EXHIBIT D-1

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CONSULTING GROUNDWATER GEOLOGISTS

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MEMORANDUM

January 25, 2019

To: Robert Long
Wappo Land Co. LLC
Sent via email (bob@montagnanapavalley.com)

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Job No. 479-NPA04

From: Chris Wick, Anthony Hicke, and Richard C. Slade
Richard C. Slade & Associates LLC (RCS)

Re: Results of Napa County Tier 1 Water Availability Analysis
Long Ranch "Parcel 12" Vineyard Development
Long Ranch Road, Vicinity Pritchard Hill, Napa County, California

Introduction

This Memorandum presents the key findings and conclusions, along with preliminary recommendations, regarding the associated Water Availability Analysis (WAA) prepared by RCS for the proposed new vineyard development at the Long Ranch "Parcel 12" property in Napa County (County), California. This document was prepared for the property owner (Wappo Land Company, LLC) to provide hydrogeologic analyses in conformance with Napa County Tier 1 requirements, as described in the Napa County WAA Guidelines (WAA, 2015).

The Long Ranch "Parcel 12" property (referred to herein as "subject property") is comprised by 41.8 acres and is located on Long Ranch Road in the Pritchard Hill area of Napa County. Figure 1, "Location Map," shows the boundaries of the subject property superimposed on the USGS topographic map for the Yountville quadrangle. Property boundaries shown on Figure 1 were adapted from parcel data provided by the project engineer, Applied Civil Engineering (ACE) of Napa, California. Also shown on Figure 1 is the location of the existing onsite water well (known herein as "Parcel 12 Existing Well") and the locations of other nearby but offsite wells. Other features shown on Figure 1 are discussed later in this Memorandum. Figure 2, "Aerial Photograph Map," shows the same property boundaries and well locations that are illustrated on Figure 1, but the basemap for Figure 2 is an aerial photograph of the area; this aerial photograph was obtained from the USGS EarthExplorer website (the date of the imagery is June 3, 2016).

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As reported by Applied Civil Engineering (ACE), the 41.8-acre subject property is primarily undeveloped, with the exception of a paved driveway through the property and the Parcel 12 Existing Well. Thus, there are no existing onsite water demands at this time. However, the Parcel 12 Existing Well has historically been used occasionally as an alternative groundwater source to fill a nearby water storage tank; that tank is used to irrigate offsite vineyards on adjacent properties also owned by Wappo Land Company, LLC .

RCS understands the proposed project is to develop approximately 13 acres of new vines on the subject property. For this project, the future groundwater demands for the new vines are proposed to be met using groundwater pumped from onsite Parcel 12 Existing Well and possibly from a proposed new well to be drilled in the future (discussed below).

The basic purpose of this Memorandum is to comply with Napa County's WAA guidelines for a "Tier 1" WAA (i.e., a Groundwater Recharge Estimate); those guidelines were promulgated by the County in May 2015. Because there are no known offsite wells located within 500 ft of the project well (the Parcel 12 Existing Well), County requirements for a "Tier 2" WAA analysis (i.e., a Well Interference Evaluation) have been "presumptively met" per the WAA Guidelines (WAA 2015).

RCS has been retained in the past by the subject property owner and other property owners in the Pritchard Hill area for various hydrogeologic services in the Pritchard Hill area. Thus, RCS is familiar with the basic geologic conditions on the subject property and the surrounding area.

Site Conditions

From review of existing data, and from a field reconnaissance visit by an RCS geologist to the subject property on November 6, 2018, the following key items were noted and/or observed (refer to Figures 1 and 2):

a. The Long Ranch "Parcel 12" property is comprised of a single parcel having a Napa County Assessor's Parcel Number (APN) of 030-220-044. The total reported area of the subject property is 41.8 acres.

b. Topographically, the subject property is located in the hills south of Lake Hennessey, and northeast of Oakville, California. Based on the topographic contours illustrated in Figure 1, ground surface on the subject property slopes moderately to steeply to the south and southwest towards Napa Valley. An ephemeral drainage is shown on the USGS topographic map within the boundaries of the subject property, as denoted by the dashed blue line on Figure 1. This marked drainage exists in the extreme southeast corner of the property and continues offsite towards the southwest. Because this drainage is ephemeral, it would contain surface water runoff only during or immediately following a rainfall event.

c. The subject property is primarily undeveloped, with the exception of the Parcel 12 Existing Well, a paved driveway (Long Ranch Road), and a graded dirt road which provides access to the Parcel 12 Existing Well. The subject property is primarily covered by bushes and small trees. No structures were observed on the subject property during our site visit.

d. Offsite areas surrounding the subject property consist primarily of vineyards, wineries, and residences. Naturally vegetated and/or wooded hillsides (i.e., undeveloped areas) were also observed farther offsite to the north and south.

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e. As shown on Figures 1 and 2, the Parcel 12 Existing Well is located in the eastern portion of the subject property. The property owner is also considering drilling a second well on the property in the future; the location of that proposed wellsite is shown on Figures 1 and 2. The estimated location for this proposed new well, which has not yet been finalized, is approximately 150 ft southwest of Parcel 12 Existing Well. Once the proposed new well has been constructed and becomes operational, it will serve as a redundant groundwater source for the new vineyard development on the subject property

f. During the November 6, 2018 site visit by RCS, the geologist also traveled along public roads that surround the subject property in attempt to identify possible locations and/or the existence of nearby but offsite wells owned by others, and to attempt to verify offsite well locations provided by others (such as those provided by ACE). RCS geologists identify possible well locations by observing typical well-house enclosures, pressure tanks, storage tanks, power lines, or direct observation of a wellhead. RCS refers to such work as "windshield surveys." In addition, RCS has provided hydrogeologic services on surrounding properties owned by others, during which similar "windshield surveys" for offsite wells have been performed. The approximate locations for these offsite wells identified by RCS or others are shown on Figures 1 and 2. It is noteworthy that none of these wells are shown to be located with 500 ft of the Parcel 12 Existing Well or the approximate location of the proposed new well to be drilled on the subject property in the future (see Figures 1 and 2).

Key Construction and Testing Data for Existing Onsite Wells

A DWR Well Completion Report (also known as a driller's log) for the Parcel 12 Existing Well (Log No. e0138360) is appended to this Memorandum. Table 1, "Summary of Well Construction and Pumping Data," provides a tabulation of key well construction data, original groundwater airlifting data, and pumping data that are available for this subject Parcel 12 Existing Well.

Well Construction Data

Key data for the Parcel 12 Existing Well listed on the available driller's log and/or identified during our site visit includes:

a. The Parcel 12 Existing Well was constructed in September 2011 by Weeks Drilling & Pump (Weeks), of Sebastopol, California; the well was drilled using the direct air rotary drilling method.

b. The pilot hole depth (the borehole drilled before the well casing was placed downwell) for the subject well was reported to be 900 feet below ground surface (bgs).

c. The Parcel 12 Existing Well was cased with PVC well casing having a nominal diameter of 6 inches; the total casing depth was reported to be 848 ft bgs.

d. Casing perforations for the Parcel 12 Existing Well are factory-cut slots and have slot opening widths of 0.032 inches (32-slot). Alternating 20-foot intervals of perforated and blank casing were placed intermittently between the depths of 468 ft and 848 ft bgs.

e. The gravel pack material shown on the driller's logs for this well is listed as "1/8 x 1/4 gravel".

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f. The Parcel 12 Existing Well is reportedly constructed with a sanitary seal consisting of concrete and bentonite, set to a depth of 52 ft bgs.

Summary of Key Airlifting "Test" Data for the Parcel 12 Existing Well

The driller's log for the Parcel 12 Existing Well provided the depth to original post-construction static water level (SWL) for the well, along with the original airlift test rate (as shown on Table 1). These data include:

- The initial static water level depth following completion of well construction was reported to be 520 ft bgs on September 28, 2011.
- The reported maximum airlift rate for initial post-construction airlifting operations in the Parcel 12 Existing Well was estimated by the driller to be 8 gallons per minute (gpm). As a rule of thumb, RCS Geologists estimate that normal operational pumping rates for a new well equipped with a permanent pump are typically on the order of only about one-half or less of the airlifting rate reported on a driller's log. However, for wells constructed in the Pritchard Hill area, the operational pumping rate for a well can, at times, be equal to or greater than the reported airlifting rates.
- "Water level drawdown" values during airlifting were not listed on the driller's log for the Parcel 12 Existing Well, because water level drawdown cannot be measured during airlifting operations; thus, the original post-construction specific capacity[1] value for the well cannot be calculated from the data on the driller's log.

Pumping Test Data by Others for the Parcel 12 Existing Well

On December 4, 2012, a ±50-hour variable rate pumping test of the Parcel 12 Existing Well was performed by McLean & Williams Well Drilling & Pumping Service (M&W) of Napa, California. Water levels during the test were measured and recorded by a water level pressure transducer (data logger) that had been installed in the well by M&W prior to testing. Figure 3, "Water Levels During December 2012 Pumping Test by Others," illustrates the water level changes in Parcel 12 Existing Well during the ±50-hour pumping test period recorded by that transducer. Key data available for the pumping test by M&W include:

- A SWL of 524.5 ft below the wellhead reference point (brp) was recorded by the transducer before the pumping test began.
- Based on the pumping rates reported by the pumper, the well was initially pumped at a rate of 35 gpm but was adjusted to 12 gpm after a period of 20 minutes to help reduce turbid water conditions. After the pumped discharge began to clear up, the pumping rate was reportedly increased to 20 gpm after 40 minutes of pumping, and then increased again to a rate of approximately 34 gpm after approximately 2 hours of pumping. Pumping continued at that rate for more than 40 hours, when there was a minor adjustment of the flow by the pumper approximately 42 hours into the pumping test. Note, the pumper listed the "well yield" to be 33 gpm after 46 hours and 45 minutes of total pumping time.
- A maximum pumping water level (PWL) of 643.6 ft brp was recorded by the transducer at the end of the ±50-hour pumping period; this represents a water level drawdown of

[1] Specific capacity, in gallons per minute per foot of water level drawdown (gpm/ft ddn), represents the ratio of the pumping rate in a well (in gpm) divided by the amount of water level drawdown (in ft ddn) created in the well while pumping at that rate.

119.1 ft at the end of the test (the permanent pump is reportedly set at a depth of 798 ft). As shown on Figure 3, water levels appeared to be stabilizing near the end of this M&W pumping test but were still slowly declining. In the last 23 hours of the pumping test, PWLs in this well only decreased by 3.1 ft, or at about 0.13 ft/hr. In the last 4 hours, PWLs were declining at a rate of only 0.08 ft/hr.

- Following the end of the pumping test, water levels recovered to the pre-test SWL of 524.5 ft brp (or 100% recovery) after a period of approximately 18 hours of non-pumping.
- Based on the reported pumping rate of 33 gpm, the specific capacity of Parcel 12 Existing Well is calculated to have been 0.28 gpm/ft ddn at the time of this M&W test in 2012.
- As seen on Figure 3, all static and pumping water levels observed during testing were below the 468-foot depth to the top of its uppermost perforations. Hence, cascading water conditions have occurred and will continue to occur in this well in the future.

Well Data from Site Visit

As discussed above, a site visit to the subject property was performed by an RCS geologist on November 6, 2018. At that time, the Parcel 12 Existing Well was observed to be equipped with a permanent pump but was not pumping at the time of our visit. A SWL of 534.2 ft below the wellhead reference point (brp) was measured by the RCS geologist at that time; the reference point for the measurement was approximately 1.9 ft above ground surface (ags). This well was equipped with a totalizer flowmeter device and was observed to have a reading of 205,902 gallons on November 6, 2018.

"Dry Holes" Drilled in the Area by Others

Shown on Figures 4 and 5 are the locations of two "dry holes" that were drilled by others in 2018. One "dry hole" was drilled near the northern boundary of the subject property and on the adjacent property to the north (not owned by Wappo Land Co., LLC). The depths of the boreholes were reportedly 560 ft bgs for the onsite borehole, and 730 ft bgs for the offsite borehole. These drilled boreholes were reported as "dry holes" by the driller and were not provided with well casing.

Long-Term Water Level Data

Figure 4, "Long-Term Water Level Data," graphically illustrates the manual measurements collected by others and by RCS geologists in the Parcel 12 Existing Well between September 2011 (post-construction) and November 2018. Also shown on Figure 4 is the accumulated rainfall departure curve, which has been generated from data gathered from the California Data Exchange Center (CDEC) "Atlas Peak" rain gage, which is located roughly 6½ miles southeast of the subject property. Note that, whenever the accumulated rainfall departure curve ascends to the right, a wet period has occurred. That is, the annual rainfall during every year in this period has generally been at or above the long-term average annual rainfall for this gage. Conversely, when the curve descends to the right, a dry period or drought has occurred, which implies that annual rainfall totals in each year of the period tended to be at or below the long-term average annual rainfall for the gage.

As shown on Figure 4, the November 6, 2018 SWL depth of approximately 534 ft brp reported by RCS is roughly 10 ft deeper than the 524-foot SWL depth reported by M&W prior to the December 2012 constant rate pumping test in Parcel 12 Existing Well, and roughly 14 ft deeper than the 520-foot post-construction SWL depth reported on the driller's log in September 2011. Overall, SWLs appear to have declined since September 2011, the observed decline could be attributed to lower rates of groundwater recharge from rainfall during the relatively dry rainfall period that occurred since 2011 to the present. However, the frequency of water level measurements in the data record for the subject well are not sufficient to definitively confirm this correlation.

A portion of the water level differences observed in these wells between their respective original, post-construction static water levels and more recent static water levels measured could also partially be the result of differences in the various manual water level measurement devices (i.e., tape sounders, airlines, etc.) used by the drilling contractor, pumpers, and RCS geologists. Differences in the time of year and antecedent rainfall are also possible causes for these water level differences over time.

Local Geologic Conditions

Figure 5, "Geology Map," illustrates the types, lateral extents, and boundaries between the various earth materials mapped at ground surface in the region by others. Specifically, Figure 5 has been adapted from the results of regional geologic field mapping of the Yountville quadrangle, as published by the California Geological Survey (CGS) in 2005. As shown on Figure 5, the key earth materials mapped at ground surface in the area from geologically oldest to youngest, include the following:

a. Alluvial-type deposits. These deposits consist of undifferentiated and/or undivided alluvium and/or alluvial fan deposits (map symbol Qf on Figure 5). These deposits are generally unconsolidated, and consist of layers and lenses of sand, gravel, silt, and clay. These geologic materials are shown to be exposed further to the southwest along the main floor of Napa Valley. These geologic materials do not occur on or near the subject property.

b. Landslide deposits. Landslide deposits[2] (map symbol Qls) have been mapped in the region by others (see the bright yellow-colored areas on Figure 5). Arrows within these mapped landslide areas show the general direction of downslope movement within each landslide mass. The landslide areas do not occur on the subject property, as shown on Figure 5, but large landslide masses have been mapped offsite, primarily to the north of the property.

c. Sonoma Volcanics. The Sonoma Volcanics are comprised by a highly variable sequence of chemically and lithologically diverse volcanic rocks. These rock types include the following: andesitic lava flows (map symbol Tsvasl); andesitic flow breccias (map symbol Tsvabsl); and ash flow tuff (map symbol Tsvt). As shown on Figure 5, andesitic lava flows (map symbol Tsvasl) are exposed at ground surface across the entirety of the subject property.

[2] Note that it was not a part of our Scope of Hydrogeologic Services for this project to study, investigate, analyze, determine, or opine on the potential activity of landslides, and/or on the potential impact that landslides might have on any of the onsite structures, or to any onsite and/or offsite wells used for the subject property.

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d. Franciscan Complex. The geologically older (Cretaceous-aged) Franciscan Complex rocks are exposed offsite at ground surface to the north of the subject property (not shown on Figure 5). These rocks consist mainly of well-consolidated to cemented, thickly bedded greywacke with minor amounts of thinly bedded shale. These geologically older rocks are considered to be the bedrock of the area. Serpentinite (may symbol sp), which is shown in a light purple color on Figure 5, is exposed at ground surface on the hillsides to the northwest of the subject property.

   RCS interpretation of the driller's descriptions of the drill cuttings listed on the available logs for Parcel 12 Existing Well, reveals that while drilling the Parcel 12 Existing Well, typical rocks of the Sonoma Volcanics were encountered. Typical driller-terminology for the drill cuttings on those logs included: "brown and gray rock;" "green and gray rock;" "red volcanics;" "red and brown volcanics;" "cemented volcanic sands;" and green, black, and brown rock some fractured." Therefore, based on the available subsurface geologic data, the Sonoma Volcanics are interpreted by RCS to extend to depths of at least 643 ft bgs to perhaps 836 ft bgs (in the vicinity of Parcel 12 Existing Well). At a depth of 836 ft bgs, the driller terminology is listed as "clayee [sic] serpentine rock"; this is interpreted to be part of the Franciscan Complex bedrock.

Local Hydrogeologic Conditions

The earth materials described above can generally be separated into two basic categories, based on their relative ability to store and transmit groundwater to wells. These two basic categories include:

Potentially Water-Bearing Materials

The principal water-bearing materials beneath the subject property and its environs are represented by the hard, fractured volcanic flow rocks and flow breccias of the Sonoma Volcanics. The occurrence and movement of groundwater in these rocks tend to be controlled primarily by the secondary porosity within the rock mass, that is, by the fractures and joints that have been created in these harder volcanic flow-type rocks over time by various volcanic and tectonic processes. Specifically, these fractures and joints have been created as a result of the cooling of these originally molten flow rocks and flow breccias deposits following their deposition, and also from mountain building or tectonic processes (faulting and folding) that have occurred over time in the region after the rocks were erupted and hardened. Some groundwater can also occur in zones of deep weathering between the periods of volcanic events that yielded the various flow rocks, and also with the pore spaces created by the grain-to-grain interaction in the volcanic tuff and ash, if those rock types exist beneath the harder, flow-type rocks.

The amount of groundwater available at a particular drill site for a well constructed into the Sonoma Volcanics beneath the subject property would depend on such factors as:

- the number, frequency, size and degree of openness of the fractures/joints in the subsurface
- the degree of interconnection of the various fracture/joint systems in the subsurface and to ground surface
- the extent to which the open fractures may have been possibly in-filled over time by chemicals precipitates/deposits and/or weathering products (clay, etc.)

- the amount of recharge from local rainfall that becomes available for deep percolation to the fracture systems
- to a lesser extent, the size of the pore-spaces formed by the grain-to-grain interactions of volcanic ash particles, if those rock types existed beneath the subject property.

As stated above, the principal rock type expected in the subsurface beneath the property is hard, volcanic flow rock that may be fractured to varying degrees. Descriptions of drill cuttings by the well driller that are recorded on the available driller's log for the Parcel 12 Existing Well are consistent with the typical descriptions of the various rocks known in the Sonoma Volcanics. From our long-term experience with the fractured flow rocks within the Sonoma Volcanics, based on numerous other water well construction projects in Napa County, pumping capacities in individual wells have ranged widely, from rates as low as 5 to 10 gpm, to rates as high as 200 gpm, or more.

Potentially Nonwater-Bearing Rocks

This category includes the geologically older and fine-grained sedimentary rocks of the Franciscan Complex, including serpentinite. These potentially nonwater-bearing rocks are interpreted to underlie the volcanic rocks that exist beneath the subject property at depths greater than 836 ft bgs. Note that, depending on the interpretation, the Franciscan Complex could be as shallow as 643 ft beneath the subject property, depending on the location, as interpreted by RCS from the driller's descriptions listed on the available driller's log for the Parcel 12 Existing Well.

In essence, these diverse rocks are well-cemented and well-lithified, and have an overall low permeability. Occasionally, localized conditions can allow for small quantities of groundwater to exist in these rocks wherever they may be sufficiently fractured and/or are relatively more coarse-grained. However, even in areas with potentially favorable conditions, well yields are often only a few gpm in these rocks, and the water quality can be marginal to poor in terms of total dissolved solids concentrations, and other dissolved constituents.

Geologic Structure

Several faults[3], as mapped by others, have been interpreted to exist northeast and southwest of the subject property as shown by the dark-colored, short dashed lines on Figure 5 (CGS 2005). Also shown on Figure 5 are several fault traces of the "Soda Creek Fault." These fault traces, shown as green-colored lines, were mapped by the USGS in conjunction with the CGS in 2000 and are available as GIS files via the USGS "Quaternary Fault and Fold Database" website. The USGS-mapped faults and the faults mapped by CGS (2005) are presumably the same faults, and their slight variation in placement on Figure 5 is likely due to GIS mapping projection inaccuracies. Specifically, one of these northwest-southeast trending fault traces is shown to be mapped near the eastern boundary of the subject property.

The possible impacts of these faults on groundwater availability in the region are unknown due to an absence of requisite data. Faults can serve to increase the number and frequency of fracturing in the Sonoma Volcanics rocks. If such fractures were to occur, they would tend to increase the amount of open area in the rock fractures which, in turn, could increase the ability of the local earth materials to store groundwater. Faults can also act as barriers to groundwater flow. Water level data collected by RCS geologists at other properties in the region (not provided herein due to confidentiality concerns), suggest that the faults may be partial barriers to groundwater flow.

[3] Note that it is neither the purpose nor within our Scope of Hydrogeologic Services for this project to assess the potential seismicity or activity of any faults that may occur in the region

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Project Groundwater Demands

For the purposes of this WAA, the Parcel 12 Existing Well is considered to be the "project well," as it is currently the only well that will be used to meet water demands of the proposed new vineyard project[4]. The Parcel 12 property is currently undeveloped and there are no existing onsite water demands. However, since its construction in 2011, the Parcel 12 Existing Well has historically been used occasionally as a backup, alternative groundwater source to fill a nearby water storage tank when the main wells that fill the tank needed service or repair; that tank is used to irrigate offsite vineyards on adjacent properties also owned by Wappo Land Company, LLC. The property owner has expressed a desire to continue using the Parcel 12 Existing Well periodically in the future as a backup, alternative groundwater source, provided the total groundwater extraction volume from the Parcel 12 property does not exceed the estimates for annual groundwater recharge provided herein.

Annual vineyard irrigation demands for the proposed 13.0 acres of new vines for the subject property were estimated by the vineyard manager to be the following:

> 13.0 acres of proposed vines * 1.0 acre-foot of water demand per acre of vines per year (AF/ac/yr) = 13.0 AF/yr

Note that as industry standard, typical water use estimates for vineyard irrigation is on the order of 0.50 AF/acre of vine/year (AF/ac/yr). This typical unit use is also reported in the Napa County WAA Guidelines (WAA 2015). Hence, the proposed vineyard irrigation demand for the proposed Parcel 12 vineyard development project is higher than typical estimates of water use for industry standards presented in the WAA Guidelines. As estimated by the vineyard manager, due to the rocky soils and hilly terrain and other factors at the Parcel 12 property, the proposed new vines will require more water than is required on less-steep vineyards. However, the vineyard manager reported that irrigation demand for the proposed vineyards could decrease over time as the vines become established.

Proposed Pumping Rates

To determine an appropriate pumping rate necessary from the Parcel 12 Existing Well (or a combined pumping rate from the Parcel 12 existing well and a new well), it will be assumed that the proposed vineyard irrigation demands (13.0 AF/yr) at the subject property will be required during a 20-week irrigation season each year, with the well(s) pumping at roughly 16 hours each day; this is the typical irrigation schedule reported to RCS by the vineyard manager. Based on these irrigation schedule assumptions, and in order to meet the proposed vineyard irrigation demands of the vineyard project (13 AF/yr), the onsite well(s) would need to pump at a total combined rate of about 31 gpm. This pumping rate assumes that the onsite well(s) would be pumped 16 hours/day, 7 days/week, during the entire 20-week irrigation season each year (as projected by the vineyard manager). This equates to a 67% operational basis during the irrigation season. Pumping rates and pumping water level data reported by M&W for the constant rate testing in December 2012 of Parcel 12 Existing Well shows that this well was successfully pumped for ±50 continuous hours at a reported rate of 33 gpm. Thus, the data suggest the Parcel 12 Existing Well can pump at rates sufficient to meet the instantaneous groundwater flow demands

[4] The Owner may also drill a new onsite well in the future. This new well would serve as a redundant water source and reduce the pumping demands on a single well to meet the irrigation water demands of the Parcel 12 vineyard development project. However, drilling of a new well in the future will not change the total groundwater use of the project.

required for the vineyard development project during the estimated 20-week irrigation season each year.

Rainfall

Long-term rainfall data are essential for estimating the average annual recharge that may occur at subject property. Average annual rainfall totals that occur specifically at the subject property are not directly known, because no onsite rain gage exists. However, relatively long-term rainfall data exist for the "Atlas Peak" rain gage, which is located roughly 6½ miles southeast of the subject property. Data for this rain gage are available from the CDEC website; this website is maintained by DWP. Data from the CDEC website for this gage are available beginning in water year (WY) 1987-88 (October 1987 - September 1988) through WY 2017-18. Note there appear to be some erroneous and/or missing data in WY 1988-89, WY 1994-95, WY 1995-96, WY 2004-05, and WY 2006-07. RCS removed these erroneous and/or missing data from the data set before calculating an average annual rainfall for this gage. Note that RCS only removed rainfall totals; no rainfall data were "added" to the date set. With these assumed erroneous data points removed from the data set, an average annual rainfall for WY 2006-07 through WY 2017-18 at this gage was calculated to be 40.3 inches (3.36 ft). This rain gage is located at a higher elevation (±1,690 ft above sea level, asl) than that of the subject property (between ±780 ft and ±1,260 ft asl), and thus, the average annual water year rainfall at the subject property could be lower than that experienced at this known gage location.

Another rain gage with a relatively short rainfall record was found to be located near the southern tip of Lake Hennessey, approximately 1-mile northwest of the subject property. Data for this "Lake Hennessey" rain gage are available from the Napa One Rain website between WY 2000-01 through WY 2017-18; this website is maintained by Napa County. There appears to be erroneous and/or missing rain data for WY 2007-08 (only 0.64 inches of rain was reported in this water year). Again, RCS removed this likely erroneous water year from the data set, and the resulting average rainfall for WY 2000-01 through WY 2017-18 was calculated to be 23.7 inches (1.98 ft). Because the period of record for this gage is short (17 years) and includes several years of drought (as defined by DWR), RCS does not consider these data to be representative of the long-term annual average rainfall in the area surrounding the subject property. The rain gage is also located at a lower elevation (±300 ft asl) than that of the subject property, and therefore the average water year rainfall at the subject property could be higher than that experienced at this gage.

The nearest rain gage to the subject property known to RCS with a significantly longer data record is located approximately 6½ miles northwest in St. Helena, California. The data for this "St. Helena" rain gage are available from the Western Regional Climate Center website. For this rain gage, the period of available record is November 1907 through July 2018; data for this gage are listed by calendar year, not water year. Note that there are several months and/or years of rainfall data missing in 1907, between 1915 and 1922, between 1979 and 1980, between 1985 and 1988, in 1992, and between 2011 and 2012. For the available period of record, the average annual rainfall at this St. Helena gage is 34.2 inches (2.85 ft), as reported by the WRCC. This rainfall gage is located at a lower elevation (±240 ft asl) than that of the subject property, and therefore the average annual rainfall at the subject property could be higher than that experienced at this known gage location.

To help corroborate the average annual rainfall data derived from the CDEC, Napa One Rain and/or WRCC gages, RCS reviewed the precipitation data published by the PRISM Climate

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Group at Oregon State University. This data set, which is freely available from the PRISM website, contains "spatially gridded average annual precipitation at 800m (800-meter) 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 Napa County, including the region of the subject property. Using this data set, RCS determined that the average rainfall for the subject property for the stated date range may be approximately 34.6 inches (2.88 ft).

An additional, though older, rainfall data source, an isohyetal map (a map showing contours of equal average annual rainfall) was prepared by the County for all of Napa County, and is freely available for download from the online Napa County GIS database (a copy of this map is not provided herein). As described in the metadata for the file (also available via the County GIS database), the isohyets are based on a 60-year data period beginning in 1900 and ending in 1960. As stated in the metadata for the file, the contour interval for the map is reported to be "variable due to the degree of variation of annual precipitation with horizontal distance", and therefore the resolution of the data for individual parcels is difficult to discern. The subject property is situated within the boundaries of the 35-inch average annual rainfall contour on this County map. Based on our interpretation of the actual isohyetal contour map (not provided herein), the long-term average annual rainfall at the subject property may be on the order of 35 inches (2.92 ft), using these rainfall data.

Table 2, "Comparison of Rainfall Data Sources," provides a comparison of the data collected from the different rainfall sources discussed above. Based on those rainfall data sources and as summarized on Table 2, RCS will consider the long-term average annual rainfall at the subject property to be 34.6 inches (2.88 ft), as derived from the PRISM data set. The 34.6-inch per year estimate is based on the data source with a relatively long period of record (29 years) and is more site-specific, when compared to the other rainfall data sources listed in Table 2 that exist at different elevations, and/or are located at a significant distance from the subject property, and/or have a shorter period of available data.

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 directly on the subject property and becomes available to deep percolate into the local aquifer system(s) over the long-term. The actual percentage of rain that deep percolates can be variable based on numerous conditions, such as: the slope of the land surface; the soil type that exists at the property; the evapotranspiration that occurs on the property; the intensity and duration of the rainfall; etc. Therefore, RCS has considered various analyses of deep percolation into the rocks of the Sonoma Volcanics, as relied upon by other consultants and government agencies for projects in the Napa Valley.

Recharge volumes estimated in this Memorandum are based on the long-term average annual rainfall values determined for the subject property using the available data presented above. Note that a calculation of average annual rainfall (by calendar year or water year) for any long-term period always includes periods of below-average rainfall and above-average rainfall that occurred during the period over which the average was calculated. Therefore, the following recharge calculations also include consideration of drought year conditions.

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<u>*Updated Napa County Hydrogeologic Conceptual Model (LSCE&MBK 2013)*</u>

Estimates of groundwater recharge as a percentage of rainfall were presented for a number of watersheds (but not all 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 on Figures 8-3 and 8-4 in that report. Herein, Figure 6, "Watershed Boundaries," was prepared for this project using those same watershed boundaries provided by MBK Engineers (MBK), for which watershed water balance data are available in the LSCE&MBK 2013 report. As shown on Figure 6, the vast majority of the subject property is located within the watershed referred to by MBK as 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 average annual rainfall that occurs within this watershed was estimated to be able to deep percolate as groundwater recharge. Note that, as shown on Table 8-8 of LSCE&MBK (2013), several sub-watershed areas are tributary to the "Napa River Watershed near Napa."

As stated above, the total surface area of the subject property is 41.8 acres. Assuming a conservative amount of 34.6 inches (2.88 ft) of rainfall occurs on the subject property on a long-term average annual basis, then the total volume of rainfall that would fall each year directly on the property over the long term would be approximately 120.4 AF/yr (41.8 acres x 2.88 ft). Assuming 17% of that average annual rainfall volume would be able to deep percolate to the groundwater beneath the subject property over the long term, then the average annual groundwater recharge at the subject property would be approximately 20.5 AF/yr. This estimated annual recharge volume is greater than the total estimated future (proposed) average annual groundwater demand of 13.0 AF/yr.

Figure 5 (and also on Figures 1 and 2) shows the locations of the "dry holes" that were drilled by others near the northern boundary of the subject property and on the adjacent property to the north. Although the circumstances for the holes being reported as "dry" are not clear, it is conservative to assume that rainfall recharge may be somewhat limited in the areas in which the "dry holes" were drilled. Hence, to present a conservative analysis, RCS delineated a theoretical "reduced" recharge area of the subject property in which recharge could theoretically be reduced due to unfavorable geologic conditions (illustrated on Figure 5 with a thick, dashed brown line). Because this boundary line is theoretical and the nature of the recharge potential of this RCS-delineated reduced area is uncertain, the boundary line shown on Figure 5 has been queried. The boundary of this "reduced" recharge area was generally determined from the location of existing wells and from topographic contours in the proximity of those dry holes. This "reduced" recharge area occupies only a small portion of the subject property. In total, only 2.7 acres of the 41.8-acre subject property are included in the reduced recharge area (due mainly to steep slopes). For the purposes of this analysis, RCS will conservatively assume that no deep percolation of rainfall occurs in these 2.7 acres.

Assuming the total revised area available for rainfall recharge at the property is now only 39.1 (41.8 acres minus 2.7 acres), and assuming 17% of the average annual rainfall could deep percolate to the groundwater beneath the subject property, then the average annual groundwater recharge at the subject property would conservatively be approximately 19.1 AF/yr.

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) reported in conjunction with the PRISM rainfall data set. Figure 7A, "Watershed Geology," shows the same watershed boundaries (LSCE&MBK 2013) shown on Figure 7, but it has been superimposed on a geologic base map of

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the region (USGS 2007); Figure 7B shows the geologic legend for that map. Importantly, a brown line is shown on the map that separates the alluvial deposits of the Napa Valley from the hillside areas of the County; this brown line has been adapted from DWR Bulletin 118-03 (DWR 2003). The tan to light yellow-colored areas west of the brown line along the floor of Napa Valley represent the Napa Valley subbasin of the Napa-Sonoma Valley Groundwater Basin, as defined in that DWR report (2003).

As discussed above, the referenced report (LSCE&MBK 2013) estimated that 17% of the average annual 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 is able to deep percolate into the alluvial deposits of the valley floor portion of the "Napa River Watershed near Napa" is higher than the percentage of rainfall that is able to deep percolate into the geologic materials that are exposed throughout the hillside areas of the watershed. The total area of the brown-colored groundwater basin boundary within the "Napa River Watershed near Napa" shown on Figure 7A is roughly 45.6 square miles (sq mi). The remainder of the "Napa River Watershed near Napa" that is not underlain by the brown-outlined 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 portion of the watershed (underlain by alluvium) is higher than it is in other portions of the watershed that are underlain by different geologic materials, then an adjusted estimate of the appropriate 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 the PRISM dataset and the GIS system defined above. Because the PRISM dataset is spatially 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 3, "Calculation of Theoretical Rainfall Recharge Percentage, Napa River Watershed near Napa," was created to determine the approximate percentage of rainfall that may be available for deep percolation.

As shown on Table 3, and assuming the average rainfall as calculated using the PRISM data set, three scenarios are presented in which the deep percolation percentage on the floor of Napa Valley is adjusted to values higher than 17%. The results of the three scenarios listed on Table 3 are as follows:

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

Therefore, based on the analyses presented in Table 3, a value of 14% could be an appropriate estimate for the percentage of rainfall that could become available to deep percolate to recharge the groundwater beneath the subject property. Assuming a deep percolation of rainfall volume of 14% and using the conservative area of the subject property available for recharge, then the average annual groundwater recharge at the revised area of subject property (39.1 acres) is

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estimated to be 15.8 AF/yr (39.1 acres x 2.88 ft of rainfall x 14% deep percolation). This recharge estimate is also greater than the average annual groundwater demand for the subject property (13.0 AF/yr).

Effect of Ground Slope Angle on Recharge Potential

Any estimate of the percentage of rainfall that becomes available for deep percolation that relies on estimates of rainfall, evapotranspiration, and surface water outflow for an entire watershed, such as those estimates provided by LSCE&MBK 2013, inherently includes the effects of slope angle in the estimate. However, to provide a more complete consideration of the potential effects of ground slope angle on groundwater recharge specifically at the subject property, a basic analysis of those effects is provided below.

Many geologic references state that recharge potential is reduced on steeper slopes, as steeper slopes can increase surface water runoff rates, and therefore less time is available for rainfall (and surface water runoff) to deep percolate. On page 56 of LSCE&MBK 2013, it is asserted that deep percolation recharge from rainfall is "significantly reduced" for land areas with slopes angles greater than 30 degrees. On page 11 of LSCE&MBK 2013, an assessment of slope angles (inclinations) greater than 30 degrees is also mentioned, and this was attributed to a prior LSCE 2011 report, namely "LSCE 2011" therein; that document is likely to be the reference listed as "2011a" on page 134 of LSCE&MBK 2013. In that referenced document (LSCE 2011), the statement is made on page 29 that "Areas in which the slope of the land surface exceeds 30 degrees, beyond which recharge potential is significantly reduced…" No other reference or data are presented in any of the above-referenced documents to quantify the qualitative description of "significantly reduced." Because the various factors that affect groundwater recharge are likely interrelated (Yeh 2009), assigning a value to define the amount of recharge that is diminished by the presence of steep slopes is extremely difficult. No references were encountered by RCS that quantify the possible reduction of deep percolation that might occur strictly as a function of slope angle/percentage.

Estimates of the deep percolation of rainfall for the entire "Napa River near Napa" watershed were based on water balance calculations by others that included rainfall throughout the entire watershed. As discussed above, those watershed-scale calculations inherently include all slopes within the watershed, including slopes greater than 30 degrees. Therefore, to evaluate the site-specific recharge potential of the property and to also include assumptions about the varying recharge potential based on slope, then the deep percolation percentage used for slopes less than 30 degrees within the entire watershed would have to be increased to offset the decrease in the percentage for slopes greater than 30 degrees.

Table 4, "Estimated Recharge Based on Slope Deep-Percolation Assumption", shows a range of values for different assumptions for the amount of deep percolation that might occur on slopes greater than 30 degrees in the rocks beneath the RCS-delineated "reduced" recharge area of the subject property. To create Table 4, deep percolation values calculated by others were adjusted with respect to slope for the entire Napa River near Napa watershed. That is, the deep percolation percentage for the slopes within the watershed that are less than 30 degrees were increased to offset the diminished deep percolation percentage for the slopes greater than 30 degrees. A range of deep percolation percentage values were calculated assuming a range of "diminishment factors" of 25%, 50%, 75%, and 100%. Once the deep percolation percentages for slopes less

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than 30 degrees were calculated for the entire watershed based on the range of assumptions, those resultant percentages shown on Table 4 were applied to the subject property.

As shown in the previous section (“Estimate of Groundwater Recharge”), a conservative recharge estimate of 15.8 AF/yr was calculated for the subject property assuming a value of 14% for the deep percolation of rainfall would occur in the 39.1-acre RCS-delineated “reduced” recharge area of the subject property defined by RCS. Approximately 5.8 acres of the subject property (in the southern portion) consist of slopes greater than 30 degrees. Hence, if the assumption is made that the deep percolation that occurs on the 5.8 acres of the recharge area with slopes greater than 30 degrees is diminished by a factor of 100%, then the average annual recharge that is conservatively estimated to occur at the subject property would be 15.4 AF/yr; see Table 4 herein. This calculated recharge volume is still 2.5 AF/yr more than the estimated future groundwater demand of 13.0 AF/yr for the subject property.

<u>Estimate of Groundwater in Storage</u>

To help evaluate possible impacts to the local aquifer system(s) that might 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 current volume of groundwater in storage strictly beneath the subject property. To estimate the amount of groundwater currently in storage beneath the subject property, the following parameters are needed:

a) Approximate surface area of recharge area on the subject property = 39.1 acres. This is calculated by subtracting the RCS-delineated “reduced” recharge area of the property (2.7 acres) from the total surface area of the subject property (41.8 acres).

b) Deepest extent of the Sonoma Volcanics in the Parcel 12 Existing Well = 836 ft bgs. For this analysis, RCS will assume the bottom of the Sonoma Volcanics (as interpreted by RCS based on the driller’s descriptions of the drill cuttings in this well) will represent RCS’s estimation of the deepest extent of the potentially water bearing volcanic rocks beneath the property for the purposes of this analysis. Rocks of the Franciscan Formation (which are interpreted to occur at a depth of 836 ft in the Parcel 12 well) are considered non-water bearing for the purposes of this Memorandum.

c) To present a conservative calculation of groundwater in storage, RCS will also assume that the current saturated thickness of the aquifer(s) beneath the recharge area is about 300 vertical feet. This value is calculated using the Parcel 12 Existing Well, by subtracting the SWL of 534 ft brp in this well (measured by RCS in November 2018) from the interpreted depth of the base of the Sonoma Volcanics in the well (at a depth of 836 ft bgs).

d) Approximate average specific yield of the Sonoma Volcanics = 2%. The specific yield is essentially the ratio of the volume of water that drains from the saturated portion of the geologic materials (due to gravity) to the total volume of rocks. Specific yield of the Sonoma Volcanics can vary greatly depending on a number of factors, including the degree and interconnection of the pore spaces and/or fracture zones within the rocks. A conservative estimate by Kunkel and Upson 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, an even more conservative estimate for specific yield of 2% has been used. Hence, to present a conservative analysis, we will assume a specific yield of 2% for the Sonoma Volcanics rocks that underlie the subject property, but the actual value, in reality, could be higher.

e) Thus, a conservative estimate of the groundwater currently in storage (S), beneath the subject property (based on November 2018 water levels) is calculated as:

S = RCS-delineated recharge area ("a") times saturated thickness ("c") times average specific yield ("d") = (39.1 ac)(300 ft)(2%) = 235 AF

In contrast, the future (proposed) average annual groundwater use for the property is estimated to be 13.0 AF/yr. Hence, the estimated groundwater demand for the entire property represents only about 6% of the groundwater conservatively estimated to currently be in storage in the volcanic rocks beneath the subject property based on site specific water level data for November 2018. Furthermore, this percentage does not include annual groundwater recharge that will occur from rainfall into the onsite aquifer(s). Based on the foregoing, the estimated groundwater demands of the proposed project and the entire subject property should not cause a net deficit in the volume of groundwater within the aquifer system(s) beneath the site so as to adversely impact water levels in nearby wells to a point that they would not support existing or permitted land uses.

<u>Possible Effects of "Prolonged Drought"</u>

California has experienced a number of periods of extended drought throughout its history. Here, drought is defined as a meteorological drought, that is, a period in which the total annual precipitation is less than the long-term average annual precipitation (DWR 2015). For similar projects in the County, Napa County PBES has asked RCS to consider what the effects on groundwater availability at a particular property might be if a period of "prolonged drought" were to occur in the region, assuming the project were to operate in the future as described herein. Recharge volumes estimated in this document are based on the long-term average rainfall value determined for the subject property using available data. Recall that a calculation of average annual rainfall for any long-term period always includes periods of below-average rainfall and above-average rainfall that occurred during the period over which the average was calculated. Therefore, it is our opinion that the preceding calculations do inherently include consideration of drought year conditions.

However, to help understand what potential 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 were 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
- Recent drought – WY 2011-12 through WY 2015-16[5] – five years

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[5] The DWR 2015 drought document was published in February 2015, and lists the recent significant drought through the 2013-14 water year only; the drought continued throughout the State into WY 2015-16. Due to the rains in WY 2016-17, various sources,

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Table 5, "Drought Period Rainfall as Percentage of Average," shows the average amount of rainfall that occurred during each drought period for which rainfall data exist at the three rain gages discussed above and shown on Table 5; that drought period rainfall amount is also expressed on Table 5 as a percentage of the total rainfall that occurred. As shown on Table 5, determining the amount of rain that might fall during a "prolonged drought" is variable, and depends on the period of record for the specific rain gage. Clearly, the WY 1975-76 to WY 1976-77 drought period recorded by the St. Helena rain gage and reported by the WRCC had the lowest total rainfall at 39% (drought period average was 13.4 inches), compared to the long-term average (34.2 inches), and that specific drought lasted two years. The WY 1928-29 to WY 1933-34 drought period lasted for six years, but rainfall during this drought was 70% of the average annual rainfall at the WRCC rain gage. It is important to note that the drought year percentage listed on Table 5 is 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 this gage is short, and includes many drought years, then the last available drought year period (WY 2011-12 to WY 2015-16) rainfall percentage is shown to be 83% of the long-term average.

Hence, for the purposes of this analysis, a "prolonged" drought period rainfall is conservatively considered to be 39% of the average annual rainfall that occurred in the region (using the rainfall data from the WRCC St. Helena rain gage). Further, to again be conservative, a "prolonged drought period" is estimated to last 6 years, which is the longest drought period on record according to DWR (DWR 2015); see Table 5. This six-year period is a conservative estimate, because the 39%-average figure corresponds with a two-year drought period, not a six-year drought period.

To meet six consecutive years of groundwater demand for the proposed subject property, a total onsite groundwater extraction of 78.0 AF is estimated to be required (13.0 AF/yr of groundwater demand multiplied by 6 years = 78.0 AF). Assuming groundwater recharge is reduced to 39% of the average annual recharge during each year of such a theoretical "prolonged drought period", then the resulting total of groundwater recharge that might occur during the six-year drought period for the subject property is calculated as follows:

- As shown herein, a conservative estimate of the average annual groundwater recharge on the subject property is estimated to be 15.4 AF/yr. Taking 39% of this annual volume yields a drought period recharge volume of 6.0 AF/yr.
- Assuming a drought period duration of 6 continuous years, then a total of 36.0 AF (6.0 AF/yr times 6 years) of water would be available to recharge the volcanic rocks beneath the property by virtue of deep percolation of the direct rainfall that occurs solely within the boundaries of the subject property.

Therefore, assuming a theoretical six-year drought period during which only 39% of the average annual rainfall might occur, a conservative estimate of the total drought-period recharge at the subject property (36.0 AF) would be less than the estimate of the total onsite groundwater demand (78.0 AF) that may occur over the same six-year period.

As conservatively estimated above, 235 AF of groundwater are in storage beneath the property (as of November 2018). Hence, the theoretical six-year long drought period groundwater

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including the National Drought Mitigation Center website (NDMC 2018), declared an end to the drought in Northern California in 2017, which included Napa County. As of January 15, 2019, the area of Napa County in which the subject property lies, is currently mapped as "moderate drought."

"recharge deficit" of 42.0 AF would represent about 18% of that volume of groundwater in storage. Temporarily removing an average of 7.0 AF of groundwater from storage every year (42.0 AF of "deficit" over the entire 6-year period) may cause water levels to decrease somewhat beneath the subject property, but removal of such a relatively small percentage of groundwater from storage over an entire 6-year period of time is not expected to significantly impact groundwater levels beneath the property. Recharge that occurs during periods of average and above-average rainfall would continue to recharge the local aquifer system(s). Again, this drought analysis is quite conservative, and assumes very extreme drought (39% of average rainfall occurring every year for six consecutive years).

Groundwater Quality

Samples of groundwater were collected by M&W from Parcel 12 Existing Well at the end of the ±50-hour constant rate pumping test on December 6, 2012. Table 6, "Summary of Available Groundwater Quality Data," summarizes water quality data from laboratory analyses of those groundwater samples; the laboratory analyses were performed by Caltest Analytical Laboratory of Napa, California. Data presented on Table 6 reveal the following with regard to key water quality constituents for groundwater pumped by Parcel 12 Existing Well:

- The character of the groundwater from the local volcanic rock aquifer system(s) appears primarily to be a magnesium-bicarbonate ($Mg\text{-}HCO_3$) type of water.
- Specific conductance (also known as electrical conductivity, or EC) was reported to be 290 microSiemens per centimeter (µS/cm).
- Total dissolved solids (TDS) was detected at 210 mg/L.
- Total hardness (TH) was reported to be 120 milligrams per liter (mg/L). Water with a TH between 120 and 180 mg/L is considered to be "hard."
- The pH of groundwater was reported to be 7.2. This value indicates that the water is neutral (pH is 7) to slightly basic (above pH 7).
- The adjusted sodium adsorption ratio (SAR) was reported to be 0.42.
- Nitrate (as NO_3) was detected at 0.51 mg/L.
- Arsenic (As) was detected at a concentration of 1.5 micrograms per liter (µg/L).
- Boron (B) was reportedly not detected in the well; vineyard managers typically desire a boron concentration of less then 1,000 µg/L (i.e., less than 1 part per million, ppm) for groundwater to be used for irrigation-supply purposes.
- Copper (Cu) was detected at a concentration of 1.2 µg/L.
- Iron (Fe) was reportedly not detected in the tested sample.
- The manganese (Mn) concentration in Parcel 12 Existing Well was reported to be 21 µg/L.

Thus, water quality from Parcel 12 Existing Well appears to be suitable for irrigation-supply purposes.

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Key Conclusions and Recommendations

1. The existing Long Ranch Parcel 12 property is currently undeveloped, with the exception of a paved roadway (Long Ranch Road) and a graded dirt road to the existing onsite well (Parcel 12 Existing Well). No structures or houses were observed on the property. The total reported property acreage is 41.8 acres.
2. The proposed project consists of developing 13 acres of new vines on the subject property.
3. There is one existing water well (Parcel 12 Existing Well) on the subject property; it is located in the eastern portion of the property. A new well is also proposed to be drilled onsite; the proposed location for this new well is approximately 300 ft west of Parcel 12 Existing Well.
4. Because the subject property is currently undeveloped, there are no existing groundwater demands for the property. The Parcel 12 Existing Well has occasionally been used as an alternative groundwater source to irrigate offsite existing vineyards on the adjacent Long Ranch properties.
5. The future average annual groundwater demand for the proposed vineyard development project on the Long Ranch Parcel 12 property was estimated by the vineyard manager to be 13.0 AF/yr, using a unit water demand of 1.0 AF/ac/yr. A unit water use of 1.0 AF/ac/yr is higher than the typical industry standard for vineyard irrigation of 0.50 AF/yr, as reported in the Napa County WAA Guidelines (WAA 2015). However, the vineyard manager anticipates higher groundwater use on the property due to rocky soils and steeper terrain at the subject property (and other factors). However, it is anticipated that groundwater use will decrease over time as the vines mature and become more established.
6. Future vineyard irrigation demands for the subject property will be met by pumping groundwater from the Parcel 12 Existing Well and the proposed new well when it becomes operational in the future. The property owner has expressed a desire to continue using the Parcel 12 Existing Well periodically in the future as a backup, alternative groundwater source, provided the total groundwater extraction volume from the Parcel 12 property does not exceed the groundwater recharge estimated herein.
7. As reported by the vineyard manager, the anticipated irrigation season at the subject property is expected to entail approximately 20 weeks each year, and the onsite wells would be pumped each day for a continuous period of 16 hours during that season. With these assumptions, to meet the average annual vineyard irrigation demands at the subject property (13.0 AF/yr), Parcel 12 Existing Well and the proposed new well would need to pump at a total combined rate of about 31 gpm (for 16 hours/day, every day, during each 20-week irrigation season in the future).
8. Based on the results of the constant rate pumping test conducted in Parcel 12 Existing Well in December 2012 (Parcel 12 Existing Well was pumped at reported average rate of 33 gpm for a period of ±50 hours), Parcel 12 Existing Well appears to be capable of pumping at rates needed to the future groundwater demands needed from the project (31 gpm is the total combined rate needed).

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The Owner is proposing to drill a new well on the subject property in the future. This additional well will allow for increased operational flexibility, so that operational pumping scenarios can be adjusted throughout the irrigation season, and distribute the groundwater demands between the two wells. Importantly, construction of an additional well at the subject property will not increase the groundwater extraction volume estimated for the proposed project on an annual basis.

9. Groundwater recharge at the subject property on an average annual basis is estimated to be 15.4 AF/yr; this value is based on conservative estimates of the average annual rainfall at the property (34.6 inches per year) and conservative estimates of rainfall (14%) that could be available to deep percolate into the fractures and jointed rocks of the Sonoma Volcanics that underlie the subject property. These estimates also consider the RCS delineated “reduced” recharge area of the property in which recharge could theoretically be reduced (illustrated on Figure 5 with a thick, dashed brown line). Also included in our conservative estimates of recharge is the assumption that deep percolation of rainfall does not occur on slopes greater than 30 degrees (recharge on slopes greater than 30 degrees are diminished by a factor of 100% for this analysis).

   This estimated groundwater recharge of 15.4 AF/yr is 2.4 AF/yr more than the 13.0 AF/yr estimated to be required for the project on an average annual basis in the future from the subject property. The Owner may elect to use some of this groundwater recharge “surplus” to help alleviate offsite wells that irrigate his adjacent offsite vineyards, if necessary, assuming the onsite wells are capable of meeting those demands.

10. Conservative estimates of recharge that may occur during a “prolonged drought” (as defined herein) show that, over a theoretical six-year period of continuous drought in which only 39% of the average annual rainfall might occur, a total of 36 AF of rainfall recharge is estimated to occur strictly within the boundaries of the subject property. This theoretical drought period recharge estimate of 36 AF is less than the estimated groundwater demand of the proposed project of 78 AF for the same continuous six-year period. Hence, the theoretical six-year long drought period groundwater recharge “deficit” of about 42 AF would represent about 18% of the volume of groundwater currently in storage (estimated to be approximately 235 AF). Rainfall recharge during years of average and above-average rainfall would then replenish groundwater in storage that has been used to the meet the groundwater demand of the entire property during a theoretical drought of six continuous years.

11. RCS recommends the immediate implementation of a groundwater monitoring program at the subject property. This would include the monitoring of static and pumping water levels in the onsite well(s), and the monitoring of instantaneous flow rates and cumulative pumped volumes from the onsite well(s) via the installation and use of dual-reading flow meters (that records both flow rate and totalizing values, respectively) on both wells. Currently, Parcel 12 Existing Well was observed to be equipped with a flow meter, installed at the well head. RCS also recommends that new water level transducers be purchased and installed in your well(s) to permit the automatic, frequent, and accurate recording of water levels in those well(s). By continuing to observe the trends in groundwater levels and future well production

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rates/volumes over time by qualified professionals, potential declines in water levels and well production in the onsite well(s), along with possible changes in operational pumping scenarios, can be addressed in a timely manner.

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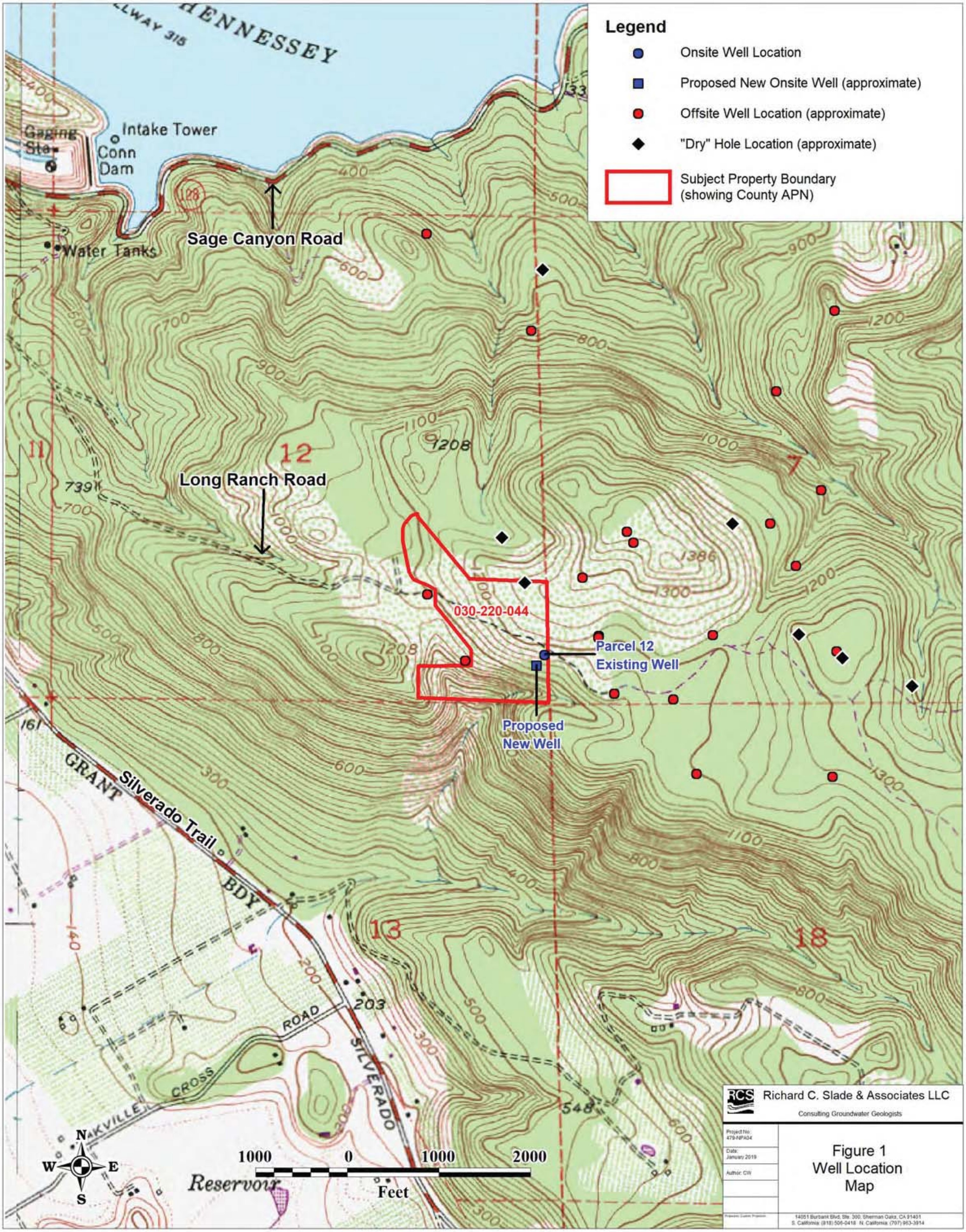
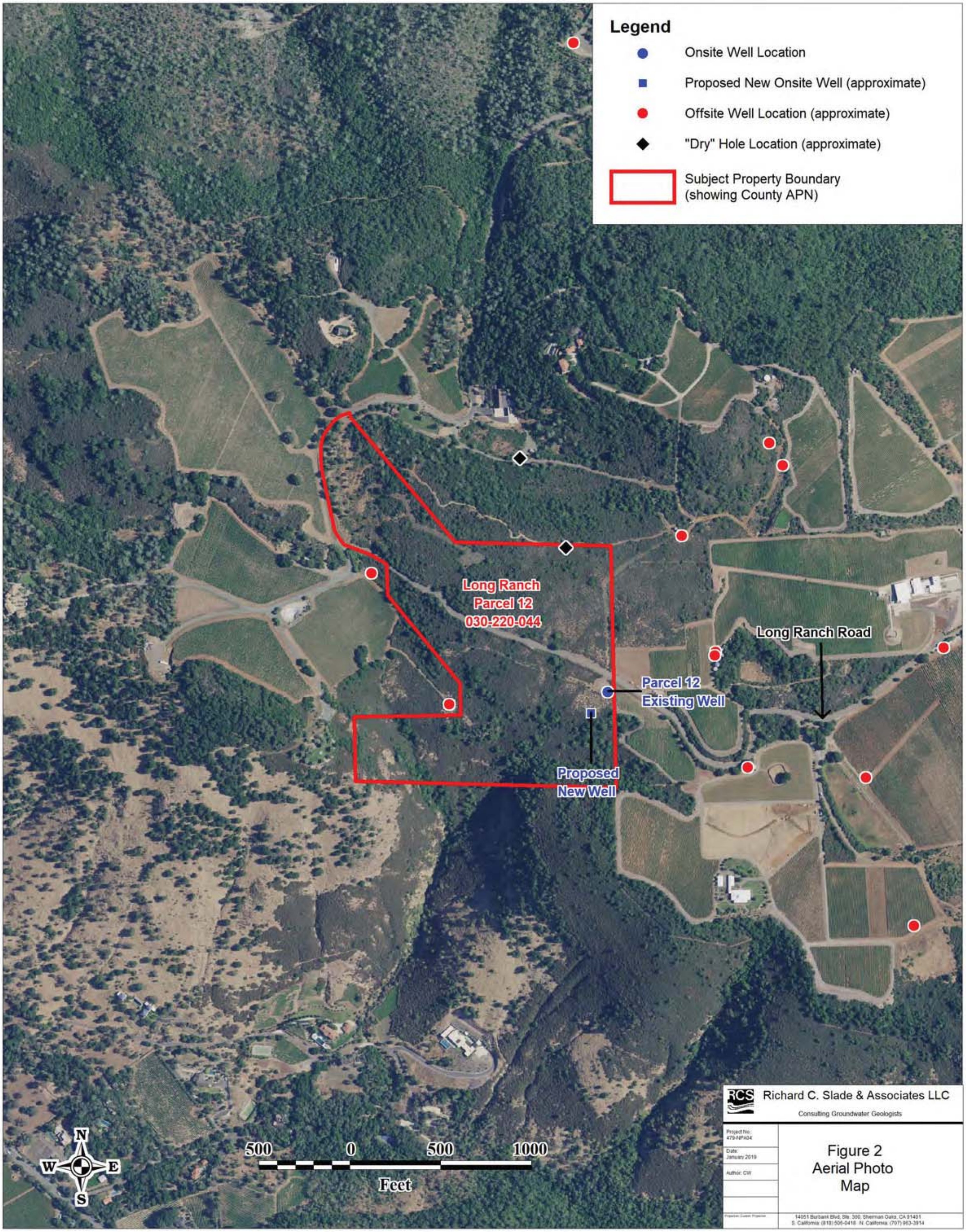


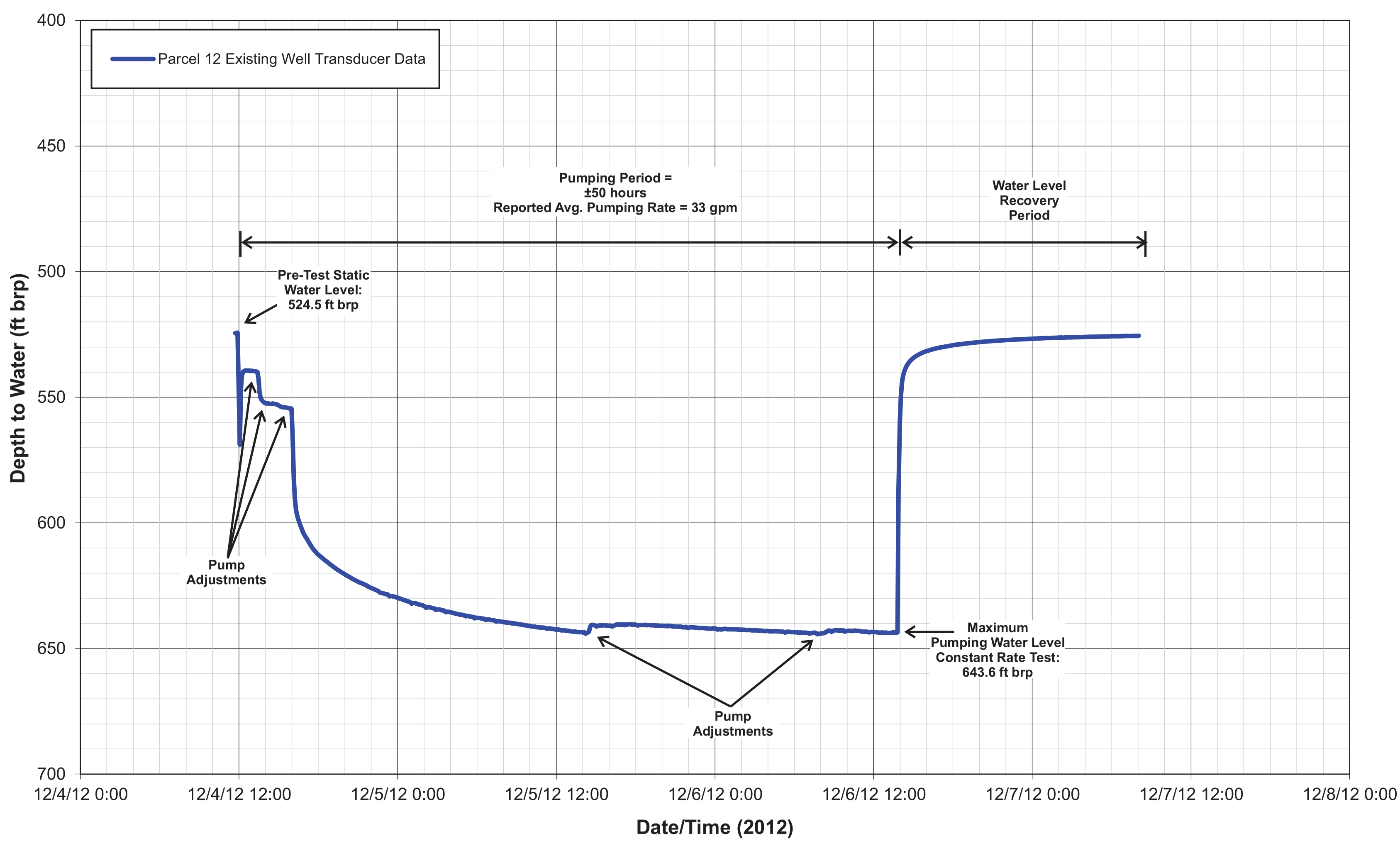
Legend
Onsite Well Location
Proposed New Onsite Well (approximate)
Offsite Well Location (approximate)
"Dry" Hole Location (approximate)
Subject Property Boundary
(showing County APN)
HENNESSEY
Intake Tower
Gaging Sta.
Conn Dam
Water Tanks
Sage Canyon Road
Long Ranch Road
030-220-044
Parcel 12
Existing Well
Proposed
New Well
Silverado Trail
GRANT
BDY
CROSS
ROAD
SILVERADO
Reservoir
12
7
11
13
18
1000 0 1000 2000
Feet
N
S
E
W
Richard C. Slade & Associates LLC
Consulting Groundwater Geologists
Project No: 479-NPA04
Date: January 2019
Author: CW
Figure 1
Well Location
Map
14051 Burbank Blvd. Ste. 300, Sherman Oaks, CA 91401
S. California: (818) 506-0418 N. California: (707) 963-3914



Richard C. Slade & Associates LLC
Consulting Groundwater Geologists

Project No: 479-NPA04	Figure 2 Aerial Photo Map
Date: January 2019	
Author: CW	

14051 Burbank Blvd, Ste. 300, Sherman Oaks, CA 91401
S. California: (818) 506-0418 N. California: (707) 963-3914



RCS

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Sherman Oaks, CA 91401
Southern California (818) 506-0418
Northern California (707) 963-3914
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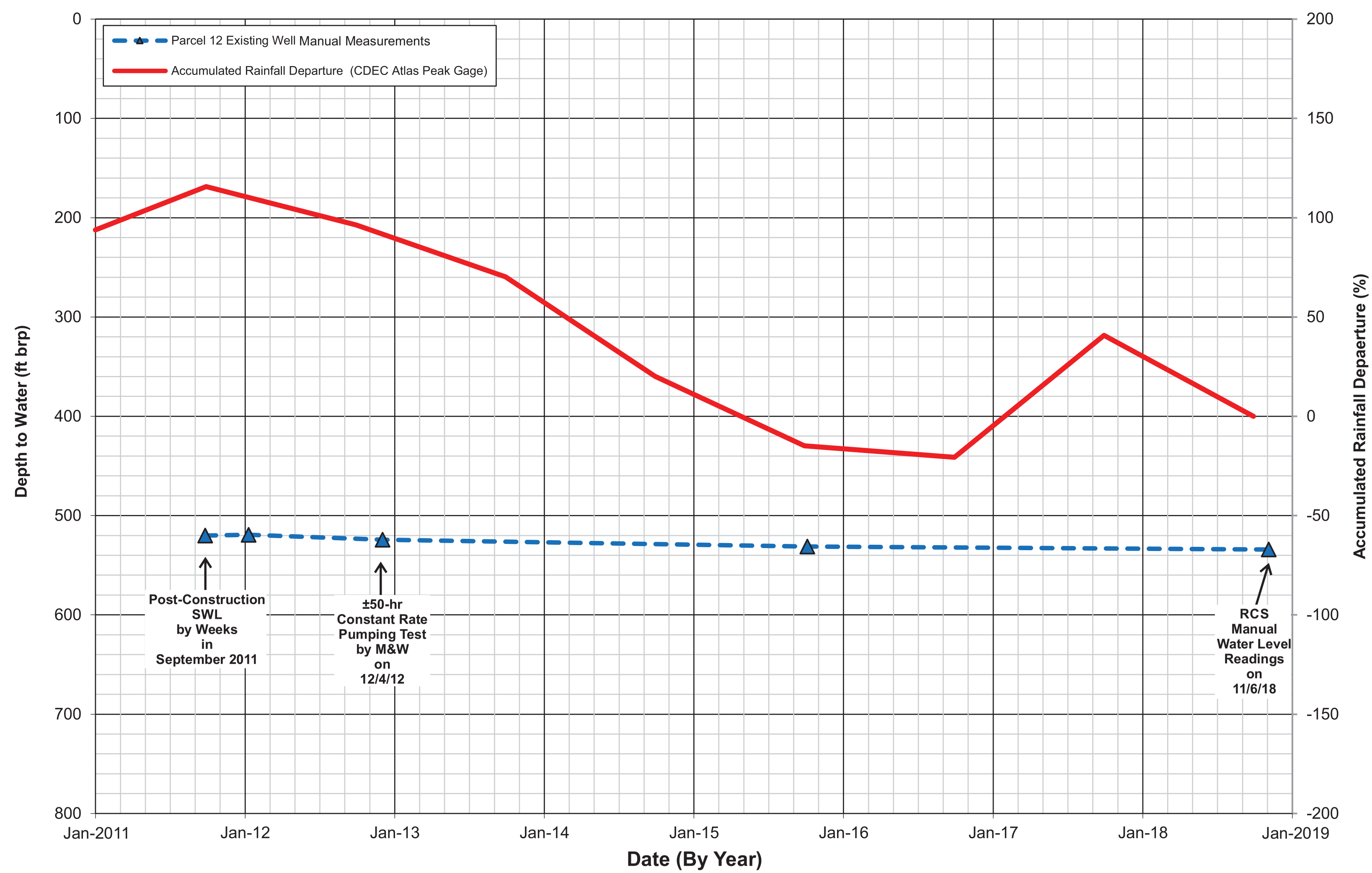
Figure 3
Water Levels During December 2012 Pumping Test by Others
Parcel 12 Existing Well - Long Ranch Parcel 12

Job No. 479-NPA04 **January 2019**



RCS
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Southern California (818) 506-0418
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Figure 4
Long-Term Water Level Data
Parcel 12 Existing Well - Long Ranch Parcel 12

Job No. 479-NPA04

January 2019

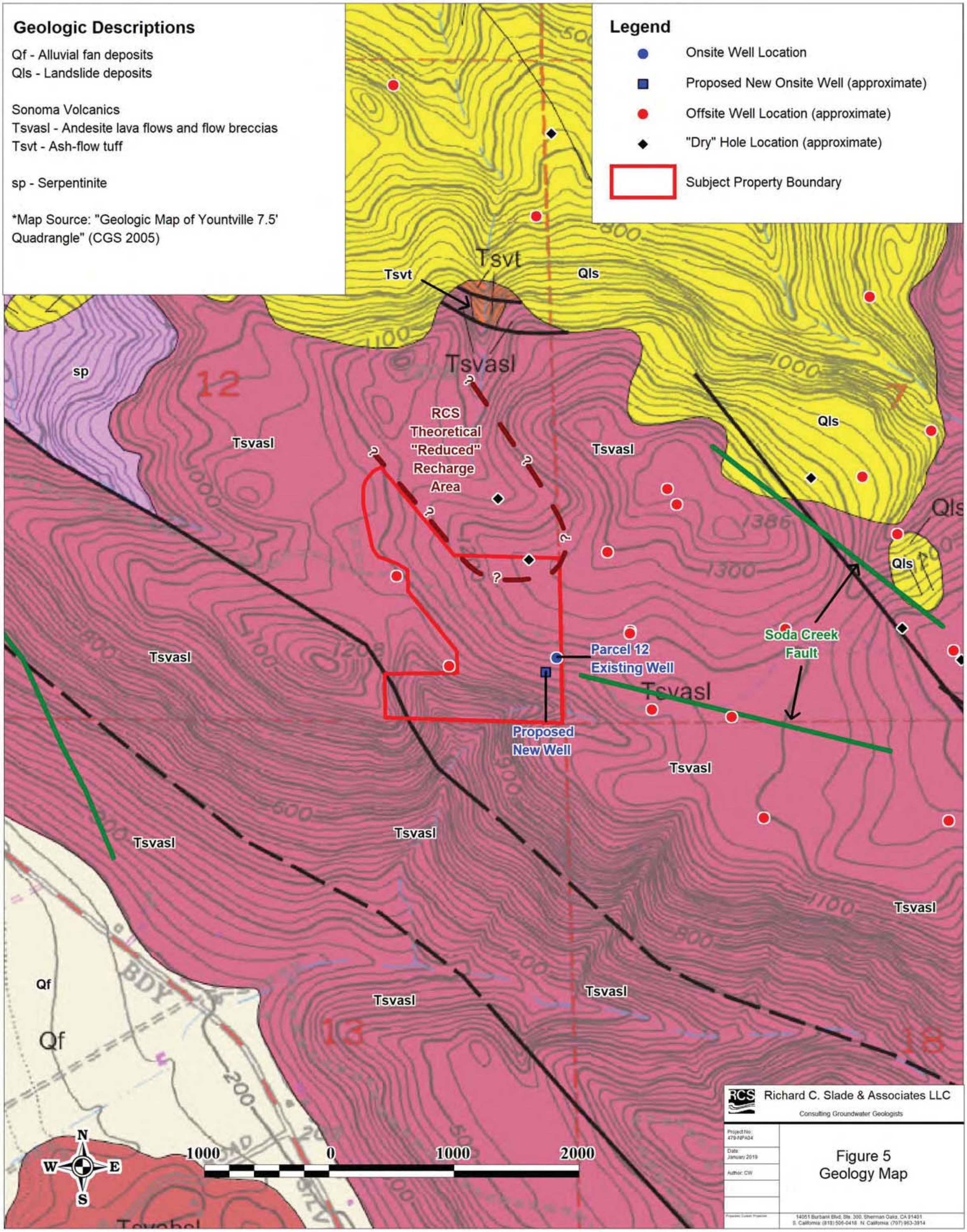


Figure 5
Geology Map

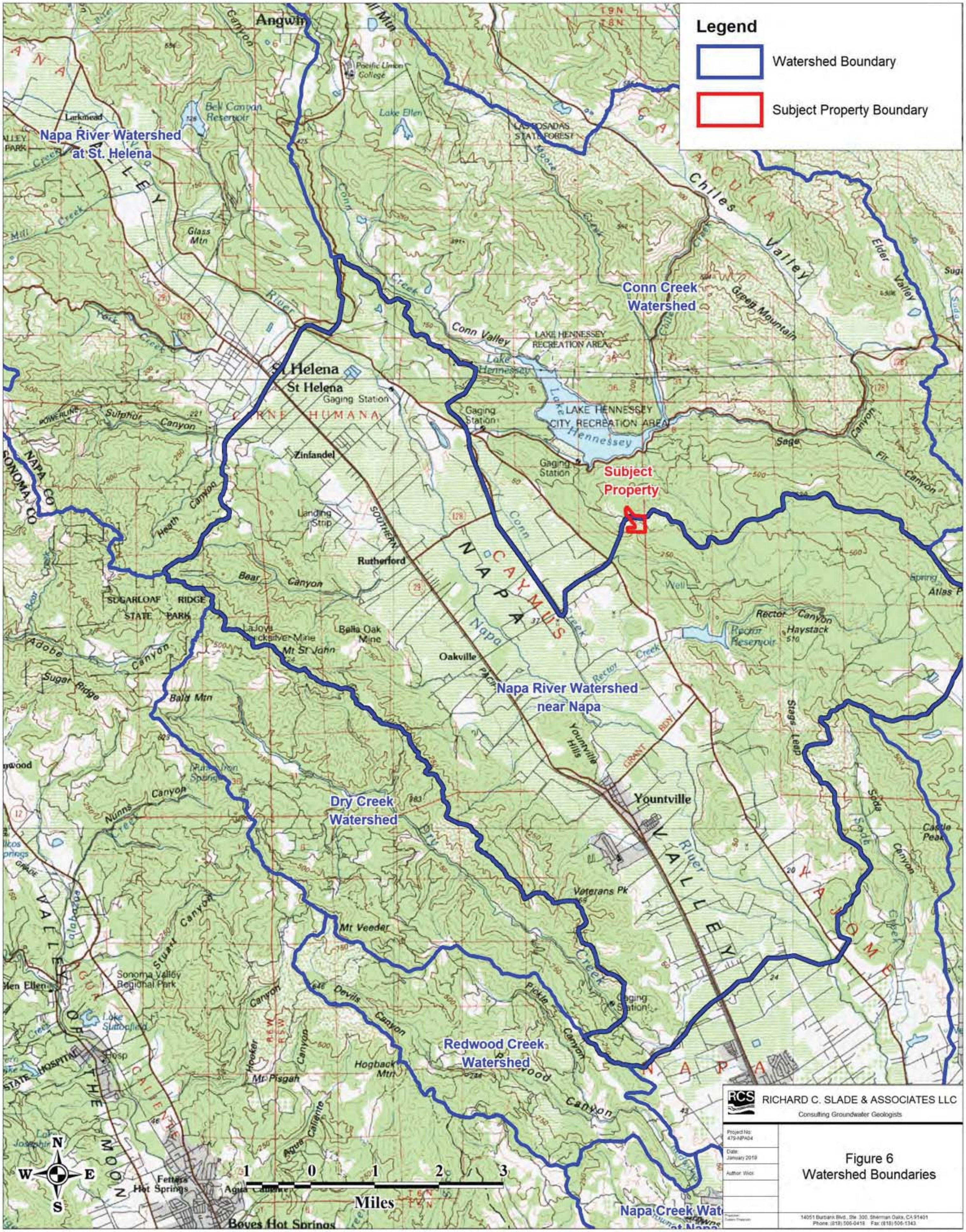
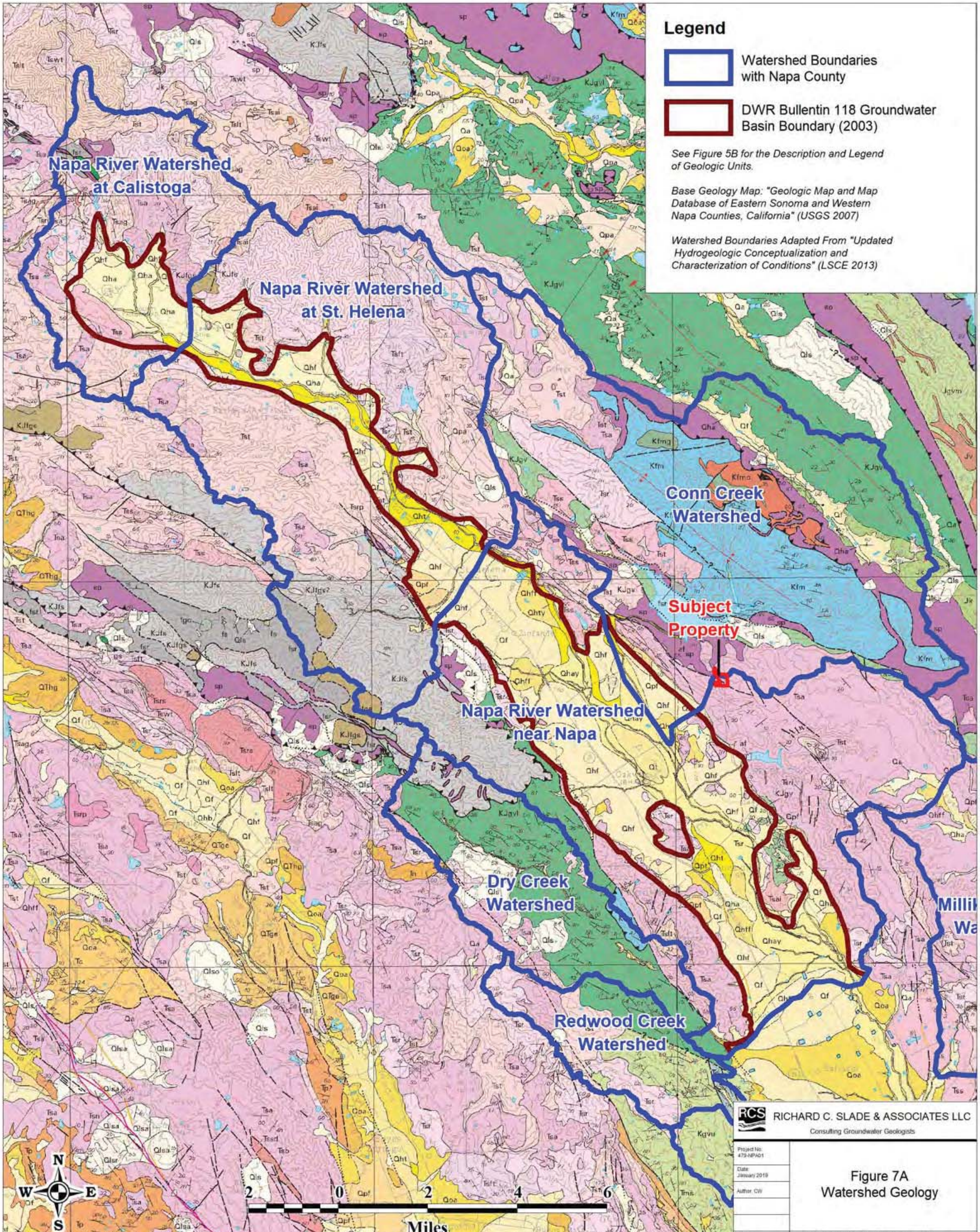


Figure 6
Watershed Boundaries


Legend
Watershed Boundaries with Napa County
DWR Bullentin 118 Groundwater Basin Boundary (2003)
See Figure 5B 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
Napa River Watershed near Napa
Dry Creek Watershed
Redwood Creek Watershed
N
W
E
S
2
0
2
4
6
Miles
RICHARD C. SLADE & ASSOCIATES LLC
Consulting Groundwater Geologists
Date: January 2019
Author: CW
Figure 7A
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

- al — 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
  - Tsn — 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)
- Jmi — Mafic intrusive complex (Jurassic)
- Jgb — Gabbro (Jurassic)
- sp — Serpentinite (Jurassic)
  - Silica-carbonate rock
  - spm — Serpentinite-matrix mélange

FRANCISCAN COMPLEX

- fsr — Mélange, including blocks, mapped locally, of:
  - sp — Serpentinite
  - fs — Graywacke
  - Chert
  - fgc — Greenstone and chert
  - Greenstone
  - 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
- Strike and dip of bedding
- Strike and dip of bedding, top indicator observed
- Strike and dip of bedding, approximate
- Overturned bedding
- Overturned bedding, top indicator observed
- Crumpled bedding
- Air photo attitude
- Vertical bedding
- Horizontal bedding
- Strike and dip of foliation
- 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 7B
DESCRIPTION AND LEGEND OF GEOLOGIC UNITS

Job No. 479-NPA04 **January 2019**

Table 1
Summary of Well Construction and Pumping Data
Long Ranch "Parcel 12"

WELL CONSTRUCTION DETAILS

Reported Well Designation	DWR Well Log No.	Date Drilled	Method of Drilling	Pilot Hole Depth (ft bgs)	Casing Depth (ft bgs)	Casing Type	Casing Diameter (in)	Borehole Diameter (in)	Sanitary Seal Depth (ft bgs)	Perforation Intervals (ft bgs)	Type and Size (in) of Perforations	Gravel Pack Interval (ft) and Size	Current Status of Well
Long Parcel 12 "Existing Well"	e0138360	September 2011	Air Rotary	900	848	PVC	6	10	0-50 (concrete) 50-52 (bentonite)	468-488; 508-528; 548-568; 588-608; 628-648; 668-688; 708-728; 748-848	Factory-cut 0.032	1/8 x 1/4 gravel	Inactive

POST-CONSTRUCITON YIELD DATA

Reported Well Designation	Date & Type of Yield Data	Duration of "Test" (hrs)	Estimated Flow Rate (gpm)	Static Water Level (ft)	Pumping Water Level (ft)	Estimated Specific Capaity (gpm/ft ddn)
Long Parcel 12 "Existing Well"	9/2011 Airlift	6	8	520	ND	ND
	12/2012 Pump	47	33	524.5	643.6	0.28

Notes: ft bgs = feet below ground surface
in = inches
hrs = hours
gpm = gallons per minute
gpm/ft ddn = gallons per minute per foot of water level drawdown

Table 2
Comparison of Rainfall Data Sources
Long Ranch "Parcel 12"

Rain Gage and/or Data Source	Years of Available Rainfall Record	Average Annual Rainfall in Inches (ft)	Elevation of Rain Gage (ft asl)	Distance of Rain Gage from Subject Property	Elevation Relative to Subject Property(1)
CDEC Atlast Peak	WY 1988-89 through WY 2016-17(2)	40.3 (3.36)	1,690	6.5	Higher
Napa One Rain Lake Hennesey	WY 2000-01 through WY 2016-17(3)	23.7 (1.98)	318	1.0	Lower
WRCC St Helena	1907 through July 2018(4)	34.2 (2.85)	240	6.5	Lower
PRISM	1981 to 2010	34.6 (2.88)	---	---	---
Napa County Isohyetal Map	1900 to 1960	35.0 (2.92)	---	---	---

Notes:

1. The subject property is located at elevations between ±780 and ±1,260 ft asl
2. Erroneous and/or missing rainfall data in WY 1988-89, WY 1994-95, WY 1995-96, WY 2004-05, and WY 2006-07.
3. Erroneous and/or missing rainfall data in WY 2007-08.
4. Missing rainfall data in 1907; 1915 to 1922; 1979 to 1980; 1985 to 1988; 1992; and 2011 to 2012.

Table 3
Calculation of Theoretical Rainfall Recharge Percentage
Napa River Near Napa Watershed

Portion of "Napa River Watershed Near Napa" (See Figure 4)	Area		Average Rainfall per PRISM Dataset (1980-2010)	Rainfall Volume	Scenario 1		Scenario 2		Scenario 3	
					Deep Percolation Percentage	Deep Percolation Volume	Deep Percolation Percentage	Deep Percolation Volume	Deep Percolation Percentage	Deep Percolation Volume
	(sq mi)	(acres)	(in)	(AF)	(%)	(AF)	(%)	(AF)	(%)	(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 4
Estimated Recharge Based on Slope Deep-Percolation Assumption

Region	Area	Average Rainfall [1][2]	Rainfall Volume	Reduced Recharge Assumption based on Slope Angle: Deep Percolation/Not Slope Dependent		Deep Percolation on >30° Slope Diminished by 25%		Deep Percolation on >30° Slope Diminished by 50%		Deep Percolation on >30° Slope Diminished by 75%		Deep Percolation on >30° Slope Diminished by 100%	
				Deep Percolation Percentage	Deep Percolation Volume	Deep Percolation Percentage	Deep Percolation Volume	Deep Percolation Percentage	Deep Percolation Volume	Deep Percolation Percentage	Deep Percolation Volume	Deep Percolation Percentage	Deep Percolation Volume
	(acres)	(in)	(AF)	(%)	(AF)	(%)	(AF)	(%)	(AF)	(%)	(AF)	(%)	(AF)
Entire Napa River Watershed Near Napa Hilside (Non Valley Areas Only)													
<30° Slope (in Hill Areas)	96,362	38.3	307,555	14.00%	43,057.8	14.52%	44,647.4	15.03%	46,237.0	15.55%	47,826.6	16.07%	49,416.2
>30° Slope	14,230	38.3	45,417	14.00%	6,358.4	10.50%	4,768.8	7.00%	3,179.2	3.50%	1,589.6	0.00%	-
TOTAL =	110,592			TOTAL =	49,416.2	TOTAL =	49,416.2	TOTAL =	49,416.2	TOTAL =	49,416.2	TOTAL =	49,416.2
Parcel 12 Property													
<30° Slope	33.3	34.6	96	14.00%	13.4	14.52%	13.9	15.03%	14.4	15.55%	14.9	16.07%	15.4
>30° Slope	5.8	34.6	17	14.00%	2.3	10.50%	1.8	7.00%	1.2	3.50%	0.6	0.00%	-
TOTAL =	39.1			TOTAL =	15.8	TOTAL =	15.7	TOTAL =	15.6	TOTAL =	15.5	TOTAL =	15.4

Note: The "Entire Napa River Watershed Near Napa" values are used to calculate the change in deep percolation percentage of <30° slopes based on the deep percolation volume of 14,230 AF calculated using the assumptions shown. Deep percolation percentage values determined for the entire watershed are then used for site specific calculations.

[1] Average Rainfall for "Napa River Watershed near Napa" and "Vangone property" per PRISM Dataset (1980-2010).

Table 5
Drought Period Rainfall as Percentage of Average

Statewide Drought Period as Defined by DWR (DWR 2005)	Drought Duration (years)	Average Rainfall by Raingage								
		St Helena WRCC Period of Record - 1907 through July 2018			Atlas Peak CDEC Period of Record - WY 1998-89 to WY 2017-18			Lake Hennessey Napa OneRain Period of Record - WY 2000-01 to WY 2017-19		
		[A] Total Gage Average (in)	[B] Drought Period Ave. (in)	[B/A] Drought Period Rainfall as % of Average	[A] Total Gage Average (in)	[B] Drought Period Ave. (in)	[B/A] Drought Period Rainfall as % of Average	[E] Total Gage Average (in)	[F] Drought Period Ave. (in)	[F/E] Drought Period Rainfall as % of Average
WY 1928-29 to WY 1933-34	6	34.2	23.9	70%	ND	ND	ND	ND	ND	ND
WY 1975-76 to WY 1976-77	2	34.2	13.4	39%	ND	ND	ND	ND	ND	ND
WY 1986-87 to WY 1991-92	6	34.2	18.3*	53%*	40.3	38.7*	96%*	ND	ND	ND
WY 2006-07 to WY 2008-09	3	34.2	24.8	73%	40.3	23.4	58%	23.7	9.4*	39%*
WY 2011-12 to WY 2015-16	5	34.2	20.7*	60%*	40.3	29.3	73%	23.7	19.6	83%

ND = No rainfall data for corresponding drought period.

* Raingage data do not extend through entire drought period and/or are missing rainfall data within drought period.

Table 6
Summary of Available Groundwater Quality Data
Long Ranch "Parcel 12" Well

Constituent Analyzed	Units	Maximum Contaminant Level	Parcel 12 Existing Well
		Date of Sample:	**12/6/2012**
General Physical Constituents			
Electrical Conductivity	µmhos/cm	900; 1,600; 2,200[(1)]	290
pH	units	6.5 to 8.5	7.2
Sodium Adsorption Ration (SAR)		None	0.42
General Mineral Constituents			
Total Dissolved Solids	mg/L	500; 1,000; 1,500[(1)]	210
Total Hardness	mg/L	None	120
Bicarbonate (Total) as HCO_3	mg/L		139
Alkalinity (Total) as $CaCO_3$	mg/L	None	114
Calcium	mg/L	None	18
Magnesium	mg/L	None	18
Sodium	mg/L	None	10
Sulfate	mg/L	250, 500, 600[(1)]	0.83
Chloride	mg/L	250, 500, 600[(1)]	18
Fluoride	mg/L	2	ND
Nitrate (as NO_3)	mg/L	45	0.51
Silica	mg/L	None	88
Detected Inorganic Constituents (Trace Elements)			
Arsenic	µg/L	10	1.5
Boron	µg/L	1000 (NL)	ND
Copper	µg/L	1000	1.2
Iron	µg/L	300	ND
Lead	µg/L	50	ND
Manganese	µg/L	50	21
Zinc	µg/L	5000	130

Notes:

µmhos/cm = micromhos per centimeter; mg/L = milligrams per liter; µg/L = micrograms per liter

ND = constituent not deteceted

NL = State Notification Level

(1) The three listed numbers represent the recommended, upper and short-term State Maximum Contaminant Levels (MCL) for the constituent.

All laboratory analyses performed by Caltest Analytical Laboratory of Napa, California.

DRAFT

APPENDIX

CALIFORNIA
DEPARTMENT OF WATER RESOURCES
WELL COMPLETION REPORT (DRILLER’S LOG)
FOR PARCEL 12 EXISTING WELL

DRAFT

DUPLICATE
Driller's Copy

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. e0138360

Owner's Well No. WELL #1
Date Work Began 9/9/2011, Ended 9/28/2011
Local Permit Agency Napa County Environmental
Permit No. E11-00324 Permit Date 7/28/2011

DWR USE ONLY -- DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD AIR FLUID N/A

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain, size, color, etc.
0	18	Boulders and brown clay
18	26	Brown and gray rock
26	90	Gray and dark gray rock
90	175	Brown and reddish brown clayee volcanics
175	225	Green and gray rock
225	260	Red volcanics
260	340	Gray and brown volcanics
340	375	Red and brown volcanics
375	430	Gray volcanics
430	495	Gray and brown volcanics
495	515	Red and brown volcanics
515	610	Dark gray volcanics, streak reddish brown volcanics
610	619	Cemented volcanic sands
619	643	Green and black rock
643	805	Green black and brown rock with clayee streaks
805	836	Green black and brown rock some fractured
836		Clayee serpintine rock

TOTAL DEPTH OF BORING 900 (Feet)
TOTAL DEPTH OF COMPLETED WELL 848 (Feet)

WELL OWNER

Name Wappo Land Company LLC
Mailing Address 1811 N Orleans #1N
Chicago IL
CITY STATE ZIP

WELL LOCATION

Address 1411 Sage Canyon Road
City Saint Helena CA
County Napa
APN Book 030 Page 220 Parcel 025
Township ___ Range ___ Section ___
Latitude ___ DEG. MIN. SEC. Longitude ___ DEG. MIN. SEC.

LOCATION SKETCH

NORTH
WEST EAST
SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER N/A (Ft.) BELOW SURFACE 1
DEPTH OF STATIC WATER LEVEL 520 (Ft.) & DATE MEASURED 9/28/2011
ESTIMATED YIELD * 8 (GPM) & TEST TYPE Air Lift
TEST LENGTH 6 (Hrs.) TOTAL DRAWDOWN 845 (Ft.)
May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	55	12-1/4								
55	900	10								
+2	468		✓				PVC	6	SDR21	
468	488			✓			PVC	6	SDR21	.032
488	508		✓				PVC	6	SDR21	
508	528			✓			PVC	6	SDR21	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	1	✓			CONCRETE
1	50	✓			
50	52		✓		
52	848			✓	1/8x1/4 GRAVE

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analysis
___ Other ___
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME Weeks Drilling & Pump
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
P.O. Box 176 Sebastopol CA 95473
ADDRESS CITY STATE ZIP
Signed [signature] 10/04/11 177681
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 11-97
IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

DUPLICATE
Driller's Copy
Page 2 of 4

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. e0138360

DWR USE ONLY -- DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

Owner's Well No. WELL #1
Date Work Began 9/9/2011, Ended 9/28/2011
Local Permit Agency Napa County Environmental
Permit No. E11-00324 Permit Date 7/28/2011

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD AIR FLUID N/A

DEPTH FROM SURFACE Ft. to	Ft.	DESCRIPTION *Describe material, grain, size, color, etc.*
0	18	Boulders and brown clay
18	26	Brown and gray rock
26	90	Gray and dark gray rock
90	175	Brown and reddish brown clayee volcanics
175	225	Green and gray rock
225	260	Red volcanics
260	340	Gray and brown volcanics
340	375	Red and brown volcanics
375	430	Gray volcanics
430	495	Gray and brown volcanics
495	515	Red and brown volcanics
515	610	Dark gray volcanics, streak reddish brown volcanics
610	619	Cemented volcanic sands
619	643	Green and black rock
643	805	Green black and brown rock with clayee streaks
805	836	Green black and brown rock some fractured
836		Clayee serpintine rock

TOTAL DEPTH OF BORING 900 (Feet)
TOTAL DEPTH OF COMPLETED WELL 848 (Feet)

WELL OWNER

Name Wappo Land Company LLC
Mailing Address 1811 N Orleans #1N
Chicago IL
CITY STATE ZIP

WELL LOCATION

Address 1411 Sage Canyon Road
City Saint Helena CA
County Napa
APN Book 030 Page 220 Parcel 025
Township ___ Range ___ Section ___
Latitude ___ DEG. MIN. SEC. Longitude ___ DEG. MIN. SEC.

LOCATION SKETCH

NORTH
WEST
EAST
SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. **PLEASE BE ACCURATE & COMPLETE.**

ACTIVITY (✓)

✓ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER N/A (Ft.) BELOW SURFACE 1
DEPTH OF STATIC WATER LEVEL 520 (Ft.) & DATE MEASURED 9/28/2011
ESTIMATED YIELD * 8 (GPM) & TEST TYPE Air Lift
TEST LENGTH 6 (Hrs.) TOTAL DRAWDOWN 845 (Ft.)
May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft. to	Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
528	548		✓				PVC	6	SDR21	
548	568			✓			PVC	6	SDR21	.032
568	588		✓				PVC	6	SDR21	
588	608			✓			PVC	6	SDR21	.032
608	628		✓				PVC	6	SDR21	
628	648			✓			PVC	6	SDR21	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to	Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	1	✓			CONCRETE
1	50	✓			
50	52		✓		
52	848			✓	1/8x1/4 GRAVE

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analysis
___ Other ___
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME Weeks Drilling & Pump
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
P.O. Box 176 Sebastopol CA 95473
ADDRESS CITY STATE ZIP
Signed Melissa G Lopez 10/04/11 177681
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 11-97
IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

DUPLICATE
Driller's Copy

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. e0138360

Owner's Well No. WELL #1
Date Work Began 9/9/2011, Ended 9/28/2011
Local Permit Agency Napa County Environmental
Permit No. E11-00324 Permit Date 7/28/2011

DWR USE ONLY -- DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD AIR FLUID N/A

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain, size, color, etc.
0	18	Boulders and brown clay
18	26	Brown and gray rock
26	90	Gray and dark gray rock
90	175	Brown and reddish brown clayee volcanics
175	225	Green and gray rock
225	260	Red volcanics
260	340	Gray and brown volcanics
340	375	Red and brown volcanics
375	430	Gray volcanics
430	495	Gray and brown volcanics
495	515	Red and brown volcanics
515	610	Dark gray volcanics, streak reddish brown volcanics
610	619	Cemented volcanic sands
619	643	Green and black rock
643	805	Green black and brown rock with clayee streaks
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TOTAL DEPTH OF BORING 900 (Feet)
TOTAL DEPTH OF COMPLETED WELL 848 (Feet)

WELL OWNER

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Chicago IL
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WELL LOCATION

Address 1411 Sage Canyon Road
City Saint Helena CA
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APN Book 030 Page 220 Parcel 025
Township ___ Range ___ Section ___
Latitude ___ DEG. MIN. SEC. Longitude ___ DEG. MIN. SEC.

LOCATION SKETCH

NORTH
WEST EAST
SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER N/A (Ft.) BELOW SURFACE 1
DEPTH OF STATIC WATER LEVEL 520 (Ft.) & DATE MEASURED 9/28/2011
ESTIMATED YIELD * 8 (GPM) & TEST TYPE Air Lift
TEST LENGTH 6 (Hrs.) TOTAL DRAWDOWN 845 (Ft.)
May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
648	668		✓				PVC	6	SDR21	
668	688			✓			PVC	6	SDR21	.032
688	708		✓				PVC	6	SDR21	
708	728			✓			PVC	6	SDR21	.032
728	748		✓				PVC	6	SDR21	
748	848			✓			PVC	6	SDR21	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	1	✓			CONCRETE
1	50	✓			
50	52		✓		
52	848			✓	1/8x1/4 GRAVE

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analysis
___ Other ___
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME Weeks Drilling & Pump
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
P.O. Box 176 Sebastopol CA 95473
ADDRESS CITY STATE ZIP
Signed [signature] 10/04/11 177681
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 11-97
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DUPLICATE
Driller's Copy

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No. e0138360

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Owner's Well No. WELL #1
Date Work Began 9/9/2011, Ended 9/28/2011
Local Permit Agency Napa County Environmental
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ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
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ACTIVITY (✓)

✓ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
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SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

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ANNULAR MATERIAL

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52	848			✓	1/8x1/4 GRAVE

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