Steps for Analyzing Alternatives to Address Groundwater Depletion

From Five Year Review Report (2014)

1) Panel/TAC to **identify potential technical, regulatory, land use and institutional response action alternatives** to mitigate declining groundwater levels. Response action alternatives could include but are not limited to additional water supply programs, conservation and efficiency programs, increased data collection and reporting, implementation of land use strategies, regulatory responses, and institutional approaches. **In Process – initial list of alternatives and assumptions developed. Will be refined upon completion of model calibration.**

2) Panel/TAC will **develop screening criteria** to evaluate the viability of possible response action alternatives. **Completed.**

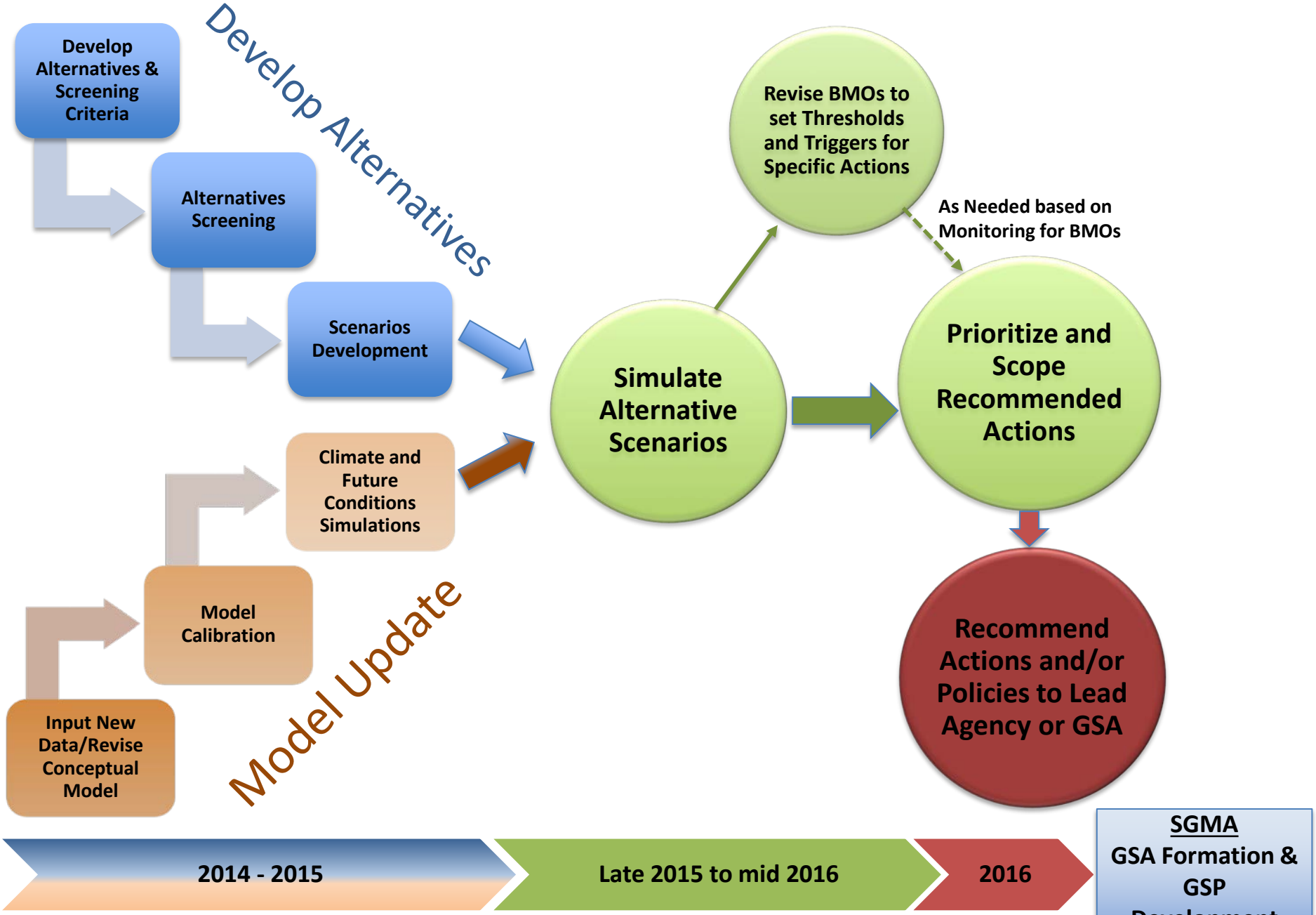
3) Panel/TAC will **prioritize response action alternatives and develop scenarios** consisting of one or more of these alternative actions, and evaluate how effective the alternative actions might be in mitigating declining groundwater levels. **In Process – prioritization and development of scenarios will be done upon completion of model calibration.**

4) Refine conceptual model in the southern Sonoma Valley and **refine MODFLOW groundwater flow model** to support scenario based planning. **In Process – model calibration anticipated to be completed late 2015**.

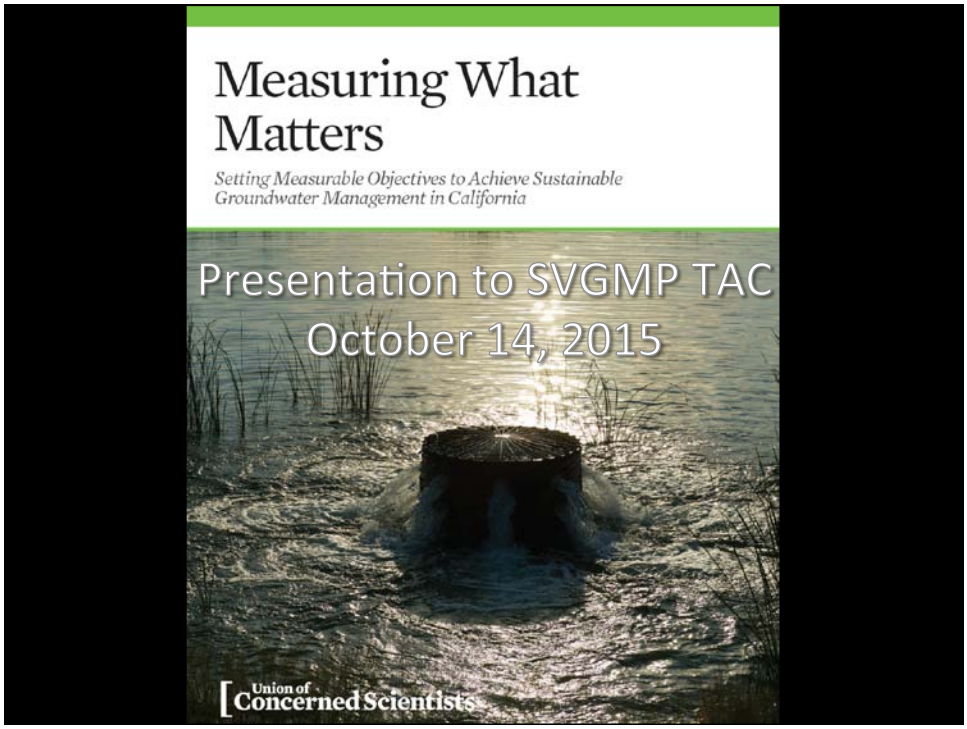
5) TAC to work with Panel and SVGMP staff for **input and review on the scenario based planning** to include baseline conditions, no action alternative, and a range of climate impacts and land use changes. **In Process – assumptions for baseline land use/climate change conditions being developed. Develop scenarios for modeling late 2015/early 2016.**

6) Panel ultimately to **approve response action alternatives screening and make recommendations regarding any technical or policy proposals** that come out of the process. **To be completed following scenario modeling. Likely in mid-2016.**

7) **Community outreach** will be needed throughout this process to educate local stakeholders of basin conditions, inform them of possible response action alternatives, policy recommendations and consider their input. **Ongoing.**



Alternatives Analysis Process to Address Groundwater Depletion is consistent with SGMA requirements and form framework for GSA to develop and implement GSP



Contrast in Plans

GMP – AB3030/SB1938

- Basins Management Objectives
- Basin maps and hydrology
- Groundwater monitoring
- Plan to involve other agencies
- Documentation of public involvement

GSP - SGMA

- Measureable objectives and interim objective
- Description of how objectives will be achieved
- Basin physical description
- Monitoring and management provisions
- Document how GSP will incorporate general plans
- Document how planning process will encourage active involvement of diverse interests

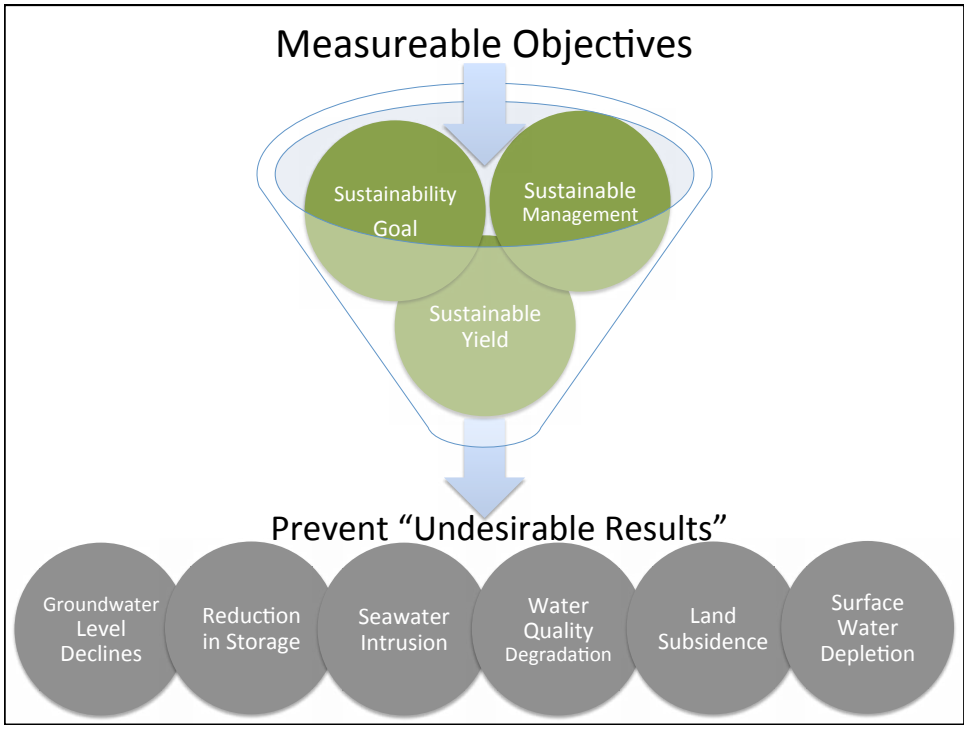
SGMA

- CWC Section 10727.2(b)(2) requires GSAs to set "measureable objectives" in GSPs to achieve the "sustainability goals for the basin"
- Does not specifically define measurable objectives or how they should be set or measured over time
- Directs GSAs to set measurable objectives that will avoid "undesirable results"

SGMA

"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 of 50 years.
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.



Effective Measurable Objectives: What They Should Accomplish

- Define Clear Baselines
- Set Quantitative Thresholds
- Develop Protective Triggers
  - Fixed Triggers
  - Flexible Triggers
- Incorporate Regular Measurement and Monitoring
- Account for Uncertainty
- Adapt to Changing Conditions and New Information

Preliminary Framework for Setting Thresholds

1. Does the threshold exceed an existing standard?
2. Was the threshold developed internally, without a transparent public process?
3. Are there potential negative impacts associated with the threshold level?
4. Does the threshold violate thresholds of any neighboring basin?
5. Does the threshold conflict with any other thresholds for undesirable results in the basin?

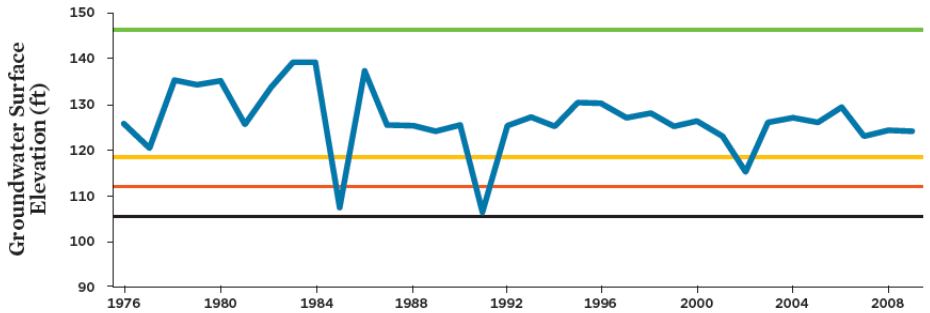
Measurable Objective	Document	Threshold Example
Groundwater Levels		
Limit groundwater extraction.	Central Sacramento County Groundwater Management Plan	The long-term average groundwater extraction rate should not exceed 273,000 acre-feet (AF)/year.
	Orange County Water District (OCWD) Groundwater Management Plan	OCWD does not have a "hard cap" on groundwater extractions, but uses economic disincentives to encourage groundwater producers to limit production to the amount established by OCWD.
	Madera Regional Groundwater Management Plan	Reduce groundwater extractions by 150,000 AF/ year.
Limit the decline in groundwater elevation to provide for sustainable yield.	Groundwater Management Area 1: Desired Future Conditions (Dockum Aquifer)	Average decline in groundwater levels must not exceed 30 feet over the next 50 years.
Groundwater Storage		
Achieve a target storage volume in the future.	Monterey Peninsula Water Management District	27,360 AF of usable storage required.
	Groundwater Management Area 1: Desired Future Conditions (Blaine Aquifer)	50% of the volume in storage will remain in 50 years.
	Orange County Water District Groundwater Management Plan	Managed groundwater basin within a 500,000 AF volume with triggers when storage levels reach various points, including reducing pumping.
	Eastern San Joaquin Integrated Regional Water Management Plan	70,000 AF/year is needed to stabilize the basin and an average of 140,000 AF/year is needed to refill the basin to 1986-1992 conditions.
Achieve a target reduction in the "remaining life of storage".	Santa Barbara County	Available storage/net overdraft + x = remaining life of storage * 0.97 (allows a 3% loss in the remaining life of storage).

Measurable Objective	Document	Threshold Example
Seawater Intrusion		
Maintain groundwater elevations that prevent further seawater intrusion.	Fox County Groundwater Management Agency Groundwater Management Plan	Groundwater elevations in monitoring wells at the coastline must average at least 5 feet above sea level to prevent seawater intrusion.
Maintain chloride concentrations within a range defined by historic maximums.	South Westside Basin Groundwater Management Plan	The threshold is set at approximately 10% above the historical maximum concentration over the past 20 years of sampling (1991–2010, with probable outliers removed).
Water Quality		
Maintain high-quality groundwater by limiting contaminant concentrations.	Central Sacramento County Groundwater Management Plan	TDS concentration should not exceed 1,000 mg/L. NO_3 concentration should not exceed 45 mg/L. Any measurable trace of VOCs in a private or public well should be considered significant.
Land Subsidence		
Restrict the amount of allowable subsidence.	Central Sacramento County Groundwater Management Plan	Protect against any potential inelastic land surface subsidence by limiting subsidence to no more than 0.007 feet per 1 foot of drawdown in the groundwater basin.
Reduce the rate of subsidence.	Madera Regional Groundwater Management Plan	Reduce the rate of subsidence by half.
Depletions of Interconnected Surface Water		
Groundwater flows will support functioning wetlands.	Water Allocation Plan for the Tindall Limestone Aquifer, Katherine (Australia)	Water level decline at the groundwater dependent ecosystem should not exceed 0.05 m/year.

Measurable Objective	Document	Trigger Example
Groundwater Levels		
Reduce decline in groundwater elevation.	Basin Management Objective, Glenn County, sub-area 8	**Trigger 1:** when any measured Spring groundwater surface elevation is below 1 Standard Deviation from the Average of the time of record utilized for the corresponding BMO Key Well **Trigger 2:** on the second and subsequent sequential years, when any measured Spring groundwater surface elevation is below 1 Standard Deviation from the Average of the time of record utilized for the corresponding BMO Key Well **Trigger 3:** when any measured Spring groundwater surface elevation is below 2 Standard Deviations from the Average of the time of record utilized for the corresponding BMO Key Well **Trigger 1, 2, and 3 actions** shall be rescinded by the WAC when the measured groundwater surface elevations return to an elevation above 1 Standard Deviation for the corresponding BMO.
	South Westside Basin Groundwater Management Plan	**Trigger 1:** the historical low minus five feet, rounded down to the nearest five **Trigger 2:** 10 feet below Trigger 1 for all wells
	Lower Platte South Natural Resources District: Rules & Regulations for the Nebraska Groundwater Management and Protection Act	**Phase I Trigger** has been designated District-wide and the District has established educational programs, groundwater monitoring and best management practices. **Phase II Trigger** shall occur when spring static groundwater elevations in 30% of the monitoring network wells have declined from the established upper elevation of the saturated thickness to an elevation that represents greater than or equal to a percent reduction in the saturated thickness and has remained below that elevation for a two consecutive year period. **Phase III Trigger** shall occur when spring static water elevation in 50% of the monitoring network wells have declined from the established upper elevation of the saturated thickness to an elevation that represents greater than or equal to a percent reduction in the saturated thickness and has remained below that elevation for a two consecutive year period.

Measurable Objective	Document	Trigger Example
Seawater Intrusion		
Maintain groundwater elevations to prevent further seawater intrusion.	South Westside Basin Groundwater Management Plan	For wells designated for seawater intrusion monitoring: **Trigger 1** is the historical low minus two feet, rounded down. **Trigger 2** is 10 feet below Trigger 1 for all wells.
Water Quality		
Reduce or eliminate contaminants.	Lower Platte South Natural Resources District: Rules & Regulations for the Nebraska Groundwater Management and Protection Act	**Phase I Trigger** has been designated District-wide and the District has established educational programs, groundwater monitoring and best management practices. **Phase II Trigger** shall occur when at least 50% of the monitoring wells in the network are at or above 50% of the Maximum Contaminant Level for a contaminant. **Phase III Trigger** shall occur when at least 80% of the monitoring wells in the network are at or above 80% of the Maximum Contaminant Level for a contaminant.
Depletions of Interconnected Surface Water		
Limit the loss of interconnected surface flows.	Central Sacramento County Groundwater Management Plan	**Trigger Point 1:** Monitoring of losses of river water to groundwater shows a 5 percent increase over the current loss rate based on total flow in the river. **Trigger Point 2:** Monitoring of losses of river water to groundwater shows a 25 percent increase over the current loss rate based on total flow in the river.

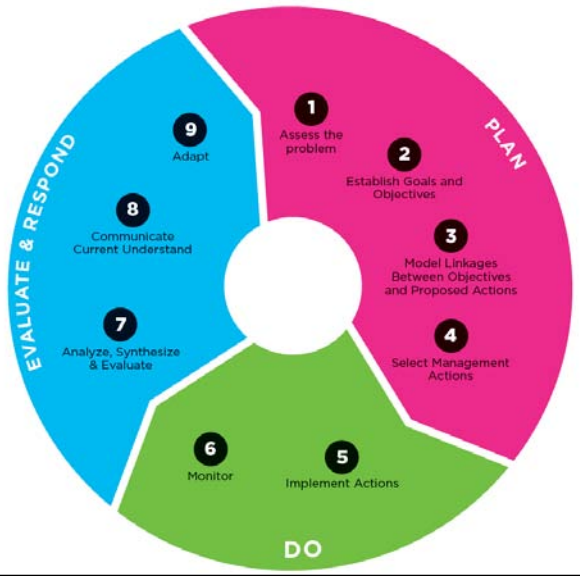
Fixed Triggers for GW Management



- Green – Land surface elevation
- Yellow – One standard deviation below average groundwater level
- Red – Two standard deviations below average groundwater level
- Black – Lowest recorded groundwater level
- Blue – Groundwater level data plotted over time

Groundwater Levels and Groundwater Storage		
Metric	**Document/Tool**	**Description**
Metering groundwater extraction	North Texas Groundwater Conservation District	All nonexempt wells must install a meter or water-flow-measuring device that can measure within plus or minus 5% accuracy.
Monitoring groundwater wells	Sacramento Central Groundwater Authority Groundwater Elevation Monitoring Plan	Operates 29 monitoring wells, which it monitors biannually (1 week before and after the 15th of each April and October). These months represent the typical seasonal high and low for groundwater levels in the basin based on historical data.
	Kings River Conservation District (KRCD)	Operates a satellite internet telemetry system at several groundwater monitoring wells. Each consists of a water-level-monitoring device that collects groundwater elevations daily and a data transmitter, which sends that data via satellite to the KRCD.
Modeling groundwater usage	GRACE: Gravity Recovery and Climate Experiment	Satellite measures variations in water stored at all levels above and within the land surface. However, the spatial (>150,000 km2) and temporal (monthly with a significant time lag) resolutions of the GRACE fields limit their fine-scale application for sub-basin water balance assessment.
	SEBAL: Surface Energy Balance Algorithm for Land	Uses Landsat satellite data to estimate water used for evapo-transpiration (ET).*
	METRIC: Mapping EvapoTranspiration at high Resolution with Internalized Calibration EvapoTranspiration at high Resolution with Internalized Calibration	Uses Landsat satellite data to estimate water used for ET.*
Metering electricity usage	Electricity meters on groundwater wells	Uses electrical consumption to estimate groundwater pumped from individual wells.

Adaptive Management



Undesirable Result	Related Agency Policies			Related Case Law
	Federal	State	Regional/Local	
Water quality	Safe Drinking Water Act, which includes the Underground Injection Control Program (Environmental Protection Agency)	Porter-Cologne Water Quality Control Act, "Anti-degradation policy"; Resolution 68-16; Recycled Water Policy (all covered by the State Water Resources Control Board)	Basin Plans; Local Salt & Nutrient Management Plans; Total Maximum Daily Loads (all covered by the Regional Water Quality Control Boards)	*Asociación de Gente Unida por el Agua v. Central Valley Regional Water Quality Control Board* (waste discharge order regulating dairies was found to violate California's Anti-degradation Policy)
Seawater intrusion		Porter-Cologne Water Quality Control Act; Recycled Water Policy; Resolution 88-63, "Sources of Drinking Water" includes a salinity standard; Water Code Section 2100 (State Water Resources Control Board)	Local Salt & Nutrient Management Plans (Regional Water Quality Control Boards)	
Subsidence				*Los Osos Valley Associates v. City of San Luis Obispo* (economic impacts related to subsidence must be borne by groundwater pumpers)
Interconnected surface flows	Endangered Species Act (Fish and Wildlife Service); Clean Water Act (Environmental Protection Agency)	Public Trust Doctrine (State Water Resources Control Board)	Bay Delta Water Quality Control Plan (State Water Resources Control Board); Instream Flow Guidelines for Northern Coastal Streams (State Water Resources Control Board); Minimum flow standards developed for Deer and Mill Creeks (Department of Fish and Wildlife); TMDL-related flow requirements on Shasta and Scott Rivers (Regional Water Quality Control Boards)	*Pacific Coast Federation of Fishermen's Association v. SWRCB* (endorses the principle that groundwater removals affecting flows in a navigable stream are subject to the public trust doctrine); National Audubon Society v. Superior Court (recognized that the State Water Resources Control Board had a duty to consider public trust when administering water rights)
Lowering of groundwater tables/loss of storage		Article X of California Constitution—prohibition against waste and unreasonable use (State Water Resources Control Board); Urban Water Management Planning Act requires 3-year-drought contingency plans and asks for agencies to consider climate change (Department of Water Resources)	Stanislaus County groundwater ordinance (County Board of Supervisors); San Luis Obispo County groundwater ordinance (County Board of Supervisors)	

POTENTIAL BMO THRESHOLDS, TRIGGERS & ACTIONS

BMO-1 Maintain Groundwater Levels for the Support of Beneficial Uses of Groundwater and to Protect Against Land Subsidence and Seawater Intrusion

Threshold (Phase) 1 Relatively Stable Groundwater Levels

- Potential Triggers
  - Groundwater levels fall below historical low or significantly exceed historical seasonal fluctuation.
  - Groundwater level trends exhibit a declining trend.
  - During wet season or wet year, recovery not occurring and/or exceedance of historic lows
- Potential Actions
  - Verification monitoring, and if appropriate, additional evaluation regarding cause of declines
  - Notifications to stakeholders in area affected
  - Promote conservation measures according to guidelines (to be developed).

Discussion Draft

POTENTIAL BMO THRESHOLDS, TRIGGERS & ACTIONS

BMO-1 Maintain Groundwater Levels for the Support of Beneficial Uses of Groundwater and to Protect Against Land Subsidence and Seawater Intrusion

Threshold 2 Persistent Groundwater Level Declines over One or More Hydrologic Cycles

- Potential Triggers
  - Groundwater levels do not recover
  - Rate of declining groundwater level trends continues
- Potential Actions
  - If appropriate, additional evaluation regarding cause of declines
  - Notifications to stakeholders in area affected and local planning agencies
  - Implement conservation measures according to guidelines (to be developed)
  - Develop list of options for actions and alternatives for increasing local supplies, redistributing pumping stresses, and reducing demands

Discussion Draft

POTENTIAL BMO THRESHOLDS, TRIGGERS & ACTIONS

BMO-1 Maintain Groundwater Levels for the Support of Beneficial Uses of Groundwater and to Protect Against Land Subsidence and Seawater Intrusion

Threshold 3 Worsening Conditions in Areas with Persistent Groundwater Level Declines

- Potential Triggers
  - Rate of groundwater level declining trends significantly worsen
  - Groundwater levels approach x feet from bottom of well perforations for x percentage of wells within the GMA
  - Documentation of wells going dry
  - Documentation of increased depletion of streamflow correlative with declining groundwater levels
  - Groundwater quality changes correlative with declining groundwater levels
- Potential Actions
  - If appropriate, additional evaluation regarding cause(s) of declines
  - Notifications to stakeholders in area affected of Phase 3 and local planning agencies
  - Implement conservation measures according to guidelines (to be developed)
  - Implement actions and alternatives identified during Threshold 2 including alternatives for increasing supplies

Discussion Draft