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CONSULTING ENGINEERS

GROUNDWATER RESOURCES
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Memorandum

DATE: August 10, 2017 PROJECT: 17-01-038

TO: **Mr. Donald Barrella**

FROM: Vicki Kretsinger Grabert, Debra M. Cannon P.G., Barbara Dalgish P.G., Reid Bryson

SUBJECT: **REVIEW OF DRAFT MEMORANDUM "RESULTS OF AQUIFER TESTING OF PROJECT WELLS AND NAPA COUNTY TIER 1 WATER AVAILABILITY ANALYSIS FOR PROPOSED ANTHEM WINERY"**

Luhdorff & Scalmanini, Consulting Engineers (LSCE) is pleased to provide this memorandum describing our review of the April 10, 2017 Draft Memorandum "Results of Aquifer Testing of Project Wells and Napa County Tier 1 Water Availability Analysis for Proposed Anthem Winery" by Richard C. Slade & Associates LLC (RCS), prepared as part of the project documentation for the pending Use Permit modification (P14-00320). Anthem Winery seeks to modify previously approved land uses authorized by vineyard conversion permits (Permit Nos. 98301 and P12-00401) and prior Use Permits[1] to allow an increase in wine production capacity from 30,000 gallons per year (GPY) to 50,000 GPY, marketing program expansion (e.g., visitation and events), and an increase in total permitted vineyard acreage of 0.95 acres with additional vineyard expansion of 2.29 acres based on prior permit approval. These land use modifications are proposed to occur on two adjoining parcels: 035-460-038 and 035-470-046[2], referenced in the RCS draft WAA as Parcel 1 and Parcel 2, respectively. Napa County is obligated by the California Environmental Quality Act (CEQA) to demonstrate that the local aquifer can support the existing and proposed project groundwater use and has requested that LSCE review the draft Anthem Water Availability Analysis (draft WAA).

The WAA Guidance Document (May 12, 2015) is to provide guidance to answer the following questions:

> "Would the project substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?"

Documents provided by Napa County include:

- A June 3, 1996 memo by Bartelt Engineering "Proposed winery waste septic system for Jessup Cellars Barrel Room" that estimates wastewater volumes and rates of wastewater production

[1] A 1996 Use Permit authorizing winery production and a subsequent Use Permit modification are referenced in documents provided to LSCE for this review, although records of permit approval and any conditions of approval were not provided to LSCE.

[2] Page 2 of the draft WAA, under paragraph a of the heading "Site Conditions", initially descries Parcel 2 as APN 032-470-046.

associated with a proposed 30,000 GPY winery with no employees and no public tours, tasting, or special events to be held at the facility.

- A July 3, 1996 memo by Bartelt Engineering "Phase One Water Availability Analysis for Jessup Cellars Barrel Room (APN 35-470-020)" that estimates total water use of 6.64 acre-feet per year (AFY) based on Napa County Department of Public Works estimated quantities by use including a primary residence (0.75 AFY), livestock (0.09 AFY), 30,000 GPY winery (0.80 AFY), five acres of vineyard (5 AFY). The memo states that water for all uses would be provided through two wells producing 35 gallons per minute (GPM) and 5 GPM, respectively.

- An October 10, 1996 memo from the Napa County Department of Public Works "Jessup Cellars-Water Availability Analysis" that describes a pump test of a "proposed winery project well". The tested well was apparently the higher capacity existing well referenced in the July 3, 1996 memo by Bartelt Engineering, based on the pumping rate used during the test. The Department of Public Works memo describes the tested well as a "new well"[3] having a total depth of approximately 220 feet and a static water level, on October 9, 1996, of 120 feet. A 30-minute test was run at a constant rate of 13 GPM. The water level in the pumped well is reported to have declined about 40 feet during the test. The memo appears to refer interchangeably to a "second, on-site well" and an "on-site monitoring well" (located approximately 150 feet from the pumped well), which is reported to have been "unaffected by the pump test". The memo also describes a "neighboring well", which was apparently not monitored during the test. The memo is difficult to interpret given the lack of detail regarding the wells that it references and the lack of documentation of the test methods and data collected.

- A November 15, 1996 memo by Bartelt Engineering "Jessup Cellars Use Permit 96006-UP, APN 35-470-020" response to Napa County Planning Commission's concerns: that recalculates the winery water usage to be 75,500 GPY (0.23 AFY) with a daily average demand of 207 gallons per day (GPD) and a peak daily water usage of 1,242 GPD. The memo also proposes three conditions of approval:

    - Water use will be metered and provided to Napa County Planning Department on an annual basis.

    - Two water storage tanks will be installed: a 10,500-gallon tank for winery use and a 3,200 gallon tank for fire purposes.

    - The project well (new well) will be pumped for 2 hours at 13 GPM and water levels will be monitored in the "Old well" and the Lemon Well (on the adjacent property to the

[3] It is not clear from the October 10, 1996 memo which well on the Jessup Cellars/Anthem parcels is referred to as the "new well". Well completion reports (WCRs) provided to LSCE by Napa County for this review include two that were constructed prior to October 9, 1996; however, the older of those, WCR 430082, has a total well depth of 213 feet and was constructed in December 1991, while the younger well, WCR 557077, has a total well depth of 345 feet and was constructed in August 1995.

north). During the test, the Lemon Well will be pumped to determine if pumping of this well will affect water levels of wells on the Wood property.

- A July 14, 2000 letter by Bartelt Engineering "Water Availability Analysis for Jessup Cellars Winery, APN 035-470-021—proposed Use Permit Modification affirming that the approved winery was "in current production" and requesting that crushing be allowed at the facility. The letter provides water use estimates for what were then "current" uses totaling 1.97 AFY (including one residence [0.75 AFY], livestock [0.09 AFY], 0.6 vineyard acres [0.60 AFY], and winery without crush [0.53 AFY]. The letter also estimates that water use on the parcel would increase, due to the addition of crush operations at the winery and planting of previously permitted vineyard acreage, to 7.16 AFY (including one residence [0.75 AFY], livestock [0.04 AFY], 5.5 vineyard acres [5.5 AFY], and winery with crush (0.87 AFY). The letter also references the following events/documents:
    - A December 7 to 11, 1996 pump test conducted by McLean and Williams, Inc. The Bartelt Engineering letter apparently included an attachment documenting the "test format and results", although that attachment was not included with the letter provided to LSCE.
    - A December 18, 1996 Use Permit approval by the Napa County Planning Commission for the establishment of a 30,000 GPY winery, "consisting of 1,600 square feet plus a bathroom and a tank pad for two fermentation tanks…." According to the excerpt provided in the July 14, 2000 letter by Bartelt Engineering, the 1996 Use Permit disallowed public tours, tasting, retail sales (even by appointment), marketing events, crush, office uses, and case goods storage. Conditions of approval for the 1996 Use Permit were apparently included as an attachment to the July 2000 letter by Bartelt Engineering, although that attachment was not included with the letter provided to LSCE.
- Erosion Control Plan Application (ECPA) P12-00401 Attachment D, Phase 1 Water Availability Analysis for parcels 035-360-027 and 035-470-020. This undated document calculates an allowable groundwater allotment of 22.32 AFY for the project parcels based on a total area of 43.63 acres and a 0.5 acre-foot per acre annual groundwater use allocation. The document shows that vineyard acreage was proposed to increase from 5.77 acres to 8.58 acres, with a corresponding increase in water use from 2.89 AFY to 4.30 AFY. Other water uses on the project parcels were shown to be unchanged between existing and future conditions, with residential use of 1.1 AFY, winery use of 2.65 AFY, and landscaping use of 1.5 AFY. Total "current" use was shown to be 8.14 AFY, and total "future" use was shown to be 9.83 AFY.

Based on information provided in the draft WAA, it is understood that current water uses on Parcels 1 and 2 total 4.39 AFY and proposed water uses will be 7.03 AFY (**Table 1**). Current water uses include only residential use, with one residence on each of the project parcels, and irrigation for 5.77 acres of vineyard on Parcel 2. It is understood that the previously approved 30,000 GPY winery is either not currently in operation or is not using water. Similarly, it is understood from the draft WAA Appendix that

the Permit P12-00401 accounted for five wine trade/industry visitors per week, although the winery does not currently host wine trade visitors.

Table 1. Summary of Existing and Proposed Water Uses, Anthem Winery Use Modification Permit Application P14-00320 (adapted from RSA+ Tier 1 Water Use Calculations, Revised April 7, 2017)

Water Use (AFY)				
	Residential	**Vineyard**	**Winery**	**Total**
Existing Project				
Parcel 1	0.75	0	-	0.75
Parcel 2	0.75	2.89	0	3.64
Total				**4.39**
Proposed Project				
Parcel 1	0.75	0.62	-	1.37
Parcel 2	0.75	2.99	1.92	5.66
Total				**7.03**

This review focused on three aspects of the draft WAA:

- Aquifer Testing Review
- Groundwater Recharge Calculation Review
- Water Use Calculation Review

AQUIFER TESTING REVIEW

A review of the aquifer test data and interpretation by RCS included reviewing the text, figures, and tables presented in association with on-site well construction, aquifer testing, and aquifer test analysis. The following summary of aquifer tests performed on three project wells provides the pertinent information for review. Aquifer tests were performed on the three project wells (Wells 3, 6, and 8) at separate times in March 2016, after a period of 4.5 days of baseline water level monitoring during which no wells were pumped. Wells were observed to recover during this baseline water level monitoring period; however, the duration of the period does not seem to have been considered significant enough by RCS to have been removed from the curve-fitting aquifer test analysis. Each well was pumped for a period of 24 hours and allowed to recover for two days. Wells 3 and 6, located approximately 175 feet apart, experienced drawdown during each other's pumping tests, but Well 8 had no discernible effect on any on-site wells.[4] **Table 2** summarizes the results of these aquifer tests.

[4] The draft WAA notes that one on-site well, Well 4, was not monitored during aquifer testing, "because it is not considered to be a project well and because of its distance to the aquifer test wells."

Table 2. Aquifer Test Summary, Anthem Winery Use Modification Permit Application P14-00320 Project Wells 3, 6, and 8 (March 2016)

Pumping Well	Pumping Rate (GPM)	Pumping Duration (hrs)	Total Drawdown in Pumped Well (ft)	Specific Capacity (GPM/ft drawdown)	Drawdown Influence Comment	Percent Water Level Recovery After 2 Days
Well 3	1.1	24	39	0.03	Only Well 6 experienced 8.5 ft of drawdown	72%
Well 6	1.1	24	45.4	0.02	Only Well 3 experienced 3.9 ft of drawdown	85%
Well 8	6.9[5]	24	303.2	0.02	No discernible influence on any project well	40%

RCS reports that they utilized Aqtesolv software to "perform the automatic curve fitting procedures" to analyze the drawdown and recovery data for the wells in each test. However, only two wells' drawdown and/or recovery curve matches are presented for analysis of the aquifer tests in the draft WAA: Well 3 (as a pumping well and as an observation well during the aquifer test at Well 6) and Well 6 (as an observation well during the aquifer test at Well 3). The draft WAA claims that the "…curve fitting portion of these analyses were determined to be unreliable for many of these solutions and thus were deemed to not be valid; thus these curves are not presented". It seems likely that type curves were not deemed valid due to several factors, including: use of the "automatic curve fitting procedures" that the Aqtesolv software offers, rather than matching the curves manually for different portions of the drawdown and recovery curves using their knowledge of the subsurface and aquifer materials; also, it is likely that there are boundary conditions present (e.g., faulting, geologic facies changes, etc.) influencing the drawdown and recovery curves making them unable to fit an analytical type curve for the entirety of the drawdown and recovery datasets.

The ability to fit the drawdown and recovery type curves to portions of the data would have allowed for insight into the aquifer materials close to the pumping well and further away from the well, depending on the portion of the curve fitted. Early drawdown can sometimes be influenced by well borehole effects, while later in the test, drawdown can be affected by local aquifer materials (or fractures) in the immediate vicinity. Even later in the test, drawdown data can be interpreted to represent aquifer materials (or fractures) that are distal or farther away from the well. The fact that Well 3 and Well 6 experienced drawdown during each other's pumping indicates that there are connections (via aquifer materials or fractures) within a lateral distance of 175 feet at depths above 310 feet below ground surface, where the two wells have similarly positioned screened intervals. The absence of drawdown at Well 8 due to pumping at Well 3 (which is just over 400 feet away) or Well 6 (about 575 feet away), despite the fact that Well 8 also is perforated above and below 300 feet below ground surface, indicates that the aquifer materials have limited horizontal extent or connection. These conclusions of limited

[5] The pumping rate in Well 8 was increased for an unreported reason to an unreported pumping rate during the last 90 minutes of the test.

vertical and horizontal extent or lack of connection (in the case of a fractured rock aquifer) were also made in the draft WAA.

Further testing of Well 8 in July 2016 occurred about four months after previous project well tests to help determine the pumping rate that can be sustained for Well 8, as pumping at 6.9 GPM resulted in less groundwater produced over the long-term.[6] In order to better represent the pumping behaviors that could occur in project wells, Well 8 was tested by pumping at lower discharge rates for 12 hours and allowed to recover for 12 hours, for a period of 5 days. The results of this testing are tabulated in **Table 3** below.

Table 3. Aquifer Test Summary, Anthem Winery Use Modification Permit Application P14-00320 Project Well 8 (July 2016)

	Day 1	Day 2	Day 3	Day 4	Day 5
Duration	12 hours on, 12 hours off	12 hours on, 12 hours off	12 hours on, 12 hours off	12 hours on, 12 hours off	12 hours on, 6 days off
Pumping Rate	2.7 GPM	3.3 GPM	2.4 GPM	1.2 GPM	1.2 GPM
Drawdown	93.8 ft	106.2 ft	60.5 ft	20.4 ft	24.9 ft
Recovery:	45.4 ft or 48%	52.4 ft or 49%	38.2 ft or 63%	28.1 ft or 138%[1]	--
Specific Capacity (GPM/ft drawdown)	0.029	0.031	0.04	0.059	0.048

[1] Drawdown and recovery results from pumping Well 8 at lower rates resulted in continuing recovery to levels seen prior to Day 4.

The additional testing in Well 8 was not analyzed to determine transmissivity values, so the only aquifer parameters of transmissivity and storativity are available from the three Aqtesolv curve-fitting exercises presented for Well 3 and Well 6. The transmissivity values of 3, 6, and 17 GPD/ft are low (converted into 0.4, 0.8, and 2.3 ft2/d), which, when converted to hydraulic conductivity using RCS's reported aquifer saturated thickness of 295 feet[7], results in 0.0014, 0.0027, and 0.0078 ft/d. These are very low conductivities. As a check, it is good practice to compare the aquifer test results to an empirical equation that can be used to convert specific capacity to transmissivity. RCS applied this empirical relationship of $T \approx 1{,}750*(Q/s)$[8], to Wells 3 and 6 only. It is unclear why RCS did not apply this empirical equation to the other aquifer test data. **Table 4** provides this analysis for comparison to the three curve-fitted transmissivity values.

[6] The draft WAA states: "…Well 8 likely could not sustain an operational pumping rate of 6.9 GPM."
[7] RCS reportedly used 295 feet for the aquifer saturated thickness for both Well 3 and Well 6 curve-fitting aquifer test analyses, based on conditions at the deeper well, Well 6.
[8] Where (*Q/s*) is the specific capacity of the pumping well: *Q* is the discharge or pumping rate in GPM and *s* is the drawdown in the pumped well in feet; and 1,750 is an empirical constant for a semi-confined aquifer system.

Table 4. Comparison of Aquifer Test Results, Anthem Winery Use Modification Permit Application P14-00320

Project Well	Pump/ Observation	Analysis Method	Specific Capacity (GPM/ft drawdown)	Transmissivity (GPD/ft)	Storativity
Well 3	Pumped well	Theis Confined Aquifer Solution Drawdown and Recovery curve-fitting	-	6	-
Well 6	Observation well during Well 3 pumping	Moench Case 2 Leaky Aquifer Solution Drawdown and Recovery curve-fitting	-	3	4.7×10^{-7}
Well 3	Observation well during Well 6 pumping	Moench Leaky Aquifer Solution Drawdown and Recovery curve-fitting	-	17	9.5×10^{-5}
Well 3	2-day pumping at 1.1 GPM	Empirical conversion of Specific Capacity for semi-confined aquifer	0.03	52	-
Well 6	2-day pumping at 1.1 GPM	Empirical conversion of Specific Capacity for semi-confined aquifer	0.02	35	-
Well 8	2-day pumping at 6.9 GPM	Empirical conversion of Specific Capacity for semi-confined aquifer	0.02	35[1]	-
Well 8	12-hr pumping at 2.7 GPM	Empirical conversion of Specific Capacity for semi-confined aquifer	0.029	50.8[1]	-
Well 8	12-hr pumping at 3.3 GPM	Empirical conversion of Specific Capacity for semi-confined aquifer	0.031	54.3[1]	-
Well 8	12-hr pumping at 2.4 GPM	Empirical conversion of Specific Capacity for semi-confined aquifer	0.04	70[1]	-
Well 8	12-hr pumping at 1.2 GPM	Empirical conversion of Specific Capacity for semi-confined aquifer	0.059	103.3[1]	-
Well 8	12-hr pumping at 1.2 GPM	Empirical conversion of Specific Capacity for semi-confined aquifer	0.048	84[1]	-

[1] Values calculated by LSCE for this review.

The draft WAA does not discuss or explain why the transmissivity values differ greatly between the curve-fitting method and the empirical method; the transmissivity values using the curve-fitting approach are much lower compared to the empirical method converting specific capacity to transmissivity. This is likely since the empirical method only considers the drawdown aspect and ignores the recovery, whereas the curve-fitting approach attempts to utilize both drawdown and recovery to determine a transmissivity value. The transmissivity values produced by the curve-fitting approach likely

represent more of a regional spatial area and are more indicative of longer-term pumping conditions. The conversion of specific capacity offers transmissivities that likely represent local aquifer conditions specific to each well.

The ability of the aquifer to transmit groundwater to each of the project wells depends on the transmissivity and storativity of the subsurface materials that the wells penetrate. The transmissivities and storativities from the RCS aquifer testing indicate very low values for each parameter. The aquifer testing indicates limited potential for project wells to significantly impact off-site wells, as the nature of the aquifer materials in the vicinity of the three project wells limits the extent of their influence, spatially. The lack of complete water level recovery in the pumped wells over a recovery period equivalent to the pumping period during most tests indicates that well capacities will be reduced when the aquifers are exercised at even relatively low pumping rates (e.g., 1 GPM or less) on a continual basis, as proposed for this project. Pumping both Well 3 and Well 6 at the same time would also produce mutual well interference, and concurrent pumping would likely not be attainable over the long-term.[9] The draft WAA does not address the impact that mutual well interference will likely have on feasible, long-term well capacities for Well 3 and Well 6.

GROUNDWATER RECHARGE CALCULATION REVIEW

The draft WAA approaches the determination of a parcel-specific water use criterion based on available long-term rainfall data and published relationships between rainfall and groundwater recharge for the Redwood Creek watershed. The draft WAA provides a summary of available precipitation data in the project vicinity, which include three reported precipitation gages and two spatial datasets. Two of the precipitation gages are described as being approximately 6 miles southeast of the project parcels and at elevations of approximately 60 feet above mean sea level (asl).[10] The third precipitation gage is described as being located approximately 0.75 to 0.8 miles west of the project parcels "at a similar elevation (± 360 ft asl) as that of the subject property…." Separately, the draft WAA notes that elevations at the project parcels range from approximately 180 ft asl to 420 ft asl.

The spatial datasets include an isohyetal map of average annual precipitation for 1900 to 1960 published by Napa County and the 1981 to 2010 water year (WY) average annual precipitation dataset published by the PRISM Climate Group at Oregon State University. The various average annual precipitation datasets presented in the draft WAA are summarized in **Table 5**. Due to various factors including the period of record and location, the draft WAA relies on a value of 30 inches per year determined from the PRISM Climate Group average annual precipitation dataset.

For this review, precipitation data from the USGS California Basin Characterization Model (BCM) were analyzed to compare with the values provided by RCS. The BCM represents major soil-water processes, including precipitation, runoff, evapotranspiration, and groundwater recharge in monthly water balance calculations conducted for different historical and predicted climate conditions (Flint et al., 2013). Among the advantages of the BCM relative to single precipitation gage datasets is that the BCM has been applied to represent hydrologic processes across all of Napa County at a grid resolution of 18

[9] This does not mean that these two wells cannot work in conjunction, but pumping at the same time would likely result in reduced capacities in both wells. Cycling one well on and the other well off might offer some relief from the mutual well interference in Wells 3 and 6.

[10] The draft WAA acknowledges that those two gages are located near to each other, according to location information provided by the California Data Exchange Center and Western Regional Climate Center, and are likely to be the same gage.

acres. The BCM also incorporates recent data through 2010, and it accounts for hydrologic processes over 30-year periods (specifically 1921 to 1950, 1951 to 1980, and 1981 to 2010). This means that water balance outputs from the BCM are available in a spatially continuous format representing longer periods of record to account for inter-annual variability. This review utilizes the most recent BCM long-term average annual summaries for observed precipitation and calculated groundwater recharge from the most recent available 30-year period, 1981 through 2010.

The BCM output indicates that average annual precipitation during water years 1981 to 2010 at the Anthem Winery parcels was 32.85 inches (**Table 5**). The difference of 2.85 inches is a 9.5% increase relative to the 30 inches per year value used by RCS in the draft WAA.

Table 5. Summary of Precipitation Data Sources and Average Annual Precipitation, Anthem Winery

Precipitation Gage or Data Source	Data Source	Distance from Project Parcels	Elevation (feet, asl)	Period of Record	Average Annual Precipitation (inches)
NSH – Napa Fire Department	California Data Exchange Center	6 miles	35[1]	WY 1905 to WY 2016[2]	24.4
Napa State Hospital	Western Regional Climate Center	6 miles	60	January 1893 to December 2016[3]	24.7
Redwood Creek at Mt. Veeder Rd	Napa County /OneRain	0.8 miles	360	WY 2001 to WY 2016	34.6
1981 – 2010 Average Annual Precipitation	PRISM Climate Group	0 miles	-	WY 1981 to WY 2010	30
Isohyetal_cnty	Napa County	0 miles	-	1900 - 1960	32
1981 – 2010 Average Annual Precipitation	USGS California Basin Characterization Model	0 miles	-	WY 1981 to WY 2010	32.85

[1] The draft WAA states that the NSH – Napa Fire Department gage is at an elevation of approximately 60 feet asl; however, as of June 23, 2017 the California Data Exchange Center website shows the elevation of that gage to be 35 feet asl.

[2] Due to missing data in water years 1981 and 1982, RCS omitted those years from the calculation of average annual precipitation at the NSH – Napa Fire Department gage.

[3] The draft WAA reports that "there are several missing months and/or years of rainfall data missing between 1897 and 1902, and between 1915 and 1916" from the WRCC precipitation gage record.

WY = Water Year, the 12-month period beginning October 1 and ending September 30 of the following calendar year. Water years are designated by the calendar year in which they end.

asl = above sea level

The draft WAA then calculates potential groundwater recharge, on an average annual basis, for the entire 44.8 acres covered by the project parcels. For their calculations RCS references the water budget analysis contained in the Updated Hydrogeologic Conceptualization and Characterization of Conditions (LSCE and MBK, 2013). RCS cites the finding from LSCE and MBK (2013) that average annual groundwater recharge in the Redwood Creek Watershed is 10% of average annual precipitation and

applies that percentage to the 30 inches of average annual precipitation at the project parcels to arrive at an estimate of average annual groundwater recharge of 11.2 AFY. The draft WAA then considers the potential for land surface slope to influence recharge at the parcel-scale and arrives at reduced estimate of average annual groundwater recharge of 11.02 AFY, 4.0 acres of the project parcels have slopes that are greater than 30 degrees and these are excluded from the potential recharge calculation.

As described above, the BCM represents hydrologic processes within 18-acre grid cells that span Napa County. Through its primary calculations the BCM calculates surface runoff and recharge (defined as water percolating below the zone of evapotranspiration in a given soil profile) for monthly time increments. Using a series of secondary equations, the runoff and recharge values calculated at monthly intervals for individual 18-acre grid cells can be aggregated across watershed areas and to distinguish further between shallow groundwater that eventually emerges as baseflow in a stream or river and deeper groundwater that is more likely to remain in the subsurface. For the project parcels, the BCM calculates average annual groundwater recharge to be 38.54 AFY across the entirety of the project parcels (i.e., 44.8 acres).

For the Redwood Creek Watershed, an analysis using the BCM secondary equations shows that the long-term ratio of deep percolation to potential recharge is 0.83.[11] Based on that value, the average annual deep percolation of infiltrated water to groundwater at the project parcels becomes 31.98 acre-feet (AF) (**Table 6**). This is 26% of the average annual rainfall of 122.66 AFY at the project parcels.

Table 6. Anthem Winery Average Annual Groundwater Recharge Summary, California Basin Characterization Model

		1981 - 2010 Average Annual Precipitation			1981 - 2010 Average Annual Groundwater Recharge Potential			1981 - 2010 Average Annual Deep Percolation	
Parcel	**Acres**	**(inches)**	**(AF)**	**(AF/Acre)**	**(inches)**	**(AF)**	**(AF/Acre)**	**(AF)**	**(AF/Acre)**
Parcel 1	19.8	32.99	54.50	**2.75**	9.81	**16.20**	**0.82**	**13.44**	**0.68**
Parcel 2	25.0	32.75	68.16	**2.73**	10.73	**22.34**	**0.89**	**18.54**	**0.74**
Parcels Combined	44.8	32.85	122.66	**2.74**	10.32	**38.54**	**0.86**	**31.98**	**0.71**
Deep percolation represents 83% of BCM recharge on an annual basis for the Redwood Creek watershed based on an analysis of water years 1988 to 2010.									

Among the attributes of the BCM is that it incorporates geologic data into its calculations of recharge. Flint et al. (2013) note that other published hydrologic models that incorporate geologic bedrock

[11] This analysis incorporates monthly BCM outputs for runoff and recharge across the Redwood Creek Watershed for the period from water years 1988 to 2010, the base period established for the water budget analysis and sustainable yield determination presented in the Napa Valley Subbasin Basin Analysis Report (LSCE, 2016). Monthly data for these two BCM outputs were post-processed using the secondary BCM equations to arrive at monthly values for shallow groundwater (with the potential to leave the subsurface as baseflow in the Creek) and deep groundwater (without the potential to become baseflow) components of the overall BCM recharge output. Because the BCM secondary equations allow for accumulation of deep groundwater over time with a delay relative to the initial percolation below the zone of evapotranspiration, the deep groundwater and recharge volumes were aggregated by water year and then compared on an annual basis for this analysis.

properties are "computationally intensive and cover small areas". The BCM includes direct consideration of the influence of underlying geology on the ability of water in the soil profile to percolate deeper into the saturated zone. However, the BCM geologic dataset is based on a coarse-scale (i.e., 1:750,000) state-wide map (Jennings, 1977). For this reason, in this area the BCM may provide a more generous estimate of the potential for recharge to occur if the BCM grid cells at the project location are mapped as having underlying geologic properties consistent with the Napa Valley alluvium rather than reflecting the more restrictive geologic sedimentary rock formations depicted in Figure 3 of the draft WAA and logged by the drillers of Wells 1, 2, 3, 5, 6, 7, and 8. This could be the case at the Anthem Winery project parcels.

The draft WAA constrains the estimate of potential groundwater recharge further by omitting portions of the project parcels located opposite a fault that is mapped as crossing the property. The three project wells (Well 3, Well 6, and Well 8) are all located west of the fault in an area determined by RCS to be 30.0 acres. With this constraint, RCS calculates average annual groundwater recharge to be 7.0 AFY, when accounting for reduced recharge on areas within those 30.0 acres with slopes greater than 30 degrees.

While the draft WAA's consideration of the fault is instructive, the actual location of the fault relative to the project wells, and by extension, the area of the project parcels located on the same side of the fault as the project wells is questionable. The fault is mapped by the California Geological Survey at a scale of 1:24,000 and given an "approximate" designation. Based on the groundwater level data and results of the aquifer testing presented in the draft WAA, the greater limitation on groundwater production on the project parcel is not the amount of water potentially available to recharge groundwater occurring on the parcel so much as the physical properties of the aquifer materials encountered by the three project wells, which limit the amounts and timing of recharge and the ability of the wells to produce groundwater.

WATER USE CALCULATION REVIEW

This section provides a review of the WAA Appendix-Tier 1 Water Use Calculation, Anthem Winery by RSA+. Water use and supply from this document are summarized in the tables below for both the existing and proposed projects. The "Approved" project is not evaluated here because it was presented for comparison purposes only. Demands are based on estimates of use (e.g., residential, vineyard, and winery) not on actual metered data. **Table 7** itemizes the vineyard acres that currently exist on the project parcels, previously approved acreage to be planted (permit P12-00401), and acreage newly proposed under permit application P14-00320.

Table 7. Existing, Approved, and Proposed Vineyard Acres, Anthem Winery

Parcel	Existing	*New, Currently Unplanted Acreage*		Total Acres
		Previously Approved, to be Planted (P12-00401)	Proposed with pending permit application (P14-00320	
Parcel 1	0	1.66	0.90	2.56
Parcel 2	5.77	0.63	0.05	6.25[1]
Total	**5.77**	**2.29**	**0.95**	**8.81**

[1] The applicant proposes to remove 0.20 acres of the existing 5.77 acres of vineyard on Parcel 2 as part of permit application P14-00320.

Table 8. Existing and Proposed Project Demands

Demand (AFY)				
	Residential	**Vineyard**	**Winery**	**Total**
Existing Project				
Parcel 1	0.75	0	-	0.75
Parcel 2	0.75	2.89	0	3.64
Total				**4.39**
Proposed Project				
Parcel 1	0.75	0.62	-	1.37
Parcel 2	0.75	2.99	1.92	5.66
Total				**7.03**

Table 9. Existing and Proposed Project Supply

Supply (AFY)							
	Groundwater Wells				**Reclaimed Process Wastewater**	**Harvested Rainwater**	**Total**
	Non-Project		**Project**	**Total GW**			
Parcel	4	1,5,7	3,6,8				
Existing Project							
Average Year							
Parcel 1	0.15		0.6	.75	-	-	
Parcel 2		3.64		3.64	-	-	
Total	**0.15**	**3.64**	**0.6**	**4.39**	**0**	**0**	**4.39**
Proposed Project							
Average Year							
Parcel 1	0.15		0.92	1.07	0	0.3	1.37
Parcel 2		3.64		3.64	0.77	1.25	5.66
Total	**0.15**	**3.64**	**0.92**	**4.71**	**0.77**	**1.55**	**7.03**
Dry Year							
Parcel 1	0.15		1.22	1.37	0	0	1.37
Parcel 2		3.64	0.50	4.14	0.77	0.75	5.66
Total	**0.15**	**3.64**	**1.72**	**5.51**	**0.77**	**0.75**	**7.03**

The existing demand on the project parcels, met entirely by groundwater, totals 4.39 AFY for 5.77 acres of vineyards and two residences (**Tables 8 and 9**). The proposed project will increase total water use to 7.03 AFY for 8.81 acres of vineyards in addition to other site uses (e.g., residences and winery). These proposed demands are to be met by groundwater (4.71 AFY in an average rainfall year and 5.51 AF in a

dry year), harvested rainwater (2.32 AFY and 1.52 AFY in average and dry years), and from winery process water (0.77 AFY in both average and dry years). This represents an increase in proposed groundwater pumping of 0.32 AFY in average years and 1.12 AFY in dry years.

The following observations are derived from a review of the draft WAA, well construction information provided by Napa County, and other supporting documentation provided by Napa County.

1. Project wells on Parcel 1 are Wells 3, 6, and 8 drilled in 2001, 2014, and 2015, respectively. These wells have provided water for existing uses (0.60 AFY)[12] and will provide 0.92 AFY (1.1 GPM for 365 days/year and 12 hrs/day) for the proposed project in an average year and 1.72 AFY in a drought year (2.1 GPM 365 days/year and 12 hrs/day).

    a. The draft WAA does not clearly document plans to store water pumped by project wells in winter for use during the dry season. Page 1 of the Appendix includes only the following general statement, "Water storage will be provided on site to normalize pump rates throughout the year." In separate documentation, the applicant provided the County site plans that depict four water tanks located in the cave area, where each tank has a storage capacity of about 100,000 gallons (Backen, Gillam Kroeger Architects, 2017) . Additionally, other plan documents, submitted as part of the Anthem Winery Use Permit Plans, show eight 10,000-gallon poly tanks located near the septic field for storage of irrigation and drinking water (RSA$^+$, 2017).

    b. The draft WAA assumes there are no known neighboring wells within 500 ft of project wells. However, a property north of Parcel 1 within 100 ft of "Project Well" 6 has a house and landscaping and may have a well that would trigger a Tier 2 evaluation to analyze well interference. The water source for this dwelling and/or landscaping should be identified.

2. Non-project wells on Parcel 2 are Wells 1, 4, 5, and 7.

    a. The draft WAA assumes that the amount pumped from Wells 1,5,7 (3.64 AFY) can be sustained into the future, however, the draft WAA also describes that water was trucked to the project parcels for two years ending in August 2014, after which time Wells 7 and 8 were installed. The draft WAA does not provide any detail as to how much water was trucked to the project parcels each year.

    b. Well 4 is reported to be an existing source of supply and is included as a future source of supply. The draft WAA Appendix shows that only 20% (0.15 AFY) of the Parcel 1 residence demand is provided by Well 4 (page 7 of Tier 1 Water Use Calculation, draft WAA Appendix).

        i. The draft WAA does not describe how water is currently or will be transported from Well 4 to the Parcel 1 residence over a distance of over 2,000 ft.

[12] Source: page 6, Appendix Tier 1 Water Use Calculations, Draft Results of Aquifer Testing of Project Wells and Napa County Tier 1 Water Availability Analysis For Proposed Anthem Winery

ii. Table 1 in the draft WAA shows the lowest estimated flow rate for Well 4 to be 1.4 GPM. The draft WAA does not include any records to demonstrate that Well 4 has provided 0.15 AFY to the residence on Parcel 1 in prior years.

3. The following proposed categories have no water use allocation in the draft WAA:
    a. 20 ft Vineyard Avenue
    b. 10 ft Vineyard Avenue
    c. Native Bunch Grasses (0.41 acres)
4. The draft WAA proposes that 100% (0.77 AFY) of reclaimed winery process water will be available for water supply; however, the draft WAA does not describe what the reclaimed water will be used for[13]. While site plans, particularly the Utility Plan (RSA+, 2017), show some engineering design details, there is no accompanying documentation that describes any required treatment or how the project will achieve zero losses of winery process water.[14]
5. In an average year, the draft WAA proposes that 1.55 AF of rainwater will be collected and used to augment water supplies; however, no engineering design is provided to demonstrate how and where this water will be captured and stored for later use. The draft WAA lacks a discussion of whether the design is subject to evaporation losses and whether those losses are accounted for in the projected volume of rainwater to be put to use at a later time.
6. The draft WAA does not provide documentation to support the reduced irrigation demand attributed to the "low-water varietal" proposed to be planted on a portion of Parcel 1.

FINDINGS AND RECOMMENDATIONS

Based on the review of the draft WAA and related documentation provided by Napa County, this section summarizes key findings and recommendations. A prior permit appears to have authorized groundwater uses based on an allocation of 0.5 AF per acre for a single parcel where the initial vineyard and winery operation was established, as part of the then Jessup Cellars Winery. In July 2000 that amounted to 7.79 AFY at Parcel 2, which was then described as covering 15.57 acres.[15] The County previously used that allocation rate for projects outside of designated groundwater deficient areas that were also outside of the Napa Valley Floor. Although the owner, or previous owners, have apparently not used the amount of groundwater authorized historically, groundwater conditions at the site indicate poorly permeable formations that limit groundwater production. The applicant indicates an intent to keep the proposed water uses for this application below the amount of groundwater authorized historically. However, groundwater supplies are limited, and the applicant proposes to meet demands by supplementing groundwater supplies with other sources of water including reclaimed winery process water and rainwater harvesting.

[13] The RSA+ Utility Plan (April 2017) notes that treated process waste water is planned to be used for irrigation.
[14] The RSA+ Utility Plan (April 2017) shows eight 10,000-gallon poly tanks to contain "IRR", "PWW", and "DW". It is anticipated that IRR is stored water for irrigation; "DW" is stored domestic water. "PWW" refers to process waste water stored for irrigation.
[15] The annual groundwater use authorization for Parcel 2 is referenced in the July 14, 2000 Bartelt Engineering letter that references parcel number 035-470-021, believed to now be designated as parcel number 035-470-046.

The total projected water uses, including proposed and existing water uses, are small, based on the estimate provided, and would not risk significantly reducing the availability of groundwater at the regional or basin scale. However, the project faces limitations between what groundwater may be available in the form of groundwater recharge and what the project wells are actually able to produce.

FINDINGS

1. The aquifer testing reported by RCS indicates very low values for two aquifer parameters that define an aquifer's ability to transmit and store water. This indicates limited potential for project wells to significantly impact off-site wells, as the nature of the aquifer materials in the vicinity of the three project wells limits the extent of their influence, spatially. However, since no specific off-site wells are acknowledged in the draft WAA, it is not clear whether any such wells may be subject to influence by the project wells.

2. The draft WAA does show that even the very low pumping rates proposed to occur at Wells 3 and 6 would affect groundwater levels in the other of those two wells. Pumping both Well 3 and Well 6 at the same time would produce mutual well interference, and concurrent pumping would likely not be attainable over the long-term.[16] The draft WAA does not address the impact that mutual well interference will have on feasible, long-term well capacities for Well 3 and Well 6.

3. The draft WAA provides a conservative estimate of groundwater recharge at the parcel-scale. Using a water budget analysis of recharge for the overall Redwood Creek watershed, the draft WAA also accounts for potential limitations on groundwater recharge due to steep slopes and fault boundaries to estimate an average annual recharge rate of 7.0 AFY.

4. Existing water uses are based on calculated estimates, rather than actual pumpage amounts. The November 15, 1996 memo mentions that water use was recommended (but not required) to be metered and provided to Napa County Planning Department on an annual basis. It is unclear whether water use has been metered and reported.

5. Total proposed demand is 7.03 AFY, and this is to be met by 2.32 AFY of non-groundwater sources (e.g., reclaimed process wastewater and harvested rainwater). The mechanics and facilities needed to accomplish this are not explained in the draft WAA (e.g., storage of 1.55 AF of rainwater in winter until use in summer and storage and reuse of 0.77 AF of process water without losses). As described above, site plans provided by the applicant show some engineering design details related to stored rainwater and treated process waste water.

6. The draft WAA assumes project wells would be pumped 12 hours per day for 365 days/yr. It is unclear, based on the analysis presented, whether this could actually be accomplished. Mutual well interference observed between Well 3 and Well 6 is not addressed with respect to the implications for reduced well production capacity. Water storage plans for the pumped groundwater are not explained in the draft WAA. Site plans provided by the applicant show the amount and location of planned water storage.

[16] This does not mean that these two wells cannot work in conjunction, but pumping at the same time would likely result in reduced capacities in both wells. Cycling one well on and the other well off might offer some relief from the mutual well interference in Wells 3 and 6.

7. It appears that a neighboring well or wells within 500 ft of project wells may be located near the northern border of Parcel 1 where a house and vineyard are within about 100 ft of Project Well 6. Structures located west of Well 3 on an adjacent parcel could also have associated wells within 500 ft of that project well. The water source for this dwelling and/or landscaping should be identified.

8. Appendix E of the WAA—Guidance Document, "Determining water use numbers with multiple parcels", states, "There will be cases where one person or entity owns multiple contiguous parcels and requests that the total water allotment below all of his or her parcels be considered in the Water Availability Analysis." However, "to protect future property owners, certain safeguards must be in place to ensure that the water allotment and transfer between parcels is clearly documented and recorded…."

    a. It appears that Parcel 1 water will be used on Parcel 2 when in a "dry year" 0.5 AF of groundwater will need to be transferred to Parcel 2.

    b. Appendix E states that If there is a transfer of water between parcels this "must be documented using the form provided by the Department of Public Works."

9. The draft WAA does not consider the potential for streamflow depletion by the three project wells. Although all three of the project wells have capacities below 10 GPM and would therefore have the Tier 3 criteria presumptively met if they are greater than 500 ft from the creek, Well 3 does have a surface seal of less than 50 ft and casing perforations above 100 ft, which could result in a potentially significant influence on streamflow.

RECOMMENDATIONS

The following recommendations are intended to provide clarity to the applicant as to the actions that should be taken to provide sufficient information for assessing current and proposed water uses, long-term well capacity, and overall water supply availability as described in the draft WAA.

1. Provide an analysis of the effect of mutual well interference between Wells 3 and 6, sufficient to address the effect on each well's capacity at pumping rates and schedules sufficient to meet the total project demand. If the analysis results in a recommendation for increased rates of groundwater pumping at Well 8 or supplying groundwater for the proposed project from non-project wells, those changes should also be analyzed to demonstrate feasibility.

2. Provide documentation or details identifying the location of wells on properties to the north and west of Parcel 1 which may be close enough to experience an impact from proposed project Wells 3 and 6, and to confirm that there are no wells on these properties that are within 500 feet of said wells. Well Completion Reports requested from the Department of Water Resources can assist identification of neighboring wells at distances less than 500 feet from proposed Project wells.

3. Provide details in the WAA regarding the proposed groundwater production schedule, winery process water schedule, and the existing or proposed means for treating and storing sufficient

groundwater, reclaimed winery process water, and captured rainwater to provide the water supply needed for the proposed project.

4. Provide slope mapping to show the acreage over 30 degrees that occurs within the holding so that the effect of ground slope on the recharge potential can be confirmed.
5. If not already done, install groundwater flow meters with totalizers on all wells on all project and non-project wells to determine the volumes of groundwater extracted at regular intervals.
6. Record quarterly static groundwater levels in all project and non-project wells for three years.
7. Detail the amounts of water trucked to supply water uses at the project parcels during the two years referenced in the draft WAA to quantify the shortfall.
8. Provide details as to how existing water uses were supplied in 2015 and 2016 (e.g., whether Wells 6 and 8 or other water sources were used to meet demands on Parcel 2).

REFERENCES

Backen, Gillam, Kroeger-Architects. 2017. Anthem Winery and Vineyards, LLC, Floor Plan Lower Level/Caves. April 10, 2017.

Flint, L.E., A.L. Flint, J.H. Thorne, R. Boynton. 2013. "Fine-scale hydrologic modeling for regional landscape applications: the California Basin Characterization Model development and performance". Ecological Processes, 2(25).

Jennings, C.W. 1977. Geologic map of California. California Division of Mines and Geology geologic data Map number 2, scale 1:750,000.

Luhdorff and Scalmanini, Consulting Engineers (LSCE) and MBK Engineers (LSCE and MBK). 2013. Updated Hydrogeologic Conceptualization and Characterization of Conditions. Prepared for Napa County.

RSA^{+}. 2017. Anthem Winery Use Permit Plans, Utility Plan (Sheet UP3.0). April 7, 2017.