Soil Investigations for Potential Vineyard

50-Acre Site
Oak Grove Road
Eola Hills
Polk County, Oregon

For: Lonnie Krawl and Judy Lassa

October 12, 2006

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INTRODUCTION AND BACKGROUND

This soil investigation was done to evaluate the soils and estimate the area of land suitable to vineyard development on a 50-acre property. Soils here are more diverse than they are shown at the 1:20,000 scale of the county soil survey. Soil diversity and soil quality within the vineyard can profoundly affect winegrape management and quality. Winegrowers use soil information to guide vineyard development and management. Winemakers are emphasizing the soil and site characteristics in their wines and are providing this information to wine drinkers who are increasingly discriminating. Site selection is a critical first step in the production of fine wine, and site specific soil and terrain information are major drivers of site selection.

Geology and Topography

The topography of the site consists of two to three levels of bedrock benches stepping down to the valley terrace. The benches are separated broken by short strongly sloping side slopes. The lowest bench projects out to the south as a gently sloping foot slope before dropping down to the terrace surface in a short, strongly sloping side slope on the west side and tapering to a very smooth toe slope on the west side.

Underlying rocks are marine siltstone and sandstone of the Oligocene and Upper Eocene (Walker and Macleod 1991). There are surface and buried stones of Columbia River Basalt along the eastern side of the property evidence of influence of basaltic material along with the sedimentary materials. A long narrow drainage swale dissects the slope and drains toward the south. Elevation ranges from about 400 to 230 feet above sea level Figure 1.

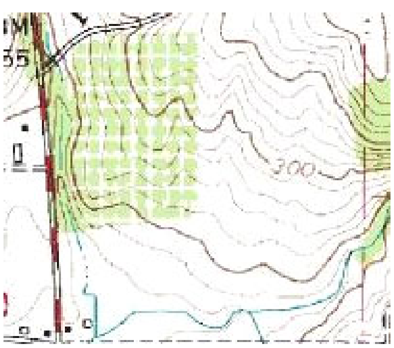

Figure 1. Topographic map of the site (from USGS original scale 1:24,000).

Previous Soil Mapping

The Soil Survey of Polk County Area delineated Helmick (30C) and Chehulpum soils (15C) on this property. The Helmick soils are deep somewhat poorly drained soils on low rolling foothills that merger into main valley terraces. These soils formed in stratified alluvium, colluvium and residuum weathered from sedimentary rocks. The Chehulpum soils are shallow, well drained soils formed in material weathered from sedimentary rock.

Current Land Use

This property is currently in vineyards on the upper slopes in the northwestern part. The lower footslopes and terrace are cropland. There is a strip of woodland and brush along the east property line. There is a home and machine shed on the property.

METHODS

This investigation was conducted in September 2006. Soil observations were made to classify soils and to record soil properties including soil drainage, depth to bedrock and rock type, surface thickness, soil texture of the surface and the subsoil. Fourteen soil borings were made in the survey area. Soils were described from 12 soil pits and an additional two soil auger holes. For each boring, soil profiles were observed to 60 inches depth, shallower where bedrock prevented deep sampling. Borings were located using a GPS receiver to better than 3 m accuracy. The criteria for potential vineyards included soil areas on slopes above the terrace level, where soils are poorly to somewhat poorly drained and more fertile formed in Willamette Silts. Boundaries of suitable areas were delineated based upon soil borings and slope measurements with a clinometer that were located on the ground with a GPS, and also based upon 1:24,000 scale topographic maps.

RESULTS

The soils of the upper slopes are sedimentary rock derived soils typical of the western slope of the Eola Hills. This includes the well drained moderately deep Willakenzie, Bellpine and Steiwer soils, and the well drained shallow Rickreall and Chehulpum soils. The toe slopes have Hazelair soils, which are moderately deep, somewhat poorly drained soils with very clayey subsoil. All of the previously listed soils are considered to be suitable to growing high quality winegrapes. The Chehulpum, Rickreall and Hazelair soils are typically micro-irrigated, and the Hazelair soils are typically artificially drained before being developed into vineyards.

At about the 260 foot contour line the toe slope grades into the Willamette Valley Terrace. Below and south of this boundary the soils are not considered to be suitable to winegrapes. Soils on the terrace are poorly to somewhat poorly drained Holcomb silt loams. The terrace is low lying and potential for frost increases compared to the higher slopes. The terrace soils are wet into the growing season and have high fertility and tend to produce excessive vine vigor. This boundary is sharpest along the east side and more diffuse along the west side where the driveway turns sharply.

There is a low swale in the footslope where the soils are somewhat poorly drained and similar to Linslaw soils, and where there is concentrated flow in winter. This area is also not considered in the suitable area although part of it may be planted if sufficient artificial drainage is done on the upslope areas.

Based on these criteria, there are about 30 acres well suited to producing high quality wine grapes. The estimated suitable acreage is subjective and depends on wine grape variety, winegrowing style, land improvements, management and acceptable risk levels for interactions between terrain and annual variations in weather.

Table 1. Summary Soil Properties From Soil Boring Data.

Boring	Soil Name(s)*	Slope (%)	Depth to Cr (soft weathered bedrock) (IN)	Rooting Depth (IN)	Depth to Seasonally high water table (IN)	Estimated Available Water Holding Capacity (IN)
1	Chehulpum		9	24	Well drained	2
2	Holcomb		>72	>72	12	10
3	Holcomb		>72	>72	10	10
4	Holcomb		>72	>72	10	10
5	Linslaw		>72	>72	10	9
6	Bellpine		24	>60	>60	4
7	Chehulpum		14	50	>60	3
8	Willakenzie		34	50	>60	5
9	Rickreall		18	48	>60	3
10	Chehulpum		9	30	>60	2
11	Steiwer		37	60	>60	7
12	Rickreall		17	45	>60	3
13	Hazelair		38	60	12	6
14	Hazelair		35	60	15	6

* no value to Cr reported where soils were stony and reported as well drained where stony or shallow.

Soil Evaluations

Important soil properties for viticulture are summarized in Table 1 for each of the 14 soil borings. Most of the soils sampled formed in colluvium and residuum of sedimentary rock, and include Bellpine, Willakenzie, Chehulpum, and Hazelair soils that are transitional between these series. Soils on the terrace were Holcomb silt loam formed in Willamette Silt. Soil depth ranges from shallow to very deep. Drainage class ranges from well drained on upper slopes to somewhat poorly drained on toe slopes. Soils on the terrace are poorly to somewhat poorly drained. Soils range from moderately slowly permeable on the loamier soils to very slowly permeable on the soils with high content of smectite clays.

Soil boundaries of the survey area are revised to show greater variability in the soils observed in this evaluation. Although these soils were originally mapped as Helmick and Chehulpum soils, the soils on the site cover a wider range of depths, drainage classes, and available water holding capacities than they were previously mapped.

A brief description is provided for each soil series observed. More detailed information is available in the Soil Survey of the Yamhill County Area and on the internet http://ortho.ftw.nrcs.usda.gov/osd/osd.html. Map unit descriptions (A through E) describe soils spatial relationships to the landscape and to each other.

Soil Series Description Summaries

Bellpine Soils

These soils occur on the mid to upper slopes. These soils grade into Rickreall where shallower and into Willakenzie where loamier. These soils typically formed on the smooth convex foothills above the Willamette Valley Terraces. The Bellpine soils are reddish, clayey, well drained soils that formed over sedimentary rocks. Bellpine soils have reddish brown subsoil. The depth to weathered rock is from 20 to 40 inches for Bellpine.

The soils that formed in this weathered sedimentary rock are ultisols, soils that exhibit the most advanced stages of weathering in this region. Grape roots can explore fissures in the weathered rock, seeking nutrients and water. #Humus-rich topsoil is an important nutrient pool of the soil, feeding the vines and supporting a healthy soil food web. The subsoil is rich in clay, and the soil derives its dusky red color from oxidized iron. Bellpine has moderate runoff on this site and moderately slow permeability. These soils are found in many of the better vineyards in the Coast Range Foothills. Vine vigor is rated as moderate to moderately high. Fertility is moderate and AWHC is moderately low to moderate. Bellpine soils have excellent potential as winesoils.

Chehulpum Soils

These soils are shallow to siltstone. They are typically well drained but may be moderately wet where they occur in swales of where significant water is draining onto these areas from upslope. The surface is dark silty clay loam 18 inches thick over soft fractured siltstone. Available water holding capacity is low and these soils are droughty. Fertility is low. Vine vigor is low and if soil moisture can be managed with irrigation and competition control these soils can produce high quality fruit.

Figure 2. Soil boring 1 showing profile of Chehulpum soils.

Linslaw Soils

The Linslaw series consists of very deep, somewhat poorly drained soils that formed in loamy glaciolacustrine deposits and clayey alluvium. These soils are along drainage ways, on terraces and on colluvial fans. These soils have slow runoff, moderately slow permeability in the Bt horizon and slow permeability in the 2C horizon. When Linslaw soils are in drainage ways, they are subject to rare flooding. An apparent water table is at its uppermost level from December to April.

Holcomb Soils

The Holcomb soils are in nearly level to slightly convex areas on broad valley terraces. Elevations are 125 to 650 feet. The soils formed in silty alluvium over silty and clayey glaciolacustrine deposits. These soils are somewhat poorly drained have slow runoff and very slow permeability. A perched water table is at its uppermost limit from November to April. This soil also has an apparent water table. The wet terrace soils including Holcomb, Amity and Dayton are not generally considered suitable to growing high quality winegrapes.

Hazelair Soils

Hazelair soils are similar to Helmick soils, which were previously mapped on this site, Helmick soils are deeper. Hazelair soils are moderately deep to weathered siltstone and shale. The Hazelair series consists of moderately well drained to somewhat poorly drained, silty clay loam over clay soils that formed in stratified medium and moderately fine textured mixed materials in the upper part and older very clayey material of unknown origin. These soils have medium to rapid runoff and very slow permeability.

Thickness of the solum above the nonconforming clay horizons ranges from 6 to 24 inches.

The Subsoil is yellowish brown to olive yellow with gray mottles. Few fine distinct yellowish or reddish brown mottles are in the solum, in some pedons, and mottles with chroma of 2 or less are at depths of less than 30 inches, indicating seasonal saturation. It is heavy silty clay loam or silty clay and has weak or moderate prismatic or subangular blocky structure. There are few fine siltstone and sandstone fragments embedded in the lower part of the subsoil in some soils. The clayey substratum has a predominantly olive yellow hue that ranges from bright to dull color chroma and is 60 to 70 percent clay that is predominantly smectite, high shrink-swell clay. The lower part of the soil contains few to many weathered siltstone or sandstone fragments.

These soils occur on lower side slopes, benches and fans. Hazelair soils are wet in the winter and spring and tend to be droughty in the late summer. On this site these soils occur on the lower sideslopes and foot slopes.

Rickreall Soils

These soils are shallow, well drained soils that formed in colluvium and residuum weathered from siltstone. The Rickreall soils are on gentle smooth ridges to steep foothills and uplands of the Coast Range at elevations of 300 to 800 feet. The soils formed in fine textured colluvium and residuum weathered from sedimentary bedrock. Rickreall soils have low available water holding capacity, low fertility and produce low vine vigor. These soils are closely associated with Bellpine.

Willakenzie Soils

These soils occur on the mid to upper benches, slopes and ridges. These soils typically formed on the smooth convex foothills above the Willamette Valley Terraces. The Willakenzie soils are yellowish brown to brown, loamy, well drained soils that formed over sedimentary rocks. The depth to weathered rock is from 20 to 40 inches.

Willakenzie has moderate runoff and moderately slow permeability. Vine vigor is rated as moderate to moderately high. Fertility is moderate and AWHC is moderately low to moderate. Willakenzie soils have excellent potential as winesoils.

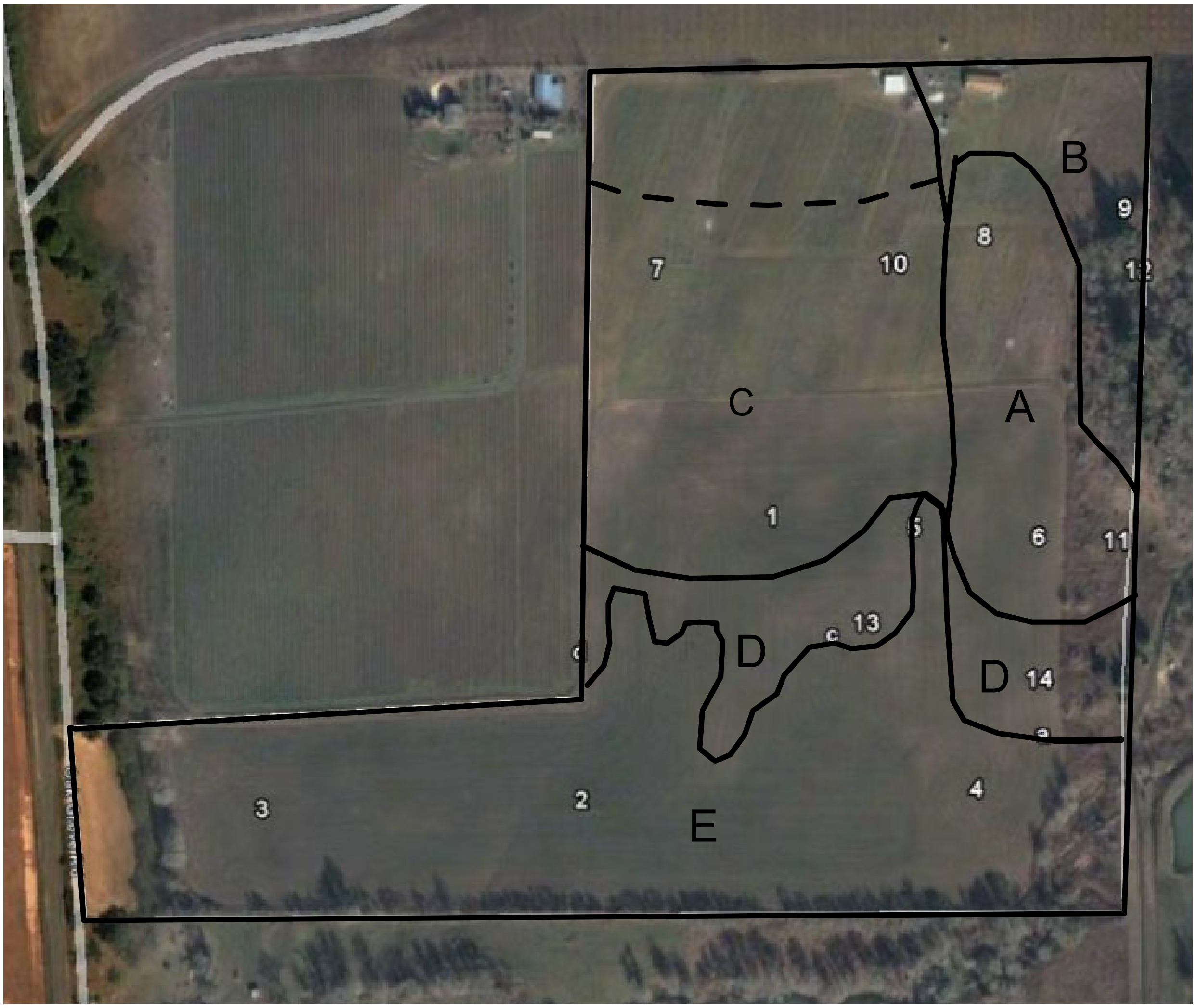

Figure 3. Map showing soil boring locations and map unit boundaries.

Map Unit Descriptions

Unit A Bellpine, Willakenzie and Steiwer Complex, 10 to 25 percent slope gradient. Six acres.

This unit is on the upper and middle part of side slope and middle bench. Soils are well drained and moderately well drained with measured soil depth from two to three feet to soft siltstone. Available water holding capacity is 4 to 7 inches, and roots extend to 50 to more than 60 inches.

Unit B Rickreall silty clay loam 10 to 25 percent slope gradients. Four acres.

This unit is on the upper bench, shoulder and sideslopes. Soils are well drained and shallow with measured soil depth about 18 inches to soft siltstone. Available water holding capacity is low 3 inches, and roots extend to 40 to 50 inches.

Unit C Chehulpum loam 4 to 12 percent slope gradients. Fifteen acres.

This unit is on the lower sideslopes, benches and footslopes. Soils are well drained and shallow to moderately well consolidated fractured siltstone. The upper boundary of hard, fractured, flaggy siltstone is at 24 to 50 inches depth and this is a root restrictive layer. Available water holding capacity is 2 to 3 inches.

Unit D Hazelair silty clay loam, 4 to 20 percent slope gradients. Five acres.

This unit is on the toe slope just above the terrace. Soils are somewhat poorly drained with measured soil depth at about three feet to soft siltstone. There is a layer of smectitic clay at about 12 to 18 inches. Available water holding capacity is about 6 inches, and roots extend 50 to more than 60 inches.

Unit E Holcomb silt loam, 2 percent slope gradient. Twenty acres.

This soil map unit is on the terrace, the lowest part of the property. The soils are somewhat poorly drained but include smaller areas of poorly drained soils. Soils formed in very deep silty over clayey alluvium. There is an abrupt textural change at 24 to 34 inches from silty clay loam to smectitic clay. Available water holding capacity is 10 or more inches and roots extend to more than 72 inches. This unit has limitations of wet soils and low lying position where cold air can collect.

Depth to Weathered Bedrock (Cr-horizon) and Bedrock (R)

The Cr-horizon retains rock structure and appearance but is soft enough to be dug into with hand tools. The R-Horizon is too hard for hand equipment to auger into.
The depth to weathered bedrock on this site is typically the depth to the top of the Cr-horizon except in some basaltic soils (like Ritner) it is the depth to the R-horizon, hard bedrock.

The Cr horizon on this site is sedimentary rock. The depth classes cover broad range of soil depths from as shallow as 18 inches to 40 inches. As noted elsewhere soil pits are needed to confirm depth of basalt bedrock or story layers in the Ritner map unit. Where soils are stony as in the Ritner soils, the boundary is gradual between the stony soil and the bedrock. Depth to bedrock affects the total rooting volume of the soil and hence also affects the available water holding capacity. Root presence was determined by observed roots in soil samples or by presence of soil morphology that is indicative of the roots presence, such as illuvial clay films and organic coatings in the rock fissures. Soil depth to bedrock can be used as a factor in designing vineyard blocks and in identifying areas that are likely to be droughty.

Available Water Holding Capacity (AWHC)

Reported AWHC is the amount of the water that can be stored in the soil profile that is available for plant uptake; it represents the amount of water held between field moisture capacity and the permanent wilting point (reported in inches of water). 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 hold more total water, but have less available water than loamier soils. Clay soils have extremely fine micropores that can retain water at highly negative matric potentials. As soil moisture potentials become more negative (as soils dry), sandy soils hold less total water than finer textured soils, because a larger percentage of the pores are large and are freely drained. Since the majority of grape roots are in the upper soil profile, the AWHC values for the upper root zone provides a useful relative scale of the variability in water supply available to the vine for the classes used here.

Potentially droughty areas of the vineyard are stony or gravelly and are moderately shallow soils that have moderately low to low AWHC (2 to 4 inches). These soils are droughty in most years. Moderately deep soils and deep soils with high content of rock fragments are estimated to have moderate amounts of available water (4 to 7 inches). These soils can be droughty after prolonged dry spells. Soils with moderately high to high AWHC (8 to11 inches) will show less moisture stress; these soils tend toward high vine vigor.

Where soils have moderately low AWHC and tend towards droughty, this condition can be addressed with management options of micro-irrigation, vine spacing, use of drought tolerant rootstocks, and managed competition from cover crops and selected native vegetation. Soils with higher AWHC can be managed under dry land conditions and rootstocks that reduce vigor are usually favored on such soils.

Varying the cover crop mixture, customizing the mowing and tillage treatments and adjusting vine spacing to match the vine vigor potential of the soil can provide managed competition towards achieving balanced vine growth. For example: more vigorous grass cover crops can be used to compete with the vines for water in deeper soils. In droughty soils, less competitive cover crops may be more appropriate. Alternate row tillage can be used to further reduce competition in low vigor potential soils. Mulching in the vine row will help conserve soil moisture.

Seasonally High Water Table (Soil Drainage Interpretation)

Soils with wet subsoil include the moderately well drained Dupee and the somewhat poorly drained Hazelair soils. Draining these areas can reduce the amount of subsurface flow and runoff in the winter and reduce water erosion, a management issue on this site. A combination of intercept drainage, which diverts water from upslope areas, should be used with pattern tile drainage to increase the depth and reduce the duration of seasonal water tables.

Saturated soils associated with perched water tables correlate with subsoil redoximorphic features of soil mottling from iron accumulations and depletions. Research in Western Oregon has shown that these Cr-horizons have very low hydraulic conductivity and often result in perched water zones. The water moves subsurface laterally on slopes. Where water tables intersect the ground surface, seeps occur, and several such areas experience overland flow in the winter rainy season. These seep areas are common along the side slope and the base of the slope, and in the summer they generally become much smaller wet spots or dry up.

Future Soil Mapping Needs: This preliminary investigation was done to evaluate and classify soils at finer resolution than the older county soil survey and to make general interpretations for vineyards. Soils in the existing vineyards were not sampled except on the edges. Prior to development, mapping soil properties with an emphasis on locating boundaries between, soil depth classes, and drainage classes allows more opportunity to strategically design blocks in the vineyard and could serve as a foundation to a more nuanced approach to viticultural soil management. Projections for a high intensity soil survey include on the average one soil observation per acre. Soil borings would be located with a GPS receiver, and soil properties including depth, drainage, and available water holding capacity would be mapped using GIS to produce color thematic maps. High intensity soil maps can guide drainage design, site specific rootstock and clonal selections and irrigation cells. Surface and subsoil fertility can be mapped as well and used to guide soil nutrient management and to further refine vineyard blocks.

Soil Depth Classes (Inches)

Shallow	<20
Moderately deep	20-40
Deep	40-60
Very Deep	>60

Drainage Classes

Class	**Depth to Seasonally High Water Table (Inches)**
Poorly Drained	12 inches or less
Somewhat poorly drained	12 to 20 inches
Moderately Well	20 to 40 inches
Well drained	>40 and rarely during growing season