RICHARD C. SLADE & ASSOCIATES LLC
CONSULTING GROUNDWATER GEOLOGISTS

October 31, 2015

DRAFT
UPDATED MEMORANDUM

To: Mr. Steven Rea
Mountain Peak Vineyards LLC
1114 Petra Drive
Napa, CA 94558

From: Anthony Hicke and Richard C. Slade
Richard C. Slade & Associates LLC

Job No. 537-NPA01

Re: Updated Summary of April 2014
Constant Rate Pumping Test,
Existing Onsite Water Well
3265 Soda Canyon Road
Napa County, California

Dear Mr. Rea:

Included herein is an Updated Memorandum summary of a constant rate pumping test performed in April 2014 at the sole existing well at your property at 3265 Soda Canyon Road in Napa County. The test was conducted to help determine the following: whether or not wells (existing and future) constructed at the subject property would be able to produce groundwater at rates sufficient to meet the anticipated water demands of the project; and what impacts, if any, might the pumping of the existing and proposed onsite wells have on nearby offsite wells owned by others. Note that this Updated Memorandum was prepared at the specific request of the Napa County Planning, Building and Environmental Services Department (PBES). In order to further address County issues with the drought, this Updated Memorandum supersedes and replaces all prior versions of this document.

Figure 1, "Location Map", shows the boundaries of the 41.76-acre subject property, along with the location of the sole existing onsite well that was subjected to the pumping test. Also shown on Figure 1 are the approximate locations of possible nearby but offsite wells owned by others. These possible offsite well locations were determined by an RCS geologist during a field visit to the subject property; the basic method used to locate these possible offsite wells is discussed below.

Background Information

We understand that groundwater pumped by the existing onsite well is currently used to meet all domestic supply and irrigation supply at the subject property. However, the sanitary seal for the existing well extends to a depth of only 21 ft below ground surface (bgs). For the proposed Mountain Peak Winery project, all water demands are to be met using groundwater. In the future, a new well will be constructed at the subject property and will be used to meet the water use demands associated with the proposed winery; the proposed location of that new well is shown on Figure 1. This proposed new well will be constructed with a similar diameter casing, but with a deeper sanitary seal that must extend to a depth of at least 50 ft below ground surface in order to meet state and county standards for a public-supply water well. Treated wastewater from an onsite wastewater treatment system will be used for a portion of the onsite vineyard irrigation, in lieu of using groundwater. After the new well is constructed, the existing onsite well would then be used for the remainder of the vineyard irrigation demands (those demands not met using the treated wastewater). For this project, the existing 28 acres of vineyards will be reduced to only 25 acres.

The constant rate pumping test described in this Memorandum was performed in April 2014 using the existing onsite well (the proposed well has not yet been constructed). Hence, for the purposes of this report, and to assess the groundwater potential of the subject property, we will assume all groundwater for the project will be pumped from the existing onsite well.

Project Groundwater Demands

Groundwater demands for the project, as discussed herein, were provided to RCS by Bartelt Engineering of Napa, CA (Bartelt) as reported in their Water Availability Analysis for the Mountain Peak Winery project, dated August 2015. Therein, an analysis of water demand (described as a “Detailed Proposed Water Demand”) was presented that is more detailed than the typical Phase 1 analysis; that more detailed analysis by Bartelt was specifically requested by Napa County. As reported by Bartelt, the average annual groundwater demands for the project, based on their “Detailed” estimates, are as follows:

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a. Winery Process Water = 1.84 acre feet per year (AF/yr)
   - These demands include water used for Winery production operations
b. Potable Water used for Marketing and Winery Non-Process Water = 1.01 AF/yr
   - These demands include potable water used by the tasting room staff as well as winery staff and administration, and also used for Private Tours, Tastings, Food and Wine Parings, Wine Club / Release Events and Action Related Events.
c. Irrigation Demand, Vineyards = 14.86 AF/yr
   - This vineyard irrigation demand estimate includes water for frost and heat protection
d. Irrigation Demand, Tasting Room Landscaping = 0.59 AF/yr
   - This demand includes all landscaping as depicted by the Water Efficiency Landscape Ordinance (WELO) shown on the landscape architect's plans..
e. The 1.84 AF/yr of groundwater used for the winery process water discussed in point "a" above will be treated and used for vineyard irrigation purposes via the wastewater treatment system proposed for the project. Hence, this volume of 1.84 AF/yr can be deducted from the irrigation volume estimated above to determine the total groundwater demand for the project.
f. Total proposed groundwater demand for project = a + b + c + d - e= 16.46 AF/yr.

As discussed above, the groundwater demands listed above will ultimately be met by pumping two onsite wells in the future. Water demands for the new Winery will be pumped from the proposed onsite well having a sufficiently deep sanitary seal, whereas irrigation demands will be provided via pumping from the existing onsite well and from the water available from the wastewater treatment system. Thus, based on the information presented above, the total average annual groundwater demand for the proposed winery project is 16.46 AF/yr.

For comparison, and as stated in Bartelt's Phase 1 study, the current (existing) water use at the subject property is 14.75 AF/yr. Hence, as calculated by Bartelt, the proposed project (16.46 AF/yr) will use 1.71 AF/yr more groundwater than is estimated by Bartelt to be currently used (14.75 AF/yr) at the subject property.

Beginning in August 2014, Mountain Peak LLC implemented an electronic flow monitoring station at their existing Well No. 1. Between August 2014 and December 2014 a total of 9.8 AF were pumped from Well No. 1. Between January 1, 2015 and September 15, 2015, 22.4 AF of groundwater have reportedly been pumped. Hence, the groundwater extracted in the year 2015 is much higher than the proposed future use of groundwater at the subject property.

Assuming this average groundwater demand for the proposed new project (16.64 AF/yr) is to be met via only one onsite well pumping at a 100% operational basis (that is, pumping 24 hours per day, every day, 365 days per year), then this onsite well would need to pump at a rate of approximately 10.3 gallons per minute (gpm). However, RCS does not recommend that a well be pumped 24 hours per day, every day (i.e., 100% of the time). On a more realistic 50% operational basis (a well pumping for only 12 hours per day, every day, throughout the year), then the well would need to pump at a rate of about 20.6 gpm to meet the total groundwater demand for the project.

As reported on Table III of their report (not included herein), Bartelt states that the greatest, average-month pumping rate would occur in July, and this rate is estimated to be 22.2 gpm (this is the combined total pumping rate of both the existing onsite well and the proposed well); this assumes that both wells are pumping simultaneously for a period of 24 hours (i.e., a 100% operational basis). Therefore, to meet the greatest average month pumping rate estimated for the proposed winery, and assuming a 50% operational pumping basis, then the largest total combined pumping rate for the project during any month in the future is estimated to be approximately 44.5 gpm (during the month of July each year).

Onsite storage tanks will be included as part of the proposed water system for this project. The sizing of these tanks will reportedly be appropriate for the project, as per the design of the project civil engineer (Bartelt).

Geology of the Subject Property

Figure 2, "Geology Map", shows the earth materials mapped at ground surface at and near the subject property and the surrounding area as adapted from publicly available maps of the area prepared by the California Geologic Survey (CGS 2005). As shown thereon, the site is completely underlain and in proximity to volcanic flow rocks attributed to the Sonoma Volcanics (map symbols, Tsa, Tst, Tsr). Typical rock types of the Sonoma Volcanics include dacite, andesitic and basaltic lava flows, and volcanic tuffs; the geologic map identifies the volcanic rocks in the area of the subject properties as primarily composed of andesitic to basaltic lava flows. The total thickness of the volcanic rocks beneath the property is unknown, but beneath nearby properties, other wells constructed by RCS have shown that the thickness of these volcanic rocks extends to depths on the order of 700 ft or greater in the region.

Groundwater within the Sonoma Volcanics typically occurs within the fractures and joints that have been created in the volcanic rocks over time by various volcanic and tectonic processes. These fractures and joints have been created as a result of the cooling of these originally-molten flow rocks following their deposition, and also from tectonic processes (faulting and folding) that have occurred over time after the rocks have hardened. Some groundwater can also occur in zones of deep weathering between the periods of volcanic events that yielded the various flow rocks. Some groundwater may also be available, although in smaller quantities, between the individual ash grains which form these finer-grained ash deposits (aka, tuff).

The amount of groundwater available at a particular drill site for a new well in such hard volcanic flow rocks depends on such factors as: the number, frequency, size and degree of openness of the fractures/joints, the degree of interconnection of the various fracture/joint systems in the subsurface; the extent to which the fractures may have been filled over time by chemicals deposits and/or weathering products (clay, etc.); and the amount of recharge available to the fracture systems.

Construction of Existing Onsite Well

A driller's log for the existing onsite well was obtained from Napa County files by McLean and Williams of Napa, CA (M&W), the pumping contractor for the recent pumping test. Thereon, the well is shown to have been constructed in July 1991 of 8-inch diameter PVC casing to a depth of 205 ft. Perforated casing extends between the depths of 45 ft and 140 ft below ground surface (ft bgs) and also from 160 ft to 205 ft bgs; the width of the openings in the perforated sections of the casing are reported to be 0.032 inches ("32-slot"). A sanitary seal consisting of bentonite pellets and concrete is shown to extend to a depth of 21 ft bgs on this log. As reported on the log, the original static water level in the well in July 1991 was 20 ft bgs, and increased to 15 ft bgs before a bailer test of the well was performed.

The pilot hole for the well was drilled to a depth of 220 ft bgs. Based on our interpretation of the driller's descriptions of the earth materials encountered during drilling, various rocks of the Sonoma Volcanics extend throughout the entire depth of the pilot borehole.

Nearby Offsite Wells Owned by Others

A number of wells exist in the vicinity of the subject property. Figure 3, "Location Map by Bartelt Engineering" shows the location of the existing onsite well and the location of the proposed new well. This Bartelt map is included as part of this Memorandum as a reference; Bartelt has also published this map as a part of their work for this project. In addition to the onsite data, the locations of offsite wells are plotted on the map. To determine their well locations, Bartelt conducted a review of well permit data for the surrounding parcels at the Napa County offices on July 1, 2014, with County Staff. As stated on the Bartelt map, the "well locations [shown on the map] are approximate and are based on data obtained from Napa County Environmental Health Division records". As seen on Figure 3, the nearest offsite well to the existing onsite well would be roughly 760 ft to the northwest, which is a well that was not mapped by RCS. Also, the proposed new onsite well would be roughly 650 ft from the nearest existing offsite well (to the northeast), which is a well mapped by Bartelt and RCS. Note that the distances described herein are those measured by Bartelt and reported to RCS. Note that the offsite wells shown on Figure 1 are the same offsite wells shown on the Figure 3 map.

Measurements of the distances between the nearby creeks and the existing and proposed onsite wells are also shown on the Figure 3 map, as defined by Bartelt. Based on that drawing, the distances between the existing and proposed wells and the existing streams are as follows:

The existing onsite well is:

- 700 ft from the "blueline" stream east of the subject property
- 530 ft from the "blueline" stream west of the subject property

The proposed onsite well would be:

- 510 ft from the "blueline" stream east of the subject property
- 750 ft from the "blueline" stream west of the subject property

Limited Pumping Test by Doshier Gregson

On September 17, 2012, prior to RCS involvement in this project, Doshier Gregson Pump & Well Service of Napa, CA (Doshier) performed a 4-hour pumping evaluation of the existing onsite well. For that evaluation, the well was reportedly pumped at a rate of 100 gpm for a period of 4 hours. Unfortunately, no water level data were reported to have been collected during that pumping period. However, based on the limited information provided, it appears that the well pumped the entire 4-hour period at that rate without any reported problems.

Summary of Constant Rate Pumping Test by McLean & Williams (M&W)

A constant rate pumping test was performed in the existing onsite well by M&W to determine whether or not this well was capable of meeting the groundwater demands of the proposed winery project. As described above, assuming a 50% operational basis, the onsite wells would need to pump at a constant rate of 20.6 gpm to meet the average annual demand for the project and at a rate of 44.5 gpm to meet the greatest average month pumping rate needed for the project (assuming a 50% operational rate); this greatest rate is estimated by Bartelt to occur in July of each year. For the April 2014 pumping test, a pumping rate of 50 gpm was utilized for the existing well. Clearly, this pumping test rate was much higher than the pumping rates needed to meet the average annual demand and the short-term peak day demand for the proposed project.

Prior to beginning any testing of the onsite well, M&W installed a water level pressure transducer into the well on April 18, 2014. That device was programmed to automatically record water level measurements at a frequency of one measurement every minute before, during and after the subject pumping test. Manual water level measurements were also occasionally collected via an electric tape water level sounder by the M&W pumper. Figure 4, "Water Levels During Constant Rate Pumping Test", graphically illustrates the water levels recorded by the pressure transducer, along with the occasional manual water level data collected by M&W during the entire test period. Note that all water level and flow rate data for this recent constant rate pumping test were collected by M&W, and then emailed to RCS geologists once the testing was complete. When reviewing Figure 4, the reader must note the large vertical scale on the y-axis; i.e., the entire y-axis represents only 20 ft of water level change because water level fluctuations during the pumping portion of the test were minimal.

Background Water Level Monitoring

Background (baseline) water level data were recorded beginning on April 18, 2014 for a period of roughly 3 days (71 hours) in the onsite well; during this period the subject well was not pumped for any purpose. The purpose of recording water level data during the period of non-pumping was to establish an accurate static water level baseline in the well. Further, recording frequent water level data during that pre-pumping period allowed RCS geologists to help determine the possible pumping impacts (if any) of nearby offsite wells on the existing onsite well, and/or to determine if water level changes were naturally occurring in the aquifer at the time of the test.

During the background water level measuring period of the test (see Figure 4), only very small fluctuations in water level (less than 0.5 feet of water level change) were observed in the onsite well. These water level changes may be due to the pumping effects on this well from an offsite well, or to natural diurnal fluctuations in the aquifer system encountered by the onsite well. In either case, these changes were minimal and were not considered to be significant.

Constant Rate Pumping Test

Following the 71-hour background water level monitoring period, a 24-hour (1,440-minute) constant rate pumping test was initiated in the well at a rate of 50 gpm on April 21, 2014. As stated above, water levels were recorded automatically throughout testing of this existing onsite well by the M&W-installed pressure transducer and also recorded manually on an occasional basis by the pump operator.

Before the pumping portion of the constant rate test began, an initial static water level (SWL) of 19.6 ft below the wellhead reference point (brp) was measured on April 21, 2014. As shown on Figure 4, two very small fluctuations in the collected water level data were likely caused by minor adjustments to the pumping rate by the M&W pumper. Following these two events, the pumping water levels in the well were relatively stable, and decreased by less than 0.5 ft for the remainder of the pumping period of the test. In fact, in the last one hour of the test, water levels were declining at a rate of less than approximately 0.1-foot per hour. A final pumping water level (PWL) was measured at a depth of 22.9 ft brp after 24 hours of continuous pumping at an average overall pumping rate of 50 gpm, as determined by the pumper. Hence, the water level drawdown was only 3.3 ft following the 24-hour period of continuous pumping by the existing onsite well.

The specific capacity of a well is defined as the pumping rate divided by the drawdown that occurred while pumping at that rate, and is measured in units of gpm per foot of drawdown (gpm/ft ddn). Essentially, the specific capacity is a measure of the "efficiency" of the well. For this test, the calculated specific capacity for the existing well is about 15.2 gpm/ft ddn (50 gpm divided by 3.3 ft of water level ddn). Such a specific capacity, in our experience, is relatively high for wells constructed into rocks of the Sonoma Volcanics; hence, the existing well is efficient and the volcanic rocks encountered by the well bore must contain numerous, interconnected and laterally continuous fractures.

Water Level Recovery

After 24 hours of continuous pumping at an overall average rate of 50 gpm, pumping in the well was ceased. Post-test water level recovery was then monitored in the well for a period of just over 53 hours (2.2 days) following the termination of the pumping portion of the test. As shown on Figure 4, water levels recovered to a depth of 20.2 ft after only 3 hours of water level recovery following pump shut-off; this depth is only about 0.6 ft below the initial SWL, prior to pump start-up. After roughly 24 hours of water level recovery, a SWL of 19.6 ft was measured. This water level depth is equal to the initial pre-test SWL and represents a full water level recovery following the pumping period. For the remainder of the post-test water level monitoring, water level fluctuations of less than 0.5 ft were observed. As discussed above, similar minor fluctuations were monitored during the background water level monitoring period, and are likely caused either by a nearby well pumping, or by natural diurnal changes in the aquifer. In either case, these small fluctuations are considered to be insignificant.

Water Quality Data

No water quality sampling was performed at the end of the April 2014 constant rate pumping test by M&W. However, water quality sampling and laboratory analyses were performed during the September 2012 pumping by Doshier. Key results of those limited analyses are as follows:

- A calcium-bicarbonate water character
- A total dissolved solids (TDS) concentration of 187 milligrams per liter (mg/L). Such a low TDS concentration is typical of wells constructed into the volcanic rock aquifers of the Sonoma Volcanics.
- A pH of 8.0
- A dissolved iron (Fe) concentration of 0.38 mg/l. This concentration exceeds the California Division of Drinking Water (DDW) Secondary Maximum Contaminant Level (MCL) for iron of 0.3 mg/L for drinking water. An appropriate treatment method to address the elevated iron will be designed and proposed by the project civil engineer (Bartelt) in the future.

- An arsenic (As) concentration of 2.3 micrograms per liter (µg/L), which is less than the DDW Primary MCL for arsenic of 10 µg/L.

Rainfall

Average rainfall totals for the subject property are avaible from various sources. The nearest rainfall gage to the subject property with a significantly long data record is the gage at the Napa State Hospital. The data for this gage are available from the Western Regional Climate Center (WRCC) website (http://www.wrcc.dri.edu), and can be accessed via http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca6074. For that raingage, the period of record is listed as the years 1893 through July 2015. Note that prior to 1919, approximately 5 years of rainfall data are missing from the data set. For the available period of record, the average rainfall at this Napa State Hospital gage is calculated to be 24.8 inches, as reported by on the WRCC website. This rainfall gage, however, is located at a lower elevation than the subject property, and therefore, the rainfall at the property would be somewhat higher than that experienced at this known gage location.

RCS also reviewed an isohyetal map (a map showing contours of average annual rainfall) for Napa County that is freely available for download from the online Napa County GIS Data Catalog (http://gis.napa.ca.gov/giscatalog/catalog.asp). The download page for the file named “isohyetal_cnty” can be accessed via:

http://gis.napa.ca.gov/giscatalog/catalog_xml.asp?srch_opt=all&db_name=x&theme=x&sort_order=layer&meta_style=fgdc&submit=Submit

That map (not provided herein) reveals that the long-term average annual rainfall at the subject property has been on the order of 35 inches per year, or more. As described in the metadata for the file (also available via the download page at the web link shown above), the isohyets are based on a 60-year data period beginning in 1900 and ending in 1960.

Rainfall data available for the Atlas Peak area gage are shown on the Napa One Rain website (https://napa.onerain.com). That Atlas Peak gage is higher in elevation than the subject property, and is located roughly 2.5 miles west of the property. Data for that gage are available for a short period of time only. Available data range from water year (WY) 2007-08 (October 2007 through September 2008) through WY 2014-15. The average annual rainfall for those water years at the Atlas Peak gage is calculated to be approximately 33.2 inches. This average includes rainfall data for WY 2014-15, even though the water year isn't yet complete at the date of this report. By including WY 2014-15 data, the assumption is inherently made that no rain will fall in the region from September 17, 2015 through September 30, 2015.

It must be noted that these data from the Napa One Rain site are available as "accumulated totals only" meaning that the data are summed throughout the year, and are not provided as daily or monthly totals. Further, there appear to be errors in the data set, in which the accumulated totals do not re-set to zero at the end of a water year, or re-set in the middle of the water year. RCS made an effort to interpret these data, but RCS has concluded that they should be considered as estimates only. Additionally, the data from the website can be downloaded as one-year blocks only, which complicates the acquisition and processing of the data.

Another raingage exists in the Atlas Peak Area. Specifically, the California Data Exchange Center (CDEC) website (http://cdec.water.ca.gov/) of the California Department of Water Resources (DWR) has an Atlas Peak Raingage (http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=ATL). This gage is reported to have very similar GPS coordinates to the Napa One Raingage, but it is unclear if the two gages are the same.

Data from the DWR CDEC shows data beginning in 1987, but WY 1987-88 and WY 1988-89 appear to have erroneous and/or missing data. In addition there appears to be erroneous data in four other years in the data set (WY 1994-95, WY 1995-96, WY 2004-05, and WY 2006-07). RCS removed the obviously erroneous data from the data set before calculating an average annual rainfall for this gage (for example, for the day of July 15, 2007, the data set includes a rainfall total of 21.62 inches; it is highly unlikely that 21.62 inches of rain fell on that single day in July 2007). Note that RCS only removed rainfall totals; no rainfall was "added" to the data set. With these assumed erroneous years removed from the data set, then an average rainfall of 40.0 inches is calculated for this Atlas Peak rain gage. As described above, the total rainfall for WY 2014-15 assumes no more rain events will occur through the end of this current water year.

Another data source to help evaluate the average rainfall at the property is the data published by the PRISM Climate Group at Oregon State University. This data set, which is freely available from the PRISM website (http://prism.oregonstate.edu/) contains "spatially gridded average annual precipitation at 800m grid cell resolution." The date range for this dataset includes the climatological period between 1981 and 2010. These gridded data provide an average annual rainfall distributed across the subject property. Rainfall data for the subject property range from an annual average between 36.9 in and 37.8 in. Further, the average rainfall for the entire subject property according to the PRISM dataset is 37.4 inches. Hence, a reasonable estimate of the average annual rainfall at the subject property could be 37 inches.

Beginning in September 2013, a raingage was installed at the Mountain Peak LLC property to monitor the site-specific amount of rainfall that falls at the subject property. Table 1, "Mountain Peak Onsite Rainfall," shows a comparison of the data collected by the onsite Mountain Peak LLC gage versus the nearby CDEC Atlas Peak gage. For each of the two water years of comparable data, the Mountain Peak property is seen to have received more rain than the Atlas Peak raingage.

Table 1 – Mountain Peak Onsite Rainfall

Water Year (WY)	***Rainfall Total (in)***	
	Onsite Mountain Peak Gage	***CDEC Atlas Peak Gage***
WY 2013-14	*21.65*	*20.08*
WY 2014-15 (to date)	*28.09*	*26.12*

Based on the available rainfall data described above, we will conservatively assume that the long-term average annual rainfall at the subject property is 35 inches, even though numerous other datasets presented above indicate that a higher average annual rainfall could occur at the subject property. This 35-inch per year estimate is based on the data source with the longest period of record (60 years) of any of the nearby rainfall data sources listed above that exist at elevations similar to the subject property.

Estimate of Groundwater Recharge

Groundwater recharge on a long-term average annual basis at the subject property can be estimated as a percentage of average rainfall that falls on the subject property and deep percolates into the aquifer over the long-term. The actual percentage of rain that deep percolates can be variable, based on such conditions as the slope of the land, the soil type that exists at the property, the evapotranspiration that occurs on the property, etc. Estimates of these factors can be spurious. Therefore, we must look to various analyses of deep percolation into the Sonoma Volcanics by RCS for other properties, and by other consultants and government agencies.

Estimates of groundwater recharge as a percentage of rainfall are presented for a number of watersheds in Napa County in the report titled "Updated Napa County Hydrogeologic Conceptual Model" (LSCE&MBK, 2013) prepared for Napa County. Watershed boundaries within Napa County are shown Figures 8-1 and 8-2 in that report. At the request of RCS, those watershed boundaries were provided to RCS by MBK Engineers via email. Figure 5, "Watershed Boundaries," attached to this Memorandum was prepared using those received boundaries. As shown on Figure 5, the subject Mountain Peak property is located within the "Napa River Watershed near Napa". As shown on Table 8-9 on page 97 of the referenced report (LSCE&MBK, 2013), 17% of the rain that falls within this watershed was estimated to deep percolate as groundwater recharge.

As stated above, the ground surface area of the subject property is 41.76 acres. Assuming a conservative value of 35 inches (2.92 ft) of rain falls on the property on a long-term average annual basis, then the total volume of rainfall available for deep percolation over the long term is approximately 121.9 AF (41.76 acres x 2.92 ft). Assuming 17% of rainfall deep percolates to the groundwater beneath the subject property, then the average annual groundwater recharge at the subject property is estimated to be 20.7 AF/yr.

It is possible that a 17% deep percolation factor is not appropriate for the Sonoma Volcanics. Recharge estimates regularly used for the volcanic rocks throughout the County range from a quite conservative estimate of 7% to perhaps 10.5% or so. RCS has typically assigned a deep percolation estimate of 9% to 10% for the Sonoma Volcanics. These estimates are based, in part, on our review of USGS Water Resources Investigation Reports WRI 77-82 WRI 03-4229 (USGS 1977 and USGS 2003, respectively) and from our experience in preparing numerous hydrogeologic assessments throughout Napa and Sonoma counties for properties underlain by the Sonoma Volcanics. One relatively recent groundwater study prepared as a part of the Napa

Pipe Project Environmental Impact Report estimated that 10.5% rainfall recharge occurred within the Sonoma Volcanics (BHFS 2011).

In the reference “Introduction to Hydrogeology” by J.C. Nonner, 2002, estimates of groundwater recharge were presented as percentages of rainfall for many different rock types in various climates (arid, temperate, and tropical). In that reference (page 172) recharge rates in volcanic rocks in arid regions were discussed in general terms. “Generally, but not everywhere, recharge rates less than 10% of the precipitation was reported for volcanic complexes in arid areas. “For example, recharge percentages on the order of 7 to 9% of an annual precipitation of about 600 mm [23.6 inches] have been assessed for the Deccan Trap basalts…” (Nonner 2002). The text goes on to state on page 173 that “Rates of recharge from precipitation… for volcanic rock complexes in temperate and tropical areas are higher than the rates for similar volcanic rocks in arid areas” (Nonner 2002). Because the subject property is underlain by volcanic rock aquifers in a temperate climate, an estimate of 10% deep percolation of rainfall is considered to be a conservative estimate by the standards set forth in the Nonner text.

Again, the ground surface area of the property is 41.76 acres. Assuming a long-term average annual rainfall of 35 inches, then the average annual groundwater recharge at the subject property is estimated to be on the order of 11 to 12 AF/yr, assuming a range of 9% to 10%, respectively, for deep percolation of rainfall for the subject property. Again, this is a very conservative estimate, and should be considered the “minimum case”.

A slightly more site-specific estimate of the deep percolation of rainfall at the subject property can be made using the data from the LSCE&MBK (2013) report in conjunction with the PRISM rainfall data set. Figure 6A shows the same watershed boundaries (LSCE&MBK, 2013) shown on Figure 5, but superimposed on a geologic base map of the region (USGS, 2007); Figure 6B shows the geologic legend for that map. Importantly, a blue line is shown on the map that separates the alluvial deposits of the Napa Valley from the hillside areas of the County; this blue line is adapted from DWR Bulletin 118-03 (DWR, 2003). The areas within that “blue line” along the floor of Napa Valley represent the Napa Valley sub basin of the Napa-Sonoma Valley Groundwater Basin, as defined therein. As discussed above, the referenced report (LSCE&MBK 2013) estimated that 17% of the rain that falls within the “Napa River Watershed near Napa” is available to deep percolate to recharge the groundwater. It is likely that, in reality, the percentage of rainfall that deep percolates into the alluvial deposits is higher than the percentage of rainfall that deep percolates into the geologic materials that are exposed throughout the hillside areas of the watershed (in general, the hillsides are composed of either volcanic rocks, or older, well-cemented sandstones and siltstones). The total area of the blue-boundary groundwater basin shown on Figure 6A is roughly 45.6 square miles (sq mi). The remainder of the "Napa River Watershed near Napa" area that is not underlain by the blue-lined groundwater basin is comprised by a total of 170.3 sq mi. By assuming that the deep percolation percentage of rainfall onto the groundwater basin (underlain by alluvium) is 25% (instead of 17%), then the estimated percentage of infiltration in the hill and mountain areas can be calculated. To do so, the amount of rain that falls in each of the areas must be determined. This can be accomplished using a GIS system and the PRISM dataset. Because the PRISM dataset is distributed for equal sized areas throughout the County, then the average rainfall can be calculated for any size or shaped area within the County. Using the Prism data set, and the assumptions stated above, Table 2, "Calculation of Theoretical Rainfall Recharge Percentage, Napa River Watershed near Napa," was created to determine the percentage of rainfall that may be available for deep percolation.

As shown on Table 2, assuming the average rainfall as calculated using the PRISM dataset, three scenarios are presented in which the deep percolation percentage of the valley floor of the Napa Valley is adjusted to values higher than 17%. The results of the three scenarios shown on Table 2 are as follows:

- Scenario 1 assumes a valley floor deep percolation percentage of 20%, with a resultant deep percolation percentage for the hill and mountain areas of the watershed of 16%.
- Assuming the deep percolation of rainfall in the alluvium is 25% for Scenario 2, the percentage of rainfall that is calculated to deep percolate at the subject property (and throughout the watershed) is 15%.
- A deep percolation percentage in the alluvium for Scenario 3 of 30% yields a deep percolation percentage for the hill and mountain areas of 14%.

Therefore, based on the analyses presented in Table 2, a value of 14% or higher may be an appropriate assumption for the percentage of rainfall that can deep percolate to recharge the groundwater beneath the subject property. Assuming a deep percolation of 14%, surface area of the subject property of 41.76 acres, and a long-term average annual rainfall total of 35 inches, then the average annual groundwater recharge at the subject property is estimated to be on the order of 17 AF/yr.

Ongoing Water Level Data Collection

Beginning in August 2014, Mountain Peak LLC implemented a program of water level monitoring in onsite Well No. 1 using a water level pressure transducer. Figure 7, "Mountain Peak Well No. 1 Water Level Data," shows the data collected to date from this ongoing monitoring program. The blue-colored line on the graph was created using the water level data collected from the Mountain Peak pressure transducer. Also shown on Figure 7 are: the data collected via transducer by RCS during the April 2014 pumping test (these data are also shown on Figure 4); two manual water level measurements collected by RCS during visits to the site; the original water level data collected by others from the well in 1991 just after the well was constructed (although not shown on the correct time scale); and weekly rainfall totals from both the Mountain Peak raingage and the CDEC raingage.

Important to note from Figure 7 is that the water levels in the onsite well have remained essentially unchanged over time. Static water level data available throughout the period of record fluctuate from a high of 15 ft (just after the well was constructed and no significant pumping had occurred) to a low of roughly 24 ft in September 2015, which occurred near the end of this current irrigation season; the onsite well has been pumping for irrigation purposes. Further, the state is currently experiencing the fourth year of a drought period. Water levels illustrated on Figure 7 show a clear correlation with rainfall events; in time of elevated rainfall, water levels show a clear increase (see December 7, 2014 on Figure 7, as an example), and vice versa. It is also noteworthy to mention that, as discussed above, the total volume of groundwater extracted from Well 1 in 2015 (through September 15) is higher than the total groundwater demand for the proposed project, and water levels appear to be relatively stable over time in Well 1.

Estimate of Groundwater in Storage

To help evaluate possible impacts to the local aquifer system that may occur as a result of pumping for the proposed project, the volume of groundwater extracted for the project can be compared to an estimate of the volume of groundwater in storage beneath the subject property. To estimate the amount of groundwater currently in storage beneath the Mountain Peak LLC property, the following parameters are needed:

a) Approximate surface area of property = 41.76 acres

b) Depth of Well No. 1 = 205 ft bgs

c) Well No. 1 has a total length of perforated casing of 140 ft, with perforation intervals between the depths of 45 ft and 140 ft bgs, and 160 ft and 205 ft bgs. To present a conservative calculation of groundwater in storage, we will assume that the saturated thickness of the aquifer in the vicinity of the Well No. 1 is 140 vertical feet (i.e., the total length of perforations in the well). In reality, the saturated volcanic rock aquifer beneath the subject property could be much deeper. Further, the static water level (at an approximate depth of 24 ft in September 2015) in the well is actually higher (i.e., above the depth to the uppermost perforations in the well; perforations begin at a depth of 45 ft bgs).

d) Approximate average specific yield of the Sonoma Volcanics = 2%. The specific yield is essentially the portion of the geologic materials from which groundwater could be extracted from the saturated portion of the fractured volcanic rocks solely beneath the subject property. Specific yield of the Sonoma Volcanics can vary greatly depending on the degree of the fracturing and interconnection within the rocks. A conservative estimate for the specific yield of the Sonoma Volcanics ranges from 3% to 5% (USGS, 1960). For other nearby properties for which RCS has performed similar analyses, a more conservative estimate for specific yield of 2% was used. Hence, to present a conservative analysis, we will assume a specific yield value of only 2% for the Sonoma Volcanic rocks that underlie the subject property, although the value may, in reality, be higher.

Thus, the groundwater currently estimated to be in storage (S, as of May 18, 2015) is calculated as:

> S = property area (a, above) times saturated thickness (c, above) times average specific yield (e, above) = (41.76 ac)(140 ft)(2%) = 116.9 AF.

In contrast, the proposed groundwater use for the proposed project is 16.64 AF/yr. Hence, this annual volume of groundwater needed for the project represents only about 14% of the groundwater conservatively estimated to be currently in storage beneath the Mountain Peak LLC property.

Possible Effects of "Prolonged Drought"

California is currently experiencing a period of drought. Here, drought is defined as a meteorological drought, that is, a period in which the total annual precipitation is less than the average annual precipitation (DWR, 2015). Napa County PBES has asked RCS to consider what the effects on groundwater availability at the subject property might be if a period of "prolonged drought" occurs in the region, and if the proposed project is constructed and operates as proposed. Recharge volumes estimated in this report have been based on the long-term average rainfall value. Recall that the average rainfall always includes times of below-average rainfall, and above average rainfall. Therefore, it is our opinion that the preceding calculations do inherently include consideration of drought year conditions.

However, to help understand what actual conditions might exist in the local volcanic rocks beneath the property during a "prolonged drought period", a "prolonged drought" must be defined. As discussed by DWR, "there is no universal definition of when a drought begins or ends, nor is there a state statutory process for defining or declaring drought." (DWR 2015). California's most significant historical statewide droughts are defined by DWR as occurring during the following periods (DWR, 2015):

- WY 1928-29 through WY1933-34 - six years
- WY 1975-76 through WY 1976-77 – two years
- WY 1986-87 through WY 1991-92 – six years
- WY 2006-07 through WY 2008-09 – three years
- Current drought – WY 2011-12 through WY 2014-15 – four years to date

Table 3, "Drought Year Rainfall." shows the average amount of rainfall that occurred during each drought period; that drought period rainfall amount is also expressed on Table 3 as a percentage of the total rainfall that fell. As shown on Table 3, determining the amount of rain that might fall during a "prolonged drought" is variable, and depends on the period of record for the raingage. Clearly, the WY 1975-76 to WY 1976-77 drought period recorded by the Napa Hospital Raingage and reported by the WRCC had the lowest total rainfall at 48% of the long-term average, and lasted two years. The WY 1928-29 to WY 1933-34 drought period lasted for six years, but rainfall was 70% of the average annual rainfall at the Napa Hospital gage. It is important to note that the drought year percentages listed on Table 3 are completely dependent on the period of record for each individual gage. An example of this is the Napa One Rain gage data. Because the period of record for the gage is short, and includes many drought years, then the two available drought year period rainfall percentages are shown to be 89% and 87% of the long-term average.

Based on the above considerations, and for this analysis, it is RCS's opinion that using data from the CDEC Atlas Peak Raingage is the appropriate gage to use for the Mountain Peak property. As discussed previously, the CDEC gage has been shown to be very similar to the data collected from the onsite Mountain Peak LLC raingage. Although the period of record for the Napa State Hospital gage is longer, data from the Atlas peak gage is more representative of the local conditions that occur at the subject property. Hence, we will consider a typical drought period rainfall to be 59% of the average annual rainfall that occurs at the CDEC Atlas peak gage. Further, to be conservative, we will estimate a "prolonged drought period" to be 6 years, which is the longest drought period on record according the DWR (DWR, 2015); see Table 3.

To meet six years of groundwater demand for the proposed subject property, a total onsite groundwater extraction of 99.8 AF is estimated to be required (16.64 AF/yr multiplied by 6 years = 99.8 AF). Assuming groundwater recharge is reduced to 59% of the average annual recharge during a theoretical "prolonged drought period", then approximately 60 AF of groundwater recharge may occur during the 6-year drought period, as calculated below:

a. From page 15, an average annual groundwater recharge at the property is estimated to be 17 AF/yr. Taking 59% of this volume to yields a drought period recharge volume of 10 AF/yr.

b. Assuming a drought period duration of 6 years, then 60 AF of groundwater would recharge the volcanic rocks beneath the property by virtue of direct rainfall recharge within the boundaries of the subject property.

Therefore, after a six year drought period in which only 59% of the average annual rainfall might occur, there may be a total "recharge deficit" of 39.8 AF (calculated by subtracting the 60 AF of groundwater recharge over the entire six years from the 99.8 AF of total onsite groundwater extractions over the entire 6-year period). Water to meet this deficit would be (and is) available during drought periods from the groundwater currently known to be in storage in those rocks.

As estimated above on page 17, 116.9 AF of groundwater are currently in storage beneath the subject property. Hence, the six-year long drought period groundwater "recharge deficit" would represent only 34% of the groundwater currently in storage. Temporarily removing an average of approximately ±6.6 AF of groundwater from storage each year (or 39.8 AF/yr of "deficit" over the entire 6-year period) may cause water levels to lower slightly, but removal of such a small percentage of groundwater from storage over a 6-year period of time is not expected to significantly affect groundwater levels beneath the subject property. Also recall that, in periods of above-average rainfall, the 24.7 AF of groundwater that might be removed from storage would be recharged and be "refilled".

Key Conclusions and Recommendations

- As described above, the future groundwater demand for the proposed project is 16.64 AF/yr. This translates into a well pumping at a rate of 20.6 gpm to meet the average annual demand for the project, assuming the well is pumped on a 50% operations basis (pumping 12 hours per day, every day). Further, the greatest monthly average pumping rate for the project is roughly 44.5 gpm (assuming a 50% operational basis in the months of July each year).
- Based on the results of the April 2014 constant rate pumping test performed by M&W, and on the limited pumping of this well performed in 2012 by Doshier, the existing onsite well is clearly capable of pumping at rates that are in excess of those needed to meet both the average and the "greatest average month" groundwater demands of the proposed project.
- Only minor water level drawdown (just 3.3 ft) was observed in this existing well following the pumping of the well for a continuous period of 24 hours, and at an overall constant rate of 50 gpm. This pumping rate is much higher than both the typical pumping rate that will be needed from the well and the peak-day pumping rate that will be necessary for the project in the future. Hence, the existing onsite well is clearly capable of meeting the groundwater demands for the proposed Winery project.
- Water levels in the existing well fully recovered back to the pre-test SWL within 24 hours of pumping.
- The nearest offsite well to the existing onsite well, according to mapping work by Bartelt (shown on Figure 3), is approximately 760 ft to the northwest of the onsite well that was tested for this project. Further, the nearest offsite well to the proposed new onsite well is approximately 650 ft to the northeast of the proposed new onsite well. As is the nature of wells pumping from any aquifer system, the water level drawdown created by virtue of pumping a well is greatest in the well being pumped. Drawdown observed at any distance from the pumping well is less than the drawdown that occurs in the pumping well. Hence, even at a distance of 650 ft (the distance to the nearest offsite well to the proposed new onsite well), any possible water level drawdown effects during pumping

on nearby wells would likely be negligible in the future, assuming the new well performs similarly to the existing onsite well.

- Because the geology beneath the subject property is known to be comprised of the Sonoma Volcanic rocks, it is very likely that a new well can be constructed at the subject property that should be capable of pumping in the future at rates similar to that used during the recent constant rate pumping test of the existing well. Note that this new well will be used to meet the groundwater demands associated with the proposed Winery only, and not for any vineyard irrigation purposes. Hence, the new well will be used to meet only 17% (2.85 AF/yr) of the groundwater demand for the proposed project (16.64 AF/yr).

- Groundwater recharge that occurs at the subject property on a long-term average annual basis is estimated to be 17.0 AF/yr, based on data available in the referenced report (LSCE&MBK 2013). This volume is higher than the estimated groundwater demand for the subject property of 16.64 AF/yr.

- Bartelt estimates that the existing annual groundwater use for the subject property has been 14.75 AF/yr, a value that is only 1.89 AF/yr lower than the proposed average future groundwater use for the proposed project. Hence, the future groundwater demand for the proposed project is only a slight increase from the estimated current use.

  When the existing onsite well was constructed, a static water level of 15 ft to 20 ft was reported by the driller (See Figure 7). Recently, just before the start of the constant rate pumping test, a water level of 19.6 ft was measured (remember that this water level was collected during a drought year, when below-average rainfall and groundwater recharge had occurred). Further, water level data collected beginning in April 2014 through September 2015 (see Figure 7) reveal static (non-pumping) water levels have remained relatively constant over time, and have fluctuated on a seasonal basis between the approximate depths of 15 ft to 24 ft bgs. These static water levels illustrate that water levels have remained essentially unchanged since the well was constructed in 1991. In addition, recall that the water use at the subject property will decrease as part of the proposed new project.

  Therefore, the essentially unchanged water levels over time, coupled with a small future increase in water use at the subject property suggest that the average annual groundwater recharge estimated for the subject property is sufficient to support the proposed project. Further, actual well extraction volumes measured at Well 1 beginning in August 2014 through September 2015 that are on the order of 23 AF/yr suggest an even higher existing annual extraction volume is possible, as evidenced by relatively stable water levels in Well 1 over that same period.

- Estimates of the recharge that may occur during a “prolonged drought” (as defined herein) show that, over a six year drought period in which only 59% of the average annual rainfall fell, only 34% of the groundwater currently in storage beneath the subject property would be utilized over the entire 6-year drought period.

- We recommend continued monitoring of the static and pumping water levels, and of the instantaneous flow rates and cumulative pumped volumes in the existing onsite well and also in the proposed onsite well, be performed on a regular basis. By continuing to

DRAFT
UPDATED MEMORANDUM

observe the trends in groundwater levels and well production rates over time evaluated by qualified professionals, the property owner can address potential declines in water levels and well production in the area (if any).

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Table 2
Calculation of Theoretical Rainfall Recharge Percentage, Napa River Watershed Near Napa

Portion of "Napa River Watershed Near Napa" (See Figure 6A)	Area (sq mi)	Area (acres)	Average Rainfall per PRISM Dataset (1980-2010) (in)	Rainfall Volume (AF)	Scenario 1 Deep Percolation Percentage (%)	Scenario 1 Deep Percolation Volume (AF)	Scenario 2 Deep Percolation Percentage (%)	Scenario 2 Deep Percolation Volume (AF)	Scenario 3 Deep Percolation Percentage (%)	Scenario 3 Deep Percolation Volume (AF)
Valley Floor Portion of Watershed	45.5	29,120	34.7	84,205	20%	16,841	25%	21,051	30%	25,262
Hillside Area Portion of Watershed	172.8	110,592	39.3	362,189	16%	58,964	15%	54,754	14%	50,544
Entire Watershed	218.3	139,712	38.3	445,914	17%	75,805	17%	75,805	17%	75,805

Table 3
Drought Period Rainfall as Percentage of Average

Statewide Drought Period as Defined by DWR (DWR 2005)	Drought Duration (years)	Average Rainfall by Raingage								
		Napa Hospital Raingage, WRCC Period of Record - 1893 through July 2015			Atlas Peak Raingage, CDEC Period of Record - 1987 through Sept 2105			Atlas Peak Raingage, Napa OneRain Period of Record - 1987 through Sept 2105		
		[A] Total Gage Average (in)	[B] Drought Period Ave. (in)	[B÷A] Drought Period Rainfall as % of Average	[D] Total Gage Average (in)	[E] Drought Period Ave. (in)	[E÷D] Drought Period Rainfall as % of Average	[G] Total Gage Average (in)	[H] Drought Period Ave. (in)	[H÷G] Drought Period Rainfall as % of Average
WY 1928-29 to WY 1933-34	6	24.8	17.3	70%	ND	ND	ND	ND	ND	ND
WY 1975-76 to WY 1976-77	2	24.8	11.8	48%	ND	ND	ND	ND	ND	ND
WY 1986-87 to WY 1991-92	6	24.8	18.5	75%	40.0***	38.7***	97%***	ND	ND	ND
WY 2006-07 to WY 2008-09	3	24.8	18.1	73%	40.0	23.4	59%	33.2***	29.4***	89%***
WY 2011-12 to WY 2014-15*	4**	24.8	20.0	81%	40.0	26.9	67%	33.2	29.0	87%

* WY 2014-15 not yet complete. Totals therefore inherently assume no rain will occur between September 17 and 30, 2015.
** Drought could potentially continue into WY 2015-16; the duration of the current drought is unknown.
*** Raingage data does not extend through the entire drought period
ND = No rainfall data avaialble for the corresponding drought period.

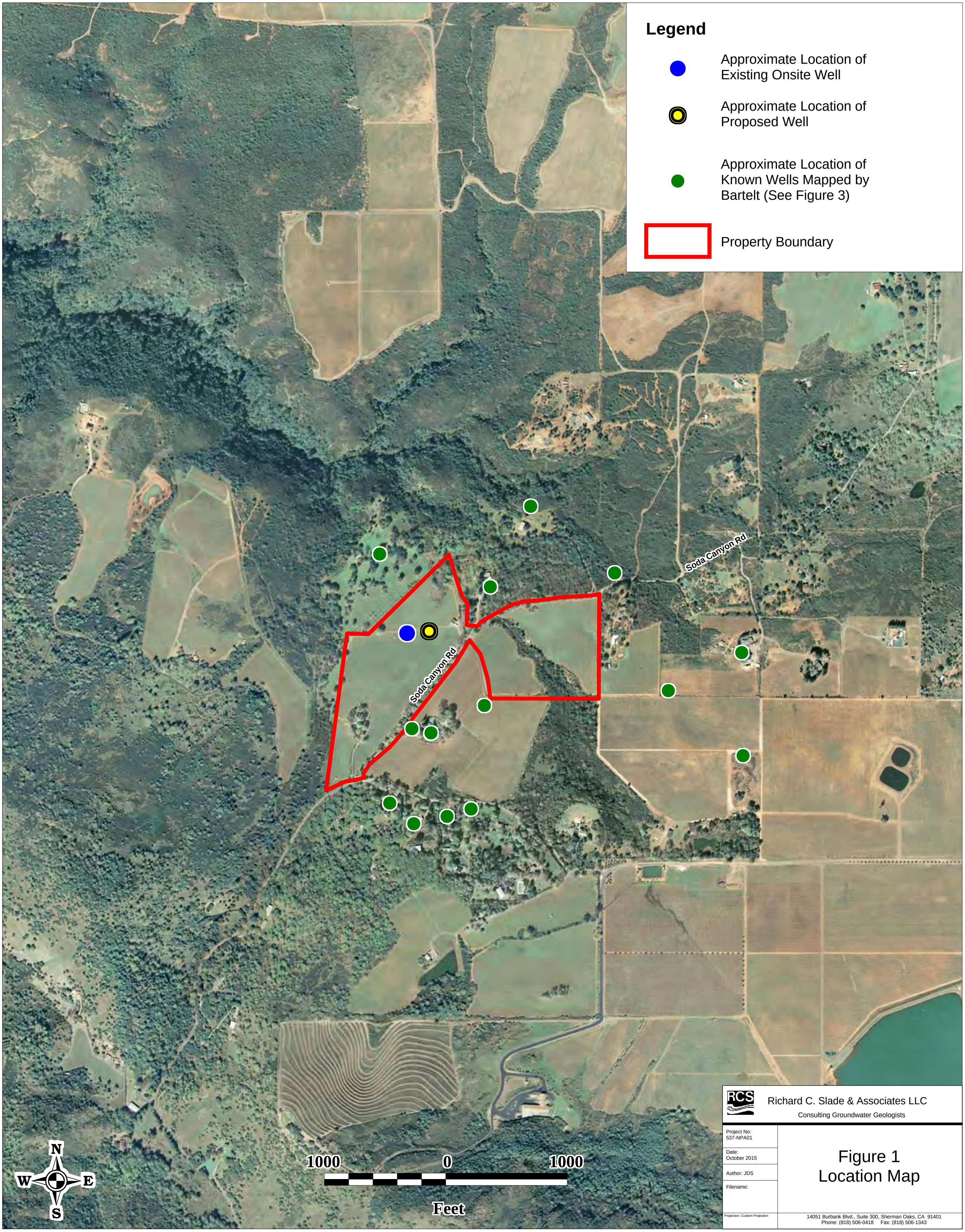
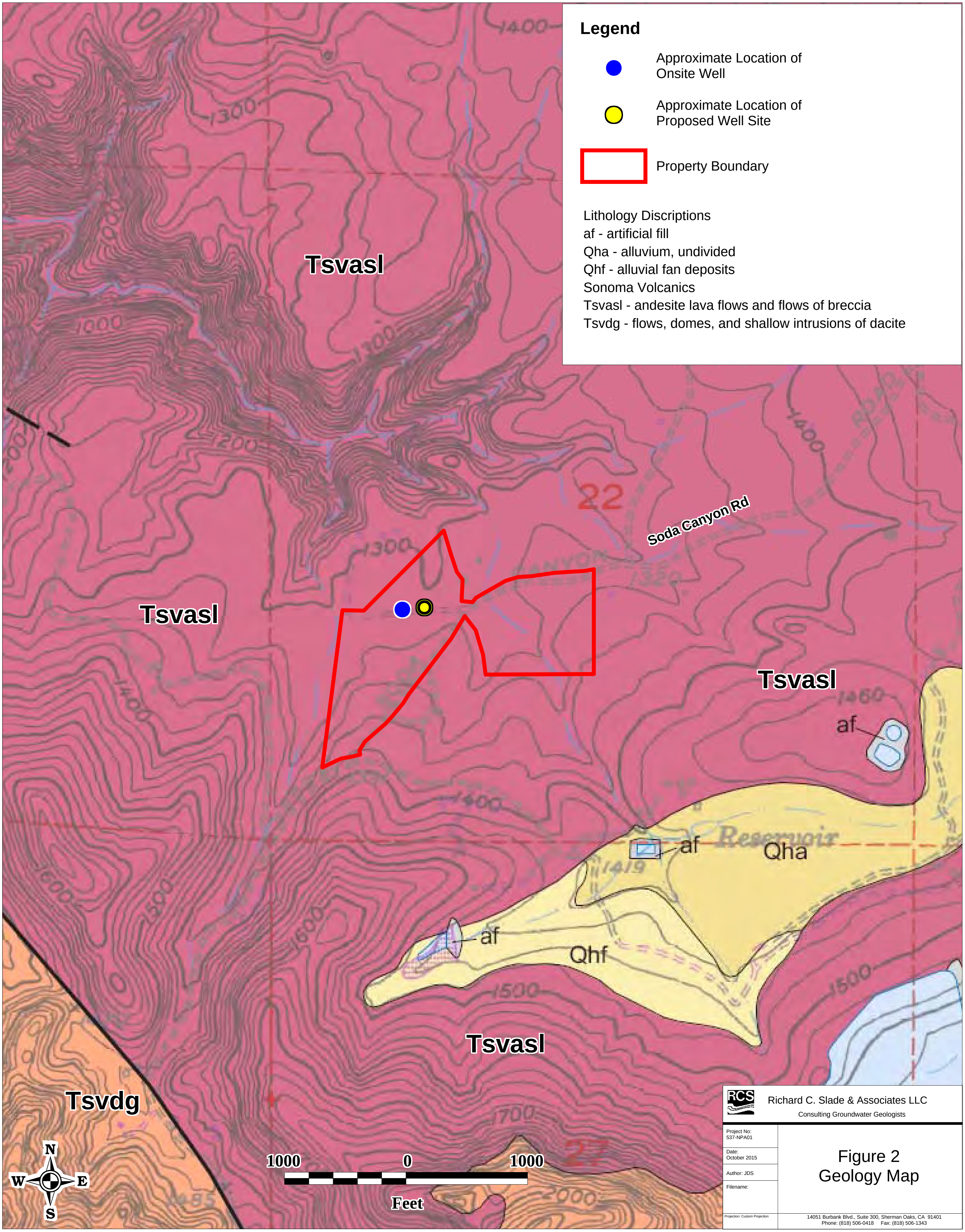


Figure 1
Location Map



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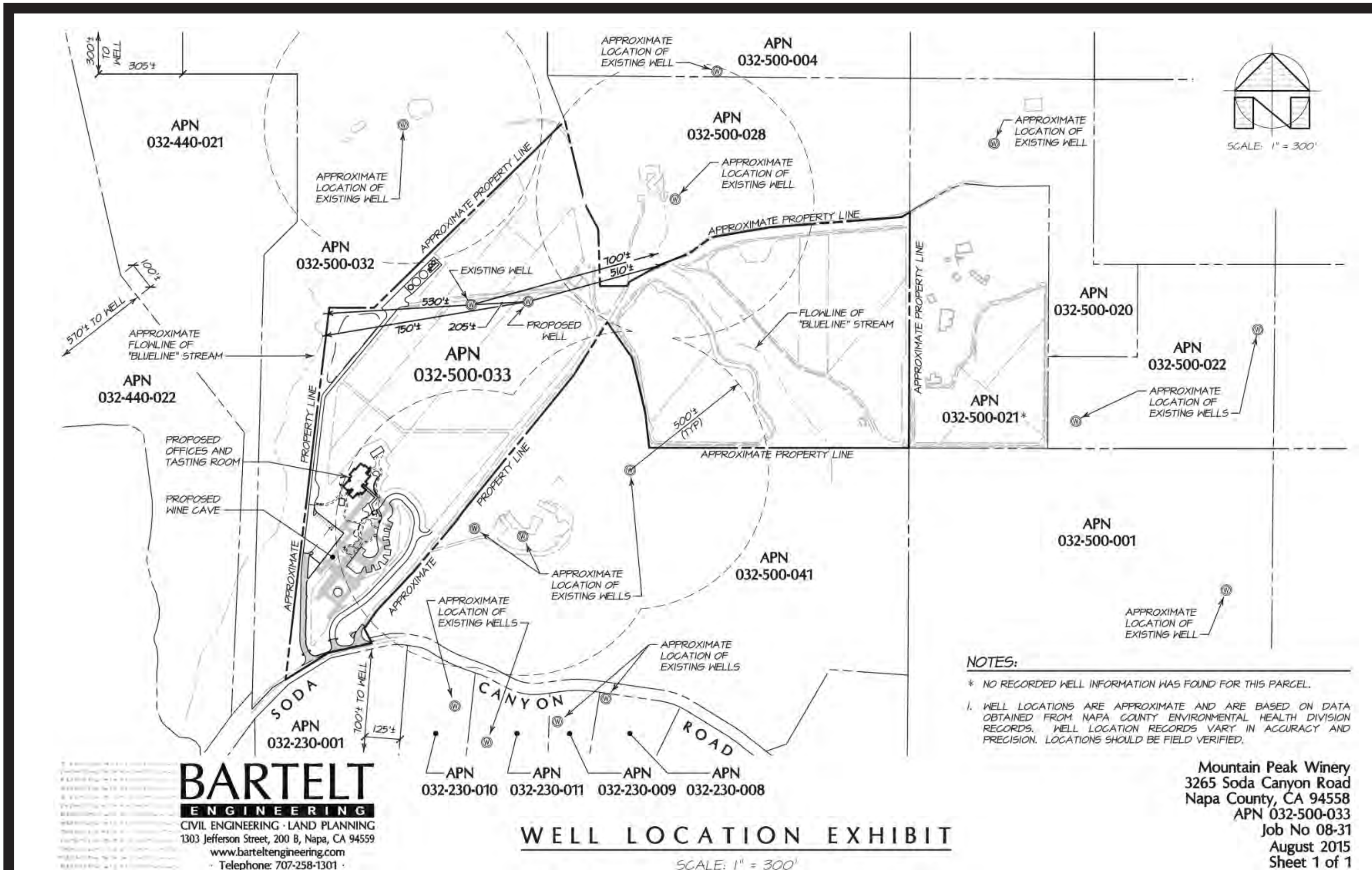
Richard C. Slade & Associates LLC
Consulting Groundwater Geologists

Project No: 537-NPA01
Date: October 2015
Author: JDS
Filename:

Figure 2
Geology Map

14051 Burbank Blvd., Suite 300, Sherman Oaks, CA 91401
Phone: (818) 506-0418 Fax: (818) 506-1343



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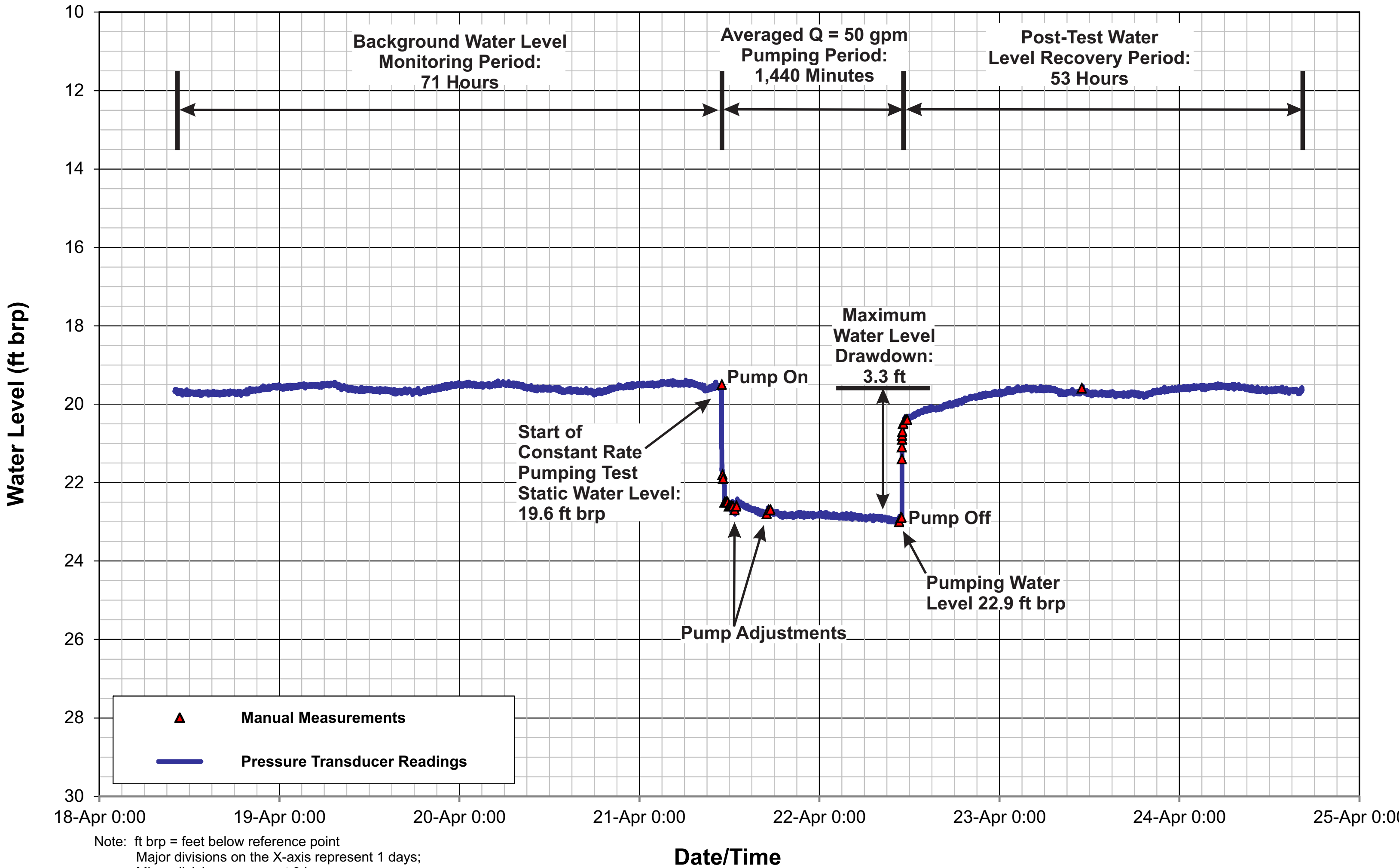
Northern California Phone (707) 963-3914

FIGURE 3
LOCATION MAP BY BARTELT ENGINEERING

Job No. 537-NPA01 **October 2015**



Note: ft brp = feet below reference point
Major divisions on the X-axis represent 1 days;
Minor divisions represent 3 hours.

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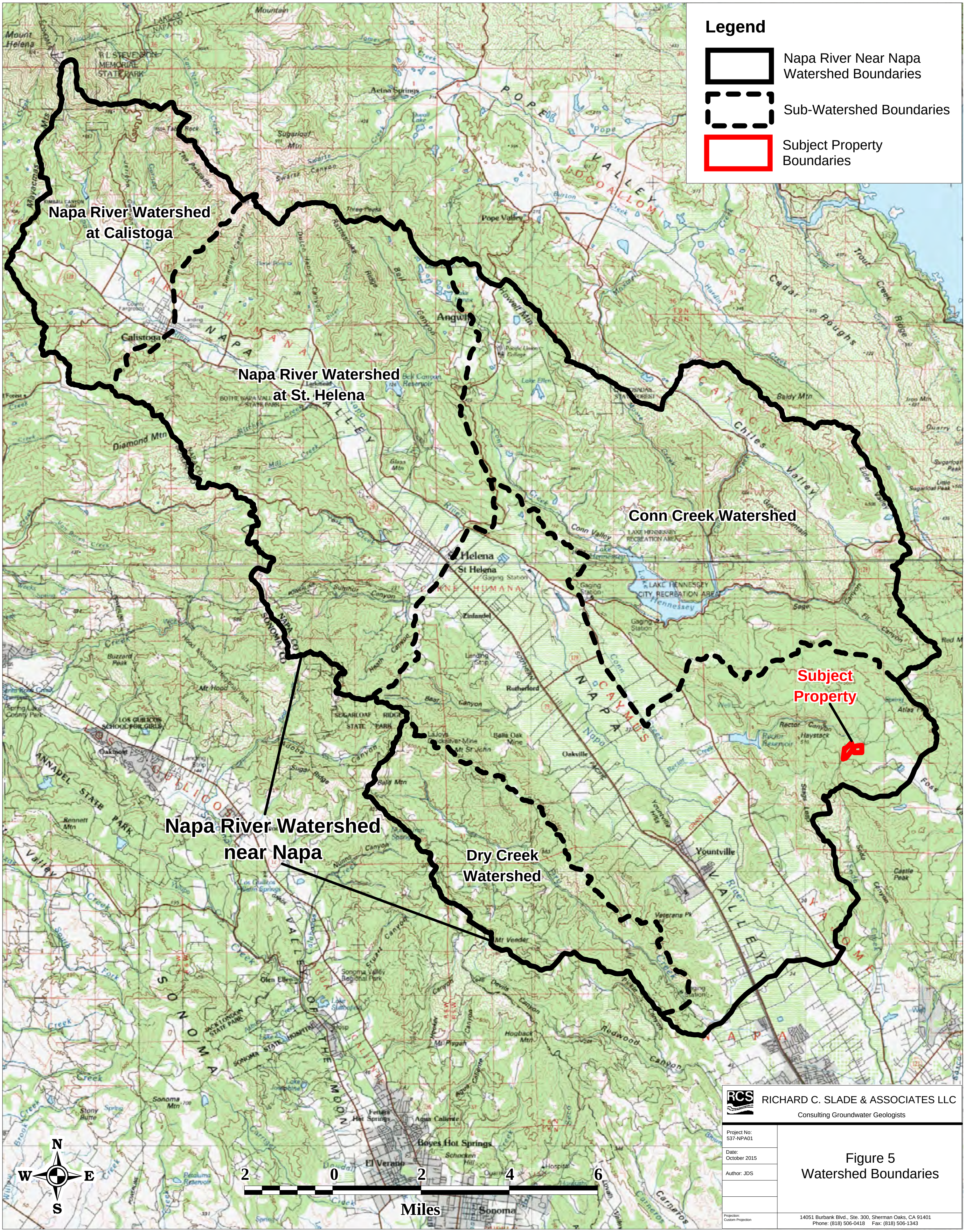
FIGURE 4
WATER LEVELS DURING CONSTANT RATE PUMPING TEST
3265 SODA CANYON ROAD

Job No. 537-NPA01 **October 2015**


Legend
Napa River Near Napa Watershed Boundaries
Sub-Watershed Boundaries
Subject Property Boundaries
Napa River Watershed at Calistoga
Napa River Watershed at St. Helena
Conn Creek Watershed
Subject Property
Napa River Watershed near Napa
Dry Creek Watershed
Calistoga
St Helena
Angwin
Yountville
Pope Valley
Oakville
Rutherford
Zinfandel
Mt Veeder
Glen Ellen
El Verano
Sonoma
Boyes Hot Springs
Lake Hennessey City Recreation Area
Chiles Valley
N
W
E
S
2
0
2
4
6
Miles
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Consulting Groundwater Geologists
Project No: 537-NPA01
Date: October 2015
Author: JDS
Projection: Custom Projection
Figure 5
Watershed Boundaries
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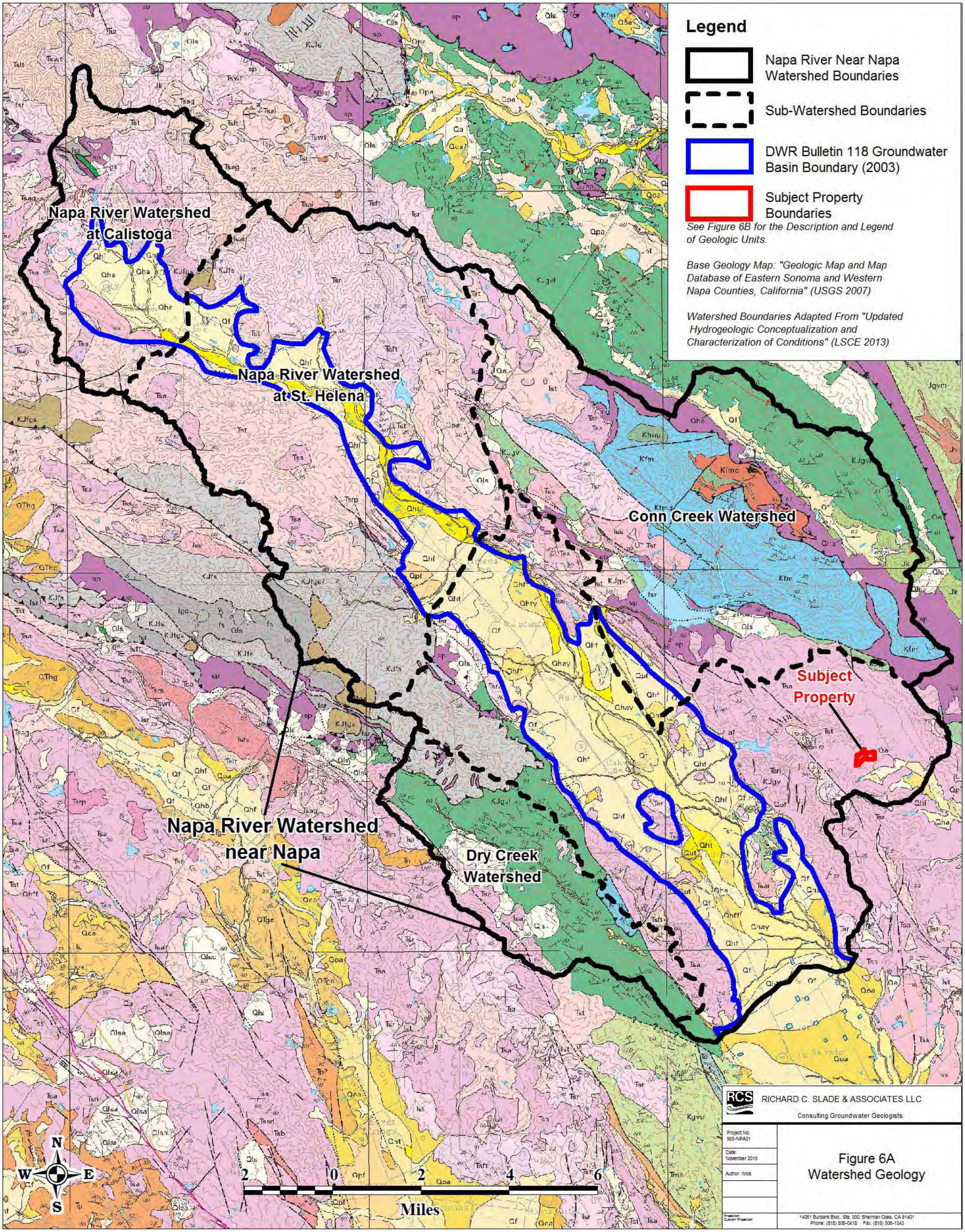
Legend
Napa River Near Napa Watershed Boundaries
Sub-Watershed Boundaries
DWR Bulletin 118 Groundwater Basin Boundary (2003)
Subject Property Boundaries
See Figure 6B for the Description and Legend of Geologic Units.
Base Geology Map: "Geologic Map and Map Database of Eastern Sonoma and Western Napa Counties, California" (USGS 2007)
Watershed Boundaries Adapted From "Updated Hydrogeologic Conceptualization and Characterization of Conditions" (LSCE 2013)
Napa River Watershed at Calistoga
Napa River Watershed at St. Helena
Conn Creek Watershed
Subject Property
Dry Creek Watershed
Napa River Watershed near Napa
N
S
E
W
2
0
2
4
6
Miles
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Figure 6A
Watershed Geology

LIST OF MAP UNITS

[Some unit exposures on the map are too small to distinguish the color for unit identification. These units are labeled where possible, and unlabeled units are attributed in the database.]

SURFICIAL DEPOSITS

af	Artificial fill (Historic)
afbm	Artificial fill over Bay mud (Historic)
alf	Artificial levee fill (Historic)
Qhc	Stream channel deposits (late Holocene)
Qhay	Younger alluvium (late Holocene)
Qhty	Terrace deposits (late Holocene)
Qha	Alluvium (Holocene)
Qht	Terrace deposits (Holocene)
Qhf	Alluvial fan deposits (Holocene)
Qhff	Fine-grained alluvial fan deposits (Holocene)
Qhl	Natural levee deposits (Holocene)
Qhb	Basin deposits (Holocene)
Qhbm	Bay mud (Holocene)
Qa	Alluvium (Holocene and late Pleistocene)
Qt	Terrace deposits (Holocene and late Pleistocene)
Qf	Alluvial fan deposits (Holocene and late Pleistocene)
Qls	Landslide deposits (Holocene and late Pleistocene)
Qlsa	Andesitic composition
Qlsr	Rhyolitic composition
Qpa	Alluvium (late Pleistocene)
Qpt	Terrace deposit (late Pleistocene)
Qpf	Alluvial fan deposits (late Pleistocene)
Qoa	Alluvium (late and early Pleistocene)
Qlso	Landslide deposits (late and early Pleistocene)

Clear Lake Volcanics

Qr	Rhyolite (Pleistocene)
QTob	Olivine basalt (Pleistocene and Pliocene)
QTt	Tuff (Pleistocene and(or) Pliocene)
Tr	Rhyolite (Pliocene)
QTc	Cache Formation (Pleistocene and(or) Pliocene)
QTge	Glen Ellen Formation (early Pleistocene? and Pliocene)
QThg	Huichica and Glen Ellen Formations, undivided (early Pleistocene? and Pliocene)

Sonoma Volcanics

Tsv	Sonoma Volcanics, undivided (Pliocene and late Miocene)
Tsr	Rhyolite flows
Tsri	Rhyolite plugs
Tsrs	Soda rhyolite flows
Tsrp	Perlitic rhyolite
Tsrb	Rhyolite breccia
Tsa	Andesite to basalt lava flows
Tsai	Andesite to dacite plugs
Tsb	Basalt flows
Tsfd	Basalt or andesite lava flows and sediments
Tst	Pumiceous ash-flow tuff
Tswt	Welded ash-flow tuff
Tstx	Tuff(?)
Tsag	Agglomerate
Tslt	Tuff breccia
Tsft	Tuff
Tss	Volcanic sand and gravel
Tssd	Diatomite
Twg	Wilson Grove Formation (late Pliocene to late Miocene)
Tc	Sand and gravel of Cotati (Pliocene and late Miocene)
Tp	Petaluma Formation (early Pliocene and late Miocene)
Tdr	Donnell Ranch Volcanics (late Miocene)
Tn	Neroly Sandstone (late Miocene)
Tci	Cierbo Sandstone (late Miocene)
Tbm	Burdell Mountain volcanics (late and middle? Miocene)
Tms	Unnamed sandstone (middle Miocene)
Tkt	Kirker Tuff (early Miocene and(or) Oligocene)
Td	Unnamed sandstone (Eocene and Paleocene)
Ts	Unnamed sandstone (Eocene? or Paleocene?)

GREAT VALLEY COMPLEX

Great Valley sequence

KJgv	Sandstone, shale, and conglomerate (Late Cretaceous to Late Jurassic)
Kgvu	Sandstone, shale, and conglomerate (Late Cretaceous)
Kv	Venado Formation (Late Cretaceous)
KJgvl	Sandstone and shale (Early Cretaceous and Late Jurassic)
KJsp	Sedimentary serpentinite member
Jk	Knoxville Formation (Late Jurassic)
Jsp	Sedimentary serpentinite member
Jgvm	Mélange

Coast Range ophiolite

Jv	Basaltic pillow lava and breccia (Jurassic)
Jm	Mafic intrusive complex (Jurassic)
Jgb	Gabbro (Jurassic)
sp	Serpentinite (Jurassic)
sc	Silica-carbonate rock
spm	Serpentinite-matrix mélange

FRANCISCAN COMPLEX

fsr	Mélange, including blocks, mapped locally, of:
sp	Serpentinite
fs	Graywacke
ch	Chert
fgc	Greenstone and chert
gs	Greenstone
m	High-grade metamorphic rocks
Kfss	Sandstone (Late Cretaceous, Turonian?)
Kfm	Metagraywacke (Late and Early Cretaceous)
Kfmc	Metachert (Late and Early Cretaceous)
Kfmg	Metagreenstone (Late and Early Cretaceous)
KJfs	Graywacke and melange (Early Cretaceous and Late Jurassic)
KJfc	Chert (Cretaceous to Jurassic)
KJfgc	Greenstone and chert (Cretaceous to Jurassic)
KJfgs	Greenstone (Cretaceous to Jurassic)

MAP SYMBOLS

Contact—Depositional or intrusive contact, dashed where approximately located, dotted where concealed

Fault—Dashed where approximately located, small dashes where inferred, dotted where concealed, queried where location is uncertain, orange denotes Quaternary-active fault, magenta denotes Holocene active-fault

Reverse or thrust fault—Dashed where approximately located, small dashes where inferred, dotted where concealed, queried where location is uncertain; sawteeth on upper plate

Anticline—Dashed where approximately located, dotted where concealed

Syncline—Dashed where approximately located, dotted where concealed

35	Strike and dip of bedding
48	Strike and dip of bedding, top indicator observed
20	Strike and dip of bedding, approximate
83	Overturned bedding
79	Overturned bedding, top indicator observed
45	Crumpled bedding
25	Air photo attitude
	Vertical bedding
	Horizontal bedding
35	Strike and dip of foliation
73	Strike and dip of foliation and bedding
	Vertical foliation
	Strike and dip of joint

Legend from "Geologic Map and Map Database of Eastern Sonoma and Western Napa Counties, California" (USGS 2007)

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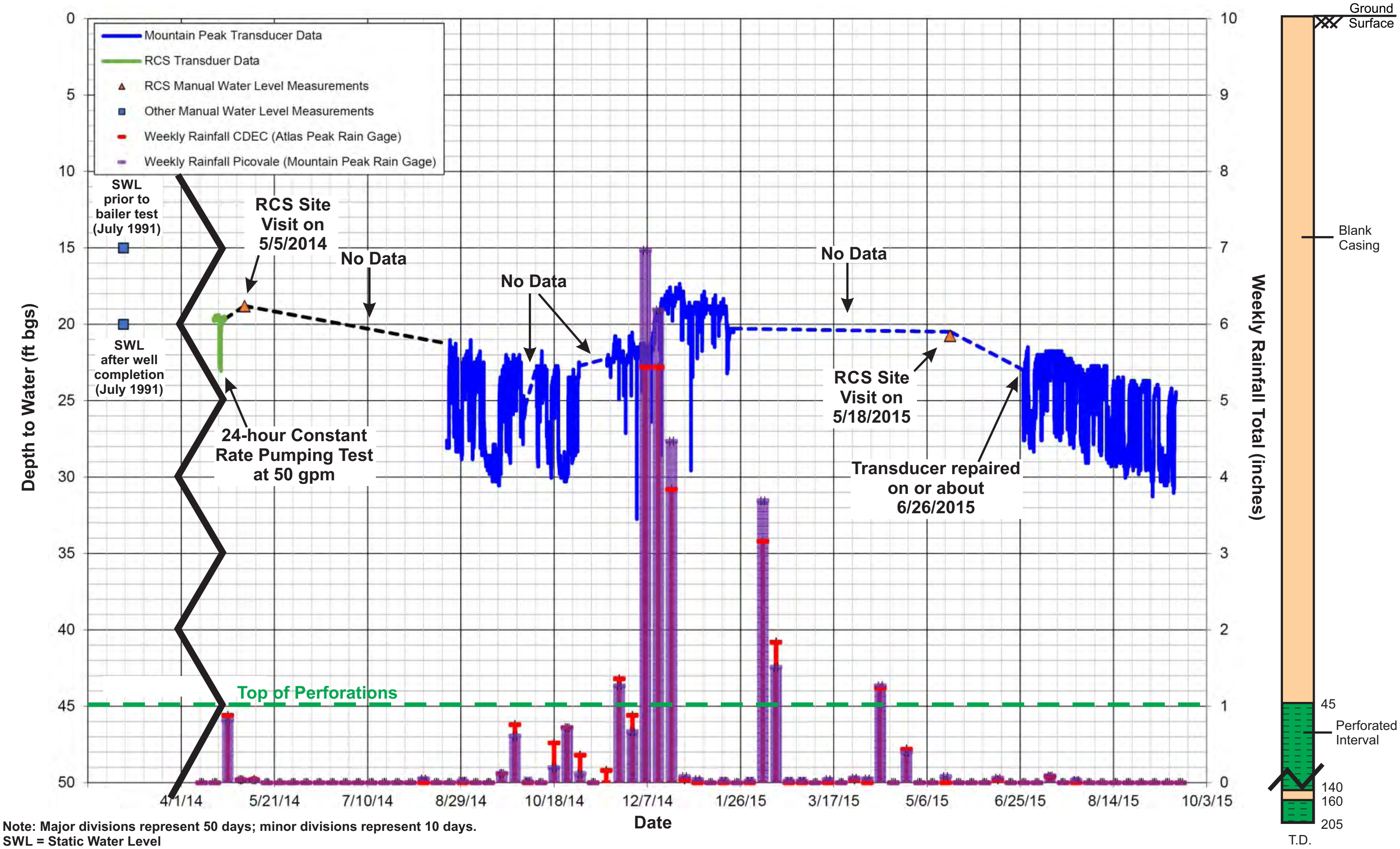
FIGURE 6B
DESCRIPTION AND LEGEND OF GEOLOGIC UNITS



Note: Major divisions represent 50 days; minor divisions represent 10 days.
SWL = Static Water Level

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FIGURE 7
MOUNTAIN PEAK WELL NO. 1
WATER LEVEL DATA

Job No. 537-NPA01

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