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3 SUSTAINABILITY MANAGEMENT CRITERIA

This section defines the conditions that direct sustainable groundwater management in the Santa Cruz Mid-County Basin, discusses the process by which the MGA characterizes undesirable results, and establishes minimum thresholds and measurable objectives for each sustainability indicator. The undesirable results, minimum thresholds, and measurable objectives define the Basin's future conditions and commits the MGA to meet these objectives. Defining Sustainable Management Criteria (SMC) requires a significant level of analysis and scrutiny, and this section includes explanation of how SMC were developed and how they influence all beneficial uses and users of groundwater.

3.1 Sustainability Goal

As required by the SGMA regulations, the MGA developed a sustainability goal for the Basin, which is to:

> Manage the groundwater Basin to ensure beneficial uses and users have access to a safe and reliable groundwater supply that meets current and future Basin demand without causing undesirable results and:

- Ensures groundwater is available for beneficial uses and a diverse population of beneficial users;
- Protects groundwater supply against seawater intrusion;
- Prevents groundwater overdraft within the Basin and resolves problems resulting from prior overdraft;
- Maintains or enhances groundwater levels where groundwater dependent ecosystems exist;
- Maintains or enhances groundwater contributions to streamflow;
- Supports reliable groundwater supply and quality to promote public health and welfare;
- Ensures operational flexibility within the Basin by maintaining a drought reserve;
- Accounts for changing groundwater conditions related to projected climate change and sea level rise in Basin planning and management; and,
- Does no harm to neighboring groundwater basins in regional efforts to achieve groundwater sustainability.

3.2 Sustainable Management Criteria

This section defines the groundwater conditions that constitute sustainable groundwater management, discusses the process by which the MGA characterizes undesirable results, and establishes minimum thresholds and measurable objectives for each applicable sustainability indicator. Undesirable results, minimum thresholds, and measurable objectives together define sustainable conditions in the Basin and commit the MGA to actions that will achieve those conditions.

Defining Sustainable Management Criteria (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 become available.

This section is organized to address all of the SGMA regulations regarding SMC. To retain an organized approach that focuses on SMC for each individual sustainability indicators, the SMC are grouped by 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 BMP (DWR, 2017). Each Sustainable Management Criteria section includes a description of:

- How locally defined significant and unreasonable conditions were developed.
- How undesirable results were developed, 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)).
- How minimum thresholds were developed, 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)).
- How measurable objectives were developed, including:
    - The methodology for setting measurable objectives (§354.30).
    - Interim milestones (§354.30 (a), §354.30 (e), §354.34 (g)(3)).

3.2.1 Sustainable Management Criteria Definitions

Definitions of undesirable results, minimum thresholds, measurable objectives, and interim milestones are provided below:

Undesirable Results: Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators defined by the Sustainable Groundwater Management Act (SGMA) are caused by groundwater conditions occurring in the Basin. Undesirable results are included as SMC as a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin. Undesirable results may be defined by minimum threshold exceedances at a single monitoring site, multiple monitoring sites, a portion of a basin, a management area, or an entire basin.

Minimum Thresholds: Minimum thresholds are quantitative values that represent groundwater conditions at representative monitoring points. Minimum thresholds are used to define undesirable results.

Measurable Objectives: Measurable objectives are quantitative goals that reflect the MGA's desired groundwater conditions in the Basin and will guide the MGA to achieve its sustainability goal within 20 years. Measurable objectives are set for each sustainability indicator at the same representative monitoring points and using the same metrics as minimum thresholds.

Measurable Objectives are set so there is a reasonable margin of operational flexibility between the minimum threshold and measurable objective that will accommodate droughts, climate change, conjunctive use operations, or other groundwater management activities.

For some sustainability indicators, projects and management actions are needed to achieve measurable objectives. Although measurable objectives are not enforceable during implementation of the GSP, the GSP needs to demonstrate that there is a planned path toward achieving measurable objectives.

Interim Milestones: Interim milestones are defined in five-year increments at each monitoring site using the same metrics as the measurable objectives and minimum thresholds. Interim milestones will be used by the MGA and the Department of Water Resources (DWR) to track progress toward meeting the Basin's Sustainability Goal. Interim milestones are coordinated with projects and management actions proposed by the MGA to achieve the sustainability goal.

3.2.2 Process of Developing Sustainable Management Criteria

Development of SMC involved initial proposals by staff, followed by discussion and refinement by the GSP Advisory Committee over multiple meetings. Prior to discussing SMCs for a particular sustainability indicator with the GSP Advisory Committee, the members were provided background information on the status of the indicator in the Basin and a brief on the groundwater conditions pertaining to the indicator. This information was provided both in written materials included in the meeting agenda packet and a presentation that was made during the meeting. Discussion during the meeting facilitated additional information sharing and clarity. Once there was comfort in understanding Basin conditions related to the sustainability indicator, the technical consultant described possible options or proposals for indicator specific significant and unreasonable groundwater conditions that indicate the Basin was unsustainable.

Based on the qualitative statement of significant and unreasonable conditions that was formed by the Committee, the same approach of providing several options for the quantitative criteria: undesirable results and minimum thresholds, were provided to the GSP Advisory Committee for consideration. This approach was taken so that it could be understood that within the various options, there are relative levels of protectiveness. Meeting summaries posted on the MGA website reflect the discussions that took place for each sustainability indicator.

Farther along in the SMC development process when minimum thresholds were generally agreed upon, options for measurable objectives were presented and discussed by the Committee. Several iterations of providing options were afforded each sustainability indicator which allowed for continual improvements to the criteria. Additionally, opportunities for public comment on the topics being discussed at the GSP Advisory Committee meetings were provided and taken into consideration during development of the SMCs.

Interim milestones were developed based on current conditions and modeled groundwater levels and did not have direct GSP Advisory Committee input.

3.3 Monitoring Network

This subsection describes the monitoring networks that currently exist in the Basin to monitor Basin conditions and that will continue to be used during GSP implementation, Representative Monitoring Points (RMPs) for which sustainable management criteria are set, and improvements to the monitoring networks that will be made as part of GSP implementation. It also includes a description of monitoring objectives, monitoring protocols, and data requirements. The monitoring network subsection is before the sustainability management criteria (SMC) subsection because it is important to describe the representative monitoring networks that measure Basin sustainability before SMC associated with the RMPs in the networks are provided.

The monitoring networks included in this subsection are based on existing monitoring networks described generally in Section 2.1.2: Water Resources Monitoring and Management Programs. To be able to relate monitoring features to sustainability indicators, monitoring networks are described below for each of the information types that are needed to evaluate the applicable sustainability indicators.

3.3.1 Description of Monitoring Networks

The SGMA regulations require monitoring networks be developed to promote the collection of data of sufficient quality, frequency, and spatial distribution to characterize groundwater and related surface water conditions in the Basin, and to evaluate changing conditions that occur during implementation of the GSP. Monitoring networks should accomplish the following:

- Demonstrate progress toward achieving measurable objectives described in the GSP.
- Monitor impacts to the 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 Santa Cruz Mid-County Basin existing monitoring networks have been used for several decades to collect information to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions. The monitoring networks include features for the collection of data to monitor the five groundwater sustainability indicators that are applicable to the Basin: chronic lowering of groundwater levels, seawater intrusion, depletion of interconnected surface water, reduction of groundwater storage, and degraded groundwater quality (Table 3-1). As discussed in Section 2: Basin Setting, land subsidence is not an applicable sustainability indictor in the Basin and therefore monitoring of land surface elevations is not included in the current monitoring network. Section 3.3.1.5 does however include a source of monitoring data for land surface elevations in the Basin that is provided for by public agencies not part of the MGA.

Table 3-1. Applicable Sustainability Indicators in the Santa Cruz Mid-County Basin

Sustainability Indicator	Metric	Proxy
Chronic Lowering of Groundwater Levels	Groundwater elevation	-
Reduction of Groundwater Storage	Volume of groundwater extracted	-
Seawater Intrusion	Chloride concentration	Groundwater elevation
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 MGA member agency has their own network of dedicated monitoring wells and production wells that monitor groundwater elevations in their service area or area of jurisdiction. Many of these monitoring sites have been used to manage the Basin since the 1980's which was prior to completion of the 1995 Groundwater Management Plan that covered the Soquel-Aptos area. These individual networks are combined into the Groundwater Management (GMP) monitoring network, as described in Section 2.1.2: Water Resources Monitoring and Management Programs. The GMP monitoring network has been added to and maintenance of the network has included replacing monitoring wells when they are damaged. Almost all monitoring wells and all production wells have data loggers to continuously monitor groundwater levels. Shallow monitoring wells used to monitor surface water / groundwater interactions are also included.

Table 3-2 summarizes the number of wells included in the existing extensive GMP monitoring network across the Basin to monitor groundwater levels. Figure 3-1 is a map showing the basin-wide distribution of groundwater level monitoring wells. The aquifers monitored by each well with their frequency of monitoring are listed in Table 3-3. With 174 wells in the Basin monitored at least twice a year, the network is demonstrably extensive and sufficient to evaluate short-term, seasonal, and long-term trends in groundwater for groundwater management purposes. Groundwater level data from many of the wells have been used since 2006 to generate fall and spring groundwater elevation contours for all of the Basin's aquifers. As there are multiple well clusters with monitoring wells completed in different aquifers at the same location included throughout the Basin, these are used to understand changes in vertical gradients between aquifers.

Table 3-2. Summary of MGA Member Agency Monitoring Well Network for Groundwater Levels

Member Agency	Number of Wells			
	Monitoring Wells	Production Wells	Total in Network	Representative Monitoring Wells
City of Santa Cruz	34	4	38	7
Soquel Creek Water District	80	18	98	26
Central Water District	6	3	9	2
Santa Cruz County	0	27	27	2
Total	*116*	*52*	*168*	*37*

Note: each well in a cluster of multi-depth wells is counted as a separate well

The groundwater level monitoring network accomplishes the following for each sustainability indicator that relies on groundwater levels either directly or using groundwater levels as a proxy to determine Basin sustainability:

- Chronic Lowering of Groundwater Levels: Monitoring wells are distributed throughout the Basin in all the aquifers used for groundwater production, and the distribution of wells is sufficient to develop groundwater elevation contours for each aquifer.

- Seawater Intrusion: The monitoring network includes coastal monitoring wells that are used to monitor seawater intrusion through groundwater quality and groundwater levels as a proxy. Each location has multiple monitoring wells completed at different depths within the productive aquifers. Protective groundwater elevations are established at each of these locations to prevent seawater intrusion. Two additional monitoring wells, one in the Tu-unit and one in the Purisima AA-unit, are needed to complete the monitoring network as described in Section 3.3.4.1: Groundwater Level Monitoring Data Gaps.

- Depletion of Interconnected Surface Water: The current shallow monitoring wells used to monitor and evaluate interactions between surface water and groundwater are focused on the lower stretch of Soquel Creek where there are several nearby municipal production wells. In addition, there are multiple depth monitoring well clusters near Soquel Creek that are included in the evaluation of surface water and groundwater interactions.

Each agency will use their own resources to continue to monitor these wells as the GSP is implemented. Groundwater level data collected, both hand soundings and recorded by data loggers, for each well will be stored in the WISKI DMS.

The only data gaps that exist for the groundwater level monitoring network are two deep coastal monitoring wells to monitor seawater intrusion in the Tu and Purisima AA aquifers, and eight shallow monitoring wells to monitor depletion of interconnected surface water. These are discussed in more detail in Section 3.3.4.1: Groundwater Level Monitoring Data Gaps.

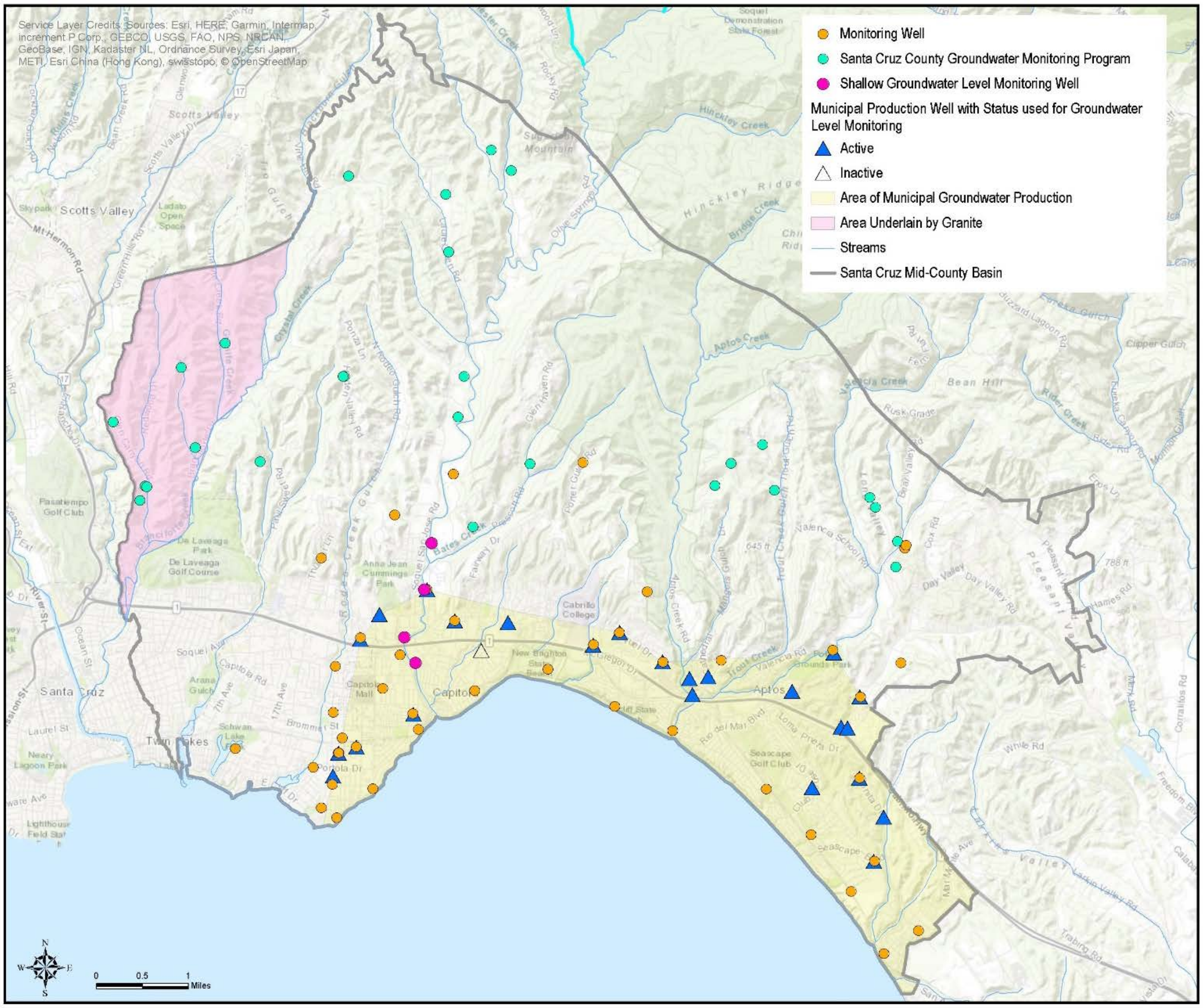


Figure 3-1. Location of Existing Basin-Wide Wells Used for Groundwater Level Monitoring

Table 3-3. Monitoring Wells for Groundwater Levels in the Santa Cruz Mid-County Basin

Aquifer Unit	Well Name	Monitoring Agency	Sounding Frequency	Data Logger
Shallow Well for Surface Water Interactions	**Balogh** [3]	SqCWD	Quarterly	y
	Main St Shallow [3]	SqCWD	Quarterly	y
	Wharf Road [3]	SqCWD	Quarterly	y
	Nob Hill [3]	SqCWD	Quarterly	y
Various	27 Private Domestic Wells Unnamed for Privacy Reasons **(2 wells used as RMPs)**	Santa Cruz County	Semi- Annually	n

Aquifer Unit	Well Name	Monitoring Agency	Sounding Frequency	Data Logger
Aromas	SC-A1C	SqCWD	Quarterly	y
	SC-A1D	SqCWD	Quarterly	y
	SC-A2RC	SqCWD	Quarterly	y
	SC-A3A [2]	**SqCWD**	**Quarterly**	**y**
	SC-A3B	SqCWD	Quarterly	y
	SC-A3C	SqCWD	Quarterly	y
	SC-A5C	SqCWD	Quarterly	y
	SC-A5D	SqCWD	Quarterly	y
	SC-A6C	SqCWD	Monthly	n
	SC-A7C [3]	**SqCWD**	**Monthly**	**n**
	SC-A7D	SqCWD	Monthly	n
	SC-A8B	SqCWD	Quarterly	y
	SC-A8C	SqCWD	Quarterly	y
	CWD-A	CWD	Quarterly	n
	CWD-B	CWD	Quarterly	n
	CWD-10 PW	CWD	Monthly	n
Aromas/ Purisima F	Polo Grounds PW	SqCWD	Annually	y
	Aptos Jr. High 2 PW	SqCWD	Annually	y
	Country Club PW	SqCWD	Annually	y
	Bonita PW	SqCWD	Annually	y
	San Andreas PW	SqCWD	Annually	y
	Seascape PW	SqCWD	Annually	y
	CWD-4 PW	CWD	Monthly	y
	CWD-12 PW	CWD	Monthly	y
Purisima F	SC-20A	SqCWD	Quarterly	y
	SC-20B	SqCWD	Quarterly	y
	SC-20C	SqCWD	Quarterly	y
	SC-23C [3]	**SqCWD**	**Quarterly**	**y**
	SC-8RF	SqCWD	Quarterly	y
	SC-A1B [2]	**SqCWD**	**Quarterly**	**y**
	SC-A2RA [2]	**SqCWD**	**Quarterly**	**y**
	SC-A2RB	SqCWD	Quarterly	y
	SC-A4A	SqCWD	Quarterly	y

Aquifer Unit	Well Name	Monitoring Agency	Sounding Frequency	Data Logger
	SC-A4B	SqCWD	Quarterly	y
	SC-A5A	SqCWD	Quarterly	y
	SC-A5B	SqCWD	Quarterly	y
	SC-A6A	SqCWD	Quarterly	n
	SC-A6B	SqCWD	Quarterly	n
	SC-A7A	SqCWD	Monthly	n
	SC-A7B	SqCWD	Monthly	n
	SC-A8A [2]	**SqCWD**	**Quarterly**	**y**
	CWD-C	CWD	Quarterly	n
	Black [3]	**CWD**	**Monthly**	**n**
	CWD-3	CWD	Monthly	n
	CWD-5 [3]	**CWD**	**Monthly**	**y**
Purisima DEF	**SC-8RD** [2]	**SqCWD**	**Quarterly**	**y**
	SC-8RE	SqCWD	Quarterly	y
	SC-9RE	SqCWD	Quarterly	y
	SC-11RD [3]	**SqCWD**	**Quarterly**	**y**
	SC-17C	SqCWD	Monthly	n
	SC-17D	SqCWD	Monthly	n
	SC-23B [3]	**SqCWD**	**Quarterly**	**y**
	SC-A1A	SqCWD	Quarterly	y
	T. Hopkins PW	SqCWD	Annually	y
	Granite Way PW	SqCWD	Annually	y
Purisima BC	SC-1B	SqCWD	Monthly April – Nov, otherwise Quarterly	y
	SC-3RC	SqCWD	Quarterly	y
	SC-5RC	SqCWD	Quarterly	y
	SC-8RB [2]	**SqCWD**	**Quarterly**	**y**
	SC-8RC	SqCWD	Quarterly	y
	SC-9RC [2]	**SqCWD**	**Quarterly**	**y**
	SC-11RB [3]	**SqCWD**	**Quarterly**	**y**
	SC-14B	SqCWD	Monthly	n
	SC-14C	SqCWD	Monthly	n
	SC-16B	SqCWD	Monthly	n
	SC-17B	SqCWD	Monthly	n

Aquifer Unit	Well Name	Monitoring Agency	Sounding Frequency	Data Logger
	SC-19 [3]	**SqCWD**	**Monthly**	**n**
	SC-23A [3]	**SqCWD**	**Quarterly**	**y**
	Madeline PW	SqCWD	Annually	y
	Ledyard PW	SqCWD	Twice monthly	n
	Aptos Creek PW	SqCWD	Annually	y
Purisima B	SC-3RB	SqCWD	Quarterly	y
	SC-5RB	SqCWD	Quarterly	y
Purisima A	**SC-1A** [2]	**SqCWD**	**Monthly April – Nov, otherwise Quarterly**	**y**
	SC-5RA [2]	**SqCWD**	**Quarterly**	**y**
	SC-8RA	SqCWD	Quarterly	y
	SC-9RA	SqCWD	Quarterly	y
	SC-10RA [1]	SqCWD	Quarterly	y
	SC-15B	SqCWD	Quarterly	y
	SC-17A	SqCWD	Monthly	n
	SC-21A	SqCWD	Quarterly	y
	SC-22A [3]	**SqCWD**	**Monthly April – Nov, otherwise Quarterly**	**y**
	Tannery 2 PW	SqCWD	Annually	y
	Monterey PW	SqCWD	Twice monthly	n
	Estates PW	SqCWD	Annually	y
	Garnet PW	SqCWD	Annually	y
	Main St. PW	SqCWD	Annually	y
	Rosedale PW	SqCWD	Annually	y
	Corcoran Lagoon Medium	City	Monthly	y
	Corcoran Lagoon Shallow	City	Monthly	n
	Moran Lake Medium [2]	**City**	**Monthly**	**y**
	Moran Lake Shallow	City	Monthly	n
	Beltz #2	City	Monthly	y
	Beltz #4 Deep	City	Monthly	y
	Beltz #4 Shallow	City	Monthly	n
	Soquel Point Shallow	City	Monthly	n
	Soquel Point Medium [2]	**City**	**Monthly**	**y**
	Pleasure Point Medium [2]	**City**	**Monthly**	**y**
	Pleasure Point Shallow	City	Monthly	n

Aquifer Unit	Well Name	Monitoring Agency	Sounding Frequency	Data Logger
	Coffee Lane Shallow [3]	**City**	**Monthly**	**y**
	Auto Plaza Med	City	Monthly	y
	Auto Plaza Shallow	City	Monthly	n
	Cory Street Medium	City	Monthly	y
	Cory Street Shallow	City	Monthly	n
	30th Ave Shallow	City	Monthly	y
	Beltz #8 PW	City	Annually	y
	Beltz #9 PW	City	Annually	y
	Beltz #7 Shallow	City	Monthly	n
	Beltz #6	City	Monthly	n
Purisima A/AA	SC-11RA	SqCWD	Quarterly	y
	SC-14A	SqCWD	Monthly	n
	SC-16A	SqCWD	Quarterly	y
	SC-3RA [2]	**SqCWD**	**Quarterly**	**y**
	Beltz #10 PW	City	Annually	y
	Beltz #7 Deep	City	Monthly	n
Purisima AA	**SC-10RAA [3]**	**SqCWD**	**Quarterly**	**y**
	SC-15A	SqCWD	Quarterly	y
	SC-18RA	SqCWD	Quarterly	y
	SC-21AA	SqCWD	Quarterly	y
	SC-21AAA	SqCWD	Quarterly	y
	SC-22AA [3]	**SqCWD**	**Monthly April – Nov, otherwise Quarterly**	**y**
	SC-22AAA	SqCWD	Quarterly, with Monthly visits April - Nov	y
	Corcoran Lagoon Deep	City	Monthly	y
	Moran Lake Deep [2]	**City**	**Monthly**	**y**
	Soquel Point Deep [2]	**City**	**Monthly**	**y**
	Pleasure Point Deep [2]	**City**	**Monthly**	**y**
	Schwan Lake	City	Monthly	y
	Coffee Lane Deep	City	Monthly	y
	Auto Plaza Deep	City	Monthly	y
	Cory Street Deep	City	Monthly	y
	30th Ave Medium	City	Monthly	y

Aquifer Unit	Well Name	Monitoring Agency	Sounding Frequency	Data Logger
	Thurber Lane Shallow	City	Monthly	y
Purisima AA/Tu	Beltz #12 PW	City	Annually	y
	O'Neill Ranch PW	SqCWD	Annually	y
Tu	SC-10AAA	SqCWD	Quarterly	y
	SC-13A [2]	**SqCWD**	**Quarterly**	**y**
	SC-18RAA	SqCWD	Quarterly	y
	Cory Street-4	City	Monthly	y
	30th Ave Deep	City	Monthly	y
	Beltz #7 Santa Margarita Test	City	Monthly	y
	Thurber Lane Deep	City	Monthly	y

PW = production well; City = City of Santa Cruz, SqCWD = Soquel Creek Water District; CWD = Central Water District; monitoring wells in bold are representative monitoring points (RMP) for groundwater elevations; [1] = RMP for depletion of interconnected surface water; [2] = RMP for seawater intrusion; [3] = RMP for chronic lowering of groundwater levels

3.3.1.2 Groundwater Quality Monitoring Network

Each MGA member agency monitors a network of dedicated monitoring wells and production wells for groundwater quality in their service area or area of jurisdiction. These monitoring sites have been used to manage the Basin and added to since the 1980's which was prior to completion of the 1995 Groundwater Management Plan that covered the Soquel-Aptos area. Table 3-4 summarizes the wells included in the existing extensive monitoring network across the Basin. A map showing the distribution of monitoring wells used to sample groundwater quality is shown on Figure 3-2, and the aquifers monitored by each well with their frequency of sampling are listed in Table 3-5. There is no established inland groundwater quality monitoring network within the areas outside of the MGA member water supply agency sphere of influence where predominantly private domestic and agricultural extractions take place. As described in Section 2: Basin Setting, groundwater quality in the inland Purisima aquifer areas of the Basin is very good, with the exception of occasional low concentrations of native arsenic, and elevated naturally occurring iron and manganese. The Aromas area of the Basin is more susceptible to surface sources of contamination because the underlying aquifers are unconfined and highly permeable. The distribution and sampling frequency of monitoring and production wells used for sampling groundwater quality reflects locational and aquifer depth susceptibility to contamination, including from seawater. Iron and manganese are sampled more frequently in municipal production wells as a necessary step in the iron and manganese treatment process.

Table 3-4. Summary of MGA Member Agency Monitoring Well Network for Groundwater Quality

Member Agency	Number of Wells			
	Monitoring Wells	Production Wells	Total in Network	Representative Monitoring Wells
City of Santa Cruz	28	4	37	18
Soquel Creek Water District	51	18	69	48
Central Water District	0	3	3	3
Total	*79*	*25*	*104*	*69*

Note: each well in a cluster of multi-depth wells is counted as a separate well

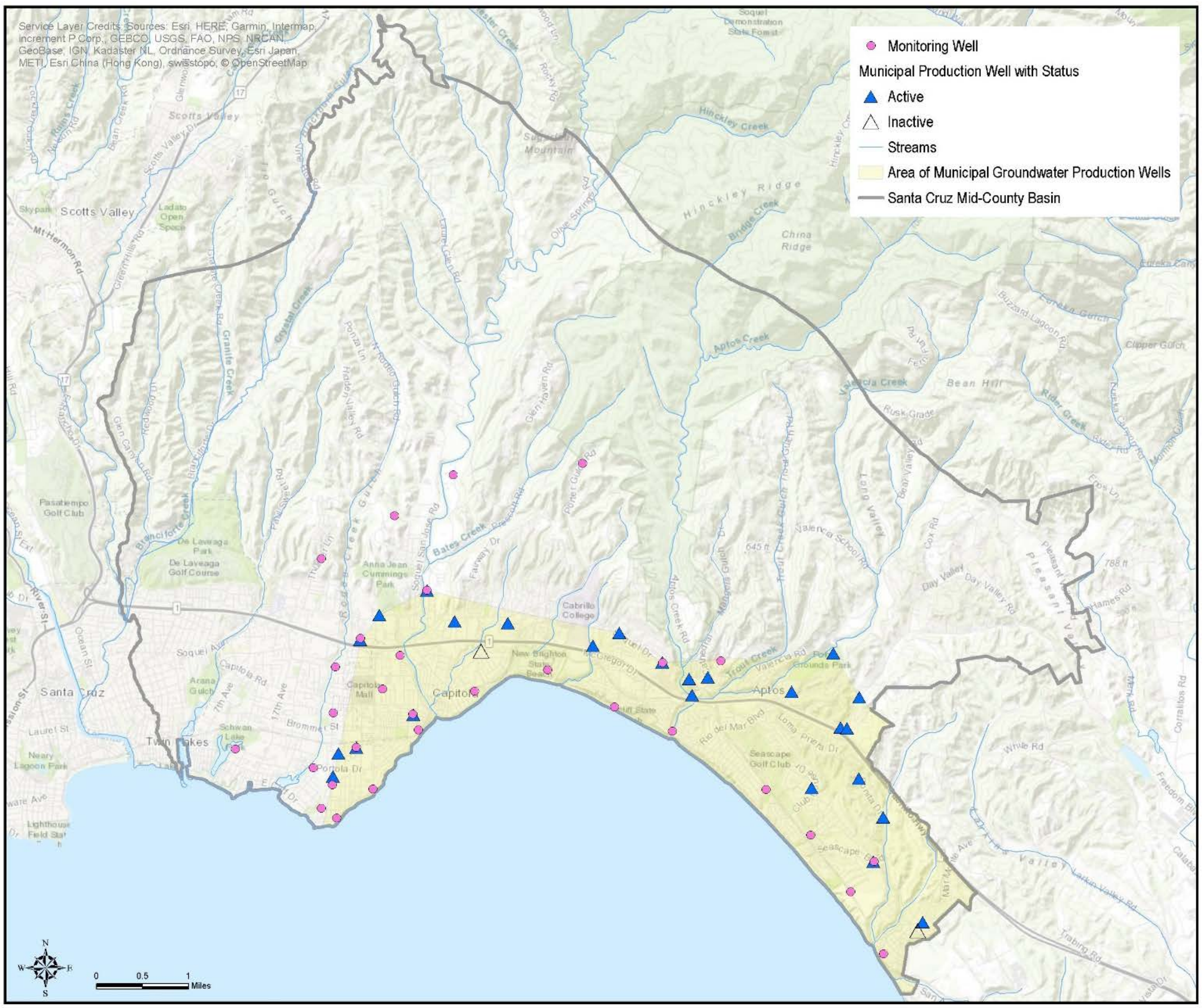


Figure 3-2. Location of Basin-Wide Wells Used for Groundwater Quality Monitoring

Table 3-5. Monitoring Wells for Groundwater Quality in the Santa Cruz Mid-County Basin

Aquifer Unit	Well Name	General Mineral Sampling Frequency	Chloride and TDS Sampling Frequency
Aromas	Altivo PW	Semi-Annually	Quarterly
	CWD-10 PW [1]	**Triennial, nitrate as (N) Annually**	**Triennial**
	SC-A1C [1]	**Annually**	**Quarterly**
	SC-A1D	Semi-Annually	Quarterly
	SC-A2RC [1]	**Semi-Annually**	**Quarterly**
	SC-A3A [1 2]	**Annually**	**Quarterly**
	SC-A3B [2]	**Annually**	**Quarterly**
	SC-A3C [1]	**Annually**	**Quarterly**
	SC-A5C	Semi-Annually	Quarterly
	SC-A5D	Annually	Quarterly
	SC-A8B [1 2]	**Semi-Annually**	**Quarterly**
	SC-A8C [1]	**Annually**	**Quarterly**
Aromas/ Purisima F	**Polo Grounds PW [1]**	**Semi-Annually, nitrate (as N) Annually**	**Quarterly**
	Aptos Jr. High 2 PW [1]	**Semi-Annually, nitrate (as N) Annually**	**Quarterly**
	Country Club PW [1]	**Semi-Annually, nitrate (as N) Annually**	**Quarterly**
	Bonita PW [1]	**Semi-Annually, nitrate (as N) Annually**	**Quarterly**
	San Andreas PW [1 2]	**Semi-Annually, nitrate (as N) Annually**	**Quarterly**
	Seascape PW [1 2]	**Semi-Annually, nitrate (as N) Annually**	**Quarterly**
Purisima F	**CWD-4 PW [1]**	**Triennial, nitrate as (N) Annually**	**Triennial**
	CWD-12 PW [1]	**Triennial, nitrate as (N) Annually**	**Triennial**
	SC-23C	Annually	Semi-Annually
	SC-8RF	Annually	Semi-Annually
	SC-A1B [2]	**Annually**	**Semi-Annually**
	SC-A2RA [1 2]	**Annually**	**Quarterly**
	SC-A2RB [2]	**Semi-Annually**	**Quarterly**
	SC-A5A [2]	**Annually**	**Quarterly**
	SC-A5B [2]	**Annually**	**Quarterly**
	SC-A8A [1 2]	**Annually**	**Quarterly**
Purisima	**T-Hopkins PW [1 2]**	**Annually**	**Annually**

Aquifer Unit	Well Name	General Mineral Sampling Frequency	Chloride and TDS Sampling Frequency
DEF	**Granite Way PW [1]**	**Annually**	**Annually**
	SC-8RD [1 2]	**Annually**	**Semi-Annually**
	SC-8RE	Annually	Semi-Annually
	SC-9RE [1]	**Annually**	**Semi-Annually**
	SC-11RD	Semi-Annually	Semi-Annually
	SC-23B	Annually	Annually
	SC-A1A [1 2]	**Semi-Annually**	**Quarterly**
Purisima BC	**Ledyard PW [1 2]**	**Annually**	**Annually**
	Madeline PW [1]	**Annually**	**Annually**
	Aptos Creek PW [1]	**Annually**	**Annually**
	SC-3RC [1]	**Annually**	**Semi-Annually**
	SC-23A [1]	**Annually**	**Annually**
	SC-8RB [1 2]	**Semi-Annually**	**Semi-Annually**
	SC-8RC	Semi-Annually	Semi-Annually
	SC-9RC [1 2]	**Annually**	**Semi-Annually**
	SC-11B	Annually	Semi-Annually
	SC-17B	Annually	Semi-Annually
Purisima B (Aquitard)	SC-3RB	Annually	Annually
	SC-5RB	Annually	Annually
Purisima A	**30th Ave Shallow [1]**	**Semi-Annually**	**Semi-Annually**
	Auto Plaza Medium	Semi-Annually	Semi-Annually
	Auto Plaza Shallow	Semi-Annually	Semi-Annually
	Corcoran Lagoon Medium	Semi-Annually	Semi-Annually
	Corcoran Lagoon Shallow	Semi-Annually	Semi-Annually
	Cory Street Medium	Semi-Annually	Semi-Annually
	Cory Street Shallow	Semi-Annually	Semi-Annually
	Pleasure Point Medium [2]	**Quarterly**	**Quarterly**
	Pleasure Point Shallow [1]	**Quarterly**	**Quarterly**
	Beltz #2 [2]	**Semi-Annually**	**Semi-Annually**
	Moran Lake Medium [2]	**Quarterly**	**Quarterly**
	Moran Lake Shallow	Quarterly	Quarterly
	Soquel Point Medium [2]	**Quarterly**	**Quarterly**
	Soquel Point Shallow	Quarterly	Quarterly

Aquifer Unit	Well Name	General Mineral Sampling Frequency	Chloride and TDS Sampling Frequency
	Tannery II PW [1]	**Annually**	**Annually**
	Estates PW [1,2]	**Annually**	**Annually**
	Main Street PW [1]	**Annually**	**Annually**
	Rosedale 2 PW [1]	**Annually**	**Annually**
	Garnet PW [1,2]	**Annually**	**Annually**
	Beltz #6	Semi-Annually	Semi-Annually
	Beltz #8 PW [1,2]	**Triennial, iron & manganese quarterly, nitrate (as N) Annually**	**Triennial**
	Beltz #9 PW [1]	**Triennial, iron & manganese quarterly, nitrate (as N) Annually**	**Triennial**
	SC-1A [2]	**Annually**	**Annually**
	SC-3RA [2]	**Annually**	**Annually**
	SC-5RA [1,2]	**Semi-Annually**	**Semi-Annually**
	SC-8RA	Quarterly	Quarterly
	SC-9RA [1]	**Quarterly**	**Quarterly**
	SC-10RA [1]	**Annually**	**Annually**
	SC-21A	Annually	Annually
	SC-22A [1]	**Annually**	**Annually**
Purisima A/AA	**Beltz #10 PW [1]**	**Triennial, iron & manganese quarterly, nitrate (as N) Annually**	**Triennial**
	SC-11RA	Annually	Annually
Purisima AA	**SC-10RAA [1]**	**Annually**	**Annually**
	SC-18RA	Annually	Annually
	SC-21AA	Annually	Annually
	SC-21AAA	Quarterly	Quarterly
	SC-22AA [2]	**Semi-Annually**	**Quarterly**
	SC-22AAA [1]	**Semi-Annually**	**Quarterly**
	30th Ave Medium	Semi-Annually	Semi-Annually
	Auto Plaza Deep	Semi-Annually	Semi-Annually
	Coffee Lane Deep [1]	**Semi-Annually**	**Semi-Annually**
	Corcoran Lagoon Deep [2]	**Semi-Annually**	**Semi-Annually**
	Cory Street Deep	Semi-Annually	Semi-Annually
	Pleasure Point Deep [1,2]	**Quarterly**	**Quarterly**

Aquifer Unit	Well Name	General Mineral Sampling Frequency	Chloride and TDS Sampling Frequency
	Moran Lake Deep [2]	**Quarterly**	**Quarterly**
	Soquel Point Deep [2]	**Quarterly**	**Quarterly**
	Thurber Lane Shallow [1]	**Semi-Annually**	**Semi-Annually**
	Schwan Lake [1] [2]	**Semi-Annually**	**Semi-Annually**
Purisima AA/Tu	**O'Neill Ranch PW [1]**	**Annually**	**Annually**
	Beltz #12 PW [1]	**Triennial, iron & manganese quarterly, nitrate (as N) Annually**	**Triennial**
Tu	30th Ave Deep	Semi-Annually	Semi-Annually
	Cory Street-4	Semi-Annually	Semi-Annually
	Thurber Lane Deep [1]	**Semi-Annually**	**Semi-Annually**
	SC-10RAAA	Semi-Annually	Semi-Annually
	SC-13A [2]	**Quarterly**	**Quarterly**
	SC-18RAA [1]	**Semi-Annually**	**Quarterly**

PW = production well; monitoring wells in bold are representative monitoring points (RMP) for groundwater quality; [1] = RMP for degraded groundwater quality; [2] = RMP for seawater intrusion

The groundwater quality monitoring network accomplishes the following for the sustainability indicators relying on groundwater quality to determine Basin sustainability:

- Degraded Groundwater Quality: Monitoring wells are distributed throughout the Basin in all the aquifers used for groundwater production, and the distribution of wells and their sampling frequency is sufficient to determine groundwater quality trends over time for each aquifer. No additional monitoring wells for degraded groundwater quality are needed until projects are implemented.

- Seawater Intrusion: The monitoring network includes coastal monitoring wells that are used to monitor groundwater quality related to seawater intrusion. Most locations have multiple monitoring wells completed at different depths within the productive aquifers. All coastal monitoring wells are sampled for chloride and TDS quarterly to ensure increases in salinity are identified quickly. The two deep monitoring wells to be added for monitoring groundwater levels as a proxy for seawater intrusion will also be part of the network to monitor groundwater quality related to seawater intrusion.

Each agency will use their own resources to continue to sample these wells as the GSP is implemented. Groundwater quality data collected for each well will be stored in the WISKI DMS.

3.3.1.3 Groundwater Extraction Monitoring

3.3.1.3.1 Metered Groundwater Extraction

Each municipal MGA member agency meters their own groundwater extraction in their service area or area of jurisdiction by individual well. All municipal production wells have SCADA systems to automatically record groundwater extraction. Manual meter readings are also recorded. Monthly extraction data by well is stored in the WISKI DMS.

Small water systems (SWS) having between 5 and 199 connections are required to meter their groundwater production with monthly meter readings that are reported annually to Santa Cruz County. Monthly metered production is also required by the State Water Resources Control Board Division of Drinking Water (DDW) under California Code of Regulations Section §64561. This requirement also includes businesses or other operations that extract groundwater and that serve more than 25 people for more than 60 days a year. Annual extractions for reporting SWSs will be stored in the WISKI DMS.

3.3.1.3.2 Unmetered Groundwater Extraction

In areas outside of the municipal service areas, there are over one thousand private wells that each extract less than 2 acre-feet per year of groundwater for domestic purposes. These are called *de minimis* users and their wells are typically unmetered. Estimates of pumping for private domestic use are made based on the number of parcels with a residence and typical water use factor per connection derived from metered SWS water use per connection. To keep a current estimate of *de minimis* pumping, records of the number of rural parcels with residences and estimates of water use per connection from SWSs need to be updated annually.

Groundwater extraction for agricultural use (irrigation and livestock) is currently unmetered in the Basin. Annual agricultural demand is estimated based on the crop irrigated, monthly reference evapotranspiration that is measured at a nearby CIMIS station, and irrigated crop acreage. The MGA will need to monitor the acreage of irrigated lands in the Basin annually, and include cannabis which was not included in the agricultural use estimates in the historical groundwater model. As part of GPS implementation, the MGA will be implementing a metering plan that will require some of the larger agricultural and other non-*de minimis* users to meter their wells and provide the MGA with extraction data.

Estimated groundwater extractions will not be included in the WISKI DMS as the data are not measured. Spreadsheets and GIS containing the data used to estimate groundwater extractions for unmetered wells will be used to store estimated extraction data.

3.3.1.4 Streamflow Monitoring

The USGS streamflow gauge No. 11160000 (Soquel Creek at Soquel) is one of five streamflow gauges currently active in the Basin. The USGS gauge has been operational since 1951 and is part of the USGS's National Water Information System.

Other streamflow monitoring in the Basin is focused on Soquel Creek (Figure 3-3 and Table 3-6). This is because SqCWD recognized the potential of stream impacts from pumping their municipal supply wells close to Soquel Creek. As part of their Soquel Creek Monitoring and Adaptive Management Plan (MAMP) described in Section 2.1.2: Water Resources Monitoring and Management Programs, SqCWD has stream water level loggers in Soquel Creek alongside the shallow monitoring wells shown on Figure 3-3. Since changes in stream levels from groundwater pumping of nearby municipal wells have not been measurable at the monitoring locations since monitoring started, stream water level monitoring may be terminated after five years of monitoring (after 2019).

Trout Unlimited is working in conjunction with the Resource Conservation District of Santa Cruz County to monitor dry season flows at four locations on Soquel Creek (Figure 3-3) to help measure the impact of stream diversions and evaluate opportunities for streamflow enhancement. The current effort is funded through 2019 under a Proposition 1 Grant from the Wildlife Conservation Board for streamflow enhancement. After 2019, ongoing monitoring of the streamflow gauges will be continued by the MGA.

All streamflow data will be stored in the WISKI DMS.

Table 3-6. Streamflow Gauges in the Santa Cruz Mid-County Basin

Monitoring Entity	Streamflow Gauge Name
USGS	USGS 11160000 Soquel Creek at Soquel
Trout Unlimited / Santa Cruz Resource Conservation District	Soquel Creek West Branch
	Soquel Creek near Olive Springs
	Soquel Creek above West Branch Confluence
	Soquel Creek above Bates Creek

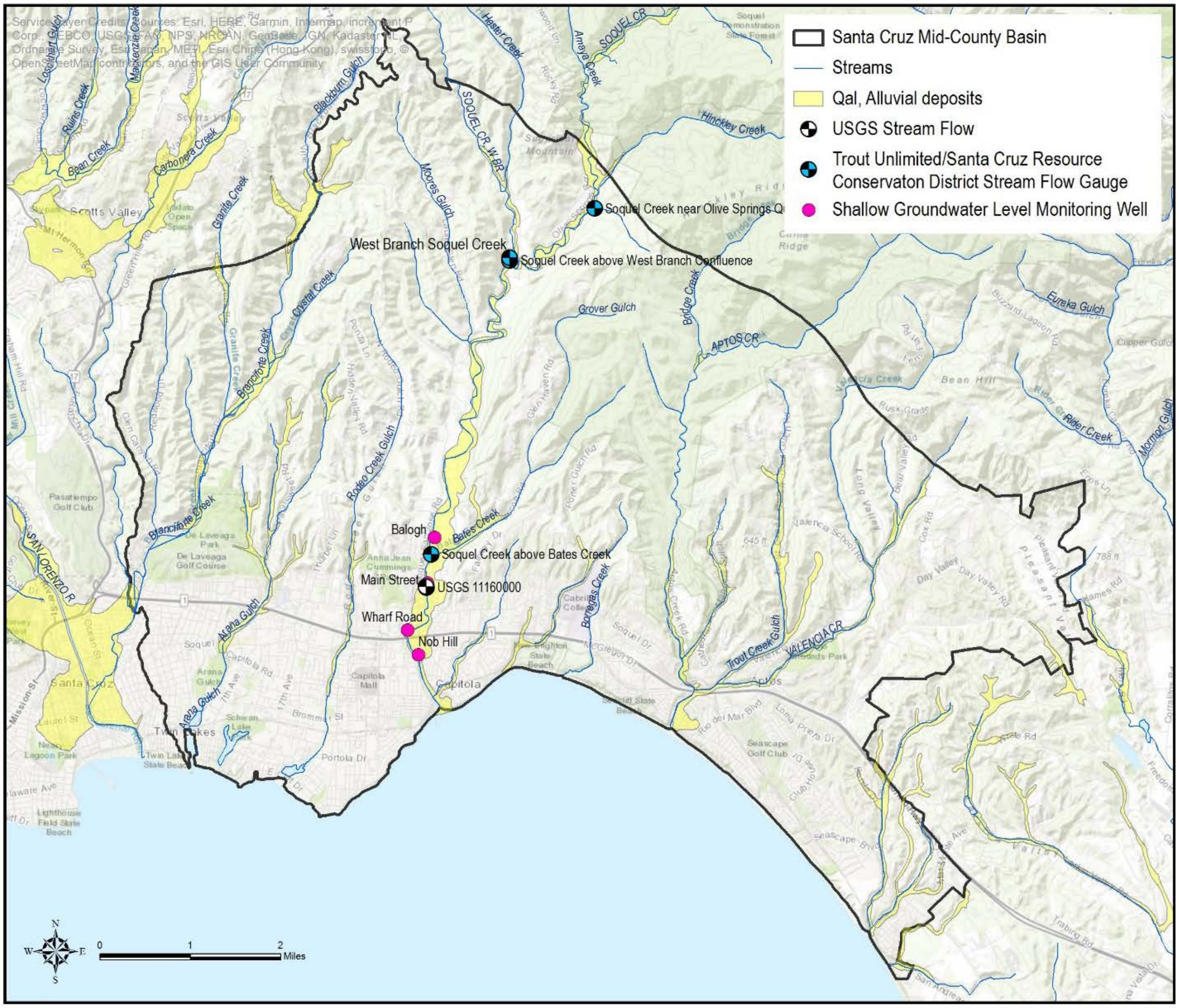


Figure 3-3. Location of Basin Streamflow Gauges

3.3.1.5 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 monitored historically, nor are there plans to monitor it in the future. There are however two land subsidence monitoring networks that are publicly available: (1) Global positioning system (CGPS) stations in the vicinity of the Basin that are part of the UNAVCO Plate Boundary Observatory network of CGPS stations, and (2) Interferometric Synthetic Aperture Radar (InSAR) data that are collected by the European Space Agency (ESA) Sentinel-1A satellite and processed by TRE ALTAMIRA Inc. (TRE).

1. The CGPS data are a subset of Plate Boundary Observatory GPS with near real-time data streams made available by UNAVCO. The data is provided as elevation (Z) and longitude (X) and latitude (Y). There is one CGPS stations (Larkin Valley CGPS station

(P212)) just outside of the Aromas area of the Basin that can be used to assess subsidence at the basin boundary (Figure 3-4).

2. Through a contract with TRE ALTAMIRA Inc. (TRE) and as part of DWR's SGMA technical assistance for GSP development and implementation, DWR has made available measurements of vertical ground surface displacement in more than 200 of the high-use and populated groundwater basins across California, including for the Santa Cruz Mid-County Basin. Vertical displacement estimates are derived from Interferometric Synthetic Aperture Radar (InSAR) data that are collected by the European Space Agency (ESA) Sentinel-1A satellite and processed by TRE. The InSAR dataset has also been ground-truthed to best available independent data. The current data covers the months between January 2015 and June 2018, and DWR is planning on supporting updating the dataset on an annual basis through 2022.

The CGPS data and TRE ALTAMIRA InSAR subsidence dataset can be used by the MGA annually to compare against groundwater elevations to confirm that subsidence is not occurring in the Basin.

3.3.1.6 Climate Monitoring

Climate conditions are collected by MGA member agencies and partners at various locations in the Basin. Monitored information includes precipitation and temperature to help provide information on recharge, soil moisture and evapotranspiration. This information is also important to consider influences on streamflow. Consideration will be given to expanding this network and providing for more direct measurement of evapotranspiration and occurrence of fog cover.

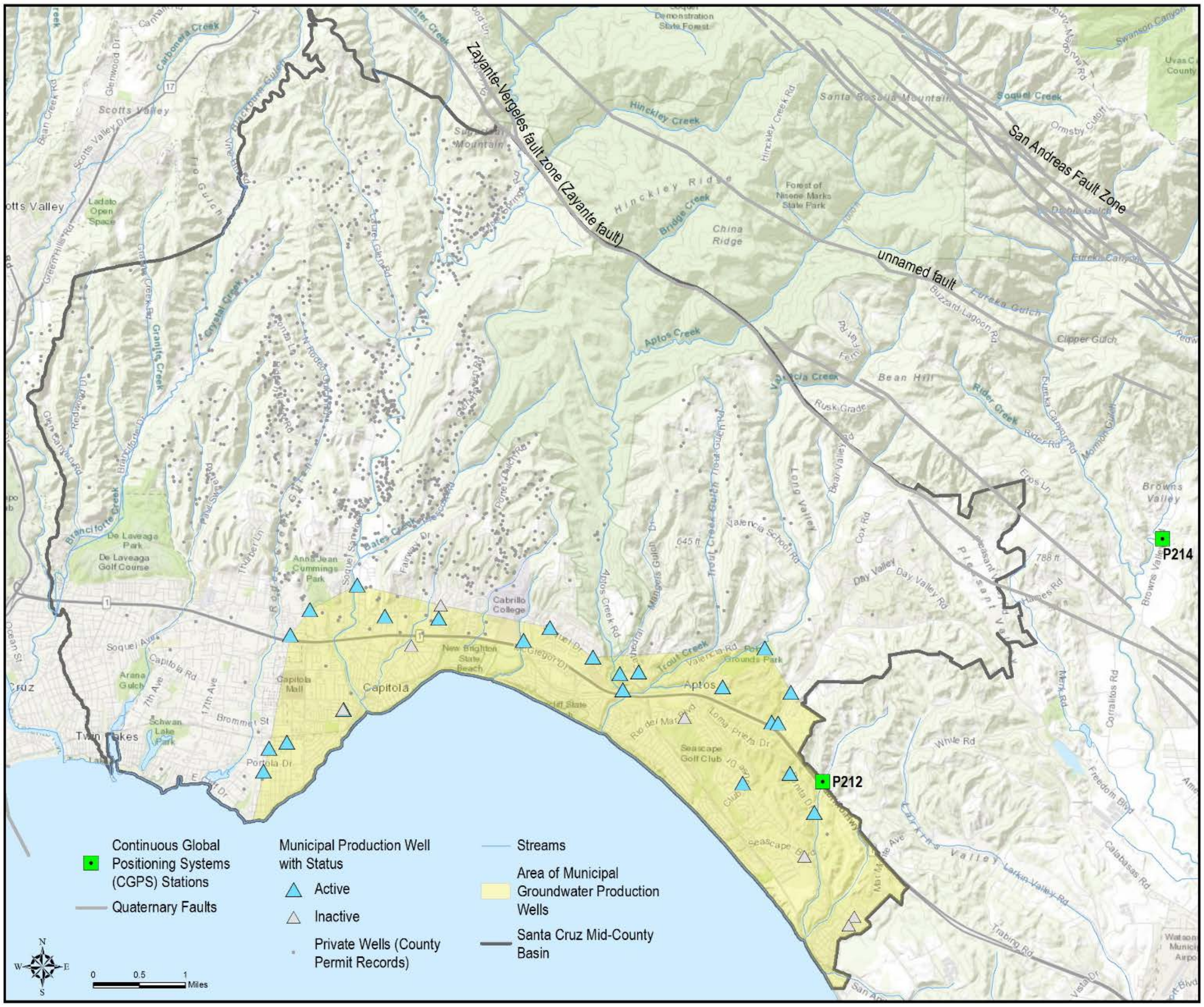


Figure 3-4. Location of Continuous GPS Stations near the Santa Cruz Mid-County Basin

3.3.2 Monitoring Protocols for Data Collection and Monitoring

Pursuant to the goals of SGMA, MGA member agencies use robust and reliable data collection protocols to monitor groundwater conditions in the Basin. Use of the monitoring protocols contained within this GSP ensure data is consistently collected by all member agencies, thereby increasing the reliability of data used to evaluate GSP implementation. Overall there are four types of data collected by MGA member agencies: groundwater elevations, groundwater quality, streamflow, volume of groundwater extracted, and climate conditions.

3.3.2.1 Groundwater Elevation Monitoring Protocols

Groundwater elevation monitoring is conducted to evaluate Basin conditions relative to the sustainable management criteria for chronic lowering of groundwater levels, seawater intrusion (proxy), and depletion of interconnected surface water (proxy), as shown in Table 3-1. Most groundwater levels in the Basin are measured and recorded at least daily using data loggers and measurements at most wells without loggers occur at least monthly. This allows the evaluation of a 'snapshot' of groundwater conditions for any given month.

All groundwater elevation measurements are referenced to a consistent elevation datum, known as the Reference Point (RP). For monitoring wells, the RP consists of a mark on the top of the well casing. For most production wells, the RP is the top of the well's concrete pedestal. The elevation of the (RP) of each well is surveyed to the National Geodetic Vertical Datum of 1929 (NGVD 29). The elevation of the RP is accurate to at least 0.5 foot, and most MGA well RPs are accurate to 0.1 foot or less.

Groundwater level measurements are taken to the nearest 0.01 foot relative to the RP using procedures appropriate for the measuring device. Equipment is operated and maintained in accordance with manufacturer's instructions, and all measurements are in consistent units of feet, tenths of feet, and hundredths of feet.

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 production wells pumping, weather, flooding, or well condition.

3.3.2.1.1 Manual Groundwater Level Measurement

Manual groundwater level measurements are made with electronic sounders or steel tape. All manual groundwater level measurements taken by MGA member agencies abide by the following protocols:

- Equipment usage follows manufacturer specifications for procedure and maintenance.
- Measurements are taken in wells that have not been subject to recent pumping. At least two hours of recovery must be allowed before a hand sounding is taken.

- For each well, multiple measurements are collected to ensure the well has reached equilibrium such that no significant changes in groundwater level are observed.

- Equipment is sanitized between well locations in order to prevent contamination and maintain the accuracy of concurrent groundwater quality sampling.

The majority of manual groundwater level measurements taken by MGA member agency utilize electric sounders. These consist of a long, 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 water. Some production wells may have lubricating oil floating on the top of the water column, in which case electric sounders will be ineffective. In this circumstance steel tape may be used. Steel tape instruments consist of simple graduated lines where the end of the line is chalked so as to indicate depth to water without interference from floating oil.

3.3.2.1.2 Groundwater Level Measurement with Continuous Recording Devices

In addition to manual groundwater level measurements, most municipal production wells, most monitoring wells, and the full subset of monitoring wells used as representative monitoring points are equipped with pressure transducers to collect more frequent data than manual measurements. Installation and use of pressure transducers abide by the following protocols:

- Prior to installation the sampler uses an electronic sounder or steel tape to measure and calculate the current groundwater level in order to properly install and calibrate the transducer. This is done following the protocols listed above.

- All transducer installations follow manufacturer specifications for installation, calibration, data logging intervals, battery life, and anticipated life expectancy.

- Transducers are set to record only measured groundwater level in order to conserve data capacity; groundwater elevation is calculated later after downloading.

- In any log or recorded datasheet, the well ID, transducer ID, transducer range, transducer accuracy, and cable serial number are all recorded.

- The sampler notes whether the pressure transducer uses a vented or non-vented cable for barometric compensation. If non-vented units are used, data are properly corrected for natural barometric pressure changes.

- All transducer cables are secured to the well head with a well dock or another reliable method. This cable is marked at the elevation of the reference point to allow estimates of future cable slippage.

- Transducer data is periodically checked against hand measured groundwater levels to monitor electronic drift, highlight cable movement, and ensure data reliability. This check occurs at least annually, typically during routine site visits.

- For wells not connected to SCADA, transducer data is downloaded as necessary to ensure no data is overwritten or lost. Data is entered into the data management system as soon as possible. When the transducer data is successfully downloaded and stored, the data is deleted or overwritten to ensure adequate data logger memory.

3.3.2.2 Groundwater Quality Monitoring Protocols

Groundwater quality samples are required to monitor the effect of GSP implementation on the degraded groundwater quality and seawater intrusion sustainability indicators (Table 3-1). All groundwater quality analyses are performed by laboratories certified under the State Environmental Laboratory Accreditation Program.

While specific groundwater sampling protocols vary depending on the constituent and the hydrogeologic context, the protocols contained here provide guidance which is applied to all groundwater quality sampling. Prior to sampling, the sampler contacts the laboratory to schedule laboratory time, obtain appropriate sample containers, and clarify any sample holding times or sample preservation requirements. Laboratories must be able to provide a calibration curve for the desired analyte and are instructed to use reporting limits that are equal to or less than the applicable data quality objectives, regional water quality objectives/screening levels, or state Detection Limit for Purposes of Reporting.

- Each well used for groundwater quality monitoring has a unique identifier (ID). This ID is written on the well housing or the well casing to avoid confusion.

- Sample containers are labeled prior to sample collection. The sample label includes: sample ID, sample date and time, sample personnel, sample location, preservative used, analyte, and analytical method.

- In the case of wells with dedicated pumps, samples are collected at or near the wellhead. Samples are not collected from storage tanks, at the end of long pipe runs, or after any water treatment.

- Prior to any sampling, the sampler cleans the sampling port and/or sampling equipment so that it is free of any contaminants, and also decontaminates sampling equipment between sampling locations to avoid cross-contamination between samples.

- At the time of sampling, groundwater elevation in the well is also measured following appropriate protocols described above in the groundwater level measuring protocols.

- For any well not equipped with low-flow or passive sampling equipment, at least three well casings volumes are purged 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 be go dry, the condition is documented and the well is allowed to recover to within 90% of original level prior to sampling.

- In addition to the constituent of interest, field parameters of dissolved oxygen, electrical conductivity, temperature, oxidation reduction potential and pH are collected for each sample during well purging, with dissolved oxygen and conductivity being the most critical parameters. Samples are not collected until these parameters stabilize. Parameters are considered stabilized at the following ranges: dissolved oxygen and oxidation reduction potential, ±10%; temperature and electrical conductivity, ±3%; and pH ±0.2%.
- All field instruments are calibrated each day of use, cleaned between samples, evaluated for drift throughout the day of use.
- Samples are collected exclusively under laminar flow conditions. This may require reducing pumping rates prior to sample collection.
- Samples are collected according to the appropriate standards listed in the Standard Methods for the Examination of Water and Wastewater and the USGS National Field Manual for the Collection of Water Quality Data. The specific sample collection procedures reflect the type of analysis to be performed and characteristics of the constituent.
- All samples requiring preservation are preserved as soon as practically possible and filtered appropriately as recommended for the specific constituent.
- Samples are chilled and maintained at 4 °C to prevent degradation of the sample.
- Samples must be shipped under chain of custody documentation to the appropriate laboratory promptly to avoid violating holding time restrictions.

3.3.2.3 Streamflow Monitoring Protocols

Streamflow discharge measurements are collected by MGA member agencies and partners to monitor streamflow interaction related to groundwater extractions, monitor stream conditions related to fish habitat, and help preserve other beneficial uses of surface water. There is one USGS gauge that is operated and monitored by the USGS according to procedures outlined by USGS (1982).

Surface water is most easily measured using a stream gauge 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 (ADCPs). Following development of an accurate ratings curve, streamflow is evaluated on a frequent basis via use of a simple stilling well and pressure transducer.

3.3.2.4 Measuring Groundwater Extraction Protocols

Groundwater extraction volumes are collected to provide data for well field management and for assessment of the Basin's water budget. Additionally, the volume of groundwater extraction is the metric for the reduction of groundwater in storage sustainability indicator. Municipal MGA member agencies measure discharge from all their production wells with calibrated flow meters. Supervisory Control and Data Acquisition (SCADA) for individual wells are used to monitor and control production in close to real-time.

Small water systems (SWS) report their annual extractions to Santa Cruz County. Meter readings are typically read monthly.

3.3.3 Representative Monitoring Points

Representative Monitoring Points (RMPs) are a subset of the Basin's overall monitoring network. Designation of an RMP is supported by adequate evidence demonstrating that the site reflects general conditions in the area. Representative monitoring points are where numeric values for minimum thresholds, measurable objectives, and interim milestones are defined. Avoiding undesirable results based on data collected at RMPs demonstrates the Basin's sustainability.

Groundwater levels may be used as a proxy for sustainability indicators whose metric is not groundwater levels 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 and indicates the seawater intrusion and depletion of interconnected surface water sustainability indicators use groundwater levels as a proxy.

3.3.3.1 Chronic Lowering of Groundwater Level Representative Monitoring Points

The objective of the chronic lowering of groundwater levels representative monitoring network is to monitor areas where there is a concentration of groundwater extraction, but not immediately adjacent to municipal production wells. This is to avoid the dynamic drawdown caused by high-capacity wells. Use of dedicated monitoring wells in the network is preferable over wells actively used for groundwater extraction. Clustered multi-depth monitoring wells are included to evaluate groundwater elevations in different aquifers at the same location and to evaluate vertical gradients between aquifers. Because groundwater elevations to protect against seawater intrusion are higher (or more stringent) than groundwater elevations to prevent chronic lowering of groundwater levels, RMPs along the coast are not included in the chronic lowering of groundwater levels monitoring network. Groundwater elevations along the coast are instead controlled by the seawater intrusion sustainable management criteria in coastal monitoring wells. Figure 3-5 includes all wells in the representative monitoring network used for monitoring chronic lowering of groundwater levels.

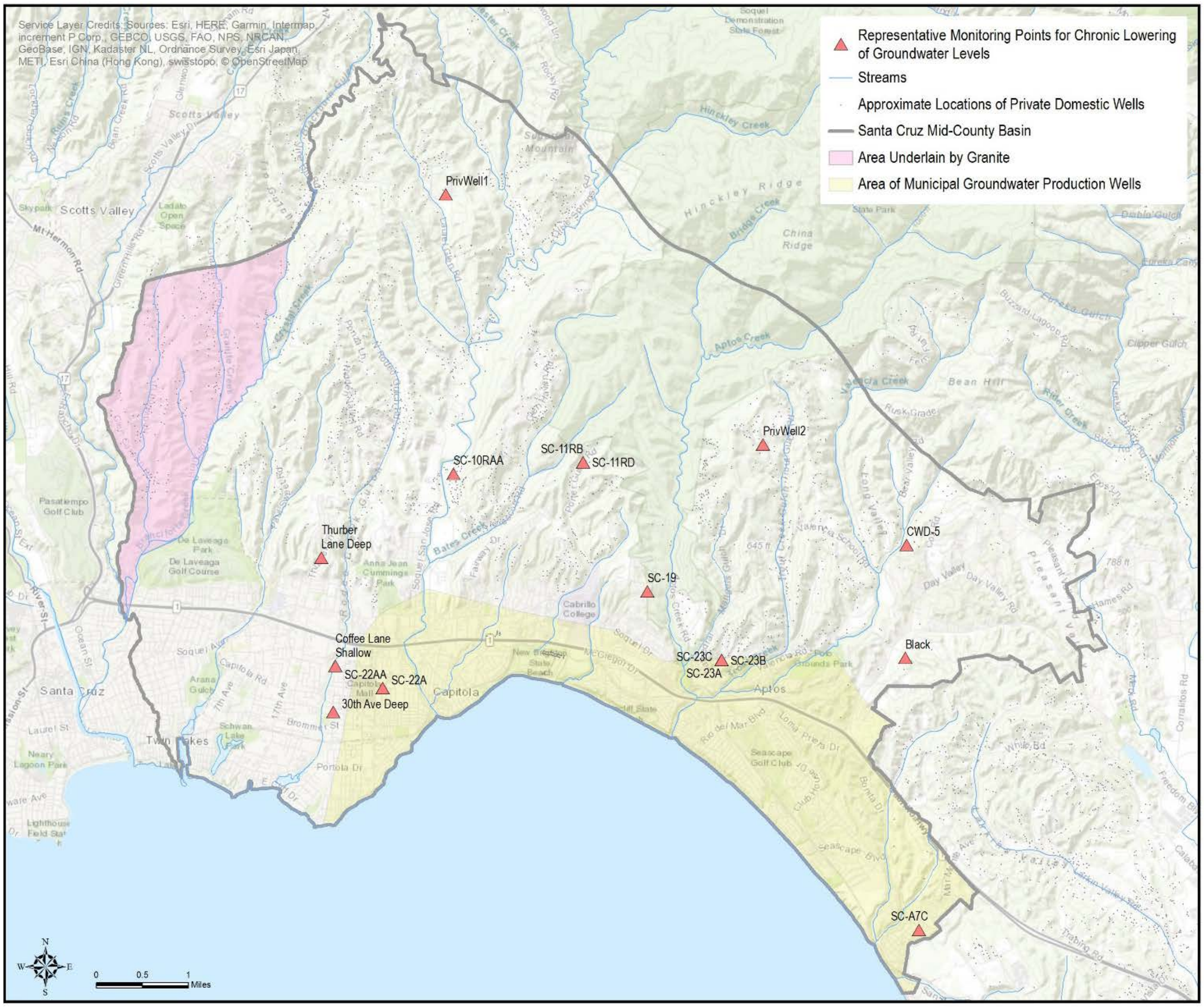
Table 3-7. Representative Monitoring Points for Chronic Lowering of Groundwater Levels

Aquifer Unit	Well Name	Rationale
Aromas	SC-A7C	Located near boundary with Pajaro Valley Subbasin
Purisima F	Private Well 2	Located in an inland area with a high concentration of private domestic wells
	Black	Located near boundary with Pajaro Valley Subbasin in an area with a high concentration of private domestic wells, and is a dedicated monitoring well
	CWD-5	Located in an area with a high concentration of private domestic wells and is a dedicated monitoring well
	SC-23C	Just inside the area of municipal production but close to municipal production wells pumping from the Purisima F-unit and a high concentration of private domestic wells
Purisima DEF	SC-11RD	Located in an area with a high concentration of private domestic wells
	SC-23B	Just inside the area of municipal production but close to municipal production wells pumping from the Purisima DEF-unit and a high concentration of private domestic wells
Purisima BC	SC-11RB	Located in an area with a high concentration of private domestic wells
	SC-19	Outside the area of municipal production but close to municipal production wells pumping from the Purisima BC-unit and in an area between private domestic well pumping centers
	SC-23A	Just inside the area of municipal production but close to municipal production wells pumping from the Purisima BC-unit and a high concentration of private domestic wells
Purisima A	Coffee Lane Shallow	Outside the area of municipal production but close to municipal production wells pumping from the Purisima A-unit
	SC-22A	Inside the area of municipal production but close to municipal production wells pumping from the Purisima A-unit
Purisima AA	SC-22AA	Inside the area of municipal production but close to municipal production wells pumping from the Purisima AA-unit
	SC-10RAA	Located in an area with a high concentration of private domestic wells
Purisima AA/Tu	Private Well 1	Located in an inland area with a high concentration of private domestic wells
Tu	30th Ave Deep	One of the few monitoring wells screened in the Tu aquifer located outside of the area of municipal production
	Thurber Lane Deep	One of the few monitoring wells screened in the Tu aquifer located outside of the area of municipal production

Figure 3-5. Chronic Lowering of Groundwater Level Representative Monitoring Network

3.3.3.2 Reduction of Groundwater in Storage Representative Monitoring Points

The physical well locations for the reduction of groundwater in storage representative monitoring network are all metered wells in the Basin (Figure 3-6). These are the only points where measured extraction data are available to evaluate the sustainability of the Basin with respect to reduction of groundwater in storage. All other groundwater extraction in the Basin will be estimated. Section 3.3.1.3 (Groundwater Extraction Monitoring) describes how small water



systems, *de minimis* private pumping, and agricultural irrigation pumping will be estimated.

Wells that are metered as part of GSP implementation will be added as RMPs to the reduction of groundwater in storage representative monitoring network.

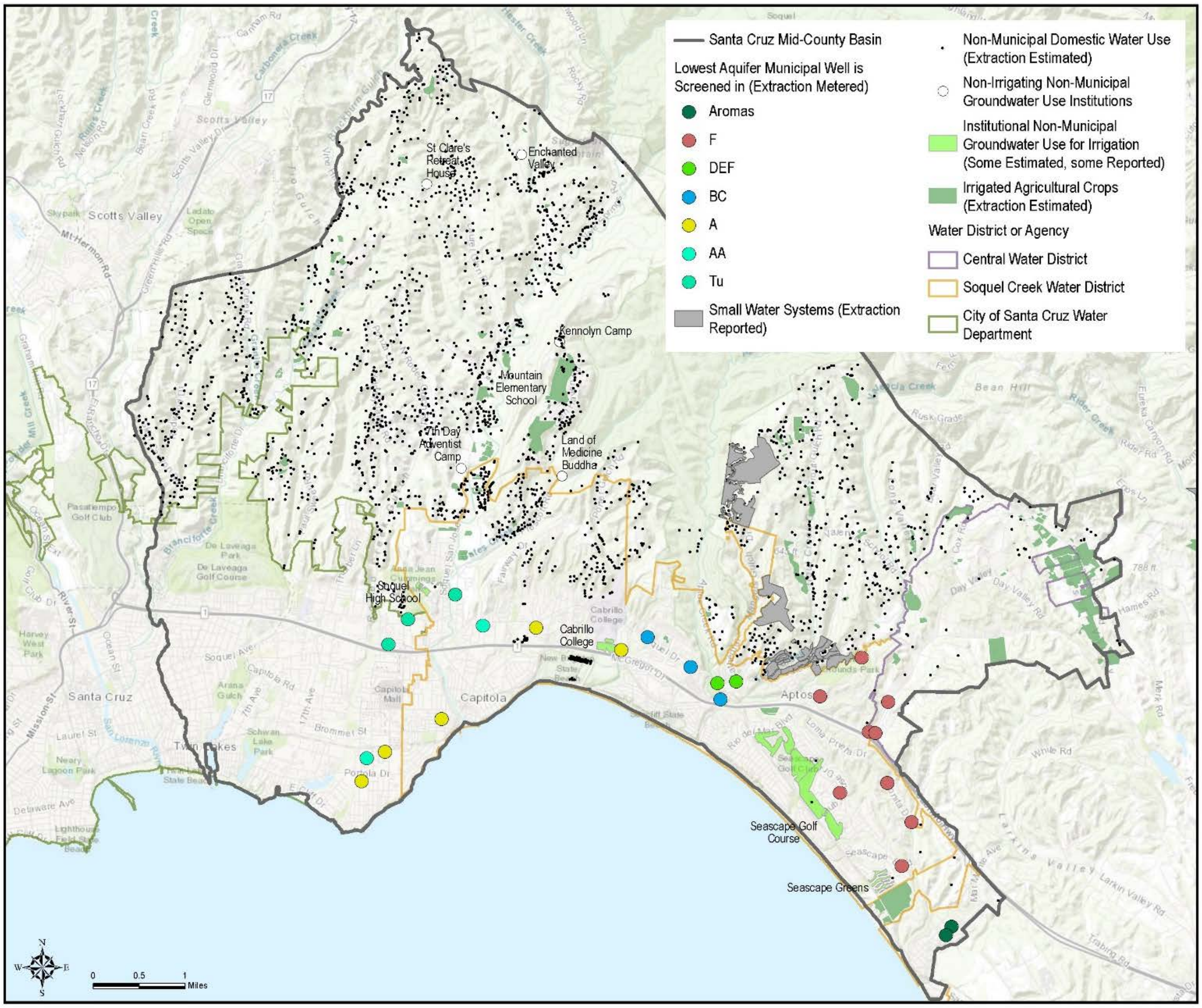


Figure 3-6. Reduction of Groundwater in Storage Representative Monitoring Network

3.3.3.3 Seawater Intrusion Representative Monitoring Points

The seawater intrusion monitoring network monitors both chloride concentration and groundwater elevations as a proxy for seawater intrusion. Chloride concentrations are monitored in wells which are at least 0.5 mile away from the coast and either side of the chloride isocontour representing a minimum threshold for seawater intrusion. The City of Santa Cruz and SqCWD have been using protective groundwater elevations in coastal monitoring wells since 2009 to monitor and manage seawater intrusion in the Basin, and these same wells plus some additional wells to monitor the very deepest aquifers will be included in the representative monitoring network for proxy monitoring of seawater intrusion. Groundwater levels are continuously monitored with data loggers in all protective elevation coastal monitoring wells, and hand soundings are taken at least quarterly.

In the event of data logger failure, monthly soundings measured during the data gap should be used to replace missing data in calculating averages used to determine if undesirable results have occurred. If no sounding measurement occurred during the data gap, the average of available hourly readings in the 7 days before and the 7 days after the data gap (up to 336 total hourly readings) should be used to replace the missing data in calculating averages. If data logger groundwater level data are shown to be inconsistent with a sounding measurement, the sounding measurement should be used to replace the inconsistent logger data in the calculation of averages. Inconsistent logger data is considered a variation of 0.5-feet between data logger and manual well soundings.

Table 3-8 shows the locations of all RMPs in the seawater intrusion monitoring network used for both chloride concentrations and groundwater elevation proxies. The wells used to measure chloride concentrations have a different symbol than those used to monitor protective groundwater elevations. Table 3-9 lists the wells in the representative monitoring network and provides a brief rationale why each well was selected as an RMP.

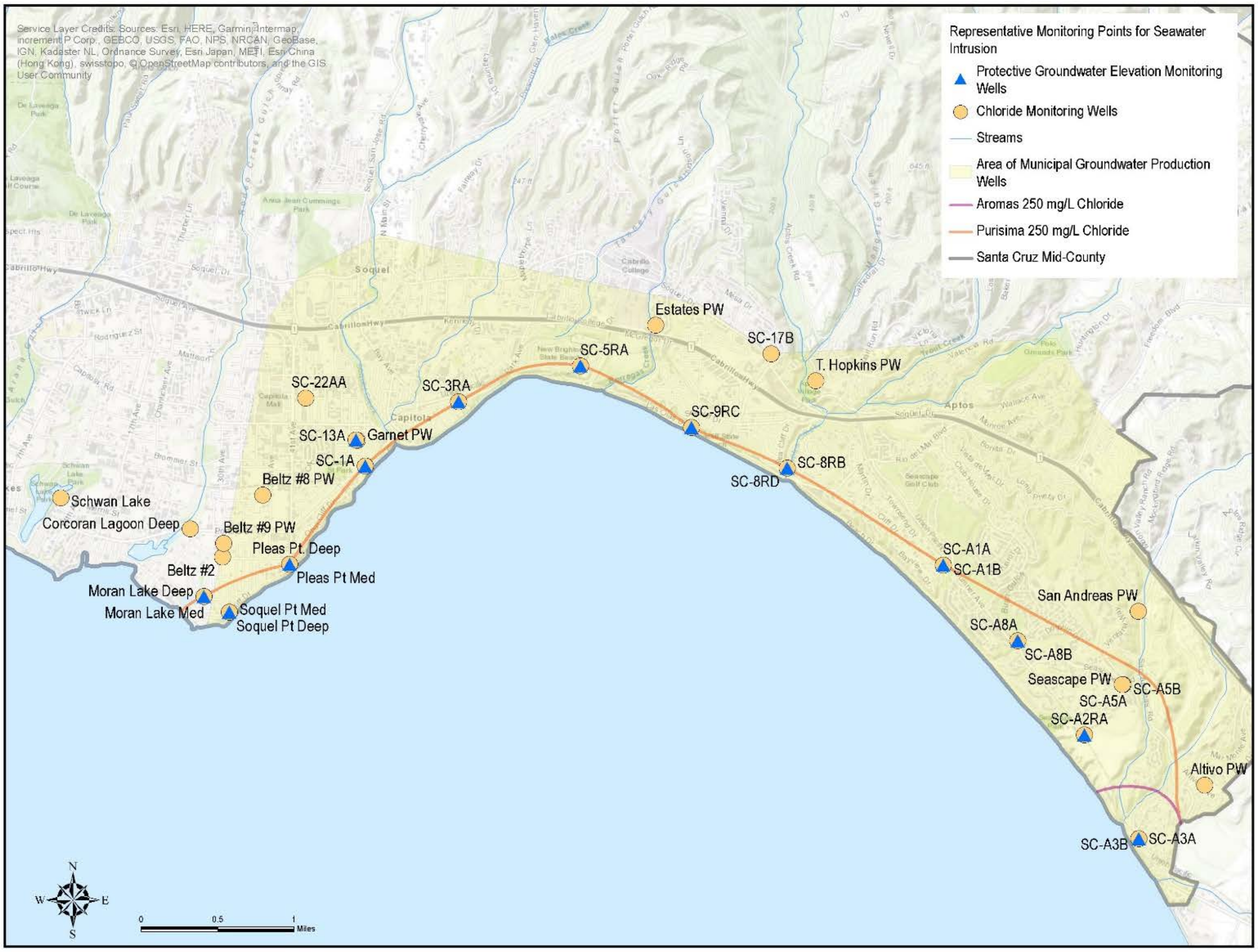


Table 3-8. Seawater Intrusion Representative Monitoring Network

Table 3-9. Representative Monitoring Points for Seawater Intrusion

Aquifer Unit	Well Name	Rationale	Metric
Aromas	Altivo PW	Municipal production well closest inland of the chloride isocontour	Chloride
	SC-A3B	Coastal monitoring well within the area intruded by seawater	Chloride
	SC-A3A	Coastal monitoring well within the area intruded by seawater	Chloride and GWL
	SC-A8B	Coastal monitoring well within the area intruded by seawater but at a depth above saltwater interface	Chloride
Aromas / Purisima F	Seascape PW	Municipal production well within the area intruded by seawater	Chloride

Aquifer Unit	Well Name	Rationale	Metric
		but at a depth above saltwater interface	
	San Andreas PW	Municipal production well closest inland of the chloride isocontour	Chloride
Purisima F	SC-A1B	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	SC-A2RA	Coastal monitoring well within the area intruded by seawater	Chloride and GWL
	SC-A2RB	Coastal monitoring well within the area intruded by seawater	Chloride and GWL
	SC-A8A	Coastal monitoring well within the area intruded by seawater	Chloride and GWL
	SC-A5A	Inland monitoring well with seawater intrusion; screened ~100 ft below Seascape PW	Chloride
	SC-A5B	Inland monitoring well at a depth above saltwater interface; screened ~20 ft below Seascape PW	Chloride
Purisima DEF	SC-8RD	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	SC-A1A	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride
	T. Hopkins PW	Municipal production well closest inland of the chloride isocontour	Chloride
Purisima BC	SC-9RC	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	SC-8RB	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	Ledyard PW	Municipal production well between the Estates and T-Hopkins production wells	Chloride
Purisima A/BC	Estates PW	Municipal production well closest inland of the chloride isocontour	Chloride
Purisima A	Moran Lake Medium	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	Soquel Point Medium	Coastal monitoring well within the area intruded by seawater	Chloride and GWL

Aquifer Unit	Well Name	Rationale	Metric
	Pleasure Point Medium	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	SC-1A	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	SC-3RA	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	SC-5RA	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	Beltz #2	Inland monitoring well that monitors inland of the chloride isocontour	Chloride
	Beltz #8 PW	Municipal production well closest inland of the chloride isocontour	Chloride
	Garnet PW	Municipal production well closest inland of the chloride isocontour	Chloride
Purisima AA	Moran Lake Deep	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	Pleasure Point Deep	Coastal monitoring well through which the 250 mg/L chloride isocontour runs through	Chloride and GWL
	Soquel Point Deep	Coastal monitoring well within the area intruded by seawater but at a depth below intrusion	Chloride and GWL
	SC-22AA	Inland monitoring well that monitors inland of the chloride isocontour	Chloride
	Corcoran Lagoon Deep	Inland monitoring well that monitors inland of the chloride isocontour	Chloride
	Schwan Lake	Westernmost monitoring well	Chloride
Tu	SC-13A	Coastal monitoring well	Chloride and GWL

PW = production well; GWL = groundwater level

3.3.3.4 Degraded Groundwater Quality Representative Monitoring Points

Figure 3-7 shows the distribution of wells selected as RMPs for the degraded groundwater quality monitoring network. Since the sustainability of the degraded groundwater quality indicator is related to quality impacts caused by projects and management actions implemented as part of the GSP, its RMPs are located in areas where projects and management actions are most likely to be located in the future, i.e., within the water districts' and City service areas.

The majority of municipal production wells in the Basin are included as RMPs for degraded groundwater quality since they are the wells that provide groundwater to the largest beneficial user group. Municipal production wells are only excluded as RMPs if there is another nearby municipal production well screened in the same aquifer that is an RMP. In the area of municipal production (yellow shaded area on Figure 3-7), monitoring wells are added as RMPs in areas where there are no municipal production wells.

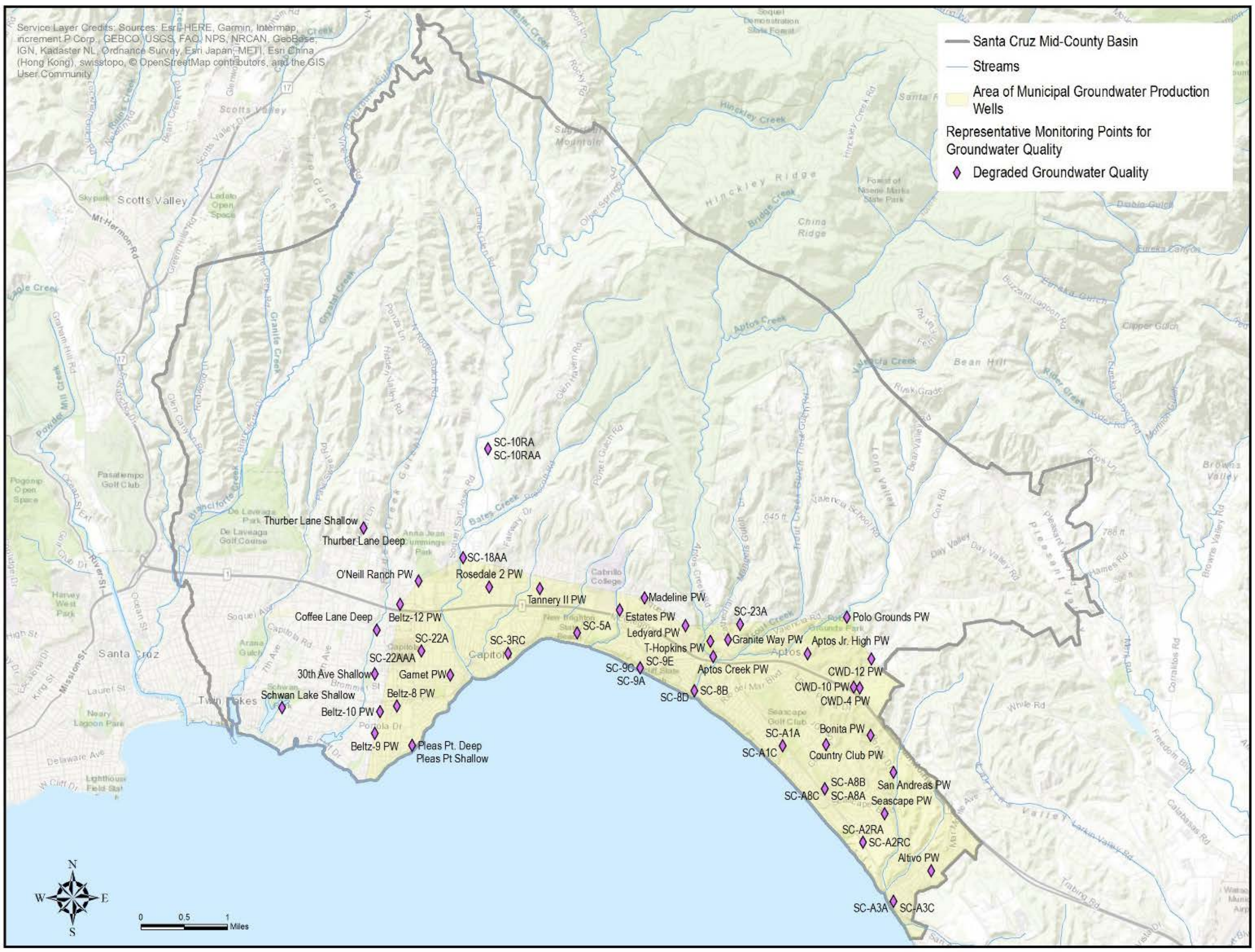


Figure 3-7. Degraded Groundwater Quality Representative Monitoring Network

Future projects implemented as part of the GSP to achieve sustainability will have designated monitoring wells, some existing and some new, as part of their permit conditions. Wells not already an RMP for degraded groundwater quality will be included as RMP in the GSP, and the constituents monitored as part of permit conditions will become constituents of concern for those particular RMPs.

Table 3-10. Representative Monitoring Points for Degraded Groundwater Quality

Aquifer Unit	Well Name	General Water Quality Sampling Frequency	Rationale
Aromas	Altivo PW*	Semi-Annual	Production well and area impacted by nitrate
	CWD-10 PW	Triennial, nitrate as (N) annual	Production well
	SC-A1C	Annual	Coastal monitoring well in area with spare monitoring wells
	SC-A2RC	Semi-Annual	Coastal monitoring well, and located between an area of private well domestic and agricultural users
	SC-A3A	Annual	Southernmost coastal monitoring well
	SC-A3C	Semi-Annual	Southernmost coastal monitoring well
	SC-A8B	Semi-Annual	Coastal monitoring well
	SC-A8C	Annual	Coastal monitoring well
Aromas/ Purisima F	Polo Grounds PW	Semi-Annual, nitrate (as N) annual	Production well
	Country Club PW*	Semi-Annual, nitrate (as N) annual	Production well
	Bonita PW	Semi-Annual, nitrate (as N) annual	Production well
	San Andreas PW	Semi-Annual, nitrate (as N) annual	Production well
	Seascape PW	Semi-Annual, nitrate (as N) annual	Production well
Purisima F	CWD-4 PW	Triennial, nitrate as (N) annual	Production well
	CWD-12 PW	Triennial, nitrate as (N) annual	Production well, inland
	Aptos Jr. High 2 PW	Semi-Annual, nitrate (as N) annual	Production well
	SC-A2RA	Annual	Coastal monitoring well, and located between an area of private well domestic and agricultural users
	SC-A8A	Annual	Coastal monitoring well
Purisima DEF	SC-8RD	Annual	Coastal monitoring well
	SC-9RE	Annual	Coastal monitoring well

Aquifer Unit	Well Name	General Water Quality Sampling Frequency	Rationale
	SC-A1A	Semi-Annual	Coastal monitoring well in area with few monitoring wells
	Granite Way PW	Annual	Production well
	T-Hopkins PW	Annual	Production well
Purisima BC	Ledyard PW	Annual	Production well
	Madeline 2 PW	Annual	Production well
	Aptos Creek PW	Annual	Production well
	SC-23A	Annual	Inland of a production wellfield
	SC-3RC	**Annual**	**Coastal monitoring well**
	SC-8RB	Annual	Coastal monitoring well
	SC-9RC	Annual	Coastal monitoring well
Purisima A	30th Ave Shallow	Semi-Annual	Just outside of area of municipal production
	Pleasure Point Shallow	Quarterly	Coastal monitoring well
	Estates PW	Annual	Production well
	Garnet PW	Annual	Production well
	Tannery II PW	Annual	Production well
	Rosedale 2 PW	Annual	Production well
	Beltz #8 PW	Triennial, iron & manganese quarterly, nitrate (as N) annual	Production well
	Beltz #9 PW	Triennial, iron & manganese quarterly, nitrate (as N) annual	Production well
	SC-5RA	Annual	Coastal monitoring well
	SC-9RA	Annual	Coastal monitoring well
	SC-10RA	Annual	Inland monitoring well
	SC-22A	Quarterly	Between several municipal production wells
Purisima A/AA	Beltz #10 PW	Triennial, iron & manganese quarterly, nitrate (as N) annual	Production well
Purisima AA	SC-10RAA	Annual	Inland monitoring well
	SC-22AAA	Semi-Annual	Between several municipal production wells
	Coffee Lane Deep	Semi-Annual	Just outside of area of municipal production
	Pleasure Point Deep	Quarterly	Coastal monitoring well
	Thurber Lane Shallow	Semi-Annual	Inland monitoring well
	Schwan Lake	Semi-Annual	Westernmost monitoring well

Aquifer Unit	Well Name	General Water Quality Sampling Frequency	Rationale
Purisima AA/Tu	O’Neill Ranch PW	Annual	Production well
	Beltz #12 PW	Triennial, iron & manganese quarterly, nitrate (as N) annual	Production well
Tu	SC-18RAA	Semi-Annual	Next to production well
	Thurber Lane Deep	Semi-Annual	Inland monitoring well and one of the few Tu unit wells

* Standby well that will not be sampled until a water treatment plant is constructed to treat 1,2,3-trichloropropane (TCP)

3.3.3.5 Depletion of Interconnected Surface Water Monitoring Representative Monitoring Points

The depletion of interconnected surface water monitoring representative network monitors shallow groundwater elevations adjacent to creeks that both support priority species and are interconnected with groundwater. Groundwater elevations as a proxy for surface water depletions are needed as a measure of sustainability because no direct measurable change in streamflow from deep groundwater extraction has been detected in over 18 years of monitoring shallow groundwater levels adjacent to lower Soquel Creek. Even though there is no measurable direct change in streamflow from groundwater extraction, there is a demonstrable indirect influence on shallow groundwater connected to the creek from deeper aquifers pumped by municipal and private wells. This is discussed in Section 2: Basin Setting.

Figure 3-1 shows the location of four shallow monitoring wells currently used to monitor depletion of interconnected surface water. These four wells are designated as RMPs for groundwater level proxy measurements. One other monitoring well, SC-10RA, is also included as an RMP because it is located within 730 feet of Soquel Creek, is screened from 110-170 feet below ground in the Purisima A-unit aquifer underlying alluvium, and has groundwater levels that correspond to changes in creek flows. Table 3-11 lists the RMPs and summarizes rationale for selection.

Since these wells only monitor the lower reach of Soquel Creek, the MGA recognizes that other shallow wells are needed to better characterize the surface water / groundwater interaction for other reaches of Soquel Creek and for other creeks that are connected to groundwater. Section 3.3.4 discusses the monitoring data gaps for this sustainability indicator.

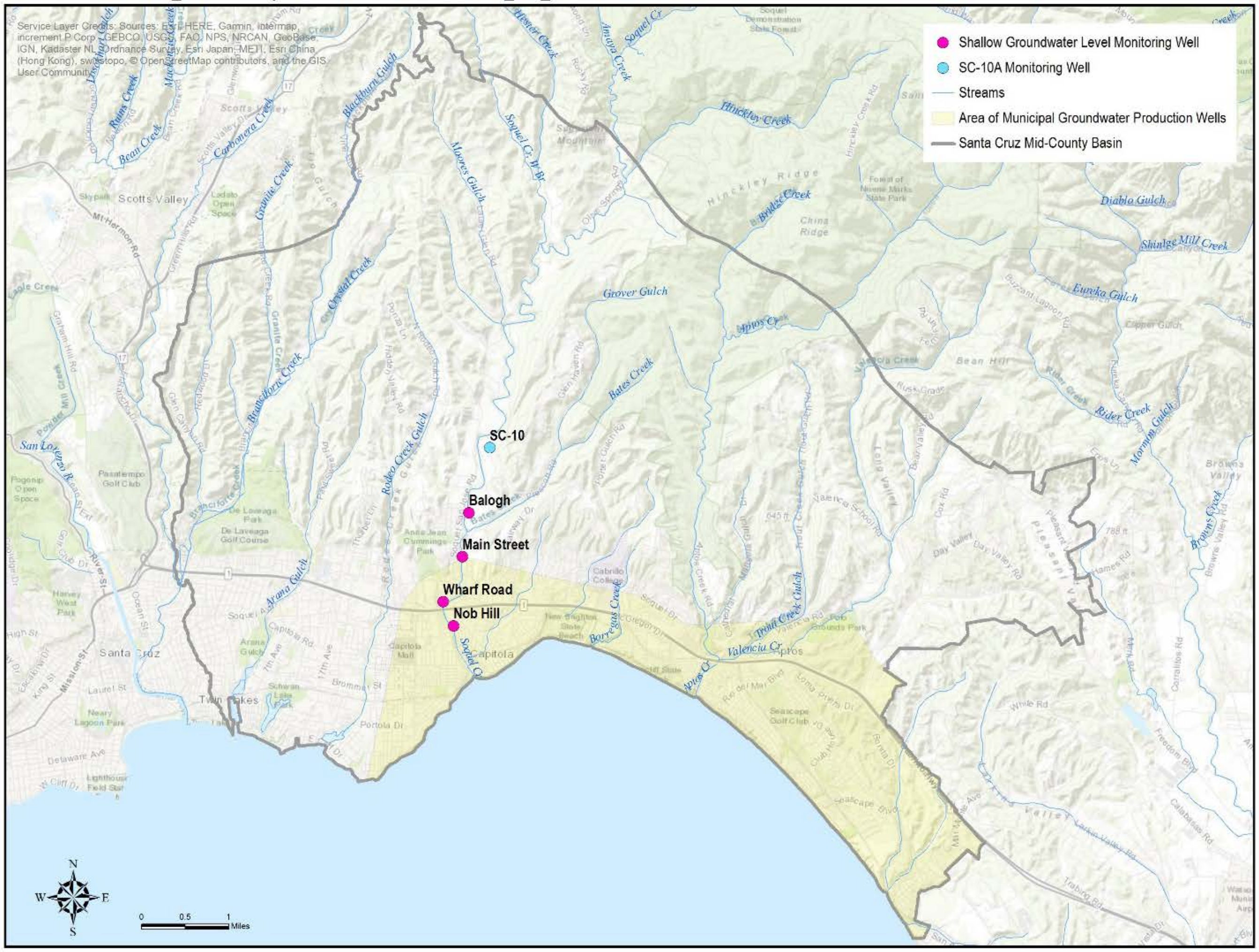


Figure 3-8. Depletion of Interconnected Surface Water Existing Representative Monitoring Network

Table 3-11. Representative Monitoring Points for Depletion of Interconnected Surface Water

Monitoring Type	Well Name	Rationale
Shallow Groundwater Levels	Balogh	Dedicated shallow groundwater / surface water monitoring well
	Main St. Shallow	Dedicated shallow groundwater / surface water monitoring well
	Wharf Road	Dedicated shallow groundwater / surface water monitoring well
	Nob Hill	Dedicated shallow groundwater / surface water monitoring well
Purisima A	SC-10RA	Shallow monitoring well 730 feet from Soquel Creek, screened in Purisima A-unit below alluvium. Groundwater levels show response to creek flows and rainfall

3.3.4 Assessment and Improvement of Monitoring Network

3.3.4.1 Groundwater Level Monitoring Data Gaps

The existing groundwater level monitoring network described in Section 3.3.1.1 (Groundwater Level Monitoring Network) is extensive laterally both across the Basin and vertically through all of the Basin's aquifers. There are however a few locations where new monitoring wells are required to evaluate groundwater levels for improved Basin characterization and to potentially include as RMPs once they have been constructed.

Seawater Intrusion monitoring: Additional deeper wells are needed in two locations along the coast. Existing monitoring wells at these locations do not extend down far enough to establish protective groundwater elevations for the deepest producing aquifers that are being used for production and in the near future potentially used for storage. Figure 3-9 shows the locations of the two proposed deep monitoring wells. One of the locations, SC-3 (AA), will involve adding a deeper monitoring well adjacent to an existing SqCWD monitoring well screened in the Purisima A-unit. The second location, will be a deep Tu monitoring well located between the City of Santa Cruz's Soquel Point and Pleasure Point monitoring cluster. The exact location is still to be determined.

Depletion of interconnected surface water monitoring: To more fully characterize interconnections between surface water and groundwater, additional monitoring of shallow groundwater levels is needed in the upper reaches of Soquel Creek and on other creeks that both support priority species and have a connection to groundwater. The locations for additional shallow wells are selected based on whether groundwater is connected to surface water, it is in an area of concentrated groundwater extraction, has a suitable nearby location for a streamflow gauge, and has potential site access. There is a fair degree of uncertainty regarding access at some of the proposed locations. The actual locations of future shallow wells will be determined based on a site suitability study that will include the ability to obtain easements. Figure 3-9 shows the locations of eight proposed shallow monitoring wells that fill monitoring gaps in the Basin. To indicate areas of concentrated groundwater extraction, Figure 3-9 shows the area of municipal pumping and the small dots are approximate locations of private domestic wells. The proposed shallow well on Lower Aptos is an example of a well site that may be moved, based in findings from the site suitability study, to a better location that may be on Valencia Creek above Aptos Creek. The shallow well on Rodeo Gulch is a lower priority site which may require synoptic measurements to establish where it is gaining and losing before finalizing a new shallow monitoring well site. Section 5 on Plan Implementation outlines how the MGA plans to finance and construct the eight shallow monitoring wells.

3.3.4.2 Streamflow Monitoring Data Gaps

Associated with the shallow groundwater level monitoring wells identified above, streamflow gauges to monitor changes in streamflow are needed to correlate changes in streamflow from groundwater extraction. The shallow monitoring wells and streamflow gauges need to be located adjacent to each other for the data to be meaningful. Figure 3-9 shows the locations of five proposed streamflow gauges that would be associated with shallow monitoring wells. Section 5 on Plan Implementation outlines how the MGA plans to finance and construct the streamflow gauges.

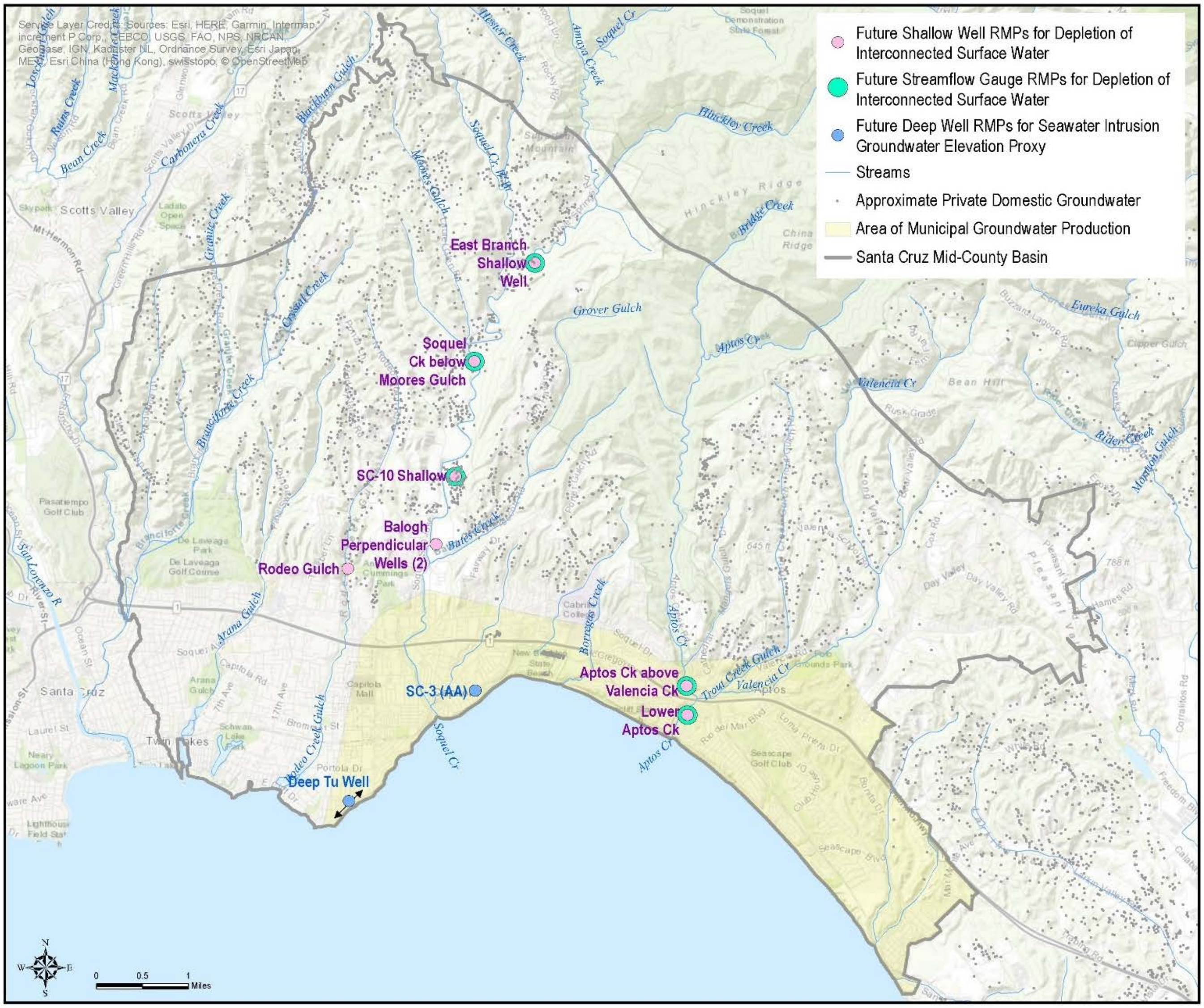


Figure 3-9. Groundwater Level and Streamflow Monitoring Data Gaps

3.3.4.3 Groundwater Extraction Monitoring Data Gaps

As part of GSP implementation, the MGA will initiate a new well metering program on new private non-*de minimis* wells that meet the following criteria:

- Pump more than 2 acre-feet per year within priority management zones to be defined by the County of Santa Cruz. These will be related to seawater intrusion and depletion of interconnected surface water.

- Wells outside of priority management zones that pump more than 5 acre-feet per year.

Implementation of a planned metering program is described in more detail in Section 5 on Plan Implementation.

3.4 Chronic Lowering of Groundwater Levels Sustainable Management Criteria

3.4.1 Undesirable Results - Chronic Lowering of Groundwater Levels

Chronic lowering of groundwater levels is considered significant and unreasonable when:

A significant number of private, agricultural, industrial, and municipal production wells can no longer provide enough groundwater to supply beneficial uses.

In the late 1980's, groundwater levels in parts of the Basin were between 35 and 140 feet lower than they are currently. Even at these lower levels, production wells were still able to extract groundwater to supply beneficial uses. Based what is considered significant and unreasonable described above, chronic lowering of groundwater levels has not historically occurred and is not currently occurring in the Basin. Although groundwater users did not lose significant capacity historically during periods of lowered groundwater levels, those lower groundwater levels caused seawater intrusion which is the reason why the Basin is classified as critically overdrafted.

3.4.1.1 Criteria for Defining Chronic Lowering of Groundwater Levels Undesirable Results

Specific groundwater level conditions that constitute undesirable results for chronic lowering of groundwater levels are:

Any average monthly representative monitoring point's groundwater elevation falls below its minimum threshold.

The definition of undesirable results is based on MGA sentiment that groundwater levels in the Basin should be managed to support all existing and/or proposed overlying land uses and environmental water user's beneficial needs. Using the criteria of monthly average groundwater levels adequately monitors and identifies seasonal low groundwater elevations that could be much lower than average annual groundwater levels

3.4.1.2 Potential Causes of Undesirable Results

The possible causes of undesirable chronic lowering of groundwater level results are significant changes in Basin pumping distribution and volumes or a significant reduction in natural recharge as a result of climate change. If the location and volumes of groundwater pumping change as a result of unforeseen rural residential, agricultural and urban growth that depend on groundwater as a water supply without supplemental supplies, these increased demands might lower groundwater to undesirable levels. Reduction in recharge or changes in rainfall patterns could also lead to more prolonged periods of lowered groundwater levels than have occurred historically.

3.4.1.3 Effects on Beneficial Users and Land Use

Undesirable results will prevent a significant number of private, agricultural, industrial, and municipal production wells from supplying groundwater to meet their water demands. Lowered groundwater levels will reduce the thickness of saturated aquifer from which wells can pump. Some wells may even go dry and new much deeper wells will need to be drilled. This would effectively increase the cost of using groundwater as a water source for all users.

3.4.2 Minimum Thresholds - Chronic Lowering of Groundwater Levels

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

Information used for establishing the chronic lowering of groundwater levels minimum thresholds and measurable objectives include:

- Definitions of significant and unreasonable conditions and desired groundwater elevations discussed during GSP Advisory Committee meetings.
- Depths, locations, and logged lithology of existing wells used to monitor groundwater levels.
- Historical groundwater elevation data from wells monitored by the MGA agencies.
- Maps of current and historical groundwater elevation data.
- Department of Water Resources well drillers' logs of domestic and agricultural wells for determining aquifers pumped, well depths and diameters, screened intervals, and estimated yield in the vicinity of RMPs.

Minimum thresholds for RMPs are based on the groundwater elevation required to meet the typical overlying water demand in the shallowest well in the vicinity of the RMP. The methodology used to estimate the groundwater elevation based on overlying water demand is documented in Appendix 3-A. If the minimum threshold elevation using this approach is greater than 30 feet below historic low groundwater elevations, the threshold elevation is increased as excessively low groundwater elevations, even if overlying water demand can be met at these lower levels, may cause undesirable results for other sustainability indicators. The 30-foot limit rationale is explained more fully in Appendix 3-A.

3.4.2.2 Chronic Lowering of Groundwater Level Minimum Thresholds

Figure 3-5 shows the location of RMPs with chronic lowering of groundwater levels minimum thresholds. Table 3-12 lists minimum thresholds for all RMPs. Historical hydrographs for RMPs showing historical groundwater elevations versus minimum thresholds and measurable objectives are provided in Appendix 3-B.

Table 3-12. Minimum Thresholds and Measurable Objectives for Chronic Lowering of Groundwater Level Representative Monitoring Points

Representative Monitoring Point	Well Type	Aquifer	Minimum Threshold	Measurable Objective
			Groundwater Elevation, feet above mean sea level	
SC-A7C	Monitoring	Aromas	0	8
Private Well #2	Production	Purisima F	562	596
Black	Monitoring		10	41
CWD-5	Monitoring		140	194
SC-23C	Monitoring		15	49
SC-11RD	Monitoring	Purisima DEF	295	318
SC-23B	Monitoring		50	85
SC-11RB	Monitoring	Purisima BC	120	157
SC-19	Monitoring		56	95
SC-23A	Monitoring		0	44
Coffee Lane Shallow	Monitoring	Purisima A	27	47
SC-22A	Monitoring		2	44
SC-22AA	Monitoring	Purisima AA	0	22
SC-10RAA	Monitoring		35	76
Private Well #1	Production	Purisima AA/Tu	362	387
30th Ave Deep	Monitoring	Tu	0	30
Thurber Lane Deep	Monitoring		-10	33

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

Section §354.28 of the SGMA regulations requires that a description of all minimum thresholds include a discussion about the relationship between the minimum thresholds for each sustainability indicator. In the SMC BMP (DWR, 2017), DWR has clarified this requirement:

1. The GSP must describe the relationship between each sustainability indicator's minimum threshold (e.g., describe why or how a water level minimum threshold set at a particular representative monitoring site is similar to or different to groundwater level thresholds in nearby RMP).

2. The GSP must describe the relationship between the selected minimum threshold and minimum thresholds for other sustainability indicators (e.g., describe how a groundwater level minimum threshold would not trigger an undesirable result for seawater intrusion).

Minimum thresholds are selected to avoid undesirable results for other sustainability indicators. If the same RMP was selected for chronic lowering of groundwater levels as another sustainability indicator's RMP that uses groundwater elevation as a metric, the shallowest groundwater elevation minimum threshold of the two sustainability indicators is set at that RMP and assigned to the sustainability indicator that has the shallowest elevation. The relationship between chronic lowering of groundwater level minimum thresholds and minimum thresholds for other sustainability indicators are discussed below.

- **Reduction of groundwater in storage**. The metrics for chronic lowering of groundwater level minimum thresholds (groundwater elevations) and reduction of groundwater in storage (volume of groundwater extracted) are different. However, since the reduction of groundwater in storage minimum thresholds are dependent on avoiding undesirable results for the Basin's other sustainability indicators, maintaining the chronic lowering of groundwater level minimum thresholds does not result in an undesirable reduction of groundwater in storage.
- **Seawater intrusion**. All near-coastal minimum thresholds for chronic lowering of groundwater levels are set at elevations no deeper than sea level so as to not interfere with seawater intrusion minimum thresholds (Figure 3-10). Where groundwater levels close to the coast determined from an estimated minimum saturated thickness are deeper than seawater intrusion's groundwater level proxy minimum thresholds, the chronic lowering of groundwater level minimum threshold is increased to ensure that it does not restrict the ability to meet or exceed protective elevations for seawater intrusion. One of the chronic lowering of groundwater levels RMPs, Thurber Lane Deep, is inland and far enough away from RMPs for seawater intrusion that groundwater levels in the Tu unit are allowed to fall below sea level without causing undesirable seawater intrusion.
- **Degraded groundwater quality**. Protecting groundwater quality is critically important to all who depend upon the groundwater resource. A significant and unreasonable condition for degraded water quality is exceeding drinking water standards for constituents of concern in supply wells due to projects and management actions proposed in the GSP. Although chronic lowering of groundwater level minimum thresholds does not direct effect degraded quality, groundwater quality could potentially be affected by projects and management action induced changes in groundwater elevations and gradients. These changes could potentially cause poor quality groundwater to flow towards supply wells that would not have otherwise been impacted. Currently, apart from one location with 1,2,3-TCP and more widespread nitrate in parts of the Aromas Red Sands aquifers, and saline water associated with seawater intrusion in two areas along the coast, the Basin's groundwater quality is good with no non-native poor groundwater quality present within productive aquifers.

- **Subsidence**. This sustainability indicator is not applicable in the Basin.
- **Depletion of interconnected surface water**. Minimum thresholds for depletion of interconnected surface water are mostly set in shallow alluvial sediments and are based on shallow groundwater levels between 2001 and 2015. Chronic lowering of groundwater level minimum thresholds are set in the deeper Purisima aquifers where the majority of production occurs and are set substantially lower than groundwater levels observed between 2001-2015. As described in more detail in Section 2, there is no immediate measurable influence on surface water flow from extraction in the deeper Purisima aquifers, but there is likely some long-term indirect connection between the deeper Purisima aquifers and shallow groundwater. In the unlikely event that groundwater levels drop to minimum thresholds for chronic lowering of groundwater levels, the vertical gradient between shallow and deep aquifers will increase and may cause undesirable results in the shallow aquifers and interconnected surface waters.

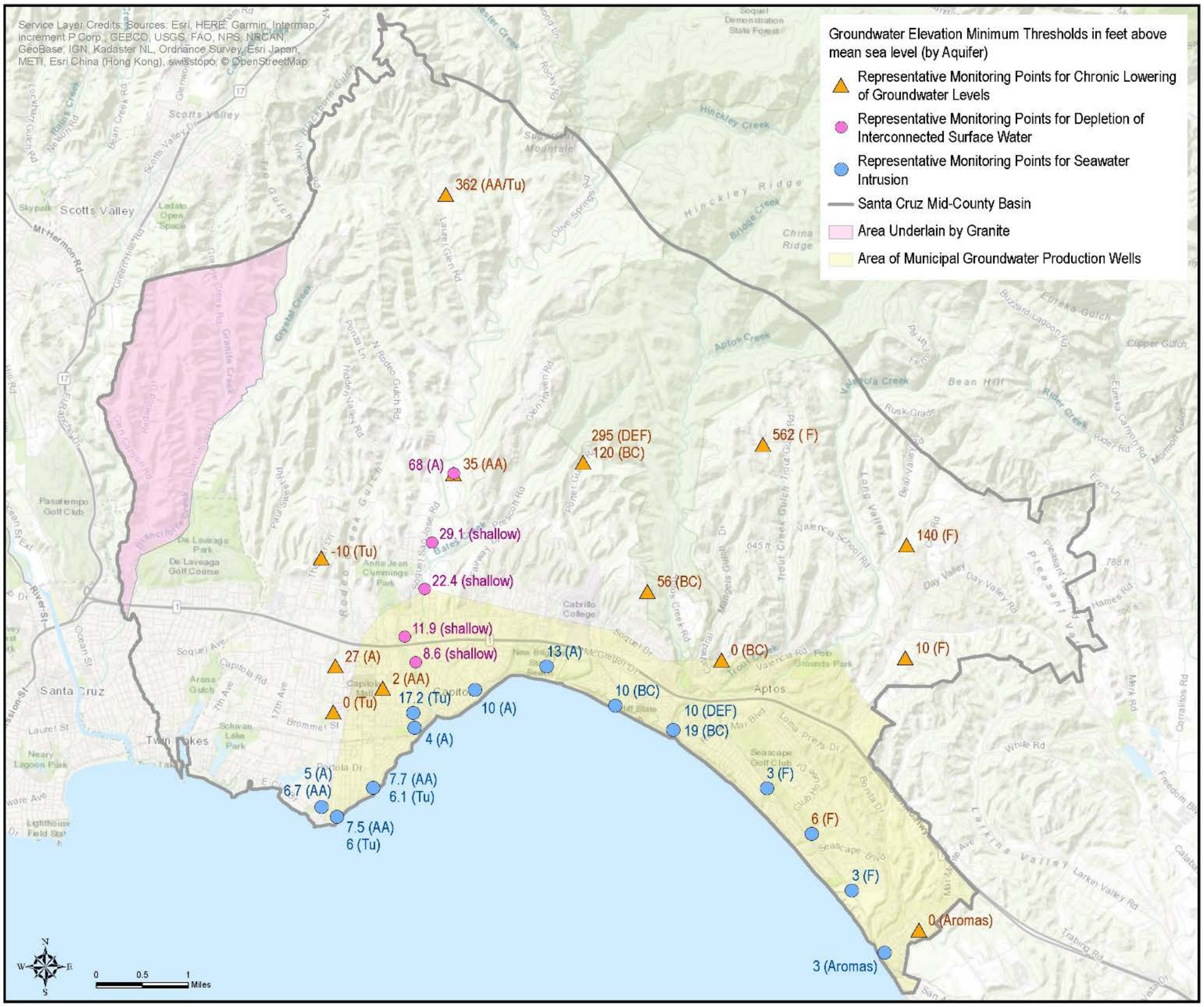


Figure 3-10. Minumum Thresholds for All Sustainability Indicators with Groundwater Elevation Minimum Thresholds

3.4.2.4 Effect of Minimum Thresholds on Neighboring Basins

Two neighboring groundwater basins are required to develop and adopt GSPs or have submitted an alternative: the medium-priority Santa Margarita Basin (to the northwest) and the critically-overdrafted Pajaro Valley Subbasin of the Corralitos Basin (to the east). There are two additional groundwater basins prioritized as very low and do not require GSPs: the Purisima Highlands Subbasin of the Corralitos Basin (to the north) and the West Santa Cruz Terrace Basin (to the west). Since the West Santa Cruz Terrace Basin is not significantly connected to the Santa Cruz Mid-County Basin due to the Purisima aquifers not extending westwards into that basin, effects of minimum thresholds on that basin are not discussed further. Anticipated effects of chronic lowering of groundwater levels minimum thresholds on the other three neighboring basins are addressed below and for subsequent sustainability indicators.

Pajaro Valley Subbasin of the Corralitos Basin (critically-overdrafted). The Pajaro Valley Subbasin is hydrogeological down- to cross-gradient of the Santa Cruz Mid-County Basin. Because of lower groundwater elevations in the Pajaro Valley Subbasin, groundwater along the coastal portion of the boundary generally flows from the Santa Cruz Mid-County Basin into the Pajaro Valley Subbasin. Purisima aquifers are not a major source of groundwater in the Pajaro Valley and are only pumped by a few deeper wells (Carollo Engineers, 2014). The Aromas Red Sands aquifer is the major producing aquifer within the Pajaro Valley Subbasin (Carollo Engineers, 2014). The Aromas Red Sands aquifer RMP (SC-A7A) in the Santa Cruz Mid-County Basin near the boundary with Pajaro Valley Subbasin has a minimum threshold that is a few feet lower than current levels. In the unlikely event that groundwater levels in this area fall to minimum thresholds, it may slightly reduce the amount of subsurface outflow to the Pajaro Valley Subbasin but would not be expected to hinder it from achieving sustainability.

Santa Margarita Basin (medium-priority). The Santa Margarita Basin is required to develop a GSP by 2022. Santa Margarita Basin is hydrogeologically downgradient of the Santa Cruz Mid-County Basin and based on the water budget, less than 400 acre-feet of groundwater flows from the Santa Cruz Mid-County Basin into the Santa Margarita Basin annually. The boundary where subsurface flows occur between the two basins is north of the Aptos Fault and four miles inland of the area where GSP projects and management actions would take place. Current groundwater levels are already well above the minimum thresholds for all RMPs and no GSP induced changes in elevations are expected as GSP activities are some distance away so it is not expected that Santa Margarita Basin will be adversely affected by activites under this GSP. However, if groundwater levels near the Santa Margarita basin drop to the minimum thresholds, flow from the Santa Cruz Mid-County Basin to Santa Margarita Basin could be reduced and could affect Santa Margarita Basin’s ability to achieve sustainability.

Purisima Highlands Subbasin of the Corralitos Basin (very low-priority). The Purisima Highlands Subbasin is hydrogeological up-gradient of the Santa Cruz Mid-County Basin. Groundwater flow, historically and projected in the future, will continue to be from the higher elevation Purisima Highlands Subbasin into the Santa Cruz Mid-County Basin. If groundwater levels in the northern portion of the Basin declined to minimum thresholds, the rate of subsurface outflow may increase slightly from the Purisima Highlands Subbasin.

3.4.2.5 Effects of Minimum Thresholds on Beneficial Users and Land Uses

Chronic lowering of groundwater elevation minimum thresholds may have several effects on beneficial users and land uses in the Basin.

Rural residential land uses and users. The chronic lowering of groundwater level minimum thresholds protects most domestic users of groundwater by protecting their ability to pump from domestic wells. However, if groundwater elevations fall to minimum thresholds, there may be limited water in some of the shallowest domestic wells (less than 100 feet deep) that may require well owners to drill deeper wells.

Agricultural land uses and users. Similar to rural residential uses and users, chronic lowering of groundwater level minimum thresholds protects agricultural users of groundwater by protecting their ability to meet their typical demands. Minimum thresholds for chronic lowering of groundwater level will not limit use of land for agricultural purposes.

Urban land uses and users. The chronic lowering of groundwater level minimum thresholds are set so that all users, including municipal groundwater pumpers can still meet their typical water demands. As most of the RMPs for the chronic lowering of groundwater levels are located inland of the area of municipal pumping which covers the majority of the Basin's urban area, it is the groundwater level proxy minimum thresholds for seawater that have a bigger influence on urban/municipal users of groundwater.

Ecological land uses and users. As described in Section 3.2.3.2, chronic lowering of groundwater level minimum thresholds are not set to protect the groundwater resource including those existing ecological habitats that rely upon it. In the unlikely event that groundwater levels drop to minimum thresholds for chronic lowering of groundwater levels, it could lead to a significant and unreasonable reduction of flow of groundwater toward streams, which could adversely affect ecological habitats.

3.4.2.6 Relevant Federal, State, or Local Standards

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

3.4.2.7 Method for Quantitative Measurement of Minimum Thresholds

Groundwater elevations in RMPs will be directly measured to determine where groundwater levels are in relation to minimum thresholds. Groundwater level monitoring will be conducted in accordance with the monitoring plan outlined in Section 3.3. All RMPs will be equipped with continuous data loggers.

There are two privately-owned wells that do not currently have data loggers. Section 5 on Plan Implementation includes planned implementation budget to purchase, install and monitor those additional RMPs. All other agency monitoring wells assigned as RMPs already have data loggers installed.

3.4.3 Measurable Objectives - Chronic Lowering of Groundwater Levels

3.4.3.1 Measurable Objectives

Measurable objectives for RMPs are the 75th percentile of historical groundwater elevations for the period of record of each monitoring point. The 75th percentile is higher than median or average groundwater elevations and reflects where the MGA would like groundwater elevations to be in the future whilst allowing for operational flexibility.

Representative monitoring point hydrographs in Appendix 3-B include measurable objectives for chronic lowering of groundwater levels compared to minimum thresholds.

3.4.3.2 Interim Milestones

Groundwater levels in the Basin are currently above minimum thresholds for all RMPs with no significant changes in levels 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 elevations as measurable objectives shown in Table 3-12.

3.5 Reduction of Groundwater in Storage Sustainable Management Criteria

3.5.1 Undesirable Results - Reduction of Groundwater in Storage

The reduction in storage sustainability indicator is not measured by a change in groundwater in storage. Rather, 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)).

Locally defined significant and unreasonable conditions for a reduction of groundwater in storage in the Basin are defined as:

> *A net volume of groundwater extracted (pumping minus annual volume of managed aquifer recharge) that will likely cause other sustainability indicators to have undesirable results.*

3.5.1.1 Criteria for Defining Reduction of Groundwater in Storage Undesirable Results

The net volume of groundwater extracted that constitutes undesirable results for reduction of groundwater storage is:

> *Five-year average net extraction exceeding the sustainable yield (minimum threshold) for any one of the groups of aquifers:*

- *Aromas Red Sands aquifer and Purisima F aquifer units,*
- *Purisima DEF, BC, A, and AA aquifer units, and*
- *Tu aquifer.*

Although only a total volume for the whole basin is required as a metric for the reduction of groundwater in storage sustainability indicator per the SGMA regulations, this GSP has separate SMC for three aquifer groups in the Basin: (1) Aromas Red Sands and Purisima F, (2) Purisima DEF, BC, A, and AA aquifers, and (3) the Tu aquifer. The SMC metrics for this indicator are based on the sustainable yields for each of the three aquifer groups estimated in Section 2.2.3.7: Projected Sustainable Yield.

Developing reduction of groundwater storage SMC for separate aquifer units reflects the stacked aquifer units of the Basin where groundwater supply in different areas of the Basin are provided by different aquifer units. To maximize capacity, municipal wells are often screened across multiple aquifers: The aquifer groupings are based on how municipal wells are typically screened. Most municipal wells screened in the Aromas Red Sands aquifer are also screened in the deeper Purisima F-unit aquifer. Other typical multiple aquifer screened wells include: the Purisima DEF and BC-units; the Purisima BC and A-units; and the Purisima A and AA-units. Although municipal wells screened in the Tu unit are also screened in the Purisima AA-unit, a high percentage of the flow in these wells is observed to be from the Tu unit. Additionally, the vertical separation of flow between the Purisima AA and Tu units is observed to be greater than the vertical separation between the Purisima A and AA-units, which further supports the Tu unit being in a group on its own.

Although sustainable yield can be estimated for individual aquifers, monitoring how much is pumped from each aquifer is not possible because of production wells being screened through multiple aquifers. Therefore, the aquifer groupings account for the extraction from the aquifers production wells are typically screened in.

The purpose of this sustainability indicator is to prevent undesirable results for other sustainability indicators. Each of these sustainability indicators are monitored by individual aquifer units. If undesirable results are observed in any aquifer unit or related to pumping from a specific aquifer unit, the most likely management action to eliminate the undesirable result is to change net pumping from the aquifer unit. The change in net pumping will be determined by what is necessary to eliminate the undesirable result, not based on the reduction of groundwater in storage criteria. Recognizing this, developing reduction of storage SMC for each aquifer unit is not necessary for planning groundwater management and may restrict operational flexibility.

3.5.1.2 Potential Causes of Undesirable Results

Future increased well density and pumping amounts can contribute to reduction of groundwater in storage undesirable results. Since the locations of groundwater extraction and MAR are not static, new private or municipal wells, or changed operations could cause localized undesirable results. To optimize operations or locations of new high-capacity wells and MAR, groundwater modeling can be used to predict if undesirable results may occur.

3.5.1.3 Effects on Beneficial Users and Land Use

Undesirable reduced groundwater in storage caused by over-pumping may cause undesirable results in any of the other four applicable sustainability indicators that potentially impact beneficial users and land uses. Groundwater levels that are too low as a result of implementing the GSP may:

1. Prevent a significant number of private, agricultural, industrial, and municipal production wells from supplying groundwater to meet their water demands.

2. Induce seawater intrusion that will render impacted portions of the Basin's aquifers unusable to its beneficial users. Land uses completely overlying seawater intrusion, such as agriculture, will need alternative sources of water if their wells are located in the affected areas.

3. Cause more surface water depletion in interconnected streams that support priority species than has occurred over the past 18 years.

4. Degrade groundwater quality if by implementation of the GSP there are changes in groundwater elevations and gradients that cause non-native poor-quality groundwater to flow towards extraction wells that were previously not impacted. Groundwater quality that does not meet state drinking water standards will need to be treated, which is a significant cost to users. For municipal pumpers, impacted wells can be taken offline until a solution is found. This will add stress on their water system by having to make up pumping in other unimpacted wells and increase the potential for further declines in groundwater levels.

3.5.2 Minimum Thresholds - Reduction of Groundwater in Storage

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

Information used for establishing the reduction of groundwater in storage minimum thresholds and measurable objectives include:

- Definitions of significant and unreasonable conditions discussed during GSP Advisory Committee meetings.
- Projected municipal agency, private domestic, institutional, and agricultural pumping at specific well locations.
- Projected injection for Pure Water Soquel and City of Santa Cruz ASR at assumed locations.
- Projected hydrographs comparing simulated groundwater levels compared to minimum thresholds for seawater intrusion and depletion of interconnected surface water.
- Sustainable yield estimates from Section 2.2.3.7.

The Basin's sustainable yields for three aquifer groups used as minimum thresholds for the reduction of groundwater in storage sustainability indicator rely on projected net pumping with GSP implementation, as described in Section 2.2.3.7: Projected Sustainable Yield. Net projected pumping for Water Years 2016 – 2069 is pumping that has been adjusted to avoid undesirable results. Adjustments to achieve minimum thresholds include redistributing pumping and the operation of City of Santa Cruz ASR and SqCWD's Pure Water Soquel.

3.5.2.2 Reduction of Groundwater in Storage Minimum Thresholds

Minimum thresholds for reduction of groundwater storage are the sustainable yields representing net annual volume of groundwater extracted (pumping minus volume of managed aquifer recharge) for each of the three groups of aquifers, as summarized in Table 3-13.

Table 3-13. Minimum Thresholds and Measurable Objectives for Reduction of Groundwater of Storage

Aquifer Unit Group	Minimum Threshold	Measurable Objective
	Groundwater Extracted, acre-feet per year	
Aromas Red Sands and Purisima F	1,740	1,680
Purisima DEF, BC, A and AA	2,280	960
Tu	930	620

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

As the sustainable yields for the three aquifer groups are based on avoiding undesirable results for all the other applicable sustainability indicators, net pumping at or below the sustainable yield should not conflict with minimum thresholds for the other sustainability indicators.

However, there could be discrepancies observed between the sustainable yields used as minimum thresholds and undesirable results observed for other sustainability indicators. Undesirable results in the other applicable sustainability indicators could still occur if net pumping is below minimum thresholds and undesirable results in the other applicable sustainability indicators might not occur if net pumping exceeds minimum thresholds. In addition to hydrologic uncertainty of the estimates for sustainable yield used for minimum thresholds, the sustainable yield estimates are highly dependent on the location of groundwater extraction and managed aquifer recharge (MAR) used to derive the estimates. Depending on the location of these activities, pumping within the sustainable yield may still cause seawater intrusion at the coast, such as if new production wells are located close to existing wells and close to the coastline.

If discrepancies with other sustainability indicators occur, the estimate for sustainable yields and the minimum thresholds should be revised to be consistent with whether or not there are undesirable results for the other sustainability indicators.

3.5.2.4 Effect of Minimum Thresholds on Neighboring Basins

Anticipated effects of the reduction of groundwater in storage minimum thresholds on neighboring basins are addressed below.

Pajaro Valley Subbasin of the Corralitos Basin (critically-overdrafted). To avoid undesirable seawater intrusion results in the Aromas area near the Basin’s boundary with the

Pajaro Valley, municipal extraction is currently and projected to be in the future very limited, unless a recharge project can provide supplemental water supplies. As a result of almost eliminating municipal extraction, groundwater levels in the Aromas area near the boundary with Pajaro Valley Subbasin are close to seawater intrusion proxy minimum thresholds. With GSP implementation, groundwater levels are expected to increase slightly higher and closer to measurable objectives at the Basin boundary. Decreased pumping in the Aromas, included in the reduction of groundwater in storage minimum threshold for the Aromas and Purisima F-unit aquifer group, is beneficial to both basins for controlling seawater intrusion. Therefore, it is unlikely that the reduction of groundwater storage minimum thresholds established for the Basin will prevent the Pajaro Valley Subbasin from achieving sustainability.

Santa Margarita Basin (medium-priority). The area of the Basin with potential to influence the Santa Margarita Basin is the western area north of the Aptos Fault where unsustainable conditions have not historically nor currently occurred. Groundwater use in this area is all for private use: mostly for *de minimis* private domestic purposes with two retreats that are non-*de minimis* users of groundwater. Groundwater use in this part of the Basin, as part of the sustainable yield, is projected to remain similar to historic use and therefore minimum thresholds for reduction of groundwater in storage will not negatively impact groundwater conditions in the Santa Margarita Basin.

Purisima Highlands Subbasin of the Corralitos Basin (very low-priority). Similar to the Basin's relationship with the Santa Margarita Basin, the area of the Basin that is closest to the Purisima Highlands Subbasin is mainly pumped by private *de minimis* groundwater users. Pumping in this area is projected to remain similar to historic use and therefore minimum thresholds for reduction of groundwater in storage will not negatively impact groundwater conditions in the Santa Margarita Basin.

3.5.2.5 Effects of Minimum Thresholds on Beneficial Users and Land Uses

The reduction of groundwater in storage (sustainable yield) minimum thresholds may have several effects on beneficial users and land uses in the Basin.

Rural residential land uses and users. Twenty-one percent of the projected sustainable yield comprises estimated pumping from *de-minimis* domestic wells. As changes in pumping in the Basin are focused on municipal wells closer to the coast to avoid undesirable seawater intrusion conditions, rural residential users are not impacted by required reductions in pumping. The model indicated that impacts of inland rural residential pumping on seawater intrusion is minimal and therefore reductions to their pumping would not help achieve protective groundwater elevations. There are therefore no effects on rural residential land uses and users from the reduction of groundwater in storage minimum thresholds.

Agricultural land uses and users. Nine percent of the projected sustainable yield comprises estimated pumping for agricultural purposes. At this time, reductions in agricultural pumping for irrigation purposes are not included in meeting the projected sustainable yield. Therefore, there are no effects on agricultural land uses and users from reduction of groundwater in storage minimum thresholds.

Urban land uses and users. Urban users and land uses are concentrated in a corridor along the coast. Municipal wells that supply water to these users are also located in this area and are therefore also close to the coast. Reductions in municipal pumping needed to increase coastal groundwater levels to control seawater intrusion need to be offset by other water sources. Reducing the amount of municipal groundwater pumping increases the cost of water for municipal users in the Basin because water agencies need to find other, more expensive water sources.

Ecological land uses and users. Groundwater dependent ecosystems would generally benefit from the reduction of groundwater in storage minimum threshold in the area of municipal pumping. Increasing groundwater levels above current levels will generally improve already sustainable conditions for groundwater dependent ecosystems.

3.5.2.6 Relevant Federal, State, or Local Standards

No federal, state, or local standards exist for reduction of groundwater in storage related groundwater extraction.

3.5.2.7 Method for Quantitative Measurement of Minimum Thresholds

Groundwater extractions in municipal and small water systems RMPs will be directly measured with water meters to determine the volume of groundwater produced in relation to minimum thresholds. Groundwater extraction monitoring will be conducted in accordance with the monitoring plan outlined in Section 3.3.2.4. For *de minimis* domestic and agricultural users that are unmetered, the groundwater extracted by these users will be estimated as described in Section 3.3.1.3.

Annual Basin extractions from each the three aquifer groups will be used in a five-year running average to compare against minimum thresholds to determine if undesirable results have occurred in any of the aquifer groups.

3.5.3 Measurable Objectives - Reduction of Groundwater Storage

3.5.3.1 Measurable Objectives

The reduction of groundwater in storage measurable objectives for each of the three aquifer groups are the maximum net annual amount of groundwater that can be extracted while ensuring that if there were four subsequent years of maximum projected net groundwater extraction, net annual groundwater extractions greater than the minimum threshold will not occur for any one of the three aquifer groups. Table 3-13 lists the measurable objectives for the three aquifer groups.

Annual net extractions for the different aquifer groups will be used to compare against measurable objectives, and not the five-year average of net extractions. This is because the measurable objective is the maximum that can be pumped if the next four years all had maximum projected pumping for undesirable results to be avoided.

It is not expected that the planned projects will achieve the measurable objective for the Purisima DEF, BC, A, and AA aquifer group; i.e., the planned projects will not provide for four consecutive years of maximum net pumping without avoiding undesirable results.

3.5.3.2 Interim Milestones

Interim milestones for this sustainability indicator track implementation of projects planned to meet sustainability described in Section 4. Section 4 describes the expected benefits of Soquel Creek Water District's Pure Water Soquel project and the City of Santa Cruz's Aquifer Storage and Recovery project as preventing undesirable results in the Basin and meeting measurable objectives in much of the Basin. The interim milestones are therefore the projected net pumping for the Basin as the projects get implemented. The interim milestones for 2025, 2030, and 2035 are the five-year averages for net pumping covering Water Years 2021-2025, Water Years 2026-2030, and Water Years 2031-2035, respectively.

Interim milestones for Water Year 2025 do not meet all of the sustainable yields because the operation of Pure Water Soquel with approximately 1,500 acre-feet per year of injection is not scheduled to begin operation until Water Year 2023. The interim milestones for 2030 and 2035 are lower than sustainable yield (minimum threshold) with planned operation of both projects occurring simultaneously by 2026. There will be no undesirable results for reduction of groundwater in storage by 2030.

Although below sustainable yield (minimum threshold), interim milestones are higher in 2035 than 2030 due to projected climate. Evaluations of net pumping versus interim milestones should consider effect of climate on injection and pumping volumes for the previous five years

.

Table 3-14. Interim Milestones for Reduction of Groundwater of Storage

Aquifer Unit Group	Interim Milestone 1 2025	Interim Milestone 2 2030	Interim Milestone 3 2035
	Trailing 5 Year Average of Groundwater Extracted, acre-feet per year		
Aromas Red Sands and Purisima F	1,930	1,630	1,670
Purisima DEF, BC, A and AA	2,110	1,970	2,120
Tu	720	710	760

3.6 Seawater Intrusion Sustainable Management Criteria

3.6.1 Undesirable Results - Seawater Intrusion

Locally defined significant and unreasonable seawater intrusion in the Basin is:

Seawater moving farther inland than has been observed from 2013 through 2017.

This statement reflects that the MGA does not want seawater intrusion to advance further into the Basin. The period from 2013 through 2017 is included in the statement because although there has not been much recent change in the distribution of seawater intrusion, there has been one seawater intruded monitoring well (Moran Lake Medium) that has experienced decreased chloride concentrations which are now below 250 mg/L. By specifying the years 2013-2017, we ensure that intrusion is not allowed back into this area, whereas if the historical maximum chloride concentration was used, Moran Lake Medium chloride concentrations could be allowed to increase back to 700 mg/L. Table 3-15 summarizes 2013-2017 average and maximum chloride concentrations for all coastal monitoring wells.

Table 3-15. Summary of Chloride Concentrations in Monitoring and Production Wells at the Coast

Well	Aquifer Unit	Historical Maximum Year	Historical Maximum	2013-2017 Average	2018 / 2017*
			Chloride Concentrations, mg/L		
Coastal Monitoring Wells - Intruded					
SC-A3A	Aromas	2010	22,000	17,955	18,000
SC-A3B	Aromas	2005	4,330	676	1,100
SC-A8A	Purisima F	2015	8,000	7,258	7,500
SC-A2RA	Purisima F	2001	18,480	14,259	15,000
SC-A2RB	Purisima F	2015 & 2018	470	355	470
Moran Lake Medium	Purisima A	2005	700	147	78
Soquel Point Medium	Purisima A	2005	1,300	1,104	1,100
Coastal Monitoring Wells - Unintruded					
SC-A8B	Aromas	2014	38	33	33
SC-A1B	Purisima F	2009	38	26	22
SC-A1A	Purisima DEF	2009	37	28	26
SC-8RD	Purisima DEF	2016	65	28	66
SC-9RC	Purisima BC	1984	63	28	31
SC-8RB	Purisima BC	2003	32	14	13
Pleasure Point Medium	Purisima A	2012	38	34	36
SC-1A	Purisima A	2013	51	41	38
SC-5RA	Purisima A	2001	94	55	58

Well	Aquifer Unit	Historical Maximum Year	Historical Maximum	2013-2017 Average	2018 / 2017*
			Chloride Concentrations, mg/L		
SC-3RA	Purisima A	1984	66	39	38
Moran Lake Deep	Purisima AA	2012	66	64	62*
Pleasure Point Deep	Purisima AA	2006	87	22	21*
Soquel Point Deep	Purisima AA	2016	144	137	140*
SC-13A	Tu	1986	114	NA	NA
Inland Monitoring and Production Wells - Unintruded					
SC-A5A	Purisima F	2015	9,800	8,575	53
SC-A5B	Purisima F	2018	130	95	83
San Andreas PW	Purisima F	2011	79	21	21
Seascape PW	Purisima F	1996	29	20	16
T. Hopkins PW	Purisima DEF	2011	71	46	42
Estates PW	Purisima BC & A	1990	63	45	45
Ledyard PW	Purisima BC	1986	87	35	33
Garnet PW	Purisima A	2009	90	81	84
Beltz #2	Purisima A	2008	97	63	61*
Beltz #8 PW	Purisima A	2012	56	51	52*
SC-22AA	Purisima AA	2018	45	39	36
Corcoran Lagoon Deep	Purisima AA	2011	120	20	21
Schwan Lake	Purisima AA	2008	97	91	94*

PW = production well; NA = not available

3.6.1.1 Criteria for Defining Seawater Intrusion Undesirable Results

Undesirable results for seawater intrusion listed below are related to the inland movement of the chloride isocontour which would be considered significant and unreasonable seawater intrusion. To be able to monitor the location of the isocontour, chloride concentrations in monitoring and production wells either side of the chloride isocontours are used in the definition of undesirable results. In addition to the chloride isocontour minimum threshold, protective groundwater elevations at coastal monitoring wells are used as a proxy for seawater intrusion minimum thresholds. For a decade, seawater intrusion in the Basin has been managed using protective groundwater elevations. Experience has shown that protective groundwater elevations are easier to measure and manage with respect to controlling seawater intrusion, compared to relying purely on chloride concentrations.

The Basin's seawater intrusion undesirable results are split into three categories as defined below.

1. Undesirable results for intruded coastal monitoring wells.
2. Undesirable results for unintruded coastal monitoring wells, and inland monitoring and production wells.
3. Undesirable results for protective groundwater elevations.

If any of these occur, undesirable results from seawater intrusion are occurring.

Undesirable Results for Intruded Coastal Monitoring Wells

Undesirable results for coastal wells hat already have experienced seawater intrusion are:

> *Any coastal monitoring well with current intrusion has a chloride concentration above the 2013–2017 maximum chloride concentration. This concentration must be exceeded in 2 or more of the last 4 consecutive quarterly samples.*

The rationale for this statement is that if seawater intrusion had not been reported in wells inland of the coastal monitoring wells when chloride concentrations in the coastal monitoring wells were at their historic high, the likelihood of seawater intruding them in the future if coastal monitoring well concentrations increased back to that level again is low. Using a five-year (2013 – 2017) historical maximum chloride concentration provides greater flexibility in avoiding undesirable results than using a five-year average concentration and is more protective than using the historical maximum, which is mostly higher than the 2013–2017 maximum concentration.

The number of chloride concentration exceedances should be set at two per year to account for occasional fluctuations not related to seawater intrusion. Two to four samples exceeding the recent historical maximum indicates that seawater intrusion has advanced farther inland, which would be considered significant and unreasonable. Table 3-15 includes a list of historical maximum chloride values versus 2013–2017 average and 2013–2017 maximum chloride concentrations for monitoring and production wells that have had or have seawater intrusion. Note that Moran Lake was previously impacted by seawater (700 mg/L) and its chloride concentration has decreased to below 250 mg/L.

Undesirable Results for Unintruded Coastal Monitoring Wells, and Inland Monitoring and Production Wells

Undesirable results for wells unintruded by seawater are broken down by general proximity to the coast:

> A. Unintruded coastal monitoring wells
>
> B. Unintruded inland wells (which includes municipal production wells closest to the coast and other non-coastal monitoring wells).

Undesirable results for unintruded coastal monitoring wells (A) are:

> *Any unintruded coastal monitoring well has a chloride concentration above 250 mg/L. This concentration must be exceeded in 2 or more of the last 4 consecutive samples (quarterly sampled wells).*

Coastal monitoring wells have been constructed to be the Basin's early warning system and first line of defense against seawater intrusion. If their chloride concentrations increase to 250 mg/L, this is a clear indication that seawater is advancing father onshore than it is currently. There are seven coastal monitoring well sites (each site contains several multi-depth monitoring wells) that currently do not show seawater intrusion. These wells' chloride concentrations are summarized in Table 3-15. Groundwater with more than 250 mg/L chloride has a salty taste but is still drinkable to 500 mg/L, which is the state's upper maximum contaminant level. To increase confidence that tested groundwater concentrations are not anomalies, the exceedance of 250 mg/L must be repeated within a year (quarterly sampled wells) to be undesirable.

Undesirable Results for unintruded inland monitoring wells (B) are:

> *Any Unintruded Inland Monitoring Well (which includes municipal production wells closest to the coast and other non-coastal monitoring wells) has a chloride concentration above 150 mg/L. This concentration must be exceeded in 2 or more of the last 4 consecutive quarterly samples*.

All unintruded wells used as data points to develop the chloride isocontour will have TDS and chloride tested on at least a semi-annual schedule until an exceedance occurs, which triggers quarterly testing. Additionally, for an undesirable result to occur, seawater must be the cause of the chloride increase and not another source, such as a localized chemical spill. These wells' chloride concentrations are summarized in Table 3-15.

<u>Undesirable Results for Protective Groundwater Elevations</u>

For coastal representative monitoring wells which have protective elevations:

> *Five-year average groundwater elevations below protective groundwater elevations for any Coastal representative monitoring well.*

A five-year averaging period is selected based on the reasoning that follows:

> Cross-sectional models used to develop most of the protective elevations are quasi-steady state models (HydroMetrics LLC, 2009). Therefore, the protective elevations estimated by the models represent long-term averages that need to be achieved to maintain the freshwater-seawater interface at the desired location. The Basin is currently considered in critical overdraft because groundwater levels are below protective elevations in a number of coastal monitoring wells. Therefore, seawater intrusion groundwater level proxies for minimum thresholds that define sustainability are based on

a multi-year average to ensure that critical overdraft is considered eliminated only when groundwater levels achieve the long-term average estimated to maintain the freshwater-seawater interface at the desired location. Achieving protective elevations in a single year should not represent elimination of the Basin's critical overdraft condition.

However, the multi-year averaging period cannot be too long because once protective elevations are achieved with a multi-year average, an overly long averaging period would allow for long periods of groundwater levels being below protective elevations and seawater to advance inland during those periods. A five-year period also corresponds with SGMA requirements for five-year updates of the GSP.

3.6.1.2 Potential Causes of Undesirable Results

Seawater intrusion is a direct result of groundwater levels falling below elevations that would keep seawater offshore. Water supply wells pumping close to the coast have the potential to cause seawater intrusion if the volumes extracted cause groundwater elevations to fall close to or below sea level. The effects on groundwater levels are increased when multiple wells pump cumulative in close proximity to each other.

3.6.1.3 Effects on Beneficial Users and Land Use

The primary detrimental effect on beneficial users and land users from seawater intrusion is that the groundwater supply will become saltier and thus impact the use of groundwater for domestic/municipal and agricultural purposes. Although groundwater with greater than 250 mg/L chloride has a salty taste, it is still drinkable. The state's upper maximum contaminant level is set at 500 mg/L, when it becomes undrinkable by humans.

Regarding effects on agriculture, chloride moves readily within soil and water and is taken up by the roots of plants. It is then transported to the stems and leaves. Sensitive berries and avocado rootstocks can tolerate only up to 120 mg/L of chloride, while grapes can tolerate up to 700 mg/L or more (Grattan, 2002).

Seawater intrusion renders impacted groundwater essentially unusable to its beneficial users without treatment. Desalinization would significantly increase the cost of water for all users. Land uses completely overlying seawater intrusion, such as agriculture, will need alternative sources of water if their wells are located in the affected areas. For municipal pumpers, impacted wells can be taken offline until a solution is found. This will add stress on their water system by having to make up pumping in other unimpacted wells and increase the potential for further declines in groundwater levels and possibly more seawater intrusion.

3.6.2 Minimum Thresholds - Seawater Intrusion

Contrary to the general rule for setting minimum thresholds for other sustainability indicators, seawater intrusion minimum thresholds do not have to be set at individual monitoring sites. Rather, the minimum threshold is set along an isocontour line in a basin or management area. However, for practical purposes of monitoring the isocontour, minimum thresholds are set at selected monitoring and production wells used to define the isocontour. Groundwater elevation minimum thresholds are also included as a proxy for seawater intrusion.

3.6.2.1 Information Used and Methodology for Establishing Seawater Intrusion Minimum Thresholds

3.6.2.1.1 Chloride Isocontours

Information used for establishing the chloride isocontour seawater intrusion minimum thresholds and measurable objectives include:

- Definitions of significant and unreasonable conditions and desired groundwater quality discussed during GSP Advisory Committee meetings.
- Depths, locations, and logged lithology of existing wells used to monitor groundwater quality.
- Historical and current chloride concentrations in monitoring and production wells near the coast as summarized in Table 3-15.

To provide for more spatial certainty of the chloride isocontour, the isocontour is anchored, where possible, to coastal monitoring wells which are mostly located within 1,000 feet of the coastline. Anchoring the isocontour at coastal monitoring wells provides a consistent point to ascertain if concentrations at a data point on the isocontour (coastal monitoring well) have increased beyond the minimum threshold concentration set for the isocontour. There are 12 points on the isocontour represented by a monitoring well from which concentration data can be obtained and no interpolation is necessary. Additionally, because the statement of significant and unreasonable seawater intrusion conditions is based on historical observations at monitoring wells, it is appropriate to use the same monitoring wells to gauge changes to the location of the isocontour in the future. It is difficult to monitor the chloride isocontour if it is set at the coast because there are no data points on the coast from which to obtain concentration data to know if that concentration has been exceeded or not.

3.1.1.1.1 Groundwater Elevations as a Proxy

The information used for establishing the seawater intrusion groundwater level proxy minimum thresholds and measurable objectives include:

- Information about local definitions of significant and unreasonable conditions and desired groundwater elevations discussed during GSP Advisory Committee meetings.
- Depths and locations of existing coastal monitoring wells used to monitor groundwater levels and seawater intrusion.
- Historical groundwater elevation data from wells monitored by the MGA agencies.
- Maps of current and historical groundwater elevation data.
- Model output from a variable density (SEAWAT 2000) cross-sectional groundwater models.

- SkyTEM geophysical resistivity data.

Cross-sectional models were used to develop both protective and target groundwater levels at coastal monitoring well clusters (HydroMetrics LLC, 2009). Using Monte Carlo uncertainty analysis, a range of protective groundwater levels were developed for each coastal monitoring well cluster (HydroMetrics LLC, 2009). This range represents the uncertainty in the aquifer characteristics. Protective groundwater elevations developed using the cross-sectional models have successfully been used by SqCWD to manage seawater intrusion in the Basin.

Protective groundwater elevations for the Basin are established using two different methods dependent on availability of cross-sectional models:

1. Cross-sectional model data available: minimum thresholds are groundwater elevations that represents at least 70% of cross-sectional model simulations being protective against seawater intrusion for each monitoring well with a protective elevation[1]. For wells where seawater intrusion has not been observed, cross-sectional models estimate protective elevations to protect the entire depth of the aquifer unit of the monitoring wells' lowest screen. For wells where seawater intrusion has been observed, the cross-sectional models estimate protective elevations to prevent seawater intrusion from advancing.

2. Cross-sectional model data not available: minimum thresholds are groundwater elevations that represent protective groundwater elevation estimated by using the Ghyben-Herzberg analytical method to protect to the bottom of the monitoring well screen.

3.6.2.1.2 Consideration of Sea-Level Rise

The chloride isocontour and associated well chloride concentrations established as seawater intrusion minimum thresholds are based on the description of significant and unreasonable conditions for the sustainability indicator. This describes seawater moving farther inland than has been observed in the past five years as significant and unreasonable conditions. Undesirable results that occur when chloride concentrations exceed minimum thresholds represent significant and unreasonable conditions even when the intrusion is a result of sea level rise. By defining chloride concentrations as minimum thresholds, the MGA is required to

[1] The cross-sectional modeling to develop protective groundwater elevations could not use specific hydrogeologic properties (properties that influence how groundwater flows) with any certainty because there are insufficient data to calibrate the models to groundwater level or concentration data. Additionally, there are limited data for hydrogeologic parameter values offshore, adding further uncertainty. To develop reliable protective groundwater levels, it was necessary to perform an uncertainty analysis that evaluates the range of reasonable outcomes given the lack of precise hydrogeologic property/parameter data.

Each coastal monitoring well location where protective groundwater elevations were developed included 99 randomized parameters model simulations Parameters varied are horizontal hydraulic conductivities of the production unit and underlying unit, and vertical conductivities of the aquitards above the production unit.

prevent significant and unreasonable seawater intrusion in the Basin resulting from sea level rise.

Groundwater level proxies for the seawater intrusion minimum thresholds also take into account current and rising sea levels. The seawater intrusion groundwater level proxies are established as groundwater elevations above mean sea level. The current datum is therefore current sea levels but the datum will rise in the future as sea levels rise. Although the elevation relative to sea level is set by the groundwater level proxy, the absolute elevations that define undesirable results will increase with rising sea levels.

This consideration of the effect of sea level rise is incorporated into the model evaluation of whether projects can raise and maintain groundwater elevations to meet and exceed the groundwater level proxies for minimum thresholds. The model incorporates projected sea level rise in the offshore boundary condition for simulations of future conditions. The boundary condition head for sea level is increased over time to 2.3 feet in 2070 over current sea level rise based on state of California projections for Monterey representing 5% probability under a High Emissions scenario (California Natural Resources Agency, 2018). Since the datum in the model is set at current sea level, simulated future groundwater levels were compared to the groundwater level proxies plus the total sea level rise of 2.3 feet. This allows evaluation of whether projects and management actions will raise and maintain groundwater elevations to meet groundwater level proxies relative to projections of higher sea levels.

3.6.2.2 Chloride Isocontour Minimum Threshold

The current extent of seawater intrusion is indicated by the circle symbols on Figure 3-11. The larger the symbol the greater the chloride concentration. The symbols are also colored by aquifer to indicate depth. Figure 3-11 shows that in the Basin, the Aromas Red Sands aquifer has seawater intrusion only in the La Selva Beach area. However, the SC-A4 monitoring well outside of the Basin in the Pajaro Valley is also intruded thus it is assumed that seawater intrusion in the Aromas Red Sands aquifer extends southwards across the Basin boundary. Current seawater intrusion in the Purisima aquifers is found in one Purisima A-unit monitoring well in the Soquel Point area with a chloride concentration of 1,100 mg/L, and in the Seascape area where chloride concentrations up to 15,000 mg/L occur in three Purisima F-unit monitoring wells (Figure 3-11).

Considering the extent of current seawater intrusion, the chloride isocontours on Figure 3-11 represents seawater intrusion minimum thresholds in both the Aromas and Purisima aquifers. A chloride concentration of 250 mg/L is selected for the minimum threshold for the Basin because native chloride concentrations in groundwater are generally below 100 mg/L. Thus, an increase up to the basin water quality objective and state drinking water standard of 250 mg/L is considered significant and unreasonable. A chloride concentration of 250 mg/L is relatively low and likely represents some seawater mixed with native groundwater. Full strength seawater has a chloride concentration of 19,000 mg/L.

Since the location of the chloride isocontour is defined by concentrations in wells, wells either side of the contour are assigned minimum threshold concentrations that determine if the isocontour is moving inland. It is not required in the SGMA regulations but as discussed in the measurable objectives subsection, chloride concentration in these wells are also used to trigger early management actions if concentrations increase above measurable objectives but are still below minimum thresholds.

If chloride concentrations inland of the isocontour increase to above the minimum threshold concentration of 150 mg/L, this indicates that seawater is moving inland and management actions to remedy it need to take place to ensure that by 2040, chloride concentrations inland of the 250 mg/L isocontour remain below the minimum threshold of 250 mg/L.

Table 3-16 summarizes the minimum thresholds for each of the wells used to define the chloride isocontour.

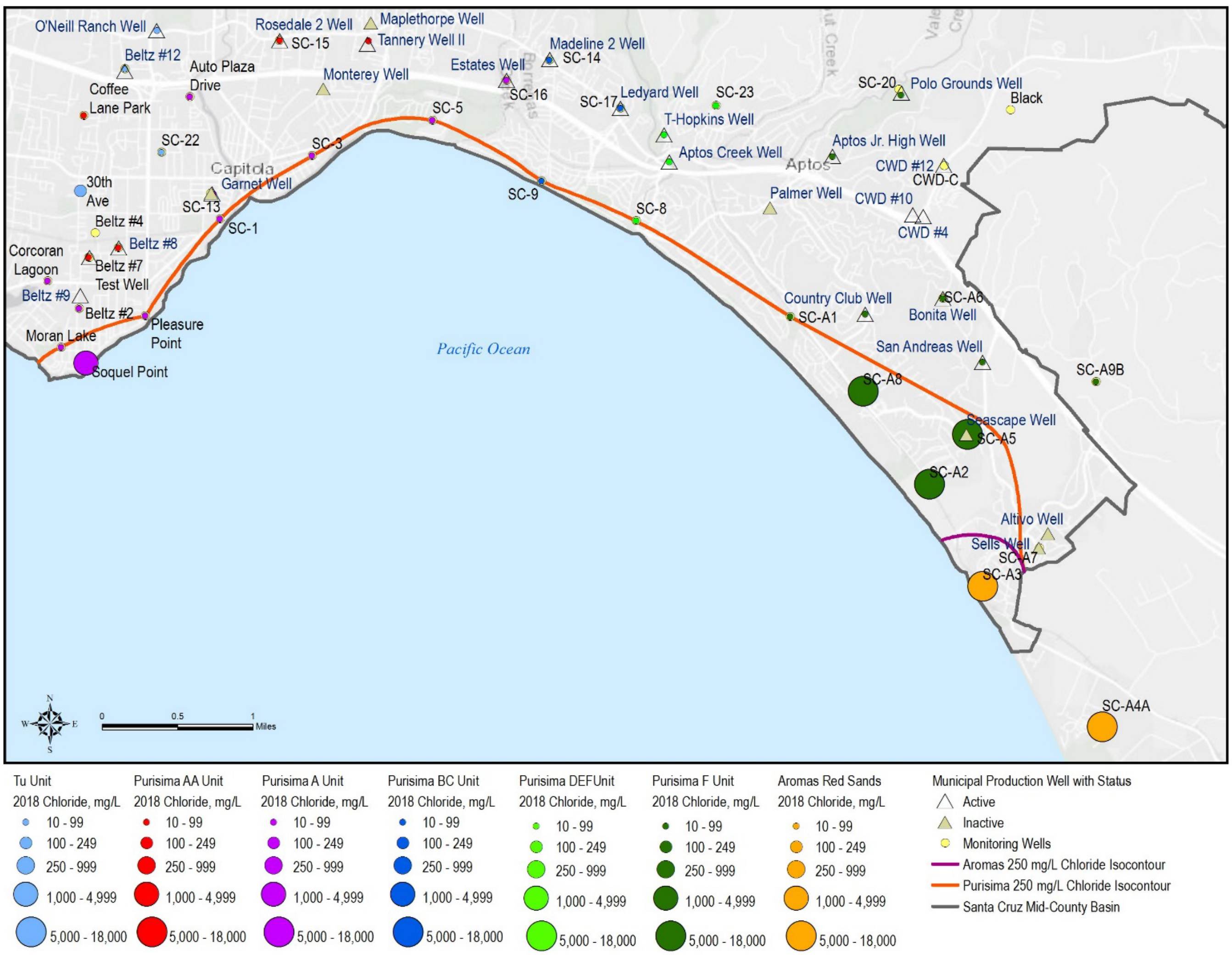


Figure 3-11. 250 mg/L Chloride Isocontour for the Aromas and Pursima Aquifers

Table 3-16. Chloride Minimum Thresholds and Measurable Objectives for Coastal and Inland Wells

Monitoring Well	Aquifer	Minimum Threshold	Measurable Objective
		Chloride Concentration, mg/L	
Coastal Monitoring Wells - Intruded			
SC-A3A	Aromas	22,000	17,955
SC-A3B	Aromas	4,330	676
SC-A8A	Purisima F	8,000	7,258
SC-A2RA	Purisima F	18,480	14,259
SC-A2RB	Purisima F	470	355
Moran Lake Med	Purisima A	700	147
Soquel Point Med	Purisima A	1,300	1,104
Coastal Monitoring Wells - Unintruded			
SC-A8B	Aromas	250	100
SC-A1B	Purisima F	250	100
SC-A1A	Purisima DEF	250	100
SC-8RD	Purisima DEF	250	100
SC-9RC	Purisima BC	250	100
SC-8RB	Purisima BC	250	100
Pleasure Point Medium	Purisima A	250	100
SC-1A	Purisima A	250	100
SC-5RA	Purisima A	250	100
SC-3RA	Purisima A	250	100
Moran Lake Deep	Purisima AA	250	100
Pleasure Point Deep	Purisima AA	250	100
Soquel Point Deep	Purisima AA	250	100
SC-13A	Tu	250	100
Inland Production and Monitoring Wells - Unintruded			
SC-A5A	Purisima F	150	100
SC-A5B	Purisima F	150	100
San Andreas PW	Purisima F	150	100
Seascape PW	Purisima F	150	100
T. Hopkins PW	Purisima DEF	150	100
Estates PW	Purisima BC & A	150	100
Ledyard PW	Purisima BC	150	100
Garnet PW	Purisima A	150	100

Monitoring Well	Aquifer	Minimum Threshold	Measurable Objective
		Chloride Concentration, mg/L	
Beltz #2	Purisima A	150	100
Beltz #8 PW	Purisima A	150	100
SC-22AA	Purisima AA	150	100
Corcoran Lagoon Deep	Purisima AA	150	100
Schwan Lake	Purisima AA	150	100

PW = production well

3.6.2.3 Groundwater Elevations as a Proxy for Seawater Intrusion Minimum Thresholds

As indicated in the SGMA Regulations Section §354.36(b) "*groundwater elevations may be used as a proxy for monitoring other sustainability indicators*." For seawater intrusion, protective groundwater elevations are used as proxies for additional minimum thresholds. Use of a proxy is appropriate because there is significant correlation between groundwater elevations and seawater intrusion. When coastal groundwater levels in aquifers connected to the ocean fall to near or below sea level, flows across the ocean/land boundary become predominantly onshore flows. As higher density seawater flows inland, a wedge forms under the less dense fresh groundwater until the water table achieves equilibrium. The lower groundwater levels are, the less pressure there is from freshwater within the aquifer to resist the intruding seawater.

Minimum thresholds for seawater intrusion using groundwater elevation proxies are the current protective groundwater elevations set at coastal monitoring wells and used for groundwater management over the past 10 years. Current protective elevations for coastal monitoring wells are listed in Table 3-17 and shown on a map as Figure 3-12. New deep monitoring wells need to be constructed in the early part of GSP implementation and protective elevations will be established when the construction details of those wells are available. Table 3-17 and Figure 3-12 identify the two new deep Tu-unit monitoring wells.

Table 3-17. Minimum Thresholds and Measurable Objectives for Groundwater Elevations Used as Proxies at Seawater Intrusion Representative Monitoring Points

Coastal Monitoring Well with Aquifer Unit in Parenthesis	Minimum Threshold (feet mean seal level)	Basis for Minimum Threshold	Measurable Objective (feet mean sea level)	Basis for Measurable Objective	Trigger for Early Management Action
SC-A3A (Aromas)	3	XS 70th	4	XS >99th	1
SC-A1B (F)	3	XS 70th	5	XS >99th	1
SC-A8RA (F)	6	XS 70th	7	XS >99th	2
SC-A2RA (F)	3	XS 70th	4	XS >99th	1
SC-8RD (DEF)	10	XS 70th	11	XS >99th	2
SC-9RC (BC)	10	XS 70th	11	XS >99th	2

Coastal Monitoring Well with Aquifer Unit in Parenthesis	Minimum Threshold (feet mean seal level)	Basis for Minimum Threshold	Measurable Objective (feet mean sea level)	Basis for Measurable Objective	Trigger for Early Management Action
SC-8RB (BC)	19	XS 70th	20	SC-8RD + GH	2
SC-5RA (A)	13	XS 70th	15	XS >99th	2
SC-3RA (A)	10	XS 70th	12	XS >99th	2
SC-1A (A)	4	XS 70th	6	XS >99th	2
Moran Lake Medium (A)	5	GH BS	6.8	GH BU	2
Soquel Point Medium (A)	6	GH BS	7.1	GH BU	2
Pleasure Point Medium (A)	6.1	GH BS	6.5	GH BU	2
Moran Lake Deep (AA)	6.7	GH BS	16	GH BU	2
Soquel Point Deep (AA)	7.5	GH BS	16	GH BU	2
Pleasure Point Deep (AA)	7.7	GH BS	16	GH BU	2
SC-13A (Tu)	17.2	GH BS	19	GH BU	2

Notes:
GH BS = Ghyben-Herzberg bottom of screen
GH BU = Ghyben-Herzberg bottom of aquifer unit
XS 70th = Cross-sectional model with 70th percentile of runs being protective
XS >99th = Cross-sectional model with greater than 99th percentile of runs being protective

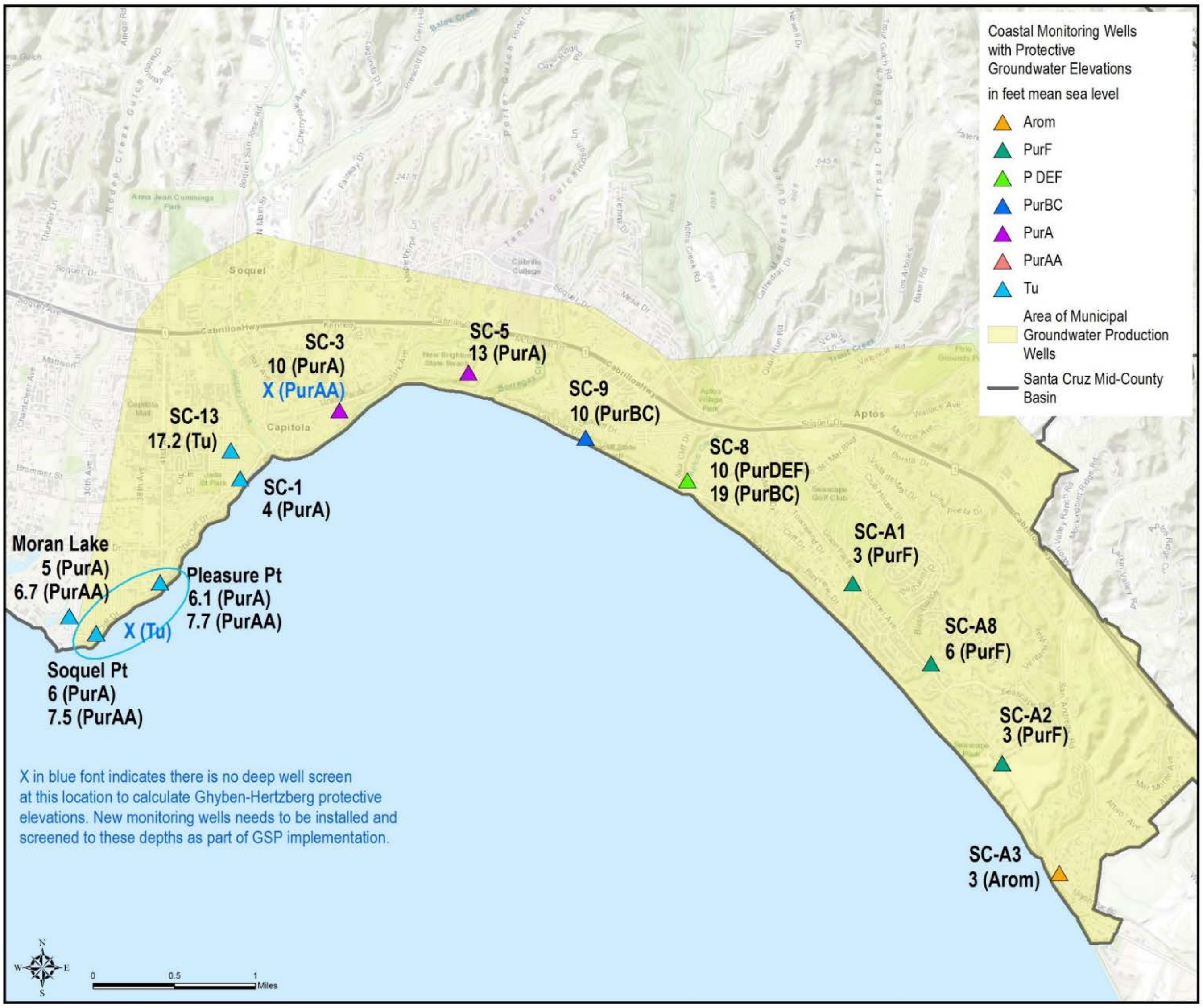


Figure 3-12. Protective Groundwater Elevations at Coastal Monitoring Wells

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

Considering the minimum thresholds for seawater intrusion are both groundwater quality and groundwater elevation metrics, the bullets below address the relationship between the seawater intrusion minimum thresholds and other sustainability indicator minimum thresholds.

- **Chronic lowering of groundwater levels.** Groundwater elevations associated with proxy minimum thresholds for seawater intrusion are more stringent than groundwater elevations that represent chronic lowering of groundwater levels. Minimum threshold groundwater elevations for chronic lowering of groundwater levels are raised from the level that would meet overlying demands so that they do not interfere with attaining minimum threshold elevations for seawater intrusion.

- **Reduction of groundwater in storage.** Minimum thresholds for reduction of groundwater in storage and seawater intrusion are dependent on each other. Minimum thresholds for reduction of groundwater in storage are volumes of groundwater, for each of the three aquifer groups that do not cause undesirable results in the other applicable sustainability indicators such as seawater intrusion.

- **Degraded groundwater quality.** The chloride isocontour minimum threshold for seawater intrusion is the same minimum threshold concentration assigned to chloride for degradation of groundwater quality. For the unintruded inland wells, a seawater intrusion chloride minimum threshold of 150 mg/L, although less than the degraded groundwater quality minimum threshold of 250 mg/L, is only used to represent if the chloride isocontour has moved inland and does not signify degraded quality.

- **Subsidence.** This sustainability indicator is not applicable to the Basin.

- **Depletion of interconnected surface water**. Minimum thresholds for interconnected surface water are shallow groundwater levels (as a proxy) that have been set in existing RMPs. Groundwater elevations used as a proxy minimum threshold shown on Figure 3-10 are above sea level and do not interfere with the ability to attain proxy seawater intrusion groundwater elevation thresholds. Since shallow groundwater level proxies set as minimum thresholds for depletion of interconnected surface water are based on observations from 2001-2015, proxy seawater intrusion groundwater elevation minimum thresholds that are generally higher than groundwater elevations from 2001-2015 should not interfere with the ability to avoid undesirable results for depletion of interconnected surface water.

3.6.2.5 Effect of Minimum Thresholds on Neighboring Basins

The anticipated effect of the degraded groundwater quality minimum thresholds on each of the neighboring basins/subbasins are addressed below.

Pajaro Valley Subbasin of the Corralitos Basin (critically-overdrafted). The Pajaro Valley Subbasin is hydrogeological down- to cross-gradient of the Santa Cruz Mid-County Basin. Because of lower groundwater elevations in the Pajaro Valley Subbasin, groundwater along the coastal portion of the boundary flows from the Santa Cruz Mid-County Basin into the Pajaro Valley Subbasin. Chloride concentrations in the La Selva area of the Basin are similar to those in the Pajaro Valley Subbasin, which has more extensive seawater intrusion along its entire length of coastline (Figure 3-11 and Figure 3-13). The goal for seawater intrusion conditions in Pajaro Valley is to halt intrusion by reducing the rate of intrusion (Carollo Engineers, 2014). Since the groundwater level proxy minimum thresholds in the Santa Cruz Mid-County Basin in the Aromas area are intended to keep seawater intrusion where it is currently, the seawater intrusion minimum thresholds assist Pajaro Valley achieve its sustainability goals for seawater intrusion by causing increased subsurface flow into Pajaro Valley thus helping to reduce the rate of intrusion. The increase in outflows to Pajaro Valley when minimum thresholds are achieved is supported by the projected groundwater budget in Section 2.

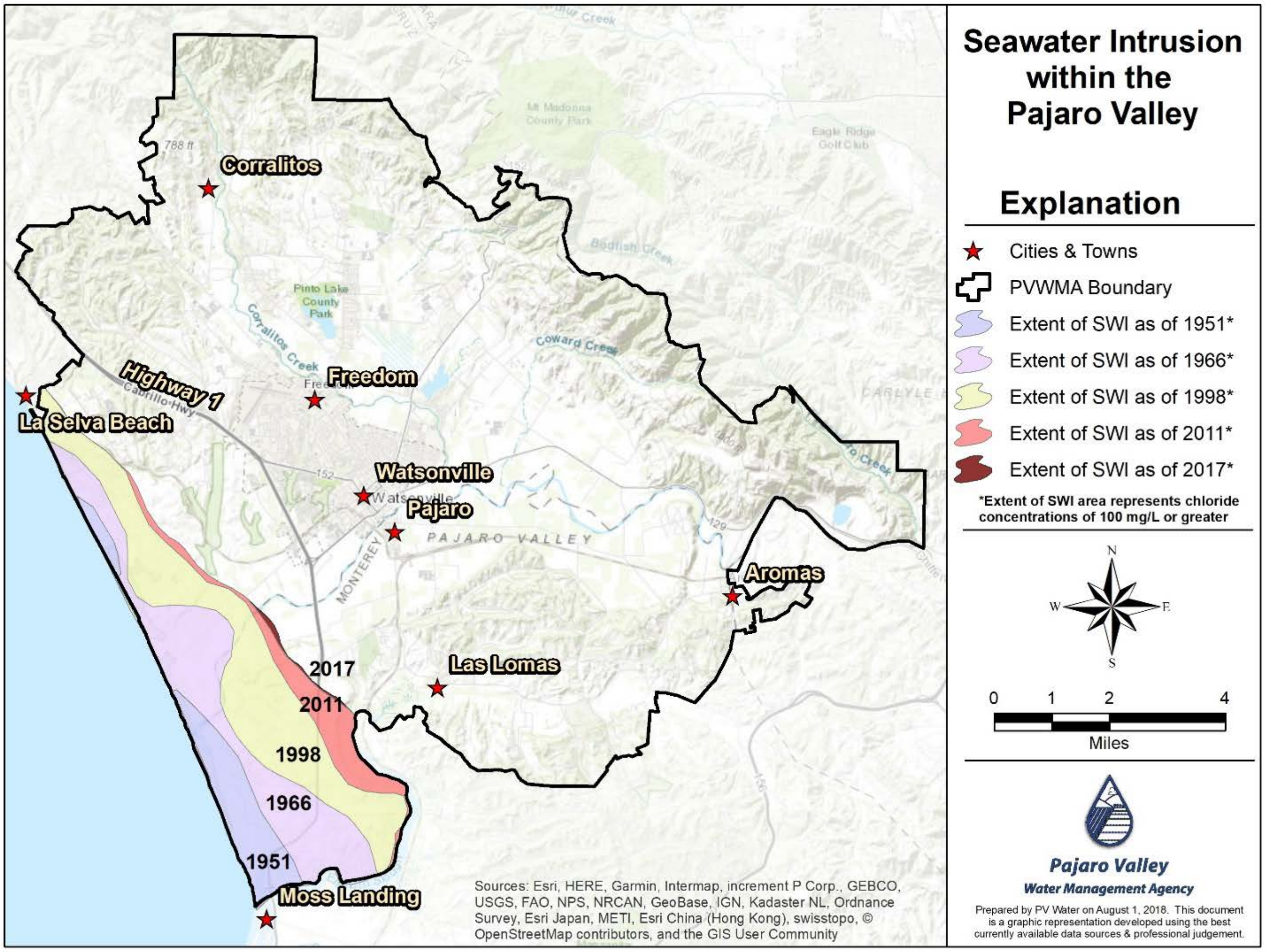


Figure 3-13. Seawater Intrusion within the Pajaro Valley (Source: PVWMA)

Santa Margarita Basin (medium-priority). The Santa Margarita Basin is an inland basin being at least 5.8 miles from the coast. Because of this distance and the fact that groundwater elevations at the chloride isocontour near the coast are roughly 550 feet lower than groundwater elevations at the boundary between the two basins, there is no potential for seawater intrusion minimum thresholds established for the Santa Cruz Mid-County Basin to affect the Santa Margarita Basin from achieving sustainability.

Purisima Highlands Subbasin of the Corralitos Basin (very low-priority). Similar to the Santa Margarita Basin, the Purisima Highlands Subbasin is an inland basin that is at an elevation of at least 340 feet above sea level and will not be impacted by seawater intrusion minimum thresholds at the coast.

3.6.2.6 Effects of Minimum Thresholds on Beneficial Users and Land Uses

Between the ocean and the chloride isocontour, land use is predominantly recreational, open space, agricultural, and residential. Private and agricultural users have their own wells while residential users of groundwater are supplied municipal water pumped in other parts of the Basin. Restricting the advancement of seawater intrusion to where it is currently will not impact more wells and an area greater than already impacted. Also, wells inland of the chloride isocontour will not be impacted by the seawater minimum thresholds.

3.6.2.7 Relevant Federal, State, or Local Standards

No federal or state standards exist for seawater intrusion. Locally, the City of Santa Cruz and Soquel Creek Water District have a cooperative monitoring / adaptive groundwater management agreement to: (1) ensure protection of the shared groundwater resource from seawater intrusion, (2) allow for the redistribution of pumping inland away from the Purisima A-unit offshore outcrop area, (3) maintain inland groundwater levels that promote continued groundwater flow toward coastal wells and the Purisima A offshore outcrop area while maintaining coastal groundwater levels that will abate seawater intrusion, and (4) provide both agencies adequate flexibility to respond to changing water demands, changing water supply availability, and infrastructure limitations. Protective groundwater elevations used as proxy measurements for seawater intrusion are aligned with the cooperative agreement's target groundwater elevations.

3.6.2.8 Method for Quantitative Measurement of Minimum Thresholds

Chloride concentrations used to define the chloride isocontour in production and monitoring well RMPs will be directly measured to determine where chloride concentrations are in relation to minimum thresholds. Groundwater quality samples will be collected and tested in accordance with the monitoring plan outlined in Section 3.3. Sampling for all coastal monitoring wells is quarterly and unintruded inland wells are sampled semi-annually, unless an exceedance of a minimum threshold is measured, whereupon the sampling frequency will be increased to quarterly.

Groundwater elevations in RMPs will be directly measured to determine where groundwater levels are in relation to minimum thresholds used a proxy metric for seawater intrusion. Groundwater level monitoring will be conducted in accordance with the monitoring plan outlined in Section 3.3. All RMPs will be equipped with continuous data loggers.

3.6.3 Measurable Objectives - Seawater Intrusion

3.6.3.1 Chloride Isocontour Measurable Objective

3.6.3.1.1 Measurable Objectives

The measurable objective chloride isocontour has the same location as the minimum threshold isocontour shown on Figure 3-11. Since all historical unintruded coastal monitoring well concentrations are below 100 mg/L (Table 3-16), the isocontour concentration for measurable objectives is reduced from 250 mg/L (minimum threshold) to 100 mg/L (measurable objective). Having the measurable objective isocontour at the same location as the minimum threshold allows the same monitoring wells along that isocontour to be used to define its location. The measurable objectives for intruded wells are their 2013 – 2017 average concentration and is 100 mg/L for all unintruded wells. Table 3-16 lists the minimum threshold and measurable objective concentrations for all wells used to define the isocontour.

3.6.3.1.2 Chloride Concentration Triggers

Although not required by the SGMA regulations, the MGA will use chloride concentration exceedances of measurable objectives as a trigger for preemptive actions to prevent significant and unreasonable conditions from occurring. This approach is being taken for this specific sustainability indicator because it is the indicator for which the Basin is in critical overdraft. If chloride concentrations exceed measurable objectives and have a continuing increasing trend, it indicates that concentrations are moving toward minimum thresholds that define undesirable results. Such a trend will be addressed immediately.

For unintruded monitoring wells where chloride concentrations are below 250 mg/L, the measurable objective for chloride concentration is 100 mg/L. Variation of chloride concentrations below 100 mg/L is not necessarily indicative of seawater intrusion. Chloride concentrations above 100 mg/L in two of four quarterly samples are more likely indicative of seawater intrusion and warrant early management action.

For intruded monitoring wells where chloride concentrations are currently above 250 mg/L, the measurable objective for chloride concentrations is the 2013-2017average concentration. As this average concentration includes seasonal and measurement variation, an annual average of four quarterly chloride samples above the measurable objective is indicative of seawater intrusion moving inland and warrants early management action.

The recommended management action for exceedances of chloride measurable objectives is for pumping to be reduced at the municipal well nearest to the monitoring well with the exceedance. The objective of this action is to raise groundwater levels in the monitoring well and prevent further increases of chloride concentrations that could result in significant and unreasonable conditions.

If the groundwater level proxy minimum threshold is being met but chloride measurable objective is exceeded at any monitoring well, this indicates that the groundwater level proxy is not protective for preventing further seawater intrusion than observed over 2013-2017. In this case, the groundwater level proxy should be revised. The groundwater level proxy may not be sufficient because the level is too low or because the multi-year averaging period is too long. Based on an evaluation of groundwater levels and chloride concentrations for what appears insufficient, the level should be raised and/or the averaging period should be shortened.

3.6.3.1.3 Interim Milestones for Chloride

The measurable objective chloride isocontour of 100 mg/L is defined in part by RMPs that currently have chloride concentrations below their measurable objective of 100 mg/L (Figure 3-11). Inland of the isocontour, RMPs are also below their measurable objectives (Table 3-15). Projects and management actions included in the GSP are designed so that current seawater intrusion does not advance inland. Therefore, interim milestones are set at the same concentration as measurable objectives (100 mg/L) as no change in inland chloride concentrations are expected as the GSP is implemented.

For RMPs currently impacted by seawater intrusion and located on the coast-side of the chloride isocontour, current concentrations represented by average 2013 – 2017 chloride concentrations are their measurable objectives. Interim milestones for these wells are set at the same concentrations as measurable objectives shown in Table 3-16, effectively representing conditions that do not allow seawater intrusion to get worse than it is currently.

3.6.3.2 Groundwater Elevations as a Proxy Measurable Objectives

3.6.3.2.1 Measurable Objectives

Groundwater elevations as a proxy measurable objectives are determined based on whether the cross-sectional groundwater model is available for the area or not.

1. <u>Cross-sectional model available</u>: measurable objectives are groundwater elevations that represents >99% of cross-sectional model simulations being protective against seawater intrusion for each monitoring well with a protective elevation. For wells where seawater intrusion has not been observed, cross-sectional models estimate protective elevations to protect the entire depth of the aquifer unit of the monitoring wells' lowest screen. For wells where seawater intrusion has been observed, the cross-sectional models estimate protective elevations to prevent seawater intrusion from advancing.

2. <u>Cross-sectional model not available</u>: measurable objectives are the groundwater elevations that represent protective groundwater elevation estimated by using the Ghyben-Herzberg method to protect the entire depth of the aquifer unit the monitoring wells are screened in.

Measurable objectives established based on the approaches above are provided in Table 3-17.

3.6.3.2.2 Protective Groundwater Elevation Triggers

Similar to the chloride concentration triggers described in Section 3.6.3.1 that initiate action based on exceeding chloride concentration measurable objectives in monitoring and production wells near the chloride isocontour, groundwater level proxy triggers at coastal monitoring wells will also initiate early management actions. As with the chloride concentration triggers, these triggers are not required by SGMA regulations but are included in the GSP as a preemptive action to prevent significant and unreasonable conditions from occurring. This approach is being taken for this specific sustainability indicator because seawater intrusion is the indicator for which the Basin is in critical overdraft. Groundwater elevations dropping below these triggers over the short-term indicate an increased risk of seawater intrusion that may not be fully addressed by minimum thresholds and measurable objectives based on five-year average elevations.

The groundwater level proxy trigger is based on the minimum groundwater elevation at coastal monitoring wells included in the existing cooperative monitoring/adaptive management groundwater management agreement between the City of Santa Cruz and Soquel Creek Water District that has been in effect since 2015. The agreement lists a minimum groundwater elevation as 2 feet above mean sea level applied to a 30 day running average at the coastal monitoring wells Moran Lake Medium, Soquel Point Medium, Pleasure Point Medium, and SC-1A. In order to maintain consistency with the cooperative agreement, the following groundwater level proxy triggers are set for other coastal monitoring wells:

- 2 feet above mean sea level is set as the groundwater elevation trigger for wells with minimum threshold groundwater level proxies for seawater intrusion of 4 feet or higher: SC-A8RA, SC-A8RD, SC-9RC, SC-8RB, SC-5RA, SC-3RA, SC-1A, Moran Lake Medium, Soquel Point Medium, Pleasure Point Medium, Moran Lake Deep, Soquel Point Deep, Pleasure Point Deep, and SC-13A.
- In order to provide operational flexibility, 1 foot above mean sea level is set as the groundwater elevation trigger for wells with minimum threshold groundwater level proxies of less than 4 feet: SC-A3A, SC-A1B, and SC-A2RA.

Table 3-17 lists the groundwater elevation triggers for early management action compared to minimum thresholds and measurable objectives for RMPs that use proxy groundwater elevations for SMC.

If data show that a 30-day running average groundwater elevation has dropped below the groundwater elevation trigger at a coastal monitoring well, MGA member agencies that pump from the aquifer unit of the monitoring well will evaluate how municipal pumping quantities and distribution may have caused the decline in groundwater levels. The MGA member agencies will then adjust municipal pumping based on the evaluation to avoid future groundwater elevations below the triggers. If municipal pumping does not appear to have caused the groundwater elevations falling below triggers, the MGA will investigate the cause of the drop.

3.6.3.2.3 Interim Milestones for Groundwater Elevation Proxies

Groundwater elevations as proxy interim milestones are based on model simulations of projects showing how projects will raise coastal groundwater levels over time to prevent undesirable results related to seawater intrusion. Section 4 contains the model results which are used to describe the expected benefits of the projects.

Interim milestones are established at each of the coastal RMPs with proxy groundwater elevations for seawater intrusion. Interim milestones are based on the five year average of model simulated groundwater elevations in Water Years 2025, 2030, and 2035.

Interim milestones at Soquel Creek Water District's coastal monitoring wells (with names beginning in SC) are based on model simulation of Pure Water Soquel because the expected benefits of that project are to raise groundwater levels above or approaching measurable objectives at the District's wells as described in Section 4. The interim milestones at City of Santa Cruz's coastal monitoring wells (Moran Lake, Soquel Point, and Pleasure Point) are based on model simulation of Pure Water Soquel and City of Santa Cruz ASR in combination because the expected benefits of the City of Santa Cruz project are to raise groundwater levels above minimum thresholds at the City's wells as described in Section 4. Table 3-18 summarizes the interim milestones for coastal RMPs.

If simulated groundwater elevations in 2025 are above minimum thresholds, the minimum thresholds are used as the interim milestone because there is some uncertainty about when projects would begin. This GSP sets as an interim milestone the elimination of undesirable results by 2025 at locations where model results show it is achievable with project implementation. If modeled groundwater levels in 2030 and 2035 are above measurable objectives, the measurable objectives are used as the interim milestones.

The model does not reliably simulate groundwater elevations in the Purisima DEF unit where SC-8RD is located. The interim milestone for this well are set at the minimum threshold so that the MGA will evaluate whether Purisima DEF unit pumping is sustainable at each five year interval (Table 3-18).

Interim milestones at Moran Lake Deep well drop slightly between 2030 and 2035. This is a result of reduced surface water supply for City ASR during this time based on projected climate variability. Evaluation of groundwater elevations against these interim milestones should account for actual surface water supply used to recharge the Basin and climate variability.

Table 3-18. Interim MIlestones for Seawater Intrusion Groundwater Elevation Proxies

Representative Monitoring Well with Aquifer Unit in Parenthesis	Minimum Threshold (feet mean seal level)	Measurable Objective (feet mean sea level)	Interim Milestone 2025 (feet mean sea level)	Interim Milestone 2030 (feet mean sea level)	Interim Milestone 2035 (feet mean sea level)
SC-A3A (Aromas)	3	7	3	3.7	3.7
SC-A1B (F)	3	5	3	5	5
SC-A8RA (F)	6	7	4.5	6.0	6.9
SC-A2RA (F)	3	4	3	4	4
SC-8RD (DEF)	10	11	10	10	10
SC-9RC (BC)	10	11	4.6	11	11

Representative Monitoring Well with Aquifer Unit in Parenthesis	Minimum Threshold (feet mean seal level)	Measurable Objective (feet mean sea level)	Interim Milestone 2025 (feet mean sea level)	Interim Milestone 2030 (feet mean sea level)	Interim Milestone 2035 (feet mean sea level)
SC-8RB (BC)	19	20	8.4	16.6	18.1
SC-5RA (A)	13	15	13	15	15
SC-3RA (A)	10	12	10	12	12
SC-1A (A)	4	6	4	6	6
Moran Lake Medium (A)	5	6.8	5	6.8	6.8
Soquel Point Medium (A)	6	7.1	6	7.1	7.1
Pleasure Point Medium (A)	6.1	6.5	6.1	6.5	6.5
Moran Lake Deep (AA)	6.7	16	6.7	8.1	7.8
Soquel Point Deep (AA)	7.5	16	7.5	8.3	8.3
Pleasure Point Deep (AA)	7.7	16	7.7	11.8	11.9
SC-13A (Tu)	17.2	19	8.3	16.7	18.1

3.7 Degraded Groundwater Quality Sustainable Management Criteria

3.7.1 Undesirable Results - Degraded Groundwater Quality

Locally defined significant and unreasonable groundwater quality degradation in the Basin is:

> *Groundwater quality, attributable to groundwater pumping or managed aquifer recharge, that fails to meet state drinking water standards.*

Recognizing there are naturally occurring groundwater quality issues in the Basin, this statement reflects that any project implemented or management actions taken by the MGA to achieve sustainability must not cause groundwater quality degradation that results in groundwater quality to be worse than drinking water standards.

3.7.1.1 Criteria for Defining Degraded Groundwater Quality Undesirable Results

For the Santa Cruz Mid-County Basin, groundwater quality degradation is unacceptable as a direct result of GSP implementation. Therefore, the degradation of groundwater quality undesirable result is:

> *Groundwater quality undesirable results in the Basin occur when as a result of groundwater pumping or managed aquifer recharge, any representative monitoring well exceeds any state drinking water standard.*

Because degraded groundwater quality undesirable results can only occur due to projects and management actions implemented to achieve sustainability in the GSP, it is important to correlate groundwater quality impacts to RMPs with quality and hydraulic gradient changes caused by projects implemented or management actions taken to achieve sustainability.

3.7.1.2 Potential Causes of Undesirable Results

Conditions that may lead to undesirable results for degraded groundwater quality include the following:

- **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 poor-quality groundwater towards a supply well at concentrations that exceed state drinking water standards.
- **Groundwater Recharge.** Active recharge of water or captured runoff could modify groundwater gradients and move poor-quality groundwater towards a supply well in concentrations that exceed state drinking water standards.
- **Recharge of Poor-Quality Water.** Recharging the Basin with water that exceeds state drinking water standards may lead to an undesirable result. Since the State Water Control Board who is responsible for regulating recharge activities enforces an anti-degradation policy, there is minimal likelihood of poor-quality water being recharged into the Basin.

3.7.1.3 Effects on Beneficial Users and Land Use

The undesirable result for degradation of groundwater quality is groundwater degradation due to actions directly resulting from GSP implementation. Degradation for this sustainability indicator only occurs if two conditions occur together: (1) there are induced changes in groundwater elevations and gradients, and (2) there is non-native poor-quality groundwater. If both these conditions occur together, the changed hydraulic gradients may move poor-quality groundwater flows towards supply wells that would not have otherwise been impacted.

Currently, apart from one location with 1,2,3-TCP and more widespread nitrate in parts of the Aromas Red Sands aquifers and saline water associated with seawater intrusion in two areas along the coast, the Basin’s groundwater quality is good with no non-native poor-quality groundwater present within productive aquifers.

If undesirable results are allowed to take place, groundwater quality that does not meet state drinking water standards needs to be treated, which is a significant cost to users. For municipal suppliers, impacted wells can be taken offline until a solution is found. This will add stress on their water system by having to make up pumping in other unimpacted wells and increase the potential for further declines in groundwater levels.

This undesirable result does not apply to groundwater quality changes that occur due to other causes not in the control of the MGA. There are a number of federal, state, and local regulatory policies related to the protection of groundwater quality that will continue to be enforced by relevant federal, state, and local agencies. A summary of these regulations is included in Appendix 3-C.

3.7.2 Minimum Thresholds - Degraded Groundwater Quality

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

The information used for establishing the degraded groundwater quality minimum thresholds included:

- Feedback about significant and unreasonable conditions from the GSP Advisory Committee and the public.
- Historical and current groundwater quality data from production and monitoring wells in the Basin.
- Federal and state drinking water quality standards.
- Depths, locations, and logged lithology of existing wells used to monitor groundwater quality.

The historical and current groundwater quality used to establish groundwater quality minimum thresholds are discussed in Section 2.2.2.4: Groundwater Quality. Based on review of historical and current groundwater quality data, federal and state drinking water standards, and irrigation water quality needs, the MGA agreed that state drinking water standards are appropriate to define degraded groundwater quality minimum thresholds.

3.7.2.2 Degraded Groundwater Quality Minimum Thresholds

Minimum thresholds are state drinking water standards for constituents of concern monitored in RMPs for degraded groundwater quality. Table 3-19 lists the constituents of concern in the Basin together with why it is of concern and their state drinking water standards that represent minimum thresholds.

Table 3-19. Constituents of Concern with Minimum Thresholds

Constituent of Concern	Reason for Concern	Minimum Threshold/ Drinking Water Standard
Total dissolved solids	basic health of basin	1,000 mg/L
Chloride	basic health of basin	250 mg/L
Iron	naturally elevated	300 µg/L
Manganese	naturally elevated	50 µg/L
Arsenic	naturally elevated	10 µg/L
Chromium (Total)	naturally elevated	50 µg/L
Chromium VI	naturally elevated	none set yet

Constituent of Concern	Reason for Concern	Minimum Threshold/ Drinking Water Standard
Nitrate as Nitrogen	septic systems & agriculture	10 mg/L
Perchlorate	agriculture related	6 µg/L
Organic compounds	human introduced	various

Each project implemented as part of the GSP will have its own unique constituents of concern that will apply to monitoring and production wells included in their use permits granted by the State Water Resources Control Board Division (SWRCB) of Drinking Water (DDW). For example, projects injecting purified recycled water into the Basin are classified as groundwater replenishment reuse projects (GRRP) and permits from SWRCB DDW are required. A compendium of groundwater replenishment reuse regulations (GRRR) (Title 22, Division 4, Chapter 3) were issued by the SWRCB in 2014 (SWRCB, 2018). Specific monitoring wells and a list of 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.

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.

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

As SGMA regulations do not require projects or management actions to improve existing groundwater quality, there are no direct actions under the GSP associated with achieving groundwater quality minimum thresholds. Therefore, there are no actions that directly influence other sustainability indicators. However, preventing migration of poor-quality groundwater may limit activities 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 raise groundwater levels in the unlikely event that 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. Therefore, the degraded groundwater quality minimum thresholds will not result in an exceedance of the groundwater storage minimum threshold.
- **Seawater intrusion**. Degraded groundwater quality minimum thresholds could influence groundwater level proxy minimum thresholds for seawater intrusion by limiting the types of water that can be used for recharge to raise groundwater levels.
- **Subsidence**. This sustainability indicator is not applicable to this Subbasin
- **Depletion of interconnected surface waters.** Degraded groundwater quality minimum thresholds do not promote additional pumping or lower groundwater elevations adjacent to interconnected surface waters. Therefore, the degraded groundwater quality minimum thresholds will not result in a significant or unreasonable depletion of interconnected surface waters.

Minimum thresholds for all constituents of concern and RMPs are uniform throughout the Basin, thus there is no conflict between individual minimum thresholds.

3.7.2.4 Effect of Minimum Thresholds on Neighboring Basins

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

Pajaro Valley Subbasin of the Corralitos Basin (critically-overdrafted). The Pajaro Valley Subbasin is hydrogeological down- to cross-gradient of the Santa Cruz Mid-County Basin. Because of lower groundwater elevations in the Pajaro Valley Subbasin, groundwater along the coastal portion of the boundary generally flows from the Santa Cruz Mid-County Basin into the Pajaro Valley Subbasin (Figure 2-50. Groundwater Budget Subareas). The groundwater quality on either side of the Basin boundary with the Pajaro Valley Subbasin is similar; having overall good quality with the exception of elevated nitrates and salinity associated with seawater intrusion at the coast. The quality of groundwater in Pajaro Valley is documented in its Salt and Nutrient Management Plan (PVWMA, 2016). The degraded groundwater quality minimum threshold is set to maintain the good-quality groundwater in the Basin that flows into the Pajaro Valley Subbasin. Therefore, it is unlikely that the groundwater quality minimum thresholds established for the Basin will prevent the Pajaro Valley Subbasin from achieving sustainability with regards to groundwater quality.

Santa Margarita Basin (medium-priority). Limited groundwater currently 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 with the exception of naturally occurring elevated iron, manganese, and occasionally arsenic. No GSP projects or management actions are likely in this area as it is far from the coast where projects and management actions to raise coastal groundwater levels preventing seawater intrusion will take place. Therefore, it is unlikely that the groundwater quality minimum thresholds established for the Basin will prevent the Santa Margarita Basin from achieving sustainability.

Purisima Highlands Subbasin of the Corralitos Basin (very low-priority). The Purisima Highlands Subbasin is hydrogeological up-gradient of the Santa Cruz Mid-County Basin. Groundwater flow, historically and projected in the future, is from the Purisima Highlands Subbasin into the Santa Cruz Mid-County Basin. For this reason, there is no possibility of groundwater quality in the Basin impacting the Purisima Highlands Subbasin. Furthermore, minimum thresholds for groundwater quality are set to maintain the good groundwater quality in both basins.

3.7.2.5 Effects of Minimum Thresholds on Beneficial Users and Land Uses

In general, degraded groundwater quality minimum thresholds will not have any negative effects on beneficial users and land uses in the Basin.

Rural residential land uses and users. The degraded groundwater quality minimum thresholds benefit domestic water users in the Basin. Ensuring constituents of concern in additional drinking water supply wells remain below state drinking water standard protects groundwater for domestic use.

Agricultural land uses and users. The degraded groundwater quality minimum thresholds generally benefit agricultural water users in the Basin. Drinking water standards are more stringent than some agricultural water quality standards, with the exception of strawberries which are very sensitive to salt in irrigation water.

Urban land uses and users. 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.

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 ecological water uses in the Basin. Preventing poor-quality groundwater from migrating will prevent unwanted contaminants from impacting groundwater dependent ecosystems.

3.7.2.6 Relevant Federal, State, or Local Standards

The degraded groundwater quality minimum thresholds specifically incorporate state drinking water standards.

3.7.2.7 Method for Quantitative Measurement of Minimum Thresholds

Groundwater quality in production and monitoring well RMPs will be directly measured to determine where groundwater quality concentrations are in relation to minimum thresholds.

Groundwater quality samples will be collected and tested in accordance with the monitoring plan outlined in Section 3.3.

3.7.3 Measurable Objectives - Degraded Groundwater Quality

3.7.3.1 Measurable Objectives

Measurable objectives for each RMP are the 2013 – 2017 average concentrations for each constituent of concern for each RMP. Table 3-20 summarizes the measurable objectives for each RMP. If a representative monitoring well does not have groundwater quality data during this period, the most recent concentrations are used.

3.7.3.2 Interim Milestones

Groundwater quality in the Basin is currently above 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 (average of 2013 – 2017 concentrations), interim milestones are set at the same concentration as measurable objectives shown in Table 3-20.

Table 3-20. Measurable Objectives for Degradation of Groundwater Quality

Aquifer Unit	Well Name	Total Dissolved Solids, mg/L	Chloride, mg/L	Iron, µg/L	Manganese, µg/L	Arsenic, µg/L	Chromium (Total), µg/L	Chromium VI, µg/L	Nitrate as Nitrogen, mg/L	Perchlorate, µg/L	Organic compounds
	Minimum Threshold	**1,000**	**250**	**300**	**50**	**10**	**50**	**NA**	**10**	**6**	**various**
Aromas	Altivo PW	209	18.9	41	4	0.2	26.5	22	1	0.2	ND
	CWD-10 PW	340	26	ND	ND	ND	11	ND	25	ND	ND
	SC-A1C	348	29	232	1378	ND	ND	ND	1	ND	ND
	SC-A2RC	355	41	114	11	ND	6	ND	4	ND	ND
	SC-A3A*	33,000	17,995	478	258	ND	1	ND	ND	ND	ND
	SC-A3C	390	62	251	17	ND	8	ND	7	ND	ND
	SC-A8B	321	33	20	188	ND	ND	ND	ND	ND	ND
	SC-A8C	298	35	23	8	ND	12	ND	4	ND	ND
Aromas/ Purisima F	Polo Grounds PW	265	21	18	181	0.4	ND	ND	ND	0.3	ND
	Aptos Jr. High 2 PW	301	31	28	181	0.9	0.9	ND	ND	ND	ND
	Country Club PW	311	34	18	6	0.4	7.5	6	4	ND	ND
	Bonita PW	287	27	21	4	0.4	9.3	11	3	ND	ND
	San Andreas PW	242	21	10	5	0.7	17.5	16	2	ND	ND
	Seascape PW	288	20	34	6	0.3	15	16	1	ND	ND
Purisima F	CWD-4 PW	30	30	0	0	ND	12	ND	25	ND	ND
	CWD-12 PW	310	24	0	0	ND	ND	ND	1.2	ND	ND

Aquifer Unit	Well Name	Total Dissolved Solids, mg/L	Chloride, mg/L	Iron, µg/L	Manganese, µg/L	Arsenic, µg/L	Chromium (Total), µg/L	Chromium VI, µg/L	Nitrate as Nitrogen, mg/L	Perchlorate, µg/L	Organic compounds
	Minimum Threshold	**1,000**	**250**	**300**	**50**	**10**	**50**	**NA**	**10**	**6**	**various**
	SC-A2RA*	28,947	14,259	1,019	1,608	ND	ND	ND	ND	ND	ND
	SC-A8A*	15,174	7,258	380	3,633	ND	6	ND	1	ND	ND
Purisima DEF	SC-8RD	319	28	5	9	ND	ND	ND	2	ND	ND
	SC-9RE	507	28	46	57	ND	ND	ND	ND	ND	ND
	SC-A1A	224	28	1842	57	ND	ND	ND	ND	ND	ND
	T. Hopkins PW	355	46	33	106	2.3	2.4	ND	ND	ND	ND
Purisima BC	Ledyard PW	363	35	98	12	0.2	0.2	ND	ND	ND	ND
	Madeline 2 PW	408	34	187	10	ND	ND	ND	ND	ND	ND
	Aptos Creek PW	463	40	405	412	4	ND	ND	ND	ND	ND
	SC-23A	272	20	530	12	ND	ND	ND	ND	ND	ND
	SC-8RB	433	14	87	10	ND	ND	ND	2	ND	ND
	SC-9RC	381	27	16	9	ND	ND	ND	ND	ND	ND
Purisima A	30th Ave Shallow	822	56	107	1,231	NT	NT	NT	ND	NT	NT
	Pleasure Point Shallow	288	37	106	119	NT	NT	NT	ND	NT	NT
	Estates PW	465	45	212	99	0.2	0.2	ND	ND	ND	ND
	Garnet PW	619	81	1,400	416	ND	ND	ND	ND	ND	ND
	Tannery 2 PW	574	60	224	140	0.18	ND	ND	ND	ND	ND

Aquifer Unit	Well Name	Total Dissolved Solids, mg/L	Chloride, mg/L	Iron, µg/L	Manganese, µg/L	Arsenic, µg/L	Chromium (Total), µg/L	Chromium VI, µg/L	Nitrate as Nitrogen, mg/L	Perchlorate, µg/L	Organic compounds
	Minimum Threshold	**1,000**	**250**	**300**	**50**	**10**	**50**	**NA**	**10**	**6**	**various**
	Rosedale 2 PW	496	44	715	255	0.18	ND	ND	ND	ND	ND
	Beltz #8 PW	448	51	1478	178	2	ND	ND	ND	ND	ND
	Beltz #9 PW	447	50	47	747	200	ND	ND	ND	ND	ND
	SC-3RC	461	46	63	36	ND	ND	ND	ND	ND	ND
	SC-5RA	534	55	2,778	180	ND	ND	ND	ND	ND	ND
	SC-9RA	390	15	14,424	19	ND	ND	ND	ND	ND	ND
	SC-10RA	349	29	223	522	ND	ND	ND	ND	ND	ND
	SC-22A	419	20	502	540	ND	ND	ND	ND	ND	ND
Purisima A/AA	Beltz #10 PW	621	58	836	277	2	ND	ND	ND	ND	ND
Purisima AA	SC-10RAA	231	10	93	72	ND	ND	ND	ND	ND	ND
	SC-22AAA	579	57	21	36	ND	ND	ND	ND	ND	ND
	Coffee Lane Deep	928	41	8	134	NT	NT	NT	ND	NT	NT
	Pleasure Point Deep	610	22	553	208	NT	NT	NT	ND	NT	NT
	Thurber Lane Shallow	No samples collected since 2006									
	Schwan Lake	400	91	316	113	NT	NT	NT	ND	NT	ND
Purisima	O'Neill Ranch PW	402	34	651	281	0.18	ND	ND	ND	3	ND

Aquifer Unit	Well Name	Total Dissolved Solids, mg/L	Chloride, mg/L	Iron, µg/L	Manganese, µg/L	Arsenic, µg/L	Chromium (Total), µg/L	Chromium VI, µg/L	Nitrate as Nitrogen, mg/L	Perchlorate, µg/L	Organic compounds
	Minimum Threshold	**1,000**	**250**	**300**	**50**	**10**	**50**	**NA**	**10**	**6**	**various**
AA/Tu	Beltz #12 PW	472	33	1,021	354	ND	ND	ND	ND	ND	ND
Tu	SC-18RAA	243	18	64	77	ND	ND	ND	ND	ND	ND
	Thurber Lane Deep	No samples collected since 2006									

NA = State Water Resources Control Board is still developing the maximum contaminant level for Chromium VI
ND = non-detect; NT = not tested
* well impacted by seawater intrusion therefore measurable objective is the same as the seawater intrusion measurable objective.

3.8 Land Subsidence Sustainable Management Criteria

3.8.1 Undesirable Results - Land Subsidence

The sustainability indicator is not applicable in the Santa Cruz Mid-County Basin as an indicator of groundwater sustainability and therefore no SMC are set. Section 2.2.2.5: Land Subsidence provides the evidence for subsidence's inapplicability as an indicator of groundwater sustainability. Even though the indicator is not applicable, a statement of significant and unreasonable subsidence caused by lowering of groundwater levels was discussed by the GSP Advisory Committee and is included below:

> *Any land subsidence caused by lowering of groundwater levels occurring in the basin would be considered significant and unreasonable.*

3.8.2 Minimum Thresholds - Land Subsidence

Subsidence is not applicable in the Santa Cruz Mid-County Basin as an indicator of groundwater sustainability and therefore no minimum thresholds are set.

3.8.3 Measurable Objectives - Land Subsidence

Land subsidence is not applicable in the Santa Cruz Mid-County Basin as an indicator of groundwater sustainability and therefore no measurable objectives or interim milestones are set.

3.9 Depletion of Interconnected Surface Water Sustainable Management Criteria

Development of SMCs for depletion of interconnected surface water is based on the only shallow well and associated streamflow data available in the Basin. Figure 3-3 shows the monitoring features concentrated along the lower Soquel Creek where the closest municipal pumping center occurs to surface water. From these data and other studies, it is understood that late summer streamflow in the mainstem of Soquel Creek between its forks and the USGS streamflow gage is influenced by many other factors in addition to contributions by groundwater. Annual rainfall, flows from the upper Soquel Creek watershed outside of the Basin, temperature and evapotranspiration individually have a much greater measurable influence on streamflow than groundwater pumping. For this reach of Soquel Creek, it has been concluded over several years of monitoring that there is not a direct measurable depletion of surface water flows from municipal pumping. There are, however, indications that there is an indirect influence where shallow groundwater levels mimic deeper regional groundwater level trends, which have been influenced by municipal pumping. As these observations are made from a few wells on the lower Soquel Creek only, further study as part of GSP implementation will revise the current understanding. This might necessitate a future change in the SMC for this sustainability indicator.

3.9.1 Undesirable Results - Depletion of Interconnected Surface Water

Significant and unreasonable depletion of surface water due to groundwater extraction, in interconnected streams supporting priority species, would be undesirable if there is more depletion than experienced since the start of shallow groundwater level monitoring through 2015.

3.9.1.1 Groundwater Elevations 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. This is a very difficult metric to quantify in the Basin since the depletion of interconnected surface water by municipal groundwater extraction is so small that it is not possible to directly measure through changes in streamflow, although these changes can potentially be seen in model results. 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. Significant correlation is difficult to prove because depletion of surface water by groundwater extractions is so small compared to the other streamflow factors mentioned above, and is not directly measurable in the streamflow. However, if groundwater elevations connected to streams are kept at or above current elevations, which are close to period of record high levels, there will be no more depletions in surface water than experienced over the past 18 years. Essentially, the minimum thresholds seek to maintain a groundwater gradient toward the stream by controlling groundwater levels near the stream.

In an effort to show correlation between volume or rate of streamflow and groundwater level proxies for minimum thresholds, groundwater model output is used to estimate the relationship. The groundwater model is used to estimate streamflow depletion from pumping during the 2001-2015 period, which is the period where shallow groundwater level data are available and from which minimum thresholds are derived. The streamflow depletion estimate is accomplished by testing the sensitivity of simulated groundwater contribution of streamflow to pumping within the Basin. This sensitivity test is outside the bounds of conditions under which the model is calibrated and adds to uncertainty of the simulated results.

Figure 3-14 shows the sensitivity results of groundwater contribution to streamflow from changes in Basin pumping. This analysis is for the entire Soquel Creek watershed during minimum flow months. Removing all Basin pumping in the model results in an increased groundwater contribution to Soquel Creek of up to 1.4 cubic-feet per second (cfs) for the 2001-2015 modeled period. This means that if more than approximately 1.4 cfs of surface water depletion is caused by groundwater extractions during low flow periods, undesirable results will occur. The estimate of 1.4 cfs simulated over 2001-2015 is the minimum threshold for streamflow depletion. To reiterate, the uncertainty of this estimate and difficulty measuring streamflow depletion from pumping affirm the appropriateness of using a groundwater level proxy to prevent the undesirable result of increases in streamflow depletion above what occurred from 2001-2015.

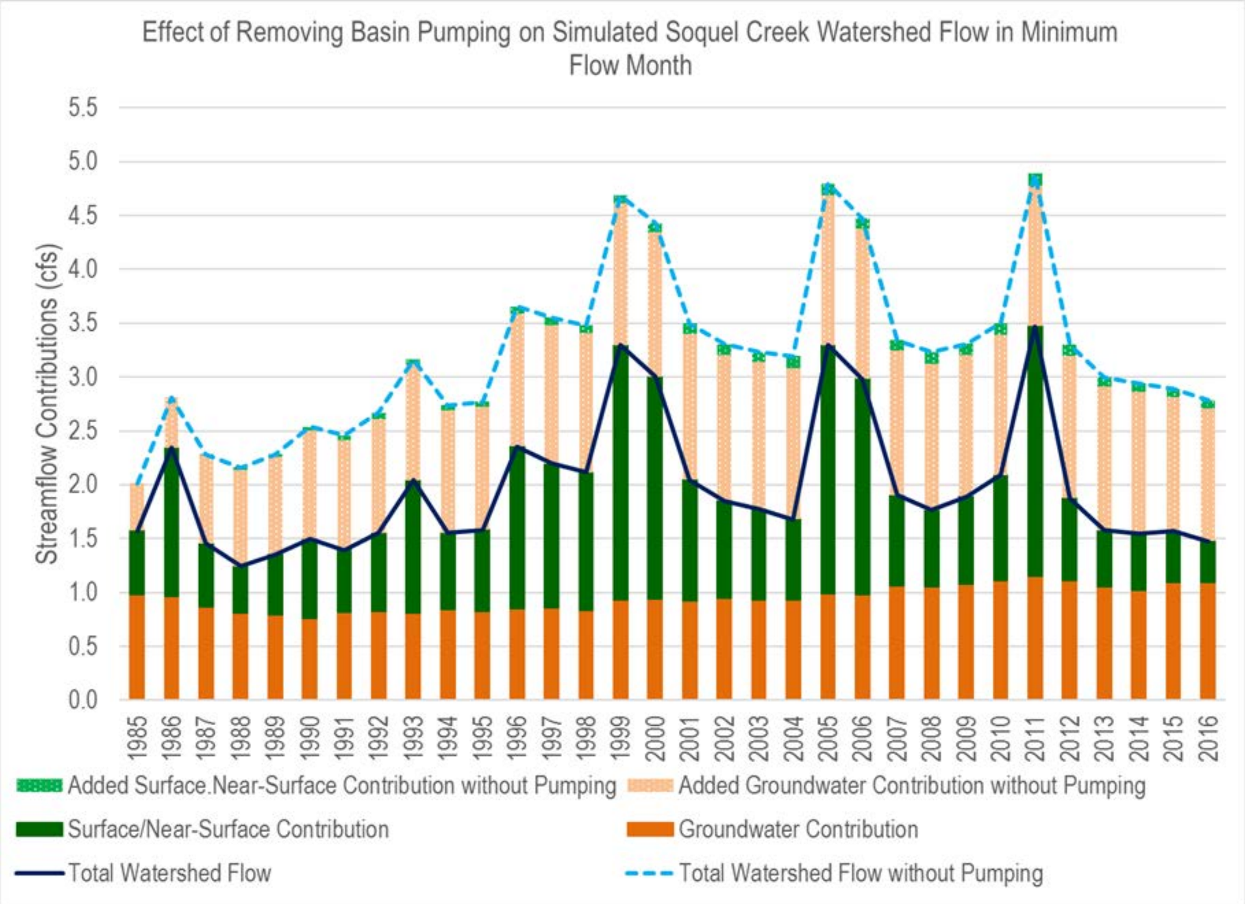


Figure 3-14. Simulated Contributions to Streamflow for Soquel Creek Watershed with and without Historical Pumping

3.9.1.2 Criteria for Defining Depletion of Interconnected Surface Water Undesirable Results

There was support in the Surface Water Working Group to move towards managing shallow groundwater so that interconnected streams have gaining flow from groundwater and are not losing flow to groundwater. Additionally, ensuring that streams do not experience more depletion than has occurred since the start of shallow groundwater level monitoring was another key condition. The Surface Water Working Group elected to take a conservative approach to defining undesirable results where any shallow RMP's groundwater elevation falling below its minimum threshold would be an undesirable result.

3.9.1.3 Potential Causes of Undesirable Results

As mentioned previously, there are many factors aside from groundwater that effect streamflow in Soquel Creek and likely other streams in the Basin. Undesirable results for depletion of interconnected surface water in the context of the GSP are related purely to the extraction of groundwater from the Basin. Increased pumping close to interconnected creeks and streams is a potential cause of undesirable results that may manifest itself in reduced groundwater levels in both the shallow and deeper underlying Purisima aquifers. From well permit records it is known there are some private domestic wells screened in shallow alluvial sediments which are directly connected to surface water. These wells may have a larger impact on shallow groundwater levels than municipal pumping from the deeper Purisima aquifers.

3.9.1.4 Effects on Beneficial Users and Land Use

Undesirable depletion of interconnected surface water from groundwater extraction will primarily effect aquatic systems mainly during the late summer. Under low flow conditions, there is a direct linear relationship between streamflow and the amount of suitable 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 temperature. In extreme conditions, dewatering of channel segments eliminates the ability of the fish to move to more suitable areas and can cause outright mortality. In even more extreme conditions lowering of groundwater levels below the root zone of riparian vegetation can result in the loss of that vegetation.

3.9.2 Minimum Thresholds - Depletion of Interconnected Surface Water

Using shallow groundwater levels adjacent to streams as a proxy for surface water depletion, undesirable results will occur if the average monthly groundwater levels fall below the minimum threshold, which is established as the highest seasonal low elevation during below- average rainfall years from the start of monitoring through 2015.

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

Information used for establishing 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 Working Group and GSP Advisory Committee meetings.
- Depths, locations, and logged lithology of existing wells used to monitor shallow groundwater levels near creeks.
- Historical groundwater elevation data from shallow wells monitored by SqCWD.
- Streamflow and stream stage data collected by the USGS, SqCWD, County of Santa Cruz, and Trout Unlimited.
- Past hydrologic reports, including annual reports for SqCWD's Soquel Creek Monitoring and Adaptive Management Plan.

The approach for developing minimum thresholds for the depletion of interconnected surface water sustainability indicator is to select groundwater elevations in shallow RMPs below which significant and unreasonable depletions of surface water due to groundwater extractions would occur.

Since significant and unreasonable conditions have not occurred since at least 2001 when shallow groundwater level monitoring began, minimum thresholds for shallow groundwater elevations in the vicinity of interconnected streams are based on the highest seasonal-low elevation during below-average rainfall years, over the period from the start of shallow groundwater level monitoring through 2015. The years after 2015 are not included because 2016 was an average rainfall year and 2017 was extremely wet, which increased overall Basin shallow groundwater elevations above all previous levels.

3.9.2.2 Depletion of Interconnected Surface Water Minimum Thresholds

Table 3-21 lists the minimum thresholds for RMPs currently available to monitor depletion of interconnected surface water. Hydrographs showing historical groundwater elevation data compared to the minimum threshold are provided in Appendix 3-D. An example of one of the RMP hydrographs with its minimum threshold is shown on Figure 3-15.

Table 3-21. Minimum Thresholds and Measurable Objectives for Representative Monitoring Points for Depletion of Interconnected Surface Water

Aquifer Unit	Well Name	Minimum Threshold	Measurable Objective
		Groundwater Elevation, feet above mean sea level	
Shallow Groundwater	Balogh	29.1	30.6
	Main St. Shallow	22.4	25.3
	Wharf Road	11.9	12.1
	Nob Hill	8.6	10.3
Purisima A	SC-10RA	68	70

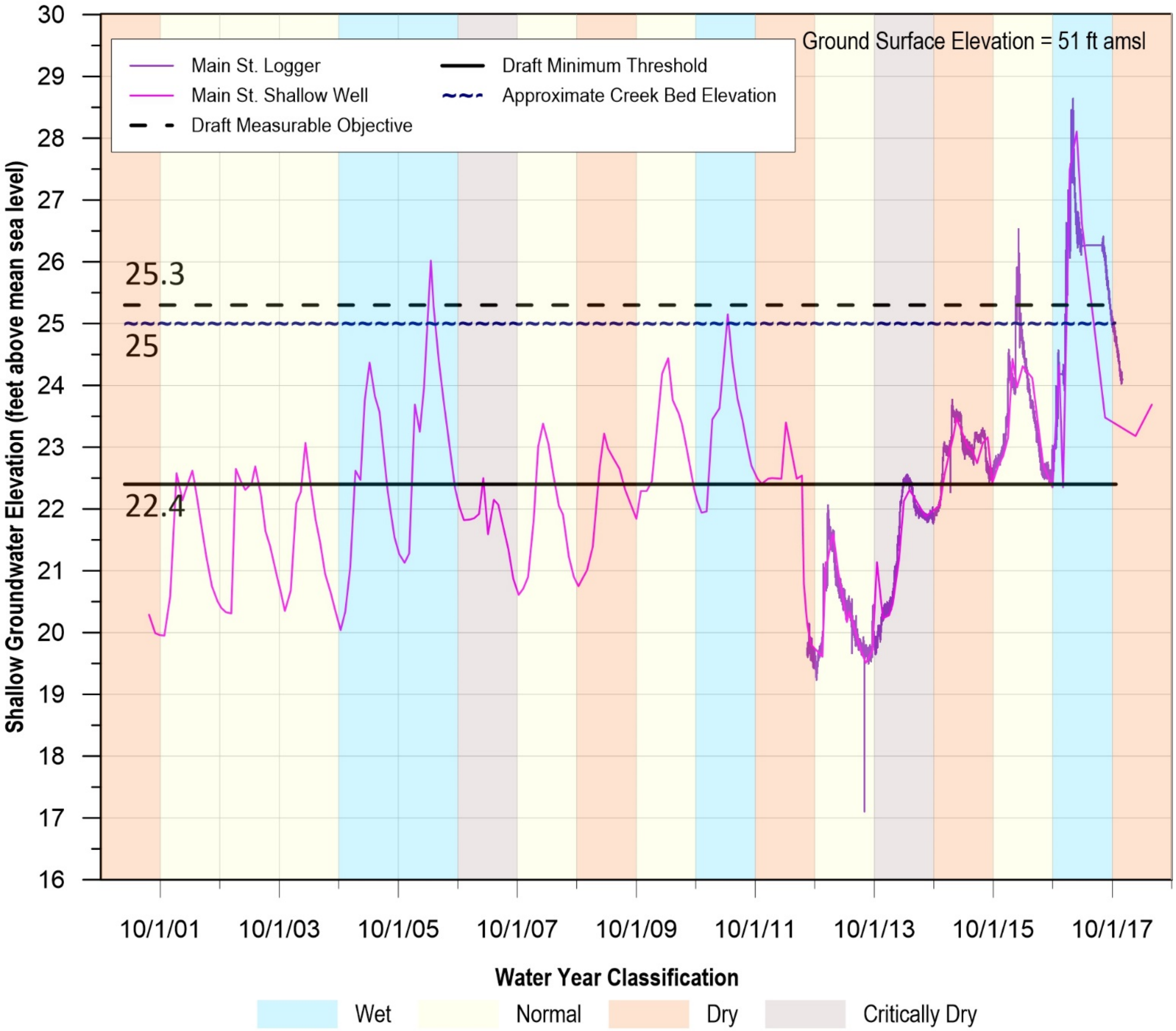


Figure 3-15. Main Street Shallow Monitoring Well Hydrograph with Minimum Threshold and Measureable Objective

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

Figure 3-10 shows proxy shallow groundwater elevations in relation to both individual minimum thresholds and other sustainability indicator minimum thresholds that use groundwater levels as a metric. Proxy groundwater elevation minimum thresholds decline in elevation downstream thereby following the surface elevation and avoiding unnatural groundwater elevations that would not be physically attainable. There are also no conflicts with other sustainability indicator minimum thresholds as upper Purisima unit RMPs for other indicators close to the creek were purposely avoided because the groundwater elevations for the depletion of interconnected surface water are much more stringent than for other indicators.

3.9.2.4 Effect of Minimum Thresholds on Neighboring Basins

None of the creeks in the Basin are upstream of any of the neighboring basins. Therefore, there will be no effects on those basins from depletion of interconnected surface water minimum thresholds.

3.9.2.5 Effects of Minimum Thresholds on Beneficial Users and Land Uses

Maintenance of interconnected surface water minimum thresholds will not have any negative effects on beneficial users and land uses in the Basin.

Rural residential and agricultural land uses and users. With the minimum thresholds for depletion of interconnected surface water being similar to shallow groundwater levels over the past few years, there will be no declines in shallow groundwater which is a general benefit for private domestic and agricultural well groundwater users. There is a possibility that when additional studies are conducted to improve understanding of this sustainability indicator, restrictions on pumping of wells close to streams may be instituted for wells screened in shallow alluvium that have a direct connection to the stream. The few existing older shallow wells could be replaced by deeper wells screened in the deeper units to minimize any direct impact on flow. There are no other anticipated effects on rural residential or agricultural land uses from the minimum thresholds.

Urban land uses and users. Where streams flow through urban areas of the Basin, there will be a small increase to no change in shallow groundwater levels. Since there are no major changes expected in urban areas, the depletion of interconnected surface water minimum thresholds will not negatively impact urban land uses and users.

Ecological land uses and users. The main benefit of these minimum thresholds is to protected species and GDEs in streams connected to groundwater. Meeting minimum thresholds effectively increases overall hydraulic gradients from the shallow groundwater to the streams allowing for more groundwater to flow into the stream.

3.9.2.6 Relevant Federal, State, or Local Standards

No explicit federal, state, or local standards exist for depletion of interconnected surface water. However, both state and federal endangered species provisions call for the protection and restoration of conditions necessary for steelhead and coho salmon habitat in Soquel and Aptos Creeks. This would include restoring unimpaired stream flows during low flow conditions and during other critical life stages.

3.9.2.7 Method for Quantitative Measurement of Minimum Thresholds

Groundwater elevations in RMPs will be directly measured to determine where groundwater levels are in relation to minimum thresholds. Groundwater level monitoring will be conducted in accordance with the monitoring plan outlined in Section 3.3. All RMPs will be equipped with continuous data loggers.

In the future, as the MGA increases its understanding of groundwater and surface water interconnections along other reaches of Soquel Creek and other streams, areas where measurable depletion from groundwater extraction may be identified. Where these conditions exist, RMPs to monitor streamflow will be added to the representative monitoring network.

3.9.3 Measurable Objectives - Depletion of Interconnected Surface Water

3.9.3.1 Measurable Objectives

Measurable objectives at RMPs are groundwater elevations greater than the minimum thresholds by the range in seasonal-low shallow elevations over the period of record through 2015. In all cases, this results in groundwater elevations that are higher than the creek bed elevation at each RMP. Increased hydraulic gradient increases groundwater contributions to streamflow.

The range in seasonal-low elevations represents known change in seasonal-low elevations that can occur and includes the years when overall groundwater elevations in the Basin have increased. The range effectively provides the operational flexibility that measurable objectives are intended to provide.

3.9.3.2 Interim Milestones

Groundwater elevations as proxy interim milestones are based on model simulations of projects to prevent undesirable results related to seawater intrusion will also raise shallow groundwater levels along Soquel Creek over time. These model results are shown in Section 4 describing the expected benefits of the projects.

Interim milestones are established at each of the shallow RMPs with proxy groundwater elevations for surface water depletion. Since the groundwater elevation proxies for surface water depletion are compared to minimum groundwater elevations each year and the minimums vary from year to year due to climate, the interim milestones are based on minimum simulated groundwater elevations at the wells over five year periods in order to be less dependent on climate simulated for a specific year. The interim milestones for Water Years 2025, 2030, and 2035 are based on the minimum model simulated groundwater elevations over Water Years 2021-2025, Water Years 2026-2030, and 2031-2035, respectively.

Interim milestones are based on model simulation of Pure Water Soquel because the expected benefits of that project are to raise groundwater levels above or approaching measurable objectives at shallow wells, as described in Section 4.

If modeled groundwater levels for 2021- 2025 are above minimum thresholds, the minimum thresholds are used as the interim milestone because there is some uncertainty about when projects would begin. This GSP sets as an interim milestone the elimination of undesirable results by 2025 at locations where model results show it is achievable with project implementation. If modeled groundwater levels in 2030 and 2035 are above measurable objectives, the measurable objectives are used as the interim milestones. Table 3-22 summarizes the interim milestone for each RMP.

Table 3-22. Interim Milestones for Deletion of Interconnected Surface Water Groundwater Elevation Proxies

Representative Monitoring Point	Minimum Threshold (feet mean seal level)	Measurable Objective (feet mean sea level)	Interim Milestone 2025 (feet mean sea level)	Interim Milestone 2030 (feet mean sea level)	Interim Milestone 2035 (feet mean sea level)
Balogh	29.1	30.6	29.1	30.6	30.6
Main St. Shallow	22.4	25.3	20.7	22.9	23.2
Wharf Road	11.9	12.1	11.3	12.1	12.1
Nob Hill	8.6	10.3	7.3	9.5	9.9
SC-10RA	68	70	68	70	70

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APPENDIX 3-A

Technical Approach for Determining Groundwater Elevation Minimum Threshold for Chronic Lowering of Groundwater Levels in Representative Monitoring Wells

The general premise for determining Minimum Thresholds for chronic lowering of groundwater levels is that groundwater levels cannot go below a level which prevents overlying groundwater users from meeting their typical water demand. Overlying water demand is determined from land use and by the well use indicated on well driller logs in the vicinity of the RMP.

The saturated thickness of an aquifer is an important factor that can limit well yields. When groundwater levels decline, the saturated thickness of the aquifer decreases. The saturated thickness may decrease to a point at which the aquifer can no longer produce water to the well at the minimum rate of pumping needed to meet typical demands.

The pump rate and aquifer properties control how much saturated aquifer thickness (distance between the bottom of the well and the groundwater level) is needed to meet water demands. Water demands by municipal wells are known as municipal agencies have detailed records of each well's pump capacity and volumes pumped. Private domestic and agricultural well users generally do not have this information, and therefore assumptions are made to estimate their water usage. For domestic use, average rates of 10 gpm were provided by a local pump contractor. For purposes of estimating the minimum saturated thickness (MST) needed, a more conservative rate of 15 gpm was used as this needs more saturated thickness than a well pumping at 10 gpm (i.e. the groundwater level needs to be higher for 15 gpm). For agricultural wells, the estimated capacity provided on the well driller's logs available indicated 250 gpm is typical.

A theoretical MST for each RMP is estimated using a spreadsheet tool developed by the Kansas Geological Survey based on the overlying water demand (Brookfield, 2016). The tool considers well efficiency, nearby pumping wells, and drawdown in the well due to pumping at a given rate. To consider uncertainties in the MST estimation, a 20% safety factor is added to the MST obtained from the spreadsheet tool. It is also assumed that a well pump can be placed no deeper than 20 feet from the bottom of the well to prevent the pump from being damaged by settled sediment in the bottom of the well. This is the typical depth well pumps are set in domestic wells according to a local pump installer. To account for this, a further 20 feet is added to the estimated MST. Figure 1 provides a generalized schematic that illustrates the method described above. The resultant adjusted MST is the minimum thickness of saturated aquifer that is needed for overlying groundwater users to meet their typical demand. In some areas, there may be two overlying uses, such as agricultural and domestic, or municipal and domestic. For these cases, the adjusted MST of the use type that results in the shallowest groundwater level is used.

As a conservative measure, the approach assumes the RMP has a depth equal to the shallowest nearby well screened in the same aquifer as the RMP. This results in a shallower groundwater elevation than if the actual depth of the RMP is used (if it is deeper than nearby wells).

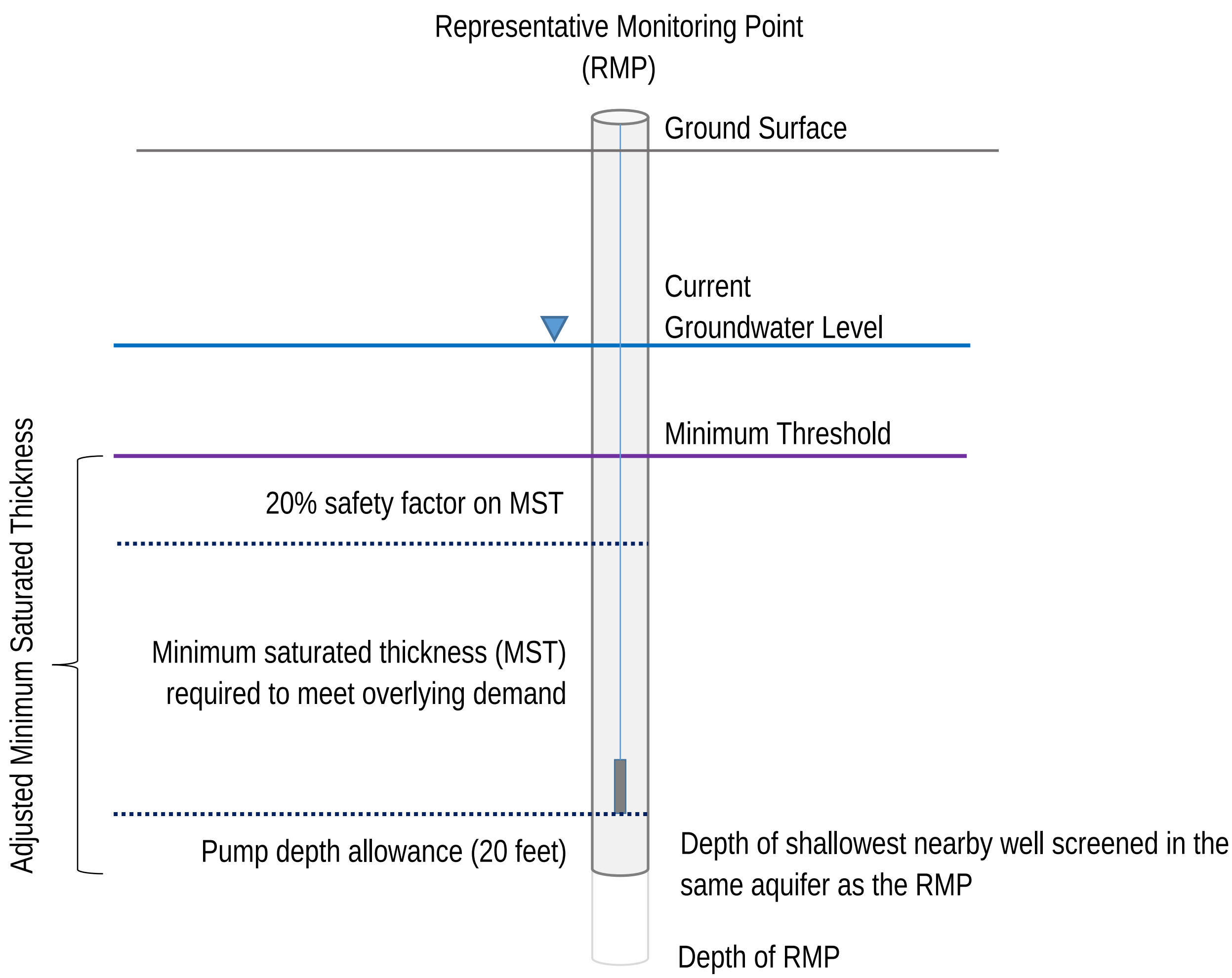

Figure 1. Schematic of Minimum Saturated Thickness Approach

Table 1 summarizes the minimum thresholds for 17 RMPs selected as representative across the Basin. There are five RMPs that had adjusted MSTs that are greater than 30 feet below historic low groundwater levels. For these RMPs, the minimum threshold was raised to 30 feet below historic low groundwater levels. This was done because, although the wells could meet their demand with a much lower groundwater level, having groundwater levels drop to these depths may influence other sustainability indicators. The rationale for selecting a maximum of 30 feet below historic low is that the majority of the RMPs have adjusted MSTs less than 30 feet below historic low levels as shown on Figure 2.

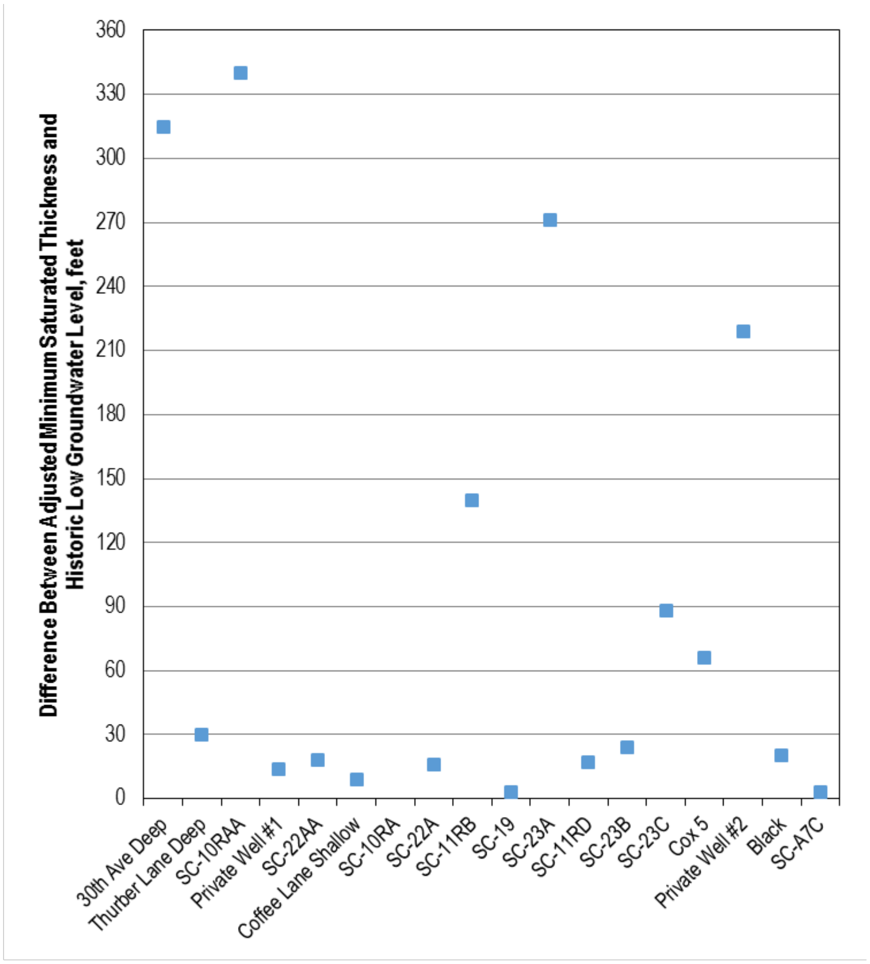

Figure 2. Representative Monitoring Points Difference between Adjusted Minimum Saturated Thickness and Historic Low Groundwater Level

There are four wells where the minimum thresholds were raised to sea level as these are close to protective elevation coastal monitoring wells and having groundwater levels below sea level will make it difficult to achieve protective elevations at the coast. Other reasons for raising elevations from the MST levels are provided in Table 1.

References

Brookfield, A. 2016. Minimum Saturated Thickness Calculator, Method Overview and Spreadseet Description. Kansas Geological Survey Open---File Report 2016---3, pp 6.

Table 1. Summary of Representative Monitoring Points with Minimum Threshold Groundwater Elevations

RMP Name	Overlying Demand Type	Aquifer	Minimum Threshold Elevation (feet amsl)	Minimum Saturated Thickness (MST) Assumptions and Adjustments made to Minimum Thresholds (MT)
30th Ave Deep	Municipal	Tu	0	No private wells screened in this very deep aquifer. There are some municipal wells screened in this aquifer > 0.8 mile to the north. Shallowest municipal well depth results in a minimum elevation of -324 ft amsl based on the MST. However, well screens are typically at 200 ft below ground so the MT is adjusted upwards to sea level which is typically above well screens.
Thurber Lane Deep	Private Domestic	Purisima AA/Tu	-10 Upward	Shallowest domestic well depth results in a minimum elevation of -33 ft amsl that still meets demands. Increase the elevation to -10 ft amsl so that there is not such a steep gradient between this RMP and the coast where there are higher protective groundwater elevations.
SC-10RAA	Private Domestic	Purisima AA/Tu	35 30 ft below low	There are no deep domestic wells in the area of this RMP that are screened in the Pur AA/Tu similar to the RMP. They are screened shallower in Pur A/AA and in the alluvium. Even using the shallowest domestic well depth (not screened in the same aquifer), adjusted MST is at -275 ft amsl, MT is therefore set to 30 ft below historic low levels.
Private Well #1	Private Domestic	Purisima AA/Tu	362	Shallowest domestic well depth in same aquifer as RMP.
SC-22AA	Municipal	Purisima AA	0	Shallowest municipal well depth and municipal well MST. The adjusted MST is --3 ft amsl, MT is therefore increased to sea level.
Coffee Lane Shallow	Municipal	Purisima A/AA	27	Shallowest domestic well depth in same aquifer as RMP.
SC-22A	Municipal/Private Domestic	Purisima A	2	Shallowest domestic well depth, adjusted MST at muni well MST is -3 ft amsl. MT set at 2 ft above SC-22AA MT because groundwater levels in SC-22A are typically 2 ft higher than SC-22AA levels, which has a minimum threshold of 0 ft amsl.
SC-11RB	Private Domestic	Purisima BC	120	Not many domestic wells are deep enough in this location to go down through the Purisima DEF and D units into the underlying Purisima BC unit. Shallowest domestic well depth in same aquifer as RMP (555 ft). MT set to 30 ft below historic low because adjusted MST results in > 30 ft below historic low level.

RMP Name	Overlying Demand Type	Aquifer	Minimum Threshold Elevation (feet amsl)	Minimum Saturated Thickness (MST) Assumptions and Adjustments made to Minimum Thresholds (MT)
SC-19	Municipal/Private Domestic	Purisima BC	56	Not many private wells nearby. Municipal wells are shallower than private wells with County records. Used shallowest municipal well depth in same aquifer as RMP.
SC-23A	Municipal	Purisima BC	0	No domestic wells at this depth in the area. Shallowest municipal well depth, adjusted MST >30 ft below historic low. Raise MT to sea level 0 ft amsl which is 21 ft below historic low.
SC-11RD	Private Domestic	Purisima DEF	295	Shallowest domestic well depth in same aquifer as RMP.
SC-23B	Small Water System/ Private	Purisima DEF	50	Shallowest domestic well depth results in a minimum elevation of -137 ft amsl that still meets demands. Increase the elevation to 50 ft amsl. Difference in groundwater levels between SC-23B and SC-23A is 50 ft during historic low levels on hydrograph.
SC-23C	Municipal	Purisima F	15	Shallowest domestic well depth results in a minimum elevation of -14 ft amsl that still meets demands. Increase the elevation to 15 ft amsl. This is both 30 ft lower than historic low and equal to the average depth below SC-23B elevation.
CWD-5	Private Domestic	Purisima F	133	Shallowest domestic well depth results in a minimum elevation of 97 ft amsl that still meets demands. Increase the MT elevation to 30 ft below average historic lows.
Private Well #2	Private Domestic	Purisima F	562	Shallowest domestic well depth results in a minimum elevation of 433 ft amsl that still meets demands. Increase the elevation to 562 ft amsl, which is 30 ft below historic lows.
Black	Private Domestic	Purisima F	21	Other domestic wells in the area are screened in both the Aromas and Purisima F, while this RMP is screened in only the Purisima F. The MT is set at a level less than 30 ft below the historic low.
SC-A7C	Ag/Municipal	Aromas	0	Shallowest Ag well depth results in a minimum elevation of --20 ft amsl that still meets demands. MT is therefore set at sea level.

APPENDIX 3-B

Hydrographs of Representative Monitoring Points for Chronic Lowering of Groundwater Levels

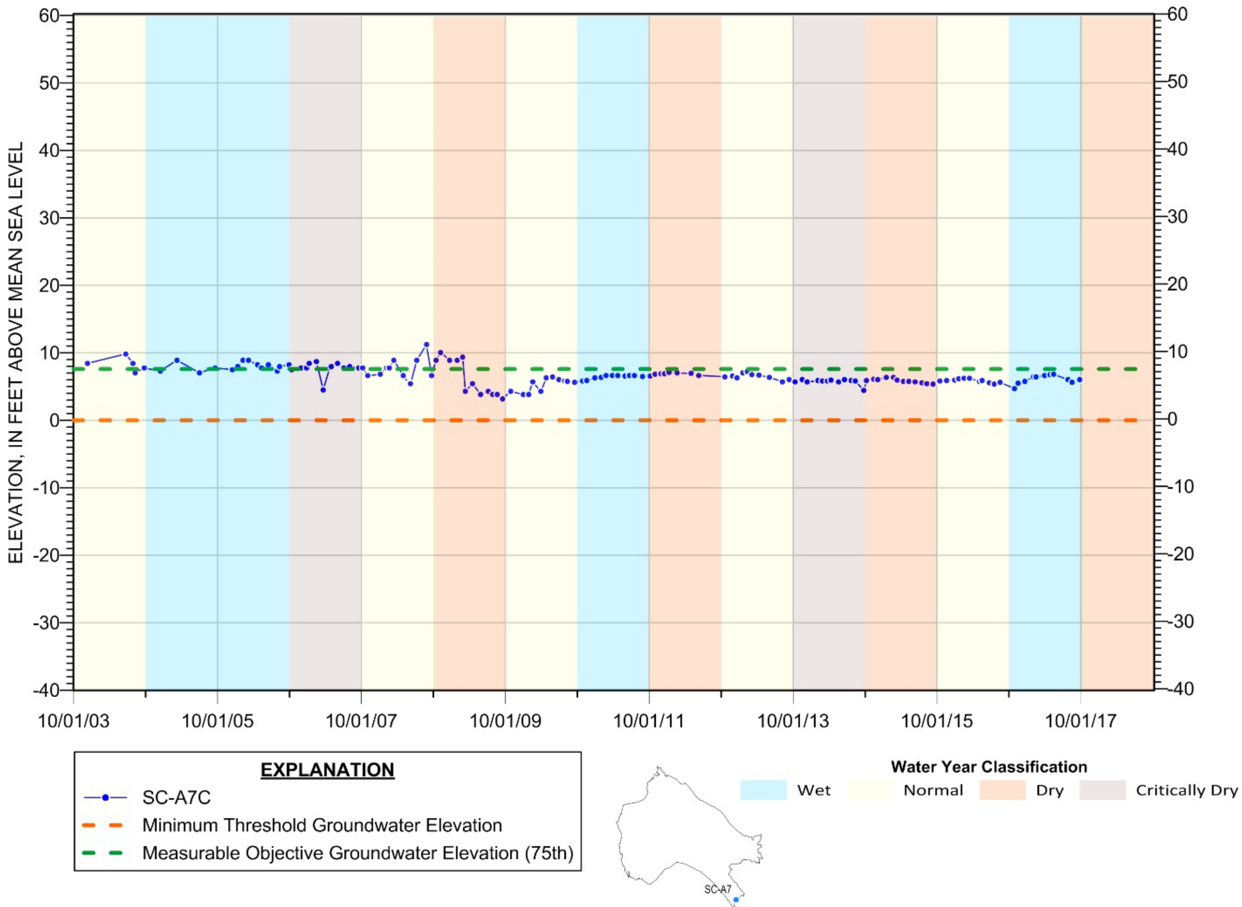

Figure 3-B.1. SC-A7C Hydrograph with Minimum Threshold and Measureable Objective

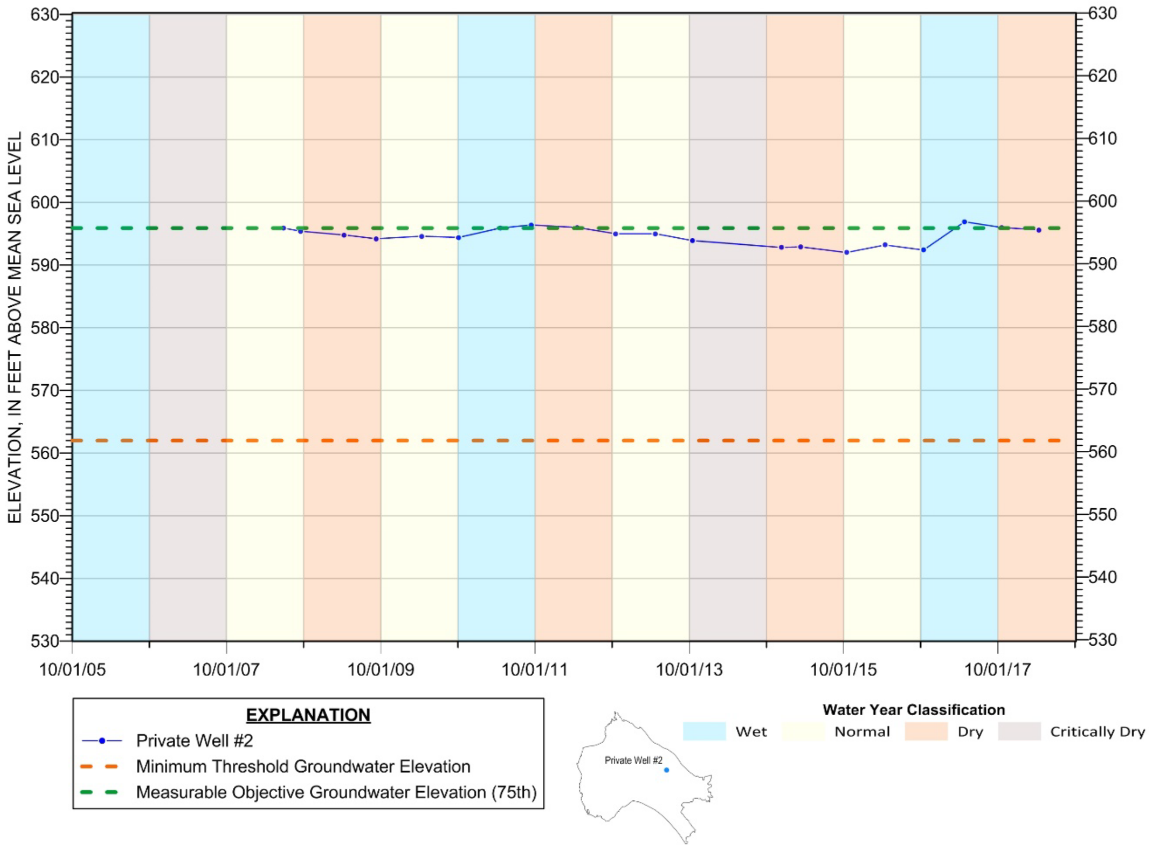

Figure 3-B.2. Private Well #2 Hydrograph with Minimum Threshold and Measureable Objective

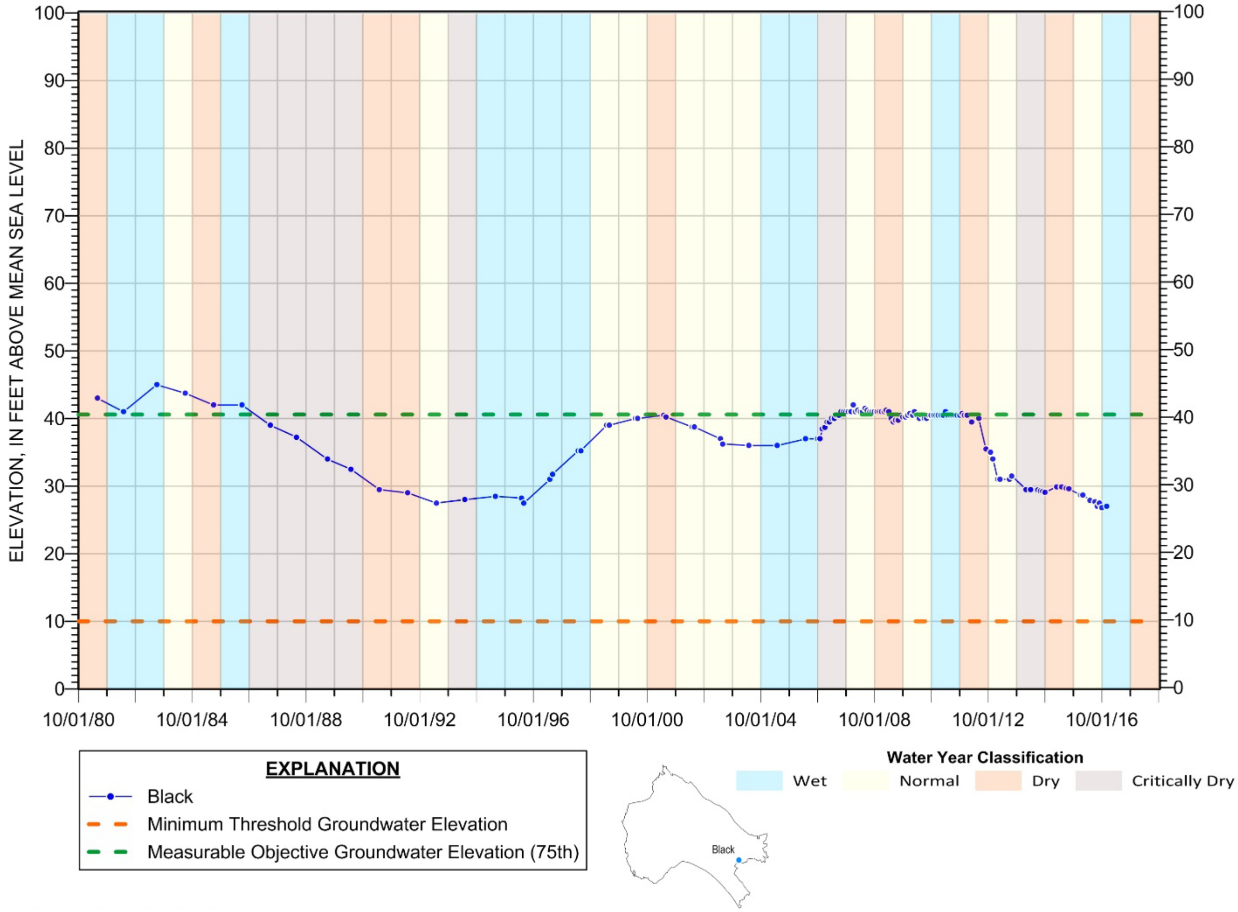

Figure 3-B.3. Black Hydrograph with Minimum Threshold and Measureable Objective

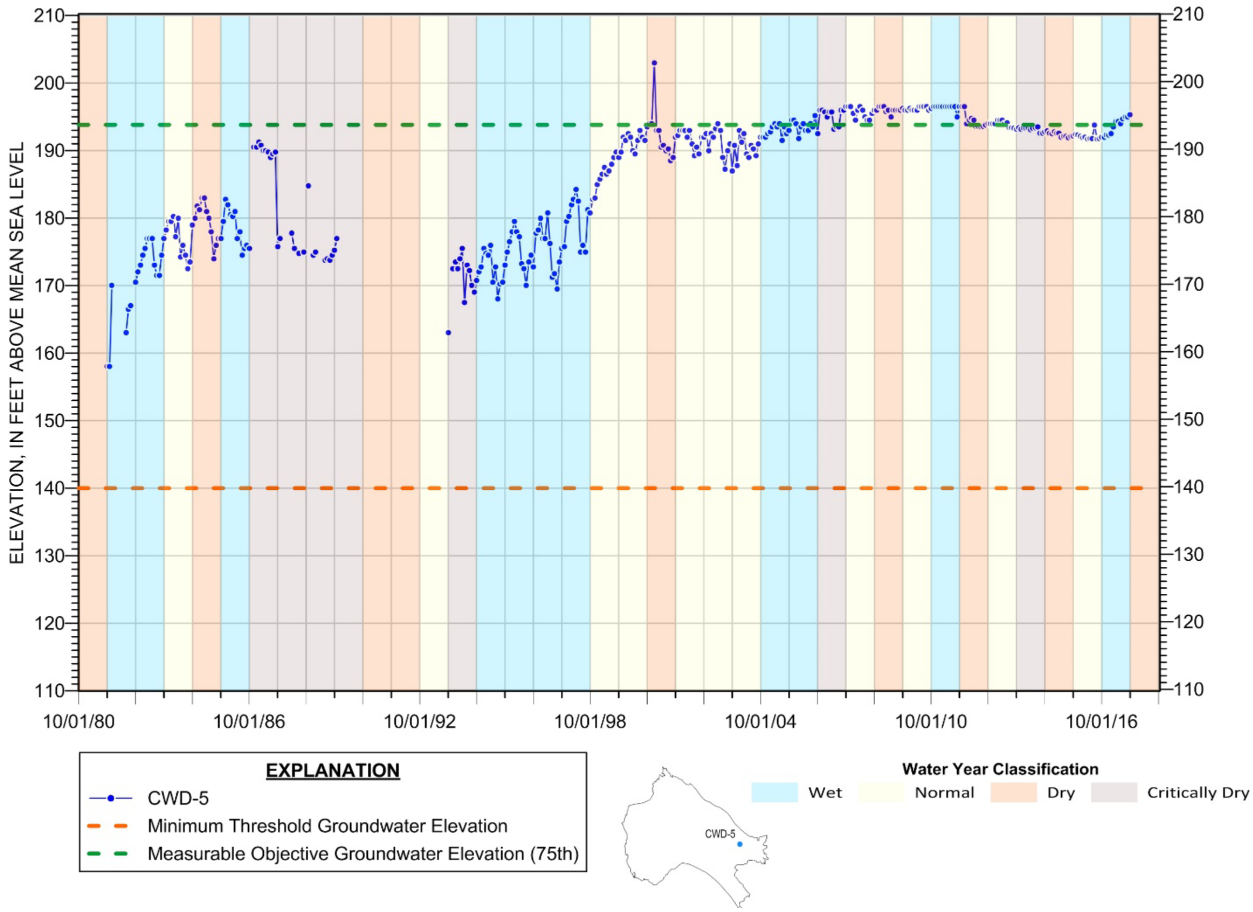

Figure 3-B.4. CWD-5 Hydrograph with Minimum Threshold and Measureable Objective

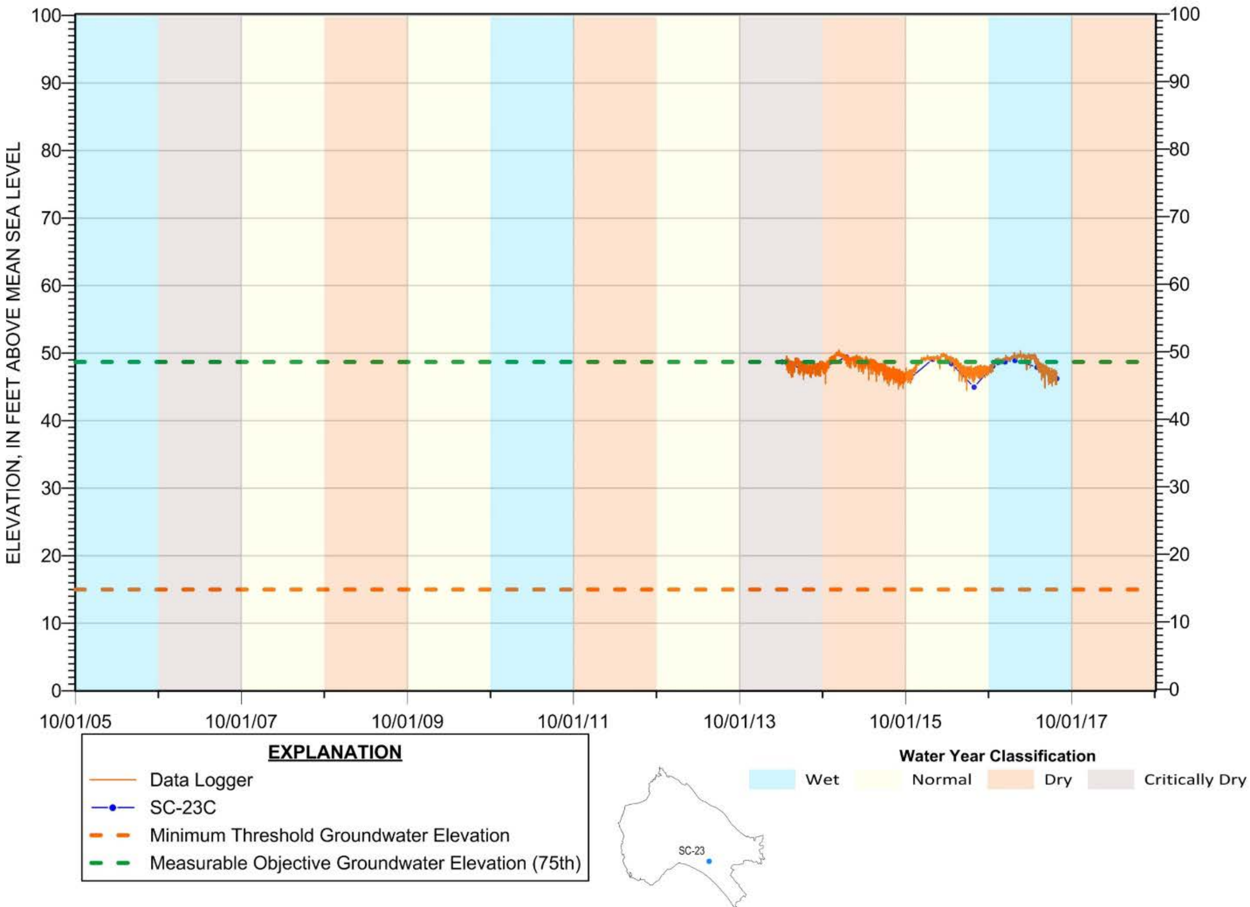

Figure 3-B.5. SC-23C Hydrograph with Minimum Threshold and Measureable Objective

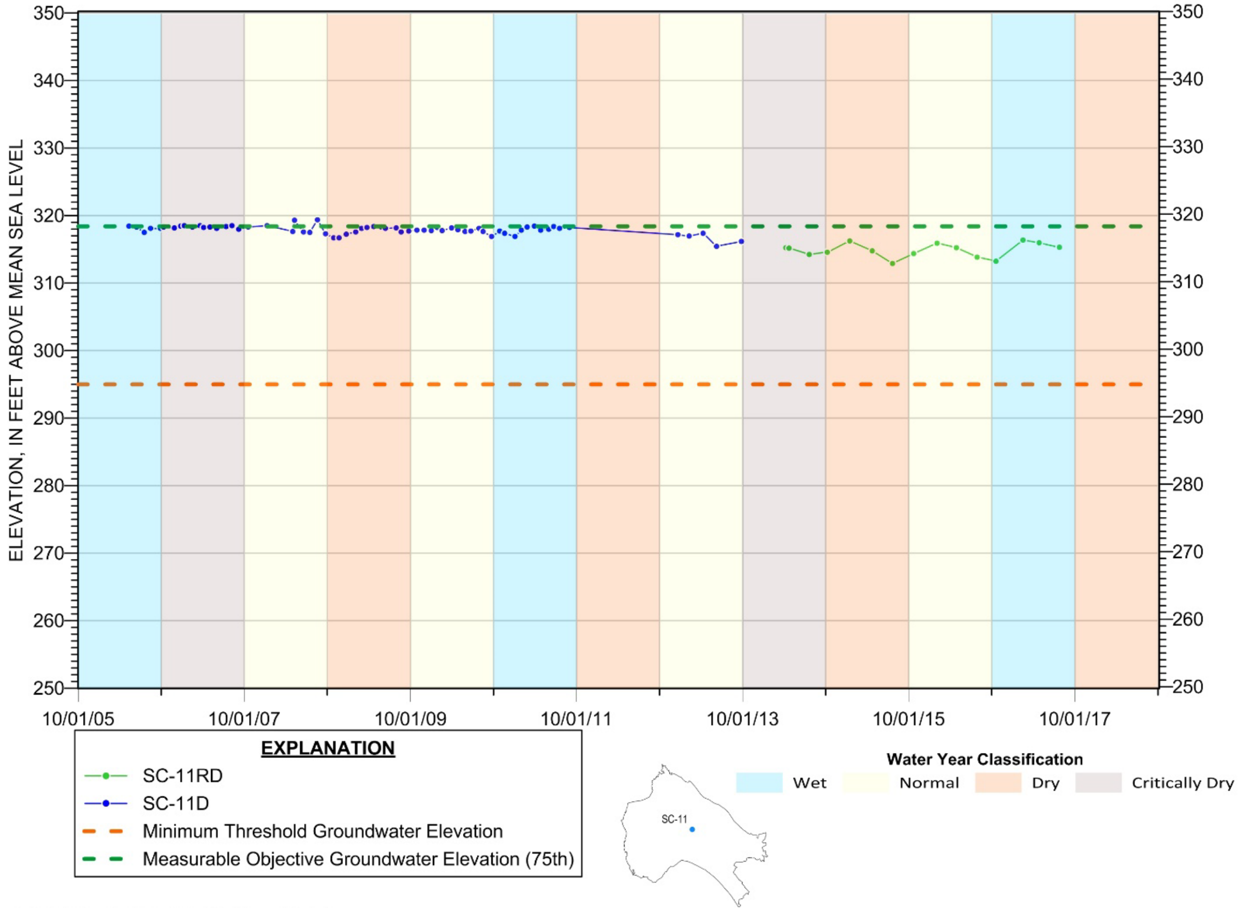

Figure 3-B.6. SC-11RD Hydrograph with Minimum Threshold and Measureable Objective

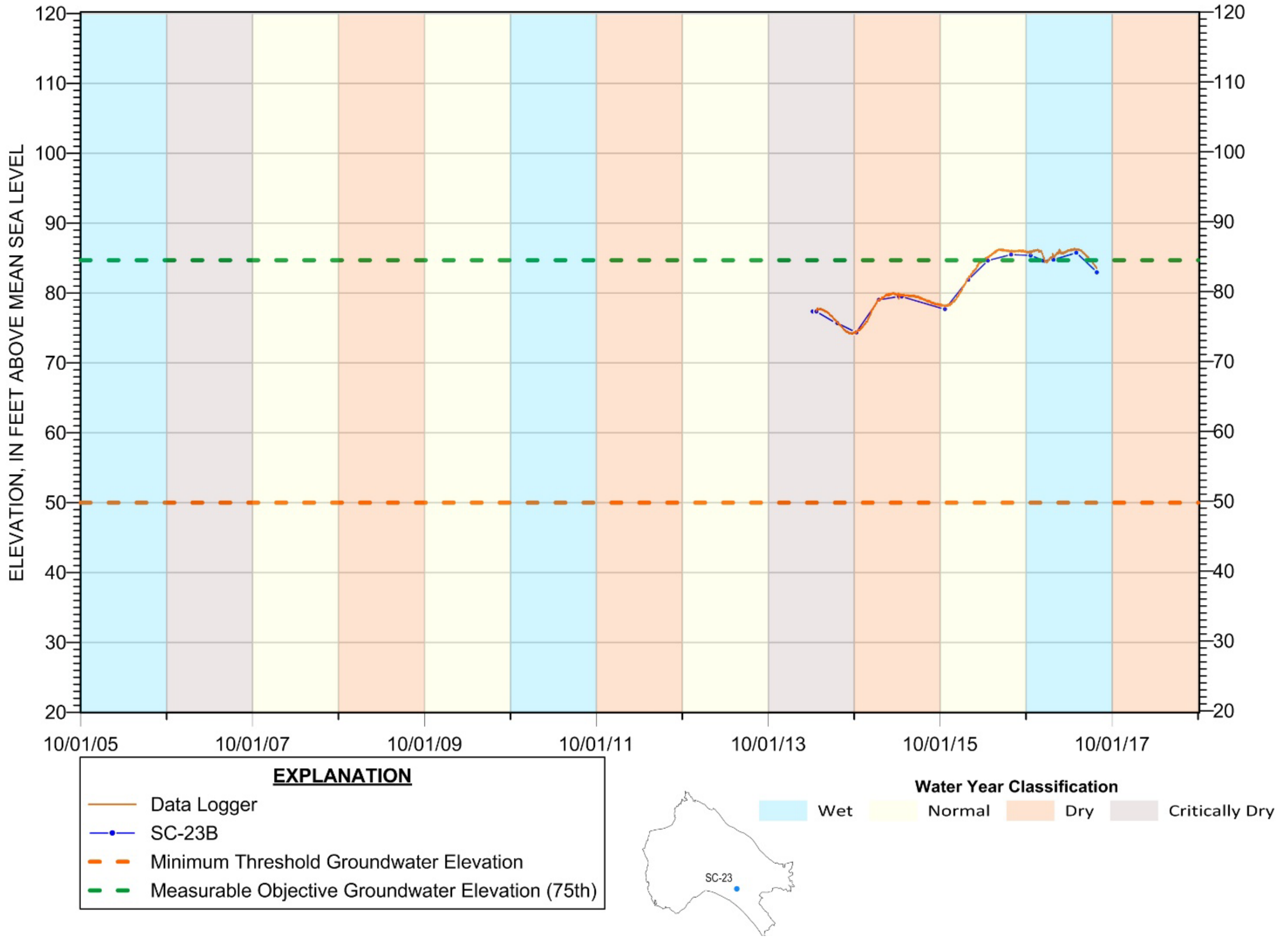

Figure 3-B.7. SC-23B Hydrograph with Minimum Threshold and Measurable Objective

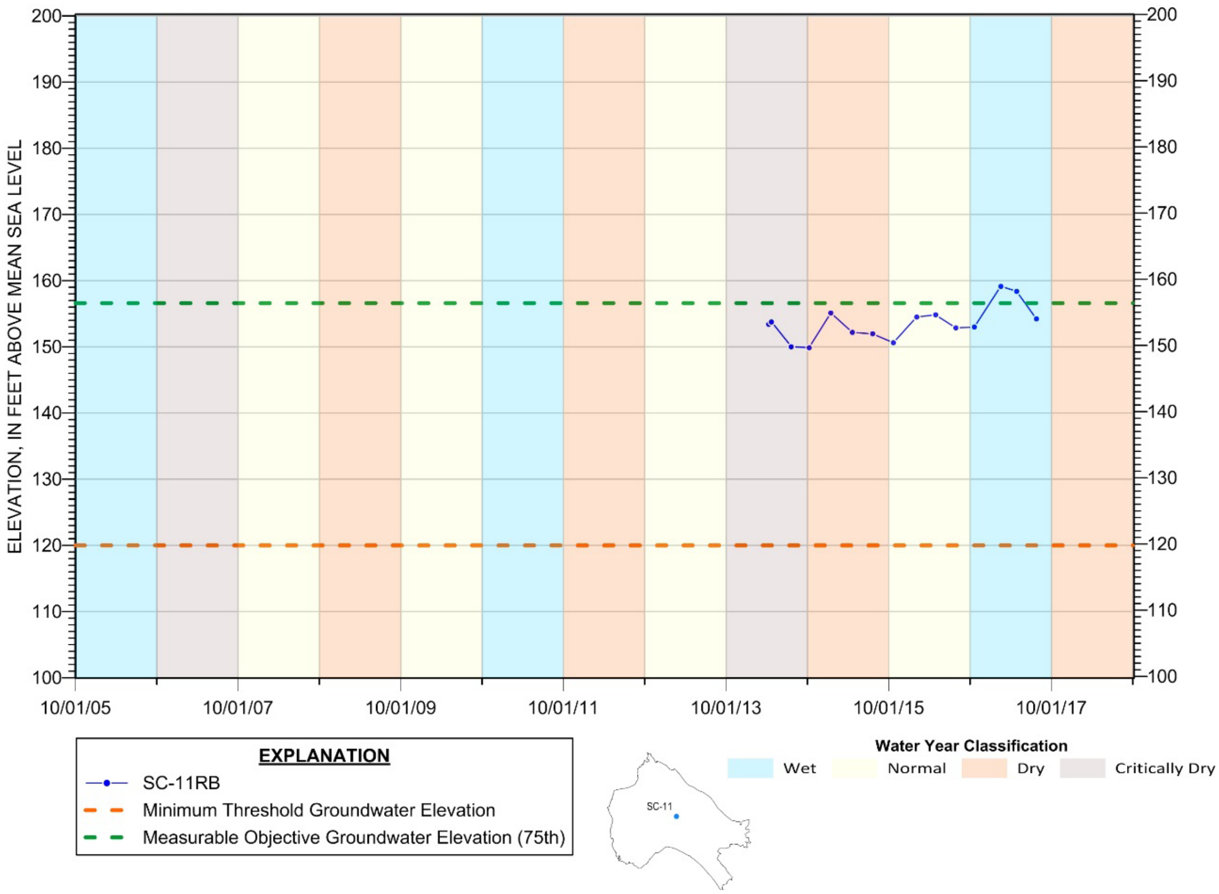

Figure 3-B.8. SC-11RB Hydrograph with Minimum Threshold and Measureable Objective

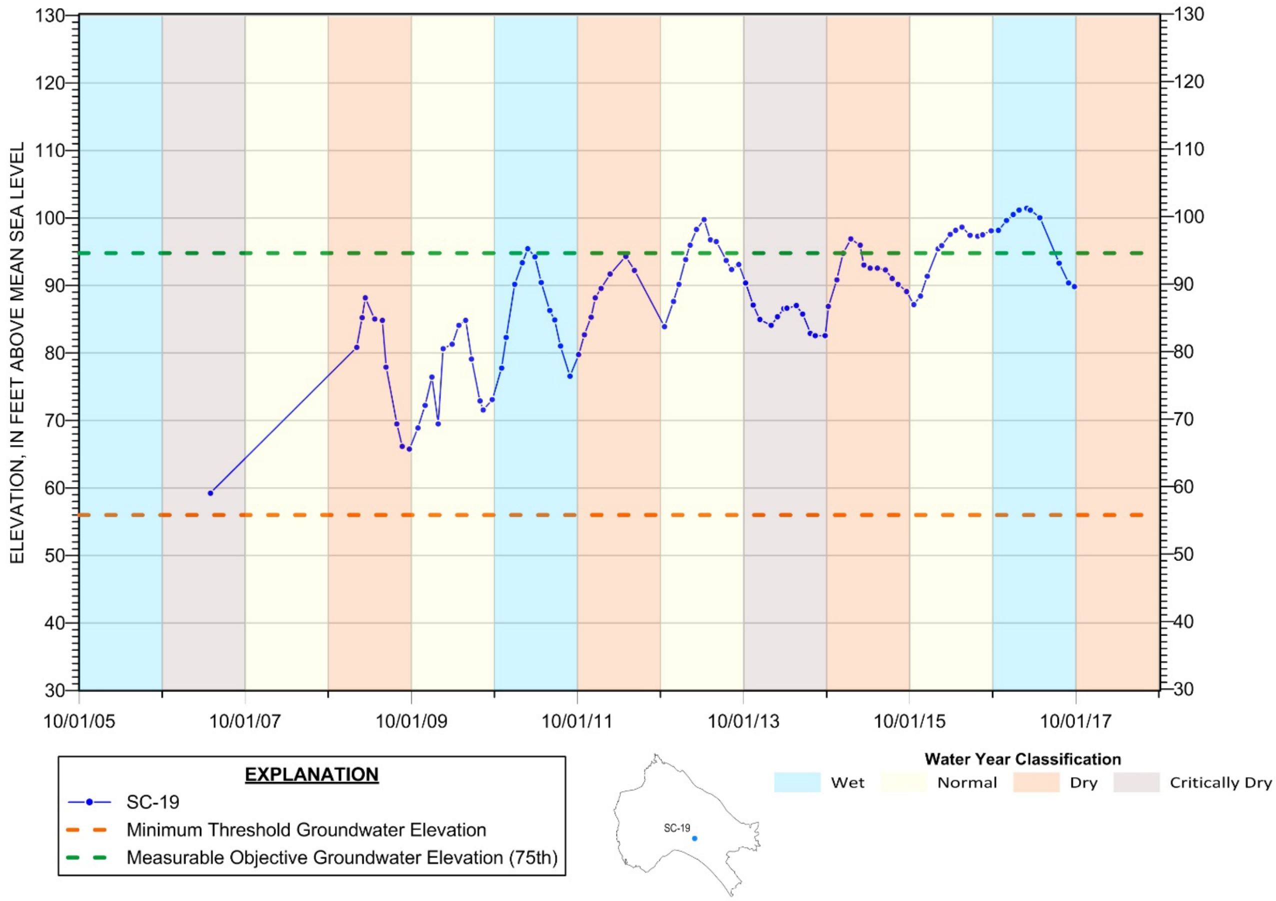

Figure 3-B.9. SC-19 Hydrograph with Minimum Threshold and Measureable Objective

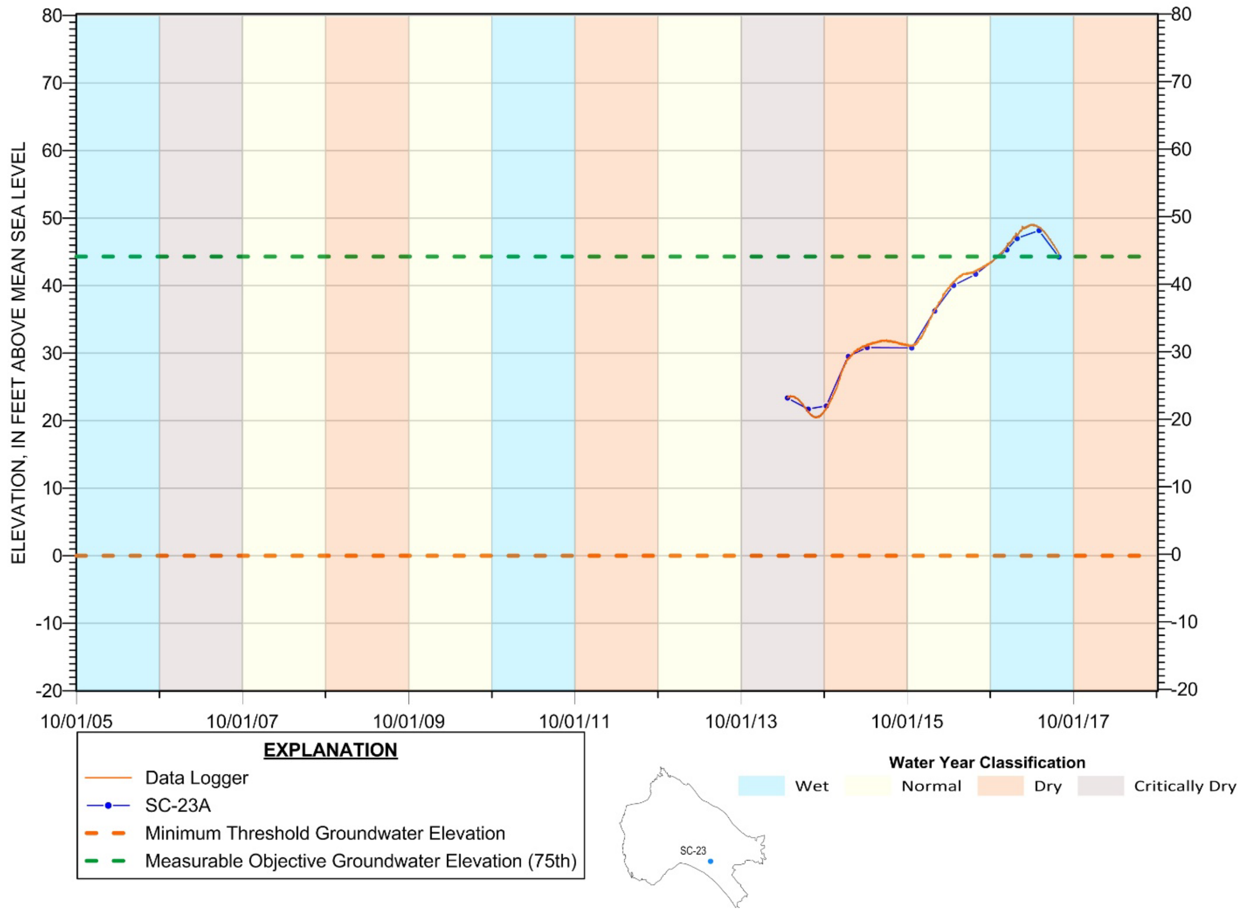

Figure 3-B.10. SC-23A Hydrograph with Minimum Threshold and Measureable Objective

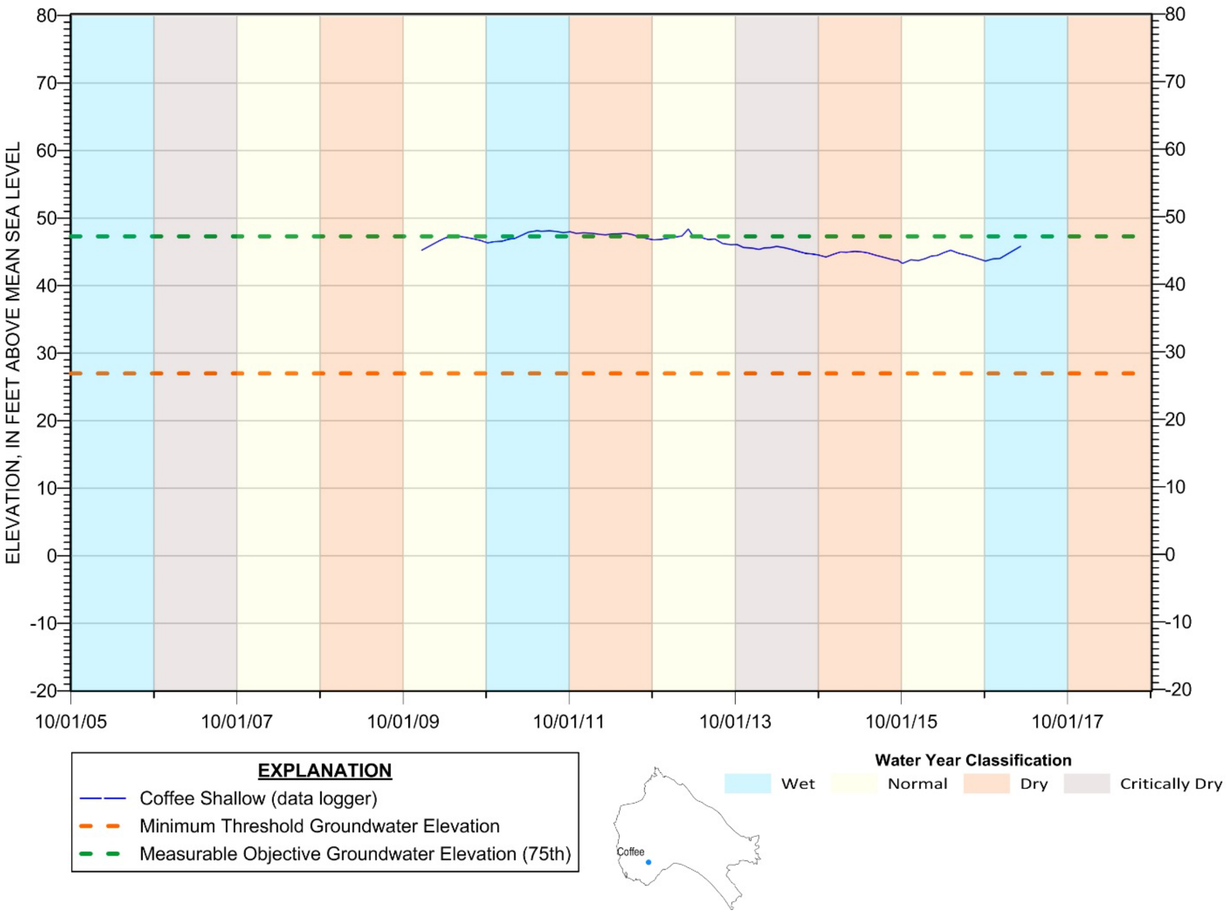

Figure 3-B.11. Coffee Lane Shallow Hydrograph with Minimum Threshold and Measureable Objective

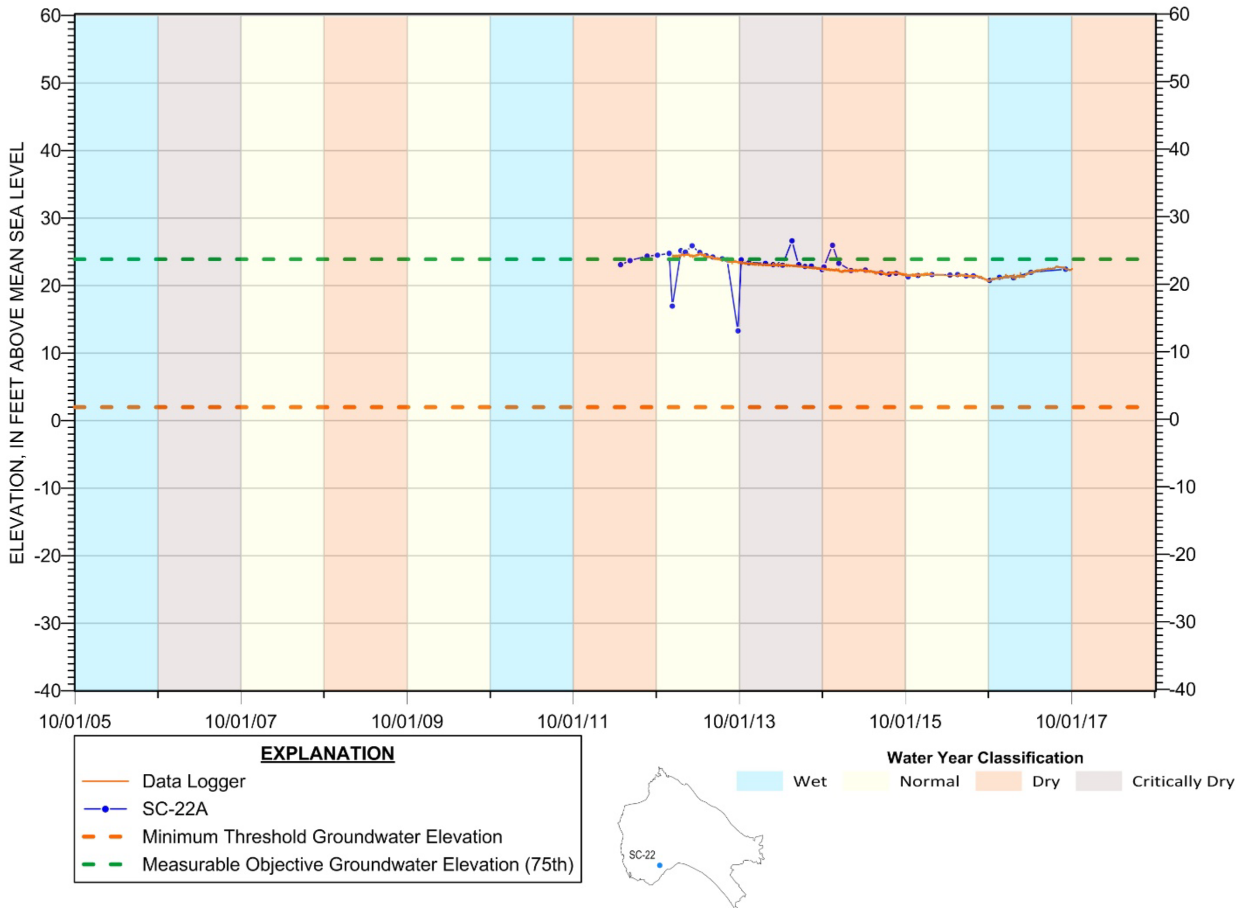

Figure 3-B.12. SC-22A Hydrograph with Minimum Threshold and Measureable Objective

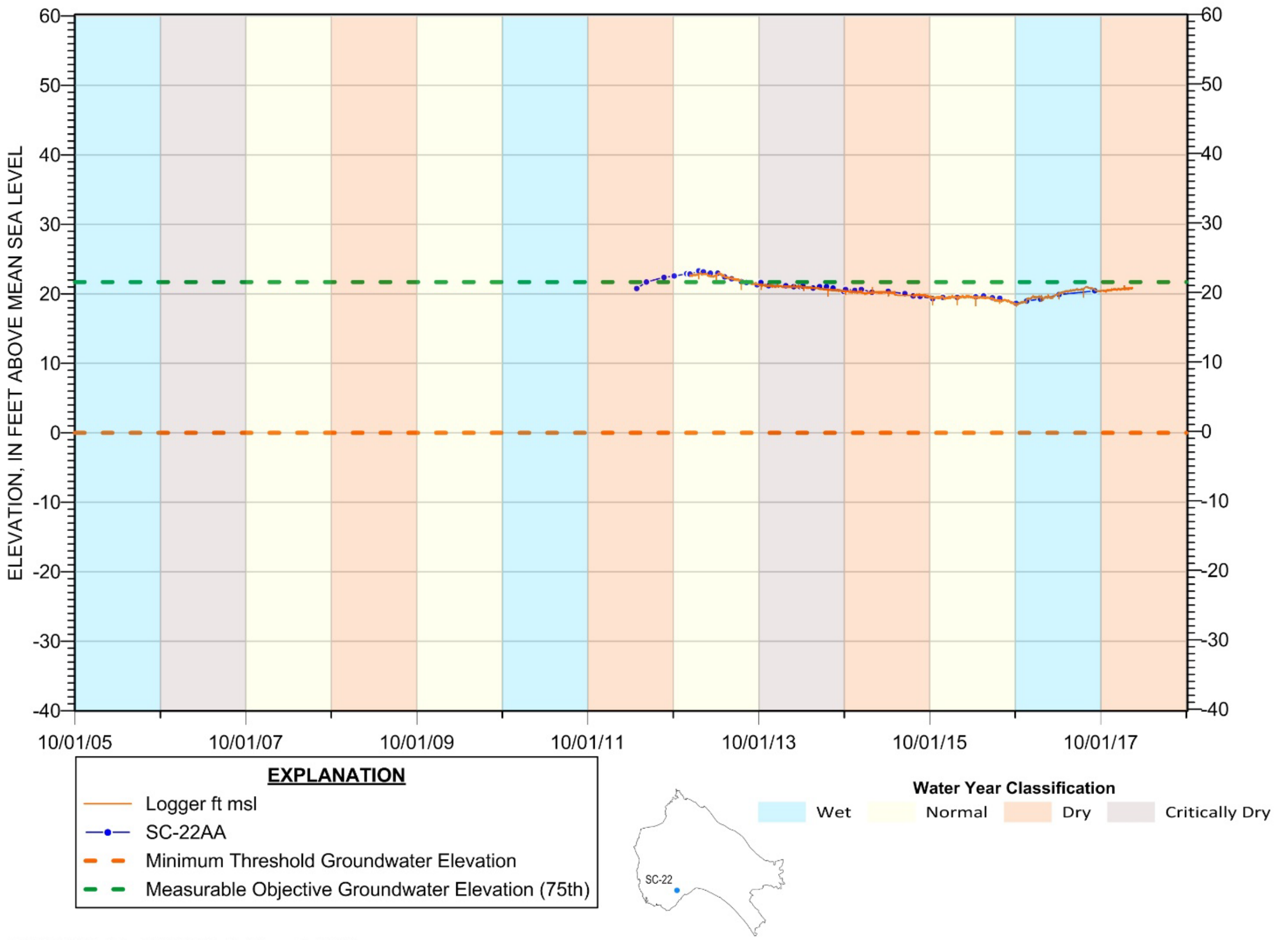

Figure 3-B.13. SC-22AA Hydrograph with Minimum Threshold and Measureable Objective

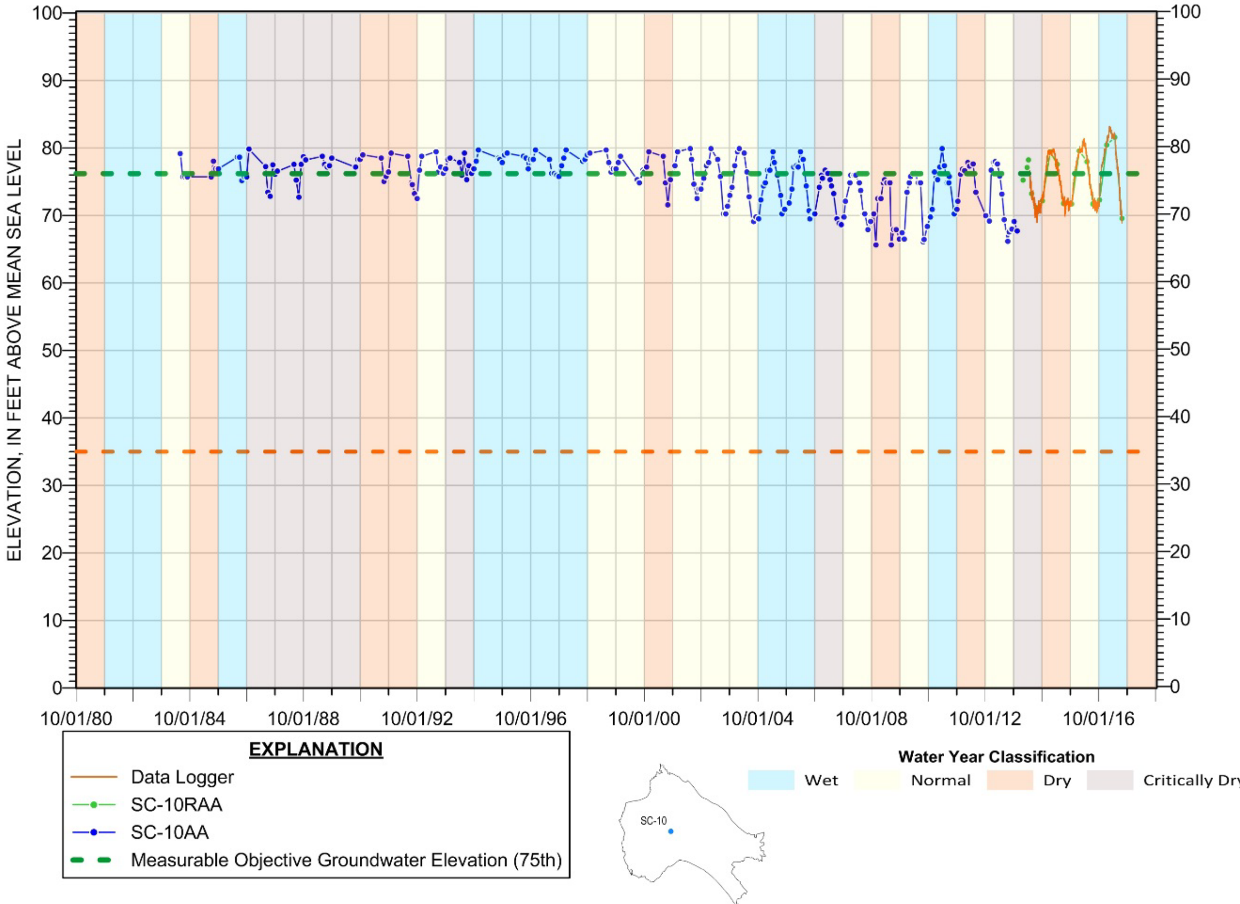

Figure 3-B.14. SC-10RAA Hydrograph with Minimum Threshold and Measureable Objective

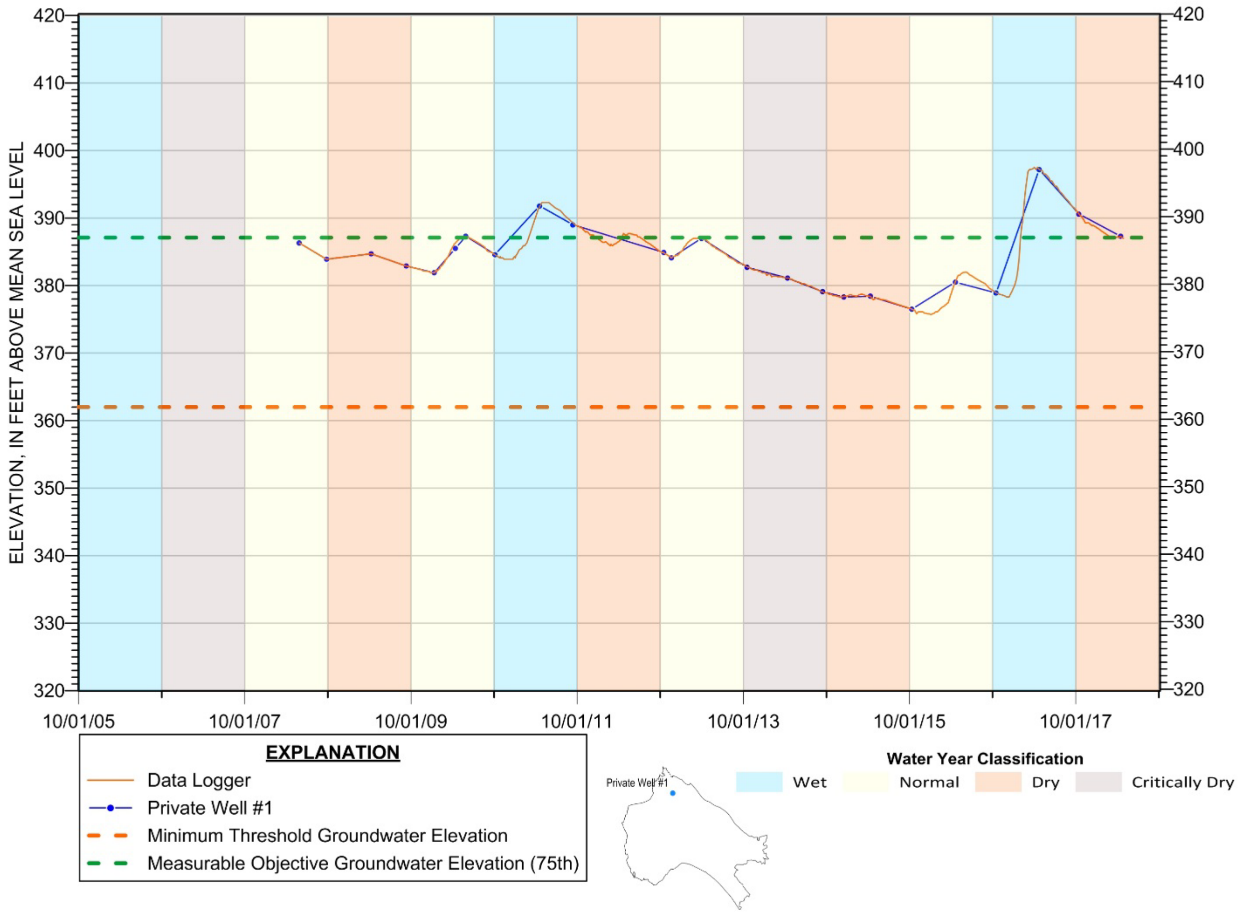

Figure 3-B.15. Private Well #1 Hydrograph with Minimum Threshold and Measureable Objective

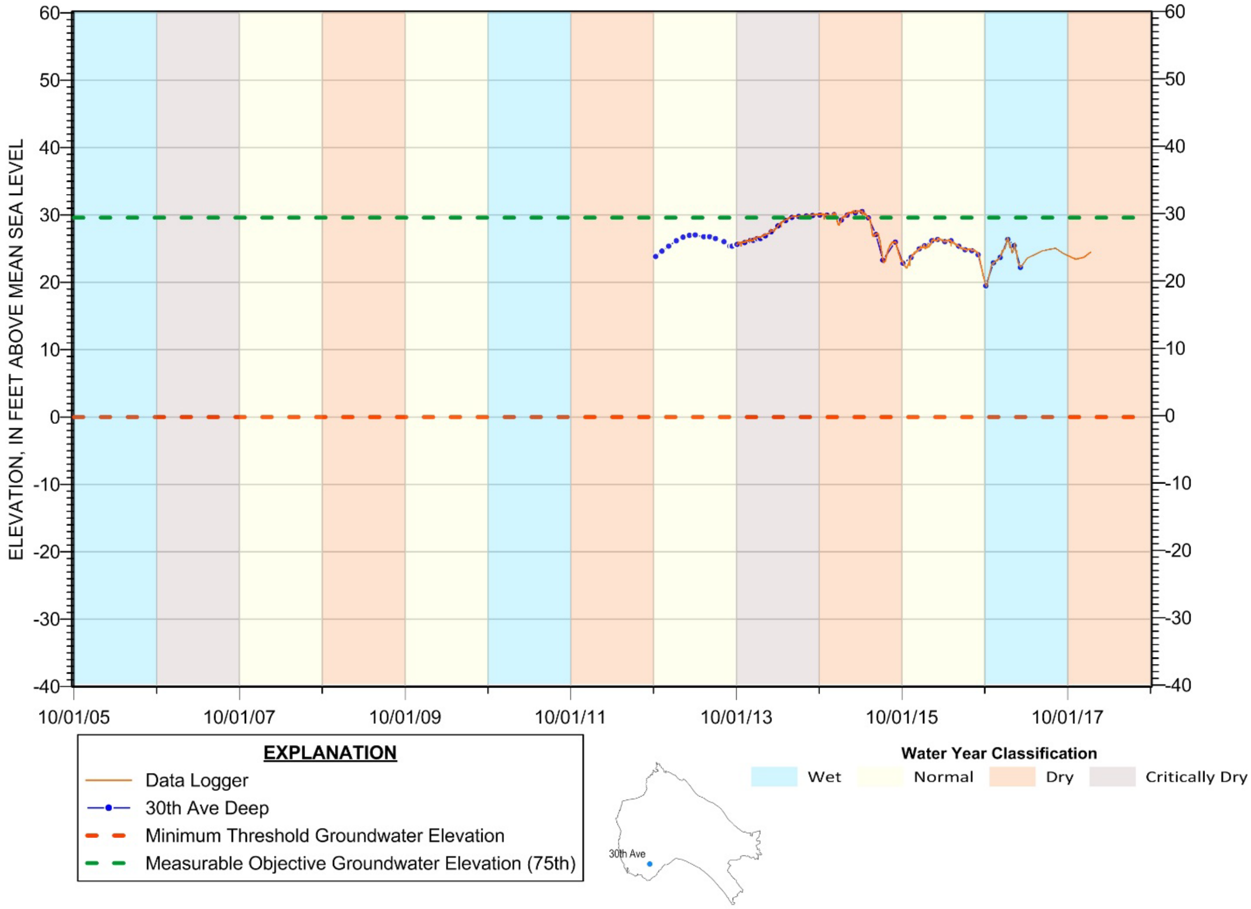

Figure 3-B.16. 30th Ave Deep Hydrograph with Minimum Threshold and Measureable Objective

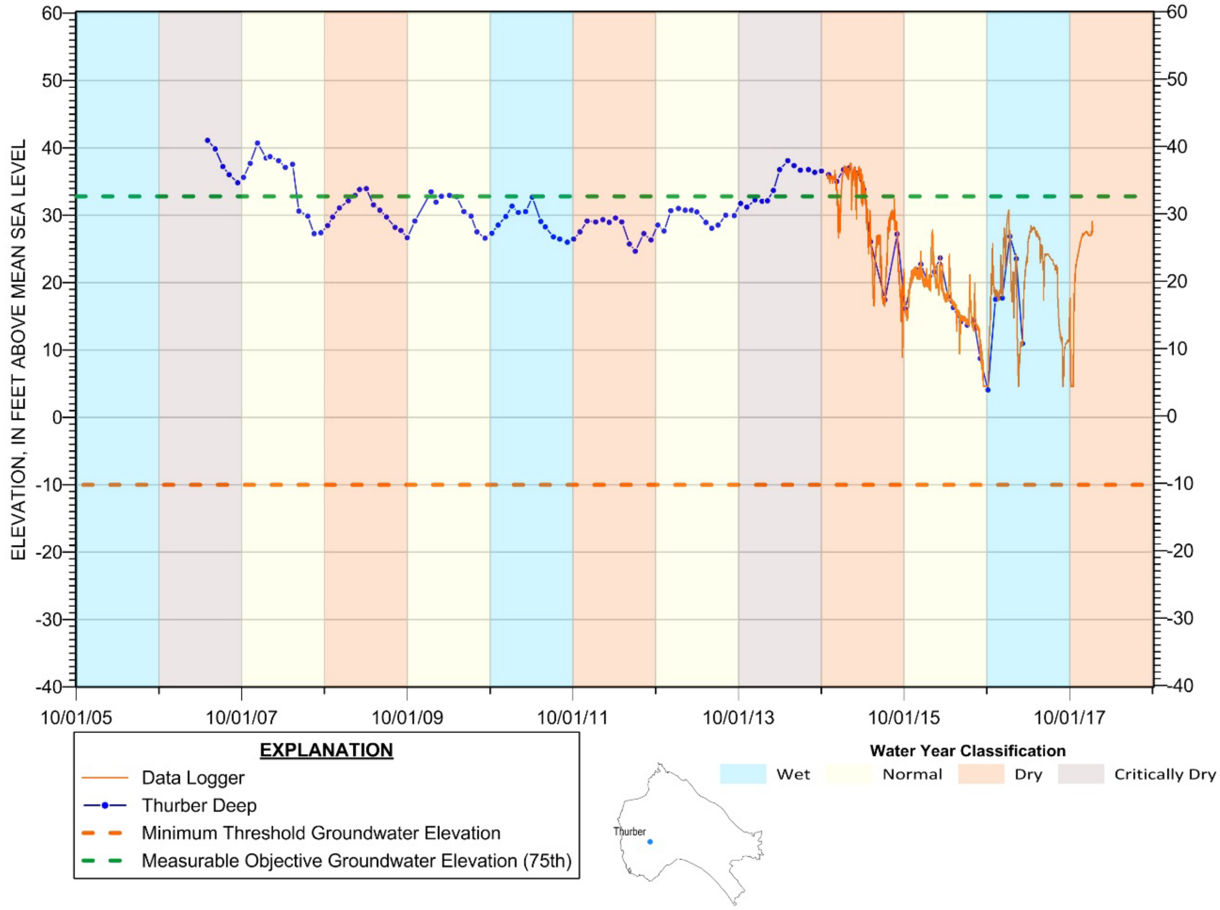

Figure 3-B.17. Thurber Lane Deep Hydrograph with Minimum Threshold and Measureable Objective

APPENDIX 3-C

Summary of Federal, State, and Local Water Quality Regulations

APPENDIX 3-D

Hydrographs of Representative Monitoring Points for Depletion of Interconnected Surface Water

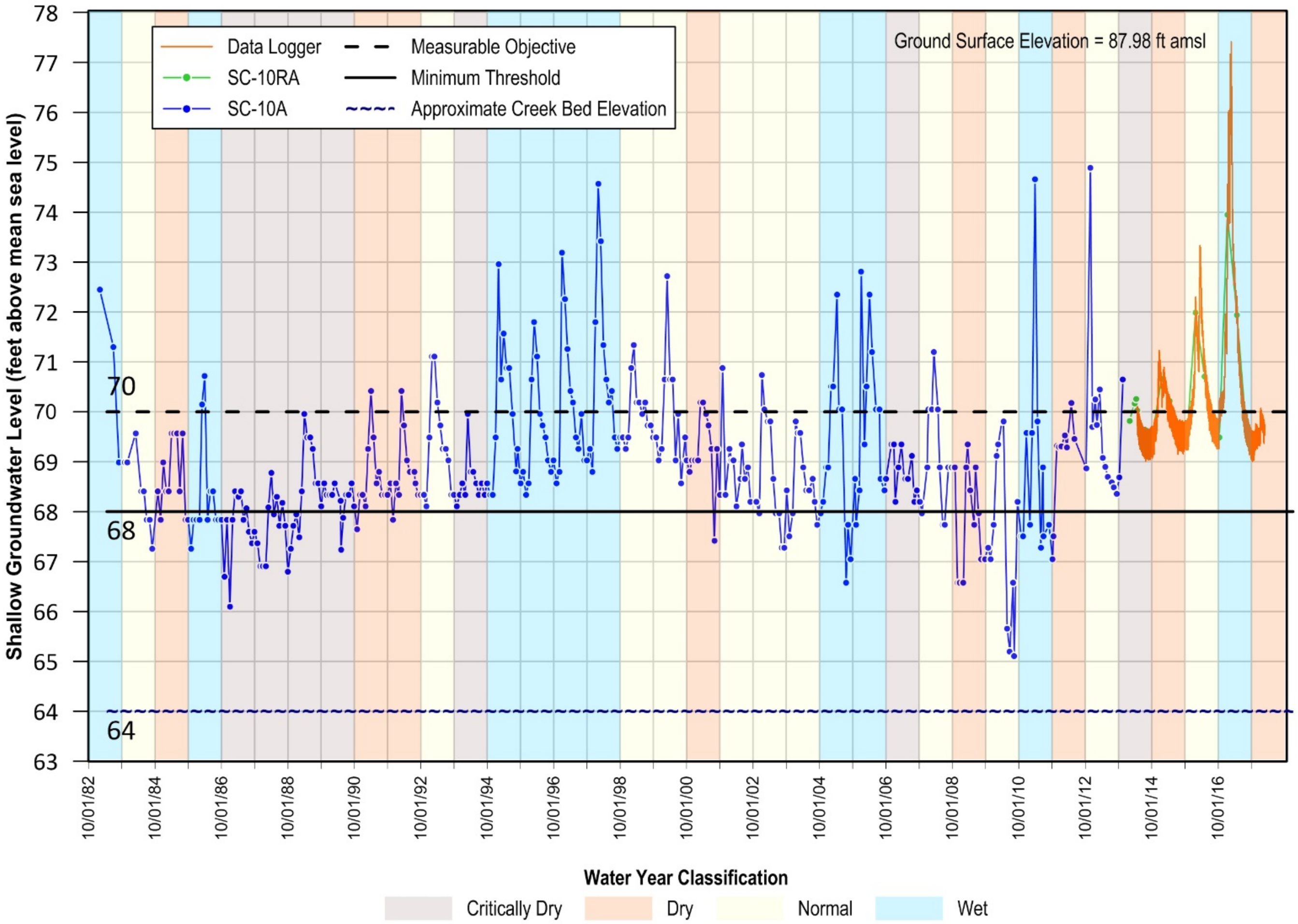

Figure 3-C.1. SC-10RA Hydrograph with Minimum Threshold and Measureable Objective

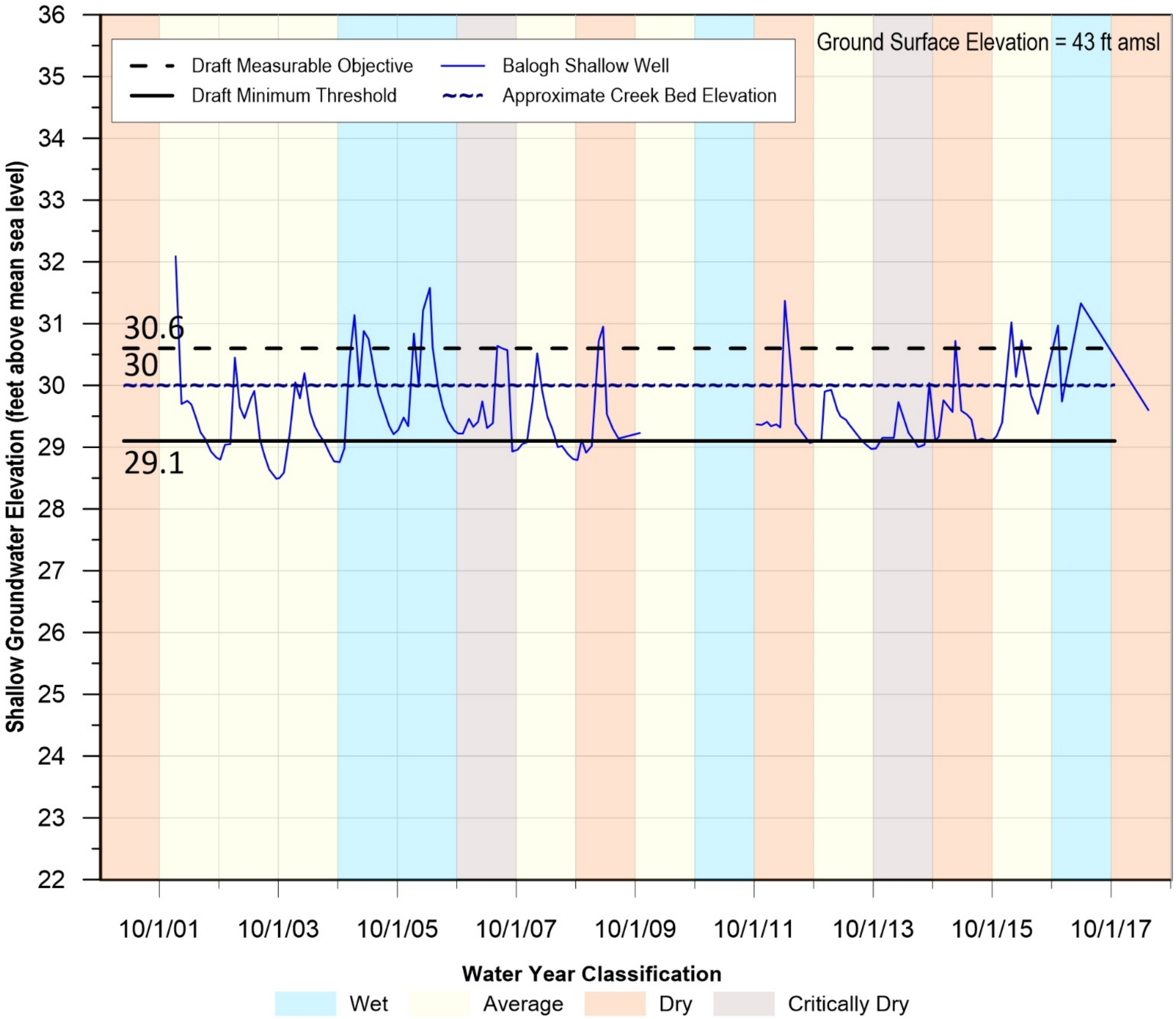

Figure 3-C.2. Balogh Shallow Monitoring Well Hydrograph with Minimum Threshold and Measureable Objective

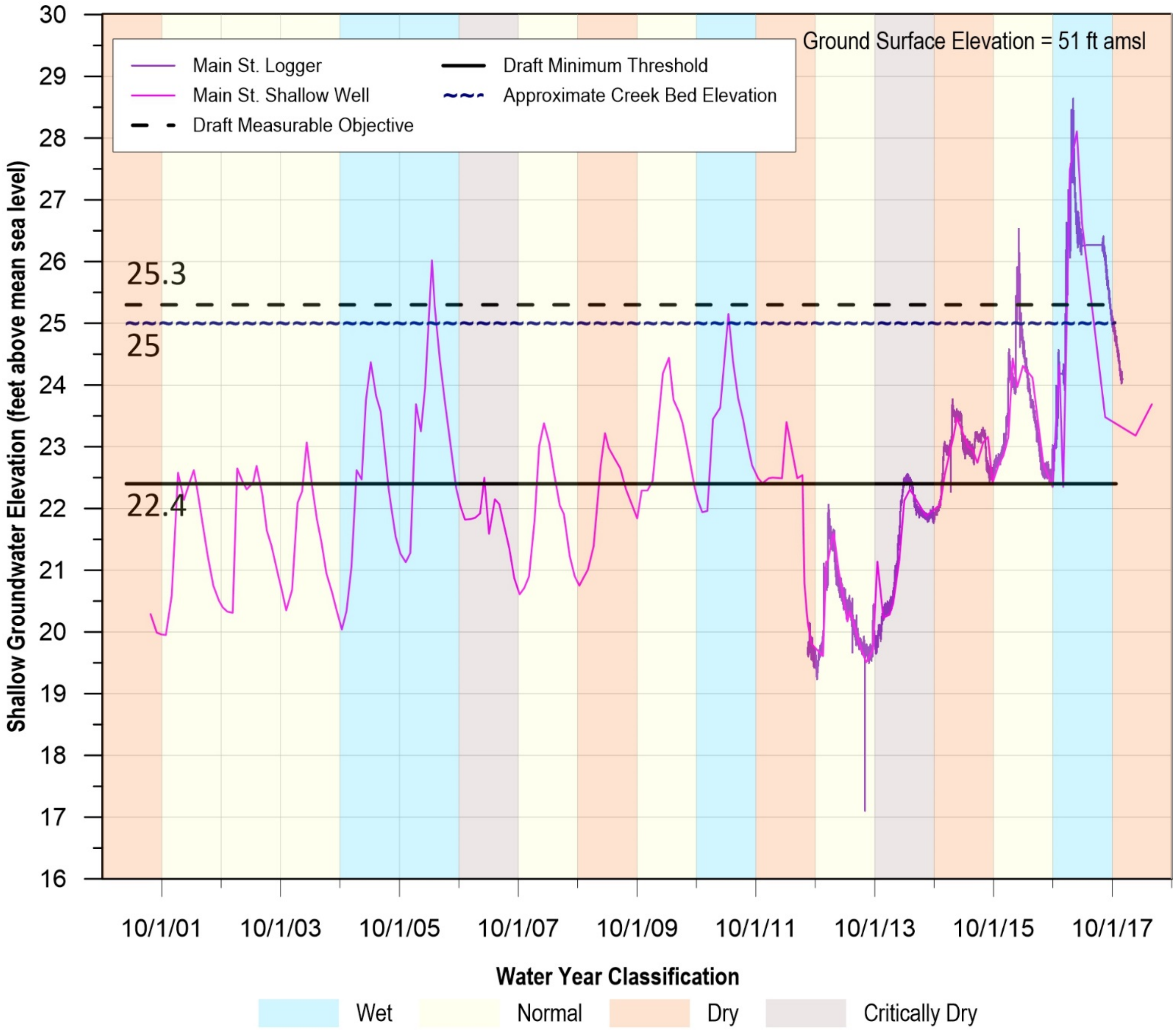

Figure 3-C.3. Main Street Shallow Monitoring Well Hydrograph with Minimum Threshold and Measureable Objective

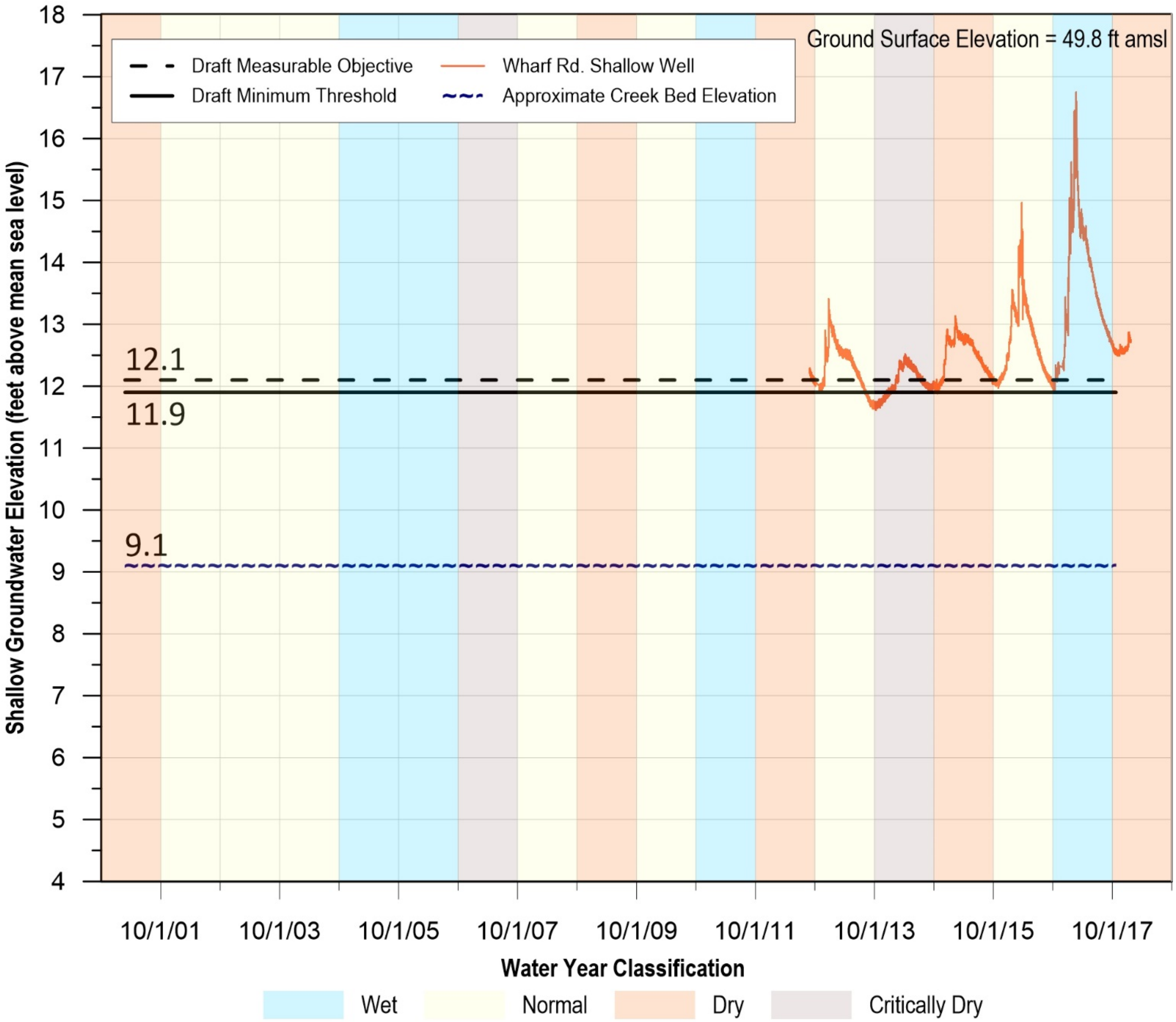

Figure 3-C.4. Wharf Road Shallow Monitoring Well Hydrograph with Minimum Threshold and Measureable Objective

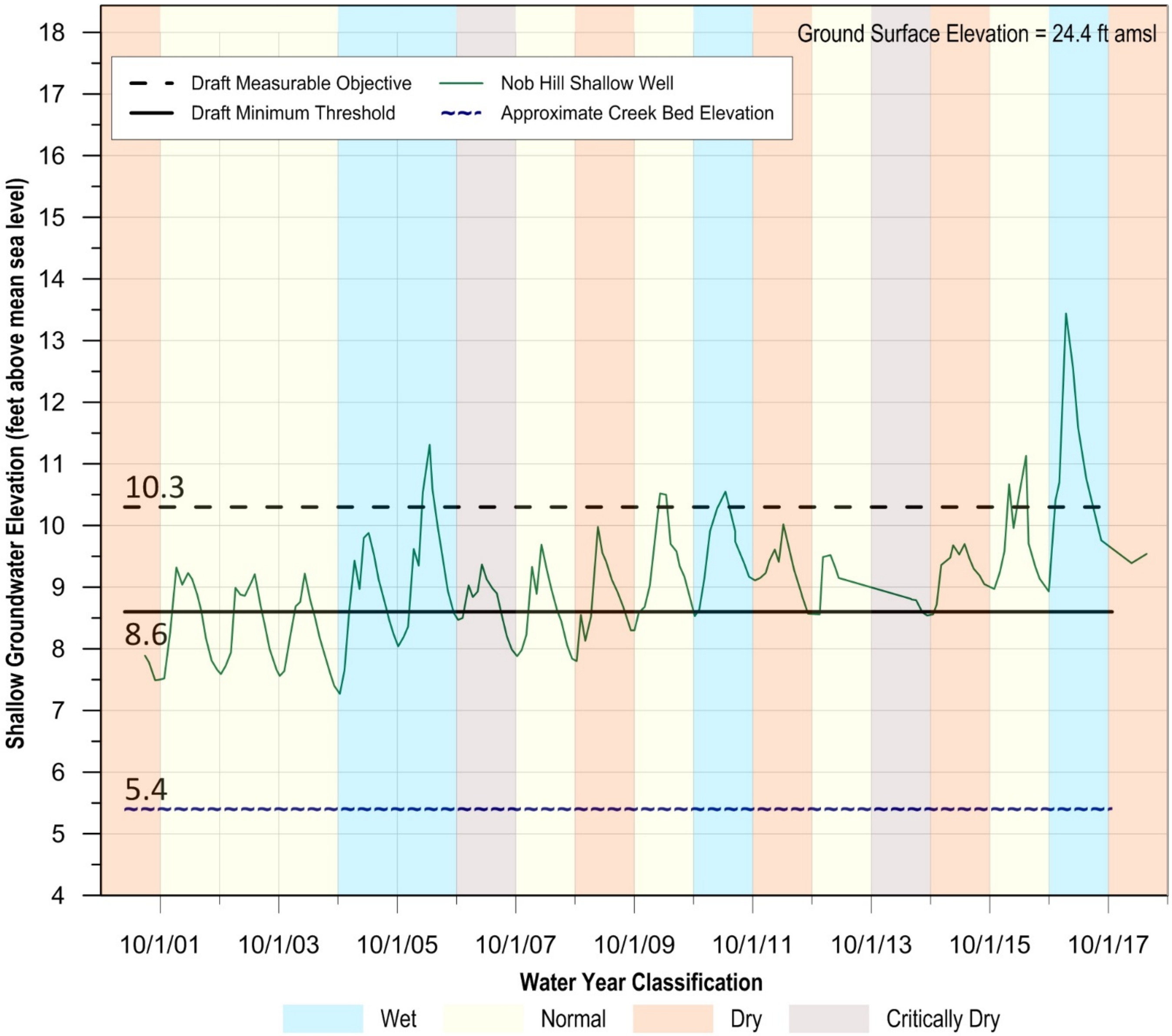

Figure 3-C.5. Nob Hill Shallow Monitoring Well Hydrograph with Minimum Threshold and Measureable Objective