Precision Soil Map for Future Vineyards
40 Acre Site

Oak Springs Farm Road
Yamhill County Oregon

For: Hugh Williams

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INTRODUCTION AND BACKGROUND

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 emphasize the soil and site characteristics in their wines and provide 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.

This soil investigation was done to evaluate the soils for vineyard development on this 40-acre site on Oak Springs Farm Road, in Yamhill County, Oregon. Soils here are more diverse than they are shown at the 1:20,000 scale of the county soil survey. This report is primarily intended to provide more detailed site-specific soil information and to identify potential viticultural soil management issues and provide an estimate of plantable acres. It is not intended to give a precise acreage suitable for vineyards, since that figure is influenced by many management decisions, practices and levels of acceptable risk. This site is currently in cropland with small areas of brush and timber on the east part.

Geology and Topography

The parcel is situated on moderately to gently sloping south aspect slopes of the foothills of the Oregon Coast Range on the west side of the Willamette Valley. There are small areas of very steep soils on the east part in the wooded area **(See slope map).**

Much of the survey area is south, southeast and southwest aspect **(See aspect map)**. Underlying rocks on the main slopes are marine sedimentary rocks. There are scattered basalt stones on the shoulder of the ridge, that may be from a former basalt cap or that may have been placed here by former inhabitants. A mantle of Willamette Silt was deposited here during the prehistoric Missoula floods, and has been largely eroded away on the slopes and is thicker on the foot slope. There are small gravel to cobble sized glacial erratics on the site especially from mid-slope and down. Elevation of the surveyed area ranges from about 305 feet on the ridge in the northwest corner down to 165 feet above sea level in the lower southeast corner **(See topographic map)**. Small intermittent streams and springs flow from north to south in two narrow, partially wooded and brushy drainage ways.

Previous Soil Mapping

The Soil Survey of Yamhill County Area delineated primarily Carlton soils on the lower slopes, Willakenzie and Hazelair soils on the upper side slopes and a small area of Panther in the southeast corner **(See NRCS soil map)**. These soils formed from colluvium and residuum of sedimentary rocks on the foothill portion of this parcel and the soils on the foot slope are from colluvial deposits (slope wash) and a mantle of Willamette Silts. (Source SCS mapping in 1974 survey republished as a GIS data layer of NRCS soils attached to this report). The soils in this foothill setting are usually moist but are dry for 45 to 60 consecutive days during the summer between depths of 4 and 12 inches.

METHODS

This investigation was conducted March 2009. Twelve borings 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. For each boring, a soil core was observed to a depth of 60 inches (or shallower where bedrock is restrictive or where wetness prevented a deeper sample). Average sampling intensity was approximately one boring per four acres. Borings were from 3 inch diameter soil cores. Boring locations were recorded using a GPS receiver to 1 m accuracy. Revised map and acreage calculations were made in ESRI ARCGIS software. An orthophotograph and topographic map of the site were used to refine delineations.

RESULTS

Soil boring data are shown in Table 1. There are an estimated 32 acres that have soils and slopes suitable for vineyards on this parcel (Areas A and B) in the revised soil map). There are about 8 acres with poorly or somewhat poorly drained soils in drainage ways that are considered unsuitable for wine grapes. Areas of concentrated flows in the winter make viticulture impractical in these areas or soils are seasonally saturated near the surface. Areas considered suitable to winegrowing on this parcel are grouped into map units A and B based on parent material, soil association or some other property such as surface stoniness. These areas require artificial drainage and some of the soils are better suited to irrigated vineyards.

All of the soils observed on this parcel range from moderately well drained to poorly drained, and while the poorly drained soils are generally not suited to growing grapes the somewhat poorly drained and moderately well drained soils need to be artificially drained in order to reduce soil wetness.

Estimates of acreage suitable for vineyards are subjective and may in practice include more or less acreage for a number of reasons including viticultural practices, easements, block layouts, other site features and inclusions of small unsuitable areas. The area considered suitable for vineyards is based on soil borings, aerial photographs, topographic maps and other information sources interpreted within the framework of prevailing winegrowing practices used in the Willamette Valley.

Table 1. Summary Soil Properties from Soil Boring Data – Rockyford Road Property.

Boring	Soil Name(s)*	Slope (%)	Depth to Seasonal high water table (IN)	Depth to Cr-horizon (IN)	Available Water Holding Capacity (IN)
1	Dupee	7	19	23	4
2	Panther (loamy phase)	18	0	60	9
3	Hazelair	4	12	32	8
4	Wellsdale	12	25	60	9
5	Wellsdale	10	33	60	9
6	Wellsdale	6	27	31	6
7	Chehalem	4	6	60	10
8	Hazelair	3	15	31	5
9	Dupee	6	17	23	4
10	Chehalem		12	60	10
11	Hazelair	6	12	39	7
12	Wellsdale	8	23	60	9

Soil Evaluations

Summary soil data and best-match classification are provided for each of the soil borings (Table 1). Soils that are named for each sample plot are the closest match of established NRCS soil series, and are managed similarly to those sampled. Where properties are outside of the range of properties for the named series they are noted and discussed. Soils summaries are provided that describe the properties of the established soil series. Additional information about these soils is available from the Soil Survey of the Yamhill County Area and on the internet (http://ortho.ftw.nrcs.usda.gov/osd/osd.html).

Slope Gradients and Aspect

Two of the attached maps were used to help delineate areas suitable for viticulture based on slope configuration. The contour map was generated from a 10-m digital elevation model and shows 5 ft contours. This contour map was field checked at soil boring locations. The attached slope aspect map is useful in showing the overlay of contour lines and color shaded slope aspect (direction that the slope faces), showing both the direction the slope faces and the steepness of the slope, which are two factors that impact the amount of solar energy available at any point.

Soil Map Unit Summaries

Soil map units are mapped as complexes of soils with two suitable soil groups A and B and other non-suitable areas are delineated C.

Map Unit A

Soil series include Dupee and Wellsdale soils, both are moderately well drained. This map unit also includes soils that are transitional between Dupee and Wellsdale soils.

The soils range from moderately shallow to deep to siltstone. These soils are moderately well drained with smaller areas where soils are somewhat poorly drained. Depth to seasonally high water tables ranges from 18 to 33 inches in this map unit. The Dupee soils are more clayey than the Wellsdale and on this site the Dupee soils are moderately shallow to weathered siltstone. Delineation of these two soils requires more intensive soil mapping prior to site preparation, block design and planting.

<u>Map Unit B</u>
Soil series in this unit are predominantly Hazelair soils but include small areas of Chehalem soils in swales. These soils are somewhat poorly to moderately well drained and have high clay content of smectitic clays in the subsoil. The soils have seasonal high water tables at a depth of 12 to 18 inches. The depth to weathered siltstone is 30 to 40 inches. These soils have moderate available water holding capacity.

<u>Map Unit C</u>
This part of the parcel is the foot slope and drainage ways where the Missoula Flood deposits lapped onto the foot slope sediments. Recent slope wash has influenced the surface layer. The soils are poorly to somewhat poorly drained Chehalem and Panther soils. These soils have a seasonally high water table at 12 inches and less.

Soil Series

<u>DUPEE SERIES</u>

The Dupee series consists of deep, moderately well or somewhat poorly drained soils that formed in moderately fine and fine textured colluvium overlying weathered sedimentary bedrock. These soils are on side slopes and ridge crests. The subsoil has moderately slow permeability. Available water holding capacity is medium low to medium. On this site the Dupee soils are predominantly moderately shallow (21 to 30 inches) to weathered rock. Rooting is generally deep. These soils are transitional to Hazelair soils in places where the substratum is smectitic clay, and are transitional to Wellsdale where the subsoil is about 35 percent clay. These soils need artificial drainage.

<u>CHEHALEM SERIES</u>
This unit consists of deep, somewhat poorly drained soils formed in colluvium and residuum derived from sandstone and tuffaceous materials. Chehalem soils are typically somewhat poorly drained with seasonal high water table at depths of 12 to 20 inches. Chehalem soils have thick dark surface with mottled clayey subsoil. They occupy the gently to moderately sloping foot slopes and toe slope (concave) slope positions. There are small areas where these soils are poorly drained and are transitional to Panther soils. The Chehalem soils are usually not suited for vineyards because they typically occur lower on the landscape where frost hazard is high.

HAZELAIR SERIES

Hazelair soils are very clayey, somewhat poorly drained to moderately well drained soils that are common, but usually minor, components of many Willamette Valley vineyards. They typically have structureless, massive, smectite clay subsoil that overlies slowly permeable weathered siltstone and shale. These soils have very slow subsoil hydraulic conductivity, which makes water-table lowering with pattern drainage impractical. These soils tend to be wet early in the growing season and then droughty around the time from color change to harvest. Producing high quality winegrapes on Hazelair soils requires soil water management including artificial drainage and irrigation. The most practical drainage strategy used for these soils is intercept drainage, which collects subsurface flow and side-hill seep water and diverts water toward outlets in natural drainage ways. Intercept drainage is typically installed prior to trellis installation and planting.

PANTHER SERIES

These are poorly drained with dark surface layer and very clayey subsoil. These soils formed from colluvium and alluvium of sedimentary rocks. They typically occur in the bases of narrow drainage ways or on side-hill seeps. These soils are not well suited to vineyards, as they tend to be too wet and too droughty in the summer. Surface ponding and seepage are common in the winter and spring. These soils have very high clay content in the subsoil and substrata and make good reservoirs

WELLSDALE SERIES

The Wellsdale series consists of deep, moderately well drained soils formed in colluvium and residuum derived from sandstone and tuffaceous materials. Wellsdale soils occur on smooth convex low hills. These soils have moderately slow permeability. An apparent water table is at its uppermost limit from November through April. Available water holding capacity is moderately high. These soils have less clay in the subsoil than Dupee. On this site the Wellsdale soils are on the eastern third of the property. Once they are artificially drained these soils make excellent winesoils.

Depth to Weathered Bedrock (Cr-horizon)

The Cr-horizon retains rock structure and appearance but is soft enough to be dug into with hand tools. The depth to weathered bedrock on this site is typically the depth to the top of the Cr-horizon, which on this site is weathered siltstone and sandstone. The observed depth to siltstone is 23 to more than 60 inches. 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. Typically there is evidence of deep rooting in these soils. Soil depth to bedrock can be used as a factor in designing vineyard blocks and in identifying areas that are likely to be droughty. These soils have good subsoil structure, deep rooting and fractured soft siltstone substrata that are conducive to deep rooting. There does not appear to be cost effective benefit of deep subsoiling on this site below a couple feet.

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 moderately shallow soils that have moderately low AWHC (4 to 5 inches). This includes the Hazelair soils and the moderately shallow Dupee soils. These soils are droughty in most years. Moderately deep soils here are estimated to have moderate amounts of available water (4 to 7 inches) and these soils can be droughty after prolonged dry spells. Soils with moderately high to high AWHC (8 to 10 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 the more drought tolerant rootstocks, and by using 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)

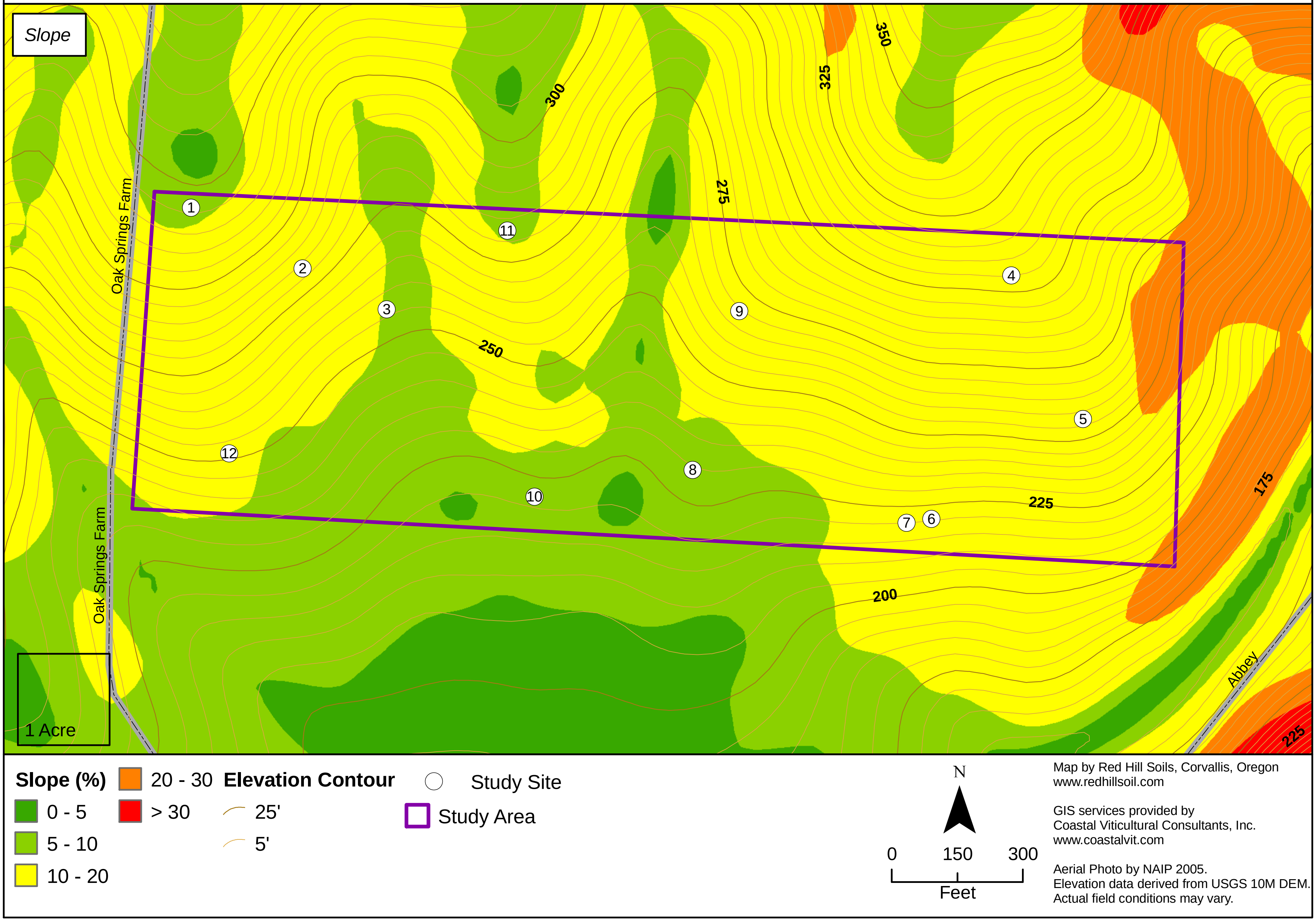
All of the soils observed here have seasonally high water tables. Installing drainage lines into these soils can reduce the duration of wetness, the amount of subsurface flow and runoff in the winter and reduce water erosion, an important management issue on this site. A combination of intercept drainage, 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. Once drained the Wellsdale soils and Hazelair are good winesoils. The Hazelair and Dupee soils on this site need artificial drainage with closer drainage line spacing than the Wellsdale.

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 soil water moves subsurface laterally down slope. Where water tables intersect the ground surface, seeps occur, and several such areas experience overland flow in the winter rainy season.

Recommended Soil Mapping Needs: This soil investigation was done to identify soil types at a finer resolution than the soil survey and to make general interpretations for vineyards in preparation for the sale of the land for development into a vineyard. It is recommended that prior to actual development, important soil properties be precision mapped in finer detail with an emphasis on accurate mapping of parent material types, soil depth classes, available water holding capacity and drainage classes. This allows more opportunity to strategically design blocks in the vineyard and can serve as a foundation to a more nuanced approach to viticultural soil management. An average recommended intensity in precision mapping is one soil observation per plantable acre.

In precision mapping soil borings are located with using a global positioning system (GPS). Soil properties including depth, drainage, and available water holding capacity can then be mapped using geographic information system (GIS) to produce color thematic maps to guide drainage design, site specific rootstock and clonal selections and irrigation cells. Surface and subsoil fertility mapping is an available option and can be used to guide site specific soil nutrient management and to further refine vineyard blocks.

Williams Property

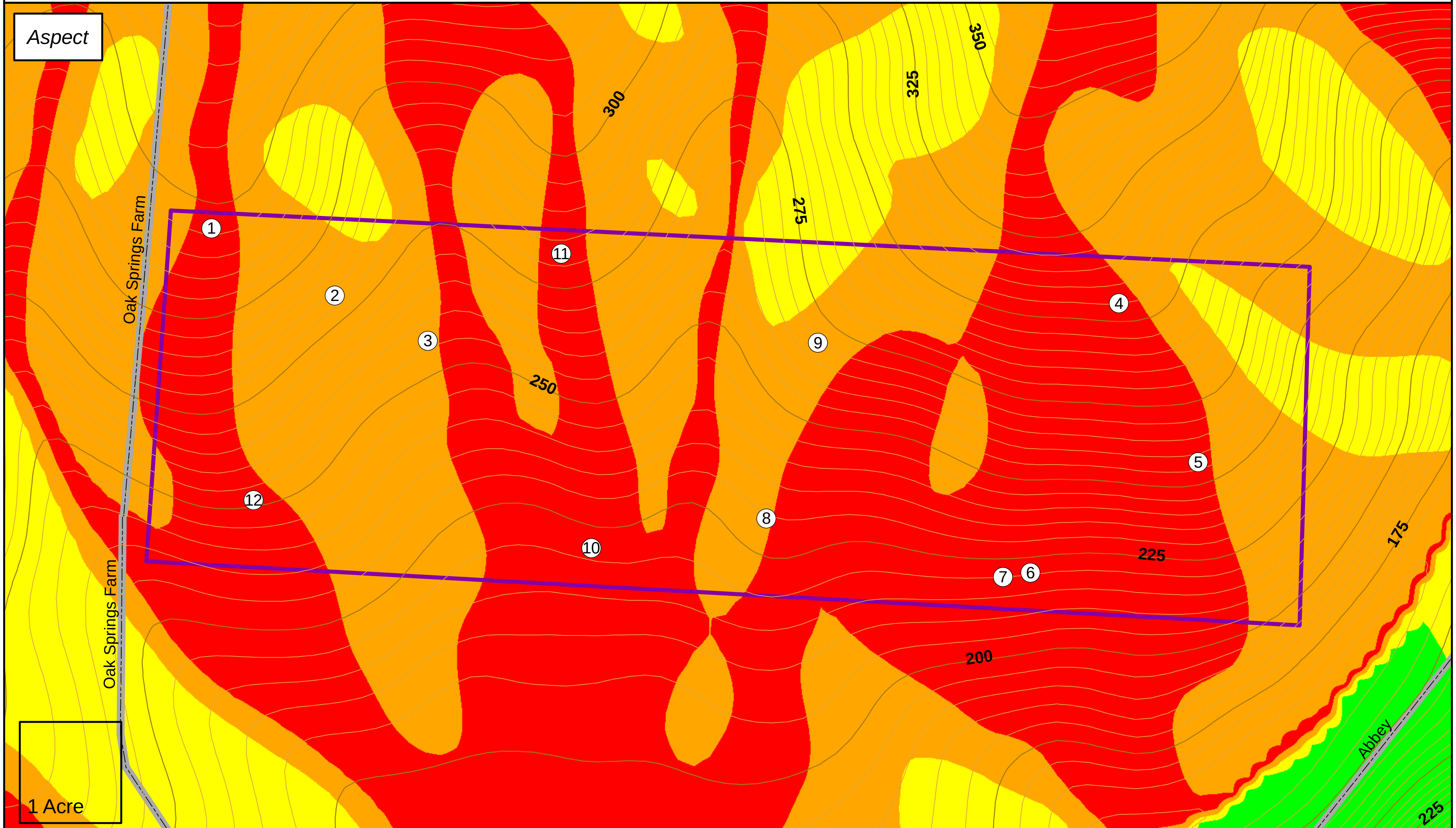


Map by Red Hill Soils, Corvallis, Oregon
www.redhillsoil.com

GIS services provided by
Coastal Viticultural Consultants, Inc.
www.coastalvit.com

Aerial Photo by NAIP 2005.
Elevation data derived from USGS 10M DEM.
Actual field conditions may vary.

Williams Property



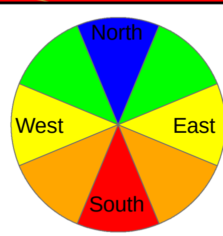
Elevation Contour

25'

5'

Study Site

Study Area



N

0 150 300

Feet

Map by Red Hill Soils, Corvallis, Oregon
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