Vineyard Site Evaluation Report

This report is provided by Virginia Tech's Center for Geospatial Information Technology for the Virginia Wine Board project "Virginia Vineyards Portal." A portion of this material is based upon research supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under Agreement No. 2010-51181-21599, "Improved grape and wine quality in a challenging environment: An eastern US model for sustainability and economic vitality."

Figure 1: VGIN: Virginia Base Mapping Program, Orthoimagery (MostRecentImagery)

Geographic Location: 39.1146, -78.2853 **Planar Area:** 3.59 acres

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Note: To report errors or problems with this report, send an email to cgitsupport@vt.edu.

*** indicates that data was unavailable when the report was requested.**

The planar area calculation is based on the two dimensional surface of the given site. Due to the spatial resolution of the available data, the area of the flat site is the most accurate representation that can currently be provided.

American Viticultural Areas

"A viticultural area for American wine is a delimited grape-growing region having distinguishing features as described in the Code of Federal Regulations (CFR) at 27 CFR part 9 and a name and delineated boundary as established in part 9 of the regulations. These designations allow vintners and consumers to attribute a given quality, reputation, or other characteristic of a wine made from grapes grown in an area to its geographic origin" - Alcohol and Tobacco Tax and Trade Bureau (ttb.gov)

The American Viticultural Areas were digitized for Virginia as enumerated by the Electronic Code of Federal Regulations (e-CFR) Title 27, Chapter I, Subchapter A, Part 9. Accessed March 2015.

The e-CFR website provides up-to-date, explicit geographic definitions of every recognized AVA under U.S. Code: Title 27 (Alcohol, Tobacco Products and Firearms).

This material is available through the support of the Virginia Wine Board, Virginia Vineyards Association, Virginia Department of Agriculture and Consumer Services, and by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under Agreement No. 2010-51181-21599.

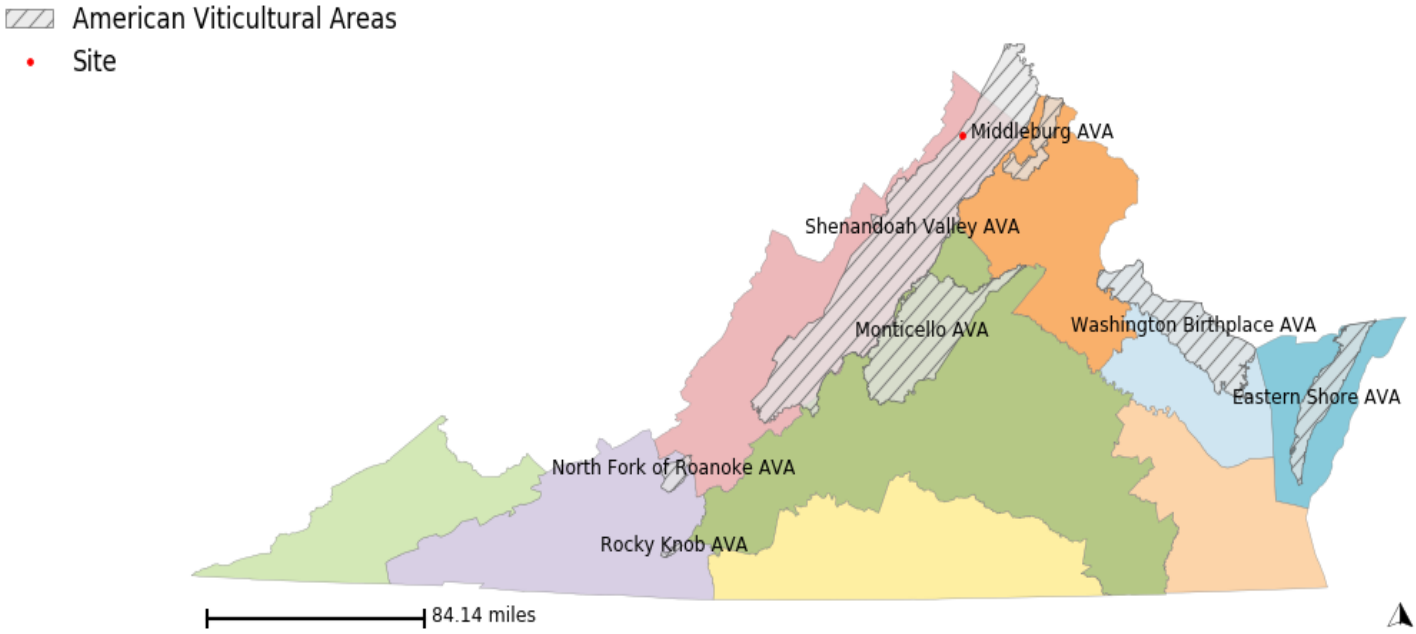


Figure 2: American Viticultural Areas and Virginia Growing Regions

Heart of Appalachia	**Blue Ridge Highlands**	**Shenandoah Valley**
Southern Virginia	**Central Virginia**	**Northern Virginia**
Hampton Roads	**Chesapeake Bay**	**Eastern Virginia**

Soil Data

Soil Aggregation Method

The soil data is aggregated according to the weighted average method outlined by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), SSURGO Data Packaging and Use document. Each soil attribute is aggregated by component based on the depth of the horizons or layers above the restrictive layer. The components are aggregated at the map unit level according to the percent composition.

$$\frac{Weighted\ Horizon}{Aggregation} = \sum Horizon\ Variable * \left(\frac{Horizon\ Depth}{Restrictive\ Depth}\right)$$

$$\frac{Weighted\ Component}{Aggregation} = \sum \frac{Weighted\ Horizon}{Aggregation\ Variable} * \left(\frac{Component\ Percent\ of\ Map\ Unit}{Total\ Map\ Unit\ Composion}\right)$$

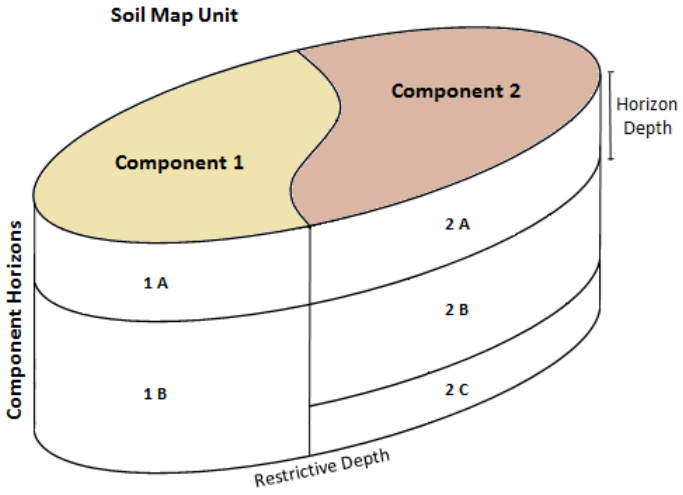


Figure 3: USDA Soil Aggregation Method

Soil Attributes

Organic Matter

Organic matter is generated by the decomposition of plant and animal waste by the communities of soil arthropods and microbial decomposers that it supports. Organic matter improves soil fertility, structure, aeration and drainage. In large quantities, organic matter releases excess Nitrogen that can lead to vigorous vine growth.

Soil Depth

Deep soil depth acts as a protective buffer against drought as it allows for greater volume of potential soil moisture and ample space for cultivation of large, healthy, perennial root structures.

Available Water Capacity (A.W.C.)

Available Water Capacity describes the quantity of water available for uptake by plants after gravitational forces have removed excess water from a saturated soil. The ability of a soil to hold water is a function of soil texture and organic matter content.

Saturated Hydraulic Conductivity (Ksat)

Ksat is a measure of the rate at which water moves through a column of saturated soil also described as permeability. Soils with Ksat values above 0.6 inches per hour tend to be better suited for viticultural production.

Cation Exchange Capacity

Cation exchange capacity represents the amount of readily exchangeable cations that can be electrically adsorbed to negative charges in the soil, soil constituent, or other material, at pH 7.0, as estimated by the ammonium acetate method.

Bulk Density

Bulk density describes the relationship between soil solids and pore space where air and water can be stored in a given volume of soil. Bulk density is a key factor in productive viticulture because bulk densities higher than 1.6 g/cm3 indicate compacted soil, restricted water movement, poor root development and loss of soil aeration.

Soil pH

Soil pH is easily amended, but the cost of amendment whether through lime or gypsum applications may be cost prohibitive for some growers if pH is above 7.5 or below 4.0. Appropriate soil pH levels are critical to vine health. Low pH values are especially detrimental to grapevines as Aluminum and Copper are made plant available which can lead to stunted growth and toxicity.

USDA-NRCS Soil Survey Geographic Database (SSURGO)

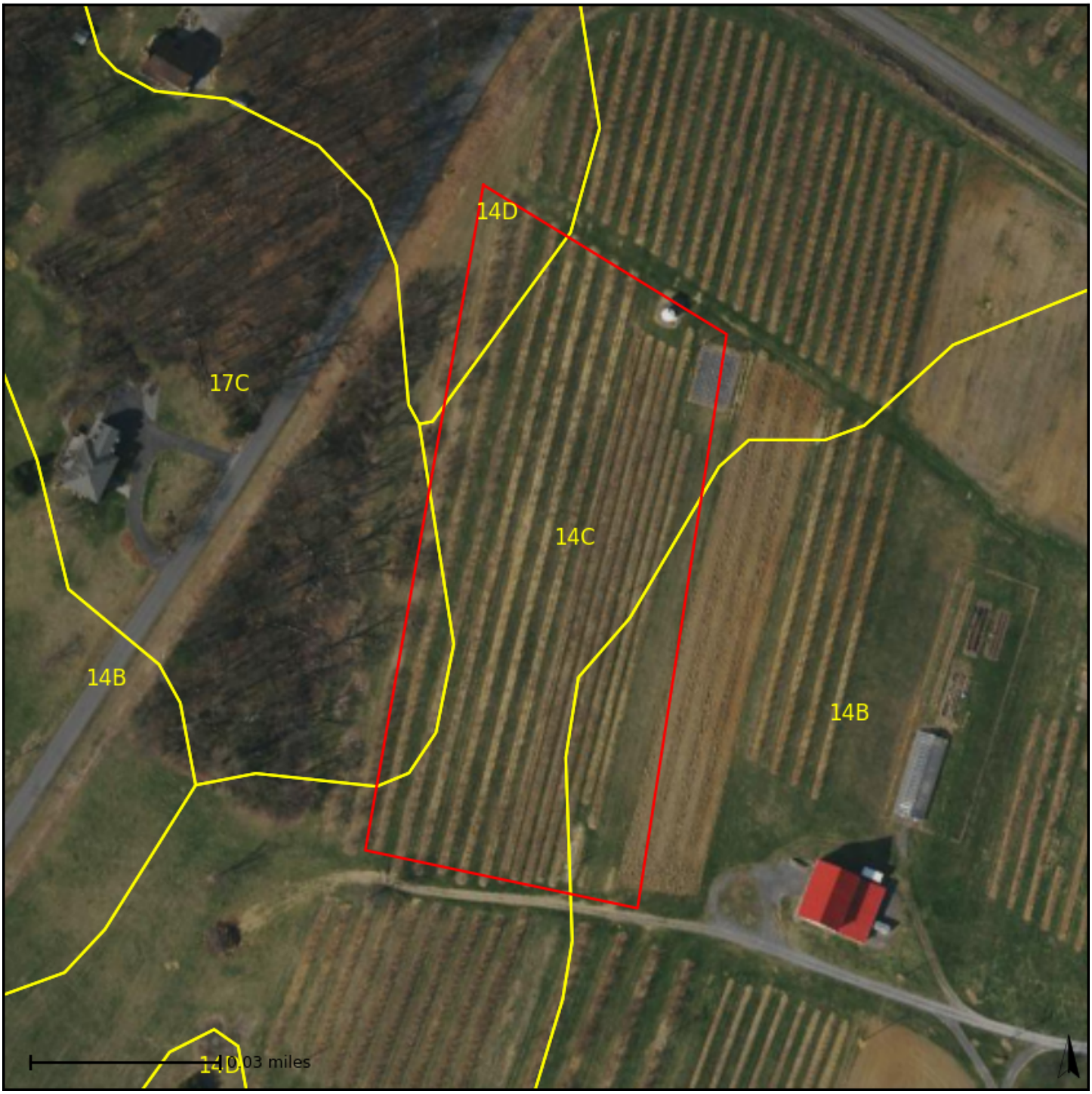


Figure 4: USDA, Natural Resources Conservation Service: Soil Survey Geographic Database, VBMP Orthoimagery (MostRecentImagery)

The following soil data is derived from the official Soil Survey Geographic Database (SSURGO). Soil attributes for each map unit within the requested site are included in this report according to the properties and characteristics stored in the National Soil Information System (NASIS).

Soil Series Attributes

Soil Series	Area (acres)	Percent of Site Area	Organic Matter (%)	Soil Depth (cm)		A.W.C. (cm/cm)	Ksat (in/hr)	Cation Exchange Capacity	Bulk Density (g/cm3)	Soil pH
Frederick-Poplimento loams, 2 to 7 percent slopes (14B)	0.57	15.79%	0.26	168.41	High	0.15	1.58	12.6	1.36	5.49
					Rep.	0.13	1.03	9.75		
					Low	0.09	0.48	6.44		
Frederick-Poplimento loams, 7 to 15 percent slopes (14C)	2.59	72.11%	0.26	168.41	High	0.15	1.58	12.6	1.36	5.49
					Rep.	0.13	1.03	9.75		
					Low	0.09	0.48	6.44		
Frederick-Poplimento loams, 15 to 25 percent slopes (14D)	0.22	6.04%	0.26	168.32	High	0.15	1.58	12.57	1.36	5.49
					Rep.	0.13	1.03	9.72		
					Low	0.09	0.48	6.43		
Frederick-Poplimento-Rock outcrop complex, 2 to 15 percent slopes (17C)	0.22	6.06%	0.27	168.91	High	0.15	1.61	12.78	1.36	5.49
					Rep.	0.13	1.05	9.9		
					Low	0.09	0.49	6.53		

Figure 5: National Soil Information System

Climate Data

The climate data in this report is based on Oak Ridge National Lab's Daymet data set, gridded estimates of daily weather parameters for North America. This data set, which is maintained by the Distributed Active Archive Center, contains daily estimates with a spatial resolution of 1 square kilometer dating back to 1980. The following derived products are a result of continued efforts of CGIT.

Temperature

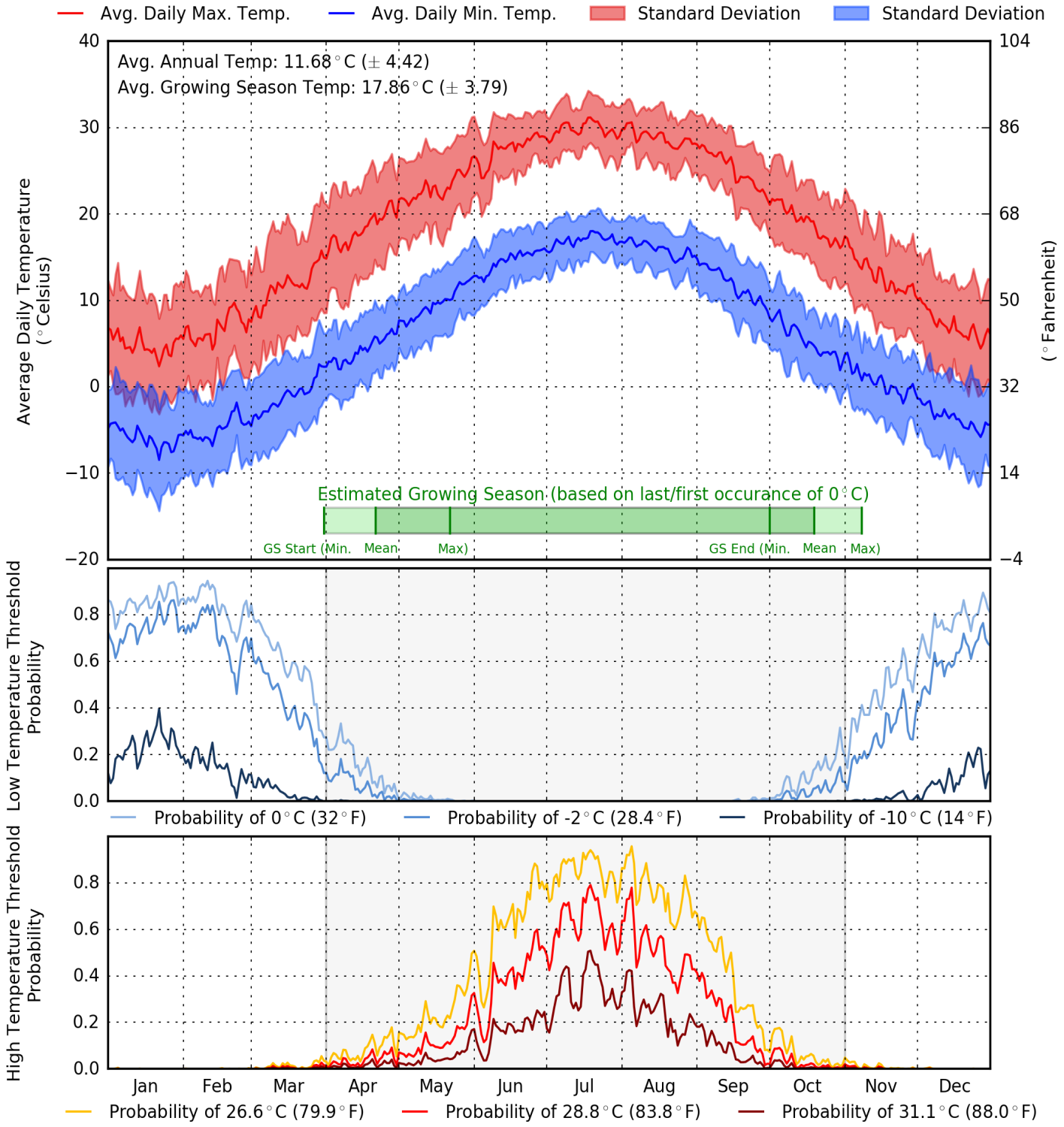
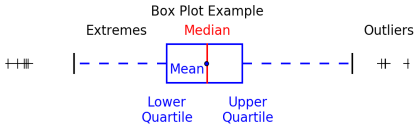


Figure 6: Daymet Temperature Graph

Growing Season

Growing season metrics are calculated based on the first and last occurrence of a given temperature threshold. The following growing season information is based on daily minimum temperatures from Daymet temperature data.



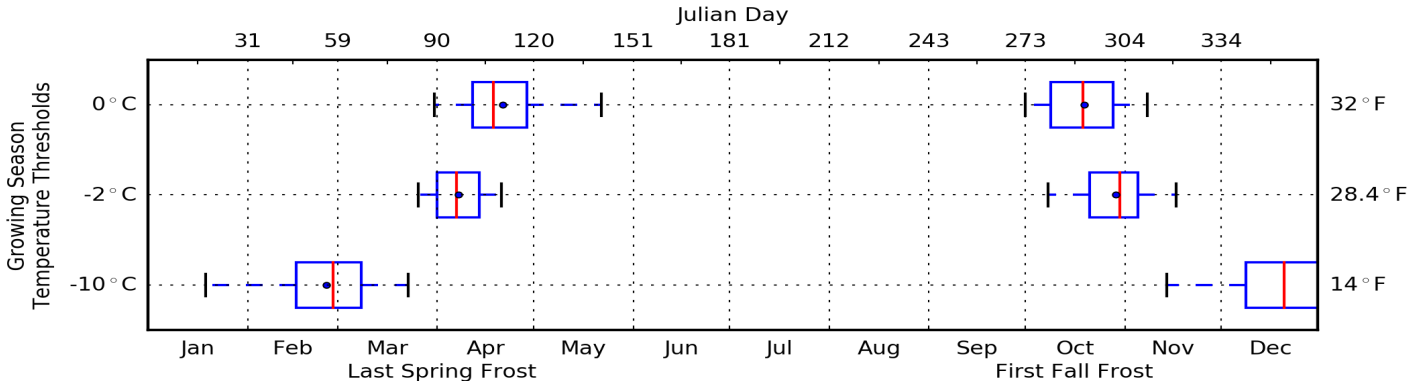


Figure 7: Daymet Growing Season Graph

Growing Season Statistics

Growing Season Temperature Thresholds	Growing Season Start				Growing Season End				Growing Season Length			
	min	max	mean	std	min	max	mean	std	min	max	mean	std
0°C (32°F)	89	141	110.44	12.57	273	311	291.42	10.54	144	211	180.97	16.66
-2°C (28.4°F)	84	110	96.56	7.62	280	320	301.14	9.66	172	235	204.58	12.53
-10°C (14°F)	18	81	55.42	15.31	317	546	395.25	87.58	237	528	339.83	91.62

Figure 8: Daymet Growing Season Statistics (Julian Day of Year)

Annual Growing Season Length

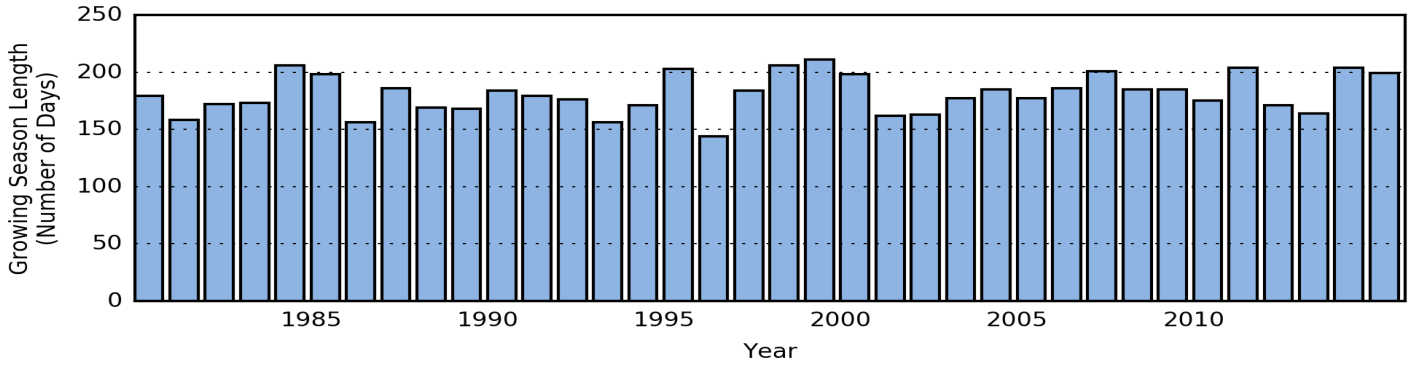


Figure 9: Daymet Annual Growing Season Graph - Calculated based on the occurrence of 0°C (32°F).

Growing Degree Day Accumulation

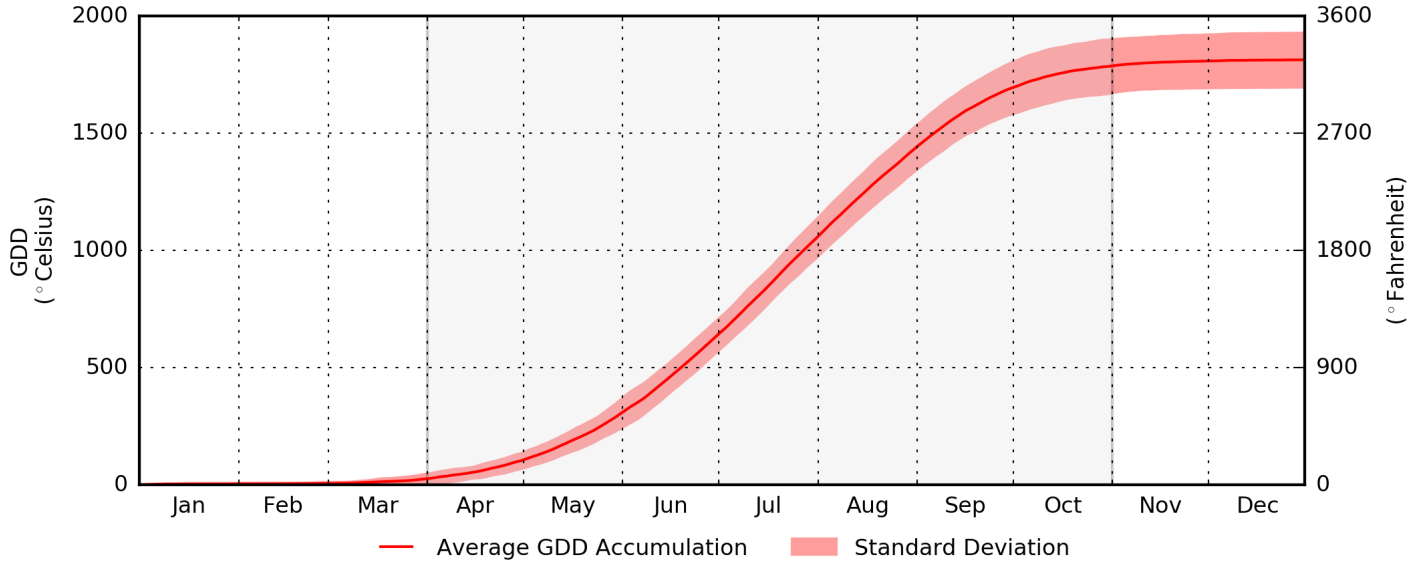


Figure 10: Daymet GDD Graph

Growing Degree Days (GDD) represent the average heat accumulation based on air temperature. GDDs are very important to predicting the stages of vine development, such as bud break, veraison, and maturity. GDD is calculated by evaluating the difference between the average daily temperature and a reference value, in this case 10°C. Figure 10 shows the average accumulation according to 36 years of accumulations calculated from Daymet temperature data.

Precipitation

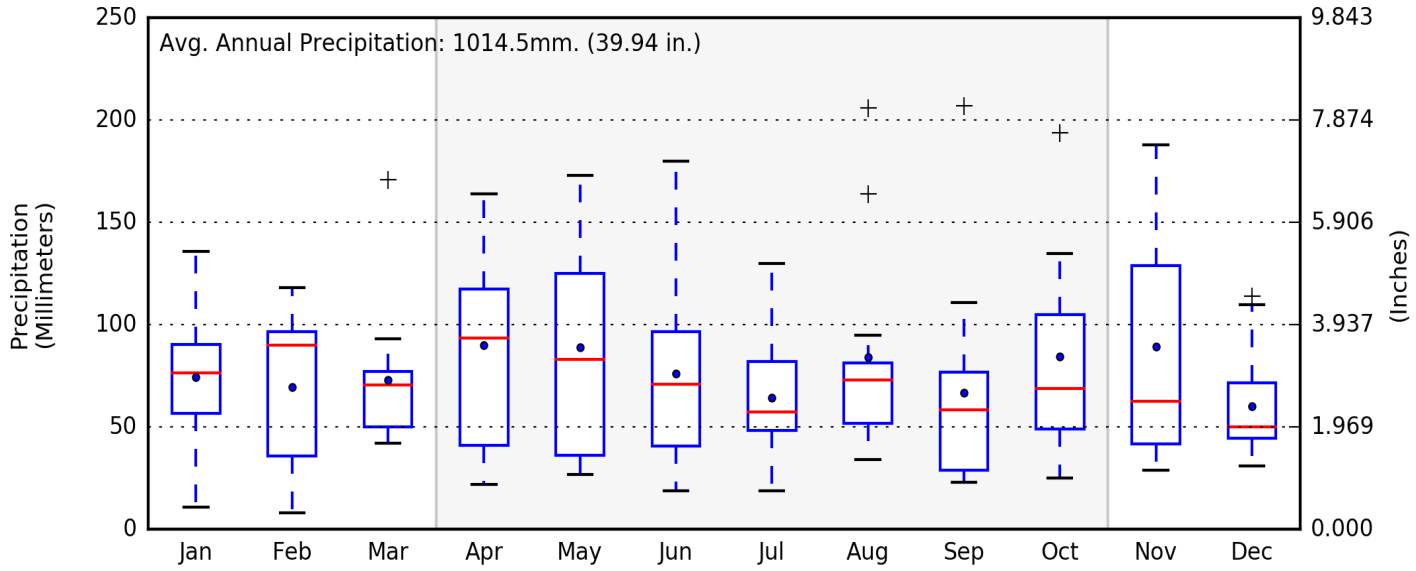
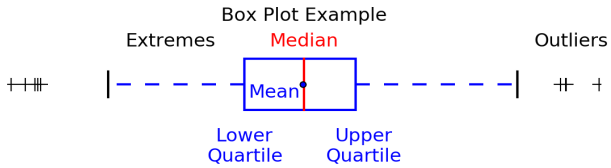


Figure 11: Daymet Precipitation Graph

The precipitation data in figure 11, represents 36 years of total precipitation each month. This data comes from Daymet daily precipitation estimates, representing the sum of all forms converted to water-equivalent.



Grapevine Climate/Maturity Groupings

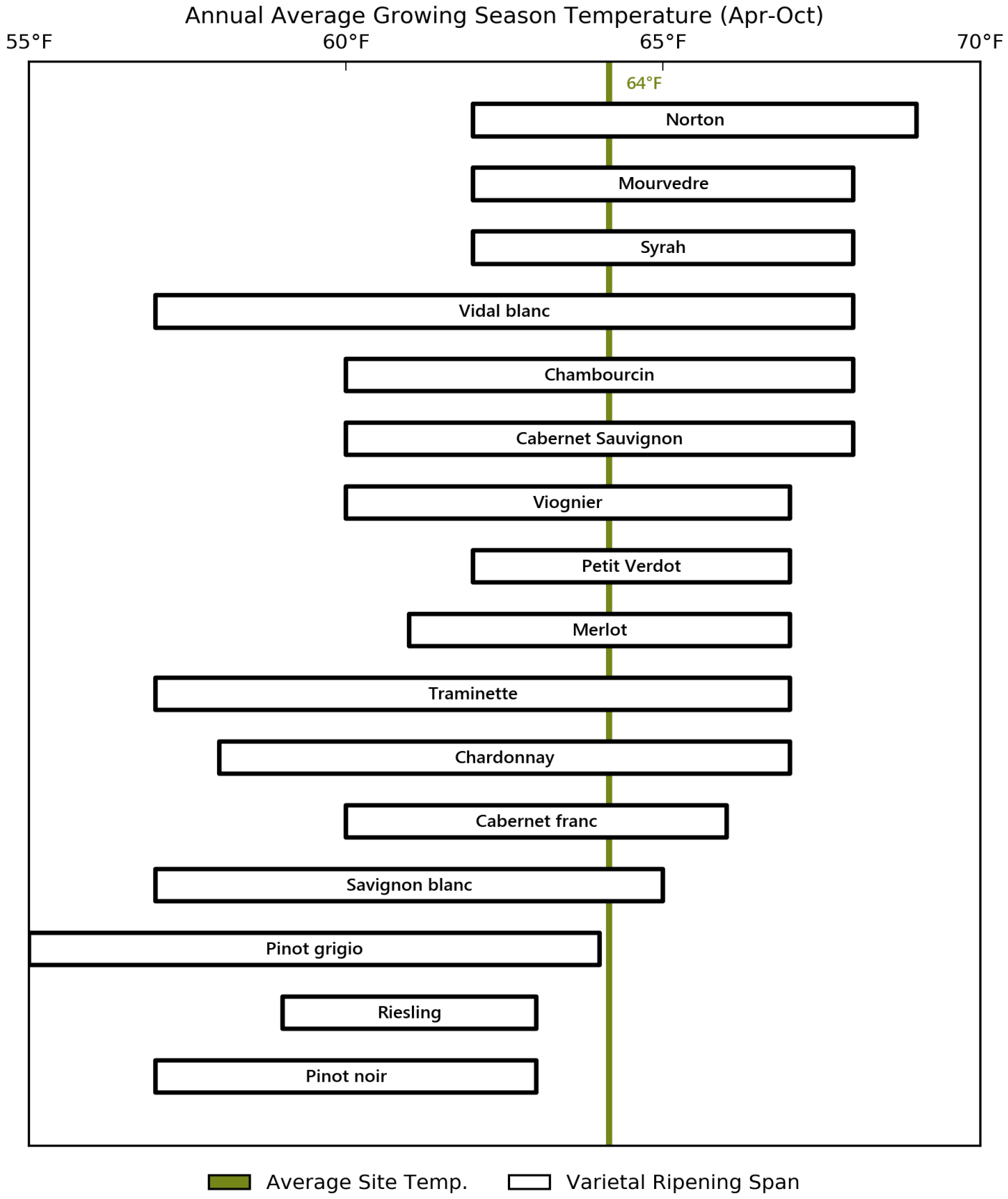


Figure 12: Maturity Grouping Graph

This graphic is based on the work of Dr. Gregory Jones (Jones 2006; Jones et al. 2012), it was adapted for the Commonwealth of Virginia by Dr. Tony Wolf during the Eastern U.S. Grape & Wine Quality Initiative.

Elevation

Figure 13: USGS National Elevation Dataset: Elevation Contours, VBMP Orthoimagery (MostRecentImagery)

Average Site Elevation: 956.65 ft Minimum Site Elevation: 928.44 ft Maximum Site Elevation: 971.34 ft

The contour map shown above is created from the USGS National Elevation Dataset. This data has a spatial resolution of 1/3 arc-second, ~ 10 meters. The contours are generated dynamically at a 10 foot interval.

Slope

The slope map shown in figure 14 is created from the USGS National Elevation Dataset. This data has a spatial resolution of 1/3 arc-second, ~ 10 meters. The slope values are calculated using GDAL, an open source geospatial python library.

Average Site Slope: 8.24 °
Minimum Site Slope: 1.38 °
Maximum Site Slope: 19.47 °

The classification method for the slope map in figure 15 was established by CGIT during the Eastern U.S. Grape & Wine Quality Initiative.

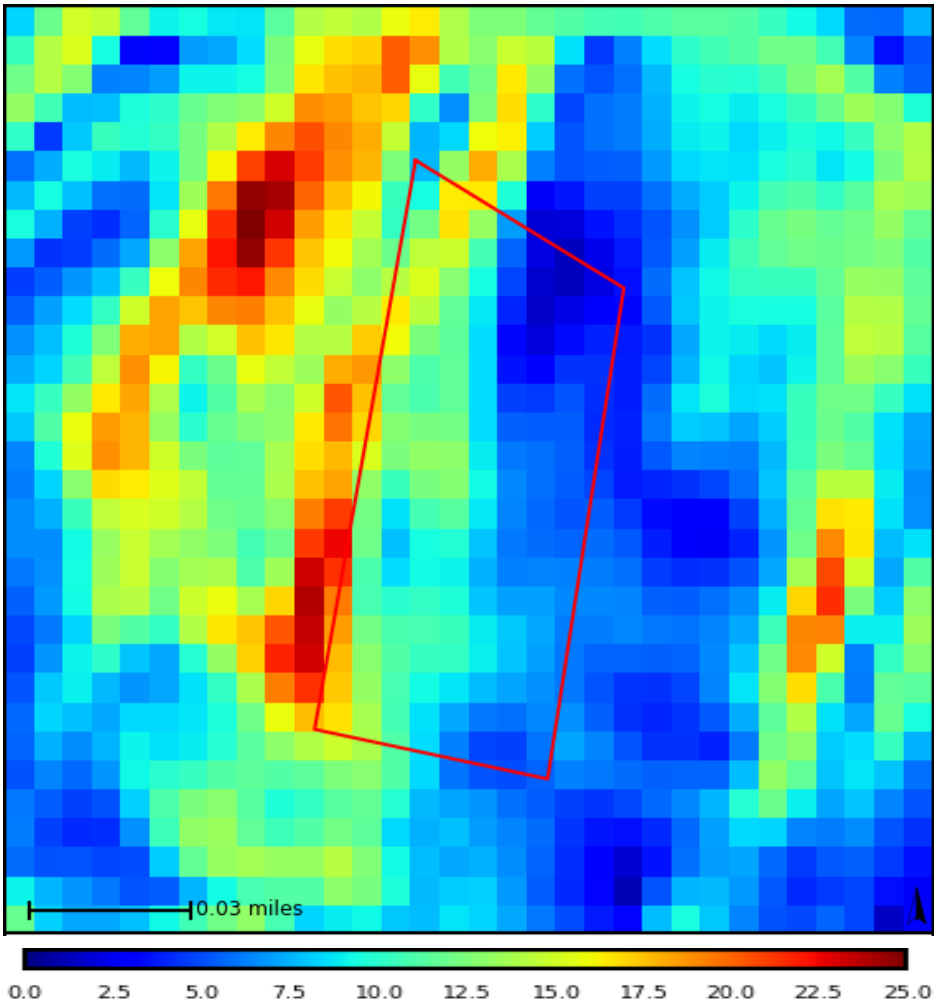


Figure 14: USGS National Elevation Dataset: Slope (calculated)

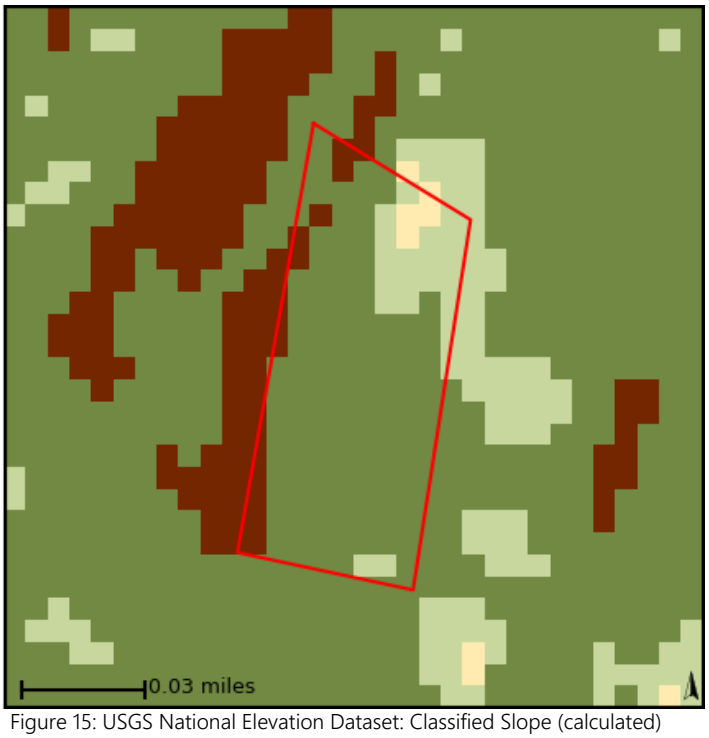


Figure 15: USGS National Elevation Dataset: Classified Slope (calculated)

	Classification Range	Percent of Site
Flat Land	0% - 2%	2.81%
Suitable	2% - 5%	19.1%
Highly Suitable	5% - 15%	70.22%
Unsuitable	> 15%	7.87%

Aspect

The aspect map shown in figure 16 is created from the USGS National Elevation Dataset. This data has a spatial resolution of 1/3 arc-second, ~ 10 meters. The aspect values are calculated using GDAL, an open source geospatial python library.

Average Site Aspect: 219.43 °
Minimum Site Aspect: 74.37 °
Maximum Site Aspect: 313.41 °

The classification method in figure 17 represents the downslope orientation as the appropriate cardinal direction.

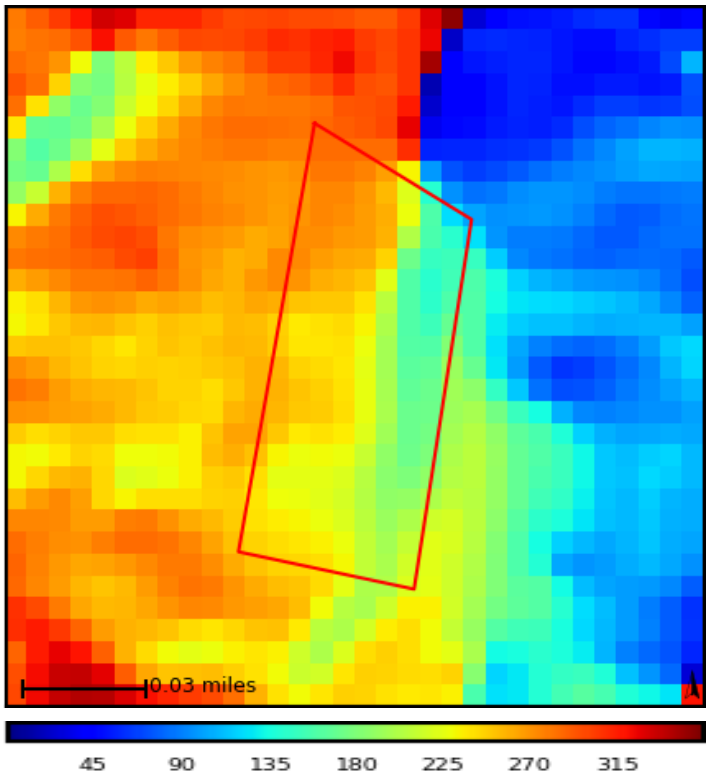


Figure 16: USGS National Elevation Dataset: Aspect (calculated)

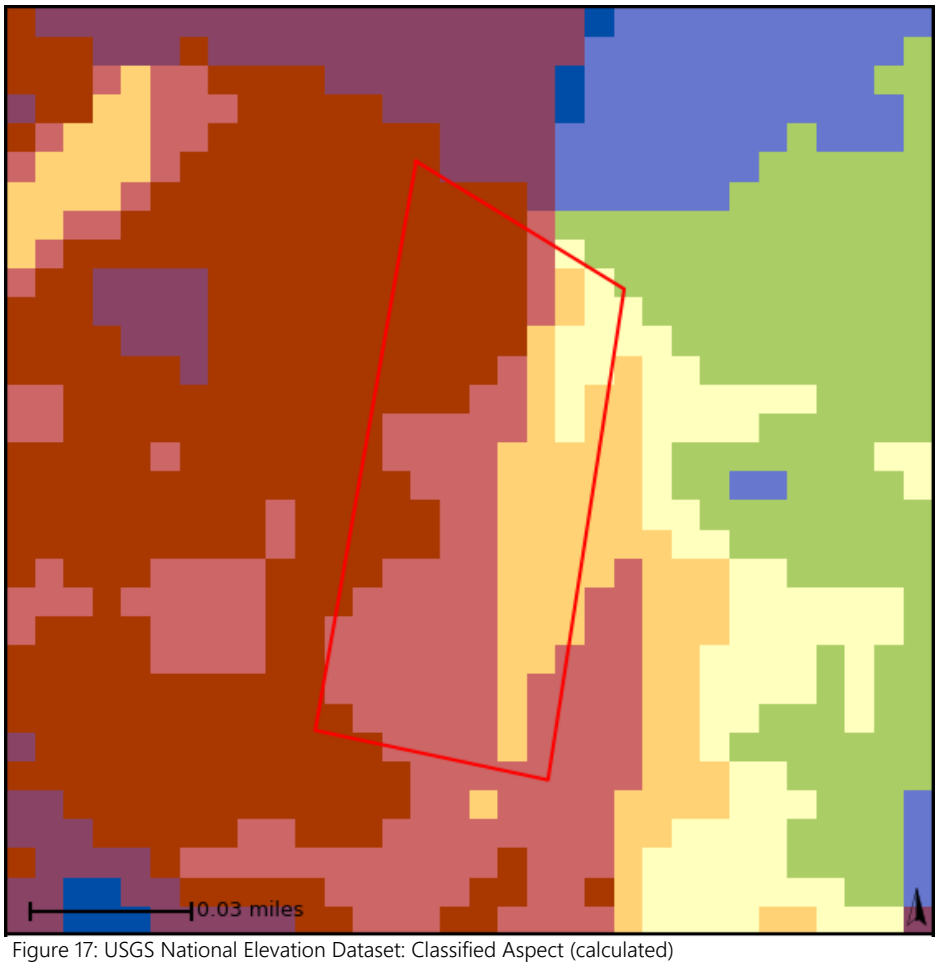


Figure 17: USGS National Elevation Dataset: Classified Aspect (calculated)

Direction	Bearing (°)	Percent of Site
Northern	337.5 to 22.5	0.0%
Northeastern	22.5 to 67.5	0.0%
Eastern	67.5 to 112.5	2.81%
Southeastern	112.5 to 157.5	6.18%
Southern	157.5 to 202.5	24.16%
Southwestern	202.5 to 247.5	37.08%
Western	247.5 to 292.5	27.53%
Northwestern	292.5 to 337.5	2.25%

Lithology

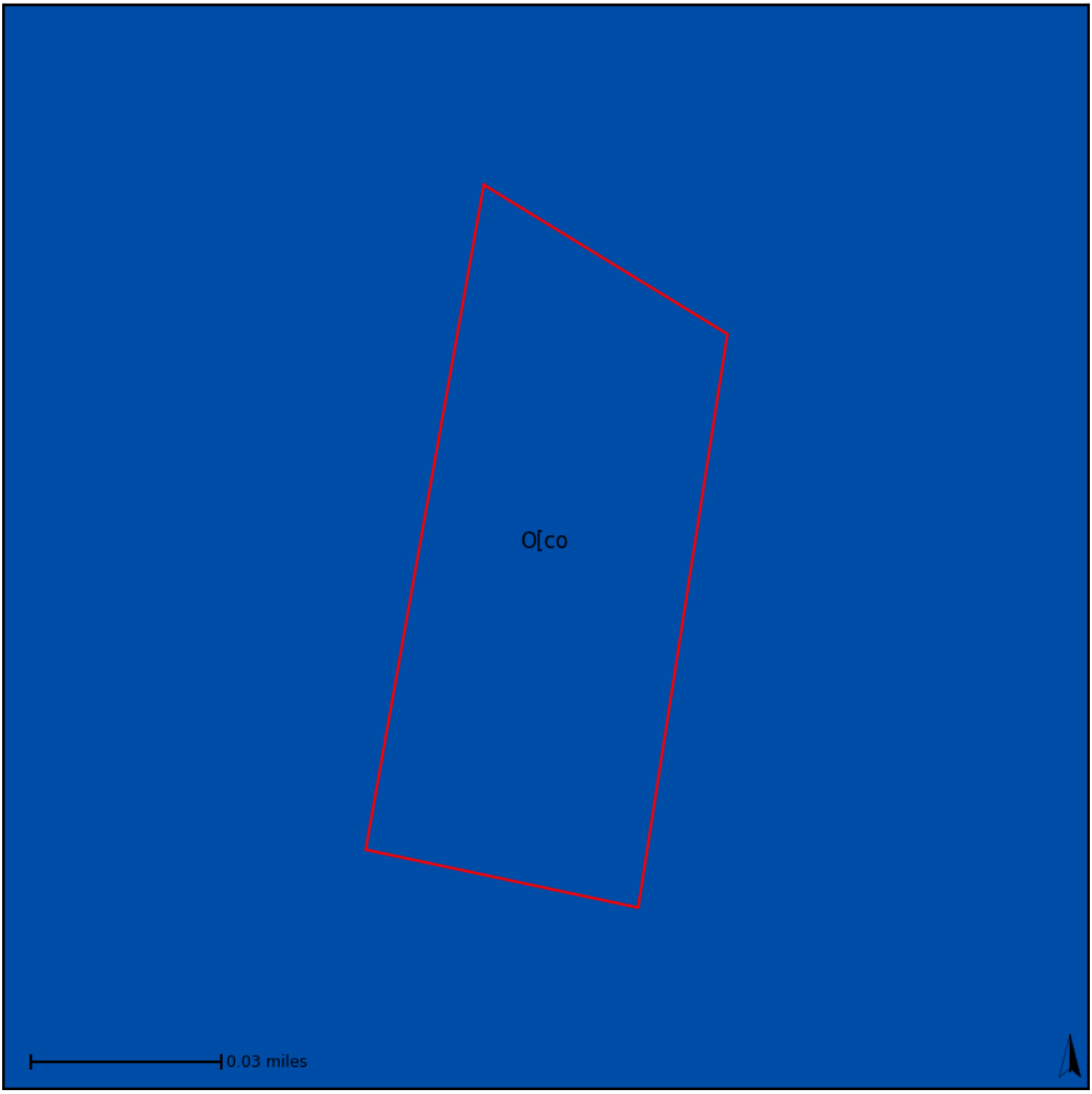


Figure 21: USGS Division of Geology and Mineral Resources, Lithology

Sedimentary, Carbonate (O[co)

Land Cover

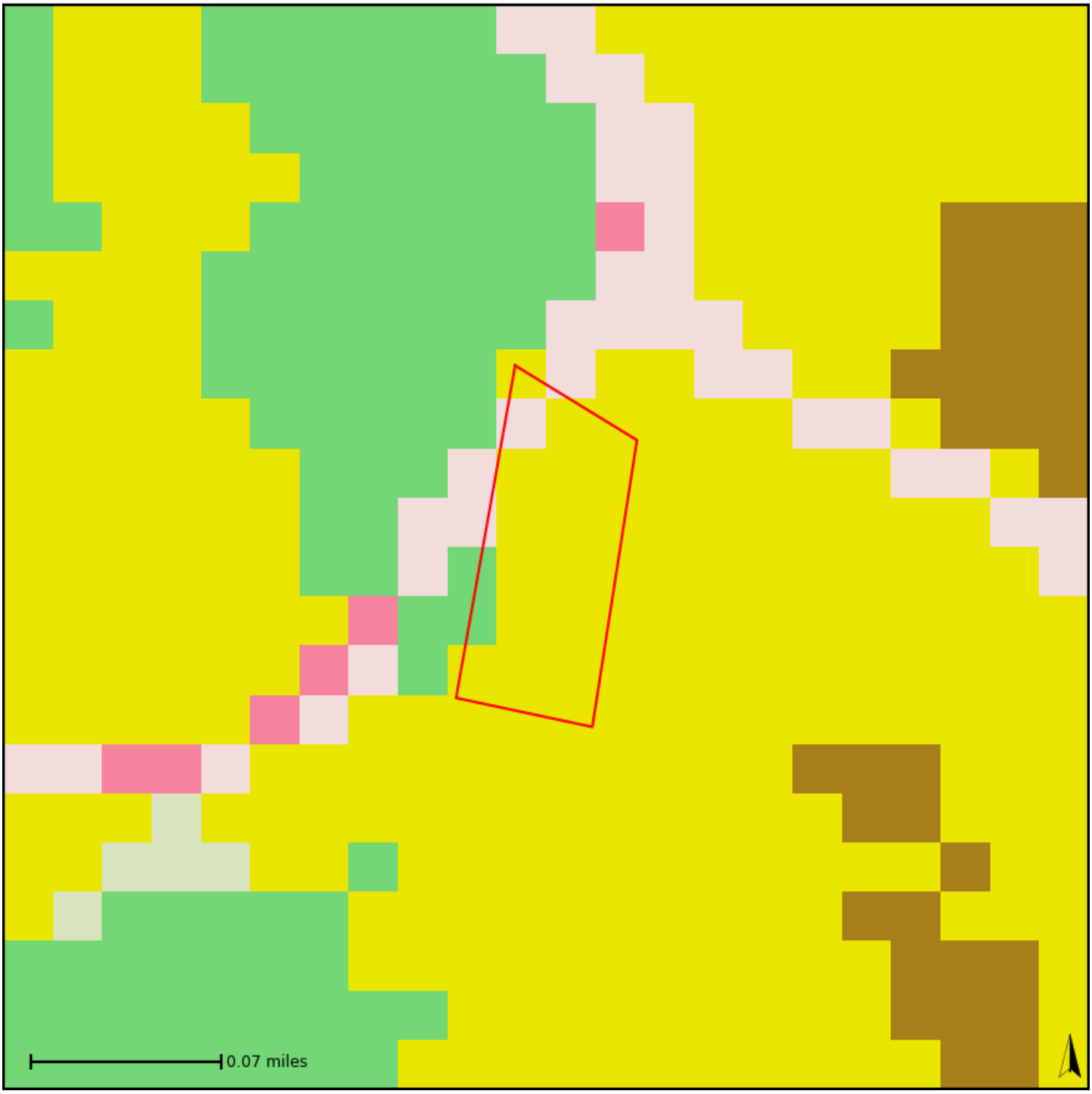


Figure 18: Multi-Resolution Land Characteristics Consortium: National Land Cover Database, 2016

0.0%	Open Water	0.0%	Barren Land	10.71%	Open Space	7.14%	Deciduous Forest
0.0%	Developed-Low Density	0.0%	Evergreen Forest	0.0%	Developed-Med. Density	0.0%	Mixed Forest
0.0%	Developed-High Density	0.0%	Shrub/Scrub	0.0%	Grassland/Herbaceous	0.0%	Woody Wetlands
82.14%	Pasture/Hay	0.0%	Herbaceous Wetlands	0.0%	Cultivated Crops		

The National Land Cover Database (NLCD) uses 16 land cover classifications. This data has a spatial resolution of 30 meters.

Land Surface Forms

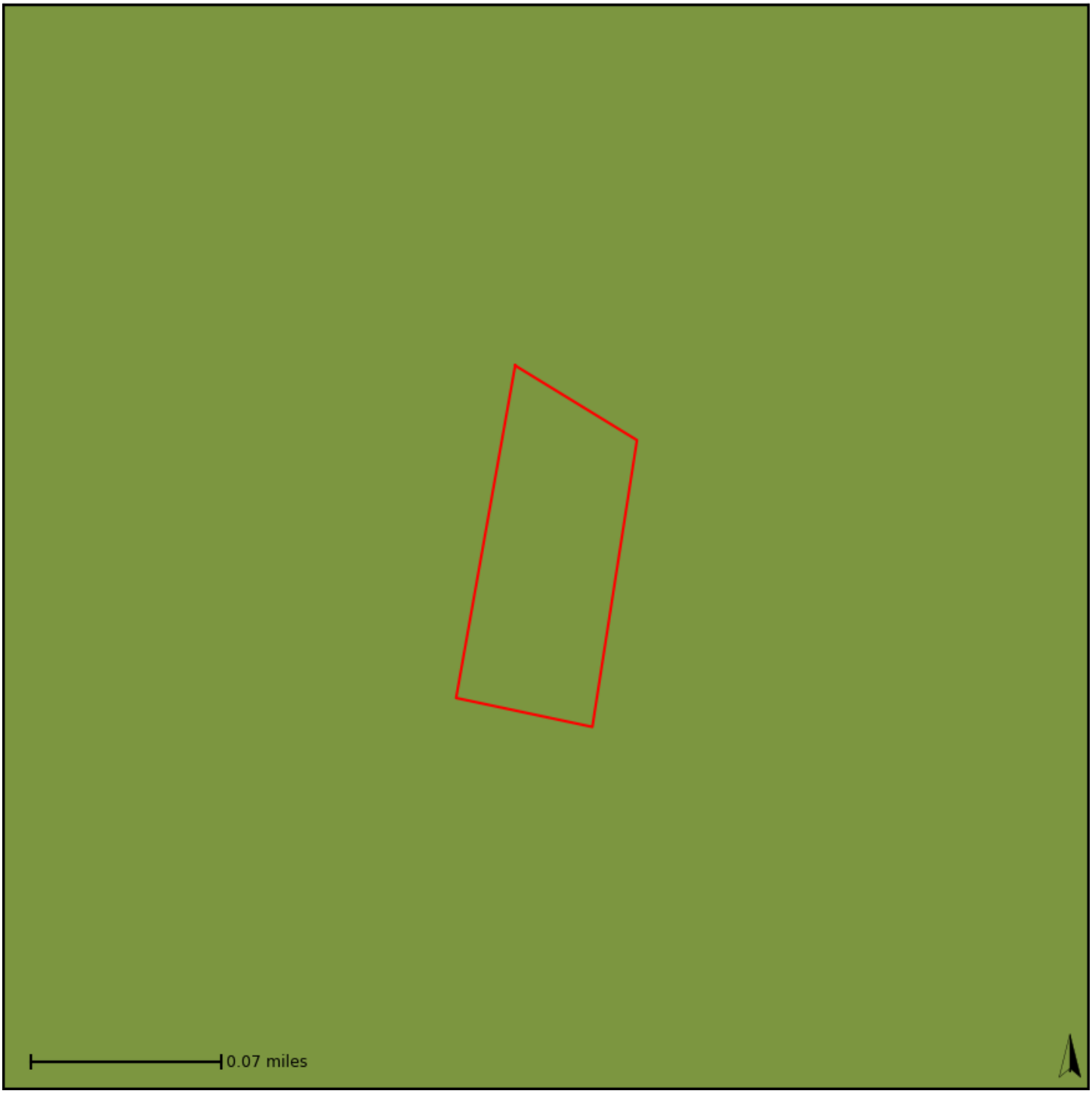


Figure 20: USGS Land Surface Form Dataset

0.0%	Flat Plains	100.0%	Irregular Plains	0.0%	Low Hills	0.0%	Breaks/Foothills	0.0%	Low Mountains
0.0%	Smooth Plains	0.0%	Escarpments	0.0%	Hill	0.0%	Drainage Channels	0.0%	High Mountains/ Deep Canyons

"As part of an effort to map terrestrial ecosystems, the U.S. Geological Survey has generated land surface form classes to be used in creating maps depicting standardized, terrestrial ecosystem models for the conterminous United States, using an ecosystems classification developed by NatureServe." (Cress, Sayre, Comer, and Warner)

Topographic Moisture Potential

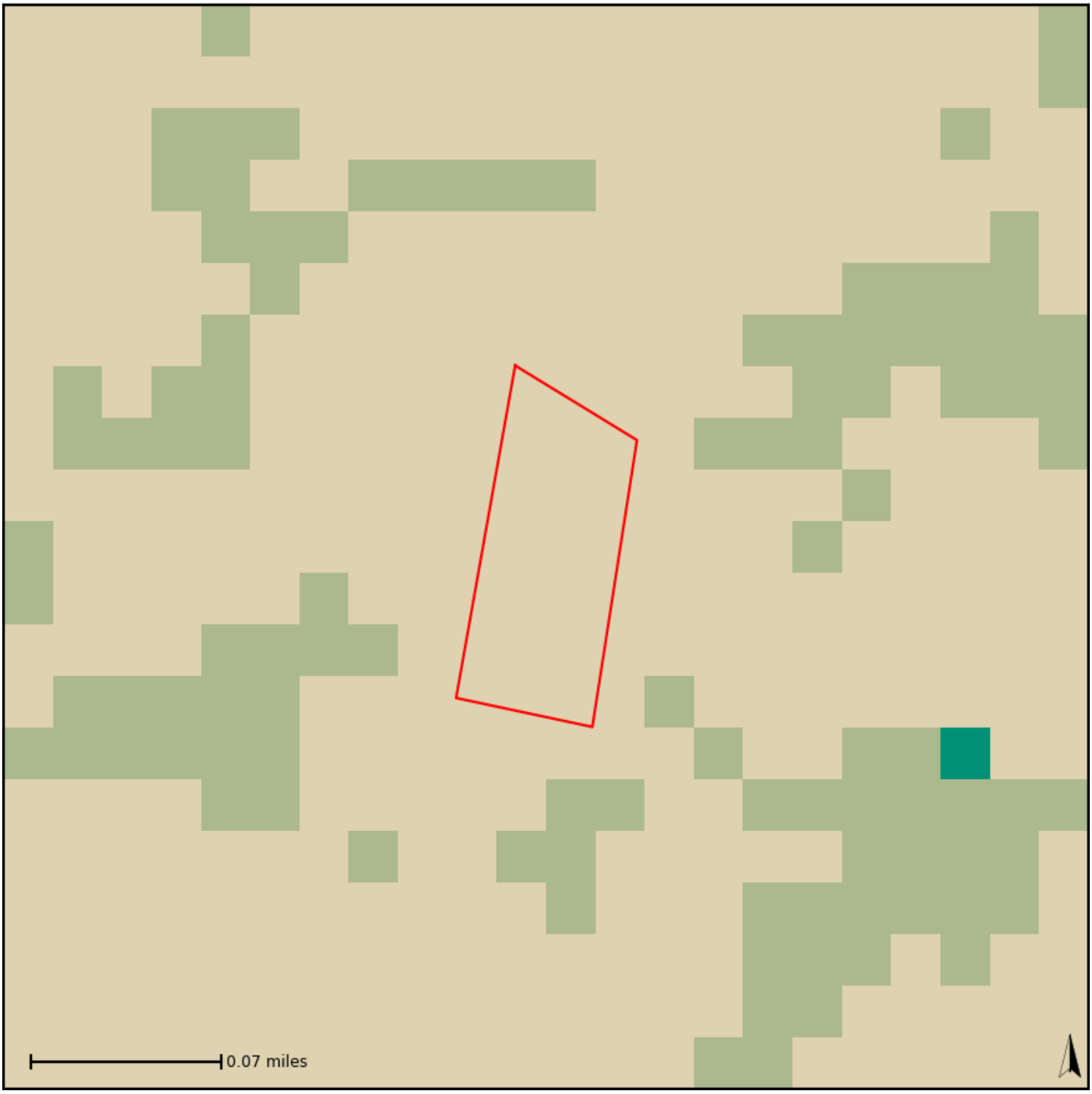


Figure 19: USGS Topographic Moisture Potential

0.0%	Mesic Uplands	100.0%	Dry Uplands	0.0%	Very Dry Uplands
0.0%	Potential Wetlands (Periodically Saturated or Flooded Land				

This dataset was derived from the Compound Topographic Index (CTI) dataset, which was itself a derivative product of the National Elevation Dataset (NED), created by the Elevation Derivatives for National Applications (EDNA) project.

Data Sources

This vineyard evaluation report was created automatically by interpreting publicly-available data as it applies to vineyard suitability. The GIS data layers used in this report are generalized and may not capture all details of a specific site. Furthermore, site management practices can significantly alter natural conditions.

Imagery:

Data available from the Virginia Geographic Information Network (VGIN). Virginia Base Mapping Program (VBMP), most recently available orthoimagery. Data collected in spring 2009, 2011, or 2012.

Soils Data:

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Soil Survey Geographic (SSURGO) Database for all available counties in Virginia, Maryland, and Ohio. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed 8/14/2020.

Climate Data:

Thornton, P.E., M.M. Thornton, B.W. Mayer, Y. Wei, R. Devarakonda, R.S. Vose, and R.B. Cook. 2016. Daymet: Daily Surface Weather Data on a 1-km Grid for North America, Version 3. ORNL DAAC, Oak Ridge, Tennessee, USA. Accessed February 17, 2016. Time period: 1980-01-01 to 2015-12-31. http://dx.doi.org/10.3334/ORNLDAAC/1328

Thornton, P.E., Running, S.W., White, M.A. 1997. Generating surfaces of daily meteorological variables over large regions of complex terrain. Journal of Hydrology 190: 204-251. http://dx.doi.org/10.1016/S00022-1694(96)03128-9

Elevation Data:

U.S. Geological Survey, 2019-2020, 1/3rd arc-second Digital Elevation Models (DEMs) - USGS National Map 3DEP Downloadable Data Collection: U.S. Geological Survey. Accessed 8/5/2020.

Land Cover Data:

Yang, Limin, Jin, Suming, Danielson, Patrick, Homer, Collin G., Gass, L., Bender, S.M., Case, Adam, Costello, C., Dewitz, Jon A., Fry, Joyce A., Funk, M., Granneman, Brian J., Liknes, G.C., Rigge, Matthew B., Xian, George, A new generation of the United States National Land Cover Database Requirements, research priorities, design, and implementation strategies: ISPRS Journal of Photogrammetry and Remote Sensing, v. 146, p. 108 to 123, at https://doi.org/10.1016/j.isprsjprs.2018.09.006. Accessed 8/5/2020.

Landforms Data:

Originator: USGS Rocky Mountain Geographic Science Center Publication_Date: November 2008 Title: Terrestrial Ecosystems Geospatial_Data_Presentation_Form: raster dataset Data Used: Compound Topographic Index (CTI), EDNA (Elevation Derivative for National Applications), US Geological Survey, http://edna.usgs.gov/edna/datalayers/cti.asp

Cress, J.J., Sayre, Roger, Comer, Patrick, and Warner, Harumi, 2009, Terrestrial Ecosystems Land Surface Forms of the Conterminous United States: U.S. Geological Survey Scientific Investigations Map 3085, scale 1:5,000,000, 1 sheet.

Topographic Moisture Potential Data:

Cress, J.J., Sayre, Roger, Comer, Patrick, and Warner, Harumi, 2009, Terrestrial Ecosystems Topographic moisture potential of the conterminous United States: U.S. Geological Survey Scientific Investigations Map 3086, scale 1:5,000,000, 1 sheet.

Lithology Data:

Horton, J.D., San Juan, C.A., and Stoeser, D.B., 2017, The State Geologic Map Compilation (SGMC) geodatabase of the conterminous United States (ver. 1.1, August 2017): U.S. Geological Survey Data Series 1052, 46 p., https://doi.org/10.3133/ds1052. Accessed 8/5/2020.