

DEPLETION OF INTERCONNECTED SURFACE WATER: A SUSTAINABLE MANAGEMENT INDICATOR

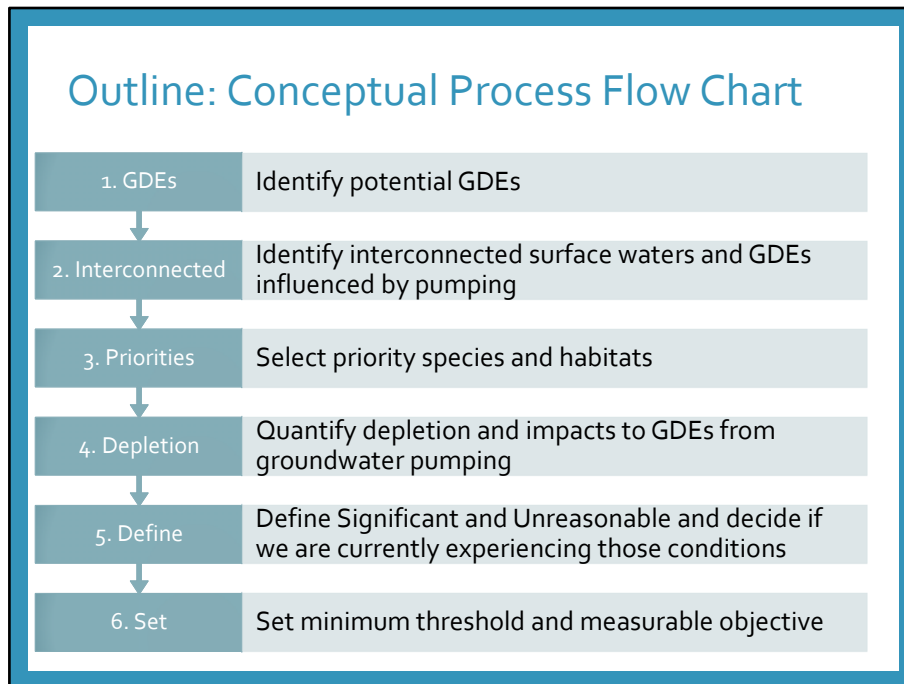
Presented to Surface Water Technical Advisory Group

by Chelsea Neill

8/14/2020



Analysis of streamflow depletion from groundwater pumping is required under SGMA to establish significant and unreasonable statements and minimum thresholds for sustainable management of the basin aquifers.



Groundwater Sustainability Agencies (GSAs) must develop and implement Groundwater Sustainability Plans (GSPs) for managing and using groundwater without causing undesirable results. At minimum, each GSP must consider the following six sustainability indicators: 1) significant groundwater-level declines, 2) groundwater-storage reductions, 3) seawater intrusion, 4) water-quality degradation, 5) land subsidence, and 6) surface-water depletion. Our job is to assist the GSA in developing “significant and unreasonable” statements and “minimum thresholds” for basin management. This presentation explains the process we’re following to reach an understanding of what significant and unreasonable levels of streamflow are, so as to develop minimum thresholds for the depletion of interconnected surface water indicator.

To address the depletion of interconnected surface flow management criteria we will use this process to get to the goal of establishing minimum thresholds and measurable objectives. This process is the same process that was used in the MidCounty GSP. Similar to the other sustainability indicators this process will be iterative.

What is a GDE?

Open Water



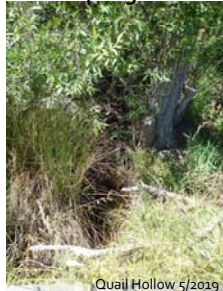
Glenwood Preserve 5/2019

Riverine and Riparian



Lompico Creek 6/2019

Springs



Quail Hollow 5/2019

Other Groundwater Dependent Wetlands

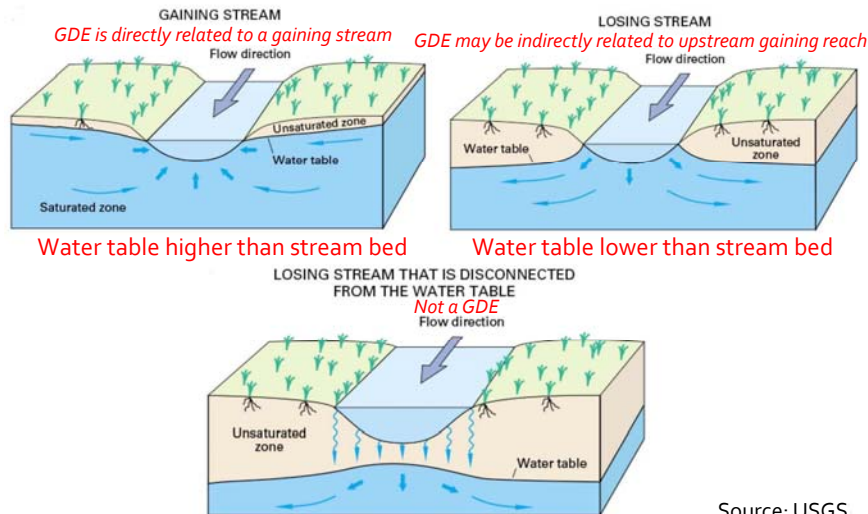


Olympia Quarry floor 5/2019

Groundwater Dependent Ecosystems found in the Santa Margarita Basin were classified into 4 categories:

1. Open water includes features such as lakes and ponds
2. Riverine and riparian includes in-stream habitat, riverine wetlands, on-channels ponds, and other wetland features that occur within the riverine corridor
3. Springs are points of discharging groundwater that can support adjacent wetlands
4. Other groundwater dependent wetlands includes quarry floor sites and seep/seep complexes

General Concepts of GDEs and Interconnected Baseflows

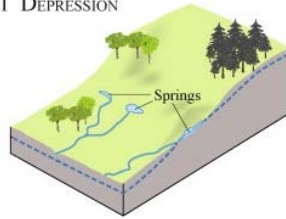


Under SMGA we are only concerned with areas where ecosystems are supported by groundwater. Specifically, SGMA defines “interconnected surface water” as surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted. Gaining streams are those where the water table is higher than the streambed and groundwater is supporting instream flow. Losing streams are those where the water table is lower than the streambed and instream flow may infiltrate to groundwater. Losing reaches may be areas of groundwater recharge. Areas where the streambed is disconnected from groundwater do not support groundwater dependent ecosystems and thus do not need to be considered under SGMA.

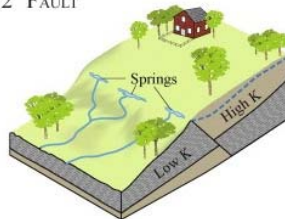
General Concepts of GDEs at Springs

A spring is discharging groundwater

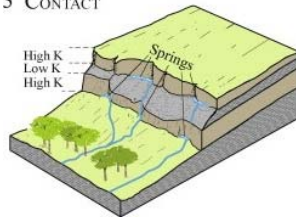
1 DEPRESSION



2 FAULT



3 CONTACT



4 FRACTURE

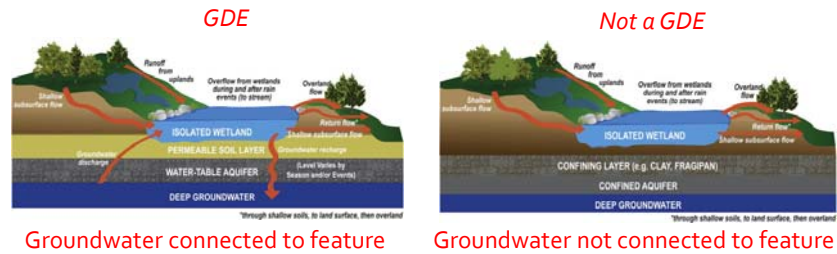


Source: Kløve and others, 2011

Springs are points where groundwater is discharged. Springs can occur as a result of a few processes:

1. In areas where there is a depression in the topography and the low-lying areas intersect groundwater
2. Where there is a fault and water easily moves along the fault and the fault contact
3. At the contact between two different geologic formation. For example, where the contact between the Santa Margarita (permeable) and the Monterey (less permeable) is exposed.
4. Along fractures within the bedrock

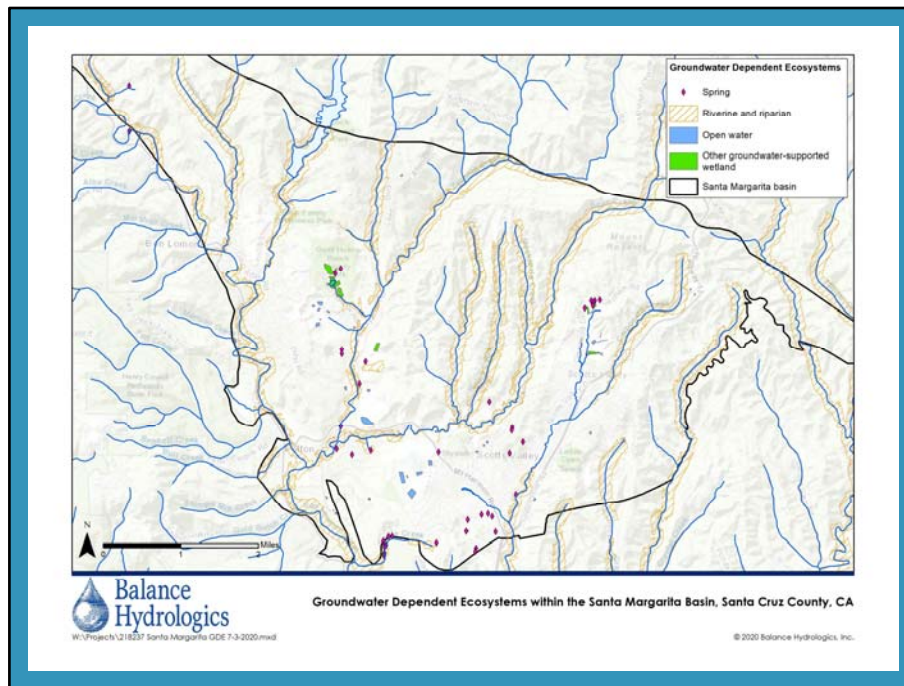
General Concepts of Open water and Other GDEs



Source: Golden and others, 2014

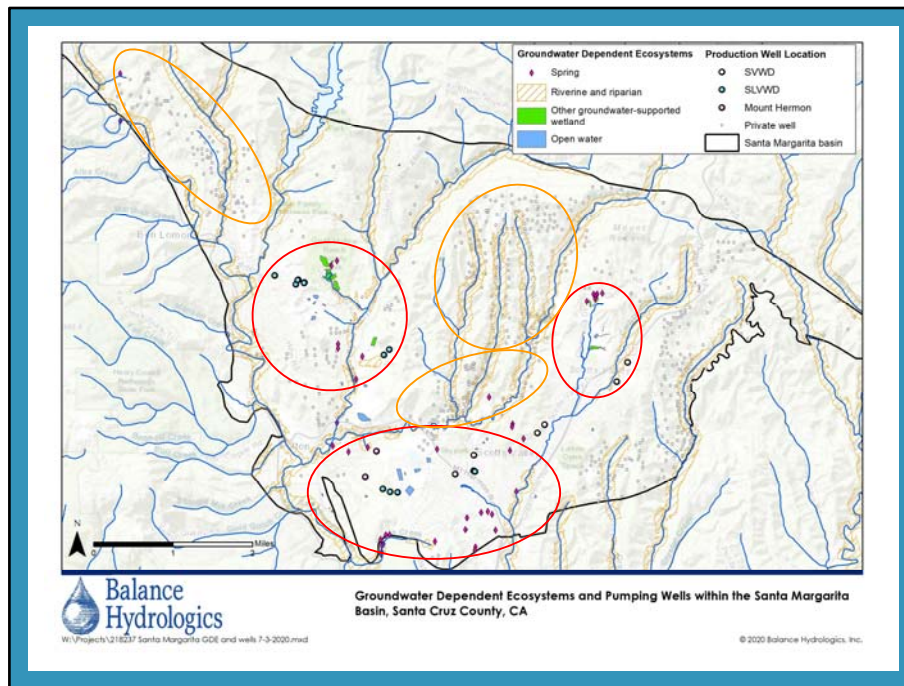
Open water features, such as ponds and lakes, and other GDEs, such as quarry floors or wetlands, function similarly. When the feature is connected to groundwater, or within the rooting depth of plants, the feature is a GDE. In instances where there is a confining layer beneath the feature, the feature is perched and not connected to groundwater. This is not a GDE. In some quarries the ground has been compacted to create a confining layer, causing the water to be perched, and thus is not a GDE.

1. IDENTIFY POTENTIAL GDES

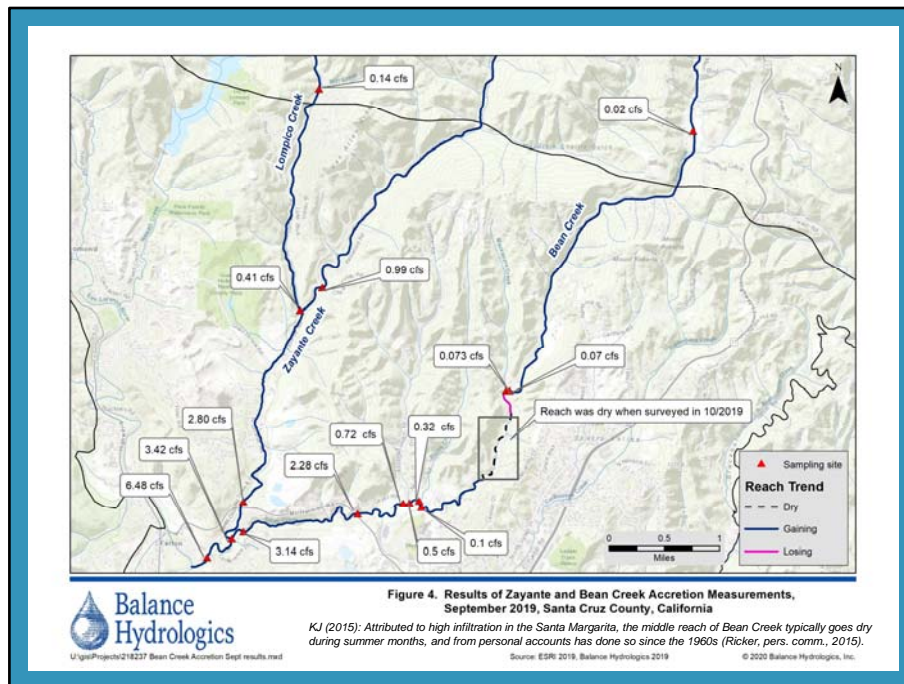


We identified the groundwater dependent ecosystems within the basin from a variety of sources including existing databases (National Wetlands Inventory, National Hydrography Dataset, CALVEG), previous studies (Kennedy Jenks 2015 report), and other known locations (project team). Under SGMA we are required to use the best available data to identify GDEs. We have already done more than that with additional GDE field verification and studies. Work is on-going to continue to identify and evaluate other GDEs within the basin. This includes using aerial imagery to identification potential GDEs, as well as field verification of GDEs. We welcome any feedback and input on potential GDE locations.

**2. IDENTIFY
INTERCONNECTED
SURFACE WATERS
AND GDES
INFLUENCED BY
PUMPING**



Through the GSP we specifically need to consider GDEs that are influenced by groundwater pumping. This map shows the location of pumping wells and their proximity to GDEs. Areas that are circled in red show the primary areas where GDEs may be impacted by municipal pumping. The areas circled in orange show the areas where GDEs may be impacted by private pumping. As previously mentioned, lower Bean Creek is one of the primary gaining streams in the basin. There are a number of pumping wells that could be impacting this area. The pumping wells located along upper Carbonera Creek are relatively far from the GDEs around the Glenwood Preserve and the Canham road springs. The impact of pumping on those GDEs needs to be further evaluated.



One method of analyzing the surface water groundwater interaction in streams is through an accretion study, which tells us where and how water enters and leaves a stream during low flow conditions. Accretion studies are conducted by measuring changes in flow and specific conductance (“salinity”) at various points from downstream to upstream in a stream system on a single day. It also tells us where the aquifer is adding flow to the stream, and where the stream is replenishing the aquifer.

In support of the GSP we conducted accretion measurements along Zayante and Bean Creek during the dry season of 2019 – on May 30-31, July 10, and September 24-25. Water year 2019 was a wet year with annual rainfall 112 percent of mean.

This map shows the results of the accretion measurements from September 24-25. Stream segments in dark blue show areas where the flow was gaining (groundwater is supporting instream flow). Segments in pink show where the flow was losing (instream flow infiltrating to groundwater).

There is one reach within Bean Creek that has historically gone dry. We walked this

reach in October, 2019 to document the extents of the dry reach. Depending on the year this dry reach may extend as far upstream as Redwood Glen (approximately one mile upstream of the dry reach surveyed in 2019).

We also just completed accretion measurements on July 7-8, 2020. Water year 2020 was a dry year with annual rainfall of 16.39 inches (approximately 32% of the long-term average) at the SLVWD Boulder Creek rain gage.

Baseflow on Bean Creek, September 2019

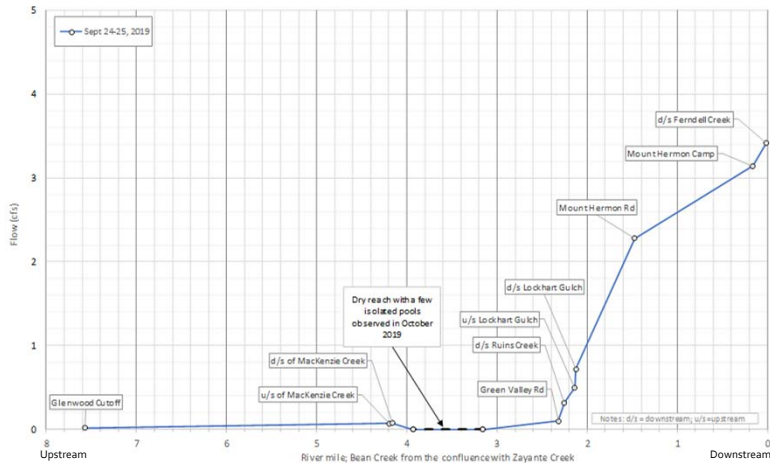


Figure 3. Bean Creek downstream changes in flow as measured during September 2019, Santa Cruz County, CA. Note location of dry reach.

This profile shows baseflow measurements during September 2019 on Bean Creek from upstream (on left) to downstream (on right). If there was no interaction between groundwater and surface water, then the profile between tributaries would be flat. However, in general we see an increase in baseflow along Bean Creek, with the greatest increase in flow near the downstream end of the Creek. This reach has been noted as being one of the largest gaining reaches within the basin.

We also measured flow during May and July of 2019. This allows us to see the seasonal variability of flow. The trends in flow were largely the same during the other times, but with more flow earlier in the season.

3. SELECT PRIORITY SPECIES AND HABITAT

Examples of priority species



Steelhead Trout



Coho Salmon



Lamprey



California Red-Legged frog



Choris popcornflower



San Francisco popcornflower

Species of concern are included as beneficial users of interconnected surface flow. These are examples of priority species. The current list came from the California Natural Diversity Database (CNDDB) with additional updates from the County Biologist. This list will be updated by the Surface Water Technical Advisory Group.

**4. QUANTIFY
DEPLETION AND
IMPACTS TO
GDES FROM
GROUNDWATER
PUMPING**

What is Streamflow Depletion?

DWR SGMA Regulations § 354.28. (c)(6)

Identify:

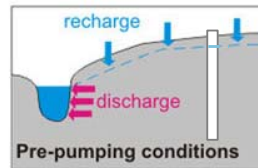
- The rate or volume of surface water depletions ...
- caused by **groundwater use** ...
- that has adverse impacts on **beneficial uses** of the surface water ...
 - and may lead to **undesirable results**.

Beneficial users of groundwater:

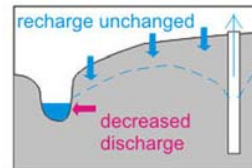
- SVWD
- SLVWD
- Environmental users-
(ecological communities or species)
- Private well owners
- City of Santa Cruz

As part of the GSP, the amount of streamflow depletion from groundwater use needs to be quantified. To quantify this amount we need to calculate what the surface flow would be if there was no groundwater pumping. We are specifically concerned with the potential impact that groundwater pumping has on beneficial users of groundwater, such as water districts and private wells, that supply people with water and species that live in GDEs.

Concept of Streamflow Depletion



- No pumping near stream
- Streamflow at 2 cfs



- Well near stream that is pumping
- Streamflow drops to 1.5 cfs

Pumping has caused 0.5 cfs decrease in streamflow

As a conceptual example, there is a stream flowing with 2 cfs when the well is not on (left). When the well is turned on the streamflow drops to 1.5 cfs (right). The streamflow has decreased by 0.5 cfs as a result of the pumping. In reality, this is very challenging (if not impossible) to measure. The impact of pumping can take many years to decades to result in a response in streamflow. Wells do not have to be near streams to cause depletion if there is overall lowering of groundwater levels.

Quantifying streamflow depletion caused by groundwater pumping is complicated because there are a number of other factors that influence streamflow, such as: rainfall/runoff, surface water diversions, surface water management, evapotranspiration, etc. Because of these factors, it is nearly impossible to accurately measure streamflow depletion. Using the model is the best approach for quantifying the depletion. The update model will be critical for quantifying streamflow depletion

Baseflow Response by Aquifer

Aquifer	Approximate contribution to groundwater discharge in basin	Historic trend in groundwater discharge to stream
Santa Margarita	68%	Relatively constant since 1980's
Monterey	15%	Relatively constant
Lompico	12%	Declining
Butano	4%	Declining

Based on previous modeling results from the 2015 Kennedy Jenks report, we can look at the contribution to groundwater discharge and the historic trend to groundwater discharge for each aquifer. The approximate contribution of groundwater discharge is the approximate amount each aquifer contributes to the total groundwater discharge within the basin. We will be able to interpret the updated model results within the next few months.

In general:

- Santa Margarita contributes by far the largest amount to groundwater discharge of all the aquifers. It has had relatively constant groundwater discharge to streams, since higher pumping began in the 1980's.
- Monterey has had relatively constant groundwater discharge to streams over the long-term record
- Lompico has had declining groundwater discharge to streams and declining dry-season baseflow.
- Butano has had declining groundwater discharge to stream

Declining from 80s to current- extent of modeling.

**5. SIGNIFICANT
AND
UNREASONABLE
DEPLETION OF
INTERCONNECTED
SURFACE WATER**

Example Statements: Significant and Unreasonable Depletion of Interconnected Surface Water

- *Significant and unreasonable depletion of surface water due to groundwater extraction, in interconnected streams supporting priority species, would be undesirable if there is more depletion than experienced since the start of shallow groundwater level monitoring through 2015. – Mid-County GSP*
- *Significant and unreasonable depletions of interconnected surface water in the Eastern San Joaquin Subbasin are depletions that result in reductions in flow or levels of major rivers and streams that are hydrologically connected to the basin such that the reduced surface water flow or levels have a significant adverse impact on beneficial uses and users of the surface water within the Subbasin over the planning and implementation horizon of this GSP. – Eastern San Joaquin and Merced GSPs*
- *Significant and unreasonable depletions of interconnected surface water are reductions in the viability of agriculture or riparian habitat within the Basin over the planning and implementation horizon of this GSP. – Cayuma Basin GSP*

Significant and Unreasonable Depletion of Interconnected Surface Water: General Format

- Statement should be descriptive, not quantitative
- Who or what is impacted?
- What kind of impact?
- Over what time period?

The significant and unreasonable statement should be descriptive and include a few key elements: who is impacted, over what time period, and what kind of impact. Beneficial users or priority species are examples of who is impacted. The time period could be since 2015 or over the planning and implementation of the GSP, for example.

Draft Statement: Significant and Unreasonable Depletion of Interconnected Surface Water

Depletion of interconnected surface water occurs where interconnected surface water is depleted due to GSP implementation and/or groundwater use. To be considered significant and unreasonable, the depletions must cause significant adverse impacts to the viability of individual priority species or GDEs or undue financial burden to beneficial users or uses of the surface water.

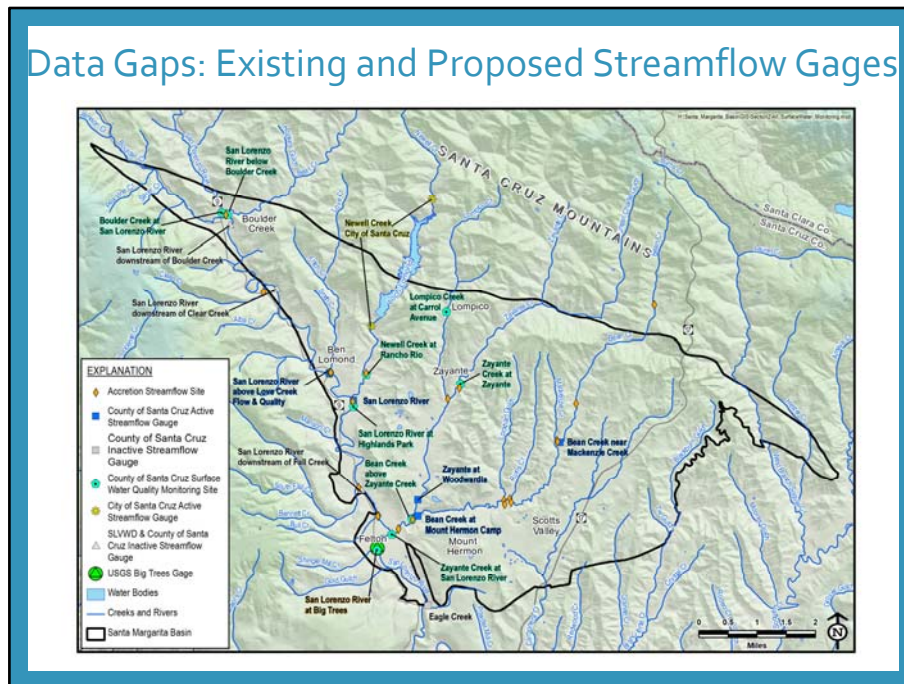
6. APPROACH FOR MINIMUM THRESHOLDS AND MEASURABLE OBJECTIVES

Challenges with Quantifying Streamflow Depletion Caused by Groundwater Use

- Most baseflow data are modeled, not measured
- Many factors other than baseflow contribute to streamflow:
 - Precipitation
 - Temperature
 - Evapotranspiration
 - Stream Diversions

Because of the many factors that influence streamflow and the simplifying assumptions associated with the groundwater model, it can be very difficult to accurately measure and quantify streamflow depletion caused by groundwater use.

Data Gaps: Existing and Proposed Streamflow Gages



The County has previously monitored streamflow at 4 gaging locations. Water year 2020 updates to the gaging network included the addition of 2 new gages: San Lorenzo River above Love Creek, and Bean Creek near Mackenzie Creek. The Eagle Creek gage was suspended for the water year 2020 monitoring season. Accretion measurements are occurring at two different times, one in July 2020 and one in late September 2020. Data from these gages was used to calibrate the model and will continue to be used for monitoring. Due to the other factors that influence baseflow and the limited period of record for the gages, using instream flow alone is likely not a viable approach to quantifying streamflow depletion and developing minimum thresholds.

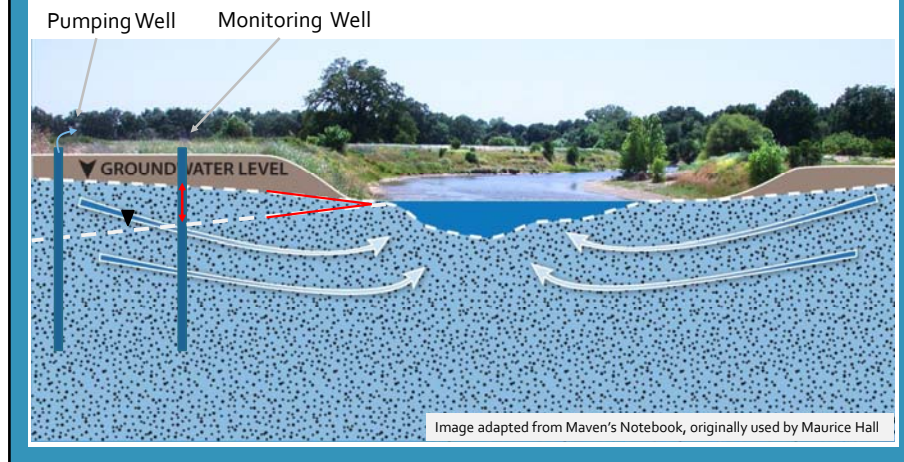
Groundwater Level as Proxy

- SGMA allows use of groundwater level as proxy for the volume or rate of streamflow depletion
- Premise (from Environmental Defense Fund approach):
 - If groundwater levels in vicinity of stream are not lower than they were prior to January 1, 2015 (allowing for inter-annual and seasonal variability), then it can be assumed that groundwater pumping is not causing significant and unreasonable depletion of surface water.
- Focuses on determination of changes in groundwater levels near streams and rivers as indicators of streamflow depletion caused by groundwater conditions.
- If groundwater levels are lowered, then the gradient of flow to stream is lowered, resulting in streamflow depletion
- Set minimum thresholds for groundwater levels in the vicinity of streams
- Need to show correlation between groundwater elevations and interconnected streamflow

Given that the use of streamflow to establish the rate of depletion is challenging and that monitoring groundwater levels is more practical, SGMA allows the use of groundwater levels as a proxy for sustainable indicators. The Environmental Defense Fund has established a rationale and methodology for this approach (Addressing Regional Surface Water Depletions in California: A Proposed Approach for Compliance with the Sustainable Groundwater Management Act).

Using the updated model will be important for evaluating the relationship between groundwater level and instream flows. Since we have limited data, the 5 year annual reports will be important for re-evaluating and refining the thresholds over time. This is also one of the reasons we will need to have enhanced monitoring.

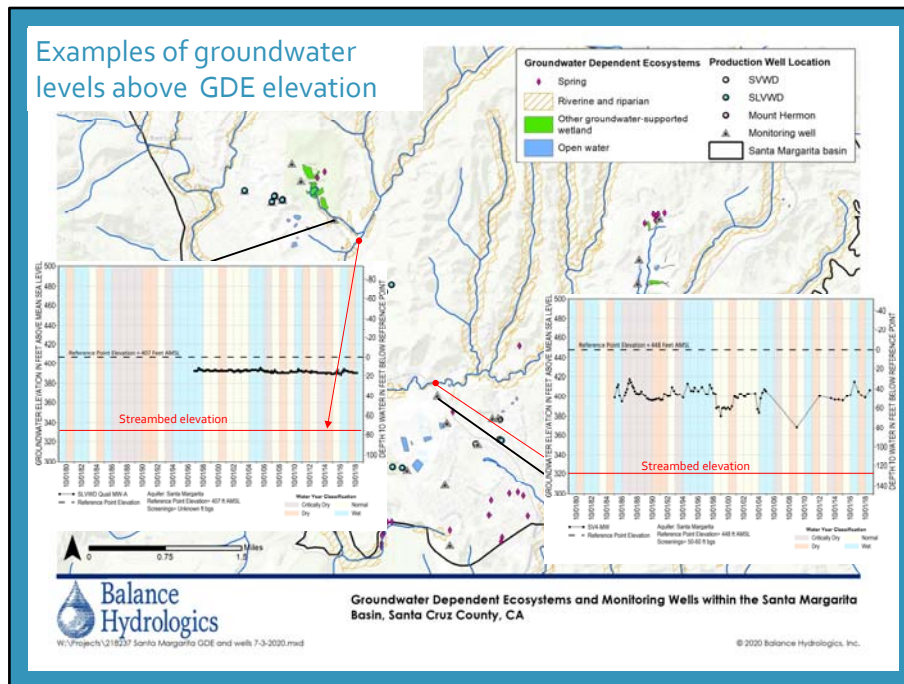
Concept of Groundwater Level as Proxy



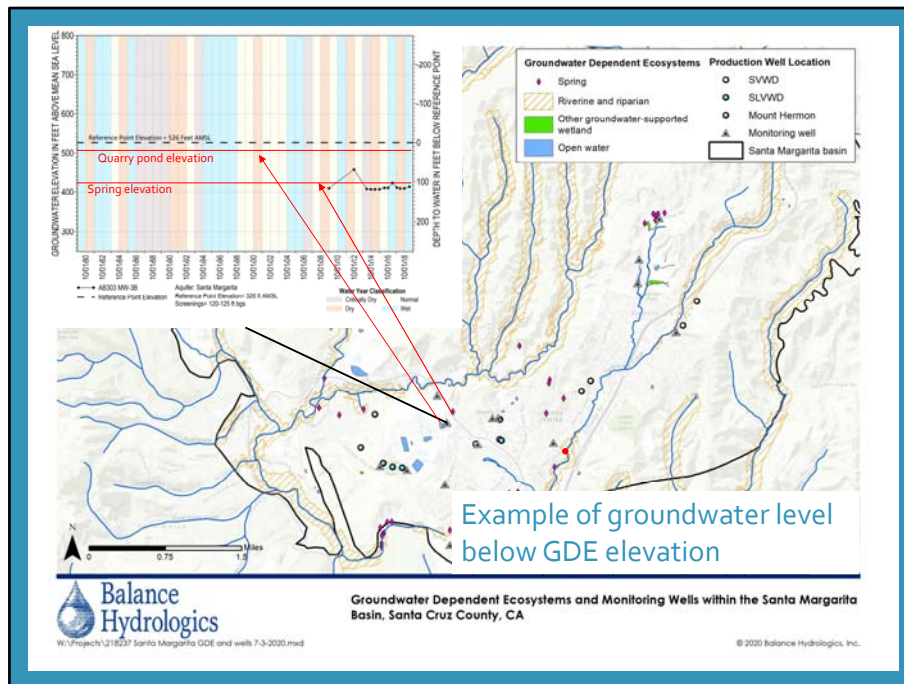
To use groundwater level as a proxy, we ideally want to have the monitoring well in between a pumping well and a GDE. We can then monitor the changes in the groundwater level. As the gradient of flow towards the GDE changes the groundwater contribution to GDEs changes.

[illegible]

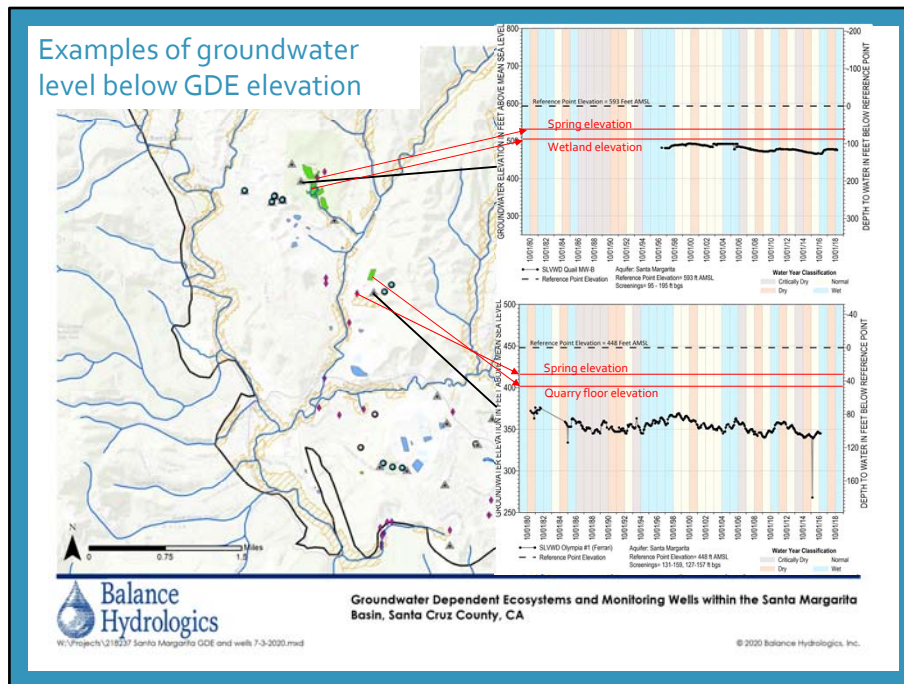
We can use the existing monitoring well data to evaluate groundwater levels near GDEs and to set minimum thresholds. The existing well monitoring is also limited throughout the basin, but provides a longer record than the streamflow gaging network. Here the proposed shallow monitoring well network is also shown, which will provide more coverage of groundwater levels.



To use groundwater elevation as a proxy we need to show that there is a correlation between groundwater level and interconnected streamflow. We can look at groundwater levels from existing monitoring wells and compare the groundwater elevation to the elevation of a nearby streambed or GDE. If the groundwater level is higher than the streambed, then groundwater is contributing to streamflow. Changes in groundwater elevation will directly relate to groundwater contribution to streams. We can then establish minimum thresholds of groundwater levels to prevent undesirable results to instream flow. There are very few monitoring wells where the groundwater elevation is higher than the nearby GDE.

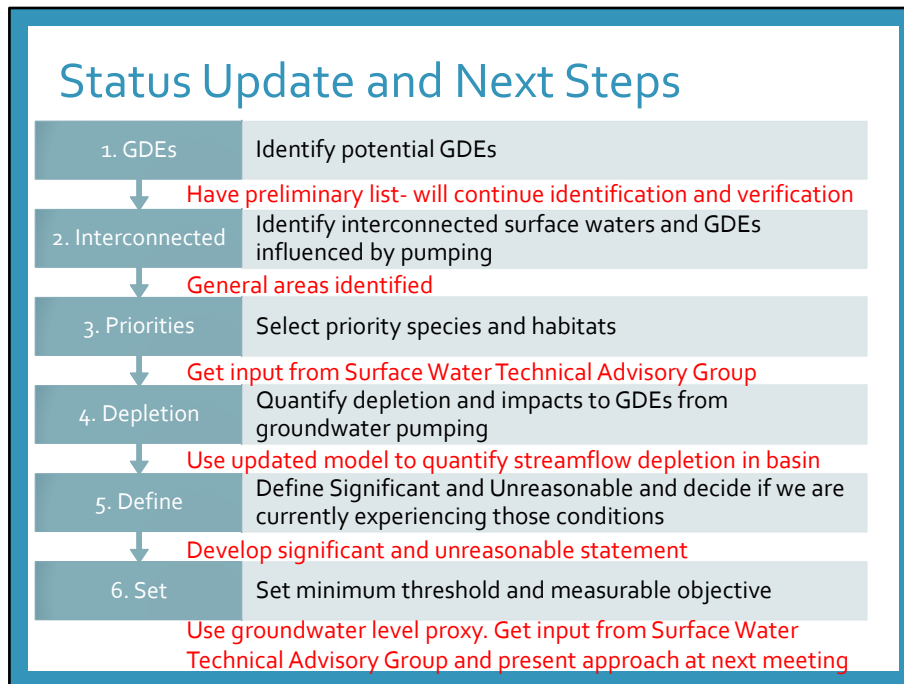


Within the existing monitoring well network there are wells where the groundwater level is below nearby GDEs. This could potentially indicate that the GDE is not actually a GDE. We will be able to use the groundwater contours from the updated model to help evaluate whether some of the GDEs should be removed from the list. We used readily available data to estimate the elevation of GDEs, this will be further refined. At this well the water level has historically been relatively constant.



Similar to the previous example there are more wells with groundwater levels below nearby GDEs. In these instances it also appears that the level in monitoring well may be influenced by pumping. Within the quail hollow area there are a number of wetlands, ponds, and springs. This is probably within the range of the rooting depth of plants within the GDEs.

7. STATUS UPDATE AND NEXT STEPS



1. We have identified potential GDEs using existing databases and other known GDEs. GDEs will continue to be identified and verified.
2. We have generally identified areas where GDEs may be influenced by pumping from both water districts and private wells. These areas will be our primary focus for evaluating GDEs and for setting minimum thresholds and measurable objectives
3. We will work with the Surface water Technical Advisory Group to refine the priority species list
4. The updated model will be used to quantify streamflow depletions
5. The board will develop a significant and unreasonable statement for the depletion of interconnected surface water. Once the statement is developed, we can evaluate the basin settings and decide if we are currently experiencing those conditions.
6. We will use groundwater levels as a proxy to set minimum thresholds and measurable objectives. We will continue to evaluate the existing data and will get input from the Surface Water Technical Advisory Group. The approach to setting minimum thresholds and measurable objectives will be discussed during the next board meeting.

QUESTIONS AND COMMENTS