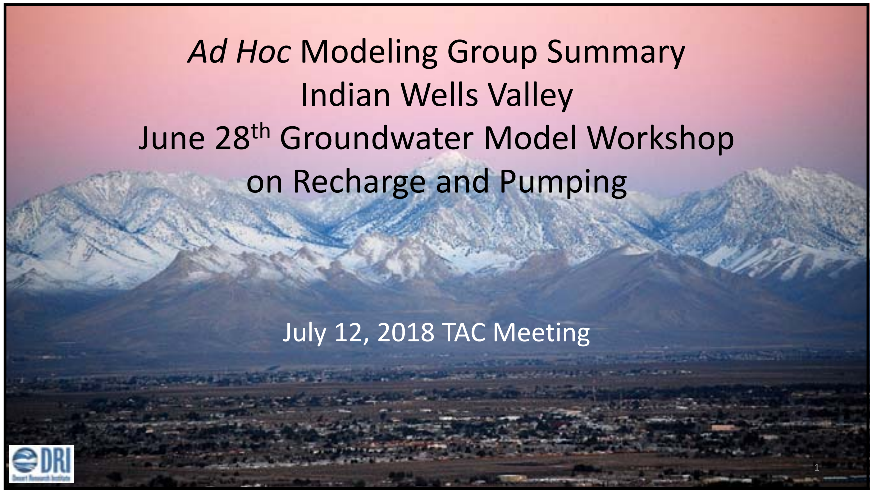
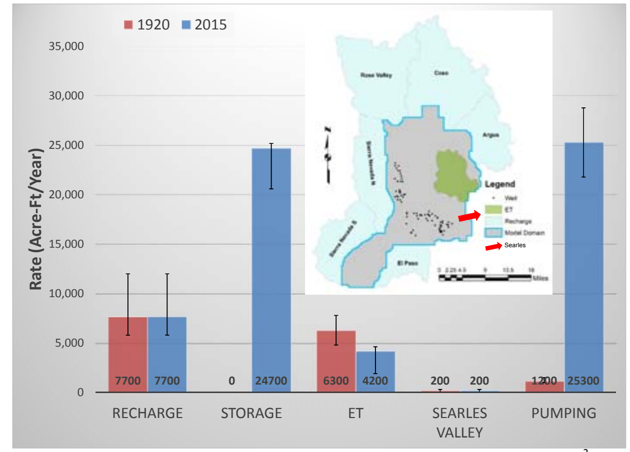
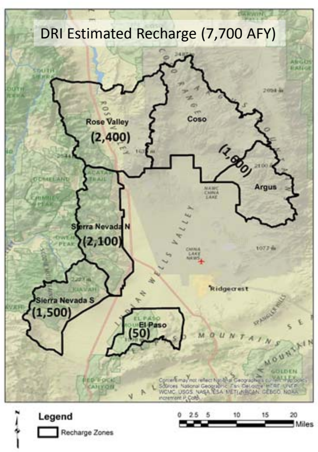
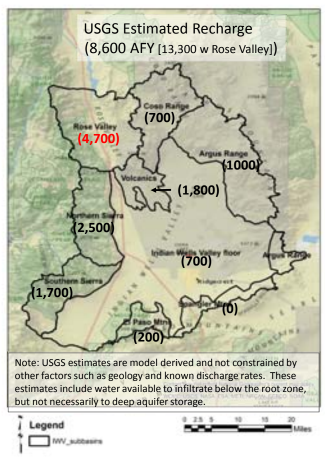


Groundwater Budget

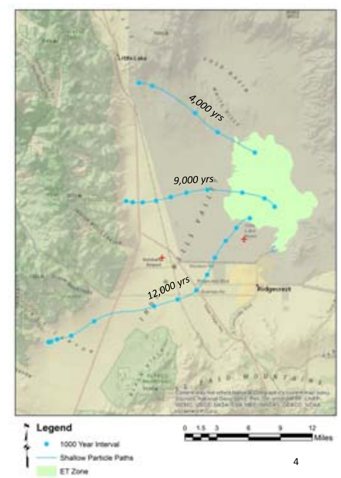






Past Recharge

- Model Reverse Particle Tracking
- Shallow travel times from
  Sierra Nevada to ET Zone
  4,000 – 12,000 years
- Deep travel times ~ 30,000 years



Recharge Estimates

Source	Sierra Nevada South (afy)	Sierra Nevada North	Rose Valley (afy)	Coso (afy)	Argus (afy)	El Paso (afy)	Total (afy)	Notes
Kunkel and Chase, 1969							11,000	Predevelopment ET Estimate
Bloyd and Robson, 1971	6,200		50	3,200		400	9,800	Calibrated Groundwater Model
Bauer, 2002			3,300					Localized Recharge Study
Daniel B. Stephens, 2011			3,900					Watershed Model
Brown and Caldwell, 2009	5,900		1,000	300	1,600	50	8,900	Assumed 15% of Precipitation Becomes Recharge
Anderson et al., 1992							4,100	Empirical Estimate
Todd Engineers, 2014	3,100 - 5,900		1,000	300	1,600	50	7,400	Reinterpretation of Existing Analysis
Epstein et al., 2010	5,200				4,100		9,300	Empirical Estimate
DRI Estimate	1,500	2,100	2,400	1,600		50	7,700	Empirical Estimates and Model Calibration
USGS Estimate (1981-2010)	1,700	2,500	4,700	700	1,000	200	8,700	BCM Model - Excludes Rose Valley
USGS Estimate (2000-2013)	2,300			500	800		6,000	BCM Model - Excludes Rose Valley

5

Alternative Recharge Conceptualization

- Recharge may be significantly lower (3,000 – 4,000 AFY) than other investigations
  - Thick clay unit may limit regional discharge at playa
  - Small hydraulic gradient in deep wells on west side
  - Chemical differences in shallow water on east side
  - Old water on both west and east side
- DRI will also evaluate a lower recharge rate in model framework
  - 4,100 AFY (Anderson, 1992)
  - Recalibrated hydraulic conductivity
  - Evaluate recent ET measurements in context of model discharge

6

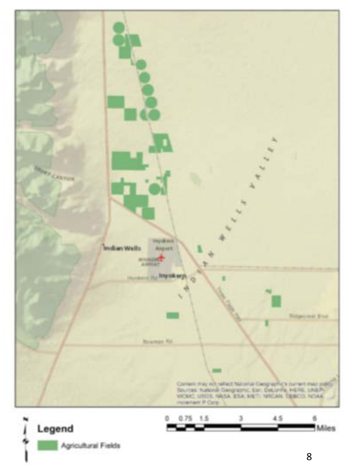
Recharge Summary

- Evaluate two recharge rates:
  - 7,700 AFY (DRI, current)
  - 4,100 AFY (Anderson, 1992)
- Send TAC comments to USGS re: BCM Recharge Study
- Use constant recharge rate in time
- Continue current climate in future

7

Annual Groundwater Pumping

- Agricultural Pumping
  - Wells are assigned pumping rates based on crop consumptive use & irrigated area
  - Irrigated area based on cropland identified in NAWS geodatabase as of 2014
- Non-Agricultural
  - Historical pumping totals for each category from:
    - 1920 to 1974, Berenbrock and Martin (USGS)
    - 1975 to 2016, IWCGMG
  - Historical data for individual wells were used if available otherwise pumping totals were divided evenly among wells



8

Pumping Summary

- Initial Pumping Estimates
  - Alfalfa = 8 ft/yr
  - Pistachio = 5 ft/yr (12-year maturation)
  - Ag pumping does not include irrigation inefficiencies or salt leaching
  - Domestic wells = 1 AFY
- Monthly rates
  - Ag based on monthly k_c curves
  - Other categories based on 2015/2016 data
- Addressed discrepancies between modeled and pumping assessment data package
- Request clarification from Ag pumpers (Eddie)
- Provide edits for Pumping Assessment Data Table 1
- Future growth from Ridgecrest's 2015 UWMP

9

Modeling Schedule

Direct Model Item for the GSP	Start	Presentation / Submittal
IWV Basin Model: Model Update and Calibration TAC Model Workshops re: Historical & Baseline Recharge and Pumping Historical Calibration Historical Model Run and Water Budget	 May 2018	 Jun 2018 workshop Aug 2018 workshop Oct 2018 TAC mtg
MODEL: Baseline through 2070 Baseline Model Assumptions and Water Budget Baseline Model Run and Water Budget	Sep 2018	 Oct 2018 TAC mtg Dec 2018 TAC mtg
MODEL: (4) Sustainable Management Alternatives through 2070 Monthly TAC discussion of Model Alternatives and Model Results	 Nov 2018	 Feb 2019
MODEL: Transport and Land Subsidence Analysis	Feb 2019	May 2019

July 12, 2018 TAC Meeting Agenda Item 4a

The following text was reformatted from emails sent from Don Decker to Jean Moran. These comments are included to provide more information on discussions that were had at the 6/28/2018 ad hoc committee model workshop re: recharge and pumping. Some of these comments have already been incorporated into the summary slides being presented at the July 12th TAC meeting.

From: Don Decker **Sent:** Thursday, July 5, 2018 11:02 PM
Jean, your slides are a summary of an IWV basin model that does not include the dramatic effects of the Pleistocene pluvial events that we know did occur. There are many other Basin aspects that are not fully understood but which are certainly in play.
1) The DRI playa discharge indicated for modern time may be supported by DRI's direct measurements but either the playa discharge from the deep aquifer that we are pumping is negligible or the Tetra Tech data supporting the Beneficial Use Change Report supplied to Lahontan is incorrect in its primary conclusion.
2) As far as modern recharge from the main Sierra Canyons, Coso volcanics and the El Pasos and the Southern Sierras there is no evidence of such water actually contained in the groundwater of the main IWV Basin. There is little to no chemical similarity, and there is certainly not anything but a minor potential recharge component apparent in the Sierra and other canyons today.
3) in examining the DRI recharge map, the so called "El Paso" fault restricts recharge not only from the west side of the El Paso Mtns, but from the Southern Sierra canyons and Freeman gulch. This was discussed at the ad hoc meeting.
4) There is also no evidence of significant Sierra fracture flow.
5) The AB303 Final Report and TetraTech have measured relatively old groundwater in areas quite close to the presumed canyon fan recharge areas with no newer water at any depth in the wells sampled which included Bureau of Reclamation 2,000 ft wells.
6) The realization that the assumed IWV Basin recharge is too high (7700 ac-ft) and that the Playa discharge is also too high is also evidenced by the systematic spatial differences in the DRI model residuals as plotted in Figure 11 of the DRI updated flow model dated Nov 2017. This plot is a striking representation of the consequences of the assumptions of the present DRI "classic" IWV Basin model. None of the observations, items 1) through 6) are new and most were summarized with references in my Dec 11, 2017 report to Stetson.

We spent about half of our 5 hours in our review last week discussing these issues. I suggest that your slides should contain at least some of the content of those discussions. I do realize that much of the Pleistocene pluvial effects are not fully documented including the evidence that much of our Basin alluvial fill was placed in such events. I asked the question last week but no one as I recall really had an answer. How do we properly account for aspects of the basin hydrology that we have good evidence for that have not been published? Ignoring these aspects is certainly not professional.

If the transmissivity is so low as to result in transit time from the Sierras to the Playa of say 9,000 years, this means that recharge has no significant role in the design of a sustainability plan that is played out over decades. We are in this case always mining water and the plan will be based on limiting pumping impacts. Since we have limited areas of high quality water to pump, spreading out pumping is not possible and limiting pumping itself is the only local remedy. One area that DRI could productively reexamine is the transmissivity data obtained from slug tests in BoR wells in comparison the values being used by DRI in the present model.

To summarize Jean, I suggest

1) that your slides contain some of the detailed discussion from last week that is contrary to the standard IWV groundwater model.
2) make it clear why we agreed there should be a 4100 ac-ft/yr recharge model trial.
3) mention that DRI will reexamine the model playa discharge and transmissivities employed.
4) I suggest mention that if playa discharge is found to be significantly lower than estimated, the basin water balance will require a reduction in estimated recharge.
5) although you have included the USGS recharge summary map you have not provided any mention of the strong criticism of the same that was offered at the ad hoc meeting. I suggest you need a slide to do so. If you need some detail here I can give you a few important points.
6) I suggest that the Pleistocene pluvial article that you mention below be supplemented by two additional related papers that I provided as part of the Sierra Canyons field trips that many TAC members were able to participate in.

1) *Late Pleistocene lakes and wetlands, Panamint Valley, Inyo County, California The Geological Society of America, Special Paper 439, 2008.* Detailed discussion of the evidence for multiple episodes of Pleistocene lacustrine deposition in Panamint Valley. Some chronology stated that relates directly to circumstances in the IWV.
2) *Structural Geology and Volcanism of Owens Valley Region, California The Geological Society of America, Special Paper 438, 2008.* Useful reference paper to Owens Valley including late Pleistocene lake geologic features. Discussion of Owens Lake flooding episodes with relationship to China Lake, Searles and Panamint Valleys.

I also did not offer any corrections to the Stetson slides as were brought up at the ad hoc meeting. Here are some corrections that should be made: 1) Slide "Estimated Recharge", the USGS map represents model derived surface water estimates and such water is not directly related to groundwater recharge at all. This modeled water is not recharge in spite of the use of the term. This clarification needs to be made on the slide. 2) Slide "Pumping Summary". The application values 5 and 8 ac-ft/yr for pistachios and alfalfa are defensible but do not include irrigation inefficiencies nor water used to control soil salt buildup. The actual application rates will be larger than 5 and 8 ac-ft/yr. After domestic wells it should read 1 ac-ft/yr.

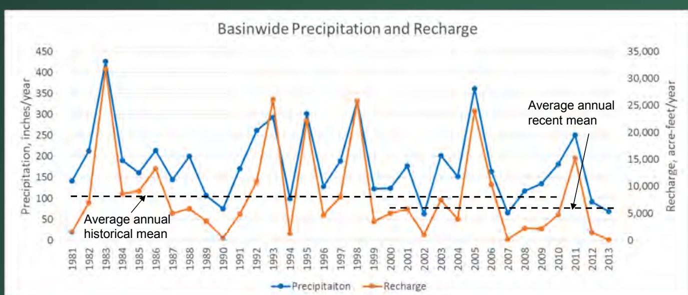
Best regards, Don D.

Estimating Natural Recharge in Indian Wells Valley
Final Progress Report, June 21, 2018

Dina Saleh, Lorrie Flint, and Alan Flint
U.S. Geological Survey
California Water Science Center

Objectives

- Locally calculate the water balance with the newly revised Basin Characterization Model in Indian Wells Valley to estimate natural recharge by constraining all components of the water balance
- Provide validation from multiple sources to increase confidence in estimates
- Evaluate historical and future patterns of natural recharge and evaporative demand in the valley



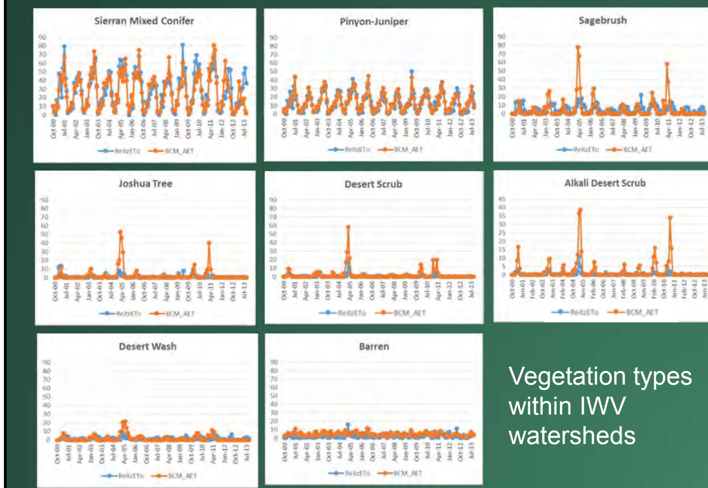
All numbers in acre-feet per year

Data Source	Recharge from Sierra Nevada	Recharge from Coso Range	Recharge from Argus Range	Recharge from El Paso Mountains	Recharge from Volcanics	Inflow from Rose Valley	Total Natural Recharge
Lee (1913)	27,000				----	----	27,000
Thompson (1929)	39,000				----	10,000	39,000
Kunkel and Chase (1969)	----	----	----	----	----	----	----
Bloyd and Robson (1971)	6,235	3,160		400	----	45	9,795
Dutcher and Moyle (1973)	----	----	----	----	----	----	----
St. Amand (1986)	----	----	----	----	----	----	----
Austin (1988)	at least 30,000	----	----	----	----	----	----
Bean (1989)	6,300	2,000	1,000	400	----	400	9,700
Berenbrock and Martin (1991)	6,236	3,170		400	----	43	9,806
Watt (1993)	8,876	975		0	----	----	9,851
Thyne and others (1999)	8,026	----	----	----	----	1,297	8,026
Bauer (2002)	----	----	----	----	----	3,300	----
Brown and Caldwell (2009)	5,890	300	1,600	50	----	1,000	7,840
Todd (2014)	3,090 to 5,890	300	1,600	50	----	1,000	9,806
Reitz and others (2016)	----	----	----	----	----	----	7,325
USGS (2018) local calibration (1981-2010)	**4,181**	**741**	**1,006**	**186**	**1,824**	**741 valley floor**	**8,680**
USGS (2018) local calibration (2000-2013)	**2,295**	**536**	**829**	**144**	**1,575**	**597 valley floor**	**5,976**

Indian Wells Valley Recharge for Sub-basins

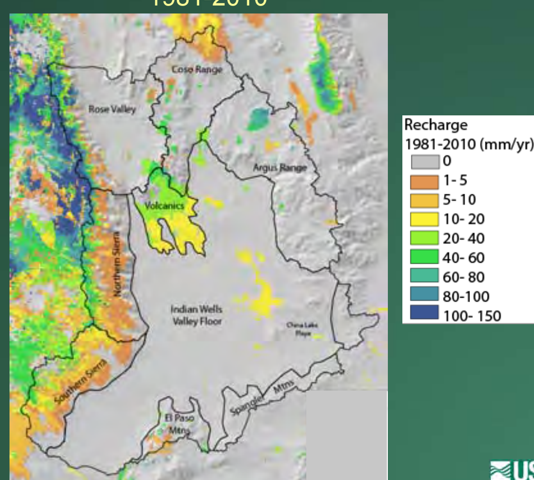
Sub-Basins	Area (km²)	Mean Recharge (mm)	Mean Recharge (acre-feet)
Northern Sierra	256	12.1	2,518
Southern Sierra	250	8.2	1,663
Coso Range	289	3.2	741
Volcanics	130	17.4	1,824
Argus Range	512	2.4	1,006
Spangler Mtns	105	0.0	--
El Paso Mtns	80	2.9	186
Indian Wells Valley floor	1,583	0.6	742
Rose Valley	414	13.9	4,674
Total w/o Rose Valley			**8,680**

Comparison of Actual Evapotranspiration Estimates



Vegetation types within IWV watersheds

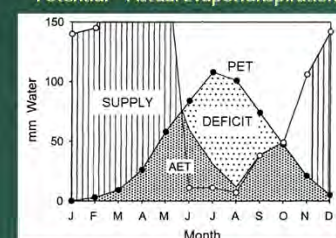
Average Annual Historical Recharge 1981-2010



Climatic Water Deficit

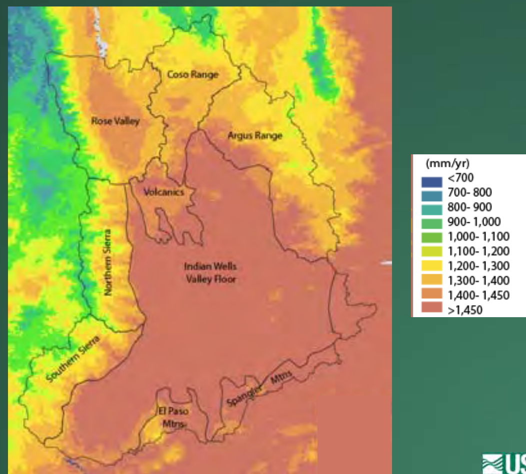
Annual evaporative demand that exceeds available water

Potential – Actual Evapotranspiration



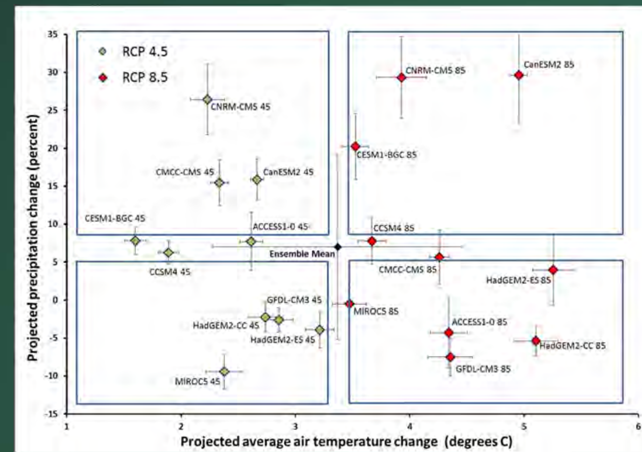
- Integrates climate, energy loading, drainage, and available soil moisture storage
- Vegetation independent (indicator)
- Address irrigation demand
- Generally increases with all future climate scenarios

Average Annual Historical Climatic Water Deficit 1981-2010



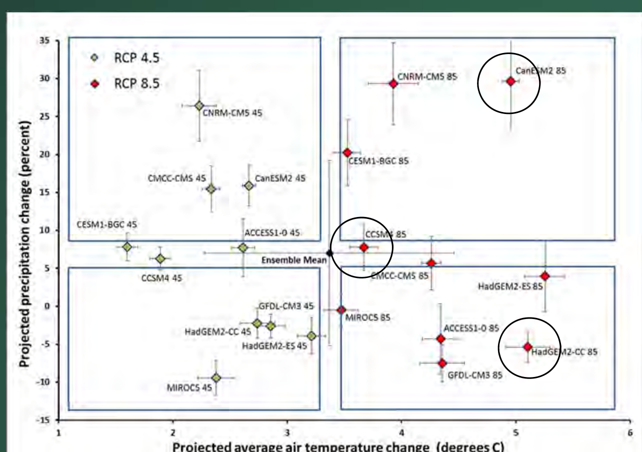
USGS

Projected changes in future climate



USGS

Projected changes in future climate



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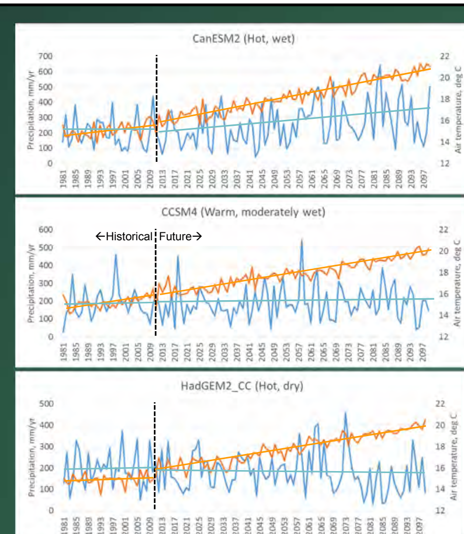
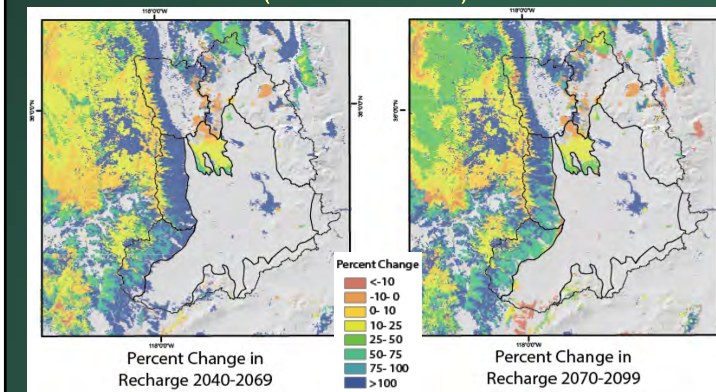


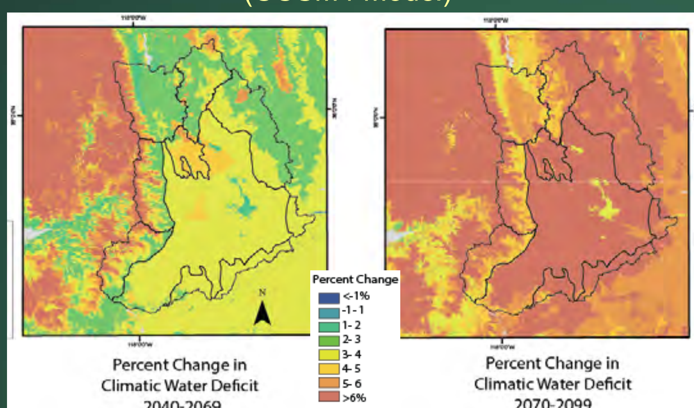
Projected change in climate

			Precipitation, mm/year				Air temperature, deg C		
			CanESM2	CCSM4	HadGEM2_CC		CanESM2	CCSM4	HadGEM2_CC
1981-2010	mean	180.2				16.3			
	SD	88.4				0.7			
			Percent change from 1981-2010				Change from 1981-2010		
2040-2069	mean		27	7	2		3.1	2.6	2.9
	SD		30	31	2		0.0	-0.1	0.1
2070-2099	mean		47	7	-22		4.9	4.0	4.4
	SD		39	-4	16		0.1	0.1	0.0

Future Projected Recharge (CCSM4 Model)



Future Projected Climatic Water Deficit (CCSM4 Model)



			Recharge, acre-feet/year				Climatic water deficit, mm/year		
			CanESM2	CCSM4	HadGEM2_CC		CanESM2	CCSM4	HadGEM2_CC
1981-2010	mean	8,680				1,393			
	SD	8,747				78			
			Percent change from 1981-2010				Percent change from 1981-2010		
2040-2069	mean		92	42	11		4	4	5
	SD		67	50	34		21	15	-17
2070-2099	mean		138	35	-28		6	6	9
	SD		91	12	41		33	-11	-13

Results and Discussion

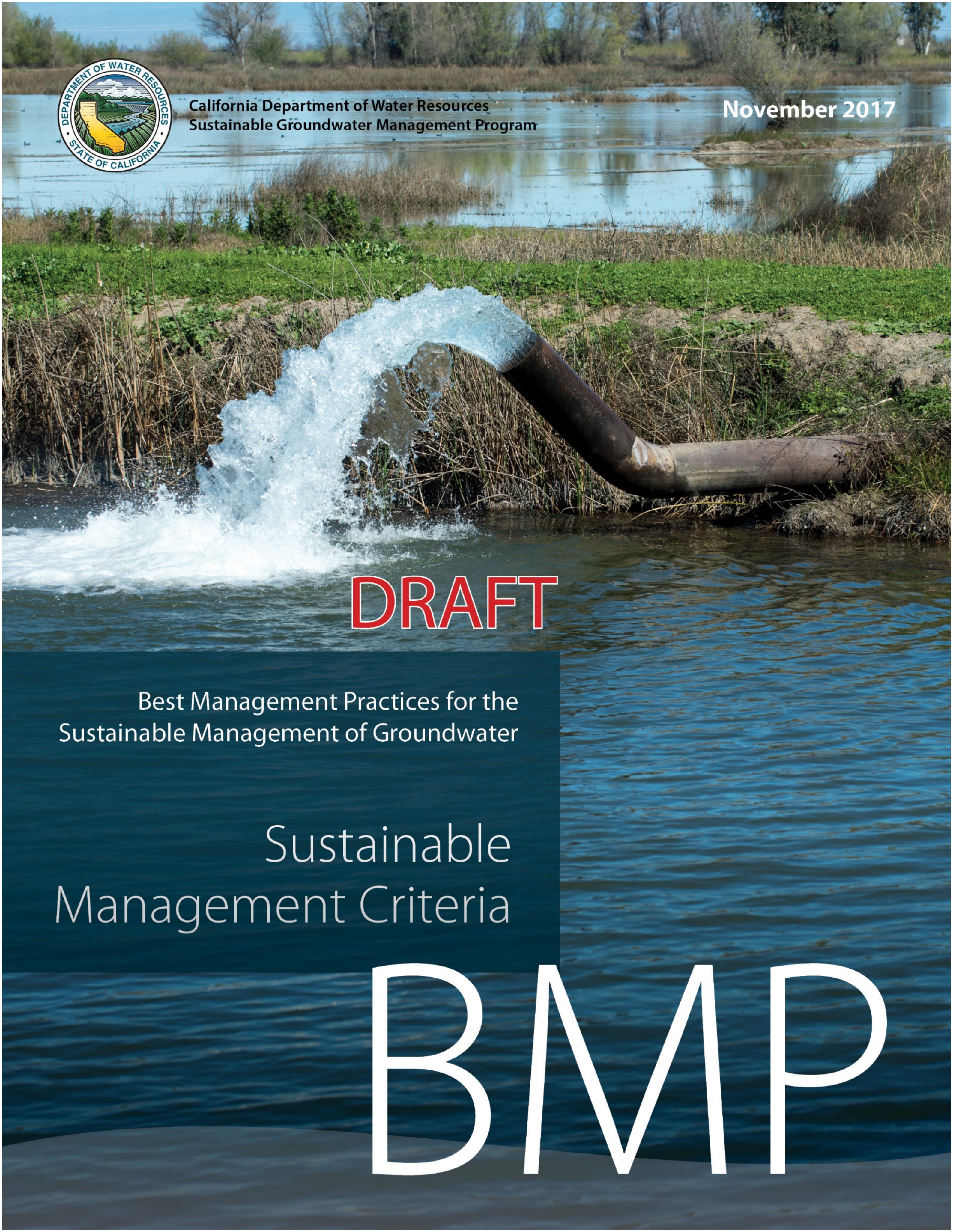
- Final recharge estimates for Indian Wells Valley from local calibration to optimize the water balance has similar values as recent studies, providing a general consensus for long term averages.
- Spatial distribution of natural recharge is a function of climate, geology, soil storage, and vegetation type
  - Most recharge comes from the Sierra Nevada, Argus Range, and volcanics.
- Three global climate models for future climate analysis were selected, CanESM2 (hot and wet), CCSM4 (hot with moderate precipitation), and HadGEM2_CC (hot and dry).

Results and Discussion

- Models show increase in climatic water deficit through end of the century, with a maximum of about 6% for the hottest scenario, suggesting that increases in irrigation demand will not increase much above those of today.
- Changes in projected recharge among models show a large degree of variability as a result of the lack of model consensus on precipitation, with increases in recharge through mid-century for all models, and reductions by end of century for the hot dry model.
- Increases in the annual variability of recharge occur for all models for all time periods in comparison to historical variability.

Progress to date

- Local calibration to calculate natural recharge for the Indian Wells Valley is complete.
- Three future climate projections were processed and evaluated.
- USGS data release is complete is and undergoing USGS review.
- USGS journal article on results of study is being prepared and should be complete, submitted to a journal, and available for cooperator comment by September 30th, 2018.



California Department of Water Resources
Sustainable Groundwater Management Program

November 2017

DRAFT

Best Management Practices for the
Sustainable Management of Groundwater

Sustainable Management Criteria

BMP

Sustainable Management Criteria Best Management Practice

1. OBJECTIVE

The Department of Water Resources (the Department) developed this Best Management Practice (BMP) document to describe activities, practices, and procedures for defining the sustainable management criteria required by the Groundwater Sustainability Plan Regulations (GSP Regulations).[1] This BMP characterizes the relationship between the different sustainable management criteria – the *sustainability goal*, *undesirable results*, *minimum thresholds*, and *measurable objectives* – and describes best management practices for developing these criteria as part of a Groundwater Sustainability Plan (GSP).

The Sustainable Groundwater Management Act (SGMA)[2] and GSP Regulations specify the requirements of a GSP. This BMP does not impose new requirements, but describes best management practices for satisfying the requirements of SGMA and the GSP Regulations. A Groundwater Sustainability Agency (GSA) is not required to follow this BMP when developing a GSP, but whatever methodology is adopted by a GSA must be reasonable and supported by the best available information and best available science.[3] While this document describes methods by which a GSA may approach the task of establishing sustainable management criteria recommended as best management practices by the Department, adopting the methods recommended in this BMP does not guarantee approval of the resulting GSP by the Department.

Examples provided in this BMP are intentionally simplified and are intended only to illustrate concepts. GSAs should not consider the level of detail in any of these simplified examples (e.g., the number of minimum thresholds defined in a hypothetical basin, the number of minimum thresholds that constitute an undesirable result, etc.) to be appropriate for their GSP.

2. INTRODUCTION

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.[4] The avoidance of undesirable results is thus critical to the success of a GSP.

GSP Regulations collect together several requirements of a GSP under the heading of "Sustainable Management Criteria" in Subarticle 3 of Article 5.[5] Sustainable management criteria include:

- **Sustainability Goal**

- **Undesirable Results**
- **Minimum Thresholds**
- **Measurable Objectives**

The development of these criteria relies upon information about the basin developed in the *hydrogeologic conceptual model*, the description of current and historical groundwater conditions, and the *water budget*.

Key terms are *italicized* the first time they are presented, indicating that a definition for the term is provided in the Key Definitions section located at the end of this document.

SGMA REQUIREMENT TO QUANTIFY SUSTAINABILITY

The enactment of SGMA in 2014 was a landmark effort to manage California's groundwater in a sustainable manner. The SGMA legislation established definitions of undesirable results, introduced the statutory framework and timelines for achieving sustainability, and identified requirements that local agencies (i.e. GSAs) must follow to engage the beneficial uses and users of groundwater within a basin, among many other important topics. The GSP Regulations developed by the Department specify the documentation and evaluation of groundwater conditions within a basin and the requirements for the development and implementation of plans to achieve or maintain sustainability required by SGMA.

As described in SGMA, sustainable conditions within a basin are achieved when GSAs meet their sustainability goal and demonstrate the basin is being operated within its *sustainable yield*. Sustainable yield can only be reached if the basin is not experiencing undesirable results. The GSP Regulations focus the development of GSPs on locally-defined, quantitative criteria, including undesirable results, minimum thresholds, and measurable objectives. Undesirable results must be eliminated through the implementation of projects and management actions, and progress toward their elimination will be demonstrated with empirical data (e.g., measurements of groundwater levels or subsidence). Quantitative sustainable management criteria allow GSAs to clearly demonstrate sustainability and allow the public and the Department to readily assess progress.

Properly documenting the requirements identified in Subarticle 3, Introduction to Sustainable Management Criteria, in Article 5 of the GSP Regulations, is imperative to maintaining an outcome-based approach to SGMA implementation and must be completed for the Department to consider the approval of a GSP.

3. PRELIMINARY ACTIVITIES

A GSA will need to understand the basin's physical condition, the overlying management and legal structures, and the basin's water supplies and demands prior to developing sustainable management criteria. As a result, before a GSA begins the process of developing sustainable management criteria, the following activities should be completed:

Understand the Basin Setting

A thorough understanding of the historical and current state of the basin is necessary before sustainable management criteria can be set. Much of this understanding is gained in the development of a hydrogeologic conceptual model, water budget, and description of groundwater conditions. For more information, see the Hydrogeologic Conceptual Model BMP, Water Budget BMP, and Modeling BMP.

Inventory Existing Monitoring Programs

Minimum thresholds and measurable objectives are set at individual representative monitoring sites. GSAs should compile information from existing monitoring programs (e.g., number of wells and their construction details, which aquifers they monitor). As sustainable management criteria are set, monitoring networks may need to be expanded and updated beyond those used for existing, pre-SGMA monitoring programs. Additional information on monitoring networks is included in the Monitoring Networks and Identification of Data Gaps BMP.

Engage Interested Parties within the Basin

When setting sustainable management criteria, GSAs must consider the beneficial uses and users of groundwater in their basin. Consideration of the potential effects on beneficial uses and users underpin the minimum thresholds. GSAs must explain their decision-making processes and how public input was used in the development of their GSPs. There are specific SGMA requirements for GSAs to engage with interested parties within a basin. For more information about requirements of engagement, refer to the Stakeholder Communication and Engagement Guidance Document.

4. SETTING SUSTAINABLE MANAGEMENT CRITERIA

This section describes the development of sustainable management criteria. The section is organized as follows:

- Assessment of *sustainability indicators*, significant and unreasonable conditions, *management areas*, and representative monitoring sites
- Minimum thresholds
- Undesirable results
- Measurable objectives
- Sustainability goal

This organization follows a chronological ordering that GSAs can use as they plan for sustainable management criteria development, although they do not have to proceed in that order. Furthermore, setting sustainable management criteria will likely be an iterative process. Initial criteria may need to be adjusted to address potential effects on the beneficial uses and users of groundwater, land uses, and property interests. The GSA should evaluate whether the sustainable management criteria, as a whole, adequately characterize how and when significant and unreasonable conditions occur, and define a path toward sustainable groundwater management in the basin.

ASSESSMENT OF SUSTAINABILITY INDICATORS, SIGNIFICANT AND UNREASONABLE CONDITIONS, MANAGEMENT AREAS, AND REPRESENTATIVE MONITORING SITES

Sustainability Indicators

Sustainability indicators are the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, become undesirable results.[6] Undesirable results are one or more of the following effects:

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods
- Significant and unreasonable reduction of groundwater storage
- Significant and unreasonable seawater intrusion
- Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies

- Significant and unreasonable land subsidence that substantially interferes with surface land uses
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water

The significant and unreasonable occurrence of any of the six sustainability indicators constitutes an undesirable result.

The default position for GSAs should be that all six sustainability indicators apply to their basin. If a GSA believes a sustainability indicator is not applicable for their basin, they must provide evidence that the indicator does not exist and could not occur. For example, GSAs in basins not adjacent to the Pacific Ocean, bays, deltas, or inlets may determine that seawater intrusion is not an applicable sustainability indicator, because seawater intrusion does not exist and could not occur. In contrast, simply demonstrating that groundwater levels have been stable in recent years is not sufficient to determine that land subsidence is not an applicable sustainability indicator. As part of the GSP evaluation process, the Department will evaluate the GSA's determination that a sustainability indicator does not apply for reasonableness.

Sustainability Indicators in the Context of SGMA versus the California Water Plan

The term "sustainability indicator" is used in GSP regulations to refer to "any of the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, cause undesirable results, as described in Water Code Section 10721(x)." It is important to note that the term 'sustainability indicator' is not unique to SGMA. The California Water Plan Update 2013 includes a California Water Sustainability Indicators Framework that uses the term 'sustainability indicator' in a way that differs from SGMA. Sustainability indicators in the context of the California Water Plan inform users about the relationship of water system conditions to ecosystems, social systems, and economic systems.

Water managers and users should not confuse sustainability indicators in the context of SGMA with sustainability indicators associated with the California Water Plan or with any other water management programs.

Significant and Unreasonable Conditions

GSAs must consider and document the conditions at which each of the six sustainability indicators become significant and unreasonable in their basin, including the reasons for justifying each particular threshold selected. A GSA may decide, for example, that localized inelastic land subsidence near critical infrastructure (e.g., a canal) and basinwide loss of domestic well pumping capacity due to lowering of groundwater levels are both significant and unreasonable conditions. These general descriptions of significant and unreasonable conditions are later translated into quantitative undesirable results, as described in this document. The evaluation of significant and unreasonable conditions should identify the geographic area over which the conditions need to be evaluated so the GSA can choose appropriate representative monitoring sites.

Use of Management Areas

A GSA may wish to define *management areas* for portions of its basin to facilitate groundwater management and monitoring. Management areas may be defined by natural or jurisdictional boundaries, and may be based on differences in water use sector, water source type, geology, or aquifer characteristics. Management areas may have different minimum thresholds and measurable objectives than the basin at large and may be monitored to a different level. However, GSAs in the basin must provide descriptions of why those differences are appropriate for the management area, relative to the rest of the basin.

Using the land subsidence example from the preceding subsection, GSAs in the hypothetical basin may decide that a management area in the vicinity of the canal is appropriate because the level of monitoring must be higher in that area, relative to the rest of the basin. GSAs may also desire to set more restrictive minimum thresholds in that area relative to the rest of the basin.

While management areas can be used to define different minimum thresholds and measurable objectives, other portions of the GSP (e.g., hydrogeologic conceptual model, water budget, notice and communication) must be consistent for the entire GSP area.

Representative Monitoring Sites

Representative monitoring sites are a subset of a basin's complete monitoring network, where minimum thresholds, measurable objectives, and *interim milestones* are set. Representative monitoring sites can be used for one sustainability indicator or multiple sustainability indicators. **Figure 1** shows how different combinations of representative monitoring sites can be used to assess seawater intrusion and lowering of groundwater levels in a hypothetical groundwater basin.

GSAs can only select representative monitoring sites after determining what constitutes significant and unreasonable conditions in a basin. Using the example discussed in the preceding subsections, the GSA would use a different combination of representative monitoring sites for localized inelastic land subsidence than it would for basinwide groundwater level decline. The GSA must explain how the combination of representative monitoring sites selected for each sustainability indicator can assess the significant and unreasonable groundwater condition.

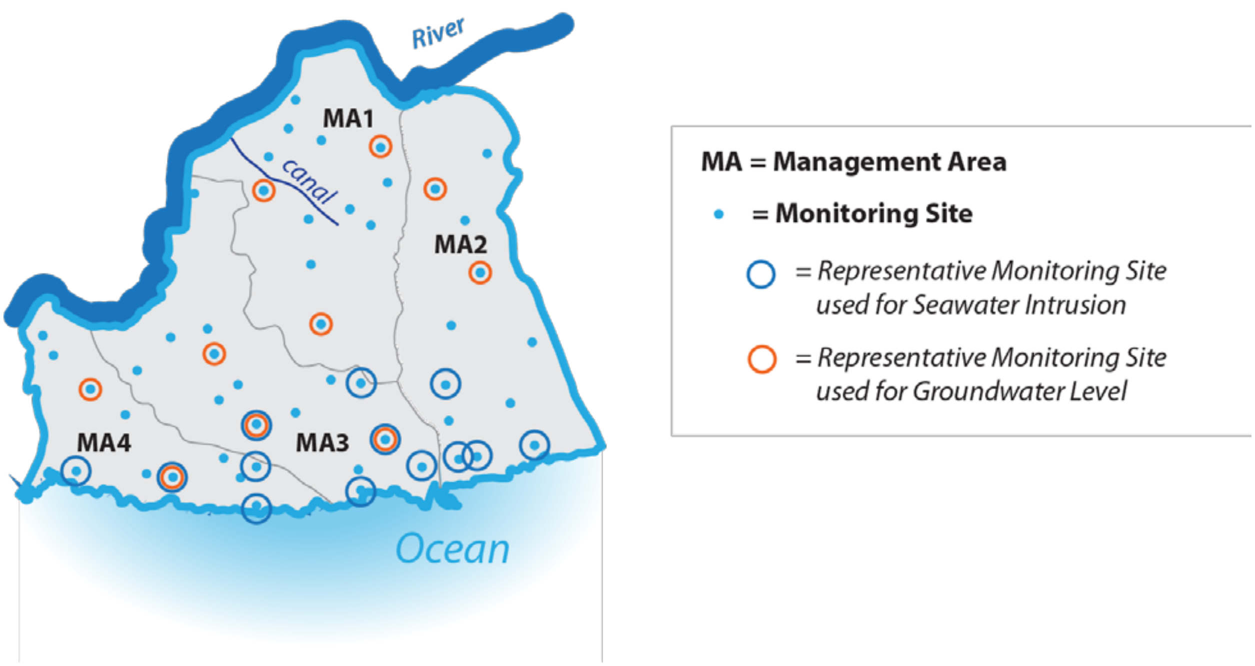


Figure 1. Example Monitoring Network and Representative Monitoring Sites

MINIMUM THRESHOLDS

A minimum threshold is the quantitative value that represents the groundwater conditions at a representative monitoring site that, when exceeded individually or in combination with minimum thresholds at other monitoring sites, may cause an undesirable result(s) in the basin. GSAs will need to set minimum thresholds at representative monitoring sites for each applicable sustainability indicator after considering the interests of beneficial uses and users of groundwater, land uses, and property interests in the basin. Minimum thresholds should be set at levels that do not impede adjacent basins from meeting their minimum thresholds or sustainability goals.

Required Components for all Minimum Thresholds

GSP Regulations require six components of information to be documented for each minimum threshold.[7] The six components (in italicized text) and considerations for how they should be addressed are as follows:

1. *The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.*

   The GSP must include an analysis and written interpretation of the information, data, and rationale used to set the minimum threshold. For instance, if a groundwater level minimum threshold is set to protect shallow domestic supply wells, the GSA should investigate information such as the depth ranges of domestic wells near the representative monitoring site, aquifer dimensions, groundwater conditions, and any other pertinent information.
2. *The relationship between the minimum thresholds for each sustainability indicator, including an explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.*

   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 water level thresholds in nearby representative monitoring sites). The GSP also must describe the relationship between the selected minimum threshold and minimum thresholds for other sustainability indicators (e.g., describe how a water level minimum threshold would not trigger an undesirable result for land subsidence).

3. *How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.*

   The GSP must describe how the minimum threshold has been set to avoid impacts to adjacent basins. This can be supported by information such as an interbasin agreement, documentation of coordination with GSAs in adjacent basins, and general descriptions of how the minimum threshold is consistent with sustainable management criteria in adjacent basins. Information provided for this component will likely be enhanced beyond the initial GSP in future annual reports and five-year updates. It may be important to inform GSAs in adjacent basins where minimum thresholds are planned and their quantitative values.
4. *How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.*

   The GSP must discuss how groundwater conditions at a selected minimum threshold could affect beneficial uses and users. This information should be supported by a description of the beneficial uses groundwater and identification of beneficial uses, which should be developed through communication, outreach, and/or engagement with parties representing those beneficial uses and users, along with any additional information the GSA used when developing the minimum threshold.
5. *How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.*

   The GSP must discuss relevant standards that pertain to the sustainability indicator and justify any differences between the selected minimum threshold and those standards. For instance, the GSP will need to justify why a different level was used if a water quality minimum threshold is set at a different level than a state or federal maximum contaminant level (MCL).
6. *How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.*

   Subarticle 4 of the GSP Regulations addresses monitoring networks. The GSP must document the metrics that will be monitored (e.g., groundwater level, groundwater quality) as well as the frequency and timing of measurement (e.g., twice per year in the spring and fall).

Descriptions for these six components are required for all minimum thresholds. However, descriptions for individual components can be shared for multiple minimum thresholds, where appropriate (e.g., in some instances a single description could be provided to describe how a group of minimum thresholds were selected to avoid causing undesirable results in an adjacent basin).

Required Minimum Threshold Metrics for Each Sustainability Indicator

In addition to the six components described above that apply to all minimum thresholds, the GSP Regulations contain specific requirements and metrics for each sustainability indicator.[8] The purpose of the specific requirements is to ensure consistency within groundwater basins and between adjacent groundwater basins.

Specific requirements for the metrics used to quantify each sustainability indicator are listed below and shown in **Figure 2**:

- The minimum threshold metric for the **chronic lowering of groundwater levels** sustainability indicator shall be a groundwater elevation measured at the representative monitoring site.
- The minimum threshold for **reduction of groundwater storage** is a volume of groundwater that can be withdrawn from a basin or management area, based on measurements from multiple representative monitoring sites, without leading to undesirable results. Contrary to the general rule for setting minimum thresholds, the reduction of groundwater storage minimum threshold is not set at individual monitoring sites. Rather, the minimum threshold is set for a basin or management area.
- The minimum threshold metric for **seawater intrusion** shall be the location of a chloride isocontour. Contrary to the general rule for setting minimum thresholds, the seawater intrusion minimum threshold is not set at individual monitoring sites. Rather, the minimum threshold is set along an isocontour line in a basin or management area.
- The minimum threshold metric for **degraded water quality** shall be water quality measurements that indicate degradation at the monitoring site. This can be based on migration of contaminant plumes, number of supply wells, volume of groundwater, or the location of a water quality isocontour within the basin. Depending on how the GSA defines the degraded water quality minimum threshold, it can be defined at a site, along the isocontour line, or as a calculated volume.
- The minimum threshold metric for **land subsidence** shall be a rate and the extent of land subsidence.
- The minimum threshold metric for **depletion of interconnected surface waters** shall be a rate or volume of surface water depletion.

Sustainability Indicators	Lowering GW Levels	Reduction of Storage	Seawater Intrusion	Degraded Quality	Land Subsidence	Surface Water Depletion
Metric(s) Defined in GSP Regulations	• Groundwater Elevation	• Total Volume	• Chloride concentration isocontour	• Migration of Plumes • Number of supply wells • Volume • Location of isocontour	• Rate and Extent of Land Subsidence	• Volume or rate of surface water depletion

Figure 2. Minimum Threshold Metrics

Examples and Considerations for Minimum Thresholds

The following provides graphical examples and considerations for use by GSAs when setting minimum thresholds. The following subsections are organized by sustainability indicator and are illustrative examples only, as GSAs may have other considerations when setting minimum thresholds.

Chronic Lowering of Groundwater Levels Minimum Threshold

Figure 3 illustrates a hypothetical groundwater level hydrograph and associated minimum threshold at a representative monitoring site. In this hypothetical example, the GSA set the minimum threshold at some level below conditions at the time of GSP submission. Note that this and many subsequent examples in this document use 2020 as the hypothetical GSP submission date. The actual GSP submission date required by SGMA varies. GSPs must be submitted by January 31, 2020 for high- and medium-priority basins determined by the Department to be critically overdrafted. All other high- and medium-priority basins must submit GSPs by January 31, 2022.

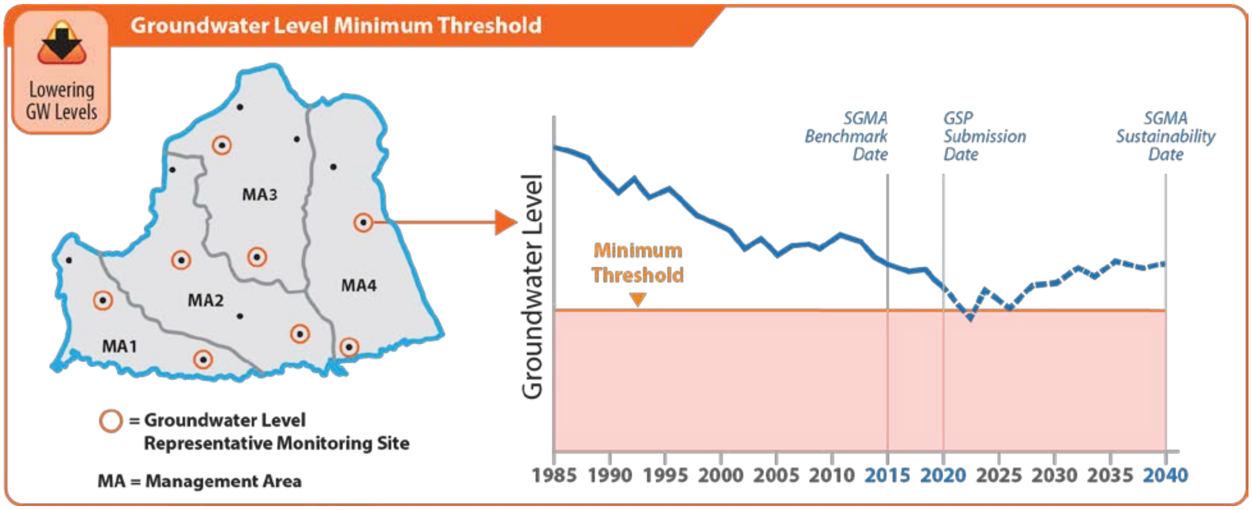


Figure 3. Example Groundwater Level Minimum Threshold Established at a Representative Monitoring Site

Considerations when establishing minimum thresholds for groundwater levels at a given representative monitoring site may include, but are not limited to:

- What are the historical groundwater conditions in the basin?
- What are the average, minimum, and maximum depths of municipal, agricultural, and domestic wells?
- What are the screen intervals of the wells?
- What impacts do water levels have on pumping costs (e.g., energy cost to lift water)?
- What are the adjacent basin's minimum thresholds for groundwater elevations?
- What are the potential impacts of changing groundwater levels on groundwater dependent ecosystems?
- Which principal aquifer, or aquifers, is the representative monitoring site evaluating?

Reduction in Groundwater Storage Minimum Threshold

Figure 4 illustrates a hypothetical graph depicting the volume of groundwater available in storage through time, and the associated minimum threshold for the basin.

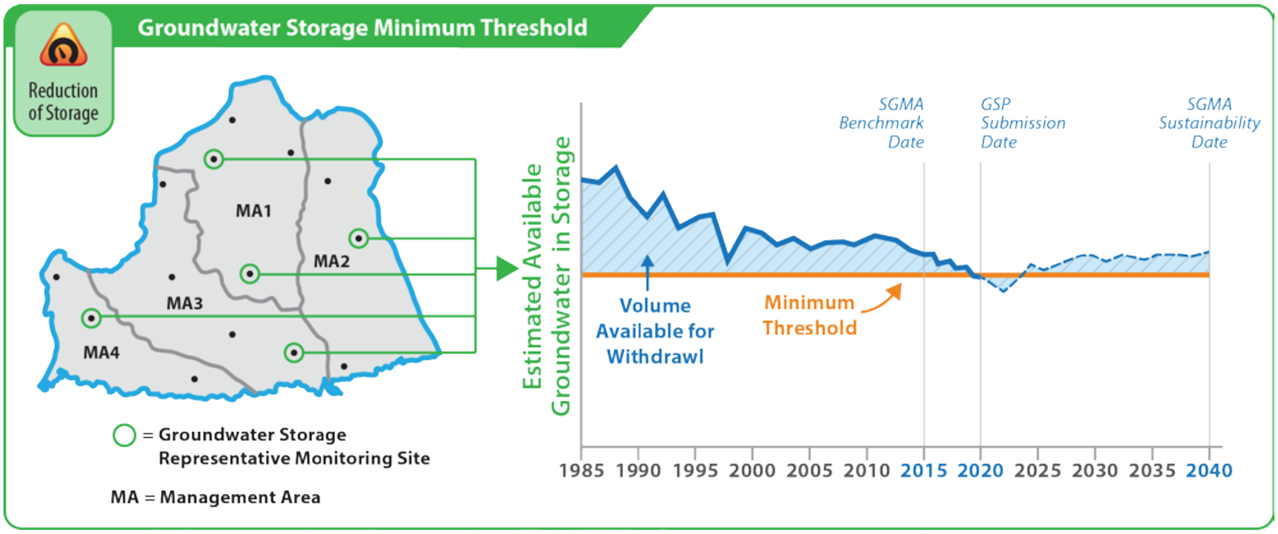


Figure 4. Example Groundwater Storage Minimum Threshold Established at the Basin Scale

Considerations when establishing the minimum threshold for groundwater storage may include, but are not limited to:

- What are the historical trends, water year types, and projected water use in the basin?
- What groundwater reserves are needed to withstand future droughts?
- Have production wells ever gone dry?
- What is the effective storage of the basin? This may include understanding of the:
  - Average, minimum, and maximum depth of municipal, agricultural, and domestic wells.
  - Impacts on pumping costs (i.e., energy cost to lift water).
- What are the adjacent basin's minimum thresholds?

Seawater Intrusion Minimum Threshold

Figure 5 illustrates hypothetical chloride isoconcentration contours for two aquifers in a coastal basin. The isoconcentration contours are used as minimum thresholds for seawater intrusion.

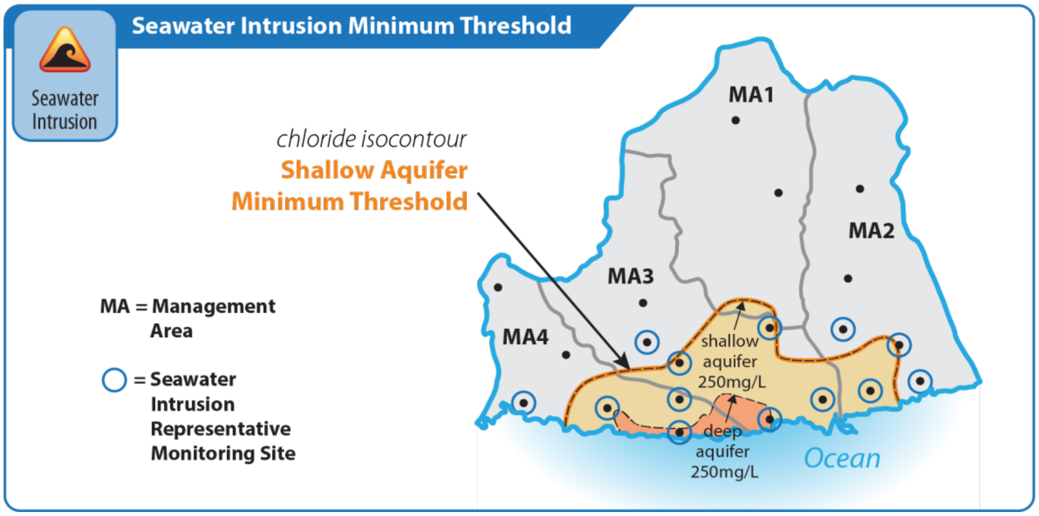


Figure 5. Example Seawater Intrusion Minimum Threshold Established at the Chloride Isocontour

Considerations when establishing minimum thresholds for seawater intrusion at a given isocontour location may include, but are not limited to:

- What is the historical rate and extent of seawater intrusion in affected principal aquifers?
- How are land uses in the basin sensitive to seawater intrusion?
- What are the financial impacts of seawater intrusion on agricultural, municipal, and domestic wells?
- What are the Regional Water Quality Control Board Basin Plan objectives?
- What are the adjacent basin's minimum thresholds?

Degraded Groundwater Quality Minimum Threshold

Figure 6 illustrates two hypothetical minimum thresholds for groundwater quality in a basin. The minimum threshold depicted on the top graph is associated with point source contamination (e.g., PCE released from a dry cleaner) and the minimum threshold depicted on the lower graph is associated with nonpoint source contamination (e.g., nitrate in groundwater from regional land use practices).

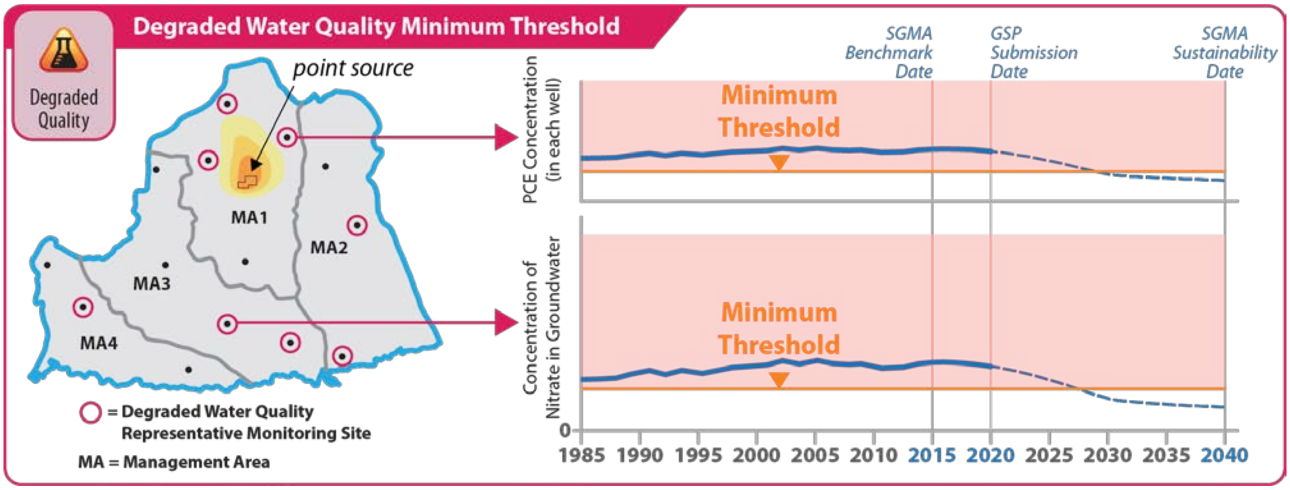


Figure 6. Example Degraded Water Quality Minimum Threshold Established for Point and Nonpoint Source Pollutants

Considerations when establishing minimum thresholds for water quality may include, but are not limited to:

- What are the historical and spatial water quality trends in the basin?
- What is the number of impacted supply wells?
- What aquifers are primarily used for providing water supply?
- What is the estimated volume of contaminated water in the basin?
- What are the spatial and vertical extents of major contaminant plumes in the basin, and how could plume migration be affected by regional pumping patterns?
- What are the applicable local, State, and federal water quality standards?
- What are the major sources of point and nonpoint source pollution in the basin, and what are their chemical constituents?
- What regulatory projects and actions are currently established to address water quality degradation in the basin (e.g., an existing groundwater pump and treat system), and how could they be impacted by future groundwater management actions?
- What are the adjacent basin's minimum thresholds?

Land Subsidence Minimum Threshold

Figure 7 illustrates a hypothetical minimum threshold for land subsidence in a basin. The minimum threshold depicts a cumulative amount of subsidence at a given point.

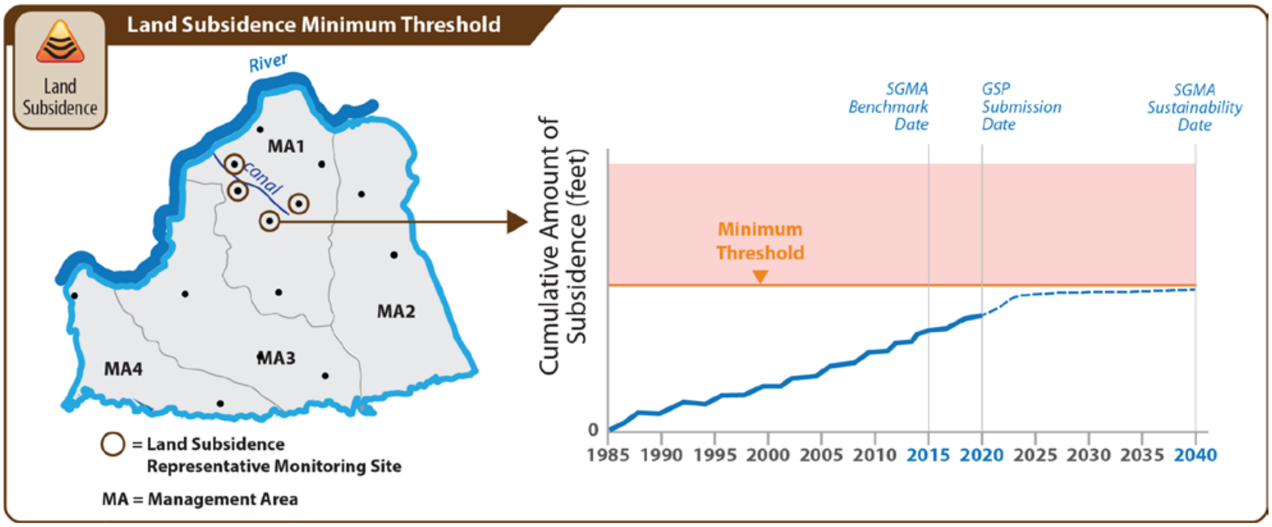


Figure 7. Example Land Subsidence Minimum Threshold

Considerations when establishing minimum thresholds for land subsidence at a given representative monitoring site may include, but are not limited to:

- Do principle aquifers in the basin contain aquifer material susceptible to subsidence?
- What are the historical, current, and projected groundwater levels, particularly the historical lows?
- What is the historical rate and extent of subsidence?
- What are the land uses and property interests in areas susceptible to subsidence?
- What is the location of infrastructure and facilities susceptible to subsidence (e.g., canals, levees, pipelines, major transportation corridors)?
- What are the adjacent basin's minimum thresholds?

Depletion of Interconnected Surface Water Minimum Threshold

Figure 8 shows a hypothetical minimum threshold for depletion of interconnected surface waters. This example presents the potential stream depletion rate (or volume) due to groundwater pumping simulated by the basin's integrated hydrologic model. Other approaches for demonstrating stream depletion, instead of the use of a numerical model, may be valid.

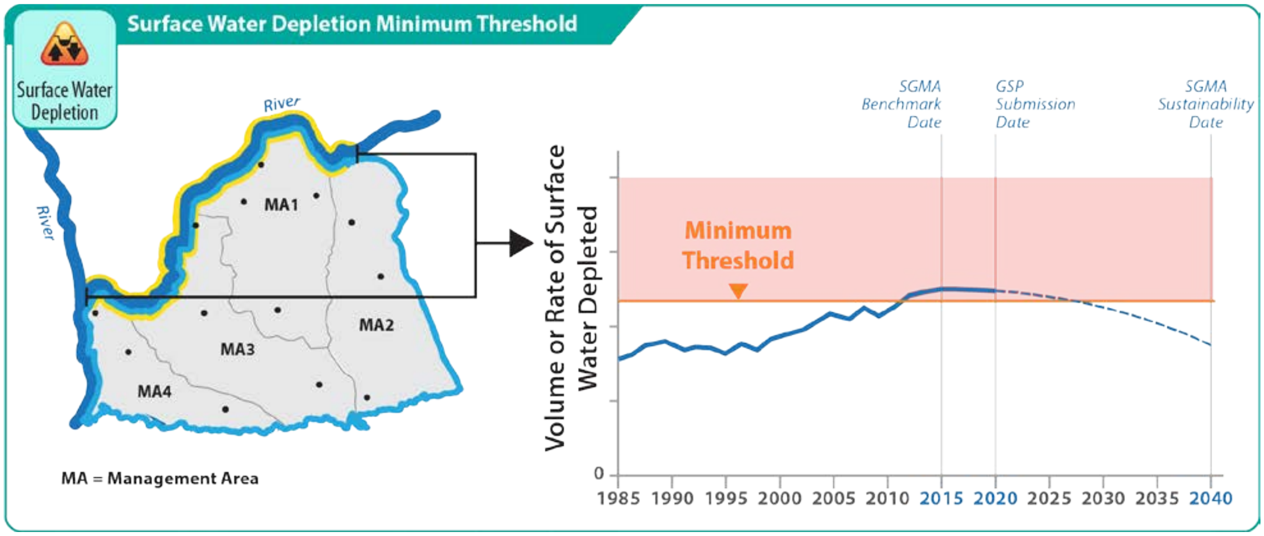


Figure 8. Example of Depletion of Interconnected Surface Water Minimum Threshold

Considerations when establishing minimum thresholds for depletions of interconnected surface water may include, but are not limited to:

- What are the historical rates of stream depletion for different water year types?
- What is the uncertainty in streamflow depletion estimates from analytical and numerical tools?
- What is the proximity of pumping to streams?
- Where are groundwater dependent ecosystems in the basin?
- What are the agricultural and municipal surface water needs in the basin?
- What are the applicable State or federally mandated flow requirements?

Using Groundwater Elevations as a Proxy

GSP Regulations allow GSAs to use groundwater elevation as a proxy metric for any (or potentially all) of the sustainability indicators when setting minimum thresholds[9] and measurable objectives[10], provided the GSP demonstrates that there is a significant correlation between groundwater levels and the other metrics.[11]

Two possible approaches for using groundwater elevation as a proxy metric for the definition of sustainable management criteria are:

(1) Demonstrate that the minimum thresholds and measurable objectives for chronic declines of groundwater levels are sufficiently protective to ensure significant and unreasonable occurrences of other sustainability indicators will be prevented. In other words, demonstrate that setting a groundwater level minimum threshold satisfies the minimum threshold requirements for not only

chronic lowering of groundwater levels but other sustainability indicators at a given site.

(2) Identify representative groundwater elevation monitoring sites where minimum thresholds and measurable objectives based on groundwater levels are developed for a specific sustainability indicator. In other words, the use of a groundwater level minimum threshold is not intended to satisfy the minimum threshold requirements for chronic lowering of groundwater but is intended solely for establishing a threshold for another sustainability indicator.

Subsidence as an Example

As described below, either approach could be applied to subsidence.

- **Approach 1** – Groundwater level minimum thresholds are above historical low groundwater levels. The GSA determines and documents that avoidance of the minimum thresholds for groundwater levels will also ensure that subsidence will be avoided. In this approach, the GSA would be applying the same numeric definition to two undesirable results – chronic lowering of groundwater and subsidence (**Figure 9**).
- **Approach 2** – The GSA has determined that specific areas are prone to subsidence, knows what the historical low groundwater levels are for those areas, and has demonstrated that no additional inelastic land subsidence will occur as long as groundwater levels remain above historical lows. The GSA develops minimum thresholds for land subsidence based on groundwater levels for the areas prone to subsidence (**Figure 9**). These land subsidence representative monitoring sites are not necessarily included as representative monitoring sites for groundwater level decline.

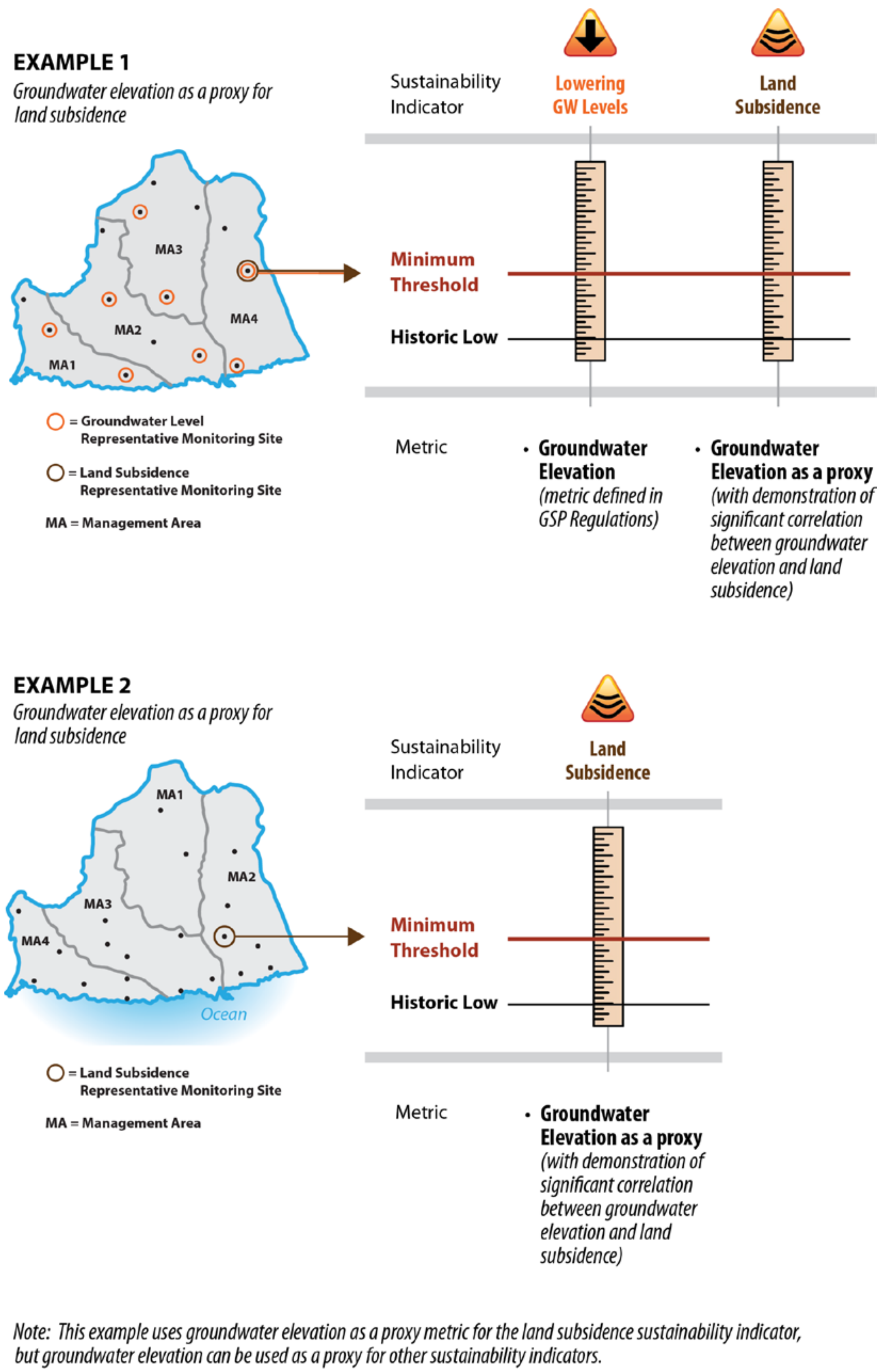


Figure 9. Example of Using Groundwater Elevation as a Proxy for Subsidence Monitoring

UNDESIRABLE RESULTS

Undesirable results occur when conditions related to any of the six sustainability indicators become significant and unreasonable. Undesirable results will be used by the Department to determine whether the sustainability goal has been achieved within the basin.

All undesirable results will be based on minimum thresholds exceedances. Undesirable results will 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. Exceeding a minimum threshold at a single monitoring site is not necessarily an undesirable result, but it could signal the need for modifying one or more management actions, or implementing a project to benefit an area before the issue becomes more widespread throughout the basin. However, the GSP must define when an undesirable result is triggered.

The GSP must include a description for each undesirable result. Undesirable results must be agreed upon by all GSAs within a basin. If there is more than one GSP in the basin, a single undesirable result description must be agreed upon and documented in the coordination agreement.

GSP Regulations require three components for each undesirable result.[12] The three components (in italicized text) and considerations for how they should be addressed are as follows:

1. *The cause of groundwater conditions occurring throughout the basin that would lead to or has led to undesirable results based on information described in the basin setting, and other data or models as appropriate.*[13]
   The GSP document the factors that may lead to, or have led to, undesirable results. These factors may be localized or basinwide. An example of a localized cause for undesirable results is a group of active wells that are inducing significant and unreasonable land subsidence in a nearby canal. An example of a basinwide cause is general overpumping of groundwater that leads to a significant and unreasonable reduction of groundwater storage. There will often be multiple causes for groundwater conditions becoming significant and unreasonable, and GSAs must investigate each. Even if a basin does not currently have undesirable results, the GSP Regulations require GSAs to consider the causes that would lead to undesirable results and define undesirable results using minimum thresholds.
2. *The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for each applicable sustainability indicator. The criteria*

shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.[14]

The GSP Regulations require undesirable results to be quantified by minimum threshold exceedances. GSAs have significant flexibility in defining the combinations of minimum threshold exceedances that constitute an undesirable result GSAs should evaluate multiple spatial scales when setting the criteria for undesirable results. Consider an example of two basins. In the first basin, 50 percent of wells have water levels below their assigned minimum threshold. In the second basin, all wells have water levels above their minimum thresholds except for one well where water levels are 800 feet below the minimum threshold. Both basins likely have an undesirable result. GSAs should define their undesirable results to be protective of both scenarios.

3. *The potential effects of the undesirable result on beneficial uses and users of groundwater, land uses, and property interests.*[15]

   The GSA, having acquired information regarding beneficial uses and users of groundwater in the basin, land uses, and property interests tied to groundwater, should describe the effects of each of the potential undesirable results for the basin. The description should make clear how potential effects on beneficial uses and users were considered in the establishment of the undesirable results.

Experiencing Undesirable Results

Avoidance of the defined undesirable results must be achieved within 20 years of GSP implementation (20-year period). Some basins may experience undesirable results within the 20-year period, particularly if the basin has existing undesirable results as of January 1, 2015. The occurrence of one or more undesirable results within the initial 20-year period does not, by itself, necessarily indicate that a basin is not being managed sustainably, or that it will not achieve sustainability within the 20-year period. However, GSPs must clearly define a planned pathway to reach sustainability in the form of interim milestones, and show actual progress in annual reporting.

Failing to eliminate undesirable results within 20 years, or failing to implement a GSP to achieve the sustainability goal established for a basin, will result in the Department deeming the GSP inadequate and could result in State Water Resources Control Board intervention. Failing to meet interim milestones could indicate that the GSA is unlikely to achieve the sustainability goal in the basin.

Example of Undesirable Results

This section provides a simplified example to illustrate the relationship between certain sustainable management criteria. The example is for one sustainability indicator (lowering groundwater levels, using the metric of groundwater elevation. The concepts in the example could be extended to other sustainability indicators using other metrics.

In the example, a hypothetical basin has set minimum thresholds, interim milestones, and measurable objectives for groundwater levels (**Figure 10**) at a network of eight representative monitoring points; to simplify this example, the criteria are assumed to be the same at each well. After considering the conditions at which lowering of groundwater levels would become significant and unreasonable, the GSA has determined that minimum threshold exceedances (i.e., groundwater levels dropping below the minimum threshold) at three or more representative monitoring sites would constitute an undesirable result.

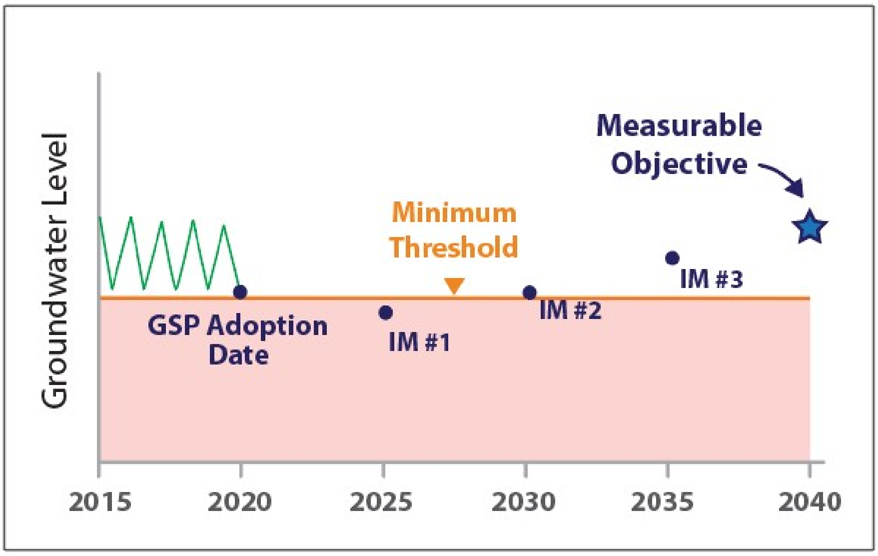


Figure 10. Example Minimum Threshold, Interim Milestones (IM), and Measurable Objective

In each of the following scenarios, the GSA monitors groundwater levels at the representative monitoring sites for the 20-year period following GSP submission.

Scenario 1 – Minimum Threshold Exceedances without an Undesirable Result

In this scenario (**Figure 11**), one of the eight representative monitoring wells has periodic minimum threshold exceedances over a several-year period after submission of the GSP. After this period, groundwater levels at the representative monitoring site increase and remain above the minimum threshold. Groundwater levels at all other representative monitoring sites remain above the minimum threshold for the entire 20-year period following GSP submission. Groundwater levels at all sites are at or above the measurable objective at the end of the 20-year period. Despite periodic minimum threshold exceedances at one representative monitoring well, the basin never experienced an undesirable result for this sustainability indicator. The original GSP submission foresaw potential minimum threshold exceedances as shown by the first five-year interim milestone set below the minimum threshold.

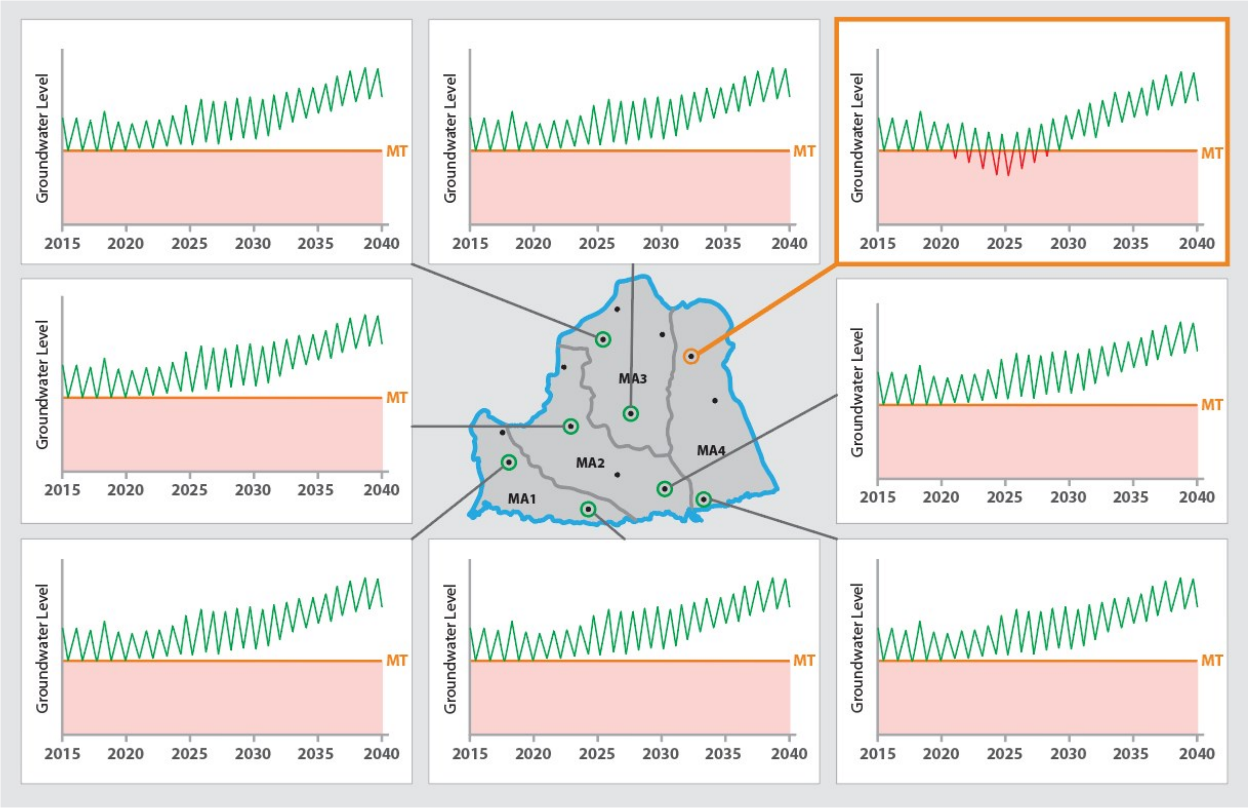


Figure 11. Example Groundwater Level Representative Monitoring Sites – Scenario 1

Scenario 2 – Minimum Threshold Exceedances with Undesirable Results Eliminated Within 20 Years

In this scenario (**Figure 12**), three of the eight representative monitoring wells have periodic minimum threshold exceedances over a several-year period after submission of the GSP. After this period, groundwater levels at the three representative monitoring sites increase and remain above their respective minimum thresholds. Groundwater levels at all other representative monitoring sites remain above the minimum threshold for the entire 20-year period following GSP submission. Groundwater levels at all sites are at or above the measurable objective at the end of the 20-year period.

As opposed to Scenario 1, this basin did experience an undesirable result during the period of minimum threshold exceedance at the three representative monitoring wells. However, the basin was sustainably managed because the GSA planned for a period of minimum threshold exceedances via their interim milestones, and because the GSA implemented necessary projects and management actions to eliminate the undesirable result and achieve the measurable objective.

Note that if the GSAs in this hypothetical basin had not planned for continued groundwater level decline via appropriate interim milestones, or had not implemented the necessary projects and management actions to eliminate the undesirable result, the Department could have determined that the GSA was not likely to achieve the sustainability goal for the basin within the 20-year period.

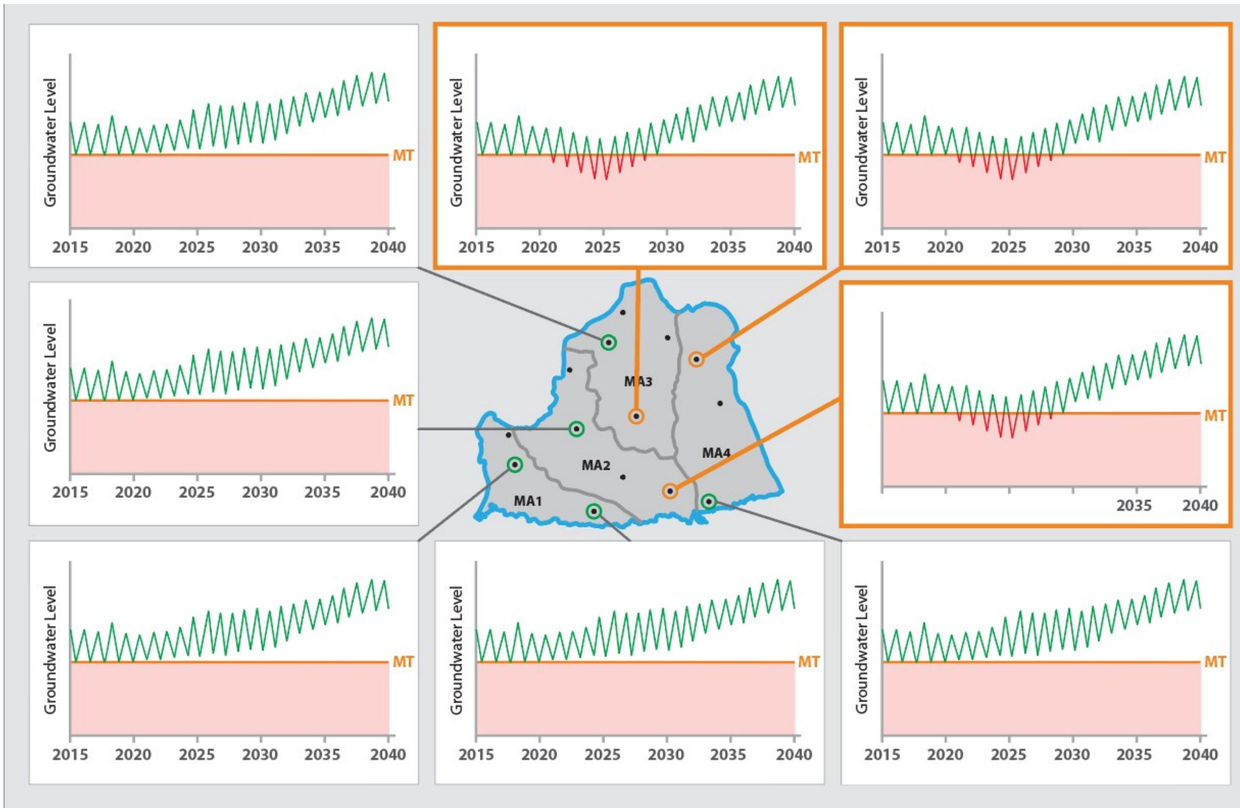


Figure 12. Example Groundwater Level Representative Monitoring Sites – Scenario 2

Scenario 3 – Minimum Threshold Exceedances with Undesirable Results Not Eliminated Within 20 Years

In this scenario (**Figure 13**), three of the eight representative monitoring wells have minimum threshold exceedances beginning approximately five years after submission of the GSP. Unlike Scenario 2, groundwater levels continue to decline at the three representative monitoring sites throughout the 20-year period following GSP submission, and are well below both their minimum thresholds and interim milestones. The basin experiences an undesirable result when the three wells begin exceeding their minimum thresholds, and the undesirable result persists throughout the 20-year period. Sustainable groundwater management was not achieved in the basin for this scenario.

Although this example shows undesirable results persisting for the 20-year period, in a real situation the Department would likely determine that the GSA was unlikely to achieve the sustainability goal at one of the interim milestones, thereby triggering State intervention much earlier in the 20-year period. It is beyond the scope of this example or this document to discuss details of State intervention, but it is important to note that State intervention can occur within the 20-year period following GSP submittal.

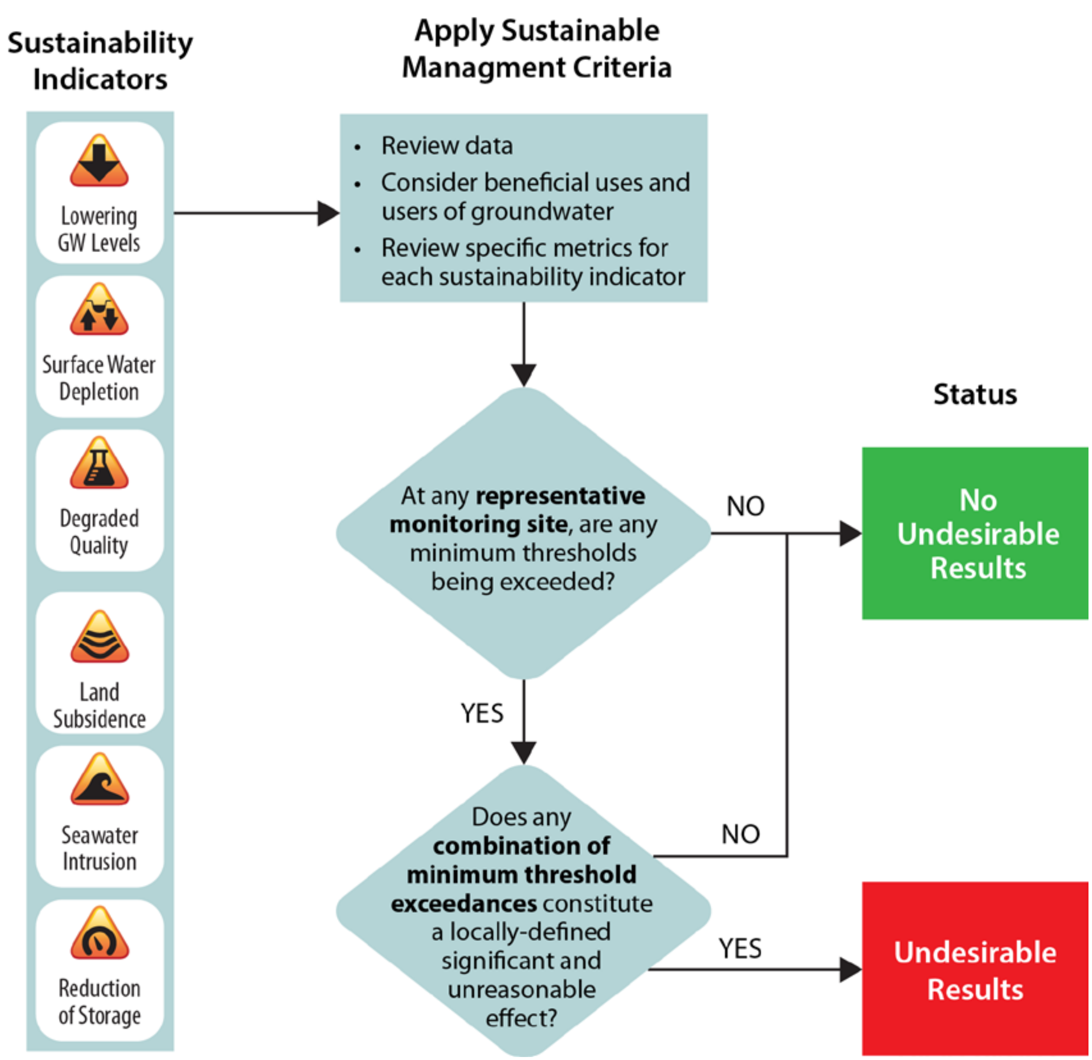
Figure 13. Example Groundwater Level Representative Monitoring Sites – Scenario 3

Relationship between Sustainability Indicators, Minimum Thresholds, and Undesirable Results

Sustainability indicators are the six effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, are undesirable results. For example, surface water depletion due to groundwater pumping is a sustainability indicator because it is an effect that must be monitored to determine whether it has become significant and unreasonable.

Sustainability indicators become undesirable results when a GSA-defined combination of minimum thresholds is exceeded. Those combinations of minimum threshold exceedances define when a basin condition becomes significant and unreasonable.

The relationship between sustainability indicators, minimum thresholds, and undesirable results is shown in the illustration below.



MEASURABLE OBJECTIVES

Measurable objectives are quantitative goals that reflect the basin's desired groundwater conditions and allow the GSA to achieve the sustainability goal within 20 years. Measurable objectives are set for each sustainability indicator at the same representative monitoring sites and using the same metrics as minimum thresholds. Measurable objectives should be set such that there is a reasonable margin of operational flexibility (**Figure 14**) between the minimum threshold and measurable objective that will accommodate droughts, climate change, conjunctive use operations, or other groundwater management activities. There are exceptions to this general rule. For example, if the minimum threshold for land subsidence is zero, the measurable objective may also be zero. Projects and management actions included in GSPs should be designed to meet the measurable objectives, with specific descriptions of how those projects and management actions will achieve their desired goals.

In addition to the measurable objective, interim milestones must be defined in five-year increments[16] at each representative monitoring site using the same metrics as the measurable objective, as illustrated in **Figure 14**. These interim milestones are used by GSAs and the Department to track progress toward meeting the basin's sustainability goal. Interim milestones must be coordinated with projects and management actions proposed by the GSA to achieve the sustainability goal. The schedule for implementing projects and management actions will influence how rapidly the interim milestones approach the measurable objectives (i.e., the path to sustainable groundwater management).

The Department will periodically (at least every five years) review GSPs to determine, among other items, whether failure to meet interim milestones is likely to affect the ability of the GSA(s) in a basin to achieve the sustainability goal.[17]

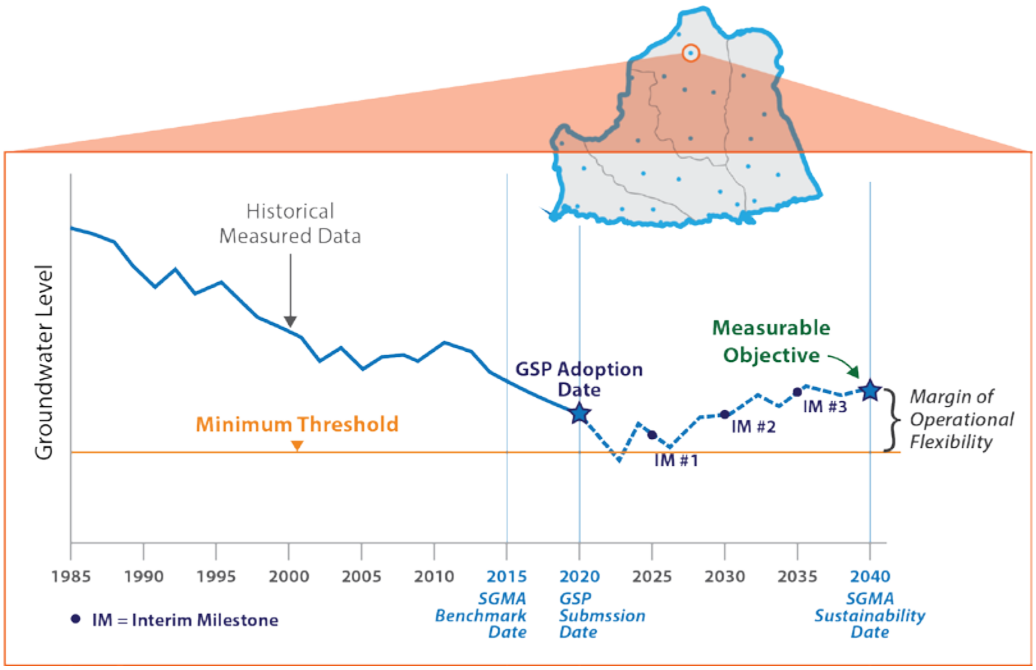


Figure 14. Relationship between Minimum Thresholds, Measurable Objectives, Interim Milestones (IM), and Margin of Operational Flexibility for a Representative Monitoring Site

The Path to Sustainable Groundwater Management

There will be many paths to sustainable groundwater management based on groundwater conditions and locally-defined values. **Figure 14** shows the relationship between minimum thresholds, measurable objectives, interim milestones, and margin of operational flexibility for a hypothetical basin. In the example used for **Figure 14**, groundwater levels are predicted to initially decline for the first five years after GSP adoption, and then rise over the subsequent 15 years to meet the measurable objective. At five-year increments, there are interim milestones to check the basin's progress towards the measurable objective. In **Figure 14**, the measured data never drops below the minimum threshold. This is just one example of a path towards reaching sustainability. The Department recognizes that there are different sustainability paths based on basin conditions, future supply and demand forecasts, and implementation of groundwater improvement projects. Three additional potential paths to sustainability are illustrated in **Figure 15**.

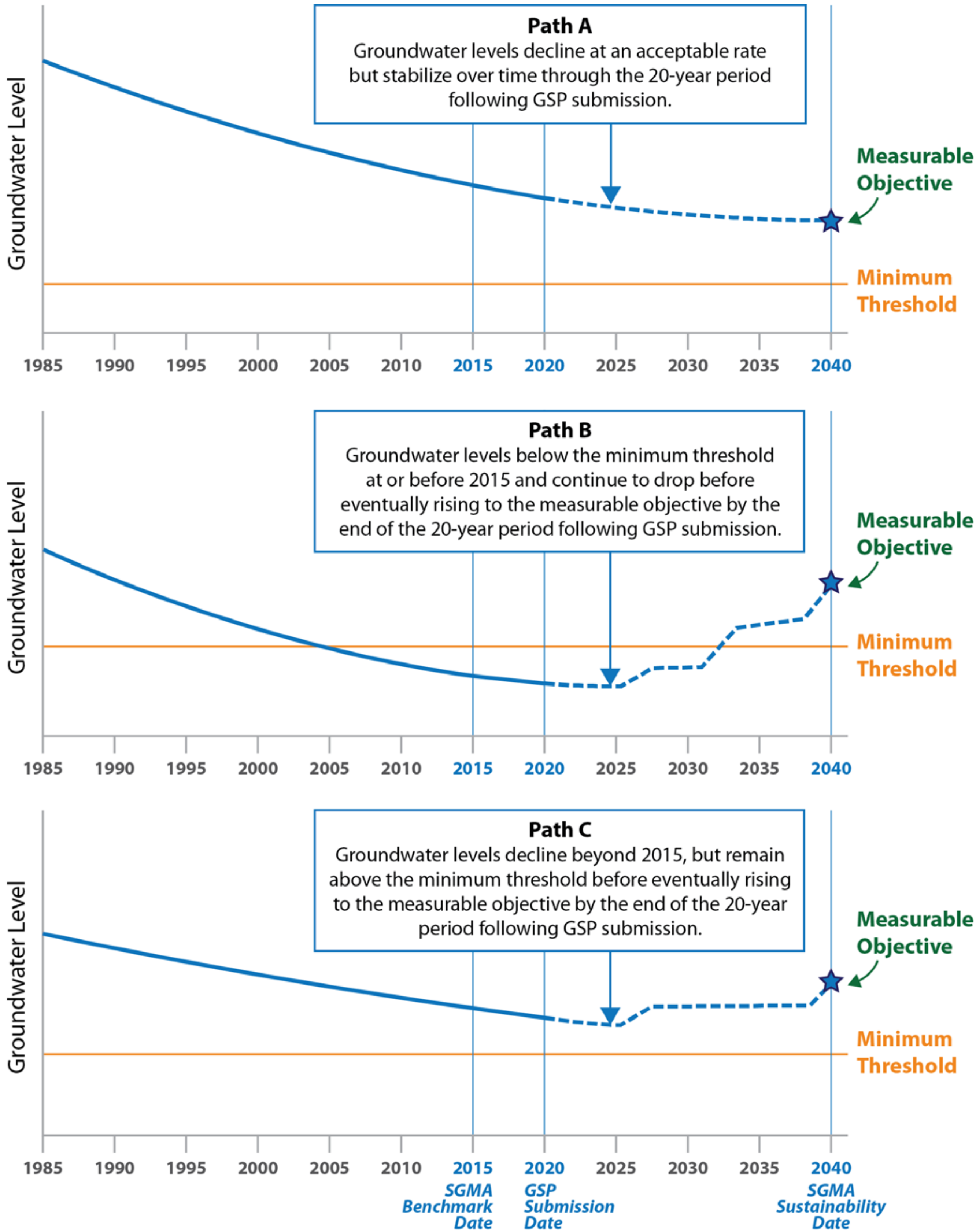


Figure 15. Potential Paths to Sustainability

Measurable Objectives when an Undesirable Result Occurred before January 1, 2015

SGMA states that a GSP "may, but is not required to, address undesirable results that occurred before, and have not been corrected by, January 1, 2015." Once minimum thresholds have been developed and an undesirable result numerically defined, the GSA may evaluate whether that undesirable result was present prior to January 1, 2015. This evaluation is not possible until the GSA has defined what constitutes a significant and unreasonable condition (an undesirable result).

If the evaluation indicates that an undesirable result occurred prior to January 1, 2015, the GSA must set measurable objectives to either maintain or improve upon the conditions that were occurring in 2015. The GSA must plan a pathway, indicated by appropriate interim milestones, to reach and maintain the 2015 conditions within the 20-year implementation timeline.

SUSTAINABILITY GOAL

GSAs must develop a sustainability goal that is applicable to the entire basin. If multiple GSPs are developed for a single basin, then the sustainability goal must be presented in the basinwide *coordination agreement*.

The sustainability goal should succinctly state the GSA's objectives and desired conditions of the groundwater basin, how the basin will get to that desired condition, and why the measures planned will lead to success.

Unlike the other sustainable management criteria, the sustainability goal is not quantitative. Rather, it is supported by the locally-defined minimum thresholds and undesirable results. Demonstration of the absence of undesirable results supports a determination that basin is operating within its sustainable yield and, thus, that the sustainability goal has been achieved.

GSA's should consider the following when developing their sustainability goal:

- **Goal description**. The goal description should qualitatively state the GSA's objective or mission statement for the basin. The goal description should summarize the overall purpose for sustainably managing groundwater resources and reflect local economic, social, and environmental values within the basin.
- **Discussion of measures**. The sustainability goal should succinctly summarize the measures that will be implemented. This description of measures should be consistent with, but may be less detailed than, the description of projects and management actions proposed in the GSP. Examples of measures a GSA could implement include demand reduction and development of groundwater recharge projects. The goal should affirm that these measures will lead to operation of the basin within its sustainable yield.
- **Explanation of how the goal will be achieved in 20 years**. The sustainability goal should describe how implementation of the measures will result in sustainability. For example, if the measures include demand reduction and implementation of groundwater recharge projects, then the goal would explain how those measures will lead to sustainability (e.g., they will raise groundwater levels above some threshold values and eliminate or reduce future land subsidence).

Note that most of the sustainability goal can only be finalized after minimum thresholds and undesirable results have been defined, projects and management actions have been identified, and the projected impact of those projects and management actions on groundwater conditions have been evaluated. Therefore, completion of the sustainability goal will likely be one of the final components of GSP development.

Role of Sustainable Yield Estimates in SGMA

In general, the sustainable yield of a basin is the amount of groundwater that can be withdrawn annually without causing undesirable results. Sustainable yield is referenced in SGMA as part of the estimated basinwide water budget and as the outcome of avoiding undesirable results.

Sustainable yield estimates are part of SGMA's required basinwide water budget. Section 354.18(b)(7) of the GSP Regulations requires that an estimate of the basin's sustainable yield be provided in the GSP (or in the coordination agreement for basins with multiple GSPs). A single value of sustainable yield must be calculated basinwide. This sustainable yield estimate can be helpful for estimating the projects and programs needed to achieve sustainability.

SGMA does not incorporate sustainable yield estimates directly into sustainable management criteria. Basinwide pumping within the sustainable yield estimate is neither a measure of, nor proof of, sustainability. Sustainability under SGMA is only demonstrated by avoiding undesirable results for the six sustainability indicators.

CONCLUSIONS

The key to demonstrating a basin is meeting its sustainability goal is by avoiding undesirable results. Sustainable management criteria are critical elements of the GSP that define sustainability in the basin.

Before setting sustainable management criteria, the GSA should understand the basin setting by establishing a hydrogeological conceptual model, engage stakeholders, and define management areas as applicable. This document addresses best management practices for developing sustainable management criteria, including minimum thresholds, undesirable results, measurable objectives, and the sustainability goal.

Setting sustainable management criteria can be a complex, time consuming, and iterative process depending on the complexity of the basin and its stakeholders. GSAs should allow sufficient time for criteria development during the GSP development process. The public should be engaged early in the process so their perspectives can be considered during sustainable management criteria development. To ensure timely stakeholder participation, it may be useful for GSAs to set a timeline for development of the sustainable management criteria.

5. KEY DEFINITIONS

The key definitions related to sustainable management criteria development outlined in applicable SGMA code and regulations are provided below for reference.

SGMA Definitions (California Water Code 10721)

(d) "Coordination agreement" means a legal agreement adopted between two or more groundwater sustainability agencies that provides the basis for coordinating multiple agencies or groundwater sustainability plans within a basin pursuant to this part.

(r) "Planning and implementation horizon" means a 50-year period over which a groundwater sustainability agency determines that plans and measures will be implemented in a basin to ensure that the basin is operated within its sustainable yield.

(u) "Sustainability goal" means the existence and implementation of one or more groundwater sustainability plans that achieve sustainable groundwater management by identifying and causing the implementation of measures targeted to ensure that the applicable basin is operated within its sustainable yield.

(v) "Sustainable groundwater management" means the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.

(w) "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.

(x) "Undesirable result" means one or more of the following effects caused by groundwater conditions occurring throughout the basin:

(1) Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.

(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.

Groundwater Sustainability Plan Regulations (California Code of Regulations 351)

(g) "Basin setting" refers to the information about the physical setting, characteristics, and current conditions of the basin as described by the Agency in the hydrogeologic conceptual model, the groundwater conditions, and the water budget, pursuant to Subarticle 2 of Article 5.

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

(q) "Interim milestone" refers to a target value representing measurable groundwater conditions, in increments of five years, set by an Agency as part of a Plan.

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

(s) "Measurable objectives" refer to specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin.

(t) "Minimum threshold" refers to a numeric value for each sustainability indicator used to define undesirable results.

(x) "Plan" refers to a groundwater sustainability plan as defined in the Act.

(y) "Plan implementation" refers to an Agency's exercise of the powers and authorities described in the Act, which commences after an Agency adopts and submits a Plan or Alternative to the Department and begins exercising such powers and authorities.

(ag) "Statutory deadline" refers to the date by which an Agency must be managing a basin pursuant to an adopted Plan, as described in Water Code Sections 10720.7 or 10722.4.

NOTES

[1] See 23 CCR § 350 *et seq*.

[2] See Water Code § 10720 *et seq*.

[3] See 23 CCR § 355.4(b)(1)

[4] See Water Code § 10721(v)

[5] See 23 CCR § 354.22 *et seq*.

[6] See 23 CCR § 351(ah); *see also* Water Code § 10721(x).

[7] See 23 CCR § 354.28(b)

[8] See 23 CCR § 354.28(c)

[9] See 23 CCR § 354.28(d)

[10] See 23 CCR § 354.30(d)

[11] See 23 CCR § 354.36(b)

[12] See 23 CCR § 354.26(b)

[13] See 23 CCR 354.26(b)(1)

[14] See 23 CCR 354.26(b)(2)

[15] See 23 CCR 354.26(b)(3)

[16] See 23 CCR § 354.30(e)

[17] See 23 CCR § 355.6(c)(1)

Sustainable Management Criteria

INDIAN WELLS VALLEY GROUNDWATER AUTHORITY
Technical Advisory Committee Meeting

July 12, 2018

Stetson Engineers Inc.

Overview

- Sustainable Management Criteria
- Sustainability Indicators
- Undesirable Results
- Minimum Thresholds
- Measurable Objectives
- Interim Milestones
- Management Areas
- Sustainability Goal
- Key Takeaways

Sustainable Management Criteria

- Sustainability Management Criteria: sustainability goal, undesirable results, minimum thresholds, and measurable objectives
- DWR Guidance:

  https://water.ca.gov/Programs/Groundwater-Management/SGMA-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents

Sustainability Indicators

- Effects caused by groundwater conditions
  - Chronic Lowering of Groundwater Levels
  - Reduction of Groundwater Storage
  - Seawater Intrusion
  - Degraded Water Quality
  - Land Subsidence
  - Depletion of Interconnected Surface Water

Undesirable Results

- When any of the six sustainability indicators become "significant and unreasonable" the effects caused by the groundwater conditions become undesirable results
- DWR default position for GSP: all six sustainability indicators apply to every basin
- Evidence must be provided that an indicator does not exist and could not occur in basin (i.e. seawater intrusion for the Indian Wells Valley)

Undesirable Results

- Required Components for description of undesirable results
  - The cause of groundwater conditions occurring that would lead to or has led to undesirable results based on information described in the basin setting
  - The criteria used to define when and where the effects of the groundwater conditions cause undesirable results (i.e. significant and unreasonable effects) for each applicable sustainability indicator.
    - Based on minimum threshold exceedances (discussed later)
  - The potential effects of the undesirable result on beneficial uses and users of groundwater, land uses, and property interests.

Minimum Thresholds

- Quantitative value that represents groundwater conditions at a representative monitoring site
- Representative monitoring site:
  - Subset of complete monitoring network
  - Can be used for one sustainability indicator or multiple sustainability indicators
  - Only selected after determining what constitutes significant and unreasonable conditions in a basin.
- Minimum thresholds are established such that an undesirable result may occur if exceeded.
- Minimum thresholds must be set for each sustainability indicator

Minimum Thresholds

- Required Components to document/establish minimum thresholds
  - Model information and basin setting information relied upon to justify threshold
  - Description of the relationship between minimum thresholds for different sustainability indicators
  - Description of how the selected minimum threshold will avoid causing undesirable results in adjacent basins or impact their sustainability
  - Description of how groundwater conditions at a selected minimum threshold could affect beneficial uses and users
  - Description of relevant standards that pertain to the sustainability indicator and justify any differences between the selected minimum threshold and those standards.
  - How each minimum threshold will be quantitatively measured (monitoring network)

Minimum Thresholds: Metrics

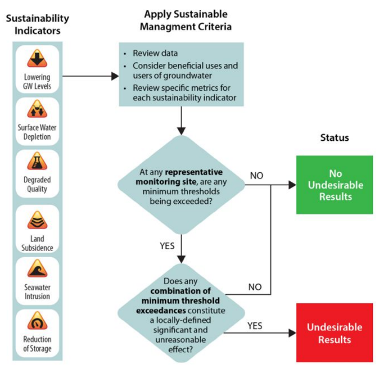
Sustainability Indicators	Lowering GW Levels	Reduction of Storage	Seawater Intrusion	Degraded Quality	Land Subsidence	Surface Water Depletion
Metric(s) Defined in GSP Regulations	• Groundwater Elevation	• Total Volume	• Chloride concentration isocontour	• Migration of Plumes • Number of supply wells • Volume • Location of isocontour	• Rate and Extent of Land Subsidence	• Volume or rate of surface water depletion

Source: DWR

Minimum Thresholds: Groundwater Levels as Proxy

- Groundwater elevations can be used as a proxy metric for any (or potentially all) of the sustainability indicators when setting minimum thresholds
- Significant correlation between groundwater levels and the other metrics must be demonstrated
- Two Options:
  1. Demonstrate that setting a groundwater level minimum threshold satisfies the minimum threshold requirements for both chronic lowering of groundwater levels and other sustainability indicators at a given site.
  2. Use a groundwater level minimum threshold solely for establishing a threshold for another sustainability indicator, but not to satisfy the minimum threshold requirements for chronic lowering of groundwater.

Applying Minimum Thresholds



Source: DWR

Measurable Objectives

- Quantitative goals that reflect the basin's desired groundwater conditions
- Set for each sustainability indicator at the same representative monitoring sites and using the same metrics as minimum thresholds.
- Should be 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.

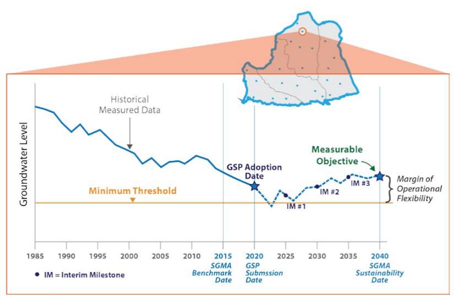
Interim Milestones

- Defined in five-year increments at each representative monitoring site using the same metrics as the measurable objective
- Used by the Authority and the DWR to track progress toward meeting the basin's sustainability goal.

Management Areas

- The Authority can define either natural or jurisdictional boundaries as management areas
  - Based on either water use sector, water source, geology, or aquifer characteristics
- Management areas can have different minimum thresholds and different measurable objectives (must be justified to DWR)

Relationship between Criteria



Source: DWR

Sustainability Goal

- Qualitative description of the Authority's objectives and desired conditions of the groundwater basin, how the basin will get to that desired condition, and why the measures planned will lead to success.
- Can only be finalized after minimum thresholds and undesirable results have been defined, projects and management actions have been identified, and the projected impact of those projects and management actions on groundwater conditions have been evaluated.
- Completion of the sustainability goal will likely be one of the final components of GSP development.

Key Takeaways

- Sustainable conditions within a basin are achieved when GSAs meet their sustainability goal and demonstrate the basin is being operated within its sustainable yield.
- Sustainability goal is met by avoiding undesirable results.
- The basin setting should be understood (Hydrogeological Conceptual Model) prior to defining the sustainable management criteria.
  - Scheduled to be completed October 2018
- Undesirable results must be eliminated through the implementation of projects and management actions.
- Establishing the sustainable management criteria will be an iterative process and finalized after the scenarios of management actions are modeled.
  - Modeling scheduled to begin November 2018

Thank You

MEMO

TO: Chairman Peggy Breeden
CC: Phil Hall, Jim Worth, Ron Strand, Alan Christensen, Don Zdeba, Steve Johnson
FROM: W Keith Lemieux
DATE: June 4, 2018
RE: Guidance for Meeting of the Technical Advisory Committee

It has recently come to our attention that questions have arisen regarding the parliamentary procedures to be used at the Technical Advisory Committee ("TAC"). The following memorandum describes the process to be used at the TAC meetings.

The role of the TAC is to ". . . assist the Water Resources Manager in the preparation of the GSP." The procedure for TAC meetings is described in Section 5.13 as follows:

- "The Water Resources Manager shall . . . set the agenda of each TAC meeting . . ."
- The purpose of the meeting is to present a forum for the Water Resources Manager to present portions of the GSP in draft form to the TAC "so as to afford the TAC a reasonable opportunity to review and conduct a thorough evaluation prior to finalization of that technical element."
- TAC is empowered to submit two written reports in response to each GSP element: (1) "written recommendations to the Water Resources Manager" and (2) "written summaries of the range of TAC comments reflecting any areas of disagreement for consideration in the final preparation of any GSP Element."
- Rather than formally vote on the adoption of these written documents, the TAC is instructed to "strive for consensus."

The TAC is subject to the Brown Act. The Brown act requires that (1) the meeting be open and public; (2) that it be proceeded by a properly noticed agenda; and (3) that there is an opportunity for the public to comment. (These requirements are also reflected in sections 5.1 and 5.2 of the Bylaws). The Brown Act does not require that there be action items (i.e. voting items) on the agenda or that minutes be prepared for a meeting.

Therefore, the agenda for the TAC must be prepared by the Water Resources Manager and should be limited to two items: (1) public comment and (2) consideration of a particular GSP element. The TAC will then meet to discuss the GSP element and strive to build consensus at the meeting. That consensus will be reduced to two written documents which will then be submitted to the Water Resources Manager.

Section 5.2 of the Bylaws describes the general rules for standing committees. Section 5.2 requires the preparation of minutes to record action taken and requires a formal vote "for the passage of any motion." However, these requirements are superseded by the specific language of section 5.13. Instead of requiring a formal vote, section 5.13 directs the TAC to act through "consensus." Instead of requiring formal minutes, section 5.13 allows the TAC to submit "written recommendations to the Water Resources Manager."

Accordingly, the TAC may elect to formalize the development of a "consensus" on proposed GSP elements through the use of formal parliamentary procedure such as a motion and vote. However, this is not required by section 5.13. The TAC could instead choose to develop consensus based on a show of hands, or any other reasonable process. Likewise, rather than formal minutes, we would recommend that the Water Resources Manager keep of a record of the proceedings through an audio recording of the meeting.

Recycled Water Opportunities and Constraints Evaluation

Indian Wells Valley Groundwater Authority
Technical Advisory Committee Meeting

July 12, 2018

Stetson Engineers Inc.

Outline

- Project summary
  - Quantities of recycled water
  - Costs
- Initial recommendation
  - Preferred project(s)
- Next Steps

Recycled Water Project Summary

- Non-Potable Reuse: landscape irrigation
  - City of Ridgecrest (City) and Naval Air Weapons Station (NAWS)
  - Cerro Coso Community College (Cerro Coso)
- Indirect Potable Reuse: deep injection
  - Treated wastewater from Inyokern and septic collection areas
  - Tertiary effluent from the City WWTF

Non-Potable Reuse – City/NAWS

- 103.5 acres of landscaping identified for irrigation with tertiary-treated recycled water
  - Estimated demand of 807 AFY
- Total estimated project cost
  - Capital cost: $20,010,000
  - Annual O&M cost: $255,000
- Cost analysis
  - Cost per acre-foot (AF): **$1,750 per AF**

Non-Potable Reuse – Cerro Coso

- 25 acres of landscaping identified for irrigation with tertiary-treated recycled water
  - Estimated demand of 195 AFY
- Total estimated project cost
  - Capital cost: $6,893,600
  - Annual O&M cost: $73,500
- Cost analysis
  - Incremental cost: Cerro Coso as an extension of the non-potable reuse project for the City/NAWS
  - Cost per acre-foot (AF): **$2,420 per AF**

Indirect Potable Reuse – Inyokern and Septic Wastewater

- Collection, full treatment (primary, secondary, tertiary, advanced), and deep injection of:
  - Inyokern Community Services District wastewater
  - Septic effluent
    - Three (3) identified septic collection areas proposed to be converted to sewer systems
    - 150 parcels within City boundaries (locations to be confirmed)
- Total supply of generated recycled water: **413 AFY** (0.4 MGD)
- Total estimated project cost
  - Capital cost: $88,742,800
  - Annual O&M cost: $976,100
- Cost analysis
  - Cost per acre-foot (AF): **$14,790 per AF**

Indirect Potable Reuse – City WWTF Effluent

- Conveyance, advanced treatment, and deep injection of tertiary effluent from the City WWTP
  - City wastewater treatment plant expected to undergo expansion and upgrades including 1.8 MGD of tertiary-treatment facilities per the recommendations of Provost & Pritchard (2015); costs not included as part of this study
- Total supply of generated recycled water: **731** (0.7 MGD)
- Total estimated project cost
  - Capital cost: $26,308,000
  - Annual O&M cost: $485,800
- Cost analysis
  - Cost per acre-foot (AF): **$2,750 per AF**

Cost Summary

Project	Annual Recycled Water Demand (AFY)	Capital Cost	Annual O&M Cost	Cost per AF of Recycled Water
NPR: City/NAWS	807	$20,010,000	$255,000	$1,750
NPR: Cerro Coso	195	$6,893,600	$73,500	$2,420
IPR: Inyokern and Septic Systems	413	$88,742,800	$976,100	$14,790
IPR: City WWTF Effluent	731	$26,308,000	$485,800	$2,750

Prioritization of Recycled Water Projects

- Landscape irrigation:
  - Areas identified within City/NAWS
  - Cerro Coso
- Deep injection of:
  - Tertiary-treated City WWTF effluent

Next Steps

- Draft Memorandum to be provided to the TAC by July 20, 2018
- TAC requested to provide comments by August 10, 2018
- Discuss comments at September 6, 2018 TAC

Alternative Opportunities and Constraints to Enhance Water Supplies

INDIAN WELLS VALLEY GROUNDWATER AUTHORITY

Technical Advisory Committee Meeting

July 12, 2018

Stetson Engineers Inc.

Overview

- Key imported water partners
  - Los Angeles Department of Water & Power (LADWP)
  - Kern County Water Agency (KCWA)
  - Antelope Valley – East Kern Water Agency (AVEK)
- Water Market
- Prioritization of alternative water opportunities
  - Conceptual uses, facilities, and costs
- AVEK - Current and proposed banking programs
- Conservation
  - Indian Wells Valley Water District
  - City of Ridgecrest
  - Agriculture
  - Industrial
- Next Steps

Key Imported Water Partners

- LADWP
  - IWV is currently being considered by LADWP as a potential groundwater banking opportunity in upcoming water resources study.
- KCWA
  - Service area covers entirety of Kern County excluding AVEK service area
    - Includes the portion of IWV basin within Kern County
  - No KCWA infrastructure exists within IWV basin
  - KCWA has no available SWP water and no water rights beyond service area
  - KCWA will be a cooperative but not proactive partner
- AVEK
  - Open to discussing transfers, exchanges, and banking

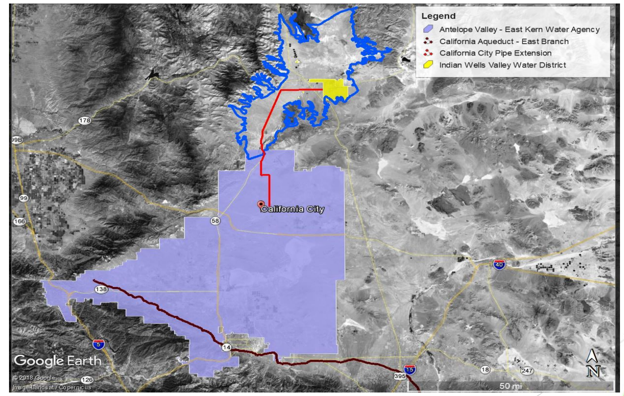
Water Market

- The water market in California currently has little activity.
  - Competition for water expected to increase in the future as other agencies complete SGMA compliance.
    - Advantage to getting into the water market sooner
- Concepts
  - Option agreements
    - Payment for first right to an agency's surplus water
  - Possibly bank water in advance of delivery

Alternative Water Opportunities: Prioritization

- First priority alternative water opportunities:
  - AVEK
    - Exchange/transfer
    - New booster station(s) and pipeline
    - Direct use
  - LADWP
    - Banking program
    - Exchange/transfer
    - LA Aqueduct turnout
    - Pipeline and recharge facilities
    - Recovery facilities

Indian Wells Valley – AVEK Facilities Extension



Conceptual Costs for Facilities – AVEK

Capital Costs

Item	Unit Price	Units	Quantity	Total
8,800 gpm booster pump station	$5,750,000	Each	2	$11,500,000
60" steel pipeline extension	$360	Linear Foot	250,000	$90,000,000
1 MG steel reservoir	$1,500,000	Each	1	$1,500,000
			Subtotal	**$103,000,000**

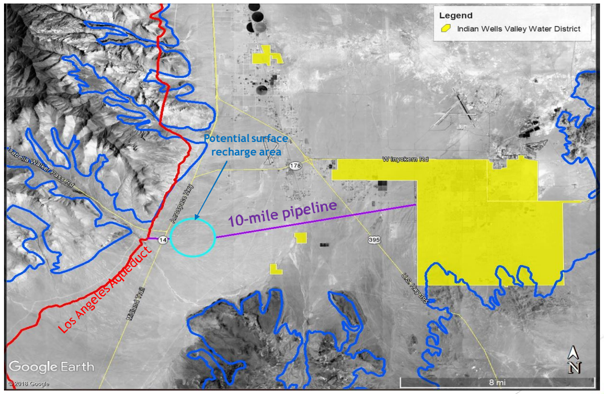
Annual O&M Costs

Item	Unit Price	Units	Quantity	Total
Pump station maintenance	$575,000	Lump sum	1	$575,000
Pump station power	$510,300	Lump sum	1	$510,300
Pipe maintenance	$175,000	Lump sum	1	$175,000
			Subtotal	**$1,260,300**

Cost Summary – AVEK Direct Use Project

- SWP water purchases (for 30,000 AFY of entitlement)
  - Table A permanent transfer unit cost of $6,000/AF
    - Total permanent transfer cost - $180,000,000
- SWP transportation charge - $422/AF
  - For 15,000 AF assumed to be delivered per year
- Wheeling and treatment charge - $634/AF
  - For 15,000 AF assumed to be delivered per year
- Facilities
  - Capital cost - $103,000,000
  - Annual O&M cost - $1,260,300
- Cost analysis
  - Cost per AF - **$2,230/AF**

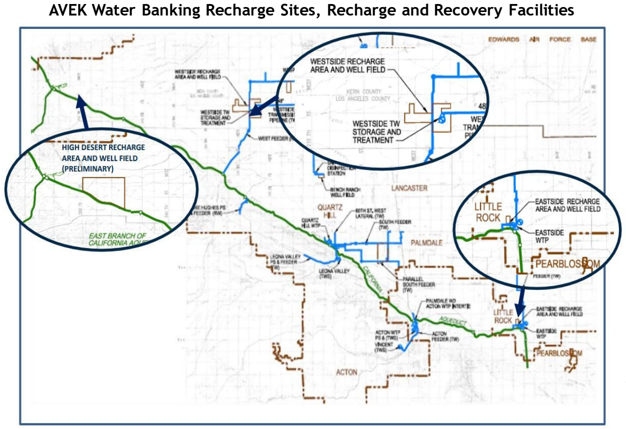
Indian Wells Valley – Los Angeles Aqueduct Facilities

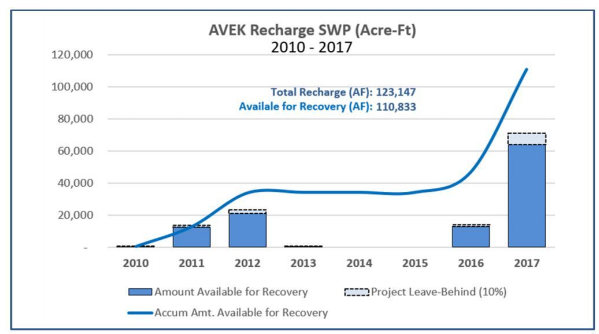


Banking Examples in AVEK

- Groundwater banking programs for storage of SWP Table A allocation during wet years
  - Improve water supply reliability during periods of high demand, disruptions in SWP deliveries, and dry years
- No deliveries made for groundwater recharge from 2013-2015 (dry years)
  - 71,163 AF of SWP water recharged in 2017
- AVEK does not recover more than 90% of banked water to account for evapotranspiration, recharge/conveyance losses, and meter accuracy
  - "Leave-behind" of 10% of banked water
- Current AVEK groundwater banking programs
  - Water Supply Stabilization Project No. 2 (Westside Water Bank)
  - Eastside Water Banking and Blending Project (Eastside Project)

AVEK Water Banking Recharge Sites, Recharge and Recovery Facilities





AVEK – Historic Groundwater Banking[1]

	2010	2011	2012	2013	2014	2015	2016	2017
Amount recharged	413	13,731	23,384	371	0	0	14,086	71,163
Accumulated recharge	413	14,144	37,528	37,898	37,898	37,898	51,984	**123,147**
Leave-Behind (10%)	41	1,373	2,338	37	0	0	1,409	7,116
Accumulated Leave-Behind (10%)	41	1,414	3,753	3,790	3,790	3,790	5,198	12,315
Water available for recovery	371	12,358	21,046	333	0	0	12,677	64,047
Accumulated water available for recovery	371	12,729	33,775	34,109	34,109	34,109	46,786	**110,833**

Notes
1. Per AVEK Annual Water Resources Report, 2017. All values in acre-feet.

Conservation - Indian Wells Valley Water District

- Per Capita Water Use
  - 10-year (1998-2007) Baseline Per Capita Water Use - 264 GPCD
  - Actual 2015 Per Capita Water Use – 189 GPCD
    - 28% Reduction in Per Capita Water Use due to conservation measures implemented by IWVWD:
      - Ordinance No. 93 – Water Efficient Landscape (May 2010)
      - Ordinances No. 90 and 91 – Water Efficient Landscape (Dec 2009)
      - Ordinance No. 96 – Excessive Use Penalties (Mar 2015)
      - Best Management Practices under the California Water Efficiency Partnership (formerly the California Urban Water Conservation Council)
      - Cash for Grass Rebate Incentive Program (Instituted June 2015)

Conservation - Indian Wells Valley Water District

- Conservation Measures implemented by IWVWD (cont.)
  - Public Outreach on Water Conservation
    - Flyers/brochures, bill stuffers, messages on water bills, information packets
    - Radio
    - Newspaper
    - News Release
    - Advertising
    - Billboards
    - School Education Programs
  - Rebate Programs
    - Cash for Grass Rebate Incentive Program

Conservation - Indian Wells Valley Water District

- Conservation Measures implemented by IWVWD (cont.)
  - Rate Structure
    - Completed 2015 Water Rate Study
    - Adopted Ordinance No. 96 – Water Sales and Service Policy Manual (Mar 2015)
    - Current Rate Structure
      - Conservation Pricing
      - 4-Tiered Usage Rates for Single Family and Non-Single Family meters
    - Penalties for Excessive Water use

Conservation - Indian Wells Valley Water District

- Conservation Measures implemented by IWVWD (cont.)
  - Stages of Action

Shortage Condition	Stage	Customer Reduction Goal	Type of Rationing Program
25-40%	1	15%	Voluntary
40-50%	2	25%	Voluntary
50-60%	3	30%	Mandatory
60%+	4	40%	Mandatory

Under Stages 3 and 4, health and safety allotment is 68 GPCD

Stage 4 is likely to be declared only as a result of a prolonged water shortage or as a result of a disaster

Conservation - Indian Wells Valley Water District

- Additional Current Conservation Measures since 2015
  - Best Management Practices under the California Water Efficiency Partnership (formerly the California Urban Water Conservation Council)
  - Ordinances No. 98 and 99 - Water Efficient Landscape (Dec 2015)
  - Water Supply Contingency Plan (adopted July 2017)
  - Ordinance No. 103 – Emergency Water Conservation Mandatory Restrictions (Sept 2017)
- IWVWD's Per Capita Water Use may be lower since 2015 with the additional current conservation measures

Conservation - Indian Wells Valley Water District

- Potential for additional water conservation measures
  - Provide more Rebate Programs

	Non-Conserving Fixtures		Habit Changes		Conserving Fixtures	
Toilets	5 Flushes x 1.6 gpf	8.0	3 Flushes x 1.6 gpf	6.4	5 Flushes x 1.28 gpf	6.4
Shower	5 minutes x 2.5 gpm	12.5	4 minutes x 2.5 gpm	10.0	5 minutes x 2.0 gpm	10.0
Washer	2 loads @ 44 gal/week*load	12.5	11.6 gpcd	11.6	2 loads @ 26.5 gal/week*load	7.6
Kitchen	5 gpcd	5.0	5 gpcd	5.0	4 gpcd	4.0
Other	7 gpcd	7.0	5 gpcd	5.0	4 gpcd	4.0
Total (GPCD)		**45.0**		**38.0**		**32.0**
Total (AFY)		**1,700**		**1,400**		**1,200**

gpf = Gallons per flush GPCD = Gallons per capita per day

gpm = Gallons per minute AFY = Acre-feet per year

Conservation - Indian Wells Valley Water District

- Potential for additional water conservation measures (cont.)
  - Melbourne, Australia (Per Capita Water Use = 39 GPCD)
    - Created new permanent mandatory water restrictions and do not have voluntary Stages of Actions
    - Eliminated all outdoor watering.
    - Gave water-saving showerheads to residents at no cost
    - Place stands outside supermarkets to distribute free water-saving equipment, like trigger nozzles
    - Offered rebates on water-efficient washing machines and rainwater tanks
    - Water saving programs for businesses

Conservation - City of Ridgecrest

- Water Efficient Landscape Ordinance
  - Ordinance No. 09-05 (Dec 2009)
  - Ordinance No. 16-01 (Feb 2016), codified in Section 12-9 of the City's Code of Ordinances. Ordinance No. 16-01 supersedes Ordinance No. 09-05

Conservation - Agriculture

- Pistachios
  - Single line drip irrigation, the most efficient irrigation system for pistachios
- Orchards
  - Use similar single line drip irrigation
  - Use approximately 3.75 to 4.0 acre-feet per acre at maturity

Conservation - Industrial

- Water provided to Searles Valley Minerals and City of Trona is pumped from wells in the IWV basin and conveyed to Searles/Trona.
- Annual water use
  - Trona
    - 214 AF in 2016
    - 217 AF in 2017
  - Searles Valley Minerals
    - 2,163 AF in 2016
    - 2,413 AF in 2017
    - Water use reported as the difference between total pumped groundwater and Trona water use.

Next Steps

- Refine sizing of required facilities
- Refine cost estimates of required facilities
- Identify potential conservation practices for Searles/Trona
- Begin drafting Alternative Water Supply memo

Thank You