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July 28, 2023

Ms. Tanowa Troupe, Secretary
Ohio Power Siting Board
Docketing Division
180 East Broad Street, 11th Floor
Columbus, Ohio 43215-3797

Re: Case No. 23-459-EL-BGA
In the Matter of the Application of Grover Hill Wind, LLC to Amend its Certificate Issued in Case No. 20-417-EL-BGN.

Supplement to Amendment Application–Geotechnical Investigation Report

Dear Ms. Troupe:

On May 3, 2023, Grover Hill Wind, LLC ("Applicant") filed an application with the Ohio Power Siting Board for a Certificate of Environmental Compatibility and Public Need to Amend Its Certificate Issued in Case No. 20-417-EL-BGN.

The purpose of this Supplement to the Amendment Application is to submit a Geotechnical Investigation Report. Attached please find the report.

We are available, at your convenience, to answer any questions you may have.

Respectfully submitted,

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CERTIFICATE OF SERVICE

The Ohio Power Siting Board's e-filing system will electronically serve notice of the filing of this document on the parties referenced in the service list of the docket card who have electronically subscribed to these cases. In addition, the undersigned certifies that a copy of the foregoing document is also being served upon the persons below this 28th day of July, 2023.

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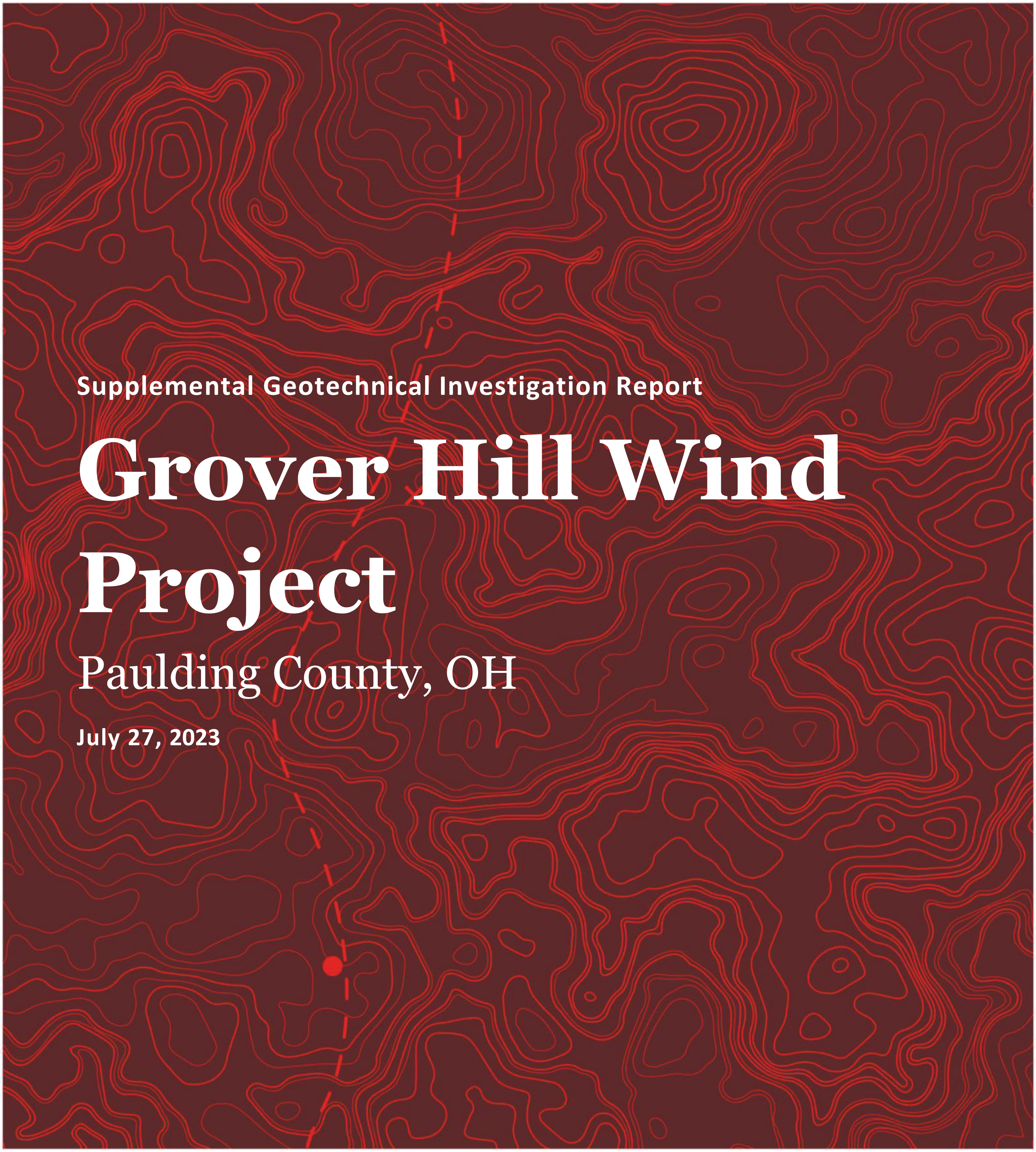

Supplemental Geotechnical Investigation Report

Grover Hill Wind Project

Paulding County, OH

July 27, 2023

PREPARED FOR:

GroverHill
WIND FARM

PREPARED BY:

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Supplemental Geotechnical Investigation Report

Grover Hill Wind Project

Paulding County, OH

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Date: July 27, 2023

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Table of Contents

1.0 Introduction 5
- 1.1 Project Description 5

2.0 Methods 5
- 2.1 Soil Borings 6
- 2.2 Laboratory Testing 6
- 2.3 Electrical Resistivity Testing 7

3.0 Site Conditions 7
- 3.1 Regional Geology 7
- 3.2 Geohazards 8
  - 3.2.1 Karst 8
  - 3.2.2 Seismicity 9
  - 3.2.3 Slope Stability/Landslides 9
  - 3.2.4 Expansive Soils 10
- 3.3 Subsurface Stratigraphy 10
- 3.4 Groundwater 11

4.0 Discussion and Recommendations 13
- 4.1 Soil Properties 13
  - 4.1.1 Moisture and Density 13
  - 4.1.2 Shear Strength of Soil 13
  - 4.1.3 Electrical Resistivity 13
  - 4.1.4 Thermal Resistivity 13
  - 4.1.5 Soil Corrosivity 14
- 4.2 General Earthwork Considerations 14
  - 4.2.1 Clearing and Grubbing 14
  - 4.2.2 Excavations and Water Control 14
  - 4.2.3 Permanent Cut and Fill Slopes 15
  - 4.2.4 Subgrade Preparation 16
  - 4.2.5 Fill Placement and Compaction 16
  - 4.2.6 Excavation Below Subgrade Procedures 17

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4.3 General Foundation Considerations 18
4.3.1 Lateral Resistance 18
4.3.2 Seismic Considerations 18
4.3.3 Frost Depth 18
4.4 Wind Turbine Foundation Design Parameters....................19
4.4.1 Bearing Capacity 19
4.4.2 Differential Settlement 19
4.4.3 Rotational Stiffness 20
4.4.4 Buoyancy....................20
4.5 Wind Turbine Foundation Considerations 20
4.5.1 Subgrade Preparation and Testing....................20
4.5.2 Ground Improvement 21
4.5.3 Previously Excavated Foundations....................22
4.6 Construction Considerations 22
5.0 Limitations 22
6.0 References 24

Tables

Table 3.1 Groundwater (GW) Depth Summary 12
Table 4.1 Fill and Backfill Material Recommendations. 16

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Attachments

Exhibits

Exhibit 1: Project Overview Map
Exhibit 2: USGS Topography Map
Exhibit 3: Surficial Soils Map

Appendices

Appendix A: Soil Boring Logs and Rock core
Appendix B: Logs SPT and RQD Summary
Appendix C: Laboratory Testing Reports
Appendix D: Electrical Resistivity Test Results

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Executive Summary

Westwood Professional Services (Westwood) is pleased to present this supplemental geotechnical investigation report to Grover Hill Wind, LLC., for the proposed Grover Hill Wind Project (Project) located in Paulding County, Ohio. The scope of work for this investigation included subsurface exploration, field and laboratory testing, engineering analysis, and preparation of this report for the proposed wind project. This investigation has generally revealed no subsurface conditions that would preclude development of the moved turbine locations within the proposed project.

Based on the information obtained from the supplemental borings at five turbine locations with standard penetration tests (SPT) advanced to depths of up to 41 feet below ground surface (bgs), the subsurface conditions at the site generally consist of 1 to 3 inches of topsoil overlying stiff to hard lean clay with variable amount of sand and gravel extending to dolomite bedrock at depths between 21 and 28 feet.

Piezometers were installed at each of the four supplemental turbine locations and re-measured at the piezometers from the initial geotechnical investigation in 2021. Groundwater was measured at depths between 3 and 6 feet below grade in the piezometers. Groundwater level fluctuations occur due to seasonal variation in the amount of rainfall, runoff, and other factors not evident at the time the borings were performed; therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than those observed during the investigation.

The below summary of recommendations may be used for wind turbine foundation designs for the locations investigated. These recommendations assume wind turbines will bear on very stiff native clay:

- Minimum depth to groundwater = 3 feet (may be confirmed with additional readings)
- Foundation backfill density (moist) = 105 pcf
- Gross allowable bearing capacity, normal loads = 3,500 psf
- Gross allowable bearing capacity, extreme loads = 5,000 psf
- Differential settlement = 1.6 inches (approximately 0.17 degrees rotation)
- Rotational stiffness = 525 GN-m/rad.

This executive summary should be read in context of the entire report for full understanding of the subsurface conditions encountered and associated recommendations. Westwood's Geotechnical Investigation Report (2021) should also be read for a full understanding of the subsurface conditions encountered across the entirety of the site.

1.0 Introduction

This report presents the findings of the supplemental geotechnical investigation conducted by Westwood Professional Services (Westwood) for the proposed Grover Hill Wind Project (Project) located in Paulding County, Ohio, surrounding the Village of Grover Hill (Exhibit 1). The primary purpose of this report is to provide geotechnical test data and analysis to support the design and construction of the proposed Project. This investigation focuses on five of the proposed wind turbine locations that have moved locations since Westwood's initial investigation in 2021. The services provided were in general conformance with the scope of work and assumptions outlined in Westwood's proposal dated April 18, 2022. This report is intended for exclusive use by Grover Hill Wind, LLC.

1.1 Project Description

Westwood understands that the proposed project will consist of 23 wind turbine generators, with up to four different turbine models being considered. The proposed project will also consist of access roads, electrical collection system, MET towers, O&M building, and collector substation. Topography across the project site can be described as generally flat to lightly undulating. The present land use is predominately agricultural fields.

2.0 Methods

A supplemental geotechnical investigation program was completed by Westwood with field work performed between May 23rd through 27th, 2022 and April 24th through 27th, 2023. EnviroCore, Inc. was retained by Westwood to perform geotechnical drilling with standard penetration testing (SPT). Westwood and Soil Engineering Testing (SET) performed laboratory testing on soil samples collected during the investigation. A Westwood geotechnical representative coordinated the field work, logged the borings, collected samples, and performed the electrical resistivity testing. The field investigation consisted of the following scope of work:

- Conducting soil borings at five proposed wind turbine locations to a target depth of 60 ft below ground surface (bgs). If auger refusal was encountered prior to a depth of 30 ft, rock coring would be performed to a minimum depth of 35 ft bgs. These five turbine locations (T-26a, 31a,

34b, 35a, and 43a) were re-drilled as a part of the supplemental investigation due to their locations moving greater than 50 ft from the original boring locations.
- Performing electrical resistivity surveys at two of the supplemental turbine locations.
- Collecting soil samples at all boring locations for laboratory testing.

Geotechnical test locations are shown on Exhibit 1. Boring locations were provided by Grover Hill Wind, LLC. based on the site layout available at the time of the field work. All test locations were staked by a Westwood engineer. Coordinates are provided on the boring logs.

2.1 Soil Borings

Soil borings were drilled using hollow stem augers and soil samples were obtained using an automatic hammer and split-spoon samplers in general accordance with ASTM D1586. Rock coring was performed in general conformance with ASTM D2113 (Standard Practice for Rock Core Drilling and Sampling of Rock for Site Exploration). Standard penetration test (SPT) N-values are recorded on the boring logs and a summary is provided in Appendix B. A Westwood geotechnical representative logged the borings and collected the soil/rock samples. Bulk soil samples were also collected from shallow auger cuttings at the substation and several turbine locations for laboratory testing. Rock coring was performed after auger refusal to a maximum depth of 41 ft bgs. Soil and rock samples were shipped to Westwood and SET for laboratory testing. Soil boring logs are included in Appendix A.

Groundwater observation piezometers were installed within each of the boreholes. Piezometers consisted of 2 inch diameter PVC pipe installed to a depth of approximately 15 ft bgs with 3 ft of pipe stickup. The bottom 5 ft of pipe was screened and backfilled with sand then bentonite above the sand. Refer to Section 3.4 for additional information on groundwater observations.

2.2 Laboratory Testing

Laboratory tests were conducted on representative soil and rock samples to aid in classification and evaluation of the physical properties and engineering characteristics of the material. Soil samples were sent to Westwood and SET for testing, which included the following:
- Moisture content (ASTM D2216)
- Sieve analysis (ASTM D6913 and D7928)
- Atterberg limits (ASTM D4318)
- Standard Proctor moisture-density relationship (ASTM D698)
- Unconfined compression (ASTM D7012)
- Chemical analysis (pH, Sulfates, Chlorides)
- Thermal resistivity with dry-out curves (ASTM D5334)

A summary of laboratory testing results is included in Appendix C, and complete test reports are included in Appendix C.

The bulk sample collected for thermal resistivity testing was prepared near the as-received moisture content and compacted to 90% of the standard Proctor maximum dry density, representing the compaction conditions typical of a backfilled utility trench, and subsequently dried out to zero moisture. Thermal resistivity measurements were taken at the compacted moisture content, zero moisture, and at several intermediate moisture contents during drying. Results of the thermal resistivity tests are discussed in Section 4.1.4 and test reports are included in Appendix C.

2.3 Electrical Resistivity Testing

Electrical resistivity measurements were taken at two of the proposed wind turbine locations, as shown on Exhibit 1. Tests were performed using the Wenner Four-Electrode Method and an AEMC Instruments Model 6470-B Multi-Function Digital Ground Resistance Tester, in general accordance with ASTM G57. At each wind turbine test location, resistivity tests were performed along two perpendicular profiles with a minimum electrode spacing of 5, 10, 20, 30, 50, and 100 feet. Refer to Section 4.1.3 and the attached Appendix D for results of the electrical resistivity tests.

3.0 Site Conditions

3.1 Regional Geology

The Grover Hill Wind Project is located within the Eastern Lake Section of the Central Lowland province (USGS, 1946) of the Interior Plains Physiographic Region. The Central Lowlands province is the largest physiographic province in the continuous US and is largely level. The Central Lowlands were subject to repeated Pleistocene glaciations, which define the landforms throughout the region (NPS, 2022). The present glacial topography at the project site is the product of the most recent glaciation event that ended approximately 10,000 years ago during the Late Wisconsin's glaciation event of the Pleistocene Epoch, where a massive continental ice sheet grew and gradually expanded southward. This created several finger-like lobes of glacial ice that engulfed the region and moved through the Superior basin. The project site is located within a geologic area known as the Maumee Lake Plain. During the Wisconsin glaciation, the project site was covered by Glacial Lake Maumee, an ancestor of present-day Lake Erie. As the glacier and lake slowly receded to the north, sediments were deposited along the path, resulting in the flat topography observed in the region today (Fullerton et. al., 2003).

The proposed project area is mapped within one geologic unit (Slucher *et al*, 2006), The Salina Group. The Salina Group formation is Silurian in age and primarily comprised of gray, thin bedded to laminated dolostone. Minor units of gypsum, shale, and anhydrite have also been identified within the formation. Refer to Exhibit 4 for mapped geologic units.

Based on Web Soil Survey data available through the United States Department of Agriculture (USDA, 2022), three major soil units and several minor units are mapped within the project area, as shown on Exhibit 3. The three major units include Paulding Clay, Latty Silty Clay, and the Nappanee Silty Clay Loam. They Latty silty clay and Paulding clay are classified as clayey glaciolacustrine deposits over clayey till, and the Nappanee silty clay is classified as till. All three units contain lean clay and fat clay throughout the soil profile, generally with a majority fat clay in the upper 5 feet.

3.2 Geohazards

3.2.1 Karst

Karst features generally develop in areas with wet subsurface conditions and soluble rock that may dissolve over time to form underground caves and ground instability. Karst geology can be particularly hazardous as caves develop slowly, while failures are rapid, often causing several feet of subsidence. According to the USGS map of Karst Hazard Potential in the United States (USGS, 2014), the project site is mapped within an area of karst potential in the form of carbonate rocks buried under less than 50 ft of glacially derived insoluble sediments in a humid climate (Exhibit 5). The Ohio Department of Natural Resources (ODGS, 2006) maps the project site in a region containing Silurian- and Devonian-age carbonate bedrock overlain by more than 20 feet of glacial drift and/or alluvium; however, the project site is not mapped in a probable karst area.

Although karst formations are relatively common in Ohio, the majority of mapped probable karst areas are located in the far north-central and far south-central portions of the state (Exhibit 5; ODNR, 2006). Although sporadic regions of probable karst have been identified throughout the western portion of the state, the nearest mapped area of probable karst is approximately 50 miles east of the project site (ODGS, 2006). According to the Ohio Department of Natural Resources' Karst Interactive Map (ODGS, 2022), there are no verified or suspected karst sinkholes or other features identified near the project site. Furthermore, Dolomite is considered the least susceptible of the karst-prone geologic formations, as compared to limestone or anhydrous/evaporate formations (BGS, 2013).

Results of the supplemental investigation indicate that the depth to dolomitic bedrock at the four supplemental turbine locations ranges between 21 ft and 28 ft bgs. At the four supplemental borings, no locations experienced notable core barrel drops. Although sandy infilling was observed at T-31 in 2021, this unit was not during the supplemental investigation at boring T-31a. It should be noted, however, that the limited recovery observed suggests highly weathered/poor quality bedrock that may be karst-susceptible. The rock cores also exhibited relatively small (<2” diameter) dissolution features, known as pits and vugs.

In general, the potential for development of surficial sinkholes on site is considered low due to the presence of relatively small dissolution features encountered and lack of mapped karst features in the region. Although no surface depressions, sinkholes, or large voids were observed during the field exploration, it is still possible that karst features exist beyond the extents of our explorations. A detailed karst/sinkhole study was beyond the scope of this investigation. Additional on-site testing and analysis may be performed to further evaluate the potential for karst features if the risk is considered unacceptable to the Owner. Supplemental borings with video logging may be performed at select turbine locations to better assess the risk of subsurface voids.

3.2.2 Seismicity

Ohio is not a historically active seismic region, as only 10 earthquake events with a magnitude greater than 2.5 on the Richter scale have been recorded within 50 miles of the site in the past 50 years. The nearest and most recent of these events was magnitude 2.6 earthquake that occurred in 2015, approximately 14 miles southwest of the project site. The largest of these events was a magnitude 4.5 event that occurred in 1986, approximately 33 miles south of the project site. According to a USGS ShakeMap available for the magnitude 4.5 earthquake, this event is expected to have been classified as a 3.0 to 4.0 on the Modified Mercalli Intensity scale at the project site, which is defined as an event that would induce a weak to light shaking with negligible to light potential for damage to structures (USGS, 2022a).

According to the USGS, there are no active fault zones within the project boundary (USGS, 2022b). The nearest mapped fault zone is the New Madrid seismic zone, located more than 200 miles southwest of the project site. The risk of liquefaction on site is also considered low due to the lack of historic seismic activity, clayey overburden soil, and shallow bedrock. See Section 4.3.2 for discussion on seismic design parameters.

3.2.3 Slope Stability/Landslides

Deep-seated slope failure can occur on steep natural slopes that experience heavy rainfall events and/or are subjected to large surcharge loads at the crest of the slope. While the project site is generally on relatively flat ground with minimal risk of slope instability, one of the supplemental turbine locations (T-31a) is sited within 200 feet of a creek or irrigation channel. Northwest Ohio does not commonly experience slope failures, as most slope failures are mapped in the southeast portion of the site, northern Lake Erie shoreline, or along the banks of the Ohio River (ODNR, 1995). Furthermore, no evidence of recent slope failure along the creek banks or irrigation channels was observed during on-site activities. The risk of landslides for these wind turbine locations may be considered low due to the lack of prior evidence of slope failure in the region, relatively flat topography, and the relatively high undrained shear strength of the soils on site. Reasonable crane walk and road setbacks should be established from the existing creeks or irrigation channels to allow for future erosion of the river banks without impacting the project site roads and turbine pads.

Any modifications to the existing slopes, including increased loads at the top of slope, removal of material from the toe of slope, and changes to surficial infiltration, can significantly affect slope stability. Discussion on fill slopes is provided in Section 4.2.3, but a detailed slope stability analysis was not a part of the scope of this investigation.

3.2.4 Expansive Soils

Based on USDA Soil Survey data, the majority of the shallow soil is classified as having moderate swell potential, although scattered pockets of soil with high potential exist throughout the site, including fat clay (CH) soil units (USDA, 2022). The U.S. Army Corps of Engineers Technical Manual (1983) maps the project site within a region where the occurrence of expansive materials are extremely limited. Although swelling soils will likely not affect the deeper turbine foundations and the humid climate will generally limit significant moisture fluctuations, shallow foundations may still be impacted by soil expansion following extreme droughts if bearing directly on high plasticity clay. Refer to sections 4.2.4 and 4.2.5 for recommendations on subgrade preparation and fill material to mitigate risk of soil expansion below foundations.

3.3 Subsurface Stratigraphy

Based on the conditions encountered at the soil boring locations within the Grover Hill Wind Project site, the general subsurface stratigraphic profile is described as follows:

- **Topsoil.** Topsoil at the four supplemental borings generally ranges from 1 to 3 inches thick, although a thicker rootzone should be expected. The topsoil encountered was generally dark brown and clayey with moderate organics and active roots. Topsoil depths could be greater in some portions of the site, particularly in topographic low areas.
- **Glacial Till - Lean Clay, Lean Clay with Sand, Clayey Gravel w/ Sand (CL, GC).** Beneath the topsoil was stiff to hard glacial till lean clay with varying fractions of sand and gravel. The soil was typically various shades of brown and gray and damp to moist. The sand and gravel fraction of this material was typically between 15 and 25%.
- **Bedrock – Dolomite.** Dolomitic bedrock was encountered at all four boring locations between 21 and 28 feet below grade. The upper 2- to 5-feet of the bedrock surface was typically highly weathered and transitioned into more competent bedrock with depth. Rock cores were typically light gray and had rock quality designation (RQD) values ranging from 0% to 90%, with the highest variability in RQD occurring in the initial 5 feet of coring. The majority of rock cores had

RQD values greater than 60%, demonstrating fair to good rock quality with moderate to sound rock continuity. Most samples had a vuggy texture with evidence of minor dissolution.

More detailed descriptions of the subsurface conditions are provided on the boring logs found in Appendix A. Rock coring photo logs are also provided in Appendix A.

3.4 Groundwater

Boreholes were observed during and shortly after drilling for the presence and level of groundwater. Piezometers were installed after completion of drilling during the initial investigation in 2021 and measured 2 to 4 weeks after installation and again during this supplemental investigation approximately 7 months after their initial measurement. Piezometers were also installed after completion of drilling during this supplemental investigation and measured more than 24 hours after installation. Depth to groundwater on site varied from 17 feet to greater than 30 feet bgs during drilling, between 5.8 and 18.7 feet bgs from the initial piezometer monitoring trip in 2021, and between 3 and 6 feet bgs during the second piezometer monitoring trip as a part of the supplemental investigation. It should be noted that only 8 of the original 23 piezometers were able to be measured during the second trip, as many of the wells had been removed by landowners. Water levels were observed shallower during the second monitoring trip than during the initial trip. Depth to groundwater measured during drilling and after the piezometer monitoring trips are recorded Table 3.1 below. The water level encountered during drilling was generally deeper compared to the longer-term water level measured in the piezometers, as expected in clayey soil.

Groundwater level fluctuations occur due to seasonal variation in the amount of rainfall, runoff, and other factors not evident at the time the borings were performed; therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than those observed during the investigation. Additional groundwater depth measurements should be taken to further evaluate groundwater fluctuations over time. Refer to Sections 4.2.2 for recommendations regarding water control.

Table 3.1 Groundwater (GW) Depth Summary

Boring ID	GW Measured During Drilling (ft)	GW Measured in Piezometer (October 2021) (ft)	GW Measured in Piezometer (May 2022) (ft)
T-11	30	5.8	*
T-13	-	18.7	4.0
T-14	22	8.7	*
T-15	-	8.1	6.0
T-16	-	7.8	4.0
T-17	22	6.3	*
T-25	-	10.5	*
T-26	-	10.4	6.0
T-27	-	12.7	*
T-28	20	9.8	*
T-29	-	10.4	*
T-30	-	*	*
T-31	-	11.0	5.0
T-32	-	13.5	*
T-33	-	7.6	3.0
T-34b	-	6.3	4.0
T-35a	-	10.5	*
T-36	-	9.5	*
T-37	-	11.3	*
T-38	-	11.3	*
T-40	17	16.7	*
T-41	25	18.5	*
T-43	21	6.2	4.0

*Unable to check piezometer due to land access or removed piezometer

4.0 Discussion and Recommendations

4.1 Soil Properties

4.1.1 Moisture and Density

The in situ gravimetric moisture content of the soil at the four supplemental borings ranges from approximately 15% to 25%, with an average moisture content of approximately 19%. For wind turbine foundation design purposes, the recommended long-term moist unit weight of the native soil backfill compacted to 95% of the standard Proctor maximum dry density is 105 pcf based on a dry density of 95 pcf and 10% residual moisture.

4.1.2 Shear Strength of Soil

Based on correlations to SPT blowcounts and pocket penetrometer tests, the clayey soils at the four supplemental turbine locations demonstrated undrained shear strength between 1,250 and greater than 5,000 psf. Based on these results, a design undrained shear strength of 1,250 psf is recommended for the soil between 0 to 10 feet below grade, and a design undrained strength of 2,000 psf is recommended for the soil greater than 10 feet below grade.

4.1.3 Electrical Resistivity

Electrical resistivity measurements were collected at two supplemental turbine boring locations using the Wenner Four-Electrode Method in accordance with ASTM G57 using electrode spacings between 2 feet and 100 feet. Electrical resistivity generally varies with material type and moisture content, and ranged between 22 ohm-meters (Ω-m) and 201 Ω-m based on test results. Resistivity general increased with depth, with the largest readings typically occurring at the largest spacing. These observed values are generally in agreement with typical published values for clay and limestone (Palacky, 1987). Results of the electrical resistivity tests are presented in Appendix D. Refer to Section 2.3 for additional information on the electrical resistivity test method.

4.1.4 Thermal Resistivity

A thermal resistivity dry-out curve was developed for a shallow soil sample collected at boring T-34a between 1 and 5 feet bgs. The bulk sample was re-compacted at the natural moisture content to 90% of the standard Proctor maximum dry density. The thermal resistivity of the soil varied with moisture content and ranged from 84°C·cm/W (natural moisture content) to 191°C·cm/W (dry). Results of the thermal resistivity test is included in Appendix C. The underground cable designer shall choose an appropriate thermal resistivity (rho) value for trench backfill with consideration to soil drying due to environmental factors as well as cable heat generation.

4.1.5 Soil Corrosivity

The chemical constituent test results indicate that the soil is neutral with a pH ranging from 7.0 to 7.3. Soluble sulfates were measured as high as 163 mg/kg and soluble chlorides measured as high as 93.1 mg/kg. Test results are presented in Appendix C and summarized in the Lab Test Summary Table.

4.2 General Earthwork Considerations

4.2.1 Clearing and Grubbing

Prior to site grading activities, existing vegetation, trees, large roots, topsoil, uncontrolled fill, old foundations, and abandoned underground utilities should be removed from the proposed structural (foundation) areas and areas to receive fill. Areas disturbed during demolition and clearing should be properly backfilled and compacted as described in Section 4.2.6. Uncontrolled fill was encountered at the substation area to depths between 2.5 and 5 feet below grade which should be fully removed and replaced with structural fill below foundations.

Topsoil or organic material should not be used for structural fill and should be stockpiled away from native excavated soil. This material may be used as fill in non-structural areas outside of the foundation, assembly area, access road, crane pad, and crane walk areas where soil strength and compressibility would not impact site infrastructure or construction.

4.2.2 Excavations and Water Control

Overburden soil at the site can generally be excavated with conventional excavation equipment, such as backhoes, dozers, loaders, or scrapers. Bedrock is not expected to impact excavations less than 15 feet below grade. Excavations should be constructed using safe side slopes unless adequately shored and/or braced as necessary for construction and safety. Per Occupational Safety and Health Administration (OSHA) Part 1926, the soil on site may generally be inferred to be a Type B material unless the excavation is below groundwater in which the soil should be considered Type C. It is the responsibility of the competent field personnel to verify *in situ* conditions during construction. Excavations should be constructed in conformance with applicable federal, state, and local standards. Refer to Section 3.2.3 for additional discussion on the stability of excavation faces.

Groundwater was measured in piezometers installed at all but one of the wind turbine boring locations (T-30), due to an inability to check on the piezometer level due to land access restrictions. Groundwater measurements are provided in the boring logs in Appendix A, and summarized in Table 3.1. Some dewatering of excavations will likely be required across the site due to the shallow groundwater levels at most turbine locations, although the clay soil profile may generally limit the total amount of groundwater infiltration into the excavations. Water and snow should be prevented from accumulating in foundation excavations at the time of foundation material placement. Sumps and portable pumps can generally be used to control water within these excavations for relatively short time periods, although more robust dewatering systems (such as well points) may be required where higher infiltration rates are encountered due to saturated sand seams. Excavations should be kept free of standing water and snow during foundation construction. The foundation subgrade should be inspected by the construction-phase geotechnical engineer, or their representative, after excavation and before placement of materials to verify water control.

4.2.3 Permanent Cut and Fill Slopes

Cut and fill slopes in native soil may be designed at an inclination of 3H:1V or flatter. Fill slopes should be constructed in horizontal lifts in accordance with the recommendations in Section 4.2.5 and 4.2.6. Although not anticipated, slopes greater than 5 feet in height should be benched into the existing slope to prevent movement between the fill and native soils. A 2 foot deep by 8 foot wide keyway should be cut down into native soil at the toe of fill slopes, extending back under the toe of the fill. As fill placement progresses up the existing slope, benches should be cut into the existing slope to bond the mass of the fill to the existing ground. Benches should generally follow the existing ground slope, with a minimum of 3 feet high and approximately 10 feet wide. Benches should be approved by the construction phase geotechnical engineer prior to placement of fill. Positive drainage is required at benched areas and at the toe of fill to remove surface water and minimize soil saturation. Appropriate erosion control measures (e.g., vegetation or erosion control matting) should be implemented immediately after cut and fill slopes are constructed to reduce the potential for significant erosion. See figure 4.1 for a detail of the benching requirements.

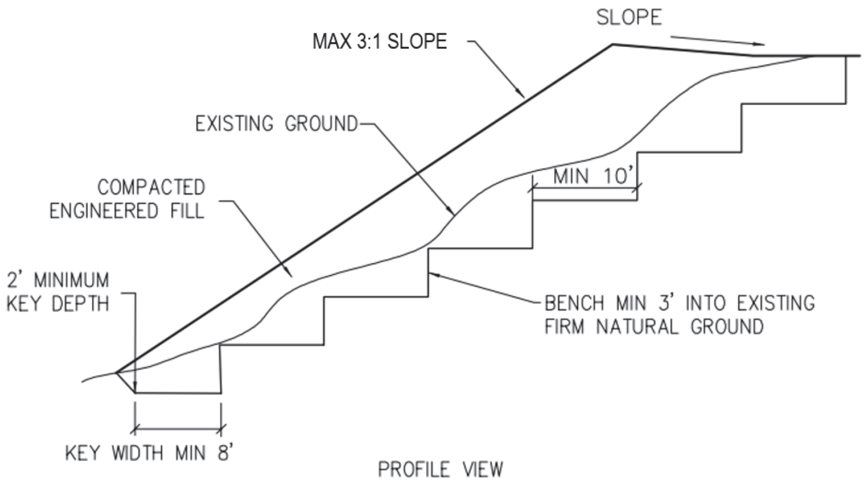

Figure 4.1 Benching detail for fill slopes greater than 5 ft

Steeper cut and fill slopes may be acceptable if adequate erosion control and/or reinforcement are utilized. Additional testing and/or analyses should be performed for steeper slopes, and the geotechnical engineer should be consulted if steeper slopes are desired. Vehicles, cranes, material storage, and foundations should be located a safe distance (as determined by the construction phase geotechnical engineer) from the top of steep slopes to avoid slope instability. Detailed global slope stability analyses are beyond the scope of this investigation, but should be performed as needed once design grades and site specific surcharge loading (e.g., cranes, component storage, etc.) information becomes available.

4.2.4 Subgrade Preparation

After clearing and grubbing, exposed areas to receive fill, including the subgrade below shallow foundation over-excavations (i.e. substation and laydown yard) and road aggregate, should be scarified to a minimum depth of 8 inches, moisture conditioned to within 0% to +4% of optimum moisture, and re-compacted to 95% of the standard Proctor maximum dry density (ASTM D698). Subgrade should also be inspected by the construction-phase geotechnical engineer, or their representative, to ensure adequate bearing capacity and water control.

Disturbance to subgrades prepared for foundations, access roads, and other areas to be filled should be minimized. Repeated traffic loading and excessive moisture due to surface water runoff, seepage, or precipitation may degrade subgrade soil. Where unsuitable subgrade is encountered, such as areas with soft soil, the unsuitable subgrade should be over-excavated as recommended by the construction-phase geotechnical engineer and replaced with structural fill in accordance with Section 4.2.6. Refer to Section 4.5.1 for wind turbine foundation subgrade preparation recommendations.

4.2.5 Fill Placement and Compaction

The native soil encountered throughout the site may be used as general fill for road embankments and wind turbine assembly areas, and may be suitable for backfilling around and above foundations, provided that organics, frozen soil, foreign material, and rock fragments larger than 6 inches in diameter are removed and all compaction requirements are met. Backfill material within 1 foot of all foundations should have no particle sizes greater than 1 inch. Cobbles and boulders, if encountered, should be removed from general fill. The moisture content of the fill should be adjusted, as necessary, to achieve compaction. See Table 4.1 below for additional recommendations.

Table 4.1 Fill and Backfill Material Recommendations.

Material	Uses	Loose Lift Thickness	Required Compaction$^{(2)}$	Moisture Content$^{(2)}$

Imported select structural fill(1)	Fill below turbine foundations, , or crane pad over-excavations	≤ 12" with heavy compaction equipment	≥ 98%	±3% of optimum moisture
General Fill - Non-organic native clay	Foundation backfill, embankments, access road subgrade, and general site grading	≤ 9" with heavy compaction equipment	≥ 95%	0% to +4% of optimum moisture
		≤ 6" with hand compaction equipment		
Native topsoil and organic soil	Landscaping non-structural areas	N/A	N/A	N/A

[1] See Section 4.2.6 for detailed select structural fill recommendations

[2] Relative to the standard Proctor maximum dry density and optimum moisture content (ASTM D698)

4.2.6 Excavation Below Subgrade Procedures

Disturbance to subgrades prepared for foundations, access roads, crane walks, crane pads, and areas to be filled should be minimized. Fine-grained clayey soils are particularly sensitive to disturbance from repeated traffic loading and excessive moisture due to surface water runoff, seepage, or precipitation, which are likely to degrade subgrade soil. Care should be taken to limit disturbance to subgrade soils across the site and prevent ponding water by promoting positive drainage. Where unsuitable turbine foundation subgrade is encountered, as discussed in Sections 4.5.1 and 4.5.3, excavation of subgrade and replacement with suitable structural fill or alternative subgrade improvement techniques may be required.

If soft/loose, disturbed, or otherwise unsuitable turbine foundation bearing soil is encountered, as determined by quality control testing described in Section 4.5.1, the subgrade should be scarified, moisture conditioned, and re-compacted to 98% of the standard Proctor maximum dry density and within 3% of optimum moisture content. Over-excavations below foundations should extend laterally beyond all edges of the footing. The lateral extent should be at least 12 inches per foot (1H:1V) of over-excavation depth below foundation base elevation. All over-excavations should be sloped or shored as required by OSHA regulations to provide stability and safe working conditions. All over-excavations should be free of water and snow prior to backfilling.

Excavations below turbine foundation and crane pad subgrade should be backfilled with select structural fill, as described in Section 4.5.1. Select structural fill should consist of well-graded aggregate with less than 10% fines, such as Ohio DOT Specification 703.11 for structural backfill. Imported select structural fill should be sampled, tested, and approved by the construction phase geotechnical engineer prior to use on site.

4.3 General Foundation Considerations

4.3.1 Lateral Resistance

A friction factor of 0.40 may be used for the ultimate frictional resistance to lateral sliding along the base of concrete footings founded on properly compacted subgrade. We recommend a factor of safety of 1.5 or greater to determine the allowable frictional resistance to lateral sliding.

4.3.2 Seismic Considerations

At the time of this report the State of Ohio has adopted the 2015 International Building Code with amendments (International Code Council, 2015). The maximum considered earthquake spectral response accelerations are presented in Table 4.2 below (ATC, 2022).

Table 4.2 Seismic Design Parameters

Parameter	Design Value
Reference	2015 IBC
Site Class	C
Coordinates (Lat., Long.)	40.99138, - 84.510207
Mapped Spectral Acceleration for Short (0.2 sec) Periods – S_s	0.144 g
Mapped Spectral Acceleration for 1-second Periods – S_1	0.063 g
Acceleration-Based Site Coefficient – F_a	1.2
Velocity-Based Site Coefficient – F_v	1.7
Max. Considered Spectral Response Acceleration – S_{MS}	0.173 g
Max. Considered Spectral Response Acceleration – S_{M1}	0.107 g
Design Spectral Response Acceleration (Short Periods) – S_{DS}	0.115 g
Design Spectral Response Acceleration (1-second Period) – S_{D1}	0.071 g
Peak Ground Acceleration, PGA	0.074 g

4.3.3 Frost Depth

Frost action can result in differential heaving and a reduction in soil strength during periods of thaw. The degree of frost action is based on frost depth, availability of water, and frost-susceptibility of shallow soil. The most severe effects of frost heave occur when ice lenses form in the voids of soil containing fine particles (i.e., silt and clay). Shallow foundations (or the structures they support) can be damaged if the foundations bear above soils that experience frost heave. The bearing capacity of soil is also reduced during periods of thaw, which can reduce the lateral capacity of pile foundations and cause bearing capacity and/or settlement issues for shallow foundations bearing above the frost depth.

The recommended design frost depth for the area is 3 ft (Bowles, 1996). Critical foundations and pipes should be placed a minimum of 3 ft below final grade or on non-frost susceptible soil extending to a depth of 3 ft for protection against frost, unless they are designed to accommodate the effects of frost.

4.4 Wind Turbine Foundation Design Parameters

Westwood understands that two different wind turbine models are being considered for the project, a Vestas 162 and Siemens-Gamesa 5MW. No preliminary foundation designs or turbine loading documents were provided prior to preparation of this report, and therefore for the basis of this analysis it was assumed turbines will be supported on 75 foot diameter octagonal or circular spread footings bearing 13 feet below grade. The recommendations provided in this report should be re-evaluated after preliminary foundation designs and loading documents are available, including alternate buoyant foundation designs for turbines bearing below the expected groundwater depth. Refer to Section 3.4 for specific turbine locations with shallow groundwater. Soil parameters recommended for use in turbine spread foundation design are discussed in Section 4.1.

4.4.1 Bearing Capacity

Design of wind turbine spread footing foundations supported on suitable subgrade may be designed for a maximum allowable gross bearing capacity of 3,500 psf for normal loading conditions and 5,000 psf for extreme loading conditions at all turbine locations. This bearing capacity likely exceeds the actual bearing pressures that may develop from a spread footing foundation design used for this site. The recommended allowable bearing pressure is based on a factor of safety of 3.0 for normal wind loading conditions and 2.25 for extreme loading conditions. An effective bearing area of 45 feet by 60 feet was assumed. Normal loading bearing capacity is controlled by the assumed maximum allowable settlement tolerance (Section 4.4.2) and extreme loading is controlled by bearing capacity failure.

4.4.2 Differential Settlement

Differential settlement or rotation of the foundation was evaluated under normal operating loads. Normal operating loads result in an eccentrically loaded foundation with a higher bearing pressure than the dead load condition. Under normal operating loads the leeward side of the foundation carries the majority of the load compared to the windward side of the foundation, causing differential settlement or rotation of the foundation.

Results of the consolidation settlement analyses indicate that the assumed turbine foundation, consisting of a 75-foot diameter spread footing embedded 13 feet bgs with a gross bearing pressure of 3,500 psf will experience a total settlement of approximately 1.6 inches and a differential rotation of 0.17 degrees across the foundation width, which is within the assumed maximum allowable differential foundation tilt of 0.17 degrees.

4.4.3 Rotational Stiffness

Based on the calculated dynamic shear modulus, as described in Section 4.1.4 of Westwood's Geotechnical Investigation Report (2021), the anticipated rotational stiffness of the foundation is expected to be approximately 525 GN-m/rad, which is presumed greater than the minimum requirement established by the turbine manufacturer. Therefore, with the assumed turbine foundation geometry and manufacturers requirement, the foundation should provide adequate rotational stiffness with no special considerations or enhancements. Rotational stiffness should be re-evaluated by the foundation designer once foundation dimensions, strain levels, and rotational stiffness requirements are known.

4.4.4 Buoyancy

The depth to groundwater was evaluated with short-term observations in boreholes during drilling and in piezometers several weeks after installation and again more than 6 months later, as discussed in Section 3.4. Results of groundwater measurements performed at each wind turbine boring location are provided in Table 3.1. The minimum depth to groundwater measured was approximately 3 feet. In general, it should be expected that all turbine locations will require a buoyant foundation considering a design groundwater depth of 3 feet below existing grades. Additional groundwater depth measurements may be taken prior to final foundation design to confirm design depth to groundwater and evaluate the potential for zoning parts of the site for different design groundwater depths. It should be noted that turbine T-30 was inaccessible during the piezometer monitoring trip and therefore does not have groundwater measurements after drilling. Although the depth to groundwater was not measured at this location during the follow-up monitoring trip, the depth to groundwater at the other locations suggests groundwater is likely shallow throughout the site.

Foundations bearing below groundwater should be designed to resist overturning while accounting for buoyant forces. The foundation designer may consider providing at least two different foundation designs based on varying depths to groundwater. Refer to Sections 3.4 and 4.2.2 for additional discussion regarding groundwater, and Table 3.1 for groundwater depths for turbine foundation design. Additional groundwater measurements are recommended to confirm seasonal groundwater fluctuation at each turbine location prior to final foundation design.

4.5 Wind Turbine Foundation Considerations

4.5.1 Subgrade Preparation and Testing

Wind turbine foundations should bear on the native stiff to hard lean clay, or native bedrock (although not anticipated), as discussed in Section 4.2.6. Based on the conditions encountered during this investigation, the soil beneath the anticipated turbine foundation bearing depths typically exhibits sufficient properties to support spread foundations.

Foundation subgrade should consist of a uniform bearing material, such that the foundation does not bear on part soil and part rock. Care should be taken during foundation excavations to minimize disturbance of the subgrade. If encountered, soft/loose soil, frozen soil, and rock fragments larger than 6 inches should be removed. Field inspection and quality control of the subgrade may identify the need for additional subgrade modification. The foundation subgrade should be inspected by a qualified geotechnical engineer, or their representative, after excavation and before placement of materials to confirm conditions. Static cone penetrometer (SCP) testing is recommended to confirm subgrade soil strength and identify areas of softer clay. SCP testing should be performed at a minimum of five (5) locations on the foundation bearing surface, one in each quadrant and one in the middle. Testing should extend a minimum of 3 feet below the surface. Foundation subgrade consisting of clay should exceed a minimum undrained shear strength of 2,000 psf. If foundation subgrade consists predominantly of sand, Westwood should be contacted for further evaluation. Field inspection and quality control of the subgrade may identify the need for additional subgrade modification. Westwood should be notified in the event that unsuitable subgrade conditions are encountered.

The foundation subgrade should be protected against freezing and snow/water accumulation after inspection and prior to foundation placement. To facilitate turbine foundation construction and to protect the subgrade, a minimum 2- to 3 inch–thick layer of lean concrete (mud mat) over the subgrade is recommended. During winter construction, heating of the subgrade may be necessary to protect the subgrade from freezing.

Dolomitic bedrock was encountered within 28 ft bgs at each of the four turbine foundations included in this report. The depth to bedrock ranged from approximately 21 ft to 28 ft bgs. Bedrock was not encountered within anticipated foundation bearing depths (less than 13 ft bgs) at any of the turbine borings. The SPT and RQD Summary attached in Appendix B summarizes depth to bedrock at each boring location. Excavations into bedrock are not anticipated for the wind turbines, but rock rippability is discussed in the seismic study report in Appendix E.

4.5.2 Ground Improvement

Although poor subgrade was not encountered below the anticipated foundation bearing depth at any of the four supplemental turbine borings, the possibility still exists for undetected soft to medium stiff clay within the turbine footprint at these locations. The foundation subgrade should be tested at all turbine locations prior to construction of the foundation per the recommendations outlined in Section 4.5.1 to confirm soil conditions. After subgrade testing at these locations, any unsuitable subgrade encountered should be remediated prior to construction of the foundations. Pending the depth of poor subgrade soil, the foundation may also bear deeper, below the weak material. Although not anticipated, over-excavation and replacement can become prohibitively expensive at improvement depths greater than 4 to 6 feet, and deep soil improvement techniques may be required.

4.5.3 Previously Excavated Foundations

Prior to the start of the 2021 field investigation, Westwood understands that excavations were conducted at two proposed turbine sites (T-26 and T-43) to approximate depths ranging from 5 ft to 10 ft. Westwood also understands that these excavations have remained open for several months, leaving the exposed subgrade susceptible to degradation from ponding water, freeze/thaw cycles, growth of vegetation, and erosion/scour. At the time of the initial investigation, both excavations were observed containing standing water and were inaccessible. These two locations were explored with geotechnical soil borings conducted outside of the excavation areas, approximately 60 feet from the turbine center point.

Westwood understands that these turbine locations have since been shifted such that they no longer overlap with the existing excavations. The new locations were drilled as a part of this supplemental geotechnical investigation. Should the original locations be used for final design, however, supplemental testing should be performed at T-26 and T-43, as well as any other locations where the proposed turbine is not within at most 50 feet of the original SPT soil boring or CPT sounding performed by Westwood. Supplemental testing at these locations shall include soil boring, CPT soundings, and/or static cone penetration (SCP) tests performed within the proposed foundation footprint during the pre-construction design phase.

4.6 Construction Considerations

To a large degree, satisfactory foundation and earthwork performance depends on construction quality control; therefore, subgrade preparation, subgrade compaction, proof-rolling, cut slopes, and placement and compaction of fill and backfill material should be observed and tested by qualified personnel. In addition, qualified staff who are experienced with the foundation design requirements should monitor and document foundation preparation and construction activities. A qualified geotechnical engineer should also inspect cut faces in rock to evaluate overall stability.

5.0 Limitations

This report has been prepared in accordance with generally accepted geotechnical engineering practice for the exclusive use by Grover Hill Wind, LLC., for the Grover Hill Wind Project. The primary focus of this report was recommendations for site grading activities and wind turbine foundation design at the four supplemental turbine boring locations.

The borings are representative of the subsurface conditions at the sampled locations and intervals, and therefore do not necessarily reflect strata variations that may exist between sampled locations and intervals. If variations from the subsurface conditions described in this study are noted during construction, recommendations in this report must be re-evaluated. Any user of this report should verify all boring locations against the final location of the respective infrastructure to determine if infrastructure has moved prior to using the recommendations provided by Westwood. In the event that any changes in the nature, design, or location of the facilities are planned, the conclusions and recommendations contained in this report should not be considered valid unless the changes are reviewed and the conclusions of this report are modified or verified in writing by Westwood. Westwood is not responsible for any claims, damages, or liability associated with the interpretation of subsurface data by others.

After plans for the facility are developed in sufficient detail and project-specific wind turbine foundation load documents and preliminary foundation designs are available, Westwood should be consulted regarding additional subsurface information required to arrive at final recommendations for design and construction. The current recommendations are based on previous projects that are similar in size, however the loads experienced by the subsurface and foundations will likely be different due to specific turbine parameters.

6.0 References

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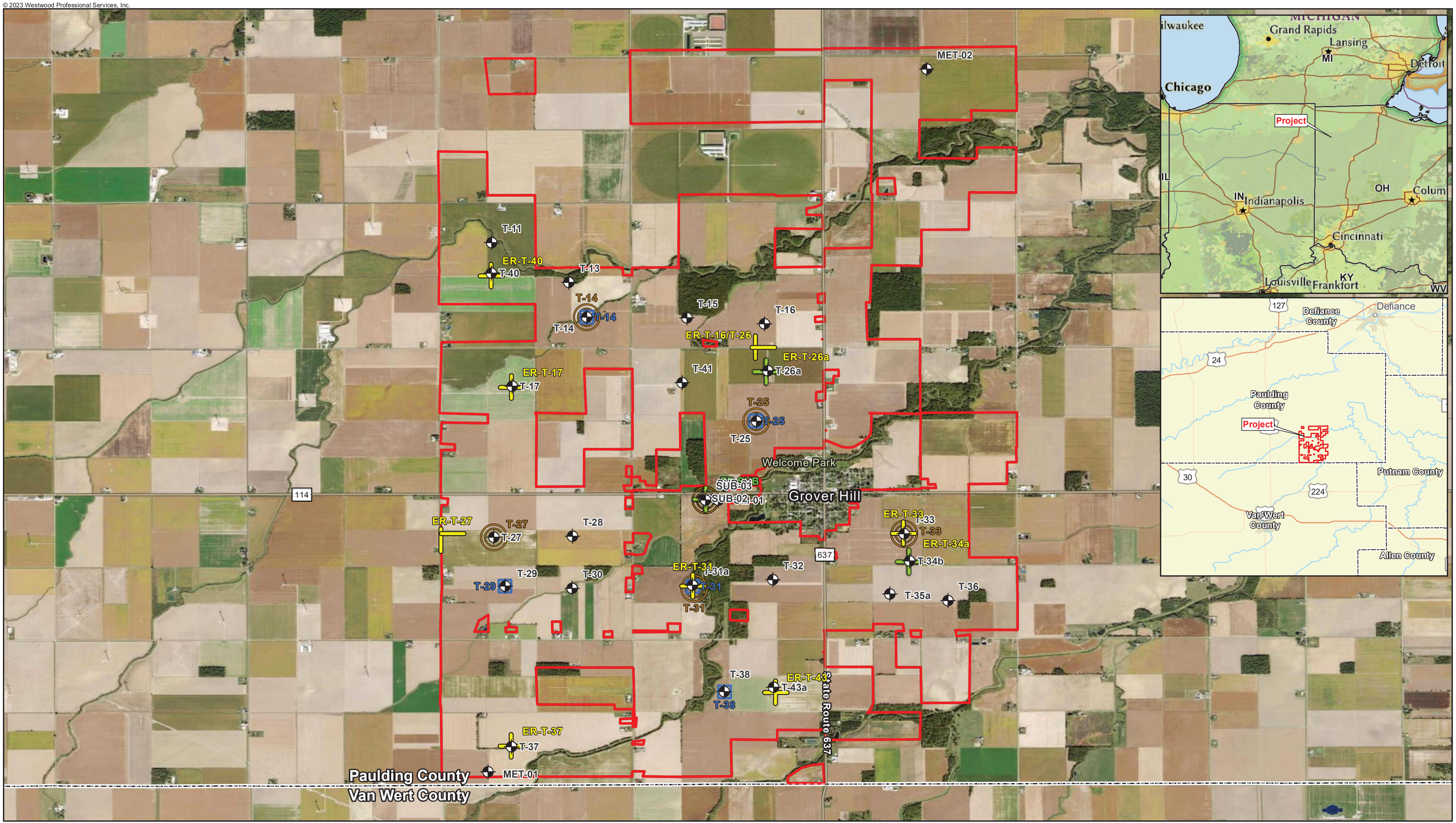
Exhibits



Data Source(s): Westwood (2023); ESRI WMS National Geographic & World Streets Basemaps (Accessed 2021); Census Bureau (2020).

Legend

- Boring Location
- 100ft ER Test Location
- 200ft ER Test Location
- 100ft ER Test Location (E/W)
- 100ft ER Test Location (N/S)
- Seismic Test
- Thermal Resistivity Test Location
- Project Boundary
- County Boundary

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Grover Hill Wind Project

Paulding County, Ohio

Project Overview Map

EXHIBIT 1

July 26, 2023

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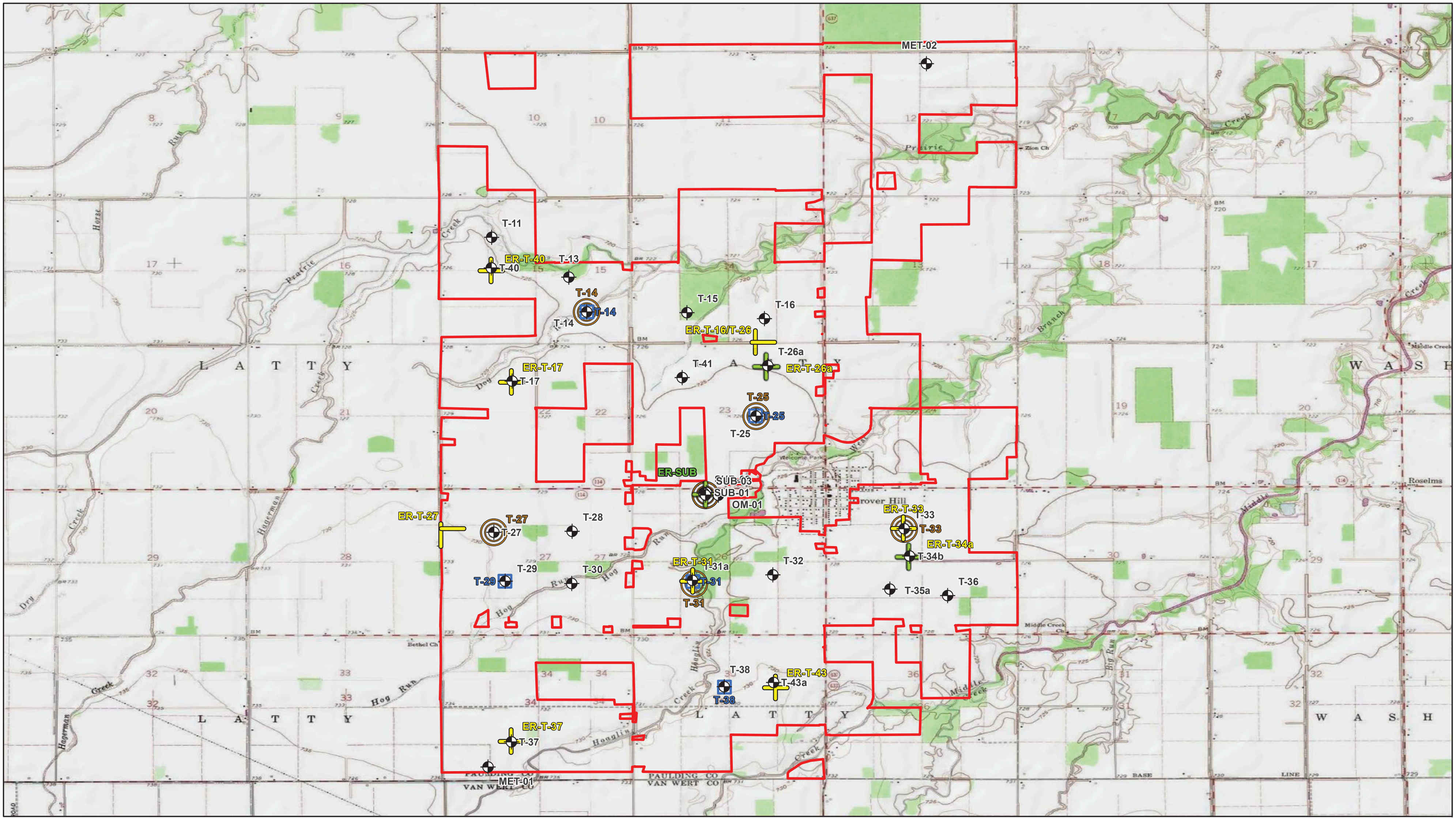

Data Source(s): Westwood (2023); ESRI WMS USA Topo Basemap (Accessed 2021); Census Bureau (2019).

Legend

- ⯐ Boring Location
- ✚ 100ft ER Test Location
- ✚ 200ft ER Test Location
- ▬ 100ft ER Test Location (E/W)
- ❘ 100ft ER Test Location (N/S)
- □ Seismic Test
- ◎ Thermal Resistivity Test Location
- ▭ Project Boundary

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Feet

Grover Hill Wind Project

Paulding County, Ohio

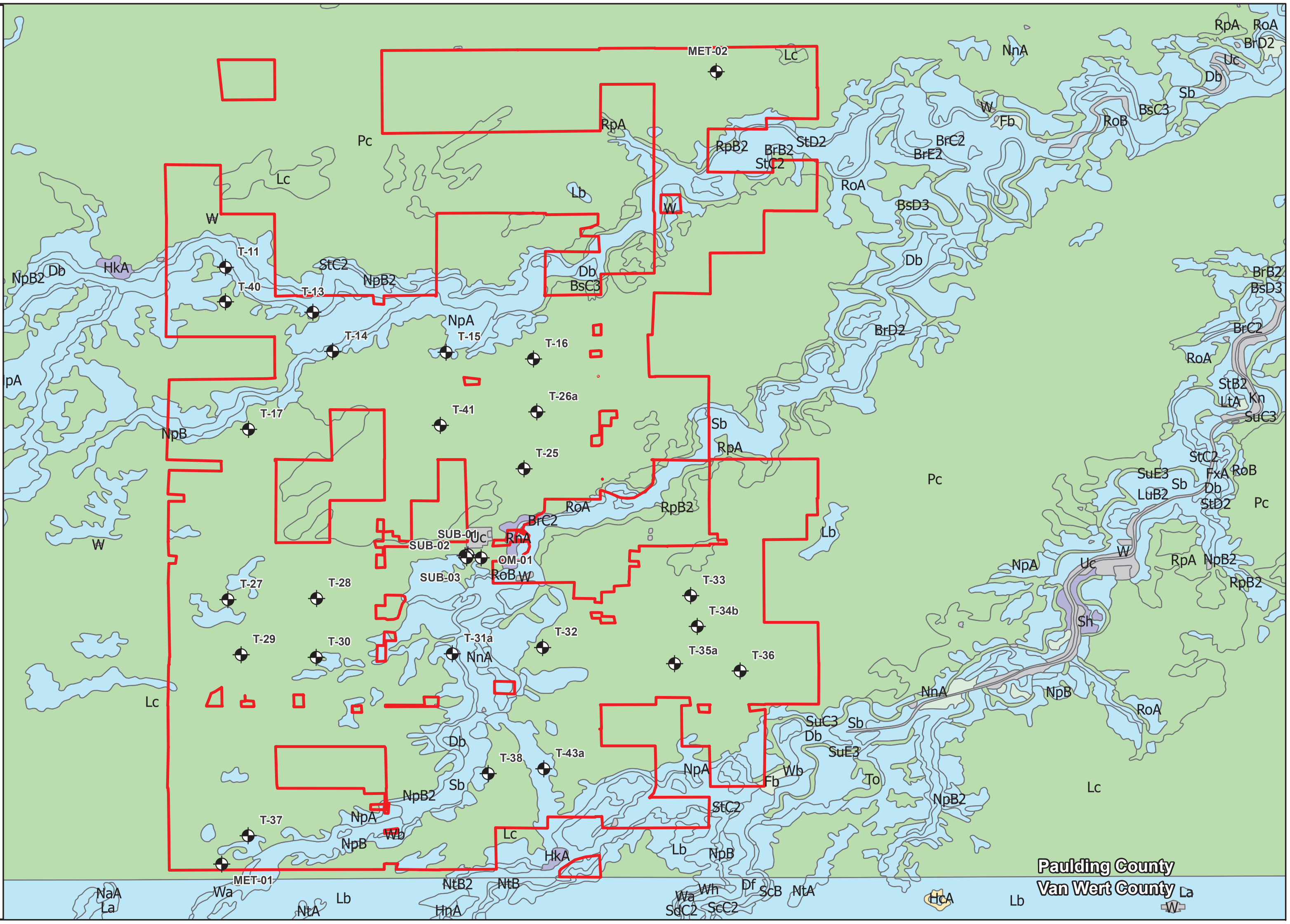
USGS Topography Map

EXHIBIT 2

July 26, 2023

Map Unit Symbol | Unified Soil Classification | Map Unit Name

- BrB2 | CL | Broughton silty clay loam, 2 to 6 percent slopes, eroded
- BrC2 | CL | Broughton silty clay loam, 6 to 12 percent slopes, eroded
- BrD2 | CL | Broughton silty clay loam, 12 to 18 percent slopes, eroded
- BrE2 | CL | Broughton silty clay loam, 18 to 35 percent slopes, eroded
- BsC3 | CH | Broughton silty clay, 6 to 12 percent slopes, severely eroded
- BsD3 | CH | Broughton silty clay, 12 to 18 percent slopes, severely eroded
- Db | CL | Defiance silty clay loam, occasionally flooded
- De | CL-ML | Defiance silt loam
- Df | CL | Defiance silty clay loam
- Fb | ML | Flatrock silt loam, occasionally flooded
- FxA | CL | Fulton silty clay loam, loamy substratum, 0 to 2 percent slopes
- HcA | MH | Hoytville silty clay loam, 0 to 1 percent slopes
- HkA | CL-ML | Haskins loam, 0 to 2 percent slopes
- HnA | CL | Haskins loam, 0 to 3 percent slopes
- HtA | MH | Hoytville silty clay, 0 to 1 percent slopes
- Kn | ML | Knoxdale silt loam, occasionally flooded
- La | CL | Latty silty clay loam
- Lb | CL | Latty silty clay loam
- Lc | CH | Latty silty clay, till substratum, 0 to 1 percent slopes
- LtA | CL | Lucas silt loam, loamy substratum, 0 to 2 percent slopes
- LuB2 | CL | Lucas silty clay loam, loamy substratum, 2 to 6 percent slopes, eroded
- NaA | CL | Nappanee loam, 0 to 2 percent slopes
- NnA | CL | Nappanee loam, 0 to 2 percent slopes
- NpA | CL | Nappanee silty clay loam, 0 to 2 percent slopes
- NpB | CL | Nappanee silty clay loam, 2 to 6 percent slopes
- NpB2 | CL | Nappanee silty clay loam, 2 to 6 percent slopes, eroded
- NtA | CL | Nappanee silty clay loam, 0 to 2 percent slopes
- NtB | CL | Nappanee silty clay loam, 2 to 6 percent slopes
- NtB2 | CL | Nappanee silty clay loam, 2 to 6 percent slopes, moderately eroded
- Pc | CH | Paulding clay, 0 to 1 percent slopes
- RnA | CL-ML | Roselms loam, 0 to 2 percent slopes
- RoA | CL | Roselms silty clay loam, 0 to 2 percent slopes
- RoB | CL | Roselms silty clay loam, 2 to 6 percent slopes
- RpA | CH | Roselms silty clay, 0 to 2 percent slopes
- RpB2 | CH | Roselms silty clay, 2 to 6 percent slopes, eroded
- Sb | CL | Saranac silty clay loam, occasionally flooded
- ScB | CL | St. Clair silt loam, 2 to 6 percent slopes
- ScC2 | CL | St. Clair silt loam, 6 to 12 percent slopes, moderately eroded
- SdC2 | CL | St. Clair silty clay loam, 6 to 12 percent slopes, eroded
- Sh | CL-ML | Shoals silt loam, occasionally flooded
- StB2 | CL | St. Clair silty clay loam, 2 to 6 percent slopes, eroded
- StC2 | CL | St. Clair silty clay loam, 6 to 12 percent slopes, eroded
- StD2 | CL | St. Clair silty clay loam, 12 to 18 percent slopes, eroded
- SuC3 | CH | St. Clair silty clay, 6 to 12 percent slopes, severely eroded
- SuE3 | CH | St. Clair silty clay, 12 to 25 percent slopes, severely eroded
- To | CH | Toledo silty clay, 0 to 1 percent slopes
- Uc | | Udorthents, clayey, hilly
- W | | Water
- Wa | CL | Wabasha silty clay loam
- Wb | CL | Wabasha silty clay loam, frequently flooded
- Wh | CL | Wabasha silty clay



Data Source(s): Westwood (2023); Census Bureau (2019); U.S. Department of Agriculture, Natural Resources Conservation Service (2021).

Legend

⊕ Boring Location
▭ Project Boundary

Unified Soil Classification

⬜ No Classification Available	🟦 CL	🟨 MH
🟩 CH	🟪 CL-ML	⬜ ML

N

0 2,500 Feet

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Paulding County, Ohio

Surficial Soils Map

EXHIBIT 3

July 26, 2023

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Appendix A

Soil Boring Logs

General Notes – Boring Log
Unified Soil Classification System (USCS)

Sample Description Format

Group Name (Group Symbol), Percent and Range of Particle Sizes, Plasticity, Color, Density/Consistency, Moisture, Additional Comments, Geologic Origin (Stratigraphic Unit)

Grain Size Terminology

Soil Fraction		Particle Size	U.S. Standard Sieve Size
Boulders		Larger than 12”	Larger than 12”
Cobbles		3” to 12”	3” to 12”
Gravel:	Coarse	¾” to 3”	3/4” to 3”
	Fine	4.75mm to ¾”	no. 4 to ¾”
Sand:	Coarse	2.00 mm to 4.75 mm	no. 10 to no. 4
	Medium	0.42 mm to 2.00 mm	no. 40 to no. 10
	Fine	0.075 mm to 0.42 mm	no. 200 to no 40.
Silt		0.005 mm to 0.075 mm	Smaller than no. 200
Clay		Smaller than 0.005 mm	Smaller than no. 200

Plasticity characteristics differentiate between silt and clay

Percentages of Gravel Relative Proportions of Cohesionless Soils

Sand and Fines (Optional)

Proportional Term	Defining Range By Percentage of Weight
Trace	0% - 5%
Few	5% - 10%
Little	15% - 25%
Some	30% - 45%
Mostly	50% - 100%

Relative Density and Consistency

Noncohesive		Cohesive		
Relative Density	N-Value	N-Value	Consistency	Pp-tons/sq.ft
		< 2	Very Soft	0.0 to 0.25
Very Loose	0-4	2-4	Soft	0.25 to 0.50
Loose	4-10	4-8	Medium Stiff	0.50 to 1.0
Medium Dense	10-30	8-15	Stiff	1.0 to 2.0
Dense	30-50	15-30	Very Stiff	2.0 to 4.0
Very Dense	Over 50	Over 30	Hard	Over 4.0

The penetration resistance, N, is the summation of the number of blows required to advance two successive 6” penetrations of the 2” split-barrel sampler. The sampler is driven with a 140 lb. weight falling 30” and is seated to a depth of 6” before commencing the standard penetration test.

Abbreviations

Drilling and Sampling

HSA	Hollow-Stem Auger
SSA	Solid-Stem Auger
HA	Hand Auger
CWR	Clear-Water Rotary
MR	Mud Rotary
AR	Air Rotary
SC	Spin-Casing
DC	Drive-Casing
SS	2” Split-Barrel Sampler
MC	Modified California Ring Sampler
ST	2” Thin-Walled Tube Sampler
ST 3	3” Thin-Walled Tube Sampler
PS	Piston Sampler
AS	Auger Cuttings Sample
RS	Rotary Cuttings Sample
SC	Soil Core
RC	Rock Core

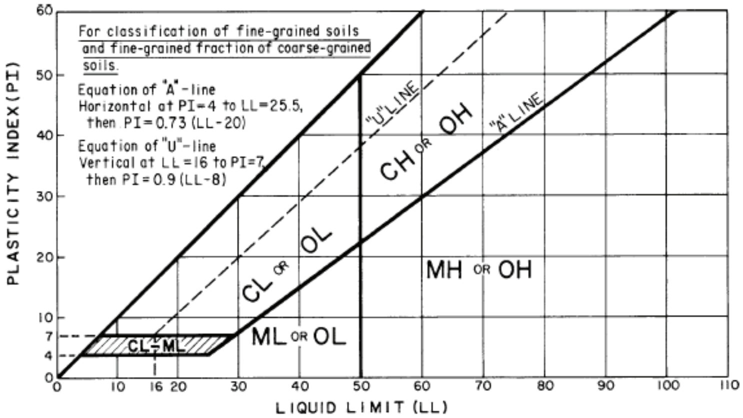


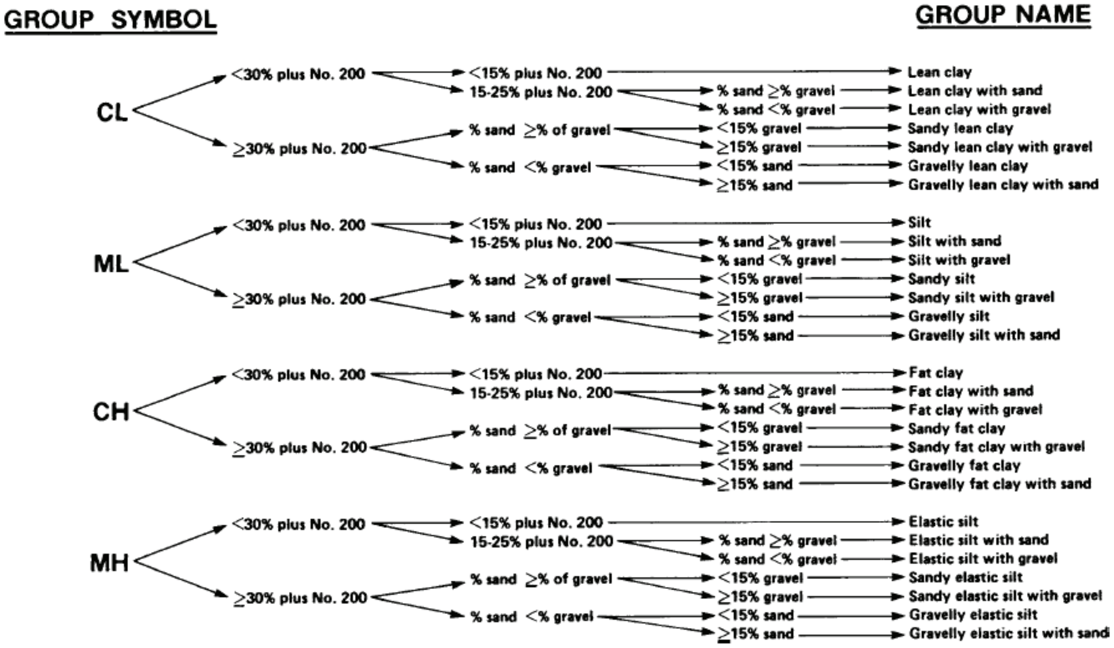
FIG. 4 Plasticity Chart

(from ASTM D 2487)

Sample Description Abbreviations

br.	Brown	tr.	Trace
gr.	Gray	ltl.	Little
yel.	Yellow	ls.	Limestone
lt.	Light	sh.	Shale
dk.	Dark	qtz.	Quartz
blk.	Black	dol.	Dolomite
gvl.	Gravel	ss.	Sandstone
sd.	Sand	lg.	Igneous
si.	Silt	meta.	Metamorphic
cl.	Clay		
f.	Fine	PP	Pocket
m.	Medium		Penetrometer
c.	Coarse		
v.	Very	Tv	Torvane

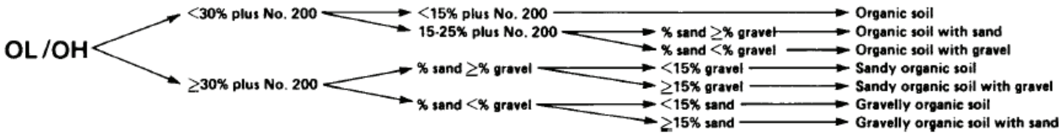
Unified Soil Classification System
(Visual-Manual Procedure)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)

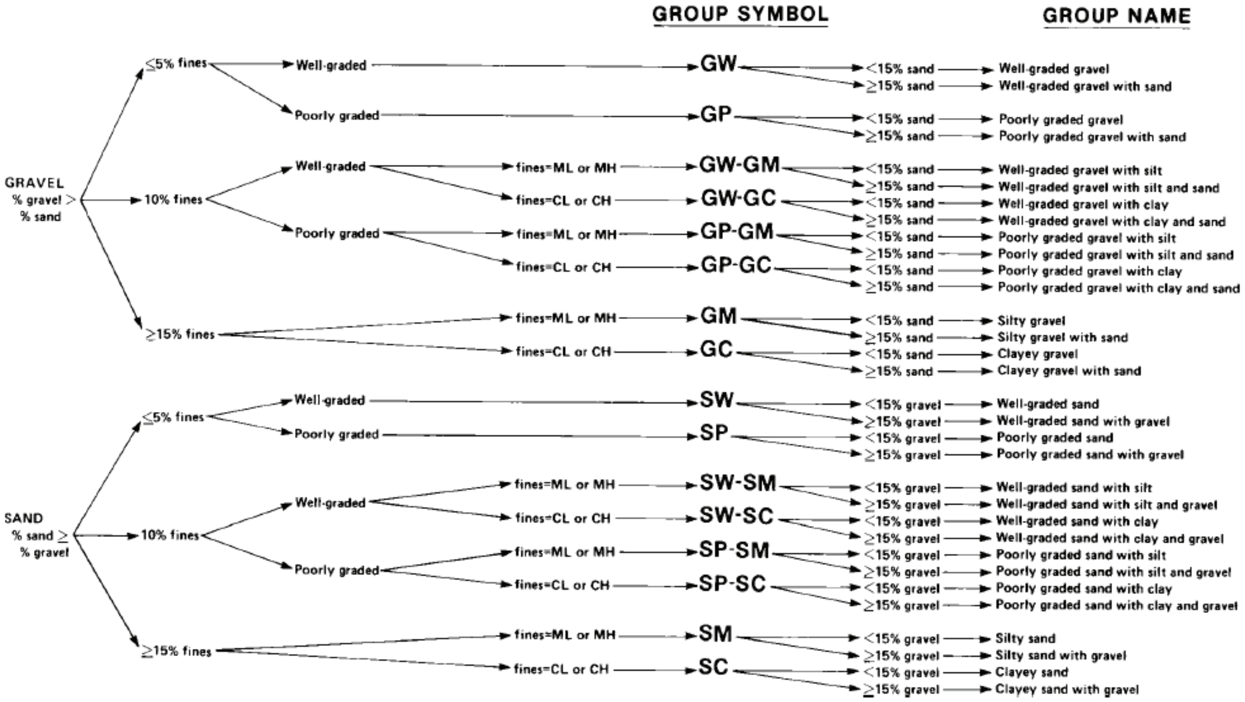
(From ASTM 2488)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1 b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)

(From ASTM 2488)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

(From ASTM 2488)

Westwood

General Notes – Description of Rock Core

General

Rock descriptions may include these components in the sequence in which they are listed:

1. Lithology
2. Rock Core Continuity
3. Field hardness
4. Weathering of rock mass
5. Color
6. Texture
7. Bedding or foliation
8. Discontinuities
9. Solution cavities
10. Other characteristics
11. Rock Quality Designation (RQD) (usually noted in separate column on log)

Lithology

Identify the rock classification (type) and mineralogic/textural modifiers; and, if possible, accepted formation names. The principal constituent is written in capital letters, e.g., SANDSTONE, Calcareous SHALE; Biotite GRANITE; Amygdaloidal BASALT.

Rock (Core) Continuity

Any break in a rock core whether or not it has undergone relative displacement (including natural and mechanical breaks):

- Extremely Fractured – Core segments less than 1 inch long
- Moderately Fractured – Core segments 1 to 4 inches long
- Slightly Fractured – Core segments 4 to 8 inches long
- Sound – Core segments greater than 8 inches long

Field Hardness

A measure of resistance to scratching or abrasion:

Very Hard (VH)	Cannot be scratched with a knife or sharp pick.
Hard (H)	Can be scratched with knife or pick only with difficulty.
Moderately Hard (MH)	Can be readily scratched with knife or pick.
Medium (M)	Can be grooved or gouged 1/16 inch deep by firm pressure on knife or pick point.
Soft (S)	Can be gouged or grooved easily with knife or pick point.
Very Soft (VS)	Can be carved with knife or excavated with pick point.

Weathering of Rock Mass

The degree of alteration produced by chemical and/or mechanical processes:

Fresh (FR)	No visible sign of alteration; perhaps slight discoloration on major discontinuity surfaces.
Slightly Weathered (SW)	Discoloration of rock material and discontinuity surfaces.
Moderately Weathered (MW)	Less than half the rock material is decomposed to soil. Some fresh or discolored rock as continuous framework or corestones.
Highly Weathered (HW)	More than half the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock as corestones or discontinuous framework.
Saprolite (SP)	All rock material disintegrated to soil. The original mass structure is still largely intact.
Residual Soil (RS)	All rock material converted to soil. Volume of mass has changed, but material has not been significantly transported.

Color

Rock color is described as basic colors or combinations such as gray, green-gray, red, red-brown; or modified such as light gray or dark brown.

Texture

General physical appearance or character of a rock, including geometric aspects and arrangement of particles or crystals. Use the following grain size ranges to describe the rock:

Fine-grained	Grains barely visible to the unaided eye, up to 1/16 inch in diameter.
Medium-grained	Grains between 1/16 and 3/16 inch in diameter.
Coarse-grained	Grains between 3/16 and ¼ inch in diameter
Very coarse-grained	Grains larger than ¼ inch in diameter.

Bedding or Foliation

The relative thickness of the beds, or the frequency of layering or bedding planes:

Laminar	< 1/16 inch
Extremely Thin	1/16 to ¾ inch
Very Thin	¾ to 2½ inches
Thin	2½ to 8 inches
Medium	8 to 24 inches
Thick	24 to 80 inches
Very Thick	80 to 240 inches
Extremely Thick	> 240 inches
Massive	No stratification observed
Occasional	Occurring less than once per foot
Frequently	Occurring more than once per foot
Interbedded	Alternating beds of different composition varying in thickness, and in approximately equal amounts

Discontinuities

Natural breaks separating the intact rock material into discrete units:

Joint	Simple fracture, along which no displacement, has occurred. May occur as group of parallel joints called a Set. May also occur as Bedding joints, Cleavage joints or Foliation joints forming parallel to the respective features.
Shear	Fracture, along which differential movement has occurred. Surfaces may be slickensided (polished or striated).
Fault	Major fracture, along which there has been appreciable displacement.
Shear or Fault Zone	Band or zone of parallel, closely space fractures, along which differential movement has occurred.

Westwood

General Notes – Description of Rock Core

Discontinuities - Orientation

Orientation of a rock discontinuity is generally described as dip angle relative to horizontal:

Horizontal	0 - 5
Low Angle	5 - 35
Moderately Dipping	35 - 55
High Angle	55 - 85
Vertical	85 - 90

Discontinuities - Spacing

The distance between discontinuities normal to the plane of the fractures in a single system:

Extremely Close	< 3/4 inch
Very Close	3/4 to 2½ inches
Close	2½ to 8 inches
Moderate	8 to 24 inches
Wide	24 to 80 inches
Very Wide	80 inches to 20 feet
Extremely Wide	< 20 feet

Discontinuities - Roughness

The texture of the discontinuity surface:

Rough
Smooth
Slickensided (polished)
Stepped
Planar
Undulating

Discontinuities - Weathering

A description of the state of weathering of the rock comprising the walls of a discontinuity:

Fresh	No visible sign of weathering of the rock material.
Discolored	The color of the original rock material is changed. Indicate degree of change from original color. Note if color change is limited to particular mineral constituents.
Decomposed	The rock is weathered to the condition of a soil in which the original fabric is still intact, but some or all of the mineral grains are decomposed.
Disintegrated	The rock is weathered to the condition of a soil in which the original fabric is still intact. The rock is friable, but the mineral grains are not decomposed.

Discontinuities - Aperture

A description of the "gap" between the walls of a discontinuity. For rock core logging, the following descriptive terminology is used:

Tight	Core pieces on either side of a discontinuity can be fitted together by hand so that no visible void spaces remain.
Open	Core pieces on either side of a discontinuity cannot be fitted tightly together and voids are visible.

Note:
A completely healed fracture or vein is not considered to be a discontinuity and is <u>not</u> included when describing rock core fracturing or calculating RQD. However, it may be described as a special set of discontinuities and include a record of the altitude (dip), spacing, thickness, type of filling, and any observed alteration.

Discontinuities - Infilling

This is material separating adjacent rock walls of discontinuities, e.g., calcite, chlorite, clay, silt, fault gouge, or breccia. The discontinuity infilling description may include the mineralogy type, thickness, and hardness of the infilling material, the relative amount of infilling (Stained, Coated, Lined, Partially Filled), water content, evidence of shear displacement, wall roughness, fracturing, or crushing of wall rock.

Solution Cavities

Approximate size of openings produced by direct solution by water penetrating pre-existing interstices:

Pit	Barely visible up to ¼ inch	Solution features may be open, crystal lined, or partially or completely filled with hydrothermal minerals, clay, silt, or ore.
Vug	¼ to 2 inches	
Cavity	2 inches to 2 feet	
Cave	> 2 feet	

Other Characteristics

Supplemental characteristics of the rock being described are used where applicable. Such characteristics are the formation name, the presence of solution cavities or voids, secondary mineralization, filling within rock discontinuities, fossils, zones of nodules, brecciation, and swelling or slaking behavior.

Core Recovery

Core recovery is the length of core recovered from a corehole in relation to the length of core drilled in a given core run, expressed as a percentage.

Rock Quality Designation (RQD)

Rock Quality Designation (RQD) is defined as the sum in inches of all pieces of moderately weathered or less weathered rock core, 4 inches in length or longer, divided by the total length in inches of the core drilled in a given core run, expressed as a percentage. If the core is broken by handling or drilling procedures, the pieces of core are fitted together and counted as one piece, provided they constitute the required 4-inch length. Where the core recovery is greater than 100 percent, RQD values are adjusted to account for the portion of the core left in the hole from the previous run. Length determination is measured down the centerline of the core. RQD determination is conducted on cores 1.875 inches in diameter and greater.

90 - 100	Excellent
75 - 90	Good
50 - 75	Fair
25 - 50	Poor
0 - 25	Very Poor

References

- ASTM D4879 Standard Guide for Geotechnical Mapping of Large Underground Openings in Rock
- ASTM D5878 Standard Guides for Using Rock-Mass Classification Systems for Engineering Purposes
- ASTM D6032 Test Method for Determining Rock Quality Designation (RQD) of Rock Core

Westwood

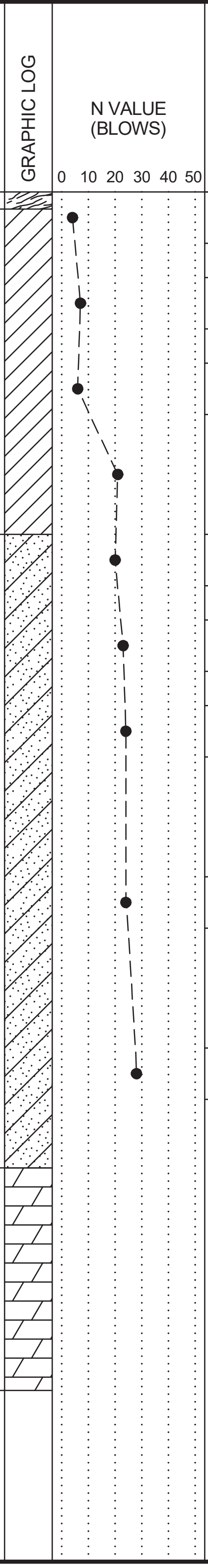
SOIL BORING LOG

BORING NO. T-26 a

Page 1 of 1

Facility/Project Name: Grover Hill Wind Project Paulding County, Ohio		Boring Location: Lat: 41.031422 Long: -84.482228	Surface Elev. (ft): ---	Total Depth (ft bgs): 35.0	Borehole Dia. (in): 4.25
Drilling Firm: Envirocore, Inc.	Drilling Method: Hollow Stem Auger	Personnel: Logger - B. Hawk Driller - S. Guyer	Date Started: 5/23/22	Date Completed: 5/23/22	Water Depth (ft bgs): DNE

SAMPLE NUMBER AND TYPE	RECOVERY (%) (RQD)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	POCKET PEN (tsf) (* = brittle failure)	IN-SITU UNIT WEIGHT (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX	P 200 (%)	COMMENTS
01 SS	72	1 1 3		**Topsoil** - 1", gravel **Lean Clay (CL)** - brown, damp to moist, soft to medium stiff		2.0 2.0						Coordinates are NAD83 Datum.
02 SS	67	2 3 4				3.0		25.2				
03 SS	100	2 2 4	5		CL	2.5 2.3						
04 SS	100	4 9 12		- very stiff								
05 SS	100	4 6 14	10	**Lean Clay w/ Sand (CL)** - brown, damp, very stiff to hard		3.5		15.3	32	14	76	
06 SS	100	5 10 13		- dark grayish brown		4.5+						
07 SS	100	5 8 16	15	- dark gray	CL	4.5+						
08 SS	100	7 11 13	20			4.5+						
09 SS	100	6 11 17	25			4.5+						
RC	94 (0)			**DOLOMITE** - hard, slightly to moderately weathered, gray, little pitting and vug								Begin rock coring at 28.5'
RC	93 (74)		30									
			35	**Boring terminated. Target depth reached.**								



Checked By:	Date:	Approved By:	Date:	Firm:
C. Enos	7/1/22	S. Jorgensen	7/6/22	Westwood Professional Services (952) 937-5150 12701 Whitewater Drive, Suite 300 Minnetonka, MN 55343

Westwood

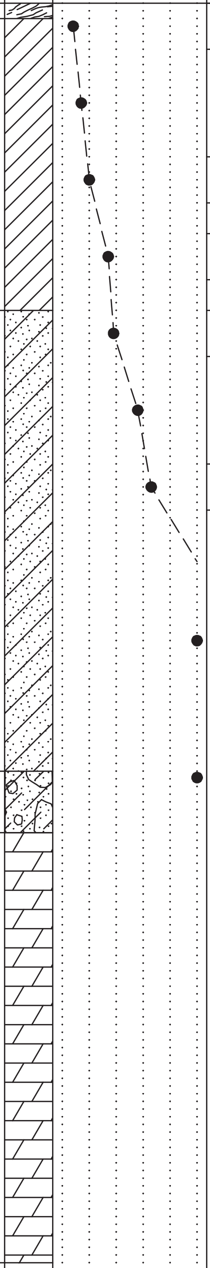
SOIL BORING LOG

BORING NO. T-31 a

Page 1 of 1

Facility/Project Name: Grover Hill Wind Project Paulding County, Ohio		Boring Location: Lat: 41.0124 Long: -84.468035	Surface Elev. (ft): ---	Total Depth (ft bgs): 41.0	Borehole Dia. (in): 4.25
Drilling Firm: Envirocore, Inc.	Drilling Method: Hollow Stem Auger	Personnel: Logger - B. Hawk Driller - S. Guyer	Date Started: 5/24/22	Date Completed: 5/24/22	Water Depth (ft bgs): DNE

SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%) (RQD)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	POCKET PEN (tsf) (* = brittle failure)	IN-SITU UNIT WEIGHT (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX	P 200 (%)	COMMENTS
01 SS	94	1 2 2		**Topsoil** - 3", organics **Lean Clay (CL)** - brown, damp, soft to medium stiff	CL	2.25 1.75						Coordinates are NAD83 Datum.
02 SS	72	3 4 3										
03 SS	100	3 4 6	5	- grayish brown, stiff to hard		4.5+						
04 SS	100	3 7 10		- brown		4.5+						
05 SS	100	5 8 11	10	**Lean Clay w/ Sand (CL)** - brown to dark gray, very stiff to hard	CL	4.5+		17.1	37	19	82	
06 SS	100	7 11 17										
07 SS	89	4 10 23	15			4.5+ 4.5						
08 SS	0	21 33 35	20									
09 SS	99	50/5	25	**Clayey Gravel w/ Sand (GC)** - gray, very dense	GC							Auger scraping
RC	29 (0)			**DOLOMITE** - hard, moderately weathered, gray, few pitting								Begin rock coring at 27'
RC	32 (0)		30 35									
RC	18 (0)		40									
				Boring terminated. Target depth reached.								



Checked By: C. Enos	Date: 7/1/22	Approved By: S. Jorgensen	Date: 7/6/22	Firm: Westwood Professional Services (952) 937-5150 12701 Whitewater Drive, Suite 300 Minnetonka, MN 55343

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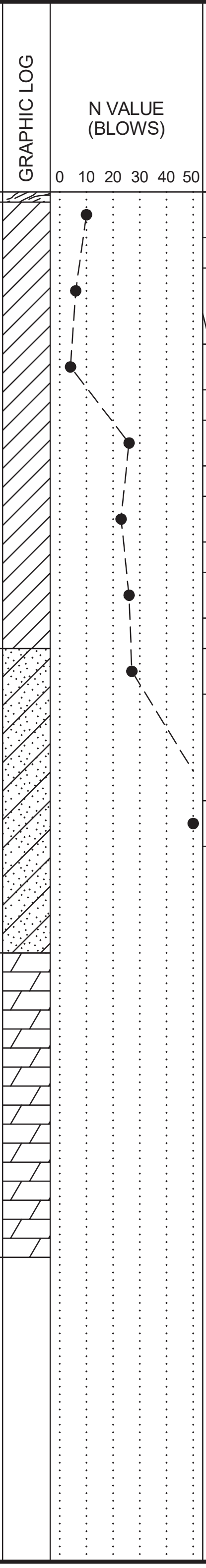
SOIL BORING LOG

BORING NO. T-34b

Page 1 of 1

Facility/Project Name: Grover Hill Wind Project Paulding County, Ohio		Boring Location: Lat: 41.0122165 Long: -84.4672998	Surface Elev. (ft): ---	Total Depth (ft bgs): 35.0	Borehole Dia. (in): 8
Drilling Firm: EnviroCore	Drilling Method: Hollow Stem Auger Auto-Hammer SPT	Personnel: Logger - D. Welch Driller - B. Raush	Date Started: 4/26/23	Date Completed: 4/26/23	Water Depth (ft bgs): >25



SAMPLE NUMBER AND TYPE	RECOVERY (%) (RQD)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	POCKET PEN (TSF)	COMPRESSIVE STRENGTH (TSF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX	P 200 (%)	COMMENTS
01 SS	28	2 4 6		**TOPSOIL** - 4 inches, brown, moist **Lean Clay (CL)** - brown, moist, very stiff		2.5						Coordinates are WGS84 Datum
02 SS	53	3 2 4				2.5 2.5 3.5						
03 SS	56	2 2 2	5			1.5 2.5						
04 SS	100	4 10 16		- brown, yellow, and gray mottling, hard	CL	4.5+						
05 SS	67	4 10 13	10			4.5+						
06 SS	86	4 10 16				4.5+						
07 SS	89	4 15 12	15	**Lean Clay with Sand (CL)** - gray, moist, hard		4.5+		12.5	30	16		
08 SS	100	5 14 48	20		CL	4.5+						
01 RC	96 (63)		25	**Dolostone** - gray, moderately fractured to sound, hard, fresh, horizontal to low angle fracturing, dissolution features			548					Auger refusal at 25 ft
02 RC	100 (92)		30									
			35	**BORING TERMINATED AT 35 FEET BGS. TARGET DEPTH REACHED**								
			40									

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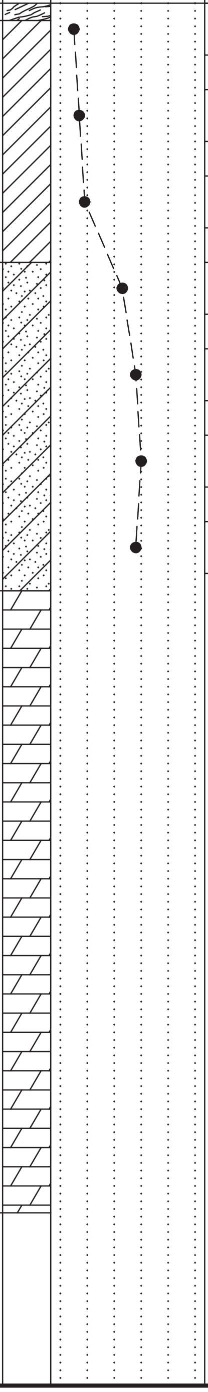
SOIL BORING LOG

BORING NO. T-35a

Page 1 of 1

Facility/Project Name: Grover Hill Wind Project Paulding County, Ohio		Boring Location: Lat: 41.0093822 Long: -84.4713852	Surface Elev. (ft): ---	Total Depth (ft bgs): 35.0	Borehole Dia. (in): 8
Drilling Firm: EnviroCore	Drilling Method: Hollow Stem Auger Auto-Hammer SPT	Personnel: Logger - D. Welch Driller - B. Raush	Date Started: 4/26/23	Date Completed: 4/26/23	Water Depth (ft bgs): >17



SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%) (RQD)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	POCKET PEN (TSF)	COMPRESSIVE STRENGTH (TSF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX	P 200 (%)	COMMENTS
01 SS	44	1 2 3		**TOPSOIL** - 6 inches, brown, moist **Lean Clay (CL)** - brown, moist, stiff to very stiff		2.0						Coordinates are WGS84 Datum
02 SS	69	2 3 4			CL	3.0 3.5						
03 SS	89	2 3 6	5			3.0 3.5						
04 SS	100	5 9 14		**Lean Clay with Gravel (CL)** - dark brown, moist, hard		4.5+ 4.5+						
05 SS	89	4 14 14	10			4.5+ 4.5+		12.9			73	
06 SS	89	6 13 17			CL	4.5+ 2.0						
07 SS	100	5 12 16	15			4.5+ 4.5+						
01 RC	92 (48)		20	**Dolostone** - gray, moderately to slightly fractured, hard, fresh, horizontal fracturing, dissolution features			237					Auger refusal at 17 ft
02 RC	98 (69)		25									
03 RC	100 (62)		30									
04 RC	100 (64)											
			35	**BORING TERMINATED AT 35 FEET BGS. TARGET DEPTH REACHED**								

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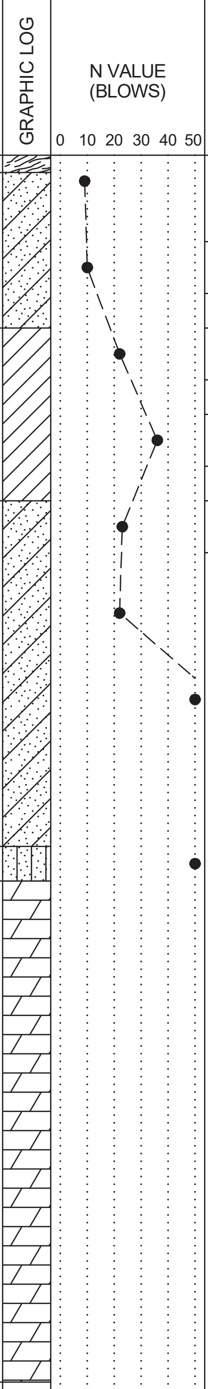
SOIL BORING LOG

BORING NO. T-43 a

Facility/Project Name:	Boring Location:	Surface Elev. (ft):	Total Depth (ft bgs):	Borehole Dia. (in):
Grover Hill Wind Project Paulding County, Ohio	Lat: 41.009978 Long: -84.489744	---	35.5	4.25

Drilling Firm:	Drilling Method:	Personnel:	Date Started:	Date Completed:	Water Depth (ft bgs):
Envirocore, Inc.	Hollow Stem Auger	Logger - B. Hawk Driller - S. Guyer	5/24/22	5/24/22	DNE



SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (%) (RQD)	BLOW COUNTS	DEPTH IN FEET	LITHOLOGIC DESCRIPTION	USCS	POCKET PEN (tsf) (* = brittle failure)	IN-SITU UNIT WEIGHT (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTICITY INDEX	P 200 (%)	COMMENTS
01 SS	78	4 4 5		**Topsoil** - 1" **Lean Clay w/ Sand (CL)** - brown, damp, stiff to hard								Coordinates are NAD83 Datum.
02 SS	94	3 4 6		- dark grayish brown	CL	4.5+						
03 SS	83	6 9 13	5	**Lean Clay (CL)** - brown, very stiff to hard		4.5						
04 SS	78	4 13 23			CL	4.5						
05 SS	100	6 10 13	10	**Lean Clay w/ Sand (CL)** - dark grayish brown, very stiff to hard		4.5+		16.5	33	15	75	
06 SS	100	6 10 12		- dark gray								
07 SS	0	20 41 18	15		CL							
08 SS	100	17 24 50	20	**Silt w/ Sand (ML)** - dark gray, hard	ML			17.0	17	3	83	
RC	100 (69)			**DOLOMITE** - hard, slightly weathered, gray, little pitting and vugging			162.1					Begin rock coring at 21'
RC	100 (91)		25									
RC	100 (52)		30 35									
				Boring terminated. Target depth reached.								

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Westwood

ROCK CORE PHOTO

BORING NO. T-26a

Project Name:
GROVER HILL
Paulding County, OH

Boring Location:
Lat: 41.031422
Long: -84.482228

Surface Elev. (ft):

Total Depth (ft bgs):
35

Borehole Dia. (in):
4.25

Drilling Firm:
EnviroCore

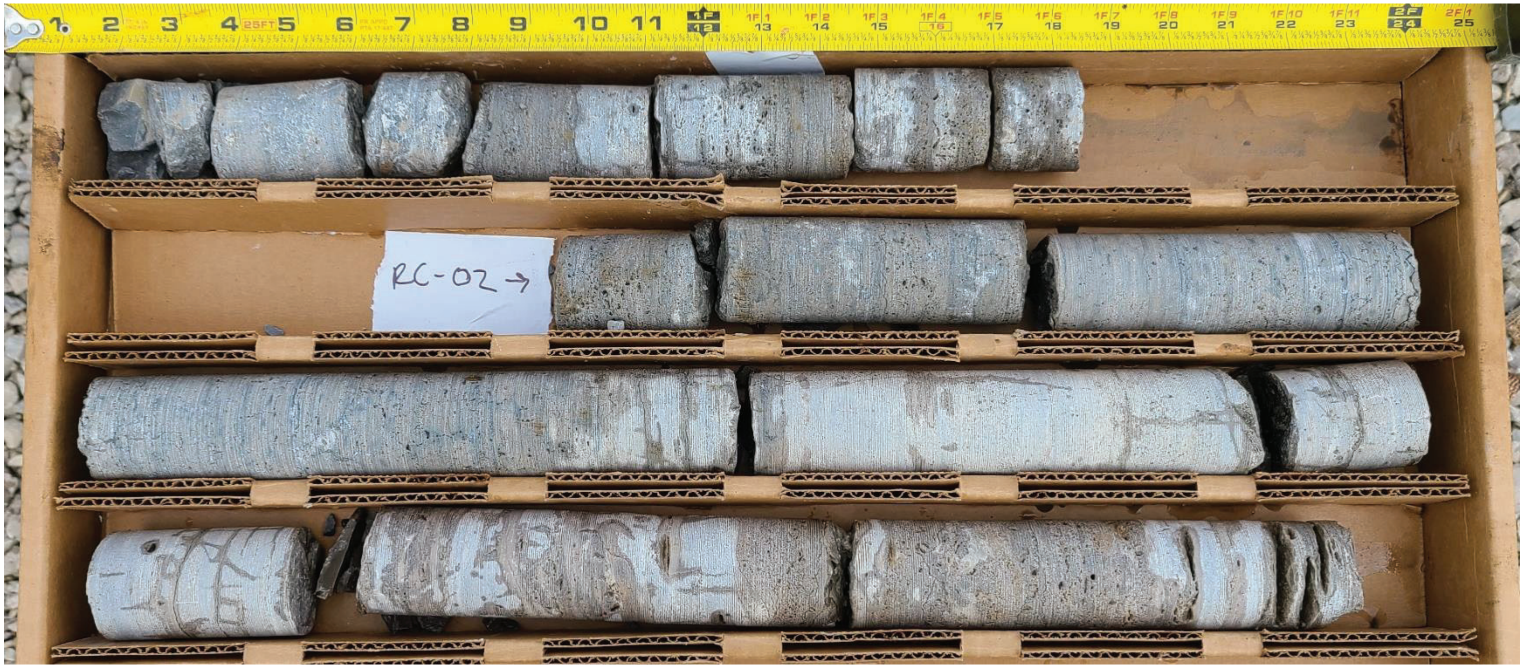
Drilling Method:
RC - Rock Core

Personnel:
Logger: B. Hawk
Driller: S. Guyer

Date Started:
5/23/2022

Date Completed:
5/23/2022

Water Depth (ft bgs):
DNE



Westwood

ROCK CORE PHOTO

BORING NO. T-31a

Project Name: GROVER HILL Paulding County, OH		**Boring Location:** Lat: 41.009978 Long: -84.489744	**Surface Elev. (ft):** ---	**Total Depth (ft bgs):** 41	**Borehole Dia. (in):** 4.25
Drilling Firm: EnviroCore	**Drilling Method:** RC - Rock Core	**Personnel:** Logger: b. Hawk Driller: S. Guyer	**Date Started:** 5/24/2022	**Date Completed:** 5/24/2022	**Water Depth (ft bgs):** DNE

Westwood

ROCK CORE PHOTO

BORING NO. T-34b

Project Name:
Grover Hill Wind Project
Paulding County, Ohio

Boring Location:
Lat: 41.0122048°
Long: -84.4672936°

Surface Elev. (ft): -

Total Depth (ft bgs): 35.0

Borehole Dia. (in): 8.0

Drilling Firm: EnviroCore, Inc.

Drilling Method: RC - Rock Core

Personnel:
Logger: D. Welch
Driller: B. Raush

Date Started: 4/26/2023

Date Completed: 4/26/2023

Water Depth (ft bgs): > 25.0

Westwood

ROCK CORE PHOTO

BORING NO. T-35a

Project Name: Grover Hill Wind Project Paulding County, Ohio		**Boring Location:** Lat: 41.0093819° Long: -84.4713857°	**Surface Elev. (ft):** -	**Total Depth (ft bgs):** 35.0	**Borehole Dia. (in):** 8.0
Drilling Firm: EnviroCore, Inc.	**Drilling Method:** RC - Rock Core	**Personnel:** Logger: D. Welch Driller: B. Raush	**Date Started:** 4/26/2023	**Date Completed:** 4/26/2023	**Water Depth (ft bgs):** > 17.0

Westwood

ROCK CORE PHOTO

BORING NO. T-43a

Project Name: GROVER HILL Paulding County, OH		**Boring Location:** Lat: 40.999784 Long: -84.481634	**Surface Elev. (ft):** ---	**Total Depth (ft bgs):** 35.5	**Borehole Dia. (in):** 4.25
Drilling Firm: EnviroCore	**Drilling Method:** RC - Rock Core	**Personnel:** Logger: B. Hawk Driller: S. Guyer	**Date Started:** 5/24/2022	**Date Completed:** 5/24/2022	**Water Depth (ft bgs):** DNE

Appendix B

SPT and RQD Summary Table

Westwood

SPT N-Value and (RQD) Summary
Grover Hill Wind Project - Paulding County, Ohio

	T-26a	T-31a	T-34b	T-35a	T-43a
Latitude:	41.031422	41.009978	41.012217	41.009382	40.999784
Longitude:	-84.482228	-84.489744	-84.467300	-84.471385	-84.481634
Depth (ft)					
0-1.5	4	4	10	5	9
2.5-4	7	7	6	7	10
5-6.5	6	10	4	9	22
7.5-9	21	17	26	23	36
10-11.5	20	19	23	28	23
12.5-14	23	28	26	30	22
15-16.5	24	33	27	28	59
20-21.5	24	68	62	(48)	74
25-26.5	28	REF	REF	(69)	(69)
30-31.5	(0)	(0)	(63)	(62)	(91)
35-36.5	(74)	(0)	(92)	(64)	(52)
40-41.5		(0)			
***Depth To Rock (ft)**	33.5	27	25	17	35.5

*Depth to rock is an estimate and gradual transitions between soil and rock make it challenging to define a top of rock surface. Excavations may still encounter challenges above this depth.

Legend

- Fat Clay
- Lean Clay
- Granular
- Weathered Rock
- **Bedrock**

(##) = Rock Quality Designation (RQD)

REF = SPT Refusal

Appendix C

Laboratory Testing Report

Westwood

1 Systems Drive
Appleton, WI 54914

main (920) 735-6900

LABORATORY TESTS OF SOILS

ASTM: D2216, D4318, D6913

Project: Grover Hill Wind Energy - Grover Hill, OH
Report To: Starwood Energy Group **Date:** 6/10/2022

Westwood Prj. No. R0015695.00
Date Delivered: 5/26/2022

			Moisture	Atterberg Limits*			Percent Passing	
Boring	**Depth**	**Sample**	**Content**	**LL**	**PL**	**PI**	**#4**	**#200**
T-26	2.5-4	SS-02	25.2%					
T-26	10-11.5	SS-05	15.3%	31.7	18.1	13.6	96	76
T-31	10-11.5	SS-05	17.1%	37.4	18.3	19.1	99	82
T-34	7.5-9	SS-04	15.6%	34.5	17.0	17.5	96	77
T-43	10-11.5	SS-05	16.5%	32.8	17.9	14.9	94	75
T-43	20-21.5	SS-08	17.0%	17.4	14.9	2.6	100	83

Westwood

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REPORT OF: LABORATORY TESTS OF SOILS

Project: Grover Hill Wind Energy - Grover Hill, OH

Report To: Starwood Energy Group

Date: 6/9/2022

Westwood Prj. No.	R30015695.00
Date Delivered:	5/26/2022
Tests Performed:	Grain Size Analysis, Atterberg Limits
Boring No.	T-34
Sample No.	Bulk
Depth	1-5'
USCS Classification:	LEAN CLAY, olive brown (CL)
USDA/ NRCS Classification:	Silty Clay Loam

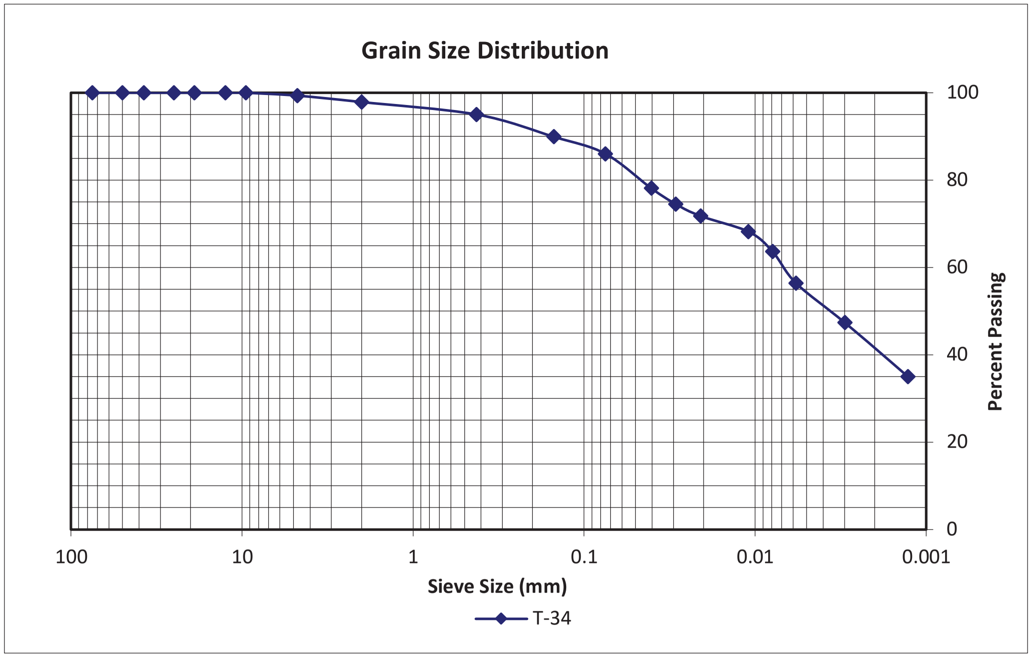
TEST RESULTS;

Grain Size Analysis (ASTM:D6913 & D7928)

SIEVE SIZE	% PASSING
3/4" (19 mm)	100
3/8" (9.5 mm)	100
#4 (.475 mm)	99
#10 (2.0 mm)	98
#40 (.425 mm)	95
#100 (.15 mm)	90
#200 (.075 mm)	86
.050 mm	80.3
.020 mm	71.5
.005 mm	53.9
.002 mm	38.4

Atterberg Limits (ASTM: D4318)

Liquid Limit, LL (%)	49.4
Plastic Limit, PL (%)	22.0
Platicity Index (%)	27.5



MOISTURE-DENSITY CURVE

Project:	Grover Hill Wind Energy - Grover Hill, OH	**Westwood Prj. No.:**	R0015695.00
Report To:	Starwood Energy Group	**Date:**	6/10/2022

Boring Number: T-34 **Depth:** 1-5'

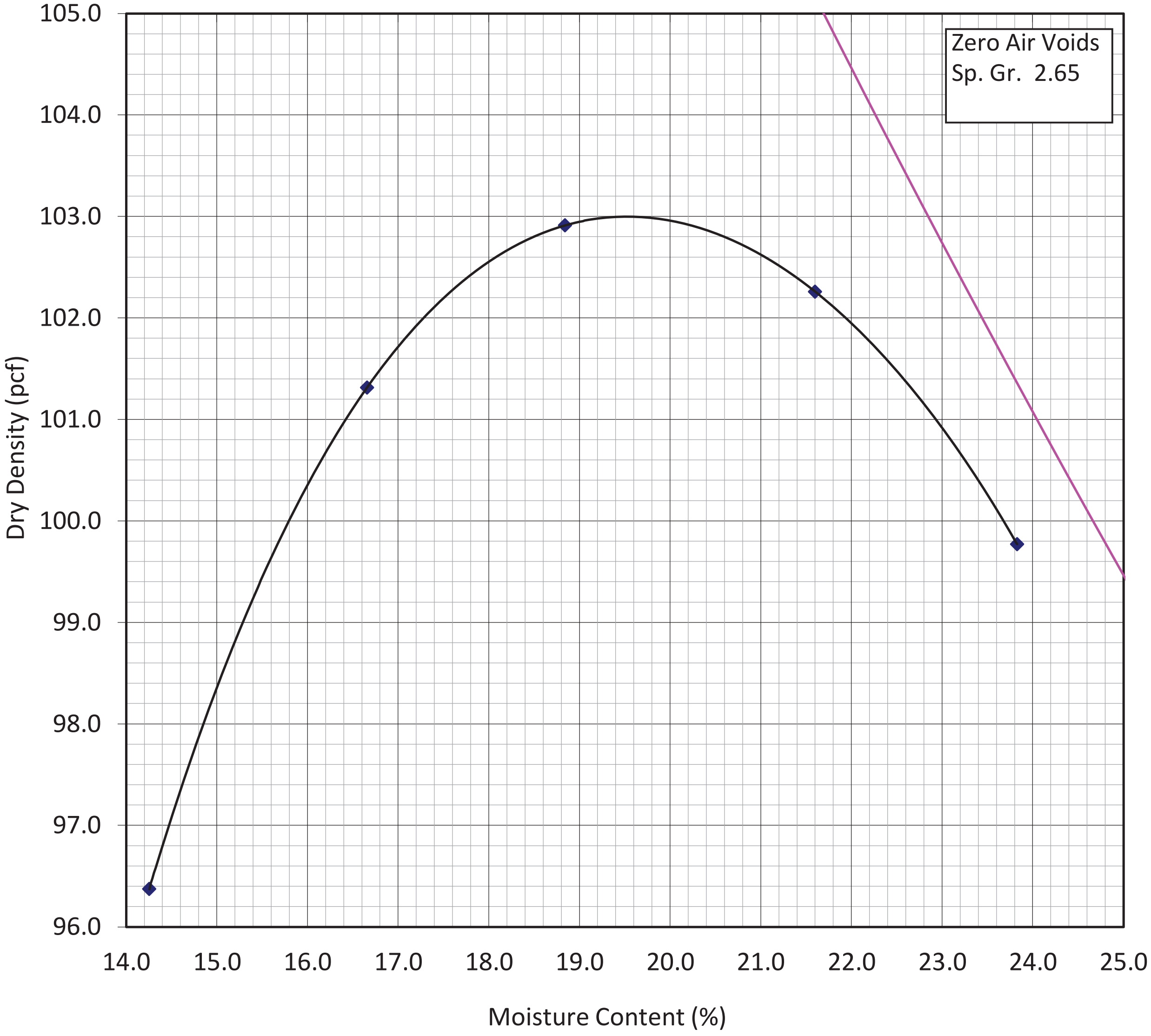
Unified Soils Classification (ASTM:D2487): LEAN CLAY, olive brown (CL)

Tests Method: Standard ASTM:D698, Method B

Preparation: Wet **Automatic Hammer**

Max. Dry Density (pcf): 103.0 **Optimum Moisture (%):** 19.4

Gravel Content (%): < 5 **As-received Moisture (%):** 23.0



Synergy Environmental Lab, LLC.

1990 Prospect Ct., Appleton, WI 54914 *P 920-830-2455 * F 920-733-0631

PAUL EGGEN
WESTWOOD PROFESSIONAL SERVICES
ONE SYSTEMS DRIVE
APPLETON WI 54914-1654

Report Date *16-Jun-22*

Project Name GROVER HILL **Invoice #** E41032
Project # R0015695.00

Lab Code 5041032A
Sample ID T-26 SS-02
Sample Matrix Soil
Sample Date

	Result	Unit	LOD	LOQ	Dil	Method	Ext Date	Run Date	Analyst	Code
General										
General										
Solids Percent	95.9	%			1	5021		6/6/2022	NJC	1
Wet Chemistry										
General										
Sulfate, Unfiltered	59.4	mg/kg	25	82.5	50	300.0		6/13/2022	BLE	1
Chlorides, Unfiltered	56.3	mg/kg	5	16.75	50	300.0		6/13/2022	BLE	1

Lab Code 5041032B
Sample ID T-34 BULK
Sample Matrix Soil
Sample Date

	Result	Unit	LOD	LOQ	Dil	Method	Ext Date	Run Date	Analyst	Code
General										
General										
Solids Percent	94.5	%			1	5021		6/6/2022	NJC	1
Wet Chemistry										
General										
Sulfate, Unfiltered	163	mg/kg	25	82.5	50	300.0		6/13/2022	BLE	1
Chlorides, Unfiltered	93.1	mg/kg	5	16.75	50	300.0		6/13/2022	BLE	1

"J" Flag: Analyte detected between LOD and LOQ LOD Limit of Detection LOQ Limit of Quantitation

Code	*Comment*
1	Laboratory QC within limits.

BLE denotes sub contract lab - Certification #445023150

All solid sample results reported on a dry weight basis unless otherwise indicated. All LOD's and LOQ's are adjusted for dilutions but not dry weight. Subcontracted results are denoted by SUB in the analyst field.

Authorized Signature

Westwood

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Appleton, WI 54914
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LABORATORY TESTS OF SOILS

ASTM: G187, G51

Project: Grover Hill Wind Energy - Grover Hill, OH
Report To: Starwood Energy Group

Date: ########

Westwood Prj. No. R0015695.00
Date Delivered: 5/26/2022

			Electrical Resistivity								
			As-Received				Saturated				
Boring	Depth	Sample	Moist%	Temp. °C	Resistance (Ohms)	Resistivity (Ohms-cm)*	Moist%	Temp. °C	Resistance (Ohms)	Resistivity (Ohms-cm)*	pH
T-26	2.5-4'	SS-02	25.2	26.4	2,550	1,700	42.4	24.1	2,550	1,700	7.3
T-34	1-5'	Bulk	23.0	24.4	2,100	1,400	42.5	25.1	1,850	1,200	7.0

* Soil box factor = 0.67

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REPORT OF: THERMAL RESISTIVITY

ASTM; D5334

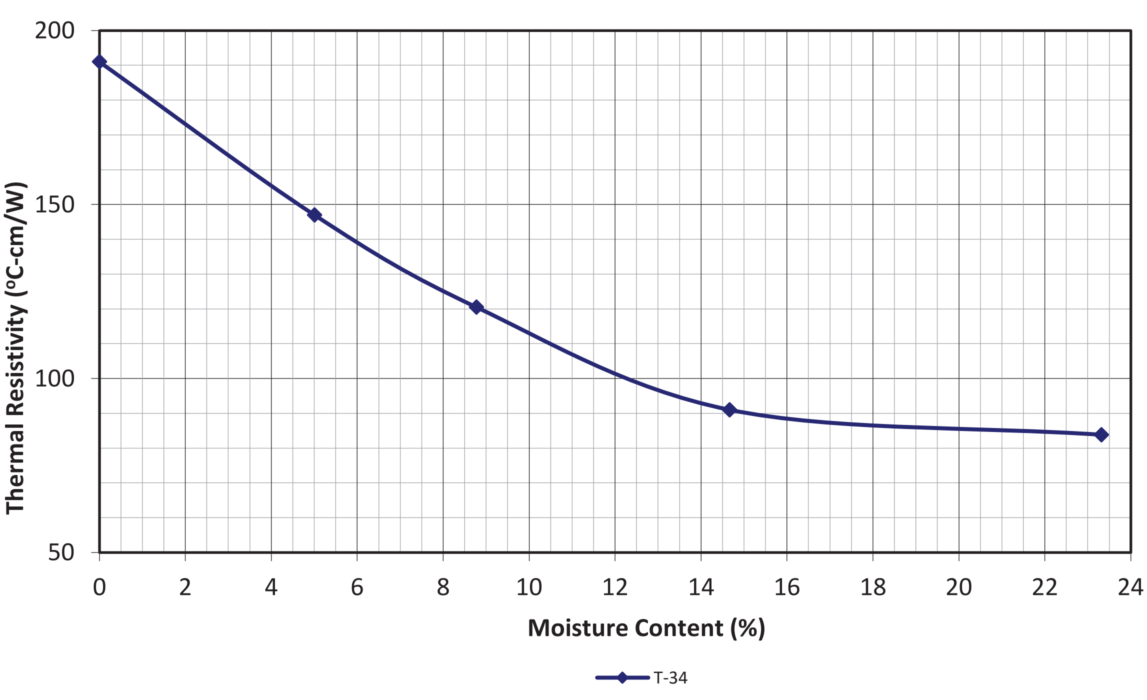
Project: Grover Hill Wind Energy - Grover Hill, OH

Report To: Starwood Energy Group

Westwood Project No. R0015695.00 **Date:** 6/22/2022

					Initial Condition			Thermal Resistivity Results	
Reconstiuted Specimen	Boring	Depth	Soil Type	Proctor Method	Sample Comp. (%)	Dry Density (pcf)	Moisture Content (%)	Moisture (%)	Thermal Resistivity (^{o}C-cm/W)
T-34	T-34	1-5'	CL	ASTM: D698, B	90	92.7	23.3	0	191
								5.0	147
								8.8	120
								14.7	91
								23.3	84

Thermal Dryout Curve (Moisture Content vs. Resistivity)



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REPORT OF: TESTS OF CORED ROCK SPECIMENS

Project: Grover Hill Wind Energy - Grover

Westwood Prj. No. R0015695.00

Report To: Starwood Energy Group

DATE: 6/3/2022

Unconfined Compressive Strength of Rock Cores (ASTM: D7012, Method C)

Core Number	T-34	T-43
Sample ID	RC-01	RC-01
Depth	21-25.5'	20-25'
Rock Type:	Dolomite	Dolomite
Diameter (in.)	1.86	1.86
Area (sq. in.)	2.72	2.72
Length (in)	4.08	3.92
Length/Diameter (L/D)	2.19	2.11
Date Tested	6/3/22	6/3/22
Load at Failure (lbs)	24,860	26,230
Compressive Strength (psi)	9,150	9,650

Unit Weight of Cored Soil or Rock (ASTM: 2216, D7263)

Bulk Specific Gravity	2.638	2.604
Density (lbs/cf)	164.2	162.1

Remarks:

Westwood

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REPORT OF: TESTS OF CORED ROCK SPECIMENS

Project: Grover Hill Wind Energy - Grover Hill, OH
Report To: Starwood Energy Group

Westwood Prj. No. R0015695.00
DATE: 6/29/2023

Unconfined Compressive Strength of Rock Cores (ASTM: D7012, Method C)

Core Number	T-34B	T-35A
Sample ID	RC-01	RC-01
Depth	27.0'-27.8'	20.2'-21.0'
Rock Description:	Gray DOLOSTONE	Gray DOLOSTONE w/ some 1/8" to 1/4" vugs
Diameter (in.)	1.86	1.86
Area (sq. in.)	2.72	2.72
Length (in)	4.72	4.74
Length/Diameter (L/D)	2.54	2.55
Date Tested	6/2/23	6/2/23
Load at Failure (lbs)	20,700	8,970
Compressive Strength (psi)	7,620	3,300

Unit Weight of Cored Soil or Rock (ASTM: 2216, D7263)

Bulk Specific Gravity	2.632	2.665
Density (lbs/cf)	163.8	165.9

Remarks:

Appendix D

Electrical Resistivity Test Data

Electrical Resistivity Test Results
Wenner 4-Electrode Method
Grover Hill - Paulding County, OH

ER-01 (T-34a)

Location:

Site Description: 65 F, cloudy with light rain, flat agriculture field, lean clay, damp

Date: 5/25/22

North-South Transect

ELECTRODE SPACING		Resistance (Ω)	APPARENT RESISTIVITY	
(feet)	(meters)		ohm-feet	ohm-meters
5.000	1.5	2.43	76.3	23.3
10	3.0	1.52	95.5	29.1
20	6.1	1.16	146	44.4
30	9.1	1.10	207	63.2
50	15	1.06	333	102
100	30	1.05	660	201

East-West Transect

ELECTRODE SPACING		Resistance (Ω)	APPARENT RESISTIVITY	
(feet)	(meters)		ohm-feet	ohm-meters
5	1.5	2.41	75.7	23.1
10	3.0	1.59	100	30.5
15	4.6	1.19	112	34.2
20	6.1	1.07	134	41.0
50	15	1.04	327	100
100	30	1.01	634	193

ER-02 (T-26a)

Location:

Site Description: 70 F, cloudy, flat agriculture field, lean clay, damp

Date: 5/23/22

North-South Transect

ELECTRODE SPACING		Resistance (Ω)	APPARENT RESISTIVITY	
(feet)	(meters)		ohm-feet	ohm-meters
5	1.5	2.34	73.5	22.4
10	3.0	1.38	86.7	26.4
20	6.1	0.92	116	35.2
30	9.1	0.79	149	45.4
50	15	0.72	226	68.9
100	30	0.69	433	132

East-West Transect

ELECTRODE SPACING		Resistance (Ω)	APPARENT RESISTIVITY	
(feet)	(meters)		ohm-feet	ohm-meters
5	1.5	2.32	72.9	22.2
10	3.0	1.42	89.2	27.2
20	6.1	0.92	116	35.2
30	9.1	0.80	151	46.0
50	15	0.73	229	69.9
100	30	0.70	440	134