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3 SUSTAINABLE MANAGEMENT CRITERIA

This section defines the groundwater conditions that constitute sustainable groundwater management, discusses the process by which the Santa Margarita Groundwater Agency (SMGWA) characterizes undesirable results, identifies the monitoring networks used to assess conditions, and establishes minimum thresholds and measurable objectives for each applicable sustainability indicator. Undesirable results, minimum thresholds, and measurable objectives together define the sustainable management criteria (SMC) and commit the SMGWA to actions that will achieve those conditions. These Sustainable Groundwater Management Act (SGMA) specific terms and others are defined in the Glossary.

Defining SMC requires significant analysis and scrutiny. This section presents the data and methods used to develop SMC and demonstrates how they influence beneficial uses and users. The SMC are based on currently available data and the application of best available science. As noted in this GSP, data gaps exist in the hydrogeologic conceptual model related to the interconnection of surface water and groundwater. Uncertainty caused by these data gaps was considered when developing the SMC. Due to uncertainty in the hydrogeologic conceptual model, the SMC are considered initial criteria that will be reevaluated and potentially modified in the future as new data becomes available.

This section is organized to address all the SGMA regulations regarding SMC. The Sustainability Goal guides development of the SMC and the monitoring network describes the monitoring features used to track progress toward meeting interim milestones and measurable objectives and what data gaps still exist. To retain an organized approach, the description of the Monitoring Network and SMCs are grouped by each individual sustainability indicator. Each subsection follows a consistent format that contains the information required by Section §354.22 *et. seq* of the SGMA regulations and outlined in the Sustainable Management Criteria Best Management Practice (BMP) (DWR, 2017). Each SMC subsection includes a description of how the following SMC were developed:

- Qualitative, locally defined significant and unreasonable conditions
- Quantitative description of undesirable results, including:
    - The criteria defining when and where the effects of the groundwater conditions cause undesirable results based on a quantitative description of the combination of minimum threshold exceedances (§354.26 (b)(2))
    - The potential causes of undesirable results (§354.26 (b)(1))
    - The effects of these undesirable results on the beneficial users and uses (§354.26 (b)(3))

- Quantitative minimum thresholds, including:
    - The information and methodology used to develop minimum thresholds (§354.28 (b)(1))
    - The relationship between minimum thresholds and the relationship of these minimum thresholds to other sustainability indicators (§354.28 (b)(2))
    - The effect of minimum thresholds on neighboring basins (§354.28 (b)(3))
    - The effect of minimum thresholds on beneficial uses and users (§354.28 (b)(4))
    - How minimum thresholds relate to relevant Federal, State, or local standards (§354.28 (b)(5))
    - The method for quantitatively measuring minimum thresholds (§354.28 (b)(6))
- Quantitative measurable objectives, including:
    - The methodology for setting measurable objectives (§354.30)
    - Interim milestones (§354.30 (a), §354.30 (e), §354.34 (g)(3))

3.1 Sustainability Goal

Per Section 1 of this GSP, the SMGWA's sustainability goals are to:

- Implement the SGMA, which requires the management and use of groundwater in the Basin in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.
- Provide a safe and reliable groundwater supply that meets the current and future needs of beneficial users.
- Support groundwater sustainability measures and projects that enhance a sustainable and reliable groundwater supply in the Basin, utilizing integrated water management principles by:
    - Safeguarding water supply availability for public health and welfare
    - Maintaining and enhancing groundwater availability for municipal, private, and industrial users and uses
    - Maintaining and enhancing groundwater contributions to streamflow, where beneficial users are dependent upon such contributions (fish, frogs, salamanders, dragonflies etc.)
    - Maintaining and enhancing groundwater levels that support groundwater dependent ecosystems

    - Maintaining and enhancing groundwater quality for existing and future beneficial uses

- Provide for operational flexibility within the Basin by supporting a drought supply reserve that takes into account future climate change.
- Plan and implement projects and activities to achieve sustainability that are cost effective and do not place undue financial hardship on the SMGWA, its cooperating agencies, or basin stakeholders. A cost-benefit analysis, taking into consideration financial, social, environmental, and adverse consequences, may be conducted to evaluate whether a project or activity results in undue financial hardship.

Measures that SMGWA cooperating agencies will take to achieve Basin sustainability are primarily focused on increasing Lompico aquifer groundwater levels in the Mount Hermon / South Scotts Valley area. The most immediate action will be to expand conjunctive use of surface water and groundwater using existing infrastructure. It is likely that this measure will be followed by development of infrastructure to gain access to San Lorenzo Valley Water District's (SLVWD) entitlement of 313 AFY of Loch Lomond water for further conjunctive use opportunities. Combining the 2 projects would potentially provide for a long-term average of 540 acre-feet per year (AFY) of in-lieu recharge by SLVWD and Scotts Valley Water District (SVWD) resting their extraction wells during the wet seasons when surface water is available for conjunctive use. Groundwater modeling has demonstrated the combined projects will raise Mount Hermon / South Scotts Valley area Lompico aquifer groundwater levels by 20 to 50 feet and Monterey Formation levels by 20 feet. Additionally, resting SVWD wells extracting from the Butano aquifer may raise Butano aquifer groundwater levels by 20 to 50 feet in the central to northern Scotts Valley areas. The anticipated increases in groundwater levels from 540 AFY of conjunctive use enables the SMGWA to meet its long-term measurable objectives for chronic lowering of groundwater levels, depletion of interconnected surface water, and reduction of groundwater in storage, while having no impact on groundwater quality.

Larger, more costly projects using either treated surface water or purified wastewater imported from outside the Basin, as described in Section 4, will be evaluated during the first 5 years of GSP implementation. The larger projects will provide the SMGWA cooperating agencies additional water supply resiliency and drought protection, beyond the level likely needed for sustainable management of groundwater in the Basin.

3.2 Process of Developing Sustainable Management Criteria

3.2.1 SMGWA Board Involvement

SMC were developed for the Basin based on historical data and desired future conditions. The SMC decision making process involved guidance by SMGWA staff, stakeholder outreach, and discussion and refinement over multiple SMGWA Board meetings. Prior to discussing SMC for a particular sustainability indicator with the SMGWA Board, Directors were provided background information describing the sustainability indicator including the past and present groundwater conditions associated with it. Discussion during the meeting was facilitated by David Ceppos from Consensus and Collaboration Program at the College of Continuing Education, Sacramento State. Facilitation focused on information sharing, topic understanding, and public participation.

Once there was comfort in understanding Basin conditions related to the sustainability indicator, the technical consultant described potential options for SMC. First, a statement that identified significant and unreasonable, or unsustainable conditions, was drafted. The statement was revisited multiple times in subsequent Board meetings until the Board was satisfied with the definition.

The significant and unreasonable conditions statement for each sustainability indicator guided development of the other SMCs, including undesirable results, minimum thresholds, and measurable objectives. Options for each SMC were provided to the SMGWA Board for consideration. This approach was taken so that the Board could understand the relative levels of protectiveness for each indicator before making decisions. Interim milestones were developed based on current conditions, measurable objectives, and future groundwater conditions predicted by the groundwater model and did not have direct SMGWA Board input.

Meeting summaries and video recordings posted on the SMGWA website reflect the discussions that took place for each sustainability indicator. The SMC were developed over several meetings of the SMGWA Board, which allowed for continual improvements to the criteria. Additionally, opportunities for public comment on the topics being discussed at the SMGWA Board meetings were provided and taken into consideration during development of the SMC.

3.2.2 Surface Water Technical Advisory Group

Representatives from the following organizations and agencies participated in 2 technical Surface Water Technical Advisory Group (TAG) meetings to provide their perspectives on the approach for development of depletion of interconnected surface water SMC and identification of groundwater dependent ecosystems (GDEs):

- Balance Hydrologics (consultant to the SMGWA)
- California Department of Fish and Wildlife
- California Department of Water Resources
- City of Santa Cruz Water Department
- County of Santa Cruz Environmental Health
- Environmental Defense Fund
- Land Trust of Santa Cruz County
- Montgomery & Associates (consultant to the SMGWA)
- National Marine Fisheries Service (NMFS, formerly NOAA Fisheries)
- The Nature Conservancy
- Resource Conservation District of Santa Cruz County
- San Lorenzo Valley Water District staff
- Santa Margarita Groundwater Agency Board (2 directors)
- Scotts Valley Water District staff
- US Fish and Wildlife Service

The 2 meetings, held on August 14, 2020, and February 24, 2021, provided the TAG background information on the hydrogeological setting of the Basin, City of Santa Cruz habitat conservation planning, Santa Cruz County fish monitoring, potential conjunctive use opportunities for SLVWD, water budget, and current understanding of the relationship between surface water and groundwater. Based on the background information available, the technical team shared potential approaches for developing SMC for the depletion of interconnected surface water and plans for GDE monitoring. The TAG was asked to provide specific input on the SMGWA Board's statement of significant and unreasonable, potential SMC approaches, and GDE monitoring plan. Their expert input was taken into account in the development of SMC and the GDE monitoring plan.

3.3 Monitoring Networks

This section describes the monitoring networks and protocols that the SMGWA will use to assess groundwater conditions and the Basin's sustainability during GSP implementation. The monitoring networks included in this subsection are based, to the extent possible, on existing monitoring networks described in Section 2.1.2: Water Resources Monitoring and Management Programs. The subsections below describe how the existing networks are adapted to meet the SGMA requirements for each applicable sustainability indicator. A subset of monitoring wells from the existing monitoring network are selected as Representative Monitoring Points (RMPs) at which to establish SMC for measuring progress towards sustainability. Finally, this section identifies monitoring network data gaps and proposed improvements for networks that are insufficient for assessing current and future conditions.

3.3.1 Description of Monitoring Networks

The SGMA regulations require that 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, and to evaluate changing conditions that occur during GSP implementation. Monitoring networks should accomplish the following:

- Demonstrate progress toward achieving interim milestones and measurable objectives described in the GSP
- Monitor impacts to beneficial uses and users of groundwater
- Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds
- Quantify annual changes in water budget components

The Basin's existing monitoring networks have been used for many decades to collect information to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface water conditions. The existing networks can be used to collect data relevant to the Basin's applicable groundwater sustainability indicators including chronic lowering of groundwater levels, depletion of interconnected surface water, reduction of groundwater in storage, and degraded groundwater quality (Table 3-1).

Table 3-1. Applicable Sustainability Indicators in the Santa Margarita Basin

Sustainability Indicator	Metric	Proxy
Chronic Lowering of Groundwater Levels	Groundwater elevation	---
Reduction of Groundwater in Storage	Volume of groundwater extracted	---
Degraded Groundwater Quality	Concentration	---
Depletion of Interconnected Surface Water	Volume or rate of streamflow	Groundwater elevation

3.3.1.1 Groundwater Level Monitoring Network

Each SMGWA member agency has its own network of dedicated monitoring wells and extraction wells that monitor groundwater elevations in their respective jurisdictions. These wells have been used for decades to evaluate short-term, seasonal, and long-term groundwater trends for groundwater management purposes, and will be incorporated into the GSP groundwater level monitoring network.

There are currently 35 wells used to monitor groundwater levels at least twice a year. Clusters of monitoring wells completed in different aquifers at the same location are used to understand changes in vertical gradients between aquifers. Table 3-2 summarizes the wells in the existing monitoring network by aquifer. Figure 3-1 shows the basin-wide distribution of groundwater level monitoring wells.

Table 3-2. Summary of Groundwater Level Monitoring Network Wells

Aquifer Unit	Well Name	Well Type	Monitoring Agency	Sounding Frequency	Data Logger
Santa Margarita Aquifer	SLWVD Quail MW-A	Monitoring	SLVWD	Monthly	N
	SLVWD Quail MW-B	Monitoring	SLVWD	Monthly	N
	SLVWD Quail MW-C	Monitoring	SLVWD	Monthly	N
	SLVWD Quail Hollow #4A	Extraction	SLVWD	Monthly	N
	SLVWD Quail Hollow #5A	Extraction	SLVWD	Monthly	N
	SLVWD Olympia #2	Extraction	SLVWD	Monthly	N
	SLVWD Olympia #3	Extraction	SLVWD	Monthly	N
	SLVWD Pasatiempo MW-2	Monitoring	SLVWD	Monthly	N
	SVWD AB303 MW-1	Monitoring	SVWD	Daily	Y
	SVWD AB303 MW-3B	Monitoring	SVWD	Daily	Y
	SVWD SV1-MW INACTIVE	Monitoring	SVWD	Inactive	Y
	SVWD SV3-MW A	Monitoring	SVWD	Daily	Y
	SVWD SV3-MW B	Monitoring	SVWD	Daily	Y
	SVWD SV4-MW	Monitoring	SVWD	Daily	Y
	SVWD TW-18	Monitoring	SVWD	Daily	Y
	Hidden Meadows Mutual Water Co #2	Extraction	County	Semi-annually	N
	Ruins Creek	*Monitoring*	*County*	*Daily*	*Y*
	Bahr Drive	*Monitoring*	*SLVWD*	*Daily*	*Y*
	Glen Arbor Road	*Monitoring*	*SLVWD*	*Daily*	*Y*
	Bean Creek ds of Mackenzie Creek	*Monitoring*	*County*	*Daily*	*Y*
	Nelson Road/Lockhart Gulch	*Monitoring*	*County*	*Daily*	*Y*
Monterey Formation	SVWD #9	Extraction	SVWD	Daily	Y
	Weston Road	*Monitoring*	*County*	*Daily*	*Y*
	Smith Creek	*Monitoring*	*SLVWD*	*Daily*	*Y*

Aquifer Unit	Well Name	Well Type	Monitoring Agency	Sounding Frequency	Data Logger
	Near SV4-MW	*Monitoring*	*SVWD*	*Daily*	*Y*
Lompico Aquifer	Mount Hermon #1	Inactive	MHA	Semi-annually	N
	Mount Hermon #2	Extraction	MHA	Semi-annually	N
	Mount Hermon #3	Extraction	MHA	Semi-annually	N
	MHA-MW1	Monitoring	MHA	Semi-annually	N
	SLVWD Pasatiempo MW-1	**Monitoring**	**SLVWD**	**Monthly**	N
Lompico Aquifer	SLVWD Pasatiempo #5A	Extraction	SLVWD	Monthly	N
	SLVWD Pasatiempo #7	Extraction	SLVWD	Monthly	N
	SLVWD Pasatiempo #8	Extraction	SLVWD	Monthly	N
	SVWD #10	**Monitoring**	**SVWD**	**Monthly**	N
	SVWD #10A	Extraction	SVWD	Monthly	Y
	SVWD #11A	**Extraction**	**SVWD**	**Monthly**	Y
	SVWD #11B	Extraction	SVWD	Monthly	Y
	SVWD AB303 MW-3A	Monitoring	SVWD	Semi-annually	Y
	SVWD TW-19	**Monitoring**	**SVWD**	**Semi-annually**	Y
	SVWD SV3-MW C	Monitoring	SVWD	Semi-annually	Y
	Graham Hill Rd/Conference Drive	*Monitoring*	*SLVWD*	*Semi-annually*	*Y*
Lompico/ Butano Aquifer	SVWD #3B	Extraction	SVWD	Monthly	Y
	SVWD Orchard Well	Extraction	SVWD	Monthly	Y
	SVWD #15 Monitoring Well	Monitoring	SVWD	Monthly	Y
Butano Aquifer	**SVWD Canham Well**	**Monitoring**	**SVWD**	**Semi-annually**	Y
	SVWD Stonewood Well	**Monitoring**	**SVWD**	**Semi-annually**	Y
	Polo Ranch Road	*Monitoring*	*SVWD*	*Daily*	*Y*

Notes: Wells in bold are Representative Monitoring Points; wells in italics are to be installed in 2022

The monitoring network contains wells within each principal aquifer in areas where municipal extraction takes place. Areas where groundwater is used but there is no groundwater level monitoring typically occur where there are a significant number of domestic supply wells or there are GDEs. Potential additions to the monitoring network that would be required to meet the goals of the GSP are discussed in Section 3.3.5.

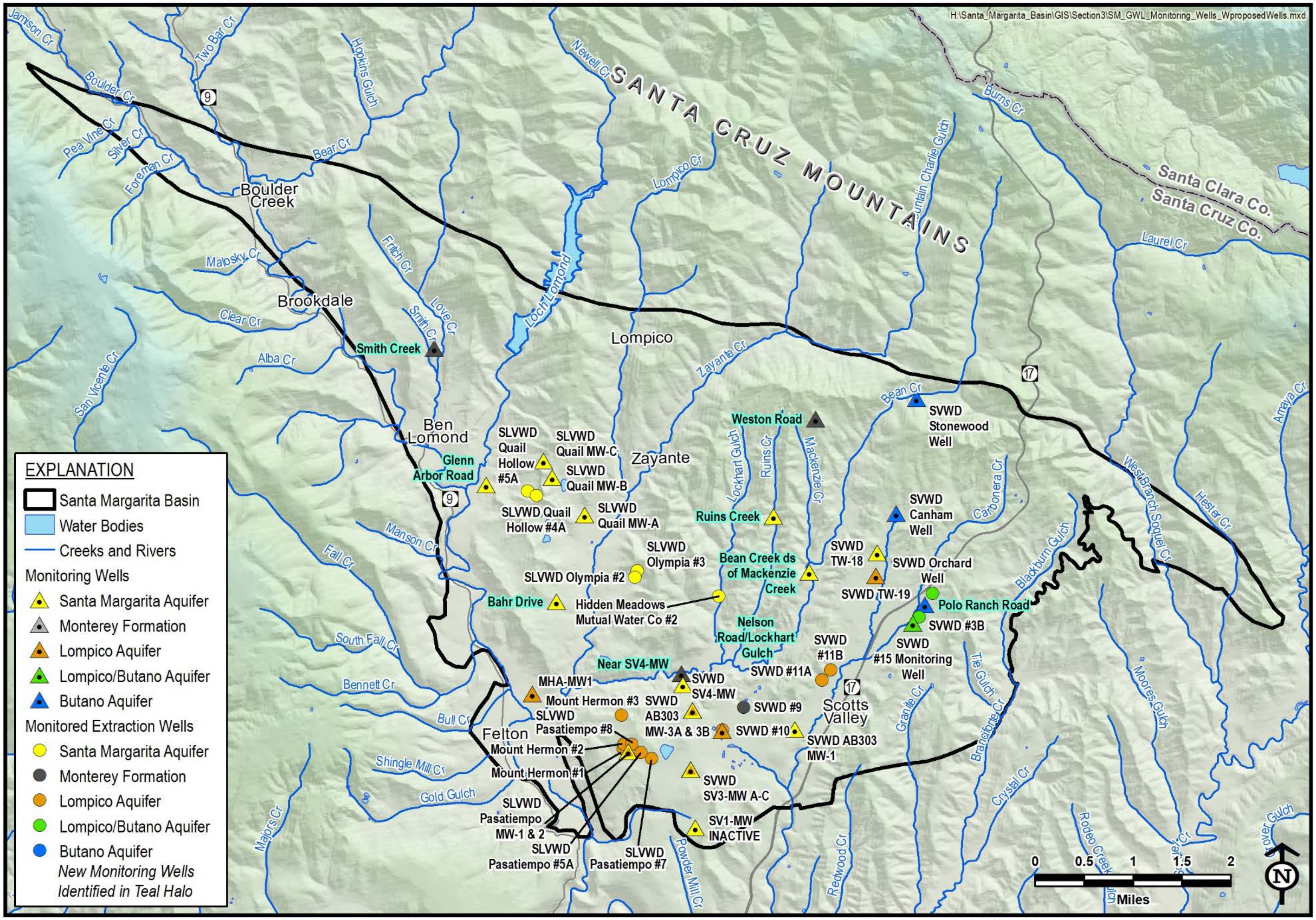


Figure 3-1. Location of Wells Used for Groundwater Level Monitoring with Proposed New Wells Labeled in Teal

Table 3-3. Summary of SMGWA Groundwater Level Monitoring Networks

Agency	Number of Wells			
	Monitoring	Extraction	Total	Representative Monitoring Points
San Lorenzo Valley Water District	5	7	12	5
Scotts Valley Water District	15	6	21	9
Mount Hermon Association	2	2	4	0
Total	*20*	*15*	*35*	*14*

The proposed groundwater level monitoring network shown on Figure 3-1 will be used to assess progress toward achieving interim milestones and measurable objectives with respect to chronic lowering of groundwater levels, and will serve as a proxy in assessing the depletion of interconnected surface water described in the GSP.

The chronic lowering of groundwater levels sustainability indicator will be monitored using existing monitoring wells, focused in areas of municipal groundwater extraction: Quail Hollow, Olympia, and Scotts Valley. In addition to existing wells, Section 3.3.4.1: Groundwater Level Monitoring Improvements describes 4 new monitoring wells that will be installed to address identified data gaps using Proposition 68 and SMGWA member agency match funds.

The depletion of interconnected surface water sustainability indicator will be monitored using 2 existing shallow monitoring wells: SVWD SV4-MW near Bean Creek and SLVWD Quail MW-A near an unnamed tributary of Zayante Creek. Recognizing that the Basin does not have enough shallow wells on the major creeks in the Basin to monitor and evaluate the effects of groundwater extractions on streamflow in interconnected surface waters, up to 5 new shallow monitoring wells will be installed using Proposition 68 and agency match funds to complete the monitoring network. The proposed new monitoring well general locations and intended use are described in more detail in Section 3.3.4.1.3.

Each agency will continue to monitor existing and new wells as the GSP is implemented. All groundwater level data collected, both hand soundings and pressure transducer records, will be stored in a regional data management system (DMS) to be managed by the County. All monitoring data uploaded to the DMS will be analyzed, compared to SMC, and included on hydrographs in the annual reports. The DMS is described in more detail in Section 3.3.2.5.

3.3.1.2 Groundwater Extraction Monitoring

Per GSP regulations, the quantitative metric for reduction of groundwater in storage is an annual volume of groundwater extracted. The volume of groundwater extracted will be measured using flow meters where available. For extraction wells that do not have flow meters, assumptions are made about water demand to estimate a volume of groundwater extracted. The location of the groundwater extraction well monitoring network is shown on Figure 3-2.

3.3.1.2.1 Metered Groundwater Extraction

The SLVWD, SVWD, and Mount Hermon Association measure monthly extraction by individual well using totalizer readings. Public Small Water Systems (SWS) with between 5 and 199 connections are required to measure and report monthly extraction data to Santa Cruz County Environmental Health (EH). Table 3-4 lists the extraction wells that are metered. All metered monthly extraction data will be stored in the DMS.

Table 3-4. Metered Extraction Wells

Aquifer	Well Name
Santa Margarita	SLVWD Quail Hollow #4A
	SLVWD Quail Hollow #5A
	SLVWD Olympia #2
	SLVWD Olympia #3
	Fernbrook Woods Mutual Water Company
	Fern Grove Water Club
	Hidden Meadows Mutual Water Company
	Karl's Dell
	Mission Springs Conference Center Well
	Vista Robles Association
Monterey	SVWD #9
	Love Creek Heights Mutual Water Association
	Moon Meadows Water Company
Lompico	SLVWD Pasatiempo #5A
	SLVWD Pasatiempo #7
	SLVWD Pasatiempo #8
	SVWD #10A
	SVWD #11A
	SVWD #11B
	Mount Hermon #2
	Mount Hermon #3
	Roaring Camp
Lompico/Butano	SVWD #3B
	SVWD Orchard Well

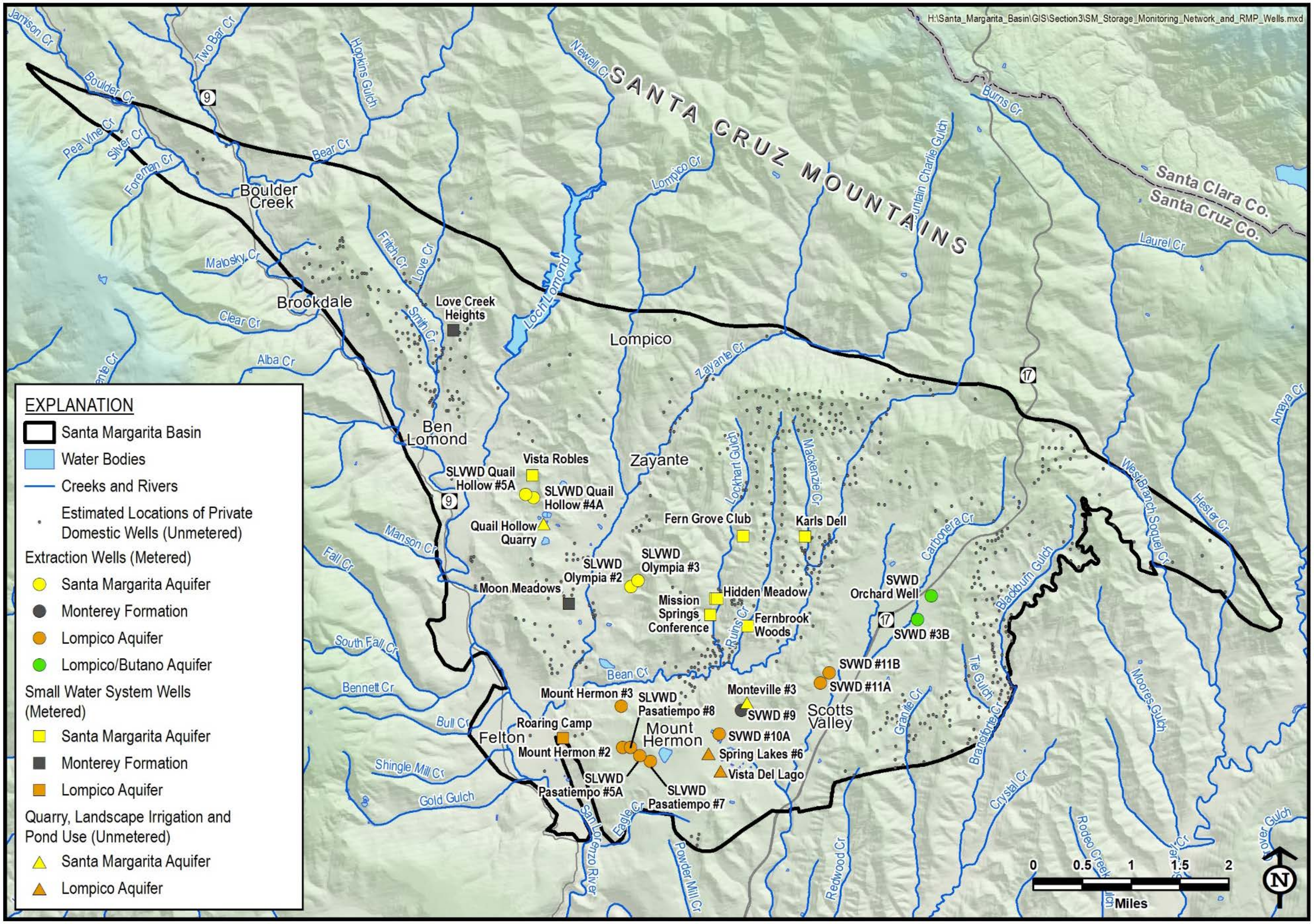


Figure 3-2. Location of Wells Used for Groundwater Extraction Monitoring

3.3.1.2.2 Unmetered Groundwater Extraction

Unmetered groundwater extraction includes pumping for private domestic supply, irrigation, and landscaping, and industrial water uses.

There are approximately 777 residences throughout the Basin that are not supplied by public water agencies, and where unmetered groundwater pumping for domestic use takes place. These users are considered *de minimis* users, which is defined by the SGMA legislation as "a person who extracts, for domestic purposes, 2 acre-feet (AF) or less per year." Under SGMA, *de minimis* groundwater pumping (less than 2 AFY) is exempted from metering. This exemption, however, does not exempt *de minimis* pumpers from addressing impacts they may have on the Basin, including cumulative impacts. Collective pumping from *de minimis* wells for domestic supply is estimated to be around 233 AFY based on an annual water use factor of 0.3 AFY, which is approximately 8% of extraction from the Basin. An update of the number of residential parcels that are not served by public water supply agencies will be updated for the GSP's 5-year updates. During GSP implementation, the amount of water extracted for domestic use will be estimated based on the number of rural parcels with domestic wells, approximate population counts for people using domestic wells for water supply, and per connection water use estimates from small water systems and individual households that are metered.

Similar to domestic pumping, industrial groundwater extraction at Quail Hollow Quarry and irrigation by other larger private pumpers is currently unmetered. As part of GSP implementation, the SMGWA will implement a metering program that will require non-*de minimis* users who pump more than 2 AFY to meter their wells and provide records to the SMGWA. The number and location of industrial, pond filling, agricultural, and landscape irrigation non-*de minimis* pumpers are known based on land use maps.

Estimated groundwater extractions will not be included in the DMS as the data are not measured. Instead, estimated extraction data will be compiled and stored in tabular format. These data will be included in GSP 5-year updates and will be used to update the model. The frequency of future groundwater model updates during GSP implementation has not yet been determined.

3.3.1.3 Groundwater Quality Monitoring Network

Routine groundwater quality monitoring is almost entirely limited to public water agencies and SWS with 15 or more connections. Table 3-5 summarizes the 21 wells that are monitored most frequently in the Basin. Well locations are shown on Figure 3-3 and sampling frequency requirements for individual wells are summarized in Table 3-6. There are no dedicated monitoring wells that are used for groundwater quality monitoring, therefore all wells shown on Figure 3-3 are extraction wells.

Private domestic wells and SWS with 5 to 14 connections are generally not sampled routinely, as described in Sections 2.1.2.4.2.1 and 2.1.2.4.2.2. These wells are typically required by Santa Cruz County EH to be sampled after installation and before use. After initial sampling, there are no sampling requirements for domestic wells and limited and sporadic requirements for SWS with fewer than 15 connections. Data for domestic and SWS wells are reported to Santa Cruz County EH. Domestic wells and SWS with less than 15 connections are not included in the GSP's groundwater quality monitoring network, though the SMGWA will evaluate options for incorporating these limited data, if available, during future GSP updates. Should more water quality data be needed, the SMGWA could partner with the County on a free or reduced cost groundwater quality testing program for private well owners willing to share their data.

Table 3-5. Summary of Groundwater Quality Monitoring Network Wells

	Number of Wells			
Member Agency	Monitoring	Extraction	Total in Network	Representative Monitoring Points
San Lorenzo Valley Water District	0	7	7	3
Scotts Valley Water District	0	6	6	6
Mount Hermon Association	0	2	2	0
Fern Grove Club	0	2	2	0
Hidden Meadows Mutual Water Co.	0	1	1	0
Mission Springs Conference Center	0	2	2	0
Vista Robles Association	0	1	1	0
Total	*0*	*21*	*21*	*9*

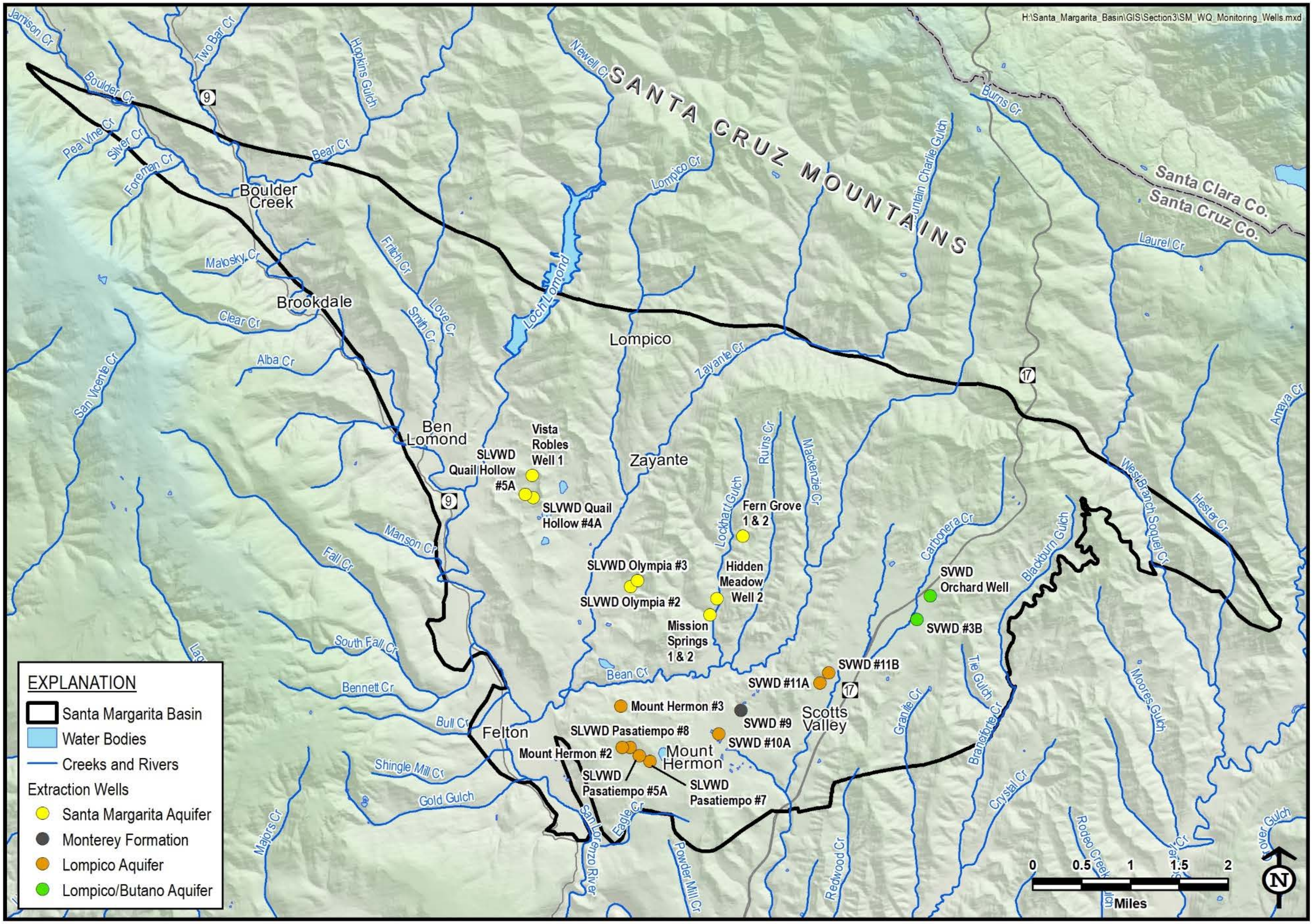


Figure 3-3. Location of Wells Used to Monitor Groundwater Quality

Table 3-6. Current Sampling Frequency of Groundwater Quality Monitoring Wells

Aquifer	Extraction Well	Inorganics	Inorganics with More Frequent Sampling				Volatile (VOC) & Synthetic (SOC) Organics
			Nitrate as N	Arsenic	Iron	Manganese	
Santa Margarita	SLVWD Olympia #2	Every 3 years	1 x year	Every 3 years	4 x year	4 x year	Every 3 years
	SLVWD Olympia #3	Every 3 years	1 x year	Every 3 years	4 x year	4 x year	Every 3 years
	SLVWD Quail Hollow #4A	Every 3 years	1 x year	Every 3 years	4 x year	4 x year	Every 3 years
	SLVWD Quail Hollow #5A	Every 3 years	1 x year	Every 3 years	4 x year	4 x year	Every 3 years
	Mission Springs Conference Center #1	Every 9 years	1 x year	Every 3 years	Every 3 years	Every 3 years	SOCs = 9 years VOCs = 6 years
	Mission Springs Conference Center #2	Every 9 years	1 x year	Every 3 years	Every 3 years	Every 3 years	SOCs = 9 years VOCs = 6 years
	Hidden Meadows Mutual Water Co #2	Every 9 years	1 x year	Every 3 years	Every 9 years	Every 9 years	SOCs = 3 years VOCs = 6 years
	Fern Grove #1	Every 3 years	1 x year	Every 3 years	Every 3 years	Every 3 years	SOCs = 3 years VOCs = 6 years
	Fern Grove #2	Every 3 years	1 x year	Every 3 years	Every 3 years	Every 3 years	SOCs = 3 years VOCs = 6 years
	Vista Robles Association #1	Every 3 years	1 x year	Every 3 years	Every 9 years	Every 9 years	SOCs = 9 years VOCs = 6 years
Monterey	SVWD #9 (standby well)	1 x year	1 x year	1 x year	1 x year	1 x year	1 x year
Lompico	MHA #2	Every 3 years	1 x year	Every 3 years	4 x year	Every 3 years	SOCs = 3 years VOCs = 6 years
	MHA #3	1 x year	1 x year	1 x year	1 x year	1 x year	SOCs = 3 years VOCs = 6 years
	SLVWD Pasatiempo #5A	Every 3 years	1 x year	12 x year	12 x year	12 x year	Every 3 years
	SLVWD Pasatiempo #7	Every 3 years	1 x year	12 x year	12 x year	12 x year	Every 3 years
Lompico (cont'd)	SLVWD Pasatiempo #8	Every 3 years	1 x year	12 x year	12 x year	12 x year	Every 3 years
	SVWD #10A	4 x year	4 x year	4 x year	4 x year	4 x year	2 x year
	SVWD #11A	4 x year	4 x year	4 x year	4 x year	4 x year	4 x year
	SVWD #11B	4 x year	4 x year	4 x year	4 x year	4 x year	4 x year
Lompico/ Butano	**SVWD #3B**	4 x year	4 x year	4 x year	4 x year	4 x year	4 x year
	SVWD Orchard Well	4 x year	4 x year	4 x year	4 x year	4 x year	4 x year

Notes: Wells in bold are Representative Monitoring Points

3.3.1.4 Streamflow Monitoring Network

Stream stage and discharge will be assessed in areas where groundwater pumping occurs in the vicinity of streams connected to groundwater. Streamflow monitoring gages are located throughout the Basin, especially in the southern portion, where tributaries consolidate into the larger stream reaches and groundwater and surface water interactions occur due to aquifers exposed at the ground surface.

There are 7 active stream gages within the Basin that will continue to be used as part of the GSP monitoring network. An additional 8th gage is planned for installation in late 2021. One of the existing gages is maintained and operated by the USGS (streamflow gage No. 11160500, San Lorenzo River at Big Trees) with funding from the City of Santa Cruz. The other active stream gages are funded and maintained by the City of Santa Cruz and the County. The USGS and City of Santa Cruz stream gages are measured monthly throughout the year and the County stream gages are typically operational during the seasonal baseflow period (approximately May to November) to record flow during the driest time of year. The stream gage network is summarized in Table 3-7 and shown on Figure 3-4. A few of the recently inactivated gages have also been included on Figure 3-4 and Table 3-7 for reference.

Beginning in 2017, Balance Hydrologics conducted annual late-season stream observation walks called accretion runs to help determine where groundwater is contributing flow to the stream, and where the stream is replenishing groundwater. Accretion studies were performed at locations along the San Lorenzo River and its tributaries shown on Figure 3-4. Results of accretion studies are described in Section 2.2.5.6.1. The SMGWA will evaluate whether further accretion studies would provide additional value based on changes observed in the groundwater levels, streamflow, and GDE health over the 5-year monitoring period before the first GSP update in January 2027.

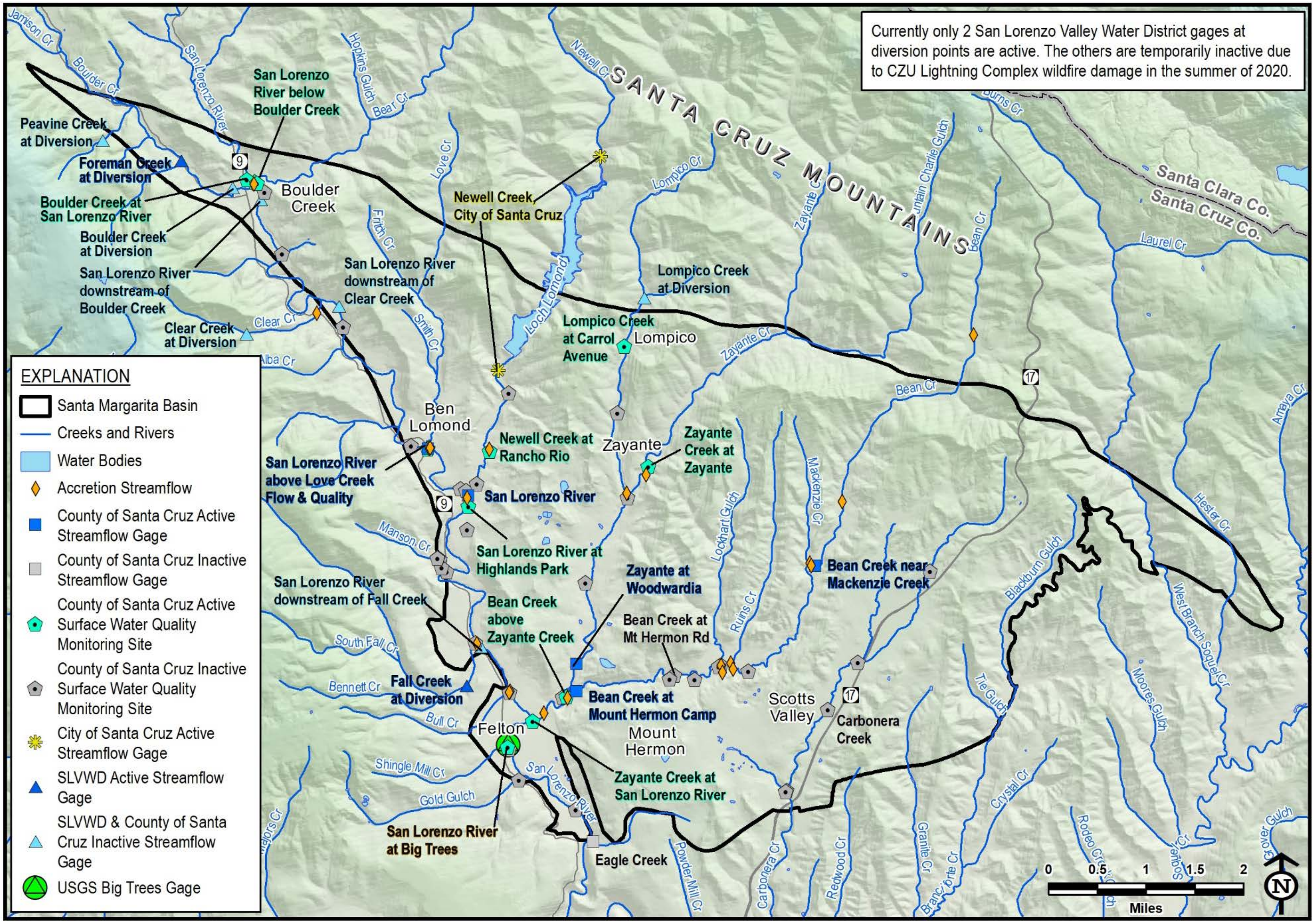


Figure 3-4. Location of Streamflow Gages and Surface Water Quality Monitoring Sites

Table 3-7. Summary of Streamflow Gages

Monitoring Agency	Streamflow Gage Name	Status	Parameters Measured	Frequency Measured
USGS	USGS 11160500 San Lorenzo River at Big Trees	Active	Streamflow	Approximately monthly
City of Santa Cruz	Newell Creek below Loch Lomond	Active	Streamflow	Approximately monthly
	Newell Creek above Loch Lomond	Active	Streamflow	Approximately monthly
San Lorenzo Valley Water District	San Lorenzo River Downstream of Fall Creek	Inactive	Streamflow, Temperature	Approximately monthly during seasonal baseflow
	San Lorenzo River Downstream of Clear Creek	Inactive	Streamflow, Temperature	Approximately monthly during seasonal baseflow
	San Lorenzo River Downstream of Boulder Creek	Inactive	Streamflow, Temperature	Approximately monthly during seasonal baseflow
County of Santa Cruz	San Lorenzo River above Love Creek	Active	Streamflow, Specific Conductance, Temperature	Approximately monthly during seasonal baseflow
	Newell Creek upstream of San Lorenzo River	Active	Streamflow, Specific Conductance, Temperature	Approximately monthly during seasonal baseflow
	Zayante at Woodwardia	Active	Streamflow, Specific Conductance, Temperature	Approximately monthly during seasonal baseflow
	Bean Creek at Mount Hermon Camp	Active	Streamflow, Specific Conductance, Temperature	Approximately monthly during seasonal baseflow
	Bean Creek near Mackenzie Creek	Planned in late 2021	Streamflow, Specific Conductance, Temperature	Approximately monthly during seasonal baseflow
	Eagle Creek Gage	Inactive after October. 2020	Streamflow, Specific Conductance, Temperature	Approximately monthly during seasonal baseflow

3.3.1.5 Groundwater Dependent Ecosystem Monitoring

As part of GSP implementation, the SMGWA will evaluate potential impacts to GDEs from groundwater use, projects, or management actions. The GDEs will be evaluated using surface water measurements, field observations, and vegetation index mapping. Groundwater and surface water monitoring networks described in Sections 3.3.1.1 and 3.3.1.4, respectively, will be an integral part of GDE monitoring. GDE monitoring protocols are described generally below; other routine GSP monitoring protocols are described in Section 3.3.2.

Work in the Basin over the past few decades indicates surface water characteristics are directly related to what is occurring in the aquifer underlying the surface water during the dry season. Surface water observations for GDE assessment will include visual inspection and water level, specific conductance, and temperature measurements at representative sites. Decades of monitoring by Santa Cruz County and other agencies have shown that these metrics vary seasonally with wet and dry periods and are resilient to most other watershed surface disturbances but are still susceptible to changes in conditions of the aquifers that control them. The timing of observations will be standardized, and field visits will occur twice a year, once in late spring/early summer (early May) and again in late summer/early fall (late September to early October). Timing may need to be adjusted slightly depending on the type of water year, and if there is late season rain, to capture the range of baseflow conditions. Measurements and observations will be documented in a standard format that will be uploaded to the DMS. Qualitative metrics, such as photo monitoring and general site observations, will also be collected during site visits to further evaluate site conditions within the context of the direct measurements. This information will be provided in annual GSP updates.

Vegetation vigor is affected by changes in groundwater, climate, and physical conditions (erosion, sedimentation, mass wasting, wildfire, etc.). Vegetation vigor datasets are generated through processing satellite imagery. State agencies have made these datasets publicly available thereby making them a cost-effective indicator of change in groundwater levels and GDE vegetation quality. The common vegetation vigor indices include Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), and Normalized Difference Moisture Index (NDMI)[1,2]. Within the Basin, the diversity in GDE types and the natural high NDVI values, make vegetation vigor a suitable long-term tool for analysis of vegetation impacts from changing groundwater levels. Remote sensing tools, such as the Nature Conservancy's GDE Pulse or Google Earth Engine will be used to qualitatively assess the health of vegetation surrounding lakes and ponds by evaluating changes in vegetation vigor indices, such as NDVI, EVI, and NDMI, over time. This information is available online and is free for the SMGWA to

[1] https://www.usgs.gov/core-science-systems/nli/landsat/landsat-enhanced-vegetation-index?qt-science_support_page_related_con=0#qt-science_support_page_related_con
[2] https://gde.codefornature.org/#/methodology

access. Vegetation vigor analysis by remote sensing methods will be conducted every 5 years using annual remote sensing data available over that 5-year period. Results of the analysis will be included in the GSP's 5-year updates. Table 3-8 summarizes GDE monitoring frequency.

Table 3-8. Summary of GDE Monitoring Frequency

Monitoring Type	Frequency
GDE Field Assessment	Twice per Year, Late Spring/Early Summer and Late Summer/Early Fall
Vegetation Vigor	Every Five Years

3.3.1.5.1 Groundwater Dependent Ecosystem Monitoring Network

As described in Section 2.2.4.9, GDEs are classified into categories: springs, open water, riverine/riparian, and other groundwater-supported wetlands. Monitoring objectives will be specific for each type of GDE summarized below, with monitoring at representative GDE monitoring sites occurring semi-annually or every 5-years, depending on the objective. Monitoring objectives and frequency are summarized in Table 3-9, and monitoring locations are summarized in Table 3-10 and shown on Figure 3-5.

Table 3-9. Groundwater Dependent Ecosystems Monitoring Objectives and Frequency

GDE Classification	Semi-Annual Frequency Late Spring/Early Summer and Late Summer/Early Fall	Frequency of Every Five Years
	Monitoring Objectives	
Springs	Flow, specific conductance, temperature, and shallow groundwater monitoring	Vegetation vigor
Open Water (lakes and ponds)	Photo monitoring, water level and shallow groundwater monitoring	Vegetation vigor
Riverine/ Riparian (perennial and ephemeral streams, riparian corridors, on-channel ponds, wetlands)	Streamflow and shallow groundwater monitoring	Vegetation vigor
Other Groundwater-Supported Wetlands (seeps, quarry floor, willow, shrub, and scrub vegetation)	Photo monitoring, shallow groundwater monitoring	Vegetation vigor

Table 3-10. Groundwater Dependent Ecosystem Representative Monitoring Sites

Site	GDE Types	Selection Rationale
Glenwood Preserve and Canham Springs	Springs and Other Groundwater-Supported Wetlands	Near SVWD pumping, near contact between Santa Margarita aquifer and Santa Cruz Mudstone
Quail Hollow	Springs, Open Water, and Other Groundwater-Supported Wetlands	Near SLVWD pumping in Santa Margarita aquifer
Zayante Creek south of Quail Hollow	Springs, Riverine and Riparian	Near SLVWD and private pumping, near contact between Santa Margarita aquifer and Monterey Formation
Redwood and Ferndell Springs	Springs	Near Mount Hermon Association pumping, springs are in the Santa Margarita aquifer
Eagle Creek Springs	Springs	At southern extent of Basin, springs are in the Santa Margarita aquifer
San Lorenzo River, Zayante Creek, and Bean Creek	Riverine and Riparian	Primary streams in the Basin that are connected to groundwater, with nearby municipal and private pumping wells

3.3.1.5.1.1 Springs

Monitoring of representative springs listed in Table 3-10 and shown on Figure 3-5 will include measurements of flow, specific conductance, and temperature, along with general observations of the spring and surrounding vegetation. These physical measurements and records will be the clearest link between hydrologic support for GDEs and groundwater management. Monitoring will occur semi-annually during the first 10 years of the monitoring program to document the relationship between surface water flow, groundwater levels, and GDE health. Springs located near streamflow gages will additionally be monitored during regular streamflow gage calibration site visits.

3.3.1.5.1.2 Open Water

Monitoring of representative open water sites listed in Table 3-10 and shown on Figure 3-5 will consist of evaluating vegetation vigor of fringe vegetation, photo monitoring, and measurements of surface water level. As previously discussed, remote sensing methods will be used to assess the changes in vegetation vigor surrounding open water GDEs during the period leading up to the GSP's 5-year update. To monitor the water surface level of the water body, a staff plate or measuring stick, will be installed at representative open water sites to document changes in water surface level at the site over time. Photos will be collected at established photo points, measurements of specific conductance and temperature will be taken, and observations of surface water stage and surrounding vegetation will be noted. Monitoring will occur semi-annually during the first 10 years of the monitoring program.

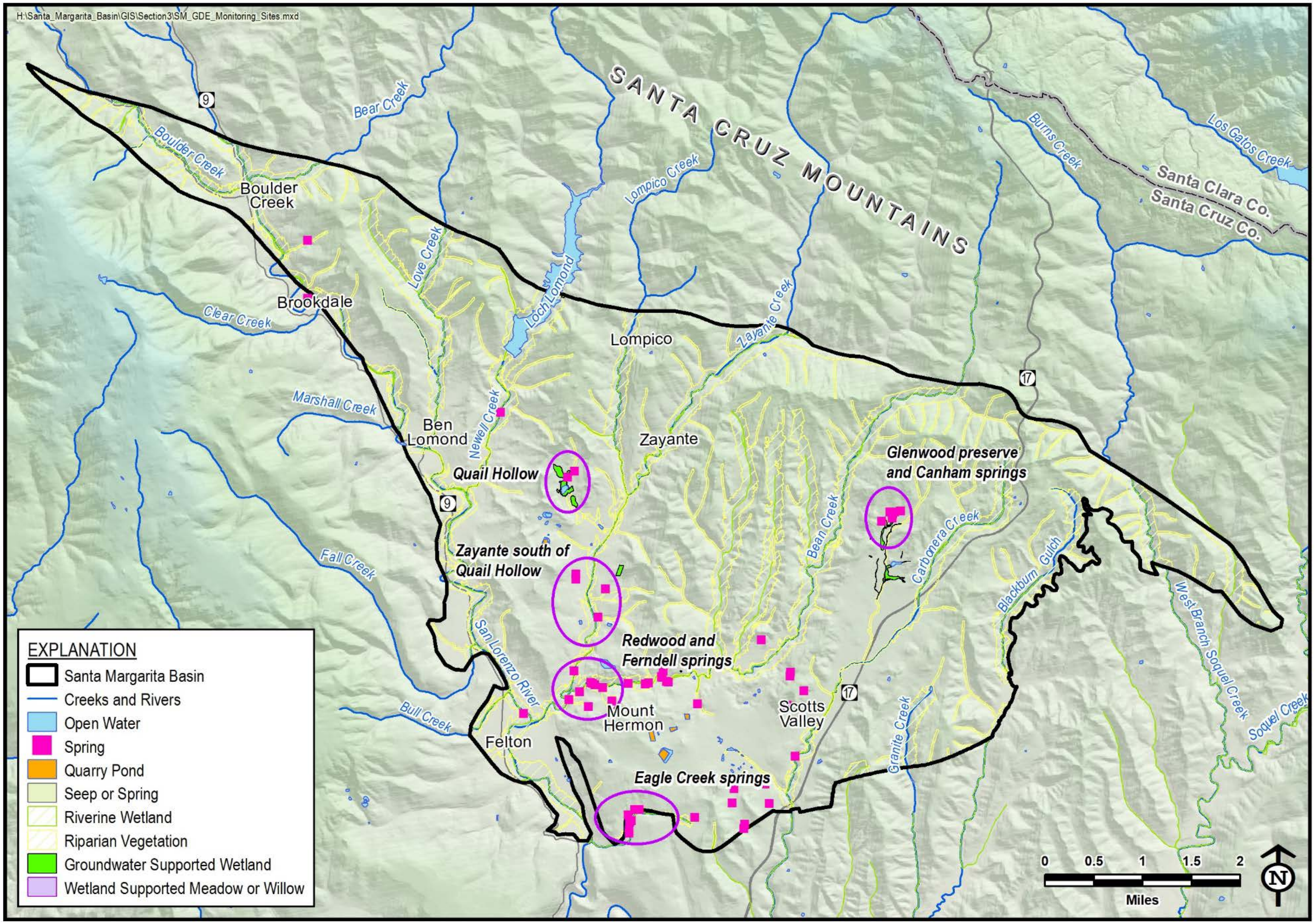


Figure 3-5. Location of Groundwater Dependent Ecosystem Monitoring Sites

3.3.1.5.1.3 Riverine and Riparian

Monitoring of representative riverine and riparian areas listed in Table 3-10 and shown on Figure 3-5 will consist of seasonal streamflow monitoring to document changes in baseflow in selected streams during a given year and compared to other years (see Section 3.3.1.4). Riverine and riparian monitoring will include evaluation of vegetation vigor along riparian corridors. Field observations will be compared with remote sensing data to assess annual changes in vegetation vigor within the riparian corridor, which can be an indicator of shallow groundwater availability for plants. The evaluation of vegetation vigor using remote sensing data will occur during the period leading up to the GSP 5-year update.

3.3.1.5.1.4 Other Groundwater-Supported Wetlands

Monitoring of representative other groundwater-supported wetland sites listed in Table 3-10 and shown on Figure 3-5 will consist of photo monitoring and evaluating vegetation vigor. As previously discussed, remote sensing methods will be used to assess the changes in vegetation vigor within representative other groundwater-supported wetlands during the period leading up to the GSP 5-year update. Semi-annual site visits during the first 10 years of the monitoring program will include collecting photos at photo monitoring locations, as well as general and qualitative site observations of the wetland and vegetation.

3.3.1.5.1.5 Representative Groundwater Dependent Ecosystem Sites

Specific sites are selected to be representative of the GDEs within the Basin (Table 3-10 and Figure 3-5). These sites will be monitored to evaluate the impacts by groundwater use, projects, or management actions on GDEs. These sites were selected based on their proximity to pumping areas, the underlying geology, and inferred or modeled stream connectivity with groundwater. The GDE data collected at representative sites will be supplemented by groundwater level and stream stage monitoring networks presented in Sections 3.3.1.1 and 3.3.1.4, respectively.

3.3.1.5.2 Groundwater Dependent Ecosystems and Priority Species

GDE monitoring will focus on areas most likely to support priority species habitat. For example, streamflow and temperature are critical components of habitat for many of the priority species within the Basin. Observations of changes in vegetation health, through monitoring vegetation vigor and photo monitoring, will indicate changes in groundwater availability for plants.

Table 3-11 lists priority species for the Basin selected for GDE management, the locations of those species, and the habitat components that will be measured through the GDE monitoring plan. Section 2.1.4.2.8 describes more broadly ecological beneficial users of groundwater including other priority species that may be found within the Basin. Other species of importance in the Basin not listed in Table 3-11 are believed to either not be dependent on groundwater or have similar needs as the priority species identified for GDE monitoring. For example, multiple plant species are included in each GDE type but are not specifically considered priority species for GDE monitoring.

Table 3-11. Priority Species Monitoring

Priority Species common name	Type of species	Location(s)	Habitat components monitored through SMGWA
Steelhead	Fish	Bean Creek, Zayante Creek, Lompico, MacKenzie, San Lorenzo River, Newell Creek, Love Creek, Boulder Creek	Streamflow, temperature
Coho Salmon	Fish	Bean Creek, Zayante Creek, San Lorenzo River	Streamflow, temperature
Lamprey	Fish	Bean Creek, Zayante Creek, Newell Creek, San Lorenzo River	Streamflow, temperature
California Red-Legged Frog	Amphibian	Bean Creek, Mountain Charlie Gulch	Streamflow, temperature, water level in open water and seeps/springs
Western Pond Turtle	Reptile	Zayante Creek, Newell Creek, San Lorenzo River	Streamflow, temperature, water level in open water and seeps/springs
California Giant Salamander	Amphibian	Probably distributed widely in basin. Bean Creek, Lockhart Gulch, Ruins Creek, Zayante Creek, Lompico Creek, San Lorenzo River	Streamflow, temperature, water level in open water and seeps/springs

3.3.1.5.3 Biological Responses

Ongoing studies, conducted by the County, SLVWD, and the City of Santa Cruz, will assist in data interpretation by providing additional information on the anticipated biological responses to surface water fluctuations and variability in GDE conditions. The Santa Cruz County Juvenile Steelhead and Stream Habitat Monitoring Program, a multi-agency partnership, has measured steelhead population density at more than 40 sites throughout the San Lorenzo, Soquel, Aptos, and Pajaro watersheds since 1989. Additionally, the County occasionally monitors riparian vegetation using the Riparian Rapid Assessment Method, a monitoring method developed by the Central Coast Wetlands Group to assess physical and biological complexity, and to infer ecological functioning and benefits (City of Santa Cruz Water Department et al., 2018). Data from these monitoring programs are anticipated to generally inform the SMGWA's ongoing consideration of potential groundwater management impacts to groundwater dependent ecosystems.

3.3.1.6 Land Elevation Monitoring

Land subsidence is not an applicable indicator of sustainability in the Basin and land surface elevations within the Basin have not been historically monitored nor are there plans to conduct such monitoring in the future. The DWR-funded vertical displacement spatial data from InSAR, described in Section 2.2.5.5, will be reviewed as part of each GSP 5-year update to confirm that subsidence is not occurring. In the analysis of the InSAR dataset, it will be important to distinguish between land elevation changes resulting from tectonic deformation due to the proximity of active faults and land elevation changes from land subsidence caused by groundwater extraction. It will also be important to take into account small seasonal elevation changes that can result from changing moisture levels in expanding soils, and to acknowledge the intrinsic precision of the measurements can result in small calculated changes that do not reflect actual surface movement.

If inelastic or permanent land subsidence from groundwater extraction is found to be occurring, it will trigger the need for dedicated subsidence monitoring.

~~3.3.1.6~~3.3.1.7 Climate Monitoring

Precipitation and temperature data are collected by the Basin's 2 municipal water agencies. The County of Santa Cruz has a county-wide rainfall sensor network (https://santacruz.onerain.com) with 1 sensor in the Basin at Ben Lomond. The collected data will be used to estimate precipitation and evapotranspiration which help refine estimates of groundwater recharge, runoff, and surface water and groundwater interactions. Climate stations are summarized on Table 3-12 and their locations are provided on Figure 2-12.

Table 3-12. Climate Stations in the Santa Margarita Basin

Monitoring Entity	Station Name	Parameters
San Lorenzo Valley Water District	Boulder Creek	Daily precipitation, daily minimum, maximum and average temperature
Scotts Valley Water District	El Pueblo Yard	Daily precipitation, daily minimum, maximum and average temperature
Santa Cruz County	Ben Lomond	Daily precipitation

3.3.2 Protocols for Data Collection and Monitoring

Pursuant to the goals of SGMA, agencies monitoring groundwater in the Basin endeavor to use reliable and effective data collection protocols to monitor groundwater conditions. Use of the monitoring protocols contained within this GSP ensures data are consistently collected thereby increasing the reliability of data used to evaluate GSP implementation. There are 5 types of data collected: groundwater level, groundwater quality, streamflow, groundwater extraction volume, and climate conditions.

3.3.2.1 Groundwater Level Measurement Protocols

Groundwater level monitoring is conducted to evaluate Basin conditions relative to the sustainable management criteria for chronic lowering of groundwater levels and depletion of interconnected surface water, as shown in Table 3-1. Groundwater levels in some wells are measured and recorded at least daily using pressure transducers with data loggers. Groundwater level measurement in wells without data loggers are collected monthly.

All groundwater level measurements are referenced to a consistent elevation datum, known as the Reference Point (RP). For monitoring wells, the RP is typically a mark on the top of the well casing. For extraction wells, the RP is typically the top of the well's concrete pedestal. Per GSP regulations, the elevation of the RP of each well is to be surveyed to the North American Vertical Datum of 1988 (NAVD 88). Currently, the elevation of the monitoring well RPs is accurate to at least 0.5 foot.

Groundwater level measurements are taken to the nearest 0.01 foot relative to the RP using procedures appropriate for the measuring device. Groundwater elevation is calculated using the following equation:

$$GWE = RPE - DTW$$

where:

GWE = groundwater elevation

RPE = reference point elevation

DTW = depth to water

In cases where the official RPE is a concrete pedestal, but the hand soundings are referenced off the top of a sounding tube, the measured DTW is adjusted by subtracting the sounding tube offset from the top of the pedestal.

All groundwater level measurements include a record of the date, well identifier, time (in 24-hour format), RPE, DTW, GWE, and comments regarding factors which may influence the recorded measurement such as nearby extraction wells pumping, weather, flooding, or well condition.

3.3.2.1.1 Manual Groundwater Level Measurement

All manual groundwater level measurements will use the following protocols:

- Measurements will be collected using an electronic sounder or steel tape. Electronic sounders consist of a graduated wire equipped with a weighted electric sensor. When the sensor is lowered into water, a circuit is completed and an audible beep is produced, at which point the sampler will record the depth to groundwater. This is the preferred method for monitoring groundwater levels, but other methods may be used. For instance, some extraction wells may have lubricating oil floating on top of the groundwater column; oil and groundwater levels in these wells will be gaged with an oil water interface probe or steel tape with oil and water indicator paste. Equipment usage will follow manufacturer specifications for procedure and maintenance.

- In wells that have been subject to recent pumping, a measurement will be taken after pumping has ceased and the water level has recovered to a stable level. If a well pump cannot be turned off during the scheduled monitoring event, then a measurement will be collected if possible, and accompanied by an explanatory note.
- For each well, multiple measurements will be collected to ensure the well has reached equilibrium such that no significant changes in groundwater level are observed.
- Equipment will be thoroughly cleaned after measurements at each well location in order to prevent cross-contamination among wells.
- The groundwater level measurement will be collected from a permanent reference mark. If a well is found to not have a permanent reference mark, one will be made on the north side of the casing to ensure subsequent measurements reference the same point.

3.3.2.1.2 Groundwater Level Measurement with Continuous Recording Devices

In addition to manual groundwater level measurements, some wells in the Basin are equipped with pressure transducers to collect more frequent data. These include SVWD extraction wells and most monitoring wells. Installation and use of pressure transducers abide by the following protocols:

- In order to calibrate the transducer data, the sampler will use a water level measurement device to measure the current groundwater level prior to installation of the probe. The groundwater level will be measured following the protocols listed above.
- All transducer installations will follow manufacturer specifications for installation and calibration. The time on the transducer internal clock will be synchronized with the computer satellite time.
- The well name, transducer name, transducer range, transducer accuracy, and cable serial number will be recorded in any log or datasheet used to document measurements.
- The sampler will note whether the pressure transducer uses a vented or non-vented cable for barometric compensation. If non-vented units are used, data will be corrected for natural barometric pressure changes using a barometric pressure logger or if unavailable, weather station data.

- All transducer cables will be secured to the well head with a well dock or another reliable method. This cable will be marked at the elevation of the reference point to allow estimates of future cable slippage (as needed).
- Transducer data will be periodically checked against manually measured groundwater levels to identify electronic drift, cable movement, and transducer failure. These checks will occur at least annually, typically during routine site visits.
- Transducer data will be downloaded when water levels are measured. Transducer data will be entered into the regional DMS as soon as possible. Once the transducer data has been successfully downloaded and stored, the data will be deleted or overwritten to ensure adequate data logger memory.
- Desiccant for vented transducers will be replaced as needed, or at least annually, in order to prevent failure of the transducers. Non-vented transducers are preferred for this reason as they do not require routine maintenance.

3.3.2.2 Groundwater Quality Monitoring Protocols

Monitoring of groundwater quality in the Basin will rely on existing sampling programs. All public water supply agencies and SWS are responsible for sampling and testing groundwater from wells used for drinking water.

For purposes of GSP implementation, groundwater quality monitoring is required to provide data to assess whether projects and/or management actions implemented to achieve sustainability are degrading groundwater quality (Table 3-1). While specific groundwater sampling protocols vary depending on the constituent and the hydrogeologic context, the protocols contained herein provide guidance which is applied to all groundwater quality sampling:

- All groundwater quality analyses will be performed by laboratories certified under the State Environmental Laboratory Accreditation Program.
- Prior to sampling, the sampler will contact the laboratory(s) to schedule sample analysis, obtain appropriate sample containers, and clarify any sample holding times or sample preservation requirements. Laboratory(s) must be able to provide a calibration curve for the desired analyte and are instructed to use reporting limits equal to or less than the applicable data quality objectives, regional water quality objectives, or screening levels.
- Each well used for groundwater quality monitoring will have a unique identifier (ID). This ID will be written on the well housing or the well casing (if not there already) to avoid confusion.
- Sample containers will be labeled prior to sample collection if possible. The sample label will include the sample ID, sample date and time, sample personnel, sample location, preservative used, analyte, and analytical method.

- Prior to any sampling, the sampler will clean the sampling port and/or sampling equipment so that it is free of any contaminants and also decontaminate sampling equipment between sampling locations to avoid cross-contamination between samples. Cleaning should be conducted using a phosphate-free detergent, such as Alconox® or Liquinox®, followed by a rinse with distilled, deionized, or purified water.
- In the case of wells with dedicated pumps, samples will be collected at or near the wellhead. Samples will not be collected from storage tanks, at the end of long pipe runs, or after any water treatment. Samples from active extraction wells that are continuously purging may be collected after flushing the sample tap.
- Should monitoring well or inactive extraction well sampling be required, sampling should follow either low-flow or three well casing volume sampling methods. Low-flow sampling consists of purging at a low rate less than 0.13 gallons per minute and measuring water quality parameters until they stabilize within a specific range (Puls and Barcelona, 1996). Low-flow sampling is best suited for wells with short well screens less than 20 feet in length. Three well casing volume sampling will consist of purging 3 standing volumes of water from the well to ensure that the groundwater sample is representative of ambient groundwater and not stagnant water in the well casing. If pumping causes a well to go dry, the condition will be documented, and the well will be allowed to recover to within 90% of the original level prior to sampling. For deep and large casing diameter wells, purging 3 well volumes may not always be applicable, so professional judgment will be practiced for purging and sampling.
- For low-flow and three well casing volume sampling protocols, field parameters including dissolved oxygen, electrical conductivity, temperature, oxidation reduction potential and pH may be collected during well purging. Samples should not be collected until these parameters stabilize. Parameters will be considered stabilized at the following ranges for 10 to 15 minutes: dissolved oxygen and oxidation reduction potential, ±10%; temperature and electrical conductivity, ±3%; and pH ±0.2%.
- All field instruments will be calibrated each day of use, cleaned between samples, and evaluated for drift throughout the day of use.
- Samples will be collected under laminar flow conditions if possible (i.e., without turbulence and bubbles). This may require reducing pumping rates prior to sample collection. For extraction wells, purging at laminar flow rates is not always an option, so professional judgment will be practiced.
- All samples requiring preservation will be preserved as soon as practically possible and filtered appropriately as recommended for the specific constituent.
- Samples will be chilled and maintained at 4 °C to prevent degradation of the sample prior to analysis.

- Samples must be promptly shipped or delivered in person to the appropriate laboratory to avoid exceeding holding times. The sampler will be responsible for providing proper chain of custody documentation for sample delivery.

3.3.2.3 Groundwater Extraction Measurement Protocols

Groundwater extraction volumes are collected to provide data for water demand operations, wellfield management, and estimate the GSP water budget. Additionally, the volume of groundwater extracted is the metric for the reduction of groundwater in storage sustainability indicator. Municipal SMGWA member agencies measure discharge from their individual extraction wells with calibrated flow meters and totalizers. SVWD and SLVWD also use SCADA systems to monitor and control extraction from individual wells in close to real time. Small water systems report monthly extractions to the County of Santa Cruz on an annual basis. the amount of water extracted for domestic use will be estimated based on the number of rural parcels with domestic wells, approximate population counts for people using domestic wells for water supply, and per connection water use estimates from small water systems that are metered.

3.3.2.4 Streamflow Monitoring Protocols

3.3.2.4.1 Stream Gage Measurements

Stream stage and discharge measurements are collected by SMGWA cooperating agencies to monitor streamflow interaction related to groundwater extractions, monitor stream conditions related to fish habitat, and help preserve other beneficial uses of surface water. The Big Trees gage on the San Lorenzo is operated and monitored by the USGS according to procedures outlined by USGS (1982).

Surface water is most easily measured using a stream gage and stilling well system, which requires development of a ratings curve between stream stage and total discharge. Several measurements of discharge at a variety of stream stages are taken to develop an accurate ratings curve. This relationship is sometimes developed with assistance from Acoustic Doppler Current Profilers. Following development of an accurate ratings curve, streamflow is evaluated on a frequent basis using a stilling well and pressure transducer.

The following stream gage monitoring protocols will be followed:

- Streamflow gages within the basin are equipped with a staff plate and pressure transducer(s), housed in a stilling well.
- Most of the gages are equipped with non-vented pressure transducers, which measure pressure, temperature, and specific conductance and are usually set to log at 15-minute intervals. All transducer installations follow manufacturer specifications for installation, calibration, data logging intervals, battery life, and anticipated life expectancy.

Non-vented pressure transducers are properly corrected for natural barometric pressure changes. See Section 3.3.2.1.2 for pressure transducer installation protocol.

- Streamflow measurements are regularly made at gauging locations following the methods established by the Federal Interagency Sedimentation Program. All field measurements are documented by date in station observers' logs, which are included with data submittals.
- Streamflow velocities are measured using a bucket-wheel meter, either a full-size Type AA ("Price"), bucket-wheel current meters, or a 60% scale smaller meter ("pygmy meter"). Flow meters must meet and exceed the required calibration test of that type of meter prior to measuring flow.
- Measurements of streamflow are taken at a variety of stream stages to develop an accurate rating curve, which establishes the relationship between stream stage and total discharge. The rating curve is used to create a continuous record of flow from the record of water depth collected by the pressure transducers.

3.3.2.4.2 Stream Accretion

To ensure consistency with previous accretion studies, any additional studies will follow the general protocol described below:

- Streamflow measurements and velocities will be collected per the protocols described in the Section above. To increase accuracy for the accretion studies, 30 or more "verticals," or discrete velocity measurements are typically collected across each stream transect.
- Streamflow velocities are measured using a bucket-wheel meter, either a full-size Type AA ("Price"), bucket-wheel current meters, or a 60% scale smaller meter ("pygmy meter"). For low flow stream discharge (less than 50 gallons per minute), measurements are taken using a bag with graduated cylinder or bucket. Flow from seeps is measured with a bucket and stopwatch or Ziploc bag and graduated cylinder where appropriate.
- Specific Conductance is measured with a calibrated specific conductance meter at field temperature and at 25 °C. Specific conductance is measured in the center of flow in the stream profile.
- Water quality samples, such as nitrate and phosphate, are collected in Polyethylene bottles. Each bottle and cap are triple rinsed at the site before sample collection. Each sampling team will collect at least 1 field duplicate per day. Samples are stored in a cooler with ice and kept at or below 4° C. Samples and the chain-of-custody forms are delivered to a state-certified laboratory at the end of the sampling day.

- All field measurements are documented by date in station observers' logs, which are included with data submittals.

3.3.2.5 Climate Monitoring Protocols

The SLVWD and SVWD both use weather stations manufactured by Davis Instruments. Instrument models include Vantage Pro and Vantage Pro2. The rain sensor is a self-emptying tipping bucket, with each tip occurring after 0.01 inches of rain. District staff operate and maintain the stations according to the user manual: https://www.davisinstruments.com/product_documents/weather/manuals/07395-333_IM-6322C-6334.pdf

3.3.3 Data Management System

A regional DMS has been developed jointly by the member agencies of the SMGWA and Santa Cruz Mid-County Groundwater Agency. The DMS platform is WISKI (Water Information Systems by Kisters) developed by KISTERS North America. WISKI also the DMS used by Soquel Creek Water District and the City of Santa Cruz Water Department for their own monitoring and operational purposes.

The DMS has been developed specifically to support water resource management that meets requirements outlined by the DWR for GSAs and can act as a regional platform for data management and access to data. It includes the following elements:

- Data repository and storage
- Data uploading using file importers
- Data quality assurance (QA) and control (QC) measures and features
- Management of multiple levels of user access with accessibility controls to ensure confidential data entered by one agency is not available to other agencies unless it relates to one of the GSAs
- Analytical and customizable reporting tools for time series and tabular data
- Capacity to accommodate system modifications and expansion to incorporate additional geographic areas or additional datasets
- Conformity with and enforcement of metadata standards
- Audit tracking options for particular data sets (i.e., a record of changes to a data set by a named user, when changes were made and what was changed)
- Potential for web portal options
- Migration of historical data into DMS

Complete end-user and technical support staff training is provided by Kisters. Under an annual support and maintenance agreement, ongoing support services and training are accessible to all end-users and IT staff.

The costs for development of the DMS is funded 83% by the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Sustainable Groundwater Planning Grant Program), administered by DWR, and 27% by the member agencies of both GSAs. Ongoing maintenance will be shared by the member agencies of both GSAs. Details on estimated cost to the SMGWA member agencies over the next 5 years are provided in Section 5 on Plan Implementation.

Cooperating agencies will be required to upload groundwater level data to the DMS twice a year quarter using simple tools developed by KISTERS for that purpose. These data are required for reporting to the SGMA portal and are also used to report on basin conditions for the Annual Reports required to be submitted to DWR by April 1 of each year following the SMGWA's adoption of the GSP. Each of the submitting agencies are responsible for QA/QC of their data, and barometric compensation and correction of data logger records prior to upload to the DMS.

Apart from groundwater level data, other data stored in the DMS include groundwater quality, streamflow stage and flow rate, GDE observations, rainfall, and groundwater extraction data. These data will also be uploaded by cooperating agencies twice a year prior to the SGMA required uploads to the SGMA portal before January 1 and July 1 of each year.

3.3.4 Assessment and Improvement of Monitoring Network

The monitoring networks will continue to be evaluated and refined during GSP implementation. The following sections describe the current data gaps and how they may be improved during GSP implementation.

3.3.4.1 Groundwater Level Monitoring Improvements

There are areas of the Basin where groundwater is being used, but there are no historical or current groundwater level data. These are areas where monitoring network improvements are needed as soon as possible. Data gap areas identified include: 1) communities where there are many private domestic wells pumping from either the Santa Margarita Sandstone or Monterey Formation; 2) deep Butano aquifer; and 3) areas where shallow groundwater is connected to surface water and groundwater pumping may be causing depletion of surface water. ~~Up to 8~~Nine new monitoring wells are scheduled to be installed in 2022. The exact locations of new monitoring wells have not been finalized yet, but locations will be in the general vicinity described in Table 3-13 and depicted on Figure 3-6. Installation of the new monitoring wells is funded using Proposition 68 and SMGWA member agency match funds.

Table 3-13. Rationale for Proposed New Monitoring Well Locations

Location Type	Aquifer	General Location	Purpose
Monitoring in Areas of Concentrated Private Domestic Pumping	Santa Margarita	Near Ruins Creek (Ruins Creek on Figure 3-6)	Address a data gap in the aquifer where there is no historical groundwater level data
	Monterey	At the headwaters of Mackenzie Creek (Weston Road on Figure 3-6)	Collect data from an area with a high concentration of private domestic pumping and no records of historical groundwater levels
	Monterey	Northwest of Basin, near Love Creek (Smith Creek on Figure 3-6)	Collect data from an area with a high concentration of private domestic pumping and no records of historical groundwater levels
Deep Butano Sandstone	Butano	In the vicinity of SVWD Orchard and #3B extraction wells which are screened in both the Lompico and Butano aquifers (Polo Ranch Road on Figure 3-6)	Establish a monitoring well screened only in the Butano aquifer near SVWD extraction wells
Shallow wells to Monitor Surface Water / Groundwater Interactions	Santa Margarita	Bean Creek, downstream of Mackenzie Creek	Collect groundwater data near a portion of Bean Creek that periodically runs dry in summer months
	Santa Margarita	Bean Creek, near its confluence with Ruins/ Lockhart Creek (Nelson Road/Lockhart Gulch on Figure 3-6)	Monitor an area that has a high concentration of private domestic pumping and is the location where Bean Creek flow resurfaces when the upgradient reach is dry
	Santa Margarita	Zayante Creek, above confluence with Bean Creek (Bahr Drive on Figure 3-6)	Monitor an area where groundwater seeps out of the valley side and into Zayante Creek
	Santa Margarita	Newell Creek, between SLVWD Quail Hollow #8 extraction well and lower Newell Creek (Glen Arbor Road on Figure 3-6)	Monitor groundwater levels in the Quail Hollow subarea
	Monterey	Bean Creek, next to an existing stream gage and slightly downstream of the Lockhart Gulch confluence (near SV4-MW on Figure 3-6)	Establish a correlation between groundwater and surface water levels in an area downgradient to a high concentration of private domestic users

3.3.4.1.1 Monitoring in Areas of Concentrated Private Domestic Pumping

A large proportion of private well owners pump from either the very productive Santa Margarita aquifer or the considerably less productive Monterey Formation. Monitoring both aquifers is critical to understanding the collective impact of individual private wells on GDEs, as well as the vulnerability of private well owners to groundwater level declines.

Relative to the Monterey Formation, the Santa Margarita Sandstone is less extensive across Basin, so only a single new monitoring well in the Santa Margarita is proposed, near Ruins Creek in an area with no historical groundwater level data (Table 3-13 and Figure 3-6). There are an additional 4 new Santa Margarita aquifer shallow monitoring wells proposed near private domestic wells to evaluate surface water/groundwater interactions as described in Section 3.3.4.1.3.

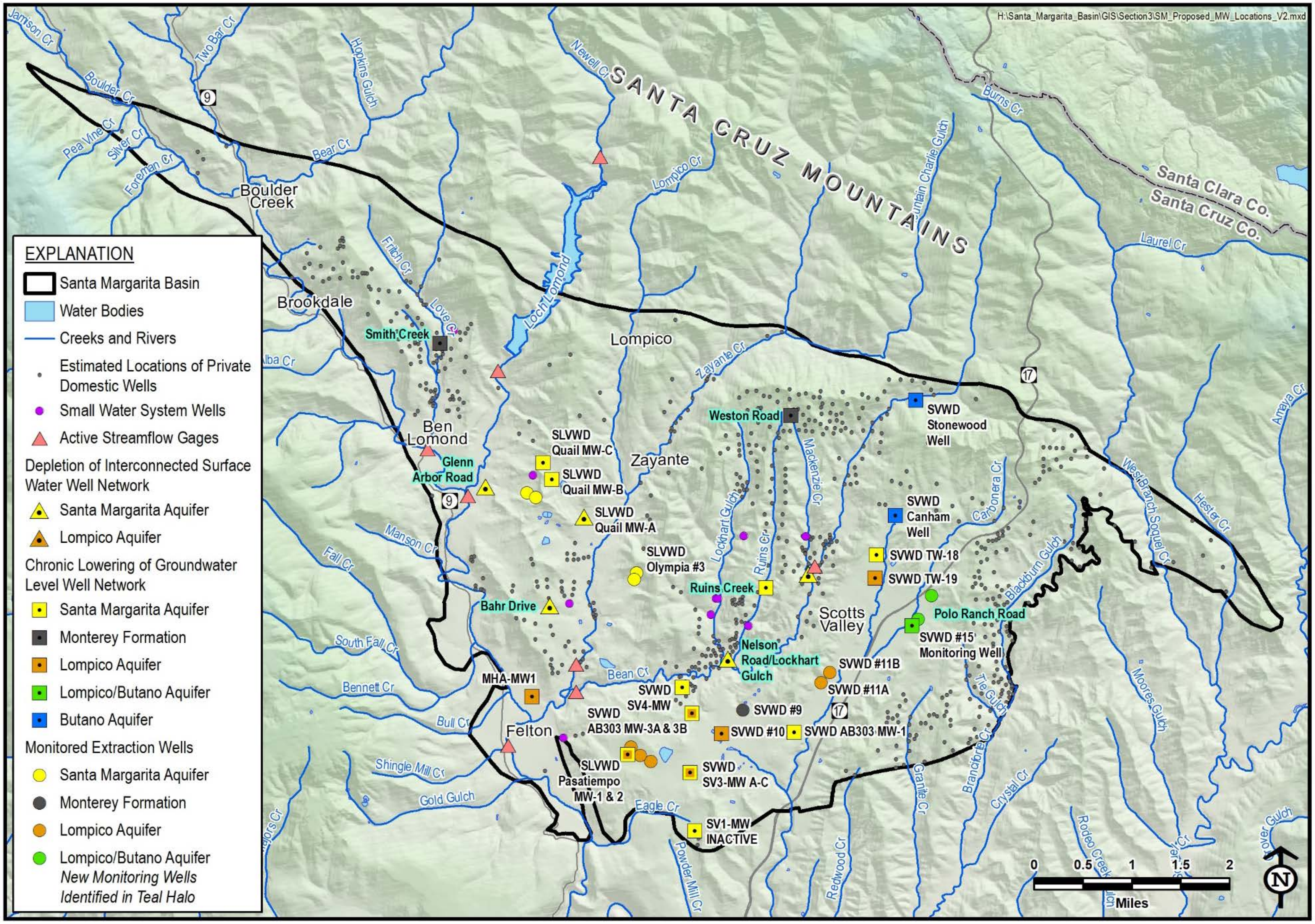


Figure 3-6. New Monitoring Wells (Teal Label) in Relation to Existing Monitoring Features and Private Wells

There is only a single groundwater level monitoring well located in the Monterey Formation within the Basin. Although not a principal aquifer, many private domestic wells extract their supply from the Monterey Formation because it is the only aquifer available to them. The largest concentrations of private domestic wells in the Monterey Formation are located where it crops out in the northwestern and northern parts of the Basin. Given that there are no long-term records of the groundwater levels in these areas, it is proposed to install 2 new monitoring wells. One well is near Love Creek and a second near the headwaters of Mackenzie Creek (Table 3-13 and Figure 3-6) in order to better understand how pumping and direct recharge effect groundwater levels.

3.3.4.1.2 Groundwater Levels in the Butano Aquifer

Groundwater level data from the Butano aquifer is limited because there are currently only 2 monitoring wells screened exclusively in the aquifer. Two municipal extraction wells and 1 monitoring well screened the Butano aquifer, are also screened in the Lompico aquifer. The 2 monitoring wells (Canham and Stonewood) screened exclusively in the Butano aquifer are located in northern Scotts Valley fairly distant from the municipal pumping center at SVWD's #3B and Orchard wells (Figure 3-1). A well dedicated to monitoring groundwater elevation in the Butano aquifer near these municipal wells (Figure 3-6) is necessary to further understand groundwater level responses to pumping and recharge in this poorly understood aquifer.

3.3.4.1.3 Shallow Monitoring Wells to Evaluate Surface Water/Groundwater Interactions

As the existing distribution of monitoring wells is largely limited to monitoring wells close to municipal pumping, additional shallow monitoring wells are required to 1) better understand the interactions between groundwater and surface water, 2) become RMPs for the depletion of interconnected surface water sustainability indicator, and 3) provide measured groundwater level data to improve simulation of groundwater and surface water interactions in the groundwater model. The 2 existing monitoring wells used as RMPs for the depletion of interconnected surface water sustainability indicator are inadequate to represent the entire Basin and it is expected that new shallow monitoring wells will become RMPs after several years of data collection.

Areas where the existing network should be improved by installation of shallow groundwater monitoring wells are listed in Table 3-13 and locations shown on Figure 3-6. There are a total of 5 proposed shallow wells: 4 monitoring wells in the Santa Margarita aquifer which contributes the greatest amount of groundwater to surface water in the Basin and 1 in the Lompico Sandstone near where the Lompico aquifer discharges to the San Lorenzo River. The locations of these new monitoring locations, although not yet finalized, are selected specifically to be paired with either existing or soon-to-be installed streamflow gages. The intent is that data from the paired monitoring features will be used to quantify surface water depletions from groundwater pumping.

3.3.4.2 Groundwater Extraction Monitoring Improvements

Where groundwater extraction is unmetered, assumptions on water usage are used in this GSP to estimate the volume of extractions by private *de minimis* (2 AFY or less) or non-*de minimis* pumpers (more than 2 AFY). SGMA does not authorize GSAs to require metering of *de minimis* extractions, however, non-*de minimis* may be required to be metered by the SMGWA.

As part of GSP implementation, the SMGWA will initiate a new well metering program requiring measurement and reporting of all non-*de minimis* groundwater extraction greater than 2 AF annually. Groundwater pumpers using more than 2 AFY include the Quail Hollow Quarry, those that pump groundwater for large scale irrigation or to fill landscape ponds, environmental remediation pump and treat operations, and SWSs with more than 5 connections. The SWS with more than 5 connections have been metered since 2015. A planned non-*de minimis* metering program is described in more detail in Section 5 on Plan Implementation.

3.3.4.3 Groundwater Quality Monitoring Improvements

Groundwater quality sampling is conducted routinely in public drinking water supply wells; therefore, there are no spatial data gaps in this network. However, the sampling frequency in some municipal extraction wells is insufficient because specific analytes are only sampled once every 4 years per DDW requirements. Increasing the frequency of groundwater quality sampling will generate current water quality information that can be used to detect degradation of groundwater quality from projects and management actions implemented to achieve the Basin's sustainability goals. SLVWD intends to increase the sampling frequency on the groundwater quality RMP wells for COCs identified in Section 2.2.5.4.

3.3.4.4 Streamflow Monitoring Improvements

As shown on Figure 3-4 there are currently no active surface water monitoring sites on Carbonera Creek within the Basin. As GDEs have been identified on Carbonera Creek within the Basin (Figure 2-30), streamflow monitoring should be established for potential correlation with nearby groundwater elevations. A new gage on Carbonera Creek will be installed within the first 5 years of GSP implementation.

3.3.5 Representative Monitoring Points

Representative Monitoring Points (RMPs) are a subset of the Basin's overall monitoring network where numeric values for SMCs, including minimum thresholds, measurable objectives, and interim milestones, are set. Per the GSP regulations, designation of an RMP must be supported by adequate evidence demonstrating that the site reflects general aquifer conditions in the area.

Groundwater levels may be used as a proxy for sustainability indicators if the following can be demonstrated:

1. Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.

2. Measurable objectives established for groundwater elevation include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

Table 3-1 lists the metrics for each of the Basin's applicable sustainability indicators. The SMC for depletion of interconnected surface water sustainability indicator were developed using groundwater levels as a proxy.

3.3.5.1 Chronic Lowering of Groundwater Level Representative Monitoring Points

The selection of RMPs used to evaluate compliance with chronic lowering of groundwater level SMC are based on considerations that they:

- Have a relatively long-term historical record
- Are representative of the aquifer in which they are screened
- Are preferably not an extraction well

Based on an evaluation of spatial well distributions, proximity to groundwater use (both municipal and private use), GDEs, available measured groundwater level data, and groundwater level trends, RMPs listed in Table 3-14 are selected as points for assessment of chronic lowering of groundwater sustainability indicator. These wells will be used for long-term monitoring and to compare against SMC established in this GSP. The rationale for selecting each RMP is provided in Table 3-14 and ~~the~~ well locations are shown on Figure 3-7.

Some or all 9 of the additional monitoring wells being installed in 2022 will be added to the RMP network once several years of data are collected. It is anticipated that the 1st 5-year update to the GSP in 2027 will include analysis of the new monitoring well data and recommendations for inclusion as RMPs and associated SMC. Figure 3-7 includes the location of these potential RMPs in relation to current RMPs, GDEs, DACs, and private domestic wells to show how they fill monitoring data gaps.

Table 3-14. Representative Monitoring Points for Chronic Lowering of Groundwater Levels

Aquifer	Well Name	Screen Interval (feet below ground)	Rationale
Santa Margarita	SLVWD Quail MW-A	38 – 88	Upgradient of Quail Hollow municipal wells, 1,600 feet from Zayante Creek, in an area with private domestic wells. Also, a depletion of interconnected surface water RMP due to shallow screen interval and proximity to the creek.
	SLVWD Quail MW-B	95 – 195	24-year record that is representative of nearby pumping wells SLVWD Quail Hollow #4A and #5A; screen overlaps with Quail Hollow #4A and just above Quail Hollow #5A (Figure 3-8)
	SLVWD Olympia #3	230 – 300	No dedicated monitoring wells in this area so an extraction well is the only option; It is selected because is screened shallower than Olympia #2 and for a greater thickness of the aquifer
	SLVWD Pasatiempo MW-2	280 – 340	30-year record in an area with historical Santa Margarita aquifer pumping. Westernmost active Santa Margarita monitoring well south of Bean Creek.
	SVWD TW-18	285 – 345	Northernmost monitoring well screened in the Santa Margarita aquifer
	SVWD SV4-MW	50 – 60	Also, a depletion of interconnected surface water RMP due to shallow screen interval and proximity to the creek. Representative of AB303 MW 3B (Figure 3-9).
Monterey	SVWD #9	155 – 195, 315 – 365	Only well screened in Monterey Formation with a long-term record that has a deep enough screened interval that has not gone dry
Lompico	SLVWD Pasatiempo MW-1	600 – 660	Representative of aquifer from which nearby extraction wells pump: Mount Hermon #2 and #3, and SLVWD Pasatiempo #5A, #7 and #8 (Figure 3-10).
	SVWD #10	190 – 220	Representative of AB303 MW-2 and AB303 MW-3A (Figure 3-11).
	SVWD #11A	399 – 419, 459 – 469, 495 – 515	No dedicated monitoring wells in this area so an extraction well is the only option; representative of SVWD #11B screened similarly (Figure 3-12).
	SVWD TW-19	960 – 1,050	Northernmost Lompico monitoring well
Lompico/ Butano	SVWD #15 Monitoring Well	700 – 1,100	Possibly convert to Butano only monitoring well. On the same site as pumping well SVWD #3B and therefore influenced by pumping
Butano	SVWD Stonewood Well	799 – 859	Northernmost Butano aquifer monitoring well in an area with private domestic pumping
	SVWD Canham Well	1,281 – 1,381	Closest Butano monitoring well to SVWD pumping in the Butano aquifer

Well names in italics are active extraction wells

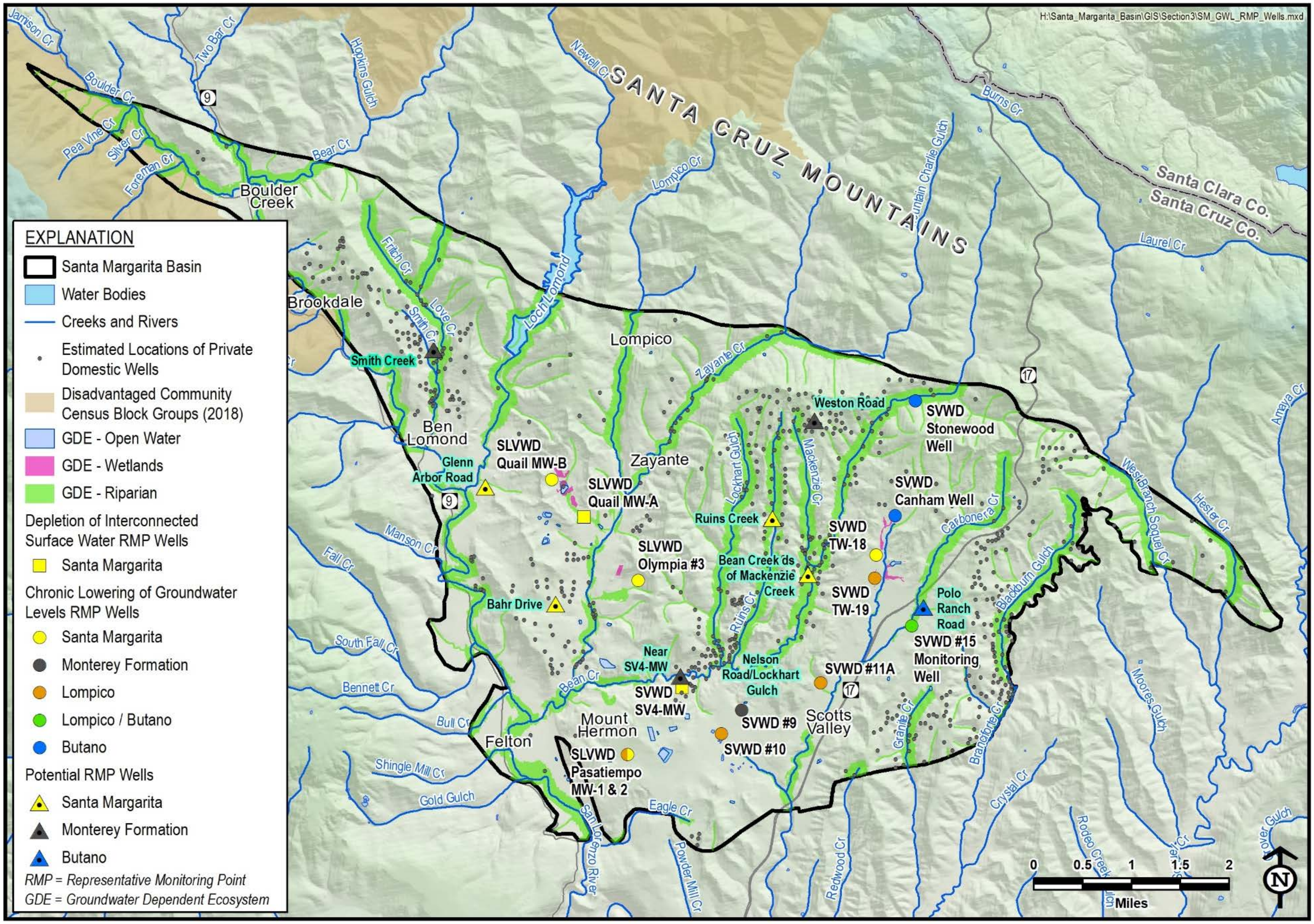
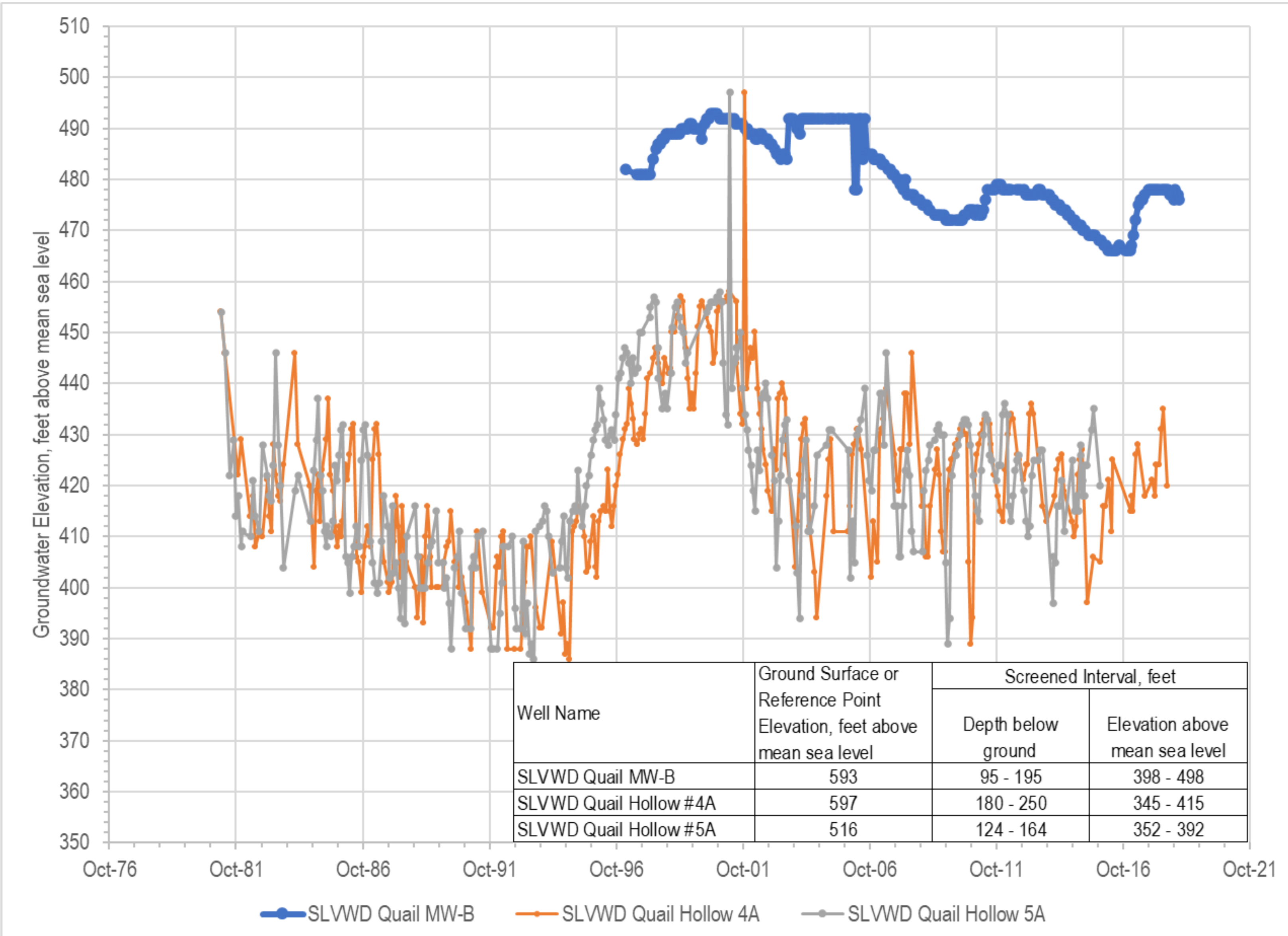
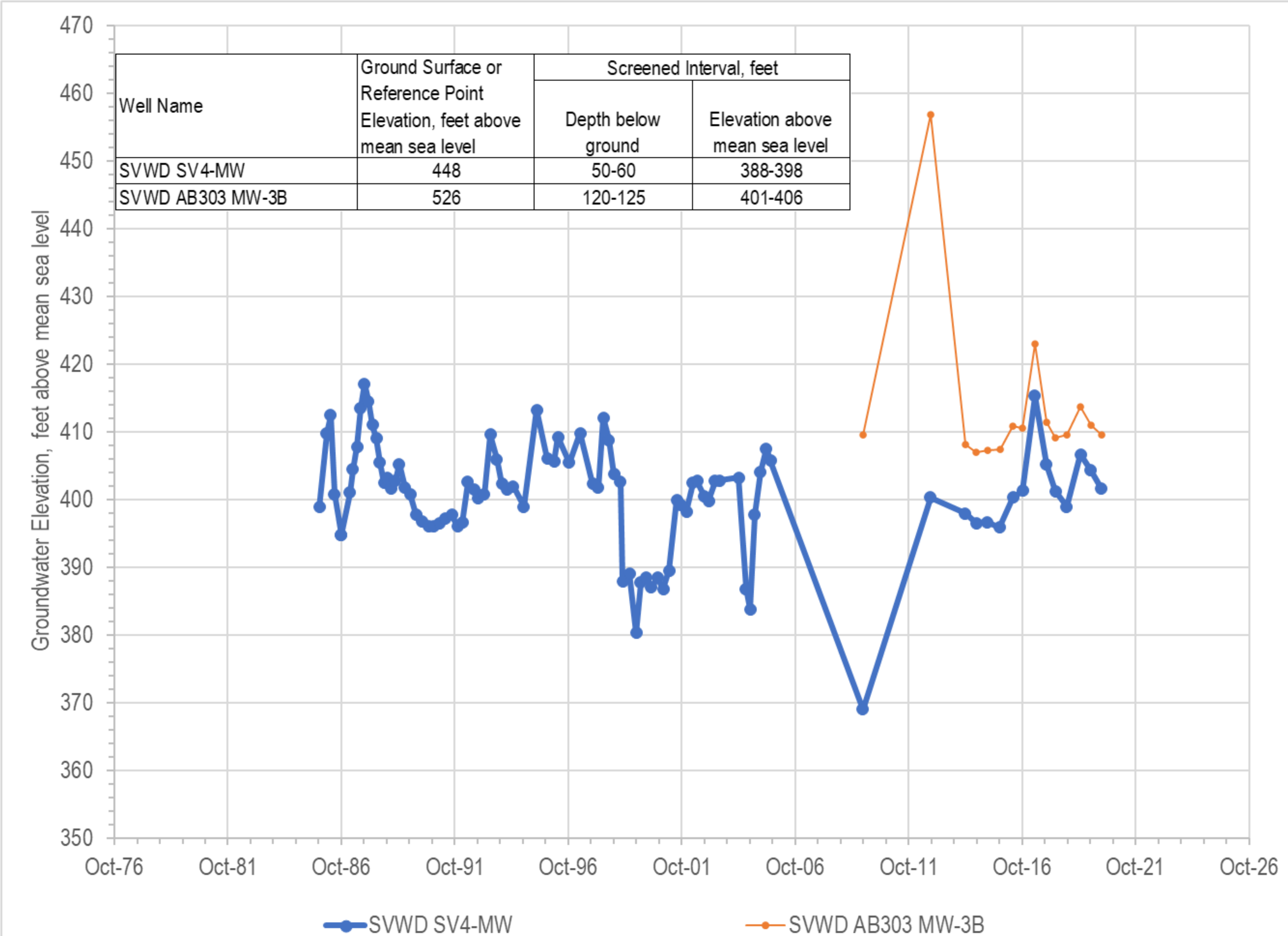


Figure 3-7. Representative Monitoring Points for Groundwater Levels



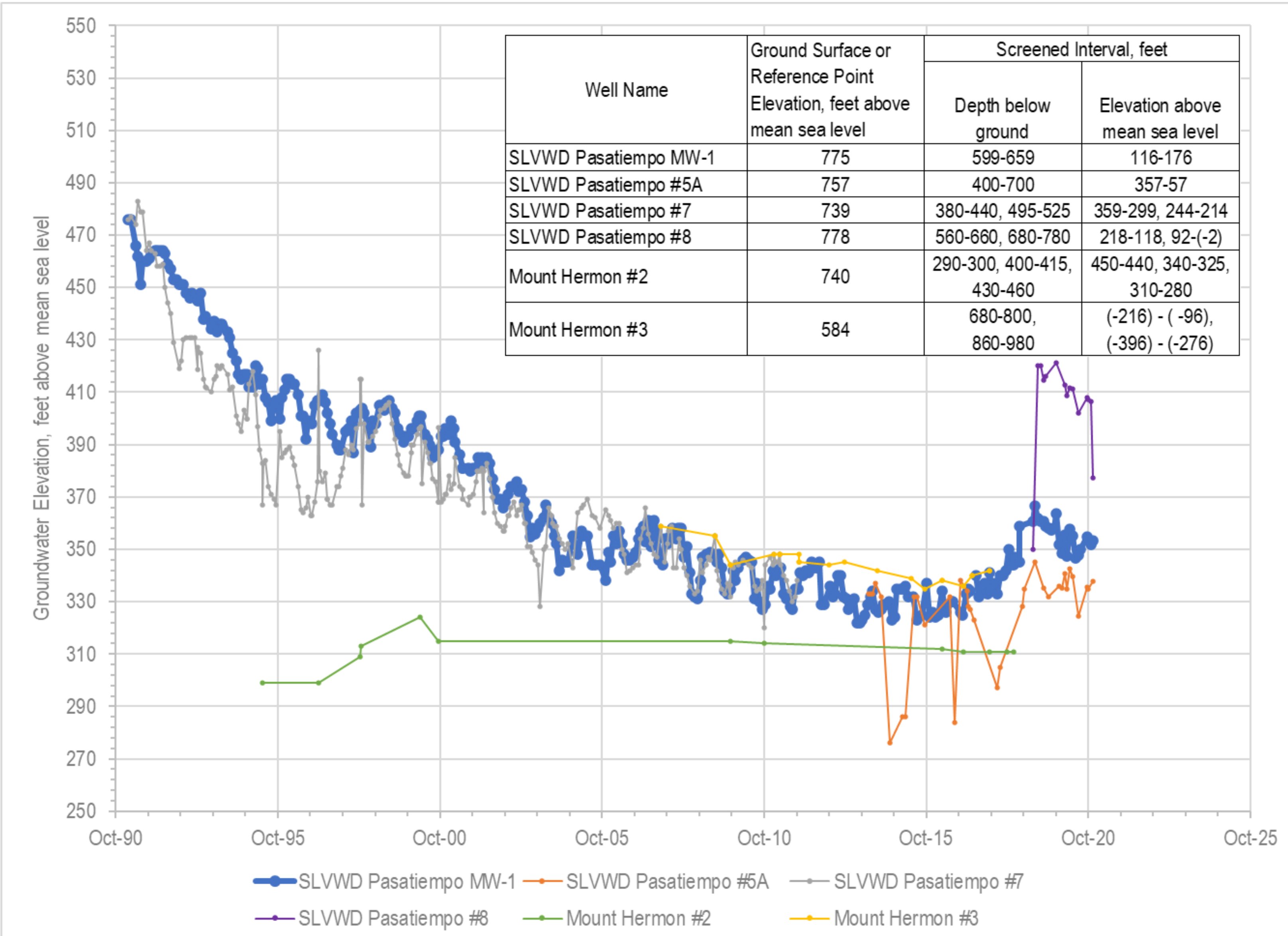
Well Name	Ground Surface or Reference Point Elevation, feet above mean sea level	Screened Interval, feet	
		Depth below ground	Elevation above mean sea level
SLVWD Quail MW-B	593	95 - 195	398 - 498
SLVWD Quail Hollow #4A	597	180 - 250	345 - 415
SLVWD Quail Hollow #5A	516	124 - 164	352 - 392

Figure 3-8. Hydrographs Showing Groundwater Elevations in Nearby Wells Relative to Representative Monitoring Point SLVWD Quail MW-B



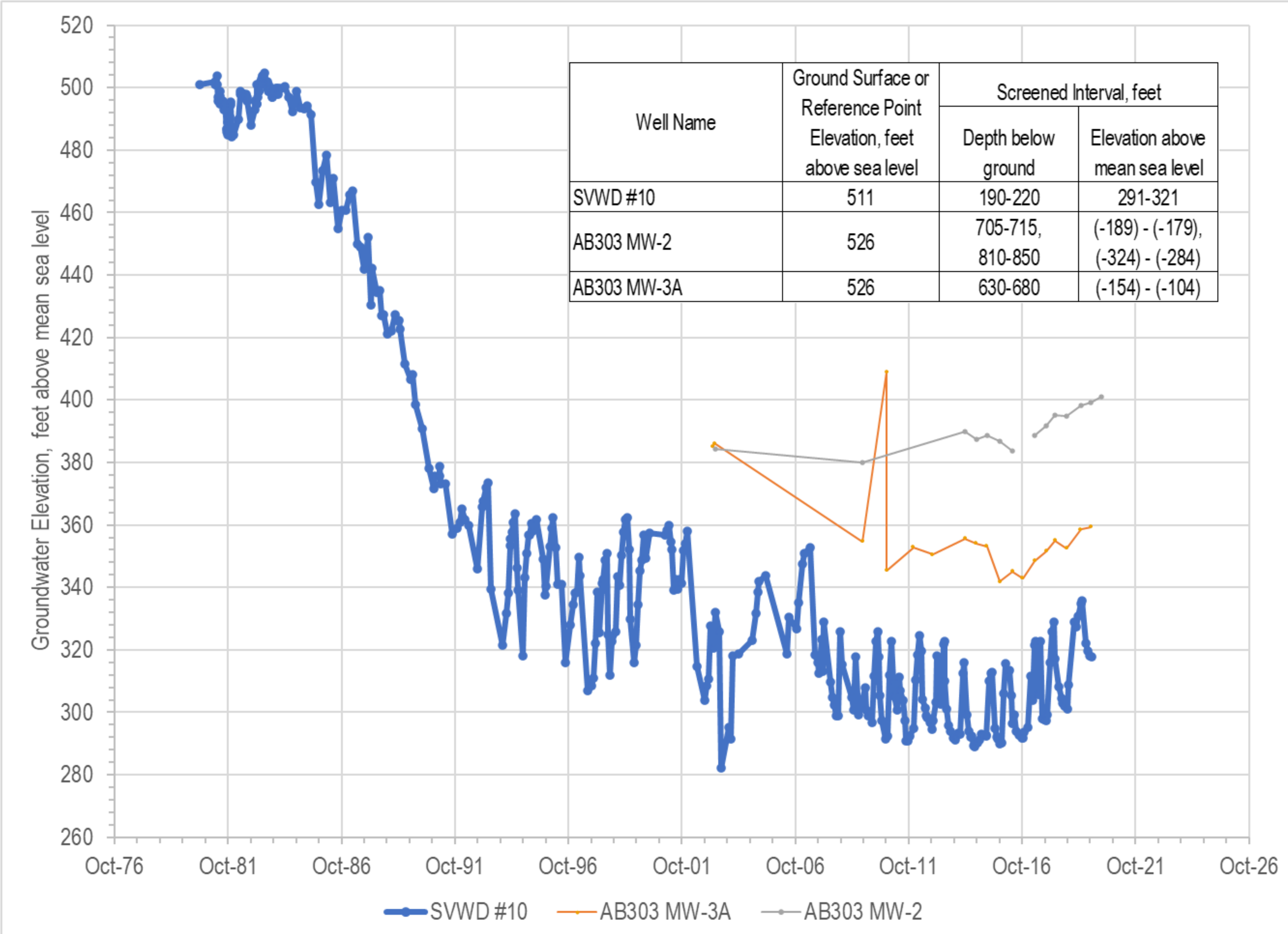
Well Name	Ground Surface or Reference Point Elevation, feet above mean sea level	Screened Interval, feet	
		Depth below ground	Elevation above mean sea level
SVWD SV4-MW	448	50-60	388-398
SVWD AB303 MW-3B	526	120-125	401-406

Figure 3-9. Hydrographs Showing Groundwater Elevation in Nearby Well Relative to Representative Monitoring Point SVWD SV4-MW



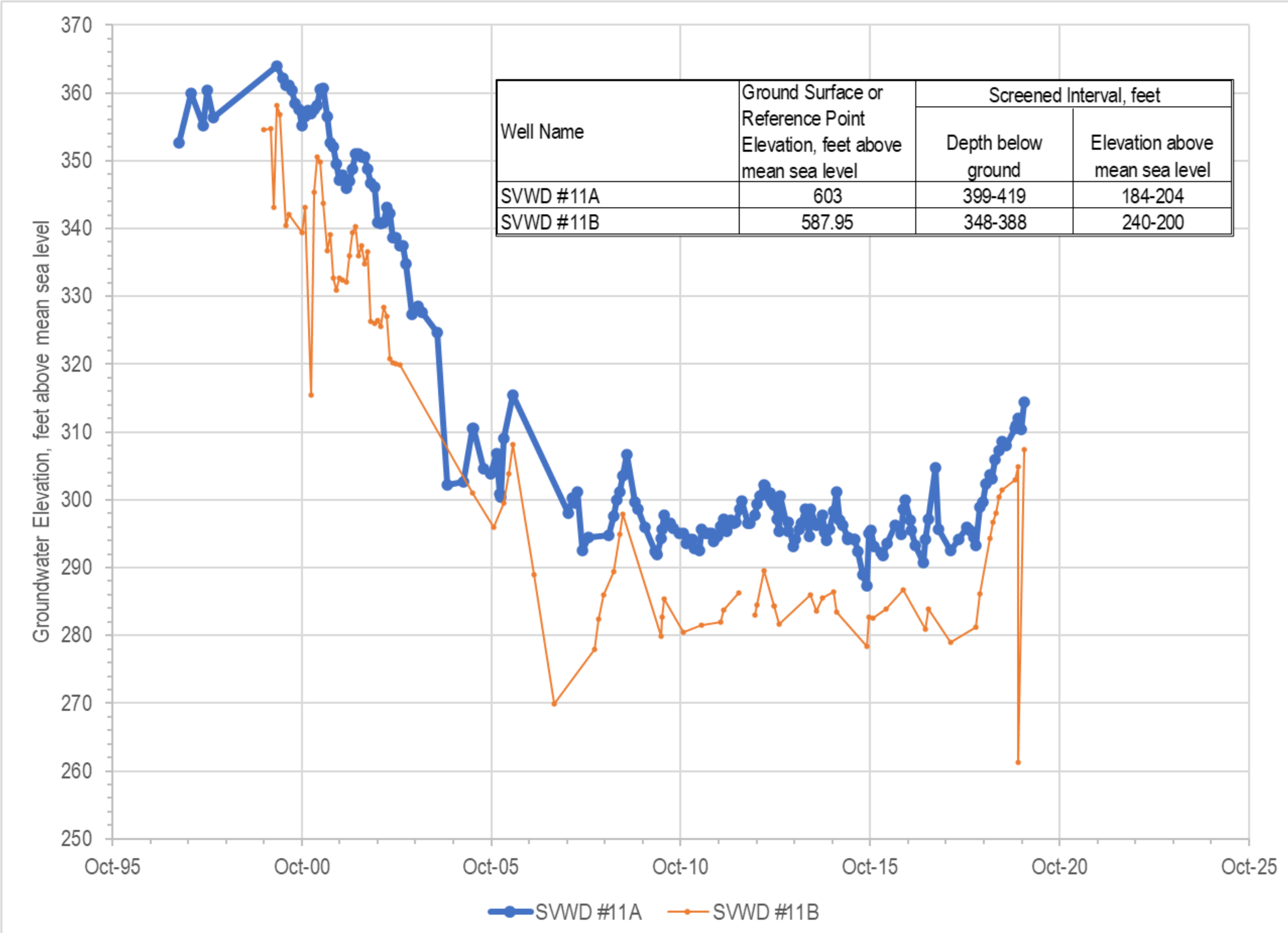
Well Name	Ground Surface or Reference Point Elevation, feet above mean sea level	Screened Interval, feet	
		Depth below ground	Elevation above mean sea level
SLVWD Pasatiempo MW-1	775	599-659	116-176
SLVWD Pasatiempo #5A	757	400-700	357-57
SLVWD Pasatiempo #7	739	380-440, 495-525	359-299, 244-214
SLVWD Pasatiempo #8	778	560-660, 680-780	218-118, 92-(-2)
Mount Hermon #2	740	290-300, 400-415, 430-460	450-440, 340-325, 310-280
Mount Hermon #3	584	680-800, 860-980	(-216) - (-96), (-396) - (-276)

Figure 3-10. Hydrographs Showing Groundwater Elevations in Nearby Wells Relative to Representative Monitoring Point SLVWD Pasatiempo MW-1



Well Name	Ground Surface or Reference Point Elevation, feet above sea level	Screened Interval, feet	
		Depth below ground	Elevation above mean sea level
SVWD #10	511	190-220	291-321
AB303 MW-2	526	705-715, 810-850	(-189) - (-179), (-324) - (-284)
AB303 MW-3A	526	630-680	(-154) - (-104)

Figure 3-11. Hydrographs Showing Nearby Groundwater Elevations in Nearby Wells Relative to Representative Monitoring Point SVWD #10



Well Name	Ground Surface or Reference Point Elevation, feet above mean sea level	Screened Interval, feet	
		Depth below ground	Elevation above mean sea level
SVWD #11A	603	399-419	184-204
SVWD #11B	587.95	348-388	240-200

Figure 3-12. Hydrographs Showing Groundwater Elevation in Nearby Well Relative to Representative Monitoring Point SVWD #11A

3.3.5.2 Reduction of Groundwater in Storage Representative Monitoring Points

The RMPs for reduction in groundwater storage consist of all municipal and private extraction wells where groundwater extraction is measured or estimated. These include metered public water supply and SWS wells and unmetered private uses such as domestic, quarry operations, pond filling, and landscape irrigation. The metered RMP wells for reduction in groundwater storage are summarized in Table 3-4 and shown on Figure 3-2.

3.3.5.3 Degraded Groundwater Quality Representative Monitoring Points

The RMPs used to evaluate groundwater quality compared to degraded groundwater quality SMC are based on the criteria that they are:

- Regularly sampled at least annually
- Representative of the aquifer in which they are screened
- Located in areas where GSP related projects and management actions are likely to influence groundwater conditions

The above criteria were used to narrow the water quality RMPs to the active municipal extraction wells listed in Table 3-15 and shown on Figure 3-13.

Table 3-15. Representative Monitoring Points for Degraded Groundwater Quality

Aquifer	Well Name	Screen Interval (feet below ground)
Santa Margarita	SLVWD Quail Hollow #5A	124-164
	SLVWD Olympia #3	230-300
Monterey	SVWD #9	155-195, 315-355
Lompico	SLVWD Pasatiempo #7	380-440, 495-525
	SVWD #10A	280-380, 400-450
	SVWD #11A	399-419, 459-469, 495-515
	SVWD #11B	348-388, 423-468, 500-515
Lompico/Butano	SVWD #3B	700-720, 880-1,050, 1,180-1,370, 1,400-1,670
	SVWD Orchard Well	705-784, 805-1,063, 1,084-1,455

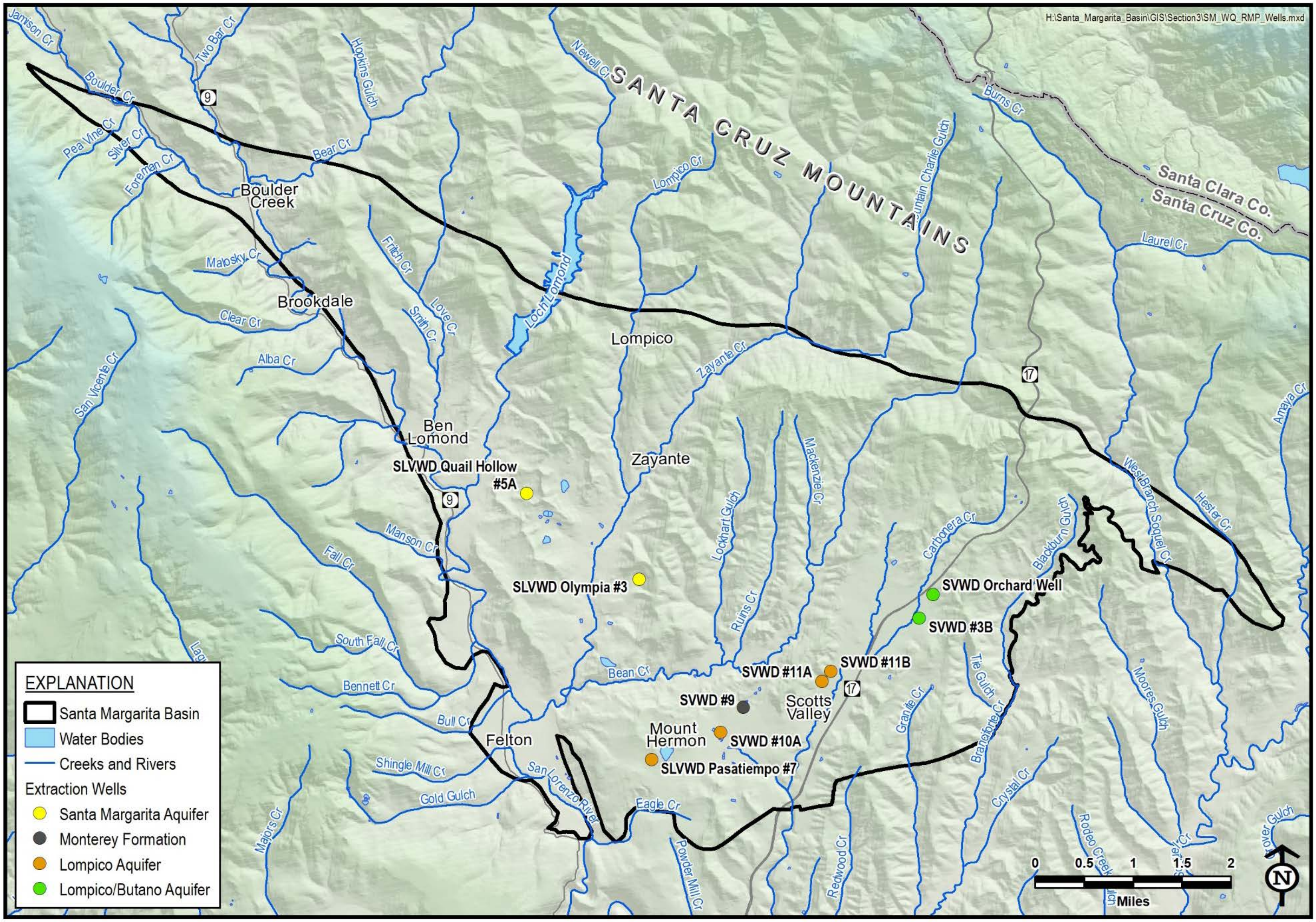


Figure 3-13. Representative Monitoring Points for Groundwater Quality

SLVWD is required to sample their extraction wells less frequent than annually for some COCs (Table 3-6); therefore, a single RMP for each of the 3 clusters of extraction wells in the Quail Hollow, Olympia, and Pasatiempo areas was selected for future increased sampling frequency on an annual basis for the COCs listed in the GSP. SLVWD extraction well water quality RMPs are Quail Hollow #5A, Olympia #3, and Pasatiempo #7. These specific wells are representative of aquifer conditions in nearby extraction wells as they are screened in the same aquifer and show similar groundwater quality trends. The wells selected either had the highest concentration in the well cluster of the COCs identified in Section 2.2.5.4, or if data were similar, had the longest sampling record in the well cluster.

3.3.5.4 Depletion of Interconnected Surface Water Monitoring Representative Monitoring Points

Direct streamflow measurements cannot be used because depletion of surface water by groundwater pumping is a fraction of the other factors influencing streamflow, such as precipitation and runoff, evapotranspiration, diversions, and natural groundwater / surface water interactions creeks. The GSP regulations allow for the use of groundwater elevations as a proxy for assessing the volume or rate of surface water depletion SMC. To use groundwater elevation as a proxy, there must be significant correlation between groundwater elevations and depletion of surface water. This correlation is demonstrated in Section 3.7.2.1.

The only existing shallow monitoring wells in the Basin that can be used for depletion of interconnected surface water RMPs are SLVWD Quail MW-A and SVWD SV4 MW (Figure 3-7). Historically, groundwater levels are measured monthly at SLVWD Quail MW-A and semi-annually at SVWD SV4-MW. SVWD SV4-MW was recently equipped with a datalogger, and SLVWD Quail MW-A will be equipped with a datalogger as part of Proposition 68 grant funds received by the SMGWA. The dataloggers will measure groundwater levels continuously. As a result, SMGWA will have a record of daily groundwater level in these wells.

Two shallow monitoring wells are not enough locations to represent the Basin’s major creeks where there is interconnected surface water and groundwater pumping. Additional shallow monitoring wells are needed to monitor and evaluate the effects of groundwater levels on streamflow where it is connected to surface water. The additional monitoring wells are described in more detail in Section 3.3.4.4

3.4 Chronic Lowering of Groundwater Levels Sustainable Management Criteria

Groundwater levels in the Basin fluctuate seasonally and over the long-term. Groundwater level change in the unconfined Santa Margarita aquifer is driven mainly by variations in precipitation, as the aquifer drains quickly during extended dry periods, but is able to fill up during a wet year. The principal confined aquifers in the Basin also respond to changes in climate, but the response is muted in comparison to the unconfined Santa Margarita aquifer.

The primary groundwater condition in the Basin that is considered unsustainable to beneficial users is lowered groundwater levels in 2 of the Basin's principal aquifers, the Lompico and Santa Margarita aquifers in the Mount Hermon / South Scotts Valley area. There is a portion of this area where the entire depth of the Santa Margarita aquifer is dewatered due to groundwater level declines of 30 to 40 feet and where there has been a 150- to 200-foot decline in groundwater levels in the Lompico aquifer. Groundwater levels in both Santa Margarita and Lompico aquifers in the Mount Hermon / South Scotts Valley area started to decline as early as the 1970s when the area underwent extensive development. The groundwater level declines were exacerbated by a 10-year drought starting in 1984. During this drought, the Scotts Valley area experienced an average rainfall deficit of 8.6 inches relative to the long-term average annual rainfall of 41.7 inches. Coinciding with climate-driven reduced natural aquifer recharge, water demand in the Basin peaked further exacerbating groundwater conditions.

Groundwater levels in the Mount Hermon / South Scotts Valley area have stabilized over the past 10 years and even experienced a small amount of recovery due to water use efficiency measures and recycled water use to offset potable demand from the aquifers. The sustainability goal strives to improve groundwater levels in this portion of the Basin and the sustainable management criteria reflect that.

3.4.1 Significant and Unreasonable Chronic Lowering of Groundwater Levels

Significant and unreasonable chronic lowering of groundwater levels occurs if lowered levels materially impair groundwater supply, negatively impact beneficial uses, or cause undue financial burden to a significant number of beneficial users.

In this context, undue financial burden means a cost or financial impact resulting from an action or inaction of the SMGWA or groundwater users in the Basin, that is unwarranted, inappropriate, or excessive and/or rising to a level that is more than necessary, acceptable, or reasonable.

3.4.2 Undesirable Results - Chronic Lowering of Groundwater Levels

3.4.2.1 Criteria for Defining Chronic Lowering of Groundwater Levels Undesirable Results

The description of undesirable results from chronic lowering of groundwater levels is based on a quantitative description of a combination of minimum threshold exceedances that cause significant and unreasonable effects in the Basin.

Criteria considered in developing undesirable results included:

- Knowledge of impacts to groundwater beneficial users during periods when groundwater levels were lowest in the Basin
- How the Basin's aquifers respond to climatic changes
- Some level of flexibility for avoiding undesirable results that gives the SMGWA and its member agencies an opportunity to implement management actions if there are short-term declines in groundwater levels.

When Santa Margarita and Lompico aquifer groundwater levels declined in the Mount Hermon/South Scotts Valley subareas from 1985 through 1994 due to a combination of a 10-year extended drought and increased groundwater use in the area, there were known impacts to human groundwater beneficial users. In the early 1990s, municipal water supply wells screened in the dewatered Santa Margarita aquifer were replaced with wells screened deeper in the Lompico aquifer. Since the South Scotts Valley is supplied municipal water, there were no significant impacts to individual domestic users of groundwater in this portion of the Basin. Chronically lowered groundwater levels have not occurred in any other areas of the Basin.

The County has records that many shallow private wells less than 100 feet in depth outside of the Scotts Valley area were deepened or replaced in response to declining groundwater levels towards the end of the Water Year (WY) 1987-1994 drought. Since that extended drought there have not been many wells deepened or replaced with deeper wells, including during the WY2012-2015 drought.

Lowering of groundwater levels in the Santa Margarita aquifer in years of drought, although not ideal, are not considered significant and unreasonable if levels can recover (either naturally, by managed recharge, or by reducing pumping). It is anticipated that climate change will cause wetter wet years and drier dry years. Multiple consecutive dry years may lead to groundwater levels falling below historical measured lows (i.e., minimum thresholds). Groundwater model simulations under projected climate conditions demonstrate the effects of climate extremes on groundwater levels, including that during wet years, the Santa Margarita aquifer fills up relatively quickly because of its high recharge rate.

The Basin's confined aquifers, Lompico and Butano, together with the Monterey Formation, do not respond as rapidly to changing climatic conditions as the Santa Margarita aquifer.

3.4.2.2 Numerical Description of Undesirable Results

Specific groundwater level conditions that constitute undesirable results for chronic lowering of groundwater levels occur if the groundwater elevation in any RMP falls below the minimum threshold in 2 or more consecutive non-drought years. If a RMP groundwater elevation below its minimum threshold is caused by emergency operational issues or extended droughts, it is not considered an undesirable result.

Per DWR's draft Sustainable Management Criteria Best Management Practices (DWR, 2017), chronic lowering of groundwater levels due to prolonged drought will not be considered undesirable results:

> "Undesirable results are one or more of the following effects: Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods".

3.4.2.3 Potential Causes of Undesirable Results

Undesirable results may be caused by unsustainable groundwater use that results in chronic lowering of groundwater levels. Temporary lowering of groundwater levels during extended drought are exempted from this. Undesirable results may occur under the following conditions:

Changes to Basin Pumping. If the location and rates of groundwater pumping change as a result of new high-capacity wells, or projects and management actions implemented to improve sustainability and water supply reliability, these changes could result in localized lowering of groundwater levels and changes in groundwater flow directions. Total Basin extraction more than the sustainable yield is another potential cause of undesirable results for groundwater levels. Total extractions include those for municipal, small water systems, industrial, private domestic and landscaping, and agricultural uses.

Groundwater Recharge. Capture and transfer of stormwater runoff as part of a project that relies on stormwater to recharge groundwater may potentially result in localized lowered groundwater levels due to loss of recharge.

Surface Water Diversions. Diversion of surface water may result in reduced recharge to groundwater in the upper reaches of the Basin's creeks where losing creek conditions occur.

Most creeks in the Basin are currently gaining year-round and surface water diversions are currently small, making this a highly unlikely cause of undesirable results if current groundwater conditions and management practices continue.

3.4.2.4 Effects on Beneficial Users and Land Use

Currently, there are no undesirable results to human beneficial users occurring due to chronic lowering of groundwater levels. As described earlier, deeper wells replaced impacted shallow wells in the 1990's. Those municipal, industrial, agricultural, and domestic users of groundwater have adjusted to the lowered groundwater levels during pre-2012 droughts. Impacts of historical chronic lowering of groundwater levels on environmental groundwater users, such as GDEs and aquatic species is less understood.

If undesirable results from chronic lowering of groundwater levels occur in the future, it will impact beneficial users of groundwater as described in the bullets below. Lowering of groundwater levels will reduce the thickness of saturated aquifer from which wells can pump and may prevent a significant number of water supply wells from pumping the amount of groundwater they have typical used to meet their water needs.

Undesirable results from chronic lowering of groundwater levels can have the following general impacts on beneficial users and land uses:

- **Urban land uses and users**. If groundwater levels fall below municipal supply well pumps, the pump can only be lowered to the point where it reaches the bottom of the well, and then a deeper replacement well needs to be drilled. Lowering the pump or drilling a deeper well in the same location is not a solution as the levels will only continue to drop. Another solution is to move pumping to an unimpacted part of the Basin to meet demands. It is possible that changing extraction to a different groundwater supply source may add stress to those unimpacted parts of the Basin groundwater. Other effects on municipal users from lowered groundwater levels is the increased pumping costs due to greater lift required to bring the water to the surface.

  Lowered groundwater levels in both Santa Margarita and Lompico aquifers result in reduced contributions to streamflow and can impact the City of Santa Cruz, a downstream surface water user, especially in light of their efforts to support enhanced streamflow to protect and restore runs of endangered coho salmon and threatened steelhead trout. One result of the City's commitments to providing instream flows for fisheries is that it is working to develop a supplemental water supply to replace supply dedicated to fisheries. Continued loss of baseflows due to lowered groundwater levels in the Santa Margarita and Lompico aquifers incurs significant costs, borne by the City because it increases the amount of supplemental supply that the City needs to develop so that adequate flows are left in the river to comply with the provisions of the City's Habitat Conservation Plan.

- **Rural residential land uses and users**. Typically, rural residential users have the shallowest wells which makes them more vulnerable to lowered groundwater levels. If groundwater levels decline below the top of well screens or below pump intakes, landowners may lose access to groundwater and be forced to lower their pumps or drill their well deeper. Additionally, when groundwater levels fall below the top of well screens, this has the potential to cause cascading water in the well. Cascading or falling water is water flowing through preferential pathways above the groundwater table that falls into the well. As it pours into the well it introduces air into the water being pumped thereby causing pump cavitation. This condition may increase the cost to pump, cause physical damage to the well and pump, and potentially degrade groundwater quality within the well due to microbial biofouling. Property values may decline if low groundwater levels cause undesirable results that require residential pumping restrictions, deepening of wells, or connection to a public water system. Some small water systems rely on springs and lowered groundwater levels may dry the springs out.
- **Industrial land uses and users**. Industrial use of groundwater in the Basin is limited to process and dust suppression water at 1 remaining sand quarry at Quail Hollow. Chronic lowering of groundwater elevations has the potential to increase pumping costs or reduce access to groundwater for similar reasons listed above for rural residential users.
- **Agricultural land uses and users**. For the very limited agriculture in the Basin, chronic lowering of groundwater elevations has the potential to increase irrigation costs or reduce access to groundwater for similar reasons listed above for rural residential users.
- **Ecological land uses and users**. GDEs have the potential to be impacted directly if groundwater depths decrease below the accessible level for GDE vegetation. Surface water bodies connected to groundwater may also incur reductions in baseflow caused by lowering of groundwater levels. Reduced baseflow may negatively impact portions of the lifecycle of aquatic species. Potential impacts to GDEs and priority species from decreased groundwater levels and interconnected surface water are further described in Section 3.7.2.5.

3.4.3 Minimum Thresholds - Chronic Lowering of Groundwater Levels

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."

3.4.3.1 Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives

The minimum thresholds and measurable objectives were established based on historical groundwater elevation data collected at RMP wells and projected groundwater levels during the GSP planning and implementation horizon. Appendix 3A includes hydrographs with historical measured and projected groundwater elevations for all RMP wells.

Board discussion on whether historical chronic lowering of groundwater levels during the recent or prior droughts had resulted in diminished supply in the past lead to general agreement that municipal, industrial, agricultural, and domestic users of groundwater adjusted to the lowered groundwater levels during past droughts. However, the SMGWA Board expressed that they did not want groundwater levels to fall below historical low levels as this would cause undue financial burden to some beneficial groundwater users.

3.4.3.2 Chronic Lowering of Groundwater Level Minimum Thresholds

As the SMGWA Board direction on chronic lowering of groundwater levels was that levels should not be allowed to fall below historical low levels, minimum groundwater elevations on record were considered to represent the minimum threshold. The absolute minimum elevation was not used for minimum thresholds because for some RMPs that value appeared anomalous. To treat each well's data consistently without the need to discard seemingly anomalous data, an average of the 5 lowest measured elevations are used to calculate a minimum elevation to use as a minimum threshold. Using this methodology, minimum thresholds for chronic lowering of groundwater levels are the average of the 5 lowest measured groundwater elevations at each RMP.

Minimum thresholds for each RMP are summarized in Table 3-16. Hydrographs showing minimum thresholds and measurable objectives for each RMP are included in Appendix 3A. Examples from a RMP in the Santa Margarita aquifer and a RMP Lompico aquifer are shown on Figure 3-14 and Figure 3-15, respectively.

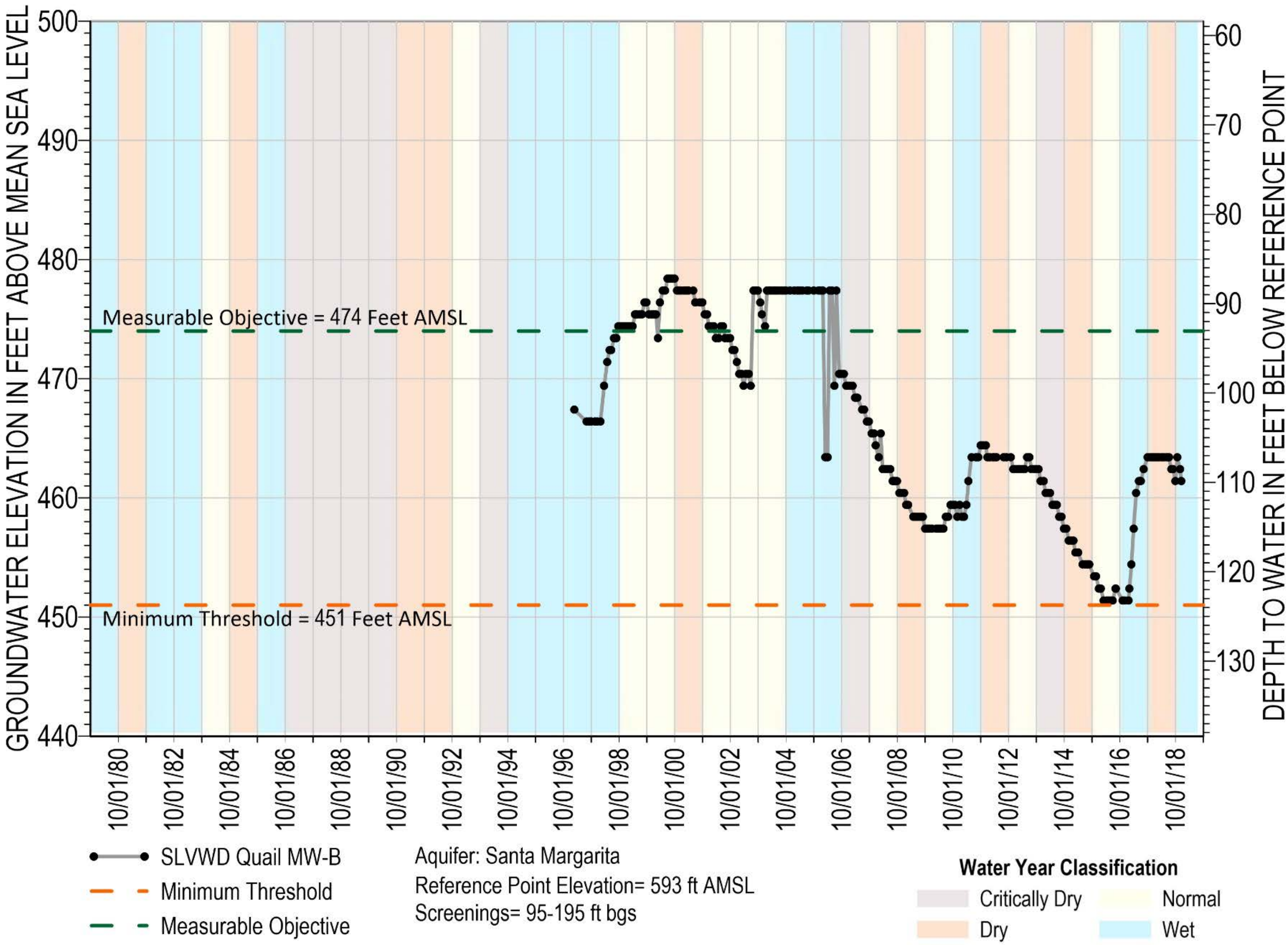


Figure 3-14: Hydrograph for SLVWD Quail MW-B in the Santa Margarita Aquifer Showing Minimum Threshold and Measurable Objective Relative to Measured Groundwater Elevations

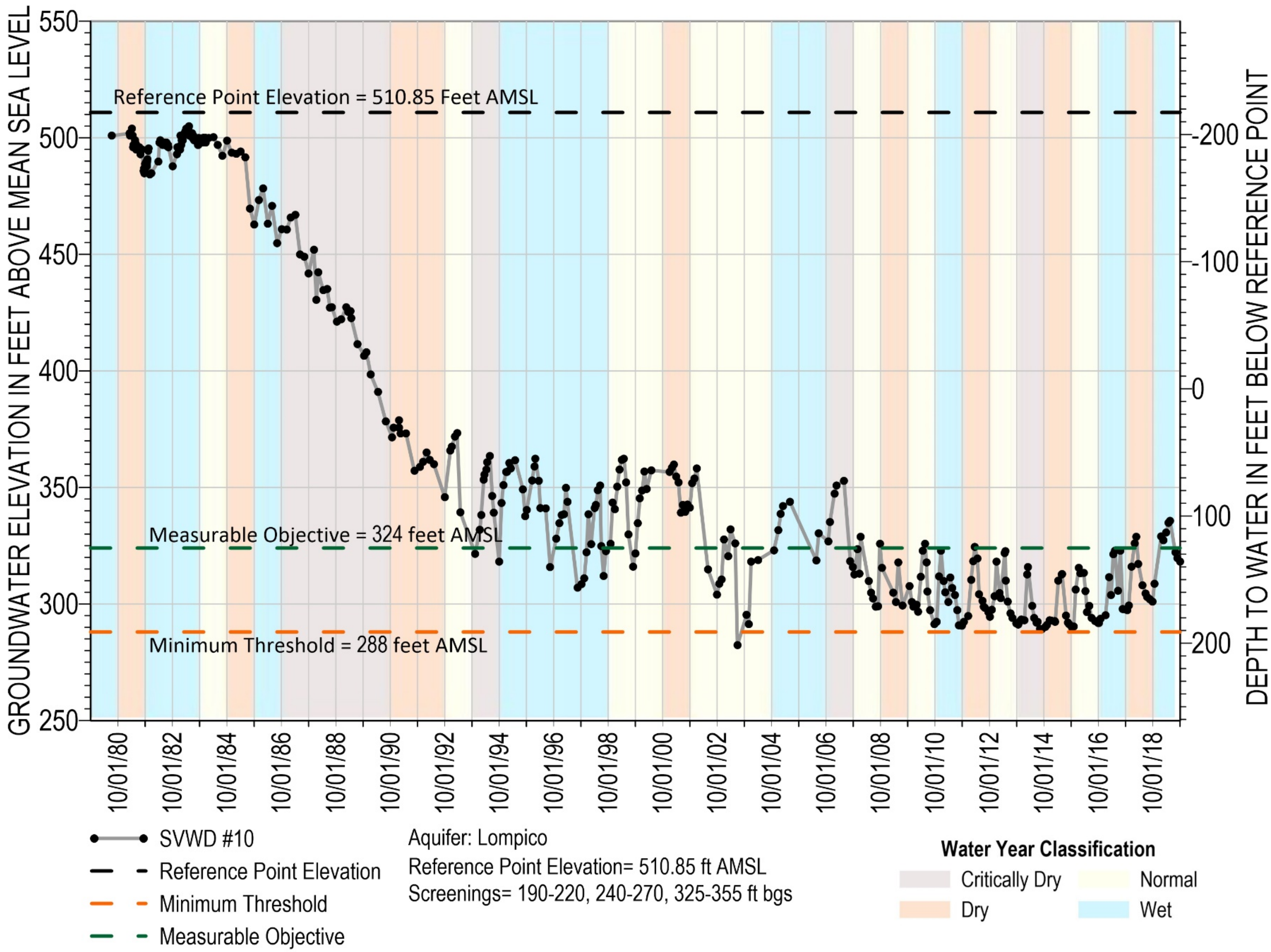


Figure 3-15: Hydrograph for SVWD Well #10 in the Lompico Aquifer Showing Minimum Threshold and Measurable Objective Relative to Measured Groundwater Elevations

Table 3-16. Minimum Thresholds, Measurable Objectives, and Interim Milestones for Chronic Lowering of Groundwater Levels

Aquifer	Well Name	Groundwater Elevation (feet above mean sea level)				
		Minimum Threshold	Interim Milestone #1 (2027)	Interim Milestone #2 (2032)	Interim Milestone #3 (2037)	Measurable Objective
Santa Margarita	SLVWD Quail MW-B	451	474	474	474	474
	SLVWD Olympia #3	304	309	309	309	309
	SLVWD Pasatiempo MW-2	500	516	516	516	516
	SVWD TW-18	462	471	471	471	471
Monterey	SVWD #9	303	342	353	356	360
Lompico	SLVWD Pasatiempo MW-1	336	341	355	359	374
	SVWD #10	288	304	316	318	324
	SVWD #11A	290	301	314	316	319
	SVWD TW-19	314	357	371	373	376
Lompico/Butano	SVWD #15 Monitoring Well	291	310	328	330	333
Butano	SVWD Stonewood Well	839	847	847	847	847
	SVWD Canham Well	427	447	461	463	466

3.4.3.3 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

Groundwater level minimum thresholds are unique to every RMP. As they are based on historical data, they represent actual achievable conditions that will not conflict other RMP minimum thresholds.

Minimum thresholds for chronic lowering of groundwater level are selected to avoid undesirable results for other sustainability indicators, as described below.

- **Reduction of groundwater in storage**. Minimum thresholds for chronic lowering of groundwater levels do not promote pumping more than the sustainable yield or cause long-term declines of groundwater in storage because they are not lower than historical groundwater elevations. Therefore, minimum thresholds for the chronic lowering of groundwater levels sustainability indicator will not result in an exceedance of the reduction of groundwater in storage minimum threshold.

- **Degraded groundwater quality**. Declines in groundwater elevation may cause wells to draw from different aquifers or hydrogeologic subunits, potentially impacting groundwater quality. Because the minimum threshold is set at the average of 5 lowest historical groundwater elevations, groundwater elevations should not be lower than historical levels. Historical groundwater levels are not believed to have caused degradation of groundwater quality, and thus chronic lowering of groundwater level minimum thresholds should not result in exceedances of groundwater quality minimum thresholds.

- **Depletion of interconnected surface water**. Minimum thresholds 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 minimum thresholds will not result in a significant or unreasonable depletion of interconnected surface water.

- **Seawater intrusion**. Not applicable.

- **Subsidence**. Not applicable.

3.4.3.4 Effect of Minimum Thresholds on Neighboring Basins

The anticipated effect of minimum thresholds for the chronic lowering of groundwater level sustainability indicator on each of the neighboring basins is addressed below.

Santa Cruz Mid-County Basin (critically-overdrafted). There is a relatively impermeable basement high that separates the 2 basins and very limited areas where the Purisima Formation, the largest supply aquifer for Santa Cruz Mid-County Basin, is in direct contact with the principal aquifers of the Santa Margarita Basin. As a result, it is very unlikely that changes in groundwater levels due to projects and management actions in either basin could change hydraulic gradients near the shared basin boundary or affect groundwater level minimum thresholds in the neighboring basin.

Purisima Highlands Subbasin of the Corralitos Basin (very low priority). The Santa Margarita Basin is hydraulically downgradient from the Purisima Highlands Subbasin, but is separated from it by the Zayante-Vergeles fault zone, which acts as a barrier to groundwater flow. Hence, it is unlikely that groundwater elevations in the Santa Margarita Basin can have an influence on groundwater in the Purisima Highlands Subbasin.

West Santa Cruz Terrace Basin (very low priority). The boundary between the Santa Margarita Basin and West Santa Cruz Terrace Basin is located where Tertiary sedimentary rocks that are the principal aquifers in Santa Margarita Basin thin abruptly against basement rocks that are exposed at the surface or are at shallow depth in the subsurface. Groundwater pumping in West Santa Cruz Terrace Basin is mostly from private wells tapping low-yielding Quaternary alluvium and terrace deposits. These Quaternary deposits are not hydrologically connected to similar deposits scattered in small patches in Santa Margarita Basin. The lack of continuity in the Quaternary deposits and thinning of the Santa Margarita Basin aquifers makes it unlikely that groundwater elevations in the Santa Margarita Basin at minimum thresholds would cause chronic lowering of groundwater levels in the West Santa Cruz Terrace Basin.

3.4.3.5 Effects of Minimum Thresholds on Beneficial Users and Land Uses

Minimum thresholds for chronic lowering of groundwater levels are set at the average of the 5 lowest historical minimum elevations. Because historical levels have not appeared to cause significant and unreasonable conditions in the past, these levels should continue to support similar beneficial use in the future. The minimum thresholds generally benefit beneficial users and land uses in the Basin as outlined in the bullets below.

- **Urban land uses and users**[3]. Maintaining groundwater elevations at or above historical levels will benefit municipal groundwater pumpers by protecting their

[3] Urban land users include a small area of a DAC supplied water by SLVWD.

ability to pump groundwater from existing municipal wells to meet public water supply demands. The City of Santa Cruz as a user of Basin surface water and implementor of habitat conservation in the San Lorenzo River watershed relies on baseflows to help achieve the Agreed Flows described in Section 2.1.4.2.8. If groundwater levels in the Basin do not fall below historical lows, baseflows should remain within the historical range of flows used to determine the Agreed Flows.

- **Rural residential land uses and users**[4]. Maintaining groundwater elevations at or above historical levels that for the most part represent low levels during the 2012-2015 drought will benefit most domestic users of groundwater by protecting their ability to pump groundwater from ~~domestic~~ their wells. There were very few reports of dry wells during the 2012-2015 drought and so not allowing levels to fall below those historical low levels will protect a majority of private domestic wells. Although most existing domestic wells are deeper than the minimum thresholds, new wells drilled near the RMPs should not have their pumps set at an elevation shallower than the minimum threshold elevation. If groundwater levels fall below minimum thresholds in RMPs, private domestic wells near those RMPs shallower than 250 feet may be at risk of dewatered.
- **Industrial land uses and users**. Maintaining groundwater elevations at or above historical levels should benefit industrial land uses and beneficial users by protecting their ability to pump groundwater from industrial wells.
- **Agricultural land uses and users**. For the very limited agriculture in the Basin, maintaining groundwater elevations at or above historical levels will benefit agricultural users and land use by protecting their ability to pump groundwater from irrigation wells.
- **Ecological land uses and users**. Maintaining groundwater elevations at or above historical levels will maintain the very connected nature of groundwater and surface water in the Basin. This will protect GDE habitat used by priority species, and generally benefit ecological land uses and users.

3.4.3.6 Relevant Federal, State, or Local Standards

No federal, state, or currently enforced local standards exist for chronic lowering of groundwater elevations.

[4] Rural land users include an estimated less than 10 DAC residents who depend on private wells for domestic use.

3.4.3.7 Method for Quantitative Measurement of Minimum Thresholds

Depth to groundwater will be directly measured at the RMPs identified in Section 3.3.5.1 for comparison to minimum thresholds. The groundwater level data will be collected in accordance with the monitoring protocols outlined in Section 3.3.2.1 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. During GSP implementation, individual groundwater level measurements collected manually and by data loggers will be reviewed for quality control and analyzed for minimum threshold exceedances during compilation of GSP annual and 5-year update reports.

3.4.4 Measurable Objectives - Chronic Lowering of Groundwater Levels

3.4.4.1 Measurable Objectives

Measurable objectives are set for each RMPs at groundwater elevations that reflect where the SMGWA would like groundwater elevations to be in 20 years while taking into account realistic project implementation and allowing for operational flexibility. To be consistent with minimum thresholds that are mostly based on annual minimum groundwater elevations, measurable objectives are also based on annual minimum groundwater elevations. Hydrographs showing measurable objectives for a Santa Margarita aquifer monitoring well and Lompico aquifer monitoring well are shown on Figure 3-14 and Figure 3-15, respectively. Hydrographs for each RMP are included in Appendix 3A.

Measurable objectives are defined as follows:

- The measurable objectives for the Santa Margarita aquifer RMPs are the annual minimum groundwater levels in each well in WY2004.
- RMPs located in the Monterey Formation and the Lompico and Butano aquifers are the average annual minimum groundwater elevation measured from 2016 to 2020 plus the projected groundwater elevation increase in annual minimum groundwater elevations simulated to result from implementing a 540 AFY conjunctive use project in the Mount Hermon / South Scotts Valley area.

Measurable objectives are defined differently in the Santa Margarita aquifer than in the underlying aquifers because of the rapid response of its groundwater levels to changes in precipitation. Absent current undesirable results, with no significant projected improvement in levels from potential projects that target the Lompico aquifer (see Section 4), the measurable objectives are based on groundwater levels observed in a typical year. WY2004 was selected because WY2004 and the 5 prior years (4 normal and 1 dry water year) had an average of 41 inches of precipitation per year, which is similar to the average of 41.7 inches for the period 1947-2020 measured at the El Pueblo Yard in Scotts Valley. Hence, the measurable objective for each RMP in the Santa Margarita aquifer is defined as the annual minimum groundwater elevation measured in WY2004.

3.4.4.2 Interim Milestones

Interim milestones in the Santa Margarita aquifer RMPs are all set equivalent to the measurable objective for the aquifer being the annual minimum WY2004 groundwater elevation because projects and management actions are not predicted to increase groundwater elevations significantly.

Interim milestones for the confined aquifers are estimated using the expected benefit (positive change in groundwater elevations) from the conjunctive use simulations compared to the baseline. Expected benefits from 2022-2027, 2028-2032, and 2033-2037 are added the average annual minimum groundwater elevations from 2016-2020. Estimation of interim milestones for the confined aquifers are consistent with the definition of measurable objectives described above that reflects projected rise in groundwater elevations with the implementation of a 540 AFY conjunctive use project. All interim milestones are included in Table 3-16.

3.5 Reduction of Groundwater in Storage Sustainable Management Criteria

Since the 1980s, and even possibly starting in the 1960s, there has been a consistent loss of groundwater stored in the Basin primarily due to overpumping of the Lompico aquifer in the South Scotts Valley area. Individual annual increases of groundwater stored in the Basin correlate with either wet years or normal years if the normal year follows a dry year. Historical normal or drier water year types generally result in groundwater lost from storage. After WY2014, cumulative change in storage appears to level out but it is anticipated that below average rainfall from 2018 through 2021 will continue the trend of declining groundwater in storage.

3.5.1 Significant and Unreasonable Reduction of Groundwater in Storage

Based on SMGWA Board input, a significant and unreasonable reduction of groundwater in storage occurs when there is a long-term decline of groundwater in storage, or the volume of groundwater extracted causes undesirable results for any other sustainability indicator.

3.5.2 Undesirable Results - Reduction of Groundwater in Storage

3.5.2.1 Criteria for Defining Undesirable Results

The reduction in storage sustainability indicator is not measured by a change of groundwater in storage. Rather, per the GSP Regulations, the reduction of groundwater in storage sustainability indicator is measured by "a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results." (§354.28 (c)(2)). This definition intersects with the definition of sustainable yield described in Section 2.2.6.5. As described there, Basin-wide groundwater pumping within the sustainable yield does not constitute proof of sustainability. Sustainability under SGMA is only demonstrated by avoiding undesirable results for all sustainability indicators applicable to the Basin. Therefore, undesirable results for reduction of groundwater in storage is total pumping that causes undesirable results in any other indicator. These total pumping amounts for each aquifer representing undesirable results for the storage indicator are based on predictive model simulations that demonstrate undesirable results for applicable sustainability indicators are avoided.

3.5.2.2 Numerical Description of Undesirable Results

Undesirable results for reduction of groundwater in storage are defined numerically as groundwater extraction volumes that exceed the reduction in groundwater storage minimum thresholds in one or multiple principal aquifers~~groundwater extraction volumes that exceed extraction volumes in simulations that avoid undesirable results for applicable sustainability indicators. An undesirable result occurs when this exceedance occurs in one or multiple principal aquifers~~.

3.5.2.3 Potential Causes of Undesirable Results

Undesirable results for reduction of groundwater in storage may occur due to pumping more than the sustainable yield in one or more of the Basin's principal aquifers. Potentially, increased groundwater extraction may result from urban or agricultural land use expansion or a failure to implement projects and management actions that supplement native groundwater extraction such as conjunctive use or managed aquifer recharge projects. Reduction of groundwater in storage due to extended dry conditions is not considered undesirable if extractions and groundwater recharge are managed as necessary to ensure reductions during a period of drought are offset by increased groundwater levels or storage during other periods.

3.5.2.4 Effects on Beneficial Users and Land Use

Undesirable results of reduced groundwater in storage impacts beneficial users of groundwater by inducing undesirable results for one or more applicable sustainability indicators. Undesirable results can have the following general impacts on beneficial users and land uses:

- **Urban land uses and users**. Continual reduction of groundwater in storage leads to groundwater elevation decline which may reduce well efficiency, increase associated pumping costs, mechanical damage to the well by cavitation, falls below pump intakes or even the bottom of wells. Reduced groundwater in storage decreases contributions to streamflow which may impacts GDEs and surface water users, including the City of Santa Cruz which is a downstream user of surface water.

- **Rural residential land uses and users**. Groundwater elevation declines associated with reduction of groundwater in storage have the potential to reduce or eliminate rural residential access to groundwater. Problems associated with declining groundwater elevations below well screens include reduced pump efficiency, mechanical damage to the well (cavitation), and microbial growth. These problems have cost ramifications for the individual property owner who may need to drill their well deeper, and to the community at large which may see a decline in property value or require connecting to public water service.
- **Industrial land uses and users**. Industrial use of groundwater in the Basin is limited to process and dust suppression water at 1 remaining sand quarry at Quail Hollow. Groundwater elevation declines associated with reduction of groundwater in storage have the potential to increase pumping costs or reduce access to groundwater for similar reasons listed above for rural residential users.
- **Agricultural land uses and users**. Groundwater elevation declines associated with reduction of groundwater in storage have the potential to increase irrigation costs or reduce access to groundwater for similar reasons listed above for rural residential users.
- **Ecological land uses and users**. GDEs have the potential to be impacted directly if groundwater depths fall below the accessible level for GDE vegetation. Surface water bodies connected to groundwater may also incur reductions in baseflow caused by falling groundwater levels expressing reduced groundwater in storage. This may negatively impact portions of aquatic species lifecycles.

3.5.3 Minimum Thresholds - Reduction of Groundwater in Storage

The reduction of storage sustainability indicator is not measured by a change in groundwater in storage. Rather, per the GSP Regulations, the reduction in groundwater in storage sustainability indicator is measured by “a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results.” (§354.28 (c)(2)).

3.5.3.1 Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives

Minimum thresholds and measurable objectives for the reduction of groundwater in storage indicator are established using a simulation from the Basin Model that projects pumping and climate change through WY2072. Minimum thresholds are developed based on pumping in the baseline model simulation (no projects or management actions implemented), while measurable objectives are based on projected pumping that corresponds with implementing a 540 AFY conjunctive use project to reduce November through April pumping by SLVWD and SVWD in an effort to recover groundwater levels in the Mount Hermon / South Scotts Valley area. The conjunctive use project is described in Sections 4.3.1.2 and 4.3.1.3 and assumptions made in developing the projected model simulation are provided in Appendix 2D.

3.5.3.2 Reduction of Groundwater in Storage Minimum Thresholds

Minimum thresholds for the reduction of groundwater in storage indicator are equivalent to aquifer-specific sustainable yield volumes described in Section 2.2.6.5 on sustainable yield. The minimum thresholds are derived from a projected baseline model simulation incorporating climate change and projected pumping that predicts undesirable results will not occur over the GSP planning and implementation horizon of 50 years. Groundwater pumping volumes from the baseline simulation are used to estimate sustainable yield and represent minimum thresholds. For all aquifers apart from the Santa Margarita aquifer the long-term period from WY2022-2072 produces relatively constant groundwater in storage, therefore the long-term average pumping over this period is used for the minimum threshold calculation. While change of groundwater in storage in the Santa Margarita aquifer is more variable, groundwater pumping in this aquifer produces near zero cumulative groundwater in storage loss from WY2030-2049, therefore this period is used for the minimum threshold calculation. Given that groundwater pumping in the model is not specifically optimized to avoid undesirable results, it is possible that slightly more pumping than the estimated sustainable yield could avoid future undesirable results. A 5 percent buffer to account for this is added to all minimum threshold calculations to allow for pumping optimization during GSP implementation. Reduction of groundwater in storage minimum thresholds and their relationships to historical and current groundwater pumping are summarized in Table 3-17.

Table 3-17. Reduction of Groundwater in Storage Minimum Thresholds by Aquifer Compared to Historical and Current Pumping

Aquifer	Historical Pumping 1985 - 2018	Current Pumping 2010 - 2018	Minimum Threshold	Minimum Threshold Calculation Based On
	(AFY)			
Santa Margarita	1,070	770	850	Average baseline pumping between 2030-2049 plus 5%
Monterey	320	180	140	Average baseline pumping after 2022 plus 5%
Lompico	1,770	1,520	1,290	Average baseline pumping after 2022 plus 5%
Butano	530	480	540	Average baseline pumping after 2022 plus 5%

3.5.3.3 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

Reduction of groundwater in storage minimum thresholds can influence other sustainability indicators. However, by design (see Section 3.5.2.1 above), minimum thresholds for reduction of groundwater in storage avoid occurrence of undesirable results in other sustainability indicators.

- **Chronic Lowering of Groundwater Levels**. Reduction of groundwater in storage minimum thresholds, by definition, prevent pumping in excess of the sustainable yield that would cause chronic lowering of groundwater level undesirable results. Therefore, the reduction of groundwater in storage minimum thresholds will not result in an exceedance of the chronic lowering of groundwater levels minimum threshold unless the pumping distribution in the Basin changes significantly.
- **Degraded groundwater quality**. Rising or falling groundwater elevations may cause wells to draw from different aquifers or hydrogeologic subunits, potentially impacting groundwater quality. Historical groundwater levels are not believed to have caused degradation of groundwater quality. Because minimum thresholds are set at volumes that avoid undesirable results and should maintain groundwater levels above historical minimums, reduction or groundwater in storage minimum thresholds should not result in exceedances of groundwater quality minimum thresholds.
- **Depletion of interconnected surface water**. Reduction of groundwater in storage minimum thresholds do not promote additional pumping or lowering of groundwater elevations adjacent to interconnected surface water. Therefore, the chronic lowering of groundwater elevations minimum thresholds will not result in a significant or unreasonable depletion of interconnected surface water.
- **Seawater intrusion**. Not applicable.
- **Subsidence**. Not applicable.

3.5.3.4 Effect of Minimum Thresholds on Neighboring Basins

The anticipated effect of the minimum thresholds for reduction in groundwater storage on each of the neighboring basins is addressed below.

Santa Cruz Mid-County Basin (critically-overdrafted). There is a relatively impermeable basement high that separates the two basins and very limited areas where the Purisima Formation, the largest supply aquifer for Santa Cruz Mid-County Basin, is in direct contact with the principal aquifers of the Santa Margarita Basin. As a result, it is very unlikely that changes of groundwater in storage due to projects and management actions in either basin could change hydraulic gradients near the shared basin boundary or affect minimum thresholds for the reduction of groundwater in storage in the neighboring basin.

Purisima Highlands Subbasin of the Corralitos Basin (very low priority). The Santa Margarita Basin is hydraulically downgradient from the Purisima Highlands Subbasin, but is separated from it by the Zayante-Vergeles fault zone, which acts as a barrier to groundwater flow. With a flow barrier between the two basins and a minimum threshold based on sustainable yield less than historical pumping, it is highly unlikely Santa Margarita Basin pumping at will have a negative influence on groundwater in storage in the Purisima Highlands Subbasin.

West Santa Cruz Terrace Basin (very low priority). The boundary between the Santa Margarita Basin and West Santa Cruz Terrace Basin is located where Tertiary sedimentary rocks that are the principal aquifers in Santa Margarita Basin thin abruptly against basement rocks that are exposed at the surface or are at shallow depth in the subsurface. Groundwater pumping in West Santa Cruz Terrace Basin is mostly from private wells tapping low-yielding Quaternary alluvium and terrace deposits. These Quaternary deposits are not hydrologically connected to similar deposits scattered in small patches in Santa Margarita Basin. The lack of continuity in the Quaternary deposits and thinning of the Santa Margarita Basin aquifers makes it unlikely that groundwater extraction at minimum thresholds in the Santa Margarita Basin would cause a reduction of groundwater in storage in the West Santa Cruz Terrace Basin.

3.5.3.5 Effects of Minimum Thresholds on Beneficial Users and Land Uses

The reduction in groundwater in storage minimum thresholds are set at volumes that avoid undesirable results in the other sustainability indicators, and therefore maintain groundwater elevations above historical lows. Since historical groundwater levels have not appeared to cause undesirable conditions in the Basin, levels no lower than the historical low should continue to support similar beneficial use in the future:

- **Urban land uses and users**. Maintaining available groundwater in storage will benefit municipal groundwater pumpers by protecting their ability to pump groundwater from municipal wells and meet public water supply demands.
- **Rural residential land uses and users**. Maintaining available groundwater in storage will benefit all domestic users of groundwater by protecting their ability to pump groundwater from their wells.
- **Industrial land uses and users**. Maintaining available groundwater in storage will benefit industrial land uses and beneficial users by protecting their ability to pump groundwater from their wells.
- **Agricultural land uses and users**. For the very limited agriculture in the Basin, maintaining available groundwater in storage will benefit those beneficial users and land uses by protecting their ability to pump groundwater from irrigation wells.
- **Ecological land uses and users**. Maintaining groundwater in storage above historical low groundwater levels will preserve groundwater's connection to surface water in

the Basin thereby protecting GDE habitat used by priority species and generally benefit ecological land uses and users.

3.5.3.6 Relevant Federal, State, or Local Standards

No federal, state, or currently enforced local standards exist for reduction of groundwater in storage.

3.5.3.7 Method for Quantitative Measurement of Minimum Thresholds

Exceedance of minimum thresholds for reduction of groundwater in storage will be quantified using metered and estimated groundwater extractions within the Basin. Municipal and small water systems have metered pumping data, while *de minimis* and non-*de minimis* pumping will be estimated.

3.5.4 Measurable Objectives - Reduction of Groundwater in Storage

Measurable objectives for reduction of groundwater in storage provide quantitative and obtainable goals for volumes of groundwater extracted from each aquifer. Measurable objectives are determined using groundwater pumping projected in a model simulation incorporating a 540 AFY conjunctive use project in the South Scotts Valley area consistent with the calculation of measurable objectives for groundwater levels. Calculations for the measurable objective are consistent with the periods used to calculate minimum thresholds described in 3.5.3.2 above. The measurable objective for the Santa Margarita aquifer uses average conjunctive use simulation pumping from 2030-2049, while the other aquifers use the long-term average from 2022-2072. Table 3-18 summarizes the measurable objectives in comparison to historical and current pumping.

Table 3-18. Reduction of Groundwater in Storage Measurable Objectives by Aquifer Compared to Historical and Current Pumping

Aquifer	Historical Pumping 1985 - 2018 (AFY)	Current Pumping 2010 - 2018 (AFY)	Measurable Objective (AFY)	Measurable Objective Calculation Based On
Santa Margarita	1,070	770	615	Average conjunctive use simulation pumping between 2030-2049
Monterey	320	180	130	Average conjunctive use simulation pumping after 2022
Lompico	1,770	1,520	1,000	Average conjunctive use simulation pumping after 2022
Butano	530	480	380	Average conjunctive use simulation pumping after 2022

3.5.4.1 Interim Milestones

Like the measurable objectives for this indicator, interim milestones are derived from pumping included in the projected conjunctive use model simulation. Simulation of conjunctive use begins in WY2025. Therefore, the interim milestones for reduction of groundwater in storage are equivalent to minimum thresholds prior to 2027 and equivalent to measurable objectives from 2027 onward. Interim milestones are summarized in Table 3-19.

Table 3-19. Reduction of Groundwater in Storage Interim Milestones by Aquifer

Aquifer	Interim Milestone prior to 2027	Interim Milestone from 2027 onward
	(AFY)	
Santa Margarita	850	615
Monterey	140	130
Lompico	1,290	1,000
Butano	540	380

3.6 Degraded Water Quality Sustainable Management Criteria

Groundwater in the Basin is generally of good quality and does not regularly exceed primary drinking water standards. However, both naturally occurring and anthropogenic groundwater quality concerns are present in some aquifers and areas. Municipal water suppliers regularly sample and test both raw and treated water sources per state requirements.

3.6.1 Significant and Unreasonable Degraded Water Quality

Significant and unreasonable water quality conditions occur if projects or management actions in support of SGMA degrade groundwater quality such that it leads to diminished supply, adverse impacts on beneficial uses or undue financial burden for mitigating such negative impacts.

In this context, undue financial burden means a cost or financial impact resulting from an action or inaction of the SMGWA or groundwater users in the Basin, that is unwarranted, inappropriate, or excessive and/or rising to a level that is more than is necessary, acceptable, or reasonable.

3.6.2 Undesirable Results - Degraded Water Quality

3.6.2.1 Criteria for Defining Degraded Water Quality Undesirable Results

There are several criteria for defining undesirable results for degraded groundwater quality:

1. There must be confirmation sampling to prove that a concentration above its minimum threshold is not sampling or laboratory error.
2. Water quality degradation must be caused by SMGWA approved projects or management actions implemented as part of this GSP to achieve and maintain sustainability.

The following are conditions that <u>do not</u> cause undesirable results as defined in this GSP:

1. It is not considered an undesirable result if activities by private individuals or companies mobilize poor quality groundwater or introduce poor quality water or contaminants into the Basin. This is because the undesirable result was not caused by the SMGWA. Although such groundwater quality degradation needs to be addressed, it does not fall under the responsibility of the SMGWA. Per the GSP Regulations, SMGWA is only responsible for its own actions and consequences of implementing the GSP. There are local and state regulatory agencies responsible for enforcing various Acts and policies protecting water resources in the Basin as described in Section 2.1.3.4.6.1 on groundwater contamination cleanup.
2. Naturally elevated concentrations already exceeding minimum thresholds are not considered an undesirable result because it was not caused by the SMGWA member or

cooperating agencies. Examples of elevated naturally occurring chemical constituents in the Basin are iron, manganese, sulfate, and arsenic. These constituents are discussed in more detail in Section 2.2.5.4.3. Although naturally occurring elevated concentrations are undesirable to users of the water and require treatment to make the water either safe for human health or aesthetically acceptable depending on the constituent, those elevated concentrations are not an undesirable result caused by implementation of the GSP.

3. Nitrates introduced into the Santa Margarita aquifer and surface water through wastewater disposal, livestock, fertilizer use, and other sources have been occurring since the lands within the Basin were first developed. County of Santa Cruz Environmental Health is responsible for improving septic tank standards and has been implementing the San Lorenzo Nitrate Management Plan since 1995 to reduce nitrate impacts in the Basin. Since nitrate impacts have been occurring for decades, SMGWA is not responsible for causing them not mitigating them.

3.6.2.2 Numerical Description of Undesirable Results

Undesirable results occur if any of the degraded groundwater quality minimum thresholds are exceeded at RMPs where:

- Minimum thresholds have not been exceeded prior to SMGWA approved project(s) or management action(s)
- An immediate resampling confirms the exceedance
- The exceedance is caused by SMGWA approved project(s) or management action(s)

3.6.2.3 Potential Causes of Undesirable Results

SMGWA approved projects and management activities may potentially degrade groundwater quality under the following conditions:

- **Changes to Basin Pumping.** If the location and rates of groundwater pumping change as a result of projects implemented or management actions taken under the GSP, these changes could alter hydraulic gradients and cause movement of existing poor-quality groundwater towards a supply well at concentrations that exceed minimum thresholds.
- **Groundwater Recharge**. Active groundwater recharge through injection wells or surface spreading could potentially modify groundwater gradients and move existing poor-quality groundwater towards a supply well in concentrations that exceed minimum thresholds. Another potential cause of groundwater degradation from recharge by injecting water into the aquifer is mobilization of metals. Introducing surface water or purified wastewater into an aquifer may change the eH or pH of groundwater in such a way that minerals in the aquifer such as pyrite break down or

trace elements are desorbed from clays, thereby releasing iron, manganese, or arsenic into the groundwater. Pilot testing can help understand geochemical impacts an ASR project may or may not have before a decision can be made on its feasibility.

- **Recharge of Poor-Quality Water.** A SMGWA approved recharge project could introduce poor quality water or contaminants into the Basin. This is highly unlikely because of the state's antidegradation policy that prevents projects from causing degradation of surface water or groundwater. -Recharge with purified wastewater has the potential to increase groundwater nitrate concentrations if nitrates in the recharge water are not removed to a level that prevents degrading groundwater. Increased nirate concentrations in groundwater will result in an increase of nitrate in surface water through groundwater's contribution to baseflows. Increased nitrate in surface water can cause biostimulation in the aquatic ecosystem, depressing dissolved oxygen levels and adversely impacting aquatic biota. It can also result in increased production of organic compounds that can cause taste and odor problems and disinfection byproducts adversely affecting municipal water supply and costs for surface water treatment.

SMGWA approved projects and management activities may potentially degrade surface water quality under the following conditions:

- **Degraded Groundwater Impacts to Surface Water**: Groundwater in the Basin is highly connected to surface water which means the quality of groundwater influences the quality of surface water. This is evident in the elevated nitrate concentrations in the San Lorenzo River influenced in large part by septic system leaching to groundwater. Users of surface water within the Basin are primarily SLVWD, and to a lesser extent a few private users and small water systems who have water rights. Surface water from the Basin is also used outside of the Basin by the City of Santa Cruz that has appropriative rights to San Lorenzo River water via licenses. These licenses allow the withdrawal of water at the San Lorenzo River Intake in Santa Cruz for delivery to the Graham Hill water treatment plant and the Felton diversion for storage at Loch Lomond Reservoir. Surface water is always treated before being used by the City of Santa Cruz for potable water. If SMGWA approved projects and management activities degrade surface water quality, additional treatment may be needed depending on the chemical constituents and concentrations.
- **Degraded Groundwater Impacts to Soil Vapor**: If SMGWA approved projects or management actions move existing plumes with vapor-forming chemicals, a potential impact on urban land use is formation of soil vapor plumes that may impact health. Vapor intrusion occurs when vapor-forming chemicals in contaminated soils or groundwater migrate into overlying buildings. Vapor-forming chemicals may include VOCs, such as TCE and benzene, select semi-volatile organic compounds, such as

naphthalene, elemental mercury, and some polychlorinated biphenyls and pesticides (USEPA, 2020).

3.6.2.4 Effects on Beneficial Users and Land Use

Undesirable results from degradation of groundwater quality can have the following general impacts on beneficial users and land uses:

- **Urban land uses and users**. If municipal supply wells cannot be pumped anymore because of contamination, an alternative water source will need to be used or the groundwater will need to be treated to drinking water standards. New wells or increased pumping in existing wells may change the groundwater pumping regime, which could promote migration of degraded groundwater. If surface water or soil vapor impacts are caused by groundwater degradation, then water or soil vapor treatment may be needed to ensure public safety. With groundwater and surface water closely connected, degraded groundwater quality can degrade surface water quality. The only urban user impacted would be the City of Santa Cruz which is a downstream user of surface water. Elevated nitrate in surface water may result in increased production of organic compounds that can cause taste and odor problems and disinfection byproducts adversely affecting municipal water supply and costs for surface water treatment. SLVWD surface water sources are outside of and upgradient of the Basin and will not be impacted.
- **Rural residential land uses and users**. Since private well owners do not routinely test groundwater pumped by their wells, there is a strong possibility that they could unknowingly drink groundwater exceeding drinking water standards and experience potential health effects. In addition, not having access to groundwater as a water source because of known undesirable results will significantly devalue properties that have no alternative water source or cannot be connected to a municipal water system. Finally, costly treatment systems may need to be installed depending on the concentration and chemical found in rural water supplies.
- **Industrial land uses and users**. Industrial use of groundwater in the Basin is limited to process and dust suppression water at 1 remaining sand quarry at Quail Hollow. Degraded groundwater quality will have limited negative effect on the use of water used at the quarry. Impacts on groundwater quality by sand mining have a greater potential negative effect than projects or management actions implemented to achieve sustainability.
- **Agricultural land uses and users**. For the very limited agriculture in the Basin, degraded groundwater quality has the potential to damage crops. It is unlikely that the agricultural land use will be impacted by degraded water quality caused by SMGWA approved projects or management actions since those land uses are many miles away from the urban settings that have known contaminant plumes.

- **Ecological land uses and users**. Groundwater dependent ecosystems have the potential to be directly impacted if baseflows become contaminated by degraded groundwater enters or is utilized by root zone of GDEs. Each species has differing tolerance to groundwater quality, but in general, groundwater quality degradation may cause nuisance or toxicity for some riparian, aquatic, or terrestrial species. Elevated nitrate in surface water may cause biostimulation in the aquatic ecosystem, depressing dissolved oxygen levels and adversely impacting aquatic biota.

3.6.3 Minimum Thresholds - Degraded Water Quality

The GSP Regulations allow three options for setting degraded water quality minimum thresholds. Section §354.28(c)(2) of the GSP Regulations states that "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, 2016). In this Basin, minimum thresholds are based on specified concentrations of constituents determined to be of concern. This metric is similar to the location of an isocontour approach in the GSP Regulations. Currently available wells monitored annually for COCs are public supply wells.

3.6.3.1 Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives

The primary information used to develop minimum thresholds and measurable objectives are historical groundwater quality data from public supply wells. Other sources of information used to develop minimum thresholds and measurable objectives are state primary and secondary drinking water standards or MCLs, and various guidance documents (DWR, 2017; Moran and Belin, 2019; Community Water Center, 2019).

3.6.3.2 Degraded Water Quality Minimum Thresholds

Minimum thresholds for COCs in degraded groundwater quality RMPs are state drinking water standards, except for nitrate (as N). Using state standards to define minimum thresholds is consistent with the SMGWA defined significant and unreasonable water quality degradation that results in adverse impacts including materially diminished water supplies or undue costs for mitigating such negative impacts. Federal, state, or local regulatory requirements are established after careful scientific study, legal review and procedural steps mandated by law. They are designed to protect public health and welfare, and they provide the clearest indication of the point beyond which there is a real risk of an undesirable result (Moran and Belin, 2019).

Nitrate (as N) concentrations in groundwater are typically less than 5 mg/L. Because nitrate in groundwater influences nitrate concentrations in the San Lorenzo River (described in Section 2.1.2.3), allowing nitrate concentrations in groundwater to increase above 5 mg/L will make it challenging to meet the San Lorenzo River's 0.33 mg/L nitrate total maximum daily load (TMDL) enforced by the Central Coast Regional Water Quality Control Board (RWQCB).

A minimum threshold of 5 mg/L is established for nitrate (as N) because:

1. Concentrations in RMPs are historically below this threshold
2. The groundwater quality goal is to prevent concentrations from worsening and concentrations above 5 mg/L are currently uncommon throughout the Basin
3. Nitrate concentrations in SMGWA approved project source waters close to 10 mg/L would increase the challenge of meeting the nitrate TMDL in the San Lorenzo River. Feasibility for future projects will need to demonstrate the Basin's good quality groundwater will not be degraded above 5 mg/L before the SMGWA can approve its implementation.

Table 3-20 lists the Basin's COCs together with why it is of concern, basis for the minimum threshold, and the minimum threshold value. Appendix 3B includes chemographs for COCs at each RMP showing historical data, minimum thresholds, and measurable objectives.

Table 3-20. Minimum Thresholds for Groundwater Quality Constituents of Concern

Constituent of Concern	Reason for Concern	Minimum Threshold Based On	Minimum Threshold (mg/L)
Total dissolved solids	basic health of basin	Upper recommended limit of State secondary MCL used county-wide	1,000
Chloride	basic health of basin	State secondary MCL	250
Iron	naturally elevated	State secondary MCL	0.30
Manganese	naturally elevated	State secondary MCL	0.05
Arsenic	naturally elevated	State primary MCL	0.01
Nitrate as Nitrogen	septic systems	Consideration of the State TMDL for San Lorenzo River	5
Methyl-tert-butyl-ether (MTBE)	Introduced into groundwater by leaking gasoline tanks	State primary MCL	0.013
Chlorobenzene		State primary MCL	0.07
Trichloroethylene (TCE)	Introduced into groundwater by Watkins-Johnson and Scotts Valley Dry Cleaners	State primary MCL	0.005
Tetrachloroethylene (PCE)		State primary MCL	0.005
1,2-Dichloroethylene (1,2-DCE)		State primary MCL	0.07

MCL = maximum contaminant level

Each future SMGWA approved project implemented as part of the GSP will have a set of COC that apply to monitoring and extraction wells included in their use permits granted by the State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW). For example, projects injecting purified recycled water into the Basin are classified as groundwater replenishment reuse projects and permits from SWRCB DDW are required. A compendium of groundwater replenishment reuse regulations (GRRR) (Title 22, Division 4, Chapter 3) was issued by the SWRCB in 2014 (SWRCB, 2018). Specific monitoring wells and a list of chemical constituents to monitor are part of specific permit conditions. The GRRR Section 60320.200 (c) requires at least four quarters of background groundwater quality data to characterize groundwater quality in each aquifer that will be receiving recycled water before injection of purified recycled water starts. Constituents of concern for implemented projects will be added to the list of COC for this GSP, and some of the monitoring wells specified in the permit will be added as RMPs.

For Aquifer Storage & Recovery (ASR) projects, the SWRCB has adopted general waste discharge requirements for ASR projects that inject water of drinking water quality 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. Oversight of these regulations is through the Regional Water Quality Control Board (RWQCB) and obtaining coverage under the General ASR Order requires the preparation and submission of a Notice of Intent (NOI) application package. The NOI includes a technical report that, amongst other things, identifies and describes target aquifers, delineates the Areas of Hydrologic Influence, identifies all land uses within the delineated Areas of Hydrologic Influence, identifies known areas of contamination within the Areas of Hydrologic Influence, identifies project-specific constituents of concern, and groundwater degradation assessment.

3.6.3.3 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

SGMA regulations do not require projects or management actions to improve existing groundwater quality, although the GSA may undertake such a goal. Since the Basin’s groundwater quality is generally below minimum thresholds, the SMGWA’s objective is to keep it at current concentrations and will not be taking any actions to improve it. Keeping groundwater quality at current concentrations, therefore, poses no threat to other sustainability indicators. However, preventing migration of poor-quality groundwater may limit projects or management actions needed to achieve minimum thresholds for other sustainability indicators.

- **Chronic lowering of groundwater levels**. Degraded groundwater quality minimum thresholds could influence groundwater level minimum thresholds by limiting the types of water that can be used for recharge to increase groundwater levels if groundwater levels started to approach minimum thresholds.
- **Change in groundwater storage**. Degraded groundwater quality minimum thresholds do not promote pumping in excess of the sustainable yield that is needed to ensure change in groundwater storage does not cause undesirable results. Therefore, the degraded groundwater quality minimum thresholds will not result in an exceedance of the groundwater storage minimum threshold.

- **Seawater intrusion**. Not applicable.
- **Subsidence**. Not applicable.
- **Depletion of interconnected surface water**. Degraded groundwater quality minimum thresholds do not promote additional pumping or lower groundwater elevations adjacent to interconnected surface water. Therefore, the degraded groundwater quality minimum thresholds will not result in a significant or unreasonable depletion of interconnected surface water.

Minimum thresholds for specific COCs are the same for each RMP throughout the Basin, thus there is no conflict between individual RMP minimum thresholds.

3.6.3.4 Effect of Minimum Thresholds on Neighboring Basins

The anticipated effect of the minimum thresholds for degraded groundwater quality on each of the neighboring basins is addressed below.

Santa Cruz Mid-County Basin (critically overdrafted). Limited groundwater flows from the Santa Cruz Mid-County Basin into the Santa Margarita Basin. Groundwater quality in the vicinity of the basins' boundary is generally good except for naturally occurring elevated iron, manganese, and occasionally arsenic. No GSP projects or management actions, for either basin, that might change hydraulic gradients or directions are likely in the vicinity of the basins' shared boundary. The Santa Cruz Mid-County Basin's minimum thresholds for groundwater quality are drinking water standards and therefore, it is unlikely that the degraded groundwater quality minimum thresholds established for the Basin will prevent the Santa Cruz Mid-County Basin from achieving sustainability. Even though the Santa Cruz Mid-County Basin's minimum threshold for nitrate (as N) of 10 mg/L is higher than the Santa Margarita Basin's minimum threshold of 5 mg/L, the lack of connection between the Santa Cruz Mid-County Basin's primary aquifer (Purisima Formation) and the Santa Margarita Basin's primary aquifers (Santa Margarita, Lompico and Butano aquifers) will not prevent the Santa Margarita Basin from achieving its nitrate (as N) minimum threshold.

Purisima Highlands Subbasin of the Corralitos Basin (very low priority). The Santa Margarita Basin is hydraulically downgradient from the Purisima Highlands Subbasin, but is separated from it by the Zayante-Vergeles fault zone, which acts as a barrier to groundwater flow. Furthermore, with minimum thresholds in the Santa Margarita Basin set at drinking water standards, groundwater quality at those concentrations or better will remain safe for Purisima Highlands Subbasin beneficial users.

West Santa Cruz Terrace Basin (very low priority). The boundary between the Santa Margarita Basin and West Santa Cruz Terrace Basin is located where Tertiary sedimentary rocks that are the principal aquifers in Santa Margarita Basin thin abruptly against basement rocks that are exposed at the surface or are at shallow depth in the subsurface. Groundwater pumping in West Santa Cruz Terrace Basin is mostly from private wells tapping low-yielding Quaternary alluvium and terrace deposits. These Quaternary deposits are not hydrologically connected to similar deposits scattered in small patches in Santa Margarita Basin. Even if the sediments in the two basins were highly connected, groundwater quality at drinking water standards would not adversely impact rural residential or GDE groundwater users in the West Santa Cruz Terrace Basin.

3.6.3.5 Effects of Minimum Thresholds on Beneficial Users and Land Uses

In general, groundwater quality concentrations at or less than the minimum thresholds will not impact beneficial users and land uses in the Basin. The selected minimum thresholds generally benefit beneficial users and land uses in the Basin:

- **Urban land uses and users**[5]. The degraded groundwater quality minimum thresholds benefit the urban water users in the Basin. Preventing groundwater for drinking water supply from exceeding state drinking water standards ensures an adequate supply of groundwater for municipal use.
- **Rural residential land uses and users**[6]. The degraded groundwater quality minimum thresholds benefit domestic water users in the Basin. Ensuring constituents of concern in water supply wells remain below state drinking water standard to protect groundwater for private domestic use.
- **Industrial land uses and users.** The degraded groundwater quality minimum thresholds generally benefit industrial water users in the Basin. Ensuring constituents of concern in water supply wells remain below state drinking water standard is more protective than is needed for industrial use.
- **Agricultural land uses and users.** The degraded groundwater quality minimum thresholds generally benefit the limited agricultural water use in the Basin by preventing impacts to crop health from degraded groundwater.
- **Ecological land uses and users**. Although the groundwater quality minimum thresholds do not directly benefit ecological uses, it can be inferred that the degraded groundwater quality minimum thresholds generally benefit the environmental water uses in the Basin. Preventing poor-quality groundwater from migrating to GDEs and surface water bodies will limit ecosystem impacts.

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[5] Urban land users include a small area of a DAC supplied water by SLVWD.

[6] Rural land users include an estimated less than 10 DAC residents who depend on private wells for domestic use.

3.6.3.6 Relevant Federal, State, or Local Standards

The degraded groundwater quality minimum thresholds are defined as the state drinking water standards with the exception of the nitrate minimum threshold, which is less than the state drinking water standard.

3.6.3.7 Method for Quantitative Measurement of Minimum Thresholds

Groundwater quality in RMPs will be directly measured by collecting and testing groundwater samples in accordance with the monitoring protocols outlined in Section 3.3.2. Chemical concentrations reported by the laboratory will be used to compare chemical COC concentrations in relation to their respective minimum thresholds. Should a minimum threshold be exceeded, follow-up sampling and analysis will be conducted to confirm that exceedances are not due to sample collection or laboratory errors.

3.6.4 Measurable Objectives - Degraded Water Quality

3.6.4.1 Measurable Objectives

All measurable objectives set for degraded groundwater quality strive to keep groundwater quality at current concentrations. Measurable objectives for each RMP are the average concentration between January 2010 and December 2019 concentrations for each COC. The measurable objectives for RMPs are shown in Table 3-21 and included on chemographs in Appendix 3B.

3.6.4.2 Interim Milestones

Groundwater in the Basin is currently of better quality than minimum thresholds for all RMPs with no changes in quality expected from projects and management actions implemented to achieve sustainability. Since the measurable objectives effectively represent current conditions, interim milestones are set at the same concentration as measurable objectives (see Table 3-21).

Table 3-21. Minimum Thresholds and Measurable Objectives for Degradation of Groundwater Quality

Aquifer Unit	Well Name	Total Dissolved Solids	Chloride	Iron	Manganese	Arsenic	Nitrate as Nitrogen	Methyl-tert-butyl-ether (MTBE)	Chlorobenzene	Trichloroethylene (TCE)	Tetrachloroethylene (PCE)	1,2-Dichloroethylene (1,2-DCE)
All units in mg/L	Minimum Threshold	1,000	250	0.3	0.05	0.01	5	0.013	0.07	0.005	0.005	0.07
Santa Margarita	SLVWD Quail Hollow #5A	123	8.00	0.020	0.003	0.002	2.13	0.003	0.001	0.0005	0.0005	0.0005
	SLVWD Olympia #3	573	8.85	0.502	0.157	0.002	0.400	0.003	0.001	0.0005	0.0005	0.0005
Monterey	SVWD Well #9	839	44.7	0.082	0.015	0.002	0.400	0.003	0.001	0.0008	0.0005	0.0005
Lompico	SLVWD Pasatiempo #7	143	7.40	0.539	0.099	0.002	0.330	0.003	0.001	0.0005	0.0005	0.0005
	SVWD #10A	290	30.6	1.51	0.099	0.002	0.390	0.003	0.001	0.0005	0.0005	0.0005
	SVWD #11A	525	27.1	0.459	0.112	0.003	0.400	0.003	0.001	0.0005	0.0005	0.0005
	SVWD #11B	367	21.3	0.826	0.077	0.009	0.400	0.003	0.001	0.0005	0.0005	0.0005
Lompico/ Butano	SVWD #3B	563	31.6	0.380	0.042	0.002	0.400	0.003	0.001	0.0005	0.0005	0.0005
	SVWD Orchard Well	450	26.3	0.063	0.004	0.002	0.400	0.003	0.001	0.0005	0.0005	0.0005

3.7 Depletion of Interconnected Surface Water Sustainable Management Criteria

Stream gauging, accretion studies, groundwater level monitoring, stream and GDE field reconnaissance, and groundwater modeling have all been used to show that surface water is connected to groundwater throughout most of the Basin. As discussed in Section 2.2.5.6.1, during the dry season from late May through October, almost all the water flowing in the Basin's streams and creeks is derived from groundwater. In the historical groundwater model simulation, there is about 2.5 times more groundwater discharge to creeks than creek recharge of groundwater. The result of net groundwater discharge to surface water is widespread gaining stream conditions that contribute to more surface water flowing out of the Basin than flowing into the Basin.

The depletion of interconnected surface water SMC is developed using groundwater levels as a proxy as discussed in Section 3.7.2.1 below. Recognizing that the Basin does not have enough shallow wells to monitor and evaluate the effects of groundwater extractions on streamflow depletion in interconnected surface waters, up to 5 new shallow monitoring wells will be installed in 2022 to complete the monitoring network. This section details the SMC for the 2 existing monitoring wells near creeks that will be used as RMP. SMC will be defined for new monitoring wells once several years of groundwater level data have been collected and a relationship between groundwater levels, groundwater extractions, rainfall, and other factors can be established. Any new RMPs and SMC developed with input from and approved by the SMGWA Board will be included in future updates to the GSP.

3.7.1 Significant and Unreasonable Depletion of Interconnected Surface Water

Significant and unreasonable depletion of interconnected surface water occurs if groundwater use, or projects or management actions in support of SGMA adversely impact the sustainability of groundwater dependent ecosystems or selected priority species or cause undue financial burden to beneficial users of surface water.

In this context, undue financial burden means a cost or financial impact resulting from an action or inaction of the SMGWA or groundwater users in the Basin, that is unwarranted, inappropriate, or excessive and/or rising to a level that is more than is necessary, acceptable, or reasonable.

3.7.2 Undesirable Results - Depletion of Interconnected Surface Water

3.7.2.1 Groundwater Elevation as a Proxy for Depletion of Interconnected Surface Water Minimum Thresholds

The metric for depletion of interconnected surface water is a volume or rate of surface water depletion. Limited data collected to date does not allow for measurement or estimation of a volume or rate of historical depletion of interconnected surface water due specifically from groundwater extractions. Data limitations include streamflow gages not paired with shallow monitoring wells and having to rely on estimates of extraction for unmetered groundwater usage by *de minimis* pumpers and some non-*de minimis* pumpers. Although there have been multiple accretion studies to understand where groundwater and surface water are interconnected, and what the groundwater contributions are to baseflow (as described in Section 2.2.5.6.1), there have been no studies conducted in the Basin to understand the effects of groundwater use on streamflow or the GDEs that rely on streamflow for supporting flora and fauna.

Even though streamflow depletion from groundwater extractions cannot be directly measured at a streamflow gage because it is only one component of many other components that make up streamflow, changes in groundwater contributions to streamflow can be simulated with a groundwater model. Sensitivity runs using the calibrated Basin model to simulate groundwater conditions and water budget with and without groundwater pumping and associated return flows shows, on average over the WY1985-2018 historical model period, there is around 1,000 AFY (approximately 1.4 cfs) of year-round surface water depletion due to groundwater extraction (Figure 3-16). The negative values on Figure 3-16 indicate the volume of pumping and return flows removed from the model in the “without pumping” simulation, while the positive values for discharge to creeks indicate the increase in discharge in response to pumping being removed.

Analysis of the model simulated water budget for the Bean Creek watershed reveals that on average from WY1985 through 2018 groundwater extractions reduce groundwater contributions to Bean Creek during low flow periods by approximately 0.5 cfs (Figure 3-17). The amount of groundwater contribution in the low flow months is highly dependent on rainfall depicted as water year type on Figure 3-17.

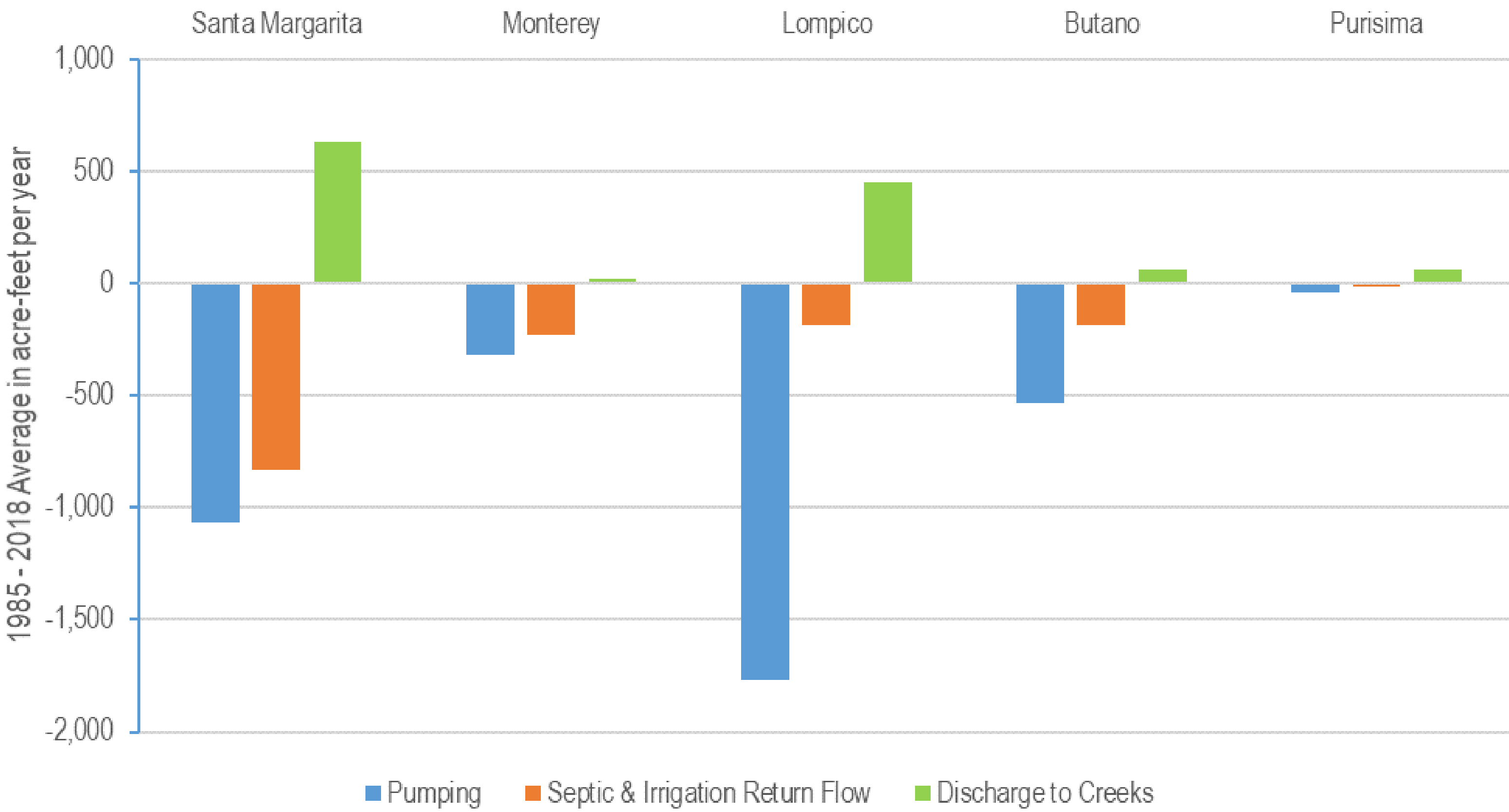

Figure 3-16. Model Simulated Effects of Groundwater Extractions on Groundwater Discharge to Creeks
(Difference between Simulations Without Pumping and With Pumping)

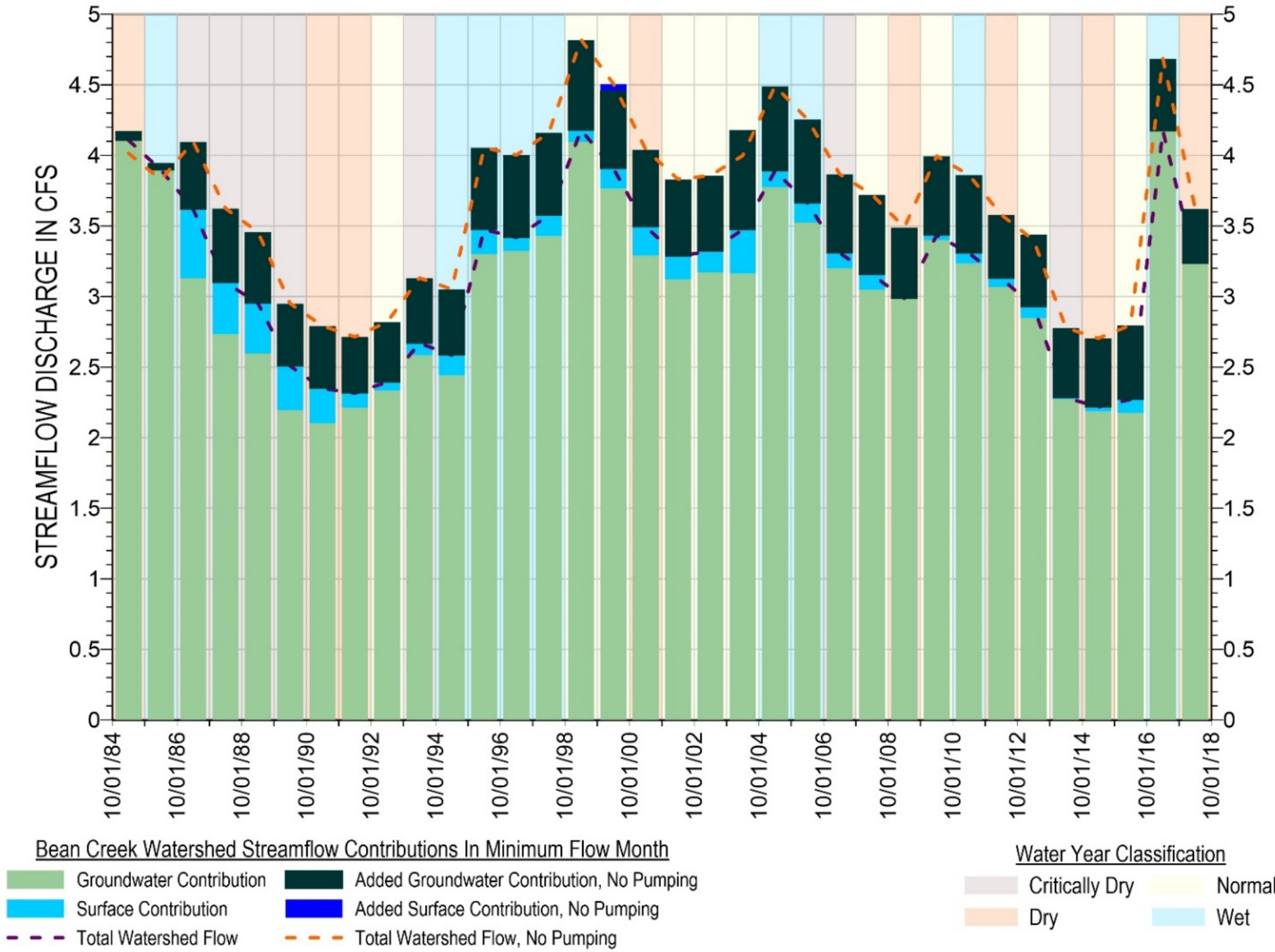

Figure 3-17. Model Simulated Effects of Groundwater Extractions on Groundwater Discharge to Bean Creek in Minimum Flow Month

There are only 2 monitoring wells from the existing monitoring network adjacent to creeks and screened in the aquifer connected to the creek that can be used as RMPs for the depletion of interconnected surface water. Each of these wells has some limitations:

- SLVWD's Quail MW-A is screened in the Santa Margarita aquifer and is closer to an unnamed non-perennial tributary of Zayante Creek than Zayante Creek. This well is included as an RMP even though its location is not ideal because it more likely represents flow in the unnamed tributary rather than Zayante Creek.

- SVWD's SV4-MW is screened in the Santa Margarita aquifer and is located south of Bean Creek in an area of known groundwater contribution to baseflows. This location is more suitable for an RMP however, it only has semi-annual historical groundwater level measurements which is not a suitable frequency for monitoring interconnected surface water. To improve data from this well, it was recently equipped with a pressure transducer to monitor groundwater levels continuously.

In 2022, up to 5 shallow monitoring wells in areas with groundwater extraction and interconnected surface water will be installed, as described in Section 3.3.4.1.3. These additional shallow wells are needed to better understand the relationship between groundwater conditions and baseflow in creeks, to improve the simulation of groundwater and surface water interactions in the groundwater model, and to add to the depletion of interconnected surface water RMP network. Some of the new shallow wells will be paired with nearby streamflow gages. Streamflow and groundwater level data from the new monitoring wells along with more frequent groundwater levels from the 2 RMPs will be used to establish a relationship between streamflow, nearby groundwater use, and other relevant components of streamflow. Until those relationships can be established and because of no other direct means to estimate depletions of interconnected surface water in streamflow records, groundwater levels in the 2 RMPs will be used in the interim to monitor groundwater levels adjacent to creeks. This approach is justified because both RMPs have had groundwater elevations well above adjacent streambed elevations over their respective periods of record (greater than 24 years). If groundwater elevations connected to creeks are kept at or above historical elevations, there will be no more depletion of surface water than experienced over the past 24 years. These historical groundwater levels are not thought to have caused significant and unreasonable impacts to groundwater dependent ecosystems or selected priority species or cause undue financial burden to beneficial users of surface water.

3.7.2.1.1 Correlation between Groundwater Elevation and Streamflow Depletion in SLVWD Quail MW-A

Model simulated streamflow adjacent to SLVWD Quail MW-A for “with pumping” and “without pumping” simulations are used to evaluate the relationship between measured groundwater elevation and baseflow in the adjacent unnamed tributary to Zayante Creek (Figure 3-7). The results plotted on Figure 3-18 and Figure 3-19 show data from September of every year of the calibrated model period (WY1985 – 2018). Data from September represent baseflow during the driest time of year.

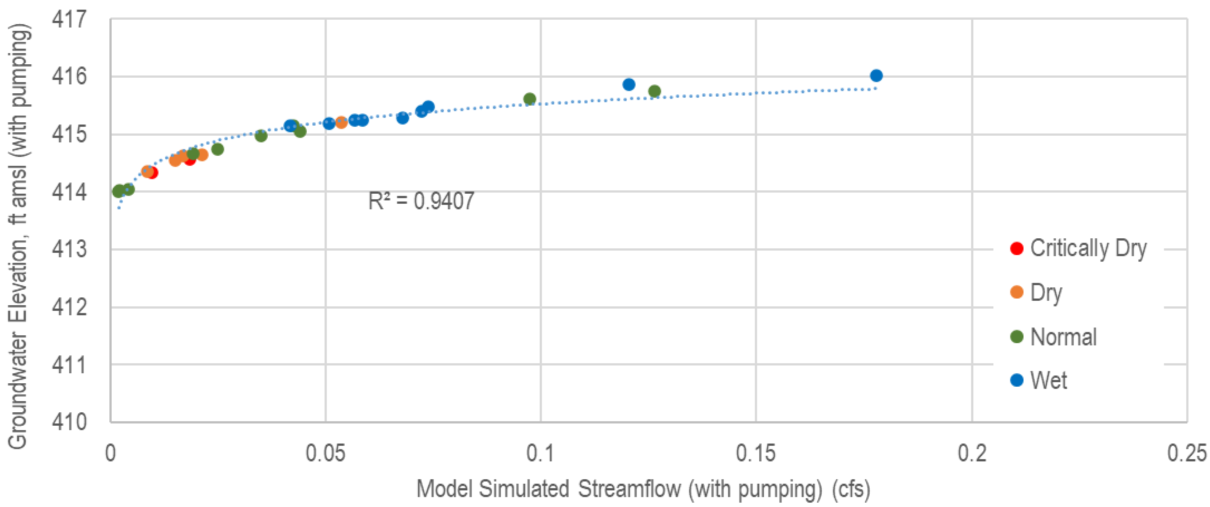

Figure 3-18. SLVWD Quail MW-A September Model Simulated Streamflow Compared to Groundwater Elevations

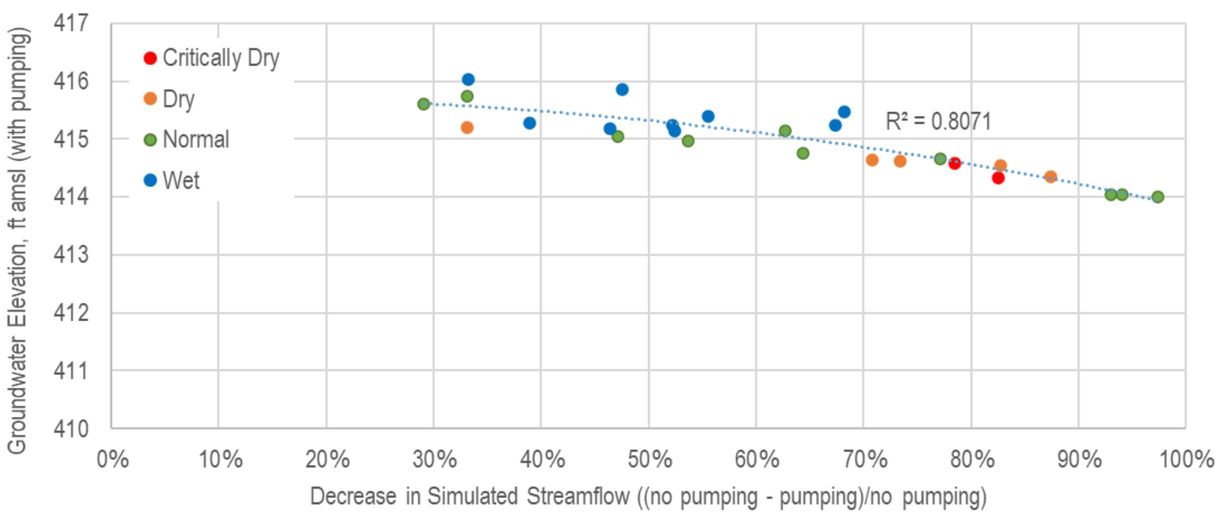

Figure 3-19. SLVWD Quail MW-A September Simulated Streamflow Depletion Compared to Groundwater Elevation

Figure 3-18 shows the relationship between simulated streamflow and measured groundwater elevations during historical Septembers with pumping. There are 8 dry and critically dry years during the interval WY1985-2018 for which there is no simulated streamflow in the unnamed tributary in September and measured groundwater elevations are lower than 414 feet above mean sea level (amsl). Those points are not included on the chart. Figure 3-18 shows a strong relationship between September streamflow and groundwater levels at SLVWD Quail MW-A. The relationship indicates with wetter years there is more groundwater recharge and higher groundwater levels leading to greater groundwater discharge to creeks.

Figure 3-19 shows simulated streamflow depletion compared to historical measured groundwater elevations. Simulated streamflow depletion is calculated as the difference between baseflow with and without pumping. Years with no baseflow are not included. Figure 3-19 shows a good correlation between simulated streamflow depletion in the unnamed tributary from pumping compared to measured groundwater elevation. Streamflow depletion at this location is sensitive to changes in groundwater elevation, with 50% reduction in streamflow occurring from a 1-foot decline in groundwater level.

3.7.2.1.2 Correlation between Groundwater Elevation and Streamflow Depletion in SVWD SV4-MW

The results of the same analysis performed on simulated streamflow and measured groundwater level data for SLVWD Quail MW-A above is shown on Figure 3-20 and Figure 3-21 for SVWD SV4-MW just south of Bean Creek. Well location is shown on Figure 3-7.

Figure 3-20 shows the relationship between simulated streamflow in Bean Creek close to the monitoring well and measured groundwater elevations in the monitoring well during historical Septembers with pumping. The relationship between streamflow and groundwater levels at this location is not as good as at SLVWD Quail MW-A, likely because of other factors that influence streamflow, one of which may be the discharge of treated water from the Watkins-Johnson Superfund site remediation efforts from October 1986 to July 2016 (described in Section 2.1.3.4.6.1).

Figure 3-21 shows simulated streamflow depletion compared to historical groundwater elevations. Streamflow depletion is calculated as the difference between baseflow with and without pumping. Unlike at SLVWD Quail MW-A, at this monitoring well there is not a good long-term relationship between simulated streamflow depletion from pumping compared to groundwater elevations potentially because of the effects of discharge of treated water from the Watkins-Johnson Superfund site. Since discharges from the Watkins-Johnson Superfund site have now stopped, groundwater levels monitored in SVWD SV4-MW over the next 5 years will be used to determine whether the relationship between groundwater elevations and modeled surface water depletions is improved and the groundwater elevations can be more confidently used as a proxy for surface water depletion.

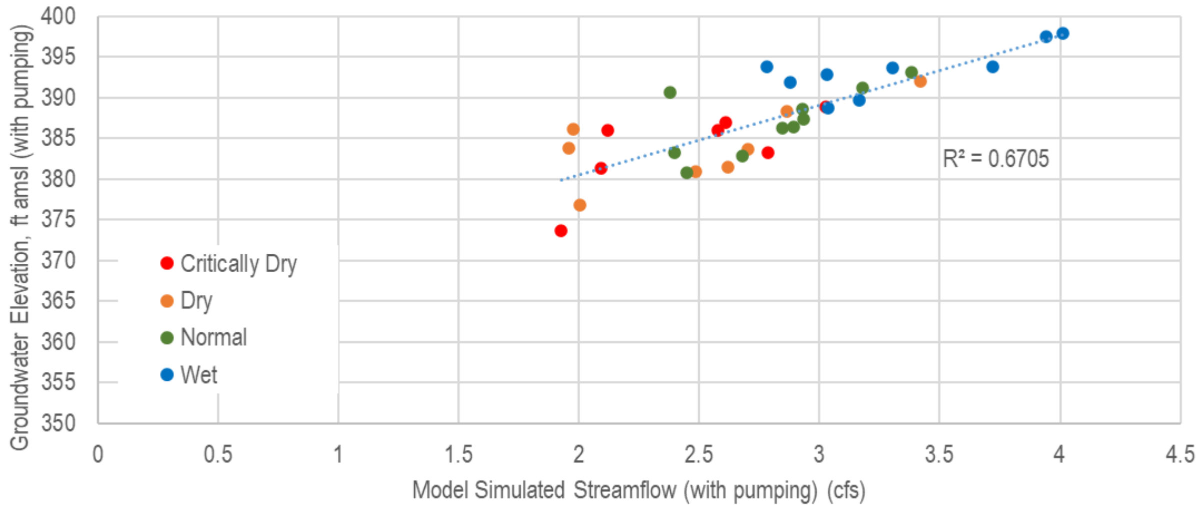

Figure 3-20. SVWD SV4-MW September Model Simulated Streamflow Compared to Groundwater Elevations

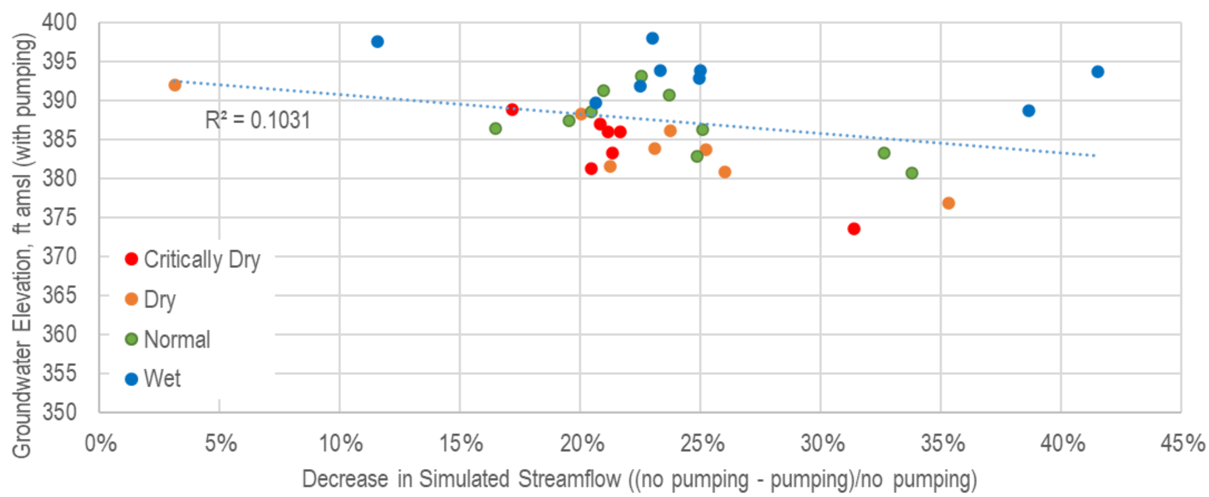

Figure 3-21. SVWD SV4-MW September Simulated Streamflow Depletion Compared to Groundwater Elevation

3.7.2.1.3 Future Evaluation of Depletion of Interconnected Surface Water from Groundwater Extraction

Development of this GSP relies on best available data and science. Until there are data collected that can inform specific studies to quantify groundwater extraction's impact on surface water, the data currently available to the SMGWA are being used to monitor groundwater's contribution to surface water. The SGMA regulations allow for the use of groundwater elevations as a proxy for volume or rate of surface water depletion. To use a groundwater elevation proxy there must be significant correlation between groundwater elevations and the sustainability indicator for which groundwater elevation measurements are to serve as a proxy.

Correlation based on the data from the 2 monitoring wells collected to date is not sufficient to establish that correlation. With a total of 8 monitoring wells collecting daily data near creeks plus stream gauging data, it is anticipated that by the first GSP 5-year update in 2027, there will sufficient data to better quantify depletions from groundwater extraction and establish whether groundwater elevations as a proxy are still applicable or not. Supplementing field measurements, there will be some component of analysis of depletion of surface water that relies on model simulation since depletion of surface water by groundwater extraction is only one component of streamflow and is not directly measurable in streamflow.

3.7.2.2 Criteria for Defining Depletion of Interconnected Surface Water Undesirable Results

The depletion of interconnected surface water undesirable result is defined using groundwater elevation as a proxy. Per the GSP Regulations, the description of undesirable results was based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the Basin.

Criteria that were considered by the SMGWA Board in defining undesirable results include avoiding conditions worse than historical conditions. Having recently had water infrastructure destroyed by wildfires, the Board believes that emergency operational issues or extended droughts are not cause for undesirable results. Fortunately, the Santa Margarita aquifer that contributes the majority of the Basin's baseflow quickly recharges in above-average water years, thereby naturally recovering after drought years and does not have a long-term effect on baseflow.

3.7.2.3 Numerical Description of Undesirable Results

Groundwater level conditions that constitute undesirable results for depletion of interconnected surface water occur if the groundwater level in any RMP falls below the minimum threshold in 2 or more consecutive non-drought years. If a RMP groundwater level below its minimum threshold is caused by emergency operational issues or extended droughts, it is not considered an undesirable result.

3.7.2.4 Potential Causes of Undesirable Results

Surface water flow is more strongly correlated with precipitation than groundwater extraction. However, undesirable results for depletion of interconnected surface water in the context of the GSP 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. Undesirable results may occur in the future to GDEs if groundwater pumping near creeks causes declines in shallow groundwater levels and baseflow to creeks, or if increased diversion of runoff results in reduced recharge in the aquifers, particular the Santa Margarita aquifer.

3.7.2.5 Effects on Beneficial Users and Land Use

Undesirable results from depletion of surface water can have the following general impacts on beneficial users and land uses:

- **Urban land uses and users**. If municipal supply wells cannot be pumped due to depletion of interconnected surface water, an alternative water source will need to be used. This will likely add stress on municipal water systems which will result in installation of new wells or increased pumping in wells distal from the impact area, which increases the potential for further depletions of interconnected surface water in other portions of the Basin. Depletion of interconnected surface water may reduce the availability of surface water for the City of Santa Cruz which is a downstream user of surface water that can only divert when there are flows greater than the Agreed Flows described in Section 2.1.4.2.8.
- **Rural residential land uses and users**. Depletion of interconnected surface water may limit the amount of available groundwater for residential groundwater supply due to reduced recharge from streams. Property values may decline if lowering of groundwater levels causes undesirable results that require residential pumping restrictions, deepening of wells, or connection to a public water system.
- **Industrial land uses and users**. Industrial use of groundwater in the Basin is limited to process and dust suppression water at 1 remaining sand quarry at Quail Hollow. Depletion of interconnected surface water has the potential to reduce access to groundwater for similar reasons listed above for rural residential users.
- **Agricultural land uses and users**. For the very limited agriculture in the Basin, depletion of interconnected surface water may reduce access to groundwater for similar reasons listed above for rural residential users.
- **Ecological land uses and users**. GDEs have the potential to be impacted directly if the depth to groundwater exceeds depths accessed by the roots of groundwater dependent vegetation. Surface water bodies connected to groundwater may also incur reductions in baseflow. Under late summer low flow conditions, there is a direct relationship between streamflow and the amount of suitable GDE habitat. Reduction of flow directly reduces the amount of suitable rearing habitat for steelhead, 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. In even more extreme conditions, lowering of groundwater levels below the root zone of riparian vegetation can result in the loss of vegetation, impacting terrestrial GDE habitat. Section 2.1.4.2.8 includes a detailed discussion of the ecological users in the basin, including: a list of priority

species and co-beneficiaries of priority species, resources and methods available to evaluate instream flows for priority species, steelhead and coho minimum passage and spawning criteria, and a summary of- on-going programs to evaluate the biological response of priority species within the basin.

3.7.3 Minimum Thresholds - Depletion of Interconnected Surface Water

3.7.3.1 Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives

Information used to establish the depletion of interconnected surface water minimum thresholds and measurable objectives include:

- Definitions of significant and unreasonable conditions and desired groundwater elevations discussed during Surface Water TAG and SMGWA Board meetings
- Depths, locations, and logged lithology of existing monitoring wells throughout the Basin
- Historical groundwater elevation data from monitoring wells
- Streamflow and stream stage data collected by the USGS, SLVWD, and County of Santa Cruz
- Input from the Surface Water TAG (described in Section 3.2.2)
- Past hydrologic reports and accretion studies

Since groundwater level is used as a proxy to define the minimum thresholds for the depletion of interconnected surface water, the approach for this sustainability indicator is consistent with the approach for defining minimum thresholds for chronic lowering of groundwater levels, described in Section 3.4.3.1.

Consistent with the approach used for chronic lowering of groundwater level minimum threshold, historical data from the 2 existing surface water depletion RMPs, SLVWD Quail MW-A and SVWD SV4-MW, is used to develop surface water depletion minimum thresholds. These RMPs are both screened in the Santa Margarita aquifer in locations close to interconnected creeks. Historical groundwater level records at SLVWD Quail MW-A have been consistent; the absolute minimum is less than 1 ft lower than the average of the 5 lowest measurements. However, at monitoring well SVWD SV4-MW there is more variation in measured groundwater levels. The absolute minimum, recorded in 2009, is approximately 12 feet lower than the average of the 5 lowest measurements. This point was the only measurement over a 7-year span and was approximately 11 feet lower than any other recorded point. The average of the 5 lowest groundwater levels is approximately 1 foot higher than the second lowest recorded groundwater level in 1999. As more data are collected, the validity of this outlying measurement at SVWD

SV4-MW will be assessed. The surface water depletion RMP network will be refined with new data and monitoring wells during the GSP 5-year update.

3.7.3.2 Depletion of Interconnected Surface Water Minimum Thresholds

Minimum thresholds for depletion of interconnected surface water RMPs are summarized in Table 3-22. Hydrographs showing historical groundwater elevation data compared to the minimum threshold and streambed elevation are provided on Figure 3-22 and Figure 3-23.

Table 3-22. Minimum Thresholds, Measurable Objectives, and Interim Milestones for Depletion of Interconnected Surface Water

Well Name	Groundwater Elevation (Feet MSL)				
	Minimum Threshold	Interim Milestone #1 (2027)	Interim Milestone #2 (2032)	Interim Milestone #3 (2037)	Measurable Objective
SLVWD Quail MW-A	413	416	416	416	416
SVWD SV4-MW	381	387	387	387	387

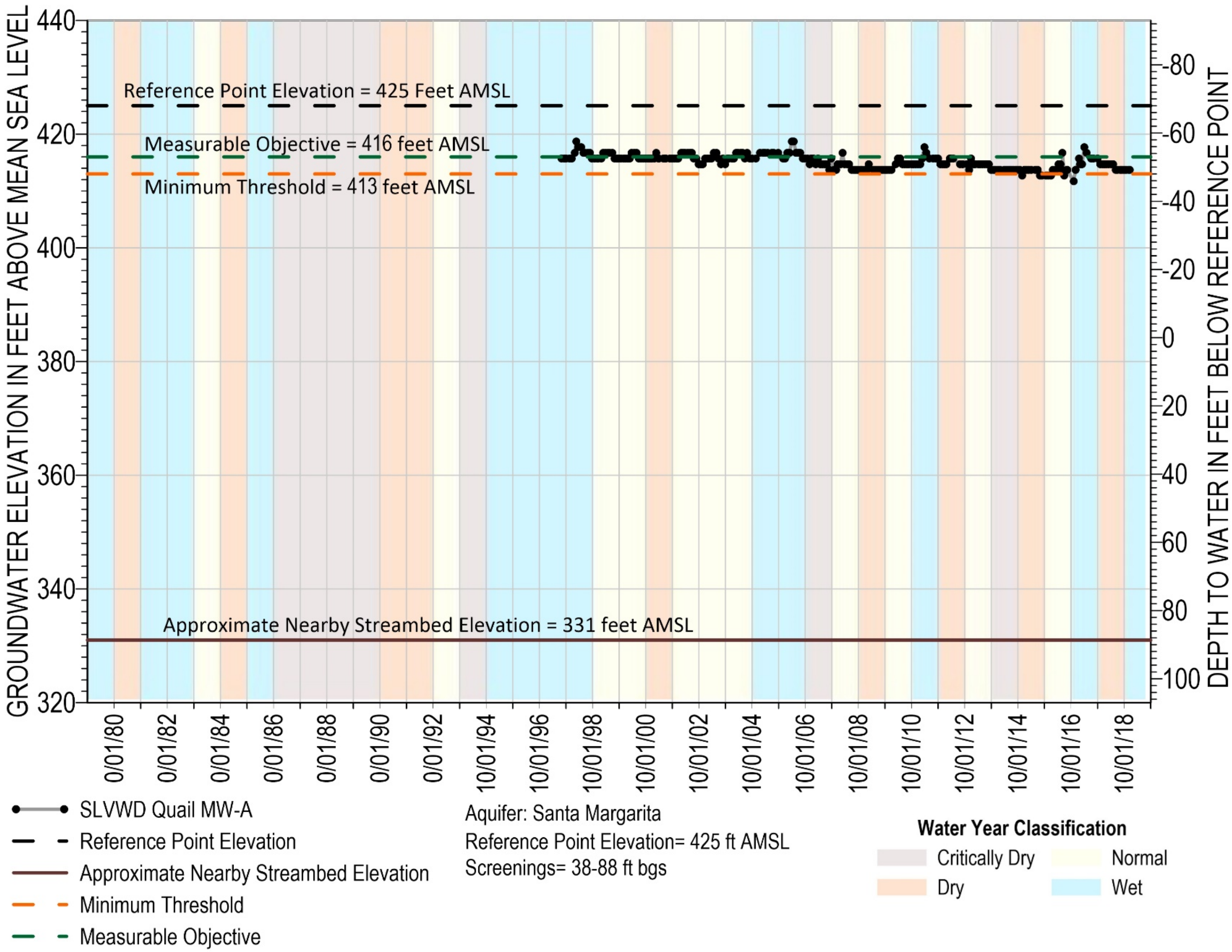

Figure 3-22: Hydrograph for SLVWD Quail MW-A in the Santa Margarita Aquifer Showing Minimum Threshold and Measurable Objective Relative to Measured Groundwater and Streambed Elevations

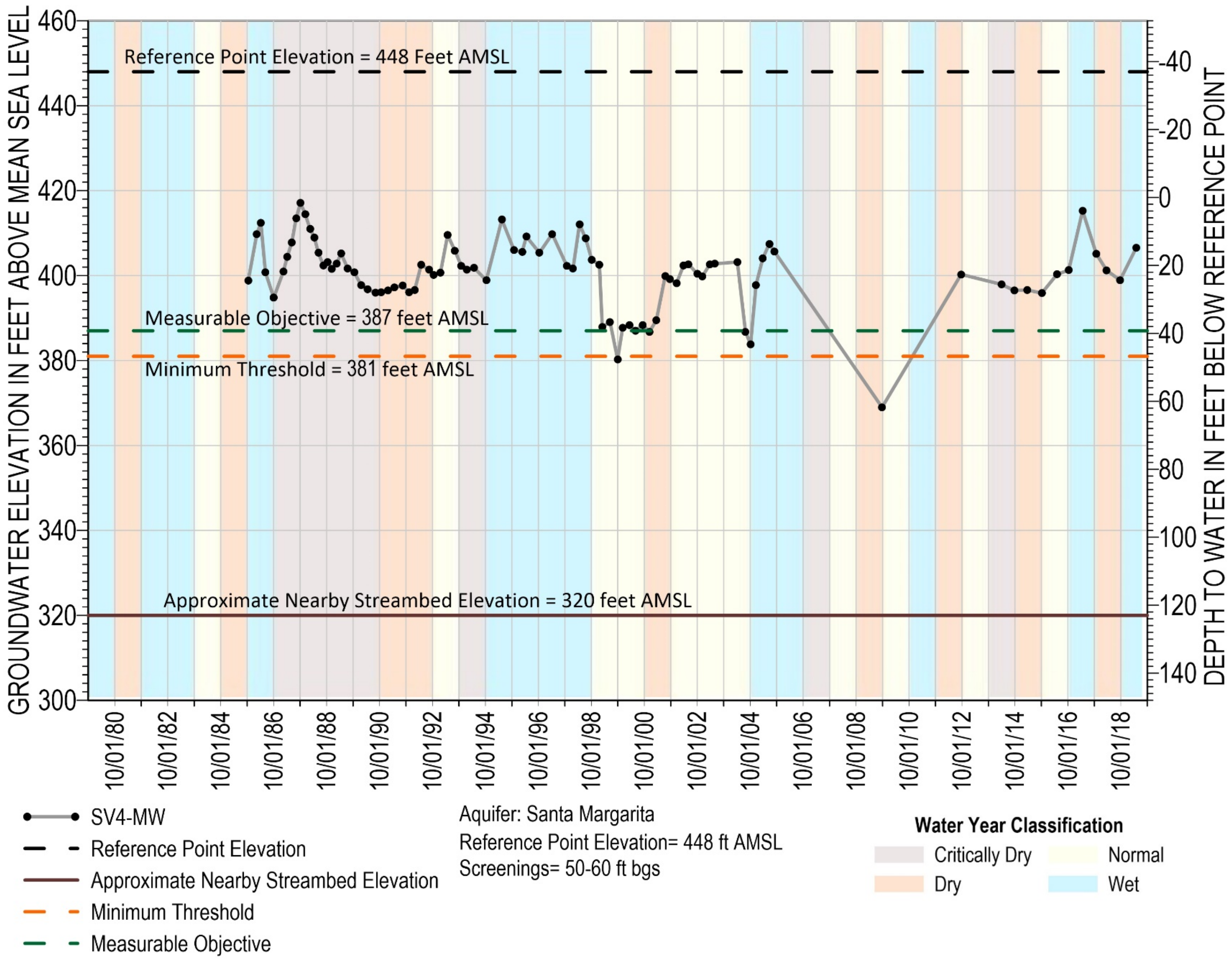

Figure 3-23: Hydrograph for SLWD SV4-MW in the Santa Margarita Aquifer Showing Minimum Threshold and Measurable Objective Relative to Measured Groundwater and Streambed Elevations

3.7.3.3 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

Since the groundwater elevations are based on historical conditions and are considered an achievable condition, the individual minimum thresholds at RMPs do not conflict with each other.

The surface water depletion minimum thresholds have the potential to influence other sustainability indicators. The groundwater level minimum thresholds are selected to avoid undesirable results for other sustainability indicators, as described below:

- **Chronic lowering of groundwater levels**. Groundwater levels are used as a proxy for monitoring the depletion of interconnected surface water minimum thresholds. The methodology for establishing minimum thresholds for both sustainability indicators are the same. If groundwater levels for chronic lowering of groundwater level RMPs are lower than their minimum thresholds, groundwater levels for streamflow depletion are also likely to be lower than their minimum thresholds.
- **Reduction of groundwater in 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.
- **Degraded groundwater quality**. Minimum thresholds for depletion of interconnected surface water are set just above the historical minimum groundwater elevation. Since historical groundwater levels are not thought to cause existing degradation of groundwater quality, depletion of interconnected surface water minimum thresholds should not result in exceedances of groundwater quality minimum thresholds.
- **Seawater intrusion**. Not applicable.
- **Subsidence**. Not applicable.

3.7.3.4 Effect of Minimum Thresholds on Neighboring Basins

The anticipated effect of the depletion of interconnected surface water minimum thresholds on each of the neighboring basins is addressed below.

Santa Cruz Mid-County Basin (critically-overdrafted). The Santa Margarita Basin is upstream of the Santa Cruz Mid-County Basin. The San Lorenzo River does not run through the Santa Cruz Mid-County Basin, but the West Branch of Soquel Creek and ~~Carbonera Creek~~Blackburn

Gulch/Branciforte Creek do. Only a very small portion of the West Branch of Soquel Creek runs through the Santa Margarita Basin~~ and Carbonera Creek is largely disconnected from groundwater~~ (Figure 2-~~70~~25). By maintaining groundwater levels above historical levels in areas near interconnected streams, the minimum thresholds do not prevent the Santa Cruz Mid-County Basin from meeting their respective surface water depletion minimum thresholds which are based on groundwater elevations slightly higher than historical lows. Groundwater flow between the Santa Cruz Mid-County Basin and the Santa Margarita Basin is limited, and there are no GSP projects or management actions planned for either basin that might change hydraulic gradients near the basins’ shared boundary. The lack of connection between the Santa Cruz Mid-County Basin’s primary aquifer (Purisima Formation) and the Santa Margarita Basin’s primary aquifers (Santa Margarita, Lompico and Butano aquifers) further reduces the likelihood of either basin affecting depletion of interconnected surface water minimum thresholds in the neighboring basin.

Purisima Highlands Subbasin of the Corralitos Basin (very low priority). The Purisima Highlands Subbasin is hydraulically upgradient from the Santa Margarita Basin and separated by the Zayante-Vergeles fault zone which acts as a barrier to groundwater flow. This hydrogeologic disconnect provides little opportunity for depletion of interconnected surface water in the Santa Margarita Basin to influence groundwater in the Purisima Highlands Subbasin.

West Santa Cruz Terrace Basin (very low priority). Most private domestic wells in the West Santa Cruz Terrace Basin pump from low yielding Quaternary alluvium and terrace deposits (DWR, 2003). These deposits are not principal aquifers in the Santa Margarita Basin nor are they hydraulically downgradient of the Santa Margarita Basin. Therefore, it is unlikely that the depletion of interconnected surface water minimum thresholds in the Santa Margarita Basin would influence the West Santa Cruz Terrace Basin.

3.7.3.5 Effects of Minimum Thresholds on Beneficial Users and Land Uses

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 Basin, will maintain historical levels of surface water depletion. Maintaining 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 minimum thresholds will benefit land and beneficial water use in the Basin:

- **Urban land uses and users**. Municipal groundwater pumpers will still be able to meet their typical water demands if surface water interconnection with groundwater remains similar to historical levels. The City of Santa Cruz as a user of Basin surface water and implementor of habitat conservation in the San Lorenzo River watershed relies on baseflows to help achieve the Agreed Flows described in Section 2.1.4.2.8.

If groundwater levels adjacent to creeks are no lower than historical levels, baseflows should remain within the historical range of flows used to determine the Agreed Flows.

- **Rural residential 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. This protects their ability to pump from domestic wells in the vicinity of creeks.
- **Industrial land uses and users**. Maintaining surface water interconnection with groundwater should benefit industrial land uses and beneficial users by supporting similar groundwater pumping to historical levels.
- **Agricultural land uses and users**. For the very limited agriculture in the Basin, maintaining interconnection of surface water and groundwater at historical levels should not impact irrigation water supply.
- **Ecological land uses and users**. The main benefit of the surface water depletion minimum thresholds is to GDEs for priority species. Meeting minimum thresholds for depletion of surface water allows for continuing gaining surface water in the vicinity of the RMPs. Based on historical conditions, these groundwater levels are considered sufficient to support GDEs for priority species.

3.7.3.6 Relevant Federal, State, or Local Standards

No explicit federal, state, or local standards exist for depletion of interconnected surface water. However, both the Central Coast RWQCB and state and federal endangered species provisions call for the protection and restoration of conditions necessary for steelhead and coho salmon habitat in San Lorenzo River. These provisions were considered in development of the surface water depletion minimum thresholds.

3.7.3.7 Method for Quantitative Measurement of Minimum Thresholds

Groundwater elevations will be measured in 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 3.3.2.1.

In addition to the direct measurement of groundwater levels, GDE monitoring described in Section 3.3.1.5.1 will be compared to proxy groundwater levels in an effort to correlate vegetation vigor with groundwater levels.

3.7.4 Measurable Objectives - Depletion of Interconnected Surface Water

3.7.4.1 Measurable Objectives

Measurable objectives are established to define an achievable average groundwater level in the depletion of interconnected surface water RMPs. The measurable objectives for the Santa Margarita aquifer surface water depletion RMPs are the annual minimum groundwater levels in each RMP from the fall of WY 2004.

Measurable objectives are based on groundwater levels that occurred in a historical average year. The average year selected is WY2004 because WY2004 and the 5 prior years cumulatively average 41 inches per year, which is similar to the average precipitation of 41.7 inches between 1947 and 2020 measured at the El Pueblo Yard in Scotts Valley. The prior 5 years comprise 4 normal and 1 dry water year.

Measurable objectives for depletion of interconnected surface water RMPs are summarized in Table 3-22 and hydrographs showing historical groundwater elevation data compared to the measurable objective are provided in Appendix 3A.

3.7.4.2 Interim Milestones

Recent groundwater levels are close to the measurable objective at both depletion of interconnected surface water RMPs. Because the 540 AFY expanded conjunctive use project used to develop the measurable objectives targets the Lompico aquifer, the RMPs in the Santa Margarita aquifer are predicted to have very small increases in groundwater levels. Interim milestones are therefore set at the same elevations as measurable objectives shown in Table 3-22.

3.8 Land Subsidence Sustainable Management Criteria

The land subsidence sustainability indicator is not applicable in the Basin as an indicator of groundwater sustainability and therefore no SMC are set. Section 2.2.5.5: Land Subsidence provides substantiating evidence for subsidence’s inapplicability as an indicator of groundwater sustainability. Even though the indicator is not applicable, the SMGWA Board agreed that any land subsidence caused by lowering of groundwater levels occurring in the Basin would be considered significant and unreasonable.

If, during GSP implementation, the Basin experiences conditions of inelastic subsidence specifically due to groundwater use, the SMGWA would develop land subsidence SMC in an update to the GSP.