Groundwater Report
APN 142-051-031, PLP02-0085
4200 Stage Gulch Road, Sonoma
Prepared per Sonoma County Policy & Procedure 8-1-14

Prepared for:

Carneros Vintners Winery
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Introduction

Carneros Vintners Winery is applying for a Use Permit Modification to increase production at their winery facility from 250,000 cases (PLP02-0085) to 2,500,000 cases along with the elimination of public tasting, tours and events. The winery is located at 4200 Stage Gulch Road (Sonoma County APN 142-051-031) approximately 3.6 miles southwest of the City of Sonoma (Figure 1). Water for the winery is supplied by a well located on a neighboring parcel approximately 2,000 feet to the east. The western portion of the project parcel is in the Class 3 groundwater area defined by Sonoma County to be an area with "marginal groundwater". The eastern portion of the project parcel and the main water supply well parcel are located in the Class 1 groundwater area defined as a "major groundwater basin" (Figure 1).

This hydrogeologic report was prepared as required by Sonoma County Permit and Resource Management Division (PRMD) pursuant to General Plan Policy WR-2e, Procedure and Policy 8-1-14, and section 10d of Exhibit A-2 of County Ordinance No. 6189 regarding water availability in Zone 3 and 4 areas where groundwater is believed to be of limited supply. This report only evaluates potential impacts of the proposed project to the hydrogeologic system. All other plans and documents related to permitting the project are being prepared by other professionals.

This hydrogeologic report includes the following elements: estimates of existing and proposed water use within the project recharge area, compilation of well completion reports (drillers' logs) from the area and characterization of local hydrogeologic conditions, estimates of annual groundwater recharge relative to existing and proposed groundwater use, and the potential for well interference between the project well and neighboring wells and streams.

Limitations

Groundwater systems of Sonoma 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, discussion with others knowledgeable about site conditions, 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 confined aquifer conditions found within the project water supply well and neighboring well and apparently significant depths to water in the project water supply well (300 plus feet), the relationship between groundwater recharge generated within the project vicinity and groundwater availability at the project well is not expected to be tightly coupled. Substantial uncertainty exists regarding the source area for groundwater flowing to the project wells.

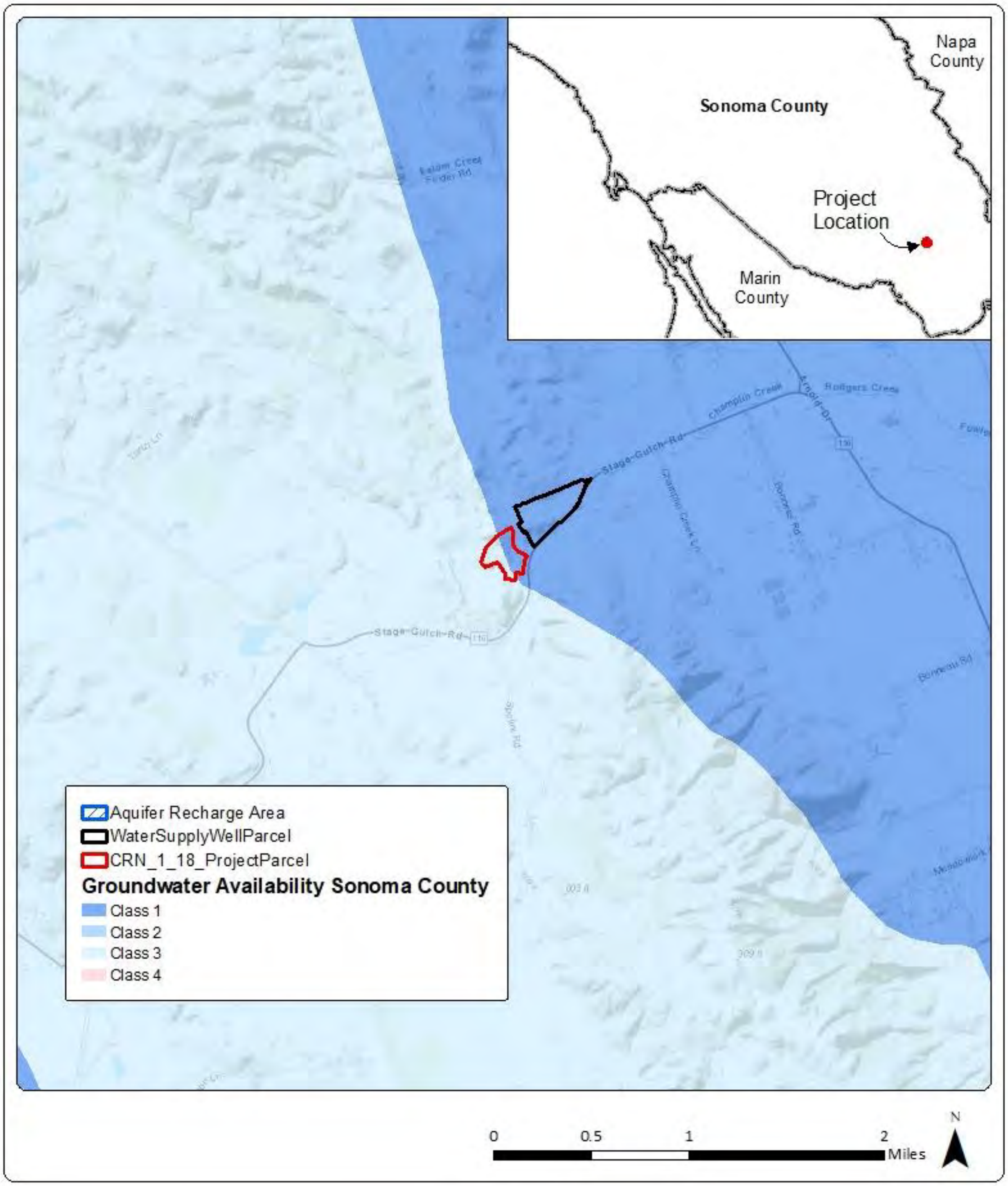


Figure 1: Project location map.

Hydrogeologic Conditions

Overview

The project parcel is located on a topographic divide between the Petaluma and Sonoma Valleys near the southern-most extent of Sonoma Mountain. The site is in the Champlin Creek watershed along the southeastern limits of the Rodgers Creek Fault Zone (Figures 1 and 2). Recent geologic mapping by Wagner and Gutierrez (2017), shows Quaternary alluvium (map unit Qha) is mapped on the project parcel along the eastern edge near the valley bottom where Champlin Creek flows through the parcel. This unit fills the valley bottom with a shallow layer of alluvium including poorly sorted sand, gravel, silt, and clay, and follows Champlin Creek as it cuts through the divide draining east towards the Sonoma Valley.

The bedrock geology mapped within the project parcel is part of the Sonoma Volcanics Formation and includes mafic flows and breccia on (map unit Tsvm) in fault contact with the Miocene-aged Rhyodacite to dacite flows (map unit Msvr) in the western lobe of the parcel. The Msvr unit located on the project parcel is a relatively small 0.1 square mile sliver bound by two approximately located fault contacts to the east and west and lies between two blocks of the Tsvm. The mafic flows and breccia underlie the alluvium on the project parcel. The Tsvm unit is associated with an approximately 5 square mile block mapped to the south and is most likely connected to the Tsvm outcropping to the north.

The main winery water supply well (Well 3) is located on APN 142-051-029 to the east (Figures 1 and 2). Most of this parcel is mapped as the Sonoma Volcanics mafic flows and breccias (map unit Tsvm). Quaternary alluvium (Qha) and Quaternary channel deposits fill the valley bottoms of the two reaches of Champlin Creek running along the north central portion and the southern corner of the project parcel. Along the northern edge of the parcel tuffaceous, gravelly sediments, presumably originating from the Sonoma Volcanics are mapped as Plio-Pleistocene sediments including gravel, conglomerate, sands and reworked tuff (map unit QPu). These sediments are up to 200 ft in thickness as noted in some local well completion reports. The mafic flows and breccia of the Sonoma Volcanics (map unit Tsvm) are mapped on the remainder of the parcel and are presumed to be a part of the larger unit mapped nearby underlying the shallow sedimentary units nearby.

In general, wells drilled in the Sonoma Volcanics tend to be low-yielding. 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 not water yielding except where fractured (DWR 1982).

In the project vicinity the Sonoma Volcanics are significantly sheared by faults associated with the Rodgers Creek Fault Zone. The Rodgers Creek Fault is active and trends northwest to southeast extending from the southern end of the Healdsburg Fault down into San Pablo Bay. This fault zone has numerous mapped traces associated with it causing complex local structures and geologic relationships. Faults can be either barriers or conduits for groundwater flow. Based on the number of documented dry holes and abandoned wells in the project area, the faulting in this area appears to have had a significant impact on groundwater resources likely due to the restricted groundwater flow to and across areas within the RCFZ.

Well Data

Well Completion Reports for several wells within the vicinity of the project parcel were obtained through the California Department of Water Resources (DWR) Well Completion Report Map Application. Well Completion Reports for the wells on the project parcel and neighboring parcels including the water supply well parcel were provided by the project applicant along with details for other local wells described in a Geology and Groundwater Potential report prepared by Eugene Boudreau (Boudreau, 2009). A subset of all logs obtained was compiled (Appendix A) and georeferenced based on parcel and location sketch information (Figure 2). Two wells serve the project parcel: Well 1 is on the project parcel and Well 3 is on a neighboring parcel to the east.

Well 1 is a productive well near the southeastern edge of the project parcel. Two other dry holes are also located on the project parcel according to Boudreau (2009). Well 1 was completed to a depth of 710 feet in 2003. At the time of completion, the well had an estimated yield of 15 gpm and had a static water level of 20 ft (Table 1). The Geologic Log from the Well Completion Report indicates that the upper 260 feet of the well is completed in strata of gray clay. At depths below 260 feet, the well intersects “Reddish Brown Rock” consistent with the underlying Sonoma Volcanics (Tsvm). This well is screened from 510 to 710 feet wholly within the rocks of the Sonoma Volcanics. Since development Well 1’s production has diminished significantly since it was drilled (as reported by the applicant), and the winery has relied on water from the water supply well parcel to the east. For approximately 10 years the project parcel winery has obtained water from Well 2 on APN 142-051-029. In the summer of 2018 Carneros Vintners Winery switched to using water from Well 3. Currently Well 1 only serves the residence located on the project parcel.

Well 2 was developed under the oversight of Jim Verhey, who owns the rights to drill on the parcel, and is located near the northeastern property line on APN 142-051-029 and as previously mentioned served as the main water source for the Carneros Vintners Winery up until the summer of 2018. Well 2 was drilled in 2004 to an initial depth of 900 ft and completed to depth of 860 ft. The geologic log reports 40 ft of clay and clay embedded with gravel of the Alluvium (Qal) followed by 200 ft of green and brown sand & gravel with clays (presumably part of the QPu unit). The remaining 660 ft of the boring intersected mostly red and black volcanic rock with some green ash interlayered. The well was constructed with three screened intervals of casing from 230 to 390 ft, 410 to 590 ft and 610 to 840 ft with each screened interval separated by 20 ft of blank casing. Water was first encountered at 100 ft but following development (which was reported to be difficult due to the large amount of water flowing into the well) the static water level was reported to be 0 ft (at the surface) with an estimated yield of 500 gpm. The artesian nature of the well indicates that the water entering the well is under pressure and is therefore emerging from a confined aquifer system. Since development, the production has been reported to be greater than initially reported, up to 800 gpm. Presently this well serves as an irrigation water source for several nearby vineyards.

Well 3 is located on APN 142-051-029 about 2,350 feet to the east of Well 1 and was also developed by Jim Verhey. According to an agreement with Mr. Verhey, beginning in 2018 rights to use water from Well 3 belong solely to the Carneros Vintners Winery and the Soils Plus rock quarry located on the adjacent parcel to the north of the project parcel (APN 142-051-041). Well 3 was drilled in 2016 to a total depth of 740 feet and completed to 715 feet. The geologic log reports 17 feet of brown and green clay with sand and gravel of the Quaternary alluvium (Qal) before penetrating over 700 feet of various types and colors of volcanic rock and ash of the Msvr unit of the Sonoma Volcanics. The reported static water level after development was 20 feet with an estimated yield of 500 gallons per minute. A permanent pumping rate of 250 gpm was selected for Well 3 following a step drawdown pumping test performed in June 2016 where the well was pumped at rates of 200, 350 and 500 gpm for three hours each. Appendix B is a memorandum authored by Richard Slade summarizing the pumping test results and well development details. During development of the well the borehole was subjected to electric log surveying by West Coast Well Logging Services (Attachment C) to further characterize the aquifer. Results of the electric log survey show four distinct zones of water bearing material starting at 300 ft and extending to the base of the well at 750 ft. It was understood based on experience with Well 2 that the lowest zone of water was under the most pressure; consequently, according to Jim Verhey, Well 3 was screened only down to 695 ft approximately 20 ft above the fourth zone of water specifically to avoid intersecting this zone (Verhey, 2019). The well is screened between 255 and 695 ft with 20 ft of blank casing between 475 and 495 ft. The depth of static water (20 ft) is significantly higher (235 ft) than the top of the screened interval indicating that the project aquifer is confined and similar to Well 2.

Well Completion Reports for five dry holes and ten other completed wells could be accurately georeferenced in the vicinity of the project parcel and project water supply parcel (Well 2, 4 – 13, Figure 2). Depths of the completed wells are typically greater than 500 ft. Well 6 is only 138 feet deep and is the outlier of this group of wells. The deepest is Well 2 which was completed to 860 feet; the average well depth is 620 feet. Yield appears to be correlated with proximity to the Rodgers Creek Fault Zone (RCFZ). A number of documented dry holes (black dots in Figure 2) are located in the area nearest the RCFZ in addition to several wells (Wells 1, 6, 7, 8 and 13) reported to have had decreased production or gone dry since development (Boudreau, 2009). Estimated yields reported at the time of development for these wells ranged between 15 and 200 gpm with an average of 65 gpm; however, the wells with the highest estimated production of 100 and 200 gpm (Well 13 and 8 respectively) have both been abandoned. The numerous dry holes and trend of declining and abandoned wells in this area suggest that faulting associated with the RCFZ has a significant impact on groundwater availability. This is likely because the faults are acting as barriers to groundwater flow. Geologic logs for the majority of these wells report layers of clay and volcanic ash and rock consistent with the mapped geology of the area.

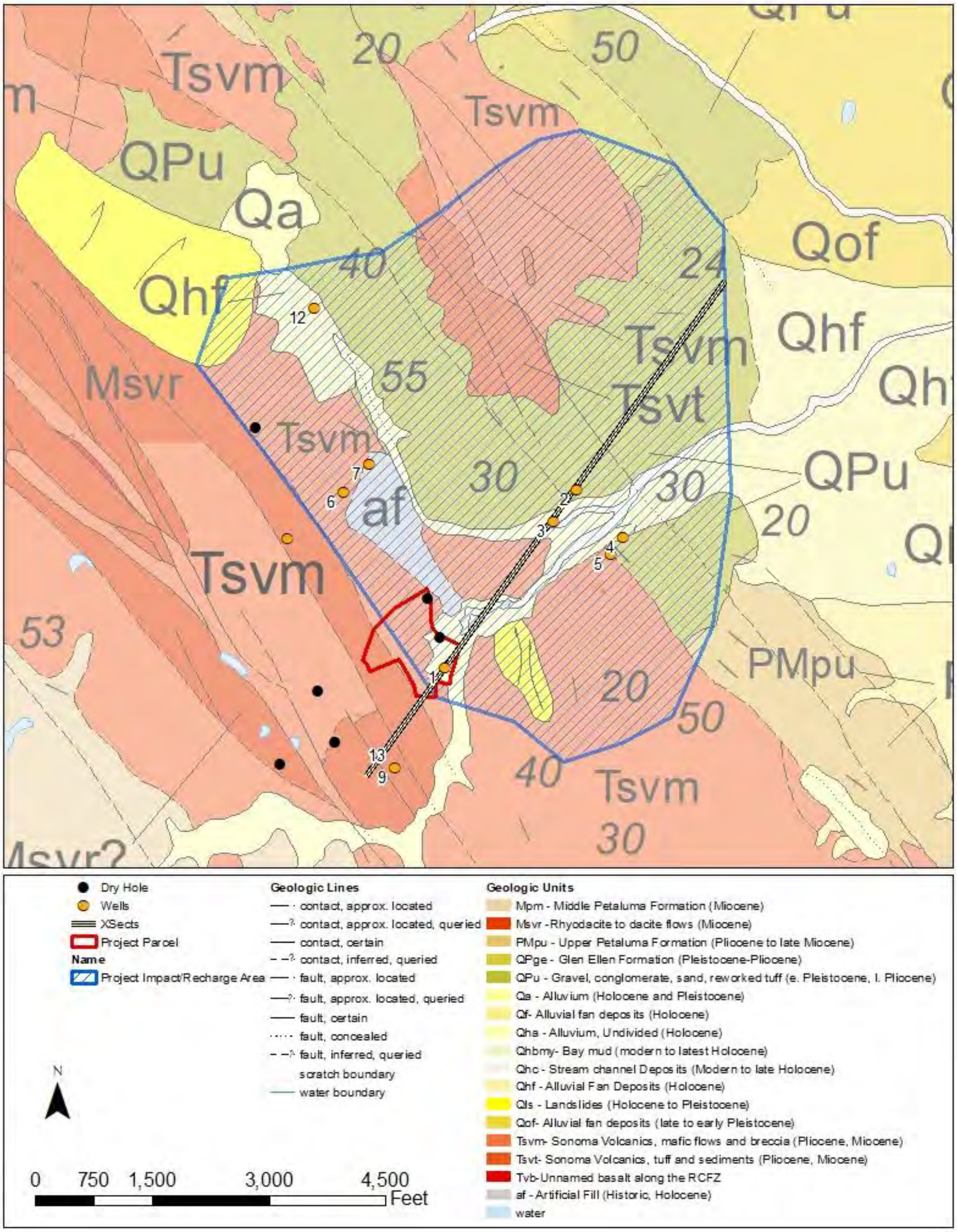


Figure 2: Surficial geology and locations of wells in the vicinity of the project parcel. Surficial geology based on data from the Geologic Map of the Napa and Bodega Bay 30' x 60' Quadrangle, California (Wagner and Gutierrez, 2017).

Wells further east of the RCFZ and closer to the project water supply well parcel (Wells 2-5) including the project water supply well are far more productive with estimated yields ranging from 300 to 500 gpm with an average of 450 gpm. These wells are all completed in the Tsvm of the Sonoma Volcanics with screened intervals extending deeper than 600 ft. All wells exhibit characteristics of a confined aquifer with two of the four reporting artesian conditions and two reporting static water levels much higher than the upper limit of screening.

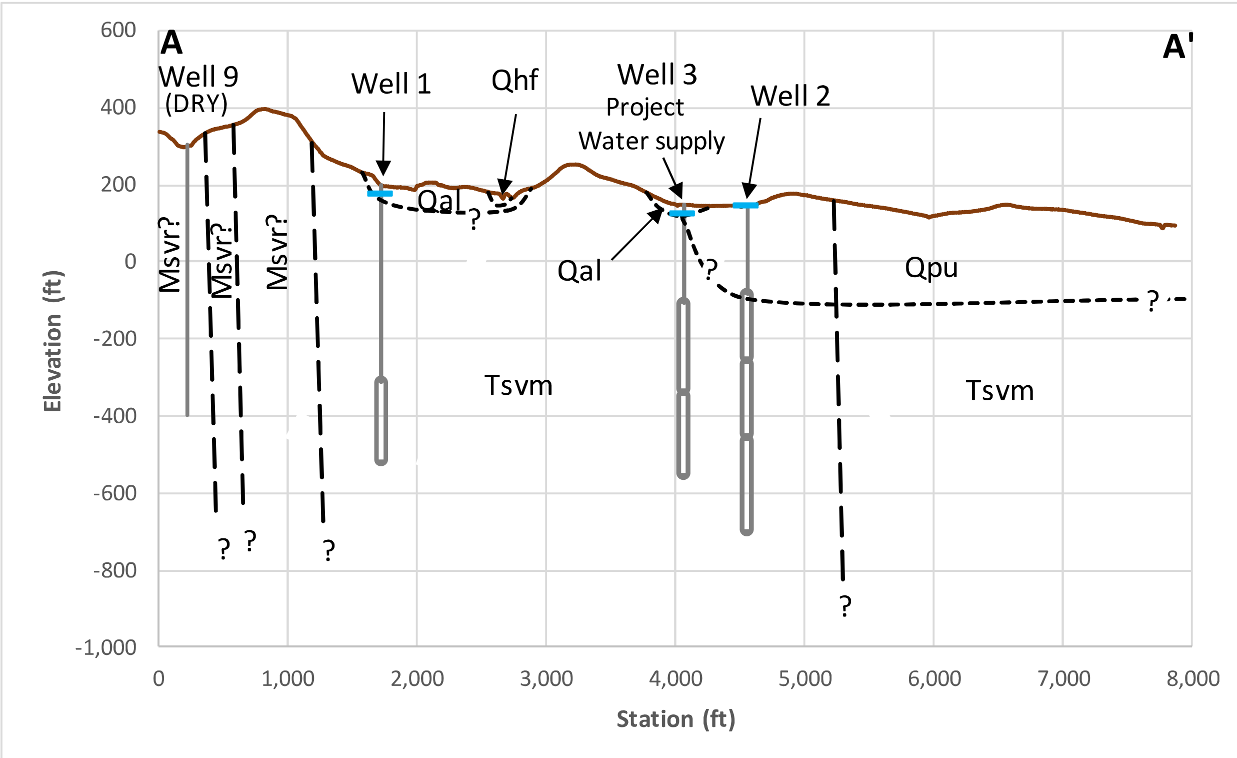
Table 1: Well completion details for wells on and near the project parcel

Well ID	1	2	3	4	5	6	7
Year Completed	2003	2004	2016	2005	2018	NA	2003
Depth (ft)	710	860	715	661	700	138	550
Estimated Yield (gpm)	15	500	500	300	500	15	18
Static Water Level (ft)	20	0	20	0	50	NA	275
Top of Screen (ft)	510	230	255	71	160	NA	210
Bottom of Screen (ft)	710	840	695	641	700	NA	520
Geologic Map Unit	Qha/Tsvm	Qpu/Tsvm	Qha/Tsvm	Qha/Tsvt	Tsvm	Tsvm	Tsvm

Well ID	8	9	10	11	12	13
Year Completed	NA	NA	1996	1998	1999	1999
Depth (ft)	510	770	520	712	700	780
Estimated Yield (gpm)	30	DRY	12	375	40	100
Static Water Level (ft)	80	NA	NA	76	28	100
Top of Screen (ft)	NA	NA	200	65	80	240
Bottom of Screen (ft)	NA	NA	520	430	400	780
Geologic Map Unit	Msvr	Msvr	Mtvr	Qhf	Qhf	Qhf

Geologic Cross-Section

A geologic cross-section oriented southwest to northeast through the project recharge area is shown in Figure 3 (see Figure 2 for location). The cross-section intersects several faults dividing members of the Sonoma Volcanics (Msvr and Tsvm) and crosses two branches of Champlin Creek. The block the project well is completed in is at least 900 feet thick and likely contains a confining layer or layers resulting in artesian or near artesian conditions in Wells 2 and 3. Due to the nature of the QPu unit its thickness is likely to be highly variable but for the purposes of this interpretation we are taking the thickness from the Geologic log for Well 2 which indicates the presence of the sand and clays associated with the unit to a depth of 240 ft. Information regarding the subsurface alignment and depth of faulting in the area is scarce and although a slight dip to the east is indicated in the cross-section faults may intersect or have a much different configuration than what is shown.



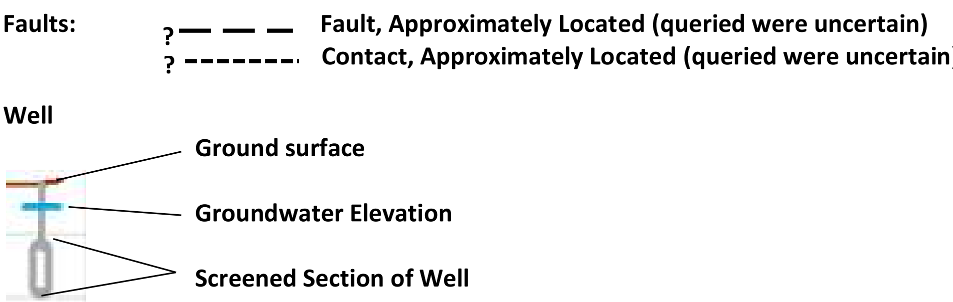


Figure 3: Hydrogeologic cross section A - A' through the vicinity of the project parcel (see Figure 2 for location).

Project Aquifer

The project impact area and estimated project recharge area is conceptualized as nearby portions of the block of the Sonoma Volcanics Formation that the project water supply well (Well 3) is completed in. Typically we are able to estimate the extent of the project aquifer however, due to the complex nature of the local geology including faulting associated with the RCFZ and confined conditions in the project well and surrounding wells, the project aquifer itself is difficult, if not impossible, to accurately delineate. In place of defining the aquifer extent we have defined a project impact area conceptualized as the potential project recharge area. The recharge area is bounded to the west by a fault contact between the Tsvm and Msvr units of the Sonoma

Volcanics while the remaining northern, southern and eastern boundaries follow surface drainage divides.

The estimated recharge area is approximately 846 acres. Although a small portion of the project recharge area is covered by a surficial layer of the gravel, conglomerate, sand and reworked tuff (map unit QPu), alluvium (Qal) and channel deposits (Qch), these do not extend to the depths the project well is screened within and so the aquifer materials are assumed to consist wholly of the rocks of the Sonoma Volcanics, mainly the Tsvm and Tsvt units. Because static water levels at the project water supply well (Well 3) are elevated above the screened interval and artesian conditions are reported at the nearby Well 2, the project aquifer is interpreted to be confined.

Groundwater Storage Volume

An estimate of the total available groundwater storage within the aquifer recharge area can be obtained as the product of the recharge area (impact area) in units of acres, the saturated aquifer thickness in units of feet, and the aquifer specific yield. This method may not be valid for confined aquifers, but it can be used for general interpretative and comparative purposes. The saturated aquifer thickness is typically estimated as the difference between the depth at which water was first encountered and the bottom of the screened interval of the project well however this information was not available and therefore the total screened interval of the well has been used instead.

The project well is screened from 255 to a depth of 695 feet yielding an estimated saturated aquifer thickness of 440 feet. This provides a minimum estimate of the saturated thickness; the Sonoma Volcanics Formation may extend to much greater depths beneath the project recharge area.

The porosity of fractured bedrock such as the Tsvm and Tsvt units of the Sonoma Volcanics is expected to lie between <1 and 10% (Freeze and Cherry, 1979; Weight and Sonderegger, 2000). To be conservative, we have used low-end estimates of specific yield of 1% for the project aquifer. This results in an estimate of the available groundwater storage of 3,722 acre-ft (846 acres x 440 feet x 0.01).

Water Demand

Within the project recharge area, water demand was estimated for both existing and proposed conditions. Water uses on the project parcel were determined using site details provided by the project applicants and from available satellite imagery. Water use rates on the project parcel were estimated using data provided by the project applicants and from wastewater data provided by Steve Martin and Associates. Water uses on other parcels in the project recharge area were determined from interviews with neighbors and available satellite imagery and water use was estimated using rates obtained from the Napa County Water Availability Analysis Guidance Document (2015).

Existing Condition

In the current condition, the project parcel contains a single primary residence, the winery facility, and four small blocks (totaling to 0.45 acres) of olive trees. Although Well 1 supplies some water to the parcel, it is unreliable and so water from Well 3 is used as the main source. Portions of vineyard shown on the west and south edges of the parcel are not managed by the project applicant; irrigation water for these is obtained from winery process wastewater stored in an on-site, off-stream reservoir and Well 2.

Well 3 supplies water to the Carneros Vintners Winery parcel (APN 142-051-031) and the Soils Plus quarry parcel (APN 142-051-041). Currently the Carneros Vintners Winery produces 250,000 cases of wine annually. According to Steve Martin and Associates (SMA) process wastewater estimates (which are assumed to be equivalent to production demand) for full production of wine requires two gallons of water per gallon of wine which results in a water demand of 1,200,000 gallons or 3.68 acre-ft (Table 4, Appendix C). The SMA report states the winery septic system is currently sized to serve 20 full-time workers and a daily maximum of five office visitors; these uses are included in the totals listed in Table 5. The current use permit lists that the winery will host tastings and events; however, the winery has not exercised their right to host any tastings or events.

The project well (Well 3) and Well 2 are on the project water supply well parcel (APN 142-051-029). Irrigation of approximately 15.8 acres of vineyard is the only water use on this parcel. Well 2 supplies all water to these vines along with an additional 85.4 acres on parcels located to the west and northwest outside of the project recharge/impact area. All vineyard areas irrigated with water from Well 2 are shown as beige polygons in Figure 4. An estimate of water demand for the irrigation of these vines was provided by the owner of the project water supply well parcel. On average for the years 2013 and 2014 the vines required 0.4 acre-ft per acre of vineyard. Applying this rate to the 101.2 acres of vines results in an estimated demand of 40.5 acre-ft annually (Table 6).

An additional 394.1 acres of vineyards (shown as light purple polygons in Figure 4) are located on seven parcels within the project recharge/impact area. Although wells were not located for every parcel, it is assumed that these vineyards are irrigated with groundwater. Assuming that the irrigation demand is similar to that of the vines located on the project water supply well parcel (0.4 acre-ft/acre), an annual irrigation demand of 157.7 acre-ft is estimated for the remaining 394.1 acres (Table 6).

Industrial use within the project impact area includes the Soils Plus quarry and the Sonoma County refuse transfer station. Water use is not expected to be large at the County transfer station; as such we defer to Boudreau (2009) who states an assumed demand for the dump of 1 acre-foot. We also will assume the dump has 10 full time employees. Soils Plus uses a significant amount of water, mostly for dust control. According to the foreman at Soils Plus, water use for dust control occurs mostly during the summer months. The two main water uses are by a water truck that sprays roads and other areas with loose sediment and the dust control system for the large rock crushing plant. The water truck holds 4,000 gallons and makes a maximum of five runs a day five days a week over the six months of the spring and summer dry season. The rock crushing plant uses a maximum of 12,000 gallons a day and runs three days a week over the six months of the spring and summer dry season. The quarry also has a maximum of nine employees working five days a week. Table 7 summarizes industrial use within the project impact area. Table 5 summarizes employee use within the project impact area.

To the south of the project site, parcel APN 142-052-022 contains a single main residence and a dairy. The total head of cattle was estimated based on available pasture located on the parcel. A rule of thumb stated by the USDA assumes a cow-calf pair requires approximately 2 acres of pasture. The parcel contains about 80 acres of herbaceous landcover according to the Sonoma County Ag and Open Space District finescale vegetation map (SCAOSD Veg map, 2015) a count of 40 milch cattle was assumed. Water use per milch cow was estimated from rates given in the Small user water report estimator (DWR, 2019) which states a daily use per cow of 30 gallons and a washout use rate of 35 gallons per day per dairy cow totaling to 65 gallons per day per cow (Table 8). A total of two full time employees are assumed to work at the dairy.

One additional primary residence was identified on parcel APN 142-052-017 just east of the dairy parcel.

Based on these uses, existing water demand within the project recharge area is estimated at 219.6 acre-ft/yr (Table 2). Of this, the majority (199.9 acre-ft/yr) comes from irrigation of vineyards on neighboring parcels. Winery, industrial, residential, livestock/dairy and employee use make up the remainder (Tables 3 – 8). Of the total use, the project parcel uses approximately 6.3 acre-ft/yr or 62% of the total.

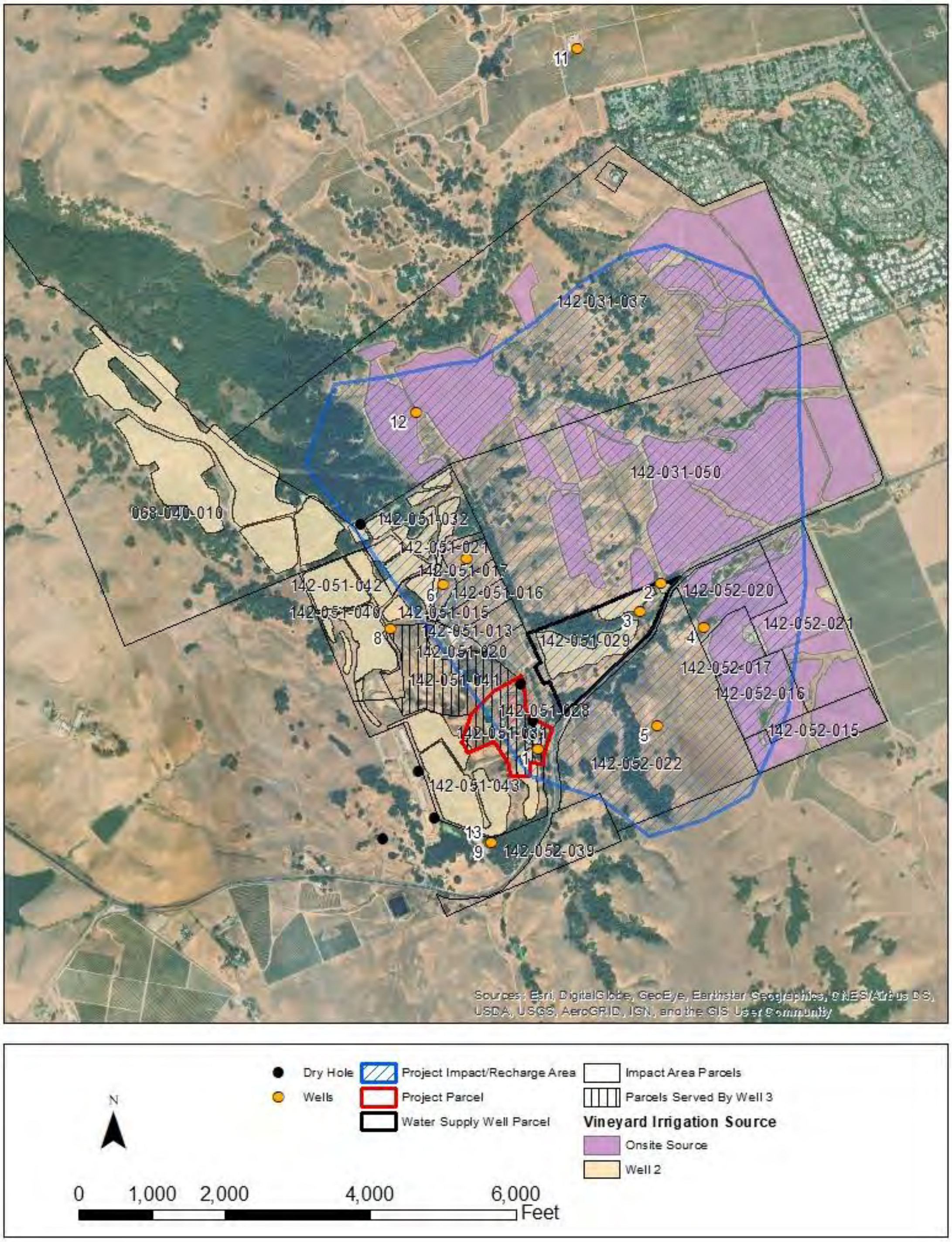


Figure 4: Satellite imagery of land uses within the project recharge area.

Table 2: Estimated existing, proposed and full buildout water demand for the project recharge area.

	Residential Use (acre-ft/yr)	Irrigation Use (acre-ft/yr)	Industrial Use (acre-ft/yr)	Livestock Use (acre-ft/yr)	Winery Use (acre-ft/yr)	Employee Use (acre-ft/yr)	Total Use (acre-ft/yr)
Existing Use	1.5	199.9	11.0	2.9	3.7	0.4	**219.5**
Proposed Use	1.5	199.9	11.0	2.9	19.2	0.4	**235.0**
Full Buildout Use	14.9	289.1	11.0	2.9	19.2	0.4	**337.5**

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

Use Category	# of Units	Use per Unit (ac-ft/yr)	Annual Water Use (ac-ft/yr)
Main Residence	3	0.50	1.50
TOTAL			**1.50**

Table 4 Estimated existing winery water use within the project recharge area.

Use Category	Count Cases	Count (gallons of wine)	PW estimate (gallons/yr)	PW estimate (acre-ft/yr)
Full Production	250,000	600,000	1,200,000	3.68
TOTAL				**3.7**

Table 5: Estimated existing and proposed employee use within the project recharge area.

Work Category	Count	Days per Year	Use per Person (gal/day)	Annual Water Use (ac-ft/yr)
Full-time Employee	41	260	15	0.49
Max Daily Office Visitors	5	260	15	0.060
TOTAL				**0.55**

Table 6: Estimated existing irrigation use within the project recharge area.

Use Category	Number of Acres	Use per Acre (ac-ft/yr)	Annual Water Use (ac-ft/yr)
Vineyard Irrigation (Well 2)	101.2	0.40	40.48
Orchard Irrigation (Well 3)	0.45	4.00	1.80
Vineyard Irrigation all other sites	394.13	0.40	157.65
TOTAL			**199.9**

Table 7: Estimated existing and proposed industrial water use within the project recharge area.

Use Category	Annual Water Use (ac-ft/yr)
Sonoma County Dump	1.00
Quarry	10.0
TOTAL	**11.0**

Table 8: Estimated existing and proposed stock water use within the project recharge area.

Use Category	Estimated Head Count*	Use per Head** (gal/day)	Annual Water Use (ac-ft/yr)
Dairy Cattle	40	65	2.9
TOTAL			**2.9**

*Assuming 40 head of milch cattle ~2 acres pasture per cow calf pair
**65 gallons per day is 30/ milch cow plus 35 washout
From: Small user water report estimator, CA DWR

Proposed Condition

In the proposed condition, the Carneros Vintner's Winery water use will increase significantly from the current annual total of 250,000 cases to 2,500,000 cases. The number of employees (20) and office visitors (five max daily) will remain the same. Table 9 summarizes the five distinct use categories and the estimated water use for each use category. Water use rates are taken from the SMA process wastewater report (Appendix C) which presents the process wastewater for each use. The increased winery production will have an estimated annual use of 19.2 acre-ft (Table 9); this is an increase of 15.5 acre-ft from the current 3.7 acre-ft total.

No other changes in demand are expected as a result of the proposed project. The project does propose the reuse of process wastewater to irrigate 30 acres of vineyard on the property adjacent to the project parcel. This reuse of the wastewater will offset the estimated irrigation demand in the project impact area by 12 acre-ft/yr reducing the irrigation water demand to 188.1 acre-ft/yr (Table 10).

Total water demand in the project recharge area is estimated to increase by 3.7 acre-ft/yr. This increase, all associated with the increased winery production, has been significantly offset from 15.5 acre-ft/yr to only 3.7 acre-ft/yr by the reuse of the process wastewater. In the proposed condition, the project parcel, will use 21.8 acre-ft/yr. This is equivalent to 6% of total use within the project recharge area.

Table 9: Estimated proposed winery water use within the project recharge area.

Use Category	Count Cases	Count (gallons of wine)	PW estimate (gallons/yr)	PW estimate (acre-ft/yr)
Full Production	55,000	132,000	264,000	0.81
Crush and Bulk Haul Offsite	289,000	693,600	693,600	2.13
Crush, Ferment Bulk haul offsite	1,056,000	2,534,400	3,801,600	11.67
Lees Wine	300,000	720,000	1,260,000	3.87
Bottling	800,000	-	240,000	0.74
TOTAL				**19.2**

Table 10: Estimated proposed irrigation water use within the project recharge area.

Use Category	Number of Acres	Use per Acre (ac-ft/yr)	Annual Water Use (ac-ft/yr)
Vineyard Irrigation	495.78	0.40	198.31
Orchard Irrigation	0.45	4.00	1.80
Process Wastewater used as irrigation	30	0.4	12.00
TOTAL			**188.1**

Full Build-Out Condition

The full build-out condition reflects the full development of parcels consistent with their current zoning. Uses in the full build-out condition were estimated using the following assumptions:

- All parcels will have primary dwellings and half will have secondary dwellings
- For parcels with existing vineyards, orchards, or other established agricultural uses, 50% of open land was considered to be developed. Open land was considered to be areas classified as non-riparian shrubs or as herbaceous by Vegetation and Habitat Map Key accompanying the Sonoma County Fine Scale Vegetation Map (SCAOSD, 2015). Limitations on maximum slope, riparian setbacks, and feasibility were not considered (except as noted below).
- Parcels without vineyard, orchard, or other established agricultural uses were not considered to have agriculture in the future
- Subdivisions and other discretionary projects were not considered

Additionally, the future build-out was only analyzed for parcels where development or wells would be within the project recharge area. If only a small portion of a parcel was included within the project recharge area or if all portions of a parcel within the project recharge area have prohibitively steep slopes, potential development on a parcel was not included.

Of the 24 parcels which would use water from the project recharge area, three have existing primary residences (the project parcel has one); 19 would be added to reach a full build-out total of 22. Two of the 24 parcels were not given main residences because they were associated with the Soils Plus quarry at APN 142-051-041 and the County transfer station at APN 142-051-020. Assuming that half of the 22 parcels will have secondary residences in the full build-out condition yields a total of 11 secondary residences in the full build-out condition.

The parcels within the project recharge area with existing vineyard (including those irrigated with water from Well 2) contain a total of 445 acres of land designated as herbaceous in addition to the vineyard areas. Applying the assumption that half of this area would be developed into additional vineyard would add 222.5 acres of vines for a full buildout total of 718.8 acres of vines which would require an annual total of 287.5 acre-ft of irrigation. Including the demand of the existing 0.45 acres of orchard (1.8 acre-ft) and applying the offset for the 30 acres irrigated by process wastewater (12 acre-ft) brings the total full buildout irrigation demand to 277.3 acre-ft.

Based on these developments, water use in the full-build out condition is estimated to be as high as 325.7 acre-ft/yr (Table 2.) This increase comes from additional residences, and an increase in vineyard acreage (Tables 12 and 13).

Table 12: Estimated full build-out residential water use within the project recharge area.

Use Category	# of Units	Use per Unit (ac-ft/yr)	Annual Water Use (ac-ft/yr)
Main Residence	22	0.50	11.00
Secondary Residences	11	0.35	3.85
TOTAL			**14.85**

Table 13: Estimated full build-out irrigation water use within the project recharge area.

Use Category	Number of Acres	Use per Acre (ac-ft/yr)	Annual Water Use (ac-ft/yr)
Vineyard Irrigation	718.8	0.40	287.5
Orchard Irrigation Well 2	0.45	4.00	1.80
Process Wastewater used as irrigation	30	0.4	12.0
TOTAL			**277.3**

Groundwater Recharge Analysis

Groundwater recharge within the project recharge area was estimated using a Soil Water Balance (SWB) model developed for Sonoma County and portions of Marin County. The SWB model was developed by the U.S. Geological Survey (Westenbroek at al., 2010) 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 D.

Groundwater recharge was simulated for Water Year 2010 which was selected as precipitation was close to the 30-year average for much of Sonoma County. During the simulated water year, precipitation averaged 26.4 inches across the project recharge area and actual evapotranspiration (AET) averaged 18.7 inches. Groundwater recharge varied across the project recharge area from 0 to 18.1 inches with a spatially averaged recharge of 4.9 inches (Table 14).

Groundwater recharge estimates can also be expressed as a total volume by multiplying the calculated recharge by the project aquifer impact/recharge area of 846.5 acres. This calculation yields an estimated mean annual recharge of 345.6 acre-ft/yr.

Water budget estimates are available for several larger watershed areas nearby including the Santa Rosa Plain, the Green Valley Creek watershed, and the Sonoma Valley. Comparisons to these water budgets are useful for determining the overall reasonableness of the results although one would not expect precise agreement owing to significant variations in climate, land cover, soil types, and underlying hydrogeologic conditions. These regional analyses estimated that mean annual recharge was equivalent to between 7% and 28% of mean annual precipitation (Farrar et. al., 2006; Flint and Flint 2014, Kobor and O'Connor, 2016; Woolfenden and Hevesi, 2014). The simulated water year 2010 groundwater recharge for the project recharge area represents approximately 19% (Table 14) of the precipitation, within the range of these regional estimates.

Table 14: Summary of water balance results from the SWB model for Water Year 2010.

	2010 Normal Year	
	inches	% of precip
Precipitation	26.4	-
AET	18.7	71%
Runoff	2.8	11%
Recharge	4.9	19%

Comparison of Water Demand and Groundwater Recharge

The total proposed groundwater use for the project recharge area is estimated to be 223.3 acre-ft/yr, 21.8 acre-ft/yr of which is for the project parcel. Groundwater use in the project recharge area is equivalent to 65% of the estimated mean annual groundwater recharge of 345.6 acre-ft/yr, indicating that there is a surplus of groundwater resources (Table 15). Given the magnitude of the surpluses, the proposed project is unlikely to result in significant reductions in groundwater levels or depletion of groundwater resources over time.

Table 15: Comparison of estimated water use and mean annual recharge within the project recharge area

		Average Water Year (2010)		
Scenario	Total Proposed Demand (ac-ft/yr)	Recharge (ac-ft/yr)	Recharge Surplus (ac-ft/yr)	Demand as % of Recharge
Proposed	223.3	345.6	122.3	65%
Full Buildout	325.8	345.6	19.8	94%

Potential Impacts to Streams and Neighboring Wells

The project well (Well 3) is in the valley adjacent to Champlin Creek. The creek is located approximately 75 feet to the south and less than 1 ft lower in elevation. The project well is screened from 255 ft to 475 ft and from 495 ft to 695 ft these intervals are located at a significant depth such that given the substantial vertical separation and confined nature of the aquifer, increased pumping from the project well is unlikely to have negative impacts on this stream.

The nearest neighboring well (Well 2) is located approximately 500 feet northeast of the project well and screened from 230 ft to 390 ft, 410 ft to 590 ft and from 610 ft to 840 ft. Although these elevations do overlap with a large portion of the screened intervals of the project well, it has been reported that the lowest section of the aquifer intersected by Well 2 which is not intersected by the Project well (Well 3) has the greatest production and is the primary layer causing the artesian conditions at the well. Due to the pressurized nature of this groundwater development of the well was difficult for the driller. This highly productive layer was identified in the e-log survey of the project well beginning at a depth of 700 ft and to avoid development difficulties, the lowest water-bearing stratum was left unscreened. This configuration is likely to reduce potential well interference between Wells 2 and 3.

The next nearest wells located with certainty are Wells 4 and 5 which are located approximately 915 ft and 840 ft respectively to the southeast and of the project well. Given the substantial horizontal separation, increased pumping from the project well is unlikely to have significant negative impacts at these locations.

Summary

Application of the Soil Water Balance (SWB) model to the project recharge area revealed that average water year recharge was approximately 4.9 inches/yr or 345.6 acre-ft/yr. The total proposed water use for the project aquifer recharge area is estimated to be 223.3 acre-ft/yr. This represents 65% of the estimated mean annual recharge within the project impact area, suggesting that the project is unlikely to result in cause a gross imbalance between recharge and groundwater utilization.

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APPENDIX A

WELL COMPLETION REPORTS

NO REPORTS FOR WELLS 6, 8 OR 9

WELL 1

ORIGINAL
File with DWR

Page 1 of 1

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. E005762

DWR USE ONLY — DO NOT FILL IN
05W06W27
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

Owner's Well No. Well No. 3

Date Work Began 2/4/2003, Ended 6/11/2003

Local Permit Agency County of Sonoma

Permit No. WEL03-0169 Permit Date 12/24/2002

GEOLOGIC LOG

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

DRILLING METHOD ROTARY FLUID Bentonite

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain, size, color, etc.
0	20	Top Soil
20	30	Olive Gray Clay
30	100	Gray Clay
100	200	Gray Clay/Gravel
200	230	Rock w/Some Clay
230	240	Gray Clay
240	260	Hard Gray Clay
260	320	Reddish Brown Rock
320	340	Reddish Brown Rock w/Silt
340	460	Reddish Brown Rock
460	490	Olive Gray Clay w/Reddish Brown Rock
490	710	Reddish Brown Rock

TOTAL DEPTH OF BORING 720 (Feet)

TOTAL DEPTH OF COMPLETED WELL 710 (Feet)

WELL LOCATION

Address 4200 Stage Gulch Rd.

City Petaluma, CA CA 94559

County Sonoma

APN Book 142 Page 051 Parcel 019

Township ___ Range ___ Section ___

Latitude ___ DEG. MIN. SEC. Longitude ___ DEG. MIN. SEC.

LOCATION SKETCH

NORTH

WEST

EAST

SOUTH

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

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR
— Deepen
— Other (Specify)

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

PLANNED USES (✓)

WATER SUPPLY
— Domestic — Public
✓ Irrigation — Industrial

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

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 4 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 20 (Ft.) & DATE MEASURED 7/1/2003

ESTIMATED YIELD * 15 (GPM) & TEST TYPE Pump

TEST LENGTH 24 (Hrs.) TOTAL DRAWDOWN 574.3 (Ft.)

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

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
+2	510	15	✓				PVC	8	.25	
510	710	15		✓			PVC	8	.25	.050

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	120	✓			
120	710				GRAVEL

ATTACHMENTS (✓)

— Geologic Log
— Well Construction Diagram
— Geophysical Log(s)
— Soil/Water Chemical Analysis
✓ Other Map

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.

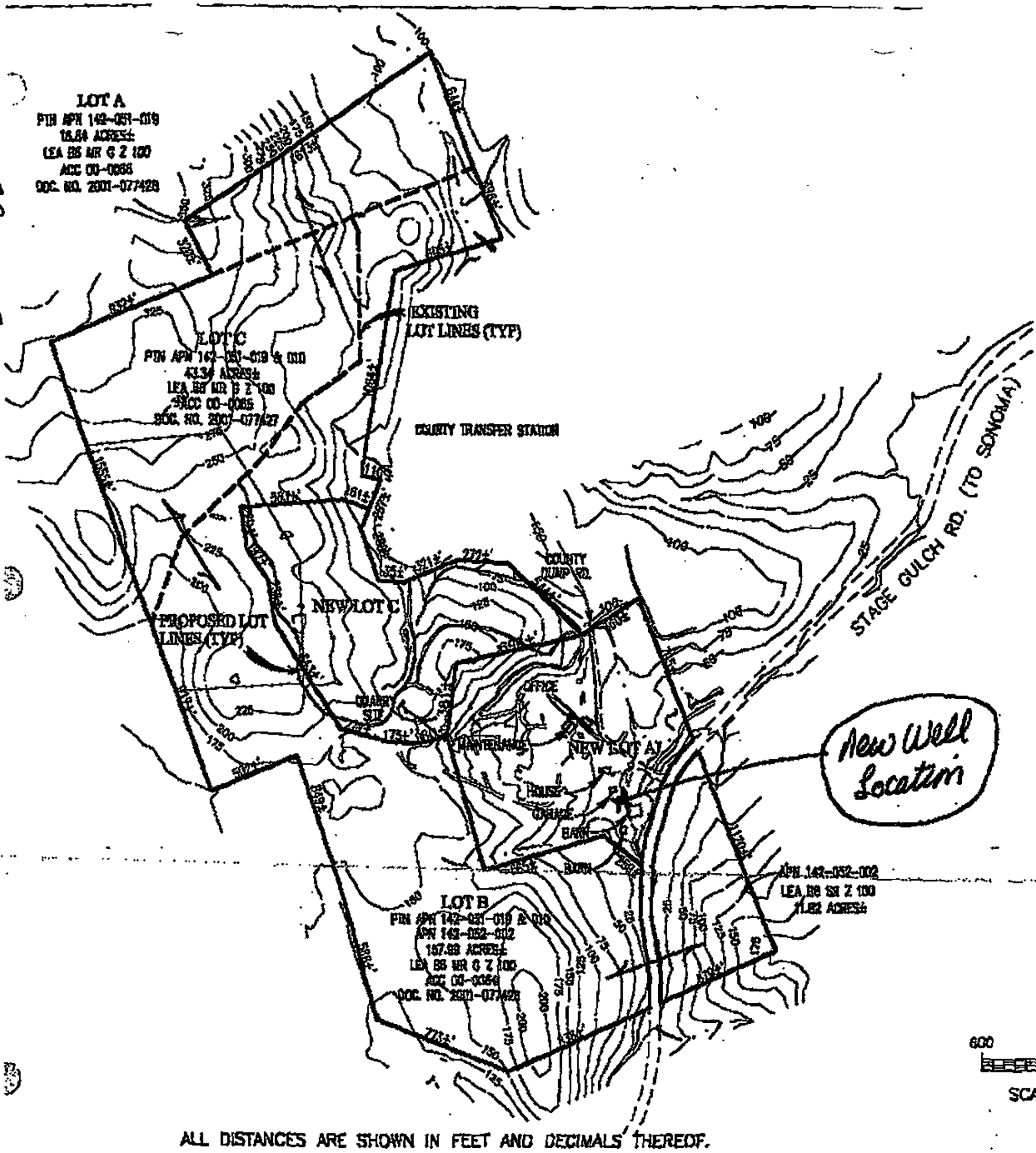
NAME WDC Exploration & Wells
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

9580 County Road 93B — Zamora — CA — 95698
ADDRESS — CITY — STATE — ZIP

Signed ___ WELL DRILLER/AUTHORIZED REPRESENTATIVE — 07/23/03 DATE SIGNED — 283326 C-57 LICENSE NUMBER

DWR 188 REV. 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM



PROPOSED PARCELS:

LOT "A"

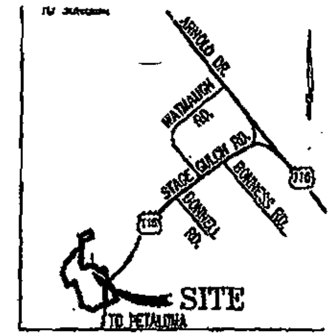
APN: ptn 142-051-019 DOC. NO.: 2001-077428
EXISTING PARCEL SIZE: 18.84 AC. ±
PROPOSED FINAL PARCEL SIZE: 26.93 AC. ±
OWNER: UCC VINEYARD FUND, LLC
1778 2ND ST.
NAPA, CA 94559-2408
PHONE # (707) 252-9200
ADDRESS: 4500 W. WAIMAUGH ROAD
PETALUMA, CA
ALL DISTANCES ARE SHOWN IN FEET AND DECIMALS THEREOF.

LOT "B"

APN: 142-052-002; PTN APN'S 142-051-019&019 DOC. NO.: 2001-077426
EXISTING PARCEL SIZE: 169.51 AC. ±
PROPOSED FINAL PARCEL SIZE: 173.47 AC. ±
OWNER: UCC VINEYARD FUND, LLC
1778 2ND ST.
NAPA, CA 94559-2408
PHONE # (707) 252-9200
ADDRESS: 4500 W. WAIMAUGH ROAD
PETALUMA, CA

LOT "C"

APN: PTN APN'S 142-051-018&019 DOC. NO.: 2001-077427
EXISTING PARCEL SIZE: 43.34 AC. ±
PROPOSED FINAL PARCEL SIZE: 27.59 AC. ±
OWNER: UCC VINEYARD FUND, LLC
1778 2ND ST.
NAPA, CA 94559-2408
PHONE # (707) 252-9200
ADDRESS: 4500 W. WAIMAUGH ROAD
PETALUMA, CA



VICINITY MAP
N.T.S.

N

600 0 600
SCALE : 1" = 600'

REGISTERED PROFESSIONAL ENGINEER
JOE A. STORY
No. C026731
Exp 3-31-03
CIVIL
STATE OF CALIFORNIA

JOE STORY, R.C.E. 26731
EXP. 3/31/03

LOT LINE ADJUSTMENT
SITE MAP

FOR A
PROPOSED LOT LINE ADJUSTMENT BETWEEN THE LANDS OF
UCC VINEYARD FUND, LLC

LOCATED IN PETALUMA RANCHO, T5N, R7W, M.D.M.

COUNTY OF SONOMA · STATE OF CALIFORNIA
SCALE: 1" = 600' FEBRUARY, 2002

CURTIS & ASSOCIATES, INC.
803 HEALDSBURG AVE. · HEALDSBURG, CA. 95448 · (707)433-...
APN 142-051-010, 019; 142-052-002 SHEET 1 OF 1

01082LLA8A.dwg 10-03-02 9:35:37 am

WELL 2

ORIGINAL
File with DWR
Page 1 of 2

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet
No. e015178

DWR USE ONLY — DO NOT FILL IN
05N06W27
STATE WELL NO./ STATION NO.
LATITUDE | LONGITUDE
APN/TRS/OTHER

Owner's Well No. Well #1-'04
Date Work Began 7/1/2004, Ended 8/9/2004
Local Permit Agency Sonoma County Environmental Mg
Permit No. WEL04-0338 Permit Date 6/30/2004

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD ROTARY FLUID BENTONITE

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	10	DARK BROWN CLAY
10	40	BROWN CLAY WITH EMBEDDED GRAVEL
40	140	GREEN SAND, GRAVEL WITH CLAY
140	160	BROWN SAND, GRAVEL
160	180	GREEN SANDY CLAY
180	200	GREEN CLAY
200	240	SAND & GRAVEL
240	250	VOLCANIC MIX
250	290	RED VOLCANICS
290	330	BLACK VOLCANICS WITH ASH STRINGERS
330	420	BLACK VOLCANICS
420	445	BLACK & RED VOLCANICS
445	495	BLACK VOLCANICS
495	520	BLACK & RED VOLCANICS
520	550	BLACK VOLCANICS
550	580	BLACK & RED VOLCANICS
580	620	BLACK VOLCANICS
620	630	RED ASHEY VOLCANICS
630	640	BLACK VOLCANICS
640	655	GREEN ASHEY VOLCANICS
655	750	HARD BLACK VOLCANICS
750	760	SOFTER BLACK & RED VOLCANICS
760	870	HARD BLACK VOLCANICS
870	900	GREEN ASHEY CLAY
		CONT. CASING LAYOUT
610	840	SCREEN STEEL 10" .050 LOUVER
840	860	BLANK STEEL 10" .250 WALL

TOTAL DEPTH OF BORING 900 (Feet)
TOTAL DEPTH OF COMPLETED WELL 860 (Feet)

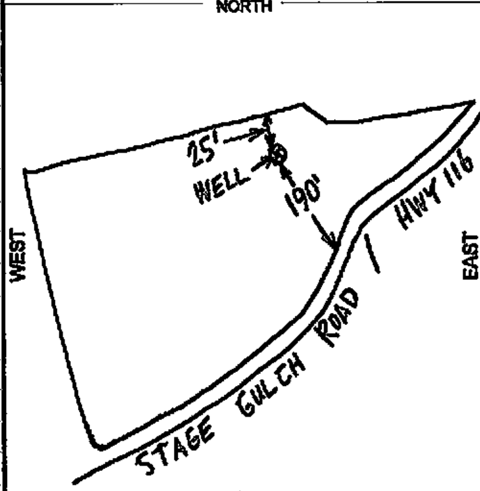
WELL OWNER

WELL LOCATION

Address 4270 Stage Gulch Road
City Sonoma CA
County SONOMA
APN Book 142 Page 051 Parcel 002
Township ___ Range ___ Section ___
Latitude ___ DEG. MIN. SEC. Longitude ___ DEG. MIN. SEC.

LOCATION SKETCH

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 & COMPLETE.**

ACTIVITY (✓)

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

PLANNED USES (✓)

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

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 100 (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL 0 (Ft.) & DATE MEASURED 8/9/2004
ESTIMATED YIELD * 500 (GPM) & TEST TYPE AIR LIFT
TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN N/A (Ft.)
May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	880	18								
0	230		✓				STEEL	10	.250	
230	390			✓			STEEL	10	.250	.050
390	410		✓				STEEL	10	.250	
410	590			✓			STEEL	10	.250	.050
590	610		✓				STEEL	10	.250	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	75	✓			CONCRETE
75	860			✓	#6 SAND
860	900			✓	CUTTINGS

ATTACHMENTS (✓)

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

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME HUCKFELDT WELL DRILLING
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
2110 Penny Lane, Napa, CA 94559
ADDRESS CITY STATE ZIP
Signed [signature] WELL DRILLER/AUTHORIZED REPRESENTATIVE
08/12/04 DATE SIGNED
439-746 C-57 LICENSE NUMBER

DWR 188 REV. 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

R: 08/09/16

WELL 3

ORIGINAL
File with DWR

Page 1 of 1

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. e0314657

DWR USE ONLY — DO NOT FILL IN
05N06W27
STATE WELL NO./STATION NO.
381452N 1223004W
LATITUDE / LONGITUDE
APN/TRS/OTHER

Owner's Well No. 1-2016

Date Work Began 5/3/2016, Ended 5/31/2016

Local Permit Agency Sonoma County PRMD

Permit No. WEL15-0224 Permit Date 8/6/2015

GEOLOGIC LOG

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

DRILLING METHOD ROTARY FLUID BENTONITE

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain, size, color, etc.*
0	10	BROWN CLAY
10	17	GREEN CLAY WITH SAND & GRAVEL
17	30	BROWN VOLCANIC ROCK
30	145	BLACK VOLCANIC ROCK
145	170	BLACK, GREEN, BROWN, RED VOLCANICS
170	251	BLACK, GREEN VOLCANICS
251	259	GREEN VOLCANIC ASH
259	300	BLACK VOLCANIC ROCK
300	305	MIXED VOLCANICS
305	337	BLACK VOLCANIC ROCK
337	345	MIXED VOLCANICS
345	410	BLACK, BROWN VOLCANICS
410	482	HARD BLACK VOLCANICS
482	494	MIXED VOLCANICS
494	500	GREEN VOLCANIC ASH
500	538	SANDY GREEN ASH
538	545	GRAY VOLCANIC SANDS
545	690	HARD GRAY VOLCANIC ROCK
690	700	BROWN VOLCANIC ROCK
700	713	HARD DARK GRAY VOLCANIC ROCK
713	717	BROWN VOLCANIC ROCK
717	730	GREEN VOLCANIC ASH
730	734	GRAY, BROWN VOLCANICS
734	740	GRAY VOLCANIC ROCK
		CONTINUED CASING LAYOUT
495	695	SCREEN PVC 10" SDR-17 .032 SLOT
695	715	BLANK PVC 10" SDR-17

TOTAL DEPTH OF BORING 740 (Feet)

TOTAL DEPTH OF COMPLETED WELL 715 (Feet)

WELL OWNER

WELL LOCATION

Address 4270 Stage Gulch Road

City Sonoma CA

County SONOMA

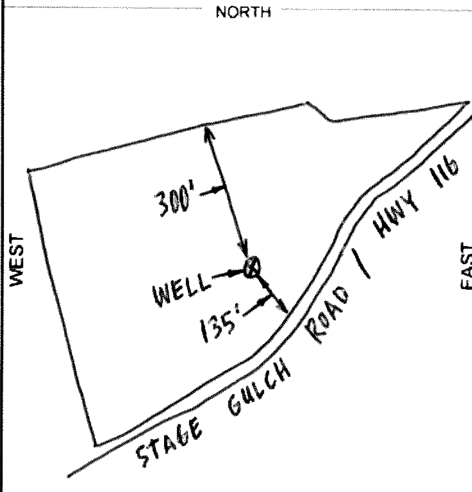
APN Book 142 Page 051 Parcel 029

Township ___ Range ___ Section ___

Latitude ___ DEG. MIN. SEC. Longitude ___ DEG. MIN. SEC.

LOCATION SKETCH

NORTH



WEST EAST SOUTH

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

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR
- ___ Deepen
- ___ Other (Specify)

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

PLANNED USES (✓)

WATER SUPPLY
- ___ Domestic ___ Public
- ✓ Irrigation ___ Industrial

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

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER N/A (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 20 (Ft.) & DATE MEASURED 5/31/2016

ESTIMATED YIELD * 500 (GPM) & TEST TYPE AIR LIFT

TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN N/A (Ft.)

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

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	60	18								
60	740	15								
0	255		✓				PVC F480	10	SDR-17	
255	475			✓			PVC F480	10	SDR-17	.032
475	495		✓				PVC F480	10	SDR-17	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	60	✓			10 SK SAND
60	110		✓		TABLETS
110	715			✓	#6 SAND

ATTACHMENTS (✓)

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

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

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

NAME HUCKFELDT WELL DRILLING, INC.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

2110 Penny Lane — Napa — CA — 94559
ADDRESS — CITY — STATE — ZIP

Signed [signature] WELL DRILLER/AUTHORIZED REPRESENTATIVE — 07/07/16 DATE SIGNED — 439-746 C-57 LICENSE NUMBER

DWR 188 REV. 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

NW-1

WELL 4

ORIGINAL
File with DWR
Page 1 of 1

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet
No. e025620

DWR USE ONLY — DO NOT FILL IN
05N06W26
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

Owner's Well No. Lot 4
Date Work Began 7/1/2005 Ended 7/22/2005
Local Permit Agency Sonoma Co. Environmental Mgmt
Permit No. WEL05-0315 Permit Date 7/1/2005

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD ROTARY FLUID BENTONITE

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain, size, color, etc.*
0	5	BROWN CLAY
5	55	TAN CLAY
55	100	VOLCANIC MIX
100	320	GREEN SANDY CLAY
320	340	VOLCANIC MIX
340	420	RED VOLCANICS
420	490	BLACK VOLCANICS
490	605	HARD BLACK VOLCANICS
605	635	RED VOLCANICS
635	680	BLACK & GREEN VOLCANICS
		CONTINUED CASING LAYOUT
541	641	SCREEN PVC 6" .032 SLOT
641	661	BLANK PVC 6"

TOTAL DEPTH OF BORING 680 (Feet)
TOTAL DEPTH OF COMPLETED WELL 661 (Feet)

WELL OWNER

142-052-020 = APN

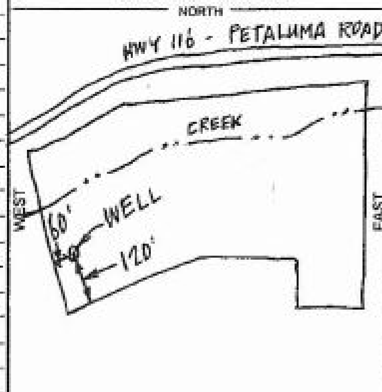
CITY STATE ZIP

WELL LOCATION

Address 5045 Stage Gulch Road
City Sonoma CA
County Sonoma 002 009
APN Book 142 Page 052 Parcel 007
Township ___ Range ___ Section ___
Latitude ___ DEG. MIN. SEC. Longitude ___ DEG. MIN. SEC.

LOCATION SKETCH

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 & COMPLETE.

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

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

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 65 (Ft.) BELOW SURFACE 1
DEPTH OF STATIC WATER LEVEL 0 (Ft.) & DATE MEASURED 7/22/2005
ESTIMATED YIELD * 300 (GPM) & TEST TYPE AIR LIFT
TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN N/A (Ft.)
** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	680	12								
0	71		✓				PVC F480	6	SDR-21	
71	101			✓			PVC F480	6	SDR-21	.032
101	321		✓				PVC F480	6	SDR-21	
321	521			✓			PVC F480	6	SDR-21	.032
521	541		✓				PVC F480	6	SDR-21	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	51	✓			CONCRETE
51	661			✓	#6 SAND

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

CERTIFICATION STATEMENT
I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME HUCKFELDT WELL DRILLING, INC.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
2110 Penny Lane Napa CA 94559
ADDRESS CITY STATE ZIP
Signed [signature] 07/27/05 439-746
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

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

State of California

Well Completion Report

Form DWR 188 Auto-Completed 7/23/2018
WCR2018-003998

Owner's Well Number: 10109 | Date Work Began: 04/26/2018 | Date Work Ended: 05/17/2018

Local Permit Agency: Sonoma County Permit & Resource Management Department

Secondary Permit Agency: | Permit Number: WEL17-0246 | Permit Date: 02/22/2018

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

Name: XXXXXXXXXXXXXXXXXXXX

Mailing Address: XXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXX

City: XXXXXXXXXXXXXXXXXXXX | State: XX | Zip: XXXXX

Planned Use and Activity

Activity: New Well

Planned Use: Water Supply Irrigation - Agriculture

Well Location

Address: 4653 STAGE GULCH RD

City: SONOMA | Zip: 95476 | County: Sonoma

Latitude: 38 Deg. 14 Min. 45.83 Sec. N | Longitude: -122 Deg. 29 Min. 56.66 Sec. W

Dec. Lat.: | Dec. Long.:

Vertical Datum: | Horizontal Datum: WGS84

Location Accuracy: | Location Determination Method:

APN: 142-052-022

Township:

Range:

Section:

Baseline Meridian:

Ground Surface Elevation:

Elevation Accuracy:

Elevation Determination Method:

Borehole Information

Orientation: Vertical | Specify:

Drilling Method: Direct Rotary | Drilling Fluid: Bentonite

Total Depth of Boring: 700 Feet

Total Depth of Completed Well: 700 Feet

Water Level and Yield of Completed Well

Depth to first water: (Feet below surface)

Depth to Static Water Level: 50 (Feet) | Date Measured: 05/17/2018

Estimated Yield*: 500 (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	1	TOP SOIL
1	2	BROWN CLAY
2	50	HARD BROWN VOLCANIC ROCK
50	375	BASALT
375	385	BASALT WITH RED VOLCANIC ROCK
385	450	BLUE/BROWN VOLCANIC ROCK WITH WITH SOME RED ROCK
450	580	BASALT WITH SOME BLUE ASH
580	618	BASALT WITH MORE BLUE CLAY
618	660	BASALT
660	700	BLUE CLAY WITH BLACK VOLCANIC ROCK

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	160	Blank	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625			
1	160	360	Screen	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625	Milled Slots	32	.032
1	360	380	Blank	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625			
1	380	480	Screen	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625	Milled Slots	32	.032
1	480	520	Blank	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625			
1	520	580	Screen	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625	Milled Slots	32	.032
1	580	620	Blank	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625			
1	620	700	Screen	PVC	OD: 8.625 in. | SDR: 17 | Thickness: 0.508 in.	0.508	8.625	Milled Slots	32	.032

Annular Material

Depth from Surface Feet to Feet		Fill	Fill Type Details	Filter Pack Size	Description
0	25	Bentonite	High Solids		
25	700	Other Fill	See description.		#6 SAND, 18 YDS.

Other Observations:
RECOMMENDED PUMP SETTING: 360' FOR 400 GPM
WATER WELL DRILLER: SCOT UNTERSEHER

Borehole Specifications

Depth from Surface Feet to Feet		Borehole Diameter (inches)
0	700	15

Certification Statement

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

Name: FISCH BROS DRILLING
Person, Firm or Corporation

5001 GRAVENSTEIN HWY N	SEBASTOPOL	CA	95472
Address	City	State	Zip

Signed

electronic signature received	05/18/2018	399226
C-57 Licensed Water Well Contractor	Date Signed	C-57 License Number

Attachments

STAGE GULCH ROAD 4653.jpg - Location Map

DWR Use Only

CSG #	State Well Number	Site Code	Local Well Number

N W

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

TRS:

APN:

ORIGINAL
File with DWR

Page 1 of 3

Owner's Well No.

Date Work Began 2/1/03, Ended 3/10/03

Local Permit Agency Sonoma Enviro. Health

Permit No. WEL02-0682 Permit Date 12-24-02

WELL 7

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 802189

DWR USE ONLY — DO NOT FILL IN

05N06W27

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

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

DRILLING METHOD Air Rotary FLUID N/A

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain size, color, etc.
0	10	Top soil
10	18	Black Basalt
18	40	yellow Ben silt
40	90	Gray silt
90	135	Gray tuff w/ Basalt chips
135	140	silt
140	200	Gray Black tuff
200	248	Brown & Gray clay
248	270	Red & Brown silty clay
270	280	Green dry silt
280	370	Tuff w/ Basalt Layers *
370	380	Green clay
380	400	Basalt
400	420	Gray clay to Tuff
420	430	Blue-green siltstone
430	462	Gray silty clay
462	490	Green clay
490	520	Gray clay w/ Sd. Stengers.
520	600	Red Brown clay - Petaluma
600	660	Silty clay - Red-Brown

* First Water

TOTAL DEPTH OF BORING 660 (Feet)

TOTAL DEPTH OF COMPLETED WELL 550 (Feet)

WELL OWNER

WELL LOCATION

Address 4200 Stage Gulch Rd.

City Petaluma

County Sonoma

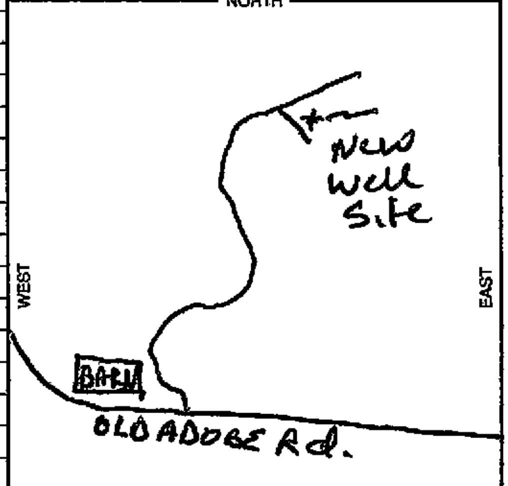
APN Book 142 Page 051 Parcel 019

Township ___ Range ___ Section ___

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

LOCATION SKETCH

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 & COMPLETE.

ACTIVITY (✓)

X NEW WELL

MODIFICATION/REPAIR

___ Deepen

___ Other (Specify)

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

PLANNED USES (✓)

WATER SUPPLY

___ Domestic ___ Public

X 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 280 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 275 (Ft.) & DATE MEASURED 4/3/03

ESTIMATED YIELD * 18 (GPM) & TEST TYPE Pump Test

TEST LENGTH 24 (Hrs.) TOTAL DRAWDOWN 436 (Ft.)

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

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
+2	210	15	✓				PVC	8	250	
210	370			✓					PSI	.040
370	390		✓							
390	520			✓						.040
520	540		✓							

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	50'	✓			
50	550			✓	SRI Sd. 8x20

ATTACHMENTS (✓)

X 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 WDC Exploration & Wells

(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

PO Box 141 Zamora Ca 95698

ADDRESS CITY STATE ZIP

Signed Tim Parks 3/28/03 283326

WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

802/189

WELL 7

Well Site #3

UCC Vaiyds

160 Dark gray WELDED TUFF w/ some white TUFF hard; pieces, 1/16 - 1/8" ø
← clayey @ 165'

180

200 Red-brown WELDED TUFF and tuff MIXTURE
brown clay @ 205'
pred. dark gray below 210'
90% gravel fragments of welded tuff.

220

– gravel to 1/2" ø @ 230'
– minor clay
multi-colored fragments

240

Red-brown SILTY CLAY

260 Gray WELDED TUFF

Olive green SILT, dry (like powder)

280 Dark Gray Black WELDED TUFF
silty 275' – 280'
(like basalt flow)

300

460

Olive-green CLAY w/ minor rd. sand grains 1/16" ø

480

– becoming brown-gray
← 1 gpm

500 Gray CLAY w/ minor rd sand grains Petaluma Fm?

– red brown

520

540

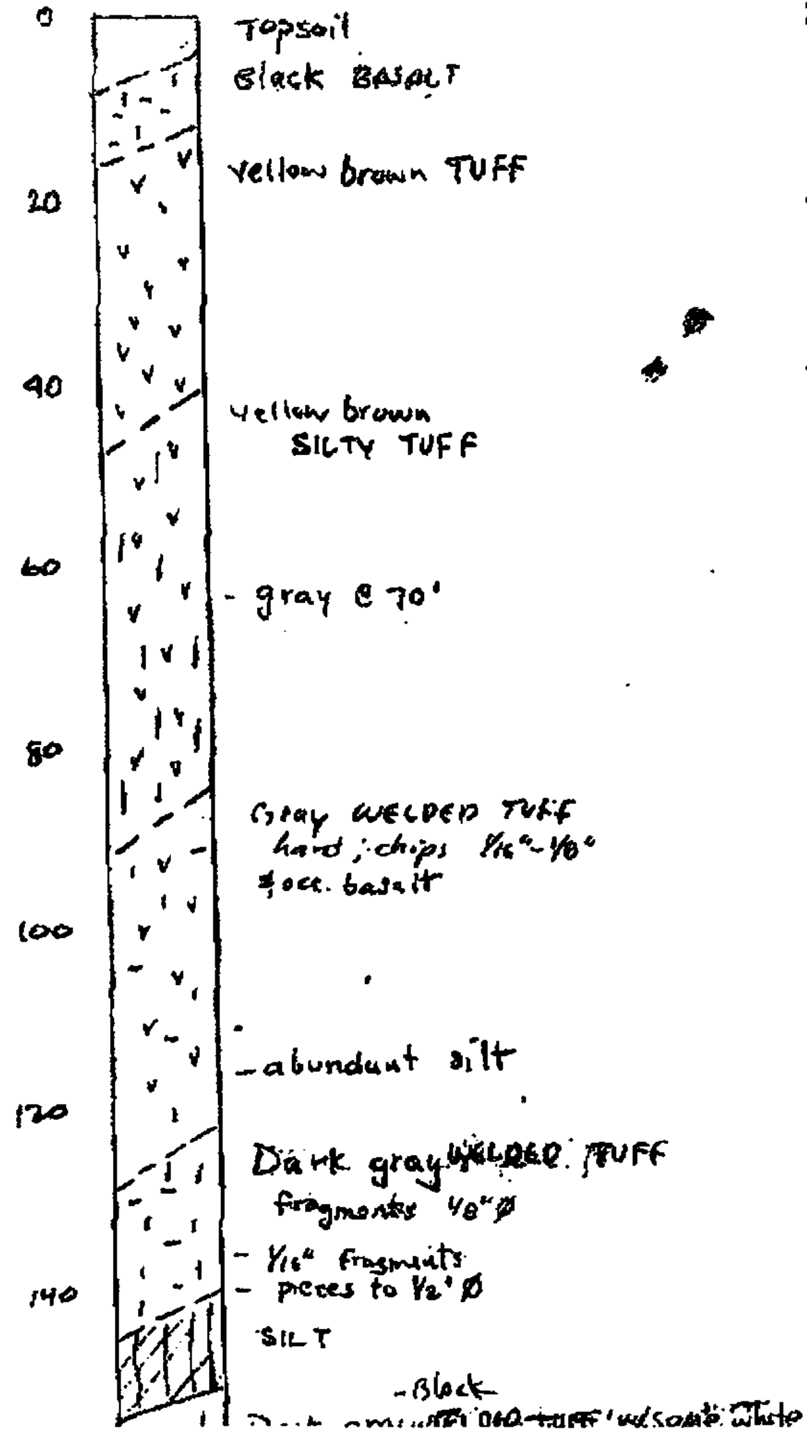
Logged 1/5/03
– MJA

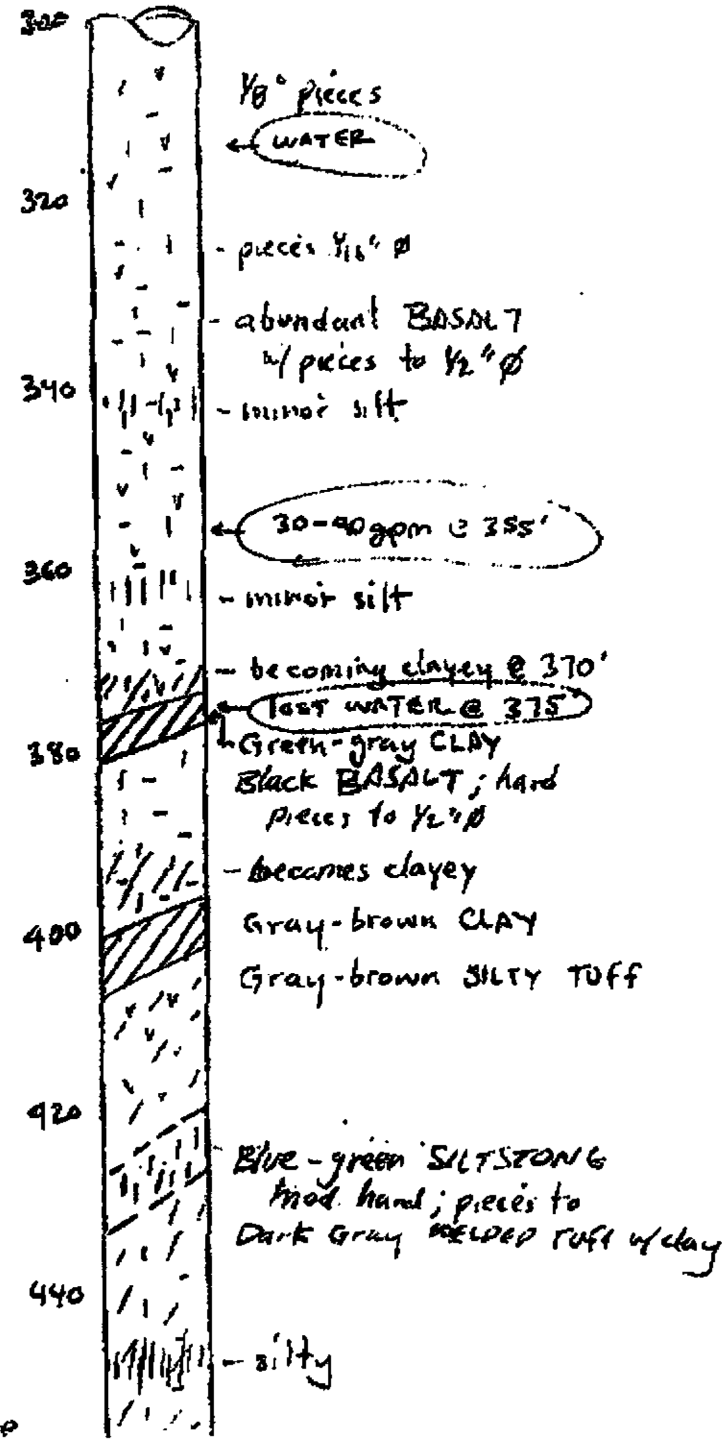
NOTE: Dark gray WELDED TUFF has outward appearance of basalt except for numerous inclusions & fine granular texture.

802189

WELL 7

Cabral Well No. 3





ORIGINAL
File with DWR

Page ____ of ____

Owner's Well No. ____

Date Work Began 8-8-96, Ended 8-20-96

Local Permit Agency Sonoma County

Permit No. WEL96-0234 Permit Date 7-2-96

WELL 10

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. 444000

E, F, G, L, K

DWR USE ONLY — DO NOT FILL IN

04N06W03E M

STATE WELL NO./STATION NO.

LATITUDE | LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

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

DEPTH TO FIRST WATER ____ (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	20	Volcanics - brown
20	26	Ash - fault line caving
26	250	Volcanic light ash
250	460	Hard basalt rock - black
460	520	Black ash
		*Development is not a test.

TOTAL DEPTH OF BORING 520 (Feet)

TOTAL DEPTH OF COMPLETED WELL 520 (Feet)

WELL OWNER

ZIP

WELL LOCATION

Address 1590 Stage Gulch Road

City Petaluma

County Sonoma

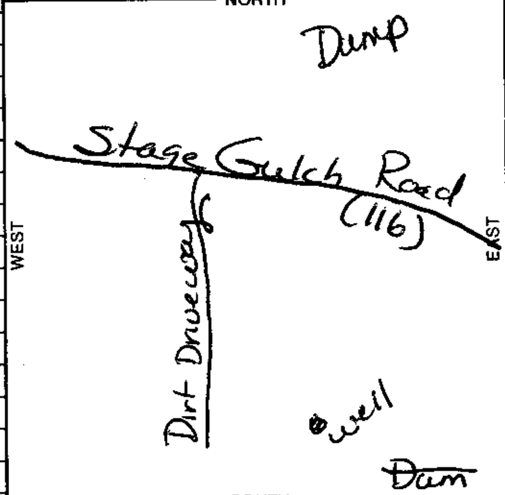
APN Book 068 Page 050 Parcel 12

or Township T5N Range R2W Section 34-A

or Latitude ____ NORTH DEG. MIN. SEC. Longitude ____ WEST DEG. MIN. SEC.

LOCATION SKETCH

NORTH



SOUTH

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 Mud FLUID water

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL ____ (Ft.) & DATE MEASURED ____

ESTIMATED YIELD* 12 (GPM) & TEST TYPE ____

TEST LENGTH 8 (Hrs.) TOTAL DRAWDOWN total (Ft.)

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

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	200	9	X				PVC	5	200	–
200	520	9m		X			PVC	5	200	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	23	X			Seal
23	520			X	Birdseye 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 A & K Drilling, Inc
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

P.O. Box 750143 Petaluma CA 94975
ADDRESS CITY STATE ZIP

Signed [signature] 4-1-97 720534
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

908

[redacted]AL
File with DWR
Page 1 of 2

STATE OF CALIFORNIA WELL 11

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 700420

DWR USE ONLY — DO NOT FILL IN

05N06W23

STATE WELL NO./STATION NO.

LATITUDE | LONGITUDE

APN/TRS/OTHER

Owner's Well No. ______

Date Work Began 12/17/98, Ended 12/31/98

Local Permit Agency Sonoma Co. Permit & Resource Mgt. Dept.

Permit No. WEL98-0542 Permit Date 11/25/98

GEOLOGIC LOG

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

DRILLING METHOD MUD ROTARY FLUID Bentonite

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	4	Adobe
4	115	Brown clay and multi-colored rock
115	152	Hard gray rock & brown clay
152	386	Multi-colored rock and brown clay
386	610	Blue clay & multi-colored rock
610	694	Blue clays & sand & gravels
694	712	Clays
		NOTE: Lower test hole was grouted with NEAT CEMENT from 470' to 510'
		*TEST PUMPED BY GROUND WATER DEVELOPMENT IN SONOMA

TOTAL DEPTH OF BORING 712 (Feet)

TOTAL DEPTH OF COMPLETED WELL 450 (Feet)

WELL OWNER

WELL LOCATION

Address 20698 Arnold Drive

City Sonoma

County SONOMA

APN Book 142 Page 031 Parcel 15

Township ______ Range ______ Section ______

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

LOCATION SKETCH

NORTH

WEST EAST

SOUTH

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

ACTIVITY (✓)

X NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

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

PLANNED USES (✓)

WATER SUPPLY
X Domestic ___ Public
X 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 ______ (Ft.) BELOW SURFACE

*DEPTH OF STATIC WATER LEVEL 76 (Ft.) & DATE MEASURED ?

ESTIMATED YIELD * 375 (GPM) & TEST TYPE PUMP TEST

TEST LENGTH ? (Hrs.) TOTAL DRAWDOWN 239 (Ft.)

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

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
460	712	7 7/8								
0	460	18								
+2	65	18	X				STEEL	8 1/8"	.250	
210	250	18	X				STEEL	8 1/8"	.250	
285	320	18	X				STEEL	8 1/8"	.250	
340	380	18	X				STEEL	8 1/8"	.250	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	50	X			
50	460			X	8x16 M. sand

ATTACHMENTS (✓)

SEE NEXT PAGE*

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

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

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

NAME WEEKS DRILLING AND PUMP COMPANY by WARD THOMPSON
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

P.O. Box 176 Sebastopol CA 95473
ADDRESS CITY STATE ZIP

Signed Ward Thompson 1/7/99 177681
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

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

WELL 11

700420

AP# 142-031-15

WELL COMPLETION REPORT # 700420

DEPTH FROM SURFACE		BORE-HOLE DIA. (Inches)	CASING(S)							
			TYPE (✓)							
Ft.	to Ft.		BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL/ GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
430	450	18"	X				STEEL	8 1/8"	.250	
65	210			X			STEEL	8 1/8"	.250	.055 Full Flo Louver
250	285			X			STEEL	8 1/8"	.250	.055 Full Flo Louver
320	340			X			STEEL	8 1/8"	.250	.055 Full Flo Louver
380	430			X			STEEL	8 1/8"	.250	.055 Full Flo Louver

WELL 12

ORIGINAL
File with DWR
Page 1 of 1

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. 572330

DWR USE ONLY — DO NOT FILL IN
05N06W26
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

Owner's Well No. Well #G
Date Work Began 4/20/99, Ended 5/20/99
Local Permit Agency Sonoma County
Permit No. WEL 99-0122 Permit Date 4/20/99

GEOLOGIC LOG

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

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

Depth from Surface Ft.	to Ft.	DESCRIPTION (Describe material, grain size, color, etc.)
0	20	Med. Brn. silty sand
20	40	Fine gravel & sand
40	60	Gray sand & silty clay
60	80	Pumice gravel
80	160	Gray, white & brn. sandstone with chips of basalt
160	260	Gray & white volcanic conglomerate
200	220	Brn. clayey sandy pebble conglomerate
220	240	Sandy pebble conglomerate
240	320	Brn. gray, sandy pebble conglomerate; basalt pebbles
320	340	Brn. sandy claystone
340	400	Brn. mudstone w/fine grain sand
400	420	Brn. sandy clayey interbedded w/sands & clay
420	460	Brn. claystone w/medium grain sand
460	480	Brn. & gray sandy clay
480	500	Gray, brn. sandy clay
500	520	Green gray mudstone
520	540	Soft mudstone fragments
540	580	Mudstone chips
580	660	Chips, precl. soft clay
660	680	Soft plastic clay
680	700	Black green shale fragment & Mini siltstone

TOTAL DEPTH OF BORING 700 (Feet)
TOTAL DEPTH OF COMPLETED WELL 430 (Feet)

WELL OWNER

WELL LOCATION

Address 1700 Watmaugh Road
City Sonoma
County Sonoma
APN Book ___ Page ___ Parcel 142031-37
Township ___ Range ___ Section ___
Latitude ___ NORTH Longitude ___ WEST
DEG. MIN. SEC.

LOCATION SKETCH

NORTH

See Attached Map

WEST EAST

SOUTH

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

DRILLING METHOD Mud Rotary FLUID Bentonite

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 28 (Ft.) & DATE MEASURED 6/15/99
ESTIMATED YIELD* 40 (GPM) & TEST TYPE Pump
TEST LENGTH 8 (Hrs.) TOTAL DRAWDOWN 170 (Ft.)
** May not be representative of a well's long-term yield.*

CASING(S)

Depth from Surface Ft.	to Ft.	Bore-Hole Dia. (Inches)	Blank	Screen	Conductor	Fill Pipe	Material/Grade	Internal Diameter (Inches)	Gauge or Wall Thickness	Slot Size if Any (Inches)
0	80	14	X				MS	8	.250	
80	260			X			MS	8		.050
260	290		X				MS	8		
290	400			X			MS	8	.250	.050
400	430		X				MS	8		

ANNULAR MATERIAL

Depth from Surface Ft.	to Ft.	Cement (✓)	Bentonite (✓)	Fill (✓)	Filter Pack (Type/Size)
0	50	X	X		
50	470			X	Med. Aquar.
470	500	X	X		
500	685			X	Pea Gravel

ATTACHMENTS (✓)

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

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 The Water Development Corporation
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

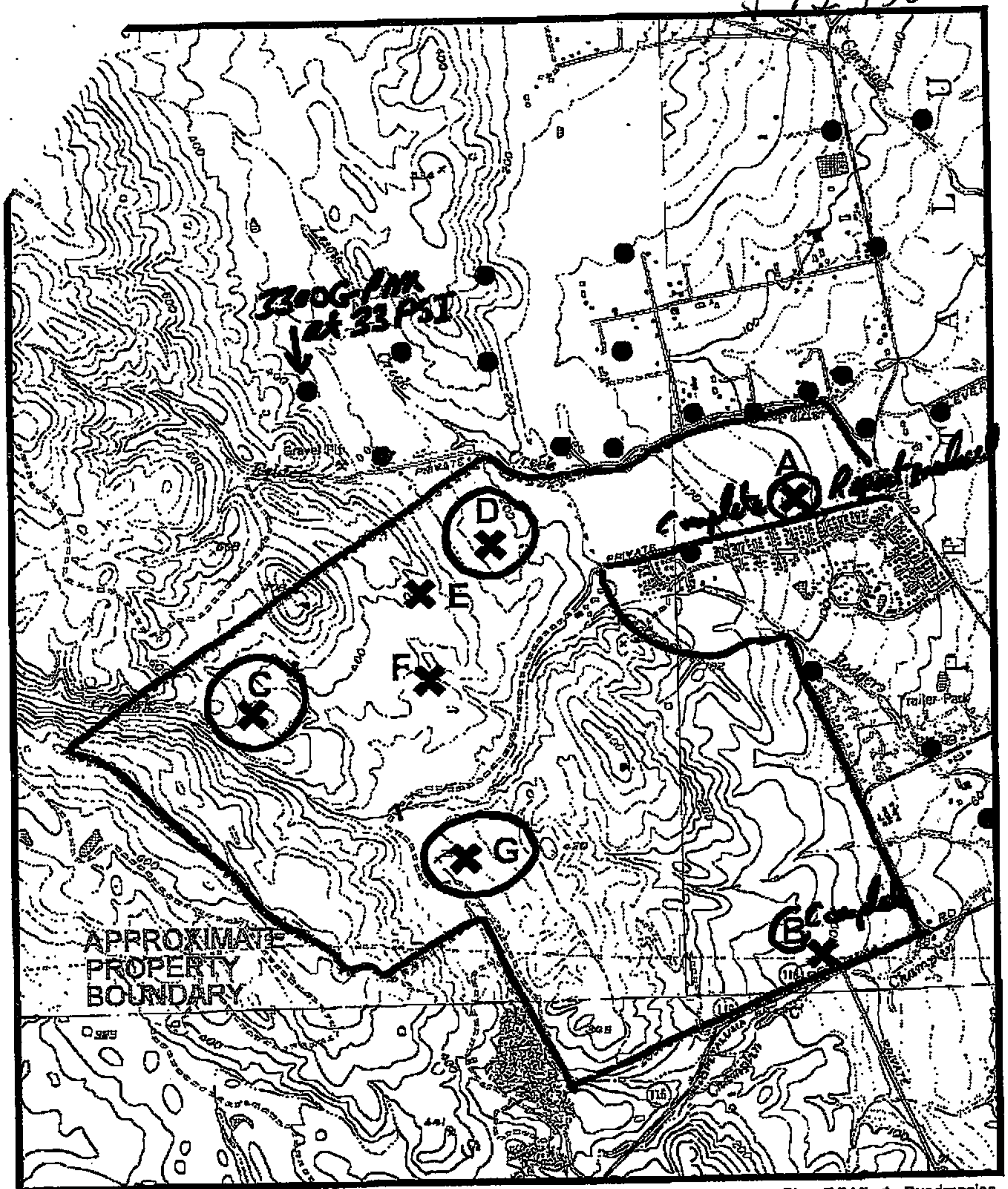
1202 E. Kentucky Avenue, Woodland, CA 95776
ADDRESS CITY STATE ZIP

Signed ___ WELL DRILLER/AUTHORIZED REPRESENTATIVE
7/6/99 DATE SIGNED
283326 C-57 LICENSE NUMBER

DWR 188 REV. 7-90

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

WELL 12 572330



NOTES: Map Adapted from USGS Sears Point, Sonoma, Glen Ellen, and Petaluma River 7.5 Minute Quadrangles
Property is in T5N/R6W, Mount Diablo Base Line and Meridian

LEGEND

✖ Location of Recommended Drill Sites; See Table 1

● Existing Offsite Well

0 2000 4000

SCALE IN FEET

N W E S

RICHARD C. SLADE & ASSOCIATES
CONSULTING GROUNDWATER GEOLOGISTS

FIGURE 1
LOCATION MAP SHOWING WELL LOCATIONS AND RECOMMENDED DRILL SITES

JOB NO. 33827 NOVEMBER 1998

DRY HOLES

ORIGINAL
File with DWR

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

Do not fill in
No. 235259 ABC

Notice of Intent No.
No. or Date #183-84 A.P.#068-050-12

State Well No.
Other Well No. 05N06W34

(1)
Add
City

(2) **LOCATION OF WELL** (See instructions):
County Sonoma Owner's Well Number
Well address if different from above same
Township Range Section
Distance from cities, roads, railroads, fences, etc.

WELL LOCATION SKETCH

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

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

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

(6) **GRAVEL PACK:**
Yes ☐ No ☐ Size
Diameter of bore
Packed from to 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
		Not cased				

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

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

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

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

from ft.	to ft.	Formation (Describe by color, character, size or material)
		Well #1 A
0	48	brown clay/gravel
48	240	blue clay
240	330	blue clay/rock ledges
330	390	clay/rock ledges
390	470	clay/rock ledges with fine gravel.
		Dry Hole
		Well #2 B
0	14	adobe clay
14	370	clay/soft rock ledges
		Dry hole
		Well #3 C
0	13	clay/loose boulders
13	70	brown clay/broken rock
70	210	blue clay/soft rock ledges
		Dry hole

Work started 6/5/ 1984 Completed 6/12 1984

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 Les Petersen Drilling & Pump, Inc.
(Well Driller)
NAME Wayne Miller
(Person, firm, or corporation) (Typed or printed)
Address 5434 Old Redwood Highway
City Santa Rosa, Ca. Zip 95401
License No. 261084 Date of this report 6/13/84

APPENDIX B

WELL 3 E-LOG SURVEY RESULTS

ELECTRIC - GAMMA RAY-TEMPERATURE LOG

West Coast Well Logging Services

P.O.Box 2797, Rancho Cordova CA 95741 · Phone: 916-858-8148 Fax: 916-858-8174 · Web: www.wcwls.com Email: wcwls@sbcglobal.net

Filing No.

COMPANY Huckfeldt Well Drilling

WELL CarnerosView Vineyards

FIELD Sonoma

STATE California COUNTY Sonoma

LOCATION:
4270 Stage Gulch Rd./Hwy 116

OTHER SERVICES:

Job No. 1315

SEC: 27 TWP: 5N RGE: 6W LAT.: 38.24728 LONG.: 122.50152

Permanent Datum: Ground Level Elev.: ______ Ft. Elevs.: K.B. ______ Ft.

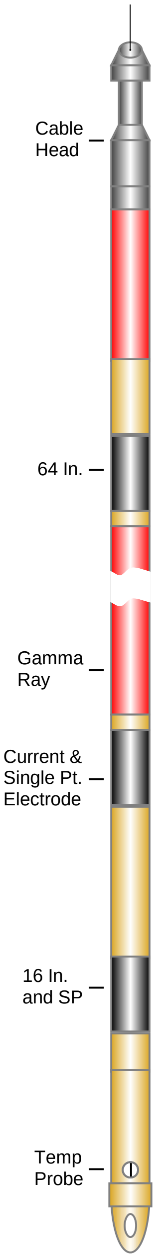
Log Measured From: Top of Casing , 0 Ft. Above Perm. Datum D.F. ______ Ft.

Drilling Measured From: Ground Level G.L. ______ Ft.

Run		One			
Date		May 11, 2016			
Depth-Driller		740 Ft	Ft	Ft	Ft
Depth-Logger		737 Ft	Ft	Ft	Ft
Top Logged Interval		0 Ft	Ft	Ft	Ft
Btm Logged Interval		737 Ft	Ft	Ft	Ft
Casing-Driller		n/a In @ Ft	In @ Ft	In @ Ft	In @ Ft
Casing - Logger In@Ft		n/a In @ Ft	In @ Ft	In @ Ft	In @ Ft
Bit Size		8.75 In @ Ft	In @ Ft	In @ Ft	In @ Ft
Time On Bottom		15:00			
Type Fluid in Hole		Bentonite			
Density	Viscosity	n/a n/a			
pH	Fluid Loss	n/a n/a ml	ml	ml	ml
Source of Sample		Shaker			
Rm @ Mea. Temp		5.6 @ 75 °F	@ °F	@ °F	@ °F
Rmf @ Mea. Temp		5.4 @ °F	@ °F	@ °F	@ °F
Rmc @ Mea. Temp		4.1 @ °F	@ °F	@ °F	@ °F
Source Rmf	Rmc	Meas			
Rm @ BHT		n/a @ °F	@ °F	@ °F	@ °F
Time Since Circ.		4 Hr	Hr	Hr	Hr
Max. Rec. Temp.		82.7 °F	°F	°F	°F
Van No.	Location	WC-1 RC			
Recorded By		Sharpless			
Witnessed By		T. Caldwell			

This Eagle Plot Heading Conforms To API RP 31A

ELECTRIC - GAMMA RAY-TEMPERATURE LOG TOOL



SPONTANEOUS POTENTIAL LOGS:
SP Logs record potentials or voltages developed between the borehole fluid and the surrounding formation and are representations of lithology and water quality. Recording of SP logs are limited to water-filled or mud-filled open holes.

NORMAL RESISTIIVITY LOGS:
Normal Resistivity Logs record the electrical resistivity of the borehole environment with lower resistivities indicative of clays and higher resistivities being sands and gravels. Normal resistivity logs are affected by bed thickness, Borehole diameter and borehole fluid.

SINGLE POINT RESISTIVITY LOGS:
Single Point Resistivity Logs record the electrical resistance from points within the borehole to an electrical ground at land surface. Single-point resistance logs are useful in the determination of lithology, water quality, and location of fracture zones.

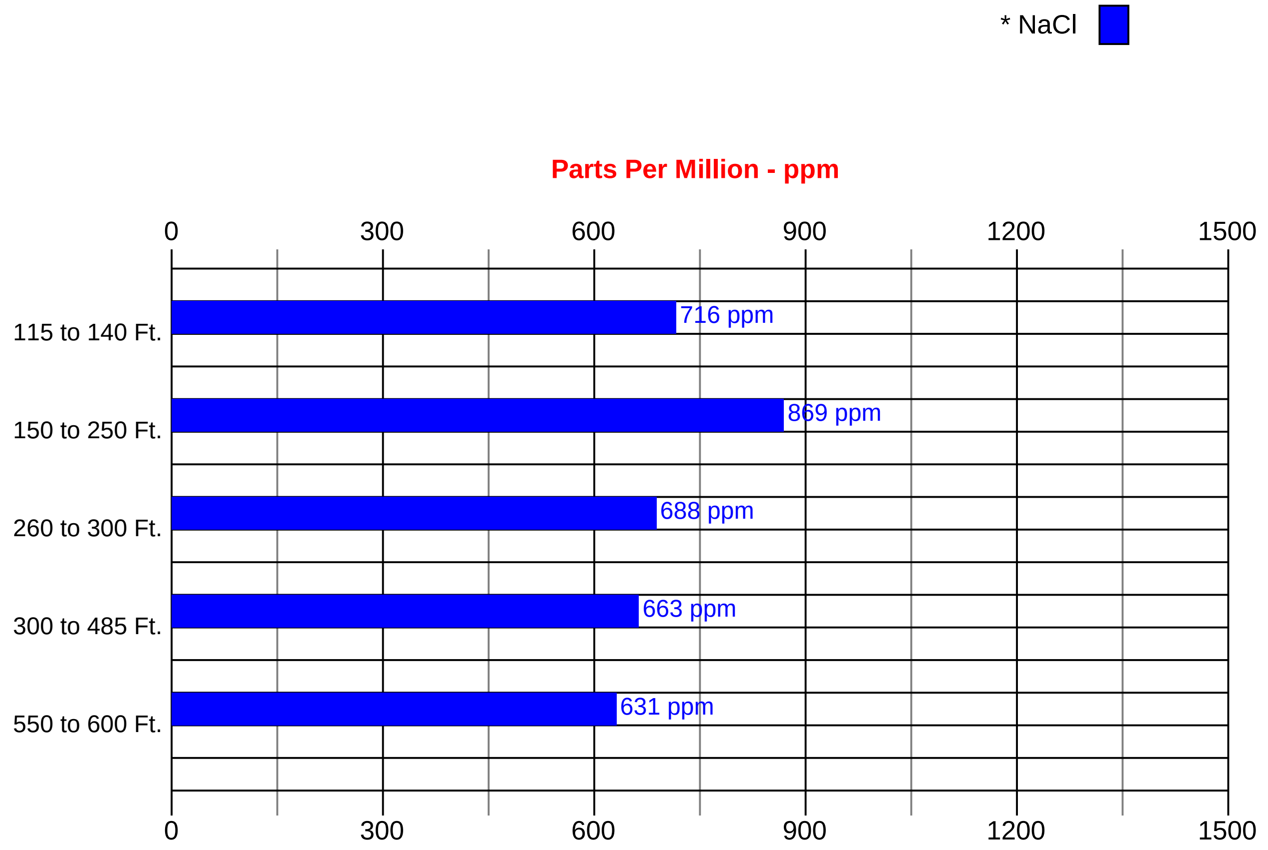
GAMMA RAY LOGS:
Gamma Ray Logs record the amount of natural gamma radiation emitted by the rocks surrounding the borehole. The most significant naturally occurring sources of gamma radiation are potassium 40 and daughter products of the uranium and thorium decay series. Clay and shale bearing rocks commonly emit relatively high gamma radiation because they include weathering products of potassium feldspar and mica and tend to concentrate uranium and thorium by ion absorption and exchange.

TEMPERATURE LOGS:
Temperature Logs record the water temperature in the borehole. Temperature logs are useful for delineating water-bearing zones and identifying vertical flow in the borehole between zones of differing hydraulic head penetrated by wells. Borehole flow between zones is indicated by temperature gradients that are less than the regional geothermal gradient.

ELECTRIC LOG SPECIFICATIONS:

Diameter	1.73 Inches
Length	8.37 Feet
Weight	21.7 Lbs.
Max. Temp	158° F
Resist. Range	0 - 10,000 ohm-m
Gamma Ray	1.97 inches long x .98 inches diameter Scintillation crystal

TOTAL DISSOLVED SOLIDS



TDS Classes

Class 1: **Excellent to Good – Less than 700 ppm**
Class 2: **Good to Injurious – 700 to 2000 ppm**
Class 3: **Injurious to Poor – More than 2000 ppm**

NaCl = Sodium Chloride

METHODOLOGY TO CALCULATE TDS FROM THE SP CURVE

Obtain freshly circulated mud and use a mud press to measure R_{mf}.:

Obtain SSP from SP to make these calculations:

1. R_{mf}^{Corr} = [R_{mf} @ meas temp x (Temp +6.77) / 81.770]
2. $R_{we} = R_{mf}^{Corr} / 10^{(ssp/-70.7)}$
3. $R_w(NaCL) = (R_{we}^{1.227}) \times .0825$
4. $R_w(NaHCO^3) = R_w \times (NaCl / 0.85)$

Solving for Electrical Conductivity (EC):

5. NaCl in MilliSiemens/cm^3 =10,000 / R_w(NaCL)
6. $NaHCO^3$ in MilliSiemens/cm^3 = 10,000 / $R_w(NaHCO^3)$

Solving for Total Dissolved Solids (TDS):

7. NaCl in ppm = 5300 / R_w(NaCL)
8. $NaHCO^3$ in ppm = 10000 / R_w(NaCL)

REFERENCES:

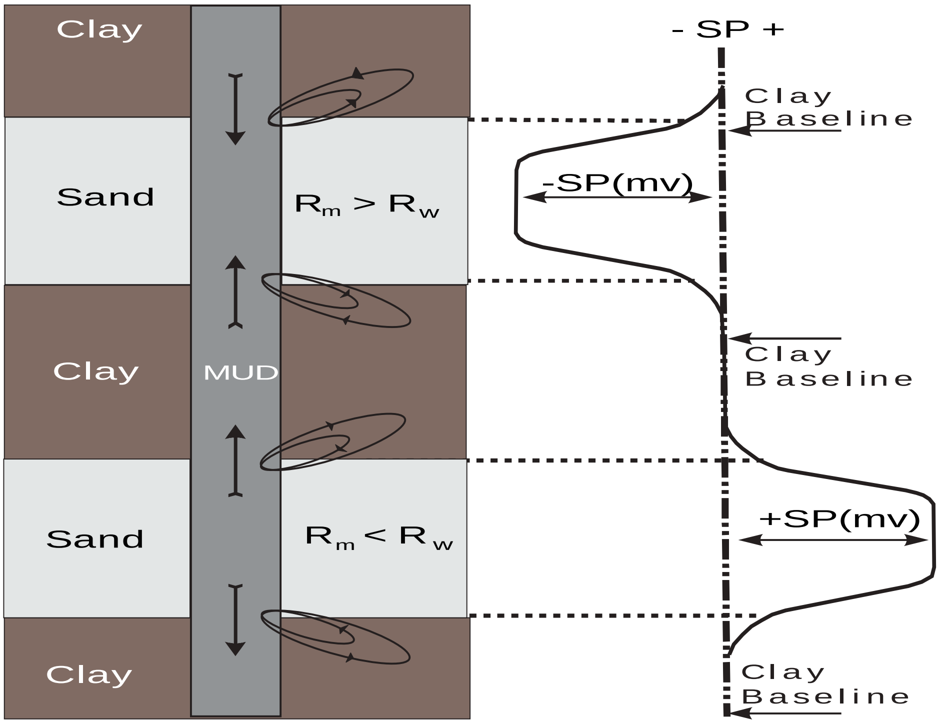
WWW.EPA.GOV?OGWDW/UIC/PDFS/HISTORICAL/STUDY_UIC_METHODS_TDS_CONC_1988.PDF

WWW.WELLLOG.COM/TDS.HTM

THE DEVELOPMENT OF THE SP CURVE

Rm = Resistivity of Mud

Rw = Resistivity of Formation Water



The Liquid Junction Potential is important for SP development. This type of potential develops when two electrolytes of different concentrations containing ions of different mobilities come in contact with each other. The Electric Log Tool is designed to measure that potential displayed as the SP Curve.

NOTICE

All interpretations are opinions based on inferences from electrical and other measurements and we do not guarantee the accuracy or correctness of any verbal or written interpretation, and we shall not, except in the case of gross or willful negligence on our part, be liable or responsible for any loss, costs, damages or expenses incurred or sustained by anyone resulting from any interpretation made by one of our officers, agents or employees. These interpretations are also subject to our General Terms and Conditions as set out in our current Price Schedule.

REMARKS

Consulting Company: Slade & Assoc.

Huckfeldt Well Drilling
CarnerosView Vineyards
May 11, 2016

ELECTRIC - GAMMA RAY-TEMPERATURE LOG

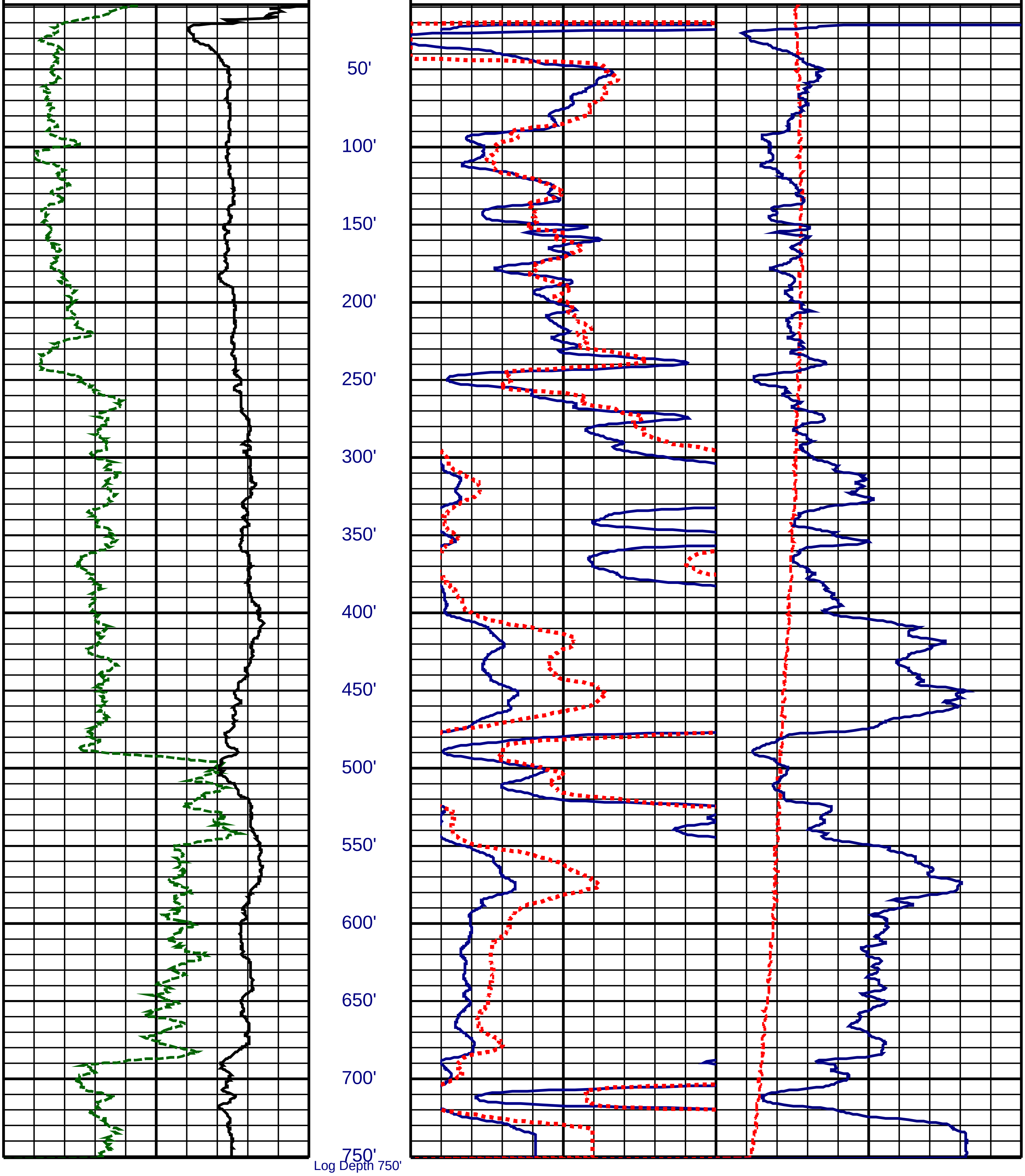
Single Page

DEPTHS (Feet)

< - S.P. (10 mV/div) S.P. + >

0 Gamma Ray(api) 150

100 64 Inch Normal (ohmm²/m) x10 1000
0 64 Inch Normal (ohmm²/m) 100
100 16 Inch Normal (ohmm²/m) x10 1000
0 16 Inch Normal (ohmm²/m) 100
0 Single Point(ohms) 100
80 Temperature (°F) 90



Log Depth 750'

APPENDIX C

STEVE MARTIN AND ASSOCIATES PROCESS WASTEWATER SUMMARY

SMA **Steve Martin Associates, Inc.**
130 South Main Street, Suite 202
Sebastopol, CA 95472
p. 707-824-9730
f. 707-824-0266

606 Alamo Pintada Road #3-221
Solvang, CA 93463
p. 805-541-9730

June 27, 2016

Sonoma County Permit Resource
Management Department
2550 Ventura Avenue
Santa Rosa, CA 95403

Attention: Ms. Becky VerMeer

Re: 4200 Stage Gulch Road
Sonoma, CA
A.P.N. 142-051-031
So. Co. PRMD File: PLP02-0085
Wastewater Feasibility Study
SMA Project No. 2008008

Dear Ms. VerMeer,

The purpose of this letter is to supplement the Use Permit Modification application for the Carneros Vintners Winery which includes an increase from 250,000 cases of wine production (see PLP02-0085) to 2,500,000 cases of wine production and the elimination of public tasting, tours, and all events. Steve Martin Associates, Inc. has prepared this Wastewater Feasibility Study for the purpose of assessing the onsite sanitary and process wastewater system treatment and disposal capacity necessary for the proposed expanded production level.

The requested 2,500,000 cases of wine production will be comprised of the following breakdown:

a. 55,000 cases (873 tons) – full production and bottled on site
b. 289,000 cases (4,587 tons) - crush and bulk off haul of juice
c. 1,056,000 cases (16,762 tons) - crush, fermentation and bulk off haul wine
d. 300,000 cases (4,762 tons) – Lees wine
e. 800,000 cases bottling only – bulk wine import for bottling on site

The sanitary wastewater (SW) consists of wastewater from the laboratory and restroom facilities. The process wastewater (PW) consists of winery wastewater generated from producing 2,500,000 cases of wine. The existing SW wastewater management system consists of a SW septic tank, SW sump tank, and a primary above ground mound system with a 200% expansion/reserve area. The existing PW wastewater system includes a PW sump and pump, rotary screen for solids filtration, and an aerated pond system.

The existing wastewater management systems described above and herein will be adequate to treat and dispose of the projected SW and PW flows generated from the increase in production of the winery facility. To assist you in the evaluation of the above conclusions, the following information is enclosed:

Attachment I: Wastewater System Flow Diagram

Attachment II: Wastewater System Design Criteria & Evaluation

Attachment III: Pond Sizing & Pond Water Balance

Attachment IV: Use Permit Plans, Mound System Plans, & PW Pond & Irrigation Area Plans

In addition, please refer to the Overall Site Plan included with this document for the locations of the Wastewater Management System components. The Overall Site Plan indicates the relative locations of buildings, roads, wastewater pretreatment area, process wastewater pond, primary and expansion mounds/leachfield area, and other site features that would be required for this project.

If you have any questions or require further information, please feel free to contact me at (707) 824-9730.

Sincerely,

Steven M. Martin, PE

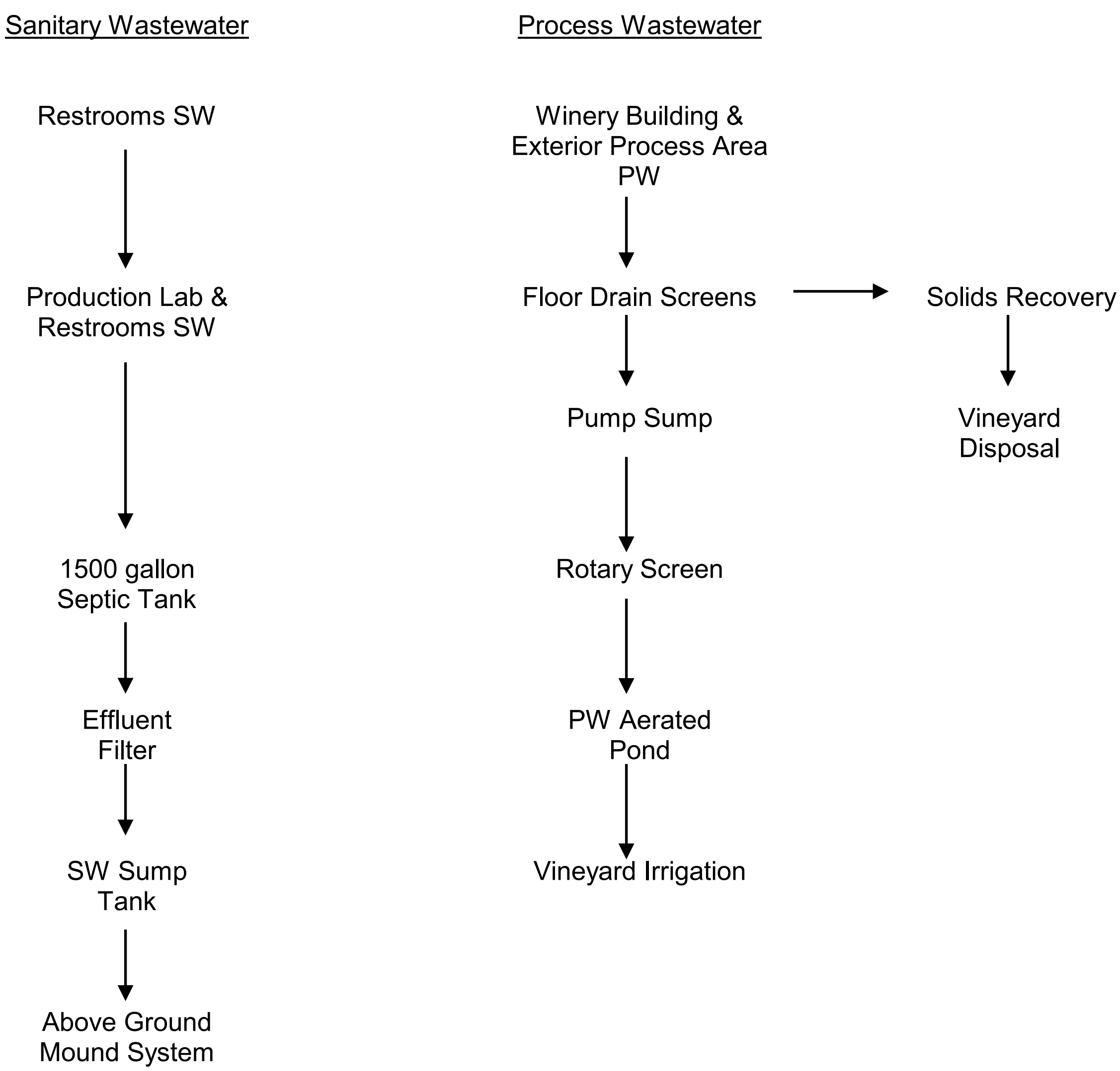
Tamara A. Martin, REHS

Attachments

ATTACHMENT I

SANITARY & PROCESS WASTEWATER MANAGEMENT SYSTEM FLOW DIAGRAM

**SANITARY & PROCESS WASTEWATER
MANAGEMENT SYSTEM
FLOW DIAGRAM**



ATTACHMENT II

SANITARY & PROCESS WASTEWATER MANAGEMENT SYSTEM DESIGN CRITERIA & EVALUATION

Carneros Vintners
4200 Stage Gulch Road
Sonoma, California

WASTEWATER MANAGEMENT SYSTEM
DESIGN CRITERIA & EVALUATION

SANITARY WASTEWATER

Sanitary wastewater (SW) at the winery will consist of typical wastewater generated from restrooms, laboratory and technical tasting facilities.

No public tasting is proposed for this Use Permit Modification. Business visitors are anticipated to average 15 per week, with a maximum of 5 on a peak day.

Anticipated SW flows are projected as follows:

SW FLOWS

AVERAGE DAY:

15 full-time employee x 15 gpcd	=	225
3 business visitors x 2.5 gpcd	=	7.5
Total	=	232.5 gpd

PEAK DAY:

20 full-time employees x 15 gpcd	=	300
5 business visitors x 2.5 gpcd	=	12.5
Total	=	312.5 gpd
Design SW flow	=	**313 gpd SW**

TREATMENT & DISPOSAL

SW LEACH FIELD OVERVIEW

In 2005, an above ground Wisconsin mound system was designed and installed to serve 10 employees only (SEP05-1043). In 2008, in anticipation of this Use Permit modification application, the mound system was expanded (SEP08-0834) to accommodate a total of 20 full time employees on a peak day and 5 business visitors.

SEPTIC TANK

The required total septic tank size for the projected SW flows based on the Manual of Septic Tank Practice is as follows:

$$\begin{aligned} V &= 1.5 \times Q \\ &= 1.5 \times 313 \text{ gpd} \\ &= 470 \text{ gallons} \end{aligned}$$

The existing 1200-gallon septic tank is sufficient for the treatment of the projected SW flows. The resulting detention time for a peak day flow would be 3.8 days.

SW MOUND SYSTEM SIZING

While the mound system that was installed in 2008 is sized appropriately based on the total flows of 313 gpd, and has the appropriate amount of rock below the pipe for a commercial system, the loading rate that was used was 1.0 gallons per square foot per day. A change in PRMD design guidelines now requires a loading rate of 0.8 g/sf/d.

DESIGN CRITERIA

- Distribution Bed Loading Rate = 0.8 gallons/s.f./day (Commercial)
  (Medium textured sand)
- Design Flow = 313 gpd
- Linear Loading Rate (LLR) = 4.0 gal. /l.f./day
- Soil Application Rate = 0.563 gallons/s.f./day
- Ground slope is 16.5 % in the area of the primary and expansion mounds

PRIMARY MOUND DESIGN

Min. Distribution Bed Area Required = $\frac{\text{Total flow}}{\text{Sand App. Rate}} = \frac{\text{313 gpd}}{\text{0.8 gal/s.f. /day}}$ = 391.25 s,f,

Existing Distribution Bed Size = 4' x 78.25' = 313 s,f,

Min. Sand Basal Area Required = $\frac{\text{Total Flow}}{\text{Soil App. Rate}} = \frac{\text{313 gpd}}{\text{0.563 gal/s.f./day}}$ = 556 s,f,

Existing Primary Sand Mound Dimensions: **27’ x 96.25’**

Total Existing Mound Footprint (with soil cover): **41’ x 104.25’**

Sand Basal Area Provided = (Distance (width) from upper side of distribution bed to downslope toe of sand) x (dist bed length) = 22’ x 78.25’ = 1721.5 s,f,

While the gravel bed area is 78.25 sf undersized, the sand basal area, is 1,165.50 sf oversized. As a result, even though a less conservative loading rate was utilized in the 2008 expansion design, the ample amount of sand basal area (which is the total effective absorption area of the entire system) that is currently provided shows that the system will not need to be expanded further.

PROCESS WASTEWATER

Process wastewater consists primarily of wastewaters collected at floor drains and trenches within the winery, receiving, crush, tank and wash-down areas, including exterior tank and process areas which are all under a roof. The screened baskets and strainers have screen opening sizes of 1/4 inch for exterior drains and 1/8 inch for interior drains.

The PW flows by gravity to a PW pump station. The gravity piping collection system provides low maintenance and no infiltration or exfiltration. The piping is compatible with process wastewaters and satisfies Uniform Plumbing Code and local PRMD requirements. A PVC force main to the ponds is sized to be adequate for the peak flow rates anticipated from the pump station. The pump conveys the PW to the rotary screen and Pond.

Biological stabilization occurs in the facultative aerated pond system which will consist of two cells, configured by a floating baffle to be installed upon approval of this Use Permit Modification. Currently the pond has no baffle installed. The total usable volume of the pond system is approximately 2.2 MG in addition to a 2 ft minimum freeboard. Surface mechanical aerators for the aeration pond have been upsized to satisfy biochemical oxygen demand as well as oxygen dispersion requirements for the increase in production. Time clock control of the aerators currently allows personnel to adjust aerator operation to changing winery functions and pond conditions. The existing flow meters measure the flows from the PW pump station to the aerated pond and from the pond to the irrigation system.

The irrigation disposal area is currently sized at 5.8 acres of grass / pasture area with no vineyard irrigation. The increase in production, will require an additional irrigation area of 30 acres of vineyard to dispose of the reclaimed wastewater via drip irrigation. The existing 80 acres of vines on site and adjacent to the winery parcel will more than provide enough vines to dispose of the treated PW. As a result, final reuse (disposal) of effluent is to be accomplished by spray irrigation of 5.4 acres of grassland and drip irrigation of 30 acres vineyard. The irrigation demand is the lowest during the wet season (November through April) and application rates should be less than 1.3 inches per day.

The irrigation system is controlled manually. The Pond Water Balance (PWB) provides operators with the projected irrigation discharge amount per month. Visual observation and monitoring of the vineyard is made weekly to ensure against surface runoff. Irrigation/disposal will be suspended for approximately 24 hours prior to, during and following any forecasted storms. Irrigation/disposal will be suspended as long as saturated soil conditions persist.

PROCESS WASTEWATER FLOWS

Based on flow data from the planned Operator's existing Carneros Vintners and Lodi Custom Crush facility as well as from wineries of similar size and characteristics, the process wastewater (PW) generation rates were determined and the projected flows are calculated as follows:

The 2.5M case wine production is projected to consist of the following breakdown:

a. 55,000 cases (873 tons) – full production and bottled on site
b. 289,000 cases (4,587 tons) - crush and bulk off haul of juice
c. 1,056,000 cases (16,762 tons) - crush, fermentation and bulk off haul wine
d. 300,000 cases (4,762 tons) – Lees wine
e. 800,000 cases bottling only – bulk wine import for bottling on site

Annual Volume

55,000 cases full production onsite:

Gallons of wine produced onsite = 2.4 gallons/case x 55,000 cases = 132,000 gal

Generation rate = 2.0 gal PW/gal wine (based on 10 yrs actual flow data from existing & Lodi facility)

Annual Volume = 132,000 gal wine x 2.0 gal PW/gal wine = 264,000 gal PW

289,000 cases crush and run:

Gallons of wine crushed and hauled offsite = 2.4 gallons/case x 289,000 cases = 693,600 gal

Generation rate = 1.0 gal PW/gal wine

Annual Volume = 693,600 gal wine x 1.0 gal PW/gal wine = 693,600 gal PW

1,056,000 cases crush, ferment, and run:

Gallons of wine crushed, fermented, and hauled offsite
= 2.4 gallons/case x 1,056,000 cases = 2,534,400 gal

Generation rate = 1.5 gal PW/gal wine

Annual Volume = 2,534,400 gal wine x 1.5 gal PW/gal wine = 3,801,600 gal PW

300,000 cases Lees wine onsite:

Gallons of Lees wine produced onsite = 2.4 gallons/case x 300,000 cases = 720,000 gal

Generation rate = 1.75 gal PW/gal wine

Annual Volume = 720,000 gal wine x 1.75 gal PW/gal wine = 1,260,000 gal PW

800,000 cases bottling onsite:

Generation rate = 0.3 gal PW/case

Annual Volume = 800,000 cases wine x 0.3 gal PW/case wine = 240,000 gal PW

Total Annual Volume = 6,259,200 gallons of Process Wastewater

Average Harvest Day Flow

Based on 10 plus years' worth of data from the operators existing Carneros Vintners and Lodi facilities, the harvest months of August – November account for approximately 16, 17.5, 13, and 9 percent of the annual PW flow, respectively.

$$6.26 \text{ Mgal PW} \times \frac{(0.16 + 0.175 + 0.13 + .09)}{122 \text{ days}} = 28,474 \text{ gal PW/day}$$

Use 28,500 gal/d PW

Average Day, Peak Harvest Month Flow

The harvest month of September accounts for approximately 17.5 percent of the annual PW flow.

$$6.26 \text{ Mgal PW} \times \frac{(0.175)}{30 \text{ days}} = 36{,}512 \text{ gal PW/day}$$

Use 37,000 gal/d PW

Peak Day Crush Flow

Maximum crush rate	=	500 tons grapes crushed/day
Wine generation rate	=	160 gal wine/ton grapes crushed
PW generation rate	=	0.5 gal PW/gal wine
Peak flow	=	500 tons/day x 160 gal wine/ton x 0.5 gal PW/gal wine
	=	40,000 gal PW/day

Use 40,000 gal/d PW

PW SYSTEM DESCRIPTION

Process wastewater will consist primarily of wastewaters collected at floor drains and trenches within the winery, receiving, crush, tank and wash-down areas. No sanitary wastewater will be discharged into the PW management system. The criteria used to evaluate the wastewater management system are summarized in this section. No distillation will occur at the facility; hence there will be no stillage waste.

Process Wastewater Conveyance, Treatment and Disposal

The following features will be incorporated into the process wastewater management system:

1) Initial screening

2) Gravity collection system

3) PW pump station

4) Pretreatment consisting of:

    i) pH control (if necessary)

    ii) Flow measurement

    iii) Solids removal screen

5) Facultative aerated pond

6) Flow measurement

7) Filter

8) Irrigation disposal (reuse)

A discussion of each of these features is provided below. Refer to the Wastewater Management System Schematic above for a flow diagram of the PW management system.

1) Initial screening -- Provided by screened baskets and strainers installed on the trench drains and floor drains within the winery. Screen opening sizes will be on the order of 1/4 inch for exterior drains and 1/8 inch for interior drains.

2) Gravity collection system -- Designed to provide low maintenance and no infiltration or exfiltration. Piping is compatible with process wastewaters and satisfies Uniform Plumbing Code and local requirements.

3) PW pump station -- The duplex pump station will be capable of pumping all of the anticipated process wastewater flow ranges (see Pond Sizing section for projected process wastewater flows) with one duty and one standby pump that can alternate functions. The duty pump would be used for all but the most extreme PW flow conditions. The second (standby) pump would be activated during peak hour events or similar events of infrequent occurrence and short duration. Storage in the pump sump would provide some additional factor of safety. A PVC force main to the ponds will be sized to be adequate for the peak flow rates anticipated from the duplex pump station. The pumps convey the PW to the Pond.

4) Pretreatment – Consisting of the following elements:

i) pH control system (if necessary)

(a) SMA's experience over the last 10 years has indicated that pH neutralization of winery PW is typically not required for aerated pond systems. The combination of naturally occurring alkalinity in the source water and the alkaline cleaning compounds used within the winery usually provides sufficient buffering to maintain pond pH above 6.5. Neutralizing chemicals should only be used when absolutely necessary. Since the Process Wastewater is ultimately disposed via irrigation, the neutralizing chemicals would be applied to the land.

(b) For the above reasons, the installation of pH control systems when the PW Management System is first constructed is not recommended. Instead, SMA recommends that the pH of the ponds be monitored for a year (monitoring is required by the RWQCB), especially through one harvest season. If at the end of the one-year monitoring period it has been demonstrated that pH control is necessary (or sooner if conditions warrant), a pH control system could be added.

ii) Flow measurement – An inline magnetic flow measurement device will be provided to measure flows from the PW pump station to the facultative aerated pond.

iii) Solids removal screen – A motorized rotary drum screen will remove the large solids from the system and, as a result, reduce the organic biological loading on and the accumulation of solids in the aerated pond system. Solids from the screening operations will be treated as pomace (residual grape solids). Refer to solid waste section for disposal description of pomace.

5) Facultative aerated pond -- Biological stabilization will occur in the facultative aerated pond system which will consist of two cells separated by a floating baffle. The first cell is approximately 1.6 Mgal and the second cell is approximately 0.6 Mgal. This pond system will be large enough to provide a normal residence time of 55 days at average day peak harvest month flow conditions. This residence time is within the 50 to 100 days detention time recommended for these types of systems. For ultimate process wastewater/rainfall inputs and evaporation/irrigation outputs, refer to the pond water balance (based on 10 year rainfall and a minimum two foot freeboard) enclosed. The total usable volume of the pond system is approximately 2.2 MG in addition to a 2 ft minimum freeboard.

   Surface mechanical aerators for the aeration pond will be upsized to satisfy biochemical oxygen demand as well as oxygen dispersion requirements for the increased flows. Time clock control of the aerators will be provided to allow operations personnel to adjust aerator operation to changing winery functions and pond conditions.

6) Flow Measurement – Flow measurement devices will be provided to measure the flows from the pretreatment area to the aerated pond and from the pond to the irrigation system.

7) Filter – A filter will be provided to screen secondary effluent prior to vineyard irrigation.

8) Irrigation disposal (reuse) -- Final reuse (disposal) of effluent is to be accomplished by spray irrigation of a minimum 5.4 acres of grassland on-site and drip irrigation of 30 acres of vineyard on site and on adjacent parcels. The irrigation demand of the grassland & vineyard exceeds the estimated annual process wastewater volume. Refer to the pond water balance for proposed application rates to the disposal area and effluent storage volumes. To meet the additional irrigation demand the treated PW can be supplemented with irrigation water if needed. The irrigation demand is the lowest during the wet season (November through April) and application rates should be less than 0.2 inches per day. Irrigation of vineyards would likely be suspended in August, just prior to harvest, to control sugar content in the grapes.

   If necessary, double check valves or similar backflow prevention devices will be installed on the existing irrigation system discharge to prevent any cross-contamination with treated effluent applied to the irrigation distribution network. The treated PW is not recycled for winery use.

OTHER CONSIDERATIONS

Odor Control

There should be no obnoxious odors from a properly designed and operated treatment system of this type. See Alternative Courses of Action for operation alternatives for unforeseen conditions.

Ground Water Contamination

The nearest water well to the winery process wastewater treatment and disposal systems is over 600 feet from the aerated pond. No disposal of reclaimed wastewater will occur within 100 feet of any existing wells.

The groundwater in the pond area will be protected from possible contamination by the liners installed in each pond.

Irrigation/disposal of treated effluent is considered a beneficial use and is considered an effective means to protect groundwater quality. Well water may be added to the treated PW when capacity permits to supplement the volume of water used for irrigation.

Surface Waters

All wastewater treatment facilities are designed with sufficient drainage facilities to divert local runoff. Irrigation/disposal operations will be routinely monitored to ensure against surface runoff. Irrigation/disposal will be suspended for approximately 24 hours prior to, during and following any forecasted storms. Irrigation/disposal will be suspended as long as saturated soil conditions persist.

Protection

Exposed wastewater treatment facilities will be posted with appropriate warning signs. The aerated ponds will be fenced, if necessary, to restrict public access.

ALTERNATIVE COURSES OF ACTION

Although no operational difficulties are foreseen, the following additional courses of action would be available if necessary:

1) Ability to add carbon dioxide to reduce pH at the pretreatment site or installation of another type of pH control.

2) Ability to add hydrogen peroxide or liquid oxygen to the ponds as a supplemental oxygen source or for odor control

3) Provision of higher aeration capacity in the pond

4) Additional stages of treatment to increase effluent quality

5) Increased use of irrigation/disposal area to increase discharge capacity

The facultative aerated ponds have been designed for retention of wastewater and rainwater through the majority of the rainy season with minimal discharges to irrigation/disposal fields (based on a 10 year seasonal rainfall). Should there be a winter with more rainfall than the design condition, several operational procedures are available to compensate:

1) Additional water conservation at winery

2) Light irrigation during periods between storms -- not exceeding the assimilative capacity of the soil

3) Increased irrigation during the months of planned irrigation.

4) Pumping and truck transfer of treated and diluted wastewater to a sewage treatment plant or land disposal site

ATTACHMENT III

PW POND SYSTEM SIZING

POND WATER BALANCE

Carneros Vintners
4200 Stage Gulch Road
Sonoma, California

PW POND SYSTEM SIZING

POND SIZING

A total retention time of 50 to 100 days for a Peak Day Flow (40,000 gpd) is recommended for this type of pond system to provide required treatment with at least 50 days.

The existing pond configuration will provide adequate residence time for the proposed flows, as calculated below with the addition of a floating baffle and increased aeration.

Pond:

Total Volume = 2.2 MG

$$\text{Detention Time} = \frac{2{,}200{,}000 \text{ gal}}{40{,}000 \text{ gal PW/day}}$$

= 55 days

Detention Time of 55 days

AERATION REQUIREMENTS

Sizing parameters for the aerators are as follows:

- BOD_5 Concentration = 5,000 mg/l
- Peak Day Peak Harvest Month Flow = 40,000 gal PW/day
- Oxygen Requirement = 1.5 lbs O_2/lb BOD
- Oxygen Transfer Rate(Vertical Turbine Aerator) = 2.2 lbs O_2/HP - hr
- Power/Vol Ratio, Cell #1 = 0.10 - 0.20 HP/1,000 cu ft
- Power/Vol Ratio, Cell #2 = 0.05 - 0.10 HP/1,000 cu ft
- Cell #1 Volume = 1.6 Mgal
- Cell #2 Volume = 0.6 Mgal
- Total Pond Volume = 2.2 Mgal

Aerated Pond – Cell No. 1:

BOD_5 Mass Loading:

(5,000 mg/L)(0.040 Mgal PW/day)(8.345 lbs/Mgal)

= 1669 lbs BOD_5/day

Oxygen Requirements:

$$\frac{(1.5 \text{ lbs } O_2/\text{lbs } BOD_5)(1669 \text{ lbs } BOD_5/\text{day})}{(24 \text{ hrs/day})} = 104 \text{ lbs } O_2/\text{hr}$$

Use 104 lbs O_2/hr

Aerator Horsepower Required:

$$\frac{104 \text{ lbs } O_2/\text{hr}}{2.2 \text{ lbs } O_2/\text{HP-hr}} = 47.3 \text{ HP}$$

Use 50 HP (2-25 HP)

Check Power-to-Volume Ratio:

$$P\backslash V = \frac{50 \text{ HP}}{2{,}200{,}000 \text{ gal}} \times \frac{7.48\text{gal}}{\text{cf}} \times \frac{10^3}{1{,}000 \text{ cf}} = 0.17 \text{ HP/1,000 cf}$$

P\V of 0.17 HP/1,000 cf is in the range of acceptable values and less than the maximum of 0.20. Therefore, oxygen transfer and mixing are expected to occur in the upper 3-4 feet of the pond as required in a facultative aerated lagoon system.

The existing pond has 1-25 HP aerator and 1-15 HP aerator in cell #1. The 15 HP aerator will need to be replaced by a new 25 HP aerator.

Aerated Pond – Cell No. 2:

Try P/V of 0.08 HP/1,000 cf

0.60 Mgal = 80.2 x 10^3 cf

Power Required = (0.08 HP/1,000 cf)(80.2 x 10^3 cf)
= 6.4 HP

Existing 10 HP aerator installed

TYPICAL WINERY WASTEWATER CHARACTERISTICS

Characteristic	Units	Crushing Season Range	Noncrushing Season Range	Reclaimed Water Range	Avg.
pH	--	2.5 - 9.5	3.5 - 11.0	6.5-9.5	7.9
Dissolved Oxygen	mg/L	0.5 - 8.5	1.0 - 10.0	1.0-10.0	6.0
BOD_5	mg/L	500 – 12,000	300 – 3,500	10-160	50
C.O.D.	mg/L	800 – 15,000	500 – 6,000	-	90
Grease	mg/L	5 - 30	5 - 50	-	0.2
Settleable Solids	mg/L	25 - 100	2 - 100	-	0.2
Nonfilterable Residue	mg/L	40 - 800	10 - 400	-	20
Volatile Suspended Solids	mg/L	150 - 700	80 - 350	-	15
Total Dissolved Solids	mg/L	80 – 2,900	80 – 2,900	8-1,500	900
Nitrogen	mg/L	1 - 40	1 - 40	-	5.0
Nitrate	mg/L	0.5 - 4.8	-	0.1-40	1.5
Phosphorous	mg/L	1 - 10	1 - 40	-	5.0
Sodium	mg/L	35 - 200	35 - 200	-	100
Alkalinity ($CaCO_3$)	mg/L	40 - 730	10 - 730	-	40
Chloride	mg/L	3 - 250	3 - 250	2.5-210	50
Sulfate	mg/L	10 - 75	20 - 75	-	25

ATTACHMENT IV

SHEET UP1
SANITARY WASTEWATER MOUND SYSTEM PLANS C1-C3
PROCESS WASTEWATER POND SHEETS PW1-PW4
RECLAIMED PROCESS WASTEWATER IRRIGAION AREAS SHEET C1

APPENDIX D

SONOMA COUNTY GROUNDWATER RECHARGE ANALYSIS

Sonoma 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 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.

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 Sonoma County. Hydrologically connected portions of Marin County, including the San Antonio Creek and Walker Creek watersheds, were also included in the model domain. This model operates on a daily timestep and calculates surface runoff based on the Natural Resources Conservation Service (NRCS) curve number method, actual evapotranspiration (AET), and recharge based on 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).

Model Development

The model was developed using a 1 arc-second (90.8-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 dataset derived from the Sonoma County Veg Map Lifeform dataset supplemented by the U.S. Forest Service (USFS) CALVEG dataset for portions of Marin County (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 a curve number, dormant and growing season interception storage values, and a rooting depth (Table 1). Curve numbers were assigned based on standard NRCS methods. Interception storage values and rooting depths were assigned based on literature values and

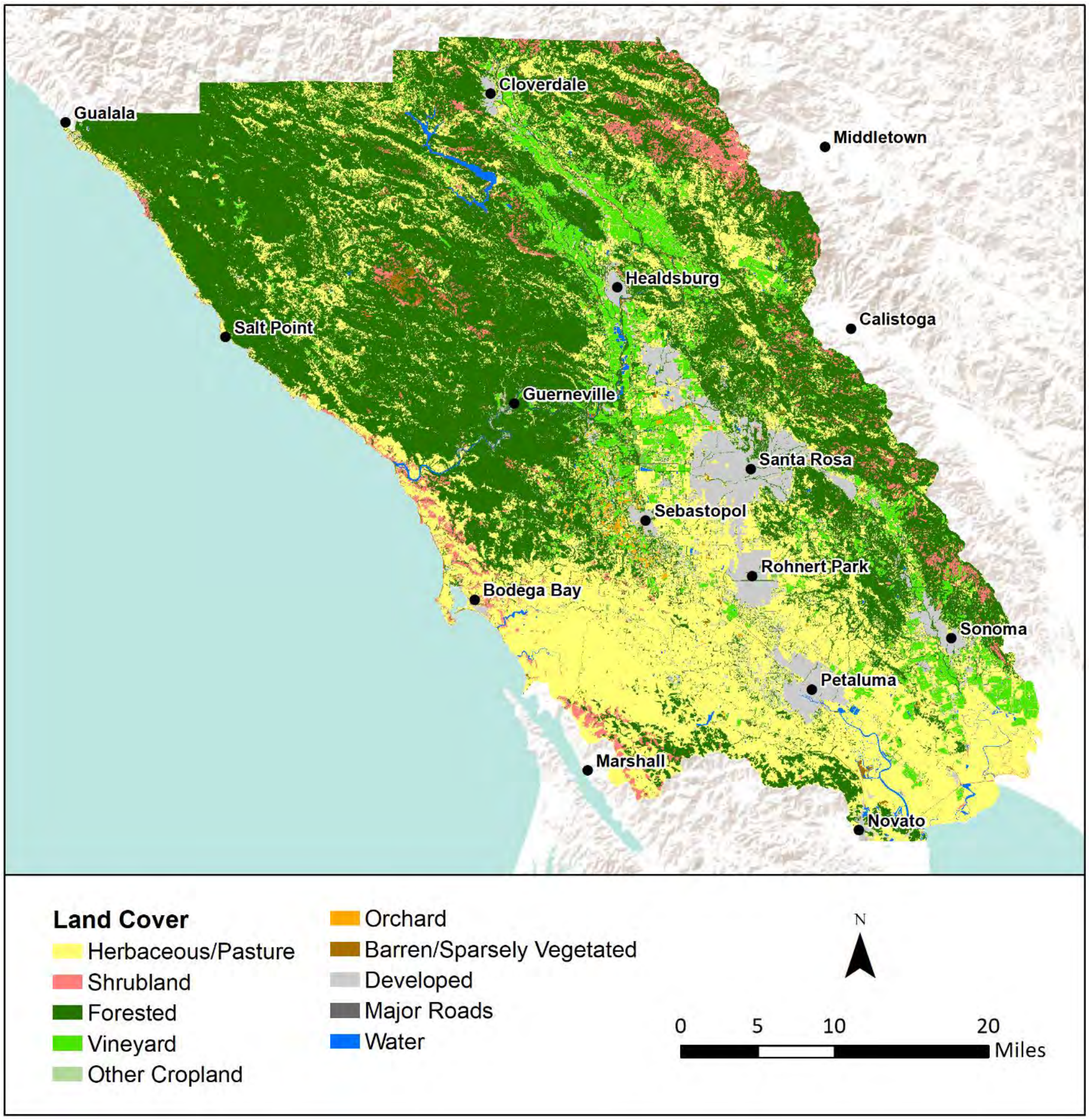


Figure 1: Land cover map used in the Sonoma County SWB model.

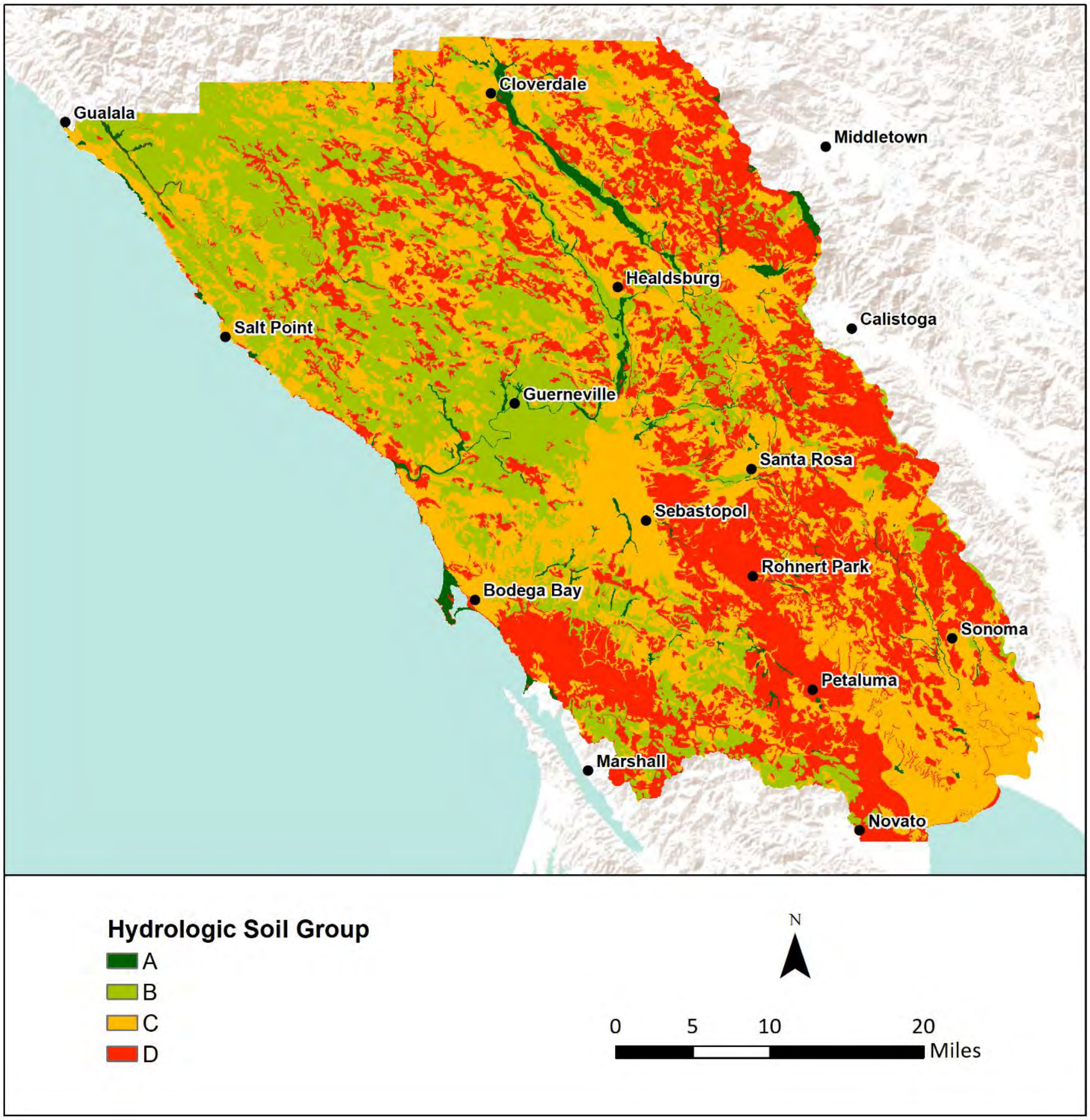


Figure 2: Hydrologic soil group map used in the Sonoma County SWB model.

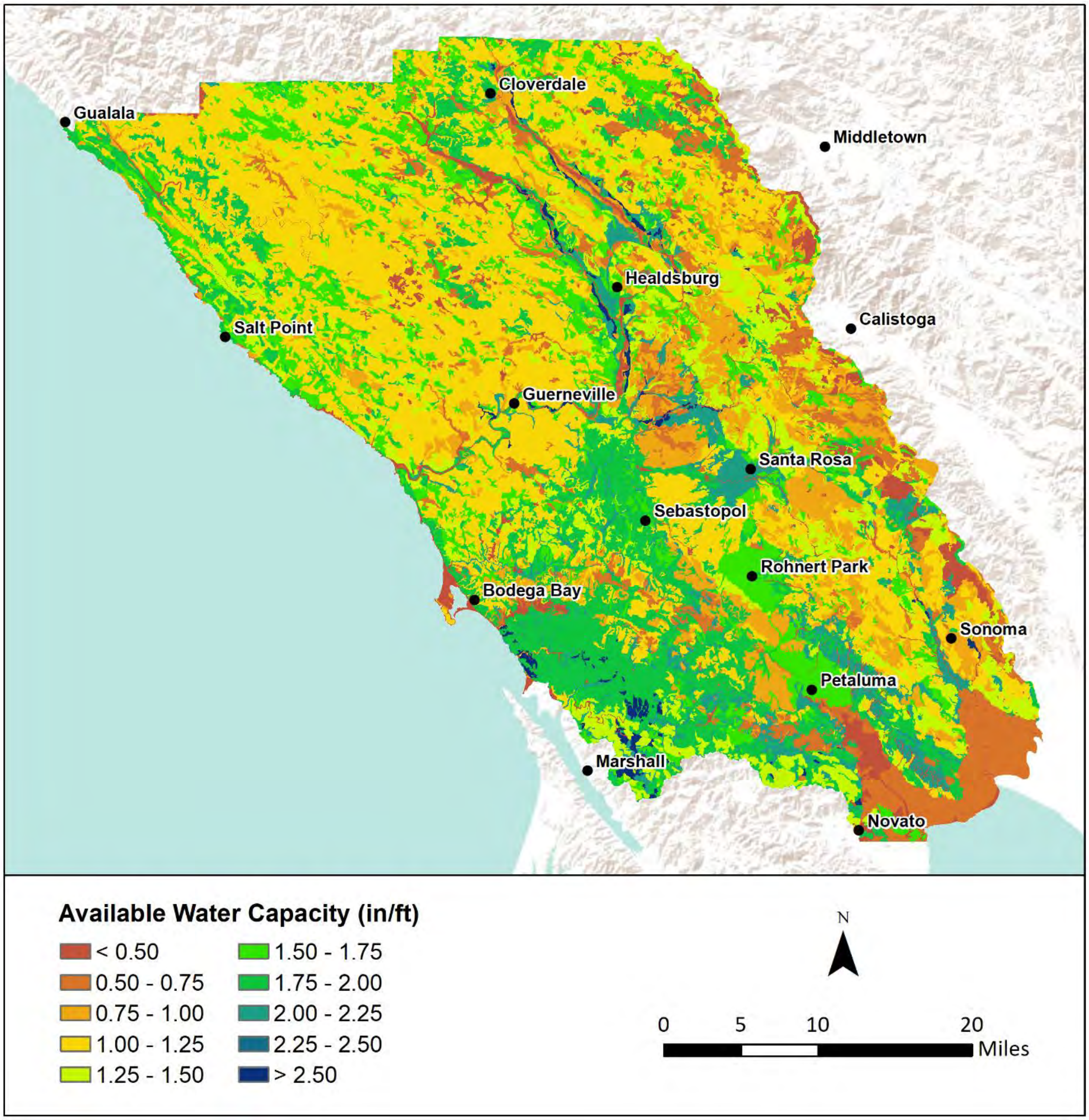


Figure 3: Available water capacity map used in the Sonoma County SWB model.

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

	Curve Number				Interception Storage Values		Rooting Depth (ft)			
Land Cover	**A Soils**	**B Soils**	**C Soils**	**D Soils**	**Growing Season**	**Dormant Season**	**A Soils**	**B Soils**	**C Soils**	**D Soils**
Herbaceous	30	58	71	78	0.005	0.004	1.3	1.1	1.0	1.0
Shrubland	30	48	65	73	0.080	0.015	3.2	2.8	2.7	2.6
Forested	30	55	70	77	0.050	0.020	5.9	5.1	4.9	4.7
Vineyard	38	61	75	81	0.080	0.015	2.2	2.1	2.0	1.9
Other Cropland	38	61	75	81	0.080	0.040	2.0	1.9	1.8	1.7
Orchard	38	61	75	81	0.050	0.015	3.2	2.8	2.7	2.6
Barren	77	86	91	94	0.000	0.000	0.7	0.6	0.5	0.4
Developed	61	75	83	87	0.005	0.002	2.3	2.1	2.0	1.8
Major Roads	77	85	90	92	0.005	0.002	0.7	0.6	0.5	0.4
Water	100	100	100	100	0.000	0.000	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

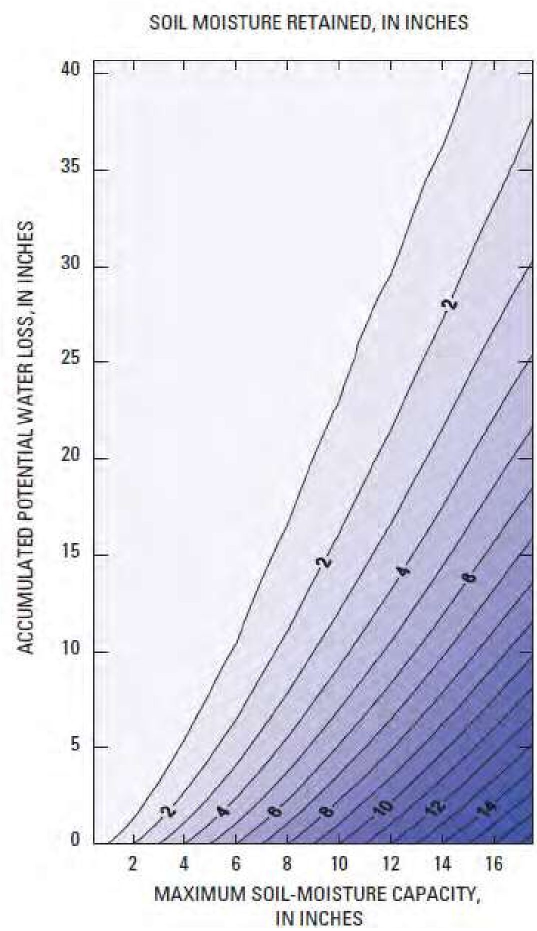


Figure 4: Soil-moisture-retention table (Thornthwaite and Mather, 1957).

previous modeling experience. 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).

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 time-series. The gridded precipitation time-series was created using data from 22 weather stations in Sonoma County, and the gridded mean temperature time-series was created using data from 10 stations (Table 3, Figures 5 & 6). These stations were selected based on completeness of the records and to provide station data across the range of climates experienced in the county. Temperature and precipitation data were obtained from the California Data Exchange Center (CDEC), the Western Regional Climate Center (WRCC), the National Climatic Data Center (NCDC), and data collected by O'Connor Environmental, Inc. from work on prior projects.

To create the gridded time-series, the model domain was divided into discrete areas represented by individual weather stations (Figures 7 and 8). This delineation was based on the USGS HUC-10 watersheds, local knowledge of climate variations across the county, and climate variations described by existing gridded mean annual (1981-2010) precipitation and temperature data (PRISM, 2010).

For the precipitation time-series, each area representing a weather station was subdivided into three to fifteen zones based on PRISM-derived 2-inch interval mean annual precipitation zones. The ratio of mean annual precipitation within a given zone and at a given gauge location was used to define scaling factors for each zone. The raw station data (daily precipitation) was then multiplied by the scaling factor to develop the final timeseries for each zone. The resulting gridded time-series is comprised of 215 individual time-series based on the scaled station data from the twenty-two stations.

The assignment of temperature stations was based on the understanding that the 10 available stations represent distinct climate zones in Sonoma County. Coastal climate conditions are best represented by the Fort Ross and Bodega Bay weather stations. The Occidental station is most representative of climate conditions in the coastal mountains of western Sonoma County, and the St. Helena station is most representative of conditions in the mountains of eastern Sonoma County. The remaining 6 stations all represent climate conditions in the inland valley bottom areas of the county. The temperature areas were not divided into additional zones for scaling because variations in temperatures within each representative area are expected to be relatively minor compared with the variations in precipitation; also the model sensitivity to temperature is expected to be small compared to the sensitivity to precipitation.

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 outlying observations were not observed at nearby stations were removed from the datasets. These and missing values were filled using scaled data from other nearby stations. Precipitation data 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 a Water Year 2010 (October 1, 2009 – September 30, 2010). This year was selected because it represents a recent year with data available from most weather stations in the county, and the total annual rainfall was near long-term average conditions at most of the weather stations. Water year 2010 rainfall ranged from 83% of long-term average conditions at the Sonoma and Petaluma 10.1 W station to 137% at the Fort Ross station based on a comparison between the station data and the 1981-2010 average precipitation from PRISM (2010) (Table 3).

Table 3: Weather stations used in the Sonoma County SWB model.

Climate Zone	Station	Data Source	Data Used	1981 - 2010 Mean Annual Precip (in)	WY 2010 Precip (in)	WY 2010 Precip (% Avg.)
Coastal	Bodega Bay 6 WSW	NOAA accessed via NCDC	Precip. & Temp.	34.06	37.11	109%
	Fort Ross	NOAA accessed via WRCC	Precip. & Temp.	35.10	48.01	137%
Western Mountains	Francini Creek	OEI Project Data	Precip. Only	46.99	59.71	127%
	Geyserville 10.6 WNW	NOAA accessed via NCDC	Precip. Only	52.34	52.97	101%
	Monte Rio	NOAA accessed via NCDC	Precip. Only	48.44	51.01	105%
	Occidental	NOAA accessed via WRCC	Precip. & Temp.	55.37	57.02	103%
	Petaluma 10.1 W	NOAA accessed via NCDC	Precip. Only	37.90	31.57	83%
	SF Fuller Creek	OEI Project Data	Precip. Only	56.49	60.89	108%
	Venado	CA DWR accessed via CDEC	Precip. Only	60.14	66.01	110%
Valleys	Cloverdale	NOAA accessed via WRCC	Precip. & Temp.	42.63	52.65	123%
	Glen Ellen 1.5 N	NOAA accessed via NCDC	Precip. Only	36.14	46.74	129%
	Graton	NOAA from WRCC	Precip. & Temp.	41.07	45.00	110%
	Healdsburg	NOAA accessed via WRCC	Precip. Only	40.95	47.65	116%
	Petaluma River Airport	NOAA accessed via WRCC	Precip. & Temp.	26.60	26.92	101%
	Rohnert Park 0.9 SW	NOAA accessed via NCDC	Precip. Only	33.36	34.73	104%
	Santa Rosa	CAL Fire accessed via CDEC	Precip. & Temp.	31.90	39.55	124%
	Sonoma	NOAA accessed via WRCC	Precip. & Temp.	31.77	26.35	83%
	Calistoga	NOAA accessed via WRCC	Temp. Only	na	na	na
	Warm Springs Dam	USACE accessed via CDEC	Precip. Only	43.44	53.29	123%
Eastern Mountains	Calistoga 4.6 WSW	NOAA accessed via NCDC	Precip. Only	39.64	44.85	113%
	Glen Ellen 1.9 WNW	NOAA accessed via NCDC	Precip. Only	49.16	46.32	94%
	Hawkeye	NOAA accessed via WRCC	Precip. Only	45.57	51.06	112%
	St. Helena 4 WSW	CA DWR accessed via CDEC	Precip. & Temp.	49.12	47.88	97%

Notes: NOAA – National Oceanic and Atmospheric Administration; CA DWR – California Department of Water Resources NCDC- National Climate Data Center; USACE – United States Army Corps of Engineers; WRCC – Western Regional Climate Center; CDEC – California Data Exchange Center

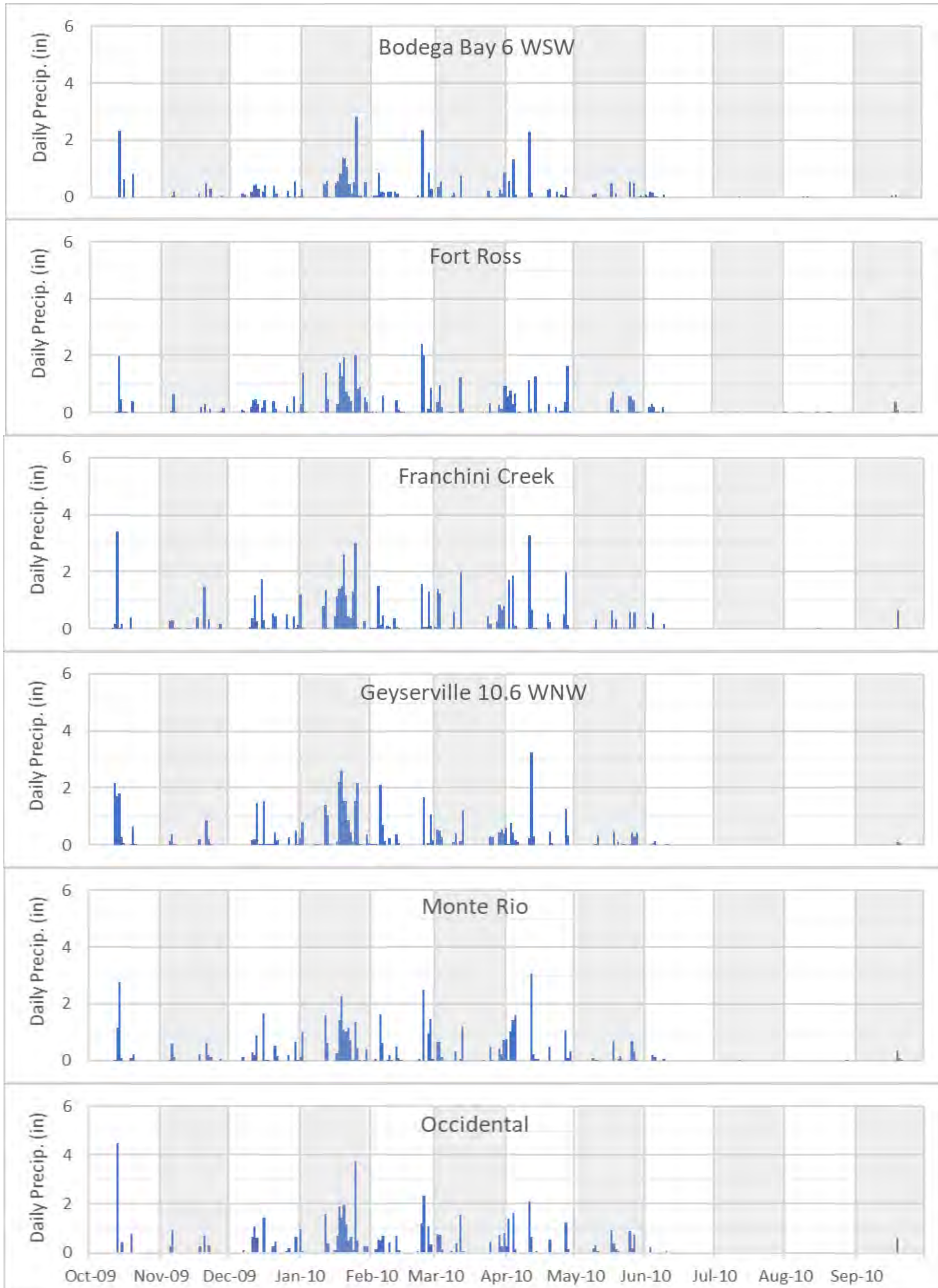
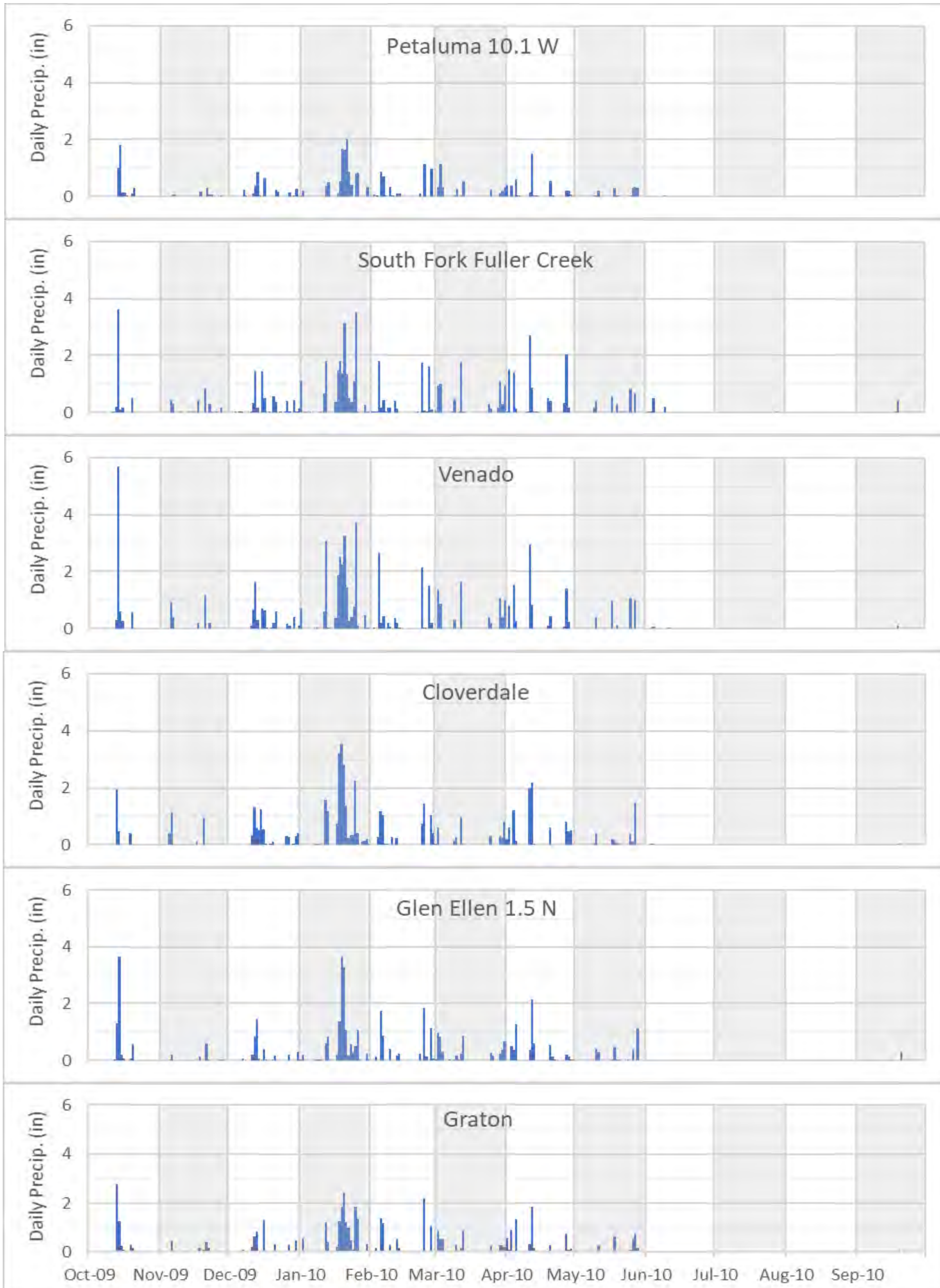


Figure 5: Daily precipitation data used in the Sonoma County SWB model.



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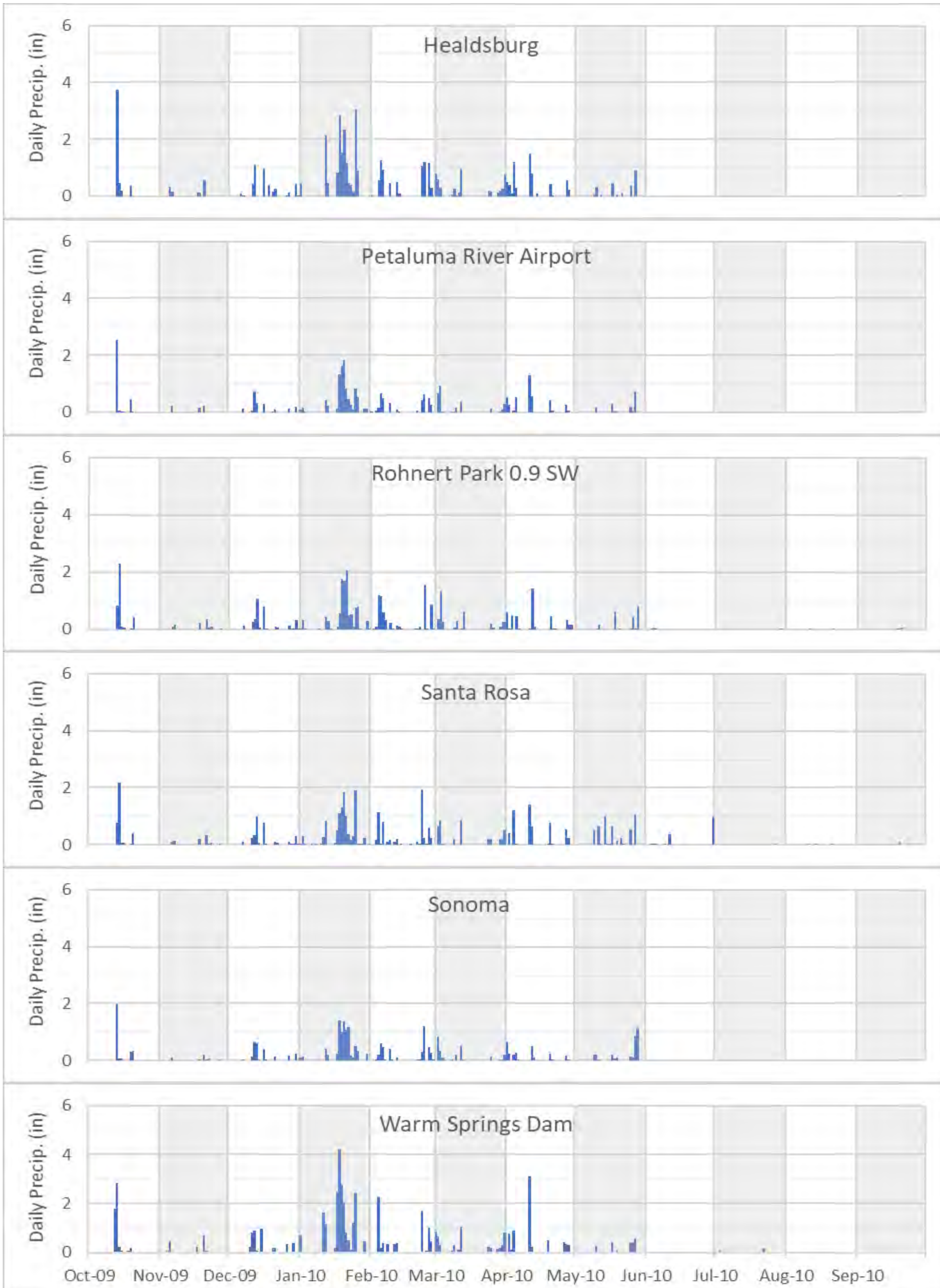

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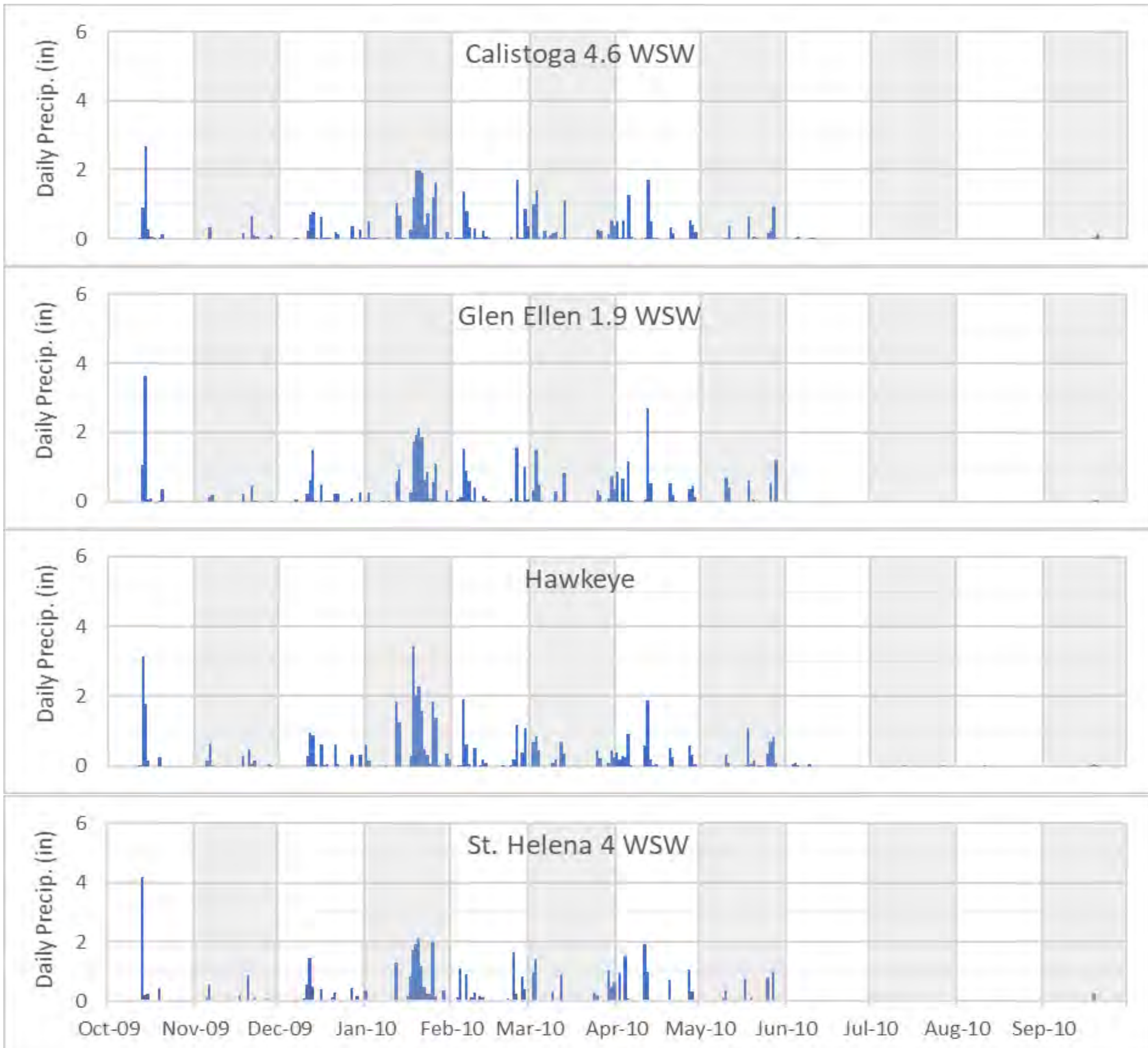

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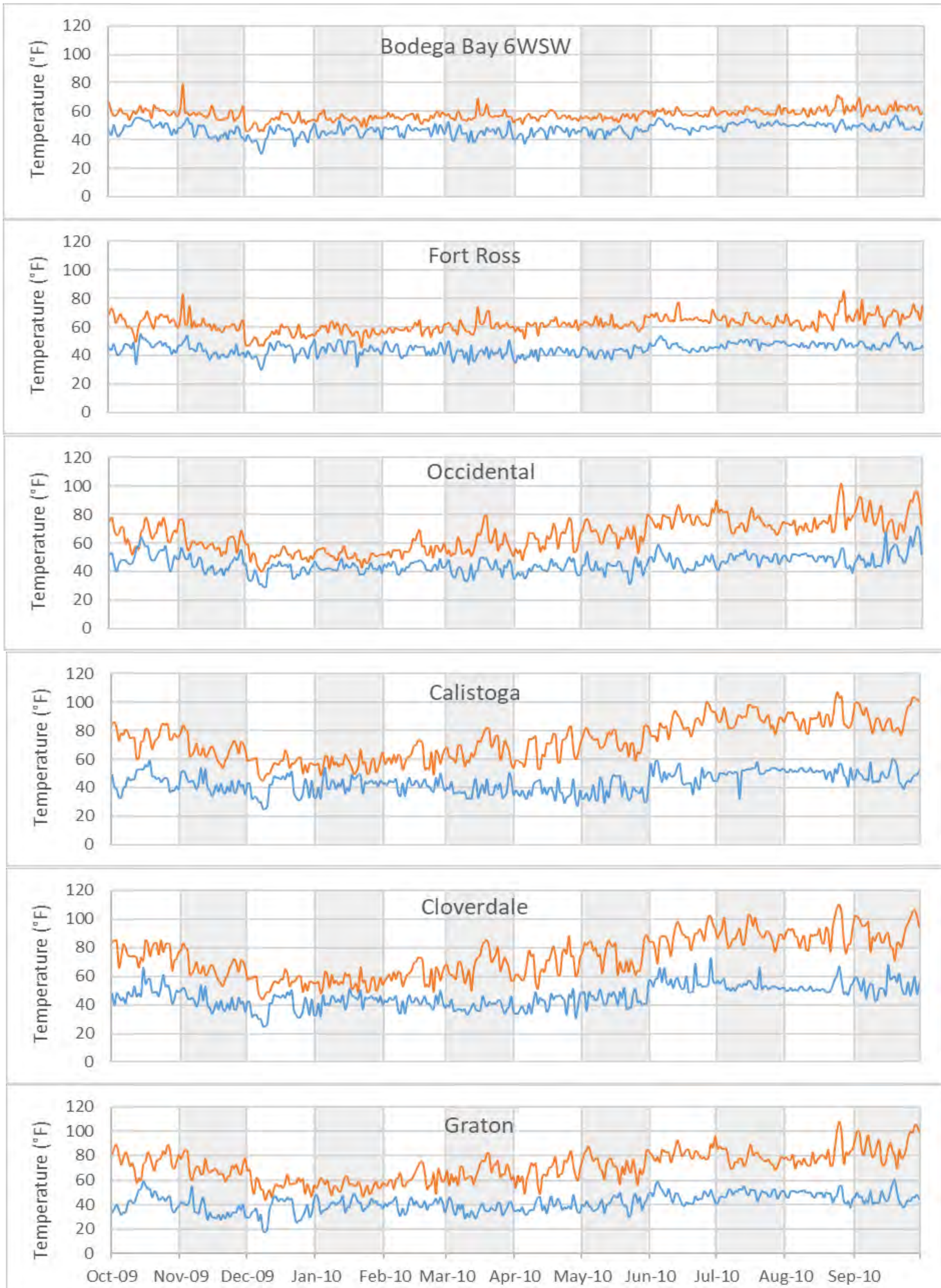
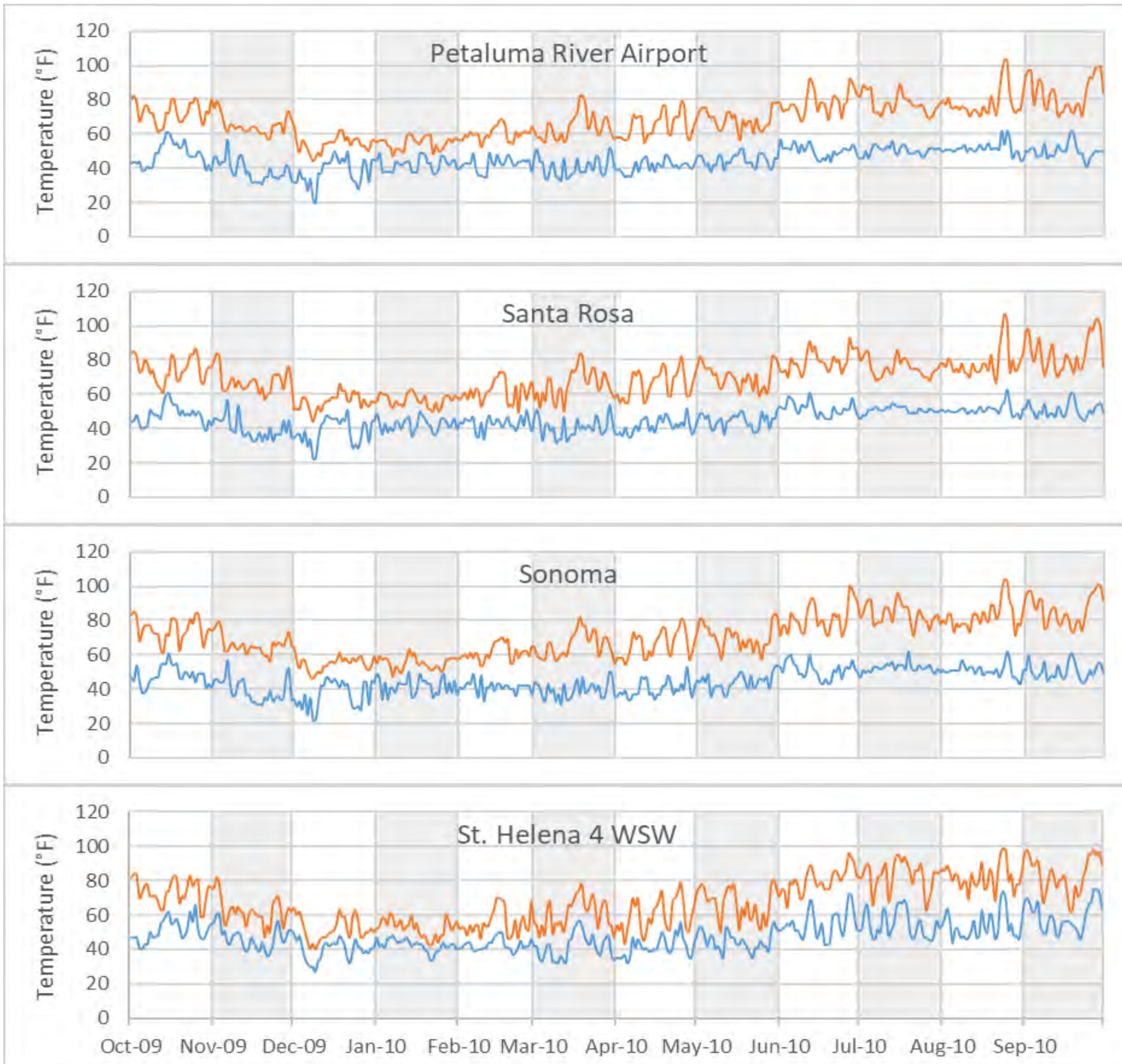


Figure 6: Daily minimum and maximum temperature data used in the Sonoma County SWB model.



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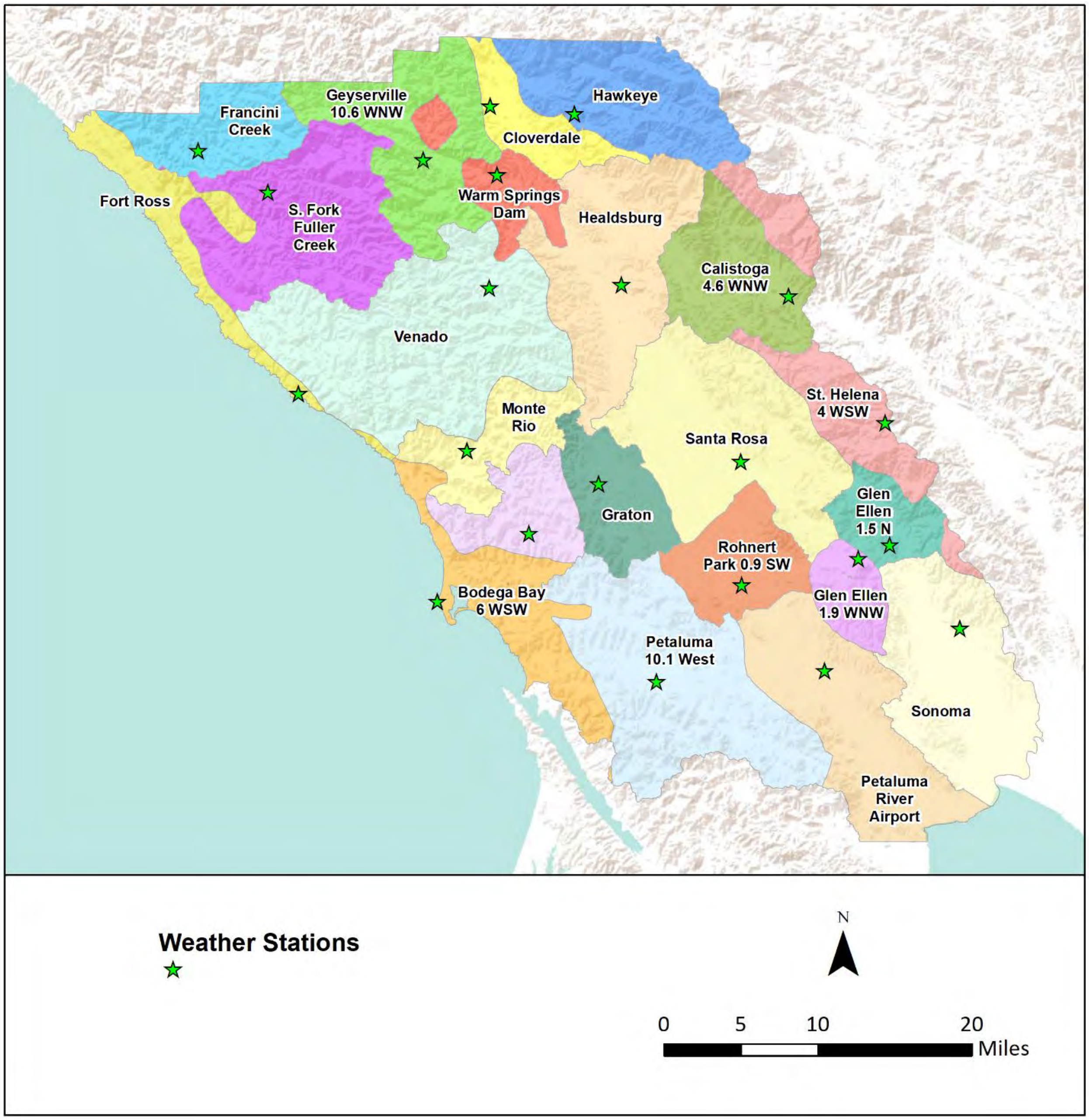

Figure 7: Precipitation zones used in the Sonoma County SWB model.

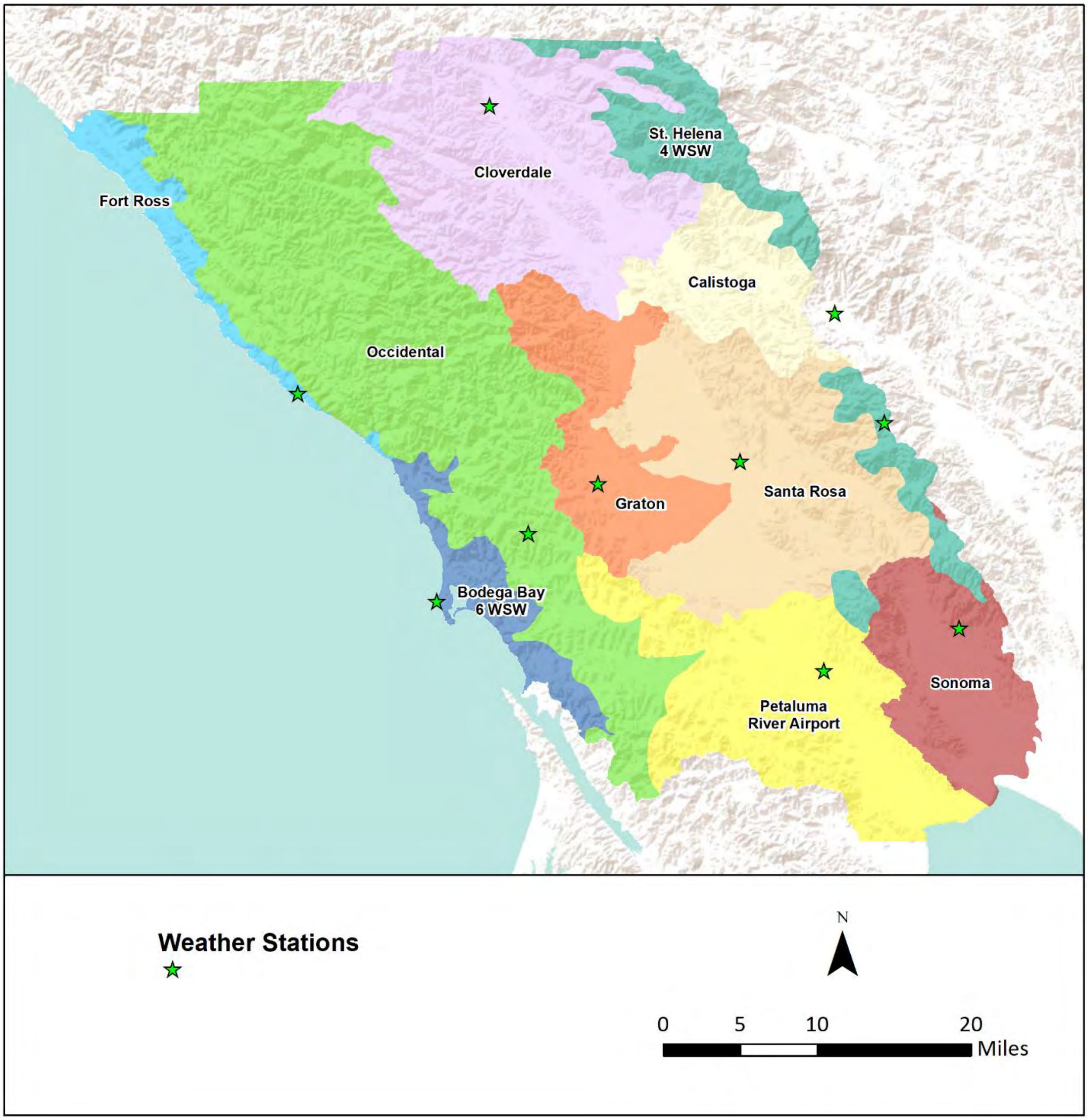

Figure 8: Temperature zones used in the Sonoma County SWB model.

Model Calibration

To provide a means of calibrating the Sonoma County SWB model, streamflow data was compiled from five gauges with available data for water year 2010 (Figure 9, Table 4). These gauges were selected because they represent relatively small watersheds 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. An overview of hydrograph separation methods may be found in Healy (2010, pp. 85-90).

We utilized the web-based Hydrograph Analysis Tool (Lim et al., 2005) to perform baseflow separations on the gauge records using the recursive digital filter method (Eckahardt, 2005) and default filter parameters for perennial streams with hard rock aquifers. Total monthly surface runoff volumes were compiled for each gauge and compared to the mean monthly surface runoff volumes predicted by SWB within each corresponding watershed area. 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 frames. The use of the total monthly surface runoff volumes provides a means of calibrating the model to measured surface runoff data within the limitations of the model's routing scheme.

The model successfully reproduced the seasonal variations in surface runoff at all five gauge locations (Figure 10). Monthly Mean Errors (ME) ranged from -0.2 to 0.4 inches with a mean value of 0.1 inches (Table 5). Monthly Root Mean Square Errors (RMSE) ranged from 0.5 to 1.5 inches with a mean value of 1.0 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 stations (Table 5). 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.

Table 4: Overview of the streamflow gauges used for calibrating the Sonoma County SWB model.

	Operated By	Drainage Area (mi^2)	Period of Record
Sonoma Creek at Kenwood, CA (#11458433)	USGS	14.3	Oct 2008 - present
Buckeye Creek	OEI	3.1	Dec 2005 - Sept. 2012
Franchini Creek	OEI	1.8	Dec 2005 - Sept. 2012
South Fork Fuller Creek	OEI	1.2	Mar 2006 - Sept. 2012
Soda Springs Creek	OEI	1.5	Dec 2005 - Sept. 2012

Notes: USGS - U.S. Geological Survey, OEI - O'Connor Environmental, Inc.

Table 5: Calibration statistics for the Sonoma County SWB model calibration.

	Annual Simulated Surface Runoff (in)	Annual Observed Surface Runoff (in)	Annual PE	Monthly ME (in)	Monthly RMSE (in)
Sonoma Creek	12.7	11.7	8.1%	0.1	0.6
Buckeye Creek	31.6	26.5	19.2%	0.4	1.2
Franchini Creek	22.1	24.5	-9.6%	-0.2	1.0
South Fork Fuller Creek	24.1	21.9	10.2%	0.2	1.5
Soda Springs Creek	24.2	24.1	0.6%	0.0	0.5
MEAN	**23.0**	**21.7**	**5.7%**	**0.1**	**1.0**

Notes: PE - Percent Error, ME - Mean Error, RMSE – Root Mean Square Error

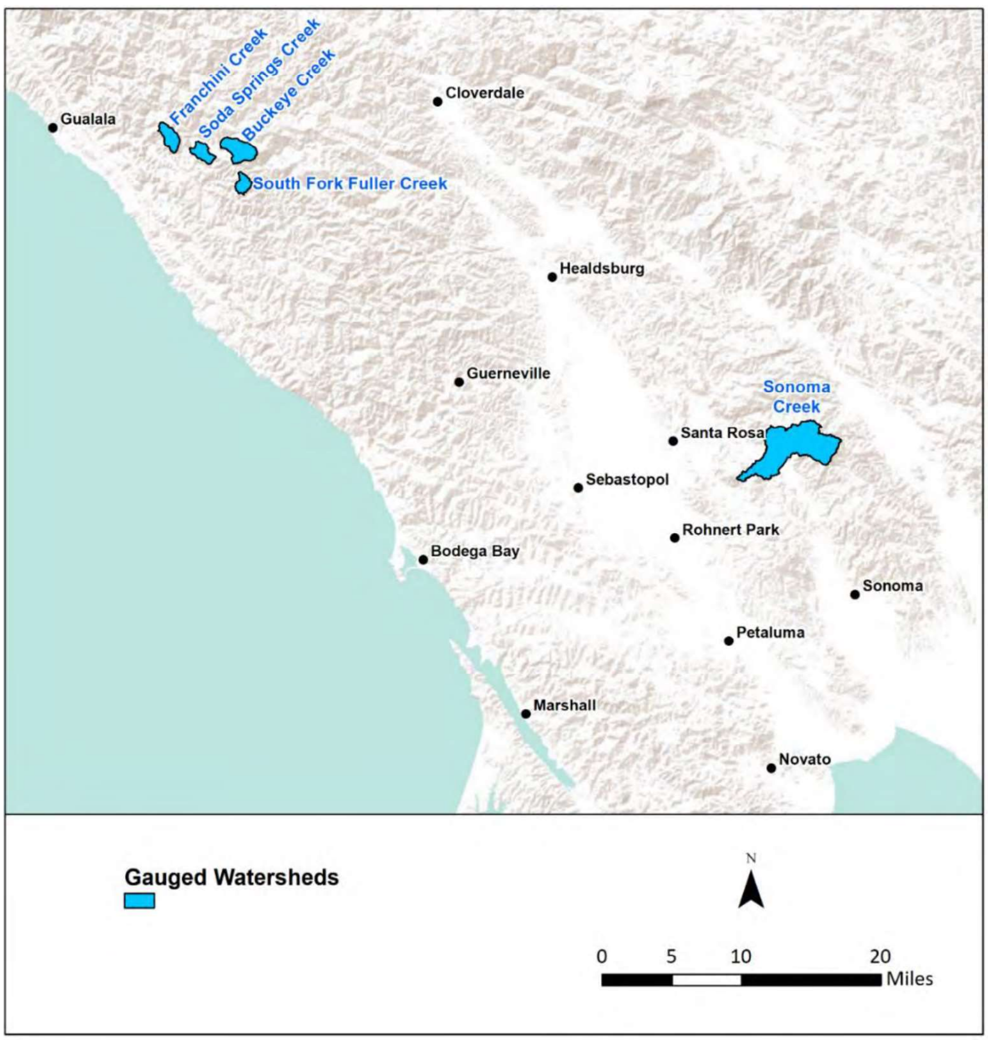

Figure 9: Gauged watersheds used to calibrate the Sonoma County SWB model.

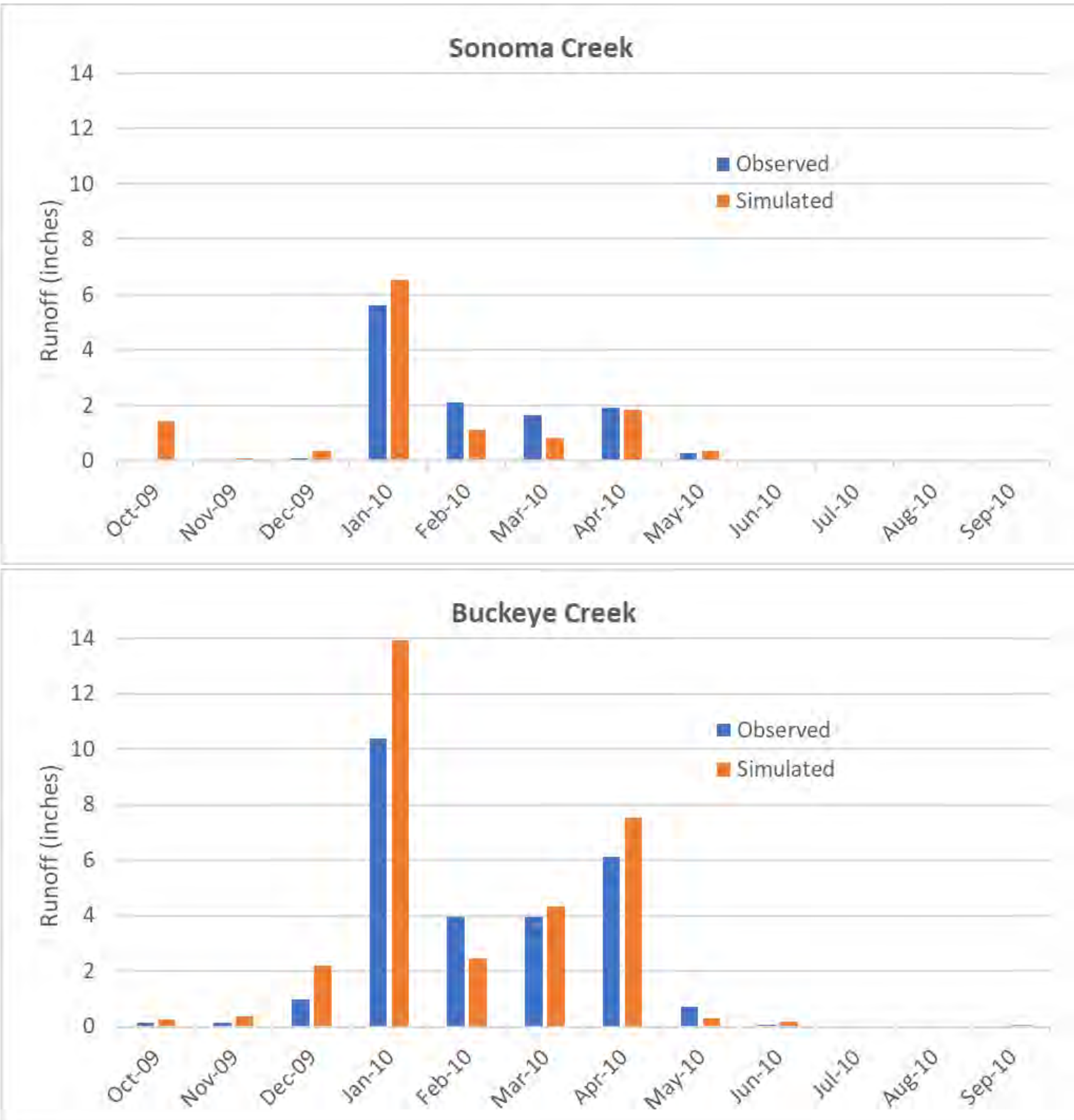

Figure 10: Comparison between monthly surface runoff computed from hydrograph separation at streamflow gauges and monthly surface runoff simulated with the Sonoma County SWB model.

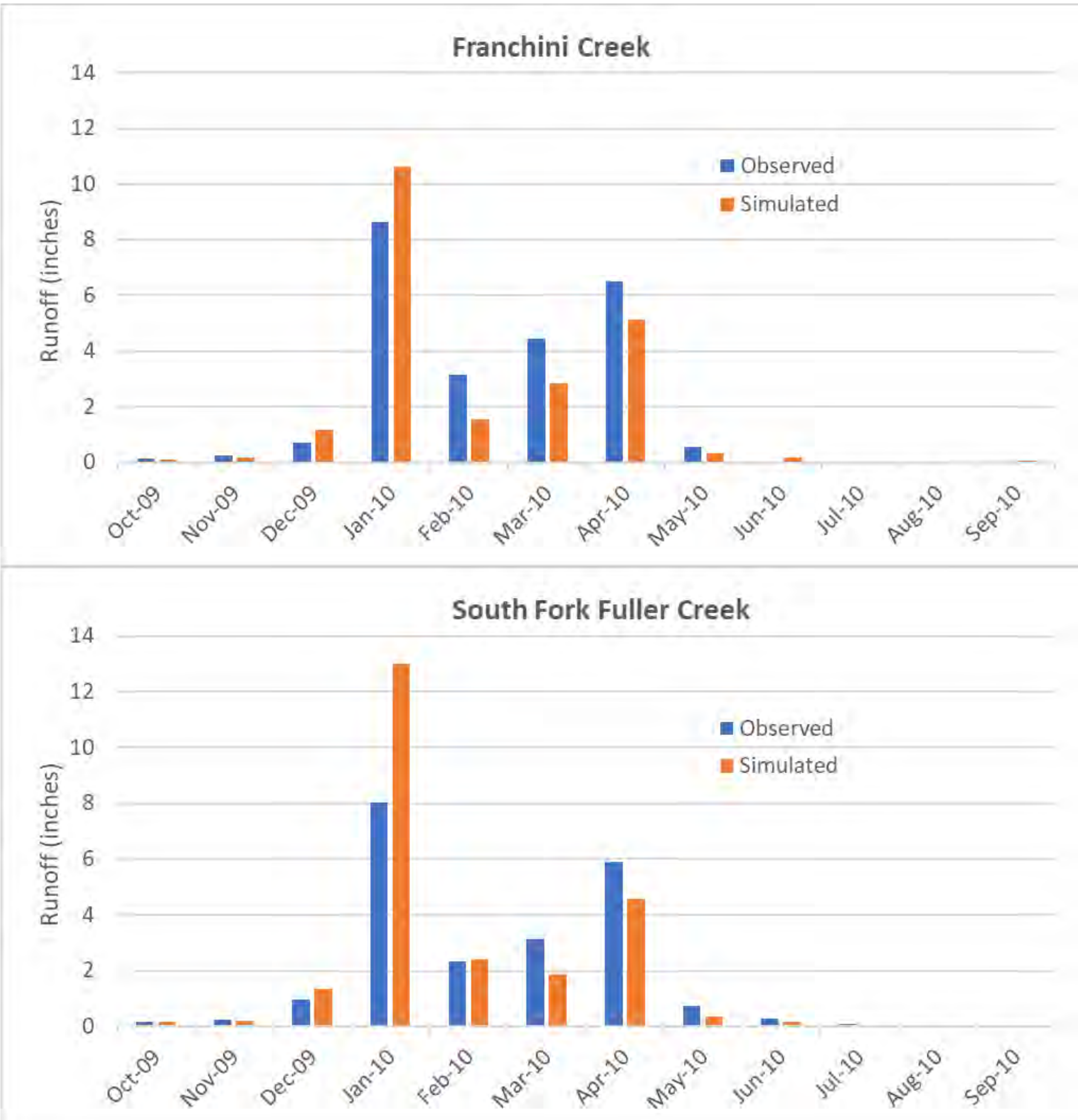

Figure 10 (continued)

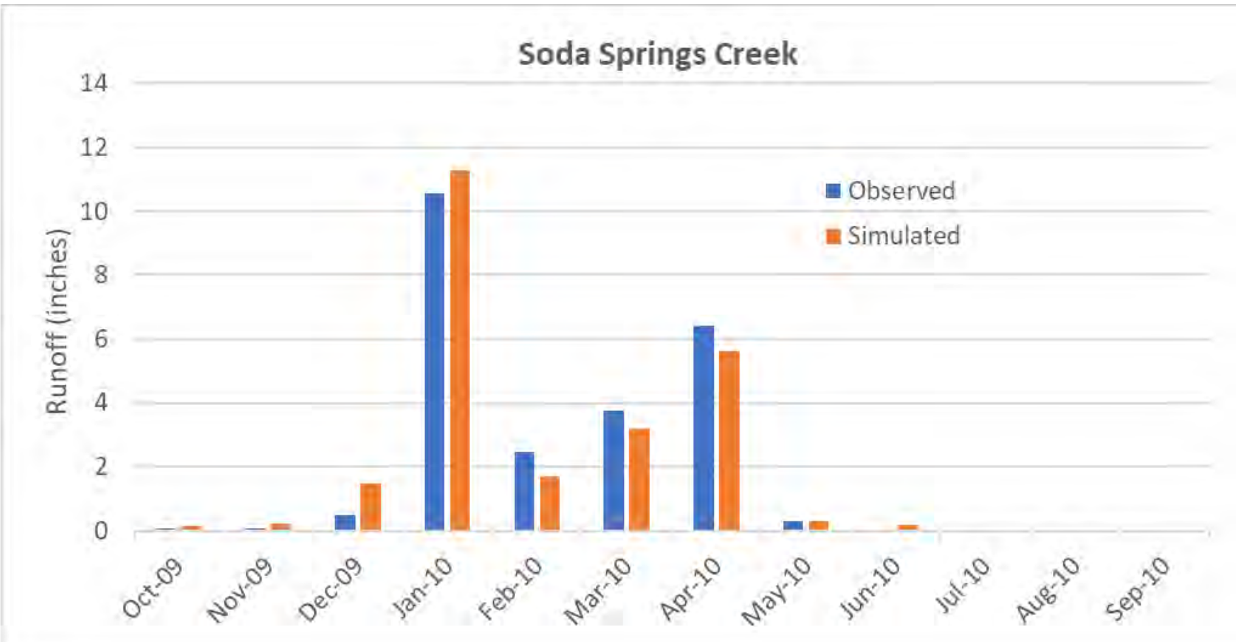

Figure 10 (continued)

Model Results

The principal elements of the annual water budget simulated with the Sonoma County SWB model for water year 2010 are shown in map form in Figures 12 through 16 and in tabular form (sorted by total annual precipitation) for 23 major watershed areas in the county in Table 6. The watersheds areas are a modified version of the USGS HUC-10 watersheds and are named for the stream which comprises the largest proportion of the area; although in many cases the areas consist of multiple tributary streams (Figure 11).

Water year 2010 precipitation varied from 26.1 inches in the Lower Sonoma Creek watershed to 70.7 inches in the Austin Creek watershed (Table 6, Figure 12). Actual evapotranspiration (AET) ranged from 17.9 inches in the San Antonio Creek watershed to 29.5 inches in the Pena Creek watershed (Table 6, Figure 13). Surface runoff ranged from 4.0 inches in the Lower Sonoma Creek watershed to 28.1 inches in the Austin Creek watershed (Table 6, Figure 14). Recharge ranged from 5.0 inches in the Lower Sonoma Creek watershed to 16.4 inches in the Austin Creek watershed (Table 6, Figure 15). Small decreases in soil moisture storage (up to 0.8 inches) occurred in 16 of the 23 watersheds and small increases (up to 0.8 inches) occurred in the remaining watersheds (Table 6, Figure 16).

When expressed as a percentage of the annual precipitation, AET ranged from 37% in the Austin Creek watershed to 69% in the Lower Sonoma Creek watershed (Table 7). Surface runoff ranged from 15% of precipitation in the Lower Sonoma Creek watershed to 40% in the Austin Creek watershed. The variations in recharge as a percentage of precipitation is relatively narrow ranging from 19% in the Lower Sonoma Creek watershed to 27% in the Salmon Creek watershed (Table 7).

Table 6: Water budgets simulated with the Sonoma County SWB model for water year 2010 (see Figure 11 for locations).

Watershed	Drainage Area (sq. mi.)	Precipitation (in)	AET (in)	Surface Runoff (in)	Recharge (in)	Soil Moisture Change (in)
Lower Sonoma Creek	120	26.1	18.0	4.0	5.0	-0.8
San Antonio Creek	79	29.6	17.9	6.0	6.4	-0.7
Petaluma River	76	31.4	19.3	5.9	6.9	-0.7
Chileno Creek	145	33.3	19.1	7.0	7.9	-0.6
Upper Laguna De Santa Rosa	62	36.2	21.6	8.0	7.5	-0.8
Mark West Creek	161	43.3	26.6	8.7	8.5	-0.5
Lower Laguna De Santa Rosa	31	43.6	25.8	9.6	9.0	-0.8
Upper Sonoma Creek	45	46.4	24.1	13.4	9.4	-0.4
Sausal Creek	46	47.8	24.3	13.4	10.8	-0.8
Maacama Creek	97	47.9	25.4	12.6	10.6	-0.7
Salmon Creek	53	48.7	22.3	13.2	13.1	0.2
Atascadero Creek	38	50.2	28.1	12.7	10.0	-0.6
Big Sulphur Creek	130	52.6	26.2	16.5	10.5	-0.5
Lower Dry Creek	42	53.5	26.4	17.2	10.7	-0.7
Willow Creek	24	53.9	22.8	18.2	12.7	0.2
Mill Creek	53	55.4	27.7	17.1	11.3	-0.6
Upper Dry Creek	89	57.4	27.0	20.0	10.9	-0.5
Dutch Bill Creek	55	57.7	25.2	18.6	13.7	0.1
Wheatfield Fork Gualala River	145	61.4	26.0	20.9	14.0	0.5
Pena Creek	23	63.0	29.5	21.6	12.5	-0.5
Buckeye Creek	60	65.7	26.4	24.0	14.4	0.8
South Fork Gualala River	65	68.2	25.7	26.2	16.1	0.1
Austin Creek	70	70.7	26.1	28.1	16.4	0.0

Table 7: Water budgets simulated with the Sonoma County SWB model for water year 2010 expressed as a percentage of annual precipitation (see Figure 11 for locations).

Watershed	Drainage Area (sq. mi.)	Precipitation (in)	AET (%)	Surface Runoff (%)	Recharge (%)
Lower Sonoma Creek	120	26.1	69%	15%	19%
San Antonio Creek	79	29.6	60%	20%	22%
Petaluma River	76	31.4	62%	19%	22%
Chileno Creek	145	33.3	57%	21%	24%
Upper Laguna De Santa Rosa	62	36.2	59%	22%	21%
Mark West Creek	161	43.3	61%	20%	20%
Lower Laguna De Santa Rosa	31	43.6	59%	22%	21%
Upper Sonoma Creek	45	46.4	52%	29%	20%
Sausal Creek	46	47.8	51%	28%	23%
Maacama Creek	97	47.9	53%	26%	22%
Salmon Creek	53	48.7	46%	27%	27%
Atascadero Creek	38	50.2	56%	25%	20%
Big Sulphur Creek	130	52.6	50%	31%	20%
Lower Dry Creek	42	53.5	49%	32%	20%
Willow Creek	24	53.9	42%	34%	24%
Mill Creek	53	55.4	50%	31%	20%
Upper Dry Creek	89	57.4	47%	35%	19%
Dutch Bill Creek	55	57.7	44%	32%	24%
Wheatfield Fork Gualala River	145	61.4	42%	34%	23%
Pena Creek	23	63.0	47%	34%	20%
Buckeye Creek	60	65.7	40%	37%	22%
South Fork Gualala River	65	68.2	38%	38%	24%
Austin Creek	70	70.7	37%	40%	23%

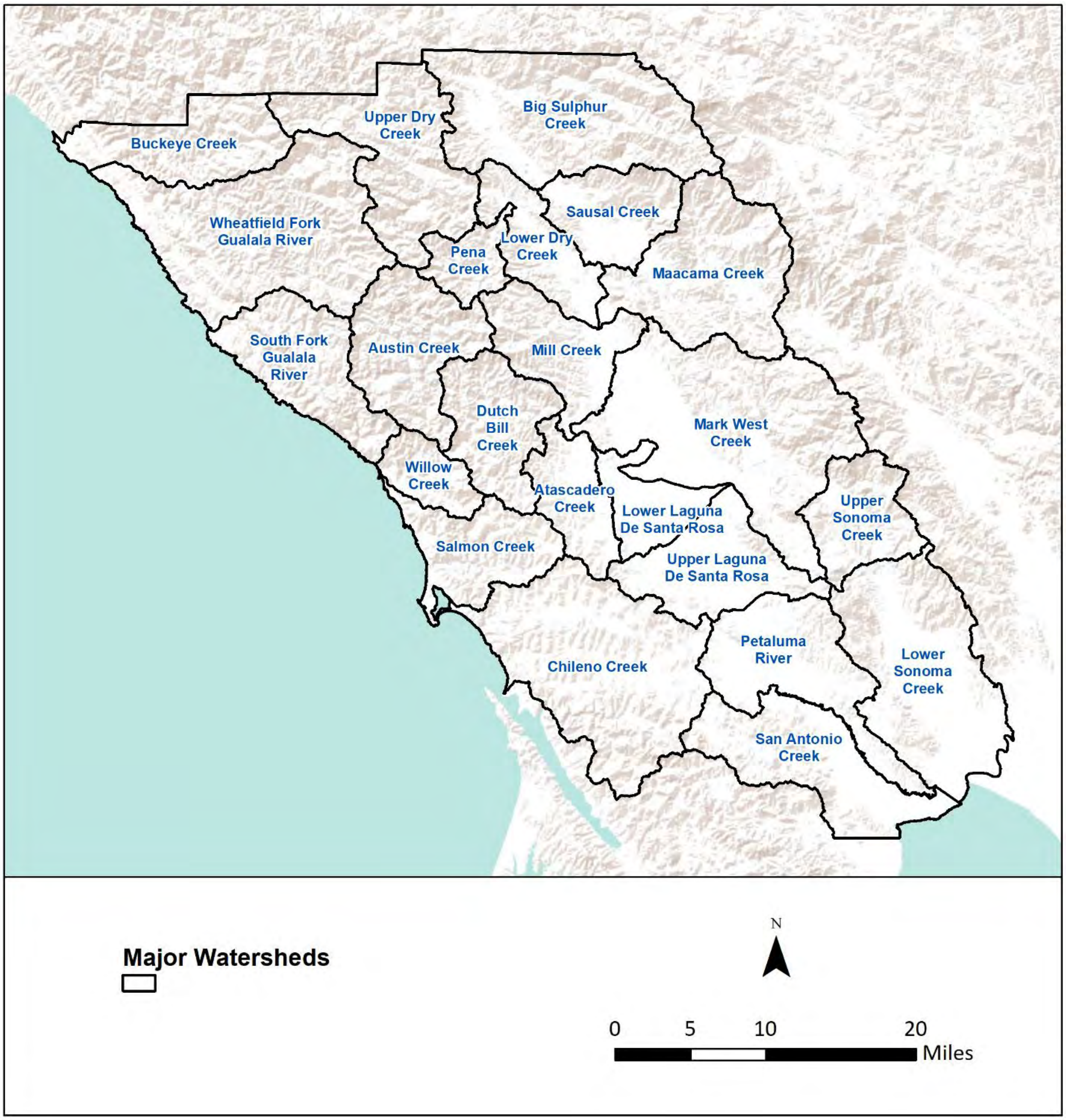

Figure 11: Major watersheds areas used to summarize water budget information in Tables 6 & 7).

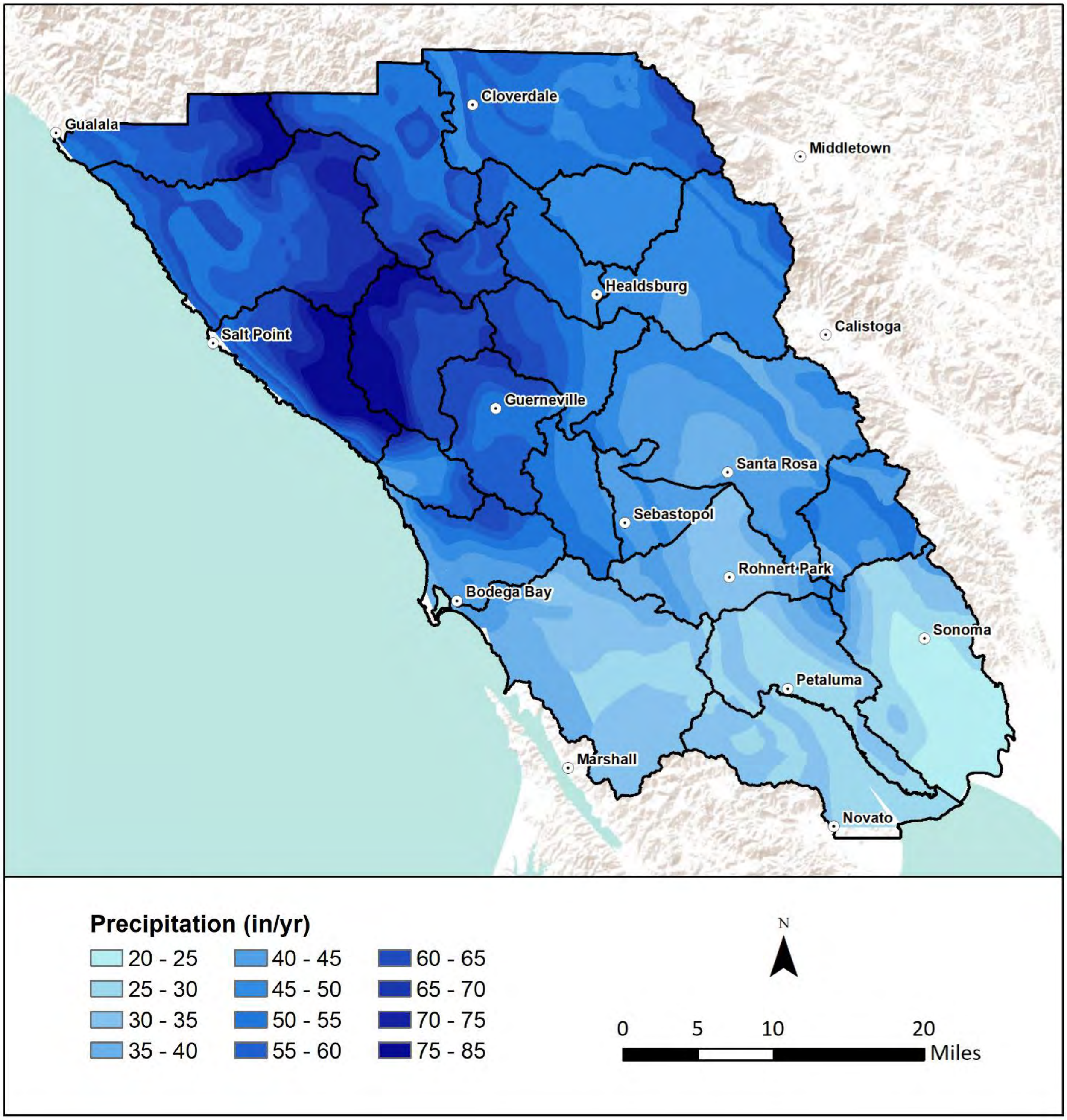

Figure 12: Water year 2010 Precipitation simulated with the Sonoma County SWB model.

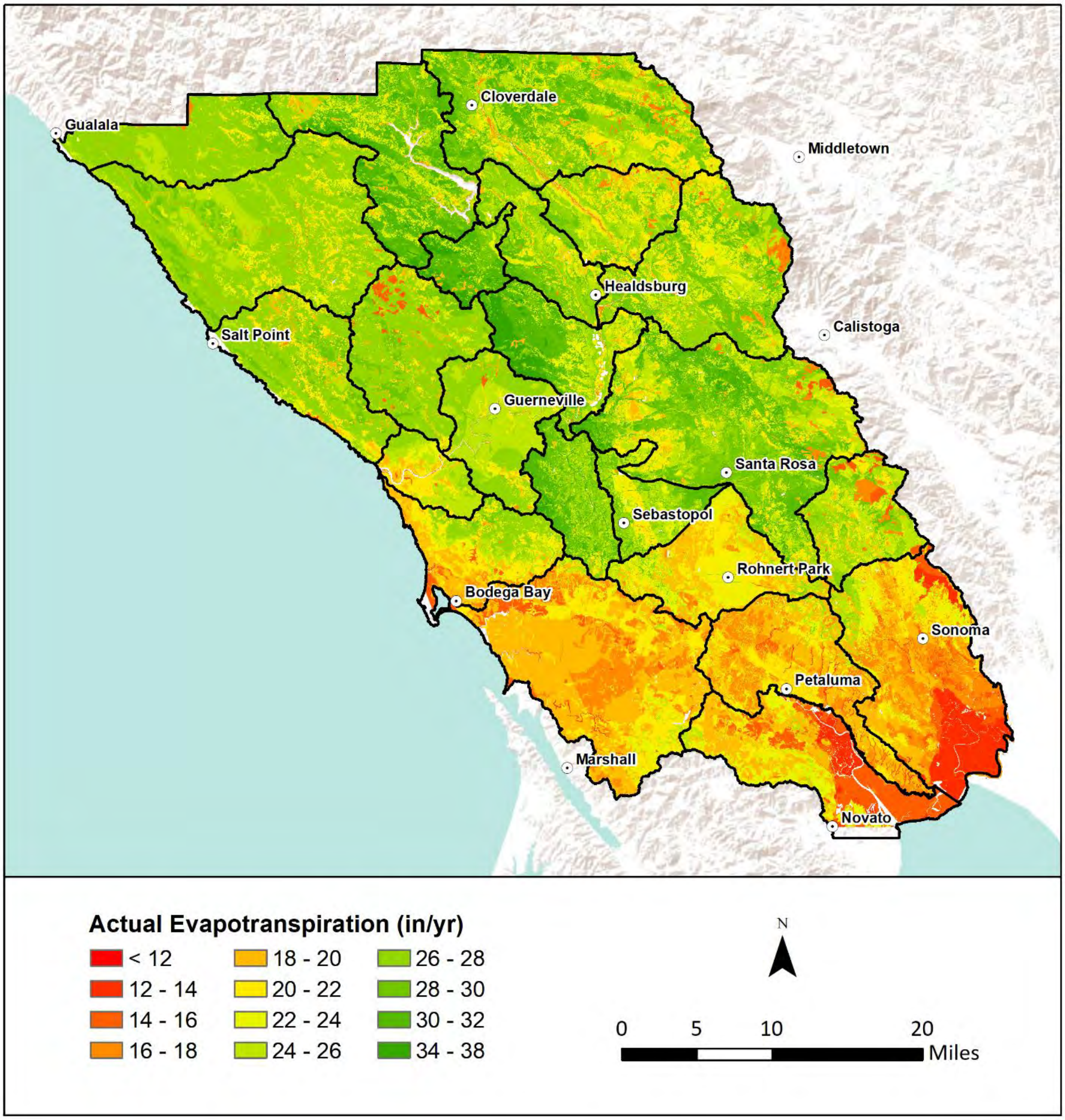

Figure 13: Water year 2010 Actual Evapotranspiration (AET) simulated with the Sonoma County SWB model.

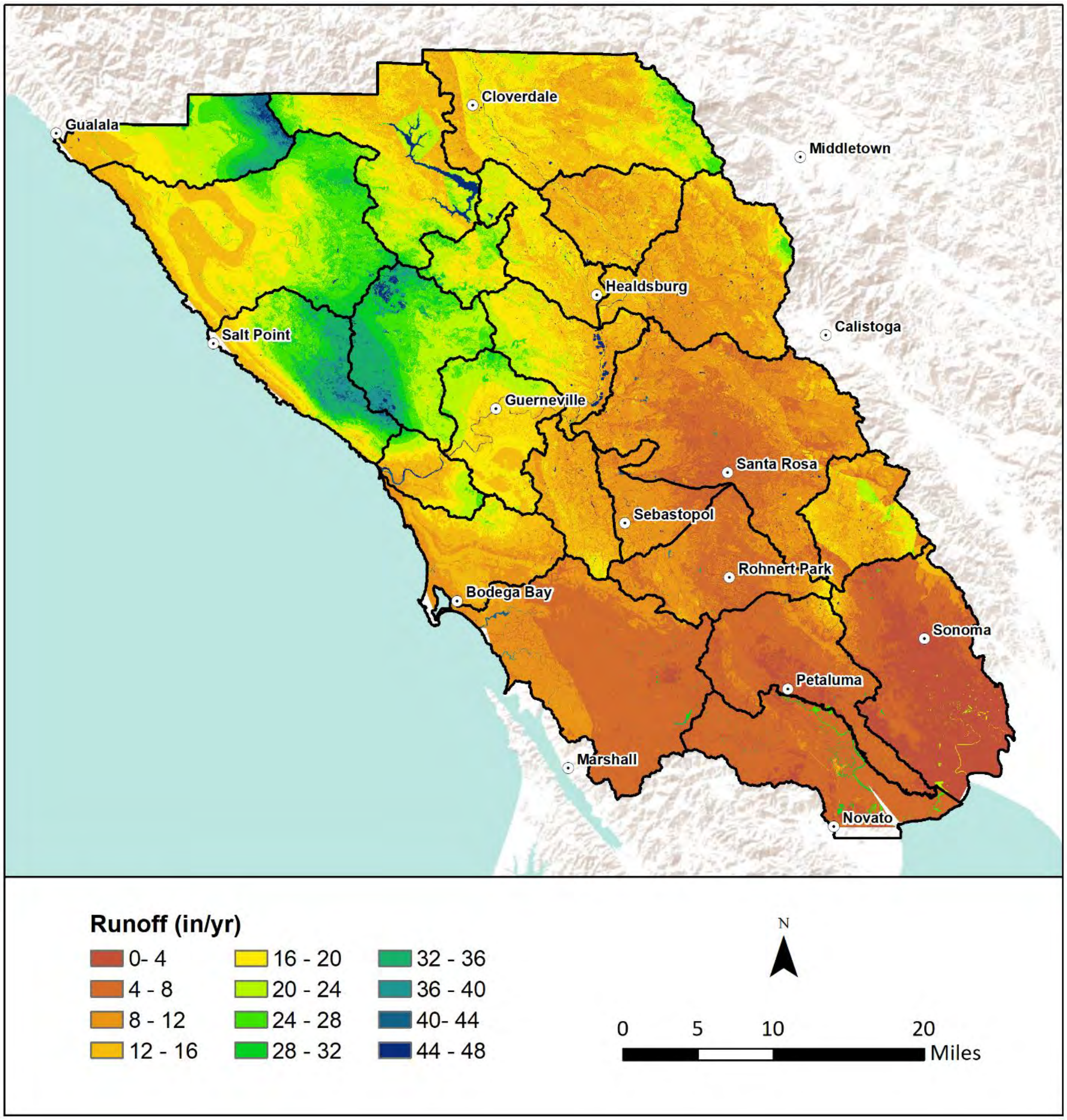

Figure 14: Water year 2010 Surface unoff simulated with the Sonoma County SWB model.

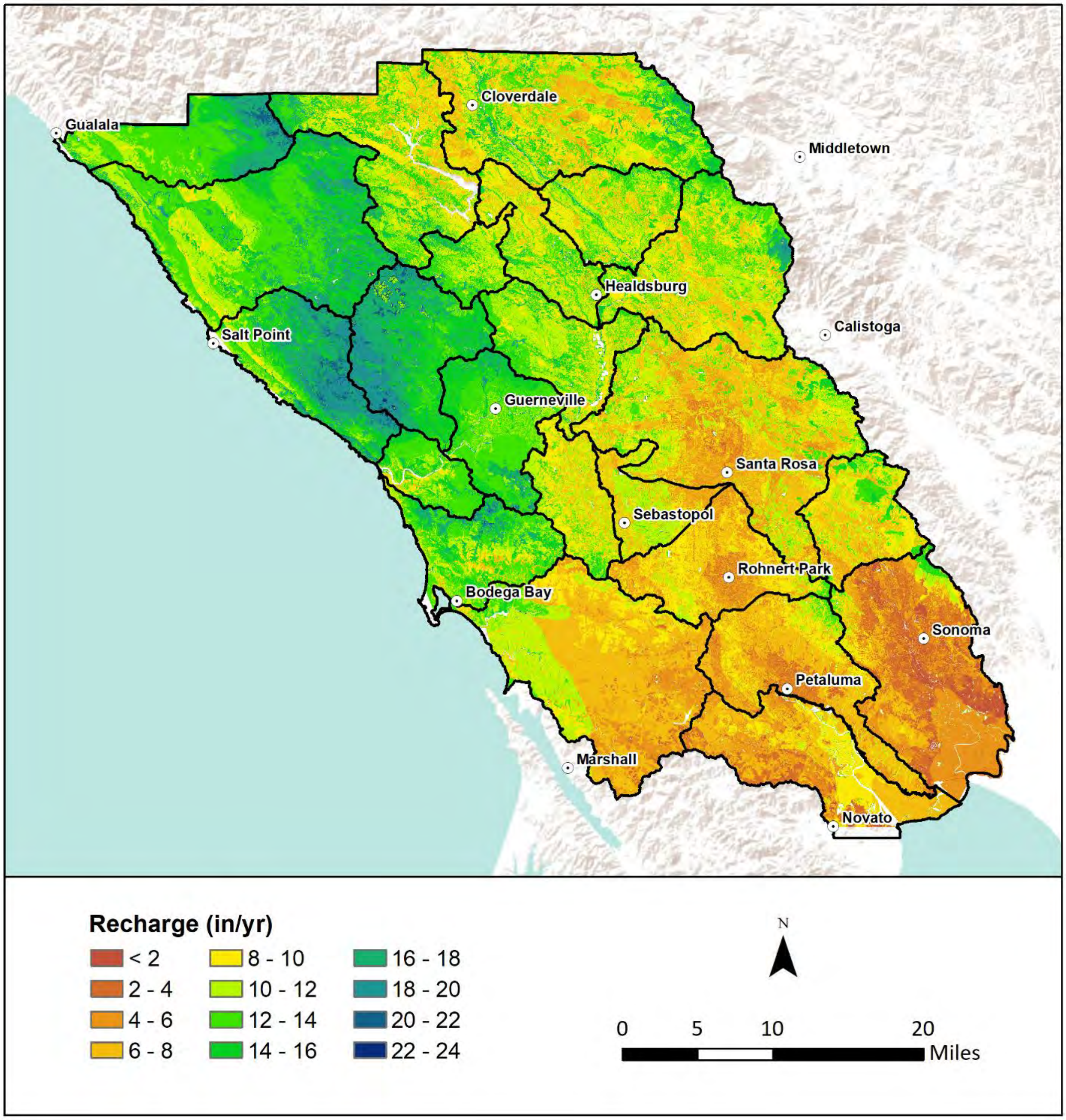

Figure 15: Water year 2010 Recharge simulated with the Sonoma County SWB model.

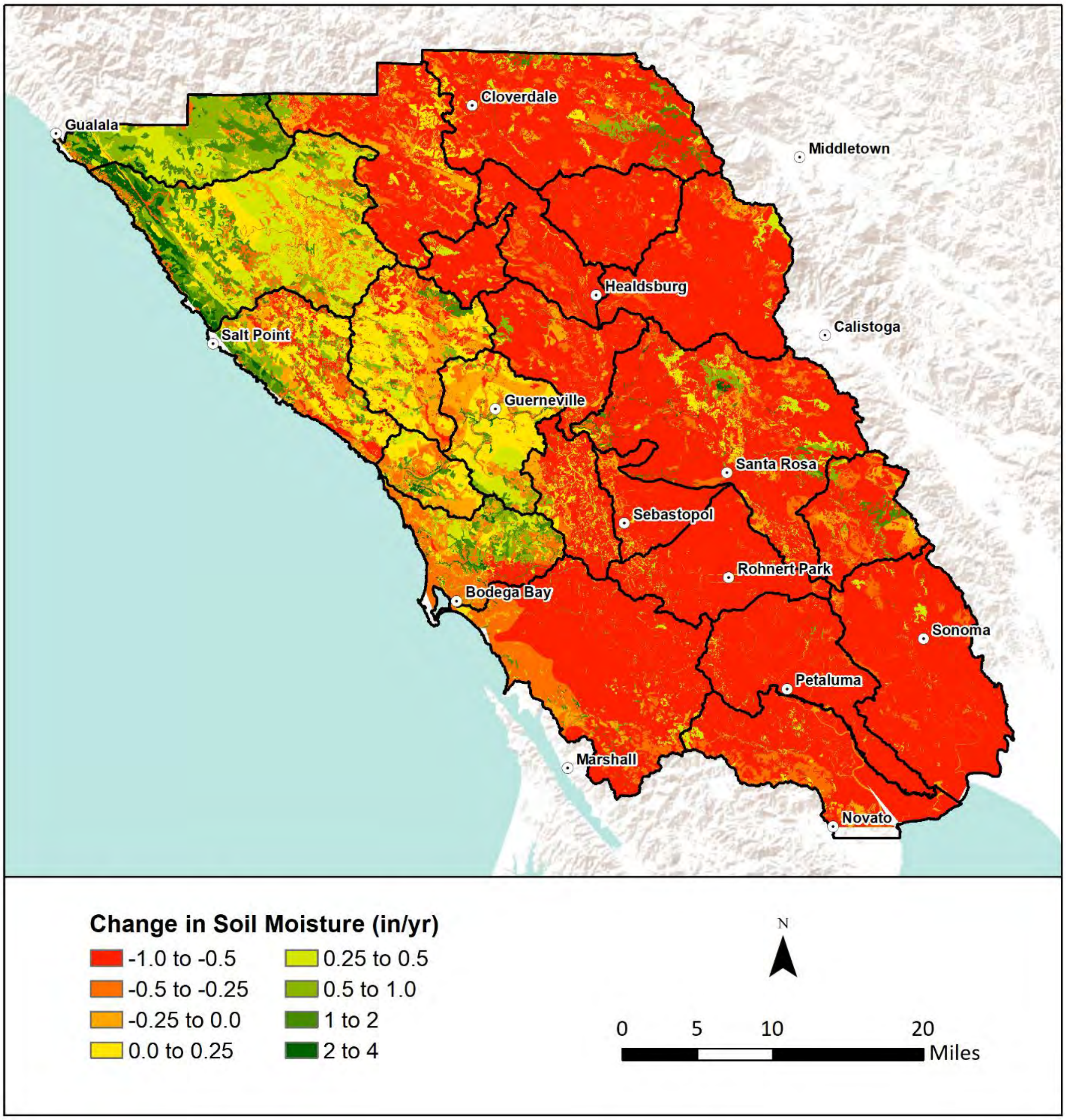

Figure 16: Water year 2010 Soil Moisture Change simulated with the Sonoma County SWB model.

Discussion and Conclusion

Previous modeling studies have estimated water budget components in several larger watershed areas in the county 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. 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 estimated that AET was equivalent to between 44% and 49% of mean annual precipitation which is consistent with this analysis where the county-wide AET was equivalent to 48% of the annual precipitation. The regional analyses estimated that surface runoff ranged from 37 to 55% of the annual precipitation which is somewhat higher than this analysis where the equivalent county-wide value was 29%. In the regional analyses, recharge varied from 7% to 19% of the annual precipitation. The equivalent county-wide value from this study is somewhat higher at 22%.

At the local scale, the simulation results indicate sensitivity of the water budget components to variations in topographic position, land cover, and soil texture, however at the watershed scale much of the variation in the principal water budget components (AET, surface runoff, and recharge) are correlated with variations in precipitation across the county (Figure 17). AET increases as a function of precipitation in watersheds with annual precipitation up to about 45 in/yr. Above 45 in/yr AET remains relatively constant (average of about 27 in/yr). This suggests that in portions of the county experiencing low precipitation, AET is limited by available soil moisture in contrast to areas of the county with higher precipitation where AET is limited by the potential ET. Although surface runoff varies more or less linearly as function of precipitation (Figure 17), the slope of the relationship with precipitation increases above precipitation of about 45 in/yr. This suggests that surface runoff increases with precipitation more sharply where precipitation is great enough to fully satisfy potential ET. Recharge also varies linearly as a function of precipitation (Figure 17).

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. The current analysis focused on a single water year, 2010, and was calibrated to streamflow gauge-derived monthly surface runoff rates at five locations. Future work to expand the analysis to additional water years and calibrate to additional gauge locations would help to further evaluate, refine, and quantify the uncertainty associated with the model's recharge estimates.

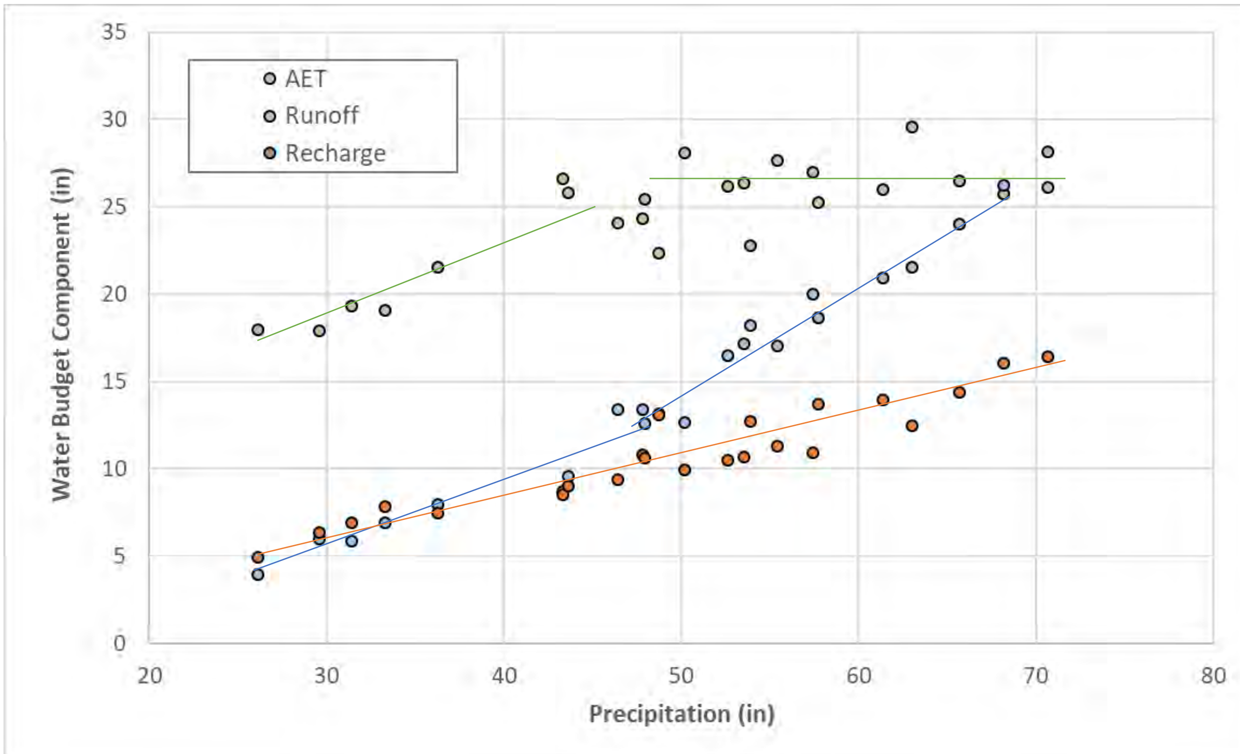

Figure 17: Principal water budget components simulated with the SWB model for major watersheds in Sonoma County as a function of annual precipitation. Trend lines fit by eye.

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