PRECISION SOIL MAP AND SOIL INTERPRETATIONS

7131 NE Highway 240 Yamhill, Oregon

By: Andy Gallagher
Red Hill Soils
Corvallis, Oregon

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Andy Gallagher, Soil Scientist PO Box 2233 Corvallis, OR 97333
Red Hill Soils
541-745-7878 avg@redhillsoil.com

INTRODUCTION

The goal of this precision soil mapping project is to provide detailed soil maps and site-specific interpretations for the planning, development, and management of the vineyards. Detailed soil mapping in other vineyards of the Willamette Valley has demonstrated that soils are more diverse than they are at the scale of the NRCS soil survey or Websoil survey, which are mapped at 1:20,000 scale. Detailed and precise soil maps and soil information are important because soil diversity and soil quality within the vineyard can profoundly affect winegrape management and quality.

This soil map and site evaluation was done on about 60 acres of an 80-acre parcel. The land is currently in cropland grass seed and small grain type crops, and had been freshly tilled and was being planted on the day of the field work.

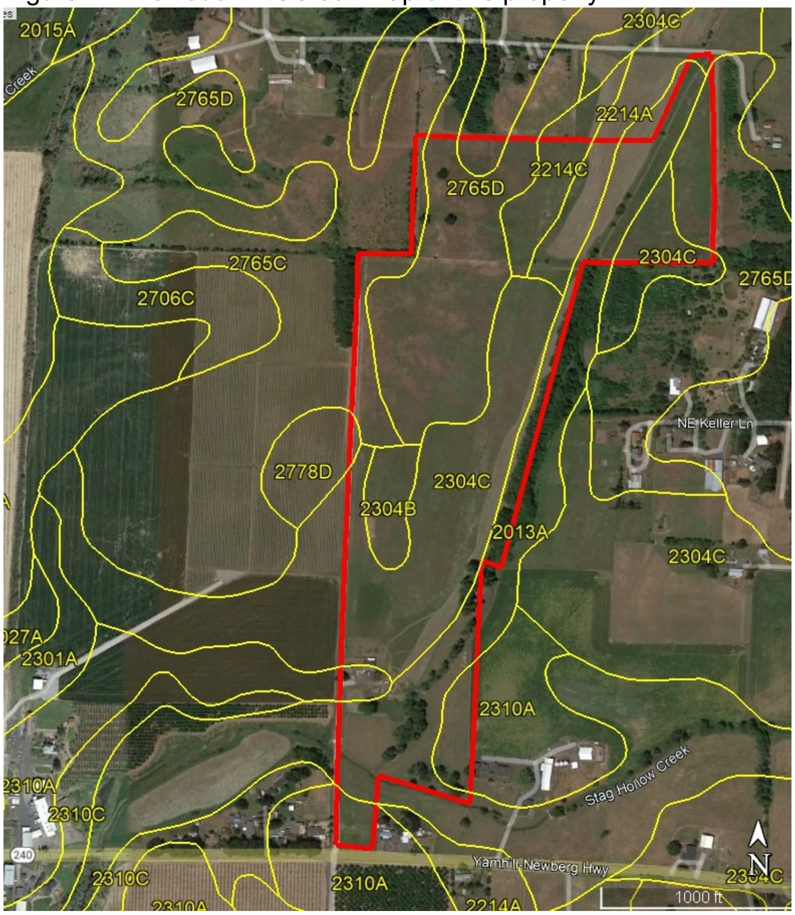
Soil mapping project objectives include:

1) Sample soils at a high intensity to better define variability in a precision soil map and report important site-specific soil data such as depth, drainage class, parent material and available water holding capacity.
2) Report results of soil mapping and soil interpretations relevant to management of the vineyard.
3) Produce precision soil map based on high intensity soil mapping.
4) Provide relevant terrain information in a detailed topographic map.
5) Sample representative parts of the site for laboratory analysis and provide interpretations of the soil fertility and chemistry data.
6) Report soil sample GPS locations.

Previous NRCS Soil Mapping

The USDA-NRCS soil map delineated most of this area as Figure 1.

Figure 1. Previous NRCS soil map of this property.



Map Symbol	Map Unit Name
2013A	Wapato, 0 to 3 percent slope
2214C	Chehalem, 3 to 12 percent slope
2304B	Carlton, 0 to 7 percent slope
2304C	Carlton, 7 to 12 percent slope
2310A	Woodburn, 0 to 3 percent slope
2765D	Goodin-Dupee-Chehulpum , 12 to 20 percent slope
2778D	Panther, 2 to 25 percent slope

Geology and Terrain

The bedrock geology of these foothills is Marine Sedimentary rocks, and there is a thin veneer of Missoula silts. The footslope blends into terrace of deep Missoula flood sediments and in the bottomland the soils formed in recent silty alluvium.

Yamhill Formation (Eocene)—Massive to thin-bedded and laminated dark-gray siltstone with minor tuff and sandstone. Tuffaceous, thin-bedded mudstone near base of Yamhill Formation contains white silicic tuff beds as much as 30 cm thick. Forms lowlands and low hills covered by thin mantle of Missoula flood silt below 400-ft elevation. (Wells and others, 2014)

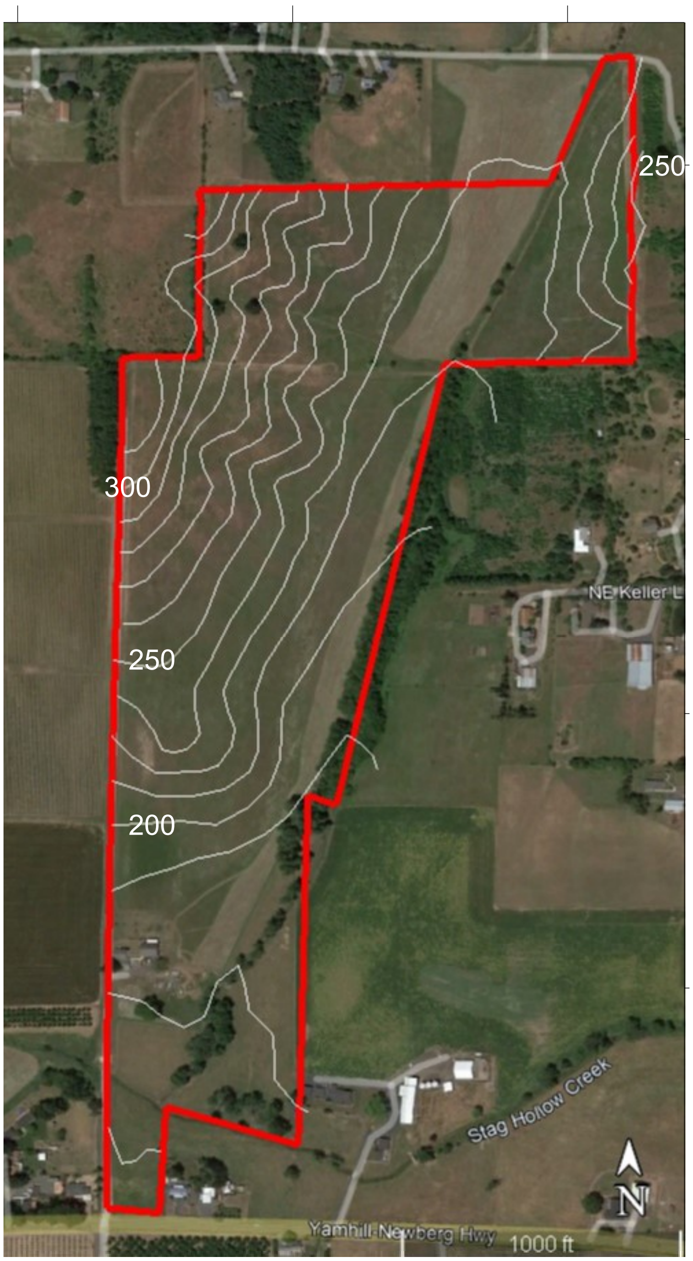


Figure 2. Topographic map with 10 ft contour interval.

The elevation of the site ranges from 306 feet on the bench down to 175 feet m.s.l. at the creek on the south side (Figure 2). This provides over 125 feet vertical relief across the property. Lower-lying areas, those with only about 20 feet of relief above the creek correspond with wetter and more fertile soils and greater frost risk. Slopes are east and southeast on the big field and west on the small field in the northeast corner. The slope gradients are from 10 to 22 percent. There are several narrow drainage swales on the slopes.

Soil Sampling and Mapping

Number of soil test pits: 15.

Average sampling intensity: one pit per two acres.

Soil test pits were sampled within the survey area to classify soils and to record important soil properties. These data were used to classify soils and to make a high intensity soil map. Soil test pits were dug to five feet deep or to the contact with hard rock if shallower. Soil sample locations were selected based on terrain, surface conditions and accessibility.

Soils were classified according to USDA-Soil Taxonomy. Soil characteristics were compared to the current Official Series Descriptions (OSD's) from the USDA-NRCS. Slopes were classified using a digital elevation model for slope gradient and slope aspect. Soil colors were determined using Munsell Soil Colors. Available water holding capacity (AWHC) for each soil was estimated based on soil texture, structure, coarse fragments, depth to rock and available water retention data for these soil series.

Soil characteristics such as drainage class, depth to bedrock, depth to gravel, depth to clayey paleosol, surface thickness, soil texture of the surface and the subsoil were recorded.   Soil test pit's locations were fixed with GPS. Interpretations for viticulture are made based on these data. Representative soil samples from surface and subsoil samples layers were analyzed at a commercial laboratory to get baseline fertility and soil chemical data to help characterize this site for winegrapes. These data are summarized, and fertilizer and lime recommendations are provided.

RESULTS

Summary data from each soil profile are presented in Table 1 and corresponding soil profile locations and revised soil map based on these data is shown in Figure 3.

Based on soil classification of 15 soil profiles and terrain analysis, approximately 34 acres have suitable soil and terrain for vineyard. Acres not included in this estimate are low lying areas where soils have seasonal high water table, high fertility and that are higher risk of late frost because of terrain. The soils here are typical of the Yamhill-Carlton AVA foothills, formed in marine sedimentary rock, with varying depth to weathered tuffaceous siltstone and sand stone. There is a varying thickness of Missoula Flood silty sediment, thickest on the lower terrace and thinner to absent on the higher benches. The ridge top is shallow Chehulpum soils with inclusions of moderately deep Steiwer soils. These soils were formed under prairie and oak savanna and are on the more convex ridges and plunging nose slopes.

Down slope from these and on more linear slopes are very clayey soils like Helmick and soils that are transitional between Dupee, Wellsdale and Carlton. I found one spot of poorly drained soil similar to Panther on the footslope (sample 8) it was less than a tenth acre. There are two main slope areas with both suitable soils and suitable terrain, and they are separated by the creek/ditch and poorly drained bottomland. The western side is the larger and is about 31 acres while in the northeastern corner there is an area of about three acres suitable soils above the bottomland and on the slope.

Grapevines grown in the shallower soils and in the more clayey soils like Helmick would benefit from irrigation because they have low to moderate available water holding capacity.

The lower and wetter soils can be planted to grapes but based on past experience these are less likely to produce higher quality wine. These will be at higher risk of frost damage and would probably need frost protection.

This report focuses on soil variability within the future vineyard blocks to provide more detailed mapping than the previous soil survey made by USDA-NRCS. Interpretations for vineyards are based on the soil properties observed in this fieldwork.

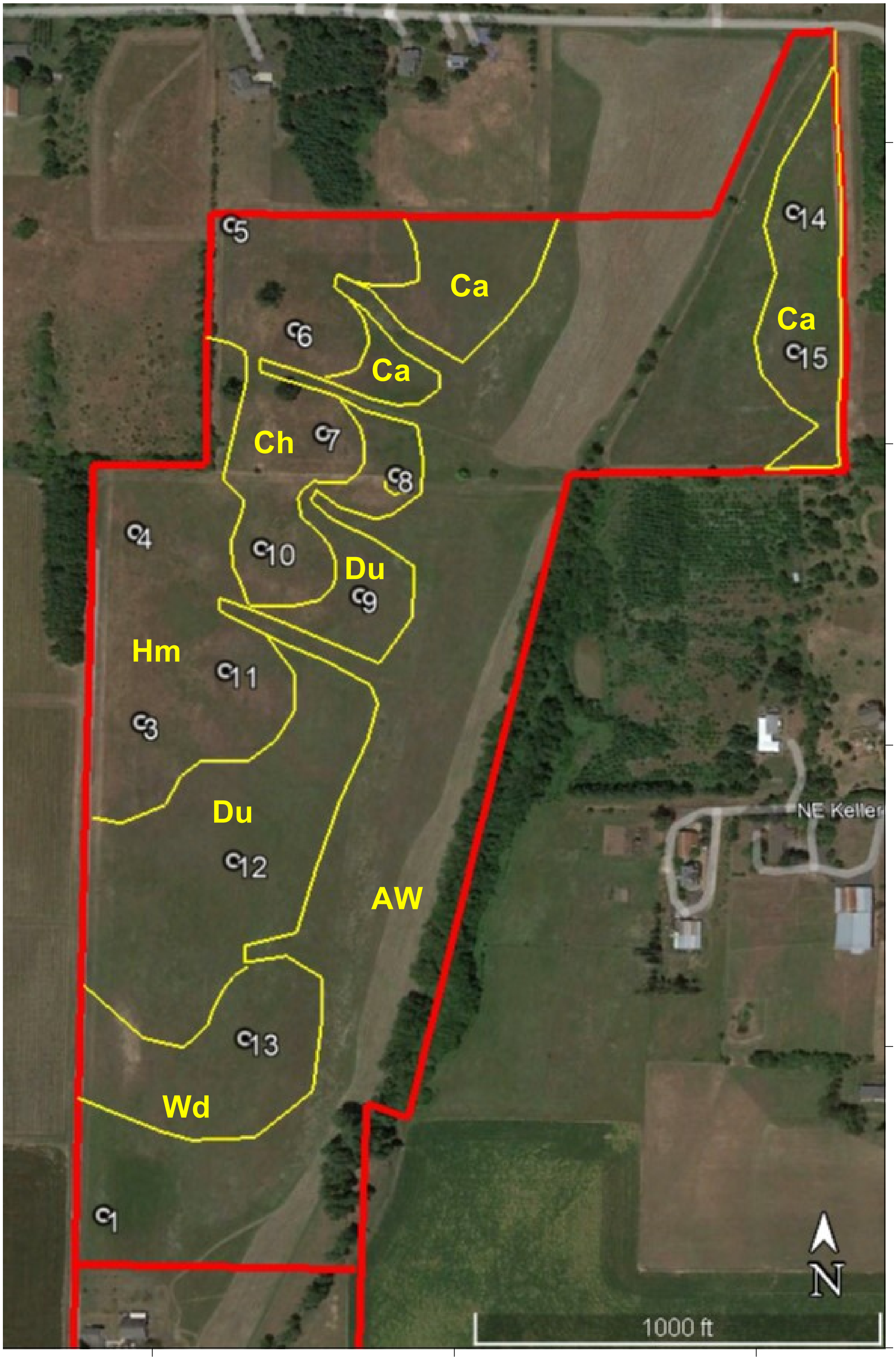


Figure 3. Revised Soil Map

Table 1. Summary of soil properties from soil profile data. Numbers correspond to samples in Figure 1.

Sample	Soil Series	Surface Thickness	Depth to Clay	Depth to very gravelly	Depth to Marine Sedimentary Bedrock	Depth to Seasonal Water table	Available Water Holding Capacity
		in	in	in	in	in	in
1	Amity	17	-	-	-	12	12
2	Helmick	11	11	51	51	6	7
3	Helmick	17	24	52	52	24	8
4	Helmick	15	15	51	51	15	8
5	Steiwer	18	--	28	28	--	7
6	Chehulpum (fill)	13	--	13	13	--	3
7	Chehulpum	14	--	14	14	--	4
8	Panther	6	6	--	--	0	No data
9	Dupee	13	13	27	27	8	6
10	Chehulpum	18	--	18	18	--	5
11	Helmick	14	9	40	40	14	8
12	Dupee	21	21	>60	>60	13	10
13	Wellsdale	29	--	>60	>60	29	12
14	Carlton	33	--	>60	>60	33	12
15	Carlton, clayey substratum	20	20	--	>60	20	9

Soil Map Units in Revised Soil Map

Soil Series Properties

Ch Chehulpum

Depth to weathered Bedrock: Shallow 12 to 20 inches.
AWHC: 3 to 5 inches
Drainage Class: Well drained
Description: Chehulpum soils are shallow to weathered siltstone and sandstone. They have weakly developed subsoil horizons and are often dark surface layer sitting directly on weathered sedimentary rocks. The rooting depth depends on how fractured and weathered the rocks are but typically there are clay-filled fissures in the rocks that allow some of the roots to penetrate deeply. On this site part of this area was previously disturbed and the upper part of the soil profile is fill (sample 6), and appears to have been site of a building pre-1985 (earliest imagery available). These soils can be droughty in late summer and irrigation improves vine growth. These are well drained and do not need artificial drainage. There are inclusions of slightly deeper Steiwer soils in this map unit (sample 5, described below.)

Steiwer

Depth to Weathered Bedrock: moderately deep 20 to 40 inches to sedimentary rocks
AWHC: 4 to 7 inches
Drainage Class: Well drained
Description: These soils formed under prairie and oak savannah and normally have thick dark silty loam and silty clay loam surface layer over a weakly developed dark brown silty clay loam subsoil and are moderately deep to sedimentary rocks. These soils are included in the Chehulpum map unit and are at the transition from Chehulpum to deeper soils. Steiwer and Chehulpum lack a subsoil clayey layer and have silty sediments sitting directly on weathered sedimentary rocks. Roots extend deep into fissures in the siltstone and sandstone. Soils have moderate vigor potential and produce excellent winegrapes. These soils are either irrigated or dry farmed depending on the depth to rock and surrounding soils and winegrowers' preference. Irrigation will be desired in droughty years. More detailed future mapping may show this to be a larger unit, it is included in the Ch map unit here.

Ca Carlton

Depth to Weathered Bedrock: Very Deep
AWHC: 9 to 12 inches
Drainage Class: Moderately well drained
Description: Carlton soils are typically formed in silty to clayey alluvium and colluvium of sedimentary rocks and basalt. They occur on lower side slopes and on foot slopes and at the heads of drainages. These soils are characterized by having thick dark surface and subsurface layers, medium loamy texture in the upper part and a seasonal high-water table in the zone of 18 to 36 inches and need artificial drainage. Vine vigor potential is high for Carlton soils. There are soils within this map unit that have very clayey smectitic clay substratum like soil sample 15.

Du Dupee

Depth to Weathered Bedrock: is typically greater than 60 inches but there are inclusions of moderately deep soils as shallow as 27 inches.
AWHC: 6 to 10 inches
Drainage Class: Moderately well drained
Description: Dupee soils are formed in clayey colluvium of sedimentary rocks and are on side slopes and in heads of drainages and on low bedrock benches with well-developed paleosol in the subsoil. These soils have a seasonally high-water table at 17 to 35 inches and need artificial drainage. The soils observed here do not fit neatly within the Dupee series since they are shallower than typical Dupee, but they are included with Dupee because they are in the same drainage class and have same clayey subsoil and there is not a closer soil series in the legend. Vine vigor in these soils will be moderate. Some pedons have thicker and darker than normal surface, these soils are transitional to Carlton but are named Dupee because they have well developed argillic layers (clay layers) that Carlton soils lack.

Hm Helmick
Depth to Weathered Bedrock: deep to siltstone
AWHC: 6 to 11 inches
Drainage Class: Somewhat poorly drained with inclusions of moderately well drained soils.
Description: These soils are on benches and linear sideslopes and sides of drainageways on foothills. The upper part is silty sediments overlying very clayey subsoil and underlying siltstone or sandstone.

These soils are often wet in winter and droughty in summer, needing artificial drainage and summer irrigation. The water table is perched on the smectitic clay subsoil and as winegrapes mature and fully occupy the soil profile they grow roots deep into the better aerated underlying sedimentary rocks where present. Helmick is very clayey, extremely firm and has very poor to structureless soil structure. Managing soil water is the key to farming these soils since they need drainage to deal with winter wetness and irrigation to overcome their droughty nature.

Panther
Depth to Weathered Bedrock: deep to very deep greater than 40 to 60 inches.
AWHC: 8 to 9
Drainage Class: Poorly drained
Description: Panther soils are in depressions and side hill seeps. On this site there is a small wet spot at point 8 it is estimated to be about 1/10 acre. It may be more practical to avoid planting this small spot since such wet spots are difficult to manage in a vineyard.

Wd Wellsdale silty clay loam
Depth to Weathered Bedrock: deep to very deep greater than 40 to 60 inches.
AWHC: 10 to 12 inches
Drainage Class: Moderately well drained
Description: Wellsdale soils formed in silty deposits, possibly loess or Missoula flood deposits depending on elevation and site history, and this silty material is over silty clay loam to clay colluvium in the deeper subsoil layers. There may be residuum or weathered siltstone and sandstone in the substratum. Wellsdale soils are on side slopes and in heads of drainages and on low bedrock benches. They are fairly extensive in some of the best-known vineyards on Ribbon Ridge. These soils have a seasonally high-water table at 18 to 35 inches and typically improved with artificial drainage prior to planting in order to lower the seasonal water table and reduce the duration of soil wetness. Vine vigor in these soils will be moderately high.

AW Amity and wet soils
Depth to Weathered Bedrock: greater than 60 inches and much deeper.
AWHC: 9 to 12 inches
Drainage Class: Somewhat poorly drained with poorly drained soils in depressions.

Description: Amity soils occur at sample 1. These are soils with seasonal high-water table within 12 inches of the surface. They formed in Missoula Flood silts and are on terraces. These soils grade into local alluvium that can be somewhat poorly drained to poorly drained and typically has higher clay content. This soil is not included in the area considered suitable for high quality wine. Some growers use these soils for higher production lower price points table wine. They are fertile with very high-water holding capacity and produce excessive vine vigor. On this site artificial drainage and frost protection and vigor management would be needed to produce grapes from these soils.

Bedrock Depth

The depth to weathered siltstone ranges from shallow (12 to 20 inches) to very deep (>60 inches). The Chehulpum map unit is shallow to siltstone with inclusions of soils that are moderately deep like Steiwer. Dupee, Helmick, Wellsdale and Carlton are deep to moderately deep. There are soils that are transitional between more than one soil series for example there is a soil similar to Dupee in being clayey and having a high water table but it also is only 27 inches to bedrock. This is a moderately deep phase of Dupee, which is normally deeper.

Available Water Holding Capacity (AWHC)

The values reported in Table 1 are estimates of inches of available water stored in the soil profile.

Where AWHC is moderate or higher, soils are good candidates for dry farmed vineyards. Where AWHC is moderately low to low in soils like Ritner irrigation is recommended though vines can in some cases be grown without irrigation, but will may have greater stress during droughty and hot weather, many growers irrigate these shallow and rocky soils.

Available Water Class	Inches of Available water in 5 ft profile	Soil Series Names
Low	<3	Chehulpum
Moderately Low	3 to 5	Chehulpum
Moderate	5 to 8	Dupee (moderately deep) Helmick Steiwer
Moderately High	8 to 10	Dupee Carlton (clayey substratum)
High	10 to 12	Dupee Wellsdale Carlton

The AWHC is an estimate of the water stored in the soil profile that is available for plant uptake, which is the amount of water held between field moisture capacity and the permanent wilting point. Field moisture capacity is the moisture content after gravity has drained the largest pores. The permanent wilting point is the moisture content where water is held so tightly by the soil micro-pores that roots cannot absorb this water and a plant will wilt without recovery.

For soils where the roots extend deeper into bedrock fissures the AWHC rating is underestimated. The total AWHC for a soil is calculated from a model based on the sum of the weighted average for each soil horizon, using values reported in the literature and measured soil profile data for each sample point.

The AWHC is a function of several soil properties including soil depth, texture, organic matter, bulk density, porosity, and soil osmotic potential. Root restricting layers decrease the depth of the soil profile and the AWHC. The hard bedrock, though fissured, restricts the volume of water the soil can hold in rocky layers.

Available water holding capacity is strongly correlated with soil texture. Sands have lower AWHC because they have greater proportion of larger pores that freely drain under gravitational force, so they have less total water at field moisture capacity.

Clay soils can hold more “total” water against gravity because they generally have greater proportion of medium to micro-sized pores. But clay soils also have a greater proportion of the ultra-micropore and smaller size classes that can hold water that is unavailable to plants at the tension exerted at the permanent wilting point. So as vines transpire and soil moisture levels drop, soil moisture tension increases, and soil water moves exponentially slower, and vines must work harder to get additional water. As soils become drier, clay soils hold a higher proportion of the total water that is unavailable vines, compared to the proportion in a silt loam, for example. Silt loams, and silty clay loams have the highest AWHC at a given bulk density.

It is not known how deeply vines will root on this site. While most grape roots are presumed to be in the upper soil profile, grapes produce roots that grow very deeply and take up water in the deep subsoil and in the substratum beyond the very deep sampling depth here. It is assumed that the AWHC values for the upper five feet provide a useful relative scale of the variability in water supply available to the vine for the AWHC classes used here.

There is spatial variability in the amount of available water soils hold from one area to the other. This variability in water holding can be addressed with vineyard block design, rootstock selection and management practices. On soils with low to moderate AWHC, strategies that include micro-irrigation, vine spacing, tillage of between rows and use of drought tolerant rootstocks can reduce stress associated with low soil moisture. On very deep and high AWHC soils, devigorating rootstocks and managed competition can help reduce vigor and canopy size, and these soils can be managed under dry land conditions.

Managed competition involves selecting combinations of cover crop mixtures, mowing and tillage options for the vegetated strips between vine rows that are suitable to the soil-water and soil-productivity balance. A more vigorous grass cover can help reduce the amount of water available to vines in deep soils. On droughty soils the use of cover crops that are less competitive and that have summer dormancy may be more suitable. Tillage of vineyard floor, either complete or alternate row during the growing season is frequently used to reduce competition but does not provide as many soil health benefits as a living cover that is managed with mowing or that is naturally summer dormant. Mulching in the vine row can help conserve soil moisture and may be useful on all soils in the establishment year before vines have put down a deep root system.

Soil Drainage

The soils observed on this vineyard range from the well drained Chehulpum and Steiwer to moderately well drained Dupee, Wellsdale and Carlton to somewhat poorly drained Helmick and Amity. There was one spot found where soils are poorly drained Panther series. The low-lying areas somewhat poor to poorly drained soils. The strong soil structure fractured underlying bedrock and slope help to remove excess water from the soils in the Chehulpum and Steiwer.

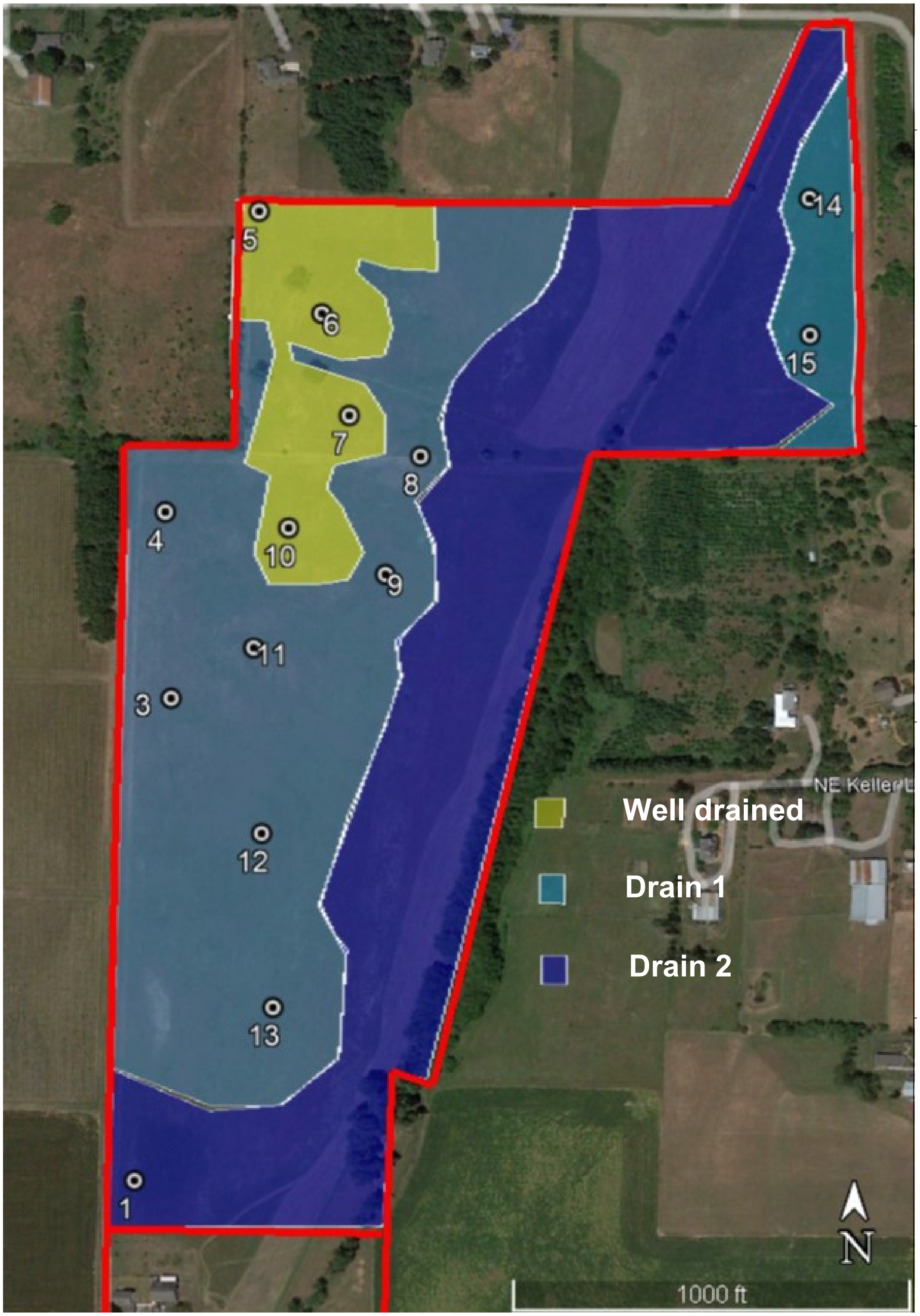


Figure 4. Drainage Groups

Figure 4 shows the drainage classes of the soils. Well drained soils are shaded yellow, and these do not need artificial drainage. The lighter blue Drain-1 map unit is somewhat poorly to moderately well drained soils, where it is recommended that artificial drainage in a intercept drainage pattern be used to reduce wetness and runoff on the hillslopes. Drain-2 map unit is the terrace and bottomland where soils are wet. The Drain 2 land is not recommended for high value winegrapes. If it is decided to plant these acres then pattern artificial drainage is recommended as long as an outlet can be practically used.

The high clay content of the subsoil causes a perched water table on the hill slopes. Some soils have seasonal high-water table in the subsoil that creates a perched water table in winter and spring. Short term concentrated flows of surface runoff can cause severe erosion in drainage areas.

Site Preparation

Since the area evaluated is currently cropland there is very little site preparation needed except for artificial drainage and liming as needed. Most of the soils have strong structure and would only need subsoiling if there is severe compaction. The Helmick soils have very high clay content of smectitic clay, these soils are unsuitable to subsoiling because the clays are easily smeared and soil structure suffers.

Slope shaping should be avoided because it tends to increase within-block variability since the cut soils tends to get shallower and the filled soils get deeper. It is practical to apply lime, as recommended by soil analysis, prior to tillage operations.

Soil erosion presents a severe hazard on these slope especially if the soil is worked late in fall and cover is not established before winter. Artificial drainage can reduce surface runoff and erosion. Cover crop establishment in September to October is important and placing straw bales in any erosion channels that may form in winter can prevent a minor problem from becoming a big one.

Other conservation practices should be employed to prevent soil erosion. Consult with Yamhill Soil and Water Conservation District for technical assistance.

Soil Fertility and Chemical Analysis

Soils were sampled for laboratory analysis across the range of soils.

There are three soil samples and three subsoil samples. Soil sample numbers correspond to boring numbers and the A designation is the surface sample from 0 to 8 in and the B designation is the subsoil sample from 24 to 36 in depth.

Samples were analyzed for organic matter, pH, macronutrient, and micronutrient levels. These data are provided for site specific baseline information, and they can help inform future sampling and interpretations of surface soil test results.

The results of the analysis are presented in soil analysis reports attached to this report. Laboratory data are attached to this report, along with recommendations from the laboratory for fertilizer and lime.

Organic matter content is good on this site with surface layers having moderate to high levels of 3.5 to 4.5 percent. The subsoil samples are low for all three pedons sampled. Good soil management should target maintaining this wonderful resource.

Soil phosphorus is medium to high in surface and medium to very low in subsoil. Soil fertilizer recommendations are for no phosphorus additions. Winegrapes are usually mycorrhizal, that is they form a symbiotic relationship with mycorrhizal fungi, and while this relationship is positive for vine growth, it complicates predicting the response of grapevines to fertilizer P. At lower soil-test P levels the mycorrhizal fungi can improve the availability of soil-P to the plant by releasing otherwise minerally-fixed phosphorus. One theory is that adding fertilizer-P to the soil reduces the mycorrhizal benefit of fungi in releasing the fixed phosphorus.

pH
The soils of the Willamette Valley foothills are “naturally” strongly acid. Soil pH in the surface is from 5.0 to 5.6 which is strongly to moderately acid. Subsoil pH is 5.1 to 6.1. The recommendation from the lab is for 2 tons per acre of lime.

Calcium (Ca):
Surface calcium is low to moderate and is 37 to 63 percent of base saturation in surface layers. Subsoil layers have 33 to 71 percent Ca. In areas where subsoil calcium is very low gypsum (calcium sulfate) can be applied to treat low subsoil calcium and can be surface broadcasted. Gypsum is more soluble than lime (calcium carbonate) and it will improve the subsoil calcium levels faster. A ton of gypsum per acre is generally recommended locally to address low subsoil calcium. Amendments of stabilized composts can also help reduce subsoil acidity. Gypsum applications also increase soil sulfur levels, and sulfur tested at the moderately low level here.

Potassium (K)
Surface potassium levels are all medium. Leaf analysis on K and other nutrients can guide plant nutrition once vines are established.

Magnesium (Mg)
Surface Mg levels range from low to high.

Sulfur (S)
Sulfur levels are medium. The moderately high organic matter content of these soils and their ability to mineralize sulfur from organic matter make it unlikely that the vines would not get sufficient sulfur. Future tests will reveal patterns and treatment. Gypsum applied for low subsoil calcium discussed earlier will improve sulfur levels as well.

Zinc (Zn)
Surface Zn is adequate, though subsoil reserves are very low. Zinc is probably best tracked and managed with foliar sampling as vines establish.

Copper (Cu)
Surface copper levels are low to medium.

Boron (B)
All samples were low, and the recommendation is for 2 pounds B. It is routine to add a pound of two of Boron regularly so nothing unusual here.

Cation Exchange Capacity
The CEC of these soils is moderate and probably reflects the very high organic matter. that contribute positively to the CEC.

Soil Health and Soil Conservation

Good soil management involves managing the physical, chemical, and biological components of the soil towards the goal of overall good soil health. Healthy soil has an active and healthy biotic community; it has good tilth and nutrient balance. Tilth is the physical condition of the soil relative to ease of tillage, its suitability as a seedbed and its lack of impedance to seedling emergence and root penetration. Organic soil amendments and additions of calcium as either lime or gypsum can improve soil aggregation, tilth and nutrient status of the soil and can stimulate the biotic community.

Maintaining soil organic matter is a soil quality target that can be met by using cover crops and reduced tillage. Under tillage organic matter content decreases over time but this can be stabilized with good soil management practices. Since the deeper soils have more potential for vigor, more aggressive use of grass and other non-legume cover crops can be used on the Wellsdale, Dupee and Carlton soils.
Very severe erosion can occur on foothill soils where soil is left unprotected or with poorly established vegetation in the winters when large runoff events occur. These

severe erosion events can be triggered by intense rain falling on saturated or frozen soils, or by rain on snow events. Such conditions may only have a calculated return period of 10 or 20 years, but if a grower is caught with sloping bare ground at such an unfortunate time, a lifetime's worth of soil development can be lost in one year. Soil loss rates from 10 to 100 t ac^{-1} yr^{-1} have been recorded for such events. It is important to protect these soils from erosion. Cover crops are typically used to control erosion in the winter rainy season. Various cover crop mixes are available to provide both cover and suitable level of competition with wine grapes.

Table 2. GPS coordinates of soil samples

Point	Latitude	Longitude
1	45.34496	-123.16446
2	45.34619	-123.15433
3	45.34827	-123.16416
4	45.34952	-123.16424
5	45.35153	-123.16335
6	45.35086	-123.16272
7	45.35018	-123.16244
8	45.34991	-123.16173
9	45.34911	-123.16207
10	45.34942	-123.16303
11	45.34861	-123.16336
12	45.34735	-123.16326
13	45.34616	-123.16314
14	45.35166	-123.15798
15	45.35073	-123.15798

Date: October 31, 2023
Report No: 103676
Grower: Ponlee
Client: Andy Gallagher Red Hill Soils
Sampler: Andy Gallagher
Sampled: 10/30/2023

Samples will be stored until 11/13/2023

KUOTESTING LABS
A Matrix Sciences Company

SUMMARY PAGE

SOIL ANALYSIS REPORT

Lab #	Depth (Inches) Start	Depth (Inches) End	Field ID	Sample ID	Crop	NO3-N (KCl) lbs/ac	NO3-N (KCl) ppm	NH4-N (KCl) lbs/ac	NH4-N (KCl) ppm	P Olsen ppm	P Bray ppm	K ppm	Ca (Ammonium Acetate) meq/100g	Mg (Ammonium Acetate) meq/100g	Na (Ammonium Acetate) meq/100g	SO4-S ppm	B ppm	Zn (DTPA) ppm	Mn (DTPA) ppm	Cu (DTPA) ppm	Fe (DTPA) ppm	pH 1:2	Sikora pH	Soluble Salts 1:1	OM %	Efferve-scence Free Lime	Estimated CEC Meq/100g	Base Saturation % Ca	% Mg	% K	% Na	% H
8298	0	8	5	A	Grape-Wine	3	1.3	14	5.2		29	237	5.7	2.8	0.05	15	0.09	1.4	20	2.2	51	5.0	6.5	0.12	4.48		15.2	37.5	18.6	3.9	0.3	39.7
8299	24	36	5	B	Grape-Wine	6	1.4	13	3.3		10	94	6.3	4.2	0.08	8	0.01	0.2	2.2	0.8	23	5.1	6.3	0.04	1.58		18.8	33.7	22.3	1.1	0.4	42.5
8300	0	8	13	A	Grape-Wine	5	1.9	15	5.6		50	248	6.3	1.7	0.04	8	0.20	0.8	12	0.5	63	5.6	6.8	0.10	4.25		11.6	54.1	14.4	5.2	0.3	26.0
8301	24	36	13	B	Grape-Wine	6	1.4	9	2.3		19	86	7.8	1.9	0.11	2	0.07	0.2	1.1	0.4	30	6.1	7.3	0.06	1.03		10.8	71.9	17.8	1.9	1.0	7.4
8302	0	8	15	A	Grape-Wine	16	6.0	12	4.5		16	166	8.7	2.7	0.08	9	0.22	0.9	28	0.9	85	5.5	7.0	0.16	3.42		13.9	62.6	19.4	2.9	0.6	14.5
8303	24	36	15	B	Grape-Wine	4	1.1	13	3.3		5	122	14.8	4.9	0.18	3	0.04	0.3	6.7	0.5	27	6.2	7.1	0.04	0.92		21.8	67.9	22.5	1.4	0.8	7.4

Soil & Plant Program 2023 NAPT Participating Laboratory

ALP Agricultural Laboratory Proficiency Program

Main Office: 119 E Main St., Othello, WA 99344
Oregon Office: 1300 Sixth St., Suite J, Umatilla, OR 97882
Pasco Office: 1320 E Spokane St., Pasco, WA 99301
(509) 488-0112 **info@kuotestinglabs.com**

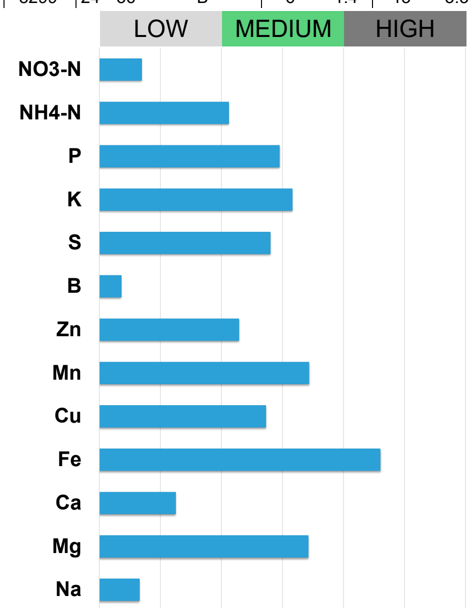
Date: October 31, 2023
Report No: 103676
Grower: Ponlee
Client: Andy Gallagher Red Hill Soils
Sampler: Andy Gallagher
Field: 5
Crop: Grape-Wine
Sampled: 10/30/2023

Samples will be stored until
11/13/2023

KTL KUO TESTING LABS
A Matrix Sciences Company

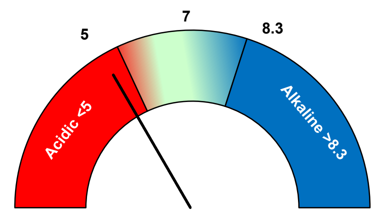
SOIL ANALYSIS REPORT

Lab #	Depth (inches) Start	Depth (inches) End	Sample ID	NO3-N KCl lbs/ac	NO3-N KCl ppm	NH4-N KCl lbs/ac	NH4-N KCl ppm	P Olsen ppm	P Bray ppm	K ppm	Ca (Ammonium Acetate) meq/100g	Mg (Ammonium Acetate) meq/100g	Na (Ammonium Acetate) meq/100g	SO4-S ppm	B ppm	Zn (DTPA) ppm	Mn (DTPA) ppm	Cu (DTPA) ppm	Fe (DTPA) ppm	pH 1:2	Sikora pH	Soluble Salts 1:1 mmho/cm	OM %	Effervescence Free Lime
8298	0	8	A	3	1.3	14	5.2		29	237	5.7	2.8	0.05	15	0.09	1.4	20	2.2	51	5.0	6.5	0.12	4.48	
8299	24	36	B	6	1.4	13	3.3		10	94	6.3	4.2	0.08	8	0.01	0.2	2	0.8	23	5.1	6.3	0.04	1.58	

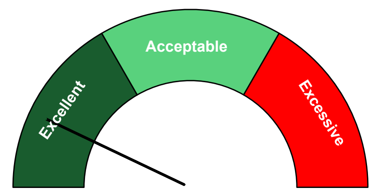


BASE SATURATION

	meq/100 g	%	Ideal Soil
Estimated CEC	15.2		
Calcium	5.7	*37.5*	65-75%
Magnesium	2.8	*18.6*	15-20%
Potassium	0.6	*3.9*	2-9%
Sodium	0.1	*0.3*	<1%
Hydrogen	6.0	*39.7*	



Soil pH (1:2)



Soluble Salts (1:1)

Fertilizer Recommendations

Nitrogen	**50**	Lbs per acre N
Phosphorus	**0**	Lbs per acre P2O5
Potassium	**0**	Lbs per acre K2O
Sulfur	**5**	Lbs per acre actual S
Boron	**2**	Lbs per acre actual B
Zinc	**0**	Lbs per acre actual Zn
Mangenese	**0**	Lbs per acre actual Mn
Copper	**0**	Lbs per acre actual Cu
Iron	**0**	Lbs per acre actual Fe
Lime Requirement	**2**	Tons per acre 100 % Lime Score material

Additional Parameters

KTL will make every effort to provide an accurate analysis. Liability is limited to the cost of the analysis and no other warranties, expressed or implied are given. Recommendations serve only as a general guide and should be adjusted to specific situations and conditions.

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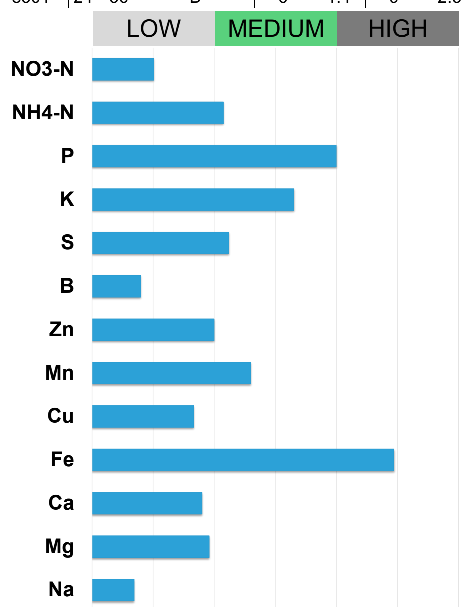
Date: October 31, 2023
Report No: 103676
Grower: Ponlee
Client: Andy Gallagher Red Hill Soils
Sampler: Andy Gallagher
Field: 13
Crop: Grape-Wine
Sampled: 10/30/2023

Samples will be stored until
11/13/2023

KUOTESTING LABS
A Matrix Sciences Company

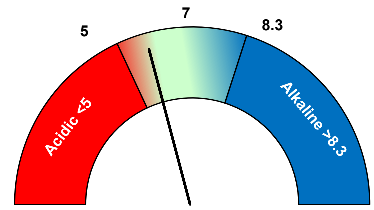
SOIL ANALYSIS REPORT

Lab #	Depth (inches) Start	End	Sample ID	NO3-N KCl lbs/ac	NO3-N KCl ppm	NH4-N KCl lbs/ac	NH4-N KCl ppm	P Olsen ppm	P Bray ppm	K ppm	Ca (Ammonium Acetate, meq/100g)	Mg (meq/100g)	Na (meq/100g)	SO4-S ppm	B ppm	Zn (DTPA) ppm	Mn (DTPA) ppm	Cu (DTPA) ppm	Fe (DTPA) ppm	pH 1:2	Sikora pH	Soluble Salts 1:1 mmho/cm	OM %	Effervescence Free Lime
8300	0	8	A	5	1.9	15	5.6		50	248	6.3	1.7	0.04	8	0.20	0.8	12	0.5	63	5.6	6.8	0.10	4.25	
8301	24	36	B	6	1.4	9	2.3		19	86	7.8	1.9	0.11	2	0.07	0.2	1	0.4	30	6.1	7.3	0.06	1.03	

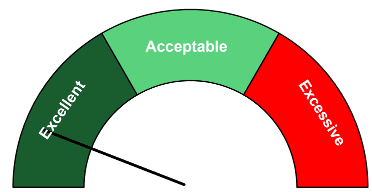


BASE SATURATION

	meq/100 g	%	Ideal Soil
Estimated CEC	11.6		
Calcium	6.3	*54.1*	65-75%
Magnesium	1.7	*14.4*	15-20%
Potassium	0.6	*5.2*	2-9%
Sodium	0.0	*0.3*	<1%
Hydrogen	3.0	*26.0*	



Soil pH (1:2)



Soluble Salts (1:1)

Fertilizer Recommendations

Nitrogen	**50**	Lbs per acre N
Phosphorus	**0**	Lbs per acre P2O5
Potassium	**0**	Lbs per acre K2O
Sulfur	**5**	Lbs per acre actual S
Boron	**2**	Lbs per acre actual B
Zinc	**0**	Lbs per acre actual Zn
Mangenese	**0**	Lbs per acre actual Mn
Copper	**0**	Lbs per acre actual Cu
Iron	**0**	Lbs per acre actual Fe
Lime Requirement	**2**	Tons per acre 100 % Lime Score material

Additional Parameters

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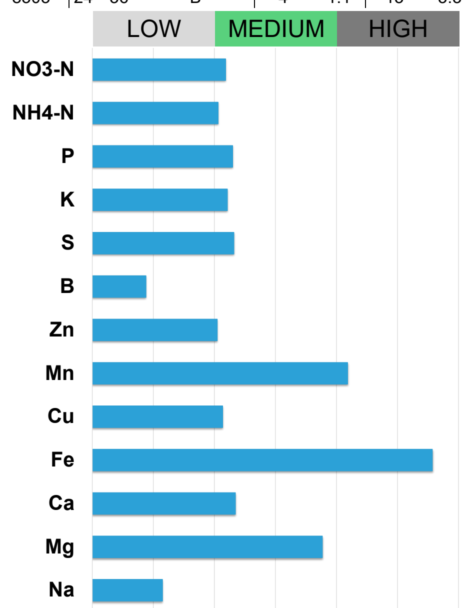
Date: October 31, 2023
Report No: 103676
Grower: Ponlee
Client: Andy Gallagher Red Hill Soils
Sampler: Andy Gallagher
Field: 15
Crop: Grape-Wine
Sampled: 10/30/2023

Samples will be stored until
11/13/2023

KUO TESTING LABS
A Matrix Sciences Company

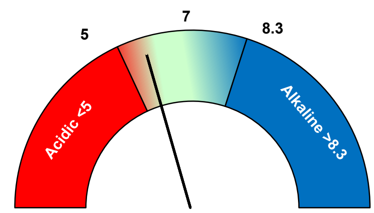
SOIL ANALYSIS REPORT

Lab #	Depth		Sample ID	NO3-N		NH4-N		P		K	Ca	Mg	Na	SO4-S	B	Zn	Mn	Cu	Fe	pH	Sikora pH	Soluble Salts	OM	Effervescence
	inches			KCl		KCl		Olsen	Bray	Ammonium Acetate						DTPA				1:2		1:1		Free Lime
	Start	End		lbs/ac	ppm	lbs/ac	ppm	ppm	ppm	ppm	----------meq/100g----------			ppm	ppm	ppm	ppm	ppm	ppm			mmho/cm	%	
8302	0	8	A	16	6.0	12	4.5		16	166	8.7	2.7	0.08	9	0.22	0.9	28	0.9	85	5.5	7.0	0.16	3.42	
8303	24	36	B	4	1.1	13	3.3		5	122	14.8	4.9	0.18	3	0.04	0.3	7	0.5	27	6.2	7.1	0.04	0.92	

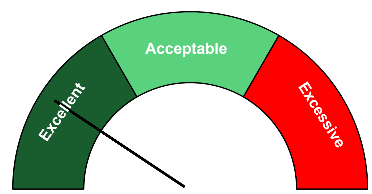


BASE SATURATION

	meq/100 g	%	Ideal Soil
Estimated CEC	13.9		
Calcium	8.7	*62.6*	65-75%
Magnesium	2.7	*19.4*	15-20%
Potassium	0.4	*2.9*	2-9%
Sodium	0.1	*0.6*	<1%
Hydrogen	2.0	*14.5*	



Soil pH (1:2)



Soluble Salts (1:1)

Fertilizer Recommendations

Nitrogen	**50**	Lbs per acre N
Phosphorus	**0**	Lbs per acre P2O5
Potassium	**100**	Lbs per acre K2O
Sulfur	**5**	Lbs per acre actual S
Boron	**2**	Lbs per acre actual B
Zinc	**0**	Lbs per acre actual Zn
Mangenese	**0**	Lbs per acre actual Mn
Copper	**0**	Lbs per acre actual Cu
Iron	**0**	Lbs per acre actual Fe
Lime Requirement	**2**	Tons per acre 100 % Lime Score material

Additional Parameters

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