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## Attachment E

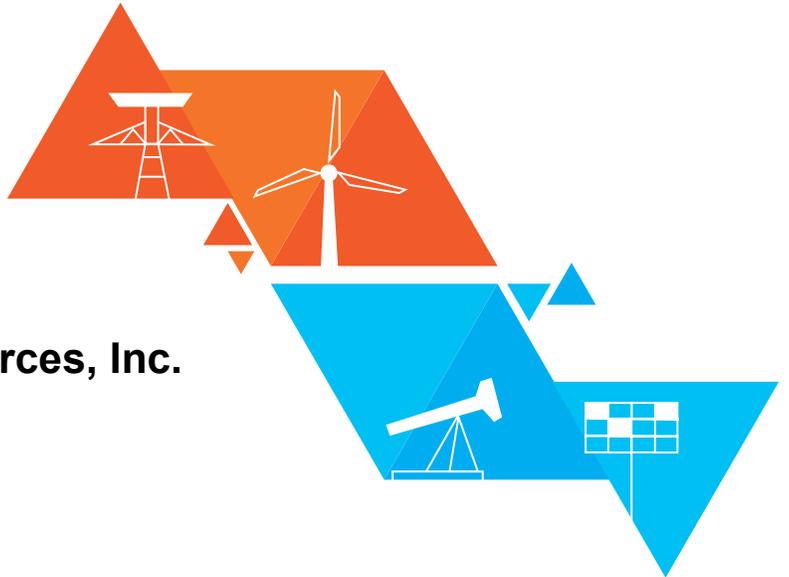
Geotechnical Evaluation

CONFIDENTIAL

# Geotechnical Report

Longspur Wind Project  
Morton County, North Dakota

PREPARED FOR  
**Minnesota Power**  
c/o Allete Renewable Resources, Inc.



Prepared By:



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RRC Project No. GE2503026  
September 19, 2025

**experience matters**



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September 19, 2025

Minnesota Power  
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30 Superior Street  
Duluth, MN 55802

Attn: Mitchell Bettenhausen

**Re: Geotechnical Report  
Longspur Wind Project  
Morton County, North Dakota  
RRC Project No. GE2503026**

RRC Power & Energy, LLC (RRC) has completed the authorized subsurface exploration and geotechnical engineering evaluation for the proposed Longspur Wind Project. The purpose of this geotechnical engineering study was to explore and evaluate the subsurface conditions at various locations on the site and develop geotechnical design and construction recommendations for the project. The attached report contains:

- A description of our findings from the field exploration and laboratory-testing program;
- Our engineering interpretation of the results with respect to the project characteristics; and
- Geotechnical engineering parameters for the design of foundation systems and access roadways.

Should you have any questions concerning this Geotechnical Report, please do not hesitate to contact us. Your business is always appreciated.

Sincerely,

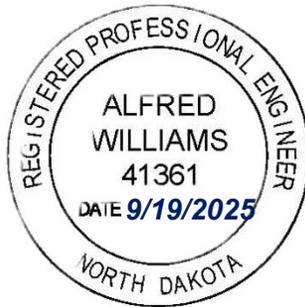
**RRC Power & Energy, LLC**

A handwritten signature in black ink, appearing to read "Manoj Keerthipati".

Manoj Keerthipati, P.E.  
Geotechnical Engineer

**REVISION HISTORY**

Revision	Description	Performed by	Reviewed by	Issued Date
0	Draft Geotechnical Report	Manoj Keerthipati	Alfred Williams	6/19/2025
0	Final Geotechnical Report	Manoj Keerthipati	Alfred Williams	9/19/2025



Prepared and Submitted by

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Reviewed by

Alfred Williams, P.E.  
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**FIRM REGISTRATION NO. ND 1788PE**

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# GEOTECHNICAL REPORT

## 1.0 INTRODUCTION

RRC Power and Energy LLC (RRC) has completed the authorized subsurface exploration and geotechnical engineering evaluation for the proposed Longspur Wind Project. This Report includes subsurface information and geotechnical design recommendations. The site is located 5 miles north of the City of Glen Ullin, in Morton County, North Dakota. The approximate boundaries of the project site are shown on Figure 1, Site Location Map.

The purpose of this geotechnical investigation and report was to:

- Explore subsurface soil, bedrock, and groundwater conditions;
- Conduct field and laboratory tests to characterize the subsurface soil and bedrock properties at selected locations across the site; and
- Provide geotechnical engineering parameters for the design of foundation systems and access roadways.

## 2.0 PROPOSED CONSTRUCTION

It is understood that the Longspur Wind project will consist of 67 wind turbine generators (WTG). The WTGs will be comprised of VESTAS 4.5 MW, 163-meter rotor diameter models with a hub height of 113 meters. The project team anticipates WTGs will be supported on gravity foundation systems with an embedment depth of about thirteen (13) feet below finished grade. RRC assumes finished turbine pad grade is at or slightly above current existing site grade.

## 3.0 SITE EXPLORATION

Facilities associated with the project are anticipated to include electrical collection lines, overhead transmission lines, MET tower, Permanent Meteorological Mast (PMM), substation, operations and maintenance (OM) building, and access roadways. Private-access roadways will most likely be surfaced with imported road-base materials from nearby quarry pits.

The exploration was based on turbine Array Turbine/Boring ID (L011\_04.26.25) which included 67 turbines, a substation, transmission line, MET tower, PMM structure, ADLS and an O&M building. Laboratory and geophysical data completed as part of the initial investigation is included within the appendices of this report.

RRC's complete subsurface exploration program consisted of:

- Drilled 67 borings at WTG locations;
- Drilled 10 borings and 14 Hand Auger borings at the substation;
- Drilled 18 borings along the Transmission Line;

- Drilled 1 borings at the MET tower location;
- Drilled 3 borings at Permanent Meteorological Mast (PMM) locations;
- Drilled 1 boring at ADLS location;
- Drilled one boring at the O&M Building;
- Installed 4 temporary piezometers at select WTG locations and 1 temporary piezometer within the substation;
- Obtained bulk samples at 14 locations for laboratory thermal resistivity (TR) testing;
- Obtained bulk samples at 2 locations for California Bearing Ratio (CBR) testing;
- Completed 18 Electrical Resistivity (ER) surveys; and
- Completed six Multi-Channel-Analysis-of-Surface-Waves (MASW) surveys.

Figures 1 to 13 in Appendix A consist of maps for the various borings relative to sample, geophysical survey and thermal resistivity test locations, site geology, and soil survey and groundwater data. A summary of subsurface exploration is provided within Table A2 within Appendix A.

### 3.1 Field Exploration and Testing

RRC geologists staked the boring locations using GPS coordinates provided by Allette Renewable Resources, Inc. Drill crews under RRC's direction drilled the borings within 15 feet of each staked location.

The borings were advanced with truck and track mounted drill rigs utilizing continuous flight hollow stem augers. During the field operations, the drill crew observed for groundwater levels. Following the completion of the drilling operations, the drillers backfilled each bore with soil cuttings in accordance with state regulations. At some locations, we added bentonite chips to supplement the soil cuttings.

Standard Penetration Test (SPT) samplers obtain disturbed soil samples. RRC documented each penetration resistance value in accordance with *ASTM D1586: Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*. This test consists of driving the sampler into the ground with a 140-pound hammer free-falling 30 inches. The number of blows required to advance the SPT sampler 18 inches is counted and recorded, with the sum of the blows to drive the last 12 inches referred to as the standard penetration resistance value (N-value). Results of the field tests are shown on the logs of boring under the "Field Data" column and are preceded by the letter "N." Each soil sample from the SPT samplers collected in the field were visually classified, placed in plastic bags to preserve moisture content, and labeled as to location and depth. All SPT samples were arranged in core boxes and transported to our laboratory facility in Round Rock, Texas for further analysis.

RRC's field geologist directed sampling of cohesive soils at selected depths using Shelby tube samplers. These are 3-inch (OD) diameter stainless steel, thin-walled tubes in accordance with *ASTM D1587: Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical*

Purposes. The intent of this sampling technique is to obtain relatively undisturbed samples. Soil samples obtained using Shelby tubes were tested for consistency utilizing a pocket-sized penetrometer, with the reading included on the log of boring, as identified by the preceded letter "P." Readings in excess of 4.5 tons per square feet (tsf), if any, indicate that the capacity of the device has been exceeded. Note that the penetrometer reading is only an approximation of general cohesion. Pocket penetrometers are not a measurement for either shear strength, unconfined compressive strength, or bearing capacity.

Modified California (MC) split-spoon samplers were used to obtain relatively undisturbed samples of both cohesive and non-cohesive soils. RRC's field geologist and/or field engineer directed drill crews to obtain these samples at intermittent locations. The Modified California sampler is similar to the SPT sampler except that the Modified California sampler obtains 2.5-inch diameter samples in a steel sleeve. The Modified California sampler is driven like the SPT sampler and the blow counts are counted and recorded similarly. Results of the field tests are also shown on the Logs of Boring under the "Field Data" column and are preceded by the letter "N". When conducting an analysis of the stratum, a correlation is needed to convert the Modified California N-value to an SPT N-value. For 3-inch outside diameter MC sampler, conversion factor is in the range of 0.45 (Lacroix and Horn, 1773 method) to 0.65 (Burmister, 1948 method). Based on the experience, RRC uses a conversion factor of 0.5 when performing soil density analysis of N-values for the Modified California sampler. A plastic cap was placed on each end of the Modified California sample to seal the sample's moisture. The sample was labeled as to location and depth. All Modified California samples were arranged in core boxes and transported to our laboratory facility in Round Rock, Texas for further analysis.

RRC classifies soils in general accordance with the Unified Soil Classification System (USCS); *ASTM D2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*. The soil and bedrock classification symbols appear on the logs of boring and are briefly described in Appendix A. Bedrock materials were classified in general accordance with the general notes for rock classification included as part of *ASTM D5878: Standard Guides for Using Rock-Mass Classification Systems for Engineering Purposes*.

RRC's field geologist prepared field logs for each boring. The logs of boring contain classification of the materials encountered during drilling as well as interpolation of the subsurface conditions between samples.

The project engineer/geologist reviewed all the field logs, soil samples, and lab test data to make appropriate modifications to the logs of boring, as necessary. Final Logs of Boring and laboratory testing completed to date are provided in Appendix A. The logs of boring describe the strata encountered, their approximate thickness, SPT results, soil and rock classifications, the various depths at which the samples were obtained, as well as the presence of groundwater.

Temporary piezometers were installed at five locations to allow for subsequent groundwater measurements. We installed the piezometers to an approximate depth of 18-feet below the ground surface. Each piezometer consisted of either 1 or 2-inch diameter schedule 40 PVC pipe.

We situated the piezometers an offset distance of about 5 to 10 feet from the boring location. The piezometers include a bottom screen/slotted section that is 5-feet long and backfilled with sand that extends about one-foot above the screened section. The remainder of the piezometer is 15-feet of PVC that extends two-feet above ground. We used bentonite to backfill the upper portion of the piezometer. Groundwater levels measured to date within the temporary piezometers are discussed in Section 4.4 of this report. At locations where piezometers were not installed the borings were backfilled with soil cuttings in accordance with the state of North Dakota regulations. The temporary piezometer locations are mapped on Figure 13 in Appendix A.

### **3.2 Laboratory Tests**

The soil samples were returned to the laboratory, examined by the project engineer/geologist, and applicable laboratory testing was assigned on selected soil samples. Laboratory testing was performed in general accordance with ASTM and locally accepted practices. The following laboratory methods of analyses were generally utilized, where sample quality allowed:

- Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System): ASTM D2487;
- Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass: ASTM D2216;
- Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils: ASTM D4318;
- Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75- $\mu$ m) Sieve: ASTM D1140;
- Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort: ASTM D698;
- Standard Test Methods for Unconfined Compressive Strength of Cohesive Soils: ASTM D2166;
- Standard Test Methods for CBR (California Bearing Ratio) of Laboratory-Compacted Soils: ASTM D1883;
- Standard Test Method for Measurement of Soil Resistivity using the Two-Electrode Soil Box Method: ASTM G187;
- Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing: ASTM G51; and
- Sulfate and Chlorides Content: EPA 300/300.1.

## **4.0 SUBSURFACE CONDITIONS**

### **4.1 Geology**

The geologic interpretations contained herein are based on available geological maps and literature, and review of the logs of excavation as part of this study. The Longspur Wind project site is located within the Missouri Plateau Section of the Great Plains Province, which includes western Northern Dakota, western South Dakota, northeastern Wyoming, and Montana. It is an area characterized by generally low relief with gentle slopes interrupted by low buttes and ridges.

The northern half of the site is glaciated, while the lower half of the site is unglaciated. (Reference 1).

At the project site, bedrock includes thick beds of Tertiary aged sandstone (Reference 2). The bedrock is covered by thin surficial unconsolidated sediments composed mostly of silt, clay, and sand. These are river, lake, and swamp deposits that range from 10 to 30 feet in thickness (Reference 2).

The Geologic map of North Dakota: U.S. Geological Survey, scale 1:500,000 (Reference 2) indicates the bedrock materials of the site consist of the following geologic units of the listed geologic time periods.

### Quaternary Period

- **Oahe Formation River Sediment (Qor):** This unit consists of river and stream sediments made of dark clay and silt. The sediments are bedded and overlies crossbedded sand. It is on the plains of modern streams. The thickness of this unit ranges from 10 to 30 feet.

### Tertiary Period

- **Golden Valley Formation (Tg):** The upper part of the unit contains yellowish brown micaceous sandstone and fluvial sediments consisting of sand, silt, and clay. The lower part of the unit consists of white or yellow clay, silt, and sand. This unit is about 265 feet.
- **Sentinel Butte Formation (Ts):** This unit consists of river, lake, and swamp sediments containing grayish brown silt, sand, clay, sandstone, and lignite. This unit is 600 feet thick.
- **Bullion Creek Formation (Tb):** This unit consists of river, lake, and swamp sediments containing yellowish brown silt, sand, clay, sandstone, and lignite. This unit is 600 feet thick.

Figure 6 and Figure 7 in Appendix A shows the geologic units within the project site.

## 4.2 Subsurface Stratigraphy

As indicated on the logs of boring, the soil stratigraphy at the site generally consisted of topsoil underlain by either clay or sand layers.

The soil layers can generally be described as:

- Soft to hard, Lean and Fat Clay soils with varying amounts of sand and gravel.
- Medium stiff to hard, Silt soils with varying amounts of sand and gravel.
- Dense sands with varying amounts of silt, clay and gravel.

Bedrock where encountered, consisted of sandstone, shale, and mudstone.

Lignite seams/layers were also noted in some of the borings. Approximate thickness and consistency of these seams/layers are noted on the logs of boring within Appendix A.

Detailed Logs of Boring present detailed stratum descriptions, soil classifications, types of sampling used, laboratory test data, and additional field data. Bore logs are presented in Appendix A. The lines separating stratum types on the Logs of Boring do not necessarily represent distinct lines of demarcation because transitions can be gradual. The Boring Log Key, defining the terms and descriptive symbols used on each log of boring, is also presented in Appendix A

### 4.3 Laboratory Test Results

RRC obtained the service of Beyond Engineering & Testing, LLC to conduct laboratory tests. Lab test results completed to date are presented below and discussed in subsequent sections.

Laboratory test results indicate the native soils possess in-situ moisture contents in the range from about 2 to 55%, with an average of 19%.

The native soils have Plasticity Indices (PI) ranging from non-plastic to 48%. Clay soils with a PI less than 15 are generally considered to exhibit a low expansive potential provided their moisture contents are stable. High plasticity clay soils with a PI greater than 25 are generally considered to exhibit a high expansive potential if their moisture contents undergo a significant moisture change

We performed 14 moisture/density relationships (proctors) to determine the maximum dry unit weight and optimum moisture content in accordance with ASTM D698 (standard method). We also conducted Atterberg Limits on these samples to assess the soil type. A summary of the test results is presented below.

**Table 4.3.1 Summary of Proctors and Atterberg Test Results**

Sample Location	Depth (feet)	Material Type	Liquid Limit (%)	Plasticity Index (%)	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)
GEO-01	2 to 4	CH	63	41	99.5	22.2
GEO-08	2 to 4	CH	57	38	107	18.2
GEO-10	2 to 4	CH	71	47	92.4	27.6
GEO-19	2 to 4	CL	30	12	111.8	16.3
GEO-22	2 to 4	SC-SM	22	6	115.6	12.7
GEO-33	2 to 4	CH	61	42	100.4	20.8
GEO-46	2 to 4	CL	41	23	112.1	15.4
GEO-48	2 to 4	CH	71	48	99.1	20.7
GEO-53	2 to 4	CH	54	35	103.1	19.5
GEO-59	2 to 4	CH	54	34	104.8	20.2
GEO-62	2 to 4	SC	26	8	113.9	12.3
GEO-67	2 to 4	CL	43	22	105.9	18.1
GEO-70	2 to 4	CH	61	41	100.6	20.8

Sample Location	Depth (feet)	Material Type	Liquid Limit (%)	Plasticity Index (%)	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)
SUB-2	2 to 4	CL	37	23	116.1	13.7

Notes: pcf = pounds per cubic foot; CL = Lean Clay; CH = Fat Clay; SC = Clayey Sand, SM = Silty Sand;

Results of Unconsolidated-Undrained Triaxial (UU) Compression testing are presented in Table 4.3.2. These tests are performed in accordance with ASTM D2166 on relatively undisturbed samples.

**Table 4.3.2 Summary of UU Triaxial Test Results**

Sample Location	Depth (feet)	Material Type	Confining Pressure (psi)	In-situ Dry Unit Weight (pcf)	Undrained Shear Strength, $s_u$ (psf)
GEO-04	12	CL	10.0	103.0	1,960
GEO-07	12	CL	10.0	99.0	6,920
GEO-46	12	CL	10.0	104.0	6,210
GEO-62	12	CL	10.0	105.0	4,510
GEO-66	12	SC	10.0	104.0	6,240
SUB-3	4	CL	3.0	108.0	1,620
OMM-1	7	SC	5.5	100.0	320

Notes: pcf = pounds per cubic foot; psf = pounds per square foot; CL = Lean Clay; SC = Clayey Sand.

Results of Unconfined Compressive Strength (UC) tests are presented in Table 4.3.3. These tests are performed in accordance with ASTM D2166 on relatively undisturbed samples.

**Table 4.3.3 Summary of Unconfined Compressive Strength Test Results**

Sample Location	Sample Type	Depth (feet)	Material Type	In-situ Dry Unit Weight (pcf)	In-situ Moisture Content (%)	Undrained Shear Strength, $s_u$ (psf)
GEO-01	MC	14	CL	111.2	20.2	5,280
GEO-04	ST	19	CL	102.3	22.1	2,600
GEO-33	MC	17	CL	111.3	16.6	9,450
GEO-36	ST	17	CL	92.9	29.9	940
GEO-37	ST	12	CL	65.1	47.0	2,660
GEO-69	ST	12	CL	95.1	24.8	4,600

Notes: pcf = pounds per cubic foot; psf = pounds per square foot; MC = Modified California; ST = Shelby tube; CL = Lean Clay.

Results of swell test performed in accordance with ASTM D4546 are presented in Table 4.3.4.

**Table 4.3.4 Summary of Swell/ Collapse Test Results**

Sample Location	Depth (feet)	Material Type	Dry Density (pcf)	Moisture Content (%)	Surcharge Load (psf)	Collapse Strain (%)
SUB-6	4	SM	101.2	18.8	500	-0.8

Notes: pcf = pounds per cubic foot; SM = Silty Sand.

We performed two California Bearing Ratio (CBR) tests on select samples. The test specimens soaked for 96 hours prior to the CBR load test. A summary of the CBR test results is presented in Table 4.3.5. Design CBR values represent strength at 95% compaction relative to the maximum dry density as determined by ASTM D698. CBR increases with increased density.

**Table 4.3.5 Summary of CBR Test Results**

Sample Location	Depth (feet)	Material Type	Design Dry Unit Weight (pcf)	Design CBR (%)
GEO-48	1 to 4	CH	94.1	0.8
GEO-62	1 to 4	SC	108.2	8.2

Notes: pcf = pounds per cubic foot; CH = Fat Clay; SC = Clayey Sand.

Results of water-soluble sulfate and chloride testing performed on shallow soil samples are presented in Table 4.3.6.

**Table 4.3.6 Summary of Sulfate and Chloride Contents**

Sample Location	Depth (feet)	Material Type	Chloride Contents (% by weight)	Sulfate Contents (% by weight)
GEO-04	1 to 13	CL	0.008	0.222
GEO-10	1 to 13	CH	0.008	0.0672
GEO-25	1 to 13	CL	0.0059	0.26
GEO-50	1 to 13	CL/CH	0.0079	0.439
GEO-64	1 to 13	CL	0.0076	0.2740
SUB-3	1 to 4	CL	0.0305	0.0240

Notes: CL = Lean Clay; CH = Fat Clay.

Results of Minimum Soil Box Resistivity and pH tests performed on shallow soil samples are summarized in Table 4.3.7.

**Table 4.3.7 Summary of Minimum Soil Box Resistivity and pH Tests**

Sample Location	Depth (feet)	Material Type	Minimum Resistivity (ohm-cm)	pH
GEO-04	1 to 13	CL	589	7.1
GEO-10	1 to 13	CH	746	6.6
GEO-25	1 to 13	CL	455	7.5
GEO-50	1 to 13	CL/CH	408	7.6
GEO-64	1 to 13	CL	294	7.3
SUB-3	1 to 4	CL	805	9.1

Notes: CL = Lean Clay; CH = Fat Clay.

A summary of laboratory tests is presented in Appendix B.

#### 4.4 Groundwater Conditions

Based upon information obtained from the borings drilled to date and historical water data for the region, it is RRC's opinion static groundwater level will affect the construction and design of shallow gravity foundation systems at select locations. Groundwater was encountered at the time

of drilling at depths in the range of about 7 to 49 feet below site grade in 37 of the 115 borings completed as part of this study. Groundwater observations for each WTG location are presented on Table A1 in Appendix A.

Temporary piezometers were installed within the foundation footprint of four select turbine sites and within the substation area to facilitate additional groundwater level measurements. Based on water measurements collected to date, the groundwater table (GWT) in 5 piezometers were found to be at depths in the range of about 1 foot to 12 feet below existing site grade. Groundwater level measurements in the piezometers were recorded immediately after installation, and approximately 24 to 72 hours after installation. A summary of the groundwater levels measured in the piezometers are presented in Table A4 within Appendix A.

RRC reviewed published water well logs for Morton County, North Dakota that were available from the North Dakota Department of Water Resources. Historical water well logs surrounding the project site reported ground water levels between 1.4 and 278.8 feet below the ground surface. The shallowest groundwater level was recorded in the year 2020 at about 1.4 feet below the ground surface at Well Report No. 9006.

It is important to note that water well records may not accurately represent seasonal fluctuations in static groundwater level or perched groundwater conditions, which should be considered during WTG foundation design.

It is also imperative to note that short-term groundwater level observations presented in this study are not an accurate evaluation of the variable groundwater conditions that may be present at each of the turbine locations. This Report is not to be interpreted as a comprehensive groundwater study. Groundwater levels are highly dependent on climatic and hydrologic conditions before and after construction, and site development including irrigation demands, drainage and other factors. As such, the presence of water during construction may vary relative to this report. It is understood that the presence of groundwater may influence certain construction activities and long-term performance of foundations and pavements; if a detailed groundwater study is desired, a groundwater hydrologist should be retained to perform these services.

RRC recommends implementing a groundwater level monitoring program to assess the impact of shallow groundwater levels on foundation design and construction.

## **4.5 Geohazard Assessment**

The following subject items represent geologic or physical hazards to the project. Within each subject, we address the level of risk associated with the particular hazard to the project.

### **4.5.1 Flood Hazard**

The Federal Emergency Management Agency (FEMA) has not completed a study to determine the flood hazard for Morton County, North Dakota.

The project civil engineer should review the structure locations within the project site, especially for those located near drainage features to verify if additional studies are needed. The design of

flood-proofing as well as the need for scour/erosion protection is the responsibility of the project Civil Engineer or Hydrology Engineer.

#### **4.5.2 Expansive Soils**

Based upon review of the logs of boring, laboratory testing results, available geological maps and literature, expansive soils are anticipated to be encountered across the project site. Expansive soils have a potential to shrink or swell when the moisture content is allowed to change significantly. WTG foundations are anticipated to have an embedment depth of approximately 13 feet, which is likely beyond the depth of moisture variations for this project site. It is our opinion that expansive soil will not cause significant movement for WTG foundation systems. The potential of expansive soils negatively impacting WTG foundations can be considered as a low risk. It is imperative that the exposed subgrade is not allowed to dry out significantly prior to concrete seal slab placement.

#### **4.5.3 Soil Collapse Due to Windblown Soils**

The project site can be classified as having a low susceptibility risk of collapse prone soils. Soil collapse is a geological feature associated with windblown soils. Windblown soil particles can be angular and when deposited lightly, they can form with high void ratios. Windblown soil is also quickly deposited and may become partially cemented. Both of these factors tend to preserve the high void ratio. When wetted and loaded, these soils can then collapse. Typically, we can identify these soils by low SPT N values and low dry densities.

Based on the log of borings and publicly available geological mapping within the project area, the potential for soil collapse is considered low.

#### **4.5.4 Frost Penetration Depth**

Based on Reference 3, the average frost penetration depth for Morton County is approximately 48 inches. Therefore, we recommend that the spread or strip footings at the site should have a minimum embedment of 48 inches below finished site grade for confinement and frost penetration.

#### **4.5.5 Corrosion Potential**

Published maps indicate that surficial soils within the project site have a low to high risk for concrete corrosion. Figure 10 in Appendix A is a map that attempts to indicate concrete corrosion risk boundaries. RRC cautions that this published map only estimates the boundaries based on soil types and cannot be precise. Based on the lab testing completed, the soils within the upper 12 feet exhibit, the risk for concrete corrosion is low to moderate..

Published maps indicate that the project site has a low to high risk for steel corrosion. Refer to Figure 11 for approximate steel corrosion risk boundaries. Again, we caution that this map is not precise and are only generalizations based on soil types. Based on the lab testing completed, the soils within the upper 12 feet exhibit "Very Corrosive" electrical characteristics with regards to galvanic corrosion of steel.

Section 5.4 discusses in greater detail laboratory test results for concrete and steel corrosion.

#### **4.5.6 Karst Potential**

Water soluble rocks located near or exposed at the surface have potential for development of karst and dissolution features. Rocks or mineral deposits, such as limestone, dolomite, gypsum/anhydrite, and salt are all susceptible to dissolution when in contact with circulating water. These soluble deposits pose the greatest risk when located within 20 feet of the ground surface, and a moderate risk when located within 20 to 100 feet of the surface. Based upon review of geologic maps and literature, bedrock formations of this project area predominately consist of sandstone, shale and mudstone, which are typically not subject to karst and dissolution features.

Based upon review of the logs of boring, available geological maps and literature, karst potential can be considered low.

#### **4.5.7 Slope Stability**

Within the project area, the site consists of broader flat to gently rolling plains. Where most of the site exhibits gradual to moderate slopes, occasional steeper slopes may exist near drainage features. For native slopes greater than 2.5:1 (horizontal:vertical), RRC recommends that the turbines are offset one foundation diameter or more from the slope crest; otherwise, it is recommended that a detailed slope stability analysis be performed. Based on current existing site topography and RRC's observations during the geotechnical field exploration, slope stability is not anticipated to be a major concern for this project site, assuming minimum site grading occurs during construction phase.

#### **4.5.8 Seismicity Hazards**

North Dakota is generally a region of relatively low seismicity. At the project area, the site modified peak ground acceleration ( $PGA_m$ ) was computed to be 0.039 g for Site Class D. This is based on the *Hazards Program*, a web-based program developed by the ASCE Hazard Tool (Reference 5) in accordance with ASCE 7-16. Based on the 2021 IBC (Reference 4), the Seismic Design Category for the site is anticipated to be category "A". Therefore, the seismic hazard risk is considered very low at the project site.

### **4.6 Geophysical Properties**

RRC performed One-Dimensional Multi-Channel Analysis of Subsurface Waves (MASW) surveys at 6 WTG locations. The purpose of MASW surveys is to obtain shear wave velocity ( $V_s$ ) profiles. The MASW survey locations are mapped on Figure 5 in Appendix A. The MASW survey methodologies and results are discussed in Section 4.6.1.

RRC also completed Earth Electrical Resistivity (ER) surveys at 18 locations across the site, including five surveys within the substation area. The test locations are mapped on Figure 5 in Appendix A. RRC conducted these surveys using the Wenner four-pin method. The electrical resistivity survey methodologies are presented in Section 4.6.2.

#### **4.6.1 MASW Survey**

The Multi-Channel-Analysis-of-Surface-Waves (MASW) method is a non-intrusive/non-destructive technique which uses Rayleigh waves to evaluate the stiffness of subsurface strata. Rayleigh waves of different wavelengths (or frequencies) travel at different velocities as they

propagate through different soils. The waves also bounce along the surface of different layers, called dispersion. MASW reports are presented in Appendix C.

For a 1-D MASW survey, twenty-four geophones with a 5-foot spacing are laid out in a linear array. The total length of the array is approximately 115 feet. A 16-pound sledgehammer striking a metal plate is employed as the seismic source located 10, 25 and 40 feet away from the first geophone. RRC uses SurfSeis 4.04 software to collect and process the seismic data.

The shear wave velocities are used to determine certain soil and bedrock characteristics based on simple equations. For example, the soil/bedrock shear modulus can be calculated using the following equation:

$$G = \rho V_s^2$$

Where:  $G$  = Shear Modulus (psf);  
 $\rho$  = Mass density (pcf/(ft/sec.<sup>2</sup>)); and  
 $V_s$  = Shear wave velocity (ft/sec.)

Young's Modulus,  $E$ , can also be calculated from the shear wave velocity data using the following equation:

$$E = 2G(1 + \nu)$$

Where:  $E$  = Young's Modulus (psf);  
 $G$  = Shear Modulus (psf); and  
 $\nu$  = Poisson's Ratio.

The weighted average is calculated based on the following formula based on the 2021 International Building Code (IBC) (reference 4):

$$\bar{V}_s = \frac{\sum_i^n d_i}{\sum_i^n \frac{d_i}{V_{si}}}$$

Where:  $d_i$  = Thickness of any layer between 0 and 100 feet; and  
 $V_{si}$  = Shear wave velocity of a layer.

Note the measured shear wave velocity using MASW may not be available down to a depth of 100 feet. In the case where measured shear wave velocity is less than 100 feet, the weighted shear wave velocity is calculated based on available depths.

To determine the rotational stiffness of the underlying soil and bedrock, the parameters outlined in Table 4.6.1.1 can be used to compute the elastic and shear moduli. These values are generic values from published sources and typical for the respective soil type.

**Table 4.6.1.1 Recommended Soil Parameters for Rotational Stiffness**

Soil/ Material Type	Poisson's Ratio <sup>(1)</sup>	Average Total Unit Weight (pcf) <sup>(1,2)</sup>
Saturated Clay and Silt Soils	0.45	115
Unsaturated Clay and Silt Soils	0.35	105
Loose to Medium Dense Sand Soils	0.35	115
Medium Dense to Dense Sand Soils	0.30	120
Structural Fill	0.30	120
Bedrock	0.30	165

Note: (1) Based on Reference 6 (see page 123 for Poisson's ratio and page 163 for unit weight).  
(2) Based on laboratory measurements (see Section 4.3).

Computed parameters from the MASW surveys represent soil behavior at small strain. The foundation designer should incorporate appropriate reduction factors to determine the rotational stiffness of the foundation system. The MASW survey results completed to date are included in Appendix C.

#### 4.6.2 Earth Electrical Resistivity Surveys

RRC performed a total of 18 field electrical resistivity (ER) surveys using the Wenner 4-pin array method. The electrical resistivity surveys were completed at 13 WTG locations and 5 surveys within the substation. The electrical resistivity survey locations are mapped on Figure 5 included in Appendix A. Each survey consists of two perpendicular arrays, both centered at the same location. Results of electrical resistivity surveys are presented in Appendix C.

*Interpretation of the electrical resistivity surveys is beyond the scope of this study and should be performed by the electrical design team.*

#### 4.6.3 Thermal Resistivity of Soils

RRC obtained bulk soil samples at 14 locations to conduct laboratory thermal resistivity (TR) tests. The samples consist of subsurface soils collected at depths of 2 to 4 feet below existing site grade. RRC obtained the services of Beyond Engineering & Testing to conduct laboratory thermal resistivity (TR) tests in accordance with IEEE 442 Method. The test locations are mapped on Figure 5 in Appendix A.

The thermal resistivity tests were performed on remolded samples targeting 92% compaction of the maximum dry density as determined by ASTM D698 at the "as-received" moisture content. Thermal resistivity samples were then tested at a series of moisture contents from "as-received" moisture content to 0% moisture content. The result is a thermal resistivity dry-out curve. Thermal resistivity test results are included in Appendix C.

*Interpretation of the thermal resistivity tests results is beyond the scope of this study and should be performed by the design team.*

## 5.0 GEOTECHNICAL RECOMMENDATIONS

It is understood the Longspur Wind Project will consist of the construction of 67 WTGs and associated facilities, including a substation, transmission line, PMM structure, MET tower and O&M building. We assume WTGs will be supported on gravity foundation systems and will bear on native soils with an embedment depth of about 13 feet below finished grade. RRC assumes finished turbine pad grade is at or slightly above current existing site grade.

The extent and location of site grading is also unknown. RRC should be retained to review the civil drawings and cross-sections for each turbine location and other critical areas along the proposed roadways. This will allow us to evaluate the need for additional studies such as slope stability analyses. If current site grade is changed at a WTG location, we can assess whether our original recommendations apply.

RRC's geotechnical recommendations presented in this report should be verified when information on the foundation design and site grading become available.

### 5.1 General Turbine Foundation Expectations

RRC performed bearing capacity and settlement calculations in general accordance with methodologies outlined in the 2<sup>nd</sup> Edition of *Guidelines for Design of Wind Turbines* (Reference 7). We also used generally accepted standard of care and practice along with experience with similar soil conditions in this type of geological setting. Detailed discussions of bearing capacity and settlement for WTG bearing on native soils are outlined in the following subsections. A summary of anticipated conditions that will require particular attention in the design and construction is presented below:

- RRC based our design parameters and construction recommendations to allow for foundations to bear at about 13 feet below the existing ground surface for an allowable end bearing capacity of 2,500 psf, with a total settlement of 2.5-inches and a maximum differential settlement or tilt potential of 0.15 degree across the foundation. Table A1, *Summary of Foundation Design Net Allowable Bearing Pressure and Design Groundwater Recommendations* in Appendix A provides net allowable end bearing capacity for each turbine site. Some locations are not capable of supporting a net allowable bearing capacity of 3,000 psf. Alternate foundation designs may be required. Otherwise, remediation of the foundation supporting soils is necessary.
- The depths of remediation required to obtain the bearing capacity and/or settlement values listed above are provided in Table A1. RRC assumes an embedment depth of 13 feet or greater. Should an embedment depth of less than 13 feet be used, RRC should be consulted to determine if additional locations require soil improvement to achieve the bearing capacity and/or settlement values listed above. These depths to remediation are based relative to naturally existing grade and foundations bearing about nine feet below grade. If final

elevations result in the foundation bearing at a different depth, then adjustments should be made to the depth of remediation.

- Over-excavation and replacement with structural fill materials may be considered for soil improvement depths up to about 16 feet below existing ground surface, if feasible. For soil improvements greater than 16 feet below existing ground surface, the cost for performing over-excavation and replacement will likely be excessive; therefore, deep soil improvement measures such as Rammed Aggregate Piers (RAP), compaction grouting or other equivalent ground improvement techniques are appropriate.
- It is anticipated excavations may be advanced with conventional earth moving equipment where native soils extend below foundation bearing elevations.
- Excavation contractors and/or underground utility installers should consider performing test pits or probing tests to evaluate proper means and methods for advancing excavations. Potential caving/sloughing within narrow and shallow utility trenches may require sidewalls of trenches to be sloped in order to install utilities. Excavated trench bottoms should be thoroughly cleaned prior to cable placement and backfilling.
- It is crucial to maintain a uniform foundation subgrade support below the turbine foundation to reduce the potential of excessive differential foundation settlement. If compacted structural fill is used below the turbine foundation, the thickness of structural fill below the turbine foundation shall be a minimum of 6 inches; the structural fill thickness shall be kept as uniform as possible with no abrupt thickness change, with an overall thickness difference of 2 feet or less across the turbine foundation footprint. Either the bedrock portion of the foundation subgrade may be excavated, or the lower portion of the soil subgrade excavation may be filled with lean concrete so that the structural fill thickness difference can be kept at 2 feet or less across the foundation width.
- Turbine foundations located adjacent to natural or man-made slopes should be setback laterally from the top of the slope. The minimum setback distance should be 25 feet or one turbine foundation diameter, whichever is larger, away from the edge of foundation to the crest of any natural or man-made slopes. Proper drainage measures should be taken to reduce impacts to man-made cut and fill slopes as well as all undisturbed natural slopes.

It is imperative that a professional geotechnical engineer, or their representative, observe each foundation excavation to verify that the exposed foundation soil bearing conditions meet the intent of this Report. This observation allows the geotechnical engineer to assess the need and limits of removal and replacement. Detailed construction recommendations and/or specifications are outlined in Section 6 of this report.

### **5.1.1 Bearing Capacity and Settlement of Gravity Foundation System**

A net allowable bearing pressure of 3,000 psf can be used for the structural design for turbine foundations bearing directly on undisturbed native soils. The allowable bearing values are based

on a safety factor of three for general shear failure. These net allowable bearing pressure values may be increased by 25% when considering short duration loading conditions such as extreme wind and seismic forces. Some locations will require remedial measures outlined in Section 6 in order to achieve the full allowable bearing pressure.

The estimated total turbine foundation settlement is expected to be about 1.5 to 2.5 inches under normal operating loading conditions at the center of the foundation. The estimated differential settlement or tilt across the foundation diameter is less than 0.15 degrees under both dead load and normal operating loading conditions.

**Table 5.1.1.1 Geotechnical Design Parameters for Gravity Foundation**

Parameters/Soil Type*	Recommended Values
Min. Undrained Shear Strength / Very Stiff Clay	1,500 (psf)
Min. Internal Friction Angle / Sand	30 (deg.)
Min. Net Allowable Bearing Capacity (Normal Operating Load, $F_s=3.0$ )	3,000 (psf)
Poisson's Ratio	0.35

Table 5.1.1.2 presents a summary of Modulus of Subgrade Reaction for different soil, bedrock, and structural fill materials.

**Table 5.1.1.2 Recommended Soil and Structural Fill Design Parameters**

Soil/ Material Type	Friction Coefficient <sup>(1)</sup>	Modulus of Subgrade Reaction, $k_s$ (pci)
Firm Clay Soils	0.35	75
Stiff to Hard Clay Soils	0.35	100
Medium Dense Sand Soils	0.35	150
Dense to Very Dense Sand Soils	0.45	200
Structural Fill Materials (Min. 1-foot thick)	0.45	225

Note: <sup>(1)</sup> If necessary, lateral passive earth pressures can be considered to develop additional resistance. The coefficient of base friction should be reduced to 0.30 when used in conjunction with passive pressure.

To determine the rotational stiffness of the underlying soils/bedrock, the foundation designer should reference the results of the MASW testing performed as part of this study. The results of these surveys completed as part of this study are presented in Appendix C.

### 5.1.2 Overburden Backfill on Turbine Foundation

The use of native soil/rock as backfill materials placed above and against the side of turbine foundations is acceptable. RRC recommends the backfill materials placed over the turbine foundations be compacted to dry densities of at least 95% of the maximum dry density as determined by ASTM D698. This compaction is necessary to support a crane pad, reduce erosion and deter settlement. RRC recommends using an average long-term moisture content of 10% for native soils used as overburden. Contractor should place overburden backfill material in accordance with specifications outlined in Section 6.4.4 of this report.

Using the Standard Proctor tests listed in Table 4.3.1, the recommended overburden backfill unit weight values for turbine foundation design are presented in Table 5.1.2.1 below.

**Table 5.1.2.1 Overburden Backfill Density Range Requirement**

Soil/ Material Type	Dry Backfill Unit Weight Range, $\gamma_d$ (pcf)	Moist Backfill Unit Weight Range, $\gamma_{total}$ (pcf)
Native Soils	88-116	118-134

Note: pcf= pounds per cubic foot;

It should be noted that some turbine sites have shallow surficial soils which are classified as fat clay soils. In areas where fat clay soils are encountered within the foundation excavation zone, increased compaction efforts or mixing with heavier soil may be required to achieve the proposed turbine foundation backfill requirements.

## 5.2 Substation, O&M Building, MET Tower and ADLS Tower Shallow Foundation Systems

Final grade elevations for the Substation, O&M Building, ADLS, and PMM were not available. RRC has assumed the finished grade will be near or slightly above the existing ground surface. Surficial soils at these locations predominantly comprise lean and fat clay soils with varying amounts of sand. These clay soils range from medium stiff to very stiff in terms of consistency.

Shallow foundations shall bear a minimum of 48 inches below the ground surface. 48 inches was selected based on the *Building and Design Criteria* for Morton County, North Dakota. We recommend that continuous footings have a minimum width of 18-inches to allow cleaning, inspection, and placement of rebar.

Shallow foundations embedded 48 inches below the ground surface at the substation, O&M Building, ADLS, and PMM can use a net allowable bearing pressures shown in the tables below. These net allowable bearing capacities include a factor of safety of 3 for general shear failure.

For reinforced concrete slabs bearing at finished grade, we recommend over-excavation of foundation subgrade soils to a minimum of four feet below the finished grade and replacement with non-frost susceptible structural fill material or flowable fill (controlled low strength material) having compressive strength of at least 150 psi. The non-frost susceptible materials should meet the requirements of Section 6.2. The excavation should extend at least four feet beyond the perimeter of the foundation.

**Table 5.2.1 Soil Parameters for Substation**

Parameter	Design Value
Design Groundwater Level below ground surface (ft)	7
Average Total Unit Weight (pcf)	115
Modulus of Subgrade Reaction of Select Fill Pad (pci)	70*
Friction Coefficient at Foundation Base (Native Soils)	0.35
Friction Coefficient at Foundation Base (Structural Fill)	0.45
Net Allowable bearing pressure for Strip or Continuous Footings (psf) bearing 4-feet below ground surface (psf) with 0.5-inch settlement	1,500
Net Allowable bearing pressure for Strip or Continuous Footings (psf) bearing 4-feet below ground surface (psf) with 1-inch settlement	2,000
Net Allowable Bearing Pressure for Continuous and Spread Footings (psf) bearing 4-feet below ground surface (psf) with 0.5-inch settlement	1,500
Net Allowable Bearing Pressure for Continuous and Spread Footings (psf) bearing 4-feet below ground surface (psf) with 1-inch settlement	2,000
Net Allowable bearing pressure for Mat Foundations on earthen pad to 4-feet below ground surface (psf) with 0.5-inch settlement	1,350
Net Allowable bearing pressure for Mat Foundations on earthen pad to 4-feet below ground surface (psf) with 1-inch settlement	1,800

Notes: pcf = pounds per cubic foot; psf = pounds per square foot; pci = pounds per cubic inch.

\* For a 1 ft. x 1 ft. Plate.

**Table 5.2.2 Soil Parameters for O&M Building**

Parameter	Design Value
Design Groundwater Level below ground surface (ft)	18
Average Total Unit Weight, pcf	115
Modulus of Subgrade Reaction of Select Fill Pad, pci	70*
Friction Coefficient at Foundation Base (Native Soils)	0.35
Friction Coefficient at Foundation Base (Structural Fill)	0.45
Net Allowable bearing pressure for Strip or Continuous Footings (psf) bearing 4-feet below ground surface (psf)	2,000
Net Allowable Bearing Pressure for Continuous and Spread Footings (psf) bearing 4-feet below ground surface (psf)	2,000
Net Allowable bearing pressure for Mat Foundations on earthen pad to 4-feet below ground surface (psf)	1,500

Notes: pcf = pounds per cubic foot; psf = pounds per square foot; pci = pounds per cubic inch.

\* For a 1 ft. x 1 ft. Plate.

**Table 5.2.3 Soil Parameters for ADLS Locations**

Parameter	Design Value
Design Groundwater Level below ground surface (ft)	20
Average Total Unit Weight, pcf	115
Modulus of Subgrade Reaction of Select Fill Pad, pci	70*
Friction Coefficient at Foundation Base (Native Soils)	0.35
Friction Coefficient at Foundation Base (Structural Fill)	0.45
Net Allowable bearing pressure for Strip or Continuous Footings (psf) bearing 4-feet below ground surface (psf)	2,500
Net Allowable Bearing Pressure for Continuous and Spread Footings (psf) bearing 4-feet below ground surface (psf)	3,000
Net Allowable bearing pressure for Mat Foundations on earthen pad to 4-feet below ground surface (psf)	2,500

Notes: pcf = pounds per cubic foot; psf = pounds per square foot; pci = pounds per cubic inch.

\* For a 1 ft. x 1 ft. Plate.

**Table 5.2.4 Soil Parameters for PMM Locations**

Parameter	Design Value
Design Groundwater Level below ground surface (ft)	20
Average Total Unit Weight, pcf	115
Modulus of Subgrade Reaction of Select Fill Pad, pci	70*
Friction Coefficient at Foundation Base (Native Soils)	0.35
Friction Coefficient at Foundation Base (Structural Fill)	0.45
Net Allowable bearing pressure for Strip or Continuous Footings (psf) bearing 4-feet below ground surface (psf)	2,000
Net Allowable Bearing Pressure for Continuous and Spread Footings (psf) bearing 4-feet below ground surface (psf)	2,500
Net Allowable bearing pressure for Mat Foundations on earthen pad to 4-feet below ground surface (psf)	2,000

Notes: pcf = pounds per cubic foot; psf = pounds per square foot; pci = pounds per cubic inch.

\* For a 1 ft. x 1 ft. Plate.

Site grading should ensure positive drainage away from the structures. This will prevent pooling of water near the foundations which could result in significant moisture changes of the soils beneath the foundations. Poorly graded sand (classified as SP) and gravel are highly permeable and allow water entry. These soils make poor overburden backfill. If the backfilled material around the structures consists of SP or Gravel, RRC recommends adding a 12-inch-thick clay cap. This clay cap should extend at least five feet beyond the foundation excavation.

### 5.3 Substation, Transmission Line, MET Tower and ADLS Tower Deep Foundation Systems

Structure elements with heavy axial loads and/or large overturning moments may utilize drilled pier foundations. Pier lengths will likely be dictated by overturning resistance. Allowable end bearing pressures and allowable skin friction values for the substation, transmission line and

MET/ADLS tower structures are presented in Appendix D. Allowable end bearing pressures and allowable skin frictions utilize a factor of safety of 3 and 2.5, respectively.

Skin friction values should be reduced by 25% when calculating pull-out resistance, where applicable. Settlement associated with drilled piers is anticipated to be about ½ to 1 inch. For proper installation of steel rebar and to monitor cleanliness, drilled shafts should have a minimum diameter of 1½ feet. The structural engineer should determine the length of the drilled piers to satisfy axial, uplift, and lateral loading.

Lateral load analysis may be performed using the LPILE computer program. LPILE uses a p-y curve finite difference technique for predicting the soil-structure interaction and response. RRC provides detailed LPILE parameters within Appendix D to evaluate drilled piers under lateral loads.

Vertical steel reinforcement to resist tensile loads caused by uplift forces should extend the full length of the pier shaft. Additional reinforcement required by structural demands for axial compressive loads, lateral loads, or minimum reinforcement required by design codes should also be satisfied.

Transmission line pole foundation systems may consist of directly embedded pre-stressed concrete pole foundation systems and would likely be designed using EPRI's MFAD computer software. Compacted granular backfill material in the annulus can be assumed to exhibit the following parameters outlined in Table 5.3.1. These values assume backfill to be compacted to a relative density of 65% or greater.

**Table 5.3.1 Parameters for Compacted Annulus Backfill**

Parameter	Compacted Granular Aggregate
Total Unit Weight (pcf)	125
Internal Angle of Friction (degree)	35
Horizontal Modulus of Elasticity (ksi)	1.6

## 5.4 Corrosivity of Soils

Water-soluble sulfate and chloride test results are presented in Table 4.3.6. The test results indicate the soils in the upper 12 feet possess a “Negligible” to “Moderate” risk for sulfate exposure and corrosion potential to concrete. Published maps indicate that in general, the area has low to moderate risk for corrosion to concrete. Foundation concrete should be designed in accordance with *ACI 318: Building Code Requirements for Structural Concrete and Commentary*.

Minimum Soil Box Electrical Resistivity and pH testing results are presented in Table 4.3.7 of this report. Soil Box Electrical Resistivity results indicate soils within the upper 12 feet exhibit “Very Corrosive” electrical characteristics with regards to galvanic corrosion of steel. Cathodic protection for buried metal pipe should be designed by a qualified corrosion engineer.

**Table 5.4.1 Effect of Soil Box Electrical Resistivity on Corrosion**

Aggressiveness	Resistivity in ohm-cm
Very Corrosive	< 700
Corrosive	700 – 2,000
Moderately Corrosive	2,000 – 5,000
Mildly Corrosive	5,000 – 10,000
Non-Corrosive	> 10,000

## 5.5 Lateral Earth Pressures

Lateral earth pressures will apply in soil strata. The WTG foundations will be designed to resist all lateral movements; therefore, the “at rest” lateral earth pressure will apply. The following “at rest” equivalent fluid pressures are recommended in Table 5.5.1. The lightweight range is more conservative and necessary for the “at rest” and “passive” condition. The heavier weights are more conservative for the “active” condition.

RRC applied unit weights listed in Table 5.2.1.3 for overburden backfill soils with minimal compaction and low moisture content. The lightweight range is more conservative and necessary for the “at rest” and “passive” condition. The heavier weights are more conservative for the “active” condition.

**Table 5.5.1 Equivalent Fluid Pressures**

Soil Type	Condition	Equivalent Fluid Pressure (psf/ft)
Clay Soils $\phi=20$ , $\gamma_t=97$ to 136 pcf	At Rest, $k_o= 0.65$	63 to 88
	Active, $k_a= 0.49$	68
	Passive, $k_p= 2.0$	195
Sand Soils $\phi=34$ , $\gamma_t=103$ to 132 pcf	At Rest, $k_o= 0.44$	41 to 53
	Active, $k_a= 0.28$	40
	Passive, $k_p= 3.5$	365

We note that for clay soils, the angle of internal friction is adjusted to correct for shear versus a lower friction angle. Theoretical correlations for the at-rest coefficient of clays are a property of Plasticity Index. For large variations in clay plasticity, RRC can provide alternate  $k_o$  coefficients. Because we expect that there will only be one foundation design, we expect that the lateral earth pressure will be dictated by the sandy condition.

Passive and active earth pressure resistance will only mobilize after significant movement of the foundation. The passive case occurs where a structural element tends to move into the soil mass. The active case occurs when the element tends to move away from the soil mass. Both cases are applicable for unrestrained foundation elements.

The above earth pressure values do not include safety factors. We recommend a minimum safety factor of 2.0 be applied when using passive earth pressure for lateral load resistance. Surcharge loads should also be considered where appropriate. The values apply only to cases where the ground surface is level. We should be contacted to provide suitable values for cases where the ground surface is sloped. Similarly, if a structure is submerged below water, then the earth pressures change dramatically and require a different analysis.

## 5.6 Seismic Design

RRC provides seismic design using 2021 International Building Code (IBC) (reference 4). Based on Logs of Boring, we recommend using a Site Class D for stiff soils. The Mapped Spectral Response Acceleration for the 1 second ( $S_1$ ) and short periods ( $S_s$ ) were computed using the ASCE Hazard Tool, which is a web-based application program (reference 5). The table below summarizes recommended seismic parameters to be used in the design.

**Table 5.6.1 Recommended Seismic Parameters**

Parameter	Recommended Value
$S_s$ – Mapped Spectral Response Acceleration at Short Period (0.2-Second)	0.053 g
$S_1$ – Mapped Spectral Response Acceleration at 1-Second Period	0.023 g
$F_a$ (Site Coefficient) – Site Class D	1.6
$F_v$ (Site Coefficient) – Site Class D	2.4
Site Modified Peak Ground Acceleration	0.039 g
Seismic Design Category	A

## 6.0 FOUNDATION CONSTRUCTION CRITERIA

### 6.1 Site Preparation

Prior to construction, we recommend adequate positive drainage be provided to maintain a relatively dry condition in the area of proposed construction. This will be very important if any work is attempted during periods of prolonged rainfall or heavy snow fall followed by warmer days. Ponding of water in the areas of construction should be avoided. Winter conditions can also impact the construction process. Newly placed fill should not be placed on frozen subgrade and frozen material should not be used for fill.

During excavation of the turbine foundations, every effort should be made to avoid disturbing subgrade materials at the planned foundation bearing elevation. When the subgrade is disturbed, the resulting surface should be re-compacted to achieve a minimum compaction of 98% of the maximum dry density as determined by ASTM D698 and moisture conditioned within 2% of optimum moisture content or drier. Soft lignite layers encountered at or near foundation bearing elevation shall be removed and replaced with suitable on-site soils or structural fill. A qualified

representative of the geotechnical engineer should verify the stability of the subgrade prior to foundation installation.

## **6.2 Structural Fill Specifications**

Structural fill material beneath foundations, where required, should consist of a non-expansive, well-graded material with sufficient binder for compaction purposes and should be in general accordance with the meets *North Dakota Department of Transportation, Section 816, Aggregate Class 5*, or better. RRC's intent is to make Structural Fill interchangeable with road base.

Structural fill should be compacted to a minimum of 95% of ASTM D1557. The structural fill should be moisture conditioned within 2% of optimum moisture content. Typically, 9-inch lifts are a maximum, but if a contractor can complete thicker lifts and it can be verified that full densification occurs throughout the lift, then lifts to 12-inches are possible.

## **6.3 Native Soils as Select Fill below Foundations**

RRC understands the importance of using native soils whenever feasible. The following specifications allow reasonable native soil reuse while maintaining structural requirements for end bearing capacity and settlement. Modification of unsuitable foundation soils shall consist of over-excavation and replacement with any of the following materials:

All soils that possess the following properties qualify as Select Fill that may be used under foundations: maximum plasticity index of 15 and a maximum liquid limit of 40, and classify as SC-SM, SC, Sandy CL, well-graded GC, and well-graded GS.

Select Fill placement under turbines should be limited to two-feet thick. Deeper replacement must be approved by the Geotechnical Engineer in order to assess settlement potentials for that specific location. Otherwise, use Structural Fill.

When dealing with subgrade pumping, rutting, or moisture, and the remediation has a maximum thickness of 12-inches, then the excavated soils may be scarified and reused to complete the remediation. Deeper remediation requires either Select Fill or Structural Fill.

All reused and Select Fill soils used under foundations shall be compacted to a minimum of 98% of the maximum dry density as determined by ASTM D698 and shall be moisture conditioned within 3% of optimum moisture content.

## **6.4 Turbine Earthwork Requirements**

RRC reviewed each log of boring for the presence of soft to medium stiff clays, loose sand layer(s) and/or non-competent materials below and near the anticipated foundation bearing elevation. In *Table A1, Summary of Foundation Design Net Allowable Bearing Pressure and Design Groundwater Recommendations* within Appendix A, we list locations that we expect will require

remediation. Following are various options and methods to remediate subsurface soils to support the intended gravity foundations. We also present other earthwork requirements related to the turbines, such as overburden backfill and crane pads on overburden fill.

#### **6.4.1 Verification of Turbine Foundation Subgrade**

Prior to placing a mud mat and rebar, the bearing surface should be verified for stability. This verification applies under all soil, fill, or rock conditions. There is a preference to perform a proof-roll test using a fully loaded water truck, or similar equipment. Conduct the proof-roll test in at least two directions with a minimum of two passes per area. Proof-roll tests should not exceed 1-inch of deflection, rutting, or pumping. Areas that fail this proof-roll shall be excavated and the removed soils be recompacted or replaced.

Where the foundation design allows for relatively soft soils with a bearing capacity below 3,000 psf, or where shallow groundwater deters the proof-roll, then the Geotechnical Engineer shall consider alternate verification methods. Alternates might consist of Dynamic Cone Penetrometer for sandy/gravelly soils or Static Cone Penetrometer for clay with low sand content.

#### **6.4.2 Subgrade Remediation Methods**

A representative of the Geotechnical Engineer should observe and verify over-excavations. In some cases, additional over-excavation may be necessary. In some cases, less excavation is sufficient.

In order to disperse the foundation load over a larger area, structural fill pads should be larger than the foundation. Deeper remediation also requires a wider distance. The over-excavated areas should extend laterally a distance such that the edge is at least a distance equal to the pad thickness. Foundation stresses extend downward and outward at a 45-degree angle through the structural fill. For example, a 3-foot thick remediation will require a pad that is 3-feet beyond the edge of the foundation.

If compacted structural fill or select fill is used below the turbine foundation, the fill thickness shall be kept uniform with a maximum thickness difference of two feet across the foundation footprint. This uniform thickness is to deter differential settlement. Where subgrade is a combination of bedrock and soil, then either excavate the rock or replace the soil with lean concrete or structural fill.

It is possible to encounter suitable soils at shallower depths. It is also feasible to verify that suspect soils are suitable to support the foundation design intent. If Table A1 recommends excavation to a depth, it is because this is the anticipated bottom of the suspect stratum. Contractor may choose to conduct additional tests to verify whether the suspect soils meet strength requirements. These tests should extend through the suspect layer. For the stiff and dense soils at this site, RRC can recommend Dynamic Cone Penetrometer (DCP) tests to conduct this verification. Once a foundation design is complete, the geotechnical team can work with the quality assurance team to devise a suitable DCP test procedure and minimum DCP test values.

The stability of the subgrade at foundation bearing elevation may be affected by the proximity to shallow groundwater levels and/or “Perched” Groundwater conditions. In areas where bearing capacity and settlement are not the concern, such as a thin layer of mud, the contractor may establish a stable platform using the following options:

- Dewater the site. Means and methods for dewatering are the responsibility of the contractor.
- Use geogrid/geotextile in combination with structural fill to create a stable surface. Obtain design input from the product manufacturer.
- Use coarse rip rap to bridge wet soils. Compact rip rap to bed the aggregate within the wet soils. Cap the rip rap with compacted structural fill then verify overall stability using a proof-roll method.

It is crucial to maintain a uniform foundation subgrade support below the turbine foundation to reduce differential foundation settlement. In areas where a combination of soil and bedrock are exposed at the foundation bearing elevation, the soil portion should be over-excavated to competent bedrock and replaced with either compacted structural fill or lean concrete having a 28-day compressive strength of 1,000 psi or higher. Do not use select fill or native soils. Alternatively, the entire foundation footprint can be over-excavated for a depth of 2 feet below the foundation bearing elevation and replaced with compacted structural fill.

Should boulders be exposed at foundation bearing elevation during excavation, remove the boulder and replace with structural fill. Foundations bearing on exposed boulders have the potential to create point loads at the bottom of the foundations. This increases differential foundation stress.

#### **6.4.3 Excavated Materials as Overburden Backfill**

The use of native clay and sand soils is acceptable as overburden backfill materials placed above and against the sides of turbine foundations. All backfill should be free of significant organics, roots, and deleterious materials and should be properly processed and compacted. See specifications below.

Overburden Backfill Placement:

- The backfill materials should be placed in loose lifts not exceeding 12 inches.
- Each lift of backfill should be moisture conditioned, compacted, and tested to meet the minimum and maximum dry and moist unit weight values specified in the foundation design drawings. If not on the drawings, refer to Section 5.1.2 of this report for target overburden weights.

- Each lift of backfill materials over turbine foundations should be compacted to dry densities of at least 95% of the maximum dry density as determined by ASTM D698. Even if this level of compaction is greater than the minimum target weights from item 2 above. This compaction reduces fill settlement, erosion, and provides support for the transformer and crane pad.

Poorly graded sand (classified as SP) and gravel is highly permeable and allow water entry. These soils make poor overburden backfill. If overburden material consists of SP or Gravel, then RRC recommends adding a 12-inch thick clay cap. This clay cap should extend at least five feet beyond the turbine foundation excavation. Alternately, the contractor can consider mixing clayey soils into the overburden backfill materials in order to create a less permeable mixture. The Geotechnical Engineer should be allowed to review such mixtures.

The top surface of the backfill should have a minimum 2% drainage slope away from the turbine to allow surface water runoff.

#### **6.4.4 Crane Pads on Overburden**

In areas where crane pads extend over the overburden backfill zone, then the crane operator's bearing capacity requirements also must apply. As a general guideline, RRC suggests a minimum three feet (in thickness) of the overburden backfill below crane pads be compacted to a minimum of 98% of the maximum dry density as determined by ASTM D698 and moisture conditioned within 2% of optimum moisture content. Refer to Section 7.2 of this Report for additional recommendations related to crane pads.

### **6.5 Substation, Transmission Line, MET Tower, PMM, ADLS and O&M Building Structures**

This section provides construction recommendations and specifications related to shallow and deep foundations for structures not consisting of turbines. This section is intended to apply for all electrical substation, switchyard, and transmission line structures. If future, more specific geotechnical studies for those facilities are conducted, then disregard this section and refer to the recommendations in those more specific studies.

#### **6.5.1 Shallow Foundation Construction**

The following construction criteria and general guidance should be observed during foundation construction:

- All foundation excavations should be observed by the engineer's qualified representative to assess proper bearing materials are present at foundation bearing elevation in accordance with the recommendations given herein, and to assess the need for densification of the subgrade materials.
- Care should be taken to protect the exposed soils from being disturbed, freezing or desiccation.

- The foundation excavation should be sloped sufficiently to create internal sumps for runoff collection and removal. Foundation excavations subject to rainfall and possible deterioration from accumulated water should be protected using a protective “mud-slab” (lean concrete). If surface runoff water or groundwater seepage accumulates at the bottom of the foundation excavation, it should be collected and removed and not allowed to adversely affect the quality of the bearing surface.
- The foundation excavations should be checked for size and cleaned prior to the placement of reinforcing steel. Take precautions during the placement of reinforcement and concrete to prevent the loose material from falling into the excavation.

### **6.5.2 Drilled Shaft Foundation Construction**

The following items are important for the successful completion of drilled shaft foundations:

- The engineer’s representative should observe all drilled shaft excavations. This inspection is to verify proper depth, bearing stratum, cleanliness, verticality (plumbness) and to record other observations regarding the drilled shaft construction.
- If water is present within the shaft, it is imperative that the contractor use proper construction methods to account for the water. Either the water must be removed, or the contractor must use tremies or pumps to allow concrete placement under water.
- Prompt placement of concrete in the excavation as it is completed, cleaned, and inspected is strongly recommended. Under no circumstances should a shaft be drilled, that cannot be filled with concrete before the end of the workday.
- The reinforcement steel cage placed in the shaft should be designed to be stable and centered during the placement of concrete.
- Varying subsurface soil conditions may be encountered. A Geotechnical Engineer or his representative should observe subsurface conditions during installation of any drilled piers to verify subsurface conditions match the design criteria.
- Drilled shaft construction should follow applicable industry standard. Means and methods of construction shall be determined by the contractor.

### **6.5.3 Directly Embedded Pole Construction**

The following items are important for the successful completion of directly embedded foundations:

- The Geotechnical Engineer or their representative should observe all excavations. Directly embedded pole construction observations are recommended to observe proper depth, bearing stratum and to record other observations regarding the construction.

- Excavations should be checked for size, and to determine all loose material and free water has been removed prior to the placement of the poles and annulus with crushed rock. Precautions should be taken during the placement of the poles and annulus materials to prevent loose excavated material from falling into the excavation.
- Prompt placement of the pole and annulus material in the excavation as it is completed, cleaned, and inspected is strongly recommended. Under no circumstances should a shaft excavation be drilled that cannot be filled with the pole and annulus material before the end of the workday.
- The pole placed in the shaft excavation should be designed to be stable and centered during the placement of the annulus backfill materials.
- Varying subsurface soil conditions may be encountered. A Geotechnical Engineer or his representative should observe subsurface conditions during installation of any drilled piers to verify subsurface conditions match the design criteria.

## 6.6 Open Excavations

With all excavations in soils, sloped excavations and trench shields are required for excavations greater than four feet in depth. The contractor's "Competent Person" (as defined by OSHA) must inspect each trench wall to determine the type of bench or slope that is required. With all excavations, only a "Competent Person" shall determine whether sloped, benched, or trench shields can be used. OSHA and applicable state and local standards should be observed and followed. Site safety is the responsibility of the contractor. For general planning purposes, RRC offers the following:

- The surficial cohesive clay soils across this site are generally stiff. This soil type classifies as an OSHA Type A material that requires the excavation's sidewall be sloped at 3/4H:1V (or flatter).
- The sandy soils at the site possess low to zero cohesion. This soil type classifies as an OSHA Type B material that requires the excavation's sidewall be sloped at a 1H:1V slope (or flatter). The silt content may give the appearance of cohesion when first excavated, but this is not correct.
- The presence of water within any excavation automatically creates a Type C classification. All Type C class excavations require a 1.5H:1V slope or bench.
- Stable Rock is a natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed, such as Limestone or Sandstone.

Protect construction slopes and permanent embankment slopes from surface runoff water. Design site grading to deter surface water from flowing down unprotected slopes. The contractor should avoid surcharge loads, either static or dynamic, adjacent to an excavation slope. Prevent construction equipment from traveling along or near the top of the excavation slope. The contractor's "Competent Person" must monitor temporary slopes, trenches, and dewatering during construction in order to detect early warnings of movement. Site safety is the responsibility of the contractor.

## **6.7 Drainage and Construction Dewatering**

Proper drainage should be provided away from the foundation elements during all phases of construction and post-construction grading. Proper drainage is essential to the long-term stability of the structures. Ponding of water near the foundation elements from improper drainage should not be permitted.

Based on the available groundwater information, shallow groundwater should not be a concern for WTG foundation excavations. If rain causes perched water conditions, we anticipate the groundwater re-charge rate should be slow enough to conduct excavation dewatering with conventional sumps and pumps.

## **7.0 ACCESS ROADWAYS AND CRANE PADS**

Private access roadways will be built for construction and maintenance purposes. Traffic volumes during construction are anticipated to be frequent with heavy equipment utilizing the access roadways. Following the construction period, the traffic volumes will be light and vehicles accessing the roadways will generally consist of pickup trucks and occasional single and multi-axle truck traffic. The section thickness design should be based upon the methodology outlined by the American Association of State Highways and Transportation Officials (AASHTO) for design of aggregate-surfaced roadways (reference 8).

Crane pads require sufficient bearing capacity to support the large cranes used to lift the turbine sections. The design intent for these crane pads is not related to regular traffic.

### **7.1 Pavement Section Thickness Recommendations**

Based on the field exploration, lean clay, fat clay and clayey sand soils were encountered at the ground surface across the site. Clay soils are considered to be poor subgrades for roadways. The Contractor and the Civil Engineer should coordinate on traffic expectations for different roadways such as to value engineer road design for different areas of the facility.

Soaked CBR tests are compacted to 95% of the maximum dry density at optimum moisture content as determined by ASTM D698. Soaked CBR values of native soils ranged from 0.8% to 8.2%. RRC used a design CBR value of 2.0 %, which is correlated to a subgrade resilient modulus ( $M_R$ ) value of 3,980 psi. It is important to understand that these CBR values are for soils without

topsoil. Leaving topsoil within the road subgrade will significantly reduce the CBR values, thus negating the recommendations below.

RRC anticipates that the project team will use crushed stone for the roadways. RRC recommends using crushed limestone that meets *North Dakota Department of Transportation, Section 816, Aggregate Class 5*, or better. Aggregate base materials should be compacted to a minimum of 95% of ASTM D1557. The thickness of the crushed stone base course is dependent on the traffic loads, traffic frequency, duration, and performance expectations. Crushed stone ‘pavement’ is not an engineered pavement and can be expected to require regular maintenance regardless of thickness. This is especially true if traffic is allowed onto it when saturated.

The following section provides a summary of design recommendations for aggregate base course roadways based on the 1993 AASHTO Design Manual. We used AASHTO’s design chart for low-volume aggregate base surface roads, which designs based on acceptable rutting. Traffic 18-kip Equivalent Single-Axle Loads (ESAL) were estimated based upon our experience with similar type projects. For this project we estimate 1,000 ESAL for each turbine. AASHTO’s 1993 nomograph from low-volume aggregate pavement design was utilized to calculate the required aggregate base layer thickness for the corresponding ESAL traffic load, with the following design parameters: 30,000 psi for the Modulus of Aggregate Base Layer ( $E_{BS}$ ), 3,980 psi for the Resilient Modulus ( $M_R$ ), and 2.0 and 3.0 inches for an Allowable Rut Depth. A summary of design parameters and recommended aggregate base course thickness are presented in Table 7.1.1.

**Table 7.1.1 Summary of Aggregate Base Course Thickness**

Number of WTG Sites per Private Access Roadway	ESAL	Aggregate Base Thickness (in.) - 2.0-inch Allowable Rutting	Aggregate Base Thickness (in.) - 3.0-inch Allowable Rutting
3 or less	3,000	5.0	4.0
5	5,000	5.5	4.5
10	10,000	7.5	5.5

RRC cautions that a 3-inch rut is essentially a failure for a roadway. Trucking and turbine providers typically reject this amount of rutting. We provide these values because it is part of the AASHTO method, and it provides the team with comparisons for the performance of different pavement cross-sections.

Strip and remove topsoil and vegetation prior to the placement of the aggregate base materials. Topsoil and organics could be up to about 8 inches or more in thickness in some areas and should not be allowed for use in structural areas or along roadway alignments. The exposed subgrade should then be compacted, and proof rolled to assess the presence of soft areas and the need for remedial measures, if any. Proof-roll test with at least two passes using a fully loaded water truck or similar. Maximum deflection or pumping should be less than one inch. In areas where excessive pumping of the subgrade is observed, removal unsuitable soils and re-compaction and/or replacement with road base. Aggregate base materials should be compacted to a minimum of 95% of ASTM D1557 where moisture content is not a pass/fail criteria.

As an alternative, consider placing geogrid (Tensar Biaxial Type 2 or equivalent) on top of geotextile (Mirafi HP 570 or equivalent) in areas where excessive pumping is observed. Consideration could also be given to performing a cement or lime mix design to stabilize the subgrade soils supporting pavement structures as an alternative. A formal cement or lime mix design should be performed prior to construction to determine design CBR values and aggregate base thicknesses.

## **7.2 Crane Pads Design and Construction Recommendations**

This Section 7.2 works in conjunction with Section 6.4.3 within the turbine earthwork requirements. That previous section defines earthwork requirements for the overburden backfill. In areas where the crane pad does not overlap with the overburden backfill, then follow the subgrade requirements below.

The crane pad should extend at least two feet beyond the footprint of the crane tracks. Strip and remove topsoil, vegetation, and other deleterious materials. When the subgrade consists of soils, scarify and rework the resulting subgrade to a depth of 12 inches. Compact the reworked soils to a minimum of 98% of the maximum dry density per ASTM D698. Also, the contractor's use of mats can affect the necessary compaction requirement.

After verifying subgrade density, perform a proof-roll test using a fully loaded water truck, or similar equipment. Conduct the proof-roll in two directions and perform at least two passes per location. Maximum allowable deflection under the proof-roll is 1-inch. If higher deflections are observed, the subgrade soil should be over-excavated to suitable material and replaced with either Select Fill or Structural Fill, defined in Section 6.

Once a suitable subgrade condition has been achieved, use flexible road base aggregate materials (structural fill) to construct the crane pad. The pad should be at least 9-inches thick. The aggregate base should conform to the requirements of Section 6.2 of this report. Compact to a minimum of 95% of the maximum dry density as determined in accordance with ASTM D1557. Moisture is not a test criteria.

These recommendations are expected to provide an ultimate bearing capacity of 5,000 psf at the finished surface. This value assumes a crane track width of six feet, treated as a mat bearing on the ground surface.

For cranes that impart loads more than that provided above, alternate designs will be necessary. The crane operators can consider load distribution mats, such as timber mats or composite mats. If crane mats are to be used, RRC should be retained to review the design of the crane mats to check that bearing capacities are met. Otherwise, an alternate crane pad cross section may be necessary.

## 8.0 LIMITATIONS

Recommendations contained in this report are based on our field observations and subsurface explorations, limited laboratory tests, and our present knowledge of the proposed construction. It is likely soil conditions will vary between or beyond the points explored. If soil conditions are encountered during construction that differ from those described herein, we should be notified immediately in order to provide supplemental recommendations (if needed). If the scope of the proposed construction, including the proposed loads or structural locations, changes from those described in this report, our data should also be reviewed.

We have prepared this report in substantial accordance with the generally accepted geotechnical engineering practice as it exists in the site area at the time of our study. No warranty is expressed or implied. The recommendations provided in this report assume RRC will conduct an adequate program of tests and observations during the construction phase in order to evaluate compliance with our recommendations.

This report may be used only by the client and only for the purposes stated, within three years from its issuance. Land use, site conditions (both on site and off site) or other factors may change over time, and additional work may be required with the passage of time. Any party other than the client, or the client's design team members for this project, who wishes to use this report shall notify RRC of such intended use. Based on the intended use of the report, RRC may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release RRC from any liability resulting from the use of this report by any unauthorized party.

Other standards or documents referenced in any given standard cited in this report, or otherwise relied upon by the authors of this report, are only mentioned in the given standard; they are not incorporated into it or "included by reference," as that latter term is used relative to contracts or other matters of law.

## 9.0 REFERENCES

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## APPENDIX A

**Table A1 - Summary of Foundation Design Net Allowable Bearing Pressure and Design Groundwater Recommendations**

Boring No.	Latitude	Longitude	Turbine/Boring ID (L011_04.26.25)	Groundwater During Drilling (ft,bgs)	Groundwater Immediately After Drilling (ft,bgs)	Minimum Piezometer Groundwater Level (bgs,ft.)	Estimated Design Groundwater Depth (bgs,ft.)	Net Allowable Bearing Capacity (qnet all) Under Normal Operating Load Conditions Based on Foundation Bearing Elevation 13 ft. (psf)	Required Soil Improvement Depth Below Existing Ground Surface (ft,bgs)	Recommended Soil Improvement to Achieve a Net Allowable Bearing Capacity of 3,000 psf (ft,bgs)	Remarks
GEO-001	46.928605	-101.860052	T01			--	20.0	2,000		14	Recommended ground improvement / Over-excavation and Replacement w/ Structural Fill
GEO-002	46.936340	-101.861568	T02			--	20.0	3,500			
GEO-003	46.939368	-101.854080	T03			--	20.0	3,000			
GEO-004	46.937945	-101.847728	T04			--	20.0	3,500	25		Deep Soil Improvement
GEO-005	46.935278	-101.841595	T05			--	20.0	3,500			
GEO-006	46.930996	-101.826168	T06			--	20.0	3,500			
GEO-007	46.913460	-101.838517	T07			--	20.0	3,000			
GEO-008	46.916400	-101.834600	T08			--	20.0	3,500			
GEO-009	46.921153	-101.828370	T09			--	20.0	3,500			
GEO-010	46.921172	-101.821962	T10			--	20.0	3,500			
GEO-011	46.921497	-101.813248	T11			--	20.0	3,250			
GEO-012	46.921525	-101.806480	T12			12.0	11.0	3,500			
GEO-013	46.900807	-101.826790	T13			--	20.0	3,500			
GEO-014	46.900966	-101.819722	T14			--	20.0	3,500			
GEO-015	46.900394	-101.810586	T15			--	20.0	3,500			
GEO-016	46.904707	-101.805945	T16			--	20.0	2,500			
GEO-017	46.886948	-101.814793	T17			--	20.0	3,500			
GEO-018	46.885050	-101.808962	T18			--	20.0	3,500			
GEO-019	46.886566	-101.800295	T19			--	20.0	3,500			
GEO-020	46.976011	-101.763598	T20			--	20.0	3,500			
GEO-021	46.973311	-101.752139	T21			--	20.0	3,500			
GEO-022	46.973116	-101.745499	T22			--	20.0	3,500			
GEO-023	46.975381	-101.721823	T23			--	20.0	3,500			
GEO-024	46.968427	-101.723739	T24			--	20.0	3,500			
GEO-025	46.959730	-101.706249	T25			--	20.0	3,500			
GEO-026	46.961450	-101.700128	T26			--	20.0	3,500			
GEO-027	46.961464	-101.693477	T27			--	20.0	3,500			
GEO-028	46.953950	-101.786611	T28			--	20.0	3,500			
GEO-029	46.959220	-101.764704	T29			12.0	11.0	3,500			
GEO-030	46.951333	-101.765145				--	20.0				Not Investigated
GEO-031	46.954390	-101.753974	T31			--	20.0	3,250			
GEO-032	46.955296	-101.743890				--	20.0				Not Investigated
GEO-033	46.954002	-101.730960	T33			--	20.0	3,500	18		Deep soil improvement
GEO-034	46.954983	-101.724356	T34			--	20.0	3,500			
GEO-035	46.944218	-101.753027	T35			--	20.0	3,500			
GEO-036	46.941605	-101.746654	T36			1.3	0.3	3,500	20		Deep soil improvement
GEO-037	46.942772	-101.740419	T37			--	20.0	3,500	15		Over-Excavation and Replacement w/ Structural Fill
GEO-038	46.940588	-101.731712	T38			--	20.0	3,000			
GEO-039	46.945336	-101.725459	T39			--	20.0	3,500			
GEO-040	46.939113	-101.709620	T40			--	20.0	3,500			
GEO-041	46.938437	-101.721078	T41			--					Not Investigated
GEO-042	46.940888	-101.695081	T42			--	20.0	3,500			
GEO-043	46.939567	-101.785665	T43			--	20.0	3,500			
GEO-044	46.937839	-101.767572	T44			--	20.0	2,500			
GEO-045	46.935204	-101.795228	T45			--	20.0	3,500			
GEO-046	46.932590	-101.787606	T46			--	20.0	3,500			
GEO-047	46.932651	-101.777749	T47			--	20.0	3,500			
GEO-048	46.922343	-101.767967	T48			--	20.0	3,500			
GEO-049	46.926427	-101.762739	T49			--	20.0	2,500			
GEO-050	46.923447	-101.751849	T50			--	20.0	3,500			
GEO-051	46.922422	-101.730508	T51			--	20.0	3,250			
GEO-052	46.923094	-101.724068	T52			--	20.0	3,500			
GEO-053	46.922764	-101.713804	T53			--	20.0	2,750	15		Over-excavation and Replacement w/ Structural Fill
GEO-054	46.922576	-101.705791	T54			--	20.0	3,000			
GEO-055	46.930926	-101.689845				--	20.0				Not Investigated
GEO-056	46.907994	-101.725116	T56			--	20.0	3,500			
GEO-057	46.910611	-101.712133	T57			--	20.0	3,500			
GEO-058	46.915340	-101.703733	T58			--	20.0	3,500			
GEO-059	46.911737	-101.695736	T59			--	20.0	3,500			
GEO-060	46.918971	-101.692605				--	20.0	3,500			Removed from L011
GEO-061	46.909107	-101.683665	T61			2.3	1.3	3,500			
GEO-062	46.908347	-101.677053	T62			--	20.0	3,000			
GEO-063	46.903391	-101.708698	T63			--	20.0	3,250			
GEO-064	46.903570	-101.686788	T64			--	20.0	3,500			
GEO-065	46.897699	-101.696096	T65			--	20.0	3,500			

**Table A1 - Summary of Foundation Design Net Allowable Bearing Pressure and Design Groundwater Recommendations**

Boring No.	Latitude	Longitude	Turbine/Boring ID (L011_04.26.25)	Groundwater During Drilling (ft,bgs)	Groundwater Immediately After Drilling (ft,bgs)	Minimum Piezometer Groundwater Level (bgs,ft.)	Estimated Design Groundwater Depth (bgs,ft.)	Net Allowable Bearing Capacity (qnet all) Under Normal Operating Load Conditions Based on Foundation Bearing Elevation 13 ft. (psf)	Required Soil Improvement Depth Below Existing Ground Surface (ft,bgs)	Recommended Soil Improvement to Achieve a Net Allowable Bearing Capacity of 3,000 psf (ft,bgs)	Remarks
GEO-066	46.896434	-101.676574	T66			--	20.0	3,000			
GEO-067	46.897586	-101.664957	T67			--	20.0	3,500			
GEO-068	46.896070	-101.651180	T68			--	20.0	3,000			
GEO-069	46.890090	-101.683948	T69			--	20.0	3,000			
GEO-070	46.881269	-101.690206	T70			--	20.0	3,500			
GEO-071	46.951278	-101.767572	T30			--	20.0	3,500			

NE = Not Encountered

**Table A2 - Summary of Subsurface Exploration and Geographic Coordinates**

Boring No.	Latitude	Longitude	Turbine/Boring ID (L011_04.26.25)	Turbine/Boring ID (L009_03.19.25)2	MASW Survey	Electrical Resistivity Testing	Thermal Resistivity Samples	Piezometer Location	Piezometer Installation Date	Test/Drilling Date	Auger (ft)	Air/Mud Rotary (ft)	Total Depth (ft)	Groundwater During Drilling (ft.)	Groundwater Immediately After Drilling (ft.)	Groundwater 24-Hours After Drilling (ft.)	Remarks
GEO-001	46.928605	-101.860052	T01	T01		5/14/2025	4/25/2025			04/25/25	55.5	0.0	55.5	30	52	NA	
GEO-002	46.936340	-101.861568	T02	T02						04/25/25	55.0	0.0	55.0	NE	NE	NA	
GEO-003	46.939368	-101.854080	T03	T03						04/24/25-04/25/25	55.5	0.0	55.5	NE	NE	NA	
GEO-004	46.937945	-101.847728	T04	T04	5/10/2025					04/25/25	55.0	0.0	55.0	NE	NE	NA	
GEO-005	46.935278	-101.841595	T05	T05						04/26/25	55.5	0.0	55.5	34	48	NA	
GEO-006	46.930996	-101.826168	T06	T06						04/23/25	55.5	0.0	55.5	NE	NE	NA	
GEO-007	46.913460	-101.838517	T07	T07						04/23/25	55.5	0.0	55.5	NE	NE	NA	
GEO-008	46.916400	-101.834600	T08	T08		5/14/2025	4/23/2025			04/23/25	55.5	0.0	55.5	NE	NE	NA	
GEO-009	46.921153	-101.828370	T09	T09						05/07/25	55.5	0.0	55.5	NE	NE	NA	
GEO-010	46.921172	-101.821962	T10	T10		5/14/2025	4/24/2025			04/23/25 - 04/24/25	55.0	0.0	55.0	NE	NE	NA	
GEO-011	46.921497	-101.813248	T11	T11						04/24/25	55.5	0.0	55.5	NE	NE	NA	
GEO-012	46.921525	-101.806480	T12	T12				X	4/24/2025	04/24/25	55.5	0.0	55.5	19	44	NA	
GEO-013	46.900807	-101.826790	T13	T13						04/22/25	55.5	0.0	55.5	NE	NE	NA	
GEO-014	46.900966	-101.819722	T14	T14	5/10/2025					04/22/25	55.5	0.0	55.5	34	48	NA	
GEO-015	46.900394	-101.810586	T15	T15						04/22/25	55.5	0.0	55.5	NE	NE	NA	
GEO-016	46.904707	-101.805945	T16	T16						04/21/25 - 04/22/25	55.5	0.0	55.5	NE	NE	NA	
GEO-017	46.886948	-101.814793	T17	T17						04/21/25	55.5	0.0	55.5	49	52	NA	
GEO-018	46.885050	-101.808962	T18	T18	5/10/2025					04/21/25	55.5	0.0	55.5	44	44	NA	
GEO-019	46.886566	-101.800295	T19	T19		5/17/2025	4/21/2025			04/21/25	55.5	0.0	55.5	NE	NE	NA	
GEO-020	46.976011	-101.763598	T20	T20						04/30/25	55.5	0.0	55.5	NE	NE	NA	
GEO-021	46.973311	-101.752139	T21	T21						05/11/25	54.5	0.0	54.5	39	23	NA	
GEO-022	46.973116	-101.745499	T22	T22		5/6/2025	5/9/2025			05/09/25	55.5	0.0	55.5	NE	NE	NA	
GEO-023	46.975381	-101.721823	T23	T23						05/09/25	55.5	0.0	55.5	NE	NE	NA	
GEO-024	46.968427	-101.723739	T24	T24						05/09/25	55.5	0.0	55.5	NE	NE	NA	
GEO-025	46.959730	-101.706249	T25	T25						05/08/25	55.5	0.0	55.5	NE	NE	NA	
GEO-026	46.961450	-101.700128	T26	T26						05/08/25	55.5	0.0	55.5	39	50	NA	
GEO-027	46.961464	-101.693477	T27	T27						05/09/25	55.0	0.0	55.0	NE	NE	NA	
GEO-028	46.953950	-101.786611	T28	T28						04/26/25	55.5	0.0	55.5	35	52	NA	
GEO-029	46.959220	-101.764704	T29	T29	5/10/2025			X	4/29/2025	04/29/25	55.5	0.0	55.5	9	55	NA	
GEO-030	46.951333	-101.765145	T30	T30													Relocated ~ 600 ft. from L011, See GEO-071
GEO-031	46.954390	-101.753974	T31	T31						05/02/25	55.5	0.0	55.5	49	49	NA	
GEO-032	46.955296	-101.743890	T32	T32													Removed From L011
GEO-033	46.954002	-101.730960	T33	T33	5/9/2025	5/18/2025	5/3/2025			05/03/25	55.5	0.0	55.5	NE	NE	NA	
GEO-034	46.954983	-101.724356	T34	T34						05/04/25	55.0	0.0	55.0	NE	NE	NA	
GEO-035	46.944218	-101.753027	T35	T35						04/03/25	55.5	0.0	55.5	30	NE	NA	
GEO-036	46.941605	-101.746654	T36	T36				X	5/5/2025	05/05/25	55.5	0.0	55.5	12	47	NA	
GEO-037	46.942772	-101.740419	T37	T37						05/04/25 - 04/05/25	54.5	0.0	54.5	NE	NE	NA	
GEO-038	46.940588	-101.731712	T38	T38						05/01/25	42.5	0.0	42.5	NE	NE	NA	
GEO-039	46.945336	-101.725459	T39	T39						05/04/25	55.5	0.0	55.5	49	54	NA	
GEO-040	46.939113	-101.709620	T40	T40						04/27/25	55.0	0.0	55.0	NE	NE	NA	
GEO-041	46.938437	-101.721078	T41	T41													Non Participating Landowner per email 04.04.25
GEO-042	46.940888	-101.695081	T42	T42						05/10/25	55.5	0.0	55.5	30	54	NA	
GEO-043	46.939567	-101.785665	T43	T43						05/07/25	55.5	0.0	55.5	NE	NE	NA	
GEO-044	46.937839	-101.767572	T44	T44						04/27/25	55.5	0.0	55.5	NE	NE	NA	
GEO-045	46.935204	-101.795228	T45	T45						04/27/25	55.5	0.0	55.5	NE	NE	NA	
GEO-046	46.932590	-101.787606	T46	T46		5/13/2025	4/26/2025			04/26/25	55.0	0.0	55.0	NE	NE	NA	
GEO-047	46.932651	-101.777749	T47	T47						04/27/25	55.5	0.0	55.5	45	48	NA	
GEO-048	46.922343	-101.767967	T48	T48		5/18/2025	5/5/2025			05/05/25	52.5	0.0	52.5	NE	NA	NA	
GEO-049	46.926427	-101.762739	T49	T49						05/06/25	55.5	0.0	55.5	NE	NE	NA	
GEO-050	46.923447	-101.751849	T50	T50						05/08/25	55.5	0.0	55.5	NE	NE	NA	
GEO-051	46.922422	-101.730508	T51	T51						05/10/25	55.0	0.0	55.0	NE	NE	NA	
GEO-052	46.923094	-101.724068	T52	T52						05/08/25 - 05/09/202	55.5	0.0	55.5	NE	NE	NA	
GEO-053	46.922764	-101.713804	T53	T53		5/18/2025	5/6/2025			05/06/25	55.5	0.0	55.5	NE	NE	NA	
GEO-054	46.922576	-101.705791	T54	T54						04/27/25	55.5	0.0	55.5	NE	NE	NA	
GEO-055	46.930926	-101.689845	T55	T55													Removed From L011
GEO-056	46.907994	-101.725116	T56	T56						05/08/25	55.5	0.0	55.5	NE	NE	NA	
GEO-057	46.910611	-101.712133	T57	T57						05/07/25	55.5	0.0	55.5	NE	NE	NA	
GEO-058	46.915340	-101.703733	T58	T58						4/27/2025 - 05/07/25	55.5	0.0	55.5	NE	NE	NA	
GEO-059	46.911737	-101.695736	T59	T59		5/17/2025	4/26/2025			04/26/25	55.5	0.0	55.5	34	NA	NA	
GEO-060	46.918971	-101.692605	T60	T60						04/25/25 - 04/26/25	55.5	0.0	55.5	NE	NE	NA	Removed From L011
GEO-061	46.909107	-101.683665	T61	T61				X	4/25/2025	04/25/25	55.5	0.0	55.5	24	NE	NA	
GEO-062	46.908347	-101.677053	T62	T62		5/17/2025	5/7/2025			05/06/25	55.5	0.0	55.5	34	52	NA	
GEO-063	46.903391	-101.708698	T63	T63						05/07/25	55.5	0.0	55.5	NE	NE	NA	
GEO-064	46.903570	-101.686788	T64	T64	5/9/2025					04/24/25	55.5	0.0	55.5	NE	NE	NA	
GEO-065	46.897699	-101.696096	T65	T65						05/08/25	55.5	0.0	55.5	NE	NE	NA	
GEO-066	46.896434	-101.676574	T66	T66						04/23/25	55.5	0.0	55.5	NE	NE	NA	
GEO-067	46.897586	-101.664957	T67	T67		5/17/2025	4/26/2025			04/25/25	55.5	0.0	55.5	45	NA	NA	
GEO-068	46.896070	-101.651180	T68	T68						04/23/25	54.5	0.0	54.5	NE	NE	NA	
GEO-069	46.890090	-101.683948	T69	T69						04/24/25	55.5	0.0	55.5	NE	NE	NA	
GEO-070	46.881269	-101.690206	T70	T70		5/11/2025	4/24/2025			04/24/25	55.5	0.0	55.5	NE	NE	NA	
GEO-071	46.951278	-101.767572	T30	T30						05/03/25	55.5	0.0	55.5	25	NE	NA	
TL-01	46.986205	-101.766771								04/29/25	50.5	0.0	50.5	NE	NE	NA	

**Table A2 - Summary of Subsurface Exploration and Geographic Coordinates**

Boring No.	Latitude	Longitude	Turbine/Boring ID (L011_04.26.25)	Turbine/Boring ID (L009_03.19.25)2	MASW Survey	Electrical Resistivity Testing	Thermal Resistivity Samples	Piezometer Location	Piezometer Installation Date	Test/Drilling Date	Auger (ft)	Air/Mud Rotary (ft)	Total Depth (ft)	Groundwater During Drilling (ft.)	Groundwater Immediately After Drilling (ft.)	Groundwater 24-Hours After Drilling (ft.)	Remarks
TL-02	46.984606	-101.766776								04/29/25	30.5	0.0	30.5	NE	NE	NA	
TL-03	46.982158	-101.766783								04/29/25	30.5	0.0	30.5	NE	NE	NA	
TL-04	46.980259	-101.766789								04/29/25	50.5	0.0	50.5	NE	NE	NA	
TL-05	46.980257	-101.763791								04/29/25	30.5	0.0	30.5	NE	NE	NA	
TL-06	46.980255	-101.760946								04/30/25	50.5	0.0	50.5	NE	NE	NA	
TL-07	46.978169	-101.760927								04/30/25	30.5	0.0	30.5	NE	NE	NA	
TL-08	46.976028	-101.760909								04/30/25	30.5	0.0	30.5	NE	NE	NA	
TL-09	46.973915	-101.760890								05/01/25	30.5	0.0	30.5	NE	NE	NA	
TL-10	46.971640	-101.760870								05/01/25	30.5	0.0	30.5	24	24	NA	
TL-11	46.969358	-101.760850								05/01/25	30.5	0.0	30.5	29	28	NA	
TL-12	46.967150	-101.760831								05/02/25	30.5	0.0	30.5	7	6.5	NA	
TL-13	46.964992	-101.760811								05/02/25	50.5	0.0	50.5	NE	NE	NA	
TL-14	46.964315	-101.761887								05/02/25	50.5	0.0	50.5	NE	NE	NA	
TL-15	46.962040	-101.761888								05/06/25	30.5	0.0	30.5	24	NA	NA	
TL-16	46.960133	-101.761890								04/29/25	30.5	0.0	30.5	25	27	NA	
TL-17	46.958219	-101.761891								04/29/25	30.5	0.0	30.5	12	54	NA	
TL-18	46.956549	-101.761892								04/29/25	50.5	0.0	50.5	10	47	NA	
MET-01	46.975132	-101.747075															
MET-02	46.937508	-101.754410															
MET-03	46.894016	-101.661035								04/23/25	34.5	0.0	34.5	NE	NE	NA	
PMM1	46.976921	-101.747421								05/11/25	35.5	0.0	35.5	NE	NE	NA	
PMM2	46.938197	-101.755101								05/05/25	35.5	0.0	35.5	NE	NE	NA	Moved ~120 ft. to avoid transmission line
PMM3	46.894397	-101.662007								05/07/25	34.5	0.0	34.5	NE	NE	NA	
ADLS-01	46.927989	-101.795361															
ADLS-02	46.927981	-101.795351								05/07/25	35.5	0.0	35.5	NE	NE	NA	
DSR-1	46.955511	-101.761935				5/12/2025				5/12/2025							
DSR-2	46.957204	-101.763285				5/12/2025				5/12/2025							
TSR-1	46.954950	-101.762055				5/13/2025				5/13/2025							
TSR-2	46.955006	-101.760905				5/13/2025				5/13/2025							
TSR-3	46.955567	-101.760980				5/12/2025				5/12/2025							
HA-1	46.955771	-101.762488								04/30/25	5.0	0.0	5.0	NE	NE	NA	
HA-2	46.955782	-101.761487								04/30/25	5.0	0.0	5.0	NE	NE	NA	
HA-3	46.955793	-101.760486								04/30/25	5.0	0.0	5.0	NE	NE	NA	
HA-4	46.955223	-101.762475								04/30/25	5.0	0.0	5.0	NE	NE	NA	
HA-5	46.955234	-101.761474								04/30/25	5.0	0.0	5.0	NE	NE	NA	
HA-6	46.955245	-101.760473								04/30/25	5.0	0.0	5.0	NE	NE	NA	
HA-7	46.954675	-101.762462								04/30/25	5.0	0.0	5.0	NE	NE	NA	
HA-8	46.954686	-101.761461								04/30/25	5.0	0.0	5.0	NE	NE	NA	
HA-9	46.954697	-101.760460								04/30/25	5.0	0.0	5.0	NE	NE	NA	
HA-10	46.954106	-101.761659								05/01/25	5.0	0.0	5.0	NE	NE	NA	
HA-11	46.954113	-101.760954								05/01/25	5.0	0.0	5.0	NE	NE	NA	
HA-12	46.953608	-101.761295								05/01/25	5.0	0.0	5.0	NE	NE	NA	
HA-13	46.953102	-101.761635								05/01/25	5.0	0.0	5.0	NE	NE	NA	
HA-14	46.953110	-101.760931								05/01/25	5.0	0.0	5.0	NE	NE	NA	
SB-1	46.955712	-101.761785								05/01/25	40.5	0.0	40.5	19.8	33	NA	
SB-2	46.955535	-101.762072				5/6/2025				05/01/25	40.5	0.0	40.5	14	35	NA	
SB-3	46.955049	-101.762273						X	5/1/2025	04/30/25	40.5	0.0	40.5	14	35	NA	
SB-4	46.955054	-101.761848								04/30/25	40.5	0.0	40.5	12	33	NA	
SB-5	46.954784	-101.761958								04/29/25	40.5	0.0	40.5	12.5	30	NA	
SB-6	46.955549	-101.760791								05/01/25	40.5	0.0	40.5	19	29	NA	
SB-7	46.955058	-101.761344								04/30/25	40.5	0.0	40.5	13	34	NA	
SB-8	46.954797	-101.760801								04/30/25	40.5	0.0	40.5	19	35	NA	
SB-9	46.953917	-101.761302								05/01/25	15.5	0.0	15.5	NE	NE	NA	
SB-10	46.953298	-101.761288								05/01/25	15.5	0.0	15.5	NE	NE	NA	
O&M -1	46.950414	-101.762334								05/03/25	35.0	0.0	35.0	18	25	NA	

NE = Not Encounter, NA = Not Available

**Table A3:** Well Log Information Obtained from the North Dakota Department of Water Resources

<b>Well Report No. (NDDWR)</b>	<b>Latitude</b>	<b>Longitude</b>	<b>Well Depth (feet below land surface)</b>	<b>Water Level Record (feet below land surface)</b>	<b>Date of Record (YYYY/MM/DD)</b>
9060	46.944751	-101.785024	890	278.8	1978/07/24
20703	46.944751	-101.785024	400	225.9	1977/10/12
9064	46.935761	-101.896039	380	13.4	1978/07/07
9066	46.899611	-101.845919	400	42.7	1993/12/07
8467	46.982237	-101.897894	380	27.7	1978/06/30
9056	46.954666	-101.699212	N/D	20.0	1967/06/20
9046	46.94992	-101.577623	N/D	10.0	1967/05/15
9049	46.954421	-101.542125	154.0	84.0	1967/06/04
9006	46.863352	-101.932869	380.0	1.4	2020/05/29
9009	46.861534	-101.930243	N/D	1.9	1973/10/24
8985	46.846777	-101.635774	360.0	104.3	1994/05/04
8988	46.878104	-101.827556	N/D	39.7	1975/08/05
8989	46.848936	-101.779908	360.0	42.6	1973/08/24

N/D = No Data Available

**Table A4 - Summary of Measured Groundwater Levels in Temporary Piezometers Installed at Selected WTG Sites**

Temp Piezometer No.	Latitude	Longitude	Date Installed	Total Depth of Temporary Piezometer (ft.) Below Existing Ground Surface	Height of Temp Piezometer Stick-up (ft.) Above Existing Site Grade	GWL (ft.) After Installation	GWL (ft.) 24 hrs after Installation	GWL (ft.) 48 hrs after Installation	GWL (ft.) 72 hrs after Installation	GWL (ft.) (05/18/25)	Minimum GWL (ft.)
GEO-012	46.921525	-101.806480	04/24/2025	18.00	2.00	NE	15.25	15.42	14.00	12.00	12.00
GEO-029	46.959220	-101.764704	04/29/2025	18.00	2.00	15.80	14.20	13.70	13.00	12.00	12.00
GEO-036	46.941605	-101.746654	05/05/2025	18.00	2.00	3.50	1.25	1.92	2.00	2.00	1.25
GEO-061	46.909107	-101.683665	04/25/2025	18.00	2.00	7.30		2.33		3.00	2.33
SB-4	46.955049	-101.762273	05/01/2025	18.00	2.00	7.00	7.50	9.33	9.42	7.00	7.00

# Figure 01 Site Location Map

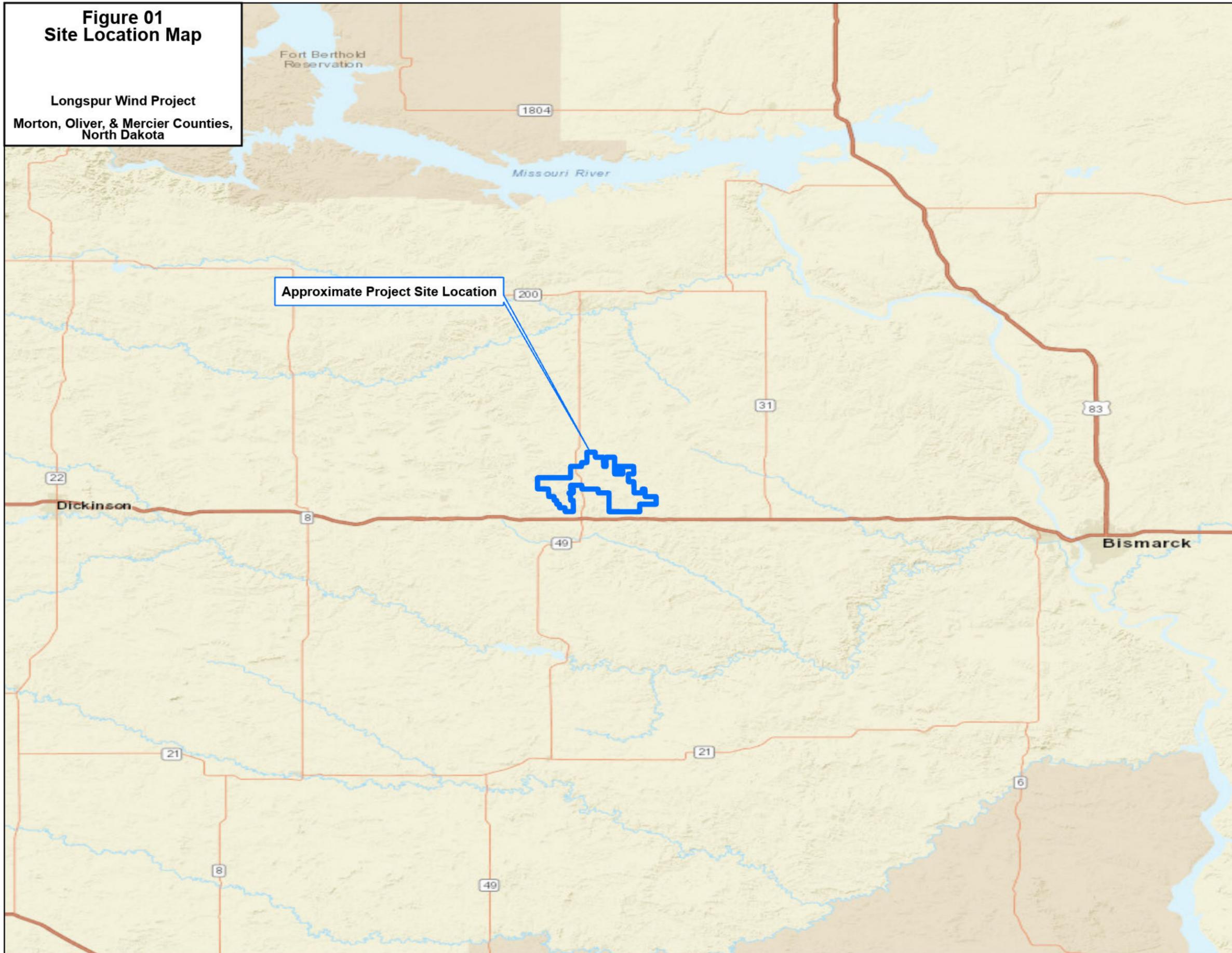
Longspur Wind Project  
Morton, Oliver, & Mercier Counties,  
North Dakota



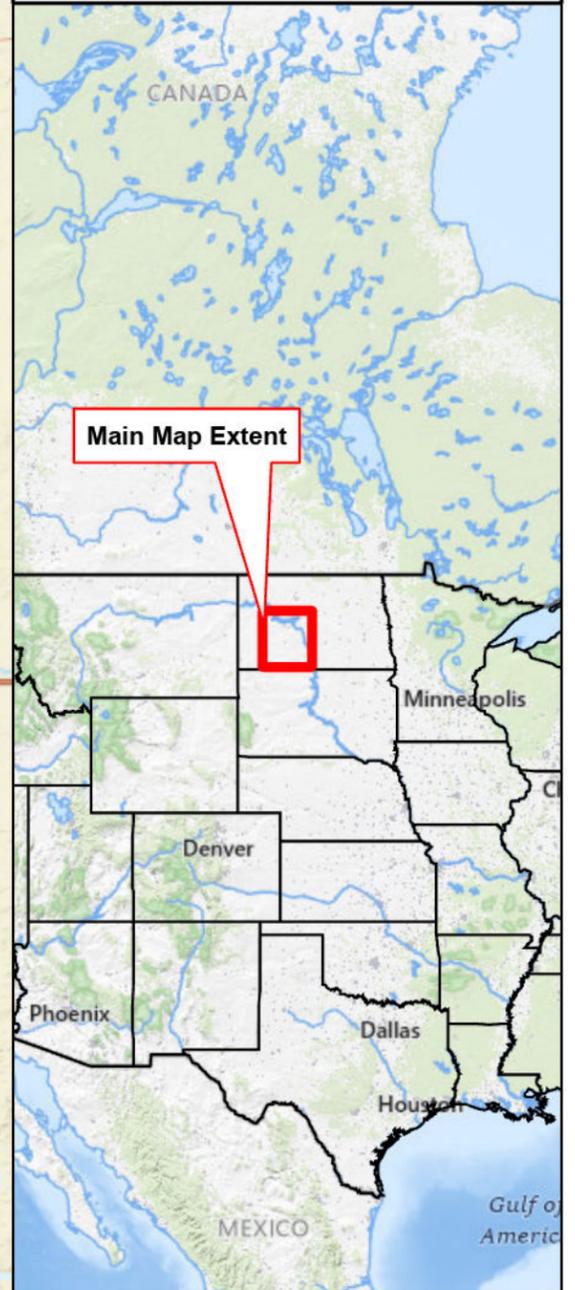
## Legend

Project Boundary

Approximate Project Site Location



Main Map Extent



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Suite 120  
Round Rock, TX 78681



**Figure 02**  
**WTG Boring Locations on**  
**a Topographic Map**

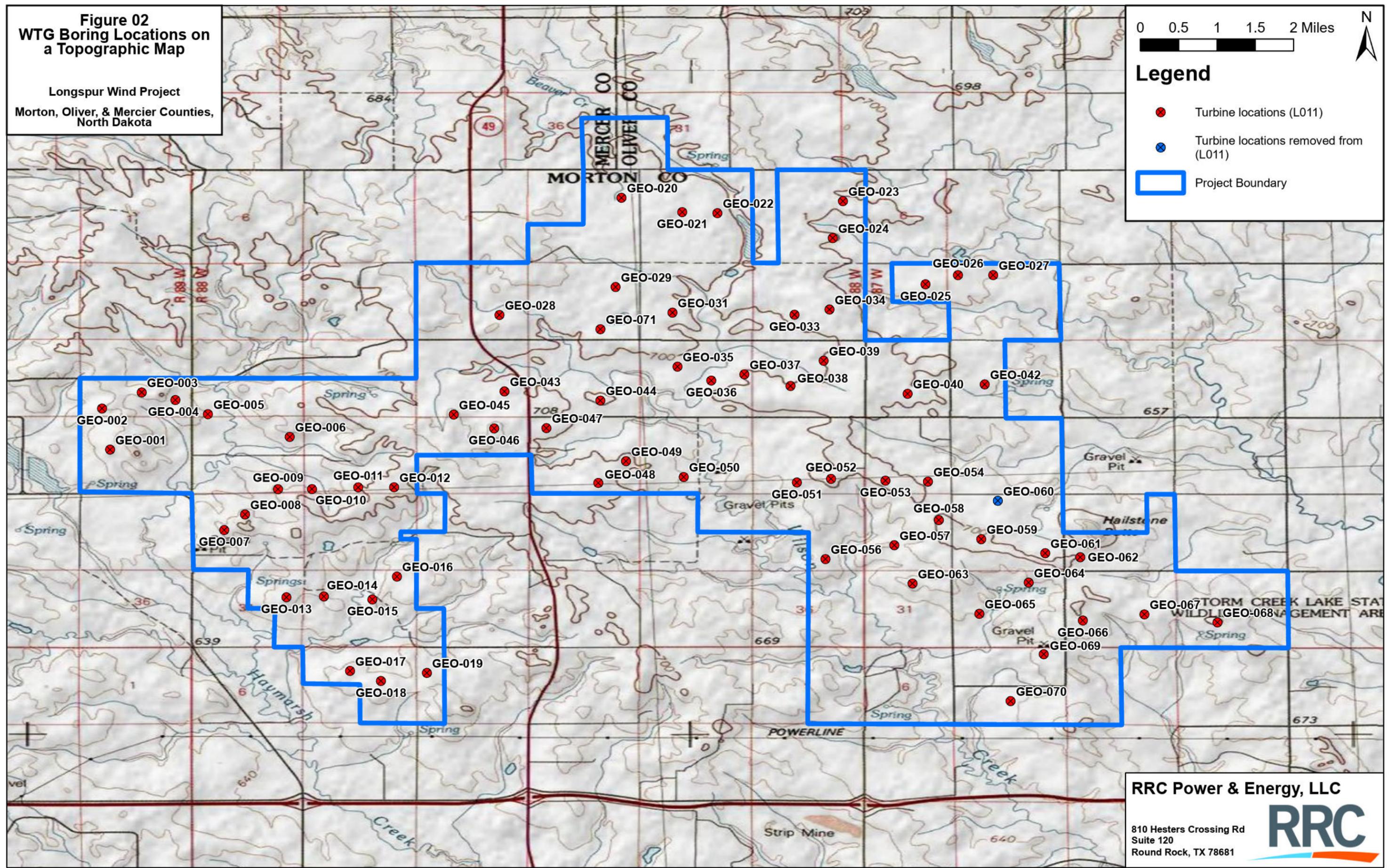
Longspur Wind Project  
Morton, Oliver, & Mercer Counties,  
North Dakota

0 0.5 1 1.5 2 Miles



**Legend**

-  Turbine locations (L011)
-  Turbine locations removed from (L011)
-  Project Boundary



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Round Rock, TX 78681



**Figure 03  
Substation & O&M Boring  
Locations on a  
Topographic Map**

Longspur Wind Project  
Morton, Oliver, & Mercer Counties,  
North Dakota

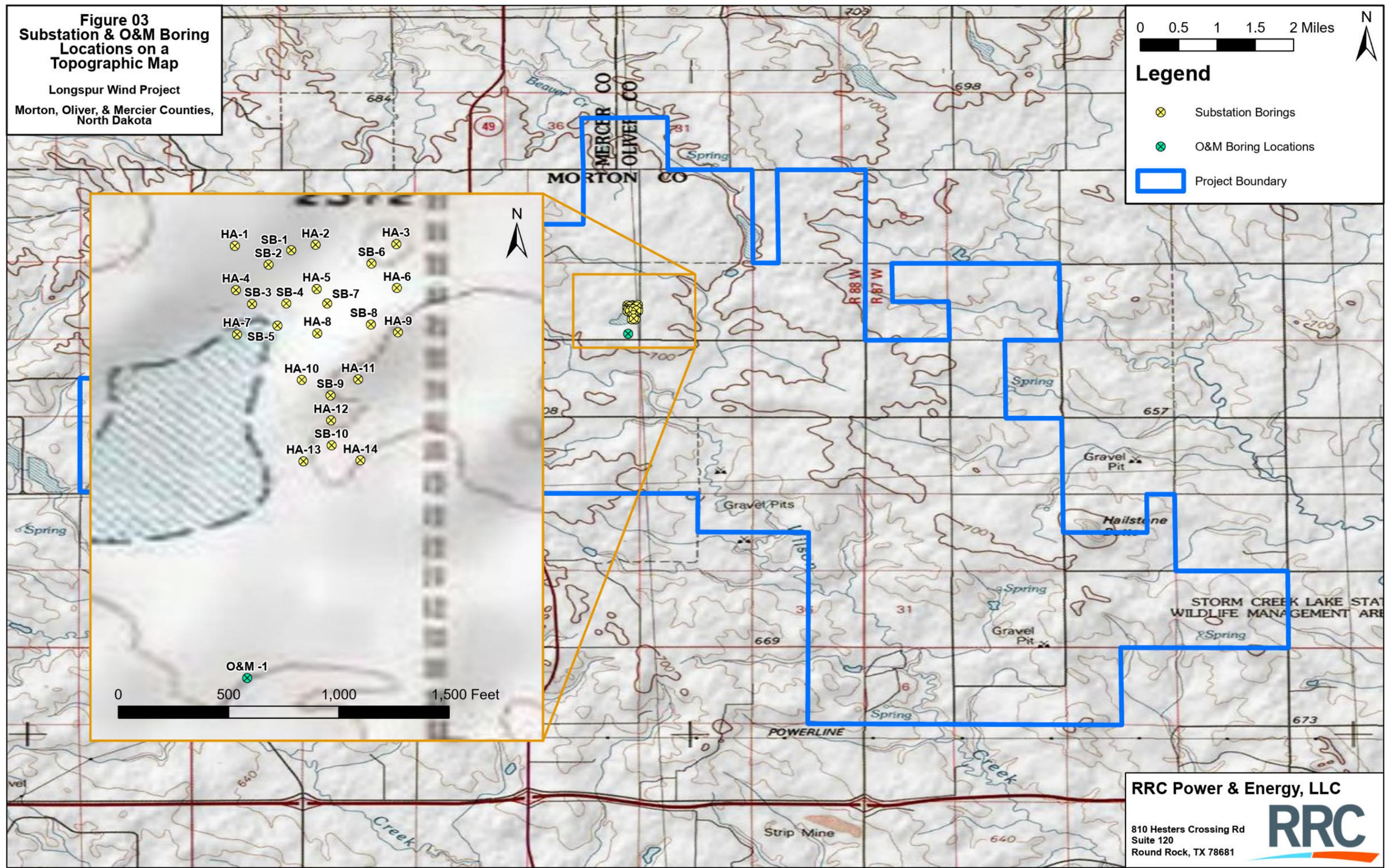
0 0.5 1 1.5 2 Miles

**Legend**

-  Substation Borings
-  O&M Boring Locations
-  Project Boundary

HA-1 SB-1 HA-2 HA-3  
 HA-4 SB-2 HA-5 SB-6  
 HA-7 SB-3 HA-8 SB-7  
 HA-9 SB-4 HA-10  
 HA-11 SB-5  
 HA-12 SB-6  
 HA-13 SB-7  
 HA-14 SB-8  
 O&M -1

0 500 1,000 1,500 Feet



**Figure 04**  
**ADLS, Transmission Line**  
**& Met Tower Boring**  
**Locations**

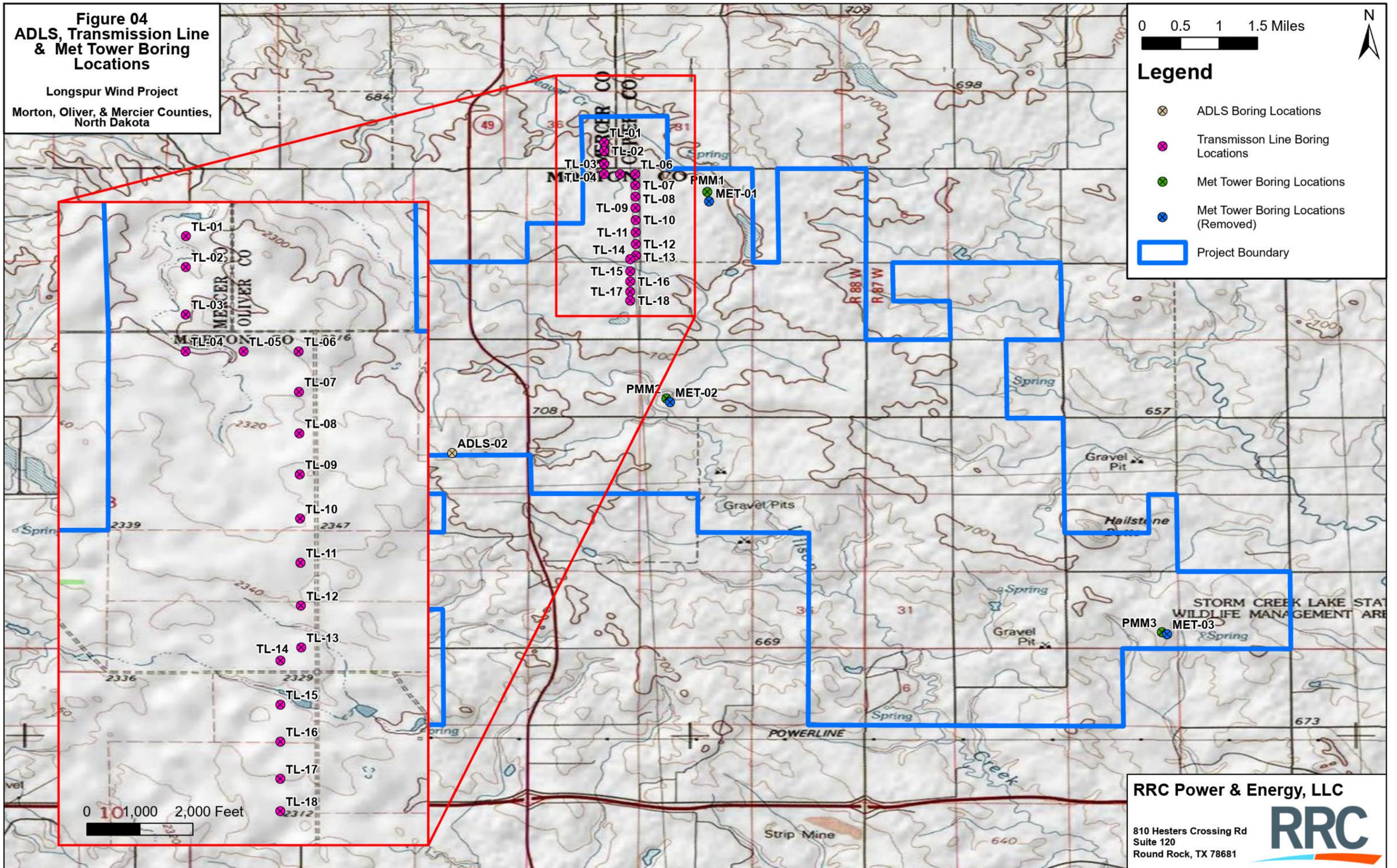
Longspur Wind Project  
 Morton, Oliver, & Mercer Counties,  
 North Dakota

0 0.5 1 1.5 Miles



**Legend**

-  ADLS Boring Locations
-  Transmission Line Boring Locations
-  Met Tower Boring Locations
-  Met Tower Boring Locations (Removed)
-  Project Boundary



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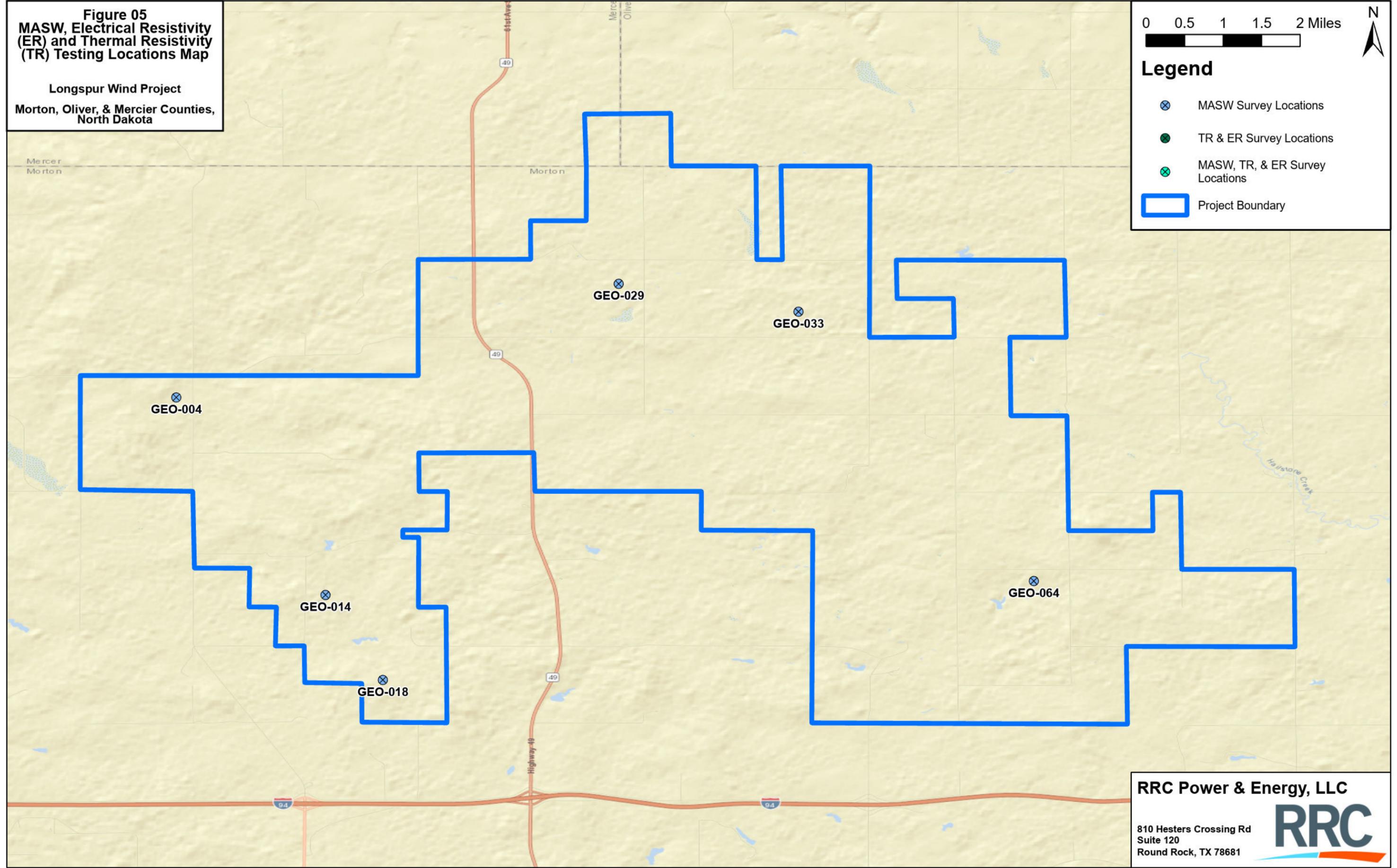
**Figure 05**  
**MASW, Electrical Resistivity (ER) and Thermal Resistivity (TR) Testing Locations Map**

Longspur Wind Project  
 Morton, Oliver, & Mercer Counties,  
 North Dakota

0 0.5 1 1.5 2 Miles

**Legend**

- MASW Survey Locations
- TR & ER Survey Locations
- MASW, TR, & ER Survey Locations
- Project Boundary



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# Figure 06 Site Vicinity Surficial Geologic Map

Longspur Wind Project  
Morton, Oliver, & Mercier Counties,  
North Dakota

0 0.5 1 1.5 2 Miles

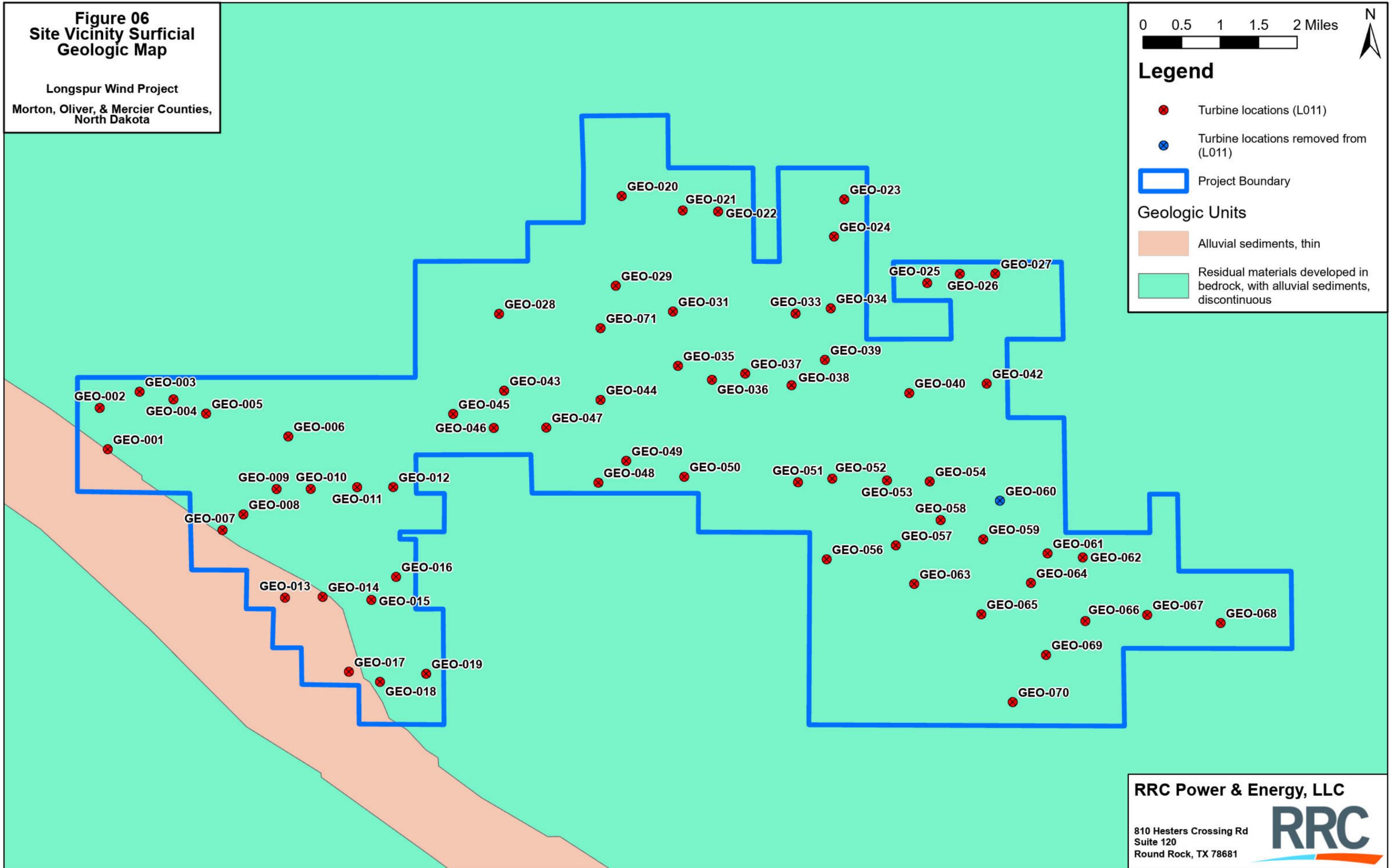


## Legend

- Turbine locations (L011)
- Turbine locations removed from (L011)
- Project Boundary

## Geologic Units

- Alluvial sediments, thin
- Residual materials developed in bedrock, with alluvial sediments, discontinuous



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**Figure 07  
Site Vicinity Bedrock  
Geologic Map**

Longspur Wind Project  
Morton, Oliver, & Mercier Counties,  
North Dakota

0 0.5 1 1.5 2 Miles

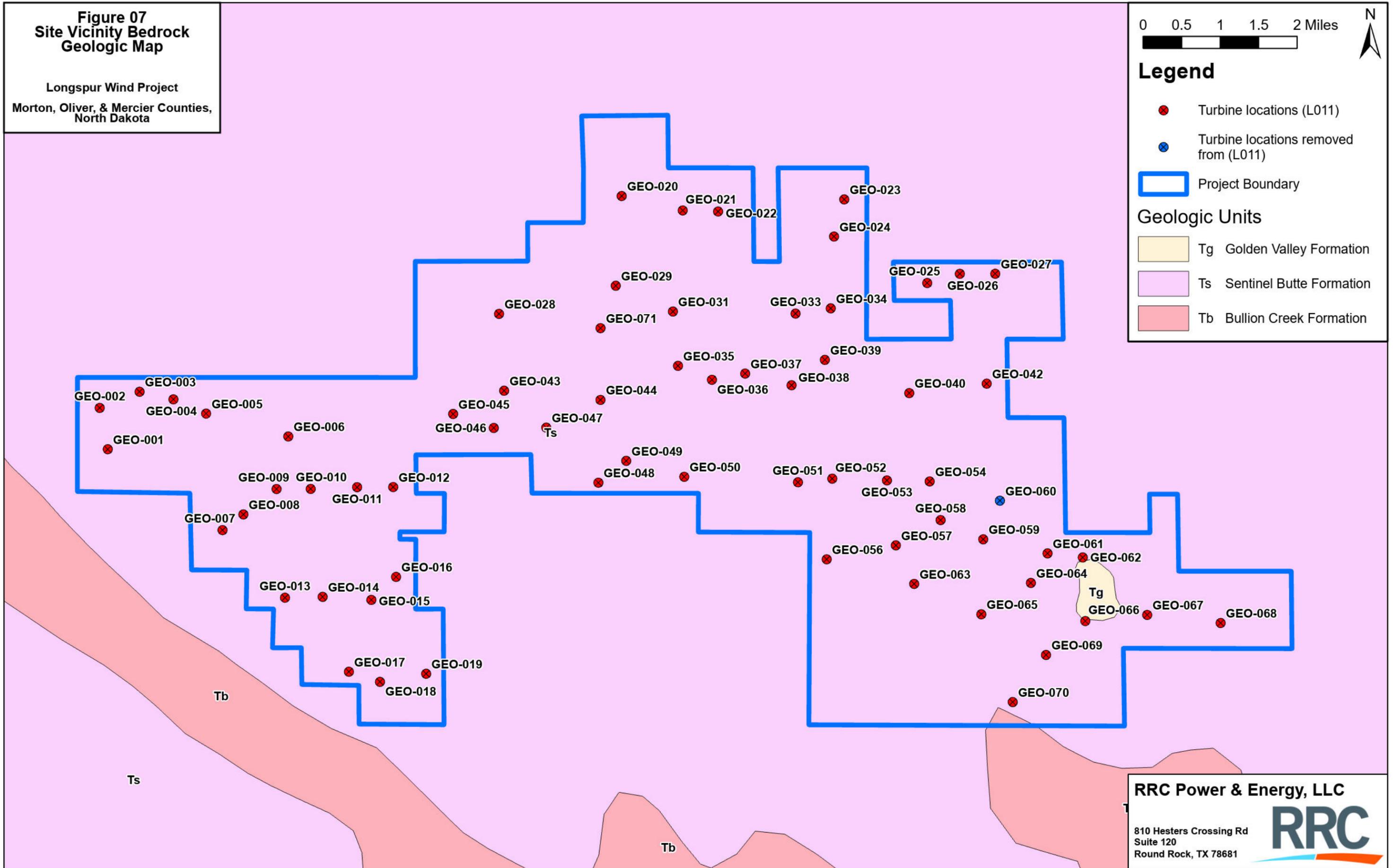


**Legend**

- ✖ Turbine locations (L011)
- ✖ Turbine locations removed from (L011)
- Project Boundary

**Geologic Units**

- Tg Golden Valley Formation
- Ts Sentinel Butte Formation
- Tb Bullion Creek Formation



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**Figure 08  
FEMA Flood Hazard Map**

**Longspur Wind Project  
Morton, Oliver, & Mercer Counties,  
North Dakota**

0 1 2 3 4 5 Miles



**Legend**

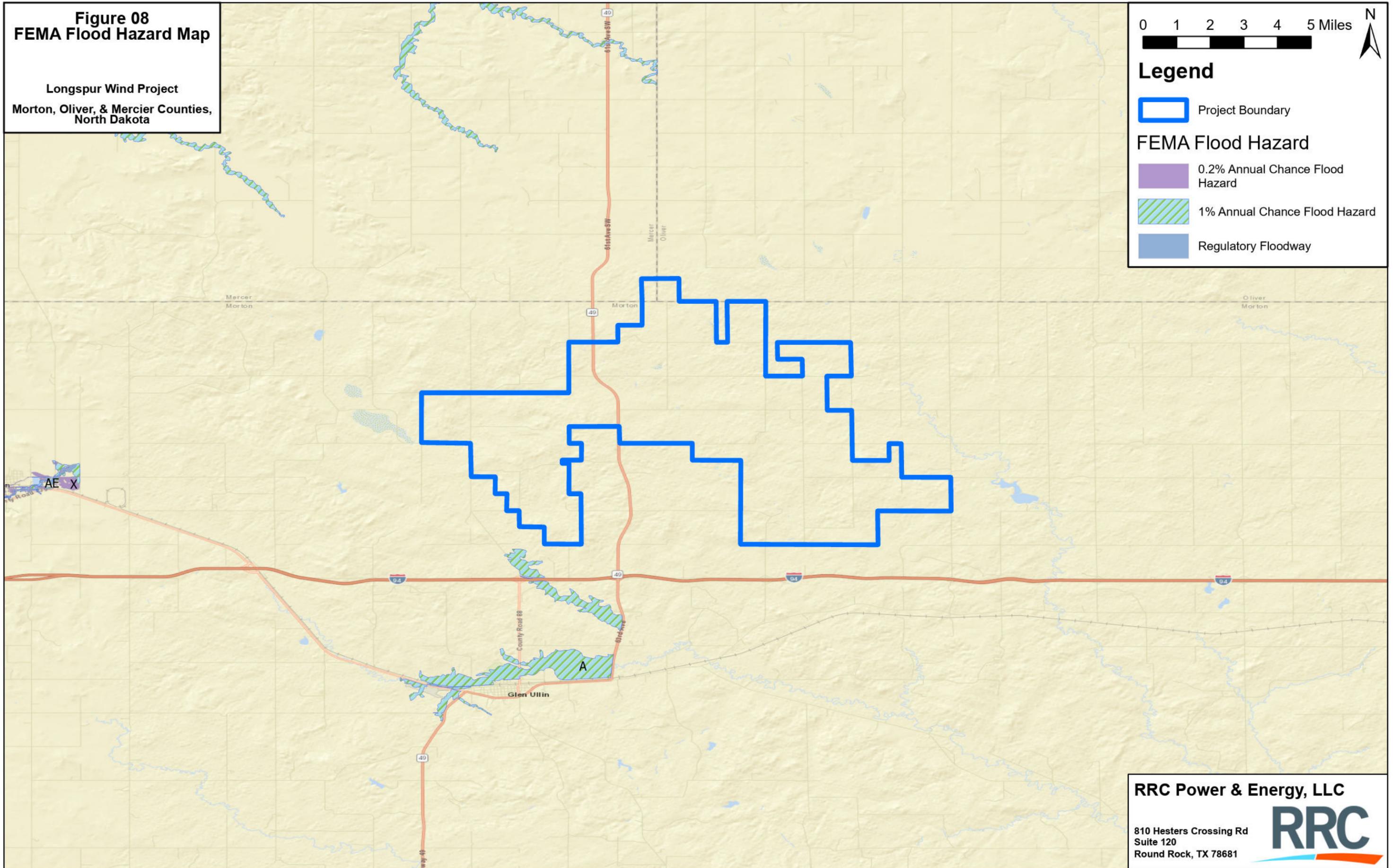
 Project Boundary

**FEMA Flood Hazard**

 0.2% Annual Chance Flood Hazard

 1% Annual Chance Flood Hazard

 Regulatory Floodway



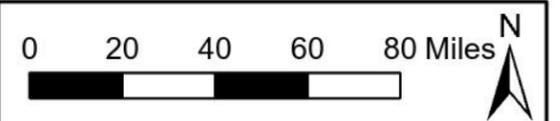
**RRC Power & Energy, LLC**

810 Hesters Crossing Rd  
Suite 120  
Round Rock, TX 78681



**Figure 09**  
**Site Vicinity Karst Hazard**  
**Map**

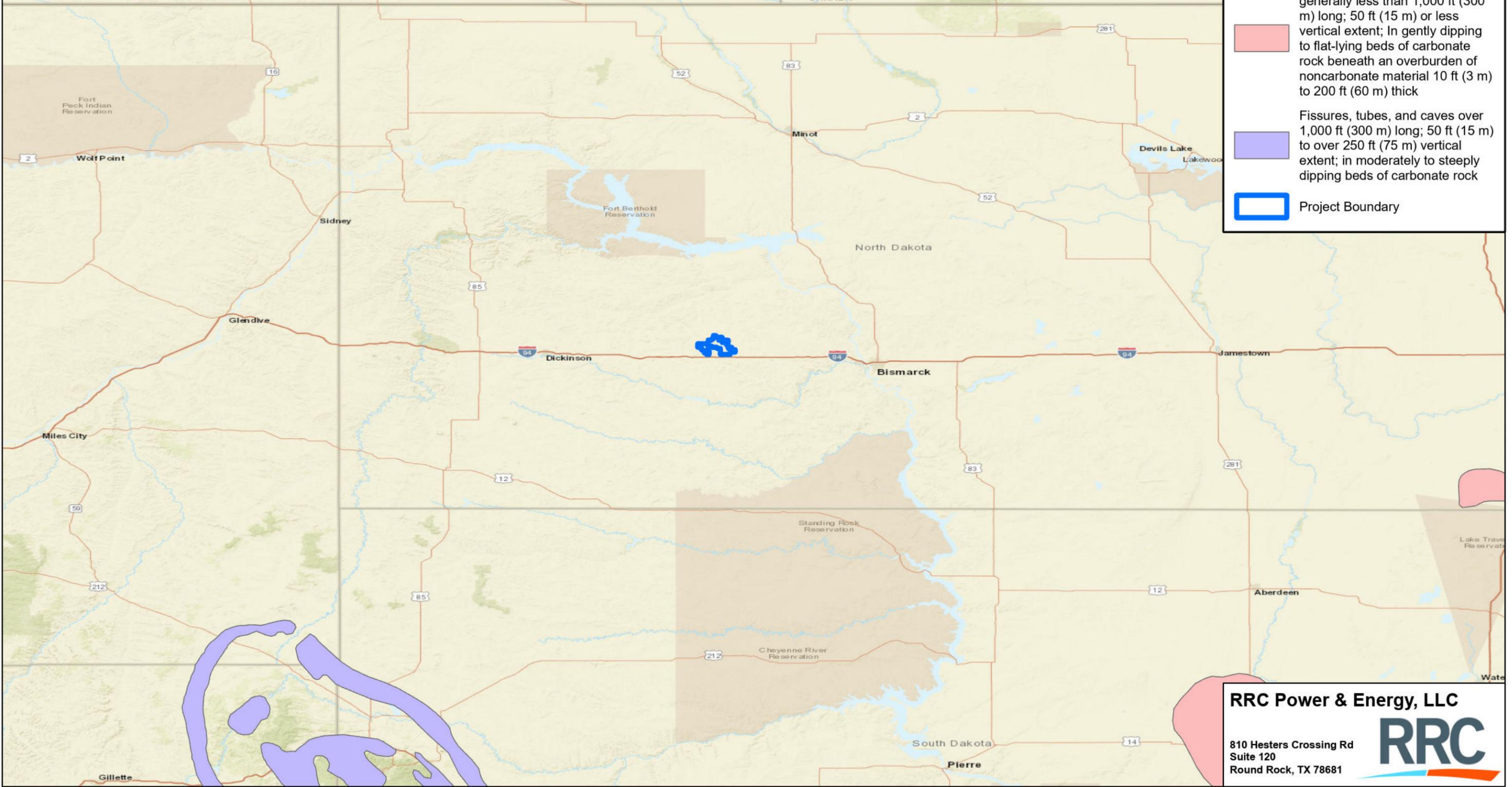
Longspur Wind Project  
Morton, Oliver, & Mercier Counties,  
North Dakota



**Legend**

**Karst Hazard**

- Fissures, tubes and caves generally less than 1,000 ft (300 m) long; 50 ft (15 m) or less vertical extent; In gently dipping to flat-lying beds of carbonate rock beneath an overburden of noncarbonate material 10 ft (3 m) to 200 ft (60 m) thick
- Fissures, tubes, and caves over 1,000 ft (300 m) long; 50 ft (15 m) to over 250 ft (75 m) vertical extent; in moderately to steeply dipping beds of carbonate rock
- Project Boundary

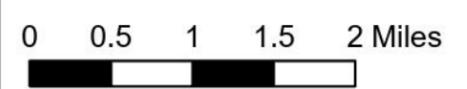


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**Figure 10**  
**Soil Corrosion of Concrete**  
**Map**

Longspur Wind Project  
Morton, Oliver, & Mercier Counties,  
North Dakota

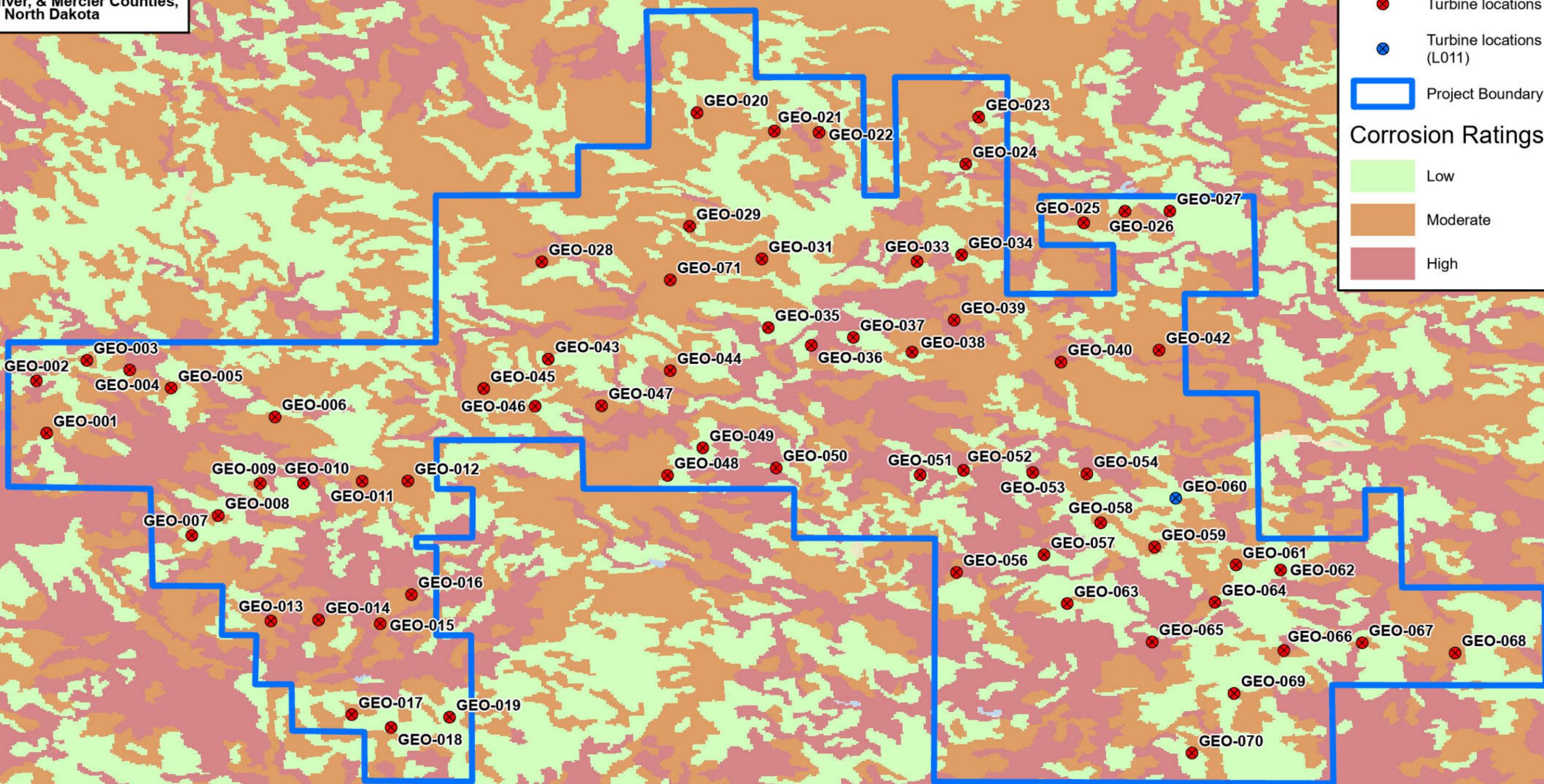


**Legend**

- Turbine locations (L011)
- Turbine locations removed from (L011)
- Project Boundary

**Corrosion Ratings**

- Low
- Moderate
- High



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Round Rock, TX 78681



# Figure 11 Soil Corrosion of Steel Map

Longspur Wind Project  
Morton, Oliver, & Mercer Counties,  
North Dakota

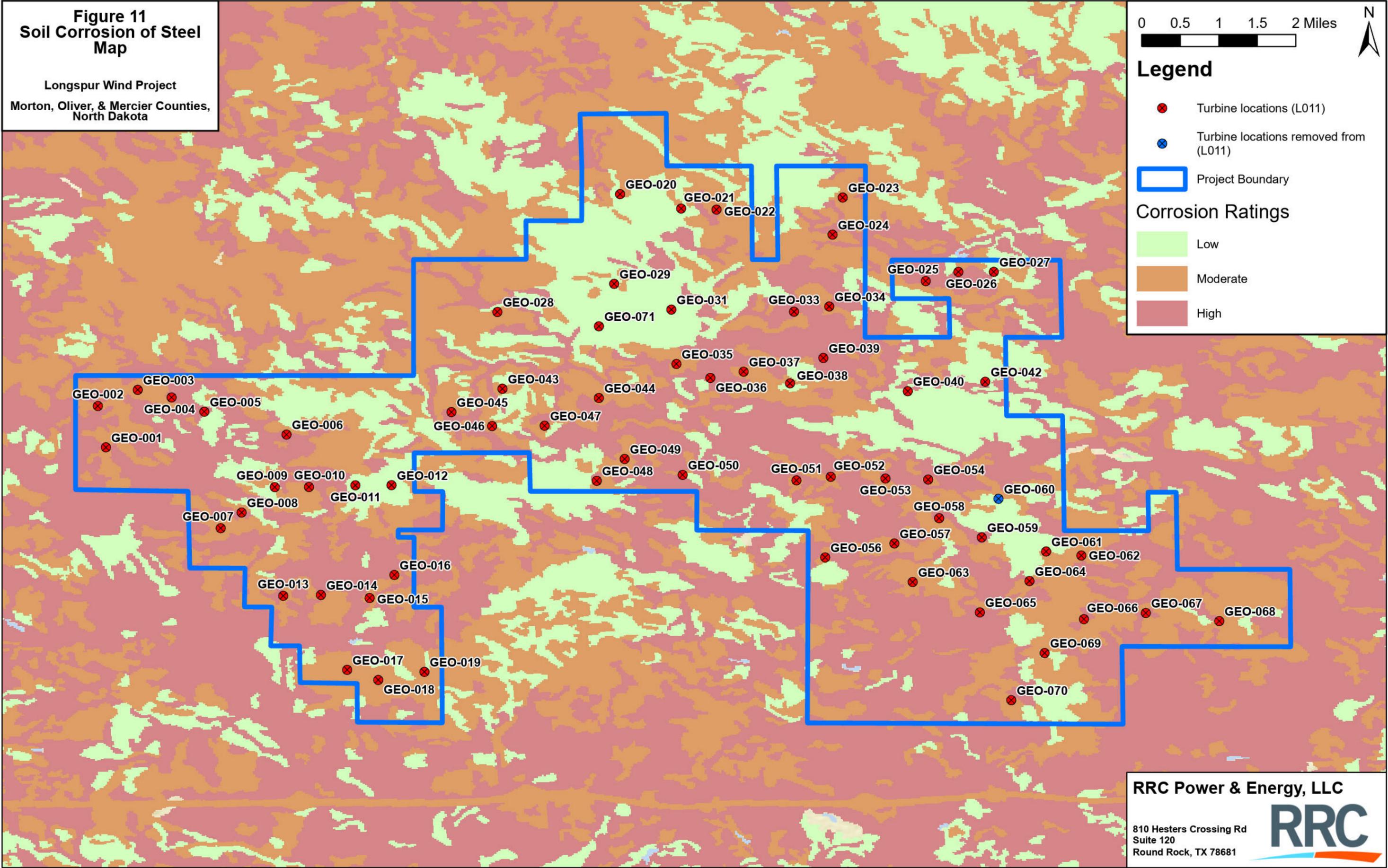


### Legend

- Turbine locations (L011)
- Turbine locations removed from (L011)
- Project Boundary

### Corrosion Ratings

- Low
- Moderate
- High



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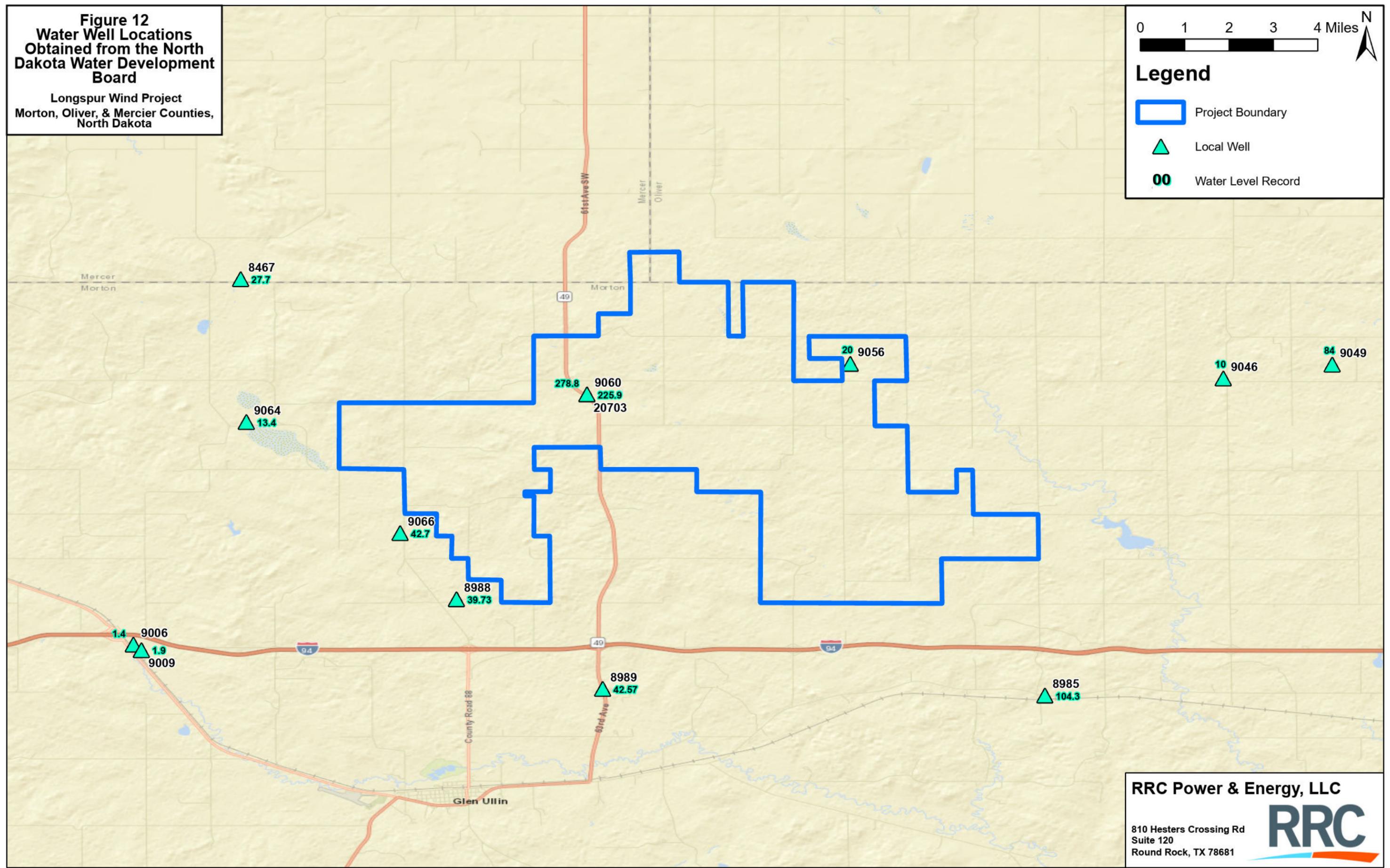
**Figure 12**  
**Water Well Locations**  
 Obtained from the North Dakota Water Development Board

Longspur Wind Project  
 Morton, Oliver, & Mercer Counties,  
 North Dakota

0 1 2 3 4 Miles 

**Legend**

-  Project Boundary
-  Local Well
- 00** Water Level Record



**Figure 13**  
**Temporary Piezometer**  
**Locations Map**

Longspur Wind Project  
Morton, Oliver, & Mercer Counties,  
North Dakota

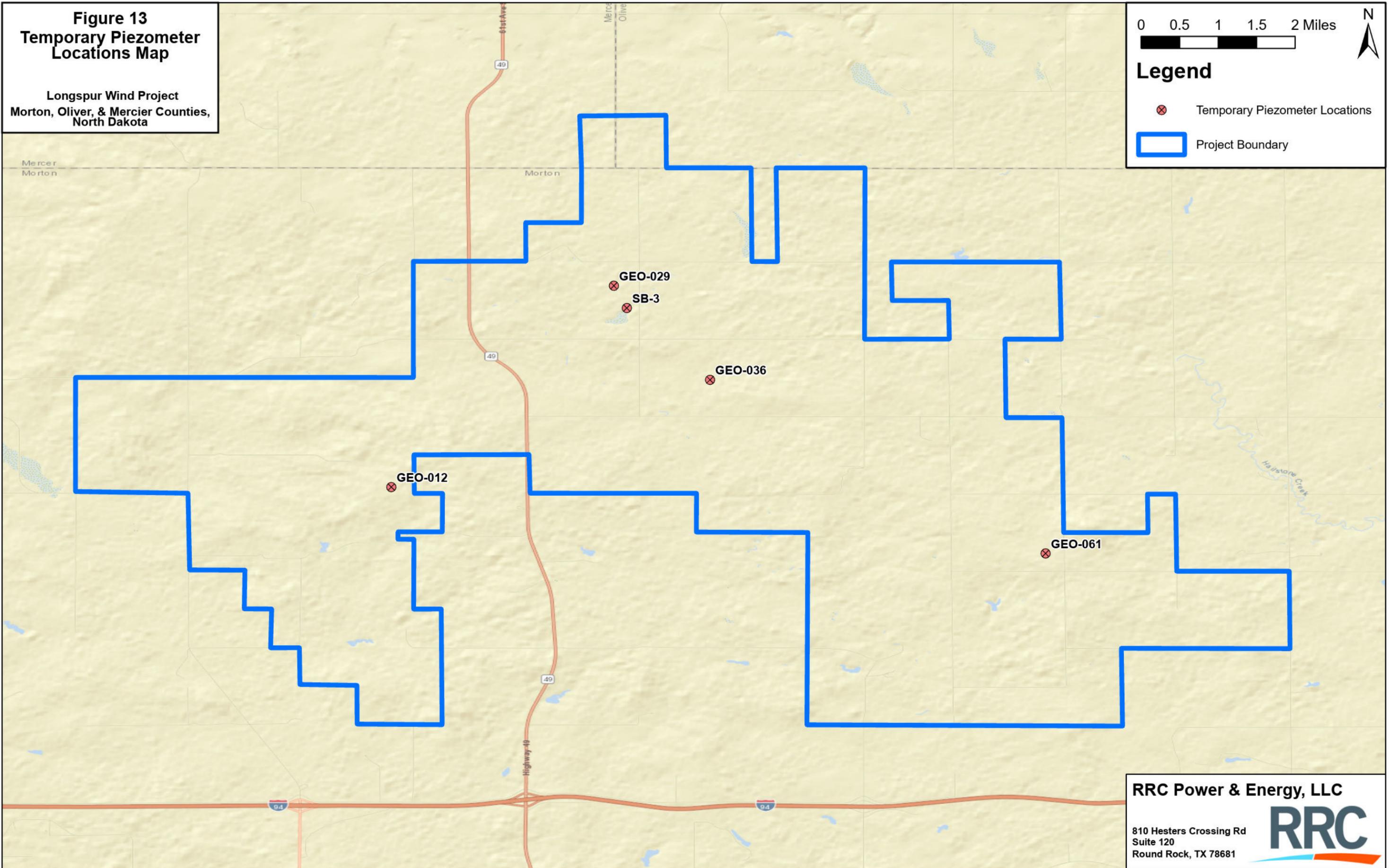
0 0.5 1 1.5 2 Miles



**Legend**

⊗ Temporary Piezometer Locations

▭ Project Boundary



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Suite 120  
Round Rock, TX 78681



# BORING LOG KEY

FIELD DATA		LABORATORY DATA							DRILLING METHOD(S): Continuous Flight Auger/Hollow-stem Auger/Wet Rotary/NX Core		
SOIL SYMBOL	DEPTH (FT)	SAMPLES N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % ROD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI					
											GROUNDWATER INFORMATION: Subsurface water was not encountered either during or upon completion of the drilling operations.
											SURFACE ELEVATION: ft.
											DESCRIPTION OF STRATUM

-- TESTING SYMBOLS DEFINITIONS --

N - STANDARD PENETRATION TEST RESISTANCE  
P - POCKET PENETROMETER RESISTANCE  
T - TXDOT CONE PENETRATION RESISTANCE  
R - ROCK CORE RECOVERY  
RQD - ROCK QUALITY DESIGNATION

## TYPICAL SOIL AND ROCK SYMBOLS (USCS CLASSIFICATION)

	Lean Clay (CL)		Poorly-Graded Sand (SP)		Claystone
	Fat Clay (CH)		Well-Graded Sand (SW)		BASALT:
	Silt (ML)		Poorly-Graded Gravel (GP)		Limestone
	Elastic Silt (MH)		Well-Graded Gravel (GW)		Sandstone
	Silty Sand (SM)		Clayey Gravel (GC)		Siltstone
	Clayey Sand (SC)		Silty Gravel (GM)		Fill Material
	Silty, Clayey Sand (SC-SM)		Silty Clay (CL-ML)		Shale

## DEGREE OF WEATHERING

- 1) Unweathered: No evidence of any chemical or mechanical alteration.
- 2) Slightly weathered: Slight discoloration on surface, slight alteration along discontinuities, less than 10% of the rock volume altered.
- 3) Moderately weathered: Discoloring evident, surface pitted and altered with alteration penetrating well below rock surfaces, weathering "halos" evident, 10% to 50% of the rock volume altered.
- 4) Highly weathered: Entire mass discolored, alteration pervading nearly all of the rock with some pockets of slightly weathered rock noticeable, some minerals leached away.
- 5) Decomposed: rock reduced to a soil with relic rock texture, generally molded and crumbled by hand.

## SOIL STRUCTURE

- Calcareous..... Containing calcium carbonate
- Slickensided..... The presence of planes of weakness having a slick and glossy appearance
- Interbedded..... Alternating layers of varying material

# LOG OF BORING GEO-01



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/25/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 30 ft. during drilling and measured at 52 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SOIL SYMBOL	DEPTH (FT)	SAMPLES N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM	
				LL	PL	PI							
	5 10 15 20 25 30 35 40 45 50 55	N = 12	23									4 in. Topsoil	
		N = 16	24	63	22	41					100	FAT CLAY (CH), trace Sand, brown to light gray, stiff to hard, moist	
		N = 15	19										Grading light brown, iron stained
		N = 30	28										Grading dark brown to brown, with organics
		N = 9	29										Grading with Lignite
		N = 50	47										Grading with Sand Grading brown to gray
		N = 50	20	52	20	32	111	5.28	7.3	0.0	81		CLAYEY SAND (SC), light gray to gray, dense, dry to moist, fine grained
		N = 35											LEAN CLAY (CL), trace Sand, dark gray to gray, very stiff to hard, dry to moist
		N = 16											Grading trace Lignite and organics Grading wet
		N = 32											SHALE, dark brown, hard to very hard, moist to wet, with Lignite
		N = 32											Grading gray
		N = 50/3"											MUDSTONE, light gray to gray, medium hard, moist to wet, trace organics Total Depth = 55.5 ft.
N = 50/6"													
N = 64													
N = 42													

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.928605, Long. -101.860051

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:58 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING GEO-02



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/25/2025

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:58 - C:\USERS\JOHN\ILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026.GPJ

FIELD DATA			LABORATORY DATA							DRILLING METHOD(S):	
SOIL SYMBOL	DEPTH (FT)	SAMPLES	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CUFT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
		N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %		LL	PL	PI					
	5	N = 10 N = 16	18 22								
	10	N = 21 N = 30 N = 22	20 19 22								
	15	N = 32									
	20	N = 50/3"									
	25	N = 47									
	30	N = 36									
	35	N = 46									
	40	N = 67									
	45	N = 81/11"									
	50	N = 50/6"									
	55	N = 50/6"									
DESCRIPTION OF STRATUM 3 in. Topsoil SANDY LEAN CLAY (CL), gray, stiff to very stiff, moist, calcareous  CLAYEY SAND (SC), light brown to gray, medium dense, moist, fine grained, iron stained, trace organics  LEAN CLAY (CL), with Sand, gray, hard, dry to moist, trace Lignite  Grading trace Sand  SILTSTONE, gray to light brown, very hard, dry to moist, with Shale interbeddings, trace Lignite  Shale interbedding grades out  Total Depth = 55 ft.											

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

REMARKS:  
 GPS COORDINATES: Lat. 46.936340, Long. -101.861568

# LOG OF BORING GEO-03



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026  
 DATE(S) DRILLED: 4/24/2025 - 4/25/2025

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:58 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

FIELD DATA		LABORATORY DATA							DRILLING METHOD(S):			
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
	5	N = 24	11									
		N = 15	16									
		N = 19	16									
	10	N = 15	19									
		N = 38	16					96				
	15	N = 42										
	20	N = 62										
	25	N = 36										
	30	N = 27										
	35	N = 79										
	40	N = 43										
	45	N = 49										
	50	N = 50/3"										
	55	N = 92										
Total Depth = 55.5 ft.												

**GROUNDWATER INFORMATION:**  
 Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

LEAN CLAY (CL), trace Sand, brown, very stiff, dry to moist, calcareous

SANDY LEAN CLAY (CL), brown, stiff to very stiff, moist, iron stained  
 Grading trace organics

Grading dark brown, trace Lignite

LEAN CLAY (CL), trace Sand, dark brown, hard, dry to moist, iron stained, calcareous

Grading trace organics

LIGNITE, black, very stiff, dry to moist

LEAN CLAY (CL), trace Sand, gray, hard, dry to moist

LIGNITE, black, hard, dry to moist

SANDSTONE, gray, very hard, dry to moist, fine grained

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.939368, Long. -101.854080

# LOG OF BORING GEO-04



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/25/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

4 in. Topsoil  
 LEAN CLAY (CL), with Sand, light brown, soft to very stiff, dry to moist, calcareous

SANDY LEAN CLAY (CL), light brown, stiff, dry to moist, calcareous

SILTY SAND (SM), light brown to gray, medium dense to dense, dry to moist, fine grained

SANDSTONE, light brown to gray, very hard, dry to moist, fine grained

Total Depth = 55 ft.

**REMARKS:**

GPS COORDINATES: Lat. 46.937945, Long. -101.847728

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\UOH\NIVILLAR\NORRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING GEO-05



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/26/2025

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

### FIELD DATA

### LABORATORY DATA

### DRILLING METHOD(S):

Solid Stem Auger

### GROUNDWATER INFORMATION:

Groundwater encountered at 34 ft. during drilling and measured at 48 ft. immediately after drilling

### SURFACE ELEVATION (FT):

### DESCRIPTION OF STRATUM

3 in. Topsoil  
 CLAYEY SAND (SC), brown, medium dense to dense, dry to moist, fine grained, iron stained

Grading trace organics

Grading wet

LIGNITE, dark brown, hard, moist to wet

SILT (ML), trace Sand, gray, hard, moist to wet

LEAN CLAY (CL), with Sand, gray, hard, moist, trace organics

Grading gray to brown

Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

### REMARKS:

GPS COORDINATES: Lat. 46.935278, Long. -101.841595



# LOG OF BORING GEO-07



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/23/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

4 in. Topsoil  
 SANDY LEAN CLAY (CL), light brown, stiff, moist, iron stained, calcareous

FAT CLAY (CL), with Sand, light brown, stiff to hard, dry to moist, trace organics  
 Grading trace Sand, gray

Grading with Gravel

Organic grades out; grading gray

LIGNITE, dark gray to dark brown, hard, dry to moist

Total Depth = 55.5 ft.

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
	5	N = 11	25									
		N = 14	22									
		N = 14	26									
	10	N = 18	27									
		N = 28	27	64	23	41	99	6.92	6.3	10.0	100	
	15	N = 20										
	20	N = 45										
	25	N = 50/1"										
	30	N = 36										
	35	N = 27										
	40	N = 41										
	45	N = 38										
	50	N = 77										
	55	N = 84										

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.913460, Long. -101.838517

# LOG OF BORING GEO-08



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/23/2025

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FIELD DATA		LABORATORY DATA							DRILLING METHOD(S):	
DEPTH (FT)	SAMPLES N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
			LL	PL	PI					
GROUNDWATER INFORMATION: Groundwater not encountered during or immediately after drilling										
SURFACE ELEVATION (FT):										
DESCRIPTION OF STRATUM										
5	N = 9 N = 15	25 22	57	19	38					99
10	N = 19 N = 22 N = 38	24 23								
15	N = 27									
20	N = 26									
25	N = 37									
30	N = 27									
35	N = 50/4"									
40	N = 37									
45	N = 41									
50	N = 64									
55	N = 43									
Total Depth = 55.5 ft.										

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

REMARKS:  
 GPS COORDINATES: Lat. 46.916400, Long. -101.834600

# LOG OF BORING GEO-09



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/7/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

8 in. Topsoil  
 LEAN CLAY (CL), with Sand, light brown, stiff to hard, dry to moist  
 Grading light brown, iron stained  
 Grading trace Sand  
 Grading dark gray to gray  
 Iron stain grades out  
 Grading dark brown to brown  
 SANDY LEAN CLAY (CL), light gray to dark gray, hard, dry to moist, trace Lignite  
 LIGNITE, dark brown to black, hard, dry to moist  
 LEAN CLAY (CL), with Sand, light gray to gray, hard, dry to moist, with Lignite  
 Lignite grades out  
 Grading trace Sand  
 Total Depth = 55.5 ft.

DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
5	N = 9		16								
	N = 17		23								
10	N = 20		25								
	N = 50/6"										
15	N = 26										
20	N = 28										
25	N = 35										
30	N = 50/6"										
35	N = 38										
40	N = 50/6"										
45	N = 56										
50	N = 52										
55	N = 71										

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.921153, Long. -101.828369

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# LOG OF BORING GEO-10



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026  
 DATE(S) DRILLED: 4/23/2025 - 4/24/2025

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### FIELD DATA

### LABORATORY DATA

### DRILLING METHOD(S):

Solid Stem Auger

### GROUNDWATER INFORMATION:

Groundwater not encountered during or immediately after drilling

### SURFACE ELEVATION (FT):

### DESCRIPTION OF STRATUM

SOIL SYMBOL	DEPTH (FT)	SAMPLES N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
	5	N = 21 N = 40	14 16	71	24	47					91
	10	N = 26 N = 26 N = 32	17 16 41								
	15	N = 50/6"									
	20	N = 38									
	25	N = 40									
	30	N = 40									
	35	N = 73									
	40	N = 50/6"									
	45	N = 88/9"									
	50	N = 50/6"									
	55	N = 50/6"									
	Total Depth = 55 ft.										

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

REMARKS:  
 GPS COORDINATES: Lat. 46.921172, Long. -101.821962



# LOG OF BORING GEO-12



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/24/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 19 ft. during drilling and measured at 44 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SANDY LEAN CLAY (CL), dark brown, soft, dry to moist

CLAYEY SAND (SC), trace Gravel, dark brown to gray, loose to medium dense, dry to moist, fine to coarse grained, calcareous  
 Calcareous feature grades out

Grading iron stained

SILTY SAND (SM), gray to brown, dense, dry to moist, fine grained

Grading trace Gravel, wet, fine to coarse grained

LEAN CLAY (CL), with Sand, gray to brown, very stiff to hard, moist to wet

Grading calcareous

Grading iron stained, with Lignite interbeddings

LIGNITE, black, hard, moist

LEAN CLAY (CL), trace Sand, gray, hard, moist

POORLY-GRADED SAND (SP), gray, very dense, moist, fine to medium grained  
 Total Depth = 55.5 ft.

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SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
	5	N = 4	12									
		N = 9	11									
		N = 11	9									
	10	N = 29	16									
		N = 37	16									
	15	N = 40										
		N = 37										
	20	N = 29										
		N = 33										
	30	N = 60/9"										
		N = 50/3"										
	40	N = 40										
		N = 36										
	50	N = 59										
	55											

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.921525, Long. -101.806480

# LOG OF BORING GEO-13



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/22/2025

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**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SOIL SYMBOL	DEPTH (FT)	SAMPLES N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
	0 - 3	N = 4	20								
	3 - 5	N = 8	26								
	5 - 10	N = 15 N = 17 N = 18	21 24 30								
	10 - 15	N = 30									
	15 - 20	N = 42									
	20 - 25	N = 35									
	25 - 30	N = 58									
	30 - 35	N = 48									
	35 - 40	N = 66									
	40 - 45	N = 58									
	45 - 50	N = 81									
	50 - 55.5	N = 90/11"									

3 in. Topsoil  
 SANDY LEAN CLAY (CL), light brown, soft, moist

CLAYEY SAND (SC), light brown, loose, moist, fine grained, iron stained

LEAN CLAY (CL), trace Sand, light brown, stiff to hard, dry to moist, iron stained  
 Grading with Sand, trace organics  
 Grading trace Sand, gray to dark brown

Grading light brown

SANDY LEAN CLAY (CL), light brown to brown, hard, dry to moist

LEAN CLAY (CL), trace Sand, gray, hard, dry to moist, iron stained

Grading brown, trace organics

Grading light gray

Grading gray to dark gray

SILTSTONE, light gray to gray, very hard, dry to moist

Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.900807, Long. -101.826790

# LOG OF BORING GEO-14



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/22/2025

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FIELD DATA		LABORATORY DATA							DRILLING METHOD(S):			
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
	5	N = 6		19								
		N = 20		22								
		N = 21		23								
	10	N = 23		22								
		N = 28		18								
	15	N = 21										
	20	N = 16										
	25	N = 42										
	30	N = 50										
	35	N = 49										
	40	N = 34										
	45	N = 39										
	50	N = 37										
	55	N = 37										
Total Depth = 55.5 ft.												

**GROUNDWATER INFORMATION:**  
 Groundwater encountered at 34 ft. during drilling and measured at 48 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

5 in. Topsoil  
 LEAN CLAY (CL), trace Sand, light brown, medium stiff to very stiff, moist

Grading with Sand, light brown to gray, calcareous, trace organics  
 Organic grades out

SANDY LEAN CLAY (CL), light gray, very stiff, moist

CLAYEY SAND (SC), light gray, medium dense, dry to moist, fine grained

LEAN CLAY (CL), trace Sand, dark brown, very stiff to hard, dry to moist, with Lignite interbeddings

Grading with Sand, brown to light brown, iron stained, trace organics

Grading trace Sand, light gray

Grading with Sand, wet

Grading gray to dark gray

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.900966, Long. -101.819722

# LOG OF BORING GEO-15



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/22/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

4 in. Topsoil  
 SILT (ML), trace Sand, light brown, very stiff, dry to moist, calcareous

LEAN CLAY (CL), trace Sand, light brown, stiff to hard, dry to moist  
 Grading light gray, with Lignite interbeddings

Grading calcareous, trace organics  
 Grading light brown to brown, iron stained

CLAYEY SAND (SC), light gray to brown, dense, dry to moist, fine grained

LEAN CLAY (CL), trace Sand, dark brown to black, very stiff to hard, dry to moist, with Lignite interbeddings, trace organics

CLAYEY SAND (SC), light gray to gray, dense, dry to moist, fine grained, trace organics

LEAN CLAY (CL), with Sand, light brown to gray, very stiff to hard, dry to moist

Grading calcareous

CLAYEY SAND (SC), dark gray to light gray, medium dense, dry to moist, fine grained  
 Total Depth = 55.5 ft.

DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
5	N = 22	7									
	N = 52	11									
	N = 12	24									
10	N = 20	23									
	N = 36	19									
15	N = 34										
20	N = 29										
25	N = 72/11"										
30	N = 48										
35	N = 48										
40	N = 35										
45	N = 28										
50	N = 36										
55	N = 30										

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.900394, Long. -101.810586





# LOG OF BORING GEO-18



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/21/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 44 ft. during drilling and measured at 44 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

3 in. Topsoil  
 CLAYEY SAND (SC), light brown to brown, medium dense to very dense, dry to moist, fine grained

SANDY LEAN CLAY (CL), dark brown to brown, hard, dry to moist, iron stained

Grading trace organics

CLAYEY SAND (SC), dark brown to brown, dense, wet, fine grained, iron stained

LEAN CLAY (CL), with Sand, gray to brown, hard, moist

Total Depth = 55.5 ft.

**REMARKS:**

GPS COORDINATES: Lat. 46.885050, Long. -101.808962

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

SOIL SYMBOL	DEPTH (FT)	SAMPLES N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
	5	N = 24 N = 39	7 9								
	10	N = 51 N = 72	9 10								
	15	N = 86 N = 39	6								
	20	N = 50/6"									
	25	N = 93/11"									
	30	N = 71									
	35	N = 56									
	40	N = 36									
	45	N = 45									
	50	N = 42									
	55	N = 32									

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

# LOG OF BORING GEO-19



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/21/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SOIL SYMBOL	DEPTH (FT)	SAMPLES N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CUFT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
	0										
	5	N = 30 N = 26	8 6 20	30	18	12					97
	10	N = 24 N = 25	29 21								
	15	N = 36 N = 25	19								
	20	N = 28									
	25	N = 24									
	30	N = 50/1"									
	35	N = 37									
	40	N = 33									
	45	N = 39									
	50	N = 39									
	55	N = 50									
											4 in. Topsoil
											LEAN CLAY (CL), trace Sand, light brown, very stiff, dry to moist
											Grading with Sand, light brown to brown, iron stained
											Grading trace Sand, gray to brown, with Lignite interbeddings
											SANDY LEAN CLAY (CL), light gray, very stiff to hard, dry to moist
											Grading iron stained, trace organics
											LEAN CLAY (CL), trace Sand, gray to light gray, very stiff to hard, dry to moist, iron stained, trace organics
											Grading with Sand, brown, with occasional Sandstone fragments
											Grading trace Sand, gray to brown
											Grading dark brown to black
											Organic grades out; grading light gray to gray
											Grading dark brown to black, trace organics
											Grading gray to light gray
											Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**

GPS COORDINATES: Lat. 46.886567, Long. -101.800295

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHN\ILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING GEO-20



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/30/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

3 in. Topsoil  
 CLAYEY SAND (SC), light brown, loose, moist, fine grained  
 SILT (ML), trace Sand, light brown, dry to moist  
 CLAYEY SAND (SC), light brown to brown, medium dense, moist, fine grained  
 LEAN CLAY (CL), with Sand, brown to gray, very stiff to hard, dry to moist, iron stained

CLAYEY SAND (SC), gray, dense to very dense, dry to moist, fine grained

Grading light gray

Grading fine to medium grained

LEAN CLAY (CL), trace Sand, gray, hard, dry to moist

SILT (ML), trace Sand, gray, hard, dry to moist

LEAN CLAY (CL), trace Sand, gray, hard, dry to moist

Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**

GPS COORDINATES: Lat. 46.976011, Long. -101.763598

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# LOG OF BORING GEO-22



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/9/2025

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FIELD DATA		LABORATORY DATA							DRILLING METHOD(S):		
DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CUFT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
5	N = 17 N = 17		10 17	22	16	6					37
10	N = 15 N = 18		22 21								
15	N = 37 N = 30										
20	P = +4.5										
25	N = 34										
30	N = 50/3"										
35	N = 36										
40	N = 44										
45	N = 53										
50	N = 55										
55	N = 49										
<b>DESCRIPTION OF STRATUM</b>											
5 in. Topsoil SILTY, CLAYEY SAND (SC-SM), light brown, medium dense, dry to moist, fine grained Grading trace Sand, light gray, iron stained, calcareous											
SANDY SILT (ML), light brown, medium dense, moist, calcareous											
SANDY LEAN CLAY (CL), brown, very stiff, moist, iron stained											
SILTY SAND (SM), light brown, medium dense, dry to moist, fine grained, iron stained, trace organics											
LEAN CLAY (CL), trace Sand, brown, very stiff to hard, dry to moist, iron stained											
CLAYEY SAND (SC), brown, dense, dry to moist, fine grained, trace organics											
LEAN CLAY (CL), trace Sand, gray, hard, dry to moist, calcareous, trace organics											
Grading with Lignite beddings											
SANDY SILT (ML), gray, dense, dry to moist											
LEAN CLAY (CL), trace Sand, gray, hard, dry to moist											
Grading with Shale beddings											
SANDY LEAN CLAY (CL), gray, hard, dry to moist, trace organics Total Depth = 55.5 ft.											
<b>REMARKS:</b> GPS COORDINATES: Lat. 46.973116, Long. -101.745499											
N - STANDARD PENETRATION TEST RESISTANCE P - POCKET PENETROMETER RESISTANCE T - TXDOT CONE PENETRATION RESISTANCE R - ROCK CORE RECOVERY RQD - ROCK QUALITY DESIGNATION											

# LOG OF BORING GEO-23



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/9/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

5 in. Topsoil  
 LEAN CLAY (CL), with Sand, light brown, medium stiff to hard, dry to moist, calcareous

Grading trace Sand, yellowish brown, iron stained

Grading trace organics

Grading with Sand, light brown

CLAYEY SAND (SC), light brown to brown, medium dense to very dense, dry to moist, fine grained, iron stained

LEAN CLAY (CL), trace Sand, gray to bluish gray, hard, dry to moist

Grading gray to black, with Lignite interbeddings

Grading light gray to gray

Grading with Sand, calcareous

Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.975381, Long. -101.721823

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# LOG OF BORING GEO-24



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/9/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

6 in. Topsoil  
 SANDY LEAN CLAY (CL), light brown to gray, stiff to very stiff, moist  
 Grading iron stained

LEAN CLAY (CL), trace Sand, gray to brown, very stiff to hard, dry to moist, iron stained, trace organics  
 Grading light brown to yellowish brown, calcareous  
 Grading with Sand

Grading trace Sand, light brown to gray

Grading with Lignite

Grading dark brown

Grading gray to dark gray, with Lignite interbeddings

Organic grades out; grading light gray

SANDY LEAN CLAY (CL), light gray, hard, dry to moist

LEAN CLAY (CL), with Sand, dark gray, hard, dry to moist, trace organics

CLAYEY SAND (SC), light gray to gray, very dense, dry to moist, fine grained

LEAN CLAY (CL), trace Sand, dark gray to gray, hard, dry to moist  
 Total Depth = 55.5 ft.

DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
5	N = 9		21								
	N = 21		19								
10	N = 17		21								
	N = 23		21								
15	P = +4.5										
	N = 28										
20	N = 22										
25	N = 41										
30	N = 52										
35	N = 54										
40	N = 61										
45	N = 62										
50	N = 78/10"										
55	N = 55										

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.968427, Long. -101.723739

# LOG OF BORING GEO-25



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/8/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

5	N = 10	19														3 in. Topsoil
	N = 14	21														LEAN CLAY (CL), with Sand, light brown, stiff to hard, dry to moist, calcareous
	N = 15	16														Grading trace Sand, trace organics
	N = 19	20														Grading iron stained
	N = 19	21														
	P = +4.5															
	N = 33															
	N = 46															Organic grades out
	N = 56															SILT (ML), trace Sand, light brown, hard, dry to moist
	N = 43															LEAN CLAY (CL), trace Sand, brown to gray, hard, dry to moist, iron stained
	N = 48															SILT (ML), with Sand, light brown, hard, dry to moist, calcareous
	N = 43															LEAN CLAY (CL), trace Sand, dark brown, hard, dry to moist, trace organics
	N = 72/9"															
	N = 36															CLAYEY SAND (SC), gray, dense, dry to moist, fine grained
	N = 47															

Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.959730, Long. -101.706249

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# LOG OF BORING GEO-26



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/8/2025

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FIELD DATA		LABORATORY DATA							DRILLING METHOD(S):			
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
	5	N = 13	18									
		N = 22	16									
	10	N = 16	18									
		N = 20	21									
	15	N = 62										
		N = 28										
	20	N = 55										
	25	N = 50/1"										
	30	N = 82/11"										
	35	N = 78										
	40	N = 58										
	45	N = 75/9"										
	50	N = 59										
	55	N = 68										
Total Depth = 55.5 ft.												

**GROUNDWATER INFORMATION:**  
 Groundwater encountered at 39 ft. during drilling and measured at 50 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

5 in. Topsoil  
 LEAN CLAY (CL), with Sand, light brown, stiff, moist

SANDY LEAN CLAY (CL), light brown to brown, very stiff, moist, iron stained

LEAN CLAY (CL), trace Sand, light gray to brown, very stiff to hard, dry to moist, iron stained  
 Grading with Sand, trace organics  
 Grading trace Sand, gray to light gray

Grading with Sand, gray to brown, with Lignite interbeddings

CLAYEY SAND (SC), light gray, very dense, dry to moist, fine grained

Grading light brown to gray, calcareous

Grading light brown to yellowish brown, with Lignite

LEAN CLAY (CL), trace Sand, dark brown to black, hard, wet, with Lignite interbeddings

Grading dark gray to black

Grading light gray to black, trace organics

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.961450, Long. -101.700128

# LOG OF BORING GEO-27



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/9/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

6 in. Topsoil  
 LEAN CLAY (CL), with Sand, light brown, stiff, moist, calcareous

SANDY LEAN CLAY (CL), dark brown, stiff, moist, iron stained, trace organics

CLAYEY SAND (SC), light brown, medium dense to dense, moist, fine grained, trace organics  
 Grading light brown to brown, iron stained

Grading light brown to gray

LEAN CLAY (CL), trace Sand, brown, hard, dry to moist, iron stained, trace organics

Grading dark brown, with Lignite

CLAYEY SAND (SC), gray, very dense, dry to moist, fine grained

LIGNITE, black to dark brown, hard, dry to moist, trace organics

Total Depth = 55 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.961464, Long. -101.693477

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# LOG OF BORING GEO-28



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/26/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 35 ft. during drilling and measured at 52 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

6 in. Topsoil  
 LEAN CLAY (CL), with Sand, light brown, medium stiff to hard, dry to moist  
 Grading iron stained, calcareous  
 Grading trace organics

SANDY LEAN CLAY (CL), light brown to brown, hard, dry to moist, iron stained

CLAYEY SAND (SC), light gray to brown, dense, dry to moist, fine grained  
 Grading iron stained  
 Grading trace Lignite  
 Organic grade out; grading dark gray  
 Grading wet

LEAN CLAY (CL), trace Sand, gray, hard, moist to wet  
 Grading calcareous

SILTSTONE, gray to light gray, hard, moist

Total Depth = 55.5 ft.

DEPTH (FT)	SAMPLES N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
			LL	PL	PI					
5	N = 6 N = 7	15 20								
10	N = 10 N = 32 N = 50/5"	22 20 7								
15	N = 62									
20	N = 41									
25	N = 35									
30	N = 40									
35	N = 43									
40	N = 33									
45	N = 35									
50	N = 47									
55	N = 73									

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.953950, Long. -101.786611

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# LOG OF BORING GEO-29



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/29/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 9 ft. during drilling and measured at 55 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

4 in. Topsoil  
 CLAYEY SAND (SC), light brown, very loose to dense, dry to moist, fine grained

Grading wet  
 Grading brown to gray, iron stained

Grading light brown to gray

Grading dark gray to gray

LEAN CLAY (CL), with Sand, light brown to gray, very stiff to hard, moist to wet

CLAYEY SAND (SC), gray to bluish gray, very dense, moist to wet, fine grained

LEAN CLAY (CL), trace Sand, dark gray to gray, hard, moist to wet

Grading with organics

Organic grades out

Grading with Lignite interbeddings

Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.959220, Long. -101.764704

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# LOG OF BORING GEO-31



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/2/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 49 ft. during drilling and measured at 49 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SOIL SYMBOL	DEPTH (FT)	SAMPLES N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
	5	N = 8 N = 7	7								
	10	N = 21 N = 15	7								
	15	P = 4.5 N = 20	15								
	20	P = +4.5									
	25	N = 31									
	30	N = 32									
	35	N = 55									
	40	N = 38									
	45	N = 50/5"									
	50	N = 40									
	55	N = 41									

6 in. Topsoil  
 CLAYEY SAND (SC), light brown to brown, loose to medium dense, dry to moist, fine grained

Grading iron stained  
 LEAN CLAY (CL), trace Sand, gray to light brown, very stiff to hard, dry to moist

Grading with Sand

Grading trace Sand, dark gray

Grading gray

Grading dark brown, trace organics

Grading gray, wet

SILT (ML), trace Sand, gray, hard, moist

Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.954390, Long. -101.753974



# LOG OF BORING GEO-34



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/4/2025

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FIELD DATA		LABORATORY DATA							DRILLING METHOD(S):		
DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
GROUNDWATER INFORMATION: Groundwater not encountered during or immediately after drilling											
SURFACE ELEVATION (FT):											
DESCRIPTION OF STRATUM											
5	N = 14 N = 17	15 12									
5 in. Topsoil CLAYEY SAND (SC), light brown, medium dense, dry to moist, fine grained, calcareous Grading brown, iron stained											
10	N = 11 N = 23 N = 32	32 22 24									
LEAN CLAY (CL), trace Sand, light brown to gray, stiff, moist											
CLAYEY SAND (SC), light brown to gray, medium dense, moist, fine grained											
LEAN CLAY (CL), with Sand, brown, hard, moist, iron stained											
15	N = 33										
CLAYEY SAND (SC), light brown to brown, dense, dry to moist, fine grained											
20	N = 23										
LEAN CLAY (CL), trace Sand, dark brown to brown, very stiff, dry to moist, iron stained, trace organics											
25	N = 27										
Grading light brown, with Lignite interbeddings											
30	N = 61										
SILT (ML), trace Sand, gray to light gray, hard, dry to moist											
35	N = 78/9"										
SHALE, dark brown to black, very hard, dry to moist, with Lignite interbeddings											
40	N = 56										
SILTSTONE, dark brown, medium hard to hard, dry to moist, trace organics											
45	N = 48										
Organic grades out; grading gray to light gray											
50	N = 90/8"										
CLAYSTONE, dark gray to gray, very hard, dry to moist, trace Lignite											
55	N = 50/6"										
Total Depth = 55 ft.											

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

REMARKS:  
 GPS COORDINATES: Lat. 46.954983, Long. -101.724356

# LOG OF BORING GEO-35



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/3/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 30 ft. during drilling and not measured immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

5 in. Topsoil  
 LEAN CLAY (CL), trace Sand, dark brown, medium stiff, moist, trace organics  
 SANDY LEAN CLAY (CL), dark brown, medium stiff, moist, iron stained, trace organics  
 LEAN CLAY (CL), with Sand, brown, medium stiff to very stiff, dry to moist, iron stained, with Lignite interbeddings, trace organics  
 Grading gray  
 POORLY-GRADED SAND (SP), dark brown, dense, dry to moist, fine grained  
 Grading iron stained  
 LEAN CLAY (CL), trace Sand, gray, very stiff to hard, moist to wet, trace organics

Total Depth = 55.5 ft.

**REMARKS:**

GPS COORDINATES: Lat. 46.944218, Long. -101.753027

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

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# LOG OF BORING GEO-36



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/5/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 12 ft. during drilling and measured at 47 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

6 in. Topsoil  
 LEAN CLAY (CL), with Sand, brown to dark gray, very stiff, moist, iron stained, trace organics  
 CLAYEY SAND (SC), brown to gray, very loose to very dense, dry to moist, fine grained  
 Grading wet  
 Grading trace organics

FAT CLAY (CH), trace Sand, gray, medium stiff to hard, moist to wet, trace organics  
 Grading with Sand, brown

Grading dark gray

Grading dark brown

Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.941605, Long. -101.746654

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# LOG OF BORING GEO-37



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/4/2025 - 5/5/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

5	N = 13	21														5 in. Topsoil
	N = 20	22														LEAN CLAY (CL), trace Sand, light brown, stiff to very stiff, moist, iron stained
	N = 17	24														
10	N = 5	97														LIGNITE, black, medium stiff to very stiff, moist, trace organics
	N = 43	47					65	2.66	3.5	0.0						
15	N = 17															LEAN CLAY (CL), trace Sand, gray, very stiff, dry to moist
20	N = 49															
25	N = 33															POORLY-GRADED SAND (SP), gray, dense, dry to moist, fine grained
30	N = 50/6"															LIGNITE, black, hard, dry to moist
35	N = 50/6"															
40	N = 43															LEAN CLAY (CL), trace Sand, gray, hard, dry to moist
45	N = 43															SILT (ML), trace Sand, gray, hard, dry to moist
50	N = 42															
	N = 50/2"															

Total Depth = 54.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.942772, Long. -101.740419

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# LOG OF BORING GEO-38



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/4/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

6 in. Topsoil  
 LEAN CLAY (CL), with Sand, light brown to brown, soft to hard, dry to moist, trace roots  
 Grading dark brown  
 Grading brown  
 Grading light brown  
 Grading trace Sand, brown, iron stained  
 Grading light brown to brown

CLAYEY SAND (SC), brown, medium dense to very dense, dry to moist, fine grained, iron stained

SANDSTONE, gray, very hard, dry to moist, fine grained

Total Depth = 42.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.940587, Long. -101.731712

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# LOG OF BORING GEO-39



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/4/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 49 ft. during drilling and measured at 54 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

5	N = 7	19													6 in. Topsoil
	N = 13	20													LEAN CLAY (CL), with Sand, dark brown to brown, medium stiff, moist
	N = 18	20													SILT (ML), trace Sand, light gray, stiff, moist
	N = 19	21													LEAN CLAY (CL), trace Sand, brown to light gray, very stiff to hard, dry to moist
	N = 56														Grading with Sand, dark brown to brown
	N = 25														
	N = 46														CLAYEY SAND (SC), brown, dense to very dense, dry to moist, fine grained
	N = 67														Grading trace Gravel, fine to coarse grained
	N = 79/11"														SANDSTONE, brown to light brown, very hard, dry to moist, fine grained, iron stained
	N = 75/10"														Grading dark gray to brown
	N = 48														SANDY CLAYSTONE, gray, medium hard, dry to moist SANDSTONE, gray, medium hard to very hard, fine grained
	N = 81/8"														
	N = 68														Grading wet
	N = 79/8"														
Total Depth = 55.5 ft.															

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.945336, Long. -101.725459

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# LOG OF BORING GEO-40



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/27/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

6 in. Topsoil  
 SANDY SILT (ML), light brown, loose, dry to moist  
 SILTY SAND (SM), light brown, dry to moist, fine grained  
 LEAN CLAY (CL), with Sand, brown to light brown, medium stiff, moist  
 CLAYEY SAND (SC), brown, medium dense to dense, dry to moist, fine to medium grained, iron stained  
 POORLY-GRADED SAND (SP), light brown to yellowish brown, dense to very dense, dry to moist, fine grained

Total depth = 55 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.939113, Long. -101.709620

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# LOG OF BORING GEO-42



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/10/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 30 ft. during drilling and measured at 54 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

5 in. Topsoil  
 LEAN CLAY (CL), trace Sand, brown, stiff, moist, iron stained, calcareous

SANDY LEAN CLAY (CL), brown, stiff to hard, dry to moist, calcareous  
 Grading iron stained

CLAYEY SAND (SC), brown, dense to very dense, dry to moist, fine grained

Grading gray, trace organics  
 Grading wet

Total Depth = 55.5 ft.

**REMARKS:**  
 GPS COORDINATES: Lat. 46.940888, Long. -101.695081

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

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# LOG OF BORING GEO-43



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/7/2025

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FIELD DATA		LABORATORY DATA							DRILLING METHOD(S):			
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
	5	N = 11 N = 29 N = 33		13 14 13								
	10	N = 35 N = 80 N = 44		12								
	15	N = 52										
	20	N = 69										
	25	N = 62										
	30	N = 92										
	35	N = 80										
	40	N = 85/10"										
	45	N = 81/10"										
	50	N = 71										
	55											
6 in. Topsoil												
CLAYEY SAND (SC), light brown, medium dense to very dense, dry to moist, fine grained, calcareous Grading brown, iron stained												
Grading gray to brown												
Grading light brown to brown												
Grading gray to brown												
Total Depth = 55.5 ft.												
N - STANDARD PENETRATION TEST RESISTANCE P - POCKET PENETROMETER RESISTANCE T - TXDOT CONE PENETRATION RESISTANCE R - ROCK CORE RECOVERY RQD - ROCK QUALITY DESIGNATION										REMARKS: GPS COORDINATES: Lat. 46.939567, Long. -101.785665		



# LOG OF BORING GEO-45



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/27/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SOIL SYMBOL	DEPTH (FT)	SAMPLES N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
				LL	PL	PI						
X	5	N = 20	16									3 in. Topsoil
X	5	N = 22	20									CLAYEY SAND (SC), light brown, medium dense, moist, fine grained, calcareous
X	10	N = 17	23									SANDY LEAN CLAY (CL), light brown to brown, very stiff, moist, iron stained, calcareous, trace organics
X	10	N = 18	18									LEAN CLAY (CL), trace Sand, light brown, very stiff, moist, iron stained, calcareous, trace organics
X	15	N = 38										SANDY LEAN CLAY (CL), light brown to gray, very stiff to hard, dry to moist, iron stained
X	15	N = 34										CLAYEY SAND (SC), gray to brown, dense, dry to moist, fine grained, iron stained
X	20	N = 23										LEAN CLAY (CL), trace Sand, brown, very stiff to hard, dry to moist, iron stained, trace organics
X	25	N = 59										Grading gray
X	30	N = 56										
X	35	N = 58										
X	40	N = 83/11"										SANDSTONE, light brown, very hard, dry to moist, fine grained
X	45	N = 84/9"										
X	50	N = 93/10"										
X	55	N = 88/10"										
												Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**

GPS COORDINATES: Lat. 46.935204, Long. -101.795228

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# LOG OF BORING GEO-46



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/26/2025

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FIELD DATA		LABORATORY DATA								DRILLING METHOD(S):		
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
5	5	N = 14		12								
		N = 29		16	41	18	23					84
		N = 15		19								
10	10	N = 17		31								
		N = 34		19								
15	15	N = 30		23	69	18	51	104	6.21	10.1	10.0	82
		N = 18										
20	20	N = 38										
		N = 47										
25	25	N = 65										
		N = 78/10"										
30	30	N = 50/5"										
		N = 50/6"										
35	35	N = 50/4"										
40	40											
45	45											
50	50											
55	55											

**GROUNDWATER INFORMATION:**  
 Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

LEAN CLAY (CL), with Sand, light brown, stiff to very stiff, moist, trace Lignite

Grading light brown to brown, iron stained

Grading trace Sand, gray to brown, trace organics

FAT CLAY (CH), with Sand, gray to brown, hard, moist

SANDY LEAN CLAY (CL), light gray to brown, very stiff, dry to moist

LEAN CLAY (CL), trace Sand, light gray to dark brown, very stiff to hard, dry to moist, trace organics

Grading with Sand

SANDY LEAN CLAY (CL), light brown to brown, hard, dry to moist, iron stained

Grading light gray

SANDY CLAYSTONE, light gray to brown, very hard, dry to moist

SANDSTONE, light gray to brown, very hard, dry to moist, fine to medium grained, weakly cemented

Total Depth = 55 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.93259, Long. -101.787606

# LOG OF BORING GEO-47



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/27/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 45 ft. during drilling and measured at 48 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

2 in. Topsoil  
 CLAYEY SAND (SC), light brown, medium dense to very dense, dry to moist, fine grained, calcareous

SANDY LEAN CLAY (CL), light brown, hard, dry to moist

CLAYEY SAND (SC), light brown, dense, dry to moist, fine grained

SANDY LEAN CLAY (CL), light brown, hard, dry to moist

CLAYEY SAND (SC), light brown, dense to very dense, dry to moist, fine grained

Grading gray

Grading wet

LIGNITE, dark brown, hard, moist

LEAN CLAY (CL), with Sand, gray, hard, moist, calcareous

Total Depth = 55.5 ft.

SOIL SYMBOL	DEPTH (FT)	SAMPLES N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
	5	N = 18 N = 74	8 7								
	10	N = 58 N = 51	11 14								
	15	N = 49 N = 39	13								
	20	N = 50									
	25	N = 52									
	30	N = 47									
	35	N = 45									
	40	N = 58									
	45	N = 56									
	50	N = 66									
	55	N = 36									

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.932651, Long. -101.777749

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# LOG OF BORING GEO-48



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/5/2025

RENEWABLE LOG - LOG A.GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHN\ILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

FIELD DATA				LABORATORY DATA							DRILLING METHOD(S):	
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
	5	N = 13 N = 15	20 23	71	23	48						96
	10	N = 19 N = 31	22 17									
	15	N = 37 N = 42	19									
	20	N = 55										
	25	N = 33										
	30	N = 83										
	35	N = 50/1"										
	40	N = 67										
	45	N = 93/11"										
	50	N = 91/7" N = 25/0"										

Hollow Stem Auger

**GROUNDWATER INFORMATION:**  
 Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

6 in. Topsoil  
 FAT CLAY (CH), trace Sand, brown to gray, stiff to hard, moist  
 Grading with Sand, iron stained

CLAYEY SAND (SC), brown to gray, dense, dry to moist, fine grained, iron stained  
 Grading yellowish brown

LEAN CLAY (CL), trace Sand, brown to dark brown, hard, dry to moist, with Lignite, trace organics  
 Grading gray

POORLY-GRADED SAND (SP-SM), with Silt, yellowish brown, very dense, dry to moist, fine grained

SANDSTONE, light yellowish brown, very hard, dry to moist, calcareous

SANDSTONE, yellowish brown, hard to very hard, dry to moist, fine grained, weakly to moderately cemented

Refusal at 52 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.922342, Long. -101.767967

# LOG OF BORING GEO-49



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/6/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

5 in. Topsoil  
 LEAN CLAY (CL), with Sand, light brown, very stiff, dry to moist, calcareous

SANDY LEAN CLAY (CL), light brown to yellowish brown, medium stiff to stiff, moist  
 Grading brown to gray

LEAN CLAY (CL), with Sand, brown to gray, stiff to hard, dry to moist, iron stained  
 Grading trace organics

SANDY ELASTIC SILT (MH), brown to gray, medium stiff to hard, dry to moist, iron stained, calcareous

Grading trace organics

Calcareous feature and organic grades out; grading with Lignite

Grading dark brown

LEAN CLAY (CL), trace Sand, dark brown to gray, very stiff to hard, dry to moist, iron stained, trace Lignite and organics

Organic grades out; grading with Sand, calcareous

SANDY LEAN CLAY (CL), gray, hard, dry to moist, calcareous

Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.926427, Long. -101.762738

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# LOG OF BORING GEO-50



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/8/2025

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FIELD DATA		LABORATORY DATA							DRILLING METHOD(S):			
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
	5	N = 9 N = 12		19 22								
	10	N = 7 N = 16		26 23								
	15	P = +4.5 N = 39		20	52	20	32	107			99	
	20	N = 29										
	25	N = 34										
	30	N = 86										
	35	N = 46										
	40	N = 41										
	45	N = 40										
	50	N = 57										
	55	N = 36										
Total Depth = 55.5 ft.												

**GROUNDWATER INFORMATION:**  
 Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**  
**DESCRIPTION OF STRATUM**

6 in. Topsoil  
 LEAN CLAY (CL), trace Sand, brown to gray, stiff, moist, calcareous  
 Grading iron stained

FAT CLAY (CH), trace Sand, dark brown to gray, medium stiff to hard, dry to moist, calcareous, with Lignite  
 Grading brown

Grading with Shale

Grading brown to gray

SANDY LEAN CLAY (CL), dark brown to gray, hard, dry to moist, trace Lignite

LEAN CLAY (CL), trace Sand, dark brown to gray, hard, dry to moist, trace Lignite

SANDY LEAN CLAY (CL), gray, hard, dry to moist

CLAYEY SAND (SC), gray, dense to very dense, dry to moist, fine grained

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.923447, Long. -101.751849

# LOG OF BORING GEO-51



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/10/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

5 in. Topsoil  
 SANDY LEAN CLAY (CL), light brown, stiff, dry to moist, iron stained, calcareous

LEAN CLAY (CL), with Sand, gray to brown, stiff to hard, dry to moist, iron stained  
 Grading trace Sand, light brown to yellowish brown, trace organics  
 Grading light brown to brown

Grading light gray

Grading with Sand, light brown to gray

Grading trace Sand, gray to dark gray

Grading with Lignite interbeddings

Total Depth = 55 ft.

DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
5	N = 9		12								
	N = 13		26								
	N = 19		23								
10	N = 16		22								
	P = +4.5										
15	N = 18										
20	N = 72/7"										
25	N = 30										
30	N = 42										
35	N = 40										
40	N = 40										
45	N = 44										
50	N = 59										
55	N = 50/6"										

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.922422, Long. -101.730508

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# LOG OF BORING GEO-52



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/8/2025 - 5/10/2025

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FIELD DATA		LABORATORY DATA							DRILLING METHOD(S):	
DEPTH (FT)	SAMPLES	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CUFT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
SOIL SYMBOL	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %		LL	PL	PI					
5	N = 15	16								
	N = 21	17								
	N = 14	20								
10	N = 22	48								
	N = 50	19								
	N = 32									
20	N = 50/6"									
	N = 43									
30	N = 36									
	N = 81									
40	N = 69									
	N = 42									
50	N = 37									
55	N = 56									
Total Depth = 55.5 ft.										

DRILLING METHOD(S):  
Solid Stem Auger

GROUNDWATER INFORMATION:  
Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

**DESCRIPTION OF STRATUM**

5 in. Topsoil  
 SANDY LEAN CLAY (CL), brown to gray, stiff, moist, calcareous

LEAN CLAY (CL), with Sand, brown to gray, stiff to very stiff, moist  
 Grading trace Sand, light brown to light gray, trace organics

Grading dark brown, with Lignite

CLAYEY SAND (SC), light brown, dense, moist, fine grained, trace organics

LEAN CLAY (CL), trace Sand, brown, hard, dry to moist, iron stained

SILTY SAND (SM), brown, very dense, dry to moist, fine grained, trace organics

LEAN CLAY (CL), trace Sand, dark brown, hard, dry to moist, with Lignite, trace organics

SANDY LEAN CLAY (CL), brown, hard, dry to moist, iron stained

CLAYEY SAND (SC), light brown, dense to very dense, dry to moist, fine grained

Grading brown to gray

Grading light brown to gray

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

REMARKS:  
GPS COORDINATES: Lat. 46.923094, Long. -101.724068

# LOG OF BORING GEO-53



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/6/2025

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FIELD DATA		LABORATORY DATA							DRILLING METHOD(S):			
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
5	5	N = 11 N = 7 N = 6		16 17 22 23	54	19	35				93	
5 in. Topsoil												
FAT CLAY (CH), trace Sand, light brown, medium stiff to stiff, moist, calcareous Calcareous feature grades out; grading with Sand, iron stained  Grading trace organics												
10	10	P = +4.5 N = 13		98	NP	NP	NP	34			66	
SANDY SILT (ML), black, loose, dry to moist, trace organics												
15	15	N = 34										
LEAN CLAY (CL), trace Sand, gray to brown, stiff to hard, dry to moist, iron stained, with Lignite  Grading dark brown, with Lignite interbeddings												
20	20	N = 9 P = +4.5		26				94				
25	25	N = 35										
Grading gray, calcareous												
30	30	N = 28										
Grading dark gray												
35	35	N = 35										
Lignite grades out												
40	40	N = 42										
45	45	N = 33										
50	50	N = 51										
Grading with Lignite interbeddings												
55	55	N = 59										
CLAYEY SAND (SC), gray, very dense, dry to moist, fine grained Total Depth = 55.5 ft.												

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

REMARKS:  
 GPS COORDINATES: Lat. 46.922764, Long. -101.713804



# LOG OF BORING GEO-56



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/8/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

6 in. Topsoil  
 LEAN CLAY (CL), trace Sand, light brown, very stiff to hard, dry to moist

Grading dark brown, with occasional Shale fragments, trace organics  
 Grading gray to dark brown

Grading with Sand, brown to gray, iron stained

Grading trace Sand, dark gray to gray, with Lignite interbeddings

SANDY LEAN CLAY (CL), light gray to gray, hard, dry to moist, trace organics

LEAN CLAY (CL), trace Sand, light gray to gray, hard, dry to moist

Grading light gray to black, with Lignite interbeddings

Grading with Sand, trace organics

SANDY LEAN CLAY (CL), dark gray to gray, hard, dry to moist, trace organics  
 Total Depth = 55.5 ft.

DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
5	N = 18 N = 20		16 19								
10	N = 27 N = 18		26 42								
15	P = +4.5 N = 39										
20	N = 84/10"										
25	N = 57										
30	N = 72										
35	N = 47										
40	N = 34										
45	N = 41										
50	N = 54										
55	N = 35										

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.907994, Long. -101.725116

# LOG OF BORING GEO-57



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/7/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

4 in. Topsoil  
 LEAN CLAY (CL), with Sand, light brown, very stiff to hard, dry to moist, calcareous

Grading trace Sand, light brown

Grading light brown to gray

LIGNITE, black, hard, dry to moist  
 LEAN CLAY (CL), trace Sand, light gray to gray, hard, dry to moist, trace organics

Grading dark gray to gray, with Lignite interbeddings

Grading gray to black

Grading light gray

Grading gray

Lignite and organic grades out

Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.910611, Long. -101.712133

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# LOG OF BORING GEO-60



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/25/2025 - 4/26/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

6 in. Topsoil  
 SILTY SAND (SM), light brown, loose to medium dense, dry to moist, fine grained

SANDY LEAN CLAY (CL), light brown, very stiff, dry to moist  
 Grading calcareous

Grading brown to dark brown

Grading brown to gray

LEAN CLAY (CL), trace Sand, gray to brown, hard, dry to moist

Grading gray to light gray, trace organics  
 SILT (ML), trace Sand, gray, hard, dry to moist, with Lignite and Sandstone interbeddings

LEAN CLAY (CL), with Sand, gray, hard, dry to moist

Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.918971, Long. -101.692604

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# LOG OF BORING GEO-61



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/25/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 24 ft. during drilling and not measured immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

5	N = 8	19															6 in. Topsoil
	N = 22	15															SANDY LEAN CLAY (CL), dark brown to brown, medium stiff, moist
	N = 26	14															CLAYEY SAND (SC), light brown, medium dense to very dense, dry to moist, fine grained, iron stained Grading light brown to brown
	N = 23	27															
	N = 54																Grading dark brown to brown
	N = 40																
	N = 42																Grading wet
	N = 70																
	N = 42																Grading gray to brown
	N = 79																
	N = 58																SANDY LEAN CLAY (CL), gray to light gray, hard, moist
	N = 67/11"																LEAN CLAY (CL), trace Sand, gray to light gray, hard, moist, with Lignite interbeddings Grading dark brown, with Lignite beddings Grading light gray
	N = 52																
	N = 44																Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.909107, Long. -101.683665

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING GEO-62



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/6/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 34 ft. during drilling and measured at 52 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SOIL SYMBOL	DEPTH (FT)	SAMPLES N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
				LL	PL	PI						
3 in. Topsoil	5	N = 4	13									3 in. Topsoil
		N = 9	8	26	18	8					49	CLAYEY SAND (SC), light brown, loose, dry to moist, fine grained, calcareous
		N = 4	12									SANDY LEAN CLAY (CL), brown, soft, moist
	10	N = 4	27									SANDY LEAN CLAY (CL), brown, soft, moist
		N = 19	22									FAT CLAY (CH), trace Sand, brown, very stiff to hard, dry to moist
		N = 29	21	56	23	33	105	4.51	6.6	10.0	91	Grading dark brown to gray
		N = 39										Grading light gray
		N = 21										Grading iron stained
	25	P = +4.5	25				101					
		N = 34										
		N = 32										Grading wet
		N = 47										
		N = 39										
	50	N = 70/7"										Grading gray
		N = 35										
												Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.908346, Long. -101.677053

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHN\ILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING GEO-63



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/7/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

5 in. Topsoil  
 LEAN CLAY (CL), with Sand, light brown, stiff to hard, dry to moist, calcareous  
 Grading light brown to yellowish brown, iron stained

Grading trace Sand

Grading with Sand, brown

Grading trace Sand, gray to dark brown, with Lignite interbedding

Grading dark brown to light brown

Grading brown

CLAYEY SAND (SC), gray to brown, medium dense, dry to moist, fine grained

SANDY LEAN CLAY (CL), light gray, hard, dry to moist

Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.903390, Long. -101.708697

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# LOG OF BORING GEO-64



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/24/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

6 in. Topsoil  
 SANDY LEAN CLAY (CL), light brown, stiff to very stiff, moist

LEAN CLAY (CL), with Sand, light brown, very stiff to hard, dry to moist, iron stained  
 Grading trace Sand, with Lignite seems  
 Grading dark gray to gray  
 Grading dark brown, with Lignite bedding

LIGNITE, dark brown, hard, dry to moist  
 SILT (ML), with Sand, gray, hard, dry to moist

SANDY LEAN CLAY (CL), gray to dark gray, hard, dry to moist

LEAN CLAY (CL), trace Sand, gray, hard, dry to moist, with Lignite bedding

Total Depth = 55.5 ft.

**REMARKS:**  
 GPS COORDINATES: Lat. 46.903570, Long. -101.686788

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

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# LOG OF BORING GEO-65



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/8/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

5 in. Topsoil  
 SANDY LEAN CLAY (CL), light brown, medium stiff to stiff, dry to moist, calcareous  
 Grading trace organics

CLAYEY SAND (SC), brown, loose, moist, fine grained, trace organics

LEAN CLAY (CL), with Sand, brown to gray, very stiff to hard, dry to moist  
 Grading light brown  
 Grading trace Sand

Grading dark gray, iron stained

Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.897699, Long. -101.696096

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# LOG OF BORING GEO-66



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/23/2025

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FIELD DATA		LABORATORY DATA								DRILLING METHOD(S):		
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
	5	N = 5		15								
		N = 6		20								
		N = 14		17								
	10	N = 11		28								
		P = 4.5		22	52	22	30	104	6.24	5.8	10.0	100
	15	N = 25										
	20	N = 26										
	25	N = 37										
	30	N = 48										
	35	N = 56										
	40	N = 55										
	45	N = 58										
	50	N = 35										
	55	N = 54										
9 in. Topsoil SANDY LEAN CLAY (CL), light brown, medium stiff to stiff, moist, calcareous, trace roots  Grading light brown to gray  FAT CLAY (CH), trace Sand, light gray to brown, stiff to hard, dry to moist, iron stained  SANDY LEAN CLAY (CL), light gray to brown, very stiff, dry to moist, iron stained  LEAN CLAY (CL), trace Sand, light gray to brown, hard, dry to moist, iron stained  SANDY LEAN CLAY (CL), light gray to brown, hard, dry to moist, iron stained  LEAN CLAY (CL), with Sand, light brown, hard, dry to moist, iron stained  SILT (ML), trace Sand, dark gray to gray, hard, dry to moist  Total Depth = 55.5 ft.												
N - STANDARD PENETRATION TEST RESISTANCE P - POCKET PENETROMETER RESISTANCE T - TXDOT CONE PENETRATION RESISTANCE R - ROCK CORE RECOVERY RQD - ROCK QUALITY DESIGNATION										REMARKS: GPS COORDINATES: Lat. 46.896434, Long. -101.676574		

# LOG OF BORING GEO-67



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026  
 DATE(S) DRILLED: 4/25/2025

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FIELD DATA				LABORATORY DATA							DRILLING METHOD(S): Hollow Stem Auger	
SOIL SYMBOL	DEPTH (FT)	SAMPLES N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	GROUNDWATER INFORMATION: Groundwater encountered at 45 ft. during drilling and not measured immediately after drilling
				LL	PL	PI						
DESCRIPTION OF STRATUM												
	0 - 6	N = 13	14									6 in. Topsoil
	6 - 10	N = 26 N = 26	14 20	43	21	22					97	LEAN CLAY (CL), trace Sand, light brown to brown, stiff to very stiff, dry to moist, calcareous  Grading iron stained
	10 - 15	N = 25 N = 48	20 18									SANDY LEAN CLAY (CL), brown, very stiff, dry to moist, iron stained
	15 - 20	N = 23 N = 32										LEAN CLAY (CL), with Sand, light brown to brown, hard, dry to moist
	20 - 25	N = 38										Grading trace Sand, iron stained
	25 - 30	N = 46										Grading light gray to brown
	30 - 35	N = 41										Iron stain grades out; grading dark gray to gray
	35 - 40	N = 72/11"										
	40 - 45	N = 60										SANDY LEAN CLAY (CL), light brown to brown, hard, dry to moist, trace organics Grading wet
	45 - 50	N = 34										LEAN CLAY (CL), with Sand, bluish gray to gray, hard, moist
	50 - 55	N = 40										SANDY LEAN CLAY (CL), bluish gray to gray, hard, moist
												Total Depth = 55.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

REMARKS:  
 GPS COORDINATES: Lat. 46.897586, Long. -101.664957

# LOG OF BORING GEO-68



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/23/2025

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**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SOIL SYMBOL	DEPTH (FT)	SAMPLES N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	
				LL LIQUID LIMIT	PL PLASTIC LIMIT	PI PLASTICITY INDEX						
	0	N = 19	15									9 in. Topsoil
	5	N = 26	20									LEAN CLAY (CL), with Sand, light brown, very stiff, moist, iron stained, calcareous
	10	N = 35	20									SANDY LEAN CLAY (CL), brown to gray, hard, moist, iron stained
	15	N = 32	19									LEAN CLAY (CL), with Sand, brown to gray, very stiff to hard, dry to moist, iron stained, with Lignite Grading trace Sand, calcareous, trace Lignite
	15	N = 25	22									
	15	N = 54										
	20	N = 28										Lignite grades out; grading trace Calcite
	25	N = 39										
	30	N = 42										Calcite grades out
	35	N = 46										Grading light brown to gray
	40	N = 81/11"										
	45	N = 50										Grading with Sand
	50	N = 73										
	54.5	N = 50/4"										Total Depth = 54.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**

GPS COORDINATES: Lat. 46.896070, Long. -101.651180

# LOG OF BORING GEO-69



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/24/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

5	N = 20	24														6 in. Topsoil
	N = 25	17														SILTY SAND (SM), light brown, medium dense, moist, fine grained
	N = 18	23														Grading dark brown, with Lignite seams
	N = 18	25														LEAN CLAY (CL), with Sand, light gray to brown, very stiff to hard, moist, iron stained, trace Calcite
	P = N/A	25					95	4.60	3.5	0.0						Grading trace Sand
	N = 22															SANDY LEAN CLAY (CL), light brown, very stiff, dry to moist
	N = 68															SILT (ML), trace Sand, light brown, hard, dry to moist
	N = 26															Grading dark brown, with Lignite beddings
	N = 32															LEAN CLAY (CL), with Sand, dark brown, very stiff, dry to moist, with Lignite beddings
	N = 39															SILTY SAND (SM), gray, dense, dry to moist, fine grained
	N = 41															LEAN CLAY (CL), trace Sand, light gray to gray, very stiff to hard, dry to moist, with Lignite seams
	N = 30															
	N = 39															
	N = 40															
Total Depth = 55.5 ft.																

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.890090, Long. -101.683948

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# LOG OF BORING GEO-70



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/24/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 34 ft. during drilling and not measured immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
					LL	PL	PI						
(Diagonal Hatching)	0 - 6	N = 22		14								99	6 in. Topsoil
(Diagonal Hatching)	6 - 10	N = 20		16	61	20	41						FAT CLAY (CH), trace Sand, light brown, very stiff, moist, calcareous
(Diagonal Hatching)	10 - 15	N = 22 N = 18		19									SANDY SILT (ML), light brown, medium dense, dry to moist
(Diagonal Hatching)	15 - 20	N = 34 N = 14		11									SANDY LEAN CLAY (CL), light brown to gray, very stiff, dry to moist, calcareous
(Diagonal Hatching)	20 - 25	N = 18		15									LEAN CLAY (CL), trace Sand, light brown to gray, stiff to very stiff, dry to moist
(Diagonal Hatching)	25 - 30	N = 34		26									Grading dark brown, trace Lignite bedding
(Diagonal Hatching)	30 - 35	N = 14											SANDY LEAN CLAY (CL), light brown to gray, very stiff to hard, dry to moist
(Diagonal Hatching)	35 - 40	N = 26											Grading brown
(Diagonal Hatching)	40 - 45	N = 33											LIGNITE, dark brown, hard, moist to wet
(Diagonal Hatching)	45 - 50	N = 43											SILT (ML), trace Sand, gray, hard, moist to wet
(Diagonal Hatching)	50 - 55	N = 50/4"											SANDY LEAN CLAY (CL), gray, hard, moist
(Diagonal Hatching)	55 - 60	N = 37											LEAN CLAY (CL), trace Sand, dark gray to light gray, hard, moist
(Diagonal Hatching)	60 - 65	N = 35											Total Depth = 55.5 ft.
(Diagonal Hatching)	65 - 70	N = 49											
(Diagonal Hatching)	70 - 75	N = 51											

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.881269, Long. -101.690206

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# LOG OF BORING GEO-71



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/3/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 25 ft. during drilling and not measured immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

4 in. Topsoil  
 CLAYEY SAND (SC), brown, loose to very dense, dry to moist, fine grained, iron stained  
 Grading light brown

SANDY LEAN CLAY (CL), light brown to gray, hard, moist, trace organics  
 CLAYEY SAND (SC), gray, medium dense, dry to moist, fine grained  
 LEAN CLAY (CL), with Sand, gray to brown, very stiff, dry to moist, trace organics  
 Organic grades out; grading iron stained

Grading trace Sand, dark gray to light gray, trace organics  
 Grading wet

CLAYEY SAND (SC), light gray to gray, dense, moist, fine grained

LEAN CLAY (CL), with Sand, light gray, very stiff to hard, moist  
 Grading light gray to gray, trace organics  
 Grading trace Sand, gray to dark gray  
 Grading light gray to gray  
 Organic grades out

Total Depth = 55.5 ft.

SOIL SYMBOL	DEPTH (FT)	SAMPLES N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
	5	N = 7 N = 8 N = 50/3"	14 11 12								
	10	N = 34 N = 30	14								
	15	N = 17									
	20	N = 25 N = 41									
	25	N = 28									
	30	N = 38									
	35	N = 30									
	40	N = 36									
	45	N = 61									
	50	N = 44									
	55	N = 38									

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.951278, Long. -101.767572

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# LOG OF BORING SUB-3



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/30/2025

RENEWABLE LOG - LOG A GNNL01.GDT - 9/18/25 15:46 - C:\USERS\JOHN\ILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

FIELD DATA		LABORATORY DATA								DRILLING METHOD(S):					
DEPTH (FT)	SAMPLES	N: BLOWS/FT	P: TONS/SQ FT	T: BLOWS	R: %	RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
								LL	PL	PI					
<b>GROUNDWATER INFORMATION:</b> Groundwater encountered at 14 ft. during drilling and measured at 36 ft. immediately after drilling															
<b>SURFACE ELEVATION (FT):</b>															
<b>DESCRIPTION OF STRATUM</b>															
															2 in. Topsoil
5	N = 6 P = 1.5						15	21	16	5	108	1.62	14.3	3.0	SILTY, CLAYEY SAND (SC-SM), dark brown to brown, loose, dry to moist, fine grained Grading light brown
10	N = 14 N = 28														CLAYEY SAND (SC), dark brown to brown, medium dense to dense, dry to moist, fine to medium grained, iron stained  Grading gray, wet
15	N = 33 N = 42														Grading light gray
20	N = 44														
25	N = 29														LEAN CLAY (CL), trace Sand, light gray to gray, very stiff to hard, moist to wet
30	N = 33														
35	N = 50														SANDY LEAN CLAY (CL), light gray to gray, hard, moist to wet
40	N = 79														Total Depth = 40.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.955049, Long. -101.762273



# LOG OF BORING SUB-5



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/29/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 12.5 ft. during drilling and measured at 30 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

3 in. Topsoil  
 SANDY LEAN CLAY (CL), light gray to gray, medium stiff, dry to moist

CLAYEY SAND (SC), dark brown to light gray, loose to dense, dry to moist, fine grained, iron stained

Grading wet  
 Grading dark gray

LEAN CLAY (CL), trace Sand, dark brown, hard, moist to wet

Grading light gray

Total Depth = 40.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.954784, Long. -101.761958

RENEWABLE LOG - LOG A GNNL01.GDT - 9/18/25 15:46 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING SUB-6



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/1/2025

RENEWABLE LOG - LOG A GNNL01.GDT - 9/18/25 15:46 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

FIELD DATA		LABORATORY DATA							DRILLING METHOD(S):			
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
	5	N = 11 P = 2.5		6	NP	NP	NP	101				27
	10	N = 12 N = 30										
	15	N = 31 N = 50/6"										
	20	N = 50										
	25	N = 59										
	30	N = 59										
	35	N = 24										
	40	N = 44										
3 in. Topsoil SILTY SAND (SM), light brown, medium dense to dense, dry to moist, fine grained, iron stained												
LEAN CLAY (CL), with Sand, brown, hard, dry to moist												
CLAYEY SAND (SC), light brown to dark brown, dense to very dense, moist to wet, fine to medium grained, iron stained  Iron stain grades out; grading gray												
LEAN CLAY (CL), trace Sand, gray, very stiff to hard, moist												
Grading with Sand, trace organics												
Total Depth = 40.5 ft.												

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

REMARKS:  
 GPS COORDINATES: Lat. 46.955549, Long. -101.760791

# LOG OF BORING SUB-7



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/30/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 13 ft. during drilling and measured at 34 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

2 in. Topsoil  
 SANDY LEAN CLAY (CL), brown, soft, dry to moist, trace roots

CLAYEY SAND (SC), light brown to brown, medium dense to very dense, dry to moist, fine to medium grained

Grading dark brown

Grading wet  
 Grading trace organics

Grading gray

LEAN CLAY (CL), trace Sand, dark brown to gray, hard, moist to wet, with Lignite interbeddings

Grading with Sand, light gray

Total Depth = 40.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.9550580, Long. -101.761344

RENEWABLE LOG - LOG A GNNL01.GDT - 9/18/25 15:46 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING SUB-8



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/30/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 19 ft. during drilling and measured at 35 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

3 in. Topsoil  
 CLAYEY SAND (SC), brown, medium dense, dry to moist, fine grained, iron stained

POORLY-GRADED SAND (SP), light brown to dark brown, medium dense to dense, dry to moist, fine grained

CLAYEY SAND (SC), brown, dense to very dense, moist, fine to medium grained, iron stained

Grading wet

Grading light brown to gray

LEAN CLAY (CL), with Sand, dark gray to dark brown, hard, moist to wet, with Lignite interbeddings

Grading trace organics

Total Depth = 40.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.954797, Long. -101.760801

RENEWABLE LOG - LOG A GNNL01.GDT - 9/18/25 15:47 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING SUB-9



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/1/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

2 in. Topsoil  
 CLAYEY SAND (SC), light brown to brown, loose to dense, dry to moist, fine grained, iron stained  
 Grading dark brown, trace roots  
 Grading light brown, fine to medium grained

Total Depth = 15.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.953917, Long. -101.761302

RENEWABLE LOG - LOG A GNNL01.GDT - 9/18/25 15:47 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING SUB-10



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/1/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

3 in. Topsoil  
 CLAYEY SAND (SC), light brown, medium dense to dense, dry to moist, fine grained  
 Grading brown  
 Grading dark brown

Total Depth = 15.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.953298, Long. -101.761288

RENEWABLE LOG - LOG A GNNL01.GDT - 9/18/25 15:47 - C:\USERS\JOHN\ILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ





# LOG OF BORING HA-3



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026  
 DATE(S) DRILLED: 4/30/2025

RENEWABLE LOG - LOG A.GN11.01.GDT - 9/19/25 11:05 - C:\USERS\JOHN\ILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

FIELD DATA		LABORATORY DATA								DRILLING METHOD(S):		
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
	1											
	2											
	3											
	4											
	5											

**DRILLING METHOD(S):**  
Solid Stem Auger

**GROUNDWATER INFORMATION:**  
Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**  
**DESCRIPTION OF STRATUM**

4 in. Topsoil

SILT (ML), trace Sand, reddish brown, dry to moist

Grading light brown

SILTY SAND (SM), light brown, dry to moist, fine grained

Total Depth = 5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
GPS COORDINATES: Lat. 46.955793, Long. -101.760486

# LOG OF BORING HA-4



RRC Power & Energy, LLC  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/30/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

2 in. Topsoil

LEAN CLAY (CL), trace Sand, dark brown, dry to moist

CLAYEY SAND (SC), light brown, dry to moist, fine grained

Total Depth = 5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**

GPS COORDINATES: Lat. 46.955223, Long. -101.762475

RENEWABLE LOG - LOG A.GNML01.GDT - 9/19/25 11:05 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING HA-5



RRC Power & Energy, LLC  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026  
 DATE(S) DRILLED: 4/30/2025

RENEWABLE LOG - LOG A.GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

FIELD DATA		LABORATORY DATA								DRILLING METHOD(S):		
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
	1											
	2											
	3											
	4											
	5											
Total Depth = 5 ft.												

GROUNDWATER INFORMATION:  
 Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

DESCRIPTION OF STRATUM

3 in. Topsoil

SILT (ML), trace Sand, dark brown, dry to moist

SILTY SAND (SM), light brown, dry to moist, fine grained

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

REMARKS:  
 GPS COORDINATES: Lat. 46.955234, Long. -101.761474

# LOG OF BORING HA-6



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/30/2025

FIELD DATA		LABORATORY DATA								DRILLING METHOD(S):		
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
	1											
	2											
	3											
	4											
	5											
3 in. Topsoil SILT (ML), trace Sand, light brown, dry to moist												
Total Depth = 5 ft.												
N - STANDARD PENETRATION TEST RESISTANCE P - POCKET PENETROMETER RESISTANCE T - TXDOT CONE PENETRATION RESISTANCE R - ROCK CORE RECOVERY RQD - ROCK QUALITY DESIGNATION											<b>REMARKS:</b> GPS COORDINATES: Lat. 46.955245, Long. -101.760473	

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHN\ILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING HA-7



RRC Power & Energy, LLC  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/30/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

3 in. Topsoil

CLAYEY SAND (SC), light brown, dry to moist, fine grained

Total Depth = 5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**

GPS COORDINATES: Lat. 46.954675, Long. -101.762462

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHN\ILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING HA-8



RRC Power & Energy, LLC  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/30/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

2 in. Topsoil  
 SILTY SAND (SM), dark brown, dry to moist, fine grained

CLAYEY SAND (SC), light brown, dry to moist, fine grained

Total Depth = 5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.954686, Long. -101.761461

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING HA-9



RRC Power & Energy, LLC  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/30/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

3 in. Topsoil

SILT (ML), trace Sand, light brown, dry to moist

Total Depth = 5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**

GPS COORDINATES: Lat. 46.954697, Long. -101.760460

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHN\ILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING HA-10



RRC Power & Energy, LLC  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/1/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SILTY SAND (SM), light brown, dry to moist, fine grained

Total Depth = 5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**

GPS COORDINATES: Lat. 46.954105, Long. -101.761659

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHN\ILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING HA-11



RRC Power & Energy, LLC  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/1/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SILTY SAND (SM), light brown, dry to moist, fine grained

Total Depth = 5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**

GPS COORDINATES: Lat. 46.954113, Long. -101.760954

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING HA-12



RRC Power & Energy, LLC  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/1/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SILTY SAND (SM), dark brown, dry to moist, fine grained

Total Depth = 5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**

GPS COORDINATES: Lat. 46.953607, Long. -101.761294

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHN\ILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ



# LOG OF BORING HA-14



RRC Power & Energy, LLC  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/1/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SILTY SAND (SM), dark brown, dry to moist, fine grained

Total Depth = 5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**

GPS COORDINATES: Lat. 46.953109, Long. -101.760930

RENEWABLE LOG - LOG A GNNL01.GDT - 9/19/25 11:05 - C:\USERS\JOHN\ILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING TL-1



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/29/2025

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
	0											
	5	N = 23										
	5	N = 42										
	10	N = 50/3"										
	10	N = 29										
	15	N = 20										
	15	N = 23										
	20	N = 31										
	25	N = 36										
	30	N = 48										
	35	N = 35										
	40	N = 50/4"										
	45	N = 58										
	50	N = 67										
Total Depth = 50.5 ft.												

**REMARKS:**

GPS COORDINATES: Lat. 46.986205, Long. -101.766771

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

# LOG OF BORING TL-2



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/29/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

3 in. Topsoil  
 FAT CLAY (CH), with Sand, light brown to gray, medium stiff to hard, dry to moist

LEAN CLAY (CL), with Sand, brown to light brown, very stiff, dry to moist, iron stained

Grading trace Sand, light gray to gray

LIGNITE, dark brown to black, hard, dry to moist

LEAN CLAY (CL), with Sand, gray, hard, dry to moist

Total Depth = 30.5 ft.

RENEWABLE LOG - LOG A.GNML01.GDT - 6/13/25 12:08 - C:\USERS\JOHN\ILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.984606, Long. -101.766776

# LOG OF BORING TL-3



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026  
 DATE(S) DRILLED: 4/29/2025

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SOIL SYMBOL	DEPTH (FT)	SAMPLES N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
3 in. Topsoil		N = 9									
CLAYEY SAND (SC), brown, loose, dry to moist, fine grained		N = 18									
	5	N = 20									
FAT CLAY (CH), trace Sand, light brown to gray, stiff to hard, dry to moist		P = 4.5									
	10	N = 26									
SILT (ML), with Sand, light brown to gray, hard, dry to moist		N = 30									
	15	N = 23									
LEAN CLAY (CL), trace Sand, brown, very stiff to hard, dry to moist		N = 33									
Grading iron stained, trace calcite and Lignite bedding		N = 26									
	20										
Iron stained and Lignite grade out; grading calcareous											
	25										
LIGNITE, dark brown to black, very stiff, dry to moist											
	30										
Total Depth = 30.5 ft.											

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.982158, Long. -101.766783



# LOG OF BORING TL-5



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/29/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

3 in. Topsoil  
 LEAN CLAY (CL), trace Sand, light brown, stiff to very stiff, dry to moist, trace calcium  
 Grading with Sand  
  
 Grading trace Sand  
 Grading iron stained  
 SANDY LEAN CLAY (CL), light brown, very stiff, dry to moist  
  
 CLAYEY SAND (SC), light brown, very dense, dry to moist, fine grained  
  
 SILT (ML), with Sand, light brown to gray, hard, dry to moist  
  
 LEAN CLAY (CL), trace Sand, gray, hard, dry to moist  
  
 Total Depth = 30.5 ft.

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
	0		N = 12									
	5		N = 9									
	10		P = 2.75 N = 13									
	15		N = 14 N = 26									
	20		N = 51									
	25		N = 78									
	30		N = 34									

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.980257, Long. -101.763791

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING TL-6



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/30/2025

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**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	
					LL	PL	PI						
	0												3 in. Topsoil
	5	N = 8 N = 30											CLAYEY SAND (SC), light brown, loose to medium dense, dry to moist, fine grained
	10	N = 8 P = 4.5											LEAN CLAY (CL), with Sand, light brown to gray, medium stiff to hard, dry to moist, trace Lignite
	15	N = 14 N = 39											Lignite grades out
	20	N = 23											
	25	N = 36											CLAYEY SAND (SC), light brown, dense, dry to moist, fine grained
	30	N = 33											
	35	N = 37											Grading gray
	40	N = 40											LEAN CLAY (CL), trace Sand, gray, hard, dry to moist
	45	N = 41											SILT (ML), trace Sand, gray, hard, dry to moist
	50	N = 84/10"											Total Depth = 50.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.980255, Long. -101.760946

# LOG OF BORING TL-7



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/30/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

6 in. Topsoil  
 SANDY FAT CLAY (CH), light brown, medium stiff, dry to moist

LEAN CLAY (CL), with Sand, light brown, very stiff, dry to moist

Grading trace Sand

CLAYEY SAND (SC), light brown, medium dense to dense, dry to moist, fine grained

LEAN CLAY (CL), trace Sand, gray, hard, dry to moist

SILT (ML), trace Sand, gray, hard, dry to moist

Total Depth = 30.5 ft.

**REMARKS:**

GPS COORDINATES: Lat. 46.978169, Long. -101.760927

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING TL-8



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/30/2025

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHN\ILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

FIELD DATA		LABORATORY DATA								DRILLING METHOD(S):					
DEPTH (FT)	SAMPLES	N: BLOWS/FT	P: TONS/SQ FT	T: BLOWS	R: %	RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
								LL	PL	PI					
SOIL SYMBOL															
0															
5	N = 7														
5	N = 5														
10	N = 43														
10	N = 36														
15	N = 3														
15	N = 16														
20	N = 38														
25	N = 42														
30	N = 40														
6 in. Topsoil															
SILTY SAND (SM), light brown, loose, dry to moist, fine grained															
CLAYEY SAND (SC), light brown, loose to medium dense, dry to moist, fine grained															
LEAN CLAY (CL), trace Sand, dark brown, soft to very stiff, dry to moist, trace organics Grading with Sand, light brown															
CLAYEY SAND (SC), light brown to light gray, dense, dry to moist, fine to medium grained, iron stained															
LEAN CLAY (CL), trace Sand, gray to dark gray, hard, dry to moist															
Total Depth = 30.5 ft.															

DRILLING METHOD(S):

Hollow Stem Auger

GROUNDWATER INFORMATION:

Groundwater not encountered during or immediately after drilling

SURFACE ELEVATION (FT):

DESCRIPTION OF STRATUM

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

REMARKS:

GPS COORDINATES: Lat. 46.976028, Long. -101.760909

# LOG OF BORING TL-9



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026  
 DATE(S) DRILLED: 5/1/2025

RENEWABLE LOG - LOG A.GN.NL01.GDT - 6/13/25 12:08 - C:\USERS\JOHN\ILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
	0 - 6											
	5	N = 15 N = 14										
	10	P = +4.5 N = 24										
	15	N = 32 N = 30										
	20	N = 44										
	25	N = 43										
	30	N = 26										

6 in. Topsoil  
 CLAYEY SAND (SC), light brown, medium dense, dry to moist, fine grained, iron stained

SANDY LEAN CLAY (CL), brown to gray, very stiff to hard, dry to moist

CLAYEY SAND (SC), gray, medium dense to dense, dry to moist, fine grained

Grading light brown to brown, trace organics

Grading light brown to gray

Total Depth = 30.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.973915, Long. -101.760890

# LOG OF BORING TL-10



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/1/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 24 ft. during drilling and measured at 24 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

6 in. Topsoil  
 CLAYEY SAND (SC), light brown, very loose to very dense, dry to moist, fine grained

Grading iron stained

Grading wet

Total Depth = 30.5 ft.

DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
0 - 5	N = 7 N = 2										
5 - 10	N = 47 N = 32										
10 - 15	N = 23 N = 32										
15 - 20	N = 51										
20 - 25	N = 44										
25 - 30	N = 59										

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.971640, Long. -101.760870

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING TL-11



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/1/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 29 ft. during drilling and measured at 28 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

6 in. Topsoil  
 CLAYEY SAND (SC), light brown, loose to very dense, dry to moist, fine grained

Grading iron stained

Grading brown

Grading gray to light brown

Grading wet

Total Depth = 30.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.969358, Long. -101.760850

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING TL-12



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/2/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 7 ft. during drilling and measured at 6.5 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
	0											
	5	N = 8 N = 6										
	10	N = 8 N = 18										
	15	N = 27 N = 33										
	20	N = 31										
	25	N = 15										
	30	N = 42										

6 in. Topsoil  
 CLAYEY SAND (SC), light brown, loose, moist, fine grained  
 Grading brown  
 SANDY LEAN CLAY (CL), light brown, medium stiff, moist to wet, iron stained  
 POORLY-GRADED SAND (SP-SC), with Clay, brown, medium dense, moist, fine to medium grained  
 CLAYEY SAND (SC), brown to light brown, medium dense to dense, moist, fine to medium grained  
 SILT (ML), trace Sand, dark gray, stiff, moist  
 CLAYEY SAND (SC), trace Gravel, gray, dense, moist, fine to coarse grained  
 Total Depth = 30.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.967150, Long. -101.760831

# LOG OF BORING TL-13



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026  
 DATE(S) DRILLED: 5/2/2025

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

FIELD DATA		LABORATORY DATA							DRILLING METHOD(S):		
DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CUFT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
5	N = 13 N = 19										
10	N = 22 N = 13										
15	P = 4.5 N = 17										
20	N = 27										
25	N = 50/5"										
30	N = 68										
35	N = 36										
40	N = 77/11"										
45	N = 57										
50	N = 34										
Total Depth = 50.5 ft.											

**GROUNDWATER INFORMATION:**  
 Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**  
**DESCRIPTION OF STRATUM**

6 in. Topsoil  
 CLAYEY SAND (SC), brown, medium dense, dry to moist, fine grained, iron stained, trace roots  
 SANDY LEAN CLAY (CL), light brown, stiff, dry to moist, iron stained  
 CLAYEY SAND (SC), light brown, medium dense, dry to moist, fine grained  
 FAT CLAY (CH), trace Sand, brown, stiff to hard, dry to moist, trace organics  
 LEAN CLAY (CL), trace Sand, gray to dark gray, very stiff, dry to moist  
 Grading with Sand  
 CLAYSTONE, gray, medium hard to very hard, dry to moist  
 Grading dark gray  
 LIGNITIC SHALE, dark brown, medium hard to very hard, dry to moist  
 Grading gray to dark gray

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.964992, Long. -101.760812

# LOG OF BORING TL-14



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/2/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

DEPTH (FT)	SAMPLES N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
			LL	PL	PI					
0 - 6	N = 8									
6 - 10	N = 5									
10 - 15	N = 21									
15 - 20	N = 25									
20 - 25	N = 25									
25 - 30	N = 15									
30 - 35	P = 4.5									
35 - 40	N = 27									
40 - 45	N = 26									
45 - 50	N = 23									
50 - 55	N = 31									
55 - 60	N = 50/2"									
60 - 65	N = 49									
65 - 70	N = 48									

6 in. Topsoil

CLAYEY SAND (SC), brown, loose to medium dense, dry to moist, fine grained, iron stained, trace roots  
 Grading light brown, fine to medium grained, micaceous

LEAN CLAY (CL), with Sand, gray to light brown, stiff to hard, dry to moist, iron stained

Grading trace Sand

Grading with Sand

Grading trace Sand

LIGNITIC SHALE, dark brown, medium hard to very hard, dry to moist

Grading gray to dark gray

Grading light gray

Total Depth = 50.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.964315, Long. -101.761880

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING TL-15



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/6/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 24 ft. during drilling and not measured immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

6 in. Topsoil  
 SILTY SAND (SM), brown, medium dense, dry to moist, fine grained

CLAYEY SAND (SC), light brown, loose, dry to moist, fine grained, iron stained

SANDY LEAN CLAY (CL), brown, hard, dry to moist, iron stained

Grading trace Sandstone fragments  
 SILT (ML), trace Sand, light brown, hard, dry to moist  
 POORLY-GRADED SAND (SP), light brown, dense to very dense, dry to moist, fine grained, iron stained, micaceous

Grading wet

Grading dark gray

Total Depth = 30.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.962040, Long. -101.761888

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING TL-16



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026  
 DATE(S) DRILLED: 4/29/2025

RENEWABLE LOG - LOG A.GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03.GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 25 ft. during drilling and measured at 27 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

2 in. Topsoil  
 CLAYEY SAND (SC), light brown to brown, medium dense to dense, dry to moist, fine grained, iron stained, trace roots  
 Grading light gray  
 Grading brown to dark brown  
 Grading wet  
 SANDSTONE, brown, very hard, moist, fine grained, weakly cemented  
 Total Depth = 30.5 ft.

DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
0 - 5	N = 14 N = 14										
5 - 10	N = 49 N = 43										
10 - 15	N = 42 N = 45										
15 - 20	N = 47										
20 - 25	N = 50										
25 - 30	N = 91/10"										

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.960133, Long. -101.761890

# LOG OF BORING TL-17



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/29/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 12 ft. during drilling and measured at 24 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

3 in. Topsoil  
 LEAN CLAY (CL), with Sand, dark brown, medium stiff, dry to moist

5  
 N = 4  
 N = 8  
 N = 19  
 N = 59  
 N = 30  
 N = 33

CLAYEY SAND (SC), light brown to light gray, loose to dense, dry to moist, fine to medium grained  
 Grading gray  
 Grading brown, iron stained  
 Grading dark gray, wet

25  
 N = 35

LEAN CLAY (CL), with Sand, dark brown to gray, hard, moist to wet, trace organics  
 Grading trace Sand, dark gray

30  
 N = 35

Total Depth = 30.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.958219, Long. -101.761891

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHN\ILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING TL-18



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/29/2025

RENEWABLE LOG - LOG A GNNL01.GDT - 6/13/25 12:08 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 10 ft. during drilling and measured at 47 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SOIL SYMBOL	DEPTH (FT)	SAMPLES N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
				LL	PL	PI						
				LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX						
	0											3 in. Topsoil
	5	N = 4 N = 3										CLAYEY SAND (SC), light brown, very loose to very dense, dry to moist, fine grained Grading gray
	10	N = 12 N = 27										Grading wet
	15	N = 36 N = 49										Grading trace Lignite
	20	N = 50/6"										Grading gray
	25	N = 41										LIGNITE, dark brown, hard, moist to wet
	30	N = 50										LEAN CLAY (CL), with Sand, gray, hard, moist to wet
	35	N = 38										
	40	N = 51										SILT (ML), trace Sand, gray, hard, moist to wet
	45	N = 37										LEAN CLAY (CL), with Sand, gray, hard, moist to wet
	50	N = 41										Grading trace Lignite
	Total Depth = 50.5 ft.											

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.956549, Long. -101.761892

# LOG OF BORING MET-3



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 4/23/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

9 in.	Topsoil
5	SANDY LEAN CLAY (CL), light brown, stiff to hard, dry to moist, iron stained, calcareous
10	SANDY SILT (ML), light brown to light gray, medium dense, dry to moist, iron stained
15	LEAN CLAY (CL), trace Sand, brown to gray, very stiff, dry to moist, iron stained, trace organics
20	LIGNITE, dark brown, very stiff, dry to moist
25	LEAN CLAY (CL), trace Sand, gray to brown, very stiff, dry to moist, iron stained, trace Lignite
30	SANDY LEAN CLAY (CL), light brown to gray, hard, dry to moist, iron stained
34.5	Grading with Sandstone beddings
30	LEAN CLAY (CL), trace Sand, gray, hard, dry to moist, trace Lignite
34.5	LIGNITE, dark brown, hard, dry to moist, iron stained, trace organics
Total Depth = 34.5 ft.	

DEPTH (FT)	SOIL SYMBOL	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
0			N = 11									
5			P = 4.5									
10			N = 26									
10			N = 21									
15			N = 21									
15			N = 27									
20			N = 39									
25			N = 65									
30			N = 43									
34.5			N = 50/4"									

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.894016, Long. -101.661035

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ



# LOG OF BORING PMM-2



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/5/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

6 in. Topsoil  
 SANDY LEAN CLAY (CL), with Gravel, brown to light brown, very stiff, dry to moist, iron stained, calcareous

FAT CLAY (CH), trace Sand, light brown to gray, medium stiff to hard, dry to moist

Grading with Sand

Grading trace Sand, iron stained

Grading calcareous, trace organics

Grading dark brown, with Lignite

Total Depth = 35 ft.

**REMARKS:**

GPS COORDINATES: Lat. 46.938197, Long. -101.755101

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

# LOG OF BORING PMM-3



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/7/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater not encountered during or immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
					LL	PL	PI					
	0											
	0		N = 19									
	5		N = 19									
	8		N = 65									
	10		N = 34									
	12		N = 47									
	14		N = 47									
	20		N = 43									
	25		N = 40									
	30		N = 52									
	34.5		N = 50/6"									

4 in. Topsoil  
 SANDY SILT (ML), light brown, medium dense, dry to moist, calcareous

LEAN CLAY (CL), with Sand, brown to gray, very stiff to hard, dry to moist, iron stained

Grading trace Sand, dark brown

Grading trace organic

Grading dark brown to gray

LIGNITE, black, hard, dry to moist, trace organics

Total Depth = 34.5 ft.

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.894397, Long. -101.662007

# LOG OF BORING ADLS-2



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/7/2025

RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ

FIELD DATA		LABORATORY DATA							DRILLING METHOD(S):		
DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
GROUNDWATER INFORMATION: Groundwater not encountered during or immediately after drilling											
SURFACE ELEVATION (FT):											
DESCRIPTION OF STRATUM											
											6 in. Topsoil
5	N = 13 N = 32										SILTY SAND (SM), light brown, medium dense to dense, dry to moist, fine grained
10	N = 36 N = 56										
15	N = 22 N = 37										LEAN CLAY (CL), trace Sand, gray, very stiff, dry to moist, iron stained, trace organics SILTY SAND (SM), light brown, dense, dry to moist, fine grained
20	N = 39										CLAYEY SAND (SC), light brown, dense, dry to moist, fine grained
25	N = 36										LEAN CLAY (CL), trace Sand, dark gray to gray, hard, dry to moist, iron stained, calcareous
30	N = 37										SILT (ML), trace Sand, gray, hard, dry to moist, iron stained, calcareous
35	N = 43										LEAN CLAY (CL), trace Sand, dark gray, hard, dry to moist
Total Depth = 35.5 ft.											

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

REMARKS:  
 GPS COORDINATES: Lat. 46.927981, Long. -101.795351

# LOG OF BORING O&M-1



**RRC Power & Energy, LLC**  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

CLIENT: ALLETE Renewable Resources, Inc.

PROJECT: Longspur Wind Project

LOCATION: Morton County, ND

NUMBER: GE2503026

DATE(S) DRILLED: 5/3/2025

**FIELD DATA**

**LABORATORY DATA**

**DRILLING METHOD(S):**

Solid Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater encountered at 18 ft. during drilling and measured at 25 ft. immediately after drilling

**SURFACE ELEVATION (FT):**

**DESCRIPTION OF STRATUM**

4 in. Topsoil  
 CLAYEY SAND (SC), dark brown, loose to medium dense, dry to moist, fine grained, calcareous  
 Grading brown, iron stained

Calcareous feature grades out; grading gray to light brown

POORLY-GRADED SAND (SP-SM), with Silt, gray to light brown, very dense, dry to moist, fine grained

CLAYEY SAND (SC), light brown, medium dense to dense, dry to moist, fine grained  
 Grading wet  
 Grading light brown to brown, iron stained

LEAN CLAY (CL), with Sand, dark gray, very stiff, moist to wet  
 Grading gray, trace organics

SANDY CLAYSTONE, gray, very hard, moist

Total Depth = 35 ft.

DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS			DRY DENSITY POUNDS/CU FT	COMPRESSIVE STRENGTH (TONS/SQ. FT)	STRAIN AT FAILURE (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)
				LL	PL	PI					
5	N = 6		17								
	N = 17		10								
10	N = 9		19			100	0.32	1.8	5.5		
	N = 23										
15	N = 50/3"										
	N = 30										
20	N = 42										
25	N = 20										
30	N = 21										
35	N = 50/5"										

N - STANDARD PENETRATION TEST RESISTANCE  
 P - POCKET PENETROMETER RESISTANCE  
 T - TXDOT CONE PENETRATION RESISTANCE  
 R - ROCK CORE RECOVERY  
 RQD - ROCK QUALITY DESIGNATION

**REMARKS:**  
 GPS COORDINATES: Lat. 46.950414, Long. -101.762334

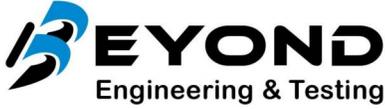
RENEWABLE LOG - LOG A GNNL01.GDT - 7/11/25 09:59 - C:\USERS\JOHN\VILLARINO\RRC COMPANIES\GEO\TECHNICAL ENGINEERING - DATABASES\03\_GINT\PROJECTS\2025\LONGSPUR WIND PROJECT-GE2503026\LONGSPUR WIND PROJECT-GE2503026.GPJ



[www.RRCcompanies.com](http://www.RRCcompanies.com)

810 Hesters Crossing Rd, Suite 120  
Round Rock, TX 78661  
512.992.2087

## APPENDIX B



Beyond Engineering & Testing, LLC  
 3801 Doris Lane, Suite B  
 Round Rock, TX 78664  
 Telephone: (512) 358-6048

# MOISTURE-DENSITY RELATIONSHIP

CLIENT: RRC Power & Energy, LLC  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Sample ID GEO-01 at 2.0 to 4.0 ft.  
 Description of Material BROWN FAT CLAY(CH)  
 Test Method ASTM D698 Method A, Automatic Hammer

### TEST RESULTS

Maximum Dry Density 99.5 PCF  
 Optimum Water Content 22.2 %

### ATTERBERG LIMITS

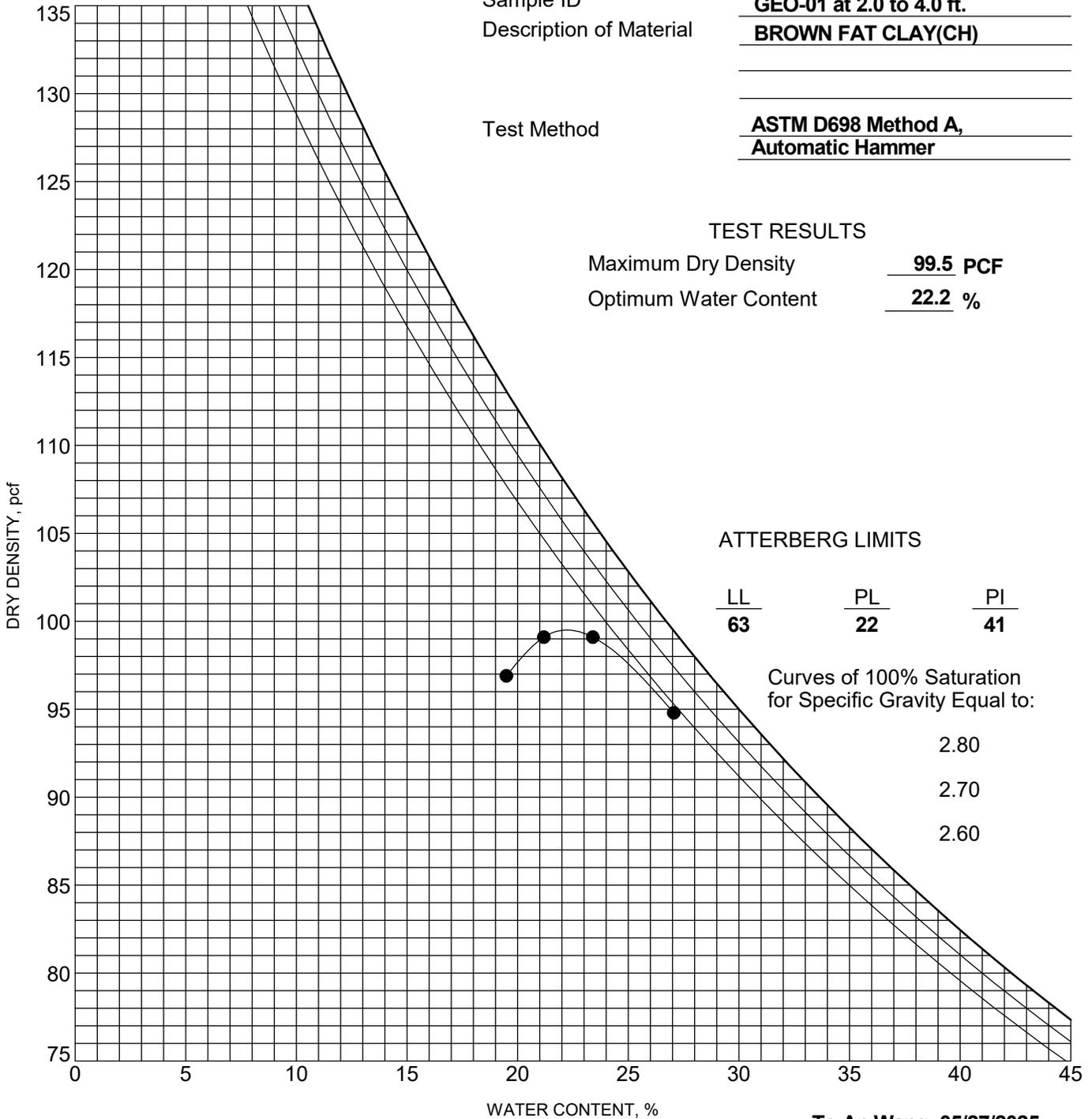
LL	PL	PI
63	22	41

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60



**Te-An Wang, 05/27/2025**

Analysis & Quality Review/Date

Specimens prepared by: T.W.

The results shown on this report are for the exclusive use of the client for whom they were obtained and apply only to the sample tested and / or inspected. They are not intended to be indicative of qualities of apparently identical products. The use of our name must receive prior written approval. Reports must be reproduced in their entirety. Unauthorized use or copying of this document is strictly prohibited by anyone other than the client for the specific project.



Beyond Engineering & Testing, LLC  
 3801 Doris Lane, Suite B  
 Round Rock, TX 78664  
 Telephone: (512) 358-6048

# MOISTURE-DENSITY RELATIONSHIP

CLIENT: RRC Power & Energy, LLC  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Sample ID: GEO-08 at 2.0 to 4.0 ft.  
 Description of Material: LIGHT BROWN FAT CLAY(CH)  
 Test Method: ASTM D698 Method A, Automatic Hammer

### TEST RESULTS

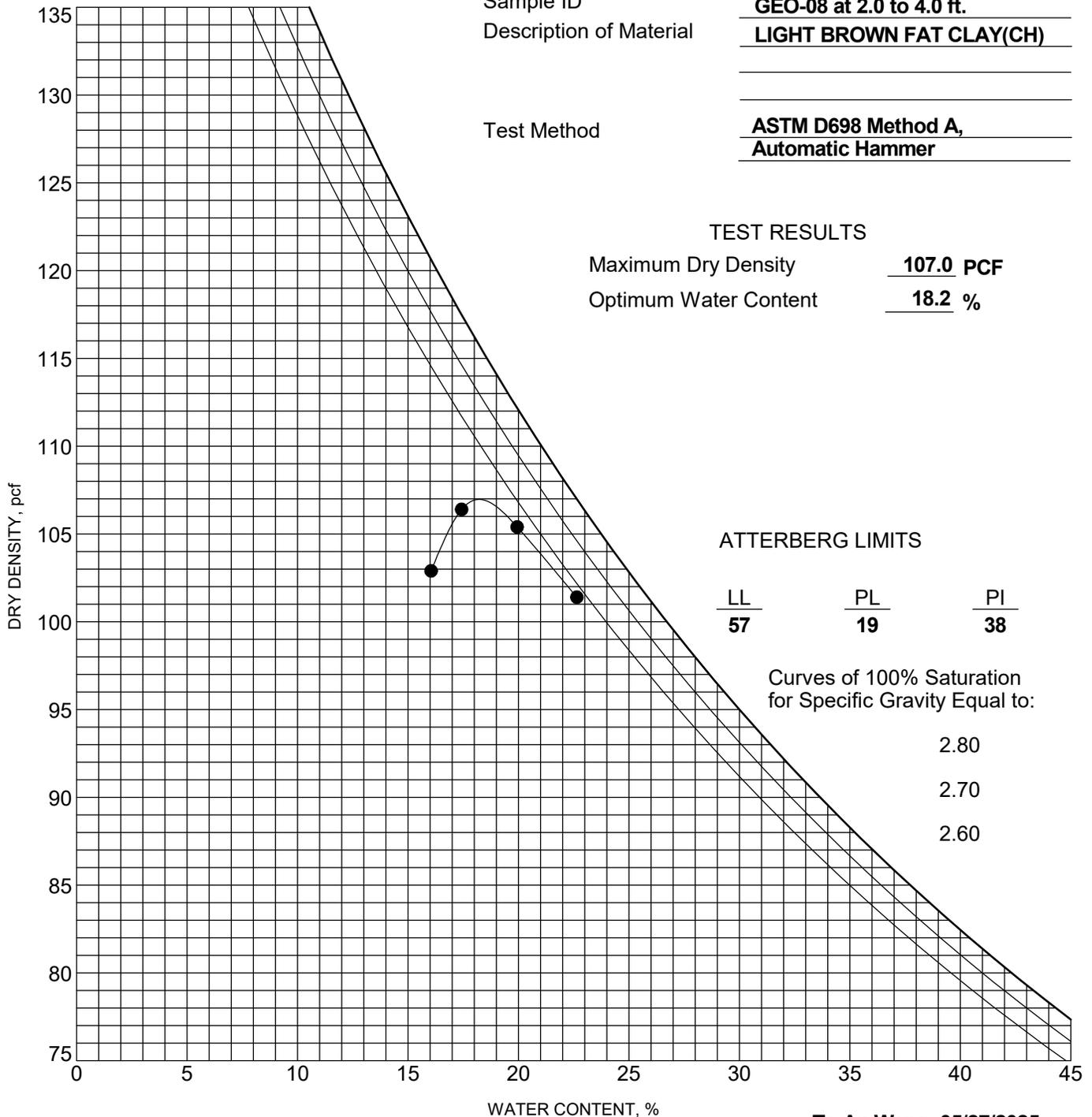
Maximum Dry Density: 107.0 PCF  
 Optimum Water Content: 18.2 %

### ATTERBERG LIMITS

LL	PL	PI
57	19	38

Curves of 100% Saturation for Specific Gravity Equal to:

2.80  
 2.70  
 2.60



**Te-An Wang, 05/27/2025**

Analysis & Quality Review/Date

Specimens prepared by: T.W.

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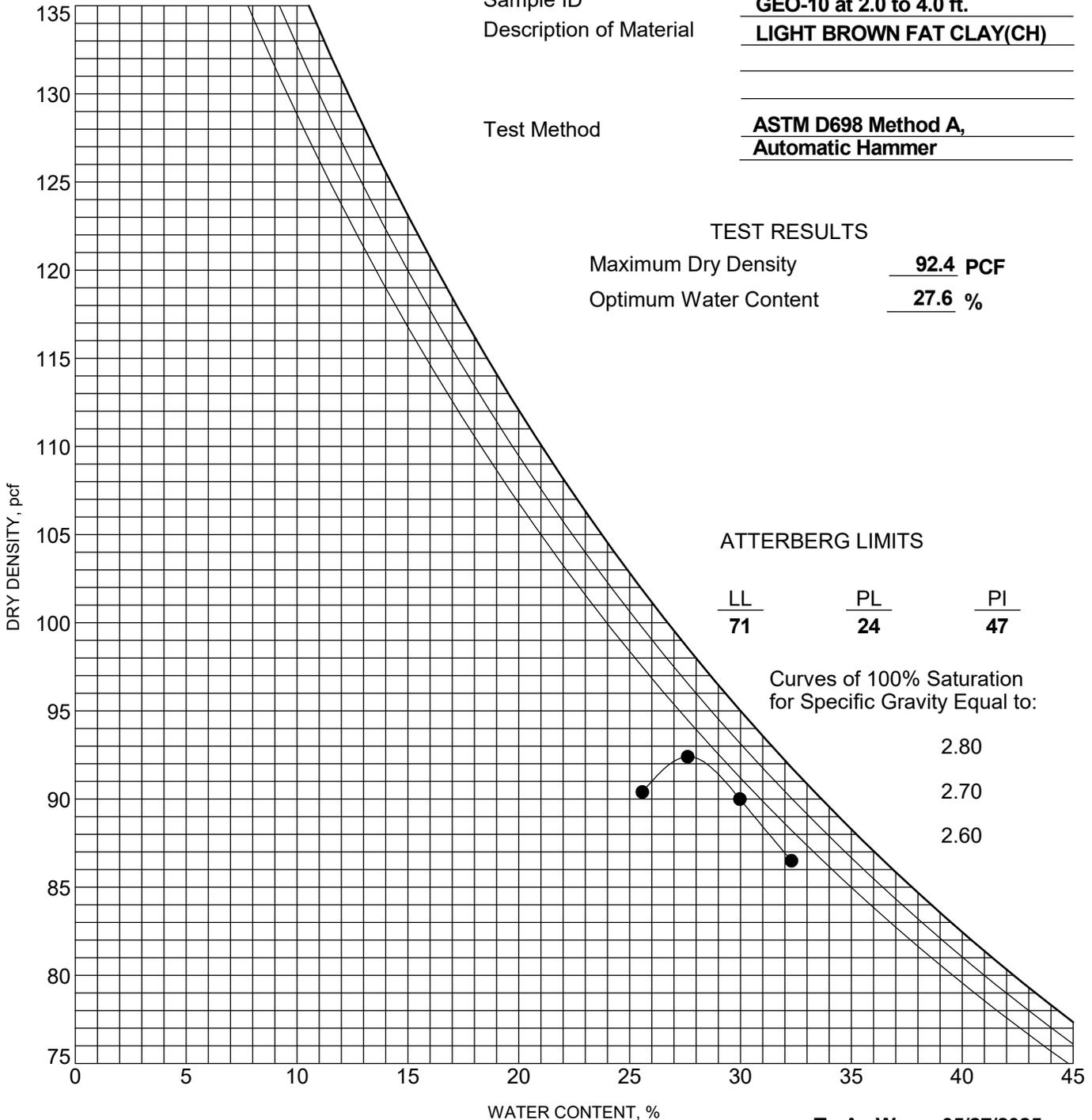


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 Round Rock, TX 78664  
 Telephone: (512) 358-6048

# MOISTURE-DENSITY RELATIONSHIP

CLIENT: RRC Power & Energy, LLC  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Sample ID: GEO-10 at 2.0 to 4.0 ft.  
 Description of Material: LIGHT BROWN FAT CLAY(CH)  
 Test Method: ASTM D698 Method A, Automatic Hammer



Te-An Wang, 05/27/2025

Analysis & Quality Review/Date

Specimens prepared by: T.W.

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# MOISTURE-DENSITY RELATIONSHIP

CLIENT: RRC Power & Energy, LLC  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Sample ID: GEO-19 at 2.0 to 4.0 ft.  
 Description of Material: LIGHT BROWN LEAN CLAY(CL)  
 Test Method: ASTM D698 Method A, Automatic Hammer

### TEST RESULTS

Maximum Dry Density: 111.8 PCF  
 Optimum Water Content: 16.3 %

### ATTERBERG LIMITS

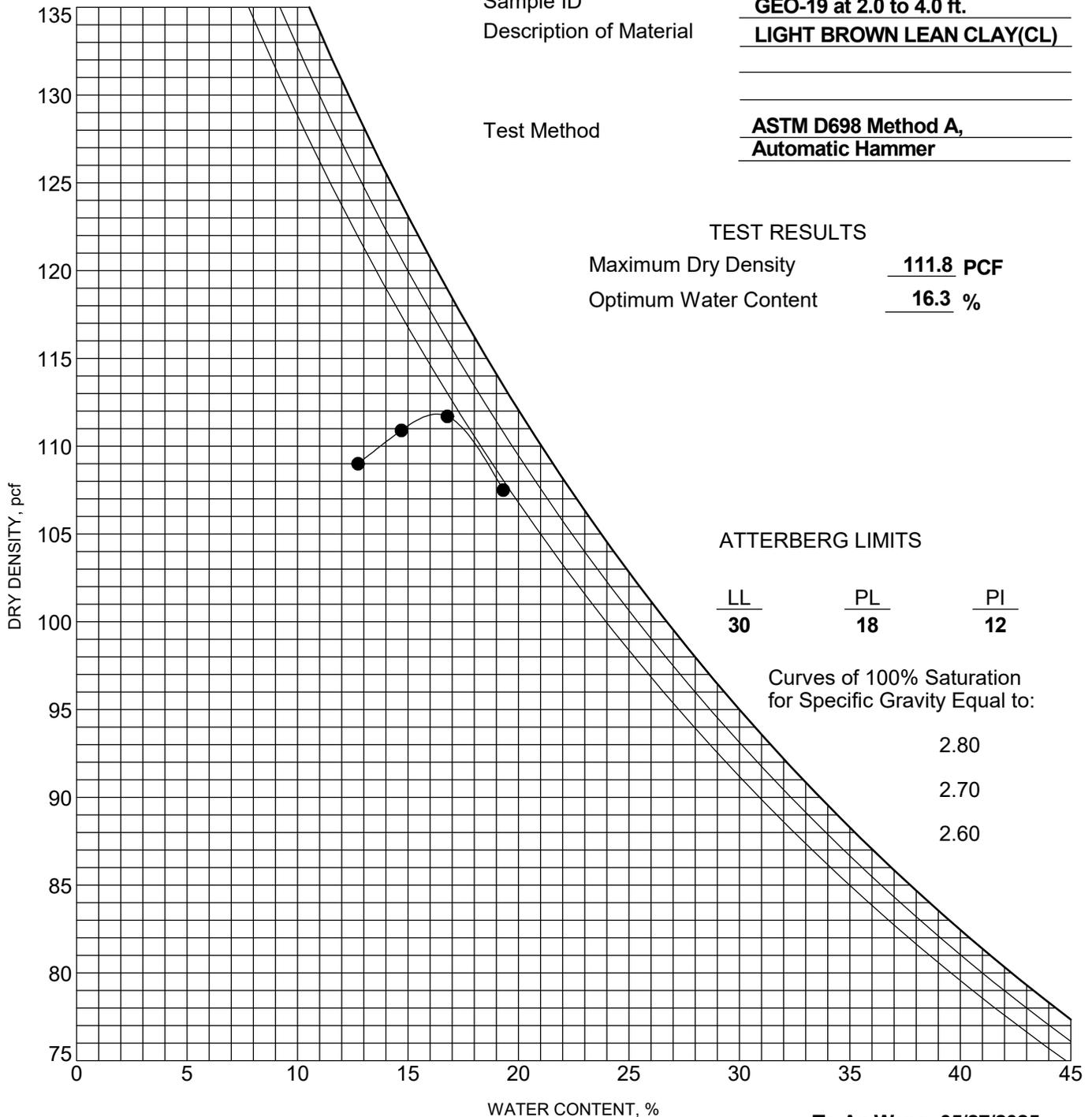
LL	PL	PI
30	18	12

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60



Te-An Wang, 05/27/2025

Analysis & Quality Review/Date

Specimens prepared by: T.W.

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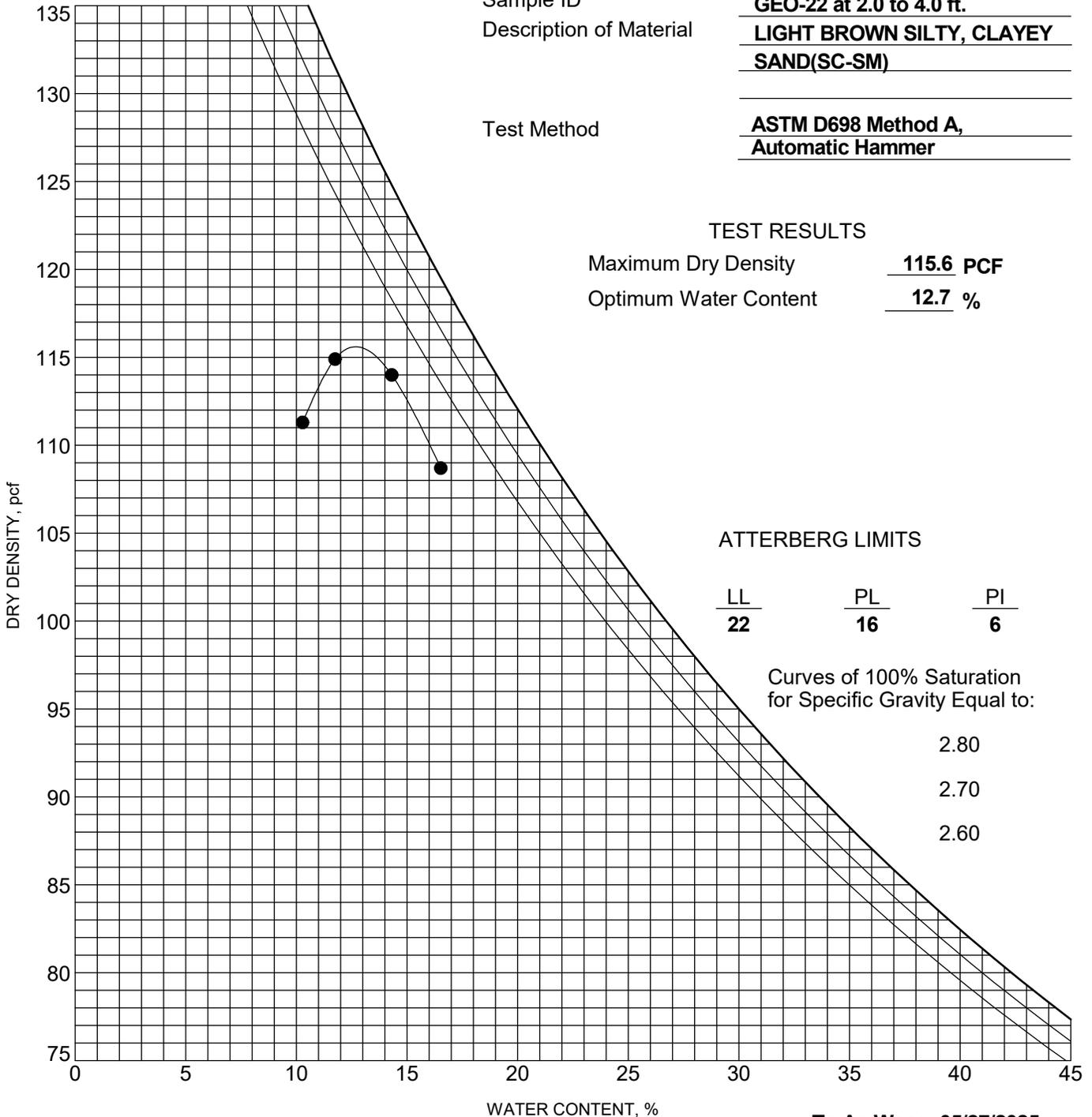


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# MOISTURE-DENSITY RELATIONSHIP

CLIENT: RRC Power & Energy, LLC  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Sample ID: GEO-22 at 2.0 to 4.0 ft.  
 Description of Material: LIGHT BROWN SILTY, CLAYEY SAND(SC-SM)  
 Test Method: ASTM D698 Method A, Automatic Hammer

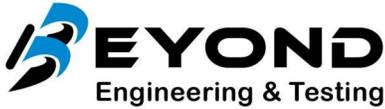


Te-An Wang, 05/27/2025

Analysis & Quality Review/Date

Specimens prepared by: T.W.

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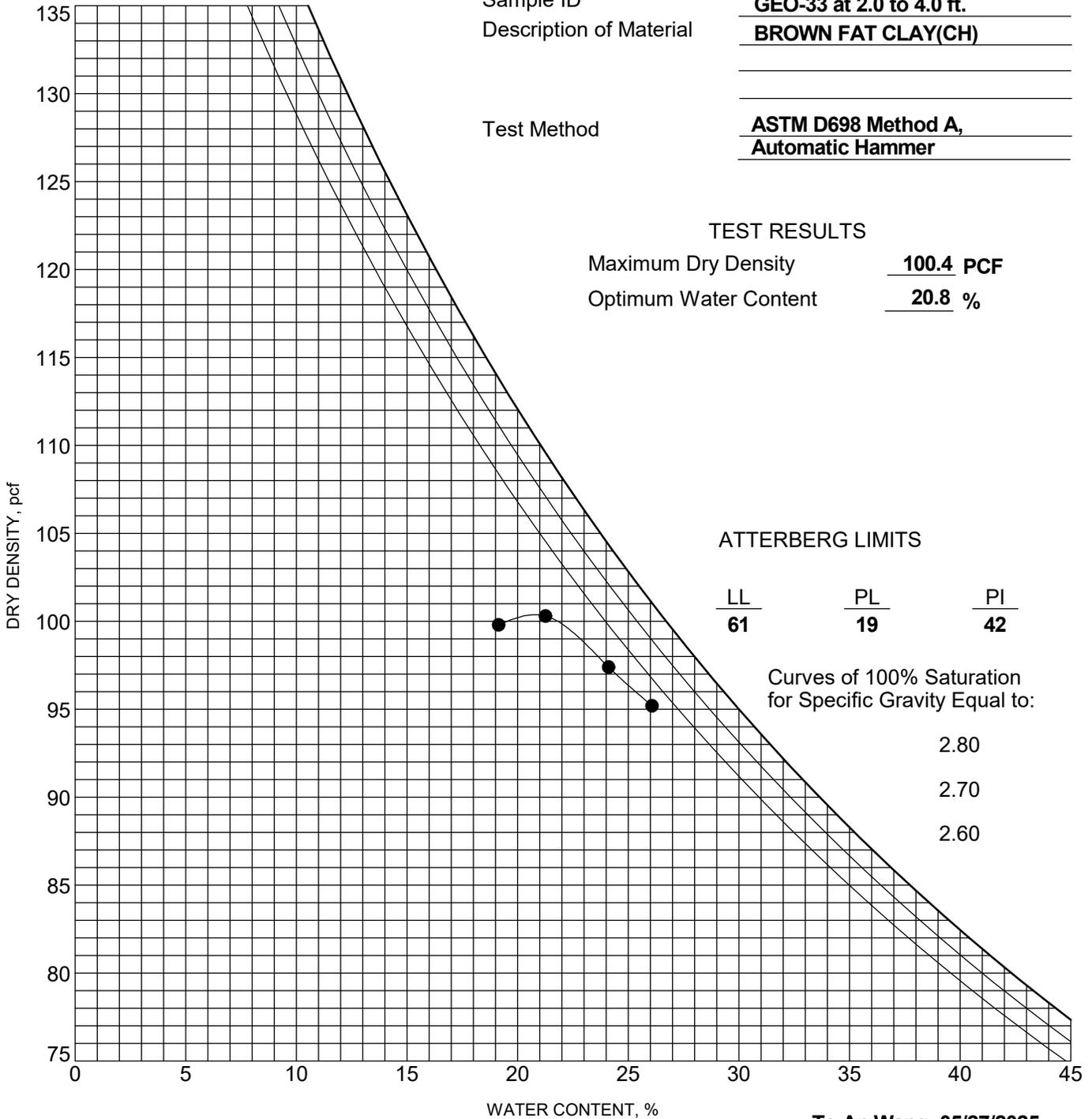


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# MOISTURE-DENSITY RELATIONSHIP

CLIENT: RRC Power & Energy, LLC  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Sample ID: GEO-33 at 2.0 to 4.0 ft.  
 Description of Material: BROWN FAT CLAY(CH)  
 Test Method: ASTM D698 Method A, Automatic Hammer

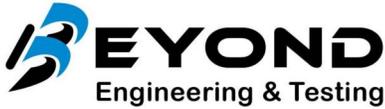


Te-An Wang, 05/27/2025

Analysis & Quality Review/Date

Specimens prepared by: T.W.

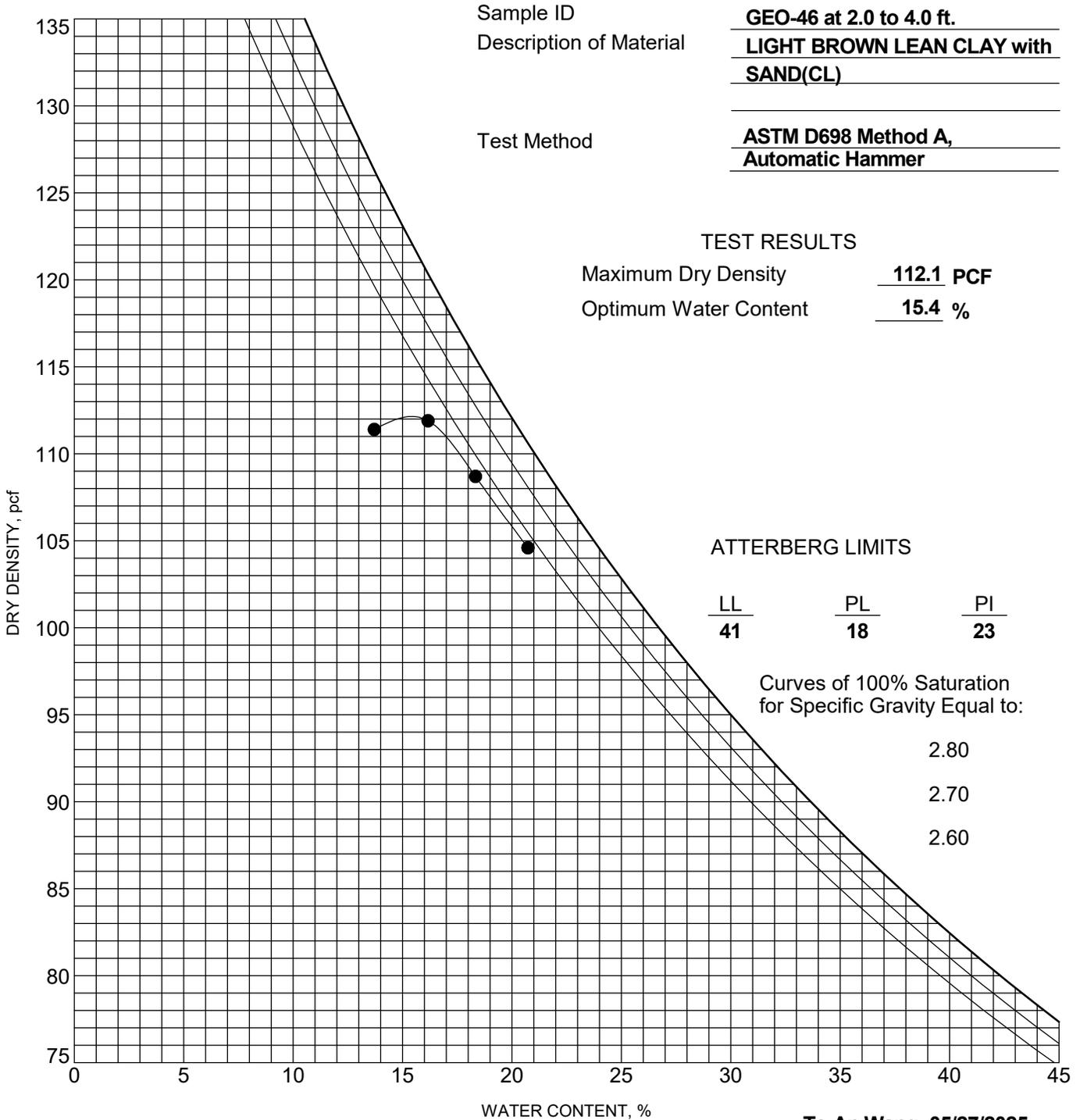
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# MOISTURE-DENSITY RELATIONSHIP

CLIENT: RRC Power & Energy, LLC  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026



Sample ID: GEO-46 at 2.0 to 4.0 ft.  
 Description of Material: LIGHT BROWN LEAN CLAY with SAND(CL)  
 Test Method: ASTM D698 Method A, Automatic Hammer

Te-An Wang, 05/27/2025

Analysis & Quality Review/Date

Specimens prepared by: T.W.

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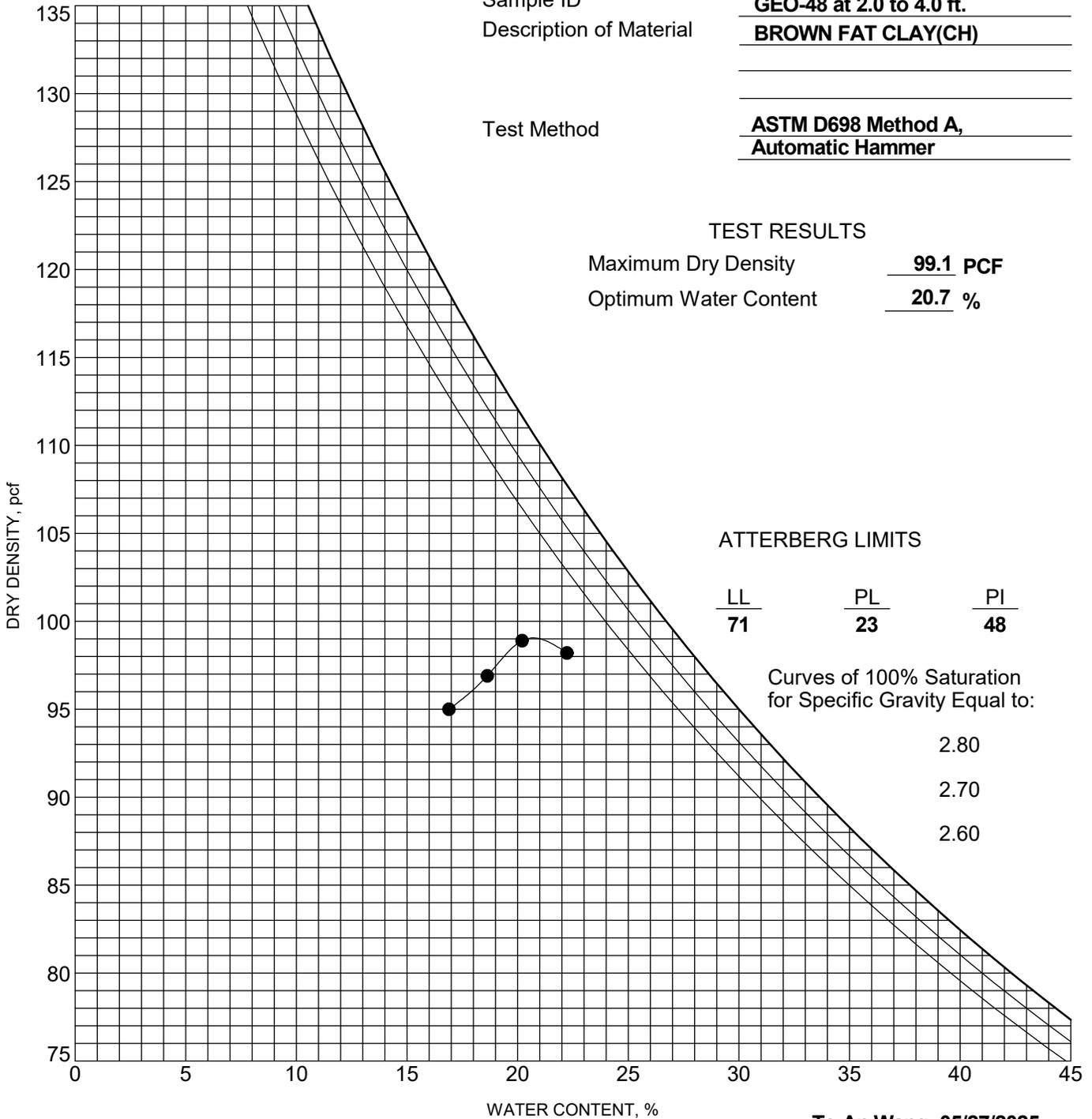


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# MOISTURE-DENSITY RELATIONSHIP

CLIENT: RRC Power & Energy, LLC  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Sample ID GEO-48 at 2.0 to 4.0 ft.  
 Description of Material BROWN FAT CLAY(CH)  
 Test Method ASTM D698 Method A, Automatic Hammer



### TEST RESULTS

Maximum Dry Density 99.1 PCF  
 Optimum Water Content 20.7 %

### ATTERBERG LIMITS

LL	PL	PI
71	23	48

Curves of 100% Saturation for Specific Gravity Equal to:

2.80  
 2.70  
 2.60

**Te-An Wang, 05/27/2025**

Analysis & Quality Review/Date

Specimens prepared by: T.W.

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# MOISTURE-DENSITY RELATIONSHIP

CLIENT: RRC Power & Energy, LLC  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Sample ID GEO-53 at 2.0 to 4.0 ft.  
 Description of Material LIGHT BROWN FAT CLAY(CH)  
 Test Method ASTM D698 Method A, Automatic Hammer

### TEST RESULTS

Maximum Dry Density 103.1 PCF  
 Optimum Water Content 19.5 %

### ATTERBERG LIMITS

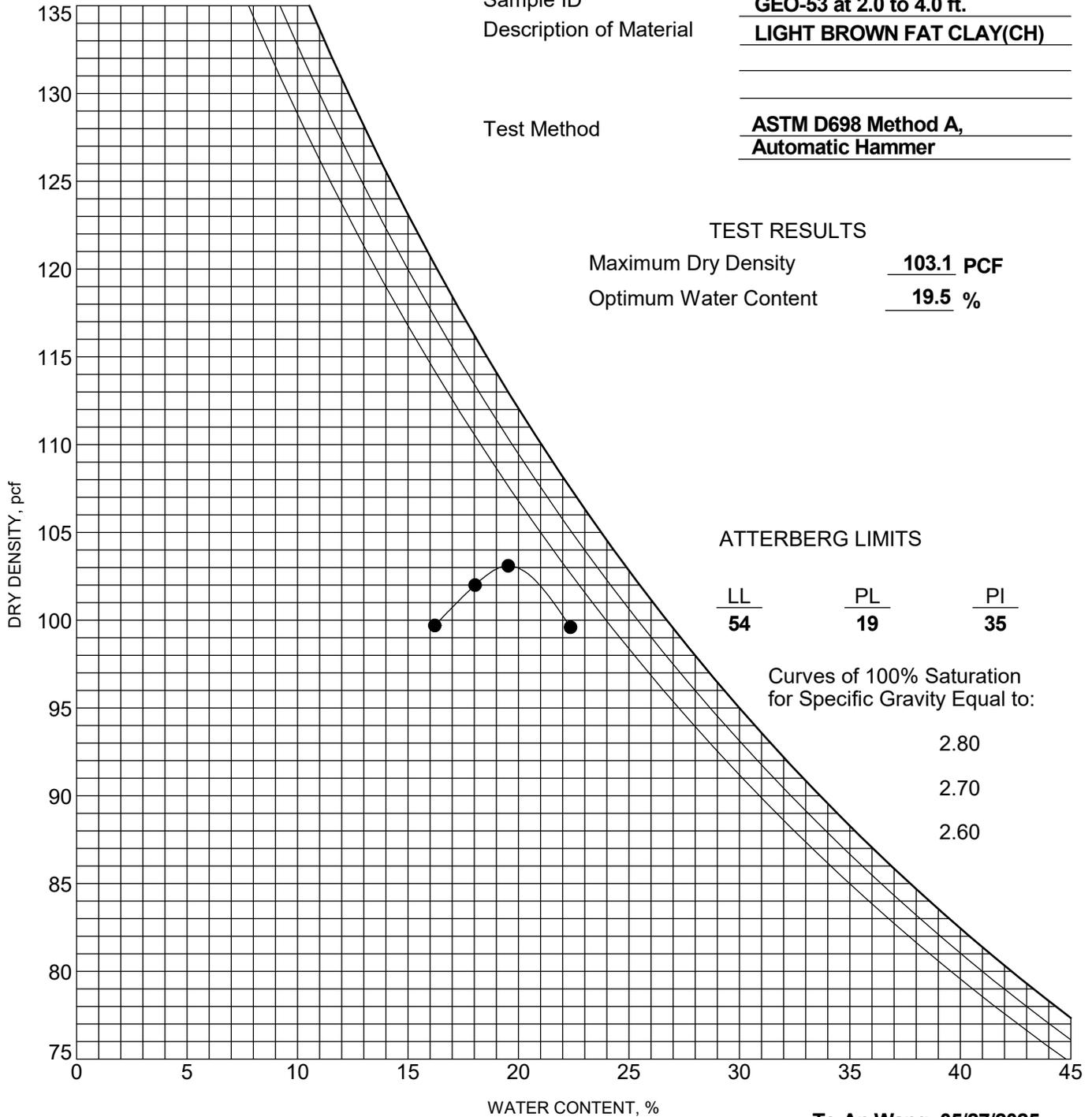
LL	PL	PI
54	19	35

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60

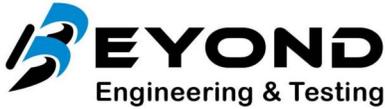


**Te-An Wang, 05/27/2025**

Analysis & Quality Review/Date

Specimens prepared by: T.W.

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# MOISTURE-DENSITY RELATIONSHIP

CLIENT: RRC Power & Energy, LLC  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Sample ID GEO-59 at 2.0 to 4.0 ft.  
 Description of Material LIGHT BROWN FAT CLAY(CH)  
 Test Method ASTM D698 Method A, Automatic Hammer

### TEST RESULTS

Maximum Dry Density 104.8 PCF  
 Optimum Water Content 20.2 %

### ATTERBERG LIMITS

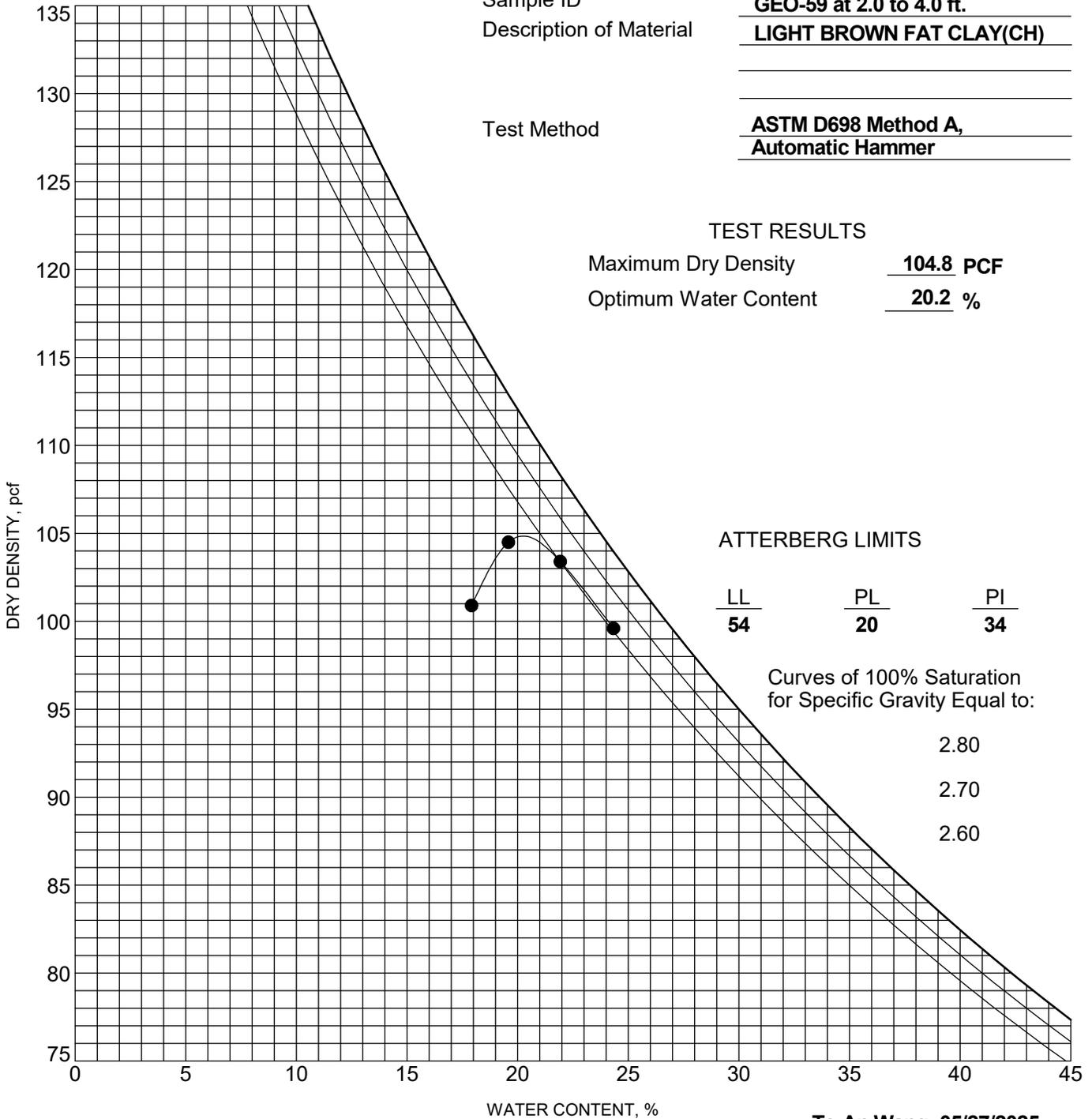
LL	PL	PI
54	20	34

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60



**Te-An Wang, 05/27/2025**

Analysis & Quality Review/Date

Specimens prepared by: T.W.

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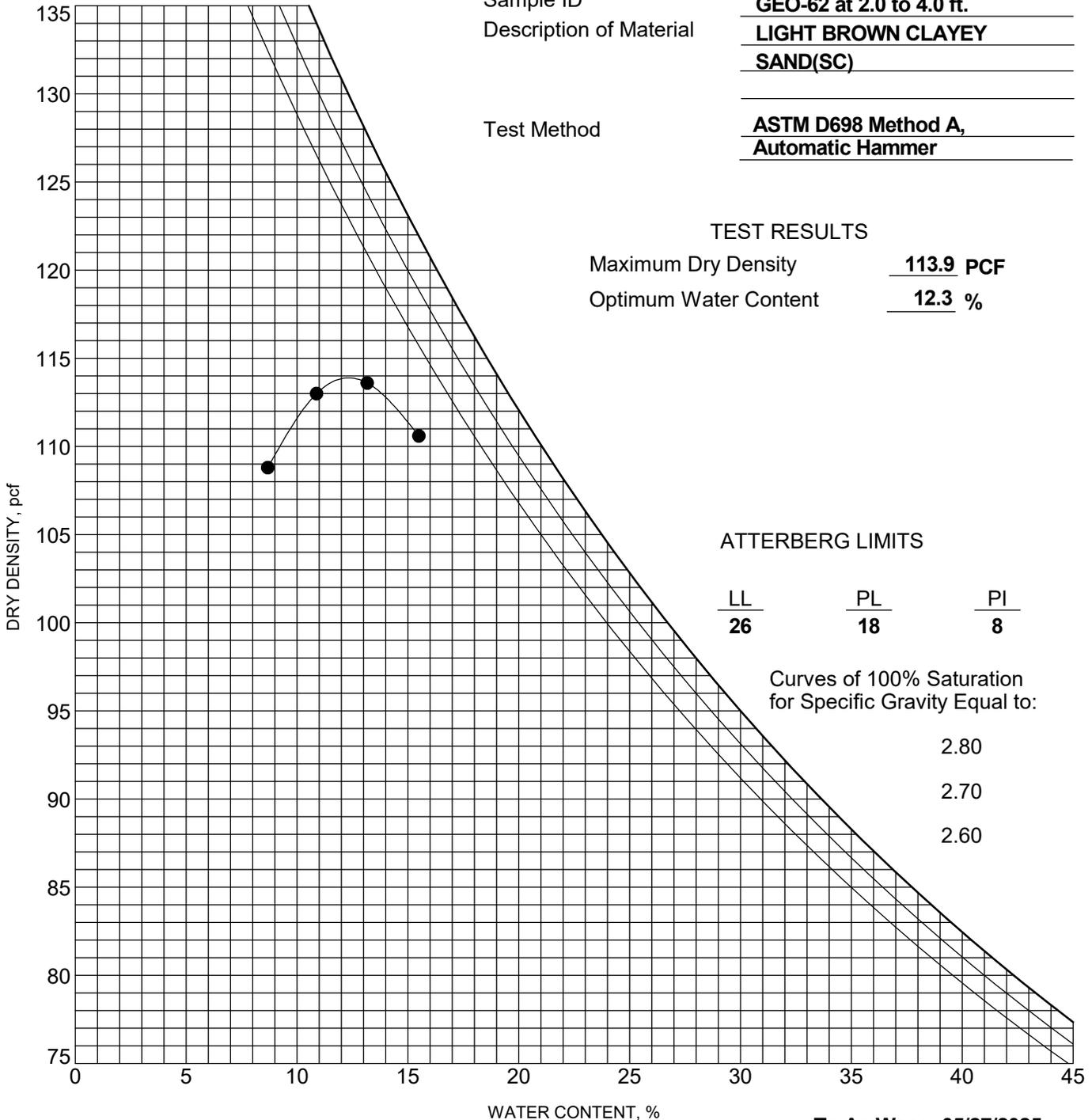


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# MOISTURE-DENSITY RELATIONSHIP

CLIENT: RRC Power & Energy, LLC  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Sample ID: GEO-62 at 2.0 to 4.0 ft.  
 Description of Material: LIGHT BROWN CLAYEY SAND(SC)  
 Test Method: ASTM D698 Method A, Automatic Hammer



Te-An Wang, 05/27/2025

Analysis & Quality Review/Date

Specimens prepared by: T.W.

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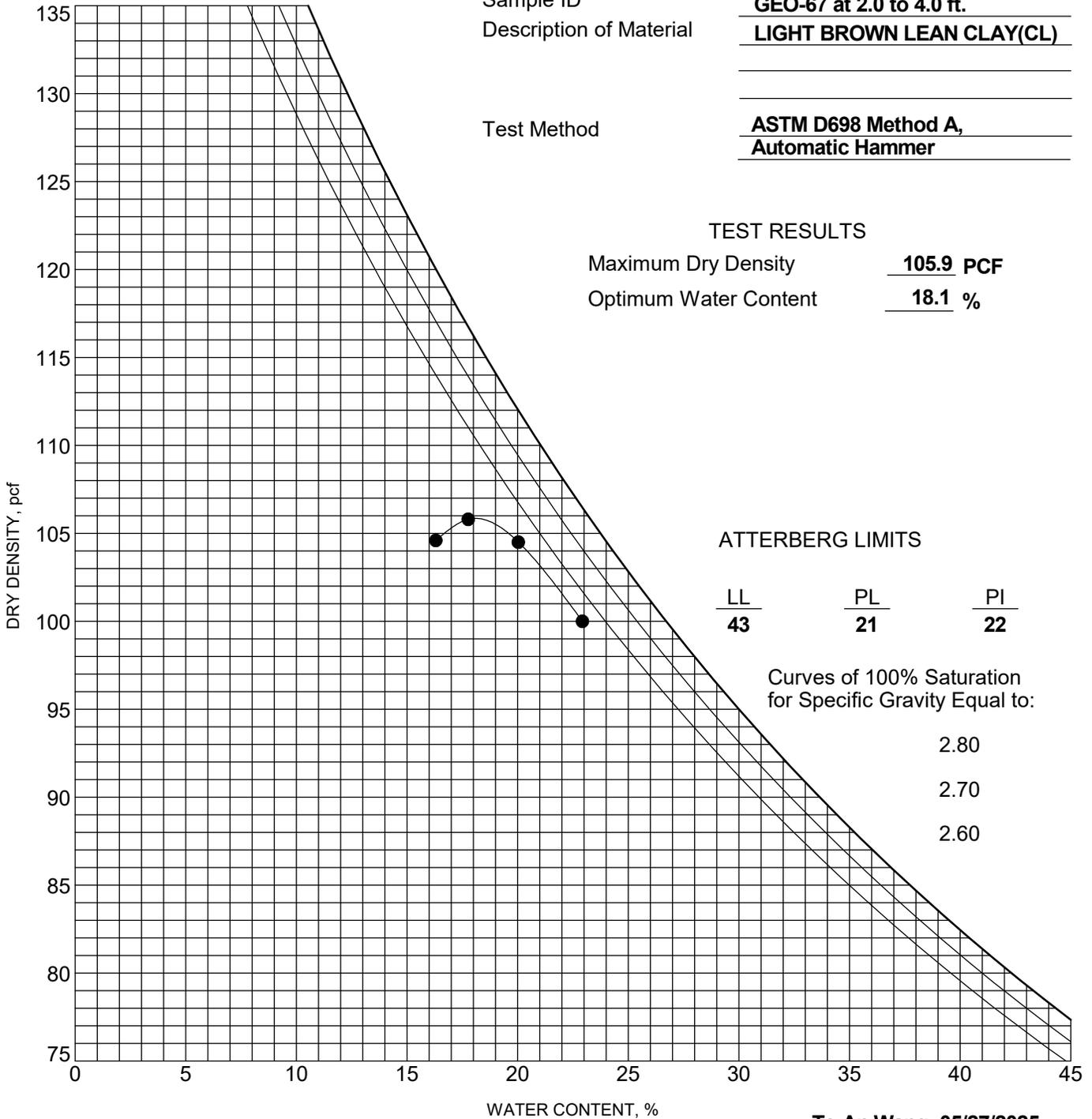


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# MOISTURE-DENSITY RELATIONSHIP

CLIENT: RRC Power & Energy, LLC  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Sample ID GEO-67 at 2.0 to 4.0 ft.  
 Description of Material LIGHT BROWN LEAN CLAY(CL)  
 Test Method ASTM D698 Method A, Automatic Hammer



### TEST RESULTS

Maximum Dry Density 105.9 PCF  
 Optimum Water Content 18.1 %

### ATTERBERG LIMITS

LL	PL	PI
43	21	22

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60

Te-An Wang, 05/27/2025

Analysis & Quality Review/Date

Specimens prepared by: T.W.

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# MOISTURE-DENSITY RELATIONSHIP

CLIENT: RRC Power & Energy, LLC  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Sample ID: GEO-70 at 2.0 to 4.0 ft.  
 Description of Material: LIGHT BROWN FAT CLAY(CH)  
 Test Method: ASTM D698 Method A, Automatic Hammer

### TEST RESULTS

Maximum Dry Density: 100.6 PCF  
 Optimum Water Content: 20.8 %

### ATTERBERG LIMITS

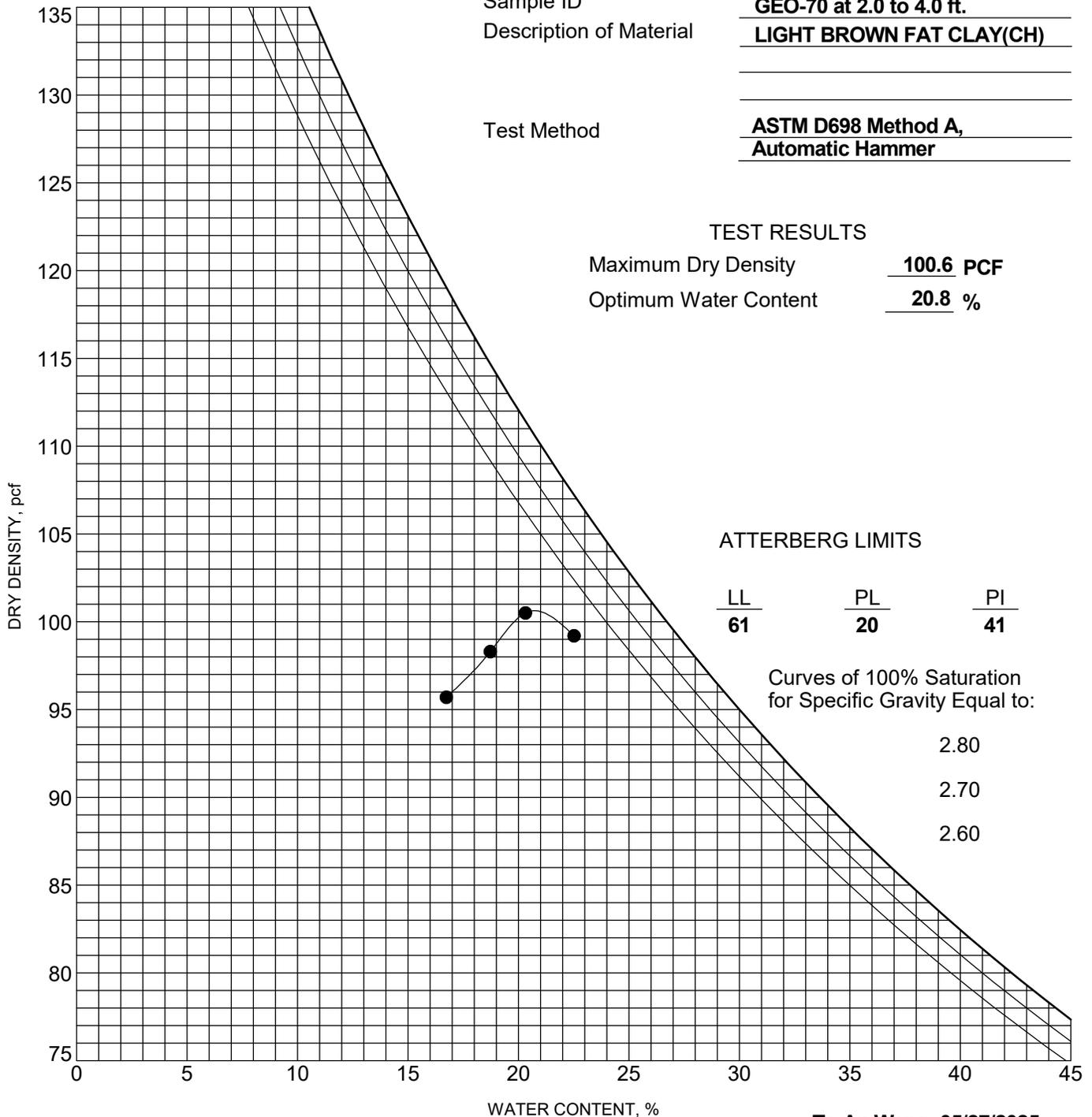
LL	PL	PI
61	20	41

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60



**Te-An Wang, 05/27/2025**

Analysis & Quality Review/Date

Specimens prepared by: T.W.

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# MOISTURE-DENSITY RELATIONSHIP

CLIENT: RRC Power & Energy, LLC  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Sample ID SUB-2 at 2.0 to 4.0 ft.  
 Description of Material DARK BROWN SANDY LEAN CLAY(CL)  
 Test Method ASTM D698 Method A, Automatic Hammer

### TEST RESULTS

Maximum Dry Density 116.1 PCF  
 Optimum Water Content 13.7 %

### ATTERBERG LIMITS

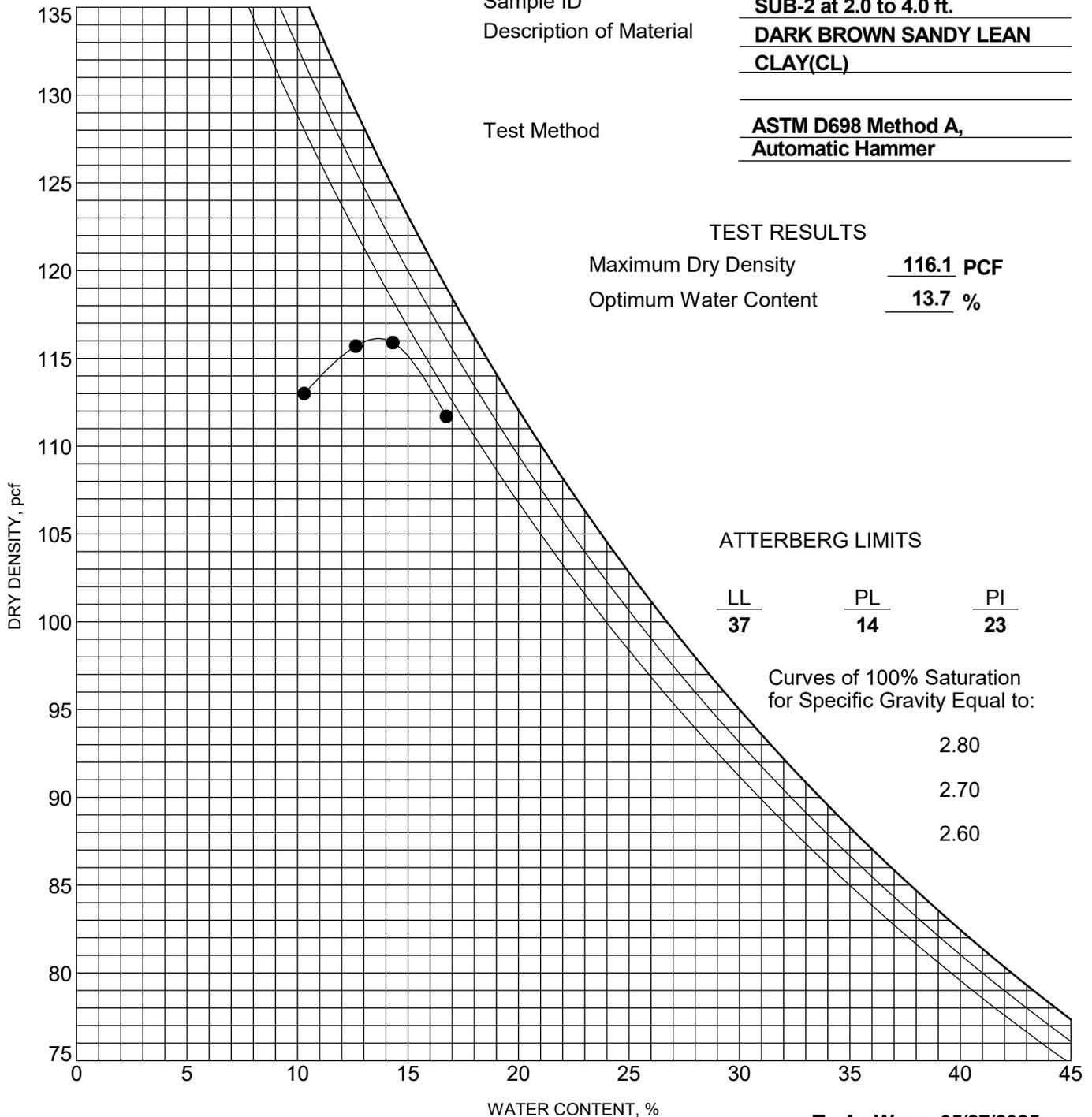
LL	PL	PI
37	14	23

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60



**Te-An Wang, 05/27/2025**

Analysis & Quality Review/Date

Specimens prepared by: T.W.

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## Unconsolidated-Undrained Triaxial Compression Test

Client: RRC Power & Energy, LLC

Project No.: GE2503026

Type of Specimen: Shelby Tube

Type of Test: Q-Test

Strain Rate: 1.0 %/min

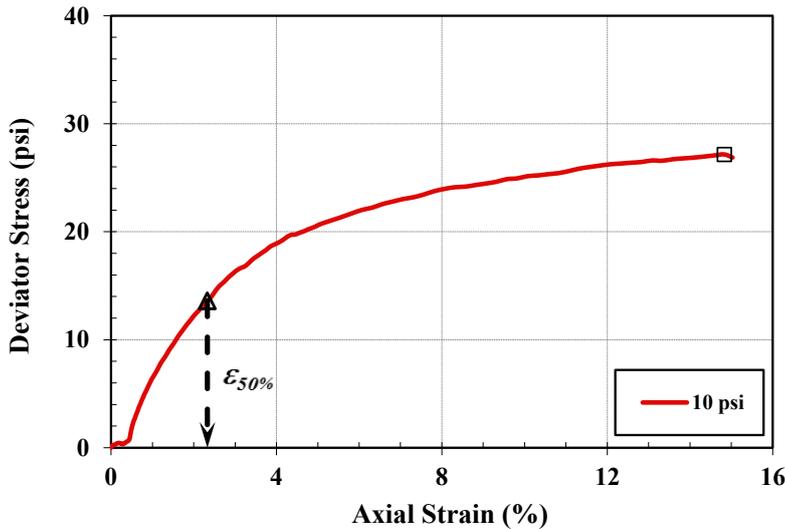
Project: Longspur Wind Project

Test Date: 6/3/2025

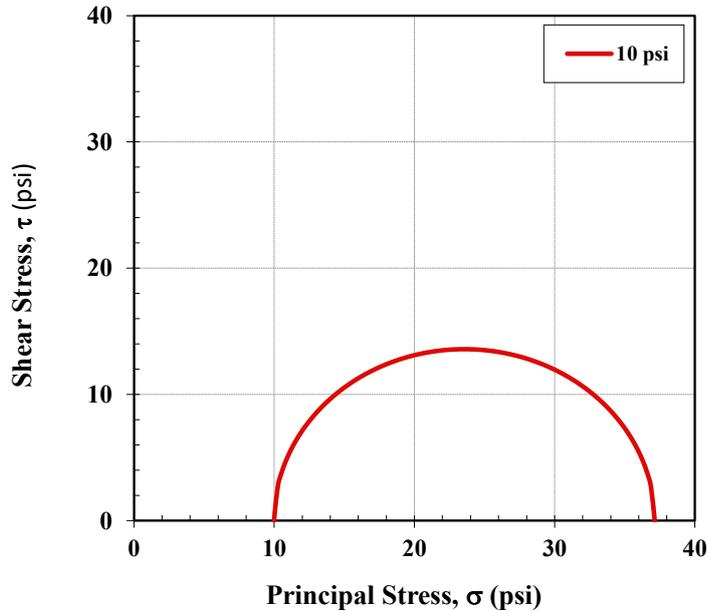
Test Method: ASTM D2850

Sample No.: GEO-04 at 12 ft

Principal Stress Difference vs. Axial Strain



Mohr Circles (Total Stress) for Peak Stress at Failure



Initial Specimen Conditions		
Confining Pressure (psi)		10.0
Avg. Diameter (in)	$D_o$	2.86
Avg. Height (in)	$H_o$	5.55
In-situ Water Content (%)	$w_o$	23.0
Total Unit Weight (pcf)	$\gamma_{total}$	126.7
Dry Unit Weight (pcf)	$\gamma_{dry}$	103.0
Saturation (%)	$S_r$	97.6
Void Ratio	$e_o$	0.64
Specific Gravity (Assumed)	$G_s$	2.70

Stresses at Failure	
Maximum Deviator Stress (psi)	27.2
Axial Strain at Failure (%)	14.8
Axial Strain at 50% of $q_u$ , $\epsilon_{50}$ (%)	2.3
Total Stresses at Failure	
Major Principal Stress Corrected, $\sigma_{1C}$ (psi)	37.1
Minor Principal Stress, $\sigma_3$ (psi)	10.0

Test Results	
Unconsolidated-Undrained Compressive Strength at Failure, $\sigma_{1C} - \sigma_3$ (tsf)	1.96

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Kainat Batool, 06/04/25

Analysis & Quality Review/Date

Specimen Prepared by: A.B.

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## Unconsolidated-Undrained Triaxial Compression Test Appendix

Client: RRC Power & Energy, LLC  
Project: Longspur Wind Project  
Specimen: GEO-04 at 12 ft

Project No.: GE2503026  
Test Method: ASTM D2850  
Test Date: 06/03/25



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## Unconsolidated-Undrained Triaxial Compression Test

Client: RRC Power & Energy,  
LLC

Project No.: GE2503026

Type of Specimen: Modified CA Tube

Type of Test: Q-Test

Strain Rate: 1.0 %/min

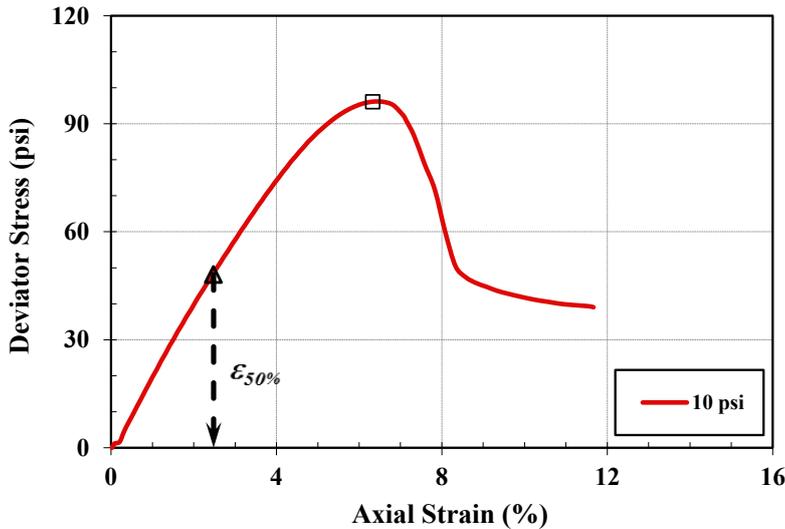
Project: Longspur Wind Project

Test Date: 6/3/2025

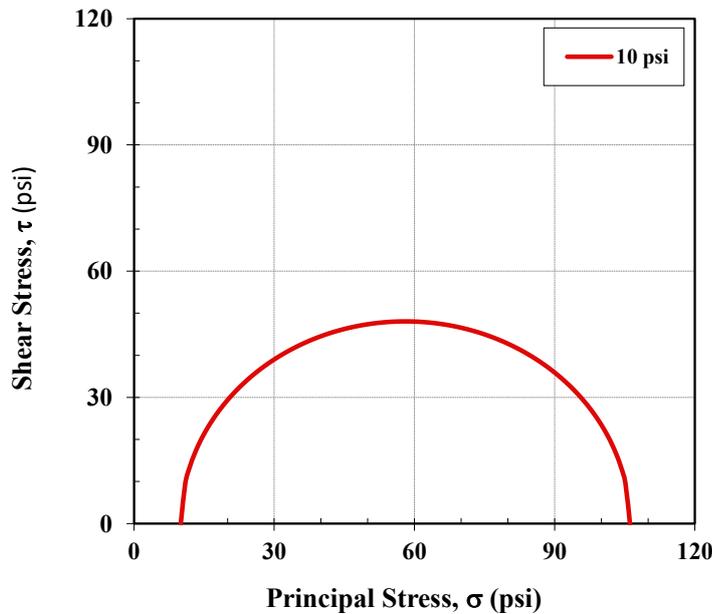
Test Method: ASTM D2850

Sample No.: GEO-07 at 12 ft

Principal Stress Difference vs. Axial Strain



Mohr Circles (Total Stress) for Peak Stress at Failure



Initial Specimen Conditions		
Confining Pressure (psi)		10.0
Avg. Diameter (in)	$D_o$	2.40
Avg. Height (in)	$H_o$	4.87
In-situ Water Content (%)	$w_o$	27.2
Total Unit Weight (pcf)	$\gamma_{total}$	125.9
Dry Unit Weight (pcf)	$\gamma_{dry}$	98.9
Saturation (%)	$S_r$	100.0
Void Ratio	$e_o$	0.70
Specific Gravity (Assumed)	$G_s$	2.70

Stresses at Failure	
Maximum Deviator Stress (psi)	96.1
Axial Strain at Failure (%)	6.3
Axial Strain at 50% of $q_u$ , $\epsilon_{50}$ (%)	2.5
Total Stresses at Failure	
Major Principal Stress Corrected, $\sigma_{1C}$ (psi)	106.1
Minor Principal Stress, $\sigma_3$ (psi)	10.0

Test Results	
Unconsolidated-Undrained Compressive Strength at Failure, $\sigma_{1C} - \sigma_3$ (tsf)	6.92

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Kainat Batool, 06/04/25

Analysis & Quality Review/Date

Specimen Prepared by: A.B.

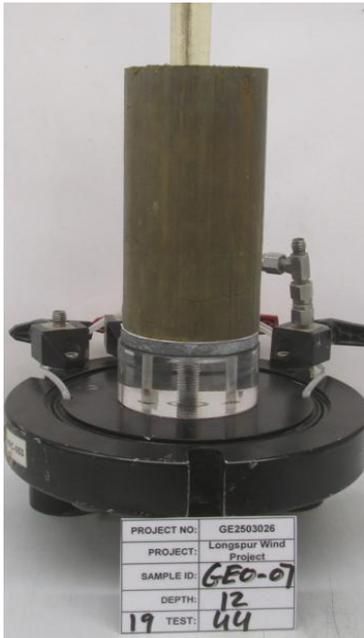
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## Unconsolidated-Undrained Triaxial Compression Test Appendix

Client: RRC Power & Energy, LLC  
Project: Longspur Wind Project  
Specimen: GEO-07 at 12 ft

Project No.: GE2503026  
Test Method: ASTM D2850  
Test Date: 06/03/25



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## Unconsolidated-Undrained Triaxial Compression Test

Client: RRC Power & Energy,  
LLC

Project No.: GE2503026  
Type of Test: Q-Test

Type of Specimen: Modified CA Tube

Strain Rate: 1.0 %/min

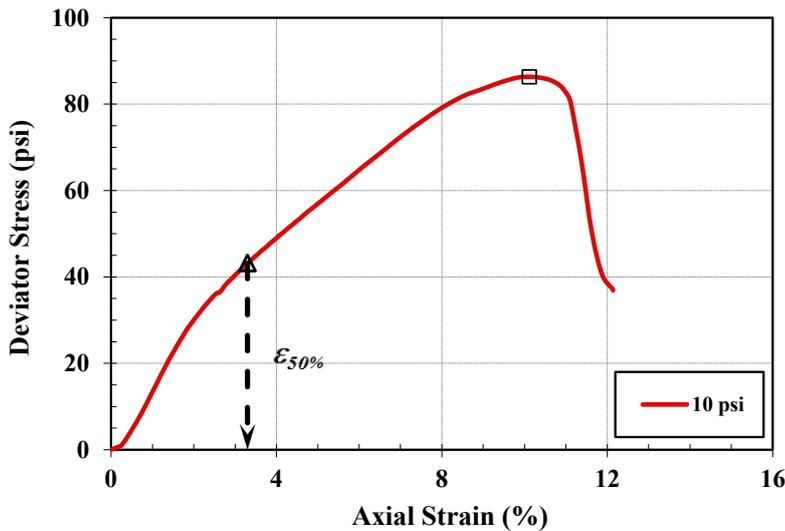
Project: Longspur Wind Project

Test Date: 6/5/2025

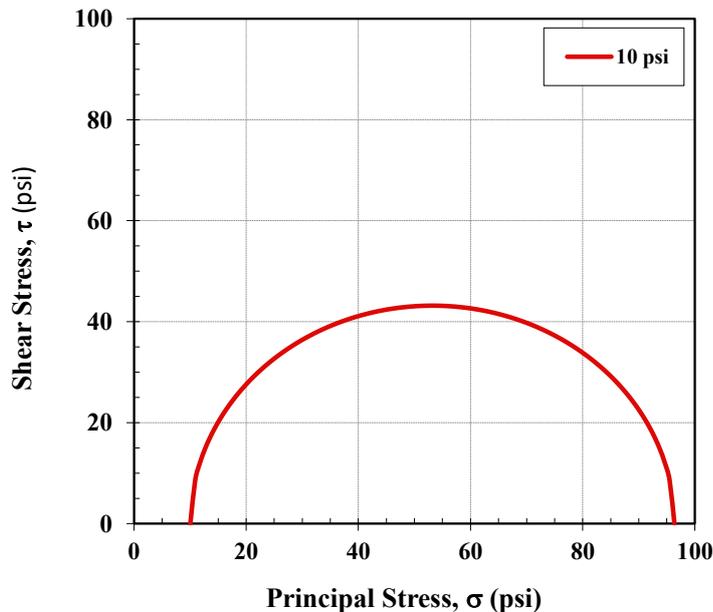
Test Method: ASTM D2850

Sample No.: GEO-46 at 12 ft

Principal Stress Difference vs. Axial Strain



Mohr Circles (Total Stress) for Peak Stress at Failure



Initial Specimen Conditions		
Confining Pressure (psi)		10.0
Avg. Diameter (in)	D <sub>o</sub>	2.40
Avg. Height (in)	H <sub>o</sub>	4.84
In-situ Water Content (%)	w <sub>o</sub>	22.6
Total Unit Weight (pcf)	γ <sub>total</sub>	127.8
Dry Unit Weight (pcf)	γ <sub>dry</sub>	104.3
Saturation (%)	S <sub>r</sub>	99.0
Void Ratio	e <sub>o</sub>	0.62
Specific Gravity (Assumed)	G <sub>s</sub>	2.70

Stresses at Failure	
Maximum Deviator Stress (psi)	86.3
Axial Strain at Failure (%)	10.1
Axial Strain at 50% of q <sub>u</sub> , ε <sub>50</sub> (%)	3.3
Total Stresses at Failure	
Major Principal Stress Corrected, σ <sub>1C</sub> (psi)	96.4
Minor Principal Stress, σ <sub>3</sub> (psi)	10.0

Test Results	
Unconsolidated-Undrained Compressive Strength at Failure, σ <sub>1C</sub> - σ <sub>3</sub> (tsf)	6.22

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whichever is obtained first.

Te-An Wang, EIT, 06/09/25

Analysis & Quality Review/Date

Specimen Prepared by: A.B.

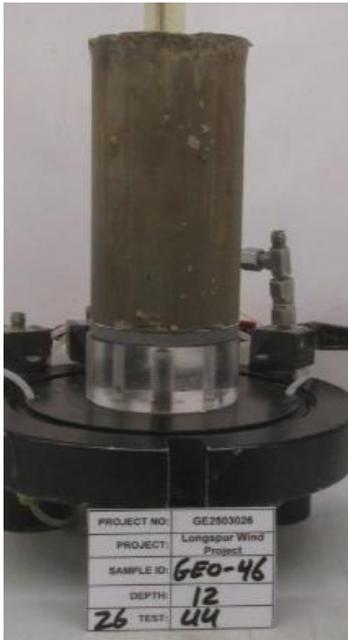
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## Unconsolidated-Undrained Triaxial Compression Test Appendix

Client: RRC Power & Energy, LLC  
Project: Longspur Wind Project  
Specimen: GEO-46 at 12 ft

Project No.: GE2503026  
Test Method: ASTM D2850  
Test Date: 06/05/25



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## Unconsolidated-Undrained Triaxial Compression Test

Client: RRC Power & Energy, LLC

Project No.: GE2503026

Type of Specimen: Modified CA Tube

Type of Test: Q-Test

Strain Rate: 1.0 %/min

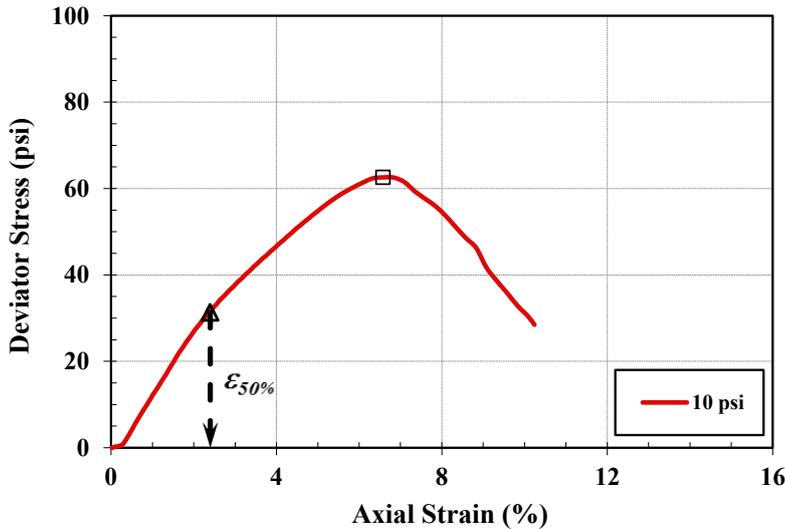
Project: Longspur Wind Project

Test Date: 6/6/2025

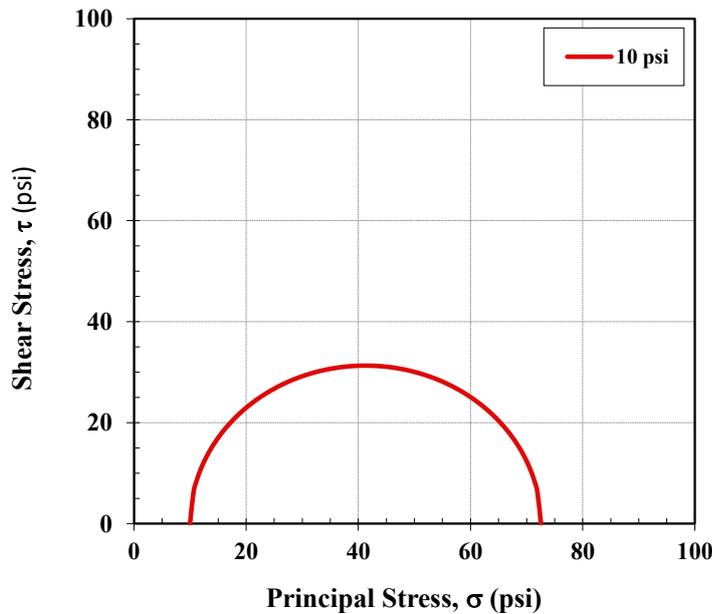
Test Method: ASTM D2850

Sample No.: GEO-62 at 12 ft

Principal Stress Difference vs. Axial Strain



Mohr Circles (Total Stress) for Peak Stress at Failure



Initial Specimen Conditions		
Confining Pressure (psi)		10.0
Avg. Diameter (in)	$D_o$	2.40
Avg. Height (in)	$H_o$	4.81
In-situ Water Content (%)	$w_o$	21.3
Total Unit Weight (pcf)	$\gamma_{total}$	127.5
Dry Unit Weight (pcf)	$\gamma_{dry}$	105.1
Saturation (%)	$S_r$	95.3
Void Ratio	$e_o$	0.60
Specific Gravity (Assumed)	$G_s$	2.70

Stresses at Failure	
Maximum Deviator Stress (psi)	62.6
Axial Strain at Failure (%)	6.6
Axial Strain at 50% of $q_u$ , $\epsilon_{50}$ (%)	2.4
Total Stresses at Failure	
Major Principal Stress Corrected, $\sigma_{1C}$ (psi)	72.6
Minor Principal Stress, $\sigma_3$ (psi)	10.0

Test Results	
Unconsolidated-Undrained Compressive Strength at Failure, $\sigma_{1C} - \sigma_3$ (tsf)	4.51

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Te-An Wang, EIT, 06/09/25

Analysis & Quality Review/Date

Specimen Prepared by: A.B.

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## Unconsolidated-Undrained Triaxial Compression Test Appendix

Client: RRC Power & Energy, LLC  
Project: Longspur Wind Project  
Specimen: GEO-62 at 12 ft

Project No.: GE2503026  
Test Method: ASTM D2850  
Test Date: 06/06/25



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## Unconsolidated-Undrained Triaxial Compression Test

Client: RRC Power & Energy,  
LLC

Project No.: GE2503026

Type of Specimen: Shelby Tube

Type of Test: Q-Test

Strain Rate: 1.0 %/min

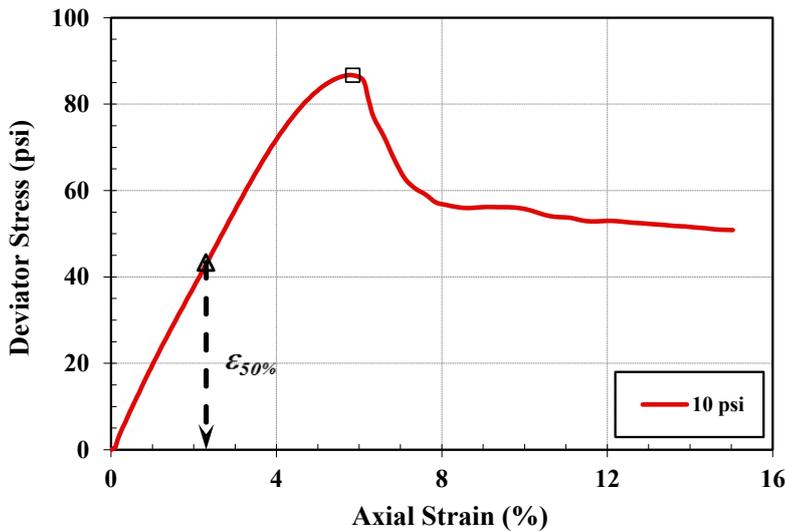
Project: Longspur Wind Project

Test Date: 6/6/2025

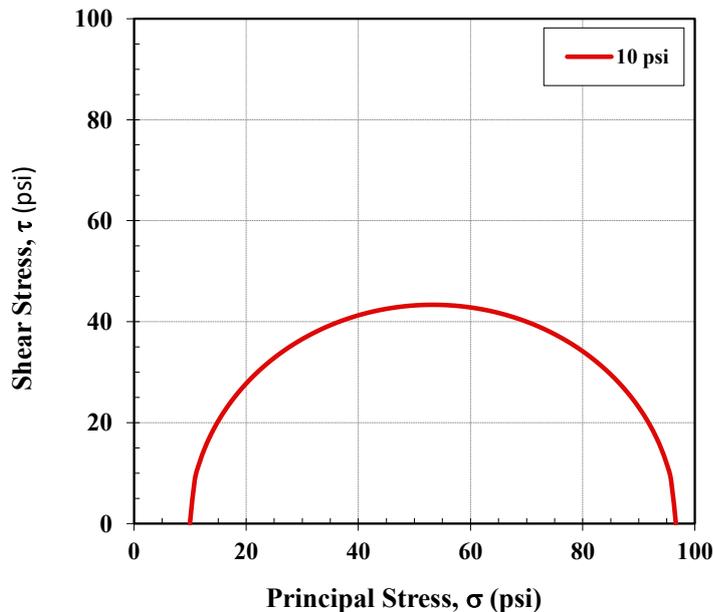
Test Method: ASTM D2850

Sample No.: GEO-66 at 12 ft

Principal Stress Difference vs. Axial Strain



Mohr Circles (Total Stress) for Peak Stress at Failure



Initial Specimen Conditions		
Confining Pressure (psi)		10.0
Avg. Diameter (in)	$D_o$	2.86
Avg. Height (in)	$H_o$	5.64
In-situ Water Content (%)	$w_o$	21.5
Total Unit Weight (pcf)	$\gamma_{total}$	126.6
Dry Unit Weight (pcf)	$\gamma_{dry}$	104.2
Saturation (%)	$S_r$	93.9
Void Ratio	$e_o$	0.62
Specific Gravity (Assumed)	$G_s$	2.70

Stresses at Failure	
Maximum Deviator Stress (psi)	86.7
Axial Strain at Failure (%)	5.8
Axial Strain at 50% of $q_u$ , $\epsilon_{50}$ (%)	2.3
Total Stresses at Failure	
Major Principal Stress Corrected, $\sigma_{1C}$ (psi)	96.6
Minor Principal Stress, $\sigma_3$ (psi)	10.0

Test Results	
Unconsolidated-Undrained Compressive Strength at Failure, $\sigma_{1C} - \sigma_3$ (tsf)	6.24

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Te-An Wang, EIT, 06/09/25

Analysis & Quality Review/Date

Specimen Prepared by: A.B.

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## Unconsolidated-Undrained Triaxial Compression Test Appendix

Client: RRC Power & Energy, LLC  
Project: Longspur Wind Project  
Specimen: GEO-66 at 12 ft

Project No.: GE2503026  
Test Method: ASTM D2850  
Test Date: 06/06/25



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## Unconsolidated-Undrained Triaxial Compression Test

Client: RRC Power & Energy,  
LLC

Project No.: GE2503026  
Type of Test: Q-Test

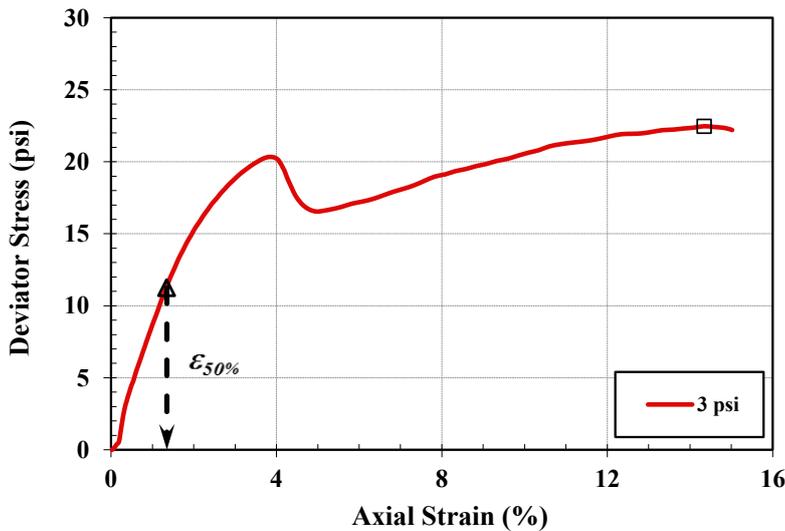
Type of Specimen: Shelby Tube  
Strain Rate: 1.0 %/min  
Test Method: ASTM D2850

Project: Longspur Wind Project

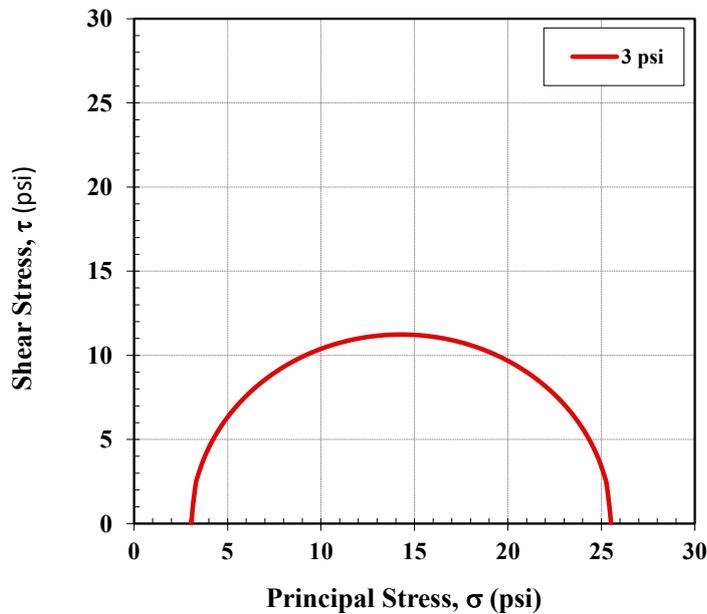
Test Date: 6/6/2025

Sample No.: SUB-3 at 4 ft

Principal Stress Difference vs. Axial Strain



Mohr Circles (Total Stress) for Peak Stress at Failure



Initial Specimen Conditions		
Confining Pressure (psi)		3.0
Avg. Diameter (in)	D <sub>o</sub>	2.89
Avg. Height (in)	H <sub>o</sub>	5.64
In-situ Water Content (%)	w <sub>o</sub>	14.8
Total Unit Weight (pcf)	γ <sub>total</sub>	123.7
Dry Unit Weight (pcf)	γ <sub>dry</sub>	107.7
Saturation (%)	S <sub>r</sub>	70.9
Void Ratio	e <sub>o</sub>	0.56
Specific Gravity (Assumed)	G <sub>s</sub>	2.70

Stresses at Failure	
Maximum Deviator Stress (psi)	22.5
Axial Strain at Failure (%)	14.3
Axial Strain at 50% of q <sub>u</sub> , ε <sub>50</sub> (%)	1.4
Total Stresses at Failure	
Major Principal Stress Corrected, σ <sub>1C</sub> (psi)	25.5
Minor Principal Stress, σ <sub>3</sub> (psi)	3.1

Test Results	
Unconsolidated-Undrained Compressive Strength at Failure, σ <sub>1C</sub> - σ <sub>3</sub> (tsf)	1.62

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Te-An Wang, EIT, 06/09/25

Analysis & Quality Review/Date

Specimen Prepared by: A.B.

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## Unconsolidated-Undrained Triaxial Compression Test Appendix

Client: RRC Power & Energy, LLC  
Project: Longspur Wind Project  
Specimen: SUB-3 at 4 ft

Project No.: GE2503026  
Test Method: ASTM D2850  
Test Date: 06/06/25



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## Unconsolidated-Undrained Triaxial Compression Test

Client: RRC Power & Energy,  
LLC

Project No.: GE2503026

Type of Specimen: Modified CA Tube

Type of Test: Q-Test

Strain Rate: 1.0 %/min

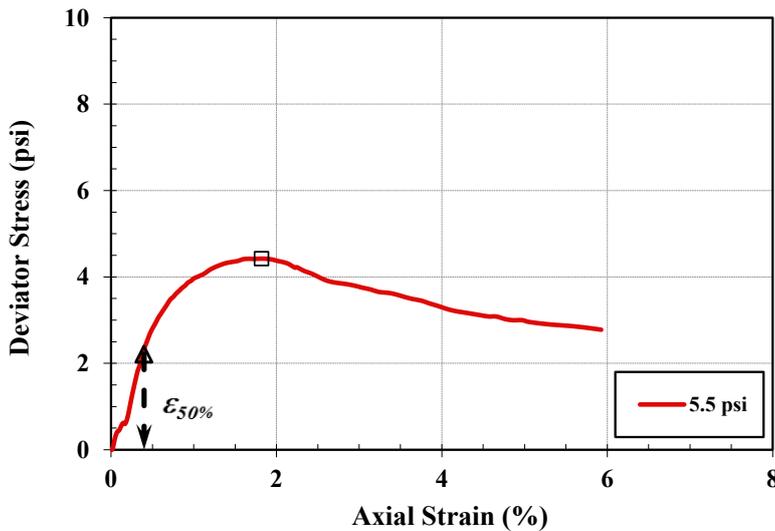
Project: Longspur Wind Project

Test Date: 6/6/2025

Test Method: ASTM D2850

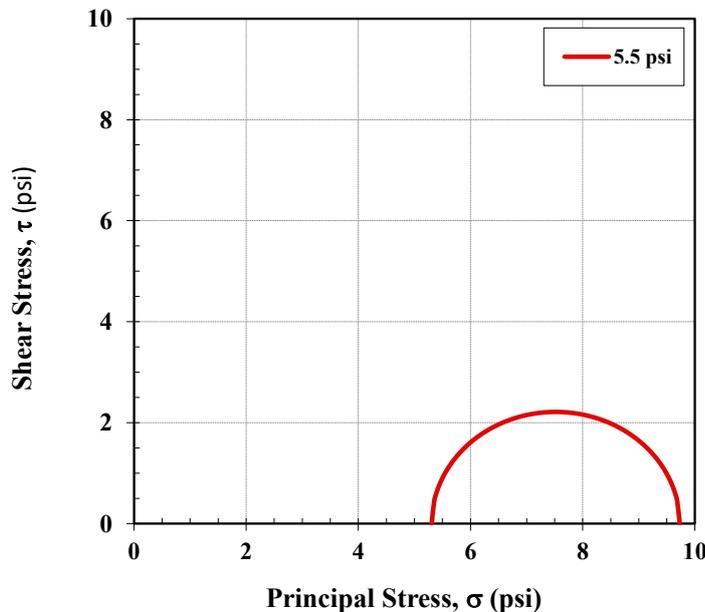
Sample No.: O&M-1 at 7 ft

Principal Stress Difference vs. Axial Strain



Initial Specimen Conditions		
Confining Pressure (psi)		5.5
Avg. Diameter (in)	D <sub>o</sub>	2.40
Avg. Height (in)	H <sub>o</sub>	4.83
In-situ Water Content (%)	w <sub>o</sub>	18.9
Total Unit Weight (pcf)	γ <sub>total</sub>	119.3
Dry Unit Weight (pcf)	γ <sub>dry</sub>	100.3
Saturation (%)	S <sub>r</sub>	75.2
Void Ratio	e <sub>o</sub>	0.68
Specific Gravity (Assumed)	G <sub>s</sub>	2.70

Mohr Circles (Total Stress) for Peak Stress at Failure



Stresses at Failure	
Maximum Deviator Stress (psi)	4.4
Axial Strain at Failure (%)	1.8
Axial Strain at 50% of q <sub>u</sub> , ε <sub>50</sub> (%)	0.4
Total Stresses at Failure	
Major Principal Stress Corrected, σ <sub>1C</sub> (psi)	9.7
Minor Principal Stress, σ <sub>3</sub> (psi)	5.3

Test Results	
Unconsolidated-Undrained Compressive Strength at Failure, σ <sub>1C</sub> - σ <sub>3</sub> (tsf)	0.32

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Te-An Wang, EIT, 06/09/25

Analysis & Quality Review/Date

Specimen Prepared by: A.B.

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## Unconsolidated-Undrained Triaxial Compression Test Appendix

Client: RRC Power & Energy, LLC  
Project: Longspur Wind Project  
Specimen: O&M-1 at 7 ft

Project No.: GE2503026  
Test Method: ASTM D2850  
Test Date: 06/06/25



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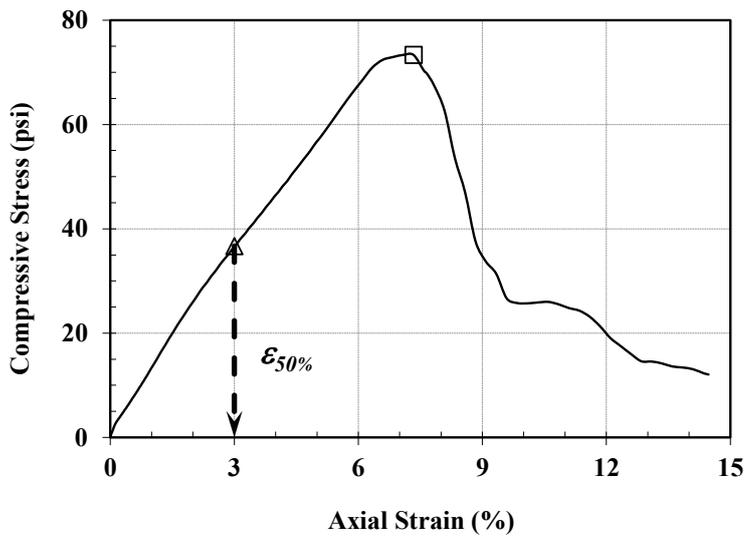


## Unconfined Compression Test Report

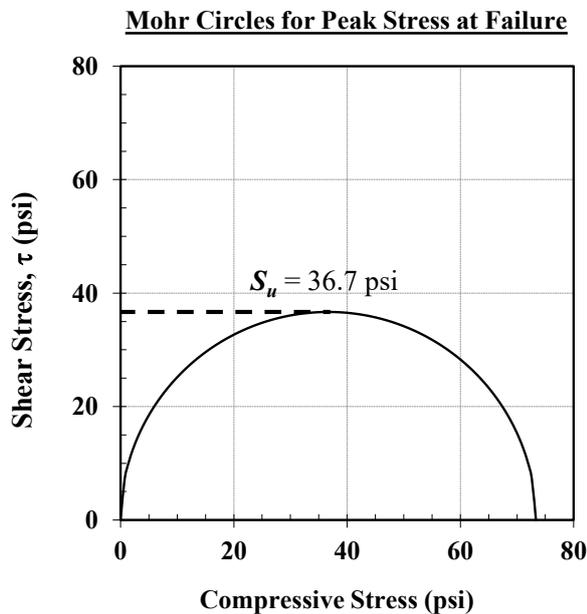
Client: RRC Power & Energy, LLC  
 Project: Longspur Wind Project  
 Sample I.D.: GEO-01 at 14 ft

Project No.: GE2503026  
 Test Method: ASTM D2166  
 Test Date: 6/4/2025

Type of Specimen: Modified CA Tube  
 Strain Rate: 1.0 %/min



Initial Specimen Conditions		
Avg. Diameter (in)	$D_o$	2.41
Avg. Height (in)	$H_o$	4.84
In-situ Moisture Content (%)	$w_o$	20.2
Total Unit Weight (pcf)	$\gamma_{total}$	133.6
Dry Unit Weight (pcf)	$\gamma_{dry}$	111.2
Saturation (%)	$S_r$	100.0
Void Ratio	$e_o$	0.52
Specific Gravity (Assumed )	$G_s$	2.70



Stresses at Failure	
Unconfined Compressive Strength, $q_u$ (psi)	73.3
Axial Strain at Failure (%)	7.3
Axial Strain at 50 % of $q_u$ (%)	3.0
Total Stresses at Failure	
Major Principal Stress, $\sigma_1$ (psi)	73.3
Minor Principal Stress, $\sigma_3$ (psi)	0
<b>Undrained Shear Strength, <math>S_u</math> (tsf)</b>	<b>2.64</b>

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whichever is obtained first.

Kainat Batool, 06/06/25

Quality Review/Date  
 Specimen prepared & tested by: A.B.

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## Unconfined Compression Test Report

Client: RRC Power & Energy, LLC

Project No.: GE2503026

Type of Specimen: Shelby Tube

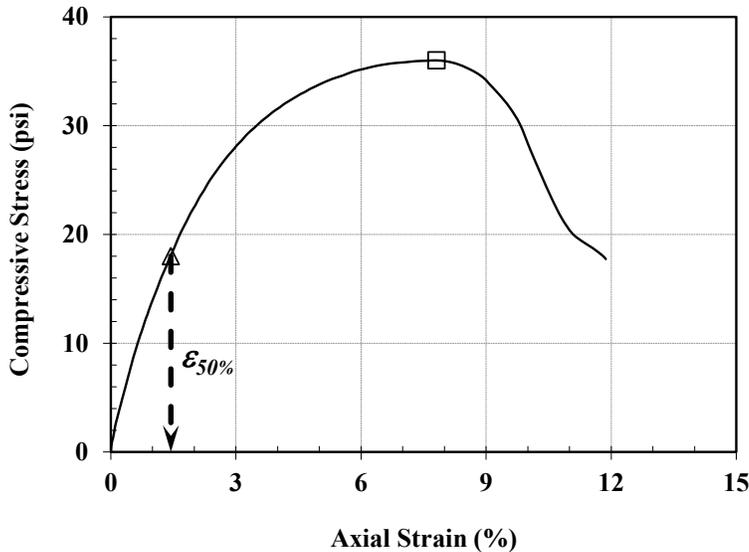
Project: Longspur Wind Project

Test Method: ASTM D2166

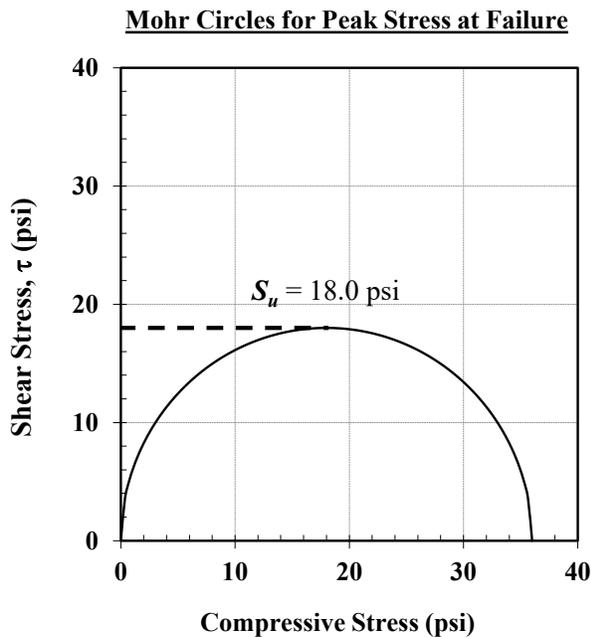
Strain Rate: 1.0 %/min

Sample I.D.: GEO-04 at 19 ft

Test Date: 6/10/2025



Initial Specimen Conditions		
Avg. Diameter (in)	D <sub>o</sub>	2.87
Avg. Height (in)	H <sub>o</sub>	5.62
In-situ Moisture Content (%)	w <sub>o</sub>	22.1
Total Unit Weight (pcf)	γ <sub>total</sub>	124.9
Dry Unit Weight (pcf)	γ <sub>dry</sub>	102.3
Saturation (%)	S <sub>r</sub>	92.0
Void Ratio	e <sub>o</sub>	0.65
Specific Gravity (Assumed )	G <sub>s</sub>	2.70



Stresses at Failure	
Unconfined Compressive Strength, $q_u$ (psi)	36.0
Axial Strain at Failure (%)	7.8
Axial Strain at 50 % of $q_u$ (%)	1.4
Total Stresses at Failure	
Major Principal Stress, $\sigma_1$ (psi)	36.0
Minor Principal Stress, $\sigma_3$ (psi)	0
<b>Undrained Shear Strength, <math>S_u</math> (tsf)</b>	<b>1.30</b>

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Kainat Batool, 06/10/25

Quality Review/Date  
Specimen prepared & tested by: A.B.

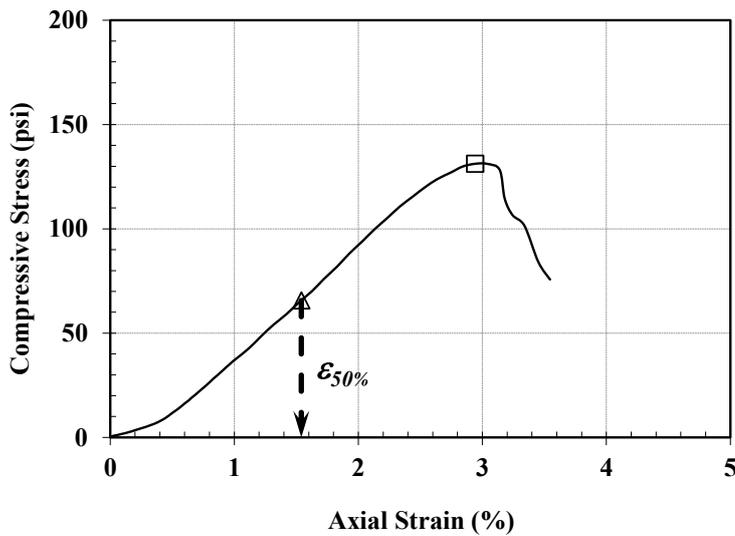


## Unconfined Compression Test Report

Client: RRC Power & Energy, LLC  
 Project: Longspur Wind Project  
 Sample I.D.: GEO-33 at 17 ft

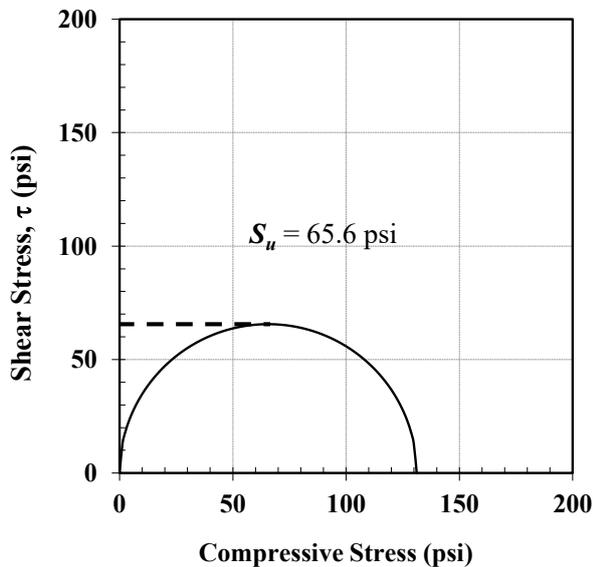
Project No.: GE2503026  
 Test Method: ASTM D2166  
 Test Date: 6/4/2025

Type of Specimen: Modified CA Tube  
 Strain Rate: 1.0 %/min



Initial Specimen Conditions		
Avg. Diameter (in)	$D_o$	2.40
Avg. Height (in)	$H_o$	4.85
In-situ Moisture Content (%)	$w_o$	16.9
Total Unit Weight (pcf)	$\gamma_{total}$	130.0
Dry Unit Weight (pcf)	$\gamma_{dry}$	111.3
Saturation (%)	$S_r$	88.4
Void Ratio	$e_o$	0.51
Specific Gravity (Assumed)	$G_s$	2.70

**Mohr Circles for Peak Stress at Failure**



Stresses at Failure	
Unconfined Compressive Strength, $q_u$ (psi)	131.2
Axial Strain at Failure (%)	2.9
Axial Strain at 50 % of $q_u$ (%)	1.5
Total Stresses at Failure	
Major Principal Stress, $\sigma_1$ (psi)	131.2
Minor Principal Stress, $\sigma_3$ (psi)	0
<b>Undrained Shear Strength, <math>S_u</math> (tsf)</b>	<b>4.72</b>

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whichever is obtained first.

Kainat Batool, 06/06/25

Quality Review/Date  
 Specimen prepared & tested by: A.B.

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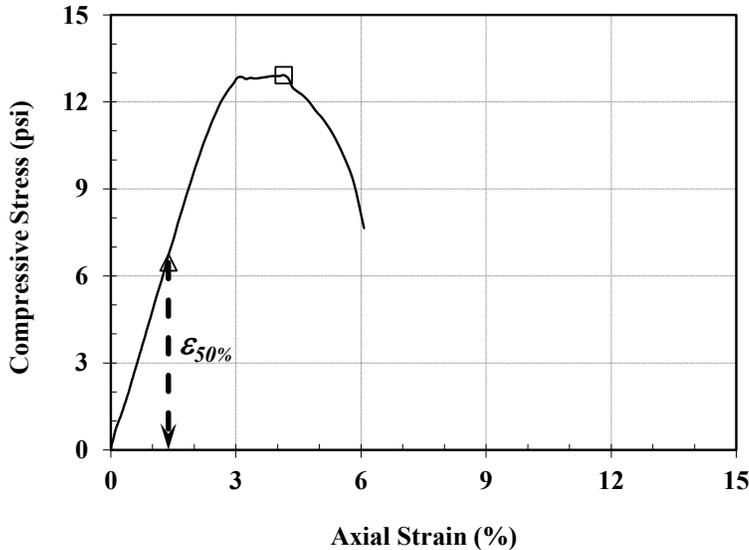


## Unconfined Compression Test Report

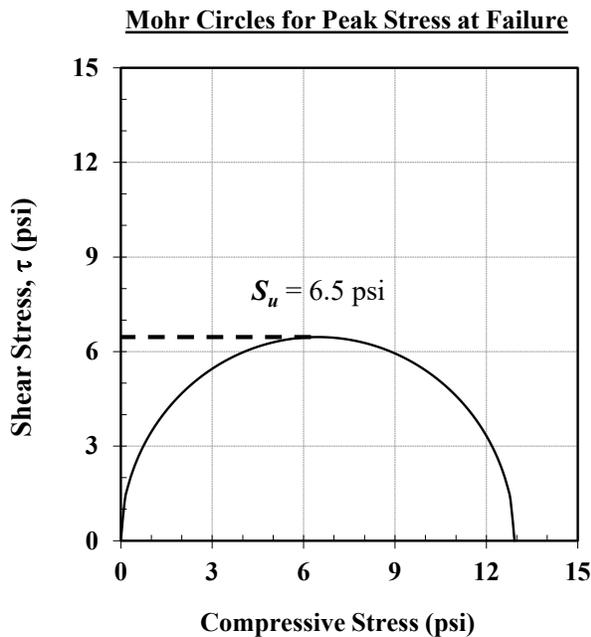
Client: RRC Power & Energy, LLC  
 Project: Longspur Wind Project  
 Sample I.D.: GEO-036 at 17 ft

Project No.: GE2503026  
 Test Method: ASTM D2166  
 Test Date: 6/10/2025

Type of Specimen: Shelby Tube  
 Strain Rate: 1.0 %/min



Initial Specimen Conditions		
Avg. Diameter (in)	D <sub>o</sub>	2.87
Avg. Height (in)	H <sub>o</sub>	5.63
In-situ Moisture Content (%)	w <sub>o</sub>	29.9
Total Unit Weight (pcf)	γ <sub>total</sub>	120.7
Dry Unit Weight (pcf)	γ <sub>dry</sub>	92.9
Saturation (%)	S <sub>r</sub>	99.2
Void Ratio	e <sub>o</sub>	0.81
Specific Gravity (Assumed )	G <sub>s</sub>	2.70



Stresses at Failure	
Unconfined Compressive Strength, q <sub>u</sub> (psi)	12.9
Axial Strain at Failure (%)	4.1
Axial Strain at 50 % of q <sub>u</sub> (%)	1.4
Total Stresses at Failure	
Major Principal Stress, σ <sub>1</sub> (psi)	12.9
Minor Principal Stress, σ <sub>3</sub> (psi)	0
<b>Undrained Shear Strength, S<sub>u</sub> (tsf)</b>	<b>0.47</b>

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Kainat Batool, 06/10/25

Quality Review/Date  
 Specimen prepared & tested by: A.B.

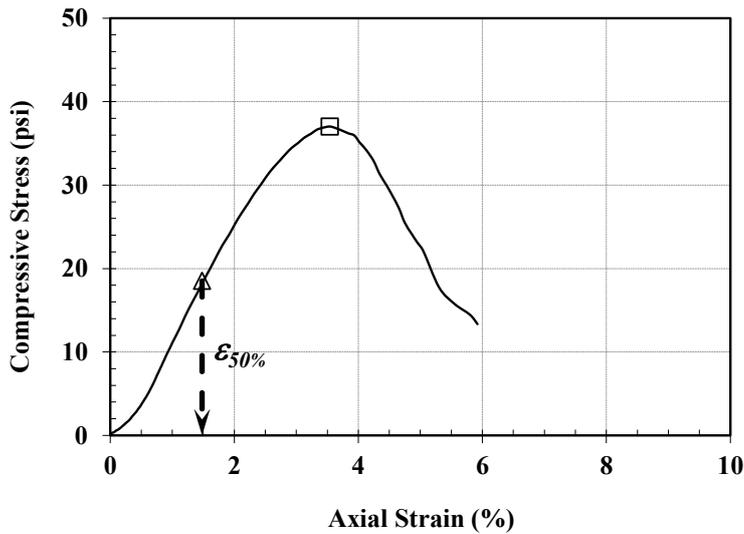


## Unconfined Compression Test Report

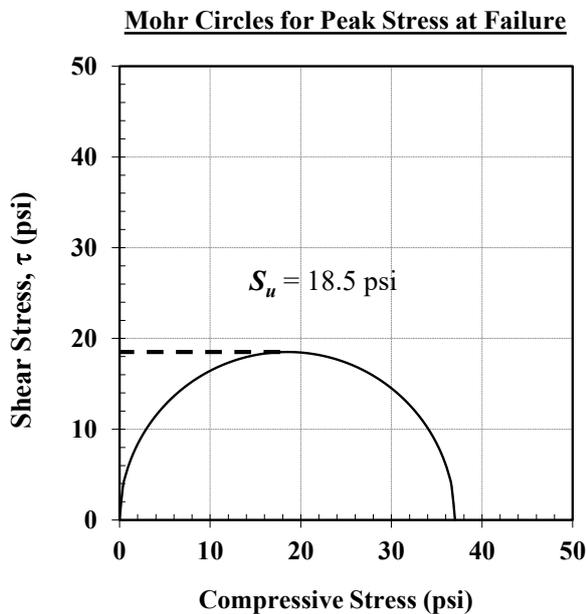
Client: RRC Power & Energy, LLC  
 Project: Longspur Wind Project  
 Sample I.D.: GEO-37 at 12 ft

Project No.: GE2503026  
 Test Method: ASTM D2166  
 Test Date: 6/4/2025

Type of Specimen: Modified CA Tube  
 Strain Rate: 1.0 %/min



Initial Specimen Conditions		
Avg. Diameter (in)	$D_o$	2.40
Avg. Height (in)	$H_o$	4.85
In-situ Moisture Content (%)	$w_o$	47.0
Total Unit Weight (pcf)	$\gamma_{total}$	95.8
Dry Unit Weight (pcf)	$\gamma_{dry}$	65.1
Saturation (%)	$S_r$	80.0
Void Ratio	$e_o$	1.59
Specific Gravity (Assumed)	$G_s$	2.70



Stresses at Failure	
Unconfined Compressive Strength, $q_u$ (psi)	37.0
Axial Strain at Failure (%)	3.5
Axial Strain at 50 % of $q_u$ (%)	1.5
Total Stresses at Failure	
Major Principal Stress, $\sigma_1$ (psi)	37.0
Minor Principal Stress, $\sigma_3$ (psi)	0
<b>Undrained Shear Strength, <math>S_u</math> (tsf)</b>	<b>1.33</b>

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whichever is obtained first.

Kainat Batool, 06/09/25

Quality Review/Date  
 Specimen prepared & tested by: A.B.

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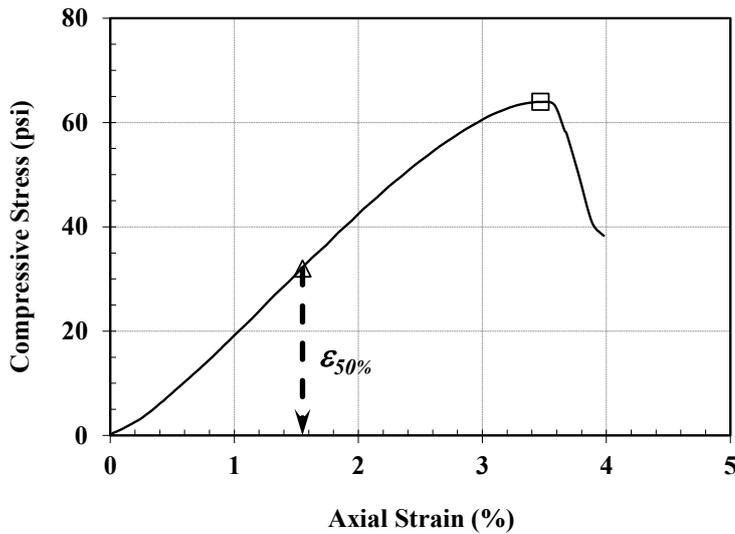


## Unconfined Compression Test Report

Client: RRC Power & Energy, LLC  
 Project: Longspur Wind Project  
 Sample I.D.: GEO-69 at 12 ft

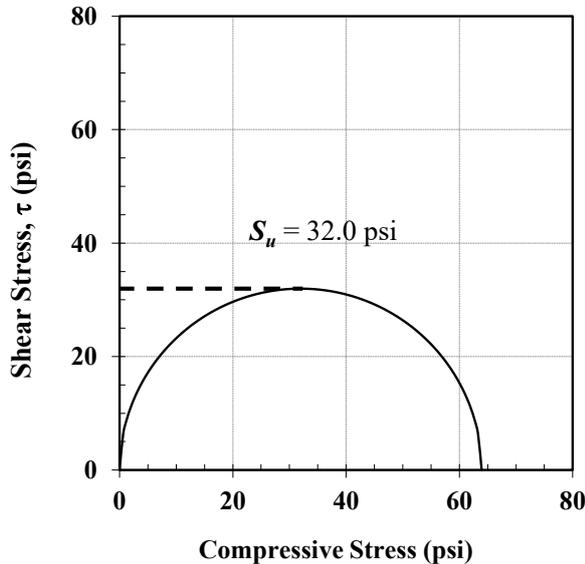
Project No.: GE2503026  
 Test Method: ASTM D2166  
 Test Date: 6/6/2025

Type of Specimen: Shelby Tube  
 Strain Rate: 1.0 %/min



Initial Specimen Conditions		
Avg. Diameter (in)	$D_o$	2.89
Avg. Height (in)	$H_o$	5.63
In-situ Moisture Content (%)	$w_o$	24.8
Total Unit Weight (pcf)	$\gamma_{total}$	118.8
Dry Unit Weight (pcf)	$\gamma_{dry}$	95.1
Saturation (%)	$S_r$	86.9
Void Ratio	$e_o$	0.77
Specific Gravity (Assumed )	$G_s$	2.70

**Mohr Circles for Peak Stress at Failure**



Stresses at Failure	
Unconfined Compressive Strength, $q_u$ (psi)	63.9
Axial Strain at Failure (%)	3.5
Axial Strain at 50 % of $q_u$ (%)	1.6
Total Stresses at Failure	
Major Principal Stress, $\sigma_1$ (psi)	63.9
Minor Principal Stress, $\sigma_3$ (psi)	0
<b>Undrained Shear Strength, <math>S_u</math> (tsf)</b>	<b>2.30</b>

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whichever is obtained first.

Kainat Batool, 06/09/25

Quality Review/Date  
 Specimen prepared & tested by: A.B.

The results shown on this report are for the exclusive use of the client for whom they were obtained and apply only to the sample tested and / or inspected. They are not intended to be indicative of qualities of apparently identical products. The use of our name must receive prior written approval. Reports must be reproduced in their entirety. Unauthorized use or copying of this document is strictly prohibited by anyone other than the client for the specific project.

## One-Dimensional Swell or Collapse of Soils

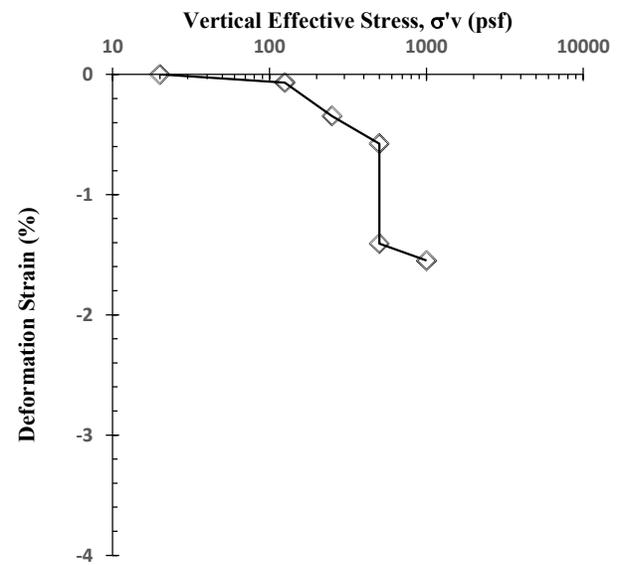
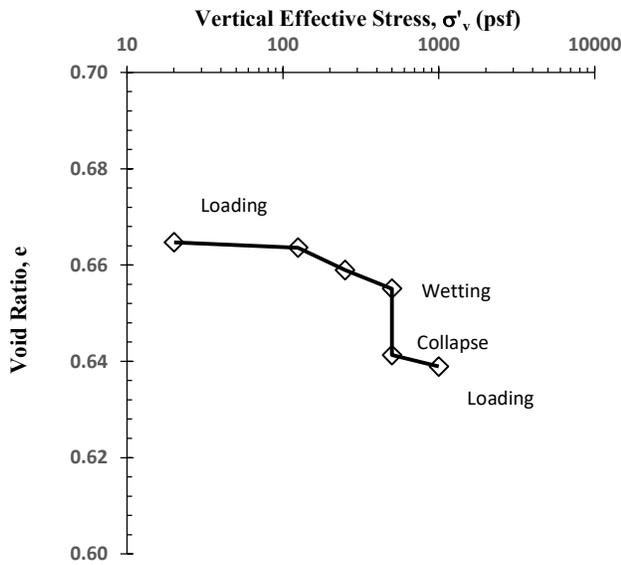
**Client:** RRC Power & Energy, LLC  
**Project Name:** Longspur Wind Project  
**Sample ID:** SUB-6 at 4 ft

**Beyond Project No.:** GE2503026  
**Test Method:** ASTM D4546, Method C  
**Test Date:** 9/13/25-9/15/25

Specimen Conditions	
Avg. Water Content of Trimmings (%)	5.6
Final Specimen Water Content (%)	18.8
Initial Specimen Height (in)	0.798
Final Specimen Height (in)	0.785
Initial Dry Unit Weight, $\gamma_o$ (pcf)	101.2
Final Dry Unit Weight, $\gamma_f$ (pcf)	102.8
Initial Void Ratio, $e_o$	0.665
Final Void Ratio, $e_f$	0.639
Initial Degree of Saturation (%)	22.8
Final Degree of Saturation (%)	79.4
Collapse Strain (%)	-0.8

Specimen was inundated with tap water during testing. Loading increment duration was minimum 24 hours. The calculation included the machine deflections that measured in each loading steps.

Gs assumed to be 2.70  
Specimen Diameter: 2.493 inches



Stage No.	Dry				Inundated	
	1	2	3	4	5	6
$\sigma'_v$ (psf)	20	125	250	500	500	1000
Height (inch)	0.798	0.797	0.795	0.793	0.787	0.785
Void Ratio, e	0.665	0.664	0.659	0.655	0.641	0.639
Axial Strain (%)	0.00	-0.07	-0.35	-0.58	-1.41	-1.55

Huamiao Cao, P.E. 09/16/25

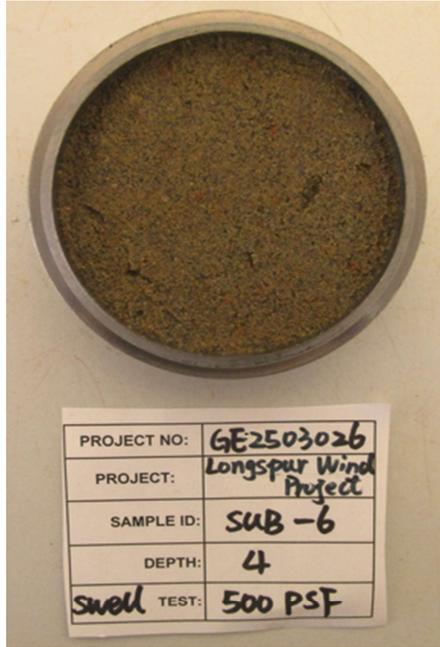
Analysis & Quality Review/Date  
Specimen prepared and tested by: J.Z.

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### One-Dimensional Swell or Collapse of Soils

**Client:** RRC Power & Energy, LLC  
**Project Name:** Longspur Wind Project  
**Sample ID:** SUB-6 at 4 ft

**Beyond Project No.:** GE2503026  
**Test Method:** ASTM D4546, Method C  
**Test Date:** 9/13/25-9/15/25

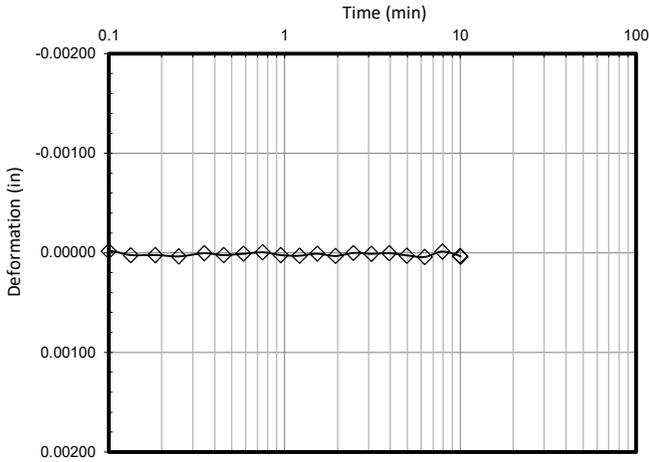


## One-Dimensional Swell or Collapse of Soils

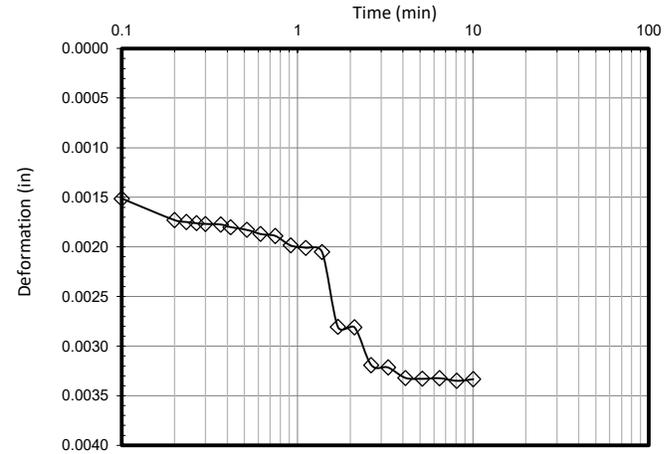
**Client:** RRC Power & Energy, LLC  
**Project Name:** Longspur Wind Project  
**Sample ID:** SUB-6 at 4 ft

**Beyond Project No.:** GE2503026  
**Test Method:** ASTM D4546, Method C  
**Test Date:** 9/13/25-9/15/25

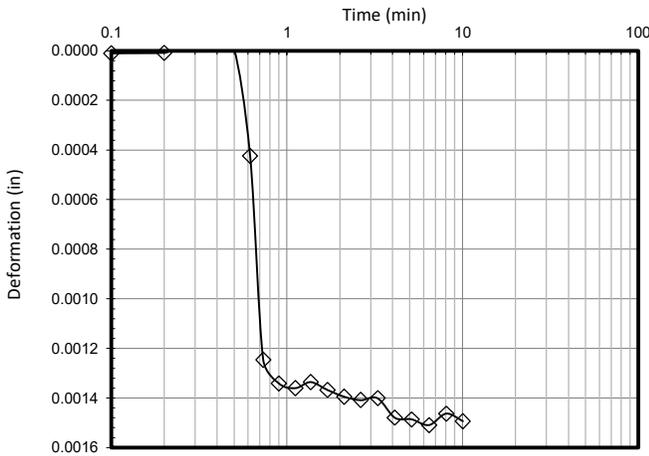
**20-psf Load (Seating Load)**



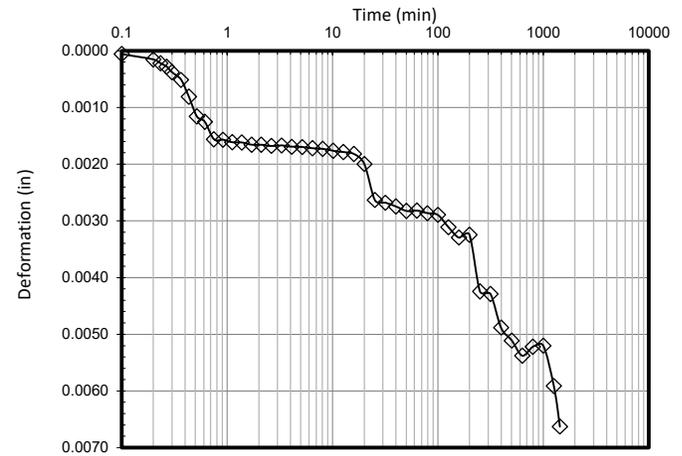
**500-psf Load**



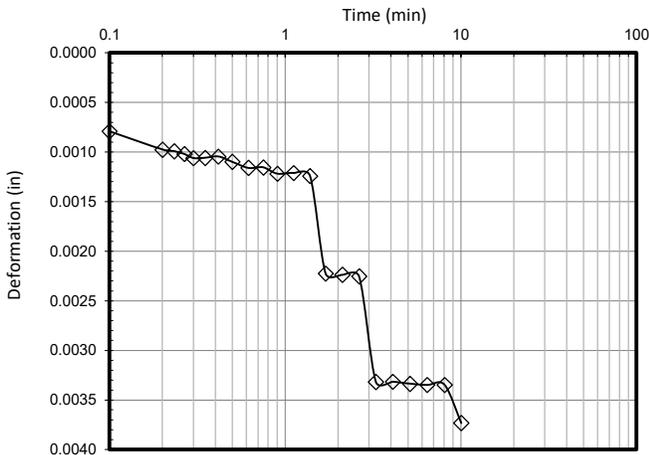
**125-psf Load**



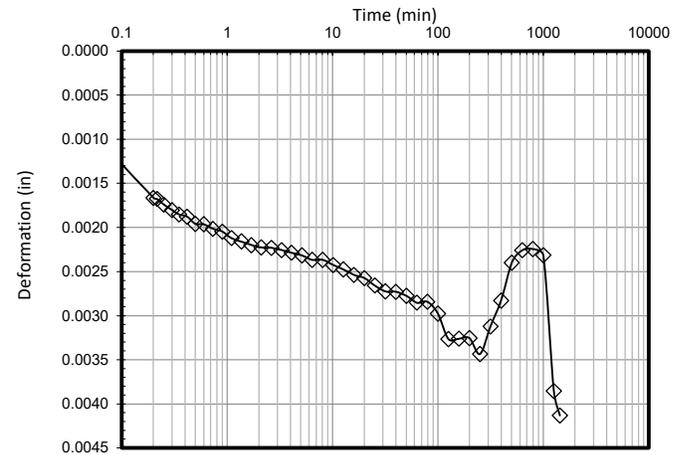
**500-psf Load (inundated)**



**250-psf Load**



**1000-psf Load (inundated)**



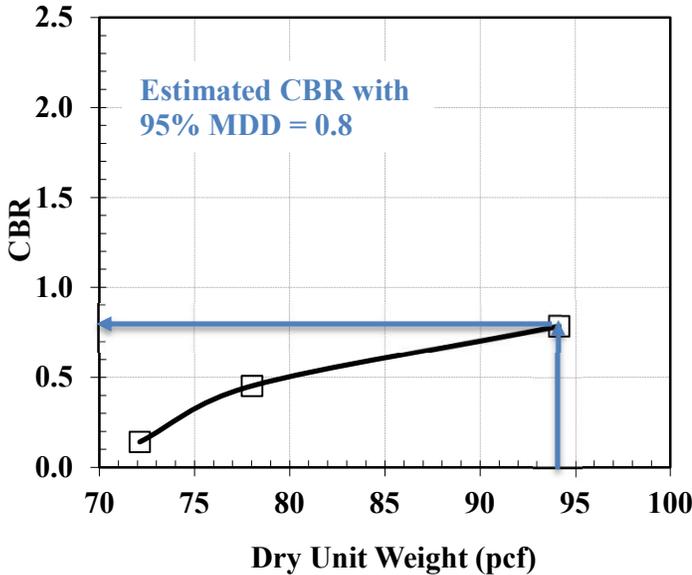


## CBR (California Bearing Ratio) Test

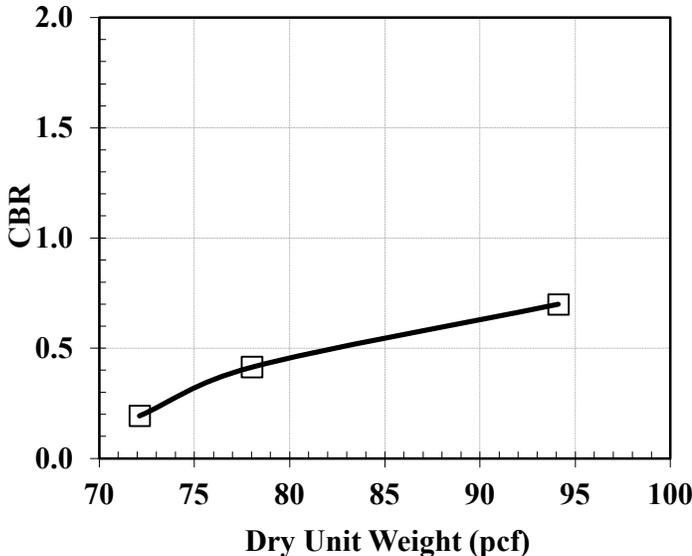
Client: RRC Power & Energy, LLC  
 Project: Longspur Wind Project  
 Sample No: GEO-048 at 1-4 ft

Beyond Project No.: GE2503026  
 Test Method: ASTM D1883  
 Test Date: 6/17/2025  
 Rate of Penetration: 0.05 in/min

**CBR for 0.100-in Penetration**



**CBR for 0.200-in Penetration**



Initial Conditions			
Specimen No.	1	2	3
Blows per Layer	15	30	60
Surcharge Weight (lbs)	10	10	10
Water Content (%)	20.6	20.9	21.3
Dry Unit Weight (pcf)	72.1	78.0	94.1
Percent Compaction (%)	72.8	78.7	95.0
Final Conditions (soaked)			
Water Content (%) at top 1-in layer after soaking	40.9	47.0	37.3
Swell (% of initial height)	4.1	6.4	5.1
Bearing Ratio of Sample at 0.100 in penetration	0.1	0.5	0.8
Bearing Ratio of Sample at 0.200 in penetration	0.2	0.4	0.7

Note: Soil specimens were molded to a range of densities using 15, 30 and 60 blows at optimum moisture content as per ASTM D 1883 to develop the CBR versus dry density curve. It was allowed the specimens to soak for 96 hrs prior bearing test. Removed the free water and allow the specimens to drain out for 15 min. The 10-lbs surcharge load was placed during bearing test.

HuaMiao Cao, P.E., 6/18/25

Analysis & Quality Review/Date  
 Specimens prepared and tested by: A.S.

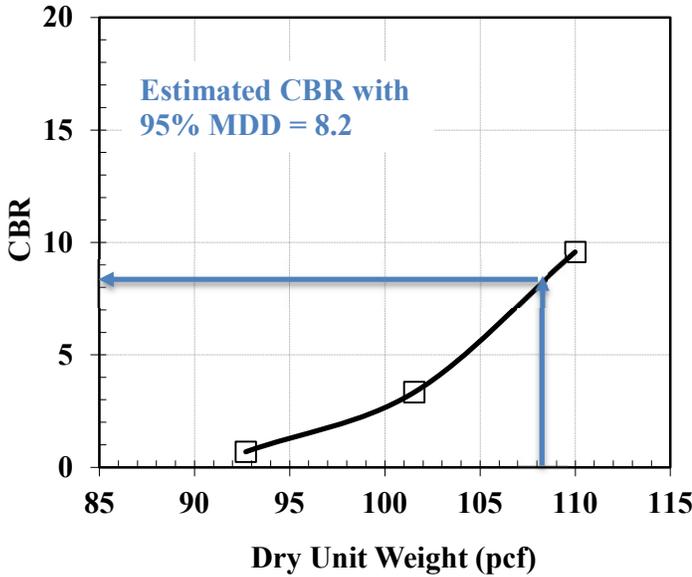


## CBR (California Bearing Ratio) Test

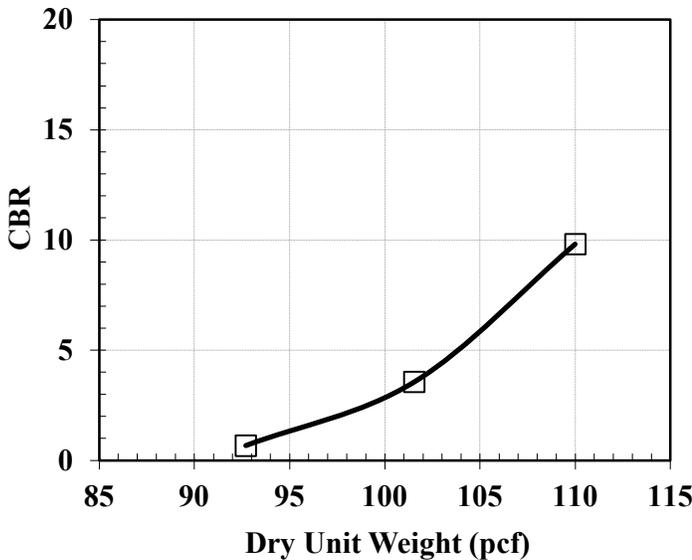
Client: RRC Power & Energy, LLC  
 Project: Longspur Wind Project  
 Sample No: GEO-062 at 1-4 ft

Beyond Project No.: GE2503026  
 Test Method: ASTM D1883  
 Test Date: 6/17/2025  
 Rate of Penetration: 0.05 in/min

**CBR for 0.100-in Penetration**



**CBR for 0.200-in Penetration**



Initial Conditions			
Specimen No.	1	2	3
Blows per Layer	10	25	60
Surcharge Weight (lbs)	10	10	10
Water Content (%)	12.2	12.0	12.4
Dry Unit Weight (pcf)	92.7	101.5	110.0
Percent Compaction (%)	81.4	89.2	96.6
Final Conditions (soaked)			
Water Content (%) at top 1-in layer after soaking	25.1	21.8	19.3
Swell (% of initial height)	0.5	0.8	0.5
Bearing Ratio of Sample at 0.100 in penetration	0.7	3.3	9.6
Bearing Ratio of Sample at 0.200 in penetration	0.7	3.6	9.8

Note: Soil specimens were molded to a range of densities using 10, 25 and 60 blows at optimum moisture content as per ASTM D 1883 to develop the CBR versus dry density curve. It was allowed the specimens to soak for 96 hrs prior bearing test. Removed the free water and allow the specimens to drain out for 15 min. The 10-lbs surcharge load was placed during bearing test.

HuaMiao Cao, P.E., 6/18/25

Analysis & Quality Review/Date  
 Specimens prepared and tested by: A.S.



Beyond Engineering & Testing, LLC  
3801 Doris Lane, Suite B  
Round Rock, TX 78664  
(512) 358-6048

Client: RRC Power & Energy, LLC  
Project: Longspur Wind Project

RRC Project No.: GE2503026  
Testing Method: EPA 300/300.1  
Test Date: 6/9/2025

No.	Sample ID & Depth	Sulfate Content (mg SO <sub>4</sub> /kg)	Chloride Content (mg/kg)
1	GEO-04 at 1-13 ft	2,220	79.9
2	GEO-10 at 1-13 ft	672	82.8
3	GEO-25 at 1-13 ft	2,600	59.3
4	GEO-50 at 1-13 ft	4,390	78.6
5	GEO-64 at 1-13 ft	2,740	76.4
6	SUB-3 at 1-4 ft	240	305
7			
8			
9			
10			

HuaMiao Cao, 6/10/25

Quality Review/Date

Tested by: XENCO



RRC Power & Energy, LLC  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

## SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-01	1.0		23												
GEO-01	2.0	CH	24		100	63	22	41							
GEO-01	4.0		19												
GEO-01	7.0		28												
GEO-01	10.0		29												
GEO-01	12.0		47												
GEO-01	14.0	CH	20	111	81	52	20	32	5.28	7.3	0.0				
GEO-02	1.0		18												
GEO-02	4.0		22												
GEO-02	7.0		20												
GEO-02	10.0		19												
GEO-02	12.0		22												
GEO-03	1.0		11												
GEO-03	4.0		16												
GEO-03	7.0		16												
GEO-03	10.0		19												
GEO-03	12.0		16	96											
GEO-04	1.0		14												
GEO-04	1.0		23									0.0080	0.2220	7.1	589
GEO-04	4.0		19												
GEO-04	7.0		22												
GEO-04	10.0		23												
GEO-04	12.0	CL	23	103	85	47	18	29	1.96	14.8	10.0				
GEO-04	19.0		22	102					2.59	7.8	0.0				
GEO-05	1.0		16												
GEO-05	4.0		15												
GEO-05	7.0		17												
GEO-05	10.0		19												
GEO-05	12.0		17												
GEO-06	1.0		14												
GEO-06	4.0		30												

ND Not Detected; D Diluted;  
 \*Denotes Total Unit Weight



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## SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-06	7.0		27												
GEO-06	10.0		30												
GEO-07	1.0		25												
GEO-07	4.0		22												
GEO-07	7.0		26												
GEO-07	10.0		27												
GEO-07	12.0	CH	27	99	100	64	23	41	6.92	6.3	10.0				
GEO-08	1.0		25												
GEO-08	2.0	CH	22		99	57	19	38							
GEO-08	4.0		22												
GEO-08	7.0		24												
GEO-08	10.0		23												
GEO-09	1.0		16												
GEO-09	4.0		23												
GEO-09	7.0		25												
GEO-10	1.0		14												
GEO-10	1.0		17									0.0083	0.0672	6.6	746
GEO-10	2.0	CH	16		91	71	24	47							
GEO-10	4.0		15												
GEO-10	7.0		16												
GEO-10	10.0		17												
GEO-10	12.0		41												
GEO-11	1.0		13												
GEO-11	4.0		12												
GEO-11	7.0		7												
GEO-11	10.0		4												
GEO-11	12.0		13												
GEO-12	1.0		12												
GEO-12	4.0		11												
GEO-12	7.0		9												
GEO-12	10.0		16												

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 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-12	12.0		16												
GEO-13	1.0		20												
GEO-13	4.0		26												
GEO-13	7.0		21												
GEO-13	10.0		24												
GEO-13	12.0		30												
GEO-14	1.0		19												
GEO-14	4.0		22												
GEO-14	7.0		23												
GEO-14	10.0		22												
GEO-14	12.0		18												
GEO-15	1.0		7												
GEO-15	4.0		11												
GEO-15	7.0		24												
GEO-15	10.0		23												
GEO-15	12.0		19												
GEO-16	1.0		3												
GEO-16	4.0		36												
GEO-16	7.0		23												
GEO-16	10.0		23												
GEO-16	12.0	MH	31		56	76	46	30							
GEO-17	1.0		13												
GEO-17	4.0		12												
GEO-17	7.0		14												
GEO-17	12.0		17												
GEO-18	1.0		7												
GEO-18	4.0		9												
GEO-18	7.0		9												
GEO-18	9.0		10												
GEO-18	12.0		6												
GEO-19	1.0		8												

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## SUMMARY OF LABORATORY RESULTS

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 NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-19	2.0	CL	6		97	30	18	12							
GEO-19	4.0		20												
GEO-19	7.0		29												
GEO-19	9.0		21												
GEO-19	12.0		19												
GEO-20	1.0		21												
GEO-20	4.0		22												
GEO-20	7.0		22												
GEO-20	9.0		22												
GEO-21	1.0		8												
GEO-21	4.0		7												
GEO-21	7.0		6												
GEO-21	9.0		7												
GEO-22	1.0		10												
GEO-22	2.0	SC-SM	17		37	22	16	6							
GEO-22	4.0		23												
GEO-22	7.0		22												
GEO-22	10.0		21												
GEO-23	1.0		13												
GEO-23	4.0		21												
GEO-23	7.0		20												
GEO-23	10.0		21												
GEO-24	1.0		21												
GEO-24	4.0		19												
GEO-24	7.0		21												
GEO-24	10.0		21												
GEO-25	1.0		19												
GEO-25	1.0		16									0.0059	0.2600	7.5	455
GEO-25	4.0		21												
GEO-25	7.0		20												
GEO-25	10.0		21												

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## SUMMARY OF LABORATORY RESULTS

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 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-26	1.0		18												
GEO-26	4.0		16												
GEO-26	7.0		18												
GEO-26	10.0		21												
GEO-27	1.0		16												
GEO-27	4.0		15												
GEO-27	7.0		15												
GEO-27	10.0		14												
GEO-27	12.0		15												
GEO-28	1.0		15												
GEO-28	4.0		20												
GEO-28	7.0		22												
GEO-28	10.0		20												
GEO-28	12.0		7												
GEO-29	1.0		19												
GEO-29	4.0		21												
GEO-29	10.0		19												
GEO-29	12.0		20												
GEO-31	1.0		7												
GEO-31	4.0		7												
GEO-31	7.0		7												
GEO-31	10.0		15												
GEO-33	1.0		14												
GEO-33	2.0	CH	17		98	61	19	42							
GEO-33	4.0		25												
GEO-33	7.0		21												
GEO-33	10.0		23												
GEO-33	12.0		19												
GEO-33	17.0		17	111					9.45	2.9	0.0				
GEO-34	1.0		15												
GEO-34	4.0		12												

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## SUMMARY OF LABORATORY RESULTS

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 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-34	7.0		32												
GEO-34	10.0		22												
GEO-34	12.0		24												
GEO-35	1.0		30												
GEO-35	4.0		24												
GEO-35	7.0		51												
GEO-35	10.0		26												
GEO-35	12.0		23												
GEO-36	1.0		14												
GEO-36	4.0		16												
GEO-36	7.0		21												
GEO-36	10.0		6												
GEO-36	12.0		10												
GEO-36	17.0	CH	30	93	100	63	26	37	0.93	4.1	0.0				
GEO-37	1.0		21												
GEO-37	4.0		22												
GEO-37	7.0		24												
GEO-37	10.0		97												
GEO-37	12.0		47	65					2.66	3.5	0.0				
GEO-38	1.0		12												
GEO-38	4.0		15												
GEO-38	7.0		23												
GEO-38	12.0	CL	21		85	38	17	21							
GEO-39	1.0		19												
GEO-39	4.0		20												
GEO-39	7.0		20												
GEO-39	10.0		21												
GEO-40	1.0		9												
GEO-40	4.0		15												
GEO-40	7.0		17												
GEO-40	9.0		16												

ND Not Detected; D Diluted;  
 \*Denotes Total Unit Weight



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## SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-42	1.0		18												
GEO-42	4.0		22												
GEO-42	7.0		22												
GEO-42	10.0		21												
GEO-43	1.0		13												
GEO-43	4.0		14												
GEO-43	7.0		13												
GEO-43	12.0		12												
GEO-44	1.0		15												
GEO-44	4.0		22												
GEO-44	7.0		19												
GEO-44	10.0		2												
GEO-44	12.0		21												
GEO-45	1.0		16												
GEO-45	4.0		20												
GEO-45	7.0		23												
GEO-45	10.0		18												
GEO-46	1.0		12												
GEO-46	2.0	CL	16		84	41	18	23							
GEO-46	4.0		19												
GEO-46	7.0		31												
GEO-46	10.0		19												
GEO-46	12.0	CH	23	104	82	69	18	51	6.21	10.1	10.0				
GEO-47	1.0		8												
GEO-47	4.0		7												
GEO-47	7.0		11												
GEO-47	10.0		14												
GEO-47	12.0		13												
GEO-48	1.0		20												
GEO-48	2.0	CH	23		96	71	23	48							
GEO-48	4.0		22												

ND Not Detected; D Diluted;  
 \*Denotes Total Unit Weight



RRC Power & Energy, LLC  
 810 Hesters Crossing Rd, Suite 120  
 Round Rock, TX 78681  
 Telephone: (512) 992-2087

## SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-48	7.0		22												
GEO-48	9.0		17												
GEO-48	12.0		19												
GEO-49	1.0		12												
GEO-49	4.0		22												
GEO-49	7.0		21												
GEO-49	10.0		22												
GEO-49	29.0	MH	81		62	88	69	19							
GEO-50	1.0		19												
GEO-50	1.0		26									0.0079	0.4390	7.6	408
GEO-50	4.0		22												
GEO-50	7.0		37												
GEO-50	9.0		23												
GEO-50	14.0	CH	20	107	99	52	20	32							
GEO-51	1.0		12												
GEO-51	4.0		26												
GEO-51	7.0		23												
GEO-51	10.0		22												
GEO-52	1.0		16												
GEO-52	4.0		17												
GEO-52	7.0		20												
GEO-52	10.0		48												
GEO-52	12.0		19												
GEO-53	1.0		16												
GEO-53	2.0	CH	17		93	54	19	35							
GEO-53	4.0		22												
GEO-53	7.0		23												
GEO-53	12.0	ML	98	34	66	NP	NP	NP							
GEO-53	22.0		26	94											
GEO-54	1.0		22												
GEO-54	4.0		22												

ND Not Detected; D Diluted;  
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## SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-54	7.0		18												
GEO-54	9.0		21												
GEO-54	12.0		56												
GEO-56	1.0		16												
GEO-56	4.0		19												
GEO-56	7.0		26												
GEO-56	9.0		42												
GEO-57	1.0		11												
GEO-57	4.0		14												
GEO-57	7.0		20												
GEO-57	10.0		20												
GEO-57	12.0		19												
GEO-58	1.0		21												
GEO-58	4.0		24												
GEO-58	7.0		13												
GEO-58	9.0		10												
GEO-58	12.0		24												
GEO-59	1.0		17												
GEO-59	2.0	CH	21		98	54	20	34							
GEO-59	4.0		20												
GEO-59	7.0		22												
GEO-59	9.0		13												
GEO-60	1.0		9												
GEO-60	4.0		21												
GEO-60	7.0		25												
GEO-60	9.0		25												
GEO-61	1.0		19												
GEO-61	4.0		15												
GEO-61	7.0		14												
GEO-61	9.0		27												
GEO-62	1.0		13												

ND Not Detected; D Diluted;  
 \*Denotes Total Unit Weight



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## SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-62	2.0	SC	8		49	26	18	8							
GEO-62	4.0		12												
GEO-62	7.0		27												
GEO-62	10.0		22												
GEO-62	12.0	CH	21	105	91	56	23	33	4.51	6.6	10.0				
GEO-62	24.0		25	101											
GEO-63	1.0		9												
GEO-63	4.0		28												
GEO-63	7.0		21												
GEO-63	10.0		20												
GEO-63	12.0		23												
GEO-64	1.0		17												
GEO-64	1.0		22									0.0076	0.2740	7.3	294
GEO-64	4.0		21												
GEO-64	7.0		23												
GEO-64	9.0		23												
GEO-64	12.0		26												
GEO-65	1.0		11												
GEO-65	4.0		27												
GEO-65	7.0		33												
GEO-65	10.0		25												
GEO-65	12.0		25												
GEO-66	1.0		15												
GEO-66	4.0		20												
GEO-66	7.0		17												
GEO-66	9.0		28												
GEO-66	12.0	CH	22	104	100	52	22	30	6.24	5.8	10.0				
GEO-67	1.0		14												
GEO-67	2.0	CL	14		97	43	21	22							
GEO-67	4.0		20												
GEO-67	7.0		20												

ND Not Detected; D Diluted;  
 \*Denotes Total Unit Weight



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## SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
GEO-67	9.0		18												
GEO-68	1.0		15												
GEO-68	4.0		20												
GEO-68	7.0		20												
GEO-68	9.0		19												
GEO-68	12.0		22												
GEO-69	1.0		24												
GEO-69	4.0		17												
GEO-69	7.0		23												
GEO-69	9.0		25												
GEO-69	12.0		25	95					4.60	3.5	0.0				
GEO-70	1.0		14												
GEO-70	2.0	CH	16		99	61	20	41							
GEO-70	4.0		19												
GEO-70	7.0		11												
GEO-70	9.0		15												
GEO-70	12.0		26												
GEO-71	1.0		14												
GEO-71	4.0		11												
GEO-71	7.0		12												
GEO-71	10.0		14												
SUB-1	1.0		11												
SUB-1	4.0		14												
SUB-2	1.0		7												
SUB-2	2.0	CL	14		51	37	14	23							
SUB-2	4.0	SM	14		20	NP	NP	NP							
SUB-3	1.0											0.0305	0.0240	9.1	805
SUB-3	4.0	SC-SM	15	108	20	21	16	5	1.62	14.3	3.0				
SUB-6	4.0	SM	6	101	27	NP	NP	NP							
SUB-9	1.0		6												
SUB-9	4.0	SC	6		23	24	16	8							

ND Not Detected; D Diluted;  
 \*Denotes Total Unit Weight



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## SUMMARY OF LABORATORY RESULTS

CLIENT: ALLETE Renewable Resources, Inc.  
 PROJECT: Longspur Wind Project  
 LOCATION: Morton County, ND  
 NUMBER: GE2503026

Borehole	Depth (ft)	USCS	Water Content (%)	Dry Unit Weight (pcf)	< No. 200 (%)	LL	PL	PI	Compressive Strength (tsf)	Strain at Failure (%)	Confining Pressure (psi)	Chlorides (%/weight)	Sulfates (%/weight)	pH	Minimum Resistivity (ohm-cm)
PMM-2	4.0	CH	25		100	77	22	55							
O&M-1	1.0		17												
O&M-1	4.0		10												
O&M-1	7.0		19	100					0.32	1.8	5.5				



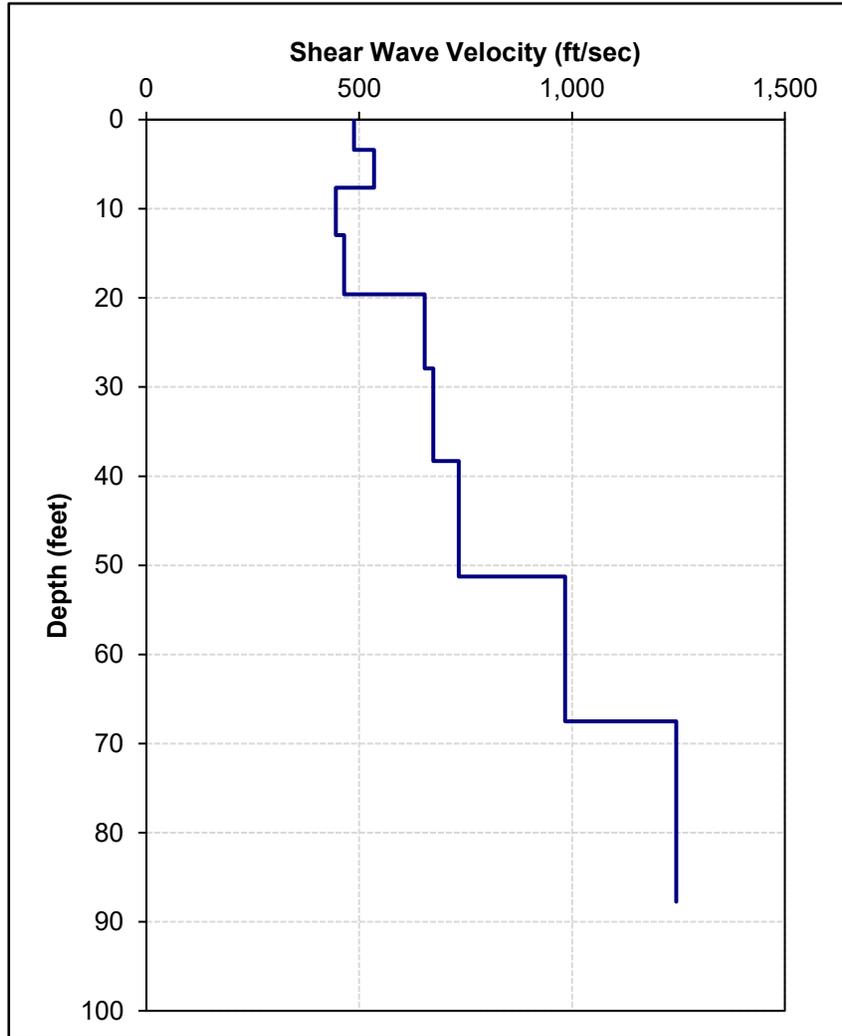
[www.RRCcompanies.com](http://www.RRCcompanies.com)

810 Hesters Crossing Rd, Suite 120  
Round Rock, TX 78661  
512.992.2087

## APPENDIX C

**Multi-Channel Analysis of Surface Waves (MASW) Survey Results for WTG No. GEO-004**

Depth (ft)	Shear Wave Velocity (ft/sec)
3.4	488
7.7	535
13.0	445
19.6	465
27.9	654
38.3	674
51.3	734
67.5	984
87.8	1,245

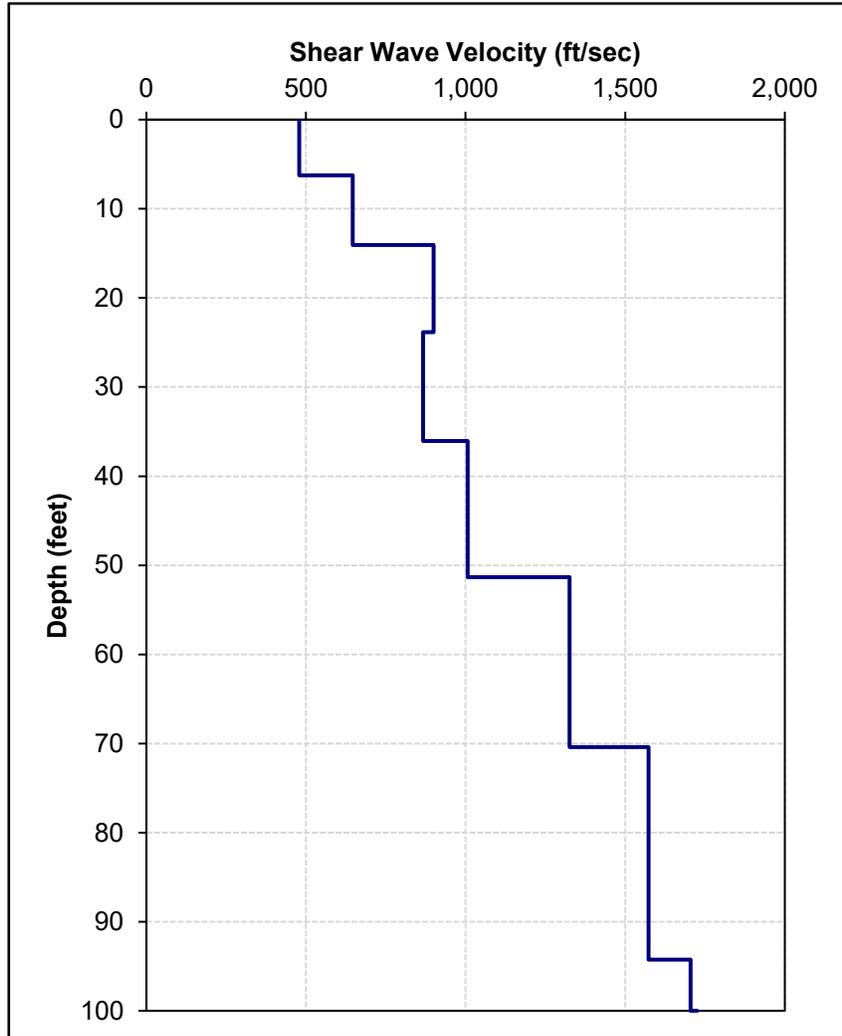


**Note:**

1. Data collected on May 09, 2025
2. SurfSeis v. 4.2.4.5 computer software developed by Kansas Geological Survey was used to process the field data.

**Multi-Channel Analysis of Surface Waves (MASW) Survey Results for WTG No. GEO-014**

Depth (ft)	Shear Wave Velocity (ft/sec)
6.3	479
14.1	646
23.8	900
36.1	867
51.3	1,007
70.4	1,326
94.3	1,573
100.0	1,705

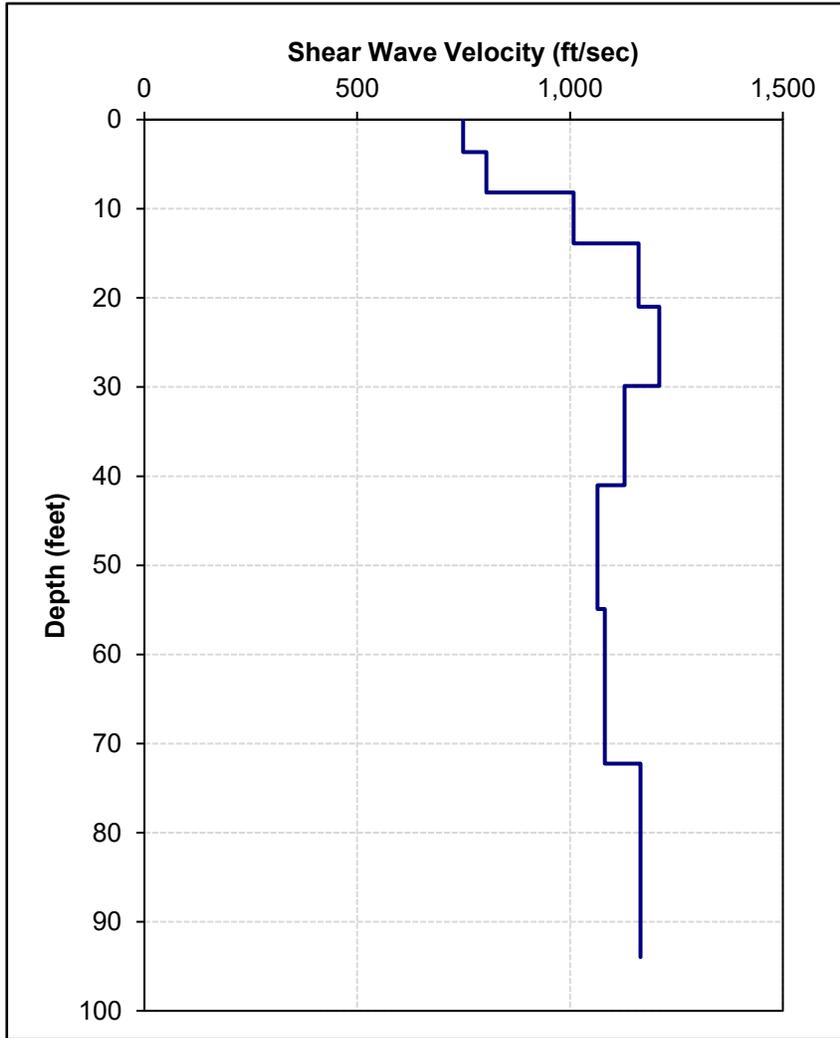


**Note:**

1. Data collected on May 09, 2025
2. SurfSeis v. 4.2.4.5 computer software developed by Kansas Geological Survey was used to process the field data.

**Multi-Channel Analysis of Surface Waves (MASW) Survey Results for WTG No. GEO-018**

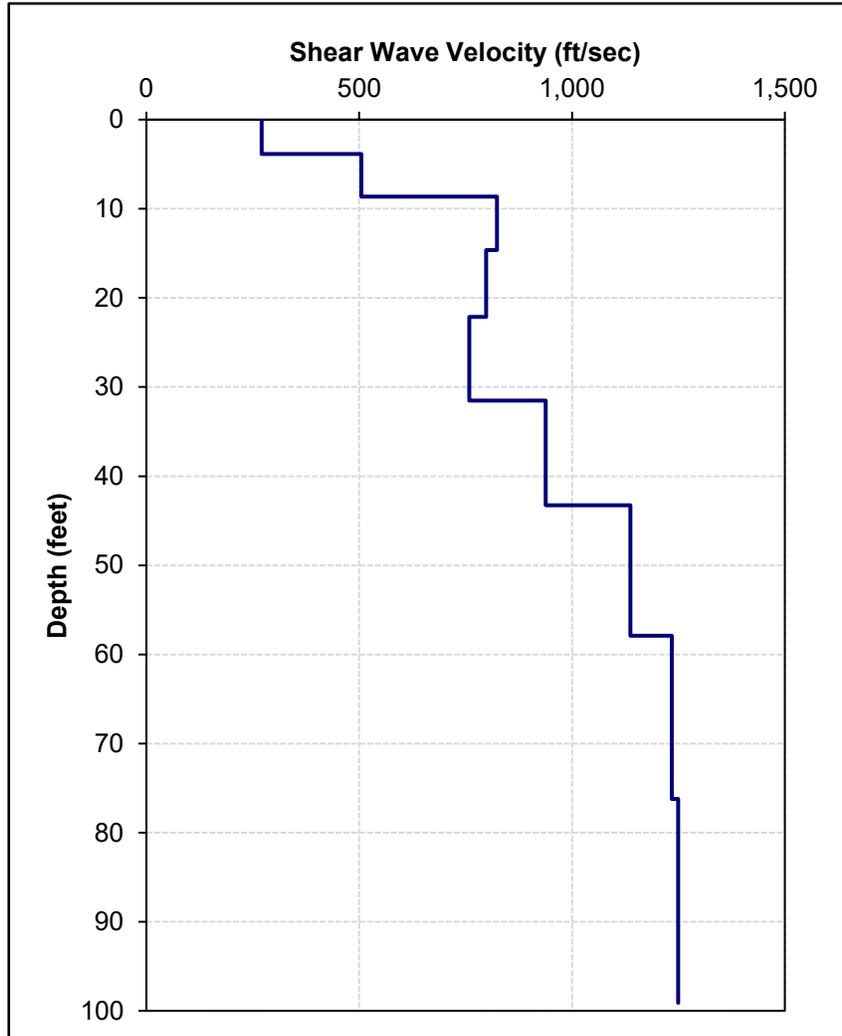
Depth (ft)	Shear Wave Velocity (ft/sec)
3.6	749
8.2	803
13.9	1,009
21.0	1,161
29.9	1,210
41.0	1,128
54.9	1,064
72.3	1,082
94.0	1,166



Note:  
1. Data collected on May 09, 2025  
2. SurfSeis v. 4.2.4.5 computer software developed by Kansas Geological Survey was used to process the field data.

**Multi-Channel Analysis of Surface Waves (MASW) Survey Results for WTG No. GEO-029**

Depth (ft)	Shear Wave Velocity (ft/sec)
3.8	271
8.6	505
14.7	824
22.2	798
31.5	759
43.3	938
57.9	1,137
76.2	1,234
99.1	1,250

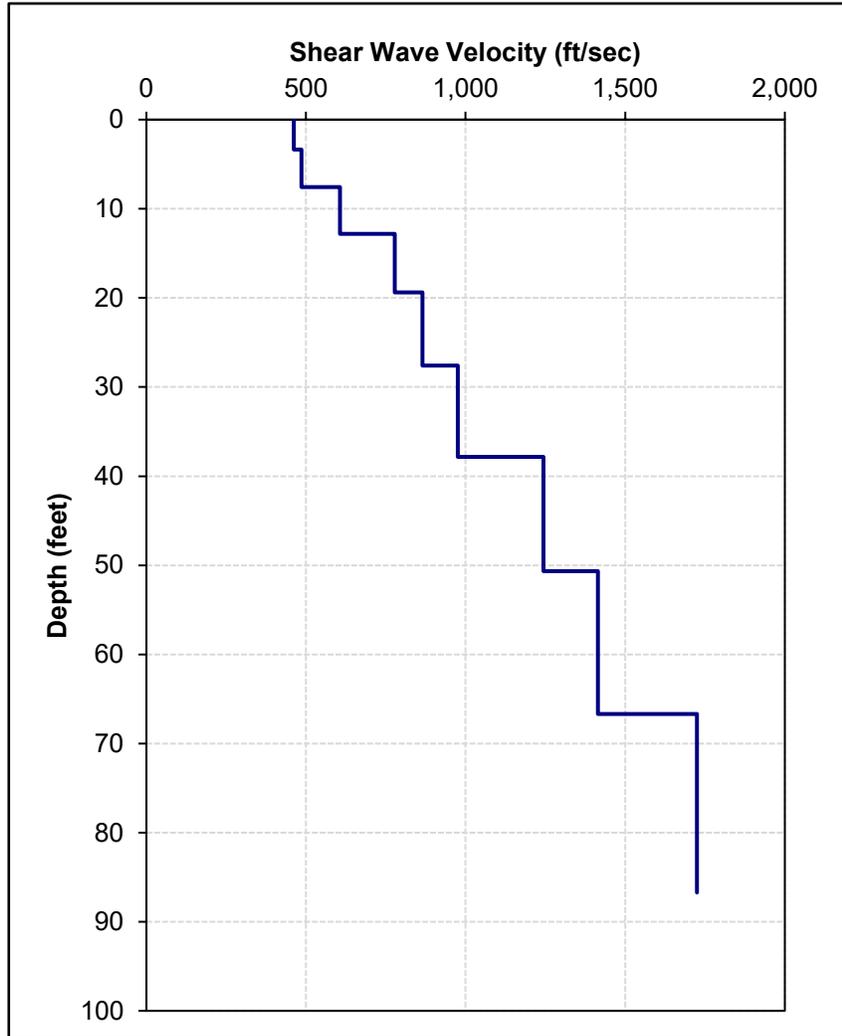


**Note:**

1. Data collected on May 09, 2025
2. SurfSeis v. 4.2.4.5 computer software developed by Kansas Geological Survey was used to process the field data.

**Multi-Channel Analysis of Surface Waves (MASW) Survey Results for WTG No. GEO-033**

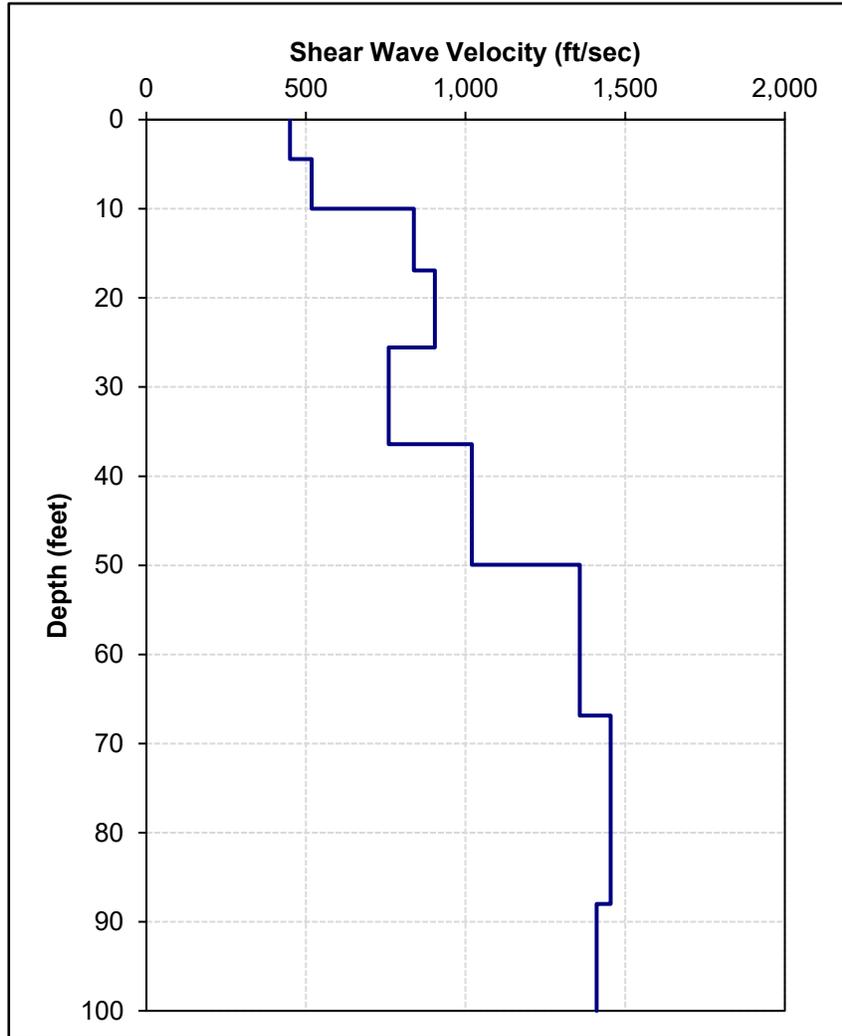
Depth (ft)	Shear Wave Velocity (ft/sec)
3.4	462
7.6	486
12.8	607
19.4	778
27.6	865
37.8	976
50.7	1,244
66.7	1,414
86.7	1,725



Note:  
1. Data collected on May 09, 2025  
2. SurfSeis v. 4.2.4.5 computer software developed by Kansas Geological Survey was used to process the field data.

**Multi-Channel Analysis of Surface Waves (MASW) Survey Results for WTG No. GEO-064**

Depth (ft)	Shear Wave Velocity (ft/sec)
4.4	450
10.0	518
16.9	838
25.6	904
36.4	760
49.9	1,020
66.9	1,357
88.0	1,455
100.0	1,411



**Note:**

1. Data collected on May 09, 2025
2. SurfSeis v. 4.2.4.5 computer software developed by Kansas Geological Survey was used to process the field data.

### In Situ Electrical Soil Resistivity Measurement Data Form

Revision 0  
Wenner Array

Project Name:	Minnesota Power - Longspur	Notes: 1. Fence Lines is at approximately 500 feet East running N-S and 350 feet South running E-W.
Black & Veatch Project No.:		
Supplier Name & Operator	RRC Power & Energy; Ashutosh Shrivastava	
Project Location:	West Morton, ND (46.955518, -101.761945)	
Date:	5/12/2025	
Measurement No. & Orientation:	DSR-1      NE-SW	
Description of Terrain & Probe Insertion:	Silt, Brown, Dry, Flat Topography; Probe insertion required some force	
Weather (Present and Recent):	Sunny, 84° F	
Meter Model Type:	Supersting; R8	
Serial No. & Calibration Date:	SS2106234, 1/28/26	

Electrode "a" Spacing (ft)	Preferred Electrode Depth (in)	Actual Electrode Depth (in)	Electrode Configuration					Source Voltage (V)	V <sub>M-N</sub> (mV) <sup>1</sup>	Current Injected, I (mA)	Standard deviation (%)	Apparent Resistance (Ohm)	Apparent Resistivity (Ohm-m)
			A (ft)	M (ft)	0	N (ft)	B (ft)						
1	1	2	1.5	0.5		0.5	1.5			9.996	0.2	126.6	242.33
2	2	2	3	1		1	3			135.9	0.1	27.75	106.23
3	4	2	4.5	1.5		1.5	4.5			158.3	0.2	10.83	62.19
6	6	4	9	3		3	9			134.6	0	3.401	39.06
10	6	4	15	5		5	15			147.0	0	1.809	34.63
20	12	6	30	10		10	30			186.3	0.1	0.832	31.85
30	12	6	45	15		15	45			135.0	0.2	0.553	31.76
60	12	12	90	30		30	90			169.0	0.2	0.214	24.58
100	12	12	150	50		50	150			213.2	0	0.0979	18.74
200	12	12	300	100		100	300			280.2	0.1	0.038	14.55
300	12	12	450	150		150	450			125.8	0.1	0.0219	12.58

<sup>1</sup> Not required if using AGI meters.

Note: Due to soil conductivity, the electrode depth may have to be increased. However, electrode depth shall not exceed 10% of "a" spacing.



















**SOIL RESISTIVITY MEASUREMENT DATA SHEET**

**Survey ID** GEO-001  
**DATE** 5/14/2025  
**CLIENT** ALLETE Renewable Resources, Inc.  
**PROJECT** Longspur Wind  
**LOCATION:** Morton County, ND  
**LATITUDE :** 46.928622  
**LONGITUDE :** -101.860048  
**WEATHER:** Sunny  
**TOP SOIL:** Silt (ML), Brown, Dry  
**TYPE OF TEST :** Wenner 4-Pin Method  
**EQUIPMENT:** SuperSting  
**SERIAL NO.** SS2106234  
**MODEL:** R8  
**CALIBRATION DUE DATE:** 1/28/2026  
**TEST PERFORMED BY :** RRC

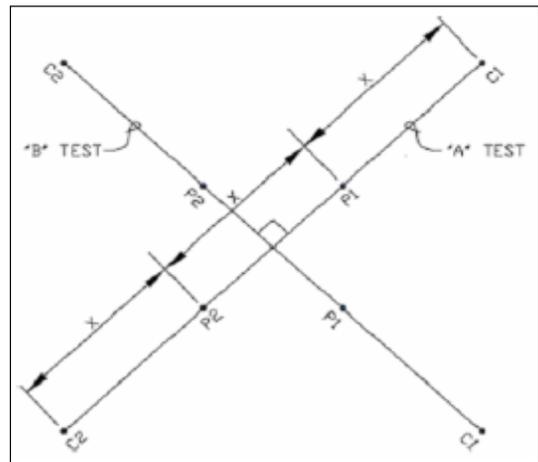
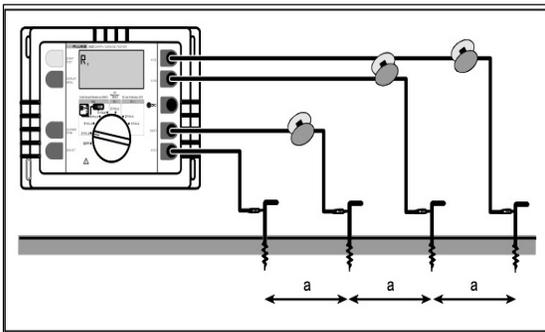
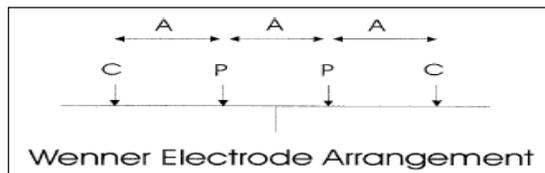
**Project No.** GE2503026

**Temp. (°F)** 69°F

**TEST SET RANGE**  
 Meter Current: 1mA - 2000mA  
 Meter Resistance: 0.01Ohm - 19.99kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE		Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)			
0.5	4	2	4.452	4.26	4.628	4.43		4.35	
1	4	2	3.531	6.76	3.318	6.35		6.55	
1.5	4	2	2.343	6.73	2.331	6.69		6.71	
2.5	4	2	1.297	6.21	1.362	6.52		6.36	
3	4	2	0.824	4.73	0.816	4.69		4.71	
5	4	2	0.384	3.68	0.399	3.81		3.75	
7	4	2	0.201	2.70	0.194	2.60		2.65	
10	12	6	0.113	2.17	0.121	2.32		2.24	
15	12	6	0.068	1.95	0.067	1.92		1.93	
20	12	6	0.054	2.06	0.052	1.99		2.03	
30	12	6	0.044	2.54	0.043	2.49		2.51	
45	12+	6+	0.037	3.16	0.037	3.20		3.18	
70	12+	6+	0.029	3.86	0.030	4.05		3.96	
100	12+	6+	0.021	4.01	0.020	3.76		3.88	

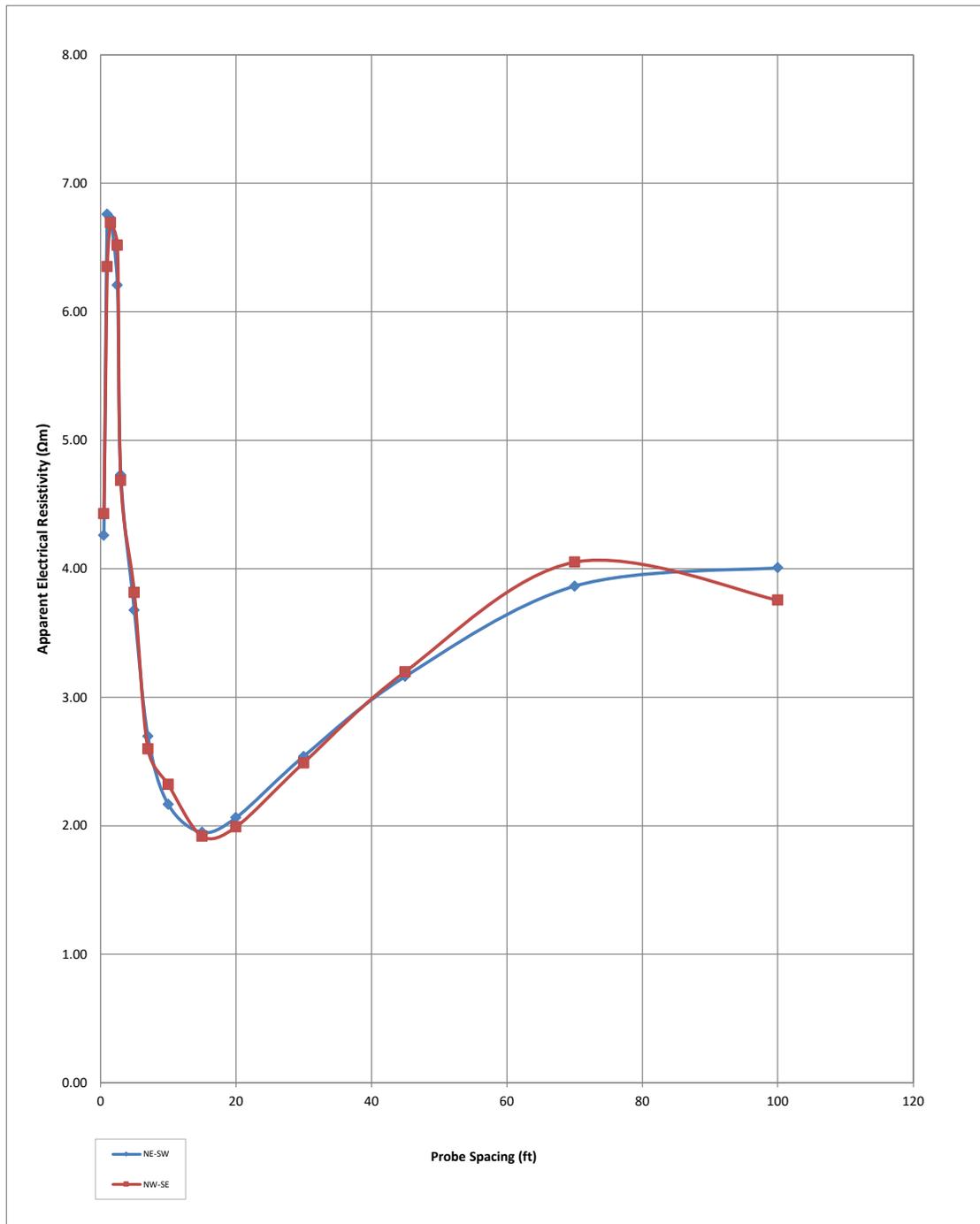
Notes: Fence line at ~300 ft south of the profile center, going E-W.



General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation:  $r=2*p*R*spacing*0.3048$ , where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind  
Electrical Resistivity Survey at GEO-001



**SOIL RESISTIVITY MEASUREMENT DATA SHEET**

**Survey ID** GEO-008  
**DATE** 5/14/2025  
**CLIENT** ALLETE Renewable Resources, Inc.  
**PROJECT** Longspur Wind  
**LOCATION:** Morton County, ND  
**LATITUDE :** 46.916389  
**LONGITUDE :** -101.834616  
**WEATHER:** Sunny  
**TOP SOIL:** Silt (ML), Brown, Dry  
**TYPE OF TEST :** Wenner 4-Pin Method  
**EQUIPMENT:** SuperSting  
**SERIAL NO.** SS2106234  
**MODEL:** R8  
**CALIBRATION DUE DATE:** 1/28/2026  
**TEST PERFORMED BY :** RRC

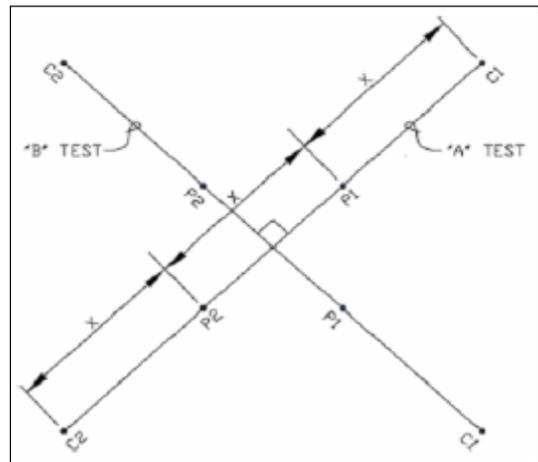
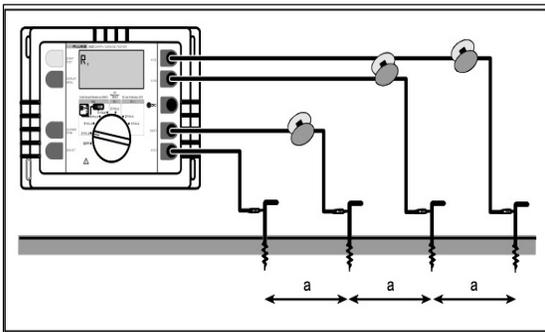
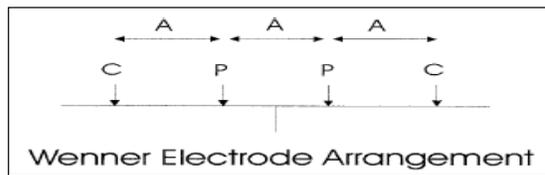
**Project No.** GE2503026

**Temp. (°F)** 72°F

**TEST SET RANGE**  
 Meter Current: 1mA - 2000mA  
 Meter Resistance: 0.01Ohm - 19.99kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE		Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)			
0.5	4	2	9.113	8.72	8.884	8.50		8.61	
1	4	2	7.573	14.50	7.424	14.21		14.35	
1.5	4	2	5.115	14.69	5.230	15.02		14.85	
2.5	4	2	3.235	15.48	3.122	14.94		15.21	
3	4	2	2.342	13.45	2.456	14.10		13.78	
5	4	2	1.265	12.11	1.315	12.59		12.35	
7	4	2	0.858	11.50	0.856	11.47		11.49	
10	12	6	0.497	9.50	0.504	9.65		9.58	
15	12	6	0.295	8.48	0.310	8.89		8.69	
20	12	6	0.203	7.78	0.202	7.72		7.75	
30	12	6	0.142	8.15	0.141	8.11		8.13	
45	12+	6+	0.097	8.32	0.093	7.97		8.14	
70	12+	6+	0.063	8.47	0.064	8.58		8.53	
100	12+	6+	0.048	9.10	0.048	9.14		9.12	

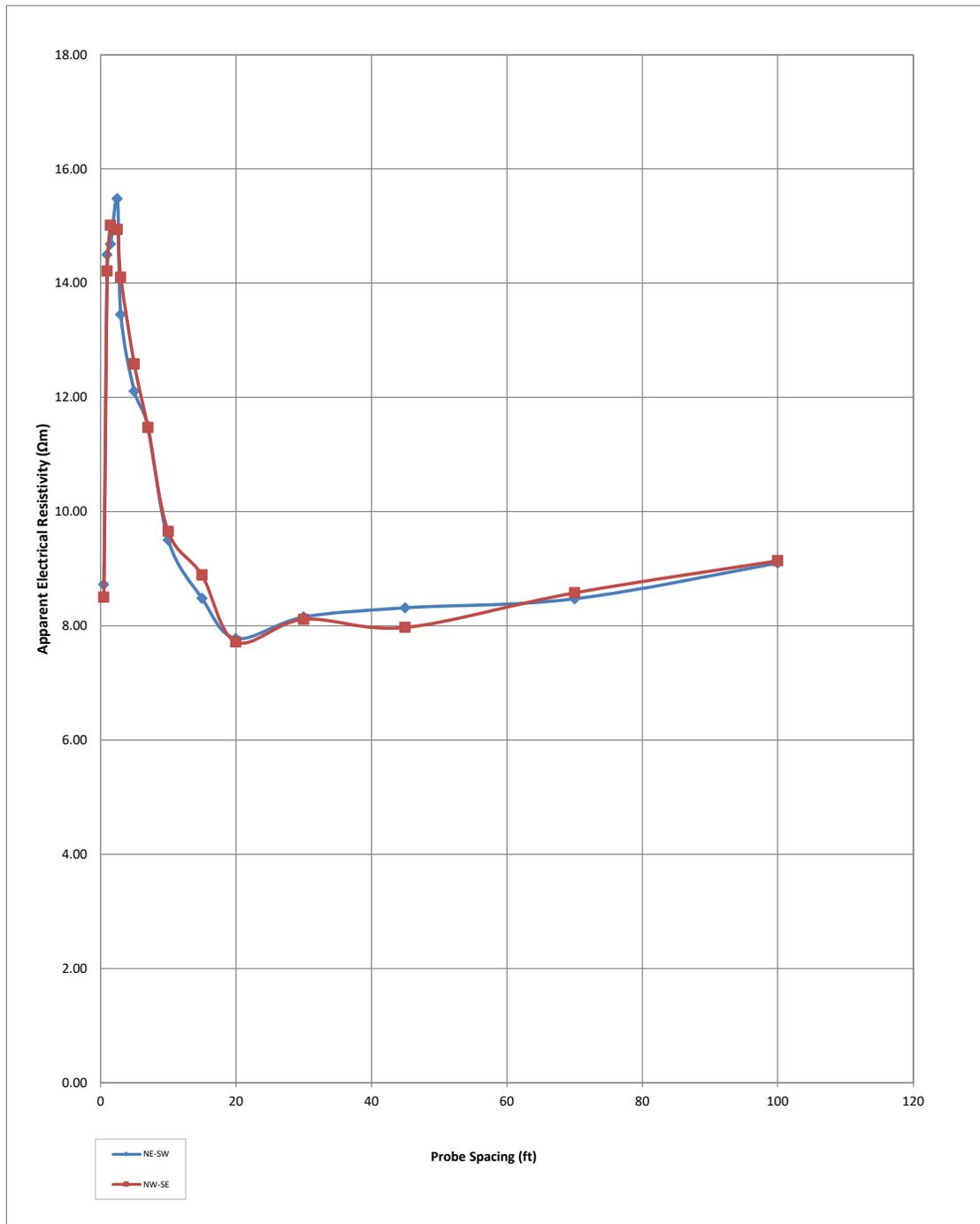
Notes:



General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation:  $r=2*p*R*spacing*0.3048$ , where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind  
Electrical Resistivity Survey at GEO-008



**SOIL RESISTIVITY MEASUREMENT DATA SHEET**

0 GEO-010

**DATE** 5/14/2025  
**CLIENT** ALLETE Renewable Resources, Inc.  
**PROJECT** Longspur Wind  
**LOCATION:** Morton County, ND  
**LATITUDE :** 46.921177  
**LONGITUDE :** -101.821968  
**WEATHER:** Partly Cloudy  
**TOP SOIL:** Silt (ML), Brown, Dry  
**TYPE OF TEST :** Wenner 4-Pin Method  
**EQUIPMENT:** SuperSting  
**SERIAL NO.** SS2106234  
**MODEL:** R8  
**CALIBRATION DUE DATE:** 1/28/2026  
**TEST PERFORMED BY :** RRC

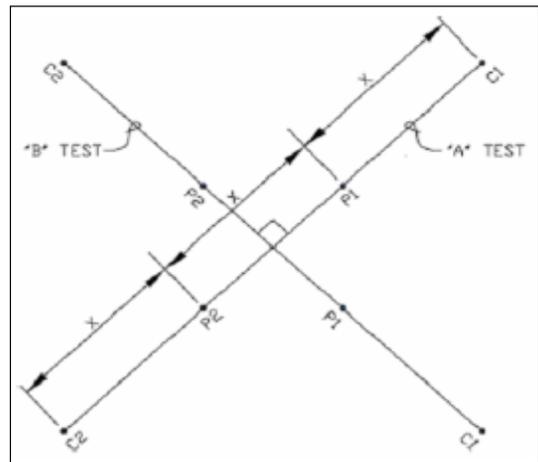
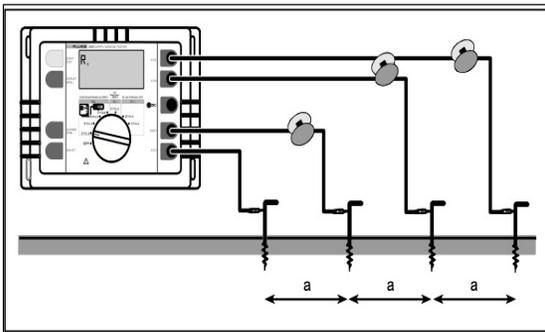
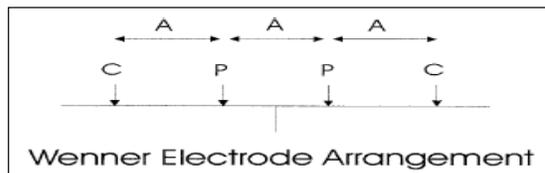
**Project No.** GE2503026

**Temp. (°F)** 69°F

**TEST SET RANGE**  
 Meter Current: 1mA - 2000mA  
 Meter Resistance: 0.01Ohm - 19.99kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE		Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)			
0.5	4	2	12.540	12.00	13.430	12.85		12.43	
1	4	2	9.440	18.07	9.272	17.75		17.91	
1.5	4	2	7.432	21.34	7.343	21.08		21.21	
2.5	4	2	5.435	26.01	5.453	26.09		26.05	
3	4	2	4.692	26.94	4.529	26.01		26.48	
5	4	2	3.356	32.12	3.524	33.73		32.92	
7	4	2	2.536	33.98	2.426	32.51		33.24	
10	12	6	1.675	32.06	1.623	31.07		31.56	
15	12	6	1.056	30.32	1.032	29.63		29.98	
20	12	6	0.743	28.44	0.734	28.11		28.28	
30	12	6	0.455	26.11	0.452	25.95		26.03	
45	12+	6+	0.279	24.06	0.297	25.62		24.84	
70	12+	6+	0.159	21.26	0.153	20.45		20.86	
100	12+	6+	0.103	19.75	0.092	17.69		18.72	

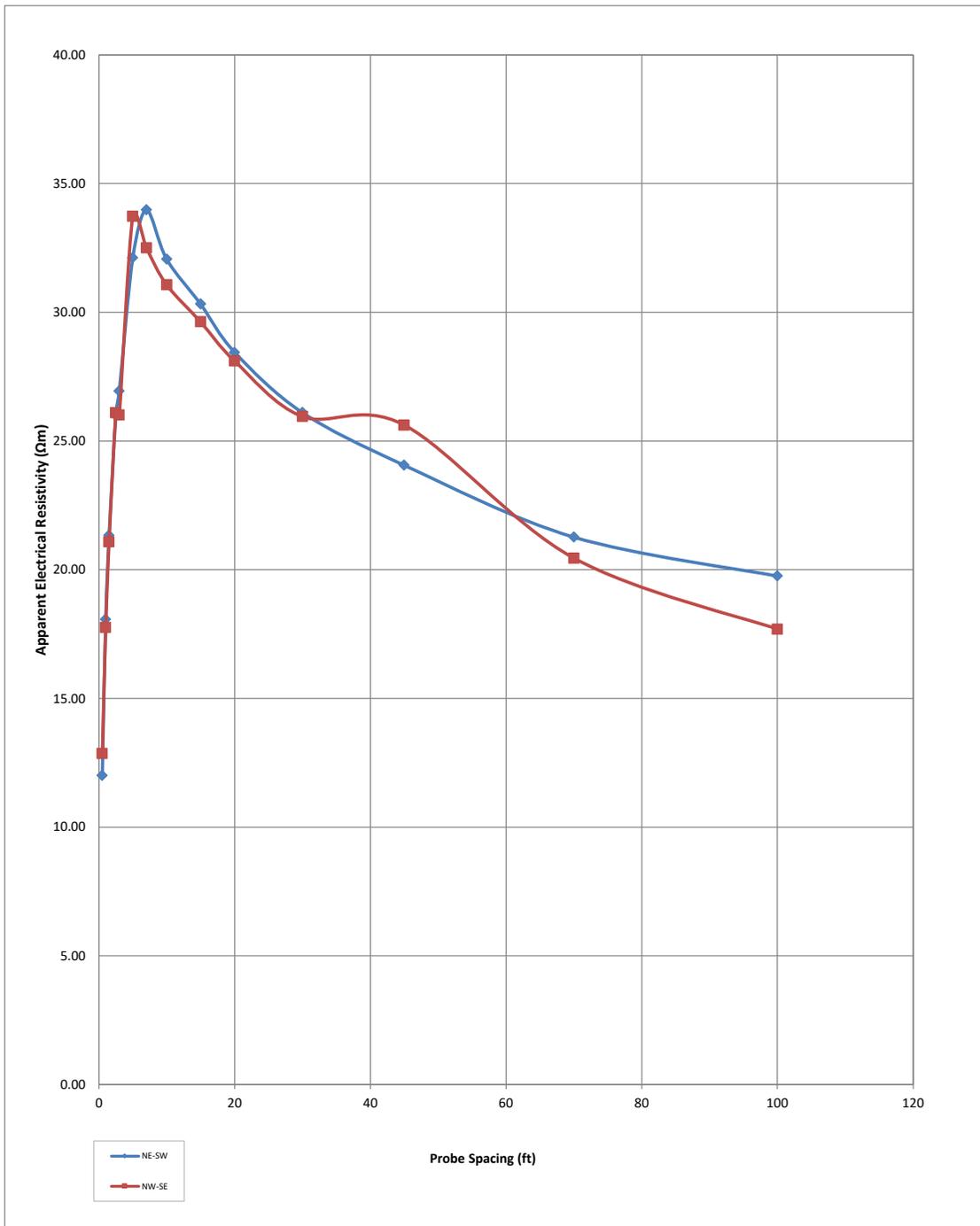
Notes: Fence line at ~300 ft west of the profile center, going N-S.



General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation:  $r=2*p*R*spacing*0.3048$ , where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind  
Electrical Resistivity Survey at GEO-010



**SOIL RESISTIVITY MEASUREMENT DATA SHEET**

**Survey ID** GEO-019  
**DATE** 5/17/2025  
**CLIENT** ALLETE Renewable Resources, Inc.  
**PROJECT** Longspur Wind  
**LOCATION:** Morton County, ND  
**LATITUDE :** 46.886393  
**LONGITUDE :** -101.800325  
**WEATHER:** Sunny  
**TOP SOIL:** Silt (ML), Brown, Dry  
**TYPE OF TEST :** Wenner 4-Pin Method  
**EQUIPMENT:** SuperSting  
**SERIAL NO.** SS2106234  
**MODEL:** R8  
**CALIBRATION DUE DATE:** 1/28/2026  
**TEST PERFORMED BY :** RRC

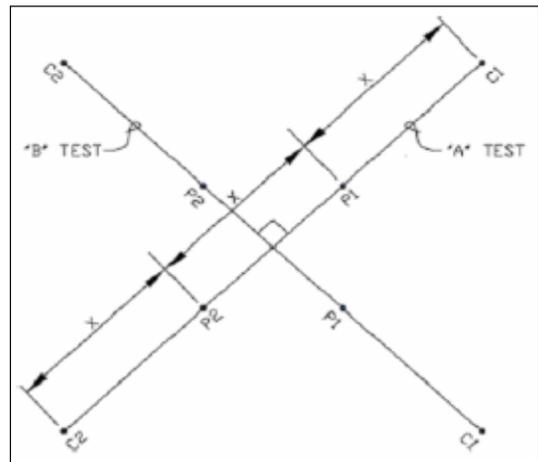
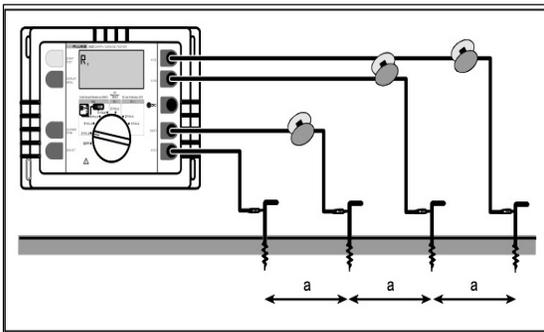
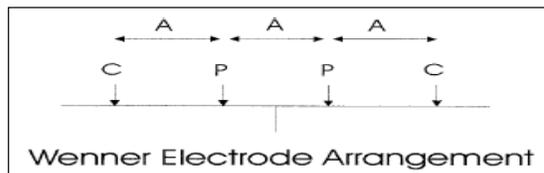
**Project No.** GE2503026

**Temp. (°F)** 49°F

**TEST SET RANGE**  
 Meter Current: 1mA - 2000mA  
 Meter Resistance: 0.01Ohm - 19.99kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE		Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)			
0.5	4	2	15.320	14.66	17.250	16.51			15.59
1	4	2	8.679	16.61	9.245	17.70			17.15
1.5	4	2	6.246	17.93	6.645	19.08			18.51
2.5	4	2	5.136	24.58	5.235	25.05			24.81
3	4	2	4.964	28.51	4.883	28.04			28.27
5	4	2	4.053	38.79	3.769	36.07			37.43
7	4	2	2.735	36.65	2.756	36.93			36.79
10	12	6	1.618	30.97	1.542	29.52			30.24
15	12	6	0.854	24.53	0.853	24.48			24.50
20	12	6	0.525	20.08	0.572	21.91			20.99
30	12	6	0.301	17.31	0.299	17.16			17.24
45	12+	6+	0.125	10.80	0.117	10.11			10.46
70	12+	6+	0.060	7.99	0.058	7.75			7.87
100	12+	6+	0.039	7.56	0.041	7.91			7.73

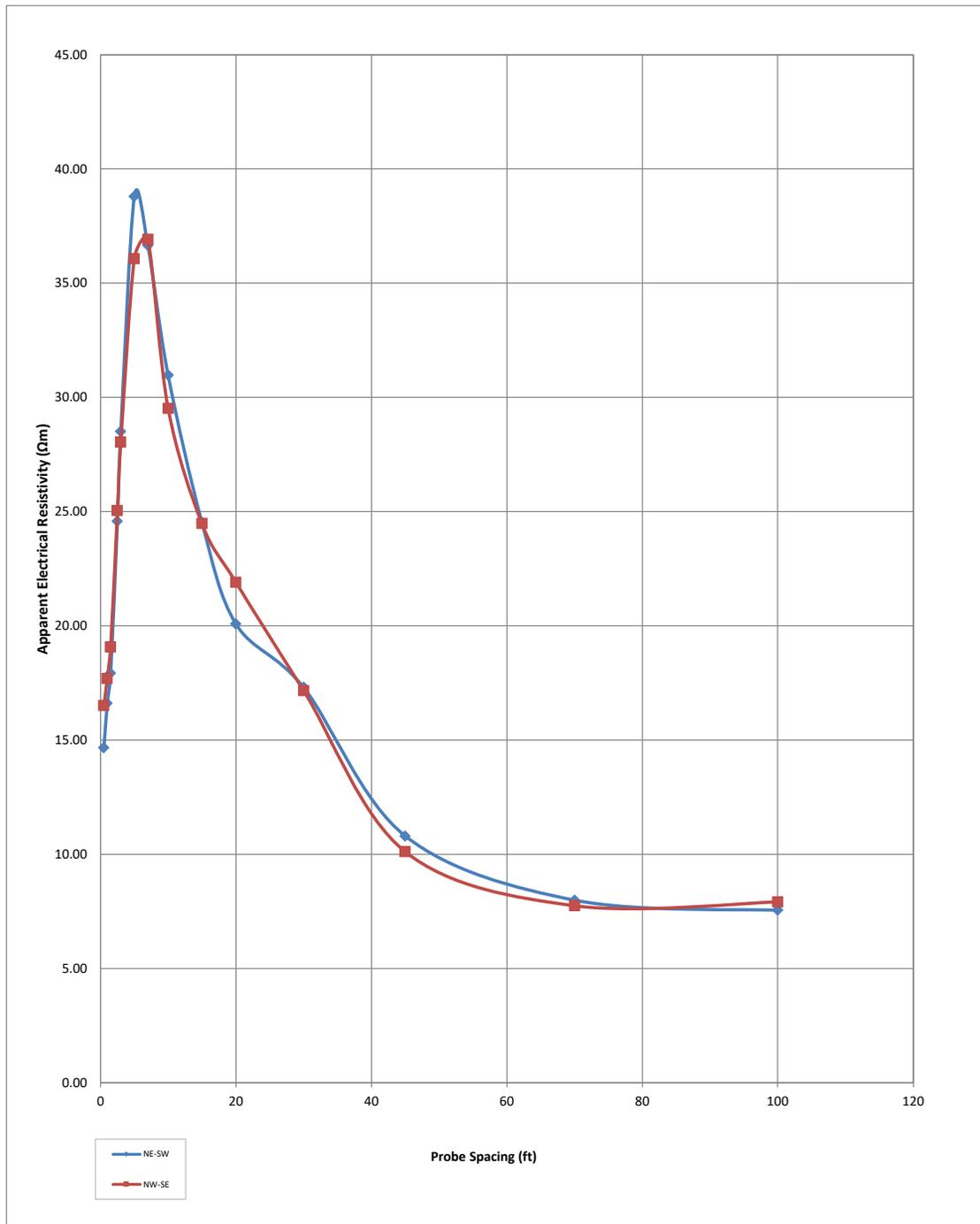
Notes: Powerlines at ~1800 ft north of the profile center, going E-W.



General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation:  $r=2*p*R*spacing*0.3048$ , where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind  
Electrical Resistivity Survey at GEO-019



**SOIL RESISTIVITY MEASUREMENT DATA SHEET**

**Survey ID** GEO-022  
**DATE** 5/6/2025  
**CLIENT** ALLETE Renewable Resources, Inc.  
**PROJECT** Longspur Wind  
**LOCATION:** Morton County, ND  
**LATITUDE :** 46.973121  
**LONGITUDE :** -101.745487  
**WEATHER:** Sunny  
**TOP SOIL:** Silty Clay, Brown, Dry-Moist  
**TYPE OF TEST :** Wenner 4-Pin Method  
**EQUIPMENT:** SuperSting  
**SERIAL NO.** SS2106234  
**MODEL:** R8  
**CALIBRATION DUE DATE:** 1/28/2026  
**TEST PERFORMED BY :** RRC

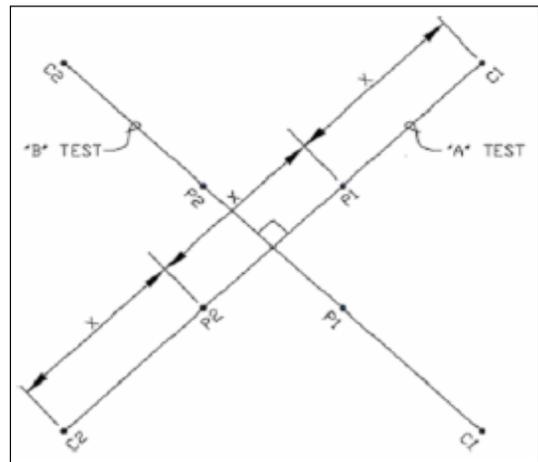
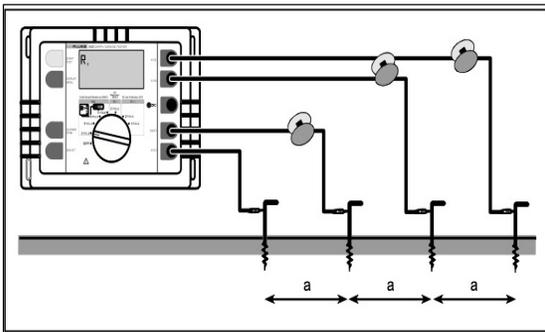
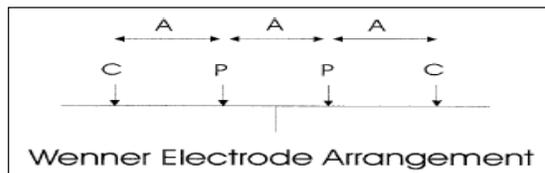
**Project No.** GE2503026

**Temp. (°F)** 65°F

**TEST SET RANGE**  
 Meter Current: 1mA - 2000mA  
 Meter Resistance: 0.01Ohm - 19.99kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE		Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)			
0.5	4	2	35.280	33.77	38.660	37.00			35.38
1	4	2	26.240	50.23	27.740	53.10			51.66
1.5	4	2	21.300	61.16	20.910	60.04			60.60
2.5	4	2	12.010	57.47	11.440	54.74			56.11
3	4	2	9.882	56.75	10.330	59.32			58.03
5	4	2	4.090	39.14	4.210	40.29			39.72
7	4	2	1.980	26.53	1.998	26.77			26.65
10	12	6	0.938	17.95	0.922	17.65			17.80
15	12	6	0.502	14.40	0.489	14.05			14.23
20	12	6	0.331	12.69	0.326	12.49			12.59
30	12	6	0.219	12.55	0.210	12.07			12.31
45	12+	6+	0.135	11.62	0.139	11.95			11.78
70	12+	6+	0.088	11.83	0.088	11.77			11.80
100	12+	6+	0.063	12.02	0.062	11.80			11.91

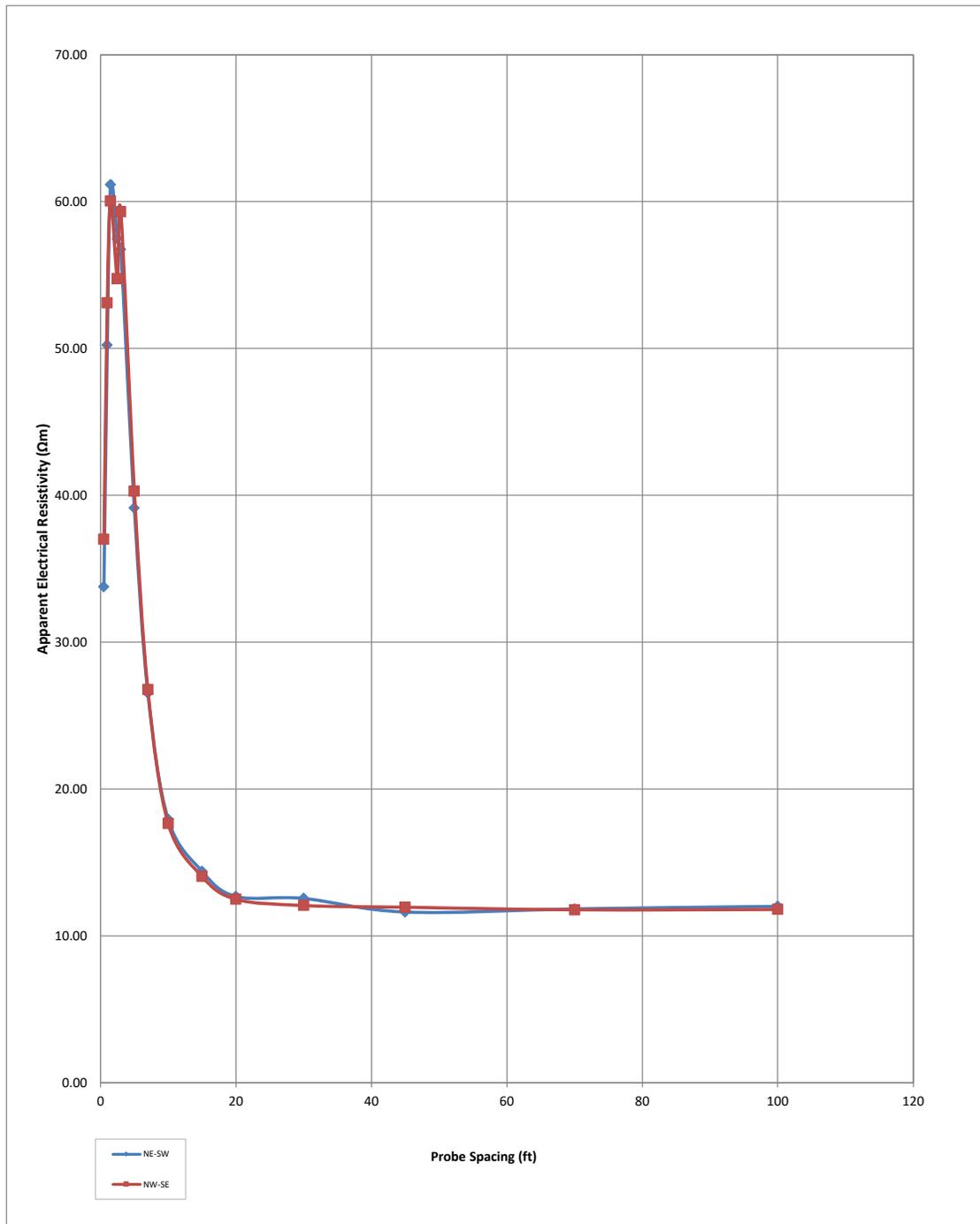
Notes: Fence line at ~300 ft east of the profile center, going N-S.



General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation:  $r=2*p*R*spacing*0.3048$ , where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind  
Electrical Resistivity Survey at GEO-022



**SOIL RESISTIVITY MEASUREMENT DATA SHEET**

**Survey ID** GEO-033  
**DATE** 5/13/2025  
**CLIENT** ALLETE Renewable Resources, Inc.  
**PROJECT** Longspur Wind  
**LOCATION:** Morton County, ND  
**LATITUDE :** 46.95389  
**LONGITUDE :** -101.730973  
**WEATHER:** Partly Cloudy  
**TOP SOIL:** Silt (ML), Brown, Dry  
**TYPE OF TEST :** Wenner 4-Pin Method  
**EQUIPMENT:** SuperSting  
**SERIAL NO.** SS2106234  
**MODEL:** R8  
**CALIBRATION DUE DATE:** 1/28/2026  
**TEST PERFORMED BY :** RRC

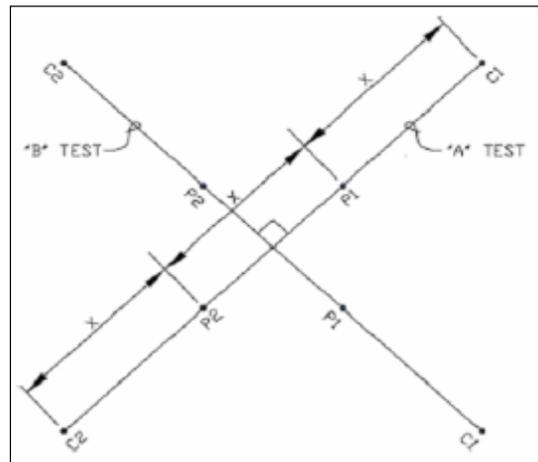
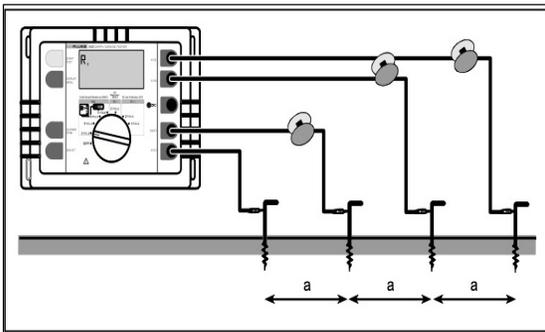
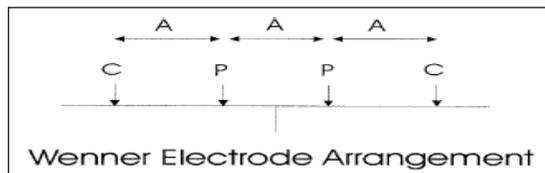
**Project No.** GE2503026

**Temp. (°F)** 42°F

**TEST SET RANGE**  
 Meter Current: 1mA - 2000mA  
 Meter Resistance: 0.01Ohm - 19.99kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE		Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)			
0.5	4	2	28.530	27.31	31.560	30.21			28.76
1	4	2	19.530	37.38	20.380	39.01			38.20
1.5	4	2	14.270	40.97	15.240	43.76			42.36
2.5	4	2	8.028	38.42	8.383	40.12			39.27
3	4	2	6.249	35.88	6.862	39.40			37.64
5	4	2	2.749	26.31	2.934	28.08			27.20
7	4	2	1.592	21.33	1.574	21.09			21.21
10	12	6	0.876	16.78	0.902	17.27			17.02
15	12	6	0.498	14.30	0.501	14.40			14.35
20	12	6	0.297	11.39	0.297	11.35			11.37
30	12	6	0.172	9.90	0.177	10.19			10.04
45	12+	6+	0.104	8.98	0.118	10.12			9.55
70	12+	6+	0.063	8.49	0.065	8.74			8.61
100	12+	6+	0.041	7.83	0.044	8.39			8.11

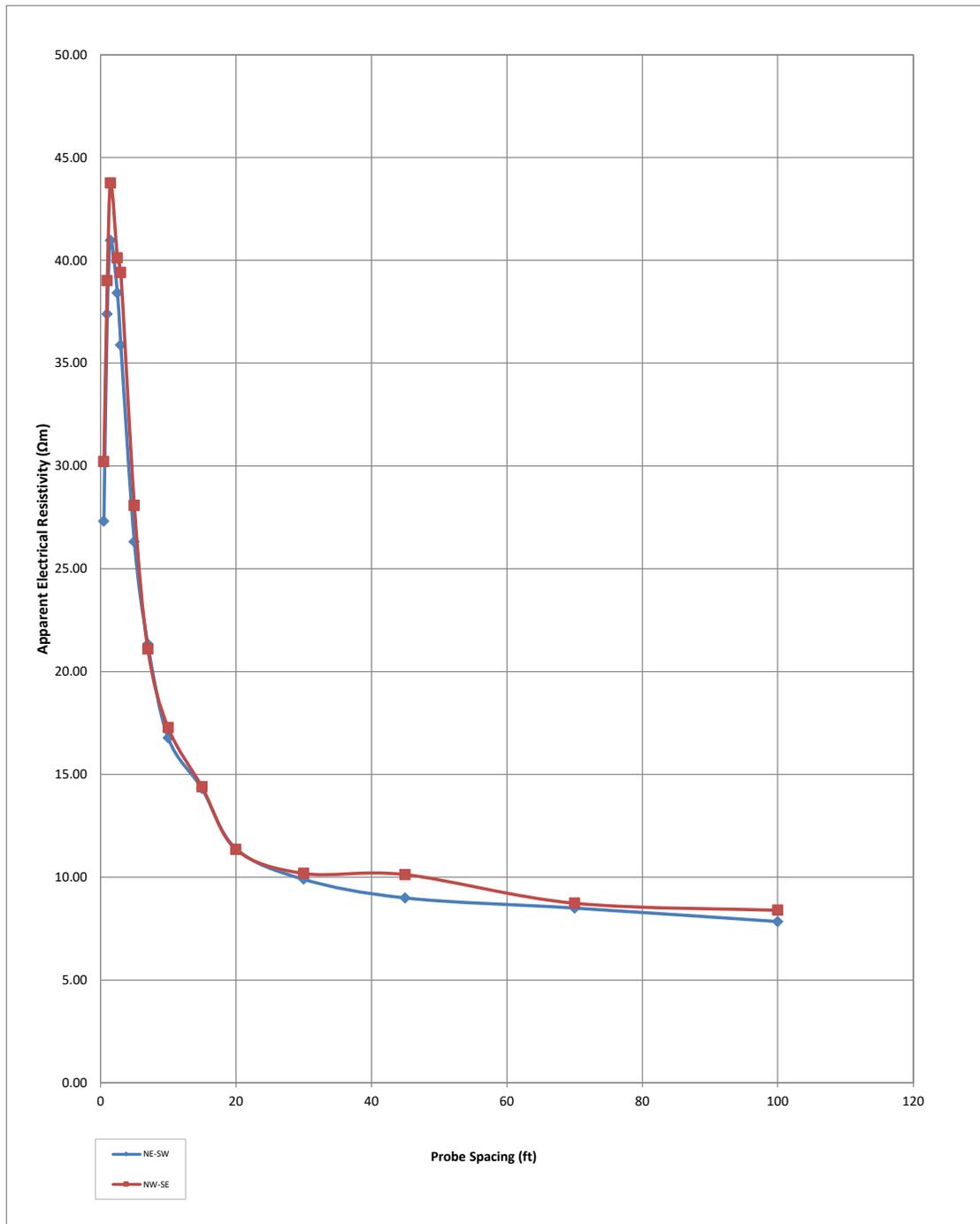
Notes:



General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation:  $r=2*p*R*spacing*0.3048$ , where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind  
Electrical Resistivity Survey at GEO-033



**SOIL RESISTIVITY MEASUREMENT DATA SHEET**

**Survey ID** GEO-046  
**DATE** 5/13/2025  
**CLIENT** ALLETE Renewable Resources, Inc.  
**PROJECT** Longspur Wind  
**LOCATION:** Morton County, ND  
**LATITUDE :** 46.932595  
**LONGITUDE :** -101.787575  
**WEATHER:** Sunny  
**TOP SOIL:** Silt (ML), Brown, Dry  
**TYPE OF TEST :** Wenner 4-Pin Method  
**EQUIPMENT:** SuperSting  
**SERIAL NO.** SS2106234  
**MODEL:** R8  
**CALIBRATION DUE DATE:** 1/28/2026  
**TEST PERFORMED BY :** RRC

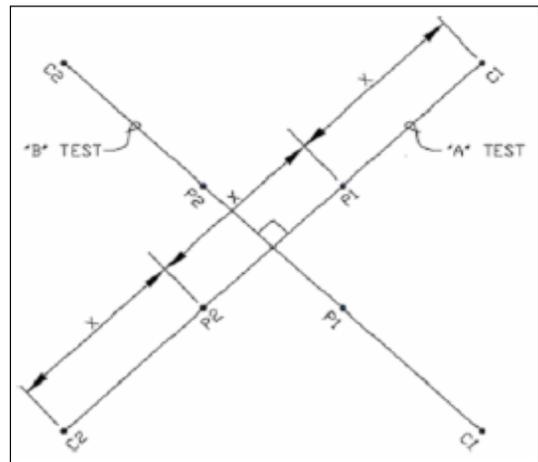
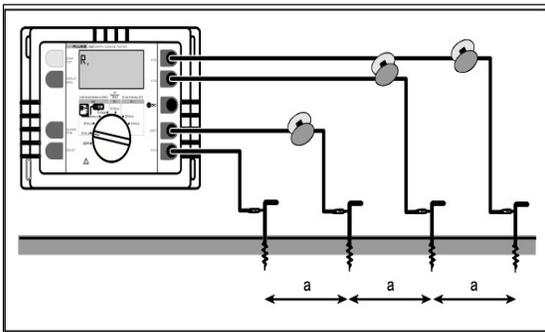
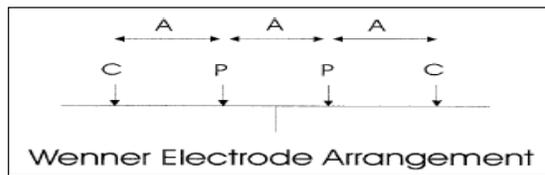
**Project No.** GE2503026

**Temp. (°F)** 82°F

**TEST SET RANGE**  
 Meter Current: 1mA - 2000mA  
 Meter Resistance: 0.01Ohm - 19.99kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE		Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)			
0.5	4	2	18.890	18.08	19.150	18.33			18.20
1	4	2	17.440	33.38	17.530	33.55			33.47
1.5	4	2	15.840	45.48	15.620	44.85			45.16
2.5	4	2	11.160	53.40	11.280	53.98			53.69
3	4	2	8.551	49.10	8.769	50.36			49.73
5	4	2	4.140	39.62	4.261	40.78			40.20
7	4	2	2.556	34.25	2.433	32.60			33.42
10	12	6	1.345	25.75	1.421	27.20			26.47
15	12	6	0.581	16.69	0.559	16.05			16.37
20	12	6	0.314	12.01	0.325	12.43			12.22
30	12	6	0.191	10.99	0.178	10.23			10.61
45	12+	6+	0.123	10.61	0.130	11.23			10.92
70	12+	6+	0.091	12.14	0.095	12.77			12.46
100	12+	6+	0.076	14.46	0.073	13.88			14.17

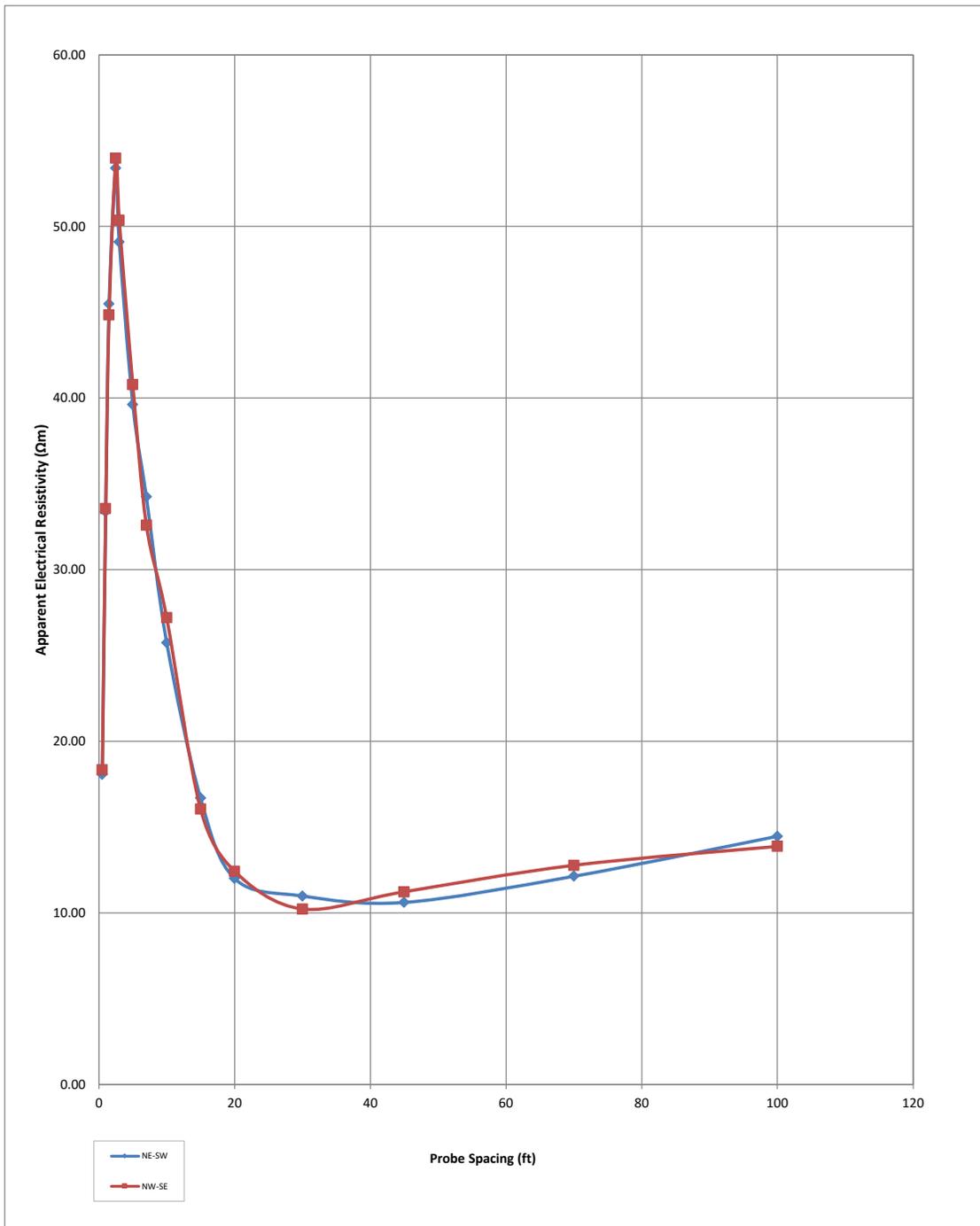
Notes:



General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation:  $r=2*p*R*spacing*0.3048$ , where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind  
Electrical Resistivity Survey at GEO-046



**SOIL RESISTIVITY MEASUREMENT DATA SHEET**

**Survey ID** GEO-048  
**DATE** 5/13/2025  
**CLIENT** ALLETE Renewable Resources, Inc.  
**PROJECT** Longspur Wind  
**LOCATION:** Morton County, ND  
**LATITUDE :** 46.932595  
**LONGITUDE :** -101.787575  
**WEATHER:** Partly Cloudy  
**TOP SOIL:** Silt (ML), Brown, Dry  
**TYPE OF TEST :** Wenner 4-Pin Method  
**EQUIPMENT:** SuperSting  
**SERIAL NO.** SS2106234  
**MODEL:** R8  
**CALIBRATION DUE DATE:** 1/28/2026  
**TEST PERFORMED BY :** RRC

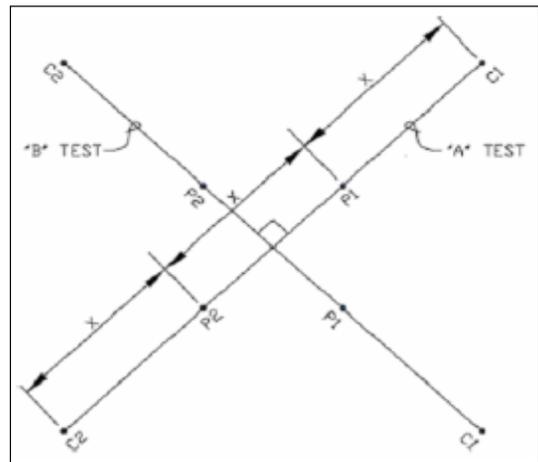
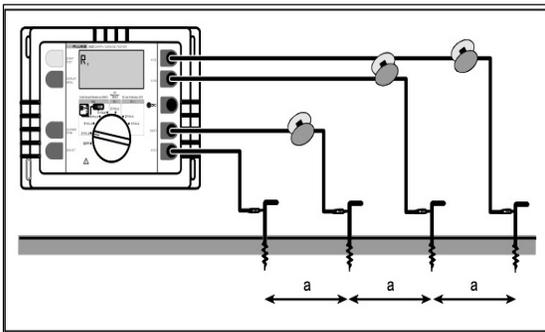
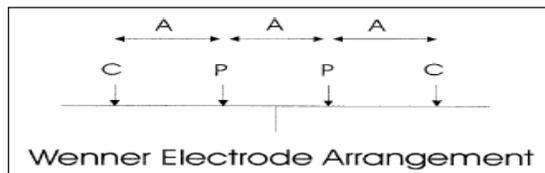
**Project No.** GE2503026

**Temp. (°F)** 82°F

**TEST SET RANGE**  
 Meter Current: 1mA - 2000mA  
 Meter Resistance: 0.01Ohm - 19.99kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE		Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)			
0.5	4	2	29.850	28.57	33.930	32.47			30.52
1	4	2	20.640	39.51	22.710	43.47			41.49
1.5	4	2	16.060	46.11	16.390	47.06			46.59
2.5	4	2	12.670	60.63	12.320	58.96			59.79
3	4	2	9.053	51.99	10.050	57.71			54.85
5	4	2	4.188	40.08	4.260	40.77			40.43
7	4	2	2.257	30.24	2.292	30.71			30.48
10	12	6	1.253	23.98	1.347	25.78			24.88
15	12	6	0.592	17.01	0.605	17.36			17.18
20	12	6	0.364	13.92	0.404	15.45			14.69
30	12	6	0.176	10.08	0.194	11.16			10.62
45	12+	6+	0.102	8.82	0.119	10.28			9.55
70	12+	6+	0.075	10.09	0.078	10.46			10.27
100	12+	6+	0.055	10.60	0.057	10.97			10.78

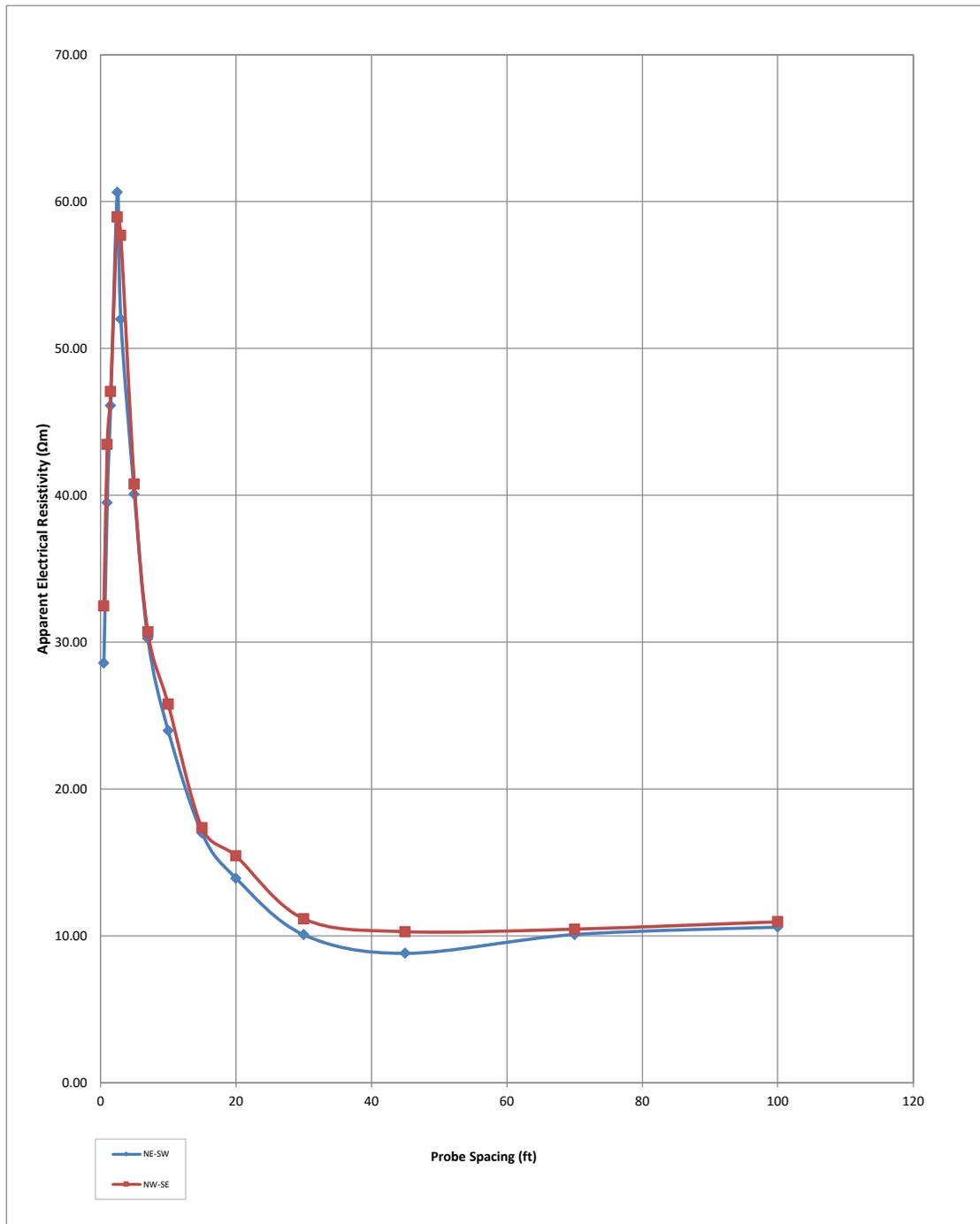
Notes:



General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation:  $r=2*p*R*spacing*0.3048$ , where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind  
Electrical Resistivity Survey at GEO-048



**SOIL RESISTIVITY MEASUREMENT DATA SHEET**

**Survey ID** GEO-053  
**DATE** 5/13/2025  
**CLIENT** ALLETE Renewable Resources, Inc.  
**PROJECT** Longspur Wind  
**LOCATION:** Morton County, ND  
**LATITUDE :** 46.932595  
**LONGITUDE :** -101.787575  
**WEATHER:** Partly Cloudy  
**TOP SOIL:** Silt (ML), Brown, Dry  
**TYPE OF TEST :** Wenner 4-Pin Method  
**EQUIPMENT:** SuperSting  
**SERIAL NO.** SS2106234  
**MODEL:** R8  
**CALIBRATION DUE DATE:** 1/28/2026  
**TEST PERFORMED BY :** RRC

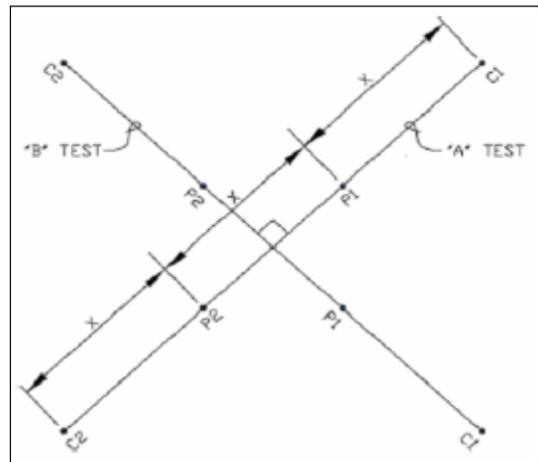
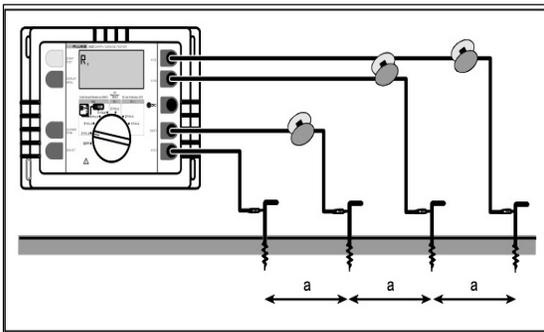
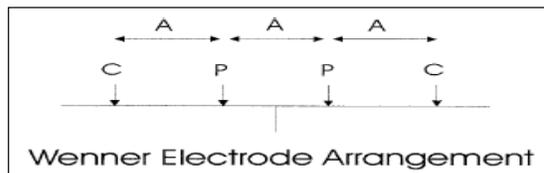
**Project No.** GE2503026

**Temp. (°F)** 82°F

**TEST SET RANGE**  
 Meter Current: 1mA - 2000mA  
 Meter Resistance: 0.01Ohm - 19.99kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE		Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)			
0.5	4	2	26.490	25.35	28.720	27.49		26.42	
1	4	2	18.470	35.35	20.820	39.85		37.60	
1.5	4	2	13.850	39.77	14.580	41.86		40.81	
2.5	4	2	8.474	40.55	9.034	43.23		41.89	
3	4	2	6.437	36.96	6.734	38.67		37.82	
5	4	2	3.309	31.67	3.573	34.20		32.93	
7	4	2	2.184	29.26	2.257	30.24		29.75	
10	12	6	1.376	26.34	1.357	25.97		26.16	
15	12	6	0.733	21.04	0.775	22.25		21.64	
20	12	6	0.387	14.80	0.397	15.21		15.00	
30	12	6	0.201	11.57	0.226	12.97		12.27	
45	12+	6+	0.128	11.06	0.129	11.07		11.06	
70	12+	6+	0.079	10.63	0.078	10.44		10.54	
100	12+	6+	0.052	9.89	0.054	10.39		10.14	

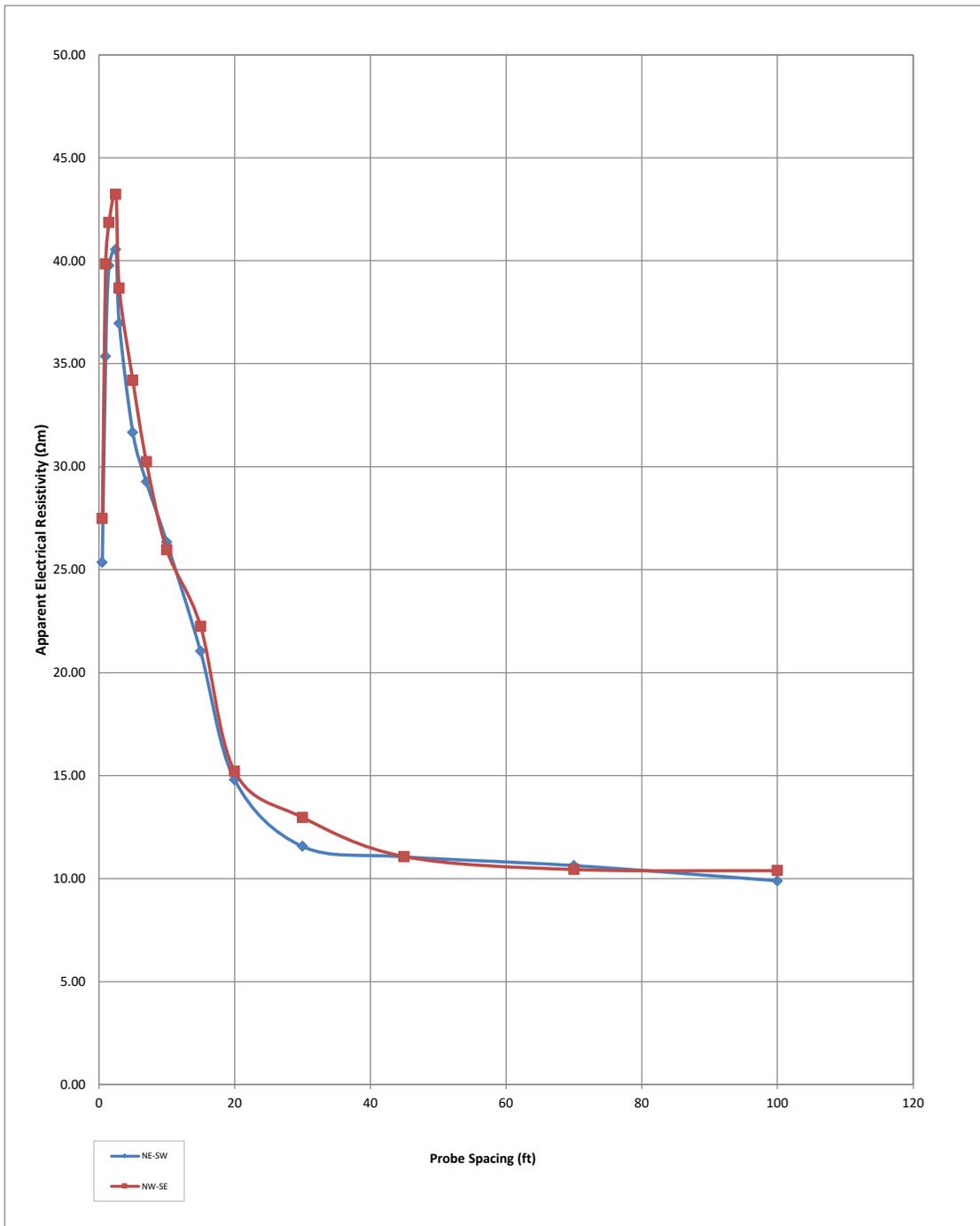
Notes: Powerlines at ~900 ft west of the profile center, going N-S.



General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation:  $r=2*p*R*spacing*0.3048$ , where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind  
Electrical Resistivity Survey at GEO-053



**SOIL RESISTIVITY MEASUREMENT DATA SHEET**

**Survey ID** GEO-059  
**DATE** 5/13/2025  
**CLIENT** ALLETE Renewable Resources, Inc.  
**PROJECT** Longspur Wind  
**LOCATION:** Morton County, ND  
**LATITUDE :** 46.911622  
**LONGITUDE :** -101.695731  
**WEATHER:** Sunny  
**TOP SOIL:** Silt (ML), Brown, Dry  
**TYPE OF TEST :** Wenner 4-Pin Method  
**EQUIPMENT:** SuperSting  
**SERIAL NO.** SS2106234  
**MODEL:** R8  
**CALIBRATION DUE DATE:** 1/28/2026  
**TEST PERFORMED BY :** RRC

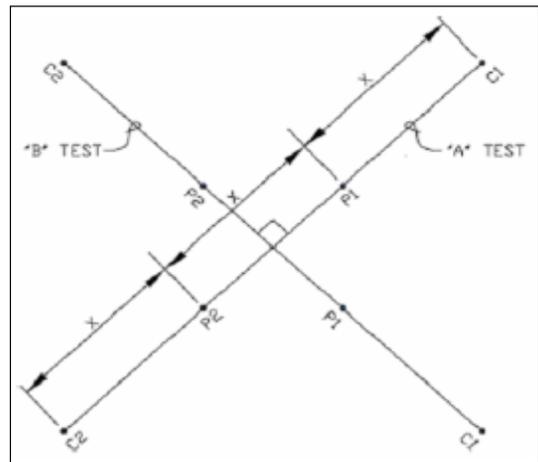
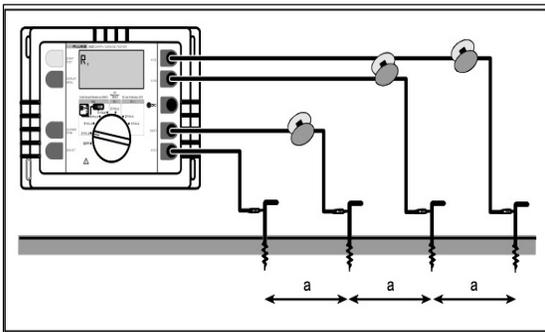
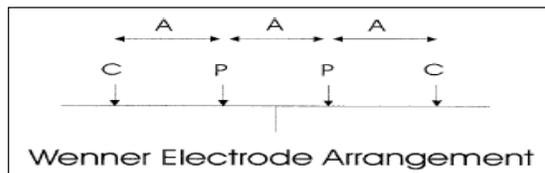
**Project No.** GE2503026

**Temp. (°F)** 61°F

**TEST SET RANGE**  
 Meter Current: 1mA - 2000mA  
 Meter Resistance: 0.01Ohm - 19.99kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE		Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)			
0.5	4	2	44.240	42.34	41.830	40.03		41.19	
1	4	2	29.240	55.97	27.810	53.23		54.60	
1.5	4	2	20.530	58.95	19.770	56.76		57.86	
2.5	4	2	15.570	74.51	15.730	75.27		74.89	
3	4	2	9.345	53.66	10.030	57.60		55.63	
5	4	2	4.532	43.37	5.024	48.08		45.73	
7	4	2	2.935	39.33	2.738	36.69		38.01	
10	12	6	1.635	31.30	1.536	29.40		30.35	
15	12	6	0.835	23.98	0.853	24.50		24.24	
20	12	6	0.413	15.82	0.473	18.12		16.97	
30	12	6	0.194	11.15	0.208	11.92		11.54	
45	12+	6+	0.093	8.05	0.114	9.81		8.93	
70	12+	6+	0.065	8.77	0.068	9.14		8.96	
100	12+	6+	0.041	7.92	0.047	9.05		8.49	

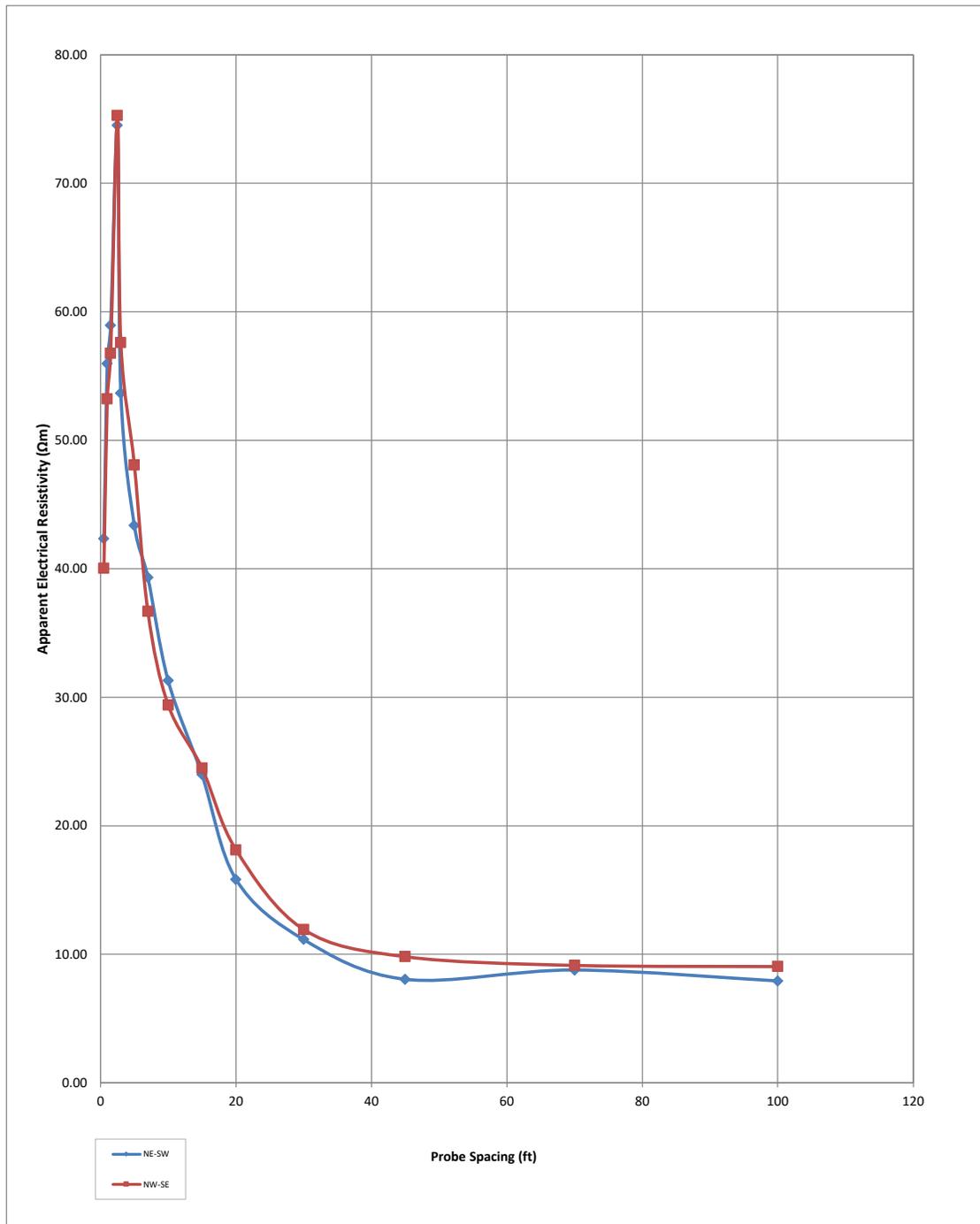
Notes:



General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation:  $r=2*p*R*spacing*0.3048$ , where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind  
Electrical Resistivity Survey at GEO-059



**SOIL RESISTIVITY MEASUREMENT DATA SHEET**

**Survey ID** GEO-062  
**DATE** 5/13/2025  
**CLIENT** ALLETE Renewable Resources, Inc.  
**PROJECT** Longspur Wind  
**LOCATION:** Morton County, ND  
**LATITUDE :** 46.908306  
**LONGITUDE :** -101.677064  
**WEATHER:** Sunny  
**TOP SOIL:** Silt (ML), Brown, Dry  
**TYPE OF TEST :** Wenner 4-Pin Method  
**EQUIPMENT:** SuperSting  
**SERIAL NO.** SS2106234  
**MODEL:** R8  
**CALIBRATION DUE DATE:** 1/28/2026  
**TEST PERFORMED BY :** RRC

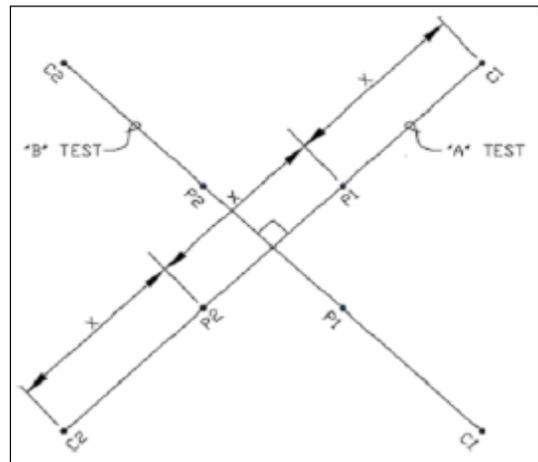
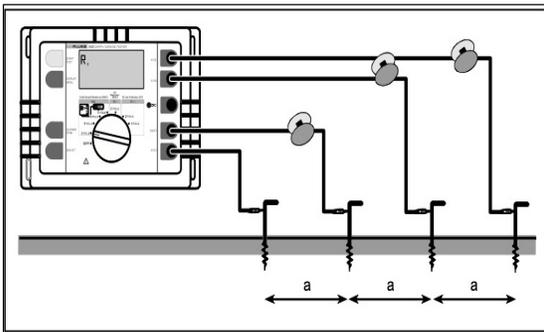
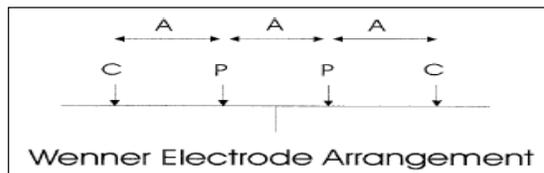
**Project No.** GE2503026

**Temp. (°F)** 59°F

**TEST SET RANGE**  
 Meter Current: 1mA - 2000mA  
 Meter Resistance: 0.01Ohm - 19.99kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE		Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)			
0.5	4	2	28.230	27.02	27.420	26.24			26.63
1	4	2	19.110	36.58	21.530	41.21			38.90
1.5	4	2	13.720	39.39	14.560	41.80			40.60
2.5	4	2	8.244	39.45	8.424	40.31			39.88
3	4	2	5.124	29.42	5.066	29.09			29.26
5	4	2	2.734	26.17	2.623	25.10			25.64
7	4	2	1.582	21.20	1.613	21.61			21.40
10	12	6	1.042	19.95	0.957	18.33			19.14
15	12	6	0.614	17.63	0.592	17.01			17.32
20	12	6	0.413	15.81	0.422	16.17			15.99
30	12	6	0.201	11.51	0.213	12.20			11.86
45	12+	6+	0.109	9.41	0.114	9.81			9.61
70	12+	6+	0.065	8.68	0.068	9.14			8.91
100	12+	6+	0.048	9.23	0.044	8.48			8.85

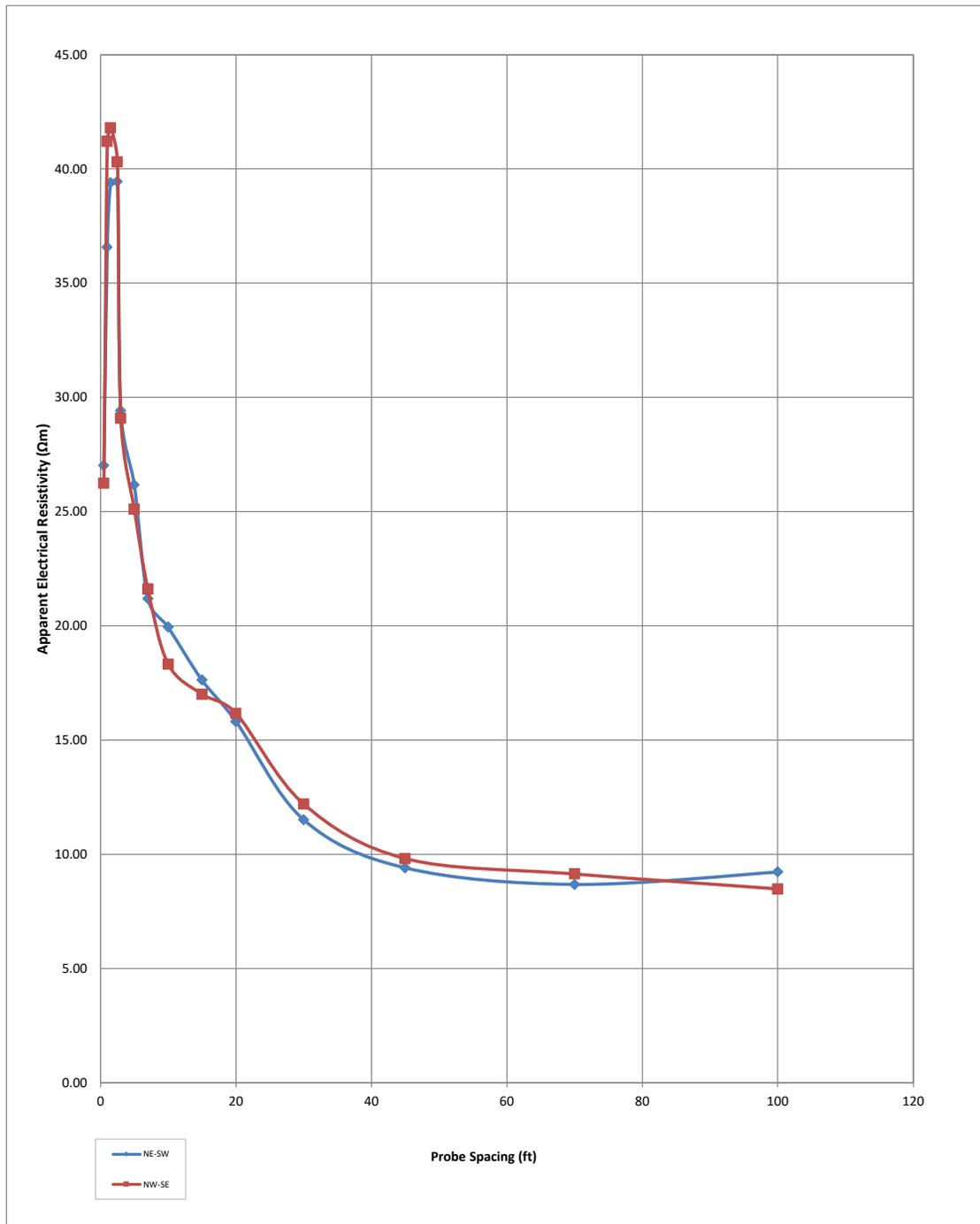
Notes: Powerlines at ~950 ft south of the profile center, going E-W.



General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation:  $r=2*p*R*spacing*0.3048$ , where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind  
Electrical Resistivity Survey at GEO-062



**SOIL RESISTIVITY MEASUREMENT DATA SHEET**

**Survey ID** GEO-067  
**DATE** 5/17/2025  
**CLIENT** ALLETE Renewable Resources, Inc.  
**PROJECT** Longspur Wind  
**LOCATION:** Morton County, ND  
**LATITUDE :** 46.897545  
**LONGITUDE :** -101.664921  
**WEATHER:** Sunny  
**TOP SOIL:** Silt (ML), Brown, Dry  
**TYPE OF TEST :** Wenner 4-Pin Method  
**EQUIPMENT:** SuperSting  
**SERIAL NO.** SS2106234  
**MODEL:** R8  
**CALIBRATION DUE DATE:** 1/28/2026  
**TEST PERFORMED BY :** RRC

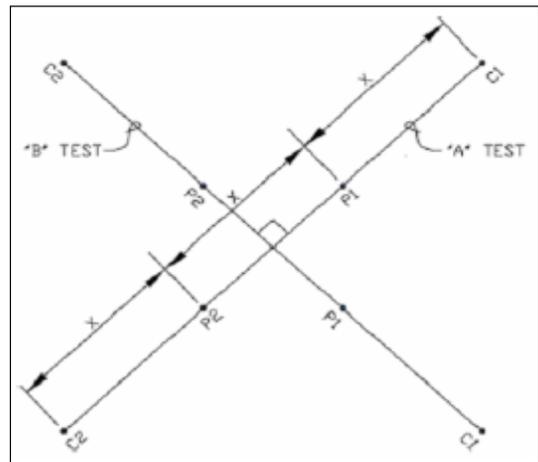
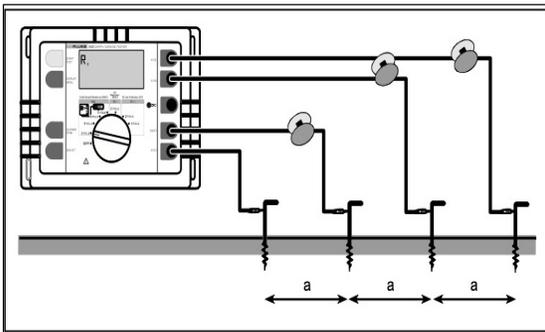
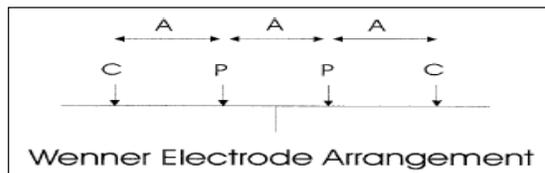
**Project No.** GE2503026

**Temp. (°F)** 55°F

**TEST SET RANGE**  
 Meter Current: 1mA - 2000mA  
 Meter Resistance: 0.01Ohm - 19.99kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE		Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)			
0.5	4	2	38.270	36.63	41.030	39.27		37.95	
1	4	2	27.540	52.72	26.580	50.88		51.80	
1.5	4	2	21.570	61.93	20.230	58.08		60.01	
2.5	4	2	16.730	80.06	15.340	73.41		76.73	
3	4	2	10.000	57.42	10.850	62.31		59.86	
5	4	2	5.253	50.27	5.248	50.23		50.25	
7	4	2	3.475	46.56	3.549	47.55		47.06	
10	12	6	1.815	34.74	1.793	34.32		34.53	
15	12	6	0.923	26.51	1.063	30.52		28.52	
20	12	6	0.514	19.69	0.542	20.76		20.22	
30	12	6	0.214	12.30	0.205	11.75		12.02	
45	12+	6+	0.111	9.59	0.103	8.91		9.25	
70	12+	6+	0.064	8.55	0.062	8.37		8.46	
100	12+	6+	0.047	8.94	0.044	8.34		8.64	

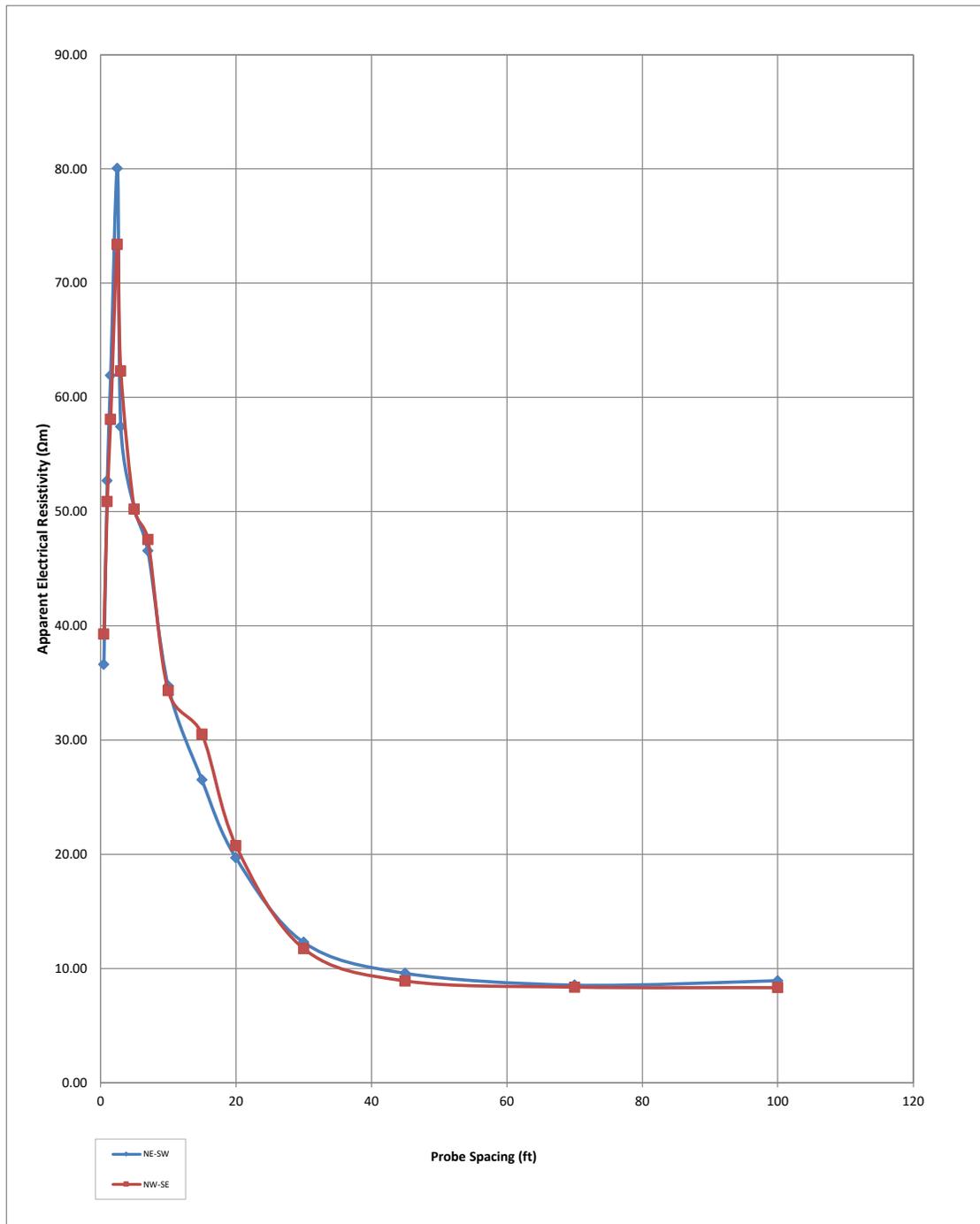
Notes: Fence line at ~350 ft north of the profile center, going E-W.



General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation:  $r=2*p*R*spacing*0.3048$ , where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind  
Electrical Resistivity Survey at GEO-067



**SOIL RESISTIVITY MEASUREMENT DATA SHEET**

**Survey ID** GEO-070  
**DATE** 5/11/2025  
**CLIENT** ALLETE Renewable Resources, Inc.  
**PROJECT** Longspur Wind  
**LOCATION:** Morton County, ND  
**LATITUDE :** 46.881276  
**LONGITUDE :** -101.690209  
**WEATHER:** Sunny  
**TOP SOIL:** Silt (ML), Brown, Dry  
**TYPE OF TEST :** Wenner 4-Pin Method  
**EQUIPMENT:** SuperSting  
**SERIAL NO.** SS2106234  
**MODEL:** R8  
**CALIBRATION DUE DATE:** 1/28/2026  
**TEST PERFORMED BY :** RRC

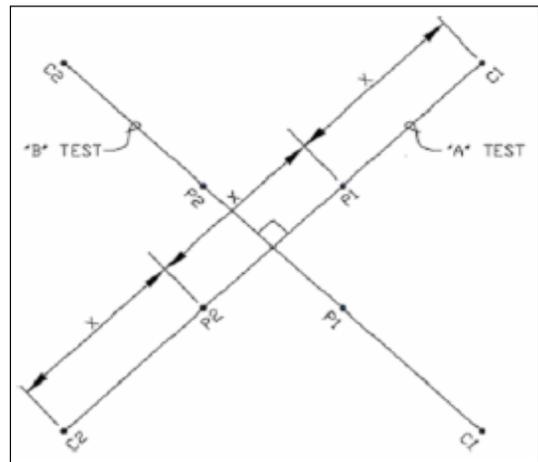
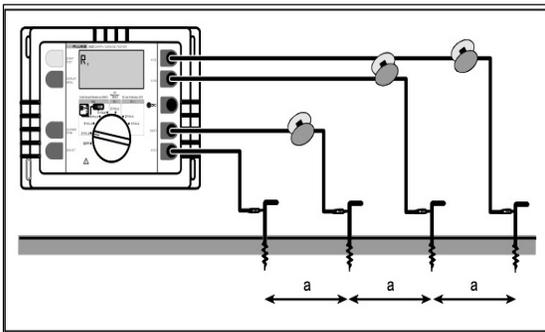
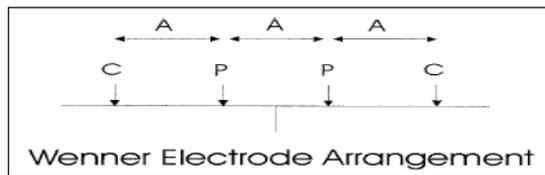
**Project No.** GE2503026

**Temp. (°F)** 97°F

**TEST SET RANGE**  
 Meter Current: 1mA - 2000mA  
 Meter Resistance: 0.01Ohm - 19.99kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			NE-SW		NW-SE		Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)			
0.5	4	2	8.899	8.52	9.018	8.63		8.57	
1	4	2	7.183	13.75	7.281	13.94		13.84	
1.5	4	2	5.038	14.47	5.162	14.82		14.64	
2.5	4	2	2.963	14.18	3.010	14.40		14.29	
3	4	2	2.246	12.90	2.307	13.25		13.07	
5	4	2	1.250	11.96	1.382	13.23		12.60	
7	4	2	0.843	11.29	0.812	10.87		11.08	
10	12	6	0.537	10.28	0.544	10.42		10.35	
15	12	6	0.337	9.66	0.311	8.93		9.30	
20	12	6	0.215	8.25	0.211	8.09		8.17	
30	12	6	0.135	7.76	0.138	7.94		7.85	
45	12+	6+	0.093	8.03	0.095	8.20		8.12	
70	12+	6+	0.060	8.06	0.059	7.91		7.98	
100	12+	6+	0.042	8.11	0.042	7.97		8.04	

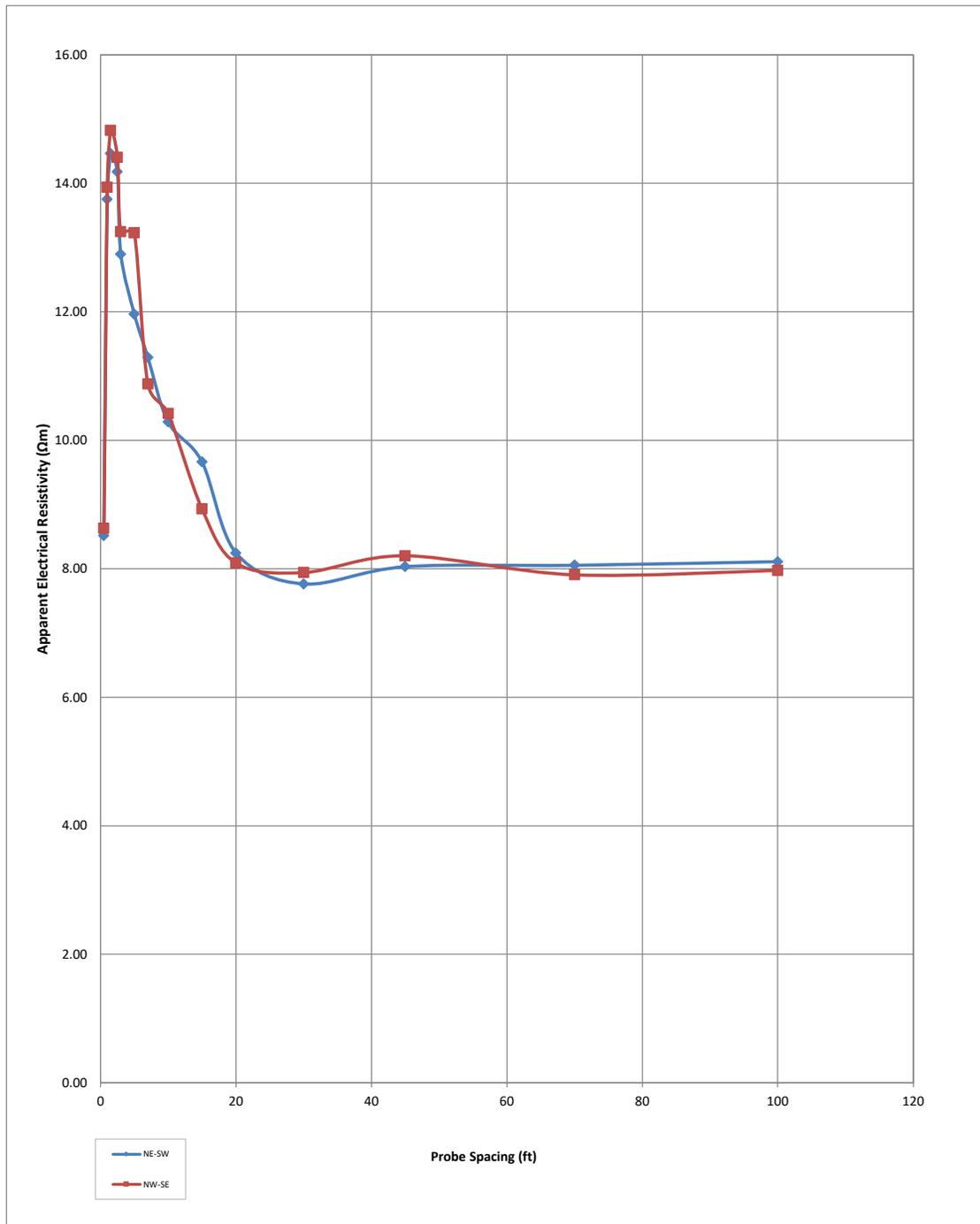
Notes: Powerlines at ~2500 ft south of the profile center, going E-W.



General Sketch of the test set up.

Total Array length is 3 times the probe spacing. The Apparent resistivity is calculated using the following equation:  $r=2*p*R*spacing*0.3048$ , where last item converts feet to meters. Wenner Array surveys were performed generally in accordance with IEEE std 81-2012 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System." and ASTM G-57.

Longspur Wind  
Electrical Resistivity Survey at GEO-070





**Soil Thermal Resistivity Sample & Testing Summary  
 Longspur Wind Project (PN: GE2503026)**

Boring	Depth	Percent Passing #200 Sieve	Maximum Dry Density (ASTM D698)	Optimum Water Content (ASTM D698)	LL	PL	PI
	ft	%	pcf	%			
GEO-001	2-4	99.5	99.5	22.2	63	22	41
GEO-008	2-4	98.8	107.0	18.2	57	19	38
GEO-010	2-4	90.7	92.4	27.6	71	24	47
GEO-019	2-4	96.5	111.8	16.3	30	18	12
GEO-022	2-4	36.8	115.6	12.7	22	16	6
GEO-033	2-4	97.7	100.4	20.8	61	19	42
GEO-046	2-4	84.0	112.1	15.4	41	18	23
GEO-048	2-4	96.2	99.1	20.7	71	23	48
GEO-053	2-4	93.2	103.1	19.5	54	19	35
GEO-059	2-4	97.9	104.8	20.2	54	20	34
GEO-062	2-4	49.0	113.9	12.3	26	18	8
GEO-067	2-4	97.4	105.9	18.1	43	21	22
GEO-070	2-4	98.7	100.6	20.8	61	20	41
SUB-2	2-4	51.2	116.1	13.7	37	14	23

Boring	Depth	Soil Type (USCS)
GEO-001	2-4	Fat Clay (CH)
GEO-008	2-4	Fat Clay (CH)
GEO-010	2-4	Fat Clay (CH)
GEO-019	2-4	Lean Clay (CL)
GEO-022	2-4	Silty, Clayey Sand (SC-SM)
GEO-033	2-4	Fat Clay (CH)
GEO-046	2-4	Lean Clay with Sand (CL)
GEO-048	2-4	Fat Clay (CH)
GEO-053	2-4	Fat Clay (CH)
GEO-059	2-4	Fat Clay (CH)
GEO-062	2-4	Clayey Sand (SC)
GEO-067	2-4	Lean Clay (CL)
GEO-070	2-4	Fat Clay (CH)
SUB-2	2-4	Sandy Lean Clay (CL)

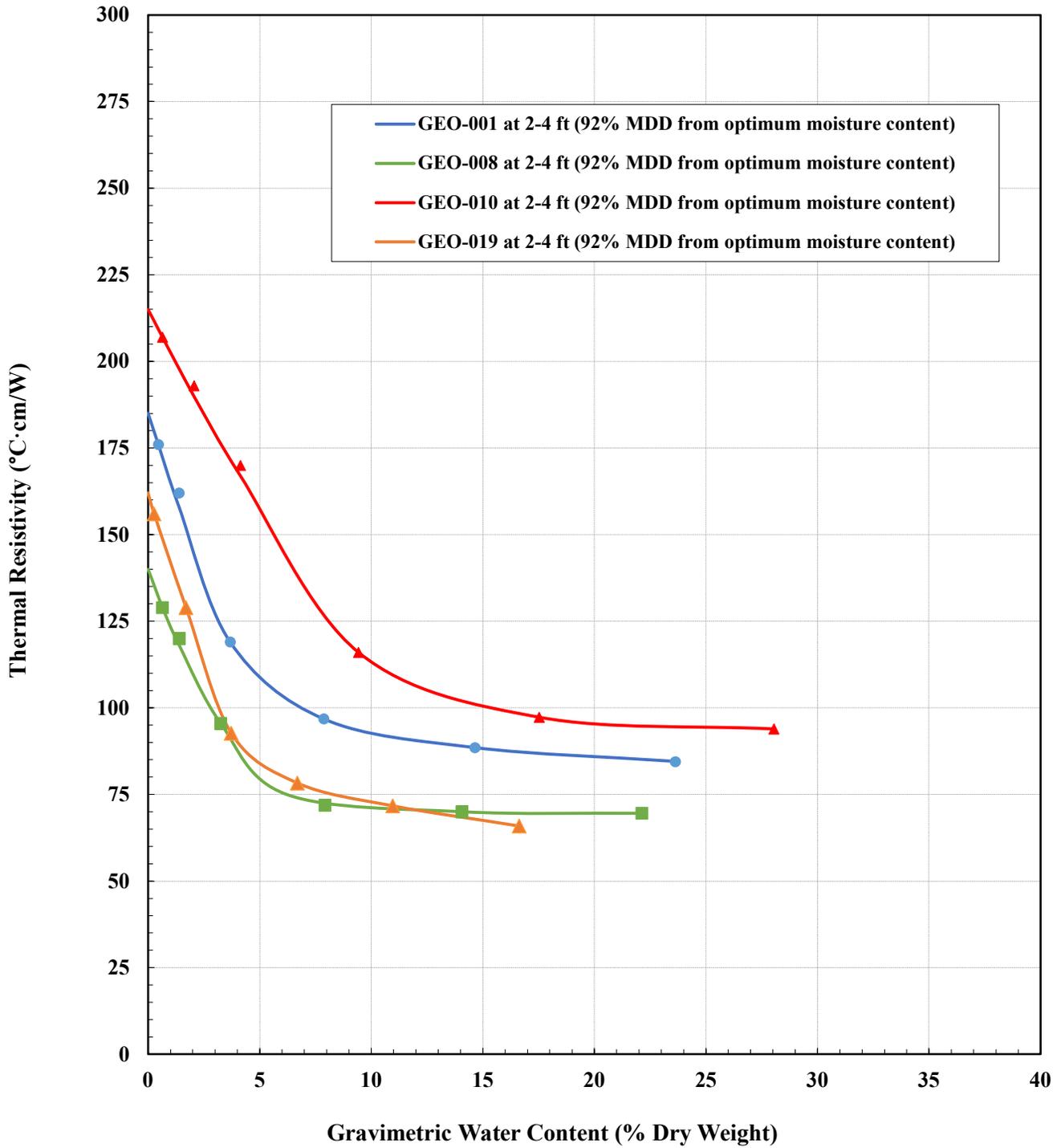


**Soil Thermal Resistivity Sample & Testing Summary**  
**Longspur Wind Project (PN: GE2503026)**

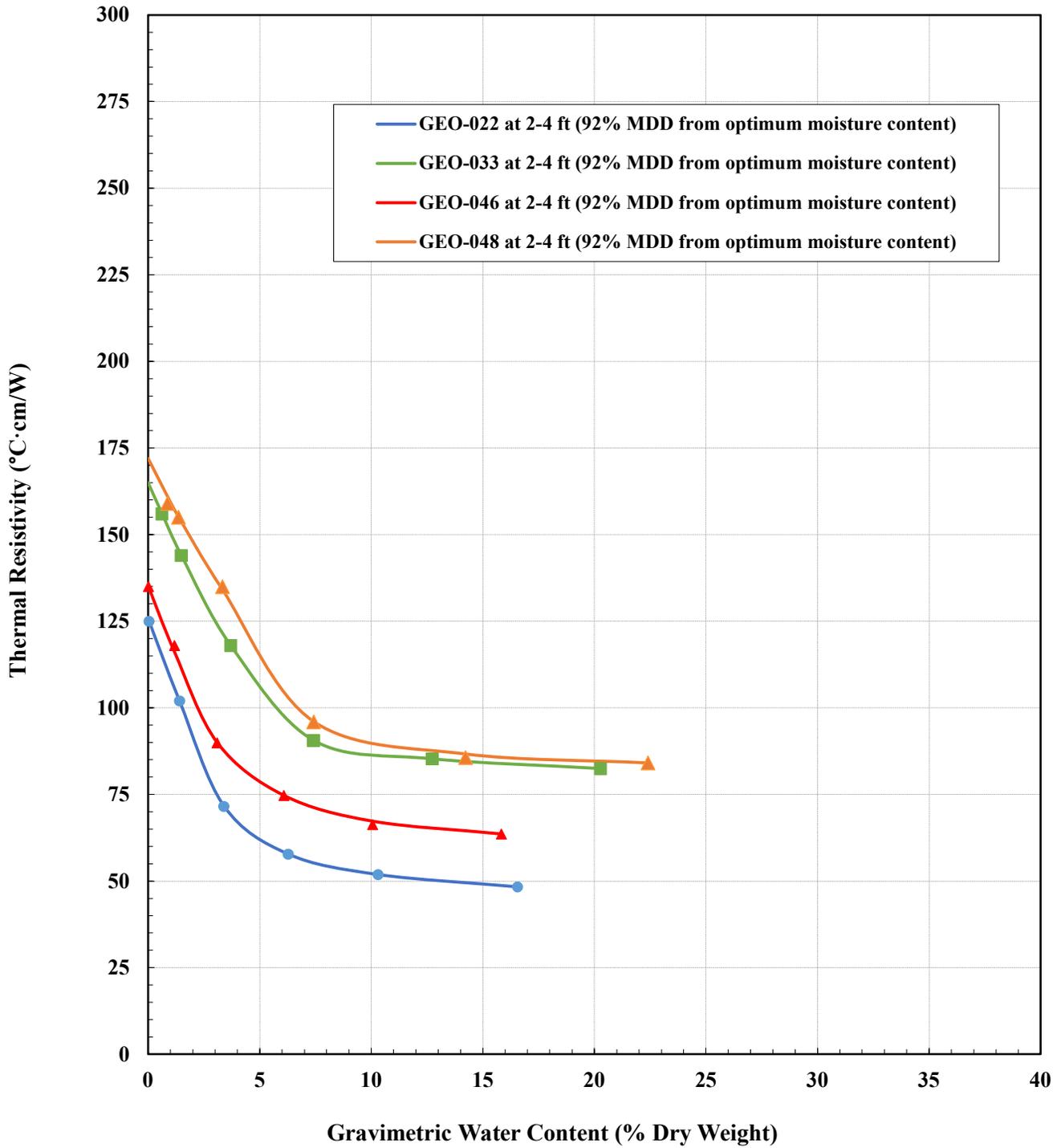
<b>Remolded Samples</b>						
<i>Boring</i>	<i>Remold Water Content</i>	<i>Percent Compaction</i>	<i>Target Remold Dry Density</i>	<i>Actual Remold Dry Density</i>	<i>Thermal Resistivity at Wet (IEEE 442)</i>	<i>Thermal Resistivity at Dry (IEEE 442)</i>
	<i>%</i>	<i>%</i>	<i>pcf</i>	<i>pcf</i>	<i>°C-cm/W</i>	<i>°C-cm/W</i>
GEO-001	23.6	92	91.5	92.2	85	185
GEO-008	22.1		98.4	100.0	70	140
GEO-010	28.1		85.0	85.2	94	215
GEO-019	16.6		102.9	103.2	66	162
GEO-022	16.6		106.4	106.9	48	126
GEO-033	20.3		92.4	93.3	83	165
GEO-046	15.8		103.1	103.8	64	136
GEO-048	22.4		91.2	92.2	84	172
GEO-053	19.7		94.9	95.6	85	168
GEO-059	21.0		96.4	97.1	76	145
GEO-062	12.7		104.8	105.0	62	162
GEO-067	18.1		97.4	98.1	73	158
GEO-070	20.6		92.6	93.9	79	169
SUB-2	14.0		106.8	107.5	58	125

HuaMiao Cao, P.E., 6/3/25  
 Analysis & Quality Review/Date

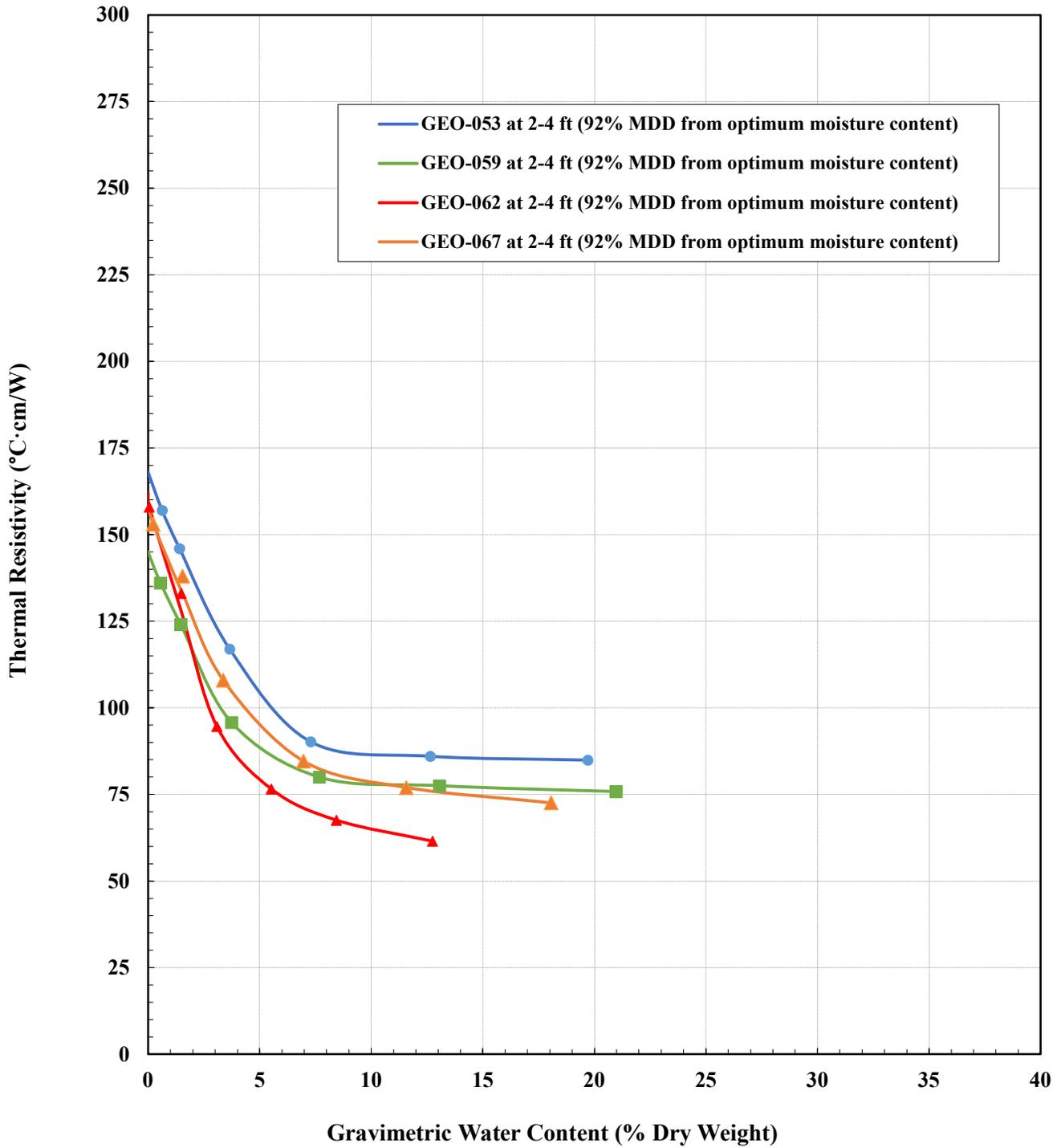
### Soil Thermal Resistivity Testing Dryout Curves Longspur Wind Project (PN: GE2503026)



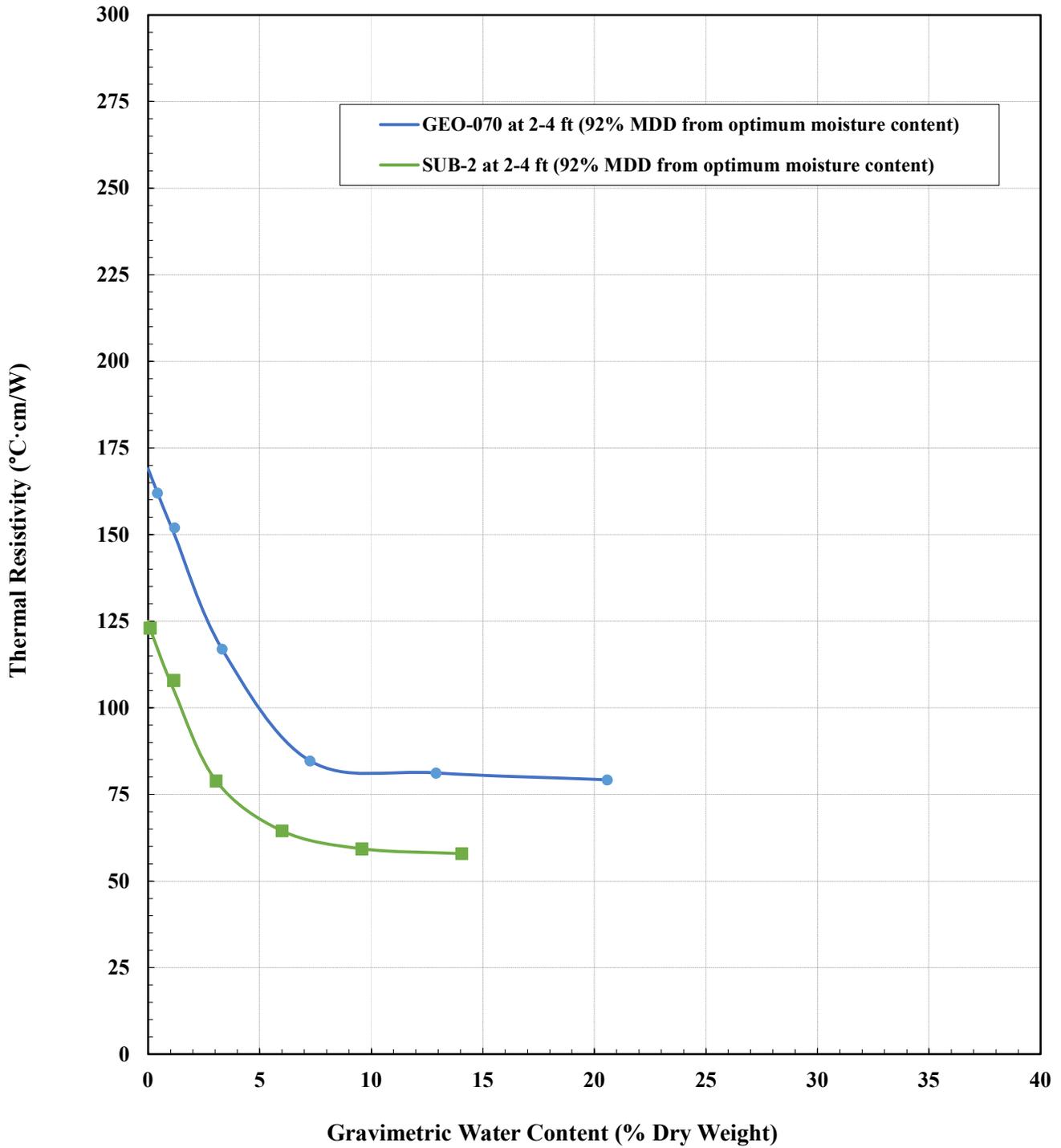
### Soil Thermal Resistivity Testing Dryout Curves Longspur Wind Project (PN: GE2503026)



### Soil Thermal Resistivity Testing Dryout Curves Longspur Wind Project (PN: GE2503026)



### Soil Thermal Resistivity Testing Dryout Curves Longspur Wind Project (PN: GE2503026)





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## APPENDIX D

**Table D1.1 – LPILE Computer Program Parameters for Lateral Load Analysis for SUB-1**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	790	--	0.01	--	--	--	--
2	3 to 4	Sand (Reese)	25	--	110	--	31	--	--	--	--	--
3	4 to 7	Sand (Reese)	90	--	110	--	35	--	--	--	--	--
4	7 to 12	Sand (Reese)	60	--	58	--	33	--	--	--	--	--
5	12 to 14	Sand (Reese)	60	--	63	--	35	--	--	--	--	--
6	14 to 19	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
7	19 to 24	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
8	24 to 29	Stiff Clay w/o Free Water	--	--	68	5,980	--	0.004	--	--	--	--
9	29 to 34	Stiff Clay w/o Free Water	--	--	67.6	3,450	--	0.005	--	--	--	--
10	34 to 40	Stiff Clay w/o Free Water	--	--	67.6	5,050	--	0.005	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D1.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for SUB-1**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	CL	105	--	790	--	3.04	6	--	0	1,700
2	3 to 4	SM	110	31	--	--	3.12	6	0.6	90	2,400
3	4 to 7	SP	110	35	--	--	3.69	30	2.9	350	6,400
4	7 to 12	SP	58	33	--	--	3.39	16	1.5	370	6,400
5	12 to 14	SC	63	35	--	--	3.69	30	2.9	590	10,300
6	14 to 19	SC	63	35	--	--	3.69	40	3.9	720	10,300
7	19 to 24	SC	63	35	--	--	3.69	38	3.7	770	10,300
8	24 to 29	CL	68	--	5,980	--	3.04	73	4.2	1,070	10,300
9	29 to 34	CL	68	--	3,450	--	3.04	26	2.2	740	10,300
10	34 to 40	CL	68	--	5,050	--	3.04	38	2.8	930	15,100

**Table D1.3 – Grout Anchor Design Parameters for SUB-1**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	CL	--
2	3 to 4	SM	9
3	4 to 7	SP	15
4	7 to 12	SP	12
5	12 to 14	SC	15
6	14 to 19	SC	18
7	19 to 24	SC	17
8	24 to 29	CL	21
9	29 to 34	CL	12
10	34 to 40	CL	18

Notes: Design depth to groundwater is 7 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D2.1 – LPILE Computer Program Parameters for Lateral Load Analysis for SUB-2**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	920	--	0.01	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water	--	--	120	920	--	0.010	--	--	--	--
3	7 to 9	Sand (Reese)	60	--	58	--	33	--	--	--	--	--
4	9 to 14	Sand (Reese)	60	--	63	--	35	--	--	--	--	--
5	14 to 19	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
6	19 to 24	Sand (Reese)	125	--	58	--	35	--	--	--	--	--
7	24 to 29	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
8	29 to 34	Stiff Clay w/o Free Water	--	--	68	5,450	--	0.005	--	--	--	--
9	34 to 39	Sand (Reese)	125	--	62.6	--	35	--	--	--	--	--
10	39 to 40	Sand (Reese)	125	--	62.6	--	35	--	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D2.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for SUB-2**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	CL	105	--	920	--	3.04	7	--	0	2,000
2	3 to 7	CL	120	--	920	--	3.04	7	1.0	200	2,000
3	7 to 9	SP	58	33	--	--	3.39	16	1.5	350	6,400
4	9 to 14	SC	63	35	--	--	3.69	27	2.6	550	10,800
5	14 to 19	SC	63	35	--	--	3.69	39	3.8	730	15,600
6	19 to 24	SP	58	35	--	--	3.69	40	3.9	800	16,000
7	24 to 29	SC	63	35	--	--	3.69	85	8.3	1,220	16,300
8	29 to 34	CL	68	--	5,450	--	3.04	41	2.9	980	16,300
9	34 to 39	SC	63	35	--	--	3.69	51	5.0	1,090	18,000
10	39 to 40	SC	63	35	--	--	3.69	45	4.4	1,060	18,000

**Table D2.3 – Grout Anchor Design Parameters for SUB-2**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	CL	--
2	3 to 7	CL	3
3	7 to 9	SP	12
4	9 to 14	SC	14
5	14 to 19	SC	17
6	19 to 24	SP	18
7	24 to 29	SC	29
8	29 to 34	CL	19
9	34 to 39	SC	20
10	39 to 40	SC	19

Notes: Design depth to groundwater is 7 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D3.1 – LPILE Computer Program Parameters for Lateral Load Analysis for SUB-3**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	790	--	0.01	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water	--	--	120	790	--	0.010	--	--	--	--
3	7 to 9	Sand (Reese)	60	--	63	--	33	--	--	--	--	--
4	9 to 14	Sand (Reese)	60	--	63	--	35	--	--	--	--	--
5	14 to 19	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
6	19 to 24	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
7	24 to 29	Stiff Clay w/o Free Water	--	--	68	3,850	--	0.005	--	--	--	--
8	29 to 34	Stiff Clay w/o Free Water	--	--	68	4,390	--	0.005	--	--	--	--
9	34 to 39	Stiff Clay w/o Free Water	--	--	67.6	5,980	--	0.004	--	--	--	--
10	39 to 40	Stiff Clay w/o Free Water	--	--	67.6	5,980	--	0.004	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D3.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for SUB-3**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	CL	105	--	790	--	3.04	6	--	0	1,700
2	3 to 7	CL	120	--	790	--	3.04	6	0.9	170	1,700
3	7 to 9	SC	63	33	--	--	3.39	14	1.3	330	5,600
4	9 to 14	SC	63	35	--	--	3.69	28	2.7	560	11,200
5	14 to 19	SC	63	35	--	--	3.69	33	3.2	680	11,500
6	19 to 24	SC	63	35	--	--	3.69	44	4.3	840	11,500
7	24 to 29	CL	68	--	3,850	--	3.04	29	2.4	790	11,500
8	29 to 34	CL	68	--	4,390	--	3.04	33	2.6	860	13,100
9	34 to 39	CL	68	--	5,980	--	3.04	50	3.3	1,070	17,900
10	39 to 40	CL	68	--	5,980	--	3.04	79	4.4	1,070	17,900

**Table D3.3 – Grout Anchor Design Parameters for SUB-3**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	CL	--
2	3 to 7	CL	3
3	7 to 9	SC	11
4	9 to 14	SC	15
5	14 to 19	SC	16
6	19 to 24	SC	19
7	24 to 29	CL	13
8	29 to 34	CL	15
9	34 to 39	CL	21
10	39 to 40	CL	21

Notes: Design depth to groundwater is 7 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma'=\gamma_{Total}-62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D4.1 – LPILE Computer Program Parameters for Lateral Load Analysis for SUB-4**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	650	--	0.01	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water	--	--	125	650	--	0.010	--	--	--	--
3	7 to 9	Sand (Reese)	60	--	63	--	32	--	--	--	--	--
4	9 to 14	Sand (Reese)	60	--	63	--	34	--	--	--	--	--
5	14 to 19	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
6	19 to 24	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
7	24 to 29	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
8	29 to 34	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
9	34 to 39	Stiff Clay w/o Free Water	--	--	67.6	5,050	--	0.005	--	--	--	--
10	39 to 40	Stiff Clay w/o Free Water	--	--	67.6	3,990	--	0.005	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D4.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for SUB-4**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	CL	105	--	650	--	3.04	5	--	0	1,400
2	3 to 7	CL	125	--	650	--	3.04	5	0.8	140	1,400
3	7 to 9	SC	63	32	--	--	3.25	11	1.1	300	4,400
4	9 to 14	SC	63	34	--	--	3.54	23	2.2	500	9,200
5	14 to 19	SC	63	35	--	--	3.69	46	4.5	790	11,900
6	19 to 24	SC	63	35	--	--	3.69	33	3.2	740	11,900
7	24 to 29	SC	63	35	--	--	3.69	39	3.8	860	11,900
8	29 to 34	SC	63	35	--	--	3.69	46	4.5	990	11,900
9	34 to 39	CL	68	--	5,050	--	3.04	38	2.8	930	11,900
10	39 to 40	CL	68	--	3,990	--	3.04	30	2.4	810	11,900

**Table D4.3 – Grout Anchor Design Parameters for SUB-4**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	CL	--
2	3 to 7	CL	2
3	7 to 9	SC	10
4	9 to 14	SC	13
5	14 to 19	SC	19
6	19 to 24	SC	16
7	24 to 29	SC	17
8	29 to 34	SC	19
9	34 to 39	CL	18
10	39 to 40	CL	14

Notes: Design depth to groundwater is 7 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D5.1 – LPILE Computer Program Parameters for Lateral Load Analysis for SUB-5**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	650	--	0.01	--	--	--	--
2	3 to 4	Stiff Clay w/o Free Water	--	--	120	650	--	0.010	--	--	--	--
3	4 to 7	Sand (Reese)	25	--	125	--	30	--	--	--	--	--
4	7 to 14	Sand (Reese)	20	--	63	--	31	--	--	--	--	--
5	14 to 19	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
6	19 to 24	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
7	24 to 29	Stiff Clay w/o Free Water	--	--	68	5,850	--	0.004	--	--	--	--
8	29 to 34	Stiff Clay w/o Free Water	--	--	68	5,450	--	0.005	--	--	--	--
9	34 to 39	Stiff Clay w/o Free Water	--	--	67.6	4,650	--	0.005	--	--	--	--
10	39 to 40	Stiff Clay w/o Free Water	--	--	67.6	5,590	--	0.005	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D5.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for SUB-5**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	CL	105	--	650	--	3.04	5	--	0	1,400
2	3 to 4	CL	120	--	650	--	3.04	5	0.8	140	1,400
3	4 to 7	SC	125	30	--	--	3.00	6	0.6	150	2,400
4	7 to 14	SC	63	31	--	--	3.12	9	0.9	290	3,600
5	14 to 19	SC	63	35	--	--	3.69	36	3.5	710	12,400
6	19 to 24	SC	63	35	--	--	3.69	31	3.0	720	12,400
7	24 to 29	CL	68	--	5,850	--	3.04	44	3.1	1,050	13,900
8	29 to 34	CL	68	--	5,450	--	3.04	41	2.9	980	13,900
9	34 to 39	CL	68	--	4,650	--	3.04	35	2.7	890	13,900
10	39 to 40	CL	68	--	5,590	--	3.04	42	3.0	1,000	16,700

**Table D5.3 – Grout Anchor Design Parameters for SUB-5**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	CL	--
2	3 to 4	CL	2
3	4 to 7	SC	9
4	7 to 14	SC	10
5	14 to 19	SC	17
6	19 to 24	SC	15
7	24 to 29	CL	20
8	29 to 34	CL	19
9	34 to 39	CL	16
10	39 to 40	CL	19

Notes: Design depth to groundwater is 7 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D6.1 – LPILE Computer Program Parameters for Lateral Load Analysis for SUB-6**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)	(psi)	(psi)	(%)		
1*	0 to 3	Soft Clay (1)	--	--	105	1,450	--	0.007	--	--	--	--
2	3 to 7	Sand (Reese)	90	--	120	--	33	--	--	--	--	--
3	7 to 9	Sand (Reese)	60	--	63	--	32	--	--	--	--	--
4	9 to 14	Sand (Reese)	60	--	63	--	35	--	--	--	--	--
5	14 to 19	Stiff Clay w/o Free Water	--	--	68	5,980	--	0.004	--	--	--	--
6	19 to 24	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
7	24 to 29	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
8	29 to 34	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
9	34 to 39	Sand (Reese)	60	--	62.6	--	33	--	--	--	--	--
10	39 to 40	Sand (Reese)	125	--	62.6	--	35	--	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D6.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for SUB-6**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	CL	105	--	1,450	--	3.04	11	--	0	3,800
2	3 to 7	SC	120	33	--	--	3.39	12	1.2	200	4,800
3	7 to 9	SC	63	32	--	--	3.25	12	1.2	300	4,800
4	9 to 14	SC	63	35	--	--	3.69	30	2.9	580	9,600
5	14 to 19	CL	68	--	5,980	--	3.04	100	5.2	1,070	9,600
6	19 to 24	SC	63	35	--	--	3.69	50	4.9	900	9,600
7	24 to 29	SC	63	35	--	--	3.69	59	5.8	1,040	9,600
8	29 to 34	SC	63	35	--	--	3.69	59	5.8	1,110	9,600
9	34 to 39	SC	63	33	--	--	3.39	24	2.3	730	9,600
10	39 to 40	SC	63	35	--	--	3.69	44	4.3	1,050	17,600

**Table D6.3 – Grout Anchor Design Parameters for SUB-6**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	CL	--
2	3 to 7	SC	11
3	7 to 9	SC	11
4	9 to 14	SC	15
5	14 to 19	CL	21
6	19 to 24	SC	20
7	24 to 29	SC	22
8	29 to 34	SC	22
9	34 to 39	SC	14
10	39 to 40	SC	19

Notes: Design depth to groundwater is 7 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D7.1 – LPILE Computer Program Parameters for Lateral Load Analysis for SUB-7**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$ (pcf)	C (psf)	$\phi$ (degree)	$\epsilon_{50}$	$E_{rm}$ (psi)	UCS (psi)	RQD (%)	$K_{rm}$
			Static	Cyclic								
1*	0 to 3	Soft Clay (1)	--	--	105	390	--	0.02	--	--	--	--
2	3 to 4	Stiff Clay w/o Free Water	--	--	115	390	--	0.020	--	--	--	--
3	4 to 7	Sand (Reese)	90	--	120	--	33	--	--	--	--	--
4	7 to 14	Sand (Reese)	60	--	63	--	35	--	--	--	--	--
5	14 to 19	Stiff Clay w/o Free Water	--	--	63	5,980	--	0.004	--	--	--	--
6	19 to 24	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
7	24 to 29	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
8	29 to 34	Stiff Clay w/o Free Water	--	--	68	5,980	--	0.004	--	--	--	--
9	34 to 39	Stiff Clay w/o Free Water	--	--	67.6	5,850	--	0.004	--	--	--	--
10	39 to 40	Stiff Clay w/o Free Water	--	--	67.6	5,980	--	0.004	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D7.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for SUB-7**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$ (pcf)	$\phi$ (degree)	C (psf)	$C'_{Rock}$ (psf)	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
2	3 to 4	CL	115	--	390	--	3.04	3	0.6	80	800
3	4 to 7	SC	120	33	--	--	3.39	14	1.3	240	5,600
4	7 to 14	SC	63	35	--	--	3.69	28	2.7	550	11,200
5	14 to 19	SC	63	--	5,980	--	3.04	85	4.7	1,070	17,500
6	19 to 24	SC	63	35	--	--	3.69	62	6.1	990	17,500
7	24 to 29	SC	63	35	--	--	3.69	68	6.6	1,110	17,500
8	29 to 34	CL	68	--	5,980	--	3.04	58	3.7	1,070	17,500
9	34 to 39	CL	68	--	5,850	--	3.04	44	3.1	1,050	17,500
10	39 to 40	CL	68	--	5,980	--	3.04	46	3.2	1,070	17,900

**Table D7.3 – Grout Anchor Design Parameters for SUB-7**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	CL	--
2	3 to 4	CL	1
3	4 to 7	SC	11
4	7 to 14	SC	15
5	14 to 19	SC	29
6	19 to 24	SC	23
7	24 to 29	SC	25
8	29 to 34	CL	21
9	34 to 39	CL	20
10	39 to 40	CL	21

Notes: Design depth to groundwater is 7 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D8.1 – LPILE Computer Program Parameters for Lateral Load Analysis for SUB-8**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,590	--	0.007	--	--	--	--
2	3 to 7	Sand (Reese)	90	--	120	--	33	--	--	--	--	--
3	7 to 9	Sand (Reese)	60	--	58	--	35	--	--	--	--	--
4	9 to 12	Sand (Reese)	125	--	58	--	35	--	--	--	--	--
5	12 to 19	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
6	19 to 24	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
7	24 to 29	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
8	29 to 34	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
9	34 to 40	Stiff Clay w/o Free Water	--	--	67.6	4,790	--	0.005	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D8.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for SUB-8**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	CL	105	--	1,590	--	3.04	12	--	0	4,200
2	3 to 7	SC	120	33	--	--	3.39	12	1.2	200	4,800
3	7 to 9	SP	58	35	--	--	3.69	30	2.9	510	12,000
4	9 to 12	SP	58	35	--	--	3.69	32	3.1	580	12,800
5	12 to 19	SC	63	35	--	--	3.69	35	3.4	680	14,000
6	19 to 24	SC	63	35	--	--	3.69	40	3.9	800	14,300
7	24 to 29	SC	63	35	--	--	3.69	47	4.6	930	14,300
8	29 to 34	SC	63	35	--	--	3.69	64	6.3	1,140	14,300
9	34 to 40	CL	68	--	4,790	--	3.04	36	2.7	900	14,300

**Table D8.3 – Grout Anchor Design Parameters for SUB-8**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	CL	--
2	3 to 7	SC	11
3	7 to 9	SP	15
4	9 to 12	SP	16
5	12 to 19	SC	16
6	19 to 24	SC	18
7	24 to 29	SC	19
8	29 to 34	SC	24
9	34 to 40	CL	17

Notes: Design depth to groundwater is 7 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D9.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-1 (POI)**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	3,060	--	0.005	--	--	--	--
2	3 to 4	Stiff Clay w/o Free Water	--	--	125	3,060	--	0.005	--	--	--	--
3	4 to 9	Sand (Reese)	225	--	120	--	35	--	--	--	--	--
4	9 to 14	Sand (Reese)	90	--	120	--	35	--	--	--	--	--
5	14 to 19	Stiff Clay w/o Free Water	--	--	125	3,060	--	0.005	--	--	--	--
6	19 to 29	Stiff Clay w/o Free Water	--	--	125	4,120	--	0.005	--	--	--	--
7	29 to 34	Stiff Clay w/o Free Water	--	--	125	5,980	--	0.004	--	--	--	--
8	34 to 39	Stiff Clay w/o Free Water	--	--	125	4,650	--	0.005	--	--	--	--
9	39 to 44	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
10	44 to 50	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D9.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-1 (POI)**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	CL	105	--	3,060	--	3.04	23	--	0	9,100
2	3 to 4	CL	125	--	3,060	--	3.04	23	2.0	670	9,100
3	4 to 9	SC	120	35	--	--	3.69	42	4.1	520	9,100
4	9 to 14	SC	120	35	--	--	3.69	29	2.8	630	9,100
5	14 to 19	CL	125	--	3,060	--	3.04	23	2.0	670	9,100
6	19 to 29	CL	125	--	4,120	--	3.04	31	2.5	830	12,300
7	29 to 34	CL	125	--	5,980	--	3.04	48	3.3	1,070	13,900
8	34 to 39	CL	125	--	4,650	--	3.04	35	2.7	890	13,900
9	39 to 44	CL	130	--	5,980	--	3.04	75	4.3	1,070	17,900
10	44 to 50	CL	130	--	5,980	--	3.04	67	4.0	1,070	17,900

**Table D9.3 – Grout Anchor Design Parameters for TL-1 (POI)**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	CL	--
2	3 to 4	CL	11
3	4 to 9	SC	18
4	9 to 14	SC	15
5	14 to 19	CL	11
6	19 to 29	CL	14
7	29 to 34	CL	21
8	34 to 39	CL	16
9	39 to 44	CL	21
10	44 to 50	CL	21

Notes: Design depth to groundwater is 50 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D10.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-2**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$ (pcf)	C (psf)	$\phi$ (degree)	$\epsilon_{50}$	$E_{rm}$ (psi)	UCS (psi)	RQD (%)	$K_{rm}$
			Static	Cyclic								
1*	0 to 3	Soft Clay (1)	--	--	105	650	--	0.01	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water	--	--	125	650	--	0.010	--	--	--	--
3	7 to 9	Stiff Clay w/o Free Water	--	--	125	3,190	--	0.005	--	--	--	--
4	9 to 12	Stiff Clay w/o Free Water	--	--	125	2,920	--	0.005	--	--	--	--
5	12 to 14	Stiff Clay w/o Free Water	--	--	125	3,990	--	0.005	--	--	--	--
6	14 to 19	Stiff Clay w/o Free Water	--	--	125	3,450	--	0.005	--	--	--	--
7	19 to 24	Stiff Clay w/o Free Water	--	--	125	5,450	--	0.005	--	--	--	--
8	24 to 29	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
9	29 to 30	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D10.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-2**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$ (pcf)	$\phi$ (degree)	C (psf)	$C'_{Rock}$ (psf)	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
2	3 to 7	CH	125	--	650	--	3.04	5	0.8	140	1,400
3	7 to 9	CL	125	--	3,190	--	3.04	24	2.1	700	8,700
4	9 to 12	CL	125	--	2,920	--	3.04	22	2.0	640	8,700
5	12 to 14	CL	125	--	3,990	--	3.04	30	2.4	810	10,300
6	14 to 19	CL	125	--	3,450	--	3.04	26	2.2	740	10,300
7	19 to 24	CL	125	--	5,450	--	3.04	41	2.9	980	16,300
8	24 to 29	CL	130	--	5,980	--	3.04	74	4.3	1,070	17,900
9	29 to 30	CL	130	--	5,980	--	3.04	61	3.8	1,070	17,900

**Table D10.3 – Grout Anchor Design Parameters for TL-2**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	CH	--
2	3 to 7	CH	2
3	7 to 9	CL	11
4	9 to 12	CL	10
5	12 to 14	CL	14
6	14 to 19	CL	12
7	19 to 24	CL	19
8	24 to 29	CL	21
9	29 to 30	CL	21

Notes: Design depth to groundwater is 30 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D11.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-3**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$ (pcf)	C (psf)	$\phi$ (degree)	$\epsilon_{50}$	$E_{rm}$ (psi)	UCS (psi)	RQD (%)	$K_{rm}$
			Static	Cyclic								
1*	0 to 3	Soft Clay (1)	--	--	105	1,190	--	0.007	--	--	--	--
2	3 to 4	Sand (Reese)	25	--	120	--	32	--	--	--	--	--
3	4 to 7	Stiff Clay w/o Free Water	--	--	125	1,190	--	0.007	--	--	--	--
4	7 to 12	Stiff Clay w/o Free Water	--	--	130	2,650	--	0.005	--	--	--	--
5	12 to 14	Stiff Clay w/o Free Water	--	--	125	3,450	--	0.005	--	--	--	--
6	14 to 19	Stiff Clay w/o Free Water	--	--	125	3,990	--	0.005	--	--	--	--
7	19 to 24	Stiff Clay w/o Free Water	--	--	125	3,060	--	0.005	--	--	--	--
8	24 to 29	Stiff Clay w/o Free Water	--	--	125	4,390	--	0.005	--	--	--	--
9	29 to 30	Stiff Clay w/o Free Water	--	--	125	3,450	--	0.005	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D11.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-3**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$ (pcf)	$\phi$ (degree)	C (psf)	$C'_{Rock}$ (psf)	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
2	3 to 4	SC	120	32	--	--	3.25	9	0.9	110	3,100
3	4 to 7	CH	125	--	1,190	--	3.04	9	1.1	260	3,100
4	7 to 12	CH	130	--	2,650	--	3.04	20	1.9	580	7,900
5	12 to 14	CL	125	--	3,450	--	3.04	26	2.2	740	9,100
6	14 to 19	CL	125	--	3,990	--	3.04	30	2.4	810	9,100
7	19 to 24	CL	125	--	3,060	--	3.04	23	2.0	670	9,100
8	24 to 29	CL	125	--	4,390	--	3.04	33	2.6	860	10,300
9	29 to 30	CL	125	--	3,450	--	3.04	26	2.2	740	10,300

**Table D11.3 – Grout Anchor Design Parameters for TL-3**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	SC	--
2	3 to 4	SC	10
3	4 to 7	CH	4
4	7 to 12	CH	9
5	12 to 14	CL	12
6	14 to 19	CL	14
7	19 to 24	CL	11
8	24 to 29	CL	15
9	29 to 30	CL	12

Notes: Design depth to groundwater is 50 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D12.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-4 (POI)**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	790	--	0.01	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water	--	--	120	790	--	0.010	--	--	--	--
3	7 to 12	Stiff Clay w/o Free Water	--	--	120	1,050	--	0.007	--	--	--	--
4	12 to 14	Stiff Clay w/o Free Water	--	--	125	3,190	--	0.005	--	--	--	--
5	14 to 19	Stiff Clay w/o Free Water	--	--	125	4,390	--	0.005	--	--	--	--
6	19 to 24	Stiff Clay w/o Free Water	--	--	125	5,190	--	0.005	--	--	--	--
7	24 to 34	Stiff Clay w/o Free Water	--	--	125	5,850	--	0.004	--	--	--	--
8	34 to 39	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
9	39 to 44	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
10	44 to 50	Sand (Reese)	225	--	125	--	34	--	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D12.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-4 (POI)**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	CL	105	--	790	--	3.04	6	--	0	1,700
2	3 to 7	CL	120	--	790	--	3.04	6	0.9	170	1,700
3	7 to 12	CL	120	--	1,050	--	3.04	8	1.1	230	2,800
4	12 to 14	CL	125	--	3,190	--	3.04	24	2.1	700	9,500
5	14 to 19	CL	125	--	4,390	--	3.04	33	2.6	860	13,100
6	19 to 24	CL	125	--	5,190	--	3.04	39	2.9	940	15,500
7	24 to 34	CL	125	--	5,850	--	3.04	44	3.1	1,050	17,500
8	34 to 39	CL	130	--	5,980	--	3.04	55	3.5	1,070	17,900
9	39 to 44	CL	130	--	5,980	--	3.04	60	3.7	1,070	17,900
10	44 to 50	SC	125	34	--	--	3.54	54	5.3	1,530	20,000

**Table D12.3 – Grout Anchor Design Parameters for TL-4 (POI)**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	CL	--
2	3 to 7	CL	3
3	7 to 12	CL	4
4	12 to 14	CL	11
5	14 to 19	CL	15
6	19 to 24	CL	18
7	24 to 34	CL	20
8	34 to 39	CL	21
9	39 to 44	CL	21
10	44 to 50	SC	21

Notes: Design depth to groundwater is 50 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D13.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-5**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,590	--	0.007	--	--	--	--
2	3 to 9	Stiff Clay w/o Free Water	--	--	120	1,190	--	0.007	--	--	--	--
3	9 to 14	Stiff Clay w/o Free Water	--	--	125	1,720	--	0.007	--	--	--	--
4	14 to 19	Stiff Clay w/o Free Water	--	--	125	3,450	--	0.005	--	--	--	--
5	19 to 24	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
6	24 to 29	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
7	29 to 30	Stiff Clay w/o Free Water	--	--	125	4,520	--	0.005	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D13.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-5**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	CL	105	--	1,590	--	3.04	12	--	0	3,100
2	3 to 9	CL	120	--	1,190	--	3.04	9	1.1	260	3,100
3	9 to 14	CL	125	--	1,720	--	3.04	13	1.4	380	4,600
4	14 to 19	CL	125	--	3,450	--	3.04	26	2.2	740	10,300
5	19 to 24	SC	125	35	--	--	3.69	51	5.0	1,080	13,500
6	24 to 29	ML	130	--	5,980	--	3.04	78	4.4	1,070	13,500
7	29 to 30	CL	125	--	4,520	--	3.04	34	2.6	880	13,500

**Table D13.3 – Grout Anchor Design Parameters for TL-5**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	CL	--
2	3 to 9	CL	4
3	9 to 14	CL	6
4	14 to 19	CL	12
5	19 to 24	SC	20
6	24 to 29	ML	21
7	29 to 30	CL	16

Notes: Design depth to groundwater is 30 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D14.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-6 (POI)**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,050	--	0.007	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water	--	--	120	3,990	--	0.005	--	--	--	--
3	7 to 12	Stiff Clay w/o Free Water	--	--	125	1,050	--	0.007	--	--	--	--
4	12 to 14	Stiff Clay w/o Free Water	--	--	125	1,850	--	0.007	--	--	--	--
5	14 to 19	Stiff Clay w/o Free Water	--	--	125	5,190	--	0.005	--	--	--	--
6	19 to 24	Stiff Clay w/o Free Water	--	--	125	3,060	--	0.005	--	--	--	--
7	24 to 39	Sand (Reese)	225	--	120	--	33	--	--	--	--	--
8	39 to 44	Stiff Clay w/o Free Water	--	--	130	5,320	--	0.005	--	--	--	--
9	44 to 49	Stiff Clay w/o Free Water	--	--	130	5,450	--	0.005	--	--	--	--
10	49 to 50	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D14.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-6 (POI)**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	SC	105	--	1,050	--	3.04	8	--	0	2,800
2	3 to 7	SC	120	--	3,990	--	3.04	30	2.4	810	2,800
3	7 to 12	CL	125	--	1,050	--	3.04	8	1.1	230	2,800
4	12 to 14	CL	125	--	1,850	--	3.04	14	1.5	400	4,900
5	14 to 19	CL	125	--	5,190	--	3.04	39	2.9	940	9,100
6	19 to 24	CL	125	--	3,060	--	3.04	23	2.0	670	9,100
7	24 to 39	SC	120	33	--	--	3.39	36	3.5	1,030	14,400
8	39 to 44	CL	130	--	5,320	--	3.04	40	2.9	950	15,900
9	44 to 49	CL	130	--	5,450	--	3.04	41	2.9	980	16,300
10	49 to 50	CL	130	--	5,980	--	3.04	100	5.2	1,070	17,900

**Table D14.3 – Grout Anchor Design Parameters for TL-6 (POI)**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	SC	--
2	3 to 7	SC	15
3	7 to 12	CL	4
4	12 to 14	CL	6
5	14 to 19	CL	18
6	19 to 24	CL	11
7	24 to 39	SC	17
8	39 to 44	CL	18
9	44 to 49	CL	19
10	49 to 50	CL	21

Notes: Design depth to groundwater is 50 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D15.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-7**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	650	--	0.01	--	--	--	--
2	3 to 4	Stiff Clay w/o Free Water	--	--	125	650	--	0.010	--	--	--	--
3	4 to 9	Stiff Clay w/o Free Water	--	--	125	2,120	--	0.007	--	--	--	--
4	9 to 12	Stiff Clay w/o Free Water	--	--	125	2,650	--	0.005	--	--	--	--
5	12 to 19	Sand (Reese)	90	--	120	--	34	--	--	--	--	--
6	19 to 24	Sand (Reese)	225	--	120	--	35	--	--	--	--	--
7	24 to 29	Stiff Clay w/o Free Water	--	--	130	5,450	--	0.005	--	--	--	--
8	29 to 30	Stiff Clay w/o Free Water	--	--	130	4,790	--	0.005	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D15.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-7**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	CH	105	--	650	--	3.04	5	--	0	1,400
2	3 to 4	CH	125	--	650	--	3.04	5	0.8	140	1,400
3	4 to 9	CL	125	--	2,120	--	3.04	16	1.6	460	6,300
4	9 to 12	CL	125	--	2,650	--	3.04	20	1.9	580	7,900
5	12 to 19	SC	120	34	--	--	3.54	27	2.6	680	10,800
6	19 to 24	SC	120	35	--	--	3.69	43	4.2	1,000	14,300
7	24 to 29	CL	130	--	5,450	--	3.04	41	2.9	980	14,300
8	29 to 30	CL	130	--	4,790	--	3.04	36	2.7	900	14,300

**Table D15.3 – Grout Anchor Design Parameters for TL-7**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	CH	--
2	3 to 4	CH	2
3	4 to 9	CL	7
4	9 to 12	CL	9
5	12 to 19	SC	14
6	19 to 24	SC	18
7	24 to 29	CL	19
8	29 to 30	CL	17

Notes: Design depth to groundwater is 30 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D16.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-8**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$ (pcf)	C (psf)	$\phi$ (degree)	$\epsilon_{50}$	$E_{rm}$ (psi)	UCS (psi)	RQD (%)	$K_{rm}$
			Static	Cyclic								
1*	0 to 3	Soft Clay (1)	--	--	105	920	--	0.01	--	--	--	--
2	3 to 7	Sand (Reese)	25	--	120	--	30	--	--	--	--	--
3	7 to 9	Sand (Reese)	90	--	125	--	34	--	--	--	--	--
4	9 to 12	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
5	12 to 14	Stiff Clay w/o Free Water	--	--	115	390	--	0.020	--	--	--	--
6	14 to 19	Stiff Clay w/o Free Water	--	--	125	2,120	--	0.007	--	--	--	--
7	19 to 24	Sand (Reese)	225	--	125	--	34	--	--	--	--	--
8	24 to 30	Stiff Clay w/o Free Water	--	--	130	5,590	--	0.005	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D16.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-8**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$ (pcf)	$\phi$ (degree)	C (psf)	$C'_{Rock}$ (psf)	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
2	3 to 7	SC	120	30	--	--	3.00	5	0.5	120	800
3	7 to 9	SC	125	34	--	--	3.54	21	2.0	440	800
4	9 to 12	SC	125	35	--	--	3.69	36	3.5	670	800
5	12 to 14	CL	115	--	390	--	3.04	3	0.6	80	800
6	14 to 19	CL	125	--	2,120	--	3.04	16	1.6	460	6,300
7	19 to 24	SC	125	34	--	--	3.54	38	3.7	910	15,200
8	24 to 30	CL	130	--	5,590	--	3.04	42	3.0	1,000	16,700

**Table D16.3 – Grout Anchor Design Parameters for TL-8**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	SM	--
2	3 to 7	SC	9
3	7 to 9	SC	13
4	9 to 12	SC	17
5	12 to 14	CL	1
6	14 to 19	CL	7
7	19 to 24	SC	17
8	24 to 30	CL	19

Notes: Design depth to groundwater is 30 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D17.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-9**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\varepsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,990	--	0.007	--	--	--	--
2	3 to 7	Sand (Reese)	90	--	120	--	33	--	--	--	--	--
3	7 to 12	Sand (Reese)	90	--	120	--	34	--	--	--	--	--
4	12 to 14	Stiff Clay w/o Free Water	--	--	125	4,250	--	0.005	--	--	--	--
5	14 to 19	Sand (Reese)	90	--	125	--	34	--	--	--	--	--
6	19 to 24	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
7	24 to 29	Sand (Reese)	225	--	125	--	34	--	--	--	--	--
8	29 to 30	Sand (Reese)	90	--	125	--	32	--	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D17.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-9**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	SC	105	--	1,990	--	3.04	15	--	0	5,300
2	3 to 7	SC	120	33	--	--	3.39	14	1.3	210	5,600
3	7 to 12	SC	120	34	--	--	3.54	24	2.3	510	9,600
4	12 to 14	CL	125	--	4,250	--	3.04	32	2.5	840	10,400
5	14 to 19	SC	125	34	--	--	3.54	30	2.9	720	10,400
6	19 to 24	SC	125	35	--	--	3.69	44	4.3	1,010	10,400
7	24 to 29	SC	125	34	--	--	3.54	43	4.2	1,060	10,400
8	29 to 30	SC	125	32	--	--	3.25	26	2.5	840	10,400

**Table D17.3 – Grout Anchor Design Parameters for TL-9**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	SC	--
2	3 to 7	SC	11
3	7 to 12	SC	14
4	12 to 14	CL	15
5	14 to 19	SC	15
6	19 to 24	SC	19
7	24 to 29	SC	18
8	29 to 30	SC	14

Notes: Design depth to groundwater is 30 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D18.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-10**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	920	--	0.01	--	--	--	--
2	3 to 7	Sand (Reese)	25	--	115	--	26	--	--	--	--	--
3	7 to 9	Sand (Reese)	90	--	120	--	35	--	--	--	--	--
4	9 to 12	Sand (Reese)	225	--	120	--	35	--	--	--	--	--
5	12 to 14	Sand (Reese)	90	--	120	--	34	--	--	--	--	--
6	14 to 19	Sand (Reese)	225	--	125	--	34	--	--	--	--	--
7	19 to 24	Sand (Reese)	225	--	130	--	35	--	--	--	--	--
8	24 to 30	Sand (Reese)	125	--	68	--	35	--	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D18.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-10**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	SC	105	--	920	--	3.04	7	--	0	800
2	3 to 7	SC	115	26	--	--	2.52	2	0.2	70	800
3	7 to 9	SC	120	35	--	--	3.69	24	2.3	480	9,200
4	9 to 12	SC	120	35	--	--	3.69	32	3.1	630	9,200
5	12 to 14	SC	120	34	--	--	3.54	23	2.2	570	9,200
6	14 to 19	SC	125	34	--	--	3.54	32	3.1	740	12,800
7	19 to 24	SC	130	35	--	--	3.69	51	5.0	1,080	17,600
8	24 to 30	SC	68	35	--	--	3.69	44	4.3	1,090	17,600

**Table D18.3 – Grout Anchor Design Parameters for TL-10**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	SC	--
2	3 to 7	SC	8
3	7 to 9	SC	14
4	9 to 12	SC	16
5	12 to 14	SC	13
6	14 to 19	SC	16
7	19 to 24	SC	20
8	24 to 30	SC	19

Notes: Design depth to groundwater is 24 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D19.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-11**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	2,390	--	0.005	--	--	--	--
2	3 to 7	Sand (Reese)	25	--	120	--	31	--	--	--	--	--
3	7 to 9	Sand (Reese)	90	--	120	--	33	--	--	--	--	--
4	9 to 12	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
5	12 to 19	Sand (Reese)	90	--	125	--	34	--	--	--	--	--
6	19 to 24	Sand (Reese)	225	--	125	--	34	--	--	--	--	--
7	24 to 28	Sand (Reese)	225	--	130	--	35	--	--	--	--	--
8	28 to 30	Sand (Reese)	125	--	68	--	35	--	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D19.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-11**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	SC	105	--	2,390	--	3.04	18	--	0	3,200
2	3 to 7	SC	120	31	--	--	3.12	8	0.8	160	3,200
3	7 to 9	SC	120	33	--	--	3.39	17	1.6	380	6,800
4	9 to 12	SC	125	35	--	--	3.69	33	3.2	640	11,600
5	12 to 19	SC	125	34	--	--	3.54	29	2.8	700	11,600
6	19 to 24	SC	125	34	--	--	3.54	31	3.0	830	12,400
7	24 to 28	SC	130	35	--	--	3.69	61	6.0	1,280	20,000
8	28 to 30	SC	68	35	--	--	3.69	58	5.7	1,300	20,000

**Table D19.3 – Grout Anchor Design Parameters for TL-11**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	SC	--
2	3 to 7	SC	10
3	7 to 9	SC	12
4	9 to 12	SC	16
5	12 to 19	SC	15
6	19 to 24	SC	15
7	24 to 28	SC	23
8	28 to 30	SC	22

Notes: Design depth to groundwater is 28 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D20.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-12**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,050	--	0.007	--	--	--	--
2	3 to 7	Sand (Reese)	25	--	115	--	31	--	--	--	--	--
3	7 to 9	Stiff Clay w/o Free Water	--	--	63	1,050	--	0.007	--	--	--	--
4	9 to 12	Sand (Reese)	60	--	63	--	33	--	--	--	--	--
5	12 to 19	Sand (Reese)	125	--	68	--	35	--	--	--	--	--
6	19 to 24	Sand (Reese)	125	--	68	--	35	--	--	--	--	--
7	24 to 29	Stiff Clay w/o Free Water	--	--	63	1,990	--	0.007	--	--	--	--
8	29 to 30	Sand (Reese)	125	--	68	--	35	--	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D20.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-12**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	SC	105	--	1,050	--	3.04	8	--	0	2,400
2	3 to 7	SC	115	31	--	--	3.12	6	0.6	130	2,400
3	7 to 9	CL	63	--	1,050	--	3.04	8	1.1	230	2,800
4	9 to 12	SP	63	33	--	--	3.39	18	1.7	410	5,300
5	12 to 19	SC	68	35	--	--	3.69	33	3.2	660	5,300
6	19 to 24	SC	68	35	--	--	3.69	31	3.0	720	5,300
7	24 to 29	ML	63	--	1,990	--	3.04	15	1.6	430	5,300
8	29 to 30	SC	68	35	--	--	3.69	42	4.1	930	16,800

**Table D20.3 – Grout Anchor Design Parameters for TL-12**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	SC	--
2	3 to 7	SC	9
3	7 to 9	CL	4
4	9 to 12	SP	12
5	12 to 19	SC	16
6	19 to 24	SC	15
7	24 to 29	ML	7
8	29 to 30	SC	18

Notes: Design depth to groundwater is 7 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D21.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-13 (POI)**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 4	Soft Clay (1)	--	--	105	1,720	--	0.007	--	--	--	--
2	4 to 6	Stiff Clay w/o Free Water	--	--	120	1,320	--	0.007	--	--	--	--
3	6 to 9	Sand (Reese)	90	--	120	--	34	--	--	--	--	--
4	9 to 14	Stiff Clay w/o Free Water	--	--	125	1,720	--	0.007	--	--	--	--
5	14 to 19	Stiff Clay w/o Free Water	--	--	125	2,250	--	0.005	--	--	--	--
6	19 to 24	Stiff Clay w/o Free Water	--	--	125	3,600	--	0.005	--	--	--	--
7	24 to 34	Stiff Clay w/o Free Water	--	--	133	5,980	--	0.004	--	--	--	--
8	34 to 39	Stiff Clay w/o Free Water	--	--	130	4,790	--	0.005	--	--	--	--
9	39 to 44	Stiff Clay w/o Free Water	--	--	133	5,980	--	0.004	--	--	--	--
10	44 to 50	Stiff Clay w/o Free Water	--	--	133	5,980	--	0.004	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D21.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-13 (POI)**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 4	SC	105	--	1,720	--	3.04	13	--	380	3,500
2	4 to 6	CL	120	--	1,320	--	3.04	10	1.2	290	3,500
3	6 to 9	SC	120	34	--	--	3.54	22	2.1	420	4,600
4	9 to 14	CH	125	--	1,720	--	3.04	13	1.4	380	4,600
5	14 to 19	CL	125	--	2,250	--	3.04	17	1.7	490	6,700
6	19 to 24	CL	125	--	3,600	--	3.04	27	2.3	760	10,800
7	24 to 34	CL	133	--	5,980	--	3.04	68	4.0	1,070	14,300
8	34 to 39	CL	130	--	4,790	--	3.04	36	2.7	900	14,300
9	39 to 44	CL	133	--	5,980	--	3.04	77	4.4	1,070	17,900
10	44 to 50	CL	133	--	5,980	--	3.04	57	3.6	1,070	17,900

**Table D21.3 – Grout Anchor Design Parameters for TL-13 (POI)**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 4	SC	--
2	4 to 6	CL	5
3	6 to 9	SC	13
4	9 to 14	CH	6
5	14 to 19	CL	8
6	19 to 24	CL	13
7	24 to 34	CL	21
8	34 to 39	CL	17
9	39 to 44	CL	21
10	44 to 50	CL	21

Notes: Design depth to groundwater is 50 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D22.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-14 (POI)**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,050	--	0.007	--	--	--	--
2	3 to 7	Sand (Reese)	25	--	115	--	30	--	--	--	--	--
3	7 to 9	Sand (Reese)	90	--	115	--	32	--	--	--	--	--
4	9 to 14	Stiff Clay w/o Free Water	--	--	125	3,320	--	0.005	--	--	--	--
5	14 to 19	Stiff Clay w/o Free Water	--	--	125	1,990	--	0.007	--	--	--	--
6	19 to 29	Stiff Clay w/o Free Water	--	--	125	3,600	--	0.005	--	--	--	--
7	29 to 34	Stiff Clay w/o Free Water	--	--	125	3,060	--	0.005	--	--	--	--
8	34 to 39	Stiff Clay w/o Free Water	--	--	125	4,120	--	0.005	--	--	--	--
9	39 to 44	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
10	44 to 50	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D22.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-14 (POI)**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	SC	105	--	1,050	--	3.04	8	--	0	2,000
2	3 to 7	SC	115	30	--	--	3.00	5	0.5	120	2,000
3	7 to 9	SC	115	32	--	--	3.25	11	1.1	300	4,400
4	9 to 14	CL	125	--	3,320	--	3.04	25	2.2	720	5,300
5	14 to 19	CL	125	--	1,990	--	3.04	15	1.6	430	5,300
6	19 to 29	CL	125	--	3,600	--	3.04	27	2.3	760	9,100
7	29 to 34	CL	125	--	3,060	--	3.04	23	2.0	670	9,100
8	34 to 39	CL	125	--	4,120	--	3.04	31	2.5	830	12,300
9	39 to 44	CL	130	--	5,980	--	3.04	50	3.3	1,070	17,900
10	44 to 50	CL	130	--	5,980	--	3.04	49	3.3	1,070	17,900

**Table D22.3 – Grout Anchor Design Parameters for TL-14 (POI)**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	SC	--
2	3 to 7	SC	9
3	7 to 9	SC	10
4	9 to 14	CL	12
5	14 to 19	CL	7
6	19 to 29	CL	13
7	29 to 34	CL	11
8	34 to 39	CL	14
9	39 to 44	CL	21
10	44 to 50	CL	21

Notes: Design depth to groundwater is 50 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D23.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-15**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$ (pcf)	C (psf)	$\phi$ (degree)	$\epsilon_{50}$	$E_{rm}$ (psi)	UCS (psi)	RQD (%)	$K_{rm}$
			Static	Cyclic								
1*	0 to 3	Soft Clay (1)	--	--	105	1,720	--	0.007	--	--	--	--
2	3 to 7	Sand (Reese)	25	--	115	--	32	--	--	--	--	--
3	7 to 9	Sand (Reese)	25	--	120	--	32	--	--	--	--	--
4	9 to 14	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
5	14 to 19	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
6	19 to 24	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
7	24 to 29	Stiff Clay w/o Free Water	--	--	68	5,980	--	0.004	--	--	--	--
8	29 to 30	Sand (Reese)	125	--	73	--	33	--	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D23.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-15**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$ (pcf)	$\phi$ (degree)	C (psf)	$C'_{Rock}$ (psf)	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
2	3 to 7	SC	115	32	--	--	3.25	8	0.8	160	3,200
3	7 to 9	SC	120	32	--	--	3.25	10	1.0	290	4,000
4	9 to 14	SC	125	35	--	--	3.69	45	4.4	770	12,800
5	14 to 19	SC	125	35	--	--	3.69	53	5.2	970	12,800
6	19 to 24	SC	125	35	--	--	3.69	50	4.9	1,070	12,800
7	24 to 29	ML	68	--	5,980	--	3.04	55	3.5	1,070	12,800
8	29 to 30	SC	73	33	--	--	3.39	32	3.1	910	12,800

**Table D23.3 – Grout Anchor Design Parameters for TL-15**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	SM	--
2	3 to 7	SC	10
3	7 to 9	SC	10
4	9 to 14	SC	19
5	14 to 19	SC	21
6	19 to 24	SC	20
7	24 to 29	ML	21
8	29 to 30	SC	16

Notes: Design depth to groundwater is 24 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D24.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-16**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$ (pcf)	C (psf)	$\phi$ (degree)	$\epsilon_{50}$	$E_{rm}$ (psi)	UCS (psi)	RQD (%)	$K_{rm}$
			Static	Cyclic								
1*	0 to 3	Soft Clay (1)	--	--	105	1,850	--	0.007	--	--	--	--
2	3 to 7	Sand (Reese)	90	--	120	--	33	--	--	--	--	--
3	7 to 9	Sand (Reese)	90	--	125	--	35	--	--	--	--	--
4	9 to 14	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
5	14 to 19	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
6	19 to 25	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
7	25 to 29	Sand (Reese)	125	--	68	--	35	--	--	--	--	--
8	29 to 30	Sand (Reese)	125	--	63	--	35	--	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D24.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-16**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$ (pcf)	$\phi$ (degree)	C (psf)	$C'_{Rock}$ (psf)	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
2	3 to 7	SC	120	33	--	--	3.39	14	1.3	210	5,600
3	7 to 9	SC	125	35	--	--	3.69	25	2.4	500	10,000
4	9 to 14	SC	125	35	--	--	3.69	43	4.2	760	17,200
5	14 to 19	SC	125	35	--	--	3.69	45	4.4	910	18,000
6	19 to 25	SC	125	35	--	--	3.69	47	4.6	1,050	18,800
7	25 to 29	SC	68	35	--	--	3.69	50	4.9	1,170	20,000
8	29 to 30	SP	63	35	--	--	3.69	100	9.8	1,640	20,000

**Table D24.3 – Grout Anchor Design Parameters for TL-16**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	SC	--
2	3 to 7	SC	11
3	7 to 9	SC	14
4	9 to 14	SC	18
5	14 to 19	SC	19
6	19 to 25	SC	19
7	25 to 29	SC	20
8	29 to 30	SP	33

Notes: Design depth to groundwater is 25 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D25.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-17**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)	(psi)	(psi)	(%)		
1*	0 to 3	Soft Clay (1)	--	--	105	790	--	0.01	--	--	--	--
2	3 to 4	Stiff Clay w/o Free Water	--	--	115	790	--	0.010	--	--	--	--
3	4 to 9	Sand (Reese)	25	--	115	--	30	--	--	--	--	--
4	9 to 12	Sand (Reese)	25	--	120	--	31	--	--	--	--	--
5	12 to 14	Sand (Reese)	60	--	68	--	35	--	--	--	--	--
6	14 to 19	Sand (Reese)	60	--	68	--	34	--	--	--	--	--
7	19 to 24	Sand (Reese)	125	--	68	--	34	--	--	--	--	--
8	24 to 30	Stiff Clay w/o Free Water	--	--	71	4,650	--	0.005	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D25.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-17**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	CL	105	--	790	--	3.04	6	--	0	1,600
2	3 to 4	CL	115	--	790	--	3.04	6	0.9	170	1,600
3	4 to 9	SC	115	30	--	--	3.00	4	0.4	150	1,600
4	9 to 12	SC	120	31	--	--	3.12	9	0.9	310	3,600
5	12 to 14	SC	68	35	--	--	3.69	30	2.9	660	12,000
6	14 to 19	SC	68	34	--	--	3.54	30	2.9	680	12,000
7	19 to 24	SC	68	34	--	--	3.54	33	3.2	770	13,200
8	24 to 30	CL	71	--	4,650	--	3.04	35	2.7	890	13,900

**Table D25.3 – Grout Anchor Design Parameters for TL-17**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	CL	--
2	3 to 4	CL	3
3	4 to 9	SC	9
4	9 to 12	SC	10
5	12 to 14	SC	15
6	14 to 19	SC	15
7	19 to 24	SC	16
8	24 to 30	CL	16

Notes: Design depth to groundwater is 12 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D26.1 – LPILE Computer Program Parameters for Lateral Load Analysis for TL-18 (POI)**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$ (pcf)	C (psf)	$\phi$ (degree)	$\epsilon_{50}$	$E_{rm}$ (psi)	UCS (psi)	RQD (%)	$K_{rm}$
			Static	Cyclic								
1*	0 to 3	Soft Clay (1)	--	--	105	520	--	0.01	--	--	--	--
2	3 to 7	Sand (Reese)	25	--	120	--	28	--	--	--	--	--
3	7 to 9	Sand (Reese)	25	--	120	--	30	--	--	--	--	--
4	9 to 14	Sand (Reese)	60	--	63	--	35	--	--	--	--	--
5	14 to 24	Sand (Reese)	125	--	68	--	35	--	--	--	--	--
6	24 to 29	Sand (Reese)	125	--	68	--	35	--	--	--	--	--
7	29 to 34	Stiff Clay w/o Free Water	--	--	71	5,980	--	0.004	--	--	--	--
8	34 to 39	Stiff Clay w/o Free Water	--	--	71	5,050	--	0.005	--	--	--	--
9	39 to 44	Stiff Clay w/o Free Water	--	--	70.6	5,980	--	0.004	--	--	--	--
10	44 to 50	Stiff Clay w/o Free Water	--	--	70.6	5,450	--	0.005	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D26.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for TL-18 (POI)**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$ (pcf)	$\phi$ (degree)	C (psf)	$C'_{Rock}$ (psf)	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
2	3 to 7	SC	120	28	--	--	2.77	3	0.3	90	1,200
3	7 to 9	SC	120	30	--	--	3.00	6	0.6	220	2,400
4	9 to 14	SC	63	35	--	--	3.69	27	2.6	580	10,800
5	14 to 24	SC	68	35	--	--	3.69	49	4.8	880	15,100
6	24 to 29	SC	68	35	--	--	3.69	41	4.0	910	15,100
7	29 to 34	CL	71	--	5,980	--	3.04	50	3.3	1,070	15,100
8	34 to 39	CL	71	--	5,050	--	3.04	38	2.8	930	15,100
9	39 to 44	CL	71	--	5,980	--	3.04	51	3.4	1,070	16,300
10	44 to 50	CL	71	--	5,450	--	3.04	41	2.9	980	16,300

**Table D26.3 – Grout Anchor Design Parameters for TL-18 (POI)**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	SC	--
2	3 to 7	SC	8
3	7 to 9	SC	9
4	9 to 14	SC	14
5	14 to 24	SC	20
6	24 to 29	SC	18
7	29 to 34	CL	21
8	34 to 39	CL	18
9	39 to 44	CL	21
10	44 to 50	CL	19

Notes: Design depth to groundwater is 9 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D27.1 – LPILE Computer Program Parameters for Lateral Load Analysis for MET-3**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$ (pcf)	C (psf)	$\phi$ (degree)	$\epsilon_{50}$	$E_{rm}$ (psi)	UCS (psi)	RQD (%)	$K_{rm}$
			Static	Cyclic								
1*	0 to 3	Soft Clay (1)	--	--	105	1,450	--	0.007	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water	--	--	125	1,450	--	0.007	--	--	--	--
3	7 to 9	Stiff Clay w/o Free Water	--	--	125	3,450	--	0.005	--	--	--	--
4	9 to 12	Stiff Clay w/o Free Water	--	--	125	2,790	--	0.005	--	--	--	--
5	12 to 14	Stiff Clay w/o Free Water	--	--	125	2,790	--	0.005	--	--	--	--
6	14 to 19	Stiff Clay w/o Free Water	--	--	125	3,600	--	0.005	--	--	--	--
7	19 to 24	Stiff Clay w/o Free Water	--	--	130	5,190	--	0.005	--	--	--	--
8	24 to 29	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
9	29 to 34	Stiff Clay w/o Free Water	--	--	130	5,720	--	0.005	--	--	--	--
10	34 to 35	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D27.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for MET-3**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$ (pcf)	$\phi$ (degree)	C (psf)	$C'_{Rock}$ (psf)	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
2	3 to 7	CL	125	--	1,450	--	3.04	11	1.3	320	3,800
3	7 to 9	ML	125	--	3,450	--	3.04	26	2.2	740	8,300
4	9 to 12	CL	125	--	2,790	--	3.04	21	1.9	610	8,300
5	12 to 14	CL	125	--	2,790	--	3.04	21	1.9	610	8,300
6	14 to 19	CL	125	--	3,600	--	3.04	27	2.3	760	10,800
7	19 to 24	CL	130	--	5,190	--	3.04	39	2.9	940	15,500
8	24 to 29	CL	130	--	5,980	--	3.04	65	3.9	1,070	17,100
9	29 to 34	CL	130	--	5,720	--	3.04	43	3.0	1,030	17,100
10	34 to 35	CL	130	--	5,980	--	3.04	50	3.3	1,070	17,900

**Table D27.3 – Grout Anchor Design Parameters for MET-3**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	CL	--
2	3 to 7	CL	5
3	7 to 9	ML	12
4	9 to 12	CL	10
5	12 to 14	CL	10
6	14 to 19	CL	13
7	19 to 24	CL	18
8	24 to 29	CL	21
9	29 to 34	CL	20
10	34 to 35	CL	21

Notes: Design depth to groundwater is 35 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D28.1 – LPILE Computer Program Parameters for Lateral Load Analysis for PMM-1**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	1,850	--	0.007	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water	--	--	125	1,320	--	0.007	--	--	--	--
3	7 to 9	Stiff Clay w/o Free Water	--	--	125	2,120	--	0.007	--	--	--	--
4	9 to 12	Stiff Clay w/o Free Water	--	--	125	3,060	--	0.005	--	--	--	--
5	12 to 14	Sand (Reese)	225	--	125	--	35	--	--	--	--	--
6	14 to 19	Sand (Reese)	90	--	125	--	33	--	--	--	--	--
7	19 to 24	Sand (Reese)	90	--	125	--	33	--	--	--	--	--
8	24 to 29	Sand (Reese)	90	--	125	--	33	--	--	--	--	--
9	29 to 34	Stiff Clay w/o Free Water	--	--	130	3,600	--	0.005	--	--	--	--
10	34 to 35	Stiff Clay w/o Free Water	--	--	130	5,050	--	0.005	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D28.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for PMM-1**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	CL	105	--	1,850	--	3.04	14	--	0	3,500
2	3 to 7	CL	125	--	1,320	--	3.04	10	1.2	290	3,500
3	7 to 9	CL	125	--	2,120	--	3.04	16	1.6	460	6,300
4	9 to 12	CL	125	--	3,060	--	3.04	23	2.0	670	8,400
5	12 to 14	SC	125	35	--	--	3.69	32	3.1	700	8,400
6	14 to 19	SC	125	33	--	--	3.39	21	2.0	600	8,400
7	19 to 24	SC	125	33	--	--	3.39	26	2.5	750	10,400
8	24 to 29	SC	125	33	--	--	3.39	29	2.8	870	10,800
9	29 to 34	CL	130	--	3,600	--	3.04	27	2.3	760	10,800
10	34 to 35	CL	130	--	5,050	--	3.04	38	2.8	930	15,100

**Table D28.3 – Grout Anchor Design Parameters for PMM-1**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	CL	--
2	3 to 7	CL	5
3	7 to 9	CL	7
4	9 to 12	CL	11
5	12 to 14	SC	16
6	14 to 19	SC	13
7	19 to 24	SC	14
8	24 to 29	SC	15
9	29 to 34	CL	13
10	34 to 35	CL	18

Notes: Design depth to groundwater is 35 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D29.1 – LPILE Computer Program Parameters for Lateral Load Analysis for PMM-2**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$ (pcf)	C (psf)	$\phi$ (degree)	$\epsilon_{50}$	$E_{rm}$ (psi)	UCS (psi)	RQD (%)	$K_{rm}$
			Static	Cyclic								
1*	0 to 3	Soft Clay (1)	--	--	105	2,390	--	0.005	--	--	--	--
2	3 to 4	Stiff Clay w/o Free Water	--	--	125	2,390	--	0.005	--	--	--	--
3	4 to 9	Stiff Clay w/o Free Water	--	--	120	1,050	--	0.007	--	--	--	--
4	9 to 12	Stiff Clay w/o Free Water	--	--	125	1,850	--	0.007	--	--	--	--
5	12 to 14	Stiff Clay w/o Free Water	--	--	125	2,250	--	0.005	--	--	--	--
6	14 to 19	Stiff Clay w/o Free Water	--	--	125	2,390	--	0.005	--	--	--	--
7	19 to 24	Stiff Clay w/o Free Water	--	--	125	2,650	--	0.005	--	--	--	--
8	24 to 29	Stiff Clay w/o Free Water	--	--	125	2,920	--	0.005	--	--	--	--
9	29 to 34	Stiff Clay w/o Free Water	--	--	130	4,520	--	0.005	--	--	--	--
10	34 to 35	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D29.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for PMM-2**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$ (pcf)	$\phi$ (degree)	C (psf)	$C'_{Rock}$ (psf)	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
2	3 to 4	CL	125	--	2,390	--	3.04	18	1.8	520	2,800
3	4 to 9	CL	120	--	1,050	--	3.04	8	1.1	230	2,800
4	9 to 12	CL	125	--	1,850	--	3.04	14	1.5	400	4,900
5	12 to 14	CL	125	--	2,250	--	3.04	17	1.7	490	6,700
6	14 to 19	CL	125	--	2,390	--	3.04	18	1.8	520	7,100
7	19 to 24	CL	125	--	2,650	--	3.04	20	1.9	580	7,900
8	24 to 29	CL	125	--	2,920	--	3.04	22	2.0	640	8,700
9	29 to 34	CL	130	--	4,520	--	3.04	34	2.6	880	13,500
10	34 to 35	CL	130	--	5,980	--	3.04	100	5.2	1,070	17,900

**Table D29.3 – Grout Anchor Design Parameters for PMM-2**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	CL	--
2	3 to 4	CL	8
3	4 to 9	CL	4
4	9 to 12	CL	6
5	12 to 14	CL	8
6	14 to 19	CL	8
7	19 to 24	CL	9
8	24 to 29	CL	10
9	29 to 34	CL	16
10	34 to 35	CL	21

Notes: Design depth to groundwater is 35 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D30.1 – LPILE Computer Program Parameters for Lateral Load Analysis for PMM-3**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$ (pcf)	C (psf)	$\phi$ (degree)	$\epsilon_{50}$	$E_{rm}$ (psi)	UCS (psi)	RQD (%)	$K_{rm}$
			Static	Cyclic								
1*	0 to 3	Soft Clay (1)	--	--	105	2,520	--	0.005	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water	--	--	125	2,520	--	0.005	--	--	--	--
3	7 to 9	Stiff Clay w/o Free Water	--	--	125	4,250	--	0.005	--	--	--	--
4	9 to 12	Stiff Clay w/o Free Water	--	--	125	4,520	--	0.005	--	--	--	--
5	12 to 14	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
6	14 to 19	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
7	19 to 24	Stiff Clay w/o Free Water	--	--	130	5,720	--	0.005	--	--	--	--
8	24 to 29	Stiff Clay w/o Free Water	--	--	130	5,320	--	0.005	--	--	--	--
9	29 to 34	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--
10	34 to 35	Stiff Clay w/o Free Water	--	--	130	5,980	--	0.004	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D30.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for PMM-3**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$ (pcf)	$\phi$ (degree)	C (psf)	$C'_{Rock}$ (psf)	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
2	3 to 7	CL	125	--	2,520	--	3.04	19	1.8	550	7,500
3	7 to 9	CL	125	--	4,250	--	3.04	32	2.5	840	12,700
4	9 to 12	CL	125	--	4,520	--	3.04	34	2.6	880	13,500
5	12 to 14	CL	130	--	5,980	--	3.04	47	3.2	1,070	15,900
6	14 to 19	CL	130	--	5,980	--	3.04	47	3.2	1,070	15,900
7	19 to 24	CL	130	--	5,720	--	3.04	43	3.0	1,030	15,900
8	24 to 29	CL	130	--	5,320	--	3.04	40	2.9	950	15,900
9	29 to 34	CL	130	--	5,980	--	3.04	52	3.4	1,070	17,900
10	34 to 35	CL	130	--	5,980	--	3.04	100	5.2	1,070	17,900

**Table D30.3 – Grout Anchor Design Parameters for PMM-3**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	CL	--
2	3 to 7	CL	9
3	7 to 9	CL	15
4	9 to 12	CL	16
5	12 to 14	CL	21
6	14 to 19	CL	21
7	19 to 24	CL	20
8	24 to 29	CL	18
9	29 to 34	CL	21
10	34 to 35	CL	21

Notes: Design depth to groundwater is 35 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D31.1 – LPILE Computer Program Parameters for Lateral Load Analysis for ADLS-2**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$ (pcf)	C (psf)	$\phi$ (degree)	$\epsilon_{50}$	$E_{rm}$ (psi)	UCS (psi)	RQD (%)	$K_{rm}$
			Static	Cyclic								
1*	0 to 3	Soft Clay (1)	--	--	105	1,720	--	0.007	--	--	--	--
2	3 to 7	Sand (Reese)	225	--	128	--	35	--	--	--	--	--
3	7 to 9	Sand (Reese)	225	--	128	--	35	--	--	--	--	--
4	9 to 12	Sand (Reese)	90	--	128	--	35	--	--	--	--	--
5	12 to 14	Stiff Clay w/o Free Water	--	--	125	2,920	--	0.005	--	--	--	--
6	14 to 19	Sand (Reese)	225	--	130	--	35	--	--	--	--	--
7	19 to 24	Sand (Reese)	225	--	125	--	34	--	--	--	--	--
8	24 to 29	Stiff Clay w/o Free Water	--	--	130	4,790	--	0.005	--	--	--	--
9	29 to 34	Stiff Clay w/o Free Water	--	--	130	4,920	--	0.005	--	--	--	--
10	34 to 35	Stiff Clay w/o Free Water	--	--	130	5,720	--	0.005	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D31.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for ADLS-2**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$ (pcf)	$\phi$ (degree)	C (psf)	$C'_{Rock}$ (psf)	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
2	3 to 7	SM	128	35	--	--	3.69	32	3.1	350	8,700
3	7 to 9	SM	128	35	--	--	3.69	36	3.5	600	8,700
4	9 to 12	SM	128	35	--	--	3.69	28	2.7	600	8,700
5	12 to 14	CL	125	--	2,920	--	3.04	22	2.0	640	8,700
6	14 to 19	SM	130	35	--	--	3.69	37	3.6	840	14,300
7	19 to 24	SC	125	34	--	--	3.54	39	3.8	940	14,300
8	24 to 29	CL	130	--	4,790	--	3.04	36	2.7	900	14,300
9	29 to 34	ML	130	--	4,920	--	3.04	37	2.8	920	14,700
10	34 to 35	CL	130	--	5,720	--	3.04	43	3.0	1,030	17,100

**Table D31.3 – Grout Anchor Design Parameters for ADLS-2**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	SM	--
2	3 to 7	SM	16
3	7 to 9	SM	17
4	9 to 12	SM	15
5	12 to 14	CL	10
6	14 to 19	SM	17
7	19 to 24	SC	17
8	24 to 29	CL	17
9	29 to 34	ML	17
10	34 to 35	CL	20

Notes: Design depth to groundwater is 35 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.

**Table D32.1 – LPILE Computer Program Parameters for Lateral Load Analysis for O&M-1 Building**

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		$\gamma'$	C	$\phi$	$\epsilon_{50}$	$E_{rm}$	UCS	RQD	$K_{rm}$
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	105	790	--	0.01	--	--	--	--
2	3 to 7	Sand (Reese)	90	--	125	--	34	--	--	--	--	--
3	7 to 9	Sand (Reese)	25	--	120	--	30	--	--	--	--	--
4	9 to 12	Sand (Reese)	90	--	125	--	34	--	--	--	--	--
5	12 to 14	Sand (Reese)	225	--	120	--	35	--	--	--	--	--
6	14 to 18	Sand (Reese)	90	--	125	--	34	--	--	--	--	--
7	18 to 24	Sand (Reese)	125	--	63	--	35	--	--	--	--	--
8	24 to 29	Stiff Clay w/o Free Water	--	--	68	2,650	--	0.005	--	--	--	--
9	29 to 34	Stiff Clay w/o Free Water	--	--	67.6	2,790	--	0.005	--	--	--	--
10	34 to 35	Stiff Clay w/o Free Water	--	--	67.6	5,980	--	0.004	--	--	--	--

Notes: \*Upper 3 feet of soil should be neglected due to seasonal moisture change.

**Table D32.2 – Direct Embedment/Drilled Pier Foundation Design Parameters for O&M-1 Building**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	$\gamma'$	$\phi$	C	$C'_{Rock}$	$K_p$	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5) <sup>(1)</sup> (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	SC	105	--	790	--	3.04	6	--	0	1,700
2	3 to 7	SC	125	34	--	--	3.54	17	1.6	250	2,000
3	7 to 9	SC	120	30	--	--	3.00	5	0.5	210	2,000
4	9 to 12	SC	125	34	--	--	3.54	23	2.2	530	7,900
5	12 to 14	SP	120	35	--	--	3.69	50	4.9	860	7,900
6	14 to 18	SC	125	34	--	--	3.54	30	2.9	720	7,900
7	18 to 24	SC	63	35	--	--	3.69	42	4.1	950	7,900
8	24 to 29	CL	68	--	2,650	--	3.04	20	1.9	580	7,900
9	29 to 34	CL	67.6	--	2,790	--	3.04	21	1.9	610	8,300
10	34 to 35	CL	67.6	--	5,980	--	3.04	100	5.2	1,070	17,900

**Table D32.3 – Grout Anchor Design Parameters for O&M-1 Building**

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Grout Bond Strength <sup>(2)</sup> (psi)
1*	0 to 3	SC	--
2	3 to 7	SC	12
3	7 to 9	SC	9
4	9 to 12	SC	13
5	12 to 14	SP	20
6	14 to 18	SC	15
7	18 to 24	SC	18
8	24 to 29	CL	9
9	29 to 34	CL	10
10	34 to 35	CL	21

Notes: Design depth to groundwater is 18 feet.

\*Upper 3 feet of soils should be neglected due to seasonal moisture change;  $K_p$ : Rankine Passive Earth Pressure Coefficient;  $\gamma'$ : Effective Unit Weight ( $\gamma' = \gamma_{Total} - 62.4$  pcf);  $\phi$ : Angle of Internal Friction.

<sup>(1)</sup> For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

<sup>(2)</sup> A minimum bond length of 10 feet in bedrock and 15 feet in soils is recommended. Estimated bond strength are for gravity grout anchors. RRC recommends grout anchor capacities be verified by pull-out test.