3 Sustainable Management Criteria

NOTE TO REVIEWERS: Section 3.1 -3.3 and the beginning of section 3.4 will be completed later and are provided mostly as an outline to provide context for the full content of Chapter 3. We are only asking you to review Sections 3.3.4 (Groundwater Quality) and 3.3.5 (Subsidence) at this time. In addition, the Water Quality Appendix that is referenced in 2.2.2.4 is also provided for review.

3.1 Introduction to Sustainable Management Criteria and Definition of Terms

This section establishes the current and desired future subbasin conditions through evaluation of the six sustainability indicators and outlines the process used to define sustainable management criteria (SMC) for each of them. The undesirable results, minimum thresholds, and measurable objectives are defined for each sustainability indicator, along with their impacts on beneficial groundwater uses and users.

The following terms, defined below, are described for the Subbasin in the following sections.

Sustainability Goal: The overarching goal for the Subbasin with respect to maintaining or improving groundwater conditions and ensuring the absence of undesirable results.

Sustainability Indicators: The effects that describe groundwater-related conditions in the Subbasin. When determined to be significant and unreasonable, these identify undesirable results. Six indicators are defined under SGMA: lowering groundwater levels, reduction of groundwater storage, seawater intrusion, degraded groundwater quality, land subsidence, and surface water depletion.

Sustainable Management Criteria: Minimum thresholds, measurable objectives, and undesirable results, consistent with the sustainability goal, that are defined for each sustainability indicator.

Undesirable Results: Conditions, defined under SGMA as: *"… one or more of the following effects caused by groundwater conditions occurring throughout a basin:*

1. Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon....
2. *Significant and unreasonable reduction of groundwater storage.*
3. *Significant and unreasonable seawater intrusion.*
4. *Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.*
5. *Significant and unreasonable land subsidence that substantially interferes with surface land uses.*
6. Depletions *of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water."*

Minimum Thresholds: A numeric value that defines an undesirable result. Groundwater conditions should not exceed the minimum thresholds defined in the GSP. The term "minimum threshold" is predominantly used in SGMA regulations and applied to most sustainability indicators. The term "maximum threshold" is the equivalent value but used for sustainability indicators with a defined maximum limit (e.g., groundwater quality).

Measurable Objectives: Specific and quantifiable goals that are defined to reflect the desired groundwater conditions in the Subbasin and achieve the sustainability goal within 20 years. Measurable objectives may be defined for the six undesirable results and are defined using the same metrics as are used to define minimum thresholds.

Interim Milestones: Periodic goals (defined every five years, at minimum) that are used to measure progress in improving or maintaining groundwater conditions and assess progress towards the sustainability goals defined by minimum thresholds and measurable objectives.

Representative Monitoring Sites: For each SMC, these sites area sub-component of the overall monitoring network, where minimum thresholds, measurable objectives, and milestones are defined.

3.2 Sustainability Goal (Reg. § 354.24) [to be developed further, not for review]

The overall sustainability goal of groundwater management in the Subbasin is to maintain groundwater resources in ways that best support the continued and long-term health of the people, the environment, and the economy in the Subbasin for generations to come. This includes managing groundwater conditions for each of the applicable sustainability indicators in the Subbasin so that:

- Groundwater quality is suitable for the beneficial uses in the Subbasin and is not significantly or unreasonably degraded.
- Significant and unreasonable land subsidence is prevented in the Subbasin. Infrastructure and agriculture production in Sierra Valley remain safe from permanent subsidence of land surface elevations.

3.3 Monitoring Networks (Reg. § 354.26)

3.3.1 Groundwater Quality Monitoring Network

3.3.1.1 Description of Groundwater Quality Network ((Reg. § 354.34)

3.3.1.1.1 Well Location

3.3.1.1.2 Monitoring History

3.3.1.1.3 Well Information

3.3.1.1.4 Well Access/Agency Support

3.3.1.2 Assessment and Improvement of Monitoring Network

3.3.1.3 Monitoring Protocols for Data Collection and Monitoring (Reg. § 352.2)

3.3.2 Subsidence Monitoring Network

3.3.2.1 Description of Monitoring Network for Land Subsidence Sustainability Indicator (Reg. § 354.34)

3.3.2.2 Monitoring Protocols for Data Collection and Monitoring for Land Subsidence Sustainability Indicator (Reg. § 352.2)

3.3.2.3 Representative Monitoring for Land Subsidence Sustainability Indicator (Reg. § 354.36)

3.3.2.4 Assessment and Improvement of Monitoring Network for Land Subsidence Sustainability Indicator (Reg. § 354.38)

3.4 Sustainable Management Criteria

3.4.1 Groundwater Elevation

3.4.2 Groundwater Storage

3.4.3 Depletion of Interconnected Surface Waters

3.4.4 Degraded Groundwater Quality

Groundwater quality in the Subbasin is generally well-suited for the municipal, domestic, agricultural, and other existing and potential beneficial uses designated for groundwater in the Water Quality Control Plan for the Sacramento River Basin and the San Joaquin River Basin (Basin Plan). Existing groundwater quality concerns within the Subbasin are identified in **Section 2.2.2.4**, and corresponding water quality figures and detailed water quality assessment are included in Appendix ## of **Chapter 2**. In **Section 2.2.2.4**, constituents that are identified as of interest with respect to groundwater quality include nitrate, TDS, arsenic, boron, pH, iron, manganese, and MTBE. Sustainability management criteria (SMCs) will be defined for two constituents: nitrate and total dissolved solids (TDS). As described in **Section 2.2.2.4**, concentrations of MTBE have diminished over the last 10 years; additionally, arsenic, boron, iron, manganese, and pH are naturally occurring and as such, SMCs are not defined for these constituents. The GSA will monitor arsenic, boron, and pH to track any possible mobilization of elevated concentrations.

Groundwater quality monitoring in the Subbasin in support of the GSP will rely on the monitoring network described in **Section 3.3.1.1**. Groundwater quality samples will be collected and analyzed in accordance with the monitoring protocols outlined in **Section 3.3.1.3**. The monitoring network will use information from existing programs in the Subbasin that already monitor for the constituents of concern, and programs where constituents could be added as part of routine monitoring efforts in support of the GSP. New wells will be incorporated into the network as necessary to fill data gaps. Because water quality degradation is typically associated with increasing rather than decreasing concentration of constituents, the GSA has decided to not use the term “minimum threshold” in the context of water quality, but instead use the term “maximum threshold”. The use of the term maximum threshold for the water quality SMC in this GSP is equivalent to the use of the term minimum threshold in other sustainability management criteria or in the SGMA regulations.

3.4.4.1 Undesirable Results

An undesirable result under SGMA has previously been defined in **Section 3.1**.

Significant and unreasonable degradation of groundwater quality is the degradation of water quality that would impair beneficial uses of groundwater within the Subbasin or result in failure to comply with groundwater regulatory thresholds including state and federal drinking water standards and Basin Plan water quality objectives. Undesirable results to groundwater that are of primary concern to the GSA include:

- adverse groundwater quality impacts to safe drinking water,

- adverse groundwater quality impacts to irrigation water use,
- the spread of degraded water quality through old or abandoned wells,
- and the spread of degraded groundwater to other areas.

Based on the State's 1968 antidegradation policy[1], water quality degradation that is not consistent with the provisions of Resolution No. 68-16 is degradation determined to be significant and unreasonable. Furthermore, the violation of water quality objectives is significant and unreasonable under the State's antidegradation policy. The CVRWQCB and the State Water Board are the two entities that determine if degradation is inconsistent with Resolution No. 68-16.

Federal and state standards for water quality, water quality objectives defined in the Basin Plan, and the management of known and suspected contaminated sites within the Subbasin will continue to be the jurisdictional responsibility of the relevant regulatory agencies. The role of the GSA is to provide additional local oversight of groundwater quality, collaborate with appropriate parties to implement water quality projects and actions, and to evaluate and monitor, as needed, water quality effects of projects and actions implemented to meet the requirements of other sustainable management criteria.

Sustainable management of groundwater quality includes maintenance of water quality within regulatory and programmatic limits (**Section 2.2.2.4**) while executing GSP projects and actions. To achieve this goal, the GSA will coordinate with the regulatory agencies that are currently authorized to maintain and improve groundwater quality within the Subbasin. This includes informing the Regional Board of any issues that arise and working with the Regional Board to rectify the problem. All future projects and management actions implemented by the GSA will be evaluated and designed to avoid causing undesirable groundwater quality outcomes. Historic and current groundwater quality monitoring data and reporting efforts have been used to establish and document conditions in the Subbasin, as discussed in **Section 2.2.2.4**. These conditions provide a baseline to compare with future groundwater quality and identify any changes observed due to GSP implementation.

As noted above, groundwater in the Subbasin is used for a variety of beneficial uses including agricultural, industrial, domestic, and municipal water supply. Groundwater supports groundwater-dependent ecosystems (GDEs) and instream environmental resources in some areas of the Subbasin. These beneficial uses, among others, are protected, in part, by the CVRWQCB through the water quality objectives adopted in the Basin Plan. Project and management actions implemented as a result of the GSP need to consider, and monitor for, potential impacts to groundwater quality that could cause degradation below these water quality objectives and affect beneficial uses of groundwater in the Subbasin.

The constituents of concern in the Subbasin, and their associated regulatory thresholds, are listed in **2.2.2.4**. The quantification of an undesirable result is included in the discussion of maximum thresholds in **Section 3.4.4.5**.

3.4.4.1.1 Potential Causes of Undesirable Results

Future GSA monitored activities with potential to affect water quality may include changes in location and magnitude of Subbasin pumping, declining groundwater levels and changes to both planned and incidental groundwater recharge mechanisms. Altering the location or rate of

[1] State Water Resources Control Board. "Resolution No. 68-16: Statement of Policy with Respect to Maintaining High Quality of Waters in California", California, October 28, 1968.

groundwater pumping could change the direction of groundwater flow which may result in a change in the overall direction in which existing or future contaminant plumes move thus potentially compromising ongoing remediation efforts. Similarly, recharge activities could alter hydraulic gradients and result in the downward movement of contaminants into groundwater or move groundwater contaminant plumes towards supply wells.

Sources and activities that may lead to undesirable groundwater quality include industrial contamination, pesticides, sewage, animal waste, and other wastewaters, and natural causes. Fertilizers and other agricultural activities can elevate analytes such as nitrate and TDS. Wastewater, such as sewage from septic tanks and animal waste, can elevate nitrate and TDS. The GSA cannot control and is not responsible for natural causes of groundwater contamination but is responsible for how project and management actions may impact groundwater quality (e.g., through mobilization of naturally occurring contaminants). Natural causes, such as local volcanic geology and soils), can elevate analytes such as arsenic, boron, iron, manganese, pH, and TDS. For further detail, see **Section 2.2.2.4**.

Groundwater quality degradation associated with known sources will be primarily managed by the entity currently overseeing these sites, the CVRWQCB. In the Subbasin, existing contaminant sites are currently being managed, and though additional degradation is not anticipated from known sources, new sites may cause undesirable results due to constituents that, depending on the contents, may include petroleum hydrocarbons, solvents, or other contaminants. The Subbasin is not currently categorized as a priority subbasin under the CV-SALTS program managed by the CVRWQCB.

Agricultural activities in the Subbasin are dominated by pasture, grain and hay, and alfalfa. Alfalfa and pasture production have low risk for fertilizer-associated nitrate leaching into the groundwater (Harter et al., 2017). Grain production is rotated with alfalfa production, usually for one year, after which alfalfa is replanted. Grain production also does not pose a significant nitrate-leaching risk. Animal farming, a common source of nitrate pollution in large, is also present in the valley, but not at stocking densities of major concern. Changes or additions to land uses may require a re-examination of risks of groundwater contamination.

3.4.4.2 Effects on Beneficial Uses and Users

Concerns over potential or actual non-attainment of the beneficial uses designated for groundwater in the Subbasin are related to certain constituents measured at elevated or increasing concentrations, and the potential local or regional effects that degraded water quality can have on such beneficial uses.

The following provides greater detail regarding the potential impact of poor groundwater quality on several major classes of beneficial users:

- Municipal Drinking Water Users – Under California law, agencies that provide drinking water are required to routinely sample groundwater from their wells and compare the results to state and federal drinking water standards for individual chemicals. Groundwater quality that does not meet state drinking water standards may render the water unusable or may cause increased costs for treatment. For municipal suppliers, impacted wells may potentially be taken offline until a solution is found, depending on the configuration of the municipal system in question. Where this temporary solution is feasible, it will add stress to and decrease the reliability of the overall system.
- Rural and/or Agricultural Residential Drinking Water Users - Residential structures not located within the service areas of a local municipal water agency or private water supplier will typically obtain their water supply through private domestic groundwater

wells. Such wells may not be monitored routinely and groundwater quality from those wells may be unknown unless the landowner has initiated testing and shared the data with other entities. Degraded water quality in such wells can lead to rural residential use of groundwater that does not meet potable water standards and results in the need for installation of new or modified domestic wells and/or well-head treatment that will provide groundwater of acceptable quality.

- Agricultural Users – Irrigation water quality is an important factor in crop production and has a variable impact on agriculture due to different crop sensitivities. Impacts from poor water quality (e.g., elevated salinity) may include declines in crop yields, crop damage, or alter which crops can be grown in the area.
- Environmental Uses – In gaining streams, poor quality groundwater may result in migration of contaminants which could impact groundwater dependent ecosystems or instream environments, and their resident species, to which groundwater contributes.

3.4.4.3 Relationship to Other Sustainability Indicators

Groundwater quality cannot typically be used to predict responses of other sustainability indicators. However, groundwater quality can, in some circumstances, be affected by changes in groundwater levels and reductions in groundwater storage, or can affect quality in interconnected surface waters, as described below. In addition, certain implementation actions may be limited by the need to achieve minimum thresholds for other sustainability indicators.

- Groundwater Levels – In some basins, declining groundwater levels potentially can lead to increased concentrations of constituents of concern in groundwater and may alter the existing hydraulic gradient, which can result in the movement of contaminated groundwater plumes. Changes in water levels may also mobilize some contaminants that may be present in unsaturated soils. In such cases, the maximum thresholds established for groundwater quality may influence groundwater level minimum thresholds by affecting the location or number of projects, such as groundwater recharge, in order to avoid degradation of groundwater quality.
- Groundwater Storage – The groundwater quality maximum thresholds will not cause groundwater pumping to exceed the sustainability yield[2] and therefore will not cause exceedances of the groundwater storage minimum thresholds.
- Depletion of Interconnected surface waters - The groundwater quality maximum threshold does not promote additional pumping or lower groundwater levels near interconnected surface waters[2]. The groundwater quality maximum threshold does not negatively affect interconnected surface waters.
- Seawater Intrusion - This sustainability indicator is not applicable in this Subbasin.
- Subsidence - The groundwater quality maximum threshold does not promote additional pumping or lower groundwater levels and therefore does not interfere with subsidence minimum thresholds.

3.4.4.4 Information and Methodology Used to Establish Maximum Thresholds and Measurable Objectives

The two constituents of concern (nitrate and TDS) for which SMCs were considered were specifically selected due to measured exceedances in the past 30 years and stakeholder input

[2] Will be confirmed by modeling effort and updated if needed

and prevalence as a groundwater contaminant in California. A detailed discussion of the concerns associated with elevated levels of each constituent of interest is described in **Section 2.2.2.4**. As the constituents of concern were identified using current and historical groundwater quality data, this list may be reevaluated during future GSP updates. In establishing maximum thresholds for groundwater quality, the following information was considered:

- Feedback about water quality concerns from stakeholders.
- An assessment of available historical and current groundwater quality data from production and monitoring wells in the Subbasin.
- An assessment of historical compliance with federal and state drinking water quality standards and water quality objectives.
- An assessment of trends in groundwater quality at selected wells with adequate data to perform the assessment.
- Information regarding sources, control options and regulatory jurisdiction pertaining to constituents of concern.
- Input from stakeholders resulting from the consideration of the above information in the form of recommendations regarding maximum thresholds and associated management actions.

The historical and current groundwater quality data used in the effort to establish groundwater quality maximum thresholds are discussed in **Section 2.2.2.4**. Based on a review of these data, applicable water quality regulations, Subbasin water quality needs, and information from stakeholders, the GSA reached a determination that the state drinking water standards (MCLs and WQOs) are appropriate to define maximum thresholds for groundwater quality. These maximum thresholds are summarized in **Table 3.4.4-1**. The established maximum thresholds for groundwater quality protect and maintain groundwater quality for existing or potential beneficial uses and users. Maximum thresholds align with the state standards for nitrate and TDS, and the Title 22 MCLs and SMCLs.

New constituents of concern may be added with changing conditions and as new information becomes available.

3.4.4.5 Maximum Thresholds

Maximum thresholds for groundwater quality in the Subbasin were defined using existing groundwater quality data, beneficial uses of groundwater in the Subbasin, existing regulations, including water quality objectives under the Basin Plan, Title 22 Primary MCLs, and Secondary MCLs, and consultation with the GSA advisory committee and stakeholders (see **Section 2.2.2.4**). As a result of this process, SMCs were developed for two constituents of concern in the Subbasin: nitrate, and TDS. Although MTBE is identified as a potential constituent of concern in **Section 2.2.2.4**, no SMC is defined for the constituent as recent MTBE data (2016-2020) resulted in no exceedances of the 5 µg/L SMCL; the highest concentration measured during this period was 0.7 µg/L. Arsenic, boron, iron, manganese, and pH do not have an SMC because they are naturally occurring.

The selected maximum thresholds for the concentration of each of the two constituents of concern and their associated regulatory thresholds are shown in **Table 3.4.4-1**. For nitrate and TDS, significant and undesirable results are experienced if these maximum thresholds for concentration are exceeded in over 10% (*or 5%*) of wells in the monitoring network, and/or increases in degradation of groundwater quality of more than 1% per year, on average over 10 years, in more than 10% (*or 5%*) of wells in the monitoring network.

3.4.4.5.1 Triggers

The GSA will use concentrations of the identified constituents of concern (nitrate and TDS) below the maximum threshold as triggers for action in order to proactively avoid the occurrence of undesirable results. Trigger values are identified for both nitrate as nitrogen and TDS, as shown in **Table 3.4.4-1**. The trigger value for TDS is 42% of the Title 22 Secondary MCL (210 mg/L), while the trigger value for nitrate is half and 90% of the Title 22 MCL (5 and 9 mg/L, respectively).

3.4.4.5.2 Method for Quantitative Measurement of Maximum Thresholds

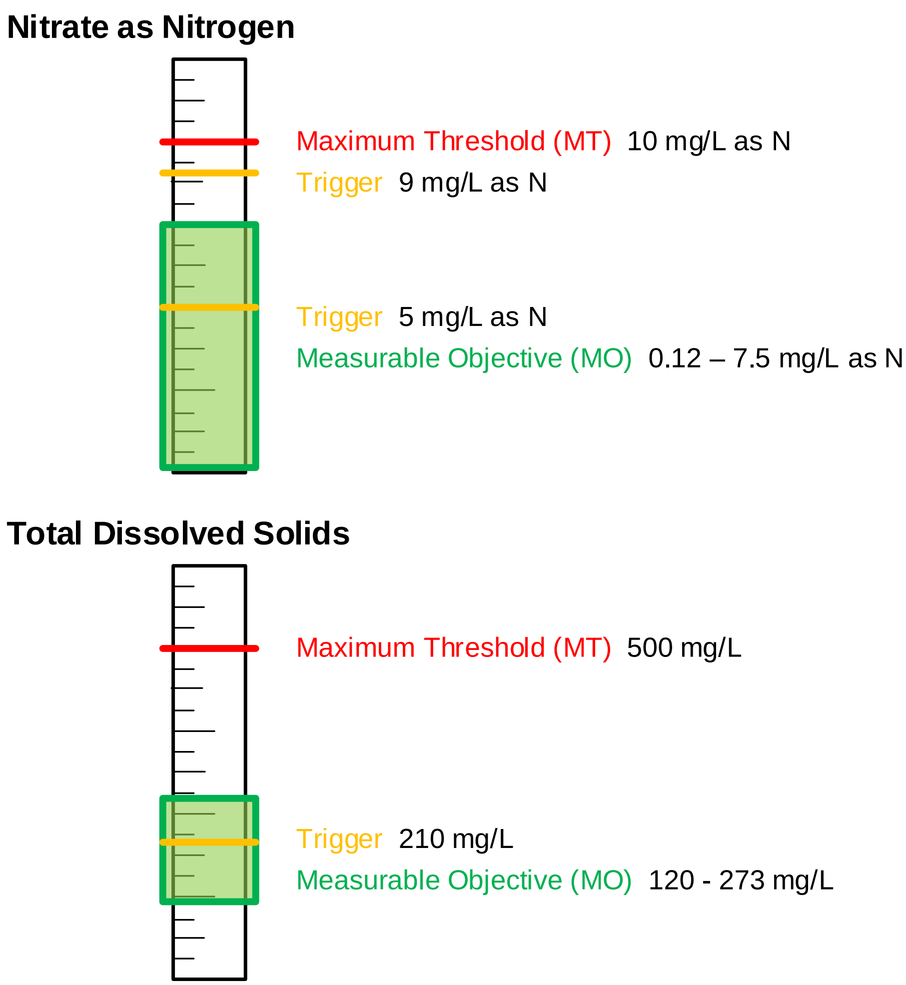
Groundwater quality will be measured in representative monitoring wells as discussed in **Section 3.3.1**. Statistical evaluation of groundwater quality data obtained from the monitoring network will be performed. The maximum thresholds for constituents of concern are shown in **Table 3.4.4-1** and **Figure 3.4.4-1**, which show “rulers” for each of the two identified constituents of concern in the Subbasin, with the associated maximum thresholds, measurable objectives, and triggers.

Table 3.4.4-1. Constituents of concern and the associated maximum thresholds.

Constituent	Maximum Threshold(1)	Regulatory Threshold
Nitrate as Nitrogen	*5 mg/L, trigger only*	10 mg/L (Title 22)
	9 mg/L, trigger only	
	10 mg/L, MT	
Total Dissolved Solids	*210 mg/L, trigger only*	500 mg/L (Secondary MCL – Title 22)
	500 mg/L, MT	

[1] Maximum thresholds also include increases in degradation of groundwater quality of more than 1% per year, on average over 10 years, in more than 10% (or 5%) of wells in the monitoring network; and, no more than 10% (or 5%) of wells in the monitoring network exceeding these maximum thresholds.

Figure 3.4.4-1. Degraded water quality rulers for the constituents of concern in the Sierra Valley Subbasin.



Measurable objectives are provided as an example and are specific to each well in the monitoring network.

3.4.4.6 Measurable Objectives

Measurable objectives are defined under SGMA as described previously in **Section 3.1**. Within the Subbasin, the measurable objectives for water quality are established to provide an indication of desired water quality at levels that are sufficiently protective of beneficial uses and users. Measurable objectives are defined on a well-specific basis, with consideration for historical water quality data.

3.4.4.6.1 Description of Measurable Objectives

The groundwater quality measurable objectives for wells within the GSA monitoring network, where the concentrations of constituents of concern historically have been below the maximum thresholds for water quality in recent years, is to continue to maintain concentrations at or below the current range, as measured by long-term trends. For wells where the concentrations of constituents of concern have ever historically exceeded or been equal to the maximum thresholds, the measurable objective is 90% of the maximum threshold To establish a quantitative measurable objective that protects uses and users from unreasonable water quality degradation, the GSA has decided to establish a list of constituents of concern. The measurable objective is defined using those constituents of concern, which include nitrate and TDS.

Specifically, for these constituents of concern, the measurable objective is to maintain groundwater quality at a minimum of 90% of wells monitored for water quality within the range of the water quality levels measured over the past 30 years (1990-2020). In addition, no significant increasing long-term trends should be observed in levels of constituents of concern.

3.4.4.7 Path to Achieve Measurable Objectives

The GSA will support the protection of groundwater quality by monitoring groundwater quality conditions and coordinating with other regulatory agencies that work to maintain and improve the groundwater quality in the Subbasin. All future projects and management actions implemented by the GSA will comply with state and federal water quality standards and Basin Plan water quality objectives and will be designed to maintain groundwater quality for all uses and users and avoid causing unreasonable groundwater quality degradation. The GSA will review and analyze groundwater monitoring data as part of GSP implementation in order to evaluate any changes in groundwater quality resulting from groundwater pumping or recharge projects (anthropogenic recharge) in the Subbasin. The need for additional studies on groundwater quality will be assessed throughout GSP implementation. The GSA may identify knowledge requirements, seek funding, and help to implement additional studies.

Using monitoring data collected as part of project implementation, the GSA will develop information (e.g., time-series plots of water quality constituents) to demonstrate that projects and management actions are operating to maintain or improve groundwater quality conditions in the Subbasin and to avoid unreasonable groundwater quality degradation. Should the concentration of a constituent of interest increase to its measurable objective (or a trigger value below that objective specifically designated by the GSA) as the result of GSA project implementation, the GSA will implement measures to address this occurrence. This process is illustrated in **Figure 3.4.4-2**.

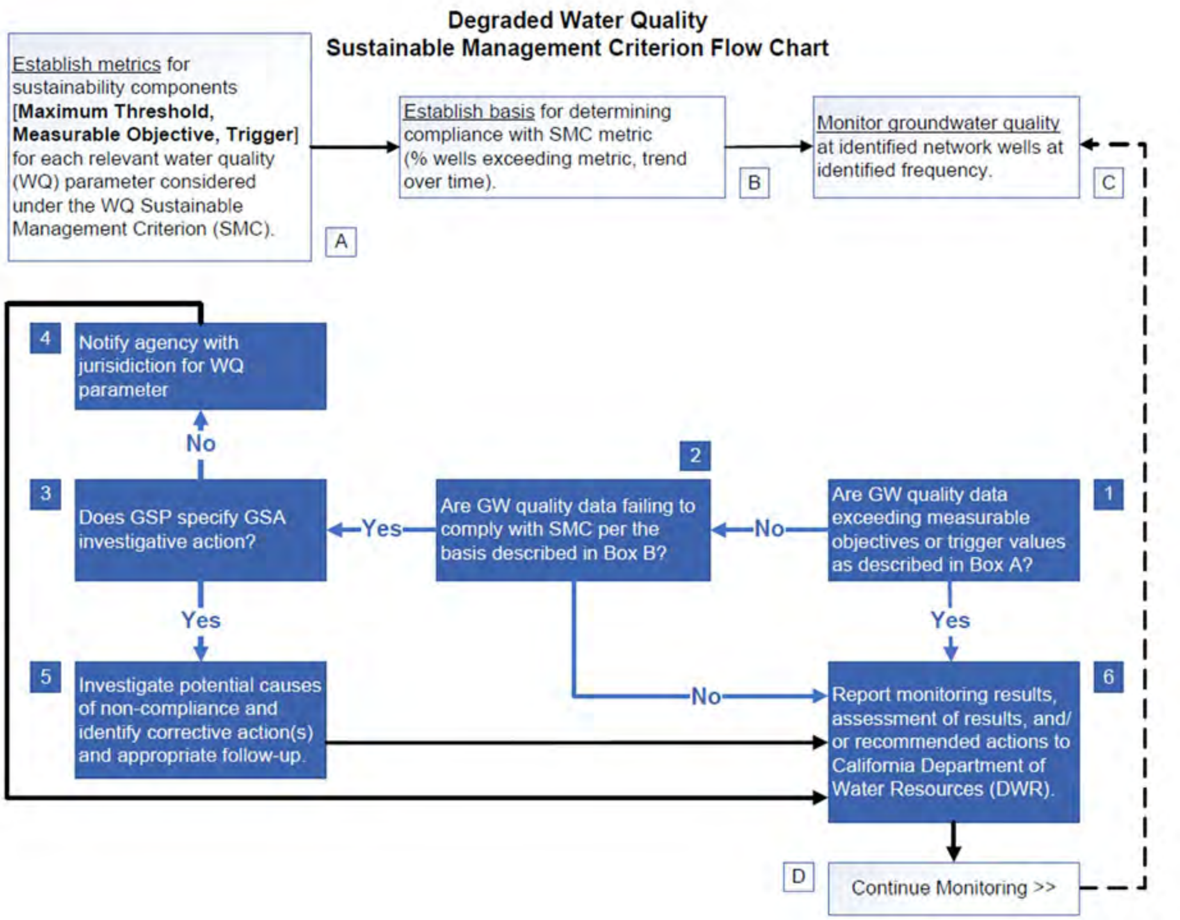
If a degraded water quality trigger is exceeded, the GSA will investigate the cause and source and implement management actions as appropriate. Where the cause is known, projects and management actions along with stakeholder education and outreach will be implemented. Examples of possible GSA actions include notification and outreach to impacted stakeholders, alternative placement of groundwater recharge projects, and coordination with the appropriate water quality regulation agency. Projects and management actions are presented in further detail in **Chapter 4**.

Exceedances of nitrate, and TDS will be referred to the CVRWQCB. Where the cause of an exceedance is unknown, the GSA may choose to conduct additional or more frequent monitoring.

3.4.4.7.1 Interim Milestones

As existing groundwater quality data indicate that groundwater in the Subbasin generally meets applicable state and federal water quality standards for nitrate and TDS, the objective is to maintain existing groundwater quality. Interim milestones are therefore set to maintain groundwater quality equivalent to the measurable objectives established for nitrate and TDS, with the goal of maintaining water quality within the historical range of values.

Figure 3.4.4-2. Degraded water quality sustainable management criteria flow chart.



The flow chart depicts the high-level decision making that goes into developing sustainable management criteria (SMC), monitoring to determine if criteria are met, and actions to be taken based on monitoring results.

3.4.5 Land Subsidence

NOTE TO REVIEWERS: This section will be developed more fully once groundwater elevation SMCs are developed. The general approach to determining SMCs for land subsidence is provided below.

3.4.5.1 Measurable Objective for Land Subsidence Sustainability Indicator (Reg. § 354.30)

While there are InSAR satellite based measures of land subsidence for the Sierra Valley groundwater basin, they are not long term measurements or do they necessarily represent measurements of only inelastic subsidence since they represent total subsidence, which includes elastic subsidence. Other ground-based data are not conclusive of long-term, inelastic subsidence either. As such, there is generally a lack of adequate, basin-specific information correlating the detailed, long-term connection between land subsidence and groundwater levels over a long period of time. However, Poland and Davis (1969) reported the land subsidence to groundwater level decline ratio is approximately 0.01 to 0.2 foot of subsidence per foot of groundwater level decline, which suggests that there is already a rough correlation that could be refined in time for this Basin's subsidence SMC. Therefore, groundwater levels are the only long-term measure of land subsidence for the Basin at present. For now, the GSP will start initially with the groundwater elevation proxy for inelastic land subsidence. Eventually, after demonstrating more robust correlations with different subsidence data types, an adaptive, composite methodology for assessing inelastic land subsidence will be developed instead of only utilizing a groundwater level proxy. This will entail the usage of groundwater levels, ground-based elevation surveys, and satellite-based InSAR data.

23 CCR §354.30(d) states: "An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence."

This allows the GSA to choose to adopt changes in groundwater level as a proxy for changes in inelastic land subsidence. The measurable objective for land subsidence for this GSP is the measurable objective for groundwater levels as detailed in Section 3.4.1. Protecting against chronic lowering of groundwater levels will directly protect against inelastic land subsidence as the lowering of groundwater levels would directly lead to inelastic land subsidence.

As groundwater levels are used as a proxy measurement for land subsidence, the margin of safety for inelastic land subsidence measurable objective is the margin of safety for the groundwater level measurable objection as detailed in Section 3.4.1.

The interim milestones for the inelastic land subsidence sustainability indicator are the same measurable objectives and interim milestones as for the chronic lowering of groundwater levels sustainability indicator detailed in Section 3.4.1.

Management areas are not planned for this GSP at this time. The measurable objectives and associated interim milestones apply to the entire subbasin area.

3.4.5.2 Minimum Thresholds for Land Subsidence Sustainability Indicator (Reg. § 354.28)

For this Basin, there is generally a lack of adequate information detailing the lithology of the aquifer and aquitard units and the long-term trend in inelastic land subsidence across the Basin to properly assess inelastic land subsidence. Although satellite-based InSAR data are useful for assessing total land subsidence, these data only cover the most recent of previous few years, but will continue indefinitely to be released during the implementation period by DWR for GSA usage. The future method desired for this Basin for calculating the minimum threshold (MT) is a function consisting of groundwater elevation proxy, InSAR land subsidence, and ground-based survey data. The goal is for the MT to be adaptive in the future once more data can be collected, compared, and correlated together to yield a more robust MT.

23 CCR §354.28(d) states: "An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence."

This allows the GSA to choose to adopt changes in groundwater level as a proxy for changes in inelastic land subsidence. The quantitative measurement for inelastic land subsidence would be through the proxy measurement of groundwater levels as detailed in Section 3.4.1. The minimum threshold for inelastic land subsidence for this GSP is the minimum threshold for groundwater levels as detailed in Section 3.4.1. Protecting against chronic lowering of groundwater levels will directly protect against inelastic land subsidence as the chronic lowering of groundwater levels would directly lead to inelastic land subsidence. Additionally, Poland and

Davis (1969) reported the land subsidence to groundwater level decline ratio is approximately 0.01 to 0.2 foot of subsidence per foot of groundwater level decline, which suggests that there is already a rough correlation that could be refined in time for this Basin's subsidence SMC.

By mainly managing groundwater pumping and avoiding the undesirable result of chronic lowering of groundwater levels, the possibility of inelastic land subsidence will be mitigated. Mitigating inelastic land subsidence through sustainably managed groundwater levels in the Basin will also mitigate undesirable impacts to other sustainability indicators. The minimum threshold proxy of stable groundwater levels will not directly lead to a degradation of groundwater quality. With stable future average groundwater levels, potential reductions to the reduction of groundwater in storage can be avoided. The depletion of interconnected surface waters can also be mitigated through the management of groundwater levels. It is possible that by mitigating chronic groundwater level declines, the proxy for inelastic land subsidence, that agricultural and urban land uses and users might be impacted in the amount of groundwater they extract. Ecological land uses and users would likely benefit in higher groundwater elevations, as generally would de-minimis domestic land uses and users as well.

There are currently no other state, federal, or local standards that relate to this sustainability indicator in the Basin.

Management areas are not planned for this GSP at this time. The minimum threshold applies to the entire subbasin area.

3.4.5.3 Undesirable Results for Land Subsidence Sustainability Indicator (Reg. § 354.26)

An undesirable result occurs when subsidence substantially interferes with beneficial uses of groundwater and surface land uses. Subsidence occurs as a result of compaction of (typically) fine-grained aquifer materials (i.e. clay) due to the overdraft of groundwater, however these aquifer materials are only moderately present in the Subbasin, mainly constricted to the western side of the Subbasin. Undesirable results would occur when substantial interference with land use occurs, including significant damage to critical infrastructure such as building foundations, roadways, other urban infrastructure elements, canals, pipes, and other water conveyance facilities, including flooding agricultural practices.

Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results could be:

- Financial impacts to all groundwater users and well owners for mitigation costs and supplemental supplies (including de minimis groundwater users and members of disadvantaged communities)
- Impacts to shallow wells due to potentially degraded water quality, requiring well treatment or abandonment
- Land subsidence causing impacts to infrastructure and/or land uses
- Lowering of groundwater levels leading to detrimental impacts to beneficial uses due to and degraded water quality including environmental uses, domestic supplies, industrial supplies, and agriculture supplies which could result in fallowing of agricultural land
- Reduction of groundwater elevations leading to a potential loss of production buffers for deeper wells for municipal, domestic, industrial, and agriculture uses, which would require deepening or replacement

3.5 References

Harter, T., K. Dzurella, G. Kourakos, A. Hollander, A. Bell, N. Santos, Q. Hart, A.King, J. Quinn, G. Lampinen, D. Liptzin, T. Rosenstock, M. Zhang, G.S. Pettygrove, and T. Tomich, 2017. Nitrogen Fertilizer Loading to Groundwater in the Central Valley. Final Report to the Fertilizer Research Education Program, Projects 11-0301 and 150454, California Department of Food and Agriculture and University of California D avis, 333p., http://groundwaternitrate.ucdavis.edu