# Exhibit E-1

RICHARD C. SLADE & ASSOCIATES LLC
CONSULTING GROUNDWATER GEOLOGISTS

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MAR 14 2019
Napa County Planning, Building & Environmental Services

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**MEMORANDUM**

January 15, 2019

To: P&M Vineyards Holdings LLC
c/o Matt Taylor
PO Box 1480
Sebastopol, CA 95473
Sent via email (matt@chamboule.com)

Job No. 622-NPA01

Cc: Mr. Cort Munselle
Munselle Civil Engineering (Munselle)
Sent via email (cort@munsellecivil.com)

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

Re: Results of Aquifer Testing of One Onsite Well and
Napa County Tier 1 and Tier 2 Water Availability Analysis
For Proposed P+M Vineyards
1300 Mt. Veeder Road
Mt. Veeder Area, Napa County, California

## Introduction

Provided herein are the key findings and conclusions, and our preliminary recommendations regarding the Water Availability Analysis (WAA) prepared by RCS for the proposed P+M Vineyards in Napa County (County), California. This WAA was prepared in conformance with Napa County Tier 1 and Tier 2 requirements, as described in the Napa County WAA Guidelines (WAA 2015). The proposed P+M Vineyards property, known herein as the "subject property," is located at 1300 Mt. Veeder Road in the Mt. Veeder area of Napa County. Figure 1, "Location Map," shows the boundaries of the subject property superimposed on USGS topographic maps for the Napa and Sonoma quadrangles. Also shown on Figure 1 are the locations of three existing onsite water wells (known herein as "Old Well", "New Well", and "Well A"). The subject property boundaries shown on Figure 1 were adapted from parcel data provided to RCS by Munselle Engineering (Munselle) of Healdsburg, California (the project civil engineer). Figure 2, "Aerial Photograph Map," shows the same property boundaries and locations of the three onsite wells on an aerial photograph of the area; this aerial photograph was obtained directly from the United States Geological Survey's (USGS) EarthExplorer website (the date of the imagery is June 3, 2016).

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As described by the project engineer, the subject property is currently developed with the following: 0.6 acres of existing vineyards; a single-family residence; and landscaping associated with the onsite residence. P&M Vineyards Holdings LLC purchased the property during the summer of 2015. Groundwater pumped from the onsite "New Well" was reportedly used in the past by the previous property owners to meet these existing domestic and landscape irrigation demands of the onsite residence and will continue to meet those demands in the future. The current property owner, P&M Vineyards Holdings LLC, reports that since the summer of 2015, the 0.6 acres of existing vines have been irrigated via water stored in onsite water tanks; these water tanks are filled by water that is trucked to the subject property. The purpose of trucking water was to simplify management of the property in the short term (while undergoing the permitting process for new vines), and thus water trucking is not a proposed long term operation for the property. It is presumed that the water demands for the residence and landscape irrigation were historically met using groundwater pumped from the New Well by the previous owners, but no information is available for historic site operations. RCS understands that the proposed project is to plant an additional 16.4 acres of new vines and 2 acres of olive groves. All future water demands for vineyard and olive grove irrigation will be met by pumping groundwater from onsite Well A (the most recently-constructed well on the property); the future vineyard irrigation water demands would include all 17.0 acres of proposed onsite vines (0.6 acres of existing vines and 16.4 acres of proposed new vines). No water is proposed to be trucked to the site in the future. After a period of 5 years following the initial planting of new vines and the olive grove, the Owner has proposed to implement "dry farming" techniques for all onsite vines and the olive grove. Reportedly, this dry farming technique will result in greatly reducing onsite water demands over time following the initial 5 years of vineyard development.

As part of the permit submittal for the proposed new vineyard and olive grove development, a Water Availability Analysis (WAA) is required by the County. The purpose of this Memorandum is to comply with Napa County's WAA guidelines for a "Tier 1" (Groundwater Recharge Estimate), which were promulgated by the County in May 2015. Also, because there are at least two offsite wells that lie within 500 ft of the onsite Well A (located on an adjacent offsite parcel), a "Tier 2" analysis (Well Interference Evaluation) was performed. Figures 1 and 2 show the locations of offsite wells located within 500 ft of the existing onsite wells. Details regarding both Tier 1- and Tier 2-type WAA analyses are discussed herein.

## Site Conditions

From our initial field reconnaissance visit to the subject property on August 24, 2016, and from our subsequent site visit on August 1, 2017, and also from conference calls with Mr. Taylor and/or the project engineer, the following key items were noted and/or observed (refer to Figures 1 and 2):

a. The single-parcel subject property has a County's Assessor Parcel Number (APN) of 034-230-029. The total acreage of the subject property was reported by the project engineer to be 115.4 acres.

b. Topographically, the subject property is situated in the foothills northwest of the City of Napa. As such, the southern, western, and central portions of the property are relatively steep and sloped to the southwest towards Mt. Veeder Road and Pickle Canyon; the northeastern portion of the property is a flatter, but topographically higher section of the property.

c. Two ephemeral drainages were observed adjacent to and/or on the subject property. One (unnamed) primary drainage was observed to exist within Pickle Canyon along Mt. Veeder Road and adjacent to the western boundary of the subject property. This drainage was observed to be predominantly dry during our initial site visit in August 2016, except for a few "wet spots" (areas of ponding) that were observed along the creek bed. A second unnamed drainage was observed to emanate near the "New Well" in the northern portion of the property, and it generally flows from north to south through a small valley on the property and eventually flows offsite; this second drainage was observed to be dry during our August 2016 site visit. Neither of these drainages are perennial; instead both are ephemeral and flow only during or immediately after a rainfall event.

d. Currently, developments on the subject property consist of 0.6 acres of existing vines, a single-family residence, and landscaping associated with the onsite residence. The 0.6 acres of existing vines were observed to be located in the northern portion of the property. The onsite residence, which is located in the central portion of the property, is currently vacant, but will reportedly be occupied during future development and operation of the onsite vineyards and olive grove. The southern, western, and central portions of the property were observed to be generally undeveloped areas covered by native brush and trees, whereas the northeastern portion of the property was observed to be predominantly open and grass covered.

e. The onsite New Well and Old Well were observed by RCS geologists during our initial August 2016 site visit. Well A, which was drilled and constructed in June 2017, was observed by the RCS geologist during his site visit to the property on August 1, 2017. As shown on Figures 1 and 2, the three existing onsite water wells are generally located in the north to northeastern portions of the property. Reportedly, the New Well has historically supplied domestic and landscape irrigation demands for the onsite residence. The Old Well may have also been used in the past to help meet demands of the onsite residence prior to construction of the New Well. The New Well and Old Well are located only 100 ft apart along one of the main onsite roads. As reported by the owner, the New Well will continue to be used to meet the future water demands of the onsite residence and landscaping. Well A, which was recently constructed in June 2017, is proposed to be used to meet the future irrigation demands of the 17.0 total acres of vines and the 2-acre olive grove proposed for the property. Well A is approximately 850 ft northeast of the New Well and Old Well.

f. The offsite areas surrounding the subject property consist primarily of existing vineyards, residences, and naturally vegetated and/or wooded hillsides.

g. During our August 2016 site visit, the RCS geologist also traveled along both internal property roads and Mt. Veeder Road, in the area surrounding the property to help identify the possible locations and/or existence of other nearby but offsite water wells owned by others. However, no other offsite wells were directly observed by the RCS geologist during that visit. Review of publicly-available published reports from other nearby WAA projects revealed the locations of three offsite water wells and three test holes on the Woolls Ranch property (County APN 035-010-054), which is located directly to the southwest (LSCE 2014); the location of these three wells and three test holes are shown on Figures 1 and 2.

During the pilot hole drilling for Well A by others, it was reported to RCS geologists by the driller on June 19, 2017 that two offsite wells were observed on the adjacent property to the east (APN 034-270-030). The exact location of these offsite wells was later confirmed by the neighbor and owner of the two wells, Mr. George Bachich. These two offsite wells, referred to herein as "Bachich Irrigation" and "Bachich Main," are located approximately 180 ft east and 380 ft north of onsite Well A, respectively, as shown on Figures 1 and 2.

RCS geologists also contacted Napa County Planning, Building, and Environmental Services (PBES) in attempt to acquire any available "Well Completion Reports" (also known as "driller's logs") for water wells that might exist on parcels adjacent to the subject property. As a result of the Napa County PBES request, driller's logs and water well drilling permits were received for seven offsite water wells, including those for the Bachich Main and Bachich Irrigation wells. Approximate locations of these known and/or possible offsite wells are shown on Figures 1 and 2; well locations shown thereon are considered to be approximate because an exact well location is difficult to ascertain from the maps included with the driller's logs and drilling permits received.

As discussed above, the two offsite Bachich wells are both recognized to be located within 500 ft of onsite Well A, whereas the New Well and Old Well appear to be greater than 500 ft from any known and/or possibly offsite well.

## Key Construction and Testing Data for Existing Onsite Wells

A California Department of Water Resources (DWR) Well Completion Report is available only for onsite Well A (Log No. e0345319); no driller's logs are available for the onsite New Well or Old Well. Available historical pumping data for the New Well and Old Well were provided to RCS by Napa County PBES. Table 1, "Summary of Well Construction and Pumping Data," provides a tabulation of available key well construction, groundwater airlifting data, and pumping data for the three onsite water wells.

### *Well Construction Data*

Key data listed on the available driller's log, information from available well pumping data, and/or identified during our August 2016 and August 2017 site visits include:

a. Well A was constructed in June 2017 by Huckfeldt Well Drilling (Huckfeldt), of Napa, California; the drilling method was reported to be direct mud rotary. A downhole geophysical log (also known as an "electric log" or "E-log") was performed in the open pilot borehole of this well. RCS geologists were involved with the siting, design, and testing of Well A, and provided recommendations for the final casing design of this well. RCS geologists were not present in the field during any part of the pilot hole drilling, reaming, and/or well construction work by Huckfeldt.

b. For Well A, the pilot hole depth (the borehole drilled before the well casing was placed downhole) was reported by Huckfeldt to be 500 ft below ground surface (ft bgs). Pilot hole depth information for the New Well and Old Well are unknown.

c. Well A was constructed using PVC well casing with a nominal diameter of 6 inches and was cased to a total depth of 460 ft bgs. The New Well was observed during the RCS field visit to be constructed of steel casing with a nominal diameter of 8 inches.

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d. Casing perforations in Well A consist of machine-cut slots that have slot opening widths of 0.032 inches (32-slot). These slots were reportedly placed continuously between the depth intervals of: 60 to 240 ft bgs; 260 ft to 400 ft bgs; and 420 ft to 440 ft bgs.

e. The gravel pack material listed on the driller's log for Well A is described as "#6 sand" and was emplaced in the annulus around the casing between the depths of 52 ft and 470 ft bgs.

f. Well A was reportedly constructed with a sanitary seal consisting of cement (grout) that was set to a depth of 52 ft bgs. Sanitary seal depths for the New Well and Old Well are unknown.

g. The dates of drilling and construction for the New Well and Old Well are unknown. Historical pumping records (from August 2002) for the New Well revealed that this well is at least 15 years or more in age. The total depth of the New Well has been reported by Dave Bess Pump & Well (Bess), of Napa, California to be 72 ft bgs. The Old Well was observed to be constructed with 5-inch nominal diameter PVC well casing, and Bess has reported the total depth of this well to be 80 ft bgs.

*Summary of Key Airlifting "Test" Data for Onsite Wells*

The driller's log for Well A provided a brief listing of its original, post-construction airlift data (as shown on Table 1). These data include:

- Following construction of Well A, an initial static water level (SWL) of 164 ft bgs was measured by Huckfeldt on June 30, 2017.
- Maximum flow rates during initial post-construction airlifting were estimated by Huckfeldt to be 90 gallons per minute (gpm) after a period of 2 hours of airlifting in Well A. As a rule of thumb, RCS geologists estimate 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.
- The "water level drawdown" amount was not listed on the driller's log, because water level drawdown cannot be measured during airlifting operations; thus the original post-construction specific capacity values for Well A could not be calculated from the data on the available driller's log. Specific capacity, in gallons per minute of 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 at that rate.

*Pre-2015 Pumping Test Data from Others*

In January 2015, separate 2-hour pumping tests were performed in both the New Well and Old Well by Bess. Key data available from these pumping tests include:

- New Well – A pre-test SWL of 13 ft below the wellhead reference point (brp) was recorded by Bess prior to testing on January 21, 2015. While pumping at a constant rate of 12 gpm, a final pumping water level (PWL) of 18 ft brp was reported by Bess. Thus, based on the total water level drawdown of 5 ft, a short-term specific capacity of 2.40 gpm/ft ddn was calculated for this 2-hour pumping test.

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- Old Well – A pre-test SWL of 10 ft brp was recorded by Bess prior to testing on January 22, 2015. Based on the total water level drawdown of 60 ft and a final pumping rate of 6 gpm at the end of the 2-hour testing period, a short-term specific capacity of 0.10 gpm/ft ddn was calculated. During the test, the pumping rate was reduced from 16 gpm to 6 gpm approximately 30 minutes into the pumping test because the pump had reportedly "broken suction" at the higher rate (i.e., water levels dropped to the depth of the pump intake and the pump was sucking air).

An older, short-term (approximately 2-hour long) pumping test was also performed in August 2002 in the New Well by McLean & Williams (M&W), of Napa, California. The final pumping rate during this 2-hour pumping test was reported to be 22 gpm. Based on a SWL of 15 ft, and a final PWL of 32 ft, the short-term specific capacity of the New Well was calculated to be 1.29 gpm/ft ddn in August 2002.

*Well Data from Site Visits*

As discussed above, site visits to the subject property were performed by RCS geologists on August 24, 2016 and August 1, 2017. The following information for the three onsite wells was gleaned from these site visits:

- New Well – This well was observed to be equipped with a small solar-powered pump, but it was not pumping at the time of our August 2016 and/or August 2017 visits. Reportedly, this well was historically plumbed to an onsite water tank near the existing onsite residence. However, during our site visits, it appeared that the discharge piping had been removed in the past. A SWL of 16.8 ft brp was measured by the RCS geologist during the August 2016 visit and 13.3 ft brp during the August 2017 visit; the reference point for these measurements is approximately 1.5 ft above ground surface (ags). Thus, it appears that water levels increased in this well by 3.5 ft in this roughly 1-year period (August 2016 to August 2017). The SWL of 13.3 ft brp in August 2017 is also roughly similar to the water level measurement collected by Bess in January 2015, but it is 1.7 ft higher than the water level recorded by M&W in August 2002. This well is currently not equipped with a totalizer flow dial device.
- Old Well – This well was observed to not be equipped with a permanent pump and no electrical and/or discharge piping was observed to be connected to the well at the time of our visit. SWLs of 14.3 ft brp and 10.6 ft brp were measured by RCS geologist during the August 2016 and August 2017 visits, respectively; the reference point for these measurements is approximately 0.8 ft ags. Similar to the New Well, it appears that water levels in the Old Well increased by 3.7 ft in a roughly 1-year period (August 2016 to August 2017). A SWL of 10 ft brp was measured by Bess prior to his testing of this well in January 2015. This well is currently not equipped with a totalizer flow dial device.
- Well A – This well was observed to be equipped with a test pump during our August 1, 2017 site visit, in preparation for the 24-hour constant rate pumping test that was performed on August 4 and 5, 2017. A SWL measurement of 170.1 ft brp was recorded by the RCS geologist during the August 1, 2017 site visit; the reference point for this measurement is approximately 2.2 ft ags. This well was not actively pumping at the time of our site visit. The SWL depth of 164 ft brp measured by Huckfeldt on

June 30, 2017 was roughly 6 ft shallower than the SWL measured by the RCS geologist on August 1, 2017.

## Local Geologic Conditions

Figure 3A, "Geologic Map (CGS 2004)," illustrates the types, lateral extents, and boundaries between the various earth materials mapped at ground surface in the region by others. Figure 3A has been adapted from the results of regional geologic field mapping of the Napa and Sonoma quadrangles, as published by the California Geological Survey (CGS) in 2004 (Clahan, Wagner, et al). Key earth materials mapped at ground surface in the area, as shown on Figure 3A include, from geologically youngest to oldest, the following:

a. Alluvial-type deposits. These deposits consist of the following: stream channel and stream terrace deposits (map symbols Qhc, Qhty, and Qht, on Figure 3A) along Dry Creek to the northeast and along Redwood Creek to the south; and alluvial fan and undivided alluvium deposits (map symbols Qhf and Qpa) along Dry Creek, Redwood Creek, and the Napa Valley floor to the east. These deposits are generally unconsolidated, and consist of layers and lenses of sand, gravel, silt, and clay. None of these alluvial-type deposits are exposed at ground surface on or near the subject property.

b. Landslide deposits (map symbol Qls). Several historic landslide areas have been mapped in the region by others (see the bright yellow-colored areas on Figure 3A), including a few at ground surface in the southern, western, and northern portions of the subject property. Arrows within these mapped landslide areas show the general direction of ground surface movement with each slide.

   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 these landslides, and/or the potential impact of these landslides on the property or on the proposed vineyard expansion.

c. Sonoma Volcanics (map symbol Tsv). The Sonoma Volcanics are comprised by a highly variable sequence of chemically and lithologically diverse volcanic rocks. These types of rocks can include the following: mafic lava flows and tuffs; rhyolite to dacite ash flow tuff; lava flows; intrusions; breccia; and tuffaceous sediment. As shown on Figure 3A, the Sonoma Volcanics are not exposed anywhere on the subject property, but are instead exposed at ground surface only northeast of the subject property. In many parts of Napa and Sonoma counties, these volcanic rocks tend to be viable aquifer systems. The RCS Geologist did not observe any outcrops of Sonoma Volcanics on the subject property during his site visits. Further, these rocks do not exist beneath any of the older sedimentary rocks that are discussed below.

d. Domengine Sandstone (map symbol Td). This sedimentary unit is shown on Figure 3A to be exposed at ground surface to the southeast of the subject property and south of a mapped fault; the fault is shown as a thick, black-colored dashed line. The Domengine sandstone unit is of Eocene age and reportedly consists of brown quartzo-felspathic sandstone with minor thin claystone interbeds. There are no outcrops of Domengine sandstone exposed on the subject property, and they do not underlie the subject property.

e. Great Valley Sequence (map symbols KJgv). These geologically old (early- and late-Cretaceous-aged) rocks are exposed at ground surface virtually throughout the subject property, as shown on Figure 3A. These rocks consist mainly of well-consolidated to cemented, thinly bedded mudstone, siltstone, and shale, with minor amounts of thinly bedded sandstone. Due to their geologic age and the high degree of consolidation, these rocks are also not considered to be a viable water-bearing formation and generally have low permeability and virtually no intergranular (primary) porosity.

   The quality and quantity of groundwater produced from this formation will depend on the fractured nature of these rocks and the amounts of average annual recharge (rainfall) experienced at the subject property. These rocks are also known to underlie all other geologically-younger rocks exposed across the region (including the landslide materials mentioned above), and are considered to be the bedrock of the area.

A second geologic map was also reviewed for this project, Figure 3B, "Geologic Map (USGS 2007)," and was adapted from the United States Geological Survey (USGS) map titled, "Geologic Map and Map Database of Eastern Sonoma and Western Napa Counties, California" (2007, Graymer, Brabb, et al). The Figure 3B map is noted to be slightly different geologically, in regard to the presence of additional geologic structure, when compared to the geology shown on Figure 3A. Specifically, Figure 3B includes a queried fault and the nomenclature used for rocks of the Great Valley Sequence that are not shown on the Figure 3A map (CGS 2004). A summary of key differences between the Figure 3A and Figure 3B geologic maps include:

a. Alluvial-type deposits. These geologic materials are shown on Figure 3A as map symbols Qhc, Qhty, Qht, Qhf, and Qpa; on Figure 3B these same materials are shown as map symbols Qhc, Qhf, and Qoa, and they are shown in more locations on Figure 3A.

b. Landslide deposits. Those landslide deposits shown on Figure 3A (map symbol Qls) are not illustrated and/or mapped on Figure 3B.

c. Great Valley Sequence. These older geologic rocks are shown on Figure 3B as map symbols Kgvu and KJgvl, as opposed to merely a single map symbol (KJgv) that is used on Figure 3A. On Figure 3B, the Great Valley Sequence has been mapped as younger and older units and are separated by a queried fault. The upper unit (Kgvu) of the Great Valley sequence is reportedly comprised of sandstone, shale, and conglomerate, whereas the lower unit (KJgvl) is reported to be comprised of sandstone and shale. The upper unit is distinguished from the older, lower unit by a greater amount of sandstone and its fossil content (USGS 2007). The geologic contact between the two units is shown as a fault on Figure 3B; in the vicinity of the subject property, this fault/geologic contact is inferred and questionable due to a heavy vegetation cover at ground surface (USGS 2007). This fault/geologic contact is not shown on Figure 3A. The location and extend of the ground surface exposures of these Great Valley Sequence rocks are generally the same on both maps.

As discussed above, RCS geologists were involved with the siting, design, construction, and testing of onsite Well A. Samples of drill cuttings collected by the driller during pilot hole drilling of Well A, were provided to RCS to be geologically logged. The earth materials observed by RCS geologists for Well A were observed to be brown to grey to greenish grey shale with interbedded layers of sandstone to a depth of 500 ft bgs. The entire pilot borehole to a depth of 500 ft bgs is therefore interpreted by RCS to consist of geologic materials that can be assigned to rocks of the Great Valley Sequence.

Review of the driller's descriptions of drill cuttings listed on the available driller's logs for other nearby offsite wells and/or test holes revealed that pilot hole drilling of these wells also encountered typical rocks of the Great Sequence Valley rocks to depths of at least 680 ft bgs. Typical driller-terminology for the drill cuttings on those driller's logs included "blue shale," "shale and clay," "shale and sandstone," and "gray shale."

*Geologic Structure*

A series of faults and/or fault zones have been mapped by others at ground surface in the region and are shown on Figures 3A and 3B; these geologic structures are typically shown by the presence of thick black lines; these lines are typically dashed or dotted where uncertain or unknown. These faults generally appear to be northwest–southeast trending faults. The Holocene-aged active West Napa fault is shown on Figures 3A and 3B to be located roughly ½ mile northeast of the subject property. As shown only on Figure 3B, an unnamed fault and/or tectonic feature is shown to transect near the central portion of the subject property.

The possible impacts of these faults on groundwater availability are unknown due to a complete absence of requisite data. Fault activity over time could have served to increase the number, size and frequency of fracturing in the local Great Valley Sequence rocks. Such activity would tend to increase the amount of open area in the rock fractures which, in turn, could increase the ability of those local earth materials to store groundwater. It is unknown if these faults are barriers to groundwater flow.

In the area of the subject property, Great Valley Sequence rocks have been moderately to strongly deformed by folding and faulting, and bedding relationships can be complex (LSCE 2014). As shown on Figures 3A and 3B, bedding attitudes (strikes and dips) reported for the beds near the subject property are shown to have strikes that are generally oriented in a northwest-southeast direction, and dips (inclination of the strata from the horizontal) that are generally 45 degrees or more to the northeast.

Based on the data discussed above, Figure 4, "Geologic Cross Section A-A'," shows the general RCS interpretation of the subsurface conditions along the alignment of Section A-A'; the location of this cross section, relative to the subject property, is shown on Figures 3A and 3B. As shown on Figure 4, Great Valley Sequence rocks (map symbol KJgv on Figure 3A, and map symbols Kgvu and KJgvl on Figure 3B) are interpreted to underlie the entire portion of the property. Specifically, the Great Valley upper unit (map symbol Kgvu on Figure 3B) is exposed at ground surface across the southern portion of the property, whereas the reportedly more shale-dominant, lower unit (map symbol KJgvl on Figure 3B) is exposed in the northern portion of the property in the area of the existing onsite wells. Based on the bedding attitude data presented on the published geologic map (USGS 2007), both upper and lower units are shown on the Figure 4 cross section with bedding planes that generally dip at 45 degrees or greater to the northeast. The shape and slope of the fault contact between the upper and lower units is only roughly estimated and has been queried, as shown on Figure 4. Due to limited information, the relative direction and/or magnitude of historic movement on the fault shown on Figure 4 is unknown.

Please note: it is neither the purpose nor within the Scope of Hydrogeologic Services for this project to assess the potential seismicity or activity of any faults that may occur in the region.

Also shown on the Figure 4 cross section are the locations of the three onsite wells (New Well, Old Well, and Well A) and the two nearby offsite wells (Bachich Irrigation and Main wells), including a simple construction schematic of each well (casing depths, sanitary seal depths, and perforation intervals, as available for each well, are illustrated on Figure 4). Water level data collected on August 4, 2017 (at the date of the constant rate pumping test in Well A). Note that some of the wells on Figure 4 have been projected onto the cross section line.

Notable on the RCS-prepared geologic cross section are the following:

- Each of the onsite wells appear to be perforated and/or constructed solely within the lower unit of the Great Valley Sequence rocks (map symbol KJgvl on Figure 3B).
- The nearby but offsite Bachich wells are also shown to be perforated in the lower unit of the Great Valley Sequence rocks. In addition, both the Bachich Main and Irrigation wells appear to be entirely perforated within the same depth intervals in which the uppermost perforated interval exists in Well A. Well A is also constructed with perforations that extend much deeper than those of the two other onsite wells and/or the offsite Bachich wells.
- The static water level elevation in Well A is shown to be significantly lower in elevation than the other wells shown on the cross section. This is particularly noteworthy with respect to the Bachich Irrigation well and the Bachich Main well, which are located 180 ft and 380 ft, respectively, from Well A. These data indicate that the local fractured rock aquifer systems are likely not continuous with respect to depth, and therefore, the deeper portions of Well A may not be in direct hydraulic communication with the Bachich wells or the other onsite wells — a likelihood discussed more in Conclusion 7 below. In essence, the groundwater in these rocks tends to be "compartmentalized" (i.e., it occurs in "pockets" in the subsurface), and Well A is likely extracting groundwater from different "pockets" in the subsurface than the Bachich wells.

## Project Groundwater Demands

### *Existing Water Demands*

Groundwater pumped from the onsite "New Well" has reportedly been used in the past to meet the historical domestic and landscape irrigation demands of the onsite residence and will continue to meet those demands in the future. Irrigation water demands for the 0.6 acres of existing vines are currently met by using water stored in onsite water tanks that are filled with water that is trucked to the subject property, as needed. Due to the relatively small amount of existing vineyards, trucked water was used since the property was acquired in late-2015 simply to keep the vines alive. The Owner's desire was to limit management activities at the subject property in the short-term while the property was being rehabilitated and waiting for permit approvals.

Below is a list of the trucked water delivery dates and volumes delivered from the date of P&M Vineyards Holdings LLC's acquisition of the property through the date of this document. No data are available for prior trucked water deliveries.

| Delivery Date | Gallons Delivered |
|---|---|
| 4/27/2018 | 2,500 |
| 5/4/2018 | 2,500 |
| 5/10/2018 | 2,500 |
| 5/19/2018 | 2,500 |
| 5/24/2018 | 2,500 |
| 6/1/2018 | 2,500 |
| 6/19/2018 | 2,500 |
| **Total** | **17,500** |

Therefore, a total of 17,500 gallons (or 0.054 AF) of water were reportedly delivered to the property between April 27 and June 19, 2018. No other deliveries were reported to have been made, thus 17,500 gallons is the total volume of water trucked to the property during the 2018 irrigation season. For 0.6 acres of vines, this translates to an estimated water use of approximately 0.1 AF of water per acre of vines. This estimated water use for the existing vineyards (0.25 AF/acre vine/yr) is less than those water use values estimated in the WAA Guidance Document (WAA 2015) for vineyards (0.50 AF/acre vine/yr).

*Proposed Water Demands*

Proposed groundwater demand estimates for the project were provided to RCS by Munselle on a worksheet titled "Water Use Worksheet for P+M Vineyards," and dated November 3, 2017. The proposed water demands for the project have been estimated by Munselle[1] to be the following:

a. Residence = 0.75 acre feet per year (AF/yr)
b. Landscaping irrigation = 1.04 AF/yr
    - Residential landscaping area is ±0.5 acres (21,780 sq. ft.)
c. Vineyard irrigation = 8.50 AF/yr
    - 0.5 AF per year per acre of vineyards (AF/yr/ac), and there are 0.6 acres of existing onsite vines and 16.4 acres of proposed new vineyards (17.0 acres of vineyards total).
d. Olive grove irrigation = 0.60 AF/yr
    - 0.3 AF/yr/ac of proposed olive grove, and there are 2 acres of proposed olive groves.
e. Total groundwater for proposed project = a + b + c + d = 10.89 AF/yr
    - Note that 1 AF = 325,851 gallons

[1] These water demand estimates were reportedly based on those values presented for specified land uses provided in Appendix B of the County's WAA Guidance Document (WAA 2015).

After an estimated five years following the initial vineyard planting, the Owner plans to begin "dry farming" the entire 17.0 acres of vines and the 2-acre olive grove proposed for the project. Once "dry farming" begins, groundwater demands for the subject property will be greatly reduced. A projection of future water demands at the property is as follows:

a. Years 1 through 5 = 10.89 AF/yr
   - o 0.75 AF/yr for the residence plus 1.04 AF/yr for landscaping plus 9.10 AF/yr, which is 100% of the estimated initial agricultural irrigation demand (including 8.50 AF/yr for vines and 0.60 AF/yr for the olive grove)
b. Years 6 through 8 = 6.34 AF/yr
   - o 0.75 AF/yr for the residence plus 1.04 AF/yr for the landscaping plus 4.55 AF/yr, which is 50% of the estimated initial agricultural irrigation demand of (including 4.25 AF/yr for the vineyards and 0.30 AF/yr for the olive grove)
c. Years 9 and beyond = 4.52 AF/yr
   - o 0.75 AF/yr for the residence plus 1.04 AF/yr for the landscaping plus of 2.73 AF/yr, which is 30% of the estimated initial agricultural irrigation demand (including 2.55 AF/yr for vines and 0.18 AF/yr for the olive grove)

As discussed above, water demands for the onsite residence and landscaping are assumed to have historically been met by pumping groundwater from the existing New Well. For the proposed project, the future water demands of the residence and landscaping (item Nos. 1 and 2 above) will not change, and will be met by using water pumped from the New Well. For the agricultural water demands described above (item Nos. 3, 4, and 5), groundwater will be pumped from Well A.

For years in which are considered to be "dry years" (or drought years), the agriculture irrigation demand is not expected increase significantly. Additionally, after the first five years following vineyard development, agriculture irrigation water demands are expected to decrease due to the implementation of dry farming. Also note that the 0.5 AF/yr estimate for vineyard irrigation is a conservative, standard estimate, and actual irrigation practices will likely result in a water use lower than that of 0.5 AF/yr.

**Proposed Pumping Rates**

To determine an appropriate estimated peak pumping rate necessary from the New Well and Well A in the future, the following will be assumed: all future residential water demands (0.75 AF/yr) at the subject property will be required year-round (365 days/year); all landscape irrigation demands (1.04 AF/yr) will be required during a 184-day irrigation season (May to October); and all agricultural (vineyard and olive grove) irrigation demands (9.10 AF/yr) will be required during a 153-day irrigation season (May to September). The irrigation periods for the landscaping, vineyard, and olive grove were provided to RCS by the Owner.

Based on these assumptions noted above, and in order to meet the future groundwater demands of the project, the New Well would need to pump at a rate of less than 4 gpm to meet the estimated average annual demand of 1.79 AF for all residential and landscaping water demands in the future. The future average annual vineyard and olive grove irrigation demand is reported to be 9.10 AF/yr for the initial five years following project build-out, and thus Well A would need to pump at a rate of about 27 gpm during the initial 5 years. During the subsequent "dry farming" period, Well A will need to pump at rates of about 14 gpm (Years 6 through 8; 4.55 AF/yr) and 8 gpm (Years 9 and on; 2.73 AF/yr). These pumping rates assume that the wells would be pumped at a 50% operational basis, that is, 12 hours/day, 7 days/week, during their respective assumed necessary pumping and/or irrigation periods each year.

## October 2016 Constant Drawdown Pumping Test of "New Well"

In October 2016, an 8-hour constant drawdown pumping test was conducted in the New Well by LGS Drilling, Inc (LGS), of Vacaville, California. The purpose of this pumping test was to determine if the New Well, pumping alone, could meet the proposed future project water demands (10.89 AF/yr for the first 5 years, or 31 gpm). Figure 5, "Water Levels During Constant Drawdown Test, New Well" illustrates the water level changes in the well during the constant drawdown testing period. A summary of key test data is as follows:

- A SWL depth of 18.9 ft brp was recorded by the pumper before the test began.
- Pumping began at an initial rate of 27 gpm. After a period of 2 hours, the pumping rate was reduced to 15 gpm by the pumper. At a rate of 15 gpm, a reported "stabilized" pumping water level (PWL) occurred and the final PWL depth recorded by the pumper was reported to be 36.8 ft brp; this represents a maximum water level drawdown of 17.9 ft, after pumping for 6 hours at that reduced rate.
- Based on a final pumping rate of 15 gpm, the specific capacity of the New Well is calculated to be 0.83 gpm/ft ddn, at the time of testing.

As a result of this pumping test, the New Well was determined by RCS to be insufficient to meet the necessary peak pumping rate of 31 gpm for the project. However, based on the final pumping rate reported by LGS during this October 2016 pumping test, it appears that the New Well is capable of meeting the estimated peak groundwater flow demands of 4 gpm for the residential and landscape irrigation water demands of the proposed project (1.79 AF/yr). Therefore, RCS recommended to the Owner that a new water well be drilled and constructed onsite in an attempt to supply the future agricultural water demands of the proposed vineyards and olive grove.

## August 2017 Aquifer Testing of "Well A"

Well A was drilled and constructed by Huckfeldt in June 2017, and was subsequently subjected to a pumping test. The primary purpose of the pumping test performed in Well A in August 2017 was to determine if the well could pump at rates necessary to supply the combined irrigation demands of the proposed 17.0 total acres of vines (8.5 AF/yr) and the 2-acre olive grove (0.6 AF/yr). The total combined pumping rate needed equates to about 27 gpm, assuming 153 days of pumping per irrigation season, for 12 hours per day.

As discussed above, two nearby offsite wells were reported to be located within 500 ft of Well A. As shown on Figures 1 and 2, the "Bachich Irrigation" and "Bachich Main" wells are located approximately 180 ft east and 380 ft north of Well A, respectively. Therefore, based on this offset distance and the Napa County WAA Guidelines, a Tier 2 WAA ("Well Interference Evaluation") was required to be performed for Well A. To perform this evaluation, RCS recommended performing an aquifer test in Well A (the pumping well) and using the New Well, Bachich Irrigation, and Bachich Main wells as additional water level observation wells while pumping Well A.

The aquifer test was designed by RCS to meet the following requirements:

1. Determine if Well A can pump at sufficient rates to meet the total combined agricultural groundwater demands of the proposed vineyards and olive grove (about 27 gpm).
2. Monitor the amount of self-induced drawdown created in the pumping well by virtue of its own pumping.
3. Monitor water level recovery rates in the pumping well following the end the pumping test.
4. Monitor the amount of water level decline (i.e., water level drawdown interference) if any, that might be induced in the onsite New Well or in the nearby offsite Bachich wells by virtue of the subject pumping test of Well A.
5. Help determine the aquifer parameters of transmissivity and possibly storativity for the Great Valley Sequence rocks encountered by the onsite wells. Storativity cannot be determined using water level drawdown data from the pumping well but, instead, can be calculated only if a water level drawdown interference is induced in the other onsite water level observation well being monitored during a pumping test.

For this Tier 2 WAA, Mr. George Bachich (the neighbor and owner of the "Bachich Irrigation" and "Bachich Main" wells) was notified in advance of the recommended aquifer test for the subject Well A, and an offer was made to Bachich to have RCS monitor water levels in his wells during the testing period. RCS geologists provided a description of the upcoming aquifer testing to be performed at Well A and necessary offsite water level monitoring protocols for a basic Tier 2 WAA pumping test requirement. Instead, Mr. Bachich opted to obtain his own water level measurements in his wells during testing of Well A and subsequently provided those data to RCS geologists following the test.

*Test Protocol*

The logistics and protocol for the subject aquifer (pumping) test of Well A were developed by RCS geologists and provided to LGS, who was contracted by the Owner to perform the aquifer test. Key portions of that aquifer test protocol included: a 3-rate step drawdown test to help determine an appropriate rate for the constant rate pumping test; a period of water level monitoring (i.e., baseline water level monitoring) prior to the start of actual pumping test; the main pumping portion of the aquifer test for Well A; and a final period of monitoring of water level recovery following the pumping portion of the test. Provided below is a summary of the key aquifer testing protocol:

- Transducer Installation – Water level pressure transducers were installed into onsite Well A and the New Well by RCS geologists during a site visit to the subject property on August 1, 2017. No transducer was installed into the Old Well due to its age, relatively close proximity to, and similar shallow well construction as that in the New Well. A barometric pressure transducer was also installed by the RCS geologist near the wellhead of Well A. All three installed devices were operational and collected water level and/or barometric pressure readings between August 1 and 9, 2017.

  In both onsite wells, 300 psi water level transducers were installed inside the well casings; the transducer manufacturer and model type were In-Situ LevelTROLL™ 400. The accuracy of the 300 psi transducer, as reported by the transducer manufacturer, is ±0.0658 ft. The barometric pressure transducer was installed at Well A, and has a manufacturer-reported accuracy of ±0.0691 ft.

As discussed above, transducers were not installed into either of the nearby offsite Bachich wells. As described above, Mr. Bachich opted to periodically collect manual water level readings in his two wells during the subject aquifer test of Well A.

- Step Drawdown Test – The purposes of the step drawdown test were to pump Well A at different rates (or steps) for specific time periods, record water levels and pumping rates at each step, and permit analysis of the test results. Evaluation of these data then allowed RCS geologists to select an appropriate pumping rate for the subsequent 24-hour constant rate pumping test in Well A. The step drawdown test was performed on August 2, 2017.

- Baseline Water Level Monitoring – The purpose of the baseline water level monitoring was to record groundwater level fluctuations that may have been occurring in the area after the step test but prior to the constant rate pumping portion of the test. Changes in such background (baseline) water levels can occur due to natural water level fluctuations in the aquifer and/or water level declines caused by possible water level drawdown interference from other pumping wells in the area. Baseline monitoring in Well A and the New Well essentially began immediately after the end of the step drawdown test on August 2, 2017, and continued until the start of the 24-hour pumping test on August 4, 2017. During this baseline monitoring period, no onsite wells were pumped.

- Constant Rate Pumping Test – The key portion of aquifer test, the 24-hour constant rate pumping test, was performed at Well A on August 4 and 5, 2017. The well was continuously pumped at an RCS-recommended rate of 30 gpm throughout the 24-hour pumping portion of the constant rate pumping test. None of the onsite or offsite water level observation wells (i.e., the New Well and/or the offsite Bachich Irrigation and Bachich Main wells) were pumped during the 24-hour pumping test period of Well A.

  Water levels were automatically recorded in Well A and the New Well by the transducers during the Well A pumping test at a frequency of one measurement every minute; the barometric pressure transducer was recording measurements once every 10 minutes. Occasional manual water level measurements were also collected in Well A by the pumper to help corroborate the transducer-collected measurements in that well. Following review of the datasets, the collected manual measurements (via the LGS pumper) were determined by RCS geologists to be in general agreement, and thus corroborated the transducer-collected water level data.

  Manual water level measurements were collected in the offsite observation wells (Bachich Irrigation and Bachich Main) solely by Mr. Bachich using his own electric tape sounder-like device during the pumping test of Well A. These data were then provided by Mr. Bachich to RCS geologists following completion of the Well A constant rate pumping test and water level recovery period.

- Water Level Recovery Monitoring – Following the end of the pumping portion of the constant rate pumping test at Well A, water level recovery data were then collected by the transducers for an additional period of roughly 4 days at Well A and the New Well.

The transducers installed in Well A and the New Well were eventually removed from those wells by RCS geologists on August 9, 2017.

- Discharge of Pumped Groundwater – During the step drawdown test and 24-hour pumping test period at Well A, groundwater was discharged into a temporary pit that had previously been used as a discharge location for fluids generated during the well's construction and development of that well; this discharge point had been previously approved by the Owner.

### *Results of August 2017 Aquifer Test*

Water level data collected between August 1 and 9, 2017 for Well A (pumping well) and the three observation wells (New Well, Bachich Irrigation, and Bachich Main) are shown on Figure 6A, "Water Level Data During Aquifer Testing." It is important to note that, although not shown independently on the water level graphs herein, barometric pressure data were also collected during the aquifer test. Before plotting each water level graph, the transducer data for Well A and the New Well were corrected using the barometric data (that is, changes is barometric pressure were factored out of each data set, so that the graphed water level data now reflect only changes in water levels in the wells). It is also noteworthy that during the entire aquifer testing period, barometric pressure measurements in the area varied by a maximum of only 0.08 pounds per square inch (psi); this approximately equates to a water level change of only 0.18 ft.

*Step Drawdown Testing*

Testing of Well A began on August 2, 2017 at 10:00 AM, via a 9-hour, three-point step drawdown test. For this step drawdown test, Well A was pumped continuously at the RCS-recommended nominal pumping rates (or steps) of 20, 35, and 50 gpm; each of the three step rates were pumped continuously for three hours. The following summarizes the key data collected during the step test for Well A:

- Prior to turning on the pump, an initial pre-test static water level of 169.1 ft brp was recorded by the transducer in Well A.
- Using the totalizer flow dial, average pumping rates for each of the three steps were calculated to be 18 gpm, 34 gpm, and 48 gpm, for Steps 1, 2, and 3, respectively. As stated from the totalizer dial readings above, each step rate was pumped continuously for three hours (180 minutes); the pump was not turned off between each of the pumping steps.
- Pumping water levels measured at the end of each step rate ranged from 175.9 ft to 202.3 ft brp, for Steps 1 through 3, respectively. These pumping levels resulted in water level drawdowns ranging from 6.8 ft to 33.2 ft for Steps 1 to 3, respectively.
- Short-term specific capacities for the step test rates ranged from 2.64 gpm/ft ddn at a pumping rate of 18 gpm (Step 1), to 1.45 gpm/ft ddn at a pumping rate of 48 gpm (Step 3). Calculated specific capacity values in wells tend to be higher at lower pumping rates (and for shorter pumping durations) and vice versa.

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*Background Water Level Monitoring*

As previously noted, background water levels were monitored for a period of roughly 2 days in Well A and the New Well, via transducers, following the end of the step drawdown test and prior to the start of the constant rate pumping test at Well A. In addition, manual water level measurements were periodically collected in the Bachich Irrigation and Bachich Main wells strictly by Mr. Bachich during this period. Below is a summary of these pre-test (background) water level observations for each well (refer to Figure 6A):

1. Onsite Wells

- Well A – Water levels appear to still be recovering from the step drawdown test in this well during the background water level monitoring period. During this 2-day period, water levels are shown on Figure 6A to have increased between August 2 and 4, 2017 from 202.3 ft brp (i.e., the pumping water level at the end of Step 3) to 170.7 ft brp (water level prior to the start of the constant rate pumping test).
- New Well – Static water levels recorded by the transducer in the New Well during the background water level monitoring period appeared to be relatively stable and were at a depth of approximately 13.4 ft brp throughout the monitoring period.

2. Offsite Wells

- Bachich Irrigation – This Bachich well was turned off on August 3 at at 9:50 AM after reportedly pumping a total of 50 gallons. Manual water level data collected by Mr. Bachich in his Irrigation well showed that water level depth then rose from 35.0 ft brp on August 3 at 9:50 AM, to 29.8 ft brp on August 4 at 9:40 AM (prior to the start of the Well A constant rate pumping test).
- Bachich Main – Similar to the New Well, water levels in the Bachich Main well appeared to be relatively stable during the background water level monitoring period. On August 2, at 4:25 PM, a water level of 100.8 ft was measured by Mr. Bachich. The following day, on August 3 at 9:50 AM, a water level of 103.5 ft was measured by Mr. Bachich. However, this well was reportedly pumped by Mr. Bachich between 9:15 AM and 9:50 AM on August 3, and in this period a total of 1,600 gallons was pumped. After the pump was shut off on at 9:50 AM on August 3, water levels recovered to 100.9 ft brp by 12:06 PM on August 3. Water levels then remained stable at water level of 100.9 ft brp between 12:06 PM on August 3 and 9:45 AM on August 4 (just prior to the start of the constant rate pumping test on August 4).

Although the basic protocol for this aquifer test of onsite Well A included the provision that none of the onsite and offsite wells that were to be monitored for water levels during the entire test should be pumped Mr. Bachich recorded relatively short pumping events in both of his wells on August 3, during the baseline water level monitoring period (see Figure 6A). As a result of that pumping, water levels declined slightly in both Bachich Wells. However, no water level impacts caused by those short pumping events in the Bachich wells were observed in the onsite Well A or the onsite New Well. These pumping events in the Bachich wells did not compromise the results of the pumping tests.

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*Constant Rate Pumping Period*

Pumping for the constant rate pumping portion of the aquifer test for Well A began at 10:00 AM on August 4, 2017, and continued for 24 continuous hours (1,440 minutes) at an average pumping rate of 31 gpm. The pumping rate was determined from totalizer dial readings recorded by the LGS pumper throughout the pumping period.

Figure 6B, "Water Level Data During Constant Rate Pumping Test," graphically illustrates the water levels as recorded by the pressure transducer and via occasional manual water level measurements obtained by the pumper. Also shown on Figure 6 are the water level data collected from the observation wells used during this aquifer testing. Below is a summary of those data:

- Well A (Pumping Well) – A pre-test static water level of 170.7 ft brp was measured in this well just before the pump was turned on to begin the subject pumping test. After 24 hours (1,440 minutes) of continuous pumping, the maximum pumping water level in Well A was measured at a depth of 205.9 ft brp, as shown on Figure 6B. This represents a maximum water level drawdown during the 24-hour constant rate pumping test of 35.2 ft and calculates to a longer-term specific capacity for this well of 0.88 gpm/ft ddn. As shown on Figure 6B, pumping water levels in this pumping well did not appear to be completely stable by the end of the pumping test. Specifically, in the last 4 hours of the pumping period, the pumping water level in this well was decreasing at a rate of about 0.65 ft per hour. Also, this final pumping water level of 205.9 ft brp was approximately 234 ft above the bottom of the perforations in the well.

  Following pump shut-off, water level recovery data were then collected for an additional period of 4 days prior to RCS geologists removing the transducer from the well on August 9, 2017. Water levels during this time period were observed to recover to a depth of 177.1 ft brp on August 6, 2017 (24 hours after the end of the pumping period); this depth represents a water level recovery of roughly 88%. Water levels continued to increase slowly throughout the remainder of the 4-day recovery period. Water levels had recovered to a depth of 171.2 ft brp by 1:30 PM on August 9, 2017. This represents a 99% recovery of the total drawdown recorded during the pumping portion of the test (see Figure 6A).

- Observation Wells
  - New Well – Water levels in the New Well remained relatively stable during the constant rate pumping test of Well A, and only fluctuated both up and down by a couple tenths of a foot during the entire pumping period. The transducer data showed that water levels declined by roughly 0.1 ft to 0.2 ft in the first 12 hours of testing, but they then increased (rose) by 0.1 ft to 0.2 ft in the final 12 hours of testing. These are likely diurnal fluctuations in the water levels because they were observed in the days preceding and following the constant rate pumping test. Therefore, no definitive water level drawdown impact was observed in the New Well during the 24-hour constant rate pumping test at Well A.
  - Bachich Irrigation – Water levels recorded by Mr. Bachich in his offsite Bachich Irrigation well also showed no definitive water level drawdown impact while pumping the 24-hour constant rate pumping test at Well A. Water levels in the Bachich Irrigation well were reported to have increased 0.87 ft (from 29.75 ft to

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28.88 ft brp) during the 24-hour pumping period at Well A. During the first 24 hours of the subsequent water level recovery period, water levels continued to increase from 28.88 ft to 28.04 ft brp. No other water level data were collected in this well by Mr. Bachich during the 4-day recovery period.

- Bachich Main – Manual water levels collected by Mr. Bachich in his other offsite well were reported to have decreased by only 0.02 ft (from 100.92 ft to 100.94 ft brp) during the 24-hour pumping test period of Well A. An initial static water level of 100.92 ft was recorded in this well at 9:45 AM on August 4 by Mr. Bachich, just before the commencement of the Well A pumping period. Multiple water level measurements reported by Mr. Bachich remained stable at a water level of 100.92 ft from 9:45 AM on August 4 until 6:45 AM on August 5. At 6:45 AM on August 5 (15 minutes before pumping ceased at Well A), Mr. Bachich reported a slightly deeper water level measurement of 100.94 ft (0.02 ft deeper than the initial static water level). Five additional water level measurements of 100.94 ft were collected throughout the day on August 5; with the final measurement being recorded at 6:12 PM. Hence water levels appear to have been stable throughout the day on August 5. On August 6 at 6:40 AM, after Well A had been shut down for over 20 hours, Mr. Bachich measured a water level of 100.98 ft brp, 0.04 ft deeper than the water level measured roughly 24-hours prior. Hence, it appears water levels again decreased in the overnight hours.

It is unclear why the water levels in the Bachich Main well were stable during most of the daylight hours, and then decreased by small amounts overnight during both the pumping period and non-pumping period (water level recovery) during the Well A pumping test.

It is theoretically possible that the small decline in water levels in the Bachich Main well (a total decline of 0.06 ft as noted above) could have been caused by pumping Well A. Aquifers with low hydraulic conductivities, such as those that exist within the Great Valley Sequence rocks that underlie the subject property, sometimes exhibit time-delayed drawdown effects in water level observation wells. Time delayed-effects, however, do not help to explain the apparent stability of water levels in the daylight hours and the subsequent decrease in water levels overnight between August 4 and August 6 in the Bachich wells. It should also be considered that the small amount of water level decline could also merely be the result of variations in measurement, as water levels in the Bachich wells were measured by Mr. Bachich using own manual-tape sounder device.

Even if the assumption is made that that 0.06 ft of water level decline measured in the Bachich wells is attributable to pumping Well A, such a small amount of drawdown is not significant. The water level decline value of 0.06 ft is far less than the "Default Well Interference Criteria" shown on Table F-1 of the May 12, 2015 Napa County WAA Guidelines. Table F-1 (not reproduced herein) presents well interference criteria that the County may apply in the determination of "significant adverse effects" when pumping water wells are spaced less than 500 ft apart. The water level drawdown values listed in Table

F-1 of the WAA Guidelines are 10 or 15 feet (depending on a few variables), both of which are much greater than 0.06 ft of water level decline noted in the Bachich wells.

Based on the data collected during the Well A pumping test, water levels in the Bachich wells were not definitively impacted during the 24-hour pumping test of Well A — and to the extent the overnight water level decline of 0.06 ft in Mr. Bachich's wells might possibly be attributable to pumping Well A, such a decline is less than significant.

It should also be noted that Mr. Bachich contends that water levels in his two wells decreased as a result of the initial drilling operations for Well A in June 2017. On June 18, 2017, when pilot hole drilling in Well A had begun, Mr. Bachich reportedly recorded a water level of 86.7 ft brp in his Main well. Pilot hole drilling in Well A was completed to a depth of 500 ft bgs on June 19, 2017. On June 20 and 21, Mr. Bachich reported water levels of 96.3 ft and 96.8 ft brp, respectively, in his Main well. However, it is unknown if these water levels are pumping or static water levels, as those important details were not reported by Mr. Bachich. Also, it is unclear if any pumping was performed by Mr. Bachich in his Irrigation well during this period (which could have had an impact on his Main well). Importantly, no water levels were recorded or reported for Mr. Bachich's wells in the weeks or months prior to pilot hole drilling of Well A. It is also possible that water levels were declining in the region prior to the commencement of drilling Well A because water levels typically decline in virtually all wells the summer and fall months of each year. Due to the proximity of Mr. Bachich's wells to the Well A drill site, and the relatively shallow depths of Mr. Bachich's wells, it is also possible that the initial drilling of Well A impacted water levels in the Bachich Irrigation and Main wells while the borehole for Well A was drilled through the shallower portions of the subsurface. However, the pumping test performed at Well A shows that no significant connection exists with Well A. Further, as illustrated on the Figure 4 cross section, significant differences in water levels existed in August 2017 between water levels in Well A and those in the Bachich wells.

## Specific Capacity Data

A useful indicator of well performance or efficiency (in terms of changes in water level drawdown over time with respect to pumping rate) is the specific capacity of a well, which can be calculated from the results of the aquifer test or from data generated during regular periods of pumping and water level monitoring. In general, when groundwater is pumped from an active water well, a hydraulic gradient is established toward the well, and a cone of water level depression forms within the local aquifer system, with the pumping well being located at the locus (center) of this cone. In general, the greater the pumping rate (and/or the longer the duration of pumping), the greater the water level drawdown is in the pumping well (drawdown represents the vertical distance between the non-pumping, or static, water level and the resulting pumping water level in the well). As an indication of the relative efficiency or productivity of a well, the term "specific capacity" is commonly used to define the amount of water (in gallons per minute) that the well will yield for each foot of water level drawdown created while the well is pumping at a particular rate. The specific capacity of a well is calculated using the pumping rate of the well (in gpm) divided by the total water level drawdown (in ft) created in that well while pumping at that rate, and is expressed in units of gallons per minute per foot of water level drawdown (gpm/ft ddn).

The specific capacity of a well depends on several factors, including the hydrogeologic characteristics and thickness of the local aquifer system, the method of well construction, the type and degree of well development performed, the age and current condition of the casing perforations and gravel park, and the pumping rate and pumping duration of the pumping event being monitored. Hence, it can be difficult to compare specific capacity values from one well to another even if the two wells are in the same aquifer system.

During the short-term, 8-hour pumping test of the New Well in October 2016, the specific capacity was calculated to be 0.83 gpm/ft ddn. Specific capacity values of 1.29 and 2.40 gpm/ft ddn were calculated following relatively short, 2-hour pumping tests by others in the New Well in 2002 and 2015, respectively. The duration of pumping periods in these pumping tests performed in the New Well have varied significantly (between 2 and 8 hours). Longer pumping periods tend to create greater water level drawdowns than shorter pumping periods at similar pumping rates; hence, specific capacity values calculated for long-term pumping tests would, as expected, be lower than calculations resulting from relatively short-term tests, assuming the tests were conducted at similar pumping rates, as observed in the pumping tests performed in the New Well. For the 24-hour constant rate pumping test of Well A performed in August 2017, the specific capacity was calculated to be 0.88 gpm/ft ddn.

In general, the higher the specific capacity for a well, the more productive (or efficient) a well is with respect to pumping rates and resulting drawdowns. However, as stated above, the specific capacity values calculated from each of the recent aquifer tests are all considered to be low and typical for the geologic materials into which the wells were constructed. Specific capacity is useful to help evaluate changes in well performance over time, and helping to determine when a well is in need of rehabilitation.

## Calculation of Aquifer Parameters

Important aquifer parameters such as transmissivity (T) and storativity (S) can often be determined using data collected during a pumping test of a well. Transmissivity is a measure of the rate at which groundwater can move through an aquifer system, and therefore is essentially a measure of the ability of an aquifer to transmit water to a pumping well. Transmissivity is expressed in units of gallons per day per foot of aquifer width (gpd/ft). Storativity (S) is a measure of the volume of groundwater taken into or released from storage in an aquifer for a given volume of aquifer materials; storativity is dimensionless and has no units. Storativity calculations can only be made using water level drawdown data, if any, monitored in an observation well during a pumping test of another well; storativity cannot be calculated using water level drawdown data acquired solely from a pumping well.

Water level drawdown and recovery data collected from Well A during the constant rate pumping test were input into the software program AQTESOLV (version 4.5 Professional). Numerous analytical solutions were then applied in attempt to determine transmissivity values using an automatic curve fitting procedure. Typically, water drawdown data from an observation wells are used in these solutions, but as discussed above, the New Well and the two offsite wells that were monitored by others (Bachich Irrigation and Bachich Main) did not show any definitive water level drawdown during the testing period of Well A (pumping well). Therefore, only water level drawdown and recovery data collected from Well A during the August 2017 aquifer test were input in AQTESOLV. Numerous analytical solutions were then applied in an attempt to determine transmissivity values using both automatic and manual curve fitting procedures. The solutions utilized consisted of unconfined, confined, semi-confined, and/or fractured aquifer solutions. Several variations of these solutions were analyzed by RCS.

Also, certain assumptions must be made about the aquifer when using these solutions. In general, for the solutions listed below, key assumptions are: that the aquifer has an infinite areal (lateral) extent; that the pumping well fully penetrates the aquifer system(s); and that water is instantaneously released from storage with the decline of hydraulic head. Also, for the purposes of this analysis, the assumption is made that the saturated aquifer thickness at Well A is 270 ft. This was determined by taking the vertical distance between the static water level in Well A (prior to the start of the recent testing) and the bottom of the casing perforations in Well A.

Shown below are the two curve-fitting solutions used, the transmissivity values calculated, the figure number in this Memorandum on which the water level data and fitted-curve are presented, and additional assumptions about the aquifer inherent in the solution. In both cases below, a storativity value could not be calculated because no definitive drawdown data were observed in the monitoring wells.

- Theis/Hantush – Figure 7A, "Constant Rate Pumping Test Analysis, Theis/Hantush Solution, Confined Aquifer, Well A (Pumping Well)." – As shown on the figure, the curve for the confined aquifer solution has been the "best fit" to the later time portion of the water level data acquired during the test and during the water level recovery period in pumping Well A. A transmissivity value of approximately 291 gpd/ft is calculated for these data. The Theis (1935)/Hantush (1961) solution assumes numerous conditions, including that the aquifer is isotropic (the same in all directions).
- Hantush-Jacob – Figure 7B, "Constant Rate Pumping Test Analysis, Hantush-Jacob, Leaky Aquifer, Well A (Pumping Well)." – As shown on the figure, the curve for the confined aquifer solution has been reasonably matched to fit much of the water level drawdown and recovery data acquired during the pumping test of Well A. A transmissivity value of approximately 260 gpd/ft is calculated for these data. The Hantush-Jacob (1955) solution assumes numerous conditions, including that the leaky aquifer is isotropic (the same in all directions).

Based on the two analytical solutions described above, transmissivity values ranged from roughly 260 gpd/ft to 291 gpd/ft; storativity values could not be determined since there was no definitive water level drawdown monitored in any of the observation wells (the onsite New Well and/or the offsite Bachich Irrigation and Bachich Main wells). As noted previously, storativity cannot be calculated using water level data solely from the well being pumped during an aquifer test.

Based on the analytical solutions performed above, transmissivity values were determined to be low. This reveals the Great Valley Sequence rock aquifer systems into which Well A and the other shallower-onsite wells are constructed are of limited areal (horizontal) extent, or lack abundant interconnected fractures beneath the property. In similar analyses done for other RCS projects for wells constructed within these Great Valley Sequence rock materials, transmissivity values have varied from about ±5 gpd/ft to ±300 gpd/ft. Therefore, the transmissivity values determined from the recent aquifer testing performed in Well A fall within this range.

An independent evaluation of transmissivity (T) as described in Driscoll (1986), using data from the subject pumping test, were made via the empirical relationship $T \approx 1{,}750*(Q/s)$, where (Q/s) is the specific capacity of the pumping well and 1,750 is an empirical constant for the semi-confined aquifer system assumed to exist in the rocks of the Great Valley Sequence. Applying this relationship to the specific capacity value calculated for the subject pumping test of Well A yields a transmissivity value on the order of 1,540 gallons per day per foot (gpd/ft). This theoretical

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transmissivity value appears to be much higher than those determined via the analytical solutions using AQTESOLV and the pumping test data. This empirical method to estimate transmissivity only considers drawdown and does not factor in any water level recovery, whereas the curve-fitting solutions used in AQTESOLV utilize both drawdown and recovery to determine transmissivity. Transmissivity values determined by the curve-fitting solutions are considered to be more representative of the regional spatial area and more indicative of long-term pumping conditions. Transmissivity values calculated solely from specific capacity data are more represented of the local aquifer conditions specific to each well.

## Rainfall

Long-term rainfall data for the subject property are essential for estimating the average annual groundwater recharge that may occur at the subject property. Average annual rainfall totals that occur specifically at the subject property are not directly known, because no onsite rain gage exists. However, a nearby rain gage exists approximately ½ mile southeast of the subject property, along Mt. Veeder Road. Data for this gage are available from the Napa One Rain website (Napa One Rain, 2017), maintained by Napa County, and the gage is named "Redwood Creek at Mt. Veeder." Data from the Napa One Rain website for this gage are available for water year (WY) 2000-01 (October 2000 – September 2001) through WY 2016-17 (October 2016 – September 2017). Note that there are several days of rainfall data missing between June 6 and September 4, 2008, and between July 31 and August 31, 2013. It is assumed that because these missing days are during the drier summer month periods, no rainfall was recorded at this gage at those times. The average annual rainfall for WY 2000-01 through WY 2016-17 at this gage is calculated to be 35.9 inches (2.99 ft). This rain gage is located at a slightly lower elevation (360 ft asl) than that of the subject property (between ±420 ft and ±1,000 ft asl), and therefore the average annual rainfall at the subject property could be slightly higher than that experienced at this gage. However, the data record for this gage is short (only 17 years in duration), and RCS does not consider these data to be representative of the long-term annual average rainfall in the area surrounding the subject property.

Another nearby Napa One Rain gage also with a relatively short rainfall record (17 years) was found to be located near Mt. Veeder, approximately 2½ miles northwest of the subject property. Data for this "Mt. Veeder" rain gage are available for WY 2000-01 through WY 2016-17. The average annual rainfall at this "Mt. Veeder" rain gage for the 17-year period of record is calculated to be 44.3 inches (3.69 ft). Because the period of rainfall record for this gage is short (17 years) and includes several years of drought, RCS does not consider these data to be representative of the long-term annual average rainfall in the area surrounding the property. This rain gage is also located at a higher elevation (1,750 ft asl) than that of the subject property, and therefore the average annual rainfall at the subject property is likely to be lower than that experienced at this gage.

The nearest rain gage with over 100 years of available data exists roughly 6 miles southeast of the subject property. Data for this gage are available from the California Data Exchange Center (CDEC) website (CDEC, 2017), maintained by the California Department of Water Resources (DWR), and the gage is named "NSH – Napa Fire Department" (NSH). Data for this CDEC gage are available beginning in 1904, but WY 1980-81 (October 1980 – September 1982) and WY 1981-82 appear to have missing data. As part of this analysis, RCS removed those water years with missing data from the data set before calculating an average annual rainfall for this gage.

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Note that RCS only removed these missing water years; no rainfall was "added" to the data set. With these assumed missing water years removed from the data set, an average rainfall of 24.5 inches (2.04 ft) is calculated for this CDEC NSH rain gage for WY 1904-05 through WY 2016-17. This rain gage is located at a lower elevation (±60 ft asl) than that of the subject property, and therefore the average annual rainfall at the subject property is likely to be higher than that experienced at this known gage location. Also, because this rain gage is located 6 miles southeast of the subject property, it is less likely that these data are representative of the long-term average annual rainfall at the subject property.

To help corroborate the average annual rainfall data derived from the CDEC and/or Napa One Rain gages, RCS reviewed the precipitation data published by the PRISM Climate Group at Oregon State University. This data set, which is freely available from the PRISM website (PRISM 2017) contains "spatially gridded average annual precipitation at 800m grid cell resolution." The date range for this dataset includes the climatological period between 1981 and 2010. These gridded data provide an average annual rainfall distributed across the subject property. Using this data set, RCS determined that the average rainfall for the subject property for the stated data range is 34.1 inches (2.84 ft).

An additional rainfall data source, an isohyetal map (a map showing contours of 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 (Napa County 2017). As described in the metadata for the file (also available via the Napa County GIS database, 2017), 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 rainfall contours on the map. Based on our interpretation of the actual isohyetal contour map (no 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," shows a comparison of the data collected from the different rainfall sources discussed above. Based on the various rainfall data sources described herein and summarized on Table 2, RCS will conservatively assume that the long-term average annual rainfall at the subject property is 34.1 inches (2.84 ft), as derived from the PRISM data set. The 34.1-inch per year estimate is based on the data source with a relatively long period of record (29 years) and is site-specific, when compared to the nearby rainfall data sources discussed above that exist at different elevations, have relatively short periods of rainfall record, and/or exist at greater distances from the subject property.

## Estimate of Groundwater Recharge

Groundwater recharge on a long-term average annual basis at the subject property can be estimated as a percentage of average rainfall that falls on the subject property and becomes available to deep percolate into the local aquifers over the long-term. The actual percentage of rain that could be available for deep percolation into the groundwater can be variable based on numerous conditions, such as the slope of the land, the soil type that exists at the property, the evapotranspiration that occurs on the property, the intensity of the rainfall, etc. Therefore, various analyses of deep percolation of rainfall into the local bedrock and/or Great Valley Sequence rocks have been reviewed for this analysis, including work by other consultants and governmental agencies.

Estimates of groundwater recharge as a percentage of rainfall are presented for a number of watersheds in Napa County in the report titled "Updated Napa County Hydrogeologic Conceptual Model" (LSCE&MBK, 2013) prepared for Napa County. Watershed boundaries within Napa County are shown on Figures 8-3 and 8-4 in that report. At the request of RCS, those watershed boundaries were provided to RCS by MBK Engineers (MBK) via email. Figure 8, "Watershed Boundaries," was prepared for this project using those watershed boundaries. As shown on Figure 8, the subject property is almost entirely located within the watershed referred to by MBK as "Redwood Creek"; roughly 3 acres in the north eastern portion of the subject property are located within the "Napa River near Napa" watershed. However, for the purposes of our recharge calculation we conservatively assume that entire subject property is located within the Redwood Creek watershed. As shown on Table 8-9 on page 97 of the referenced report (LSCE&MBK, 2013), 10% of the average annual rainfall that occurs within the "Redwood Creek" watershed was estimated to be able to deep percolate as groundwater recharge.

As stated above, the ground surface area of the subject property is 115.4 acres. Assuming a conservative value of 34.1 inches (2.84 ft) of rain falls on the property on a long-term average annual basis, then the total volume of rainfall available for deep percolation over the long term is approximately 327.7 AF (115.4 acres x 2.84 ft). Assuming 10% of that average annual rainfall could deep percolate to the groundwater beneath the subject property, then the average annual groundwater recharge at the subject property would be approximately 32.8 AF/yr.

A Phase 2 Water Availability Analysis was performed for the Woolls Ranch property (LSCE 2014), which is located on an adjacent parcel to the south of the subject property. Notably from that published report was the existence of three test holes that were drilled on the western side of the Woolls Ranch property; the location of each of these test holes is shown on Figures 1, 2, and 3 of this Memorandum. These test holes were reported as "dry holes" and were not completed as water wells. Also, as described in their report and shown on a LSCE-prepared geologic cross section (LSCE 2014), due to the lack of subsurface geologic data, the hydrogeology between those test holes and the nearby Woolls "Pond Well" is relatively unknown. Due to the proximity of the western portion of the subject P+M Vineyards property, rainfall recharge may also be somewhat limited in those areas. In addition, because of the unknown hydrogeologic conditions described by LSCE 2014, RCS excluded from recharge estimates a similar portion of the subject property. To present a conservative analysis, RCS reduced the area of the subject property that may be available for deep percolation of rainfall. Figure 9, "Conservative Recharge Area," illustrates the portion of the subject property available for deep percolation of rainfall as part of our conservative estimate. This conservative recharge area generally occupies only the northeastern one-third of the subject property. The southern boundary of this conservative recharge area was determined from information gleaned from geologic cross sections presented in the Woolls Ranch WAA (LSCE 2014). The strike (or orientation) of this southern boundary was determined by RCS based on bedding attitudes reported on geologic maps (USGS 2007). In total, only 44.1 acres of the 115.4-acre subject property were conservatively assumed to be available for rainfall recharge.

Assuming the total area available for rainfall recharge at the property is only 44.1 acres, and assuming 10% 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 12.5 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, analysis of those effects is provided below.

Many basic geologic references assume 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 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, and 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 as a function of slope angle/percentage.

Estimates of the deep percolation of rainfall for the entire "Redwood Creek" 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 3, "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 conservative recharge area of the subject property. To create Table 3, deep percolation values calculated by others were adjusted with respect to slope for the entire Redwood Creek 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 than 30 degrees were calculated for the entire watershed based on the range of assumptions, those resultant percentages shown on Table 3 were applied to the subject property.

As shown in the previous section ("Estimate of Groundwater Recharge"), a conservative recharge estimate of 12.5 AF/yr was calculated for the subject property assuming a value of 10% for the deep percolation of rainfall would occur in the 44.1-acre conservative recharge area of the subject property defined by RCS. Approximately 3.8 acres of this conservative recharge area consist of slopes greater than 30 degrees (see Figure 9). Hence, if the assumption is made that the deep percolation that occurs on the 3.8 acres of the conservative 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 12.4 AF/yr; see Table 3 herein. This calculated recharge volume is still greater than the estimated future groundwater demand of 10.89 AF/yr for the subject property. Also recall that that onsite groundwater demands will be reduced significantly after an initial period of 5 years.

## Estimate of Groundwater in Storage

To help evaluate possible impacts to the local aquifer systems that may occur as a result of pumping for the proposed project, the volume of groundwater extracted for the project can be compared to an estimate of the 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 conservative recharge area (approximately 44.1 acres) . To be conservative, only groundwater in storage within the 44.1-acre conservative recharge area of the property is estimated herein.

b) Bottom of Perforations of Well A = 440 ft bgs. This represents RCS's estimation of the deepest extent of the saturated aquifer rocks beneath the property for the purposes of this analysis. Rocks of the Great Valley Sequence likely extend much deeper than the depth of Well A and it is possible that the saturated zone beneath the property could extend somewhat deeper.

c) To present a conservative calculation of groundwater in storage, we will also assume that the current saturated thickness of the aquifer(s) beneath the conservative recharge area is 270 vertical feet. This value is calculated for Well A by subtracting the transducer-measured SWL of about 170 ft brp in this well (measured in August 2017) from the reported depth to bottom of the perforations in the well at 440 ft bgs.

d) Approximate average specific yield of Great Valley Sequence rocks = 2%. Specific yield of these rocks can vary greatly depending on a number of factors, including the degree and interconnection of the pore spaces and/or fracturing within the rocks. A conservative estimate by Kunkel and Upson for the specific yield of the local sedimentary-type rocks ranged from 3% to 5% (USGS 1960). Values for the specific yield of the different rock types were discussed on page 65 and 78 of that Kunkel and Upson report (USGS 1960). Although no specific yield values are stated directly for the Great Valley Sequence rocks, comparisons can be made to the rocks types listed as "cemented conglomerate; cemented sand, gravel, and clay;" "cemented sand and boulders;" "sandrock;" and/or "sandstone" in that report (USGS 1960). For other nearby properties in similar geologic materials for which RCS has performed similar analyses, a more conservative estimate for specific yield of 1% was used. Hence, to present a conservative analysis, we will assume a specific yield value of 1% for these consolidated and/or possibly cemented rocks that underlie the subject property, although the value may, in reality, be somewhat higher.

e) Thus, a conservative estimate of the groundwater currently in storage (S), beneath the northern property (as of August 2017 water levels) is calculated as:

S = conservative recharge area (subpart a, above) times saturated thickness (subpart c, above) times average specific yield (subpart d, above) = (44.1 ac)(270 ft)(1%) = 119.1 AF

In contrast, the estimated average annual groundwater use for the proposed project is 10.89 AF/yr. Hence, the estimated groundwater demands for the project represent 9% of the groundwater conservatively estimated to currently be in storage in the rocks beneath the subject property based on water level data for August 2017. Furthermore, this 9% figure does not include annual groundwater recharge that will occur in the onsite aquifers. Based on the foregoing, the proposed project's groundwater demands should not cause a net deficit in the volume of groundwater within the aquifers beneath the site so as to impact nearby wells to a point that they would not support existing or permitted land uses. In addition, the groundwater demands for the project will also be significantly reduced when dry farming operations commence for the project beginning in year 5, and therefore will represent and even smaller percentage of the groundwater in storage beneath the subject property.

## Possible Effects of "Prolonged Drought"

California has recently experienced a period of prolonged drought. 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 Memorandum 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 account for drought year conditions.

However, to help understand what potential conditions might exist in the local sedimentary 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[2] – five years

Table 4, "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 two of the three rain gages discussed above and shown on Table 4; that drought period rainfall amount is also expressed on Table 4 as a percentage of the total rainfall that occurred. The Napa One Rain "Mt. Veeder" rain gage has been omitted from Table 4 due its short period of rainfall record (17 years); relative distance from the subject property, and limited number of drought periods available for the analysis presented in Table 4. As shown on Table 4, 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 NSH rain gage and reported by the CDEC had the lowest total rainfall at 48%, compared to the long-term average, and it lasted for two years. The WY 1986-87 to WY 1991-92 drought period lasted for six years, but rainfall during this drought was 76% of the average annual rainfall at the NSH rain gage. It is important to note that the drought year percentage listed on Table 4 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 rainfall percentage is shown to be 79% of the long-term average.

Hence, for the purposes of this Memorandum, a "prolonged" drought period rainfall is conservatively considered to be 48% of the average annual rainfall that occurred in the region (using the data from the CDEC NSH 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 4. This six-year period is a conservative estimate, because the 48%-average figure corresponds with a two-year drought period, not a six-year drought period.

As discussed previously, the property owner will implement dry farming techniques for the proposed onsite vines and olive orchards after a period of 5 years. For this calculation, RCS will conservatively assume that the first five years of the "prolonged drought" period will coincide with the initial groundwater demands estimated for the property which are higher than all subsequent years when dry farming operations begin. During this initial five-year period, the total water demand for the proposed project would be 54.45 AF (10.89 AF/yr multiplied by 5 years). For the remaining year of a six-year drought period, dry farming will require less irrigation water, and therefore, the estimated groundwater demand for the project will be 6.34 AF (4.55 AF for the vines and olive grove plus 0.75 AF for the onsite residence plus 1.04 AF for landscape irrigation). Therefore, in order to meet six years of estimated groundwater demand for the subject property, a total onsite groundwater extraction of 60.79 AF is estimated to be needed (54.45 AF in the first five years, and 6.34 AF in the sixth year). Assuming groundwater recharge is reduced to 48% of the average annual recharge during such a theoretical "prolonged drought period," then a total of approximately 36.0 AF of groundwater recharge might occur during the six-year drought period in the "conservative recharge area", as calculated below:

[2] The DWR 2015 drought document was published in February 2015, and lists the recent drought through the 2013-14 water year only; the drought continued throughout the state into the 2015-16 water year. Due to the in the 2016-17 water year, various sources, including the National Drought Mitigation Center website (NDMC 2017), declared an end to the drought in Northern California, which would include Napa County.

- From page 25 herein, a conservative estimate of the average annual groundwater recharge at the subject property is 12.4 AF/yr. Taking 48% of this annual volume yields a drought period recharge volume of 6.0 AF/yr.
- Assuming a drought period duration of 6 years, then 36.0 AF (6.0 AF/yr times 6 years) of groundwater would be able to recharge the property by virtue of deep percolation of the direct rainfall solely within the boundaries of the subject property.

Therefore, assuming a theoretical six-year drought period during which only 48% of the average annual rainfall might occur, a total recharge "deficit" of 24.79 AF (calculated by subtracting the 36.0 AF of groundwater recharge over the entire six years from the 60.79 AF of total onsite groundwater extractions over the entire 6-year period) might occur. Water to meet this deficit would be (and is) available during drought periods from the 119.1 AF of groundwater currently estimated to be in storage beneath the subject property.

As conservatively estimated above, 119.1 AF of groundwater are in storage beneath the property (as of August 2017 water levels). Hence, the six-year long drought period groundwater "recharge deficit" of 23.14 AF would represent about 21% of that volume of groundwater in storage. Temporarily removing an average of 4.13 AF of groundwater from storage every year (a total of 24.79 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 a 6-year period of time is not expected to significantly affect groundwater levels beneath the property. Recharge that occurs during periods of average rainfall would then recharge the aquifers. Again, this drought analysis is quite conservative, and assumes very extreme drought (48% of average rainfall occurring <u>every year</u> for six consecutive years), and also assumes that the finite period of higher water use at the property (years 1-5) coincides with that theoretical extreme drought.

## <u>Groundwater Quality</u>

Samples of groundwater from Well A were collected for laboratory testing by LGS near the end of the constant rate pumping test on August 5, 2017. Table 5, "Summary of Available Groundwater Quality Data," summarizes those water quality laboratory test results for Well A in August 2017. The laboratory analysis was performed by CalTest Analytical Laboratory of Napa, California. Data presented on Table 5 reveal the following with regard to the key water quality constituents of groundwater pumped from Well A:

- The character of the groundwater from the local aquifer system appears to be a sodium-bicarbonate (Na-$HCO_3$) type of water.
- Specific conductance (also known as electrical conductivity, or EC) was reported to be 650 micromhos per centimeter (µmhos/cm).
- Total hardness (TH) was reported to be 100 milligrams per liter (mg/L).
- The pH of groundwater was reported to be 8.1, indicating that the pumped groundwater is slightly basic (above pH 7).
- Nitrate (as N) was reportedly not detected (ND).
- Arsenic (As) was detected at a concentration of 4.4 micrograms per liter (µg/L).

- Boron (B) was detected at a concentration of 280 µg/L; vineyard managers typically desire a boron concentration of less than 1,000 µg/L (i.e., less than 1 part per million, ppm).
- Iron (Fe) was detected at a concentration of 55 µg/L. Iron has a State Secondary MCL of 300 µg/L for water to be used for domestic purposes.
- Manganese (Mn) was detected at a concentration of 47 µg/L. The State Secondary MCL for this constituent is 50 µg/L for domestic use.

Based on the results of the water quality testing performed for Well A on August 5, 2017, it does not appear that treatment will be needed for Well A, since this well is proposed to be used for irrigation purposes only.

## Key Conclusions and Recommendations

1. The existing property is currently developed with a single-family residence, landscaping, and 0.6 acres of vineyards. Much of the 115.4-acre property was observed to be generally undeveloped and covered by native brush, trees, and grasses.
2. Because the existing residence is currently unoccupied, existing water demands for the property consist only of the irrigation water used for the 0.6 acres of existing vines. Irrigation water for these vines in 2018 was provided by trucking water to the subject property; the Owner has reported that 17,500 gallons of water were delivered to the site in 2018. Water was trucked to the property to simplify the short term property management for the Owner, and trucking water is not proposed as part of the long term operation of the vineyard once the project is approved.
3. The proposed project consists of the development of 16.4 acres of new onsite vineyards and a 2-acre olive grove. Thus, the total proposed future vineyard area (including the existing 0.6 acres) is proposed to be 17.0 acres.
4. The future average annual groundwater demand for the entire property (including the existing domestic and landscape irrigation demands, and new vineyard and olive grove irrigation water demands) is estimated to be 10.89 AF/yr for the first five years of development. This groundwater demand estimate includes a total future vineyard irrigation groundwater demand of 8.50 AF/yr for the 17.0 acres of future vines (including 0.6 acres of existing vines), and total olive grove irrigation groundwater demand of 0.60 AF/yr for the 2-acre olive orchard. After a period of 5 years following the initial planting, dry farming techniques will be implemented at the subject property. Between 6 and 8 years, the average annual groundwater demand is proposed to be 6.34 AF/yr. After 9 years, the average annual groundwater demand will be reduced to 4.52 AF/yr.
5. All future agricultural irrigation (vineyard and olive grove) demands at the subject property will be met by pumping groundwater from Well A; the New Well will continue to be used to supply residential (domestic) and landscape irrigation demands for the onsite residence. No water is proposed to be trucked to the site in the future (once the project is approved). To meet the estimate peak groundwater demand each year, Well A would need to pump at an operational pumping rate of about 27 gpm during an assumed 153-day irrigation season. This pumping rate assumes Well A would be pumped on a 50% operational basis (pumping 12 hours per day, every day) throughout the entire 153-day irrigation season

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each year. For the New Well, the necessary pumping rate to meet the existing demands of the onsite residence and associated landscaping (1.79 AF/yr) is conservatively estimated to be 4 gpm.

6. Based on the results of the October 2016 constant drawdown pumping test in the New Well, and the August 2017 constant rate pumping test in Well A, the two wells appear to be capable of pumping at rates needed to meet the future groundwater demands of the project; both pumping tests were managed by LGS. The New Well was pumped at a final rate of 15 gpm and is required to pump at only 4 gpm for the project. Well A was pumped at an average rate of 31 gpm during its pumping test and is required to pump at a rate of 27 gpm.
7. Because there are at least two offsite wells (the Bachich Irrigation well and the Bachich Main well) located within 500 ft of the onsite Well A, a Tier 2 WAA was performed. This Tier 2 WAA included aquifer testing (step drawdown test, background water level monitoring, and a constant rate pumping test) of Well A. The 24-hour pumping test was performed on August 4 and 5, 2017. Water level measurements were automatically recorded by water level pressure transducers that were installed by RCS geologists into Well A and the New Well. Manual water level measurements were collected by Mr. Bachich in his two wells during the Well A pumping test. Results of this pumping test of Well A revealed that after 24 hours of continuous pumping at an average pumping rate of 31 gpm, a final pumping water level of 205.9 ft brp was recorded by the pressure transducer installed in Well A. Based on a static water level 170.7 ft brp, a maximum water level drawdown of 35.2 ft was created; this calculates to a current specific capacity value for Well A of 0.88 gpm/ft ddn. This depth is also approximately 270 ft above the bottom-most perforations in the well. Results of the Well A pumping test also showed that water levels did not become completely stable at the end of the pumping portion of the aquifer test. Following 24 hours of water level recovery, water levels in the well recovered to a level of 88% of the total drawdown during the testing period. After approximately 4 days, water levels reached 99% of their pre-pumping test levels.
8. During the pumping portion of the Well A aquifer test, no significant water level drawdown impacts were induced in the onsite "New Well" or either of the two nearby Bachich wells. Even if the water level decline recorded in the Bachich Main well reported by Mr. Bachich is assumed to have been induced by the pumping of Well A, the amount of drawdown reported (approximately 0.06 ft) is insignificant, and is much smaller than significance values recommended in the County WAA guidelines (WAA 2015). Additionally, as shown on Figure 4, the static water level elevation of Well A compared to those nearby Bachich wells appears to be significantly lower (as reported on August 4, 2017. Well A is separated from the Bachich Irrigation and Bachich Main wells by only 180 ft and 380 ft, respectively. The fact that these three wells are relatively proximal to each other and have significant variations in water level elevations (as shown on Figure 4) could mean the wells are constructed into and draw water primarily from different "compartmentalized" fractured rock aquifers.
9. Often, water levels in aquifer systems similar to those found beneath the subject property decline during the drier spring and summer months, when irrigation demand is higher, when rainfall recharge is low, and when wells constructed into these fractured rock aquifers are pumping. Water levels in the local aquifer systems tend to recover once the

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**MEMORANDUM**

rainy season in underway because that rainfall becomes available for deep percolation and recharge into these sedimentary rocks.

10. Groundwater recharge at the subject property on an average annual basis is estimated to be 12.4 AF/yr; this value is based on conservative estimates of average annual rainfall at the property and conservative estimates of the percentage (approximately 10.8%) of rainfall (over a long-term average annual basis) that could be available to deep percolate into the fractures and jointed rocks of the Great Valley Sequence that underlie the conservative recharge area of the property; the conservative recharge area considered for these analyses represents the northeastern third of the property (see Figure 9). 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). The estimated average annual recharge volume of 12.4 AF/yr is greater than the annual groundwater demand estimated for the subject property of 10.89 AF/yr for the first five years of the proposed project. After this initial five-year period, onsite groundwater demands will be reduced as part of the proposed dry farming operations.

11. Conservative estimates of recharge that may occur during a "prolonged drought" (as defined above) show that, over a theoretical six-year drought period in which only 48% of the average annual rainfall might occur, a total of 36 AF of rainfall recharge would occur within the boundaries of the subject property. This recharge estimate of 36 AF is less than the total estimated groundwater demand of 60.79 AF for that same six-year period. Conservatively assuming that the initial five years of the property development coincides with a period of extended drought in which only 48% of the average rainfall occurs, then about 21% of the groundwater currently estimated to be in storage beneath roughly one third of the subject property would be utilized over that entire six-year drought period. Rainfall recharge during years of average and above-average rainfall would then replenish groundwater in storage that used to meet the groundwater demand during the drought. After five years, water use at the subject property is projected to be considerably reduced once dry farming operations are implemented. Therefore, if the initial five years of development occurs during a period of normal rainfall, or if the drought period is not as severe as assumed herein, the percentage of groundwater in storage used by the project would be much less than 21%.

12. In the future, after permanent pumps have been installed in the New Well and Well A, RCS recommends monitoring of static and pumping water levels, and of the instantaneous flow rates and cumulative pumped volumes in those wells, be performed on a regular basis. By continuing to observe the trends in groundwater levels and future well production rates over time evaluated by qualified professionals, the property owner can address potential declines in water levels and well production in the area (if any).

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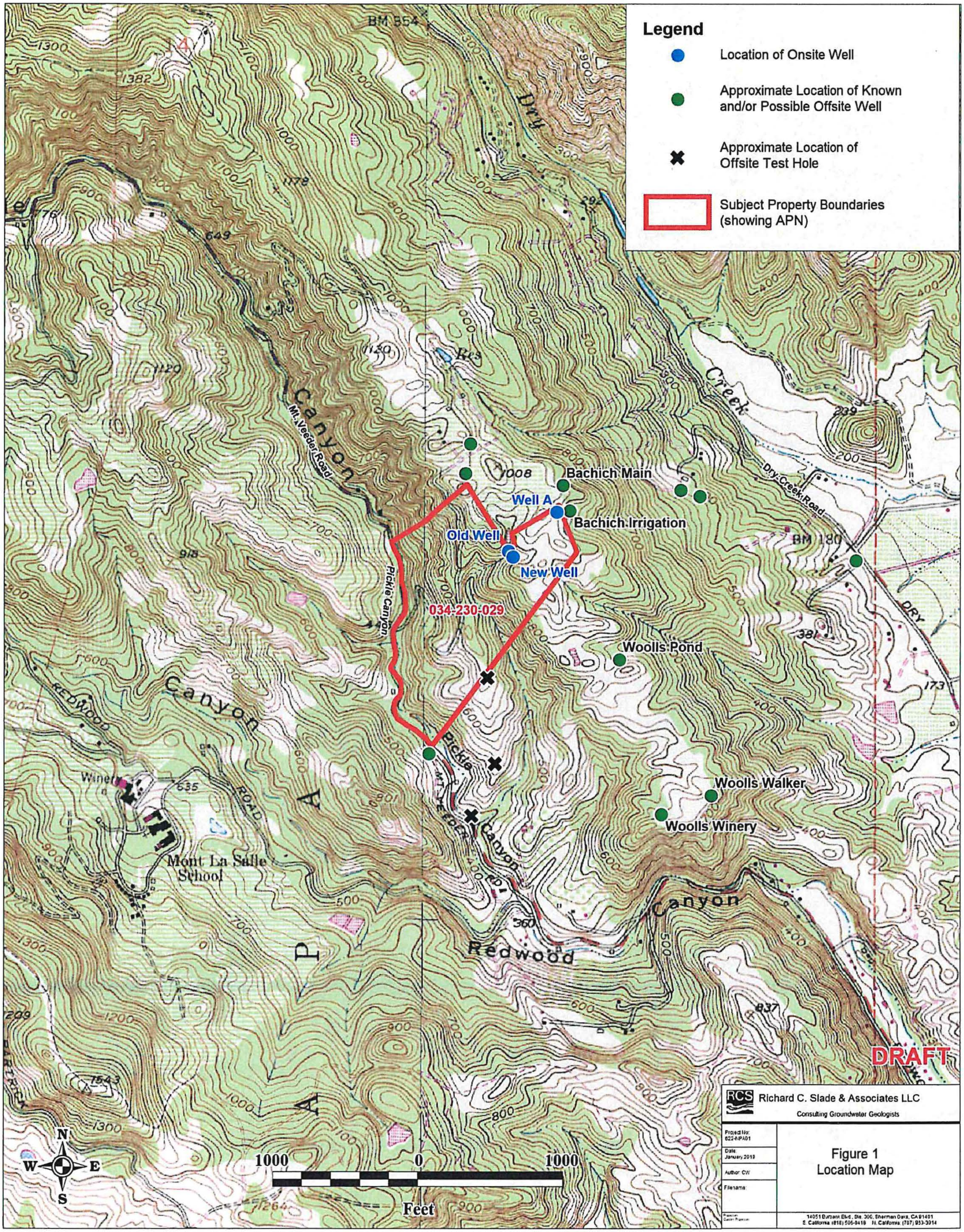
Legend
Location of Onsite Well
Approximate Location of Known and/or Possible Offsite Well
Approximate Location of Offsite Test Hole
Subject Property Boundaries (showing APN)
Bachich Main
Well A
Bachich Irrigation
Old Well
New Well
034-230-029
Woolls Pond
Woolls Walker
Woolls Winery
Pickle Canyon
Mt. Veeder Road
Canyon
Dry Creek Road
Dry
Creek
Res
Redwood
Canyon
Mont La Salle School
BM 854
BM 180
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1000
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1000
Feet
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S
E
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Figure 1
Location Map

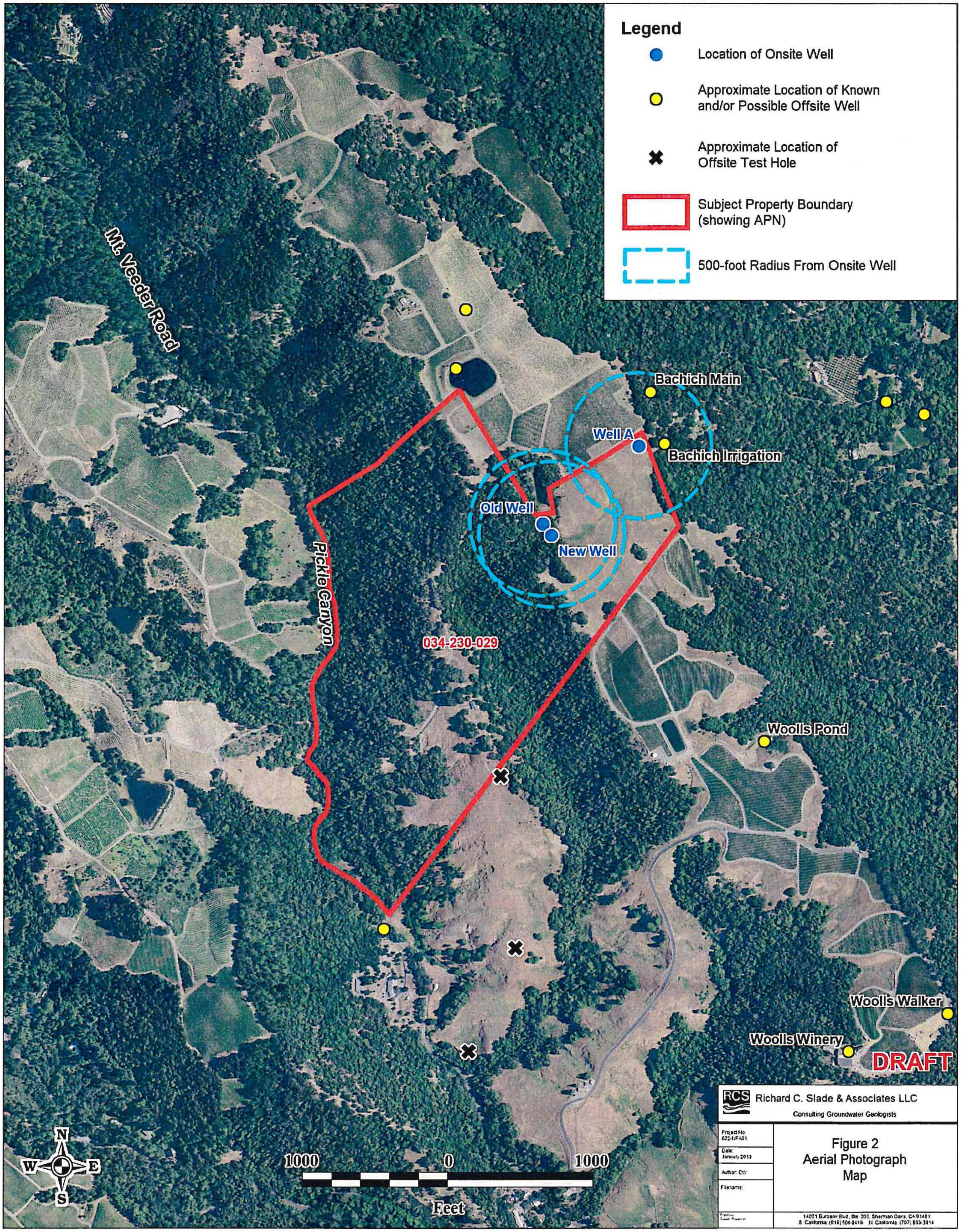
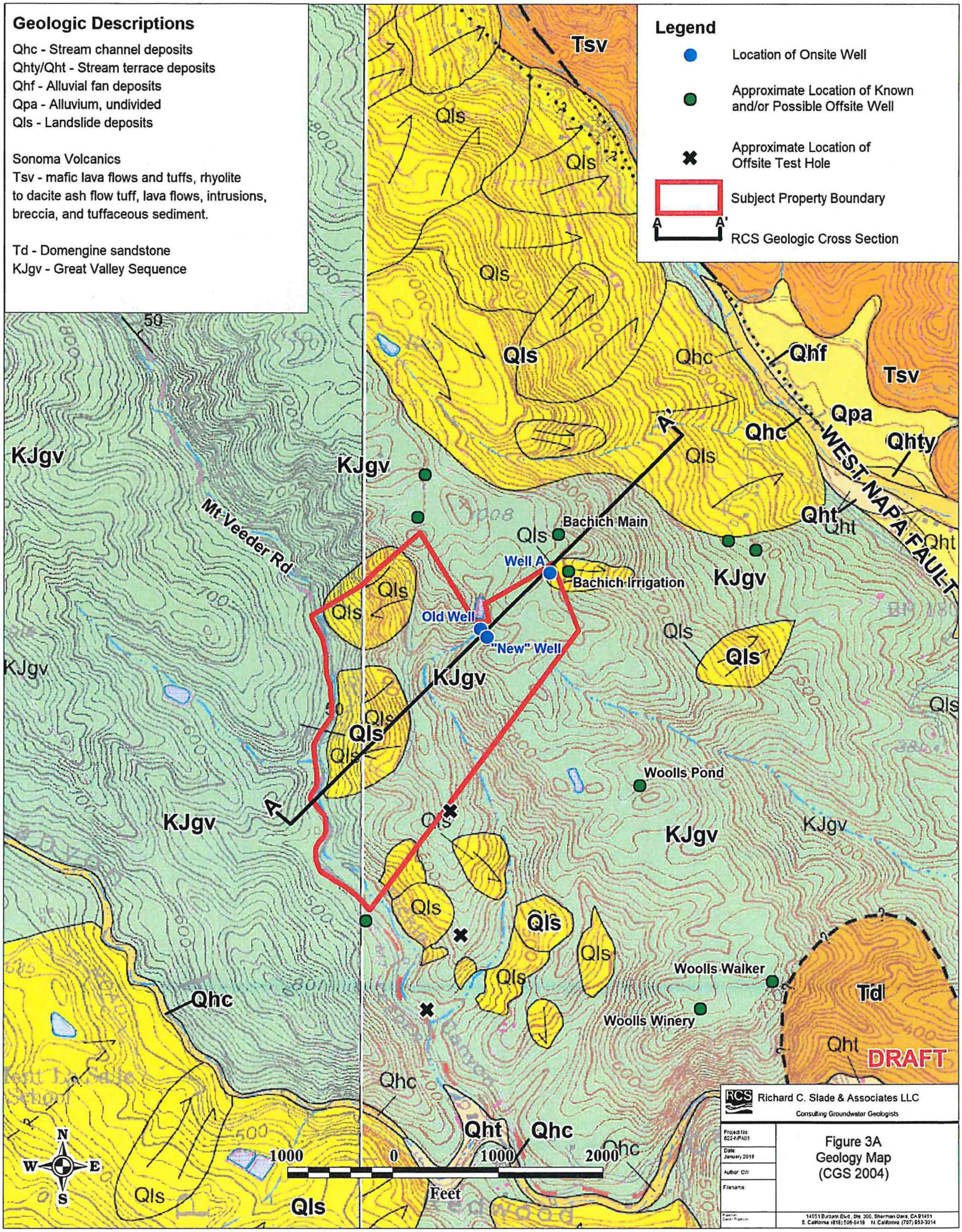


Figure 2
Aerial Photograph
Map



Geologic Descriptions
Qhc - Stream channel deposits
Qhty/Qht - Stream terrace deposits
Qhf - Alluvial fan deposits
Qpa - Alluvium, undivided
Qls - Landslide deposits
Sonoma Volcanics
Tsv - mafic lava flows and tuffs, rhyolite to dacite ash flow tuff, lava flows, intrusions, breccia, and tuffaceous sediment.
Td - Domengine sandstone
KJgv - Great Valley Sequence
Legend
Location of Onsite Well
Approximate Location of Known and/or Possible Offsite Well
Approximate Location of Offsite Test Hole
Subject Property Boundary
A A'
RCS Geologic Cross Section
Tsv
Qls
Qhc
Qhf
Qpa
Qhty
Qht
WEST NAPA FAULT
KJgv
Mt Veeder Rd
Bachich Main
Well A
Bachich Irrigation
Old Well
"New" Well
Woolls Pond
Woolls Walker
Woolls Winery
Td
DRAFT
A
A'
1000 0 1000 2000
Feet
N
W E
S
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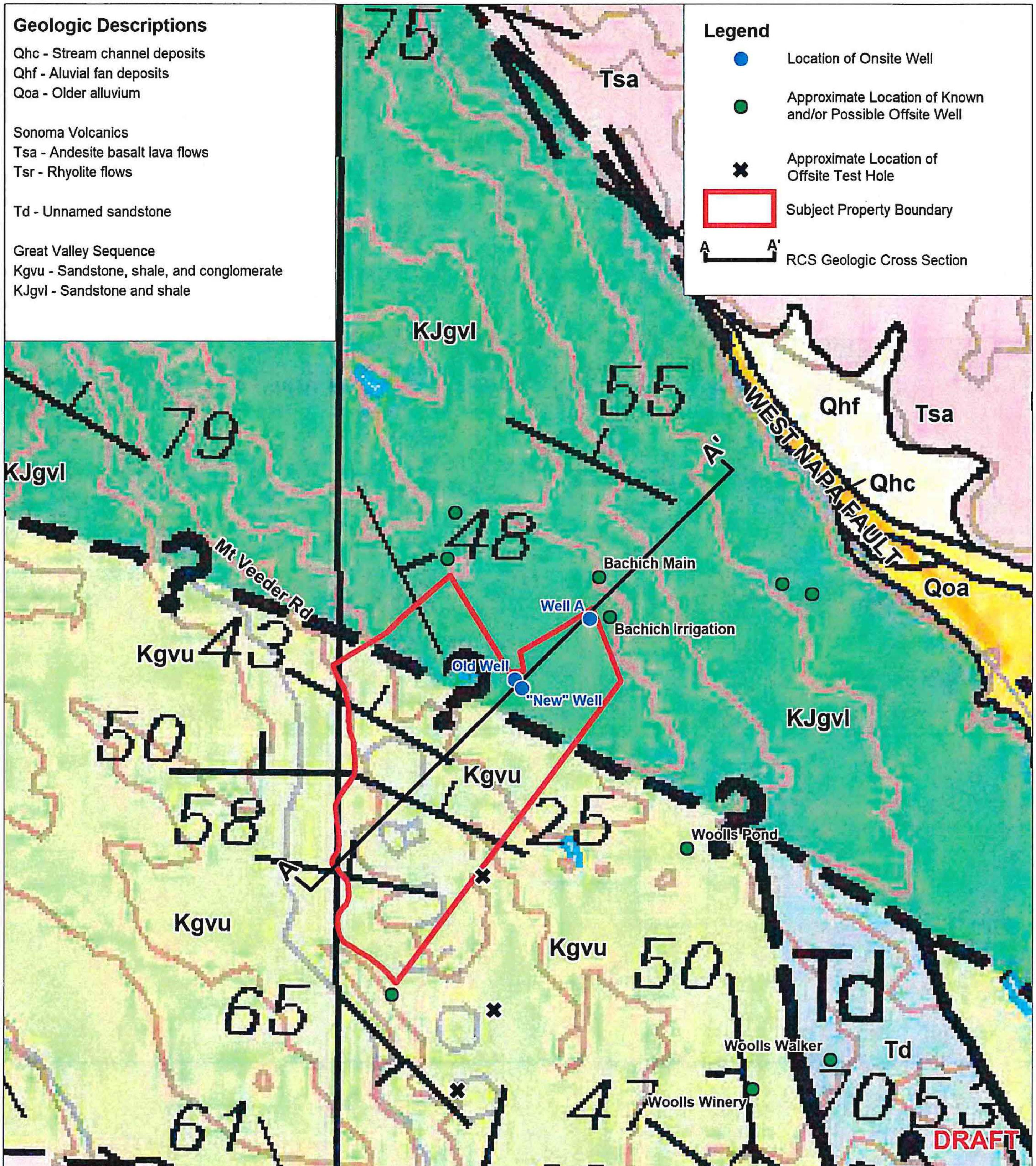
Figure 3A
Geology Map
(CGS 2004)

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| | |
|---|---|
| Project No. 622-NPA01 | Figure 3B Geology Map (USGS 2007) |
| Date: January 2019 | |
| Author: CW | |
| Filename: | |

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S. California (818) 506-0418 N. California (707) 953-3214

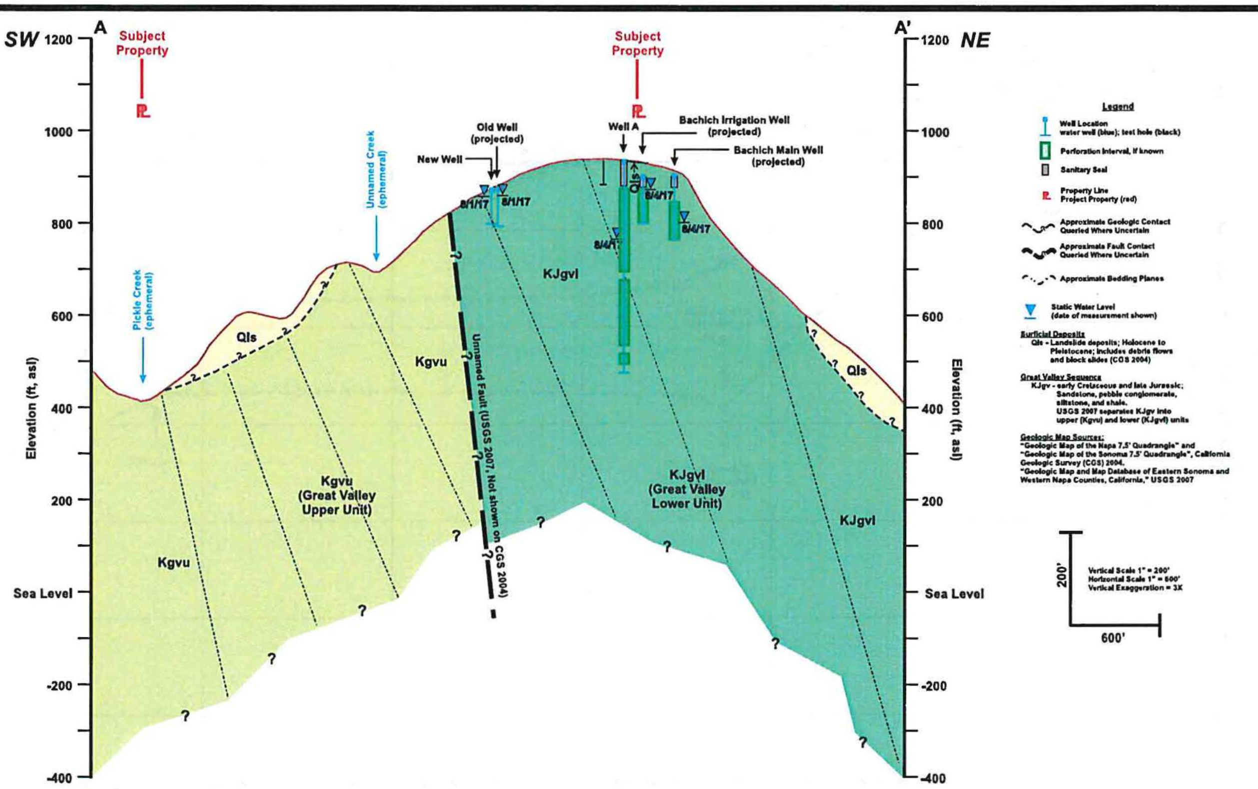


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Figure 4
Geologic Cross Section A-A'

Job No. 622-NPA01

January 2019

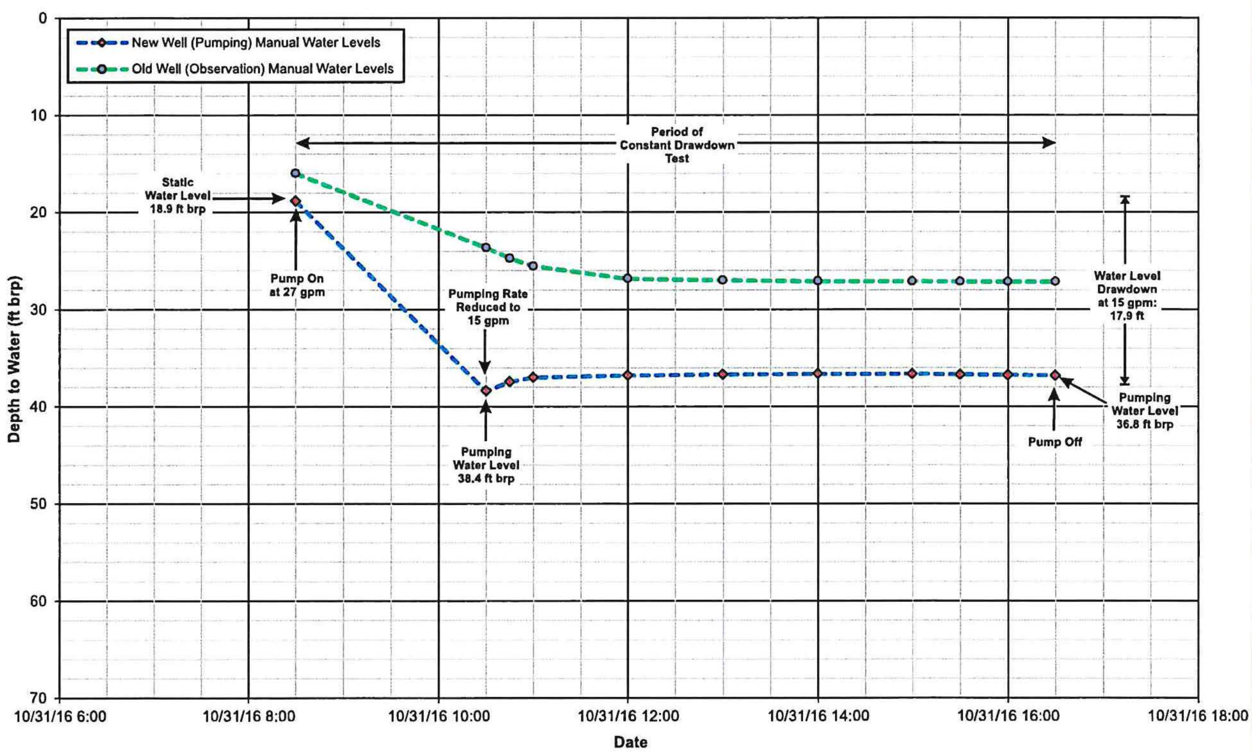



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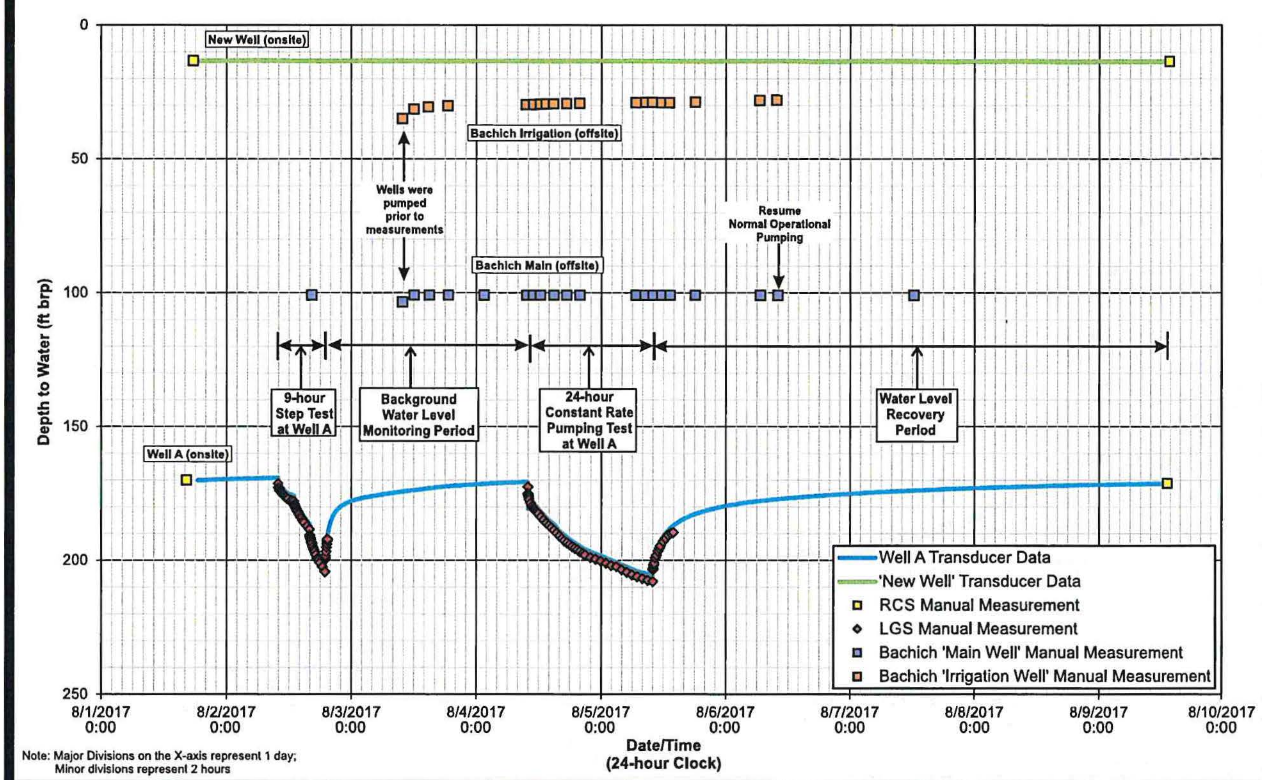
**FIGURE 5**
**WATER LEVEL DATA DURING CONSTANT DRAWDOWN TEST**
**NEW WELL**
**PROPOSED P + M VINEYARDS PROPERTY**

**Job No. 622-NPA01** **January 2019**




Note: Major Divisions on the X-axis represent 1 day;
Minor divisions represent 2 hours


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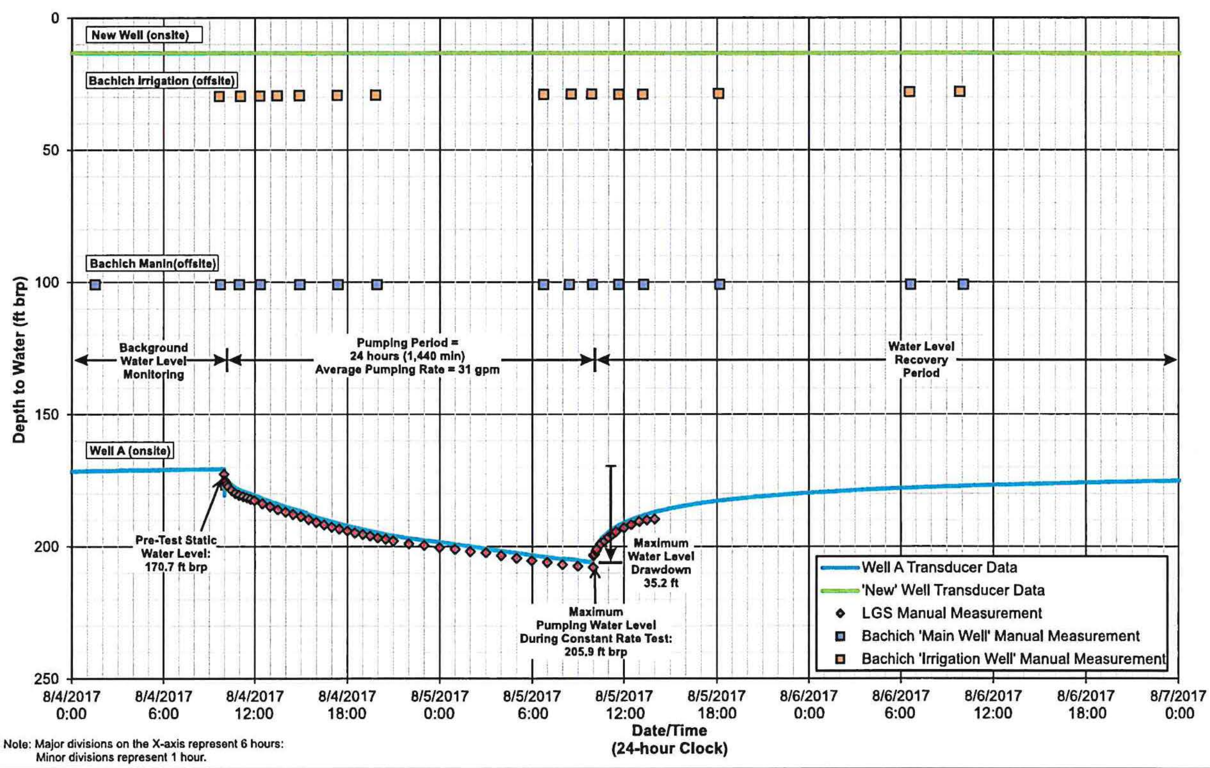
**FIGURE 6A**
**WATER LEVEL DATA DURING AQUIFER TESTING**
**PROPOSED P + M VINEYARDS PROPERTY**

Job No. 622-NPA02

January 2019




Note: Major divisions on the X-axis represent 6 hours: Minor divisions represent 1 hour.

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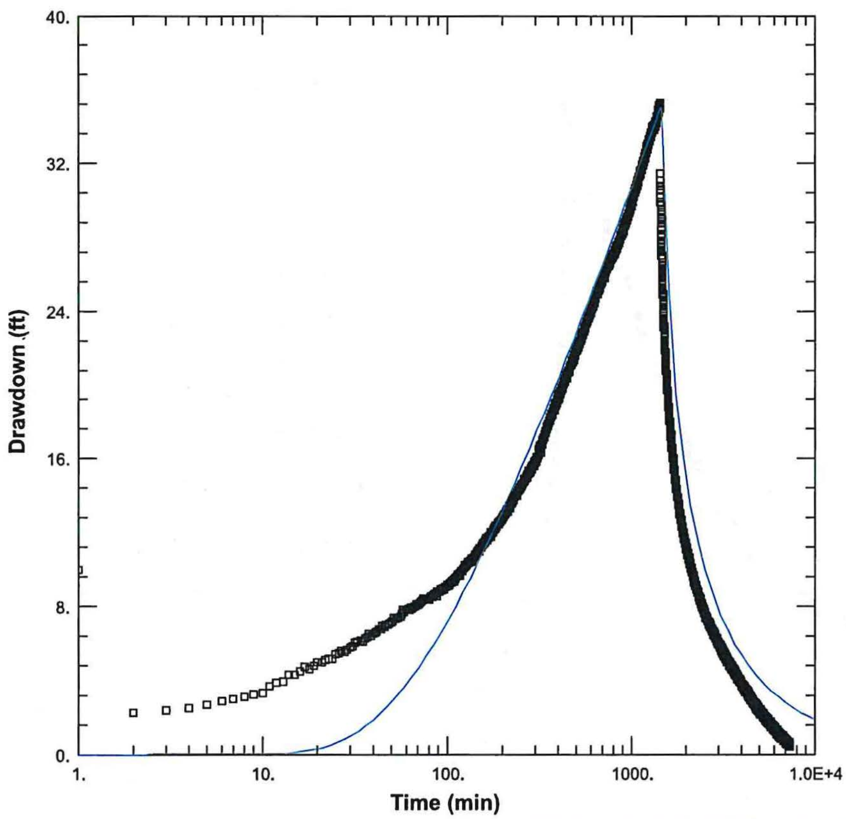
**FIGURE 6B**
**WATER LEVEL DATA DURING CONSTANT RATE PUMPING TEST**
**WELL A**
**PROPOSED P + M VINEYARDS PROPERTY**

**Job No. 622-NPA02** **January 2019**




**Obs. Wells**

□ Well A (pumping well)

**Aquifer Model**

Confined

**Solution**

Theis/Hantush

**Parameters**

T = 291 gal/day/ft

*A storativity (S) value can only be calculated from the observation well water level data.

Test Date = August 4-5, 2017 (24-hour test)

Pre-Test Static Water Level = 170.7 ft brp

Average pumping rate = 31 gpm

Graphical Solution by:
AQTESOLV Vers. 4.50 Pro
by Hydrosolve, Inc.


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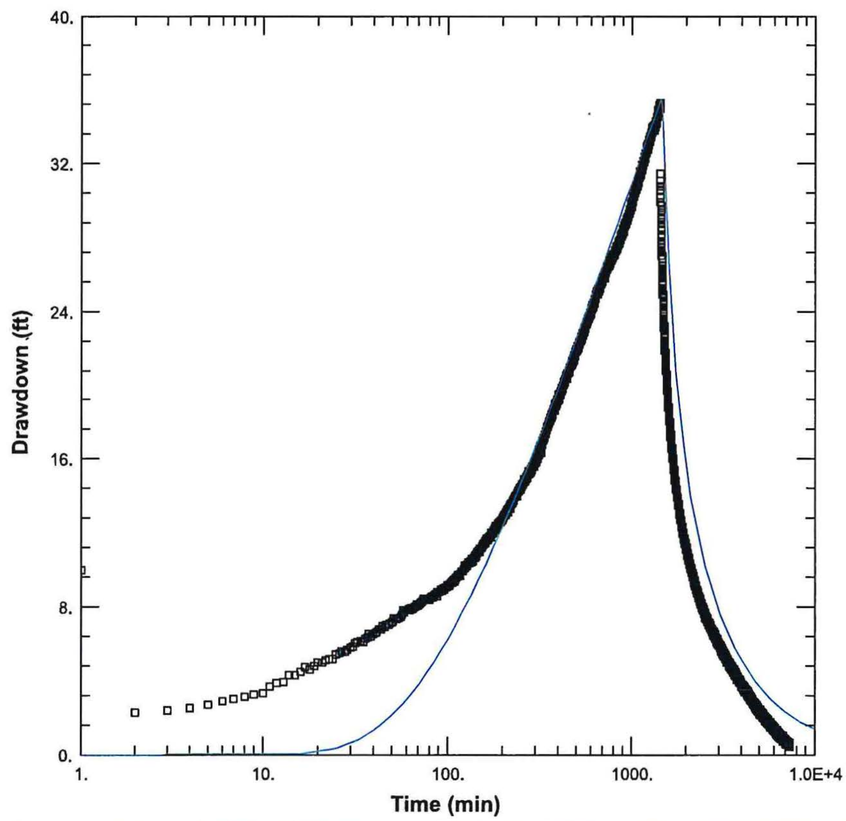
**FIGURE 7A**
**CONSTANT RATE PUMPING TEST ANALYSIS**
**THEIS/HANTUSH CONFINED AQUIFER SOLUTION**
**WELL A (PUMPING WELL)**

Job No. 622-NPA01 January 2019




**Obs. Wells**

□ Well A (pumping well)

**Aquifer Model**

Leaky

**Solution**

Hantush-Jacob

**Parameters**

T = 260 gal/day/ft

*A storativity (S) value can only be calculated from the observation well water level data.

Test Date = August 4-5, 2017
(24-hour test)
Pre-Test
Static Water Level = 170.7 ft brp

Average pumping rate = 31 gpm

Graphical Solution by:
AQTESOLV Vers. 4.50 Pro
by Hydrosolve, Inc.

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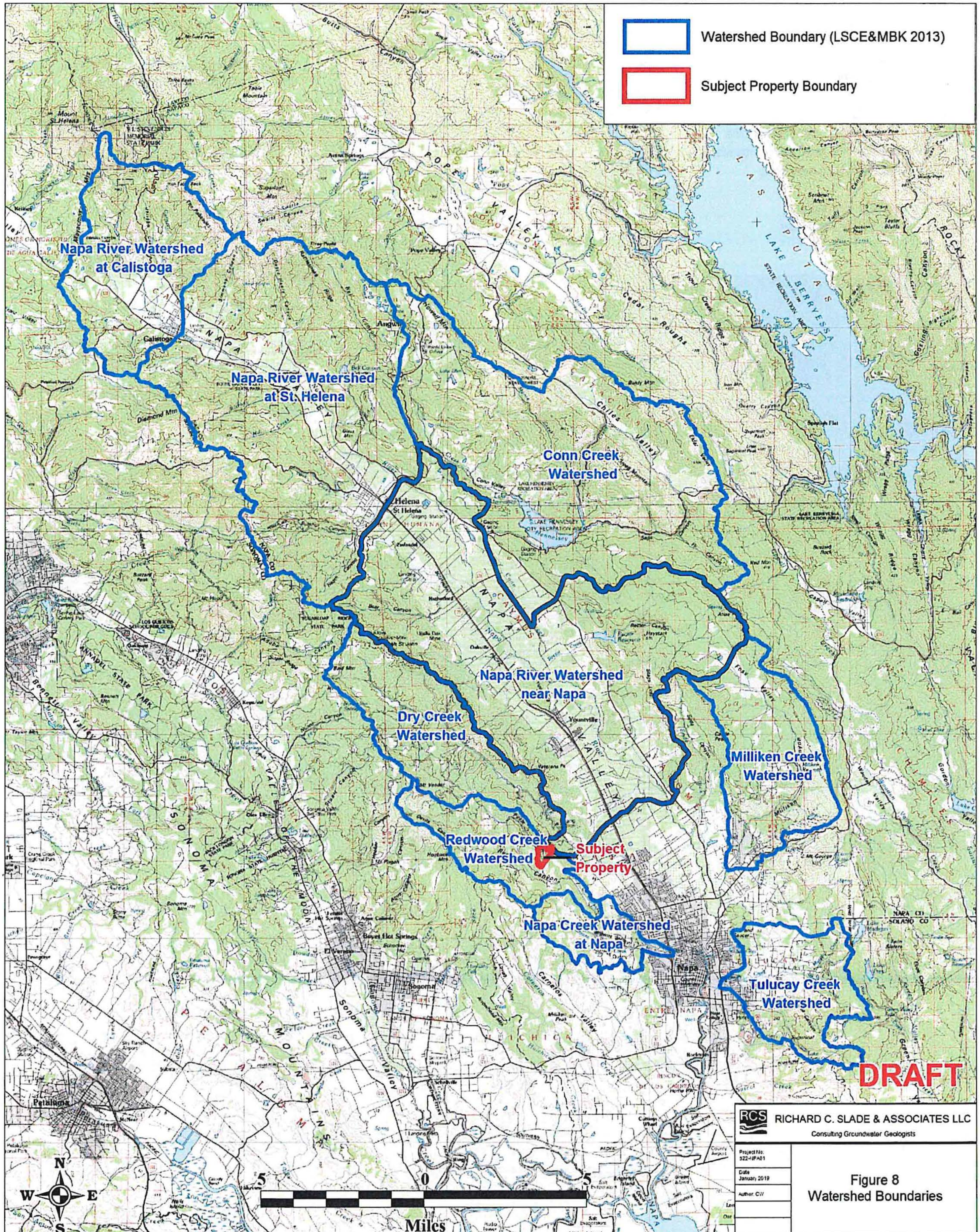
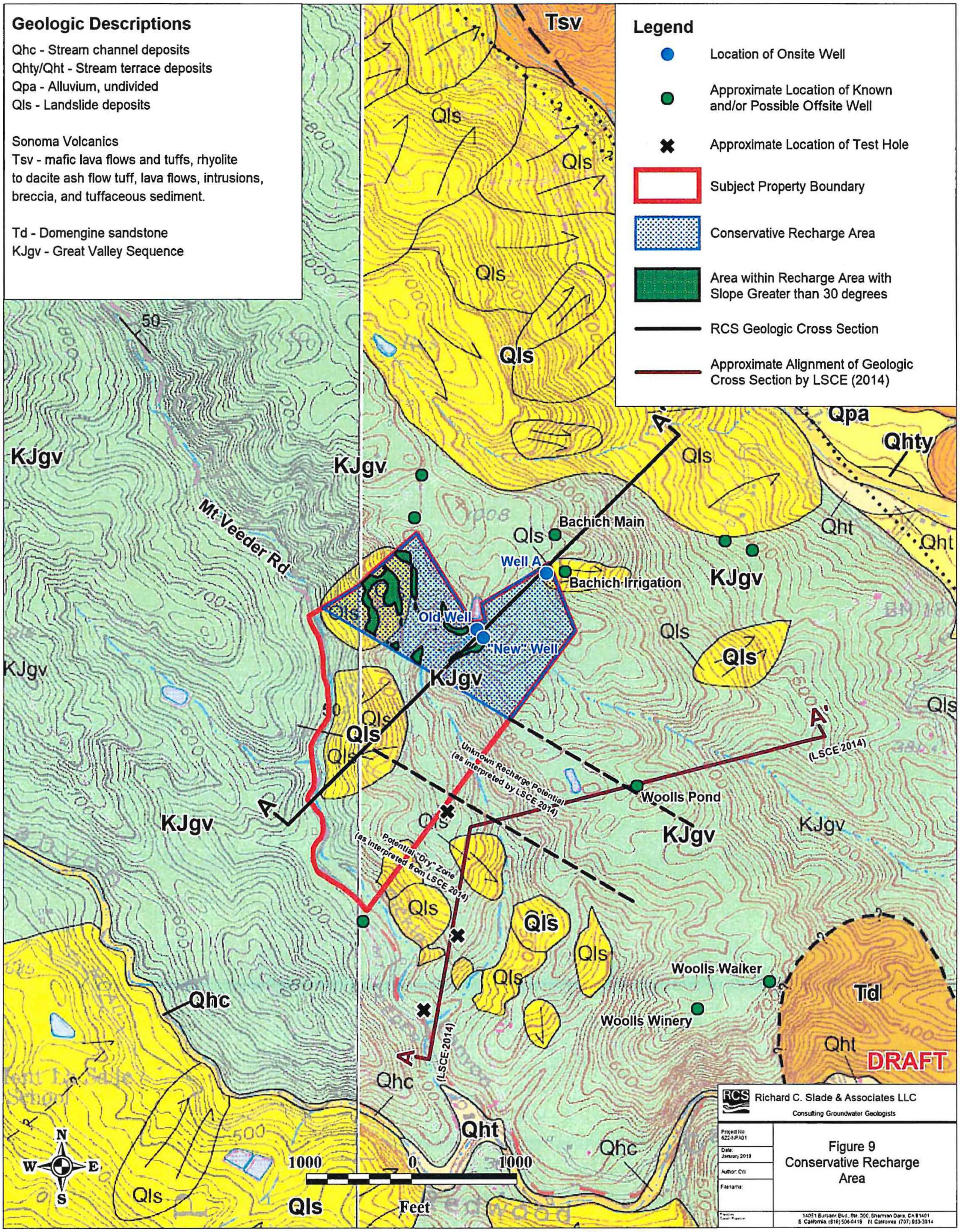
**FIGURE 7B**
**CONSTANT RATE PUMPING TEST ANALYSIS**
**HANTUSH-JACOB LEAKY AQUIFER SOLUTION**
**WELL A (PUMPING WELL)**

Job No. 622-NPA01

January 2019


Watershed Boundary (LSCE&MBK 2013)
Subject Property Boundary
Napa River Watershed at Calistoga
Napa River Watershed at St. Helena
Conn Creek Watershed
Napa River Watershed near Napa
Dry Creek Watershed
Milliken Creek Watershed
Redwood Creek Watershed
Subject Property
Napa Creek Watershed at Napa
Tulucay Creek Watershed
LAKE BERRYESSA
DRAFT
N
S
E
W
5
0
5
Miles
RICHARD C. SLADE & ASSOCIATES LLC
Consulting Groundwater Geologists
Date January 2019
Figure 8
Watershed Boundaries



Geologic Descriptions
Qhc - Stream channel deposits
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Tsv - mafic lava flows and tuffs, rhyolite to dacite ash flow tuff, lava flows, intrusions, breccia, and tuffaceous sediment.
Td - Domengine sandstone
KJgv - Great Valley Sequence
Legend
Location of Onsite Well
Approximate Location of Known and/or Possible Offsite Well
Approximate Location of Test Hole
Subject Property Boundary
Conservative Recharge Area
Area within Recharge Area with Slope Greater than 30 degrees
RCS Geologic Cross Section
Approximate Alignment of Geologic Cross Section by LSCE (2014)
Tsv
Qls
Qpa
Qhty
Qht
KJgv
Mt Veeder Rd
Bachich Main
Well A
Bachich Irrigation
Old Well
"New" Well
Unknown Recharge Potential (as interpreted by LSCE 2014)
Potential "Dry" Zone (as interpreted from LSCE 2014)
Woolls Pond
A'
(LSCE 2014)
A
Qhc
Woolls Walker
Woolls Winery
Td
DRAFT
1000
0
1000
Feet
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Figure 9
Conservative Recharge Area

## Table 1
## Summary of Well Construction and Pumping Data
## Proposed P+M Vineyards Property

| Reported Well Designation | DWR Well Completion Report 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 | Post-Construction Yield Data | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | Date & Type of Yield Data | Duration of "Test" (hrs) | Estimated Flow Rate (gpm) | Static Water Level (ft) | Pumping Water Level (ft) | Estimated Specific Capacity (gpm/ft ddn) |
| New Well | ND | | | | 72 | Steel | 8 | ND | | | | | Active | 8/2002 Pump | 2 | 22 | 15 | 32 | 1.29 |
| | | | | | | | | | | | | | | 1/2015 Pump | 2 | 12 | 13 | 18 | 2.40 |
| | | | | | | | | | | | | | | 10/2016 Pump | 8 | 15 | 19 | 37 | 0.83 |
| Old Well | ND | | | | 80 | PVC | 5 | ND | | | | | Active | 1/2015 Pump | 2 | 6 | 10 | 70 | 0.10 |
| Well A | e0345319 | Jun-17 | Direct Mud Rotary | 500 | 460 | PVC | 6 | 9 | 52 | 60-240<br>260-400<br>420-440 | Factory-Cut Slots 0.032" | 52-470 #6 sand | Active | 6/2017 Airlift | 2 | 90 | 164 | ND | ND |
| | | | | | | | | | | | | | | 8/2017 Pump | 24 | 31 | 171 | 206 | 0.88 |

Notes: ft bgs = feet below ground surface
SWL = static water level
brp = below reference point, generally top of well head

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## Table 2
## Comparison of Rainfall Data Sources
## Proposed P + M Vineyards

| 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[1] (mi) | Elevation Relative to Subject Property |
|---|---|---|---|---|---|
| CDEC NSH - Napa Fire Department | WY 1904-05 through WY 2015-17[2] | 24.5 (2.04) | 60 | 6.0 | Lower |
| Napa One Rain Mt. Veeder | WY 2000-01 through WY 2016-17 | 44.3 (3.69) | 1,750 | 2.5 | Higher |
| Napa One Rain Redwood Creek at Mt. Veeder Rd | WY 2000-01 through WY 2016-17[3] | 35.9 (2.99) | 360 | 0.5 | Lower |
| PRISM Climate Group | 1981 to 2010 | 34.1 (2.84) | --- | --- | --- |
| Napa County Isohyetal Map | 1900 to 1960 | 35.0 (2.92) | --- | --- | --- |

Notes:

1. The subject property is located at an elevation between ±420 and ±1,000 ft asl
2. Erroneous and/or missing data in WY 1980-81 and WY 1981-82.
3. Missing data in WY 2007-08 and WY 2012-13.

## Table 3
## Estimated Recharge Based on Slope Deep Percolation Assumption

| Region | Area | Average Rainfall [1] | 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 Redwood Creek Watershed** | | | | | | | | | | | | | |
| <30° Slope | 5,951 | 38.2 | 18,944 | 10.00% | 1,894.40 | 10.20% | 1,932.52 | 10.40% | 1,970.64 | 10.60% | 2,008.76 | 10.80% | 2,046.88 |
| >30° Slope | 479 | 38.2 | 1,525 | 10.00% | 152.48 | 7.50% | 114.36 | 5.00% | 76.24 | 2.50% | 38.12 | 0.00% | - |
| TOTAL = | 6,430 | | | TOTAL = | 2,046.88 | TOTAL = | 2,046.88 | TOTAL = | 2,046.88 | TOTAL = | 2,046.88 | TOTAL = | 2,046.88 |
| **"Conservative Recharge Area" of Property** | | | | | | | | | | | | | |
| <30° Slope | 40.4 | 34.1 | 115 | 10.00% | 11.47 | 10.20% | 11.70 | 10.40% | 11.93 | 10.60% | 12.16 | 10.80% | 12.39 |
| >30° Slope | 3.8 | 34.1 | 11 | 10.00% | 1.08 | 7.50% | 0.81 | 5.00% | 0.54 | 2.50% | 0.27 | 0.00% | - |
| TOTAL = | 44.1 | | | TOTAL = | 12.54 | TOTAL = | 12.50 | TOTAL = | 12.47 | TOTAL = | 12.43 | TOTAL = | 12.39 |

Note: The "Entire Redwood Creek Watershed" values are used to calculate the change in deep percolation percentage of <30° slopes based on the deep percolation volume of 3,192 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 "Redwood Creek Watershed" and "Conservative Recahrge Area of Property" per PRISM Dataset (1980-2010)

**Table 4**
**Drought Period Rainfall as Percentage of Average**

| Statewide Drought Period as Defined by DWR (DWR 2005) | Drought Duration (years) | Average Rainfall by Raingage | | | | | |
|---|---|---|---|---|---|---|---|
| | | NSH-Napa Fire Deparment, CDEC Period of Record - 1904 through Sept 2017 | | | Redwood Creek at Mt. Veeder Road, Napa One Rain Period of Record - 2000 through Sept 2017 | | |
| | | [C] Total Gage Average (in) | [D] Drought Period Average (in) | [D÷C] 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 | 24.5 | 17.3 | 71% | ND | ND | ND |
| WY 1975-76 to WY 1976-77 | 2 | 24.5 | 11.8 | 48% | ND | ND | ND |
| WY 1986-87 to WY 1991-92 | 6 | 24.5 | 18.5 | 76% | ND | ND | ND |
| WY 2006-07 to WY 2008-09 | 3 | 24.5 | 19.0 | 78% | 35.9 | 29.4 | 82% |
| WY 2011-12 to WY 2015-16 | 5 | 24.5 | 21.1 | 86% | 35.9 | 28.2 | 79% |

ND = No rainfall data available for the corresponding drought period.



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**Table 5**
**Summary of Available Groundwater Quality Data**
**Proposed P + M Vineyards Property**

| Constituent Analyzed | Units | Maximum Contaminant Level | Well A |
|---|---|---|---|
| | | **Date of Samples:** | **8/5/2017** |
| **General Physical Constituents** | | | |
| **Electrical Conductivity** | umhos/cm | 900; 1,600; 2,200(1) | 650 |
| **pH** | units | 6.5 to 8.5 | 8.1 |
| **Turbidity** | NTU | 5 | 0.9 |
| **Adjusted Sodium Adsorption Ration (SAR)** | | None | 5.5 |
| **General Mineral Constituents** | | | |
| **Total Dissolved Solids** | mg/L | 500; 1,000; 1,500(1) | 400 |
| **Total Hardness** | mg/L | None | 100 |
| **Alkalinity (Total) as $CaCO_3$** | mg/L | None | 292 |
| **Bicarbonate** | mg/L | None | 356 |
| **Calcium** | mg/L | None | 24 |
| **Magnesium** | mg/L | None | 10 |
| **Sodium** | mg/L | None | 110 |
| **Sulfate** | mg/L | 250, 500, 600(1) | 32 |
| **Chloride** | mg/L | 250, 500, 600(1) | 6.5 |
| **Fluoride** | mg/L | 2 | ND |
| **Nitrogen, Nitrate (as N)** | mg/L | 10 | ND |
| **Silica** | mg/L | None | 19 |
| **Detected Inorganic Constituents (Trace Elements)** | | | |
| **Arsenic** | µg/L | 10 | 4.4 |
| **Boron** | µg/L | 1000 (NL) | 280 |
| **Iron** | µg/L | 300 | 55 |
| **Manganese** | µg/L | 50 | 47 |
| **Zinc** | µg/L | 5000 | 370 |

**Notes:**

ND = constituent not deteceted

NL = State Notification Level

(1) The three listed numbers represent the recommended, upper and short-term State Maximum

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



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