybe I am getting the two mixed up.

King – Yes, we got a lot more specific in the Undesirable Results.

Boland – Could you remind me of the distinction between Undesirable Results and Significant and Unreasonable.

King – The Significant and Unreasonable are conditions you don't want in the basin, a general guiding statement. If you didn't know anything about SGMA, you would think they are very similar. In the SGMA process, the Undesirable Results are defined as a combination of Minimum Threshold exceedances. You can have Minimum Thresholds set in your monitoring wells, and these Undesirable Results allow you to fall below the Minimum Thresholds a certain number of times without being classified as Undesirable. It is a definition of how many times you can exceed Minimum Thresholds.

Potential Methodology for Determining ISW SMC

Marcus Trotta provided an overview of the technical work staff has been doing and what we need to do to move forward with this Sustainable Management Criteria. He presented the Strawman methodology for determining Interconnected Surface Water SMC.

Stephen Maples, Sonoma Water went into detail on work completed so far and presented model results intended to help indicate surface water behavior that might be occurring in the basin. Maples explained the goal is to leverage measurements and models to characterize groundwater – surface water interactions and surface water depletion.

Marcus Trotta suggested it might make sense to set interim SMC while working to build datasets and model capabilities during GSP implementation.

1. For Remote Monitoring Points where we have less than five years of data, use autumn groundwater-level contour maps of shallow aquifer system from year with greatest simulated SWD (e.g., autumn 2015 for SRP) to pick Minimum Threshold elevations at the locations of the Remote Monitoring Points
2. For any Remote Monitoring Points with more than five years of data, use measured historical low elevations

3. For Measurable Objectives, pick a year representative of lower values of surface water depletion or set "aspirational" Measurable Objectives of maintaining groundwater levels above streambed?
4. Include a detailed plan in the GSP for how we will build our datasets and improve simulation capabilities to more fully incorporate the correlation assessment methodology we have tested.

Sam Magill then asked for feedback and reactions from the group about what Stephen presented.

Questions/Comments

Hall (chat) - What does RMP mean again?

Trotta (chat) – Representative Monitoring Point, which is where SMCs are set and monitored.

Maurice Hall – You indicated your modeling didn't overlap with the monitoring period. I am guessing that will be corrected and you extend your model into the monitoring period?

Trotta – We recently updated the model through 2018 conditions for the GSP. We will be making refinements and extending the model period during the implementation phase of the GSP so we can better capture more recent high-resolution data once we have more than one year's data to calibrate.

Rogers – How will the relationship between stream flow depletion and impact of surface water beneficial uses be fleshed out? Are there plans in the future?

Trotta – I think Stephen's analysis show that some of the metrics could be incorporated into setting the groundwater level as an SMC are potential increases of streamflow at certain times of the year or year-round. If there are certain flow requirements for certain beneficial users in certain areas that need to be considered, I think this methodology would be well suited to address that.

Rogers – So, in the interim are we going to be flushing those out in the future or will it happen in the first couple years of the GSP? When would those thresholds be developed?

Trotta – Those thresholds are where we would need longer data sets to better correlate the model results with our observations. And to help develop what the targets and thresholds are that are considered for beneficial uses in the streams. How we do that will be detailed in the GSP.

Maples – This type of analysis can tell us if you have a flow during a certain year, what would it have been without the pumping. Based on the results of biological studies, here is what an ebb and flow should be in this tributary, then we can go back and say this is what the model is telling us.

Hall – It looks like you have some nice approaches for correlating with groundwater levels to stream depletions and an amazing set of data. Tracking as best I could from what was provided, I would say in no case would you want to set your targets at or below one of the more severe droughts on record. You would want a margin of error above thresholds, because you don't want to go that low, and there is uncertainty in the model. I would also say you should consider having target levels that vary for different year times. Seems you would want to set targets at or above historic levels and do it for different times of the year. One additional point is that SGMA does allow to continue depletions at historic levels if it is the best you can do. Adding onto the basic SGMA requirement we should try to characterize how we can go above and beyond the basic requirements and have projects that raise levels above historic levels.

Boland – On the graph that shows the water level line with and without pumping - could a similar graph be made for stream flows with and without surface diversion?

Maples– I think it would be possible. I think turning of the pumping in the model is relatively easy to do.

Boland – I don't think it is necessary for the SMC but paints a picture of what is happening in the stream system.
Maples – Yes, it could give some context to pumping relative to surface water deletion.
Boland – Certain years and times of year are more important.

Zimmer – The original SRP model modelled all diversions as groundwater pumping. We have some data from the 2014-2015 drought. Data show that surface water diversions are not the major type of diversion in the summer and groundwater pumping becomes more prevalent due to supply, there isn't enough surface water to divert. That is the pattern that surface water diversions can drop off during the summer.
Andy Rich – I think the total surface water rights is about 200 acre-feet per year total face value within the subbasin. My gut feeling is the 200 acre-feet per year value is going to be a lot smaller than the total stream flow depletion caused by overall pumping in the basin and areas outside it. I don't think removing the surface water rights will cause a big change in the overall stream flow.
Maples – The model suggests it is much more than the 200-acre feet of stream flow depletion due to pumping.
Boland – If you pair it with management actions that involve coordinate surface water activities, it may make the depletion more reasonable.
Lisa Parker – One could also say that it is significant but not unreasonable. It could be significant for other reasons. If it doesn't affect beneficial users, then it isn't unreasonable.
Boland – I think you should keep in mind what management actions could be done.

Jasperse (chat) – What about wells pumping under riparian rights?
Boland. The Russian River is unique. Riparian rights aren't subject to the authority of SGMA. I believe the well pumping into the riparian rights would not be contributing to depletions as defined by SGMA.

Rohde – It would be good to understand what biological flow requirements are necessary for key ecological assets identified as being a GDE or endangered and seeing what their needs are when establishing aspirational measurable objectives. If people will have to reduce or cease pumping to achieve a measurable objective, it will have to be for a good reason.

Hall – I assume you are open to receiving feedback after this meeting about what was presented today?
Trotta – Yes, Stephen's presentations will be sent to you with specific questions.

Natalie Stork – You have all done some great work and I appreciate getting everyone together to provide feedback. Very helpful conversations. Thank you for sharing.

Rogers – I believe that whatever thresholds we come up with, they need to have a linkage to what the impact is to the beneficial use of the surface water. I am looking forward to working with everyone to figure out what this might be.

Andrew Renshaw – I would like to emphasize bullet #4 on slide 16. One thing to consider is developing a plan and schedule for filling data gaps and describing how you would move from an interim type SMC to something more permanent.

Representative Monitoring Point (RMP) Overview and Next Steps

Marcus Trotta shared the work currently being done related to identifying Representative Monitoring Points for surface water depletion and presented maps.

Questions/Comments

Maxfield (chat) – Can files of these maps be shared with us? I would like to look at them more closely and it is hard to read them here.

Trotta – Yes, we will send out the maps and hydrographs.

Review Meeting Action Items / Next steps

Marcus covered next steps in developing SMC for Depletion of Interconnected Surface Water that include:

1. *Continue developing DRAFT Significant and Unreasonable Statement*
2. *Complete GDE and ISW mapping*
3. *Further evaluate potential RMP network*
4. *Develop draft SMC at each proposed RMP based on potential methodology*
5. *Provide update on potential methodology at January AC meetings*

Marcus suggested Sam schedule an additional meeting for this group in early January.

Jay Jasperse reiterated there is lots of work ahead of us. He thanked the folks for participating and wished everyone happy holidays.

Questions/Comments

Hall (chat) – Thanks to you folks at the GSA - thanks for the opportunity to weigh in. I look forward to seeing the materials, digging in a bit more, and hopefully providing some useful input.

Attendees

Jessie Maxfield, CA Department of Fish and Wildlife
Natalie Stork, State Water Resources Control Board
Val Zimmer, State Water Resources Control Board
Sam Boland-Brien, State Water Resources Control Board
Maurice Hall, Environmental Defense Fund
Melissa Rohde, The Nature Conservancy
Rick Rogers, National Marine Fisheries Service
Andrew Renshaw, Dept. of Water Resources

Lisa Porta, Montgomery & Associates
Georgina King, Montgomery & Associates
Jay Jasperse, Sonoma Water
Marcus Trotta, Sonoma Water
Andy Rich, Sonoma Water
Mitch Buttress, Sonoma Water
Stephen Maples, Sonoma Water
Sam Magill, Work Group Facilitator
Simone Peters, Sonoma Water (recorder of meeting notes)

SANTA ROSA PLAIN • PETALUMA VALLEY • SONOMA VALLEY

GROUNDWATER SUSTAINABILITY AGENCIES

SUSTAINABLE MANAGEMENT CRITERIA FOR DEPLETION OF INTERCONNECTED SURFACE WATER

Time	Agenda Item
1:00	Agenda Review and Work Group Introductions Sam Magill , Work Group Facilitator All Work Group Participants
1:05	Summary of ISW SMC Work Group Input to Date Sam Magill
1:15	Review and Discuss Draft Significant and Unreasonable Conditions Statement • Review Initial Draft Statement • Summary of Previous Advisory Committee Input • Review Updated Draft Statement Marcus Trotta, Sonoma Water Sam Magill
1:35	Potential Methodology for Determining ISW SMC • Correlation Assessment of Simulated Streamflow Depletion with Groundwater Levels • Discussion of Potential Methodology Approaches for establishing minimum thresholds (MTs) and measurable objectives (MOs) Marcus Trotta Stephen Maples, Sonoma Water
2:35	Representative Monitoring Point (RMP) Overview and Next Steps Marcus Trotta, Sonoma Water
2:55	
3:00	Meeting Adjourns

Summary of ISW SMC Work Group Input to Date

Summary of Initial Work Group Input from 10/7 Meeting

- Characterizing hydrologic variability is important
- Measuring potential impacts and defining cause/effect to surface water depletion is important for establishing MTs
- Start by defining where the critical areas for preserving surface water levels; placing monitoring at these “choke points” could help define impacts
- Analysis is promising, and shows the connection between groundwater levels and stream flows
- 2015 baseline- using a dry year could lower MTs; use a variety of document water years and habitat conditions
- Think about in terms of what can be done to manage the SMC
- Recommend developing significant and unreasonable statement to guide SMC development

Review and Discuss Draft Significant and Unreasonable Conditions Statement

Significant & Unreasonable Depletion of Interconnected Surface Water

Statement of **Significant & Unreasonable** is a qualitative statement describing groundwater conditions unacceptable to beneficial uses and users of water in the basin. These describe what conditions are to be avoided and serve as an initial framework around which the quantitative SMC are developed.

As defined in the draft DWR SMC BMP (DWR, 2017), statements of significant and unreasonable conditions should identify the following:

- Who or what is impacted by significant and unreasonable conditions,
- What kind of impact constitutes significant and unreasonable,
- Over what time period are conditions significant and unreasonable, and
- Over what geographic area are conditions evaluated.

Example Statements from Other GSPs

Santa Cruz Mid-County Basin GSP:

Significant and unreasonable depletion of surface water due to groundwater extraction, in interconnected streams supporting priority species, would be undesirable if there is more depletion than experienced since the start of shallow groundwater level monitoring through 2015.

Eastern San Joaquin and Merced GSPs:

Significant and unreasonable depletions of interconnected surface water in the Eastern San Joaquin Subbasin are depletions that result in reductions in flow or levels of major rivers and streams that are hydrologically connected to the basin such that the reduced surface water flow or levels have a significant adverse impact on beneficial uses and users of the surface water within the Subbasin over the planning and implementation horizon of this GSP.

Example Statements from Other GSPs

Salinas 180/400 Subbasin GSP:

Significant and unreasonable depletion of interconnected surface water in theSubbasin is depletion of interconnected surface water flows that may prevent the MCWRA from meeting biological flow requirements in the Salinas River, or would induce an unreasonable impact on other beneficial uses and users such as surface water rights holders. The GSA does not have authority to manage reservoir releases and is not required to manage surface waters.

Cayuma Basin GSP:

Significant and unreasonable depletions of interconnected surface water are reductions in the viability of agriculture or riparian habitat within the Basin over the planning and implementation horizon of this GSP.

Significant and Unreasonable Conditions- Initial Advisory Committee Input

- **Who/what is impacted by S&U conditions?**
  - Recreation
  - Water well levels
  - Desiccation of riparian vegetation/habitat or direct impacts to species
  - Surface water rights holders (particularly in late summer/fall)
  - Specific areas of impact:
    - Nathanson Creek
    - Other?

Advisory Committee Input (cont.)

- **What kind of impact constitutes S&U?**
  - Easter San Joaquin model may be useful- maintain stream flows to protect beneficial users and uses
  - Lowering of static and dynamic well-water levels could be an early warning trend
  - Any groundwater pumping activities which stop or reverse recovery of sensitive species
  - Repeated or progressive surface water depletions impacting surface water withdrawal

Initial Advisory Committee Input (cont.)

- **Over what time period are conditions S&U?**
  - Year round- there could be negative impacts in wet months due to over pumping
  - Year-to-year surface water depletions can severely impact species (in addition to impacts within a single year)
  - Over various water-year types- impacts are dependent on how much/how little rainfall in a given year

Initial Advisory Committee Input (cont.)

- **Over what geographic area are conditions evaluated?**
  - Atascadero/Green Valley Creeks serve as recharge for Sebastopol-to-Graton GSA should be included
  - Areas near stream channels not already encroached on/urbanized
  - Critical recharge areas
  - Stream courses/wetlands with high past/current saturation zones

Current Strawman Significant and Unreasonable Statement

Significant and unreasonable depletion of surface water from interconnected streams, occurs when groundwater pumping within the Basin/Subbasin depletes streamflows below historical levels and adversely impacts the viability of GDEs or other beneficial surface water users.

Potential Methodology for Determining ISW SMC

Potential Methodology for Determining ISW SMC

1. Correlation Assessment of Simulated Streamflow Depletion with Groundwater Levels
   - Incorporates available historical data and variety of water-year types
   - Analysis of groundwater pumping effects on surface water depletion
   - Use simulation analysis and historical data together to inform selection of SMCs
   - Allow for any potential future instream flow requirements, etc.

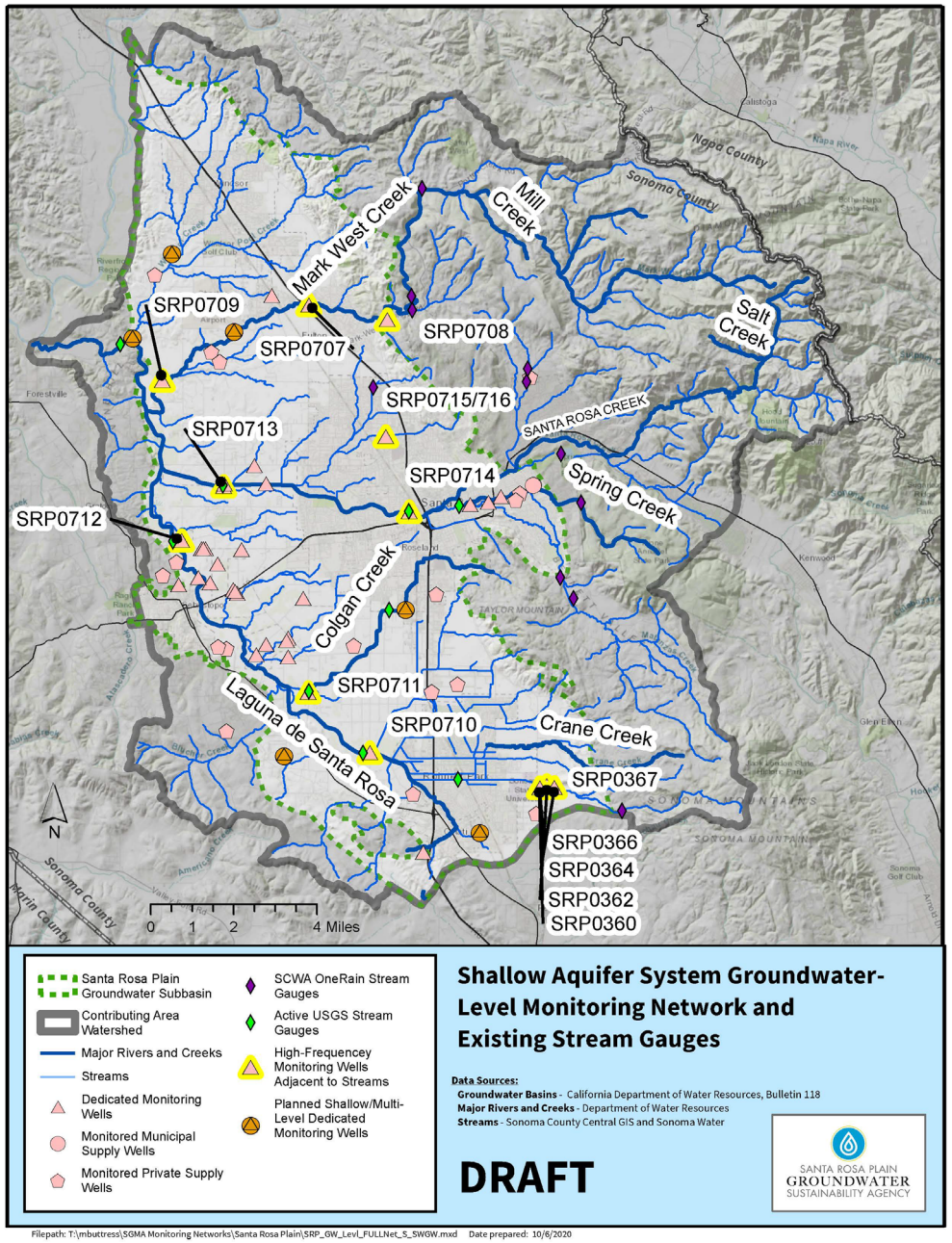
2. Discussion of potential methodology approaches for establishing minimum thresholds (MTs) and measurable objectives (MOs)

Strawman Methodology for Determining ISW SMC

Strawman proposal for setting "interim" SMCs while we work to build datasets and model capabilities during GSP implementation:

1. For RMPs where we have less than 5-years of data, use Fall groundwater-level contour maps of shallow aquifer system from year with greatest simulated SWD (eg, Fall 2015 for SRP) to pick MT elevations at the locations of the RMPs
2. For any RMPs with >5 years of data, use measured historical low elevations
3. For MOs, pick a year representative of lower values of SWD or set "aspirational" MO of maintaining GWLs above streambed?
4. Include a detailed plan in the GSP for how we will build our datasets and improve simulation capabilities to more fully incorporate the correlation assessment methodology we have tested.

Representative Monitoring Point (RMP) Overview and Next Steps


Mark West Creek
Mill Creek
Salt Creek
SRP0709
SRP0708
SRP0707
SRP0715/716
SANTA ROSA CREEK
SRP0713
SRP0714
Spring Creek
SRP0712
Colgan Creek
SRP0711
Laguna de Santa Rosa
SRP0710
Crane Creek
SRP0367
SRP0366
SRP0364
SRP0362
SRP0360
N
0 1 2 4 Miles
Santa Rosa Plain Groundwater Subbasin
Contributing Area Watershed
Major Rivers and Creeks
Streams
Dedicated Monitoring Wells
Monitored Municipal Supply Wells
Monitored Private Supply Wells
SCWA OneRain Stream Gauges
Active USGS Stream Gauges
High-Frequency Monitoring Wells Adjacent to Streams
Planned Shallow/Multi-Level Dedicated Monitoring Wells
Shallow Aquifer System Groundwater-Level Monitoring Network and Existing Stream Gauges
Data Sources:
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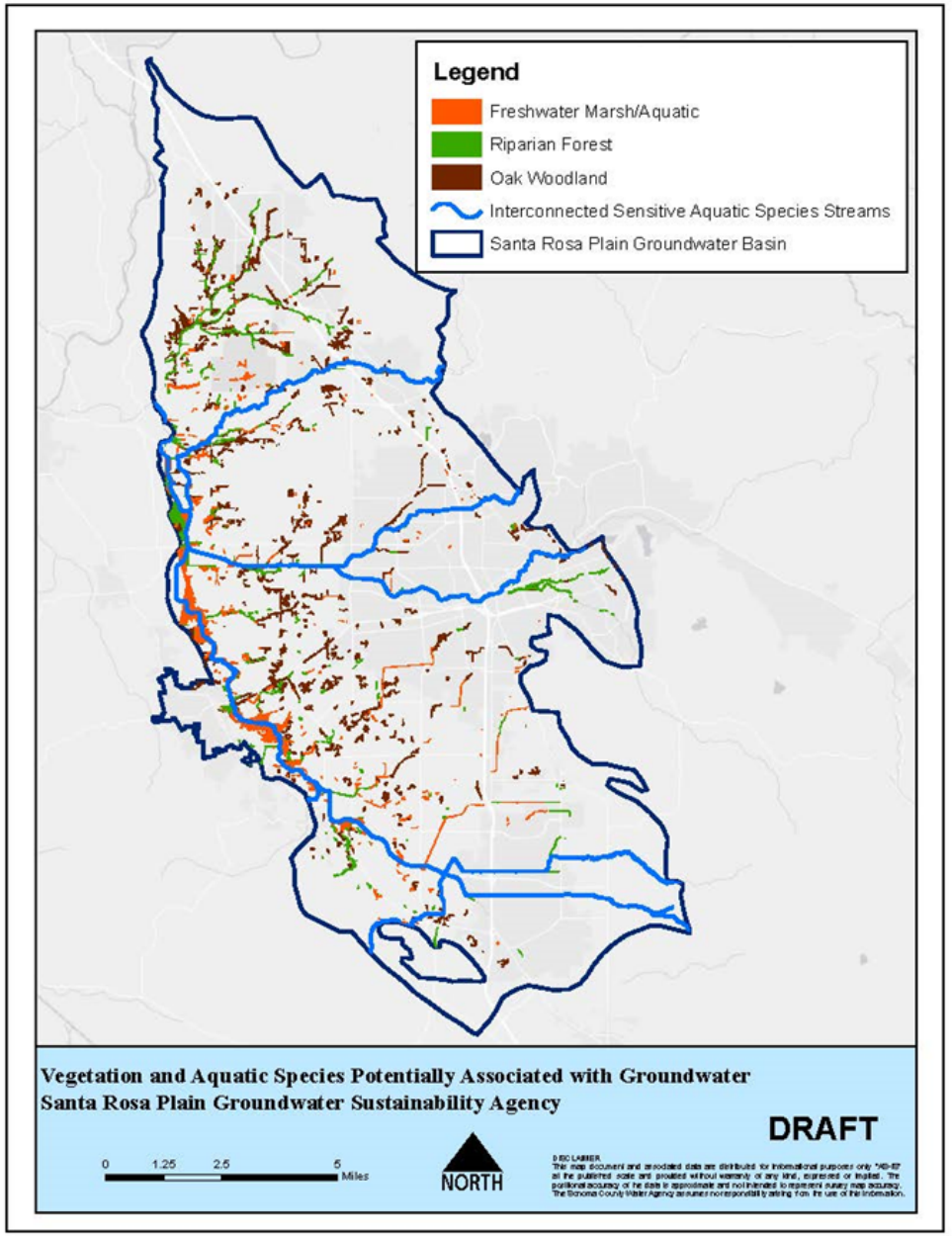
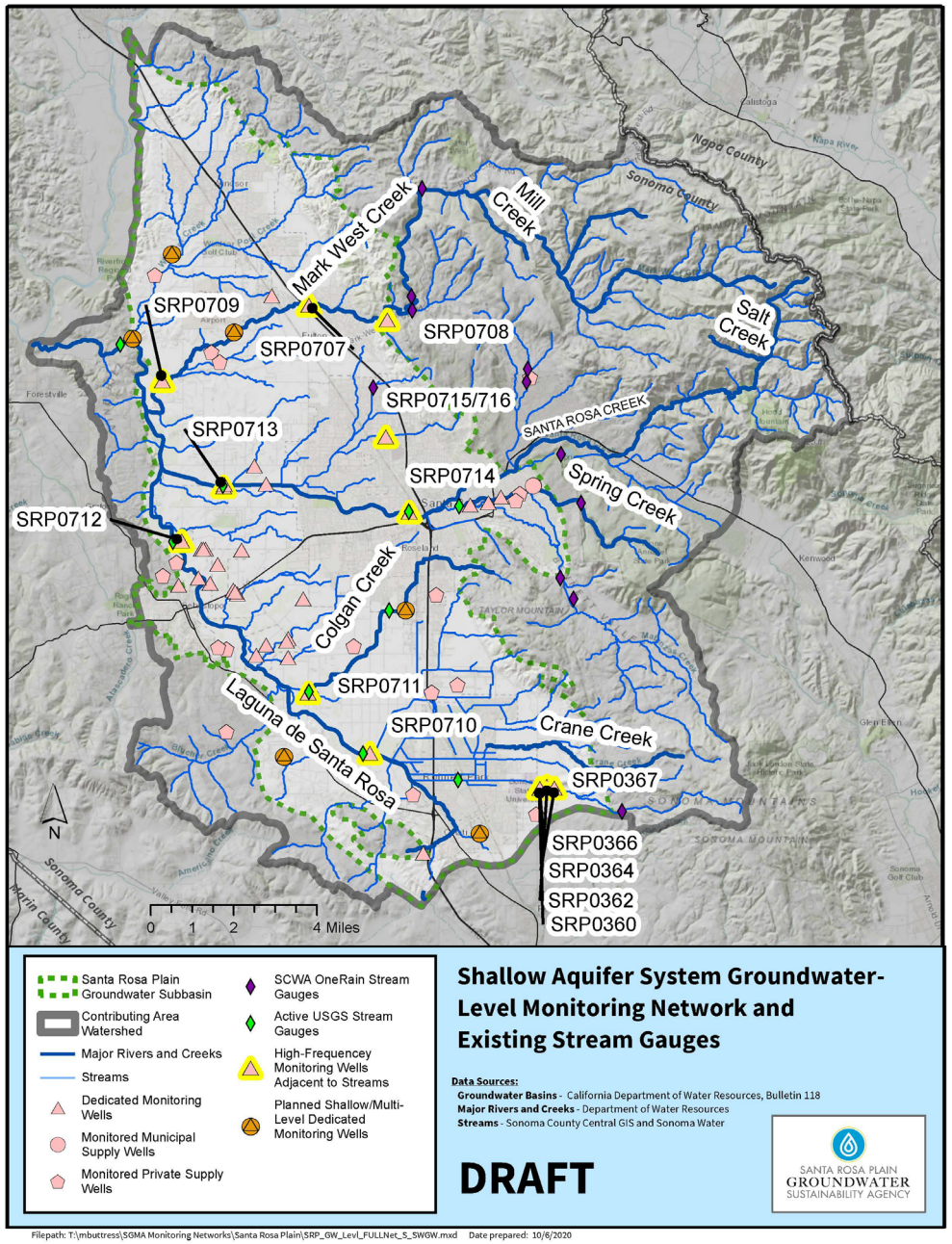
SANTA ROSA PLAIN GROUNDWATER SUSTAINABILITY AGENCY
Filepath: T:\mbuttress\SGMA Monitoring Networks\Santa Rosa Plain\SRP_GW_Levl_FULLNet_S_SWGW.mxd Date prepared: 10/6/2020


Legend
Freshwater Marsh/Aquatic
Riparian Forest
Oak Woodland
Interconnected Sensitive Aquatic Species Streams
Santa Rosa Plain Groundwater Basin
Vegetation and Aquatic Species Potentially Associated with Groundwater
Santa Rosa Plain Groundwater Sustainability Agency
DRAFT
0 1.25 2.5 5 Miles
NORTH


Mark West Creek
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Crane Creek
SRP0367
SRP0366
SRP0364
SRP0362
SRP0360
Napa County
Sonoma County
Marin County
N
0 1 2 4 Miles
Santa Rosa Plain Groundwater Subbasin
Contributing Area Watershed
Major Rivers and Creeks
Streams
Dedicated Monitoring Wells
Monitored Municipal Supply Wells
Monitored Private Supply Wells
SCWA OneRain Stream Gauges
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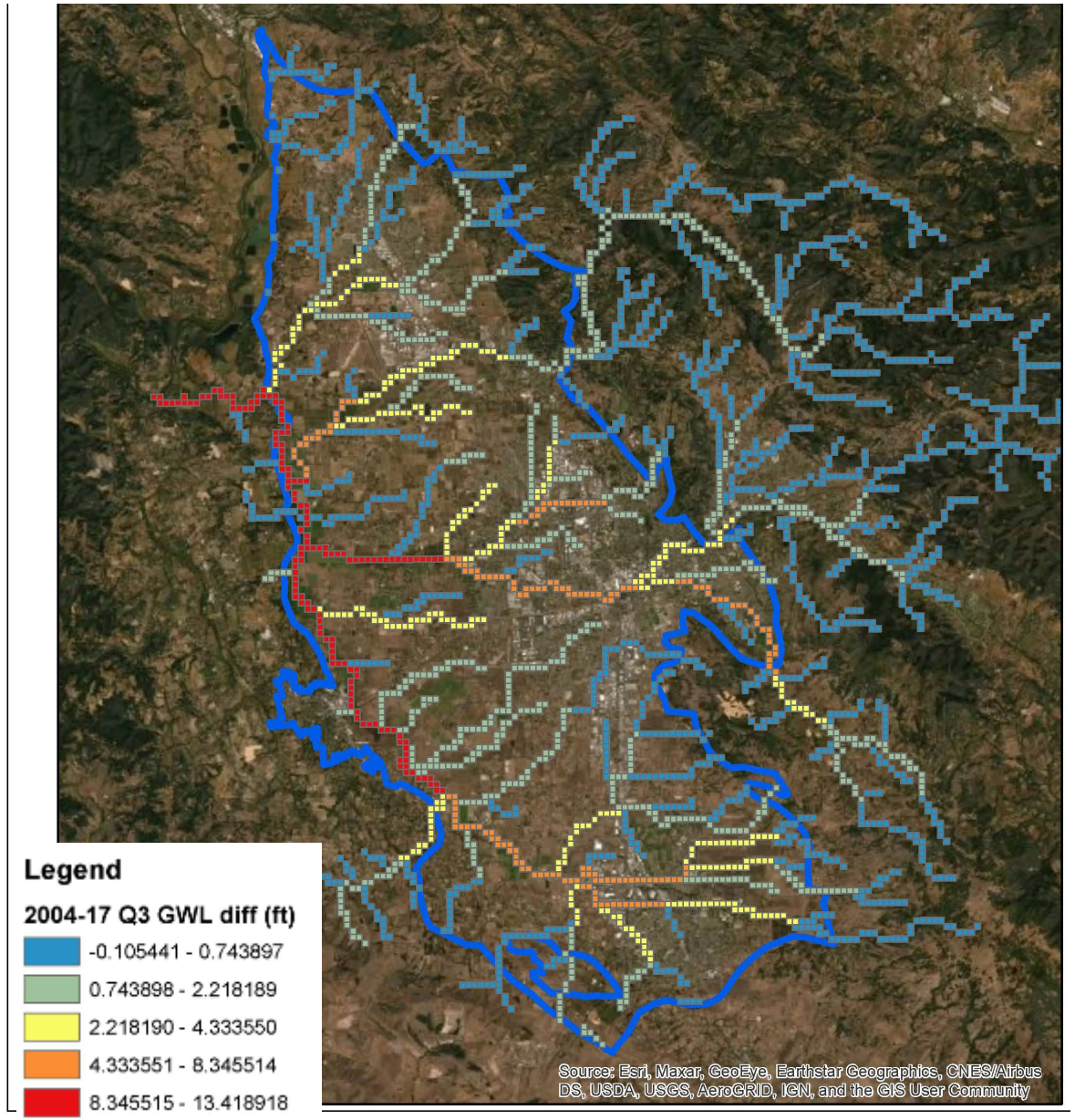
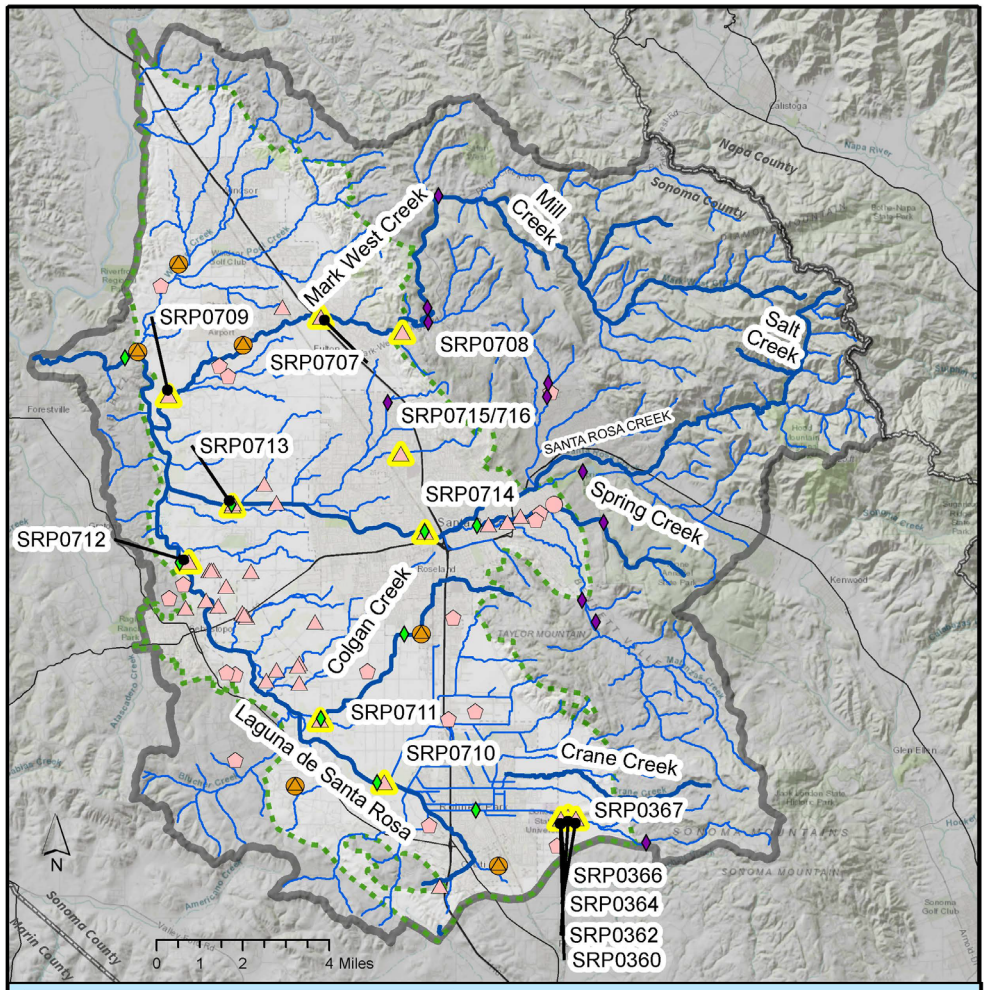
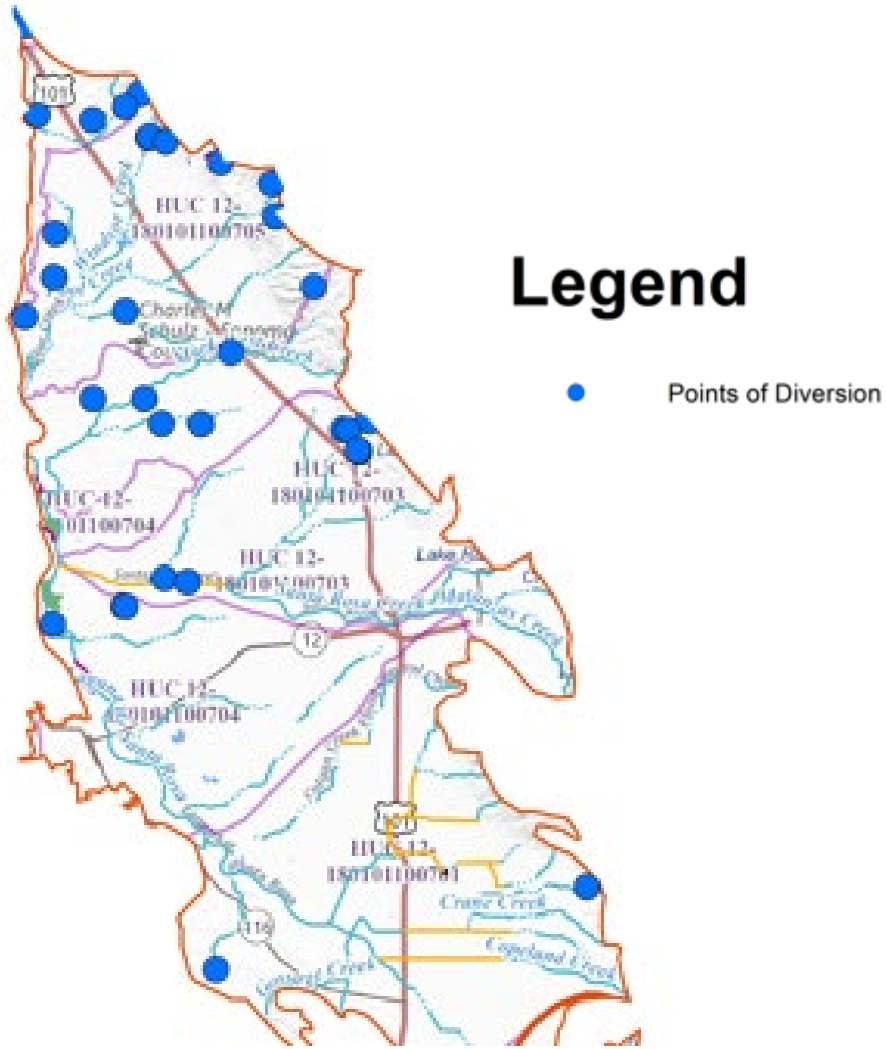

Legend
2004-17 Q3 GWL diff (ft)
-0.105441 - 0.743897
0.743898 - 2.218189
2.218190 - 4.333550
4.333551 - 8.345514
8.345515 - 13.418918
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community





Locations of Surface Water Diversions

Next Steps in Developing SMC for Depletion of Interconnected Surface Water

1. Continue developing DRAFT Significant and Unreasonable Statement
2. Complete GDE and ISW mapping
3. Further evaluate potential RMP network
4. Develop draft SMC at each proposed RMP based on potential methodology
5. Provide update on potential methodology at January AC meetings

SANTA ROSA PLAIN • PETALUMA VALLEY • SONOMA VALLEY

GROUNDWATER SUSTAINABILITY AGENCIES

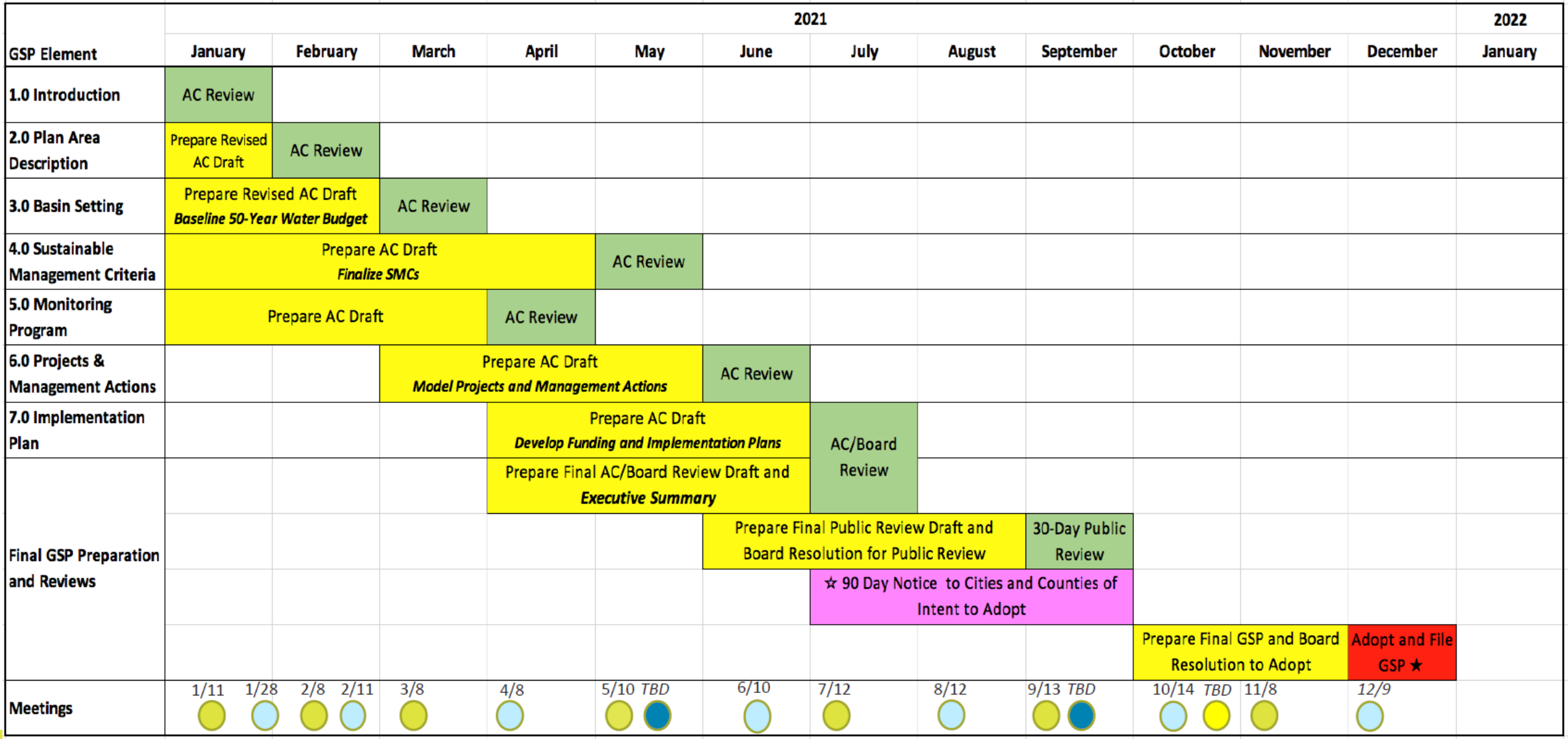
SUSTAINABLE MANAGEMENT CRITERIA FOR DEPLETION OF INTERCONNECTED SURFACE WATER

PRACTITIONER WORK GROUP MEETING #3

Agenda

1. Welcome and Intro (5 min)
2. Schedule (5 min)
3. Revisit SMC S&U and assumptions (15 min)
4. Methodology Options for MTs/MOs (45 min):
    a. Methodology descriptions with examples
    b. Discussion of benefits/issues with each example
    c. Workgroup input on approach preferences
5. Possible options for URs (20 min)
6. Data Gaps and Future Recommended Activities (30 min)
7. Next Steps

DRAFT GSP Schedule – Santa Rosa Plain



GSA Board Meeting GSA Advisory Committee Meeting GSA Community Meeting GSP Public Hearing

Work Group Schedule

January 26 Work Group Meeting (today): *Revisit Significant and Unreasonable statement, recommendations on MT/MO methodology, discuss options for URs, develop initial list of data gaps and future recommended activities for implementation plan*

February 8-10 Advisory Committee (AC) Meetings: Technical staff brief ACs on methodology approach

February 18 - Final Work Group Meeting: *Review draft MTs and MOs for each basin, develop recommendations on options for GSA Board consideration for URs, final list of data gaps and recommendations/prioritization for future activities to further develop SMC*

March 8-10 AC Meetings: Technical staff present Recommendations to ACs (Work Group members welcome to attend, help with questions)

March 11, 22, and 25 GSA Board Meetings: Technical staff present recommendations to GSA Boards for consideration (Work Group members welcome to attend, help with questions)

Revisit Significant and Unreasonable Statement

"Significant and unreasonable conditions" - phrase used to identify conditions that lead to undesirable results - not specifically defined in the GSP Regulations.

Often confused with, or used interchangeably with, undesirable results.

Significant and unreasonable conditions are physical conditions to be avoided; an undesirable result is a quantitative assessment based on minimum thresholds.

Defining significant and unreasonable conditions early in the process of developing SMC for each sustainability indicator helps set the framework by which the quantitative SMC metrics are determined.

Previous S&U Statement

Significant and unreasonable depletion of surface water from interconnected streams, occurs when groundwater pumping within the Basin/Subbasin depletes streamflows below historical levels and adversely impacts the viability of GDEs or other beneficial surface water users.

ISW SMC Practitioner Work Group 12/7/20 Feedback

- Remove reference to “stream flows below historical levels”; the goal is to be protective of stream levels independent of a historical baseline
- Maintain reference to historical levels; may provide reference point for long-term health of streams and potential impacts or fluctuations in groundwater usage
- “Stream flows” may be too restrictive; consider using “surface water” generally to cover groundwater impacts to wetlands as well
- Consider replacing “significant and unreasonable” with “adverse impacts to beneficial uses.”

Revised Strawman Significant and Unreasonable Statement

Significant and unreasonable depletion of surface water from interconnected streams occurs when surface water depletion, caused by groundwater pumping within the Basin/Subbasin, exceeds ~~depletes streamflows below~~ historical depletion ~~and~~ or adversely impacts the viability of groundwater dependent ecosystems (GDEs) or other beneficial users of surface water ~~users~~.

Notes/definitions:

- Provides guidance for technical staff to move forward with methodology based on available historical information and allows for future incorporation of flow targets or other information concerning adverse impacts to beneficial users developed by others
- "Groundwater pumping" excludes any diversions by surface water rights holders
- "Historical levels" to be defined using minimum threshold methodology
- "groundwater dependent ecosystems" defined in Basin Setting
- "other beneficial users of surface water" include surface water rights holders and recreational uses (where applicable)

Potential Methodology for Determining ISW SMC

Potential Methodology for Determining ISW SMC

Correlation Assessment of Simulated Streamflow Depletion with Groundwater Levels

- Incorporate available historical data and variety of water-year types
- Analysis of groundwater pumping effects on surface water depletion
- Use simulation analysis and historical data together to inform selection of SMCs
- Allow for any potential future instream flow requirements, etc.
- Include a detailed plan in the GSP for how we will build our datasets and improve simulation capabilities to more fully incorporate the correlation assessment methodology we have tested.

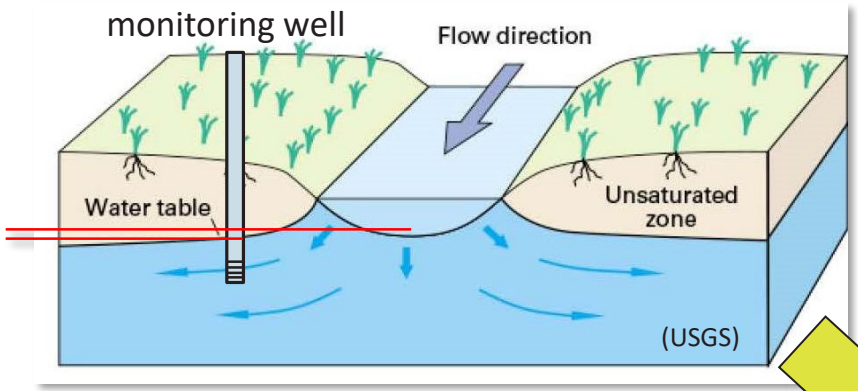
Challenges:

- At majority of potential Representative Monitoring Points (RMPs), we only have one years worth of groundwater-level data
- Variable levels of correlation between simulated streamflow depletion and groundwater levels
- Potential instream flow targets not available
- Limited data and information for assessing presence of any historical significant and unreasonable conditions

ISW SMC Practitioner Work Group Feedback on SMC Methodology Approaches

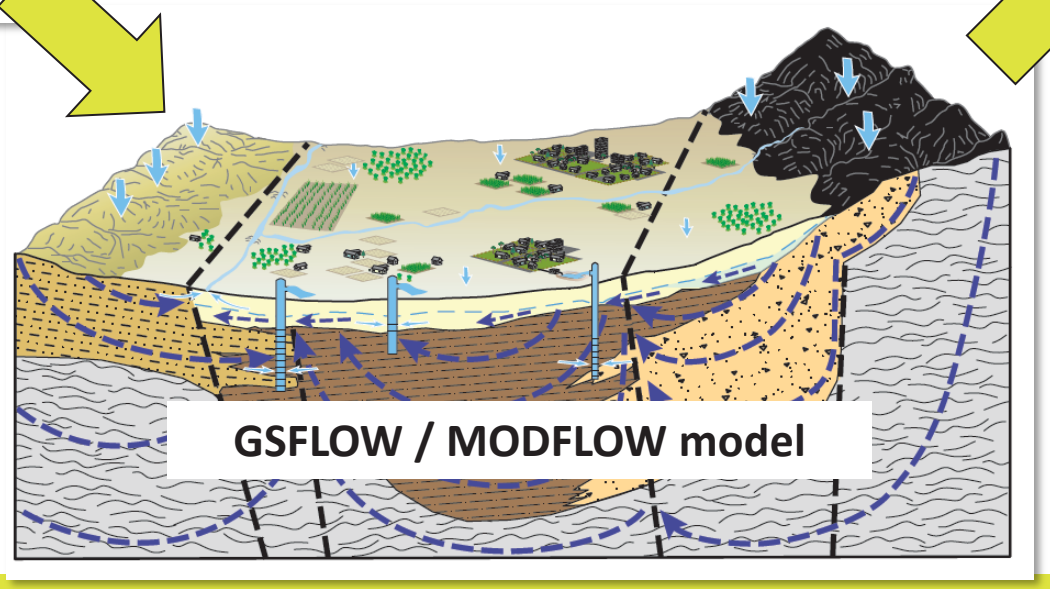
- General support for straw methodology
- Clearly linking stream flow depletion to adverse impacts from groundwater usage is important for successful implementation of the SMC
- Thresholds should not be set to one or more severe droughts in the historical records
- Linking existing biological flow requirements to the SMC may help illustrate the importance of any actions associated with the SMC
- The SMC will require an explanation of when data gaps will be filled in during the GSP implementation process

How can we leverage measurements and models to characterize GW/SW interactions and SW depletion?

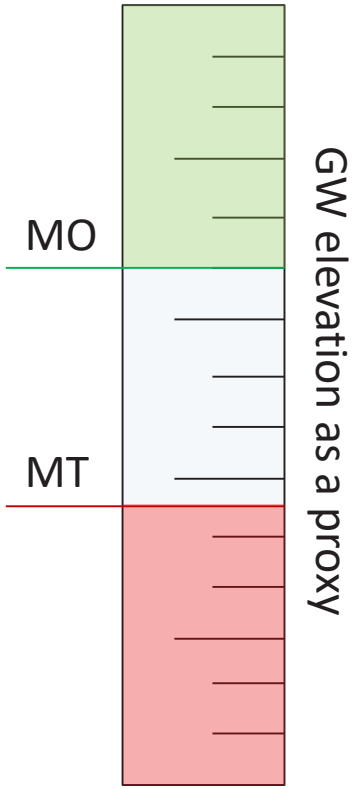


Local GW elevation (measured/simulated)

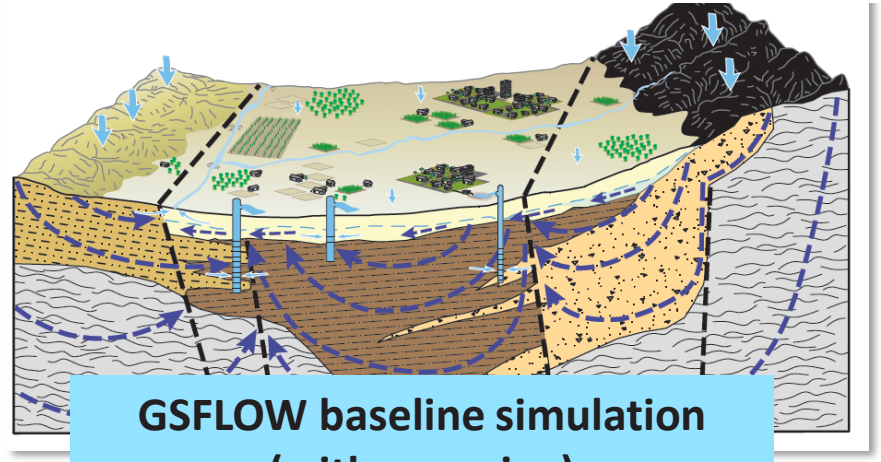
Regional SW depletion characterization (simulated)



SMCs are tied to GW elevations and informed by simulation results

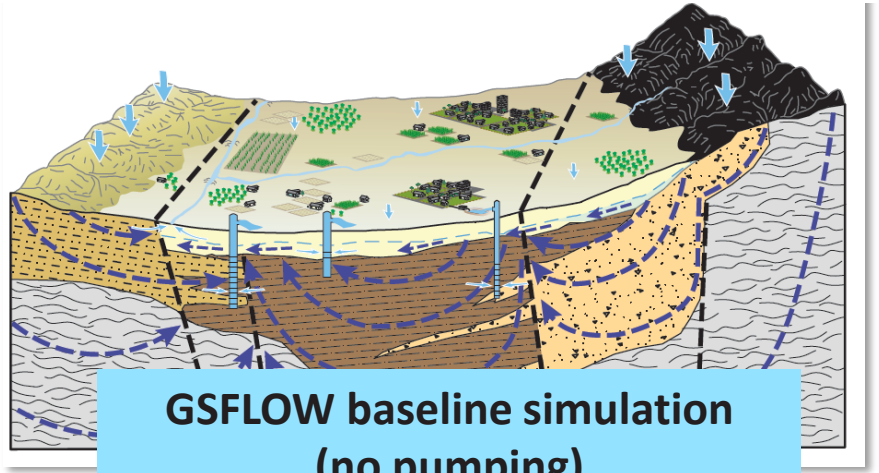


Isolate GW pumping impacts by “differencing” a historical baseline simulation (with pumping) from a identical simulation without pumping



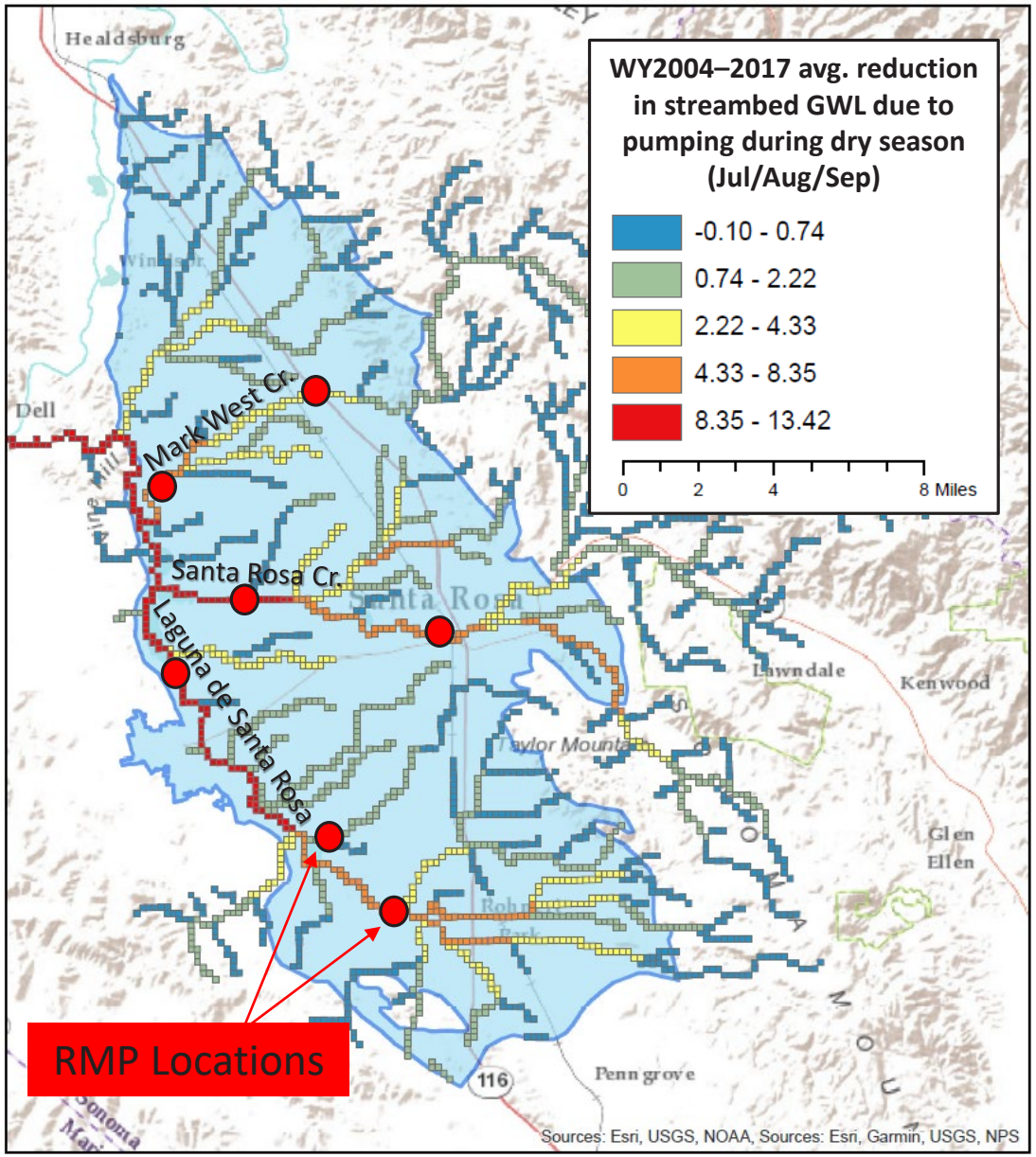
GSFLOW baseline simulation (<u>with</u> pumping)

minus



GSFLOW baseline simulation (<u>no</u> pumping)

Isolate Surface Water Depletion (SWD) from groundwater pumping



Where does pumping have greater potential to impact streamflows?

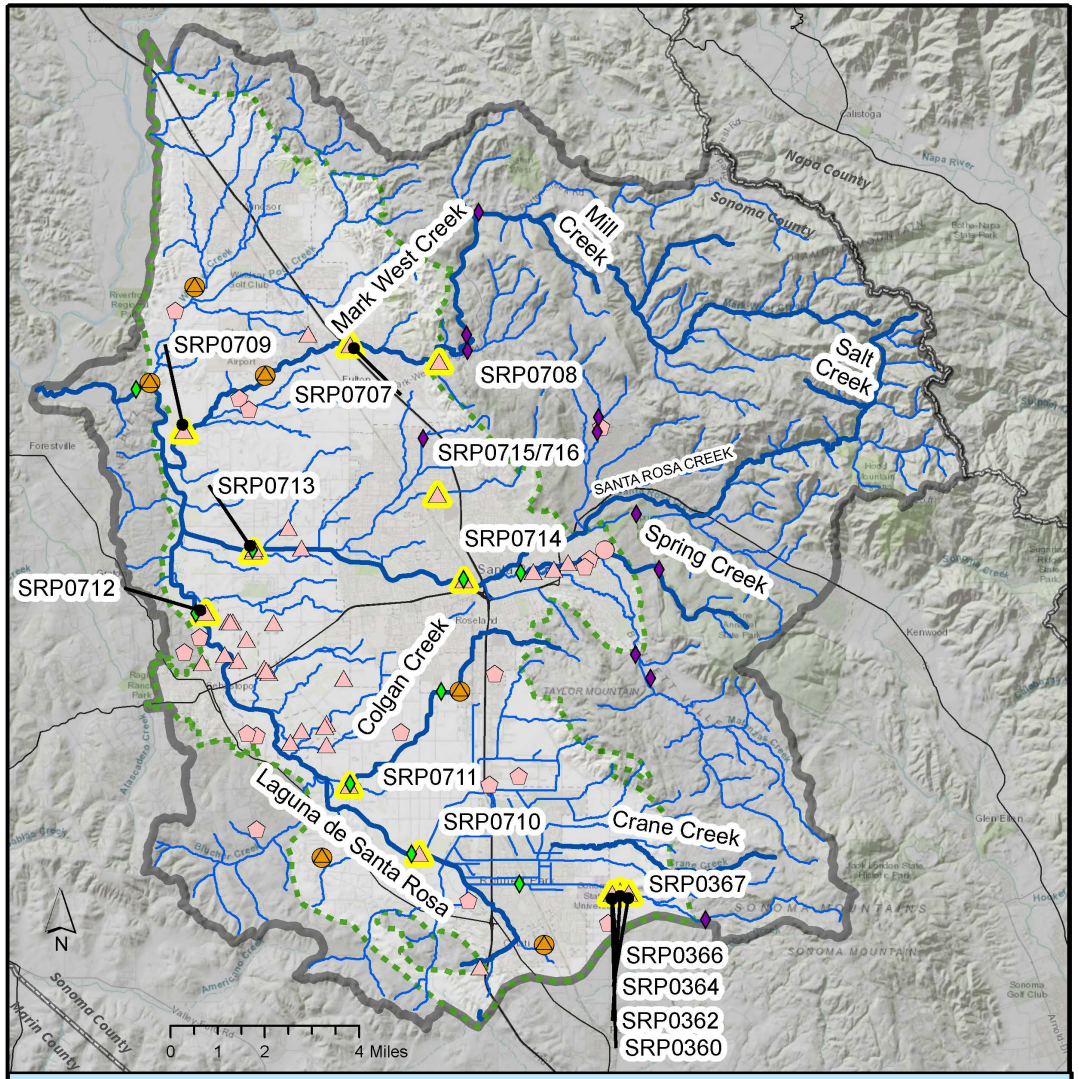
Modeling suggests that pumping has greater potential to impact streamflows on:

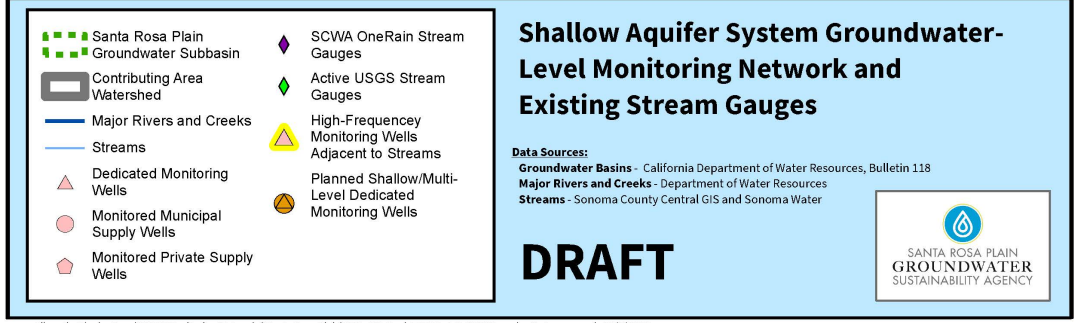
Laguna de Santa Rosa
Santa Rosa Cr.
Mark West Cr.

Actual impacts are very dependent upon:

(1) streambed/shallow aquifer hydraulic conductivity
(2) stream/aquifer configuration

What is the impact of pumping on outflows from the basin?





Shallow Aquifer System Groundwater-Level Monitoring Network and Existing Stream Gauges

Data Sources:
Groundwater Basins - California Department of Water Resources, Bulletin 118
Major Rivers and Creeks - Department of Water Resources
Streams - Sonoma County Central GIS and Sonoma Water

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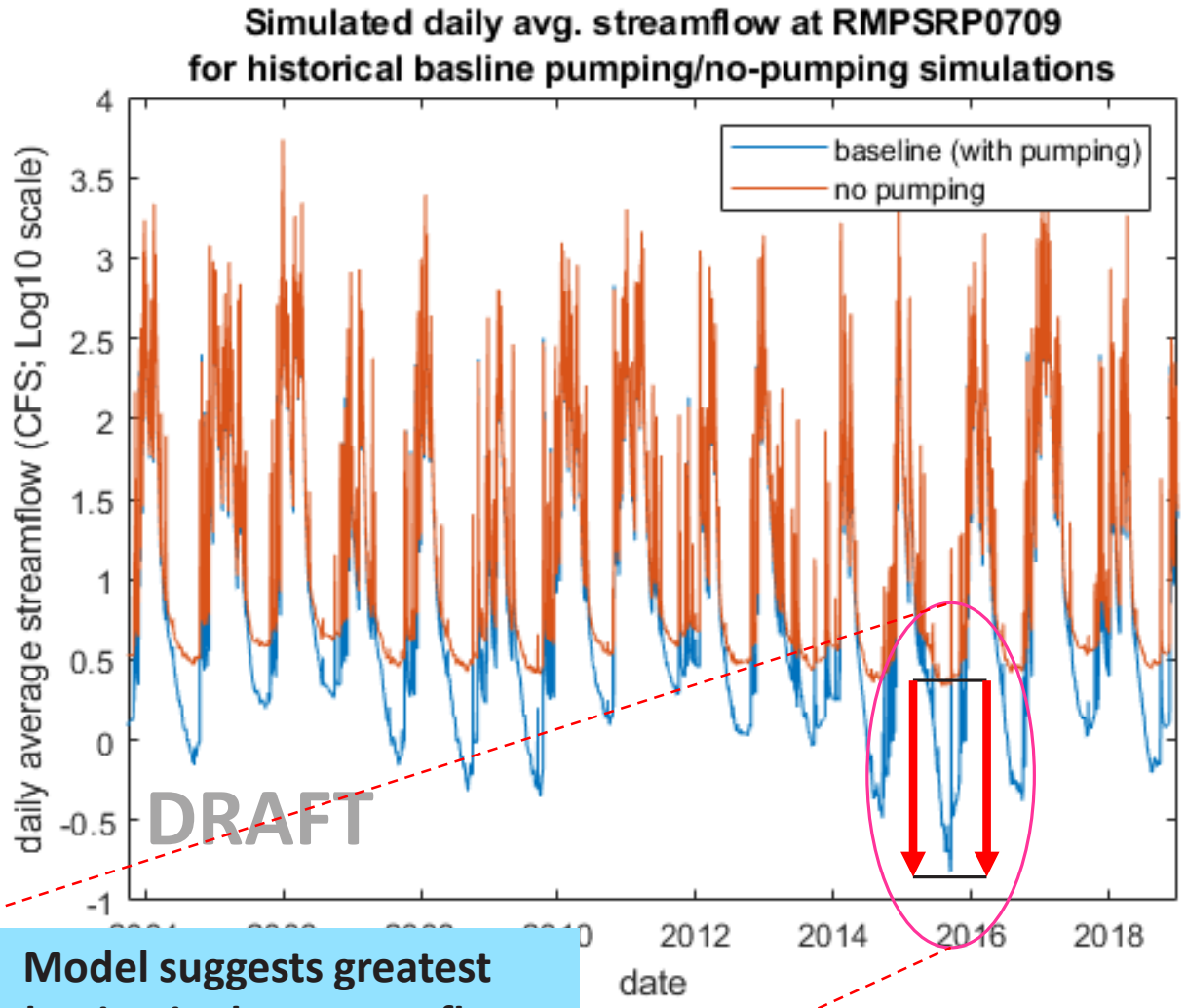
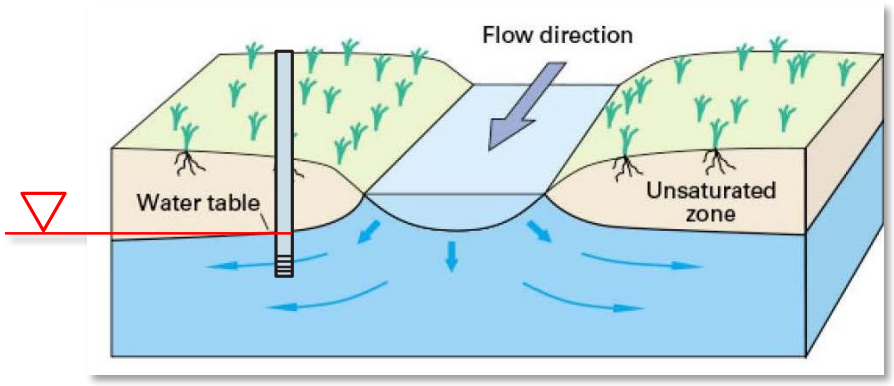
SANTA ROSA PLAIN GROUNDWATER SUSTAINABILITY AGENCY

Filepath: T:\mbuttress\SGMA Monitoring Networks\Santa Rosa Plain\SRP_GW_Levl_FULLNet_S_SWGW.mxd Date prepared: 10/6/2020

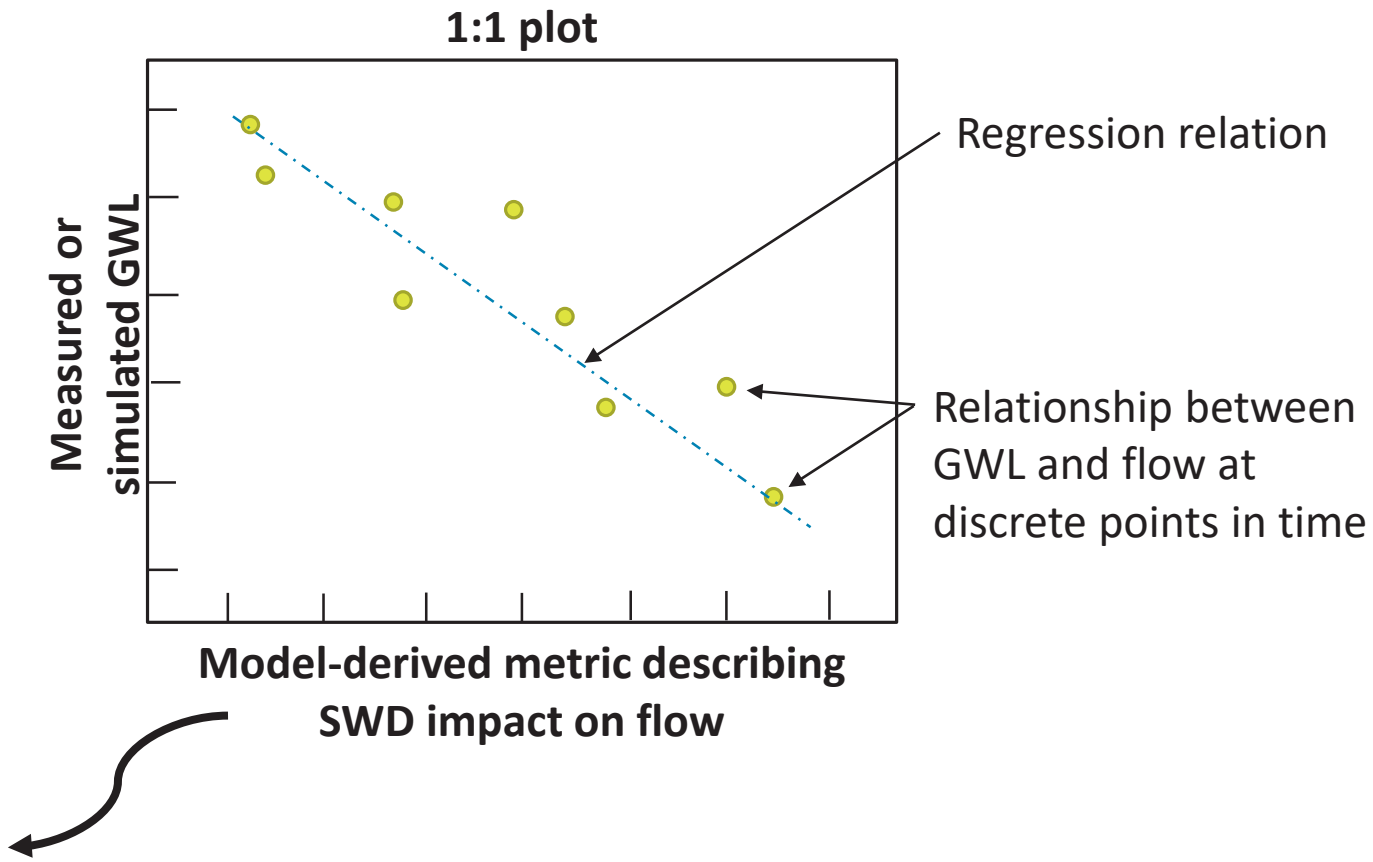


Model suggests greatest reduction in dry-season flows due to pumping during 2015

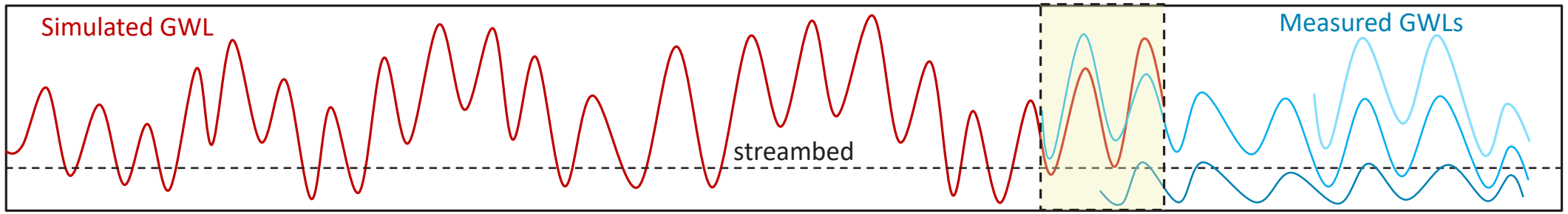
How can GWL be used as a proxy for surface water depletion?



1. **Percent reduction in streamflow due to pumping (over entire WY)**
2. **Percent reduction in streamflow due to pumping (during low-flow periods)**
3. **Number of days that SWD exceeds threshold value**



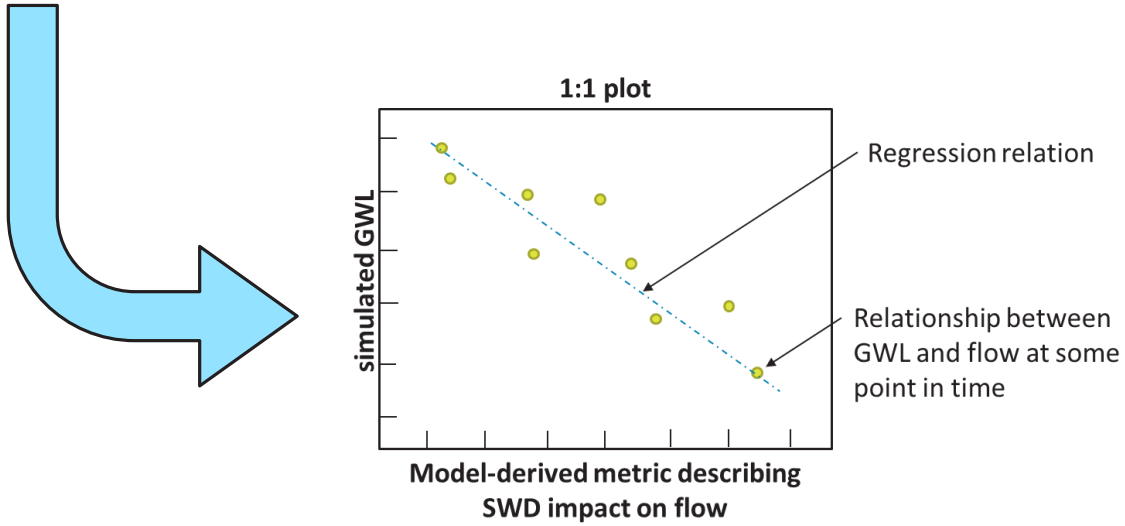
How can GWL – SWD relationship be used to inform SMC choice?



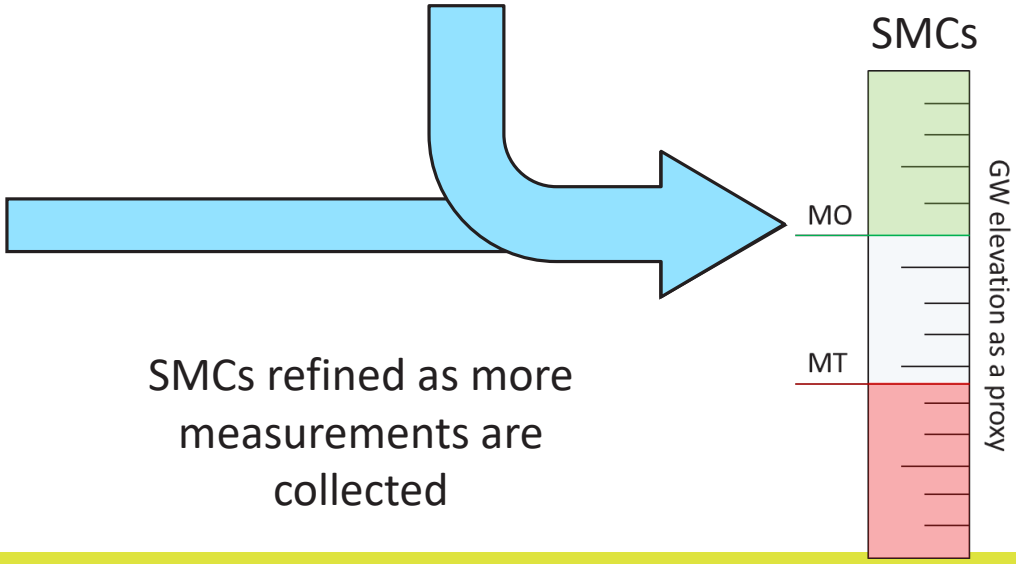
Simulation Period (1974–2018)

Little or no temporal overlap

Measurement Period (recent past-present)



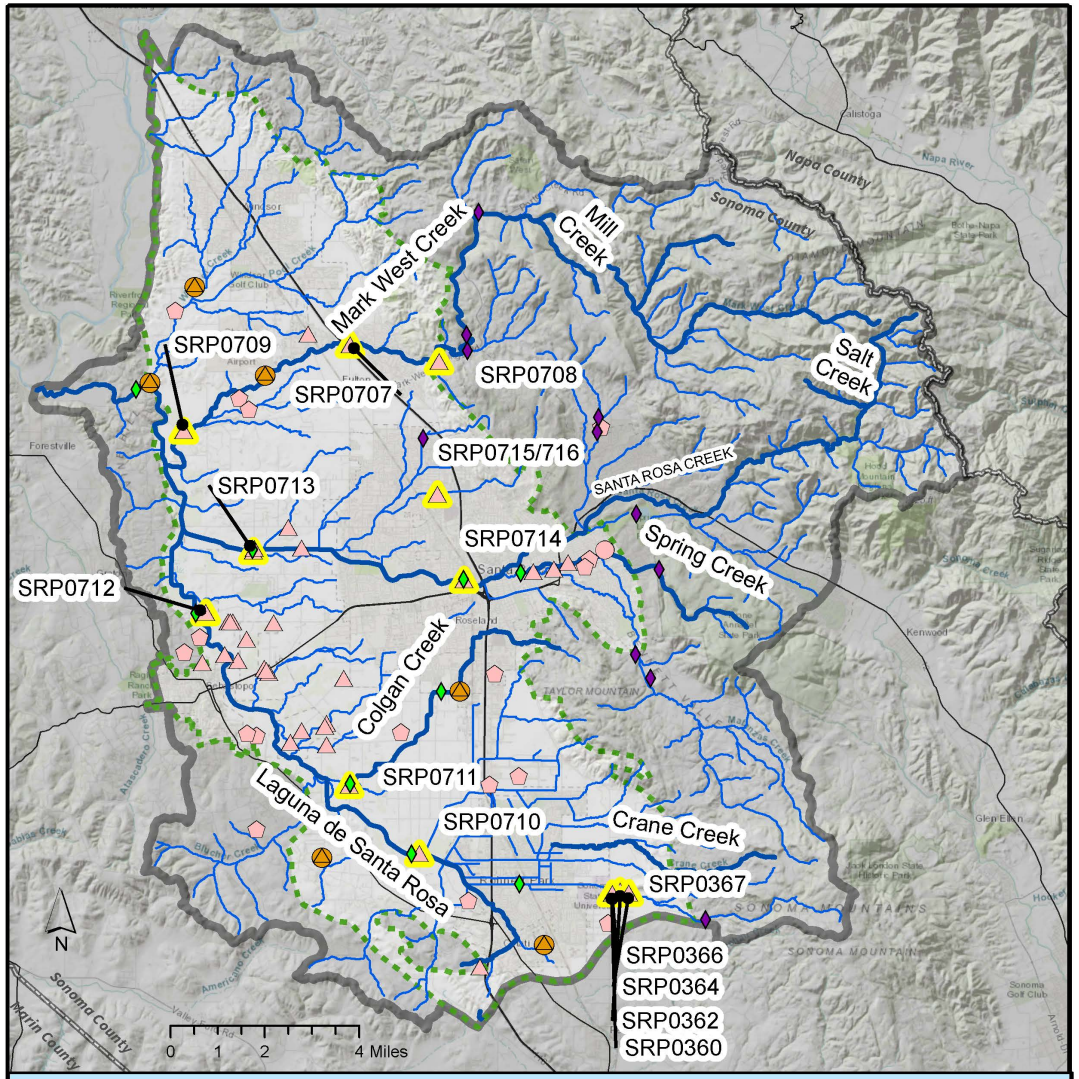
SMC choices informed by modeled SWD

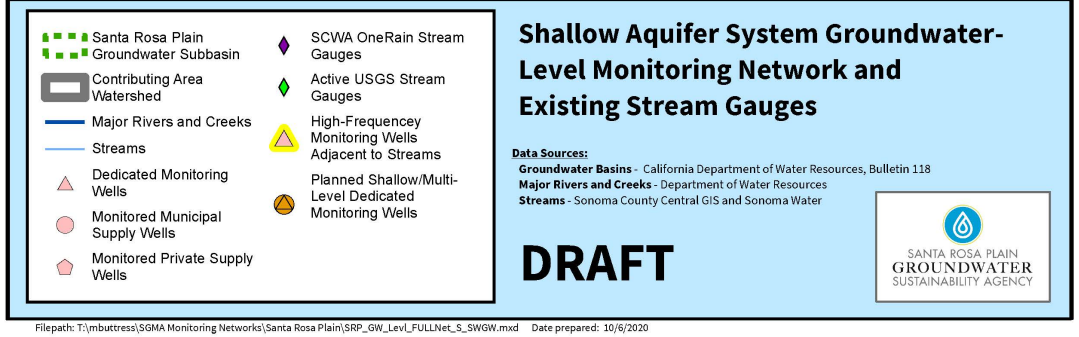


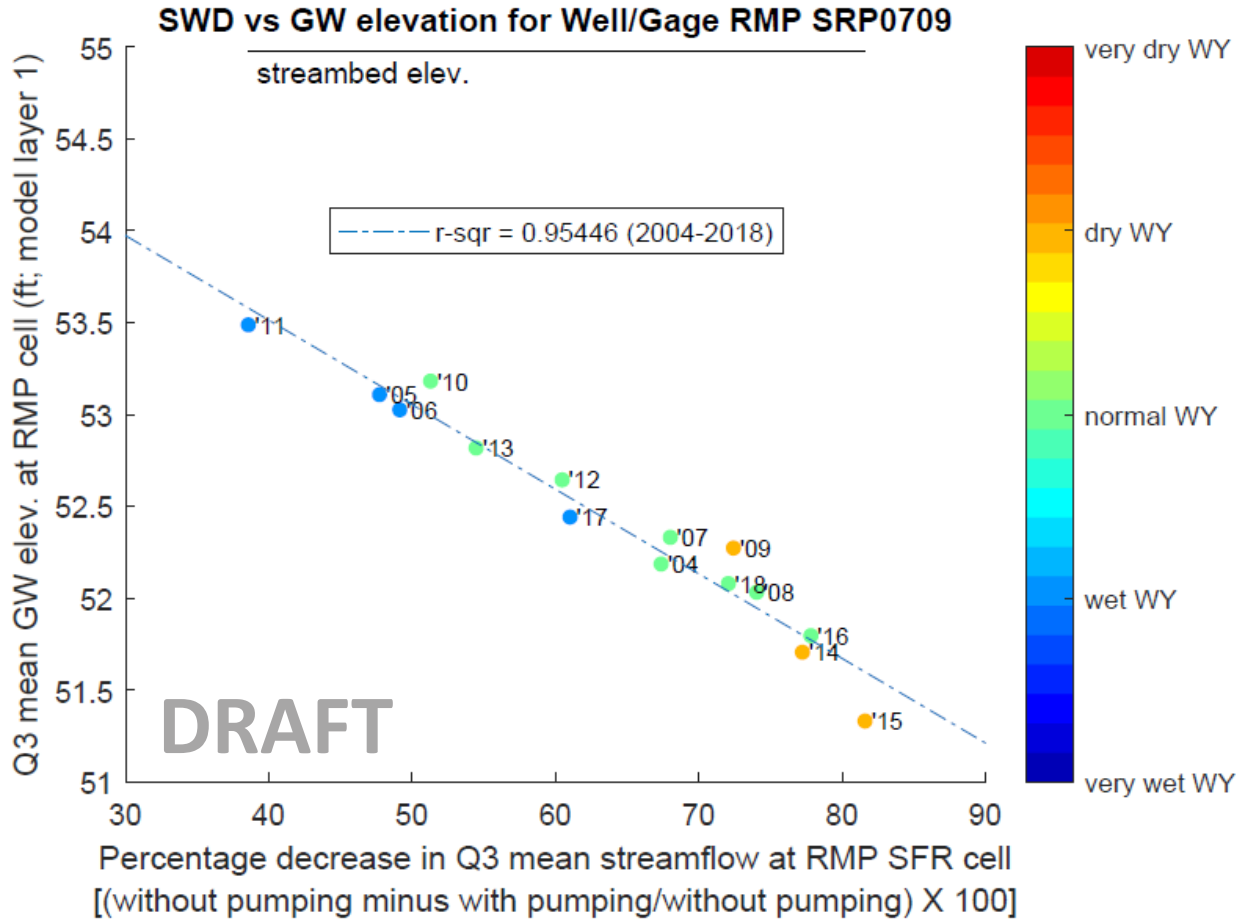
SMCs refined as more measurements are collected

Can we use GW levels as a proxy for SWD?

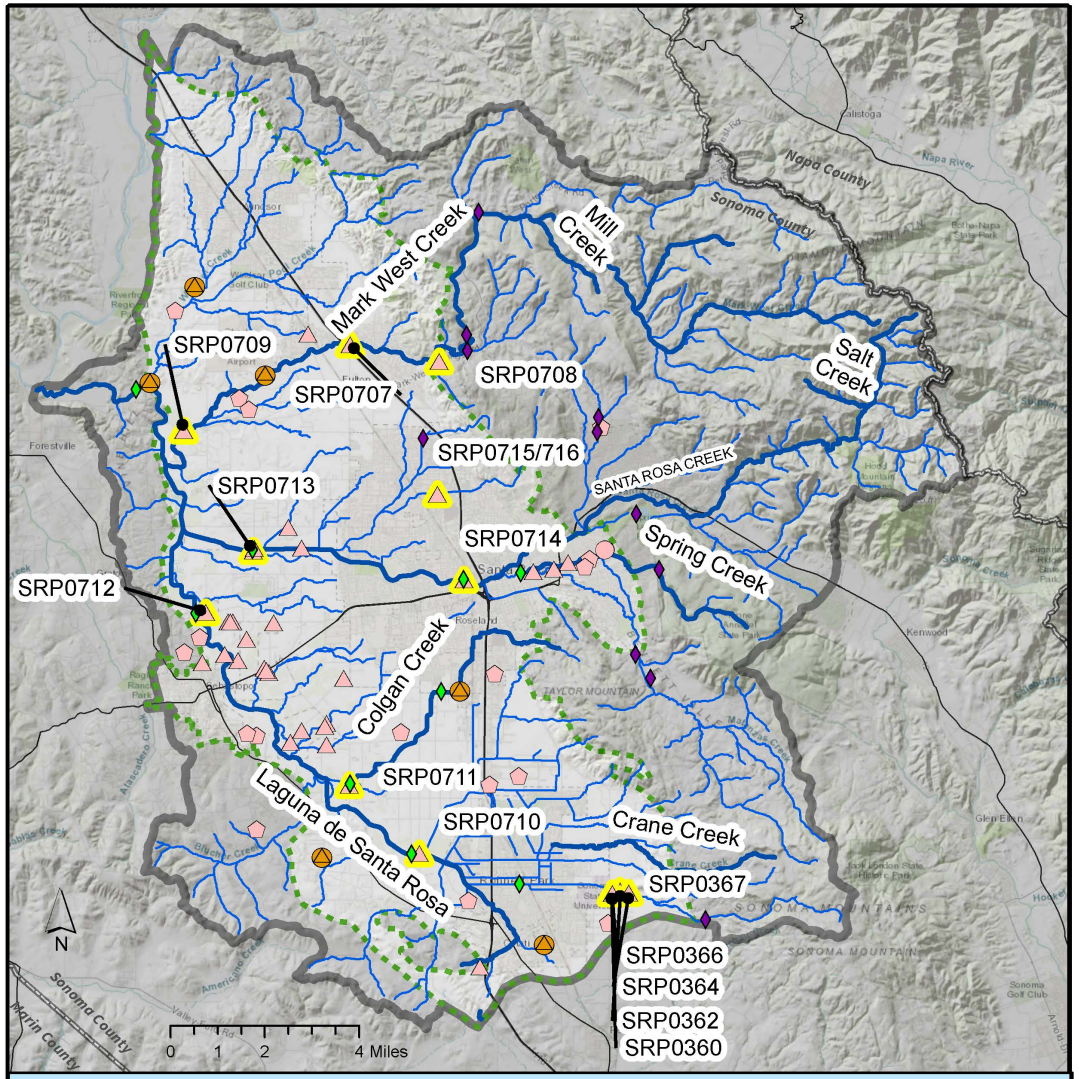
Good correlation … for simulated GW levels and SWD at some RMPs

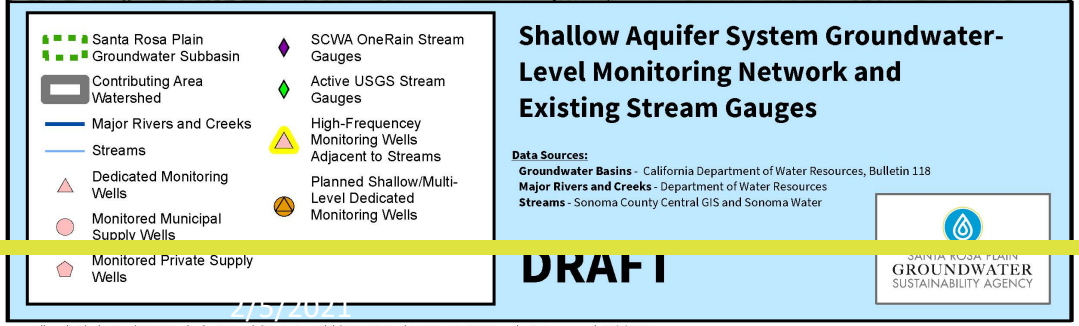


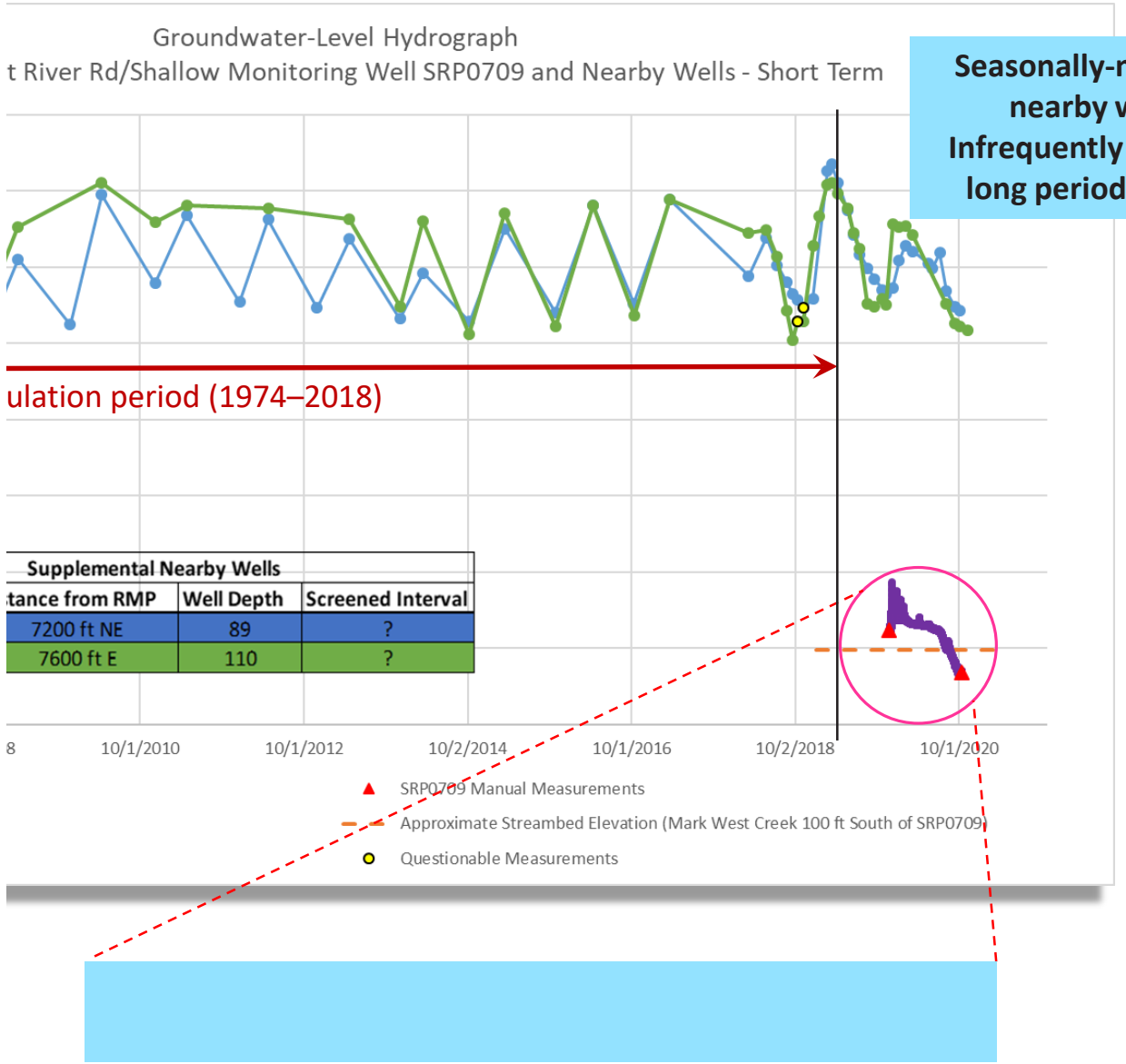




What GWL measurements do we have at RMPs?

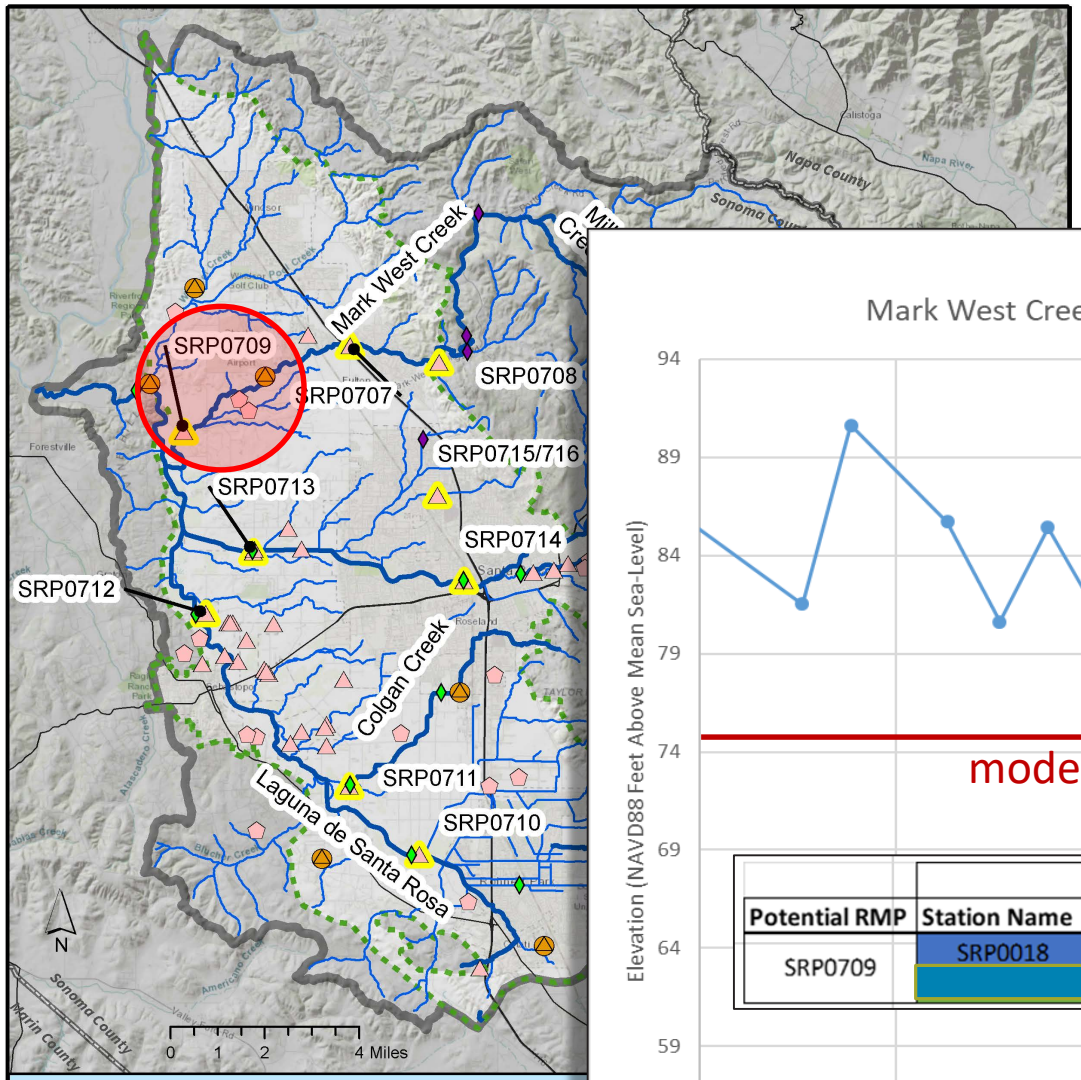


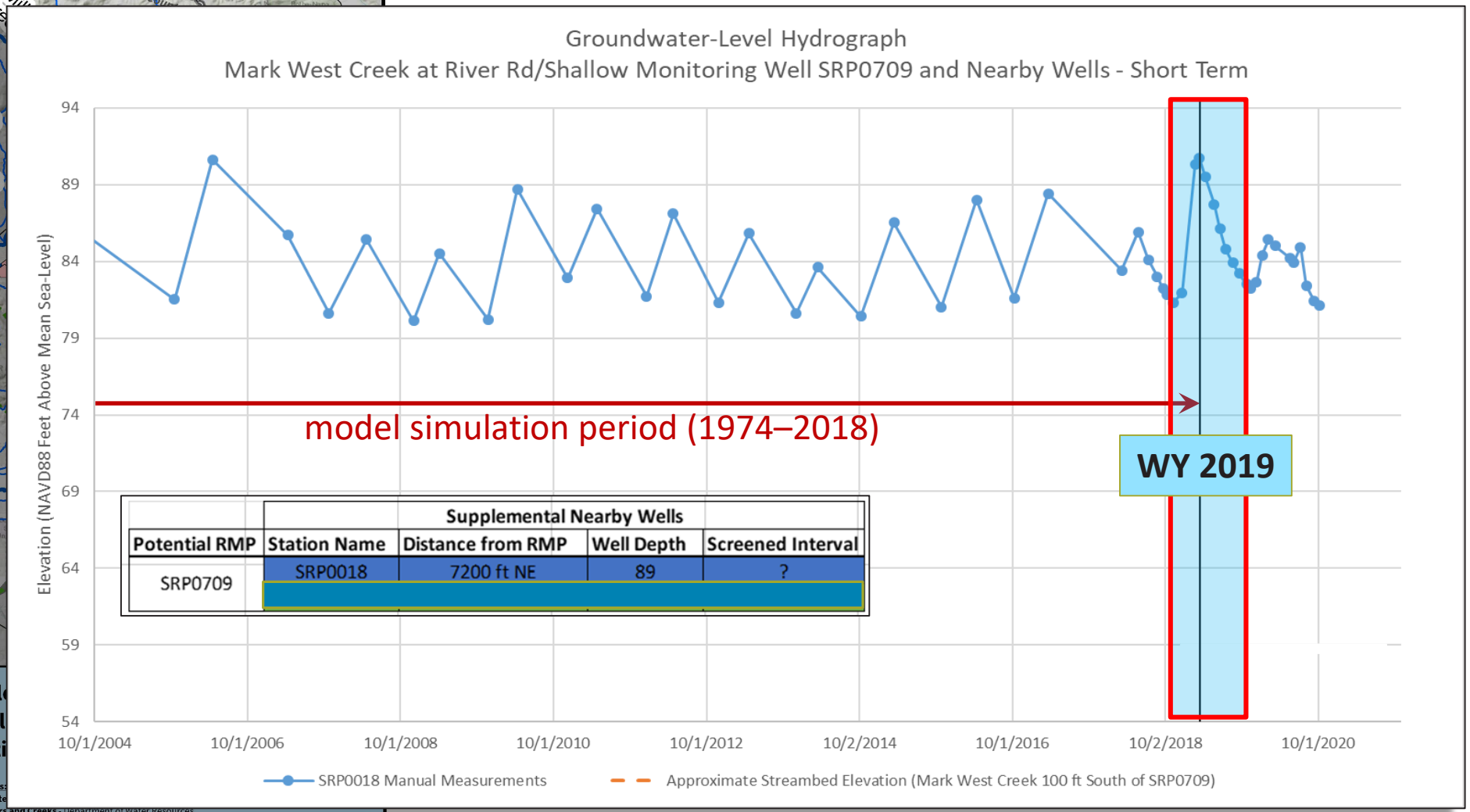




Seasonally-monitored, nearby wells …
Infrequently measured, long period of record

How do we use model results to characterize SWD from measurements? Example: WY 2019





Potential RMP	Supplemental Nearby Wells			
	Station Name	Distance from RMP	Well Depth	Screened Interval
SRP0709	SRP0018	7200 ft NE	89	?

Santa Rosa Plain Groundwater Subbasin
Contributing Area Watershed
Major Rivers and Creeks
Streams
Dedicated Monitoring Wells
Monitored Municipal Supply Wells
Monitored Private Supply Wells
SCWA OneRain Stream Gauges
Active USGS Stream Gauges
High-Frequency Monitoring Wells Adjacent to Streams
Planned Shallow/Multi-Level Dedicated Monitoring Wells

Data Sources:
Groundwate
Major Rivers and Creeks - Department of Water Resources
Streams - Sonoma County Central GIS and Sonoma Water

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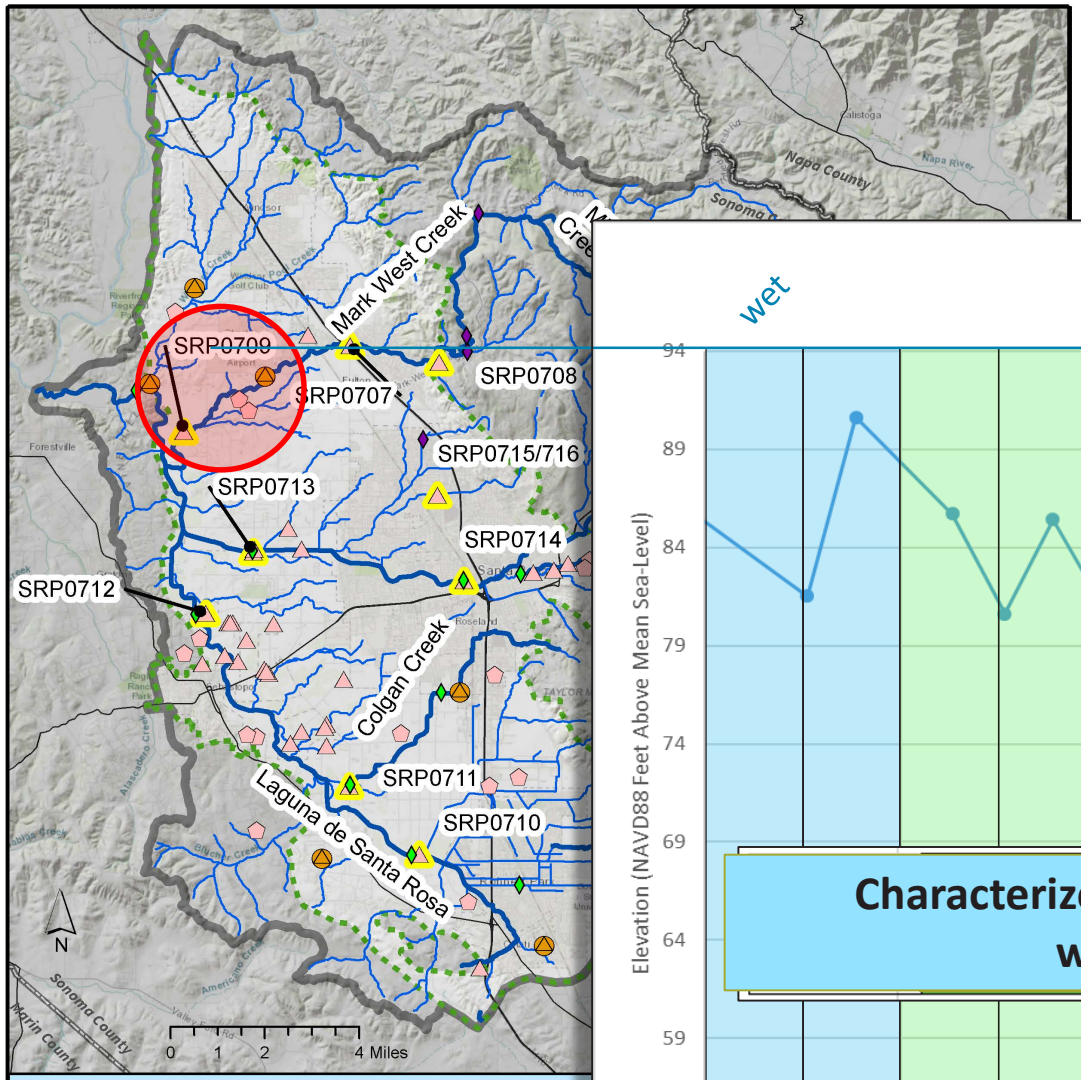
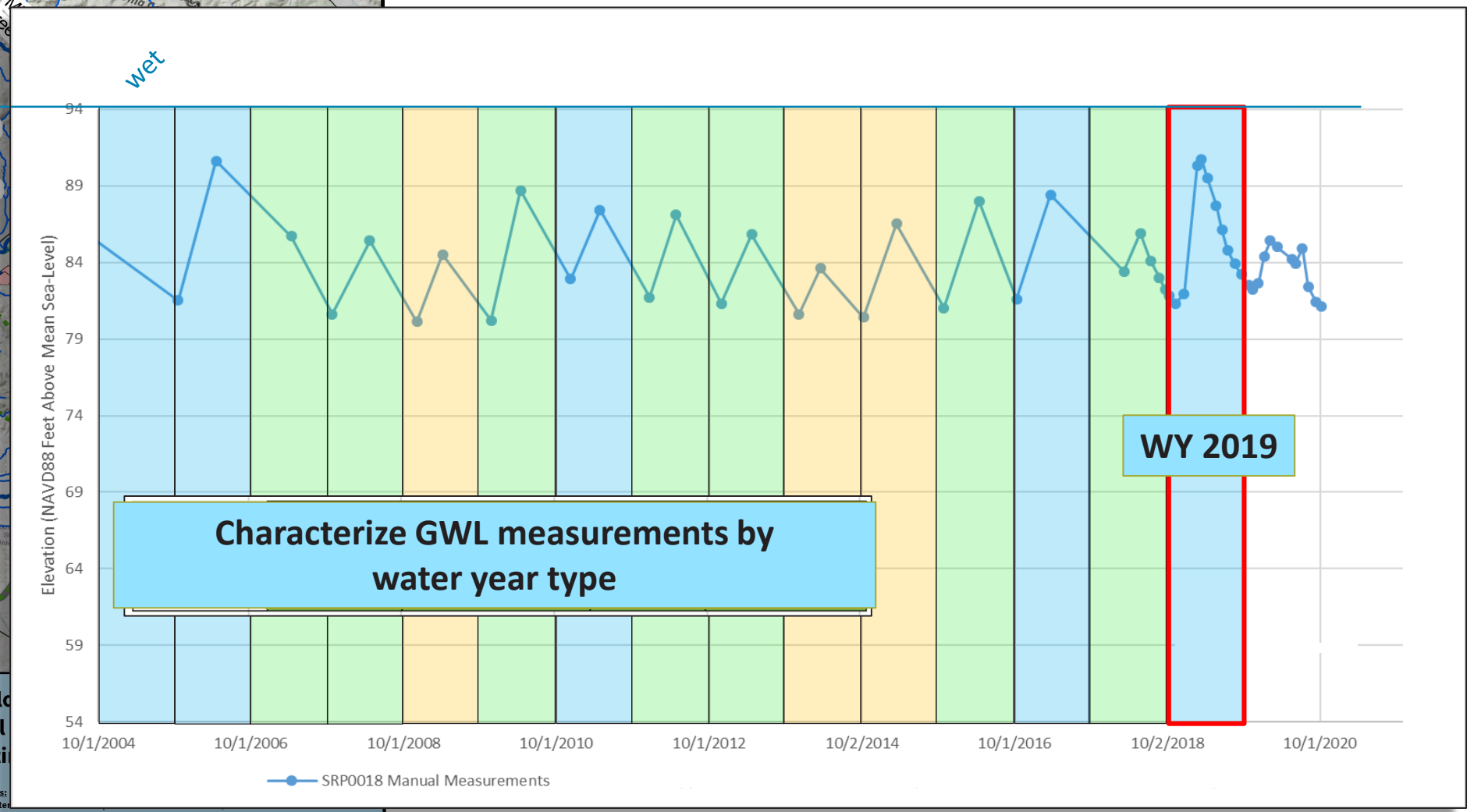
SANTA ROSA PLAIN GROUNDWATER SUSTAINABILITY AGENCY

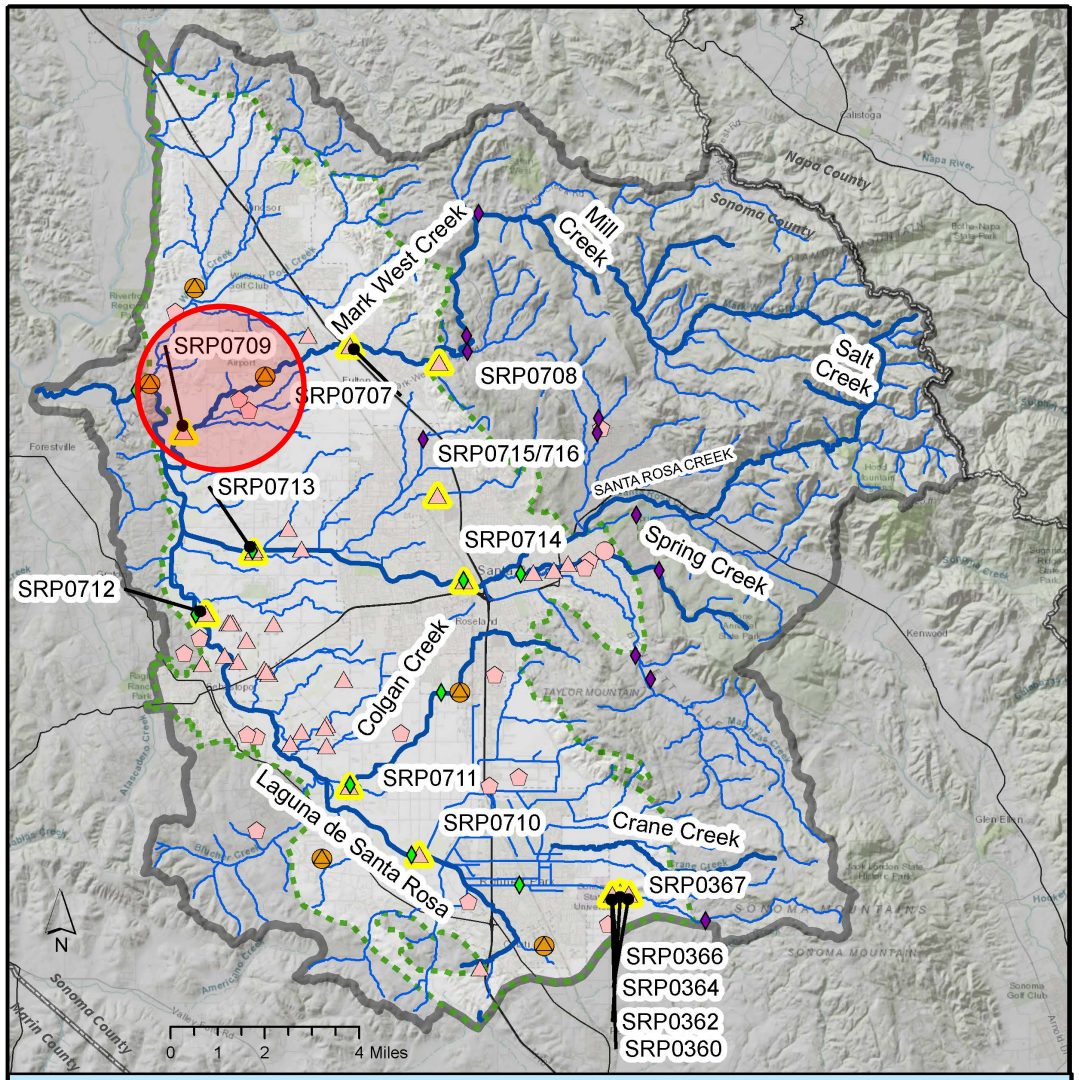
Filepath: T:\mbuttress\SGMA Monitoring Networks\Santa Rosa Plain\SRP_GW_Levl_FULLNet_S_SWGW.mxd Date prepared: 10/6/2020

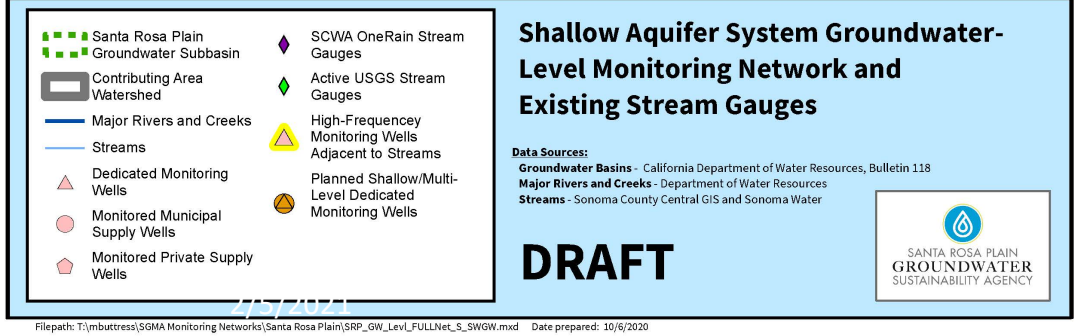
How do we use model results to characterize SWD from measurements? — Example: WY 2019

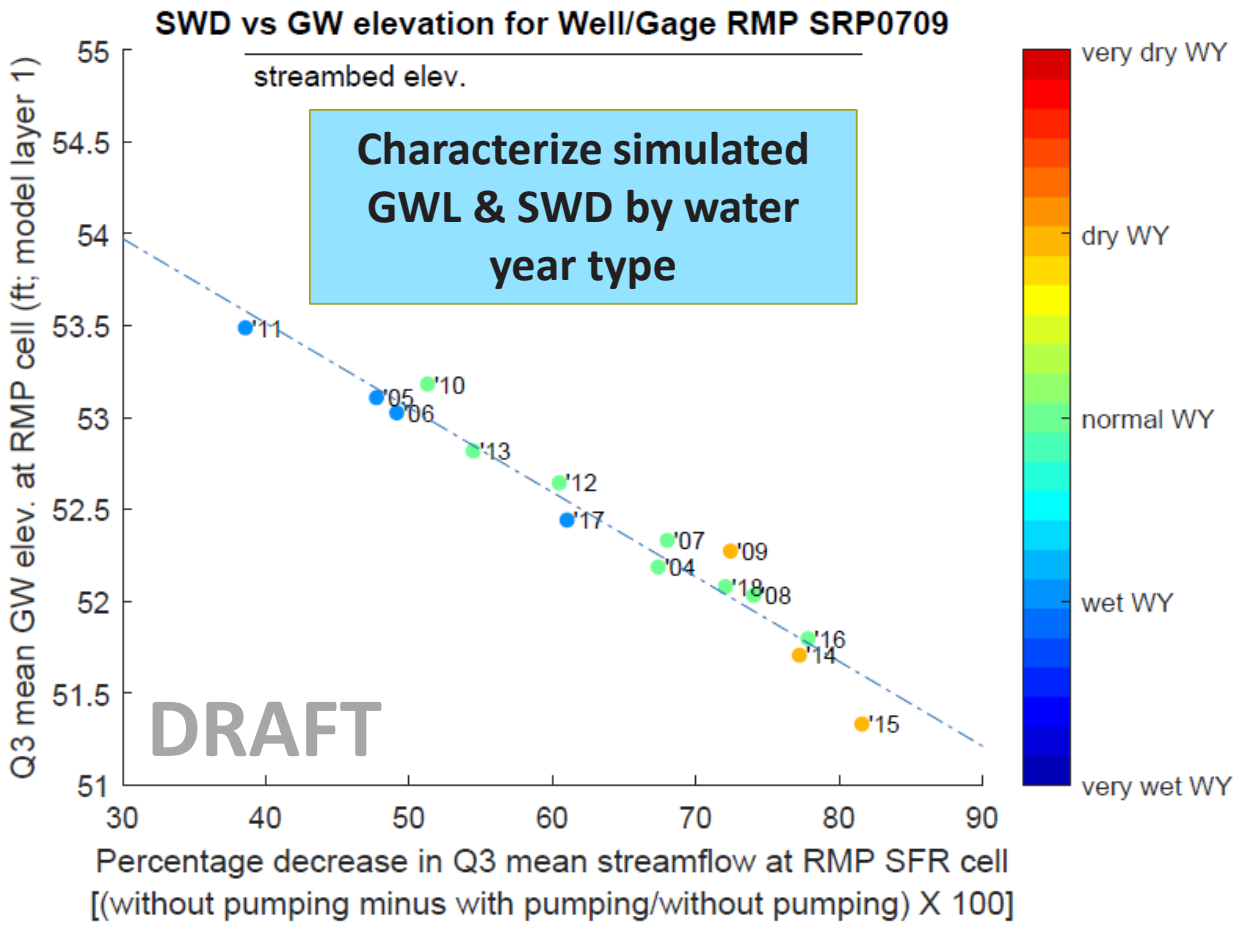




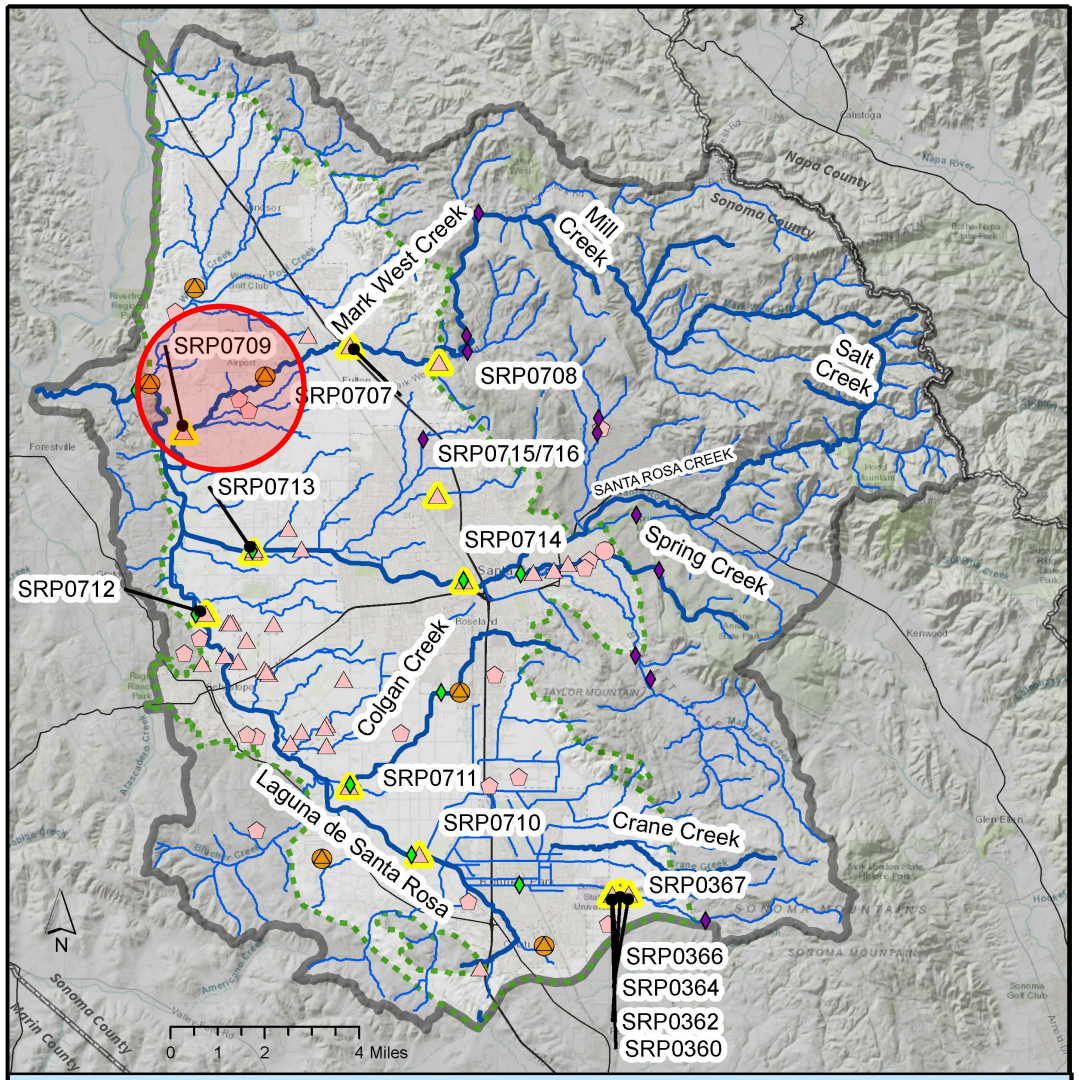
How do we use model results to characterize SWD from measurements? — Example: WY 2019

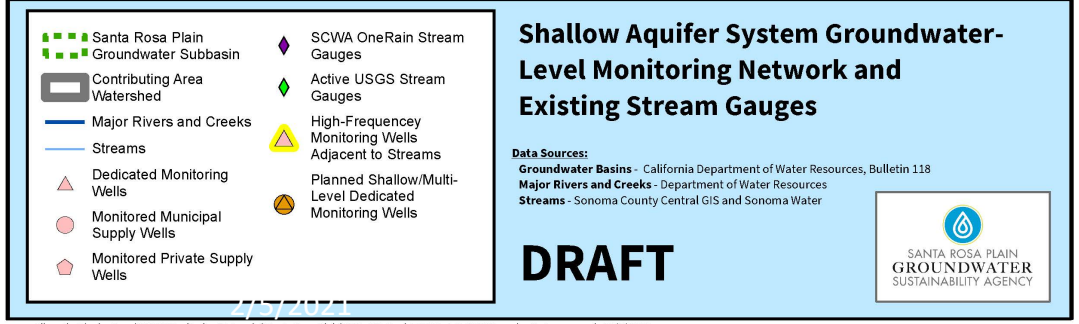


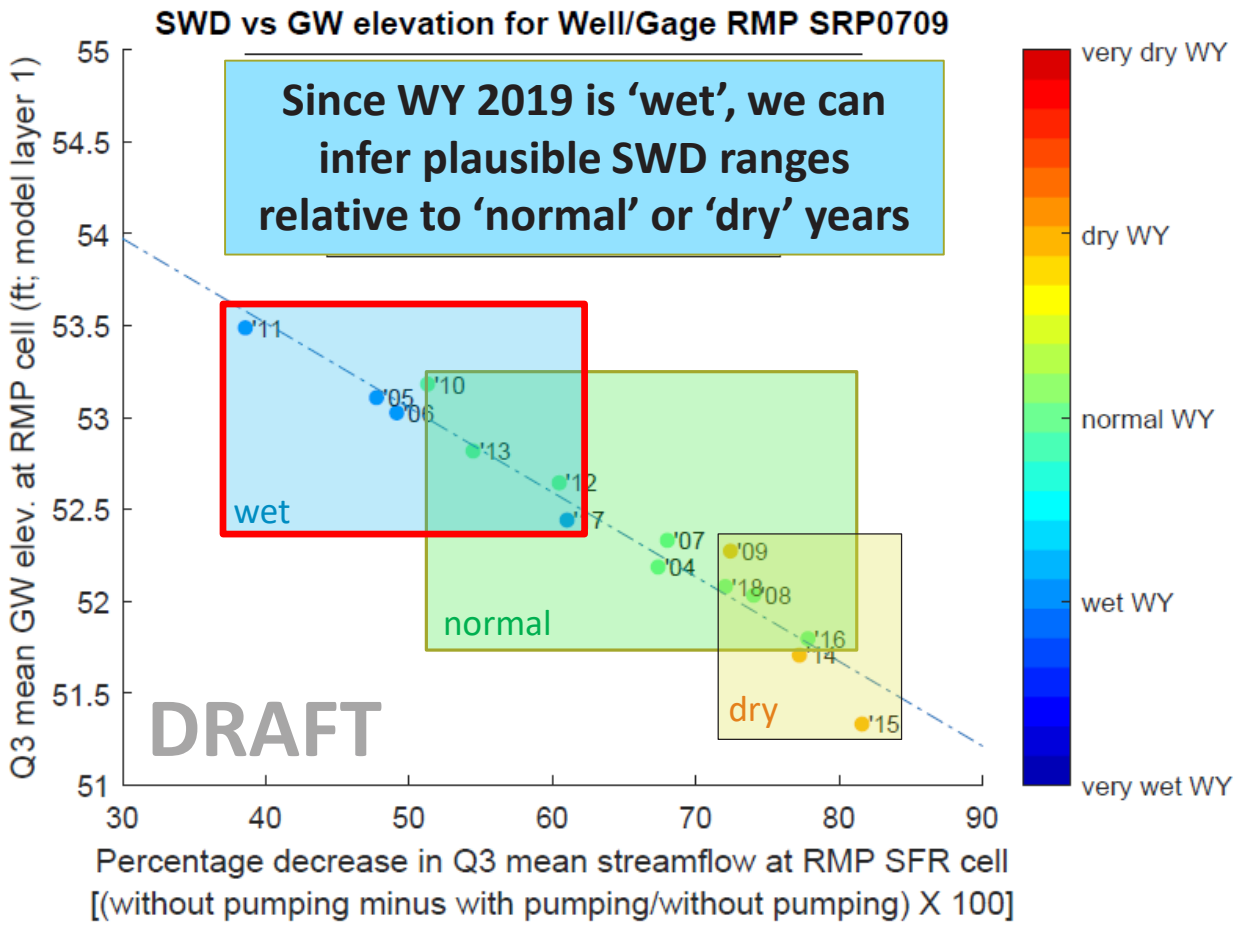




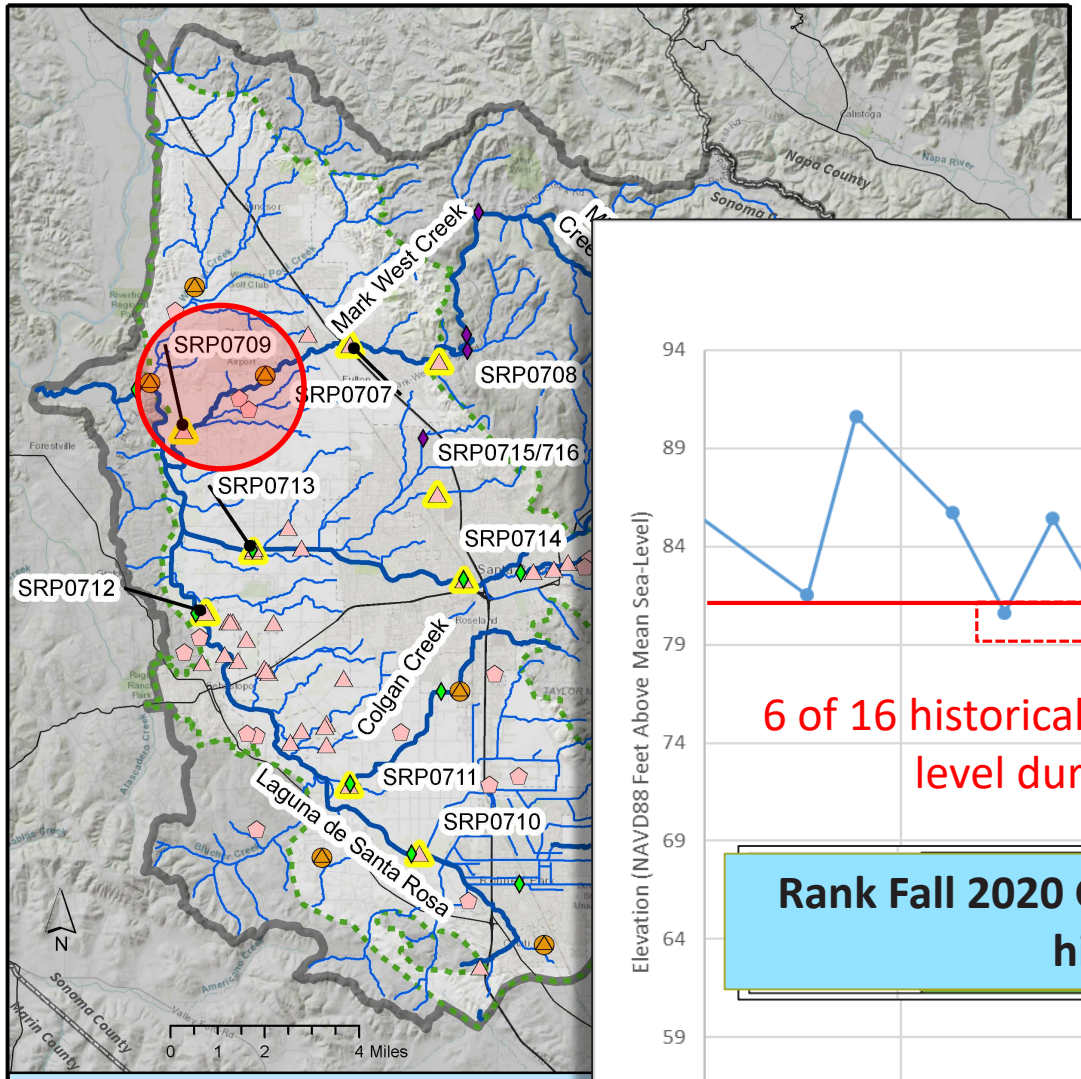
How do we use model results to characterize SWD from measurements? — Example: WY 2019

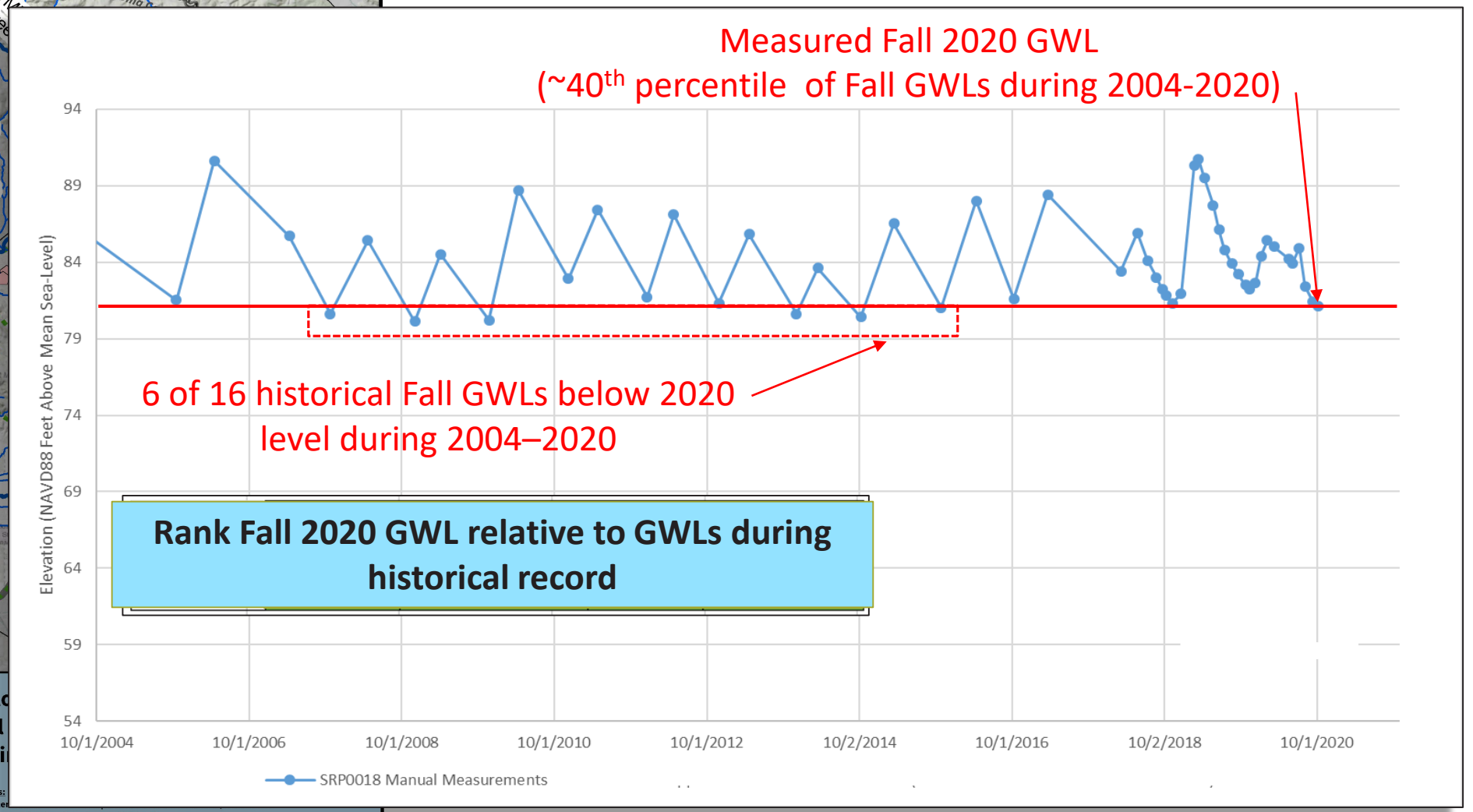




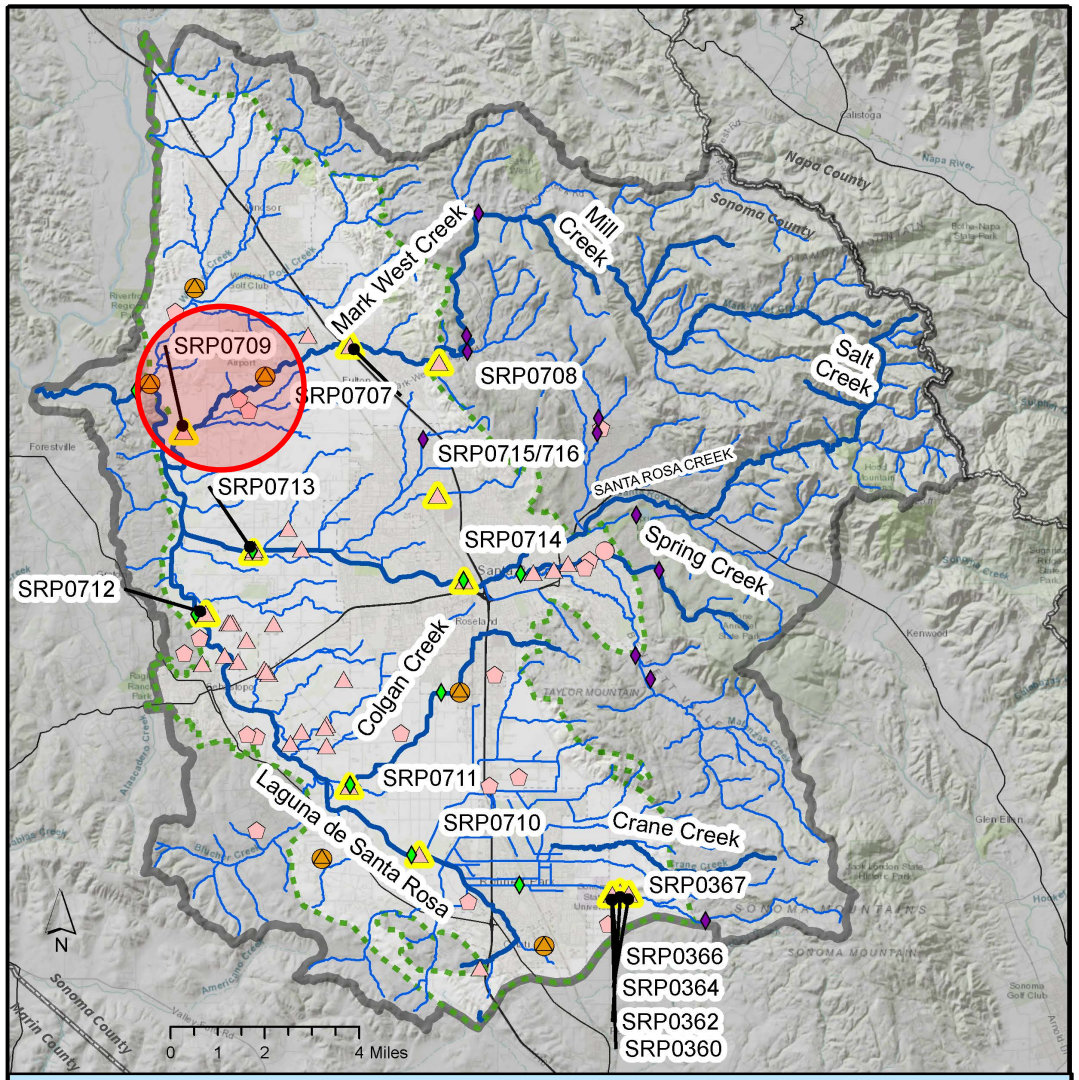


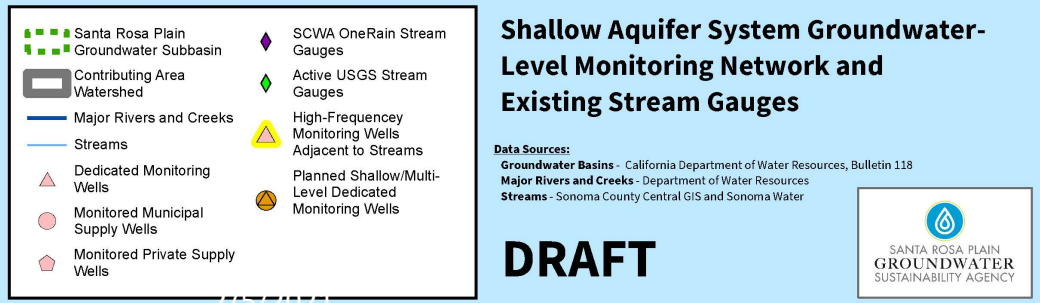
How do we use model results to characterize SWD from measurements? — Example: Fall 2020 GWL

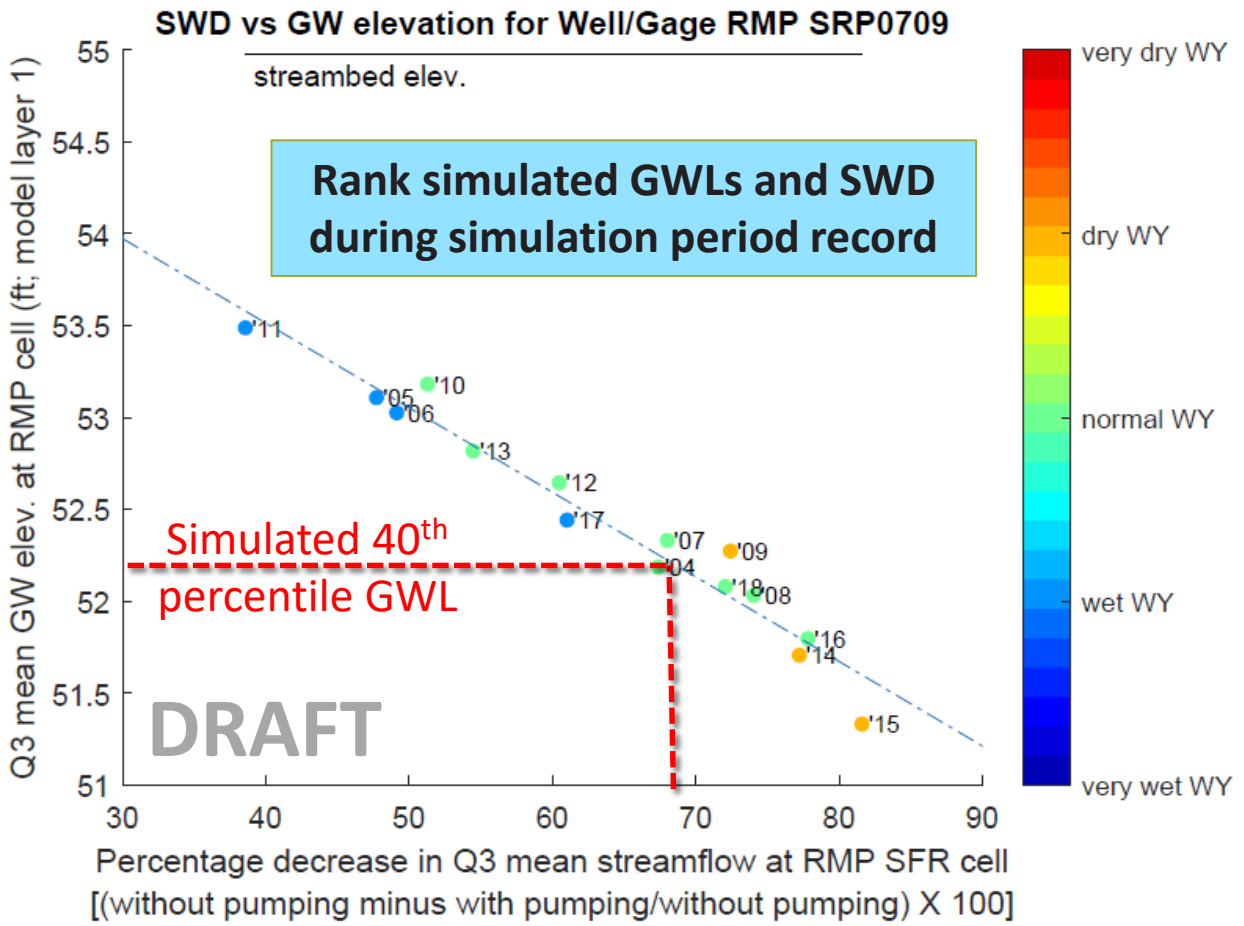


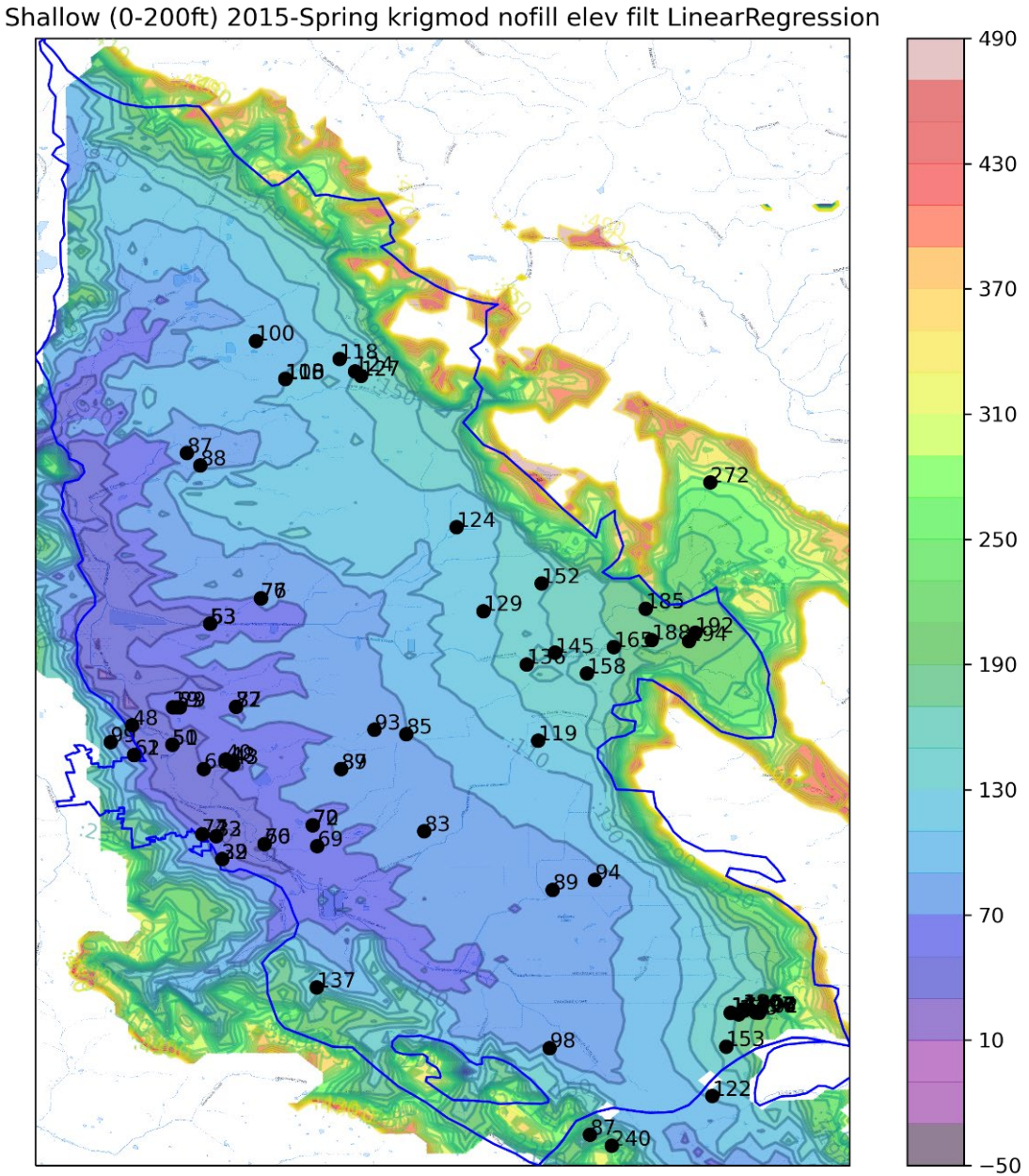


How do we use model results to characterize SWD from measurements? — Example: Fall 2020 GWL

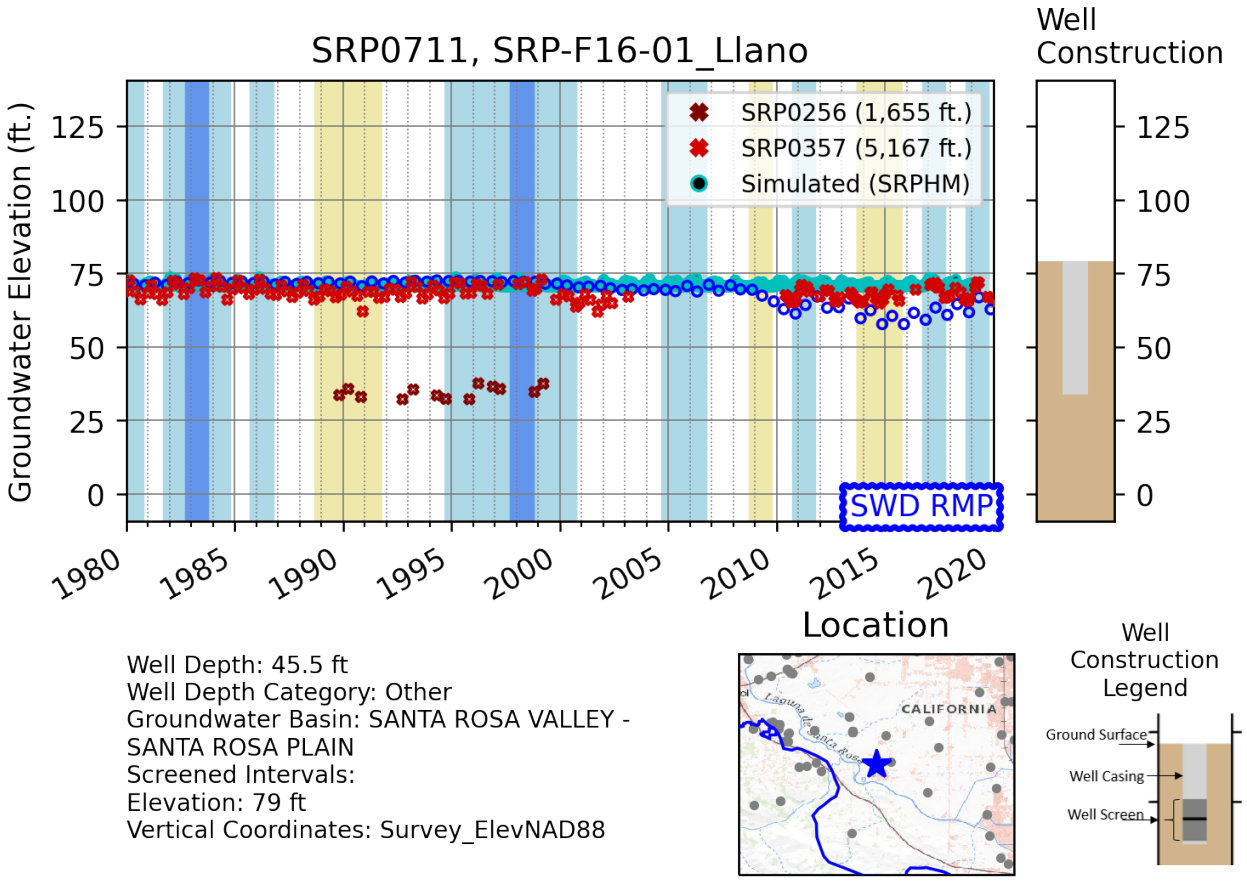








Machine learning techniques can leverage historical GWLs to generate historical GWL hydrographs at RMP locations



Well Depth: 45.5 ft
Well Depth Category: Other
Groundwater Basin: SANTA ROSA VALLEY - SANTA ROSA PLAIN
Screened Intervals:
Elevation: 79 ft
Vertical Coordinates: Survey_ElevNAD88

Surface Water Depletion Methodology Options

Technical staff evaluated a number of different options:

- Historical method (eg, 2015 or other historical conditions)
- Straight Surface water depletions thresholds (percentage discharge)
- Surface water depletions thresholds based on summertime threshold (discharge)
- Surface depletion impacts on streamflow (discharge)

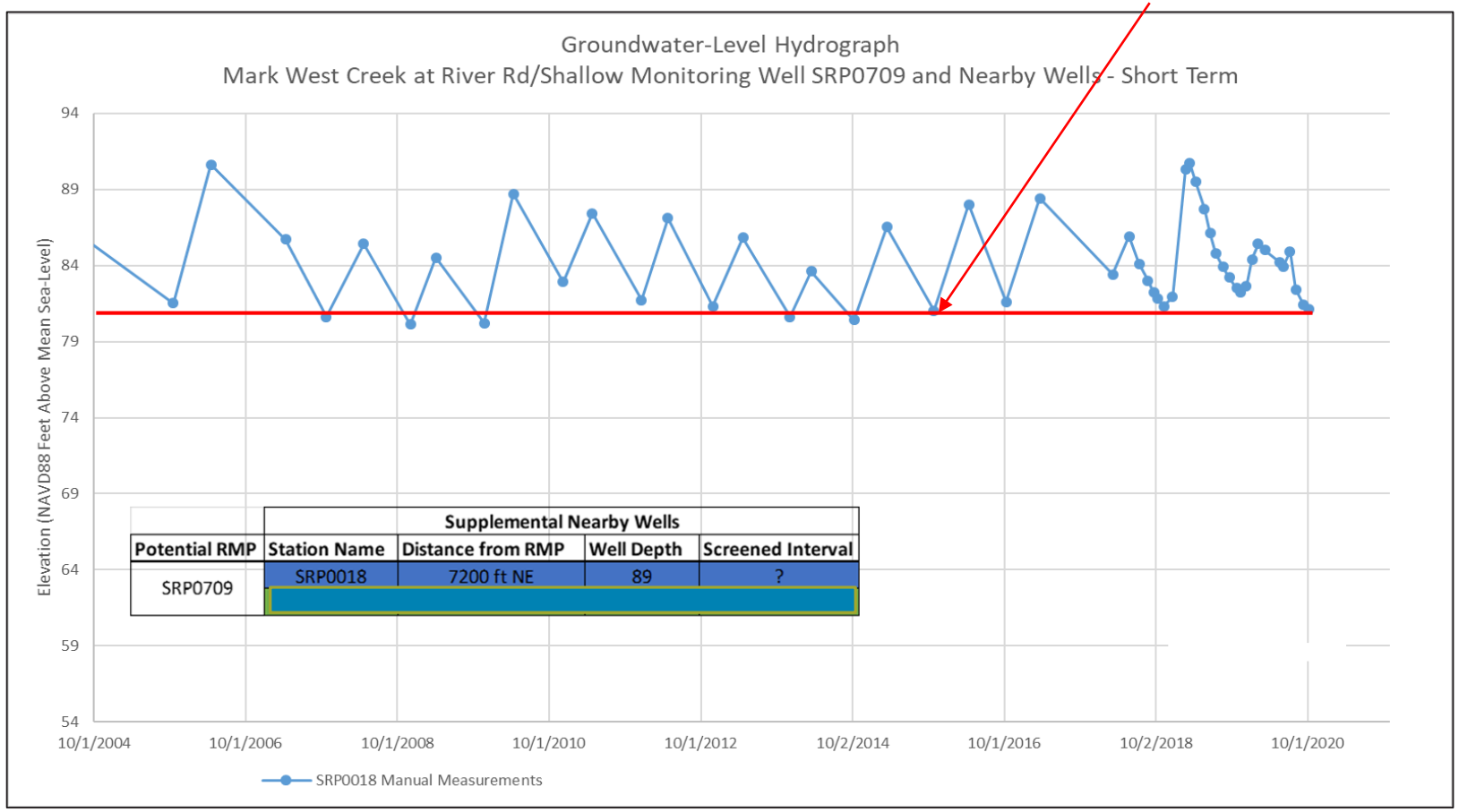
Paired down to two options for consideration today:

1. Fall 2015 GWL as Minimum Threshold
2. SWD Threshold (percentage of discharge) as Minimum Threshold

Surface Water Depletion SMC Strawman Options

1. Fall 2015 GWLs as Minimum Threshold

Measured 2015 Fall GWL



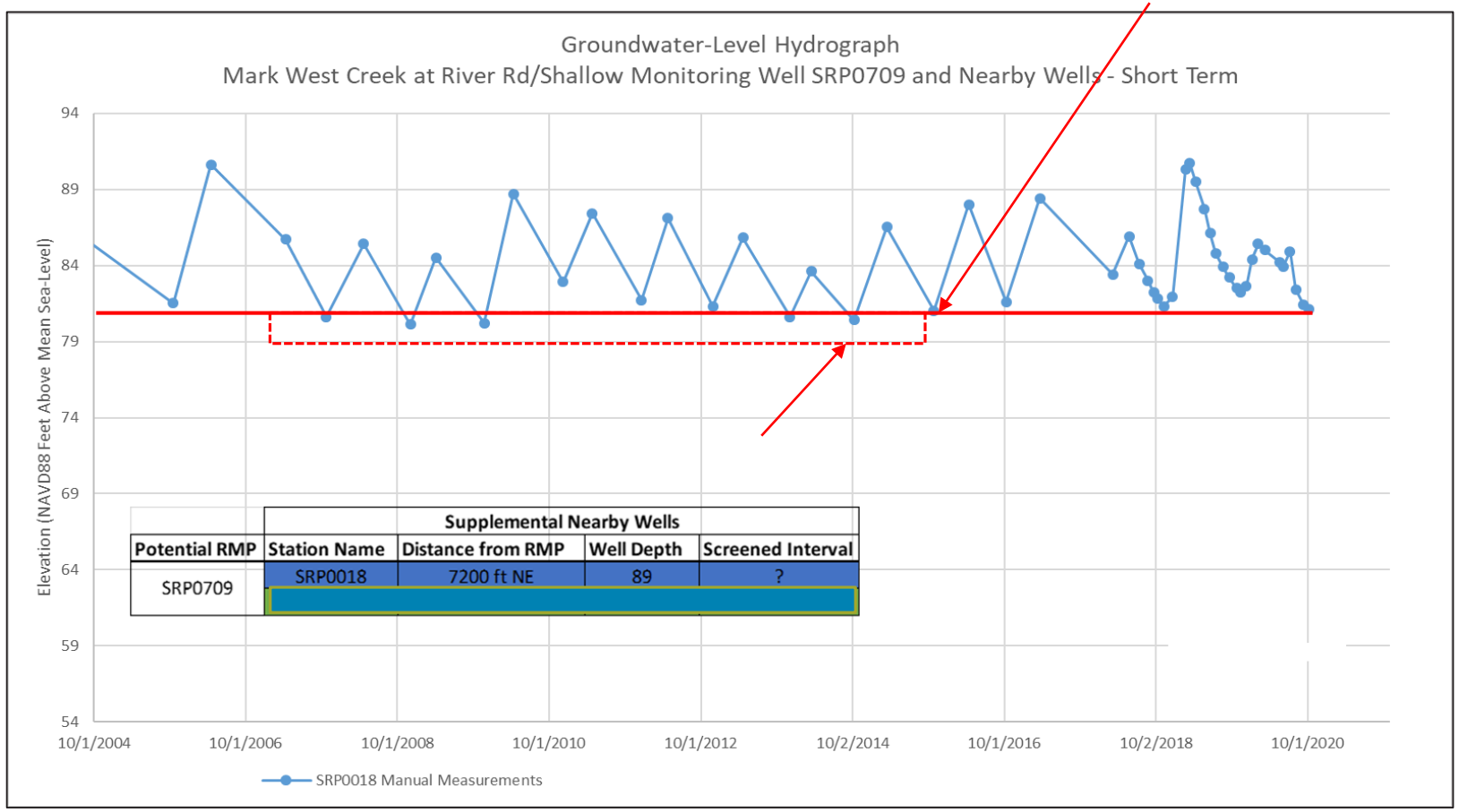
	Supplemental Nearby Wells			
Potential RMP	Station Name	Distance from RMP	Well Depth	Screened Interval
SRP0709	SRP0018	7200 ft NE	89	?

Surface Water Depletion SMC Strawman Options

1. Fall 2015 GWLs as Minimum Threshold

Set SMC based on GWL, use relationship to infer SWD impact

Measured 2015 Fall GWL (~30th percentile during 2004-2020)



	Supplemental Nearby Wells			
Potential RMP	Station Name	Distance from RMP	Well Depth	Screened Interval
SRP0709	SRP0018	7200 ft NE	89	?

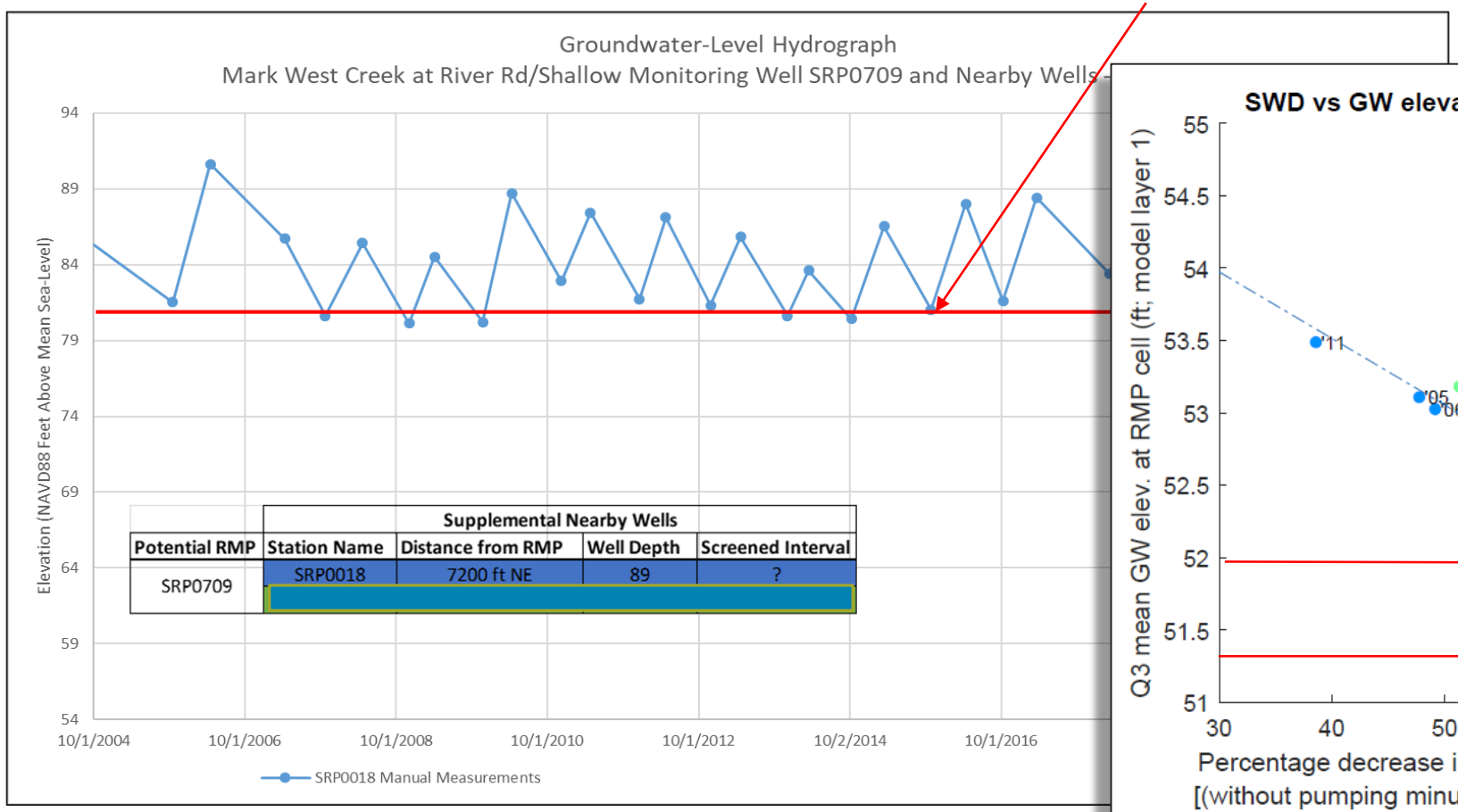
Surface Water Depletion SMC Strawman Options

1. Fall 2015 GWLs as Minimum Threshold

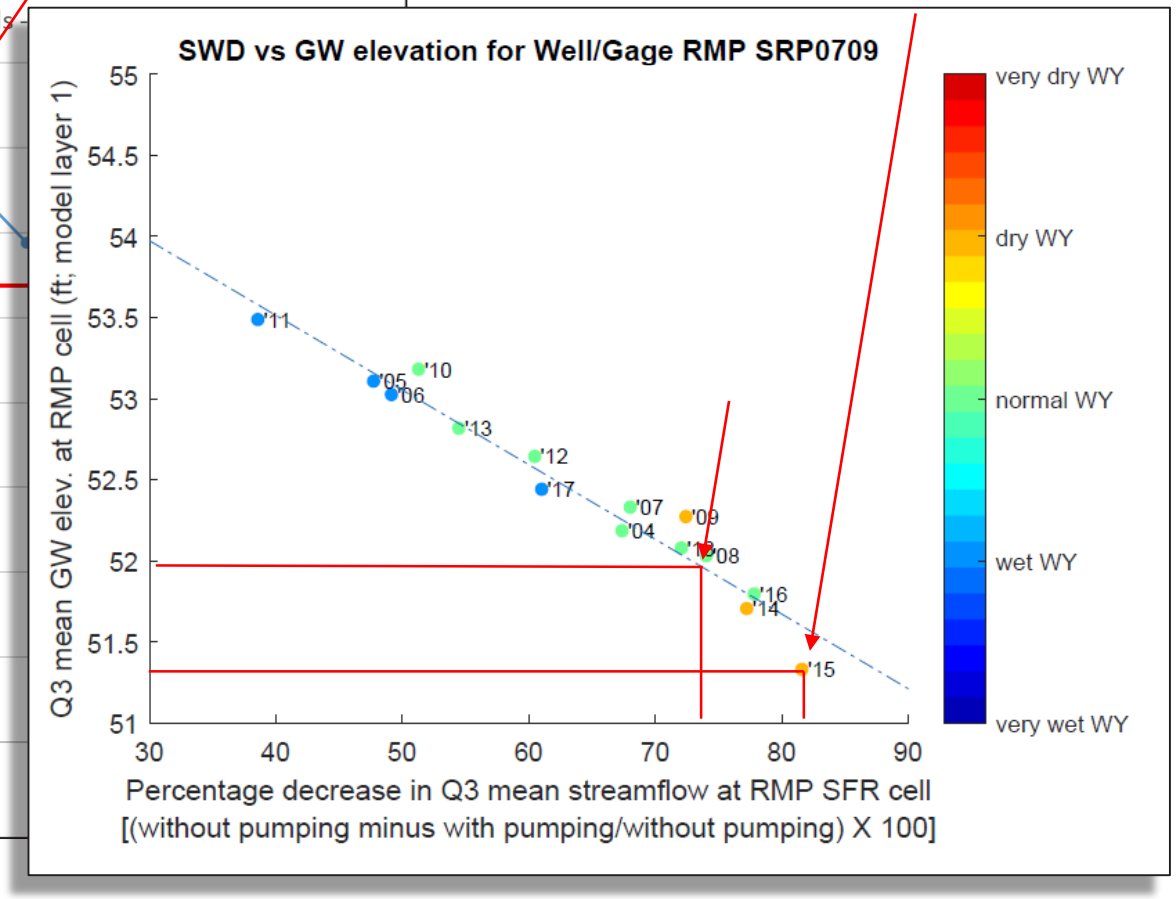
Set SMC based on GWL, use relationship to infer SWD impact

Measured 2015 Fall GWL (~30th percentile during 2004-2020)

Simulated 2015 Q3 GWL (lowest during 2004-2020)



	Supplemental Nearby Wells			
Potential RMP	Station Name	Distance from RMP	Well Depth	Screened Interval
SRP0709	SRP0018	7200 ft NE	89	?



Surface Water Depletion SMC Strawman Options … Pros/Cons

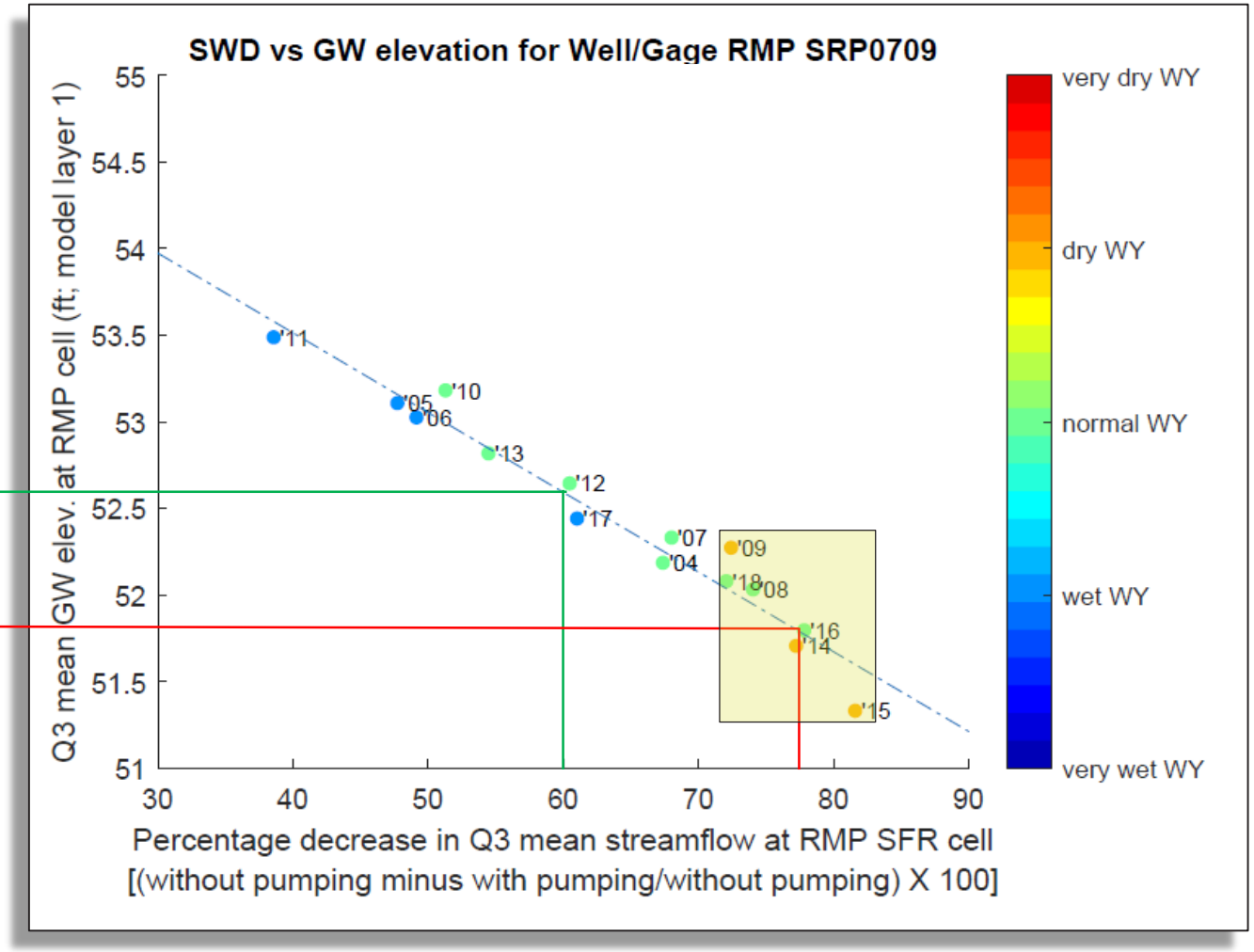
2. SWD Threshold (percentage of discharge) as Minimum Threshold

Use relationship to determine GWL proxy for SWD threshold.

… Requires very high confidence in model results

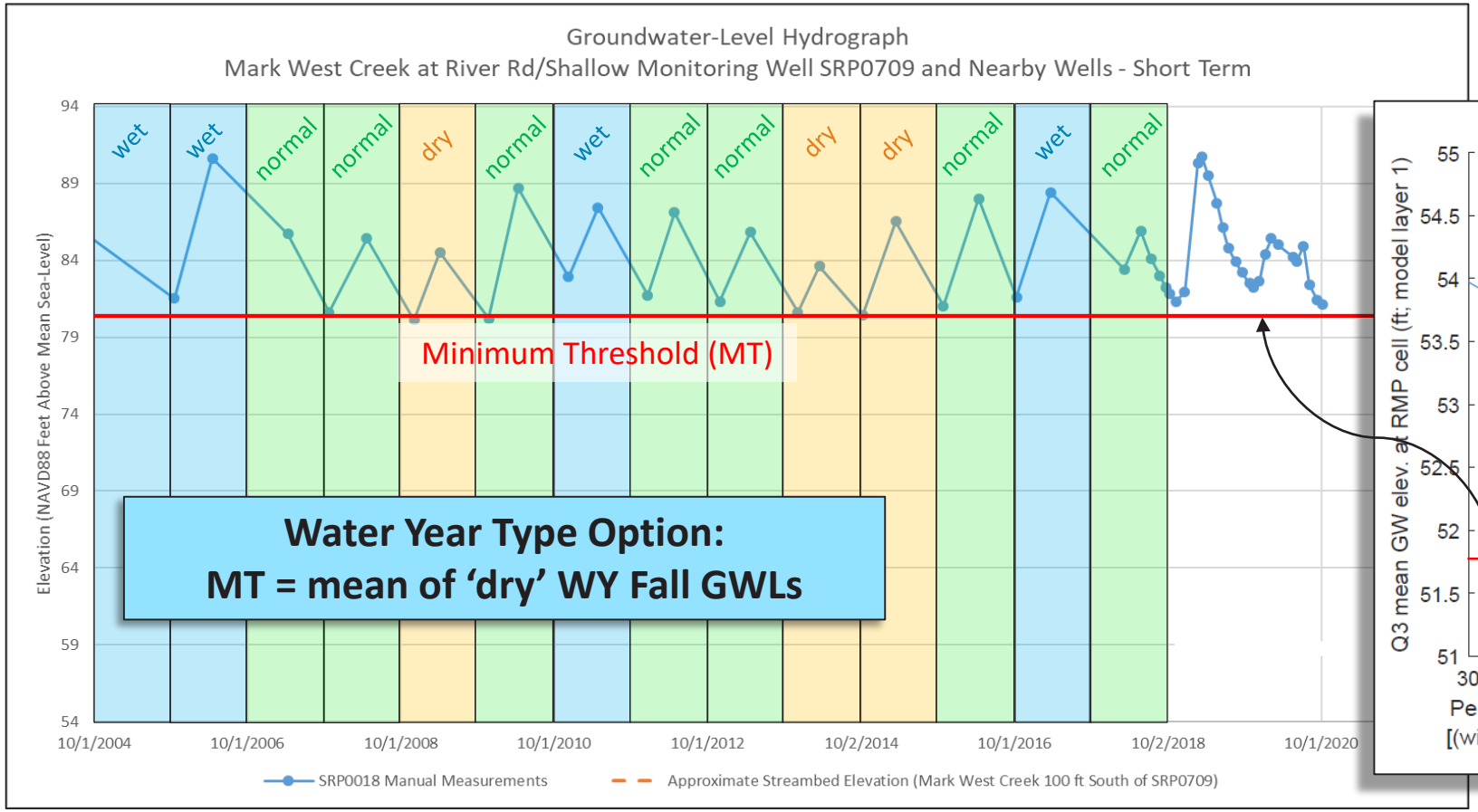
Example measurable objective (MO) =
No more than mean depletion during ’04–’18 i.e., 60% during Jul/Aug/Sep (Q3)

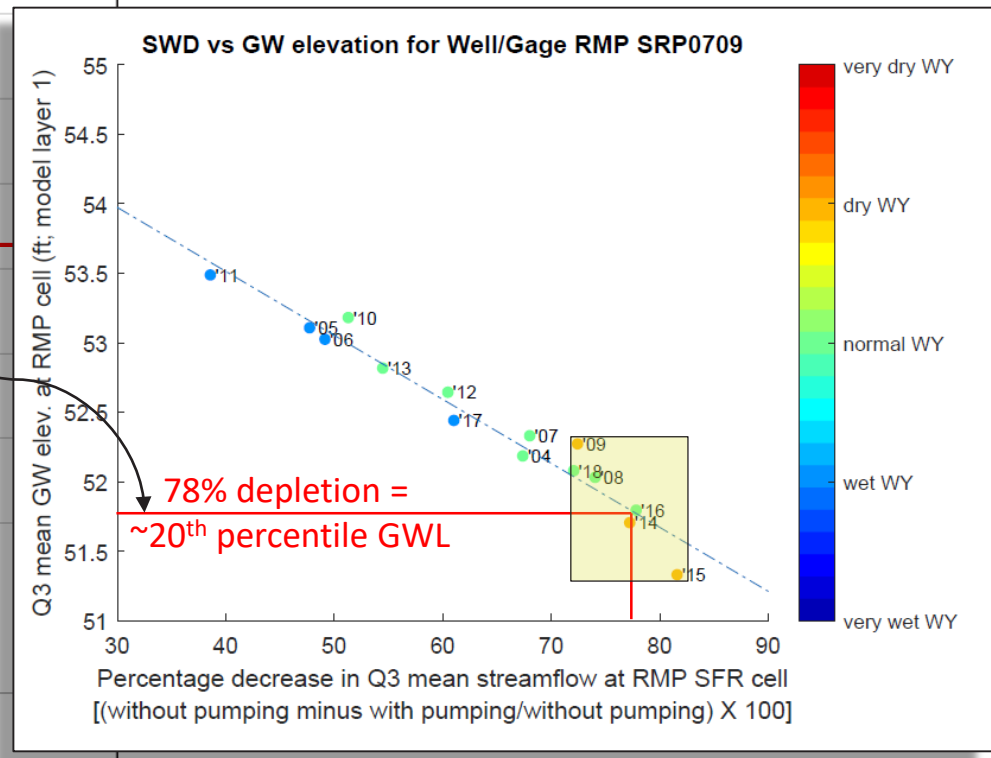
Example minimum threshold (MT) =
Goal of no more than ~78% depletion during Jul/Aug/Sep (Q3): Mean depletion during dry years.



Surface Water Depletion SMC Strawman Options … Pros/Cons

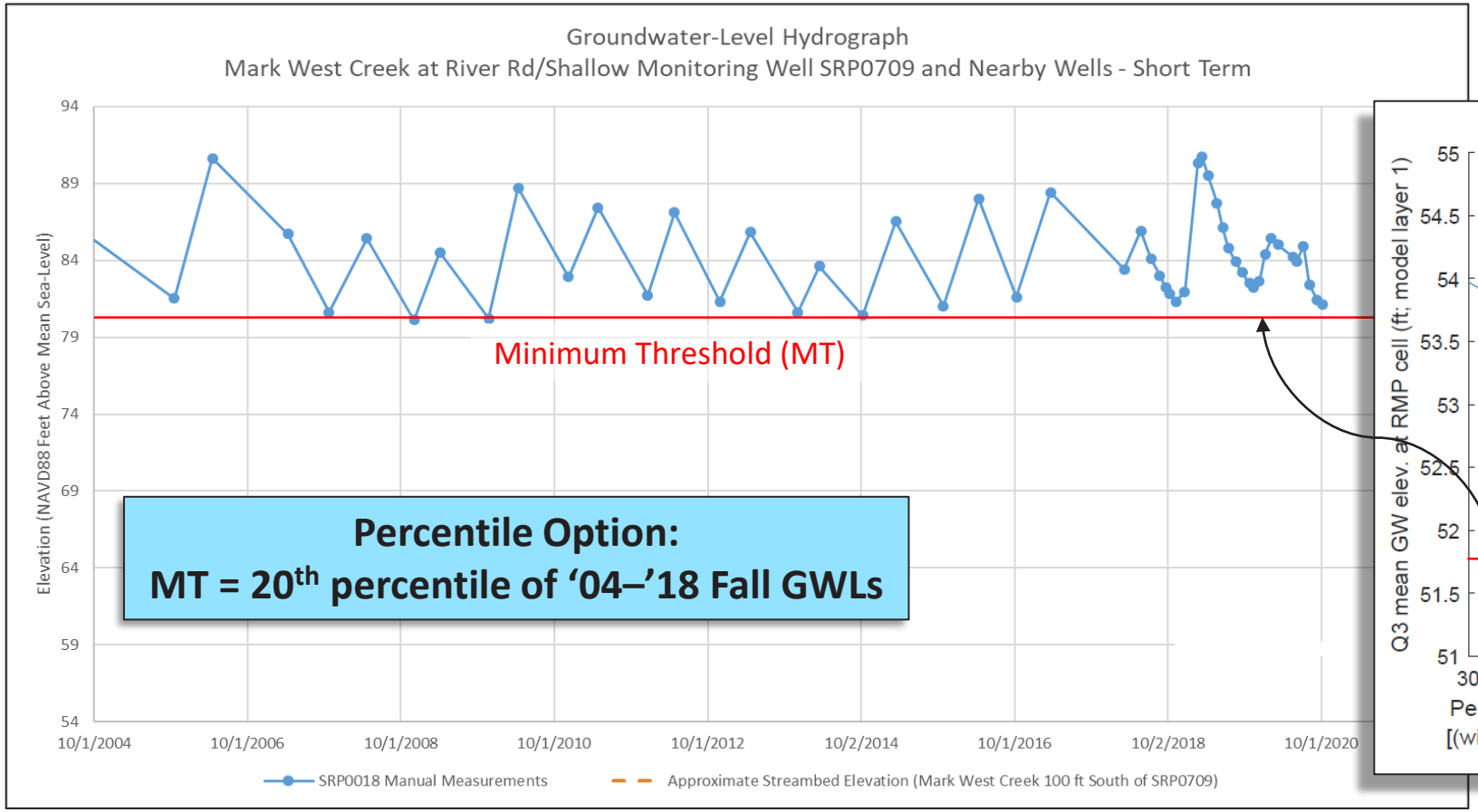
2. SWD Threshold (percentage of discharge) as Minimum Threshold

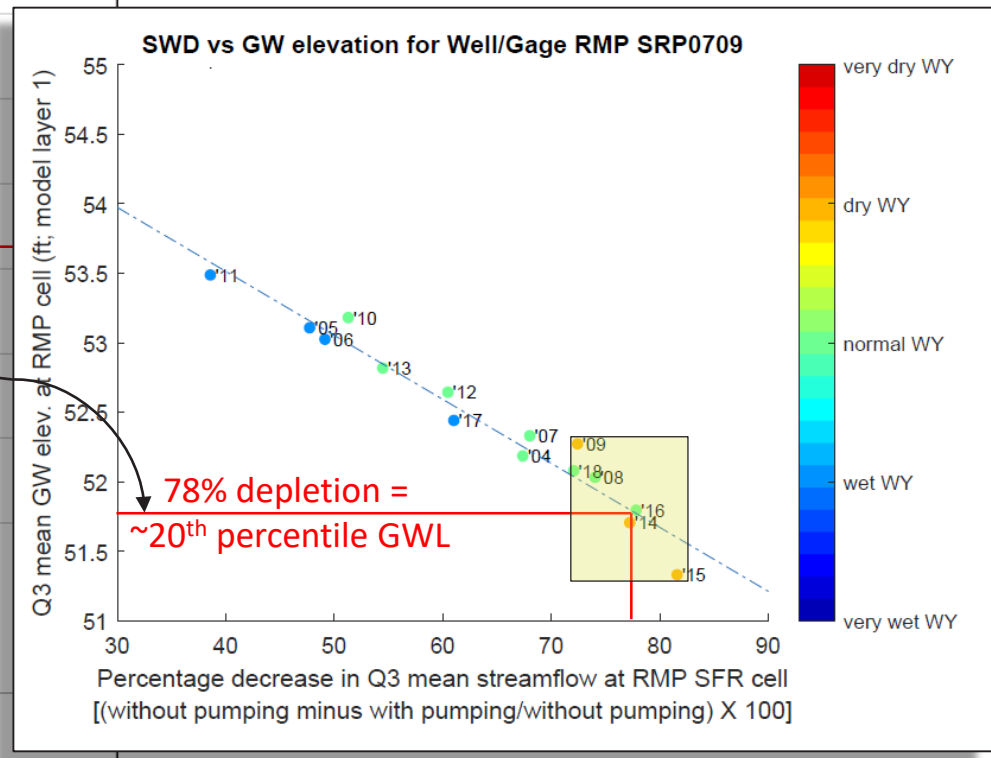


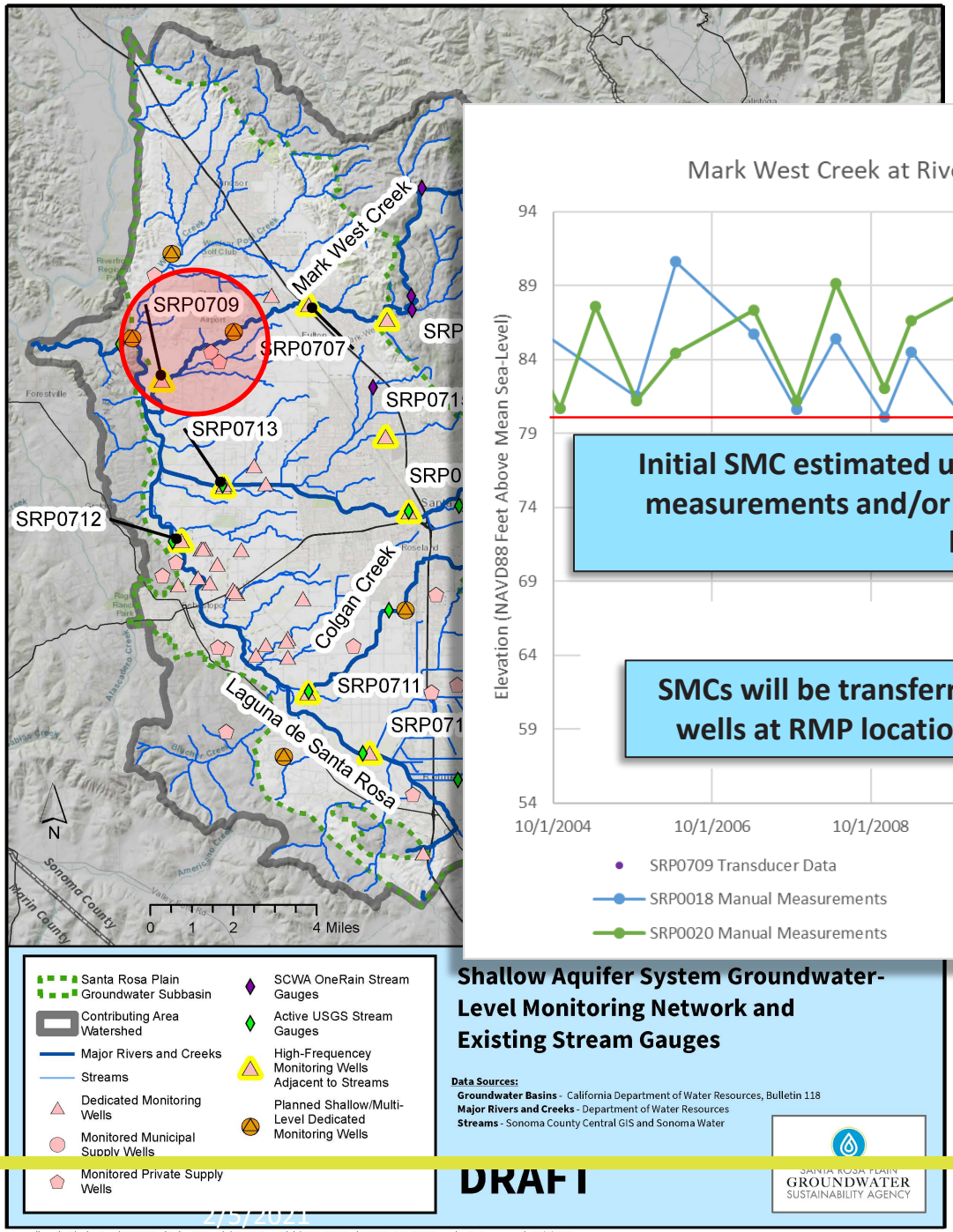


Surface Water Depletion SMC Strawman Options … Pros/Cons

2. SWD Threshold (percentage of discharge) as Minimum Threshold






Mark West Creek
SRP0709
SRP0707
SRP0713
SRP0712
Colgan Creek
SRP0711
Laguna de Santa Rosa
N
0 1 2 4 Miles
Santa Rosa Plain Groundwater Subbasin
Contributing Area Watershed
Major Rivers and Creeks
Streams
Dedicated Monitoring Wells
Monitored Municipal Supply Wells
Monitored Private Supply Wells
SCWA OneRain Stream Gauges
Active USGS Stream Gauges
High-Frequency Monitoring Wells Adjacent to Streams
Planned Shallow/Multi-Level Dedicated Monitoring Wells
Shallow Aquifer System Groundwater-Level Monitoring Network and Existing Stream Gauges
Data Sources:
Groundwater Basins - California Department of Water Resources, Bulletin 118
Major Rivers and Creeks - Department of Water Resources
Streams - Sonoma County Central GIS and Sonoma Water
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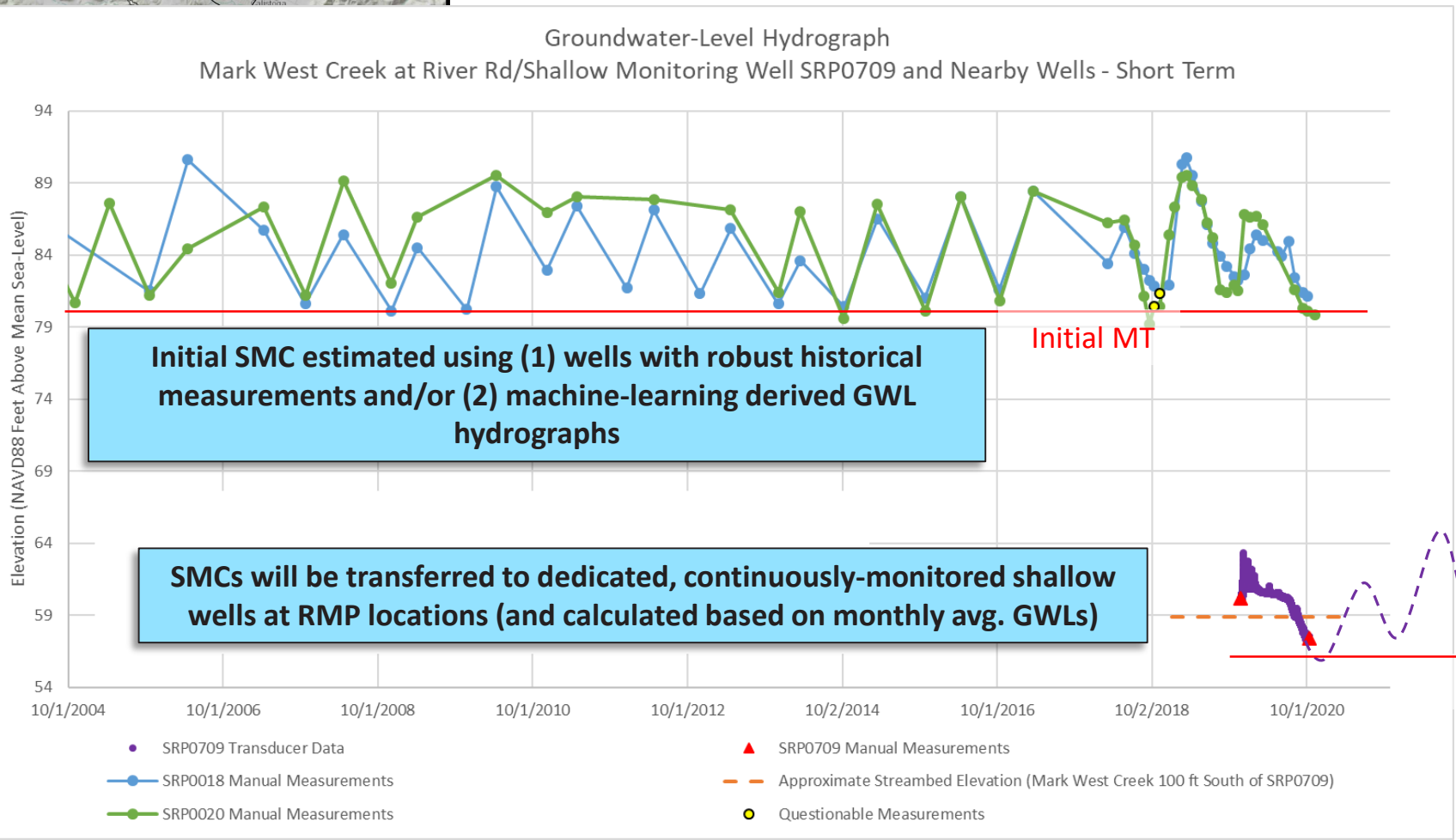
SANTA ROSA PLAIN GROUNDWATER SUSTAINABILITY AGENCY
Filepath: T:\mbuttress\SGMA Monitoring Networks\Santa Rosa Plain\SRP_GW_Levl_FULLNet_S_SWGW.mxd Date prepared: 10/6/2020


Groundwater-Level Hydrograph
Mark West Creek at River Rd/Shallow Monitoring Well SRP0709 and Nearby Wells - Short Term
Elevation (NAVD88 Feet Above Mean Sea-Level)
94
89
84
79
74
69
64
59
54
10/1/2004
10/1/2006
10/1/2008
10/1/2010
10/1/2012
10/2/2014
10/1/2016
10/2/2018
10/1/2020
Initial MT
Initial SMC estimated using (1) wells with robust historical measurements and/or (2) machine-learning derived GWL hydrographs
SMCs will be transferred to dedicated, continuously-monitored shallow wells at RMP locations (and calculated based on monthly avg. GWLs)
Final MT
SRP0709 Transducer Data
SRP0709 Manual Measurements
SRP0018 Manual Measurements
Approximate Streambed Elevation (Mark West Creek 100 ft South of SRP0709)
SRP0020 Manual Measurements
Questionable Measurements

Surface Water Depletion SMC Strawman … Two Examples … Pros/Cons

1. Fall 2015 GWL as Minimum Threshold
2. SWD Threshold (percentage of discharge) as Minimum Threshold

Criteria	Fall 2015 GWLs	SWD Thresholds (percentage of discharge)
Reliance on simulated data	Medium/Low	High (simulated depletion + discharge)
Relevance to Potential Beneficial User Impacts	Low	Medium/High
Pros	Indirectly supported by regulations	Emphasizes lower flows, good correlation w/ modeled heads in SRPHM. More easily tied to Undesirable Results
Cons	No established relationship with SWD, inflexible, some locations with no data	No established relationship with GDEs; not a depletion volume
Adaptable to future knowledge, instream flow thresholds	No	Yes
Simplicity/Communication	Easy to communicate/Estimate	Moderately easy to communicate/Estimate
Arbitrary?	Low	Currently High

Questions/Discussion/Work Group Input

Initial Discussion of Possible Options for Undesirable Results

Undesirable Result: *Quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the Basin/Subbasin.*

Goal is to provide options for the GSA Board to consider for determining Undesirable Results:

1. Some percentage of MT exceedances (eg, 25% of RMPs, etc.)
2. Multiple years of MT exceedances (eg, 2 consecutive years)
3. Some combination of 1 and 2
4. Other ideas?

Prior to determining if undesirable results are occurring based on MT exceedances, the GSA would need to assess whether potential causes of exceedances are related to depletions associated with groundwater pumping or other activities related to surface water rights. Developing a description of this assessment in coordination with SWRCB.

Data Gaps and Future Recommended Activities

Initial List of Data Gaps and Future Recommended Activities

- Informational Data Gaps:
  - Location, completion details and pumping estimates for existing water wells (particularly near streams)
  - Type, location and rates of permitted surface water diversions (including any diversions made through wells)
- Monitoring Needs:
  - Additional shallow monitoring wells in data gap areas and near existing RMPs to better assess hydraulic gradients and potential causes of depletion
  - Additional streamflow gauges and/or routine seepage measurements to better evaluate spatial and temporal gaining/losing conditions
- Modeling Improvements:
  - Improve ability of models to accurately simulate shallow aquifer system groundwater levels and surface water/groundwater interaction: incorporate data that will be collected from new shallow monitoring wells and other studies/monitoring conducted during initial GSP implementation period
- Others?

Next Steps in Developing SMC for Depletion of Interconnected Surface Water

1. Complete GDE and ISW mapping
2. Further evaluate potential RMP networks
3. Develop draft SMC at each proposed RMP for all three basins based on potential methodology
4. Develop options for Undesirable Result determination
5. Develop narrative for GSP SMC section

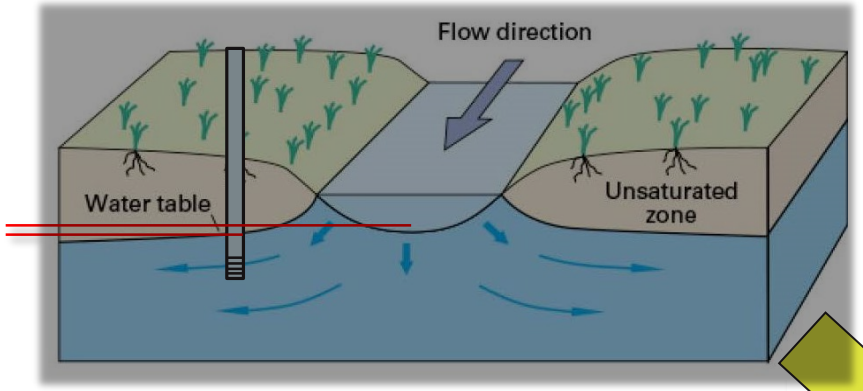
SANTA ROSA PLAIN
GROUNDWATER
SUSTAINABILITY AGENCY

SW Depletion SMC Development

STEPHEN MAPLES

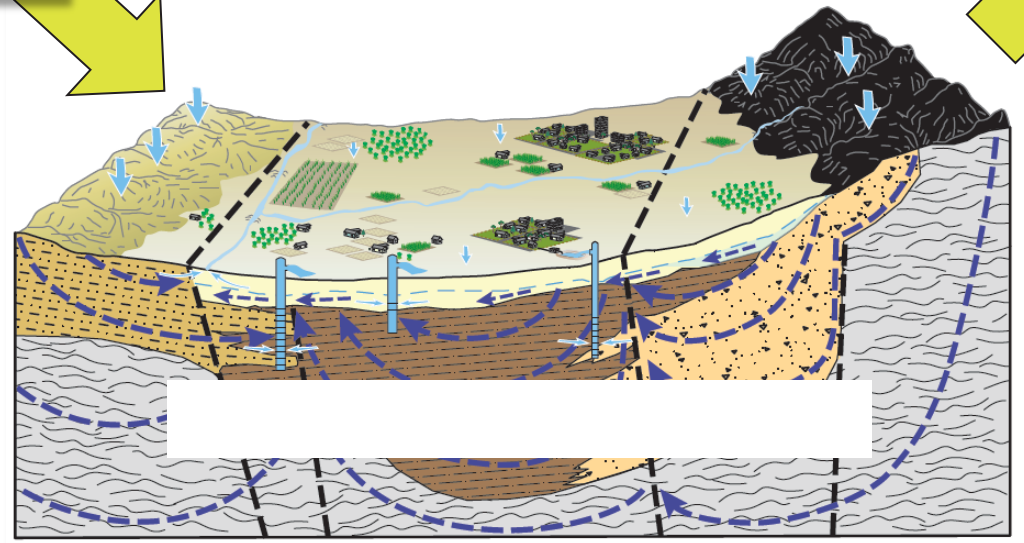
12/09/2020 UPDATE

How can we leverage measurements and models to characterize GW/SW interactions and SW depletion?

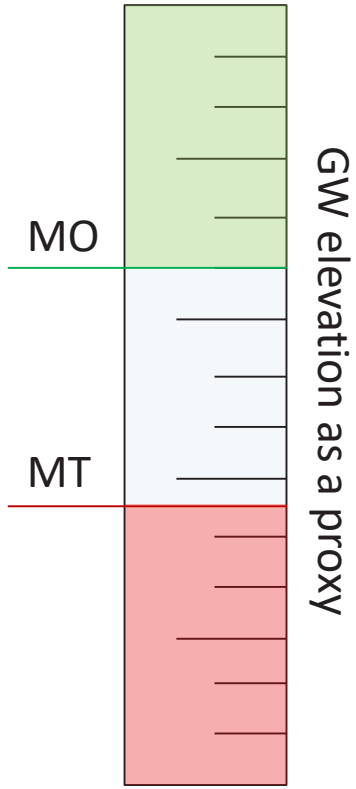


Local GW elevation (measured/simulated)

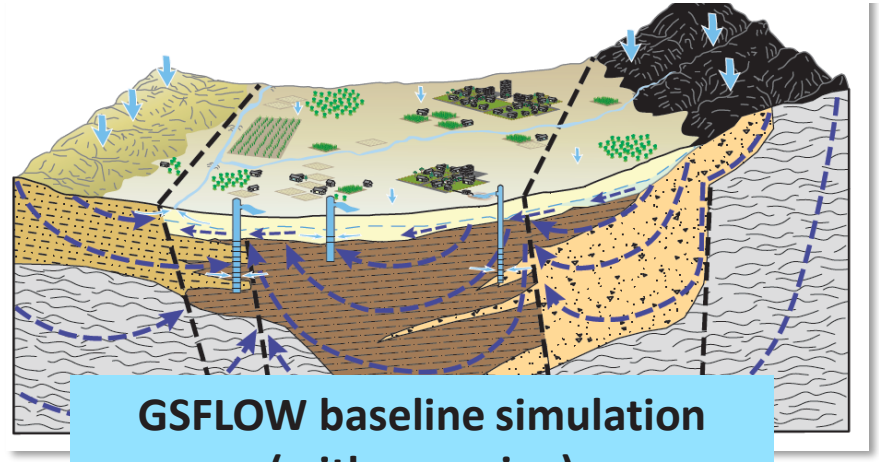
Regional SW depletion characterization (simulated)



SMCs are tied to GW elevations and informed by simulation results

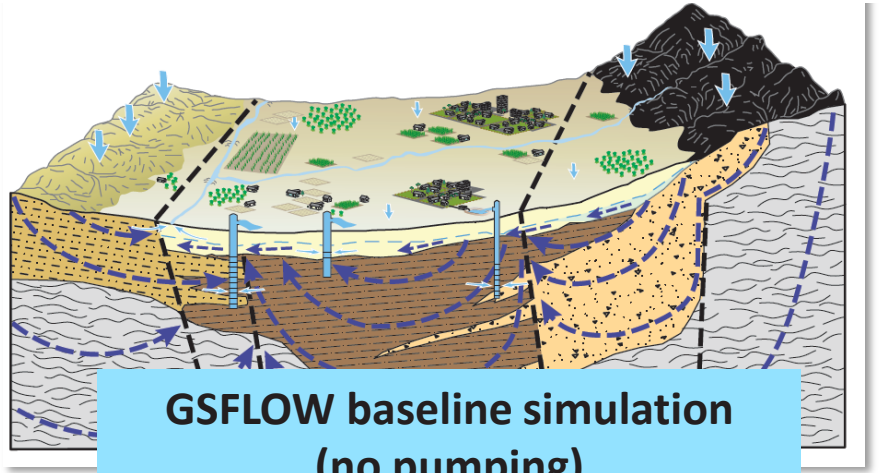


Isolate GW pumping impacts by “differencing” a historical baseline simulation (with pumping) from a identical simulation without pumping



GSFLOW baseline simulation (<u>with</u> pumping)

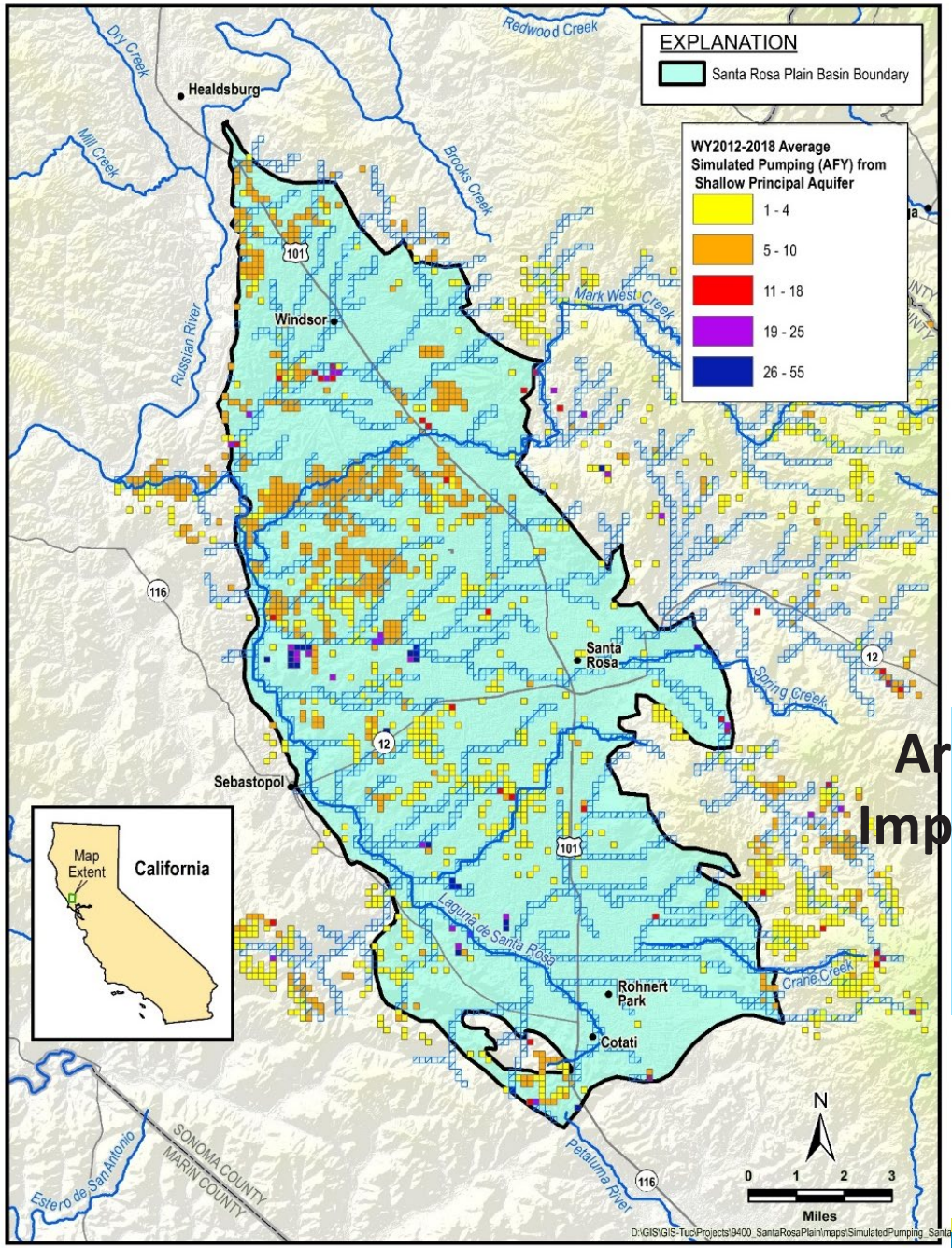
minus



GSFLOW baseline simulation (<u>no</u> pumping)

Isolate Surface Water Depletion (SWD) from groundwater pumping

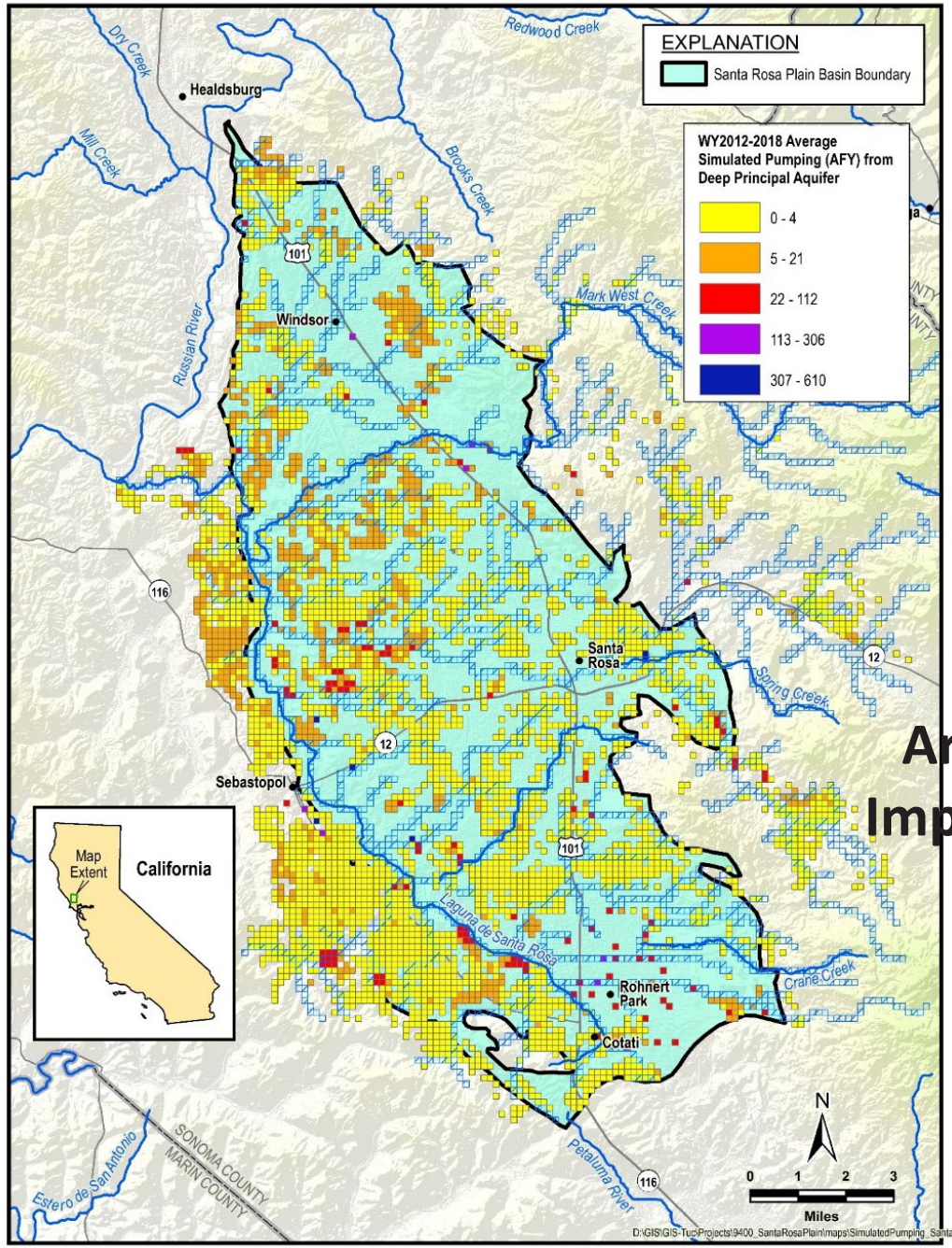
Where does pumping occur within the basin?



Areal Extent of Pumping Impacts in Santa Rosa Plain

Layer 1

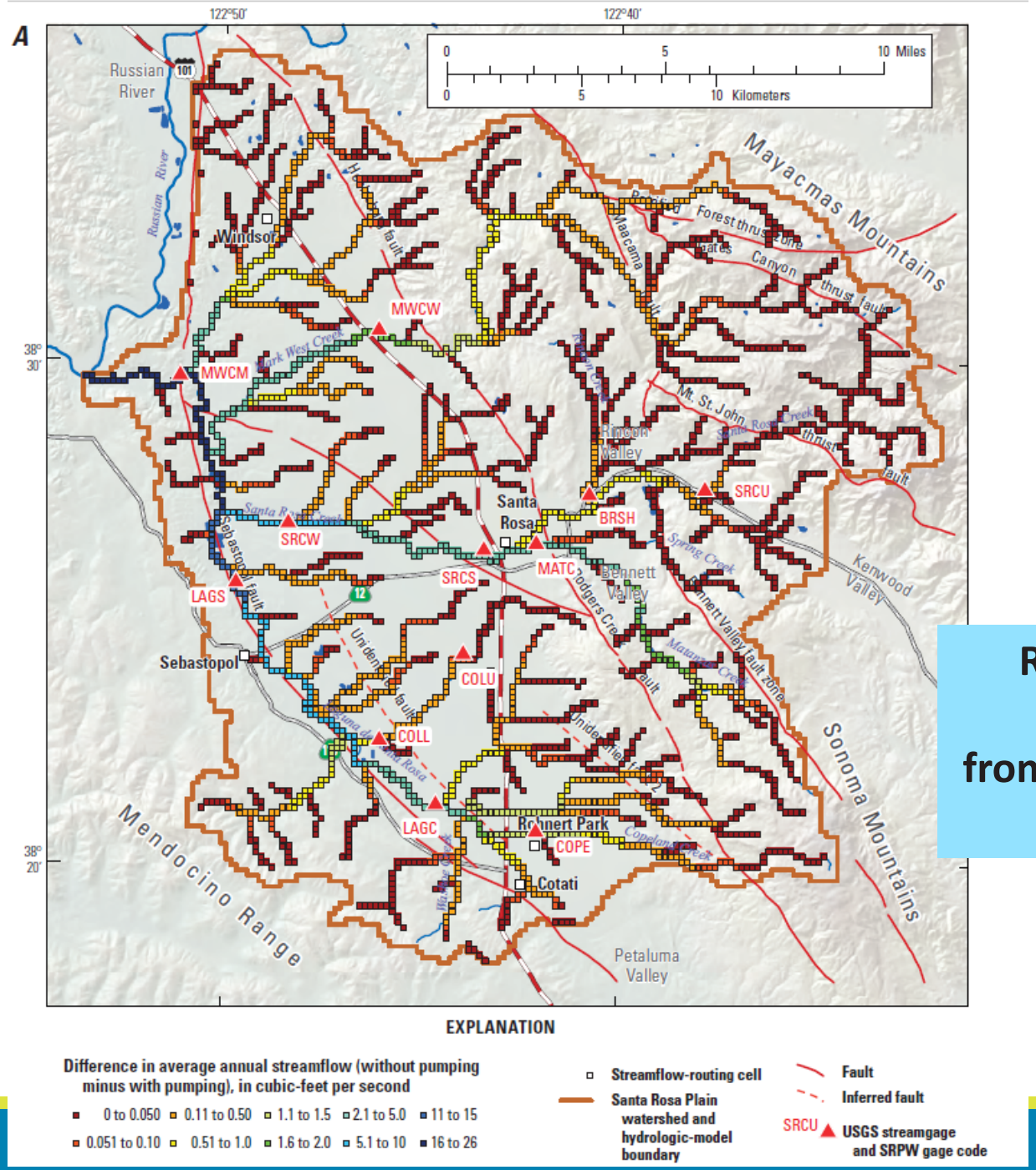
Where does pumping occur within the basin?



Areal Extent of Pumping Impacts in Santa Rosa Plain

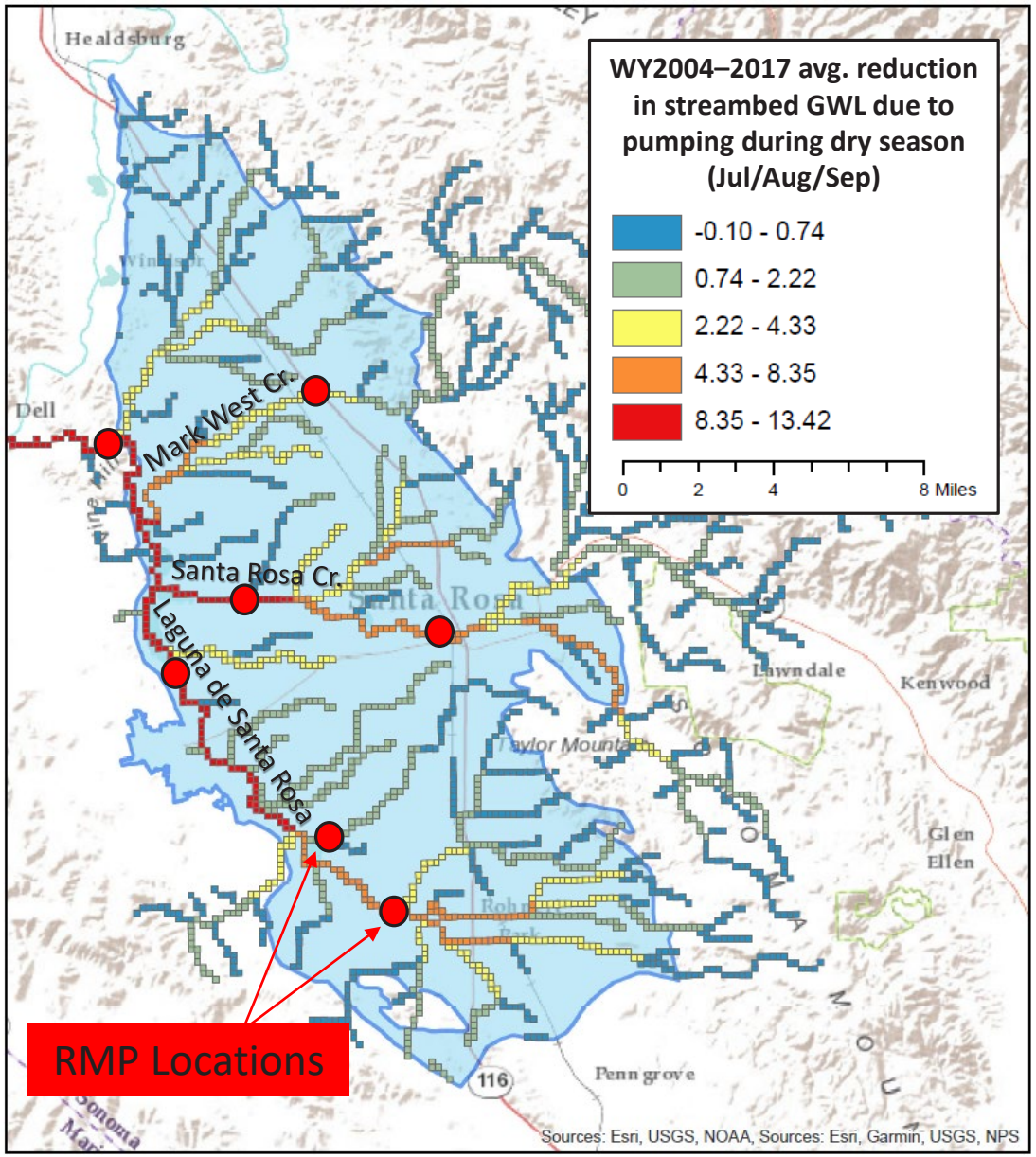
Layers 2–8

Where does pumping have greater potential to impact streamflows?



Reductions in streamflow due to pumping.

from: Woolfenden and Nishikawa, 2014, Chapter E Figure 9A



Where does pumping have greater potential to impact streamflows?

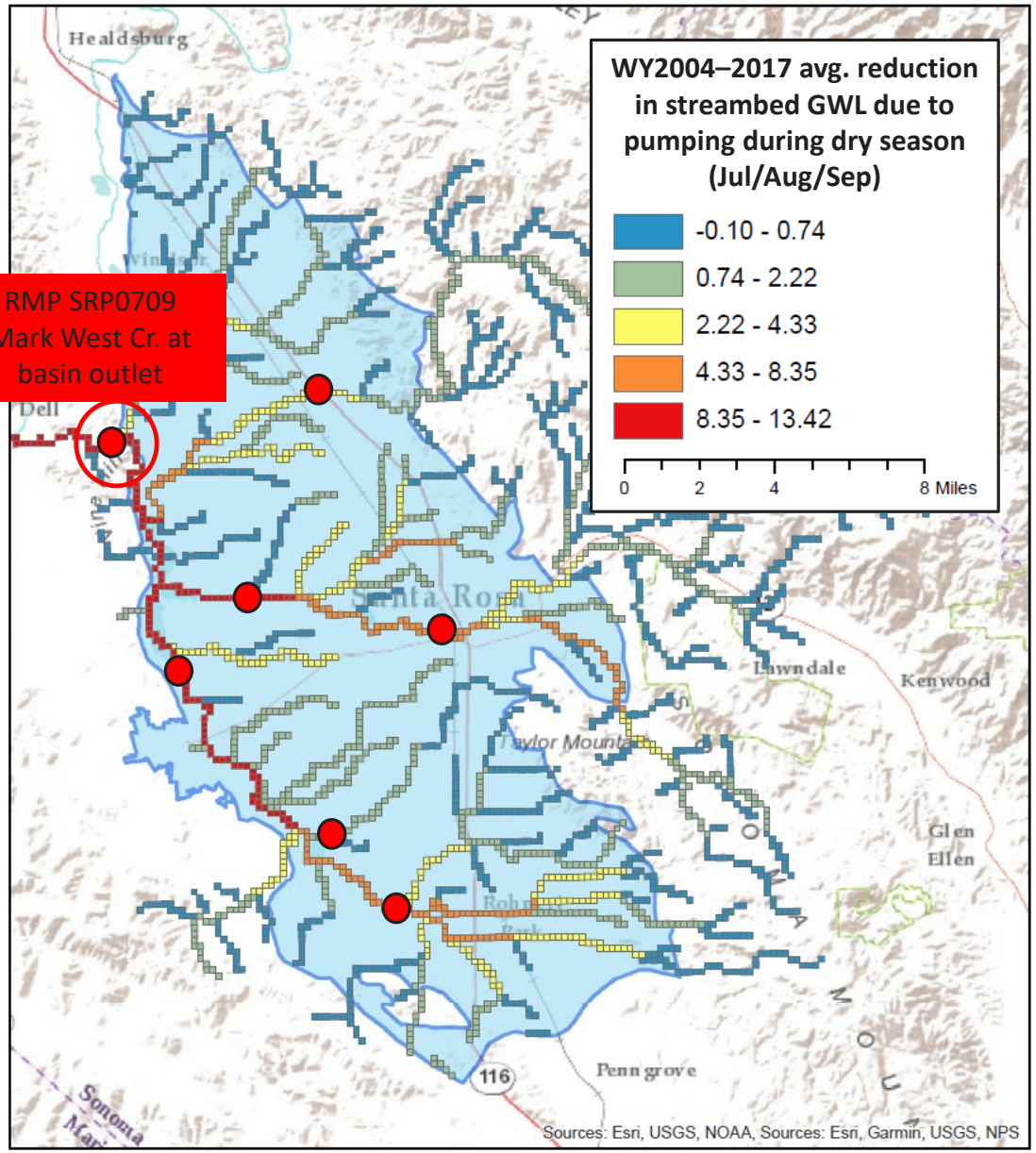
Modeling suggests that pumping has greater potential to impact streamflows on:

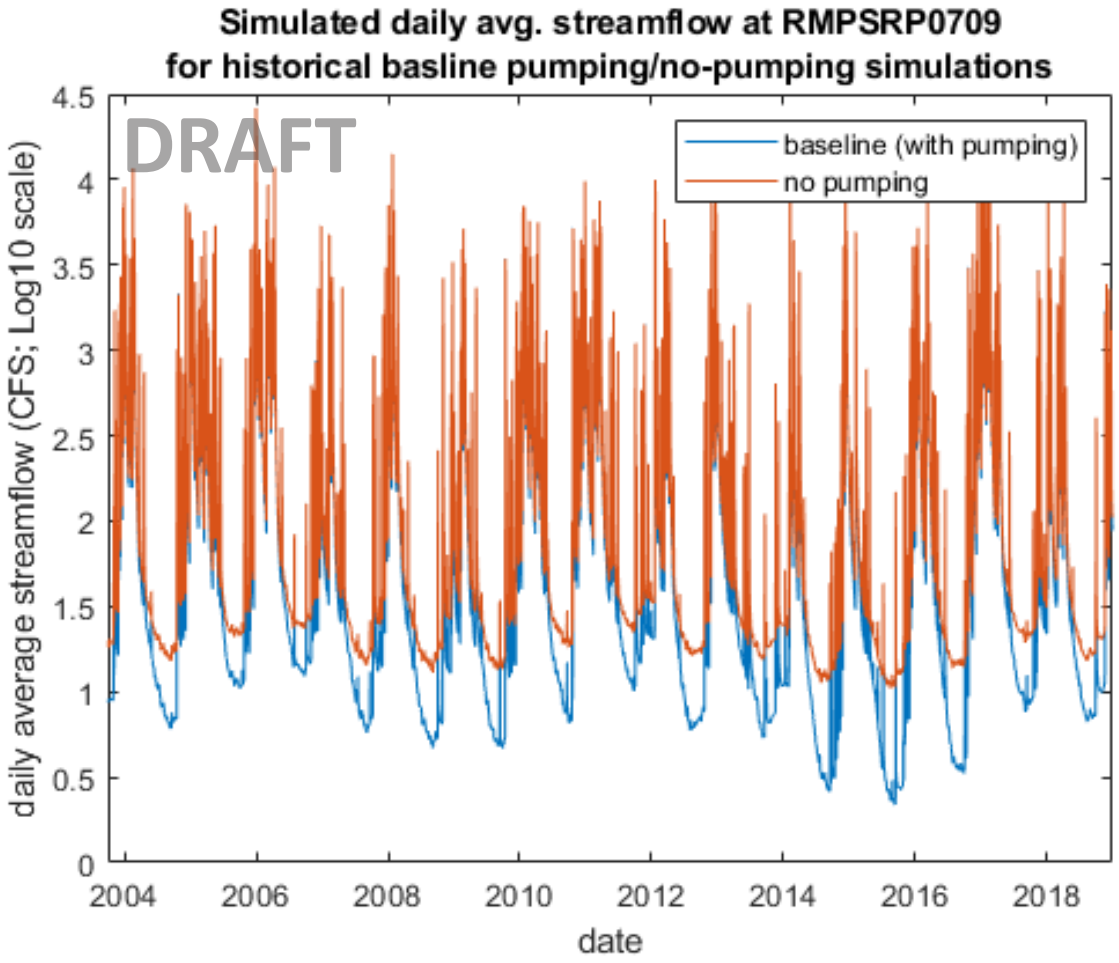
Laguna de Santa Rosa
Santa Rosa Cr.
Mark West Cr.

Actual impacts are very dependent upon:

(1) streambed/shallow aquifer hydraulic conductivity
(2) stream/aquifer configuration

What is the impact of pumping on outflows from the basin?





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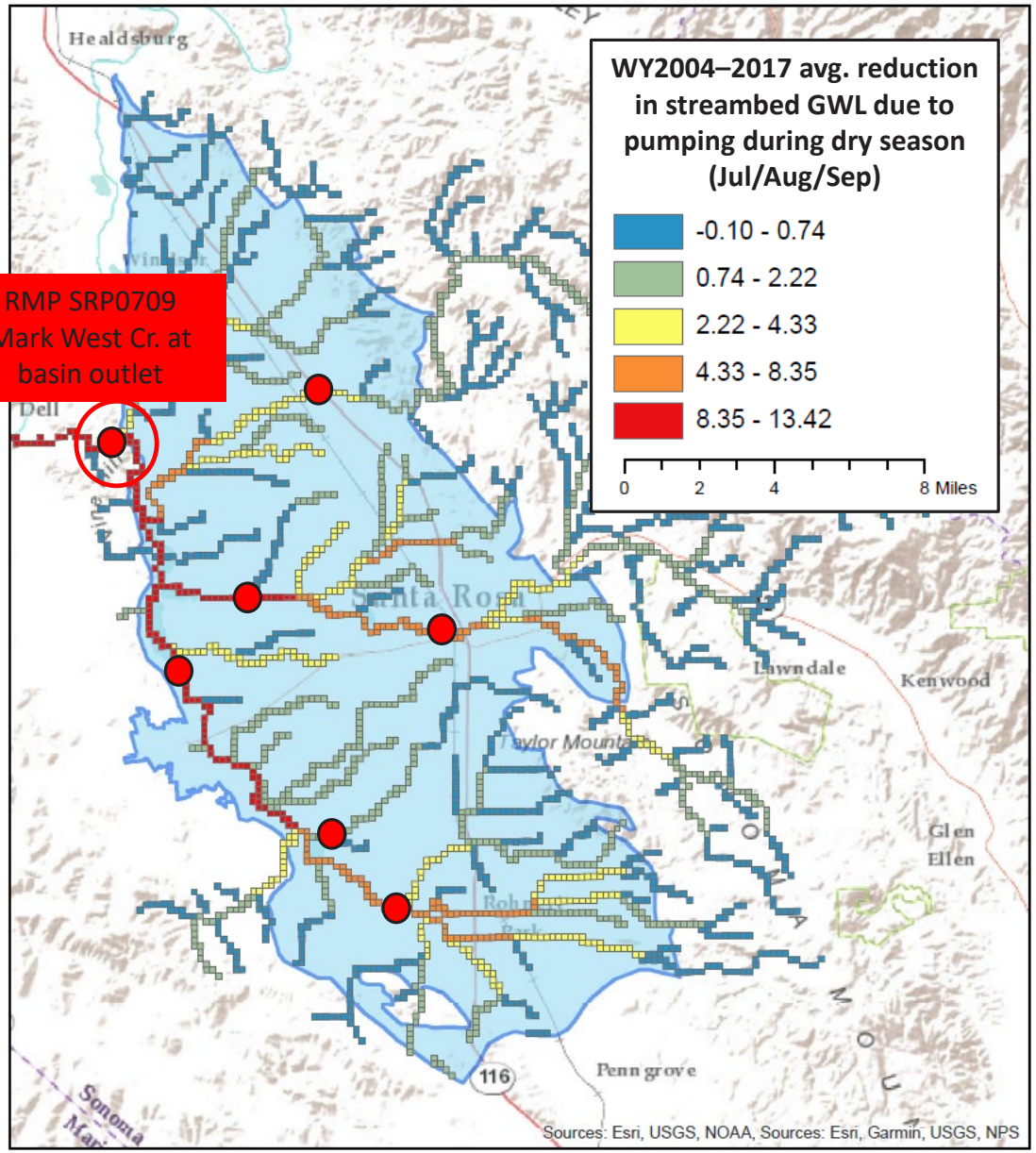
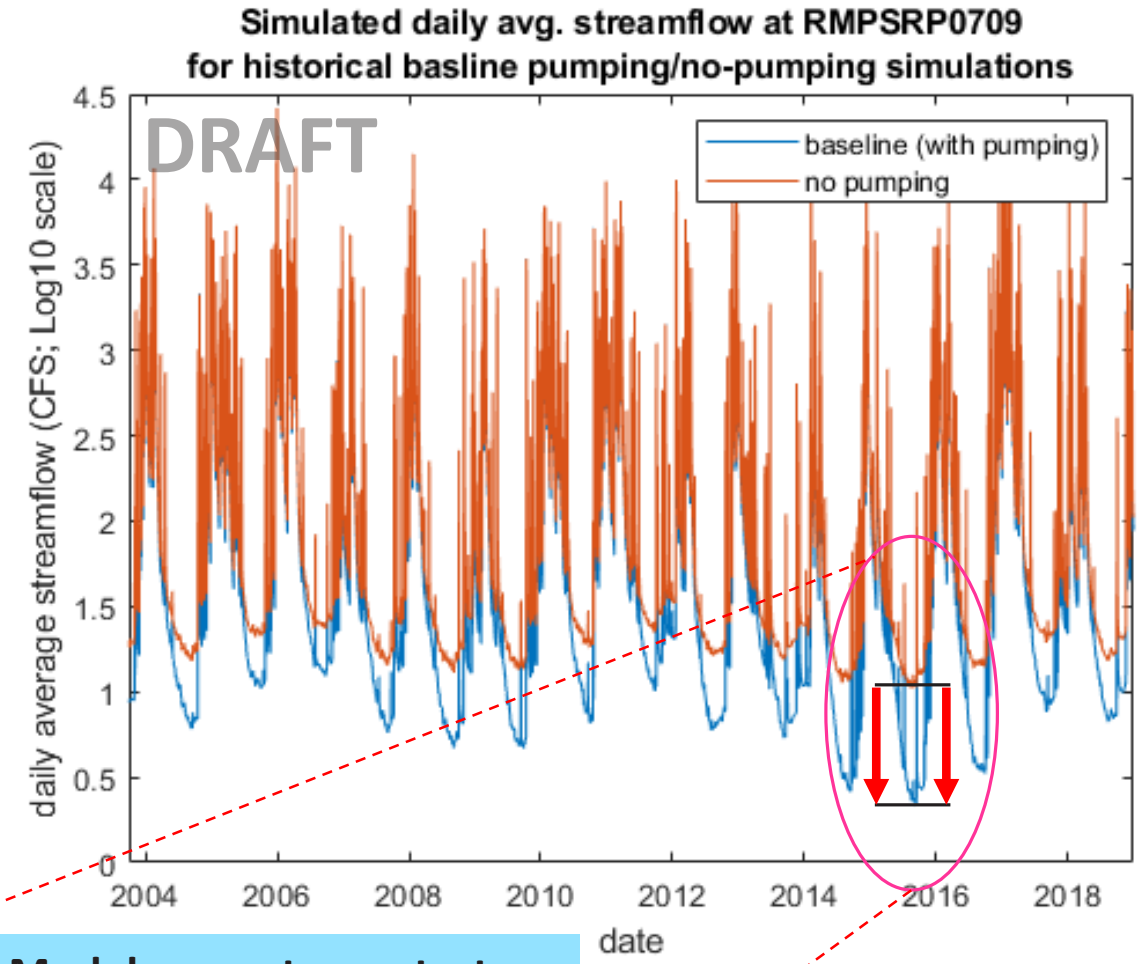
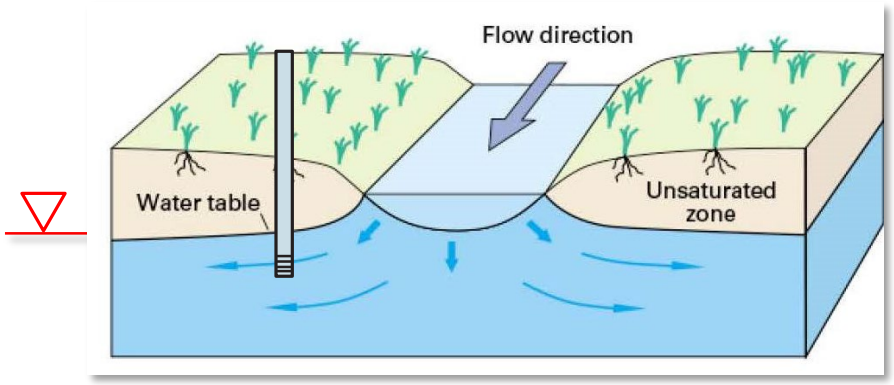


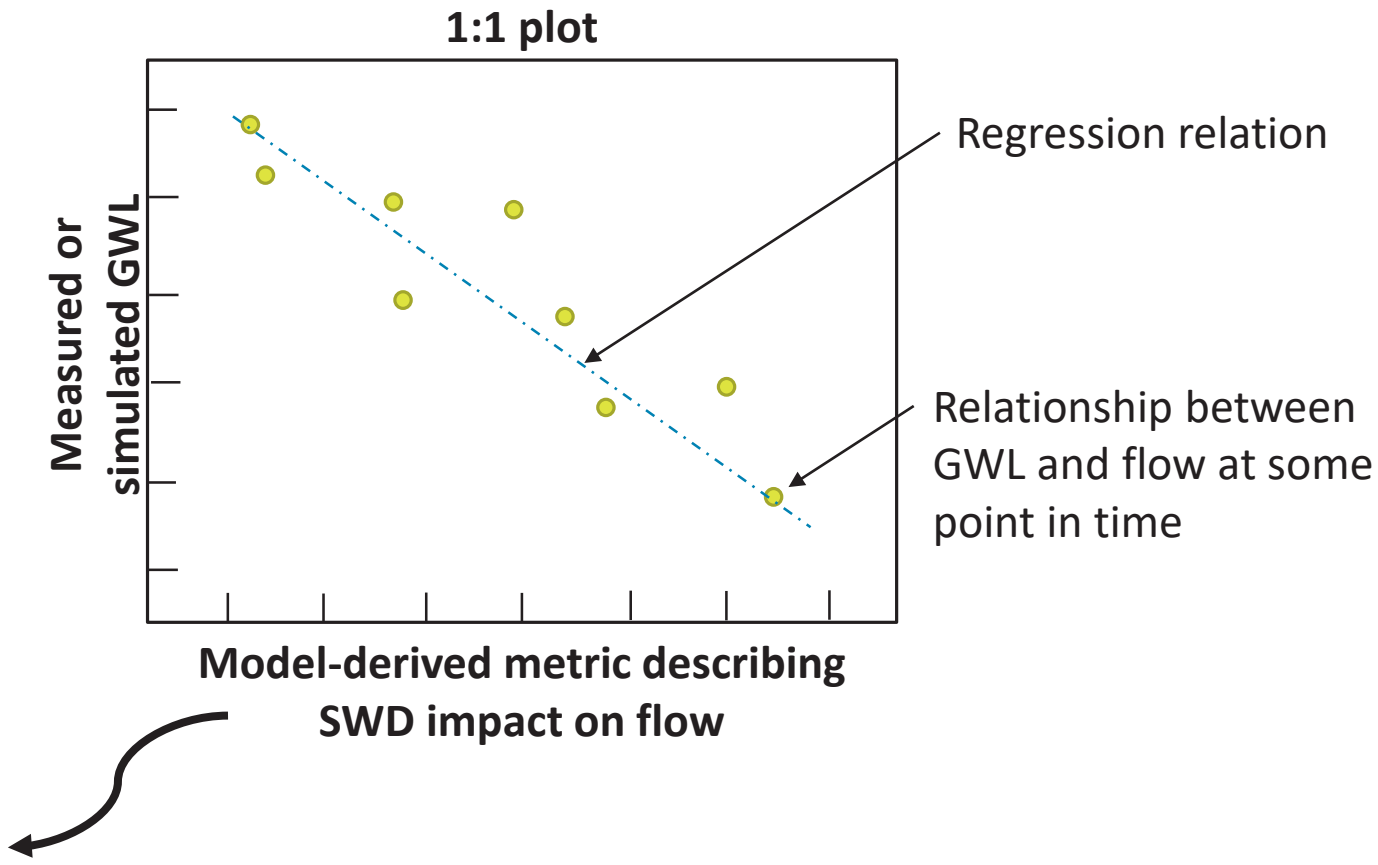


Model suggests greatest reduction in dry-season flows due to pumping during 2015

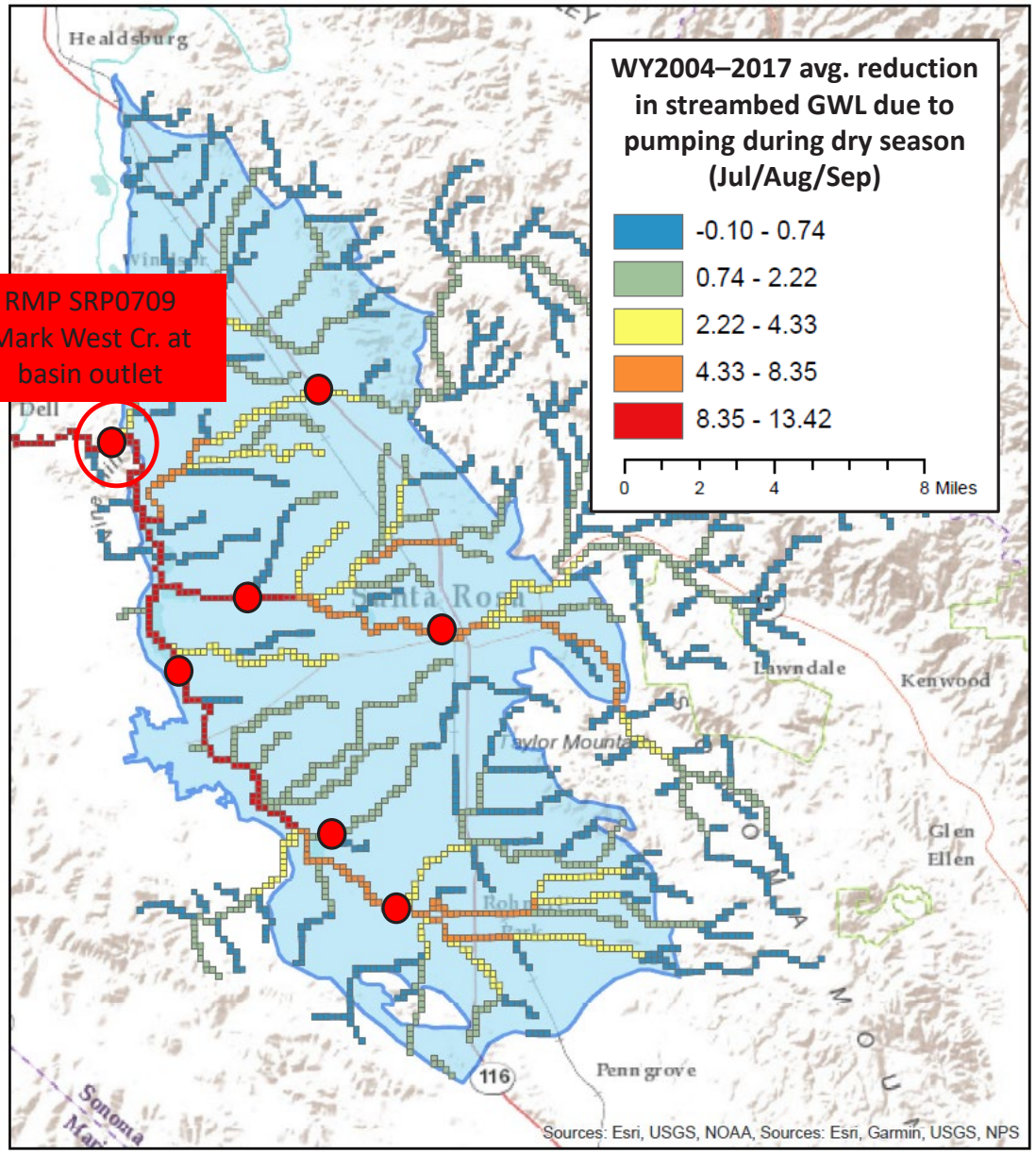
How can GWL be used as a proxy for surface water depletion?



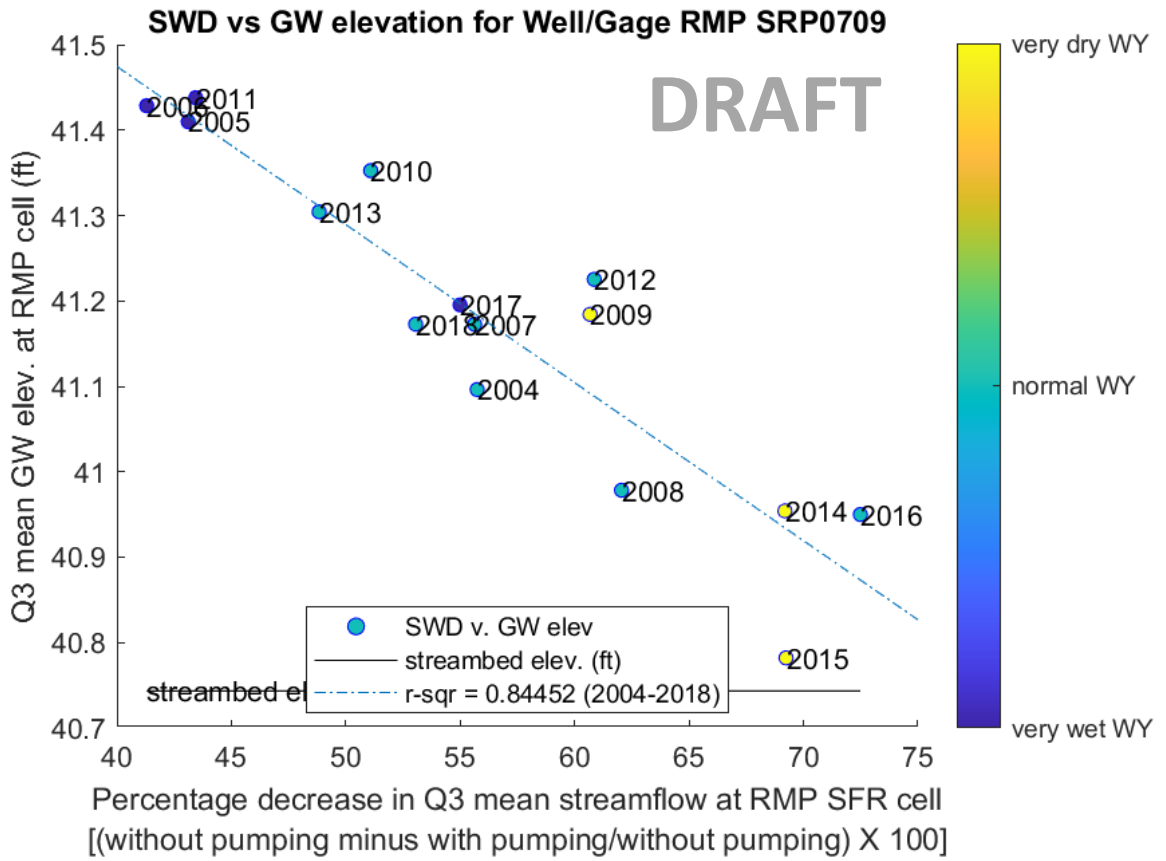
1. **Percent reduction in streamflow due to pumping (over entire WY)**
2. **Percent reduction in streamflow due to pumping (during low-flow periods)**
3. **Number of days that SWD exceeds threshold value**



Can we use GW levels as a proxy for SWD?



Good correlation … for simulated GW levels and SWD at some RMPs



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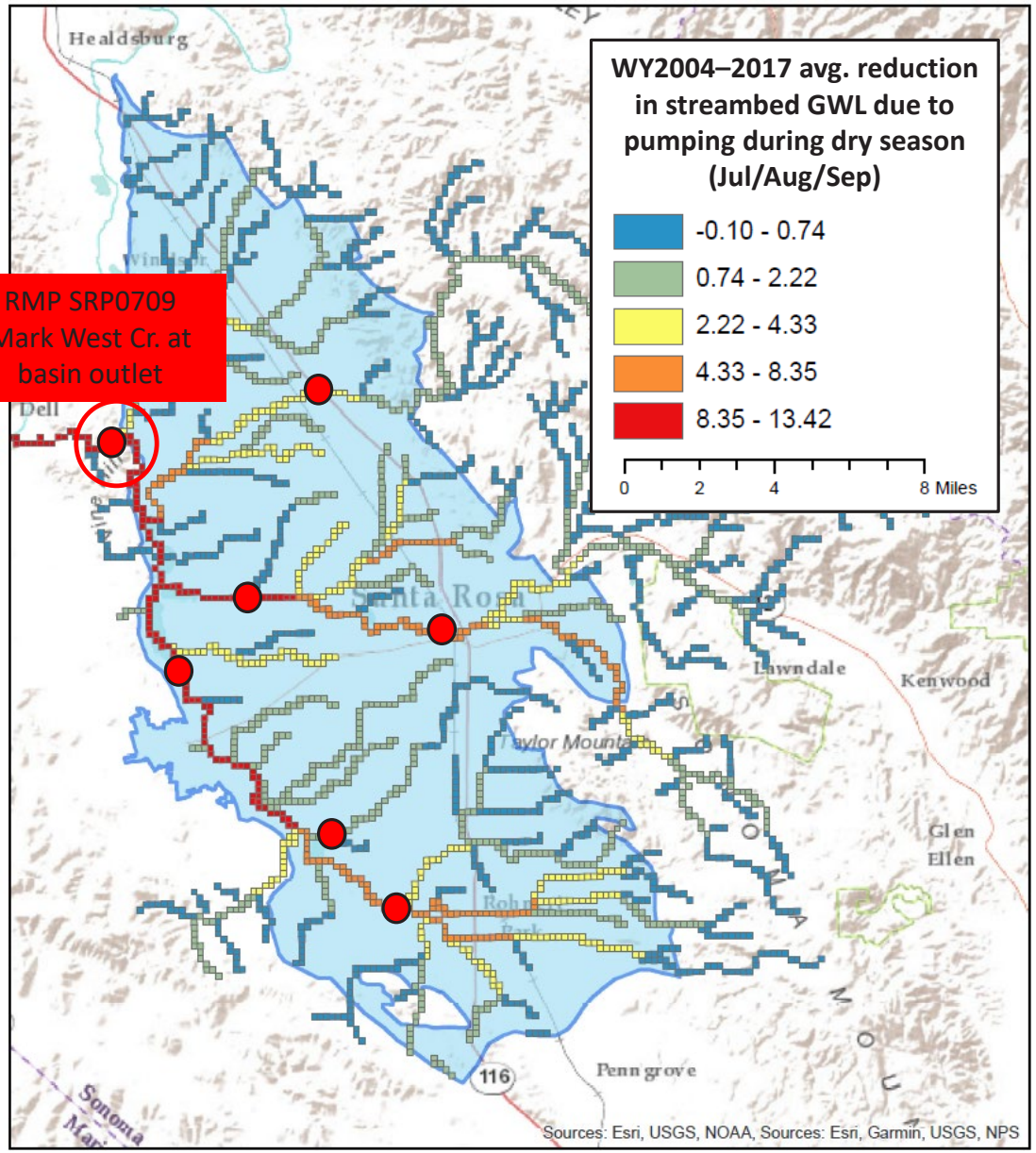

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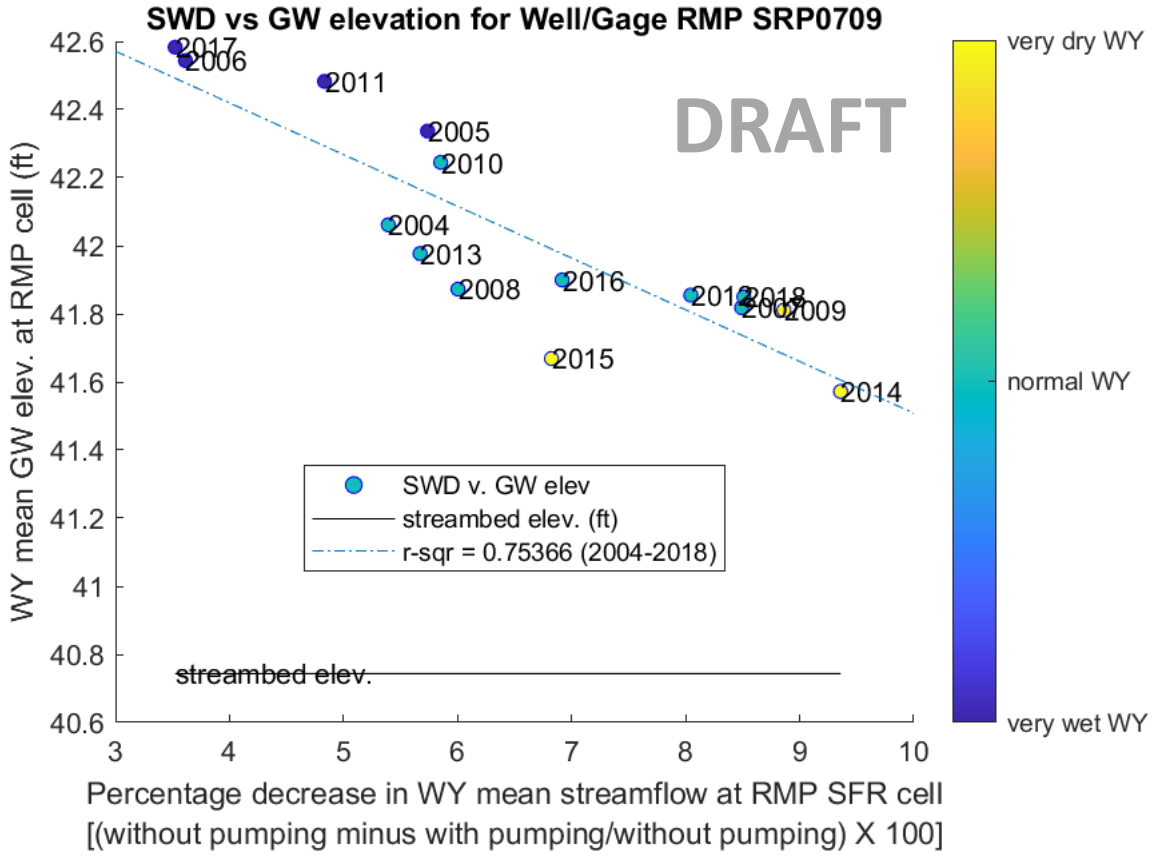
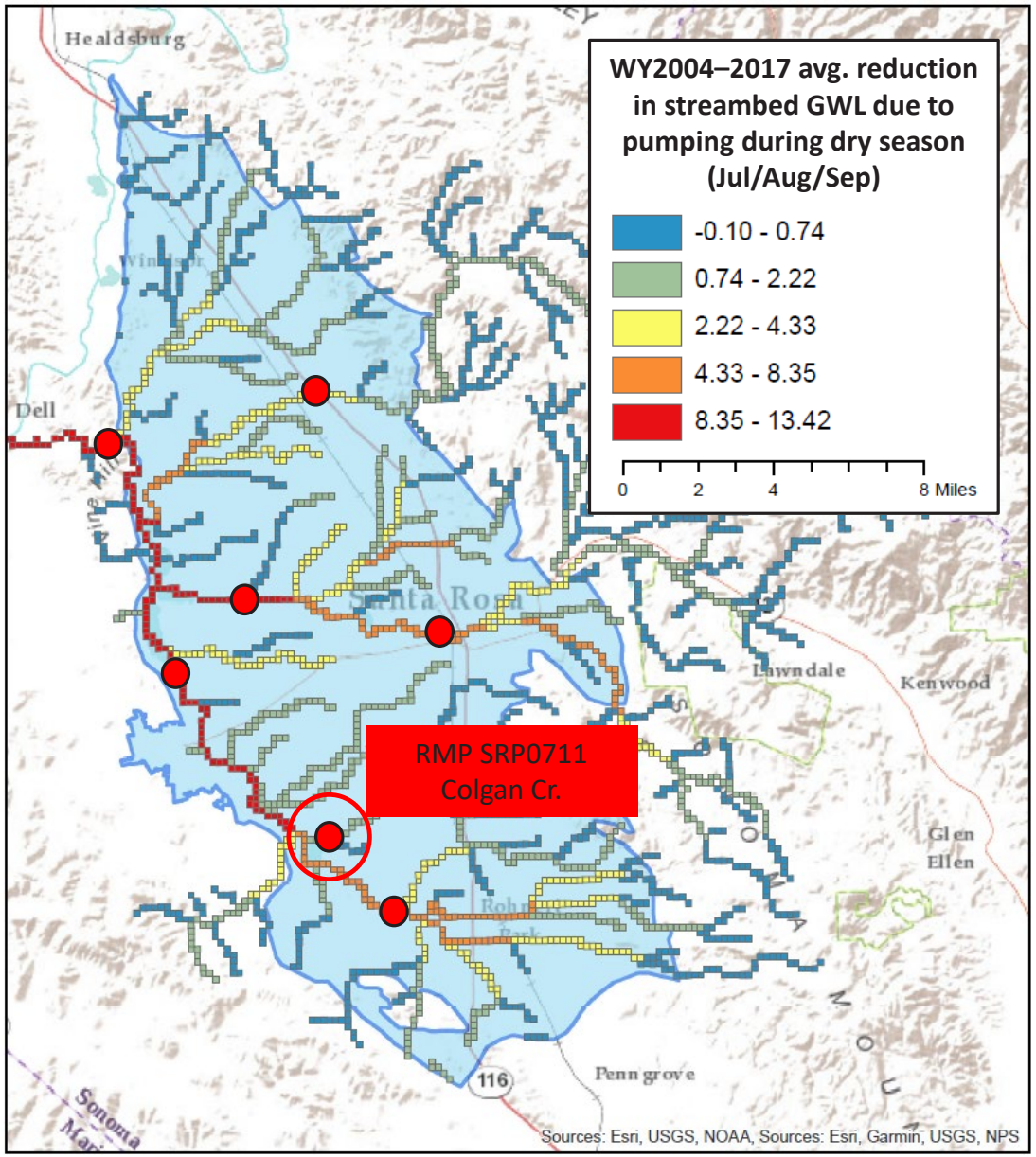
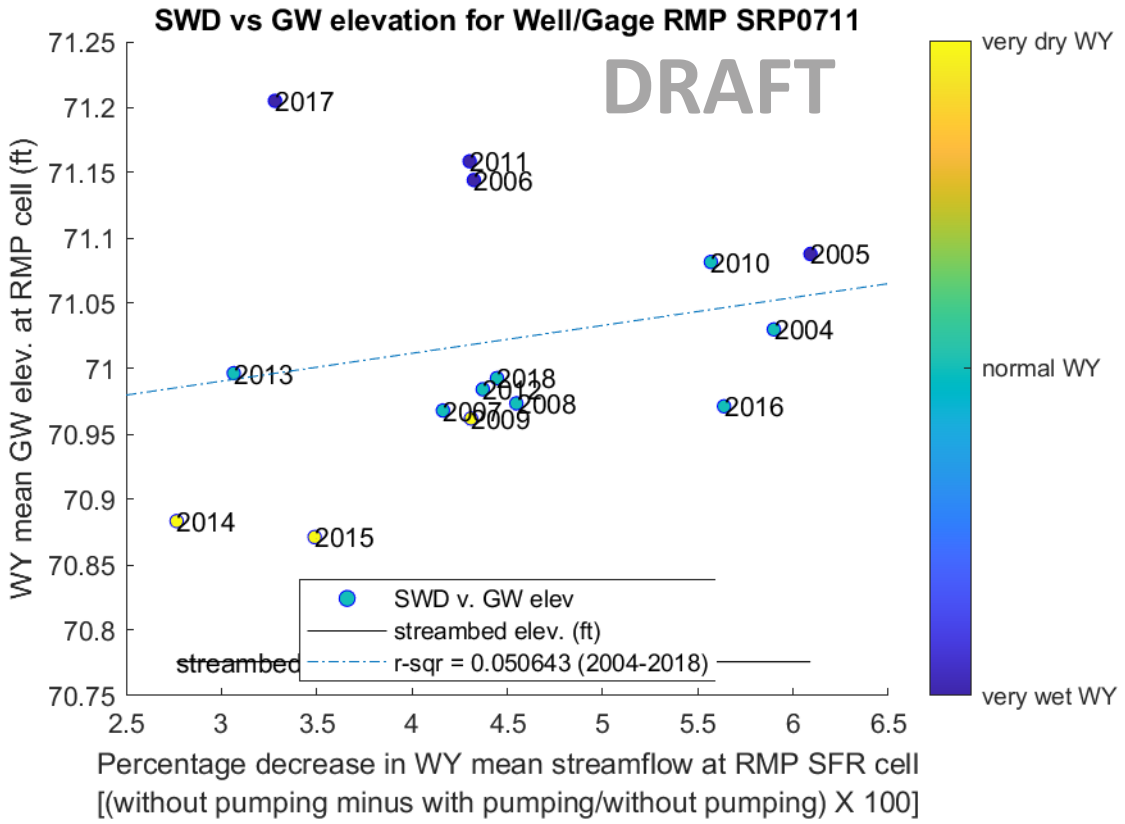


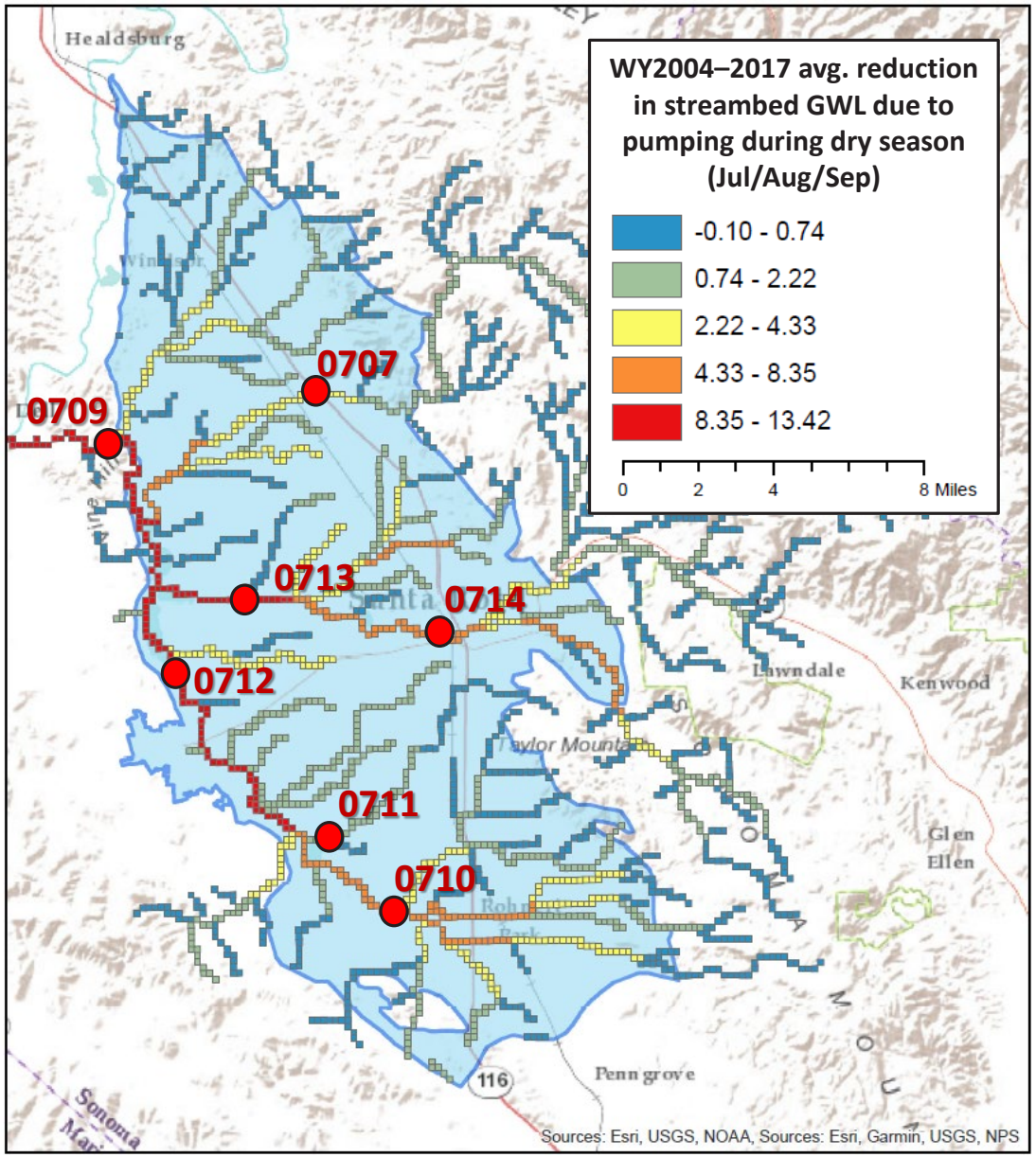
Can we use GW levels as a proxy for SWD?



Poor correlation … for some RMPs where little SWD is occurring

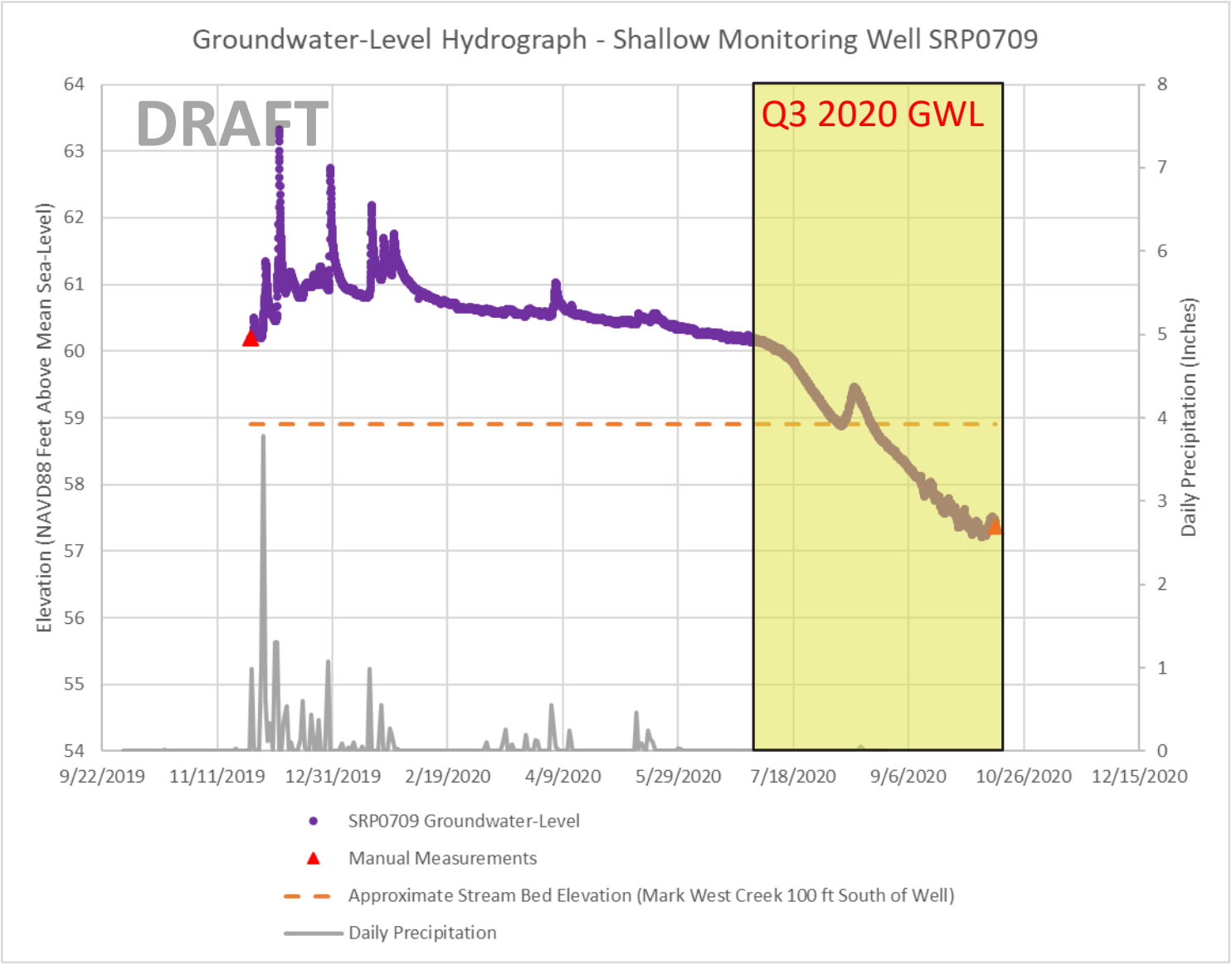


Can we use GW levels as a proxy for SWD?



Good correlation between modeled GWL and SWD is noted at several monitoring locations.

RMP	r-squared agreement between GWL and SWD	
	Full Water Year (WY)	Q3 dry period (Jul/Aug/Sep)
SRP0707	0.72	0.78
SRP0709	0.75	0.84
SRP0710	0.49	0.03
SRP0711	0.05	0.16
SRP0712	0.28	0.74
SRP0713	0.54	0.13
SRP0714	0.71	0.27



Model results show promise … How do they compare with measured data?

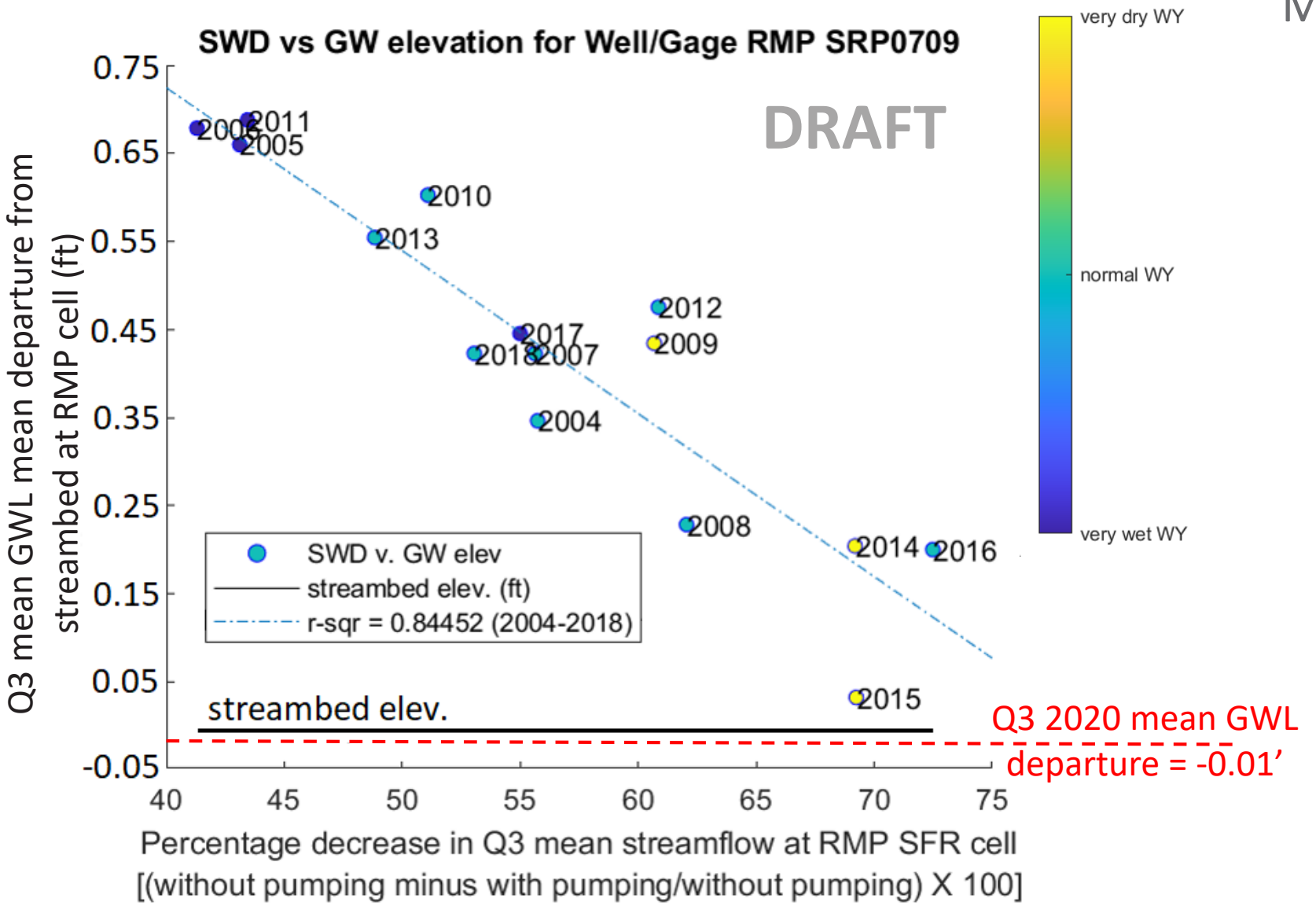
Problem:

Model simulation period (WY1974–2018) does not overlap with RMP data collection (2019–present)

Reliance on model results assumes well calibrated model, esp. at RMP locations.

Potential Solution:

Compare measured/modeled behavior for similar WY type.
(WY2020 = dry year)



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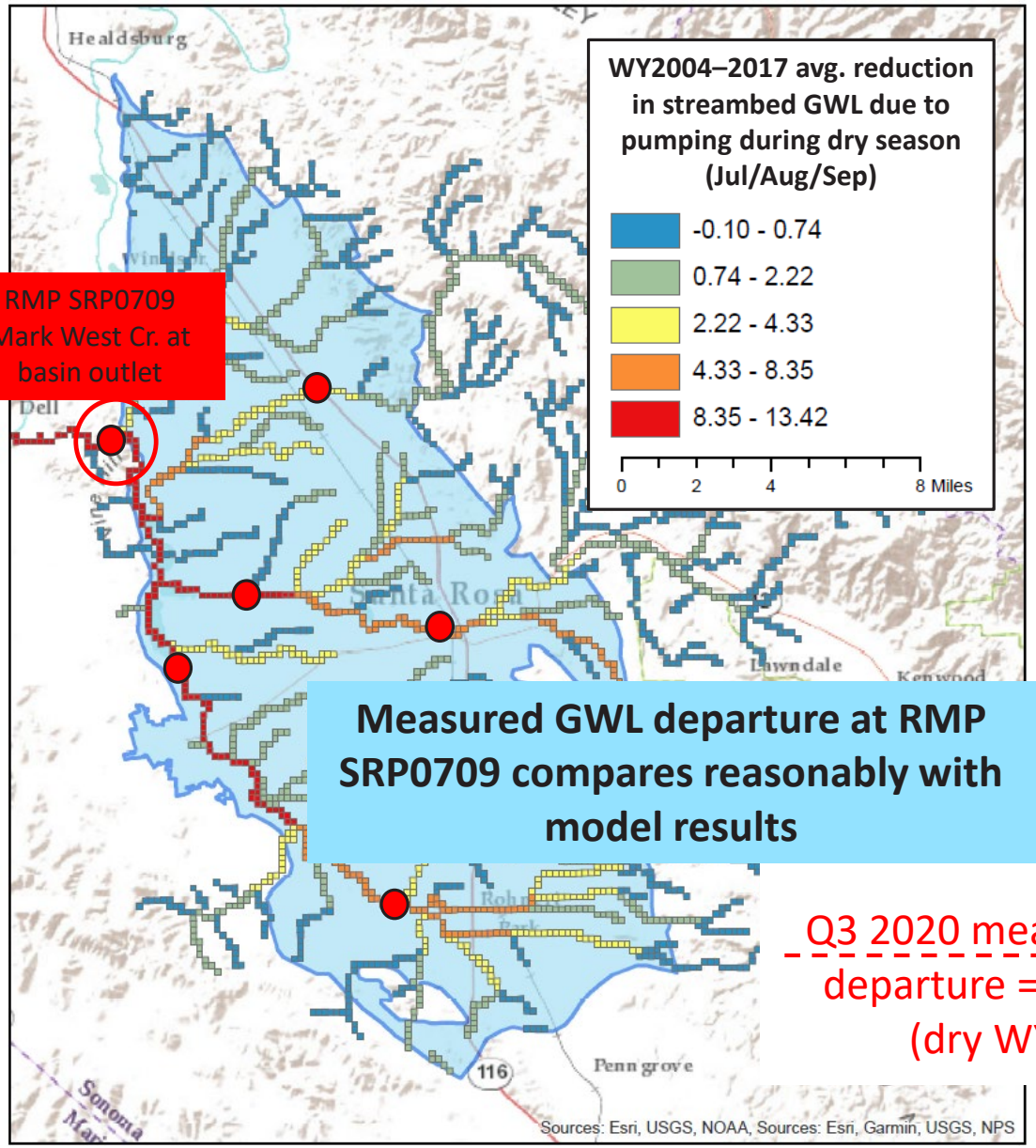

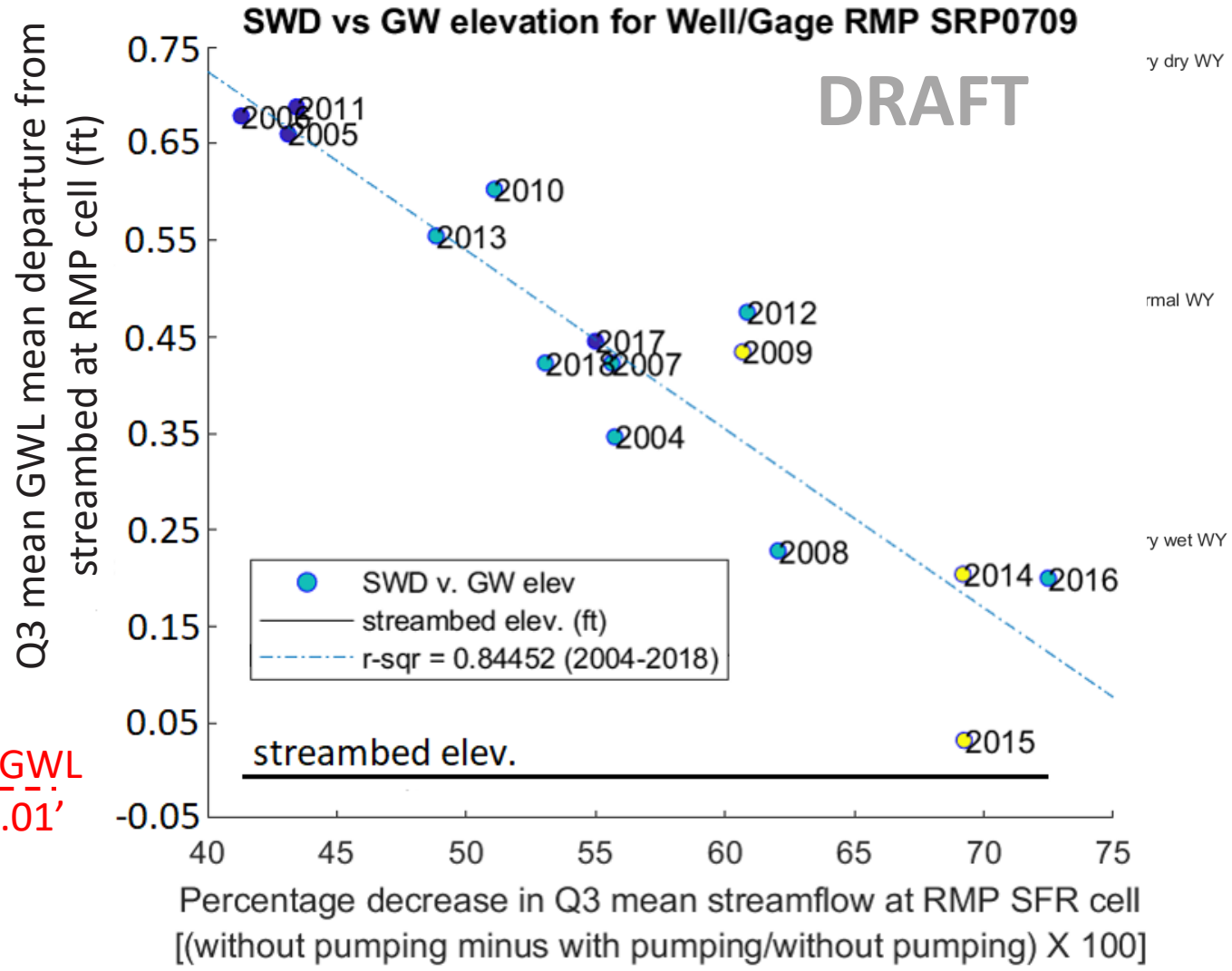

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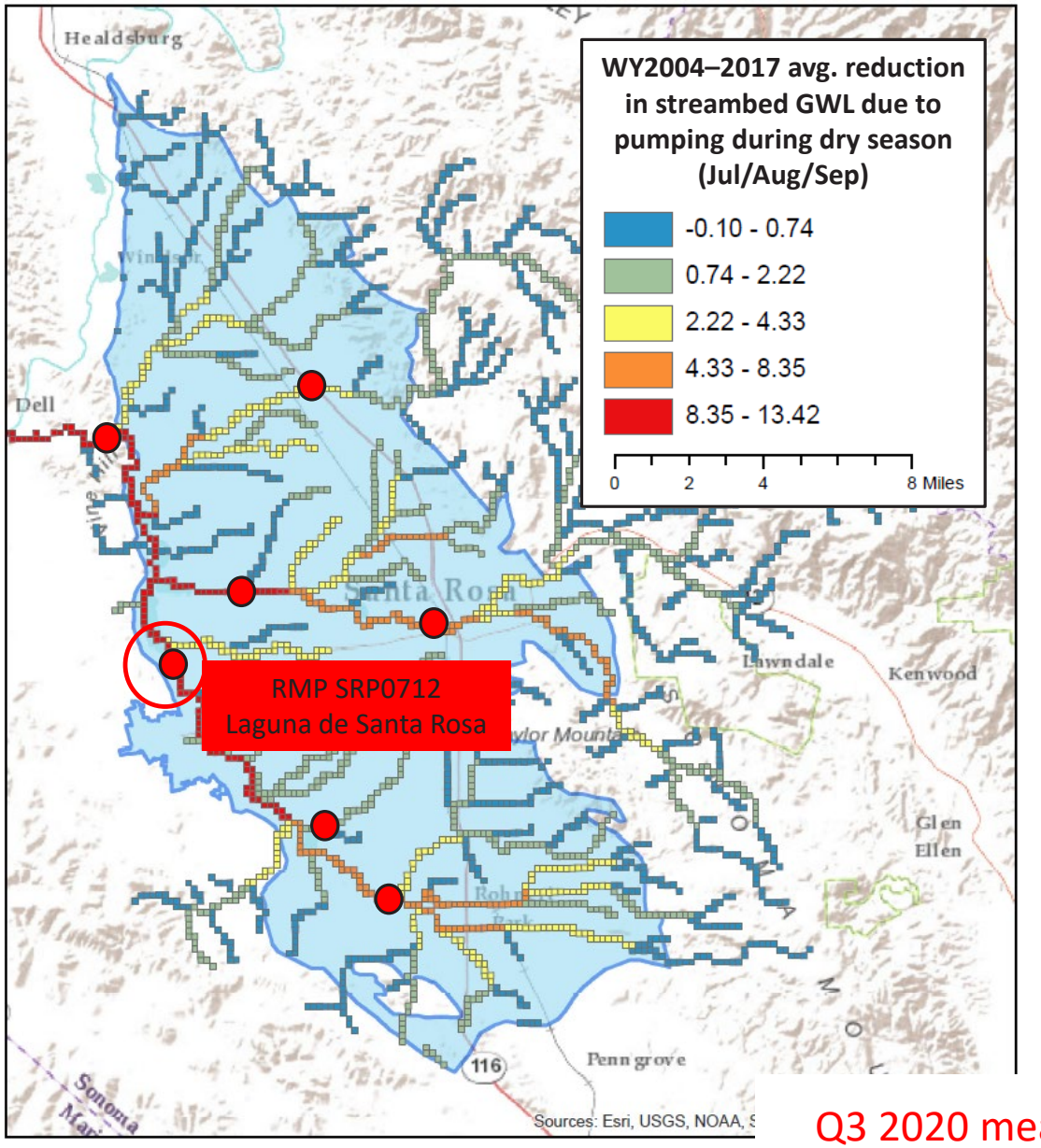
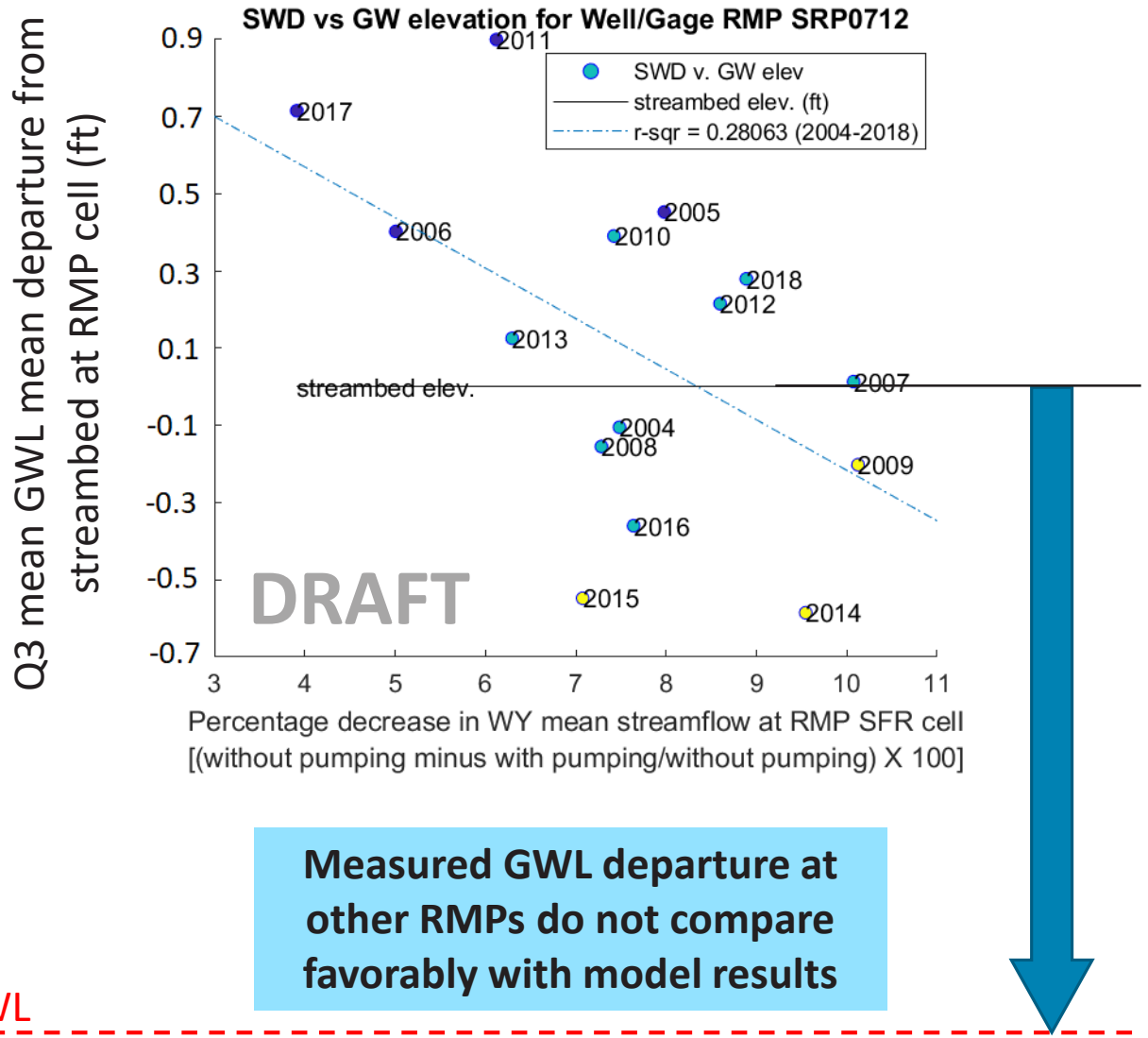


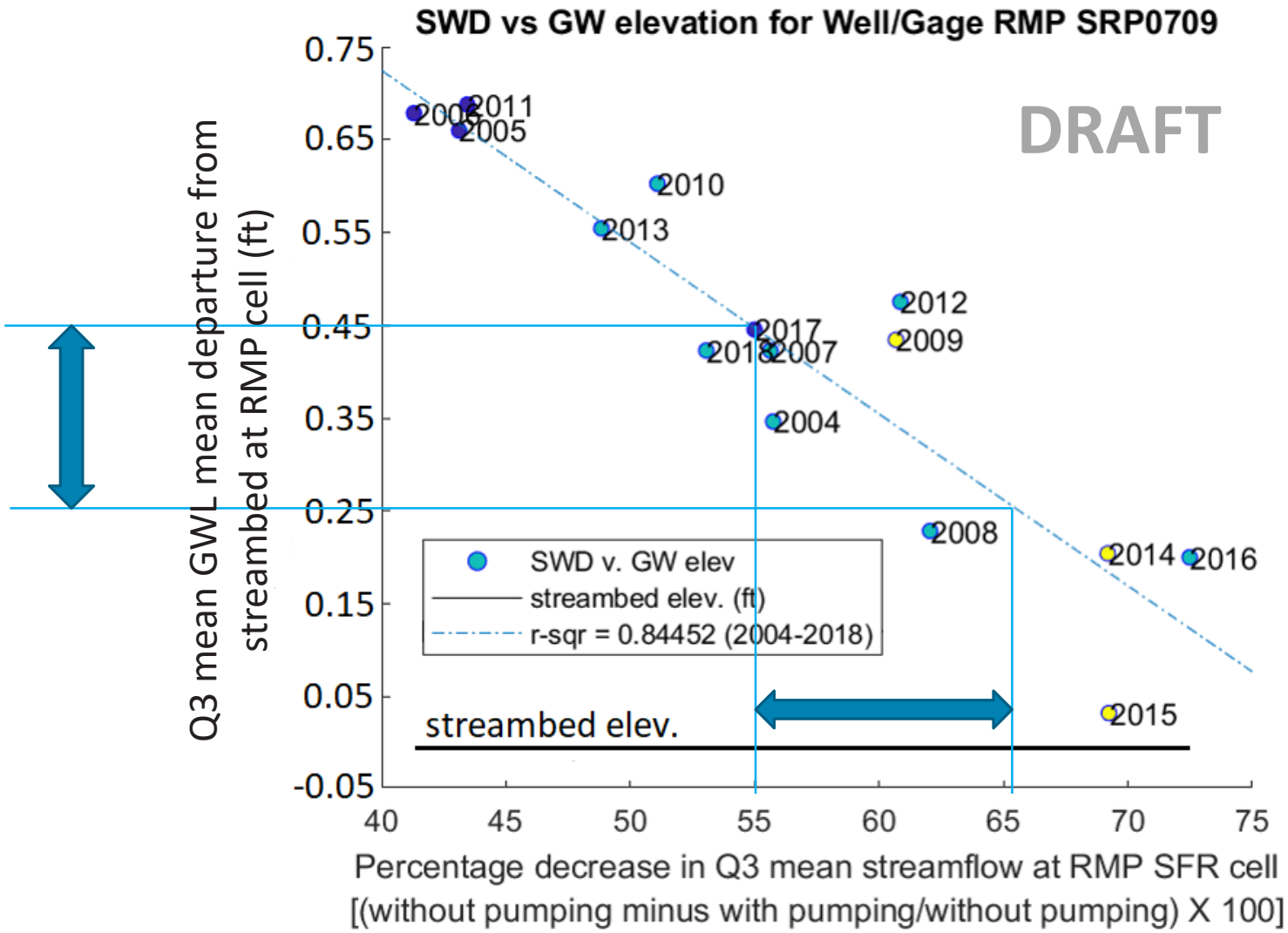


Measured GWL departure at other RMPs do not compare favorably with model results

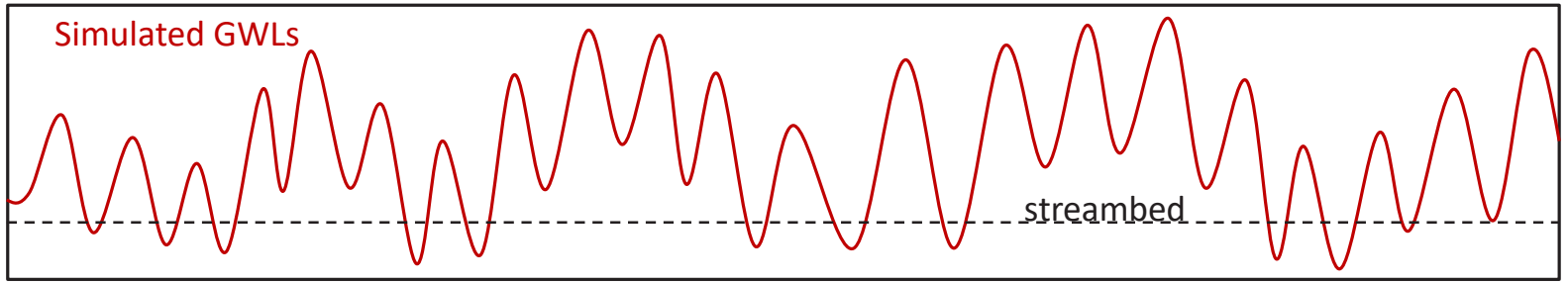
Q3 2020 mean GWL departure = -4.5’ (dry WY)

How can GWL – SWD relationship be used to inform SMC choice?
… Assuming good agreement between measured data and model results

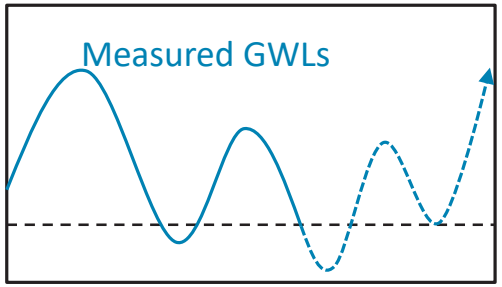
Relationship suggests 0.1 ft reduction in mean Q3 GWL corresponds with ~10% increase in SWD.



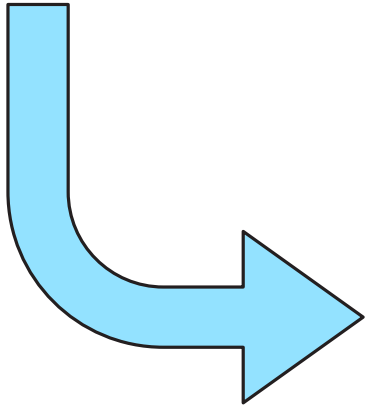
How can GWL – SWD relationship be used to inform SMC choice?

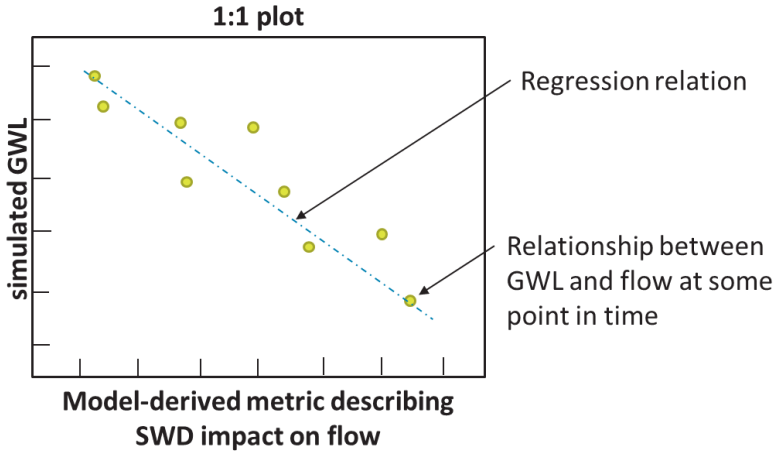


Simulation Period (1974–2018)

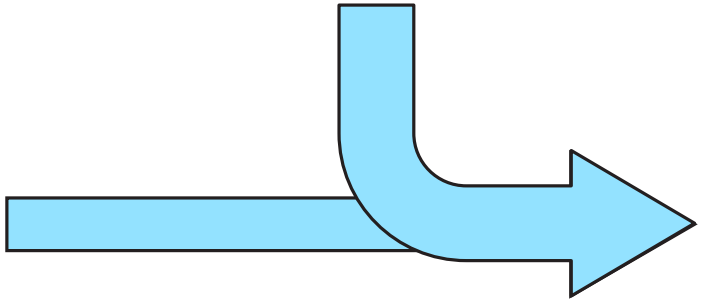


Measurement Period
(2019–present and beyond)

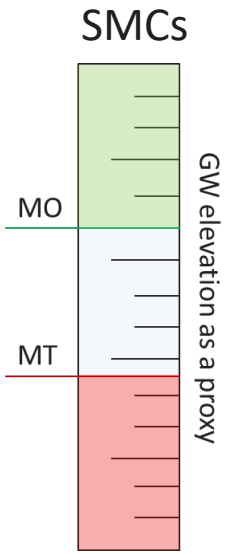




Initial SMC choices informed by model results



SMCs refined as more measurements are collected



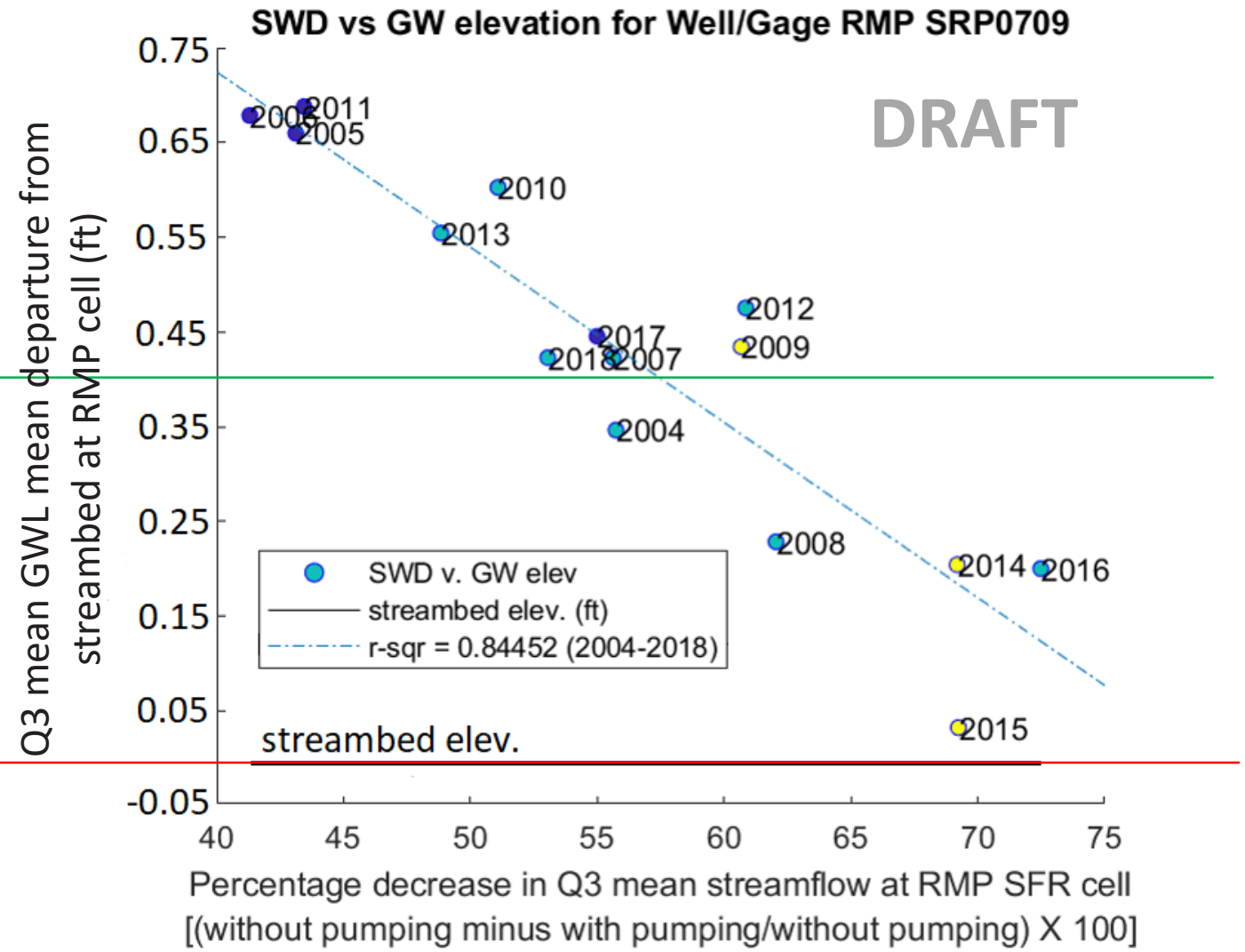
How can GWL – SWD relationship be used to inform SMC choice?
… Assuming good agreement between measured data and model results

Potential Approach:

Set SMC based on GWL, use relationship to infer SWD impact

Example measurable objective (MO) =
Q3 GWL > mean Q3 GWL during 2004–2018
= ~55-60% avg. decrease in Q3 streamflow

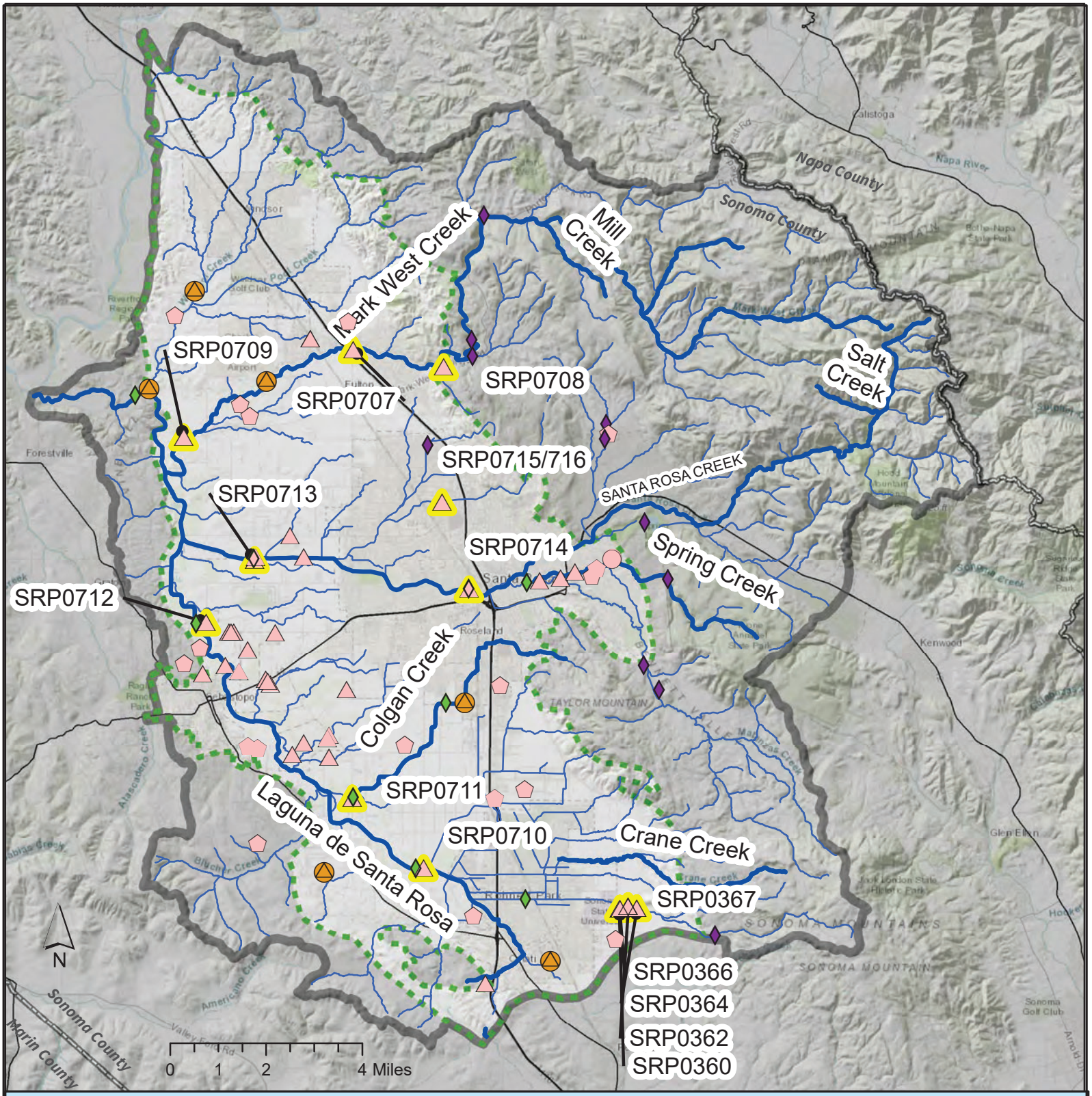
Example minimum threshold (MT) =
Q3 GWL > streambed elev.
= >75% avg. decrease in Q3 streamflow



Shallow TSS Monitoring Well Details
Santa Rosa Plain Groundwater Subbasin

Station Name	Station Number	Location Description	Well Depth (ft BGS)	Screened Interval (ft BGS)	Well TOC Elevation (ft MSL)	Approximate Distance from Well to Creek (ft)	Direction of Well from Creek
SRP0707	SRP-F07-04_Fulton	Mark West Creek at Fulton Rd	50.5	30-50	143.92	200	S
SRP0708	SRP-H07-01_Mark West	Mark West Creek at Mark West Springs Rd.	25.5	15-25	196.18	275	SE
SRP0710	SRP-H18-02_Stony	Laguna de Santa Rosa at Stony Point Rd.	45.5	35-45	89.67	75	N
SRP0709	SRP-C09-01_River Rd	Mark West Creek at River Rd	33.5	23-33	71.86	100	N
SRP0711	SRP-F16-01_Llano	Colgan Creek at Llano Rd.	45.5	35-45	79.26	110	S
SRP0712	SRP-C13-03_Sanford	Laguna de Santa Rosa at Occidental Rd.	48.5	28-48	69.28	1135	E
SRP0713	SRP-D11-02_Willow	Santa Rosa Creek at Willowside Rd.	45.5	25-45	78.77	115	S
SRP0714	SRP-H12-01_Pierson	Santa Rosa Creek at Pierson St.	51.5	41-51	150.34	65	S
SRP0715	SRP-H10-04_Hardies	Paulin Creek at Hardies Ln.	40.5	30-40	135.45	35	S
SRP0716	SRP-H10-04s_Hardies	Paulin Creek at Hardies Ln - Shallow	20.5	15-20	135.55	35	S

Notes:
ft BGS - Feet Below Ground Surface
ft MSL - Feet Above Mean Sea Level (North American Vertical Datum of 1988)
TOC - Top of Casing



- Santa Rosa Plain Groundwater Subbasin
- Contributing Area Watershed
- Major Rivers and Creeks
- Streams
- Dedicated Monitoring Wells
- Monitored Municipal Supply Wells
- Monitored Private Supply Wells
- SCWA OneRain Stream Gauges
- Active USGS Stream Gauges
- High-Frequency Monitoring Wells Adjacent to Streams
- Planned Shallow/Multi-Level Dedicated Monitoring Wells

Shallow Aquifer System Groundwater-Level Monitoring Network and Existing Stream Gauges

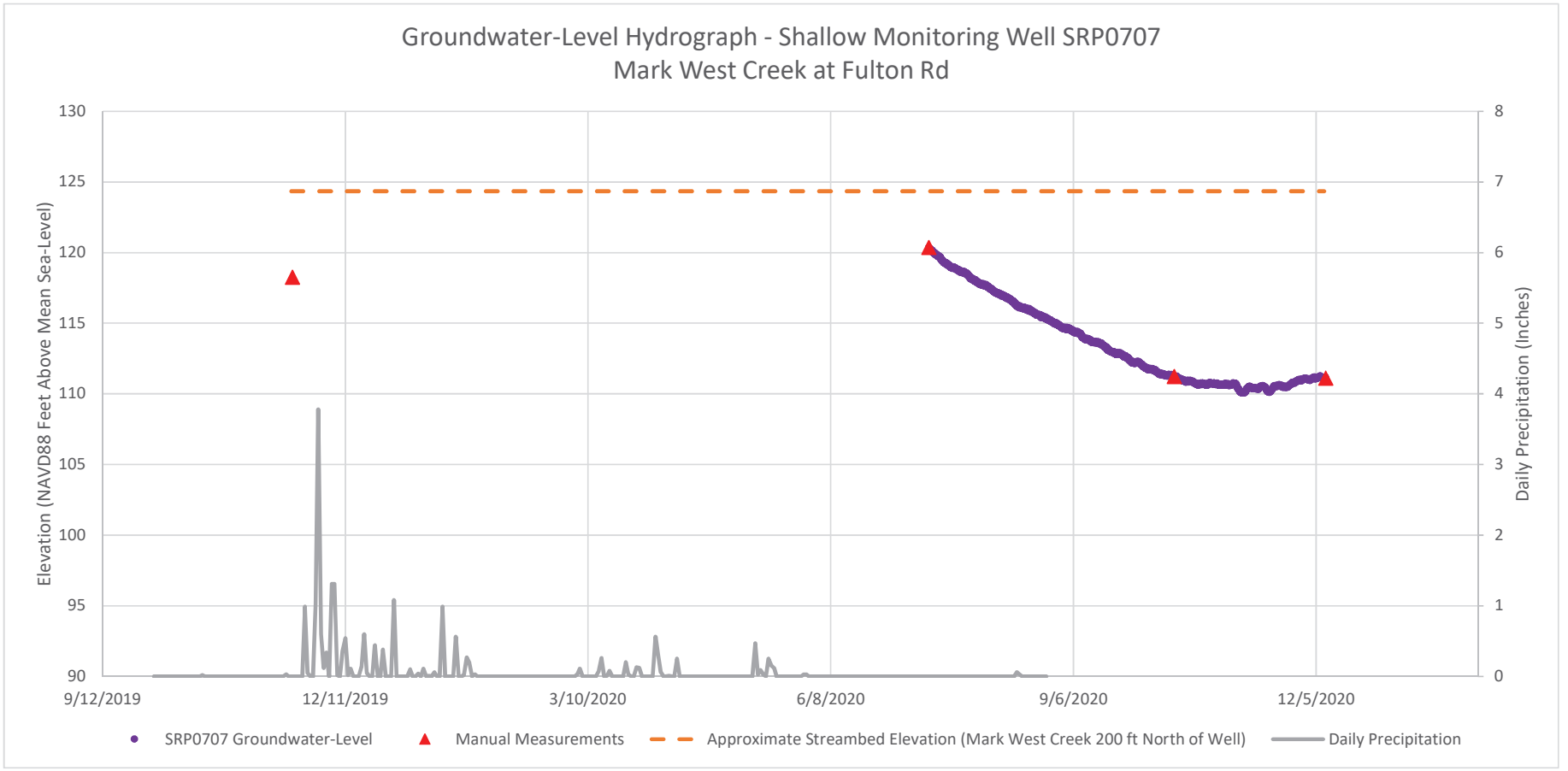
Data Sources:

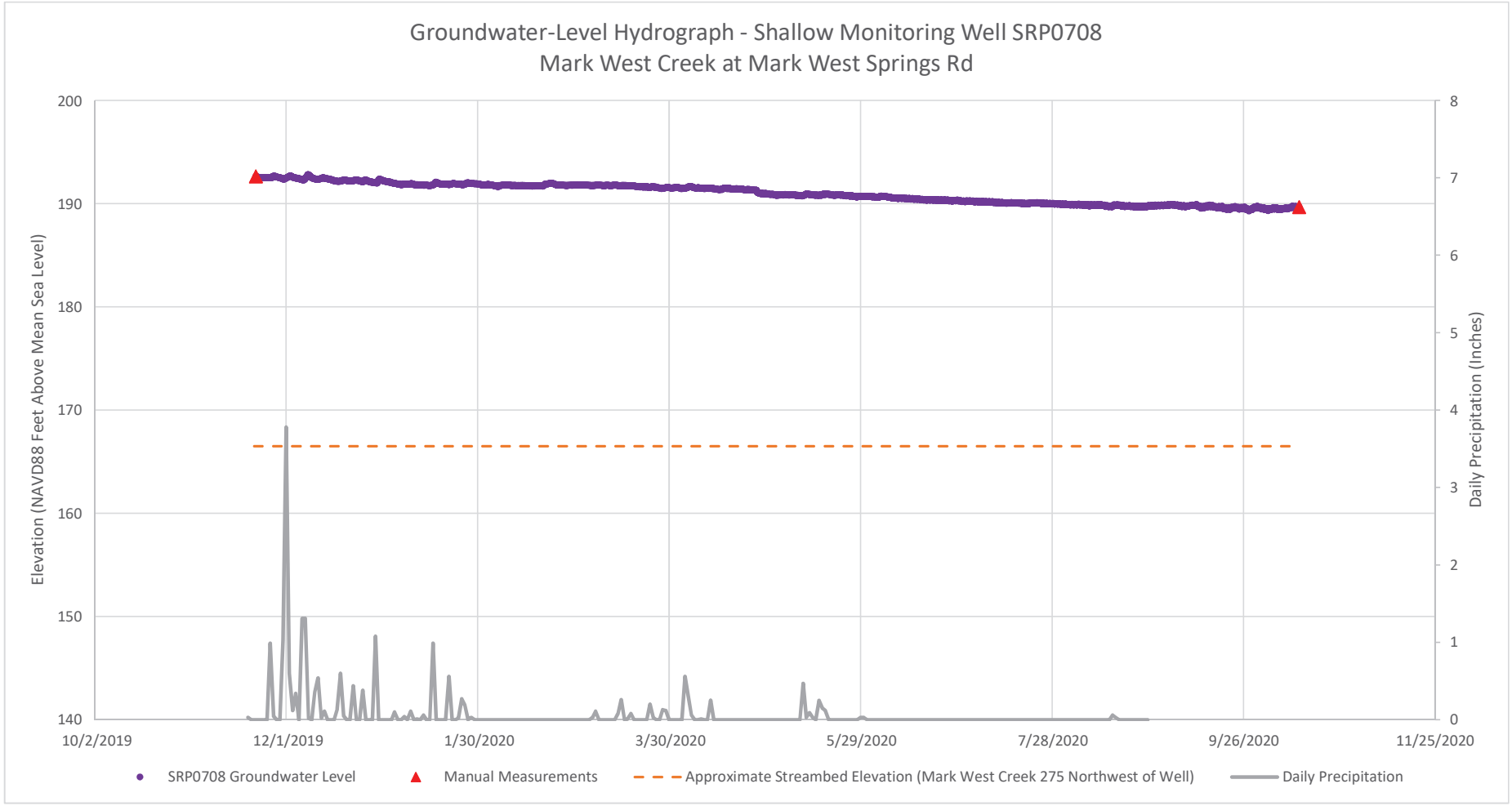
Groundwater Basins - California Department of Water Resources, Bulletin 118
Major Rivers and Creeks - Department of Water Resources
Streams - Sonoma County Central GIS and Sonoma Water

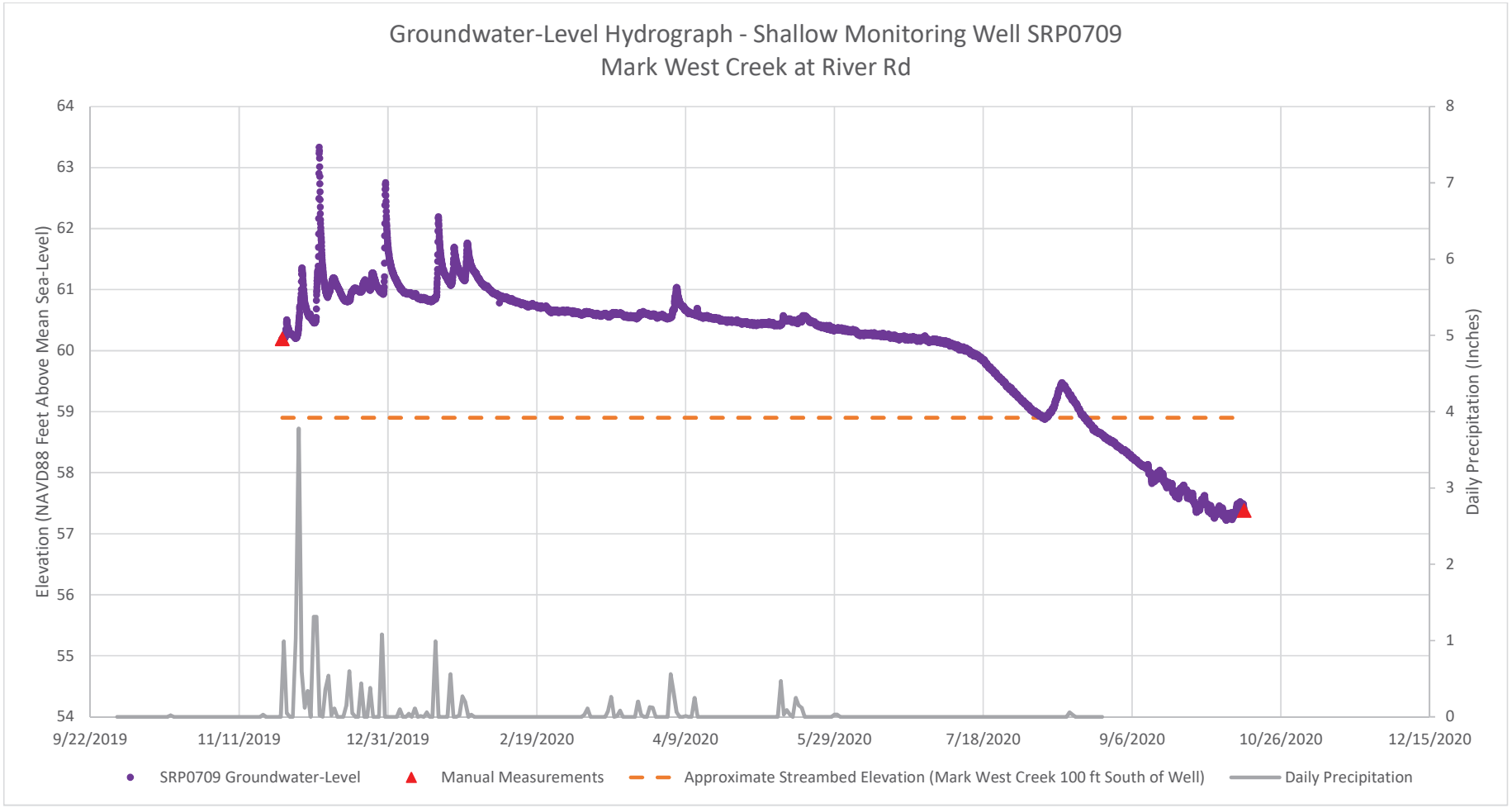
DRAFT

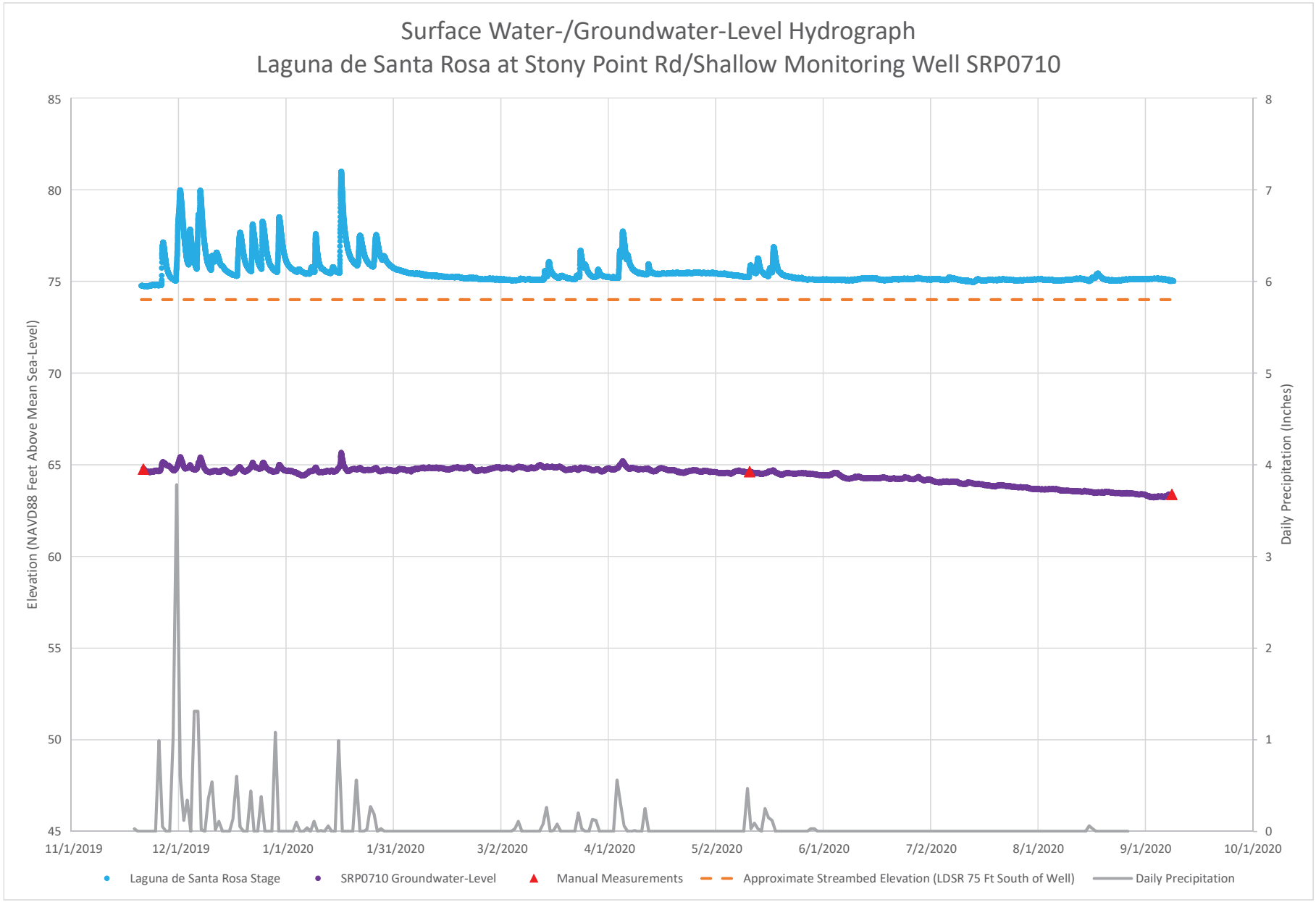
SANTA ROSA PLAIN GROUNDWATER SUSTAINABILITY AGENCY

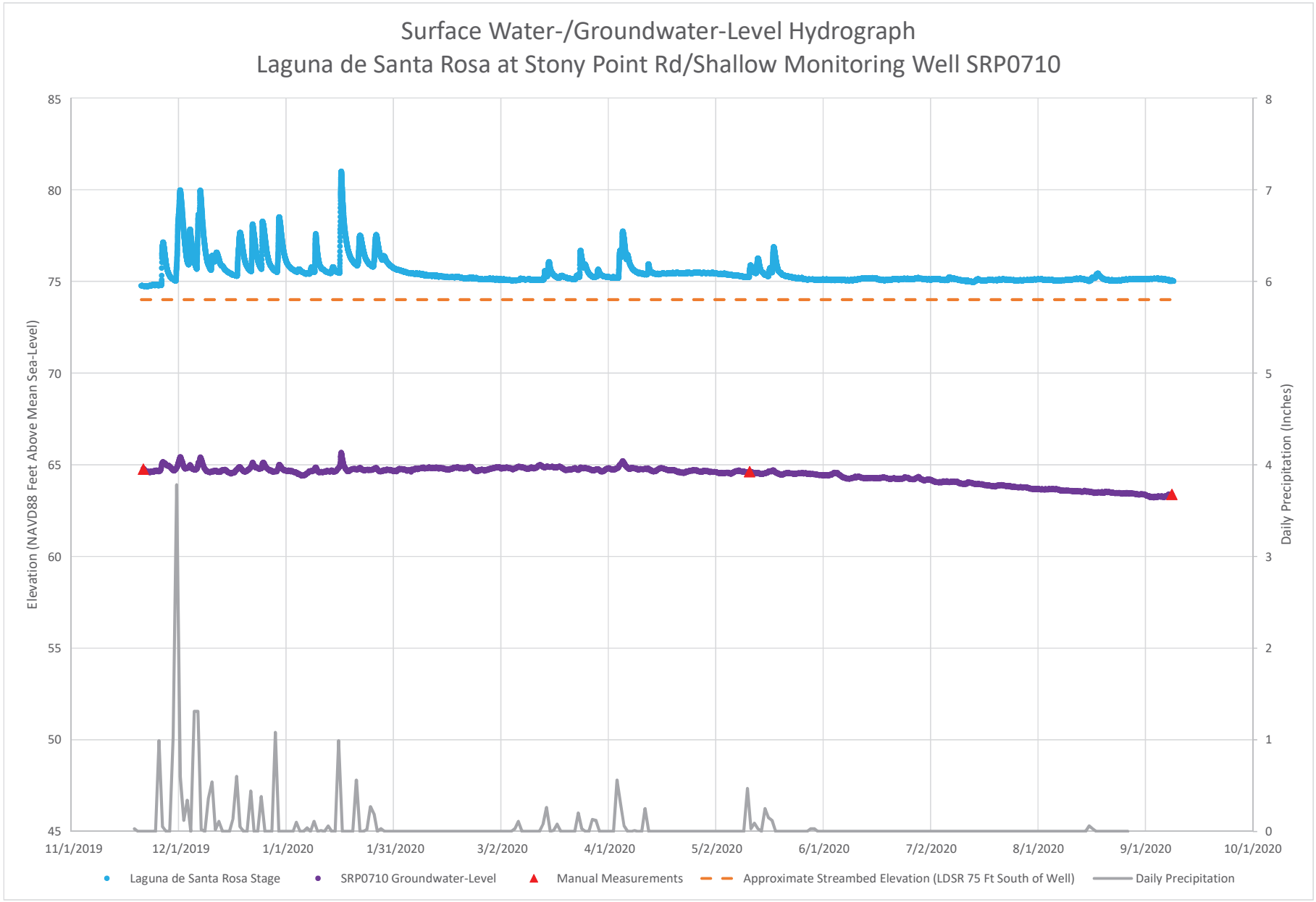
Filepath: T:\mbuttress\SGMA Monitoring Networks\Santa Rosa Plain\SRP_GW_Levl_FULLNet_S_SWGW.mxd Date prepared: 10/6/2020

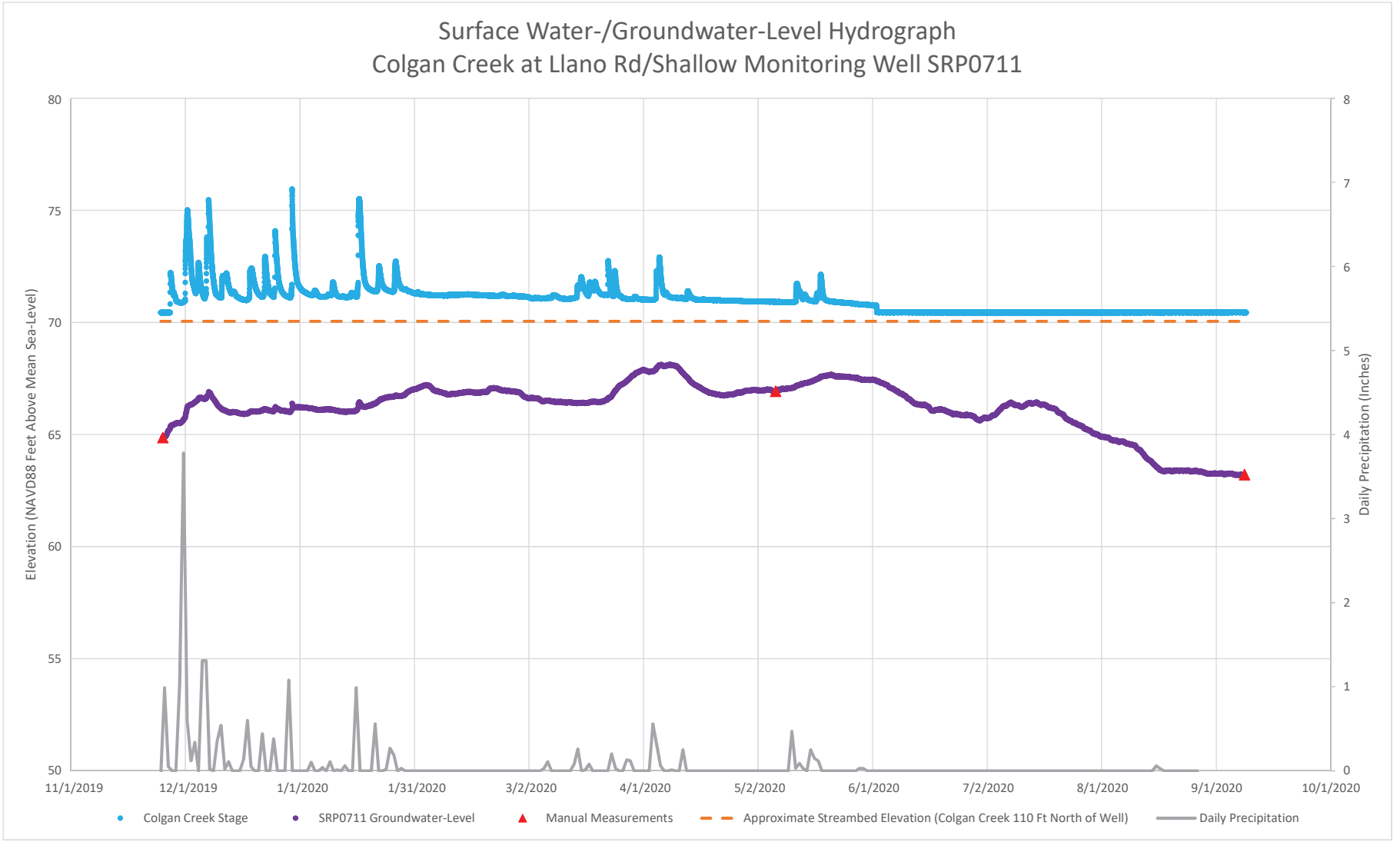

Groundwater-Level Hydrograph - Shallow Monitoring Well SRP0707
Mark West Creek at Fulton Rd
Elevation (NAVD88 Feet Above Mean Sea-Level)
Daily Precipitation (Inches)
130
125
120
115
110
105
100
95
90
8
7
6
5
4
3
2
1
0
9/12/2019
12/11/2019
3/10/2020
6/8/2020
9/6/2020
12/5/2020
SRP0707 Groundwater-Level
Manual Measurements
Approximate Streambed Elevation (Mark West Creek 200 ft North of Well)
Daily Precipitation

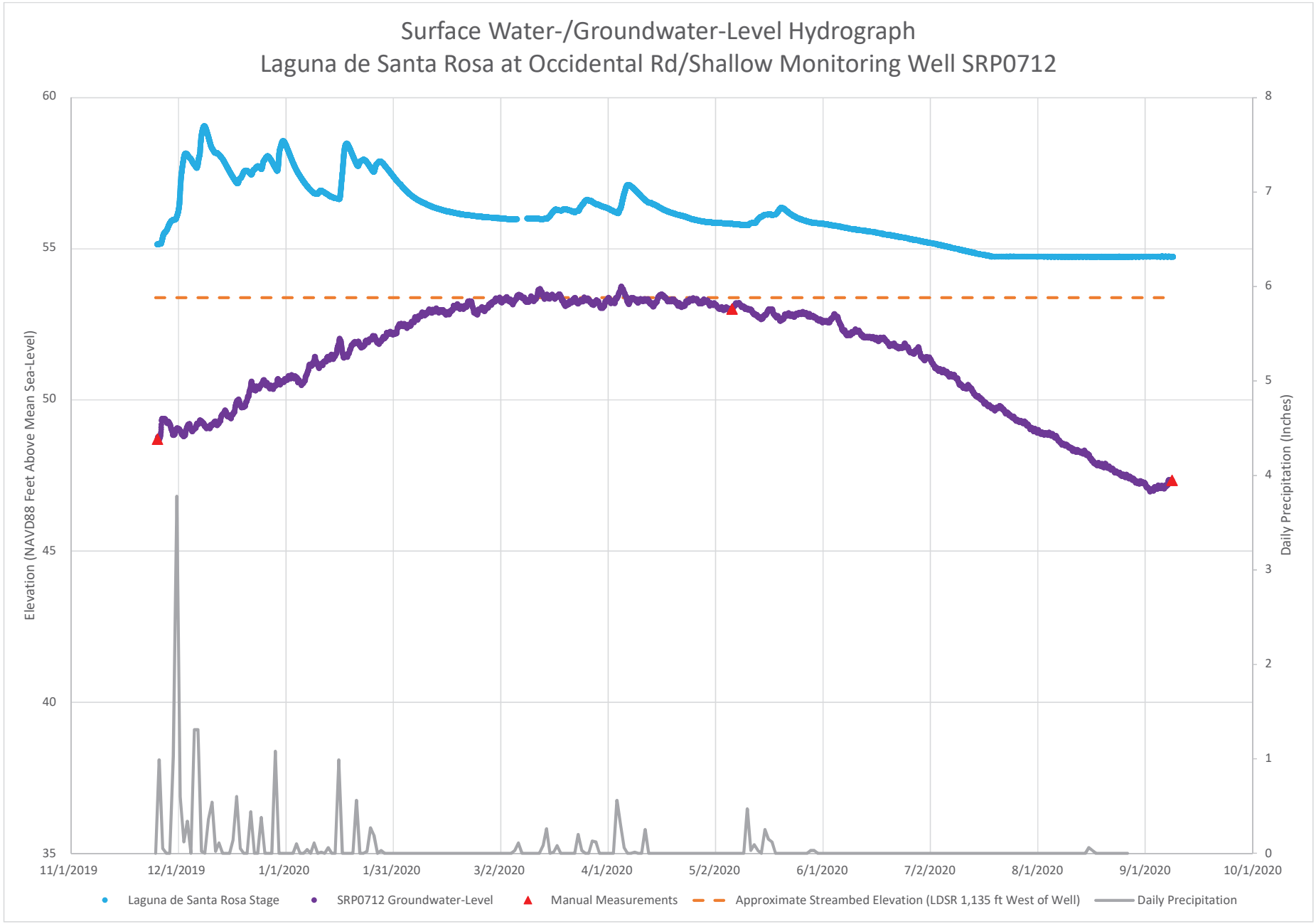

Groundwater-Level Hydrograph - Shallow Monitoring Well SRP0708
Mark West Creek at Mark West Springs Rd
Elevation (NAVD88 Feet Above Mean Sea Level)
Daily Precipitation (Inches)
200
190
180
170
160
150
140
8
7
6
5
4
3
2
1
0
10/2/2019
12/1/2019
1/30/2020
3/30/2020
5/29/2020
7/28/2020
9/26/2020
11/25/2020
SRP0708 Groundwater Level
Manual Measurements
Approximate Streambed Elevation (Mark West Creek 275 Northwest of Well)
Daily Precipitation

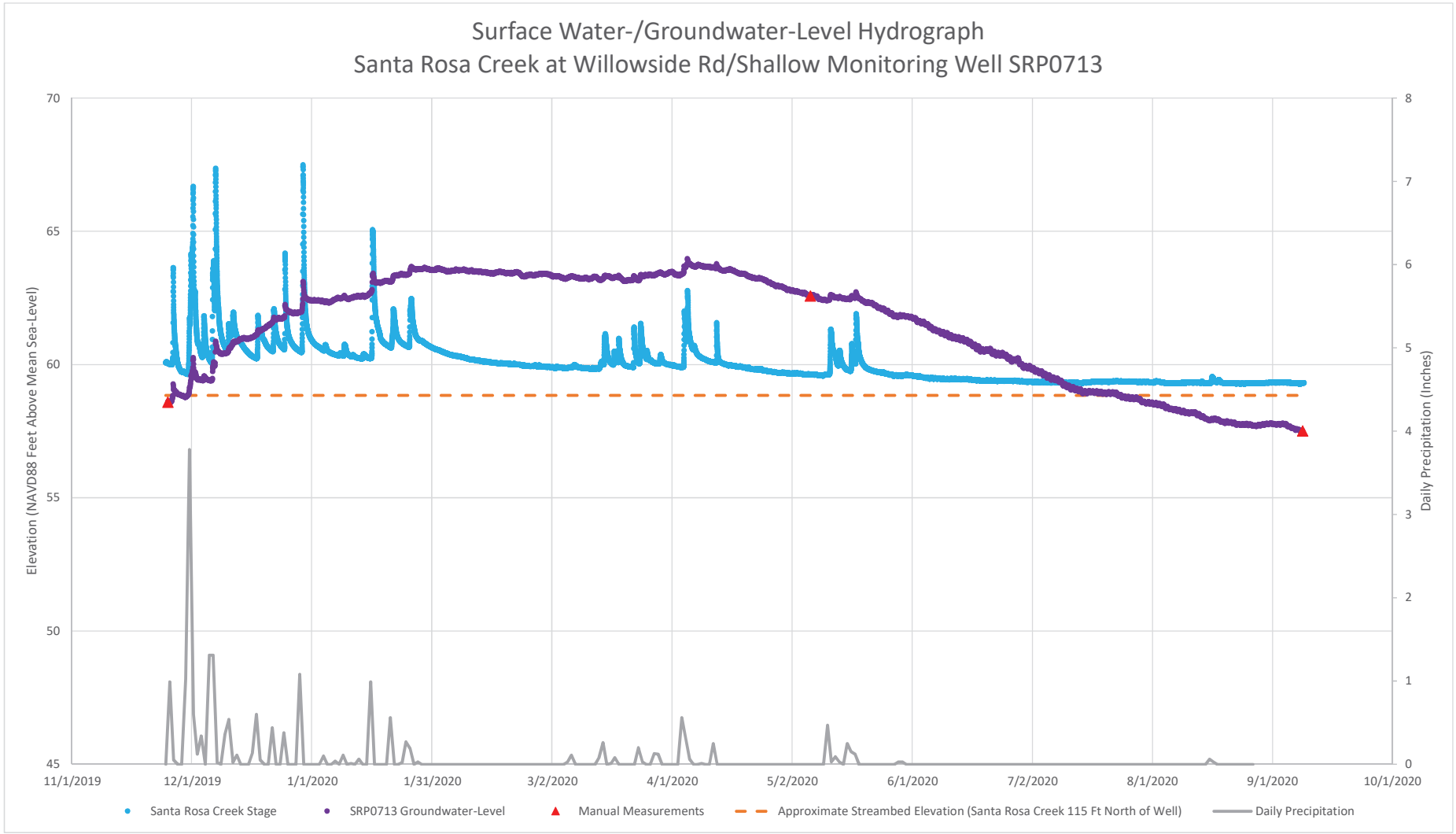

Groundwater-Level Hydrograph - Shallow Monitoring Well SRP0709
Mark West Creek at River Rd
Elevation (NAVD88 Feet Above Mean Sea-Level)
Daily Precipitation (Inches)
64
63
62
61
60
59
58
57
56
55
54
8
7
6
5
4
3
2
1
0
9/22/2019
11/11/2019
12/31/2019
2/19/2020
4/9/2020
5/29/2020
7/18/2020
9/6/2020
10/26/2020
12/15/2020
SRP0709 Groundwater-Level
Manual Measurements
Approximate Streambed Elevation (Mark West Creek 100 ft South of Well)
Daily Precipitation

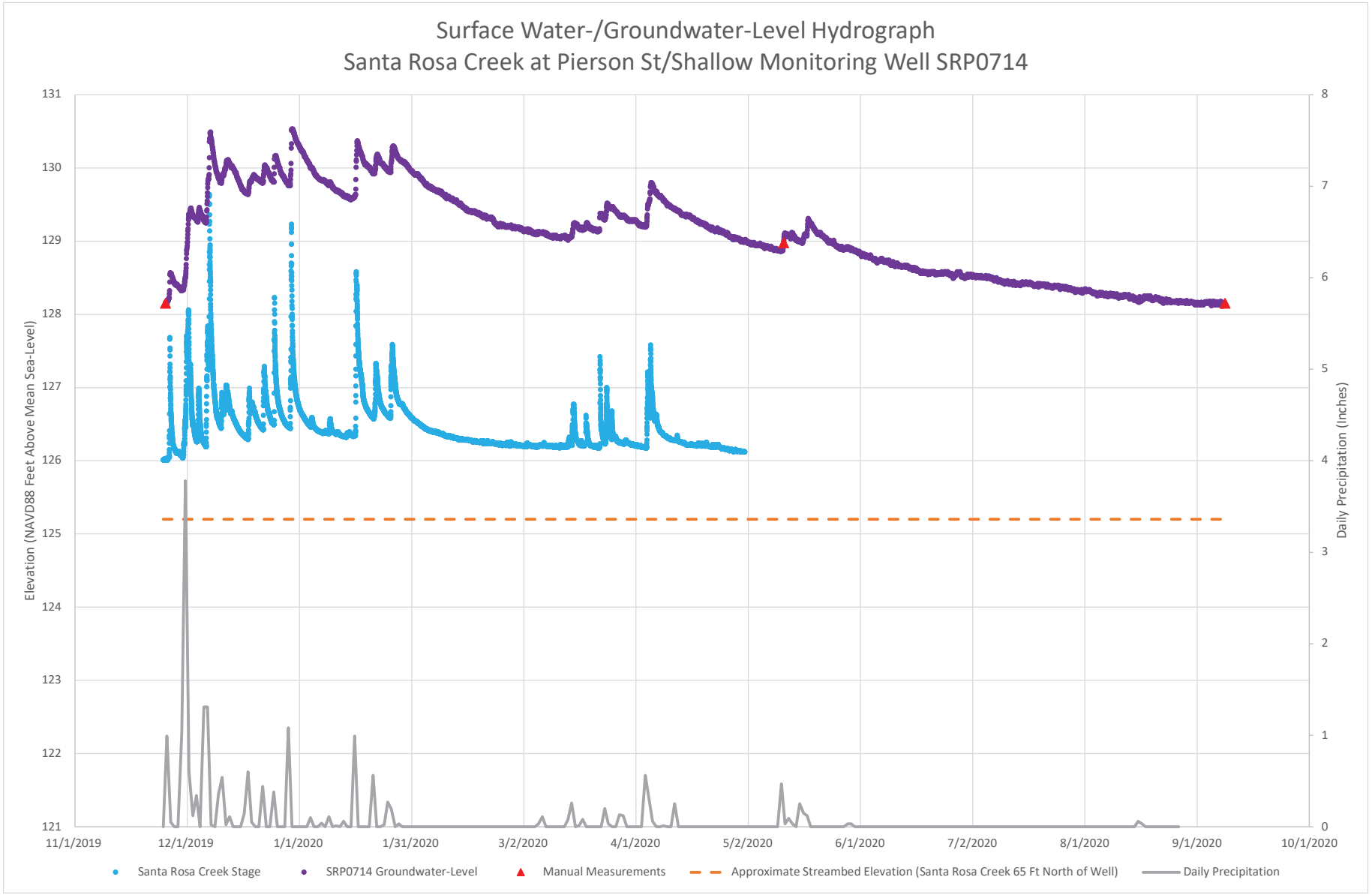

Surface Water-/Groundwater-Level Hydrograph
Laguna de Santa Rosa at Stony Point Rd/Shallow Monitoring Well SRP0710
Elevation (NAVD88 Feet Above Mean Sea-Level)
Daily Precipitation (Inches)
85
80
75
70
65
60
55
50
45
8
7
6
5
4
3
2
1
0
11/1/2019
12/1/2019
1/1/2020
1/31/2020
3/2/2020
4/1/2020
5/2/2020
6/1/2020
7/2/2020
8/1/2020
9/1/2020
10/1/2020
Laguna de Santa Rosa Stage
SRP0710 Groundwater-Level
Manual Measurements
Approximate Streambed Elevation (LDSR 75 Ft South of Well)
Daily Precipitation

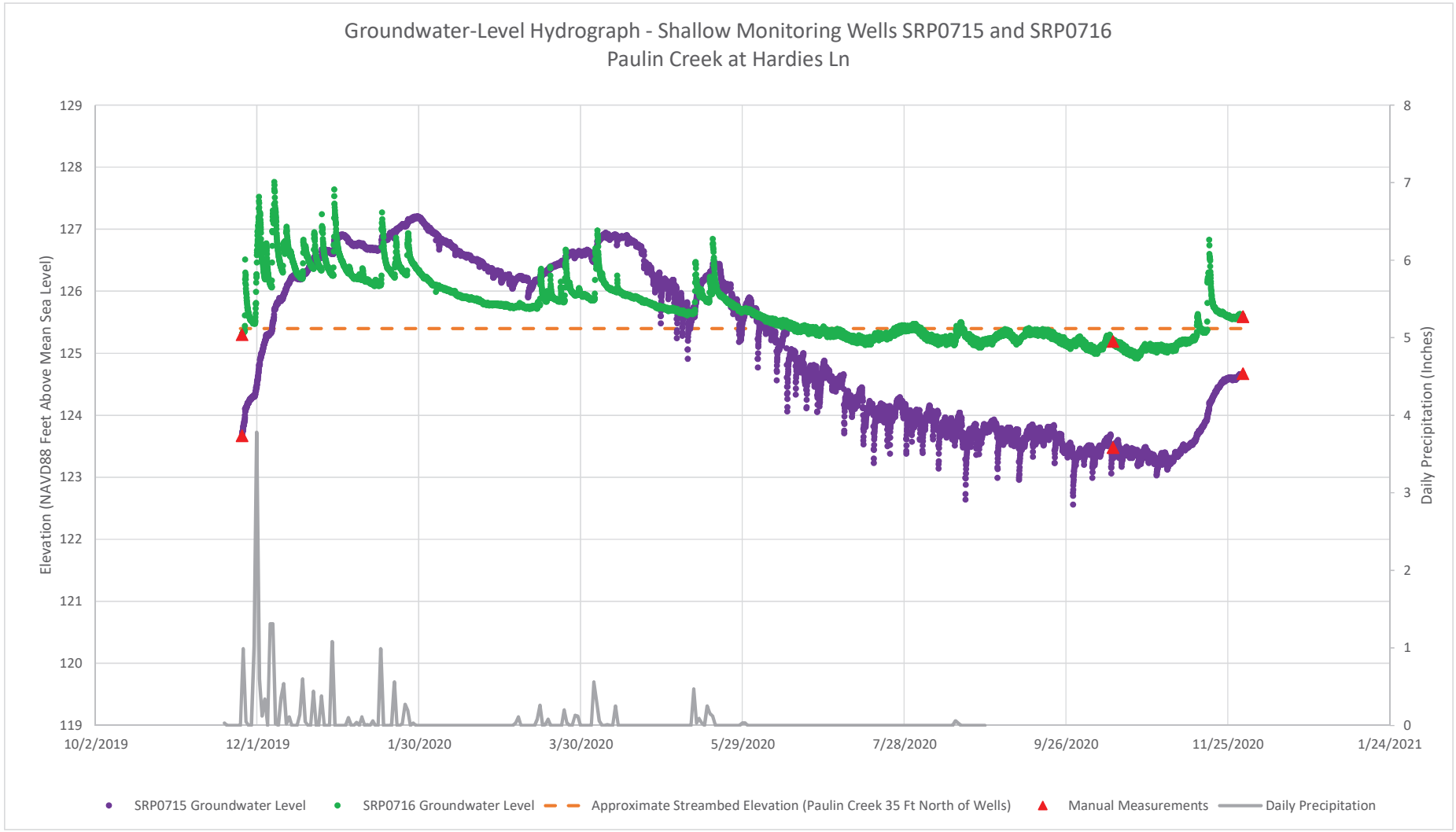

Surface Water-/Groundwater-Level Hydrograph
Laguna de Santa Rosa at Stony Point Rd/Shallow Monitoring Well SRP0710
Elevation (NAVD88 Feet Above Mean Sea-Level)
Daily Precipitation (Inches)
85
80
75
70
65
60
55
50
45
8
7
6
5
4
3
2
1
0
11/1/2019
12/1/2019
1/1/2020
1/31/2020
3/2/2020
4/1/2020
5/2/2020
6/1/2020
7/2/2020
8/1/2020
9/1/2020
10/1/2020
Laguna de Santa Rosa Stage
SRP0710 Groundwater-Level
Manual Measurements
Approximate Streambed Elevation (LDSR 75 Ft South of Well)
Daily Precipitation


Surface Water-/Groundwater-Level Hydrograph
Colgan Creek at Llano Rd/Shallow Monitoring Well SRP0711
Elevation (NAVD88 Feet Above Mean Sea-Level)
Daily Precipitation (Inches)
80
75
70
65
60
55
50
8
7
6
5
4
3
2
1
0
11/1/2019
12/1/2019
1/1/2020
1/31/2020
3/2/2020
4/1/2020
5/2/2020
6/1/2020
7/2/2020
8/1/2020
9/1/2020
10/1/2020
Colgan Creek Stage
SRP0711 Groundwater-Level
Manual Measurements
Approximate Streambed Elevation (Colgan Creek 110 Ft North of Well)
Daily Precipitation


Surface Water-/Groundwater-Level Hydrograph
Laguna de Santa Rosa at Occidental Rd/Shallow Monitoring Well SRP0712
Elevation (NAVD88 Feet Above Mean Sea-Level)
Daily Precipitation (Inches)
60
55
50
45
40
35
8
7
6
5
4
3
2
1
0
11/1/2019
12/1/2019
1/1/2020
1/31/2020
3/2/2020
4/1/2020
5/2/2020
6/1/2020
7/2/2020
8/1/2020
9/1/2020
10/1/2020
Laguna de Santa Rosa Stage
SRP0712 Groundwater-Level
Manual Measurements
Approximate Streambed Elevation (LDSR 1,135 ft West of Well)
Daily Precipitation


Surface Water-/Groundwater-Level Hydrograph
Santa Rosa Creek at Willowside Rd/Shallow Monitoring Well SRP0713
Elevation (NAVD88 Feet Above Mean Sea-Level)
Daily Precipitation (Inches)
70
65
60
55
50
45
8
7
6
5
4
3
2
1
0
11/1/2019
12/1/2019
1/1/2020
1/31/2020
3/2/2020
4/1/2020
5/2/2020
6/1/2020
7/2/2020
8/1/2020
9/1/2020
10/1/2020
Santa Rosa Creek Stage
SRP0713 Groundwater-Level
Manual Measurements
Approximate Streambed Elevation (Santa Rosa Creek 115 Ft North of Well)
Daily Precipitation


Surface Water-/Groundwater-Level Hydrograph
Santa Rosa Creek at Pierson St/Shallow Monitoring Well SRP0714
Elevation (NAVD88 Feet Above Mean Sea-Level)
Daily Precipitation (Inches)
131
130
129
128
127
126
125
124
123
122
121
8
7
6
5
4
3
2
1
0
11/1/2019
12/1/2019
1/1/2020
1/31/2020
3/2/2020
4/1/2020
5/2/2020
6/1/2020
7/2/2020
8/1/2020
9/1/2020
10/1/2020
Santa Rosa Creek Stage
SRP0714 Groundwater-Level
Manual Measurements
Approximate Streambed Elevation (Santa Rosa Creek 65 Ft North of Well)
Daily Precipitation


Groundwater-Level Hydrograph - Shallow Monitoring Wells SRP0715 and SRP0716
Paulin Creek at Hardies Ln
Elevation (NAVD88 Feet Above Mean Sea Level)
Daily Precipitation (Inches)
129
128
127
126
125
124
123
122
121
120
119
8
7
6
5
4
3
2
1
0
10/2/2019
12/1/2019
1/30/2020
3/30/2020
5/29/2020
7/28/2020
9/26/2020
11/25/2020
1/24/2021
SRP0715 Groundwater Level
SRP0716 Groundwater Level
Approximate Streambed Elevation (Paulin Creek 35 Ft North of Wells)
Manual Measurements
Daily Precipitation

Identification and Mapping
Groundwater Dependent Ecosystems Workgroup
Meeting Summary

Date/Time: Tuesday, July 7, 2020 | 1:00 p.m. - 3:00 p.m.
Location: https://csus.zoom.us/j/99011901938
Contact: Sam Magill, Practitioner Work Group Facilitator
Email: s.magill@csus.edu | Phone: (831) 251-4127

MEETING SUMMARY

Welcome and Introductions / Agenda and Meeting Schedule Review

Sam Magill, Work Group Facilitator walked through the agenda for the day and reminded the participants of the focus of the workgroup:

a. Description of existing datasets, model tools and preliminary mapping efforts
b. Discuss process for integration of datasets for developing Potential GDE Maps
c. Discussion of data gaps

Marcus Trotta, Hydrogeologist, welcomed the group and conveyed his appreciation for the attendees participating in the work group. He mentioned the input from this group will feed into the second Ecosystems work group.

Sam Magill then suggested a round of introductions.

Sustainable Groundwater Management Act (SGMA) Update and Need for Identification of Groundwater Dependent Ecosystems

Objective: Provide brief overview of SGMA requirements, update on GSP development, and need for GDE identification

Marcus Trotta started with a high-level overview of SGMA and mentioned the three steps of compliance:

1. Form GSA by June 30, 2017
2. Develop GSP by January 31, 2022
3. Achieve sustainability 20 years after adoption of plan

Failure to meet any of the deadlines, triggers intervention by the State Water Resources Control Board.

There is one Groundwater Sustainability Plan in development for each of the three basins, Petaluma Valley, Santa Rosa Plain, and Sonoma Valley. The three agencies were formed in June 2017 and have been working on their GSP since then. Sonoma Water is leading the technical work on each of the plans with support from different consultants, the Advisory Committee, and the Board.

Trotta gave an overview of the main points for GDE Mapping:

- Focus on ecosystems that can be affected by groundwater conditions and management are within jurisdiction of the GSAs
- Utilize available statewide and local datasets to develop best available information
- Consider using "indicator" species and/or grouping of GDWs with similar characteristics/habitat needs
- Prioritize GDEs for consideration in developing SMCS for surface water depletion (separate workgroup)

Questions/Discussion

Dusterhoff – Is there a state defined definition for GDE that basins are following to determine what we consider GDEs or is it basin dependent and the scientists in the basin define what GDEs are?

> Trotta – The Definition under SGMA is that GDEs are ecological communities of species that depend on groundwater emerging from aquifers or groundwater occurring near the surface (i.e. areas of shallow groundwater, could be roots of vegetation are able to tap into groundwater to support their growth). The state through its partnership with the Nature Conservancy has developed initial indicators of groundwater dependent ecosystems. They encourage GSAs to use that information as well as local information. So, there are state guidance and suggestions, but how they are mapped out within each basin is up to the local GSA.
>
> Magill – That would include low lying wetlands not directly connected to existing surface water sources?
>
> Trotta – It could, provided there is a connection with groundwater for those wetlands.

Trowbridge – For this discussion, are we narrowing our focus to groundwater dependent ecosystems but can be impacted by the GSA? The SRP GSA only covers groundwater in the Santa Rosa Plain, but if the water is coming from the Mayacamas, no amount of management change in the Santa Rosa Plain is going to change that. Also, vernal pools, they fill through rainwater but could become groundwater. How does that fit in?

> Trotta – Vernal pools that are primarily perched features, rainwater that perches on low permeability layer, they do eventually contribute to groundwater. In terms of their dependency on groundwater, I wouldn't categorize them as being dependent on groundwater. We would want to focus on groundwater dependent ecosystems connected with aquifers that the GSA would have control over managing. For areas that are outside the basins, the GSA's jurisdiction is limited to those basin areas. They are required to demonstrate their Groundwater Sustainability Plan will not affect neighboring groundwater basins. In terms of upstream areas, we have been including information from those up lying adjoining areas in the contributing watershed in the basin. The GSA

could support projects that enhance conditions in those areas but that don't have direct control of groundwater use or anything that would affect groundwater conditions in those areas.

Marcus Trotta gave a high-level introduction overview of existing datasets for preliminary mapping of potential groundwater dependent ecosystems. Andy Rich talked about their work in identifying interconnected surface water in the basins. Definition in the GSP Regulations as 'surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.' Our approach to identifying the interconnect surface water is dependent on the information we have for the basins Santa Rosa Plain and Sonoma Valley. For Sonoma Valley, we have a lot of observed data using seepage run monitoring results. For Santa Rosa Plain, we are much more dependent on model results from the USGS flow model developed for the SRP in 2014. We are currently updating the model, but the results presented here are from 2014.

Questions

Rogers – Just for clarification on interconnected definition: SGMA defines 'interconnected surface water' as 'surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.'

Rogers – It seems like some of the graphs, figures and analyses in the presentation, focus on the percent of time when stream reach is gaining, but losing streams are interconnected surface water also, based on the definition.

Rich – Good point, we need to reconsider a little more.

Rohde – Are there shallow groundwater data prior to 2016? Using groundwater data from 2016 to characterize groundwater conditions in the basin is technically past the SGMA date. Also, it's important to understand inter-annual groundwater fluctuations across multiple water year types (i.e., dry, wet, average).

Trotta – Yes, we have initially contoured 2016, as it represented the largest dataset of observed groundwater levels at the time. We can evaluate earlier years as well. Additionally, each point (well) on those maps has a time series of groundwater levels that can be examined if certain areas are of interest.

Rohde - Fantastic! The depth-to-groundwater maps look very nice. The lidar ground elevation data makes a difference and is much better than interpolating depth to groundwater measurements between wells.

Dusterhoff – Would you see a different story in a dry period versus a wet period?

Rich – Certainly, as the groundwater system dries during a dry period. Based on observed data, you should see a decrease amount of interconnected surface water. The point raises the question of when is the best time to do the analysis?

Dusterhoff – You are doing the best you have with the funding you have to collect the data. Story can be skewed by the time data is retrieved. How do you plan on acknowledging drier periods versus wetter periods?

Rich – For the simulated data from Santa Rosa Plain, which is focused from 2000 to 2010, I don't think we are capturing too biased climate period. With the observed data, much of it is from the last five years which is a drier period. But, given the difficulty in replicating some of the observed data, it is hard to have data that reflects not so dry conditions.

Gaffney – Will the data be available once peer reviewed and completed? Will the recording of the meeting and presentation be available too?

Magill – Yes, we will make the presentations available. The meeting is also being recorded and there will be a meeting summary that can be shared.

Trotta – We can provide you all copies of the figures that we are presenting either as a packet or through a file share site, I know some of these can be hard to view on Zoom. We also have draft write-ups for how we developed the Interconnected Surface Water maps.

Gaffney - I am wondering about underlying "raw" data, specifically GIS data.

Rich – As there are a lot of GIS data, I think it would be better to have an offline discussion, we are happy to share the information.

Marcus Trotta then showed Santa Rosa Plain, Petaluma Valley and Sonoma Valley preliminary maps from the Nature Conservancy of groundwater dependent ecosystems, draft Steelhead streams maps and draft vegetation-related potential groundwater dependent ecosystem maps before handing over to Melissa Rohde, from the Nature Conservancy for comment, and to David Cook and Patrick Lei, both from Sonoma Water.

Melissa Rohde mentioned the map is basically a starting point and much of the map features are taken from aerial imagery, there been lots of expert review and ground truthing, maps of springs and other hydrologic features. In order to know the ecosystems are related to groundwater, it is important to look at the depth of groundwater. In most parts of the state there often isn't good data of shallow groundwater. Absence of evidence isn't evidence of absence! It is important to ensure that our groundwater data network is dense enough to pick up what the conditions are in the eco systems and to validate if they are groundwater dependent. These species are typically known to use groundwater, but the species are opportunistic and can use other sources of water, so it is important to make sure there is groundwater there.

David Cook said they wanted to find an indicator species that would represent groundwater dependent species throughout the three basins. Initially we focused on fish and amphibians and we were also looking for a solid data set. Through that process we found that steelhead are quite well distributed throughout the basins, and we had detailed data sets. Unfortunately, there wasn't one single dataset used for all three basins. For Petaluma and Sonoma Valley, we used a 2005 report from Leidy, this was supplemented with information from Sonoma Water. For Santa Rosa Plain, we had a good dataset from the Coastal Monitoring Program, along with in-house data from the Shawn Chase database. We put all the steelhead bearing streams on maps, excluded anything outside of the three basins and included any stream further downstream from a section that was identified as steelhead habitat. That is how we arrived at our process to get the steelhead layer.

Patrick Lei – We relied heavily on the Sonoma Veg Map and focused on communities with strong riparian composition such as willow and cottonwood, or species that may rely on groundwater in some parts of the year, such as oak. One limitation of maps is depth of groundwater. We probably will not include vernal pools in the final maps because we don't think there is much of a groundwater connection, but where there is, we would include it.

Questions

Trowbridge – How are the maps of groundwater dependent ecosystems going to inform SGMA? Are we expecting the maps to change over time as groundwater management changes or are we going to monitor attributes of these communities that we would expect to change with groundwater management? It seems like what is driving the maps is development.

> Trotta – The way that groundwater dependent ecosystems are written into SGMA and requirements related to them in the groundwater sustainable plan regulations that DWR has established, is related to identifying their occurrence and distribution and taking them into consideration during the development of GSP and SMC, establishing how much groundwater lowering can occur in the basin before there are impacts in the basin or how much surface depletion there is before there are impacts. I am envisioning the mapping based on our existing available data sets will be utilized by the second workgroup that would be focused on what are the minimum thresholds set for surface water depletion in the basin. Are there certain areas that should be prioritized more than others? Are there areas where there should be a focus on monitoring? Going forward, I would expect the maps to change over time as new information is developed. How does the distribution of these groundwater dependent ecosystems match up with where higher densities of groundwater pumping are occurring in the basins?
>
> Lee – Related to that concept of previous development and how it affects this. Things about the seepage and springs around, there are lots of places in the watershed where early in the history of the area, they were found and developed where there are stock ponds in the hills now, where the original seepage would have been. Now they are characterized by ponds more than whatever vegetation we are looking for otherwise.

Lee – Another question about the Veg map, there are lots of places on the developmental property, there is spring activity under forested cover, would that be one area of data gap? I guess you can't see through the upper canopy to see the lower plants.

> Lei – I agree with you, that would be one example of a data gap. We do have limitations, In the early discussion before putting the map together we talked about seepage and springs but decided to keep those out of this map.
>
> Lee – If we want to talk about those kinds of places that are not showing up in your analyses at this point, that is where local knowledge can come in.
>
> Trotta – Seepage and springs that may be missed by the veg mapping, could be picked up in the maps Andy Rich went through. It may not capture all of them but could give an insight. Also, maps that have been developed by USGS that include seepage and springs, that we could also incorporate.

Rohde – When you create the GDE map, it would be great to see how the Sonoma Veg data overlap with the NC dataset. It would be helpful to see which vegetation are added under the Sonoma veg database that weren't originally available in the NC dataset.

Trotta – What we see as some of the next steps is going to be integration of different data sets. We can produce various maps that highlight the differences between the maps or show where we are intersecting data. We will make sure the data is clearly shown on the next set of maps.

Sam Magill said staff would be very interested to hear if there are other existing data sources that should be included for the Groundwater Sustainability Plan, and what additional data collection is recommended for the implementation phase of the GSP.

Rogers – I have a question about the steelhead distribution maps – were those generated from records current steelhead distribution or were they taken from steelhead critical habitat maps? Some areas that probably don't have steelhead, might not have steelhead because of stream flow depletion impacts. How was that dynamic factored in the map making?

Cook – It is based on current information, doesn't account for any impact on groundwater. It was the most accurate data set we could find. Something up for discussion – how do you define what steelhead stream?

Rogers – What is the data here? What is the timeline? In more recent years, steelhead have been absent due to decrease in stream flow. Since the Leidy study was completed, Yulupa creek has dried considerably and has a significant passage barrier. I wouldn't consider it a steelhead stream currently, but it could become one again. Are we looking to restore past conditions through this or maintain existing GDEs as of a certain dateline?

Trotta – Ultimately it would be a GSA Board decision. No need to correct or address issues before GSA was enacted in 2017 – it is not a requirement of SGMA. Many GSPS have held it as a baseline in their criteria. We are aware of the baseline; it will depend on the costs and priorities of the GSA in complying with SGMA. At a minimum they would support to restore conditions to improve fisheries and other ecosystems in their plans. Whether it would be built into the criteria would be up for discussion.

Gaffney – Definitely, there is an opportunity for continued collaborative data collection and local refinement. When we developed the Sonoma Veg Map program, the intention was to create a fine scale veg map for the million-acre county that aligned with the CDFW MCV standards. There is a significant opportunity to continually refine with local data via this process, as well as through I-naturalist, stream maintenance program etc. Ag & Open Space has developed additional data sets related to future potential riparian habitat based on physical attributes and processes.

There are also relatively accurate maps for the main stem Russian (alluvial reaches) that document riparian and land use cover from 1940-1942, 1990. Combined with modeled outputs for where riparian "could" exist based on fluvial-geomorphic processes, this could contribute to this initiative one more potential gap (please forgive my ignorance of the constraints of this process): multi-benefit criteria such as agricultural use (such as rangelands) that are compatible with GW sustainability, biological diversity, etc. Since Ag & Open Space is a potential tool for protecting these areas (via conservation easements)

it would be helpful to understand how you are looking at this (or if it is outside the realm of this effort).

Rich – Regarding the comment of the main stem of the Russian River, none of the three basins covers the main stem of the Russian River so, it won't be directly useful here, but it is interesting information

Trowbridge – To piggyback on Karen Gaffney's historic data, we have been working on a historical ecology map. We wouldn't want the GSA to be beholden to restoring it, we are working on a vision for restoration and it does seem like the historical ecology would be indicative of groundwater and how groundwater used to be in the basin, so it would provide valuable baseline information about groundwater even if some of the ecology has changed.

Trotta – What is the timeframe for that work?

Dusterhoff – It is a two-part project. Part 1 is developing restored landscape vision and Part is using the vision to identify several restoration concepts. The vision was completed in April; we are in the process of making some updates, but it is a public document now. Restoration plan will be done by February 2021. Here is the link for Laguna de Santa Rosa Restoration Vision: https://www.sfei.org/sites/default/files/biblio_files/Restoration%20Vision%20for%20the%20Laguna%20de%20Santa%20Rosa%20SFEI%20041520%20med%20res.pdf

Gaffney – Am I mistaken that the Ukiah reach of Russian River is not a high or medium priority basin? The middle Reach looks to be involved too.

Trotta – It is a medium priority basin and there is a GSA creating a plan for that basin in Mendocino county. We aren't directly involved in the development of that plan. The data sources you mention would most likely be of interest to that GSA, I can put you in contact with consultants working with GSA in that area.

Magill to Trotta – Should meeting participants send additional information to staff between meetings?

Trotta – Yes, that would be helpful; we will discuss offline, maybe a single point of contact or file share location would be best.

Lee – In terms of existing data sources to be included – there are local and anecdotal knowledge of data that exists out there. In terms of another data source, we at the Ecology Center, have installed 11 stream gauges in upper Sonoma creek in the last two years. Having the continuous data that can be used in an upstream and downstream fashion, is another potential data source that could be valuable and is available. Also, we recently installed a series of temperature loggers around the watershed for the dry season. In terms of additional data collection to be recommended, seeing more of the continuous stream flow data around the different watersheds beyond the USGS gauges is available, and could be valuable moving forward.

Pennington – Great work. I was thinking about other species of concern and endangered species. You chose steelhead but it does seem there are other species that are dependent on having water in the summer and into the fall, when the streams are most sensitive to groundwater depletion. I would recommend looking at species such as freshwater shrimp and where they

existed historically. Think about steelhead passed through these streams but aren't necessarily there when the groundwater dependent ecosystems are sensitive to groundwater depletion.

David Cook – We can look at other species. The reason we selected steelhead is that it encompasses species that are most sensitive in the summertime. Steelhead streams, we are really talking about juvenile steelhead and they encapsulate all the amphibians such as CA giant salamander, etc. that need perennial water. Fresh water shrimp distribution is so patchy that there are no known occurrences within the three basins. It doesn't encapsulate enough to be of value for this kind of type of analysis.
Pennington – What about the possibility of using multiple species?
David Cook – We may add additional section in the streams. In general, when you look at the basins, lots of amphibians are outside the basin.

Rohde – We also need to consider how other state and federal listed species are impacted by groundwater. Here is a document that identifies what protected status species are likely reliant on groundwater in California:
https://groundwaterresourcehub.org/public/uploads/pdfs/Critical_Species_LookBook_web.pdf
This is an effort that Rick Rogers (NOAA), Briana Seepy (DFW), Xeronimo Castaneda (Audabon), and I have put together.

Review Meeting Action Items

Sam Magill restated the action items from the meeting:

- Data sharing – staff to discuss offline how to share additional data, meeting summary, and other meeting materials
- Discussion for staff how to share raw data
- Marcus Trotta to connect Karen Gaffney to the GSA for the Ukiah reach of the Russian River

Next Steps and Planning for Meeting #2

Objective: Discuss next steps for planning workgroup meeting #2.

Marcus Trotta said he will look at file share, take input received today and make any refinements and revisions to maps. He will develop a GIS process to integrate surface water maps to species and veg maps with the goal of having the information and those maps for a second meeting. Then we can determine if we need a third meeting or not. Would like a discussion of the importance of understanding their habitat needs including critical time periods. We are probably looking at the second or third week of August for the next meeting for this group. Sam Magill will reach out to you.

We proposed the other workgroup would meet on the tail end of this one. We will look at the overall schedule, it may make sense to have the two groups overlap a little to do some work in tandem with this workgroup.

Marcus Trotta and Andy Rich thanked the group for participating and said the comments were very helpful.

Attendees:

Andres Ticlavilca, National Marine Fisheries Service
Karen Gaffney, Ag & Open Space Preservation District
Melissa Rohde, The Nature Conservancy
Rick Rogers, National Marine Fisheries Service
Robert Pennington, Permit Sonoma
Scott Dusterhoff, San Francisco Estuary Institute
Steve Lee, Sonoma Ecology Center
Wendy Trowbridge, Santa Rosa de Laguna Foundation

Staff/Presenters

Marcus Trotta, Sonoma Water
Andy Rich, Sonoma Water
David Cook, Sonoma Water
Patrick Lei, Sonoma Water
David Manning, Sonoma Water
Ann DuBay, Sonoma Water
Simone Peters, Sonoma Water (recorder of meeting notes)

Facilitator

Sam Magill, Sacramento State University – Consensus and Collaboration Program

SANTA ROSA PLAIN • PETALUMA VALLEY • SONOMA VALLEY

GROUNDWATER SUSTAINABILITY AGENCIES

IDENTIFICATION AND MAPPING OF GROUNDWATER DEPENDENT ECOSYSTEMS

Workgroup Meeting #1

July 7, 2020

MEETING AGENDA

1. Welcome and Introductions
2. Agenda Review
3. Sustainable Groundwater Management Act (SGMA) Update and Need for Identification of GDEs
   - SGMA overview
   - Groundwater Sustainability Plan (GSP) status and schedule
   - How will identified GDEs be used in the GSPs
   - Proposed process for mapping GDEs
   - Questions/Discussion
4. Existing Datasets for Preliminary Mapping of Potential GDEs
   - Indicators of GDEs (iGDE) maps (The Nature Conservancy)
   - Draft Steelhead streams maps (Sonoma Water)
   - Draft Vegetation-related GDE maps (Sonoma Water)
   - Draft Interconnected Surface Water maps (Sonoma Water)
   - Draft Depth-to-Groundwater (DTW) maps for shallow unconfined aquifer system (Sonoma Water)
   - Discussion of Data Gaps
5. Next Steps and Planning for Meeting #2
6. Review Action Items
7. ADJOURN

Required Steps to Groundwater Sustainability



Failure to meet any of these deadlines triggers intervention by the State Water Resources Control Board

Sustainable Management Criteria

Sustainable Management Criteria (SMCs) are defined locally based on ***basin conditions*** to avoid *significant and unreasonable* ***Undesirable Results*** for SGMA ***Sustainability Indicators***.

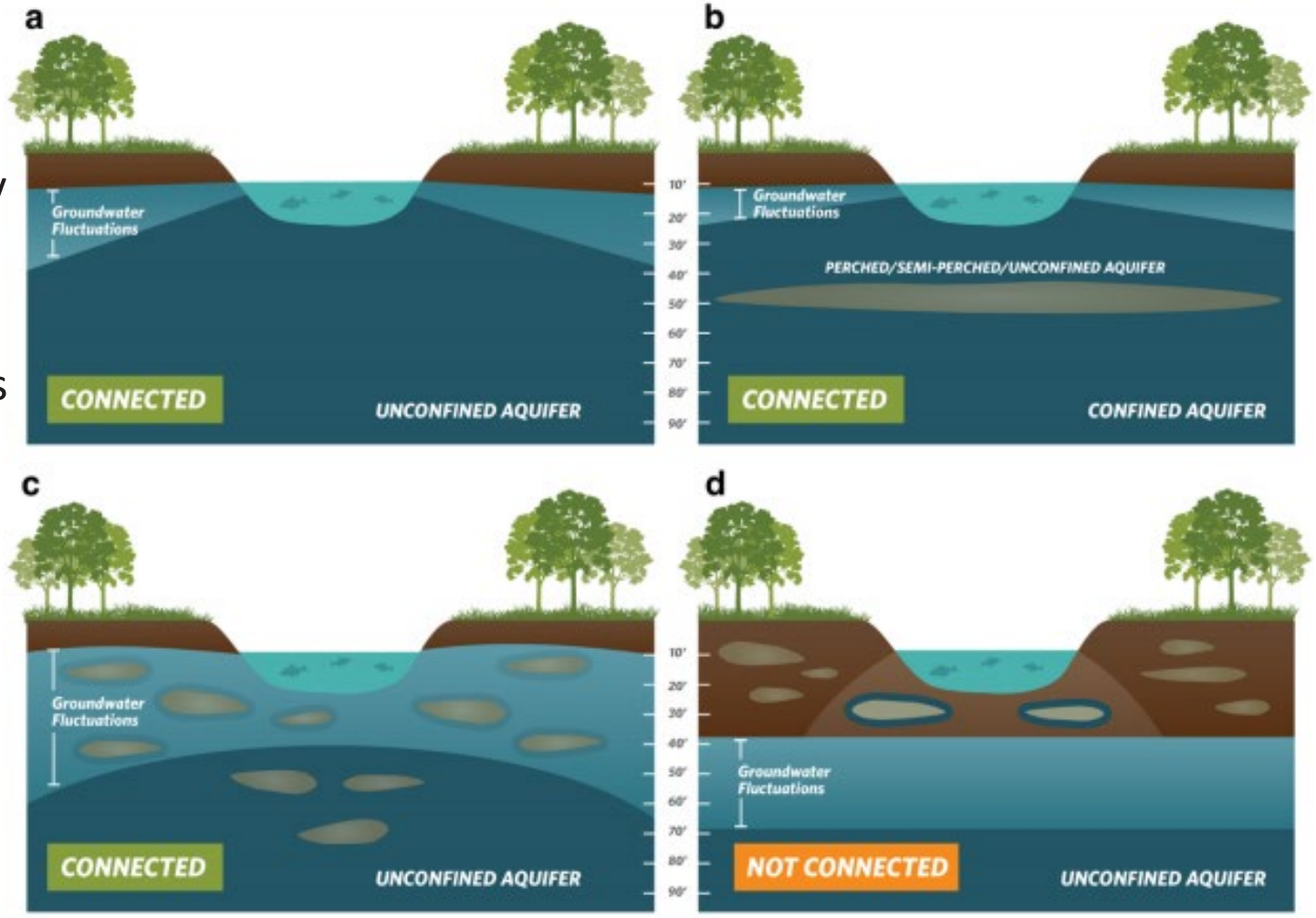
Iterative Process which will involve significant stakeholder engagement, modeling of future climate, growth, and projects and actions

Sustainability Indicators



Proposed Approach for GDE Mapping

- Focus on ecosystems that can be affected by groundwater conditions and management and are within jurisdiction of GSAs
- Utilize available statewide and local datasets to develop best available information
- Consider using “indicator” species and/or grouping of GDEs with similar characteristics/habitat needs
- Prioritize GDEs for consideration in developing SMCs for Surface Water Depletion (separate workgroup)



https://groundwaterresourcehub.org/

Source: The Nature Conservancy, Identifying GDEs Under SGMA Best Practices for using the NC Dataset, 2019

Focus of Workgroup Meetings

Meeting 1 - *July 7*

a. Background and Focus of Workgroup
b. Description of existing datasets, model tools and preliminary mapping efforts
c. Discuss process for integration of datasets for developing Potential GDE Maps
d. Discussion of data gaps

Technical Work between Meetings 1 and 2

a. Completion and refinement of maps based on Workgroup input
b. Develop initial information to support characterizing habitat needs and ecological value for potential grouping of GDEs

Focus of Workgroup Meetings

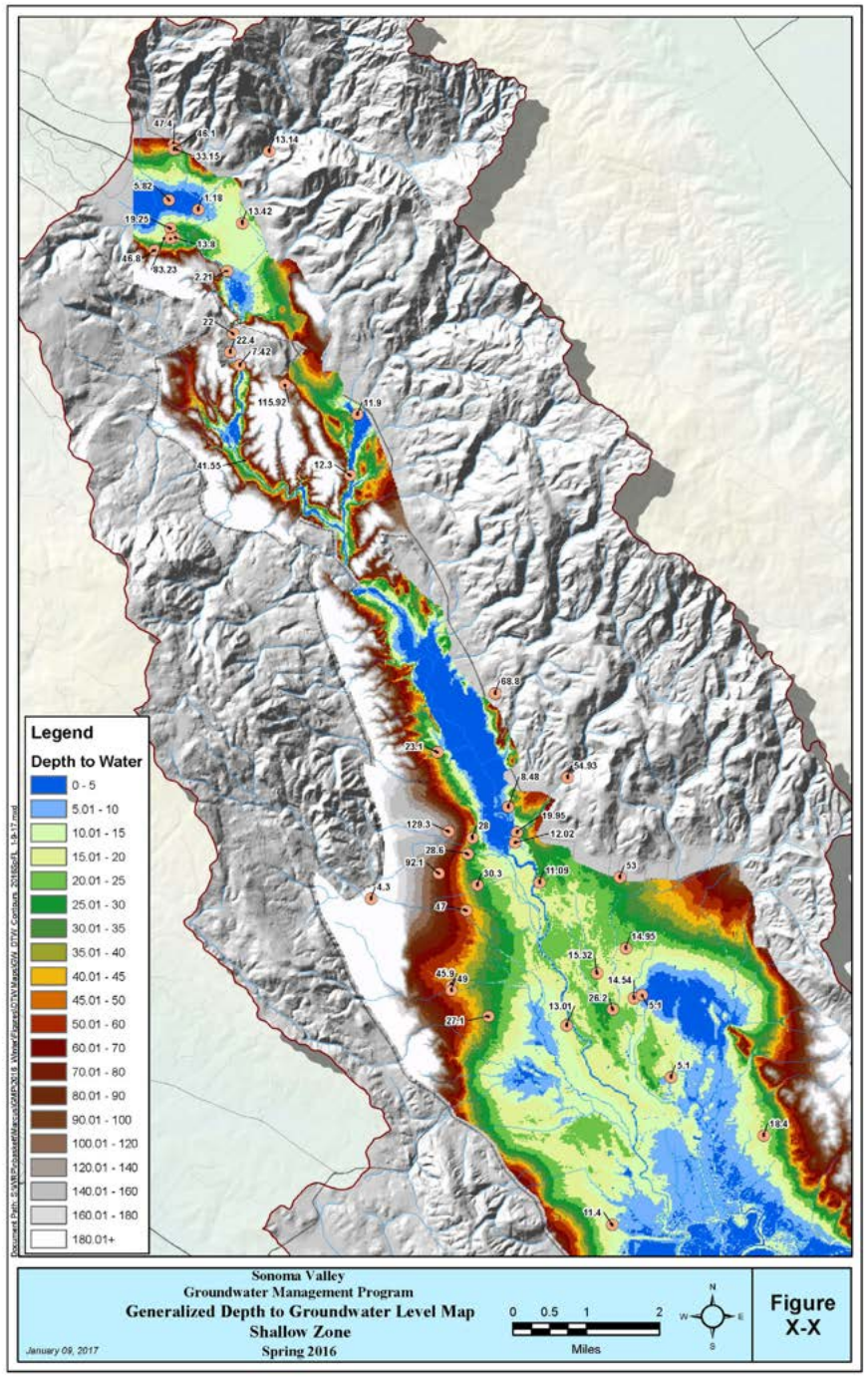
Meeting 2 (and 3?) - *August?*

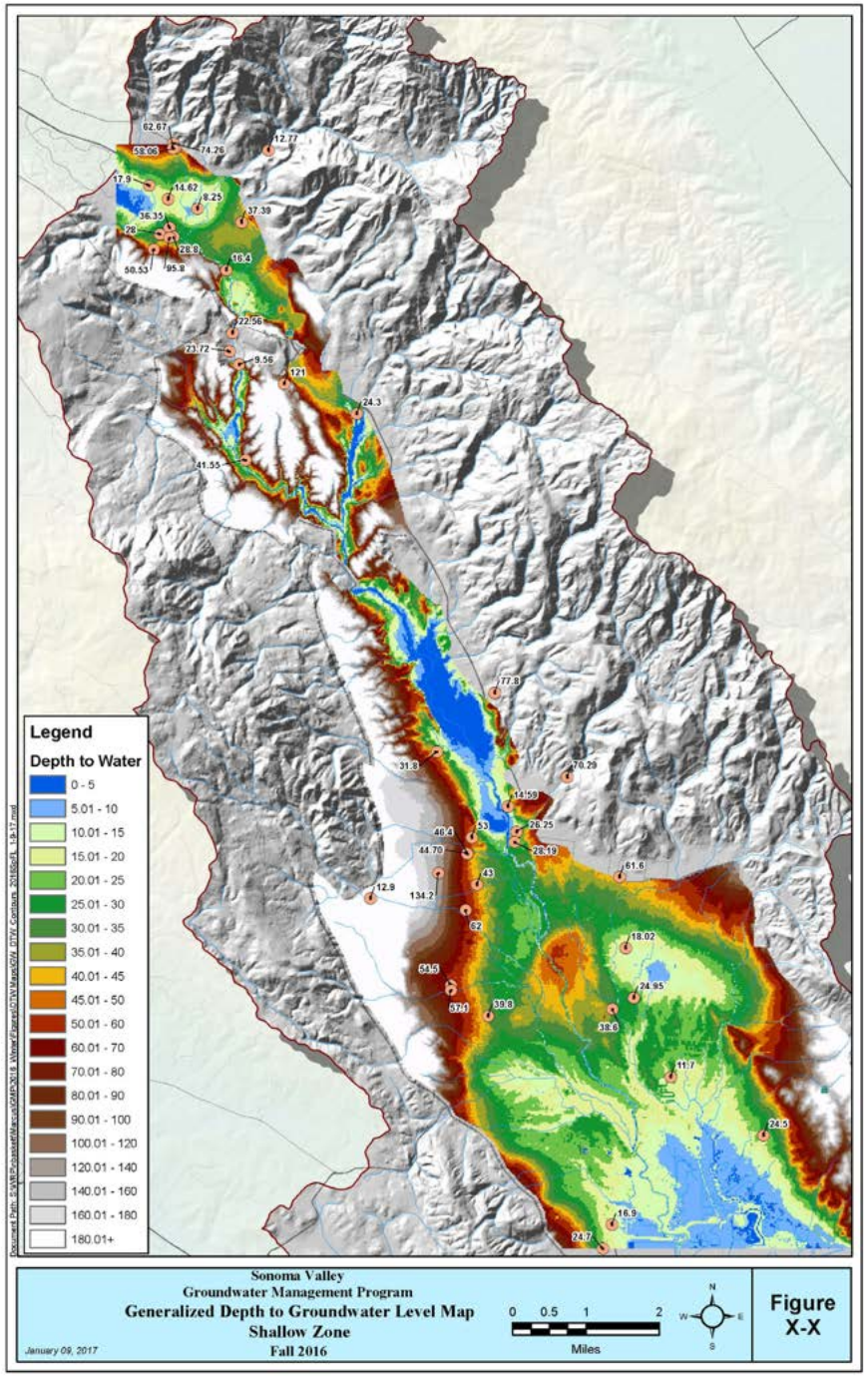
a. Review/discuss new maps and map revisions based on Meeting 1
b. Characterizing GDEs
    - General habitat needs (flow, temperature, critical time periods etc)
    - Group individual GDEs into GDE communities based on locations, habitat needs, connection to groundwater, density/amount of groundwater pumping etc. (as applicable)
    - Relative ecological value of each GDE community
    - Develop “priority” species/communities whose needs would cover others if they are met?

Hydrologic Datasets and Tools

- Draft Depth-to-Groundwater (DTW) maps for shallow unconfined aquifer system
  - Initial maps for Santa Rosa Plain and Sonoma Valley
  - Under development for Petaluma Valley
- Draft Interconnected Surface Water (ISW) maps
  - Initial maps for Santa Rosa Plain and Sonoma Valley
  - Petaluma Valley to be developed following completion of USGS integrated hydrologic model

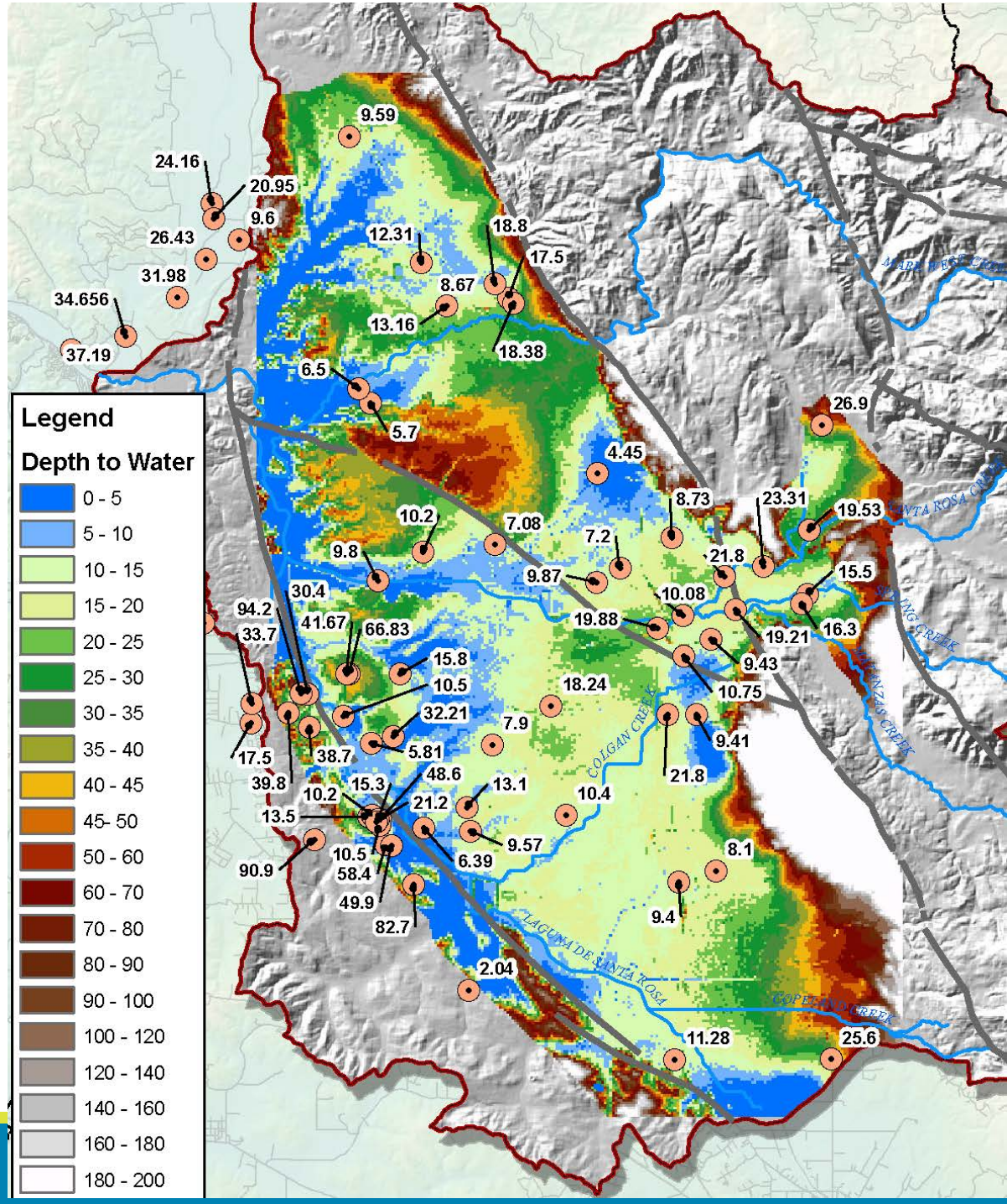
Depth-to-Groundwater Maps for Shallow Unconfined Aquifer System: Sonoma Valley – Spring and Fall 2016



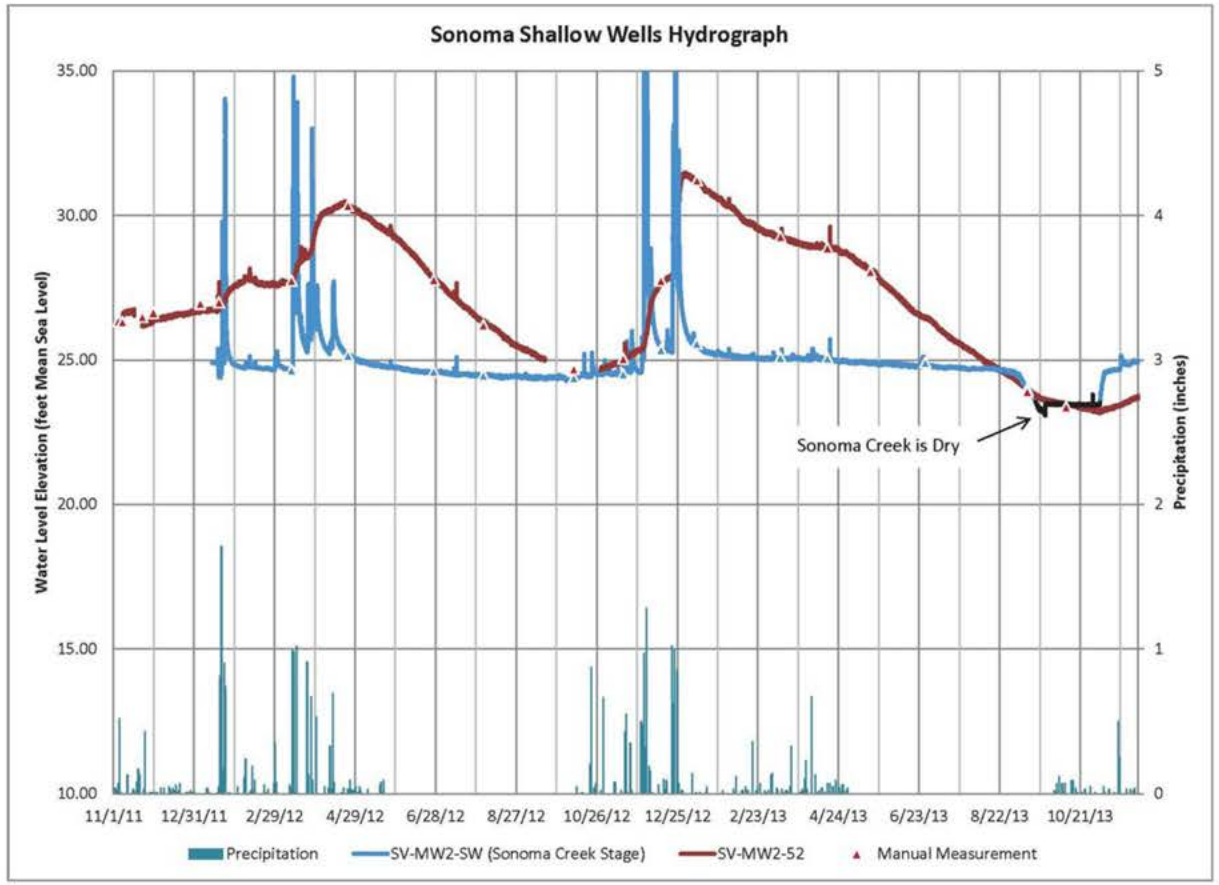


Depth-to-Groundwater Maps for Shallow Unconfined Aquifer System: Santa Rosa Plain – Spring 2015

- Consider seasonal fluctuations and temporal trends

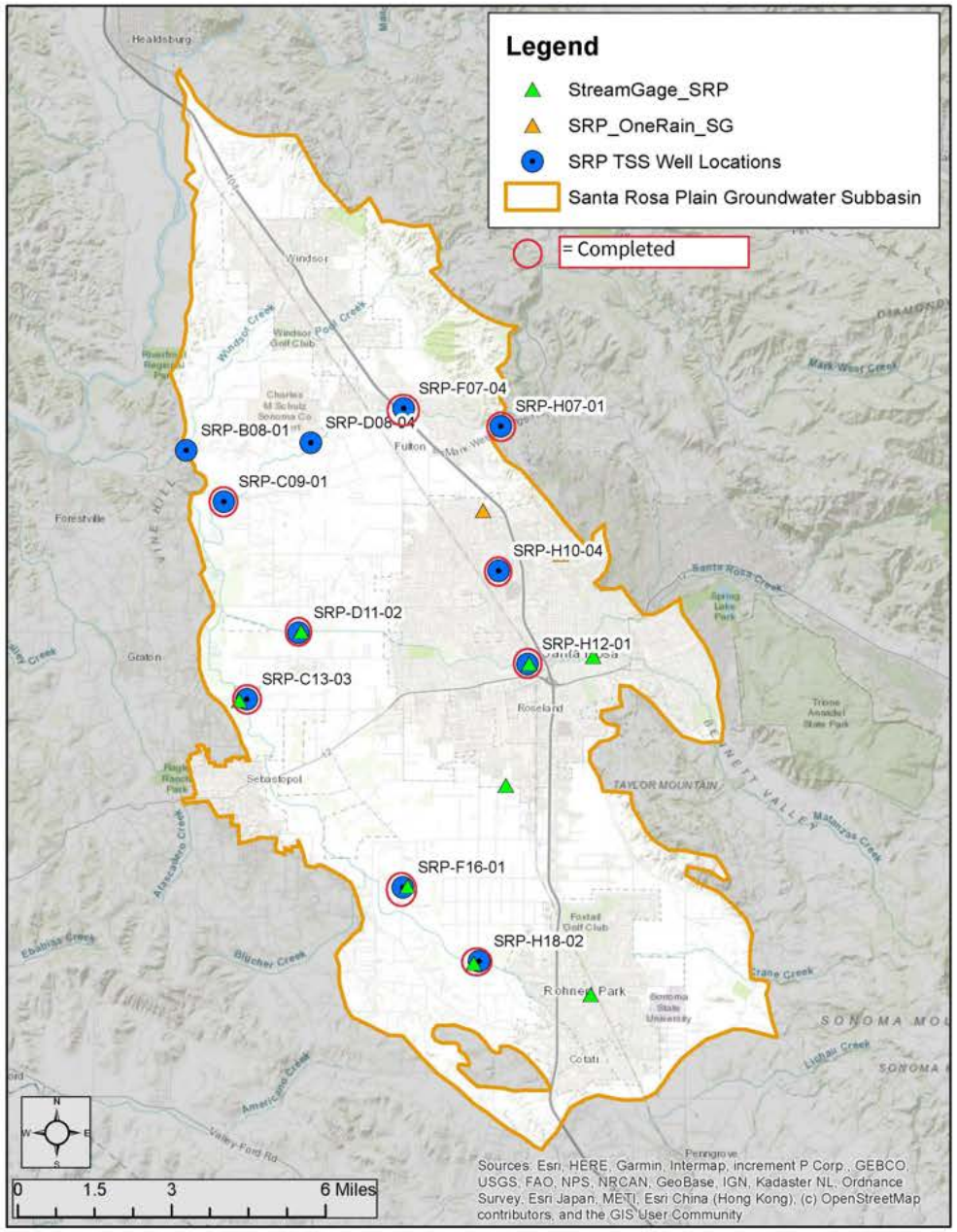


Additional Data Sources: Paired Shallow Monitoring Wells with Stream Gauges



*Note: Gaps in data occur when pressure transducer is temporarily out of service or removed for sampling

TSS Shallow Monitoring Well Locations
Santa Rosa Plain Groundwater Subbasin



Interconnected Surface Water – Requirements and Approach

Defined in the GSP Regulations as ***surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted*** (DWR, 2016).

Define with available data/existing tools using multiple lines of evidence (tools and datasets vary for each basin)

Sonoma Valley Approach

(1) results of seepage run monitoring;

(2) frequency of observed or measured streamflow;

(3) comparison of interpolated groundwater levels within the shallow aquifer system and streambed elevations; and

(4) high frequency groundwater level observations from shallow monitoring wells located near streams.

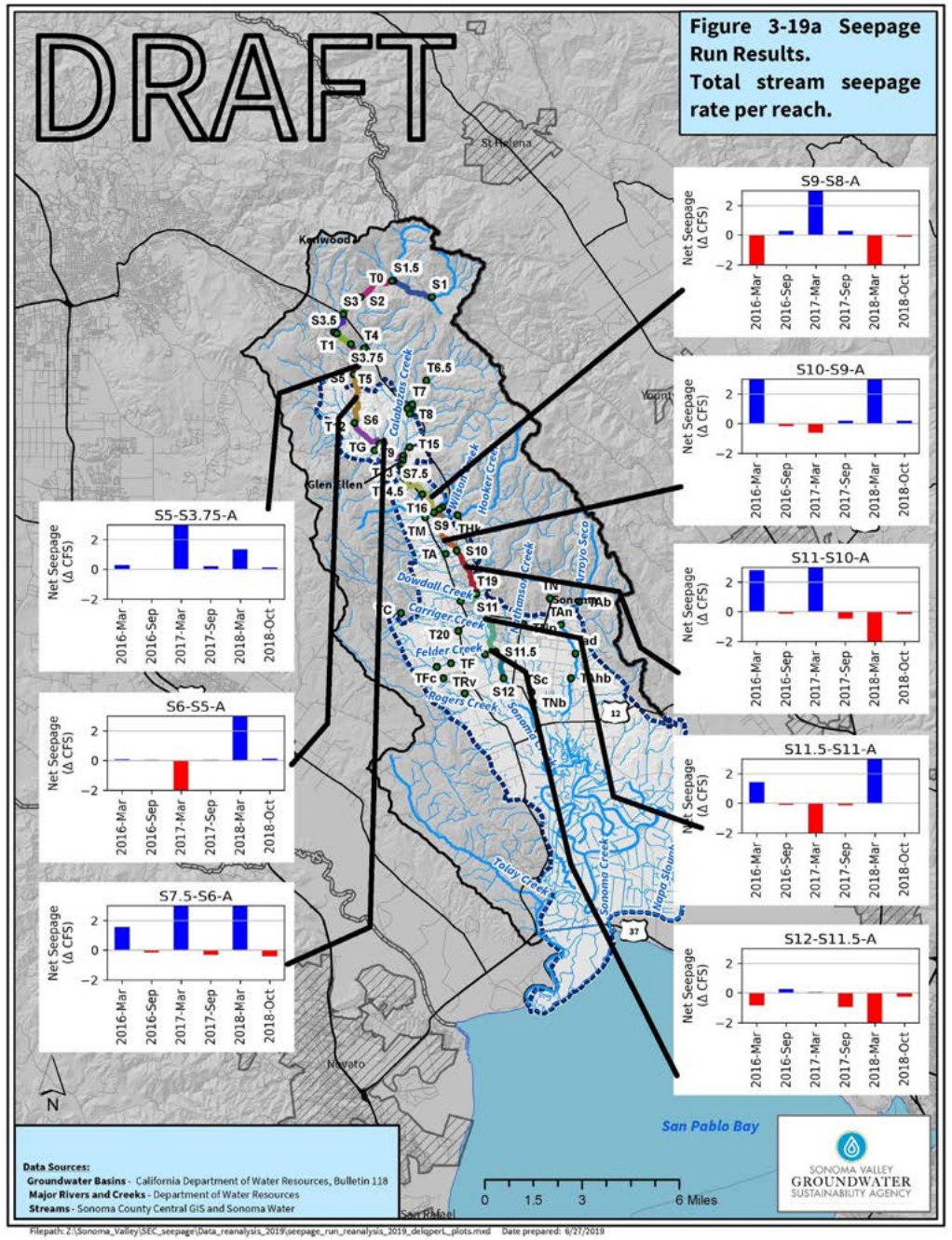
Did not use modeled interactions

Santa Rosa Plain Approach

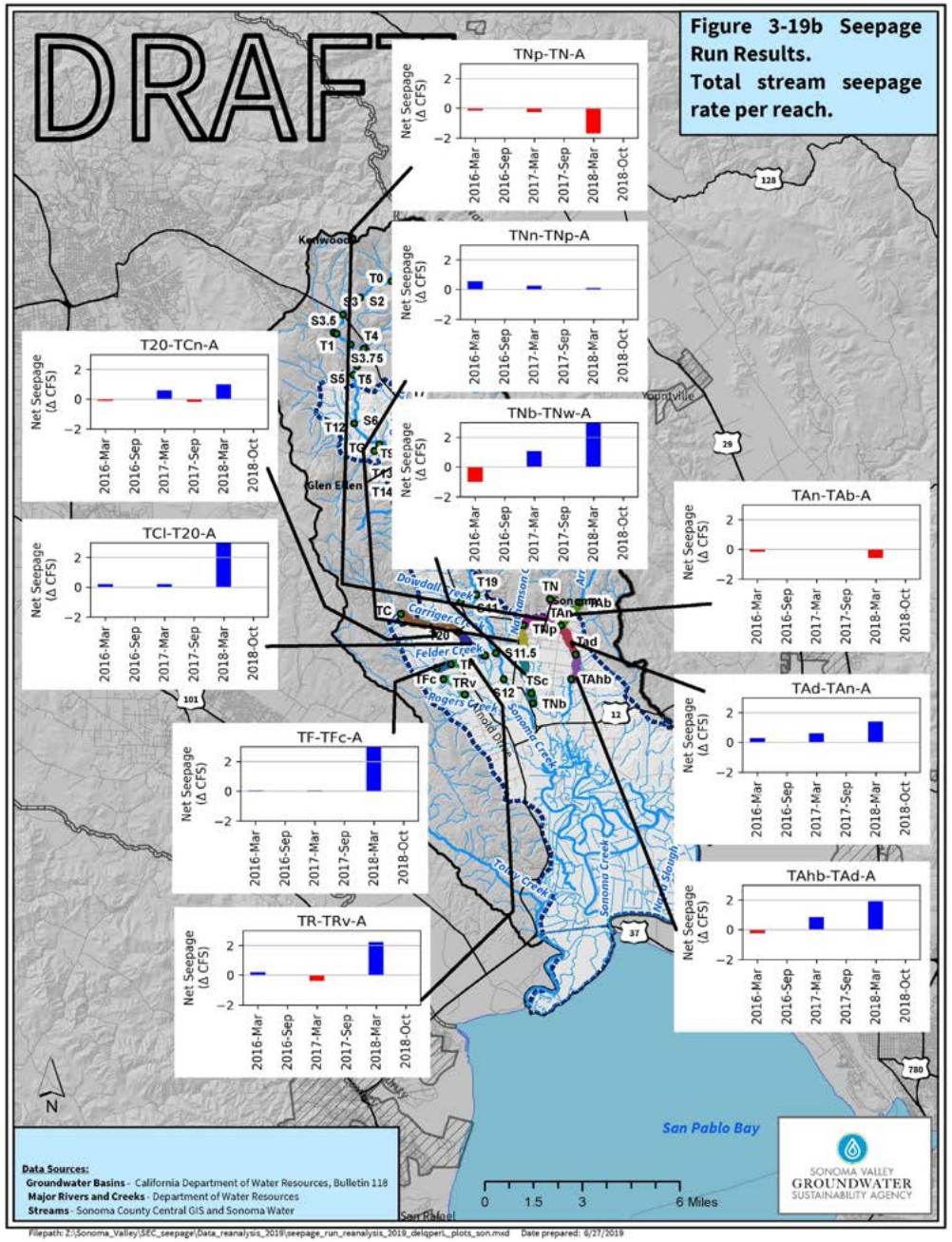
1) measured groundwater level and streambed elevation differences
2) modeled output derived from Wolfenden et al (2014)
    - Percent of time stream is gaining
    - Median streamflow
    - Surface leakage

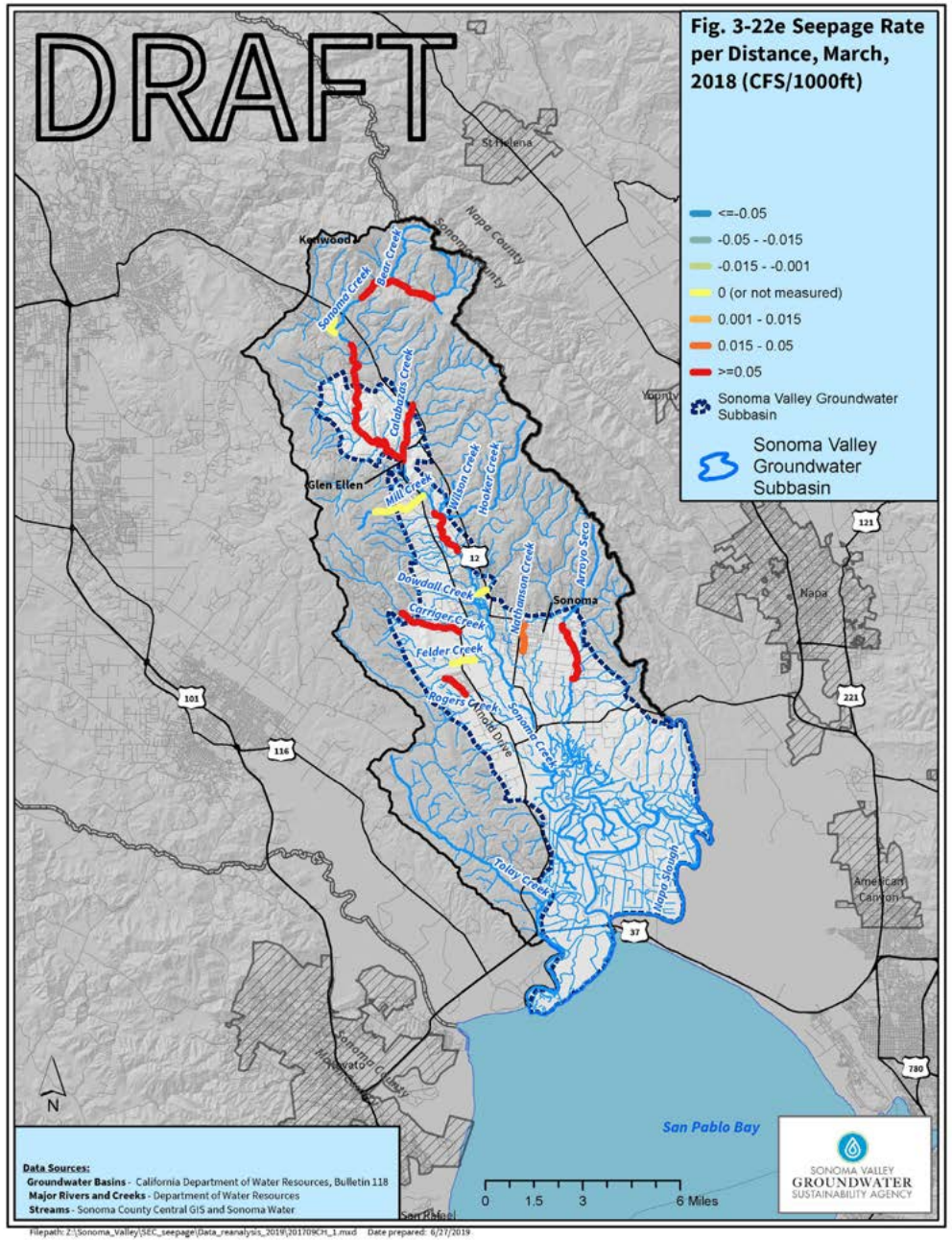
Additional information used in the assessment:

- streamflow seepage exchange through differential gaging
- baseflow separation of observed streamflow records

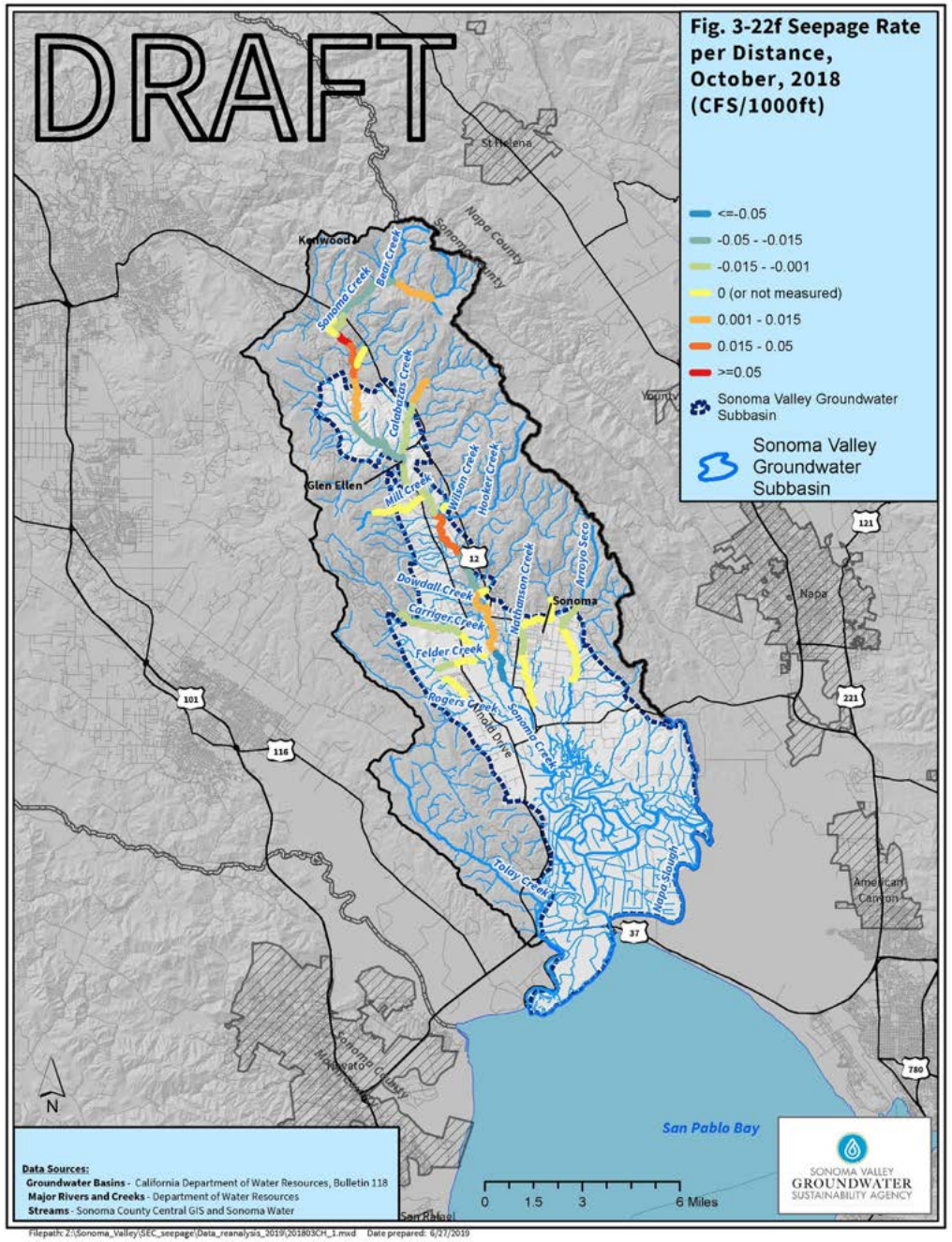


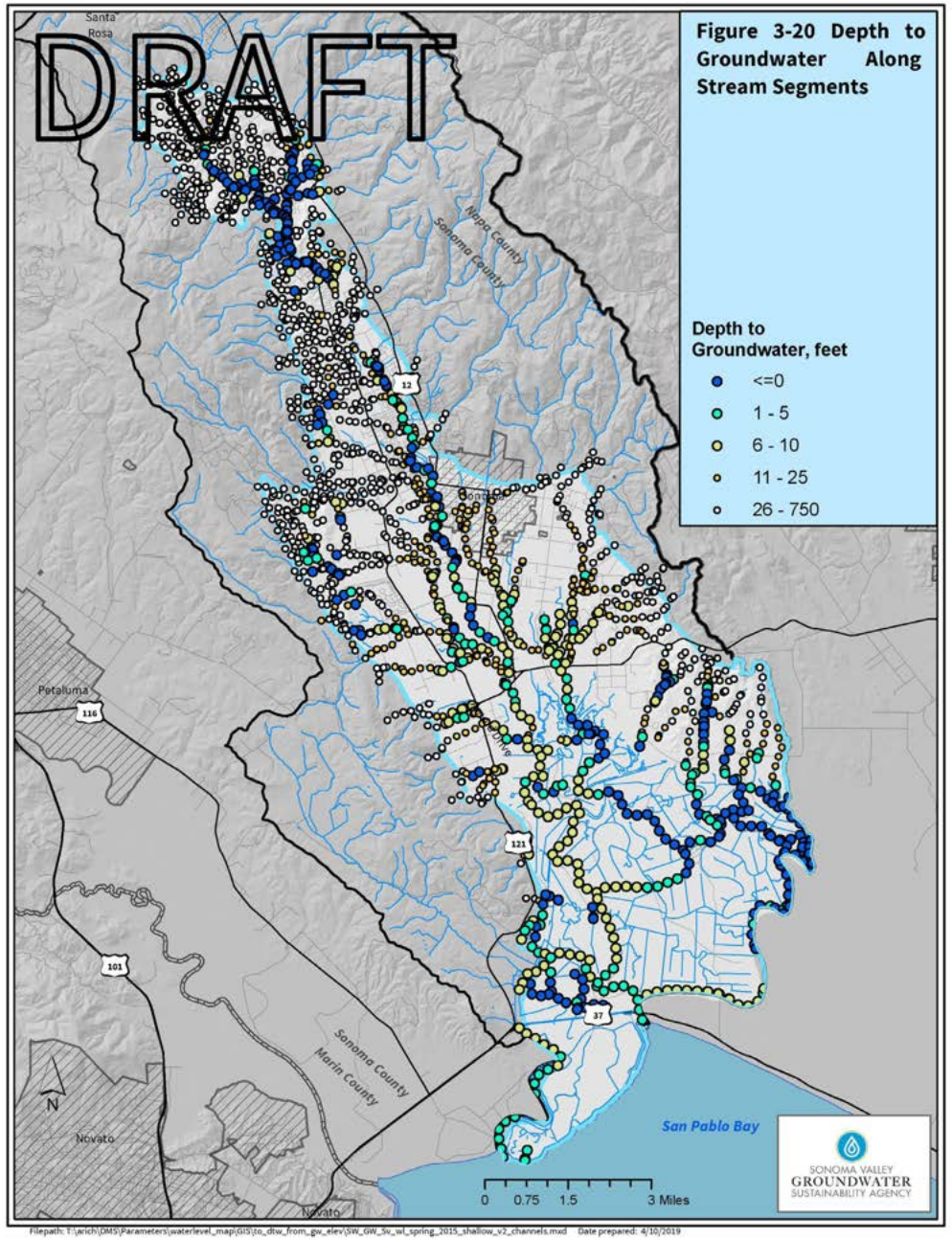
Sonoma Valley Seepage Runs: Total Seepage Rate per Reach



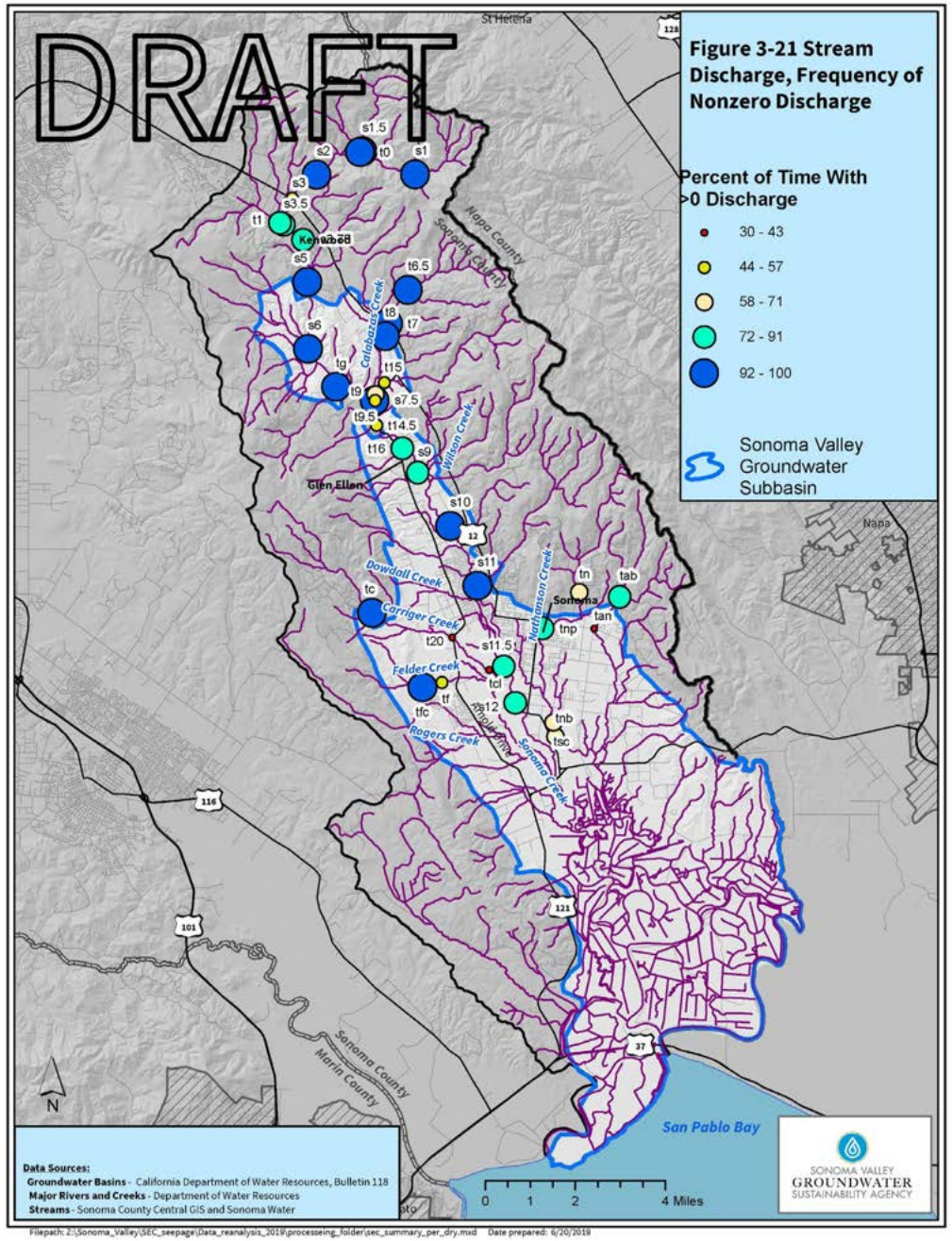


Sonoma Valley Seepage Runs: Total Seepage Rate Distance





Sonoma Valley Depth to Groundwater along Stream Segments & Frequency of Nonzero Discharge



Sonoma Valley Interconnected Surface Water Map

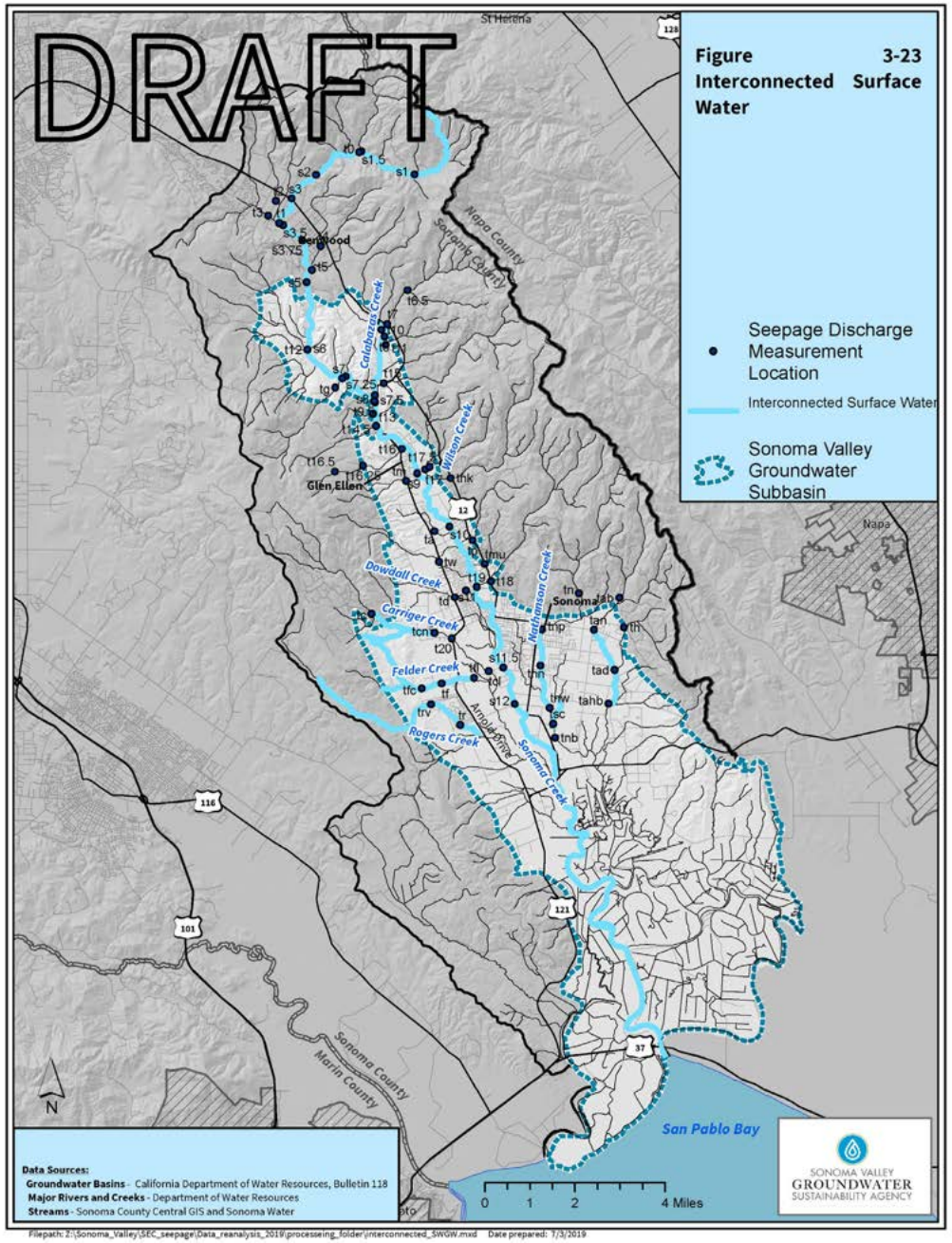


Figure 3-18b Percent of time Stream is Gaining, from 2000 to 2010

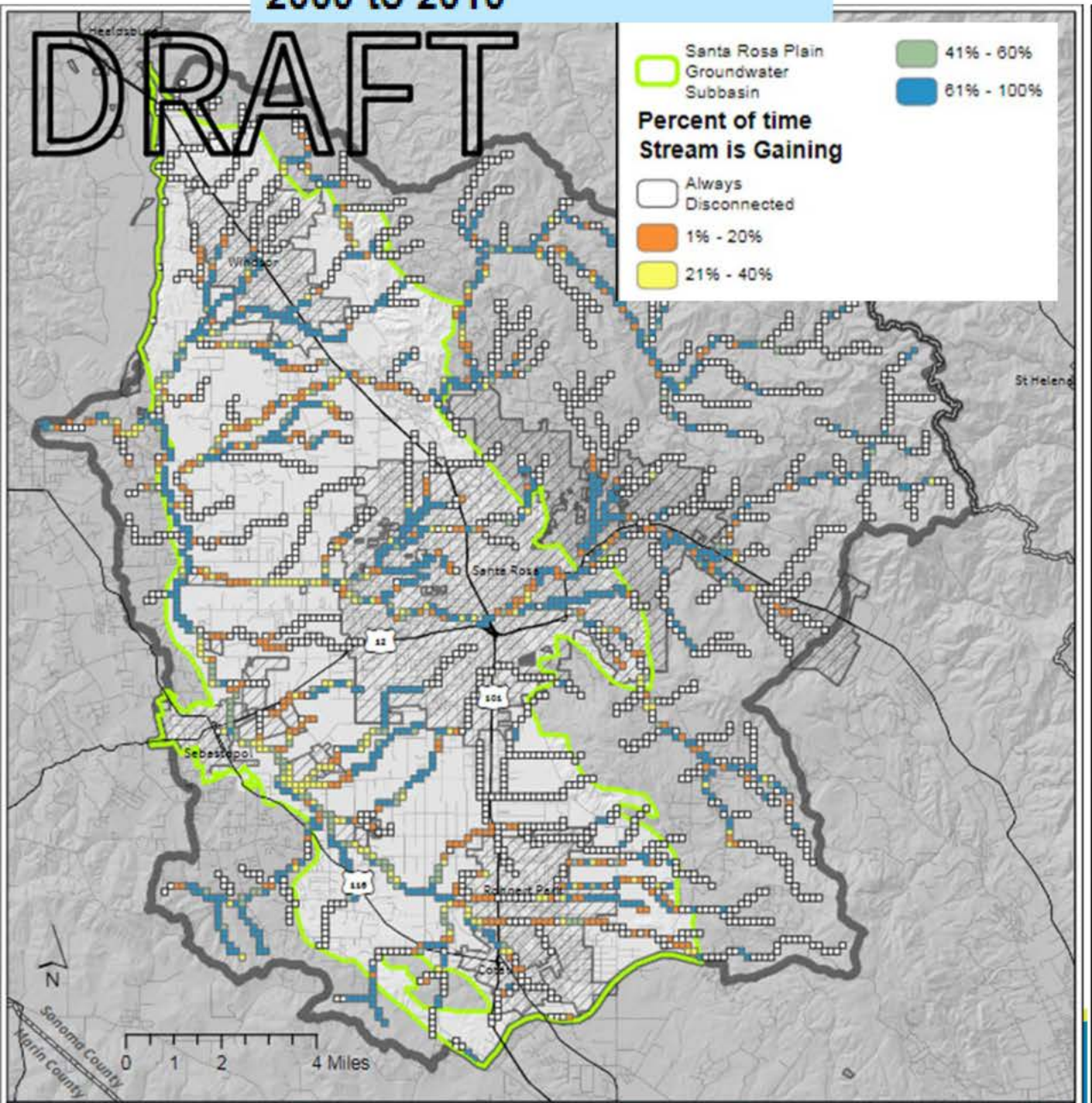


Figure 3-18a Depth to Water Along Stream Channels, Spring 2015

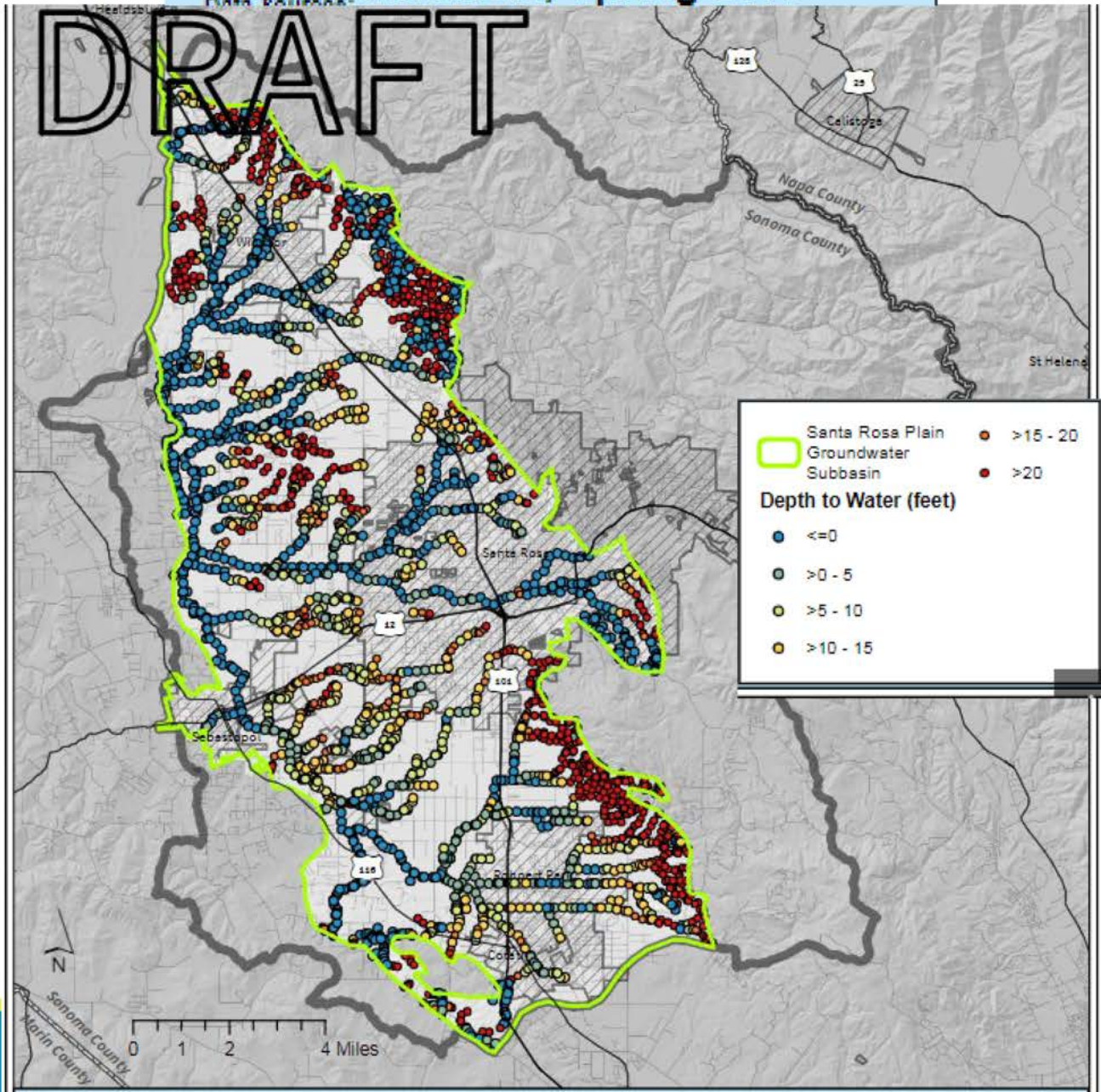


Figure 3-18d Surface Leakage, 2006

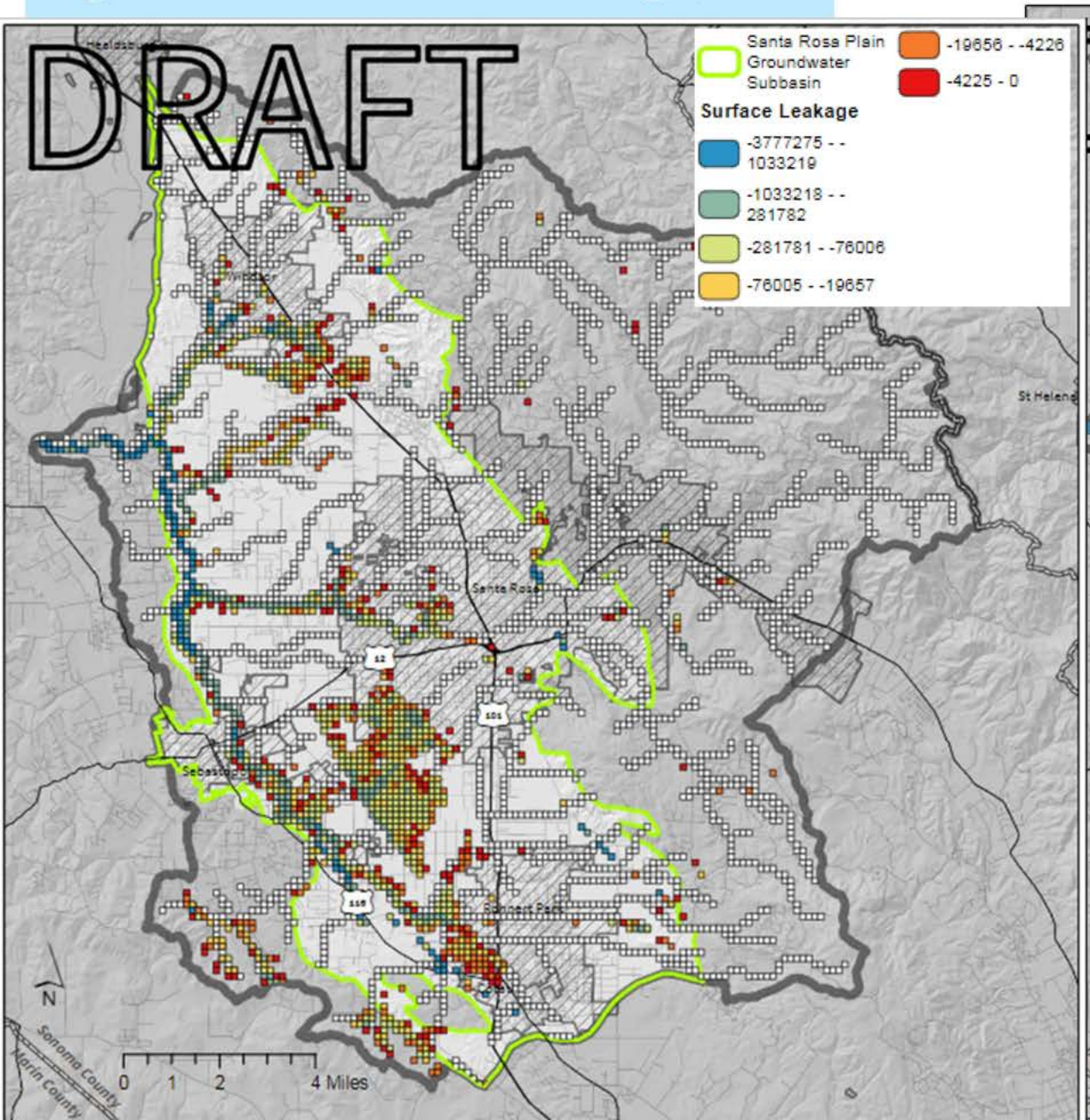
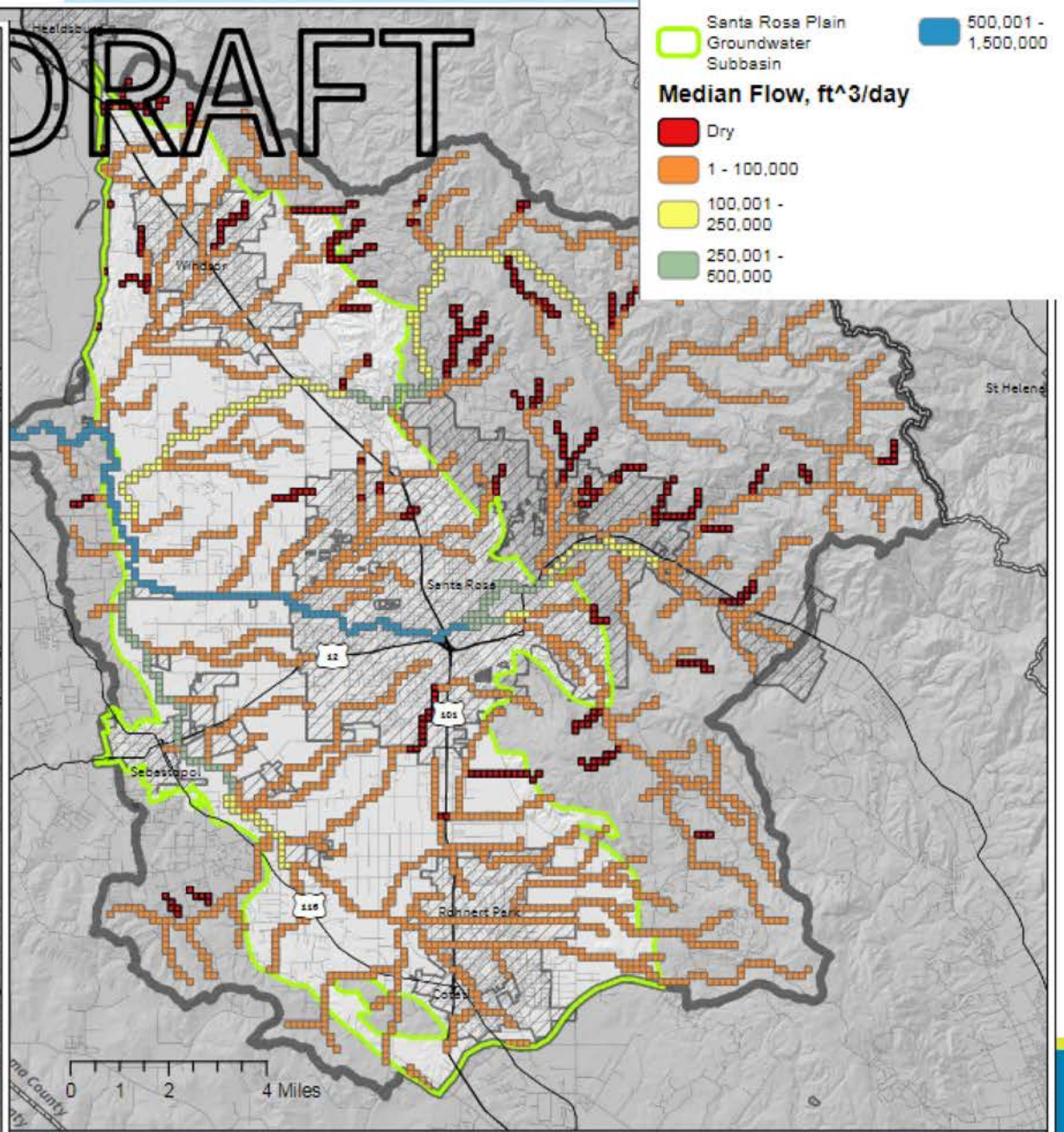


Figure 3-18c Median Flow, from 2000 to 2010



Santa Rosa Plain Interconnected Surface Water Mapping:

- Initial selection of Interconnected Surface Water based on Stream Reaches with 7 or more points (orange –colored cells

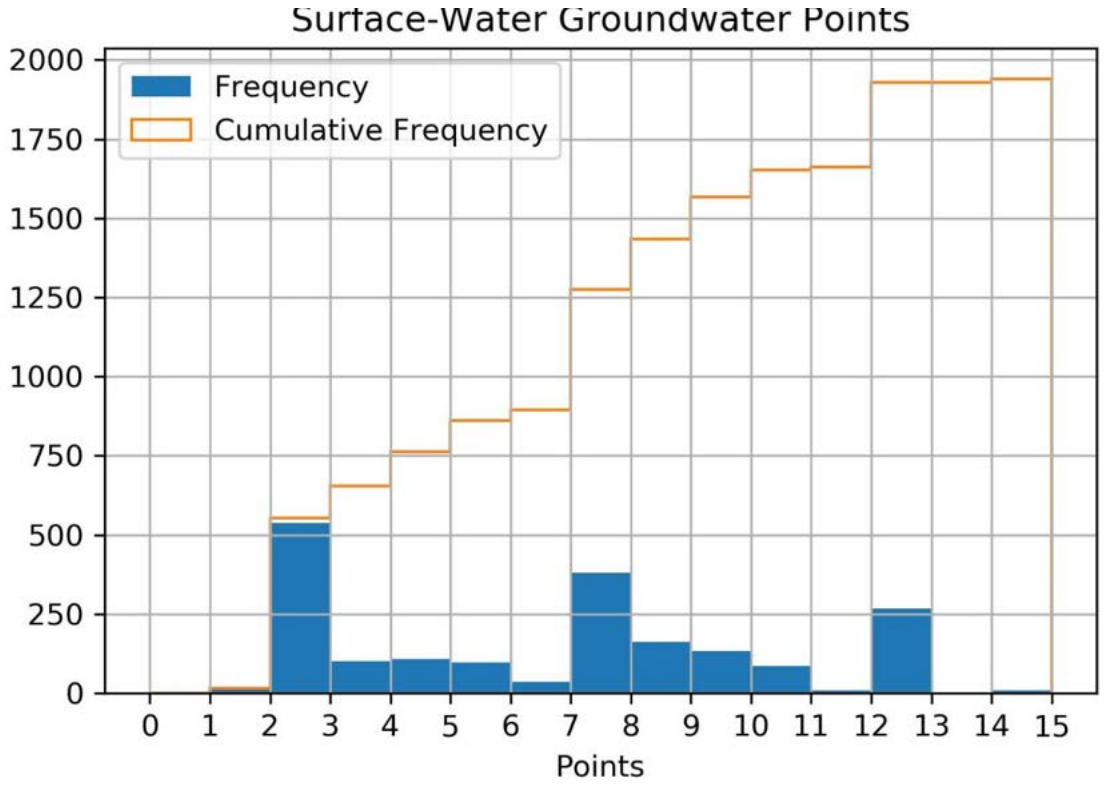
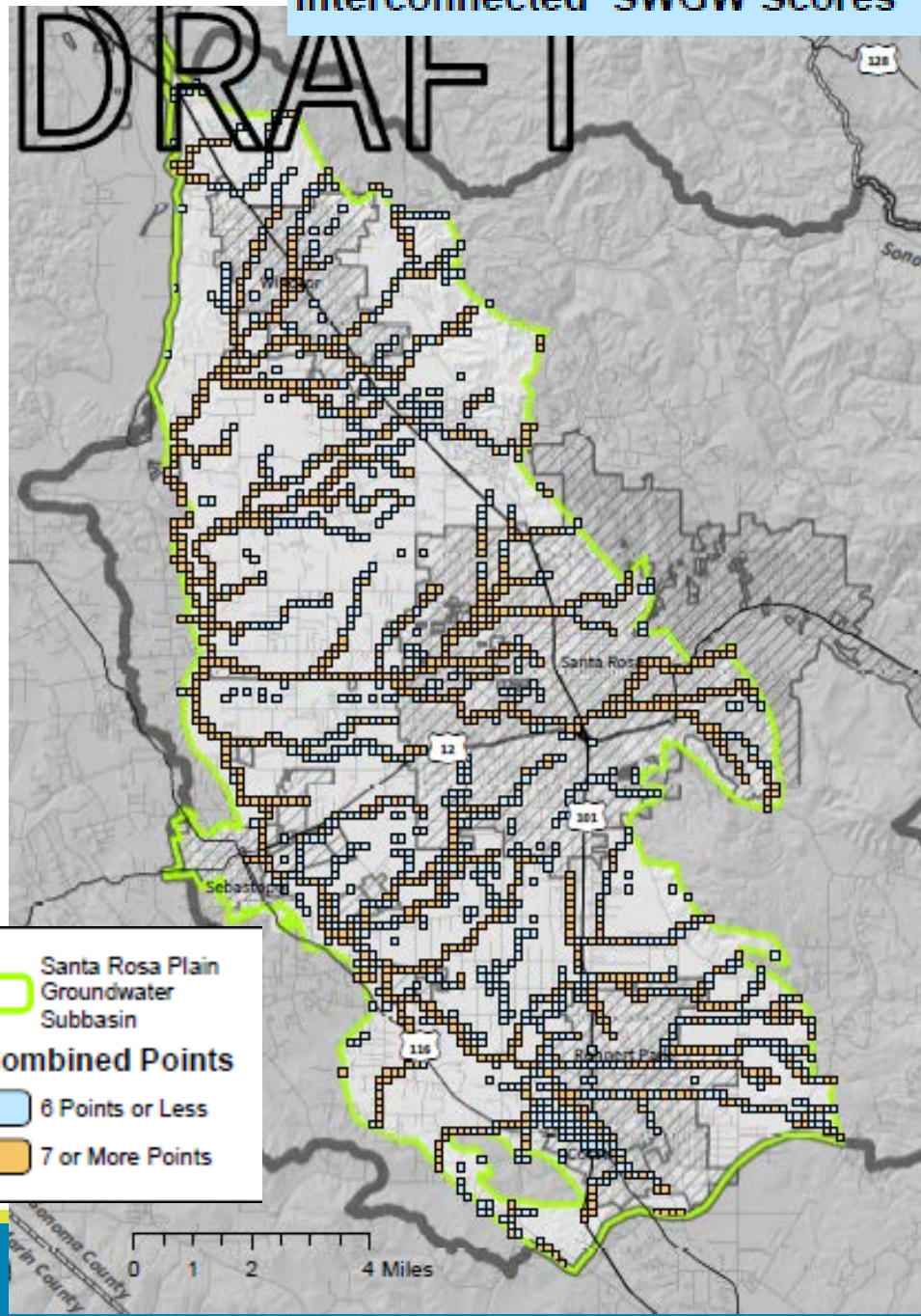


Figure 3-18f Combined Interconnected SWGW Scores

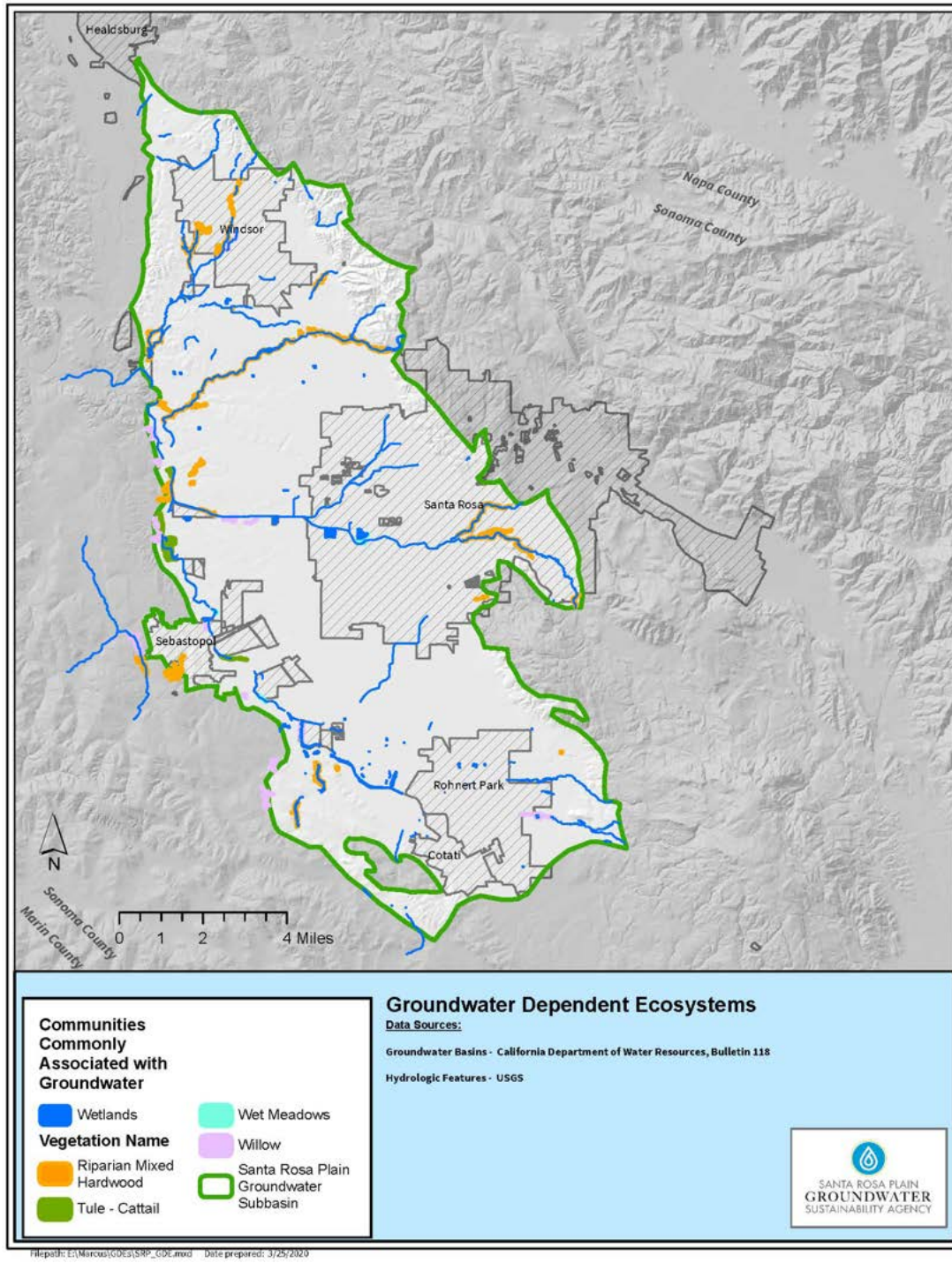


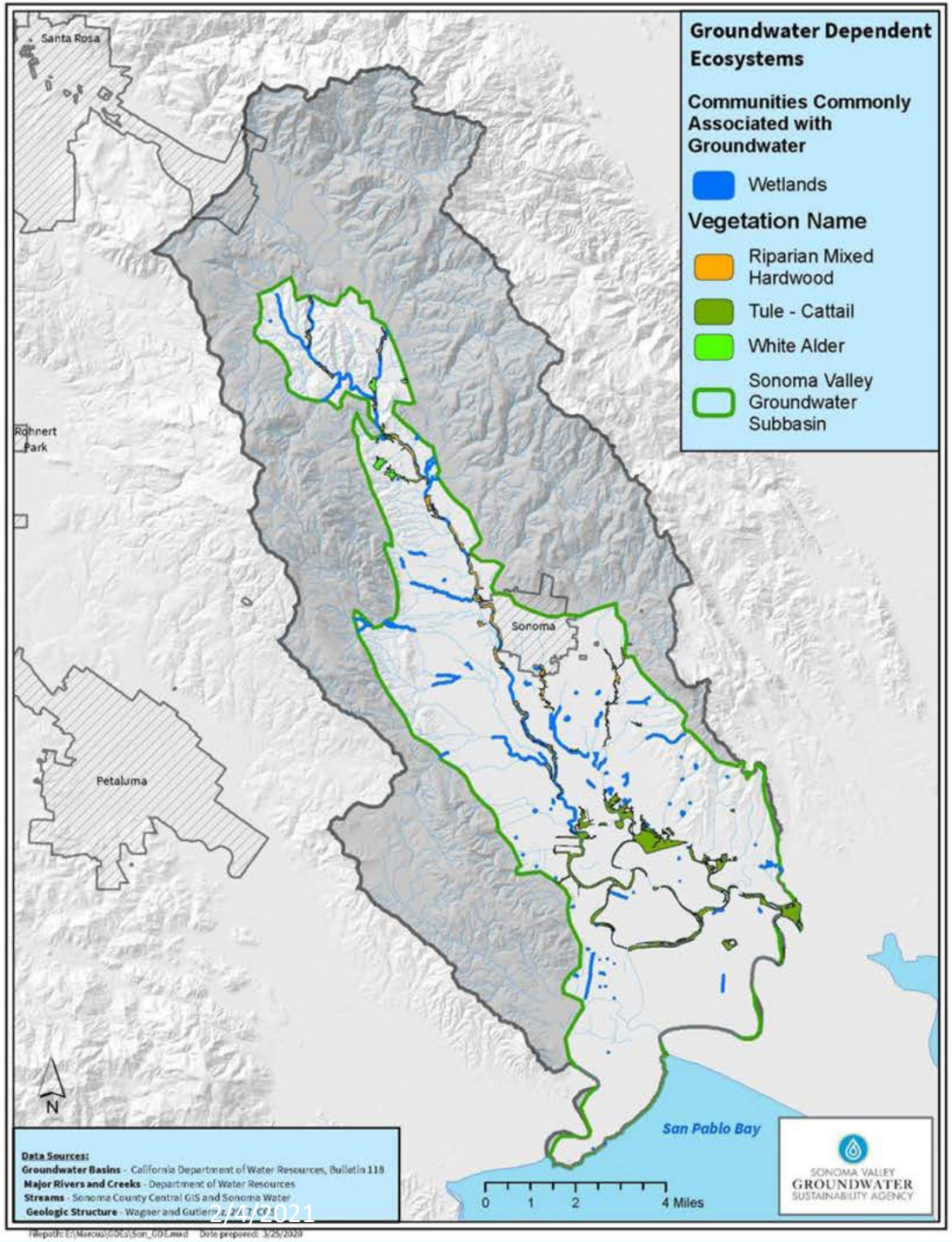
Preliminary GDE Mapping

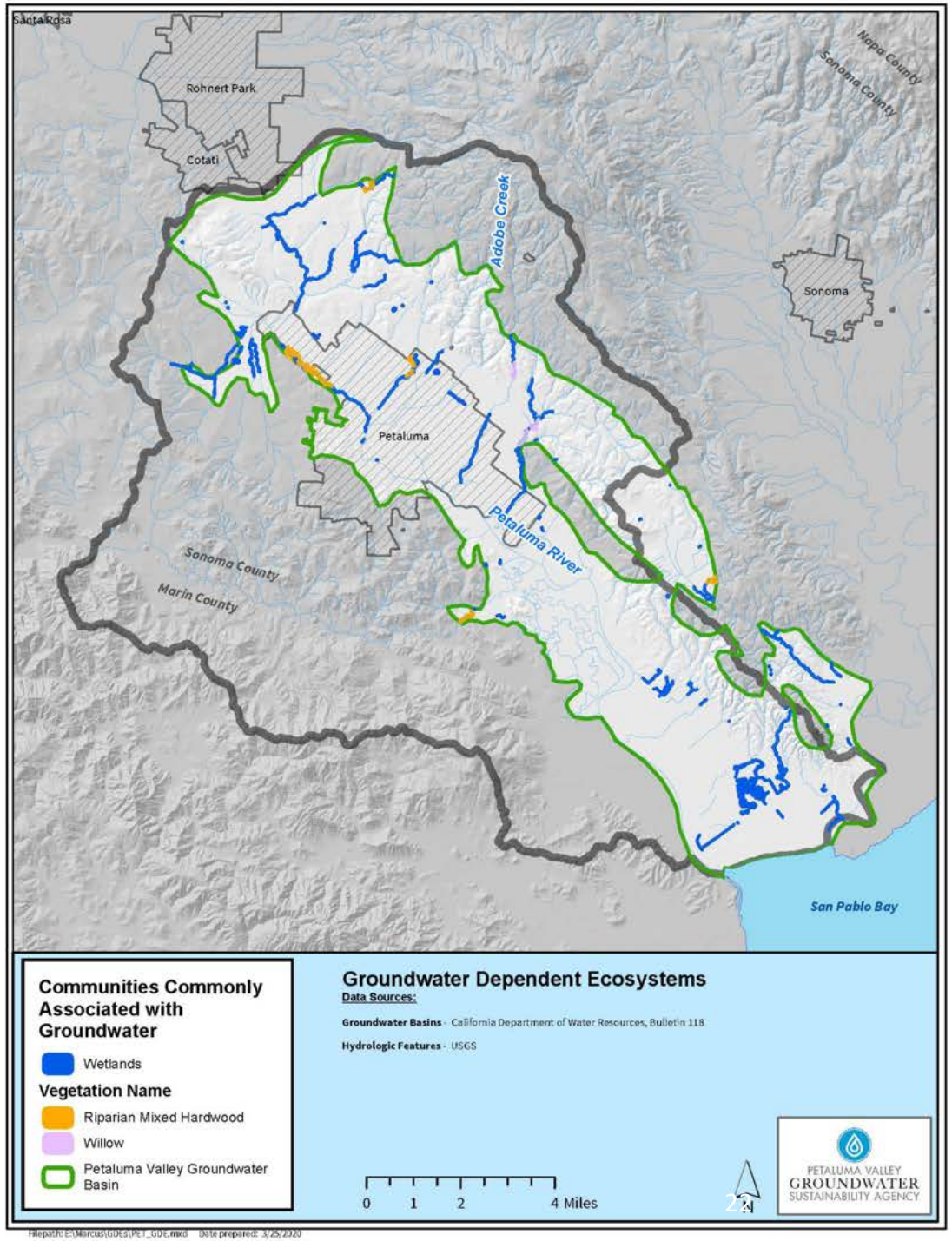
- Indicators of GDEs (iGDE) maps (The Nature Conservancy)
- Draft Steelhead streams maps (Sonoma Water)
- Draft Vegetation-related potential GDE maps (Sonoma Water)

Indicators of GDEs (iGDEs) Mapping (TNC):

- Natural Communities Commonly Associated with Groundwater (NC Dataset).
- https://gis.water.ca.gov/app/NCDatasetViewer/

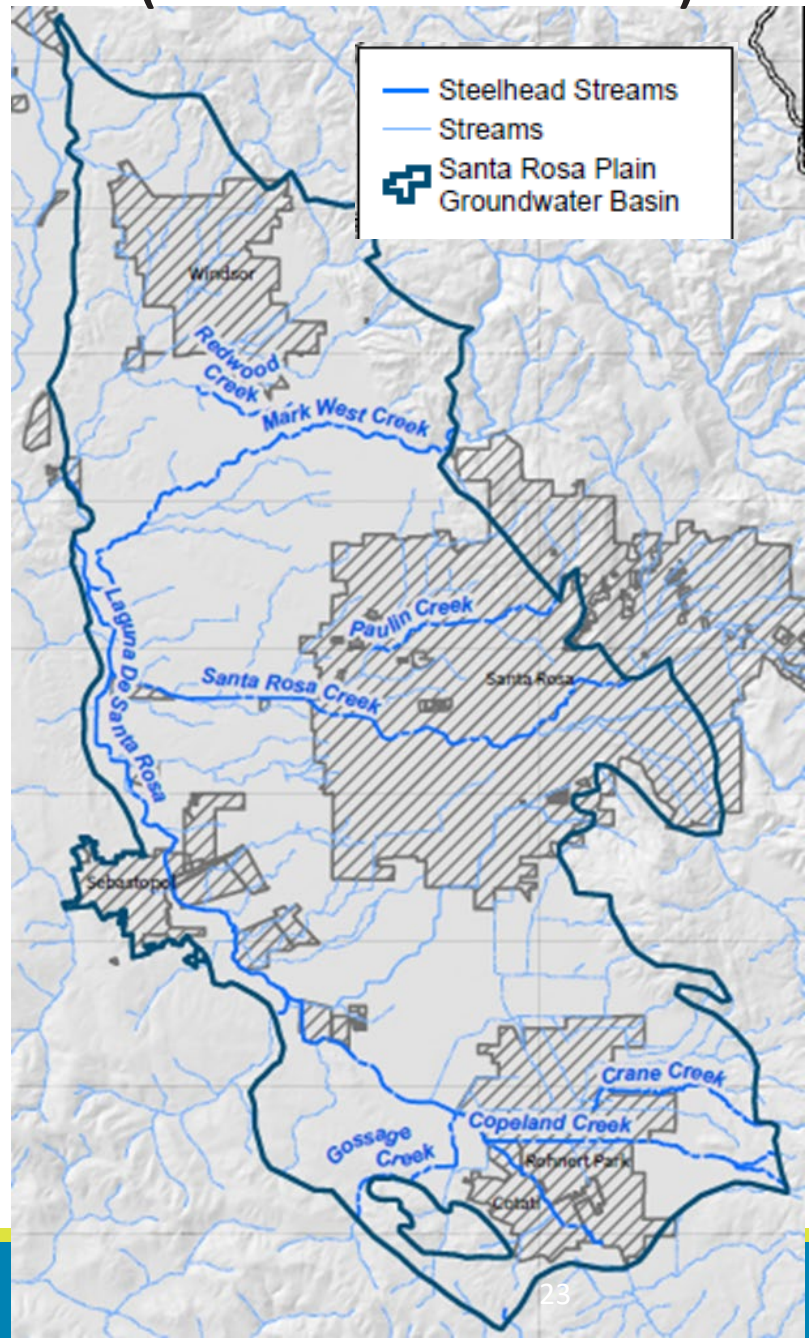



Groundwater Dependent Ecosystems
Communities Commonly Associated with Groundwater
Wetlands
Vegetation Name
Riparian Mixed Hardwood
Tule - Cattail
White Alder
Sonoma Valley Groundwater Subbasin
Santa Rosa
Rohnert Park
Sonoma
Petaluma
San Pablo Bay
N
0 1 2 4 Miles
Data Sources:
Groundwater Basins - California Department of Water Resources, Bulletin 118
Major Rivers and Creeks - Department of Water Resources
Streams - Sonoma County Central GIS and Sonoma Water
Geologic Structure - Wagner and Gutierrez, 2017, CGS
SONOMA VALLEY GROUNDWATER SUSTAINABILITY AGENCY

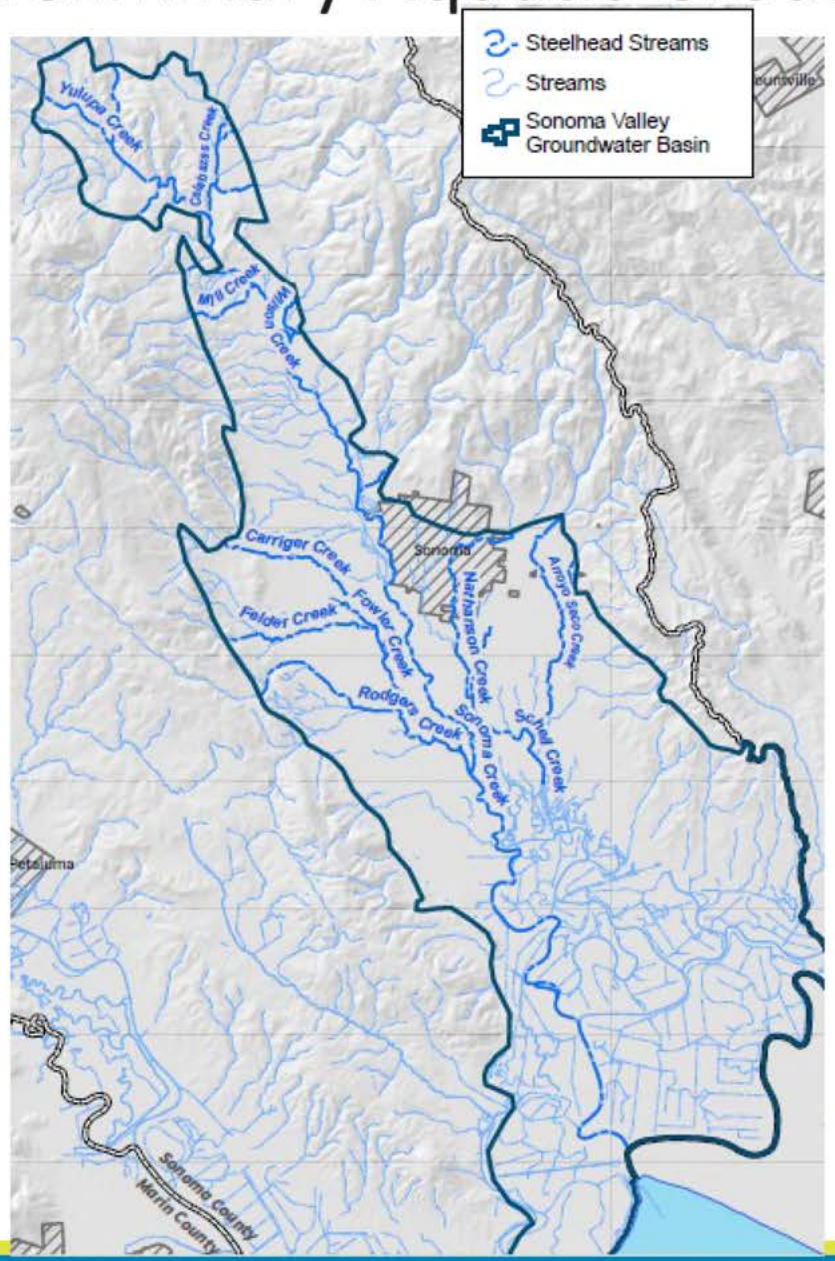

Santa Rosa
Rohnert Park
Cotati
Napa County
Sonoma County
Adobe Creek
Sonoma
Petaluma
Petaluma River
Sonoma County
Marin County
San Pablo Bay
Communities Commonly Associated with Groundwater
Wetlands
Vegetation Name
Riparian Mixed Hardwood
Willow
Petaluma Valley Groundwater Basin
Groundwater Dependent Ecosystems
Data Sources:
Groundwater Basins - California Department of Water Resources, Bulletin 118
Hydrologic Features - USGS
0 1 2 4 Miles
PETALUMA VALLEY GROUNDWATER SUSTAINABILITY AGENCY

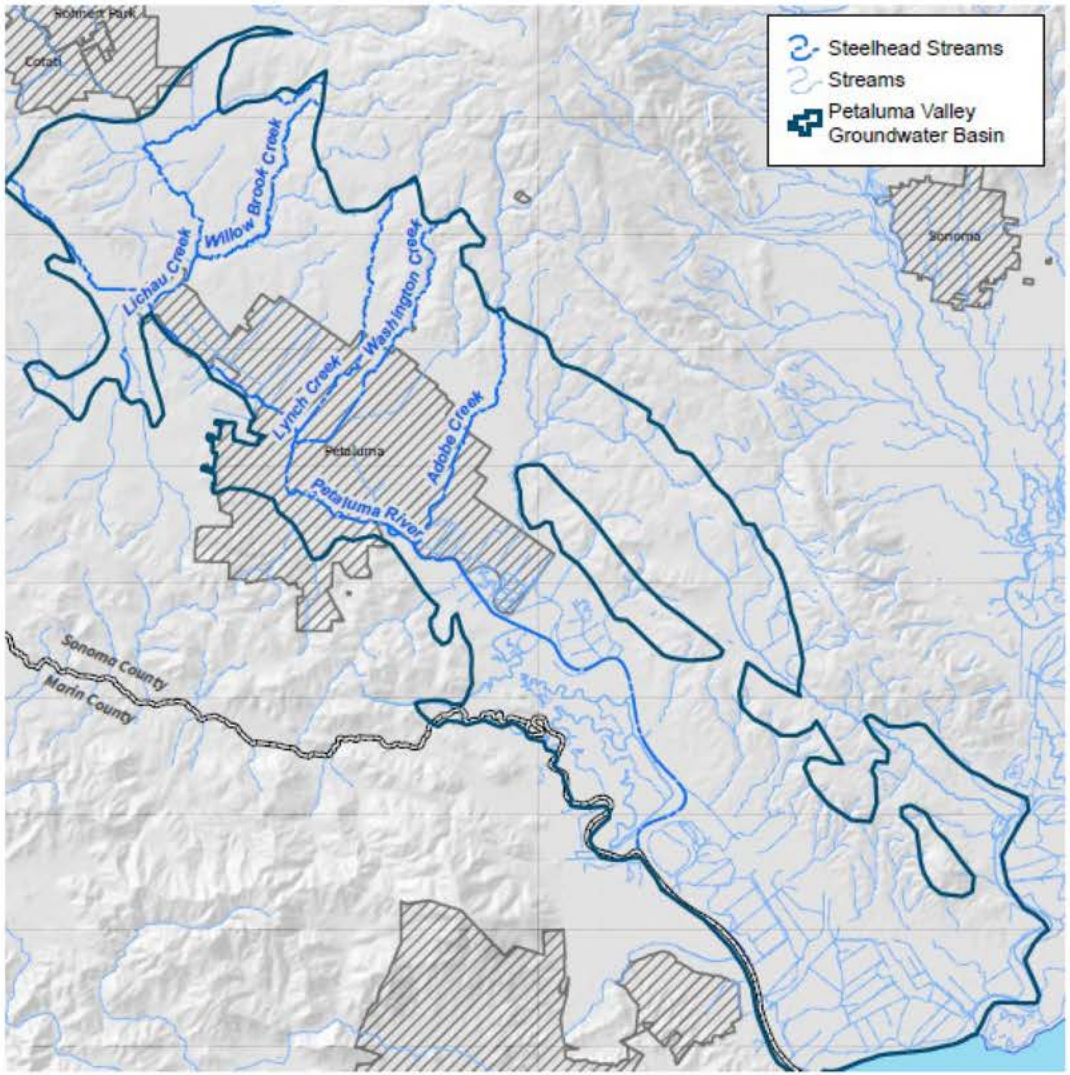
Preliminary Aquatic Groundwater Dependent Species (Sonoma Water)

- Steelhead used as priority indicator species to cover all groundwater dependent species
- Source documents used to identify steelhead streams in three ground water basins
  - Petaluma and Sonoma Ground Water Basins
    - Leidy, R.A., G.S. Becker, B.N. Harvey. 2005. Historical distribution and current status of steelhead/rainbow trout (*Oncorhynchus mykiss*) in streams of the San Francisco Estuary, California. Center for Ecosystem Management and Restoration, Oakland, CA.
    - Stream Maintenance Program (SMP). Sonoma Water steelhead habitat evaluation database.
  - Santa Rosa Plain Ground Water Basin
    - Coastal Monitoring Program (CMP). Habitat evaluation for salmonids conducted by Sonoma Water and approved by NMFS and CDFW.
    - Shawn Chase database. Sonoma Water in-house database of known occurrences of steelhead in the Russian River watershed.
- Assumptions
  - Connecting stream reaches downstream of steelhead creeks included in steelhead GDE.



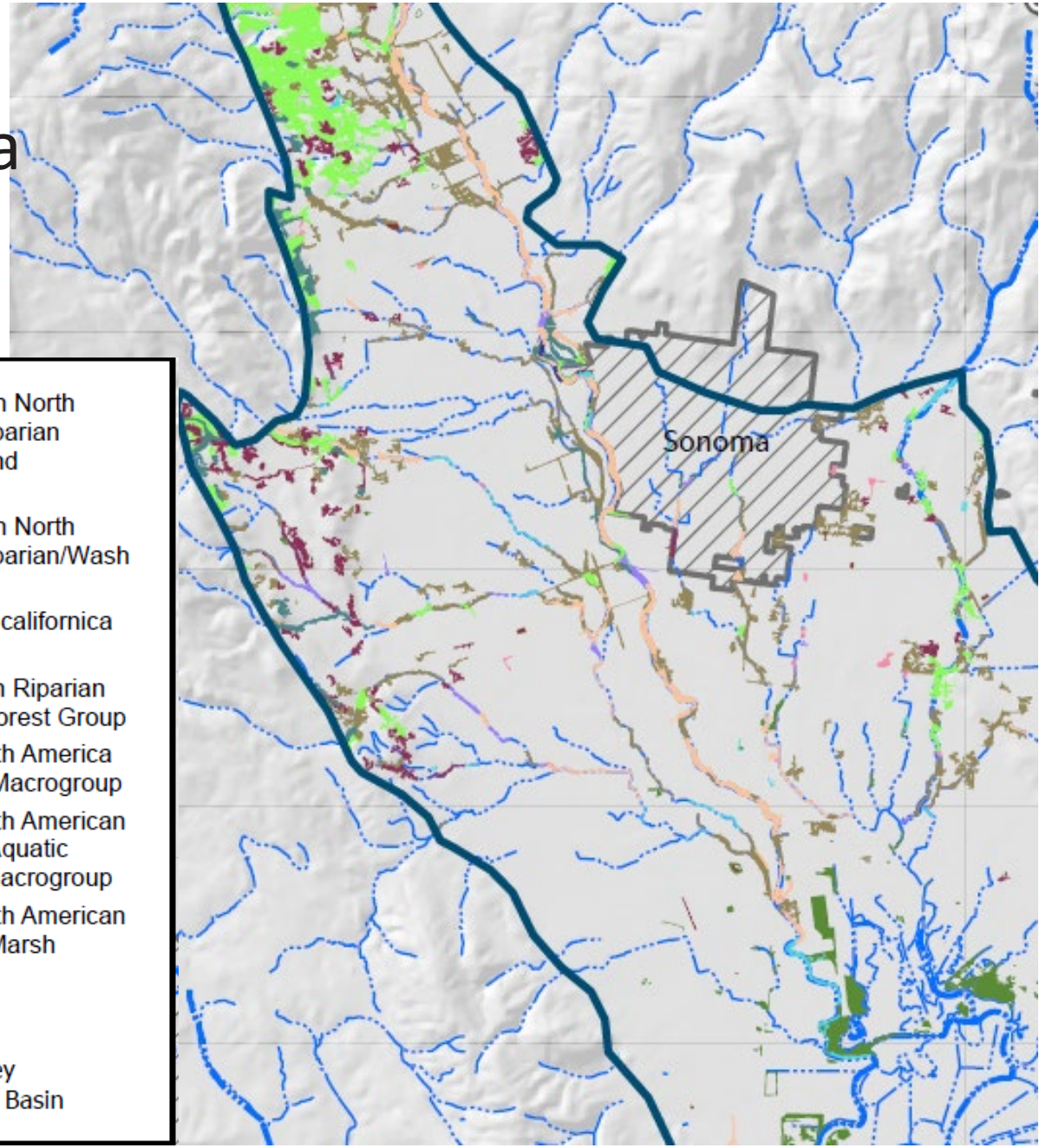
Preliminary Aquatic Groundwater Dependent Species (Sonoma Water)





Preliminary mapping of vegetation associated with groundwater (Sonoma Water): - Sonoma Valley Example

- Primary data source: Sonoma Veg Map
- Focus on communities with strong riparian composition (willows and cottonwoods) or species that may rely on groundwater some parts of year (oaks)



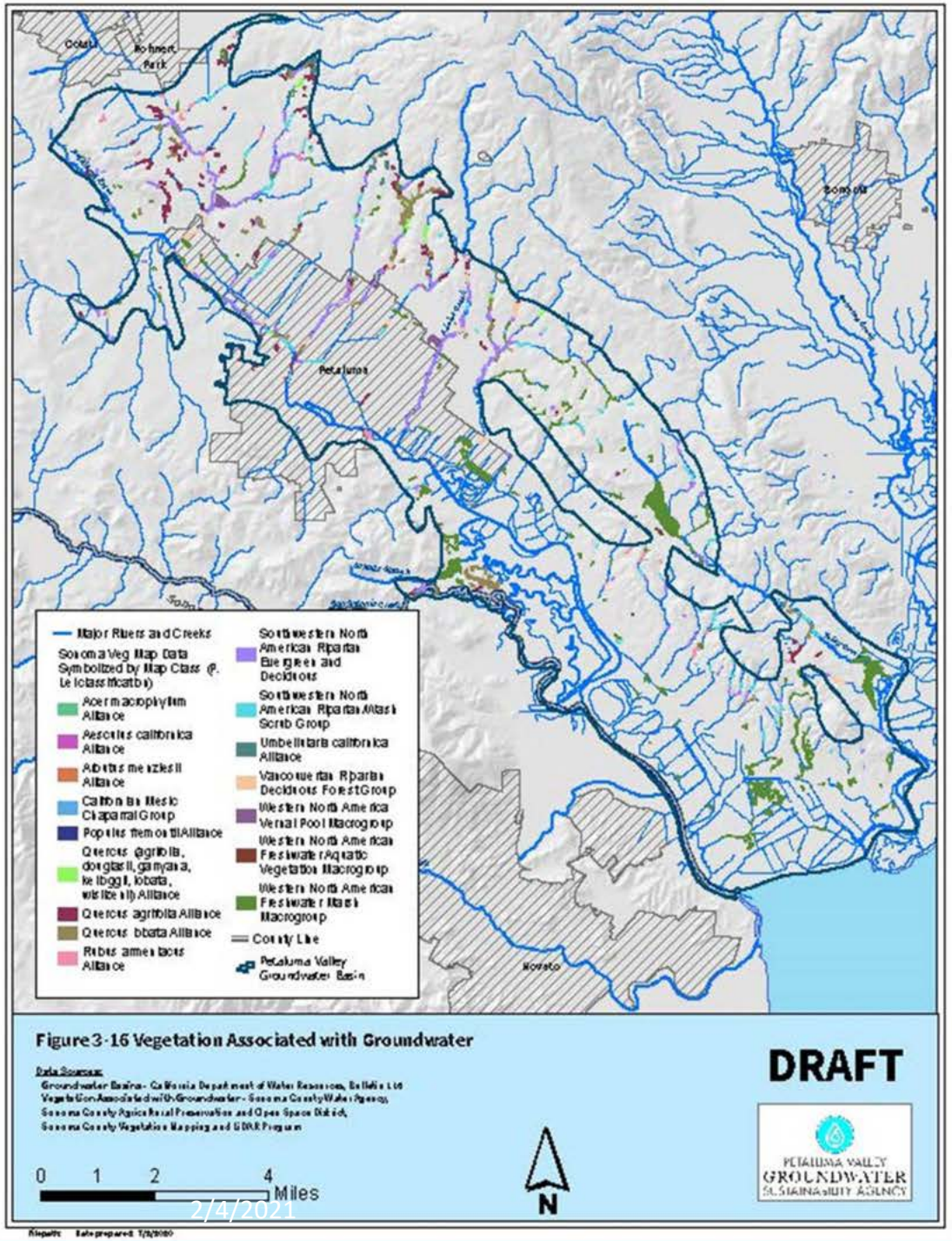


Figure 3-16 Vegetation Associated with Groundwater

DRAFT

Data Sources:
Groundwater Basins - California Department of Water Resources, Bulletin 118
Vegetation Associated with Groundwater - Sonoma County Water Agency,
Sonoma County Agricultural Preservation and Open Space District,
Sonoma County Vegetation Mapping and LIDAR Program

0 1 2 4 Miles

N

PETALUMA VALLEY GROUNDWATER SUSTAINABILITY AGENCY

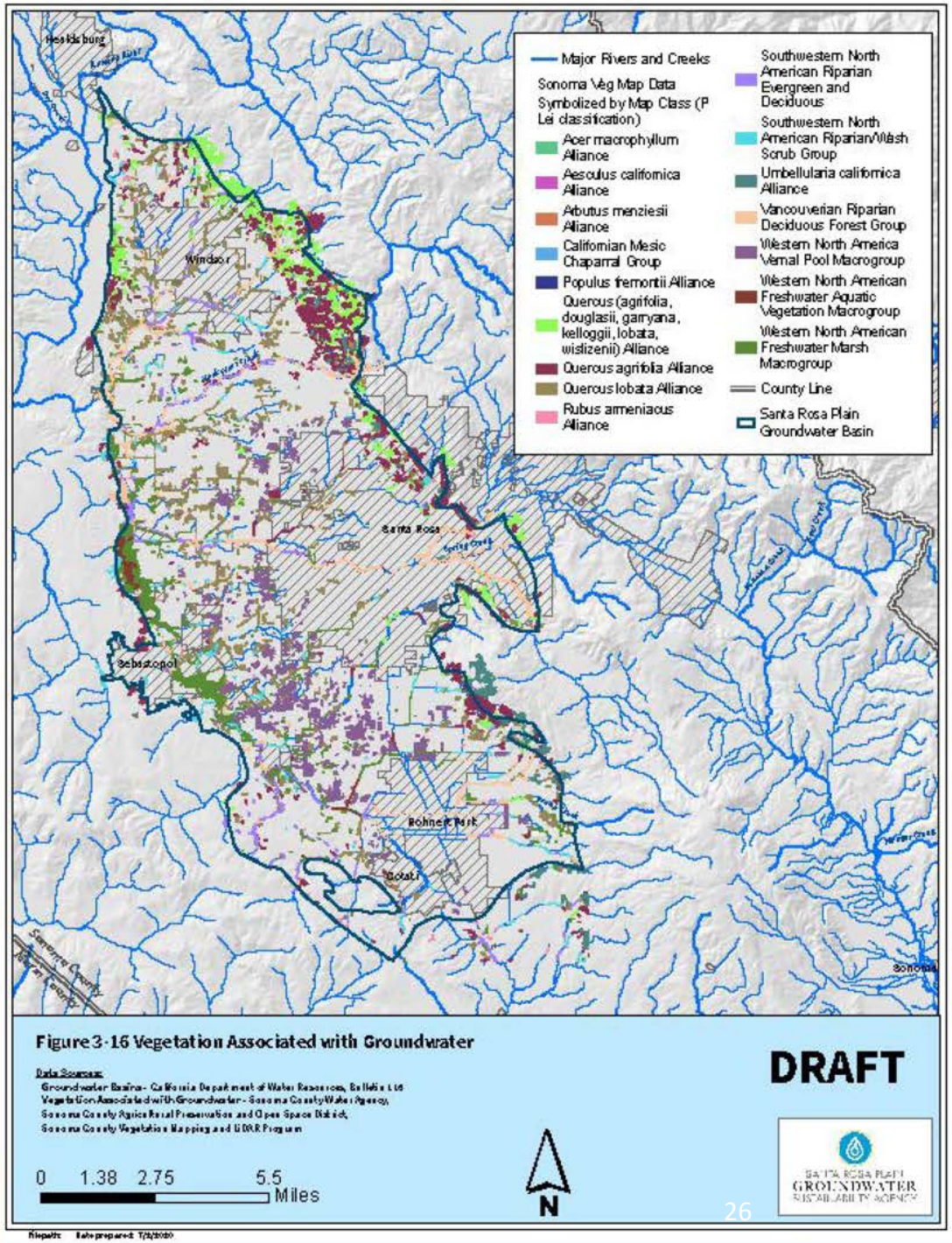


Figure 3-16 Vegetation Associated with Groundwater

DRAFT

Data Sources:
Groundwater Basins - California Department of Water Resources, Bulletin 118
Vegetation Associated with Groundwater - Sonoma County Water Agency,
Sonoma County Agricultural Preservation and Open Space District,
Sonoma County Vegetation Mapping and LIDAR Program

0 1.38 2.75 5.5 Miles

N

SANTA ROSA PLAIN GROUNDWATER SUSTAINABILITY AGENCY

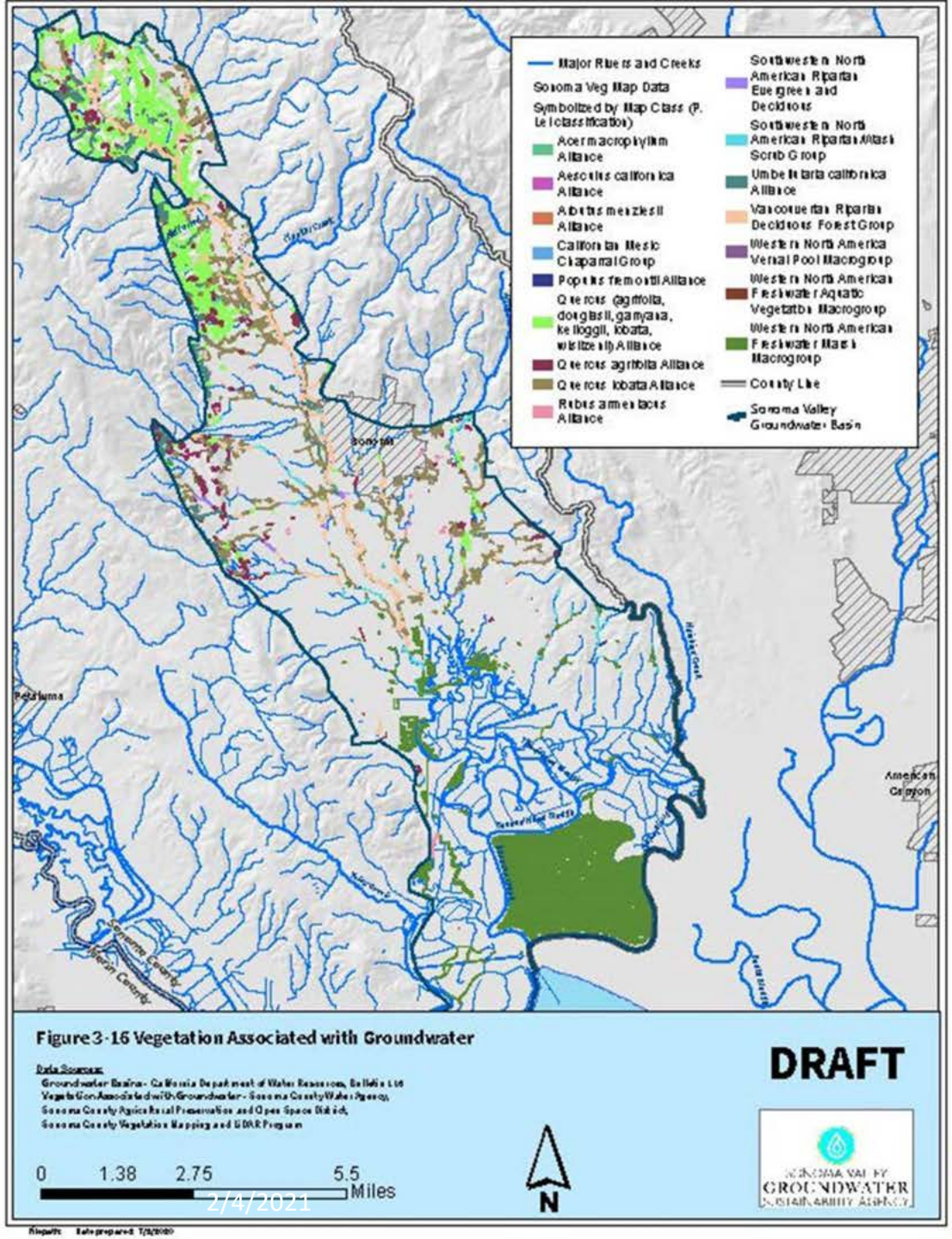


Figure 3-16 Vegetation Associated with Groundwater

DRAFT

Data Sources:
Groundwater Basins - California Department of Water Resources, Bulletin 118
Vegetation Associated with Groundwater - Sonoma County Water Agency,
Sonoma County Agricultural Preservation and Open Space District,
Sonoma County Vegetation Mapping and LiDAR Program

Kleinfelder Date prepared: 7/2/2020

Questions/Discussion

Discussion of Data Gaps

1. Are there other existing data sources that should be included for GSP?
2. What additional data collection is recommended for implementation phase of GSP?

Identification and Mapping
Groundwater Dependent Ecosystems Workgroup
Meeting Notes

Date/Time: Thursday, November 19, 2020 | 2:30 p.m.
Location: https://csus.zoom.us/j/87923439778
Contact: Sam Magill, Practitioner Work Group Facilitator
Email: s.magill@csus.edu | Phone: (831) 251-4127

MEETING SUMMARY

Welcome and Introductions / Agenda and Meeting Schedule Review

Sam Magill, Work Group Facilitator welcomed the group then ran through the day's agenda. He mentioned this meeting was the last one scheduled for the group, but staff would consider an additional meeting if needed.

Marcus Trotta welcomed the group and said there are some revisions and updates to the mapping that he wanted to share and receive input. He also was looking forward to hearing thoughts on prioritizing the GDEs' to help focus development of Sustainable Management Criteria and future monitoring of the GSA, future data collections, studies, and approaches of the implementation phase of the GDE.

Update on Groundwater Dependent Ecosystem (GDE) Mapping Process

Marcus Trotta presented updated maps for sensitive aquatic species and vegetation and then presented draft integrated preliminary GDE maps. Patrick Lei, Sonoma Water, explained that three data sources are used to create the maps: 1) Sonoma Vegetation Map; interconnected surface water data; and depth to water threshold <30 feet. The analyses (presented by Marcus Trotta) help make sure we encompass areas that could potentially have groundwater within 30 feet. The maps have been shared with the Nature Conservancy and compared with their maps; there are some slight differences.

Questions/Comments

Rogers (chat) – What do the green stream channels signify in the Petaluma Valley map? Are those where riparian corridors exist but no sensitive aquatic species? I don't see the same on the other maps.

> Patrick Lei – I think we are seeing an artifact of the mapping; the orders and layers of the maps.

Wendy Trowbridge (chat) – The assumption here is that vegetation is an innocent victim of groundwater decline. How would the GSA deal with a situation where warmer summer conditions lead to an increase in evapotranspiration and the vegetation causes a decline in groundwater? It could create a difficult situation for the GSA.

> Trotta – Good question. That is something that will have to be considered and factored in. We will be developing 50-year projected model scenarios that will incorporate a climate future. It is something we could look at with the models and is factored into the SMC if it looks like a significant issue.

Magill – Maybe it is something we could flag for the Interconnect Surface Water work group.

Maxfield (chat) – How will diversions of surface water be factored in?

Trotta (chat) - Surface water diversions will need to be considered when developing the SMC for surface water depletion. I don't think they necessarily come in to play for GDE mapping.

Robert Pennington (chat) – Is this monitoring for GDE mapping or monitoring for SMC criteria?

Trotta (chat) – Monitoring for GDE mapping, although there could very well be overlap with SMC criteria.

Steve Rogers – For groundwater dependent vegetation, it seems the 30-foot threshold is specific to the rooting depth of oaks, but oaks have some of the deepest rooting systems of groundwater dependent vegetation species. Probably there are other shallower root species. Do they address other species besides oaks? It seems 30 feet wouldn't take into consideration other species.

Trotta – The 30 feet threshold is intended for consideration in mapping the potential presence of GDEs in the basin to be somewhat conservative.

Lei – We are trying to filter out eco systems that currently are not within 30 feet and probably not dependent on groundwater. It is a conservative model.

Rogers – I see now it is used for mapping vegetation and won't be used for management criteria for vegetation.

Lei – My understanding is that that is the next step.

Rogers – Makes sense.

Steven Lee – Looking at Sonoma Valley, there is one tributary, Stewart Creek off Calabasas, that might be underrepresented. It is a tributary that has Steelhead. It looks like Stewart Creek isn't listed on the map.

Trotta – Stewart Creek was included in the Steelhead mapping that David Cook did.

Lee – I don't think so.

Rob Pennington – Are there Steelhead present in the alluvial basin part of the groundwater basin or are they present in the upper watershed?

Lee – They have probably been cut off alluvially during the dry season months. I want to raise the issue, maybe it is intentionally left off the map.

Trotta – It looks like it is one of the streams filtered out through looking at the interconnected surface water. That stream isn't mapped as being interconnected surface water. We can follow up with David Cook.

Lee – What is the criteria for the delineation?

Trotta – If it isn't interconnected surface water, groundwater is below the streambed throughout the year and isn't contributing to the flow of water in that creek.

Lee – I recently did some temperature monitoring. Based on the way temperature data look, it seems there is a connection with groundwater feeding it.

Lee – In the areas identified less than 30 feet to the groundwater, it looks like the channels themselves, it doesn't seem to get wide beyond the channel area. Some monitoring I have done recently shows the groundwater is shallow southeast of Calabasas Creek, 500 yards or so off the creek.

Trotta – It would be great to see any additional data you have.

Melissa Rohde – Could you elaborate more why saltmarshes aren't included?

> Lei – We have been working under the assumption of tidally influenced rather than groundwater influenced. If we think it could be groundwater influenced, we should include saltwater marsh and aquatic. The map classes we have been working on from the beginning didn't include saltwater marsh.
>
> Rohde – It is worth considering, these ecosystems are defined as being dependent on groundwater near the earth's surface. If it is about using groundwater and is groundwater dependent, the species don't use multiple sources of water simultaneously at different times of the year. If the saltwater marsh areas were impacted by pumping there could be an inadvertent impact on the ecosystem if connected to groundwater.

Lei – If anyone has further questions about why some habitats were included or excluded from the maps, let me know, and I can get them added to the maps. I look forward to hearing your input.

Preliminary Data Gaps/Recommendations on Future Data Collection

Marcus Trotta presented a slide with questions about recommendations for additional data collection and studies and asked the group for input.

1) *Are there additional monitoring needs for surface/groundwater interaction to better understand CDEs?*
2) *Are field verification surveys required to confirm maps?*
3) *Are there certain GDE parameters that should be considered?*
4) *How should any recommended studies/monitoring be prioritized for GSP implementation?*

Rogers – Are you planning on getting people together to discuss this?

> Trotta – It would be good to get initial ideas here on types of monitoring and prioritization of locations for monitoring, etc. The Surface Water Depletion workgroup will also have a discussion on monitoring related to surface water depletion.
>
> Rogers – My suggestion would be to put in monitoring that would best inform the modelling effort.
>
> Andy Rich – All the models that we are developing are data rich, there could be some improvement, such as the data collected by the Ecology Center of surface water - groundwater interactions.
>
> Lee – Basically we have most of the important creeks included in this. The question is what other areas aren't included? In terms of data gaps, when using vegetation mapping as a basis for the analysis, it seems underneath the canopy of other tree species that would indicate groundwater dependent eco-systems that wouldn't show up in those, I am thinking of seeps. Most areas I am thinking of are higher up in the watershed.

Trowbridge – I would be curious to hear how other GSAs have dealt with vernal pools. Clearly, there are perched aquifers, but water does flow out of vernal swells. And seepage runs. Also, another pitch for the importance of measuring evapotranspiration.

> Rohde – With regards to vernal pools, they are not generally included in the mapping. If the groundwater that the eco-systems are accessing and not connected to a principal aquifer it is not groundwater dependent in the context of SGMA. We have a GDE pulse we put together that includes satellite data from the last 35 years for mapped polygons, it doesn't include data from

your mapping. It would be good for us to talk about how you could do that. How to update the GDE pulse with recent data. Maybe we could give you the code.

Trowbridge – It seems like some of the differences between Sonoma Water's vegetation mapping and the TNC's vegetation maps in Santa Rosa Plain are related to perched aquifers associated with vernal pools.

Rohde – My understanding is the hydrogeology of the area is mostly unconfined aquifers. Can you explain the hydrogeology of the basin?

Trotta – The shallow groundwater conditions in the central portions of the plain, the shallow aquifer system is primarily unconfined. It is interesting the oaks are coinciding with areas of vernal pools.

Rohde – Is the groundwater essentially at the surface because of vernal pools or are the vernal pools there because the groundwater is at the surface?

Trotta – The vernal pools are superficial features that fill from precipitation in areas where the shallowest soils are sufficiently low permeability that allows for the formation of the vernal pools rather than filled by seasonal high groundwater fluctuations.

Rohde – When we are mapping the eco systems, one of the challenges is that we have a poor understanding of the shallow aquifer systems and the perched clay lands. SGMA is about adaptive management. If the vernal pools are driven by precipitation and surface run-off, under SGMA they wouldn't have to be categorized as groundwater dependent eco systems. We don't have data to prove that, so I think we should keep vernal pools in and address it as we move forward.

Pennington – Are there ideas for the SMC of the non-stream GDEs? What would the monitoring network look like? Will we have the monitoring such that it improves the mapping will make much difference in the end in terms of evaluating impacts of GDEs?

Trotta – I think it will for some of the next upcoming topics. If we had some areas that were higher priorities, maybe it would help identify monitoring needs.

Pennington – So you are thinking of using water levels for the GDE's sustainable management criteria.

Rich – It could be useful for identifying data gaps in the future.

Rohde – In general the non-riparian vegetation types should be considered when you are establishing SMC for chronic lowering of groundwater levels. You would have to define what an Undesirable Result looks like for that accounting for all the other beneficial users that rely on groundwater levels in the basin.

Trowbridge – I would encourage more monitoring. It seems like much of the Santa Rosa Plain where there are vernal pools are underlined by clay layers. I wonder if much of the riparian vegetation along the creeks isn't groundwater dependent on the deep groundwater so much as dependent on the shallow groundwater in the same way the vernal pools are. I don't think we have the information to say one way or another.

Trotta – When we look at the areas that have been mapped, we limited it to segments that have been mapped as interconnected surface water. Based on that data, those segments are connected to the shallow aquifer system. With all the clay in the Santa Rosa Plain, the continuity and degree of the connection is variable. We don't have a fine scale subsurface portion of the aquifer system to differentiate that. That is why the streams are made as interconnected.

Trowbridge – I think Santa Rosa Creek is interconnected. I wonder about some of the other smaller creeks that run by vernal pools, the lower parts of Copeland for example.

Trotta – Sounds like an area for future investigation and monitoring.

Pennington – In terms of what would be helpful, more shallow monitoring wells near streams would be useful for answering that question. I agree with the seepage runs, very useful. My knowledge of the stream gauging network is that it is quite good, I am not sure if there is a gauge is the upper end of Mark West Creek near Wikiup/Larkfield. Maybe one there would be useful. For Sonoma Creek, Sonoma Ecology Center would be able to advise.

Lee – We have three gauges in Sonoma Creek and a whole series of additional ones we have been trying to answer similar questions with other funding. Having more gauges and tracking more tributary flows would be an additional useful support. Steven Lee showed examples of stream temperature monitoring that he had done in the summer around the watershed. Temperature can be used as additional data to help inform this topic.

Rohde – I attended an fascinating session on groundwater dependent eco systems. There is interesting research being done using thermal imagery to map springs. There is some utility of using temperature to fill in data gaps.

Trotta – We have been using temperature as a tracer for groundwater-surface water interaction for years. It is a robust tool that can be used. In most applications it is usually more a focused study versus basin wide. New technology is coming out, it is worth considering.

GDE Grouping and Prioritization

Marcus presented a slide with guiding questions for the group and asked for initial input on the topics.

1) *Do we need to prioritize different GDEs?*
2) *How do we assign value to different vegetation classes?*
3) *Are there certain streams or stream reaches that should be prioritized for focusing SMC development and monitoring?*
4) *How do we select areas for additional monitoring?*

Questions/Comments

Rohde – Have you thought of grouping them into units first based on hydrogeologic setting? Associating polygons that are near each other and sharing same groundwater conditions – similar processes, easier to rank and monitor them?

Trotta – I have thought about it but not about how to implement it. It would be good to identify areas that have document groundwater level declines. Otherwise grouping based on hydrogeology could be a little challenging. The Bulletin 118 basins' mapping is similar hydrogeology in terms of superficial units, it may be difficult to parse them out that way.

Rohde – Well maybe not by hydrogeology but by location and habitat type? That would be my approach.

Rich – I think we could use some of the sub areas that were developed for the models. Some are based on hydrogeology and other groupings that might be helpful.

Trowbridge – One concern I have is that trees are a lagging indicator of groundwater depletion. What would be constrained are smaller trees and regeneration, and smaller vegetation. By using mature trees, you will miss the signal until it is too late.

Rohde – Yes, I echo Trowbridge's point. We need to maintain groundwater levels to ensure saplings survive. It is critical to ensuring the forests remain intact in the long term. It is key that groundwater needs to support spawning in future.

Lee – I appreciate the prioritization examples. Maybe there is a bit of a logic gap here. By choosing Steelhead streams we selected for high priority streams off the bat. But there are other streams that aren't Steelhead streams but that are fed by springs and have bugs and ecological value and

are dependent on groundwater. Maybe they aren't the high value ones, but they are groundwater dependent eco systems that have been selected in the process.

Pennington – In terms of David Manning's assessment, the most sensitive GDE are the streams, riparian vegetation, and then the oak woodland. My feeling for the oak woodland is that their rooting depths can change significantly, probably a little more resilient and cover a large area. Also, in terms of Steelhead streams, once the streams have been mapped, it would probably be good to stop labeling them as Steelhead streams. There is a framework, CA Environmental Flows Framework that relates different flow criteria and beneficial uses and functions.

Rohde – My colleague, Julie Zimmerman is co-leading that effort, if you are interested, I can put you in touch with her. I second the eco-system approach.

Trotta – We have been moving away from calling them Steelhead streams or Steelhead maps and changing it to Aquatic streams and maps. It is a change you will see going forward.

Pennington – In terms of grouping by stream, it would be useful to group them by what periods/seasons the different species exist in the streams.

Marcus Trotta said staff would send out the questions and PDFs of the maps for the group to review and consider and provide input, especially on prioritization of grouping. When staff receives your input, we will make additional adjustments and develop a draft narrative for the Advisory Committee and Surface Water Depletion workgroup. If needed, we can schedule another meeting to discuss remaining issues.

Marcus Trotta closed with a slide indicating next steps including: initial draft narrative describing process and how mapping will be used in GSP; develop draft assignment of ecological value; share maps and approach with Surface Water Depletion SMC workgroup; and compile list of prioritized recommended data collection activities.

Review Meeting Action Items

Marcus Trotta, Andy Rich and Rob Pennington thanked the attendees for their time, thoughts and interest.

Melissa Rohde asked if there would be a meeting on SMC for groundwater levels regarding groundwater dependent eco systems. Marcus Trotta said there is a separate workgroup meeting to discuss Interconnected Surface Water SMC. He said it would be great to get any thoughts from this group for developing the SMC for lowering groundwater levels and added that maybe we can loop this group into the discussions with the Advisory Committee.

Rob Pennington asked if draft SMC on chronic lowering of groundwater levels already been developed in all the basins.

Trotta – There have been some initial drafts of our proposed methodology, we are currently working on it and plan to bring it to the Advisory Committee in January.

Pennington – In discussions so far, have there been any conversations about the ecosystem?

Trotta – Most of the discussions have been about maintaining groundwater levels within or above historical ranges and making sure they stay above nearby wells. We did say we would revisit the SMC with information from groundwater eco system mapping but there hasn't been discussion yet on how it would be incorporated.

Attendees:

Jessie Maxfield, CA Department of Fish & Wildlife
Melissa Rohde, The Nature Conservancy (joined 3:10)
Rick Rogers, National Marine Fisheries Service
Robert Pennington, Permit Sonoma
Steve Lee, Sonoma Ecology Center
Wendy Trowbridge, Santa Rosa de Laguna Foundation

Staff/Presenters

Marcus Trotta, Sonoma Water
Andy Rich, Sonoma Water
Patrick Lei, Sonoma Water
Simone Peters, Sonoma Water (recording meeting notes)

Facilitator

Sam Magill, Sacramento State University – Consensus and Collaboration Program

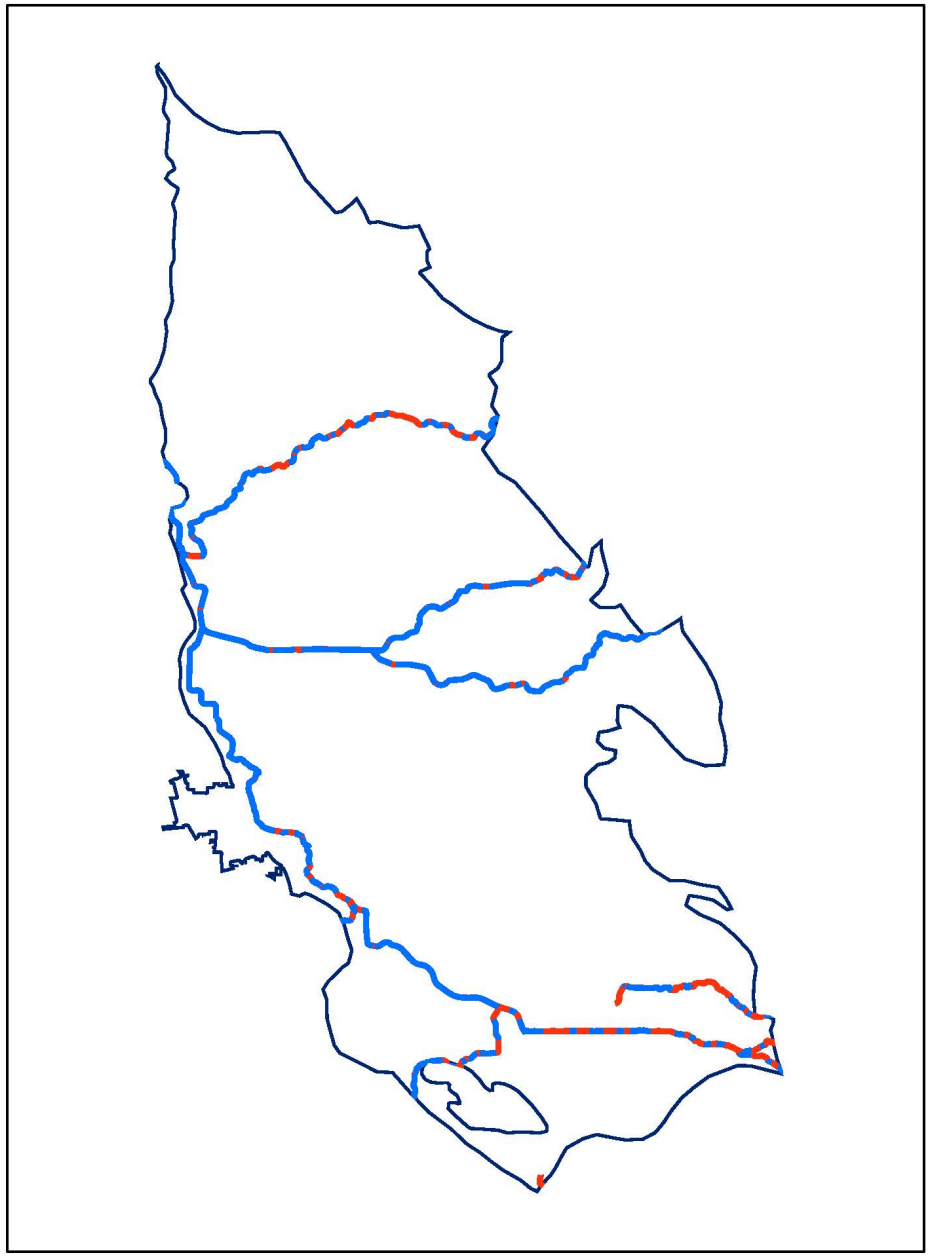
SANTA ROSA PLAIN • PETALUMA VALLEY • SONOMA VALLEY

GROUNDWATER SUSTAINABILITY AGENCIES

IDENTIFICATION AND MAPPING OF GROUNDWATER DEPENDENT ECOSYSTEMS

Workgroup Meeting #3

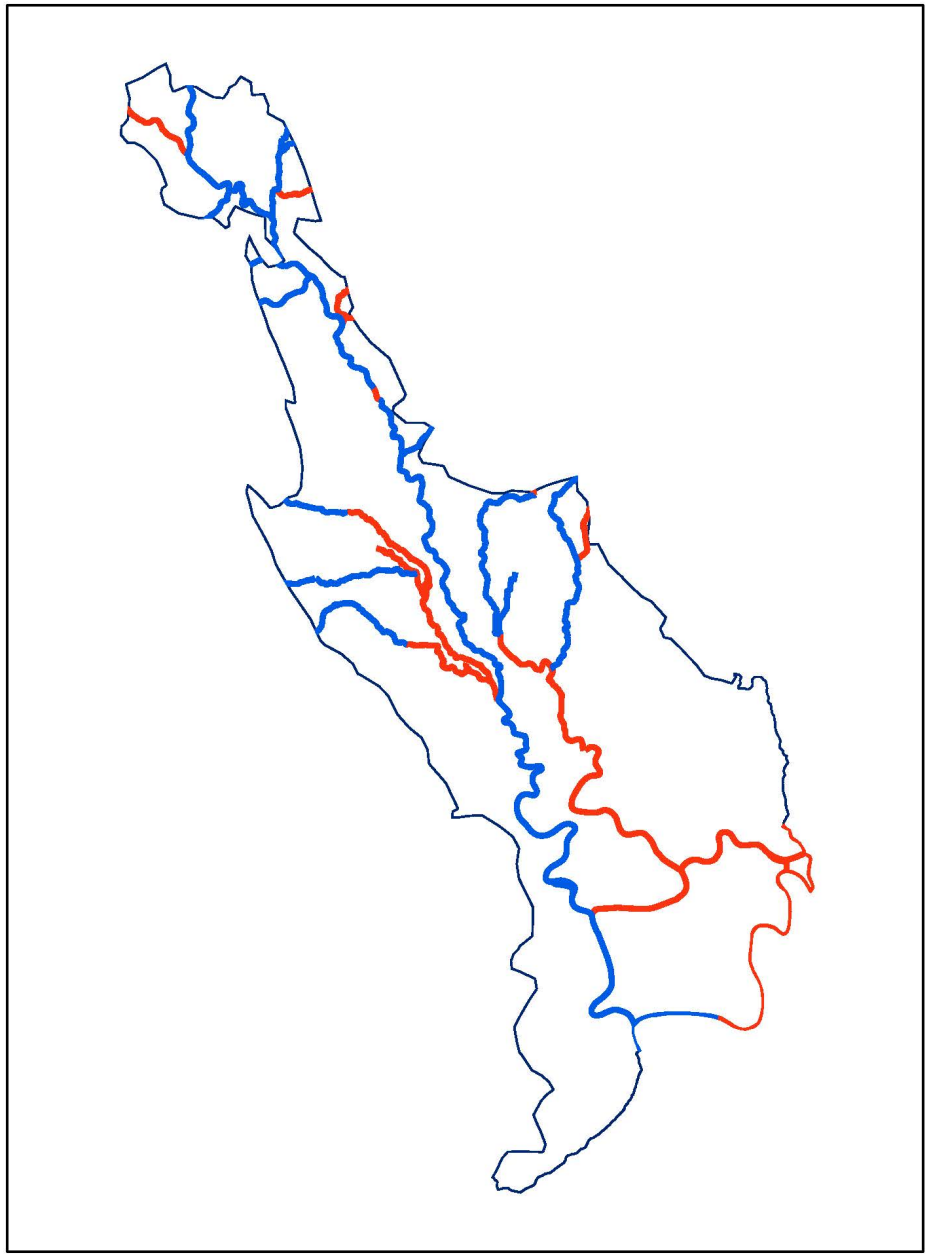
November 19, 2020



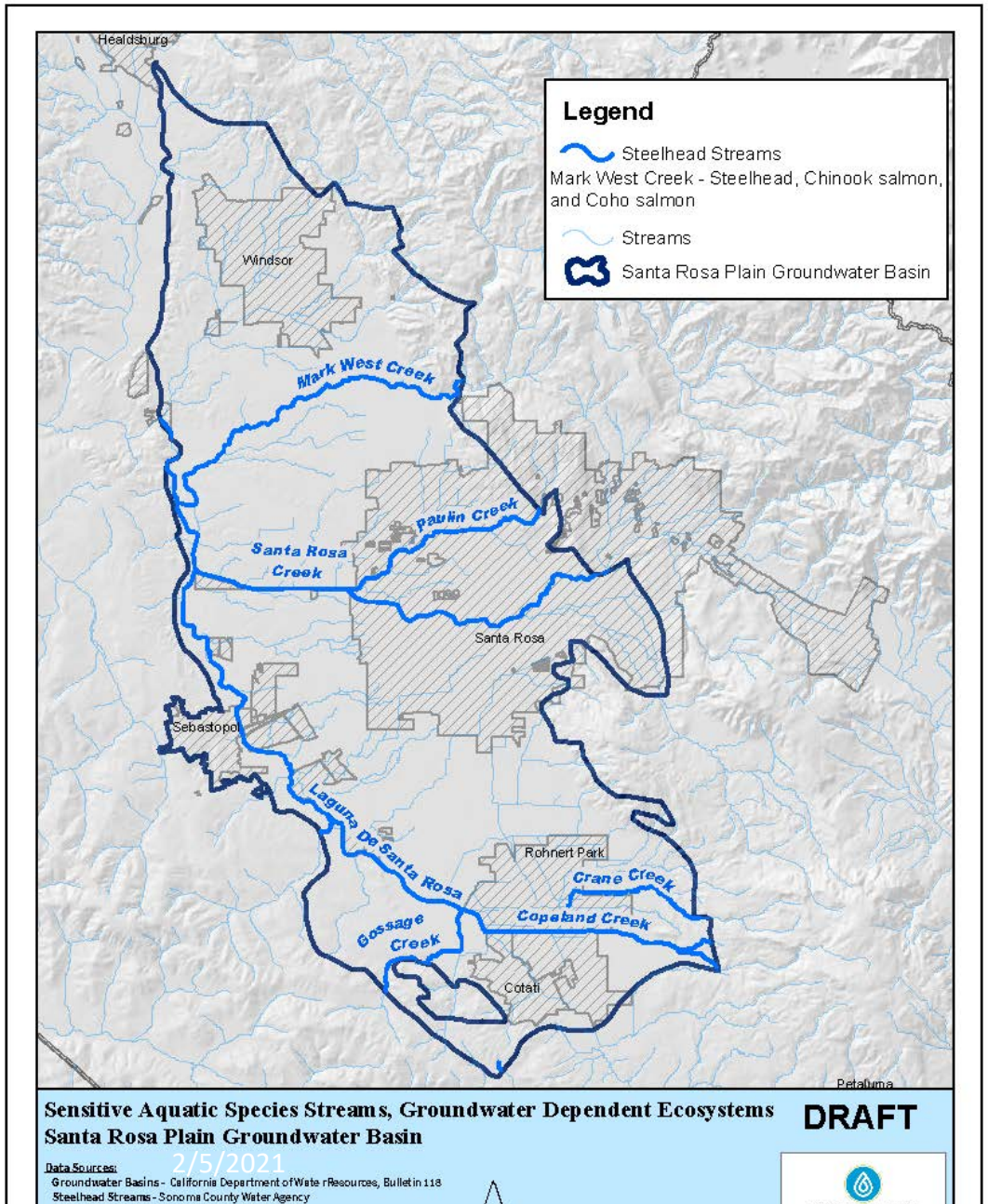
Sensitive Aquatic Species GDE Mapping Process (SRP and SV*)

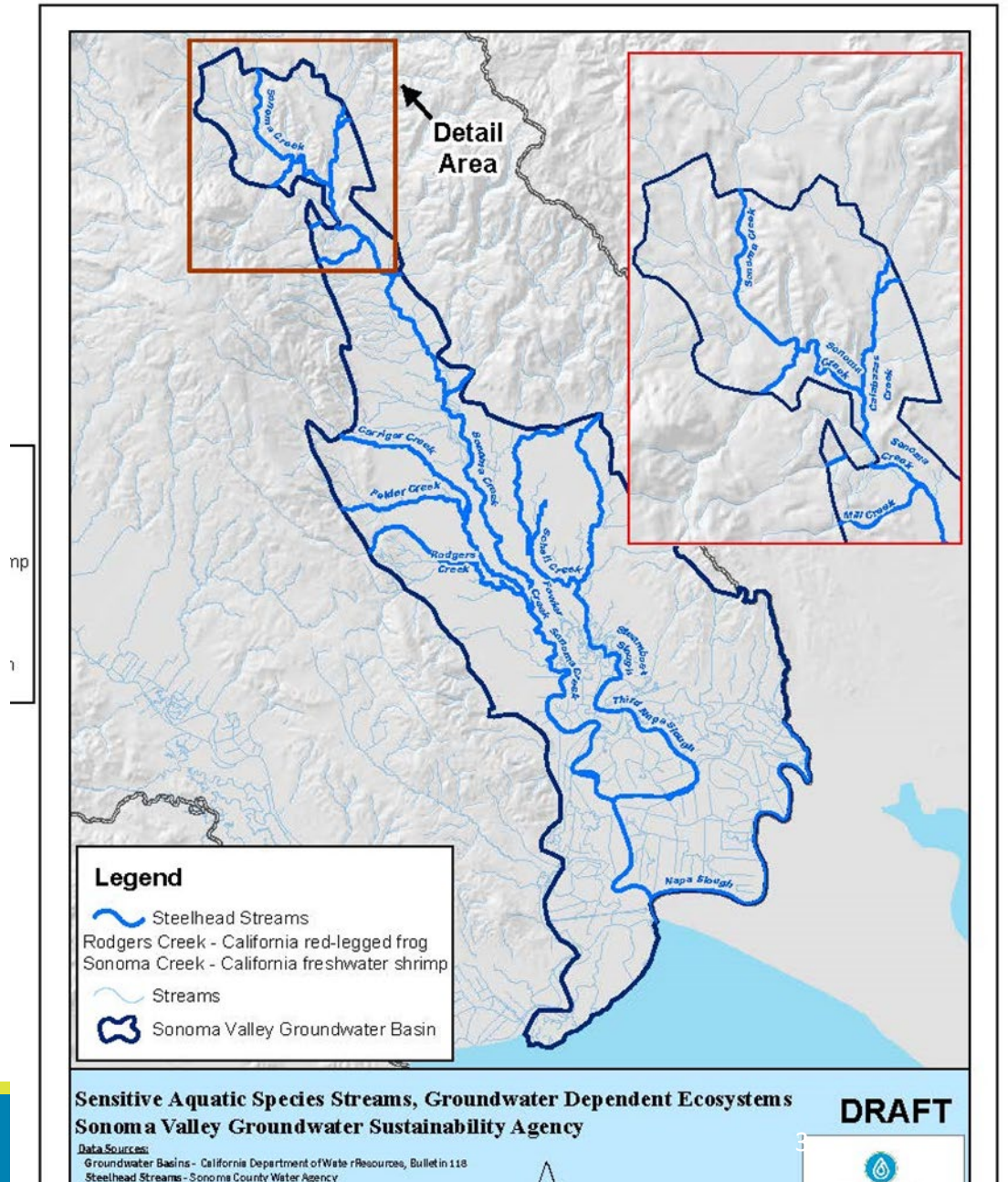
If any segment of a Sensitive Aquatic Species stream (**red**) intersects with mapped interconnected surface water (**blue**), entire reach of stream downstream of interconnected portion included as Sensitive Aquatic Species GDE.

*Petaluma Valley Interconnected Surface Water Mapping is pending completion

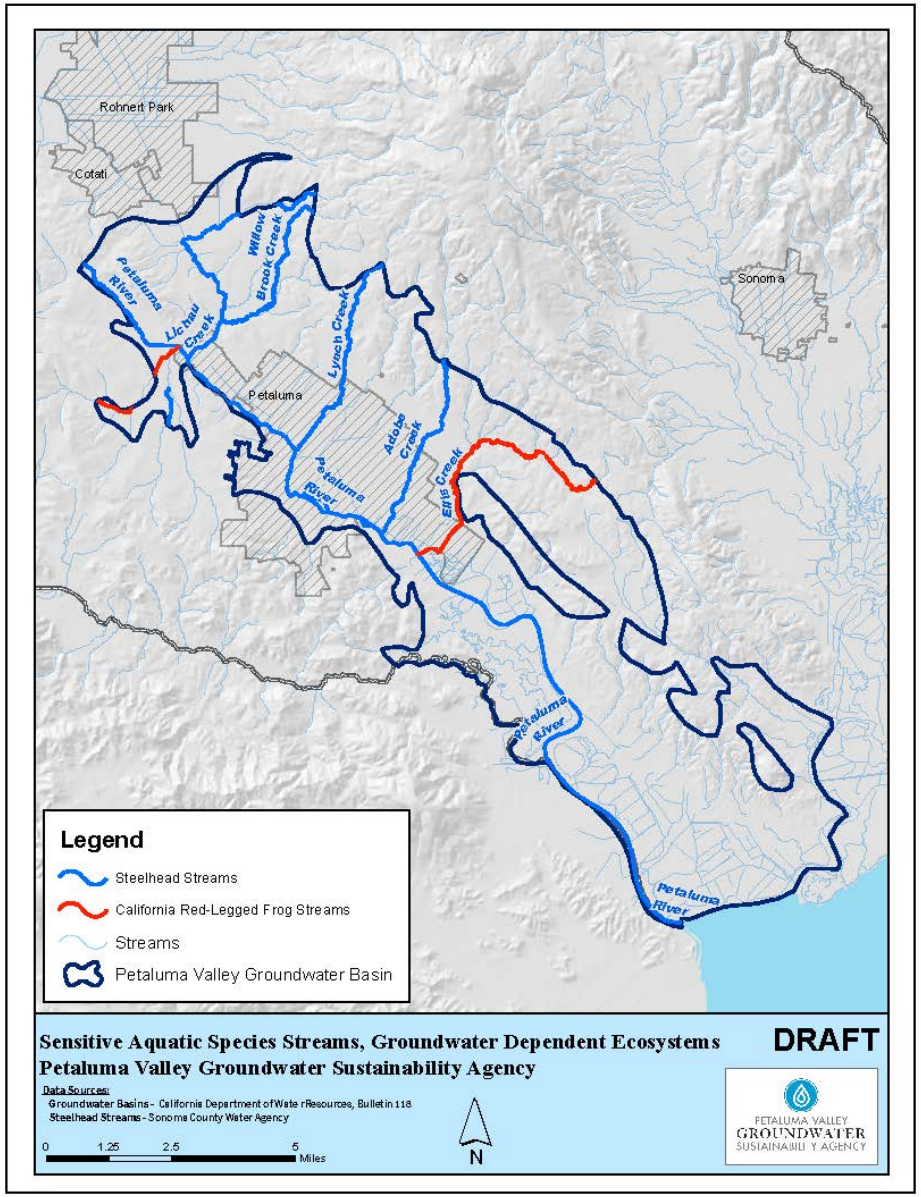


Updated Preliminary Aquatic Groundwater Dependent Species



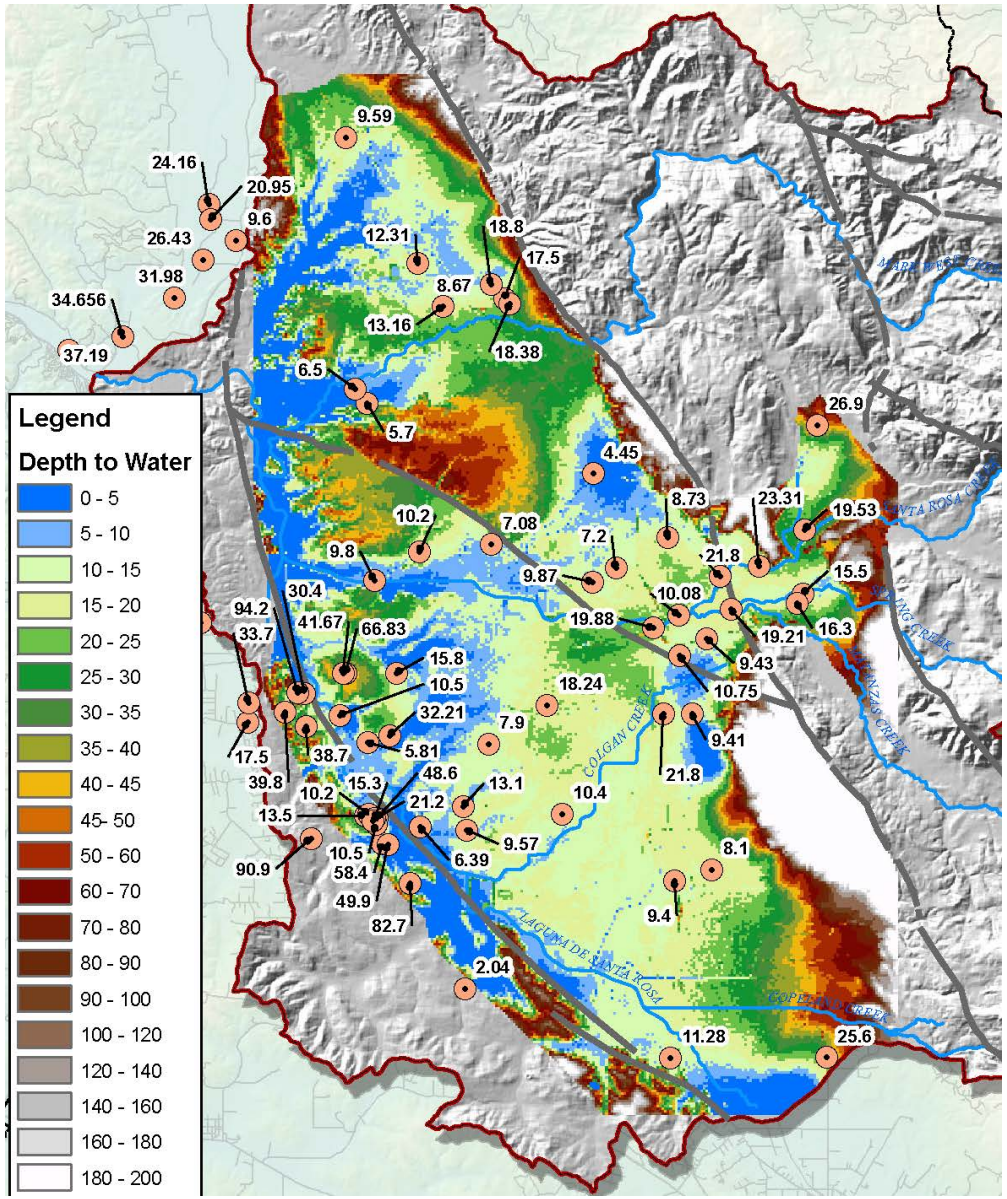


Updated Preliminary Aquatic Groundwater Dependent Species

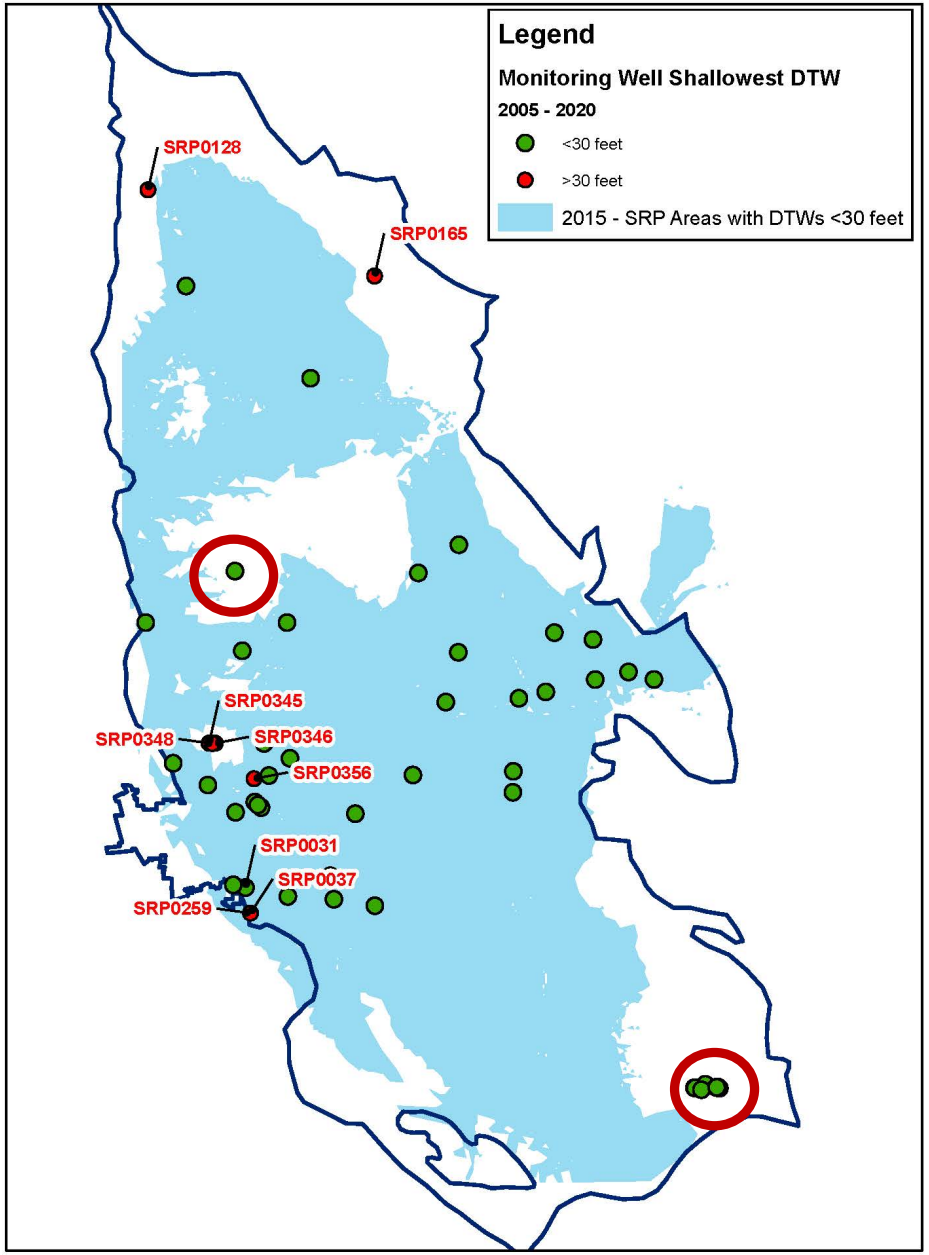


Petaluma Valley (draft pending mapping of ISW)

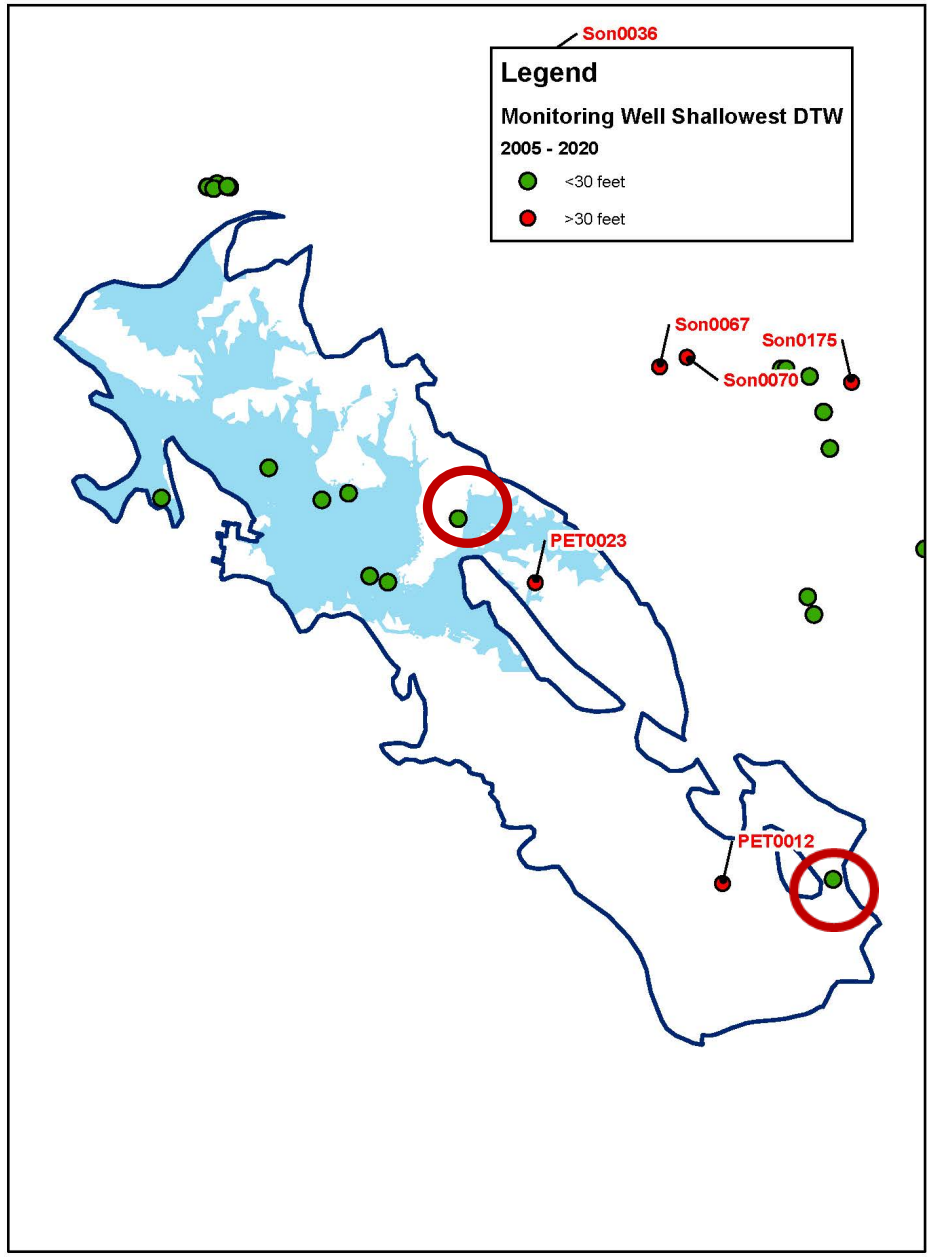
Vegetation Mapping Update (DTW maps)

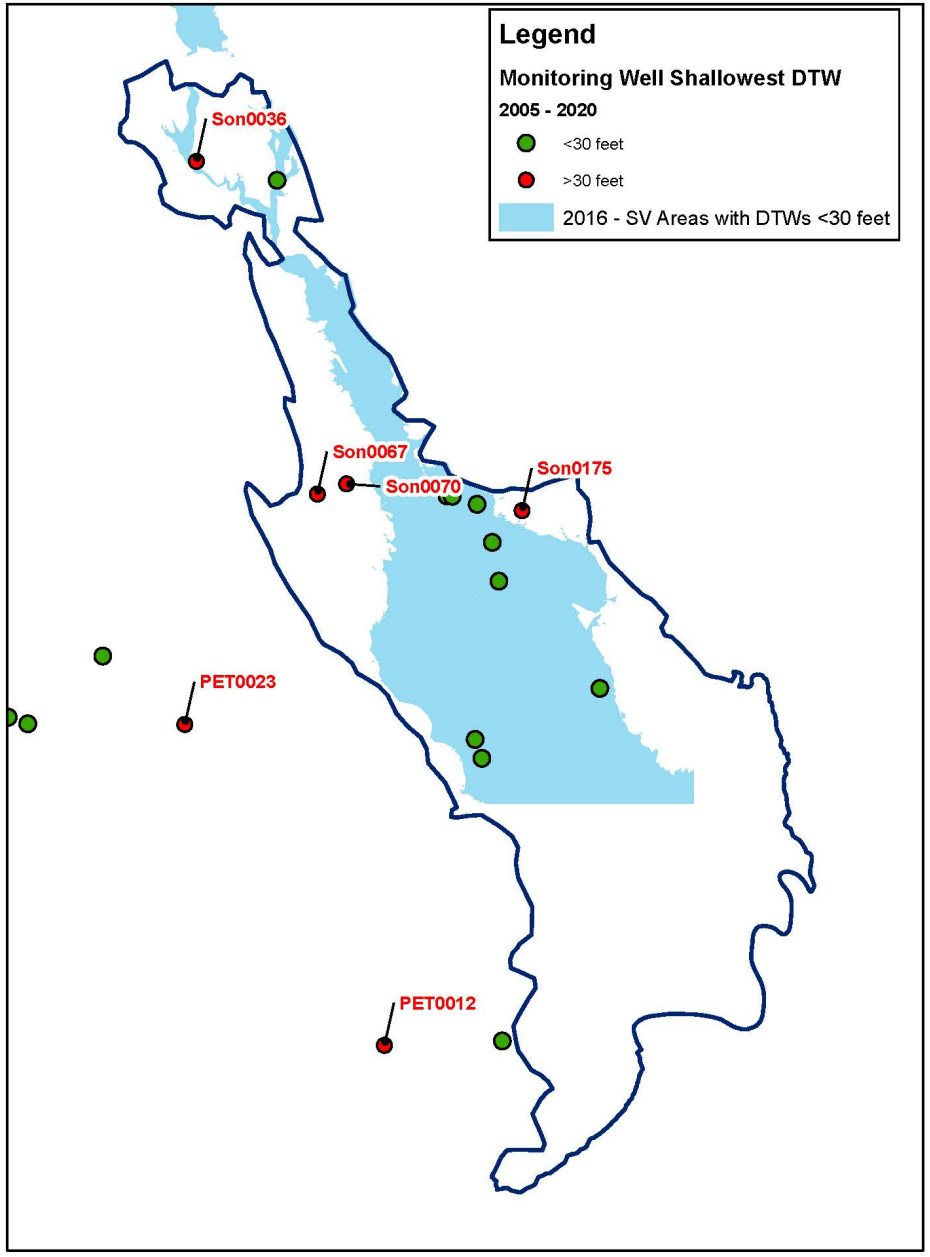


- Analyzed all availab groundwater-level data from 2005-202 for shallowest deptl to water on record for each well
- Identified a few are for further investigation and modification

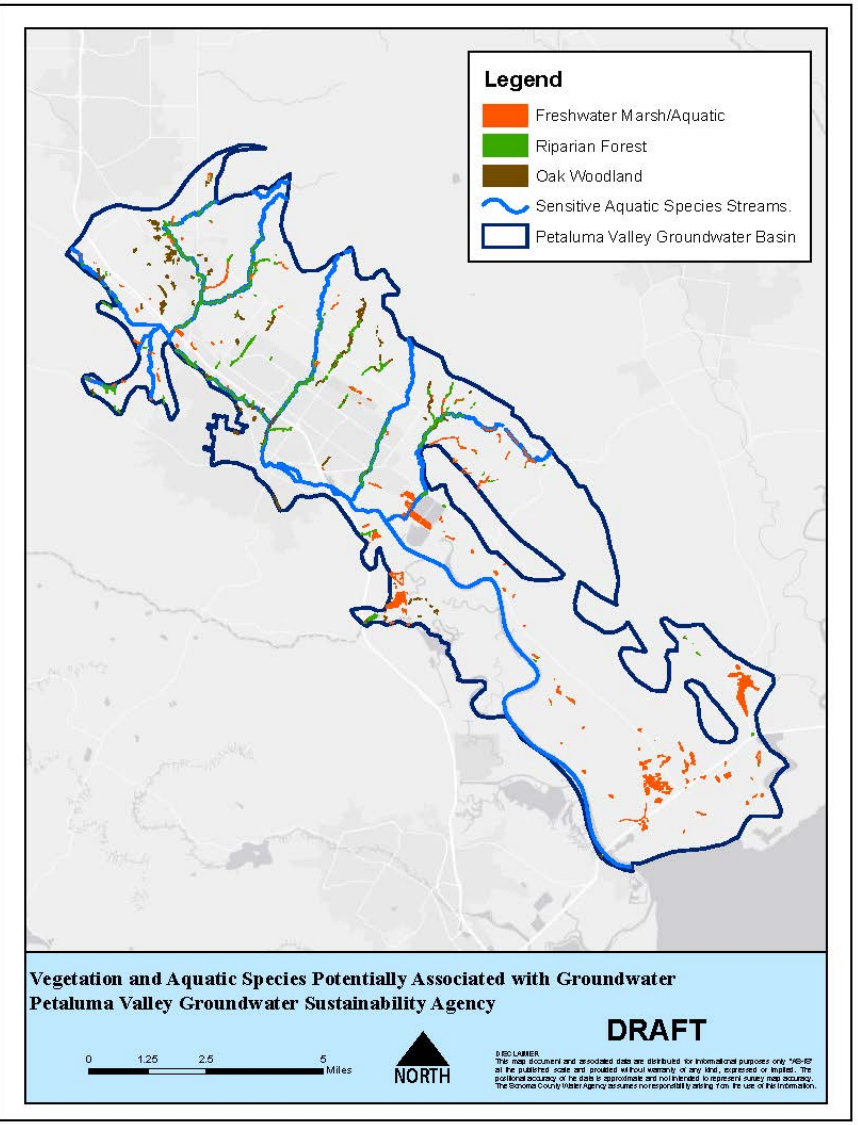


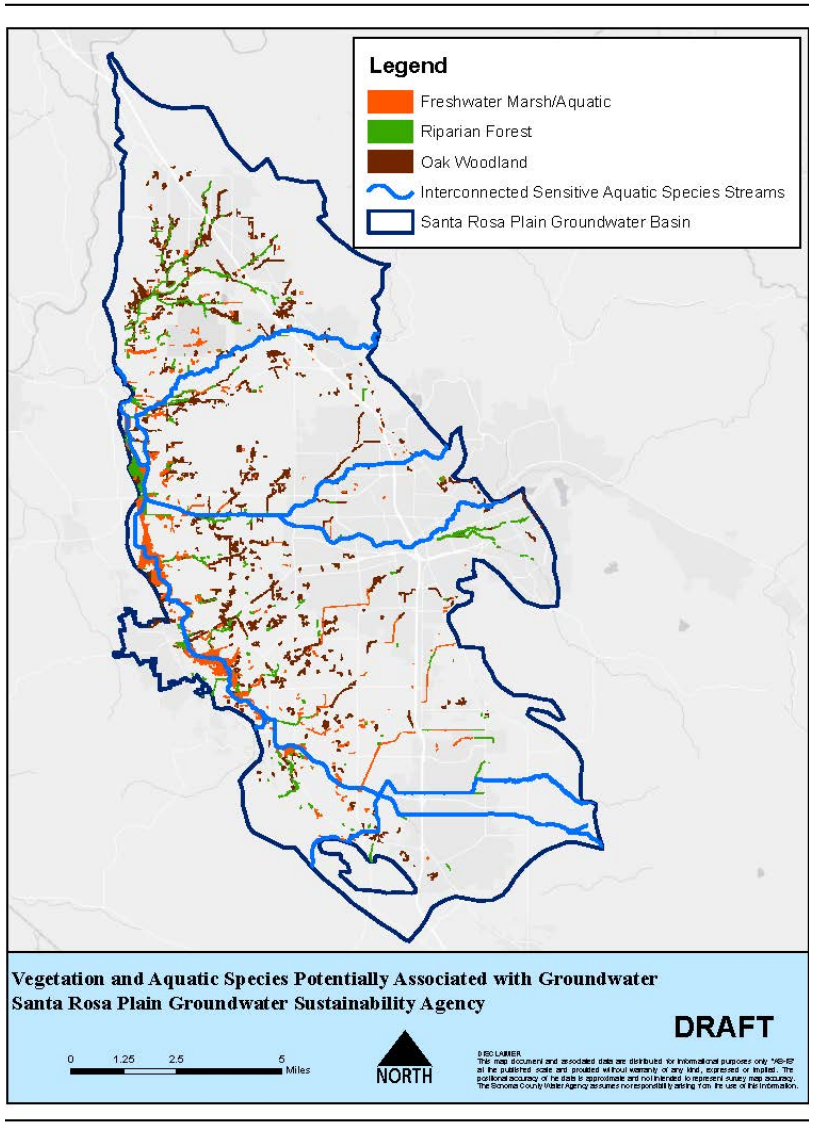
Vegetation Mapping Update (DTW maps)

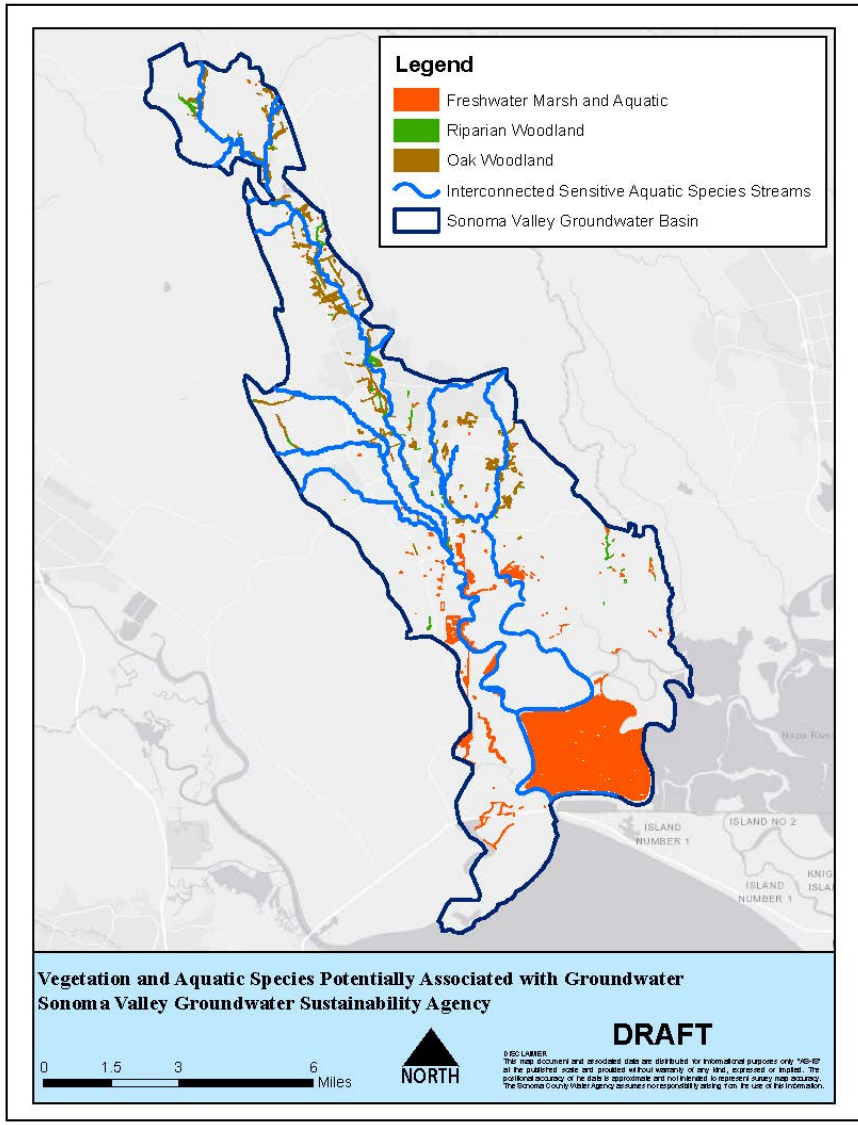


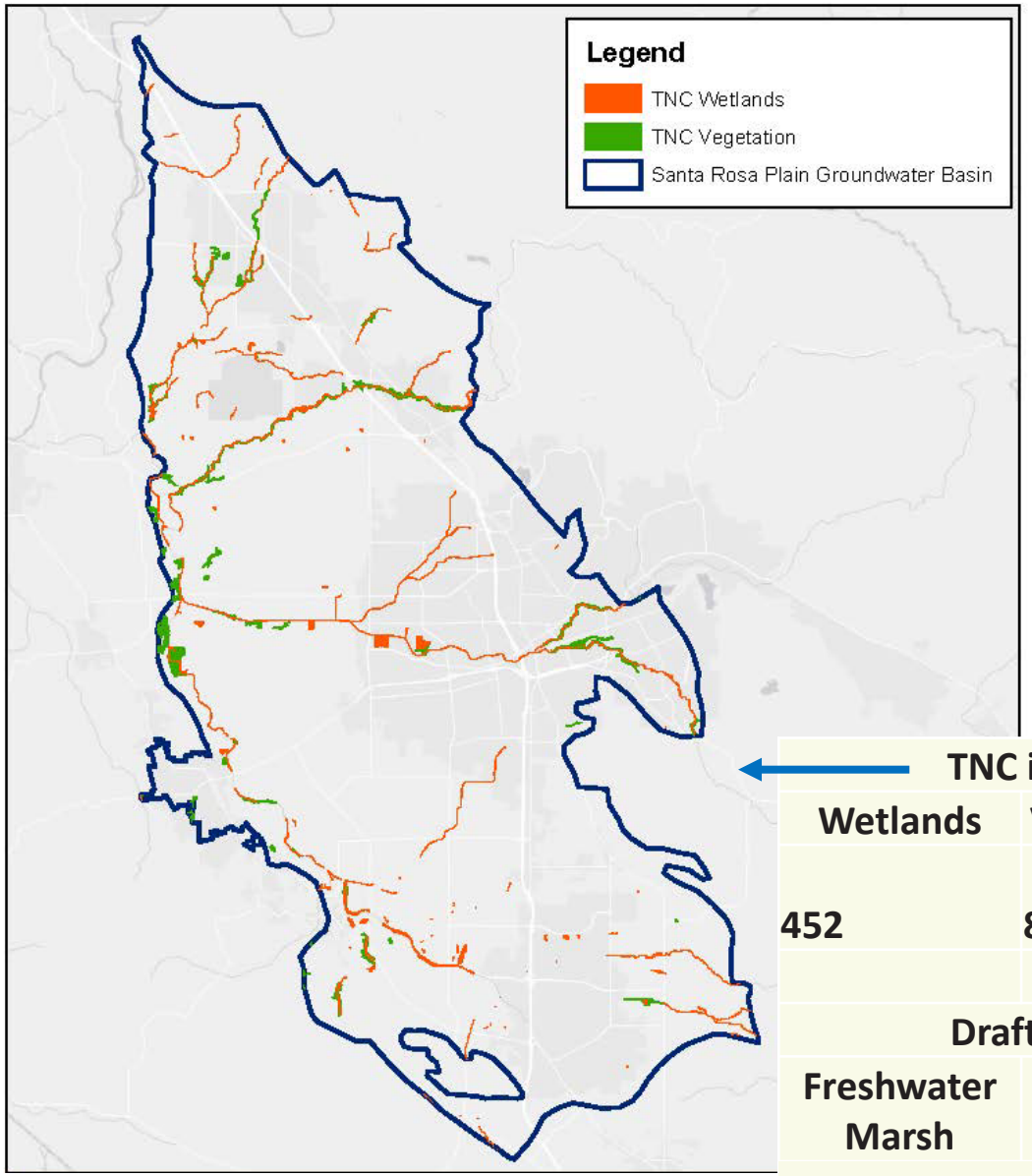


Draft Integrated Preliminary GDE Maps







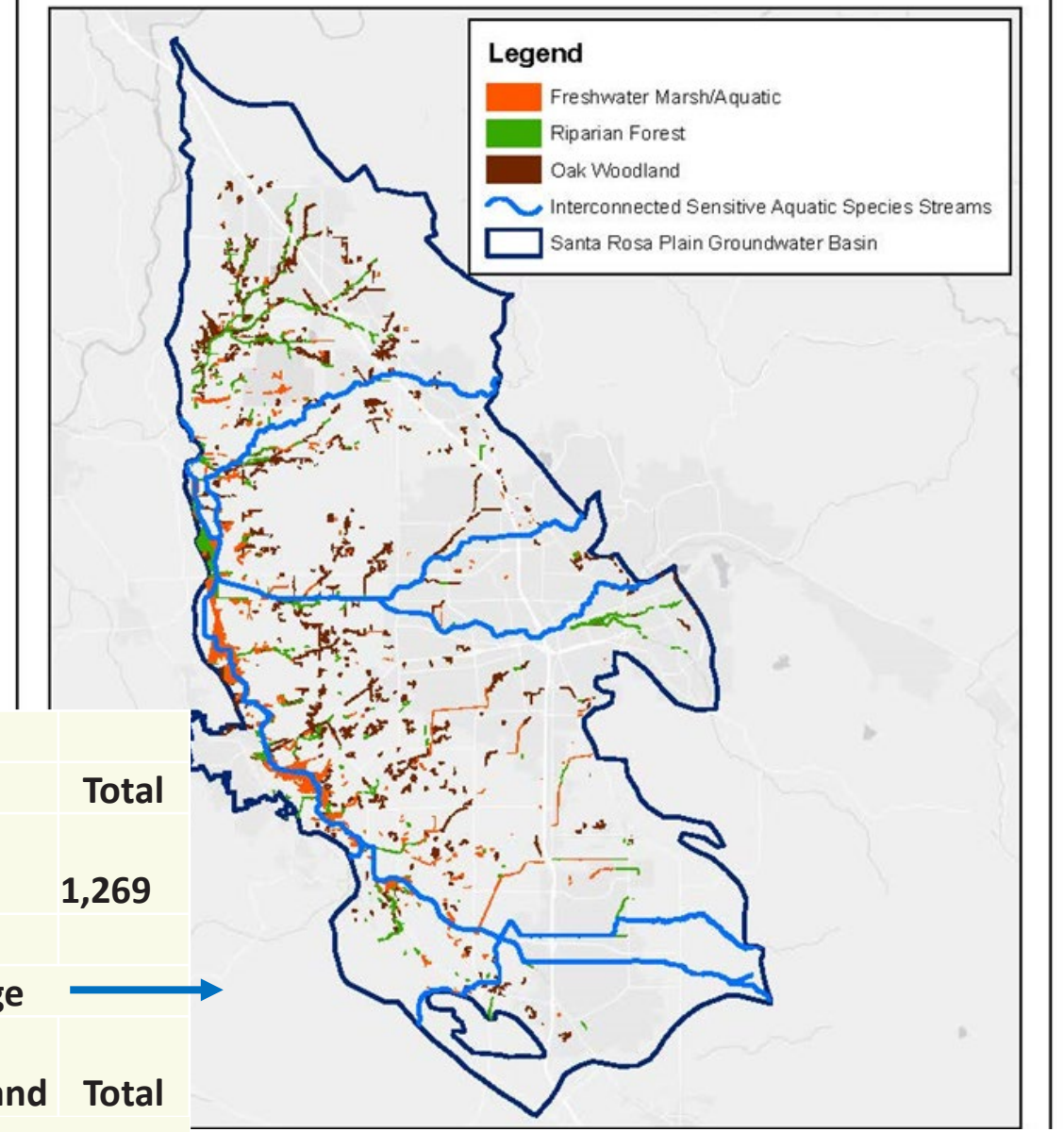


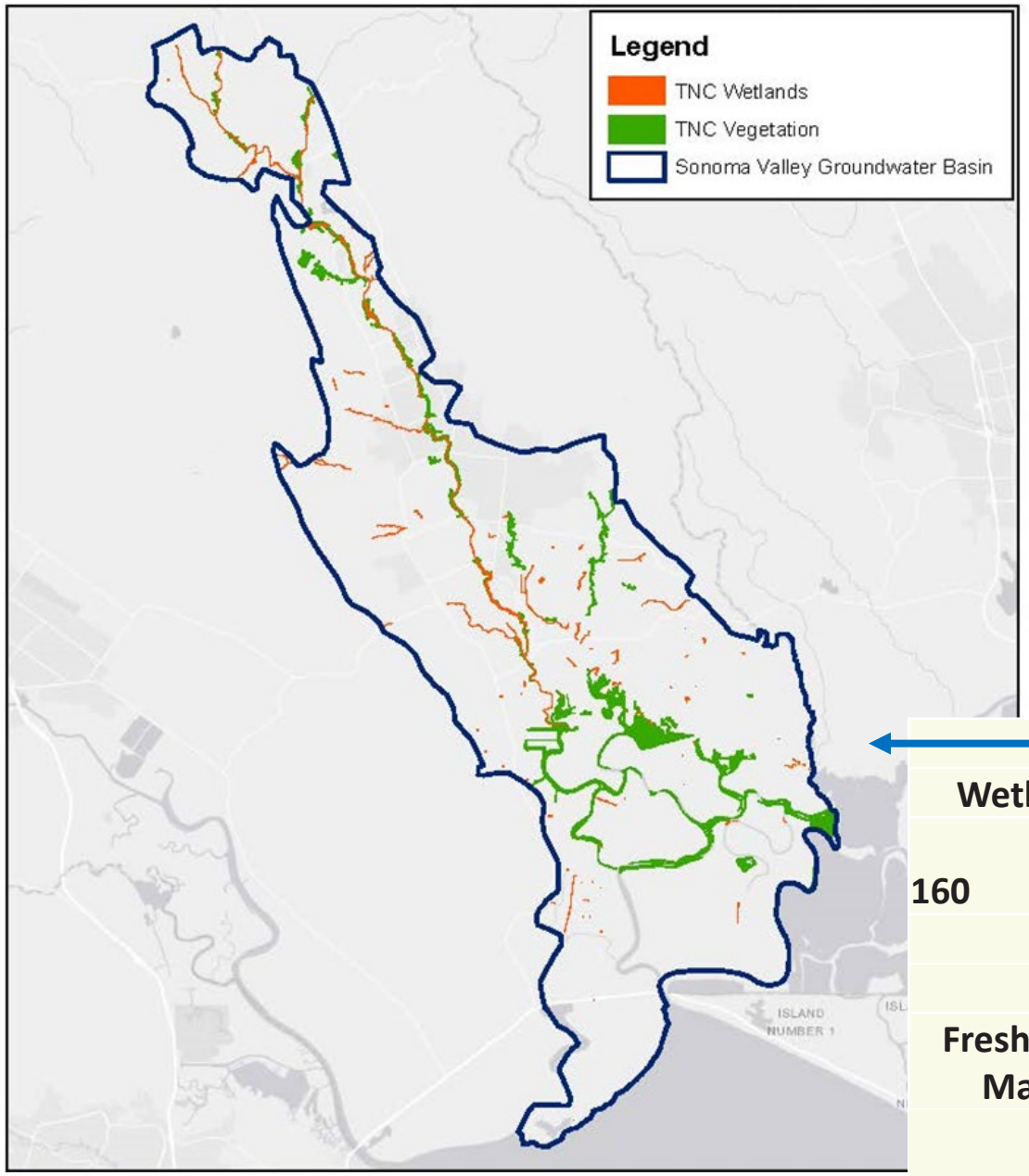
TNC iGDE Acreage

Wetlands	Vegetation		Total
452	817		1,269

Draft Prelim GDE Acreage

Freshwater Marsh	Riparian Forest	Oak Woodland	Total
952	1,152	1,710	3,813



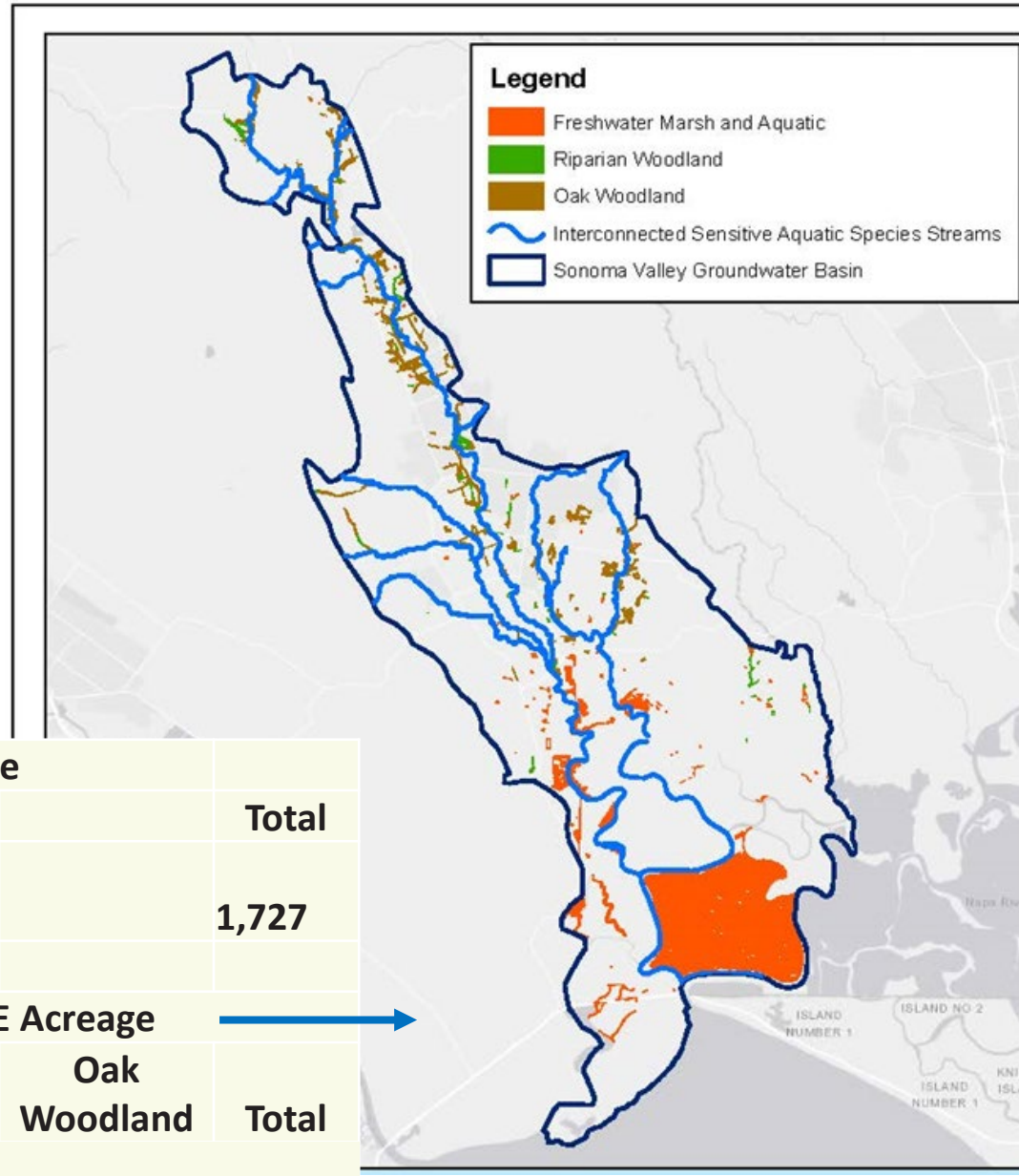


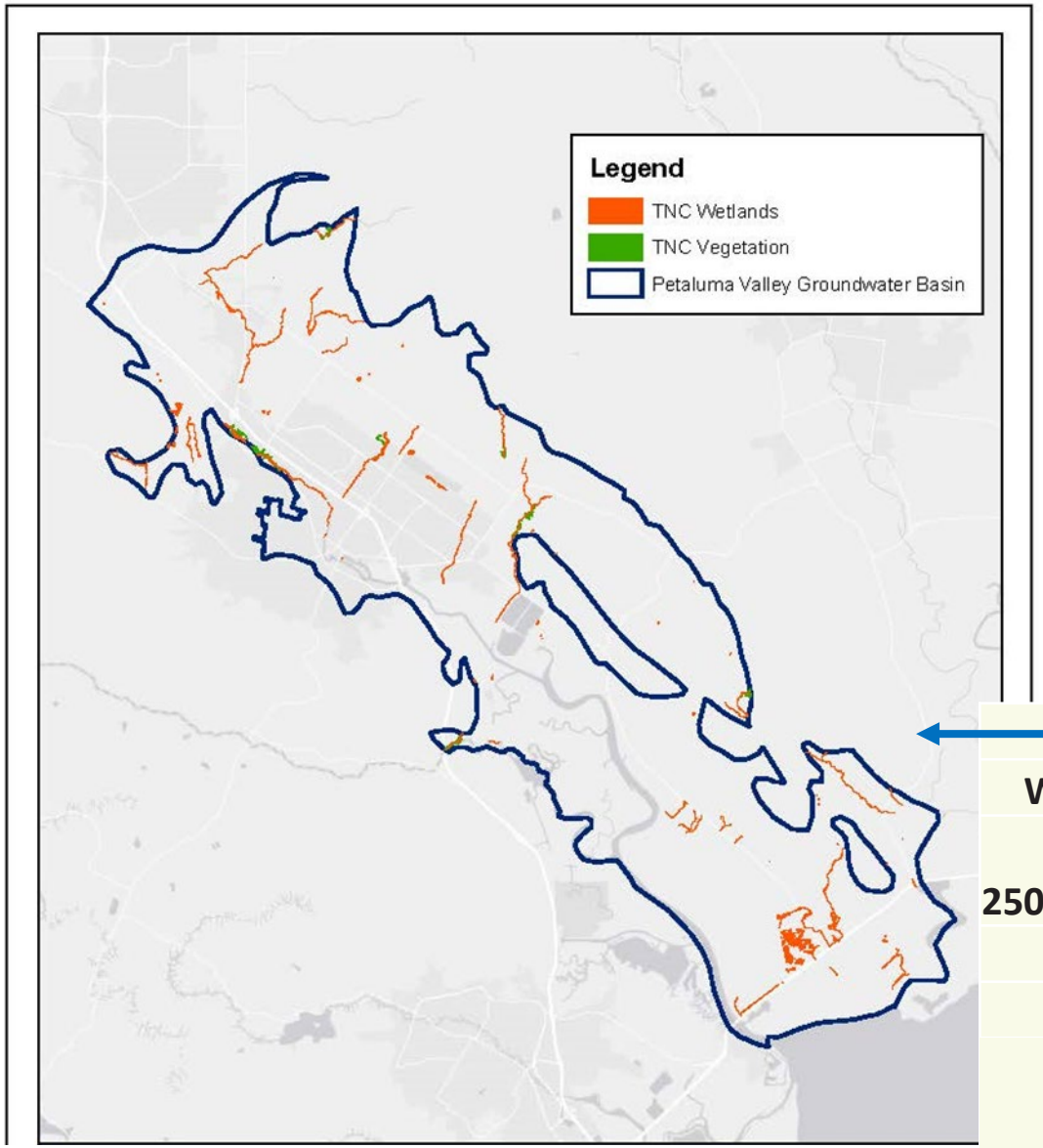
TNC iGDE Acreage

Wetlands	Vegetation		Total
160	1,567		1,727

Draft Prelim GDE Acreage

Freshwater Marsh	Riparian Forest	Oak Woodland	Total
	556	880	1,644



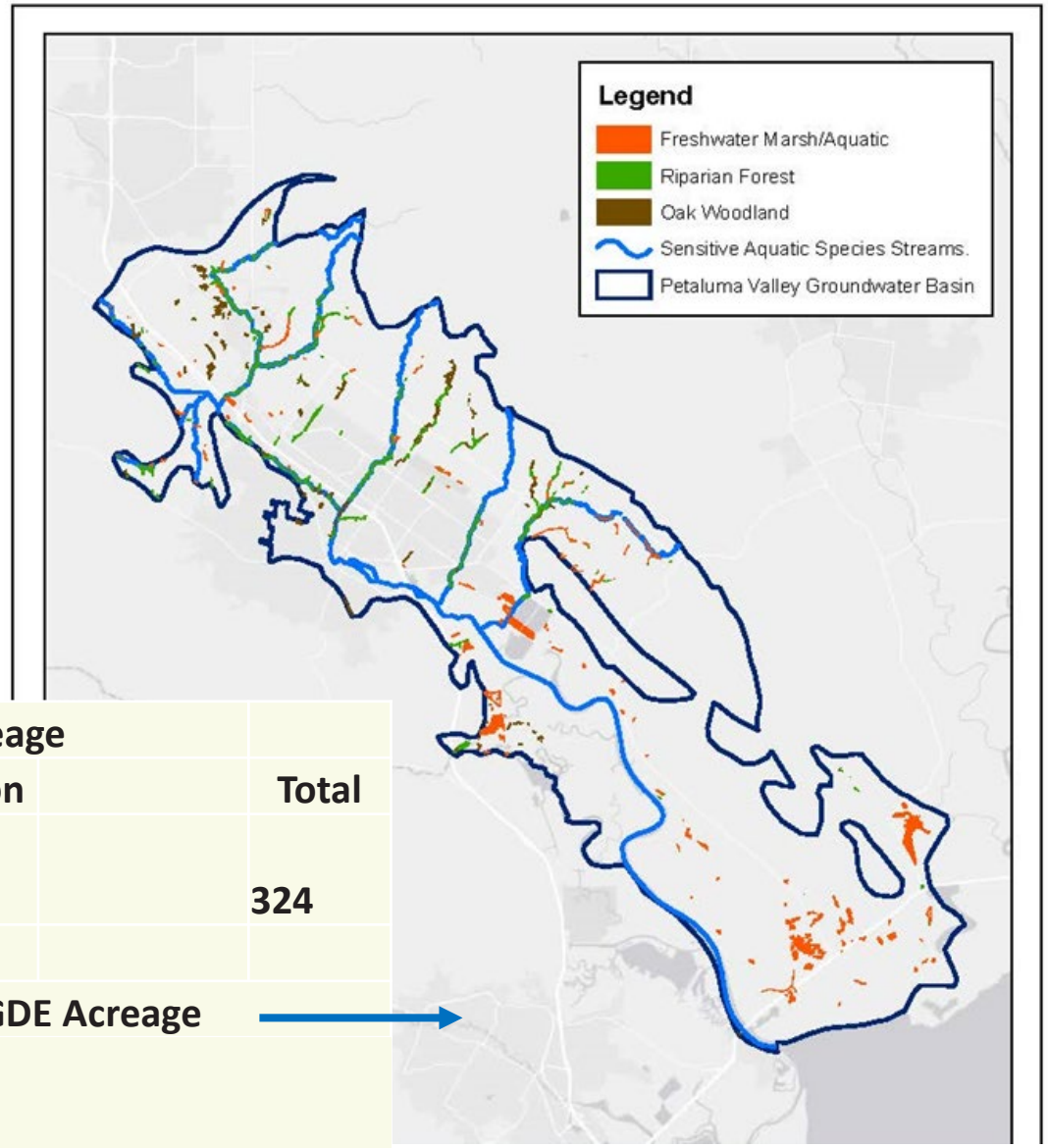


TNC iGDE Acreage

Wetlands	Vegetation		Total
250	74		324

Draft Prelim GDE Acreage

431	299	172	903



Recommendations for Additional Data Collection/Studies for GSP Implementation

- Are there additional monitoring needs for surface/groundwater interaction to better understand GDEs?
  - Shallow monitoring wells, stream gauges, seepage runs, etc.
- Are field verification surveys required to confirm maps?
- Are there certain GDE parameters that should be considered?
  - Rooting depths, Normalized Difference Vegetation Index (NDVI), etc.
- How should any recommended studies/monitoring be prioritized for GSP implementation?

Grouping/Prioritization of GDEs

- Do we need to prioritize different GDEs?
  - Steelhead/special status species?
  - Oak woodland vs. riparian?
- How do we assign value to different vegetation classes?
- Are there certain streams or stream reaches that should be prioritized for focusing SMC development and monitoring?
- How do we select areas for additional monitoring?

TNC Guidance for Assigning Ecological Value

High Ecological Value

- All or part of the GDE unit has been designated as having important significance by environmental agencies, by other laws, in international agreements, or by local GSA stakeholders
- Contains species that are entirely dependent on groundwater (obligate) for their survival, are extremely sensitive to environmental characteristics provided by groundwater, or are rare or unique.
- Contains species or ecological communities that are vulnerable to slight to moderate changes in groundwater discharge or groundwater levels that would result in a substantial change in their distribution, species composition, and/or health.

TNC Guidance for Assigning Ecological Value

Moderate Ecological Value

- The species or ecological communities within the GDE are not legally protected but may have been designated as a beneficial use and/or as having important significance by environmental agencies, local conservation plans, or local stakeholders.
- Contains mostly species that are partially dependent on groundwater (facultative).
- Contains species or ecological communities that are somewhat vulnerable to slight to moderate changes in groundwater discharge or groundwater levels that would result in some change(s) in their distribution, species composition, and/or health.

TNC Guidance for Assigning Ecological Value

Low Ecological Value

- The species or ecological communities within the GDE are not legally protected and have not been designated as having important significance by other environmental agencies, local conservation plans, or local stakeholders.
- Contains only species that are partially dependent on groundwater (facultative).
- Contains species or ecological communities that are not vulnerable to slight to moderate changes in groundwater discharge or water tables, resulting in minimal change(s) in their distribution, species composition, and/or health.

Next Steps

- Initial draft narrative describing process and how mapping will be used in GSP
- Develop draft assignment of ecological value
- Share maps and approach with Surface Water Depletion SMC Workgroup
- Compile list of prioritized recommended data collection activities

Appendix 4-D
Development of Sustainable Management Criteria of Interconnected Surface Water – Santa Rosa Plain

Development of Sustainable Management Criteria for Depletion of Interconnected Surface Water

Santa Rosa Plain Groundwater Sustainability Plan

Determination of Sustainable Management Criteria (SMCs) for depletion of interconnected surface water (ISW) by groundwater pumping is based on a methodology that uses shallow groundwater level (GWL) measurements as a proxy for surface water depletion by pumping at dedicated shallow monitoring wells installed at representative monitoring point (RMP) locations adjacent to ISW. The use of GWLs as a proxy for a rate or volume of surface water depletion relies on correlation between surface water depletion by pumping and shallow GWLs at RMP locations that is demonstrated using model simulations. Quantifying surface water depletion due to pumping is a challenge because (1) it cannot be measured directly and (2) the influence of surface water depletion by pumping is often obscured by other factors, such as precipitation and runoff, diversions, evapotranspiration, and natural groundwater/surface-water interactions. The specific approach for setting SMCs at individual RMP locations varies depending on historical GWL data availability at RMP locations or from adjacent wells. For some RMP locations, especially those with limited data, future changes to SMCs for this sustainability indicator will likely be needed as more data become available.

1 Selection of Depletion of Interconnected Surface Water RMPs

Groundwater elevations from 9 shallow monitoring wells located near streams in the Santa Rosa Plain are equipped with high frequency monitoring provided by dedicated pressure transducers. These monitoring wells provide location-specific groundwater level data on the distribution and timing of surface water-groundwater interconnectivity in the Subbasin (Figs. 1–2). Streambed elevations near each monitoring well were obtained from LiDAR datasets to compare with groundwater elevations and assess interconnectedness, as not all shallow wells have stream-surface water measurements near enough to assess the presence of gaining or losing conditions. One of the locations has multiple wells completed at different depths within the shallow aquifer system (SRP0715 and SRP0716; located along Santa Rosa Creek). Monitoring well SRP0716 was considered most representative for assessing interconnected surface water conditions for the shallow principal aquifer system at this location. Six of the 9 shallow monitoring wells were included as RMPs based on observed interconnection at these locations (Table 1). Two of the 9 locations were not included as RMPs due to lack of observed interconnection. Additional details of shallow monitoring wells near streams are included in Section 5.3 of the GSP.

2 Methodology for Demonstrating Correlation between Groundwater Levels and Surface Water Depletion

SGMA regulations define the metric for depletion of ISW as a volume or rate of surface water depletion by groundwater pumping. Since direct measurement of depletion of ISW by groundwater pumping is not possible, SGMA allows groundwater elevations to be used as a proxy for the volume or rate of depletion of ISW, provided significant correlation between groundwater elevations and depletion of ISW can be demonstrated. The methodology outlined below relies on groundwater modeling to demonstrate the correlation between shallow GWLs and depletion of ISW.

2.1 Modeling Framework for Isolating Impacts of Groundwater Pumping on Streamflow

Even though depletion of ISW by groundwater pumping cannot be measured directly, the volume or rate of depletion can be estimated with model simulations. To isolate the impact of depletion of ISW by groundwater pumping, a sensitivity approach was used by subtracting simulated streamflow outputs from two scenarios simulated with the Santa Rosa Plain Integrated Hydrologic Model. The general procedure is derived from Barlow and Leake (2012)[1] and is illustrated in Steps 1–2 in Fig. 3:

1. Simulate (a) a historical baseline scenario, which includes historical groundwater pumping, and (b) an identical historical baseline scenario, but remove historical groundwater pumping, i.e., a no-pumping scenario.
2. At each time step, subtract historical baseline simulated streamflow outputs from no-pumping scenario at each RMP location.

The resulting streamflow volume is an estimate of ISW depletion from groundwater pumping that occurred at all ISW locations upstream of each RMP location at each time step (e.g., as illustrated in Step 2 in Fig. 3). In effect, the volume of ISW depletion is the amount of additional streamflow volume at each RMP location if historical groundwater pumping had not occurred. Of course, the no-pumping scenario is outside the bounds of real-world conditions and is not presented as an aspirational goal for the basin, but instead provides a means to estimate the relative magnitude of ISW depletion over time and across locations. Simulated differences in streamflow for pumping and no-pumping scenarios are shown for all RMPs in Figs. 4–10.

While the Santa Rosa Plain Integrated Hydrologic Model offers a robust platform to evaluate potential impacts of surface water depletion by groundwater pumping, there are significant uncertainties related to this approach. Namely, the no-pumping scenario outlined above is a substantial simplification that (1) does not differentiate between wells accessing surface water underflow from wells accessing groundwater and does not account for potential changes in surface water demand that may occur in the absence of groundwater pumping, and (2) simulates conditions outside of the calibrated range of the model. These additional uncertainties compound the uncertainties and simplifications inherent to the calibrated model itself. Despite these limitations, this analysis is especially useful for evaluating the relative magnitudes of surface water depletion between RMPs and through time.

2.2 Demonstrating Correlation between Groundwater Levels and Surface Water Depletion at RMP Locations

To evaluate the correlation between surface water depletion from groundwater pumping and shallow groundwater levels at RMP locations, this methodology focused on a 15-year simulation period from 2004–2018 representing recent historical groundwater pumping conditions in the basin. Surface water depletion was estimated at each RMP location as the percent decrease in minimum monthly simulated streamflow during the July-September period at the corresponding SFR cell for each year during 2004–2018. The corresponding shallow groundwater level was estimated as the minimum monthly simulated groundwater level in model layer 1 at each RMP location during the July–September period for each year. Correlation was determined with linear regression and evaluated using the coefficient of

[1]

determination (R-squared). R-squared values greater than 0.60 were determined to be sufficiently correlated. R-squared values for each RMP location are summarized in Table 1. Correlation between surface water depletion from groundwater pumping and shallow groundwater levels is illustrated in Step 3 in Fig. 3 and is shown for each RMP location in Figs. 11–17.

Two RMP locations (SRP0713, SRP0714; Figs. 15–16) showed poor simulated correlation between surface water depletion from groundwater pumping and shallow groundwater levels (R-squared values less than 0.60). Groundwater-level proxy SMC values were still set for these RMP locations because poor correlation at these sites was attributed to poor process representation in the model at these RMP locations rather than insufficient hydrologic connection between surface water and shallow groundwater levels. Shallow groundwater levels at these sites are close to the streambed elevation and show response to fluctuations in surface water stage, indicating hydrologic connection between surface water and shallow groundwater levels. As outlined in subsequent Section 3.3, future improvements in the model will focus on improving process representation at these RMP locations.

3 Methodology for Determining Minimum Thresholds and Measurable Objectives for Depletion of Interconnected Surface Water at RMPs

Prior to setting SMCs for individual RMP locations, basin-wide yearly estimates of surface water depletion by groundwater pumping were assessed by evaluating surface water depletion at the basin's outlet (USGS gage 1146800, Mark West Creek at Mirabel Heights; Fig. 1–2), thereby aggregating all surface water depletion that occurs upstream within the SRP basin. Daily average simulated streamflow for pumping/no-pumping scenarios at the basin outlet are shown in Fig. 18, and annual dry-season surface water depletion estimates for 2004–2018 are shown for the basin outlet in Fig. 19.

Based on input from the Depletion of Interconnected Surface Water Work Group, as well from the SRP Advisory Committee and Board, it was determined that MT values at RMP locations should be sufficiently protective so as to not exceed the average, basin-wide, dry-season (July–September) surface water depletion from pumping that occurred during the three years with the greatest depletion over the 2004–2018 evaluation period. As shown in Fig. 19, the three years with the greatest simulated depletion were 2014, 2015, and 2016. Accordingly, the resultant MT is more protective than if the MT were chosen to reflect the single year with the greatest depletion.

The methodology for setting MT values using groundwater-level proxies relies on the correlation between simulated surface water depletion from groundwater pumping and simulated shallow groundwater levels at each RMP location (Figs. 11–17). To set the groundwater-level proxy MT value equivalent to the average dry-season surface water depletion from pumping that occurred during 2014–2016, the average percentile ranking of simulated groundwater levels during 2014–2016 is first determined at each RMP location (e.g., 10th percentile groundwater level for RMP SRP0709; Fig. 12). These values are summarized for each RMP location in Table 1.

3.1 Methodology for Determining Groundwater-Level Minimum Thresholds at RMP Locations

3.1.1 Substituting Groundwater-Level Minimum Threshold Percentile Ranking Value from Adjacent Well(s)

To set the groundwater-level proxy MT value at each RMP location, the method relies on evaluating the resultant percentile ranking for each RMP (Table 1) using available observed historical dry-season low groundwater levels during 2004–2020. However, the dedicated shallow monitoring wells at RMP locations were installed in fall 2019, so there is presently insufficient data to directly evaluate the percentile-ranking of historical dry-season groundwater levels at these dedicated wells. Instead, the MT percentile ranking is evaluated at an adjacent well with a longer period of record, and the resultant MT value is then translated to the dedicated RMP well using the position of the MT value relative to measured 2019 and 2020 dry-season groundwater levels (i.e., match points). This procedure is illustrated in Step 4 in Fig. 3. For locations with multiple adjacent wells, the average position of the MT value for those multiple wells relative to 2019 and 2020 dry-season groundwater levels is used. MT values for RMP wells that use the match-point methodology are summarized in Table 1 and are shown in Figs. 20–36. The relationship between RMP wells and adjacent wells that use the match-point methodology is given in Tables 2–6.

3.1.2 Determining Groundwater-Level Minimum Threshold from Approximate Streambed Elevation

For RMP wells that do not have adjacent wells with a sufficiently long period of record to use as a substitute MT, groundwater-level proxy MT values were set at an elevation to maintain the observed local gradient between groundwater levels and streambed elevation, so as to maintain historical gaining/losing conditions. For RMP SRP0714, the MT value was set as 1 ft. above the approximate streambed elevation, so as to maintain observed gaining conditions (Table 1; Fig. 35). Similarly, for RMP SRP0716, the MT value was set to 1 ft. below the observed streambed elevation, so as to maintain observed interconnection (Table 1; Fig. 36).

3.2 Methodology for Determining Groundwater-Level Measurable Objectives at RMP Locations

Based on input from the Depletion of Interconnected Surface Water Work Group, as well as from the SRP Advisory Committee and Board, it was determined that MO values at RMP locations should maintain the observed average dry-season surface water depletion from pumping that occurred during the years with available observations during 2004–2020. Accordingly, MO values at each RMP are set to reflect average dry-season observed groundwater levels during the years with available observations during 2004–2020. MO values for each RMP are summarized in Table 1 and are shown in Figs. 20–36.

3.2.1 Transferring Groundwater-Level Measurable Objective Percentile Ranking Value from Adjacent Wells

Since the dedicated shallow monitoring wells at RMP locations were installed in fall 2019, there is limited data to directly estimate the average dry-season groundwater levels during 2004–2015 at these dedicated wells. Similar to setting MT values, the groundwater-level proxy MO value at each RMP location relies on evaluating the average dry-season groundwater level at an adjacent well with a longer period of record, and then translating the MO value to the dedicated RMP well using the position of the

MO value relative to measured 2019 and 2020 dry-season groundwater levels (i.e., match points). For locations with multiple adjacent wells, the average position of the MO value for those multiple wells relative to 2019 and 2020 dry-season groundwater levels is used. MO values for RMP wells that use the match-point methodology are summarized in Table 1 and are shown in Figs. 20–34. The relationship between RMP wells and adjacent wells that use the match-point methodology is given in Tables 2–6. For RMP locations without adjacent well data (SRP0714 and SRP0716), the MO is set as the average of 2019 and 2020 dry-season groundwater levels at the dedicated RMP well (Table 1; Figs. 35–36).

3.3 Future Methodology for Determining Groundwater-Level Minimum Thresholds and Measurable Objectives at RMP Locations with Sufficient Groundwater Level Period of Record

Once a sufficient period of record of groundwater level observations is established at each dedicated RMP monitoring well (i.e., at or before the 5-year update), the methodology for setting MT and MO values will be modified to establish the MT and MO approaches directly to observed groundwater levels at each dedicated RMP well, rather than relying on adjacent wells with a longer period of record. Additionally, the groundwater level percentile ranking for each RMP location may be modified once improvements are made to the model that more accurately simulate groundwater/surface-water interactions and depletion of interconnected surface water by groundwater pumping.

4 Figures

4.1 Site Overview

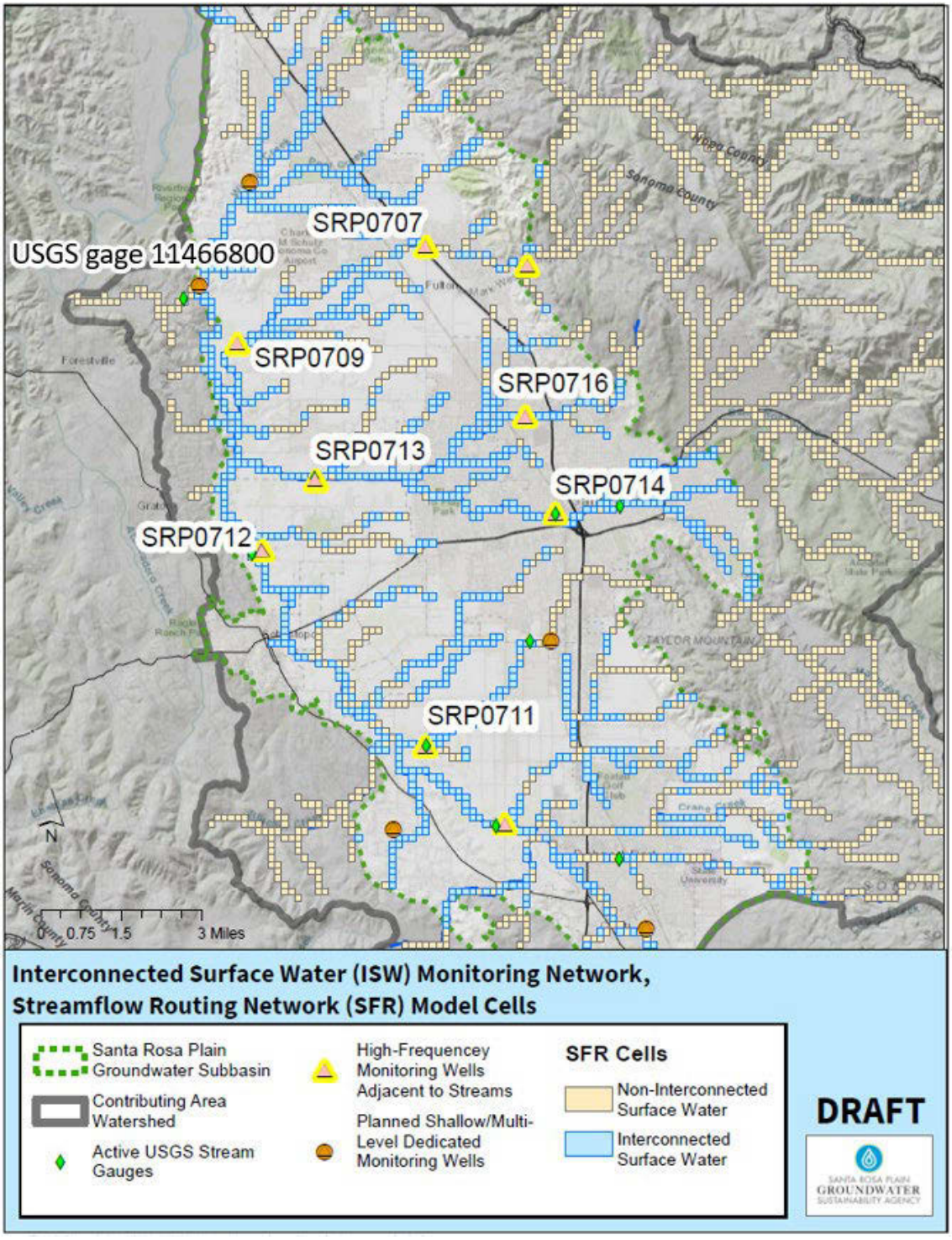


Figure 1: Santa Rosa Plain depletion of interconnected surface water RMP locations along with streamflow routing network cells identified as interconnected surface water.

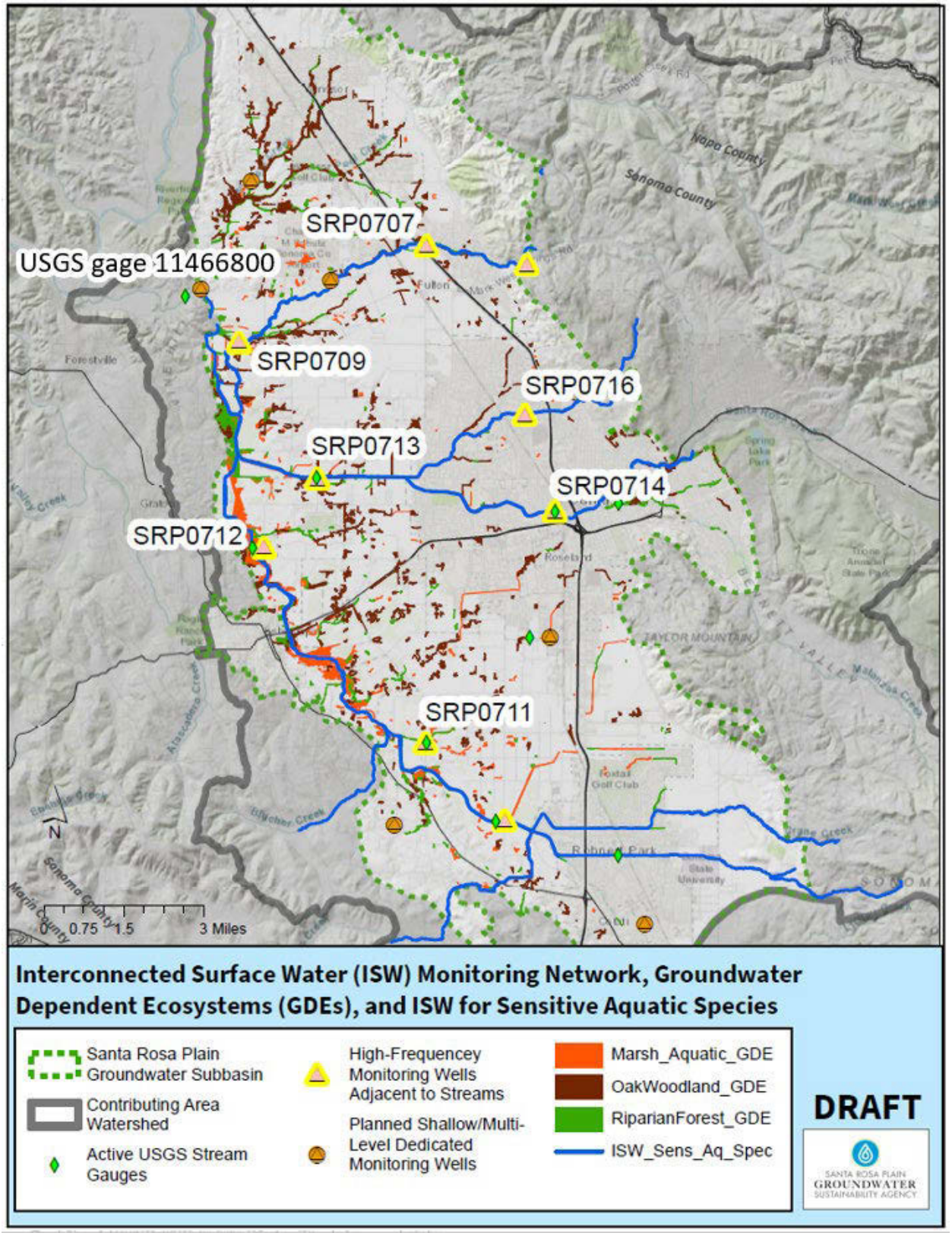


Figure 2: Santa Rosa Plain depletion of interconnected surface water RMP locations along with mapped GDE locations.

4.2 Methodology Overview

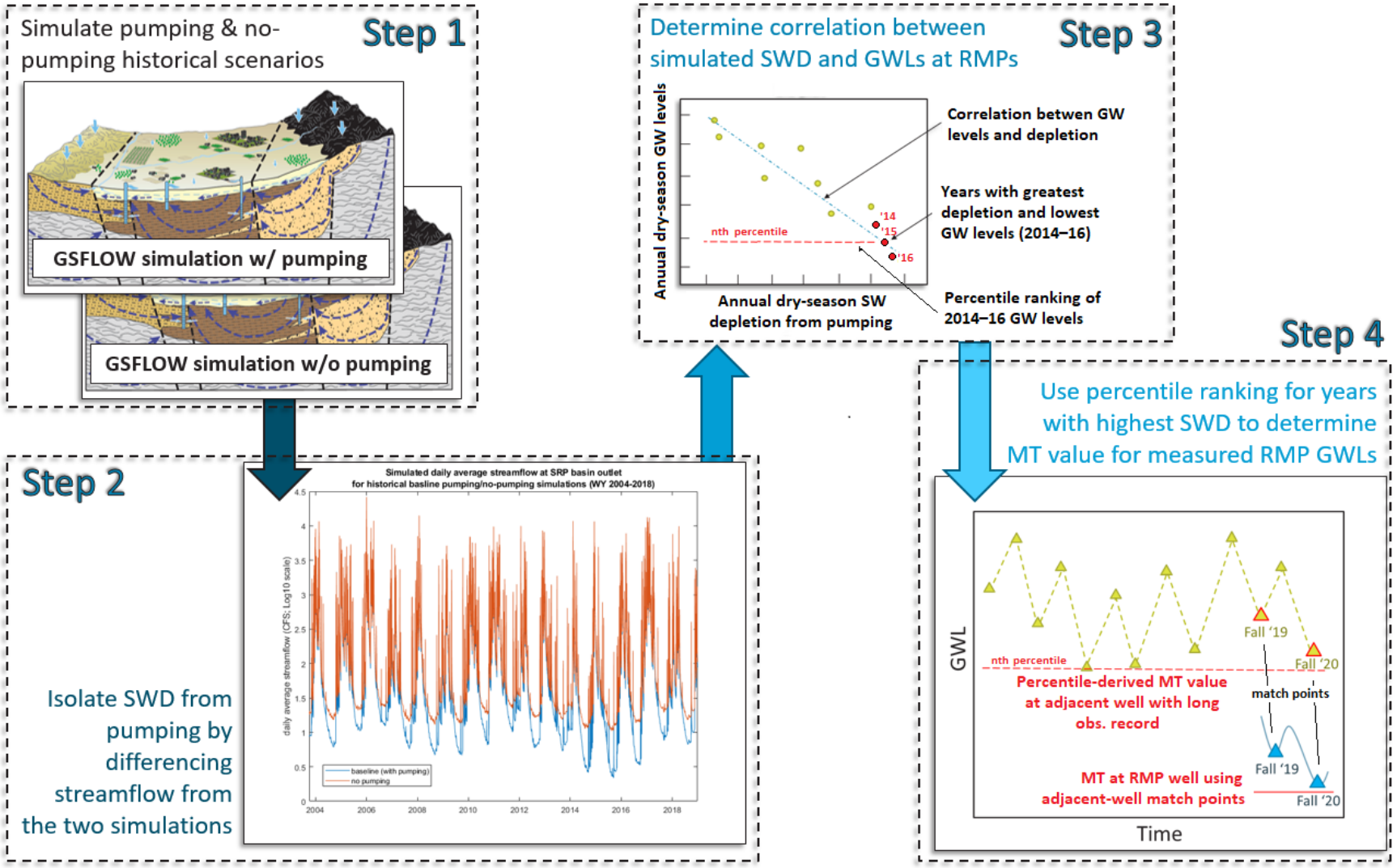


Figure 3: Methodology conceptualization for establishing depletion of interconnected surface water SMCs.

4.3 Simulated Reductions in Streamflow due to Pumping

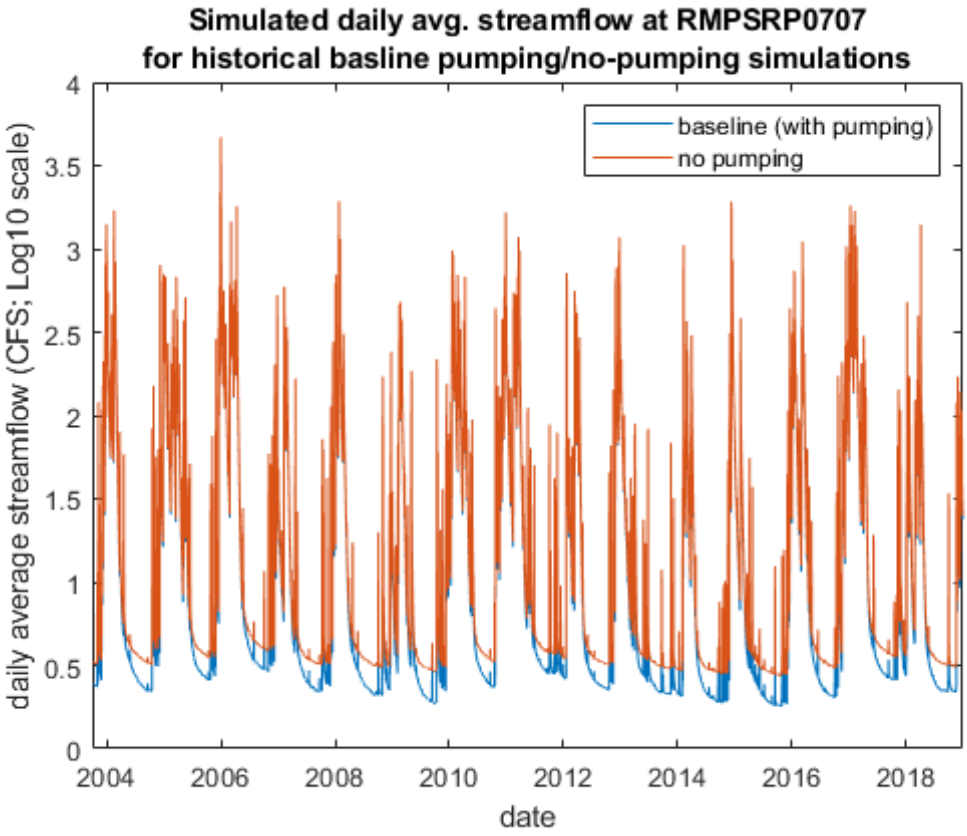


Figure 4: Differences in simulated streamflow at RMP SRP0707 during 2004–2018.

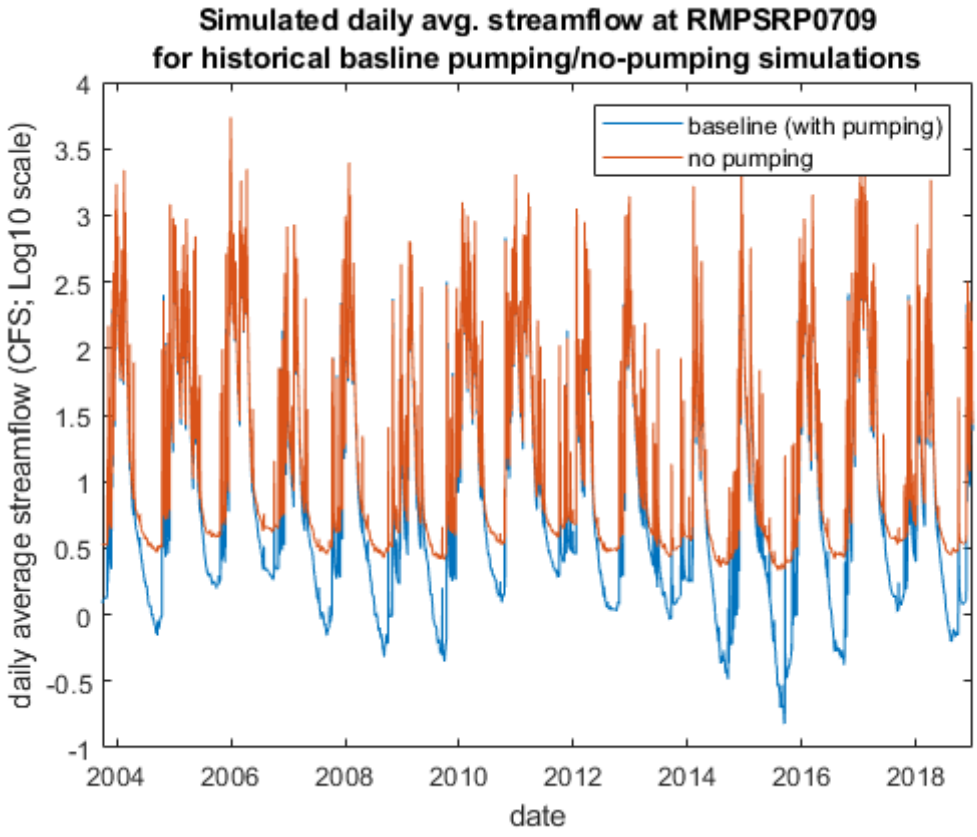


Figure 5: Differences in simulated streamflow at RMP SRP0709 during 2004–2018.

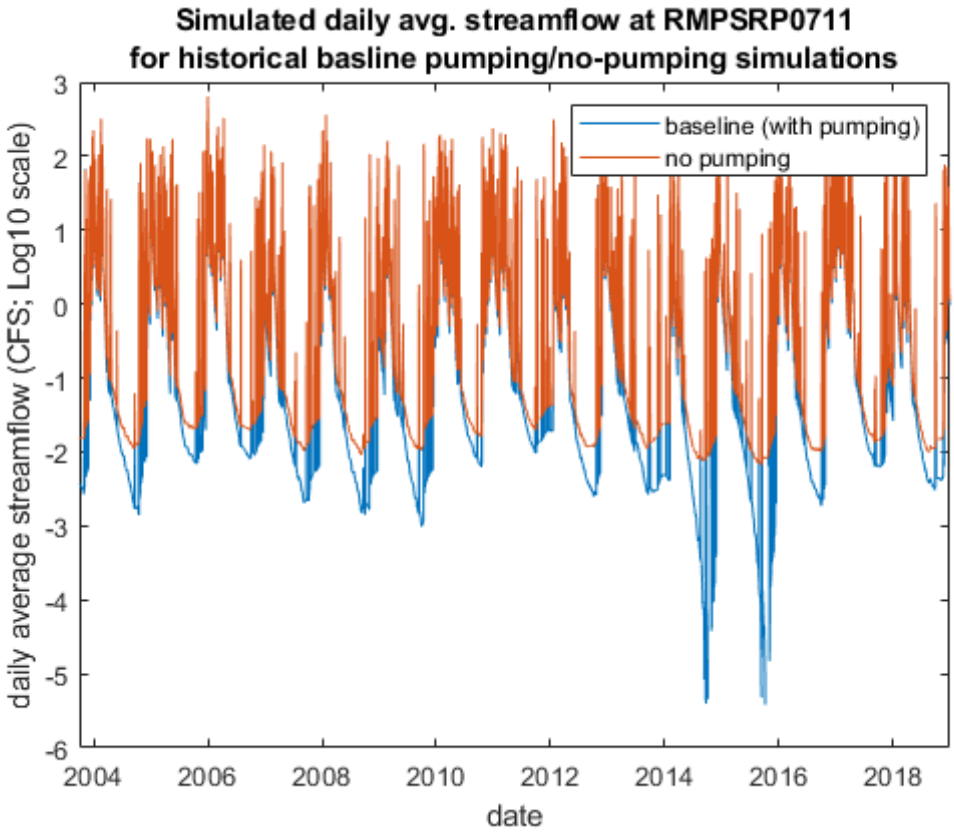


Figure 6: Differences in simulated streamflow at RMP SRP0711 during 2004–2018.

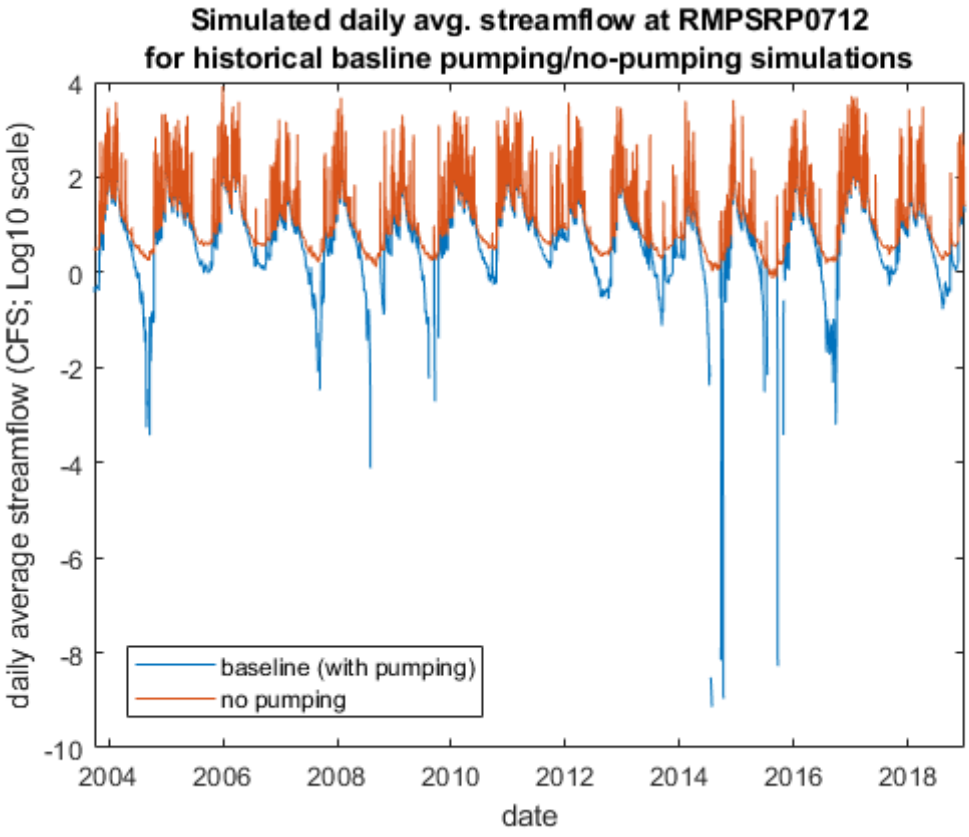


Figure 7: Differences in simulated streamflow at RMP SRP0712 during 2004–2018.

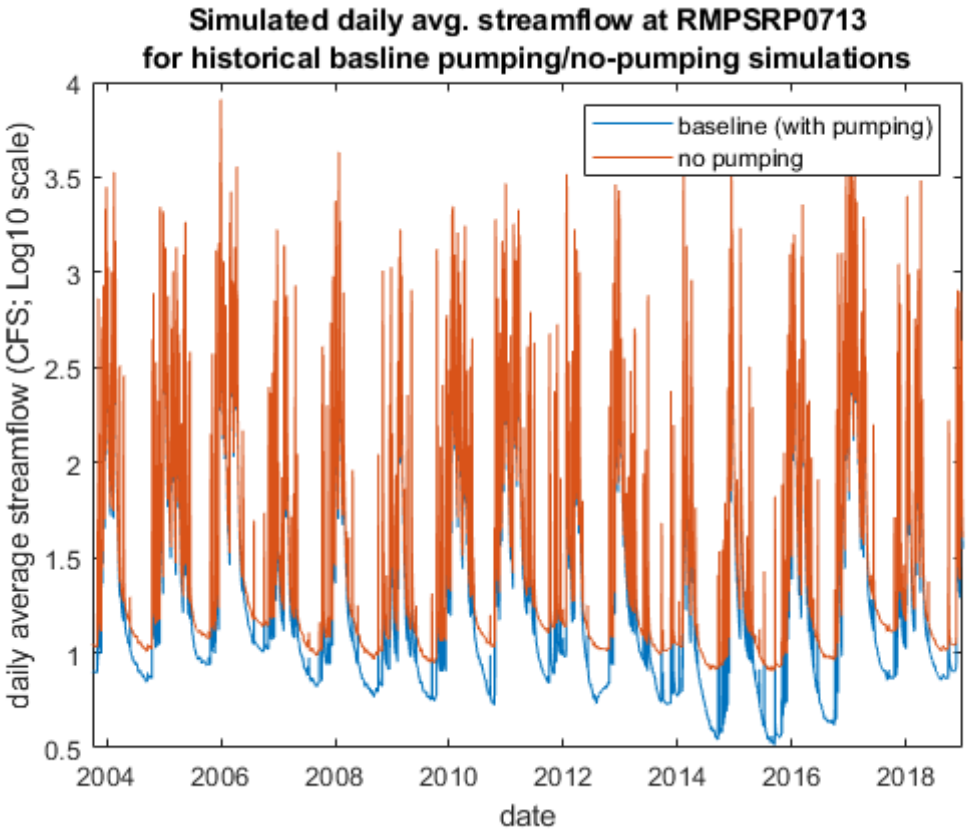


Figure 8: Differences in simulated streamflow at RMP SRP0713 during 2004–2018.

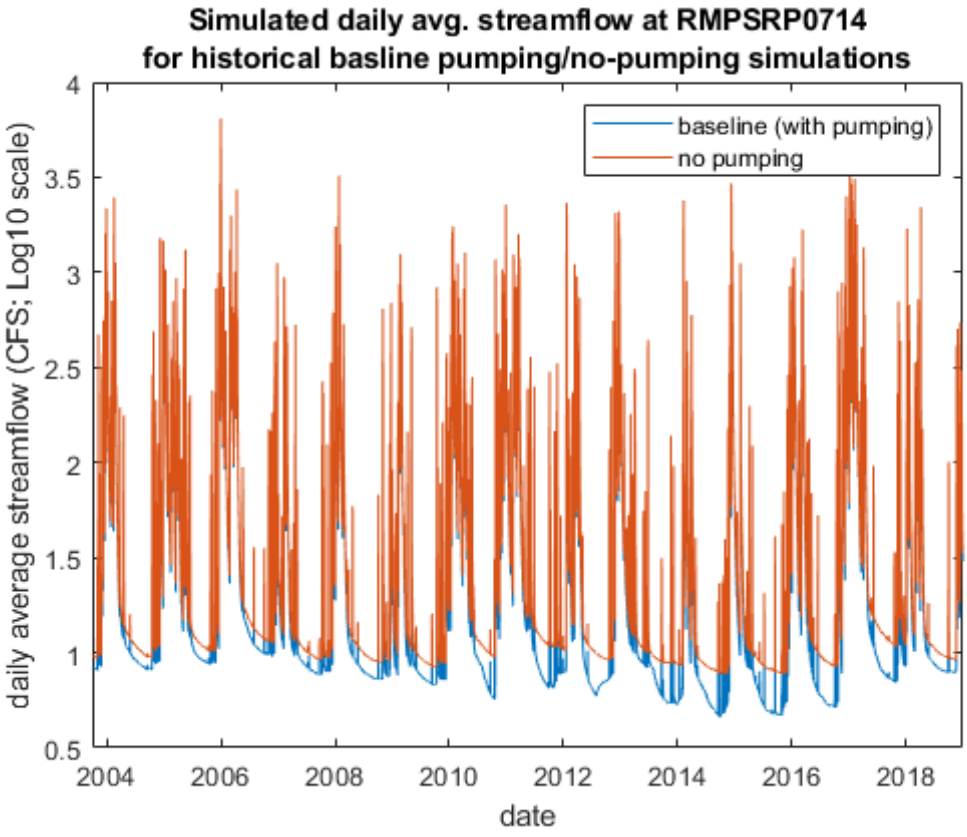


Figure 9: Differences in simulated streamflow at RMP SRP0714 during 2004–2018.

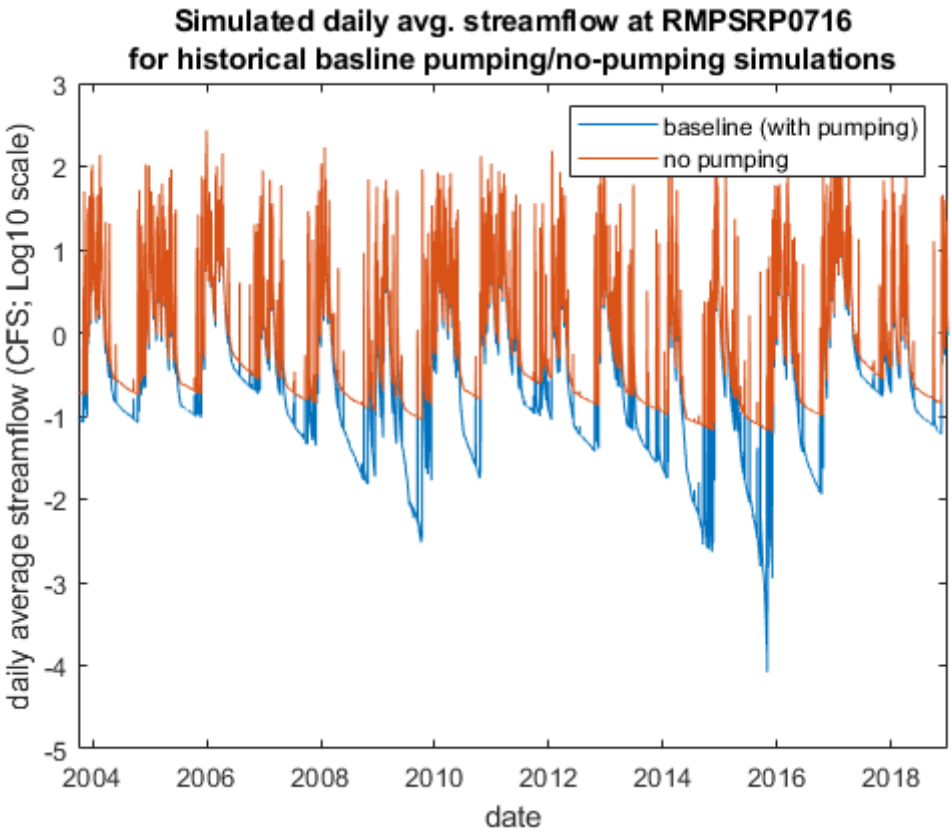


Figure 10: Differences in simulated streamflow at RMP SRP0716 during 2004–2018.

4.4 Simulated Correlation between Surface Water Depletion and Groundwater Levels

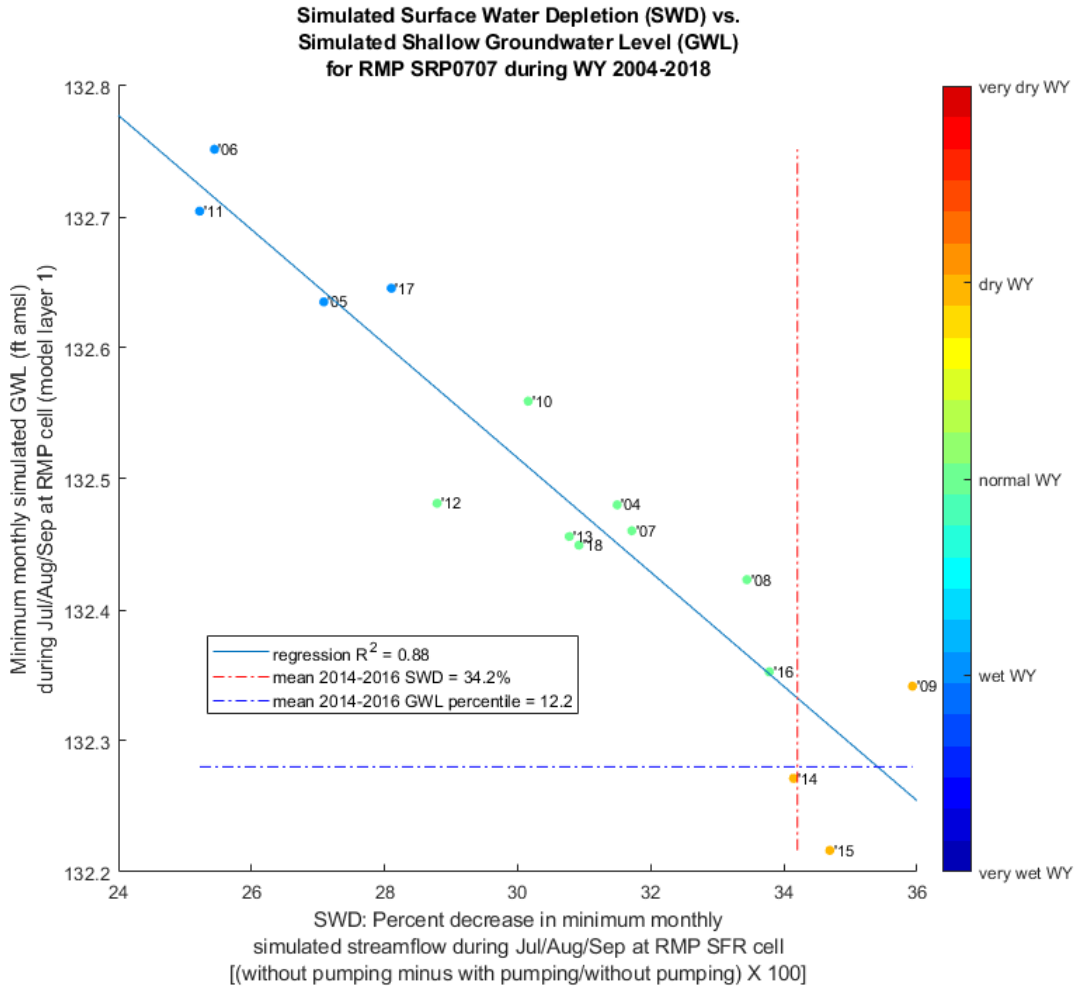


Figure 11: Correlation between simulated dry-season surface water depletion and simulated dry-season shallow groundwater levels at RMP SRP0707 during 2004–2018, along with the average groundwater-level percentile ranking for 2014–2016.

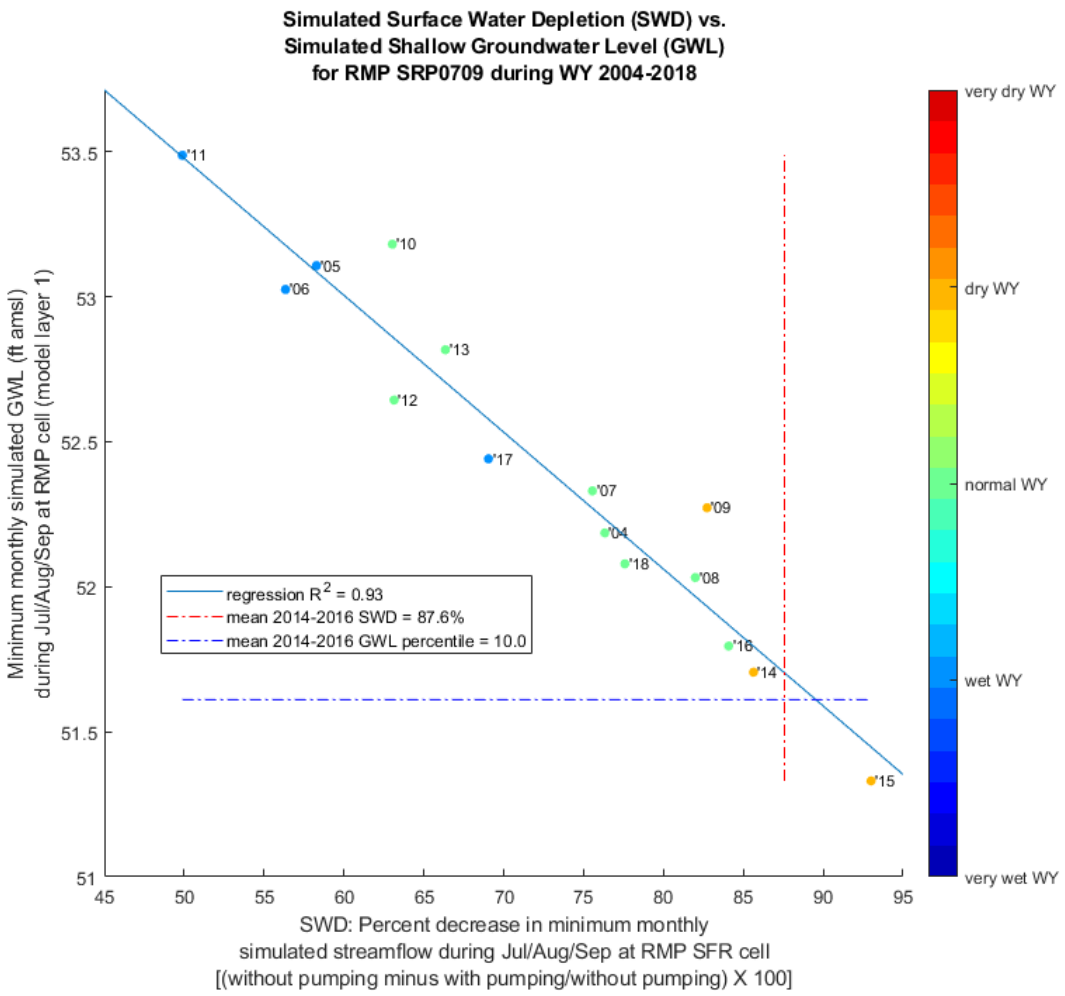


Figure 12: Correlation between simulated dry-season surface water depletion and simulated dry-season shallow groundwater levels at RMP SRP0709 during 2004–2018, along with the average groundwater-level percentile ranking for 2014–2016.

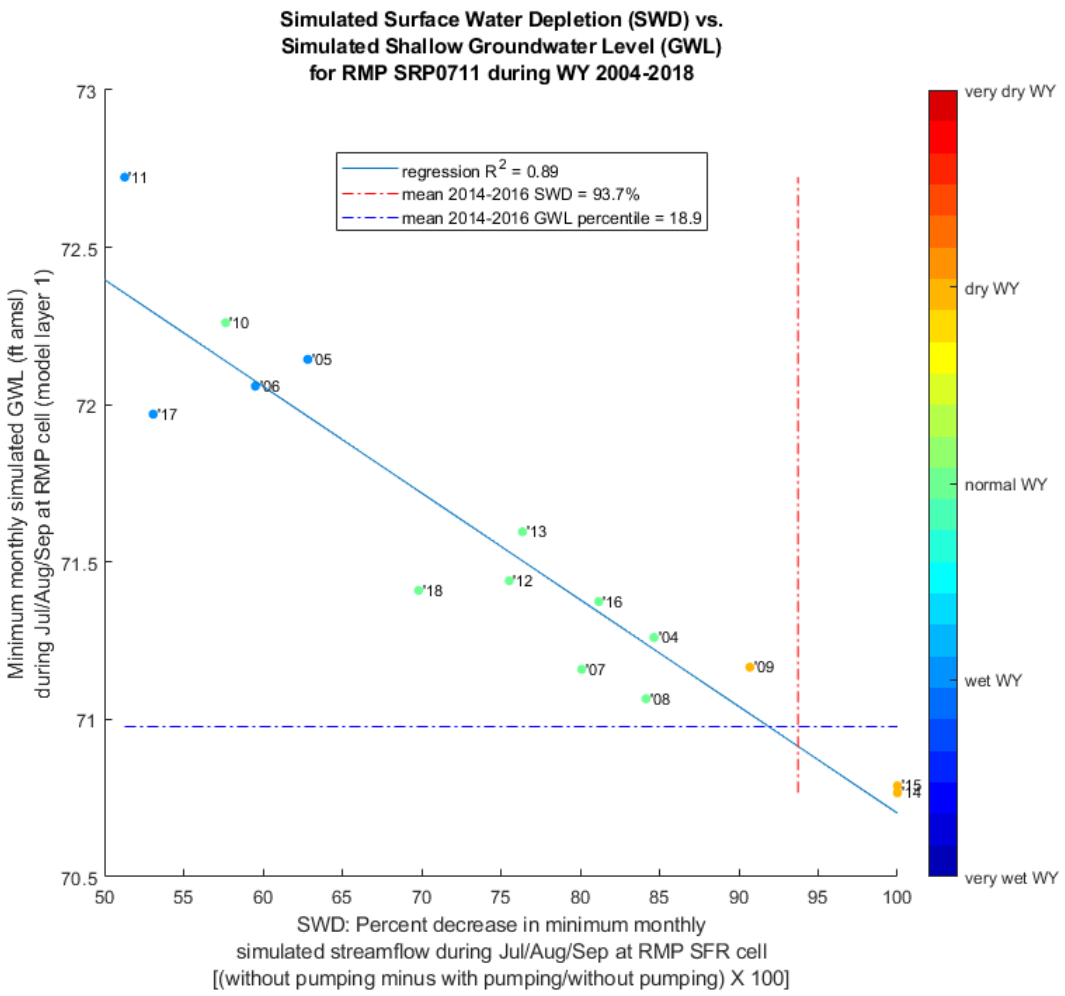


Figure 13: Correlation between simulated dry-season surface water depletion and simulated dry-season shallow groundwater levels at RMP SRP0711 during 2004–2018, along with the average groundwater-level percentile ranking for 2014–2016.

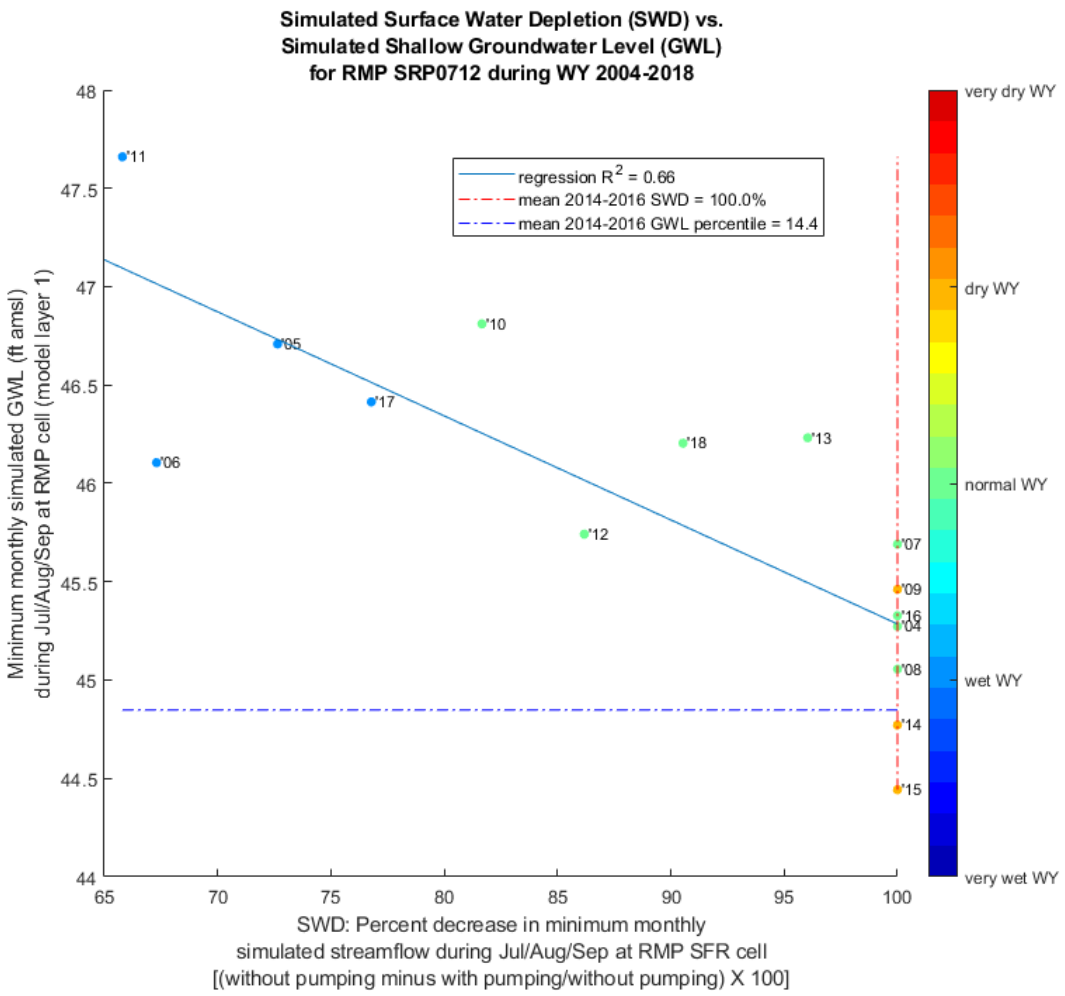


Figure 14: Correlation between simulated dry-season surface water depletion and simulated dry-season shallow groundwater levels at RMP SRP0712 during 2004–2018, along with the average groundwater-level percentile ranking for 2014–2016.

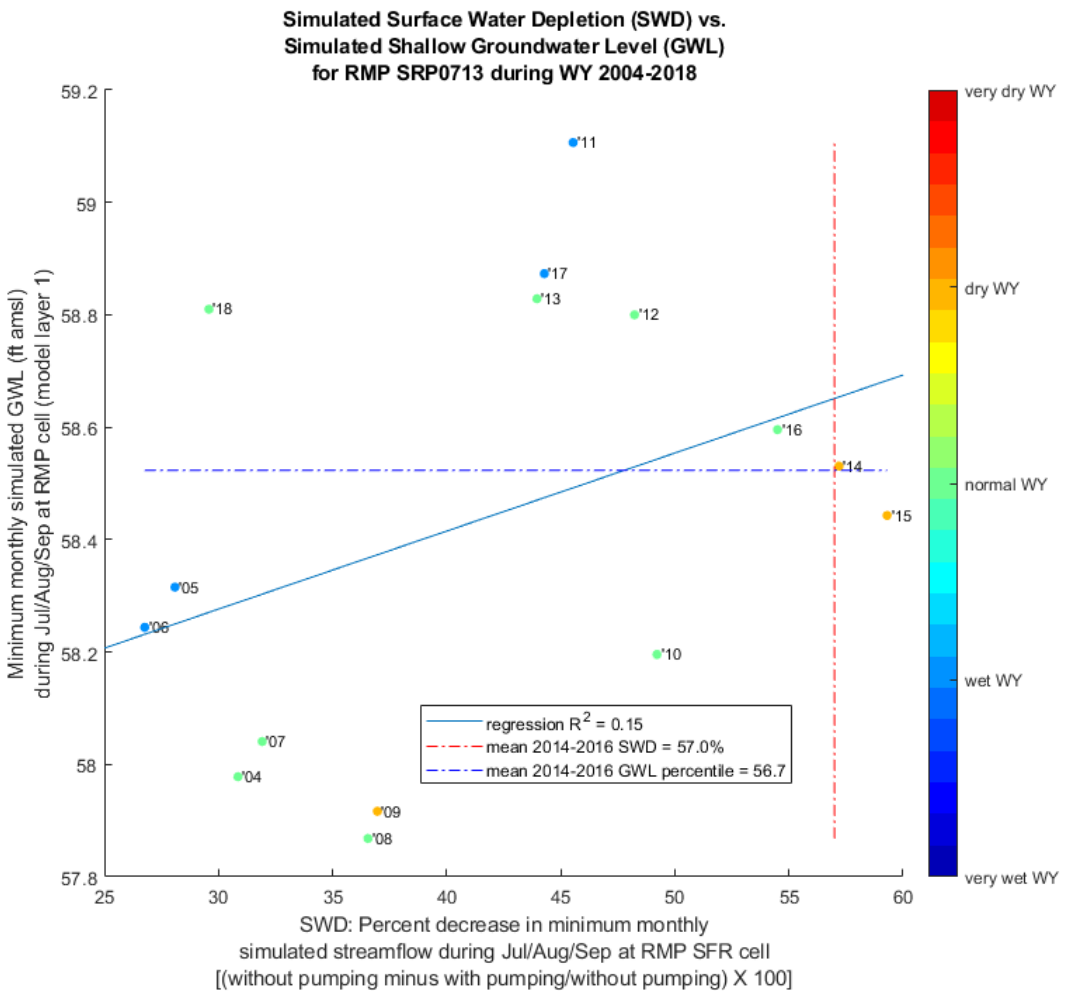


Figure 15: Correlation between simulated dry-season surface water depletion and simulated dry-season shallow groundwater levels at RMP SRP0713 during 2004–2018, along with the average groundwater-level percentile ranking for 2014–2016.

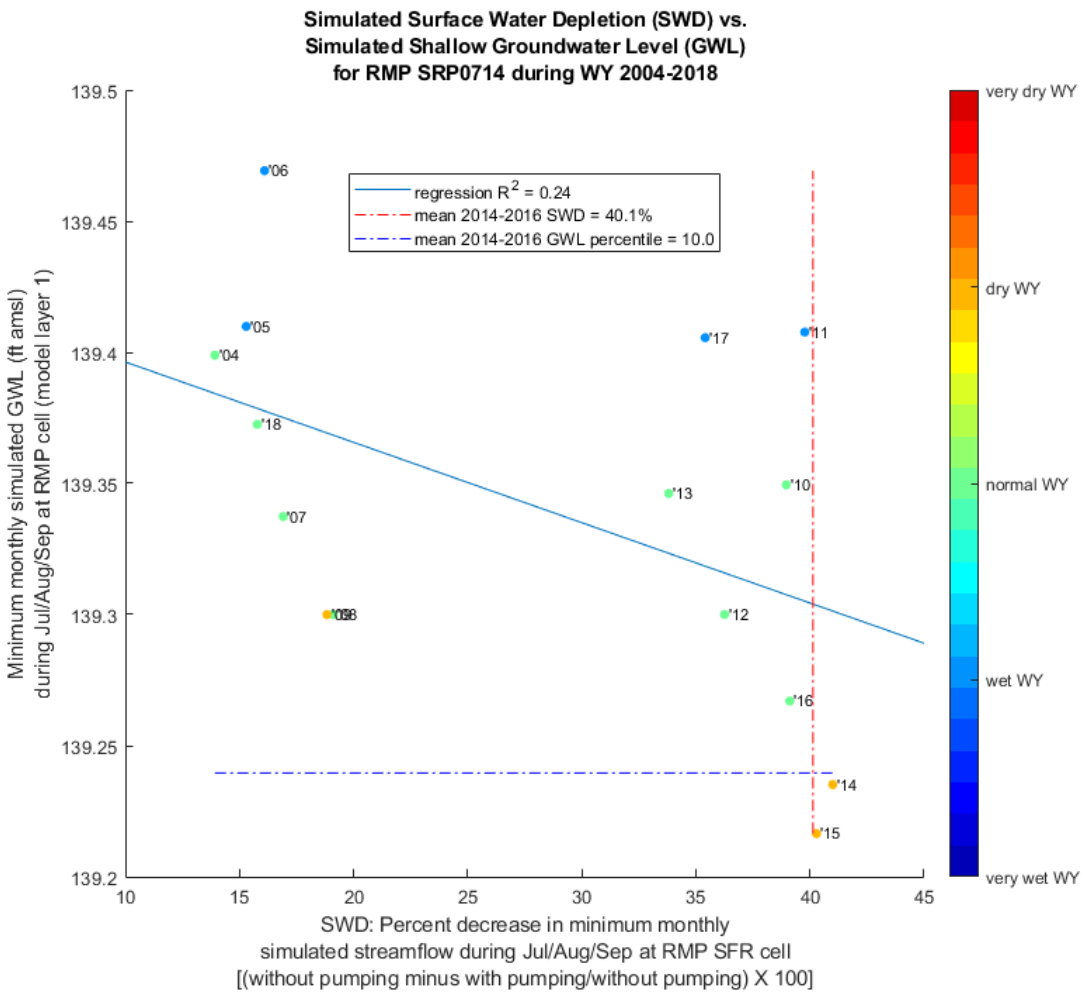


Figure 16: Correlation between simulated dry-season surface water depletion and simulated dry-season shallow groundwater levels at RMP SRP0714 during 2004–2018, along with the average groundwater-level percentile ranking for 2014–2016.

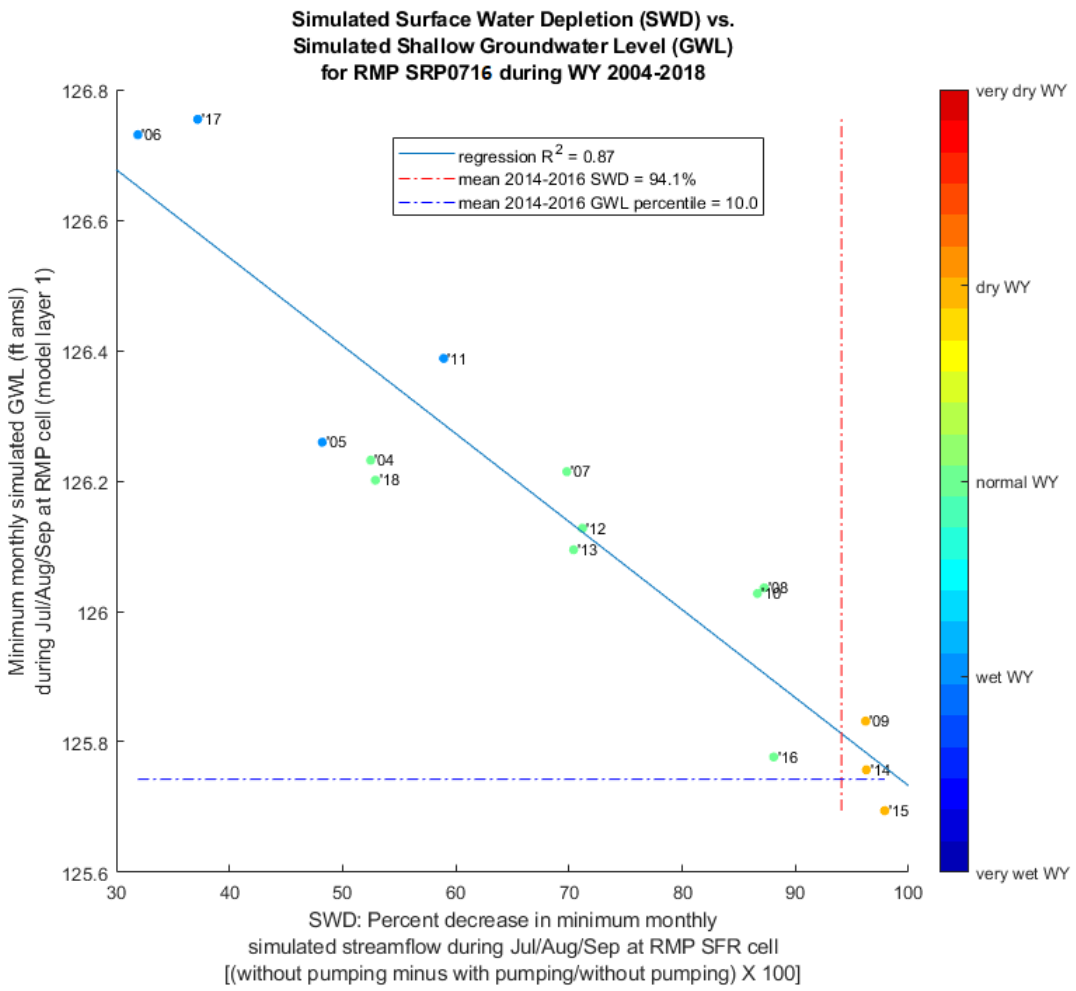


Figure 17: Correlation between simulated dry-season surface water depletion and simulated dry-season shallow groundwater levels at RMP SRP0716 during 2004–2018, along with the average groundwater-level percentile ranking for 2014–2016.

4.5 Simulated Surface Water Depletion at the Basin Outlet

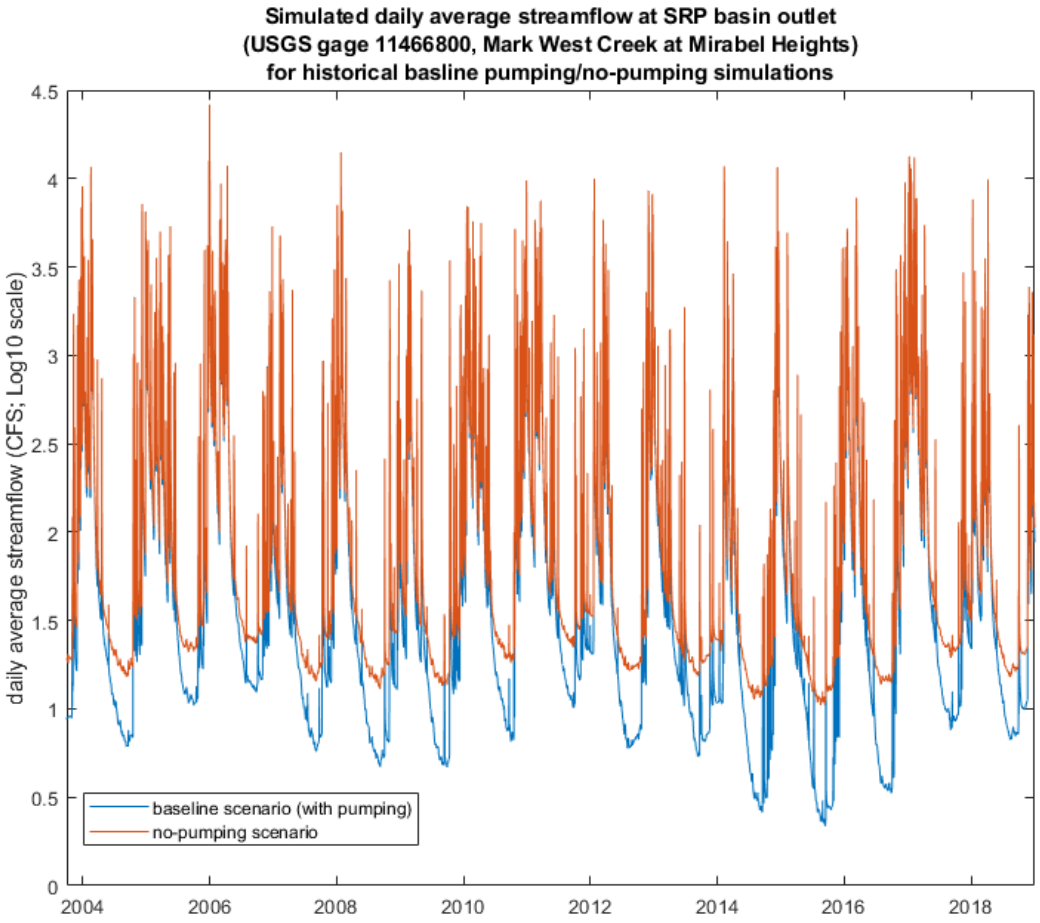


Figure 18: Differences in simulated streamflow at the Santa Rosa Plain basin outlet on Mark West Creek during 2004–2018.

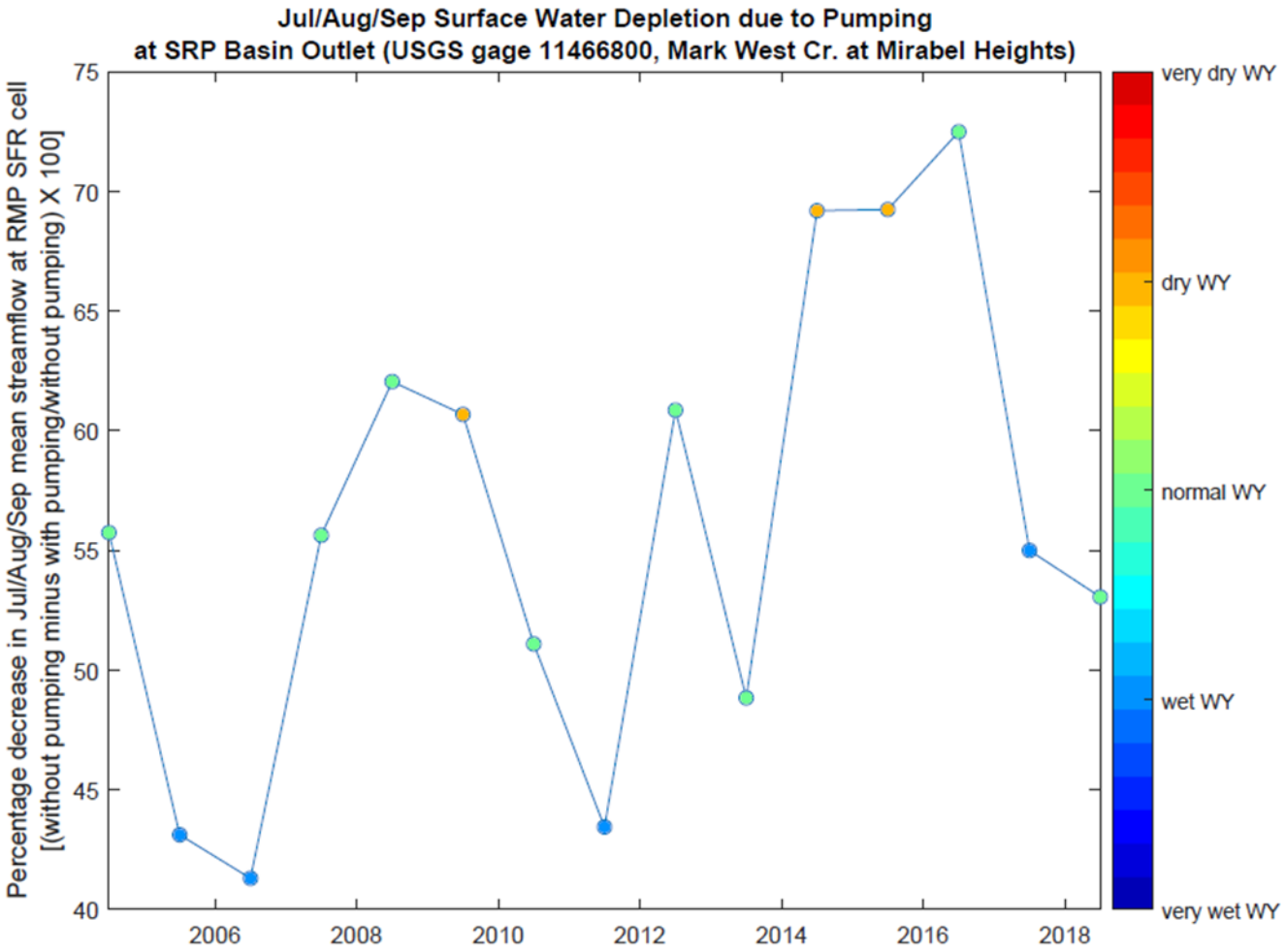


Figure 19: Annual estimated dry-season depletion of interconnected surface water at the Santa Rosa Plain basin outlet during 2004–2018.

4.6 Minimum Thresholds and Measurable Objectives at RMP Locations

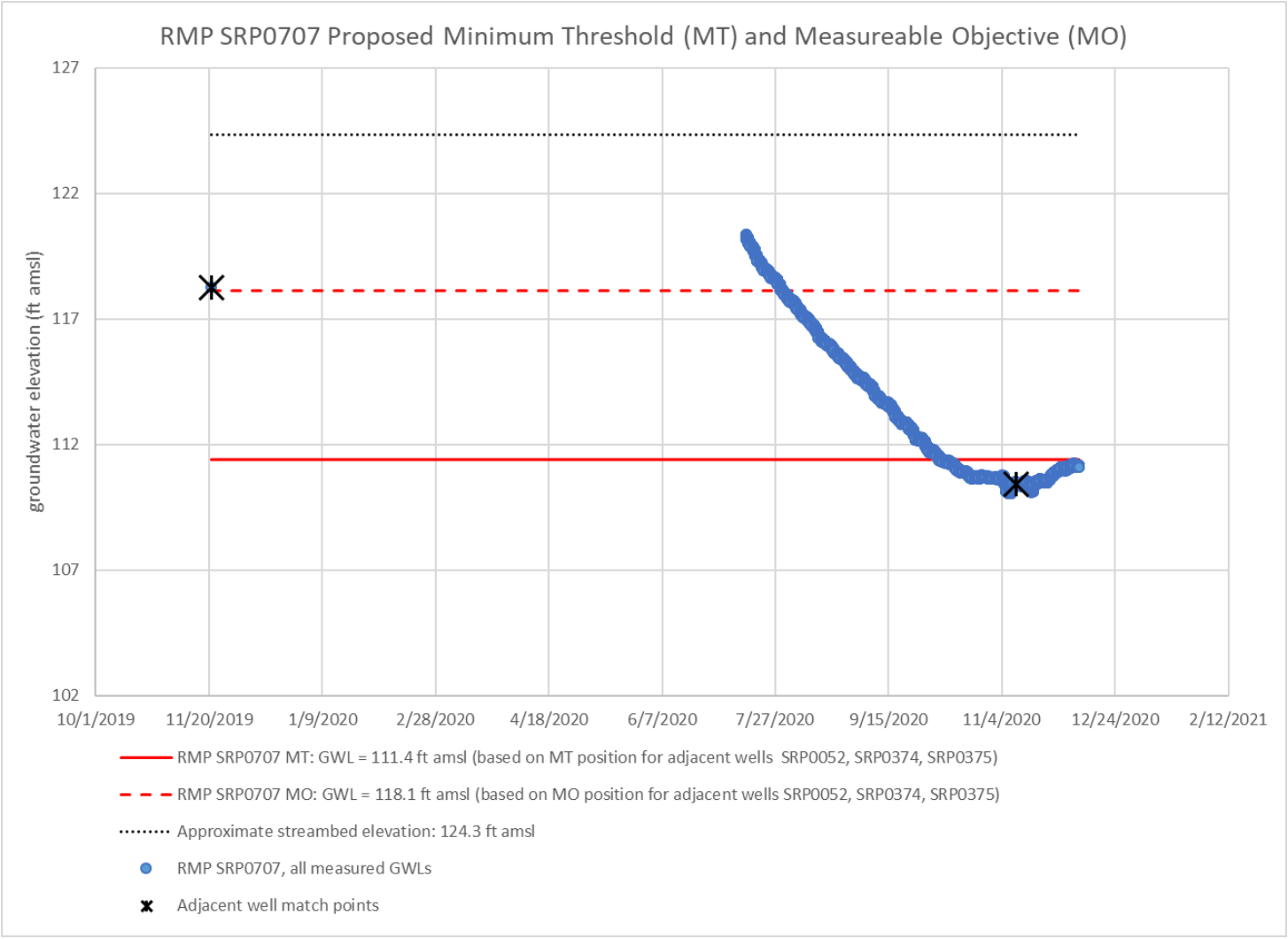


Figure 20: Measured groundwater levels at RMP SRP0707, along with Minimum Threshold and Measureable Objective groundwater level proxies for depletion of interconnected surface water by groundwater pumping.

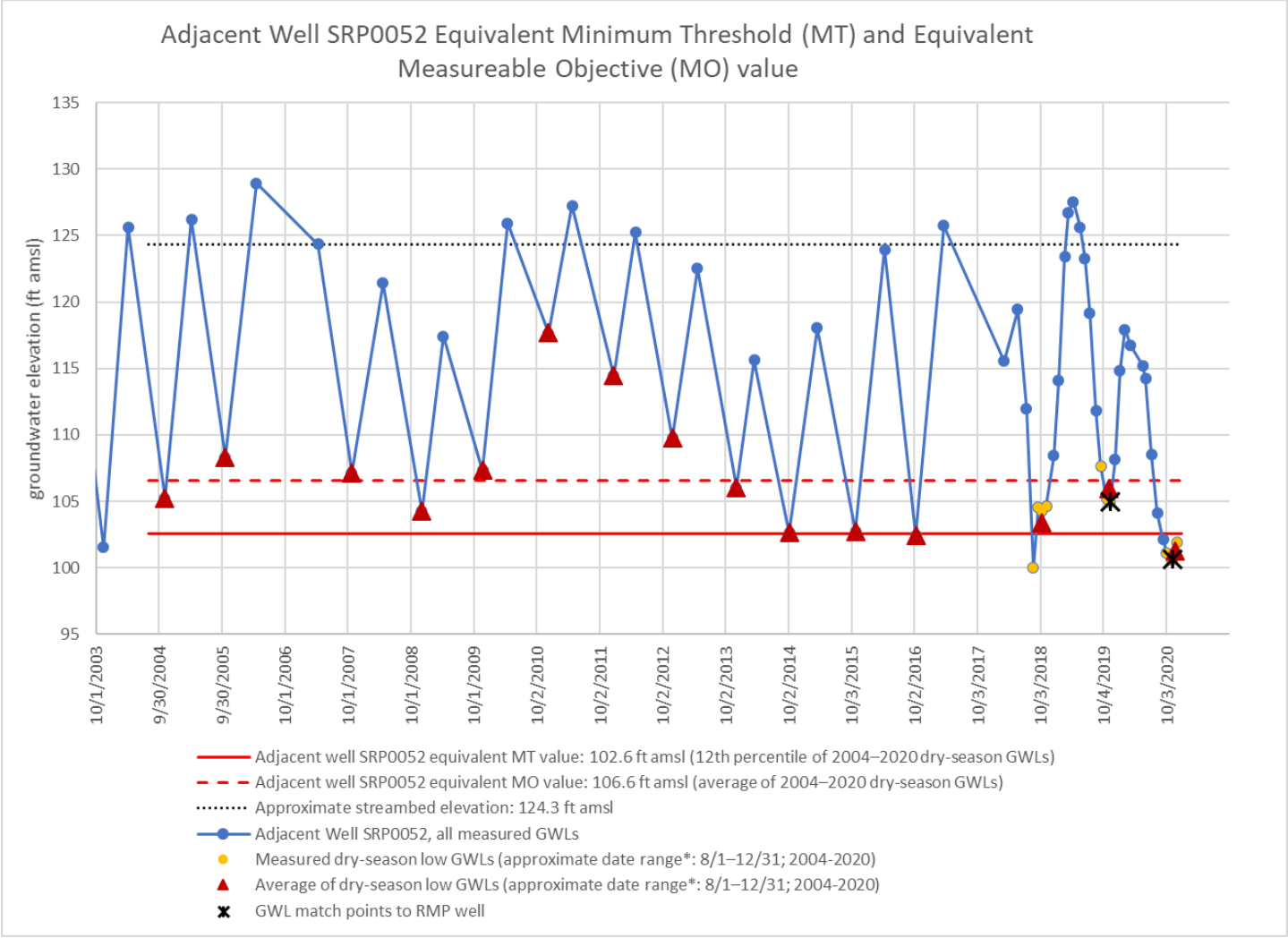


Figure 21: Measured groundwater levels at SRP0052, an adjacent well to RMP SRP0707, along with Minimum Threshold and Measureable Objective groundwater level proxy values for depletion of interconnected surface water by groundwater pumping.[*]

[*] Note that the approximate date range may have been manually adjusted to capture the true dry-season minimum groundwater levels

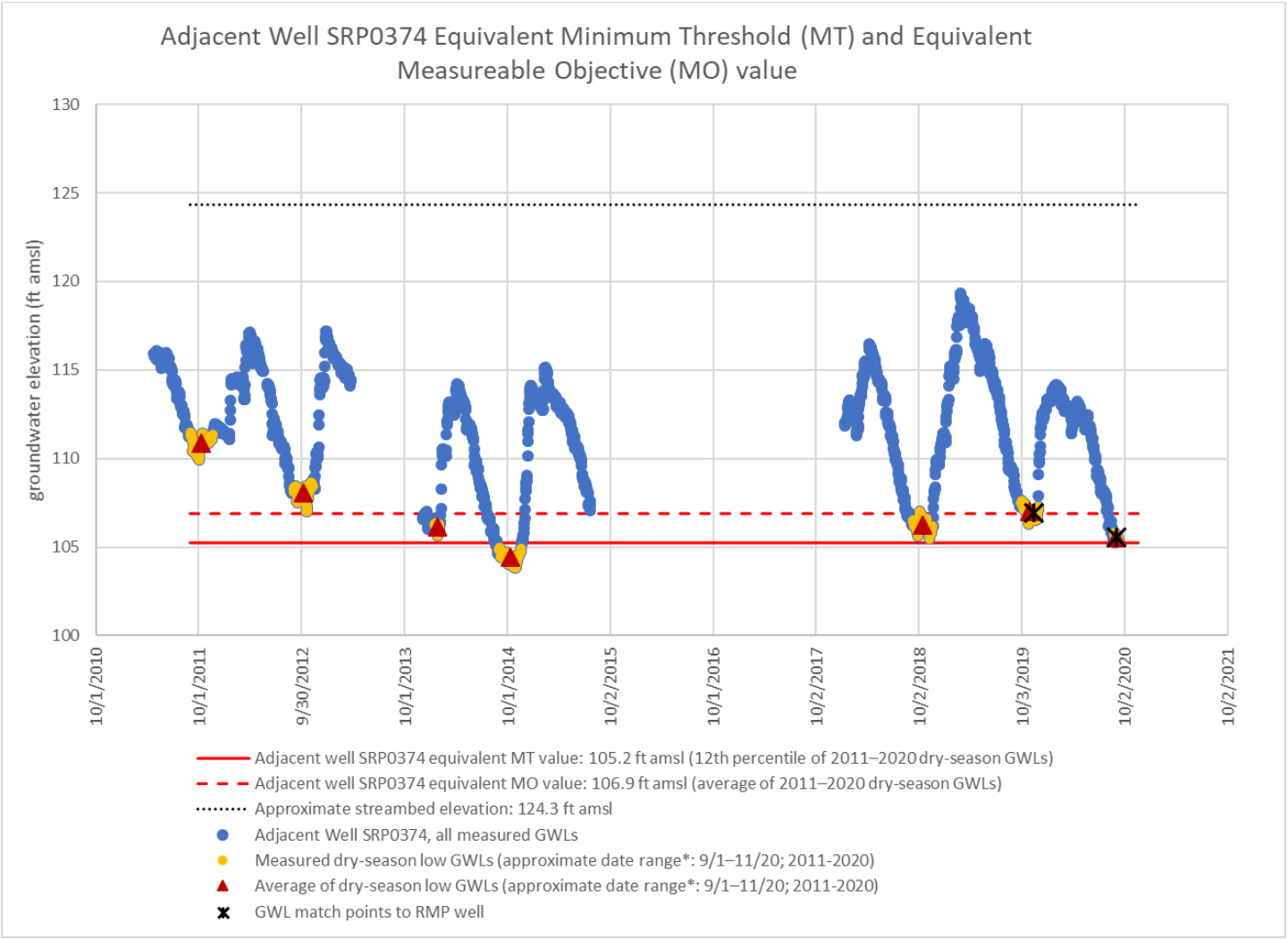


Figure 22: Measured groundwater levels at SRP0374, an adjacent well to RMP SRP0707, along with Minimum Threshold and Measureable Objective groundwater level proxy values for depletion of interconnected surface water by groundwater pumping.[*]

[*] Note that the approximate date range may have been manually adjusted to capture the true dry-season minimum groundwater levels

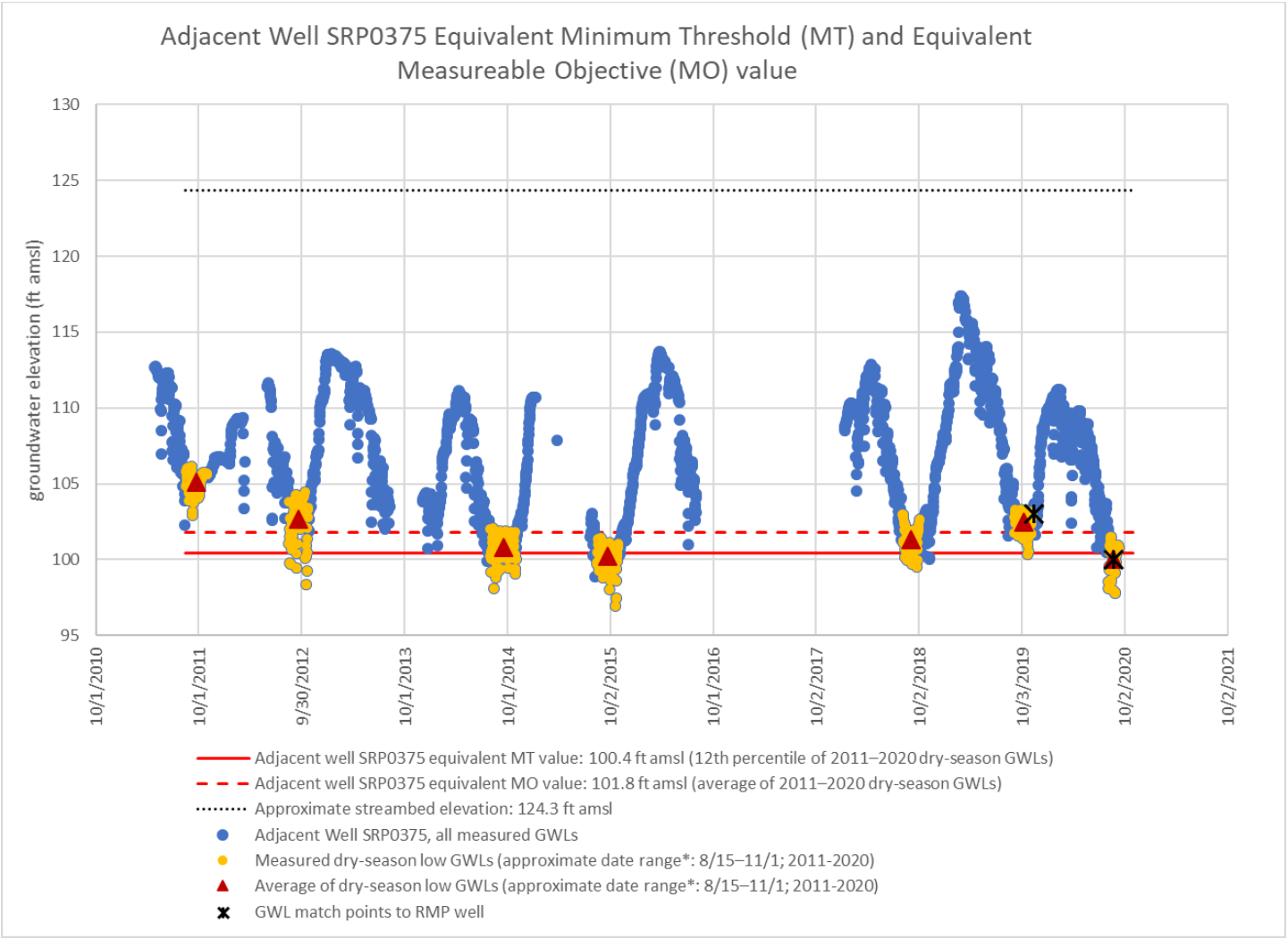


Figure 23: Measured groundwater levels at SRP0375, an adjacent well to RMP SRP0707, along with Minimum Threshold and Measureable Objective groundwater level proxy values for depletion of interconnected surface water by groundwater pumping.[*]

[*] Note that the approximate date range may have been manually adjusted to capture the true dry-season minimum groundwater levels

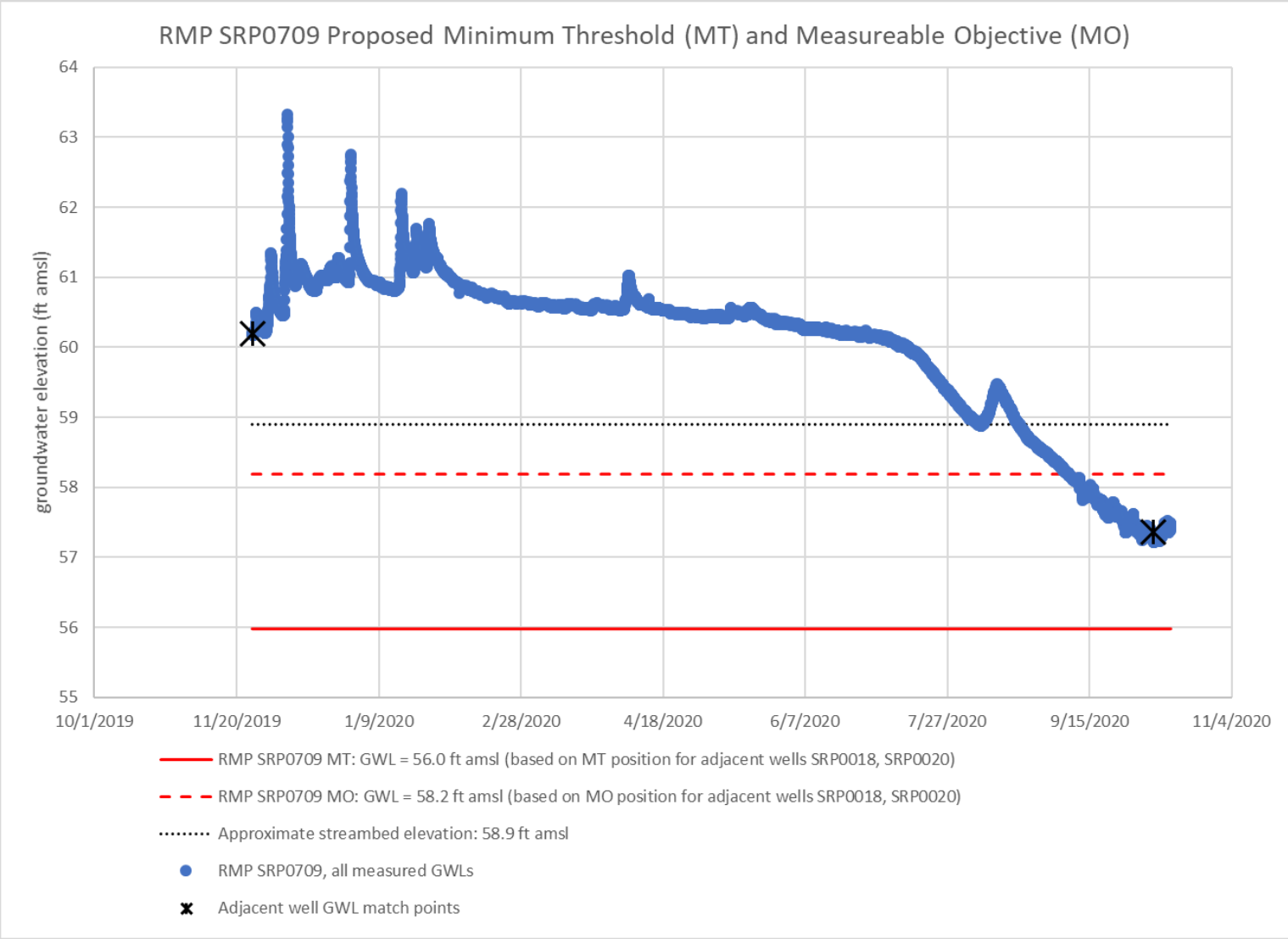


Figure 24: Measured groundwater levels at RMP SRP0709, along with Minimum Threshold and Measureable Objective groundwater level proxies for depletion of interconnected surface water by groundwater pumping.

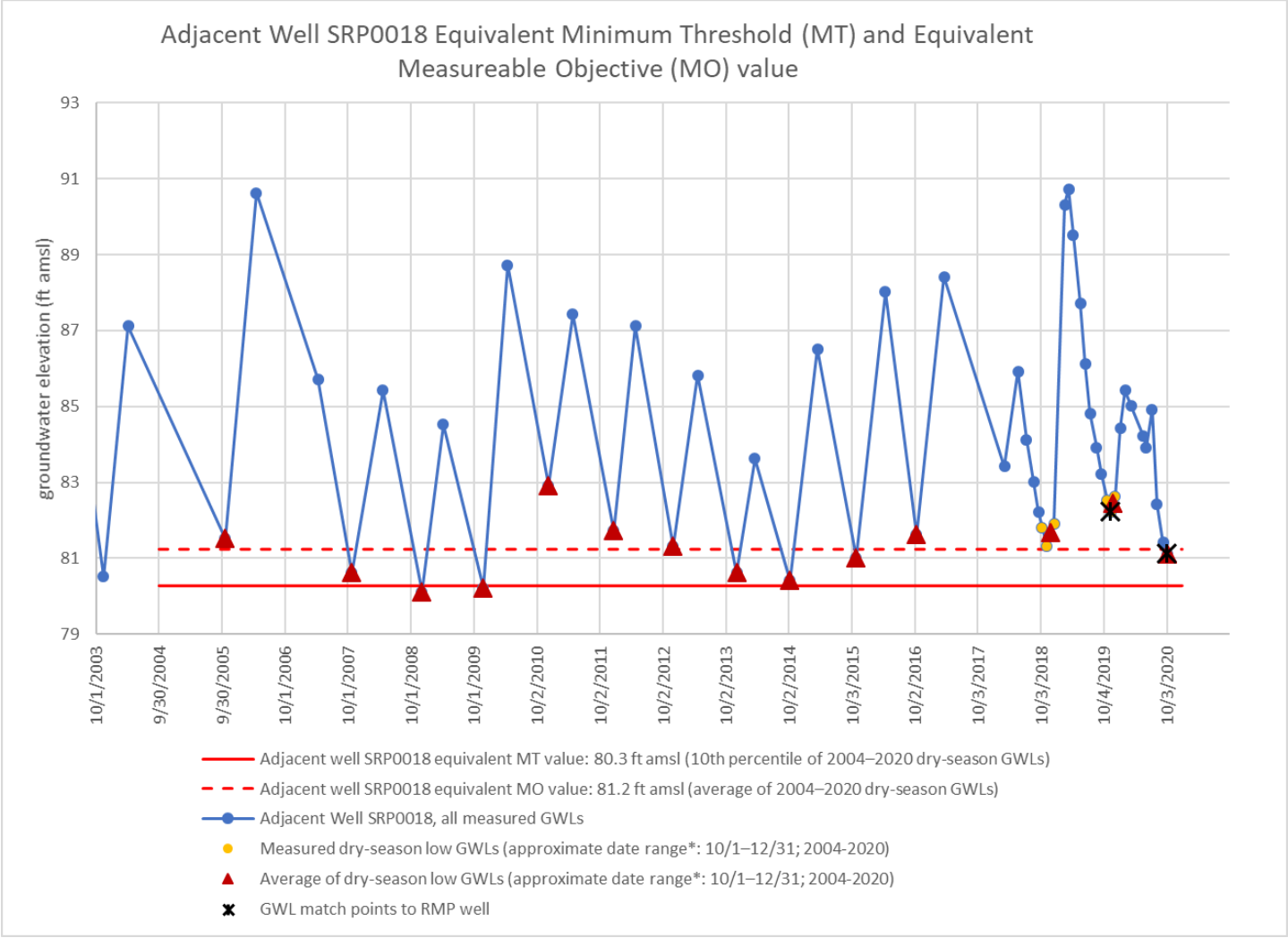


Figure 25: Measured groundwater levels at SRP0018, an adjacent well to RMP SRP0709, along with Minimum Threshold and Measureable Objective groundwater level proxy values for depletion of interconnected surface water by groundwater pumping.[*]

[*] Note that the approximate date range may have been manually adjusted to capture the true dry-season minimum groundwater levels

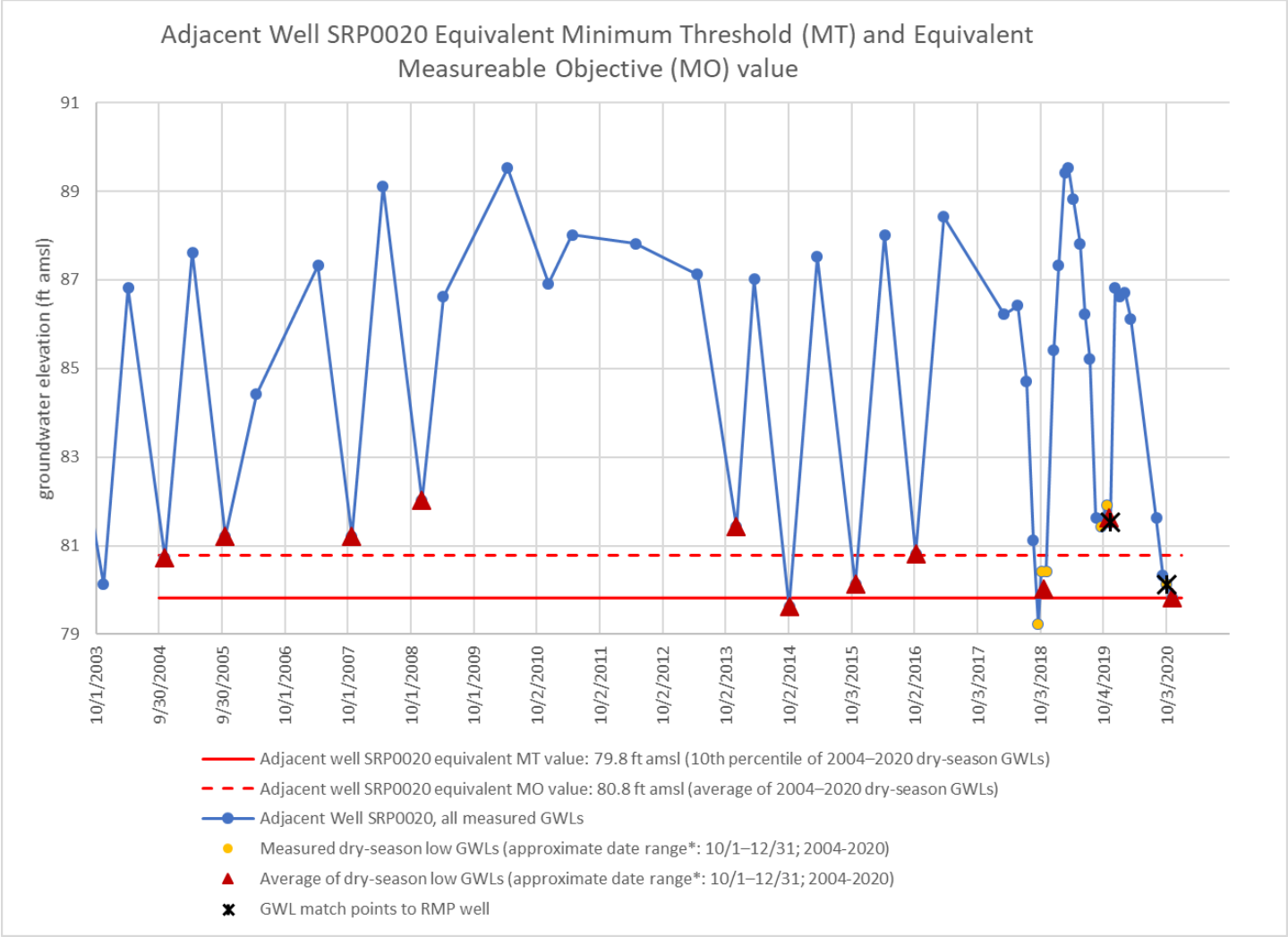


Figure 26: Measured groundwater levels at SRP0020, an adjacent well to RMP SRP0709, along with Minimum Threshold and Measureable Objective groundwater level proxy values for depletion of interconnected surface water by groundwater pumping.[*]

[*] Note that the approximate date range may have been manually adjusted to capture the true dry-season minimum groundwater levels

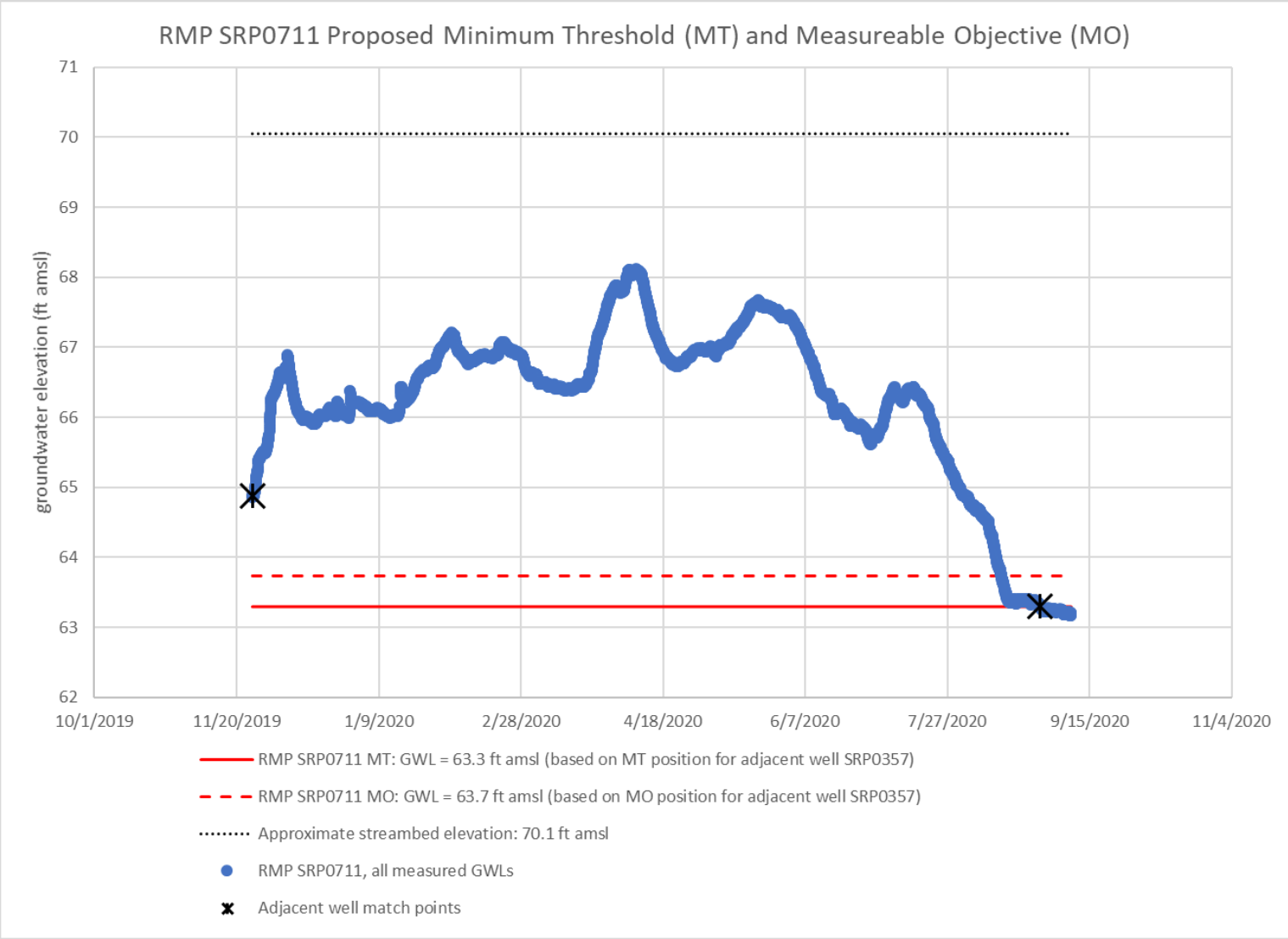


Figure 27: Measured groundwater levels at RMP SRP0711, along with Minimum Threshold and Measureable Objective groundwater level proxies for depletion of interconnected surface water by groundwater pumping.

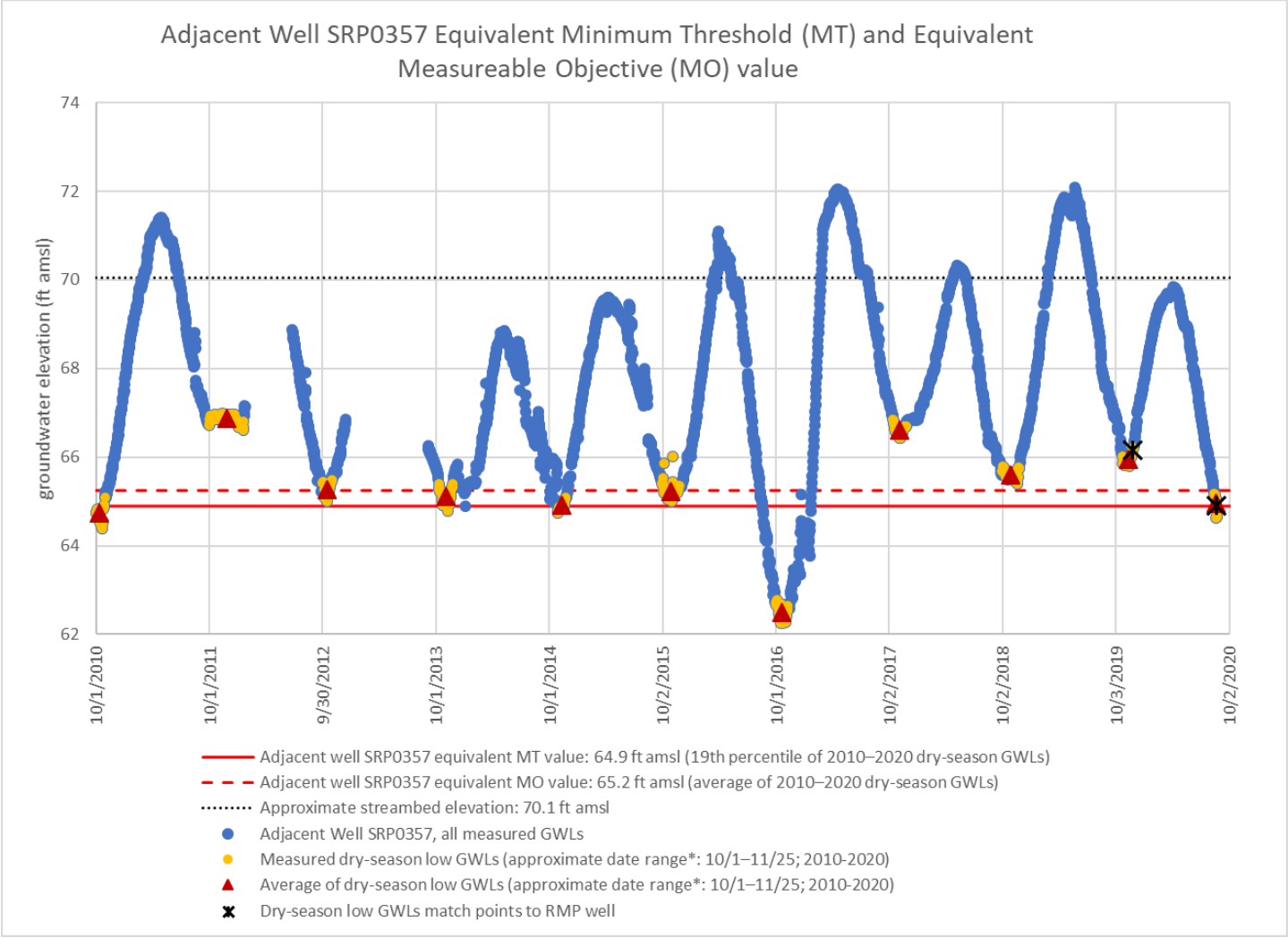


Figure 28: Measured groundwater levels at SRP0357, an adjacent well to RMP SRP0711, along with Minimum Threshold and Measureable Objective groundwater level proxy values for depletion of interconnected surface water by groundwater pumping.[*]

[*] Note that the approximate date range may have been manually adjusted to capture the true dry-season minimum groundwater levels

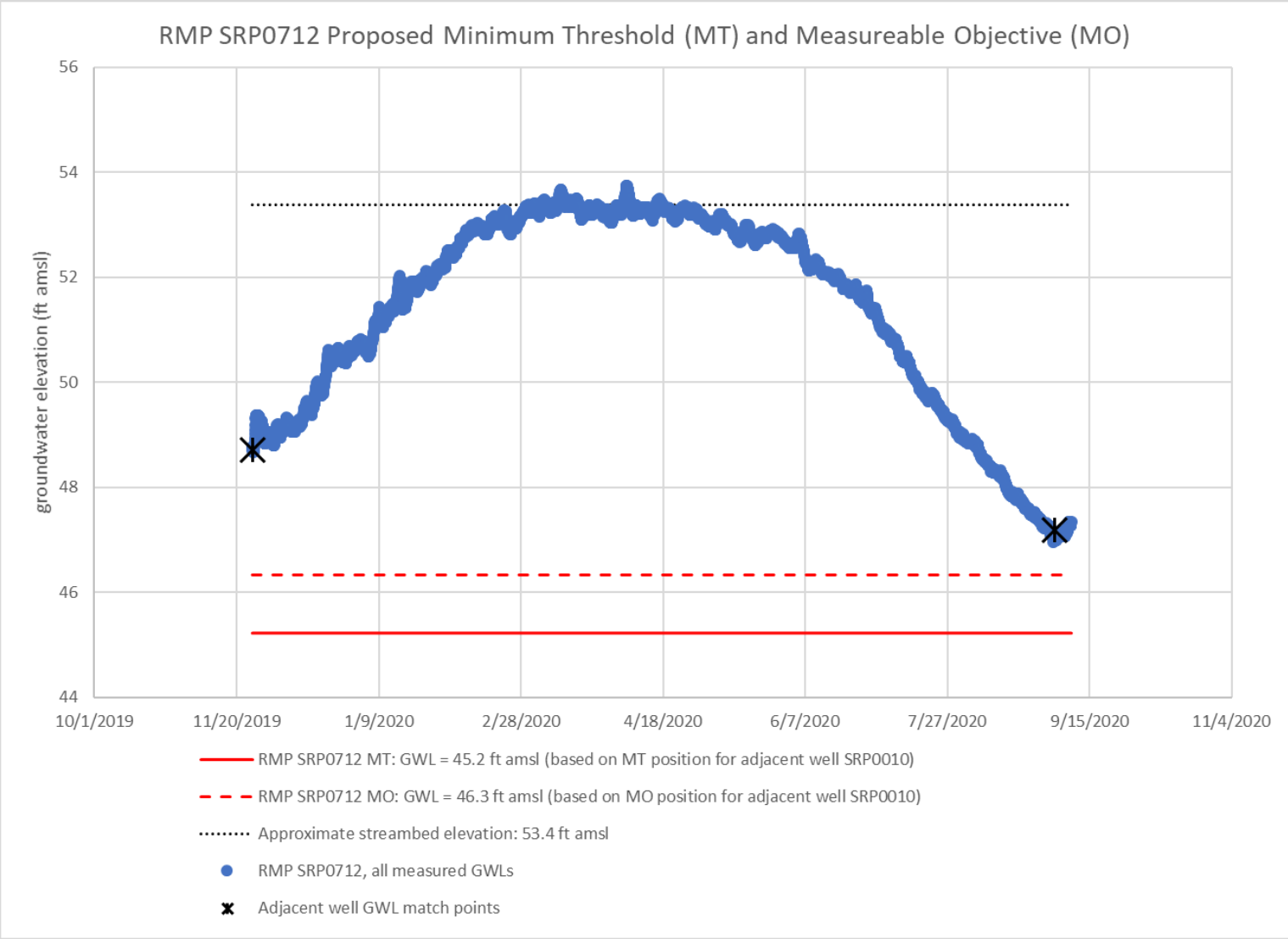


Figure 29: Measured groundwater levels at RMP SRP0712, along with Minimum Threshold and Measureable Objective groundwater level proxies for depletion of interconnected surface water by groundwater pumping.

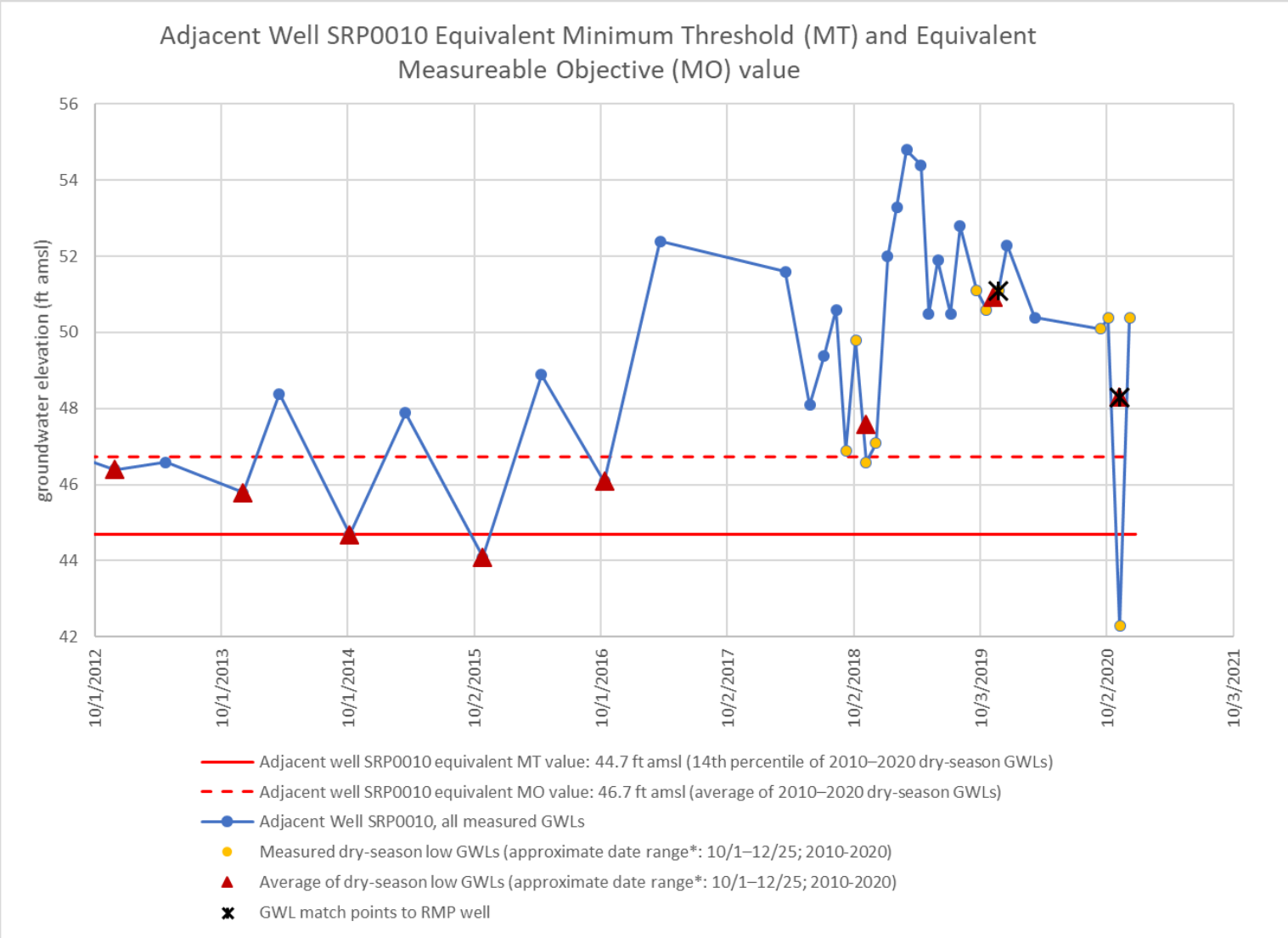


Figure 30: Measured groundwater levels at SRP0010, an adjacent well to RMP SRP0712, along with Minimum Threshold and Measureable Objective groundwater level proxy values for depletion of interconnected surface water by groundwater pumping.

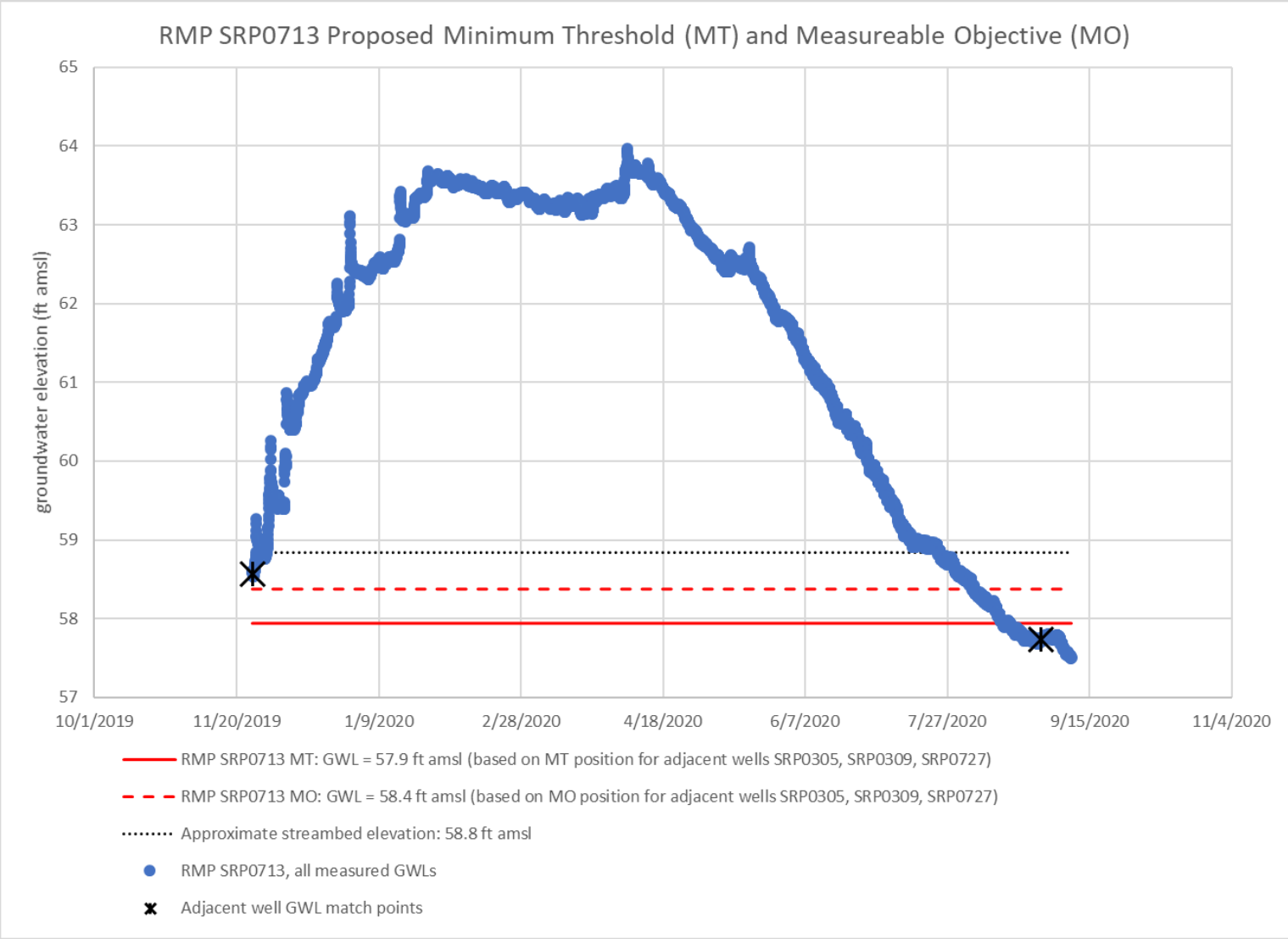


Figure 31: Measured groundwater levels at RMP SRP0713, along with Minimum Threshold and Measureable Objective groundwater level proxies for depletion of interconnected surface water by groundwater pumping.

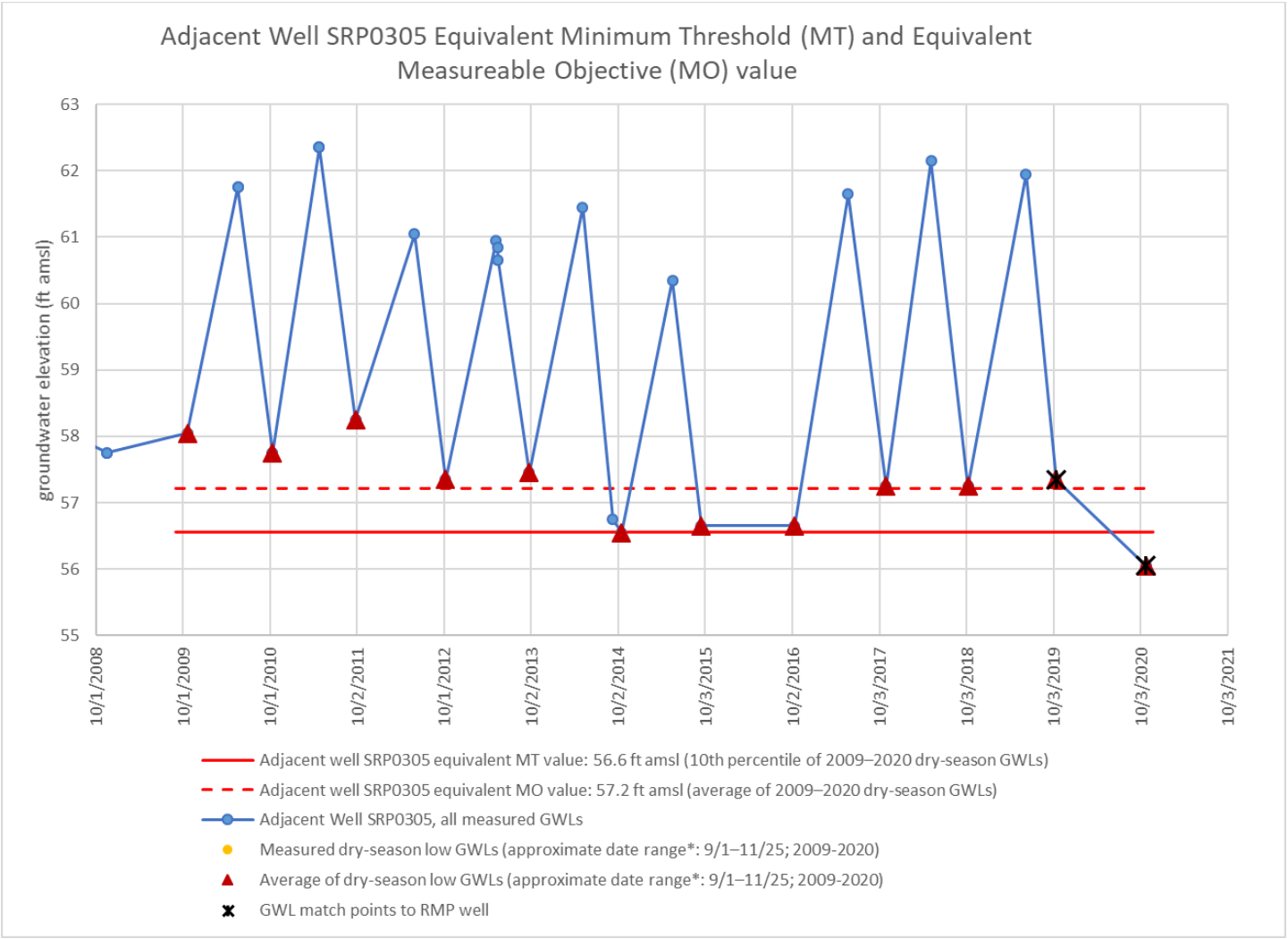


Figure 32: Measured groundwater levels at SRP0305, an adjacent well to RMP SRP0713, along with Minimum Threshold and Measureable Objective groundwater level proxy values for depletion of interconnected surface water by groundwater pumping.[*]

[*] Note that the approximate date range may have been manually adjusted to capture the true dry-season minimum groundwater levels

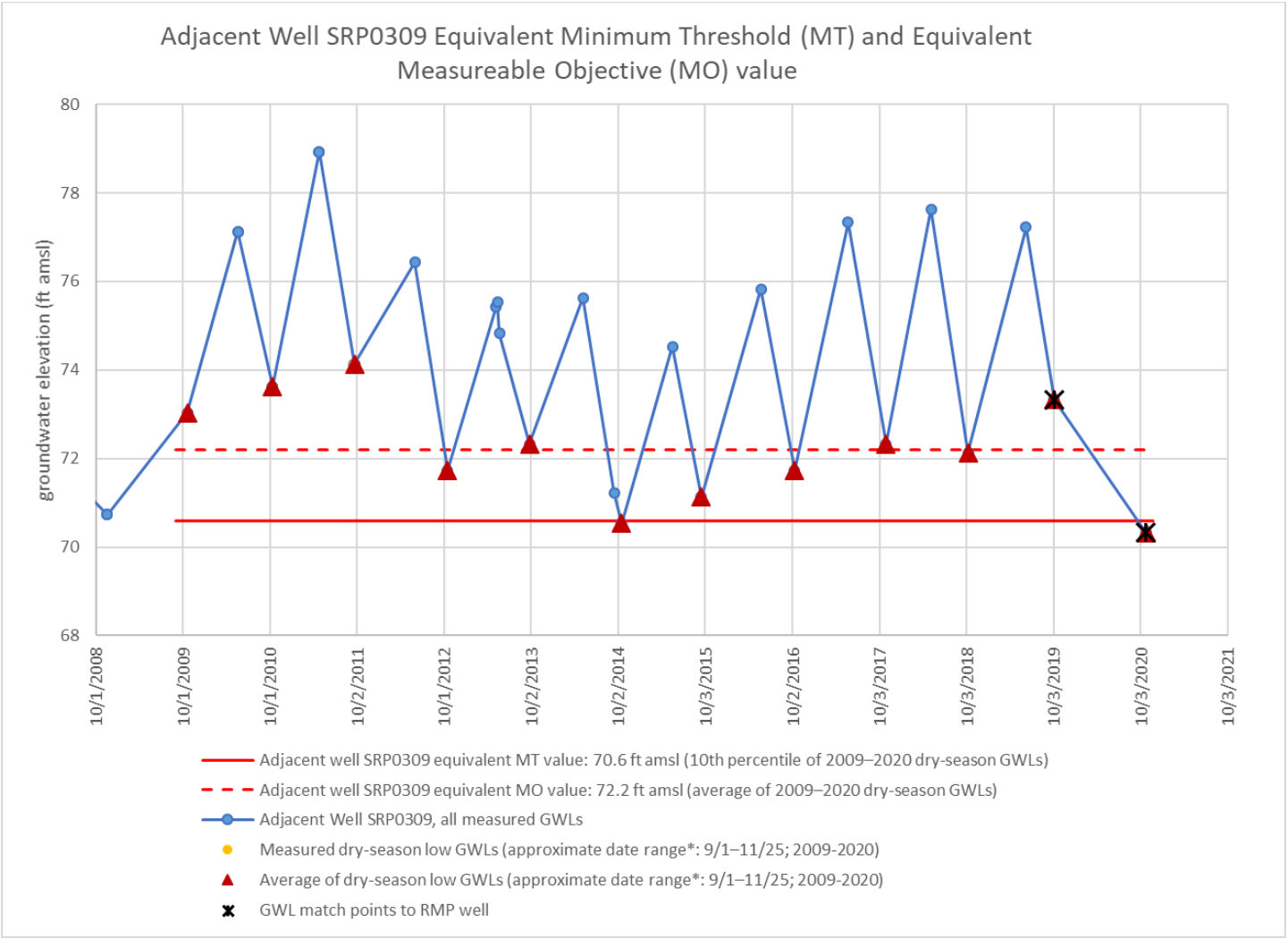


Figure 33: Measured groundwater levels at SRP0309, an adjacent well to RMP SRP0713, along with Minimum Threshold and Measureable Objective groundwater level proxy values for depletion of interconnected surface water by groundwater pumping.[*]

[*] Note that the approximate date range may have been manually adjusted to capture the true dry-season minimum groundwater levels

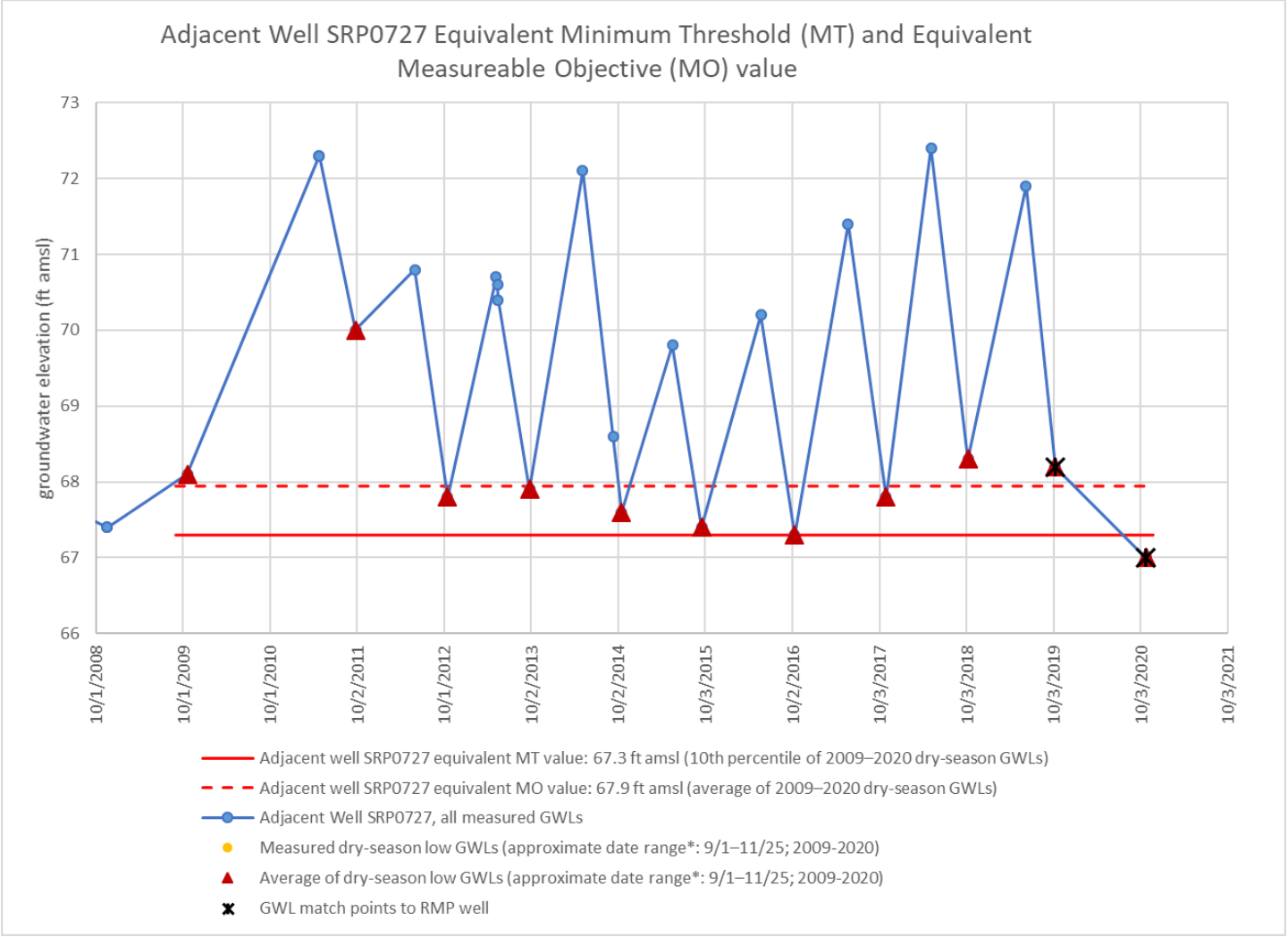


Figure 34: Measured groundwater levels at SRP0727, an adjacent well to RMP SRP0713, along with Minimum Threshold and Measureable Objective groundwater level proxy values for depletion of interconnected surface water by groundwater pumping.[*]

[*] Note that the approximate date range may have been manually adjusted to capture the true dry-season minimum groundwater levels

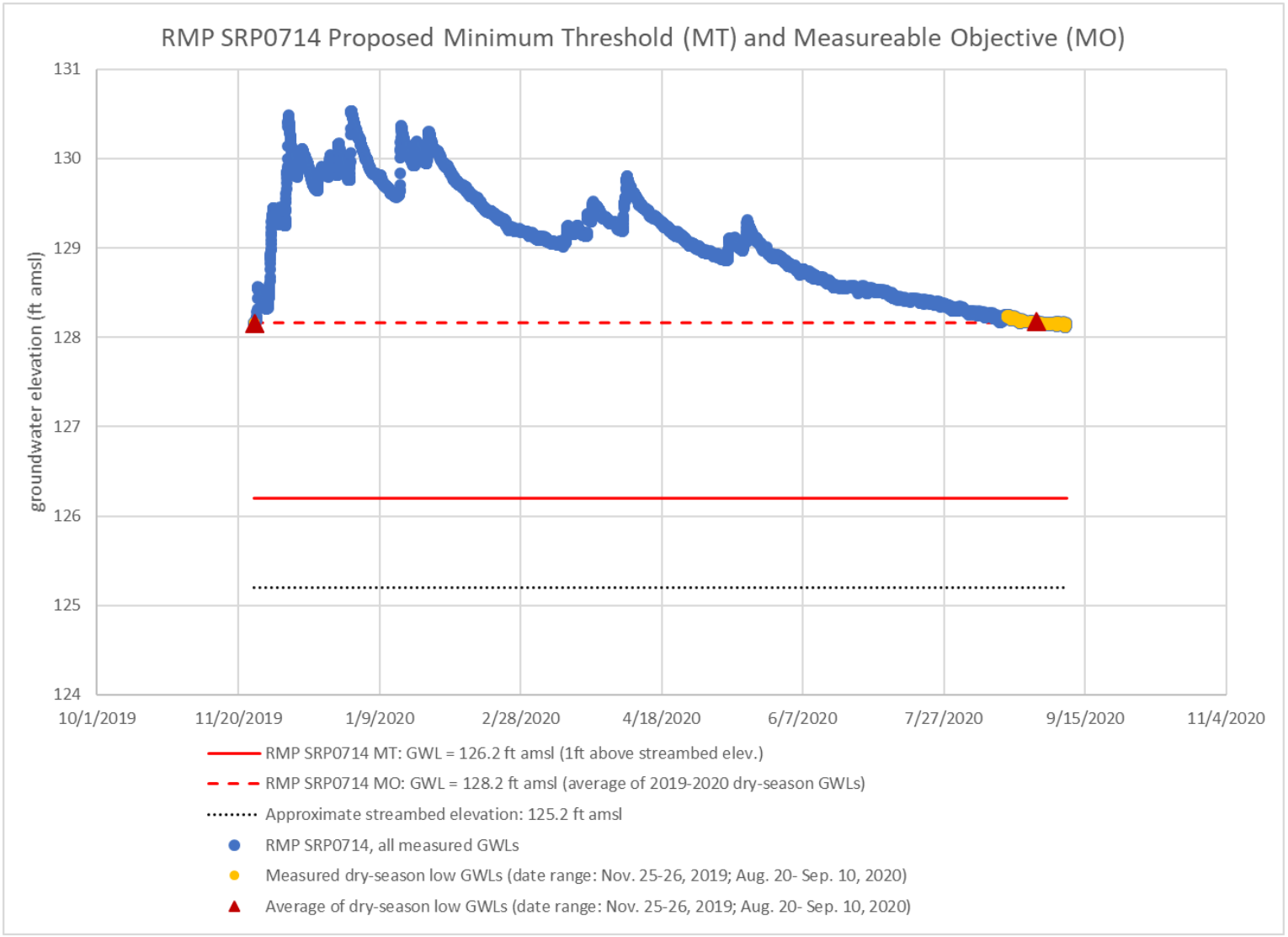


Figure 35: Measured groundwater levels at RMP SRP0714, along with Minimum Threshold and Measureable Objective groundwater level proxies for depletion of interconnected surface water by groundwater pumping.

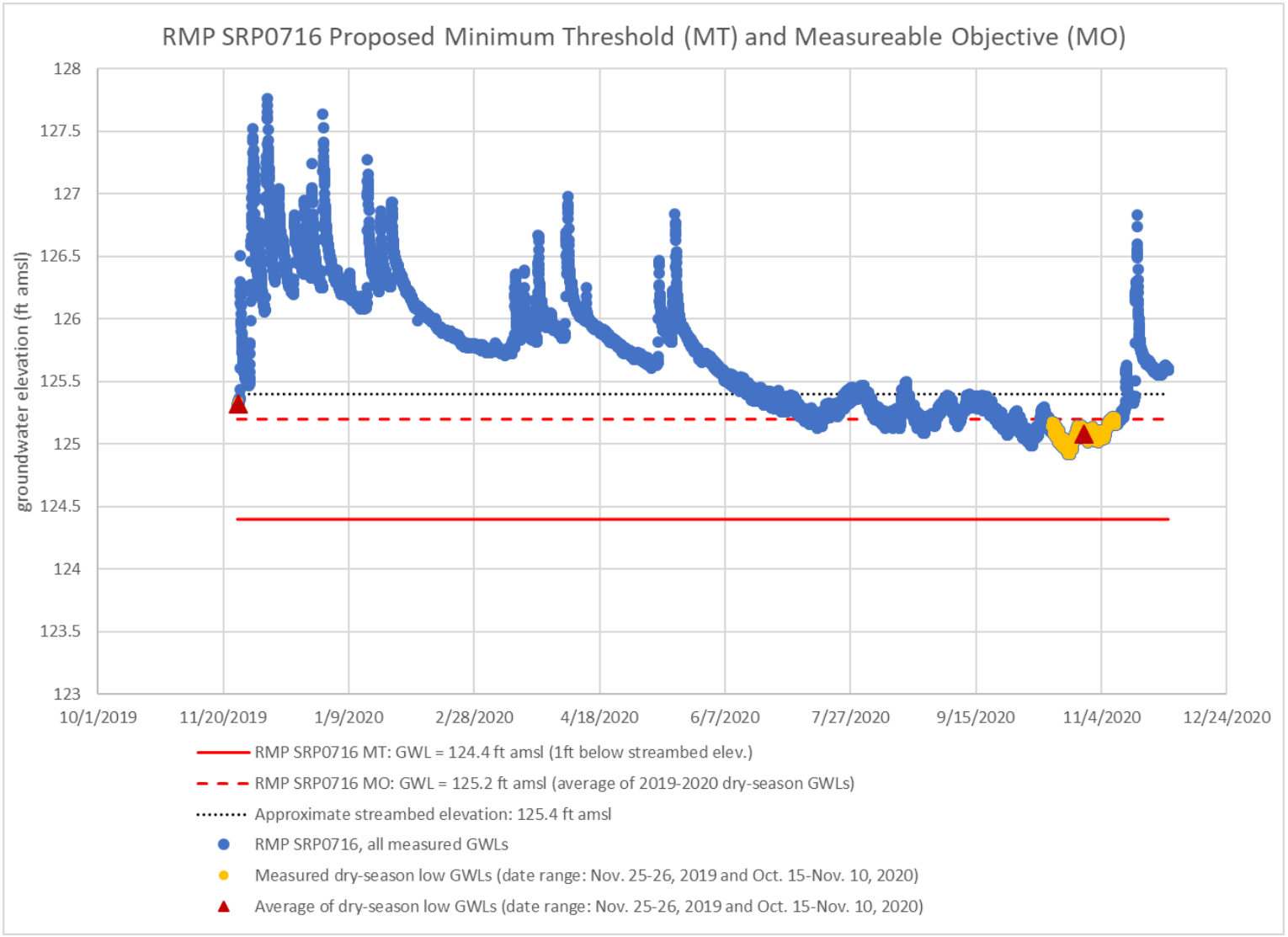


Figure 36: Measured groundwater levels at RMP SRP0714, along with Minimum Threshold and Measureable Objective groundwater level proxies for depletion of interconnected surface water by groundwater pumping.

5 Tables

5.1 Summary Table

Table 1: Summary table depletion of interconnected surface water SMCs at RMP locations.

RMP Well	Proposed MT (ft amsl)	Proposed MO (ft amsl)	MT Method	Number of Adjacent Wells Used	Simulated 2004–2018 SWD-GWL Correlation (R-squared)	Simulated Mean 2014–2016 GWL Percentile Ranking
SRP0707	111.4	118.1	adjacent-well match point	3	0.88	12.2
SRP0709	56.0	58.2	adjacent-well match point	2	0.93	10.0
SRP0711	63.3	63.7	adjacent-well match point	1	0.89	18.9
SRP0712	45.2	46.3	adjacent-well match point	1	0.66	14.4
SRP0713	57.9	58.4	adjacent-well match point	3	< 0.60	56.7*
SRP0714	126.2	128.2	1 ft. above streambed elevation	---	< 0.60	10.0
SRP0716	124.4	125.2	1 ft. below 2020 dry-season low GWL	---	0.87	10.0

notes:

*Median 10th-percentile substituted due to poor SWD-GWL correlation at RMP SRP0713.

RMP: Representative Monitoring Point

MT: Minimum Threshold

MO: Measurable Objective

GWL: Groundwater Level

SMC: Sustainable Management Criteria

5.2 RMP Adjacent Well Information

Table 2: Summary of adjacent well information used to establish SMCs with the match-point methodology for RMP SRP0707.

RMP SRP0707 Adjacent Well(s)						
RMP Well	**Adjacent Well**	**MT position relative to 2nd match point (units = 2019-2020 match-point difference)**	**MO position relative to 2nd match point (units = 2019-2020 match-point difference)**	**Distance and Direction of Adjacent Well from RMP Well**	**Adjacent Well Depth (ft bls)**	**Adjacent Well Screened Interval (ft bls)**
SRP0707	SRP0052	0.45	1.38	3200 ft N	95	?
	SRP0374	-0.21	0.99	4800 ft W	60	40–60
	SRP0375	0.13	0.59	4800 ft W	140	120–140
		0.12	0.98	**<-- Avg. MT & MO position relative to 2nd match point**		
		111.4	118.1	**<-- Avg. calculated MT and MO at RMP well (ft amsl)**		

Table 3: Summary of adjacent well information used to establish SMCs with the match-point methodology for RMP SRP0709.

RMP SRP0709 Adjacent Well(s)						
RMP Well	**Adjacent Well**	**MT position relative to 2nd match point (units = 2019-2020 match-point difference)**	**MO position relative to 2nd match point (units = 2019-2020 match-point difference)**	**Distance and Direction of Adjacent Well from RMP Well**	**Adjacent Well Depth (ft bls)**	**Adjacent Well Screened Interval (ft bls)**
SRP0709	SRP0018	-0.76	0.11	7200 ft NE	89	?
	SRP0020	-0.21	0.47	7600 ft E	110	?
		-0.49	0.29	**<-- Avg. MT & MO position relative to 2nd match point**		
		56.0	58.2	**<-- Avg. calculated MT and MO at RMP well (ft amsl)**		

Table 4: Summary of adjacent well information used to establish SMCs with the match-point methodology for RMP SRP0711.

RMP SRP0711 Adjacent Well(s)						
RMP Well	**Adjacent Well**	**MT position relative to 2nd match point (units = 2019-2020 match-point difference)**	**MO position relative to 2nd match point (units = 2019-2020 match-point difference)**	**Distance and Direction of Adjacent Well from RMP Well**	**Adjacent Well Depth (ft bls)**	**Adjacent Well Screened Interval (ft bls)**
SRP0711	SRP0357	0.00	0.28	5150 ft NW	80	60-80
		0.00	0.28	**<-- Avg. MT & MO position relative to 2nd match point**		
		63.3	63.7	**<-- Avg. calculated MT and MO at RMP well (ft amsl)**		

Table 5: Summary of adjacent well information used to establish SMCs with the match-point methodology for RMP SRP0712.

RMP SRP0712 Adjacent Well(s)						
RMP Well	**Adjacent Well**	**MT position relative to 2nd match point (units = 2019-2020 match-point difference)**	**MO position relative to 2nd match point (units = 2019-2020 match-point difference)**	**Distance and Direction of Adjacent Well from RMP Well**	**Adjacent Well Depth (ft bls)**	**Adjacent Well Screened Interval (ft bls)**
SRP0712	SRP0010	-1.28	-0.56	2850 ft S	110	?
		-1.28	-0.56	**<-- Avg. MT & MO position relative to 2nd match point**		
		45.2	46.3	**<-- Avg. calculated MT and MO at RMP well (ft amsl)**		

Table 6: Summary of adjacent well information used to establish SMCs with the match-point methodology for RMP SRP0713.

RMP SRP0713 Adjacent Well(s)						
RMP Well	**Adjacent Well**	**MT position relative to 2nd match point (units = 2019-2020 match-point difference)**	**MO position relative to 2nd match point (units = 2019-2020 match-point difference)**	**Distance and Direction of Adjacent Well from RMP Well**	**Adjacent Well Depth (ft bls)**	**Adjacent Well Screened Interval (ft bls)**
SRP0713	SRP0309	0.09	0.62	4700 ft NE	42	10–40
	SRP0305	0.39	0.90	320 ft NE	42	10–40
	SRP0727	0.25	0.79	5400 ft E	28	?
		0.24	0.77	**<-- Avg. MT & MO position relative to 2nd match point**		
		57.9	58.4	**<-- Avg. calculated MT and MO at RMP well (ft amsl)**		

Appendix 5-A
Monitoring Protocols

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Appendix 5-A

Monitoring Protocols
Santa Rosa Plain Groundwater Subbasin

In accordance with the GSP Regulations, monitoring protocols have been established for the Santa Rosa Plain Groundwater Subbasin monitoring networks. The following monitoring protocols, intended to ensure the quality and consistency of data, are adapted from DWR's BMPs for Monitoring Protocols, Standards and Sites (DWR 2016).

General Well Monitoring Information

- Long-term access agreements should be maintained for each monitoring site. Access agreements should include year-round site access to allow for increased monitoring frequency. At the time of GSP submittal, some sites included in the monitoring networks for GSP implementation may lack or have outdated access agreements. A Subbasin-wide inventory of access agreement status and efforts to standardize access agreements will be conducted in the early phases of GSP implementation.

- Each monitoring site shall have unique identifier and documentation should include a general written description of the site location, date established, access instructions and point of contact (if necessary), type of information to be collected, latitude, longitude, and elevation. Each monitoring location should also track all modifications to the site in a modification log. This information is stored in the Data Management System (DMS).

- Groundwater elevation data from Spring and Fall semi-annual measurement events will form the basis of Basin-wide potentiometric surface maps and should approximate conditions at a discrete period in time. Therefore, all groundwater-level measurements for the semi-annual events should be collected within as short a time as possible, preferably within a 1-to-2-week period.

- Depth to groundwater must be measured relative to an established Reference Point (RP) on the well casing. The RP is usually identified with a permanent marker, paint spot, or a notch in the lip of the well casing. By convention in open casing monitoring wells, the RP reference point is located on the north side of the well casing. If no mark is apparent, the person performing the measurement should measure the depth to groundwater from the north side of the top of the well casing.

- The elevation of the RP of each well must be surveyed to the North American Vertical Datum of 1988 (NAVD88), or a local datum that can be converted to NAVD88. The elevation of the RP must be accurate to within 0.5 foot. It is preferable for the RP elevation to be accurate to 0.1 foot or less. At the time of GSP submittal, some sites included in the monitoring networks for

GSP implementation lack sufficient RP survey data. Information related to this data gap, including plans to address it, is included in Section 5 of this GSP.

- Depth to groundwater must be measured to an accuracy of 0.1 foot below the RP. It is preferable to measure depth to groundwater to an accuracy of 0.01 foot. Air lines and acoustic sounders may not provide the required accuracy of 0.1 foot. While the GSA recognizes that acoustic sounders may not produce data as accurate as that produced by electronic sounding tape or steel tape, for certain privately owned wells in voluntary monitoring programs, an acoustic sounder may be used if requested by the well owner or deemed the only feasible measurement device. For all groundwater-level measurements, the measurement device type shall be noted.

Groundwater-Level Measurement and Field Data Recording Protocols

- The sampler should remove the appropriate cap, lid, or plug that covers the monitoring access point listening for pressure release. If a release is observed, the measurement should follow a period of time to allow the water level to equilibrate. For measuring wells that are under pressure, multiple measurements should be collected to ensure the well has reached equilibrium such that no significant changes in water level are observed. Every effort should be made to ensure that a representative stable depth to groundwater is recorded. If a well does not stabilize, the quality of the value should be appropriately qualified as a questionable measurement. In the event that a well is artesian, site-specific procedures should be developed to collect accurate information and be protective of safety conditions associated with a pressurized well.

- Measure depth to water in the well using procedures appropriate for the measuring device. A typical measuring device should be an electronic sounding tape (electronic water-level meter) capable of 0.01-foot accuracy unless conditions at a particular well require an alternate type of measuring device. Equipment must be operated and maintained in accordance with manufacturer's instructions. Groundwater levels should be measured to the nearest 0.01 foot relative to the RP.

- The sampler should calculate the groundwater elevation as:

  GWE = RPE – DTW

  Where:
  GWE = Groundwater Elevation
  RPE = Reference Point Elevation
  DTW = Depth to Water

  The sampler must ensure that all measurements are in consistent units of feet, tenths of feet, and hundredths of feet. Measurements and RPEs should not be recorded in feet and inches.

- The sampler should record the well identifier, date, time (24-hour format), RPE, height of RP above or below ground surface, DTW, GWE, and comments regarding any factors that may influence the depth to water readings such as weather, nearby irrigation, flooding, potential for tidal influence, or well condition. If there is a questionable measurement or the measurement cannot be obtained, it should be noted. Standardized field forms should be used for all data collection.

- The sampler should replace any well caps or plugs and lock any well buildings or covers.

- The water-level meter and/or any other downhole equipment should be decontaminated after measuring each well.

- All data should be entered into the DMS as soon as possible. Care should be taken to avoid data entry mistakes and the entries should be checked by a second person for quality assurance.

Pressure Transducer Protocols

Pressure transducers with dataloggers are used in many dedicated monitoring wells and inactive supply wells in the Santa Rosa Plain Groundwater Subbasin monitoring networks to record groundwater-level, temperature, and conductivity data. The following monitoring protocols apply to the use of pressure transducers:

- When installing pressure transducers, care must be exercised to ensure that the data recorded by the transducers is confirmed with hand measurements.

- The sampler must use an electronic water-level meter and follow the protocols listed above to measure the groundwater level and calculate the groundwater elevation in the monitoring well to properly program and reference the pressure transducer installation. It is recommended that transducers record pressure or measured groundwater level to conserve data capacity; groundwater elevations can be calculated at a later time after downloading.

- The sampler must note the well identifier, the associated transducer serial number, transducer range, transducer accuracy, and cable serial number.

- Transducers must be able to record groundwater levels with an accuracy of at least 0.1 foot. Professional judgment should be exercised to ensure that the data being collected is meeting the monitoring objectives and that the instrument is capable. Consideration of the battery life, data storage capacity, range of groundwater level fluctuations, and natural pressure drift of the transducers should be included in the evaluation.

- The sampler must note whether each pressure transducer uses a vented or non-vented cable for barometric compensation. If non-vented units are utilized, they must be properly corrected for natural barometric pressure changes. This requires the consistent logging of barometric pressure to coincide with measurement intervals.

- Follow manufacturer specifications for installation, calibration, data logging intervals, battery life, correction procedure (if non-vented cables used), and anticipated life expectancy to assure that monitoring objectives are being met for the GSP.
- Secure the cable to the well head with a well dock or another reliable method. Mark the cable at the elevation of the reference point with tape or a permanent marker to allow for estimates of future cable slippage.

- Manual groundwater-level measurements should be collected in accordance with the procedures outlined above at least semi-annually to confirm the accuracy of transducer data and monitor for electronic drift or cable movement.

- The data should be downloaded as necessary (at least semi-annually) to ensure no data is lost and entered into the Data Management System following established protocols as soon as possible. Data collected with non-vented data logger cables should be corrected for atmospheric barometric pressure changes, as appropriate. After the sampler is confident that the transducer data have been safely downloaded and stored, the data should be deleted from the data logger to ensure that adequate data logger memory remains.

Protocols for Installation of New Monitoring Wells

It is anticipated that several new dedicated monitoring wells will be installed to fill data gaps during GSP implementation. The design, installation, and documentation of new monitoring wells must consider the following:

- Construction consistent with California Well Standards as described in Bulletins 74-81 and 74-90, and local permitting agency standards of practice.

- Logging of borehole cuttings under the supervision of a California Professional Geologist and described consistent with the Unified Soil Classification System methods according to ASTM standard D2487-11.

- Written criteria for logging of borehole cuttings for comparison to known geologic formations, principal aquifers and aquitards/aquicludes, or specific marker beds to aid in consistent stratigraphic correlation within and across basins, to the extent feasible.

- Geophysical surveys of boreholes to aid in consistency of logging practices, when funding allows. Methodologies should include resistivity, spontaneous potential, spectral gamma, or other methods as appropriate for the conditions. Selection of geophysical methods should be based upon the opinion of a professional geologist or professional engineer and address the objectives for the specific borehole and characterization needs.

- Ensure that the drilling contractor submits State well completion reports according to the requirements of §13752. Well completion report documentation should include geophysical logs, detailed geologic log, and formation identification as attachments, if available.

Groundwater Quality Monitoring Protocols

In general, the GSP relies on water quality data generated through existing programs. In some cases, it may be necessary to collect additional water quality data to support monitoring programs or evaluate specific projects. The USGS National Field Manual for the Collection of Water Quality Data (USGS, 2018) should be used to guide the collection of reliable data.

While specific groundwater sampling protocols vary depending on the constituent being sampled for, the protocols listed below provide guidance which is applied to all groundwater quality sampling.

- Prior to sampling, the sampler must contact the laboratory to schedule laboratory time, obtain appropriate sample containers, and clarify any sample holding times or sample preservation requirements.

- Each well used for groundwater quality monitoring must have a unique identifier. This identifier should appear on the well housing or the well casing to avoid confusion.

- In the case of wells with dedicated pumps, samples should be collected at or near the wellhead. Samples should not be collected from storage tanks, at the end of long pipe runs, or after any water treatment.

- The sampler should clean the sampling port and/or sampling equipment and the sampling port and/or sampling equipment must be free of any contaminants. The sampler must decontaminate sampling equipment between sampling locations or wells to avoid cross-contamination between samples.

- The groundwater elevation in the well should be measured following the protocols described above.

- For any well not equipped with low-flow or passive sampling equipment, an adequate volume of water should be purged from the well to ensure that the groundwater sample is representative of ambient groundwater and not stagnant water in the well casing. Purging three well casing volumes is generally considered adequate. Professional judgment should be used to determine the proper configuration of the sampling equipment with respect to well construction such that a representative ambient groundwater sample is collected. If pumping causes a well to be evacuated (go dry), document the condition and allow well to recover to within 90% of original level prior to sampling.

- Field parameters of pH, electrical conductivity, and temperature should be collected for each sample. Field parameters should be evaluated during the purging of the well and should stabilize prior to sampling. Other parameters, such as oxidation-reduction potential (ORP), dissolved oxygen (DO - in situ measurements preferable), or turbidity, may also be useful for meeting monitoring objectives and assessing purge conditions. All field instruments should be calibrated daily and evaluated for drift throughout the day.

- Sample containers should be labeled prior to sample collection. The sample label must include: sample ID (often well ID), sample date and time, sample personnel, sample location, preservative used, and analytes and analytical method.

- Samples should be collected under laminar flow conditions. This may require reducing pumping rates prior to sample collection.

- All samples requiring preservation must be preserved as soon as practically possible, ideally at the time of sample collection. Ensure that samples are appropriately filtered as recommended for the specific analyte. Entrained solids can be dissolved by preservative leading to inconsistent results of dissolve analytes. Specifically, samples to be analyzed for metals should be field-filtered prior to preservation; do not collect an unfiltered sample in a preserved container.

- Samples should be chilled and maintained at 4 °C to prevent degradation of the sample. The laboratory's Quality Assurance Management Plan should detail appropriate chilling and shipping requirements.

- Samples must be transported under chain of custody documentation to the appropriate laboratory promptly to avoid violating holding time restrictions.

- Instruct the laboratory to use reporting limits that are equal to or less than applicable Sustainable Management Criteria values or regional water quality objectives/screening levels.

Protocols for Measuring Streamflow

Monitoring of streamflow is necessary for incorporation into water budget analysis and for use in evaluation of stream depletions associated with groundwater extractions. The use of existing streamflow monitoring locations is incorporated into the Subbasin's monitoring networks to the greatest extent possible.

Establishment of new streamflow discharge sites should consider the existing network and the objectives of the new location. Professional judgment should be used to determine the appropriate permitting that may be necessary for the installation of any monitoring locations along surface water bodies. Regular frequent access will be necessary to these sites for the development of ratings curves and maintenance of equipment.

To establish a new streamflow monitoring station special consideration must be made in the field to select an appropriate location for measuring discharge. Once a site is selected, development of a relationship of stream stage to discharge will be necessary to provide continuous estimates of streamflow. Several measurements of discharge at a variety of stream stages will be necessary to develop the ratings curve correlating stage to discharge. The use of Acoustic Doppler Current Profilers (ADCPs) can provide accurate estimates of discharge in the correct settings. Professional judgment must be exercised to determine the appropriate methodology. Following development of the ratings curve a

simple stilling well and pressure transducer with data logger can be used to evaluate stage on a frequent basis.

Streamflow measurements should be collected, analyzed, and reported in accordance with the procedures outlined in USGS Water Supply Paper 2175, Volume 1. – Measurement of Stage Discharge and Volume 2. – Computation of Discharge (Rantz and others, 1982). This methodology is currently used by both the USGS and DWR for existing streamflow monitoring throughout the State.

Protocols for Monitoring Land Subsidence

Evaluating and monitoring inelastic land subsidence can utilize multiple data sources to evaluate the specific conditions and associated causes. At the time of GSP submittal, the GSA generally relies on existing Interferometric Synthetic Aperture Radar (InSAR) data and data from continuous GPS (CGPS) stations. Subsidence can also be estimated from numerous other techniques including: level surveying tied to known stable benchmarks or benchmarks located outside the area being studied for possible subsidence; installing and tracking changes in borehole extensometers; or obtaining data from static GPS surveys or Real-Time-Kinematic (RTK) surveys. No standard procedures exist for collecting data from the potential subsidence monitoring approaches. However, an approach may include:

Identification of Land Subsidence Conditions

- Evaluation of existing regional long-term leveling surveys of regional infrastructure, i.e., roadways, railroads, canals, and levees.

- Inspection of existing County and State well records where collapse has been noted for well repairs or replacement.

- Determining if significant fine-grained layers are present such that the potential for collapse of the units could occur should there be significant depressurization of the aquifer system.

- Inspection of geologic logs and the hydrogeologic conceptual model to aid in identification of specific units of concern.

- Analysis of regional remote-sensing information such as InSAR.

- Review of seismic related data and records that might explain land subsidence observations.

- Review of groundwater elevation measurements and trends in Representative Monitoring Points (established as part of groundwater-level Sustainable Management Criteria) and other nearby wells being monitored, including an assessment as to whether groundwater levels are below historical lows or exceeding Minimum Thresholds.

- Evaluation of known or estimated groundwater pumping patterns within the vicinity of any observed potential land subsidence.

Monitor regions of suspected subsidence where potential exists

- Establish CGPS network to evaluate changes in land surface elevation.

- Establish leveling surveys transects to observe changes in land surface elevation.

- Establish extensometer network to observe land subsidence. Extensometer design should be based on local conditions, professional judgement, and monitoring objectives.

Standards and guidance documents for collecting data for land subsidence monitoring include:

- GPS and Leveling surveys must follow surveying standards set out in the California Department of Transportation's Caltrans Surveys Manual (California Department of Transportation, various dates).

- Instruments installed in borehole extensometers must follow the manufacturer's instructions for installation, care, and calibration.

References

- California Department of Transportation, various dates. *Caltrans Surveys Manual*.
- California Department of Water Resources (DWR). 2016. *Best Management Practices for the Sustainable Management of Groundwater, Monitoring Protocols, Standards, and Sites*. December
- Rantz, S.E., and others, 1982. *Measurement and computation of streamflow*; U.S. Geological Survey, Water Supply Paper 2175.
- U.S. Geological Survey, 2018, *Preparations for water sampling*: U.S. Geological Survey Techniques and Methods, book 9, chap. A1.

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Appendix 5-B
Comparative Hydrographs – Chronic Lowering of Groundwater Levels Representative Monitoring Points

Figure 5--B-1. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-1

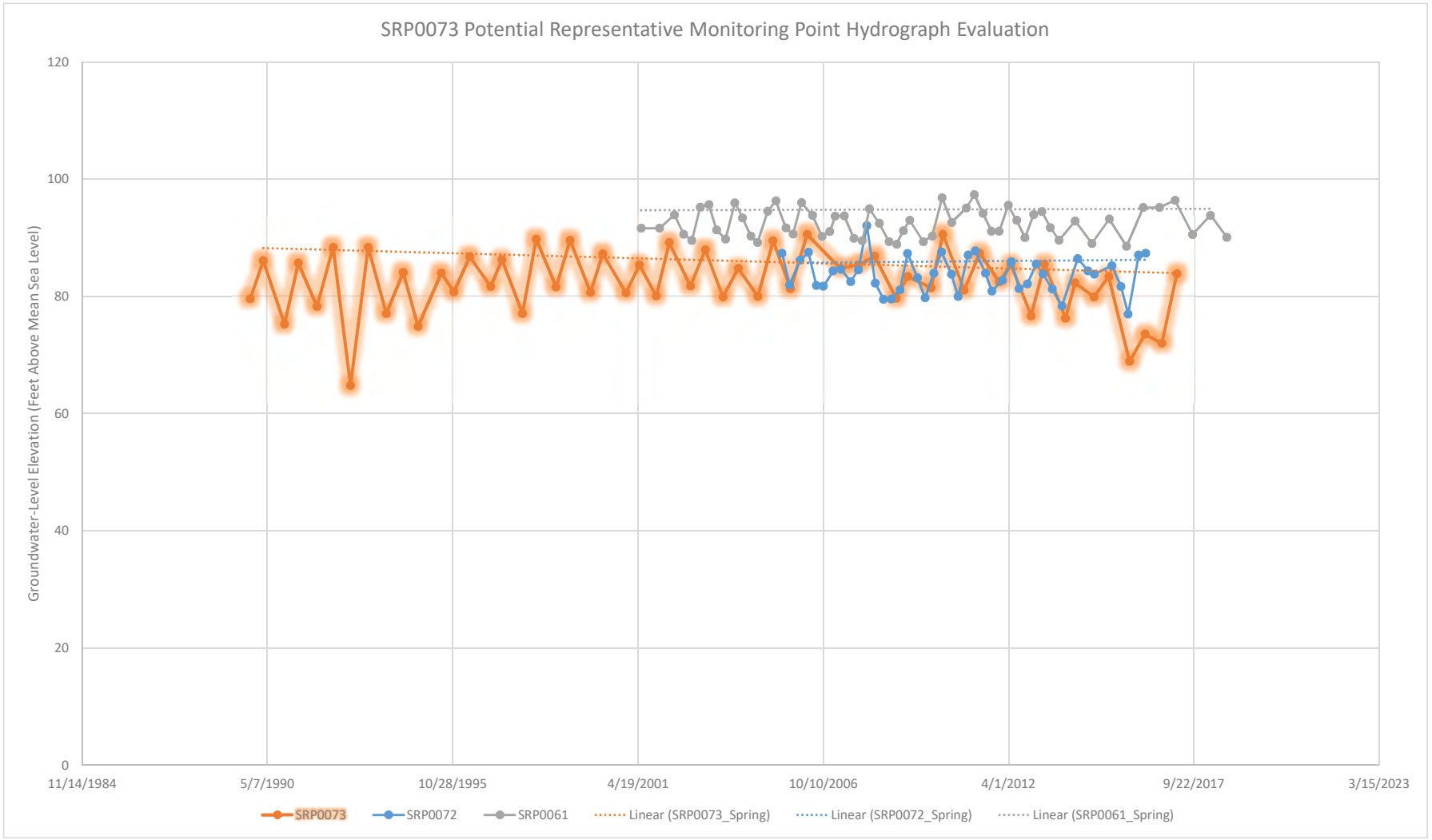


Figure 5-B-2. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-2

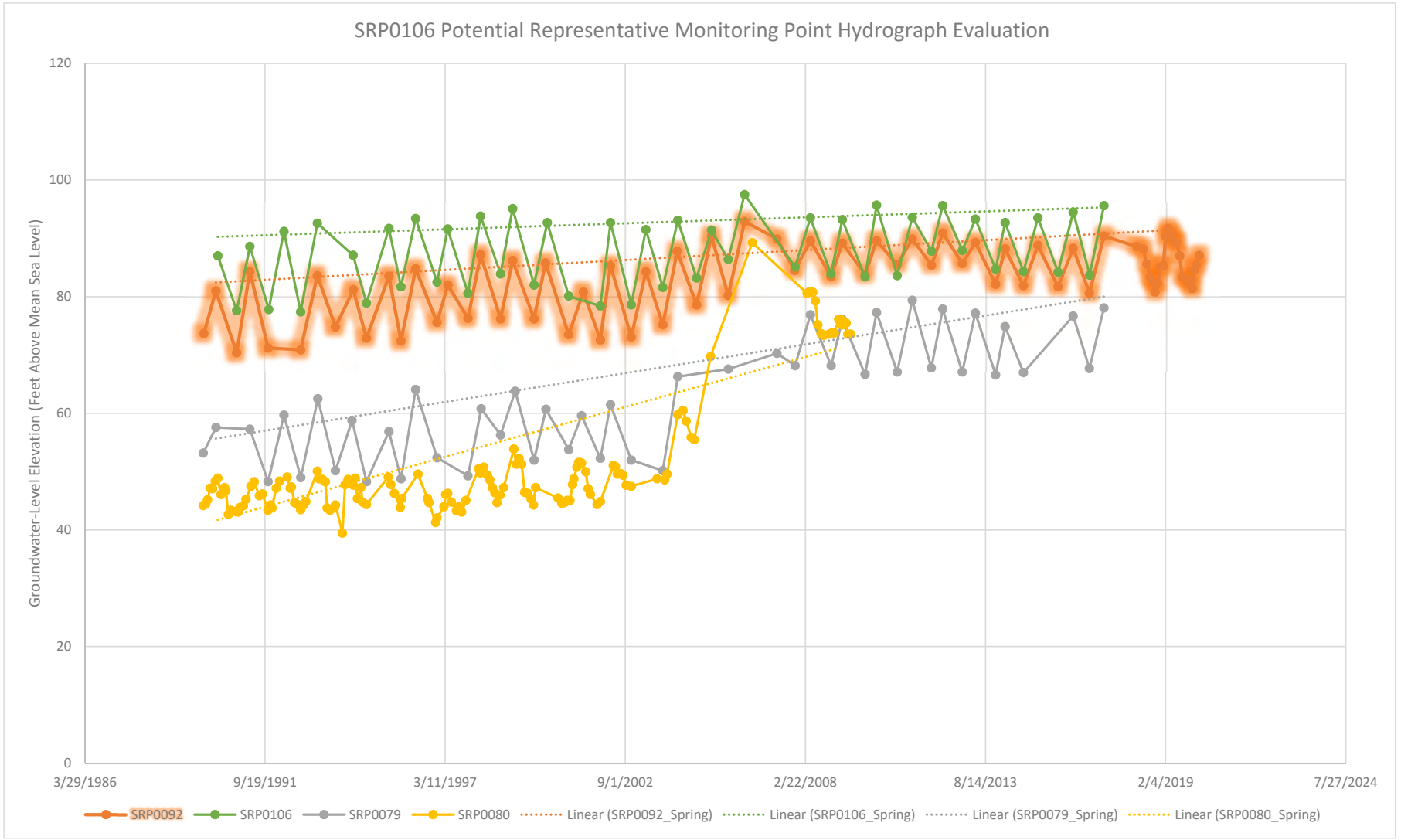


Figure 5-B-3. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-3

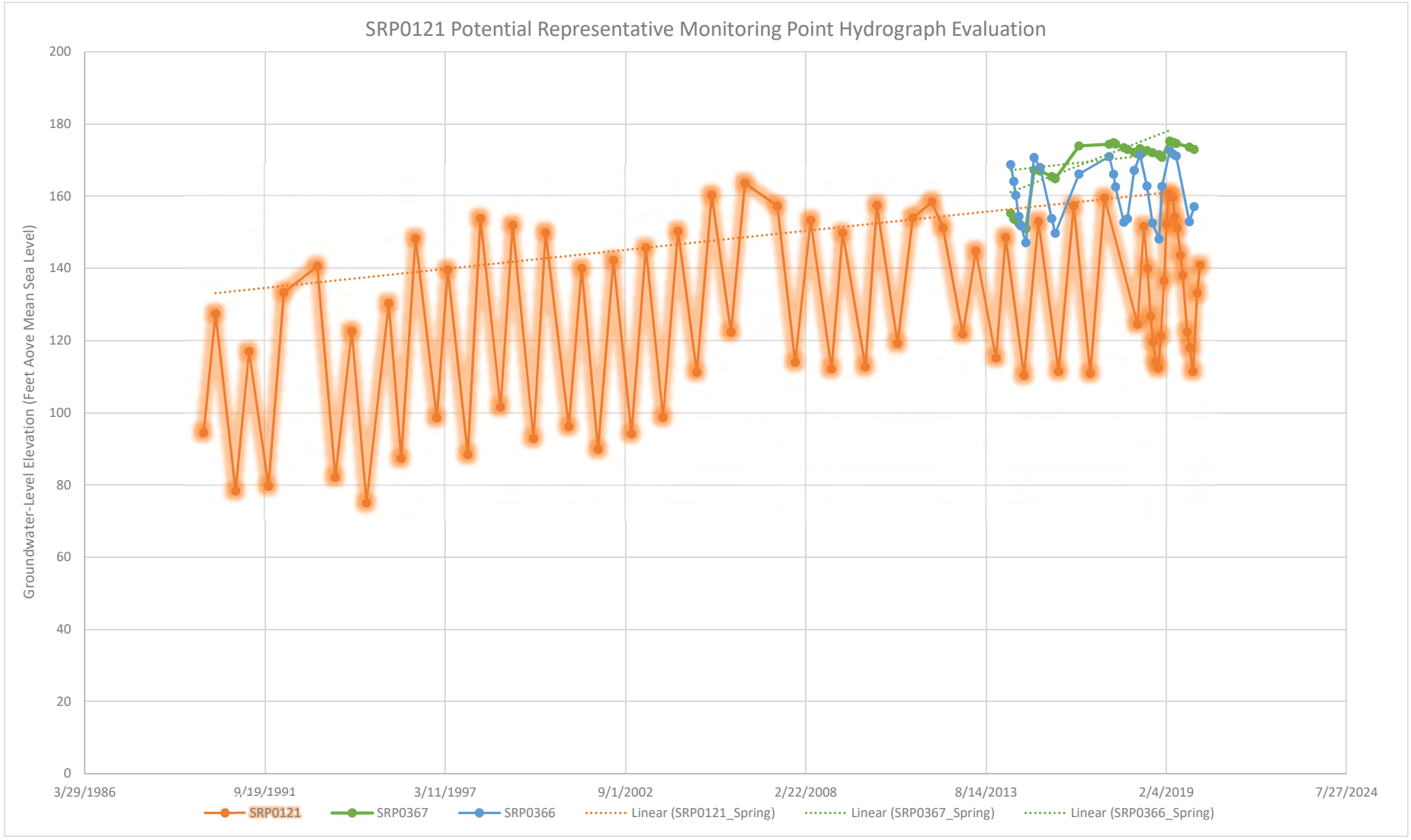


Figure 5-B-4. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-4

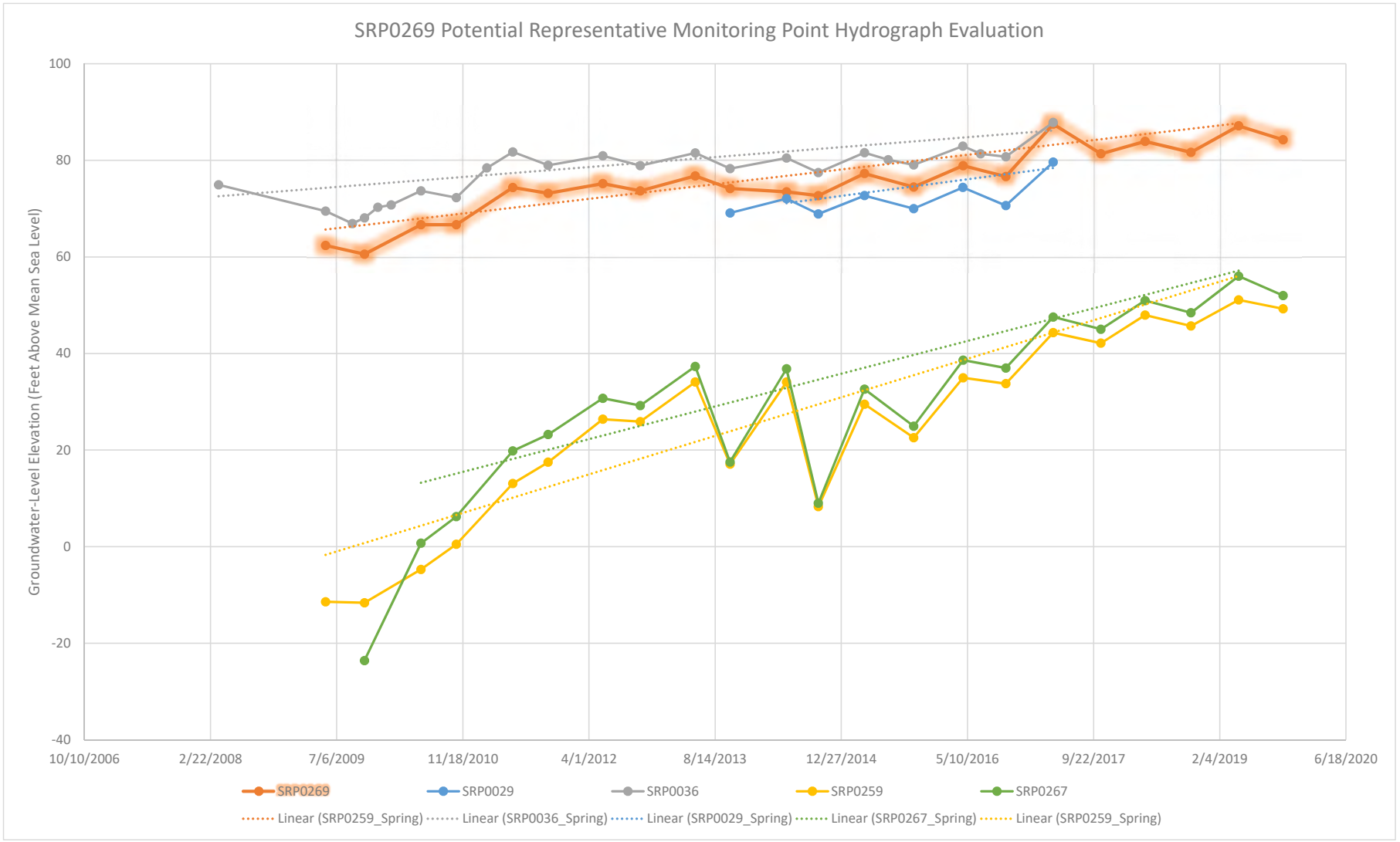


Figure 5-B-5. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-5

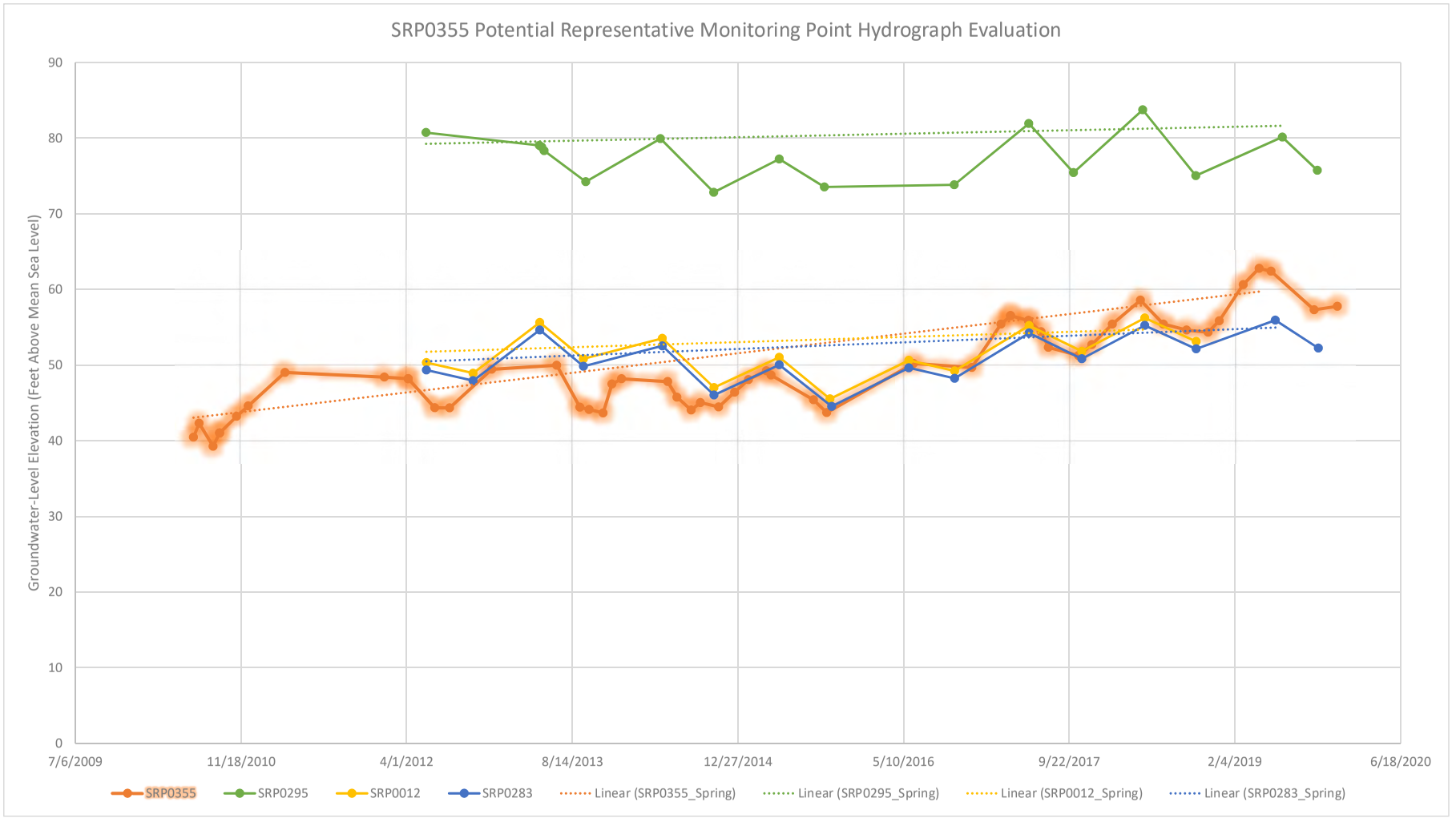


Figure 5-B-6. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-6

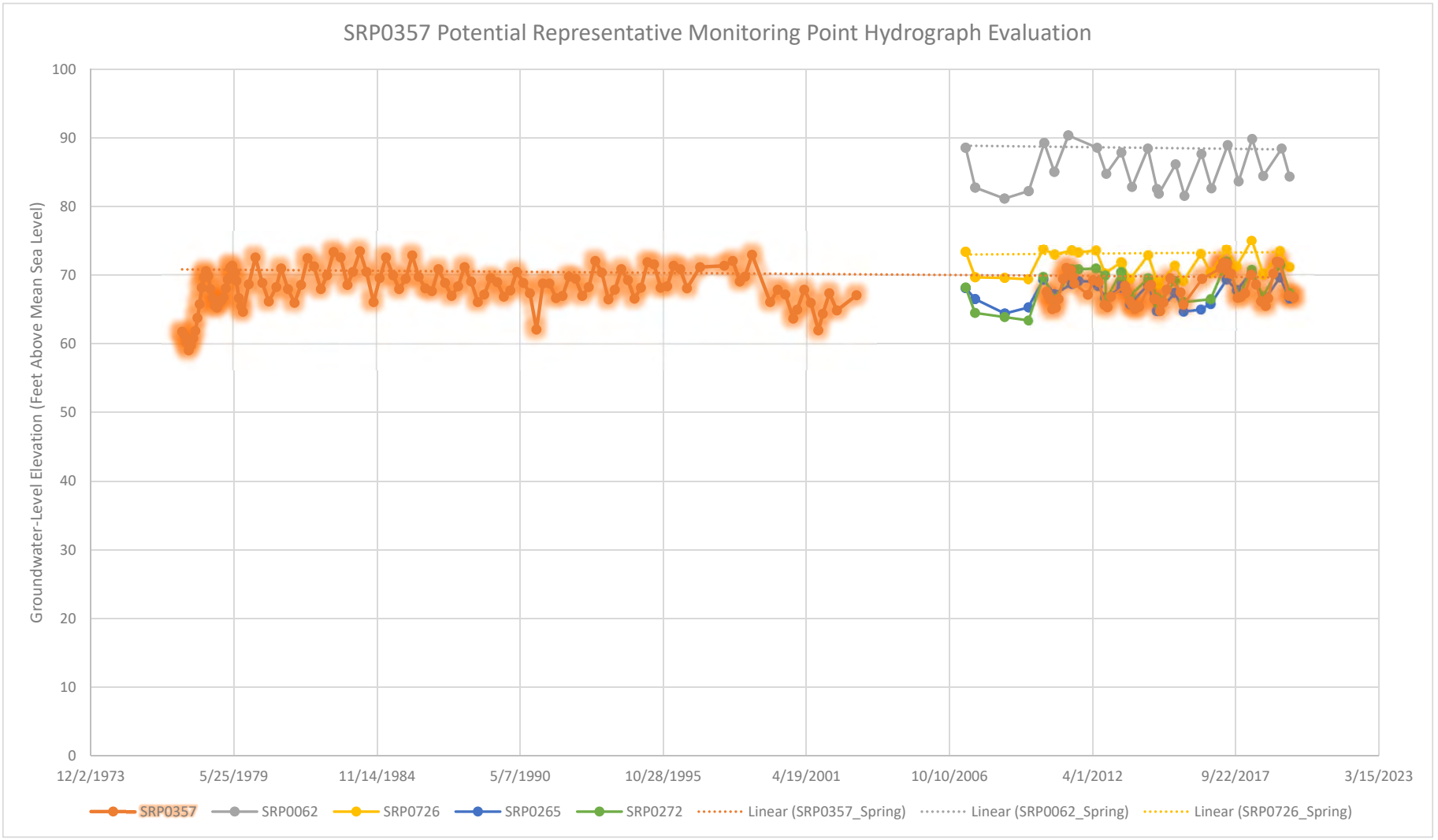


Figure 5-B-7. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-7

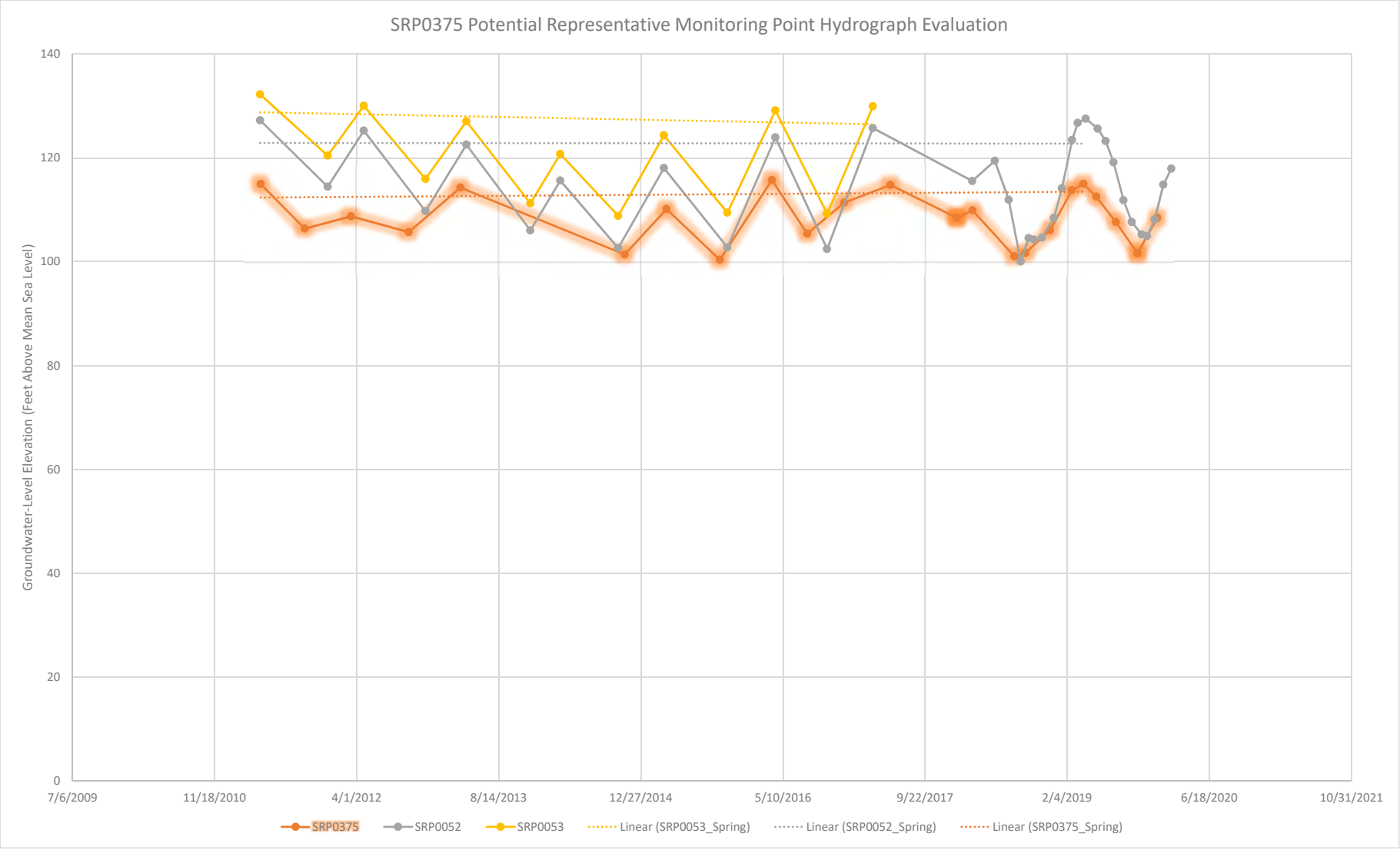


Figure 5-B-8. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-8

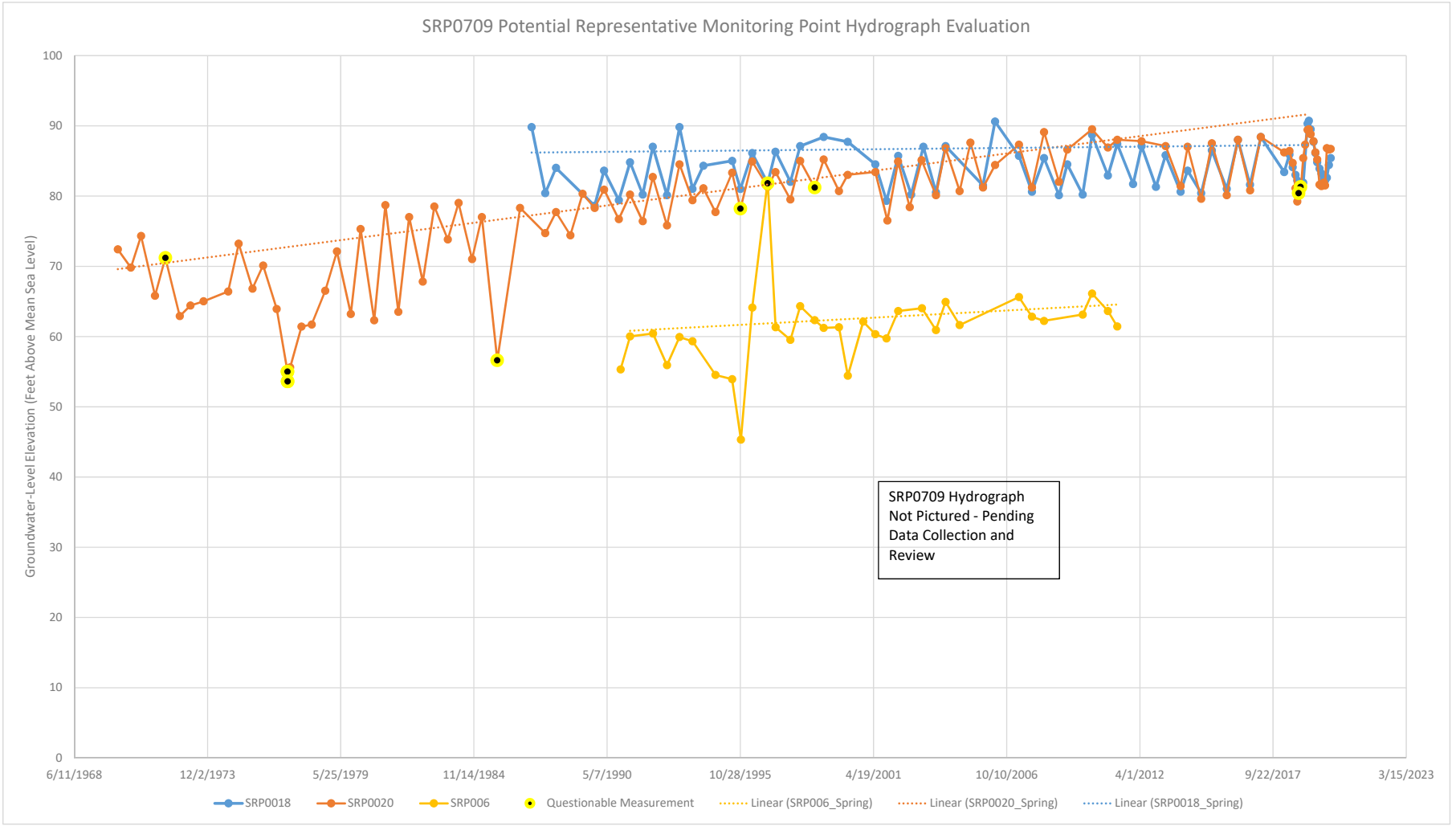


Figure 5-B-9 Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-9

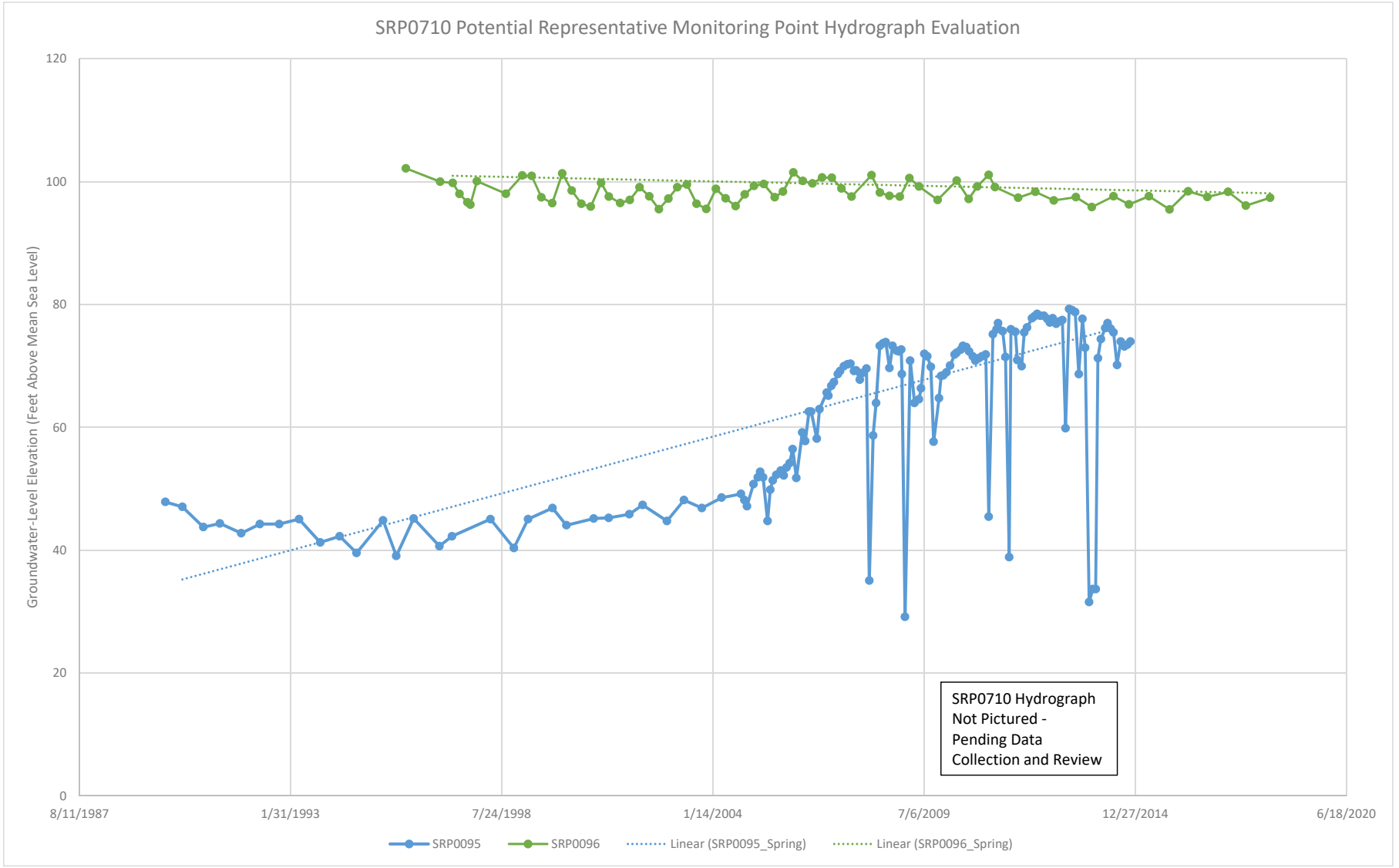


Figure 5-B-10 Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-10

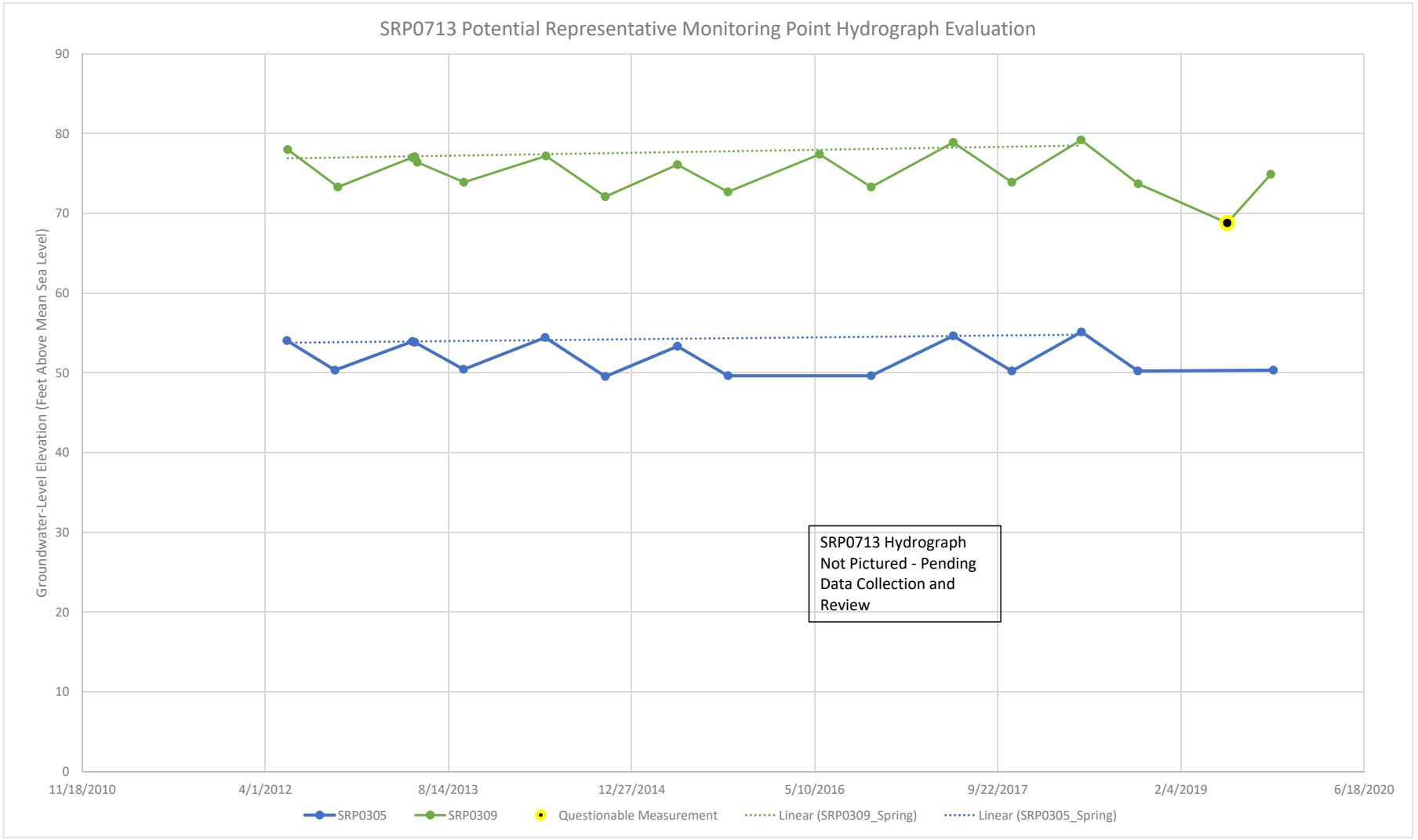


Figure 5-B-11. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-11

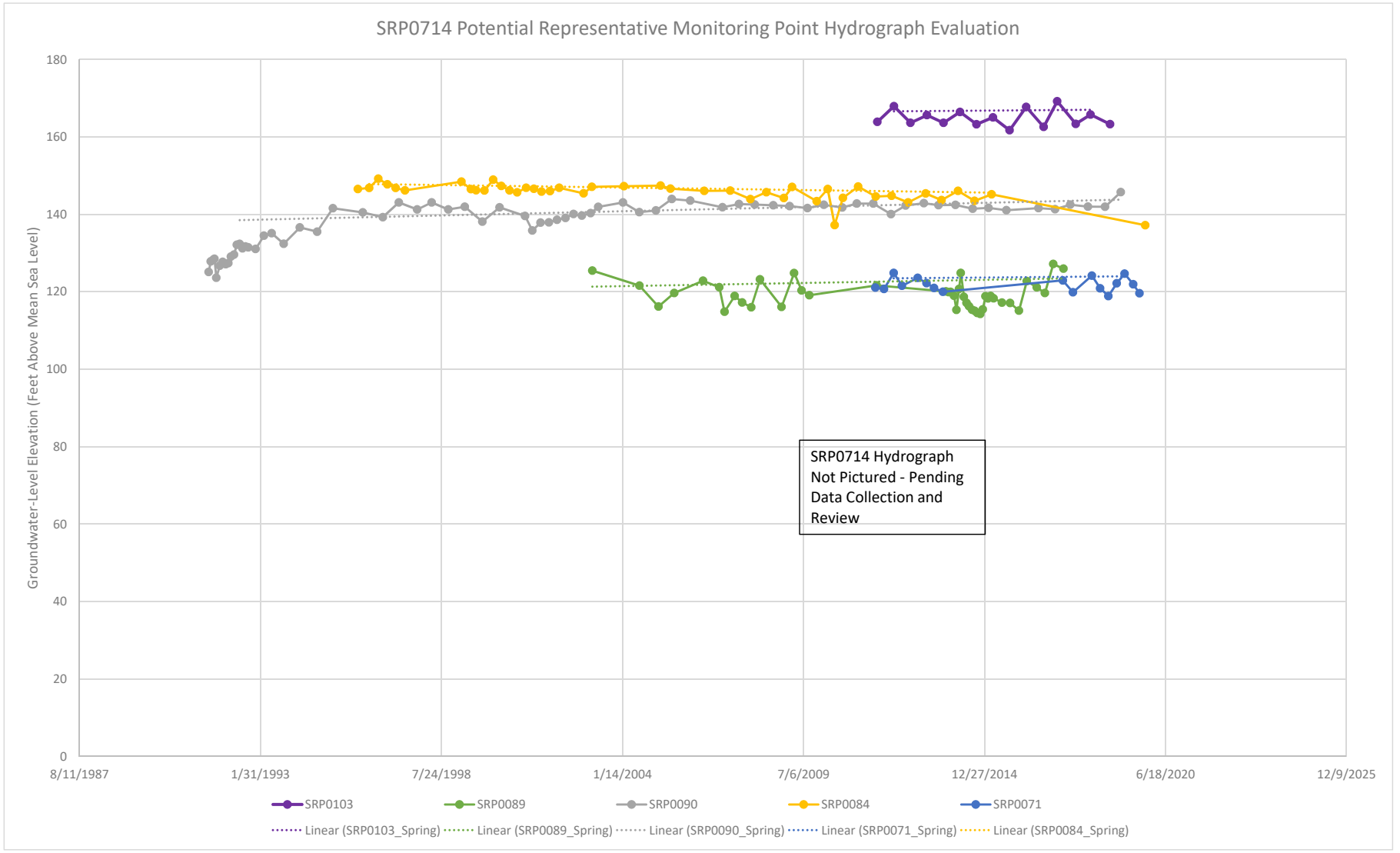


Figure 5-B-12. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-12

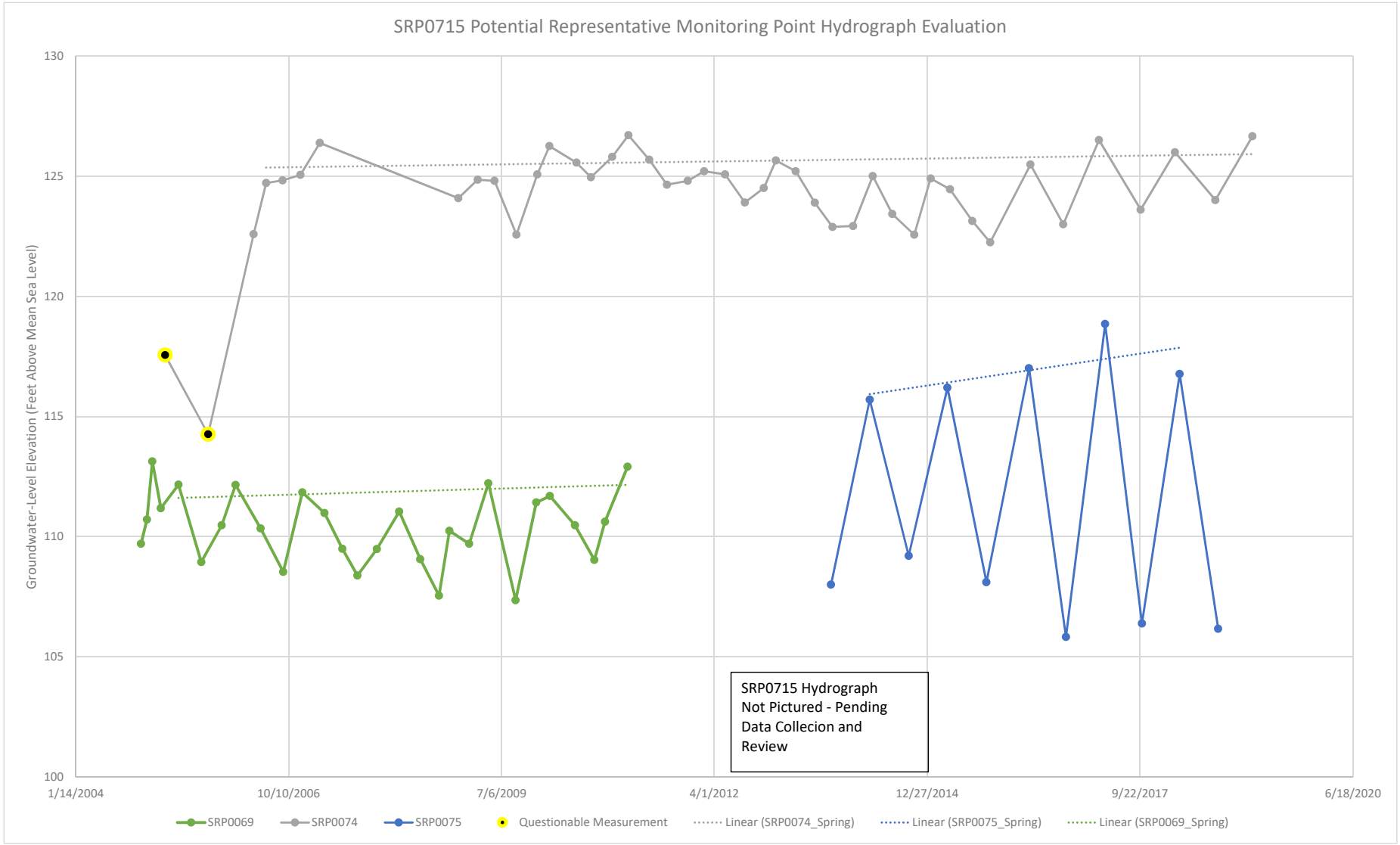


Figure 5-B-13. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-13

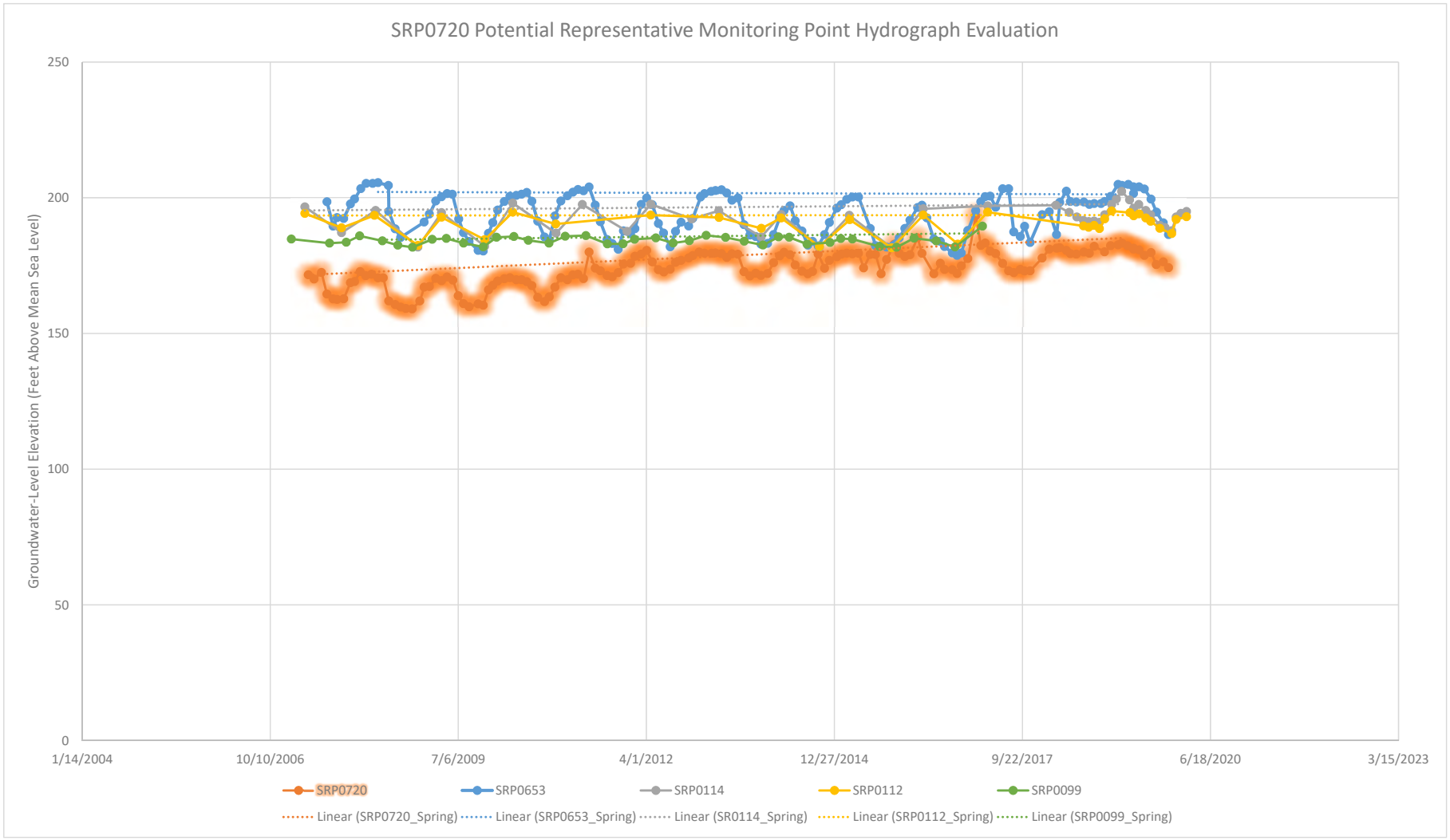


Figure 5-B-14. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-14

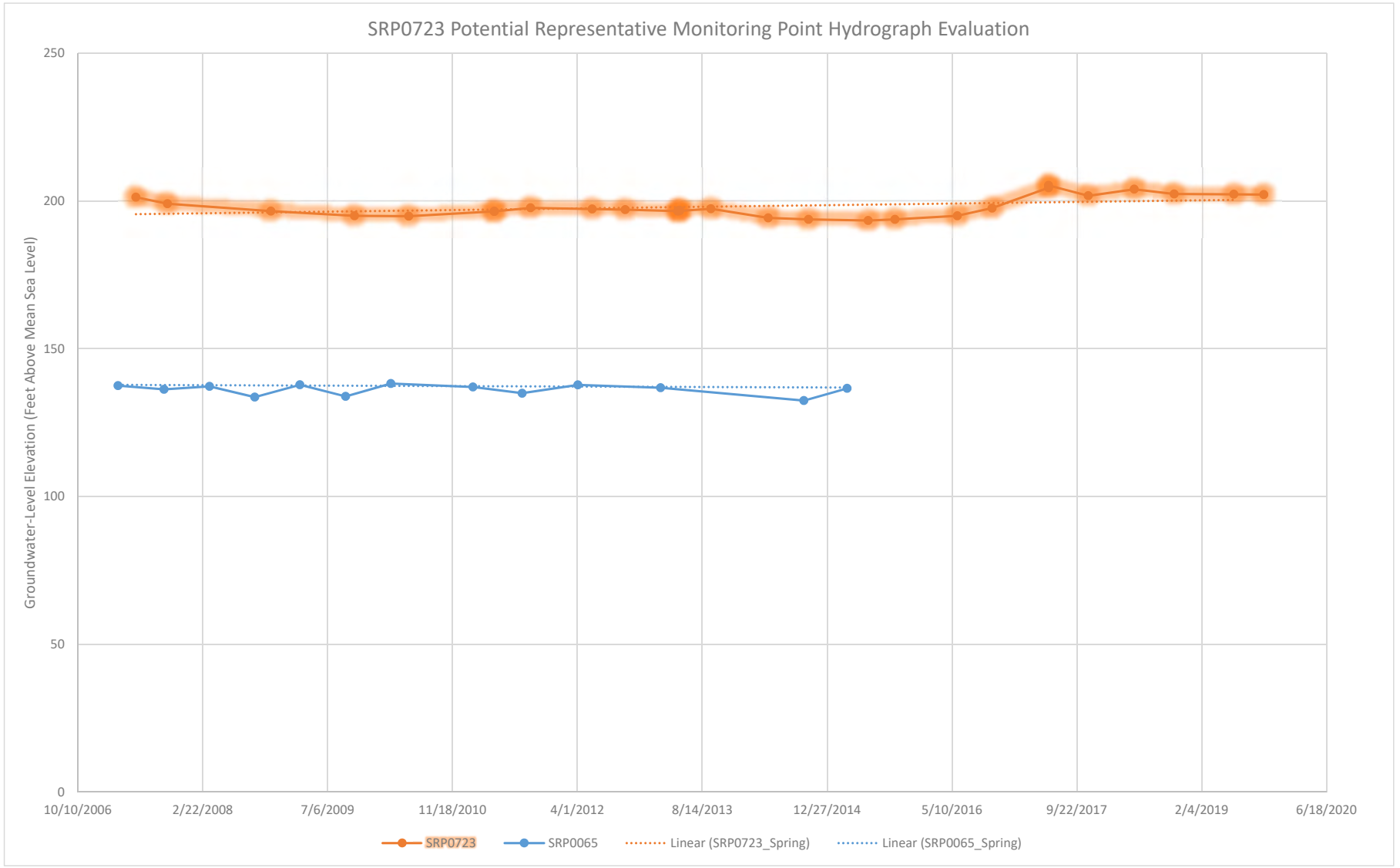


Figure 5-B-15. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-15

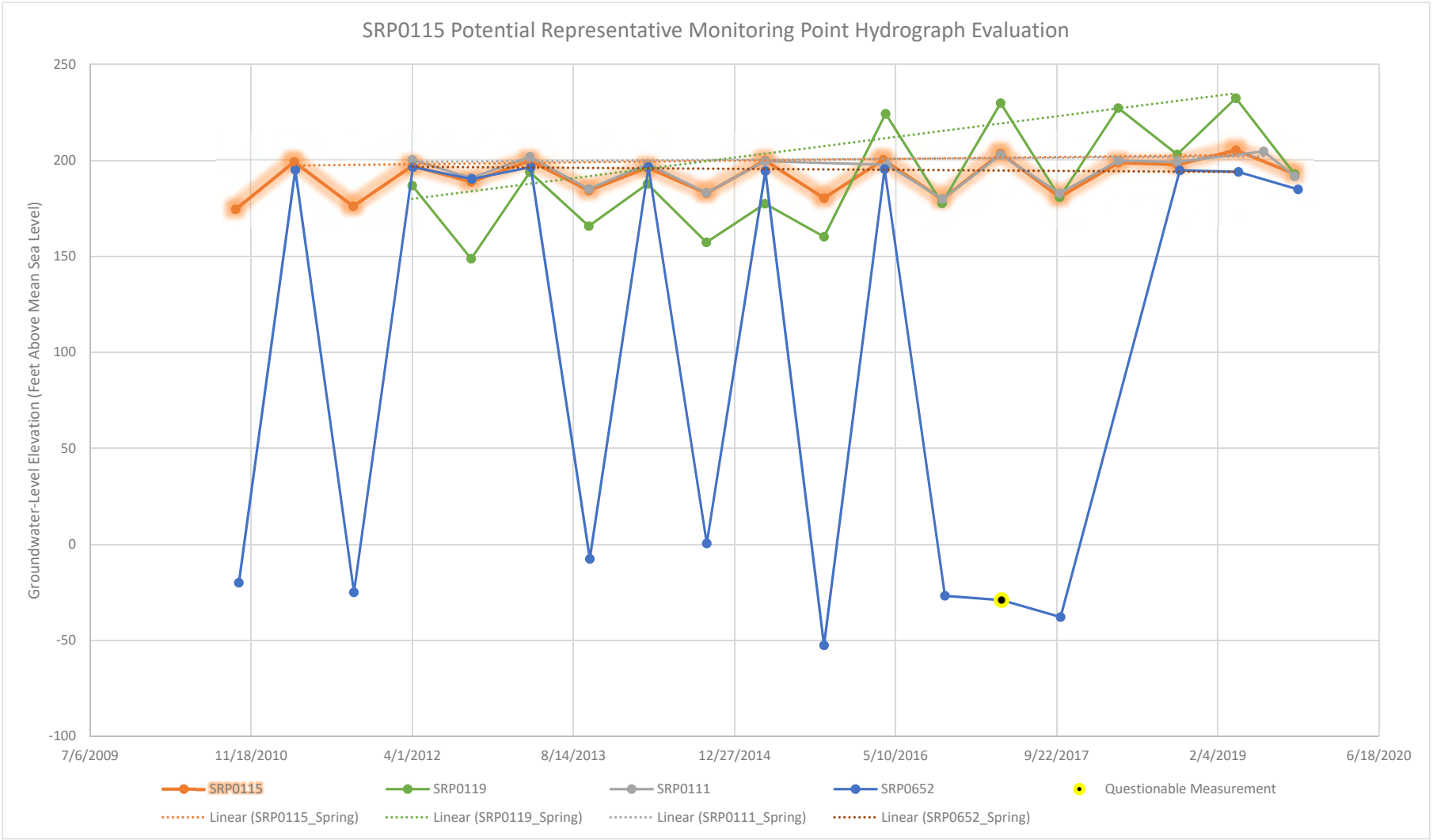


Figure 5-B-16. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-16

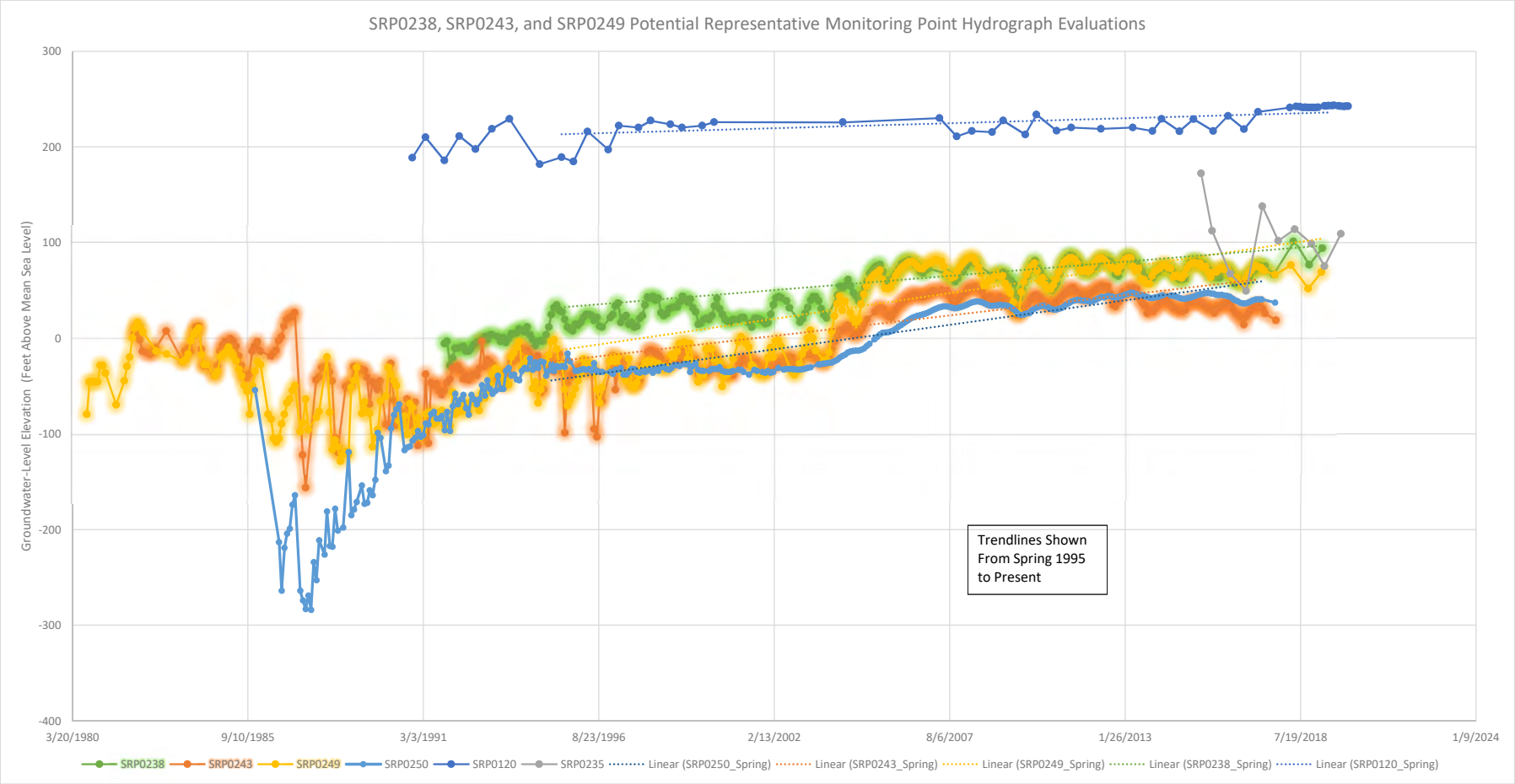


Figure 5-B-17. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-17

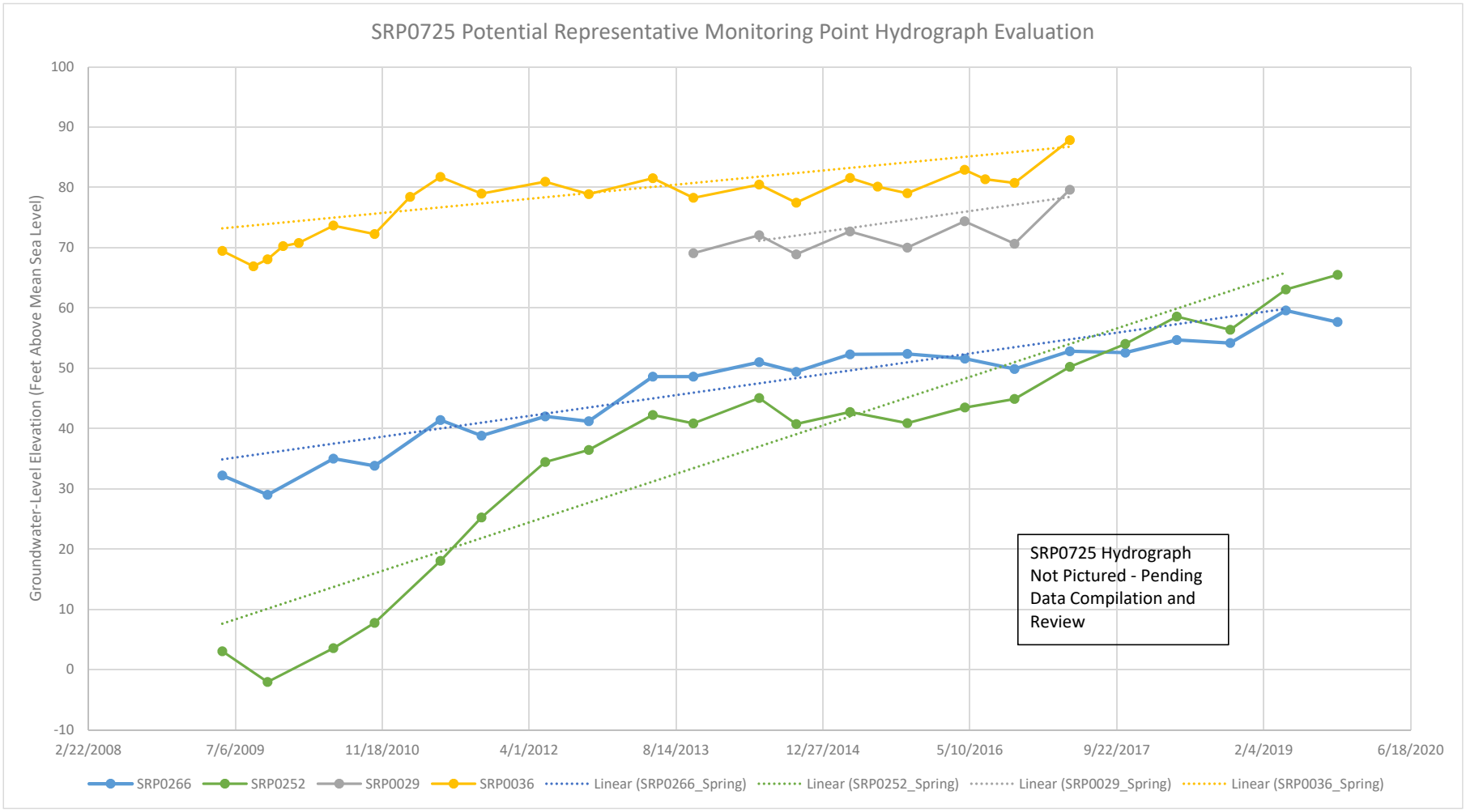


Figure 5-B-18. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-18

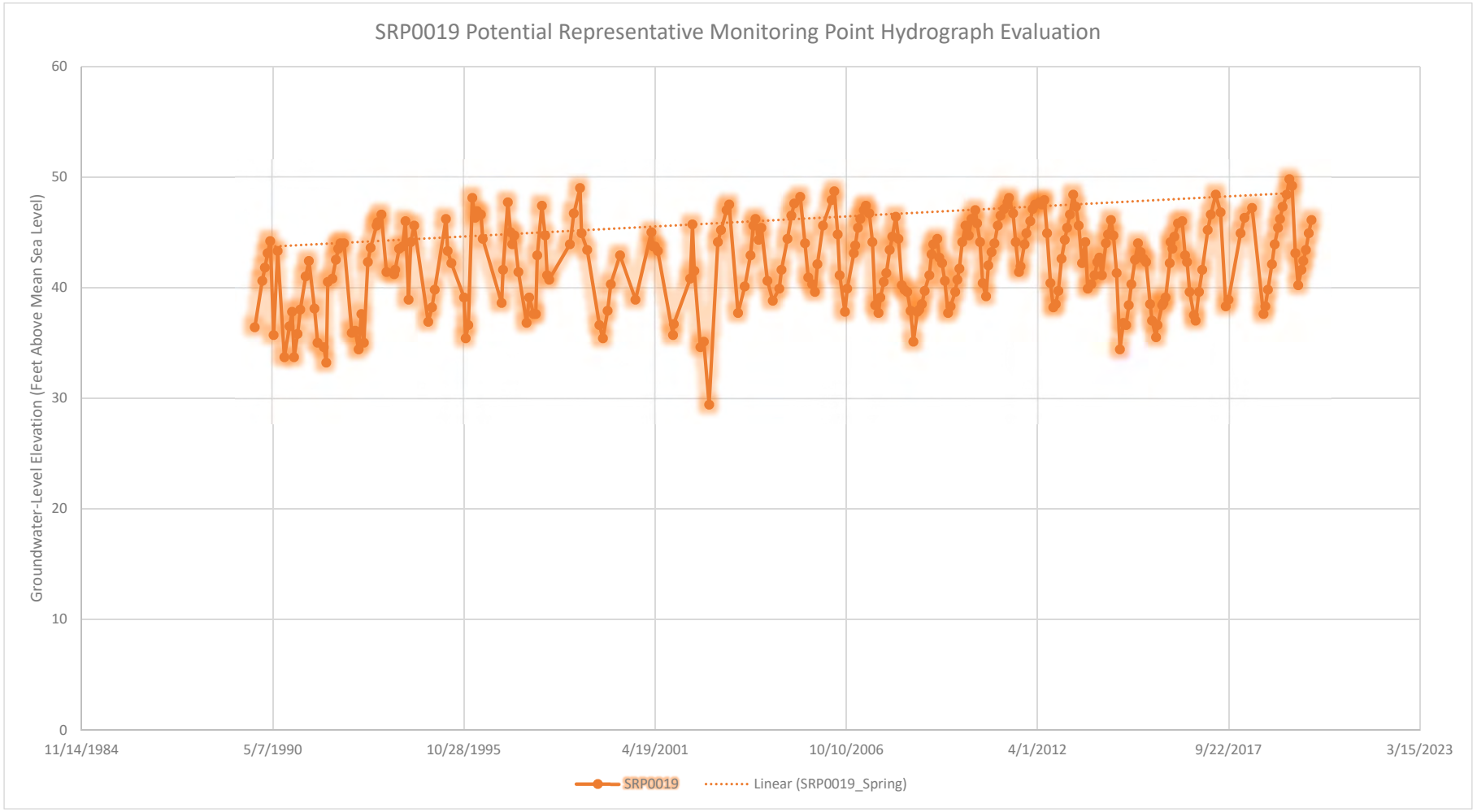


Figure 5-B-19. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-19

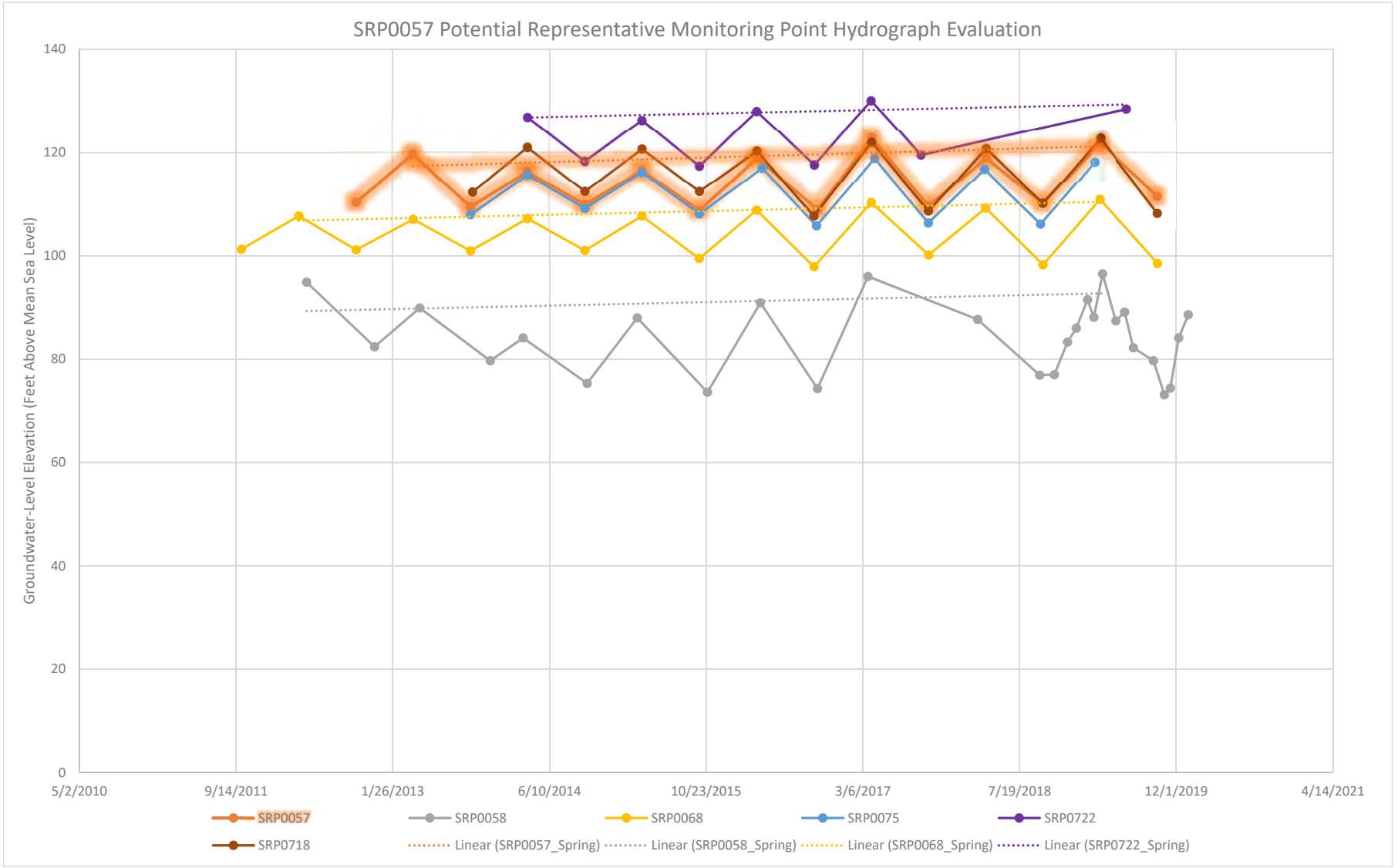


Figure 5-B-20. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure-5-B-20

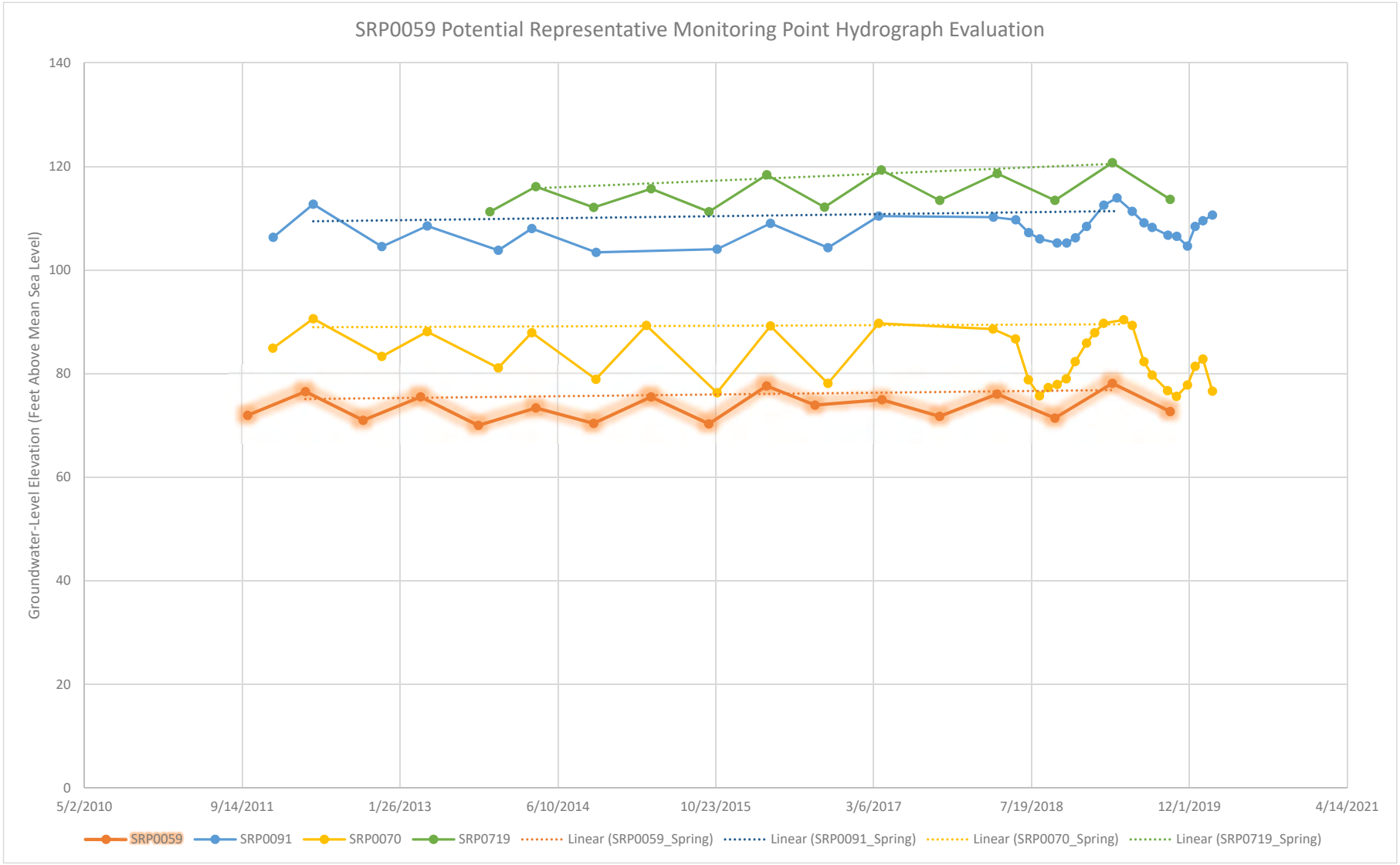


Figure 5-B-21. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-21

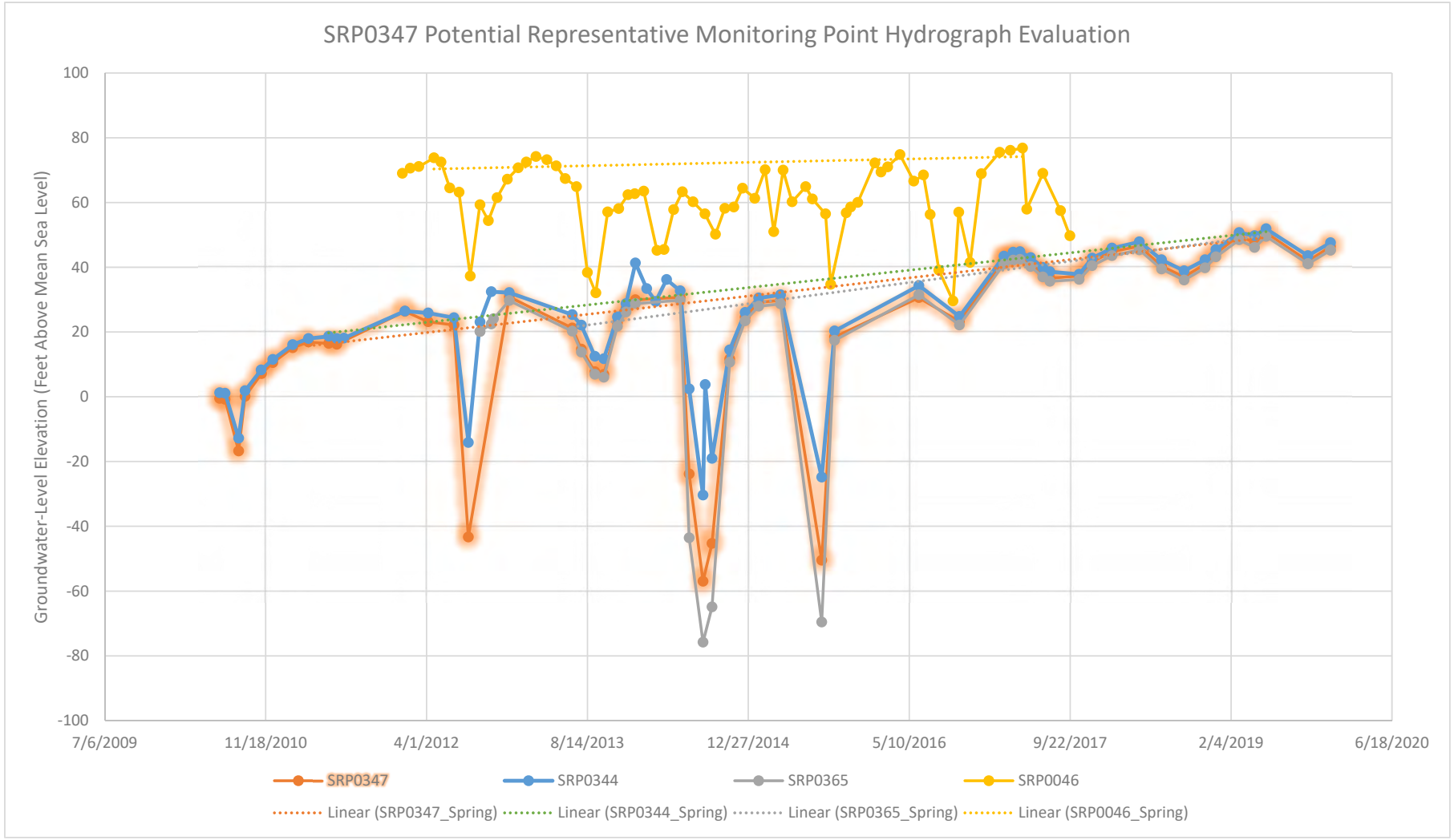


Figure 5-B-22. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-22

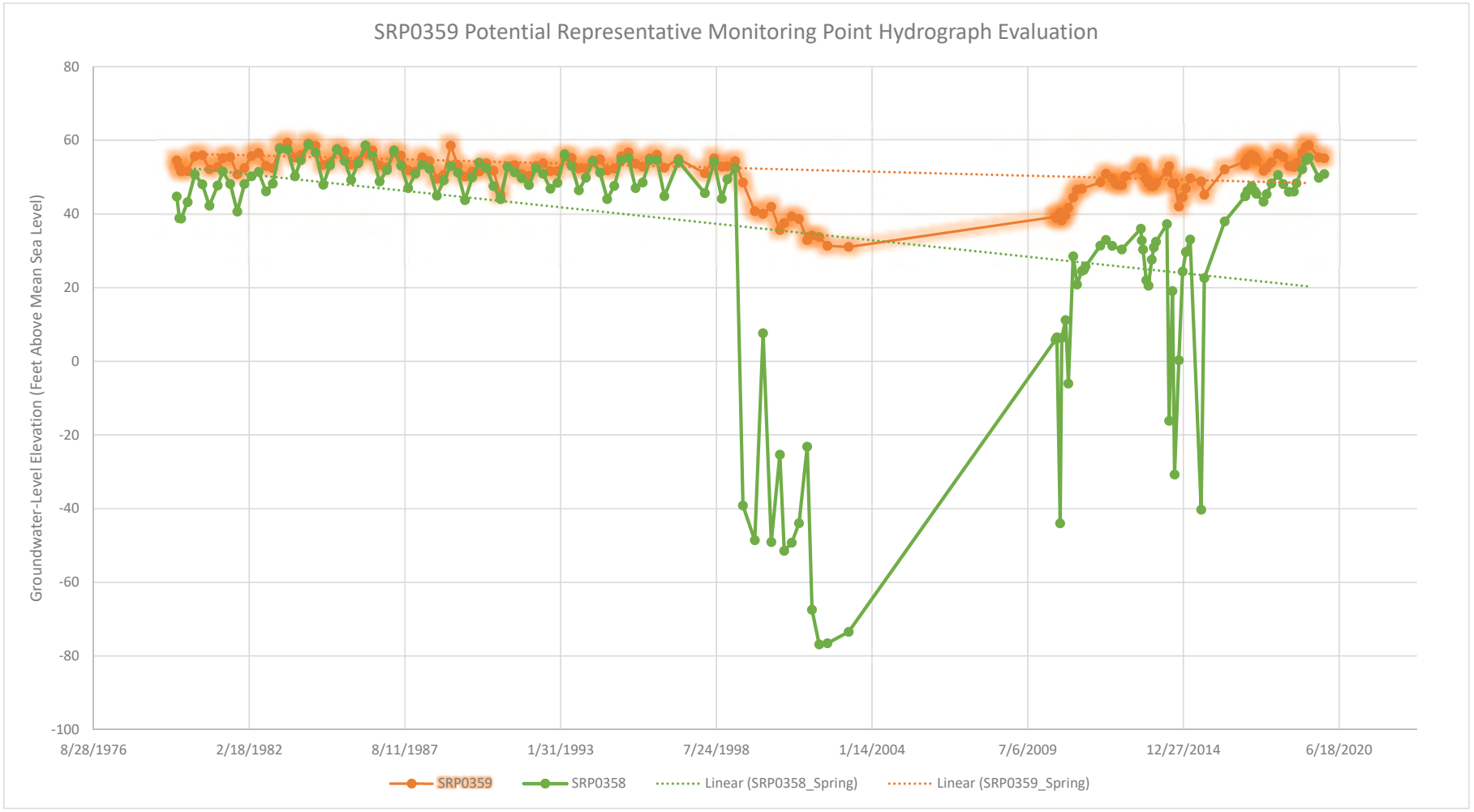
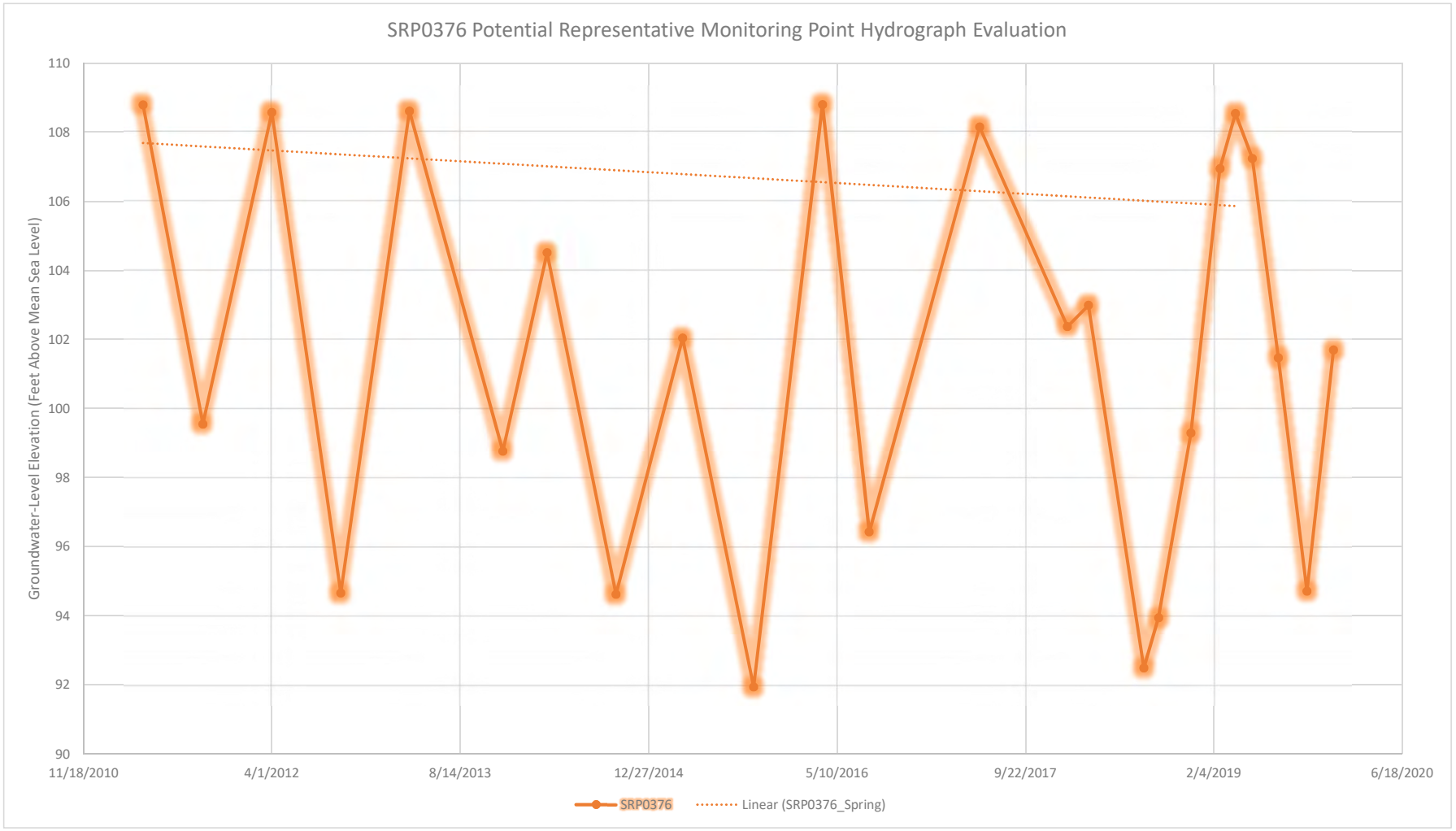


Figure 5-B-23. Groundwater level elevation in feet above mean sea level. Data from 1989 to 2018.

Figure 5-B-23



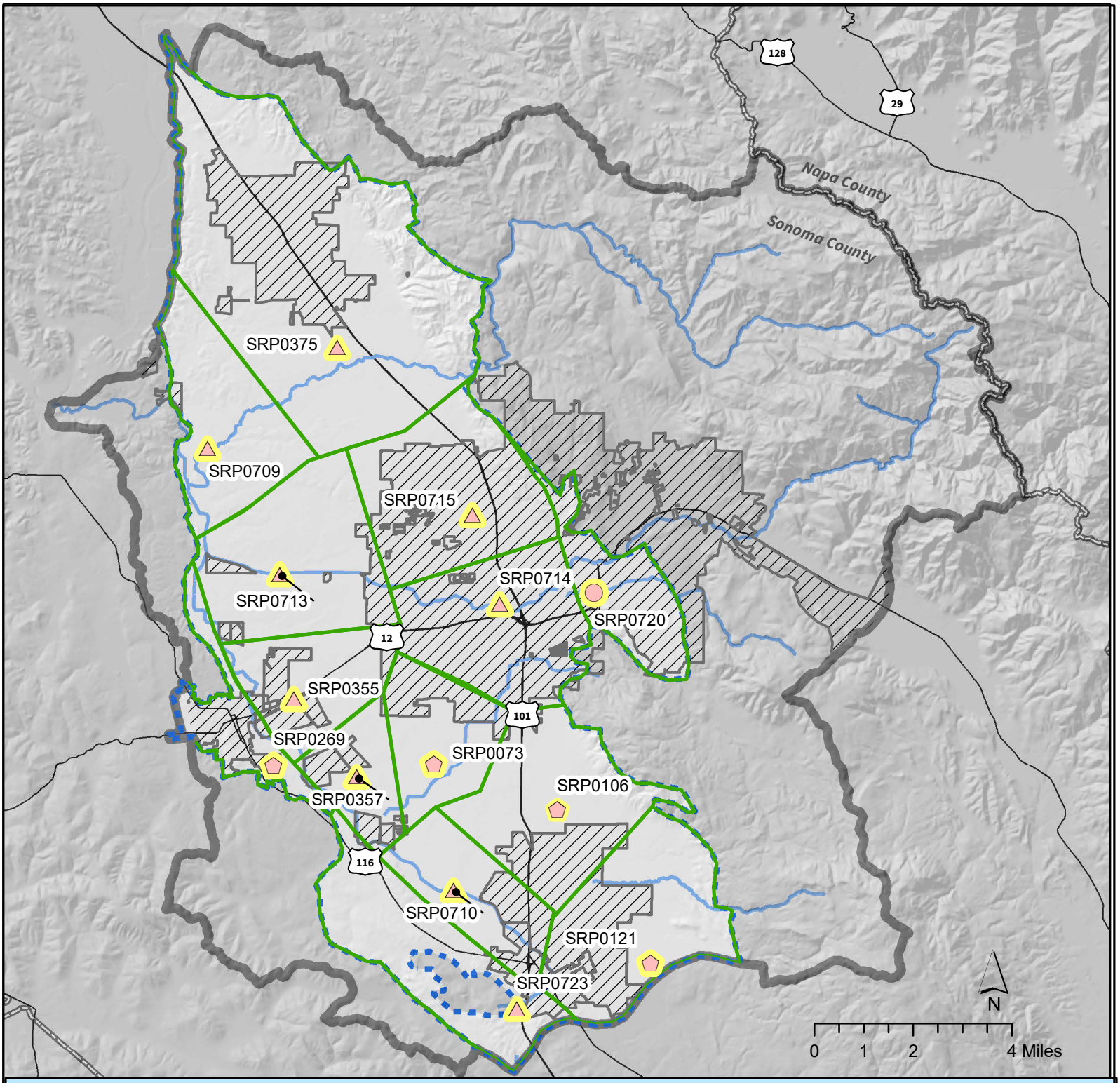


Figure 5-B-24

RMPs for Chronic Lowering of Groundwater Levels with Vicinity Areas used for Supply Well Statistic Calculations - Shallow Aquifer System

- RMPs - Dedicated Monitoring Wells
- RMPs - Municipal Supply Wells
- RMPs - Private Supply Wells
- RMP Vicinity Areas/Santa Rosa Plain Groundwater Subbasin
- Contributing Area Watershed
- Major Rivers and Creeks
- City Footprints

SANTA ROSA PLAIN GROUNDWATER SUSTAINABILITY AGENCY

Filepath: T:\mbuttress\SGMA Monitoring Networks\Santa Rosa Plain\SRP_Potential_RMPs_Shallow.mxd Date prepared: 11/5/2021

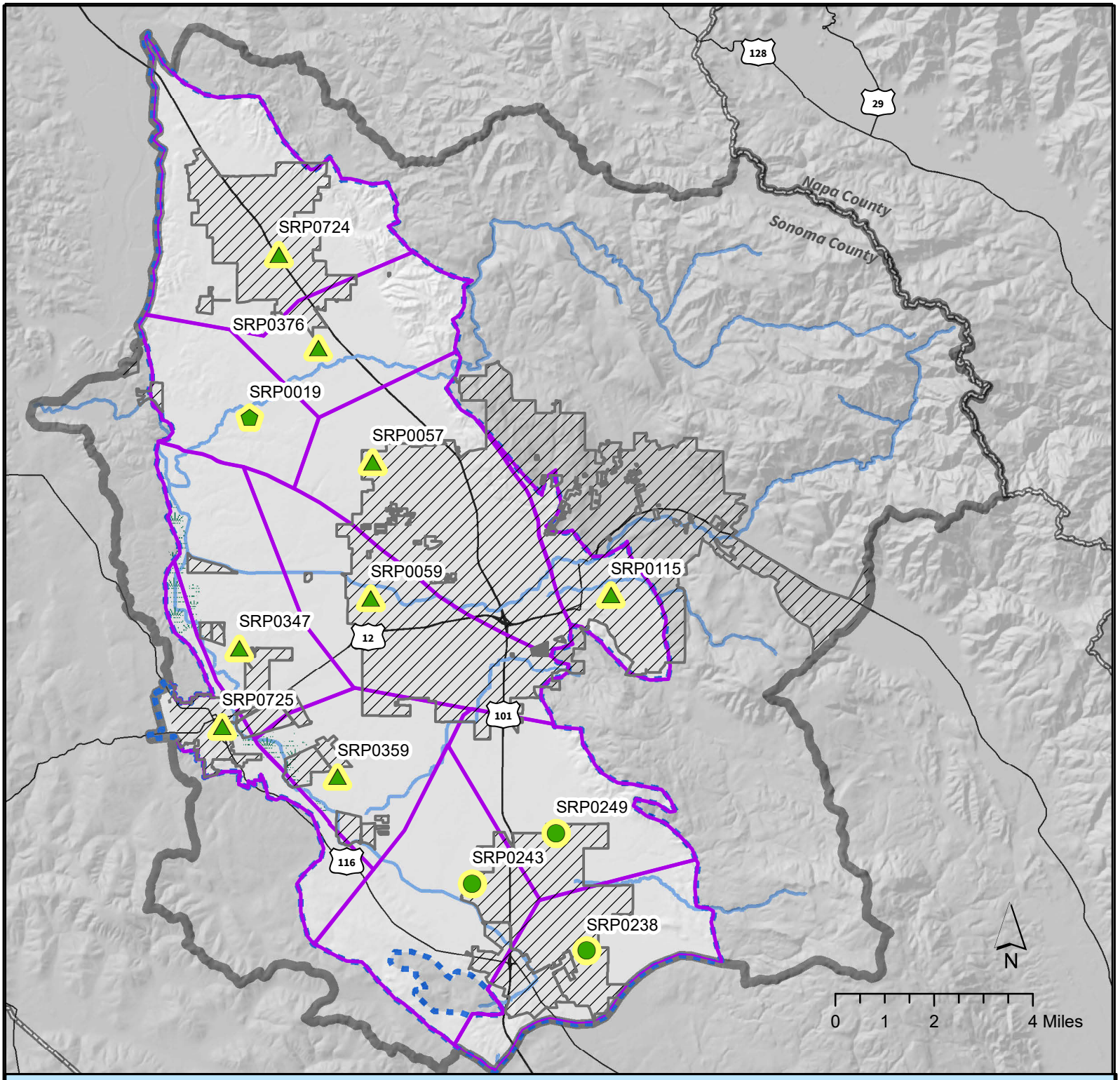


Figure 5-B-25
RMPs for Chronic Lowering of Groundwater Levels with Vicinity Areas used for Supply Well Statistic Calculations - Deep Aquifer System

- RMPs - Dedicated Monitoring Wells
- RMPs - Municipal Supply Wells
- RMPs - Private Supply Wells
- RMP Vicinity Areas/Santa Rosa Plain Groundwater Subbasin
- Contributing Area Watershed
- Major Rivers and Creeks
- City Footprints

SANTA ROSA PLAIN GROUNDWATER SUSTAINABILITY AGENCY

Filepath: T:\mbuttress\SGMA Monitoring Networks\Santa Rosa Plain\SRP_Potential_RMPs_Deep.mxd Date prepared: 11/5/2021

Table 5-B-1
Representative Monitoring Points for Chronic Lowering of Groundwater Levels with Supply Well Statistics - Shallow Aquifer System
Santa Rosa Plain Groundwater Subbasin

Data Management System ID						Data Record														
Station Name	Station Number	Type of Well	Well Depth (ft BTOC)	Screened Interval(s) (ft BTOC)	Current Monitoring Frequency	From	Until	Addditional Information	TOC Elevation* (ft MSL)	BOC Elevation* (ft MSL)	Well Owner	Well Screened in Single Aquifer?	Total Shallow Supply Wells in Vicinity Area[1]	98th Percentile Shallowest Supply Well in Vicinity Area[2] (ft BGS)	98th Percentile Shallowest Well with 10 ft Buffer Elev. at RMP (ft MSL)	95th Percentile Shallowest Supply Well in Vicinity Area[2] (ft BGS)	95th Percentile Shallowest Well with 10 ft Buffer Elev. at RMP (ft MSL)	90th Percentile Shallowest Supply Well in Vicinity Area[2] (ft BGS)	90th Percentile Shallowest Well with 10 ft Buffer Elev. at RMP (ft MSL)	Average Depth of Shallow Supply Wells in Vicinity Area[2] (ft BGS)
SRP0710	SRP-H18-02_Stony	Observation	45.5	35-45	Hourly	11/21/2019	Present	Laguna de Santa Rosa at Stony Point Rd.	89.02	43.52	SRPGSA	Yes	120	56	43.02	56	43.02	64	35.02	130
SRP0709	SRP-C09-01_River Rd	Observation	33.5	23-33	Hourly	11/25/2019	Present	Mark West Creek at River Rd.	70.39	36.89	SRPGSA	Yes	178	52	28.39	57	23.39	60	20.39	112
SRP0713	SRP-D11-02_Willow	Observation	45.5	25-45	Hourly	11/25/2019	Present	Santa Rosa Creek at Willowside Rd.	71.44	25.94	SRPGSA	Yes	490	48	33.44	52	29.44	60	21.44	110
SRP0714	SRP-H12-01_Pierson	Observation	51.5	41-51	Hourly	11/25/2019	Present	Santa Rosa Creek at Pierson St.	151.56	100.06	SRPGSA	Yes	424	44	117.56	48	113.56	52	109.56	91
SRP0715	SRP-H10-04_Hardies	Observation	40.5	30-40	Hourly	11/25/2019	Present	Paulin Creek at Hardies Ln.	136.34	95.84	SRPGSA	Yes	514	40	106.34	47	99.34	50	96.34	89
SRP0355	SCWA_SEB_MW_07	Observation	90	70-90	Hourly	2/14/2008	Present		81.46	-8.54	SCWA	Yes	390	45	46.46	50	41.46	58	33.46	102
SRP0357	SCWA_TODD_RED	Observation	80	60-80	Hourly	6/1/1977	Present		79.05	-0.95	SCWA	Yes	206	40	49.05	52	37.05	60	29.05	101
SRP0375	SCWA_Airport_MW_02	Observation	140	120-140	Hourly	4/29/2011	Present	385117N1227863W001, SRP-E07-02	121.6	-18.4	SCWA	Yes	821	50	81.6	59	72.6	64	67.6	114
SRP0720	Hoen Well	Municipal	115	?	Monthly	4/1/2005	11/8/2019		194.58	79.58	City of Santa Rosa	Yes	169	48	156.58	50	154.58	56	148.58	102
SRP0723	MW-114	Observation	?	?	Semi-Annual	5/30/2007	10/10/2019		223.29	Unknown	City of Santa Rosa	Yes	514	44	189.29	53	180.29	60	173.29	122
SRP0073	SRP-G15-01	Unknown	80	?	Semi-Annual	11/3/1989	3/21/2017	06N08W04Q001M	93.78	13.78	Private	Yes	252	40	63.78	44	59.78	55	48.78	103
SRP0106	SRP-J16-01	Unknown	90	?	Monthly	10/3/1989	2/9/2021	06N08W12M001M	101.6	11.6	Private	Yes	512	48	63.6	56	55.6	60	51.6	106
SRP0121	SRP-L19-01	Unknown	150	?	Monthly	11/9/1989	2/13/2020	06N07W30R001M	178.57	28.57	Private	Yes	150	65	123.57	78	110.57	84	104.57	149
SRP0269	WGFH-08	Unknown	160	100-160	Semi-Annual	5/23/2009	10/13/2019	383889N1228088W001	90.77	-69.23	Private	Yes	129	52	48.77	60	40.77	70	30.77	138

Notes
ft BTOC - Feet Below Top-of-Casing
TOC Elevation - Top-of-Casing Elevation
BOC Elevation - Bottom-of-Casing Elevation
* - Accuracy of Well Casing Elevation Data Varies. Top-of-Casing Elevations to be Surveyed in Accordance with SGMA Requirements.
ft MSL - Feet Above Mean Sea Level
ft BGS - Feet Below Ground Surface
1: Only Wells with Known Total Depth Used in Calculations. This Represents Only a Subset of All Supply Wells in the Subbasin
2: Statistics Calculated Using Only Supply Wells With Total Depths of 40 Feet or Greater
SCWA - Sonoma County Water Agency
SRPGSA - Santa Rosa Plain Groundwater Sustainability Agency

Table 5-B-2
Representative Monitoring Points for Chronic Lowering of Groundwater Levels with Supply Well Statistics - Deep Aquifer System
Santa Rosa Plain Groundwater Subbasin

Data Management System ID						Data Record														
Station Name	Station Number	Type of Well	Well Depth (ft BTOC)	Screened Interval(s) (ft BTOC)	Monitoring Frequency	From	Until	Addditional Information	TOC Elevation* (ft MSL)	BOC Elevation* (ft MSL)	Well Owner	Well Screened in Single Aquifer?	Total Deep Supply Wells in Vicinity Area[1]	Shallowest Deep Zone Supply Well in Vicinity Area[2] (ft BGS)	98th Percentile Shallowest Deep Zone Supply Well in Vicinity Area[3] (ft BGS)	98th Percentile Shallowest Well with 50 ft Buffer Elev. at RMP (ft MSL)	95th Percentile Shallowest Deep Zone Supply Well in Vicinity Area[3] (ft BGS)	95th Percentile Shallowest Well with 50 ft Buffer Elev. at RMP (ft MSL)	90th Percentile Shallowest Deep Zone Supply Well in Vicinity Area[3] (ft BGS)	90th Percentile Shallowest Well with 50 ft Buffer Elev. at RMP (ft MSL)	Average Depth of Deep Supply Wells in Vicinity Area (ft BGS)
SRP0359	SCWA_TODD_WHITE	Observation	257	237-257	Hourly	8/2/1979	Present		79.05	-177.95	SCWA	Yes	79	250	252	-122.95	252	-122.95	260	-130.95	411
SRP0347	SCWA_OCC_MW_04	Observation	300	?	Hourly	6/28/2010	Present		95.4	-204.6	SCWA	Unknown	152	211	231	-85.6	231	-85.6	250	-104.6	414
SRP0376	SCWA_Airport_MW_03	Observation	360	340-360	Hourly	4/25/2011	Present	CASGEM ID: 385117N1227863W002, SRP-E07-03	121	-239	SCWA	Yes	98	208	208	-37	245	-74	249	-78	450
SRP0115	SRP-K12-04	Observation	870	500-860	Sub-Daily	4/22/2010	Present	MARTHA WAY	215.71	-654.29	City of Santa Rosa	Yes	81	240	240	25.71	240	25.71	255	10.71	415
SRP0057	SRP-F09-02	Observation	360	200-350	Sub-Daily	5/20/2011	Present	NORTHWEST VILLAGE	141.57	-218.43	City of Santa Rosa	Yes	155	220	250	-58.43	263	-71.43	276	-84.43	457
SRP0059	SRP-F12-01	Observation	694	199-684	Sub-Daily	5/20/2011	Present	PLACE TO PLAY	101.32	-592.68	City of Santa Rosa	No	133	212	213	-61.68	225	-73.68	250	-98.68	418
SRP0238	SRP-K19-01	Municipal	380	130-380	Sub-Daily	11/1/1991	Present	CASGEM ID: 383350N1226841W001, RP Well 37	128.18	-251.82	City of Rohnert Park	No	232	230	230	-51.82	243	-64.82	250	-71.82	444
SRP0249	SRP-J17-01	Municipal	462	302-462	Sub-Daily	9/1/1980	Present	CASGEM ID: 383694N1226960W001, RP Well 17	103.35	-358.65	City of Rohnert Park	Yes	183	230	250	-96.65	250	-96.65	290	-136.65	441
SRP0243	SRP-H18-01	Municipal	582	258-582	Sub-Daily	3/1/1982	Present	CASGEM ID: 383544N1227271W001, RP Well 24	90.74	-491.26	City of Rohnert Park	Yes	307	219	224	-83.26	230	-89.26	243	-102.26	384
SRP0724	Windsor_Bluebird	Municipal	765	695-745	NM	NM	NM	BLUEBIRD WELL	118.75	-646.25	Town of Windsor	Yes	197	208	216	-47.25	225	-56.25	240	-71.25	406
SRP0725	Sebastopol Well #5	Municipal	528	138-528	Sub-Daily	2/1/2007	Present		85.14	-442.86	City of Sebastopol	No	215	219	220	-84.86	227	-91.86	240	-104.86	308
SRP0019	SRP-D08-02	Unknown	1048	?	Monthly	3/16/1976	2/5/2020	08N09W36P001M	93.62	-954.38	Private	Unknown	123	221	235	-91.38	250	-106.38	255	-111.38	461

Notes
ft BTOC - Feet Below Top-of-Casing
TOC Elevation - Top-of-Casing Elevation
BOC Elevation - Bottom-of-Casing Elevation
* - Accuracy of Well Casing Elevation Data Varies. Top-of-Casing Elevations to be Surveyed in Accordance with SGMA Requirements.
ft MSL - Feet Above Mean Sea Level
ft BGS - Feet Below Ground Surface
1: Only Wells with Known Total Depth Used in Calculations. This Represents Only a Subset of All Supply Wells in the Subbasin
2: Shallowest Supply Well with More than Half of Screened Interval Below 200 feet BGS
3: Determined by Calculating the 98th Percentile (from Deepest to Shallowest) of the Total Depth Values for all Supply Wells with More than Half of Screened Interval Below 200 feet BGS within a Vicinity Area
SCWA - Sonoma County Water Agency
NM - Not Currently Monitored

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Appendix 6-A
Simulation of Projects and Management Actions for the Santa Rosa Plain Groundwater Sustainability Plan

Appendix 6-A

Simulation of Projects and Management Actions for the Santa Rosa Plain Groundwater Sustainability Plan

Table of Contents

1 INTRODUCTION 5
2 PROJECT ASSUMPTIONS FOR FUTURE SIMULATIONS 5
2.1 Description of Projects 5
2.1.1 Group 1 5
2.1.2 Group 2 5
2.1.3 Group 3 9
2.2 Implementation of Projects in Model 10
3 SIMULATION RESULTS 12
3.1 Simulated Project Yields 12
3.2 Groundwater Budget 13
3.3 Groundwater Elevations 16
3.3.1 Changes in Simulated Groundwater Elevation for Group 1, Group 2 and Group Scenarios 24
3.3.2 Actual Simulated Waterlevels For Group 1, Group 2, and Group 3 Scenarios 36
4 CONCLUSIONS 52

Tables

Table 1. ASR Well Simulation Method 12
Table 2. Simulated Project Yields 12
Table 3. Average change in groundwater storage for each scenario by period 14
Table 4. Average annual net stream leakage by period 15
Table 5. Number of Years with Water Levels Below Minmum Threshold for Shallow RMP Wells 20
Table 6. Number of Years with Water Levels Below Minimum Threshold for Deep RMP Wells . 20

Table 7 Summary of Waterlevel exceedances by depth and period 21

Figures

Figure 1. Group 2 Scenario Model PMA Locations 7
Figure 2. Monthly Diversion and Stormwater Capture in Group 2 Simulation 8
Figure 3 Total Yearly Diversions and Diversions Per Month, Group 2 Scenario 9
Figure 4 Location of Injection Wells for Group 3 Scenario 10
Figure 5. Projected Annual Cumulative Change in Storage for Model Scenarios 13
Figure 6. Impact of PMA's on Net Streambed Exchange 14
Figure 7 Change in Summer Streamflow Due to Implementation of Group 2 15
Figure 8 Groundwater Pumpage by Water Use Sector for all Scenarios 16
Figure 9 Representative Monitoring Point locations 17
Figure 10. Water Level Hydrograph for Shallow RMP Well SRP0106 18
Figure 11. Water Level Hydrograph for Deep RMP Well SRP0376 19
Figure 12. Number RMP of Wells Below Minimum Threshold 22
Figure 13 Number of Waterlevel Exceedances for all Scenarios 23
Figure 14. Number of Wells Below Minimum Threshold for Three Consecutive Years for RMP Wells. Undesirable results occur when 30% of RMP's experience Minimum Threshold exceedances for three consecutive years 24
Figure 15. Projected Shallow Aquifer Groundwater Elevation Benefit in September 2040 for Group 1 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red 25
Figure 16. Projected Shallow Aquifer Groundwater Elevation Benefit in September 2040 for Group 2 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red 26
Figure 17. Projected Shallow Aquifer Groundwater Elevation Benefit in September 2040 for Group 3 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red 27
Figure 18. Projected Deep Aquifer Groundwater Elevation Benefit in September 2040 for Group 1 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red 28
Figure 19. Projected Deep Aquifer Groundwater Elevation Benefit in September 2040 for Group 2 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red 29

Figure 20. Projected Deep Aquifer Groundwater Elevation Benefit in September 2040 for Group 3 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red 30
Figure 21. Projected Shallow Aquifer Groundwater Elevation Benefit in September 2070 for Group 1 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red..... 31
Figure 22. Projected Shallow Aquifer Groundwater Elevation Benefit in September 2070 for Group 2 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red..... 32
Figure 23. Projected Shallow Aquifer Groundwater Elevation Benefit in September 2070 for Group 3 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red..... 33
Figure 24. Projected Deep Aquifer Groundwater Elevation Benefit in September 2070 for Group 1 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red 34
Figure 25. Projected Deep Aquifer Groundwater Elevation Benefit in September 2070 for Group 2 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red 35
Figure 26. Projected Deep Aquifer Groundwater Elevation Benefit in September 2070 for Group 3 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red 36
Figure 27 Actual Simulated Waterlevels for the Shallow Aquifer for the Future Baseline, Sep 2040. Positive Values Outlined in Black, Negative Values Outlined in Red..... 37
Figure 28 Actual Simulated Waterlevels for the Shallow Aquifer for Scenario 1, Sep 2040. Positive Values Outlined in Black, Negative Values Outlined in Red..... 38
Figure 29 Actual Simulated Waterlevels for the Shallow Aquifer for Scenario 2, Sep 2040. Positive Values Outlined in Black, Negative Values Outlined in Red..... 39
Figure 30 Actual Simulated Waterlevels for the Shallow Aquifer for Scenario 3, Sep 2040. Positive Values Outlined in Black, Negative Values Outlined in Red..... 40
Figure 31 Actual Simulated Waterlevels for the Deep Aquifer for the Future Baseline, Sep 2040. Positive Values Outlined in Black, Negative Values Outlined in Red..... 41
Figure 32 Actual Simulated Waterlevels for the Deep Aquifer for Scenario 1, Sep 2040. Positive Values Outlined in Black, Negative Values Outlined in Red 42
Figure 33 Actual Simulated Waterlevels for the Deep Aquifer for Scenario 2, Sep 2040. Positive Values Outlined in Black, Negative Values Outlined in Red 43
Figure 34 Actual Simulated Waterlevels for the Deep Aquifer for Scenario 3, Sep 2040. Positive Values Outlined in Black, Negative Values Outlined in Red 44

Figure 35 Actual Simulated Waterlevels for the Shallow Aquifer for the Future Baseline, Sep 2070. Positive Values Outlined in Black, Negative Values Outlined in Red..... 45
Figure 36 Actual Simulated Waterlevels for the Shallow Aquifer for Scenario 1, Sep 2070. Positive Values Outlined in Black, Negative Values Outlined in Red..... 46
Figure 37 Actual Simulated Waterlevels for the Shallow Aquifer for Scenario 2, Sep 2070. Positive Values Outlined in Black, Negative Values Outlined in Red..... 47
Figure 38 Actual Simulated Waterlevels for the Shallow Aquifer for Scenario 3, Sep 2070. Positive Values Outlined in Black, Negative Values Outlined in Red..... 48
Figure 39 Actual Simulated Waterlevels for the Deep Aquifer for the Future Baseline, Sep 2070. Positive Values Outlined in Black, Negative Values Outlined in Red..... 49
Figure 40 Actual Simulated Waterlevels for the Deep Aquifer for Scenario 1, Sep 2070. Positive Values Outlined in Black, Negative Values Outlined in Red 50
Figure 41 Actual Simulated Waterlevels for the Deep Aquifer for Scenario 2, Sep 2070. Positive Values Outlined in Black, Negative Values Outlined in Red 51
Figure 43 Actual Simulated Waterlevels for the Deep Aquifer for Scenario 3, Sep 2070. Positive Values Outlined in Black, Negative Values Outlined in Red 52

1 INTRODUCTION

The purpose of this appendix is to describe the modifications to the future baseline predictive groundwater model used to simulate potential projects and management actions (PMAs). The proposed PMAs for the Santa Rosa Plain Subbasin are selected to address areas experiencing groundwater level declines and potential undesirable results. The various PMAs are intended to prevent undesirable results from occurring. PMAs for the Santa Rosa Plain subbasin include reductions in rural-domestic pumping, reductions of vineyard consumptive use, aquifer storage and recovery (ASR) and managed aquifer recharge (MAR) of surface water diversions.

2 PROJECT ASSUMPTIONS FOR FUTURE SIMULATIONS

PMAs are divided into three model simulations: Group 1, Group 2 and Group 3. Each PMA simulation builds upon the future baseline simulation (GSP Water Budget, Section 3) by adding water conservation measures and supplemental supply. The future baseline scenario runs from water year 2021 through water year 2070 and uses the SRPHM numerical flow model with projected land use changes, population growth and climate change. Climate change is simulated using the RCP8.5 scenario of the HadGEM2-ES climate model. To observe the incremental improvements from adding additional water management measures, each successive PMA builds upon the previous simulation, i.e., Group 3 contains all the PMAs in Group 1 and Group 2, and Group 2 simulations include Group 1 PMAs.

2.1 Description of Projects

2.1.1 Group 1

The Group 1 project scenario builds upon the future baseline scenario by adding reductions in water use for rural domestic water users and reductions in vineyard consumptive use.

The Group 1 scenario simulates the impacts of a 20% reduction in all rural domestic use and a 10% reduction in consumptive use for all vineyards, both beginning in 2025.

2.1.2 Group 2

The Group 2 projects implement .

Group 2: The Group 2 scenario builds upon the assumptions used for the Group 1 scenario but also includes stormwater capture for managed aquifer recharge (MAR). Figure 1 shows the location of the Group 2 projects along the lower Mark West Creek. MAR locations were selected based on identifying simulated irrigated agricultural model cells principally downslope of the diversion location selected. There are 184 model cells, or 1,840 acres, that receive equal amounts of diverted water. A 200 AF diversion that is engineered to infiltrate over 1,840 acres

of a month results in an infiltration rate of 0.04 inches per day. Such a rate would likely be feasible for a managed aquifer recharge project (Beganskas and Fisher, 2017; Dahlke et al,). Conceptually the diverted water would be recharged via flooding of the vineyards. The amount of stormwater available for diversion was calculated by:

1. Calculating the 90th percentile flow for the diversion location based on simulated monthly streamflow.

2. If a given winter month (December – March) exceeded the 90th percentile flows, 20% of the flow could be collected as stormwater. Diversion volumes were limited to 200 AF per month, or about 3.3 CFS, to incorporate engineering and diversion limitations.

Figure 2 shows the simulated discharge at the diversion location along with the diversions and cumulative diversions for the 50-year simulation period. A total of 12,000 AF are diverted and recharged during the simulation period. The average annual stormwater diversion for Mark West Creek is approximately 240 AFY. From WY 2021 to WY 2052 about 10,400AF of water is diverted and recharged, whereas for the last 17 years only 1,700AF is water diverted. A five-year period starting in WY 2052 experiences zero diversions, followed by a period 10-year period of either zero or 200AFY of diversions (Figure 3).

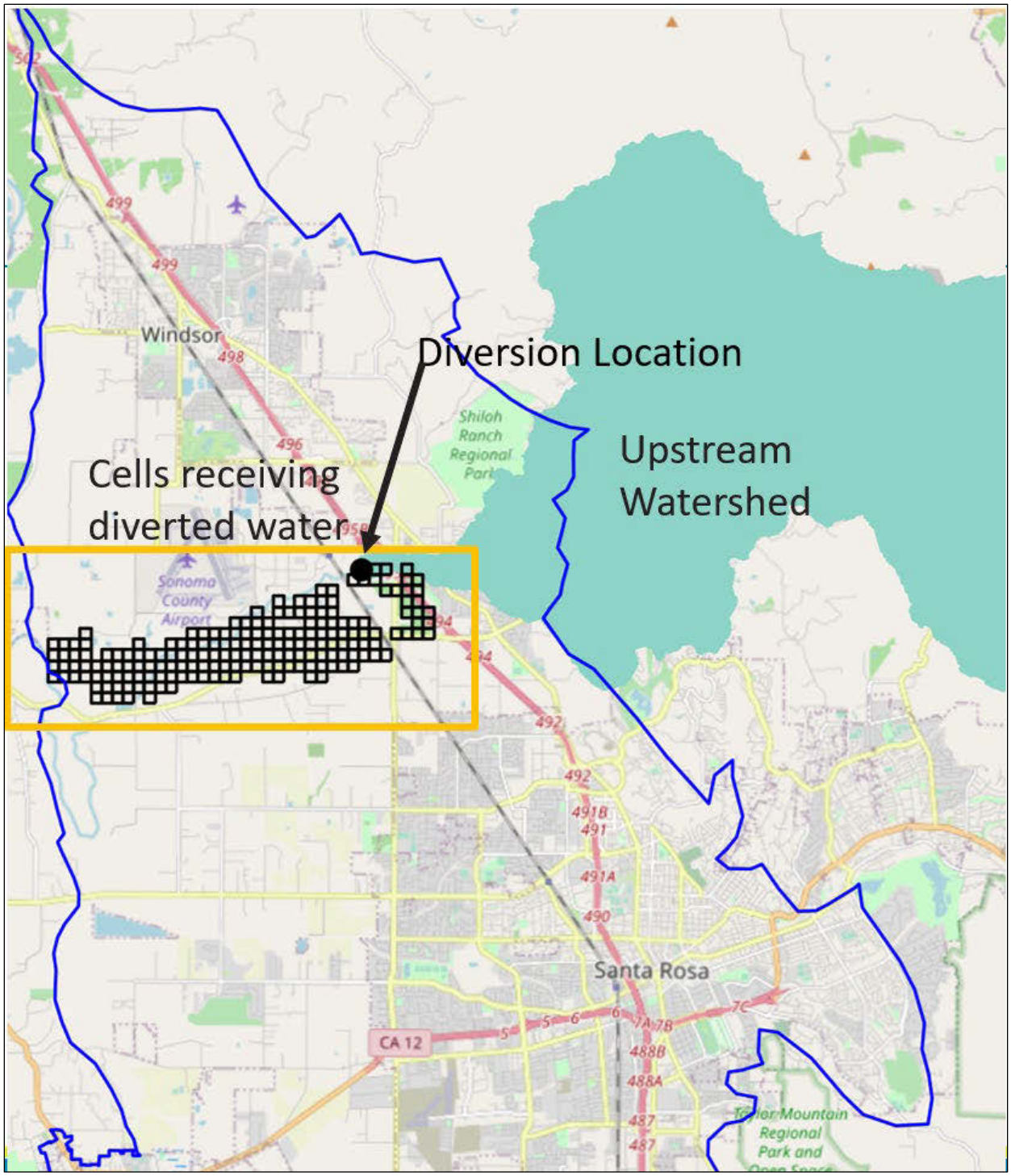

Figure 1. Group 2 Scenario Model PMA Locations

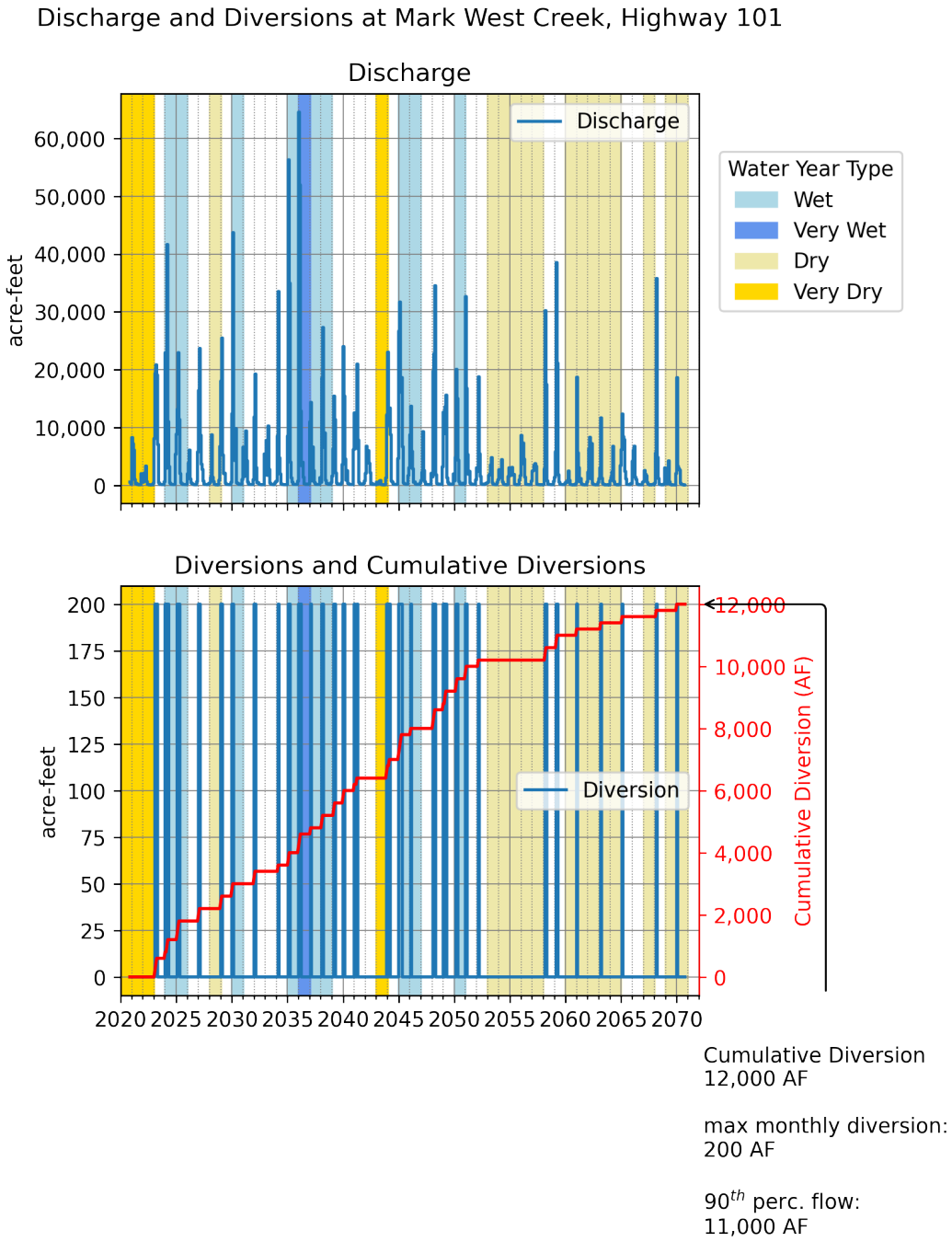

Figure 2. Monthly Diversion and Stormwater Capture in Group 2 Simulation

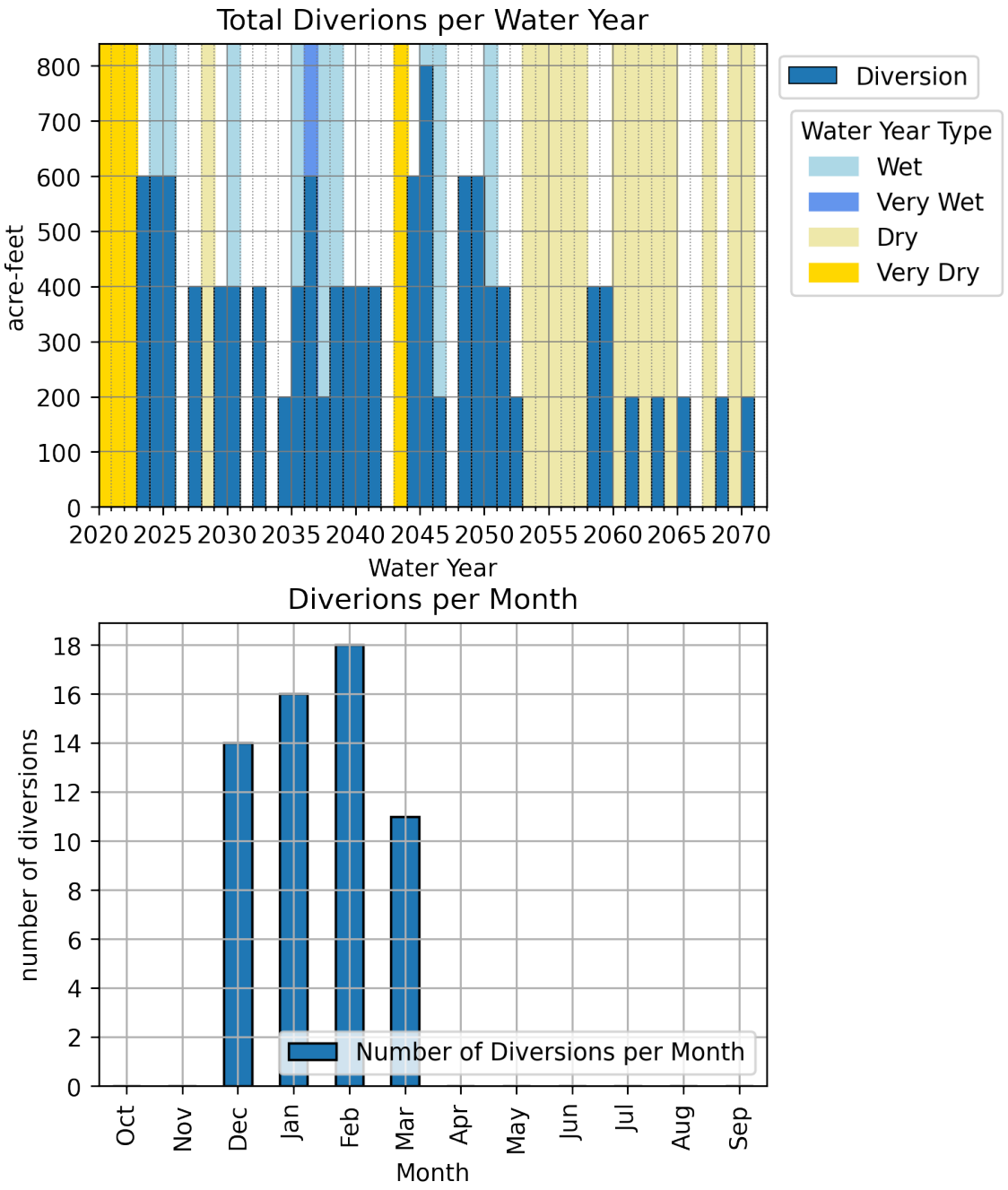

Figure 3 Total Yearly Diversions and Diversions Per Month, Group 2 Scenario

2.1.3 Group 3

Aquifer storage and recovery projects are implemented in the Group 3 scenario. There are 5 wells that are used for the project (Figure 4). They are assumed to receive Russian River water and will inject continuously from November to April. Injection will occur at wells belonging to the Sonoma County Water Agency, City of Santa Rosa, Town of Windsor, Rohnert Park, and City of Cotati. Once the wells are online, yearly injection will total 940AFY, with the well belonging

to the Sonoma County Water Agency accounting for 53% of the total. Recovery of injected water will occur via normal operations simulated in the Projected Baseline Simulation.

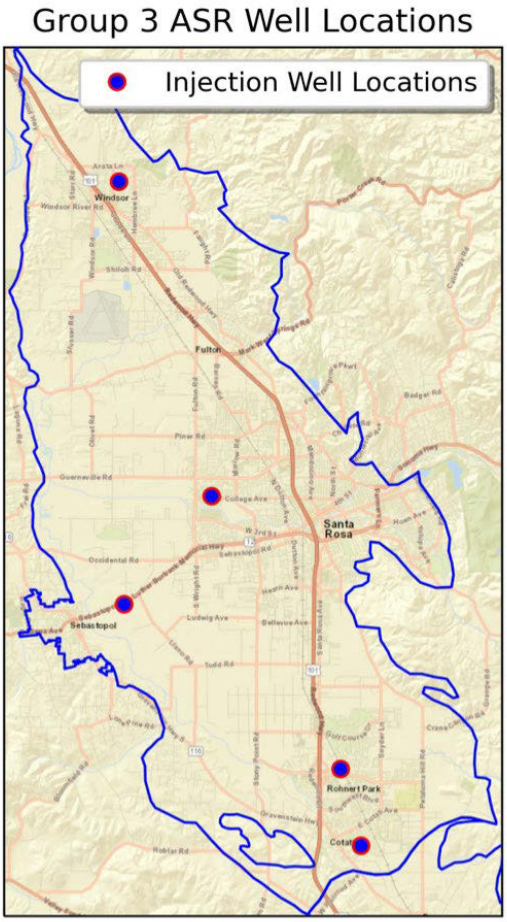

Figure 4 Location of Injection Wells for Group 3 Scenario

2.2 Implementation of Projects in Model

In each PMA scenario, each type of project is implemented in the model in the same way.

Crop Consumptive Use: Crop consumptive use reductions are simulated by reducing crop coefficients (K_c) by 10% during the growing season, beginning in water year 2025. This has the effect of lowering the potential evapotranspiration. As a result, the AG package calculates lower groundwater pumping to meet crop demand.

Rural Domestic Pumping: Rural domestic pumping reductions are simulated by rescaling specified pumping rates. From WY 2025 until the end of the simulation, the rural domestic pumping rates are reduced by 20%. These declines in water use are assumed to occur via

reductions in outdoor water use only. Because indoor water does not decline, septic return flows are assumed to remain the same as those of the Projected Baseline simulation.

Stormwater Manager Aquifer Recharge: In the Group 2 scenario, MAR of stormwater is simulated by adding water to the soil zone. The stormwater is recharged to the soil zone by adding it to the external water source option in the Precipitation and Runoff Module System component of GSFLOW. Water applied to the soil zone may be consumed by evapotranspiration or it may be lost through runoff or other soil zone processes, instead of becoming recharge to the underlying groundwater system. The diverted water is applied evenly to each of the model cells for the period in which the water was diverted.

Aquifer Storage and Recovery: The Group 3 scenario simulates ASR injection at both new and existing wells. Injection is simulated using the Multi-Node, Drawdown-Limited Well Package (MNW1) package. Table 1 lists the ASR wells for the Group 3 simulation and how the well is simulated in the model.

Table 1. ASR Well Simulation Method

Well	Model Layer(s)	Existing Well
Sonoma County Water Agency	6, 7	yes
Town of Windsor	4	no
Santa Rosa	4	no
Rohnert Park	4, 5, 6	yes
City of Cotati	3, 4, 5	yes

3 SIMULATION RESULTS

This section contains an overview of key water budget components, hydrographs of representative monitoring point (RMP) wells and projected groundwater elevation benefits.

3.1 Simulated Project Yields

Table 2 shows the simulated project yields for each simulation, for each project category. Volumes added by each project are added to the previous simulation.

Table 2. Simulated Project Yields

Project	Group 1	Group 2	Group 3
Reduce Crop Consumptive Use	Averages 1,200 AFY less agricultural pumping than baseline simulation	Same as Group 1	Same as Group 1
Reduce Rural Domestic Pumping	Averages 600 AFY less pumping than the baseline simulation	Same as Group 1	Same as Group 1
Stormwater Managed Aquifer Recharge	None	Average deliveries of 240 AFY	Same as Group 2
Aquifer Storage and Recovery	None	None	940 AFY

3.2 Groundwater Budget

Each simulation contains the PMAs used in the previous simulation – Group 2 simulations include PMAs from Group 1, and Group 3 simulations include PMAs from Group 1 and Group 2. As a result of this sequential modeling process, each simulation shows a progressive improvement in storage change over the simulation. Figure 5 shows cumulative change in storage for the future baseline, Group 1, Group 2 and Group 3 scenarios. Table 3 shows the average annual change in storage for each for the four simulations, rounded to the nearest 100 AFY. Implementation of each Scenario causes a reduction in total groundwater storage decline. Group 1 results in the greatest reduction in total storage decline. Despite the injection of 940 AFY in Group 3, there is only minor benefit to groundwater storage in this scenario. This occurs because a number of fluxes offset the increased inflows. Group 3 groundwater budget shows reduced groundwater recharge, increased groundwater ET, increased stream leakage, and increased surface leakage, compared to Group 2.

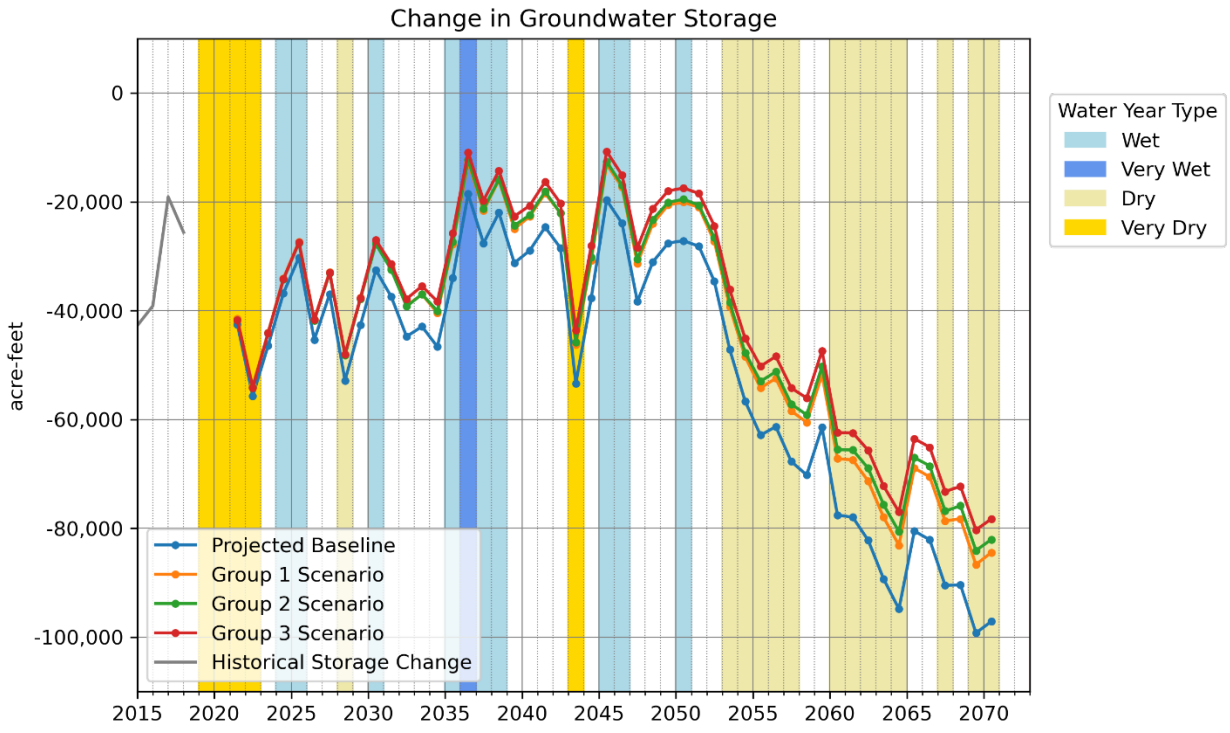

Figure 5. Projected Annual Cumulative Change in Storage for Model Scenarios

Table 3. Average change in groundwater storage for each scenario by period.

Average annual change in groundwater storage (AFY)	Baseline	Group 1	Group 2	Group 3
2021 – 2070	-1,400	-1,200	-1,100	-1,100

Figure 6 shows the impact of each project scenario on net stream leakage. Table 4 shows average annual net stream leakage for each simulation. Negative values indicate net leakage from surface water to groundwater, positive values indicate net leakage from groundwater to surface water. Results show that with Group 1, Group 2, and Group 3 projects, there is a projected reduction in net streamflow depletion due to reduced pumping and increased recharge. Group 2 is slightly more negative than Group 1 likely due to increased runoff to streams and greater stream leakage to groundwater. Figure 7 shows the impact of Group 2 projects on summertime streamflow in the Group 2 project area. Along lower Mark West creek summertime discharges increase up to 10% more than the Baseline due to the implementation of Group 2 projects.

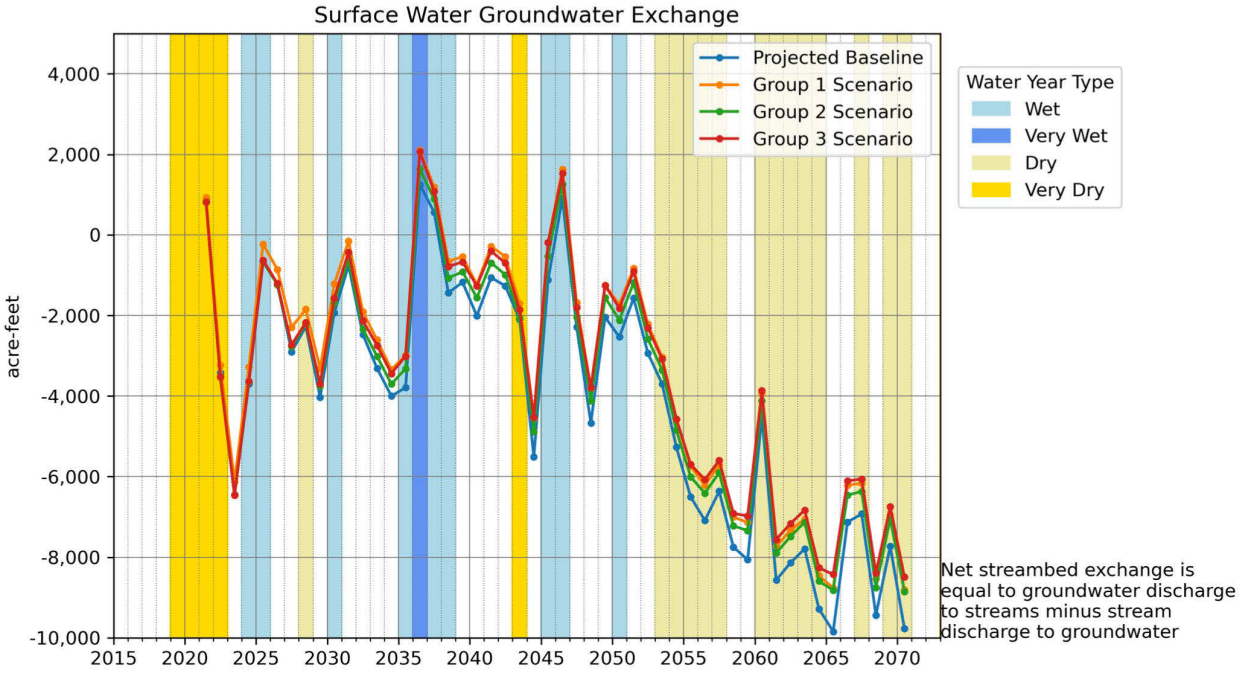

Figure 6. Impact of PMA's on Net Streambed Exchange

Table 4. Average annual net stream leakage by period

Mean Net Stream Leakage (AFY)	Baseline	Group 1	Group 2	Group 3
2021 – 2070	-4,100	-3,400	-3700	-3,400

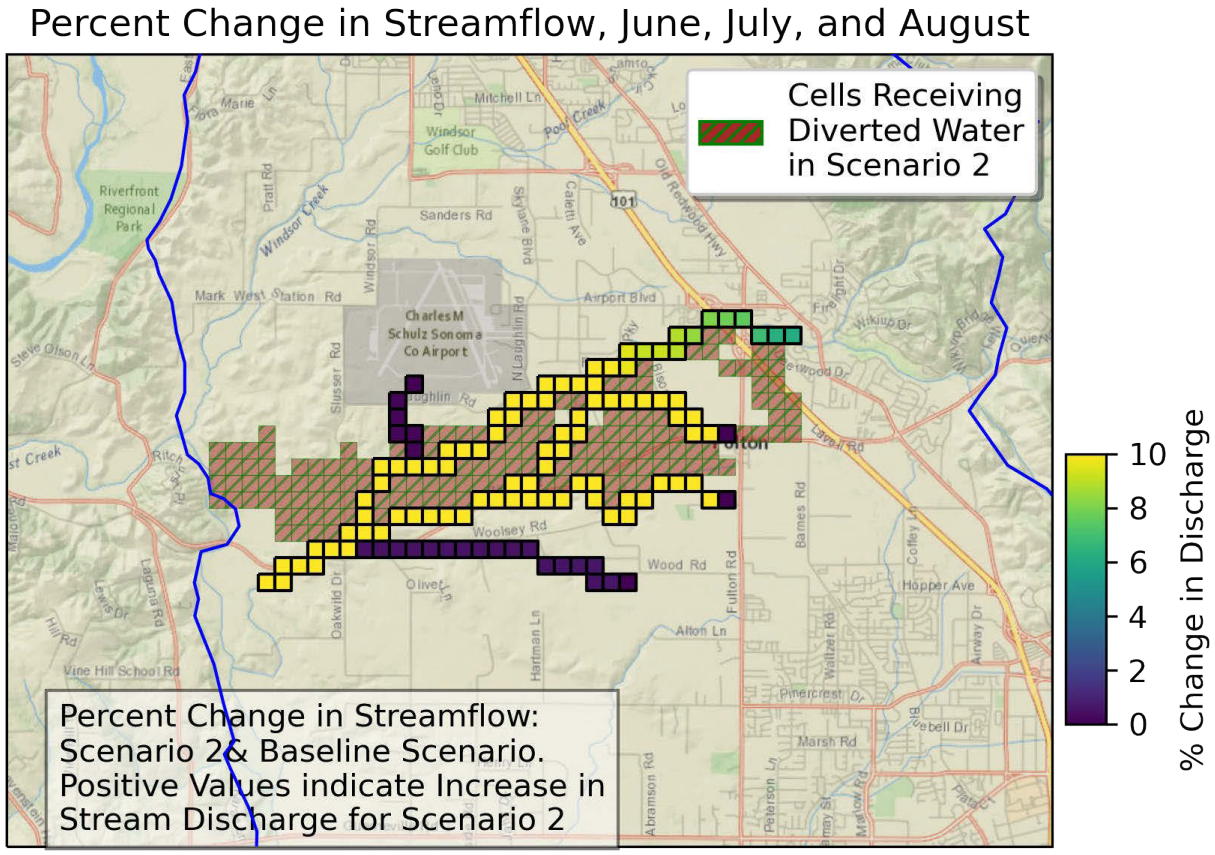

Figure 7 Change in Summer Streamflow Due to Implementation of Group 2

Figure 8 shows the groundwater pumpage for each of the scenarios by water use sector.

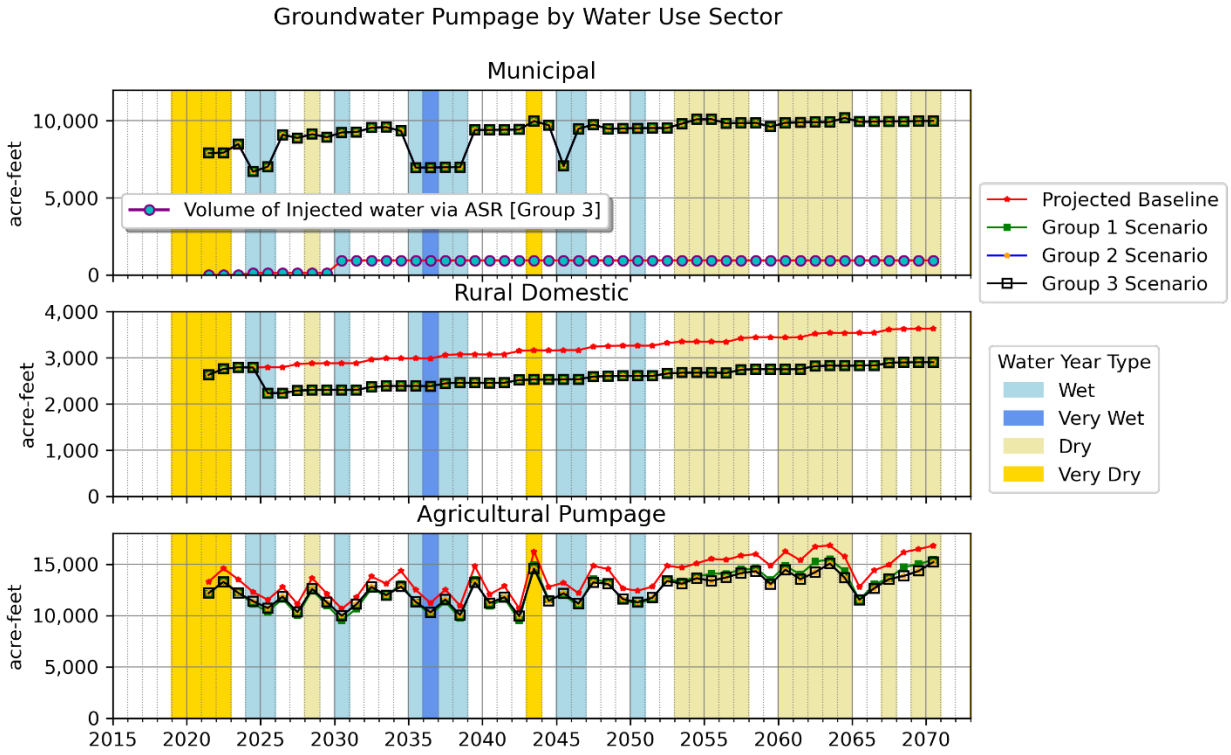

Figure 8 Groundwater Pumpage by Water Use Sector for all Scenarios

3.3 Groundwater Elevations

Simulated monthly water levels for Santa Rosa Plain were compared to equivalent measured monthly water levels for the most recent part of the historical record (usually 2017-2018). The difference between measured and simulated water levels during those most recent years were then averaged to derive an offset for each RMP well. The offset was applied to the future simulated dataset to generate a dataset of adjusted projected annual water levels for the future. All projected water levels shown in hydrographs in this appendix are annual average water levels.

For each simulation, adjusted projected water levels at RMP wells (Figure 9) were compared against measurable objectives (MO) and minimum thresholds (MT). Figure 10 shows an example water level hydrograph for the shallow RMP Well SRP0106. The groundwater elevation of the baseline and all group scenarios for SRP0106 is above the MT for the entire projected water budget period.

Figure 11 shows an example water level hydrograph for deep RMP Well SRP0376. In this case, the baseline scenario RMP first experiences MT exceedances in the mid 2030's, and then

continuously starting in 2043. Primarily through the implementation of the Group 1 PMA's, the SRP0376 RMP does not begin to experience MT exceedances until 2052, at which point exceedances occur continuously until 2070.

Appendix 6-A-1 shows hydrographs for each scenario for the remaining shallow and deep RMP wells and the corresponding MO and MT for that well.

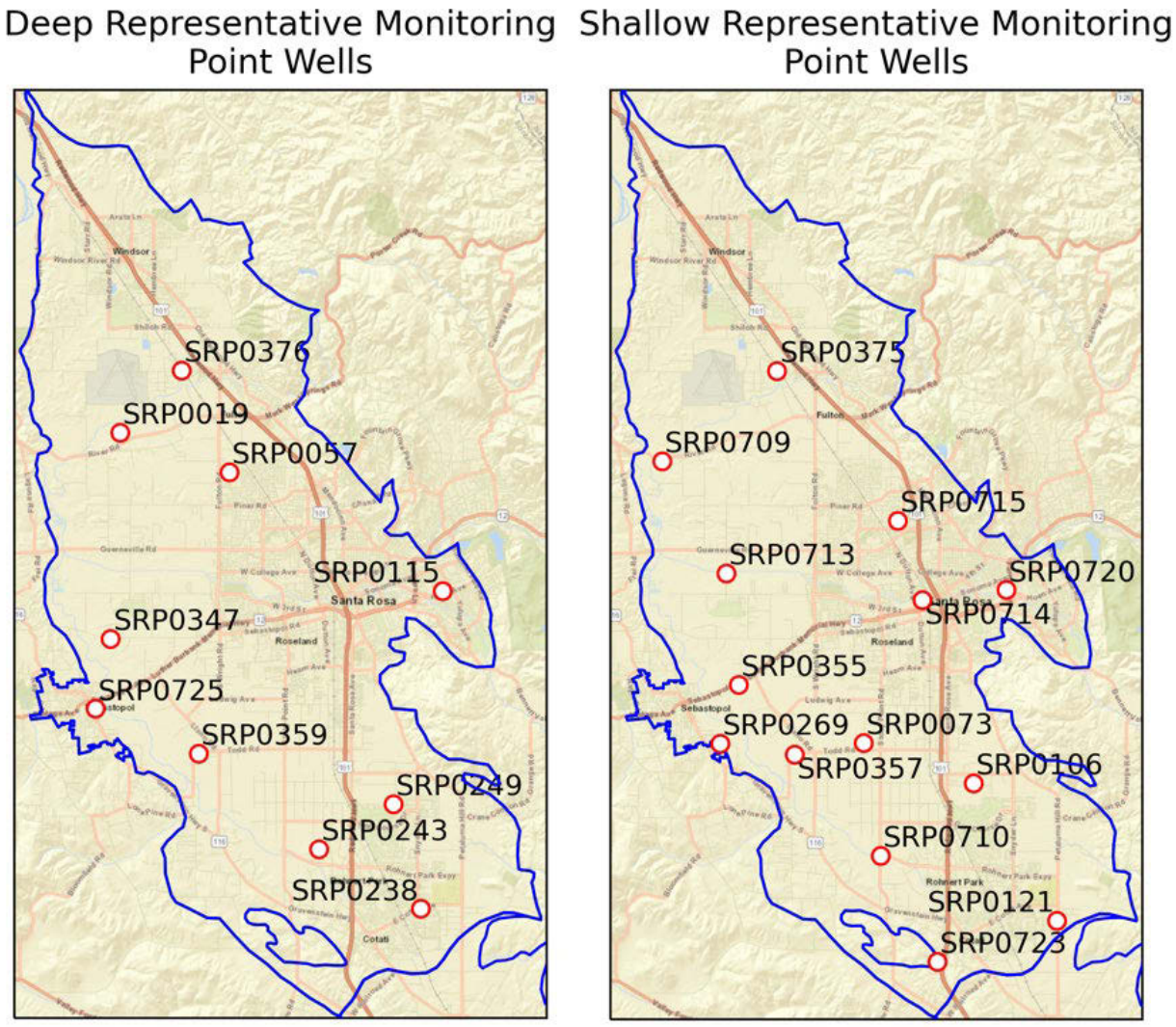

Figure 9 Representative Monitoring Point locations

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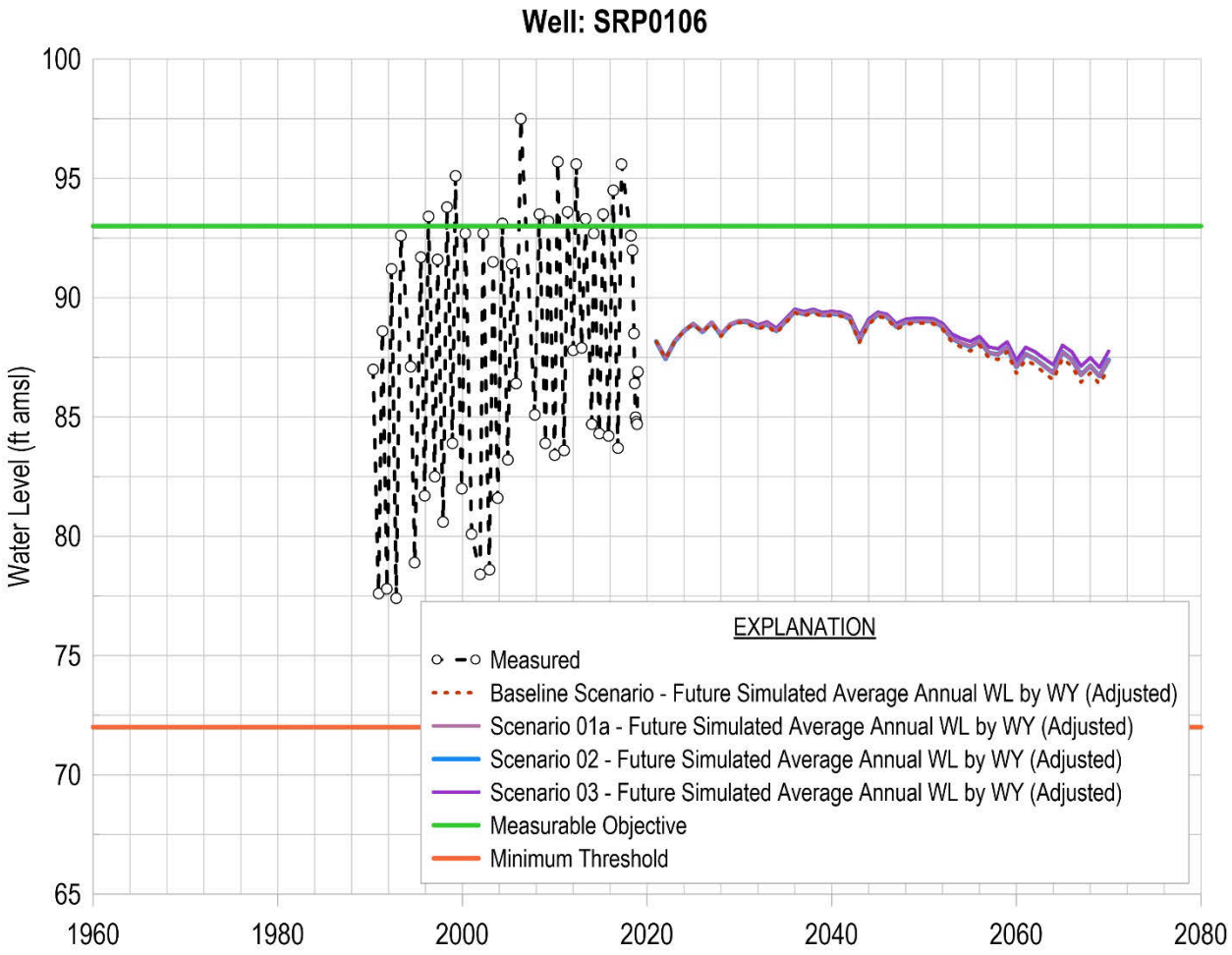

Figure 10. Water Level Hydrograph for Shallow RMP Well SRP0106

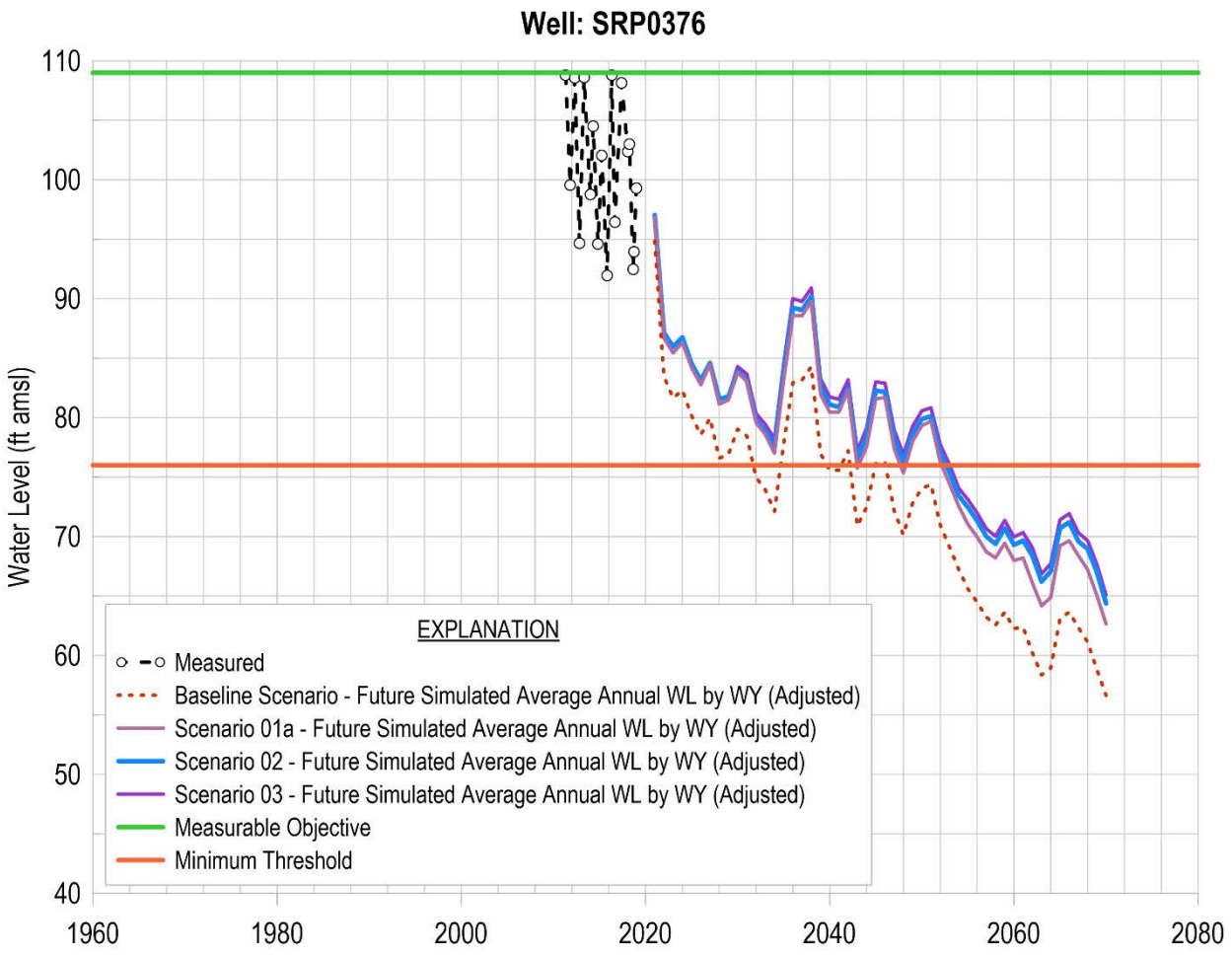

Figure 11. Water Level Hydrograph for Deep RMP Well SRP0376

Table 5 and Table 6 display the number of years where water levels are below the minimum threshold for shallow and deep RMP wells, respectively. These values are summarized in Table 7. The number of MT exceedances for each well depth category and scenario are plotted in Figure 12 and Figure 13. As additional projects are added for each simulation, the number of years with MT exceedances decreases for each time period. Implementation of Group 1 results in greatest decline in MT exceedances, whereas implementation of Group 3 results in a minimal decrease of MT exceedances, changing from 19 to 18 exceedances, compared to Group 2.

Table 5. Number of Years with Water Levels Below Minmum Threshold for Shallow RMP Wells

RMP Well	Baseline		Group 1		Group 2		Group 3	
	2021 - 2040	2041- 2070	2021 - 2040	2041- 2070	2021 - 2040	2041- 2070	2021 - 2040	2041- 2070
SRP0121	0	0	0	0	0	0	0	0
SRP0720	0	0	0	0	0	0	0	0
SRP0269	0	0	0	0	0	0	0	0
SRP0355	0	0	0	0	0	0	0	0
SRP0723	0	0	0	0	0	0	0	0
SRP0073	0	0	0	0	0	0	0	0
SRP0106	0	0	0	0	0	0	0	0
SRP0357	0	0	0	0	0	0	0	0
SRP0375	0	4	0	0	0	0	0	0
SRP0709	0	0	0	0	0	0	0	0
SRP0710	0	0	0	0	0	0	0	0
SRP0713	0	0	0	0	0	0	0	0
SRP0714	0	0	0	0	0	0	0	0
SRP0715	0	0	0	0	0	0	0	0

Table 6. Number of Years with Water Levels Below Minimum Threshold for Deep RMP Wells

RMP Well	Baseline		Group 1		Group 2		Group 3	
	2021 - 2040	2041- 2070	2021 - 2040	2041- 2070	2021 - 2040	2041- 2070	2021 - 2040	2041- 2070
SRP0238	0	0	0	0	0	0	0	0
SRP0243	0	0	0	0	0	0	0	0
SRP0249	0	0	0	0	0	0	0	0
SRP0347	0	0	0	0	0	0	0	0
SRP0359	0	0	0	0	0	0	0	0
SRP0019	0	16	0	4	0	0	0	0
SRP0115	0	0	0	0	0	0	0	0
SRP0376	4	27	0	20	0	18	0	17
SRP0724	0	0	0	0	0	0	0	0
SRP0725	0	0	0	0	0	0	0	0
SRP0057	0	15	0	2	0	1	0	1

Table 7 Summary of Waterlevel exceedances by depth and period

		Number of years with projected WL below MT	
	Depth	**Deep**	**Shallow**
Period	**Scenario**		
2021 - 2040	**Scenario - Baseline**	4	0
	Scenario - Group 1	0	0
	Scenario - Group 2	0	0
	Scenario - Group 3	0	0
2040 - 2070	**Scenario - Baseline**	58	4
	Scenario - Group 1	26	0
	Scenario - Group 2	19	0
	Scenario - Group 3	18	0

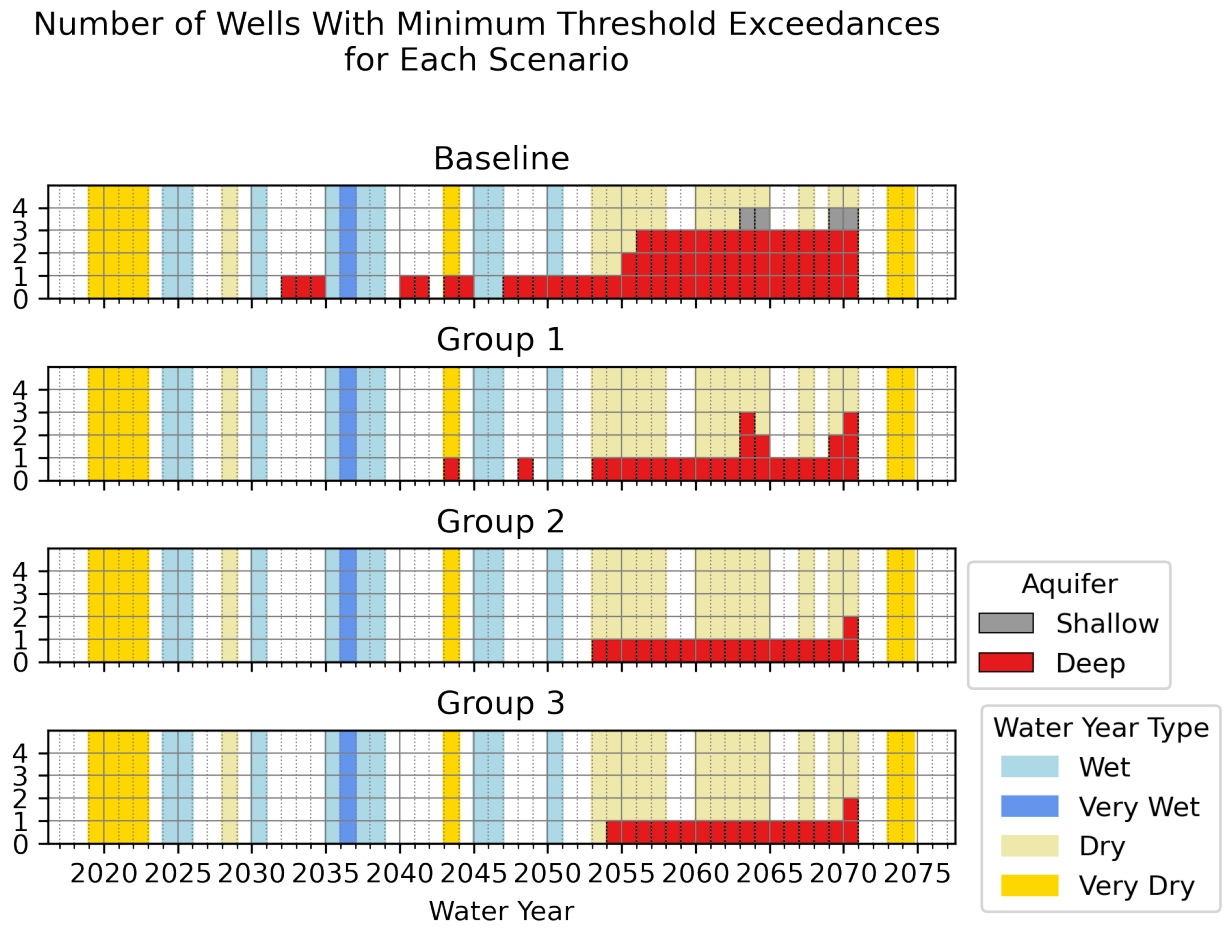

Figure 12. Number RMP of Wells Below Minimum Threshold

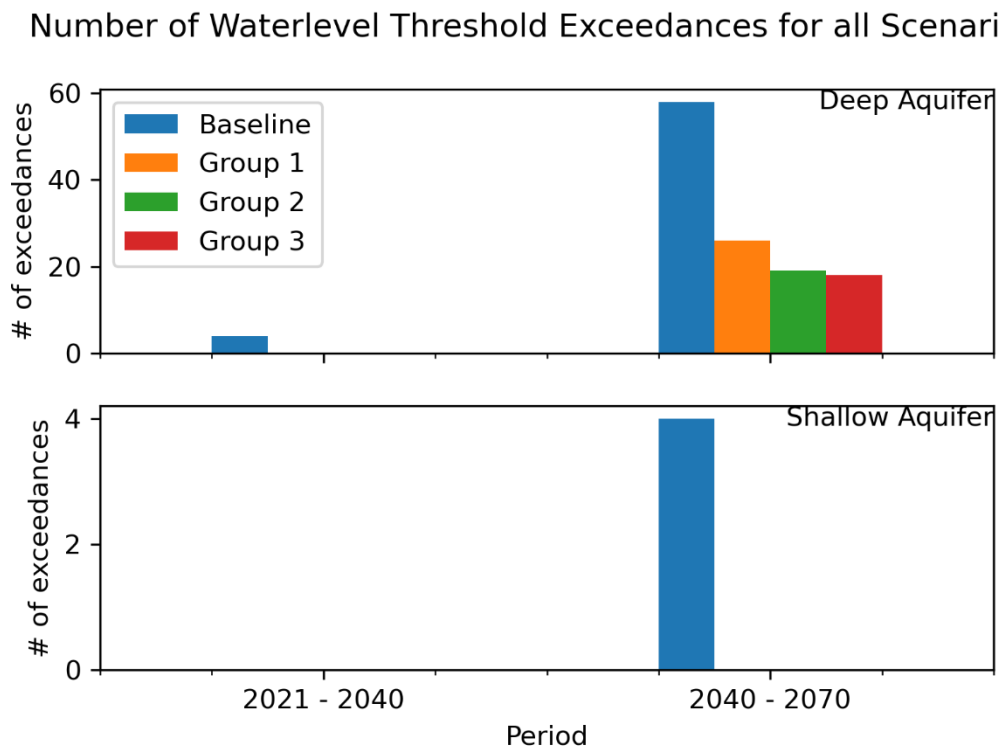

Figure 13 Number of Waterlevel Exceedances for all Scenarios

Each simulation was evaluated for undesirable results. Undesirable results are defined to occur when projected water levels at 30% of RMP wells fall below the MT for three consecutive years. For the shallow aquifer this occurs when 4 out of the 14 wells concurrently have MT exceedances, while for the deep aquifer this occurs when 3 out of the 11 wells concurrently have MT exceedances.

In the baseline scenario, undesirable results do not occur in the shallow aquifer but do occur in the deep aquifer from WY 2059 to WY 2070 (Figure 14). Undesirable results do not occur in the Group 1, Group 2, or Group 3 scenarios for either aquifer.

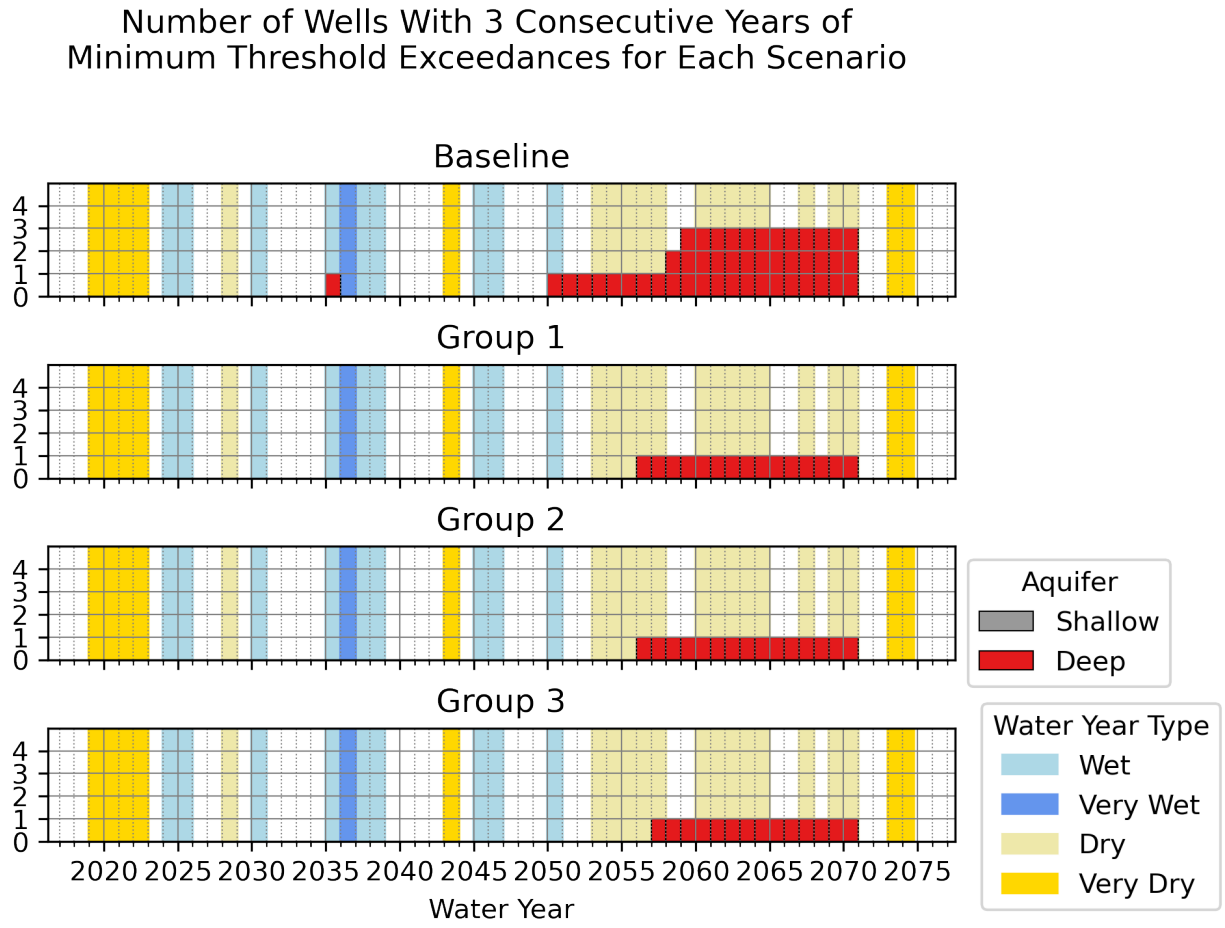

Figure 14. Number of Wells Below Minimum Threshold for Three Consecutive Years for RMP Wells. Undesirable results occur when 30% of RMP's experience Minimum Threshold exceedances for three consecutive years

3.3.1 Changes in Simulated Groundwater Elevation for Group 1, Group 2 and Group Scenarios

This section shows the projected changes in groundwater elevation between the baseline and the group scenarios. The maps are presented in the following order: shallow waterlevel differences at WY 2040 (Figure 15, Figure 16, and Figure 17), deep waterlevel differences at WY 2040 (Figure 18, and Figure 19, and Figure 20), shallow waterlevel differences at WY 2070 (Figure 21, Figure 22, and Figure 23), and deep waterlevel differences at WY 2070 (Figure 24, Figure 25, and Figure 26). Figure 15, Figure 16, and Figure 17 demonstrate that the implementation of the three PMA's have little effect on shallow waterlevels at WY 2040. Deep waterlevels do benefit from the implementation of the PMA's (Figure 18, and Figure 19, and Figure 20). The Group 1 shows positive changes generally northeast of the Trenton Ridge. The Group 2 scenario shows the smallest areal change in groundwater levels, with little benefit when compared to Group 1. The Group 3 scenario shows areas of positive waterlevel changes

in the same areas as Group 1 and 2, but also in the southern portion of the subbasin, from the City of Cotati to the northern border of the Rohnert Park. The shallow waterlevel changes at WY 2070 show little benefit due to the implementation of the PMA's (Figure 21, Figure 22, Figure 23), similar to the WY 2040 water level differences. The deep aquifer at WY 2070 shows similar but expanded patterns as the deep aquifer in WY 2040 (Figure 24, Figure 25, and Figure 26). For Group 1 and Group 2 the waterlevel benefits are concentrated around the area northeast of the Trenton Ridge Fault. The Group 3 scenario shows expanded benefits in the both the area northeast of the Trenton Ridge Fault and much of the southern third of the subbasin.

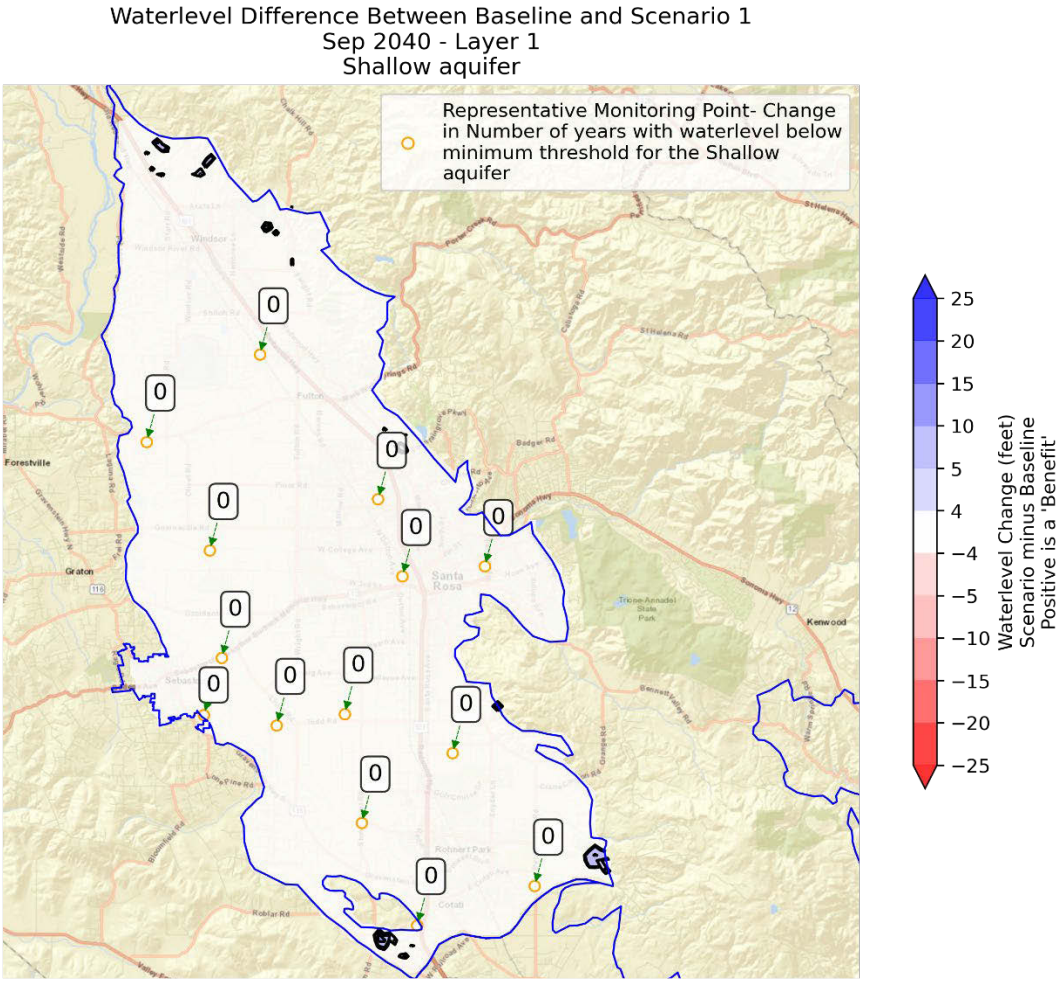

Figure 15. Projected Shallow Aquifer Groundwater Elevation Benefit in September 2040 for Group 1 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red

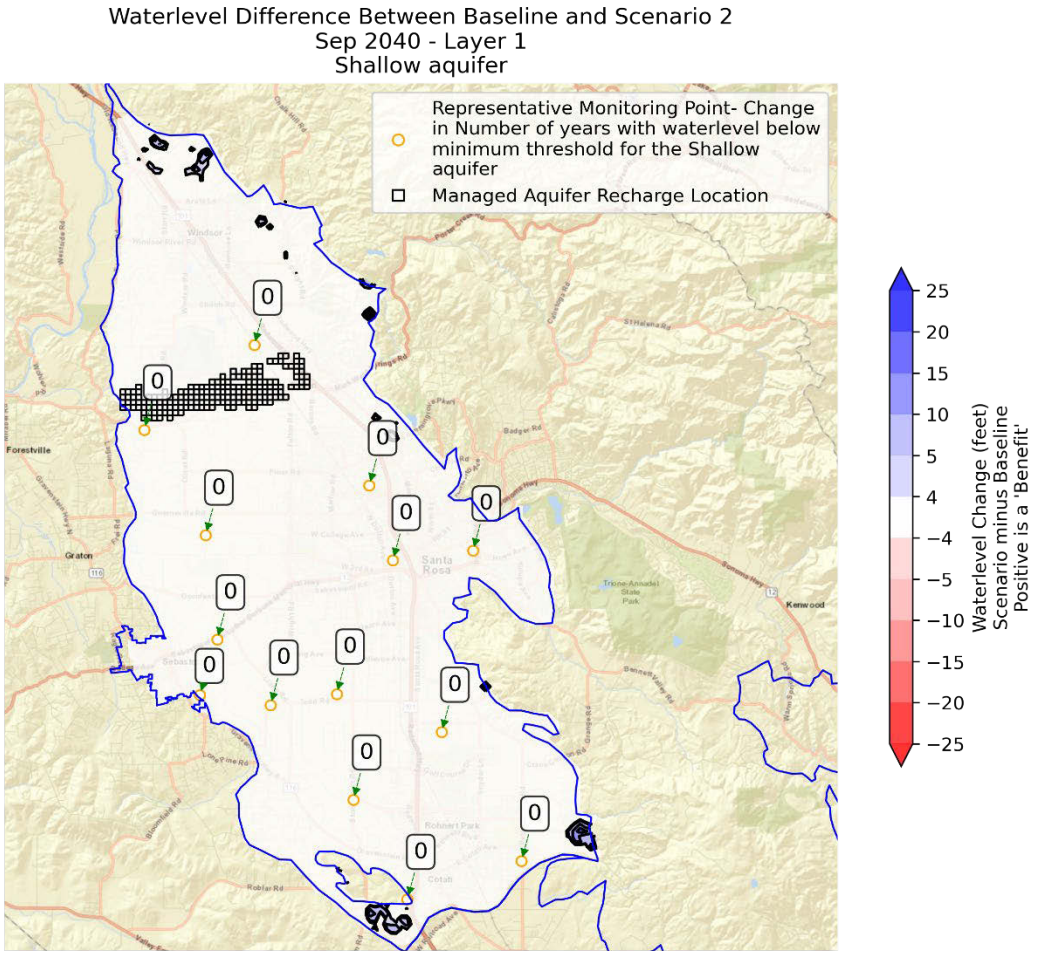

Figure 16. Projected Shallow Aquifer Groundwater Elevation Benefit in September 2040 for Group 2 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red

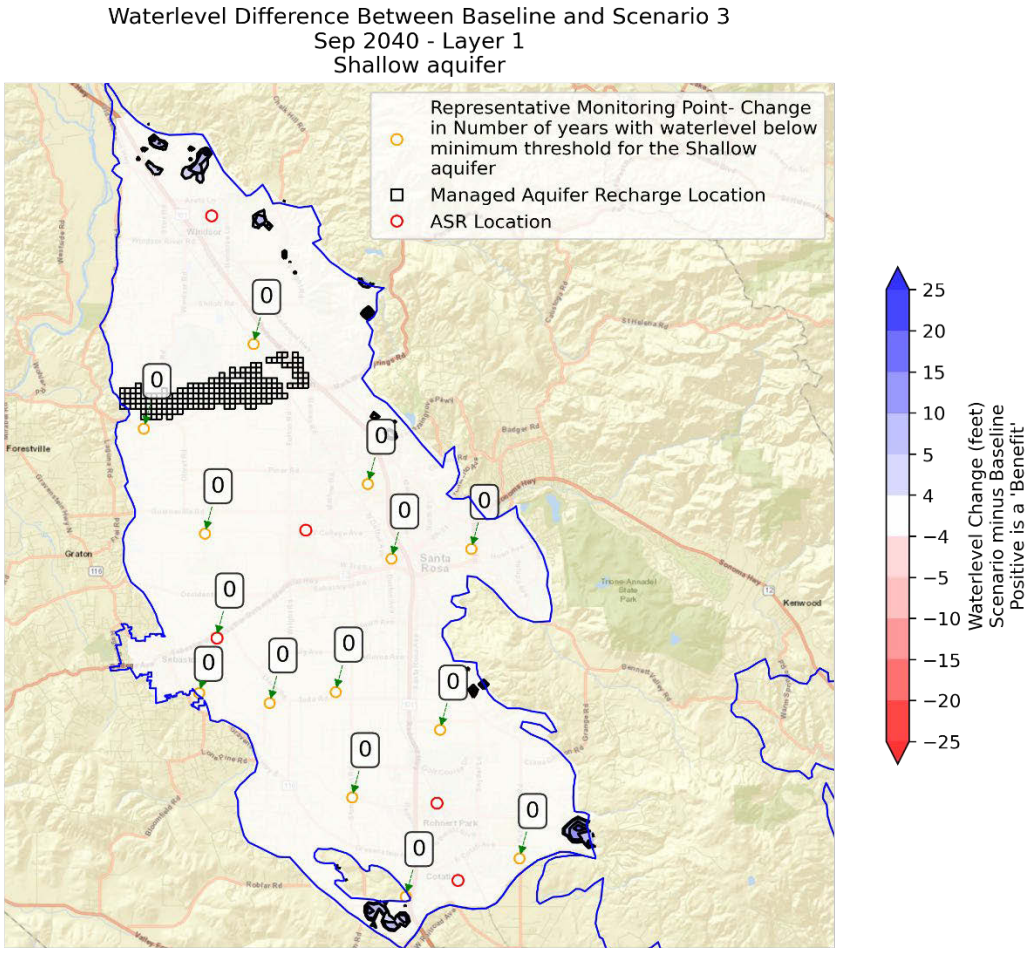

Figure 17. Projected Shallow Aquifer Groundwater Elevation Benefit in September 2040 for Group 3 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red

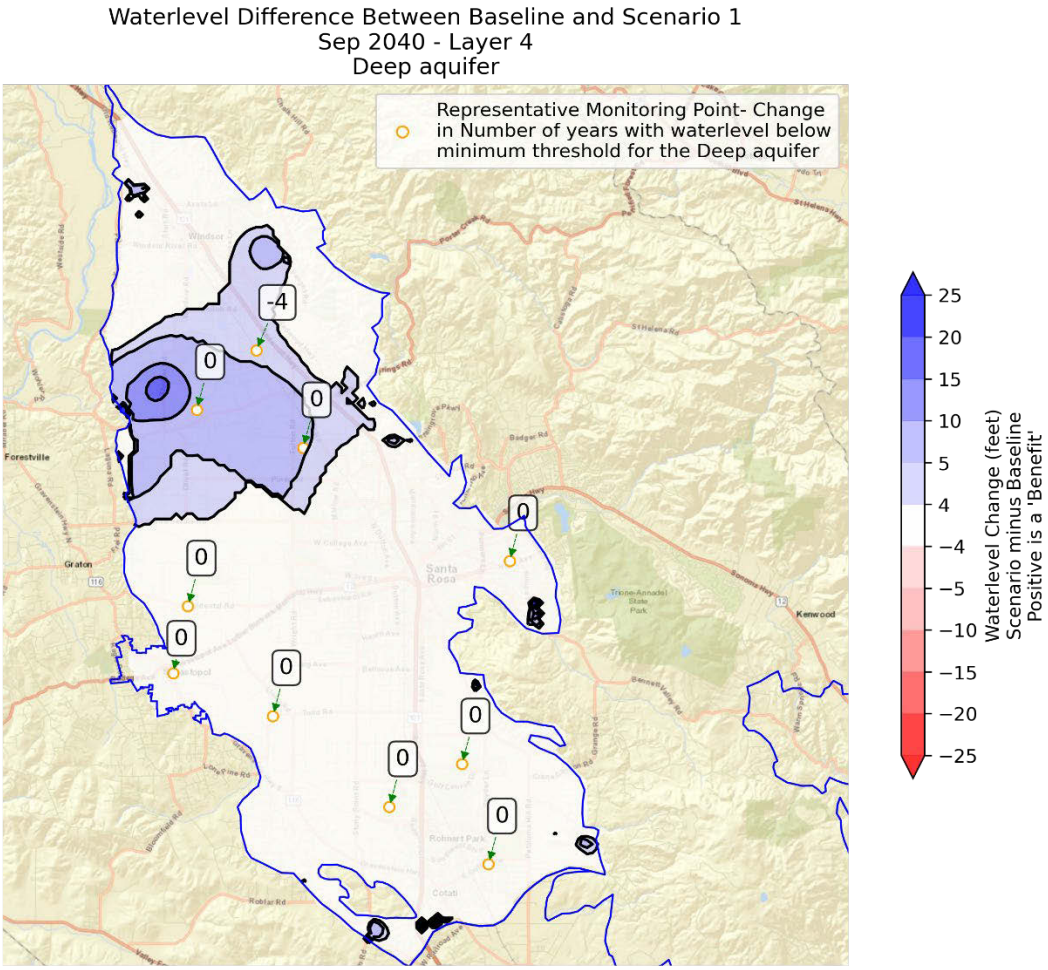

Figure 18. Projected Deep Aquifer Groundwater Elevation Benefit in September 2040 for Group 1 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red

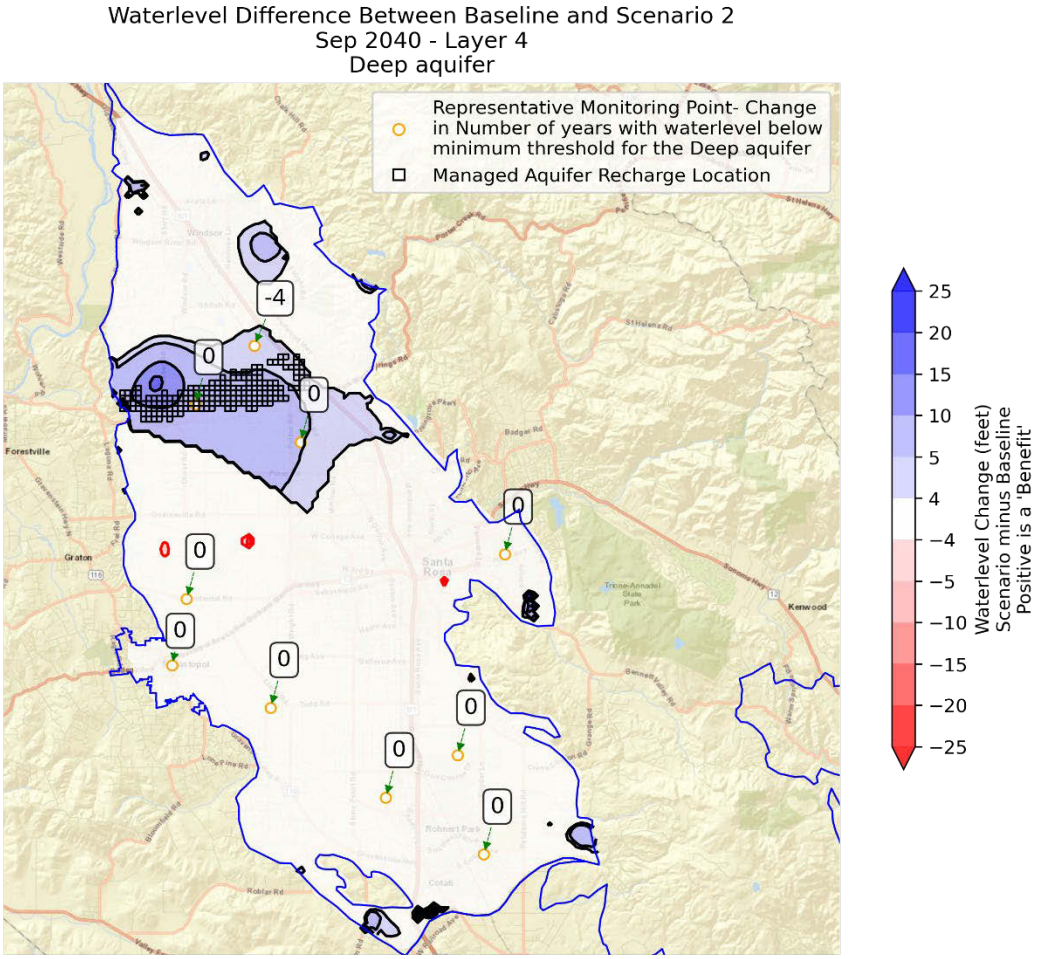

Figure 19. Projected Deep Aquifer Groundwater Elevation Benefit in September 2040 for Group 2 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red

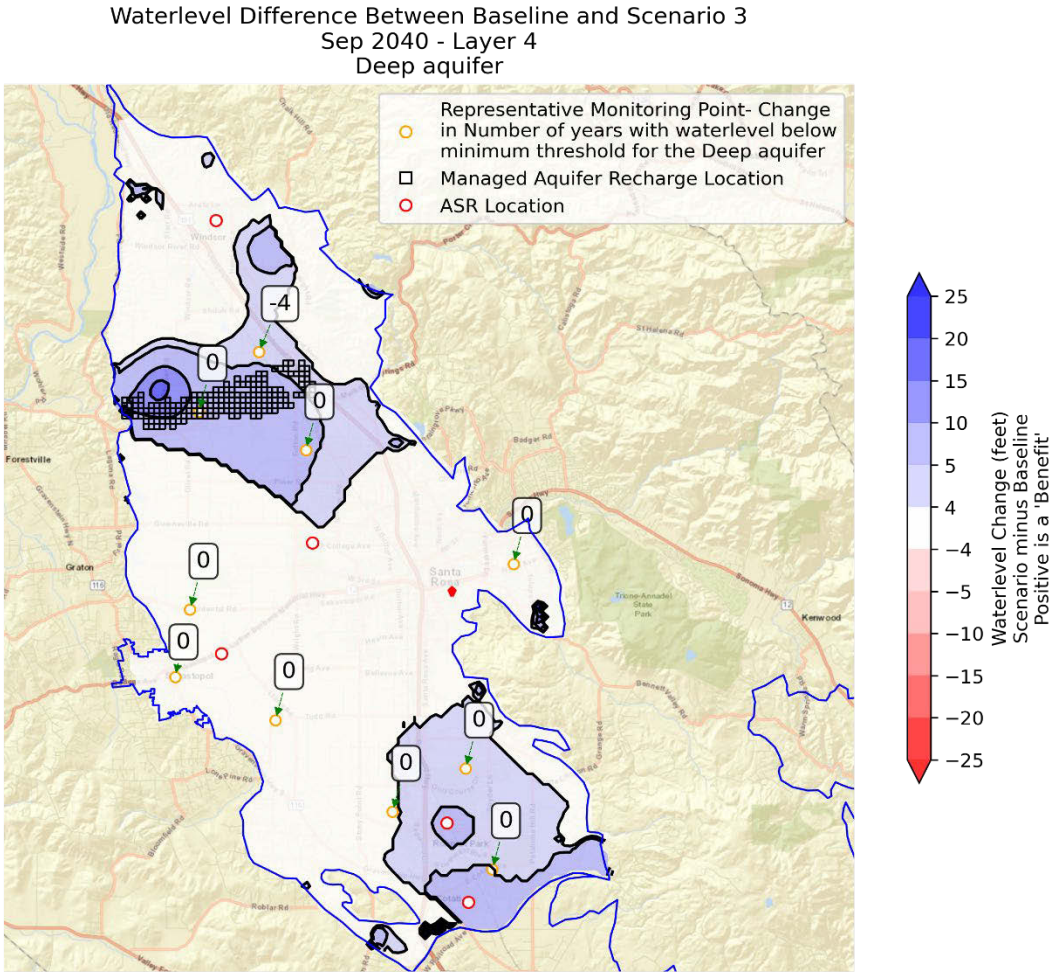

Figure 20. Projected Deep Aquifer Groundwater Elevation Benefit in September 2040 for Group 3 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red

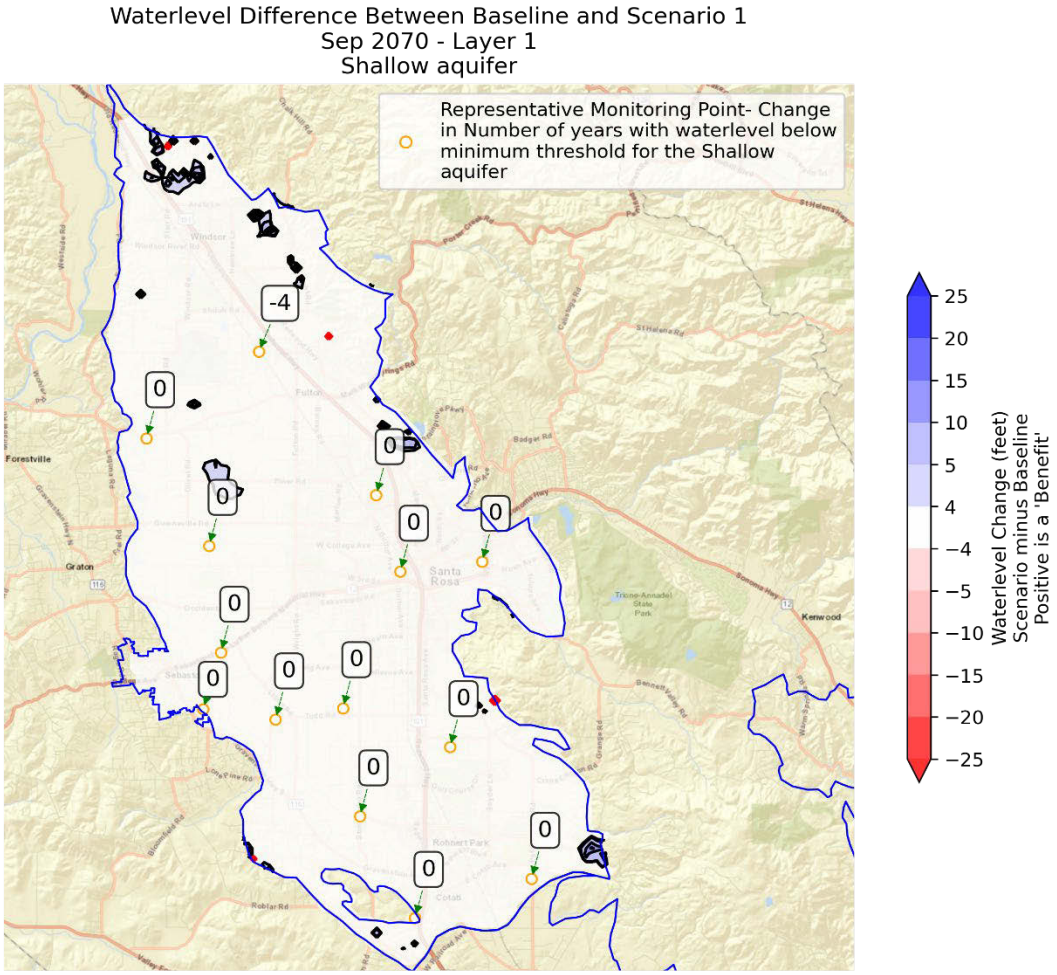

Figure 21. Projected Shallow Aquifer Groundwater Elevation Benefit in September 2070 for Group 1 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red

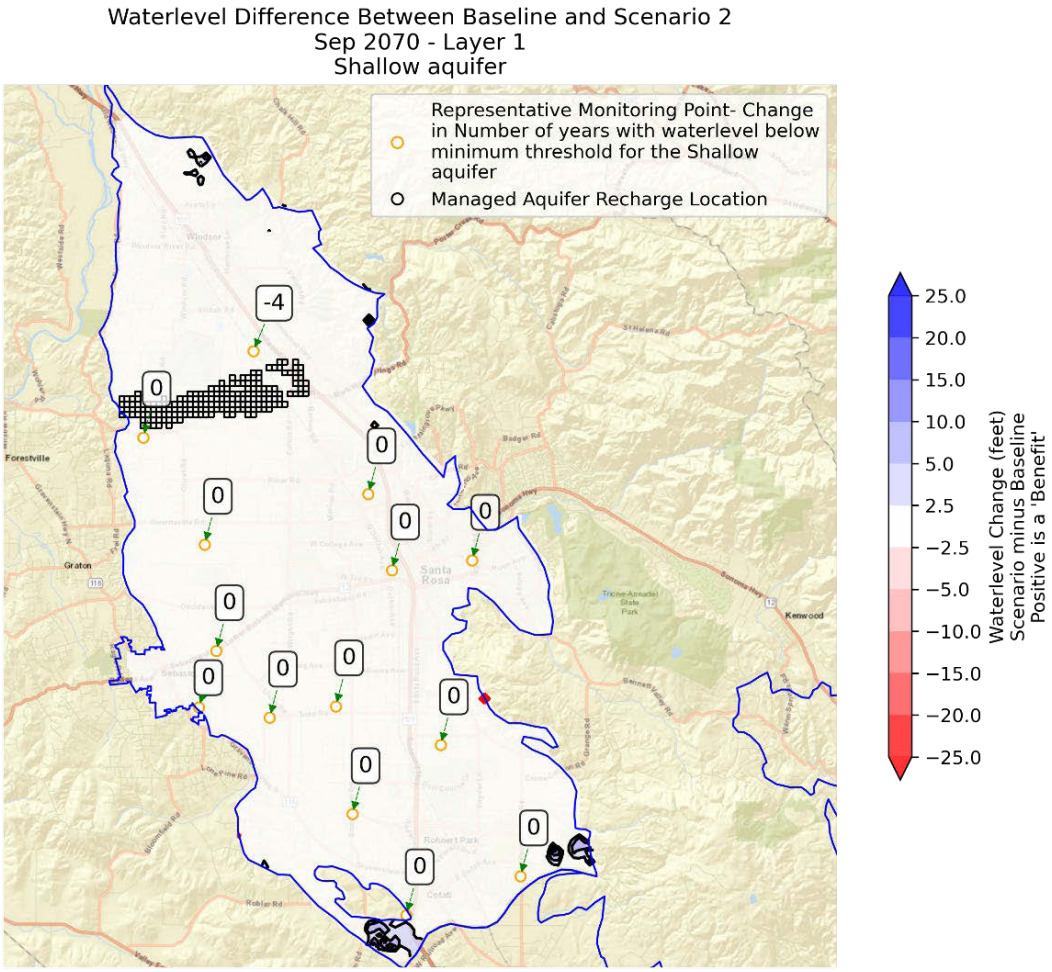

Figure 22. Projected Shallow Aquifer Groundwater Elevation Benefit in September 2070 for Group 2 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red

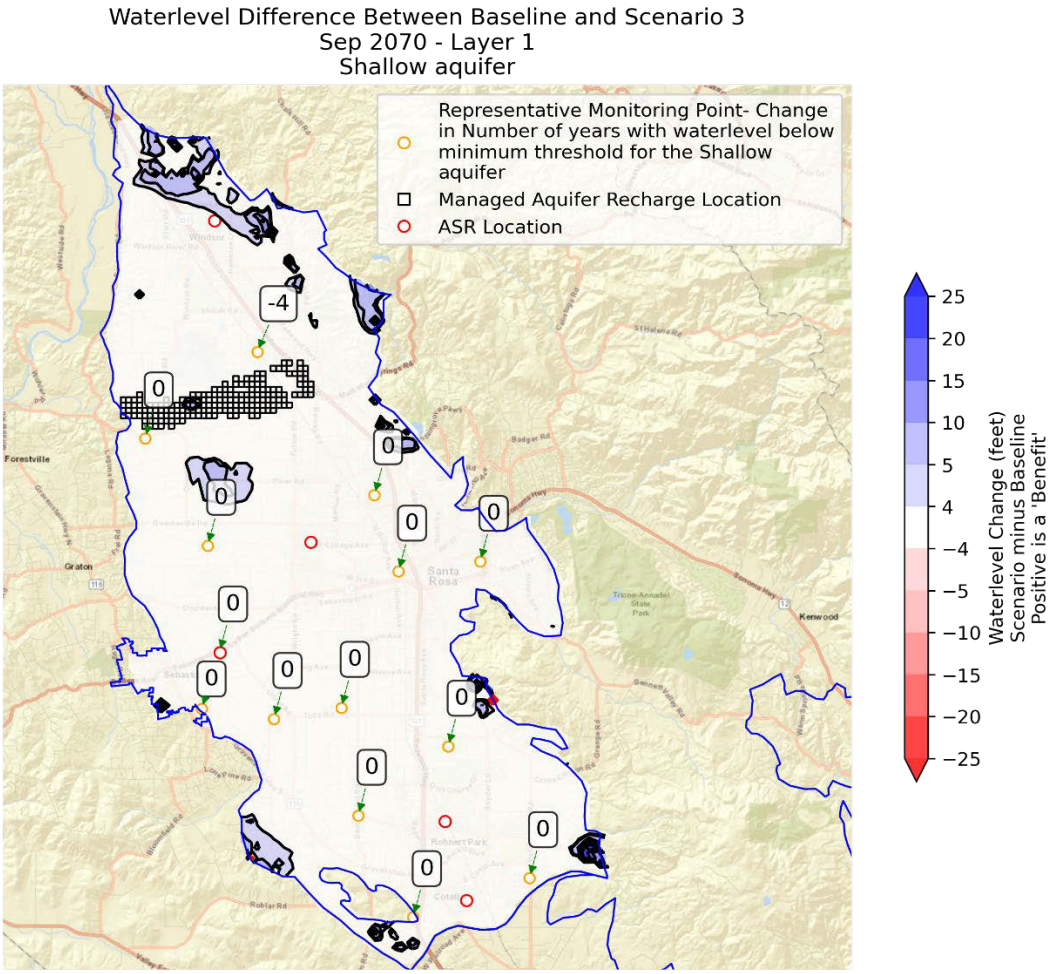

Figure 23. Projected Shallow Aquifer Groundwater Elevation Benefit in September 2070 for Group 3 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red

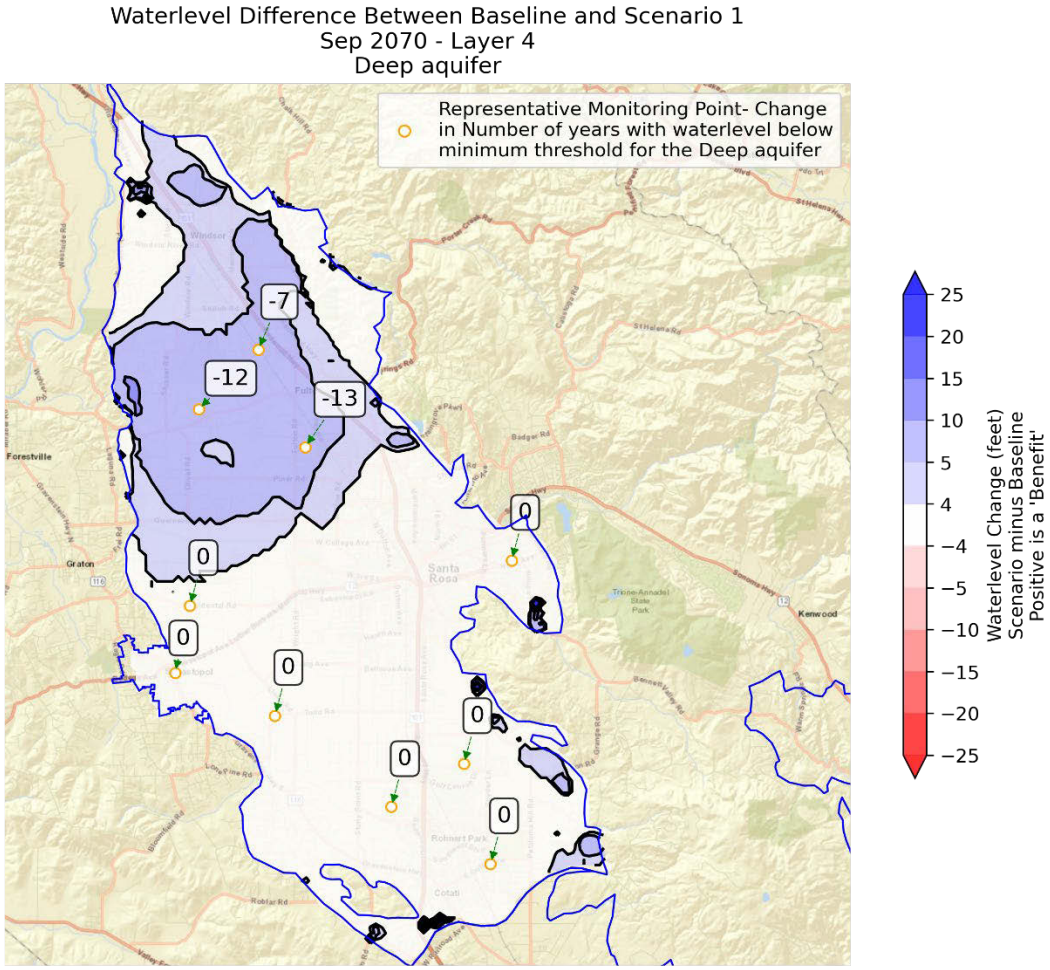

Figure 24. Projected Deep Aquifer Groundwater Elevation Benefit in September 2070 for Group 1 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red

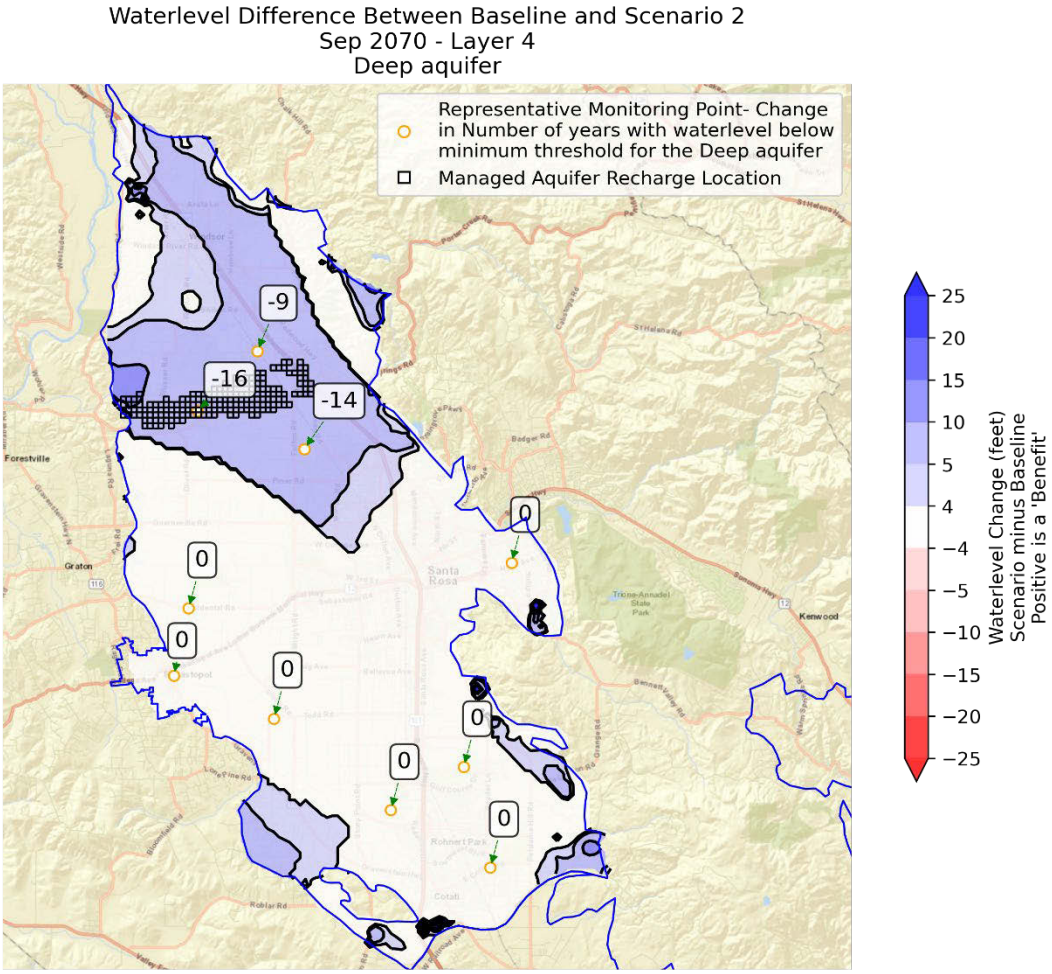

Figure 25. Projected Deep Aquifer Groundwater Elevation Benefit in September 2070 for Group 2 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red

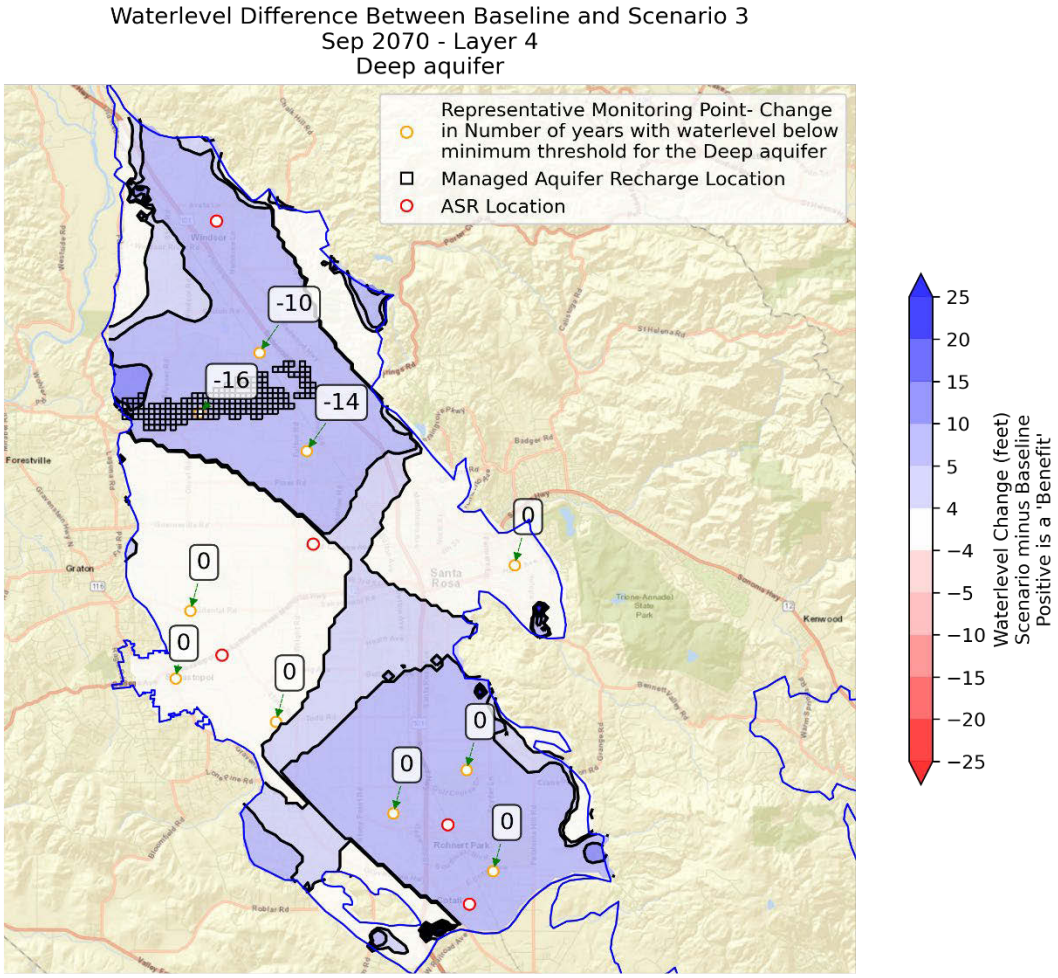

Figure 26. Projected Deep Aquifer Groundwater Elevation Benefit in September 2070 for Group 3 PMA's Versus Baseline. Positive Changes Outlined in Black, Negative Changes Outlined in Red

3.3.2 Actual Simulated Waterlevels For Group 1, Group 2, and Group 3 Scenarios

The following figures show the actual simulated waterlevels at each referenced time and depth, for each scenario. They are the corresponding simulated waterlevels used to calculate waterlevel differences and changes in MT exceedances in Figure 15 to Figure 26. The maps are presented in the following order: shallow waterlevel at WY 2040 (Figure 27, Figure 28, Figure 29, and Figure 30), deep waterlevel at WY 2040 (Figure 31, Figure 32, Figure 33, and Figure 34), shallow waterlevel at WY 2070 (Figure 35, Figure 36, Figure 37, and Figure 38), and deep waterlevel at WY 2070 (Figure 39, Figure 40, Figure 41 and Figure 42).

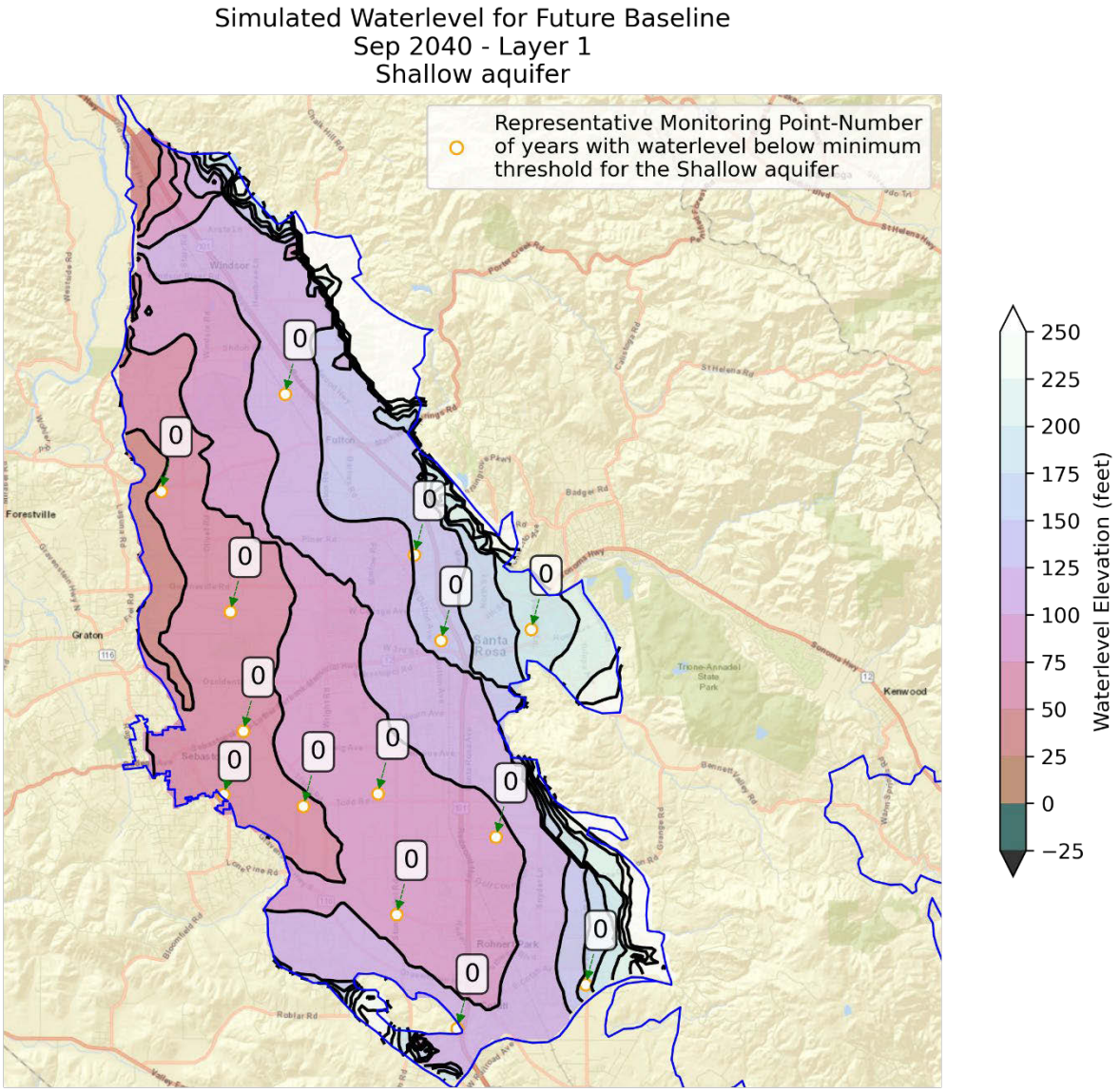

Figure 27 Actual Simulated Waterlevels for the Shallow Aquifer for the Future Baseline, Sep 2040. Positive Values Outlined in Black, Negative Values Outlined in Red

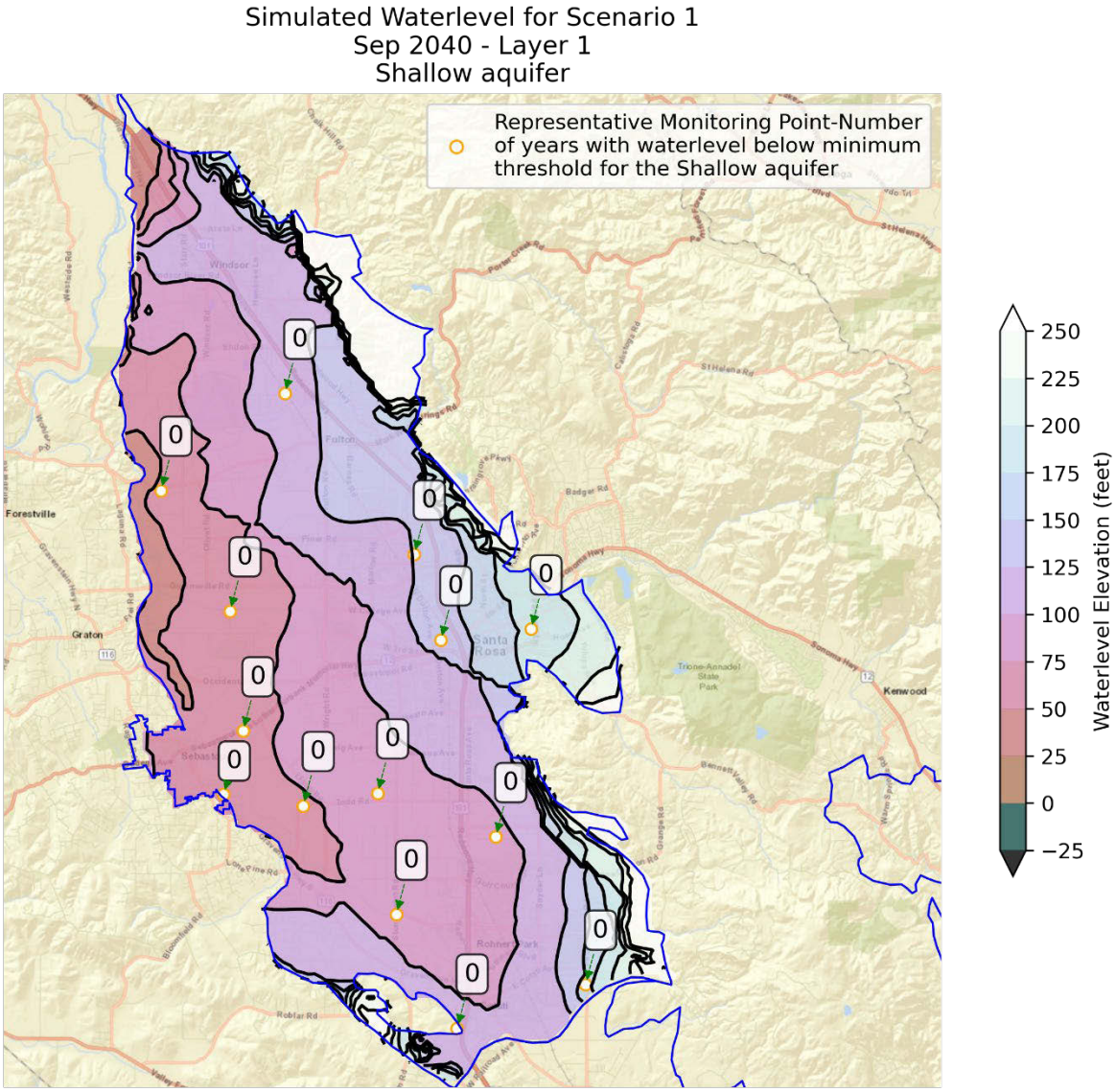

Figure 28 Actual Simulated Waterlevels for the Shallow Aquifer for Scenario 1, Sep 2040. Positive Values Outlined in Black, Negative Values Outlined in Red

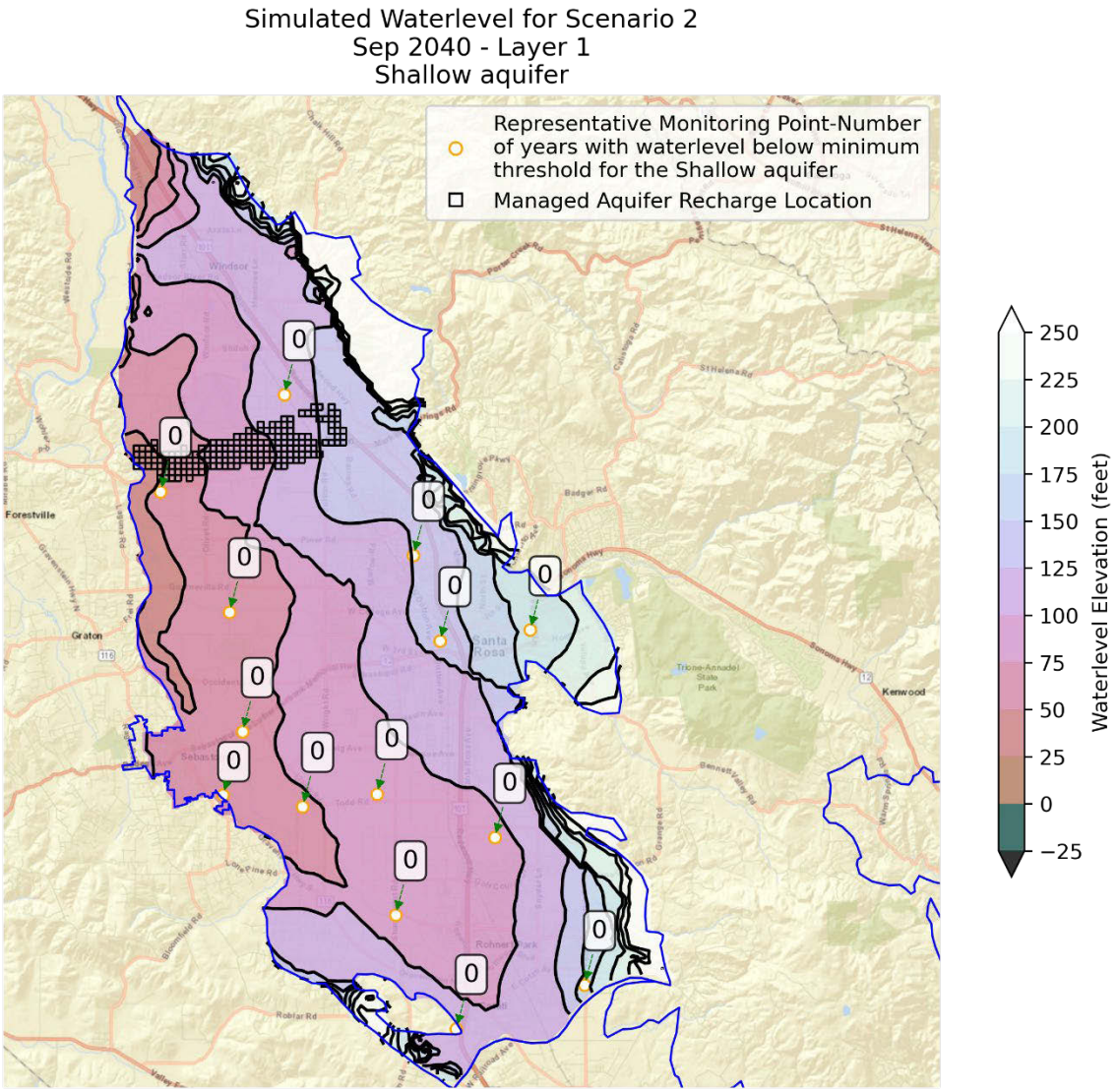

Figure 29 Actual Simulated Waterlevels for the Shallow Aquifer for Scenario 2, Sep 2040. Positive Values Outlined in Black, Negative Values Outlined in Red

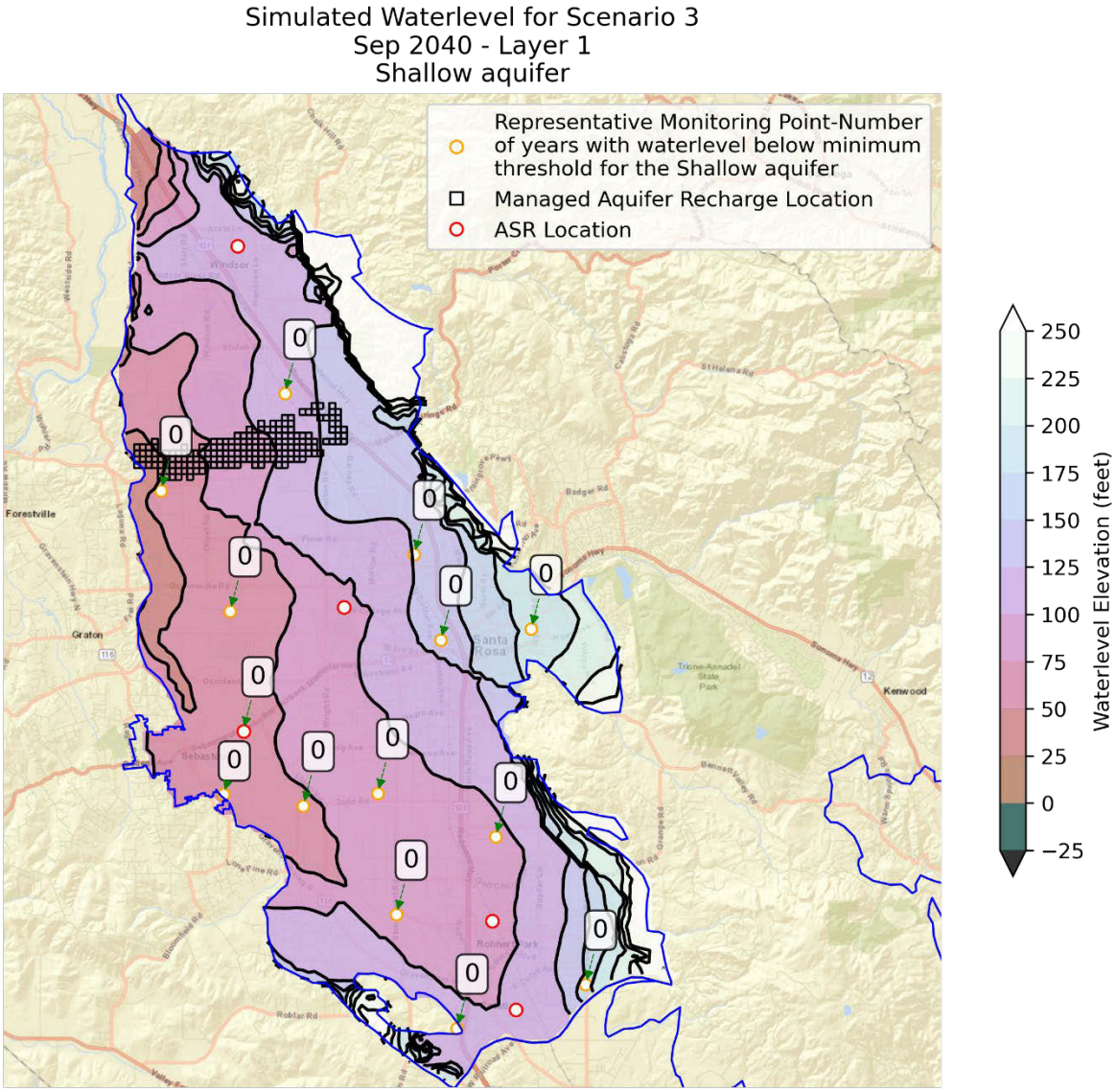

Figure 30 Actual Simulated Waterlevels for the Shallow Aquifer for Scenario 3, Sep 2040. Positive Values Outlined in Black, Negative Values Outlined in Red

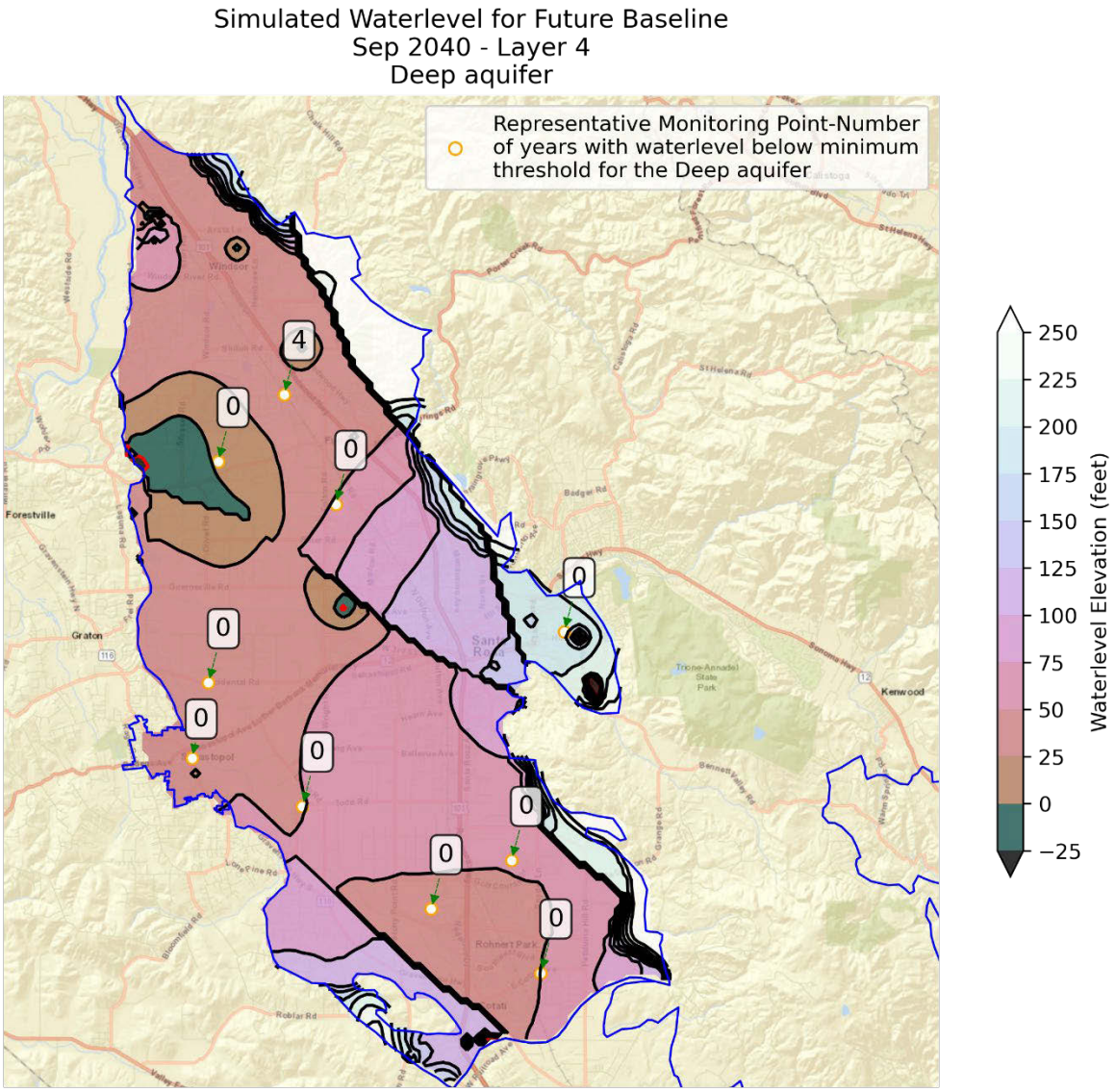

Figure 31 Actual Simulated Waterlevels for the Deep Aquifer for the Future Baseline, Sep 2040. Positive Values Outlined in Black, Negative Values Outlined in Red

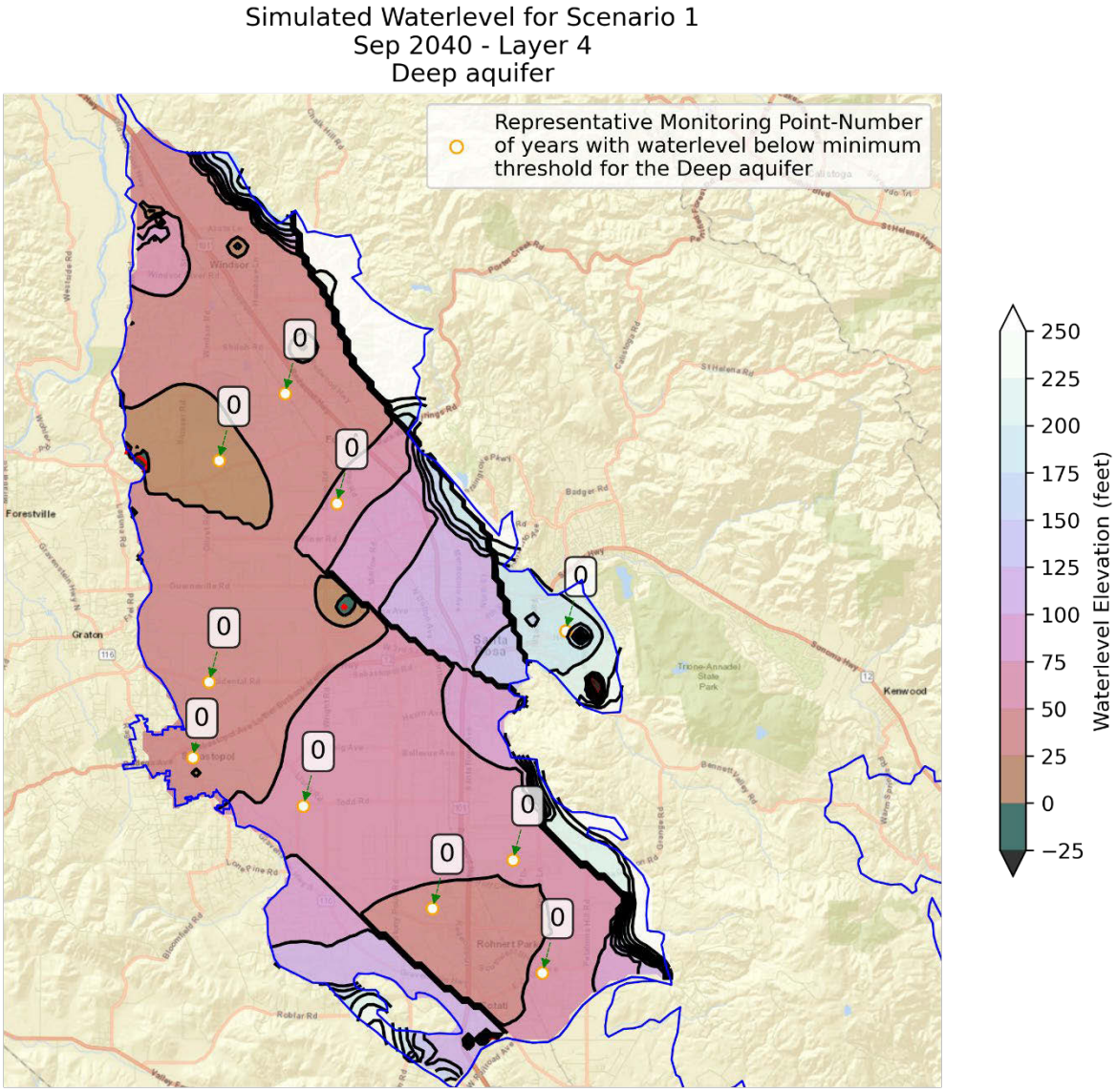

Figure 32 Actual Simulated Waterlevels for the Deep Aquifer for Scenario 1, Sep 2040. Positive Values Outlined in Black, Negative Values Outlined in Red

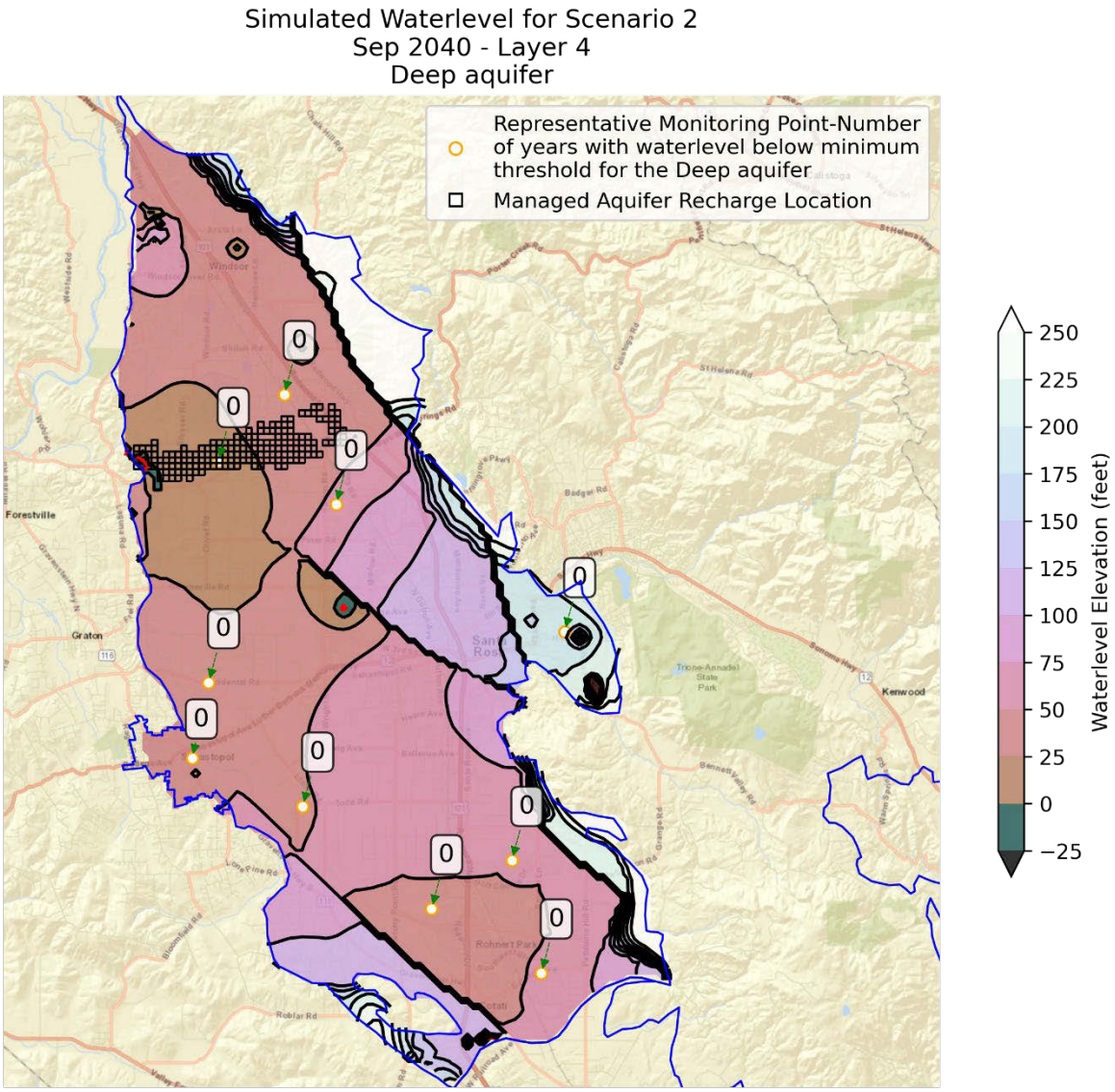

Figure 33 Actual Simulated Waterlevels for the Deep Aquifer for Scenario 2, Sep 2040. Positive Values Outlined in Black, Negative Values Outlined in Red

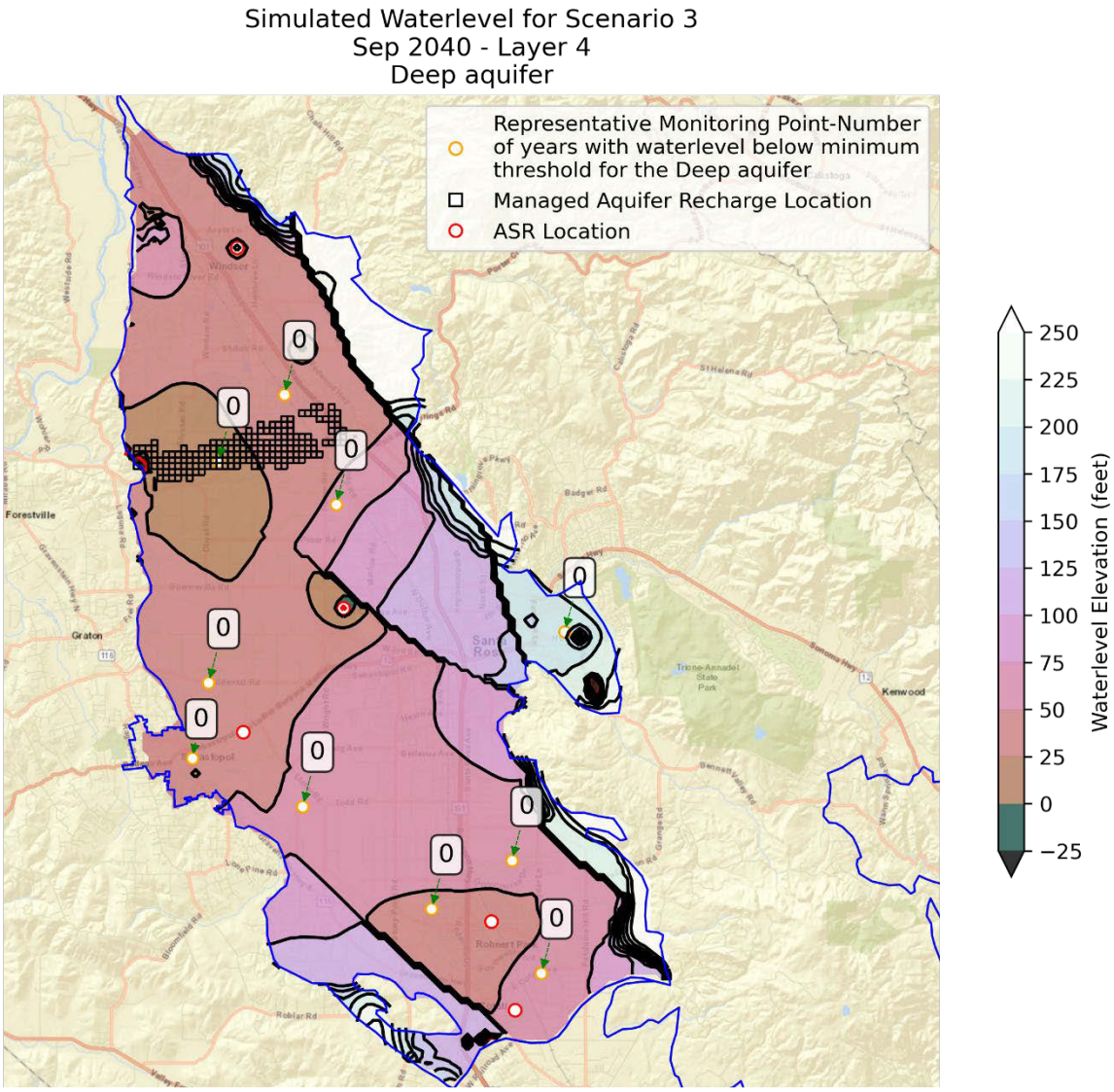

Figure 34 Actual Simulated Waterlevels for the Deep Aquifer for Scenario 3, Sep 2040. Positive Values Outlined in Black, Negative Values Outlined in Red

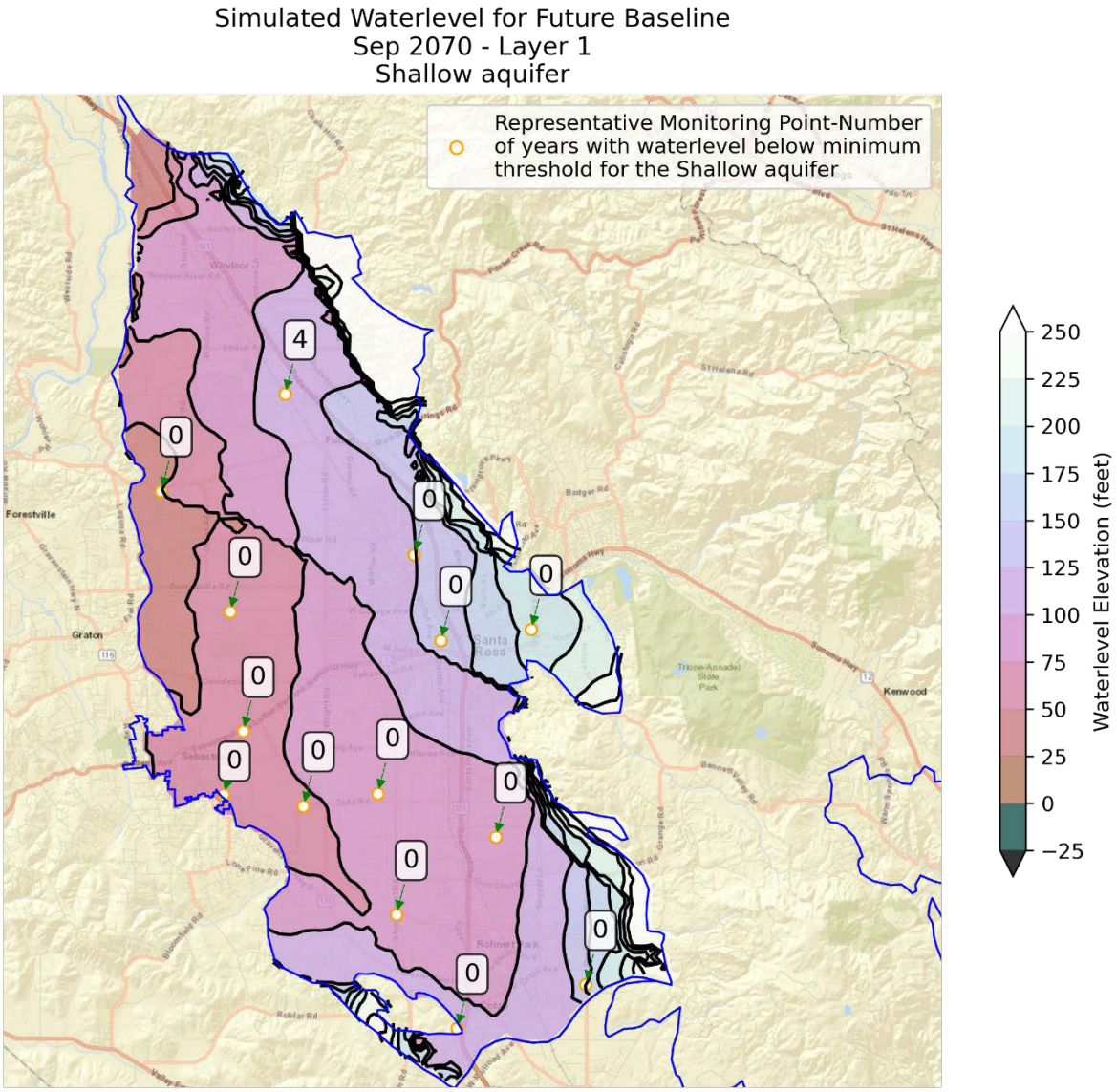

Figure 35 Actual Simulated Waterlevels for the Shallow Aquifer for the Future Baseline, Sep 2070. Positive Values Outlined in Black, Negative Values Outlined in Red

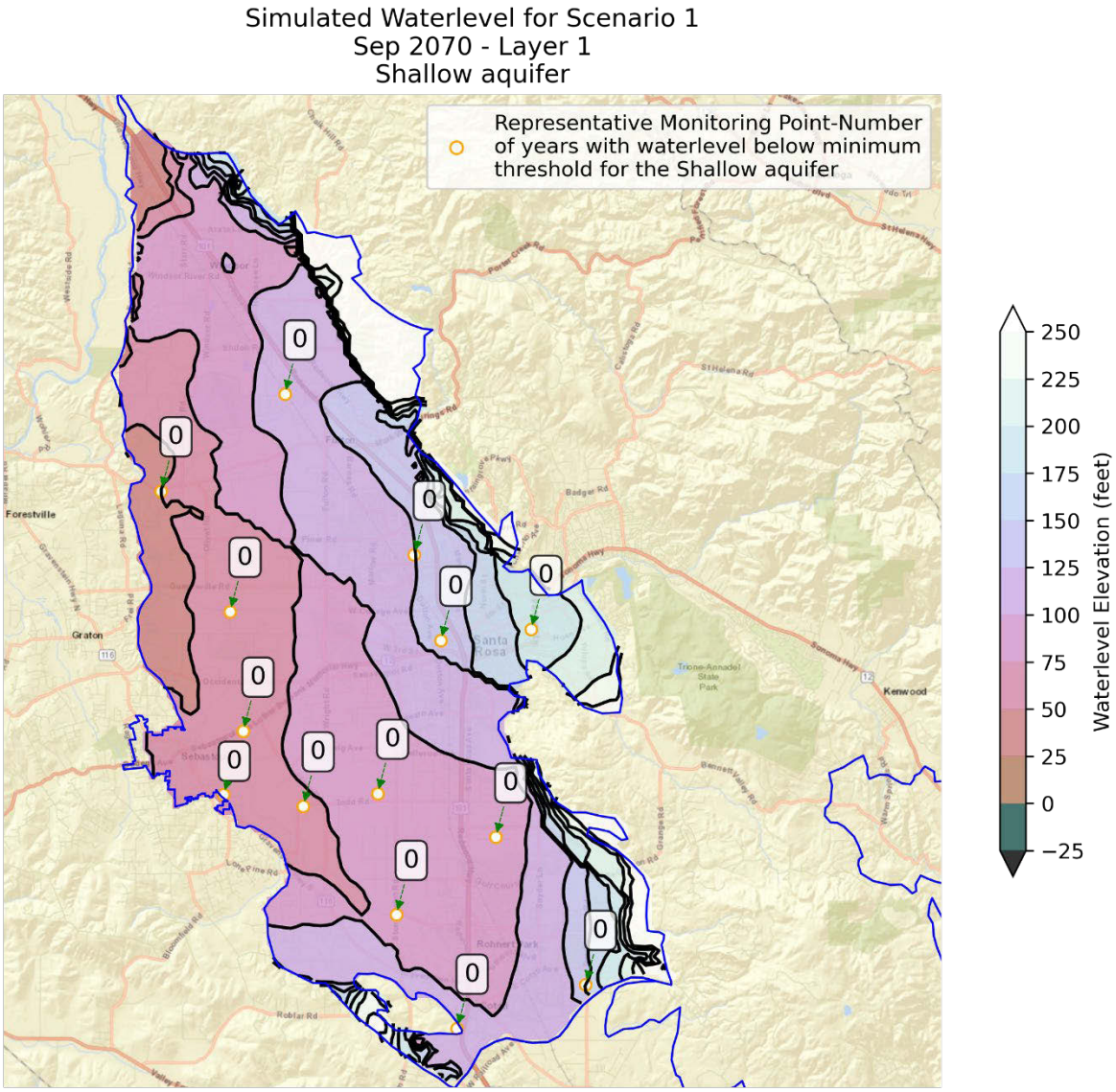

Figure 36 Actual Simulated Waterlevels for the Shallow Aquifer for Scenario 1, Sep 2070. Positive Values Outlined in Black, Negative Values Outlined in Red

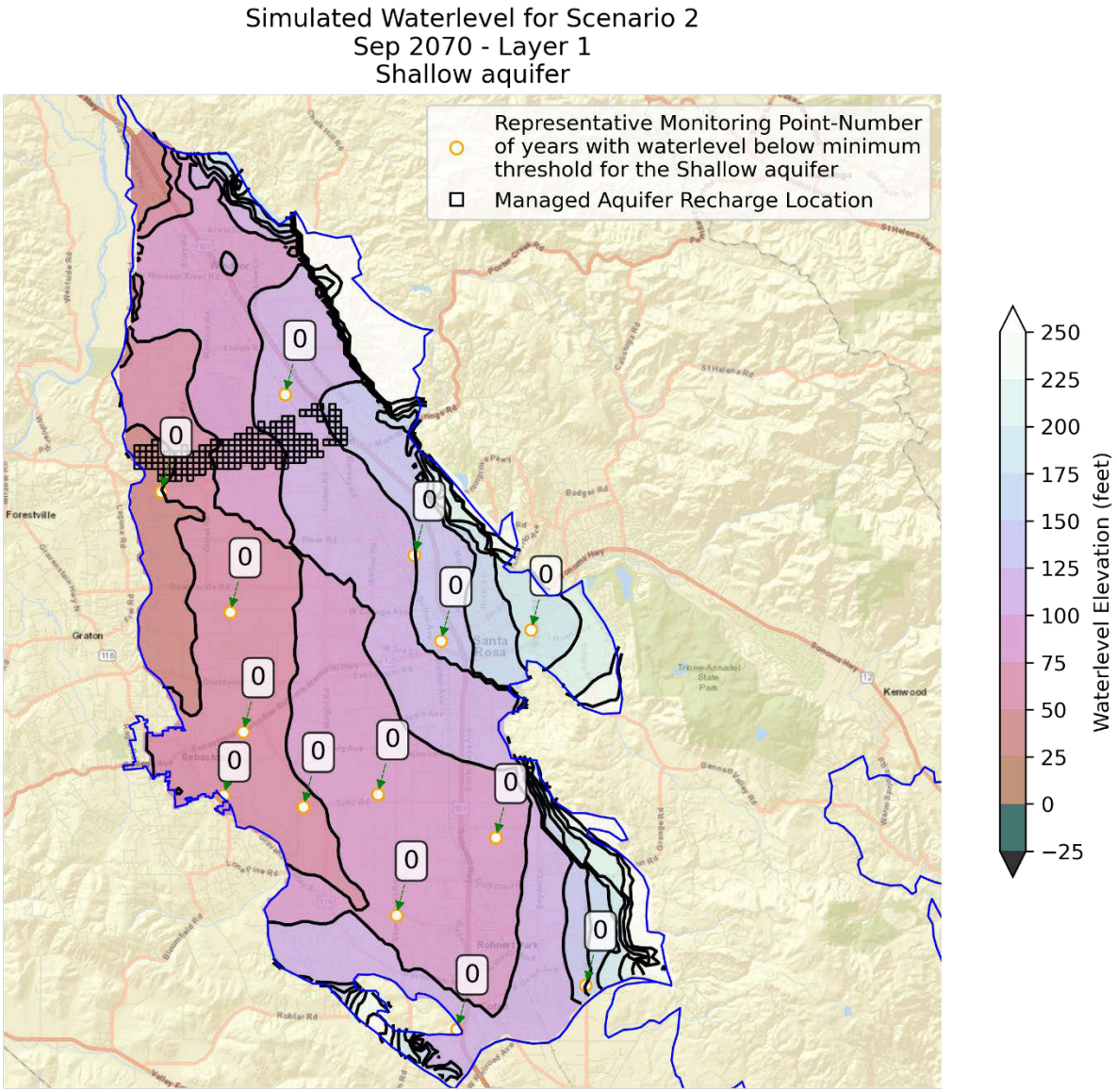

Figure 37 Actual Simulated Waterlevels for the Shallow Aquifer for Scenario 2, Sep 2070. Positive Values Outlined in Black, Negative Values Outlined in Red

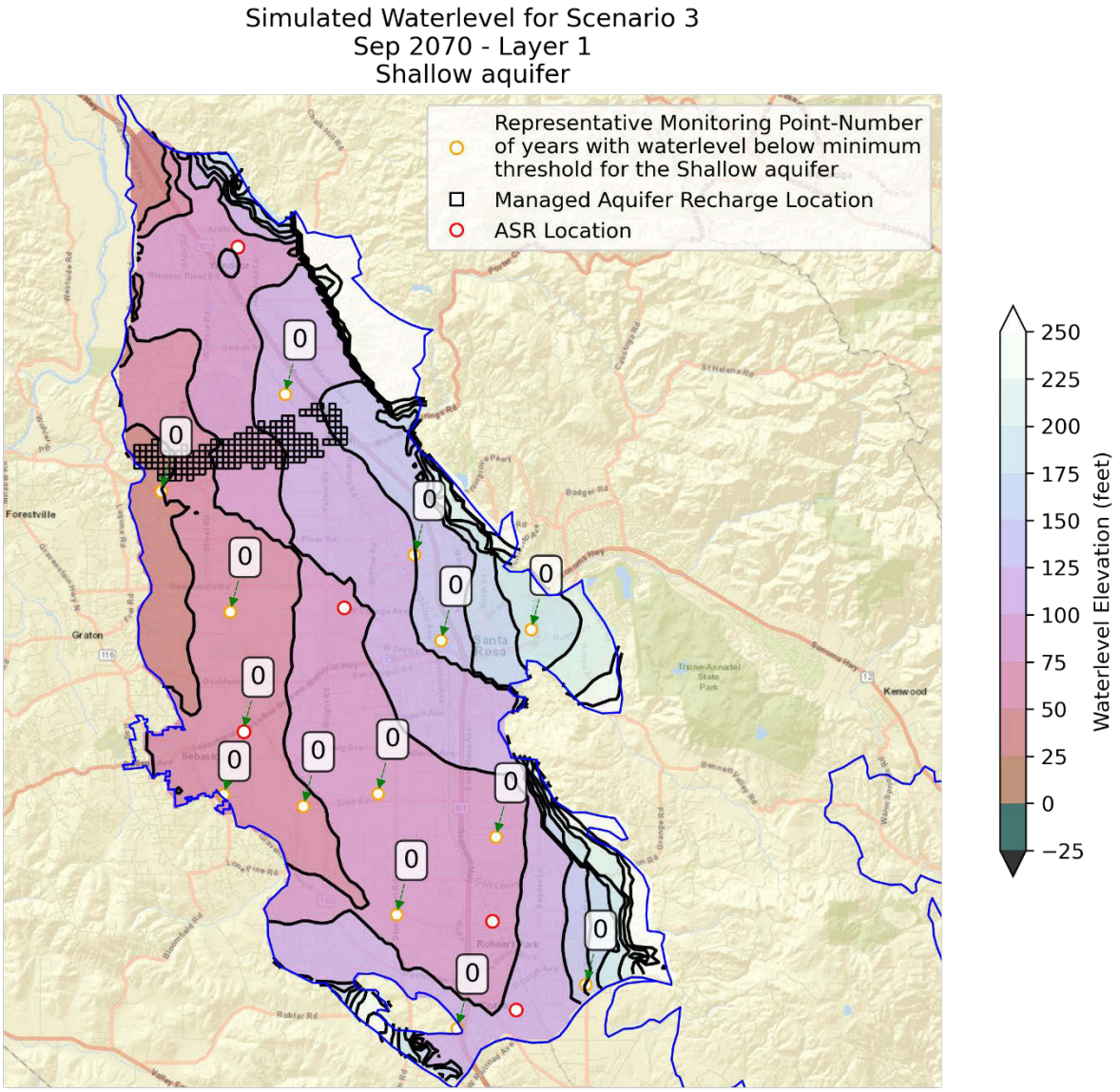

Figure 38 Actual Simulated Waterlevels for the Shallow Aquifer for Scenario 3, Sep 2070. Positive Values Outlined in Black, Negative Values Outlined in Red

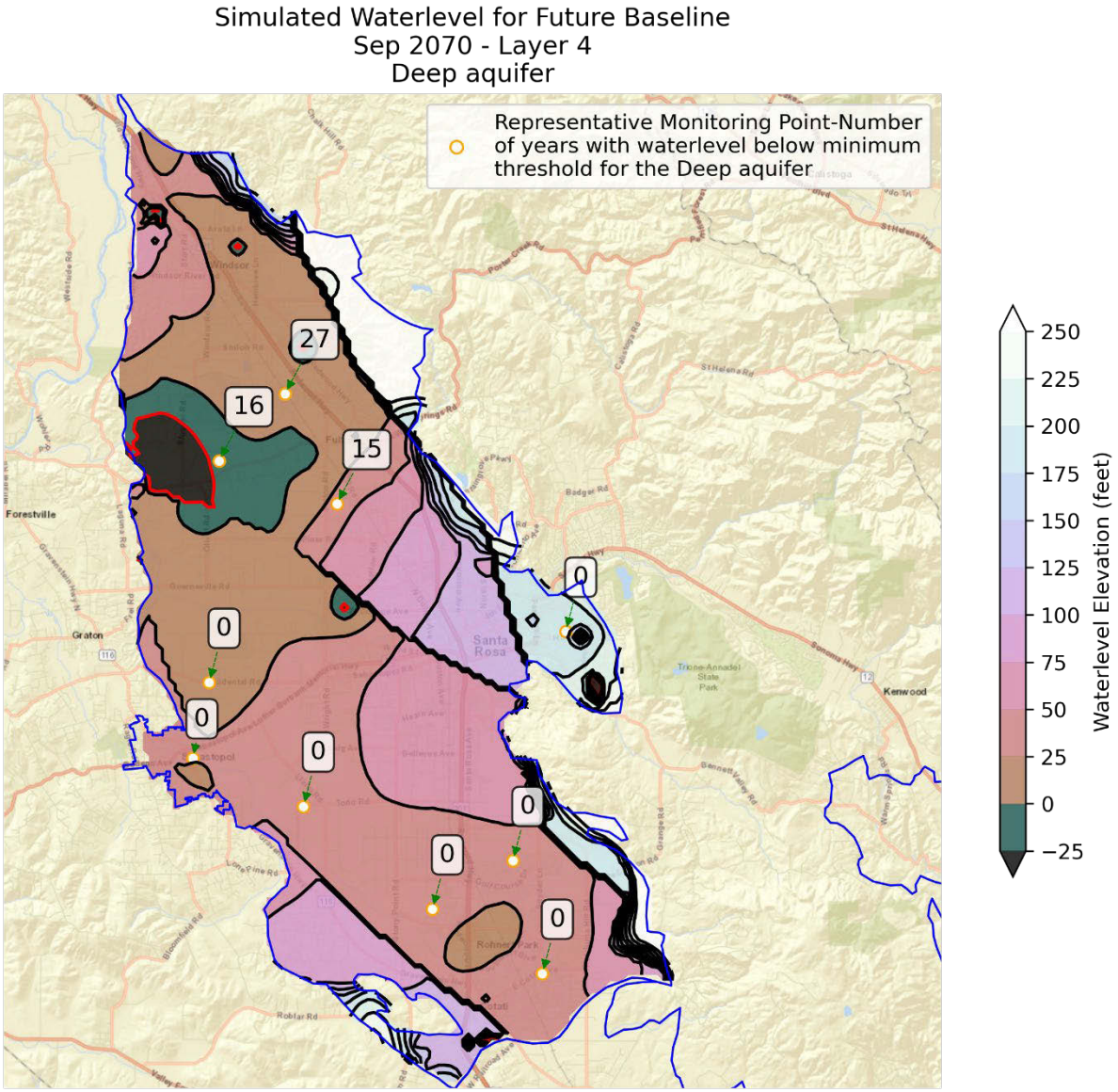

Figure 39 Actual Simulated Waterlevels for the Deep Aquifer for the Future Baseline, Sep 2070. Positive Values Outlined in Black, Negative Values Outlined in Red

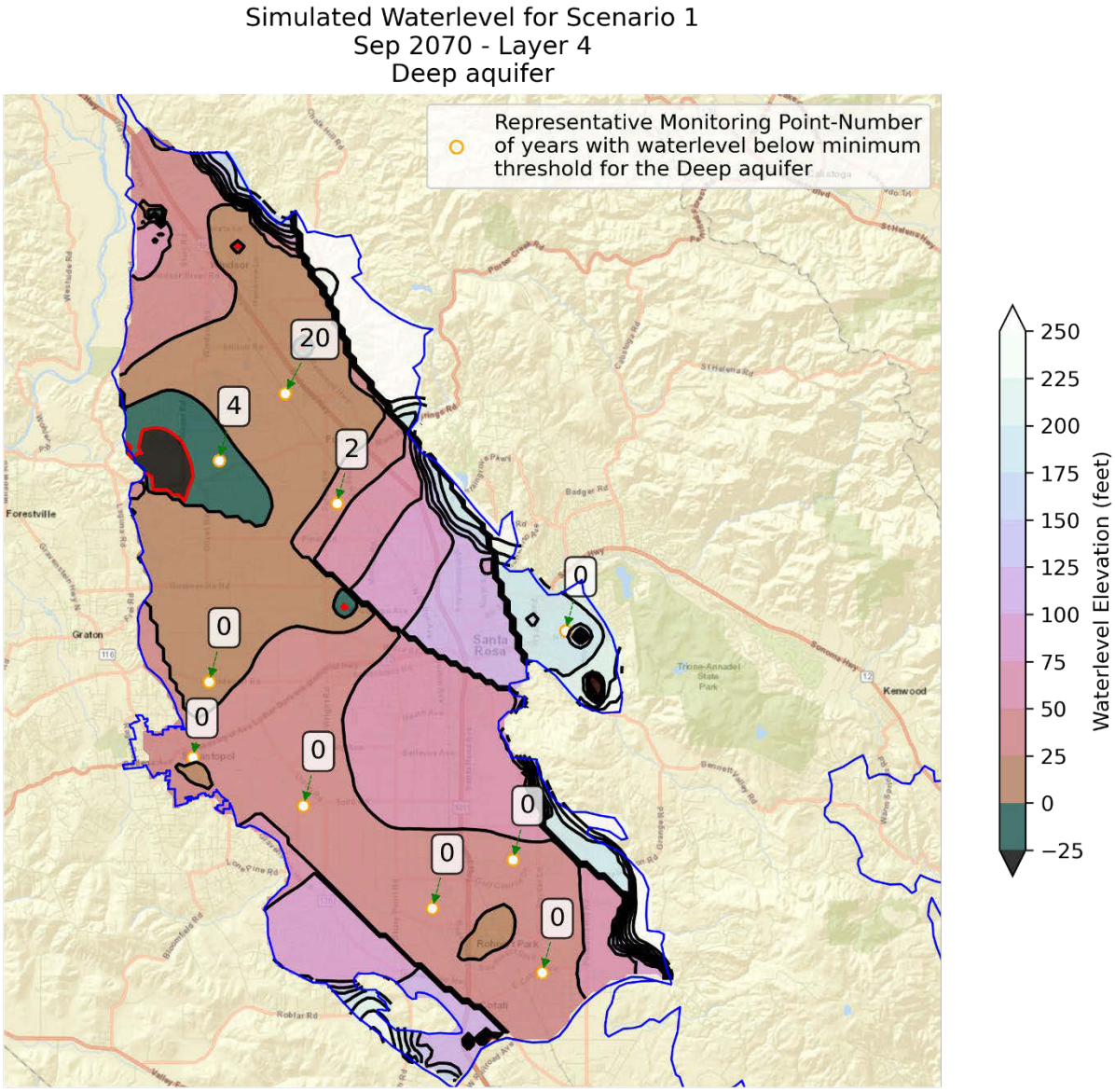

Figure 40 Actual Simulated Waterlevels for the Deep Aquifer for Scenario 1, Sep 2070. Positive Values Outlined in Black, Negative Values Outlined in Red

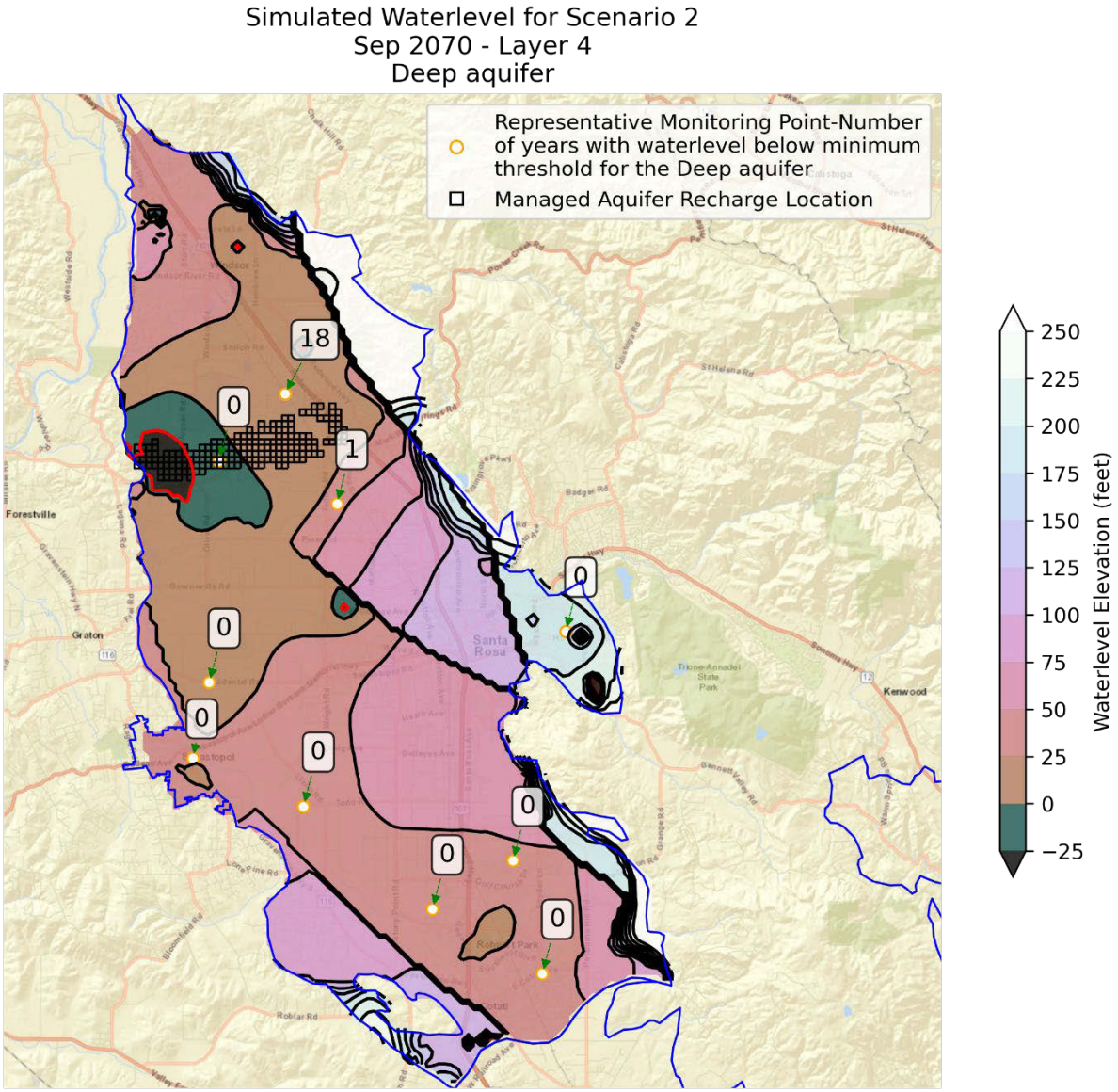

Figure 41 Actual Simulated Waterlevels for the Deep Aquifer for Scenario 2, Sep 2070. Positive Values Outlined in Black, Negative Values Outlined in Red

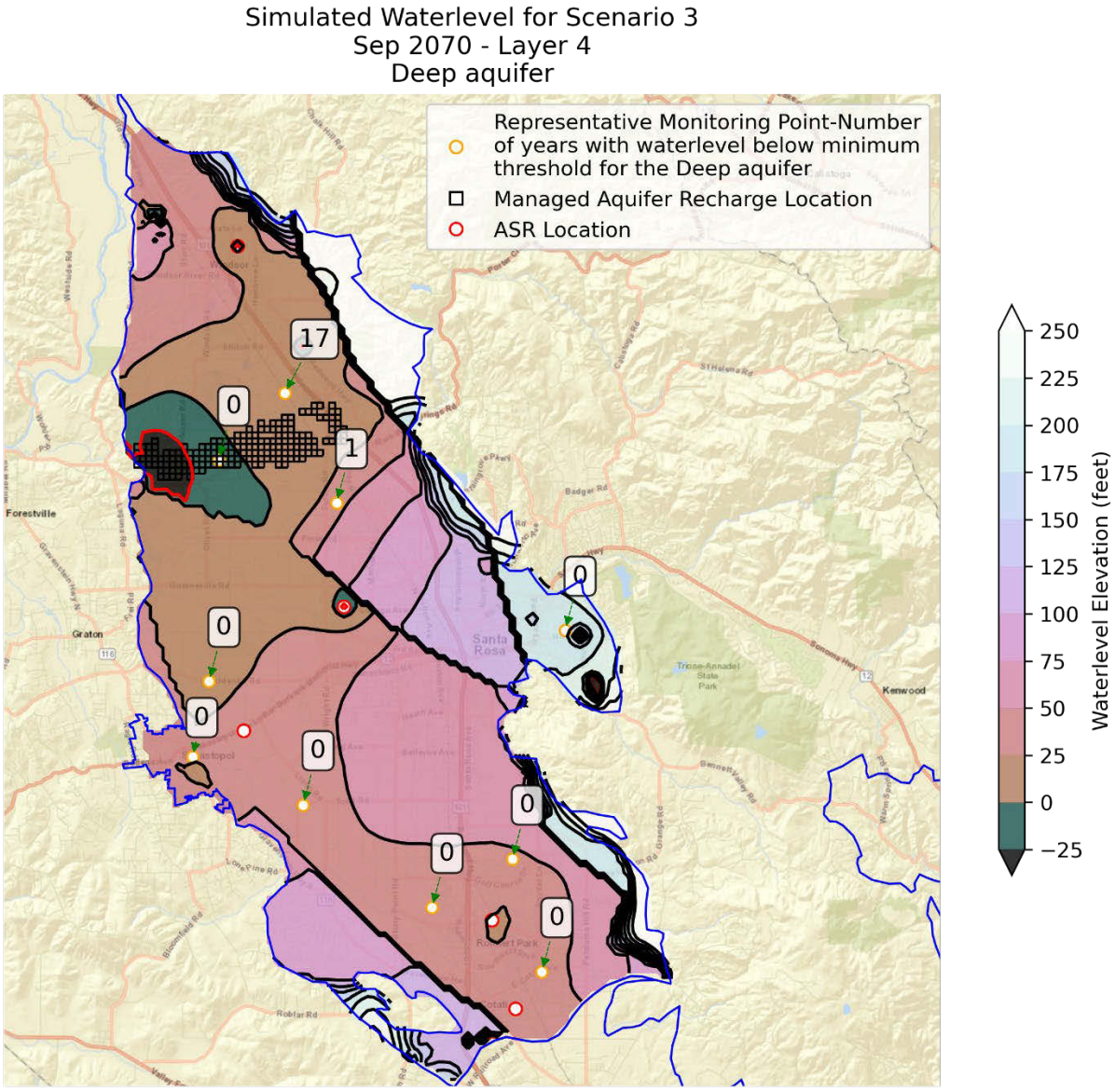

Figure 42 Actual Simulated Waterlevels for the Deep Aquifer for Scenario 3, Sep 2070. Positive Values Outlined in Black, Negative Values Outlined in Red

4 CONCLUSIONS

The Group 1, Group 2 and Group 3 project scenarios improve groundwater conditions and reduce the number of MT exceedances. Implementation of Group 1, 2 and 3 prohibit the occurrence of undesirable results. Each successive scenario shows improvement in the number of MT exceedances. Each successive group also shows improvement in the rate of groundwater storage decline. The baseline change in groundwater storage is -1,400 AFY but improves to -

1,100 in the Group 3 Scenario. The Group 1 and Group 3 show positive improvements in groundwater elevation for the deep aquifer. The Group 2 project does not cause significant improvement in groundwater elevations compared to Group 1 but does increase summertime discharge in the lower Mark West Creek area by 10%. Group 3 shows small improvement in MT exceedance and causes improvements to the areal coverage of the groundwater elevation benefits, especially in the southern third of the Subbasin. Additional data collection and project conceptualization during early phases of GSP implementation will help refine these scenarios.

5 References

Beganskas S, Fisher A.T., Coupling distributed stormwater collection and managed aquifer recharge: Field application and implications, Journal of Environmental Management, Volume 200, 2017, Pages 366-379

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Appendix 6-B
Simulated Waterlevel Hydrographs from the Simulation of Projects and Management Actions

Figure 1 Waterlevel Hydrograph for SRP0725 3
Figure 2 Waterlevel Hydrograph for SRP0724 4
Figure 3 Waterlevel Hydrograph for SRP0723 5
Figure 4 Waterlevel Hydrograph for SRP0720 6
Figure 5 Waterlevel Hydrograph for SRP0715 7
Figure 6 Waterlevel Hydrograph for SRP0714 8
Figure 7 Waterlevel Hydrograph for SRP0713 9
Figure 8 Waterlevel Hydrograph for SRP0710 10
Figure 9 Waterlevel Hydrograph for SRP0709 11
Figure 10 Waterlevel Hydrograph for SRP0376 12
Figure 11 Waterlevel Hydrograph for SRP0375 13
Figure 12 Waterlevel Hydrograph for SRP0359 14
Figure 13 Waterlevel Hydrograph for SRP0357 15
Figure 14 Waterlevel Hydrograph for SRP0355 16
Figure 15 Waterlevel Hydrograph for SRP0347 17
Figure 16 Waterlevel Hydrograph for SRP00269 18
Figure 17 Waterlevel Hydrograph for SRP00249 19
Figure 18 Waterlevel Hydrograph for SRP00243 20
Figure 19 Waterlevel Hydrograph for SRP0238 21
Figure 20 Waterlevel Hydrograph for SRP0121 22
Figure 21 Waterlevel Hydrograph for SRP0115 23
Figure 22 Waterlevel Hydrograph for SRP0106 24
Figure 23 Waterlevel Hydrograph for SRP0073 25
Figure 24 Waterlevel Hydrograph for SRP0057 26
Figure 25 Waterlevel Hydrograph for SRP0019 27

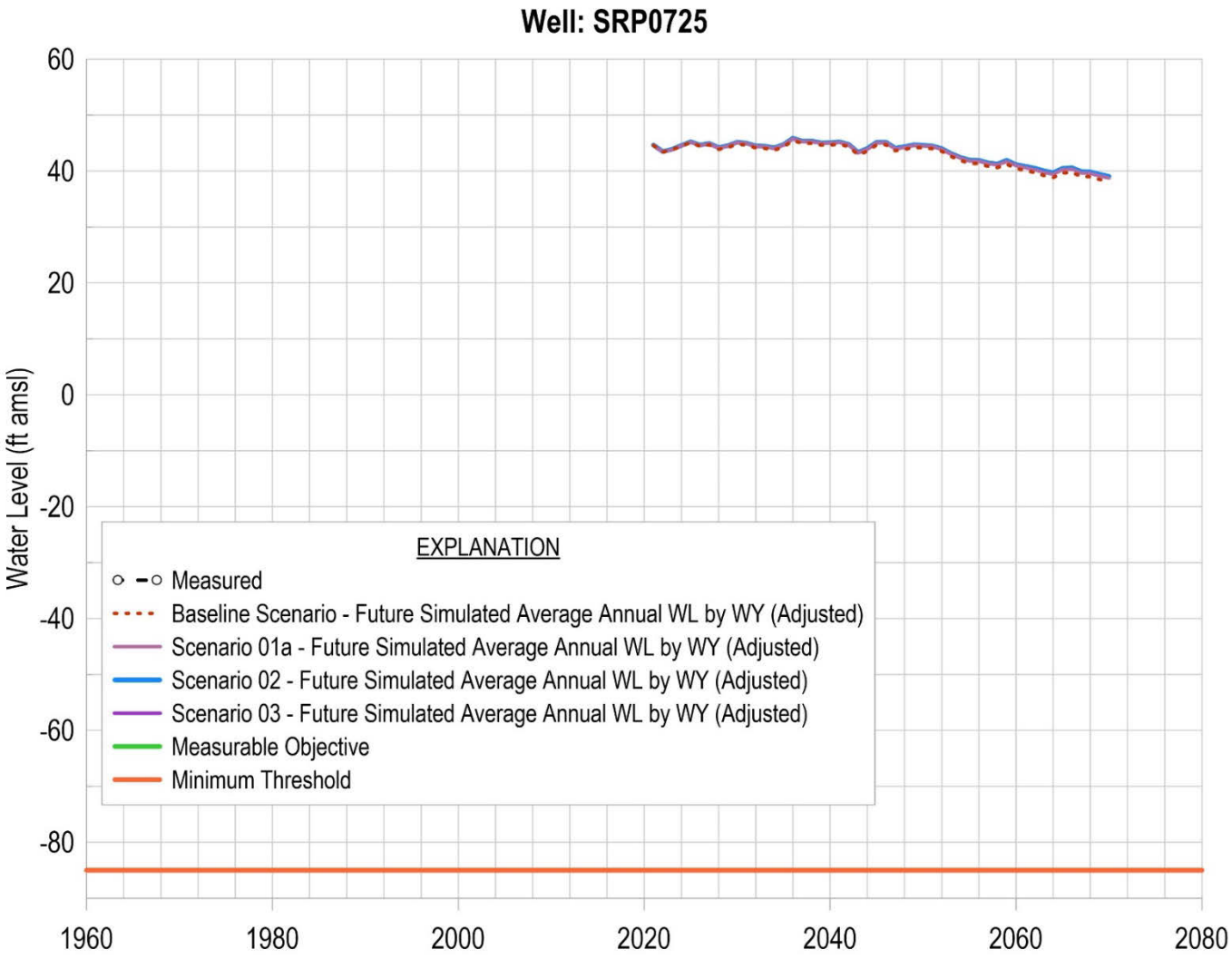

Figure 1 Waterlevel Hydrograph for SRP0725

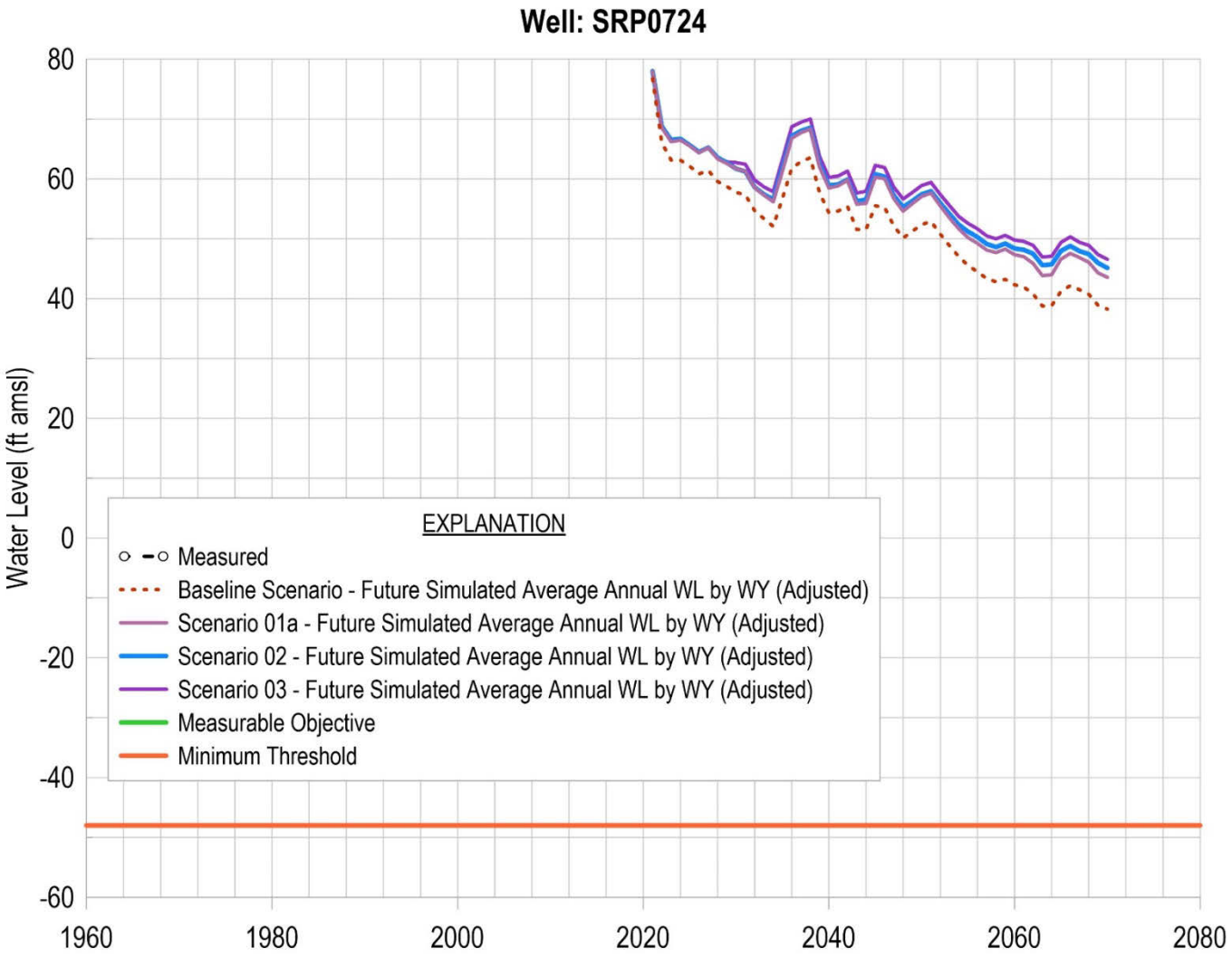

Figure 2 Waterlevel Hydrograph for SRP0724

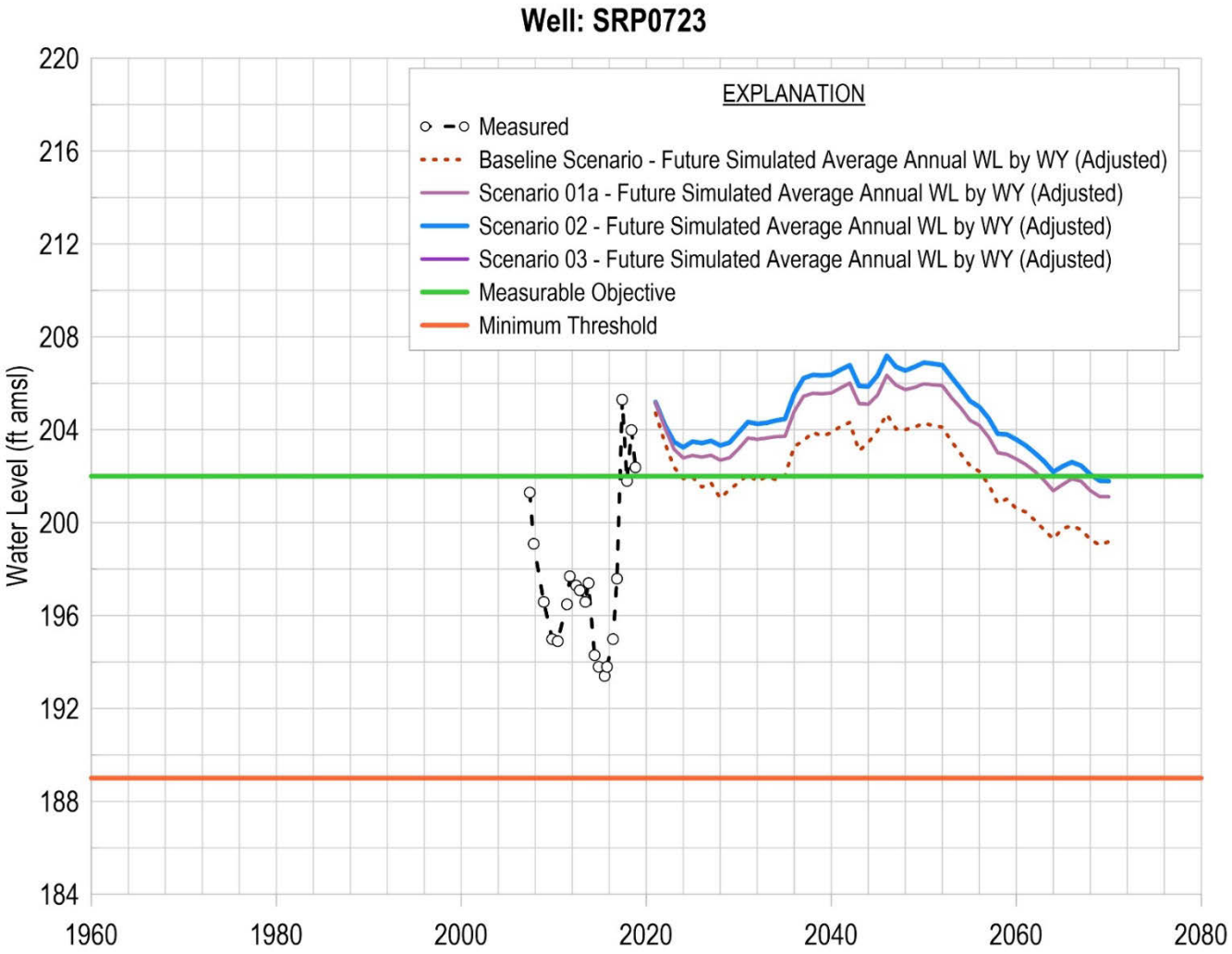

Figure 3 Waterlevel Hydrograph for SRP0723

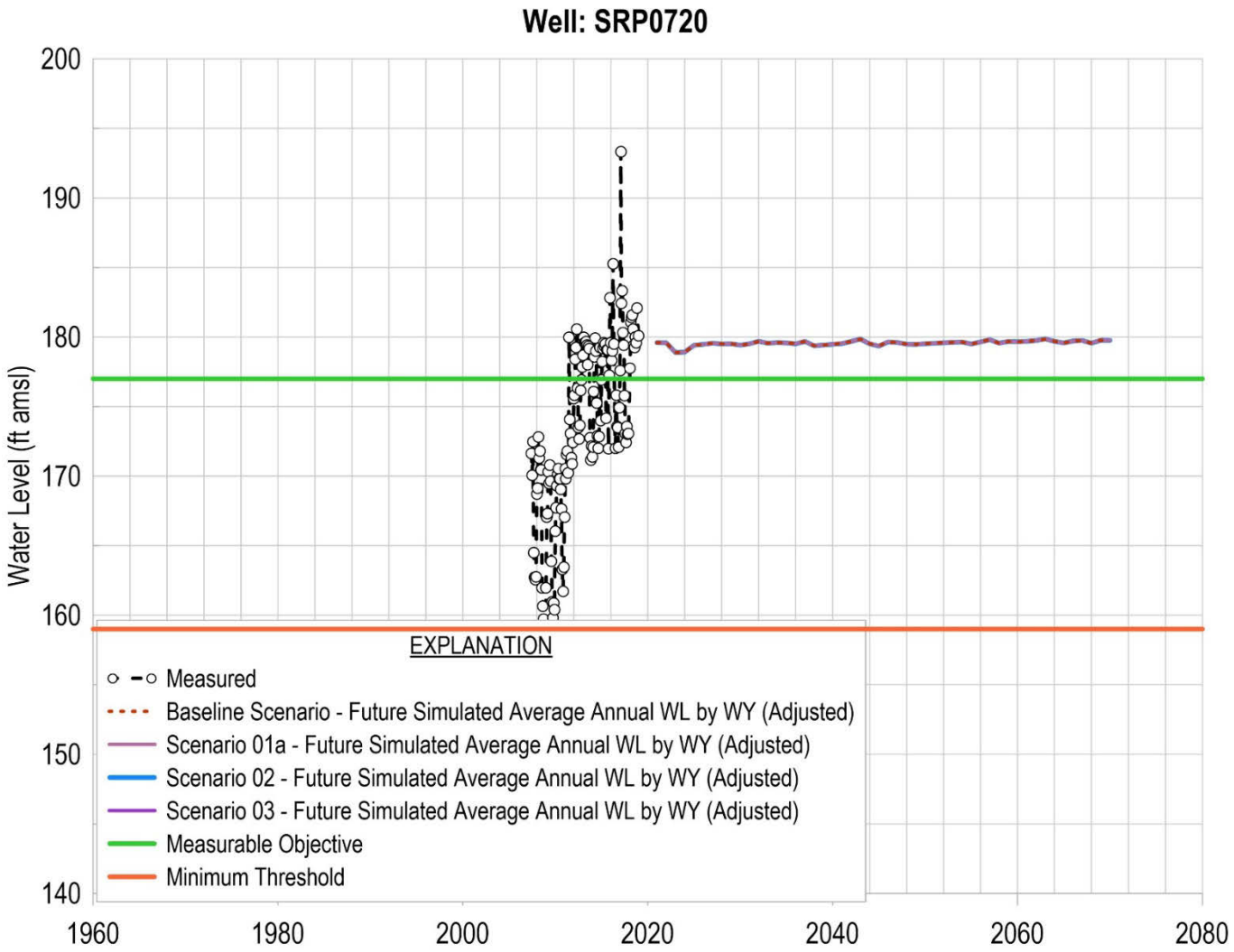

Figure 4 Waterlevel Hydrograph for SRP0720

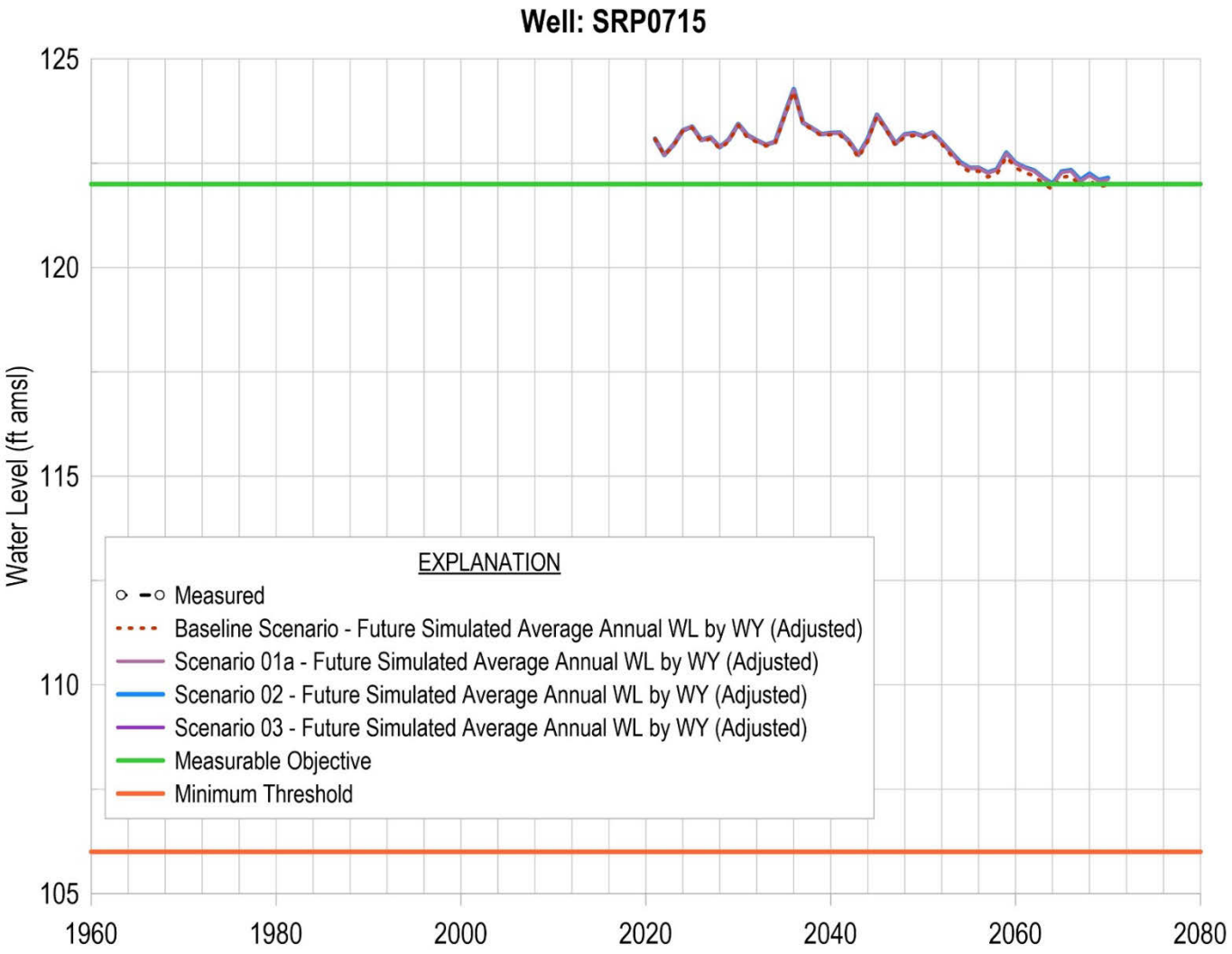

Figure 5 Waterlevel Hydrograph for SRP0715

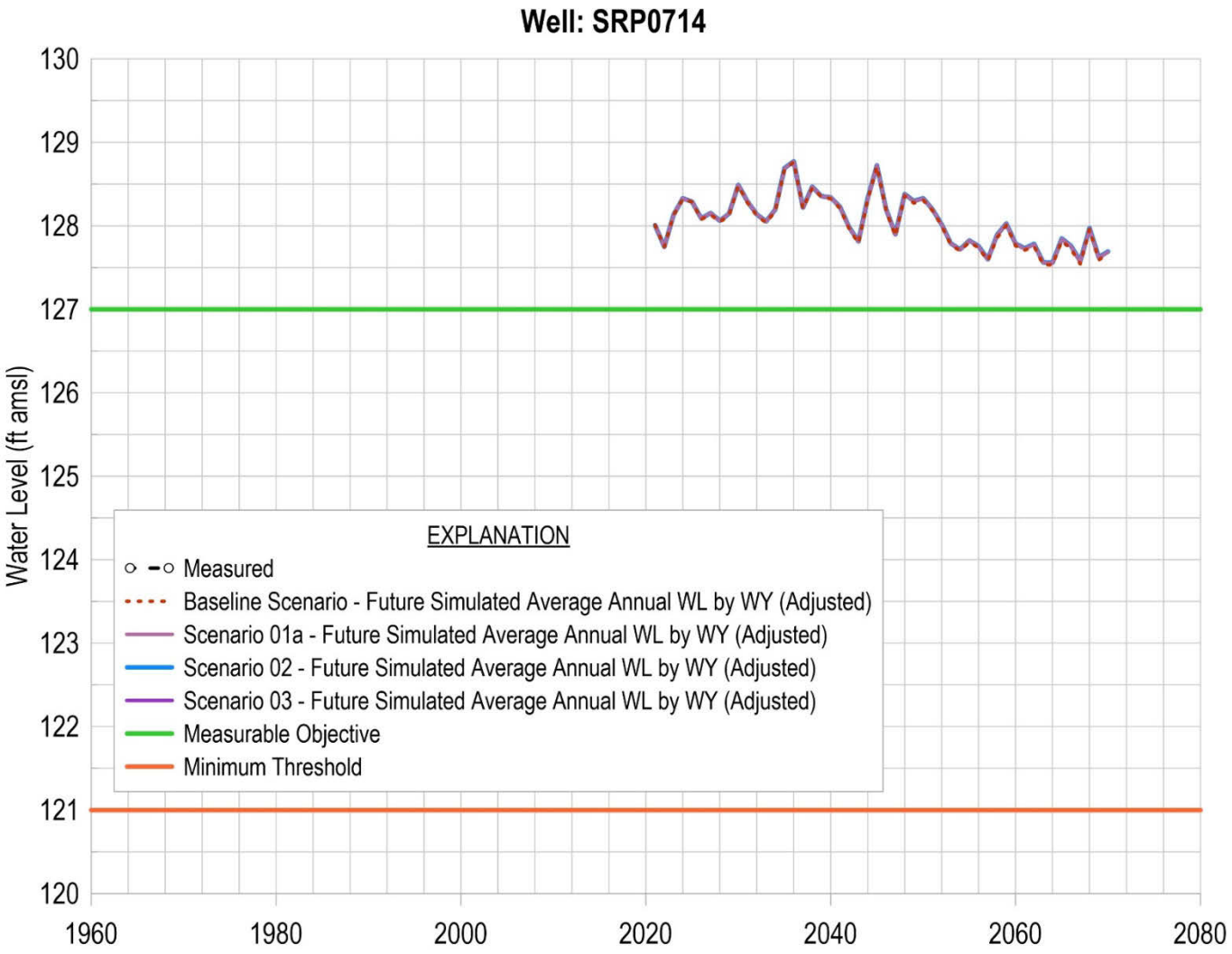

Figure 6 Waterlevel Hydrograph for SRP0714

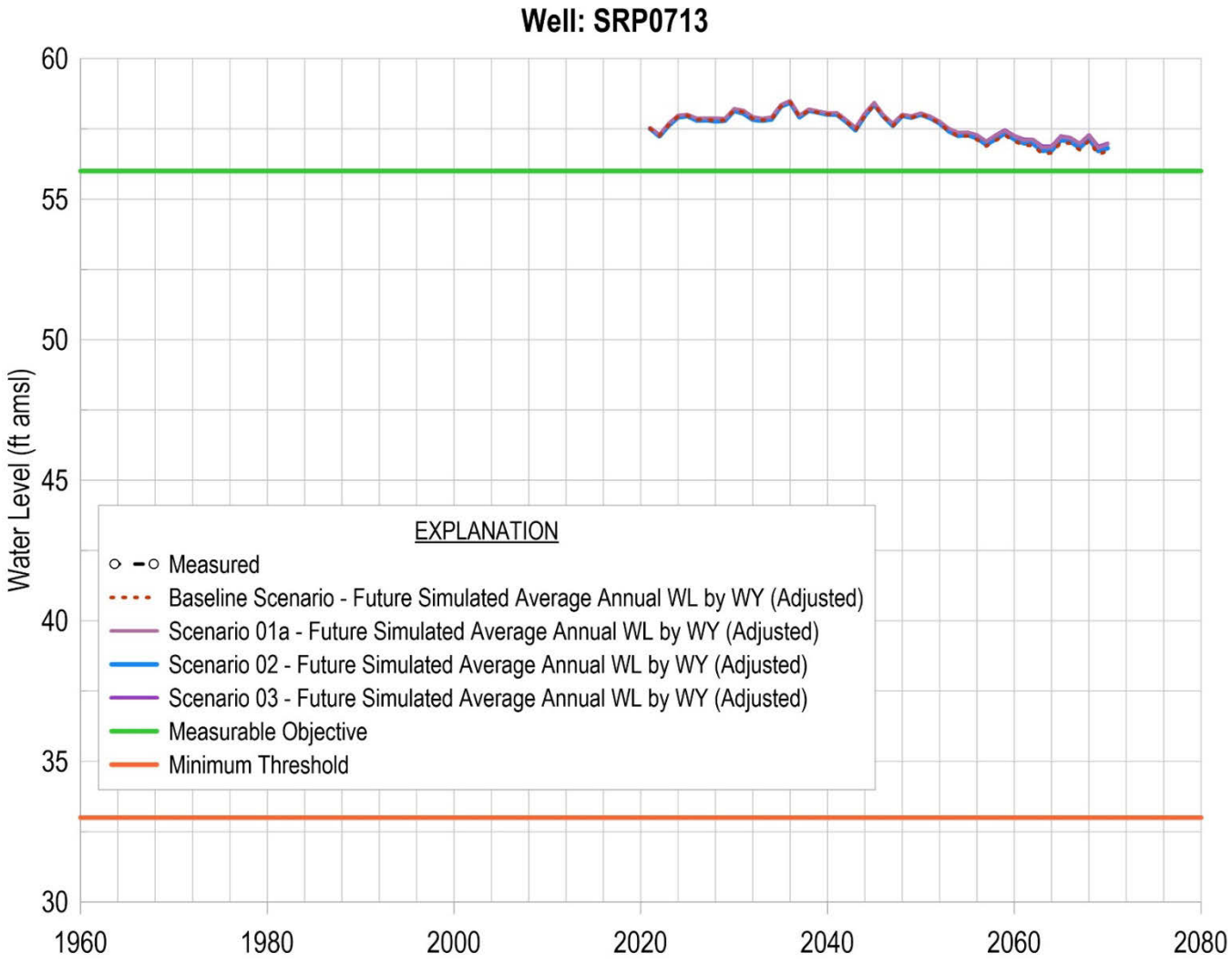

Figure 7 Waterlevel Hydrograph for SRP0713

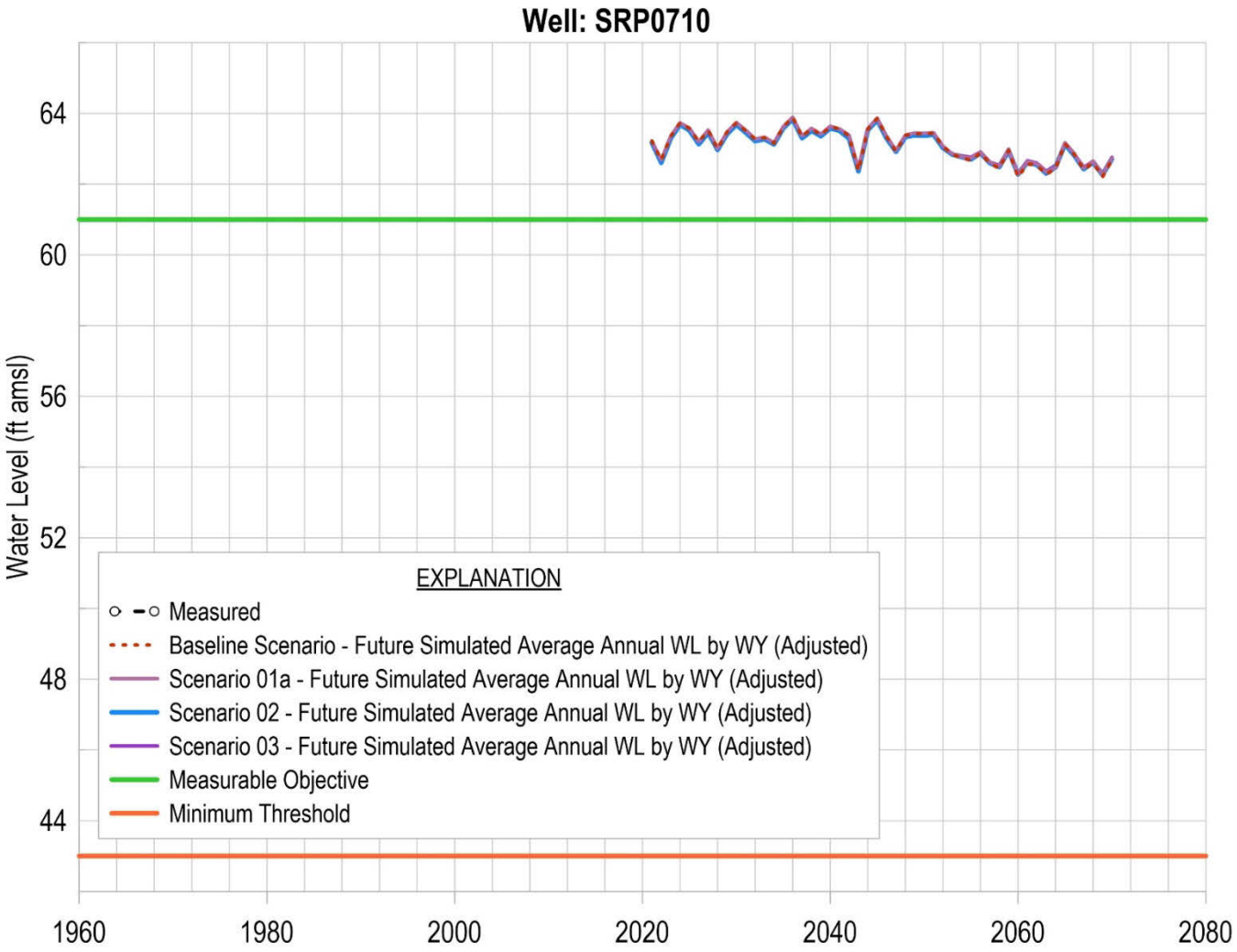

Figure 8 Waterlevel Hydrograph for SRP0710

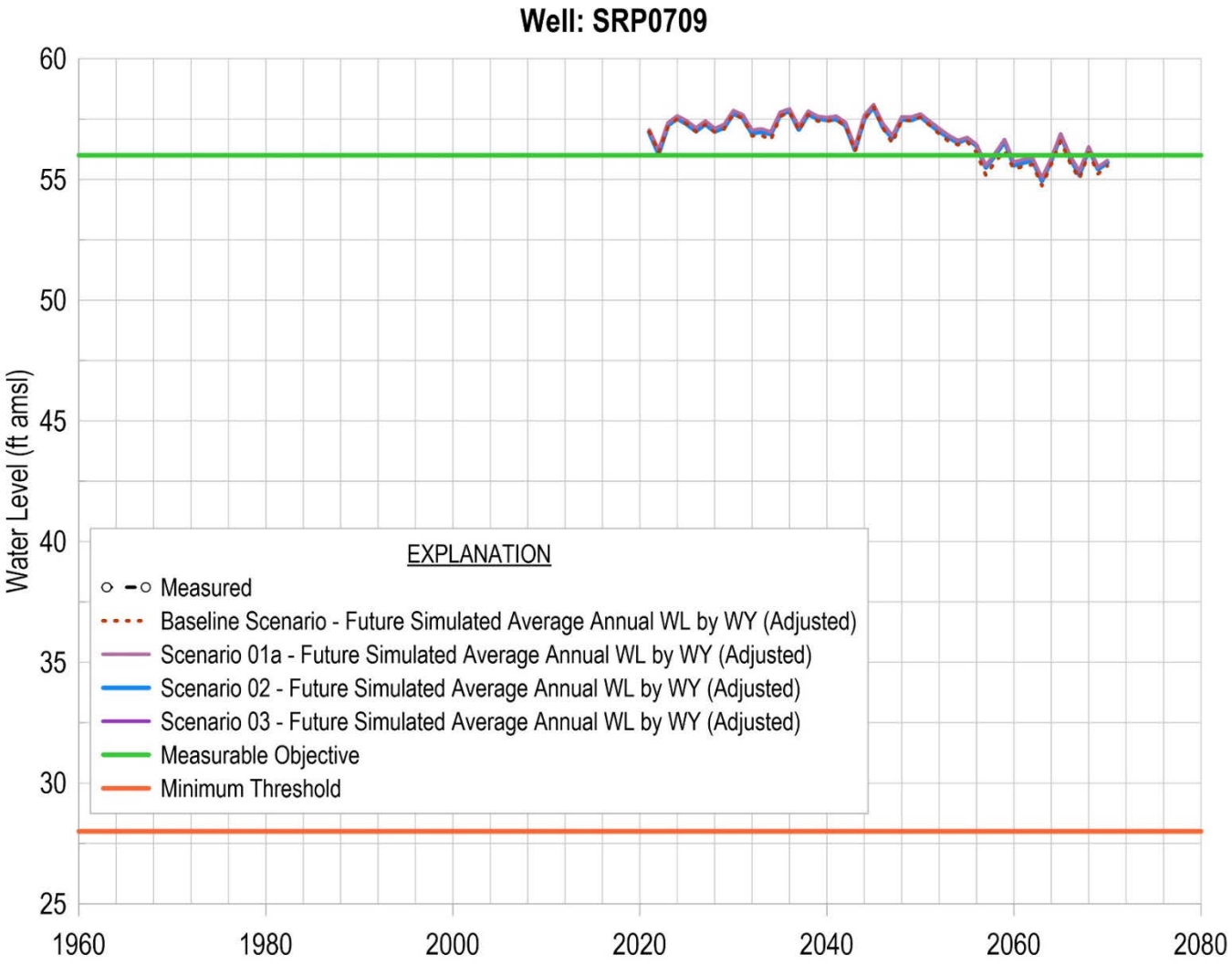

Figure 9 Waterlevel Hydrograph for SRP0709

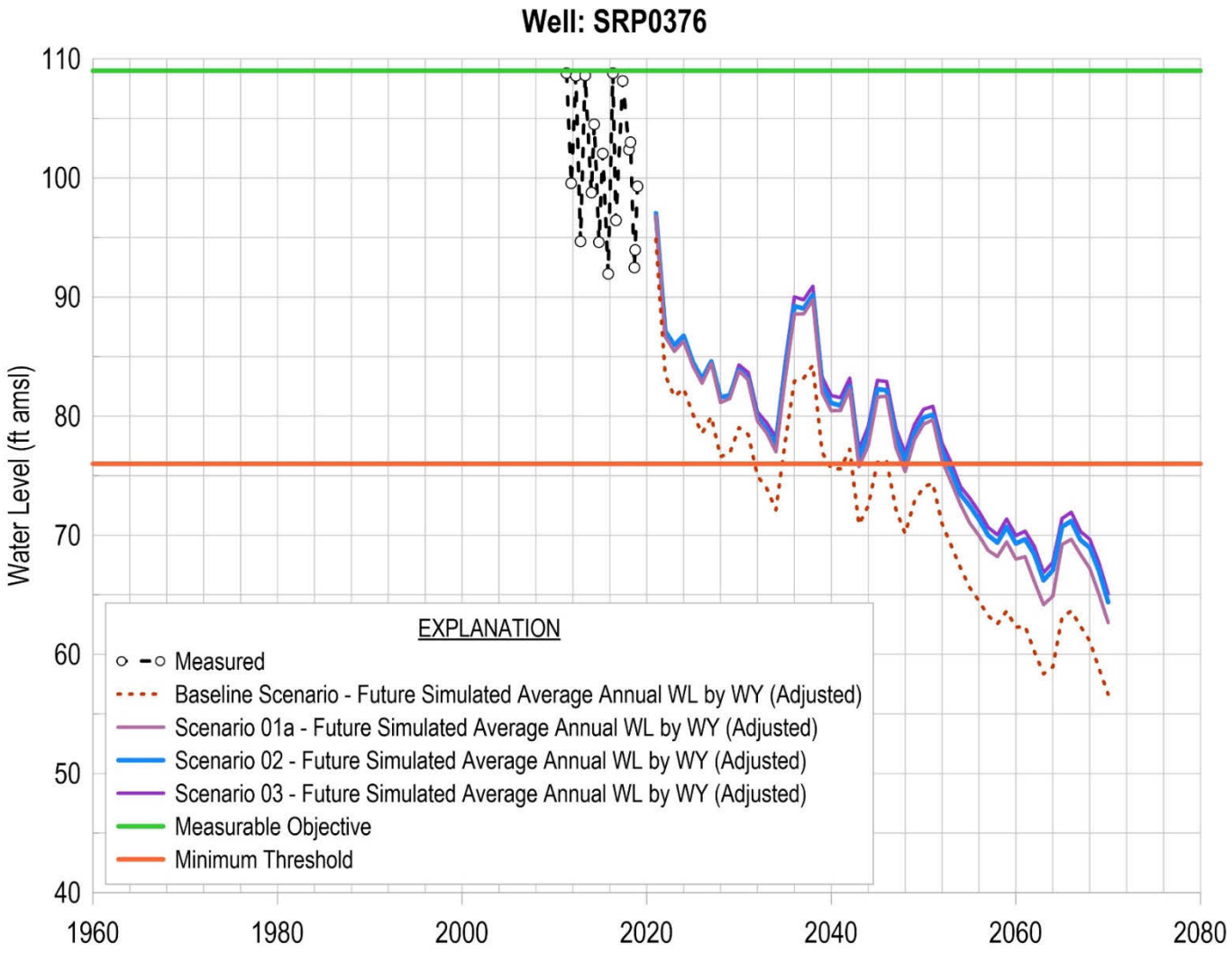

Figure 10 Waterlevel Hydrograph for SRP0376

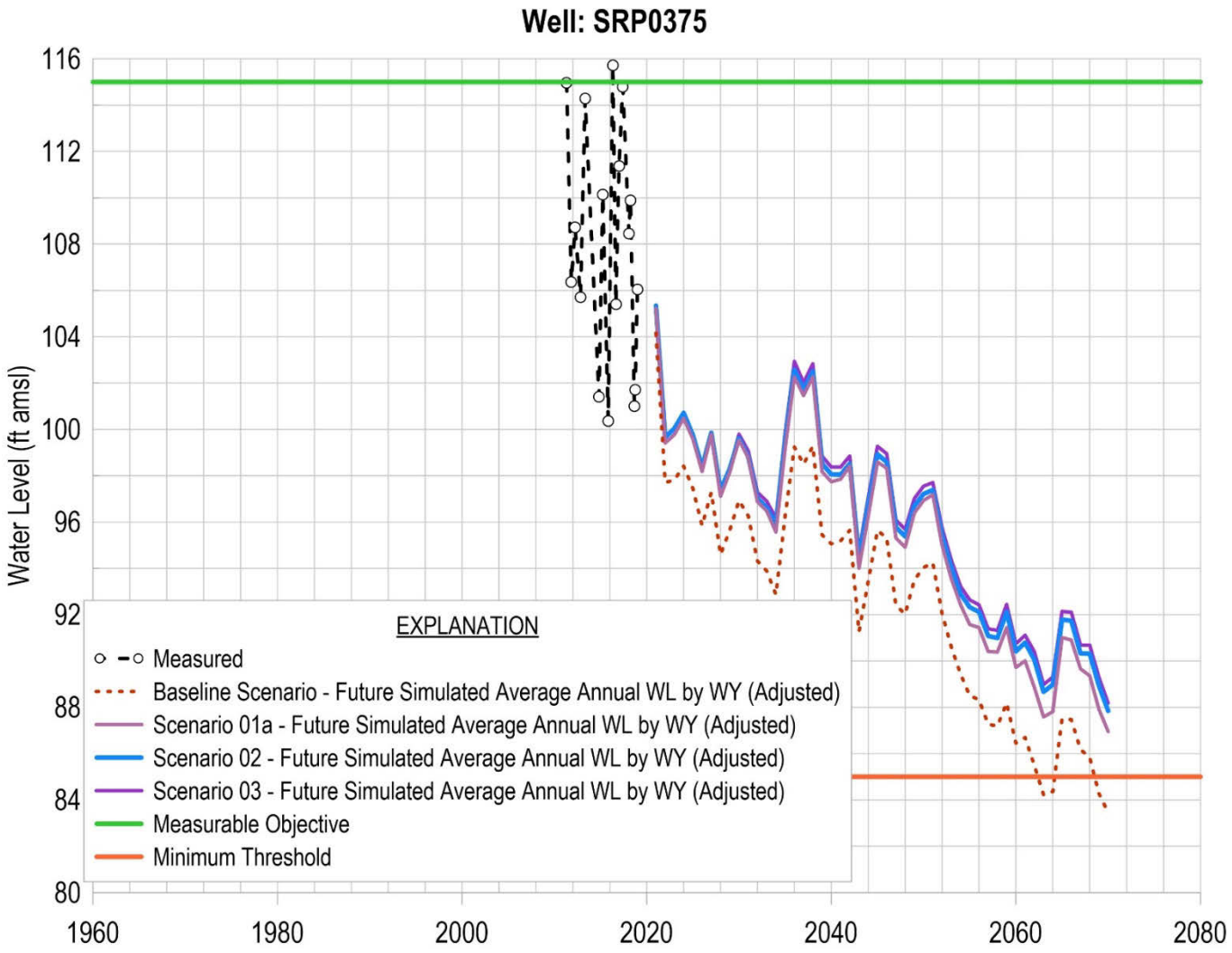

Figure 11 Waterlevel Hydrograph for SRP0375

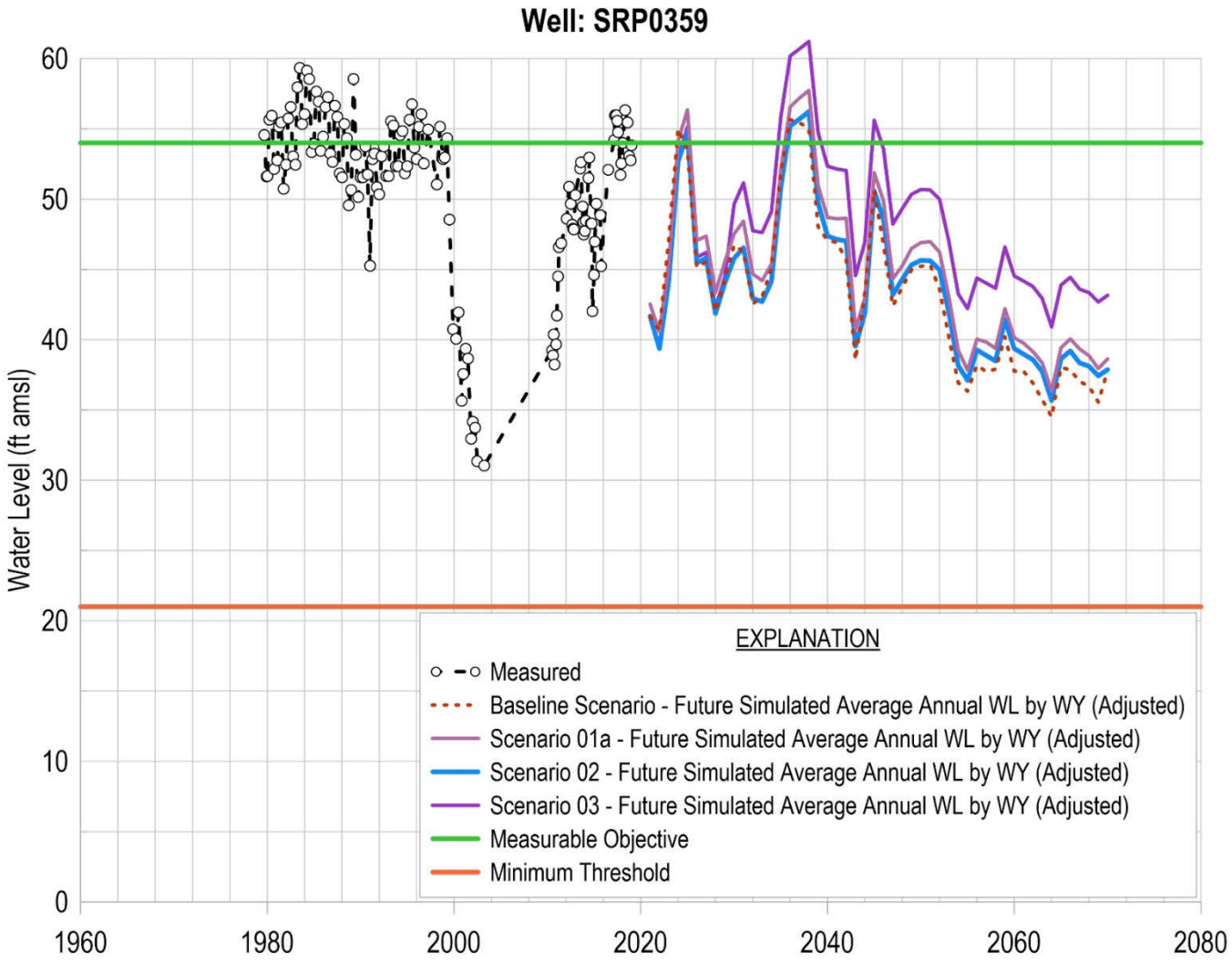

Figure 12 Waterlevel Hydrograph for SRP0359

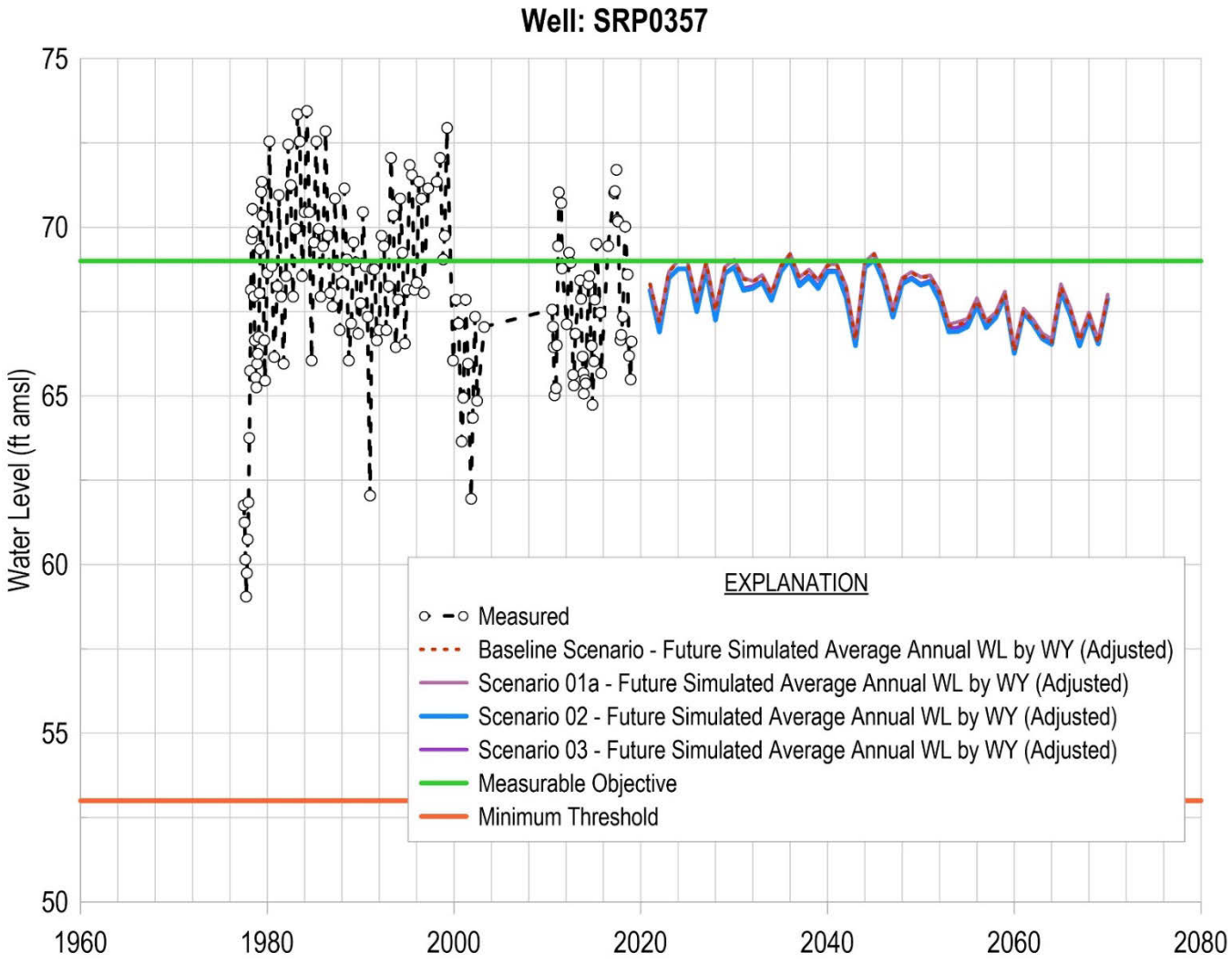

Figure 13 Waterlevel Hydrograph for SRP0357

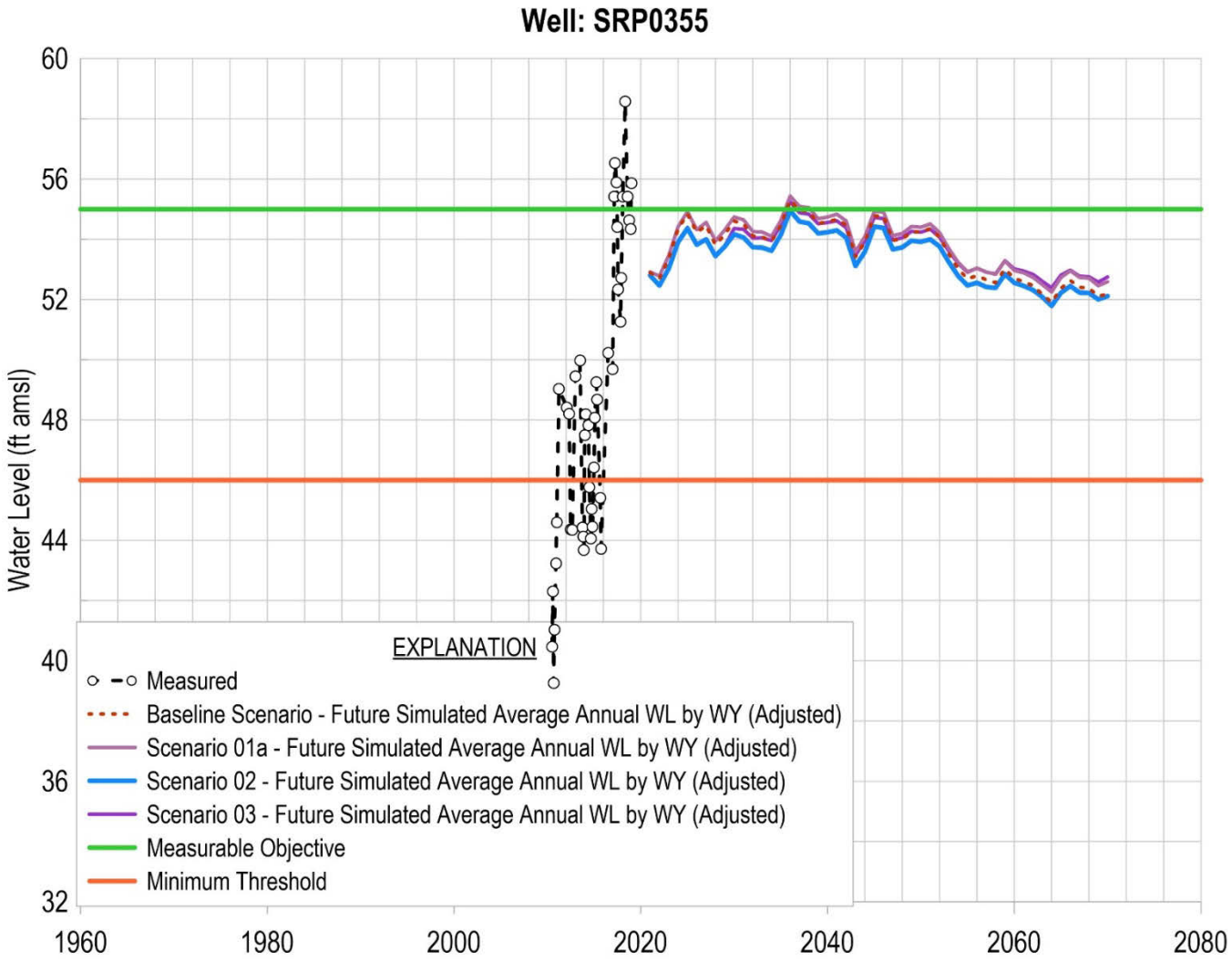

Figure 14 Waterlevel Hydrograph for SRP0355

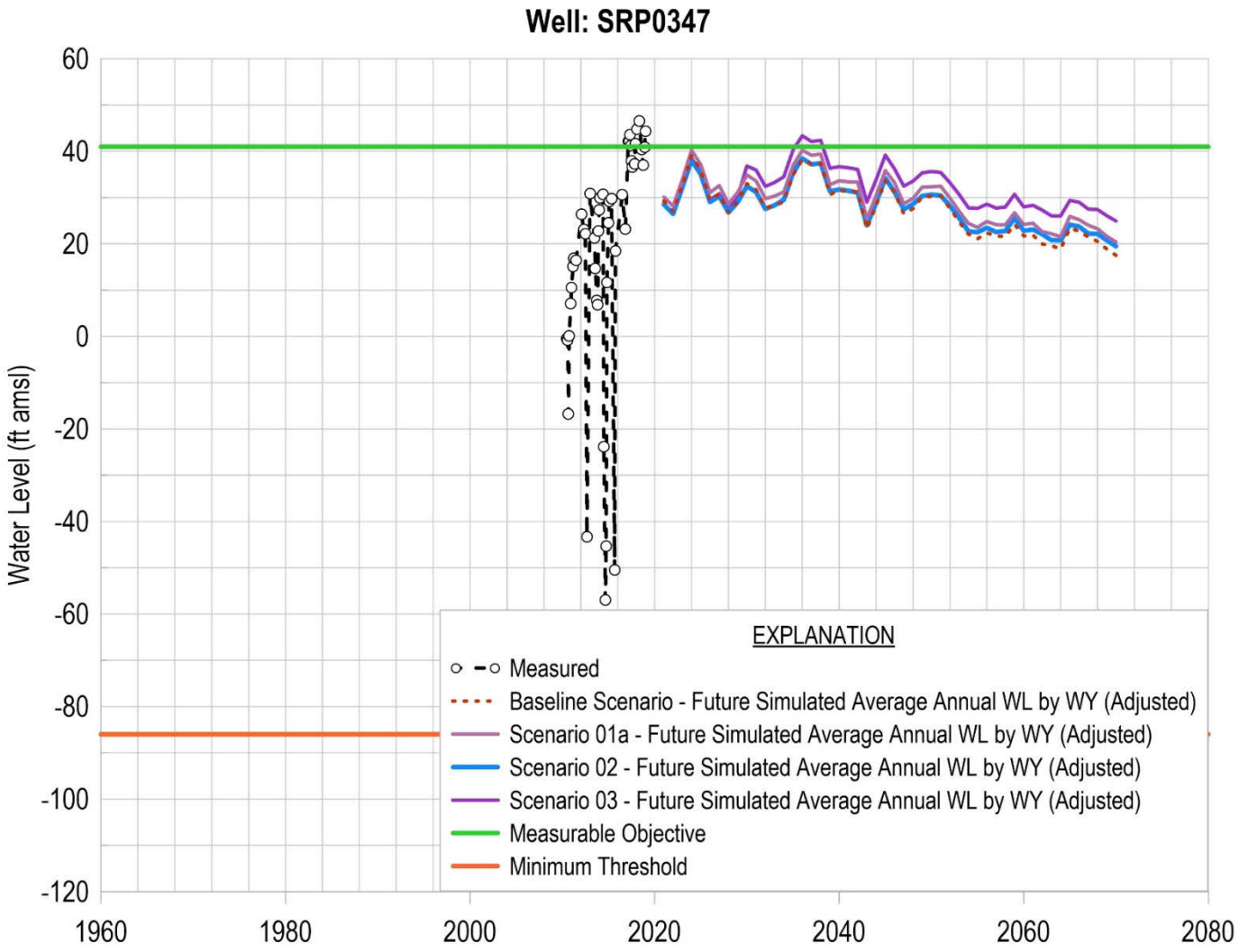

Figure 15 Waterlevel Hydrograph for SRP0347

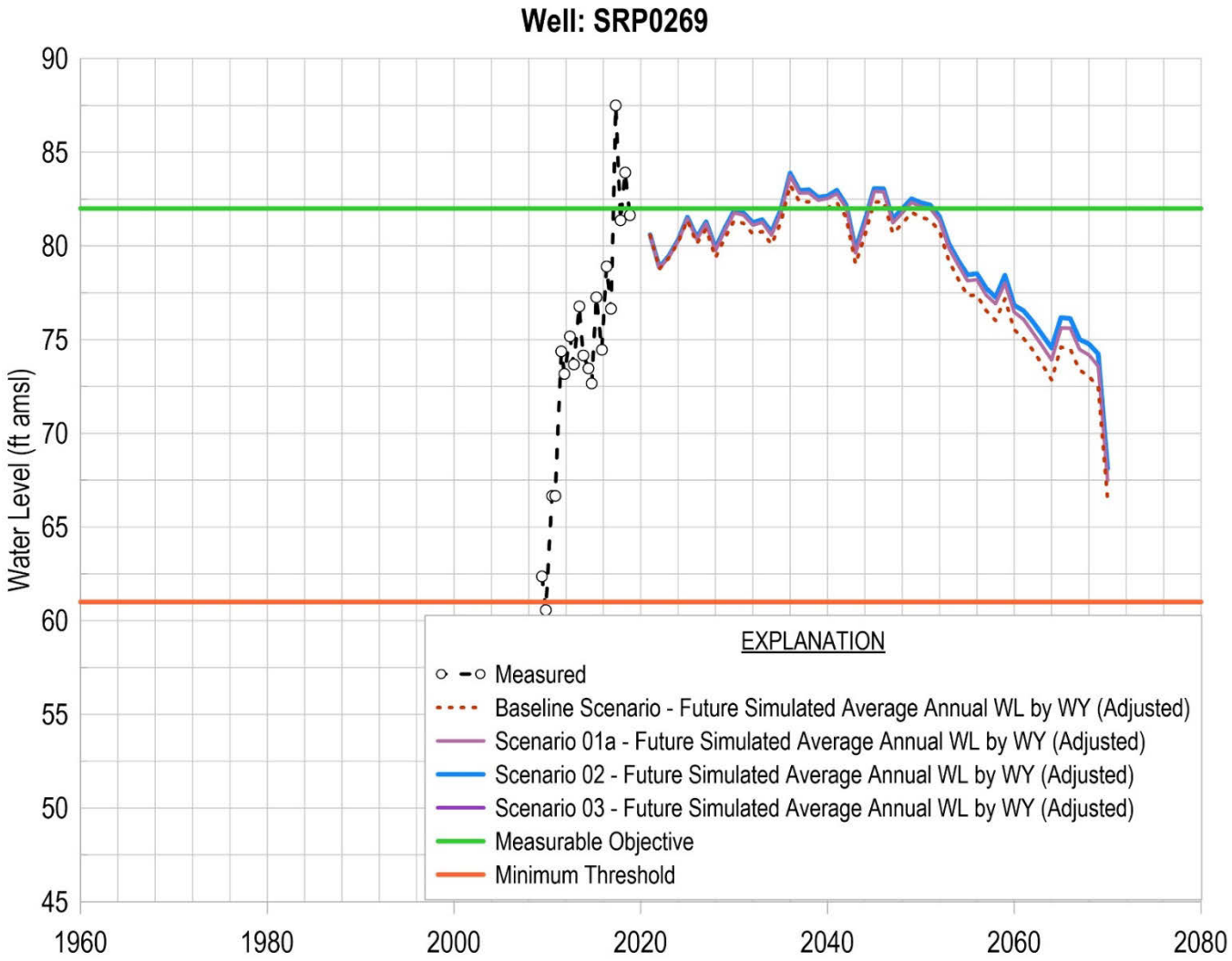

Figure 16 Waterlevel Hydrograph for SRP00269

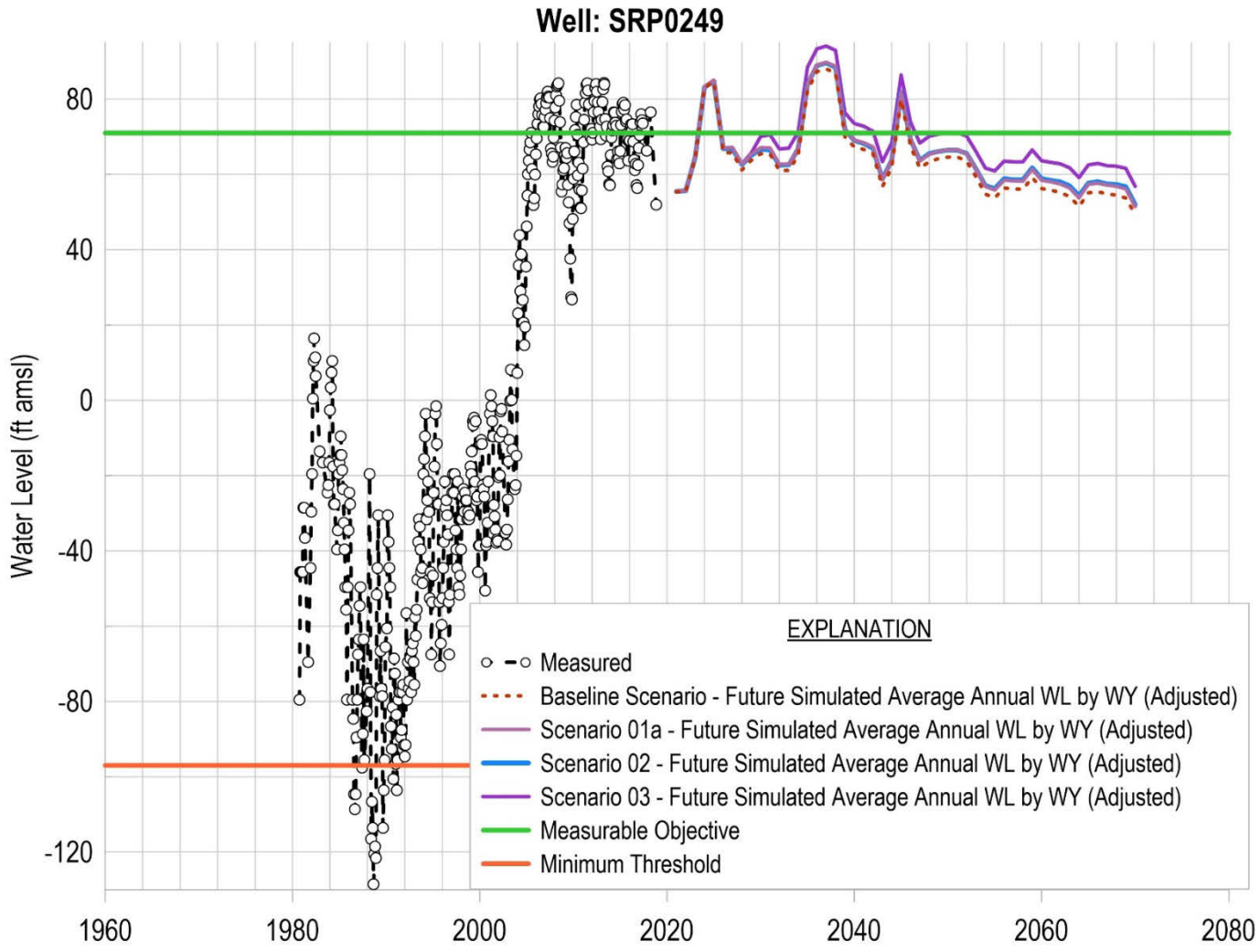

Figure 17 Waterlevel Hydrograph for SRP00249

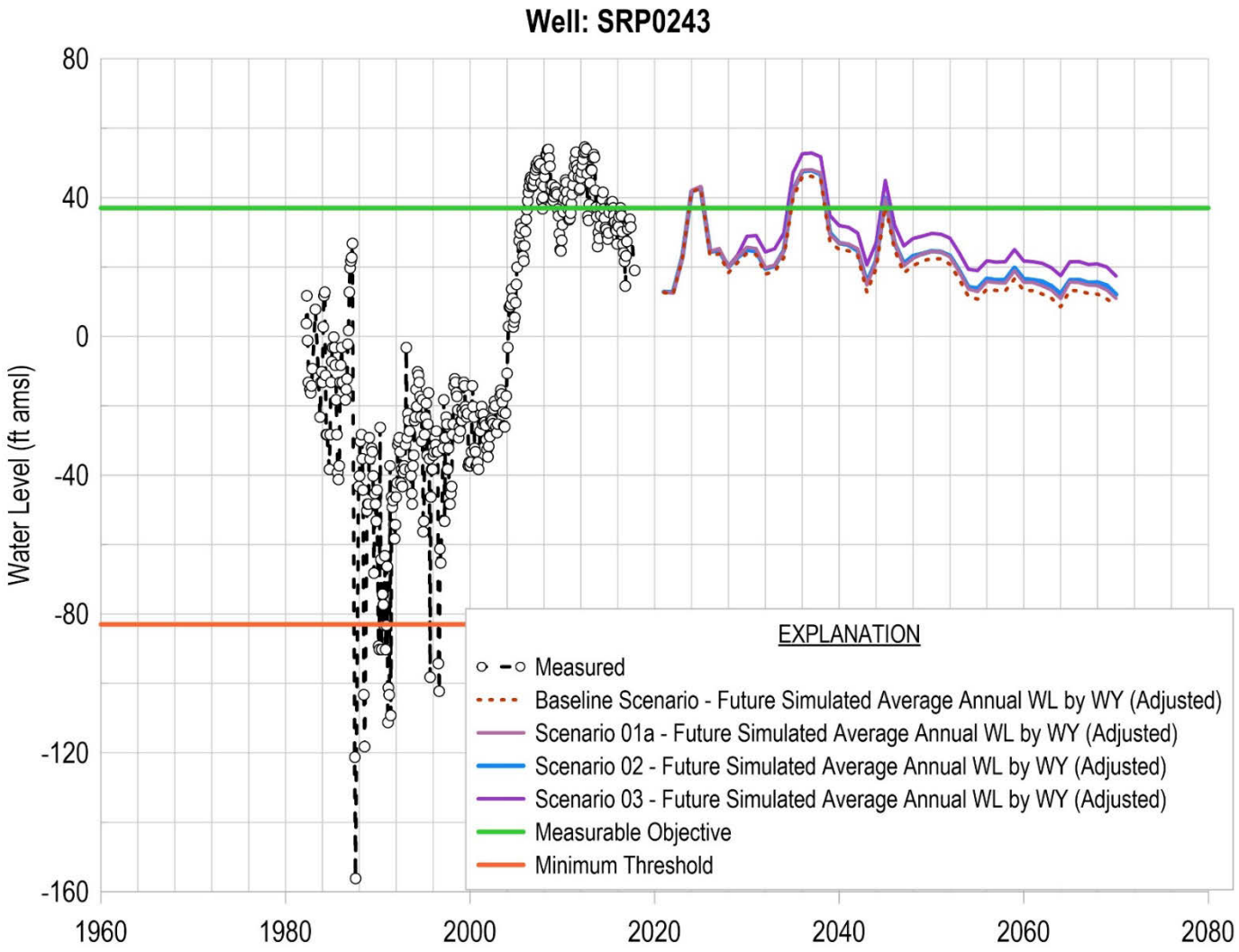

Figure 18 Waterlevel Hydrograph for SRP00243

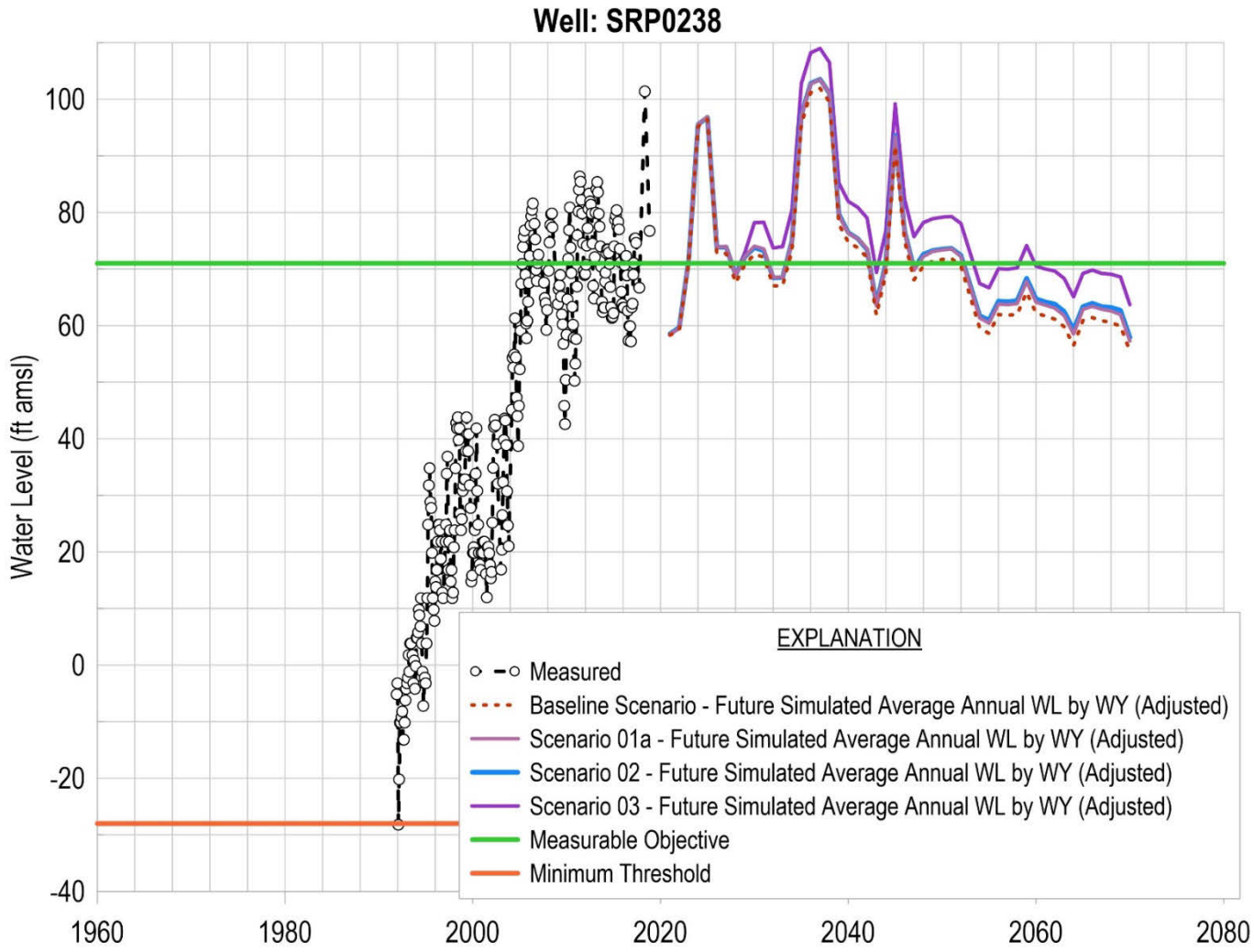

Figure 19 Waterlevel Hydrograph for SRP0238

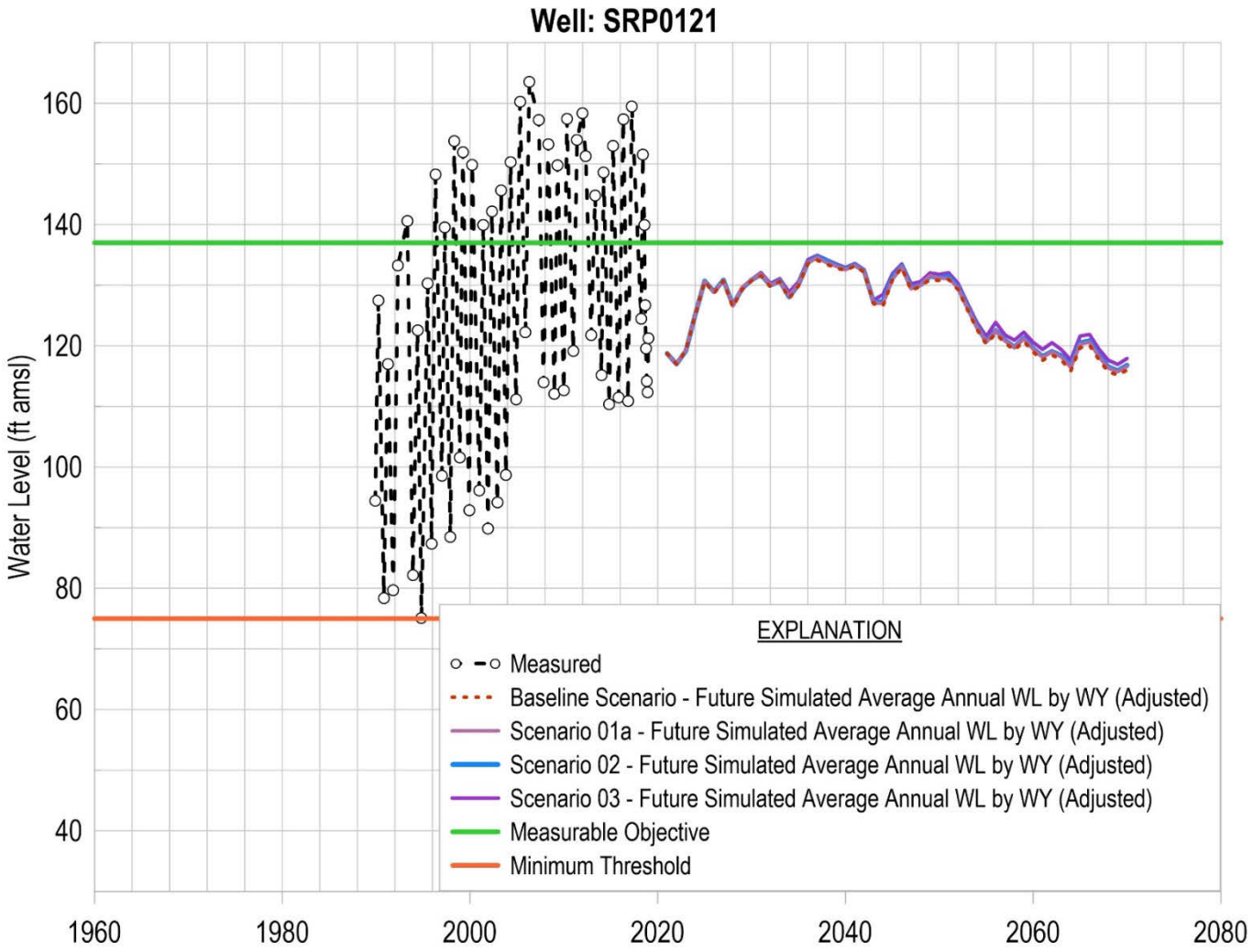

Figure 20 Waterlevel Hydrograph for SRP0121

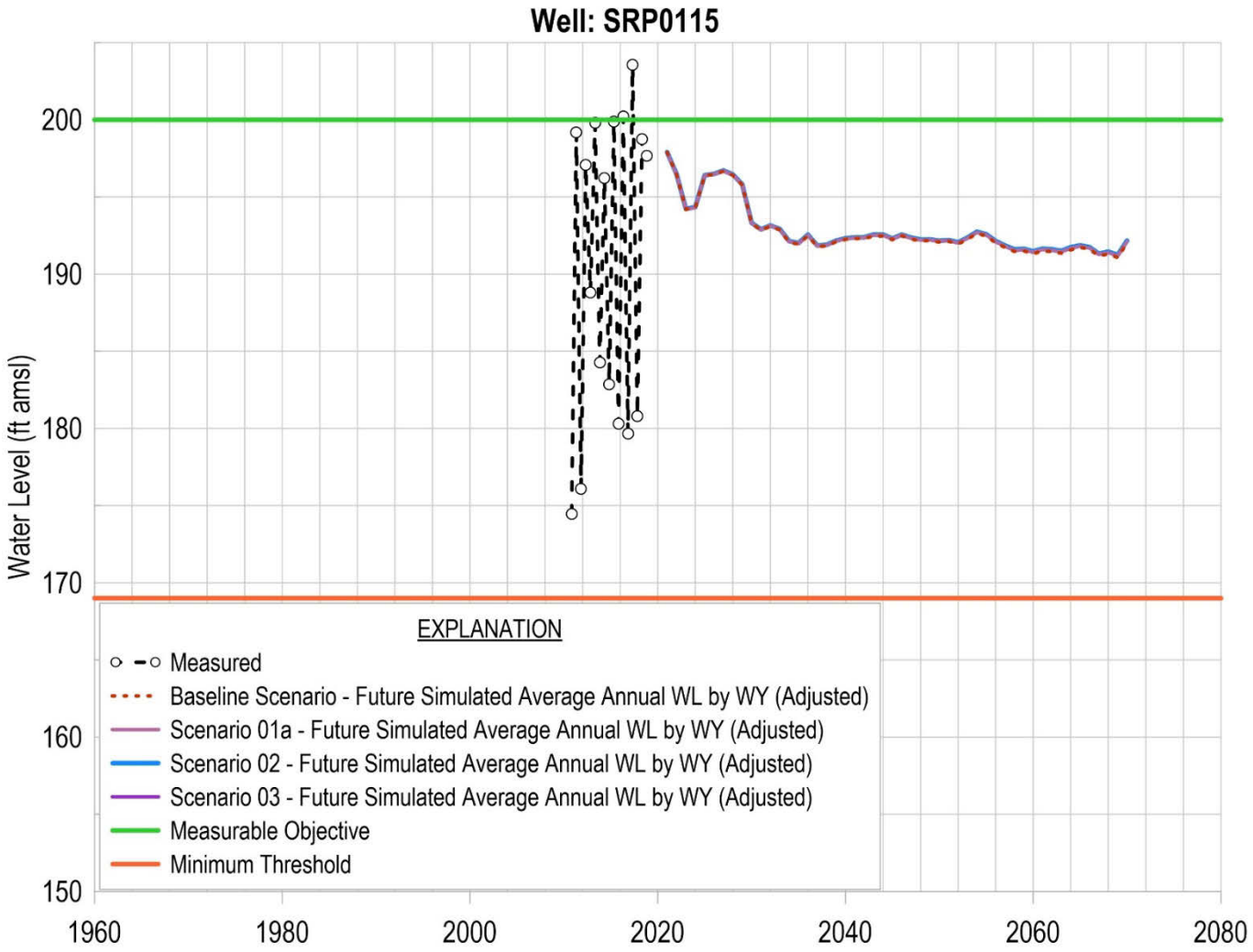

Figure 21 Waterlevel Hydrograph for SRP0115

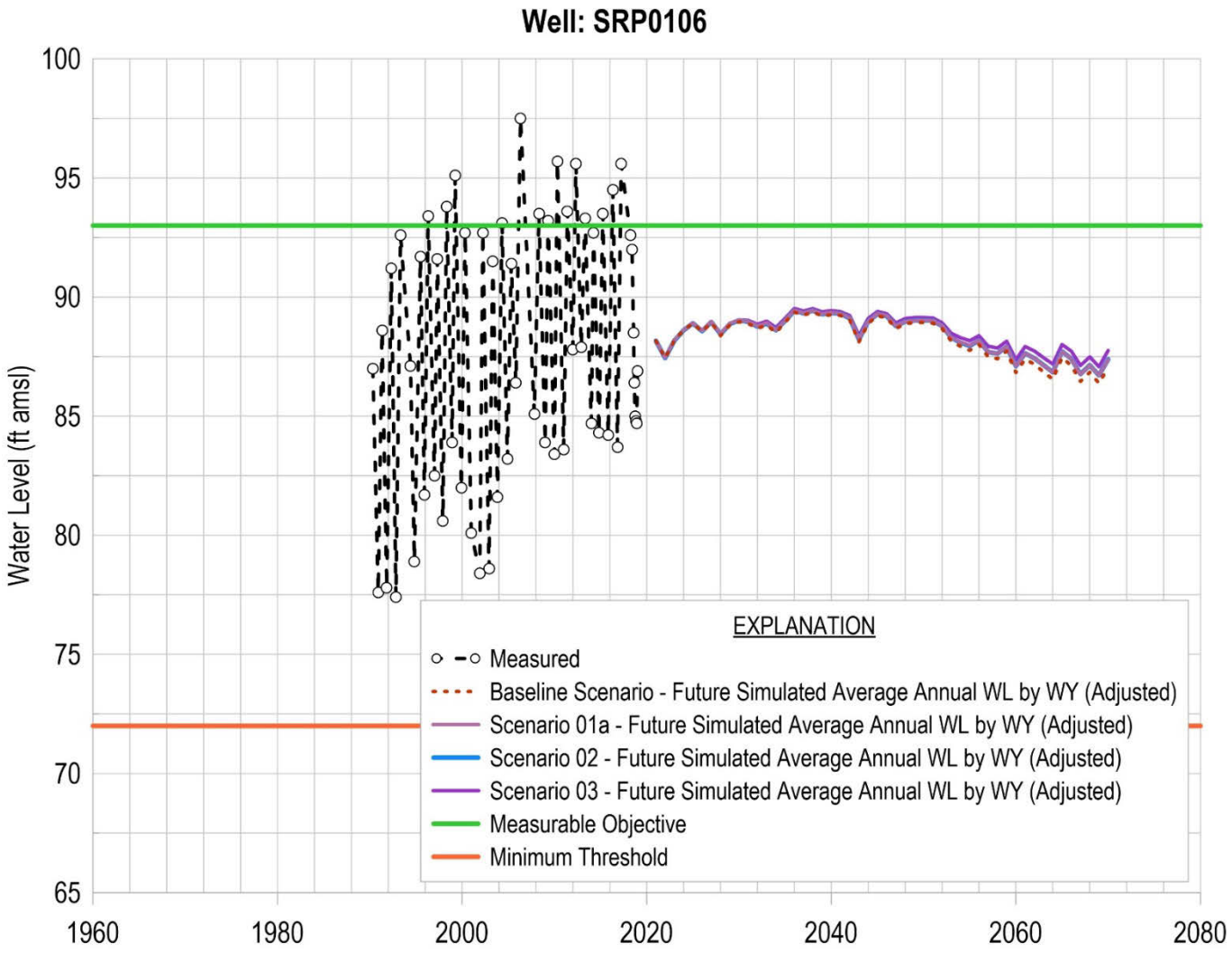

Figure 22 Waterlevel Hydrograph for SRP0106

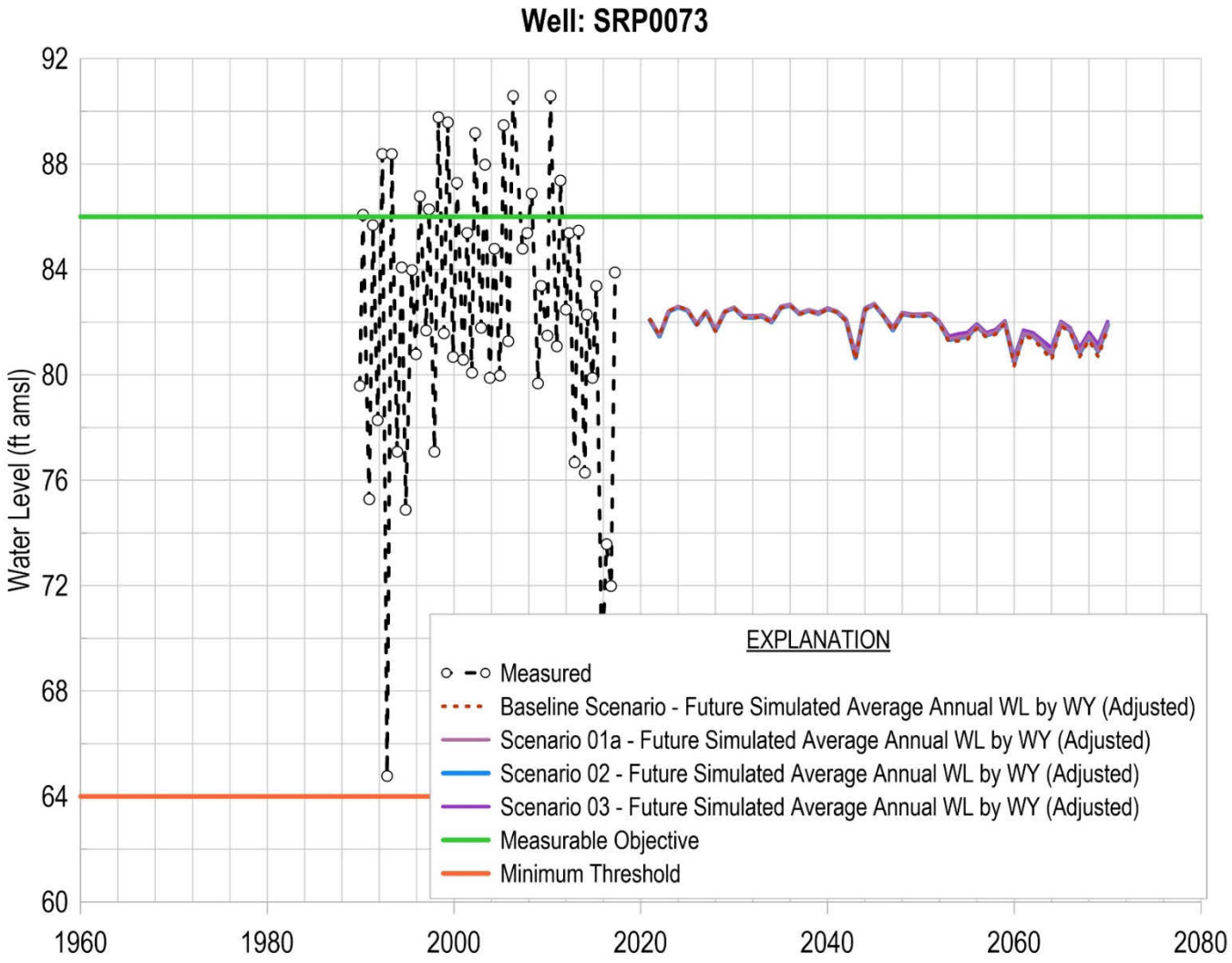

Figure 23 Waterlevel Hydrograph for SRP0073

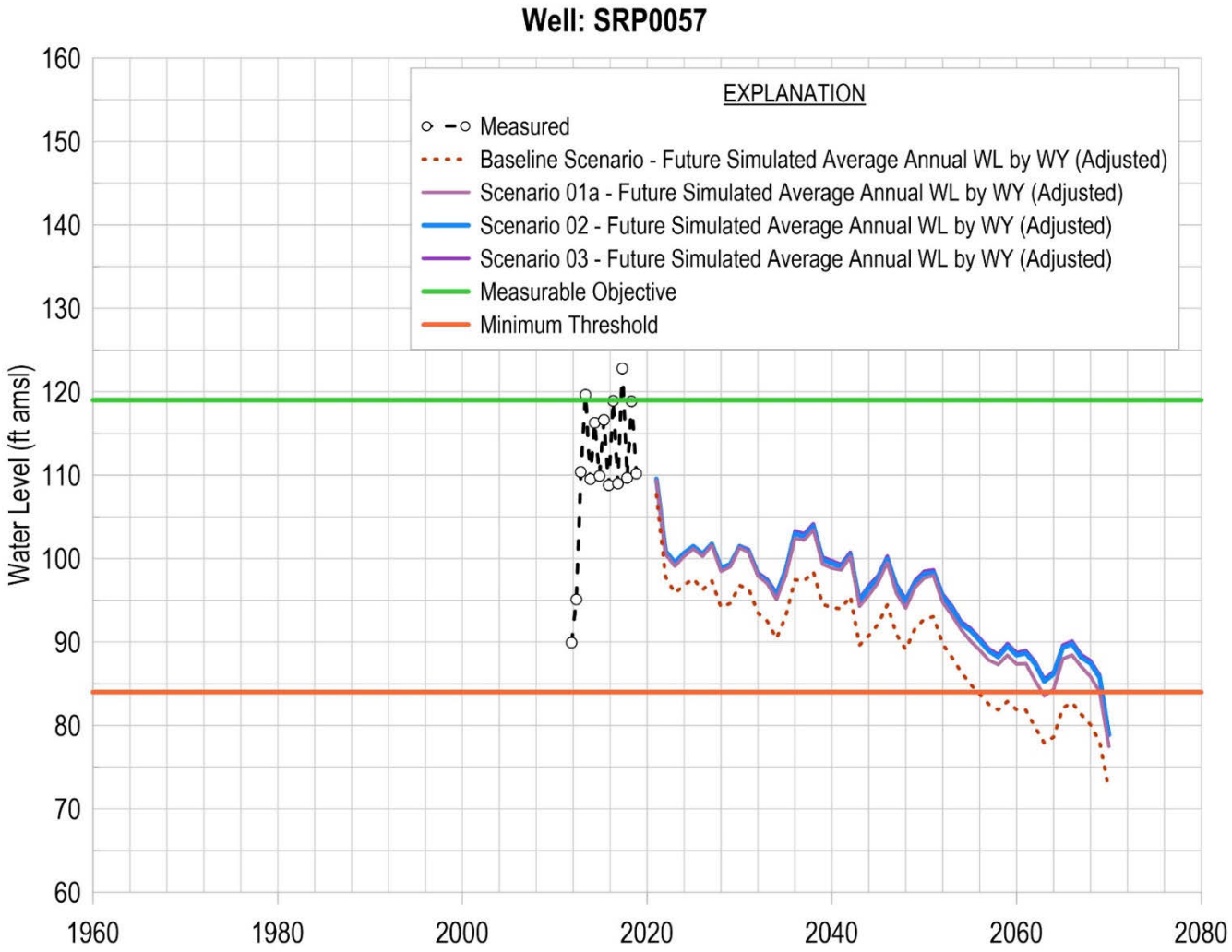

Figure 24 Waterlevel Hydrograph for SRP0057

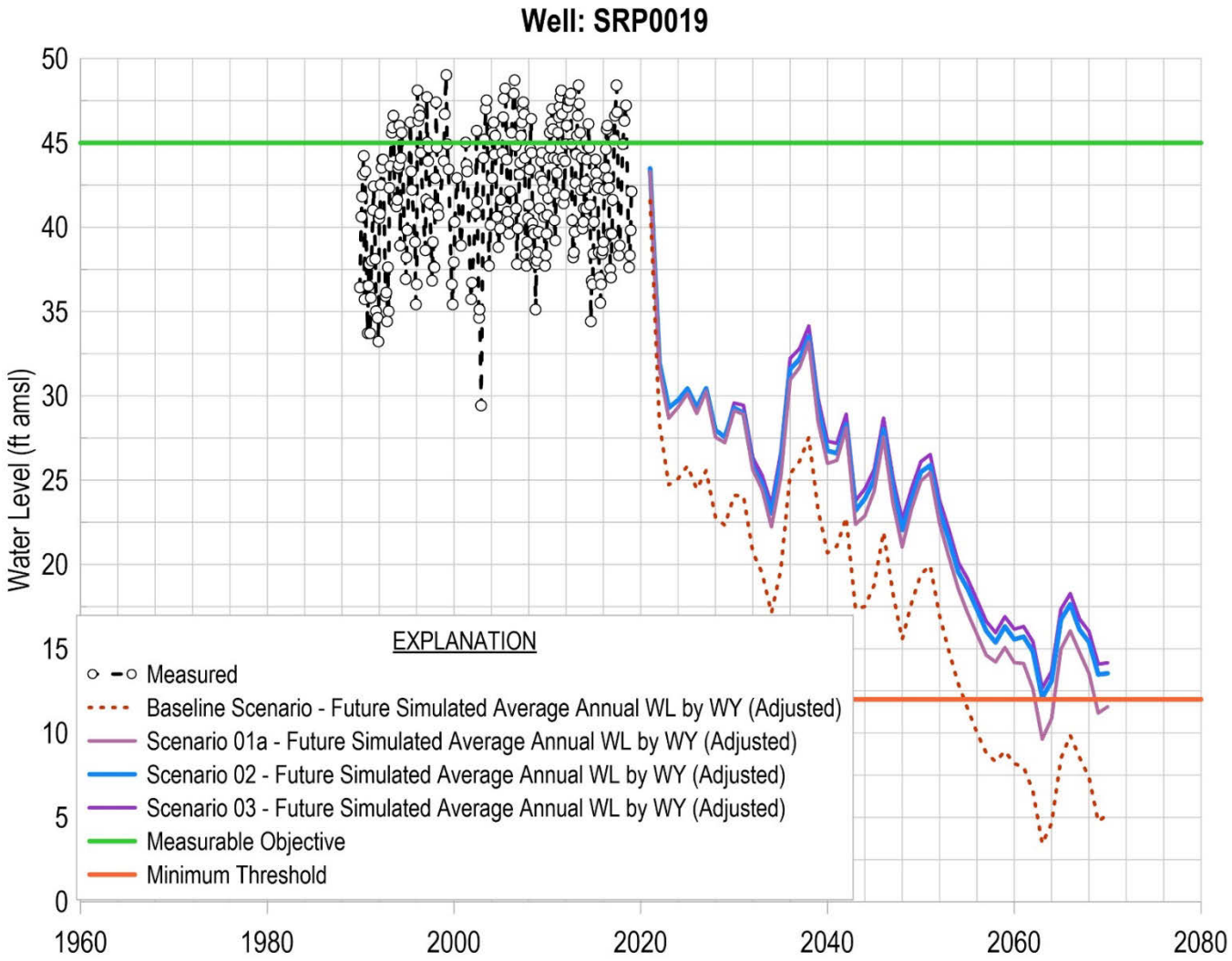

Figure 25 Waterlevel Hydrograph for SRP0019

Appendix 7-A
Model Maintenance and Improvements for the Santa Rosa Plain Groundwater Sustainability Plan

DRAFT

Appendix 7-A:
Model Maintenance and Improvements
Groundwater Sustainability Plan
Santa Rosa Plain Groundwater Subbasin

Table of Contents

1 INTRODUCTION 2
2 Update Data Inputs to Model 2
2.1 Update Simulation Period 2
2.2 Verify Model Inputs Against Available Data 3
2.3 Verify Model Outputs Against Available Data 3
3 Improvements to Model Structure 3
4 Five-Year Model Update and Maintenance 4
4.1 Update Historical and Current Water Budgets for Reporting 4
4.2 Update Future Projected Conditions 5

1 Projects and Management Actions

The Groundwater Sustainability Plain (GSP) for the Santa Rosa Plain (Subbasin) relied on groundwater modeling to support development of historical, current, and projected water budgets, and to evaluate projected benefits from implementing Projects and Management Actions (PMA) scenarios.

The Santa Rosa Plain Hydrologic Model (SRPHM) is a thoroughly developed, documented, and tested tool that has been used in the development of the GSP. The SRPHM was originally developed by the USGS (Wolfenden and Nishikawa, 2014), and revised by Sonoma Water for purposes of developing more accurate water budgets in the Subbasin. The accuracy of the model is dependent on the data available used to inform its development. As new data becomes available assessments will be made to determine if changes to the model may be necessary. Changes to the model could be small, such as adjusting a parameter that controls runoff, or it may be systemic, such as changing location of a boundary or fault or hydraulic properties of a local area. Recommended model improvements that are relevant to GSP implementation will be addressed during the first five years of GSP implementation. In addition to recommended model improvements, routine model maintenance activities will also be conducted during GSP implementation. Routine model update tasks include updating the model with recent land use, pumping, and climate data, and recalibrating the model, if necessary. Finally, model predictive simulations will be updated to reflect new information on alternative future climate scenarios and PMA planning and implementation.

All model improvements incorporated during GSP implementation will build on additional data collection and interpretation activities described in GSP Section 7. These additional data will be used to verify model inputs (Section 2.2), compare against model outputs (Section 2.3), and guide improvements to model structure (Section 3).

This appendix summarizes model improvements that are planned during the first five years of GSP implementation, including updating input data, improving the model structure, and refining the representation of projected PMAs for the 5-year GSP assessment.

2 Update Data Inputs to Model

2.1 Update Simulation Period

The SRPHM simulation period covers the period from 1976 through 2018. During GSP implementation, the simulation period will be extended through Water Year (WY) 2025 for the 5-year GSP update due in 2027. As part of extending the simulation period, the following data inputs will be updated and incorporated in the model:

- Update land use with available spatial dataset(s), both inside and outside of the Subbasin, if available
- Update agricultural irrigation pumping based on new information and land use changes
- Update rural domestic pumping based on updated parcel database and/or updated rural domestic pumpage estimates, if available
- Update municipal and industrial pumping rates, add new wells if necessary
- Streamflow diversion locations and rates
- Update recycled water deliveries and distribute to receiving model cells
- Precipitation and reference evapotranspiration

2.2 Verify Model Inputs Against Available Data

During assessment of SRPHM, several model inputs were identified as sources of uncertainty due to uncertain or limited data. During GSP implementation, these model inputs will be validated against the following additional datasets collected as part of GSP implementation, depending on necessity and impact:

- Irrigation well locations and depths
- Metered irrigation pumping
- Locations and rates of surface water diversions and surface-water storage
- Assignment of distribution of model hydraulic properties, which will be compared against updated hydrogeologic conceptual model from future aquifer test results and airborne electromagnetic survey data
- Estimates of riparian consumptive use to include as model structure improvements

2.3 Verify Model Outputs Against Available Data

Existing groundwater level and interconnected surface water networks will be expanded during GSP implementation (GSP Section 7.2.4). Data collected from these monitoring networks will be used to check model simulation results, and provide guidance to model re-calibration planned toward the end of the first 5 years of GSP implementation.

- Compare simulated streamflow against discharge measurements where available
- Compare simulated shallow groundwater levels against recent data from interconnected surface water wells
- Comparison of mapped seeps and springs against simulated exfiltration
- Compare observed actual evapotranspiration rates to simulated rates for agricultural areas in order calibrate agricultural pumpage

3 Improvements to Model Structure

The following model structural improvements will be addressed during GSP implementation:

- Incorporate updates to model code of AG Package as they become available and if applicable. Such improvements would include surface-water diversions and water-storage for agriculture uses
- Examine how agricultural irrigation practices are implemented in model, and compare with newly available data, existing studies, and other information
- Consider developing explicit representation of riparian consumptive use
- Review and consider any appropriate and necessary modifications to boundary conditions along the Petaluma Valley basin, Healdsburg Area, and Wilson Grove Formation Highlands Groundwater Basin (Wilson Grove Basin). Given the nature and importance of the Wilson Grove boundary, specific tasks are recommended to assess how this boundary is currently simulated by the model and whether the model domain should be expanded further into the Wilson Grove Basin:
    - Evaluate in detail the groundwater conditions at this boundary, focusing on determining the hydraulic gradient, estimated fluxes and its sensitivity to nearby groundwater pumping
    - Perform sensitivity analyses of existing model to determine sensitivity of boundary flux
    - Analyze groundwater levels, groundwater geochemistry, and other information
    - Analyze hydraulic properties of the faults along the Wilson Grove boundary that are likely to be at least 'minor barriers to flow' (p. 140; Nishikawa, 2013)

4 Five-Year Model Update and Maintenance

The SRPHM, incorporating model updates and improvements described in GSP Sections 2 and 3, will be used to support the five-year update to the GSP. The updated model will be re-calibrated to both existing and new data collected during GSP implementation, and will be used to update historical and current water budgets (Section 4.1, below), and to provide future projected water budgets and water levels for comparison against Sustainable Management Criteria (Section 4.2, below) and to support planning and implementation of PMAs.

As part of the five year update to the GSP, the latest available projected climate science and data will be reviewed and considered for incorporation into the scenarios for the Water Year 2026 through 2072 projected period.

4.1 Update Historical and Current Water Budgets for Reporting

As part of the five-year update to the GSP, the model will be assessed to determine if recalibration is necessary. If necessary, recalibration will occur after completing the model update and improvement tasks described in the above Sections 2 and 3. Model recalibration would entail adjusting model hydraulic properties and other model parameters to improve the goodness-of-fit between hydrologic and hydrogeologic datasets, and their model-simulated equivalents. At a minimum, datasets to be used during model calibration would include:

- Groundwater level hydrographs at groundwater-level and interconnected surface water Representative Monitoring Point (RMP) wells, including all new wells
- Streamflow hydrographs from existing and any new stream gages
- Individual low-flow discharge measurements and groundwater-surface water exchange rates collected during future seepage runs

After completing model recalibration, revised simulated historical and current water budgets will be prepared through the extended simulation period (Section 2.1, above).

4.2 Update Future Projected Conditions

A number of PMAs were evaluated using the SRPHM (GSP Appendix 6A). These included implementation of water-use efficiency and other demand reduction projects, construction and operation of ASR wells and construction and operation of stormwater recharge facilities. Specific project details, such as assumptions for water-use efficiency programs, ASR and stormwater recharge volumes and schedules, and infrastructure locations, were defined based on limited best available information at the time.

As stated in Section 7.2.6 of the GSP, the GSA plans to immediately begin implementation of select PMAs. This will include permitting and conceptual design. As specific project details are refined, the representation of PMAs in the model will be updated so that groundwater model projections are based on updated designs of PMAs. Specific areas of update for each project grouping are summarized below:

Simulation of Group 1 Projects

- Update simulation to include refined estimates of conservation and groundwater-use efficiency

Simulate Group 2 Projects:

- Improve simulations of On-Farm and other dispersed recharge by incorporating information as it becomes available

Simulation of Group 3 Projects:

- Simulate proposed ASR projects, optimize project implementation, and additional recycled water opportunities
    - Update source water availability and transmission system capacity assumptions
    - Optimize and update locations and operations, with cost benefit analysis for future alignment options

Management Actions:

- Simulate potential policy options for future GSA consideration or recommendation, including the below initial list of potential policy options:
    - Water conservation plan requirements for new development
    - Low impact development or water efficient landscape plan requirements

Predictive simulation results based on the updated and recalibrated model, with refined representation of PMAs, will then be processed to provide:

- Projected water budgets
- Projected groundwater levels relative to Sustainable Management Criteria for RMP wells
- Projected changes in exchange with interconnected surface water

Updated future projected conditions will likely vary from projections in the GSP due to the following:

- Starting head distributions will reflect groundwater responses to climate and pumping stresses through WY2025
- The model structure and calibration will be revised relative to the SRPHM
- Details of PMAs will have been further developed since GSP preparation

Citations

Nishikawa, Tracy, ed., 2013, Hydrologic and geochemical characterization of the Santa Rosa Plain watershed, Sonoma County, California: U.S. Geological Survey Scientific Investigations Report 2013–5118, 178 p.