EXHIBIT F

Water Availability Analysis
Chappellet Vineyards APN 032-560-022 and 033

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Introduction

Chappellet Vineyard LLC is seeking to plant 34.2 acres net (41.9 acres gross) of vineyard on two subject parcels with APN's 032-560-022 and 032-560-033 (Figures 1 and 2). Parcel APN 032-560-022 covers about 120 +/- acres and has approximately 12.8 acres of existing vineyard to which would be added approximately 11.2 net acres (13.7 gross acres). Parcel APN 032-560-033 is approximately 118 +/- acres and does not have existing vineyard; 23 net acres (28.2 gross acres) are proposed for new planting on this parcel. The existing vineyard is presently irrigated using primarily diverted surface water stored in reservoirs under existing water rights. The existing irrigation system is described in the water demand section of this report. The proposed new vineyard acreage will be irrigated using an existing well (Well 2, Vineyard Well) along with a new well (Well 14, location shown on Figure 2).

The Chappellet Vineyard LLC and Chappellet Winery Inc. own six additional parcels in the area (032-560-014, 032-560-015, 032-560-016, 032-560-021, 032-560-030, 032-560-031), including the two parcels with proposed vineyard areas; these eight parcels comprise approximately 605 acres (Figure 2). The Chappellet Winery, whose water supply well is located on parcel APN 032-560-031, between to two project parcels (Figures 1 and 2) has previously submitted plans to modify an existing County of Napa use permit to expand winery production, add employees, and increase the number of annual visitors to the winery for tours, tastings, and events. The impacts of that proposed change upon groundwater supply has been documented in a previous study by O'Connor Environmental dated July 27, 2018. The groundwater recharge area defined in the prior report includes the vineyard water supply well (Well 2, Figures 1 and 2) and is used again for this analysis. This report builds on the previous evaluation considering the conditions proposed by the winery project and adding the proposed changes in groundwater demand related to the vineyard expansion.

This Water Availability Analysis (WAA) was developed based on the guidance provided in the Napa County Department of Planning, Building, & Environmental Services' Water Availability Analysis Guidance Document formally adopted by the Napa County Board of Supervisors in May 2015. The WAA includes the following elements: estimates of existing and proposed water uses within the project recharge area, compilation of drillers' logs from the area and characterization of local hydrogeologic conditions, analyses to estimate groundwater recharge relative to proposed uses (Tier 1), and a screening analysis of the potential for well interference at neighboring wells located within 500-ft of the project well (Tier 2), and an analysis of potential for significant stream flow depletion of sensitive streams identified by County of Napa within 1,500 ft of project wells (Tier 3).

This document has been revised in September 2021 and January 2022 to include additional details regarding proposed project wells and an evaluation of drought water use conditions. A memorandum responding to comments detailed in a communication from Don Barrella of Napa County dated November 4, 2021, accompanies this revision. A memorandum responding to comments detailed in a communication from Don Barrella of Napa County dated December 10, 2020, also accompanied the September 2021 revision. Additionally, at the time of this revision the Chappellet Winery Use permit modification #P18-00307-MOD has been officially approved. However, all uses associated with that permit remain referenced as proposed in this report as this approval had not occurred at the time of the original completion of this analysis. The January 2023 revision incorporates a new baseline precipitation for estimating groundwater recharge instituted by County of Napa in late November 2022 and a more detailed Tier 3 analysis.

Limitations

Groundwater systems of Napa County and the Coast Range are typically complex, and available data rarely allows for more than general assessment of groundwater conditions and delineation of aquifers. Hydrogeologic interpretations are based on the drillers' reports made available to us through the California Department of Water Resources, available geologic maps and hydrogeologic studies, and professional judgment. This analysis is based on limited available data and relies significantly on interpretation of data from disparate sources of disparate quality.

Given the significant depths to water in the project wells (350 and 400ft), the relationship between groundwater recharge generated within the project parcel area and groundwater availability at the project wells is not expected to be tightly coupled. It is likely that water flowing to the project wells is primarily supplied by groundwater inflows from surrounding areas rather than from recharge occurring on the overlying landscape. Analysis of the age and sources of the deep groundwater occurring beneath the project parcel is beyond the scope of this study.

Hydrogeologic Conditions

The project parcels are located on Pritchard Hill east of Lake Hennessey on a topographic bench oriented northwest to southeast in the mountains east of the Napa Valley. The bedrock geology mapped in the area of the project parcels is typical of the uplands east of the southern half of Napa Valley. The main geologic unit mapped at the project site and intersected by the project well (Well 1) is andesitic and basaltic lava flows of the Tertiary-aged Sonoma Volcanics (Map unit Tsa, see Figure 2). This portion of the Tsa unit is part of an approximately 32 square-mile northwest to southeast oriented block bound to the north and east by a contact with the older Mesozoic-aged rocks of the Coast Range Ophiolite which is a portion of the Great Valley Complex, the Franciscan Complex, and a relatively large Quaternary landslide and to the west by overlying alluvium of the Napa Valley. The Tsa unit is part of the lower member of the Sonoma Volcanics which was described by Weaver (1949) as individual lava flows displaying great variability in thickness and texture over short distances. Given this heterogeneity it can be expected that hydrogeologic conditions exhibit similar spatial variability and yields from wells completed anywhere in the Tsa unit. Reconnaissance confirmed the mapped bedrock geology.

Rocks of the Sonoma Volcanics overlie the basement rocks of the Mezosoic-age Coast Range Ophiolite and the Franciscan Complex. Several driller’s logs including that of the project well (Well 1) report encountering serpentine at depths of 600 ft or more (Appendix A). The Serpentinite (sp) unit of the Coast Range Ophiolite is of Jurassic (144-208 My) age and is mainly sheared serpentinite but also can include harzburgite (Graymer, 2007).

The rocks of the Coast Range Ophiolite are generally considered poor aquifer material; however, successful wells of generally limited capacity are common in this highly variable geologic unit. Primary porosity in the Coast Range Ophiolite is low and groundwater occurs primarily in fractures. Well yields are variable depending on the degree of fracturing; however, yields are generally low and on the order of a few gallons per minute; dry test holes are also common within these rocks (LCSE, 2013).

In general, wells drilled in the Sonoma Volcanics tend to have low to moderate yield. Storativity in the Volcanics are reported to range from 0 to 15%(Nishikawa,2013) Typical yields range from 16 to 50 gallons per minute (gpm) with reported yields as high as several hundred gpm (LSCE 2013). Unwelded sections of tuff are considered to be good water producers (DWR 1982). Bedrock units such as the Andesite to Basalt Lava Flows (map unit Tsa) typically have low primary porosity and are only water yielding where fractured (DWR 1982).

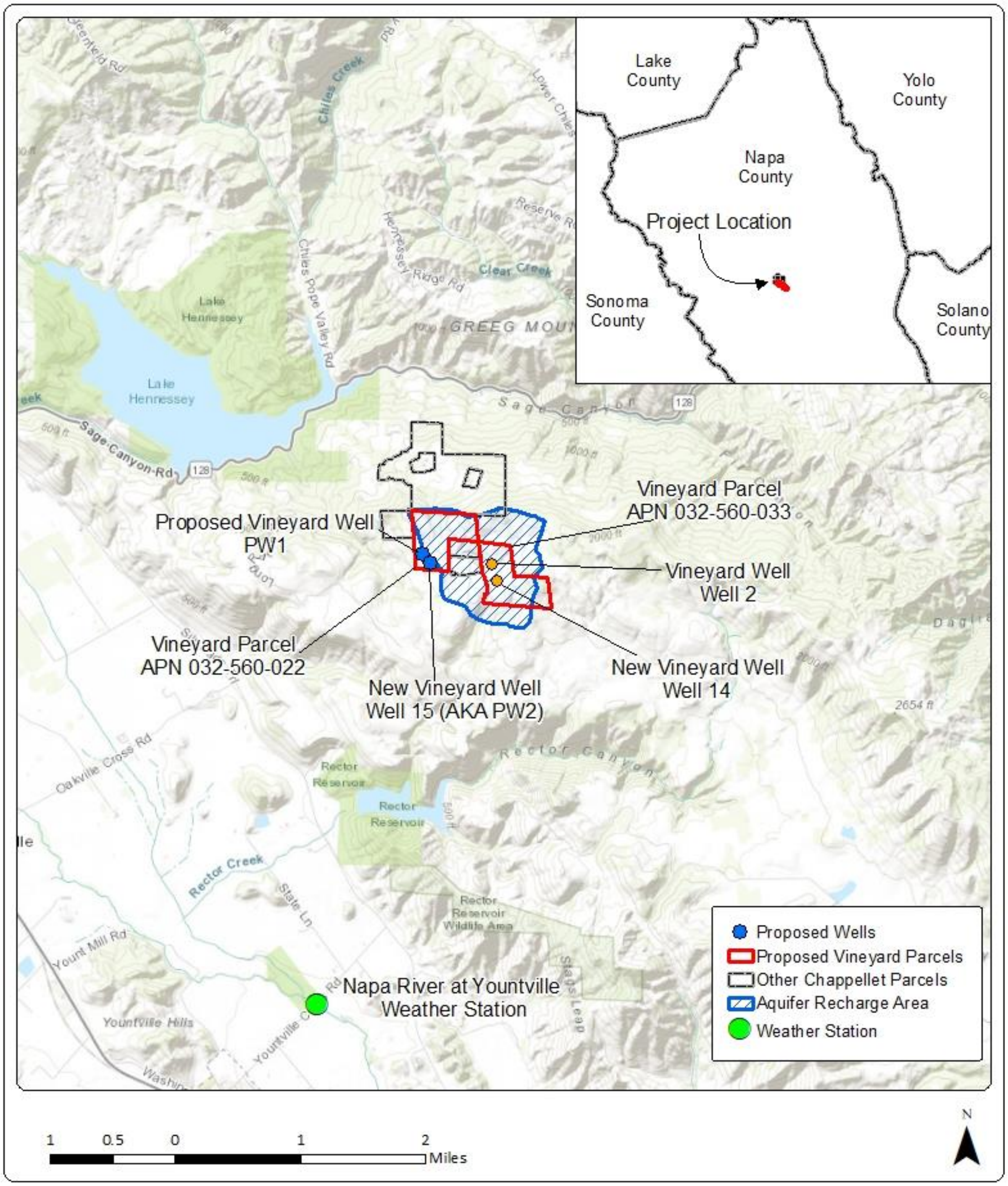


Figure 1: Project location map

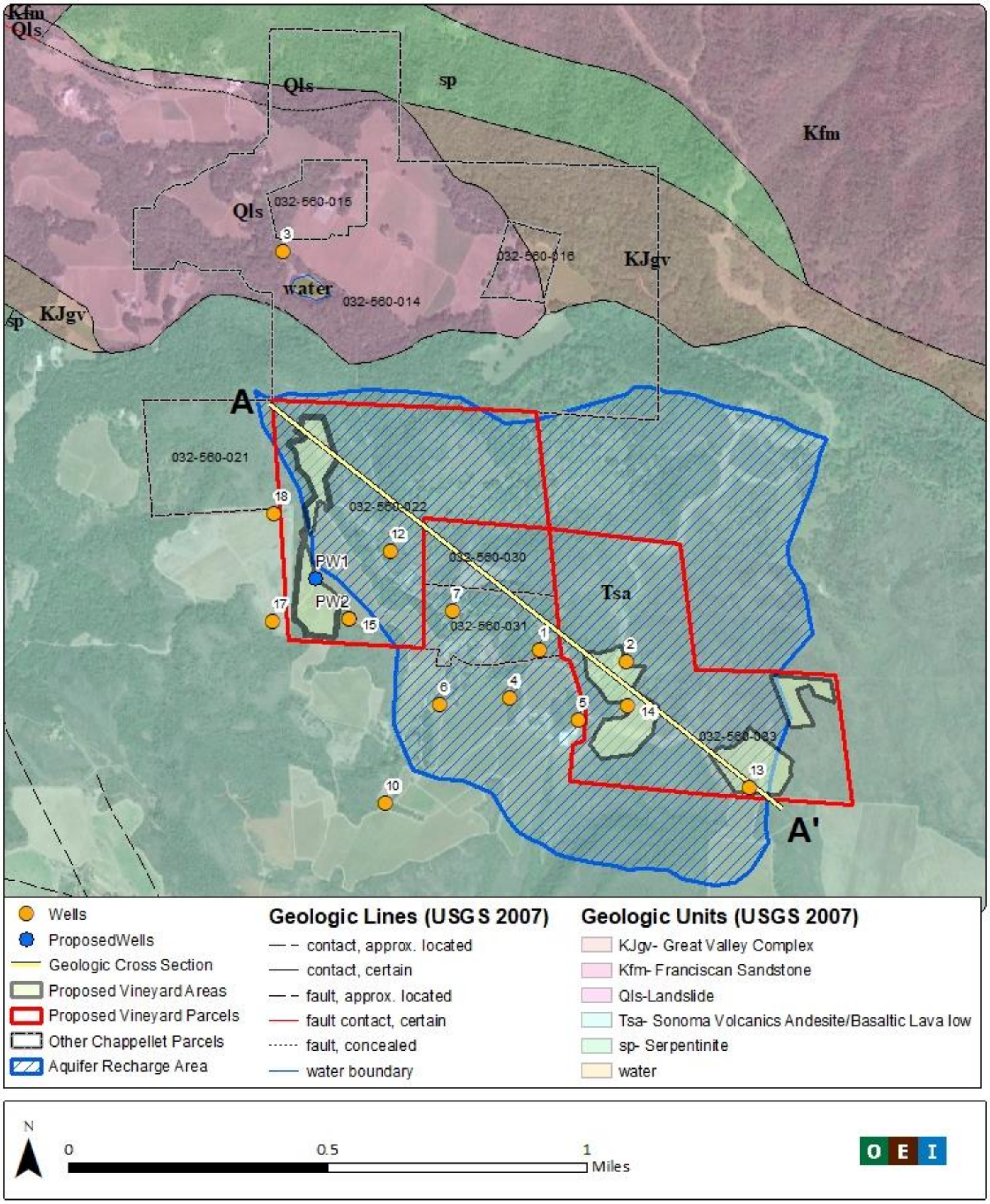


Figure 2: Surficial geology and locations of wells on and near the project parcel. Surficial geology based on data from the Geologic Map of Eastern Sonoma and Western Napa Counties (Graymer et al., 2007).

Well Data

Our search of the Department of Water Resources and County of Napa records found a total of 11 well completion reports for wells completed in similar geology and located within approximately one mile of the project parcels. Of the 11 wells, 10 were located specifically on surrounding parcels while one was only located generally in the Pritchard Hill area; data for this latter well was used to summarize local hydrogeologic characteristics but was not used in any geospatial analysis. Several well locations were identified by Chappellet staff while the remaining wells on surrounding parcels were located using the locations marked on the well logs as guidance and then confirmed using aerial photos of the area.

In July of 2018 Well 12 was drilled to 650 ft and water was first encountered at 580 ft; however, the drill rig lost equipment down the well bore and in the process of recovery the well bore was destroyed so a static water level is not reported in Table 1. A well log describing the geologic materials encountered during drilling was not available at the time of the writing of this report. Later in October of 2018 another well (Well 13, log found in Appendix A) was drilled to the southeast on the eastern vineyard parcel however no water was encountered.

After the submission of the earlier version of this WAA two new wells were proposed (PW1 and PW2 in Figures 2 and 4). At the time of this December 2022 revision both wells have been permitted by Napa County and one (PW2, now Well 15) has been constructed. Well 15 is now considered a project well in addition to Wells 2 and 14. PW1 is expected to be constructed in the next year (2023). This well, if successful, will in addition to existing Wells 2, 14 and 15, supply water to all existing and proposed Chappellet Vineyards, supplementing surface water as needed in some cases (see Water Demand and Drought Water Use Considerations sections later in this report for more details). Another two wells located on neighboring parcels that have been constructed since the original version of this report have also been added to the map and Table 1. Wells 17 and 18 are located just west of the northern project parcel. All well locations are shown in Figure 2. Applicable well information was compiled and is shown in Table 1, see Appendix A for well logs.

Most wells in the area are productive, Well 13 being the exception. Well bores range from 398 to 798 feet deep, with an average depth of about 658 feet. Geologic materials encountered in all wells are described by drillers as hard gray volcanic or dark rock interbedded with ash of varying color and/or red to brown hard rock. These descriptions are consistent with what we would expect to find in an area mapped as andesitic and basaltic lava flows within a larger geologic formation made up of various volcanic rocks. Geologic logs for all wells within the project recharge area report rocks consistent with the Sonoma Volcanics to depths of approximately 600 ft. Wells 1, 2 and 7 all report green rock or green serpentine with gray shale beginning at depths between 600 and 615 ft deep. This boundary is likely the contact between the Sonoma Volcanics and the underlying serpentinite (sp) basement rocks of the of the Coast Range ophiolite. Reported static water level for all 11 wells ranged between 240 and 565 feet below ground surface with an average depth of 401 feet. In several wells the depths at which water was encountered coincided with layers of ash or tuff and fractured basalt or andesite. Well yields reported on Well Completion Reports ranged from 10 to 150 gallons per minute, with an average of 41 gallons per minute. Typically, operational well yields are about half or less compared to yields reported on Well Completion Reports.

Table 1: Well completion details for the project well (Well 2) and nearby wells.

Well Number	1	2	3	4	5	6	7	8
Year Completed	2008	2014	1982	2010	2007	1995	1991	1992
Depth (ft)	627	625	640	798	750	620	700	398
Estimated Yield (gpm)	45	30	10	35	25	20	30	40
Static Water Level (ft)	400	350	450	420	460	400	460	249
Top of Screen (ft)	447	225	420	500	300	420	440	258
Bottom of Screen (ft)	627	625	640	798	750	620	700	398
Geologic Unit	Tsa	Tsa	Tsa	Tsa	Tsa	Tsa	Tsa	Tsa

Well Number	9	10	11	12	13	14	15	17	18
Year Completed	1988	2008	2014	2018	2018	2019	2021	2019	2019
Depth (ft)	650	755	560	650	785	670	890	820	738
Estimated Yield (gpm)	20	45	150	Lost Eqp.	DRY HOLE	25	125	250	38
Static Water Level (ft)	420	565	240	-	-	400	535	429	541
Top of Screen (ft)	440	605	280	-	-	450	530	500	518
Bottom of Screen (ft)	650	755	560	-	-	670	870	800	718
Geologic Unit	Tsa	Tsa	Tsa	Tsa	Tsa	Tsa	Tsa	Tsa	Tsa

The first project well, Well 2, known as the Vineyard Well, is located on the southern vineyard parcel APN 032-560-033. The Vineyard Well was completed in 2014 to a depth of 625 feet and had a static water level of 350 feet below the ground surface. The well is completed in materials consistent with what would be expected in the Tsa unit: “Hard gray fractured rock”, “Hard purple rock” and “Soft green ash”, “Black ash” and “White ash” down to a depth of 600 feet. At 600 feet the driller reports “Green Serpentine with Gray Shale” which is evidence that they penetrated the basement rocks of the Coast Range ophiolite. Screened intervals begin at a depth of 225 ft and alternate every 20 feet with blank casing until the bottom of the well at 625 ft. From 605 to 625 ft the casing is blank while 585 to 605 ft is perforated, therefore only 5 ft of the screened interval is within the serpentinite (sp). Due to the small section of perforated pipe within the rocks of the sp and the generally poor aquifer characteristics of the sp the project aquifer is assumed to be within the Sonoma Volcanics. After four hours of pumping the well driller reported an estimated yield of 30 gallons per minute with a drawdown of 270 ft.

Well 14, the second project well that will supply water to the proposed vineyards, is located 445 ft south of Well 2 on parcel APN 032-560-033. This well was drilled in July 2019 to a depth of 670 ft. The Geologic Log describes materials similar to those encountered in Well 2 consistent with what would be expected in the Tsa unit down to 600 feet: “Red Black clay” “Black basalt”, “Hard grey rock” and “Black red volcanics”. At 600 ft feet the driller first reports 20 ft of “Green rock Green S[e]rp[e]ntine” followed by 20 ft of “yellow rock rust signs”, 20 ft of “White ash” and a final 20 ft of “Green S[e]rp[e]ntine“ at the bottom of the borehole. Again the presence of serpentine rock is evidence that the boring penetrated to the basement rocks of the Coast Range ophiolite at 600 ft. Well 14 is screened between 450 ft and 670 ft with alternating 20 ft lengths of blank casing. Most of the screened interval intersects rocks within the Sonoma Volcanics with at most 40 ft of perforated casing intersecting serpentine (sp) rocks of the ophiolite. Due to the relatively small section of perforated pipe within the rocks of the sp and the generally poor aquifer characteristics of the sp the project aquifer is assumed to be within the Sonoma Volcanics. Depth to first water is reported as 430 ft; after development the static water level was reported as 400 ft. A four-hour air lift test was performed at the time of development with an estimated yield of 25 gpm; 100 ft of drawdown was observed.

Well 1, is also known as the Corral Well and is located about 900 ft west of Well 2 and on parcel number 032-560-031. This parcel is owned by Alexa Chappellet et al, an official easement allowing the winery to use this water is included in the 2014 Transient Non-community Water System technical, managerial and financial report by Applied Engineering (Applied Civil Engineering, 2014). The Corral Well was drilled in 2008 to a depth of 710 ft and completed to a depth of 627 ft. The geologic log describes a sequence of clays and gray rock for the first 125 ft, ash and gray rock were encountered between 125 ft and 450 ft, and hard light gray and hard green and gray rock from 450 ft to 615 ft. The sequence of rocks described to this depth is consistent with the Tsa unit. At 615 ft rocks described as “gray and green shale with streaks of serpentine” are recorded to the bottom of the hole at 710 ft, indicating that they penetrated the basement rocks of the Coast Range ophiolite. Well 1 is screened between 447 ft and 627 ft. Approximately 12 ft of the screened interval is within the serpentinite (sp). Due to the generally poor aquifer characteristics of this rock and the relatively short section of perforated well casing in the serpentinite, the project aquifer is assumed to be within the Sonoma Volcanics.

The Well Completion Report for Well 1 also indicates depth to first water as 440 ft and a static water level of 400 ft after development in May 2008. A pump test was performed in August 2011 and reported a pre-pumping water level of 408 ft. After six hours of pumping at rate of 30 gallons per minute the water level had drawn down eight ft to 416 ft and remained stable for the last two hours of the test. Within four minutes after shutting off the pump the water level had recovered to its initial level of 408.

Using the spatial distribution of groundwater levels for Wells 1-10, an interpolated groundwater surface was generated using the Kriging method (a procedure fitting a surface to data) in ArcGIS. A contour layer is displayed in Figure 2. It should be noted that the groundwater elevation data used for this interpolation comes from well logs up to 36 years old and may not be representative of current conditions. However, more recent water elevations are generally consistent with older elevations. As shown in Figure 2, the groundwater contours indicate a general flow direction from east to west with a slight ridge of groundwater running east-west along a line from Well 2 to Well 7. This ridge marks a potential divide in the groundwater flow directions, one to the northwest and one to the southwest. Wells 2 and 1 are located along this ridge due to the nature of the interpolation. A cross section displaying the ground surface, interpolated groundwater surface and well locations is shown in Figure 3.

Geologic Cross-Section

A geologic cross-section oriented northwest by southeast is shown in Figure 3 (see Figure 2 for location). The interpolated groundwater surface is displayed along with the approximated contact between Tsa and sp. Depths and casing intervals are also shown for Wells 1, 2, 7, 12 and 14. This representation shows the groundwater table dipping to the northwest at a depth of approximately 400 to 700 feet below ground surface. Water was not encountered in the recently drilled Well 13, as such the approximate groundwater surface does not extend to Well 13.

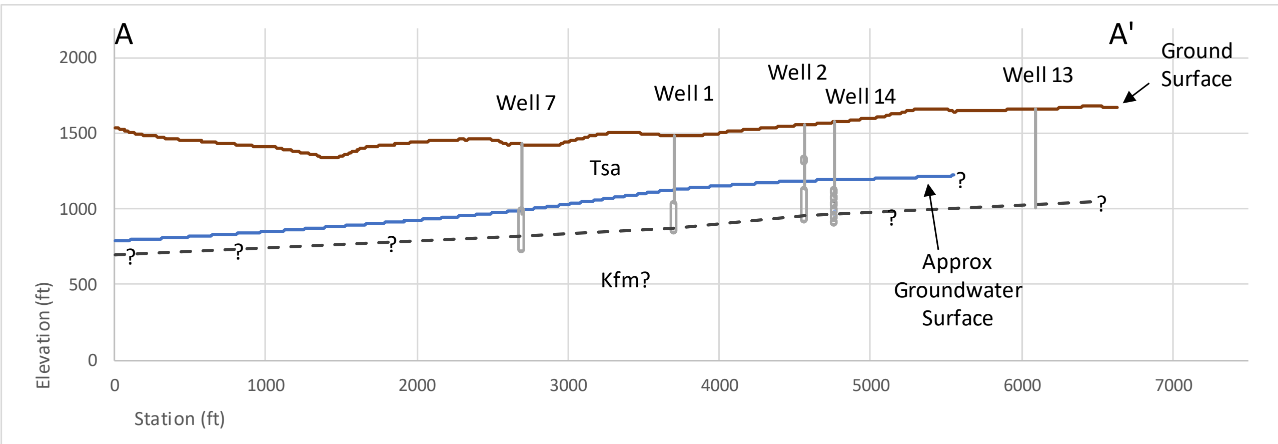


Figure 3: Hydrogeologic cross section A -A' through the vicinity of the project parcel (see Figure 2 for location).

Project Aquifer

The extent of the project aquifer/project recharge area is defined by surface water drainage patterns and the interpolated groundwater surface. The northern, northwestern, and eastern boundaries of the project aquifer are defined by surface drainage divides directing flows towards the main channel that flows through the northeast corner of the winery well parcel. The southern and southwestern boundary extends to include a portion of the drainage to the south of the winery well parcel to include a portion of the interpolated groundwater surface draining to the south that is potentially intersected by Well 1, 2, and 14.

The total area of the project aquifer is 459 acres. The recharge area is underlain by the Tsa unit of the Sonoma Volcanics. The project wells (Well 2, Vineyard Well and Well 14) are screened within the Sonoma Volcanics and proposed wells PW1 and PW2 are also expected to be completed in the same formation. Given that depths to groundwater are relatively deep and given that impermeable layers of material including clays are present within the Sonoma Volcanics, the project aquifer is likely confined or semi-confined.

The extent of the project aquifer/recharge area was initially delineated to include the recharge area to Project Wells 1, 2 and 14 prior to the planning for the newly proposed project wells PW1 and PW2. In a previous draft of this WAA (February 2020) we evaluated water demand within this recharge area on the project parcel and neighboring parcels and compared proposed groundwater use to estimated recharge. In our tabulation of uses we made the conservative assumption that all uses on neighboring parcels to the west associated with the Continuum Winery (APN's 032-560-029, 032-560-032, 032-030-043 and 032-030-044 in Figure 4) use groundwater associated with the project recharge area (Figure 4). Proposed Project well PW2 is to be located less than 200 ft outside of the recharge boundary delineated for Wells 1, 2 and 14 (Figure 2). The existing analysis already accounts for groundwater use outside the recharge boundary in this area, so the addition of this well outside the recharge boundary does not alter our estimate of groundwater use.

Groundwater Storage Estimate

An estimate of the total available groundwater storage within the aquifer recharge area can be obtained as the product of the aquifer area in units of acres, the saturated aquifer thickness in units of feet, and the specific yield of the aquifer. This method is generally applicable to unconfined aquifers with primary porosity and are not generally appropriate for confined aquifers. The project aquifer is likely semi-confined or confined with water storage primarily in fractures. The estimate of groundwater storage is an approximation for general interpretive and comparative purposes.

The saturated thickness of the aquifer was estimated as the difference between the average static water level and average base of screened interval in the wells in the project vicinity (Table 1). The mean depth of the static water level of the productive wells within the project recharge area is 397 feet while the average depth to the bottom of the screened interval is 643 feet. Subtracting the mean static water level from the mean depth to the bottom of the screened interval estimates a saturated thickness of 246 feet. This is a conservative estimate of aquifer thickness as the Sonoma Volcanics Formation likely extends to significantly greater depths within the project recharge area. As reported above specific yield estimates for the Sonoma Volcanics range from 0 to 15% (Nishikawa, 2013). To be conservative, we have used a low-end estimate of specific yield of 2% for the project aquifer. This results in an estimated groundwater storage of 2,257 ac-ft (459 acres x 246 feet x 0.02).

Water Demand

Within the project recharge area, water demand was estimated for both the existing and proposed conditions. Water use at the winery and vineyards on surrounding parcels owned by Chappellet was determined using information provided by Chappellet and verified using available satellite imagery. The project recharge area also includes portions of six neighboring parcels. Use on these parcels was estimated using Napa County agricultural and winery GIS database information along with satellite imagery. One additional parcel that has the same ownership and a contiguous vineyard with a parcel intersecting the recharge area was included in the existing water use estimate. Uses within the recharge area include winery use, residential use and irrigation for vineyards and small orchards.

Existing Use

In the existing condition, the Chappellet winery parcel (APN 032-560-015) contains a residence, a portion of vineyard, a barrel storage building and the winery. The demand of the modestly sized single-family residence was 0.5 ac-ft annually; this rate is in the middle of the range provided by Napa County guidance for single family dwellings. The vineyard on the winery parcel part of a larger block of vines that extend onto the adjacent parcels APN's 032-560-014 and 032-560-016 also owned by Chappellet. These vines are irrigated using surface water diversions and do not require groundwater from the project well. Irrigation practices of vineyards on adjacent parcels are discussed later in this report.

The following summary of existing groundwater use focuses on total uses within the project well recharge area (Figure 2 and Figure 4), and therefore includes groundwater use estimated for other parcels along with the Chappellet parcels (Tables 2-7). Total existing water use by the Chappellet Winery parcel, served by Well 1, is described in detail below.

Currently the winery is permitted to produce 150,000 gallons of wine a year with a total of 24 combined full time and part time employees. Based on Napa County water use guidelines, demand for winery processing water is 2.15 ac-ft per 100,000 gallons of wine while winery domestic and landscaping demand is an additional 0.5 ac-ft per. Annual production of 150,000 gallons gives a total demand of approximately 4 ac-ft. Employee daily use is estimated to be 15 gallons per employee per Napa County. Assuming the 24 employees work five days a week all year or 260 days the total demand equals 0.29 ac-ft annually in addition to the 4 ac-ft required by the winery.

Daily tours and tastings at the winery are approved to host a maximum of 40 visitors a day. Assuming 40 visitors a day, 365 days a year, this totals to a maximum of 14,600 tasting visitors annually. For marketing events that include on-site catering Chappellet is approved for several events with varying numbers of guests totaling a maximum of 2,470 guests annually. Napa County guidance assumes a daily water use of 3 gallons per tasting visitor and 15 gallons per marketing events visitors. Using these rates, the existing maximum annual demand for all 17,070 visitors to the winery is 0.25 ac-ft.

In addition to uses on the Chappellet winery parcel, use on the surrounding parcels within the project recharge area includes three additional residences, landscaping associated with these houses, vineyard, a small orchard, and the Continuum winery. Two residences are large and are assumed to have a demand of 0.75 ac-ft per year the upper limit suggested by Napa County guidance (Table 3). The third residence is located on the winery well parcel and is smaller so a demand of 0.5 ac-ft per year (similar to that of the winery parcel residence) is applied. Lawn and landscaping areas above the first 1,000 ft^2 on these parcels total 32,165 ft^2 and 5,050 ft^2 respectively (Table 3).

A total of 88.1 acres of vineyard is located on or connected to parcels with wells within the project recharge area. Of this Chappellet owns 14.2 acres and irrigates with water collected via surface water diversions stored in existing reservoirs. Four existing water rights (A020616, A026508, A027298 and D032686 are registered to Chappellet Vineyard LLC in the California Department of

Water Resources database with a total of 134 ac-ft allowed annually. Although the rights allow for the diversion of 134 ac-ft, the existing reservoirs are only able to capture approximately 50 ac-ft. In addition to diversions, 3 ac-ft of water is recycled from winery use and approximately 3 ac-ft of rainwater is collected from roofs and stored in the onsite ponds. An additional 93.7 acres of vineyard farmed by Chappellet is located on parcels to the north of the recharge area (032-560-014, 015, and 016, and 320-010-010 see Figure 4). These vines are also irrigated using recycled water, rainwater and water collected into the reservoirs as mentioned above. However, under extreme drought conditions they would require to be irrigated with groundwater from project wells, an evaluation of this condition is made later in this report. Chappellet estimates irrigation demand for all 107.9 acres of existing vineyard varies between 30 and 40 ac-ft depending on the season. Applying this demand to the total area of vineyard computes to a range of demand per unit area of 0.28 to 0.37 ac-ft/ac/yr.

Nearly all the water used for irrigation of <u>existing</u> Chappellet vineyards is recycled water or stored surface water; in addition, a very small amount of water from Well 2 and Well 14 (and Wells PW1 and PW2 in the future) may be used at the end of the growing season. Chappellet estimates this amount to be less than 1% of the total irrigation volume. If we assume conservatively that this amount is 1% of the upper end of the annual demand of 40 ac-ft this would be a demand of 0.4 ac-ft (Table 4).

For the January 2022 revision of this WAA, Chappellet staff provided additional irrigation details for the years 2017 through 2021 summarized Appendix B which contains a detailed summary of 2017-2021 irrigation data. All water for irrigation for these years was provided by surface water diverted and stored under existing Water Rights, recycled wastewater, rainwater catchment and groundwater. Over the last five years, which have included both relatively wet (WY2017 and WY 2019) and very dry (WY2020 and WY 2021) conditions, irrigation has ranged from 0.16 ac-ft/ac to 0.38 ac-ft/ac with an average rate of 0.24 ac-ft/ac. Extremely dry winters over the past two seasons (2020 and 2021) have required reductions in irrigation to conserve severely limited surface water supplies.

Total irrigation has ranged from 17.5 ac-ft to 24.5 ac-ft annually for the 2017 -2021 period. This recorded range is far below the original assumptions (30-40 ac-ft annual use) presented in previous versions of this analysis and indicate that our estimates of use (which include the upper end of County Guidance irrigation rates) have been quite conservative.

The remaining 73.6 acres of vineyard within the project recharge area are located on four parcels west of the project well (APN's 032-560-029, 032-560-032, 032-030-043 and 032-030-044 in Figure 4) these parcels are all associated with the Continuum Winery. Although the parcel boundary for 032-030-043 does not intersect the recharge area it does have continuous vineyard with the adjacent parcel to the east (APN 032-030-044). To be conservative, it is assumed that along with all vineyards on Continuum this vineyard uses water from a well located within the recharge area. Two reservoirs are located on these parcels and are associated with three appropriative water rights totaling 25 ac-ft annually. Assuming annual vineyard irrigation demand of 0.5 ac-ft per acre per year, the 73.6 acres of vines would require 36.8 ac-ft annually. Although the specific practices are not known for these vineyards it is highly likely that this diverted water is used to irrigate these 73.6 acres of vineyard. The allotted 25 ac-ft would be sufficient to meet about 68% of the estimated demand of 36.8 ac-ft; it is assumed that the remaining 11.8 ac-ft of vineyard irrigation (equivalent to 23.6 acres of vineyard) is supplied by one of the wells located on the Continuum parcels within the project recharge area. Additional vineyard area located on neighboring parcel (032-030-010 Figure 4) on the southwest edge of the recharge area was not included because no wells were identified within the recharge area.

In addition to the vineyards, 0.7 acres of orchard were identified on a parcel within the recharge area. Napa county guidance lists an annual demand of 4 ac-ft per acre for orchards which results in an annual demand of 2.8 ac-ft for the existing condition.

Water use for the Continuum winery was estimated using information reported in the Napa County Winery GIS shapefile. The current information associated with permit P10-00255-MOD for Continuum shows an annual production of 28,000 gallons with 16 employees which amounts to a total winery demand of 0.93 ac-ft. Tastings are by appointment only and a maximum of 2 visitors/day (728 annually) are allowed. For marketing events a maximum annual count of 450 visitors is listed. Assuming a usage of 3 gallons per visitor for tastings and 15 gallons per visitor for marketing events the maximum visitor use for Continuum is 0.03 ac-ft annually.

Based on these uses, the existing water demand within the project recharge area is estimated to be 26.4 ac-ft/yr (Table 2). Residential water demand is estimated to be 6 ac-ft/yr (Table 3), irrigation demand is estimated to be 15 ac-ft/yr (Table 4), winery use is estimated to be 4.7 ac-ft/yr (Table 5) winery guest use is estimated to be 0.28 ac-ft/yr (Table 6), and winery employee use is estimated to be 0.48 ac-ft/yr (Table 7).

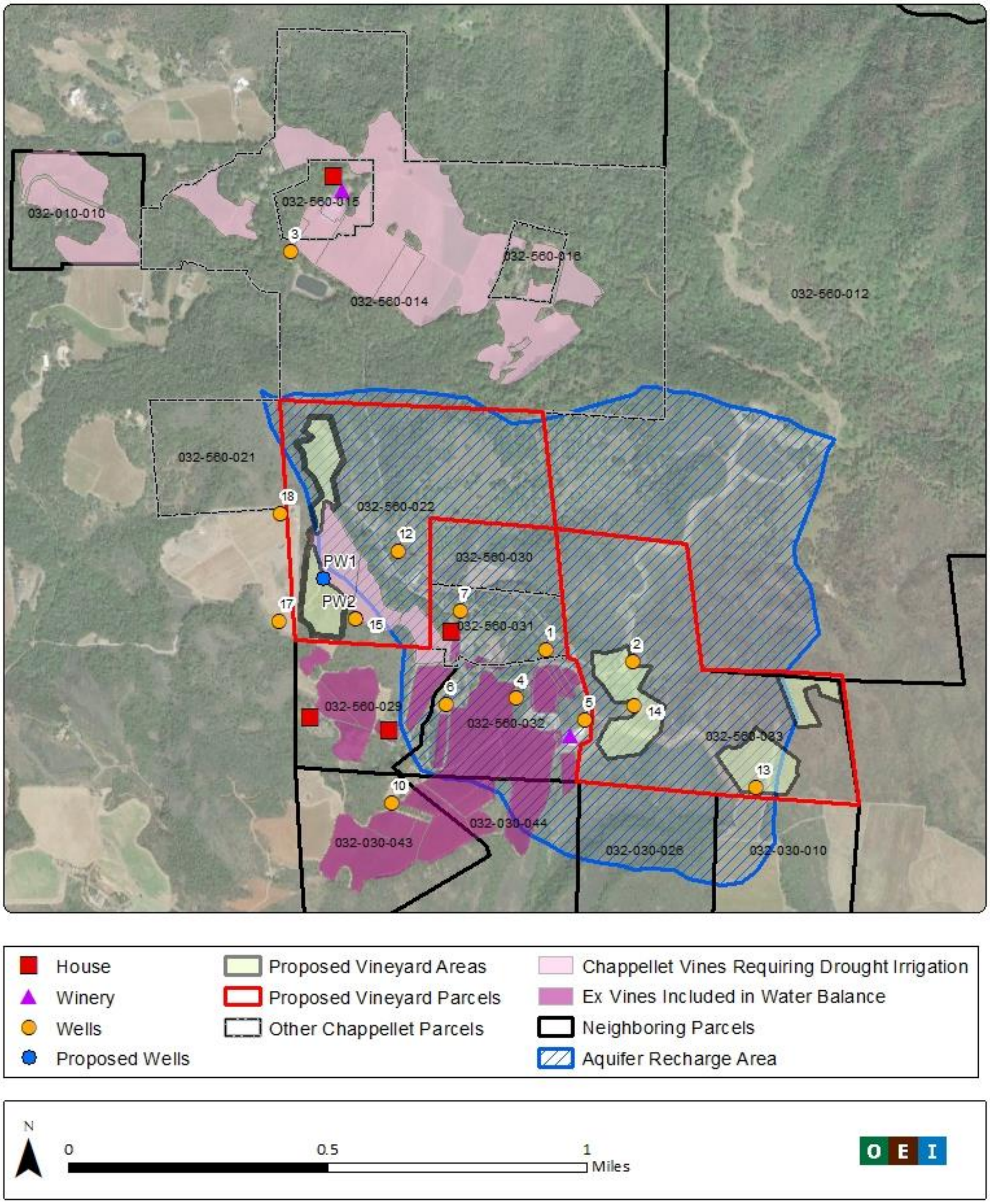


Figure 4. Existing and proposed uses within project recharge area.

Table 2: Existing and proposed groundwater uses within the project recharge area.

	Irrigation Use (acre-ft/yr)	Residential use (acre-ft/yr)	Winery Use (acre-ft/yr)	Employee Use (acre-ft/yr)	Event Use (acre-ft/yr)	Total Use (acre-ft/yr)
Existing Use	15.0	6.0	4.7	0.5	0.3	**26.4**
Proposed Use Low - High Vineyard Irrigation Rate (includes increased demand from Winery and Additional Vines)	23.2 - 32.1	6.0	7.4	0.6	0.5	**37.6 - 46.5**

Table 3: Estimated existing and proposed residential groundwater use within the project recharge area.

Use Category	# of Units	Use per Unit (ac-ft/yr)	Use per 1,000 square feet above first 1,000 (ac-ft/yr)	Annual Water Use (ac-ft/yr)
Oversized Main Residence	2	0.75		1.50
Main Residence	2	0.50		1.00
Lawn	32		0.10	3.22
Other Landscaping	5		0.05	0.25
TOTAL				**6.0**

Table 4: Estimated existing vineyard and orchard irrigation groundwater use within the project recharge area.

Use Category	Number of Acres	Use per Acre (ac-ft/yr)	Supplemental Chappellet Use (ac-ft/yr)	Annual Water Use (ac-ft/yr)
Existing Non- Chappellet Vineyard Irrigation	23.6	0.5	0.4	12.2
Existing Orchard Irrigation	0.70	4		2.8
TOTAL				**15.0**

Note: Under normal rainfall conditions all existing Chappellet vineyards are irrigated using recycled water, collected rainwater and surface water except the additional 0.4 ac-ft end of season irrigation which is provided by groundwater. New Chappellet vineyard irrigation demand will be met with groundwater from Wells 2, 14 PW1 and PW2. Non Chappellet vineyard irrigation represents a portion of the total acreage as a portion of these vines are assumed to be irrigated by surface water.

Table 5: Estimated existing winery groundwater use by wells located within the project recharge area. This includes Chappellet winery use (pre 2020 Use Permit modification) and Continuum winery use.

Use Category	Annual Production (gal/yr)	Use per 100,000 gal of production	Annual Water Use (ac-ft/yr)
Winery Process Use	178,000	2.15	3.83
Winery Domestic Use	178,000	0.50	0.89
TOTAL			**4.7**

Table 6: Estimated existing winery guest groundwater use by wells located within the project recharge area. This includes Chappellet winery use (pre 2020 Use Permit modification) and Continuum winery use.

Visitor Category	# of Vistors	Use per Visitor	Annual Water Use
Tours and Tastings	15,288	**3**	0.14
Marketing w/ Onsite Catering	2,920	15	0.13
TOTAL			**0.28**

Table 7: Estimated existing employee groundwater use by wells located within the project recharge area. This includes Chappellet winery use (pre 2020 Use Permit modification) and Continuum winery use.

Work Category	# of Employees	# Work Days per Year	Use per Employee (gal/day)	Annual Water Use (ac-ft/yr)
Full-time	40	260	15	0.48
TOTAL				**0.48**

Proposed Use

In the proposed condition, 34.2 net acres (41.9 acres gross) of vineyard will be added to two project parcels (032-560-022 and 032-560-033) and the Chappellet Winery will increase wine production by 100,000 gallons for a total annual production of 250,000 gallons. The total number of visitors annually will increase by 21,835 to 38,905. Six new employees will be added for a total of 30 employees. New vineyard will be irrigated using groundwater from the vineyard well (Well 2), the new Well 14 (Figures 1 and 2) and if successful proposed wells PW1 and PW2.

As explained above irrigation rates for existing Chappellet vineyards averaged 0.24 ac-ft/ac annually for the past five years. To account for new vine establishment periods when irrigation rates are greater, proposed use is estimated for a range of rates between 0.24 acre ft/ acre/yr (the five year average) and 0.5 ac-ft/ac/yr (the maximum rate listed in the Napa County guidance). It is assumed that during most years, including dry years, Chappellet will be using the lower irrigation rate. During extreme drought years such as water years 2020 and 2021 Chappellet will need to reduce rates even further as they did in 2020/2021. This scenario is described in detail in the Drought Water Use Considerations section below.

Applying the range of demands per unit area (ac-ft/ac) produces estimated demand ranging from 8.6 to 17.5ac-ft/yr for the proposed vineyard areas (Table 8). Winery water demand (Tables 9-11) will be met by groundwater pumped from the Corral Well (Well 1).

No other uses will change as part of the proposed projects. In this condition the estimated water use will increase by a maximum of 20.1 ac-ft/yr to 46.5 ac-ft/yr; 3 ac-ft/yr for the winery use modification and 17.1 ac-ft/yr for the additional vineyard acreage (Table 2). All increases in groundwater use are from increases in irrigation use (Table 8), winery processing and domestic use (Table 9), winery guest use (Table 10) and winery employees (Table 11).

Table 8. Proposed vineyard and orchard irrigation groundwater use by wells located within the project recharge area.

Use Category	Number of Acres	Use per Acre (ac-ft/yr)	Supplemental Chappellet Use	Annual Water Use (ac-ft/yr)
Non Chappellet Vineyard Irrigation	23.6	0.5		11.8
Proposed Chappellet Vineyard Irrigation	34.2	0.24 - 0.5	0.4	**8.6 - 17.5**
Orchard Total	0.70	4.0		2.8
TOTAL				**23.2 - 32.1**

Table 9: Estimated proposed winery groundwater use by wells located within the project recharge area. This includes Chappellet winery use post 2020 Use Permit modification and Continuum winery use.

Use Category	Annual Production	Use per 100,000 gal of	Annual Water Use (ac-ft/yr)
Winery Process Use	278,000	2.15	6.0
Winery Domestic Use	278,000	0.50	1.4
TOTAL			**7.4**

Table 10: Estimated proposed winery guest groundwater use by wells located within the project recharge area. This includes Chappellet winery use post 2020 Use Permit modification and Continuum winery use.

Visitor Category	# of Vistors	Use per Visitor	Annual Water Use
Tours and Tastings	35,403	**3**	0.33
Marketing w/ Onsite Catering	4,680	15	0.22
TOTAL			**0.54**

Table 11: Estimated proposed employee groundwater use by wells located within the project recharge area. **This includes Chappellet winery use post 2020 Use Permit modification and Continuum winery use.**

Work Category	# of Employees	# Work Days per Year	Use per Employee (gal/day)	Annual Water Use (ac-ft/yr)
Full-time	46	260	15	0.55
TOTAL				**0.55**

Groundwater Recharge Analysis

Groundwater recharge within the project recharge area was estimated using a Soil Water Balance (SWB) of Napa County developed by OEI. This model implements the U.S. Geologic Survey's SWB modeling software and produces a spatially distributed estimate of annual recharge. This model operates on a daily timestep and calculates runoff based on the Natural Resources Conservation Service (NRCS) curve number approach and Actual Evapotranspiration (AET) and recharge based on a modified Thornthwaite-Mather soil-water-balance approach (Westenbroek et al., 2010). Details of this model are included in Appendix C.

To address elevated concerns regarding groundwater availability during the current extended regional drought, Napa County has specified that groundwater recharge estimates must use a 10-year precipitation average from Water Years 2012 to 2021 developed by the PRISM Group at Oregon State University for Napa County. The PRISM data provides spatially distributed data adjusted for orographic factors based on gauged precipitation data. OEI's SWB modeling has also utilized PRISM precipitation data.

OEI's earliest application of SWB for WAA for Chappellet projects pre-dated OEI's comprehensive SWB implementation covering all of Napa County. For the January 2023 WAA revision, OEI is utilizing SWB simulations described in Appendix C as described below, in addition to a unique SWB implementation for Water Year 2021 previously developed for a prior WAA revision to address County concerns regarding the potential effects of extended drought on groundwater recharge.

OEI's use of the SWB model is believed to provide more accurate estimates of potential groundwater recharge because it is a physically based distributed model that incorporates information characterizing the water balance in the soil column. Calculation of evapotranspiration using local climate data along with soil moisture storage and precipitation is believed to provide a more accurate representation of local conditions; evapotranspiration is the largest component of the water balance. Unfortunately, the SWB model structure does not allow for a groundwater recharge calculation based on a mathematical average because the model is driven by daily climate data. Consequently, OEI has adapted the SWB model estimates for the prior "average year" (WY 2010), the "drought year" (WY 2014), and the "extreme drought year" (WY 2021) to provide an estimate for the average annual rainfall for the period 2012-2021 developed by County of Napa.

The first, Water Year 2010, was selected to represent average year conditions because annual precipitation totals across most of Napa County were close to their long-term 30-year averages. The second, Water Year 2014, was selected to represent drought average conditions because annual precipitation totals were between 41 and 73% of long-term 30-year averages for much of Napa County. The third year, Water Year 2021, was selected to represent extreme drought conditions in Napa County.

OEI has utilized SWB models for WY 2010 and WY 2014 for dozens of project sites in the County of Napa. We have observed that potential recharge for WY 2010 is consistently much greater than for WY 2014 across a wide variety of terrain, vegetation, soils and climate. This is most easily characterized by the percentage of annual precipitation available for recharge that we calculate for each project site. Our approach for adapting the SWB model outputs to estimate groundwater recharge for the specified annual average precipitation (2012- 2021) is to assume that the percentage of annual rainfall available for groundwater recharge is a linear function of annual rainfall and interpolating between the recharge percentage for WY 2010, WY 2014 and WY 2021. The interpolation procedure is unique for each project site; the application for this project site is graphically displayed in Figure 5. The water balance data from the SWB model years is tabulated in Table 12.

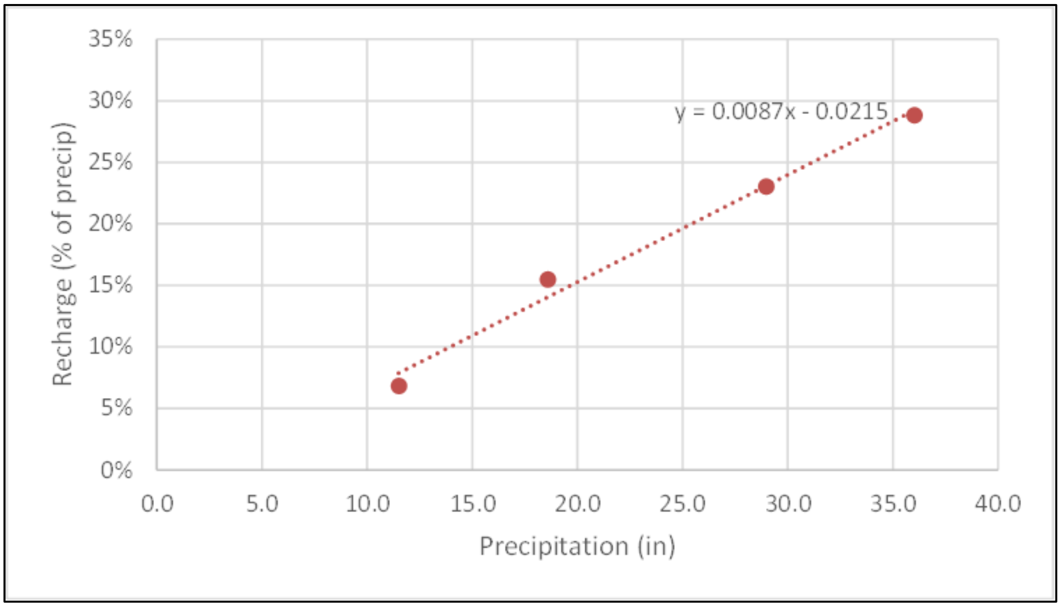


Figure 5: Relationship between precipitation and percent of precipitation as recharge.

Results

The simulated Water Year 2010 (average water year) recharge results indicate that recharge varied across the project recharge area from near zero to 14.8 inches. Spatially averaged over the project recharge area, recharge accounted for 10.4 of the 36.0 inches (29%) of precipitation in 2010 (Table 12). The simulated Water Year 2014 (drought water year) recharge results indicate that recharge varied across the project recharge area from near zero to 6.52 inches). Spatially averaged over the project recharge area, only 2.9 of the 18.6 inches of precipitation (15%) was recharge (Table 12). Results from the simulated Water Year 2021 (extreme drought water year) recharge were spatially averaged over the project recharge area to be 0.8 inches or 7% of the 11.5 inches of precipitation for Water Year 2021 (Table 12). The spatially-averaged precipitation for the project recharge area for the Water Years 2012-21 PRISM average is 29.0 inches. Based on the linear relationship between annual precipitation for WY 2010, 2014 and 2021, and corresponding SWB estimates of groundwater recharge as a percentage of annual precipitation (Figure 5), Water Years 2012 to 2021 had an average of 6.7 inches of recharge or 23% of the 29.0 inches of precipitation (Table 12).

Table 12: Summary of recharge results for the project recharge area from the SWB model.

	2010 Normal Year		2014 Dry Year		2021 Extreme Drought Year		2012-2021 WY Average	
	inches	% of precip	inches	% of precip	inches	% of precip	inches	% of precip
Precipitation	36.0	-	18.6	-	11.5	-	29.0	-
AET	18.8	52%	14.3	77%	13.5	117%	-	-
Runoff	7.5	21%	4.6	25%	0.9	8%	-	-
Δ Soil Moisture	-0.6	-2%	-3.3	-18%	-3.7	-32%	-	-
Recharge	10.4	29%	2.9	15%	0.8	7%	6.7	23%

Groundwater recharge estimates can also be expressed as a total volume by multiplying the calculated recharge by the project aquifer recharge area of 459 acres. This calculation yields an estimate of total recharge of 110.2 ac-ft/yr during the drought conditions of Water Year 2014 and of 397.1 ac-ft/yr for the average Water Year of 2010. For the extreme drought year conditions of 2021 total recharge calculated to 30.1 ac-ft/yr. For the impact area the averaged 2012-2021 WYs the recharge is estimated to be 255.3 ac-ft/yr (Table 13).

LSCE (2013) estimated recharge based on water balance modeling in several watersheds in the county underlain primarily by Sonoma Volcanics (Milliken Creek, Tulucay Creek, Conn Creek and Napa River above Calistoga). The recharge estimates in these watersheds ranged from 5 to 21% of annual precipitation. The recharge estimates produced from this study (29% of average water year precipitation, 15% of the dry water year precipitation and 23% of the 2012-2021 average water year precipitation) using SWB fall within and slightly above the range of the LSCE estimates for larger watershed areas underlain by Sonoma Volcanics and appear to be reasonable.

The total proposed groundwater use for the project recharge area is estimated to range from 37.6 ac-ft/yr to 46.5 ac-ft/yr combined for all parcels intersecting the recharge area (Table 3). Estimated groundwater use in the project recharge area is equivalent to between 15% and 18% of the estimated average of 2012-2021 water years groundwater recharge of 255.3 ac-ft/yr. This use is equivalent to between 9% and 12% of the estimated average water year groundwater recharge of 397.1 ac-ft/yr. Assuming Chappellet irrigates at the rate of 0.24 ac-ft/ac during dry years similar to WY 2014, total use of 37.6 ac-ft represents 34% of the estimated dry water year recharge of 110.2 ac-ft/yr (Table 14). <u>Average year groundwater recharge should be used for comparison with groundwater use for determination of long-term water availability</u>.

These comparisons indicate that there is a substantial surplus of groundwater resources in terms of estimated average annual groundwater recharge to the project recharge area. This is considering both the WY2010 SWB recharge estimate and the interpolated recharge estimate based on the WY 2012-2021 average PRISM rainfall (Table 13). <u>Given the magnitude of this surplus, the increase in water use associated with the proposed increase in vineyard acreage (8.2</u>

– 17.1 ac-ft) along with the additional winery production, employees and guest attendance associated with the use permit modification (3.0 ac-ft) is unlikely to result in significant long-term reductions in groundwater levels or depletion of groundwater resources.

Table 13: Evaluation of groundwater demand as a percentage of estimated groundwater recharge comparing water use estimated for the project recharge area including proposed project use for both low and high vineyard irrigation estimates on the project parcels.

USE		Average Water Year (2010)			Dry Water Year (2014)		
	Total Proposed Demand (ac-ft/yr)	Recharge (ac-ft/yr)	Recharge Surplus (ac-ft/yr)	Demand as % of Recharge	Recharge (ac-ft/yr)	Recharge Surplus (ac-ft/yr)	Demand as % of Recharge
Project Recharge Area Low Vineyard Irrigation Rate	37.6	397.1	359.4	9%	110.2	72.5	34%
Project Recharge Area High Vineyard Irrigation Rate	46.5	397.1	350.5	12%	-	-	-

USE		2012-2021 WY Average		
	Total Proposed Demand (ac-ft/yr)	Recharge (ac-ft/yr)	Recharge Surplus (ac-ft/yr)	Demand as % of Recharge
Project Recharge Area Low Vineyard Irrigation Rate	37.6	255.3	217.7	15%
Project Recharge Area High Vineyard Irrigation Rate	46.5	255.3	208.8	18%

Similarly, to give a perspective of demand versus estimated recharge at the project parcel scale, recharge can also be estimated for each project parcel. The northern vineyard parcel (APN 032-010-076) is approximately 120 acres and has a spatially averaged recharge of 103.8 ac-ft/yr for average conditions (Water Year 2010), 28.8 ac-ft/yr of recharge for drought conditions (Water Year 2014), and 66.7 ac-ft/yr of recharge for the average of 2012-2021 Water Years. The southern project parcel (APN 320-010-094) is approximately 118 acres has a spatially averaged recharge of 102.1 ac-ft/yr for average conditions (Water Year 2010), 28.3 ac-ft/yr of recharge for drought conditions (Water Year 2014), and 65.6 ac-ft/yr of recharge for the average of 2012-2021 Water Years. Table 14 presents a summary of estimated recharge on the two project parcels.

At the project parcel scale, proposed vineyard water use (the only proposed use) can be compared to estimated recharge across each project parcel. On the northern vineyard project parcel (APN 032-560-022) the estimated demand ranges from 2.7 ac-ft/yr to 5.6 ac-ft/yr which is 4% and 8% of the 66.7 ac-ft of estimated recharge during the averaged 2012-2021 water years period. Demand on the northern vineyard parcel ranges from 2.7 corresponds tobetween 3% and 5% of the 103.8 ac-ft of estimated recharge during the average water year. Assuming only the low vineyard irrigation rate (0.24 ac-ft/ac) is used during the dry years, the 2.7 ac-ft demand represents and 9% of the 28.8 ac-ft of estimated dry year recharge (Table 14). In the southern vineyard project parcel (APN 032-560-033) the estimated demand ranges from 5.5 ac-ft/yr to 11.5 ac-ft/yr which is equivalent to 5% and 11% of the 65.6 ac-ft of estimated recharge during the averaged 2012-2021 water years period. The estimated southern parcel represents between 8% and 18% of the 102.1 ac-ft of estimated average year recharge. The demand is19% of the 28.3ac-ft of estimated dry year recharge (Table 14).

Table 14: Comparison of proposed water use to average, dry year and the 2012-2021 groundwater recharge on proposed vineyard parcels. Note during dry year conditions the vineyard irrigation rate of 0.24 ac-ft/ac is applied.

USE	Total Proposed Demand (ac-ft/yr)	Average Water Year (2010) Recharge (ac-ft/yr)	Average Water Year (2010) Recharge Surplus	Average Water Year (2010) Demand as % of	Dry Water Year (2014) Recharge (ac-ft/yr)	Dry Water Year (2014) Recharge Surplus	Dry Water Year (2014) Demand as % of
Project Parcel North 032-560-022 Low Vineyard Irrigation Rate	2.7	103.8	101.1	3%	28.8	26.1	9%
Project Parcel South 032-560-033 Low Vineyard Irrigation Rate	5.5	102.1	96.6	5%	28.3	22.8	19%
Project Parcel North 032-560-022 High Vineyard Irrigation Rate	5.6	103.8	98.2	5%	-	-	-
Project Parcel South 032-560-033 High Vineyard Irrigation Rate	11.5	102.1	90.6	11%	-	-	-

USE	Total Proposed Demand (ac-ft/yr)	2012-2021 WY Average Recharge (ac-ft/yr)	2012-2021 WY Average Recharge Surplus	2012-2021 WY Average Demand as % of
Project Parcel North 032-560-022 Low Vineyard Irrigation Rate	2.7	66.7	64.0	4%
Project Parcel South 032-560-033 Low Vineyard Irrigation Rate	5.5	65.6	60.1	8%
Project Parcel North 032-560-022 High Vineyard Irrigation Rate	5.6	66.7	61.1	8%
Project Parcel South 032-560-033 High Vineyard Irrigation Rate	11.5	65.6	54.1	18%

Drought Water Use Considerations

Recent drought conditions have required many growers to adjust water use including the project applicant. For growers like Chappellet Vineyards, who use surface water diversions, if winter rains fail to fill their storage reservoirs, they will likely turn to groundwater as their alternative water source. Representatives of Chappellet Vineyards have indicated that this would be the case and so we have evaluated a scenario where this occurs. During severe drought conditions Chappellet Vineyards report that they have reduced irrigation rates down to minimum rate of approximately 0.16 ac-ft/ac/yr as shown in Appendix B.

Table 15 shows proposed irrigation demand across the project recharge area where Chappellet use has been reduced to 0.16 ac-ft/ac and in addition to the proposed 34.2 acres of new vineyard, includes an additional 107.9 acres of Chappellet vineyard normally irrigated with diverted surface water (See Figure 4). It should be noted that even during the very dry 2021 growing season Chappellet staff report that a small amount of surface water (approximately 25% of normal capacity) was available for irrigation indicating that water demand assumptions presented for the drought condition are conservative. For this scenario we assume that all other water uses within the recharge area, except for vineyard irrigation on neighboring parcels, remained the same. In the case of vineyard irrigation, we also assume that all reservoirs on the neighboring Continuum parcels to the west are dry and vineyards on these neighboring parcels are entirely irrigated with groundwater. Drought year irrigation rates for the Continuum vineyards are not known and we have assumed a range of irrigation rates between 0.2 ac-ft/ac and 0.5ac-ft/ac (Table 15). Table 16 shows a summary of proposed water use within the project recharge area under the drought conditions where total annual use increases from 26.4 ac-ft to between 54.7 to 76.8 ac-ft.

Table 15. Proposed irrigation demand across the project recharge area under drought conditions.

Use Category	Number of Acres	Use per Acre (ac-ft/yr)	Annual Water Use (ac-ft/yr)
Existing Neighboring Vineyard Irrigation	73.6	0.2 - 0.5	14.7 - 36.8
Proposed Chappellet Vineyard Irrigation	142.1	0.16	22.7
Existing Orchard Total	0.70	4.0	2.8
TOTAL			**40.3 - 62.3**

Table 16: Total proposed groundwater use in the project recharge area under drought water use conditions.

	Irrigation Use (acre-ft/yr)	Residential use (acre-ft/yr)	Winery Use (acre-ft/yr)	Employee Use (acre-ft/yr)	Event Use (acre-ft/yr)	Total Use (acre-ft/yr)
Existing Use	15.0	6.0	4.7	0.48	0.28	**26.4**
Proposed Use (includes increased demand from Winery)	40.3 - 62.3	6.0	7.4	0.55	0.51	**54.7 - 76.8**

Table 17: Comparison of proposed groundwater use by all wells within the project recharge area during drought conditions to extreme drought year groundwater recharge under drought water use conditions. Note a range of irrigation values were used for irrigation of non-project vineyards.

USE	Total Proposed Demand (ac-ft/yr)	Extreme Drought Water Year (2021) Recharge (ac-ft/yr)	Recharge Surplus (ac-ft/yr)	Demand as % of Recharge
Project Recharge Area Low Vineyard Irrigation Rate	54.7	30.1	-24.6	182%
Project Recharge Area High Vineyard Irrigation Rate	76.8	30.1	-46.7	255%

The total proposed groundwater use for the project recharge area during drought conditions where all Chappellet vineyards are irrigated with groundwater at a reduced rate equivalent to what was used in 2021(0.16 ac-ft/ac) and neighboring vineyards are irrigated over a range of rates between 0.2 ac-ft/ac and 0.5 ac-ft/ac is estimated to range from 54.7 ac-ft/yr to 76.8 ac-ft/yr for all parcels intersecting the recharge area. Estimated groundwater use in the project recharge area would be equivalent to between 182% and 255% of the extreme drought water year groundwater recharge of 30.1 ac-ft (Table 17).

This comparison shows that under extreme drought conditions, even if irrigation rates are reduced to conserve water an overdraft of groundwater resources in terms of estimated average annual groundwater recharge to the project recharge area will result. This would mean that during years when annual rainfall was not sufficient to recharge the project aquifer local wells would be accessing groundwater reserves stored in the aquifer. As described earlier in this report the project aquifer has approximately 2,257 ac-ft in storage. The total maximum demand of 76.8 ac-ft under extreme drought conditions represents 3% of this storage reservoir. Although there is uncertainty regarding the volume of groundwater storage, the magnitude of storage relative to use indicates that there is a significant quantity of water stored in the aquifer that will buffer imbalances in recharge and use that occurs in dry years. Higher rates of recharge in wet years compensate for extreme dry years when water use exceeds recharge. Water use greater than recharge may occur in some years, but aquifer storage is believed to be sufficient to maintain access to groundwater in wells in the project areas.

Well Interference Analysis (Tier 2 WAA)

There are no non-project wells within 500 feet of the project well(s). The nearest neighboring well that could be precisely located (Well 5) is 517 feet southwest of the proposed well location on the southern project parcel (Figure 2). Based on the WAA guidance document, a Tier 2 well interference analysis is not required given that all non-project wells are located greater than 500-feet from the project wells.

Groundwater/Surface Water Interactions (Tier 3 WAA)

Napa County Tier 3 WAA guidance for assessment of groundwater-surface water interactions was modified in late-2022, in part owing to the emergency policy adopted in June 2022. The County has identified streams of concern for potential streamflow depletion by groundwater pumping and now requires analysis of this potential for all wells within 1,500 feet of designated streams.

Project Wells and Potential Streamflow Depletion

The nearest surface waters to the project wells belong to two unnamed tributaries to Conn Creek and one unnamed tributary to Rector Creek (Figure 6). Project wells 2, 14, 15, and proposed project well PW1 are all within 1,500 feet of these waterbodies and per Napa County guidance a Tier 3 analysis is necessary to evaluate potential project impacts to surface waters.

The northern unnamed tributary to Conn Creek flows to the north bisecting the northern project parcel. The southern unnamed tributary to Conn Creek flows to the northwest approximately 870 feet to the southwest of the northern project parcel. Both watercourses flow into Lake Hennessey which empties into Conn Creek and thence the Napa River. The proposed project well PW1 and Well 15 are located approximately 740 feet and 825 feet from the northern watercourse, respectively. Project Well 15 is located 1,400 feet from the southern unnamed tributary to Conn Creek while PW1 is 1,550 feet away.

The unnamed tributary to Rector Creek originates on a neighboring parcel just south of the southern project parcel and flows to the south and east into the Rector Reservoir which empties into Rector Creek and thence the Napa River. Project wells 14 and 2 are located 1,025 and 1,480 feet respectively from the head of this unnamed tributary (Figure 6).

These stream reaches have been identified as having intermittent flow in a 2015 mapping effort by the Napa County Resource Conservation District (LSCE, 2022). In contrast with perennial streams, which are assumed to have a hydraulic connection to groundwater, intermittent streams are believed to have the potential to be connected for only limited periods of time. Typically, intermittent streams are connected during times of higher flows during winter and spring (seasonal intermittency). The periods when these streams would be expected to contain surface flow do not coincide with periods of higher groundwater use associated with the irrigation season. During the late summer and fall both creeks would most likely be disconnected from groundwater and not susceptible to potential impacts related to pumping of the project well.

All project wells are understood to be screened entirely within rocks of the Sonoma Volcanics, a fractured bedrock aquifer which is known to have relatively low permeability. Based on local geologic mapping and field inspections both tributaries intersect the Tsa unit of the Sonoma Volcanics (Figures 2 and 3). Although there is a likely to be some exchange of groundwater between the stream and underlying bedrock, connectivity to groundwater accessed by project wells is expected to be very limited by the relatively low hydraulic conductivity of the fine-grained rocks across the significant thickness of material between the surface and elevation at which project wells encounter groundwater. Regardless of the hydraulic characteristics of the aquifer material, there is significant horizontal and vertical separation between the wells and the streams of concern.

Groundwater elevations reported in well completion reports were used with Napa County LiDAR to estimate the vertical separation between the stream bed and groundwater surface. The vertical separation between 1) groundwater elevation and the nearest stream elevation and 2) uppermost well perforations (well screen) and nearest stream elevation are summarized in Table 18 along with other relevant information about the wells. The vertical separations range from 257 feet in Well 14's WSE to the unnamed tributary to Rector Creek up to 445 feet separating Well 15's WSE from the bed of the northern unnamed tributary to Conn Creek. Similarly, the vertical separation between the nearby stream bed and the upper limit of well screens in project wells was determined for each well; these values range from 180 feet in Well 2 to 440 feet in Well 15. Figures 7 and 8 show relative elevations of groundwater surfaces and well screens with respect to the nearest stream channel elevations based on the 2003 Napa County LiDAR elevation DEM. Note that proposed project well PW1 is expected to be constructed within very similar materials with a similar depth and extent of perforations to Well 15 and so we expect a very similar depth to groundwater and therefore vertical separation from the nearby stream beds as seen with Well 15.

Table 18. Project well completion details and vertical separation of groundwater elevation

Well Number	2	14	15
Year Completed	2014	2019	2021
Depth (ft)	625	670	890
Estimated Yield (gpm)	30	25	125
Static Water Level Elevation (ft)	1219.5	1161.8	919.6
Top of Screen Elevation (ft)	1344.5	1141.8	954.6
Bottom of Screen Elevation (ft)	944.5	921.8	584.6
Depth of Cement Seal (ft)	56	55	58
Geologic Unit	Tsa	Tsa	Tsa
Approximate vertical separtion from WSE to closest stream channel elevation (ft)	**305**	**257**	**445**
Approximate vertical separation from top of screen to closest stream channel elevation (ft)	**180**	**307**	**440**

For additional context regarding potential streamflow depletion, the nearest locations on each tributary with the same elevation as the groundwater elevation in corresponding wells has been identified for Wells 2, 14 and 15 in Figure 6. Distances between Well 15 and the 920 foot elevation point on each of the unnamed tributaries to Conn Creek range from 3,130 feet on the southern tributary to 4,550 feet on the northern tributary. Well 2 is located approximately 2,700 feet from where the unnamed tributary to Rector creek crosses the 1,220 foot elevation while Well 14 is about 3,050 feet from the 1,162 foot elevation. The heterogenous nature of the andesite of the Sonoma Volcanics, a fractured bedrock aquifer, makes it very unlikely that at these distances any significant connection to streamflow could occur. Note that groundwater elevations in these uplands generally mimic the surface topography and it is expected that at the set of points identified above the local groundwater elevation is likely to be at substantial depth below the stream elevation.

Due to the low permeability of the project aquifer, relatively large vertical and horizontal separation between the project well and surface waters of the tributaries we do not expect the proposed project to have any significant impacts on streamflow in the nearby intermittent streams of concern. Further discussion of Tier 3 WAA guidance with respect to well pumping capacity, well construction and distance from streams is provided below.

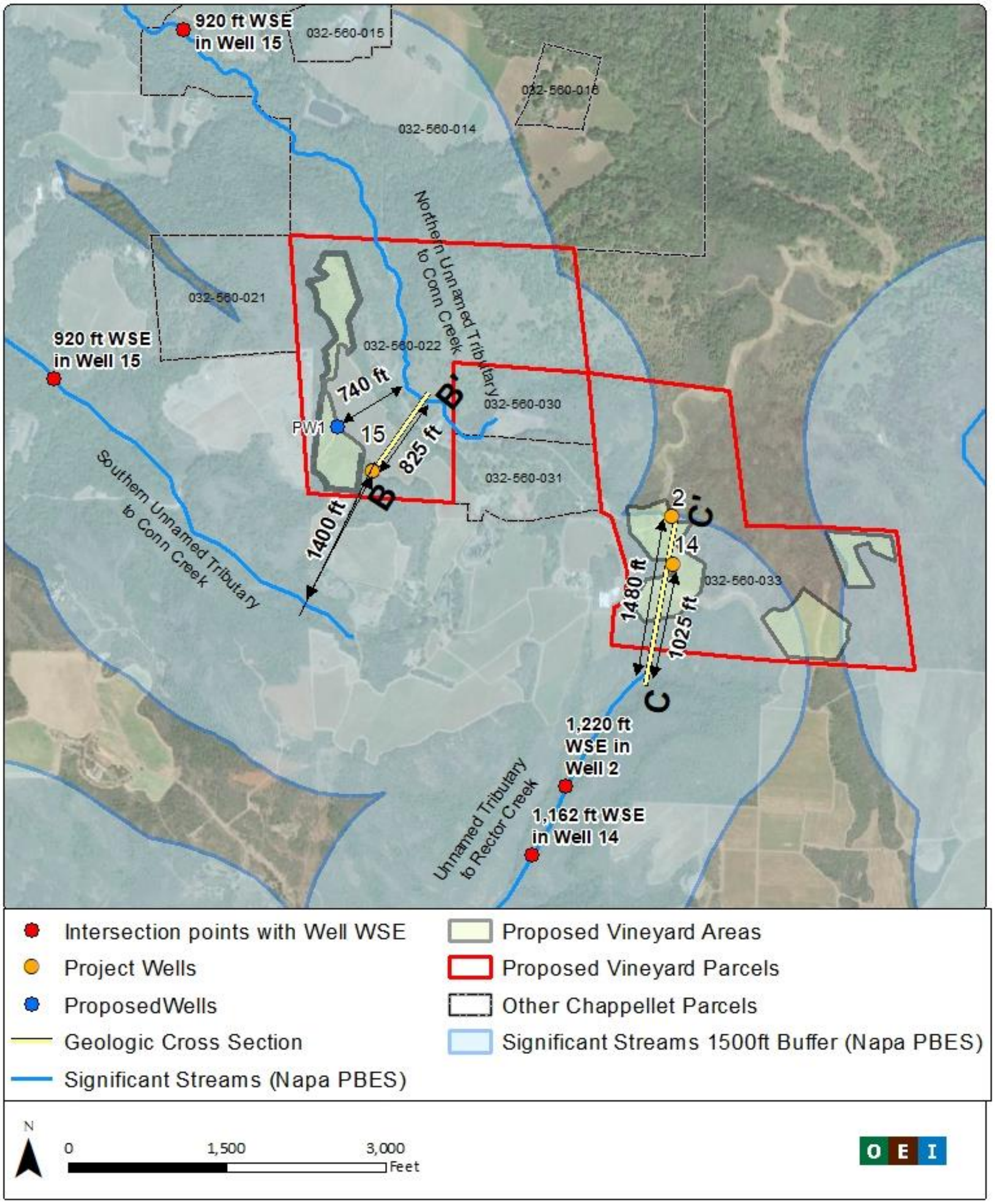
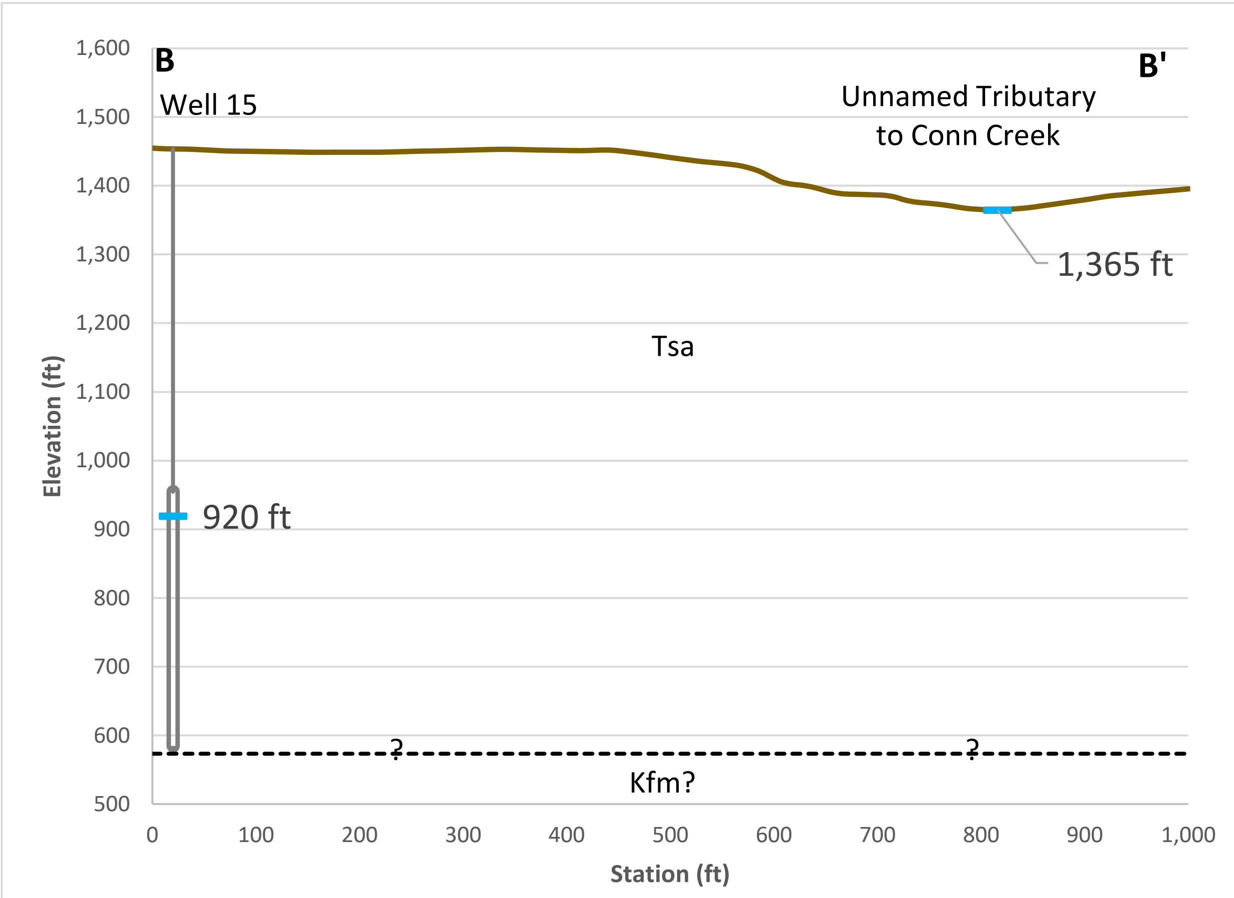


Figure 6. Project well locations in relation to Napa County defined Significant Streams.



Well

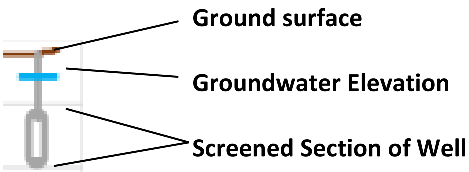
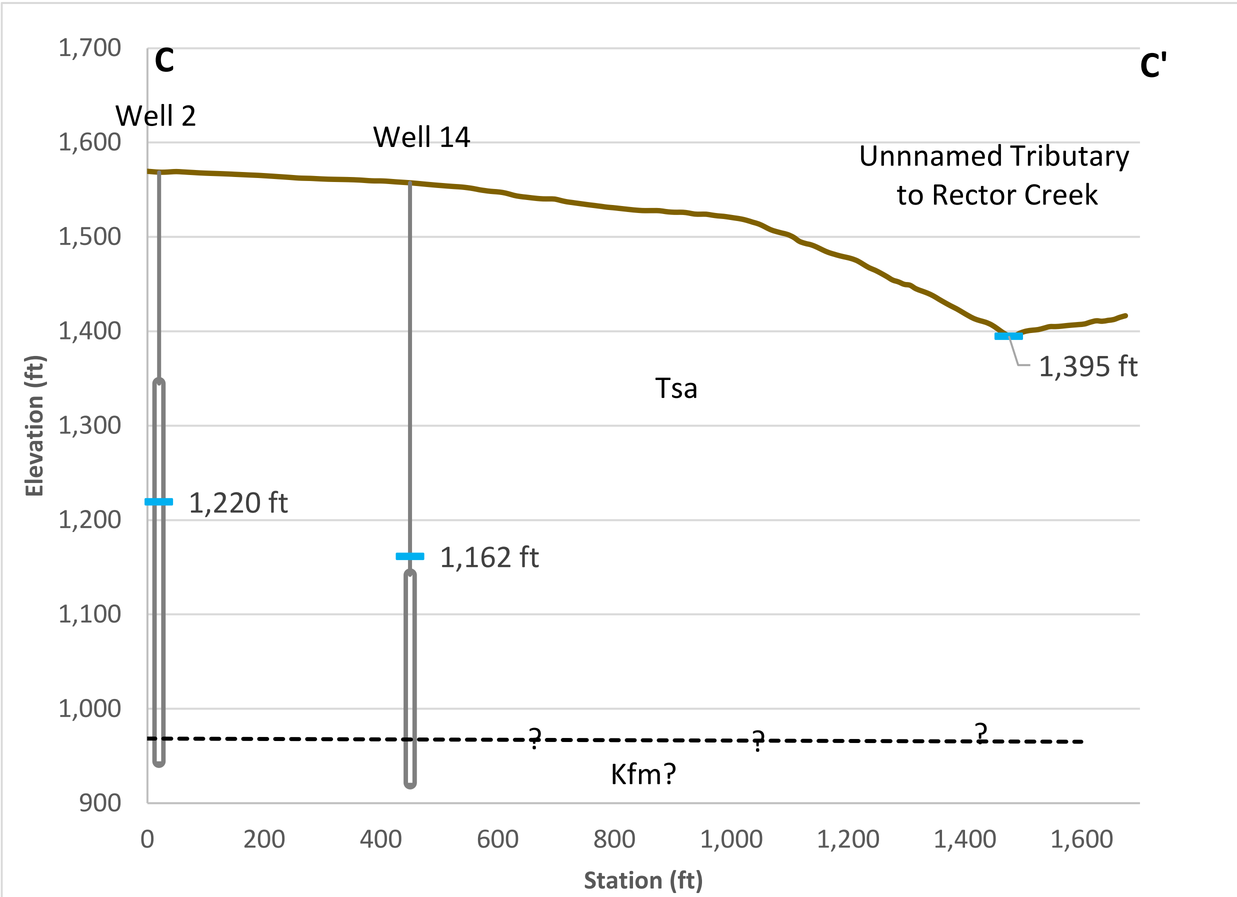


Figure 7. Hydrogeologic cross section B -B' through the vicinity of project Well 15 (see Figure 6 for location).



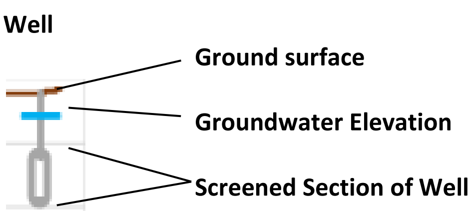


Figure 8. Hydrogeologic cross section C -C' through the vicinity of project Wells 2 and 14 (see Figure 6 for location).

Tier 3 WAA Guidance

As noted above, Napa County guidance for Tier 3 analyses presents well distance standards and construction assumptions that "if applicable would be expected to preclude and significant adverse effects on surface waters" (Napa, 2015). Specifically the "Tier 3 Groundwater Surface Water Interaction Criteria" section (Pgs 10-13 of the Napa) states:

> *Tier 3 analysis is only conducted when substantial evidence in the record determines the need for such an analysis. The groundwater/surface water criteria are presumptively met if the distance standards and project well construction assumptions are met (see Tables 3, 4, and 5).*

These standards consider the planned pumping rate of the project well, depth of screened interval and well seal along with aquifer hydraulic conductivity values and present acceptable distances based on specific combinations of these parameters. Tables 3, 4 and 5 in the Napa WAA guidance document present these distance standards and assumptions for wells constructed in unconsolidated aquifer materials. The project wells (Wells 2, 14, and 15) are screened entirely within the andesite unit of the Sonoma Volcanics. The screened intervals and surface seal depths are shown in Table 18 above. All wells are screened at depths greater than or equal to 225 feet and all are sealed with cement to a depth of 55 feet or greater. Well yields range from 25 gallons per minute (gpm) to 125 gpm (Tables 1 and 19 and Appendix A).

The project wells have reported yields of 25, 30 and 125 gpm for Wells 14, 2 and 15 respectively. Wells 2 and 14 have yields that place them in the "Low capacity pumping rate" category of wells (defined by Napa County to be between 10 gpm and 30 gpm); therefore, distance standards are evaluated using Table 4 (reproduced below from page 12 of the Napa WAA Guidance document).

Table 4. Well Distance Standards and Construction Assumptions; Low capacity pumping rates (i.e., between 10 gpm and 30 gpm), constructed in unconsolidated deposits in the upper part of the aquifer system (unconfined aquifer conditions).

Aquifer Hydraulic Conductivity (ft/day)	Acceptable Distance from Surface Water Channel			Minimum Surface Seal Depth (feet)	Depth of Uppermost Perforations (feet)
	500 feet	1000 feet	1500 feet		
80			✓	50	150
50			✓	50	150
30			✓	50	100
0.5		✓		50	100

Well 15's yield puts it into the "Moderate to High capacity pumping rate" category of wells (defined by Napa County to be greater than 30 gpm); therefore, distance standards are evaluated using Table 5 (reproduced below form page 13 of the Napa WAA Guidance document).

Table 5. Well Distance Standards and Construction Assumptions; Moderate to high capacity pumping rates (i.e., greater than 30 gpm), constructed in unconsolidated deposits in the upper part of the aquifer system (unconfined aquifer conditions).

Aquifer Hydraulic Conductivity (ft/day)	Acceptable Distance from Surface Water Channel			Minimum Surface Seal Depth (feet)	Depth of Uppermost Perforations (feet)
	500 feet	1000 feet	1500 feet		
80			✓	50	150
50			✓	50	150
30			✓	50	100
0.5			✓	50	100

It should be noted that these tables have been constructed based on well construction in unconsolidated materials and the Napa Guidance (2015) states on page 11:

> *Distance standards for project wells completed in consolidated formations will generally be no more restrictive than those shown in Tables 3, 4, and 5 for hydraulic conductivity values of 0.5 ft/day.*

For a well in a consolidated formation such as the andesite unit of the Sonoma Volcanics, the *de facto* hydraulic conductivity category would be 0.5 ft/day. In our professional experience in performing and reviewing well pumping tests in the region; hydraulic conductivity of the Sonoma Volcanics can be less by one or more factors of 10. Per Table 4 above an acceptable distance of 1,000 ft is recommended for Wells 2 and 14 in low pumping capacity wells category. Project Wells 2 and 14 are both located at distances greater than 1,000 feet from the unnamed tributary to Rector Creek indicating that distance and construction standards are met and that impacts of pumping of Wells 2 and 14 related to the proposed project upon flows in this creek are not likely to be significant.

Per Table 5 above project Well 15 which has a stated capacity of 125 gpm would require a distance of 1,500 feet to meet construction standards indicating that pumping will not impact streamflows. Well 15 is located approximately 825 feet from the northern unnamed tributary to Conn Creek and 1,400 feet from the southern unnamed tributary to Conn Creek (Figure 5). Although these distances do not meet the distance standards presented in Table 5, as described above, the depth to upper perforations in Well 15 (530 ft) is significant. The stream bed intersects this elevation 3,130 feet on the southern tributary to Conn Creek and 4,550 feet on the northern tributary to Conn Creek. We presume the proposed project well PW1 will have characteristics similar to Well 15.

Based on the preceding characterization of the unnamed tributaries to both Conn Creek and Rector Creek as intermittent streams with little connection to groundwater throughout the season of most groundwater use, the relatively large horizontal separation from the wells (740 ft at the least with PW1), vertical separation between project wells and each of the unnamed tributaries (at least 180 ft from the upper perforations in Well 2 up to the channel bottom of the unnamed tributary to Rector Creek), and the low permeability of the local bedrock, we do not expect that the proposed project will have a significant impact on flows in the unnamed tributaries to Conn Creek or the unnamed tributary to Rector Creek.

Summary

Application of the Soil Water Balance model (SWB) to the project recharge area revealed that average water year (based upon Water Year 2010 data) recharge was approximately 10.4 inches/yr or 397.1 ac-ft/yr. The total proposed water use for the project aquifer recharge area is estimated to be at most 46.5 ac-ft/yr during normal rainfall years. This represents about 12% of the mean annual recharge (Water Year 2010). An additional analysis of the averaged 10-year period of precipitation for Water Years 2012-2021 was performed to estimate recharge for a more recent time period including years of significant drought. This resulted in an estimated recharge of 6.7 inches/yr or 255.3 acre-ft/yr across the project recharge area. Proposed total project use (46.5 ac-ft/yr) represents 18% of the mean annual recharge for the averaged 2012-2021 water year period. Comparison of proposed project groundwater use to both normal rainfall year (Water Year 2010) and multiyear average (Water Years 2012 – 2021) recharge estimates show substantial surplus of recharge will occur indicating that the project is unlikely to result in declines in groundwater elevations or depletion of groundwater resources over time.

The nearest neighboring wells are all located more than 500-ft from the project wells indicating that a Tier 2 well interference analysis is not required. Three intermittent streams of concern are located within 1,500 feet of project wells. Based on the horizontal and vertical separation between project wells and these streams, as well as the low permeability of the local bedrock we do not expect the proposed project will have any significant impact to surface water flows.

References

Cronshey, R., McCuen, R., Miller, N., Rawls, W., Robbins, S., and Woodward, D., 1986. Urban hydrology for small watersheds - TR-55 (2nd ed.), Washington, D.C., U.S. Department of Agriculture, Soil Conservation Service, Engineering Division, Technical Release 55, 164 p.

Department of Water Resources (DWR), 1982. Evaluation of Ground Water Resources: Sonoma County. California Department of Water Resources in Cooperation with the County of Sonoma.

Graymer, R.W., Brabb, E.E., Jones, D.L., Barnes, J., Nicholson, R.S., and Stamski, R.E., 2007. Geologic Map and Database of Eastern Sonoma and Western Napa Counties, California. Pamphlet to accompany Scientific Investigations Map 2956. U.S. Department of the Interior U.S. Geological Survey

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Nishikawa, Tracy, ed., 2013, Hydrologic and geochemical characterization of the Santa Rosa Plain watershed, Sonoma County, California: U.S. Geological Survey Scientific Investigations Report 2013–5118, 178 p.

PRISM, 2010. 30 arcsecond resolution gridded total precipitation data for the conterminous United States, PRISM Climate Group, Oregon State University, www.prismclimate.org.

Thornthwaite, C.W., and Mather, J.R., 1957. Instructions and Tables for Computing Potential Evapotranspiration and the Water Balance, Publications in Climatology, v. 10, no. 3, pgs 185-311.

Weaver, C.E., 1949. Geology of the Coast Ranges immediately north of the San Francisco Bay Region, California, California Department of Natural Resources, Division of Mines, Bulletin 149.

Westenbroek, S.M., Kelson, V.A., Dripps, W.R., Hunt R.J., and Bradbury, K.R., 2010. SWB - A Modified Thornthwaite-Mather Soil-Water-Balance Code for Estimating Groundwater Recharge, U.S. Geological Survey Techniques and Methods 6-A31, 60 pgs.

APPENDIX A

WELL COMPLETION REPORTS

ORIGINAL
File with DWR

Page ___ of ___

Owner's Well No. ______

Date Work Began 05/09/2008 , Ended 05/15/2008

Local Permit Agency Napa County

Permit No. E07-00092 Permit Date 01/01/2008

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 1073634

DWR USE ONLY — DO NOT FILL IN — Well 1

07N04W08

STATE WELL NO./STATION NO.

LATITUDE | LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) XX VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD Rotary FLUID Air

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain size, color, etc.
0	38	Hard Gray Clay
38	42	Brown Clay & Gray Rock
42	125	Hard Gray Rock
125	295	Hard Gray Rock & Yellow Ash
295	330	Red Ash
330	375	Red Ash & Gray Rock
375	435	Hard Gray Rock
435	450	Red Ash
450	510	Hard Light Gray Rock
510	615	Hard Green & gray Rock
615	710	Gray & Green Shale with streaks of Serpintine

TOTAL DEPTH OF BORING 710 (Feet)

TOTAL DEPTH OF COMPLETED WELL 627 (Feet)

WELL OWNER

N
M
C

WELL LOCATION

Address 1581 Sage Canyon Road

City Saint Helena

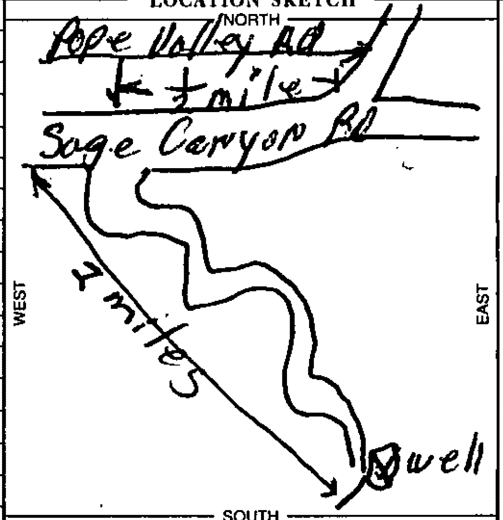
County Napa

APN Book 032 Page 010 Parcel 074-000

Township ___ Range ___ Section ___

Lat ___ DEG. MIN. SEC. N Long ___ DEG. MIN. SEC. W

LOCATION SKETCH



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

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
✓ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 410 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 400 (Ft.) & DATE MEASURED 5-15-08

ESTIMATED YIELD * 45 (GPM) & TEST TYPE Air Lift

TEST LENGTH 4 (Hrs.) TOTAL DRAWDOWN 4K (Ft.) GPM at day of Test

* *May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	50	12	✓				Plastic	6	F480	
50	447	9	✓				"	"	"	
447	627	9		✓			"	"	"	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	53	✓			
53	627				Well Pack Gravel

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Pulliam Well Exploration
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

5110 State Highway 128 Napa, CA 94558
ADDRESS CITY STATE ZIP

Signed Tom Pulliam 5-30-08 808-508
C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 05-03

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

OSP 03 78836

Old 032-010-028

*The free Adobe Reader may be used to view and complete this form. However, software must be purchased to complete, save, and reuse a saved form.

Well 2

File Original with DWR

State of California
Well Completion Report
Refer to Instruction Pamphlet
No. e0205845

Page ________ of ________
Owner's Well Number ________
Date Work Began 03/03/2014   Date Work Ended 3/13/2014
Local Permit Agency Napa County
Permit Number E14-00115   Permit Date 2/19/14

DWR Use Only – Do Not Fill In
07N 04W 08
State Well Number/Site Number
38 28 05 N   122 19 31 W
Latitude   Longitude
APN/TRS/Other

Geologic Log

Orientation ⦿ Vertical ○ Horizontal ○ Angle Specify ________
Drilling Method Direct Rotary   Drilling Fluid Air

Depth from Surface Feet	to Feet	Description (Describe material, grain size, color, etc)
0	20	Hard Gray Rock
20	60	Hard Solid Red Rock With Red Clay
60	400	Hard Gray Fractured Rock
400	480	Hard Purple Rock
480	560	Soft Green Ash
560	580	Black Ash
580	600	White Ash
600	680	Green Serpentine with Gray Shale
		Perforation Layout
		B = Blank
		P = Perforation
		0 to 225 ft Blank
		P
		245 to 425 Blank
		P
		B
		P
		B 505 ft
		P
		B
		P
		P
		B 605 ft
		P 625 ft bottom

Total Depth of Boring 680 Feet
Total Depth of Completed Well 625 Feet

Well Owner

Name
Mailing Address
City

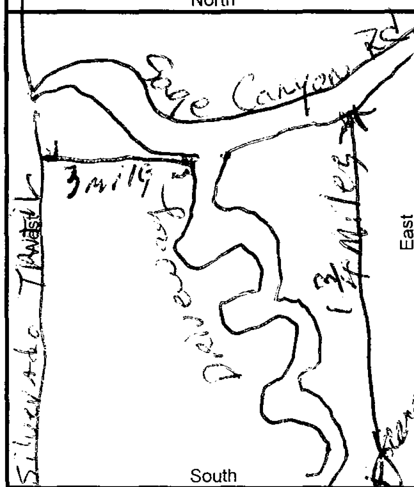
Well Location

Address 1581 Sage Canyon Rd
City St. Helena   County Napa
Latitude ___ Deg. ___ Min. ___ Sec. N   Longitude ___ Deg. ___ Min. ___ Sec. W
Datum ______ Dec. Lat. ______ Dec. Long. ______
APN Book 032   Page 010   Parcel 094-000
Township ______ Range ______ Section ______

Location Sketch

(Sketch must be drawn by hand after form is printed.)

North



West   East

South

Illustrate or describe distance of well from roads, buildings, fences, rivers, etc. and attach a map. Use additional paper if necessary. Please be accurate and complete.

Activity

⦿ New Well
○ Modification/Repair
○ Deepen
○ Other ________
○ Destroy
Describe procedures and materials under "GEOLOGIC LOG"

Planned Uses

⦿ Water Supply
☐ Domestic ☐ Public
☑ Irrigation ☐ Industrial
○ Cathodic Protection
○ Dewatering
○ Heat Exchange
○ Injection
○ Monitoring
○ Remediation
○ Sparging
○ Test Well
○ Vapor Extraction
○ Other ________

Water Level and Yield of Completed Well

Depth to first water 400 (Feet below surface)
Depth to Static Water Level 350 (Feet)   Date Measured 03/13/2014
Estimated Yield * 30 (GPM)   Test Type Air Lift
Test Length 4.0 (Hours)   Total Drawdown 270 (Feet)
*May not be representative of a well's long term yield.

Casings

Depth from Surface Feet	to Feet	Borehole Diameter (Inches)	Type	Material	Wall Thickness (Inches)	Outside Diameter (Inches)	Screen Type	Slot Size if Any (Inches)
0	60	12	Blank	PVC Sch. 40	R21	6		
60	225	10	Blank	PVC Sch. 40	R21	6		
225	245	10	Screen	PVC Sch. 40	R21	6	Milled Slots	0.032
245	425	10	Blank	PVC Sch. 40	R21	6		
425	625	10	Screen	PVC Sch. 40	R21	6	Milled Slots	0.032

Annular Material

Depth from Surface Feet	to Feet	Fill	Description
0	54	Cement	
54	625	Filter Pack	# 6 well pack

Attachments

☐ Geologic Log
☐ Well Construction Diagram
☐ Geophysical Log(s)
☐ Soil/Water Chemical Analyses
☐ Other ________
Attach additional information, if it exists.

Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief
Name Pulliam Well Exploratioin Inc
Person, Firm or Corporation
4371 Cantelow Road   Vacaville   CA   95688
Address   City   State   Zip
Signed Tony Pulliam   3/19/2014   808-508
C-57 Licensed Water Well Contractor   Date Signed   C-57 License Number

DWR 188 REV. 1/2006

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Well 3

08 E/F M/L

ORIGINAL

File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

Do not fill in

No. 119501

State Well No. ______

Other Well No. 07N04W08

Notice of Intent No. ______

Local Permit No. or Date ______

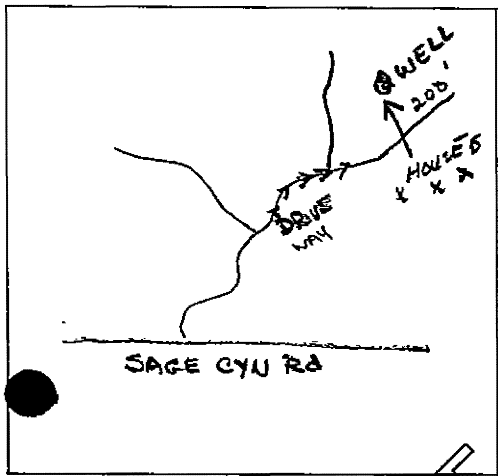
(2) LOCATION OF WELL (See instructions):

County Napa Owner's Well Number 32-010-27

Well address if different from above ______

Township ______ Range ______ Section ______

Distance from cities, roads, railroads, fences, etc. ______



WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well X Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic X
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) EQUIPMENT:
Rotary ☐ Reverse ☐
Cable ☐ Air X
Other ☐ Bucket ☐

(6) GRAVEL PACK:
Yes ☐ No X Size ______
Diameter of bore 8½
Packed from ______ to ______ ft.

(7) CASING INSTALLED:
Steel ☐ Plastic X Concrete ☐

(8) PERFORATIONS:
Type of perforation or size of screen ______

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	420	6	160	420	640	1/8 x 3

(9) WELL SEAL:
Was surface sanitary seal provided? Yes X No ☐ If yes, to depth 21 ft.
Were strata sealed against pollution? Yes ☐ No X Interval ______ ft.
Method of sealing cement

(10) WATER LEVELS:
Depth of first water, if known 475 ft.
Standing level after well completion 450 ft.

(11) WELL TESTS:
Was well test made? Yes X No ☐ If yes, by whom? driller
Type of test Pump ☐ Bailer ☐ Air lift X
Depth to water at start of test 450 ft. At end of test ______ ft
Discharge 10 gal/min after ______ hours Water temperature ______
Chemical analysis made? Yes ☐ No X If yes, by whom? ______
Was electric log made? Yes ☐ No X If yes, attach copy to this report

(12) WELL LOG: Total depth 640 ft. Depth of completed well 640 ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	25	topsoil-gray rock
25	50	gray & red rock-med hard
50	100	gray rock hard
100	175	gray rock stringers brwn clay
175	200	gray red & brown rock-med hard
200	275	brown black & gray rock-med har
275	300	red rock-med hard
300	325	red black green & brown rock-med hard
325	375	black brown rock-med hard fract
375	450	black brown & red rock fract-med hard
450	475	black red rock stringers-green hard fract
475	575	gray green red brown black rock med hard fract
575	600	gray & black rock-med hard
600	620	green red & black rock
620	640	black gray & green rock-med har

Work started 3/19 1982 Completed 4/7 1982

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED [signature] (Well Driller)

NAME Doshier & Gregson Drilling, Inc (Person, firm, or corporation) (Typed or printed)

Address 5365 Napa Vallejo Hwy

City Vallejo, Ca Zip 94589

License No. 294001 Date of this report 4/9/82

ORIGINAL
File with DWR

Page ____ of ____

Owner's Well No. ____________

Date Work Began 05/07/2010, Ended 05/14/2010

Local Permit Agency Napa County

Permit No. E10-00143 Permit Date 05/06/2010

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 0945281

DWR USE ONLY — DO NOT FILL IN | Well 4

07N04W08

STATE WELL NO./STATION NO.

LATITUDE | LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) XX VERTICAL ____ HORIZONTAL ____ ANGLE ____ (SPECIFY)

DRILLING METHOD Rotary FLUID Air

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain size, color, etc.
0	3	Red Dirt & Rocks
3	20	Hard Gray Rocks & Clay
20	120	Yellow Clay & Black Ash
120	240	Red & Black Ash
240	280	Red Ash
280	400	Hard Dark Gray Rock
400	420	Black Ash
420	440	Red Ash
440	470	Black Ash
470	500	Black, Red Ash
500	680	Dark Gray Fractured Rock
680	760	Dark Gray Rock & Black Fractured rock
760	800	Hard Green Rock

TOTAL DEPTH OF BORING 800 (Feet)

TOTAL DEPTH OF COMPLETED WELL 798 (Feet)

WELL OWNER

Address 1683 Sage Canyon Road

City St. Helena

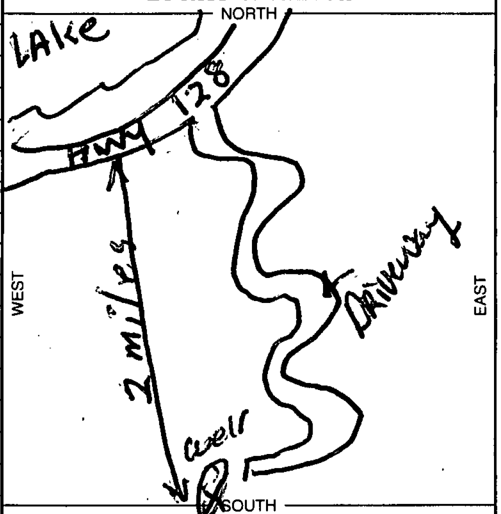
County Napa

APN Book 032 Page 010 Parcel 061-000

Township ____ Range ____ Section ____

Lat ____ N DEG. MIN. SEC. Long ____ W DEG. MIN. SEC.

LOCATION SKETCH



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

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR
____ Deepen
____ Other (Specify)

____ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

USES (✓)

WATER SUPPLY
✓ Domestic ____ Public
✓ Irrigation ____ Industrial

MONITORING ____
TEST WELL ____
CATHODIC PROTECTION ____
HEAT EXCHANGE ____
DIRECT PUSH ____
INJECTION ____
VAPOR EXTRACTION ____
SPARGING ____
REMEDIATION ____
OTHER (SPECIFY) ____

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 490 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 420 (Ft.) & DATE MEASURED 5-14-10

ESTIMATED YIELD * 35 (GPM) & TEST TYPE Air Lift

TEST LENGTH 5 (Hrs.) TOTAL DRAWDOWN UK (Ft.) GPM at day of test

** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	55	12¼	✓				Plastic	6	F480	=21
55	500	9	✓				"	"	"	
500	798	9		✓			"	"	"	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	55	✓			
55	798				Well Pack Gravel

ATTACHMENTS (✓)

____ Geologic Log
____ Well Construction Diagram
____ Geophysical Log(s)
____ Soil/Water Chemical Analyses
____ Other ____

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Pulliam Well Exploration Inc
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

5110 State Highway 128 Napa CA 94558
ADDRESS CITY STATE ZIP

Signed Tom Pulliam 5-19-10 808-508
C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 05-03 IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM OSP 03 78836

Well 5

ORIGINAL
File with DWR

Page ___ of ___

Owner's Well No. ______

Date Work Began 03/21/2007, Ended 03/29/2007

Local Permit Agency Napa County

Permit No. E07-00091 Permit Date 03/12/2007

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 0938182

DWR USE ONLY — DO NOT FILL IN

07N04W08

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD Rotary FLUID Air

DEPTH FROM SURFACE Ft. to Ft.		DESCRIPTION *Describe material, grain size, color, etc.*
0	13	Brown Clay & Gray Rock
13	30	Red Clay & Red Ash
30	125	Hard Gray, Red & Brown Ash
125	215	Hard Gray Volcanic Rock
215	225	Red Ash
225	340	Green & Black Ash, Yellow Clay
340	360	Red Ash & Red Clay
360	500	Hard Gray & Black Rock, some Yellow Ash
500	512	Red Ash
512	630	Gray Rock
630	655	Gray Rock & Gray Clay
655	715	Green & Gray Ash
715	730	White Ash
730	750	Gray & Green Shale
750	790	Green Shale

TOTAL DEPTH OF BORING 790 (Feet)

TOTAL DEPTH OF COMPLETED WELL 750 (Feet)

WELL OWNER

N

M

C

WELL LOCATION

Address 1683 Sage Canyon Road

City Saint Helena

County Napa

APN Book 032 Page 010 Parcel 061-000

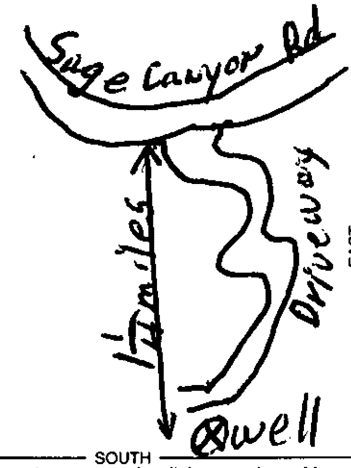
Township ___ Range ___ Section ___

Lat ___ DEG. MIN. SEC. N Long ___ DEG. MIN. SEC. W

LOCATION SKETCH

NORTH

WEST



EAST

SOUTH

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

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (*Describe Procedures and Materials Under "GEOLOGIC LOG"*)

USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
✓ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 490 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 460 (Ft.) & DATE MEASURED 3-29-07

ESTIMATED YIELD * 25 (GPM) & TEST TYPE Air Lift

TEST LENGTH 3 (Hrs.) TOTAL DRAWDOWN UK (Ft.) GPM at day of test

* *May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft. to Ft.		BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	30	11	✓				Plastic	6	F480	
30	300	9	✓				"	"	"	
300	750	9		✓			"	"	"	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to Ft.		CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	26	✓			
26	750				Well Pack Gravel

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ______

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Pulliam Well Exploration
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

5110 Highway 128 Napa CA 94558
ADDRESS CITY STATE ZIP

Signed Tom Pulliam 4-1-07 808-508
C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 05-03 IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM OSP 03 78836

ORIGINAL
File with DWR

Page 1 of 1

Owner's Well No. 1

Date Work Began 2/27/95, Ended 3/31/95

Local Permit Agency Napa County Environmental Health

Permit No. 38402 Permit Date 2/17/95

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 547433

Well 6

DWR USE ONLY — DO NO[T FILL IN]

07N04W08

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIF[Y])

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION (Describe material, grain size, color, etc.)
0	5	Boulders
5	20	Gray rock fract.
20	40	Red rock soft
40	55	Gray rock, brown soil
55	70	Black rock,stringers brown soft
70	85	Lt brown and black rock soft
85	100	Dk brown rock soft
100	115	Brown & black rock soft
115	145	Dk red,black & brown rock hard
145	160	Black & red rock soft
160	175	Black, Brown & red rock fract
175	190	Black, dk/red rock fract med
190	220	Gray,red & black rock fract
220	250	Gray rock hard fract
250	280	Gray & black rock hard fract
280	295	Gray & red rock hard & fract
295	310	Gray,black & red rock fract
310	355	Gray black & brown rock hard fract
355	400	Gray & brown rock hard fract
400	415	Red, black, brown, gray rock hard
415	445	Gray rock hard & fract
445	460	Black, brown & gray rock fract hard
460	505	Black rock fract & hard
505	550	Gray, black rock hard fract
550	605	Gray rock stringers black hard
605	625	Black & gray rock med hard
625	665	Gray rock stringers black med

TOTAL DEPTH OF BORING 665 (Feet)

TOTAL DEPTH OF COMPLETED WELL 620 (Feet)

WELL OWNER

WELL LOCATION

Address 1677 Sage Canyon Road

City St. Helena

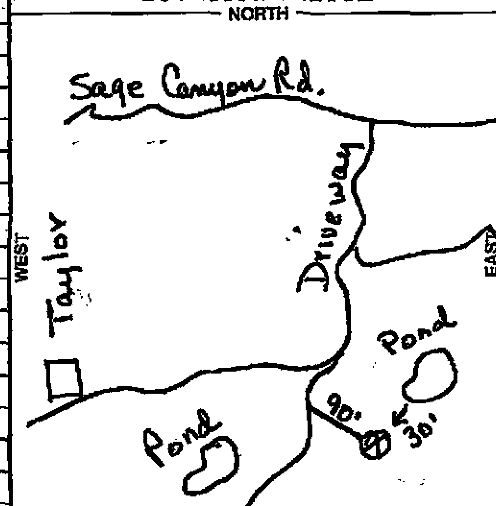
County Napa

APN Book 32 Page 010 Parcel 61

Township ___ Range ___ Section ___

Latitude ___ NORTH Longitude ___ WEST (DEG. MIN. SEC.)

LOCATION SKETCH



Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

X NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USE(S) (✓)

___ MONITORING

WATER SUPPLY
X Domestic
___ Public
___ Irrigation
___ Industrial
___ "TEST WELL"
___ CATHODIC PROTECTION
___ OTHER (Specify)

DRILLING METHOD Air Rotary FLUID Wter foam

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 400 (Ft.) & DATE MEASURED 3/30/95

ESTIMATED YIELD* 20 (GPM) & TEST TYPE Air

TEST LENGTH 5 (Hrs.) TOTAL DRAWDOWN complete

* May not be representative of a well's long-term yield.

CASING(S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches) 9 7/8"	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
620	420			X			I-C-1	6	F-480	.032
420	1		X				I-C-1	6	F-480	
2	1	12 3/4			X					

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
665	30			X	Pea gravel
30	29		X		
29	1	X			

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Doshier-Gregson Inc. 220
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

5365 Napa Vallejo Highway, American Canyon, CA. 94589
ADDRESS CITY STATE ZIP

Signed Raymond Webster 3/30/95 258826
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 7-90

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

E/E
M/L

ORIGINAL

File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
WATER WELL DRILLERS REPORT

Well 7

Do not fill in

No. 120020

State Well No. ______

Other Well No. 07N04W08

e of Intent No. ______

Permit No. or Date ______

(12) WELL LOG:
Total depth 710 ft. Depth of completed well 700 ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	30	Br. rock hard
30	75	Red & Black rock m-hard
75	90	Black rock some red hard
90	148	Black rock hard to m-hard
148	206	Red & Black rock m-hard
206	237	Black & brown rock m-hard
237	263	Black & br. some stringers of red rock
263	285	Black & hard green rock stringers of brown & red rock
285	340	Black rock hard
340	427	Red rock with hard stringers of black rock
427	450	Black rock with hard stringers of green rock
450	464	Red rock
464	604	Hard black rock fractured
604	611	Red rock soft
611	670	Green rock soft
670	695	Green rock with m-hard stringers of grey rock
695	710	Soft green rock

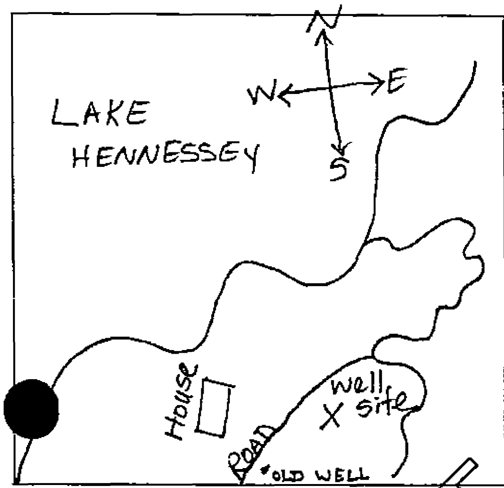
Work started 12-16 19 90 Completed 1-14 19 91

(2) LOCATION OF WELL (See instructions):
County Napa Owner's Well Number 032-010-27

Well address if different from above ______

Township 07N Range 04W Section 08

Distance from cities, roads, railroads, fences, etc. ______



WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well ☒ Deepening ☐

Reconstruction ☐

Reconditioning ☐

Horizontal Well ☐

Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic ☐

Irrigation ☒

Industrial ☐

Test Well ☐

Stock ☐

Municipal ☐

Other ☐

(5) EQUIPMENT:
Rotary ☒ Reverse ☐

Cable ☐ Air ☒

Other ☐ Bucket ☐

(6) GRAVEL PACK:
Yes ☒ No ☐ Size Pea

Diameter of bore 12¼"

Packed from 25 to 700 ft.

(7) CASING INSTALLED:
Steel ☐ Plastic ☒ Concrete ☐

(8) PERFORATIONS:
Type of perforation or size of screen

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	440	6	200	440	460	.032
460	480	6	200	480	580	.032
580	600	6	200	600	700	.032

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 25 ft.

Were strata sealed against pollution? Yes ☐ No ☒ Interval ______ ft.

Method of sealing Bentonite & Concrete

(10) WATER LEVELS:
Depth of first water, if known 470 ft.

Standing level after well completion 460 ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? driller

Type of test Pump ☐ Bailer ☐ Air lift ☒

Depth to water at start of test 460 ft. At end of test 460 ft

arge 30 gal/min after 4 hours Water temperature ______

ical analysis made? Yes ☒ No ☐ If yes, by whom? ______

Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED [signature] (Well Driller)

NAME Doshier-Gregson, Inc.
(Person, firm, or corporation) (Typed or printed)

Address 5365 Napa-Vallejo Hwy.

City Vallejo, CA Zip 94589-9679

License No. 258826 Date of this report 1-21-91

8

ORIGINAL

File with DWR

STATE OF CALIFORNIA 08 N/P
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
WATER WELL DRILLERS REPORT

Do not fill in

No. 120017

e of Intent No.

Permit No. or Date

State Well No.

Other Well No. 07N04W08N

1677 Sage Canyon (032-010-091)

60

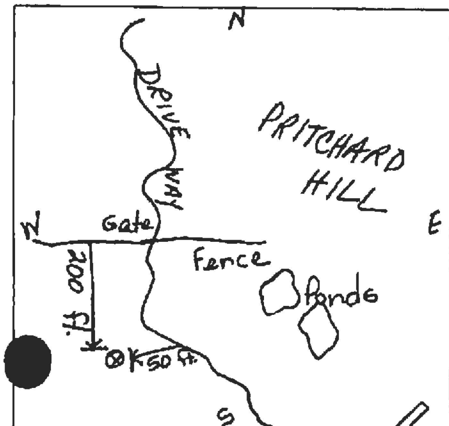
(2) LOCATION OF WELL (See instructions):

County Napa Owner's Well Number 32-010-29

Well address if different from above Pritchard Hill

Township Range Section

Distance from cities, roads, railroads, fences, etc.



WELL LOCATION SKETCH

(3) TYPE OF WORK:

New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:

Domestic ☐
Irrigation ☒
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) EQUIPMENT:

Rotary ☐ Reverse ☐
Cable ☐ Air ☒
Other ☐ Mud Bucket ☐

(6) GRAVEL PACK:

Yes ☒ No ☐ Size Pea
Diameter of bore 9 7/8"
Packed from 610 to 25 ft.

(7) CASING INSTALLED:

Steel ☐ Plastic ☒ Concrete ☐

(8) PERFORATIONS:

Type of perforation or size of screen

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	480	6	200	480	610	.032

(9) WELL SEAL:

Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 25 ft.

Were strata sealed against pollution? Yes ☐ No ☐ Interval ft.

Method of sealing Bentonite Pellets & concrete

(10) WATER LEVELS:

Depth of first water, if known 495 ft.

Standing level after well completion 470 ft.

(11) WELL TESTS:

Was well test made? Yes ☒ No ☐ If yes, by whom? driller

Type of test Pump ☐ Bailer ☐ Air lift ☒

Depth to water at start of test 495 ft. At end of test ft

harge 50 gal/min after 3 hours Water temperature

mical analysis made? Yes ☒ No ☐ If yes, by whom? lab

Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG: Total depth 610 ft. Depth of completed well 610 ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
2	20	Red & Brown clay
20	55	Gray & Blaack rock med hard
55	70	Gray & black rock stringer brown clay
70	130	Black brown & red rock med hard
130	160	Black & red rock hard fract
160	220	Black red & gray rock hard fract
220	265	Brown red & black rock hard fract
265	295	Black brown red rock hard fract
295	390	Black gray red rock stringers dark & light brown
390	495	Black gray red rock hard fract
495	600	Black red dk. green brown rock hard fract
600	610	Gray rock hard

Work started 12-14 1990 Completed 1-8 1991

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED Raymond Webster
(Well Driller)

NAME Doshier - Gregson, Inc.
(Person, firm, or corporation) (Typed or printed)

Address 5365 Napa-Vallejo Hwy.

City Vallejo, CA Zip 94589-9679

License No. 258826 Date of this report 1-11-91

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Well 8

ORIGINAL

File with DWR

E/F
M/L

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
WATER WELL DRILLERS REPORT

Well 9

Do not fill in

No. 245581

[redacted] of Intent No.

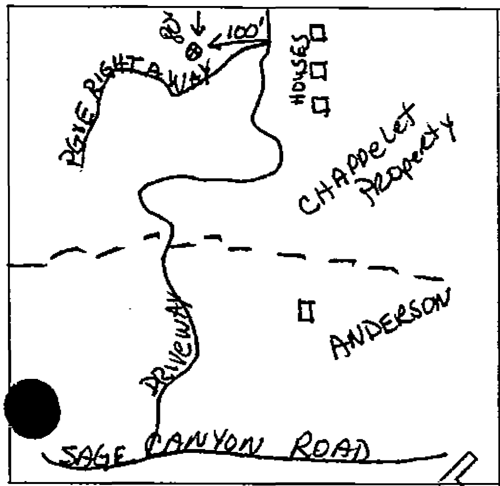
[redacted] Permit No. or Date

FRICHARD HCL

State Well No.
Other Well No. 07N04W08

(

(2) LOCATION OF WELL (See instructions):
County Napa Owner's Well Number 32-010-27
Well address if different from above
Township St. Helena Range , Section
Distance from cities, roads, railroads, fences, etc.



[redacted]

WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic ☒
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(12) WELL LOG: Total depth 665 ft. Depth of completed well 650 ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	- 1	Top Soil
1	- 3	Gray rock hard
3	- 20	Red rock stringer brown clay
20	- 40	Red and black hard
40	- 55	Red rock med hard
55	- 85	Black red and gray rock med hard
85	- 145	Red black rock med hard
145	- 175	Brown and gray rock hard
175	- 245	Black brown gray hard
245	- 305	Black and brown rock hard
305	- 325	Dk red rock hard fract
325	- 365	Dk red black and brown rock hard fract
365	- 425	Black rock hard fract
425	- 485	Dk red and black rock hard fract
485	- 505	Dk red rock med hard fract
505	- 525	Green white and gray rock med hard fract
	-	stringers black rock
525	- 585	Lt green and gray hard fract
585	- 615	Gray rock hard
615	- 650	Black red green gray stringers white rock soft
650	- 665	Black green white stringers shale

(5) EQUIPMENT:
Rotary ☐ Reverse ☐
Cable ☐ Air ☒
Other ☐ Bucket ☐

(6) GRAVEL PACK:
Yes ☒ No ☐ Size Pea
Diameter of bore 9 7/8 & 8 3/4
Packed from 650 to 26 ft.

(7) CASING INSTALLED:
Steel ☐ Plastic ☒ Concrete ☐

(8) PERFORATIONS:
Type of perforation or size of screen Machine

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	440	6	200	440	500	.032
500	520	6	200	520	650	.032

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 26 ft.
Were strata sealed against pollution? Yes ☐ No ☐ Interval ft.
Method of sealing Bentinite Pellets and Concrete

(10) WATER LEVELS:
Depth of first water, if known 450 ft.
Standing level after well completion 420 ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? Driller
Type of test Pump ☐ Bailer ☐ Air lift ☒
Depth to water at start of test 420 ft. At end of test 650 ft
[redacted] arge 20 gal/min after 4 hours Water temperature
[redacted] ical analysis made? Yes ☐ No ☒ If yes, by whom?
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

Work started 7/1/88 Completed 7/12/88 19

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED (signature) (Well Driller)
NAME Doshier-Gregson, Inc.
(Person, firm, or corporation) (Typed or printed)
Address 5365 Napa Vallejo Hwy
City Vallejo Zip 94589
License No. 258826 Date of this report 7/14/88

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL
File with DWR

Page ___ of ___

Owner's Well No. ______

Date Work Began 05/16/2008, Ended 05/28/2008

Local Permit Agency Napa County

Permit No. E07-00121 Permit Date 03/21/2007

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 1073633

Well 10

DWR USE ONLY — DO NOT FILL IN

07N04W18

STATE WELL NO./STATION NO.

LATITUDE | LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) XX VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD Rotary FLUID Air

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain size, color, etc.
~~0~~	~~25~~	~~Red Clay & Red Ash~~
~~25~~	~~70~~	~~Brown Clay & hard Gray Rock~~
~~70~~	~~115~~	~~Hard Gray Volcanic Rock~~
~~115~~	~~150~~	~~Brown Ash~~
~~150~~	~~255~~	~~Hard Gray & Green Volcanic Rock~~
~~255~~	~~290~~	~~Red, Brown, & White Ash~~
~~290~~	~~360~~	~~Hard Gray Rock & Red Volvanic Ash~~
~~360~~	~~440~~	~~Hard Gray Rock~~
~~440~~	~~495~~	~~Red Ash & Gray Rock~~
~~495~~	~~530~~	~~Hard Gray Rock~~
~~530~~	~~590~~	~~Red & Green Volcanic Rock~~
~~590~~	~~660~~	~~Green Hard Rock~~
~~660~~	~~755~~	~~Hard Black & Green Rock~~

TOTAL DEPTH OF BORING 755 (Feet)

TOTAL DEPTH OF COMPLETED WELL 755 (Feet)

WELL OWNER

Name ______

Mailing Address ______

CITY ______ STATE ______ ZIP ______

WELL LOCATION

Address 1677 Sage Canyon Road

City St. Helena

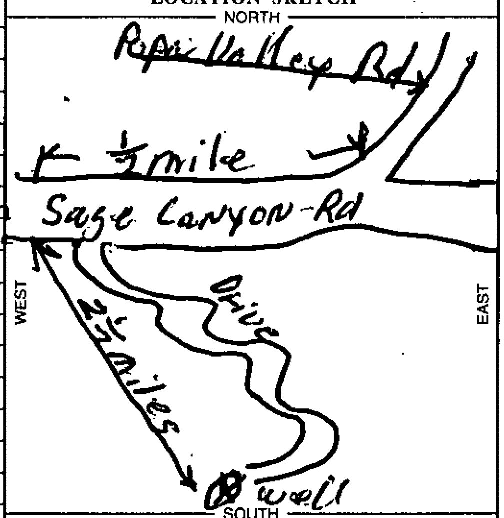
County Napa

APN Book 032 Page 030 Parcel 043-000

Township ______ Range ______ Section ______

Lat ___ DEG. ___ MIN. ___ SEC. N Long ___ DEG. ___ MIN. ___ SEC. W

LOCATION SKETCH



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

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

USES (✓)

WATER SUPPLY
___ Domestic ___ Public
✓ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 600 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 565 (Ft.) & DATE MEASURED 5-28-08

ESTIMATED YIELD * 45 (GPM) & TEST TYPE air lift

TEST LENGTH 4 (Hrs.) TOTAL DRAWDOWN UK (Ft.) GPM at day of test

* *May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	53	12	✓				Plastic	6	F480	
53	605	9	✓				"	"	"	
605	755	9		✓			"	"	"	.030

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	53	✓			
53	755				Well Pack Gravel

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ______

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Pulliam Well Exploration
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

5110 State Highway 128 Napa, CA 94558
ADDRESS CITY STATE ZIP

Signed [signature] 5-30-08 808-508
C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 05-03 IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM OSP 03 78836

10

E14-00578

*The free Adobe Reader may be used to view and complete this form. However, software must be purchased to complete, save, and reuse a saved form.

File Original with DWR

Page 1 of 1

Owner's Well Number Krupp Knief #2

Date Work Began 03/05/2015 Date Work Ended 3/25/2015

Local Permit Agency planning, Building and Environmental

Permit Number E14-00578 Permit Date 7/21/14

State of California

Well Completion Report

Refer to Instruction Pamphlet

No. e0260575

DWR Use Only – Do Not Fill In
State Well Number/Site Number
N Latitude / W Longitude
APN/TRS/Other

Geologic Log

Orientation ⦿ Vertical ○ Horizontal ○ Angle Specify

Drilling Method Air Drilling Drilling Fluid Air

Depth from Surface Feet	to Feet	Description (Describe material, grain size, color, etc)
0	200	Soft volcanics
200	250	Hard black rock
250	300	Same rock but fractured and 20 gpm
300	400	soft yellow ash
400	490	Hard fractured black, green and brown rock
490	510	soft red volcanics
510	565	soft yellow volcanics and ash
565	590	Hard fractured black rock

RECEIVED
MAR 31 2015
Napa County Planning, Building & Environmental Services

Total Depth of Boring 590 Feet

Total Depth of Completed Well 560 Feet

Well Owner

Name Krupp Vineyards

Mailing Address Soda canyon rd

City napa State ca Zip 94558

Well Location

Address Soda canyon rd

City napa County Napa

Latitude ___ Deg. ___ Min. ___ Sec. N Longitude ___ Deg. ___ Min. ___ Sec. W

Datum ___ Decimal Lat. ___ Decimal Long. ___

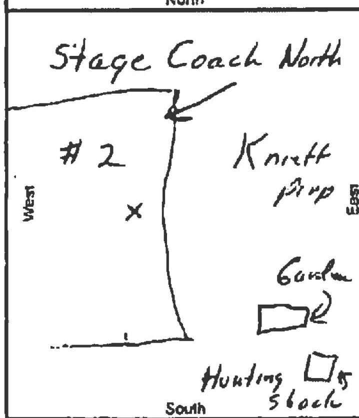
APN Book 032 Page 010 Parcel 086

Township ___ Range ___ Section ___

Location Sketch

(Sketch must be drawn by hand after form is printed.)

North



South

Illustrate or describe distance of well from roads, buildings, fences, rivers, etc. and attach a map. Use additional paper if necessary. Please be accurate and complete.

Activity

- ⦿ New Well
- ○ Modification/Repair
  - ○ Deepen
  - ○ Other
- ○ Destroy
  - Describe procedures and materials under "GEOLOGIC LOG"

Planned Uses

- ⦿ Water Supply
  - ☐ Domestic ☐ Public
  - ☑ Irrigation ☐ Industrial
- ○ Cathodic Protection
- ○ Dewatering
- ○ Heat Exchange
- ○ Injection
- ○ Monitoring
- ○ Remediation
- ○ Sparging
- ○ Test Well
- ○ Vapor Extraction
- ○ Other

Water Level and Yield of Completed Well

Depth to first water 240 (Feet below surface)

Depth to Static Water Level 240 (Feet) Date Measured 03/26/2015

Estimated Yield * 150 (GPM) Test Type Air Lift

Test Length 2.0 (Hours) Total Drawdown 0 (Feet)

*May not be representative of a well's long term yield.

Casings

Depth from Surface Feet	to Feet	Borehole Diameter (Inches)	Type	Material	Wall Thickness (Inches)	Outside Diameter (Inches)	Screen Type	Slot Size if Any (Inches)
0	20	14	Blank	PVC Sch. 80		8		
20	280	14	Blank	PVC Sch. 80		8		
280	560	14	Staggered	PVC Sch. 80		8	Milled Slots	0.032

Annular Material

Depth from Surface Feet	to Feet	Fill	Description
0	20	Bentonite	seal
20	590	Filter Pack	pea gravel

Attachments

- ☐ Geologic Log
- ☐ Well Construction Diagram
- ☐ Geophysical Log(s)
- ☐ Soil/Water Chemical Analyses
- ☐ Other

Attach additional information, if it exists.

Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

Name D. Bess pump & Well (Person, Firm or Corporation)

1115 mt george ave (Address) napa (City) CA (State) 94558 (Zip)

Signed ___ (C-57 Licensed Water Well Contractor) Date Signed ___ 487027 C-57 License Number

Well 11

WELL 13

State of California
Well Completion Report
Form DWR 188 Submitted 11/27/2018
WCR2018-010626

Owner's Well Number 032-010-094-000 Date Work Began 09/26/2018 Date Work Ended 10/06/2018

Local Permit Agency Napa County Planning Building and Environmental Services

Secondary Permit Agency Permit Number e18-00795 Permit Date 10/08/2018

Well Owner (must remain confidential pursuant to Water Code 13752)

Name CHAPPELLET VINEYARD LP,

Mailing Address 1581 SAGE CANYON ROAD

City ST. HELENA State CA Zip 94574

Planned Use and Activity

Activity Drill and Destroy

Planned Use Destruction

Well Location

Address 1581 SAGE CANYON RD

City ST HELENA Zip 94574 County Napa

Latitude 38 Deg. 29 Min. 12.3871 Sec. N Longitude -122 Deg. 21 Min. 12.4804 Sec. W

Dec. Lat. 38.4867742 Dec. Long. -122.3534668

Vertical Datum Horizontal Datum WGS84

Location Accuracy Location Determination Method

APN 032-010-094-000

Township 07 N

Range 04 W

Section 06

Baseline Meridian Mount Diablo

Ground Surface Elevation

Elevation Accuracy

Elevation Determination Method

Borehole Information

Orientation Vertical Specify

Drilling Method Direct Rotary Drilling Fluid Air

Total Depth of Boring 780 Feet

Total Depth of Completed Well Feet

Water Level and Yield of Completed Well

Depth to first water 0 (Feet below surface)

Depth to Static Water Level 0 (Feet) Date Measured 10/06/2018

Estimated Yield* 0 (GPM) Test Type Air Lift

Test Length 0 (Hours) Total Drawdown 0 (feet)

*May not be representative of a well's long term yield.

Geologic Log - Free Form

Depth from Surface Feet to Feet		Description
0	40	RED ASH CLAY
40	80	HARD BLACK BASALT
80	120	BROWN ASH
120	200	HARD GREY ROCK
200	220	BROWN ASH
220	420	HARD GREY ROCK
420	440	RED ASH
440	620	GREEN HARD FRACTURED ROCK
620	660	BLACK BASALT FRACTURED ROCK
660	750	GREEN SURPINTINE
750	780	GREEN SERPINTINE

Casings

Casing #	Depth from Surface Feet to Feet		Casing Type	Material	Casings Specificatons	Wall Thickness (inches)	Outside Diameter (inches)	Screen Type	Slot Size if any (inches)	Description

Annular Material

Depth from Surface Feet to Feet		Fill	Fill Type Details	Filter Pack Size	Description
0	780	Filter Pack	Other Gravel Pack	6	BIRDS EYE GRAVEL

Destruction Details:
BACK FILLED WITH GRAVEL UP TO 35 FEET, SEAL DEPTH, CEMENT TO FROM 35 FEET TO 5 FEET. BACKFILLED FROM 5 FEET TO 0 WITH NEEDED MATERIAL.

Other Observations:

Borehole Specifications

Depth from Surface Feet to Feet		Borehole Diameter (inches)
0	780	12

Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

Name PULLIAM WELL EXPLORATION INC
Person, Firm or Corporation

1663 HOWELL MTN RD	ANGWIN	CA	94508
Address	City	State	Zip

Signed Electronic Signature Received — 11/27/2018 — 808508
C-57 Licensed Water Well Contractor — Date Signed — C-57 License Number

DWR Use Only

CSG #	State Well Number	Site Code	Local Well Number

N — Latitude Deg/Min/Sec

W — Longitude Deg/Min/Sec

TRS:

APN:

WELL 14

State of California

Well Completion Report

Form DWR 188 Submitted 8/23/2019

WCR2019-011930

Owner's Well Number 032-010-094-000 Date Work Began 07/17/2019 Date Work Ended 07/30/2019

Local Permit Agency Napa County Planning Building and Environmental Services

Secondary Permit Agency Permit Number E19-00154 Permit Date 07/26/2019

Well Owner (must remain confidential pursuant to Water Code 13752)

Name CHAPPELLET VINEYARD LLC,

Mailing Address 1581 SAGE CANYON ROAD

City ST. HELENA State CA Zip 94574

Planned Use and Activity

Activity New Well

Planned Use Water Supply Irrigation - Agriculture

Well Location

Address 1581 SAGE CANYON RD

City ST HELENA Zip 94574 County Napa

Latitude 38 Deg. 29 Min. 12.3871 Sec. N

Longitude -122 Deg. 21 Min. 12.4804 Sec. W

Dec. Lat. 38.4867742 Dec. Long. -122.3534668

Vertical Datum Horizontal Datum WGS84

Location Accuracy Location Determination Method

APN 032-010-094-000

Township 07 N

Range 04 W

Section 06

Baseline Meridian Mount Diablo

Ground Surface Elevation

Elevation Accuracy

Elevation Determination Method

Borehole Information

Orientation Vertical Specify

Drilling Method Direct Rotary Drilling Fluid Air

Total Depth of Boring 670 Feet

Total Depth of Completed Well 670 Feet

Water Level and Yield of Completed Well

Depth to first water 430 (Feet below surface)

Depth to Static Water Level 400 (Feet) Date Measured 07/30/2019

Estimated Yield* 25 (GPM) Test Type Air Lift

Test Length 4 (Hours) Total Drawdown 100 (feet)

*May not be representative of a well's long term yield.

Geologic Log - Free Form

Depth from Surface Feet to Feet		Description
0	60	HARD GREY BOULDERS AND BROW CLAY
60	140	HARD GREY ROCK
140	160	RED BLACK ASH
160	300	BLACK BASALT
300	560	HARD GREEN ROCK
560	580	BLACK BASALT
580	600	BLACK RED VOLCANICS
600	620	GREEN ROCK GREEN SURPINTINE
620	640	YELLOW ROCK RUST SIGNS
640	660	WHITE ASH
660	670	GREEN SURPINTINE

Casings

Casing #	Depth from Surface Feet to Feet		Casing Type	Material	Casings Specificatons	Wall Thickness (inches)	Outside Diameter (inches)	Screen Type	Slot Size if any (inches)	Description
1	0	450	Blank	PVC	OD: 6.625 in. | SDR: 21 | Thickness: 0.316 in.	0.316	6.625			
1	450	470	Screen	PVC	OD: 6.625 in. | SDR: 21 | Thickness: 0.316 in.	0.316	6.625	Milled Slots	0.032	
1	470	490	Blank	PVC	OD: 6.625 in. | SDR: 21 | Thickness: 0.316 in.	0.316	6.625			
1	490	510	Screen	PVC	OD: 6.625 in. | SDR: 21 | Thickness: 0.316 in.	0.316	6.625	Milled Slots	0.032	
1	510	530	Blank	PVC	OD: 6.625 in. | SDR: 21 | Thickness: 0.316 in.	0.316	6.625			
1	530	550	Screen	PVC	OD: 6.625 in. | SDR: 21 | Thickness: 0.316 in.	0.316	6.625	Milled Slots	0.032	
1	550	570	Blank	PVC	OD: 6.625 in. | SDR: 21 | Thickness: 0.316 in.	0.316	6.625			
1	570	590	Screen	PVC	OD: 6.625 in. | SDR: 21 | Thickness: 0.316 in.	0.316	6.625	Milled Slots	0.032	
1	590	610	Blank	PVC	OD: 3.500 in. | Thickness: 0.300 in.	0.3	3.5			
1	610	630	Screen	PVC	OD: 6.625 in. | SDR: 21 | Thickness: 0.316 in.	0.316	6.625	Milled Slots	0.032	
1	630	650	Blank	PVC	OD: 6.625 in. | SDR: 21 | Thickness: 0.316 in.	0.316	6.625			
1	650	670	Screen	PVC	OD: 6.625 in. | SDR: 21 | Thickness: 0.316 in.	0.316	6.625	Milled Slots	0.032	

Annular Material

Depth from Surface Feet to Feet		Fill	Fill Type Details	Filter Pack Size	Description
0	55	Cement	10.3 Sack Mix		
0	670	Filter Pack	Other Gravel Pack	10	Bird's Eye Gravel Well Pack

Other Observations:

Borehole Specifications

Depth from Surface Feet to Feet		Borehole Diameter (inches)
0	55	12
55	670	12

Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

Name: PULLIAM WELL EXPLORATION INC
Person, Firm or Corporation

1663 HOWELL MTN RD	ANGWIN	CA	94508
Address	City	State	Zip

Signed

electronic signature received	08/23/2019	808508
C-57 Licensed Water Well Contractor	Date Signed	C-57 License Number

DWR Use Only

CSG #	State Well Number	Site Code	Local Well Number

N — Latitude Deg/Min/Sec

W — Longitude Deg/Min/Sec

TRS:

APN:

WELL 15

State of California

Well Completion Report

Form DWR 188 Submitted 9/9/2021
WCR2021-011524

Owner's Well Number: ___ Date Work Began: 08/03/2021 Date Work Ended: 09/07/2021

Local Permit Agency: Napa County Planning Building and Environmental Services

Secondary Permit Agency: ___ Permit Number: E21-00234 Permit Date: 07/30/2021

Well Owner (must remain confidential pursuant to Water Code 13752)

Name: CHAPPELLET VINEYARD, LLC,

Mailing Address: 1581 Sage Canyon Road

City: St. Helena State: Ca Zip: 94574

Planned Use and Activity

Activity: New Well

Planned Use: Water Supply Irrigation - Agriculture

Well Location

Address: 1581 Sage Canyon RD

City: St. Helena Zip: 94574 County: Napa

Latitude: 38 Deg. 28 Min. 11 Sec. N Longitude: -122 Deg. 20 Min. 6 Sec. W

Dec. Lat.: 38.4697222 Dec. Long.: -122.335

Vertical Datum: ___ Horizontal Datum: WGS84

Location Accuracy: ___ Location Determination Method: ___

APN: 032-560-022

Township: 07 N

Range: 04 W

Section: 08

Baseline Meridian: Mount Diablo

Ground Surface Elevation: ___

Elevation Accuracy: ___

Elevation Determination Method: ___

Borehole Information

Orientation: Vertical Specify: ___

Drilling Method: Direct Rotary Drilling Fluid: Air

Total Depth of Boring: 920 Feet

Total Depth of Completed Well: 890 Feet

Water Level and Yield of Completed Well

Depth to first water: 75 (Feet below surface)

Depth to Static Water Level: 535 (Feet) Date Measured: 09/07/2021

Estimated Yield*: 125 (GPM) Test Type: Air Lift

Test Length: 2 (Hours) Total Drawdown: ___ (feet)

*May not be representative of a well's long term yield.

Geologic Log - Free Form

Depth from Surface Feet to Feet		Description
0	2	brown clay with cobbles
2	25	brown clay
25	50	brown volcanics with tuff
50	55	soft mixed volcanics with red ash
55	68	50% dark gray volcanics / 50% brown volcanics
68	80	hard dark gray volcanics
80	128	hard brown volcanics
128	140	soft red volcanics
140	175	hard dark gray volcanics
175	230	soft mixed volcanics
230	300	dark gray volcanics
300	330	soft gray & red volcanics
330	448	hard gray volcanics
448	500	brown volcanics
500	520	soft gray & green volcanics

520	595	hard gray volcanics
595	605	soft gray volcanics
605	635	fractured gray volcanics
635	655	soft gray volcanics
655	675	hard gray volcanics
675	685	hard red volcanics
685	798	hard gray volcanics
798	800	red volcanics
800	815	brown volcanics
815	820	gray volcanics
820	840	soft gray volcanics
840	870	gray sandy tuff
870	875	gray ash
875	880	brown ash
880	920	80% shale / 20% sandstone

Casings

Casing #	Depth from Surface Feet to Feet		Casing Type	Material	Casings Specificatons	Wall Thickness (inches)	Outside Diameter (inches)	Screen Type	Slot Size if any (inches)	Description
1	0	530	Blank	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625			
1	530	610	Screen	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625	Milled Slots	0.032	
1	610	630	Blank	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625			
1	630	750	Screen	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625	Milled Slots	0.032	
1	750	770	Blank	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625			
1	770	810	Screen	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625	Milled Slots	0.032	
1	810	830	Blank	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625			
1	830	870	Screen	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625	Milled Slots	0.032	
1	870	890	Blank	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625			

Annular Material

Depth from Surface Feet to Feet		Fill	Fill Type Details	Filter Pack Size	Description
0	58	Cement	10.3 Sack Mix		
58	400	Other Fill	See description.		pea gravel
400	890	Other Fill	See description.		#6 sand

Other Observations:

Borehole Specifications

Depth from Surface Feet to Feet		Borehole Diameter (inches)
0	900	12
900	920	9

Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

Name: HUCKFELDT WELL DRILLING INC
Person, Firm or Corporation

994 KAISER ROAD	NAPA	CA	94558
Address	City	State	Zip

Signed

electronic signature received	09/09/2021	439746
C-57 Licensed Water Well Contractor	Date Signed	C-57 License Number

DWR Use Only

CSG #	State Well Number	Site Code	Local Well Number

N — Latitude Deg/Min/Sec

W — Longitude Deg/Min/Sec

TRS:

APN:

WELL 17

State of California

Well Completion Report

Form DWR 188 Submitted 8/29/2019

WCR2019-012338

Owner's Well Number 2-2019 Date Work Began 07/18/2019 Date Work Ended 08/29/2019

Local Permit Agency Napa County Planning Building and Environmental Services

Secondary Permit Agency Permit Number E16-00645 Permit Date 12/12/2018

Well Owner (must remain confidential pursuant to Water Code 13752)

Name COLGIN CELLARS,

Mailing Address P.O. Box 254

City St. Helena State CA Zip 94574

Planned Use and Activity

Activity New Well

Planned Use Water Supply Irrigation - Agriculture

Well Location

Address 220 Long Ranch RD

City St. Helena Zip 94574 County Napa

Latitude 38 Deg. 28 Min. 11 Sec. N Longitude -122 Deg. 20 Min. 16 Sec. W

Dec. Lat. 38.4697222 Dec. Long. -122.3377778

Vertical Datum Horizontal Datum WGS84

Location Accuracy Location Determination Method

APN 032-010-070

Township 07 N

Range 04 W

Section 07

Baseline Meridian Mount Diablo

Ground Surface Elevation

Elevation Accuracy

Elevation Determination Method

Borehole Information

Orientation Vertical Specify

Drilling Method Direct Rotary Drilling Fluid Air

Total Depth of Boring 840 Feet

Total Depth of Completed Well 820 Feet

Water Level and Yield of Completed Well

Depth to first water 485 (Feet below surface)

Depth to Static Water Level 429 (Feet) Date Measured 08/28/2019

Estimated Yield* 250 (GPM) Test Type Air Lift

Test Length 2 (Hours) Total Drawdown (feet)

*May not be representative of a well's long term yield.

Geologic Log - Free Form

Depth from Surface Feet to Feet		Description
0	8	boulder & red clay
8	110	hard light gray volcanics
110	115	hard fractured gray volcanics
115	155	soft red volcanics
155	180	hard black volcanics
180	200	mixed volcanic sands
200	230	soft tan, gray volcanics
230	280	black, red volcanics
280	485	hard gray volcanics
485	525	red, tan volcanics
525	560	light gray volcanics
560	660	black, gray volcanics
660	685	black, red volcanics
685	700	black, green volcanics
700	720	hard fractured black volcanics

720	770	gray volcanics
770	785	soft red volcanics
785	800	light red, white volcanics
800	805	soft brown volcanics
805	810	soft green volcanics
810	815	soft gray volcanics
815	840	serpentine

Casings

Casing #	Depth from Surface Feet to Feet		Casing Type	Material	Casings Specificatons	Wall Thickness (inches)	Outside Diameter (inches)	Screen Type	Slot Size if any (inches)	Description
1	0	500	Blank	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625			
1	500	640	Screen	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625	Milled Slots	0.032	
1	640	660	Blank	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625			
1	660	740	Screen	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625	Milled Slots	0.032	
1	740	760	Blank	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625			
1	760	800	Screen	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625	Milled Slots	0.032	
1	800	820	Blank	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625			

Annular Material

Depth from Surface Feet to Feet		Fill	Fill Type Details	Filter Pack Size	Description
0	56	Cement	10.3 Sack Mix		
56	200	Other Fill	See description.		pea gravel
200	820	Other Fill	See description.		#6 sand
820	840	Other Fill	See description.		cuttings

Other Observations:

Borehole Specifications

Depth from Surface Feet to Feet		Borehole Diameter (inches)
0	55	15
55	825	12
825	840	9

Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

Name HUCKFELDT WELL DRILLING INC
Person, Firm or Corporation

994 KAISER ROAD	NAPA	CA	94558
Address	City	State	Zip

Signed

electronic signature received	08/29/2019	439746
C-57 Licensed Water Well Contractor	Date Signed	C-57 License Number

DWR Use Only

CSG #	State Well Number	Site Code	Local Well Number

							N								W

Latitude Deg/Min/Sec Longitude Deg/Min/Sec

TRS:

APN:

E16-00646 wl

State of California

Well Completion Report

Form DWR 188 Submitted 7/18/2019
WCR2019-009834

WELL 18

Owner's Well Number 1-2019 Date Work Began 07/03/2019 Date Work Ended 07/17/2019

Local Permit Agency Napa County Planning Building and Environmental Services

Secondary Permit Agency Permit Number E16-00646 Permit Date 12/12/2018

Well Owner (must remain confidential pursuant to Water Code 13752)

Name COLGIN CELLARS,

Mailing Address P.O. Box 254

City St. Helena State CA Zip 94574

Planned Use and Activity

Activity New Well

Planned Use Water Supply Irrigation - Agriculture

Well Location

Address 220 Long Ranch RD

City St.Helena Zip 94574 County Napa

Latitude 38 Deg. 28 Min. 21 Sec. N Longitude -122 Deg. 20 Min. 13 Sec. W

Dec. Lat. 38.4725 Dec. Long. -122.3369444

Vertical Datum Horizontal Datum WGS84

Location Accuracy Location Determination Method

APN 032-010-070

Township 07 N

Range 04 W

Section 07

Baseline Meridian Mount Diablo

Ground Surface Elevation

Elevation Accuracy

Elevation Determination Method

Borehole Information

Orientation Vertical Specify

Drilling Method Direct Rotary Drilling Fluid Air

Total Depth of Boring 840 Feet

Total Depth of Completed Well 738 Feet

Water Level and Yield of Completed Well

Depth to first water 550 (Feet below surface)

Depth to Static Water Level 541 (Feet) Date Measured 07/17/2019

Estimated Yield* 38 (GPM) Test Type Air Lift

Test Length 2 (Hours) Total Drawdown (feet)

*May not be representative of a well's long term yield.

Geologic Log - Free Form

Depth from Surface Feet to Feet		Description
0	20	large boulders with red clay
20	72	hard black fractured volcanics
72	95	tan sandy ash
95	135	black volcanic rock
135	140	tan volcanic ash
140	200	black volcanic rock
200	260	red volcanic rock
260	375	hard black volcanic rock
375	420	red volcanic rock
420	460	hard gray volcanic rock
460	480	dark red, gray volcanics
480	722	hard black volcanic rock
722	760	green volcanic ash
760	775	tan volcanic ash
775	780	green volcanic ash

780	810	blue, gray volcanic ash
810	830	sandstone
830	840	sandstone & shale

Casings

Casing #	Depth from Surface Feet to Feet		Casing Type	Material	Casings Specificatons	Wall Thickness (inches)	Outside Diameter (inches)	Screen Type	Slot Size if any (inches)	Description
1	0	398	Blank	PVC	OD: 6.625 in. | SDR: 17 | Thickness: 0.390 in.	0.39	6.625			
1	398	518	Blank	PVC	OD: 6.625 in. | SDR: 21 | Thickness: 0.316 in.	0.316	6.625			
1	518	618	Screen	PVC	OD: 6.625 in. | SDR: 21 | Thickness: 0.316 in.	0.316	6.625	Milled Slots	0.032	
1	618	638	Blank	PVC	OD: 6.625 in. | SDR: 21 | Thickness: 0.316 in.	0.316	6.625			
1	638	718	Screen	PVC	OD: 6.625 in. | SDR: 21 | Thickness: 0.316 in.	0.316	6.625	Milled Slots	0.032	
1	718	738	Blank	PVC	OD: 6.625 in. | SDR: 21 | Thickness: 0.316 in.	0.316	6.625			

Annular Material

Depth from Surface Feet to Feet		Fill	Fill Type Details	Filter Pack Size	Description
0	76	Cement	10.3 Sack Mix		
76	750	Filter Pack	Other Gravel Pack	#6	sand
750	840	Filter Pack	Other Gravel Pack		cuttings

Other Observations:

Borehole Specifications

Depth from Surface Feet to Feet		Borehole Diameter (inches)
0	80	12
80	840	9

Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

Name HUCKFELDT WELL DRILLING INC
Person, Firm or Corporation

994 KAISER ROAD — Address
NAPA — City
CA — State
94558 — Zip

Signed *electronic signature received* — C-57 Licensed Water Well Contractor
07/18/2019 — Date Signed
439746 — C-57 License Number

DWR Use Only

CSG #	State Well Number	Site Code	Local Well Number

N — Latitude Deg/Min/Sec

W — Longitude Deg/Min/Sec

TRS:

APN:

APPENDIX B

CHAPPELLET IRRIGATION RECORDS 2017 -2021

Chappellet Annual Irrigation Summary 2017-2021

Irrigation Hours

	Acres	2017	2018	2019	2020	2021
CB4	3	71	83	63	77	118
CF1	1.51	18	0	10	0	22
CF8	3.14	110	105	107	83	52
CS3	3.92	32	11	18	34	38
CS4	4.37	19	17	12	19	19
CS9	4.29	61	34	42	35	48
CS10	3.57	72	41	57	67	64
CS11	1.47	73	72	77	75	51
CS13	4.34	36	28	22	22	38
CS16	1.52	67	62	94	31	16
CS17	3	28	29	33	31	20
CS18	1	25	31	28	42	18
CS19	2.7	69	79	55	29	32
CS20	1.46	35	28	21	36	17
CS21	2	33	28	21	36	25
CS22	0.73	17	22	22	34	26
CS23	0.72	19	36	21	48	38
CS24	0.6	19	21	0	16	24
CS25	3	72	51	64	60	37
CS26	1.94	88	73	53	10	18
CS29	1.61	109	95	83	70	70
CS30	1.85	90	83	65	63	60
CS31	1.93	93	83	92	95	68
CS32	2.01	94	96	97	96	71
CS33	2.56	85	86	102	98	65
CS34	5.05	103	71	74	34	46
CS35	2.68	67	57	54	37	42
CS36	2.25	57	64	77	35	38
CS37	5.12		63	81	59	44
MB1	2.94	8	0	0	22	22
MB2	1.62	44	26	0	12	28
MB3	2.71	49	31	18	30	35
PV2	4	83	90	77	81	69
PV3	3.93			115	44	18
WRCS1	0.56	72	84	88	57	52
WRCS2	1.41	66	88	91	49	56
WRCS3	1.2	72	88	99	49	62
WRCS4	1.14	55	92	90	49	52
WRCS5	1.13	65	73	67	36	45
WRCS6	1.49	66	91	71	36	45
WRCS7	1.27	68	62	82	35	41
WRCS8	0.48	72	61	81	36	50
WRCS9	2.5	67	141	107	54	47
WRCS10	0.32	63	61	88	40	37
WRCS11	2.05	71	66	86	44	63
WRCS12	1.1	54	62	90	41	61
	103.19	**2637**	**2665**	**2795**	**2087**	**2008**

Gallons/Block

	2017	2018	2019	2020	2021
CB4	196730	114990	87281	213355	326959
CF1	20912	0	11618	0	25559
CF8	455323	434626.5	442905.1	343561.9	215243.6
CS3	144804	49777	81453	153855	171955
CS4	79875	71467	50448	79875	79875
CS9	302092	168379	207997	173331	237711
CS10	296732	168972	234913	276126	263762
CS11	123885	122188	130674	127280	86550
CS13	180459	140357	110280	110280	190484
CS16	154824	143270	217215	71635	36973
CS17	77613	80385	91473	85929	55438
CS18	23135	28687	25911	38866	16657
CS19	215178	246363	171519	90437	99793
CS20	59026	47221	35416	60713	28670
CS21	75907	64406	48304	82807	57505
CS22	23913	30946	30946	47825	36572
CS23	26424	50066	29205	66755	52847
CS24	22033	24352	0	18554	27831
CS25	356185	252298	316609	296821	183040
CS26	196914	163349	118596	22377	40278
CS29	231773	202004	176488	148845	148845
CS30	220088	202970	158952	154061	146725
CS31	236691	211240	234146	241781	173064
CS32	249100	254400	257050	254400	188150
CS33	287419	290800	344903	331377	219791
CS34	500044	344691	359255	165063	223321
CS35	236709.66	201379.86	190780.92	130720.26	148385.16
CS36	168873.9	189612.8	228127.9	103694.5	112582.6
CS37	0	621054	798498	581622	433752
MB1	27144.48	0	0	74647.32	74647.32
MB2	68560.8	40513.2	0	18698.4	43629.6
MB3	128084.04	81032.76	47051.28	78418.8	91488.6
PV2	383240.88	415562.4	355536.72	374006.16	318597.84
PV3	0	0	596091	228069.6	93301.2
WRCS1	53424	62328	65296	42294	38584
WRCS2	133712.64	163426.56	183854.88	90998.88	103998.72
WRCS3	113793.12	139080.48	156465.54	77442.54	97988.52
WRCS4	82786	138478.4	135468	73754.8	78270.4
WRCS5	97080.1	109028.42	100067.18	53767.44	67209.3
WRCS6	129845.76	179029.76	139682.56	70824.96	88531.2
WRCS7	168306.8	153456.2	202958.2	86628.5	101479.1
WRCS8	45639.36	38666.68	51344.28	22819.68	31694
WRCS9	220943.22	464970.06	352849.62	178073.64	154990.02
WRCS10	38732.4	37502.8	54102.4	24592	22747.6
WRCS11	192138.78	178607.88	232731.48	119071.92	170489.34
WRCS12	78590.52	90233.56	130984.2	59670.58	88778.18
	7124684	**7212168**	**7995445**	**6145725**	**5694744**

Acre Feet/Block

	2017	2018	2019	2020	2021
CB4	0.60	0.35	0.27	0.65	1.00
CF1	0.06	0.00	0.04	0.00	0.08
CF8	1.40	1.33	1.36	1.05	0.66
CS3	0.44	0.15	0.25	0.47	0.53
CS4	0.25	0.22	0.15	0.25	0.25
CS9	0.93	0.52	0.64	0.53	0.73
CS10	0.91	0.52	0.72	0.85	0.81
CS11	0.38	0.37	0.40	0.39	0.27
CS13	0.55	0.43	0.34	0.34	0.58
CS16	0.48	0.44	0.67	0.22	0.11
CS17	0.24	0.25	0.28	0.26	0.17
CS18	0.07	0.09	0.08	0.12	0.05
CS19	0.66	0.76	0.53	0.28	0.31
CS20	0.18	0.14	0.11	0.19	0.09
CS21	0.23	0.20	0.15	0.25	0.18
CS22	0.07	0.09	0.09	0.15	0.11
CS23	0.08	0.15	0.09	0.20	0.16
CS24	0.07	0.07	0.00	0.06	0.09
CS25	1.09	0.77	0.97	0.91	0.56
CS26	0.60	0.50	0.36	0.07	0.12
CS29	0.71	0.62	0.54	0.46	0.46
CS30	0.68	0.62	0.49	0.47	0.45
CS31	0.73	0.65	0.72	0.74	0.53
CS32	0.76	0.78	0.79	0.78	0.58
CS33	0.88	0.89	1.06	1.02	0.67
CS34	1.53	1.06	1.10	0.51	0.69
CS35	0.73	0.62	0.59	0.40	0.46
CS36	0.52	0.58	0.70	0.32	0.35
CS37	0.00	1.91	2.45	1.78	1.33
MB1	0.08	0.00	0.00	0.23	0.23
MB2	0.21	0.12	0.00	0.06	0.13
MB3	0.39	0.25	0.14	0.24	0.28
PV2	1.18	1.28	1.09	1.15	0.98
PV3	0.00	0.00	1.83	0.70	0.29
WRCS1	0.16	0.19	0.20	0.13	0.12
WRCS2	0.41	0.50	0.56	0.28	0.32
WRCS3	0.35	0.43	0.48	0.24	0.30
WRCS4	0.25	0.42	0.42	0.23	0.24
WRCS5	0.30	0.33	0.31	0.17	0.21
WRCS6	0.40	0.55	0.43	0.22	0.27
WRCS7	0.52	0.47	0.62	0.27	0.31
WRCS8	0.14	0.12	0.16	0.07	0.10
WRCS9	0.68	1.43	1.08	0.55	0.48
WRCS10	0.12	0.12	0.17	0.08	0.07
WRCS11	0.59	0.55	0.71	0.37	0.52
WRCS12	0.24	0.28	0.40	0.18	0.27
	21.86	**22.13**	**24.54**	**18.86**	**17.48**

Acre Feet/Acre

	2017	2018	2019	2020	2021	
CB4	0.20	0.12	0.09	0.22	0.33	CB4
CF1	0.04	0.00	0.02	0.00	0.05	CF1
CF8	0.45	0.42	0.43	0.34	0.21	CF8
CS3	0.11	0.04	0.06	0.12	0.13	CS3
CS4	0.06	0.05	0.04	0.06	0.06	CS4
CS9	0.22	0.12	0.15	0.12	0.17	CS9
CS10	0.26	0.15	0.20	0.24	0.23	CS10
CS11	0.26	0.26	0.27	0.27	0.18	CS11
CS13	0.13	0.10	0.08	0.08	0.13	CS13
CS16	0.31	0.29	0.44	0.14	0.07	CS16
CS17	0.08	0.08	0.09	0.09	0.06	CS17
CS18	0.07	0.09	0.08	0.12	0.05	CS18
CS19	0.24	0.28	0.19	0.10	0.11	CS19
CS20	0.12	0.10	0.07	0.13	0.06	CS20
CS21	0.12	0.10	0.07	0.13	0.09	CS21
CS22	0.10	0.13	0.13	0.20	0.15	CS22
CS23	0.11	0.21	0.12	0.28	0.23	CS23
CS24	0.11	0.12	0.00	0.09	0.14	CS24
CS25	0.36	0.26	0.32	0.30	0.19	CS25
CS26	0.31	0.26	0.19	0.04	0.06	CS26
CS29	0.44	0.39	0.34	0.28	0.28	CS29
CS30	0.37	0.34	0.26	0.26	0.24	CS30
CS31	0.38	0.34	0.37	0.38	0.28	CS31
CS32	0.38	0.39	0.39	0.39	0.29	CS32
CS33	0.34	0.35	0.41	0.40	0.26	CS33
CS34	0.30	0.21	0.22	0.10	0.14	CS34
CS35	0.27	0.23	0.22	0.15	0.17	CS35
CS36	0.23	0.26	0.31	0.14	0.15	CS36
CS37	0.00	0.37	0.48	0.35	0.26	CS37
MB1	0.03	0.00	0.00	0.08	0.08	MB1
MB2	0.13	0.08	0.00	0.04	0.08	MB2
MB3	0.15	0.09	0.05	0.09	0.10	MB3
PV2	0.29	0.32	0.27	0.29	0.24	PV2
PV3	0.00	0.00	0.47	0.18	0.07	PV3
WRCS1	0.29	0.34	0.36	0.23	0.21	WRCS1
WRCS2	0.29	0.36	0.40	0.20	0.23	WRCS2
WRCS3	0.29	0.36	0.40	0.20	0.25	WRCS3
WRCS4	0.22	0.37	0.36	0.20	0.21	WRCS4
WRCS5	0.26	0.30	0.27	0.15	0.18	WRCS5
WRCS6	0.27	0.37	0.29	0.15	0.18	WRCS6
WRCS7	0.41	0.37	0.49	0.21	0.25	WRCS7
WRCS8	0.29	0.25	0.33	0.15	0.20	WRCS8
WRCS9	0.27	0.57	0.43	0.22	0.19	WRCS9
WRCS10	0.37	0.36	0.52	0.24	0.22	WRCS10
WRCS11	0.29	0.27	0.35	0.18	0.26	WRCS11
WRCS12	0.22	0.25	0.37	0.17	0.25	WRCS12
	0.23	**0.23**	**0.25**	**0.18**	**0.17**	

Vineyard 5 Year water use summary

C, MB and P Blocks

Average acre feet/block					Average acre feet/acre					Total acre feet				
2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
0.52	0.49	0.56	0.47	0.42	0.21	0.19	0.20	0.18	0.16	17.71	16.75	19.00	16.10	14.27

WR Blocks

Average acre feet/block					Average acre feet/acre					Total Acre feet				
2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
0.35	0.45	0.46	0.23	0.27	0.29	0.35	0.38	0.19	0.22	4.16	5.39	5.54	2.76	3.21

2017	2018	2019	2020	2021

APPENDIX C

NAPA COUNTY SWB RECHARGE ANALYSIS

OEI

Napa County Groundwater Recharge Analysis

Introduction

Developing accurate estimates of the spatial and temporal distribution of groundwater recharge is a key component of sustainable groundwater management. Efforts to quantify recharge are inherently difficult owing to the wide variability of factors controlling hydrologic processes, the wide range of available tools/methods for estimating recharge, and the difficulty in assessing the accuracy of estimates because direct measurement of recharge rates is, for the most part, infeasible (Healy 2010, Seiler and Gat 2007).

Numerical modeling is a common approach for developing recharge estimates. Soil-water-balance modeling is one category of numerical models particularly well-suited for estimating recharge across large areas with modest data requirements. This study describes an application of the U.S. Geological Survey's (USGS) Soil Water Balance Model (SWB) (Westenbroek et al. 2010) to develop spatial and temporal distributions of groundwater recharge across Napa County. This model operates on a daily timestep and calculates surface runoff based on the Natural Resources Conservation Service (NRCS) curve number method and potential evapotranspiration based on the Hargreaves-Samani methods (Hargreaves and Samani 1985). Actual evapotranspiration (AET) and recharge are calculated using a modified Thornthwaite-Mather soil-water-balance approach (Westenbroek et al. 2010).

It is important to note that the SWB model focuses on surface and soil-zone processes and does not simulate the groundwater system or track groundwater storage over time. The model also does not simulate surface water/groundwater interaction or baseflow; thus, the runoff estimates represent only the surface runoff component of streamflow resulting from rainstorms and the recharge estimates represent only the infiltration recharge component (also referred to as diffuse recharge) of total recharge (stream-channel recharge is not simulated).

This modeling work and summary report has been prepared by O'Connor Environmental, Inc., for it's private use in relation to Water Availability Analyses (WAA) prepared on behalf of private clients for projects using groundwater in "hillside" areas of Napa County as required by Napa Planning, Building & Environmental Services. The modeling to-date is complete in its current form but remains subject to revision; it is considered a working draft with information suitable for use to support WAA projects. Parties interested in obtaining more information regarding the modeling or who may wish to offer comments should contact O'Connor Environmental, Inc.

Model Development

The model was developed using a 30-meter (98.4 ft) resolution rectangular grid. Water budget calculations were made on a daily time step. Key spatial inputs included a flow direction map developed from the USGS 1 arc-second resolution Digital Elevation Model (DEM), a land cover map derived from the U.S. Forest Service (USFS) CALVEG dataset that was supplemented by a database of agricultural areas maintained by the County of Napa (Figure 1), a distribution of Hydrologic Soil Groups (A through D classification from lowest to highest runoff potential; Figure 2), and a distribution of Available Water Capacity (AWC) developed from the NRCS Soil Survey Geographic Database (SSURGO) (Figure 3).

A series of model parameters were assigned for each land cover type/soil group combination including an infiltration rate, a curve number, dormant and growing season interception storage values, and a rooting depth (Table 1).

Infiltration rates for hydrologic soil groups A through D were applied based on Cronshey et al. (1986) (Table 2) along with default soil-moisture-retention relationships based on Thornthwaite and Mather (1957) (Figure 4). Curve numbers were assigned based on standard NRCS methods. Interception storage values and rooting depths were assigned based on literature values and from previous modeling experience including a SWB model covering Sonoma County and calibrated using runoff volumes from several stream gages (OEI 2017).

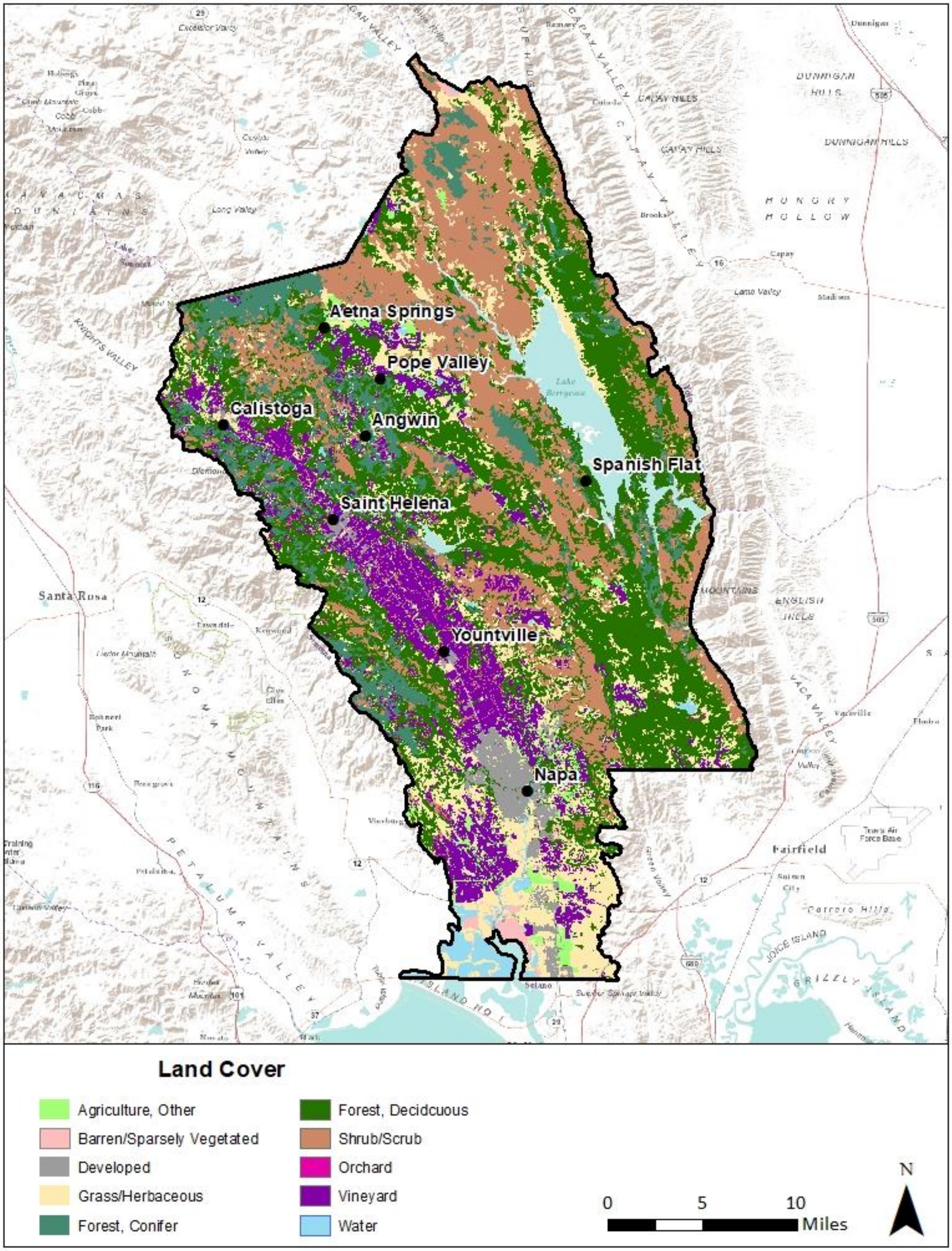


Figure 1: Land cover distribution used in the Napa County SWB model.

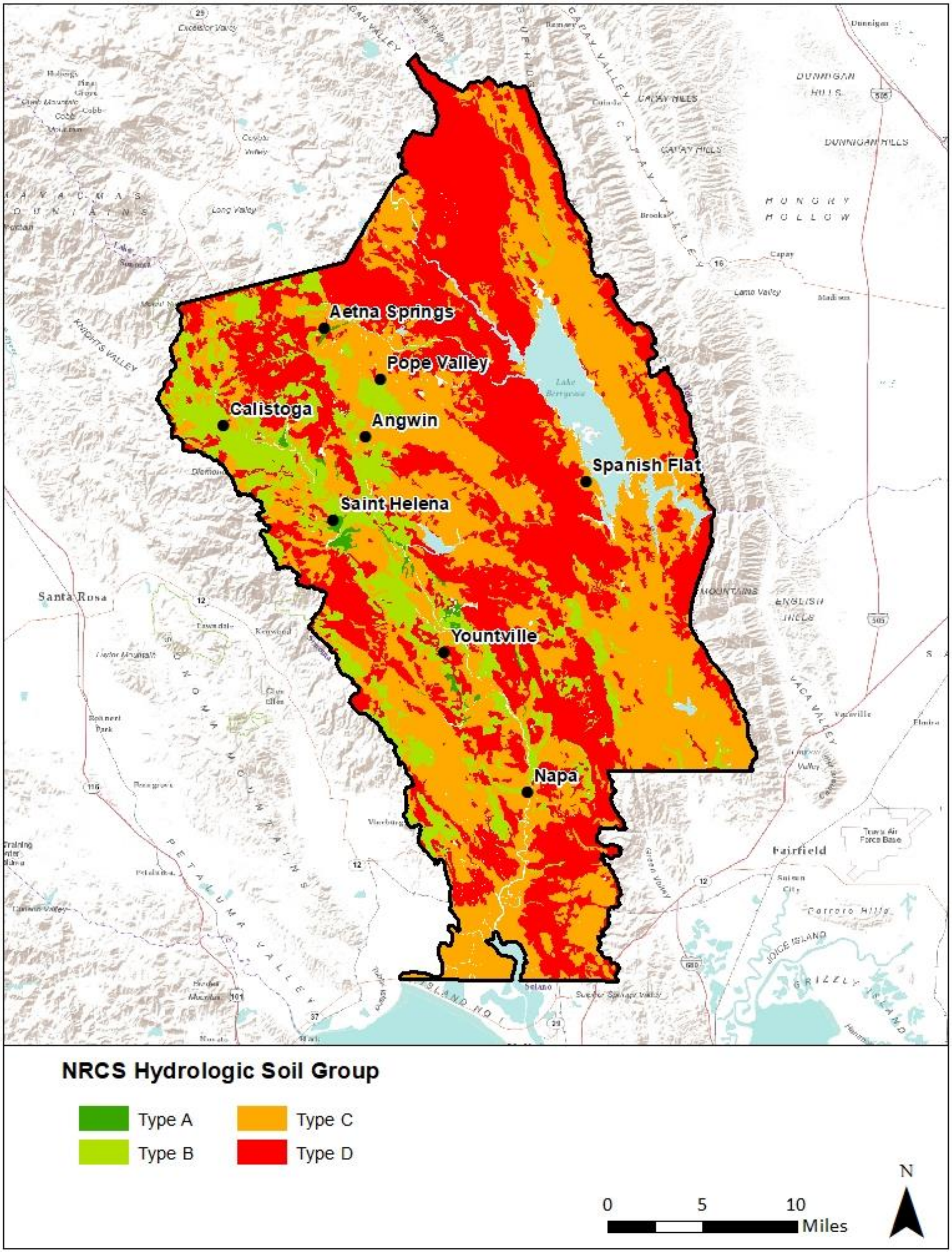


Figure 2: Hydrologic soil group distribution used in the Napa County SWB model.

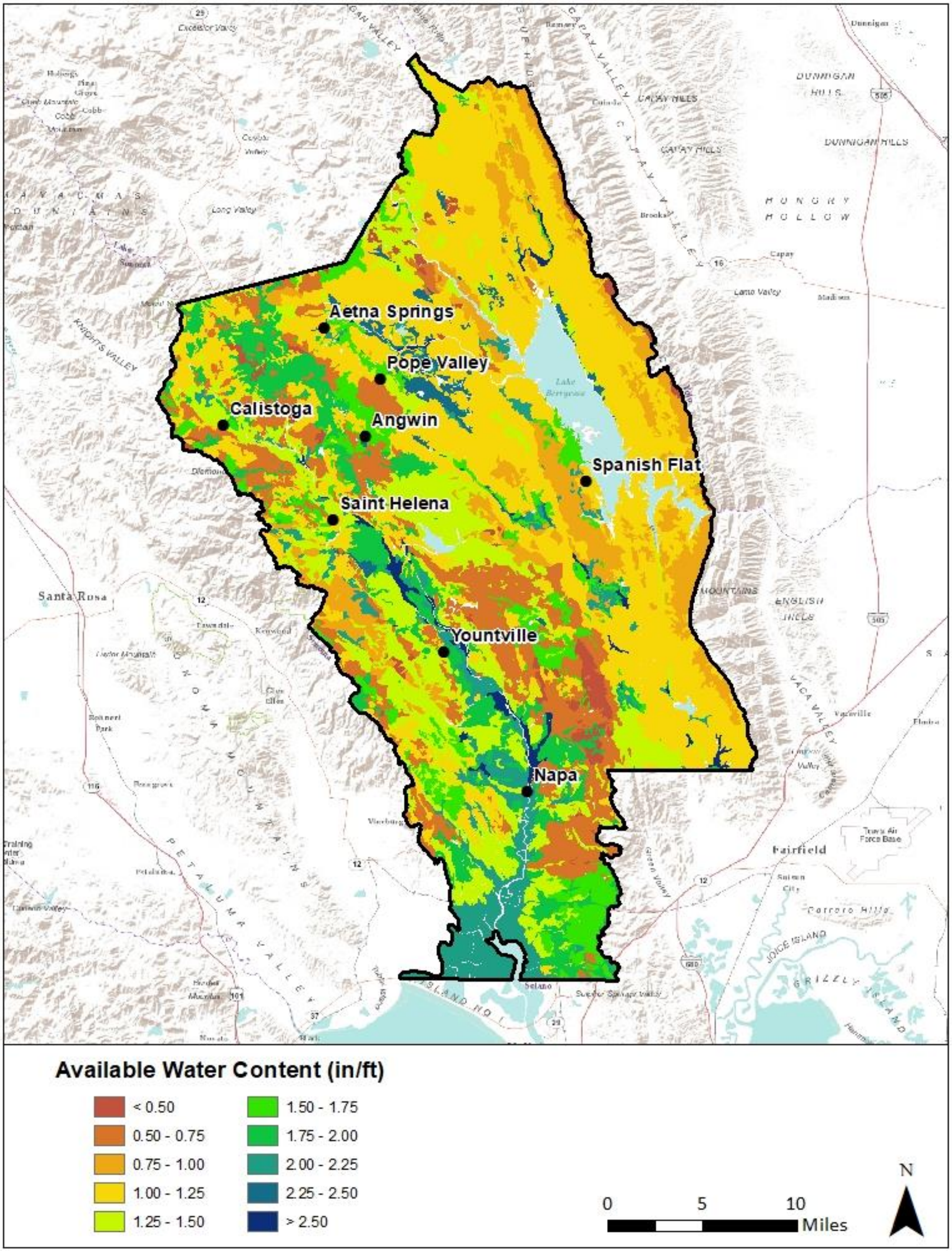


Figure 3: Available water capacity distribution used in the Napa County SWB model.

Table 1: Soil and land cover properties used in the Napa County SWB model.

Land Cover	Interception Storage Values ()		Curve Number by NRCS Soil Type ()				Rooting Depth by NRCS Soil Type (ft)			
	Growing Season	Dormant Season	Type A	Type B	Type C	Type D	Type A	Type B	Type C	Type D
Agriculture, Other	0.080	0.040	38	61	75	81	2.0	1.9	1.8	1.7
Barren	0.000	0.000	77	86	91	94	0.0	0.0	0.0	0.0
Developed	0.005	0.002	61	75	83	87	2.3	2.1	2.0	1.8
Grassland/Herbaceous	0.005	0.004	30	58	71	78	1.3	1.1	1.0	1.0
Forest, Coniferous	0.050	0.050	30	55	70	77	5.9	5.1	4.9	4.7
Forest, Deciduous	0.050	0.020	30	55	70	77	5.9	5.1	4.9	4.7
Shrub/Scrub	0.080	0.015	30	48	65	73	3.2	2.8	2.7	2.6
Orchard	0.050	0.015	38	61	75	81	3.2	2.8	2.7	2.6
Vineyard	0.080	0.015	38	61	75	81	2.2	2.1	2.0	1.9
Water	0.000	0.000	100	100	100	100	0.0	0.0	0.0	0.0

Table 2: Infiltration rates for NRCS hydrologic soil groups (Cronshey et al. 1986).

Soil Group	Infiltration Rate (in/hr)
A	> 0.3
B	0.15 - 0.3
C	0.05 - 0.15
D	<0.05

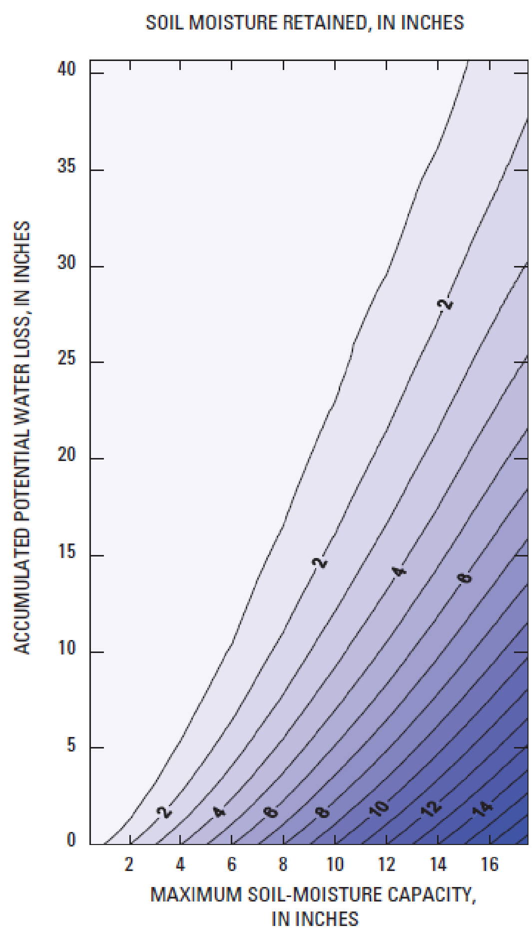


Figure 4: Soil-moisture-retention table (Thornthwaite and Mather 1957).

The SWB model utilizes daily precipitation and mean daily temperature data derived from climate stations. To account for the spatial variability of these parameters, daily precipitation and mean daily temperature were input as gridded (spatially-distributed) time-series. The gridded precipitation time-series was created using data from 15 weather stations in Napa County, and the gridded mean temperature time-series was created using data from 8 stations (Table 3). These stations were selected based on completeness of the records and to provide station data representative of the range of climates experienced in the county. Data was obtained from the California Data Exchange Center (CDEC), the National Climatic Data Center (NCDC), and from Napa One Rain.

To create the gridded time-series, the model domain was divided into discrete areas represented by individual weather stations (Figures 5 and 6). This delineation was based on climate variations described by existing gridded mean annual (1981-2010) precipitation and temperature data (PRISM 2010) and local knowledge of climatic variations across the county.

For the precipitation time-series, each area representing a weather station was subdivided into four to twenty-three zones based on 1-inch average annual precipitation contours. Within each zone the raw station data was multiplied by a unique scaling factor. This scaling factor was calculated as the ratio of average annual precipitation within a zone to average annual precipitation at the representative rain gage. In certain locations, typically near the boundary of areas represented by gages located on the valley bottom and at higher elevations, this scaling was unable to smoothly resolve differences in annual and event precipitation totals. To more accurately estimate precipitation near these boundaries, precipitation records from the two gages in question were averaged using weights calculated proportionally to the difference between PRISM mean annual precipitation at a rain gage and within a selected zone. The resulting gridded time-series is comprised of 220 individual time-series based on the scaled station data from 15 stations.

The assignment of temperature stations was based on the understanding that the spatial variability of temperatures across Napa County is relatively homogenous, with elevation being the primary variable. Temperature records were classified either as Mountain, Valley Bottom, or East County and applied within areas the PRISM datasets described as being similar. To smooth the transition from Mountain zones to Valley Bottom and East County zones, Hillside zones were created where the temperature records of the two nearest gages were averaged.

Missing and suspect data was encountered in the raw precipitation and temperature data from the weather stations used by the model. Values that were significantly outside the typical range, and where similar observations were not found at nearby stations, were removed from the datasets. These and missing values were filled using scaled data from other nearby stations. Precipitation data used for gap filling was scaled using the ratio of the 1981 to 2010 mean annual precipitation (PRISM 2010) between the two stations. Temperature data was scaled using the ratio of the 1981 to 2010 mean monthly minimum and maximum temperatures (PRISM 2010) between the two stations.

The current analysis focuses on Water Year 2010 (October 1, 2009 – September 30, 2010) and Water Year 2014 (October 1, 2013 – September 30, 2014). These years were selected because they represent periods with data available from most weather stations in the county and where most stations reported annual precipitation totals close to the long-term average (WY 2010) and significantly below the long term average (WY 2014). Based on a comparison between station data and PRISM average precipitation depths during Water Year 2010, rainfall averaged 101% of long-term average conditions and ranged from 78% at Lake Hennessey to 111% at the Napa County Airport. In Water Year 2014, rainfall averaged 55% of long-term average conditions and ranged from 41% at Lake Hennessey to 73% at the Napa State Hospital (Table 3).

Table 3: Weather stations used in the Napa County SWB model. See Figures 7- 9 for associated timeseries.

Station	Data Used	1981 - 2010 Mean Annual Precip (in)	WY 2010 Precip (in)	WY 2010 % Avg	WY 2014 Precip (in)	WY 2014 % Avg
Angwin[1]	Precip & Temp	42.54	44.64	105%	25.04	59%
Atlas Peak[1]	Precip & Temp	41.76	39.04	93%	20.08	48%
Berryessa[1]	Precip & Temp	28.97	28.16	97%	13.97	48%
Calistoga[2]	Precip	39.41	41.75	106%	18.18	46%
Knoxville Creek[1]	Temp Only	-	-	-	-	-
Lake Hennessey[3]	Precip Only	34.09	26.52	78%	13.92	41%
Mt. George[3]	Precip Only	31.15	29.64	95%	18.24	59%
Mt. Veeder[3]	Precip Only	44.81	46.44	104%	28.6	64%
Napa County Airport[2]	Precip & Temp	21.14	23.56	111%	9.87	47%
Napa River at Yountville Cross Rd[3]	Precip Only	31.86	32.72	103%	14.93	47%
Napa State Hospital[2]	Precip & Temp	26.81	28.85	108%	19.66	73%
Petrified Forest[3]	Precip Only	42.39	46.6	110%	22.84	54%
Redwood Creek At Mt. Veeder Road[3]	Precip Only	34.71	37.36	108%	23.48	68%
Saint Helena[2]	Precip & Temp	37.43	39.11	104%	19.11	51%
Saint Helena 4WSW[1]	Precip & Temp	45.44	47.88	105%	28.88	64%
Sugarloaf Peak[3]	Precip Only	32.20	26.16	81%	17.12	53%

1 – Data accessed from California Data Exchange Center (CDEC)
2 – Data accessed from National Climate Data Center (NCDC)
3 – Data access from Napa One Rain

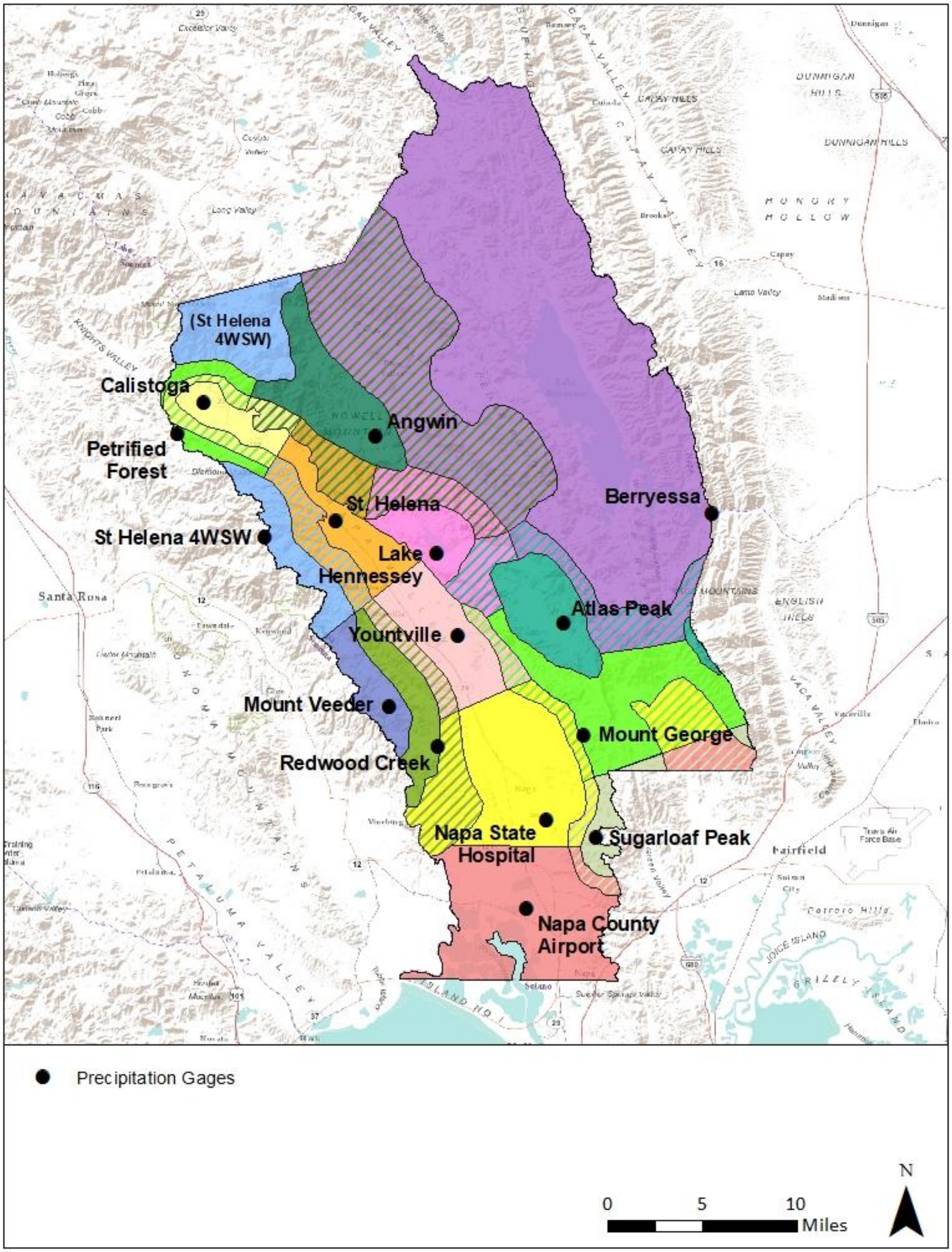


Figure 5: Precipitation zones used in the Napa County SWB model. Hatching indicates areas where two precipitation records were averaged across a zone.

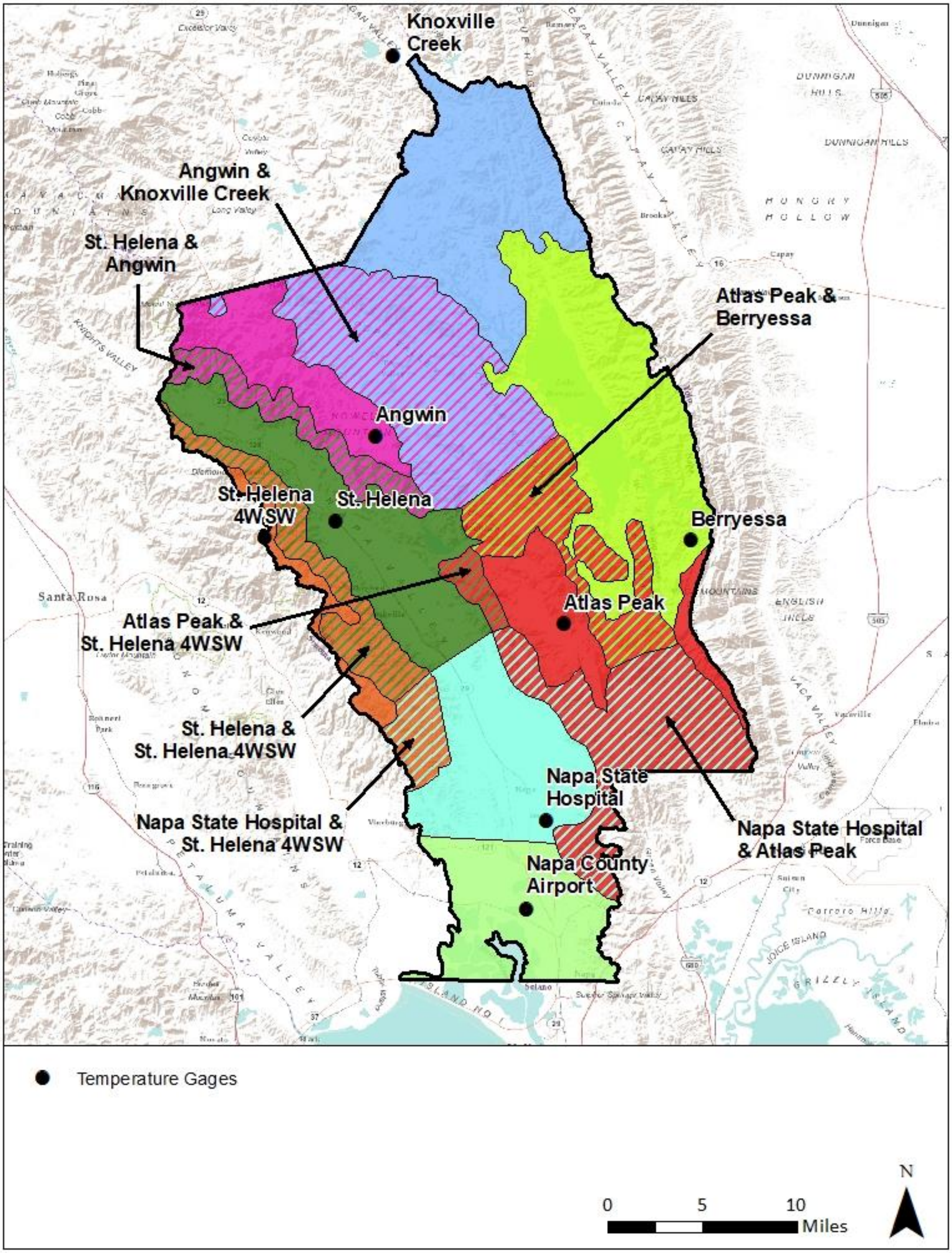


Figure 6: Temperature zones used in the Napa County SWB model. Hatching indicates areas where two temperature records were averaged across a zone.

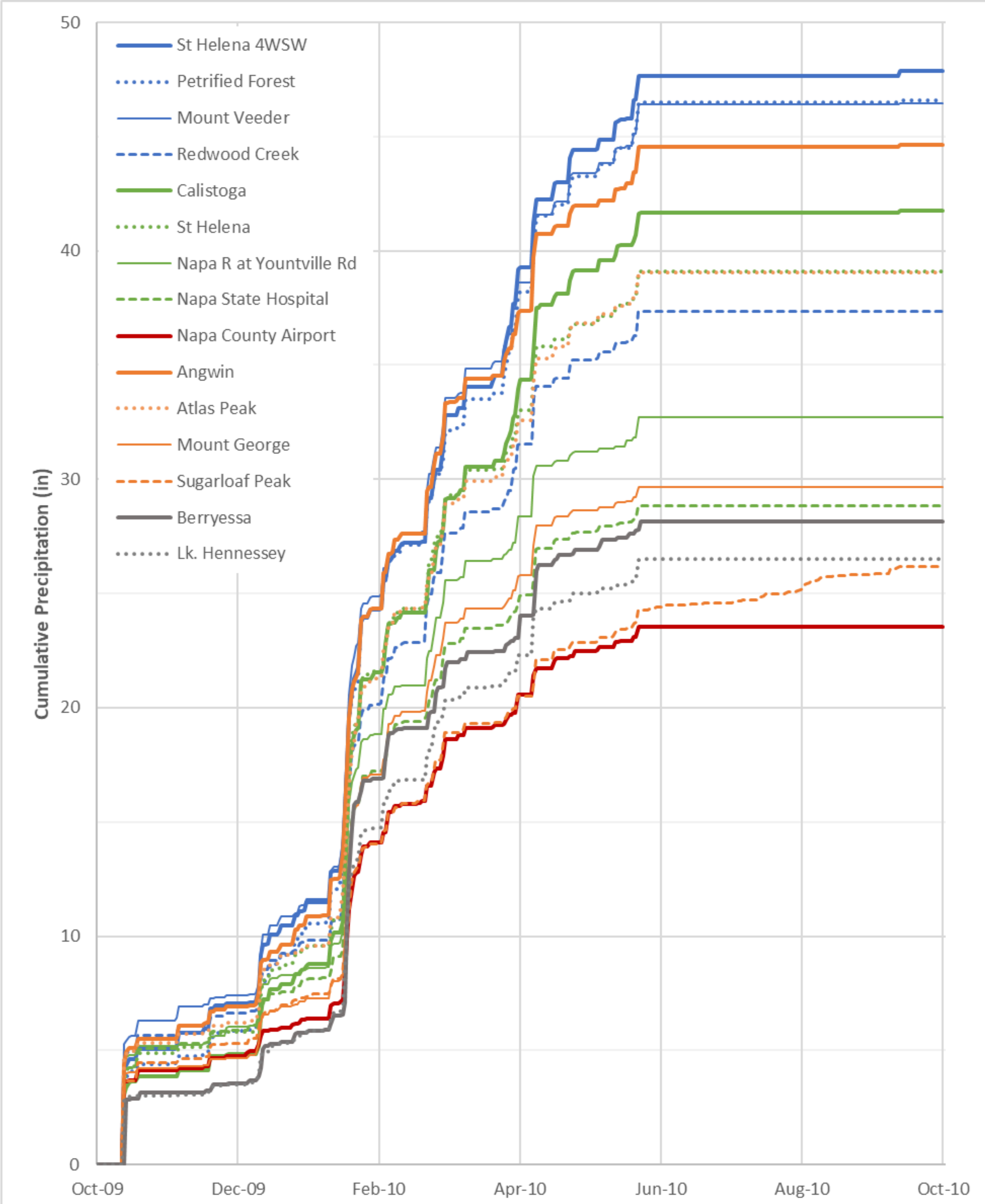


Figure 7a: Daily precipitation data used in the Napa County SWB model for WY 2010.

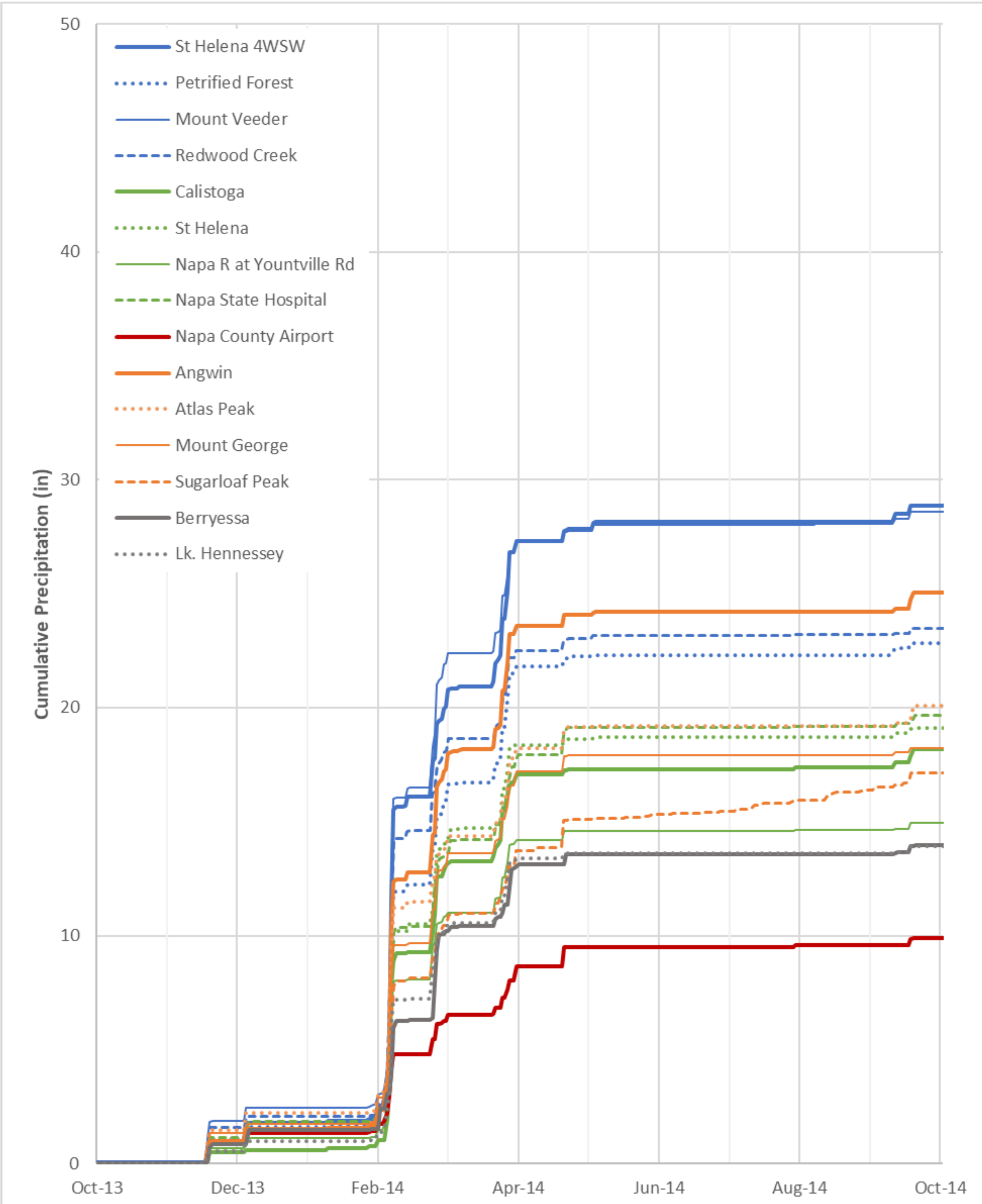


Figure 7b: Daily precipitation data used in the Napa County SWB model for WY 2014.

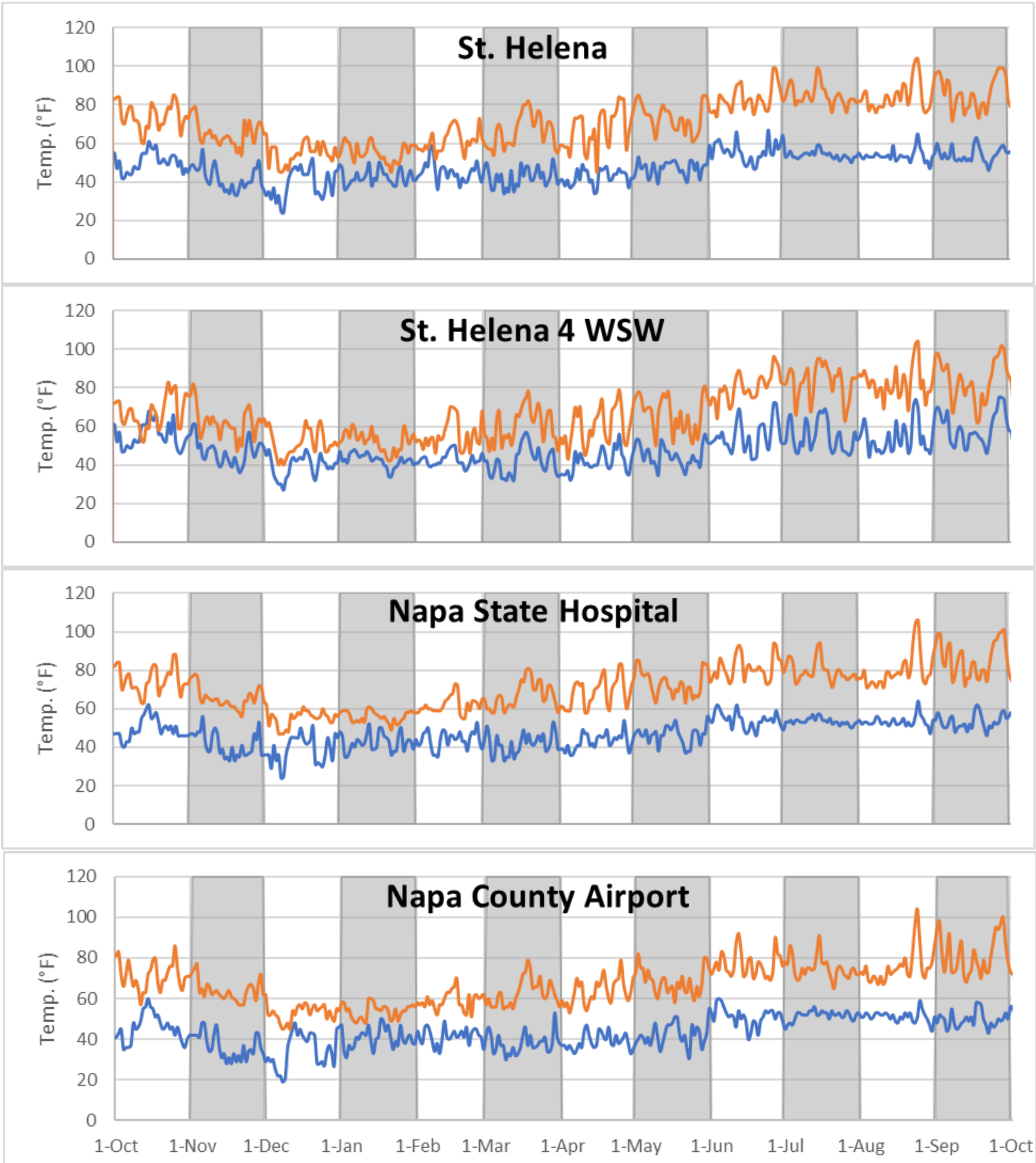


Figure 8: Daily minimum and maximum temperature data used in the Sonoma County SWB model for WY 2010.

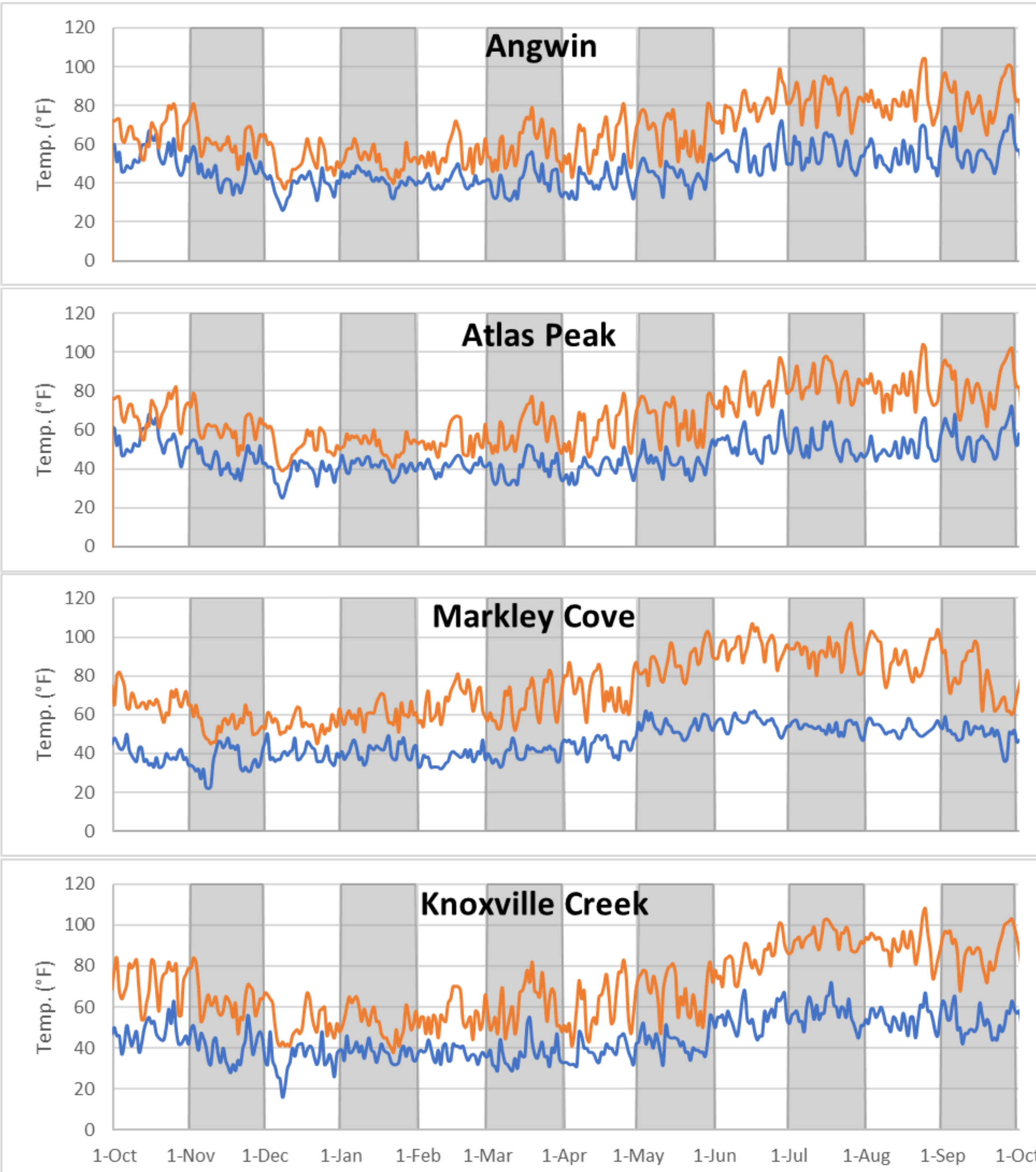


Figure 8 – cont.

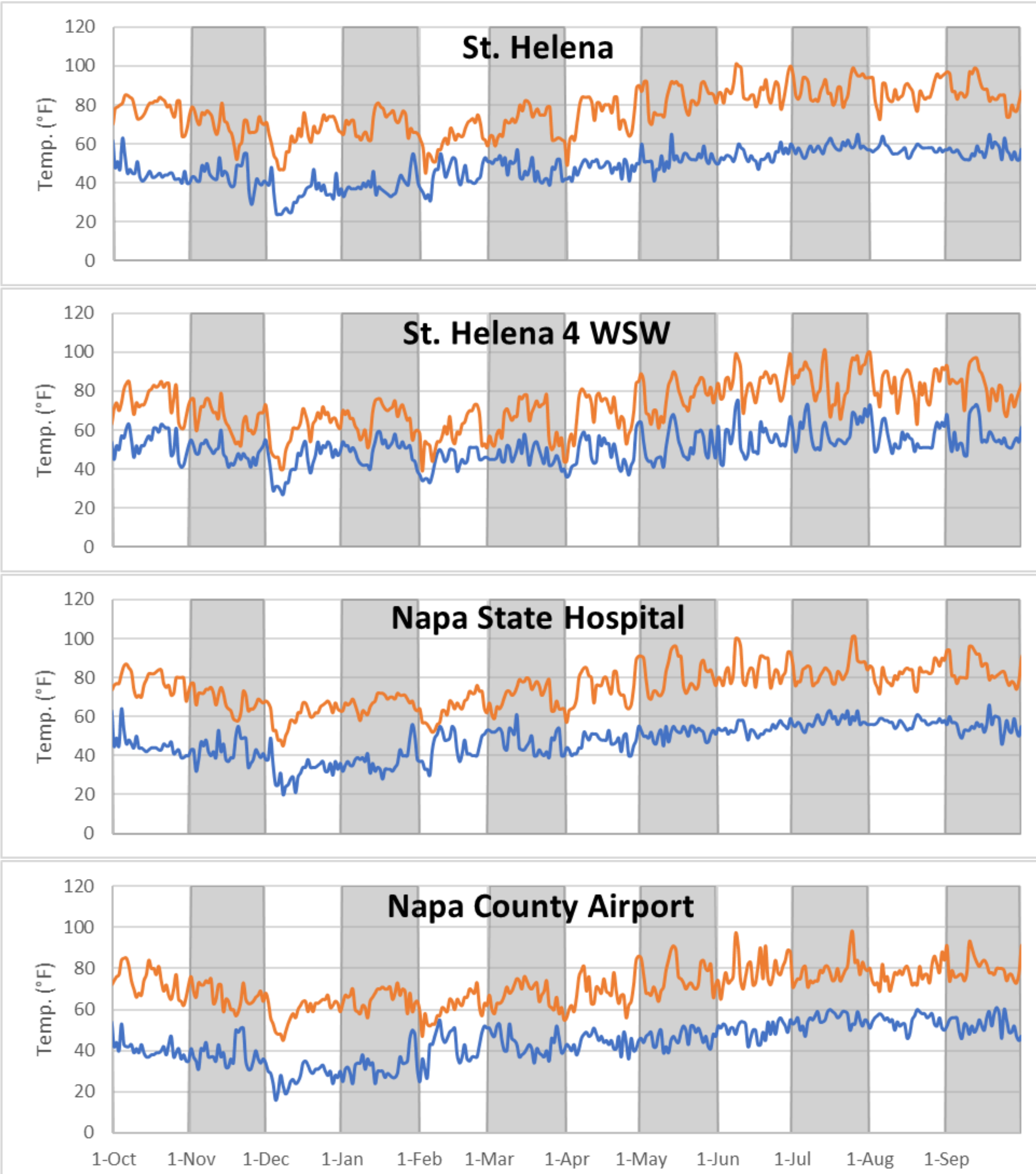


Figure 9: Daily minimum and maximum temperature data used in the Sonoma County SWB model for WY 2010.

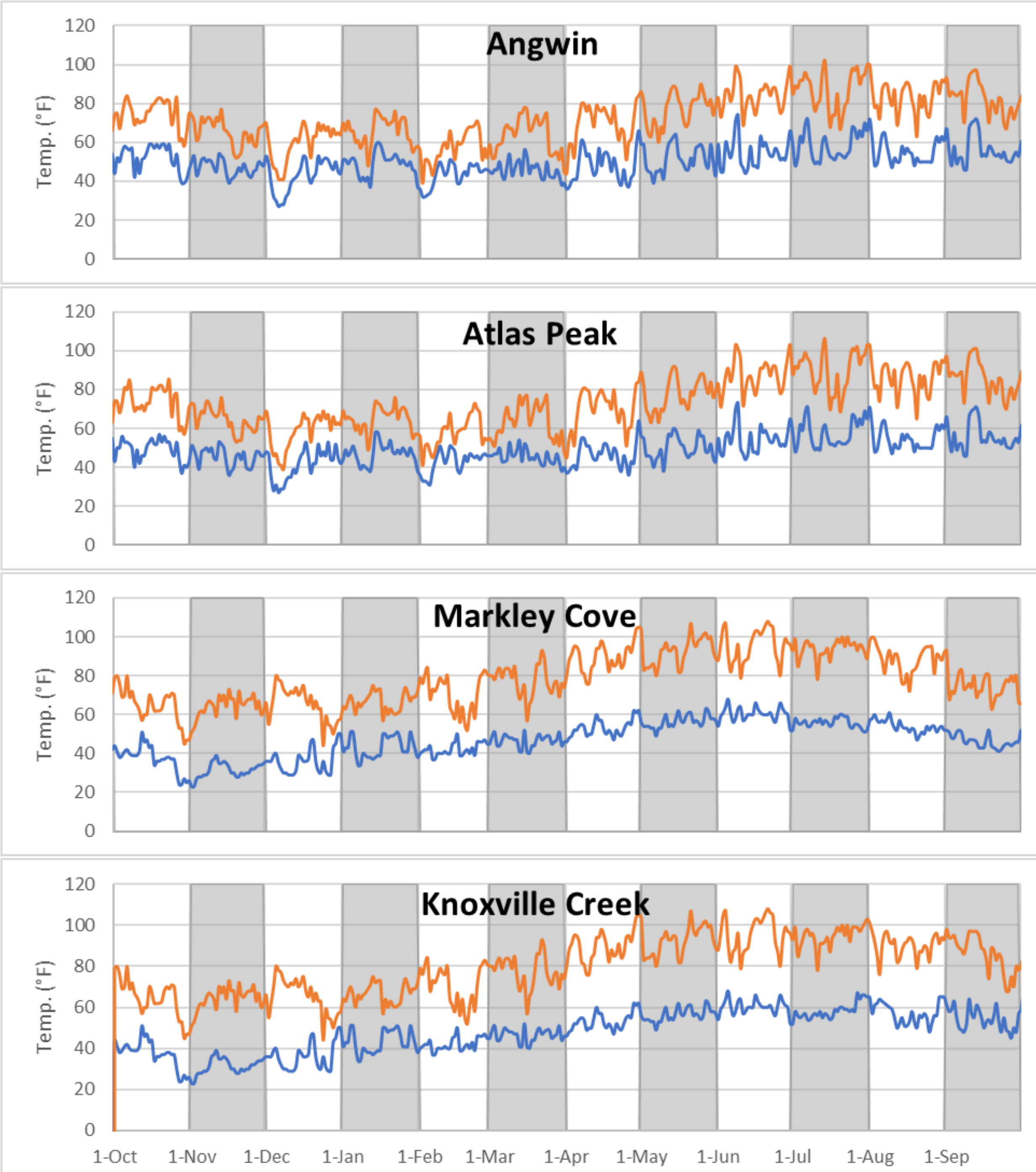


Figure 9 – cont.

Model Calibration

Available data are insufficient to calibrate the Water Year 2010 and 2014 SWB simulations; however, the land cover and soil properties used in the model were obtained from a previously prepared and calibrated SWB model of Sonoma County (OEI 2017). The Sonoma County model was calibrated against total monthly runoff volumes derived using baseflow separation of streamflow data for five watersheds within Sonoma County. Gages were selected because they represented relatively small watersheds (1.2 – 14.3 mi^2) without significant urbanization, diversions, groundwater abstraction, reservoir impoundments, or large alluvial bodies where significant exchanges between surface water and groundwater may be expected. These attributes are desirable because the hydrographs can more readily be separated into surface runoff and baseflow components and the surface runoff pattern is more directly comparable to the SWB simulated surface runoff which does not account for water use, reservoir operations, or surface water/groundwater exchange.

SWB utilizes a simplified routing scheme whereby surface runoff is routed to downslope cells or out of the model domain on the same day in which it originates as rainfall, thus it is not capable of accurately estimating streamflow over short time periods. The use of the total monthly surface runoff volumes provided a means of calibrating the Sonoma County SWB model to measured surface runoff data within the limitations of the model's approach to simulating surface runoff.

The SWB model of Sonoma County reproduced seasonal variations in surface runoff in all five calibration watersheds. Monthly Mean Errors (ME) ranged from -0.2 to 0.4 inches with a mean value of 0.1 inches. Annual surface runoff totals ranged from an under-prediction of approximately 10% at Franchini Creek to an over-prediction of approximately 19% at Buckeye Creek, with a mean over-prediction of approximately 6% across the five watersheds. These results indicate that the SWB model was able to reproduce monthly surface runoff volumes with a reasonable degree of accuracy and that the model tends to over-predict surface runoff somewhat, suggesting that the model may generate a low-range estimate of recharge.

Although the climate in Napa County is slightly drier than in Sonoma County, the vegetation, soils, and geology are similar and parameters calibrated using data from Sonoma County should be applicable to Napa County. Calibration of the Napa County SWB model was not performed due to a lack of publicly-available contemporary discharge records in suitable watersheds. Contemporary discharge records exist for USGS gaging stations located along the Napa River near St. Helena and Napa, but the watersheds above these gages are large and contain significant groundwater abstraction, reservoir impoundments, and alluvial bodies. USGS gages on smaller watersheds in Napa County have been inactive since 1983 or earlier. Discharge records exist through Napa One Rain for several streams gaged by the Napa County Resource Conservation District (RCD) but the RCD has cautioned against use of these discharge records for calibration purposes due to incomplete rating curve development.

Estimates of groundwater recharge are also available from an earlier model prepared by Luhdorff and Scalmanini Engineers and MBK Engineers (LSCE 2013). This report provided estimates of average annual recharge as a percentage of average annual precipitation for nine watersheds in Napa County. Averaged across the same nine watersheds, the SWB model predicts significantly higher rates of recharge than the model prepared by LSCE, which predicts slightly lower AET but significantly more runoff (Table 4). Differences in methodology between these two models complicate direct comparisons. The LSCE model calculated infiltration into the soil as the difference between monthly precipitation and discharge volumes within each watershed. Discharge volumes were calculated from USGS stream gages and included both direct runoff and baseflow from groundwater. Inclusion of baseflow with direct runoff in these calculations may inappropriately reduce the estimated volume of water infiltrated into the soil and available for recharge.

Table 4: Comparison of results from SWB model and Luhdorff and Scalmanini model.

USGS Gage	HUC	Mean Precip, 2010 (in)	Mean AET, 2010 (% Precip)		Mean Runoff, 2010 (% Precip)		Mean Recharge, 2010 (% Precip)	
			SWB	LSCE	SWB	LSCE	SWB	LSCE
Conn Ck nr Oakville	11456500	34.8	59%	53%	21%	25%	21%	21%
Dry Ck nr Napa	11457000	41.5	56%	50%	18%	43%	25%	6%
Milliken Ck nr Napa	11458100	32.3	52%	41%	20%	51%	28%	8%
Napa Ck at Napa	11458300	36.6	61%	43%	16%	46%	23%	11%
Napa R nr Napa	11458000	39.5	56%	48%	20%	35%	24%	17%
Napa R nr St Helena	11456000	47.9	46%	45%	23%	42%	30%	14%
Redwood Ck nr Napa	11458200	39.6	53%	49%	26%	40%	22%	10%
Tulucay Ck nr Napa	11458300	27.0	64%	49%	16%	47%	20%	5%

Model Results

The principal elements of the annual water budget simulated with the Napa County SWB model for Water Years 2010 and 2014 are presented in map form in Figures 10 - 19 and in tabular form for 27 major watershed areas in Napa County (Tables 5 - 8). The watersheds are based on USGS HUC-12 watersheds and are named for the stream which comprises the largest proportion of the area; in many cases the areas consist of multiple tributary streams (Figure 20).

In Water Year 2010 (representing "average" hydrologic conditions) precipitation varied from 21.8 inches in the Ledgewood Creek watershed to 53.3 inches in the Saint Helena Creek watershed (Figure 10, Table 5). Actual evapotranspiration (AET) ranged from 13.4 inches in the Jackson Creek watershed to 25.2 inches in the Saint Helena Creek watershed (Figure 11). Surface runoff ranged from 3.4 inches in the Ledgewood Creek watershed to 13.5 inches in the Saint Helena Creek watershed (Figure 12). Recharge ranged from 3.3 inches in the Ledgewood Creek watershed to 14.4 inches in the Saint Helena watershed. (Figure 13). Small decreases in soil moisture storage (up to 1.8 inches) occurred in most watersheds, with changes in most watersheds being less than an inch (Figure 14). Note that the San Pablo Bay estuaries have been excluded from these comparisons.

Expressed as a percentage of the annual precipitation, AET ranged from 77% in the Ledgewood Creek watershed to 45% in the Jackson Creek watershed (Table 6). Surface runoff ranged from 15% of precipitation in the Ledgewood Creek watershed to 42% in the Jackson Creek watershed. Recharge ranged from 10% of the precipitation in the Jackson Creek watershed to 27% in the Saint Helena watershed.

In Water Year 2014 (representing “dry” hydrologic conditions during the second year of an extreme three-year drought) precipitation varied from 10.1 inches in the American Canyon Creek watershed to 32.2 inches in the Saint Helena Creek watershed (Figure 15, Table 7). Actual evapotranspiration (AET) ranged from 10.3 inches in the Jackson Creek watershed to 17.8 inches in the Saint Helena Creek watershed (Figure 16). Surface runoff ranged from 0.7 inches in the American Canyon Creek watershed to 13.2 inches in the Saint Helena Creek watershed (Figure 17). Recharge ranged from 0.6 inches in the Wragg Canyon watershed to 4.1 inches in the Saint Helena watershed. (Figure 18). Large decreases in soil moisture storage of between 2.3 and 4.3 inches were also simulated (Figure 19).

Expressed as a percentage of the annual precipitation, AET ranged from 55% in the Saint Helena Creek watershed to 121% in the Jackson Creek watershed (Table 8). These very large AET rates caused significant decreases in soil moisture. Decreases in soil moisture ranged from 9% of precipitation in the Saint Helena watershed to 36% in the American Canyon Creek watershed. Surface runoff ranged from 7% of precipitation in the American Canyon Creek watershed to 41% in the Saint Helena Watershed. Recharge ranged from 18% in the Milliken Creek Watershed to 5% in the Jackson Creek and Wragg Canyon watersheds.

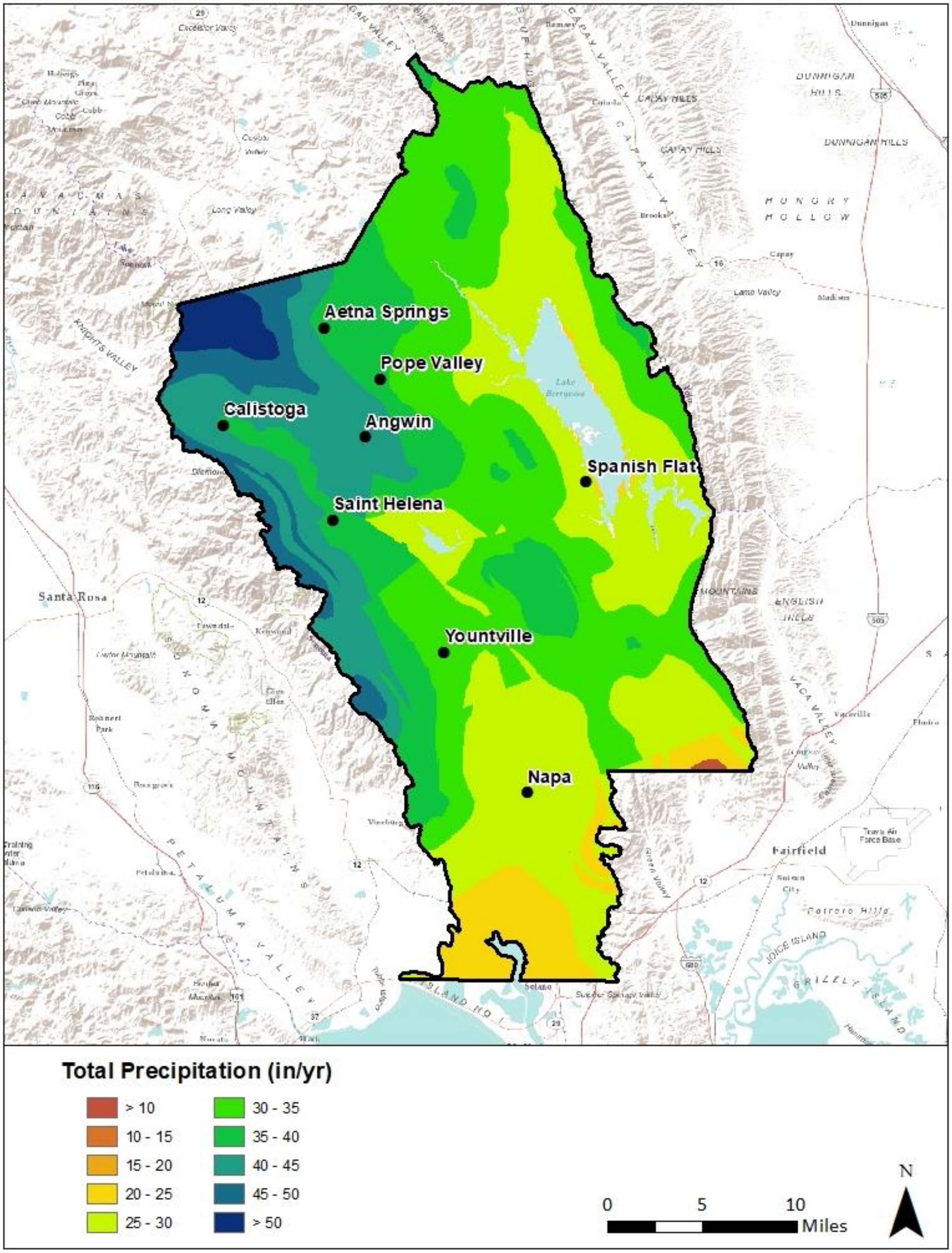


Figure 10: Water Year 2010 precipitation simulated with the Napa County SWB model.

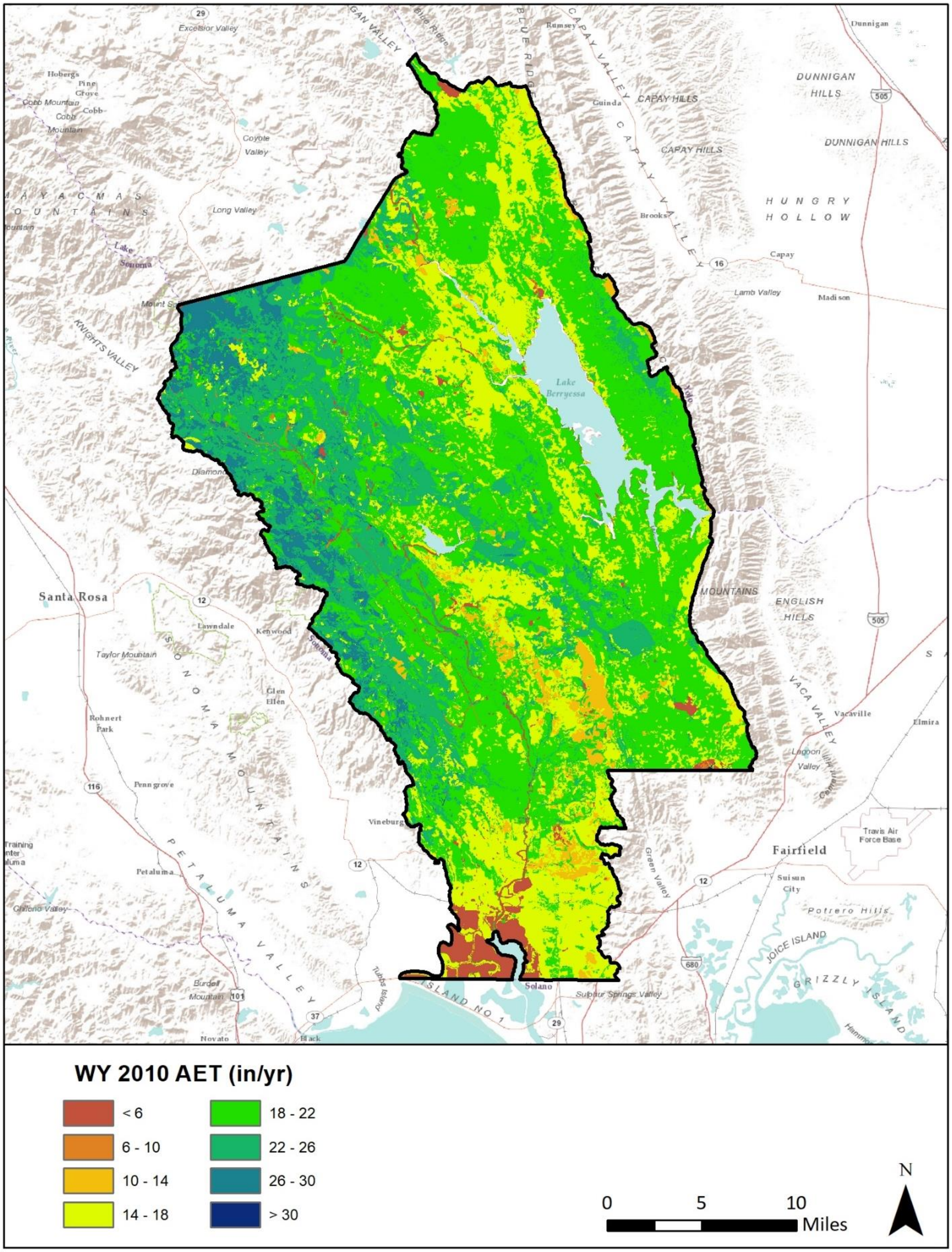


Figure 11: Water Year 2010 AET simulated with the Napa County SWB model.

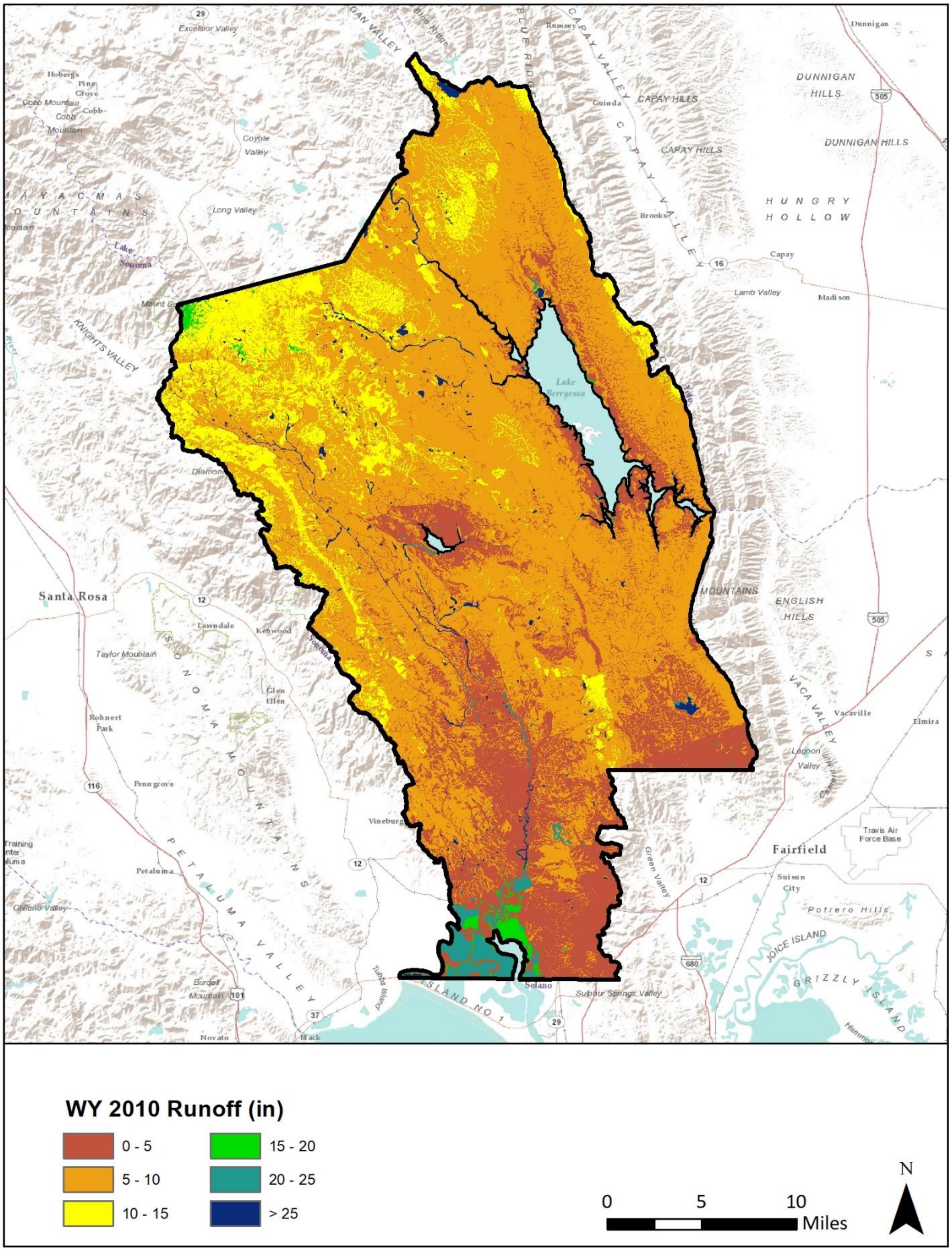


Figure 12: Water Year 2010 runoff simulated with the Napa County SWB model.

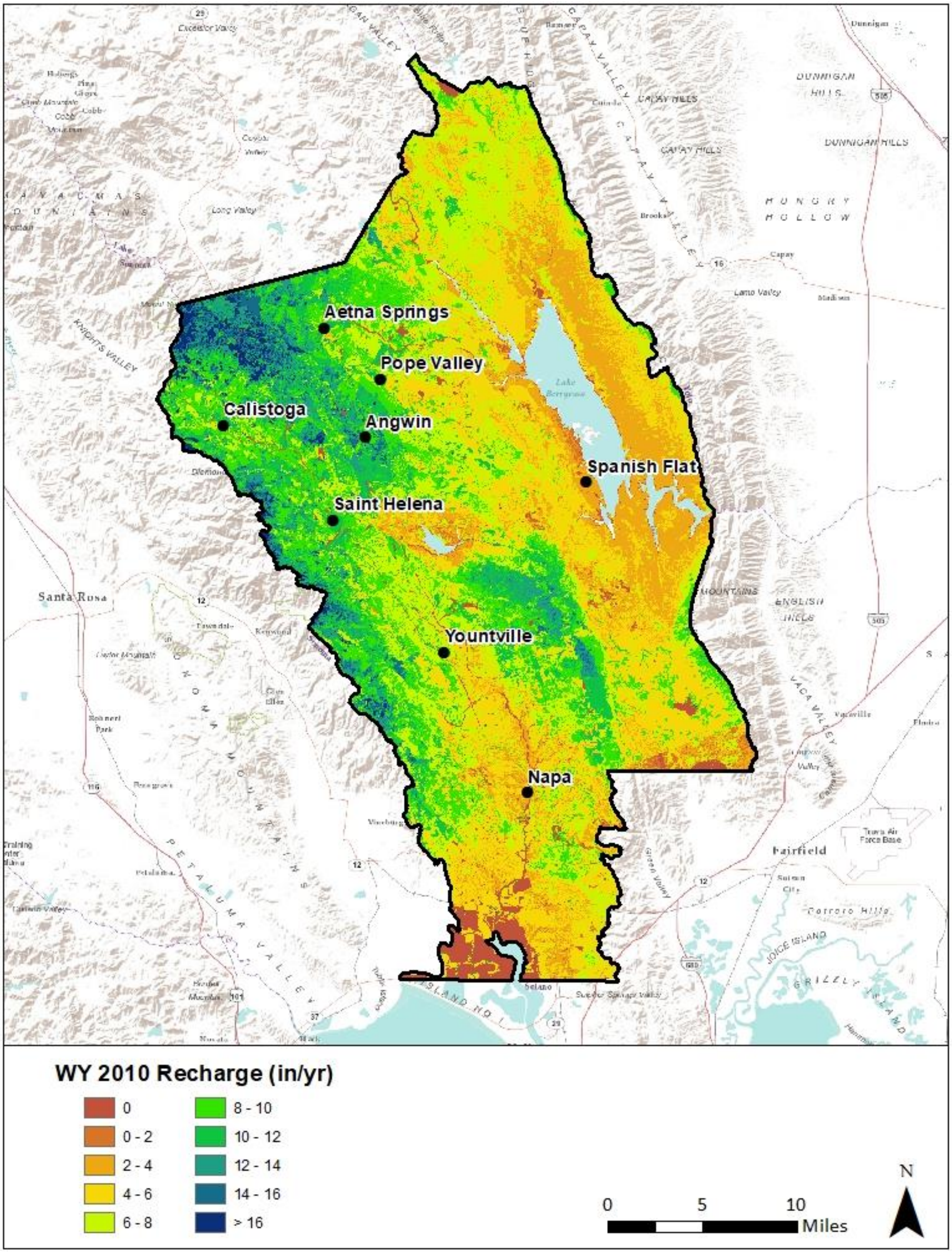


Figure 13: Water Year 2010 recharge simulated with the Napa County SWB model.

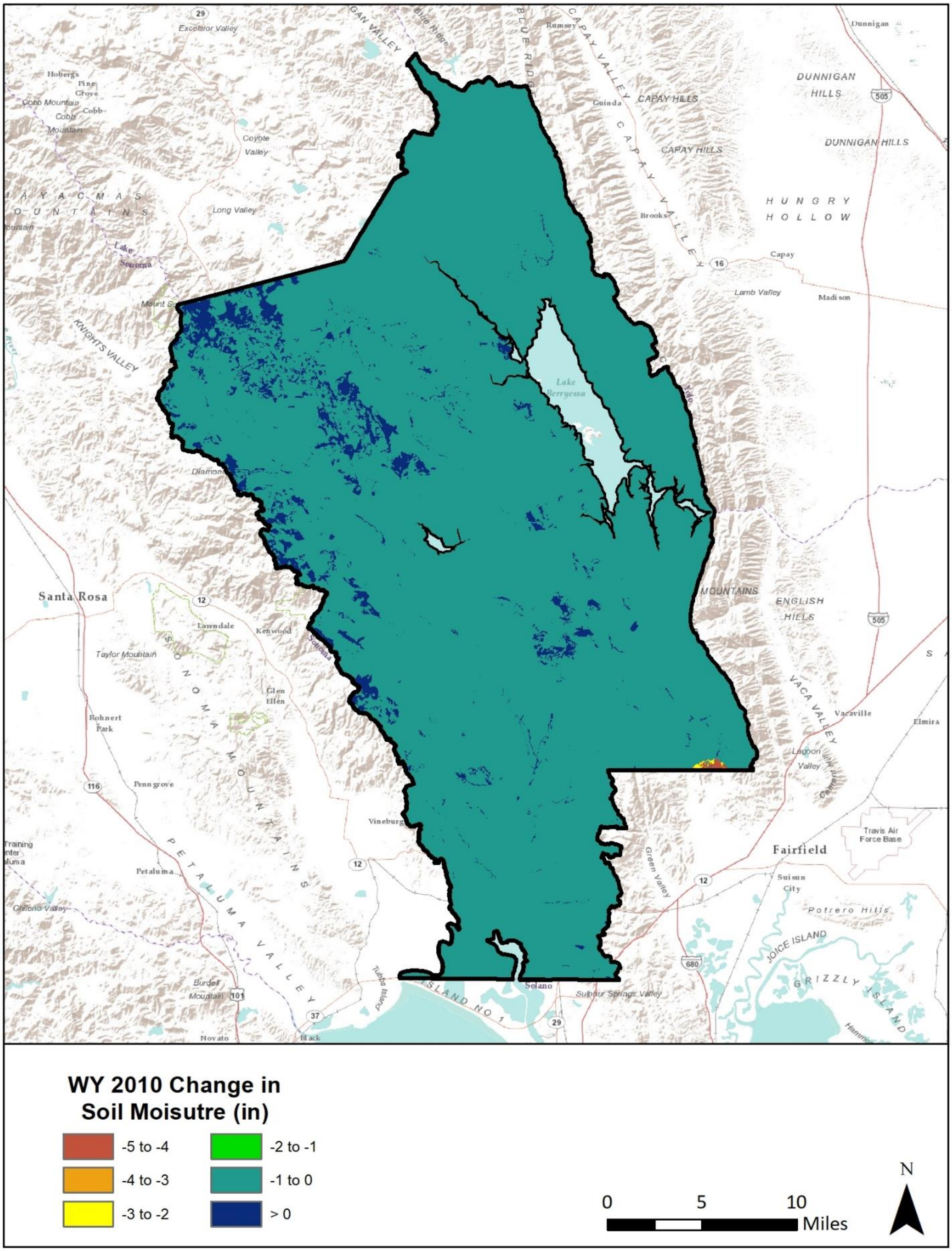


Figure 14: Water Year 2010 change in soil moisture content simulated with the Napa County SWB model.

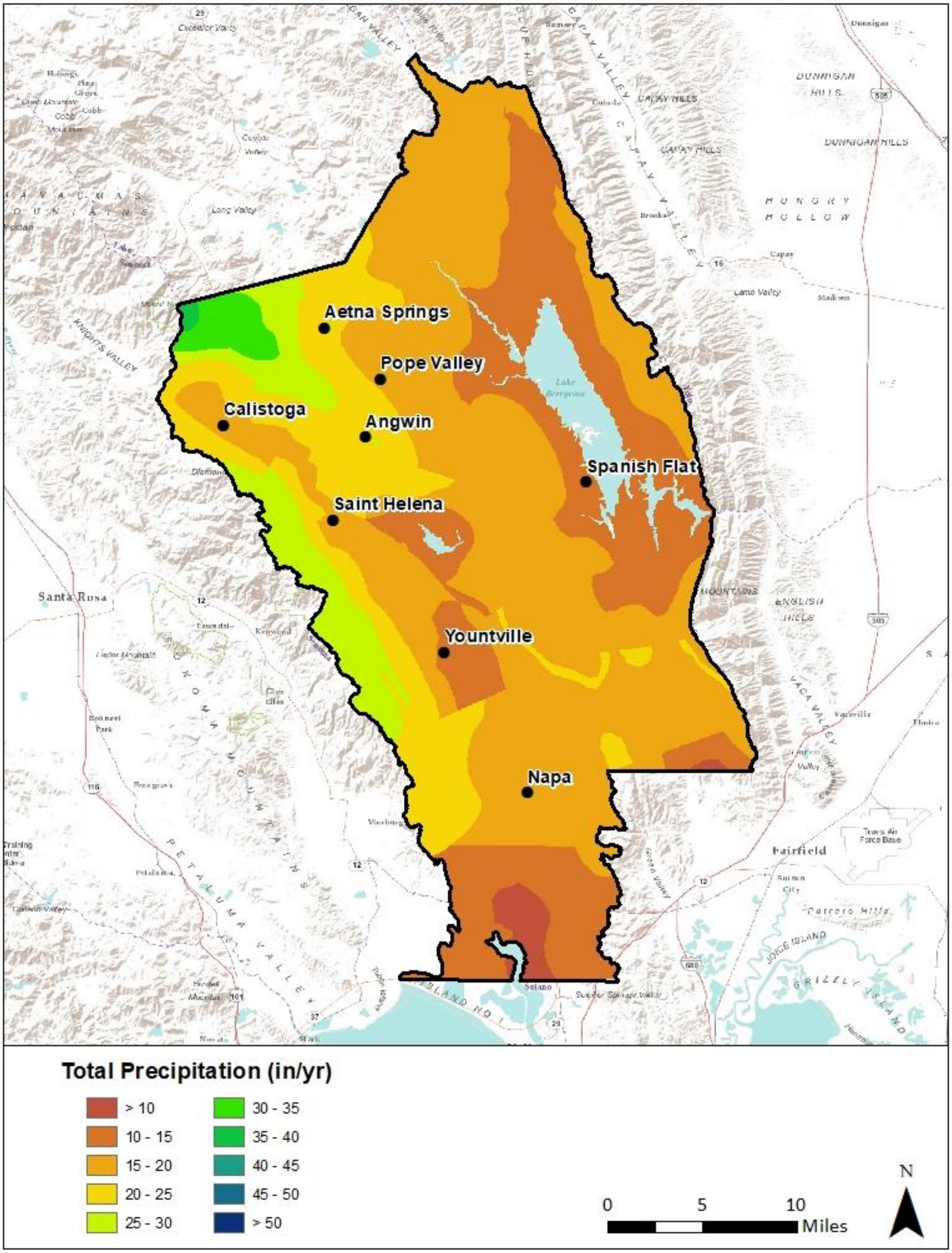


Figure 15: Water Year 2014 precipitation simulated with the Napa County SWB model.

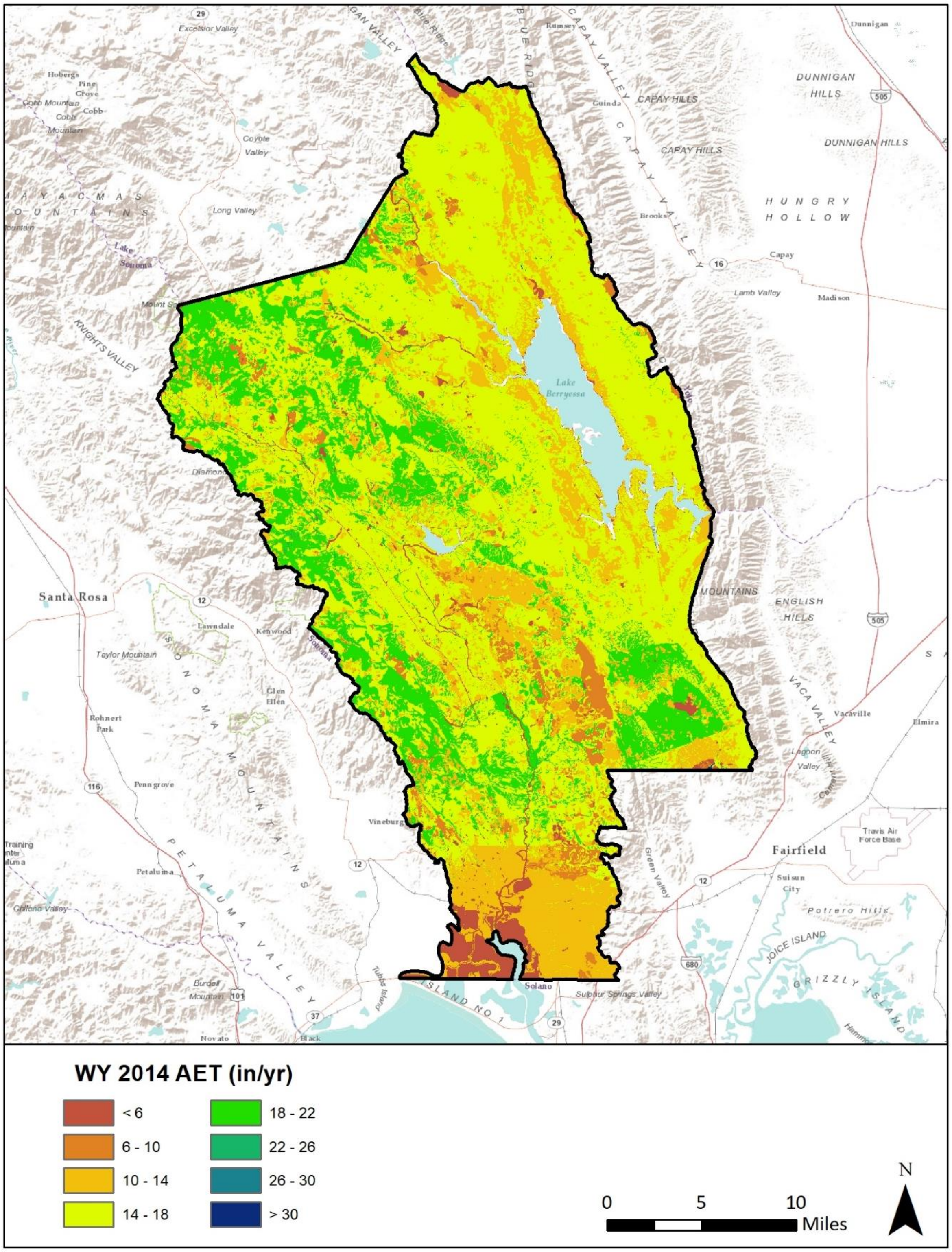


Figure 16: Water Year 2014 AET simulated with the Napa County SWB model.

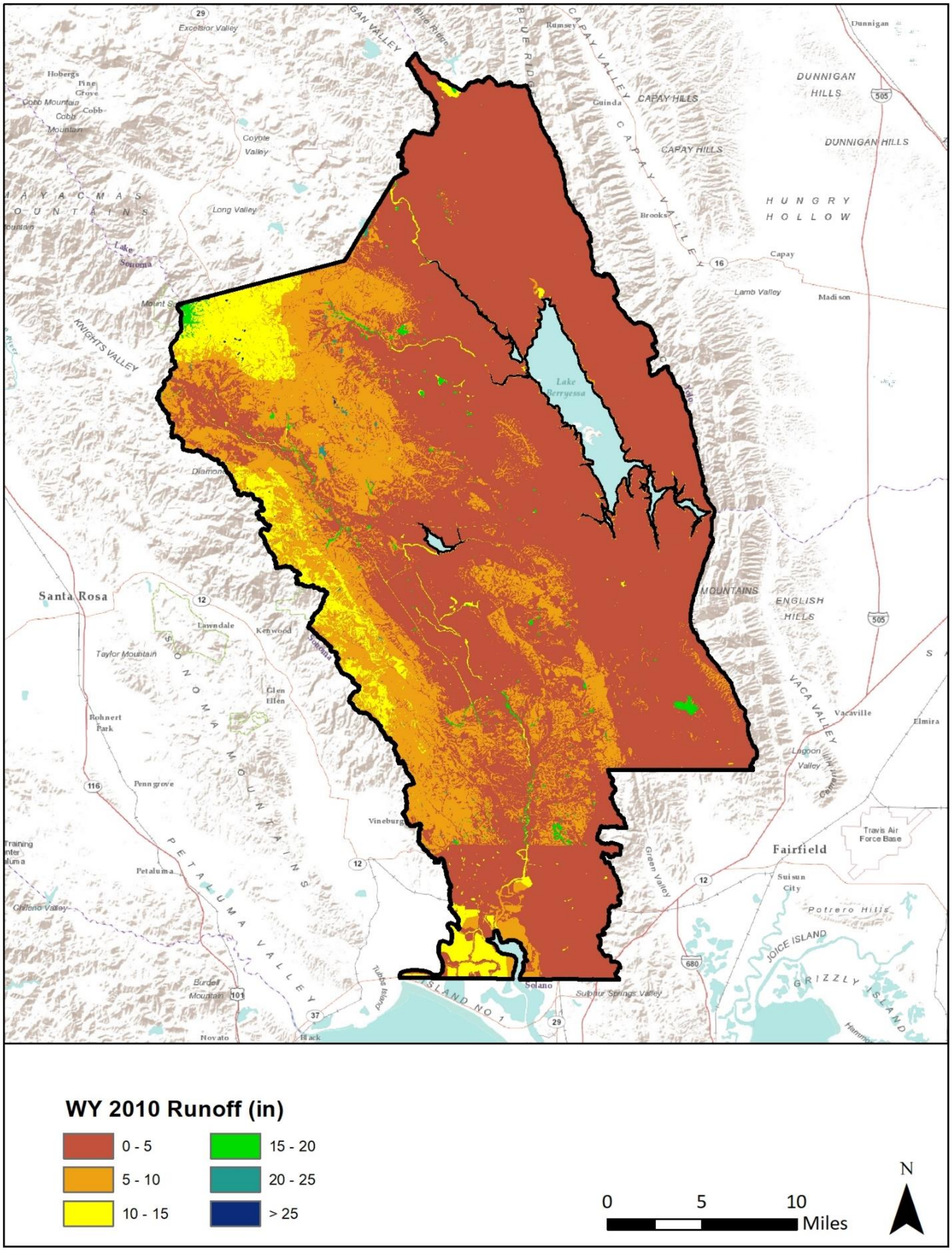


Figure 17: Water Year 2014 recharge simulated with the Napa County SWB model.

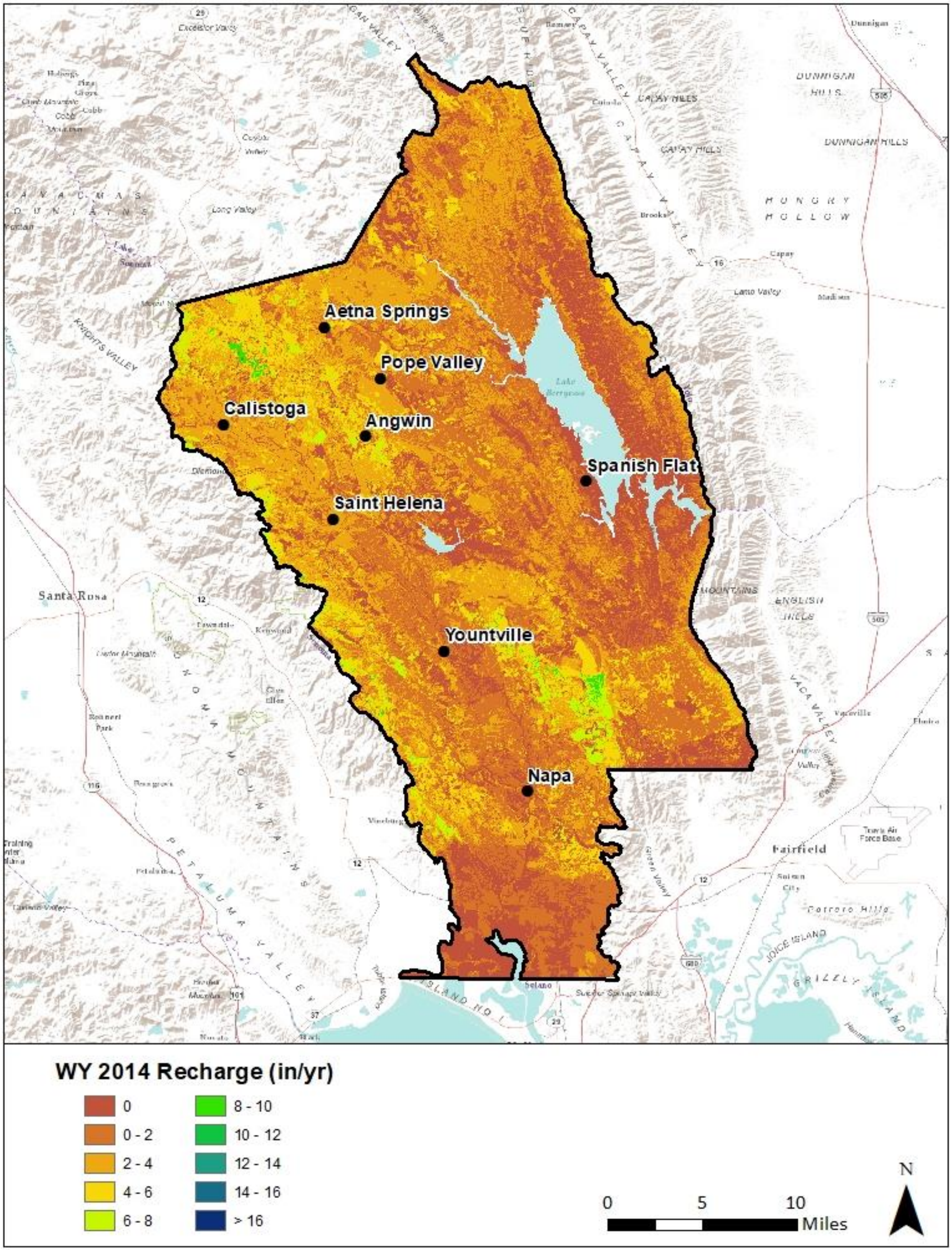


Figure 18: Water Year 2014 recharge simulated with the Napa County SWB model.

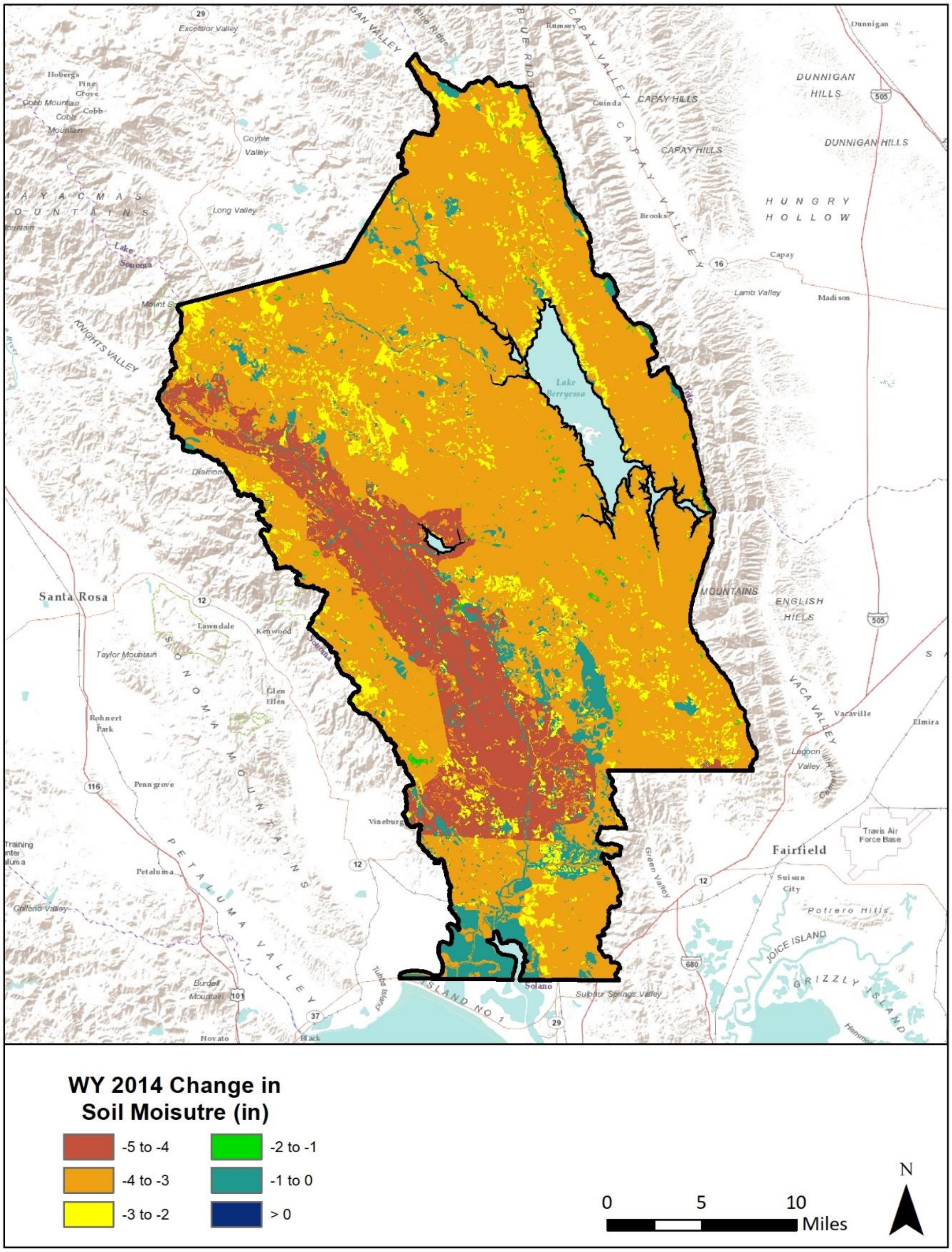


Figure 19: Water Year 2014 change in soil moisture content simulated with the Napa County SWB model.

Table 5: Simulated precipitation and recharge values averaged across HUC-12 watersheds in Napa County for Water Year 2010 expressed as depths. See Figure 20 for watershed locations.

Name	Drainage Area (mi^2)	Precipitation (in)	AET (in)	Surface Runoff (in)	Recharge (in)	Soil Moisture Change (in)
American Canyon Creek	10.8	24.1	16.3	3.7	4.7	-0.6
Bucksnort Creek	1.9	47.9	24.5	12.1	11.1	0.1
Butts Creek-Putah Creek	49.9	33.0	17.4	9.7	6.2	-0.7
Capell Creek	43.0	31.1	19.1	7.4	5.0	-0.6
Carneros Creek	29.7	28.0	18.6	5.2	5.5	-0.6
Chiles Creek	32.0	34.6	21.1	7.1	6.8	-0.5
Dry Creek	28.8	37.0	22.2	7.2	8.4	-0.5
Hunting Creek	12.0	33.7	19.0	9.7	5.7	-0.8
Jackson Creek-Putah Creek	54.5	29.9	13.4	12.6	3.0	-0.5
Lake Curry-Suisun Creek	16.4	30.7	18.9	6.5	5.9	-0.6
Lake Hennessey-Conn Creek	20.0	35.1	19.6	8.5	7.3	-0.4
Ledgewood Creek	6.4	21.8	16.9	3.4	3.3	-1.8
Lower Eticuera Creek	44.0	30.0	17.7	8.1	4.7	-0.7
Lower Napa River	45.0	31.7	19.9	5.6	6.7	-0.6
Lower Pope Creek	31.8	33.9	18.0	9.7	6.5	-0.6
Maxwell Creek	35.1	34.7	19.6	8.7	6.9	-0.6
Middle Napa River	60.3	39.9	22.8	8.5	9.2	-0.5
Milliken Creek	29.7	30.9	16.9	6.6	7.9	-0.6
Rector Creek-Conn Creek	22.3	32.8	18.0	7.1	8.2	-0.7
Saint Helena Creek	7.7	53.3	25.2	13.5	14.4	0.1
San Pablo Bay Estuaries	19.5	23.9	8.1	13.8	2.3	-0.3
Tulucay Creek	34.2	26.1	16.7	4.6	5.4	-0.7
Upper Eticuera Creek	25.6	31.2	17.2	8.6	6.1	-0.8
Upper Napa River	44.6	44.7	23.6	10.6	10.8	-0.4
Upper Pope Creek	21.7	44.5	22.7	10.5	11.5	-0.3
Wooden Valley & Suisun Creeks	23.3	29.0	19.0	5.1	5.5	-0.6
Wragg Canyon-Putah Creek	34.2	28.3	16.3	8.6	3.3	-0.6

Table 6: Simulated precipitation and recharge values averaged across HUC-12 watersheds in Napa County for Water Year 2010 expressed as a percentage of precipitation. See Figure 20 for watershed locations.

Name	Drainage Area (mi^2)	Precipitation (in)	AET (%)	Surface Runoff (%)	Recharge (%)	Soil Moisture Change (%)
American Canyon Creek	10.8	24.1	67%	15%	19%	-3%
Bucksnort Creek	1.9	47.9	51%	25%	23%	0%
Butts Creek-Putah Creek	49.9	33.0	53%	29%	19%	-2%
Capell Creek	43.0	31.2	61%	24%	16%	-2%
Carneros Creek	29.7	29.7	66%	19%	20%	-2%
Chiles Creek	32.0	34.6	61%	21%	20%	-1%
Dry Creek	28.8	37.8	60%	20%	23%	-1%
Hunting Creek	12.0	33.7	56%	29%	17%	-2%
Jackson Creek-Putah Creek	54.5	29.7	45%	42%	10%	-2%
Lake Curry-Suisun Creek	16.4	30.7	61%	21%	19%	-2%
Lake Hennessey-Conn Creek	20.0	36.0	56%	24%	21%	-1%
Ledgewood Creek	6.4	21.8	77%	15%	15%	-8%
Lower Eticuera Creek	44.0	30.0	59%	27%	16%	-2%
Lower Napa River	45.0	31.7	63%	18%	21%	-2%
Lower Pope Creek	31.8	33.9	53%	29%	19%	-2%
Maxwell Creek	35.1	34.7	56%	25%	20%	-2%
Middle Napa River	60.3	40.4	57%	21%	23%	-1%
Milliken Creek	29.7	30.9	55%	21%	26%	-2%
Rector Creek-Conn Creek	22.3	32.8	55%	22%	25%	-2%
Saint Helena Creek	7.7	53.3	47%	25%	27%	0%
San Pablo Bay Estuaries	19.5	23.9	34%	58%	10%	-1%
Tulucay Creek	34.2	26.1	64%	18%	21%	-3%
Upper Eticuera Creek	25.6	31.2	55%	28%	19%	-3%
Upper Napa River	44.6	44.7	53%	24%	24%	-1%
Upper Pope Creek	21.7	44.5	51%	23%	26%	-1%
Wooden Valley & Suisun Creeks	23.3	29.0	65%	18%	19%	-2%
Wragg Canyon-Putah Creek	34.2	28.3	58%	31%	12%	-2%

Table 7: Simulated precipitation and recharge values averaged across HUC-12 watersheds in Napa County for Water Year 2014 expressed as depths. See Figure 20 for watershed locations.

Name	Drainage Area (mi^2)	Precipitation (in)	AET (in)	Surface Runoff (in)	Recharge (in)	Soil Moisture Change (in)
American Canyon Creek	10.8	10.1	12.3	0.7	0.7	-3.6
Bucksnort Creek	1.9	28.8	17.6	11.5	2.6	-3.0
Butts Creek-Putah Creek	49.9	16.9	14.2	3.9	1.9	-3.2
Capell Creek	43.0	15.8	14.8	3.1	1.1	-3.1
Carneros Creek	29.7	15.0	14.7	4.6	2.0	-3.7
Chiles Creek	32.0	18.3	16.5	3.7	1.5	-3.3
Dry Creek	28.8	21.5	16.5	6.8	2.5	-3.7
Hunting Creek	12.0	16.7	15.4	3.1	1.6	-3.4
Jackson Creek-Putah Creek	54.5	14.9	10.3	6.1	0.7	-2.3
Lake Curry-Suisun Creek	16.4	18.4	16.1	3.7	1.9	-3.4
Lake Hennessey-Conn Creek	20.0	19.1	14.8	5.7	2.2	-3.2
Ledgewood Creek	6.4	12.2	13.9	1.7	0.8	-4.3
Lower Eticuera Creek	44.0	14.9	14.0	2.6	1.3	-3.1
Lower Napa River	45.0	19.4	15.9	5.0	2.2	-3.6
Lower Pope Creek	31.8	17.8	14.5	4.5	2.0	-3.2
Maxwell Creek	35.1	18.3	15.9	3.8	2.0	-3.3
Middle Napa River	60.3	21.3	16.5	6.6	2.5	-3.7
Milliken Creek	29.7	18.7	13.7	4.5	3.4	-2.9
Rector Creek-Conn Creek	22.3	16.5	13.6	4.0	2.3	-3.4
Saint Helena Creek	7.7	32.2	17.8	13.2	4.1	-3.0
San Pablo Bay Estuaries	19.5	10.4	6.0	5.6	0.5	-1.6
Tulucay Creek	34.2	14.6	13.5	2.6	1.7	-3.3
Upper Eticuera Creek	25.6	15.5	14.1	2.5	2.1	-3.2
Upper Napa River	44.6	22.9	16.2	6.9	3.3	-3.5
Upper Pope Creek	21.7	25.6	16.8	8.5	3.5	-3.2
Wooden Valley & Suisun Creeks	23.3	17.9	16.4	3.1	2.0	-3.5
Wragg Canyon-Putah Creek	34.2	14.1	12.6	3.6	0.6	-2.8

Table 8: Simulated precipitation and recharge values averaged across HUC-12 watersheds in Napa County for Water Year 2014 expressed as a percentage of precipitation. See Figure 20 for watershed locations.

Name	Drainage Area (mi^2)	Precipitation (in)	AET (%)	Surface Runoff (%)	Recharge (%)	Soil Moisture Change (%)
American Canyon Creek	10.8	10.1	121%	7%	7%	-36%
Bucksnort Creek	1.9	28.8	61%	40%	9%	-10%
Butts Creek-Putah Creek	49.9	16.8	84%	23%	11%	-19%
Capell Creek	43.0	15.8	94%	20%	7%	-20%
Carneros Creek	29.7	17.6	98%	30%	13%	-25%
Chiles Creek	32.0	18.4	90%	20%	8%	-18%
Dry Creek	28.8	22.1	77%	32%	12%	-17%
Hunting Creek	12.0	16.7	92%	18%	10%	-20%
Jackson Creek-Putah Creek	54.5	14.7	69%	41%	5%	-16%
Lake Curry-Suisun Creek	16.4	18.4	88%	20%	10%	-19%
Lake Hennessey-Conn Creek	20.0	19.6	78%	30%	12%	-17%
Ledgewood Creek	6.4	12.2	114%	14%	7%	-35%
Lower Eticuera Creek	44.0	14.9	94%	18%	9%	-21%
Lower Napa River	45.0	19.4	82%	26%	11%	-19%
Lower Pope Creek	31.8	17.8	81%	25%	11%	-18%
Maxwell Creek	35.1	18.3	87%	21%	11%	-18%
Middle Napa River	60.3	21.8	77%	31%	12%	-18%
Milliken Creek	29.7	18.7	74%	24%	18%	-16%
Rector Creek-Conn Creek	22.3	16.5	83%	24%	14%	-21%
Saint Helena Creek	7.7	32.2	55%	41%	13%	-9%
San Pablo Bay Estuaries	19.5	10.4	58%	53%	4%	-16%
Tulucay Creek	34.2	14.6	93%	18%	12%	-23%
Upper Eticuera Creek	25.6	15.5	91%	16%	14%	-21%
Upper Napa River	44.6	22.9	71%	30%	14%	-15%
Upper Pope Creek	21.7	25.6	66%	33%	14%	-12%
Wooden Valley & Suisun Creeks	23.3	17.9	91%	17%	11%	-20%
Wragg Canyon-Putah Creek	34.2	14.1	90%	26%	5%	-20%

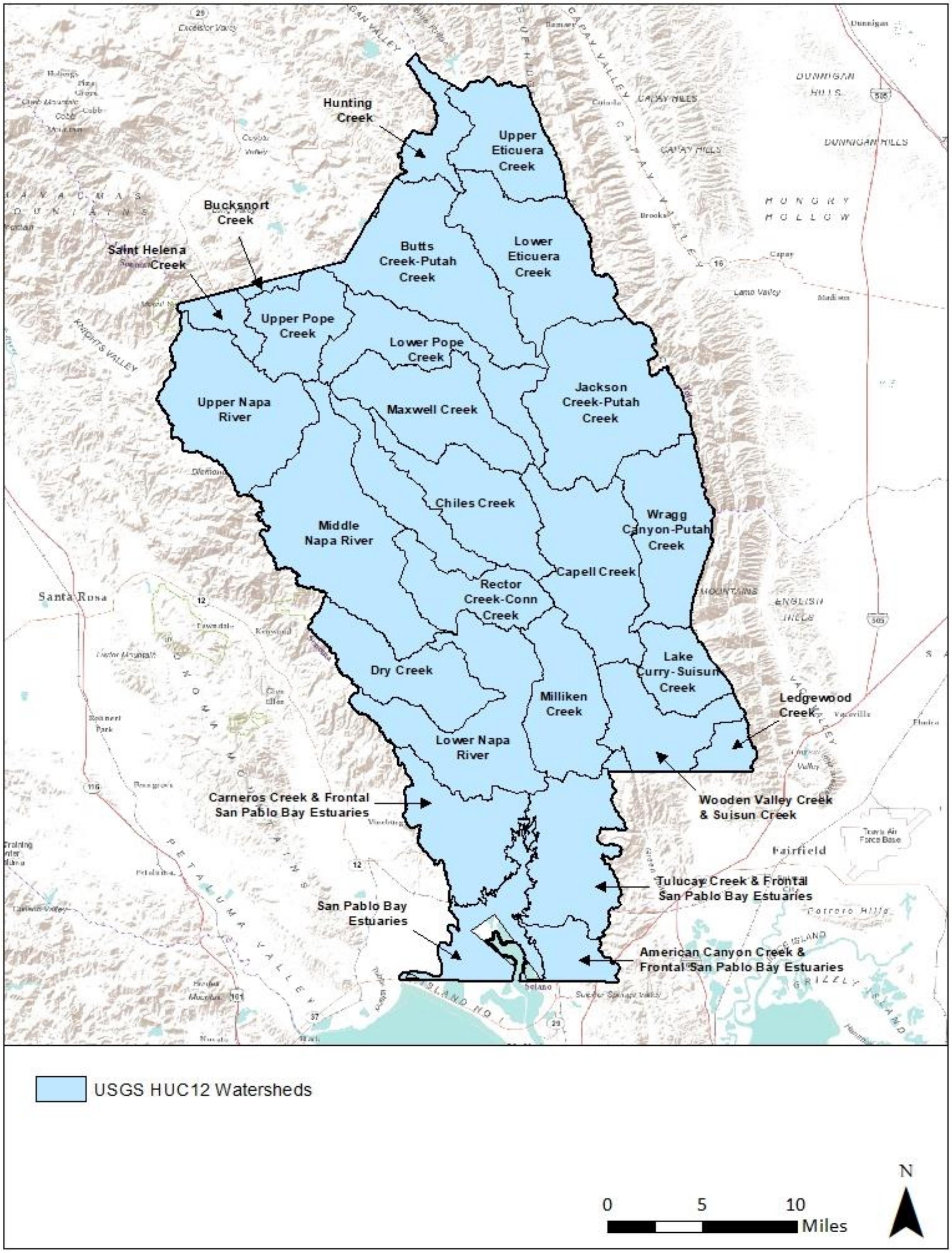


Figure 20: Major watersheds areas used to summarize water budget information in Tables 5 - 8.

Discussion and Conclusion

Numerous previous modeling studies have estimated water budget components in several larger watershed areas in Sonoma and Napa Counties including the Santa Rosa Plain, the Green Valley and Dutch Bill Creek watersheds, and the Sonoma Valley (Farrar et. al., 2006; Kobor and O'Connor, 2016; Woolfenden and Hevesi, 2014). Comparisons to these water budgets are useful for evaluating the SWB results, but one would not expect precise agreement owing to significant variations in climate, land cover, soil types, underlying hydrogeologic conditions, and different spatial scales of modeling studies. These regional analyses estimate that average annual recharge varies from 7% to 19% of the annual precipitation. The equivalent county-wide value from this study is slightly higher at 20%.

Water budgets for the Napa River and selected sub-basins were also estimated in a previous study by Luhdorff and Scalmanini Engineers and MBK Engineers (LSCE 2013). The LSCE study estimated that, as a percentage of annual precipitation, AET comprised slightly less, runoff significantly more, and recharge substantially less of the typical annual water budget. LSCE (2013) calculated infiltration of precipitation based on the difference between total monthly streamflow at selected gaging stations and total monthly precipitation for the gages' drainage area. Streamflow volumes include both direct runoff (overland flow and interflow) and baseflow from groundwater. <u>Inclusion of baseflow with direct runoff in these calculations may inappropriately reduce the estimated volume of water infiltrated into the soil and available for recharge; the LSCE approach therefore tends to underestimate groundwater recharge</u>. Additionally, many of the gauging stations used for the analysis are located in reaches that may be significantly influenced by upstream reservoir releases, surface water diversions, groundwater abstraction, and/or surface water groundwater exchanges, further complicating the interpretation of the LSCE (2013) runoff rates and the interrelated calculations of AET and recharge rates. In contrast, the SWB model presented here is based on calibrated parameter values developed for a similar model in Sonoma County which was calibrated to gauges specifically selected to minimize the effects of reservoir releases, water use, or significant surface water/groundwater interaction, and after separating and removing the baseflow component of streamflow.

The recharge estimates presented here arguably represent the best available county-wide estimates produced at a fine spatial resolution using a consistent and objective data-driven approach. This analysis focused on two Water Years, 2010 and 2014, which represent average and drought conditions respectively. Input parameters were determined based on literature values and values calibrated through prior modeling experience in Sonoma County.

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