INCREASED SHALLOW GROUNDWATER LEVELS FROM RECHARGE ABOVE USE (RAU) ON VINEYARDS IN SONOMA COUNTY

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SUMMARY OF KEY FINDINGS

- Recharge Above Annual Groundwater Use (RAU) can be successfully implemented on vineyards in Sonoma Count at rates exceeding annual groundwater demand for irrigation. With around 60,000 vineyard acres in Sonoma County, RAU provides great potential to benefit regional groundwater.
- RAU results in extended shallow groundwater mounding. Increased shallow groundwater levels adjacent to streams will benefit nearby streams by increasing groundwater flows to gaining streams and by decreasing groundwater flows from losing streams. If implemented at scale, RAU could potentially benefit aquatic habitat in local streams, such as Mark West Creek in which all salmonid populations are endangered.
- RAU can increase root zone soil moisture levels, particularly in areas with higher shallow groundwater levels. Increasing soil moisture in the root zone can potentially decrease irrigation demand, reducing deep groundwater pumping. Increased root zone soil moisture can potentially be a vine health concern. However, RAU effects on vine health due to soil saturation need to be considered in the context of what conditions vineyards tolerate during wet years. Years not atypical but with higher than average precipitation, such as the 2019 water year, also elevate and extend root zone moisture levels. Considering the annual variance in rainfall trends, RAU can potentially extend past March and into April and not result in atypical root zone soil moisture levels or trends. Concerns over RAU effects on soil moisture and vine health can be mitigated by selecting sites where groundwater is deeper below ground elevations such that groundwater levels under RAU do not reach as near the ground surface.
- High area precipitation in Sonoma County flush salts from the root zone and dilutes salt levels in shallow groundwater.

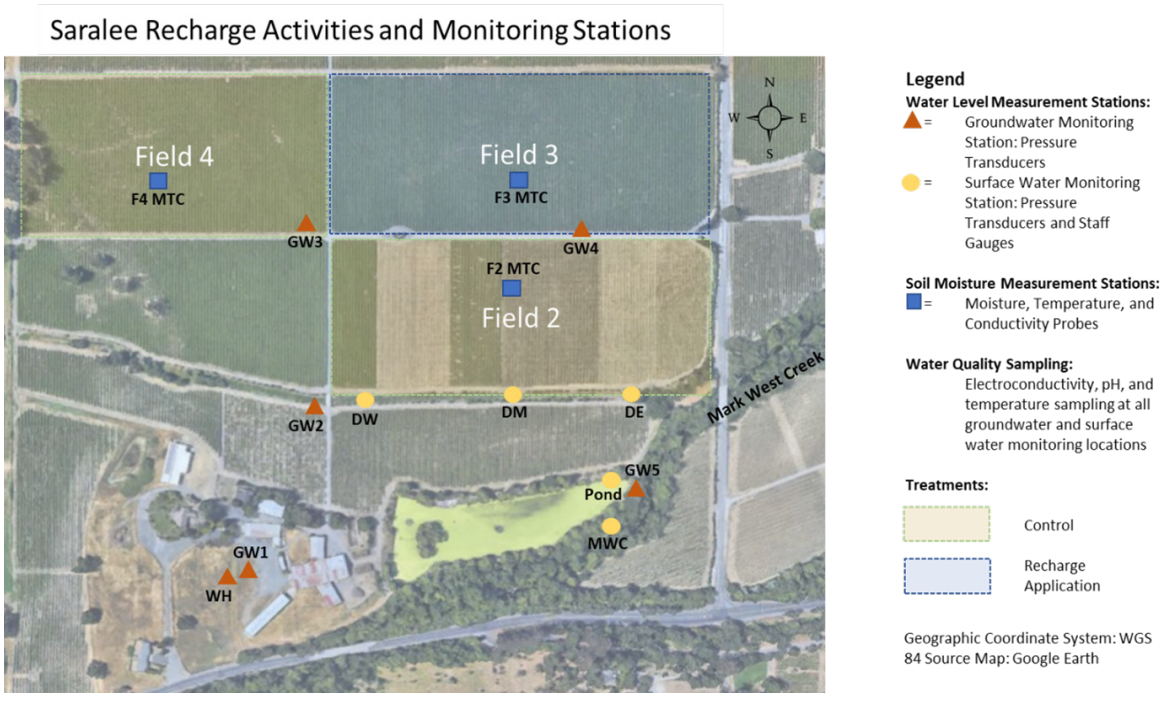

Figure 1. Hydrologic treatments and associated monitoring for RAU pilot test.
Moisture probes were set at the center of each field to gather data to on root zone moisture. Groundwater wells water levels were used to observe groundwater response to RAU. Monitoring devices were also installed at selected surface water locations.

INTRODUCTION

The three groundwater basins in Sonoma County, the Santa Rosa Plain, the Petaluma Valley, and Sonoma Valley, are currently designated high or medium priority basins under the Sustainable Groundwater Management Act (SGMA). Region wine growers have begun investigating strategies to reduce their groundwater demand and to help support regional SGMA compliance efforts.

Jackson Family Wines (JFW) conducted a vineyard groundwater recharge project in the Santa Rosa Plain adjacent to Mark West Creek (MWC) during the 2018 and 2019 water years.[1] During the 2018 water year, captured surface water was applied using impact sprinklers to Field 3 (F3, Figure 1), a 21 Ac field, to demonstrate the feasibility of groundwater recharge on high quality vineyards. Two other fields (F2, F4) were managed as experimental "controls" with no recharge water applied. Fields were instrumented to measure groundwater level responses, stream levels, and soil moisture and salinity. Farm water application totals and precipitation data were collected. The project's goal was to recharge groundwater above annual irrigation use. This approach was termed Recharge Above Use (RAU). During the following year, no recharge water was applied though groundwater levels and soil conditions were again monitored as a comparison to the previous RAU study year. Key results are detailed below.

KEY FINDINGS

Recharge Above Annual Groundwater Use (RAU) and Regional Implications

RAU totaled nearly 0.5 Ac-Ft/Ac over a 6-week period from late February through early April 2018. RAU exceeded annual irrigation demands at Saralee which were calculated as less than 0.1 Ac-Ft/Ac in both water years. Typical annual irrigation rates on vineyards in Sonoma County are estimated at 0.25 – 0.5 Ac-Ft/Ac. Thus, RAU was 1 – 2X those estimated annual rates. Total vineyard acreage in Sonoma County is around 60,000 acres[2], showing high potential to benefit regional groundwater through application of RAU at scale.

Increased Shallow Groundwater Mounding Effects Stream Flows with Potential Benefits to Salmonids

Early season groundwater trends were similar during both water years, showing MWC a slightly losing stream based on groundwater gradients trending slightly away from the stream (Figure 2). After 17.5 inches of rain, MWC had transitioned to a gaining stream both water years. However, for the 2018 water year when RAU occurred, groundwater gradients were steeper with a drop 0.5 – 1 foot greater.

The steeper gradient shows greater groundwater flows to MWC from beneath F3 than in the 2019 water year. Groundwater flows depend upon the hydraulic gradient and soil types, with finer soils such as loams and silts having lower flow rates than coarser soils such as sands (Figure 3). Raised groundwater levels will generally benefit both gaining and losing streams by increasing groundwater flow rates into the streams under gaining conditions and decreasing flow rates from the streams under losing conditions. Groundwater mounding beneath F3 extended into September during the 2018 water year.

Benefiting stream flows is important in Sonoma County. For instance, MWC, a Russian River tributary, is one of five priority stream systems in California, with all anadromous salmonid fish in the creek listed as Endangered Species.[3] MWC loses significant baseflow during the dry season, resulting in low flow and no flow regions that increase risks to salmonids survival. If implemented at a sufficient scale throughout the Santa Rosa Plain. RAU potentially offers opportunities for vineyard growers to increase spring and summer baseflows in MWC, benefitting at-risk salmonids. This result could be true for other Sonoma County streams and creeks as well.

Hydrologic, Vine Health and Grower Considerations

During the relatively dry 2018 water year, RAU increased soil moisture levels throughout the root zone as compared to soil moisture profiles in the adjacent control fields. The increased soil moisture levels potentially decreased irrigation demand pressure on the RAU field as compared to the control fields. Decreasing irrigation demand can reduce pumping from deeper area groundwater.

Vine health comparison between RAU and control fields was not specifically conducted in 2018. However, as soil moisture levels were lower than in the subsequent 2019 water year, a wet but not atypical year, we concluded soil moisture increases under RAU did not likely affect crop health. Further, given that elevated soil moisture levels during the 2019 water year extended into May at levels higher than found in both RAU and control fields during the previous year, we concluded RAU can extend beyond March with no increase in vine health risks beyond those found during wetter years.

Concerns about RAU affecting soil moisture from rising groundwater can be mitigated by selecting locations where groundwater is deeper below the ground surface. Groundwater at this site was about 7 to 10 feet deep below the fields by late fall before the 2018 and 2019 water year rains. This was not deep enough to avoid groundwater reaching to within about 4 feet of ground surface under 0.5 Ac-Ft/Ac

[1] The 2018 water year occurred from October 1, 2017 – September 30, 2018.
[2] Sonoma County Crop Report, 2017. Sonoma County Department of Agriculture.
[3] 2014 California Water Action Plan. https://www.wildlife.ca.gov/Conservation/Watersheds/Instream-Flow/Studies/Mark-West-Creek-Study

RAU during a relatively dry winter. Groundwater deeper below the surface would have greater capacity to accept RAU without groundwater levels rising as near to ground surface.

Another benefit of conducting RAU at sites with deeper groundwater is the assurance that RAU water will add to aquifer stores, at least temporarily. For instance, RAU conducted during the 2018 water year increased the groundwater level and gradient toward MWC and also increased root zone soil moisture. If considerable rain had fallen after the RAU application, groundwater might have risen to near ground surface as occurred during the wetter 2019 water year, with groundwater flowing into the ditch and evaporating from puddles in the fields; little benefit from RAU would have been realized.

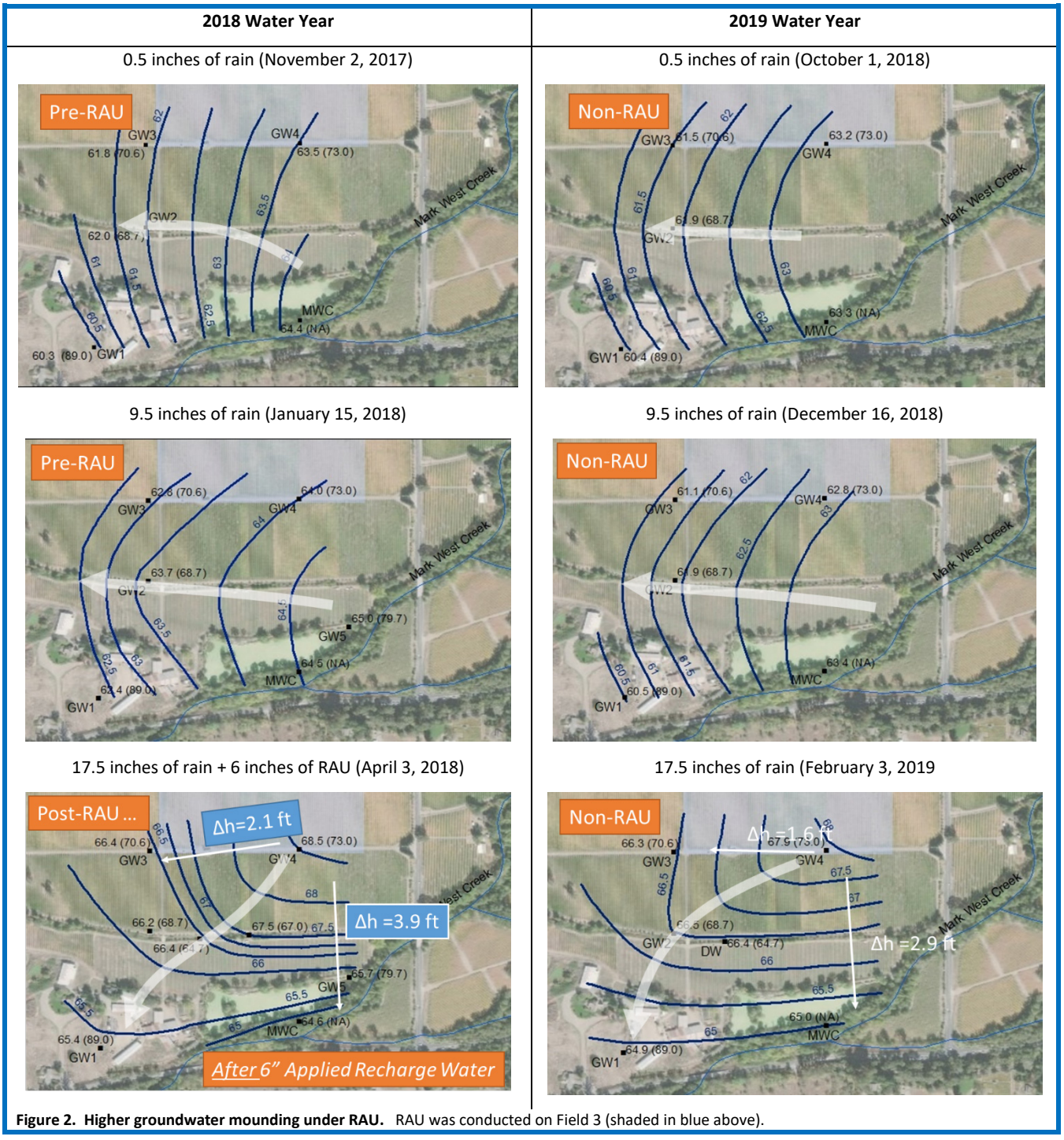

Figure 2. Higher groundwater mounding under RAU. RAU was conducted on Field 3 (shaded in blue above).

Thus, there are benefits to conducting RAU later in the Spring, where possible. At sites with relatively shallow groundwater, RAU conducted after a low rainfall winter will be unlikely to cause excessive groundwater mounding or immediate loss to surface water. RAU water will also be more likely to both contribute *in-lieu* irrigation and infiltration into the creek later in the summer, when it is most needed. However,

at a site where groundwater is deep enough, RAU conducted at any time will be beneficial to the SGMA process by simply contributing groundwater to the shallow aquifer.

Salinity Considerations

RAU during the 2018 water year did not increase root zone salinity levels. Average precipitation throughout Sonoma County varies spatially from about 20 to 40 inches per year; the region is amongst the wetter regions in California. These high precipitation rates help flush salts from soils and dilute salinity accumulation in groundwater.

During the 2018 water year, salinity trends in the RAU field, which used tertiary treated water, were similar to trends found in the control fields. Salinity levels in the root zone of all fields typically increased during early winter but eventually decreased at all depths with increasing rainfall. Shallow groundwater initially experienced increasing salinity levels beneath all fields as salts flushed from the root zone, but returned to pre-winter levels by summer. Thus, no salt accumulation appeared to be occurring in either the root zones or the shallow groundwater. Salinity levels in the deeper groundwater were not affected. Salinity levels for both shallow and deep groundwater were in the 600 – 800 uS/cm range throughout the year beneath all fields during the 2018 water year.

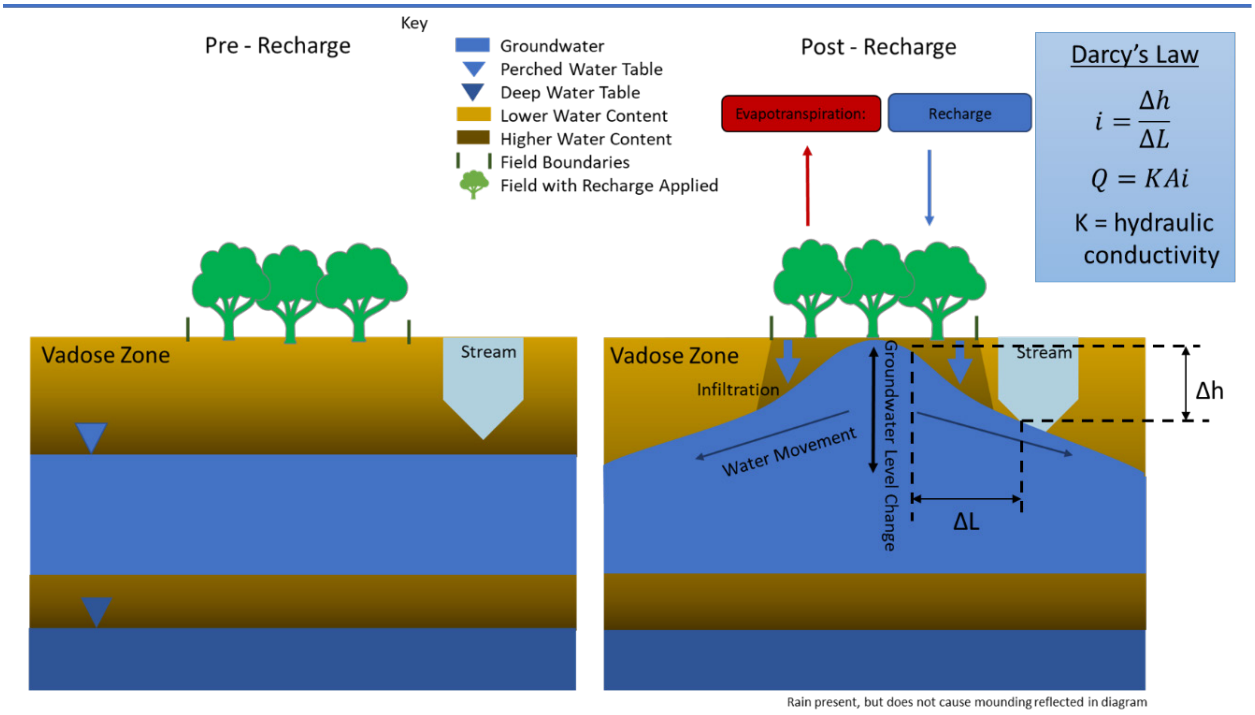

Figure 3. The Conceptual Model of hydrologic conditions before and after RAU.
The model emphasizes three different effects: (1) RAU application infiltration creating a mound, and thus lateral groundwater movement, (2) groundwater outflowing to the stream, (3) limited flow between the shallow and deep aquifer due to a confining layer. Groundwater flow rates are modeled using Darcy's Law with dependence on hydraulic head differences and soil hydraulic conductivity.

MORE INFORMATION

More information can be found on these projects by contacting the following people:

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