Soil Investigations for Vineyard Suitability
4110 Beach Lane
Salem, Oregon

For: John Burnham

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INTRODUCTION

This report provides more detailed site and soil information on the vineyard suitability of the future Burnham Vineyard on Beach Lane in the Eola Hills. Detailed soil mapping in other vineyards of the Willamette Valley has demonstrated that soils are much more diverse than they are at the scale of the county soil survey. Soil diversity and soil quality within the vineyard can profoundly affect wine grape management and quality. Precision maps of relevant soil properties are needed to support decision making in existing and new plantings and to meet the intensive management associated with wine grape production.

In this investigation soils were sampled at a high intensity to evaluate existing soil mapping and to determine soil variability. This report provides precise soil sample locations using GPS and reports results and soil interpretations relevant to the suitability of the soils for vineyards.

Soil investigations included transects of the property to sample soil profiles in order to classify soils and to record soil drainage characteristics, soil depth to bedrock, depth to gravel, surface thickness, soil texture of the surface and the subsoil. Borings locations were recorded with a global positioning system (GPS).

BACKGROUND AND METHODS

Previous Soil Mapping

The previous NRCS soil survey map of the site showed predominantly very deep Jory (36D, 36E), moderately deep Nekia soils (52C and 52E) and shallow Witzel soils (76C, 76E) (See NRCS soil map Figure 1). Soils in the north part of the property in the woods were mapped as Ritner (61D). The number letters of the map unit symbol is the soil series and the capital letter is the slope class (C= 3 to 12%, D=12 to 20%, E=20 to 30% slopes.)

Geology and Terrain

The geology of this site is Columbia River Basalt. Slopes on the surveyed area are less than 30 percent except on short very steep slopes in the wooded area. The slope aspect is east, southeast and northeast. About one to two acres have north aspect and slopes greater than 20 percent that may be cooler microclimate compared to the rest of area surveyed. Elevation ranges from 400 feet up to about 740 feet above sea level Figure 2.

Soil Mapping and Sampling

Seven soil borings were made on the property on the upland ridges and side slopes. Soil samples are not evenly spaced and this sampling pattern is intended to capture soil variability on the main landscape components. Based on the number of samples and acres of the parcel there are an average of one sample per two acres averaged over about 15 acres. Borings were made with soil pits about 60 inches deep or to the contact with hard bedrock if shallower.

Figure 1. Previous soil map by NRCS

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 a Munsell Color Chart. Available water holding capacity (AWHC) for each soil was estimated based on soil textures, structure, coarse fragments, depth to rock and available water retention data for these soil series. Effective rooting depth for each profile was assumed to be that of the deepest observed roots or the lowest depth of distinctive rhizosphere soil morphology.

Precision Sampling

There are several improvements in the revised high intensity (precision) soil information over the previous NRCS soil mapping. Sampling intensity is much higher in this investigation than in the NRCS soil survey, and soil boring locations are reported and embedded in the map. All soil boring locations were recorded with a GPS.

RESULTS

Data from seven soil borings are presented in Table 1. Soil boring locations are shown on figure 2 and 3. All of the soils observed in this sampling are well drained and formed from colluvium and residuum of Columbia River basalt. Depth to bedrock ranges from shallow to very deep. These are the classic Red Hill Soils of the Willamette Valley. This soil association makes up many of the best vineyards in the Dundee Hills, Eola

Hills and Chehalem Mountain AVAs. The surface is typically silty clay loam and the subsoil is reddish brown clay. The shallow Witzel soils lack the red clay layer and are brownish black gravelly loam.

There are about 14 acres of suitable soils and terrain for planting winegrapes in the area soil mapped. There may be more smaller shallow and rocky soil areas on the ridgetop than we discovered in this investigation. We were limited on the day of sampling by high fire danger and tall grass so we purposefully avoided some areas. These should be sampled prior to vineyard development.

Soil Classification and Soil Map Legend

Nk – Nekia Soils (2.7 acres)

Depth to Weathered Basalt Bedrock: 20 to 40 inches to soft bedrock
Depth to Hard Basalt Bedrock: >40 inches
Depth to Seasonally High Water Table: greater than 40 inches and typically greater than 60 inches.
AWHC: 4 to 7 inches
The Nekia series are well drained moderately deep to weathered basalt; they formed in colluvium and residuum from basalt. These soils have less AWHC than the deeper Jory soils, but are also suited to non-irrigated viticulture.

Jr – Jory Soils (6.0 acres)

Depth to Weathered Basalt Bedrock: Greater than 60 inches
Depth to Hard Basalt Bedrock: Greater than 60 inches
Depth to Seasonally High Water Table: greater than 60 inches and typically greater than 60 inches
AWHC: 9 to 11 inches
The Jory series consists of very deep, well drained soils that formed in colluvium and residuum from basalt. Jory soils have the potential to produce higher vine vigor than the shallower basaltic soils. Devigorating rootstocks and cover crops can be used to help control vigor.

Rt – Ritner Soils (3.5 acres)

Depth to Hard Basalt Bedrock: 20 to 40 inches
Depth to Seasonally High Water Table: greater than 40 inches and typically greater than 60 inches.
AWHC: 4 to 7 inches
The Ritner series is similar to Nekia in that they are well drained moderately deep to weathered basalt; they formed in colluvium and residuum from basalt. Ritner is very gravelly in the surface and subsoil and therefore have less AWHC than Nekia and other soils on this parcel. On this site the Ritner soils are very cobbly and extremely stony and moderately deep with inclusions of deep gravelly clay soils like MacDunn. Winegrapes grown on these soils may show stress at droughty times and while they can be grown without irrigation they are often irrigated for vineyards. This map unit was extended upslope partially based on observed gravelly profiles at several points along the road cut for the driveway.

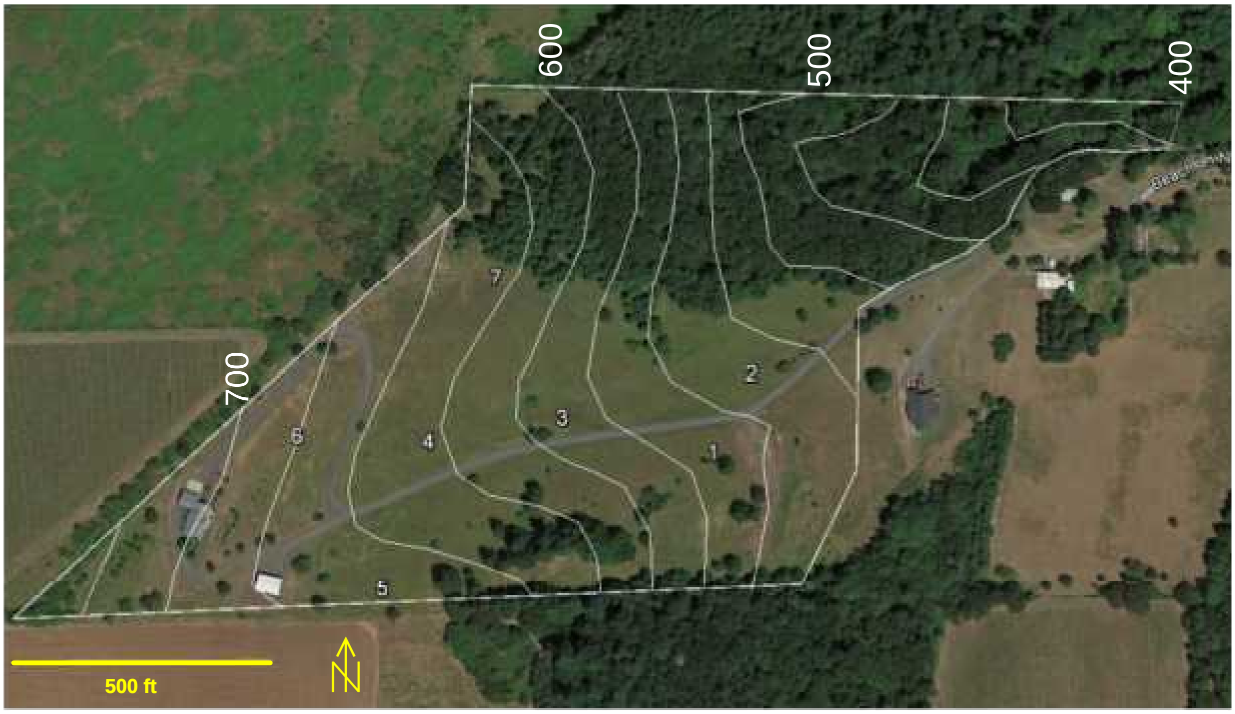
Wt—Witzel Soils (2.7 acres)

Depth to Hard Basalt Bedrock: 12 to 20 inches to fractured basalt bedrock
Depth to Seasonally High Water Table: greater than 40 inches and typically greater than 60 inches.
AWHC: 2 to 3 inches
The Witzel series is well to somewhat extremely drained and shallow to hard fractured basalt. The surface is gravelly and cobbly loam and clay loam. These soils have low AWHC and yield lower vine vigor. Winegrapes grown on these soils commonly show stress at droughty times and while they can be grown without irrigation they are often irrigated for vineyards. In some Witzel soils with proper rootstock selection grape roots grow deep into the fractured rock. Caution should be exercised during site preparation not to rip (deep subsoil tillage) since doing so will bring up excessive amounts of rock and will not materially improve AWHC.

Table 2. Summary soil boring data.

Boring	Soil Name	Surface Thickness (IN)	Depth to very gravelly layer (IN)	Depth to Basalt Bedrock (IN)	Available Water Holding Capacity (IN)
1	Ritner-McDunn	18	7	48	6
2	Nekia	17	29	36	7
3	Jory	19	--	>60	10
4	Jory	22	--	>60	10
5	Jory	17	--	>60	10
6	Witzel	8	8	16	2
7	Witzel	17	6	17	2

Figure 2. Topographic map (25 ft contour interval)



Bedrock (R horizon)

Basaltic soils in this region are classified largely on the depth to bedrock. Jory soils are very deep, Nekia and Ritner are moderately deep (20 to 40 inches). These soils have reddish brown clay subsoil overlying bedrock. The shallow member of this association is Witzel gravelly loams and are from 12 to 20 inches depth to bedrock. The harder basalt rocks restrict roots to the space in fissures in the rock and also limit available water holding capacity. There is a lot of jointing or fracturing of the Columbia River basalt and structurally the rocks are either in columns with fissures that are oriented vertically so roots and water can move into this space or in a hackly entablature with joints angling in many different directions.

Available Water Holding Capacity (AWHC)

The AWHC values reported are the AWHC in the upper five feet of soil and represents an estimate of the water that can be 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 (reported in inches of water). For very deep soils like Jory, where grapevine roots extend below sixty inches this AWHC value is an underestimate. The value reported is calculated from a model based on the sum of the weighted average AWHC for each soil horizon, using values reported in the literature and measured soil profile data at each numbered point.

The AWHC is a function of 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.

Clay soils can hold more “total” water because they have greater pore space at a given bulk density, however because the average pore volume is smaller, clay soils hold a greater proportion water that is unavailable at greater soil moisture tension. Since the majority of grape roots are in the upper soil profile, it can be 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 classes used here.

In an NRCS vineyard soil study that included pedons from around the Willamette Valley, the water retention measurements for whole soils show that on a volumetric water basis, AWHC values for Jory soils ranged from 0.08 to 0.15 (inches AWHC per inch depth). Organic matter content and silt content are positively correlated with AWHC.

Since the majority of grape roots are found in the upper soil profile, it is assumed that the AWHC values for the upper five feet provides a useful relative scale of the variability in water supply available to the vine.

The Witzel and Ritner soils have the least AWHC and the Jory has the most for soils mapped on this site.   This variability can be addressed with blocking and management practices including can be addressed by combinations of micro-irrigation, vine spacing, use of drought tolerant rootstocks, and managed competition from cover crops and weeds. Soils with higher AWHC can be managed under dry land conditions, and a rootstock selection may favor those that reduce vigor.

Managed competition involves selecting combinations of cover crop mixtures, mowing and tillage options that are suitable to the soil water and soil productivity balance. More vigorous grass cover crops can help reduce water available to vines in deep soils, and
in droughty soils less competitive cover crops may be more appropriate and alternate row tillage can be used to further reduce competition. Mulching in the vine row will help conserve soil moisture and may be especially useful on all soils in the establishment year before vines have put down a deep root system.

Soil Drainage

The soils sampled on this property are well drained. Vineyards should not be planted in the bottoms of drainage ways since short term concentrated flows of surface runoff can cause severe erosion.

Soil Quality and Soil Conservation

Soil quality involves managing the physical, chemical and biological components of the soil towards the goal of overall soil health. Healthy soil has an active and healthy biotic community; it has good tilth and nutrient balance. Tilth is defined as the physical condition of the soil relative to ease of tillage, its suitability as a seedbed and its 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.

Where soil organic matter is low a soil quality target should be to increase soil organic matter using cover crops and compost additions. Since the deeper soils have more potential for vigor more aggressive use of cover crops can be used.

Historical records for the Willamette Valley have documented very severe erosion on foothill soils where soils were left unprotected or with poorly established vegetation in the winters when large runoff events occurred. 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 tons $acre^{-1}$ $year^{-1}$ have been recorded for such events in the Willamette Valley.

Therefore it is critical to protect these soils from erosion. Cover crops are typically used to control erosion. Various cover crop mixes are available to provide both cover and suitable level of competition with wine grapes.

Table 2. Location of soil borings

Boring	Latitude	Longitude
1	45.047968	-123.115451
2	45.048415	-123.115232
3	45.048195	-123.116672
4	45.048080	-123.117691
5	45.047303	-123.118042
6	45.048123	-123.118686
7	45.048967	-123.117174

Figure 3. Revised soil map and boring locations 1-7. Yellow lines are soil boundaries.