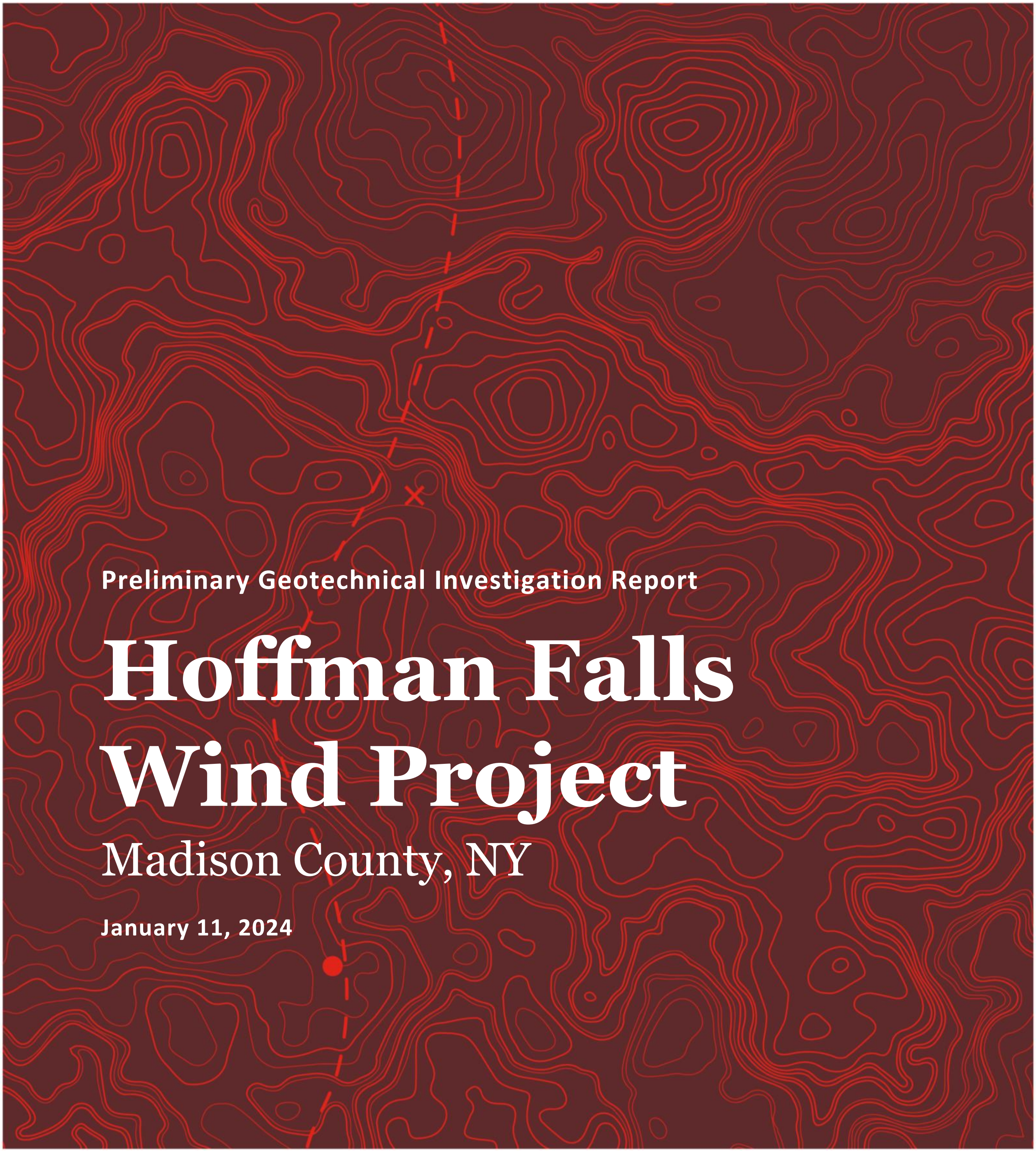

Preliminary Geotechnical Investigation Report

# Hoffman Falls Wind Project

## Madison County, NY

January 11, 2024

**PREPARED FOR:**

liberty renewables

**PREPARED BY:**

Westwood

Westwood

# PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

## Hoffman Falls Wind Project

Madison County, NY

STATE OF NEW YORK
ALEJANDRO ALVARADO
101100
LICENSED PROFESSIONAL ENGINEER

1/11/24

**Prepared for:**
Liberty Renewables
90 State Street
Suite 700
Albany, New York 12207

**Prepared by:**
Westwood Professional Services
12701 Whitewater Drive, Suite 300
Minnetonka, MN 55343
(952)-906-7470

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# Executive Summary

Westwood Professional Services (Westwood) is pleased to present this geotechnical investigation report to Liberty Renewables for the proposed Hoffman Falls Wind Project (Project) located in Madison County, New York. The scope of work for this investigation included subsurface exploration, field and laboratory testing, engineering analysis, and preparation of this report for the proposed Project. The investigation has generally revealed no subsurface conditions that would preclude development of the proposed Project, although shallow bedrock may require specialized excavation equipment and processes for construction of turbine foundations.

Based on the information obtained from standard penetration test (SPT) borings advanced up to 50 feet below ground surface (bgs), the subsurface conditions at the approximate wind turbine (B-01 through B-06) and substation (Sub-01) locations generally consist of up to 12 inches of topsoil overlying medium stiff to hard lean clay with variable amounts of sand and gravel overlying medium dense to very dense clayey sand. Underlying the clay and sand overburden was shale bedrock at borings B-03, B-05, B-06, encountered at depths ranging from 5 to 30 feet bgs. The shale typically transitioned from highly weathered to fresh, with increasing rock continuity with depth. Very soft organic clay with a sporadic boulder was encountered to a depth of 33 feet beneath the single boring that was performed at the proposed horizontal direction drilling (HDD) location. Underlying the organic clay was a very loose saturated sand, observed to a depth of 40 feet.

Groundwater was encountered between depths of 4.25 and greater than 25 feet bgs based on piezometer measurements recorded approximately three months after installation. 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. Long-term depth to groundwater should be confirmed with piezometers installed at each turbine location.

The below summary of recommendations may be used for preliminary wind turbine foundation designs for the locations investigated. These recommendations assume turbines will bear on stiff clay, medium dense sand, or shale bedrock, and should be reevaluated during the final geotechnical investigation:

- Minimum depth to groundwater = 5 ft
- Foundation backfill density (moist) = 120 pcf
- Gross allowable bearing capacity, normal loads = 3,800 psf
- Gross allowable bearing capacity, extreme loads = 6,000 psf
- Differential settlement = 1.5 inches (approximately 0.17 degrees rotation)

The lean clay encountered below the topsoil is generally considered poor to adequate subgrade for gravel access roads. Access roads constructed on native clay subgrade compacted to 95% of the maximum dry density may be designed using a California bearing ratio (CBR) of 2, assuming the subgrade is prepared in accordance with the recommendations in this report.

This executive summary should be read in context of the entire report for full understanding of the conditions encountered and associated recommendations. This report is considered preliminary and the recommendations should be reevaluated with a comprehensive final geotechnical investigation.

# 1.0 Introduction

This report presents the findings of the preliminary geotechnical investigation conducted by Westwood Professional Services (Westwood) for the proposed Hoffman Falls Wind Project (Project) located in Madison County, New York, approximately 20 miles southeast of Syracuse, New York (Exhibit 1). The primary purpose of this report is to provide geotechnical test data and analysis to support the preliminary design and construction of the proposed Project. This investigation focused on six proposed wind turbine generator (WTG) locations, the proposed substation, and one horizontal directional drill (HDD) location. The services provided were in general conformance with the scope of work and assumptions outlined in the Scope of Work and Fee Proposal dated April 27, 2023. This report is intended for exclusive use by Liberty Renewables (Client) for the Hoffman Falls Wind Project.

Westwood understands that the proposed Project will consist of up to 24 wind turbine generators (WTGs) and associated access roads, electrical collection system, collector substation, and ancillary structures, such as meteorological towers and the operations and maintenance (O&M) building, that were not investigated as a part of this preliminary investigation. Topography across the Project Site (approximately 4,000 acres) can be described as lightly to moderately steep rolling hills. The present land use is predominately agricultural fields and forested areas.

# 2.0 Methods

A geotechnical investigation program was completed by Westwood with field work performed between July 10th and 17th, 2023. Earth Dimensions, Inc. was retained by Westwood to perform geotechnical drilling with standard penetration testing (SPT). 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 six (6) proposed wind turbine locations (B-01 through B-06) to a target depth of 60 ft below ground surface (bgs). If auger refusal was encountered prior to a depth of 35 ft, rock coring would be performed to a maximum depth of 35 ft bgs. If auger refusal was encountered beyond a depth of 35 ft, the boring would be terminated.
- Conducting one soil boring at the proposed HDD location to a target depth of 40 ft bgs.
- Conducting one soil boring at the proposed substation (SUB-01) to a target depth of 40 ft bgs. If auger refusal was encountered prior to a depth of 20 ft, rock coring would be performed to a target depth of 20 ft bgs.
- Installing a temporary polyvinyl chloride (PVC) standpipe piezometer at each proposed turbine boring to a depth of approximately 17 feet bgs.
- Performing electrical resistivity surveys at four (4) turbine locations to a maximum ‘a’ spacing of 100 ft and at one (1) location within the proposed substation to a maximum ‘a’ spacing of 200 ft at the substation.
- Collecting soil and rock samples at all boring locations for laboratory testing.

Geotechnical test locations are shown on Exhibit 1. Turbine locations were provided by Liberty Renewables and boring locations selected from the array based on geologic mapping, spatial coverage, site access, and property accessibility. All test locations were staked by a Westwood representative. 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 American Society of Testing Materials (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). The SPT N-values are recorded on the boring logs and a summary is provided in Appendix A. Westwood geotechnical representatives 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 35 ft bgs. Three (3) bulk soil samples were also collected from shallow auger cuttings. Soil and rock samples were shipped to Westwood and SET for laboratory testing. Soil boring and rock core logs are included in Appendix A.

## 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)
- Density (ASTM D7263)
- Chemical analysis (pH, Sulfates, Chlorides)
- California bearing ratio (CBR) (ASTM D1883)
- Thermal resistivity with dry-out curves (ASTM D5334)

A summary of laboratory testing results and complete test reports are included in Appendix C. Bulk samples collected for thermal resistivity tests were prepared near the as-received moisture contents 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 4.1.7 and test reports are included in Appendix C.

## 2.3 Electrical Resistivity Testing

Electrical resistivity measurements were recorded at four proposed turbine locations and one substation location, as shown on Exhibit 1. Tests were performed using the Wenner Four-Electrode Method and an Advanced Environmental Monitoring and Control (AEMC) Instruments Model 6470-B Multi-Function Digital Ground Resistance Tester, in general accordance with ASTM G57. At each test location, resistivity tests were performed to their maximum spacing along two perpendicular profiles with electrode spacing of 5, 10, 20, 30, 50, 100, and 200 feet. Refer to Section 4.1.6 and the attached Appendix B for results of the electrical resistivity tests.

# 3.0 Site Conditions

## 3.1 Regional Geology

The Project Site is located within the Appalachian Plateaus Province within the Appalachian Highlands physiographic region (USGS, 2013). The Appalachian region was formed near the equator beneath a shallow sea, where sedimentary rocks formed over time, such as limestone and shale. As Pangea assembled and the oceanic plates collided during the mid-Paleozoic era, around 480 million years ago (mya), the sedimentary rocks were uplifted into mountainous formations. Fluvial deposits (sediments deposited by a stream) eroded the mountains and were deposited into the lowlands nearby, creating the Appalachian Plateaus. Eventually, after a period of uplift approximately 65 mya, the highland topography of today was formed. In the New York state area of the Appalachian Plateaus, glaciers and their remnants have contributed to shaping the nearby Finger Lakes, which were carved out during the Pleistocene ice age approximately 2 mya.

The Geologic Map of New York maps the bedrock beneath the Project Site as two primary units: the Ludlowville Formation and Skaneateles Formation.

- **Skaneateles Formation:** comprises the majority of the Project Site and is part of the Hamilton Group, noted as 200 to 500 ft thick, and consists of fossiliferous shale and some limestone at the base of the formation – Age: Middle Devonian.
- **Ludlowville Formation:** noted as part of the Hamilton Group and is composed of shales and limestones – Age: Middle Devonian.
- **Oriskany Formation:** noted as part of Onondaga Limestone and Ulster Group and is composed of sandstone with incidental limestone units. Age: Lower Devonian

According to Web Soil Survey available through the United States Department of Agriculture (USDA, 2023), a number of soil units have been mapped within the Project boundary, as shown on Exhibit 3. The major soil units are:

- **Honeoye Silt Loam**: described as loamy glacial till and mapped as lean clay (CL)
- **Lansing Gravelly Silt Loam**: described as glacial till and mapped as gravelly clay (CL), lean clay (CL), and silty sand (SM)

The minor soil unit are:

- **Aurora Silt Loam**: described as glacial till and mapped as lean clay (CL)
- **Conesus Silt Loam**: described as glacial till and mapped as lean clay (CL) and silty sand (SM)
- **Mardin Channery Silt Loam**: described as glacial till and mapped as gravelly clay (CL)
- **Wayland Soils complex**: described as alluvium and mapped as organic soils (PT)

See Exhibit 3 for mapped soil units and associated soil classifications. The majority of these soils are well drained and derived from glacial till.

## 3.2 Geohazards

### 3.2.1 Karst

Karst features generally develop in areas with wet subsurface conditions and soluble bedrock including carbonate rock (limestone and dolomite) or evaporite rock (e.g., gypsum, anhydrite, and halite minerals) that may dissolve over time to form underground caves and create ground instability. Karst geology can be particularly hazardous as caves develop slowly while failures are rapid, often causing several feet of subsidence and sinkholes at the surface. In areas with high risk of karst features, the risk to wind turbines ranges from slight tilting to catastrophic failure.

According to the United States Geological Survey (USGS) map of Karst Hazard Potential in the United States (USGS, 2014a), the Project Site is mapped 2 miles southeast from the Onondaga Limestone, a noted area of karst potential in the form of carbonate rocks greater than 50 ft below the surface in a humid climate (Exhibit 4). Results of the field investigation indicate the depth to weathered shale bedrock at turbine locations ranges between 5 ft to greater than 50 ft bgs, with rock typically encountered within the southeastern portion of the site. At the four borings where rock coring was performed, no core barrel drops (indicative of subsurface voids in the rock) were observed. However, fluid loss was encountered at B-05 around 30 ft, which may also be indicative of a highly fractured/weathered layer. In general, the potential for aggressive groundwater or for karst features to develop on site is considered low due to the bedrock being classified as shale, a non-carbonate rock.

### 3.2.2 Seismicity

In general, the state of New York is not considered a seismically active region. According to the USGS fault database (USGS, 2023a), there are no active Quaternary faults within or near the Project Site, and there is very little potential for surface fault rupture to occur. Nine earthquakes above magnitude (M) 3.0 have been recorded within 100 miles of the Project Site in the past 50 years (USGS, 2023b). The largest of these events was a M4.0 earthquake that occurred approximately 60 miles southeast of the Project Site in 1991. The most recent of these was a M3.6 earthquake that occurred approximately 66 miles to the north of the Project Site in 2023. The nearest of these events was a M3.5 earthquake that occurred approximately 51 miles northeast of the Project Site in 1980. The overall hazard from earthquakes and associated seismicity is considered low.

### 3.2.3 Expansive Soils

Expansive or swelling soils have the potential to undergo volume expansion upon wetting or drying. Swell potential depends strongly on physicochemical interactions between particles, and swelling soils predominantly occur in arid and semiarid areas where the soil contains large amounts of lightly weathered clay minerals. The majority of surficial soils on site are classified as lean clay, clayey sand, and clayey gravel, which are not expected to have significant expansion potential. Fat clay was encountered at the HDD boring during the field investigation; however, this boring is located adjacent to the Morrisville Swamp, where no proposed turbines are located. The infrastructure located in this area is also anticipated to be sufficiently deep to minimize the impacts of soil expansion. The mapped soil units on site are primarily mapped as having a low to moderate linear extensibility (USDA, 2023). The United States Army Corps of Engineers technical manual for foundations in expansive soils (USACE, 1983) maps the Project area in an area of non-expansive soil to extremely limited expansion occurrence. The overall risk of expansive soil is considered low.

### 3.2.4 Collapsible Soils

Collapsible soils are found throughout the world in soil deposits that are eolian, subaerial, colluvial, mudflow, alluvial, residual, or manmade fills. They are defined as any unsaturated soil that undergoes a radical rearrangement of particles and greatly decreases in volume upon wetting, additional loading, or both. Collapsible soils are typically found in arid or semiarid regions with a loose soil structure, and a water content far less than saturation. Typically, the structure of these low-unit weight, unconsolidated sediments consist of coarser particles bonded at their contact points by the finer silt and/or clay fraction, or possibly by surface tension in the water at the air-water interfaces. Collapse is unlikely to occur in soils which lie below the water table.

According to the Web Soil Survey (USDA, 2023) and the laboratory testing performed on soil samples, most soils underlying the Project Site have a significant clay fraction. In the presence of moisture, the clay particles will act as binder and counteract soil collapse. The potential for collapsible soil is considered low for this site due to the relatively high clay content and humid climate.

### 3.2.5 Mining, Oil, and Gas

New York is an active mining state and ranks as the third leading state in terms of value produced (NY DEP, 2023a). The primary extracted mineral commodities come in the form of salt from Central New York and crushed stone, sand, and gravel for construction scattered throughout the state. The remaining mineral resource in the state is largely comprised of metal ores and gem minerals in the mountainous regions. According to the New York Department of Environmental Conservation (NYSDEC, 2023b), no mines or oil/gas wells are mapped within the Project Site, although three quarries and one dry oil/gas well are mapped within several miles of the Project Site. The overall risk of mining or oil/gas activity to affect the Project is generally considered low. A detailed mine study was beyond the scope of this investigation.

## 3.3 Subsurface Stratigraphy

Based on the conditions encountered at the soil boring locations within the Hoffman Falls Wind Project Site, the general subsurface stratigraphic profile is described as follows:

**Topsoil.** Topsoil on site was observed as thick as approximately 12 inches. 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.

**Organic Clay (OH).** Underlying the topsoil at the HDD was an organic clay that was typically various shades of brown, gray, and black, damp to wet, and very soft. The organic clay extended to a depth of 35 ft bgs and overlaid black, very loose, saturated sand. The HDD boring was located adjacent to the Morrisville Swamp, which likely contains highly organic soils throughout. A boulder was encountered within this unit at approximately 16.4 feet bgs before transitioning back into organic clay at 18 feet.

**Overburden Soil**

**Lean Clay, Lean Clay w/ Sand/Gravel, Sandy Lean Clay, Sandy Lean Clay w/ Gravel, Gravelly Lean Clay, Gravelly Lean Clay w/ Sand, Clayey Sand w/ Gravel (CL, SC).** The primary overburden soil on site was a clay with varying amounts of sand and gravel and sand with varying amounts of clay and gravel. The clayey soil was typically medium stiff to hard, brown to gray, and moist to wet. The sandy soil was typically gray with occasional yellow mottling and very dense. This unit extended to bedrock or a transitionary residual rock layer.

**Poorly Graded Gravel, Gravelly Lean Clay (GP, CL).** Underlying the primary overburden soil before transitioning into bedrock was a layer of highly weathered or residual bedrock composed predominately of gravel with varying amounts of clay and sand**.** This unit was typically various shades of brown and gray, very dense, and moist to wet.

**Bedrock**

**Shale.** Shale bedrock was observed at five of the eight boring locations and inferred due to auger refusal at two additional locations between depths of 5 and 50 feet bgs. The shallower portion of the bedrock was typically weathered and transitioned into more competent bedrock with depth. Rock cores were typically light gray to gray with rock quality designation (RQD) values generally ranging from approximately 0% to 60%. The majority of shallow rock cores had RQD values less than 25%, indicating poor rock quality with very limited rock continuity.

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 also installed after completion of drilling and measured shortly after installation, as well as approximately three months later in December, 2023. During the investigation, a static groundwater level was observed in two of the boreholes (HDD and B-01) between depths of 8 and 10 feet bgs. Gray clay, often indicative of long-term saturation, was encountered between depths of 5 and 6 feet bgs at three boring locations (B-01, B-02, and HDD). It should be noted that rock coring techniques introducing water were used at several turbine boring locations, which prevents accurate short-term groundwater measurements. In addition, a predominately clay subsurface profile does not lend itself to accurate short-term groundwater level measurements due to clay's low permeability and tendency to create perched water tables. Auger drilling techniques can also "seal" the borehole sidewalls in clayey soil preventing accurate groundwater infiltration and measurements from being made following completion of the borehole.

Depth to groundwater were measured following a piezometer monitoring trip in December 2023, approximately 3 months after installation. The depth to groundwater on site varied from approximately 5.2 feet to greater than 50 feet bgs during drilling and between 4.25 feet and greater than 25 feet bgs during the piezometer monitoring trip in December 2023. It should be noted that one of the original piezometers (B-01) appears to have been removed by the landowner and could not be checked during the December 2023 monitoring trip. The depths to groundwater measured during drilling and after the piezometer monitoring trip are recorded Table 3.4 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.

Table 3.4 Groundwater depth summary

| **Boring ID** | **Groundwater Measured During Drilling (ft)** | **Groundwater Measured in Piezometer (December 2023) (ft)** |
|---|---|---|
| B-01 | 5.2 | N/A$^{(2)}$ |
| B-02 | - | 4.25 |
| B-03 | 28 | 12 |
| B-04 | >23.7$^{(1)}$ | 16.5 |
| B-05 | >10.3$^{(1)}$ | - |
| B-06 | >5.0$^{(1)}$ | 12.75 |

(1) Measurements past this depth not recorded due to water added for rock coring.
(2) Piezometer removed prior to monitoring trip.

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 observed during construction or at other times in the life of the structure may be higher or lower than those observed during the investigation. Depth to groundwater should be recorded during the final geotechnical investigation, and piezometers should be installed at proposed turbine locations for dynamic observation of water levels. Refer to Sections 4.2.2, 4.4.4, and 4.5.2 for recommendations regarding water control.

# 4.0 Discussion and Recommendations

## 4.1 Soil Properties

### 4.1.1 Moisture and Density

The in situ gravimetric moisture content of the soil on site ranges from approximately 3% to 20%, excluding the 74% moisture content measured in the organic clay encountered in the HDD boring. The lean clay typically had moisture contents ranging from 13% to 20% and the coarse-grained units typically had moisture contents between approximately 2% to 8%.

For preliminary 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 115 pcf based on a dry density of 105 pcf and 10% long-term moisture content.

### 4.1.2 Shear Strength of Soil

The undrained shear strength of the clayey soil at or below the anticipated turbine foundation depths on site generally ranges from approximately 1,500 tsf to 4,000 tsf based on correlations to SPT blowcounts, pocket penetrometer tests, and unconfined compression testing. Zones of lower-strength organic clay were encountered at the boring HDD location; however, soil strength is not anticipated to affect design of the underground cabling. The recommended undrained shear strength used for preliminary design of bearing capacity for turbine and substation foundations is 2,000 psf, provided that lower strength material, if encountered, is over-excavated and replaced with compacted structural fill. Refer to Section 4.4.4 for turbine foundation subgrade recommendations.

### 4.1.3 Dynamic Shear Modulus

No shear wave velocities were measured on site as part of this preliminary investigation, and the dynamic shear modulus was evaluated based on correlations to geotechnical investigation findings and available literature. Wind loading of a turbine system induces a cyclic tower vibration, which is then transferred through the tower base into the underlying foundation subgrade. Should the subgrade stiffness be insufficient, the magnitude of the tower vibration can become excessive, potentially reducing the efficiency of the turbine system, and in extreme cases, induce large fatigue loads resulting in tower buckling long-term. A sufficiently stiff foundation and bearing soil is necessary to adequately reduce this vibration, and the dynamic shear modulus is needed to analyze the rotational stiffness.

The dynamic shear modulus is best determined via measurements of shear wave velocity, however, shear wave velocity measurements were not recorded as part of the scope of this preliminary investigation. Correlations (Det Norske Veritas, 2002) indicate that the estimated shear wave velocity in the overburden soil strata at the boring locations is approximately 800 ft/s, which corresponds to a shear modulus of approximately 2,400 ksf. Based on these findings and the shallow bedrock encountered throughout the site, there is no indication that the proposed site will be prohibitive to turbine construction on the grounds of rotational stiffness; however, shear wave velocity measurements should be taken at turbine locations during the final geotechnical investigation to verify suitable subsurface conditions.

### 4.1.4 Poisson’s Ratio

Poisson’s ratio is a unit-less material parameter defined as the ratio of transverse strain and axial strain for a material under loading. The parameter measures the phenomenon in which a material tends to expand or contract in a direction orthogonal to the direction of compression or tension. Poisson’s ratio is often used to relate various elastic parameters of a given material and is a factor in calculating the rotational stiffness of a wind turbine foundation system. Poisson’s ratio was evaluated based on correlations to geotechnical investigation findings and available literature. For the clayey overburden, a Poisson’s ratio of 0.4 is recommended for preliminary design, but should be confirmed with seismic shear and compression wave velocities measured during the final geotechnical investigation. For rock, a Poisson’s ratio of 0.1 may be used.

### 4.1.5 California Bearing Ratio

The field strength of access road subgrade may be assessed using the CBR. One shallow soil sample was collected between 1 ft and 5 ft bgs at a proposed turbine location (B-01). The sample was classified as lean clay with sand (CL). A design CBR of 2.0 is recommended for road subgrade compacted to 95% of the standard Proctor MDD. Refer to Section 4.6 for recommendations on access road design.

### 4.1.6 Electrical Resistivity

Electrical resistivity measurements were collected at four wind turbine boring locations and one substation boring location using the Wenner Four-Electrode Method in accordance with ASTM G57 using electrode spacings between 2 feet and 200 feet. Electrical resistivity generally varies with material type and moisture content, and ranges on site between 3,720 ohm-cm (Ω-m) and 124,900 Ω-cm based on test results. These observed values are generally in agreement with typical published values for clay and sands (Palacky, 1987). Results of the electrical resistivity tests are presented in Appendix B. Refer to Section 2.3 for additional information on the electrical resistivity test method.

### 4.1.7 Thermal Resistivity

Thermal resistivity dry-out curves were developed for shallow soil samples collected at two proposed wind turbine locations (B-01 and B-03), and one at the proposed substation. All samples were collected between 1 and 5 feet bgs. Bulk samples were re-compacted at the natural moisture content to approximately 90% of the standard Proctor maximum dry density. The thermal resistivity of the soil varied with soil type, moisture content, and density, and ranged from 56°C·cm/W to 220°C·cm/W. Thermal resistivity measurements should be performed at the HDD location prior to final design as peat and organic soils may have high thermal resistivity. Results of the thermal resistivity tests are 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.

### 4.1.8 Soil Corrosivity

The chemical constituent test results indicate that the soil is neutral with a pH ranging from 7.0 to 7.2. Soluble sulfates were measured as high as 138 mg/kg and soluble chlorides measured as high as 10.4 mg/kg. Chloride exposure is considered to be class C1, and sulfate exposure is considered low with concrete exposure class S0 (ACI, 2019). Test results are presented in Appendix C and summarized in the Lab Test Summary Table.

## 4.2 General Earthwork Considerations

General earthwork includes activities such as mass grading, electrical trenching, and site preparation for future activities. Subgrade preparation and fill recommendations specific to foundations and access roads are provided in those design recommendation sections, respectively.

### 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 4.2.5.

Westwood understands portions of the site are currently forested or and will require clearing prior to Project construction. After trees are cleared the site should be grubbed. Grubbing activities include the removal of brush, stumps, and roots, typically by one of two methods; grind in place or excavate out of the ground. Some smaller roots (less than ½" in diameter) may also be left in place if it determined that they will have limited impact on the construction and performance of Project infrastructure. Larger roots should be removed, as they may create obstructions to trenching, excavations, or cause differential settlement of shallow foundations as they decay over time.

After clearing and grubbing is complete, the site will need to be rough graded to promote positive drainage and prevent water from ponding. Rough grading may also include filling in holes left behind from grubbing activities. Holes in structural areas, such as below foundations and access roads, should be backfilled with non-organic native soil or imported fill backfilled in lifts compacted in accordance with the recommendations provided in Sections 4.2.5 and 4.2.6.

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. Three of the investigated proposed turbine locations (B-04, B-05 and B-06) encountered very dense sand/gravel or bedrock shallower than the anticipated excavation depth of 10 feet bgs. See Table 4.2.1 for a summary of depth to bedrock, and Section 4.2.3 for more discussion on rock rippability.

**Table 4.2.2 Depth to Bedrock Encountered During Investigation**

| Boring Location | Depth to Bedrock (ft) |
|---|---|
| B-01 | 35 |
| B-02 | >50 |
| B-03 | 28 |
| B-04 | 10 |
| B-05 | 8 |
| B-06 | 5 |
| HDD | >40 |
| SUB-01 | 8 |

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 clayey overburden soil on site may generally be inferred to be a Type B soil, although 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.

Groundwater may accumulate in excavations on site at select turbine locations. Although the high clay content of the subgrade soil will generally limit the amount of groundwater infiltration into foundation excavations, some dewatering of excavations may be required to remove precipitation and surface water runoff, groundwater seepage through sandy/gravelly layers, or upwelling through exposed fractured bedrock. 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. 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 Rock Rippability

Bedrock with varying degrees of weathering was encountered within anticipated foundation excavation depths (less than 10 to 12 feet bgs) at three of the six turbine locations investigated (see Table 4.2.1). The rock generally consisted of shale with the degree of weathering ranging from highly weathered near the surface to slightly weathered at depths beyond 30 feet bgs. Based on observations of hollow stem auger and rock coring operations and Westwood's experience with similar sites, the rock encountered within the upper 10 feet is generally expected to be rippable. It should be noted that competent bedrock may exist at locations uninvestigated as a part of this preliminary investigation, which may require specialized rock ripping equipment or blasting. A rock trencher may be needed in isolated portions of the site to excavate collector trenches in areas with very shallow bedrock. A geophysical survey including seismic refraction testing to measure P-wave velocities should be performed during the final geotechnical investigation to better assess rock rippability.

### 4.2.4 Permanent Cut and Fill Slopes

Cut and fill slopes in native soil may be preliminarily 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 generally 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.

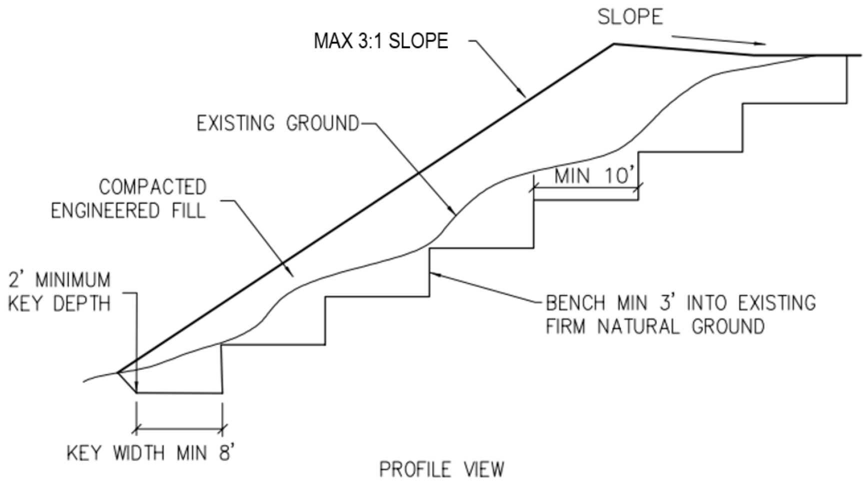

**Figure 4.1 Benching detail for fill slopes greater than 5 ft**

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.

### 4.2.5 Subgrade Preparation

After clearing and grubbing, exposed areas to receive general fill used for raising site grades should be scarified, moisture conditioned to within 3% of optimum moisture content, and compacted to 95% of the standard Proctor maximum dry density (ASTM D698). The depth of subgrade compaction should extend at least 12 inches below fill areas. Where possible, subgrade below general fill areas should be proof-rolled prior to placing fill to identify soft areas. Proof-rolling can be performed with a fully loaded dump truck. Soft areas with rutting greater than 1.5 inches should be removed or re-compacted prior to placing fill. Refer to Sections 4.4.4, 4.5.1, and 4.6 for more information on turbine foundations, substation shallow foundations, and access road subgrade preparation, respectively.

Disturbance to areas prepped for subgrade fill should be minimized. Repeated traffic loading and excessive moisture due to precipitation may degrade subgrade soil. Native clayey soils are expected to be sensitive to the addition of water and may become unstable if not carefully monitored. Repeated traffic loading and excessive moisture due to precipitation may degrade subgrade soil. Care should be taken to limit disturbance to subgrade soils across the site and prevent ponding water by promoting positive drainage and minimizing the time of exposure to precipitation. Where unsuitable subgrade, such as soft clay or loose sand/gravel, is encountered, the subgrade should be moisture conditioned and re-compacted as described above, or unsuitable subgrade should be over-excavated as recommended by the construction-phase geotechnical engineer and replaced with structural fill in accordance with Sections 4.4.4 and 4.5.1.

### 4.2.6 Fill and Backfill

The native non-organic 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. Organic clay should not be used as general fill. 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, and excavated bedrock should be crushed to appropriate particle sizes prior to use as fill. General fill shall be placed in maximum loose lifts of 9 inches thick and compacted to a minimum 95% of the standard Proctor maximum dry density (ASTM D698) and within 3% of optimum moisture content. See Table 4.2.2 below for additional recommendations.

Trenches may be backfilled using native material, provided that it is screened of particles larger than 3/8" and moisture conditioned to near optimum moisture content and compacted to a minimum of 90% of the standard Proctor maximum dry density (ASTM D698) in non-structural areas and 95% of the maximum dry density in structural areas (i.e., within 5 feet of foundations and below access roads). Highly organic soil, such as the organic clay observed at the HDD location adjacent to Morrisville Swamp, may be challenging to achieve adequate compaction and typically has unfavorable thermal properties, so consideration should be given to using imported material for trench backfill in areas with highly organic soil.

**Table 4.2.2 Fill and Backfill Material Recommendations.**

| Material | Uses | Loose Lift Thickness | Required Compaction(1) | Moisture Content(1) |
|---|---|---|---|---|
| Imported select structural fill | Fill below turbine foundations or crane pad over-excavations | ≤ 12" with heavy compaction equipment | ≥ 98% | As-needed |
| Non-frost susceptible structural fill | Fill below shallow foundations bearing within the frost depth | ≤ 12" with heavy compaction equipment | ≥ 98% | As-needed |
| Non-organic native clay general fill | Foundation backfill, embankments, access road subgrade, and general site grading | ≤ 9" with heavy compaction equipment<br>≤ 6" with hand compaction equipment | ≥ 95% | ±3% of optimum moisture |
| Native topsoil and organic soil | Landscaping non-structural areas | N/A | N/A | N/A |

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

## 4.3 General Foundation Considerations

### 4.3.1 Lateral Resistance

A friction factor of 0.35 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 New York has adopted the 2018 International Building Code. The maximum considered earthquake spectral response accelerations are presented in Table 4.2 below (ATC, 2023).

**Table 4.3.2 Seismic Design Parameters**

| Parameter | Design Value |
|---|---|
| **Reference** | 2018 IBC |
| **Site Class** | C, D(1) |
| **Coordinates (Lat., Long.)** | (42.915871, -75.636078) |
| **Mapped Spectral Acceleration for Short (0.2 sec) Periods – $S_s$** | 0.148 g |
| **Mapped Spectral Acceleration for 1-second Periods – $S_1$** | 0.053 g |
| **Peak Ground Acceleration, PGA** | 0.074 g |

(1) Refer to Table 1 (attached) for site class recommendations for each turbine location.

### 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 4 ft (Bowles, 1996). Critical foundations and pipes should be placed a minimum of 4 ft below final grade or on non-frost susceptible soil extending to a depth of at least 4 feet for protection against frost, unless they are designed to accommodate the effects of frost.

## 4.4 Wind Turbine Foundations

Westwood understands that a number of turbine models are being considered for the Project. A variety of preliminary load documents from each manufacturer under consideration were provided by the Client. No preliminary foundation designs were provided prior to preparation of this report, and therefore for the basis of this analysis it was assumed turbines will be supported on approximately 70-foot diameter octagonal or circular spread footings bearing approximately 10 feet below grade with an effective bearing area of approximately 30 feet by 45 feet. The recommendations provided in this report should be re-evaluated during the final geotechnical investigation when Project-specific loading documents and preliminary foundation designs are available, including alternate buoyant foundation designs for turbines bearing below the expected groundwater depth. Soil parameters recommended for use in turbine spread foundation design are discussed in Section 4.1.

### 4.4.1 Bearing Capacity

Although no turbine locations contained weak material below the anticipated foundation bearing depths, subgrade strength should be confirmed in the field per Section 4.4.4. Typical turbine spread footing foundations supported on native soil or select structural fill should be designed for the following maximum allowable bearing capacities, provided ground improvement is performed, where required, in accordance with Section 4.4.5.

Table 4.4.1: Bearing capacity summary.

| **Loading Condition** | **Controlling Condition** | **Safety Factor** | **Allowable Bearing Capacity (psf)** | |
|---|---|---|---|---|
| | | | **Gross** | **Net[2]** |
| Normal | Bearing Capacity | 3.0 | 3,800 | 3,500 |
| Extreme | Bearing Capacity | 2.25 | 6,000 | 5,600 |

(1) Net allowable bearing capacity assumes a bulk soil unit weight of 120 pcf.

### 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 settlement analyses indicate that the assumed turbine foundation, consisting of an assumed 70-foot diameter spread footing embedded 10 feet bgs with a gross bearing pressure of 3,800 psf will experience a total settlement of approximately 1.5 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 Buoyancy

The depth to groundwater was evaluated with short-term observations in boreholes and long-term observations in piezometers installed during drilling. It should be noted that rock coring techniques introducing water were used at several turbine boring locations, which prevents accurate short-term groundwater measurements. In addition, short term observations in clayey soil typically do not accurately reflect the long-term water level, and fluctuations should be expected. During the investigation, a static groundwater level was observed at three locations (HDD, B-01, and B-03) between depths of approximately 5 and 28 feet bgs. Gray clay, often indicative of long-term saturation, was encountered between depths of 5 and 6 feet bgs at boring locations B-01 and B-02.

Depth to groundwater measured during piezometer monitoring trip in December, 2023 varied from approximately 4.25 feet and greater than 25 feet bgs during the piezometer monitoring trip in December, 2023. It should be noted that one of the original piezometers (B-01) appears to have been removed by the landowner and could not be checked during the monitoring trip. The depths to groundwater measured during drilling and after the piezometer monitoring trip are summarized in Section 3.4. 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.

It Is expected that, due to the spatial variability of the groundwater depth on site, groundwater depth is expected to be shallower than the anticipated foundation bearing depth at a portion of turbines, while groundwater will likely be deeper at others. 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 Section 3.4 for additional discussion regarding groundwater. Additional groundwater measurements through the use of piezometers installed at each turbine location are recommended during the final geotechnical investigation to confirm seasonal groundwater fluctuation prior to final foundation design.

### 4.4.4 Subgrade Preparation

Turbine foundations should bear on native medium stiff to stiff clay, medium dense to dense sand or gravel, or, if required, compacted select structural fill. 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. It should be noted that the possibility still exists for undetected weak clay or loose sand/gravel within the turbine footprint at the locations investigated, as well as at turbine locations not investigated as a part of this preliminary investigation, particularly if they are set in topographic lowlands, valleys, or near wetlands where water may pond.

Disturbance to the subgrade within foundation excavations should be minimized throughout construction. Fine-grained 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. If encountered, soft/loose soil, frozen soil, and rock fragments larger than 6 inches should be removed. Care should be taken to prevent ponding water by promoting positive drainage and minimizing the time of exposure to precipitation. The foundation subgrade should be also protected against freezing and snow/water accumulation after inspection and prior to foundation placement. During winter construction, heating of the subgrade may be necessary to protect the subgrade from freezing. 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. If disturbed, foundation subgrade should be scarified and recompacted in accordance with Section 4.2.5 prior to the placement of the mud mat or select structural fill.

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. If soft/loose, disturbed, or otherwise unsuitable turbine foundation bearing soil is encountered, as determined by the quality control testing described below, the excavation should be remediated based on the depth of unsuitable subgrade.

Static Cone Penetrometer (SCP) or Dynamic Cone Penetrometer (DCP) testing is recommended to confirm subgrade soil strength and identify areas of soft clay or loose sand/gravel, respectively. Subgrade testing should be performed at a minimum of five (5) locations on the excavation and 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 should exceed the undrained shear strength or friction angle necessary to achieve the minimum required bearing capacities noted in Section 4.4.1. The foundation subgrade should also consist of a uniform bearing material, such that the foundation does not bear on part soil and part rock. Field inspection and quality control of the subgrade may identify the need for additional subgrade modification, such as over-excavation of unsuitable material and replacement with select structural fill. The design-phase geotechnical engineer-of-record should be notified in the event that unsuitable subgrade conditions are encountered. Although generally not anticipated to be required based on the results of this preliminary investigation, subgrade remediation options should be recommended and discussed as needed based on the results of the final geotechnical investigation.

## 4.5 Substation Foundations

### 4.5.1 Shallow Foundations

Results of the geotechnical investigations performed at the proposed substation suggest that shallow spread/strip footings and mat foundations are feasible to support various substation structures.

#### 4.5.1.1 Subgrade Preparation

After clearing and grubbing, exposed areas to receive fill, including the subgrade below shallow foundation over-excavations and road aggregate, should be scarified to a minimum depth of 9 inches, moisture conditioned to within 3% percent of optimum moisture, and re-compacted to 95% of the standard Proctor maximum dry density (ASTM D698). Subgrade below shallow foundations should have the native soil over-excavated to a minimum depth of 4 feet below final grade, or 1 foot below the bottom of the foundation, whichever is deeper, and replaced with non-frost susceptible structural fill (see Section 4.5.1.2) to minimize differential heave/movement. 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 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.

#### 4.5.1.2 Fill Placement and Compaction

Native soil should not be used as structural fill for supporting shallow foundations. Imported non-frost susceptible structural fill should consist of well-graded aggregate with less than 5% fines. The fill should be sampled and tested prior to use on site. Non-frost susceptible structural fill placed beneath foundations and slabs shall be moisture conditioned as needed, placed in loose lifts of 12 inches thick, and compacted to a minimum 98% of the standard Proctor maximum dry density (ASTM D698).

#### 4.5.1.3 Bearing Capacity and Settlement

Provided the recommendations of this report are followed, including over-excavation and replacement in accordance with Section 4.5.1.2, preliminary designs of large slab-on-grade equipment foundations (i.e., 10 to 20 feet wide) and conventional spread and strip footing foundations (i.e., 4 feet wide) may use a preliminary maximum allowable gross bearing capacity of 3,500 psf.

A total estimated settlement of less than 1 inch is anticipated for shallow foundations. Differential settlement can generally be assumed to be ½ to ¾ of the total settlement. Proper drainage should be provided around foundations to minimize the potential for foundation movement. Shallow foundations should be reinforced as necessary to reduce the potential for damage caused by differential movement.

A vertical modulus of subgrade reaction of 125 pounds per cubic inch (pci) may be used for mat foundations bearing on a minimum 2 feet of structural fill. This vertical modulus of subgrade reaction represents a 1-foot square foundation and should be modified as needed for larger foundation sizes.

### 4.5.2 Deep Foundations

Deep foundations, such as concrete piers/shafts, may be used to support the equipment at the proposed substation. The recommendations provided may be used for design of drilled shaft foundations at the substation. Drilled shafts should have a minimum diameter of 2 feet.

#### 4.5.2.1 Constructability

The overburden soil profile within the substation area generally consists of topsoil overlying lean clay that transitions into weathered rock. Underlying the overburden soil is shale bedrock, which was encountered at a depth of approximately 8 feet bgs. Given the existing slope of the proposed substation area, the depth to bedrock is likely variable within the footprint. The depth to and competency of bedrock should be confirmed during the final geotechnical investigation and construction.

The relative ease of drilling will depend on the hardness/density of the soil, amount of gravel, cobbles, and boulders present, as well as the depth to and competency of bedrock. Conventional auger drilling is expected to be feasible while drilling though the overburden soil but may be ineffective when drilling through cobbles, boulders, and weathered bedrock. Specialized rock drilling equipment will be required to extend deep foundations to their target embedment depths. If the foundation design embedment depth relies on bearing in competent bedrock, the foundation should be socketed a minimum of 1.0 times the foundation diameter into competent rock. Shallower rock sockets may be acceptable if the design does not rely on the rock strength for axial or lateral support. Soil and rock conditions, along with MFAD capacity and deflection values, should be considered when determining embedment into rock. See Appendix E for further details.

During the investigation, a static groundwater level or wet soil was not observed prior to the addition of water for rock coring, but may still be present beyond the depth where rock coring started (see Section 3.4). Perched groundwater above or within bedrock may also be possible, particularly during periods of extended/heavy rainfall. The accumulation of groundwater within boreholes/excavations may occur based on the depth to groundwater observed during the geotechnical investigation. The depth to groundwater recommended for design aligns with the depth that rock coring began and are included in Appendix E. Borehole sidewalls may collapse if casing is not used through sand and gravel layers, especially if they are saturated. Should any water collect within the excavations, the bottom of foundation excavations should be cleared of any water and loose material prior to the placement of concrete or pole, or concrete may be poured using tremie method. Concrete should be placed as soon as possible after foundation excavation to minimize the potential for sidewall disturbance and water accumulation.

#### 4.5.2.2 Axial and Lateral Capacity

The proposed substation structures may be supported on concrete piers/shafts. Drilled shaft foundations will develop their axial capacity through a combination of skin friction and end bearing when in compression and skin friction alone when in uplift, although skin friction should be ignored and only end bearing relied upon when for drilled shafts in compression and bearing on bedrock. Skin friction should be applied to the surface area of the pier, and end bearing should be applied to the full area at the bottom of piers in compression. Skin friction and end bearing values for concrete shafts are provided in Appendix E. These values are allowable and include a safety factor of 2.0 for skin friction and 3.0 for end bearing.

The lateral capacity of drilled pier foundations was evaluated with correlations to laboratory and field test results. The lateral response of the shafts/poles may be modeled using the program MFAD by FAD Tools. The recommended soil and rock model input parameters for design of drilled shafts are also provided in Appendix E.

Consideration should be given to neglecting at least the upper 2 feet of embedment to account for the potential for erosion/scour, frost, and moisture/strength changes, as shown in Appendix E.

## 4.6 Access Roads

Access roads will be required during construction to accommodate construction equipment and deliveries. The access roads will also facilitate long-term operation and maintenance of the Project. These roads will be subjected to heavy loads, but only for limited duration and frequency. The suitability of the shallow site soil for use as access roads will depend primarily on the strength and moisture condition of the soil at the time the traffic occurs. The shallow non-organic lean clay soil on site below the root zone is generally considered adequate subgrade for gravel access roads, although special consideration should be given to the moisture sensitivity of the shallow clayey soil. The shallow organic clay, where present, is considered poor subgrade for roads due to its low strength, regardless of compaction. Access roads should have an aggregate surface to help ensure accessibility during wet conditions.

### 4.6.1 Subgrade Preparation

For areas on site with non-organic lean clay or sand, clearing and grubbing of the topsoil should be performed. Exposed areas for access road construction should be scarified, moisture conditioned to within 3% of optimum moisture content, and compacted to 95% of the standard Proctor maximum dry density (MDD) (ASTM D698). The depth of subgrade compaction should extend at least 12 inches below access road areas. Subgrade below access roads areas should be proof-rolled prior to placing fill to identify soft areas. Proof-rolling can be performed with a fully loaded dump truck. Soft areas with rutting greater than 1.5 inches should be removed or re-compacted prior to placing fill. Where unsuitable subgrade, such as soft clay, is encountered, the subgrade should be moisture conditioned and re-compacted as described above, or over-excavated as recommended by the construction-phase geotechnical engineer and replaced with structural fill in accordance with Section 4.2.6.

### 4.6.2 Aggregate Section

A preliminary subgrade CBR of 2.0 is recommended for the design of aggregate-surfaced roads on non-organic lean clay constructed in accordance with the recommendations in this report based on the results of laboratory testing. Aggregate-surfaced roads should consist of well-graded aggregate in accordance with NYSDOT Section 733-11A Type I or Type II Subbase and shall be moisture conditioned as needed and compacted to a minimum 98% of the standard Proctor maximum dry density (ASTM D698). In general, at least 12 inches of aggregate may be required to support construction traffic, although conditions vary with subgrade moisture, strength, compaction effort, and soil type. Less aggregate, such as 6 to 8 inches, may be used if the subgrade is stabilized (e.g., with a mid-strength geotextile reinforcement, lime, or cement).

Loose, saturated, and highly organic subgrade material are typically the limiting conditions for access roads. Strengthening the subgrade with crushed rock, geosynthetics, or other suitable material, and/or mixing the base material with additives such as cement will minimize damage to the subgrade. Project specific tests are recommended to more accurately define the mix design and access road cross section. Establishing adequate side ditches and other surface water control features will help to reduce damage caused by surface water and saturated road subgrade conditions.

### 4.6.3 Maintenance

It is expected that aggregate-surfaced access roads will require ongoing maintenance to keep them in a serviceable condition, regardless of the aggregate thickness and subgrade preparation. It is not practical to design an aggregate section of adequate thickness that prevents ongoing maintenance. Ruts, depressions, and soft/loose subgrade should be repaired as needed to facilitate traffic. Additional aggregate may be placed in ruts and depressions, or the entire aggregate section and soft subgrade may be removed and replaced with a new aggregate section.

Surface vegetation root zones and other soft or otherwise unsuitable material should be stripped from access roadways and the surface graded to provide positive drainage. In order to identify potentially unsuitable soil, the road subgrade should be compacted and subsequently proof-rolled with a fully loaded tandem axle or tri-axle truck with a minimum gross weight of 25 tons and minimum axle loading of 10 tons. Subgrade preparation should be monitored by a representative of the construction-phase geotechnical engineer at the time of construction. At locations where pumping or unacceptable rutting of the subgrade occurs, the soft soil should be removed and replaced with properly compacted fill in accordance with Section 4.2.6.

## 4.7 Horizontal Directional Drilling

One soil boring was performed at a proposed HDD location to assess the drilling feasibility and risk of inadvertent return (i.e. “frac-out”). A frac-out occurs when the drilling fluid pressure exceeds the confining ability of the soil overburden, resulting in a release of drilling fluid at the surface. Frac-out is most common in soils with limited clay and silt content, artesian groundwater, weak overburden soil, and a large elevation gap between HDD entry and exit.

Based on the results of the soil boring, the subsurface consists of approximately 33 ft of soft to medium stiff organic clay overlying very loose sand. The relative ease of directional drilling will depend on the hardness/density of the soil, amount of gravel, cobbles, and boulders present, as well as the depth to and competency of bedrock. Conventional directional drilling is expected to be feasible while drilling though the soft overburden soil, but may be ineffective when drilling through cobbles, boulders, or weathered bedrock, which may be present along portions of the HDD route.

Although the overburden soil observed has a high clay content, which will limit permeability, the shallow organic clay is expected to be soft. Moreover, groundwater is expected to be relatively shallow based on measurements taken during drilling and the mapped wetlands surrounding the boring location. The entry and exit points of the HDD were not known at the time of this investigation, but should be considered in future frac-out analyses. In general, the risk of frac-out during directional boring at this location is considered moderate if not properly accounted for.

## 4.8 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 Liberty Renewables, for the Hoffman Falls Wind Project. The primary focus of this report was preliminary recommendations for site grading activities, wind turbine foundation design, and access roads. This report is considered preliminary, and a comprehensive geotechnical investigation should be performed prior to final design of the proposed Project.

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 Project 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.

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New York State Department of Environmental Conservation. (NYSDEC). 2023. *Water Well Information*. DEC Water Well Applications. https://www.dec.ny.gov/cfmx/extapps/WaterWell/index.cfm?view=searchByCounty

# Tables

**Westwood**

# SPT N-Value and (RQD) Summary

## Hoffman Wind Project - Madison County, New York

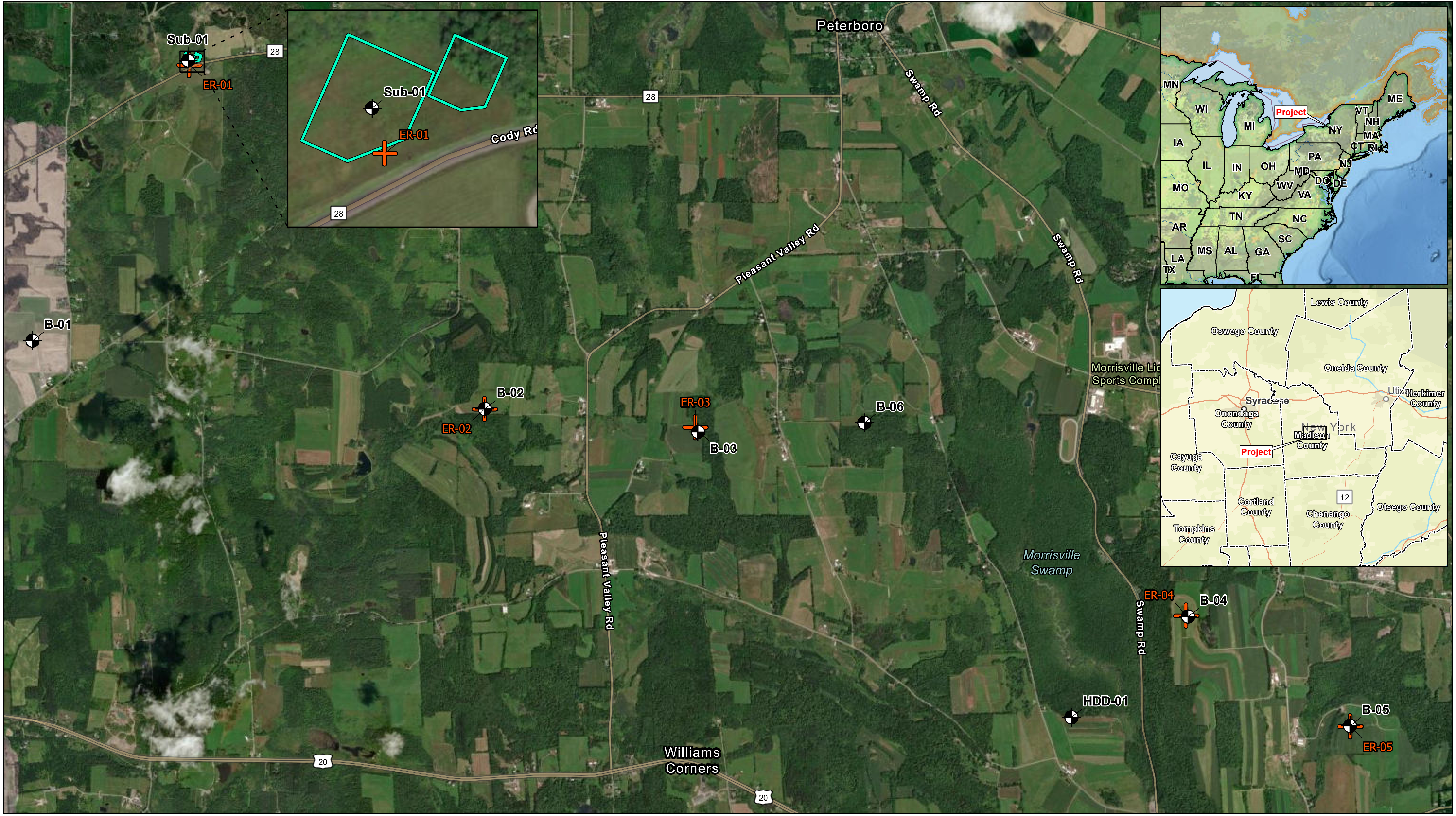
| | B-01 | B-02 | B-03 | B-04 | B-05 | B-06 |
|---|---|---|---|---|---|---|
| **Seismic Site Class** | D | D | C | C | C | C |
| **Depth (ft)** | | | | | | |
| **0 - 1.5** | 5 | 12 | 10 | 10 | 13 | 25 |
| **2 - 3.5** | 7 | 32 | 15 | 9 | 15 | REF |
| **4 - 5.5** | 20 | 23 | 15 | REF | 11 | REF |
| **6 - 7.5** | 23 | 33 | 21 | 52 | 32 | (0) |
| **8 - 9.5** | 22 | 40 | 18 | 60 | REF | |
| **10 - 11.5** | 23 | 33 | 31 | 68 | REF | (0) |
| **12 - 13.5** | 27 | 57 | 33 | 67 | (0) | |
| **14 - 15.5** | 32 | 55 | 62 | 41 | (0) | (0) |
| **18 - 19.5** | 43 | 61 | 56 | REF | | |
| **23 - 24.5** | 54 | 31 | REF | REF | (0) | (30) |
| **28 - 29.5** | 48 | REF | REF | (15) | (12) | (57) |
| **33 - 34.5** | REF | 35 | 56 | (63) | (60) | (0) |
| **38 - 39.5** | | 30 | | | | |
| **43 - 44.5** | | 43 | | | | |
| **48 - 49.5** | | 28 | | | | |
| ***Depth To Rock (ft)** | 35.8 | 50 | 28 | 10 | 8 | 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**

Lean Clay
Granular
Weathered Rock
Bedrock
(##) = Rock Quality Designation (RQD)
REF = SPT Refusal

# Exhibits



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

## Legend

- ⊕ Boring Location
- ✚ Electrical Resistivity Test Location
- ▭ Substation
- ▭ State Boundary
- ⬚ County Boundary

N

Feet

0 1,500

**Westwood**

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# Hoffman Wind

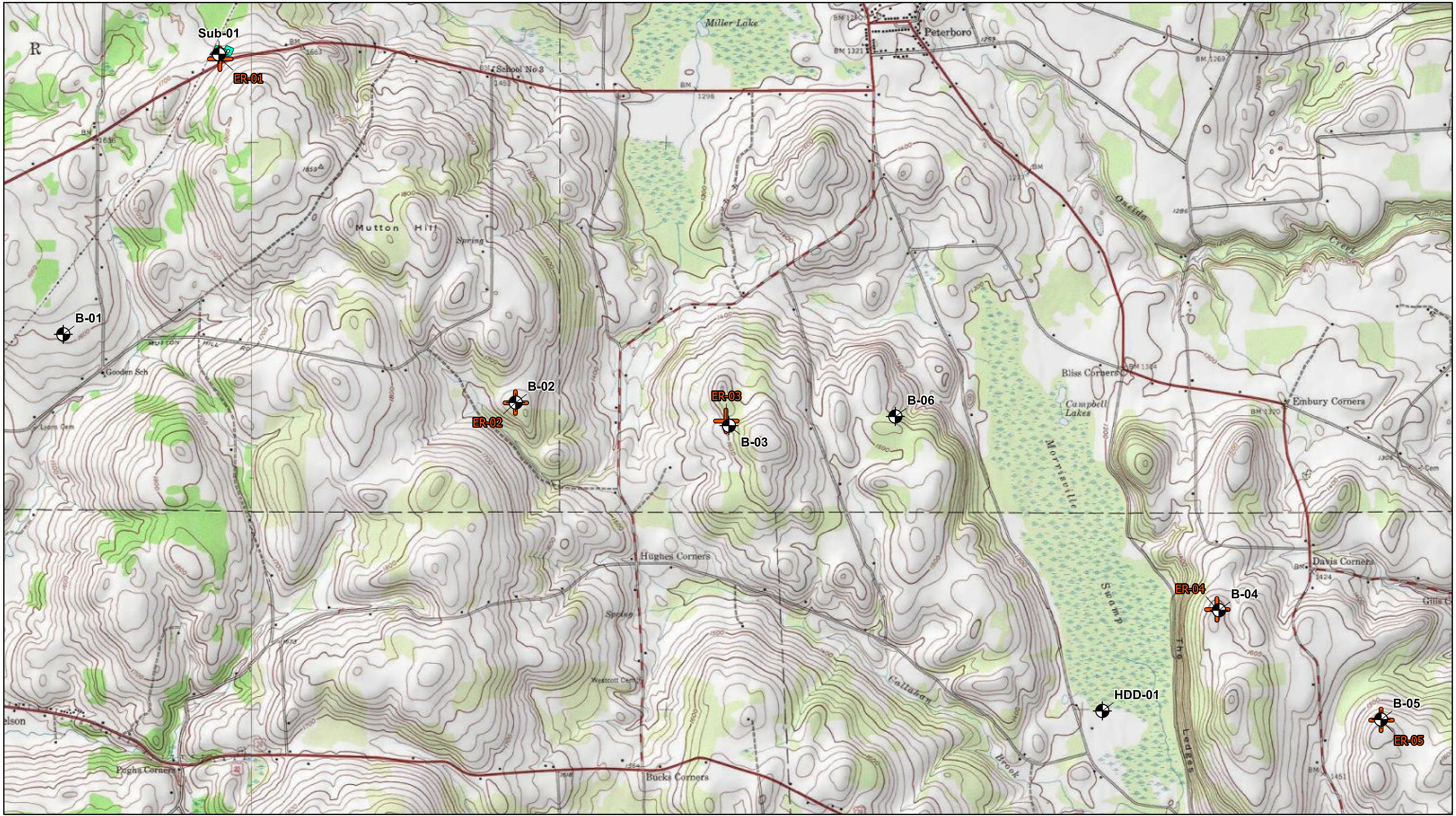
Madison County, NY

## Project Overview Map

EXHIBIT 1

October 2, 2023

Map Document: N:\0042618.01_GIS_ArcPro\R0042618_01_080_Hoffman_Geotech_Collector\R0042618_01_080_Hoffman_Geotech_Collector.aprx 2023-10-02 9:11 PM CHeins



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

## Legend

- ● Boring Location
- ✚ Electrical Resistivity Test Location
- ▭ Substation

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N

Feet
0 1,500

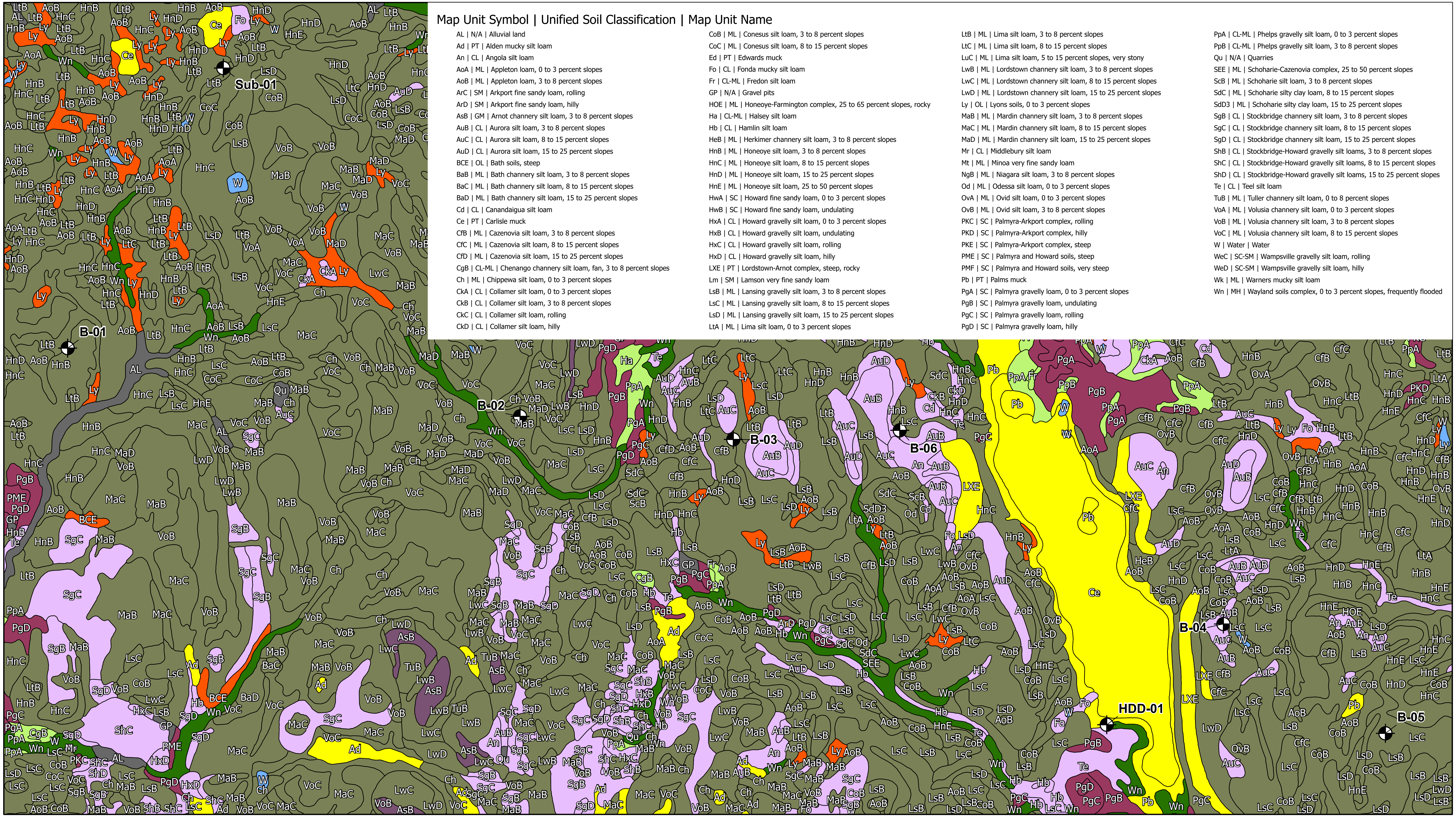
# Hoffman Wind

Madison County, NY

USGS Topography Map
EXHIBIT 2

October 2, 2023

Map Document: N:\0042618.01_GIS_ArcPro\R0042618_01_080_Hoffman_Geotech_Collector\R0042618_01_080_Hoffman_Geotech_Collector.aprx 2023-10-02 9:11 PM CHeins



| Map Unit Symbol | Unified Soil Classification | Map Unit Name |
|---|---|---|
| AL | N/A | Alluvial land |
| Ad | PT | Alden mucky silt loam |
| An | CL | Angola silt loam |
| AoA | ML | Appleton loam, 0 to 3 percent slopes |
| AoB | ML | Appleton loam, 3 to 8 percent slopes |
| ArC | SM | Arkport fine sandy loam, rolling |
| ArD | SM | Arkport fine sandy loam, hilly |
| AsB | GM | Arnot channery silt loam, 3 to 8 percent slopes |
| AuB | CL | Aurora silt loam, 3 to 8 percent slopes |
| AuC | CL | Aurora silt loam, 8 to 15 percent slopes |
| AuD | CL | Aurora silt loam, 15 to 25 percent slopes |
| BCE | OL | Bath soils, steep |
| BaB | ML | Bath channery silt loam, 3 to 8 percent slopes |
| BaC | ML | Bath channery silt loam, 8 to 15 percent slopes |
| BaD | ML | Bath channery silt loam, 15 to 25 percent slopes |
| Cd | CL | Canandaigua silt loam |
| Ce | PT | Carlisle muck |
| CfB | ML | Cazenovia silt loam, 3 to 8 percent slopes |
| CfC | ML | Cazenovia silt loam, 8 to 15 percent slopes |
| CfD | ML | Cazenovia silt loam, 15 to 25 percent slopes |
| CgB | CL-ML | Chenango channery silt loam, fan, 3 to 8 percent slopes |
| Ch | ML | Chippewa silt loam, 0 to 3 percent slopes |
| CkA | CL | Collamer silt loam, 0 to 3 percent slopes |
| CkB | CL | Collamer silt loam, 3 to 8 percent slopes |
| CkC | CL | Collamer silt loam, rolling |
| CkD | CL | Collamer silt loam, hilly |
| CoB | ML | Conesus silt loam, 3 to 8 percent slopes |
| CoC | ML | Conesus silt loam, 8 to 15 percent slopes |
| Ed | PT | Edwards muck |
| Fo | CL | Fonda mucky silt loam |
| Fr | CL-ML | Fredon silt loam |
| GP | N/A | Gravel pits |
| HOE | ML | Honeoye-Farmington complex, 25 to 65 percent slopes, rocky |
| Ha | CL-ML | Halsey silt loam |
| Hb | CL | Hamlin silt loam |
| HeB | ML | Herkimer channery silt loam, 3 to 8 percent slopes |
| HnB | ML | Honeoye silt loam, 3 to 8 percent slopes |
| HnC | ML | Honeoye silt loam, 8 to 15 percent slopes |
| HnD | ML | Honeoye silt loam, 15 to 25 percent slopes |
| HnE | ML | Honeoye silt loam, 25 to 50 percent slopes |
| HwA | SC | Howard fine sandy loam, 0 to 3 percent slopes |
| HwB | SC | Howard fine sandy loam, undulating |
| HxA | CL | Howard gravelly silt loam, 0 to 3 percent slopes |
| HxB | CL | Howard gravelly silt loam, undulating |
| HxC | CL | Howard gravelly silt loam, rolling |
| HxD | CL | Howard gravelly silt loam, hilly |
| LXE | PT | Lordstown-Arnot complex, steep, rocky |
| Lm | SM | Lamson very fine sandy loam |
| LsB | ML | Lansing gravelly silt loam, 3 to 8 percent slopes |
| LsC | ML | Lansing gravelly silt loam, 8 to 15 percent slopes |
| LsD | ML | Lansing gravelly silt loam, 15 to 25 percent slopes |
| LtA | ML | Lima silt loam, 0 to 3 percent slopes |
| LtB | ML | Lima silt loam, 3 to 8 percent slopes |
| LtC | ML | Lima silt loam, 8 to 15 percent slopes |
| LuC | ML | Lima silt loam, 5 to 15 percent slopes, very stony |
| LwB | ML | Lordstown channery silt loam, 3 to 8 percent slopes |
| LwC | ML | Lordstown channery silt loam, 8 to 15 percent slopes |
| LwD | ML | Lordstown channery silt loam, 15 to 25 percent slopes |
| Ly | OL | Lyons soils, 0 to 3 percent slopes |
| MaB | ML | Mardin channery silt loam, 3 to 8 percent slopes |
| MaC | ML | Mardin channery silt loam, 8 to 15 percent slopes |
| MaD | ML | Mardin channery silt loam, 15 to 25 percent slopes |
| Mr | CL | Middlebury silt loam |
| Mt | ML | Minoa very fine sandy loam |
| NgB | ML | Niagara silt loam, 3 to 8 percent slopes |
| Od | ML | Odessa silt loam, 0 to 3 percent slopes |
| OvA | ML | Ovid silt loam, 0 to 3 percent slopes |
| OvB | ML | Ovid silt loam, 3 to 8 percent slopes |
| PKC | SC | Palmyra-Arkport complex, rolling |
| PKD | SC | Palmyra-Arkport complex, hilly |
| PKE | SC | Palmyra-Arkport complex, steep |
| PME | SC | Palmyra and Howard soils, steep |
| PMF | SC | Palmyra and Howard soils, very steep |
| Pb | PT | Palms muck |
| PgA | SC | Palmyra gravelly loam, 0 to 3 percent slopes |
| PgB | SC | Palmyra gravelly loam, undulating |
| PgC | SC | Palmyra gravelly loam, rolling |
| PgD | SC | Palmyra gravelly loam, hilly |
| PpA | CL-ML | Phelps gravelly silt loam, 0 to 3 percent slopes |
| PpB | CL-ML | Phelps gravelly silt loam, 3 to 8 percent slopes |
| Qu | N/A | Quarries |
| SEE | ML | Schoharie-Cazenovia complex, 25 to 50 percent slopes |
| ScB | ML | Schoharie silt loam, 3 to 8 percent slopes |
| SdC | ML | Schoharie silty clay loam, 8 to 15 percent slopes |
| SdD3 | ML | Schoharie silty clay loam, 15 to 25 percent slopes |
| SgB | CL | Stockbridge channery silt loam, 3 to 8 percent slopes |
| SgC | CL | Stockbridge channery silt loam, 8 to 15 percent slopes |
| SgD | CL | Stockbridge channery silt loam, 15 to 25 percent slopes |
| ShB | CL | Stockbridge-Howard gravelly silt loams, 3 to 8 percent slopes |
| ShC | CL | Stockbridge-Howard gravelly silt loams, 8 to 15 percent slopes |
| ShD | CL | Stockbridge-Howard gravelly silt loams, 15 to 25 percent slopes |
| Te | CL | Teel silt loam |
| TuB | ML | Tuller channery silt loam, 0 to 8 percent slopes |
| VoA | ML | Volusia channery silt loam, 0 to 3 percent slopes |
| VoB | ML | Volusia channery silt loam, 3 to 8 percent slopes |
| VoC | ML | Volusia channery silt loam, 8 to 15 percent slopes |
| W | Water | Water |
| WeC | SC-SM | Wampsville gravelly silt loam, rolling |
| WeD | SC-SM | Wampsville gravelly silt loam, hilly |
| Wk | ML | Warners mucky silt loam |
| Wn | MH | Wayland soils complex, 0 to 3 percent slopes, frequently flooded |

Data Source(s): Westwood (2023); Census Bureau (2019); U.S. Department of Agriculture, Natural Resources Conservation Service (2021). USGS Web Soil Survey data (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx)

## Legend

⌖ Boring Location

### Unified Soil Classification

- CL
- CL-ML
- GM
- MH
- ML
- OL
- PT
- SC
- SC-SM
- SM
- Not Available
- Water

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# Hoffman Wind

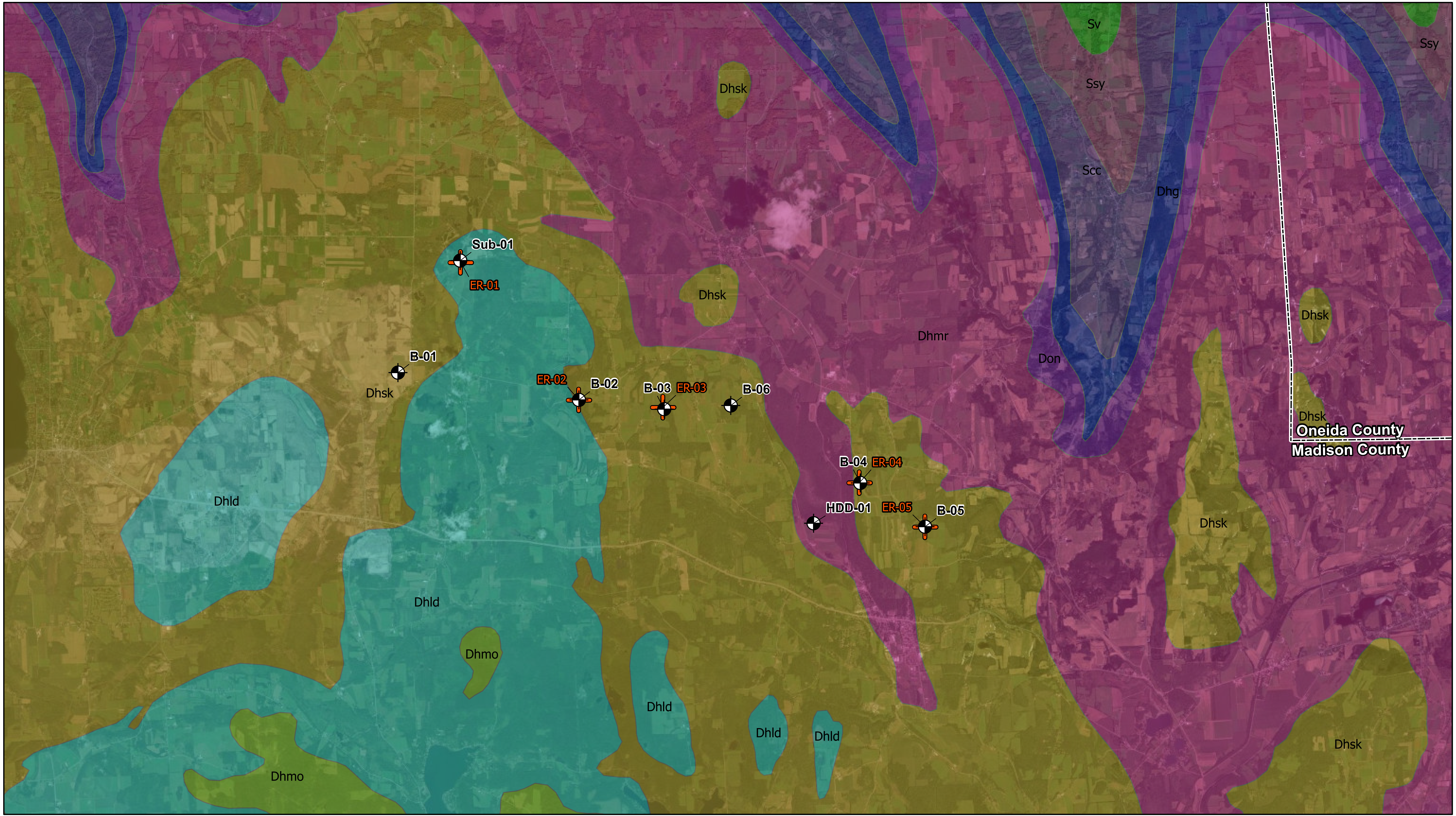
Madison County, NY

## Surficial Soils Map

EXHIBIT 3

October 2, 2023

Map Document: N:\0042618.01_GIS_ArcPro\R0042618_01_080_Hoffman_Geotech_Collector\R0042618_01_080_Hoffman_Geotech_Collector.aprx 2023-10-02 9:11 PM CHeins



Data Source(s): Westwood (2023); Iowa NAIP Imagery (2019); Census Bureau (2020); USGS (2018).

## Legend

⊕ Boring Location

✚ Electrical Resistivity Test Location

⬚ County Boundary

## Geologic Unit Symbol | Geologic Unit Name | Geologic Unit Age

- ■ Dhg | Helderberg Group | Phanerozoic - Paleozoic - Devonian - Early-Devonian
- ■ Dhld | Ludlowville Formation | Phanerozoic - Paleozoic - Devonian - Middle-Devonian - Givetian
- ■ Dhmo | Moscow Formation | Phanerozoic - Paleozoic - Devonian - Middle-Devonian - Givetian
- ■ Dhmr | Marcellus Formation | Phanerozoic - Paleozoic - Devonian - Middle-Devonian - Eifelian
- ■ Dhsk | Skaneateles Formation | Phanerozoic - Paleozoic - Devonian - Middle-Devonian
- ■ Don | Onondaga Limestone | Phanerozoic - Paleozoic - Devonian - Middle-Devonian - Eifelian
- ■ Scc | Cobleskill Limestone | Phanerozoic - Paleozoic - Silurian - Pridoli
- ■ Ssy | Syracuse Formation | Phanerozoic - Paleozoic - Silurian - Pridoli
- ■ Sv | Vernon Formation | Phanerozoic - Paleozoic - Silurian - Pridoli

N

Feet
0 5,000

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# Hoffman Wind

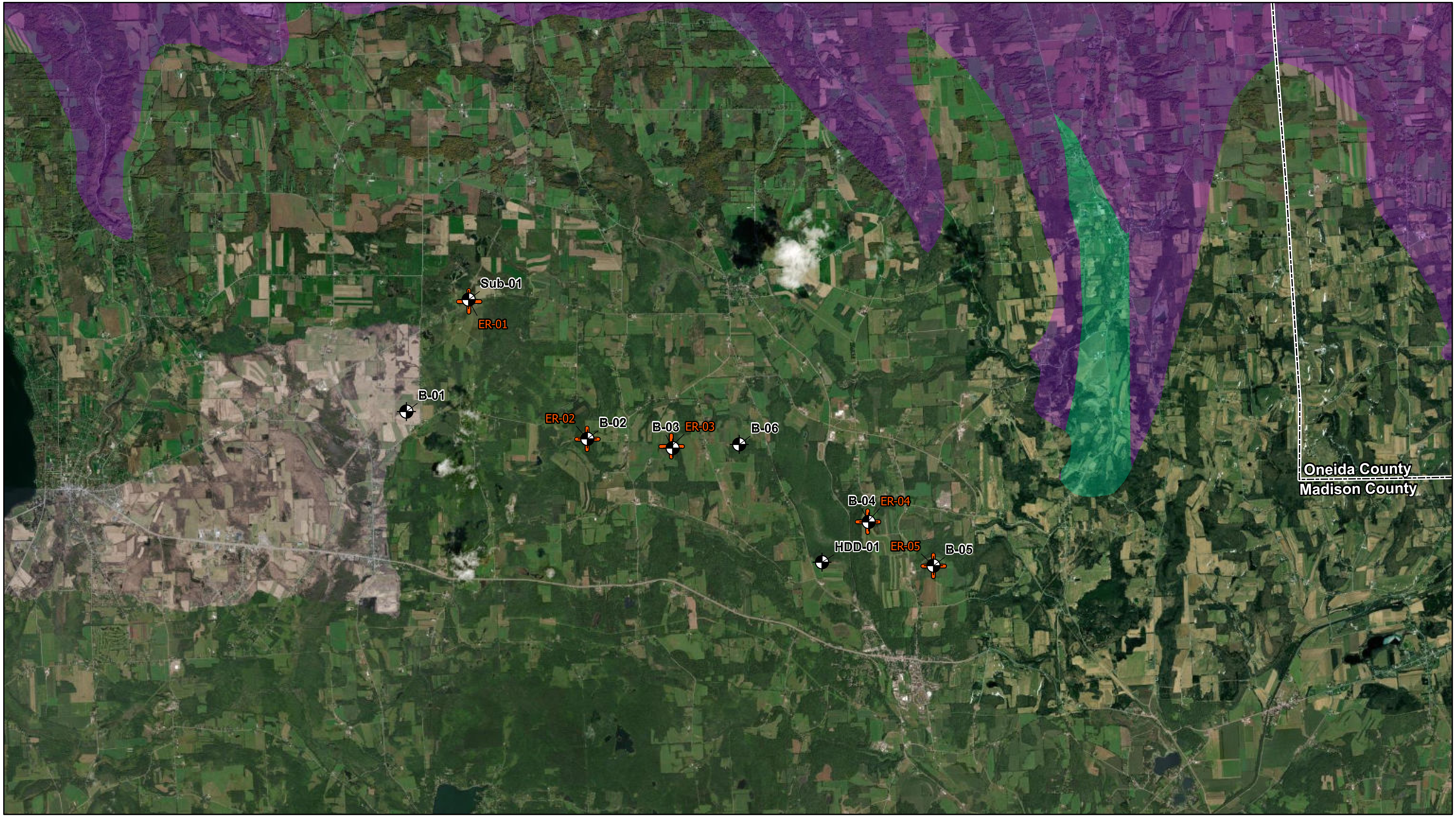
Madison County, NY

## Local Geology Map

EXHIBIT 4

October 2, 2023

Map Document: N:\0042618.01_GIS_ArcPro\R0042618_01_080_Hoffman_Geotech_Collector\R0042618_01_080_Hoffman_Geotech_Collector.aprx 2023-10-02 9:11 PM CHeins



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

## Legend

- ⊕ Boring Location
- ✚ Electrical Resistivity Test Location
- ⬚ County Boundary

## Carbonate Karst

- 🟩 Carbonate rocks buried under >50 ft of glacially derived insoluble sediments in a humid climate
- 🟪 Carbonate rocks buried under ≤50 ft of glacially derived insoluble sediments in a humid climate

N

Feet
0 5,000

# Hoffman Wind

Madison County, NY

Karst Map
EXHIBIT 5

October 2, 2023

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# Appendix A

Soil Boring Logs

**Westwood**

# SOIL BORING LOG

## BORING NO. B-01

Page 1 of 1

Facility/Project Name: Hoffman Wind Project, Madison County, New York

Boring Location: Lat: 42.944222 Long: -75.76848

Surface Elev. (ft): ---

Total Depth (ft bgs): 35.8

Borehole Dia. (in):

Drilling Firm: Earth Dimensions

Drilling Method: Autohammer CME 55

Personnel: Logger - T. Lopez, Driller - A. Kempisty

Date Started: 7/14/23

Date Completed: 7/14/23

Water Depth (ft bgs): 5.2

| SAMPLE NUMBER AND TYPE | SAMPLE RECOVERY (%) | BLOW COUNTS | DEPTH IN FEET | POCKET PEN (tsf) ( * = brittle failure) | COMPRESSIVE STRENGTH (TSF) | MOISTURE CONTENT (%) | LIQUID LIMIT | PLASTICITY INDEX | P 200 (%) |
|---|---|---|---|---|---|---|---|---|---|
| 01 SS | 4 | 2<br>2<br>3 | | * | | | | | |
| 02 SS | 42 | 4<br>3<br>4 | | 2.5<br>4.5 | | 20.2 | 36 | 15 | |
| 03 SS | 17 | 9<br>8<br>12 | | 1.5 | | | | | |
| 04 SS | 100 | 9<br>11<br>12 | | 3.0<br>1.5 | | | | | |
| 05 SS | 100 | 9<br>10<br>12 | | 3.5 | | 8.3 | 23 | 8 | 22 |
| 06 SS | 100 | 9<br>11<br>12 | 10 | 4.0 | | | | | |
| 07 SS | 100 | 10<br>12<br>15 | | 2.5 | | | | | |
| 08 SS | 100 | 17<br>12<br>20 | | | | | | | |
| | | | | | | | | | |
| 09 SS | 100 | 17<br>21<br>22 | | | | | | | |
| | | | 20 | | | | | | |
| 10 SS | 100 | 21<br>25<br>29 | | 3.5 | | | | | |
| | | | | | | | | | |
| 11 SS | 100 | 20<br>25<br>23 | | | | | | | |
| | | | 30 | | | | | | |
| 12 SS | 67 | 50/6 | | 4.5+ | | | | | |
| | | | 40 | | | | | | |
| | | | 50 | | | | | | |

LITHOLOGIC DESCRIPTION

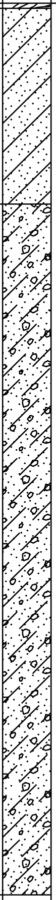
**Topsoil** - 1", roots

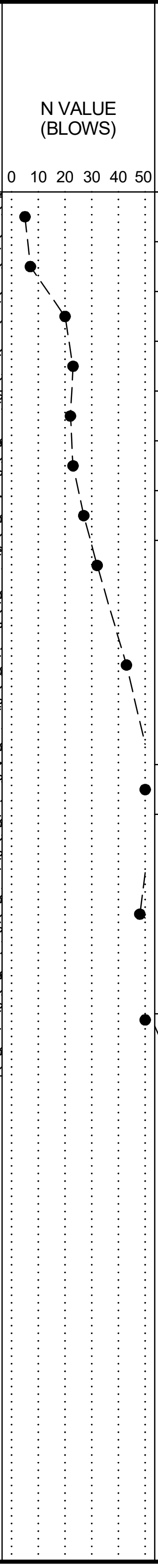
**Lean Clay with Sand (CL)** - moist, medium stiff to very stiff — USCS: CL

**Clayey Sand with Gravel (SC)** - gray, moist, medium dense to very dense - wet — USCS: SC

**BORING TERMINATED. TARGET DEPTH REACHED.**

GRAPHIC LOG





COMMENTS

Coordinates are NAD83 Datum. Bulk sample collected from auger cuttings between 1 ft and 5 ft bgs.

Groundwater encountered at 10 ft bgs during drilling. Rose to 5 ft bgs.

Piezometer installed to a depth of 20 ft bgs with 5 ft of screen

Groundwater measured at 10.2 ft bgs after drilling.

Checked By: C. Enos | Date: 9/8/23 | Approved By: S. Jorgensen | Date: 9/13/23

Firm: Westwood Professional Services (952) 937-5150
12701 Whitewater Drive, Suite 300 Minnetonka, MN 55343

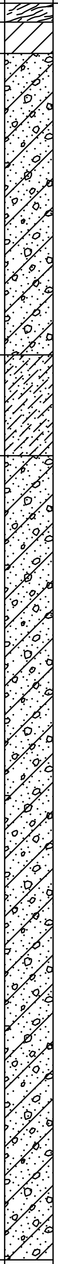
**Westwood**

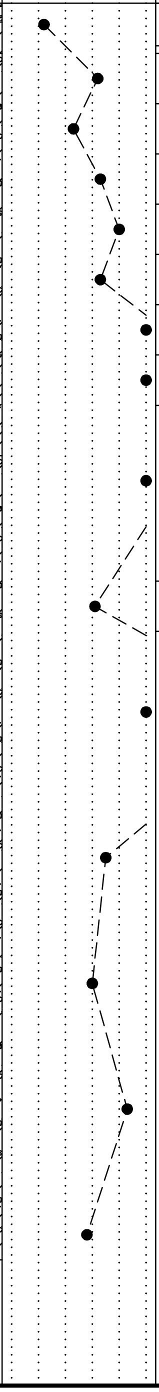
# SOIL BORING LOG

## BORING NO. B-02

Page 1 of 1

| | | | | | | |
|---|---|---|---|---|---|---|
| Facility/Project Name: Hoffman Wind Project<br>Madison County, New York | | Boring Location: Lat: 42.939202<br>Long: -75.723022 | Surface Elev. (ft): --- | Total Depth (ft bgs): 50.0 | Borehole Dia. (in): | |
| Drilling Firm: Earth Dimensions | Drilling Method: Autohammer<br>CME 55 | Personnel: Logger - T. Lopez<br>Driller - A. Kempisty | Date Started: 7/13/23 | Date Completed: 7/13/23 | Water Depth (ft bgs): DNE | |





| SAMPLE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER AND TYPE | RECOVERY (%) | BLOW COUNTS | DEPTH IN FEET | LITHOLOGIC DESCRIPTION | USCS | POCKET PEN (tsf) ( * = brittle failure) | COMPRESSIVE STRENGTH (TSF) | MOISTURE CONTENT (%) | LIQUID LIMIT | PLASTICITY INDEX | P 200 (%) | COMMENTS |
| 01 SS | 98 | 3<br>5<br>7 | | **Topsoil** - 10", brown<br>**Lean Clay (CL)** - light brown, gray, moist, stiff | CL | 2.5<br>3.5 | | | | | | Coordinates are NAD83 Datum. |
| 02 SS | 100 | 11<br>16<br>16 | | **Gravelly Lean Clay w/ Sand (CL)** - gray, dry, hard | | 4.5 | | | | | | |
| 03 SS | 92 | 11<br>11<br>12 | | - moist, very stiff to hard | | 3.0<br>4.5 | | | | | | |
| 04 SS | 92 | 12<br>15<br>18 | | | | 4.5 | | | | | | |
| 05 SS | 100 | 19<br>22<br>18 | | | CL | 4.5 | | | | | | |
| 06 SS | 100 | 10<br>15<br>18 | 10 | | | 4.5 | | | | | | |
| 07 SS | 100 | 17<br>24<br>33 | | | | 4.5 | | | | | | |
| 08 SS | 100 | 17<br>31<br>24 | | **Clayey Sand (SC)** - gray, moist, hard | SC | 4.5 | | 8 | 24 | 9 | 21 | |
| 09 SS | 100 | 10<br>35<br>26 | 20 | **Sandy Lean Clay w/ Gravel (CL)** - gray, moist, hard to very stiff | | | | | | | | Piezometer installed to a depth of 20 ft bgs with 5 ft of screen |
| 10 SS | 100 | 9<br>12<br>19 | | | | 4.5 | | | | | | |
| 11 SS | 63 | 50/5 | 30 | | | | | | | | | |
| 12 SS | 100 | 15<br>16<br>19 | | | CL | | | | | | | |
| 13 SS | 100 | 6<br>12<br>18 | 40 | | | | | | | | | |
| 14 SS | 100 | 12<br>15<br>28 | | | | | | | | | | |
| 15 SS | 100 | 10<br>13<br>15 | 50 | | | | | | | | | |
| | | | | **BORING TERMINATED. AUGER REFUSAL AT 50 FT.** | | | | | | | | |

| | | | | |
|---|---|---|---|---|
| Checked By: C. Enos | Date: 9/8/23 | Approved By: S. Jorgensen | Date: 9/13/23 | Firm: Westwood Professional Services (952) 937-5150<br>12701 Whitewater Drive, Suite 300 Minnetonka, MN 55343 |

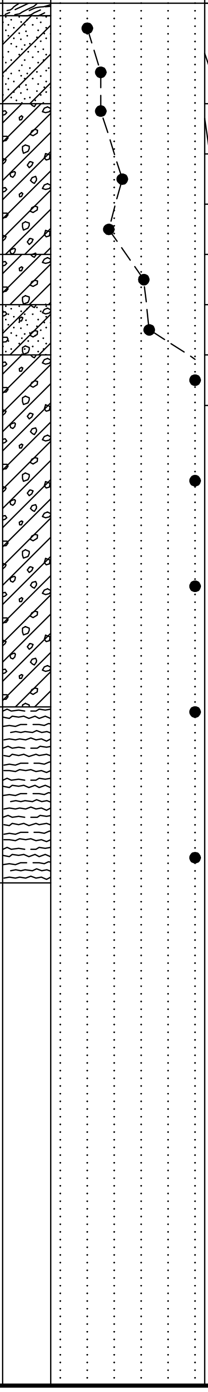
**Westwood**

# SOIL BORING LOG

## BORING NO. B-03

Page 1 of 1

| | | | | | |
|---|---|---|---|---|---|
| Facility/Project Name: Hoffman Wind Project<br>Madison County, New York | Boring Location: Lat: 42.937502<br>Long: -75.701599 | Surface Elev. (ft): --- | Total Depth (ft bgs): 36.0 | Borehole Dia. (in): | |
| Drilling Firm: Earth Dimensions | Drilling Method: Autohammer<br>CME 55 | Personnel: Logger - T. Lopez<br>Driller - A. Kempisty | Date Started: 7/12/23 | Date Completed: 7/12/23 | Water Depth (ft bgs): 28.0 |



| SAMPLE NUMBER AND TYPE | RECOVERY (%) | BLOW COUNTS | DEPTH IN FEET | LITHOLOGIC DESCRIPTION | USCS | POCKET PEN (tsf) ( * = brittle failure) | COMPRESSIVE STRENGTH (TSF) | MOISTURE CONTENT (%) | LIQUID LIMIT | PLASTICITY INDEX | P 200 (%) | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 SS | 75 | 3<br>4<br>6 | | **Topsoil** - 5"<br>**Lean Clay w/ Sand (CL)** - brown, moist, stiff | CL | 2.5<br>2.0 | | | | | | Coordinates are NAD83 Datum. Bulk sample collected from auger cutitngs between 1-5 ft bgs. |
| 02 SS | 0 | 8<br>7<br>8 | | | | 4.0 | | 17.6 | 35 | 16 | | |
| 03 SS | 99 | 13<br>8<br>7 | | **Lean Clay w/ Gravel (CL)** - brown, moist, stiff to very stiff | CL | 2.5<br>2.0 | | | | | | |
| 04 SS | 100 | 11<br>11<br>12 | | | | 2.0 | | | | | | |
| 05 SS | 75 | 19<br>10<br>8 | | | | 3.0<br>2.0 | | | | | | Auger Grinding, rig shaking |
| 06 SS | 75 | 38<br>16<br>15 | 10 | **Gravelly Lean Clay (CL)** - hard | CL | | | | | | | |
| 07 SS | 100 | 15<br>14<br>19 | | **Sandy Lean Clay (CL)** - light gray, moist, hard | CL | 2.0 | | | | | | |
| 08 SS | 100 | 16<br>34<br>28 | | **Gravelly Lean Clay (CL)** - light gray, moist, possible residual rock or saprolite | CL | 2.5 | | | | | | |
| | | | | | | | | | | | | |
| 09 SS | 100 | 17<br>21<br>35 | | | | | | | | | | |
| | | | 20 | | | | | | | | | Piezometer installed to a depth of 20 ft bgs with 5 ft of screen |
| 10 SS | 63 | 50/3 | | | | | | | | | | |
| 11 SS | 63 | 50/2 | 30 | **Highly Weathered Rock (Shale)** - highly weathered rock, light gray, wet, lots of fractures along bed planes, medium hardness | | | | | | | | |
| 12 SS | 100 | 50<br>33<br>23 | | | | | | | | | | |
| | | | | **BORING TERMINATED. AUGER REFUSAL AT 36 FT.** | | | | | | | | |
| | | | 40 | | | | | | | | | |
| | | | 50 | | | | | | | | | |

WW_BORING LOG_PP_HOFFMAN WIND FARM PROJECT_SOIL BORING LOGS.GPJ RMT_CORP.GDT 0042618.01 10/3/23

| Checked By: | Date: | Approved By: | Date: | Firm: |
|---|---|---|---|---|
| C. Enos | 9/8/23 | S. Jorgensen | 9/13/23 | Westwood Professional Services (952) 937-5150<br>12701 Whitewater Drive, Suite 300 Minnetonka, MN 55343 |

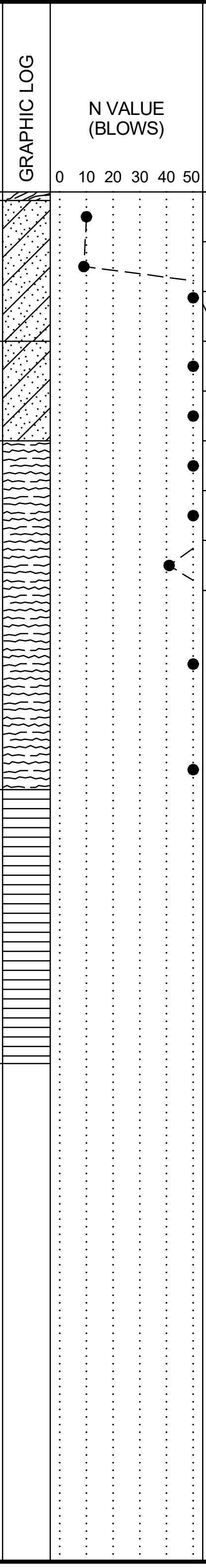
Westwood

# SOIL BORING LOG

## BORING NO. B-04

Page 1 of 1

| | | | | | |
|---|---|---|---|---|---|
| Facility/Project Name:<br>Hoffman Wind Project<br>Madison County, New York | Boring Location:<br>Lat: 42.92392<br>Long: -75.652358 | Surface Elev. (ft):<br>--- | Total Depth (ft bgs):<br>35.0 | Borehole Dia. (in): | |
| Drilling Firm:<br>Earth Dimensions | Drilling Method:<br>Autohammer<br>CME 55 | Personnel:<br>Logger - T. Lopez<br>Driller - A. Kempisty | Date Started:<br>7/11/23 | Date Completed:<br>7/11/23 | Water Depth (ft bgs):<br>> 23.7 |



| SAMPLE NUMBER AND TYPE | SAMPLE RECOVERY (%) (RQD) | BLOW COUNTS | DEPTH IN FEET | LITHOLOGIC DESCRIPTION | USCS | POCKET PEN (tsf) ( * = brittle failure) | COMPRESSIVE STRENGTH (TSF) | MOISTURE CONTENT (%) | LIQUID LIMIT | PLASTICITY INDEX | P 200 (%) | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 SS | 75 | 5<br>6<br>4<br>5 | | **Topsoil** - 4", roots<br>**Lean Clay w/ Sand (CL)** - light brown, light gray, stiff to hard | CL | 4.5+ | | | | | | Coordinates are NAD83 Datum. |
| 02 SS | 67 | 4<br>4<br>5<br>8 | | | | 4.0<br>3.0 | | | | | | |
| 03 SS | 67 | 25<br>50/0 | | | | 4.0 | | | | | | |
| 04 SS | 100 | 11<br>15<br>37<br>26 | | **Sandy Lean Clay (CL)** - light brown, moist, hard, rock fragments | CL | 4.0 | | 13.1 | 26 | 10 | 56 | |
| 05 SS | 100 | 15<br>22<br>38<br>38 | | | | | | | | | | |
| 06 SS | 100 | 22<br>29<br>39<br>49 | 10 | **Highly Weathered Rock (Shale)** - gray, lots of fractures along cleavage planes, soft hardness<br>- cobble | | 4.5+ | | | | | | |
| 07 SS | 100 | 26<br>33<br>34<br>51 | | | | 4.5+ | | | | | | |
| 08 SS | 100 | 15<br>21<br>20<br>23 | | | | 4.5+ | | | | | | |
| 09 SS | 100 | 24<br>55<br>50/5 | | | | | | | | | | |
| | | | 20 | | | | | | | | | Piezometer installed to a depth of 20 ft bgs with 5 ft of screen |
| 10 SS | 83 | 50/4 | | - cobble | | | | | | | | |
| 01 RC | 100<br>(0) | | | **Shale** - weathered rock, light gray, laminar bedding with horizontal orientation | | | | | | | | Auger refusal at 23.7 ft bgs. Begin rock core. |
| 02 RC | 100<br>(15) | | | | | | | | | | | |
| 03 RC | 100<br>(63) | | 30 | | | | 548.4 | 0.7 | | | | |
| 04 RC | 83<br>(60) | | | | | | | | | | | |
| | | | | **BORING TERMINATED. TARGET DEPTH REACHED.** | | | | | | | | |
| | | | 40 | | | | | | | | | |
| | | | 50 | | | | | | | | | |

| Checked By: | Date: | Approved By: | Date: | Firm: |
|---|---|---|---|---|
| C. Enos | 9/8/23 | S. Jorgensen | 9/13/23 | Westwood Professional Services (952) 937-5150<br>12701 Whitewater Drive, Suite 300 Minnetonka, MN 55343 |

Westwood

# SOIL BORING LOG

## BORING NO. B-05

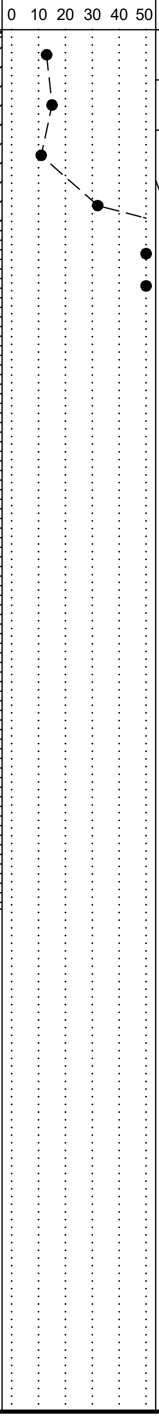
Page 1 of 1

| | | | | | |
|---|---|---|---|---|---|
| Facility/Project Name:<br>Hoffman Wind Project<br>Madison County, New York | | Boring Location:<br>Lat: 42.915871<br>Long: -75.636078 | Surface Elev. (ft):<br>--- | Total Depth (ft bgs):<br>35.0 | Borehole Dia. (in): |
| Drilling Firm:<br>Earth Dimensions | Drilling Method:<br>Autohammer<br>CME 55 | Personnel:<br>Logger - T. Lopez<br>Driller - A. Kempisty | Date Started:<br>7/10/23 | Date Completed:<br>7/10/23 | Water Depth (ft bgs):<br>> 10.3 |

| SAMPLE NUMBER AND TYPE | SAMPLE RECOVERY (%) (RQD) | BLOW COUNTS | DEPTH IN FEET | LITHOLOGIC DESCRIPTION | USCS | POCKET PEN (tsf) ( * = brittle failure) | COMPRESSIVE STRENGTH (TSF) | MOISTURE CONTENT (%) | LIQUID LIMIT | PLASTICITY INDEX | P 200 (%) | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 SS | 100 | 4<br>6<br>7 | | **Topsoil** - 4", roots<br>**Sandy Lean Clay (CL)** - brown, gray staining, moist, stiff | CL | 4.5+ | | | | | | Coordinates are NAD83 Datum. |
| 02 SS | 100 | 8<br>8<br>7 | | | | 2.5<br>3.5 | | | | | | |
| 03 SS | 100 | 6<br>5<br>6 | | | | 2.0<br>3.0<br>1.0 | | 15.7 | 33 | 15 | 59 | |
| 04 SS | 100 | 7<br>10<br>22 | | | | | | | | | | |
| 05 SS | 100 | 9<br>26<br>50/2 | | **Shale** - gray, highly weathered rock, soft to medium field hardness, laminar bedding, moderate rock continuity, smooth discontinuities | | | | | | | | |
| 06 SS | 63 | 50/3 | 10 | | | | | | | | | Auger refusal at 10.3 ft bgs. Begin rock core. |
| 01 RC | 99<br>(0) | | | | | | | | | | | |
| 02 RC | 100<br>(0) | | | | | | | | | | | |
| 03 RC | 100<br>(0) | | 20 | | | | | | | | | Piezometer installed to a depth of 20 ft bgs with 5 ft of screen |
| 04 RC | 100<br>(12) | | | | | | | | | | | |
| 05 RC | 100<br>(60) | | 30 | - increase in rock continuity | | | | | | | | |
| | | | | **BORING TERMINATED. TARGET DEPTH REACHED.** | | | | | | | | |
| | | | 40 | | | | | | | | | |
| | | | 50 | | | | | | | | | |

GRAPHIC LOG

N VALUE (BLOWS)



| | | | | |
|---|---|---|---|---|
| Checked By:<br>C. Enos | Date:<br>9/8/23 | Approved By:<br>S. Jorgensen | Date:<br>9/13/23 | Firm: Westwood Professional Services (952) 937-5150<br>12701 Whitewater Drive, Suite 300 Minnetonka, MN 55343 |

**Westwood**

# SOIL BORING LOG

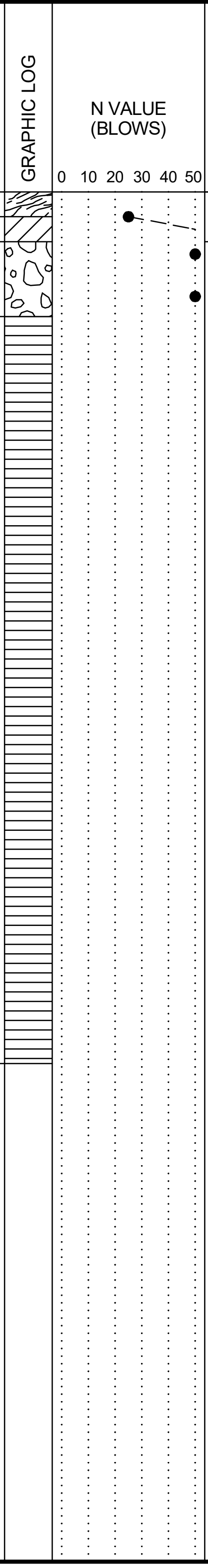
## BORING NO. B-06

Page 1 of 1

| Facility/Project Name: | Boring Location: | Surface Elev. (ft): | Total Depth (ft bgs): | Borehole Dia. (in): |
|---|---|---|---|---|
| Hoffman Wind Project<br>Madison County, New York | Lat: 42.938132<br>Long: -75.684922 | --- | 35.0 | |

| Drilling Firm: | Drilling Method: | Personnel: | Date Started: | Date Completed: | Water Depth (ft bgs): |
|---|---|---|---|---|---|
| Earth Dimensions | Autohammer<br>CME 55 | Logger - T. Lopez<br>Driller - A. Kempisty | 7/12/23 | 7/12/23 | > 5.0 |

| SAMPLE NUMBER AND TYPE | SAMPLE RECOVERY (%) (RQD) | BLOW COUNTS | DEPTH IN FEET | LITHOLOGIC DESCRIPTION | USCS | POCKET PEN (tsf) ( * = brittle failure) | COMPRESSIVE STRENGTH (TSF) | MOISTURE CONTENT (%) | LIQUID LIMIT | PLASTICITY INDEX | P 200 (%) | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 SS | 100 | 2<br>3<br>22 | | **Topsoil** - 12"<br>**Lean Clay (CL)** - brown, moist, very stiff | CL | 3.0<br>3.0 | | | 32 | 13 | | Coordinates are NAD83 Datum. |
| 02 SS | 92 | 16<br>50/5 | | | | | | 2.8 | | | 5 | |
| 03 SS | 83 | 50/4 | | **Poorly-Graded Gravel (GP)** - gray rock fragments | GP | | | | | | | |
| 01 RC | 97<br>(0) | | | **Shale** - highly weathered rock, moderate rock continuity, light gray. laminar bedding, discontinuities have clay. | | | | | | | | Auger refusal at 5 ft bgs. Begin rock core. |
| 02 RC | 100<br>(0) | | 10 | | | | | | | | | |
| 03 RC | 100<br>(0) | | | | | | | | | | | |
| 04 RC | 100<br>(30) | | 20 | - increase in rock continuity | | | | | | | | Piezometer installed to a depth of 20 ft bgs with 5 ft of screen |
| 05 RC | 100<br>(57) | | | | | | 591.6 | 0.9 | | | | |
| 06 RC | 100<br>(0) | | 30 | | | | | | | | | |
| | | | | **BORING TERMINATED. TARGET DEPTH REACHED.** | | | | | | | | |
| | | | 40 | | | | | | | | | |
| | | | 50 | | | | | | | | | |



| Checked By: | Date: | Approved By: | Date: | Firm: |
|---|---|---|---|---|
| C. Enos | 9/8/23 | S. Jorgensen | 9/13/23 | Westwood Professional Services (952) 937-5150<br>12701 Whitewater Drive, Suite 300 Minnetonka, MN 55343 |

Westwood

# SOIL BORING LOG

## BORING NO. HDD-01

Page 1 of 1

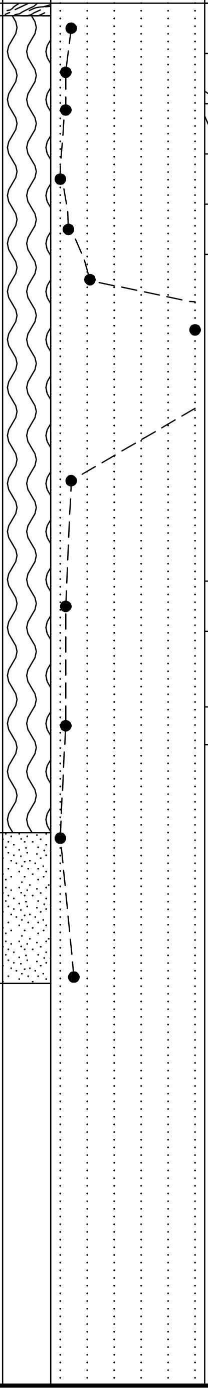
| Facility/Project Name: | Boring Location: | Surface Elev. (ft): | Total Depth (ft bgs): | Borehole Dia. (in): |
|---|---|---|---|---|
| Hoffman Wind Project<br>Madison County, New York | Lat: 42.916577<br>Long: -75.664235 | --- | 40.0 | |

| Drilling Firm: | Drilling Method: | Personnel: | Date Started: | Date Completed: | Water Depth (ft bgs): |
|---|---|---|---|---|---|
| Earth Dimensions | Autohammer<br>CME 55 | Logger - T. Lopez<br>Driller - A. Kempisty | 7/11/23 | 7/11/23 | 8.0 |

| SAMPLE NUMBER AND TYPE | RECOVERY (%) | BLOW COUNTS | POCKET PEN (tsf) ( * = brittle failure) | COMPRESSIVE STRENGTH (TSF) | MOISTURE CONTENT (%) | LIQUID LIMIT | PLASTICITY INDEX | P 200 (%) |
|---|---|---|---|---|---|---|---|---|
| 01 SS | 100 | 2<br>2<br>2 | 2.0<br>2.0 | | | | | |
| 02 SS | 100 | 2<br>1<br>1 | 0.5<br>0.5 | | | | | |
| 03 SS | 83 | 0<br>0<br>2 | 0.5 | | 74.0 | 82 | 46 | 98 |
| 04 SS | 100 | 0<br>0<br>0 | 0.5 | | | | | |
| 05 SS | 100 | 0<br>1<br>2 | 0.5 | | | | | |
| 06 SS | 100 | 2<br>4<br>7 | | | | | | |
| 07 SS | 100 | 5<br>5<br>50/2 | | | | | | |
| 08 RC | 0 | | | | | | | |
| 09 SS | 100 | 4<br>2<br>2 | | | | | | |
| 10 SS | 100 | 2<br>1<br>1 | 0.5 | | | | | |
| 11 SS | 100 | 0<br>0<br>2 | 0.5 | | | | | |
| 12 SS | 93 | 0<br>0<br>0 | | | | | | |
| 13 SS | 0 | 0<br>2<br>3 | | | | | | |

DEPTH IN FEET: 10, 20, 30, 40, 50

| LITHOLOGIC DESCRIPTION | USCS |
|---|---|
| **Topsoil** - 7", roots | |
| **Organic Clay (OH)** - gray , moist, medium stiff<br>- dark brown, soft<br>- light gray, very soft<br>- light brown, soft, wet<br>- stiff<br>- moist, boulder<br>- light gray, wet<br>- boulder<br>- light gray, soft | OH |
| **Poorly Graded Sand (SP)** - loose, black<br>- flowing sands | SP |
| **BORING TERMINATED. TARGET DEPTH REACHED.** | |



COMMENTS

Coordinates are NAD83 Datum.

Auger refusal at 13.5 ft. Rock cored through suspected boulder.

| Checked By: | Date: | Approved By: | Date: | Firm: |
|---|---|---|---|---|
| C. Enos | 9/8/23 | S. Jorgensen | 9/13/23 | Westwood Professional Services (952) 937-5150<br>12701 Whitewater Drive, Suite 300 Minnetonka, MN 55343 |

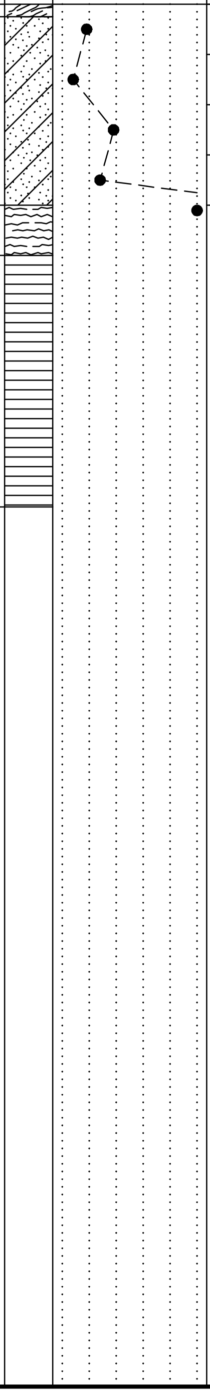
**Westwood**

# SOIL BORING LOG

## BORING NO. SUB-01

Page 1 of 1

| | | | | | |
|---|---|---|---|---|---|
| Facility/Project Name: Hoffman Wind Project<br>Madison County, New York | | Boring Location: Lat: 42.964824<br>Long: -75.752839 | Surface Elev. (ft): --- | Total Depth (ft bgs): 20.0 | Borehole Dia. (in): |
| Drilling Firm: Earth Dimensions | Drilling Method: Autohammer<br>CME 55 | Personnel: Logger - T. Lopez<br>Driller - A. Kempisty | Date Started: 7/17/23 | Date Completed: 7/17/23 | Water Depth (ft bgs): > 10.0 |

| SAMPLE NUMBER AND TYPE | SAMPLE RECOVERY (%) (RQD) | BLOW COUNTS | DEPTH IN FEET | LITHOLOGIC DESCRIPTION | USCS | GRAPHIC LOG | N VALUE (BLOWS) 0 10 20 30 40 50 | POCKET PEN (tsf) ( * = brittle failure) | COMPRESSIVE STRENGTH (TSF) | MOISTURE CONTENT (%) | LIQUID LIMIT | PLASTICITY INDEX | P 200 (%) | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 SS | 63 | 3<br>4<br>5 | | **Topsoil** - 6", roots<br>**Sandy Lean Clay (CL)** - brown, moist, medium stiff<br>- dark brown, soft | CL |  | | 1.25<br>1.75 | | 22.4 | | | 69.2 | Coordinates are NAD83 Datum.<br>Bulk sample collected from auger cuttings between 1 ft and 4 ft. |
| 02 SS | 67 | 3<br>2<br>2 | | | | | | 0.75<br>1.75 | | | | | | |
| 03 SS | 29 | 4<br>9<br>10 | | | | | | 1.5<br>1.5 | | | | | | |
| 04 SS | 75 | 8<br>6<br>8 | | | | | | 4.5 | | | | | | |
| 05 SS | 100 | 50/5 | | **Highly Weathered Rock (Shale)**- highly weathered rock, light gray, dense to very dense | | | | | | | | | | |
| 01 RC | 97<br>(7) | | 10 | **Shale**- weathered rock, dark gray, laminar bedding with horizontal orientation | | | | | | | | | | Auger refusal at 10 ft. Begin rock coring. |
| 02 RC | 100<br>(7) | | | | | | | | | | | | | |
| | | | 20 | **BORING TERMINATED. TARGET DEPTH REACHED.** | | | | | | | | | | |
| | | | 30 | | | | | | | | | | | |
| | | | 40 | | | | | | | | | | | |
| | | | 50 | | | | | | | | | | | |

| | | | | |
|---|---|---|---|---|
| Checked By: C. Enos | Date: 9/8/23 | Approved By: S. Jorgensen | Date: 9/13/23 | Firm: Westwood Professional Services (952) 937-5150<br>12701 Whitewater Drive, Suite 300 Minnetonka, MN 55343 |

**Westwood**

# ROCK CORE PHOTO

## BORING NO. B-04

| | | | | | |
|---|---|---|---|---|---|
| **Project Name:**<br>Hoffman Wind Project<br>Madison County, New York | | **Boring Location:**<br>Lat: 42.923943°<br>Long: -75.652366° | **Surface Elev. (ft):**<br>- | **Total Depth (ft bgs):**<br>35.0 | **Borehole Dia. (in):**<br>8.0 |
| **Drilling Firm:**<br>Earth Dimensions, Inc. | **Drilling Method:**<br>RC - Rock Core | **Personnel:**<br>Logger: T. Lopez<br>Driller: A. Kempisty | **Date Started:**<br>7/11/2023 | **Date Completed:**<br>7/11/2023 | **Water Depth (ft bgs):**<br>DNE |

Westwood

# ROCK CORE PHOTO

## BORING NO. B-05

| | | | | | |
|---|---|---|---|---|---|
| **Project Name:**<br>Hoffman Wind Project<br>Madison County, New York | | **Boring Location:**<br>Lat: 42.915871°<br>Long: -75.636078° | **Surface Elev. (ft):**<br>- | **Total Depth (ft bgs):**<br>35.0 | **Borehole Dia. (in):**<br>8.0 |
| **Drilling Firm:**<br>Earth Dimensions, Inc. | **Drilling Method:**<br>RC - Rock Core | **Personnel:**<br>Logger: T. Lopez<br>Driller: A. Kempisty | **Date Started:**<br>7/10/2023 | **Date Completed:**<br>7/10/2023 | **Water Depth (ft bgs):**<br>DNE |

**Westwood**

# ROCK CORE PHOTO

## BORING NO. B-06

**Project Name:**
Hoffman Wind Project
Madison County, New York

**Boring Location:**
Lat: 42.938175°
Long: -75.684876 °

**Surface Elev. (ft):**
-

**Total Depth (ft bgs):**
35.0

**Borehole Dia. (in):**
8.0

**Drilling Firm:**
Earth Dimensions, Inc.

**Drilling Method:**
RC - Rock Core

**Personnel:**
Logger: T. Lopez
Driller: A. Kempisty

**Date Started:**
7/12/2023

**Date Completed:**
7/12/2023

**Water Depth (ft bgs):**
N/A

**Westwood**

# ROCK CORE PHOTO

## BORING NO. SUB-01

**Project Name:**
Hoffman Wind Project
Madison County, New York

**Boring Location:**
Lat: 42.964824°
Long: -75.752839°

**Surface Elev. (ft):**
-

**Total Depth (ft bgs):**
20.0

**Borehole Dia. (in):**
8.0

**Drilling Firm:**
Earth Dimensions, Inc.

**Drilling Method:**
RC - Rock Core

**Personnel:**
Logger: T. Lopez
Driller: A. Kempisty

**Date Started:**
7/17/2023

**Date Completed:**
7/17/2023

**Water Depth (ft bgs):**
N/A

# Appendix B

Electrical Resistivity Test Reports

## Electrical Resistivity Test Results
## Wenner 4-Electrode Method
## Hoffman Wind - Madison County, New York

**ER-SUB-01**

**Location:** 42.964499, -75.752718

**Site Description:** 83°, sunny, brush, moist clay

**Date:** 7/14/2023

North-South Transect

| ELECTRODE SPACING | | Measured Resistance (Ω) | APPARENT RESISTIVITY | |
|---|---|---|---|---|
| (feet) | (meters) | | ohm-feet | ohm-meters |
| 2 | 0.6 | 61.4 | 771 | 235 |
| 4 | 1.2 | 21.7 | 545 | 166 |
| 6 | 1.8 | 12.2 | 460 | 140 |
| 8 | 2.4 | 9.72 | 488 | 149 |
| 10 | 3.0 | 8.14 | 511 | 156 |
| 20 | 6.1 | 4.75 | 597 | 182 |
| 30 | 9.1 | 3.42 | 644 | 196 |
| 50 | 15 | 2.29 | 719 | 219 |
| 60 | 18 | 1.64 | 618 | 188 |
| 200 | 61 | * | - | - |

East-West Transect

| ELECTRODE SPACING | | Measured Resistance (Ω) | APPARENT RESISTIVITY | |
|---|---|---|---|---|
| (feet) | (meters) | | ohm-feet | ohm-meters |
| 2 | 0.6 | 15.1 | 190 | 57.8 |
| 4 | 1.2 | 6.77 | 170 | 51.9 |
| 6 | 1.8 | 4.12 | 155 | 47.3 |
| 8 | 2.4 | 2.95 | 148 | 45.2 |
| 10 | 3.0 | 2.30 | 144 | 44.0 |
| 20 | 6.1 | 1.49 | 187 | 57.1 |
| 30 | 9.1 | 1.40 | 264 | 80.4 |
| 50 | 15 | 1.34 | 421 | 128 |
| 100 | 30 | 1.11 | 697 | 213 |
| 200 | 61 | 0.71 | 892 | 272 |

*Erroneous instrument reading. Data not reported

**ER-B-02**

**Location:** 42.939208, -75.723011

**Site Description:** 70°, recently clear, rolling hills, glacial till & clay

**Date:** 7/13/2023

North-South Transect

| ELECTRODE SPACING | | Measured Resistance (Ω) | APPARENT RESISTIVITY | |
|---|---|---|---|---|
| (feet) | (meters) | | ohm-feet | ohm-meters |
| 2 | 0.6 | 277 | 3480 | 1061 |
| 4 | 1.2 | 98.8 | 2482 | 757 |
| 6 | 1.8 | 46.1 | 1737 | 530 |
| 8 | 2.4 | 22.9 | 1151 | 351 |
| 10 | 3.0 | 12.6 | 791 | 241 |
| 20 | 6.1 | 4.07 | 511 | 156 |
| 30 | 9.1 | 2.67 | 503 | 153 |
| 50 | 15 | 1.43 | 449 | 137 |
| 100 | 30 | 0.96 | 603 | 184 |

East-West Transect

| ELECTRODE SPACING | | Measured Resistance (Ω) | APPARENT RESISTIVITY | |
|---|---|---|---|---|
| (feet) | (meters) | | ohm-feet | ohm-meters |
| 2 | 0.6 | 303 | 3807 | 1161 |
| 4 | 1.2 | 163 | 4096 | 1249 |
| 6 | 1.8 | 50.9 | 1918 | 585 |
| 8 | 2.4 | 20.0 | 1005 | 306 |
| 10 | 3.0 | 14.1 | 886 | 270 |
| 20 | 6.1 | 3.92 | 492 | 150 |
| 30 | 9.1 | 2.38 | 449 | 137 |
| 50 | 15 | 1.68 | 528 | 161 |
| 100 | 30 | 0.73 | 459 | 140 |

**ER-B-03**

**Location:** 42.9378883, -75.7018956

**Site Description:** 83°, sunny, hilly, moist clay

**Date:** 7/14/2023

North-South Transect

| ELECTRODE SPACING | | Measured Resistance (Ω) | APPARENT RESISTIVITY | |
|---|---|---|---|---|
| (feet) | (meters) | | ohm-feet | ohm-meters |
| 2 | 0.6 | 21.0 | 264 | 80.4 |
| 4 | 1.2 | 8.35 | 210 | 64.0 |
| 6 | 1.8 | 4.54 | 171 | 52.2 |
| 8 | 2.4 | 3.12 | 157 | 47.8 |
| 10 | 3.0 | 2.14 | 134 | 41.0 |
| 20 | 6.1 | 0.97 | 122 | 37.2 |
| 30 | 9.1 | 0.76 | 143 | 43.7 |
| 50 | 15 | 0.48 | 151 | 46.0 |
| 100 | 30 | 0.30 | 187 | 57.0 |

East-West Transect

| ELECTRODE SPACING | | Measured Resistance (Ω) | APPARENT RESISTIVITY | |
|---|---|---|---|---|
| (feet) | (meters) | | ohm-feet | ohm-meters |
| 2 | 0.6 | 72.0 | 905 | 276 |
| 4 | 1.2 | 16.4 | 412 | 126 |
| 6 | 1.8 | 10.2 | 384 | 117 |
| 8 | 2.4 | 7.98 | 401 | 122 |
| 10 | 3.0 | 6.19 | 389 | 119 |
| 20 | 6.1 | 3.37 | 423 | 129 |
| 30 | 9.1 | 2.55 | 481 | 147 |
| 50 | 15 | 1.90 | 597 | 182 |
| 100 | 30 | 1.40 | 879 | 268 |

## Electrical Resistivity Test Results
## Wenner 4-Electrode Method
## Hoffman Wind - Madison County, New York

**ER-B-04**

**Location:** 42.923988, -75.652538

**Site Description:** 83°, sunny, top of hill, moist clay

**Date:** 7/14/2023

North-South Transect

| ELECTRODE SPACING | | Measured Resistance (Ω) | APPARENT RESISTIVITY | |
|---|---|---|---|---|
| (feet) | (meters) | | ohm-feet | ohm-meters |
| 2 | 0.6 | 52.9 | 665 | 203 |
| 4 | 1.2 | 12.0 | 302 | 91.9 |
| 6 | 1.8 | 6.85 | 258 | 78.7 |
| 8 | 2.4 | 5.02 | 252 | 76.9 |
| 10 | 3.0 | 4.19 | 263 | 80.2 |
| 20 | 6.1 | 2.45 | 308 | 93.8 |
| 30 | 9.1 | 1.99 | 375 | 114 |
| 50 | 15 | 1.46 | 459 | 140 |
| 100 | 30 | 1.00 | 628 | 192 |

East-West Transect

| ELECTRODE SPACING | | Measured Resistance (Ω) | APPARENT RESISTIVITY | |
|---|---|---|---|---|
| (feet) | (meters) | | ohm-feet | ohm-meters |
| 2 | 0.6 | 39.4 | 495 | 151 |
| 4 | 1.2 | 14.9 | 374 | 114 |
| 6 | 1.8 | 7.51 | 283 | 86.3 |
| 8 | 2.4 | 5.41 | 272 | 82.9 |
| 10 | 3.0 | 4.34 | 273 | 83.1 |
| 20 | 6.1 | 2.51 | 315 | 96.1 |
| 30 | 9.1 | 2.01 | 379 | 115 |
| 50 | 15 | 1.41 | 443 | 135 |
| 100 | 30 | * | - | - |

*Erroneous instrument reading. Data not reported

**ER-B-05**

**Location:** 42.9158714, -75.6360781

**Site Description:** 72°, sunny, rolling hills, moist clay

**Date:** 7/15/2023

North-South Transect

| ELECTRODE SPACING | | Measured Resistance (Ω) | APPARENT RESISTIVITY | |
|---|---|---|---|---|
| (feet) | (meters) | | ohm-feet | ohm-meters |
| 2 | 0.6 | 20.6 | 259 | 78.9 |
| 4 | 1.2 | 14.5 | 364 | 111 |
| 6 | 1.8 | 9.15 | 345 | 105 |
| 8 | 2.4 | 6.79 | 341 | 104 |
| 10 | 3.0 | 5.53 | 347 | 106 |
| 20 | 6.1 | 3.02 | 379 | 116 |
| 30 | 9.1 | 2.41 | 454 | 138 |
| 50 | 15 | 1.93 | 606 | 185 |
| 100 | 30 | 1.41 | 886 | 270 |

East-West Transect

| ELECTRODE SPACING | | Measured Resistance (Ω) | APPARENT RESISTIVITY | |
|---|---|---|---|---|
| (feet) | (meters) | | ohm-feet | ohm-meters |
| 2 | 0.6 | 28.1 | 353 | 108 |
| 4 | 1.2 | 11.4 | 286 | 87.3 |
| 6 | 1.8 | 7.20 | 271 | 82.7 |
| 8 | 2.4 | 5.70 | 286 | 87.3 |
| 10 | 3.0 | 5.05 | 317 | 96.7 |
| 20 | 6.1 | 3.15 | 396 | 121 |
| 30 | 9.1 | 2.55 | 481 | 147 |
| 50 | 15 | 2.09 | 656 | 200 |
| 100 | 30 | * | - | - |

*Erroneous instrument reading. Data not reported

# Appendix C

Laboratory Testing Reports

**Westwood**

## Laboratory Soil Test Data Summary
## Hoffman Wind - Madison County, New York

| BORING ID | SAMPLE DEPTH (ft) | SAMPLE ID | USCS CLASSIFICATION[2][3][4] | NATURAL MOISTURE CONTENT (%) | GRAIN-SIZE DISTRIBUTION[1][4] | | | | ATTERBERG LIMITS [5] | | IN-SITU UNIT WEIGHT (pcf) | UNCONFINED COMPRESSIVE STRENGTH (tsf) | CHEMICAL CONSTITUENTS | | | SOIL BOX ELECTRICAL RESISTIVITY (Ω-cm) | | MODIFIED (85% COM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | % Gravel | % Sand | % Silt | % Clay | LL | PI | | | pH | CHLORIDE (mg/kg) | SULFATES (mg/kg) | As-Received | Saturated | MAX DRY DENSITY (pcf) |
| B-01 | 1-5 | BULK | **Sandy Lean Clay w/ Gravel** | 19.6 | 18.9 | 25.5 | 37.6 | 18 | 36 | 15 | | | 7.0 | 6.9 | 14.8 | 3690 | 3090 | 108.9 |
| B-01 | 8-10 | SS-05 | **Clayey Sand w/ Gravel** | 8.3 | 38.5 | 39.1 | 22 | | 23 | 8 | | | | | | | | |
| B-02 | 14-16 | SS-08 | **Clayey Gravel w/ Sand** | 8.0 | 61 | 18.1 | 21 | | 24 | 9 | | | | | | | | |
| B-03 | 1-5 | BULK | **Sandy Lean Clay w/ Gravel** | 17.9 | 13.4 | 26.3 | 41.7 | 18.7 | 35 | 16 | | | 7.2 | 10.4 | 138 | 3910 | 3130 | 110.8 |
| B-04 | 6-8 | SS-04 | **Sandy Lean Clay w/ Gravel** | 13.1 | 14.5 | 29.9 | 56 | | 26 | 10 | | | | | | | | |
| B-05 | 4-6 | SS-03 | **Sandy Lean Clay** | 15.7 | 11.3 | 30.2 | 59 | | 33 | 15 | | | | | | | | |
| B-06 | 0-2 | SS-01 | **Lean Clay** | | | | | | 32 | 13 | | | | | | | | |
| B-06 | 2-4 | SS-02 | **Gravel w/ Silt and Sand** | 2.8 | 78.8 | 15.9 | 5.3 | | | | | | | | | | | |
| HDD | 4-6 | SS-03 | **Organic Clay** | 74.0 | 0 | 2 | 98 | | 82 | 46 | | | | | | | | |
| SUB-01 | 1-4 | BULK | Sandy Lean Clay w/ Gravel | 22.4 | 6.5 | 24.3 | 48.8 | 20.4 | | | | | | | | | | 109.8 |
| B-04 | 33.7-34.1 | RC-03 | | 0.7 | | | | | | | 166.8 | 548.4 | | | | | | |
| B-06 | 29-29.7 | RC-05 | | 0.9 | | | | | | | 167.5 | 591.6 | | | | | | |

**Footnotes:**

(1) % Gravel = part. greater than 4.75 mm (#4 sieve); % Sand = part. between 0.075 mm (#200 sieve) and 4.75 mm (#4 sieve); % Silt = part. between 0.002 mm and 0.075 mm (#200 sieve); % Clay = part. smaller than 0.002 mm.

(2) Some samples were combined to achieve sufficient volume and were taken from same soil stratum.

(3) Visual classification, informed where possible by laboratory testing. Bold font indicates sufficient lab data for precise USCS classification

(4) Represents soil fraction captured in split spoon, does not include cobbles/large gravel that may have been in profile.

Created by: T. Lopez
Checked by: B. Hawk

# Water Content Test Summary (ASTM:D2216)

Project: Hoffman Wind Job: 14511

Client Westwood Surveying & Engineering Date: 8/11/2023

Sample Information & Classification

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Boring # | B-01 | B-02 | B-04 | B-05 | B-06 | HDD-01 | | |
| Sample # | SS-05 | SS-08 | SS-04 | SS-03 | SS-02 | SS-03 | | |
| Depth (ft) | 8-10 | 14-16 | 6-8 | 4-6 | 2-4 | 4-6 | | |
| Type | Bag | Bag | Bag | Bag | Bag | Bag | | |
| Material Classification | Clayey Sand w/gravel (SC) | Clayey Gravel w/sand (GC) | Sandy Lean Clay w/a little gravel (CL) | Sandy Lean Clay w/a little gravel (CL) | Gravel w/silt and sand (GP-GM/GP) | Organic Clay (OH) | | |
| Water Content (%) | 8.3 | 8.0 | 13.1 | 15.7 | 2.8 | 74.0 | | |

Sample Information & Classification

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Boring # | | | | | | | | |
| Sample # | | | | | | | | |
| Depth (ft) | | | | | | | | |
| Type | | | | | | | | |
| Material Classification | | | | | | | | |
| Water Content (%) | | | | | | | | |

Sample Information & Classification

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Boring # | | | | | | | | |
| Sample # | | | | | | | | |
| Depth (ft) | | | | | | | | |
| Type | | | | | | | | |
| Material Classification | | | | | | | | |
| Water Content (%) | | | | | | | | |

Sample Information & Classification

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Boring # | | | | | | | | |
| Sample # | | | | | | | | |
| Depth (ft) | | | | | | | | |
| Type | | | | | | | | |
| Material Classification | | | | | | | | |
| Water Content (%) | | | | | | | | |

# Laboratory Test Summary

Project: Hoffman Wind    Job: 14511

Client: Westwood Surveying & Engineering    Date: 8/11/2023

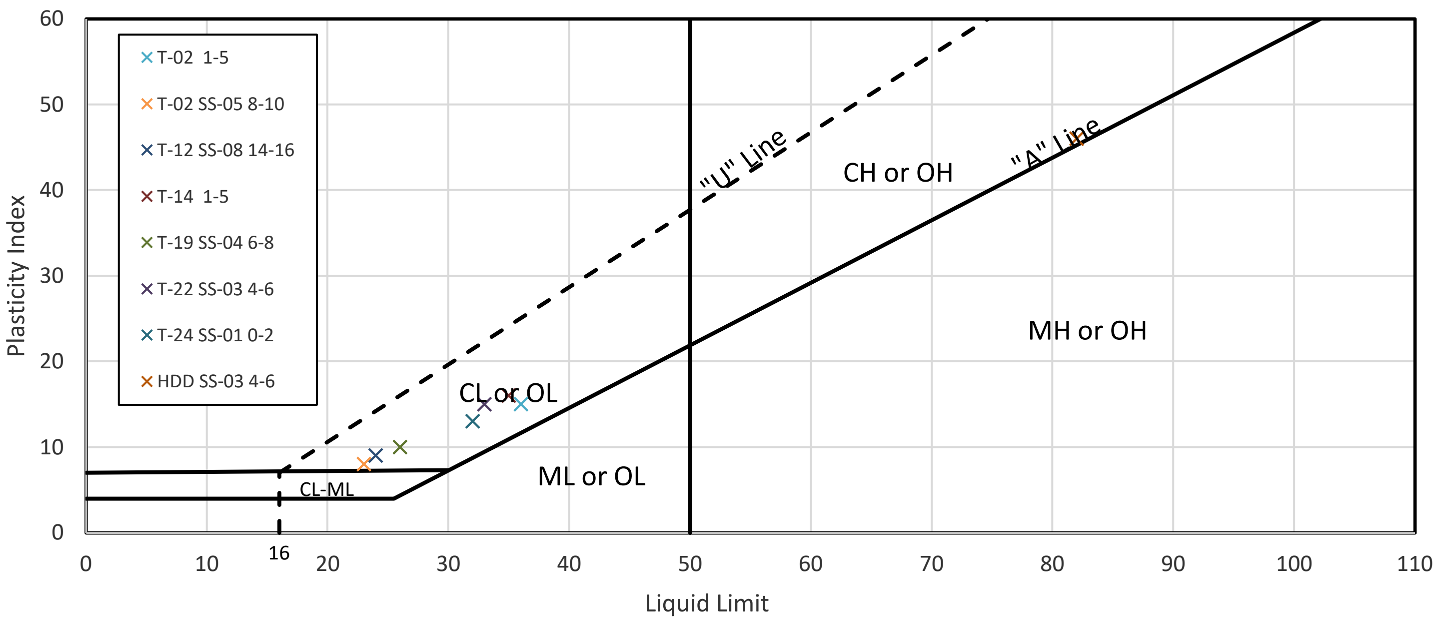
## Sample Information & Classification

| Boring # | B-01 | B-01 | B-02 | B-03 | B-04 | B-05 | B-06 | HDD-01 |
|---|---|---|---|---|---|---|---|---|
| Sample # |  | SS-05 | SS-08 |  | SS-04 | SS-03 | SS-01 | SS-03 |
| Depth (ft) | 1-5 | 8-10 | 14-16 | 1-5 | 6-8 | 4-6 | 0-2 | 4-6 |
| Sample Type | Bulk | Bag | Bag | Bulk | Bag | Bag | Bag | Bag |
| Material Classification | Lean Clay w/sand and a little gravel (CL) | Clayey Sand w/gravel (SC) | Clayey Gravel w/sand (GC) | Lean Clay w/sand and a little gravel (CL) | Sandy Lean Clay w/a little gravel (CL) | Sandy Lean Clay w/a little gravel (CL) | Lean Clay (CL) | Organic Clay (OH) |

## Atterberg Limits (ASTM:D4318)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Liquid Limit | 36 | 23 | 24 | 35 | 26 | 33 | 32 | 82 |
| Plastic Limit | 21 | 15 | 15 | 19 | 16 | 18 | 19 | 36 |
| Plasticity Index | 15 | 8 | 9 | 16 | 10 | 15 | 13 | 46 |

## Plasticity Chart (ASTM:D2487)

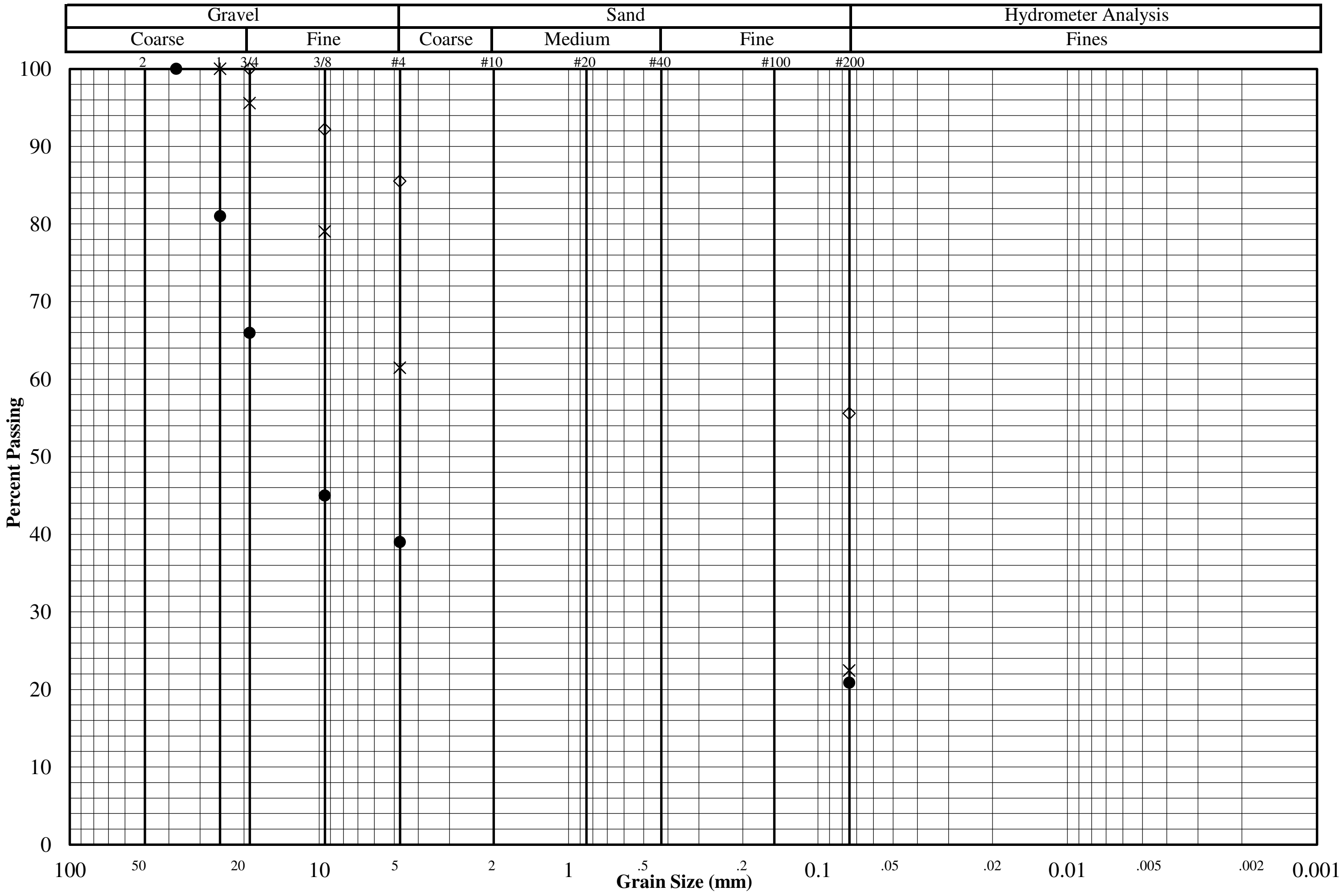


# Grain Size Distribution ASTM D1140

Job No. : **14511**

| | | | |
|---|---|---|---|
| Project: | Hoffman Wind | Test Date: | 7/27/23 |
| Reported To: | Westwood Surveying & Engineering | Report Date: | 8/11/23 |

| | Location / Boring No. | Sample No. | Depth (ft) | Sample Type | Soil Classification |
|---|---|---|---|---|---|
| * | B-01 | SS-05 | 8-10 | Bag | Clayey Sand w/gravel (SC) |
| ● | B-02 | SS-08 | 14-16 | Bag | Clayey Gravel w/sand (GC) |
| ◇ | B-04 | SS-04 | 6-8 | Bag | Sandy Lean Clay w/a little gravel (CL) |



| Additional Results | * | ● | ◇ |
|---|---|---|---|
| Liquid Limit | 23 | 24 | 26 |
| Plastic Limit | 15 | 15 | 16 |
| Plasticity Index<br>ASTM:D4318 | 8 | 9 | 10 |
| Water Content<br>ASTM:D2216 | 8.3 | 8.0 | 13.1 |
| Dry Density (pcf)<br>ASTM:D7263 | | | |
| Specific Gravity<br>ASTM:D854 | | | |
| Porosity | | | |
| Organic Content<br>ASTM:D2974 | | | |
| pH<br>ASTM:D4972 Method B | | | |

Percent Passing

| | * | ● | ◇ |
|---|---|---|---|
| Mass (g) | 361.2 | 283.8 | 349.9 |
| 2" | | | |
| 1.5" | | 100.0 | |
| 1" | 100.0 | 81.0 | |
| 3/4" | 95.6 | 66.0 | 100.0 |
| 3/8" | 79.0 | 45.0 | 92.2 |
| #4 | 61.5 | 39.0 | 85.5 |
| #10 | | | |
| #20 | | | |
| #40 | | | |
| #100 | | | |
| #200 | 22.4 | 20.9 | 55.6 |

| | * | ● | ◇ |
|---|---|---|---|
| $D_{60}$ | | | |
| $D_{30}$ | | | |
| $D_{10}$ | | | |
| $C_U$ | | | |
| $C_C$ | | | |

Remarks:

(* = assumed)

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Bloomington, MN 55431

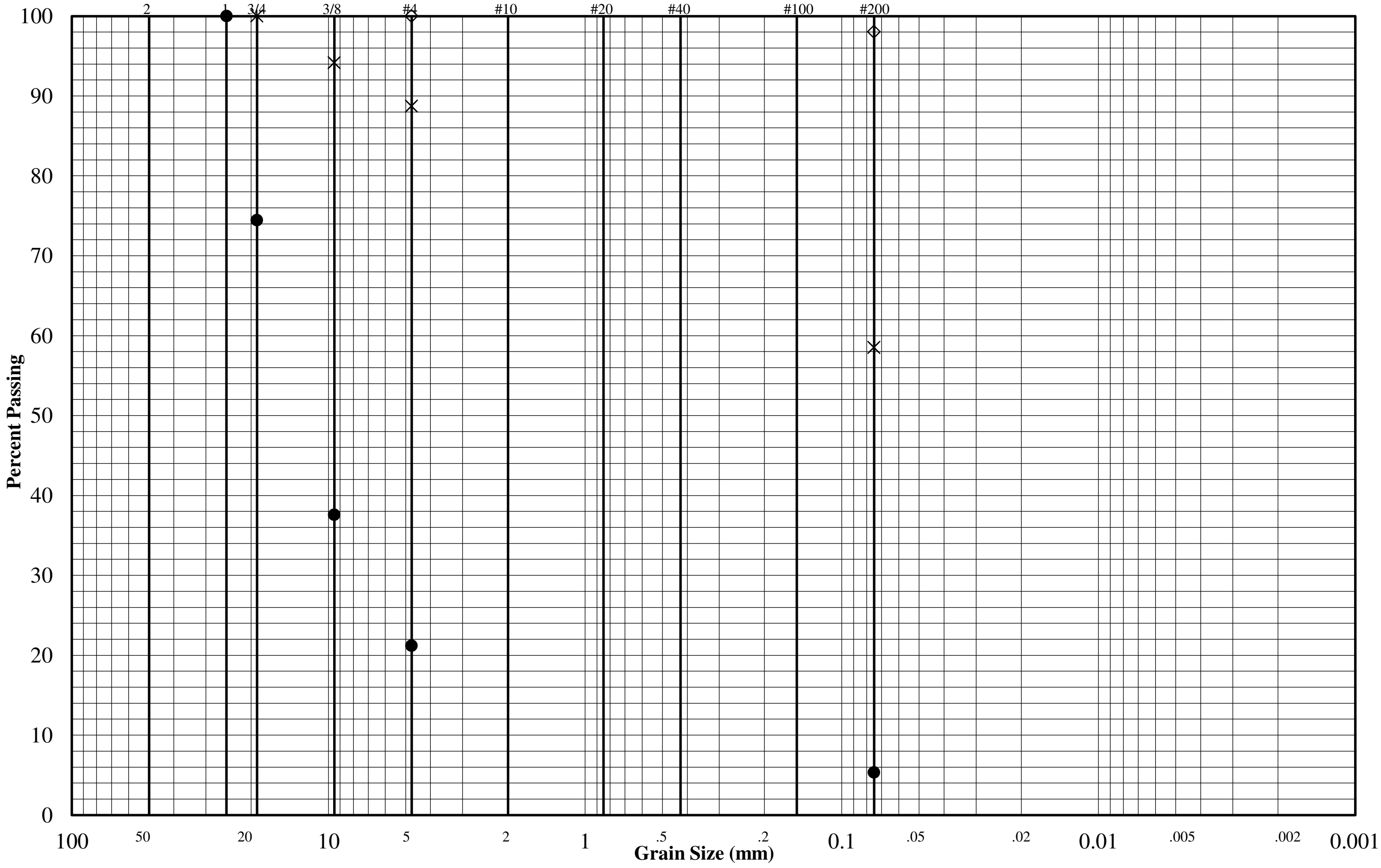
# Grain Size Distribution ASTM D1140

**Job No. :** **14511**

| | | | |
|---|---|---|---|
| **Project:** | Hoffman Wind | **Test Date:** | 7/27/23 |
| **Reported To:** | Westwood Surveying & Engineering | **Report Date:** | 8/11/23 |

| | Location / Boring No. | Sample No. | Depth (ft) | Sample Type | Soil Classification |
|---|---|---|---|---|---|
| ∗ | B-05 | SS-03 | 4-6 | Bag | Sandy Lean Clay w/a little gravel (CL) |
| ● | B-06 | SS-02 | 2-4 | Bag | Gravel w/silt and sand (GP-GM/GP) |
| ◇ | HDD-01 | SS-03 | 4-6 | Bag | Organic Clay (OH) |

| Gravel | | Sand | | | Hydrometer Analysis |
|---|---|---|---|---|---|
| Coarse | Fine | Coarse | Medium | Fine | Fines |



| Additional Results | ∗ | ● | ◇ |
|---|---|---|---|
| Liquid Limit | 33 | | 82 |
| Plastic Limit | 18 | | 36 |
| Plasticity Index<br>ASTM:D4318 | 15 | | 46 |
| Water Content<br>ASTM:D2216 | 15.7 | 2.8 | 74.0 |
| Dry Density (pcf)<br>ASTM:D7263 | | | |
| Specific Gravity<br>ASTM:D854 | | | |
| Porosity | | | |
| Organic Content<br>ASTM:D2974 | | | |
| pH<br>ASTM:D4972 Method B | | | |

(* = assumed)

Percent Passing

| | ∗ | ● | ◇ |
|---|---|---|---|
| Mass (g) | 505.3 | 221.8 | 39.5 |
| 2" | | | |
| 1.5" | | | |
| 1" | | 100.0 | |
| 3/4" | 100.0 | 74.5 | |
| 3/8" | 94.2 | 37.6 | |
| #4 | 88.7 | 21.2 | 100.0 |
| #10 | | | |
| #20 | | | |
| #40 | | | |
| #100 | | | |
| #200 | 58.5 | 5.3 | 98.0 |

| | ∗ | ● | ◇ |
|---|---|---|---|
| $D_{60}$ | | | |
| $D_{30}$ | | | |
| $D_{10}$ | | | |
| $C_U$ | | | |
| $C_C$ | | | |

Remarks:

# Soil Resistivity Results

## (ASTM G57 - Laboratory Soil Box)

| | | | |
|---|---|---|---|
| **Project:** | **Hoffman Wind** | **Job #:** | **14511** |
| **Client:** | **Westwood Surveying & Engineering** | **Date:** | **8/4/23** |

## Sample Information & Classification

| | | | | | | |
|---|---|---|---|---|---|---|
| Boring | B-01 | B-03 | | | | |
| Sample | | | | | | |
| Depth (ft) | 1-5 | 1-5 | | | | |
| Sample Type | Bulk | Bulk | | | | |
| Soil Classification | Lean Clay w/sand and gravel (CL) | Lean Clay w/sand and a little gravel (CL) | | | | |

### Water Content & Density (As Received)

| | | | | | | |
|---|---|---|---|---|---|---|
| Water Content (%) | 20.2 | 17.6 | | | | |
| Dry Density (PCF) | 104.2 | 101.6 | | | | |

### Water Content & Density (Saturated)

| | | | | | | |
|---|---|---|---|---|---|---|
| Water Content (%) | **22.0** | **23.0** | | | | |
| Dry Density (PCF) | **102.7** | **101.4** | | | | |

## Resistivity (ohm-cm) (ASTM G57)

| | | | | | | |
|---|---|---|---|---|---|---|
| As Received Moisture Content Resistivity (ohm-cm) | **3,690** | **3,910** | | | | |
| Saturated Condition Resistivity (ohm-cm) | **3,090** | **3,130** | | | | |

# pH Testing Summary Sheet (ASTM:D4972)

Project: **Hoffman Wind**

Job: **14511**

Client: **Westwood Surveying & Engineering**

Date: **8/16/2023**

| Boring / Location | Sample | Sample Type | Depth (ft) | pH | Visual Classification |
|---|---|---|---|---|---|
| **B-01** | | **Bulk** | **1-5** | **7.0** | **Lean Clay w/sand and gravel (CL)** |
| **B-03** | | **Bulk** | **1-5** | **7.2** | **Lean Clay w/sand and a little gravel (CL)** |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

# California Bearing Ratio ASTM:D1883

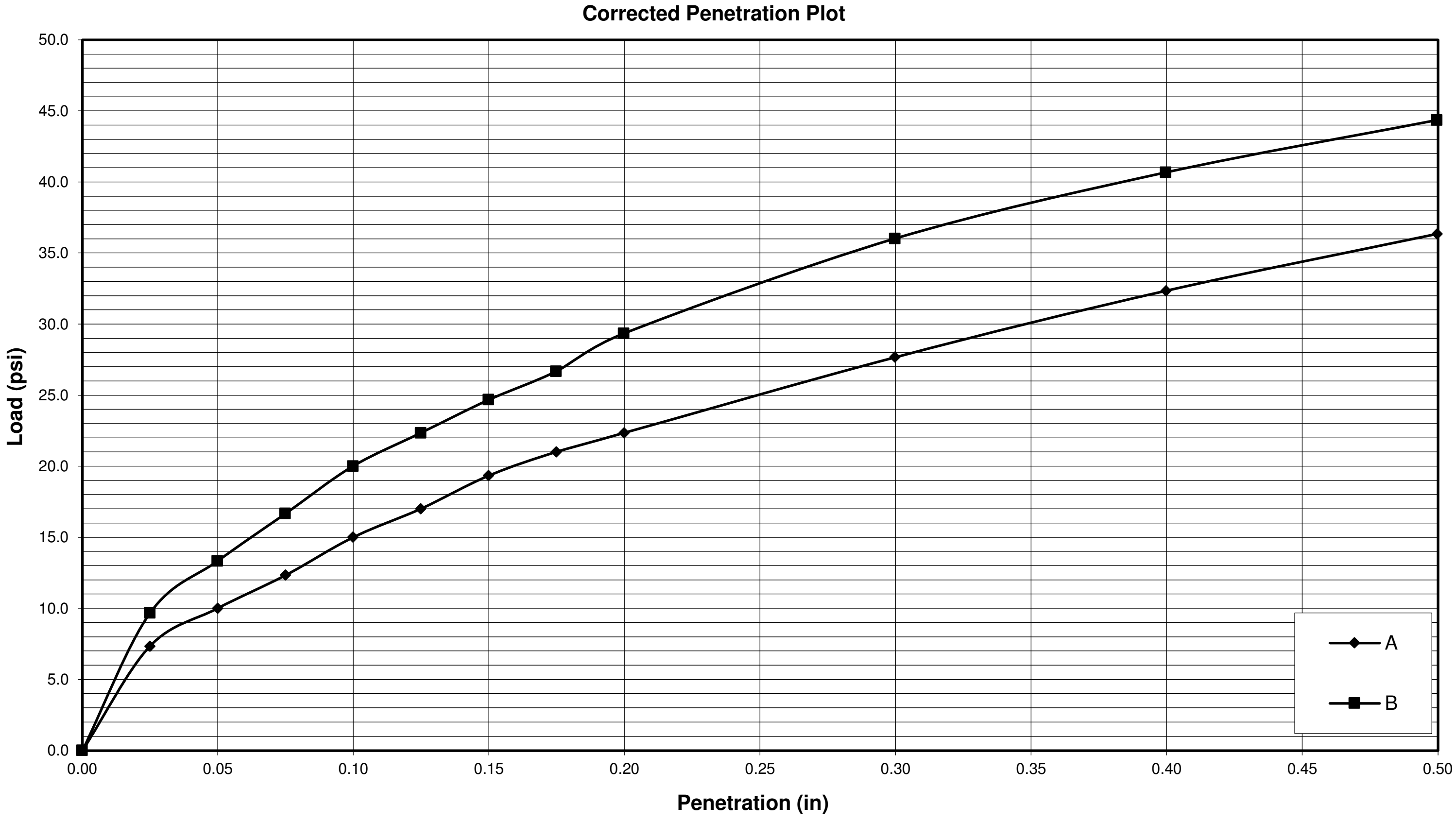
| | | | |
|---|---|---|---|
| Project: | Hoffman Wind | Job: | **14511** |
| Client: | Westwood Surveying & Engineering | Date: | 8/8/23 |

| | | |
|---|---|---|
| Boring #: | B-01 | Procedural Method: |
| Sample: | | Specimens compacted to approximately 90% and 95% of maximum standard proctor density at the as received moisture content. Specimens soaked for a period of 4 days before CBR test was performed. |
| Depth (ft): | 1-5 | |
| Type: | Bulk | |
| Classification: | Lean Clay w/sand and a little gravel (CL) | |

| Laboratory Moisture-Density Values | | Index Properties | | |
|---|---|---|---|---|
| Method: | ASTM:D698 Method B | LL: | 36 | Gs: |
| Maximum Dry Density (PCF): | 113.6 | PL: | 21 | Organic Content: |
| Optimum Water Content: | 15.6% | PI: | 15 | pH: |

| Initial Molding Conditions | | | |
|---|---|---|---|
| Specimen | A | B | |
| Compaction Hammer: | 5 lb | 5 lb | |
| Number of Layers: | 3 | 3 | |
| Blows per Layer: | NA | NA | |
| Initial Moisture Content: | 19.6% | 19.6% | |
| Initial Dry Density (PCF) | 102.3 | 108.0 | |
| Relative Compaction | 90.1% | 95.0% | |
| **Soaking Phase** | | | |
| Days Soaked | 4 | 4 | |
| Surcharge (psf) | 50 | 50 | |
| Total Swell (%) | 0.0% | -0.2% | |
| **Penetration Phase** | | | |
| Surcharge (psf) | 50 | 50 | |
| Corrected CBR Values | | | |
| at 0.1 inch (%) | **1.5%** | **2.0%** | |
| at 0.2 inch (%) | 1.5% | 2.0% | |
| **Moisture Content After Penetration** | | | |
| Top 1" of Specimen: | 20.4% | 20.3% | |
| Average of specimen: | 19.8% | 19.3% | |

Stress vs. Penetration Graph



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# Moisture Density Curve ASTM: D698, Method B

Project: **Hoffman Wind** Date: **8/8/23**

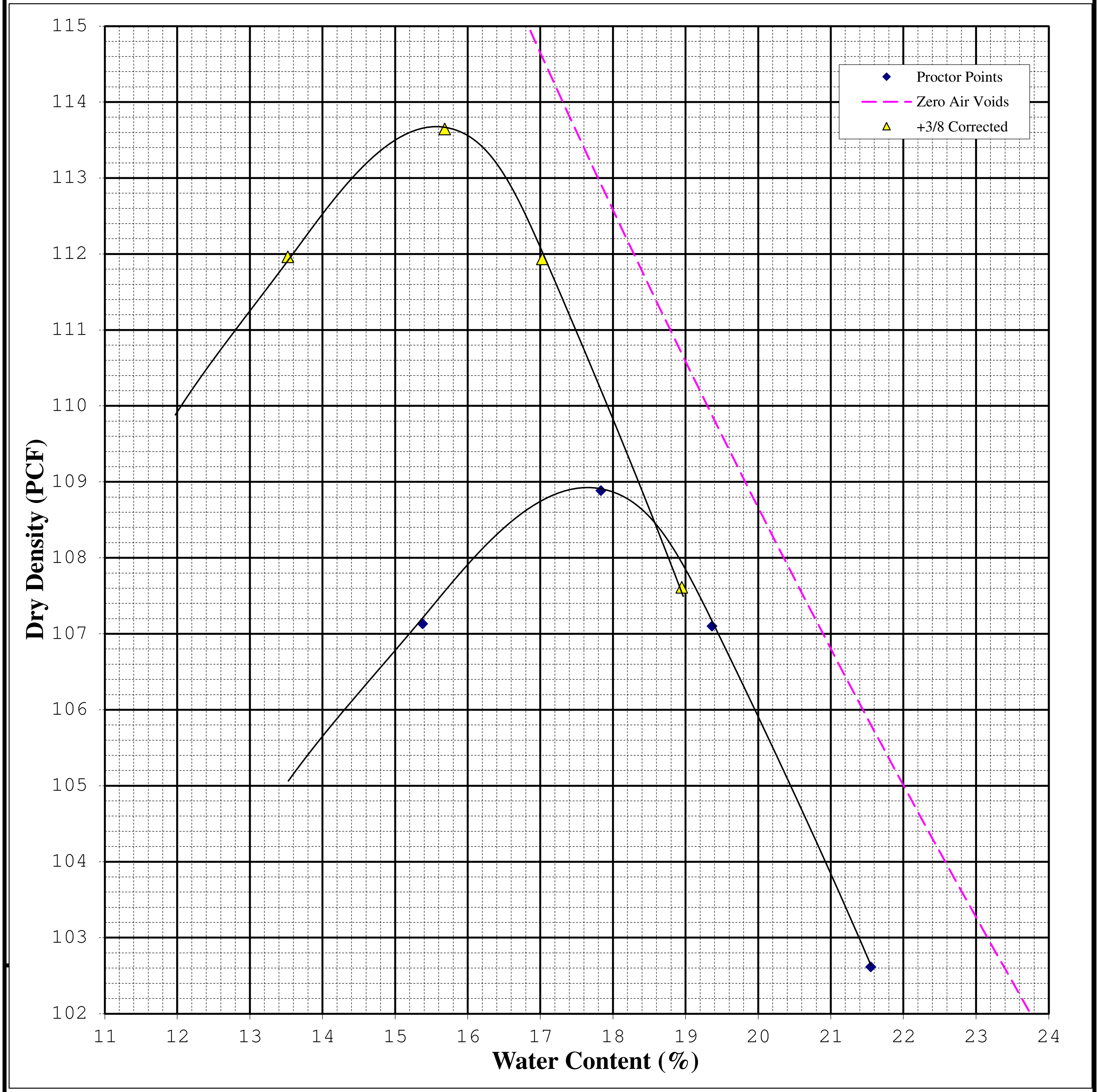
Client: **Westwood Surveying & Engineering** Job No. **14511**

Boring No.: **B-01** Sample: Depth(ft): **1-5** Location:

Soil Type: **Lean Clay w/sand and a little gravel (CL)**

As Received W.C. (%): **19.6** LL: **36** PL: **21** PI: **15** Specific Gravity: **2.67** *Assumed

Maximum Dry Density (pcf): ◆ **108.9** △ **113.6** Opt. Water Content (%): ◆ **17.9** △ **15.6**



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SET-R18a

## Moisture Density Curve ASTM: D698, Method B

Project: **Hoffman Wind** Date: **8/8/23**

Client: **Westwood Surveying & Engineering** Job No. **14511**

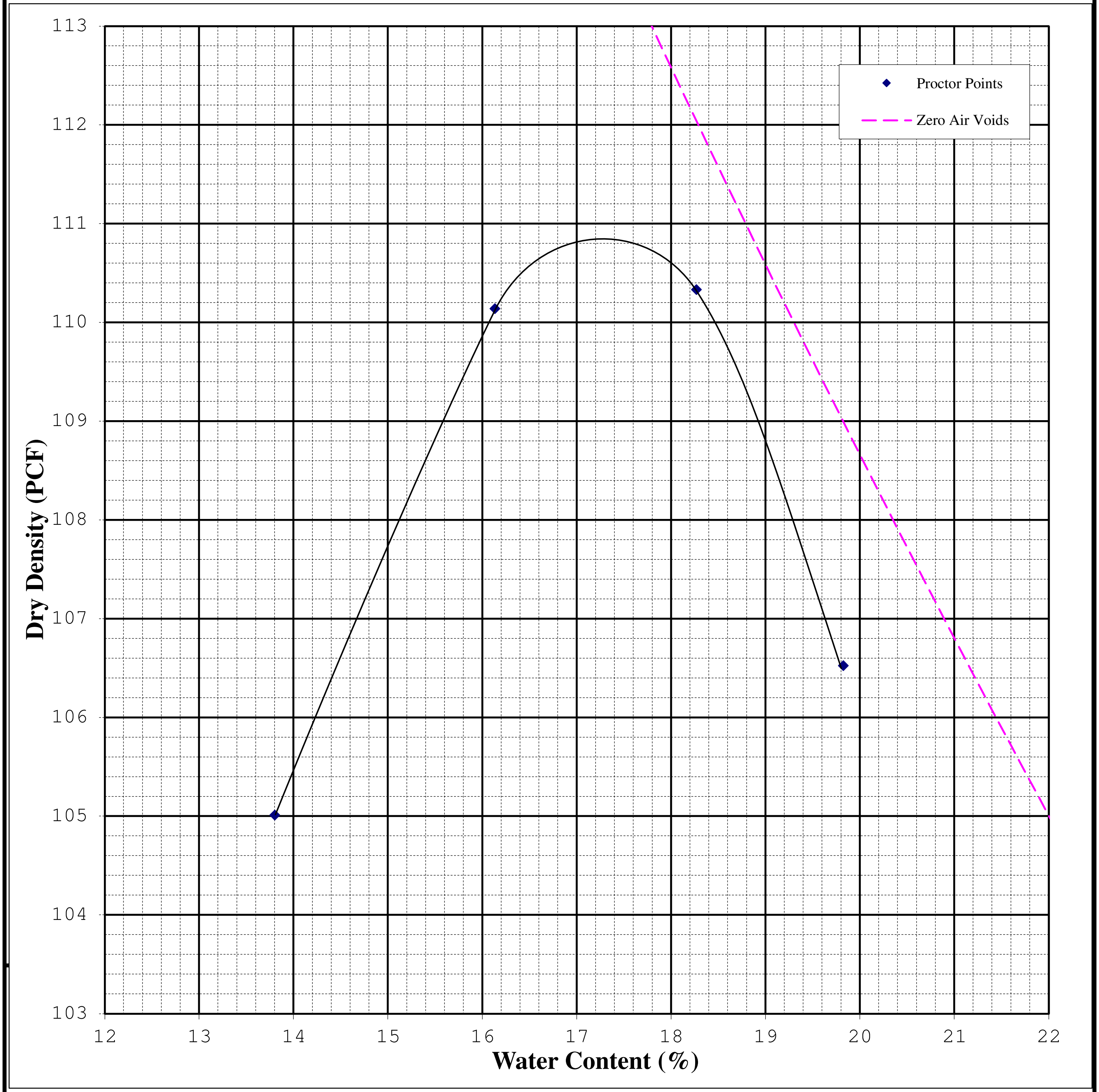
Boring No.: **B-03** Sample: Depth(ft): **1-5** Location:

Soil Type: **Lean Clay w/sand and a little gravel (CL)**

As Received W.C. (%): **17.9** LL: **35** PL: **19** PI: **16** Specific Gravity: **2.67** *Assumed

◆ △ ◆ △

Maximum Dry Density (pcf): **110.8** Opt. Water Content (%): **17.3**



# Moisture Density Curve ASTM: D698, Method B

Project: **Hoffman Wind** Date: **8/28/23**

Client: **Westwood Surveying & Engineering** Job No. **14511-A**

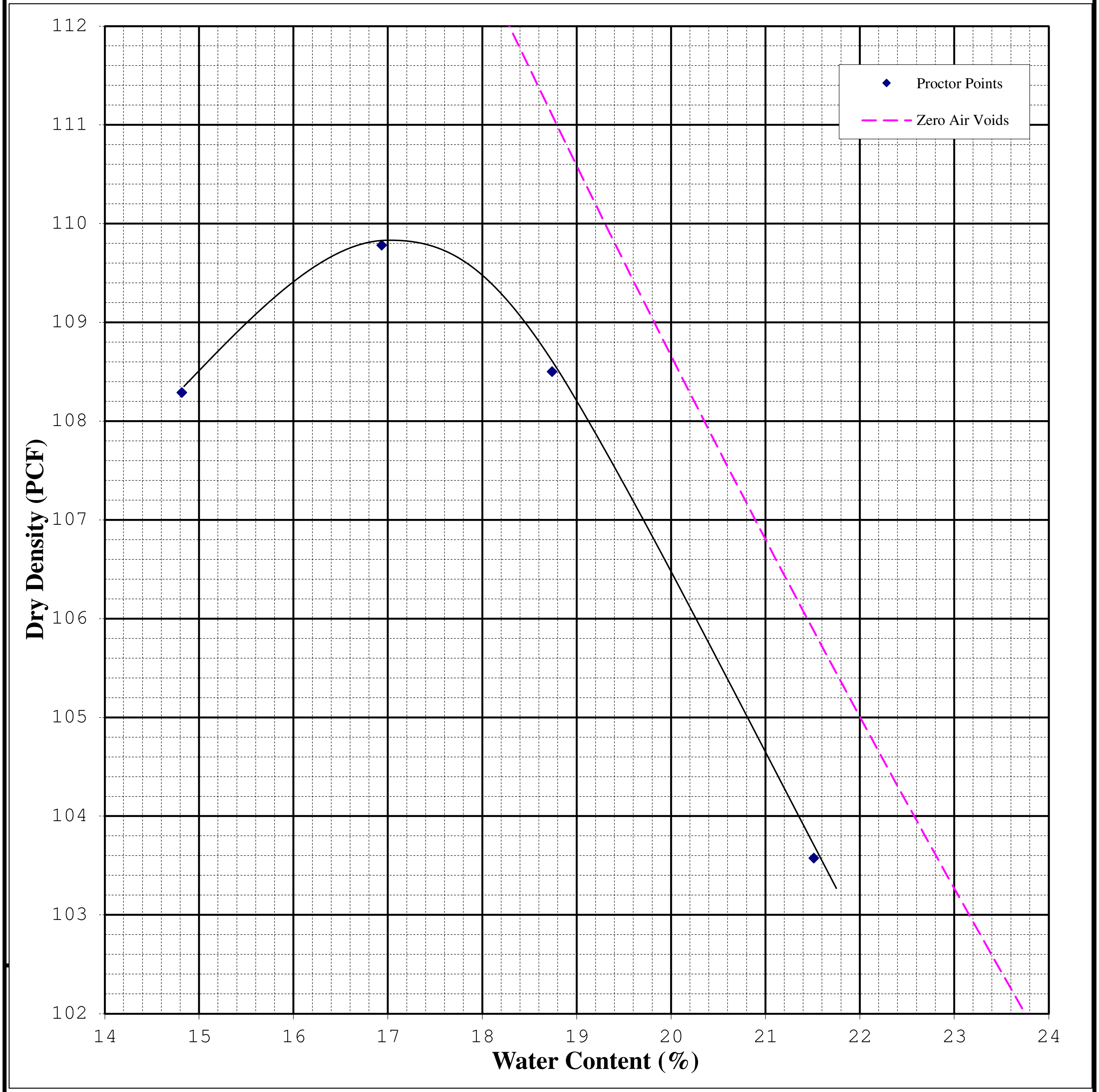
Boring No. **Sub-01** Sample: Depth(ft): **1-4** Location:

Soil Type: **Sandy Lean Clay w/a little gravel (CL)**

As Received W.C. (%): **22.3** LL: PL: PI: Specific Gravity: **2.67** *Assumed

◆ △ ◆ △

Maximum Dry Density (pcf): **109.8** Opt. Water Content (%): **17.1**



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SET-R18a

# Thermal Resistivity Report ASTM D:5334

Project: **Hoffman Wind**

Job #: **14511**

Client: **Westwood Surveying & Engineering**

Date: **8/15/23**

| | | | | | Proctor Values | | Initial Conditions | | | Dry |
|---|---|---|---|---|---|---|---|---|---|---|
| Boring | Specimen Type | Depth (ft) | Type | Classification | Maximum Dry Density (PCF) | Optimum Moisture (%) | Dry Density (PCF) | WC (%) | Thermal Resistivity (ºC-cm/W) | Thermal Resistivity (ºC-cm/W) |
| **B-01** | **Reconstituted** | **1-5** | **Bulk** | **Lean Clay with sand and a little gravel (CL)** | **108.9** | **17.9%** | **98.0** | **19.7%** | **64** | **215** |
| **B-03** | **Reconstituted** | **1-5** | **Bulk** | **Lean Clay with sand and a little gravel (CL)** | **110.8** | **17.3%** | **99.8** | **17.9%** | **67** | **220** |
| | | | | | | | | | | |

**Specimens reconstituted to approximately 90% of maximum standard proctor density near the as received moisture content.**

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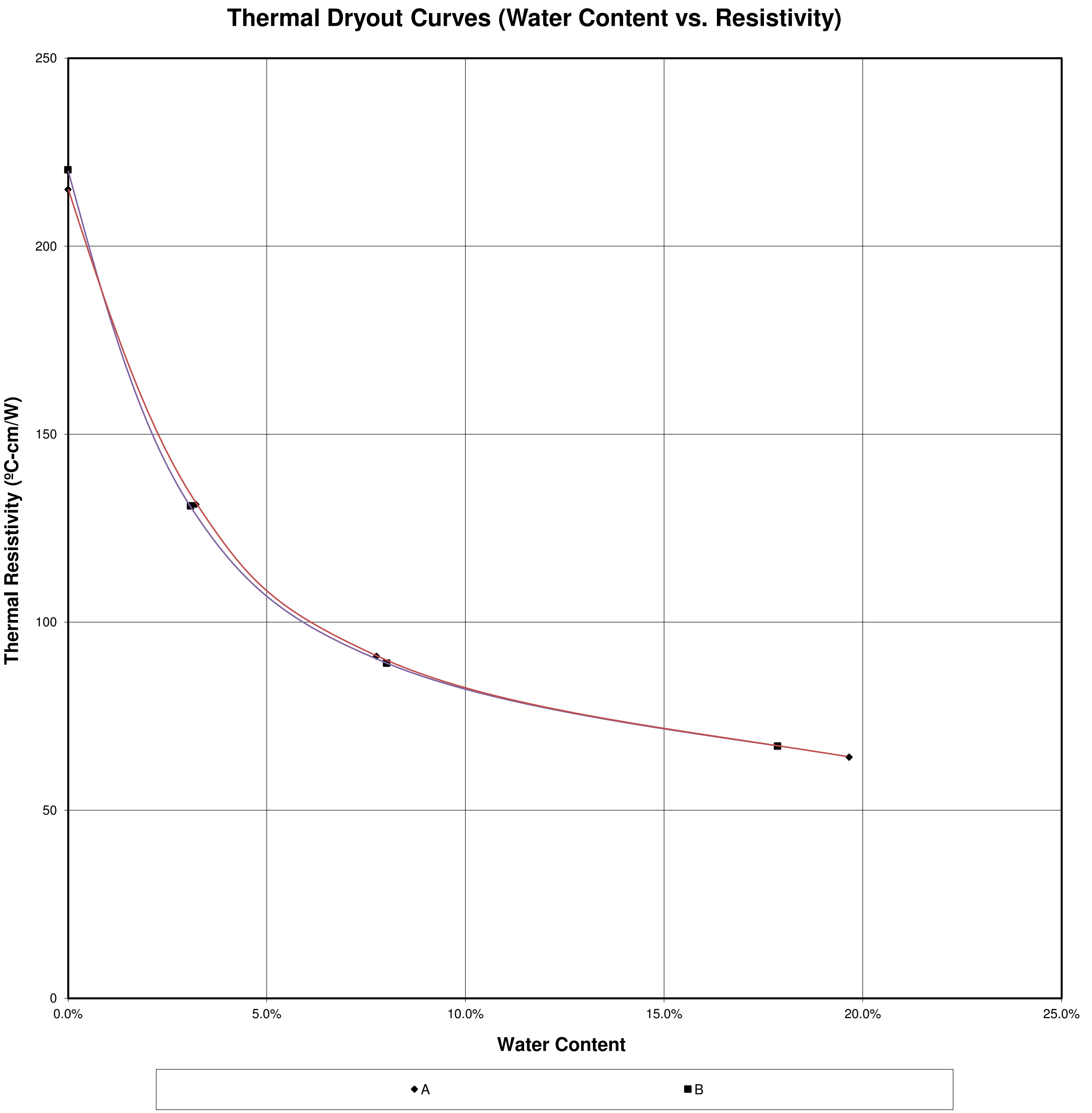
Bloomington, MN 55431

http://www.soilengineeringtesting.com

# Thermal Resistivity Report ASTM D:5334

| | | | |
|---|---|---|---|
| Project: | Hoffman Wind | Job: | 14511 |
| Client: | Westwood Surveying & Engineering | Date: | 8/15/23 |

| | Boring | Depth (ft) |
|---|---|---|
| Specimen A: | B-01 | 1-5 |
| Specimen B: | B-03 | 1-5 |



# Thermal Resistivity Report ASTM D:5334

Project: **Hoffman Wind** Job #: **14511-A**
Client: **Westwood Surveying & Engineering** Date: **9/6/23**

| | | | | | Proctor Values | | Initial Conditions | | | Dry |
|---|---|---|---|---|---|---|---|---|---|---|
| Boring | Specimen Type | Depth (ft) | Type | Classification | Maximum Dry Density (PCF) | Optimum Moisture (%) | Dry Density (PCF) | WC (%) | Thermal Resistivity (ºC-cm/W) | Thermal Resistivity (ºC-cm/W) |
| **Sub-01** | **Reconstituted** | **1-4** | **Bulk** | **Sandy Lean Clay with a little gravel (CL)** | **109.8** | **17.1%** | **98.7** | **22.4%** | **56** | **188** |
| | | | | | | | | | | |
| | **Specimens reconstituted to approximately 90% of maximum standard proctor density near the as received moisture content.** | | | | | | | | | |
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9530 James Ave South

SOIL ENGINEERING TESTING, INC.

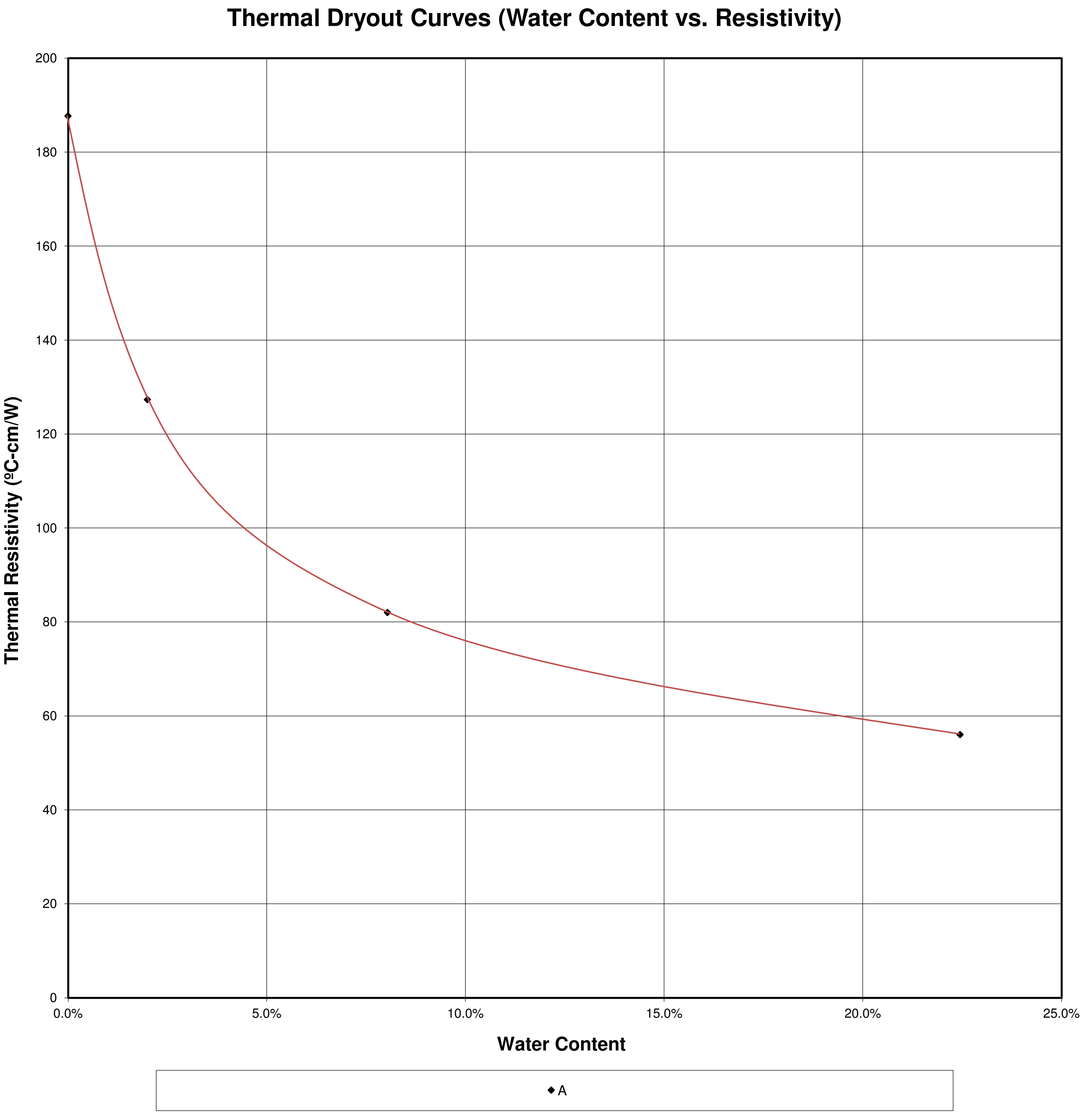
Bloomington, MN 55431

http://www.soilengineeringtesting.com

# Thermal Resistivity Report ASTM D:5334

Project: Hoffman Wind
Client: Westwood Surveying & Engineering
Job: 14511-A
Date: 9/6/23

| | Boring | Depth (ft) |
|---|---|---|
| Specimen A: | Sub-01 | 1-4 |



RMB
Environmental Laboratories, Inc.
www.rmbel.com

Bloomington
2200 West 94th Street
Bloomington, MN 55431
952-456-8470

Detroit Lakes
22796 County Highway 6
Detroit Lakes, MN 56501
218-846-1465

Hibbing
1111 7th Ave. E.
Hibbing, MN 55746
218-440-2043

August 11, 2023
Laboratory Report

Soil Engineering Testing, Inc
Tyler Sandoz
9530 James Ave S
Bloomington, MN 55431

RE: Hoffman Wind
Work Order :B009957

Enclosed are the results of analyses for samples received by the laboratory on 07/28/2023 13:30. If you have any questions concerning this report, please feel free to reach out to customer service at 888-200-5770 or the contacts listed below:

| | | | |
|---|---|---|---|
| Chad Hadler | Senior Project Manager | Chad.Hadler@rmbel.com | (952) 456-8470 |
| Justin Tweedale | Senior Project Manager | Justin.Tweedale@rmbel.com | (218) 849-8747 |
| Kathleen Mitchell | Quality Assurance Director | Kathleen.Mitchell@rmbel.info | (785) 493-1633 |
| Robert Borash | President \| CEO | Robert.Borash@rmbel.info | (218) 849-6420 |

Report approved by:

Kathleen A. Mitchell

Kathleen Mitchell
Senior Quality Assurance Director
kathleen.mitchell@rmbel.com

Detroit Lakes (DL) Certification / Accreditation Numbers: EPA Lab ID MN00918 • Minnesota Department of Health 027-005-336 • North Dakota Department of Environmental Quality R-187
Bloomington (BL) Certification / Accreditation Numbers: EPA Lab ID MN01091 • Minnesota Department of Health 027-053-475 • North Dakota Department of Environmental Quality R-231
Hibbing (HB) Certification / Accreditation Numbers: EPA Lab ID MN01082 • Minnesota Department of Health 027-137-480 • North Dakota Department of Environmental Quality R-228

**Report Date: August 11,2023**

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**Soil Engineering Testing, Inc**
**9530 James Ave S**
**Bloomington MN, 55431**

**Project:** Hoffman Wind
**Project Number:** 14511

**Date/Time Received**
7/28/2023 1:30:00PM

---

## ANALYTICAL REPORT FOR SAMPLES

| Laboratory ID | Sample Name | Matrix | Date/Time Sampled |
|---|---|---|---|
| B009957-01 | B-01 | Solid | 07/28/2023 07:15 |
| B009957-02 | B-03 | Solid | 07/28/2023 07:15 |

**Additional information:**

All samples will be retained for 30 days from date sampled, unless otherwise requested.
Record retention policy is 5 years unless otherwise agreed to in writing.
All calculations are performed using the raw data results.

**Laboratory Results**

**August 11, 2023**

| Lab Number | Analyte | Sample Name | Result | Units | Sample RL | DF | Analysis Method | Analyzed | Batch | Analyte Qualifiers | Facility |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Chemistry Parameters** | | | | | | | | | | | |
| B009957-01 | Chloride | B-01 | **6.9** | mg/Kg wet | 5.2 | 1 | EPA 9056A | 08/08/23 00:08 | BG06001 | | DL |
| B009957-01 | Sulfate as SO4 | B-01 | **14.8** | mg/Kg wet | 5.2 | 1 | EPA 9056A | 08/08/23 00:08 | BG06001 | | DL |
| B009957-02 | Chloride | B-03 | **10.4** | mg/Kg wet | 5.0 | 1 | EPA 9056A | 08/09/23 05:50 | BG06001 | | DL |
| B009957-02 | Sulfate as SO4 | B-03 | **138** | mg/Kg wet | 5.0 | 1 | EPA 9056A | 08/09/23 05:50 | BG06001 | | DL |

## Chemistry Parameters - Quality Control

| Analyte | Result | Units | Qualifiers | Sample RL | DF | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Batch BG06001 - EPA 9056A** | | | | | | | | | | | |
| **Blank** (BG06001-BLK1) | | | | | | | | | | | |
| Prepared & Analyzed: 08/07/2023 | | | | | | | | | | | |
| **Chloride** | < 5.0 | mg/Kg wet | | 5.0 | 1 | | | | | | |
| **Sulfate as SO4** | < 5.0 | mg/Kg wet | | 5.0 | 1 | | | | | | |
| **Blank** (BG06001-BLK2) | | | | | | | | | | | |
| Prepared: 08/07/2023 Analyzed: 08/09/2023 | | | | | | | | | | | |
| **Chloride** | < 5.0 | mg/Kg wet | | 5.0 | 1 | | | | | | |
| **Sulfate as SO4** | < 5.0 | mg/Kg wet | | 5.0 | 1 | | | | | | |
| **Blank** (BG06001-BLK3) | | | | | | | | | | | |
| Prepared: 08/07/2023 Analyzed: 08/08/2023 | | | | | | | | | | | |
| **Chloride** | < 5.0 | mg/Kg wet | | 5.0 | 1 | | | | | | |
| **Sulfate as SO4** | < 5.0 | mg/Kg wet | | 5.0 | 1 | | | | | | |
| **LCS** (BG06001-BS1) | | | | | | | | | | | |
| Prepared & Analyzed: 08/07/2023 | | | | | | | | | | | |
| **Chloride** | 252 | mg/Kg wet | | 5.0 | 1 | 250 | | 101 | 90-110 | | |
| **Sulfate as SO4** | 257 | mg/Kg wet | | 5.0 | 1 | 250 | | 103 | 90-110 | | |
| **LCS** (BG06001-BS2) | | | | | | | | | | | |
| Prepared: 08/07/2023 Analyzed: 08/09/2023 | | | | | | | | | | | |
| **Chloride** | 257 | mg/Kg wet | | 5.0 | 1 | 250 | | 103 | 90-110 | | |
| **Sulfate as SO4** | 259 | mg/Kg wet | | 5.0 | 1 | 250 | | 104 | 90-110 | | |
| **LCS** (BG06001-BS3) | | | | | | | | | | | |
| Prepared: 08/07/2023 Analyzed: 08/08/2023 | | | | | | | | | | | |
| **Chloride** | 257 | mg/Kg wet | | 5.0 | 1 | 250 | | 103 | 90-110 | | |
| **Sulfate as SO4** | 259 | mg/Kg wet | | 5.0 | 1 | 250 | | 104 | 90-110 | | |
| **Matrix Spike** (BG06001-MS1) | | | | | | | | | | | |
| Prepared: 08/07/2023 Analyzed: 08/08/2023 | | | | | | | | | | | |
| Source: B009957-01 | | | | | | | | | | | |
| **Chloride** | 192 | mg/Kg wet | | 5.0 | 1 | 191 | 6.9 | 97 | 80-120 | | |
| **Sulfate as SO4** | 200 | mg/Kg wet | | 5.0 | 1 | 191 | 14.8 | 97 | 80-120 | | |
| **Matrix Spike Dup** (BG06001-MSD1) | | | | | | | | | | | |
| Prepared: 08/07/2023 Analyzed: 08/08/2023 | | | | | | | | | | | |
| Source: B009957-01 | | | | | | | | | | | |
| **Chloride** | 217 | mg/Kg wet | | 5.2 | 1 | 209 | 6.9 | 100 | 80-120 | 12 | 20 |
| **Sulfate as SO4** | 226 | mg/Kg wet | | 5.2 | 1 | 209 | 14.8 | 101 | 80-120 | 12 | 20 |

## Qualifiers and Definitions

| Item | Definition |
|---|---|
| RL | Reporting Limit (Corrected for dilution factor when applicable due to sample preparation variation.) |
| MDL | Method Detection Limit (Corrected for sample preparation variation.) |
| DF | Dilution Factor |
| DL | Indicates test performed by RMB Environmental Laboratories - Detroit Lakes |

# RMB Environmental Laboratories, Inc.

Bloomington, MN 1.888.200.5770 | Detroit Lakes, MN rmbel@rmbel.info | Hibbing, MN www.rmbel.info

# CHAIN OF CUSTODY RECORD

Page 1 of 1

Electronic version available at http://www.rmbel.info/lab/chains-of-custody/

B009957

Client: Soil Engineering Testing, Inc.
Phone #:
Fax #:
Project Name: Hoffman Wind
Project Task Code: 14511
PO/WO #:
Sampler: (print name)
Sampler Phone #
Report to: Tyler Sandoz
Bill to: Tyler Sandoz
Report to Email: tsandoz@soilengineeringtesting.com
Bill to Email: tsandoz@soilengineeringtesting.com

☐ "EQUIS" EDD Lab Format - MPCA Data Submittal

## Analyses Requested

| Lab Code | Station ID/Sample Description | Date | Time | # of Bottles | Sample Method | Start Depth | End Depth | Sample Type | Matrix | Sulfate | Chloride | Redox | Sulfide | Sample Comments: (Equipment Type, Filtration, AIS, Preservation) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | T-02 | 7/28/23 | 7:45 | 1 | SW-SOIL | 1 | 5 | Sample | Soil-Sub | X | X | | | |
| 02 | T-14 | ↓ | ↓ | 1 | ↓ | 1 | 5 | ↓ | ↓ | X | X | | | |
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TS (Initials) In the event that samples are received by the lab at a temperature greater than 6 ° C, I hereby authorize RMB Environmental Laboratories to process the samples as received.

_______ (Initials) In the event that samples are received by the lab at a temperature greater than 6 ° C, please contact client at phone # ________________ before processing samples.

| Relinquished by: (client signature) | Date | Time | Relinquished by Lab: (signature) | Date | Time |
|---|---|---|---|---|---|
| | 7/28/23 | 7:45 | | | |

| Received by Lab: (signature) | Date | Time | Received by Lab: (signature) | Date | Time |
|---|---|---|---|---|---|
| | 7/28/23 | ~~1530~~ 1330 JB | | | |

☒ DOES meet proper sample storage and transportation guidelines
☐ Does NOT meet proper sample storage and transportation guidelines
Explain:
☐ Rcvd on ice ☐ Rcvd at room temp Rcvd Temp: 23.3 ° C
☒ Samples received same day as collection LTG: 01
Comments: Chlorine: No Yes NA

☐ DOES meet proper sample storage and transportation guidelines
☐ Does NOT meet proper sample storage and transportation guidelines
Explain:
☐ Rcvd on ice ☐ Rcvd at room temp Rcvd Temp: ° C
☐ Samples received same day as collection LTG:
Comments:

**BILLING**
Shipping / Courier:
Mileage:
Field Staff:
Equipment:
Other:

**SHIPPING TO LAB**
☐ Speedee
☐ UPS
☐ USPS
☐ FedEx
☑ Hand Delivery
☐ Courier
☐ RMB Courier

**INTERLAB SHIPPING**
☐ Speedee
☐ UPS
☐ USPS
☐ FedEx
☐ Courier
☐ RMB Courier

CMH 08/01/23

# Appendix D

MFAD Input Design Parameters

**Westwood**

# MFAD Input Design Parameters
## Hoffman Wind Project(3)(4)

| Boring ID | Depth to Groundwater (ft) | Depth (ft) | Model | Total Unit Weight (pcf) | Modulus of Deformation (ksi) | Friction Angle (deg) | Undrained Shear Strength or Rock Cohesion (ksf) | Rock / Concrete Bond Strengh (ksf) | Allowable Skin Friction (ksf)(1) | Allowable End Bearing (ksf)(1) |
|---|---|---|---|---|---|---|---|---|---|---|
| SUB-01 | 10 | 0 - 2 | Ignore due to moisture change/scour. | | | | | | | |
| | | 2 - 5 | Soil | 110 | 0.6 | - | 1.00 | - | 0.15 | - |
| | | 5 - 8 | Soil | 120 | 0.9 | - | 1.50 | - | 0.20 | 3.0 |
| | | 8 - 10 | Soil(2) | 140 | 10 | 42 | - | - | - | 20 |
| | | 10 - 20 | Rock | 165 | 160 | 30 | 2.10 | 19 | - | 30 |

**Notes:**

(1) A safety factor of 2.0 has been applied for skin friction and 3.0 for compressive end bearing.

(2) Some rock was modeled as soil due to a high degree of weathering/fractures, thick soil seams/infilling, or potential boulder.

(3) If the foundation is bearing on rock, only end bearing is to be used for axial design.

(4) If the foundation design embedment depth relies on bearing in competent bedrock, the foundation should be socketed a minimum of 1.0 times the foundation diameter into competent rock. Shallower rock sockets may be acceptable if the design does not rely on the rock strength for axial or lateral support. Soil and rock conditions, along with MFAD capacity and deflection values, should be considered when determining embedment into rock.