3. SUSTAINABLE MANAGEMENT CRITERIA

Sustainable management criteria (SMC) offer guideposts and guardrails for groundwater managers seeking to achieve sustainable groundwater management. SGMA defines sustainable groundwater management as “the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results,” where the planning and implementation horizon is 50 years with the first 20 years spent working toward achieving sustainable groundwater management and the following 30 years (and beyond) spent maintaining it (California Water Code §10721; Figure 3-1). For the Vina Subbasin, SMC were formulated by working with the Vina GSA and the Rock Creek Reclamation District GSA Boards of Directors, the SHAC, and members of the public. This stakeholder outreach process was facilitated by the Consensus Building Institute (CBI) with sessions documented on the Vina Subbasin GSA website. Outreach included a robust discussion and broad agreement on the Vina Subbasin sustainability goal as well as what constitutes locally defined undesirable results. The sustainability goal is meant to reflect the GSAs desired condition, maintained over time, for the groundwater basin.

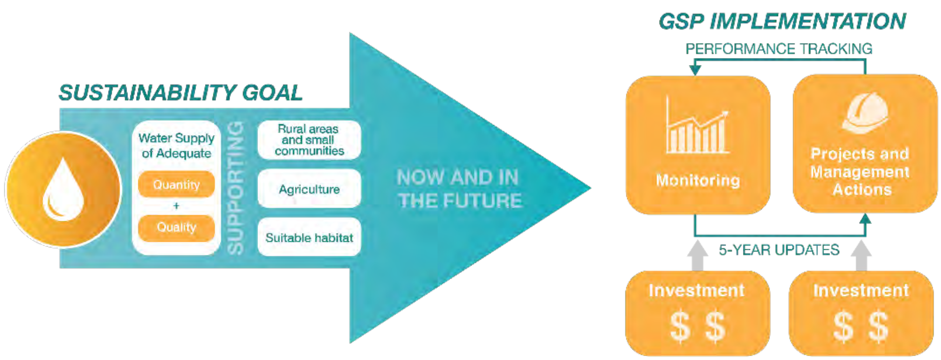


Figure 3-1: Flow Chart for Sustainability

Undesirable results are associated with up to six SIs, including groundwater levels, groundwater storage, water quality, seawater intrusion, land subsidence, and interconnected surface water. SGMA defines undesirable results as those having significant and unreasonable negative impacts. Failure to avoid undesirable results on the part of the GSAs may lead to intervention by the State. Once the sustainability goal and undesirable results have been locally identified, projects and management actions are formulated to achieve the sustainability goal and avoid undesirable results.

The Vina Subbasin is divided into three MAs: North, Chico, and South. The associated undesirable results for each SI have been defined similarly across the three MAs within the Vina Subbasin. In turn, the rationale and approach for determining MT and MO for each SI are the same across all MAs in the Vina Subbasin.

The terminology for describing SMC is defined as follows:

- Undesirable Results – Significant and unreasonable negative impacts associated with each SI.

- MT– Quantitative threshold for each SI used to define the point at which undesirable results may begin to occur.
- MO – Quantitative target that establishes a point above the MT that allows for a range of active management to prevent undesirable results.
- Margin of Operational Flexibility – The range of active management between the MT and the MO.
- Interim Milestones (IMs) – Targets set in increments of five years over the implementation period of the GSP offering a path to sustainability.

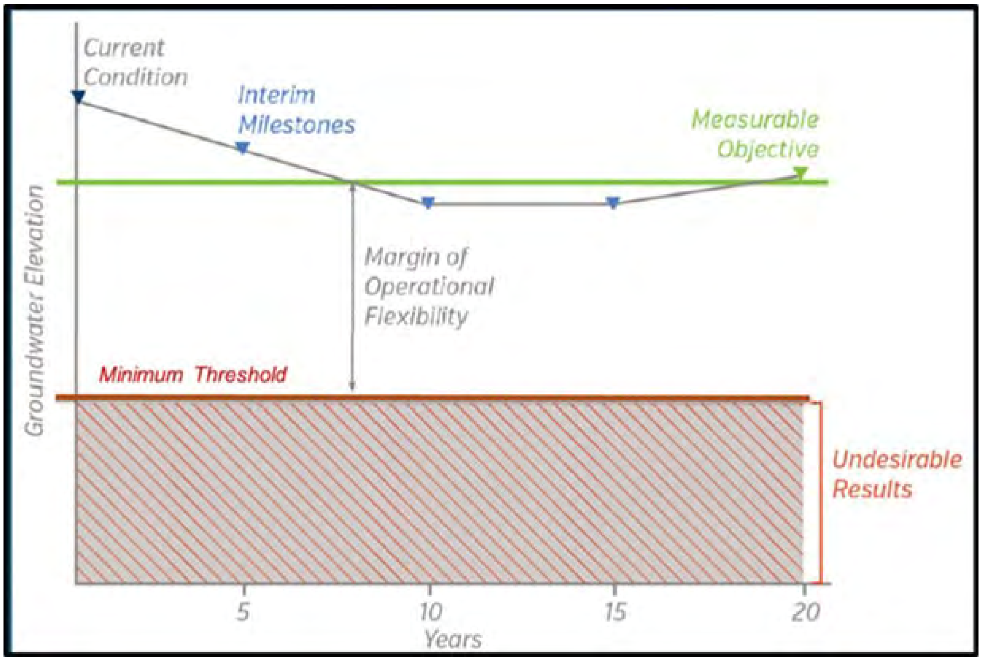


Figure 3-2: Illustration of Terms Used for Describing Sustainable Management Criteria Using the Groundwater Level SI

Figure 3-2 illustrates these terms for the groundwater level SI.

SIs are intended to be measured and compared against quantifiable SMC throughout a monitoring framework of RMS (Section 4.9). Ongoing monitoring of SI can:

- Determine compliance with the adopted GSP
- Offer a means to evaluate the effectiveness of projects and management actions over time
- Allow for course correction and adaptation in five-year updates
- Facilitate understanding among diverse stakeholders
- Support decision-making on the part of the GSAs into the future

To quantify SMC for the Vina Subbasin, information from the HCM (Section 2), descriptions of current and historical groundwater conditions and input from stakeholders have been considered.

3.1 Sustainability Goal

The sustainability goal for the Vina Subbasin is:

> *to ensure that groundwater is managed to provide a water supply of adequate quantity and quality to support rural areas and communities, the agricultural economic base of the region, and environmental uses now and in the future.*

Implementation of the Vina GSP may achieve sustainability before 2042; however, groundwater levels in the Vina Subbasin may continue to decline during the implementation period. As projects and management actions are implemented, sustainable groundwater management will be achieved. The Vina Subbasin will be managed to prevent undesirable results throughout the implementation period, despite the possible decline of groundwater levels. This sustainability goal is supported by locally defined MT that will avoid undesirable results. Demonstration of stable groundwater levels on a long-term average basis combined with the absence of undesirable results will ensure that the Vina Subbasin is operating within its sustainable yield and the sustainability goal will be achieved. SMC within the Vina Subbasin emphasize management objectives related to domestic, municipal, and agricultural wells as well as suitable habitat. Groundwater management has already been occurring throughout Butte County, and the Vina Subbasin will be managed within its sustainable yield by adapting existing management objectives and strategies to address current and future conditions, or by developing new ones. Sustainable yield means the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result. The Vina Subbasin intends to achieve its sustainability goal by implementing GSP projects and management actions that both augment water supply and increase efficiency of water application (see Section 5 for proposed projects and management actions and Section 6 for the implementation plan to achieve sustainability).

The BCDWRC has been participating in groundwater management activities for many years, including within the Vina Subbasin. In the last several years, the BCDWRC has increased groundwater level and water quality monitoring and has worked with other entities to collect and disseminate water data. In addition, the BCDWRC assists with other locally driven groundwater management activities. The Vina Subbasin intends to build on this ongoing county-wide process and broadly shares the objective of long-term maintenance of high-quality groundwater resources within the region for domestic, agricultural, and environmental uses.

3.2 Sustainability Indicators, Minimum Thresholds, and Measurable Objectives

3.2.1 Sustainability Indicators

Six SIs are defined by SGMA and are used to characterize groundwater conditions throughout a basin or subbasin. SGMA requires development of locally defined SMC for each SI and allows for identification of SI that are not applicable. For example, sea water intrusion is not applicable in the Vina Subbasin due to its distance from the Pacific Ocean.

SI and associated undesirable results, if significant and unreasonable

3.2.2 Minimum Thresholds

As noted earlier, MT are those quantitative thresholds for each SI used to define the point at which undesirable results may begin to occur. Undesirable results are those having significant and unreasonable negative impacts, avoidance of which is required by SGMA. Potential impacts and the extent to which they are considered “significant and unreasonable” were determined by the GSAs Boards of Directors with input from the SHAC and members of the public. The GSAs established MT intended to prevent such significant and unreasonable negative impacts from occurring. If observed data trend toward the locally defined MT, this will trigger action on part of the GSAs to reverse this trend before reaching the MT. For this reason, MT are like guardrails. Actions to reverse a trend toward a MT could be taken at any time during GSP implementation that will follow an adaptive management process working with stakeholders to ensure actions are implemented at appropriate times.

3.2.3 Measurable Objectives

MO are those quantitative targets that establish a point above the MT that allows for a range of active management to achieve the sustainability goal and prevent undesirable results. This range of active management between the MT and the MO is referred to as the margin of operational flexibility.

MO were determined by the GSAs Boards of Directors with input from the SHAC and members of the public. The GSAs established MO intended to preserve the desired condition throughout the Vina Subbasin while offering flexibility in GSP implementation. IM are targets set in increments of 5 years over the implementation period of the GSP offering a path to sustainability. For this reason, the MO and IM are like guideposts.

3.3 Groundwater Levels Sustainable Management Criteria

Groundwater Levels SMC are those meant to address the chronic lowering of groundwater levels and avoid the depletion of supply at a given location that may lead to undesirable results caused by groundwater pumping. The locally defined undesirable result, MT, and MO are discussed in the next sections.

3.3.1 Undesirable Result

An undesirable result caused by the chronic lowering of groundwater levels is experienced if:

> *sustained groundwater levels are too low to provide a water supply of adequate quantity and quality to support rural areas and communities, and the agricultural economic base of the region, or if significant and unreasonable impacts to environmental uses of groundwater occur.*

3.3.2 Minimum Thresholds

The Groundwater Levels MT represent quantitative thresholds used to define the point at which undesirable results may begin to occur, avoidance of which is required under SGMA. To establish locally defined MT, the GSAs Boards of Directors, SHAC, and members of the public explored potential impacts of declining groundwater levels.

Potential impacts identified by stakeholders from declining groundwater levels included:

- Wells going dry
- Reduced pumping capacity of existing wells
- Need for deeper well installations and/or lowering of pumps
- Increased pumping costs due to greater lift
- Reduced flows in rivers and streams supporting aquatic ecosystems
- Water table depth dropping below the maximum rooting depth of Valley Oak or other deep-rooted tree species

Issues related to reduced flows in rivers and streams and/or water tables that support deep-rooted tree species are addressed in the Interconnected Surface Water SMC (Section 3.8).

In recent years, Butte County has documented a number of domestic wells that have "gone dry," meaning groundwater levels have fallen below the depth of the well installation and/or pump. This occurred during summer months of recent drought years and heightened concern among some stakeholders. For example, in the critically dry year of 2021, 44 wells were reported dry county-wide through the State's online reporting system. As a result, domestic well reliability and protection are the focus of the Groundwater Levels MT. From a policy perspective, sustainably constructed domestic wells going dry during non-dry year conditions would be a "significant and unreasonable" undesirable result of groundwater management. The quantitative Vina Subbasin Undesirable Result for the Chronic Lowering of Groundwater Levels occurs when:

> *Two RMS wells within a management area reach their MT for two consecutive years of non-dry year-types.*

Non-dry year types include wet, above normal, and below normal as defined by the Sacramento Valley Water Year Index. Dry year types include dry and critical water year types. See Section 2.3.1 for more information on the Sacramento Water Year Index.

As shown in the figures presented in Appendix 3-A showing the average depth of domestic, irrigation, and public supply wells, domestic wells are generally shallower than other wells throughout the Vina Subbasin. These figures were constructed using data from DWR OSWRC. Protection of domestic wells was therefore deemed to be additionally protective of other well types, such as agricultural wells. In addition, the lowering of groundwater levels during two or more consecutive dry and/or critically dry year types is not considered significant and unreasonable and therefore not considered an undesirable result, as long as the groundwater levels rebound to levels greater than the MT following those consecutive dry and/or critically dry years.

The Vina Subbasin SMC for Chronic Lowering of Groundwater Levels is based on groundwater levels throughout the Vina Subbasin that would support sustainably constructed domestic wells. Sustainably constructed implies wells that have been installed following the relevant County Well standards within permeable aquifer material and the wells have been appropriately maintained (e.g., well problems are not due to clogging of well screens or silting of well). Exceeding the MT may lead to significant and unreasonable effects during drought years and impacts to domestic wells and other groundwater uses may occur and would not constitute an Undesirable Result. Local and state drought response play a role in addressing dry year impacts. However, once a drought period ends, it is anticipated that groundwater conditions should return to the MO levels. Year-type is defined according to the Sacramento Valley Water Year Hydrologic Classification and groundwater level is defined based on groundwater elevation above msl.

To establish appropriate MT levels protective of sustainably constructed domestic wells, a representative zone is established for each RMS well. The DWR domestic well database provides information on all submitted WCRs when a well is drilled. This database contains information on characteristics of the wells, including well location, groundwater surface elevation of the well, and total well depth. These well characteristics, however, are not always accurate or precise, and, unfortunately, it is not known which of the wells in the database are in use or have been abandoned or replaced.

To refine the dataset, wells installed before 1980 were removed. This removes the oldest wells and wells likely to have been replaced as a result of historically low groundwater conditions that occurred during the 1976-1977 drought. Wells that remain are more likely to be consistent with current well standards and currently serving domestic water needs. Still, there is much information that remains to be gathered to further refine the dataset given the unknowns previously identified, as well as relationships to changes in surface elevation. Therefore, additional characterization of active domestic wells within the subbasin may be considered during GSP implementation (see Section 5.4.3).

Using the refined data set, each MA was divided into polygons that represent proximate areas to each RMS well (see figures in Appendix 3-B). Due to the size, the Chico MA was not separated into polygons and the MT was calculated using the entire domestic well data for each RMS well (i.e. the same MT is applied to all RMS wells within the Chico MA). Each point (or represented well) within each area is closer to its respective RMS well than any other RMS well. The size of each polygon depends on the density of the RMS network. For example, the higher the density of RMS wells in a MA, the smaller the polygons. Each polygon is a different shape and size, determined by the distribution of the RMS wells in the MA. Ground surface elevation change across the RMS polygon was also considered when establishing the MT. The result is a more refined dataset that more proximately reflects the relationship of domestic wells with each RMS well. In addition, rather than just looking at a percentage of domestic wells to protect, the elevation levels were examined in comparison to what would be considered sustainable domestic wells as defined above for the area (see individual graphs for each RMS well in Appendix 3-B). The result is setting an MT for each RMS well that corresponds with elevation changes and provides operational flexibility between the MO and the MT.

Figure 3-3 illustrates the graphing method for RMS well 25C001M within the Vina North MA. Each red point on the graph represents a domestic well and shows the elevation of the bottom of the well. All of the individual domestic wells are shown relative to the RMS well's ground surface elevation. The graphs were used to identify the MT that would be protective of the majority of the domestic wells in the RMS zone while recognizing the RMS well is not fully representative of wells within the zone due to changes in ground surface and water surface elevation throughout the area. Wells that plot above the MT elevation tend to be especially shallow (less than 100 feet deep) or have a significantly different (higher) ground surface elevation than the RMS well.

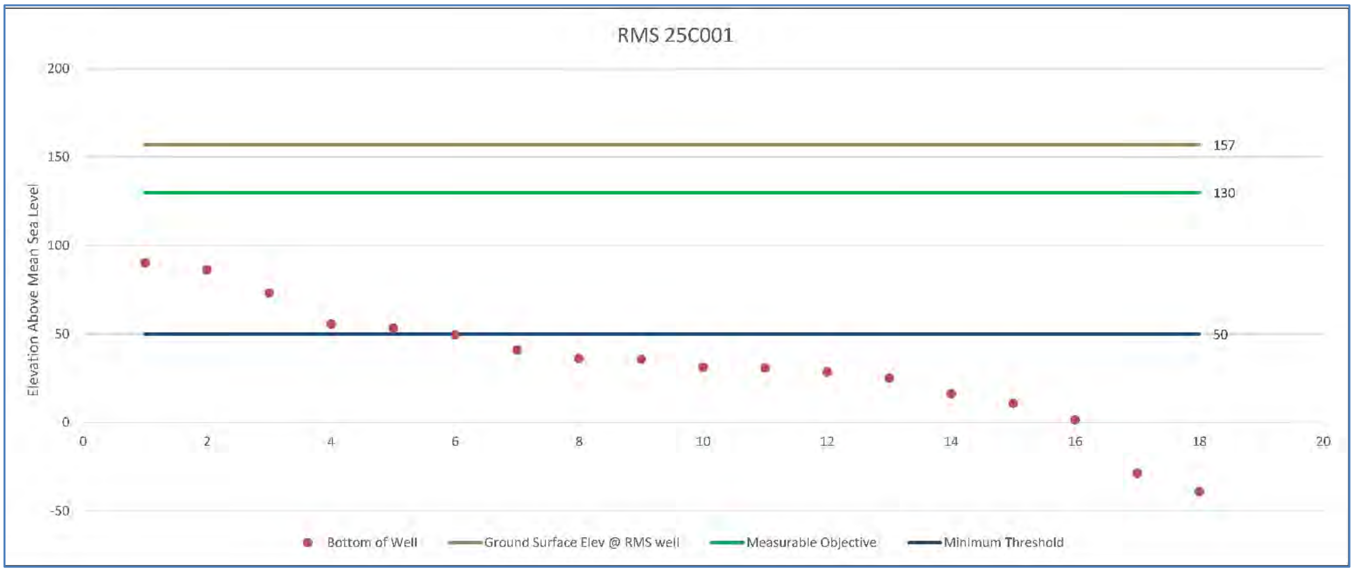


Figure 3-3: Graph Showing Graphing Method Used to Establish MTs for Each RMS Well. Red dots represent bottom elevation of each domestic well within the polygon associated with the RMS well (example is for well 25C001M in Vina North) relative to ground surface elevation at the RMS well

3.3.3 Measurable Objectives

The Groundwater Levels MO represent quantitative targets that establish a point above the MT allowing for a range of active management to prevent undesirable results and reflect the desired state for groundwater levels at the year 2042. To establish the MO, the water-level hydrograph of observed groundwater levels at each RMS was evaluated. The historical record at these locations shows cyclical fluctuations of groundwater levels over a four- to seven-year cycle consistent with variations in water year type according to the Sacramento Valley Water Year Hydrologic Classification. Groundwater levels are typically lower during dry years and higher during wet years. Superimposed on this four- to seven-year short-term cycle is a long-term decline in groundwater levels. In other words, groundwater levels during more recent dry-year cycles are lower than groundwater levels in earlier dry-year cycles.

The wet-dry cycles are climatically induced, and the GSAs have no ability to change this cyclical behavior; there will always be short-term cyclical fluctuations in groundwater levels. The MO are therefore intended to address the long-term trend of the "peaks and valleys" of the short-term cycles and stop the long-term decline in groundwater levels during dry years. Because the GSAs cannot immediately augment water supply and/or increase efficiency of water application, some continuation of the long-term decline in groundwater levels is possible in the near future. Currently (in 2021), the Vina Subbasin appears to be coming out of a wet period of a short-term cycle (2017 and 2019 being wet years) and beginning the next dry period of a short-term cycle starting in 2020. The MO was therefore based on the trend line of observed historical data extended to the year 2030. The year 2030 was chosen as a reasonable time frame in which the GSAs could implement projects and management actions to address long-term groundwater level decline while recognizing that groundwater levels may experience another dry period of the short-term cycle in the intervening years. The MO for the Groundwater Levels SMC is:

> *the groundwater level based on the groundwater trend line of the RMS well for the dry periods (since 2000) of observed short-term climatic cycles extended to 2030.*

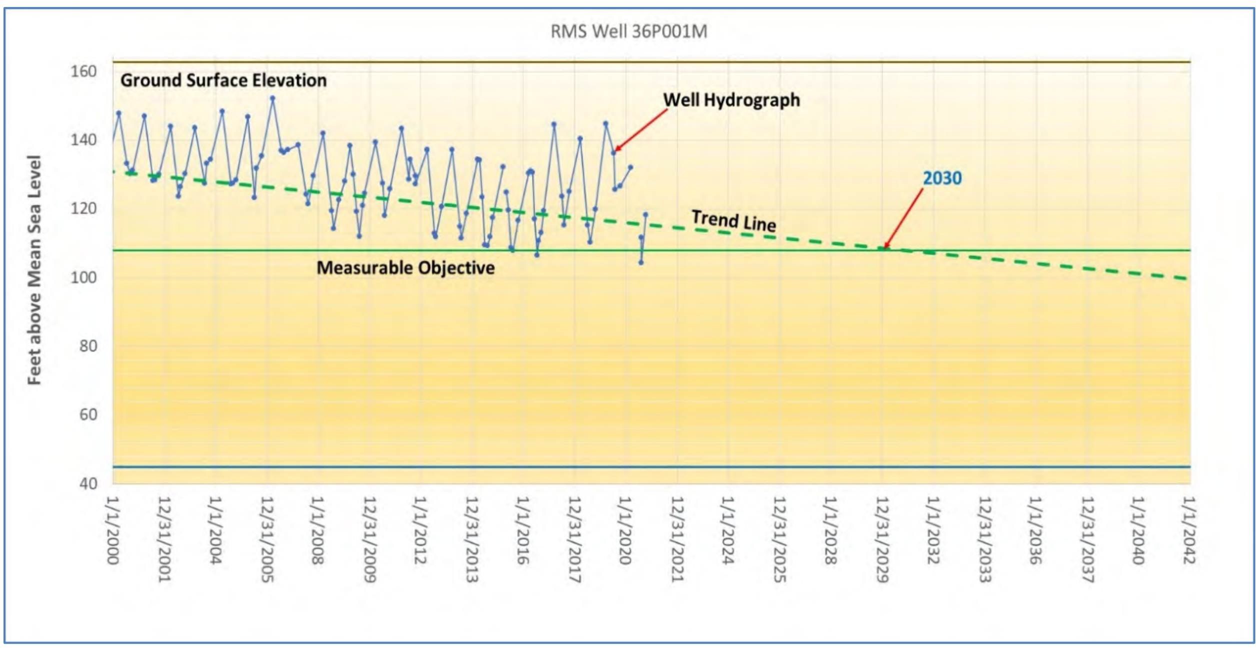


Figure 3-4: Illustration of Long-term Trend Using Historical Water Levels Extended to 2030 for Development of Measurable Objectives

The projection of groundwater levels for each RMS was based on a simple non-statistical linear projection of the observed data (Figure 3-3). Generally, the lowest groundwater levels of a given cycle were used for the projection, unless they appeared to be outliers relative to the general long-term trend of the non-dry years in the cycle.

IMs for groundwater levels between 2022 and 2042 were interpolated based on the linear projection of groundwater level at each RMS. By projecting based on the dry years in the cycle, the observed groundwater levels may be higher than the IM. This will be addressed in the annual reports and interim GSP updates based on what occurs with respect to the short-term cycles in the future. Appendix 3-C contains the hydrographs for each RMS.

3.3.4 Summary

To achieve the sustainability goal and therefore preserve the desired condition for the groundwater basin over time, the GSAs, in setting Groundwater Levels SMC, will implement appropriate projects and/or management actions as necessary to maintain groundwater levels within operational flexibility to limit the decline in groundwater levels to certain values and manage groundwater levels within certain ranges at each RMS shown in Table 3-1. (See Section 4, Figure 4-5, and Table 4-6 for relevant information on the RMS for groundwater levels.)

Table 3-1: Groundwater Levels SMC by RMS in Feet Above Mean Sea Level

RMS Well ID	MT	MO	IM		
			2027	2032	2037
Vina Subbasin – North Management Area					
25C001M	50	130	130	130	130
10E001M	80	136	137	136	136
07H001M[a]	72	136	140	136	136
05M001M	31	115	116	115	115
36P001M	45	108	110	108	108
33A001M	72	125	128	125	125
Vina Subbasin – Chico Management Area					
CWSCH01b	85	106	107	106	106
CWSCH02		105	108	105	105
CWSCH03		108	109	108	108
CWSCH07		95	97	95	95
28J003M		111	113	111	111
Vina Subbasin – South Management Area					
21C001M	10	64	67	64	64
18C003M	65	130	132	130	130
10C002M	20	92	93	92	92
24C001M	18	77	81	77	77
09L001M	30	91	93	91	91
26E005M	36	95	97	95	95

Note:

[a] MO is associated with GSP Well ID 18A001M.

3.4 Groundwater Storage Sustainable Management Criteria

Groundwater Storage SMC are those meant to address the reduction of groundwater storage caused by groundwater pumping. The locally defined undesirable result, MT, and MO are discussed in the next sections.

3.4.1 Undesirable Result

An undesirable result coming from the reduction of groundwater storage is experienced if:

> *sustained groundwater storage volumes are insufficient to support rural areas and communities, the agricultural economic base of the region, and environmental uses.*

This undesirable result is closely related to that associated with groundwater levels. Because groundwater levels and groundwater storage are closely related, measured changes in groundwater levels can serve as a proxy for changes in groundwater storage. For this reason, the SMC developed for groundwater levels are used for groundwater storage to ensure avoidance of the undesirable result.

3.4.2 Minimum Thresholds

As Groundwater Levels SMC are used by proxy, the MT for groundwater storage is the same as for groundwater levels:

> *Two RMS wells within a management area reach their MT for two consecutive years of non-dry year-types.*

In the historical record, there are isolated incidences of shallow wells going dry during summer months of recent critically dry years. This was noted in the earlier section addressing the development of Groundwater Levels SMC. MT intended to prevent significant and unreasonable negative impacts related to the chronic lowering of groundwater levels are assumed adequate to protect against significant and unreasonable reductions of groundwater storage.

3.4.3 Measurable Objectives

As Groundwater Levels SMC are used by proxy, the MO for groundwater storage is the same as for groundwater levels:

> *the groundwater level based on the groundwater trend line of the RMS well for the dry periods (since 2000) of observed short-term climatic cycles extended to 2030.*

The aquifer system in the Vina Subbasin generally has sufficient groundwater storage capacity to take additional groundwater recharge during wet periods and remain saturated during dry periods, allowing for a range of active management reflecting the desired state for groundwater storage at the year 2042.

3.5 Water Quality Sustainable Management Criteria

Water Quality SMC are those meant to address degraded water quality caused by groundwater pumping. The locally defined undesirable result, MT, and MO are discussed in the next sections.

3.5.1 Undesirable Result

An undesirable result coming from degraded water quality is experienced if:

> *groundwater pumping that degrades water quality and compromises the long-term viability of rural areas and communities, the agricultural economic base of the region, and environmental uses for suitable habitat.*
>
> *This occurs in the Vina subbasin when two RMS wells exceed their MT for two consecutive non-dry years.*

Salinity is the only water quality constituent for which MT are established in the Vina Subbasin. Although no areas with naturally occurring high salinity have been identified in the Vina

Subbasin, the potential exists for movement of underlying brackish water from greater depths into the freshwater pool where groundwater pumping for beneficial uses occurs. Other constituents, as discussed in Section 2.2.4, are managed through existing management and regulatory programs within the Vina Subbasin, such as the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) and the ILRP, which focus on improving water quality by managing septic and agricultural sources of salinity and nutrients. Additionally, point-source contaminants are managed and regulated through a variety of programs by the Regional Water Quality Control Board (RWQCB, DTSC, and the USEPA. Through coordination with existing agencies, the Vina Subbasin GSAs will know if existing regulations are being met or groundwater pumping activities in the Vina Subbasin are contributing to significant and unreasonable undesirable effects related to degraded water quality from these constituents.

3.5.2 Minimum Threshold

The Water Quality MT represents a quantitative threshold used to define the point at which undesirable results may begin to occur, avoidance of which is required under SGMA. To establish a locally defined MT, the GSAs Boards of Directors, SHAC, and members of the public explored potential impacts of degraded water quality.

Potential impacts identified by stakeholders were:

- Aesthetic concerns for drinking water
- Reduced crop yield and quality
- Increased reliance on surface water for “blending”

To address the potential impacts of concern related to degraded water quality, the GSAs, in setting an MT, commits to avoiding a decline in water quality as it relates to specific conductance, a measure of the water’s saltiness, which can impact the suitability of the water as a source for drinking water, agricultural irrigation, and other uses. An undesirable result is considered “significant and unreasonable” if groundwater quality degrades such that the specific conductance exceeds the upper limit of the Secondary Maximum Contaminant Level (SMCL) of 1,600 microsiemens per centimeter (µS/cm) based on State Secondary Drinking Water Standards. Values of specific conductance exceeding this number are typically unacceptable for drinking water. Secondary Drinking Water Standards are set on the basis of aesthetic concerns. For that reason, there is no public health goal or maximum contaminant level goal associated with specific conductance. The MT for the Water Quality SMCL is:

> *the upper limit of the SMCL for specific conductance based on the State Secondary Drinking Water Standards.*

Undesirable results related to water quality as a result of groundwater pumping in the Vina Subbasin have not occurred historically, are not currently occurring, and are not likely to occur in the future. Observations of specific conductance at RMS from 2008 through 2019 ranged between 148 and 364 µS/cm and demonstrated no trend (Figure 3-4).

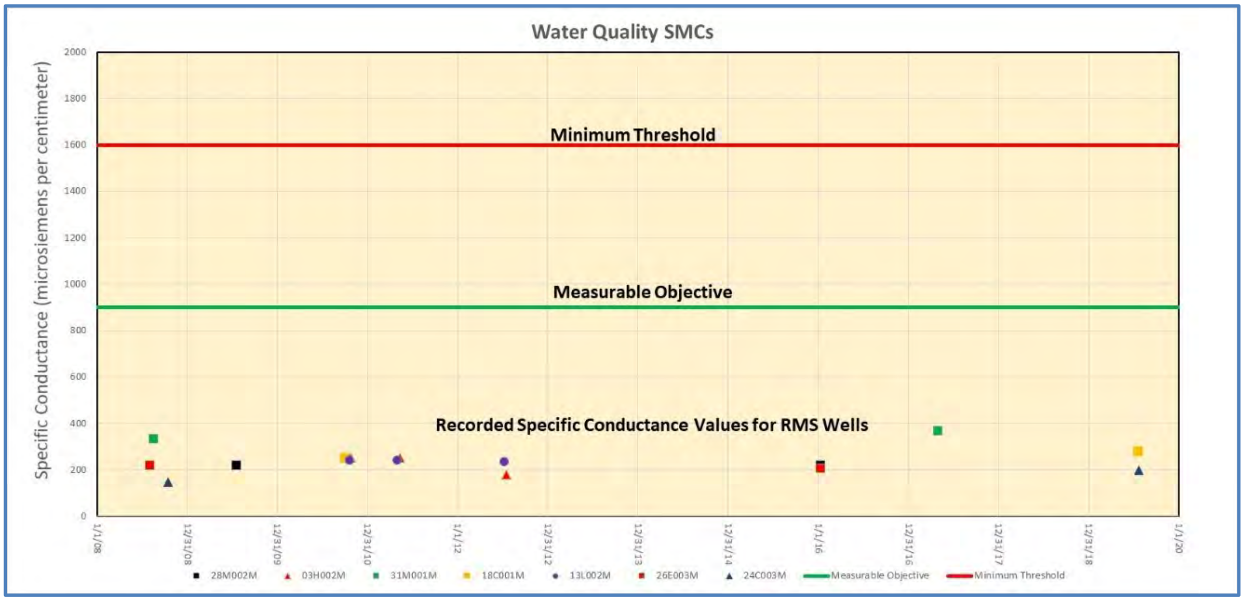


Figure 3-5: Water Quality Measurable Objectives and Minimum Thresholds in Relation to Reported Historical Specific Conductance for Representative Monitoring Site Wells

3.5.3 Measurable Objective

The Water Quality MO represents a quantitative target that establishes a point above the MT allowing for a range of active management to prevent undesirable results and reflect the desired state for groundwater quality at the year 2042. To address the potential impacts of concern related to degraded water quality, the MO was established for specific conductance at the recommended SMCL of 900 µS/cm based on State Secondary Drinking Water Standards. The MO for the Water Quality SMC is:

> *the recommended SMCL for specific conductance based on the State Secondary Drinking Water Standards.*

Water quality monitoring implemented for compliance with SGMA will build upon Butte County's existing groundwater quality monitoring program. Additional monitoring by DWR and other agencies will continue to track constituents not managed by the GSAs, including minerals, metals, pesticides, and herbicides.

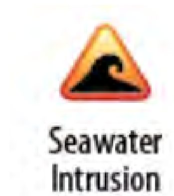
3.5.4 Summary

To achieve the sustainability goal and therefore preserve the desired condition for the groundwater basin over time, the GSAs, in setting the Water Quality SMC, commits to managing groundwater quality in line with the State Secondary Drinking Water Standards at each RMS shown in Table 3-2. (See Section 4, Figure 4-6, and Table 4-8 for relevant information on the RMS for water quality.)

Table 3-2: Water Quality Sustainability Management Criteria by Representative Monitoring Site in µS/cm

<table>
<tr><th rowspan="2">GSP Well ID</th><th rowspan="2">MT</th><th rowspan="2">MO</th><th colspan="3">IM</th></tr>
<tr><th>2027</th><th>2032</th><th>2037</th></tr>
<tr><td colspan="6">Vina Subbasin – North Management Area</td></tr>
<tr><td>28M002M</td><td rowspan="3">1,600</td><td rowspan="3">900</td><td rowspan="3">900</td><td rowspan="3">900</td><td rowspan="3">900</td></tr>
<tr><td>03H002M</td></tr>
<tr><td>31M001M</td></tr>
<tr><td colspan="6">Vina Subbasin – Chico Management Area</td></tr>
<tr><td>28J005M</td><td>1,600</td><td>900</td><td>900</td><td>900</td><td>900</td></tr>
<tr><td colspan="6">Vina Subbasin – South Management Area</td></tr>
<tr><td>18C001M</td><td rowspan="4">1,600</td><td rowspan="4">900</td><td rowspan="4">900</td><td rowspan="4">900</td><td rowspan="4">900</td></tr>
<tr><td>13L002M</td></tr>
<tr><td>26E003M</td></tr>
<tr><td>24C003M</td></tr>
</table>

3.6 Seawater Intrusion Sustainable Management Criteria



Seawater intrusion is not applicable to the Vina Subbasin due to its distance from the Pacific Ocean (Figure 1-2) which is the source of saline intrusion to freshwater aquifers along coastal subbasins.

3.7 Land Subsidence Sustainable Management Criteria

Land Subsidence SMC are those meant to address land subsidence that substantially interferes with surface land uses caused by groundwater pumping. The locally defined undesirable result, MT, and MO are discussed in the next sections.

3.7.1 Undesirable Result and Minimum Thresholds

The SGMA regulations define the MT for significant and unreasonable land subsidence to be the "rate and the extent of land subsidence." The harmful effects of subsidence result from the damage it may cause to critical infrastructure and the costs of repairing or mitigating those damages. In the instance of the Vina Subbasin, critical infrastructure that could be affected by subsidence includes federal state and county roads and highways, irrigation district infrastructure, railroad infrastructure, and power transmission lines.

Based on this definition, the undesirable result coming from land subsidence for the Vina Subbasin is experienced if:

> *groundwater pumping leads to changes in the ground surface elevation severe enough to disrupt critical infrastructure, development of projects that enhance the viability of rural areas, communities, and the agricultural economic base of the region.*

Land subsidence typically occurs concurrently or shortly after significant declines in groundwater levels; therefore, measured changes in groundwater levels can serve as a proxy for potential land subsidence. For this reason, the SMC developed for groundwater levels are used for land subsidence to ensure avoidance of the undesirable result.

As Groundwater Levels SMC are used by proxy, the quantitative Undesirable Result for land subsidence is the same as for groundwater levels:

> *Two RMS wells within a management area reach their MT for two consecutive years of non-dry year-types.*

Undesirable results related to land subsidence in the Vina Subbasin have not occurred historically, are not currently occurring, and are not likely to occur in the future. To assess land subsidence in the Sacramento Valley, a subsidence monitoring network was established consisting of observation stations and extensometers managed jointly by the United States Bureau of Reclamation (USBR) and DWR. This subsidence monitoring network includes 19 GPS monuments located within the Vina Subbasin, on the boundary between Butte and Tehama counties, or on the boundary between the Vina and Butte Subbasins. The subsidence monitoring network also includes three extensometers in Butte County with a period of record beginning in 2005. (There are no extensometers in the Vina Subbasin.) By 2019, a review of the data showed that changes in ground surface elevations were slight and remained at or above baseline levels, indicating that inelastic land subsidence has not been an observed in the Vina Subbasin. This is likely due to historically relatively stable groundwater levels and subsurface materials that are not conducive to compaction. For this reason, inelastic land subsidence due to groundwater pumping is unlikely to produce an undesirable result in the Vina Subbasin.

3.7.2 Measurable Objectives

As Groundwater Levels SMC are used by proxy, the MO for land subsidence is the same as for groundwater levels:

> *the groundwater level based on the groundwater trend line of the RMS well for the dry periods (since 2000) of observed short-term climatic cycles extended to 2030.*

3.8 Interconnected Surface Water Sustainable Management Criteria

Interconnected Surface Water SMC are those meant to address depletions of interconnected surface water caused by groundwater pumping. Relevant context, the Interconnected Surface Water SMC framework, and the locally defined undesirable result, MT, and MO are presented in the next sections.

3.8.1 Relevant Context

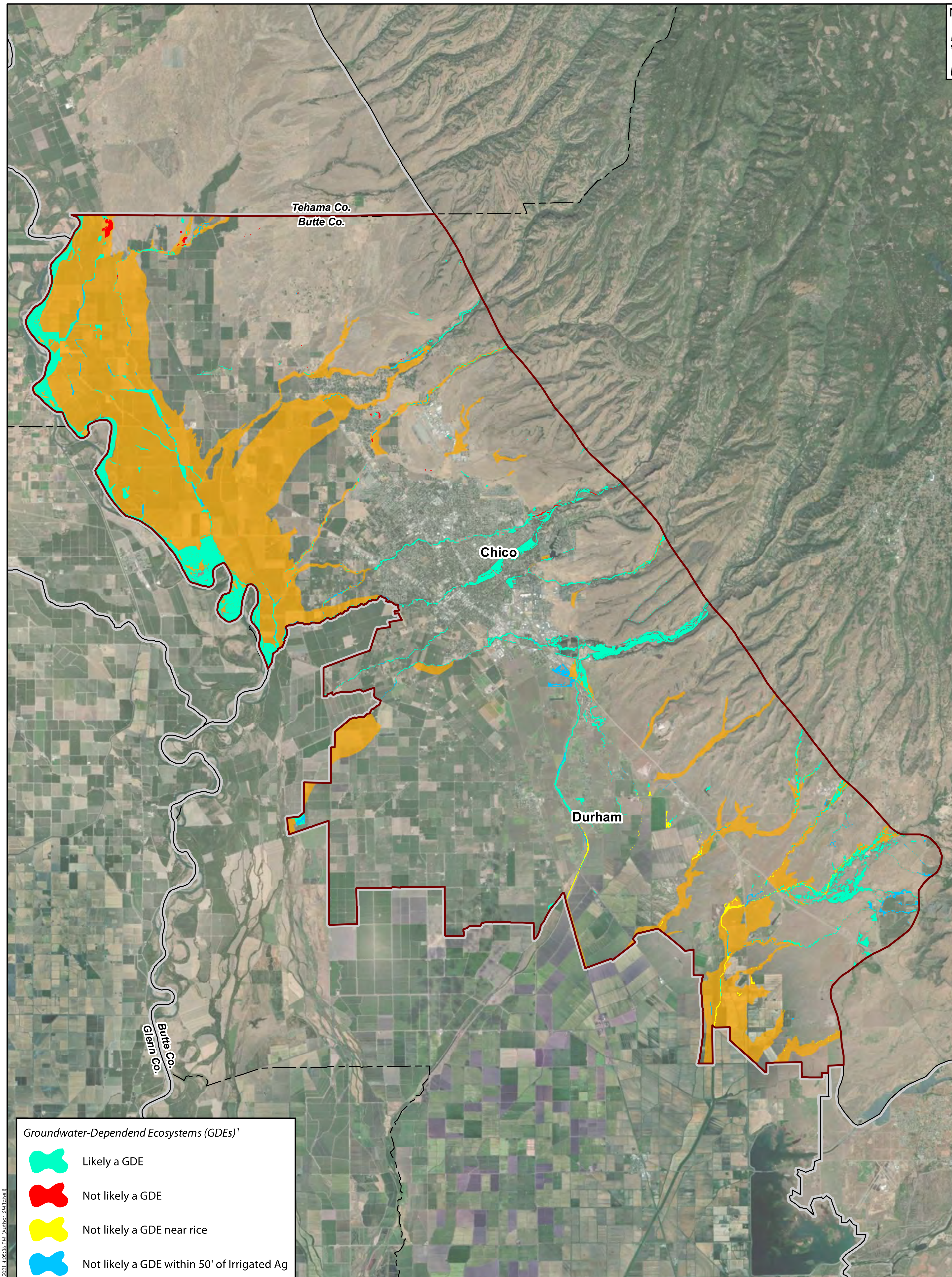
The objective of the Interconnected Surface Water SMC is to avoid significant and unreasonable adverse impacts on beneficial uses of the surface water. To address this SMC, DWR has provided various forms of guidance, including mapping of potential GDEs. GDEs are a sub-class of aquatic and riparian habitat that depend on groundwater for optimum ecological function. The distinction between an ecosystem's dependence on groundwater versus its dependence on surface water and the associated riparian zone or floodplain is important. In addition, the distinction between the shallow aquifer zone and the deep aquifer zone is also important. The deeper aquifer zone only influences surface water to the extent that it affects water levels in the shallow aquifer zone which then influences the shallow aquifer zone's connection to the stream. The Vina Subbasin includes upland streams (e.g., Big Chico Creek) and their associated riparian zones and the mainstem floodplain of the Sacramento River (Figure 3-6). The scales of the ecosystems and associated hydrologic dependencies in these two landscapes are quite different. Streamflow and adjacent narrow riparian areas in the upland stream systems are very sensitive to watershed and climatic conditions outside of the Vina Subbasin in the foothills of the Cascades and Sierra Nevada. The Sacramento River and its floodplain are affected by much larger and cumulative hydrologic processes, including operation of multiple reservoirs and the cumulative hydrology of multiple watersheds extending to the headwaters of the Cascades.

Potential impacts of the depletion of interconnected surface water were discussed by stakeholders during technical discussions covering the fundamentals of groundwater-surface water interactions and mapping analysis of GDEs as discussed in Section 2.2.7. The GDE mapping analysis is presented in Chapter 2.2.7.

Potential impacts identified by stakeholders were:

- Disruption to GDEs
- Reduced flows in rivers and streams supporting aquatic ecosystems and water right holders
- Degradation of "Urban Forest" habitat in the City of Chico
- Streamflow changes in upper watershed areas outside of the Vina Subbasin boundary
- Water table depth dropping below the maximum rooting depth of Valley Oak or other deep-rooted tree species
- Cumulative groundwater flow moving toward the Sacramento River from both the Vina Subbasin and surrounding GSAs on both the east and west side of the river

The Vina Subbasin acknowledges that overall function of the riparian zone and floodplain is dependent on multiple components of the hydrologic cycle that may or may not have relationships to groundwater levels in the principal aquifer. For example, hydrologic impacts outside of the Vina Subbasin, such as upper watershed development or fire-related changes in runoff, could result in impacts to streamflow, riparian areas, or GDEs that are completely independent of any connection to groundwater use or conditions within the Vina Subbasin.



Legend

Groundwater Subbasins[2]

Vina Subbasin

Other subbasins[2]

FEMA Flood Zones[3]

FEMA Flood Zone A

Boundaries[4]

County boundaries

Notes:
1) More detailed descriptions of GDEs are available in Appendix "X".
2) California Department of Water Resources (CA DWR).
3) Federal Emergency Management Agency (FEMA).
4) TIGER/Line, U.S. Census Bureau.

4 2 0 4 Miles

Groundwater-Dependent Ecosystems
Vina Groundwater Subbasin GSP

Geosyntec consultants

Project No.: SAC282 | December 2021

Figure 3-6

Data needed to develop this SMC include definition of stream reaches and associated priority habitat; streamflow measurements to develop profiles at multiple time periods; and measurements of groundwater levels directly adjacent to stream channels, first water bearing aquifer zone, and deeper aquifer zones. These data are not available and are a data gap for the GSP. Section 2.2.6.2 discusses the limited information that is available that includes:

- One nested monitoring well (23N01W31M001-004; Figure 2-22) that includes a well completed in the shallow aquifer zone and three wells within deeper zones. The hydrograph for the shallow wells suggests it is completed within what could be termed “floodplain sediments” and is in direct hydraulic communication with the Sacramento River. A nested well completed further away from the Sacramento River indicates that the shallow well is in clear connection with deeper zones and does not indicate any connection to the Sacramento River.
- Hydrographs for eight shallow wells located within the City of Chico have water levels below the elevation of adjacent stream channels, indicating that groundwater levels are not capable of interacting directly with the adjacent stream channel.

The GSAs in the Vina Subbasin intend to further evaluate this SMC to avoid undesirable results to aquatic ecosystems and GDEs. To that end, an Interconnected Surface Water SMC framework has been developed for the GSP as described below. This framework will guide future data collection efforts to fill data gaps, either as part of GSP projects and management actions or plan implementation. As additional data are collected and evaluated, the Vina Subbasin GSAs will evaluate the development of additional SMC, as appropriate, for specific stream reaches and associated habitat where there is a clear connection to groundwater pumping in the principal aquifer.

3.8.2 Interconnected Surface Water Sustainable Management Criteria Framework

To evaluate the potential for depletion of interconnected streams, an integrated assessment of both surface water and groundwater is required that includes (see Figure 3-5 for illustration):

- Definition of stream reaches and associated priority habitat. This is typically developed using a combination of geomorphic classification of the stream channel and ecological classification of the associated habitat.
- Multiple streamflow measurements in each stream reach to develop a profile of streamflow at multiple time periods over at least one year. Comparison of flow rates in each reach defines whether the reach is gaining (water moving from the groundwater system to the stream/river) or losing (water moving from the stream/river to the groundwater system). A reach can be both gaining and losing, depending on the time of year (i.e., losing during high flow periods and gaining during low flow periods).
- Measurement of groundwater levels directly adjacent to the stream channel in the adjacent riparian zone or floodplain. Groundwater measurement of this type is typically done with piezometers, or “mini-piezos,” which may be very shallow (less than 15 feet deep) and hand-driven (i.e., not requiring a drill rig). Groundwater levels are collected simultaneous to streamflow profiles.

- Measurement of groundwater levels in the first water bearing aquifer zone. This is the first regional or sub-regional aquifer that interacts with the stream by either discharging water into the stream or gaining water from the stream. These wells are typically between 20 and 100 feet deep and require a drill rig for installation. It is important for the screen interval of these wells to cross the water table. Groundwater levels are collected simultaneous to stage measurements along the streamflow profile. Water level differences between the shallow aquifer and the water surface elevation of the nearest stream reach are evaluated.
- Measurement of groundwater levels in deeper aquifer zones. These are typically regional or sub-regional aquifers that are used for regional supply. Water levels in these aquifers can be higher or lower than water levels in the overlying aquifer. The degree of connectivity to the nearest stream reach depends on how stratigraphically isolated the deeper zone is from the shallow zone. These wells are typically greater than 100 feet deep and require a drill rig for installation. It is important to conduct a pumping test of the deeper aquifer and measure water levels in the overlying aquifer to determine how hydraulically connected it is to the overlying aquifer. It is important to complete wells in the shallow aquifer across the water table. Groundwater levels are collected simultaneous to streamflow profiles. Additional AEM (geophysical) data would be valuable in further understanding the structure and potential interconnection of the aquifers in different zones.

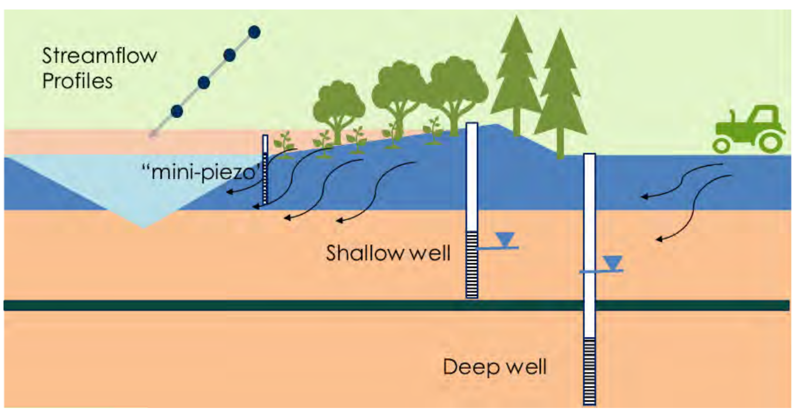


Figure 3-7: Illustration of Monitoring Points Needed to Develop Sustainability Management Criteria for Interconnected Surface Waters

This information is then integrated to define which surface water reaches are connected to the shallow aquifer zones and where those shallow aquifer zones are influenced by pumping of the deeper aquifer zones.

3.8.3 Undesirable Result

The undesirable result for this SMC is focused on connectivity where there is a measurable connection between groundwater levels in the principal aquifer and streamflow or associated aquatic habitat viability. The Vina Subbasin specifically recognizes deep-rooted tree species, such as Valley Oak, that are common along riparian corridors in both upland streams and the

Sacramento River and found elsewhere throughout the subbasin as depicted in Appendix 2-A. This connectivity is not well measured or understood in the Vina Subbasin at this time. For now, an undesirable result coming from the depletion of interconnected surface water is simply defined as:

> *Avoiding significant and unreasonable depletion of surface water flows caused by groundwater pumping that significantly impacts beneficial uses*

For this reason, the SMC developed for groundwater levels are used as a proxy for interconnected surface water in an interim manner until data gaps are addressed. As outlined in Section 6, an aggressive schedule has been provided to fill these data gaps, and the GSAs are committed to addressing these issues and develop appropriate SMCs for the Vina Subbasin.

3.8.4 Minimum Thresholds

The potential impact of groundwater levels on aquatic habitat or GDEs is typically specific to a certain stream reach or geographic area. Groundwater modeling conducted in association with the HCM (Section 2) incorporates the interaction of surface water and groundwater at a regional scale, including all the GSAs in Butte County. While the model is a useful tool for evaluating regional behavior of the groundwater system overall, there are significant data gaps that limit calibration of the groundwater response in the uppermost layer of the model, where the dynamics and "interconnectedness" between surface water and groundwater actually occur. Therefore, at this time, Groundwater Levels SMC are used by proxy and the MT for interconnected surface water is the same as for groundwater levels:

> *Two RMS wells within a management area reach their MT for two consecutive years of non-dry year-types.*

3.8.5 Measurable Objectives

As Groundwater Levels SMC are used by proxy, the MO for interconnected surface water is the same as for groundwater levels:

> *the groundwater level based on the groundwater trend line of the RMS well for the dry periods (since 2000) of observed short-term climatic cycles extended to 2030.*

As described previously, the historical record of groundwater levels shows fluctuations over a four- to seven-year cycle consistent with variations in water year type according to the Sacramento Valley Water Year Hydrologic Classification. It is not known whether streamflow and associated aquatic habitat and GDEs that are connected to groundwater have also experienced a long-term decline. In the upland streams, it is likely that similar long-term declines have occurred, since the recharge that produces the groundwater level fluctuations likely correlates with streamflow in the upper watershed areas. However, long-term declines in Sacramento River streamflow may have been avoided by reservoir releases aimed at maintaining streamflow levels. As described previously, the wet-dry cycles are climatically induced, and the GSAs have no ability to change this cyclical behavior; there will always be short-term cyclical fluctuations in surface water availability, particularly in the upland streams. The MO are therefore intended to address the long-term trend of the "peaks and valleys" of the short-term cycles. A focus on long-term trends will be maintained as more data are collected to inform future MOs for the shallowest zone of the aquifer system.