Applicant Exhibit 38

BEFORE
THE OHIO POWER SITING BOARD

In the Matter of the Application of Firelands Wind, LLC for a Certificate of Environmental Compatibility and Public Need to Construct a Wind-Powered Electric Generation Facility in Huron and Erie Counties, Ohio.	)))))	Case No: 18-1607-EL-BGN

DIRECT TESTIMONY OF

Alfred Williams
Geotechnical Department Manager
Beyond Engineering & Testing, LLC

on behalf of
Firelands Wind, LLC

September 11, 2020

/s/ Christine M.T. Pirik
Christine M.T. Pirik (0029759)
(Counsel of Record)
Terrence O'Donnell (0074213)
William Vorys (0093479)
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K&L Gates LLP
925 Fourth Avenue, Ste. 2900
Seattle, Washington 98104
(206) 370-7652

1. Please state your name, current title, and business address.

My name is Alfred Williams, Geotechnical Engineer, 3801 Doris Lane, Round Rock, Texas 78644

2. Please summarize your educational background and professional experience.

I received my Bachelor of Science in Civil Engineering from the Georgia Institute of Technology. I worked at RRC Power & Energy ("RRC"), LLC from April 2012 to February 2020. Currently, I am a Geotechnical Department Manager at Beyond Engineering & Testing, LLC. Beyond Engineering & Testing, LLC is an engineering consultant firm that provides geotechnical engineering and laboratory testing services to RRC. My duties, as a Geotechnical Engineer while at RRC, mainly consisted of managing crew/field personnel to conduct subsurface explorations, assigning and assessing laboratory tests to characterize properties of soil and bedrock, assess geohazards and groundwater conditions that pose a risk to structures, bearing capacity and settlement analysis of shallow foundations for wind turbine design and bearing capacity and settlement analysis of shallow foundations and skin friction and axial capacity of deep foundations at ancillary structure locations.

I have worked on numerous utility-scale wind project throughout the United States. Of these projects, many of them contained geohazards, such as flooding, expansive/collapsible soils, seismic activity or development of karst features, which required analysis to ensure the stability of the proposed structure. I received my initial Professional Engineer License in the State of Texas, and I am currently licensed in the states of Nebraska, Ohio, Pennsylvania, South Dakota, Texas, and Wyoming. My resume is attached as Attachment AW-1.

3. On whose behalf are you offering testimony?

I am testifying on behalf of the Applicant in the case, Firelands Wind, LLC ("Applicant" or "Firelands"), which is seeking to develop the proposed Emerson Creek Wind Farm ("Project").

4. What is the purpose of your testimony?

The purpose of my testimony is to describe the information presented in the Groundwater, Hydrogeological, and Geotechnical Report, which was prepared by Hull & Associates, Inc. ("Hull Report"), and is Exhibit E to the Application for Certificate of Environmental Compatibility and Public Need filed on January 31, 2019 ("Application"). In addition, I am testifying with regard to the Geotechnical Report dated April 29, 2020 that was prepared by RRC ("RRC Report") and is Attachment AW-2 to my testimony. I am prepared to testify generally regarding groundwater, geologic, geotechnical conditions and construction recommendations as they may pertain to the Project. My testimony, together with the other witnesses for Firelands testifying in this case, supports the Ohio Power Siting Board's ("Board's") adoption of the Joint Stipulation and Recommendation ("Stipulation"), which was filed in this docket on September 11, 2020, and is being offered in this proceeding as Joint Exhibit 1.

5. Please describe the history of your involvement with the Project.

RRC was authorized by Apex Clean Energy Management, LLC ("Apex") to perform a geotechnical subsurface exploration and geotechnical engineering evaluation for the Project. The purpose of the geotechnical engineering study was to explore and evaluate subsurface conditions at the proposed building sites, geological/geotechnical risk hazard assessments and develop geotechnical design and construction recommendations for the Project. The subsurface exploration program consisted of geotechnical borings at most of the proposed wind turbine sites, temporary standpipe piezometers to obtain periodic groundwater levels and laboratory testing program to characterize properties of soil and bedrock encountered at the Project site.

6. Please describe the requirements set forth in the rule of the Board and the documentation provided by Firelands in response to the requirements.

In accordance with Ohio Administrative Code ("O.A.C.") Rule 4906-04-08, Firelands submitted the following information:

- An evaluation of the impact to public and private water supplies due to construction and operation of the proposed facility.

- An evaluation of the impact to public and private water supplies due to pollution control equipment failures.
- Existing maps of aquifers, water wells, and drinking water source protection areas that may be directly affected by the proposed facility.
- How construction and operation of the facility will comply with any drinking water source protection plans near the Project area.
- An analysis of the prospects of floods for the area, including the probability of occurrences and likely consequences of various flood stages, and plans to mitigate any likely adverse consequences.
- A description of the suitability of the site geology and plans to remedy any inadequacies.
- A description of the suitability of soil for grading, compaction, and drainage, and plans to remedy any inadequacies and restore the soils during post-construction reclamation.
- A description of plans for the test borings, including closure plans for such borings and a timeline for providing the test boring logs and the following information to the Board: (i) subsurface soil properties; (ii) static water level; (iii) rock quality description; (iv) percent recovery; and (v) depth and description of bedrock contact.

The Hull Report and the RRC Report address each of these requirements set forth within the Board's rules.

7. What is the role of you and your firm in regards to the RRC Report?

RRC was authorized by Apex to perform a geotechnical study including a subsurface exploration program and provide geotechnical design and construction recommendations at the Project. The subsurface exploration program consisted of geotechnical borings at each of the proposed wind turbine sites, with the exception of Turbine Nos. 2, 5, 38, 55, 84, 85, and 86. Temporary standpipe pipe piezometers were also installed at turbine sites, in order to facilitate periodic groundwater measurements. The RRC Report provides geotechnical design and construction recommendations including,

- A description of the suitability of the site geology and plans to remedy any inadequacies.

- A description of the suitability of soil for grading, compaction, and drainage, and plans to remedy any inadequacies and restore the soils during post-construction reclamation.
- A description of plans for the test borings, including closure plans for such borings and a timeline for providing the test boring logs and the following information to the Board: (i) subsurface soil properties; (ii) static water level; (iii) rock quality description; (iv) percent recovery; and (v) depth and description of bedrock contact.

8. What work have you performed on this Project?

I oversaw the subsurface exploration and geotechnical engineering evaluation for the Project. I reviewed the findings and results of the investigations and developed geotechnical design and construction recommendations for the Project.

9. Please generally summarize the findings of the RRC Report.

Based on the findings and results of the subsurface exploration, the site is suitable for the proposed construction. Soils were encountered in each of the geotechnical borings and extended to the top of bedrock, which was encountered at depths in the range of 2 to 49 feet below existing site grade. Bedrock at the Project site mainly consisted of shale and limestone from the Ohio Shale, Prout Limestone, Delaware Limestone, and Columbus Limestone formations.

Portions of the Project lie within areas where there may be a potential for karst features to develop. Karst is a type of topography that forms over soluble bedrock such as limestone, dolomite or evaporites, such as gypsum. The development of karst is a process due to the movement of water. Water percolates through soil towards soluble bedrock and becomes more acidic as is absorbs more carbon dioxide, which leads to a carbonic acid solution. Eventually water will encounter fractures and fissures which allow water to move through the bedrock mass. Due to the increased acidity of the water, a chemical reaction occurs between the water and carbonate bedrock, which leads to dissolution of the carbonate bedrock, specifically calcium carbonate. This dissolution of carbonate bedrock leads to the development of fissures, tubes and eventually caves.

Overtime, the dissolution of carbonate bedrock may create a complex network of conduits for water movement and storage. Surface water will continue to infiltrate through the soil above the bedrock mass, and as the water moves through the soil sediment may be transported into this network of conduits. Overtime, as more of the soil sediment is transported into the bedrock mass, cavities may form within the soil mass at or above the bedrock interface or channels may form within the soil mass. Since soils have very little tensile strength, eventually the soil mass above the cavity will experience settlement or a potential collapse, depending on the size of the void. This land subsidence when caused by development of karst is typically called sinkholes. Areas that are prone to karst development can be identified by the presence of sinkholes, throats, and springs. From an engineering standpoint it is important to ensure buildings or structures do not experience settlements that may lead to failure or serviceability concerns.

Most of the proposed turbine sites are located in the Ohio Shale Formation, which is not prone to karst development. However, in the northwestern portion of the Project site underlying bedrock formations consist of limestone, such as the Prout Limestone, Delaware Limestone and Columbus Limestone formations. Limestone is a type of carbonate bedrock and may be susceptible to karst features such as voids and other solution cavities. At the Project site, the Columbus Limestone is known for its susceptibility to karst development. The aforementioned karst formations occurring within 20 feet below the ground surface have a high probability of occurring. These formations when occurring at 20 to 100 feet below the ground surface, depending on size and depth, the probability can be considered as low to moderate. The probability of occurring can be reduced by performing remedial measures such as bedrock grouting.

Turbine sites that are located within the Ohio Shale Formation are found to have a low probability to karst development. Turbine sites that are located within the Prout Limestone, Delaware Limestone, and Columbus Limestone formations have a low to high risk of karst development. Based on the geotechnical investigations, potential solution cavities within bedrock were encountered during the drilling activities, such as Turbine Nos. 24 and 42. In addition, based on available geologic maps and literature, Turbine Nos. 73 and 74 are

near mapped karst features. At sites where the karst hazard assessment indicated a moderate to high probability associated with karst development, RRC recommends additional testing/investigations, such as Electrical Imaging or Void Assessment. At sites where karst features are identified, RRC recommends bedrock grouting to remediate the karst features encountered in limestone bedrock formations. The purpose of bedrock grouting is to reduce the movement of water in soluble bedrock, preventing possible land subsidence to occur. Since sites are situated at higher elevations, compared to surrounding land, bedrock grouting is not anticipated to induce flooding of surrounding areas. It is RRC's opinion that once the remedial measures are performed the risk of karst development is anticipated to be low.

10. What degree of confidence do you have in the RRC Report?

I have a high degree of scientific certainty in the findings and recommendations in the RRC Report. This conclusion stems from:

1. The detailed subsurface exploration program completed at the project site, and review of the Logs of Boring and field and laboratory test results obtained from the geotechnical investigations.
2. Review of available geologic maps and literature within the Project area.
3. RRC's experience with design and construction of wind projects with similar geological conditions of karst development and geotechnical conditions in this region and across the United States. RRC has implemented void assessment and mitigation measures in other wind projects with successful outcomes.

11. Please explain what, if any, additional testing needs to be performed prior to construction.

Based on review of Logs of Boring and geologic maps and literature, a moderate to high probability of karst development was identified at Turbine Nos. 24, 25, 26, 43, 73, 74 and 75. At these sites, RRC recommends to perform additional subsurface investigations, such as Electrical Imaging, or remediate potential solution cavities encountered during drilling activities with additional void assessments and grouting. The purpose of Electrical Imaging is to assess the presence of solution cavities within the bedrock mass, which would

indicate a potential of karst development. If results of the Electrical Imaging indicate there is not a presence of solution cavities or karst development, the probability of karst development can be considered low and remedial measures such as bedrock grouting will not be required. RRC's opinion that once the remedial measures are performed the probability of karst development is anticipated to be low.

12. Do the Board's rules require that a final geotechnical report be prepared before construction begins?

Yes. O.A.C. Rule 4906-4-09(A)(2)(b)(i) requires that Firelands submit a fully detailed geotechnical exploration and evaluation 60 days before the preconstruction conference. This final report will address whether proposed turbine locations are located above karst formations and whether potential mitigation measures are recommended.

13. Have you reviewed the Stipulation that was filed in this docket on September 11, 2020?

Yes.

14. Is it your opinion that Condition 2 laid out in the Stipulation requires the Applicant to comply with O.A.C. Rule 4906-4-09(A)(2)(b)(i)?

Yes.

15. Are your opinions and conclusions in your testimony made with a reasonable degree of scientific certainty?

Yes.

16. Does this conclude your testimony?

Yes. However, I reserve the right to update this testimony to respond to any further testimony, reports, and/or evidence submitted in this case.

CERTIFICATE OF SERVICE

The Ohio Power Siting Board's e-filing system will electronically serve notice of the filing of this document on the parties referenced in the service list of the docket card who have electronically subscribed to these cases. In addition, the undersigned certifies that a copy of the foregoing document is also being served upon the persons below this 11th day of September, 2020.

/s/ Christine M.T. Pirik
Christine M.T. Pirik (0029759)

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Attachment AW-1

Resume

DICKINSON WRIGHT PLLC

BEYOND Engineering & Testing

Alfred Williams
Geotechnical Group Manager

Education

- Bachelor of Science, Civil Engineering, Georgia Institute of Technology, Atlanta, GA

PE Registration

- Minnesota
- Nebraska
- Ohio
- Pennsylvania
- South Carolina
- South Dakota
- Texas
- Wyoming

Alfred Williams has over 7 years of experience in geotechnical engineering and project management involving wind and solar energy projects. He has been active for the past 7 years in the wind industry providing geotechnical recommendations for the design of wind turbine generator and ancillary structure foundations. His responsibilities include engineering analysis, project management of numerous projects and developing proposals for geotechnical engineering services of wind energy projects. He is proficient in field site investigations, geotechnical site characterization, bearing capacity and settlement analysis of shallow and deep foundations and pavement analysis.

Project Experience

- Turtle Creek Wind Project – St. Ansgar, IA: This 193 MW project consisted of construction of 56 wind turbine generators. Duties included managing field subsurface exploration, performing subsurface characterization, analyzing field and laboratory data, performing risk assessment due to voids and karst formations and recommending mitigation measures, generating geotechnical calculations and writing the geotechnical report.

- Pegasus Wind Project – Caro, MI: This 150 MW project consisted of construction of 60 wind turbine generators. Duties included managing field subsurface exploration, reviewing and interpreting CPT data for bearing capacity and settlement analyses of wind turbine foundations, providing technical input of selection of confirmation SPT borings and MASW seismic survey locations, and writing the geotechnical report.

- Blue Summit II Wind Project – Vernon, TX: This 100 MW project consisted of construction of 41 wind turbine generators. Duties included managing field subsurface exploration, performing subsurface characterization, analysis of field and laboratory data, generating geotechnical calculations and writing geotechnical reports.

- Minco IV and V Wind Projects – Hinton, OK: This 350 MW project consisted of construction of 172 wind turbine generators. Duties included managing field subsurface exploration, performing subsurface characterization, analysis of field and laboratory data, generating geotechnical calculations and writing geotechnical reports.

Alfred Williams
Geotechnical Group Manager

Industry Tenure

Beyond Engineering and Testing: Geotechnical Group Manager (2020-Current)

RRC Power & Energy: Geotechnical Engineer (2012-2020)

RRC Power & Energy: Construction Materials Testing Technician (2012-2013)

Attachment AW-2

April 2020
Geotechnical Report

DICKINSON WRIGHT PLLC

Geotechnical Report

EMERSON CREEK WIND PROJECT
ERIE AND HURON COUNTIES, OHIO

Prepared By:

RRC

3801 Doris Lane
Round Rock, TX 78664

512.992.2087 | www.RRCcompanies.com

April 29, 2020
RRC Project No. MD1901007

experience matters

www.RRCcompanies.com

3801 Doris Lane
Round Rock, TX 78664
512.992.2087

April 29, 2020

Apex Clean Energy Management, LLC
310 Fourth Street NE, Suite 200
Charlottesville, VA 22902

Attn: Mr. Dylan Fraser

Re: Geotechnical Report
Emerson Creek Wind Project
Erie and Huron Counties, Ohio
RRC Project No. MD1901007

Dear Mr. Fraser:

RRC Power & Energy, LLC (RRC) has completed the authorized subsurface exploration and geotechnical engineering evaluation for the proposed Emerson Creek Wind Project. The purpose of the geotechnical engineering study was to explore and evaluate subsurface conditions at selected locations across the site, and to 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
- Our geotechnical site development and foundation design recommendations for the planned project.

We appreciate the opportunity to be of service to Apex Clean Energy Management, LLC. We are prepared to provide construction materials testing services during the construction phase of the project. Please call us if you have any questions concerning this report or any of our services.

Respectfully submitted,
RRC Power & Energy, LLC (RRC)

Yuqing "Jeffrey" Liu, EIT
Geotechnical Engineer

GEOTECHNICAL REPORT

EMERSON CREEK WIND PROJECT
ERIE AND HURON COUNTIES, OHIO

prepared for

APEX CLEAN ENERGY MANAGEMENT, LLC
CHARLOTTESVILLE, VIRGINIA

Revision	Date	Description
--	8/2/2019	Draft V1
--	2/7/2020	Draft V2
0	3/6/2020	Final Submittal
1	4/29/2020	Revision.1: • Appendix A: Update Table A1 • Appendix A: Add Table A4

Prepared by

Yuqing "Jeffrey" Liu, EIT
Geotechnical Engineer

4/29/2020

Reviewed by

Alfred Williams, P.E. (OH)
Geotechnical Engineer

Checked by

Rohit Rai Pant, Ph.D., P.E. (LA)
Geotechnical Group Manager

April 29, 2020 ***Project No. MD1901007***

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GEOTECHNICAL REPORT

EMERSON CREEK WIND PROJECT
ERIE AND HURON COUNTIES, OHIO

1.0 INTRODUCTION

RRC has completed the authorized final subsurface exploration and geotechnical engineering evaluation for the proposed Emerson Creek Wind Project. The site is located within Erie and Huron Counties near Bellevue, Ohio. The approximate location of the project site is shown in Figure 1, Site Location Map, within Appendix A.

The purpose of this investigation was to:

- Explore subsurface soil, bedrock and groundwater conditions;
- Conduct field and laboratory testing 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.

The recommendations contained in this report are based upon results of field and laboratory testing, engineering analyses, experience with similar soil and bedrock conditions, and our understanding of the proposed project.

As part of the scope of work for the final phase site investigation, RRC performed 1-D Multi-Channel Analysis of Surface Waves (MASW) and Electrical Resistivity surveys at designated locations across the project site. RRC collected shallow soil samples from selected locations within the project site and transported the samples to RRC's laboratory and Geotherm, USA to obtain the relationships of the maximum dry density with the optimum moisture content, California Bearing Ratio (CBR) testing and thermal resistivity testing.

Our recommendations contained herein are also based on in-situ geophysical survey results, interpretation of published geological maps, and groundwater level data collected from published well logs.

2.0 PROPOSED CONSTRUCTION

We understand this phase of this project will consist of the construction of approximately 300 MW of wind power provided by about 52 to 71 unspecified wind turbine generators (WTG's) and associated facilities, which will be selected from the locations included within the turbine layout used in this study. Anticipated unfactored loads for WTG's are not available during the preparation of this geotechnical report.

The WTG's are anticipated to be supported on gravity foundation systems with an anticipated embedment depth of about 12 feet below the finished grade. We have assumed the finished turbine pad grade is at or slightly above the existing ground surface. Private-access roadways will most likely be surfaced with imported road-base materials from nearby quarry pits to support construction and vehicular traffic loads during and after construction.

3.0 SITE EXPLORATION

The final subsurface exploration program at the project site was conducted and consisted of drilling conventional geotechnical borings at 80 proposed WTG locations, substation location and O&M Building location. A total of 7 proposed WTG locations are currently on hold per Client's request. In addition, a total of 5 test pits were excavated to perform in-situ Thermal Resistivity testing by Geotherm, and bulk soil samples were collected at depths of about 2 to 4 feet for Thermal Resistivity (TR) tests at locations provided by Apex Clean Energy Management, LLC.

Figure 2 within Appendix A shows WTG Boring Locations on a Topographic Map. Figure 3 within Appendix A shows Substation and O&M Building boring locations drilled as part of the site investigation. Figure 4 shows the MASW survey locations. Figure 5 shows the Electrical Resistivity testing locations. Figure 6 shows the Thermal Resistivity testing locations.

Engineering properties of the subsurface materials were assessed through laboratory testing on selected soil and bedrock samples. The following section describes our site exploration program in detail.

3.1 Field Exploration and Testing

A summary of geographic latitude and longitude coordinates and depth of each boring drilled as part of this subsurface exploration program is presented in Table A2 within Appendix A.

The borings were advanced with two track-mounted drill rigs utilizing continuous flight hollow stem augers to a depth of practical auger refusal. Disturbed samples were obtained using Standard Penetration Test (SPT) samplers. Representative bulk samples of the subgrade materials were also obtained from selected locations for maximum dry density-optimum moisture content relationships, laboratory thermal resistivity testing and CBR testing.

Disturbed samples were obtained using Standard Penetration Test (SPT) samplers. Penetration resistance values were recorded using methods based on the standard penetration test (SPT), 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 utilizing a 140-pound hammer with a free-falling distance of 30 inches. The number of blows required to advance the sampler 18 inches is counted and recorded, with the sum of the blows to drive the last 12 inches. The sum of the blows driving the sampler for the last 12 inches was referred to as the standard penetration resistance value (N-value) for SPT samplers.

Results of the field tests are shown on the logs of boring under the “Field Data” column and are preceded by the letter “N”. Subsurface materials were collected from the SPT samplers in the field, visually classified, placed in plastic bags, and labeled as to location and depth. All SPT samples were arranged in core boxes and transported to the laboratory for further analysis.

NX coring techniques, with a 2-inch inside diameter NX wire-line core barrels, were utilized to advance the borings from a depth of practical auger refusal to the full depth of exploration. The rock-like materials were qualitatively evaluated using the Rock Quality Designation (RQD) index system. The RQD is a modified core recovery percentage in which all of the pieces of sound core greater than 4 inches long are summed and divided by the length of the core run (generally 5 to 10 feet). The RQD values are shown on the logs of boring under the "Field Data" column. Core run intervals are typically 60 to 120 inches in length and are delineated on the logs of boring. The RQD values are categorized according to Table 3.1.1 presented below in accordance with ASTM D6032. All rock core samples were arranged in core boxes and transported to the laboratory for further analysis.

Table 3.1.1 Rock Quality Designation

RQD (%)	Rock Quality
0 – 25	Very Poor
25 – 50	Poor
50 – 75	Fair
75 – 90	Good
90 – 100	Excellent

Soils were classified 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. Bedrock percent recovery and rock quality designation (RQD) were recorded in accordance with ASTM D6032: Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core.

Field logs were prepared for each boring at the time of drilling by RRC’s field geologist and field engineer. The project engineer and geologist reviewed each field logs of boring and the soil and bedrock samples, and appropriate modifications were made if necessary.

The field logs of boring contain visual classification of the materials encountered during drilling as well as the interpretation of the subsurface conditions between samples. Final logs of boring, included in Appendix A, represent our interpretation of the field logs of boring and necessary modifications based on laboratory testing performed on select samples. The final logs of boring

describe the materials encountered, their approximate thickness, and the various depths at which the samples were obtained.

The field testing and sampling were conducted in general accordance with the requirements of the following:

- ASTM D1586: Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils;
- ASTM D6032: Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core; and
- Locally accepted practices in this area.

During the field operations, the borings were observed for groundwater levels and noted at the top of the logs of boring. Following the completion of the drilling operations, the borings were backfilled in accordance with the state regulations.

3.2 Laboratory Analysis

The soil/bedrock samples were returned to the laboratory, examined by the project engineer and geologist, and applicable laboratory testing was assigned on selected soil/bedrock 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-µm) Sieve: ASTM D1140;
- Standard Test Method for Particle-Size Analysis of Soils: ASTM D6913;
- Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures: ASTM D7012;
- Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort: ASTM D698;
- Standard Test Methods for California Bearing Ratio (CBR) 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;
- Standard Test Method for Water-Soluble Sulfate in Soil: ASTM C1580; and

- Standard Method of Test for Determining Water-Soluble Chloride Content in Soil: AASHTO T291.

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. Sedimentary rock from the Devonian Period constitutes the bedrock geology across project site. Shale and Limestone are the major rock types found within the rock formations locally. Overlying the area bedrock are glacial till deposits from the Quaternary Period. The Geologic map of the Lorain and Put-in-Bay 30' x 60' quadrangle and Quaternary geologic map of the Lake Erie 4° x 6° quadrangle, United States (References 1 and 2), indicate that the subsurface materials on the site consist of the following geologic units of the listed geologic time periods.

Quaternary Period

- **Clayey Till** (tca)**:** Yellowish-brown, pale-brown, brown, or grayish-brown to gray calcareous silty clay loam and clay loam, locally overlain by peat or swamp deposits. Generally 6 to 30 feet thick. Consists of both ground moraine and end moraine glacial deposits.

Devonian Period

- **Shale** (Sh)**:** Ohio Shale, black to brown, silty, carboniferous, fissile parted shale with gray to green soft clay shale beds.
- **Shale with minor Limestone** (S-L)**:** Prout Limestone, Plum Brook Shale, and Olentangy Shale. The Prout Limestone is hard, siliceous, gray to brown limestone 3 to 10 feet thick and underlain by the Plum Brook Shale which is a gray to green, soft, fossiliferous and calcareous clay shale 50 to 80 feet thick. South of the Plum Brook is the Olentangy Shale which is a greenish-gray, calcareous, slightly fossiliferous clay shale.
- **Limestone** (Ls)**:** Delaware and Columbus Limestones. Delaware Limestone is medium brown, fine to medium crystalline, fossiliferous and cherty with thin shale layers. Columbus Limestone is light to medium gray to brown, fine to coarse crystalline, fossiliferous and cherty. The lower portion of the Columbus is light brown to gray, dolomitic, massively bedded and contains quartz grains in the basal ten feet. Combined the Delaware and Columbus Limestones are 200 feet thick.

Figure 7 and 8 in Appendix A shows the project boundaries approximately plotted on geologic and bedrock geologic maps.

Based on the available geologic maps and studies, WTG foundation sites in the northwestern portion of the project site are located within an area where carbonate rocks (limestone) are present and may be susceptible to karst features such as voids and other solution cavities. Karst features typically occur in limestone, dolomite, or dolomitic limestone bedrock, as well as

evaporite deposits such as gypsum. Figure 9 within Appendix A depicts the project boundaries in conjunction with mapped karst zones near the project site.

4.2 Subsurface Stratigraphy

As indicated on the logs of boring for locations drilled as part of this study, native soils were encountered approximately beneath 0 to 18 inches of the topsoil and extended to the top of the bedrock at depths ranging from approximately 2 to 49 feet below the existing ground surface or extended to the full depth of exploration. The native soils generally consisted of the following:

- Soft to hard lean to fat clay with varying amounts of silt, sand and gravel;
- Loose to very dense sand with varying amounts of clay, silt and gravel;
- Medium dense to very dense gravel with varying amounts of clay, silt and sand.

Limestone and Shale are the predominant types of bedrock encountered across the site. When encountered, the limestone/shale bedrock extended to the full depth of exploration. Some limestone formations exhibited potential open voids or fissures within the bedrock matrix such as WTG sites T-24 and T-43. The limestone/shale bedrock materials encountered in the borings were very hard based upon SPT N Values.

The limestone/shale bedrock encountered in the borings varied from soft to hard in rock hardness. Some limestone/shale formations exhibited slightly to highly weathered seams and layers. Fractures in the limestone were noted to be filled with clay or sand at some locations. In addition, the limestone bedrock encountered exhibited vuggy characteristics. The bedrock materials ranged from Very Poor to Excellent in terms of Rock Quality.

It should be noted loss of drilling fluids and/or potential voids were observed within the limestone in some of borings. The potential voids observed were based on core barrel drops, sudden loss of drilling fluid circulation and poor core recovery as observed by the drillers, field engineer and field geologist during the coring operations. Sudden loss of fluid circulation may indicate the presence of open voids and/or fractures within the limestone. These WTG locations are summarized in Table A1 within Appendix A.

The above descriptions are general and depth ranges shown on the logs of boring are approximate because boundaries between different strata are seldom clear and abrupt in the field. In addition, the lines separating major strata types do not necessarily represent distinct lines of demarcation of the various strata. Detailed logs of boring for locations drilled as part of this study, which present the stratum descriptions, types of sampling used and laboratory test data, are presented in Appendix A. 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

Standard Proctor tests were performed to obtain the maximum dry unit weight and optimum moisture content in accordance with ASTM D698 on representative bulk soil samples collected

at selected locations as part of this study. A summary of the test results is presented in Table 4.3.1.

Table 4.3.1 Summary of Standard Proctor Test Results

Sample Location	Depth (feet)	Material Type	Liquid Limit (%)	Plasticity Index (%)	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)
TR-1 (T-63)	2 to 4	CH	51	31	102.9	21.0
TR-2 (T-48)	2 to 4	CL	41	22	107.0	18.3
TR-3	2 to 4	CL	37	18	107.4	18.0
TR-4 (T-08)	2 to 4	CL	27	11	113.1	14.5
TR-5 (SUB)	2 to 4	CL	46	27	101.1	20.3

Notes: % = percent; pcf = pounds per cubic foot; CL = Lean Clay; CH = Fat Clay.

Results of Unconsolidated-Undrained (UU) Triaxial tests performed, in accordance with ASTM D2850, on undisturbed soil samples from selected boring locations are summarized in Table 4.3.2.

Table 4.3.2 Summary of Unconsolidated-Undrained Triaxial Test Results

Boring No.	Depth (feet)	Material Type	Confining Pressure (psi)	In-Situ Dry Unit Weight (pcf)	In-Situ Moisture Content (%)	Undrained Shear Strength, S_u (psf)
T-58	12	CL	9.5	120.9	14.7	2,050
T-66	24	CL	19.0	116.6	17.2	2,770
T-82	24	CL	19.0	110.3	20.7	1,480
T-83	21	CL	16.0	115.0	18.4	1,460

Notes: pcf = pounds per cubic foot; % = percent; CL = Lean Clay.

Results of Unconfined Compressive Strength (UC) tests performed, in accordance with ASTM D2166, on undisturbed soil samples are summarized in Table 4.3.3.

Table 4.3.3 Summary of Unconfined Compressive Strength Test Results

Sample Location	Depth (feet)	Material Type	In-situ Dry Unit Weight (pcf)	In-situ Moisture Content (%)	Unconfined Compressive Strength, q_u (psf)
T-65	24	CL	120.8	14.8	9,040
T-70	34	CL	120.7	15.4	7,320

Notes: pcf = pounds per cubic foot; % = percent; psf = pounds per square foot; CL = Lean Clay.

Results of rock core compressive strength testing performed in accordance with ASTM D7012 on selected rock core samples will be summarized in Table 4.3.4.

Table 4.3.4 Summary of Rock Core Compressive Strength Test Results

Sample Location	Depth (feet)	Material Type	Unit Weight (pcf)	Compressive Strength of Rock Cores, q_u (tsf)
T-01	8	LIMESTONE	168.4	1,065
T-07	17	LIMESTONE	165.3	1,099
T-20B	15	LIMESTONE	165.7	923
T-30	21	SHALE	163.0	357
T-34	12.5	LIMESTONE	164.3	849
T-36	16	SHALE	148.2	922
T-43	16	LIMESTONE	174.7	1,092
T-45B	29	SHALE	153.7	734
T-75	13	LIMESTONE	182.7	1,613
T-87	12.5	LIMESTONE	168.3	784

One-dimensional consolidation tests were performed in accordance with ASTM D2435, on selected relatively undisturbed soil samples. Results of these tests are summarized in Table 4.3.5.

Table 4.3.5 Summary of 1-D Consolidation Test Results

Sample Location	Depth (feet)	Material Type	σ'_{vo} (psf)	p'_c (psf)	C_c	C_r	e_o	OCR
T-66	24	CL	2,074	4,200	0.103	0.015	0.479	2.0
T-82	24	CL	2,260	2,300	0.097	0.013	0.495	1.0

Notes: psf = pounds per square foot; σ'_{vo}= estimated in-situ Effective Vertical Stress; p'_c = Preconsolidation Pressure; C_c = Compression Index; C_r = Recompression Index; e_o = Initial Void Ratio; OCR = Over-consolidation Ratio; CL = Lean Clay.

Results of water-soluble sulfate and chloride testing performed in accordance with ASTM C1580 and AASHTO T-290 on shallow soil samples from selected borings will be summarized 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)
T-06	4	CL	ND	0.0021
T-26	4	CL	ND	0.0022
T-45A	1	CL	ND	0.0111
T-54	4	CL	0.0014	0.0136
T-66	4	CL	ND	0.0048
SUB-1	4	CL	ND	0.0081

Notes: % = percent; ND = Not Detected; CL = Lean Clay.

Results of Minimum Resistivity and pH testing performed in accordance with ASTM G187 and ASTM G51 respectively on shallow soil samples from selected borings will be summarized in Table 4.3.7.

Table 4.3.7 Summary of Minimum Resistivity and pH Test Results

Sample Location	Depth (feet)	Material Type	Minimum Resistivity(ohm-cm)	pH
T-06	1	CL	1,830	7.5
T-26	1	CL	1,480	7.4
T-45A	4	CL	2,290	7.6
T-54	1	CL	1,370	7.7
T-66	1	CL	2,030	7.4
SUB-1	1	CL	2,660	6.8

Notes: CL = Lean Clay.

Laboratory CBR tests were performed on shallow soil subgrade samples. A summary of the CBR test results along with the design dry unit weight values (at 95% of the maximum dry density as determined by ASTM D698 at the optimum moisture content) is presented in Table 4.3.8.

Table 4.3.8 Summary of CBR Test Results

Sample Location	Depth (feet)	Material Type	Design Dry Unit Weight (pcf)	CBR at 95% Compaction (%)
T-63	2 to 4	CH	97.8	1.7
T-08	2 to 4	CL	107.4	1.3

Notes: pcf = pounds per cubic foot; % = percent; CH = Fat Clay; CL = Lean Clay.

Graphical test results of laboratory testing completed as part of this study along with the summary of laboratory testing are presented in Appendix B.

4.4 Groundwater Conditions

For foundation design purposes, the groundwater can be assumed to be 0 to 2 feet below the ground surface for investigated WTG locations, recommended design groundwater level for each turbine site was shown in the Table A1 within Appendix A. The design groundwater levels, which RRC recommends at investigated turbine sites in Table A1, are for turbine foundation structural design purposes only, and incorporate about 2 feet of buffer for seasonal groundwater variations; those design groundwater levels should not be relied on to characterize the groundwater condition for the purpose of construction dewatering.

Groundwater was encountered between 4 to 52 feet during drilling prior to rock coring. As part of the rock coring operations, water was introduced into the borehole at a majority of the WTG locations to facilitate wet rotary rock coring drilling methods. The introduction of water inhibits groundwater level measurements during and immediately after drilling. Upon completion of the

drilling operations, the borings were backfilled in accordance with the state of Ohio and local regulations; therefore, subsequent groundwater measurements are not available.

RRC installed temporary standpipe piezometers at each investigated WTG location due to the presence of shallow groundwater. Groundwater table (GWT) in the 80 installed piezometers was measured at depths ranging from about 0.3 to deeper than 13 feet below existing site grade during the monitoring periods. Summary of groundwater levels measured in the piezometers are presented in the Table A1 within Appendix A. These readings are initial readings and may not reflect the final groundwater level after equilibrium.

Based upon review of published well logs in Erie and Huron Counties, Ohio, available from Reference 4 (Ohio Department of Natural Resources), within the project site, static groundwater levels were reported to be between 2 and 90 feet below the ground surface at well locations summarized in Table A3 within Appendix A. The shallowest groundwater level was recorded at about 2 feet below the ground surface at Well No. 901470 located within project area. The well locations shown on Table A3 are plotted on Figure 10, Well Locations Obtained from the Ohio Department of Natural Resources), within Appendix A.

It should be noted the water wells were installed to deep aquifers below typical turbine foundation depth and indicate piezometric or static groundwater level within those deep aquifers only. The static water levels from the deep wells do not always provide useful groundwater information for shallow aquifers or perched water tables near turbine foundation depths that should be considered in turbine foundation design. Based upon the information obtained from the borings drilled as part of this study and a review of well log records, it is our opinion that static groundwater level should have an impact on shallow gravity foundation system design and construction at the locations drilled as part of this study.

It is imperative to note that the short-term groundwater level observations performed as part of this study are not an accurate evaluation of groundwater levels at the project site, and this report should not be interpreted as a comprehensive groundwater study. The observations during this investigation may also not represent conditions at the time of construction and it should be understood the presence of groundwater may have influences on certain construction activities and long-term performance of foundations and roadways. Groundwater levels are highly dependent on climatic and hydrologic conditions before and after construction, the site development including irrigation demands, drainage and other factors. If a detailed groundwater study is desired, a groundwater hydrologist should be retained to provide these services.

4.5 Geophysical Properties

RRC performed 1-D MASW surveys and electrical resistivity (ER) tests at selected turbine and substation locations during the second mobilization, which was on January, 2020. The purpose of MASW surveys is to obtain shear wave velocity (V_s) profiles at selected WTG locations. The MASW survey methodologies and results are discussed in Section 4.5.1. The Electrical Resistivity survey methodologies are presented in Section 4.5.2.

4.5.1 MASW Survey

The Multi-Channel-Analysis-of-Surface-Waves (MASW) method is a non-intrusive/non-destructive technique which uses the nature of the Rayleigh waves to evaluate engineering and geotechnical properties (stiffness) of subsurface materials. Rayleigh waves of different wavelengths (or frequencies) travel at different velocities when they propagate along the surface of a layered system (material properties vary with depth). This property is called dispersion. In other words, the velocity of Rayleigh wave is dependent on the wavelength in the non-homogeneous system. Also, Rayleigh waves of different wavelengths travel/sample within different depth ranges (usually, waves of shorter wavelengths travel within shallower depth ranges).

Typically, for 1-D MASW survey, a linear array composed of twenty-four 4.5 Hz geophones with 5-foot equal spacing between each pair is laid out in the selected locations. Total length of the array is approximately 115 feet. A 16-pound sledge hammer is employed as the seismic source to generate a desired frequency (wavelength) range of the seismic waves by striking on a plate (placed 10, 25 and 40 feet away from the first geophone) aligned within the geophone array. Seismic data are collected using the data recording device and processed using SurfSeis 4.0.4 computer software developed by Kansas Geological Survey (KGS).

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

$$G = \rho V_S^2$$

where:

G = Shear Modulus (psf);
ρ = Mass density (pcf/(ft/sec.^{2})); 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:

$$E = 2G(1 + v)$$

where:

E = Young's Modulus (psf); and

v = Poisson's Ratio.

The weighted average is calculated based on the following formula based on the 2015 International Building Code (IBC) (Reference 5):

$$\overline{V_S} = \frac{\sum_i^n d_i}{\sum_i^n \frac{d_i}{V_{si}}}$$

Where:

d_i = Thickness of any layer between 0 and 100 feet; and

V_{si}= Shear wave velocity of a layer.

Figure 11 within Appendix A show weighted average of measured shear wave velocity at the project site for the selected turbine locations where MASW was conducted. Note that the measured shear wave velocity using MASW may not be available up to 100 feet. In the case where measured shear wave velocity is available for 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 4.5.1.1 can be used in the computation of the elastic and shear moduli when shear wave velocities are determined by geophysical methods.

Table 4.5.1.1 Recommended Soil and Bedrock Parameters

Soil/ Material Type	Poisson's Ratio	Average Total Unit Weight (pcf)
Soft to Medium Stiff Clay Soils	0.30(1)	115(1)
Stiff to Hard Clay Soils	0.30(1)	120(1)
Loose to Medium Dense Sand and Silt Soils	0.35(1)	115(1)
Dense to Very Dense Sand and Silt Soils	0.35(1)	120(1)
Limestone/Shale Bedrock	0.30	150
Structural Fill Materials (minimum 5 feet thick)	0.35	120

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

Computed parameters from the MASW surveys represent soil behavior at small strain; appropriate reduction factor should be used by the foundation designer to determine the rotational stiffness of the foundation system for large strain case.

Results of the MASW surveys are presented within Appendix C of this report.

4.5.2 Electrical Resistivity Survey

RRC performed electrical resistivity surveys at selected locations during the second mobilization, which was on January 2020. The electrical resistivity testing was conducted utilizing a digital ground resistance tester using the Wenner 4-pin array method. The tests were performed using 2 perpendicular array arrangements at 'a' spacing ranging from 2 to 60 feet at

selected WTG locations and from 2 to 200 feet at the proposed Substation site. It shall be considered by designer as these surveys were performed when ground was partially frozen, additional tests may be needed for design purposes.

Results of the electrical resistivity testing are presented in Appendix C.

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

4.6 Rho Thermal Resistivity Surveys

In-situ thermal resistivity testing was performed by Geotherm USA, at a total of 5 selected locations. Bulk samples of native soil samples were collected at locations shown in Figure 6 within Appendix A for laboratory thermal resistivity testing in accordance with IEEE Standard. Thermal resistivity tests were performed on remolded soil samples obtained at depths ranging from 2 to 4 feet below existing site grade. The disturbed soil samples were remolded to 92% of their respective maximum dry density as determined by ASTM D698 at "as-received" moisture content prior to the thermal resistivity testing. Thermal resistivity values were then tested with samples at a series of moisture contents from "as-received" moisture content to 0% moisture content to provide a thermal resistivity dry-out curve. Results of thermal resistivity tests are presented within Appendix C.

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

4.7 Preliminary Geohazard Assessment

4.7.1 Flood Hazard

Based on Federal Emergency Management Agency (FEMA) maps, topographic maps and aerial imagery, it appears that the proposed turbine locations can be considered a low risk to flood hazard. FEMA flood hazard maps indicate the sites investigated as part of this study are in an area identified as Zone X. Areas identified as Zone X are considered as 0.2% or less annual chance flood event, or areas of minimal flood hazard.

4.7.2 Expansive Soils

Based upon review of the logs of boring and available geological maps and literature expansive soils are not expected to be encountered within the majority of project site and can be considered as a low risk.

4.7.3 Frost Penetration Depth

According to USACE EM 1110-1-1905 (Reference 7), the average frost penetration depth is approximately 3.5 feet below finished site grade for the project site.

4.7.4 Karst Potential

Water soluble rocks located near, or exposed at, the surface have the potential for the development of karst and dissolution features. Rocks, or mineral deposits, such as limestone, dolomite, gypsum/anhydrite and salt are all soluble to groundwater. The aforementioned formations within 20 feet below the ground surface have a high risk potential, while remain problematic when encountered at 20 to 100 feet below the ground surface.

Based upon review of the logs of boring and available geological maps and literature, karst potential is considered low to high. For sites classified as moderate to high, as shown in Table A1 within Appendix A, RRC recommends performing void assessment and mitigation prior to construction. Geophysical study such as Electrical Imaging (EI) may also be considered to further assess risk for karst/sinkhole features within foundation footprint, particularly at sites deemed as Moderate Risk, to confirm if further void mitigation using pilot holes is necessary. Once the high-risk sites are identified and remedial measures are implemented during construction, the risk to foundation support can be considered low.

4.7.5 Slope Stability

Based on existing site topography and RRC's observations during geotechnical field exploration, the investigated WTG sites are setback a sufficient distance away from the escarpment edges and crests of slopes; therefore, slope stability is not anticipated to be a major concern for this project site, assuming minimum site grading occurs during construction phase.

4.7.6 Seismicity

The state of Ohio as a whole is a region with relatively low seismicity. The peak horizontal ground accelerations near the project site were computed to be 0.063g for Site Class D. In addition, based on 2015 IBC, the Seismic Design Category is "A" for the project site. Therefore, the risk of seismic hazard is considered very low at the project site.

5.0 GEOTECHNICAL RECOMMENDATIONS

5.1 General

The turbine sites drilled as part of this study appear suitable for the proposed construction. A summary of anticipated conditions that will require attention for the design and construction is presented below:

- Each log of boring was carefully reviewed for the presence of soft to medium stiff clays, loose sand layer(s) and/or non-competent materials below and near anticipated foundation bearing elevation. Net allowable bearing capacity at WTG sites are outlined in the Table A1, Summary of Foundation Design Net Allowable Bearing Pressure and Design Groundwater Recommendations, within Appendix A. The subgrade soils and bedrock at anticipated bearing elevation for majority of the turbine locations drilled as part of this study are generally suitable for support of shallow gravity foundations without modifications. However, if soft to medium stiff clays, loose sand layer(s) or non-

competent materials are encountered below or near anticipated foundation bearing elevation during foundation excavations, these materials should be over-excavated to a competent soil or bedrock layer. The removed materials may be re-compacted or replaced with on-site suitable materials or structural fill meeting the requirements outlined in subsequent sections of this report. Excavations should be observed by a qualified representative of the geotechnical engineer prior to backfilling to assess the suitability of the foundation soils and to verify the over-excavation depths. In some cases, additional over-excavation may be necessary.

Replacement materials should be compacted to a minimum of 97% of the maximum dry density as determined by ASTM D698 and moisture conditioned to within 2% of optimum moisture content. The over-excavated area should extend a minimum of 2 feet beyond the edges of the foundation and then downward at a 1H:1V slope to the required over-excavation depth. The foundation excavations should be sloped and/or shored in accordance with OHSA regulations as required.

- The north section of project site is mapped in an area where carbonate rocks, such as limestone, are located near the ground surface. Carbonate rocks are susceptible to solution cavities or karst features. Dissolution features were observed within rock core samples at some of the boring locations. Water loss during rock core and/or what appear to be potential voids were also encountered in some of the turbine borings (T-24 and T-43) at the time of our field exploration. The water loss during rock core in some of the borings appears to be the results of the highly fractured and/or porous and vuggy nature of the limestone bedrock in this area.

  There is a risk associated with constructing foundations in areas where karst is mapped. Additional investigations such seismic refraction, electrical imaging combined with exploratory bore holes are methods generally utilized to further investigate karst features. Based on the exploratory boreholes, RRC has identified the risk as low to high at this project site. Recommendations for electrical imaging and void assessment with grouting are included within Table A1 in Appendix A. Recommended turbine locations for additional assessment are shown on Figures 12 and 13, within Appendix A. It is our understanding that further void assessment and void mitigation using pilot holes will be performed by the contractor during construction phase. Depending on the results of the additional investigation, mitigation and the determination of a geotechnical engineer, these turbines may be built safely at these locations.

- Based on results of soil/bedrock borings, the presence of voids can be further verified by drilling pilot holes to minimum depths of about 15 to 30 feet below existing site grade prior to implementing a grouting program at selected problematic sites. The pilot holes should be drilled by a qualified contractor using an air percussion drill rig equipment or similar in a pre-determined pattern. Pressure grouting to depths of about 20 to 30 feet below existing site grade will be required for boreholes where voids are verified.

- The pilot boreholes should be drilled by a qualified contractor using a percussion drill rig equipment or similar in a pattern as described in Section 6.12 of this report.

  Pilot borehole observations should be made by a qualified representative of the geotechnical engineer. Voids can be detected by observation of sudden pressure drop while drilling pilot boreholes. Approximate void depths and thickness should be documented during assessment using pilot boreholes; and if voids are encountered, additional pilot boreholes should be drilled as outlined in Section 6.12. Gravity and or pressure grouting to a required depth below foundation bearing elevation will be required for boreholes where voids are encountered and documented. Recommendations for gravity fed or pressure grouting are included in the Pressure Grout Injection section of this report.

- It is anticipated excavations may be advanced with conventional earth moving equipment where native soils extend below foundation bearing elevations. The use of heavy-duty excavation equipment such as hydraulic rock hammer along with blasting to advance foundation excavations will most likely be required where hard bedrock is encountered at shallow depths. If blasting is utilized, the blasting contractors should have sufficient experience with blasting of limestone bedrock in this area. The limestone in this area may contain variable amounts of solution cavities and differing degrees of fracturing, with shale being interbedded with limestone in some areas.

  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.

- In areas where a combination of soil or bedrock are exposed at foundation bearing elevation, the soil subgrade should be over-excavated to competent bedrock and replaced with either lean concrete having a minimum 28-day compressive strength of 1,000 psi or compacted structural fill.

  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, and the structural fill thickness shall be kept as uniform as possible with no abrupt thickness change.

- To bring the turbine pads to construction grade, as well as for the construction of the proposed access roadways, the proposed project site may require grading operations within some areas. The extent and location of the site grading is unknown at this time.

The Geotechnical Engineer of Record shall be retained to review the civil drawings and cross-sections for each of the turbine pads and critical areas along the proposed roadways once they become available if significant grading is planned. This will allow us to be able to further assess the need for additional studies such as slope stability analyses. However, we anticipate the majority of turbine foundations will bear on bedrock or other strong geo-materials with minimal slope stability concerns provided measures outlined in this report are implemented.

- WTG 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 from the edge of foundation to the crest of any natural or man-made slopes. Proper drainage measures should be taken to reduce the impacts from water to man-made cut and fill slopes as well as all undisturbed natural slopes.

It is imperative that a qualified representative of the geotechnical engineer observe each foundation excavation at the time of excavation to verify exposed foundation soil and bedrock bearing conditions and to assess the need and limits of removal and replacement.

Detailed foundation design and construction recommendations are outlined in subsequent sections of this report. The geotechnical recommendations presented in this report, including but not limited to foundation bearing capacity values, anticipated ground improvement depths and estimated foundation settlements, deep foundation design soil parameters and lateral deflection analysis parameters, are based on assumed or anticipated finished site grade, foundation type/size/depth and foundation bearing pressure. RRC's geotechnical recommendations presented in this report should be verified when information on the foundation design and site grading become available.

Detailed foundation design and construction recommendations are outlined in subsequent sections of this report.

5.2 Turbine Gravity Foundation System

The use of gravity foundation systems for support of the WTG's is considered acceptable. Bearing capacity and settlement calculations were performed in general accordance with methodologies outlined in the 2nd Edition of "Guidelines for Design of Wind Turbines" (Reference 9) and 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 and bedrock are outlined in the following subsections.

5.2.1 Bearing Capacity and Settlement of Gravity Foundation System

Net allowable bearing pressures presented in Table A1 in Appendix A can be used in the structural design for foundation bearing directly on native soils and bedrock provided the remedial measures outlined in Section 5.1 and in Table A1 within Appendix A are followed.

Information obtained from ODNR Division of Geological Survey was also to determine recommendations for additional assessment and remedial measures of potential karstic areas, which are included within Table A1 in Appendix A. Recommended electrical imaging testing locations map is shown as Figure 12 within Appendix A, and recommended void assessment and grouting locations map is shown as Figure 13 within Appendix A.

Based upon anticipated structural loading, the total settlement is estimated to be on the order of 1.0 inch or less under normal operating loading condition. The estimated differential settlement across the foundation diameter is anticipated to be less than 0.3% under both dead load and normal operating loading conditions.

Table 5.2.1.1 presents a summary of design parameters for on-site soil/bedrock and structural fill materials required for the foundation design.

Table 5.2.1.1 Recommended Soil and Bedrock Design Parameters

Soil/ Material Type	Friction Coefficient [1]	Modulus of Subgrade Reaction, k_s [2] (pci)
Loose Sand	0.40	50
Medium Dense Sand	0.45	100
Dense to Very Dense Sand Soils	0.45	150
Soft to medium Stiff Clay	0.35	40
Stiff to Hard Clay and Silt Soils	0.35	75
Limestone/Shale Bedrock	0.50	150

Note: [1] 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.
[2] For 1-ft. X 1-ft. Plate.

The use of on-site clay, sand or gravel, and well-graded processed limestone/shale bedrock as backfill against foundations is considered acceptable provided the materials are properly processed and placed. Overburden backfill over foundations should be compacted to a minimum of 95% of the maximum dry density as determined by ASTM D698 to reduce the potential of erosion and/or scour events. Recommendations for use of on-site materials, borrow material or structural fill are discussed further in subsequent sections within this report.

5.3 Substation and O&M Building Shallow Foundation System

The finished site grade at the proposed Substation and O&M Building location is not available during preparation of this report, and we have assumed the finished grade is at or slightly above the existing ground surface. Clay soils with varying amounts of sand and silt were encountered at or near foundation bearing elevation in the borings drilled within the footprint of the Substation and O&M Building locations. The clay soils encountered at the anticipated foundation bearing elevation drilled as part of this study are considered stiff to hard in terms of consistency. In areas where clay soils are encountered beneath shallow foundation bearing elevation, small lightly loaded structures within these facilities may utilize continuous or pad footings bearing on native soils or newly placed engineered fill materials.

The footing should have a minimum embedment of 3.5 feet below finished site grade for confinement and frost penetration. A minimum width of 18 inches for strip footings and a minimum of 24 inches for spread footings are recommended.

For reinforced concrete slabs bearing at finished grade, we recommend over-excavation of foundation subgrade soils to a minimum of 3.5 feet below the finished grade. Within the frost depth (about 0 to 3.5 feet), the native soils should be replaced with non-frost susceptible fill material or flowable fill (controlled low strength material) having compressive strength of at least 150 psi. The non-frost susceptible fill material, consisting of granular materials which have less than 5% passing a No. 200 Sieve, should be moisture conditioned within 2% of optimum moisture content and should be compacted to a minimum of 97% of the maximum dry density as determined by ASTM D698. Other alternatives such as thermal insulation may be used to protect against frost and the contractor or designer of thermal insulation shall be responsible for compliance with local building codes. A net allowable bearing pressure 1,000 psf can be used for reinforced concrete slabs bearing at finished graded provided the above design guidelines are followed.

For shallow foundation systems, net allowable bearing pressures, which include a factor of safety of 3, outlined in Table 5.3.1 and Table 5.3.2 can be used for the Substation and O&M Building structure locations. Anticipated settlement of the foundations under service loads will be on the order of about 1.0 inches or less.

Table 5.3.1 Recommended Soil Parameters for Structural Design of Footing and Mat Foundations at Substation Location

Parameter	Design Value at Substation Location
Design Groundwater Depth, ft	>10
Average Unit Weight, pcf	115
Modulus of Subgrade Reaction, pci	45*
Undrained Shear Strength, psf	1,000
Friction Coefficient at Foundation Base	0.35
Net allowable bearing pressure for Strip or Continuous Footings (psf) width 1.5 feet or larger	2,000
Net allowable bearing pressure for Square or Pad Footings (psf) width 2 feet or larger	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 5.3.2 Recommended Soil Parameters for Structural Design of Footing and Mat Foundations at O&M Building Location

Parameter	Design Value at O&M Building Location
Design Groundwater Depth, ft	7.5
Average Unit Weight, pcf	115
Modulus of Subgrade Reaction, pci	35*
Undrained Shear Strength, psf	650
Friction Coefficient at Foundation Base	0.35
Net allowable bearing pressure for Strip or Continuous Footings (psf) width 1.5 feet or larger	1,250
Net allowable bearing pressure for Square or Pad Footings (psf) width 2 feet or larger	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.

It is recommended that a qualified representative of a geotechnical engineer observe shallow foundation excavations in this area to assess the need for any over-excavation and re-compaction and/or replacement.

For structural design of the footings and mat foundations, the parameters outlined in Table 5.3.1 and Table 5.3.2 can be used. Other design and construction recommendations are outlined in the ACI design Manual should be followed. It is imperative that proper drainage be maintained during construction and throughout the life of the substation structures to provide for adequate shallow foundation performance.

5.4 Substation 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 at the substation location 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. Settlement associated with drilled piers is anticipated to be on the order of about ½ to 1 inch. For proper installation of steel rebar and concrete piers should have a minimum diameter of 1½ feet. The length of the drilled piers should be determined by the structural engineer to satisfy axial and lateral loading.

It is imperative that the design provides positive drainage away from the foundations during construction and throughout the life of the structure.

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. Based on our interpretation of the subsurface strata and the results of the field and laboratory

tests, the parameters outlined within Appendix D may be used 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 be satisfied.

5.5 Lateral Earth Pressures

Lateral earth pressures will apply in strata where soils are the main constituent. The turbine will be designed to resist all lateral movements; therefore, the "at rest" lateral earth pressure will develop. Where the design includes restrained elements, the following "at rest" equivalent fluid pressures are recommended as shown in Table 5.5.1.

Table 5.5.1 Recommended Equivalent Fluid Pressures for "At Rest" Lateral Earth Pressures

Material Type	"At Rest" Coefficient of Lateral Earth Pressure, Ko	Equivalent Fluid Pressure for "At Rest" Lateral Earth Pressure (psf/ft)
Clay Soils	0.59	71.0
Sand Soils	0.47	56.0
Limestone/Shale Bedrock	0.29	44.0

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.

For soils above any free water surface, recommended equivalent fluid pressures for unrestrained foundation elements when using on-site soils as backfill are shown on Table 5.5.2 and Table 5.5.3 for active and passive lateral earth pressures, respectively.

Table 5.5.2 Recommended Equivalent Fluid Pressures for Active Lateral Earth Pressures

Material Type	Active Coefficient of Lateral Earth Pressure, Ka	Equivalent Fluid Pressure for Active Lateral Earth Pressure (psf/ft)
Clay Soils	0.42	50.0
Sand Soils	0.31	37.0
Limestone/Shale Bedrock	0.17	25.0

Table 5.5.3 Recommended Equivalent Fluid Pressures for Passive Lateral Earth Pressures

Material Type	Passive Coefficient of Lateral Earth Pressure, Kp	Equivalent Fluid Pressure for Passive Lateral Earth Pressure (psf/ft)
Clay Soils	2.37	285.0
Sand Soils	3.25	390.0
Limestone/Shale Bedrock	5.83	875.0

The equivalent pressures listed above are based on an average total unit weight of 120 pcf for on-site clay and sand soils, and 150 pcf for bedrock. For soils below the free water surface, hydrostatic pressure should be added to the lateral earth pressure, and the equivalent fluid pressures should be calculated using the effective unit weights (the above total unit weight minus 62.4 pcf) multiplied by the appropriate earth pressure coefficient (Ko, Ka, & Kp). The above earth pressure values do not include safety factors. 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.

5.6 Seismic Considerations

For structural designs based upon the 2015 International Building Code (IBC) (Reference 5), Site Class D should be used for WTG sites as part of this project. The Mapped Spectral Response Acceleration for the 1 second (S_1) and short periods (S_S) were computed using the U.S. Seismic Design Maps Web-based application Program developed by the United States Geological Survey (USGS) (Reference 8). Table 5.6.1 summarizes recommended seismic parameters to be used in the design.

Table 5.6.1 Recommended Seismic Parameters

Parameter	Recommended Calculated Value
S_S – Mapped Spectral Response Acceleration at Short Period (0.2-Second)	0.129
S_1 – Mapped Spectral Response Acceleration at 1-Second Period	0.056
F_a (Site Coefficient) – Site Class D	1.6
F_v (Site Coefficient) – Site Class D	2.4

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. 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.

Site preparation should begin by removing surface vegetation, organic topsoil, and major root systems within the foundation areas. Deleterious materials should be placed in non-structural areas or removed from the site. During excavation of the turbine foundations, every effort should be made to avoid disturbing the 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 97% of the maximum dry density as determined by ASTM D698 and moisture conditioned within 2% of optimum moisture content. In areas where removal of the subgrade materials is required, proper slopes meeting federal, and state OSHA requirements should be maintained. The base of each foundation excavation should be observed by a geotechnical engineer or a qualified representative prior to foundation installation.

6.2 On-Site Excavated Materials as Overburden Backfill

The use of on-site clay, sand, gravel and processed bedrock material is considered acceptable as overburden backfill materials placed above and against the sides of turbine foundations provided the materials are properly processed and placed. The backfill materials should be free of organics, roots and deleterious materials, and approved by the on-site geotechnical representative prior to use. Excavated bedrock shall be processed to a maximum size of 6 inches or smaller prior to use within the overburden backfill matrix. During excavation and grading, proposed backfill material not immediately placed and compacted shall be stockpiled and protected from moisture by sealing the surface with light compaction.

Based on our experience with these types of materials and results of maximum dry density-optimum moisture content relationships performed as part of this study (ASTM D698), anticipated overburden backfill densities are outlined in Table 6.2.1.

Table 6.2.1 Overburden Backfill Density Range Requirement

Soil/ Material Type	Dry Backfill Unit Weight Range, γ_d (pcf)	Moist Backfill Unit Weight Range, γ_{total} (pcf)
Processed Bedrock with Soil Mixture*	110-130	115-140
On-site Lean Clay soils	95-115	105-135

Note: pcf= pounds per cubic foot; *estimated

The backfill materials should be placed in thin, loose lifts not exceeding 12 inches prior to compacting. Each lift of backfill material should be compacted, moisture conditioned properly, and tested to meet the minimum and maximum dry and moist unit weight values specified in the foundation design drawing. In addition, each lift of backfill material over turbine foundations should be compacted to dry densities of at least 95% of the maximum dry density as determined by ASTM D698, to reduce the potential of erosion and fill settlement. The top surface of the backfill should be kept with sufficient drainage slope (minimum 2% gradient) to allow surface water runoff during construction.

In areas where granular materials or properly processed limestone bedrock are used for the overburden backfill, consideration could be given to use a minimum of 12-inch cap using clay soils on top of overburden backfill zone to reduce any surface water infiltration. The clay cap should be extended a minimum of 5 feet beyond the turbine foundation perimeter.

In areas where structural elements such as transformer pads are supported on overburden backfill materials or where crane pads are extended to the overburden backfill zone, we recommend the overburden backfill below the transformer pads or crane pads follow the general foundation overburden backfill requirements outlined above, as well as specific specifications from the pad designer to satisfy both bearing capacity and settlement requirement of the pad design. As a general guideline, RRC suggests a minimum 3 feet (in thickness) of the overburden backfill below the transformer pads or crane pads be compacted to a minimum of 97% of the maximum dry density as determined by ASTM D698 and moisture conditioned within 2% of optimum moisture content; the suggested backfill compaction should extend a minimum lateral distance of 1 foot beyond the edges of the crane/transformer pad and then downward at a slope of 1:1 (H:V) below the foundation elevation.

6.3 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 recommended to meet the Ohio Department of Transportation Type 2 or better. As a guide, structural fill meeting the following specifications is recommended:

	Percent Finer by Weight
1 “	100
¾ “	100
3/8 “	80-100
No. 4 Sieve	60-100
No. 8 Sieve	45-95
No. 50 Sieve0	7-55
No. 200 Sieve	0-15
• Maximum Plasticity Index	6
• Maximum Liquid Limit	25
• Percent of wear, Los Angeles test, maximum	50%

Structural fill should be placed in lifts having a maximum loose lift thickness of 12 inches and should be compacted to a minimum of 95% per ASTM D 1557 or a minimum of 97% per ASTM D 698. The structural fill should be moisture conditioned within 2% of optimum moisture content.

6.4 Reuse of On-site Materials as Structural Fill Below Foundation

Modification of unsuitable foundation soils shall consist of over-excavation and replacement with any of the following materials:

1. On-site lean clay and sand/gravel soils may be reused beneath the foundation with approval of the proposed material by a geotechnical engineer.

    i. On-site material used beneath the foundation shall have a maximum plasticity index of 12 and a maximum liquid limit of 40.
    ii. These reused materials shall be compacted to a minimum of 97% of the maximum dry density as determined by ASTM D698 or 95% as determined by ASTM D1557 and shall be moisture conditioned within 2% of optimum moisture content.

2. Borrow lean clay and sand/gravel soils may be used beneath the foundation with approval of the proposed material by a geotechnical engineer. Borrow material shall meet the requirements outlined in the items (i) and (ii) above.

3. Structural fill meeting the criteria shown in Section 6.3 of this report.

6.5 Shallow Foundation Construction

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

- All foundation excavations should be observed by a Geotechnical Engineer or a 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.

- Special care should be taken to protect the exposed soils from being disturbed, freezing or drying out prior to the placement of structural fill.

- The foundation contactor should determine proper excavation means and methods. 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” (concrete) not less than 2 inches in thickness. 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 of loose material and debris prior to the placement of reinforcing steel. Precautions should be taken during the placement of reinforcement and concrete to prevent the loose excavated material from falling into the excavation. A proof-roll of the excavation subgrade should be performed with a fully-loaded front-end loader or a similar equipment to assess the need for any shallow remedial measures. If excessive deflection or soft areas are observed while performing the proof-roll operations, the remedial measures outlined in previous sections of this report should be followed, if applicable. The proof-roll operations should be observed by a qualified representative of the geotechnical engineer. In addition, Static or Dynamic Cone Penetrometer (depending on the subgrade materials exposed at foundation bearing elevation) should be conducted to verify foundation design bearing pressures are met.

- Prior to the placement of concrete, water or frozen ground if present must be removed from the foundation excavation.

- Prompt placement of concrete in the excavation as it is completed, cleaned, and observed is strongly recommended.

6.6 Drilled Pier Foundation Construction

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

- A Geotechnical Engineer or his representative should observe all pier excavations. This pier inspection is to verify proper depth, bearing stratum, soil conditions and to record other observations regarding the pier construction.

- The pier excavations shall be checked for size and to determine that free water (for dry pier excavation) and loose material have been removed prior to the placement of concrete. Precautions should be taken during the placement of the pier reinforcement and concrete to prevent the loose excavated material from falling into the excavation.

- Prompt placement of concrete in the excavation as it is completed, cleaned, and inspected is strongly recommended. Under no circumstances should a pier/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.

- We recommend that the construction contract include a budget for temporary casing and/or slurry drilling, in case the sloughing of sands or entry of water prevents the proper construction of the piers.

- Drilled pier/shaft construction should follow applicable industry standard. Means and methods of construction shall be determined by the design/build contractor.

6.7 Open Excavations

Temporary construction slopes and/or permanent embankment slopes should be protected from surface runoff water. Site grading should be designed to allow drainage at planned areas where erosion protection is provided, instead of allowing surface water to flow down unprotected slopes.

Surcharge loads, either static or dynamic, should not be applied to an excavation slope. Construction equipment should be prevented from traveling along or near the top of the excavation slope. Monitoring of temporary slopes, trenches, and dewatering during construction should be undertaken by the contractor to detect early warnings of movement within slopes, structures, pavements, etc.

In all cases of excavations, sloped excavations and trench shields are recommended for excavations greater than 4 feet in depth. OSHA and applicable state and local standards should be observed and followed. Site safety is the responsibility of the contractor.

6.8 Corrosivity

Water-soluble sulfate and chloride testing results, shown in Section 4.3 of the report, indicated the surficial soils exhibit “Negligible” (S0) sulfate contents and “non-aggressive to aggressive” chloride content. The use of Type I cement should be considered for all at grade and below ground concrete at majority of the structures within the project area. However, if there is minimal cost differential, the use of Type II cement could be considered for higher sulfate resistance. Foundation concrete should be designed in accordance with Chapter 4 of ACI 318: Building Code Requirements for Structural Concrete and Commentary.

Minimum resistivity and pH testing results, shown in Section 4.3 of the report, indicated the surficial soils exhibit “Corrosive” to “Moderately Corrosive” characteristics for majority sites as shown in Table 6.8.1 based on Reference 10. Cathodic protection for buried metal pipe should be designed by a qualified corrosion engineer, if required.

Table 6.8.1 Effect of 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

6.9 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 shall be considered as a concern for the turbine foundation excavation dewatering at the proposed project site. If shallow perched water is present at turbine sites where clay soils are exposed within the turbine foundation excavation depths, we anticipate the groundwater re-charge rate may be slow enough to conduct excavation dewatering with conventional sumps and “trash” pumps.

6.10 Foundation Excavation and Rippability

Seismic Velocity (seismic p-wave velocity) is indication of hardness and fracture density of the rock, which in turn can be correlated to rippability of bedrock material. MASW surveys will be performed when site access is available, then p-wave velocity of the bedrock material within shallow foundation embedment depth can be estimated, which will be included in the final report. Generally, seismic p-wave velocities less than 3,000 feet per second indicate native soil or heavily weathered bedrock materials. On the other hand, p-wave velocities larger than 10,000 feet per second indicate non-weathered bedrock materials. Limestone/Shale rocks with p-wave velocity less than 6,000 feet per second can be ripped using CAT Multi- or Single Shank No. 8 Series D Ripper or equivalent (Reference 11). For higher p-wave velocity (greater than 7,500 feet per second), larger equipment (D9R, D10R or D11R) may be required.

It should be noted that rippability using p-wave velocity is only one of the various aspects for rippability of the bedrock. Proper equipment selection and sound ripping techniques are critical to effective and economic ripping. The ripping contractor/operator, familiar with local geology, shall be consulted for further evaluation. In addition to p-wave velocity, other features such as degree of weathering, joints, discontinuities and other structural features also influence rippability. In some cases uses of hydraulic rock hammer or blasting may be required to facilitate efficient ripping and removal of bedrock. Means and methods for foundation excavation should be determined by construction contractor.

6.11 Access Roadways and Crane Pads Design and Construction Recommendations

Access Roadways: It is our understanding that 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- unit 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 12).

The surficial materials encountered within a majority of the borings indicated native soils consisting of clay and sand soils with varying amounts of silt and gravel. The sand soils are generally considered to be a moderate material in terms of supporting vehicular and construction traffic as defined by AASHTO when used for support of pavement structures, while the clay soils are generally considered as poor material to support pavement structures.

Laboratory CBR testing indicated the subgrade soils for the private access roadways when compacted to about 95% of the maximum dry density as determined by ASTM D698 at optimum moisture content have CBR value ranging from 1.3 to 1.7%. The access roadways actual pavement thickness should be determined by the design/build contractor, keeping in mind the frequency, duration and requirements of the turbine manufacturer.

Prior to the placement of the aggregate base materials along access roadway alignments, stripping and removal of existing vegetation and other deleterious materials from the proposed roadway alignment should be performed. Topsoil and organics could be up to about 30 inches or more in thickness in some areas and should not be allowed for use in structural areas or along roadway alignments. The subgrade along access roadways should be scarified to a minimum depth of 12 inches; moisture conditioned within 2 percent of the optimum moisture content and re-compacted to a minimum of 95% of the maximum dry density as determined in accordance with ASTM D698. The exposed subgrade should then be proof-rolled prior to the placement of the aggregate base course materials to assess the presence of soft areas and the need for remedial measures, if any. In areas where bedrock is encountered at the surface, proof roll is not necessary. In areas where excessive “pumping” of the subgrade is observed, consideration should be given to placing geogrid (Tensar Biaxial Type 2 or equivalent) on top of geotextile (Mirafi HP 570 or equivalent) above the exposed subgrade soils, otherwise removal of unsuitable soils in these areas and re-compaction and/or replacement with granular soils will be required. Aggregate base materials should be compacted to a minimum of 95% of ASTM D1557 or a minimum of 98% of ASTM D698 and within 2% of the optimum moisture content. Consideration could be also be given to performing a cement or lime mix design to stabilize the subgrade soils supporting pavement structures as an alternative. Aggregate base thickness for stabilized access roadway sections could be reduced.

Crane Pads: Based upon review of logs of boring for the turbine sites completed as part of this study stiff to hard clay soils and medium dense to very dense sand soils are expected to be encountered below topsoil at the majority of the crane pads areas adjacent to WTG sites. To improve the performance of the subgrade soils supporting crane pads, we recommend the exposed subgrade (after stripping and removal of organic soils, vegetation and other deleterious materials) be scarified and reworked to a depth of 12 inches below existing site grade. The reworked area should extend a minimum horizontal distance of 3 feet beyond the edges of the crane pads. Reworked on-site subgrade soils should be compacted to a minimum of 97% of the maximum dry density within 2% of optimum moisture content per ASTM D698. In areas where bedrock is encountered at the surface, scarification and reworking are not required.

We recommend the compacted subgrade be tested by proof-rolling. A fully loaded 40,000 lbs., double-axle water-truck or equivalent should be used for proof-roll tests. The subgrade soil should not deflect more than 1-inch under the imposed loads. If higher deflections are observed, the subgrade soil should be over-excavated to suitable material and replaced with a properly compacted material in accordance with Section 6.3 or Section 6.4 of this report. In addition, consideration should be given to the use of either Static or Dynamic Cone Penetrometer (depending on the subgrade materials exposed at foundation bearing elevation) as an added measure to verify design bearing pressures and the need for any remedial measures.

Once a suitable subgrade condition has been achieved, a structural gravel pad should be placed to a thickness of approximately 18 inches. The crushed stone or aggregate base should conform to the requirements of the Section 6.3 of this report or better. The base material should be compacted to a minimum of 98% of the maximum dry density and within 2% of optimum moisture content as determined in accordance with ASTM D698. Crane pads constructed as recommended above are anticipated to have an allowable bearing capacity of about 3,000 to 5,500 psf at finished crane pad level. For bearing loads in excess of this amount, load distribution mats should be utilized so that the bearing capacity is not exceeded. Composite mats are capable of widely distributing the crane loads to the underlying soils for crane pads. The type and number of layers of these composite mats should be determined by the contractor and/or manufacturer to assure proper performance of the crane pads.

As existing sinkholes within project site are reported by ODNR data summary, proposed crane pads and crane walks shall not be constructed at or near reported sinkholes. Additional investigation, such as Electrical Imaging (EI), is recommended in order to lower the risk of potential sinkholes or other potential karst features near the proposed crane walk sections.

General Considerations: It is imperative that proper drainage of the subgrade be provided in the construction of the roadways and crane pads to enhance their performance. Post-construction proof rolling of the subgrade materials should be performed prior to re-opening the roadways for traffic after periods of heavy rainfall/snow melt to assess stability of the roadway and the need for remedial measures. The proof-roll should be accomplished with a fully loaded

water truck or similar heavy equipment. Areas where remedial measures are required should be re-worked and corrected prior to acceptance. It is also imperative that periodic inspection of the access roadways be performed following periods of rainfall or snowmelt to assess the condition of the roads and the need for remedial measures.

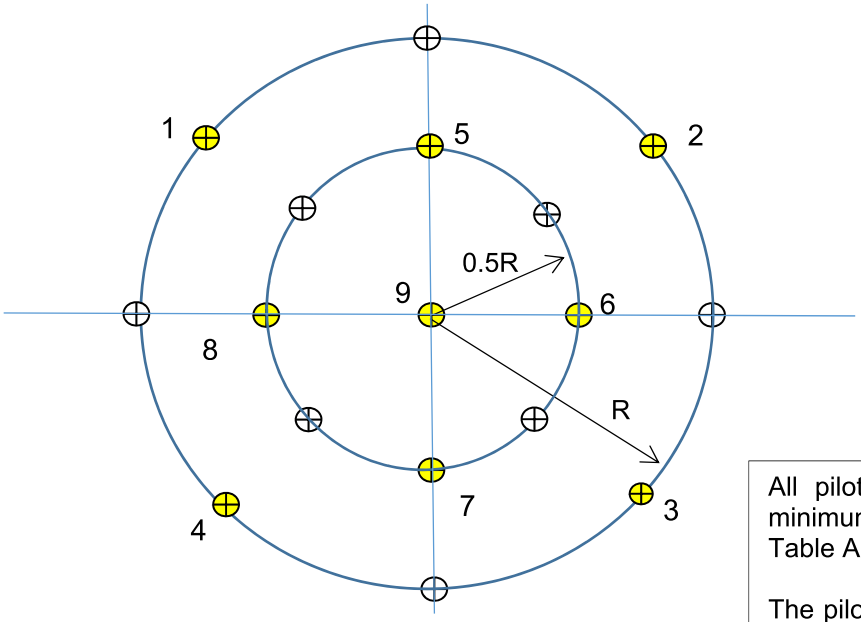
6.12 Foundation Grout and Compaction Injection

Based on our experience with pressure grouting for several wind farm projects, guidelines for void assessment and a remedial grouting program are discussed here in this section. The gravity-fed and/or pressure grouting should be performed by a qualified contractor experienced with grouting methods and techniques. Final void assessment configuration, grout mix design parameters and grouting procedures and/or means and methods shall be determined by the qualified design/built contractor. Following grouting means and methods determined by the qualified design/built contractor, this practice can be considered as a safe process which has been used for remediation purposes on previous projects. The effect of grouting for unintentional surface flooding can be considered as low.

Pilot holes for the pressure grouting program may be placed in accordance with the pattern indicated on Figure 6.12.1. Boreholes 1 through 9 should be drilled first. If any void or anomalies are encountered, the adjacent 3 pilot holes will need to be drilled. If no voids or anomalies are encountered within pilot holes 1 through 9, no additional pilot holes need to be drilled. All pilot holes shall be drilled to the minimum required depth as presented in Table A1 within Appendix A.

The following procedure should be followed during the pilot hole drilling operations:

- The locations of probe holes shall be marked on the ground surface under the footprint of the proposed foundation according to the patterns.
- Probing operations shall be observed/monitored by the driller and the field engineer or his/her representative. Changes in air pressure, downward rod resistance, color of cuttings, and sudden drops of steel rods or drilling tools shall be recorded.
- The drilling rig shall be equipped with reasonably accurate tools to measure the rate of advancement of the probe and vertical rod drops if they occur.
- A void shall be defined as a minimum rod drop of 3 inches.
- All probe holes shall be advanced below the bottom of foundation to the minimum depths outlined. Probes indicating existence of voids shall be pressure grouted per the procedure outlined below.



All pilot holes shall be drilled to the minimum depth as recommended in Table A1.

The pilot holes should be a minimum of 3.5-inch diameter.

⊕ Initial Pilot Borehole Placement

Figure 6.12.1 Recommended Pilot Hole Placement for Pressure Grout Injection.

After void assessment, pilot holes indicating existence of voids or anomalies shall be pressure grouted per the procedure outlined below; pilot holes where no voids or anomalies are detected may be filled via gravity-fed grouting. The geotechnical engineer shall be retained to oversee the pilot hole drilling program and make site-specific adjustments to the drilling or grouting program as required. The gravity grouting or pressure grouting should be performed by an experienced, qualified grouting contractor. Grout mix design, grout pump pressure/rate, and grouting equipment/procedures shall be submitted by the contractor to the geotechnical engineer and structural engineer for review and approval, prior to mobilization of the grouting contractor. The cement grout mix should be sufficiently fluid to allow proper placement while providing a minimum compressive strength of 150 psi at 28 days.

The following provides a general guideline for gravity grouting:

- Cement grout shall be adequately mixed and free of lumps prior to placement.
- The grout should be placed by gravity through a funnel attached to a grout pipe or tremie. Grout shall be placed from the bottom of the pilot holes, upward to the surface in one continuous operation. The bottom end of the grout pipe should be kept full of grout and remain submerged in grout during the operation. The grout pipe is gradually withdrawn as the grout fills the hole.
- Grouting start time, end time, and volume of grout placed shall be recorded. Grouting should continue until the pilot hole has been filled to the foundation bearing elevation.
- Pouring grout directly into the pilot holes from the surface is not allowed since it may result

in bridging and prevent the grout from reaching the bottom. Grouting at each probe hole should be completed within the same work shift.

The following provides a general guideline for pressure grouting:

- The casing/nozzle shall be lowered to approximately one to two feet above the bottom of the pilot hole. The packer rod shall then inflate to seal the opening.
- The grout shall be pumped through the hose and packer rod until practical grouting refusal. Grouting start time, end time, pump pressure and volume of grout pumped for each interval shall be recorded. Practical grouting refusal is determined by monitoring the pressure below the packer or by monitoring the grout pumping rate.
- After a practical grouting refusal has been achieved, the grout casing/nozzle shall be raised at 5-foot interval or to a depth where potential voids or dissolution matrix are observed during the void assessment. The pressure grouting should continue until the pilot hole has been filled to the foundation bearing elevation.
- Pressure grouting requires a continuous injection process for each probe hole; grouting at each probe hole should be completed within the same work shift.

Following the completion of grouting, the pilot holes shall be monitored for a minimum of 15 minutes for grout loss. If needed, grout shall be added and the hole shall be monitored for a minimum of 15 minutes. Monitoring and replenishing the grout shall continue until there is no grout loss. Pilot hole grouting at each turbine site should be staggered in a way that current hole grouting operation has as large distance as possible (hence less disturbance) to newly placed fresh grout holes. If grout is observed entering an adjacent hole, the current hole will continue to be filled with grout and the adjacent hole will be re-drilled, and re-grouted.

The Contractor should develop a foundation void assessment and grouting plan and submit to the Geotechnical and Structural Engineer of Record for approval. The submittal should include proposed drilling/grouting equipment, procedure and material as well as grout mix design. The geotechnical engineer shall be retained to oversee the grouting program and make site-specific adjustments to the grouting program as required. If excessive grout intake is encountered in certain pilot holes, additional pilot holes may need to be drilled and grouted.

6.13 Permanent Slope Configuration

In general, the following slope configurations outlined in Table 6.13.1 should be followed for cut slopes based upon material types.

Table 6.13.1 Permanent Cut Slope Configurations

Material Type	Maximum Slope Configuration (Horizontal:Vertical)
On-site Soils	3:1
Bedrock	0.75:1

The outlined configuration should be further evaluated prior to construction to assure stability throughout the life of the structure. The grading plans should provide for mid-height benches to aid in diverting surface water flow from the embankment's face if the slope height exceeds 15 feet. The face of the cut slopes should be observed by a qualified geologist to assess the need for any slope configuration modifications or the use of reinforcing measures.

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 structure. Ponding of water near the foundation elements from improper drainage should not be permitted.

7.0 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 are based on the assumption 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 particular 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.

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APPENDIX A

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

Boring ID (FIR_LAY_057)	Latitude	Longitude	Groundwater During Drilling (ft.)	Groundwater Immediately After Drilling (ft.)	Piezometer GWL after installation (ft.)	Piezometer GWL on December 2019 (ft.)	Piezometer GWL on January 2020 (ft.)	Piezometer GWL on February 2020 (ft.)	Recommended Design Groundwater Depth (ft.)	Net Allowable Bearing Capacity (qnet all) Under Normal Operating Load Conditions Based on Foundation Bearing Elevation of 12 ft. (bgs, psf)	Recommendations for Soil Improvement	Depth of Potential Voids Encountered within Borehole (ft, bgs)	Karst Risk Assessment	Void Assessm
T1	41.337091	-82.797344	NE	NA	NE	--	--	0.7	0.0	6,000	--	NO	LOW	
T2	41.334851	-82.770474												
T3	41.331470	-82.687070	4.0	NA	8.5	--	1.7	2.5	0.0	6,000	--	NO	LOW	
T4	41.327524	-82.684174	19.0	NA	9.6	--	1.6	1.4	0.0	6,000	--	NO	LOW	
T5	41.327437	-82.680044												
T6	41.318510	-82.797720	NE	NA	NE	--	--	5.3	2.0	6,000	--	NO	LOW	
T7	41.318050	-82.783112	NE	NA	NE	--	--	1.6	0.0	6,000	--	NO	LOW	
T8	41.316612	-82.776072	NE	NA	NE	--	--	3.8	2.0	6,000	--	NO	LOW	
T9	41.314163	-82.787932	NE	NA	NE	--	--	--	2.0	5,000	--	NO	LOW	
T10	41.311303	-82.784857	NE	NA	NE	--	--	2.0	0.0	5,000	--	NO	LOW	
T11	41.309756	-82.799754	NE	NA	NE	--	--	2.4	0.0	5,000	--	NO	LOW	
T12	41.305617	-82.787640	NE	NA	NE	--	--	4.7	2.0	6,000	--	NO	LOW	
T13	41.305128	-82.781567	NE	NA	NE	--	--	1.2	0.0	6,000	--	NO	LOW	
T14	41.303804	-82.696969	11.5	NE	NE	--	3.0	2.0	0.0	6,000	--	NO	LOW	
T15	41.303059	-82.688400	7.5	13.5	NE	--	1.6	--	0.0	6,000	--	NO	LOW	
T16	41.301861	-82.683923	7.0	36	NE	--	0.8	1.2	0.0	6,000	--	NO	LOW	
T17	41.297773	-82.741589	7.0	NA	9.2	--	0.8	0.9	0.0	6,000	--	NO	LOW	
T18	41.294908	-82.754023	7.0	24	NE	--	--	3.7	1.0	6,000	--	NO	LOW	
T19	41.295016	-82.737826	NE	NA	NE	--	8.5	4.1	2.0	6,000	--	NO	LOW	
T20	41.291780	-82.735204	NA	NA	NE	--	4.2	4.5	2.0	6,000	--	NO	LOW	
T21	41.286773	-82.755319	5	NA	NE	--	--	--	0.0	6,000	--	NO	LOW	
T22	41.284045	-82.736863	14	NA	NE	--	2.8	3.1	1.0	4,500	--	NO	LOW	
T23	41.263784	-82.757024	NE	NA	NE	--	2.7	2.0	0.0	6,000	--	NO	LOW	
T24	41.261475	-82.809764	NE	NA	NE	--	--	1.4	0.0	6,000	--	11 to 13	HIGH	Perform void assessment and/or bedrock
T25	41.256898	-82.811454	4.5	NA	NE	--	--	1.4	0.0	4,500	--	NO	HIGH	Perform void assessment and/or bedrock
T26	41.255529	-82.804800	15	NA	NE	--	3.4	3.5	1.0	6,000	--	NO	MODERATE	Perform E
T27	41.247740	-82.775587	NE	NA	NA	--	3.3	--	1.0	6,000	--	NO	LOW	
T28	41.247445	-82.755309	12	NA	NA	--	2.1	1.6	0.0	6,000	--	NO	LOW	
T29	41.246008	-82.796827	7	NA	9.2	--	1.5	0.6	0.0	6,000	--	NO	LOW	
T30	41.244491	-82.771245	7	NA	NA	--	4.2	3.0	1.0	6,000	--	NO	LOW	
T31	41.244309	-82.752195	7	14	NA	--	3.0	2.2	0.0	4,500	--	NO	LOW	
T32	41.242334	-82.797954	9	NA	10.4	--	4.1	1.5	0.0	6,000	--	NO	LOW	
T33	41.241983	-82.744461	4	NA	NA	--	3.4	3.0	1.0	4,500	--	NO	LOW	
T34	41.240369	-82.832115	NA	NA	NE	--	--	2.2	0.0	6,000	--	NO	LOW	
T35	41.238171	-82.771065	4	NA	NA	--	2.8	--	0.0	6,000	--	NO	LOW	
T36	41.238015	-82.750999	NE	NA	NA	--	3.4	2.1	0.0	4,500	--	NO	LOW	
T37	41.235902	-82.826303	NE	NA	NE	--	--	2.2	0.0	6,000	--	NO	LOW	
T38	41.234841	-82.833897												
T39	41.229091	-82.804853	12	NA	7.3	--	--	2.5	0.0	4,500	--	NO	LOW	
T40	41.207509	-82.781587	9	NA	7.7	--	--	1.5	0.0	6,000	--	NO	LOW	
T41	41.203875	-82.781489	7	NA	1.7	--	--	1.8	0.0	6,000	--	NO	LOW	
T42	41.200363	-82.777263	NE	NA	NE	2.7	2.3	--	0.0	6,000	--	NO	LOW	
T43	41.198112	-82.831090	NE	NA	NE	--	--	1.3	0.0	6,000	--	17 to 18	HIGH	Perform void assessment and/or bedrock
T44	41.192592	-82.774713	14	NA	NE	--	1.5	--	0.0	4,000	--	NO	LOW	
T45	41.187731	-82.775036	NE	NA	NE	--	--	3.2	1.0	5,000	--	NO	LOW	
T46	41.181870	-82.781886	9	NA	NE	--	--	3.1	1.0	5,000	--	NO	LOW	
T47	41.176582	-82.829454	NE	NA	NE	--	--	0.9	0.0	4,000	--	NO	LOW	
T48	41.154781	-82.811484	NE	31	NE	NA	--	2.9	1.0	4,000	--	NO	LOW	
T49	41.151717	-82.781455	NE	NA	NE	--	--	1.5	0.0	3,500	--	NO	LOW	
T50	41.150265	-82.822230	9	4	6.5	NA	--	1.9	0.0	4,000	--	NO	LOW	
T51	41.148395	-82.811766	14	NA	3	NA	--	3.0	1.0	4,000	--	NO	LOW	
T52	41.141995	-82.832667	19	NA	13	2.8	--	1.5	0.0	4,000	--	NO	LOW	
T53	41.138732	-82.832555	19	NA	NE	--	1.9	1.3	0.0	3,000	--	NO	LOW	
T54	41.139042	-82.770782	44	NA	NE	--	--	1.7	0.0	3,500	--	NO	LOW	
T55	41.137589	-82.776792												
T56	41.137179	-82.791465	24	NA	NE	--	--	1.6	0.0	3,500	--	NO	LOW	
T57	41.136254	-82.825618	NE	NA	13	3.9	--	1.6	0.0	4,000	--	NO	LOW	
T58	41.132702	-82.769033	24	23	NE	NE	--	2.1	0.0	2,500	--	NO	LOW	
T59	41.130820	-82.822057	NE	NA	5.0	--	--	0.7	0.0	4,000	--	NO	LOW	
T60	41.115596	-82.744422	NE	NE	NE	0.6	--	1.6	0.0	4,000	--	NO	LOW	
T61	41.113883	-82.809371	NE	NA	6.5	--	--	1.0	0.0	3,500	--	NO	LOW	
T62	41.110964	-82.744297	52	40	NE	1.3	--	1.4	0.0	4,000	--	NO	LOW	
T63	41.107601	-82.807071	14	NA	NE	--	1.1	1.0	0.0	3,000	--	NO	LOW	
T64	41.098514	-82.827851	47	24	NE	1.8	--	1.8	0.0	4,000	--	NO	LOW	
T65	41.096579	-82.806805	NE	NE	NE	--	1.6	2.2	0.0	4,000	--	NO	LOW	
T66	41.095647	-82.763703	13	NA	NE	--	1.2	1.5	0.0	3,500	Perform Deep Soil Improvement to 34 feet	NO	LOW	
T67	41.094265	-82.770634	NE	NA	NE	--	6.3	--	2.0	3,500	Perform Deep Soil Improvement to 29 feet	NO	LOW	
T68	41.092712	-82.777417	NE	NA	NE	--	1.7	1.0	0.0	2,500	--	NO	LOW	
T69	41.091692	-82.788934	NE	NA	NE	--	--	--	0.0	2,500	--	NO	LOW	
T70	41.088115	-82.817980	39	NA	NE	--	1.3	1.6	0.0	3,000	--	NO	LOW	
T71	41.087076	-82.777013	14	NA	NE	--	2.2	1.9	0.0	4,000	--	NO	LOW	
T72	41.317416	-82.790099	NE	NA	NE	--	4.2	2.3	0.0	6,000	--	NO	LOW	
T73	41.309842	-82.815969	NE	NA	NE	--	2.5	1.3	0.0	6,000	--	NO	MODERATE	Perform Electrical I
T74	41.307049	-82.817887	NE	NA	NE	--	2.4	12.7	1.0	6,000	--	NO	MODERATE	Perform Electrical I
T75	41.260506	-82.803113	7	NA	NE	--	--	1.3	0.0	6,000	--	NO	HIGH	Perform void assessment and/or bedrock
T76	41.197831	-82.755836	14	NA	NE	--	0.3	2.5	0.0	6,000	--	NO	LOW	
T77	41.197446	-82.776172	NE	NA	NE	4.2	1.6	--	0.0	6,000	--	NO	LOW	
T78	41.133708	-82.823198	NE	NA	11.4	--	--	1.2	0.0	6,000	--	NO	LOW	
T79	41.110892	-82.740271	40	30	NE	1.3	--	1.8	0.0	4,000	--	NO	LOW	
T80	41.065264	-82.824944	NE	NE	NE	1.8	--	--	0.0	4,000	--	NO	LOW	
T81	41.058500	-82.824749	19	28	NE	0.7	1.4	0.8	0.0	3,500	--	NO	LOW	
T82	41.049640	-82.827139	29	16	NE	9.5	1.9	--	0.0	3,250	--	NO	LOW	

Table A2 - Summary of Subsurface Exploration and Geographic Coordinates

Boring ID	Latitude	Longitude	MASW Survey	Electrical Resistivty Survey	Thermal Resistivity Testing	Drilling/Test Date	Auger (ft)	Air Rotary (ft)	Rock Core (ft)	Total Depth (ft)	RQD	Gr
T1	41.337091	-82.797344				4/17/19	4.0	0.0	20.0	24.0	Poor	
T2	41.334851	-82.770474										
T3	41.331470	-82.687070				4/2/19	19.0	0.0	0.0	19.0	NA	
T4	41.327524	-82.684174				4/3/19	25.0	0.0	0.0	25.0	NA	
T5	41.327437	-82.680044										
T6	41.318510	-82.797720				4/22/19	10.0	0.0	17.0	27.0	Good	
T7	41.318050	-82.783112				4/23/19	7.0	0.0	20.0	27.0	Poor	
T8	41.316612	-82.776072				4/23/19	8.0	0.0	20.0	28.0	Poor	
T9	41.314163	-82.787932				4/24/19	13.0	0.0	15.0	28.0	Good	
T10	41.311303	-82.784857				4/24/19	21.0	0.0	4.0	25.0	NA	
T11	41.309756	-82.799754				4/22/19	14.0	0.0	14.0	28.0	Good	
T12	41.305617	-82.787640				4/25/19	8.0	0.0	20.0	28.0	Good	
T13	41.305128	-82.781567				4/25/19	21.0	0.0	10.0	31.0	Good	
T14	41.303804	-82.696969				4/2/19	30.5	0.0	0.0	30.5	NA	
T15	41.303059	-82.688400	X	X		4/1/19	29.0	0.0	0.0	29.0	NA	
T16	41.301861	-82.683923				4/1/19	40.0	0.0	0.0	40.0	NA	
T17	41.297773	-82.741589				5/22/19	28.0	0.0	10.0	38.0	NA	
T18	41.294908	-82.754023				4/3/19	48.0	0.0	0.0	48.0	NA	
T19	41.295016	-82.737826				5/23/19	48.0	0.0	0.0	48.0	NA	
T20	41.291780	-82.735204				5/24/19	4.0	0.0	28.0	32.0	Poor	
T21	41.286773	-82.755319				4/16/19	10.0	0.0	20.0	30.0	Poor	
T22	41.284045	-82.736863				4/4/19	19.0	0.0	0.0	19.0	NA	
T23	41.263784	-82.757024				4/16/19	10.0	0.0	15.0	25.0	Very Poor	
T24	41.261475	-82.809764				4/28/19	5.0	0.0	23.0	28.0	Very Poor	
T25	41.256898	-82.811454				4/27/19	16.0	0.0	15.0	31.0	Fair	
T26	41.255529	-82.804800				4/29/19	30.0	0.0	0.0	30.0	NA	
T27	41.247740	-82.775587				4/17/19	7.0	0.0	18.0	25.0	Very Poor	
T28	41.247445	-82.755309				4/22/19	16.0	0.0	8.0	24.0	Very Poor	
T29	41.246008	-82.796827				5/20/19	31.0	0.0	0.0	31.0	NA	
T30	41.244491	-82.771245				4/18/19	10.0	0.0	20.0	30.0	Very Poor	
T31	41.244309	-82.752195				4/25/19	25.0	0.0	0.0	25.0	NA	
T32	41.242334	-82.797954				5/20/19	31.0	0.0	0.0	31.0	NA	
T33	41.241983	-82.744461				4/23/19	19.5	0.0	0.0	19.5	NA	
T34	41.240369	-82.832115				5/22/19	2.0	0.0	25.0	27.0	Poor	
T35	41.238171	-82.771065				4/23/19	7.0	0.0	12.0	19.0	Very Poor	
T36	41.238015	-82.750999				4/26/19	12.0	0.0	8.0	20.0	Poor	
T37	41.235902	-82.826303				5/1/19	5.0	0.0	23.0	28.0	Fair	
T38	41.234841	-82.833897										
T39	41.229091	-82.804853				5/25/19	26.0	0.0	0.0	26.0	NA	
T40	41.207509	-82.781587				4/5/19	18.5	0.0	0.0	18.5	NA	
T41	41.203875	-82.781489				4/5/19	10.0	0.0	20.0	30.0	Poor	
T42	41.200263	-82.777263	X	X		12/30/20	13.0	27.0	0.0	30.0	NA	

Table A2 - Summary of Subsurface Exploration and Geographic Coordinates

Boring ID	Latitude	Longitude	MASW Survey	Electrical Resistivty Survey	Thermal Resistivity Testing	Drilling/Test Date	Auger (ft)	Air Rotary (ft)	Rock Core (ft)	Total Depth (ft)	RQD	Gr
T55	41.137589	-82.776792										
T56	41.137179	-82.791465				5/14/19	39.5	0.0	0.0	39.5	NA	
T57	41.136254	-82.825618				12/17/19	25.0	15.0	0.0	40.0	NA	
T58	41.132702	-82.769033				12/18/19	54.0	0.0	0.0	54.0	NA	
T59	41.130820	-82.822057				5/12/19	28.0	0.0	0.0	28.0	NA	
T60	41.115596	-82.744422				12/12/19	35.0	0.0	0.0	35.0	NA	
T61	41.113883	-82.809371				5/12/19	48.0	0.0	0.0	48.0	NA	
T62	41.110964	-82.744297				12/11/19	54.0	0.0	0.0	54.0	NA	
T63	41.107601	-82.807071				5/8/19	55.0	0.0	0.0	55.0	NA	
T64	41.098514	-82.827851				12/8/19	47.0	0.0	0.0	47.0	NA	
T65	41.096579	-82.806805				5/10/19	55.0	0.0	0.0	55.0	NA	
T66	41.095647	-82.763703				5/3/19	55.5	0.0	0.0	55.5	NA	
T67	41.094265	-82.770634	X	X		5/2/19	55.5	0.0	0.0	55.5	NA	
T68	41.092712	-82.777417				5/8/19	55.5	0.0	0.0	55.5	NA	
T69	41.091692	-82.788934				5/7/19	55.5	0.0	0.0	55.5	NA	
T70	41.088115	-82.817980				5/11/19	55.5	0.0	0.0	55.5	NA	
T71	41.087076	-82.777013				5/6/19	55.5	0.0	0.0	55.5	NA	
T72	41.317416	-82.790099				4/23/19	8.0	0.0	20.0	28.0	Fair	
T73	41.309842	-82.815969				4/18/19	8.0	0.0	15.0	23.0	Fair	
T74	41.307049	-82.817887				4/18/19	11.0	0.0	15.0	26.0	Fair	
T75	41.260506	-82.803113				4/28/19	13.0	0.0	15.0	28.0	Poor	
T76	41.197831	-82.755836				4/9/19	44.5	0.0	0.0	44.5	NA	
T77	41.197446	-82.776172				12/19/19	19.0	20.0	0.0	39.0	NA	
T78	41.133708	-82.823198				5/14/19	29.5	0.0	0.0	29.5	NA	
T79	41.110892	-82.740271				12/11/19	55.5	0.0	0.0	55.5	NA	
T80	41.065264	-82.824944	X			12/6/19	55.5	0.0	0.0	55.5	NA	
T81	41.058500	-82.824749				12/6/19	55.5	0.0	0.0	55.5	NA	
T82	41.049640	-82.827139				12/8/19	55.5	0.0	0.0	55.5	NA	
T83	41.048849	-82.823246				12/7/19	55.5	0.0	0.0	55.5	NA	
T84	41.329691	-82.741715										
T85	41.329173	-82.753069										
T86	41.327917	-82.736451										
T87	41.241977	-82.827098				5/21/19	7.0	0.0	23.0	30.0	Poor	
TR-1 (T63)	41.107602	-82.807065			X							
TR-2 (T48)	41.154774	-82.811374			X							
TR-3	41.209883	-82.788517			X							
TR-4 (T8)	41.316613	-82.776070			X							
TR-5 (SUB)	41.268924	-82.765749			X							
SUB-1	41.268959	-82.764984		X		4/28/19	10.0	0.0	10.0	20.0	Very Poor	
SUB-2	41.268962	-82.763493				4/28/19	6.5	0.0	0.0	6.5	NA	
SUB-3	41.269448	-82.763495				4/28/19	6.5	0.0	0.0	6.5	NA	

Table A3: Well Log Information Obtained from Ohio Division of Water Resources (Reference 3)

Well Number (Ohio Division of Water Resources)	**Latitude** (NAD83)	**Longitude** (NAD83)	**Elevation** (feet above sea level)	**Total Well Depth** (feet below Elevation)	**Aquifer Type**	**Static Water Level** (feet below Elevation)	**Date Measured** (MM/DD/YYYY)
984232	41.30517	-82.82758	689	135	LIMESTONE	25	07/15/2008
984229	41.33978	-82.76012	758	150	LIMESTONE	17	06/30/2008
984228	41.30135	-82.79292	714	150	LIMESTONE	21	06/25/2009
1010305	41.35133	-82.82367	676	120	LIMESTONE	80	11/04/2008
984231	41.3375	-82.80008	705	150	LIMESTONE	24	07/07/2008
984230	41.31848	-82.77013	723	150	LIMESTONE	15	07/02/2008
901470	41.35767	-82.74134	NA	34	ROCK	2	10/02/2000
2048717	41.104242	-82.759795	NA	62	CLAY	29	07/30/2014
923274	41.20637	-82.8219	NA	120	LIMESTONE	36	11/03/2000
2039555	41.2855	-82.825833	822	200	LIMESTONE	80	09/10/2012
2063967	41.280267	-82.832767	781	155	LIMESTONE	75	08/09/2017
2063968	41.281133	-82.830417	734	155	LIMESTONE	70	08/11/2017
2063969	41.280867	-82.8337	796	175	LIMESTONE	80	08/14/2017
2071987	41.2871	-82.833967	577	215	LIMESTONE	80	01/23/2019
2022084	41.08271	-82.75841	895	68	GRAVEL	22	04/23/2009
962332	41.08287	-82.78278	NA	120	SHALE	15	05/28/2003
2068615	41.277867	-82.82875	737	215	LIMESTONE	45	06/28/2018
946817	41.2816	-82.8302	757	140	LIMESTONE	70	05/17/2003
2070373	41.266767	-82.830883	781	175	LIMESTONE	90	08/27/2018
2048941	41.272867	-82.8389	748	120	LIMESTONE	70	08/14/2014
2012854	41.27195	-82.8387	NA	31	LIMESTONE	30	08/17/2007
2012877	41.271983	-82.83875	NA	41	LIMESTONE	30	08/16/2007
2012879	41.271833	-82.838667	NA	37	LIMESTONE	33	08/15/2007
2012880	41.27195	-82.838633	NA	41	LIMESTONE	30	08/18/2007
2027295	41.272333	-82.839017	NA	37	LIMESTONE	25	05/18/2010
2027300	41.27285	-82.839433	NA	38	LIMESTONE	30	05/19/2010
2027303	41.27205	-82.83925	NA	37	LIMESTONE	30	05/18/2010
2031690	41.271767	-82.838967	NA	38	LIMESTONE	37	01/31/2011
2031691	41.271883	-82.839333	NA	42	LIMESTONE	37	01/31/2011
2070408	41.281133	-82.833300	791	195	LIMESTONE	75	09/26/2018
2070409	41.281167	-82.831967	780	215	LIMESTONE	70	09/25/2018
910925	41.089580	-82.741640	NA	87	CLAY & SHALE	25	06/28/2000
2064530	41.179957	-82.813109	NA	160	LIMESTONE	26	09/13/2017
954233	41.115410	-82.760140	NA	60	SHALE	13	10/07/2002
2045511	41.106681	-82.785501	NA	56	SHALE	20	10/28/2013

Table A4 - Summary of Utility Locate Tickets (Ohio 811)

Boring ID	Latitude	Longitude	Ticket Number	Remarks
T1	41.337091	-82.797344	B908001045	
T2	41.334851	-82.770474		ON HOLD
T3	41.331470	-82.687070	B908001062	
T4	41.327524	-82.684174	B908001074	
T5	41.327437	-82.680044		ON HOLD
T6	41.318510	-82.797720	B908001080	
T7	41.318050	-82.783112	B908001083	
T8	41.316612	-82.776072	B908001089	
T9	41.314163	-82.787932	B908001107	
T10	41.311303	-82.784857	B908001113	
T11	41.309756	-82.799754	B908001122	
T12	41.305617	-82.787640	B908001133	
T13	41.305128	-82.781567	B908001136	
T14	41.303804	-82.696969	B908001144	
T15	41.303059	-82.688400	B908001153	
T16	41.301861	-82.683923	B908001158	
T17	41.297773	-82.741589	B908001166	
T18	41.294908	-82.754023	B908001168	
T19	41.295016	-82.737826	B908001173	
T20	41.291780	-82.735204	B908001177	
T21	41.286773	-82.755319	A908501854	
T22	41.284045	-82.736863	A908501888	
T23	41.263784	-82.757024	A908501919	
T24	41.261475	-82.809764	A908501961	
T25	41.256898	-82.811454	A908501977	
T26	41.255529	-82.804800	A908501989	
T27	41.247740	-82.775587	A908502000	
T28	41.247445	-82.755309	A908502016	
T29	41.246008	-82.796827	A908502022	
T30	41.244491	-82.771245	A908502034	
T31	41.244309	-82.752195	A908502044	
T32	41.242334	-82.797954	A908502056	
T33	41.241983	-82.744461	A908502068	
T34	41.240369	-82.832115	A908502084	
T35	41.238171	-82.771065	A908502110	
T36	41.238015	-82.750999	A908502115	
T37	41.235902	-82.826303	A908502127	
T38	41.234841	-82.833897		ON HOLD
T39	41.229091	-82.804853	A908502151	
T40	41.207509	-82.781587	A908502166	
T41	41.203875	-82.781489	A908502176	
T42	41.200363	-82.777263	B933001192	
T43	41.198112	-82.831090	A908502202	
T44	41.192592	-82.774713	A908502251	
T45	41.187731	-82.775036	A908503485	
T46	41.181870	-82.781886	A908503501	
T47	41.176582	-82.829454	A908503514	
T48	41.154781	-82.811484	B933001195	
T49	41.151717	-82.781455	A908503542	
T50	41.150265	-82.822230	B933001199	
T51	41.148395	-82.811766	B933001202	
T52	41.141995	-82.832667	B933001205	

Table A4 - Summary of Utility Locate Tickets (Ohio 811)

Boring ID	Latitude	Longitude	Ticket Number	Remarks
T53	41.138732	-82.832555	A908503587	
T54	41.139042	-82.770782	A908503603	
T55	41.137589	-82.776792		ON HOLD
T56	41.137179	-82.791465	B908700558	
T57	41.136254	-82.825618	B933001208	
T58	41.132702	-82.769033	B933001211	
T59	41.130820	-82.822057	B908700566	
T60	41.115596	-82.744422	B933001213	
T61	41.113883	-82.809371	B908700585	
T62	41.110964	-82.744297	B933001217	
T63	41.107601	-82.807071	B908700597	
T64	41.098514	-82.827851	B933001220	
T65	41.096579	-82.806805	B908700610	
T66	41.095647	-82.763703	B908700614	
T67	41.094265	-82.770634	B908700618	
T68	41.092712	-82.777417	B908700624	
T69	41.091692	-82.788934	B908700647	
T70	41.088115	-82.817980	B908700652	
T71	41.087076	-82.777013	B908700657	
T72	41.317416	-82.790099	B908001181	
T73	41.309842	-82.815969	B908001186	
T74	41.307049	-82.817887	B908001194	
T75	41.260506	-82.803113	B908700665	
T76	41.197831	-82.755836	B908700670	
T77	41.197446	-82.776172	B933001222	
T78	41.133708	-82.823198	B908700678	
T79	41.110892	-82.740271	B933001223	
T80	41.065264	-82.824944	B933001225	
T81	41.058500	-82.824749	B933001228	
T82	41.049640	-82.827139	B933001230	
T83	41.048849	-82.823246	B933001235	
T84	41.329691	-82.741715		ON HOLD
T85	41.329173	-82.753069		ON HOLD
T86	41.327917	-82.736451		ON HOLD
T87	41.241977	-82.827098	B908700706	

Figure 1
Site Location Map

Emerson Creek Wind Project
Huron and Erie Counties, Ohio

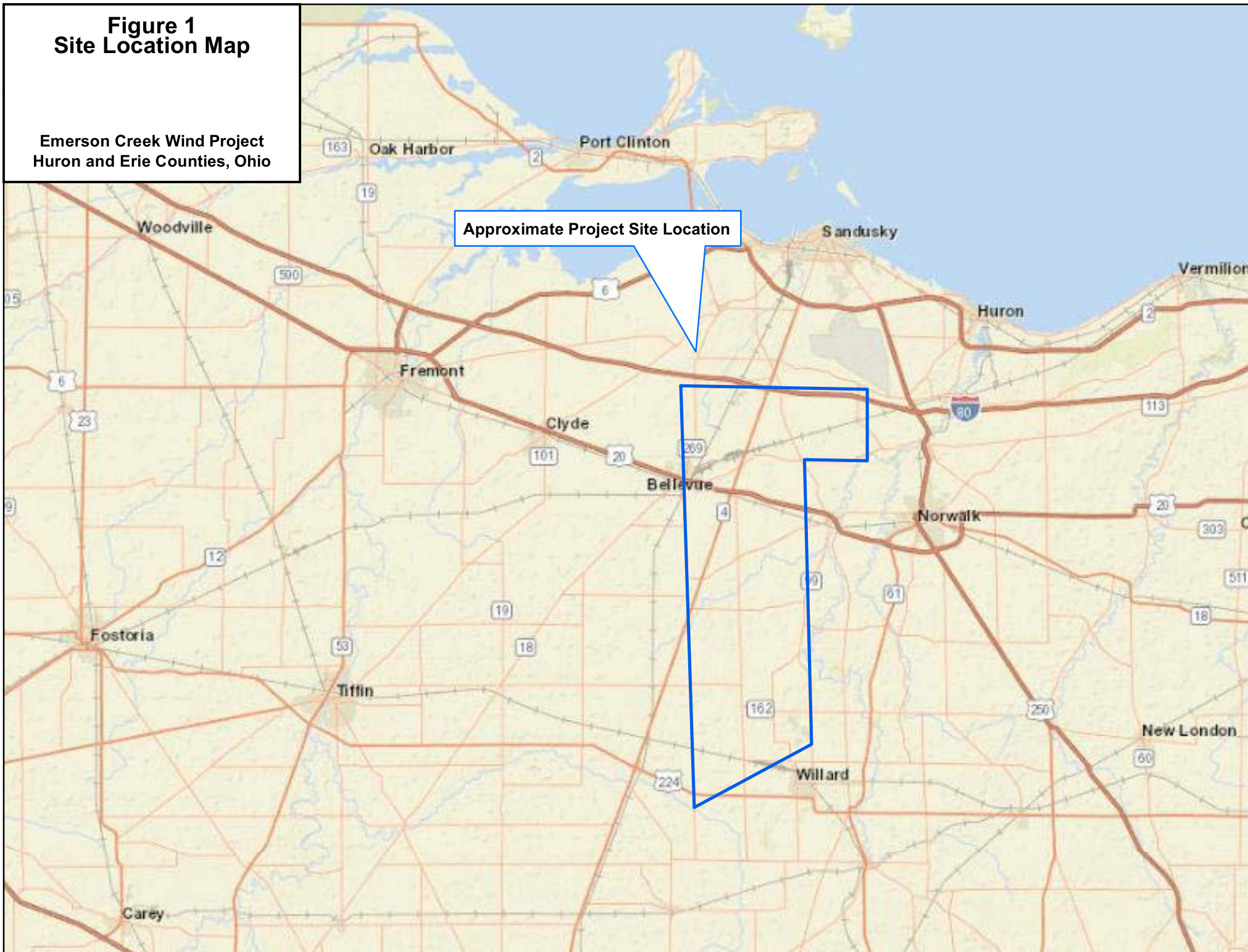


Figure 2
WTG Boring Locations on a Topographic Map

Emerson Creek Wind Project
Huron and Erie Counties, Ohio

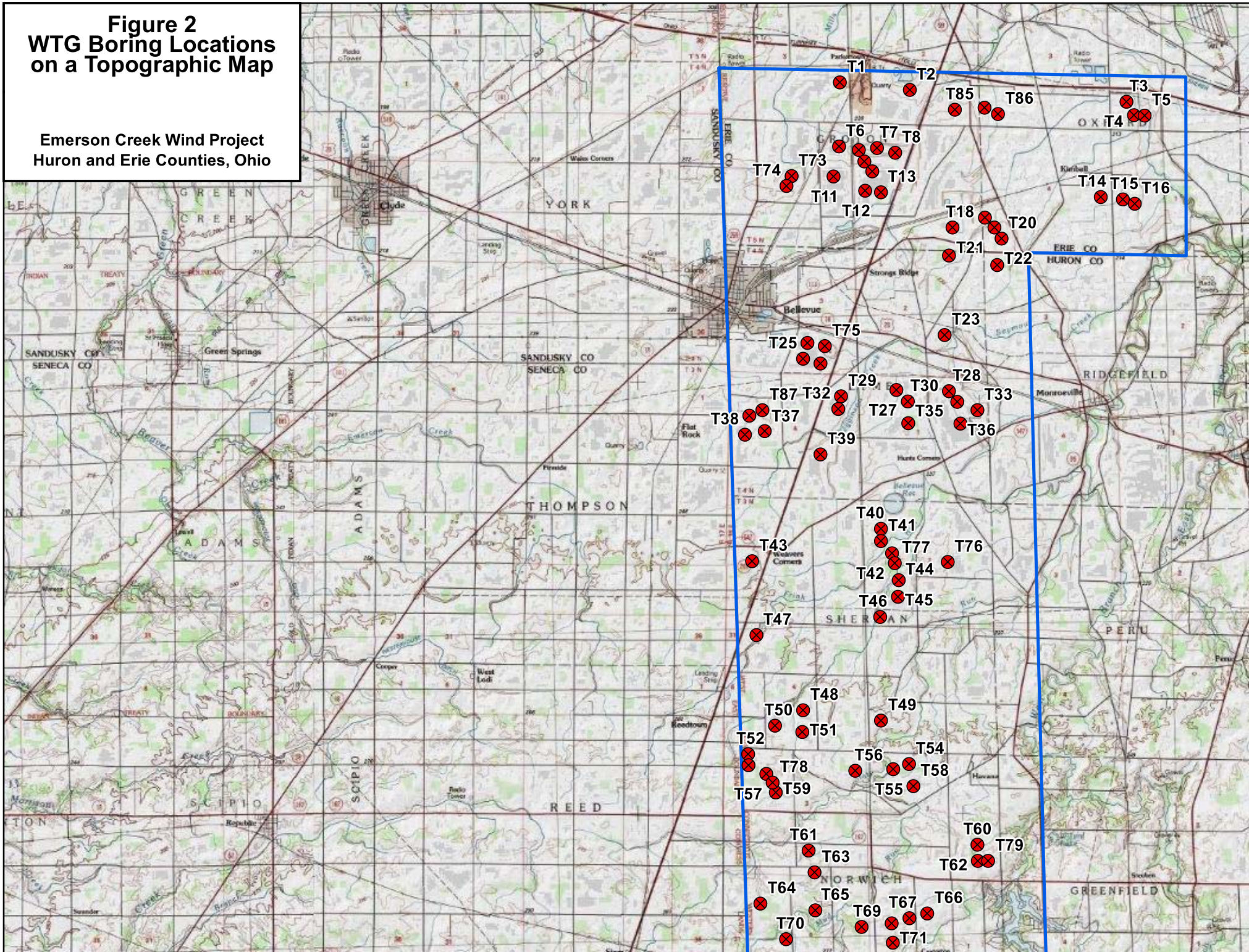


Figure 3
Substation and O&M Building Boring Locations Map

Emerson Creek Wind Project
Huron and Erie Counties, Ohio

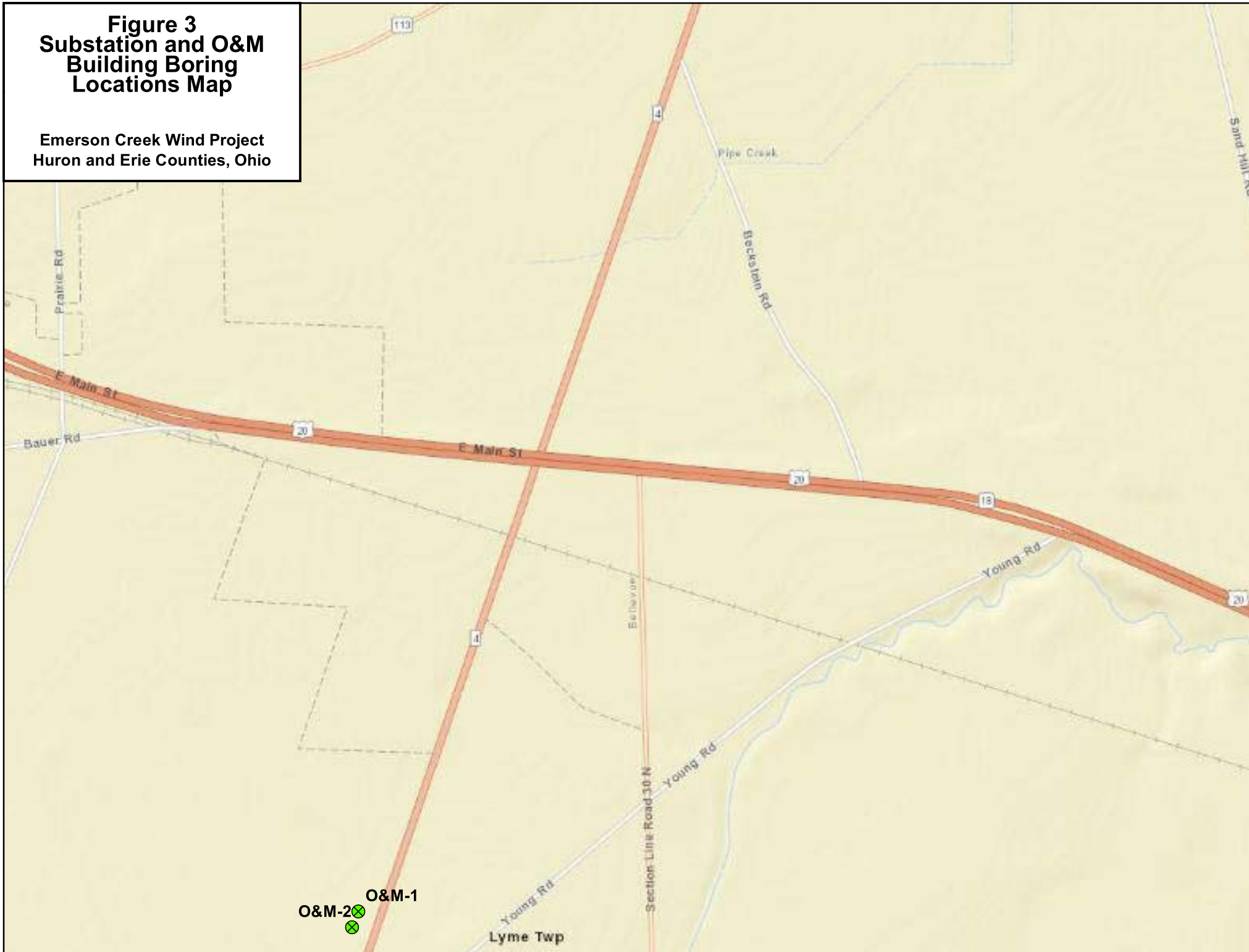


Figure 4
MASW Survey Locations Map

Emerson Creek Wind Project
Huron and Erie Counties, Ohio

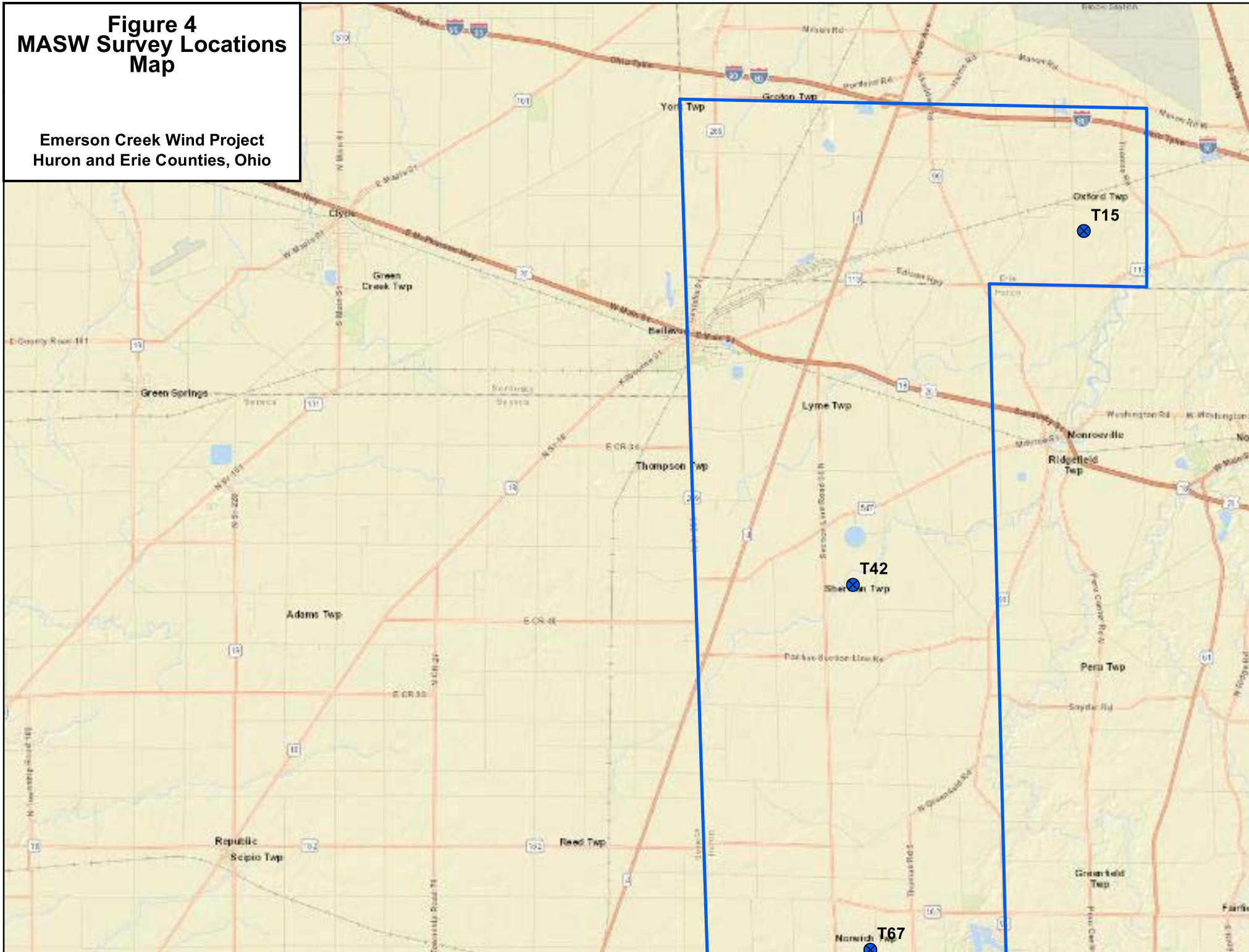


Figure 5
Electrical Resistivity (ER) Testing Locations Map

Emerson Creek Wind Project
Huron and Erie Counties, Ohio

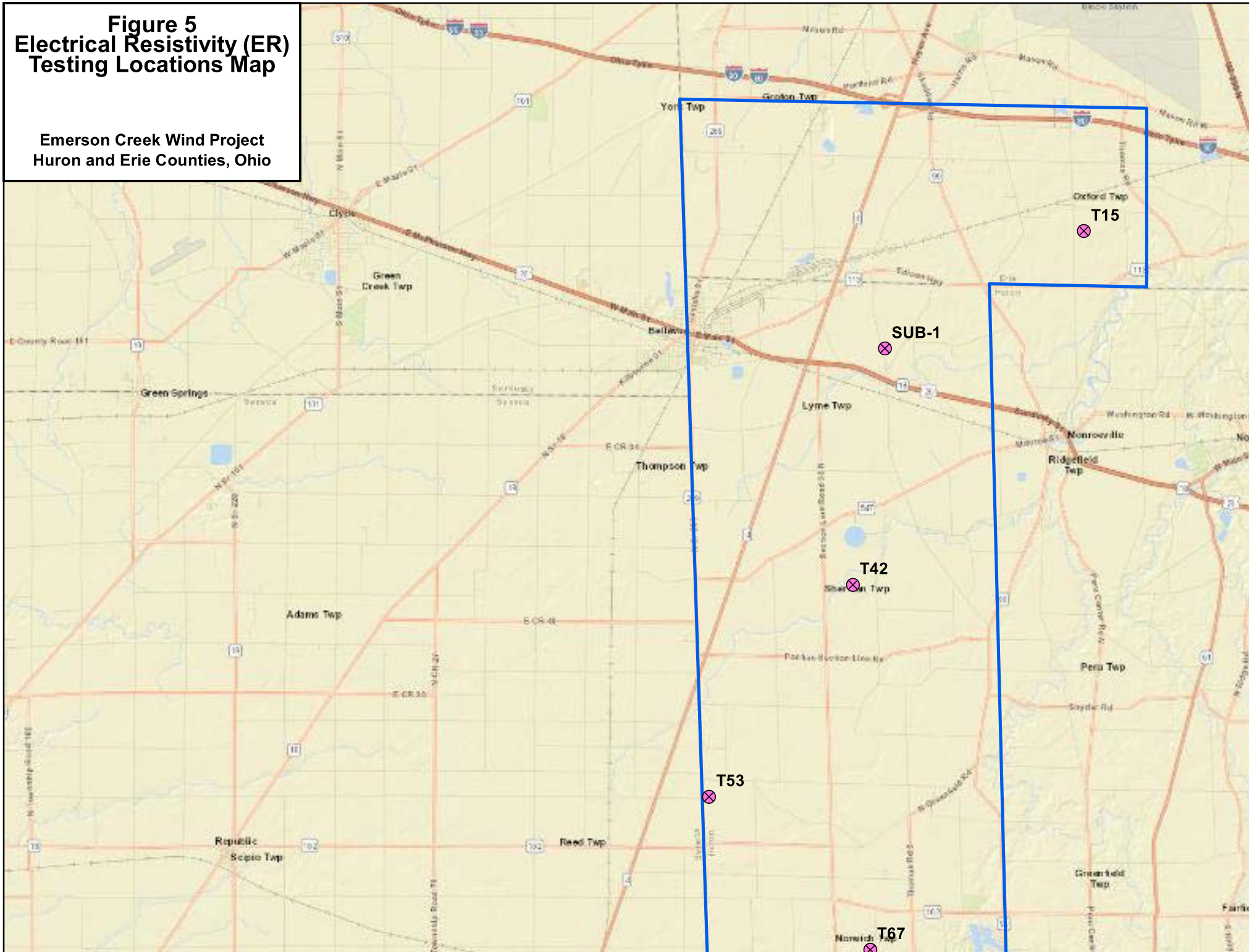


Figure 6
Thermal Resistivity (TR) Testing Locations Map

Emerson Creek Wind Project
Huron and Erie Counties, Ohio

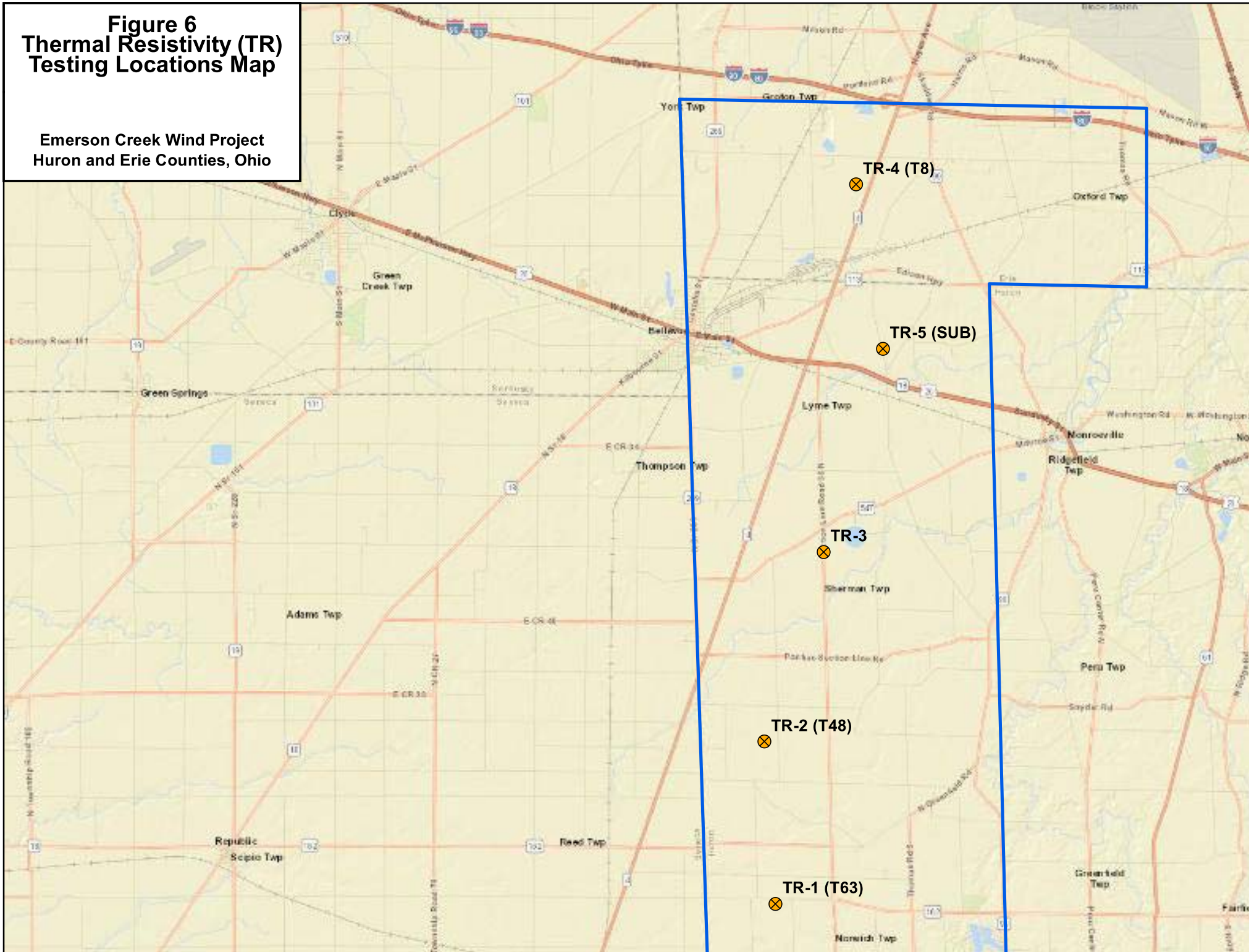


Figure 7
Site Vicinity Geologic Map

Emerson Creek Wind Project
Huron and Erie Counties, Ohio

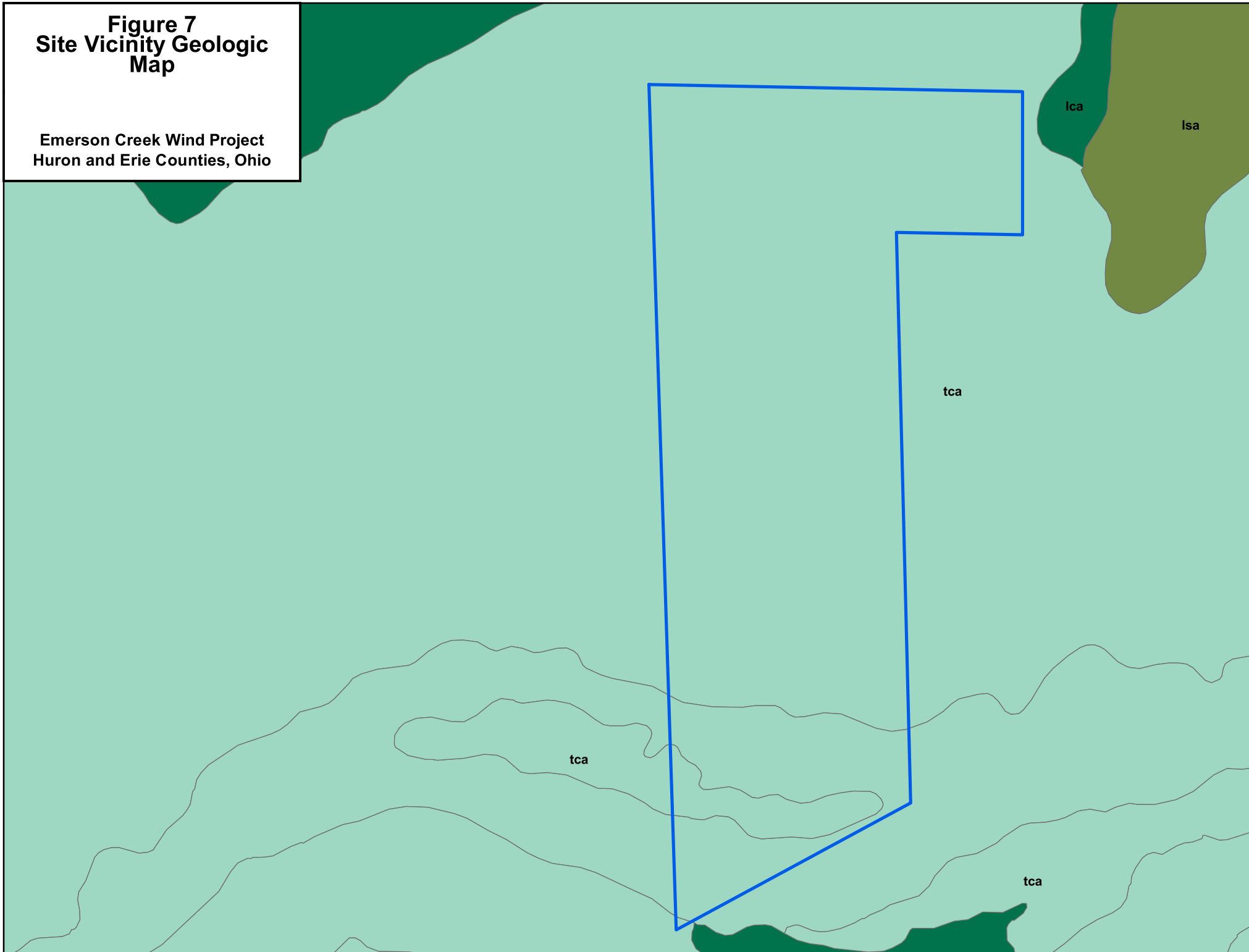


Figure 8
Site Vicinity Bedrock Geologic Map

Emerson Creek Wind Project
Erie and Huron Counties, Ohio

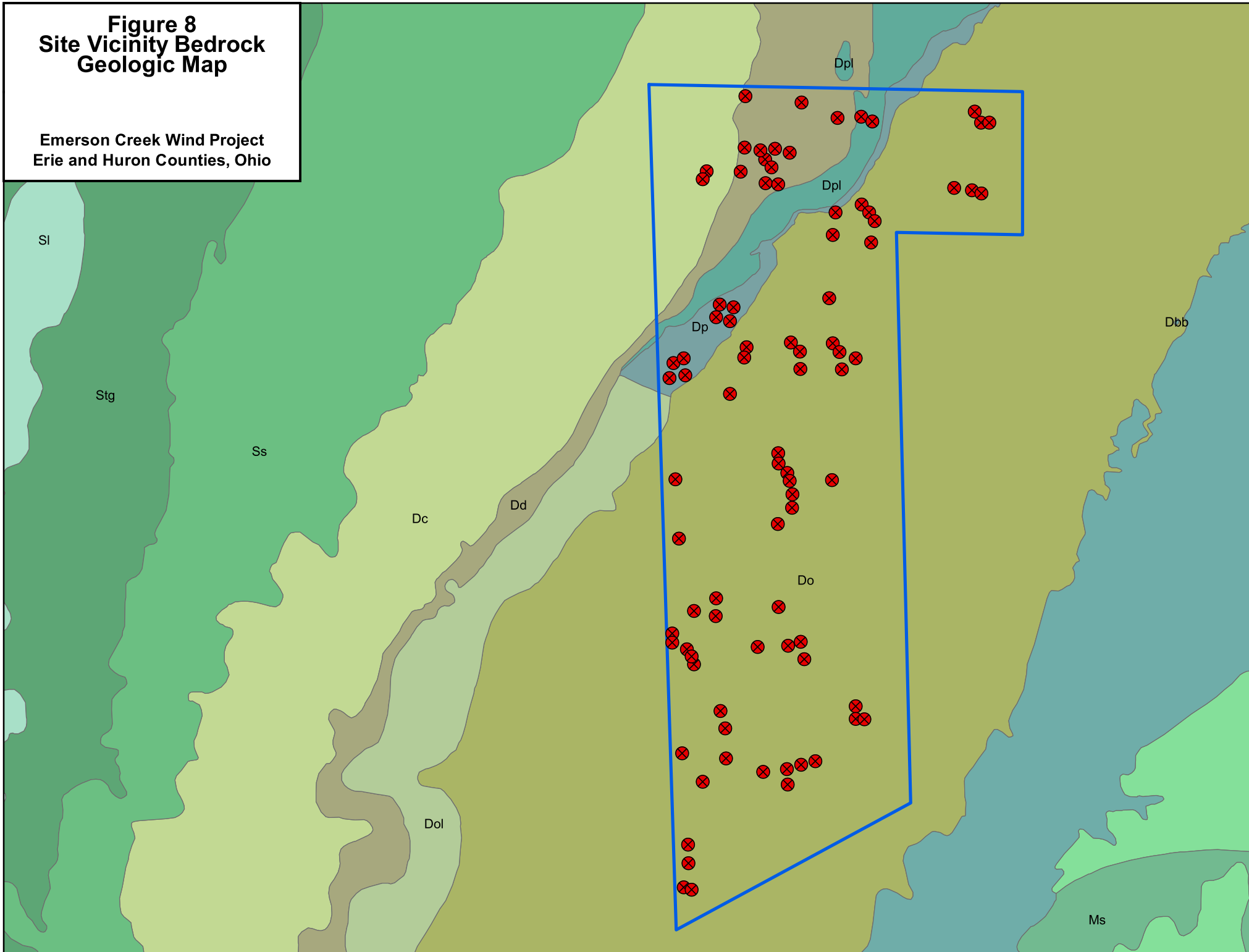


Figure 9
Site Vicinity Karst Map

Emerson Creek Wind Project
Huron and Erie Counties, Ohio

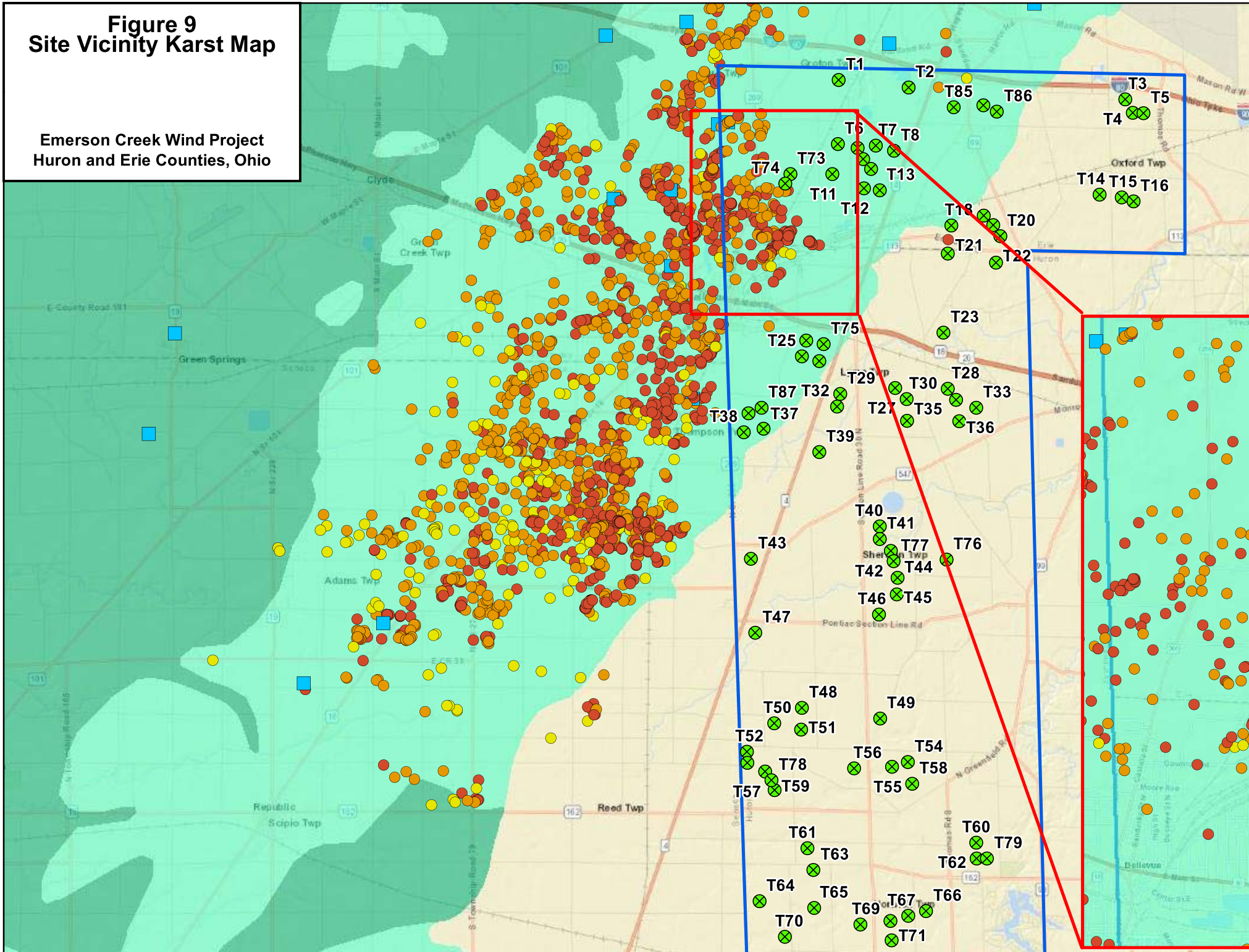
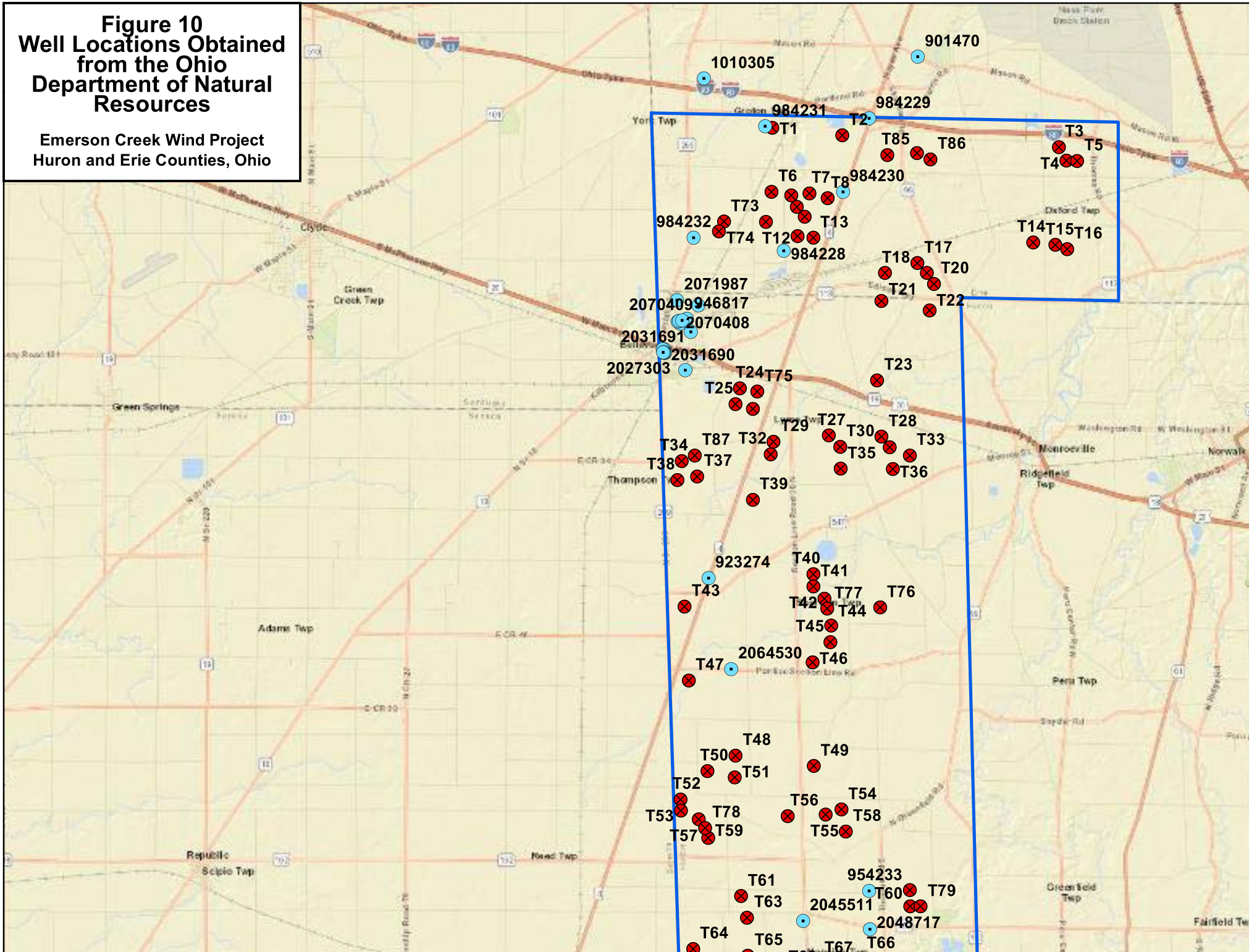


Figure 10
Well Locations Obtained from the Ohio Department of Natural Resources

Emerson Creek Wind Project
Huron and Erie Counties, Ohio



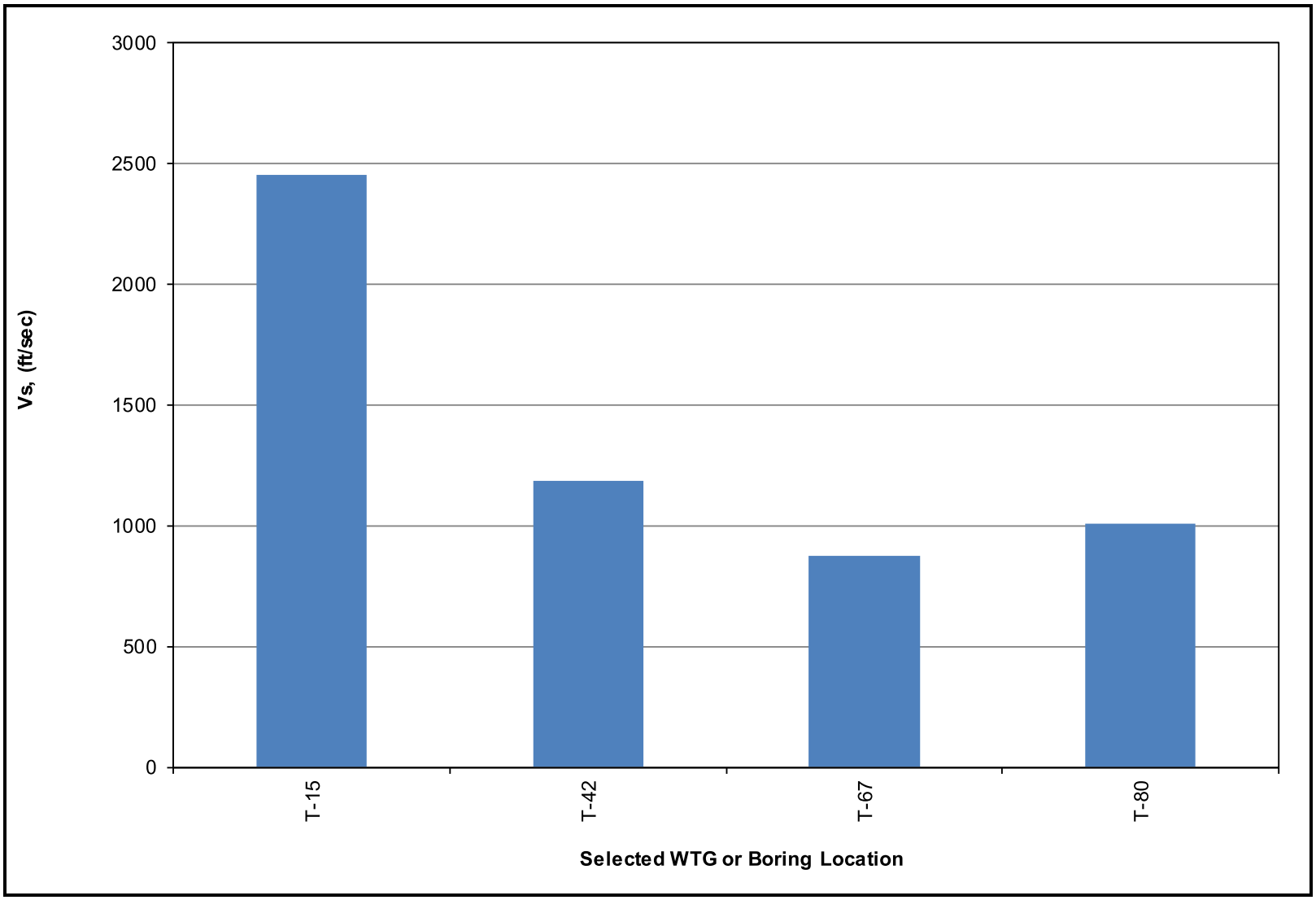


Figure 11 – Weighted Average Shear Wave Velocity at Selected WTG Sites

Figure 12
Recommended Electrical Imaging Testing at Selected WTG Sites

Emerson Creek Wind Project
Huron and Erie Counties, Ohio

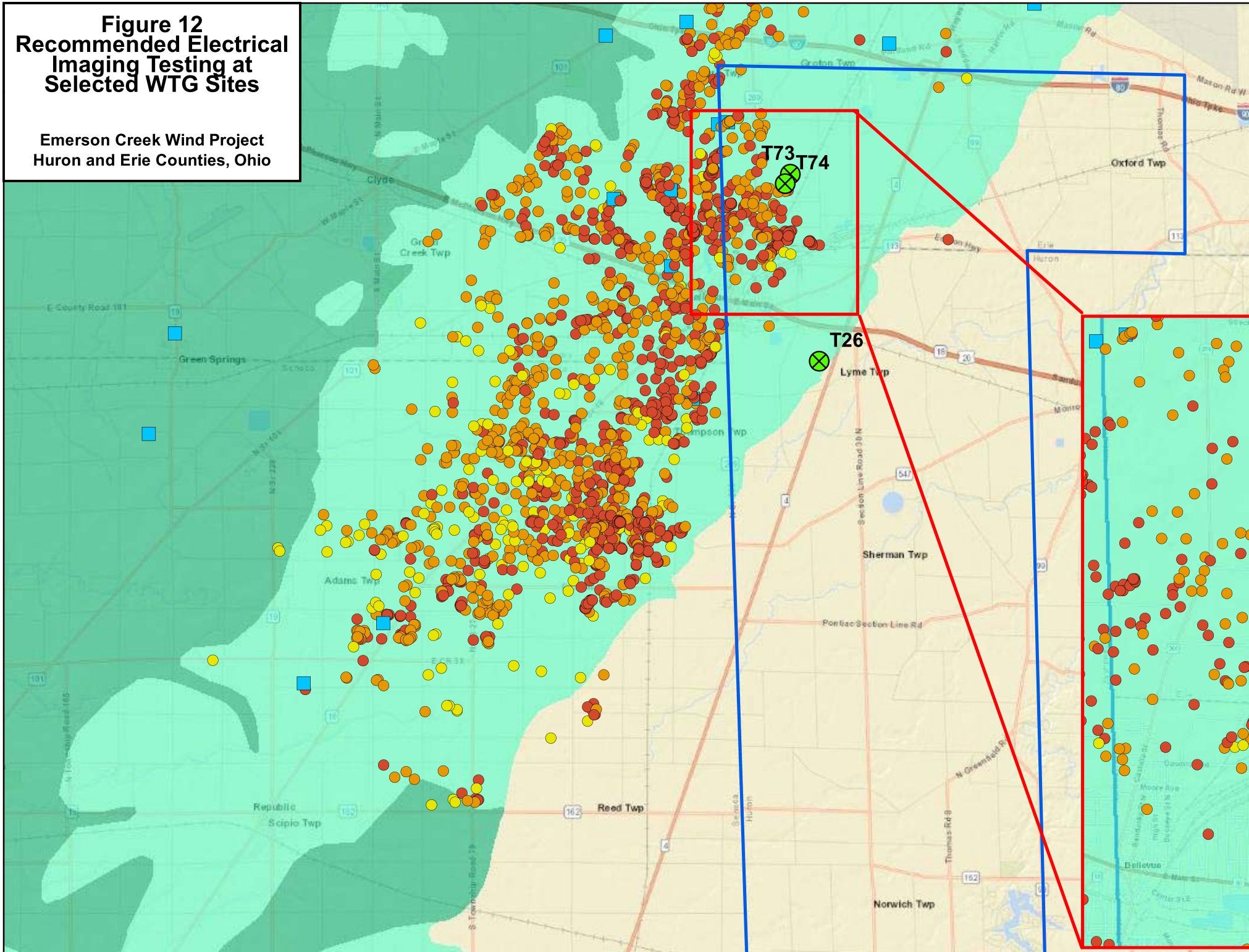
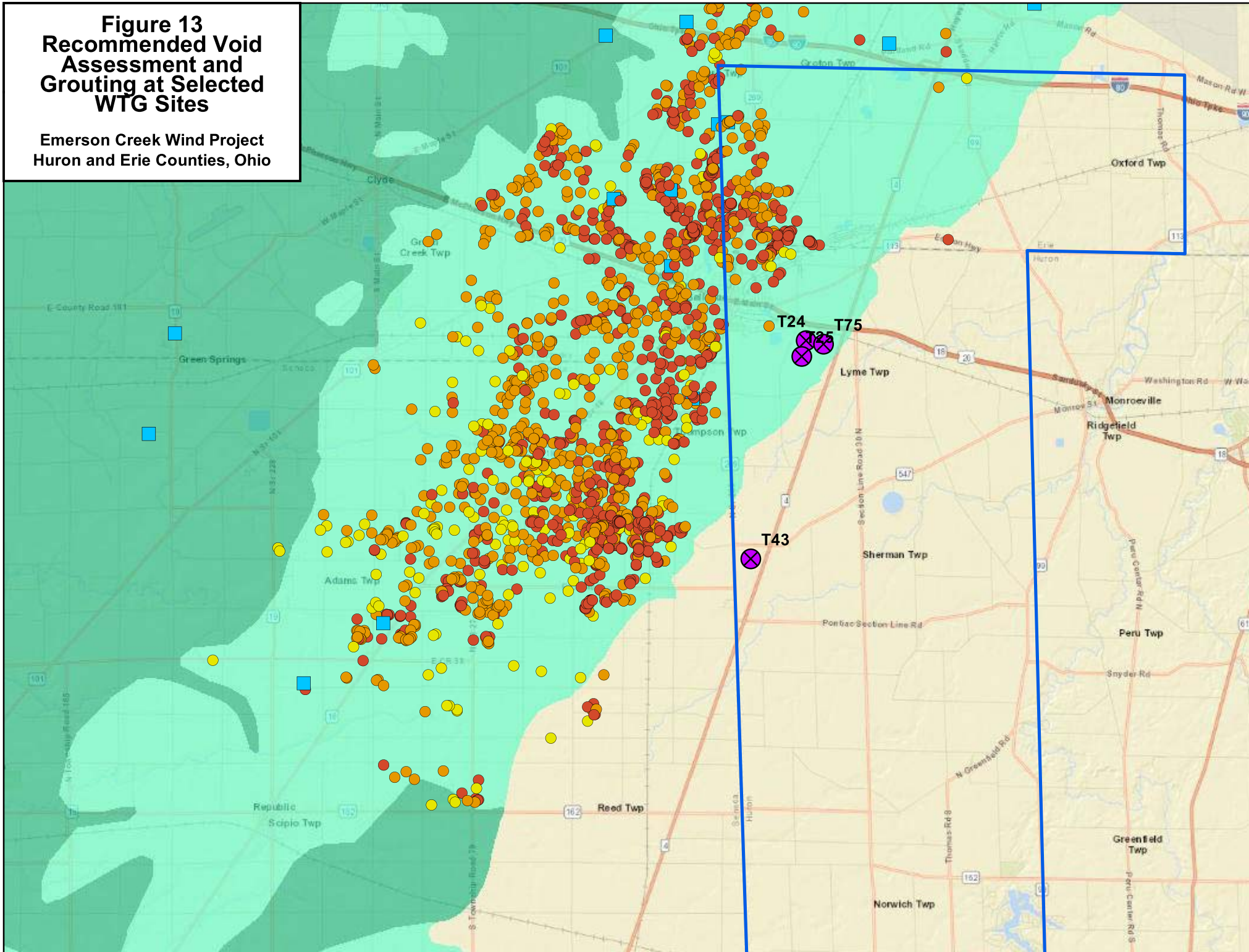
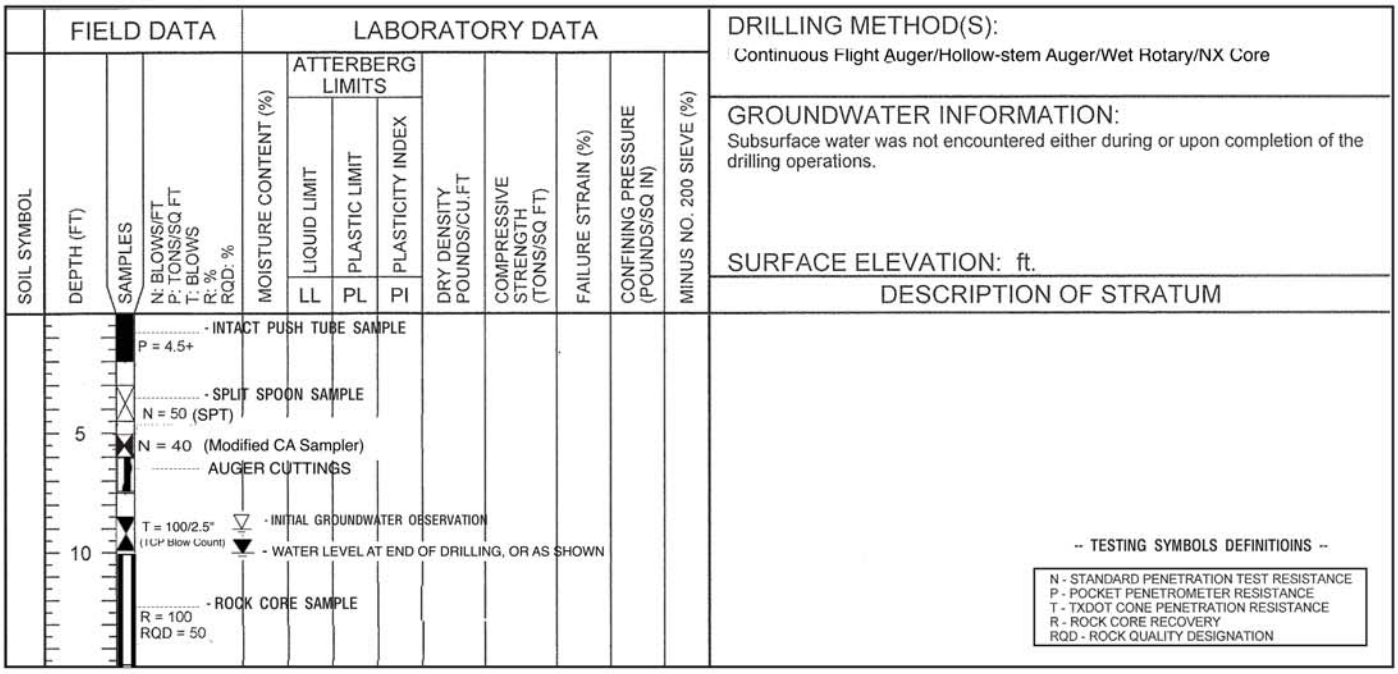


Figure 13
Recommended Void Assessment and Grouting at Selected WTG Sites

Emerson Creek Wind Project
Huron and Erie Counties, Ohio



BORING LOG KEY



TYPICAL SOIL AND ROCK SYMBOLS (USCS CLASSIFICATION)

- Lean Clay (CL)
- Fat Clay (CH)
- Silt (ML)
- Elastic Silt (MH)
- Silty Sand (SM)
- Clayey Sand (SC)
- Silty, Clayey Sand (SC-SM)
- Poorly-Graded Sand (SP)
- Well-Graded Sand (SW)
- Poorly-Graded Gravel (GP)
- Well-Graded Gravel (GW)
- Clayey Gravel (GC)
- Silty Gravel (GM)
- Silty Clay (CL-ML)
- Claystone
- BASALT
- Limestone
- Sandstone
- Siltstone
- Fill Material
- 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 relicit 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 T-01

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/17/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 4 ft.; NX Wet Rock Coring: 4 to 24 ft.

GROUNDWATER INFORMATION:
No groundwater encountered during drilling prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													3 in. Topsoil
			N = 50/1"	32									LEAN CLAY (CL), with Sand, with Gravel, dark brown, hard, dry to moist
			N = 50/3"										SILTY GRAVEL (GM), gray, very dense, fine to coarse grained, subangular to subrounded
	5		R = 100 RQD = 25					168*	1064.88		0.0		LIMESTONE, gray, fine grained, slightly to moderately weathered, weak to moderately strong rock
	10		R = 99 RQD = 25										
	15		R = 100 RQD = 62										
	20		R = 96 RQD = 80										
													Total Depth = 24 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. 41.337091, Long. -82.797344
*Denotes Total Unit Weight

LOG OF BORING T-03

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/2/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
			N = 7	40									10 in. Topsoil LEAN CLAY (CL), with Sand, light brown to light gray, medium stiff, moist
	5		N = 65	10									SHALE, dark gray, hard to very hard, moist to wet
			N = 50/1"										
	10		N = 50/1"	4									Grading dry to moist
			N = 50/1"										
	15		N = 50/1"										
			N = 50/1"										Auger Refusal = 19.5 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. 41.331470, Long. -82.687070
Auger refusal at 7 ft.; offset 32 ft. north of stake, drill to 19.5 ft.

LOG OF BORING T-04

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/3/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 19 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

FIELD DATA | LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
			N = 7	30									10 in. Topsoil LEAN CLAY (CL), trace Sand, light brown, medium stiff, dry to moist
	5		N = 50/1"										SHALE, dark gray, hard, dry to moist
			N = 50/1"	3									
	10		N = 25/0"										
			N = 50/1"										
	15		N = 50/1"	2									
	20		N = 50/1"										
			N = 25/0"										Auger Refusal = 24 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. 41.327524, Long. -82.684174

LOG OF BORING T-06

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/22/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 10 ft.; NX Wet Rock Coring: 10 to 27 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													1 in. Topsoil
			N = 7	17									LEAN CLAY (CL), with Sand, gray to brown, medium stiff to hard, dry to moist
	5		N = 15	13									
			N = 41	12									Grading gray
	10		N = 50/4"										
			R = 100 RQD = 23										LIMESTONE, gray, fine grained, slightly weathered, weak to moderately strong rock
	15		R = 98 RQD = 75										
			R = 97 RQD = 90										
	20												
			R = 100 RQD = 100										
	25												Total Depth = 27 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. 41.318510, Long. -82.797720

LOG OF BORING T-07

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/23/0219

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 7 ft.; NX Wet Rock Coring: 7 to 27 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													2 in. Topsoil
			N = 5	19									LEAN CLAY (CL), trace Sand and Gravel, brown, medium stiff, dry to moist
	5		N = 50/4"	13									CLAYEY GRAVEL (GC), brown, very dense, moist, coarse grained, subangular to subrounded
	10		R = 88.3 RQD = 15										LIMESTONE, fine to medium grained, moderately weathered, weak to moderately strong rock
	15		R = 100 RQD = 45										
	20		R = 100 RQD = 91					165*	1098.72		0.0		Grading slightly to moderately weathered
	25		R = 100 RQD = 87										
													Total Depth = 27 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. 41.318050, Long. -82.783112
*Denotes Total Unit Weight

LOG OF BORING T-08

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/23/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 8 ft.; NX Wet Rock Coring: 8 to 28 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													1 in. Topsoil
			N = 6	18									LEAN CLAY (CL), with Sand and Gravel, light reddish brown, medium stiff to hard, dry to moist
	5		N = 12	11									
			N = 50/3"	11									Grading gray
	10		R = 87.5 RQD = 15										LIMESTONE, gray, fine grained, slightly weathered, weak to moderately strong rock
	15		R = 100 RQD = 40										Grading fresh to slightly weathered
	20		R = 100 RQD = 96										
	25		R = 100 RQD = 95										
													Total Depth = 28 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. 41.316612, Long. -82.776072

LOG OF BORING T-09

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/24/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 13 ft.; NX Wet Rock Coring: 13 to 28 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													3 in. Topsoil
			N = 6										LEAN CLAY (CL), with Sand, light reddish brown, medium stiff to hard, dry to moist
	5		N = 18	17									Grading grayish brown
			N = 23	13									
	10		N = 23	10	24	16	8					72	
			N = 50/2"										Grading gray
	15		R = 99 RQD = 70										LIMESTONE, gray, fine grained, slightly weathered, weak to moderately strong rock
	20		R = 98 RQD = 92										
	25		R = 94 RQD = 81										
													Total Depth = 28 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. 41.314163, Long. -82.787932

LOG OF BORING T-10

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/24/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													3 in. Topsoil
			N = 6										LEAN CLAY (CL), with Sand, brown, medium stiff to hard, dry to moist
	5		N = 8	15									Grading trace Gravel
			N = 21	15									
	10		N = 41	9									
			N = 31										
			R = 100										WEATHERED SHALE, gray, fine to coarse grained, moderately weathered, weak rock, compacted conglomerate looking material
	15		RQD = 92										
													WEATHERED SHALE, dark gray, very hard, dry to moist
	20		N = 71/8"	17									
			N = 50/2"										
	25												Total depth = 25 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. 41.311303, Long. -82.784857

LOG OF BORING T-11

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/22/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 14 ft.; NX Wet Rock Coring: 14 to 28 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: BLOWS, R: %, RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													1 in. Topsoil
			N = 7	21									LEAN CLAY (CL), trace Sand, brown, medium stiff, dry to moist
	5		N = 8	18									
			N = 30										CLAYEY SAND (SC), brown, medium dense to dense, moist, fine to medium grained
	10		N = 34										
			N = 66/10"	12									FAT CLAY (CH), trace Sand, brown, hard, dry to moist
	15		R = 97 RQD = 78										LIMESTONE, gray, fine grained, slightly weathered, weak to moderately strong rock
	20		R = 98 RQD = 92										
	25		R = 100 RQD = 95										
													Total Depth = 28 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. 41.309756, Long. -82.799754

LOG OF BORING T-12

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/25/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 8 ft.; NX Wet Rock Coring: 8 to 28 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													2 in. Topsoil
			N = 6	21									LEAN CLAY (CL), with Sand, brown, medium stiff to hard, dry to moist
	5		N = 11										
			N = 50/2"	16									
	10		R = 92 RQD = 53										LIMESTONE, gray, fine grained, slightly weathered, weak to moderately strong rock
	15		R = 96 RQD = 75										Grading moderately weathered
	20		R = 99 RQD = 97										
	25		R = 100 RQD = 92										
													Total Depth = 28 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. 41.305617, Long. -82.787640

LOG OF BORING T-13

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007
DATE(S) DRILLED: 4/25/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 21 ft.; NX Wet Rock Coring: 21 to 31 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													1 in. Topsoil
			N = 5	28									FAT CLAY (CH), trace Sand, brown, medium stiff, dry to moist
	5		N = 6										
			N = 12	19									LEAN CLAY (CL), with Sand, brown, stiff, dry to moist
	10		N = 51	11									SHALE, gray, hard, dry to moist
			N = 93/7"										
	15		N = 50/4"	16									
	20		N = 50/5"										
			R = 100 RQD = 88										LIMESTONE, gray, fine grained, slightly weathered, weak to moderately strong rock
	25												
			R = 100 RQD = 92										
	30												
													Total Depth = 31 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. 41.305128, Long. -82.781567

LOG OF BORING T-14

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007
DATE(S) DRILLED: 4/2/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 11.5 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													10 in. Topsoil
			N = 8										LEAN CLAY (CL), trace Sand, light brown, medium stiff, moist
	5		N = 5	22									
			N = 75/9"	26									SHALE, dark gray, very hard, wet
	10		N = 50/2"										
			N = 50/2"										Grading dry to moist, interbedded with occasional Clay seams
	15		N = 50/2"										
	20		N = 50/4"	13									
	25		N = 50/5"										
	30		N = 50/3"										
													Auger Refusal at 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. 41.303804, Long. -82.696969

LOG OF BORING T-15

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/1/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 2.5 ft. during drilling and measured at 13.5 ft. immediately after drilling

SURFACE ELEVATION (FT):

FIELD DATA | LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
			N = 23	16									10 in. Topsoil LEAN CLAY (CL), with Sand, dark brown, very stiff, moist
	5		N = 50/5"	15									SHALE, gray, very hard, moist to wet
			N = 50/4"										
	10		N = 50/1"										Grading light gray
			N = 50/3"										
	15		N = 50/4"	10									Grading gray
	20		N = 50/4"										
	25		N = 50/4"										
													Auger Refusal at 29 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. 41.303059, Long. -82.688400

LOG OF BORING T-16

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/1/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 7 ft. during drilling and measured at 36 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													6 in. Topsoil
			N = 6	24									FAT CLAY (CH), with Sand, dark brown, medium stiff to stiff, dry to moist
	5		N = 11	16									Grading trace Gravel
			N = 50/3"										SHALE, dark brown hard, dry to moist
	10		N = 50/2"	11									Grading dark gray
			N = 50/2"										
	15		N = 50/1"										
	20		N = 50/4"										
	25		N = 50/2"										
	30		N = 50/3"	5									
	35		N = 50/3"										
			N = 50/3"										Auger Refusal = 39.5 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. 41.301861, Long. -82.683923

LOG OF BORING T-17

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 5/22/2019 - 5/23/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 11 ft., 19 to 38 ft.; NX Wet Rock Coring: 11 to 19 ft.

GROUNDWATER INFORMATION:
Groundwater encountered at 7 ft. during drilling prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	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
													1 in. Topsoil
			N = 4										LEAN CLAY (CL), with Sand, brown, soft to hard, dry to moist
	5		N = 2	26									
			P = N/A*										
	10		N = 93/10"	14									Grading trace Gravel
			R = 7 RQD = 0										LIMESTONE, gray, fine grained, moderately weathered, weak to moderately strong rock
	15		R = 3 RQD = 0										
	20		N = 41										SHALE, brown, medium hard, dry to moist, with occasional Gravel
	25		N = 44	11	28	18	10					65	
	30		N = 94/9"										Grading grayish black, moist
	35		N = 50/4"										
													Auger Refusal at 38 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. 41.297773, Long. -82.741589
*No Recovery

LOG OF BORING T-18

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/3/2019 - 4/4/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 7 ft. during drilling and measured at 24 ft. immediately after drilling

SURFACE ELEVATION (FT):

FIELD DATA | LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													10 in. Topsoil
			N = 7										LEAN CLAY (CL), trace Sand, light brown, medium stiff to stiff, wet
	5		N = 14	14									
			N = 23										WEATHERED SHALE, gray, hard, dry to moist
	10		N = 48	6									
			N = 81										SHALE, gray, hard, dry to moist
	15		N = 79	10									
	20		N = 96/8"										
	25		N = 50/3"										
	30		N = 50/2"										
	35		N = 50/5"	16									
	40		N = 50/5"										
			N = 50/2"										Auger Refusal = 44.5 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. 41.294908, Long. -82.754023

LOG OF BORING T-19

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007
DATE(S) DRILLED: 5/23/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													3 in. Topsoil
			N = 8	17									LEAN CLAY (CL), with Sand, brown, medium stiff to very stiff, dry to moist
	5		N = 20										
			N = 39	15									WEATHERED SHALE, dark gray, hard, dry to moist
	10		N = 35										
			N = 51	9									
	15		N = 38										SANDY LEAN CLAY, trace Gravel, dark gray, hard, dry to moist
	20		N = 63/12"										
	25		N = 63	9									
	30		N = 66										
	35		N = 69										SHALE, gray, hard, dry to moist
	40		N = 50/4"										
	45		N = 50/4"										
													Auger Refusal at 48 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. 41.295016, Long. -82.737826

LOG OF BORING T-20

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 5/24/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 4 ft.; NX Wet Rock Coring: 4 to 32 ft.

GROUNDWATER INFORMATION:
No groundwater encountered during drilling prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
			N = 16	21									2 in. Topsoil SANDY LEAN CLAY (CL), brown, very stiff, dry to moist
	5		N = 50/3" R = 46 RQD = 25	4									LIMESTONE, brown, very hard, dry to moist LIMESTONE, light brown, fine grained, slightly to moderately weathered, weak to moderately strong rock
	10		R = 73 RQD = 36										
	15		R = 68 RQD = 12					166*	923.04		0.0		
	20		R = 94 RQD = 23										
	25		R = 83 RQD = 25 R = 100 RQD = 44										
	30		R = 92 RQD = 33										
													Total Depth = 32 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. 41.291780, Long. -82.735204
Auger refusal at 9 ft.; Offset and drill to 32 ft. *Denotes Total Unit Weight.

LOG OF BORING T-21

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/4/2019 - 4/6/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 10 ft.; NX Wet Rock Coring: 10 to 30 ft.

GROUNDWATER INFORMATION:
Groundwater encountered at 5 ft. during drilling prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													10 in. Topsoil
			N = 5	24									LEAN CLAY (CL), with Sand, light gray to brown, medium stiff, moist
	5		N = 53										SHALE, dark gray, hard to very hard, moist to wet
			N = 50/2"										Grading dry to moist
	10		N = 50/1"										
			R = 100 RQD = 48										LIMESTONE, gray, fine grained, moderately weathered, weak rock, vertical fracture from 12 to 13 ft.
	15		R = 42 RQD = 23										
	20		R = 100 RQD = 42										
	25		R = 100 RQD = 42										Grading highly weathered
	30												Total depth = 30 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. 41.286773, Long. -82.755319
Auger refusal at 10 ft.; offset 30 ft. east of stake for coring.

LOG OF BORING T-22

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/4/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 14 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	LABORATORY DATA: ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	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
													10 in. Topsoil
			N = 7	24									LEAN CLAY (CL), trace Sand, dark brown, medium stiff to hard, wet
	5		N = 8	17									Grading trace Sand, brown, dry to moist
			N = 27										Grading dark grayish brown
	10		N = 39	30									
			N = 38										
	15		N = 50/5"	12									SHALE, dark gray, hard, dry to moist
													Auger Refusal at 19 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. 41.284045, Long. -82.736863

LOG OF BORING T-23

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/16/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 8 ft.; NX Wet Rock Coring: 8 to 23 ft.

GROUNDWATER INFORMATION:
No groundwater encountered during drilling prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													10 in. Topsoil
			N = 5	25									LEAN CLAY (CL), trace Sand, brown, medium stiff to stiff, wet
	5		N = 26										Grading with Sand, dark gray, dry to moist
			N = 50/4"	6									SHALE, gray, hard, dry to moist
	10		R = 60 RQD = 0										SHALE, gray, very fine grained slight to moderately weathered, very weak to weak rock
	15		R = 93 RQD = 0										
	20		R = 100 RQD = 0										
	25		R = 100 RQD = 67										
													Total Depth = 28 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. 41.263784, Long. -82.757024

LOG OF BORING T-24

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/27/2019 - 4/28/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 5 ft.; NX Wet Rock Coring: 5 to 28 ft.

GROUNDWATER INFORMATION:
No groundwater encountered during drilling prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													3 in. Topsoil
			N = 5	15									SANDY LEAN CLAY (CL), brown, medium stiff, moist
			N = 50/2"	35									CLAYEY GRAVEL (GC), brown, very dense, moist, coarse grained, subangular to subrounded
	5		R = 83 RQD = 0										LIMESTONE, gray, fine to medium grained, moderately to highly weathered, moderately strong rock
	10		R = 66 RQD = 0										Potential void from 11 to 13 ft.
	15		R = 98 RQD = 27										
	20		R = 95 RQD = 13										SHALE, gray, fine grained, highly weathered, weak rock
	25		R = 100 RQD = 67										
													Total Depth = 28 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. 41.261475, Long. -82.809764

LOG OF BORING T-25

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/27/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 16 ft.; NX Wet Rock Coring: 16 to 31 ft.

GROUNDWATER INFORMATION:
Groundwater encountered at 4.5 ft. during drilling prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													1 in. Topsoil
			N = 6	18									SANDY LEAN CLAY (CL), brown, medium stiff, moist to wet
	5		N = 7										CLAYEY SAND (SC), brown, very loose to very dense, moist to wet, fine to coarse grained
			N = 2										
	10		N = 50/4"	17									
			N = 50/2"										
	15		N = 25/0"										
			R = 84 RQD = 55										LIMESTONE, gray, fine grained, slightly to moderately weathered, weak to moderately strong rock, slightly vuggy
	20												
			R = 99 RQD = 79										
	25												
			R = 96 RQD = 83										
	30												Total Depth = 31 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. 41.256898, Long. -82.811454

LOG OF BORING T-26

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/29/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 15 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													3 in. Topsoil
			N = 5	27									LEAN CLAY (CL), with Sand, brown to gray, medium stiff to stiff, moist
	5		N = 11	31									
			N = 50/5"										SHALE, dark brown to gray, very hard, dry to moist
	10		N = 50/3"										
			N = 50/4"										
	15		N = 50/5"	▽ 5									
	20		N = 50/2"										
	25		N = 50/2"										
	30		N = 50/2"										
													Auger Refusal at 31 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. 41.255529, Long. -82.804800

LOG OF BORING T-27

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/17/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 7 ft.; NX Wet Rock Coring: 7 to 27 ft.

GROUNDWATER INFORMATION:
No groundwater encountered during drilling prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
			N = 4	21									LEAN CLAY (CL), with Sand, brown, soft, moist to wet
	5		N = 46										WEATHERED SHALE, dark gray, hard, dry to moist
			N = 50/5"										
			R = 0 RQD = 0										SHALE, gray, fine grained, moderately to highly weathered, very weak rock
	10		R = 100 RQD = 0										
	15		R = 100 RQD = 0										
	20		R = 100 RQD = 26										
	25		R = 100 RQD = 11										
													Total Depth = 27 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. 41.247740, Long. -82.775587

LOG OF BORING T-28

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/22/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 16 ft.; NX Wet Rock Coring: 16 to 24 ft.

GROUNDWATER INFORMATION:
Groundwater encountered at 12 ft. during drilling prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													8 in. Topsoil
			N = 4	19									LEAN CLAY (CL), trace Sand, brown, soft to stiff, moist
	5		N = 4	21									Grading gray
			N = 10										
	10		N = 11	9	25	15	10					90	
			N = 58	13									WEATHERED SHALE, dark gray, hard, dry to moist
	15		N = 69/10"	11									SHALE, dark gray, hard, wet
			N = 50/1"										
			R = 74 RQD = 0										SHALE, gray, very fine grained slight to moderately weathered, very weak to weak rock
	20		R = 95 RQD = 16										
													Total Depth = 24 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. 41.247445, Long. -82.755309

LOG OF BORING T-29

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 5/21/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 7 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													2 in. Topsoil
			N = 7										SANDY LEAN CLAY (CL), brown, medium stiff to very stiff, dry to moist
	5		N = 24	25									
			N = 74/11"										SHALE, olive gray to gray, very hard, dry to moist
	10		N = 50/6"	16									
			N = 50/6"										
	15		N = 50/2"										
	20		N = 50/3"	17									
	25		N = 50/4"										
	30		N = 50/3"										
													Auger Refusal at 31 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. 41.246008, Long. -82.796827

LOG OF BORING T-30

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007
DATE(S) DRILLED: 4/18/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 10 ft.; NX Wet Rock Coring: 10 to 30 ft.

GROUNDWATER INFORMATION:
Groundwater encountered at 7 ft. during drilling prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													8 in. Topsoil
			N = 5	23									SANDY LEAN CLAY (CL), brown, medium stiff, moist
	5		N = 13										LEAN CLAY (CL), with Sand, brown, stiff, dry to moist
			N = 45	9									WEATHERED SHALE, dark gray, hard, dry to moist
	10		N = 50/1"										
			R = 80 RQD = 0										SHALE, gray, very fine grained, slight to moderately weathered, very weak rock to weak rock
	15		R = 80 RQD = 7										
	20		R = 100 RQD = 29					163*	357.12		0.0		
	25		R = 100 RQD = 22										
	30												Total Depth = 30 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. 41.244491, Long. -82.771245
*Denotes Total Unit Weight

LOG OF BORING T-31

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/25/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 7 ft. during drilling and measured at 14 ft. immediately after drilling

SURFACE ELEVATION (FT):

FIELD DATA | LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													8 in. Topsoil
			N = 5										SANDY LEAN CLAY (CL), brown, soft to very stiff, dry to moist
	5		N = 2	20									
			N = 28										
	10		N = 19	9									WEATHERED SHALE, dark gray, very stiff to hard, dry to moist
			N = 58										
	15		N = 34	20									CLAYEY SAND (SC), brown, medium dense to dense, wet, fine to medium grained
	20		N = 24										
			N = 50/4"	13									SHALE, dark gray, hard, dry to moist
													Auger Refusal = 24.5 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. 41.244309, Long. -82.752195

LOG OF BORING T-32

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007
DATE(S) DRILLED: 5/20/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 9 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: BLOWS, R: %, RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													3 in. Topsoil
			N = 9										LEAN CLAY (CL), trace Sand, brown, stiff to very stiff, dry to moist
	5		N = 21	11									Grading moist
			N = 12	12									
	10		N = 50/3"										SHALE, gray, very hard, moist to wet
			N = 50/3"										
	15		N = 50/4"										
	20		N = 50/4"	7									Grading light olive gray, dry to moist
	25		N = 50/5"										
	30		N = 50/2"										
													Auger Refusal at 31 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. 41.242334, Long. -82.797954

LOG OF BORING T-33

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/23/2109 - 4/24/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 4 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													8 in. Topsoil
			N = 3	20									LEAN CLAY (CL), trace Sand, brown, soft to medium stiff, moist
	5		N = 6										
			N = 7	25	22	15	7					49	SILTY, CLAYEY SAND (SC-SM), brown, loose, wet, fine to coarse grained
	10		N = 44										SHALE, dark gray, hard, dry to moist
			N = 31	9									
	15		N = 54										
			N = 50/1"										LIMESTONE, gray, hard, dry to moist
													Auger Refusal = 19.25 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. 41.241983, Long. -82.744461

LOG OF BORING T-34

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 5/21/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 2 ft.; NX Wet Rock Coring: 2 to 27 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													2 in. Topsoil
													LIMESTONE, light brown, dry to moist
	5		R = 78 RQD = 8										LIMESTONE, light brown, fine grained, slightly to moderately weathered, weak to moderately strong rock
	10		R = 82 RQD = 43										
								164*	848.88		0.0		
	15		R = 88 RQD = 28										
	20		R = 87 RQD = 8										
	25		R = 85 RQD = 68										
													Total Depth = 27 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. 41.240369, Long. -82.832115
*Denotes Total Unit Weight

LOG OF BORING T-35

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/23/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 8 ft.; NX Wet Rock Coring: 8 to 20 ft.

GROUNDWATER INFORMATION:
Groundwater encountered at 4 ft. during drilling prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													8 in. Topsoil
			N = 6	24									SANDY LEAN CLAY (CL), brown, medium stiff, moist
	5		N = 6	17									LEAN CLAY (CL), trace Sand, brown, medium stiff, moist
			N = 50/2"	16									
	10		R = 67 RQD = 0 R = 100 RQD = 0										SHALE, gray, very fine grained, slight to moderately weathered, very weak to weak rock
	15		R = 100 RQD = 18										
	20												Total Depth = 20 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. 41.238171, Long. -82.771065

LOG OF BORING T-36

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/29/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 12 ft.; NX Wet Rock Coring: 12 to 20 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													8 in. Topsoil
			N = 7	25									LEAN CLAY (CL), trade Sand, brown, soft to hard, dry to moist
	5		N = 2	23									
			N = 23										Grading gray
	10		N = 19	17									
			N = 50/3"										
			R = 72 RQD = 24										SHALE, gray, very fine grained, slightly weathered, very weak rock
	15		R = 100 RQD = 75					148*	921.60		0.0		
	20												Total Depth = 20 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. 41.238015, Long. -82.750999
*Denotes Total Unit Weight

LOG OF BORING T-37

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/30/2019 - 5/1/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 5 ft.; NX Wet Rock Coring: 5 to 28 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													2 in. Topsoil
			N = 11	17									LEAN CLAY (CL), trace Sand, brown, stiff, moist
			N = 50/2"	1									SILTY GRAVEL (GM), gray, very dense, dry to moist, fine to coarse grained, subangular to subrounded
	5		R = 79 RQD = 0										LIMESTONE, gray, fine grained, slightly to moderately weathered, weak to moderately strong rock
	10		R = 98 RQD = 32										
	15		R = 97 RQD = 61										Grading fresh to slightly weathered
	20		R = 100 RQD = 66										Grading with occasional calcareous nodules
	25		R = 97 RQD = 89										
													Total Depth = 28 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. 41.235902, Long. -82.826303

LOG OF BORING T-39

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 5/25/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 12 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: BLOWS, R: %, RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
			N = 7										1 ft. Topsoil LEAN CLAY (CL), trace Sand, brown, medium stiff to stiff, dry to moist
	5		N = 10	15									Grading with Sand
			N = 9										Grading grayish black
	10		N = 20	15									SHALE, grayish black, firm to very hard, dry to moist, dry to moist
			N = 55										
	15		N = 50/6"	17									
	20		N = 50/1"										
	25		N = 50/3"										
													Auger Refusal at 26 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. 41.229091, Long. -82.804853

LOG OF BORING T-40

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/5/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 9 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													10 in. Topsoil
			N = 9	20									LEAN CLAY (CL), trace Sand, brown, medium stiff, dry to moist
	5		N = 10	18									
			N = 50/5"	11									SHALE, gray, hard, dry to moist
	10		N = 50/1"										
			N = 50/1"										
	15		N = 50/1"										
													Auger Refusal at 18.5 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. 41.207509, Long. -82.781587
Auger refusal at 15 ft.; offset, auger refusal at 18.5 ft.

LOG OF BORING T-41

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/5/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 11 ft.; NX Wet Rock Coring: 11 to 30 ft.

GROUNDWATER INFORMATION:
Groundwater encountered at 7 ft. during drilling prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

FIELD DATA | LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													10 in. Topsoil
	5		N = 7	22									LEAN CLAY (CL), trace Sand, light brown, medium stiff to very stiff, moist to wet
			N = 21	13									
			N = 76/8"										SHALE, dark brown, very hard, moist
	10		N = 50/3"	11									
			R = 100 RQD = 0										SHALE, gray, very fine grained, slightly to moderately weathered, very weak to weak rock
	15		R = 98 RQD = 33										
	20		R = 92 RQD = 78										
	25		R = 100 RQD = 88										
	30												Total Depth = 30 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. 41.203875, Long. -82.781489
Auger refusal at 11 ft.; offset and drill to 30 ft.

LOG OF BORING T-42

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007
DATE(S) DRILLED: 12/19/2019 - 12/20/2020

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 12 ft.; Mud Rotary: 12 to 39 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													10 in. Topsoil
			N = 4										FAT CLAY (CH), trace Sand, brown, soft to hard, dry to moist
	5		N = 8	29									
			N = 83/11"										Grading black to gray
	10		N = 50/5"										
			N = 50/3"	20									
	15		N = 50/6"	26									POORLY GRADED SAND (SP), black, very dense, moist to wet, fine to medium grained
	20		N = 25/0"										
	25		N = 25/0"										
	30		N = 25/0"										
	35		N = 25/0"										
			N = 25/0"										SHALE, olive gray, very hard, wet
													Total Depth = 39 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. 41.200363, Long. -82.777263

LOG OF BORING T-43

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/29/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 9 ft.; NX Wet Rock Coring: 9 to 20 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													2 in. Topsoil
			N = 8	19									LEAN CLAY (CL), trace Sand, brown, medium stiff to hard, moist
	5		N = 35										
			N = 18										SANDY LEAN CLAY (CL), brown, trace Gravel, medium dense to very dense, dry to moist
			N = 50/2"										
	10		R = 67 RQD = 33 R = 98 RQD = 13										LIMESTONE, fine grained, moderately weathered, weak to moderately strong rock, vertical fracture from 9.5 to 10 ft.
	15		R = 35 RQD = 16					175*	1092.24		0.0		Potential void from 17 to 18 ft.
	20												Total Depth = 20 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. 41.198112, Long. -82.831090
*Denotes Total Unit Weight

LOG OF BORING T-44

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/6/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 18 ft.; NX Wet Rock Coring: 18 to 33 ft.

GROUNDWATER INFORMATION:
Groundwater encountered at 14 ft. during drilling prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													10 in. Topsoil
			N = 13	14									LEAN CLAY (CL), with Sand, brown, stiff to very stiff, wet
	5		N = 22	15									
			N = 26										
	10		N = 16	10									WEATHERED SHALE, gray, stiff to hard, dry to moist
			N = 98/9"										
	15		N = 50/3"										
	20		R = 82 RQD = 38										SHALE, dark gary, fine grained, slightly to moderately weathered, very weak to weak rock
	25		R = 70 RQD = 53										
	30		R = 58 RQD = 17										
													Total Depth = 33 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. 41.192592, Long. -82.774713

LOG OF BORING T-45A

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/6/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													10 in. Topsoil
			N = 10	20									LEAN CLAY (CL), with Sand, light brown, stiff to very stiff, dry to moist
	5		N = 17	15									
			N = 30										SANDY LEAN CLAY (CL), light brown, vert stiff to hard, dry to moist
	10		N = 35	11									
			N = 60										SHALE, dark gray, hard to very hard, dry to moist
	15		N = 50/6"										Auger Refusal at 15 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. 41.187731, Long. -82.775036

LOG OF BORING T-45B

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/6/2019 - 4/7/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 22 ft.; NX Wet Rock Coring: 22 to 37 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
	5												Undifferentiated Overburden. Refer to T-45a for detailed soil description.
	10												
	15												
	20		N = 50/1"										SHALE, dark brown, very hard, dry to moist
	25		R = 93 RQD = 75										SHALE, dark gray, fine grained, slightly to moderately weathered, very weak rock
	30		R = 95 RQD = 83					154*	734.40		0.0		
	35		R = 100 RQD = 92										
													Total Depth = 37 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. 41.187731, Long. -82.775036
*Denotes Total Unit Weight

LOG OF BORING T-46

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/8/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 23 ft.; NX Wet Rock Coring: 23 to 33 ft.

GROUNDWATER INFORMATION:
Groundwater encountered at 9 ft. during drilling prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													10 in. Topsoil
			N = 2	39									LEAN CLAY (CL), with Sand, light brown, soft, dry to moist
	5		N = 17										SHALE, dark brown, weathered to very hard, moist to wet
			N = 34	10									
	10		N = 51										
			N = 38										
	15		N = 40	17									
	20		N = 92/7"										
	25												SHALE, light gray, very fine grained, slightly to moderately weathered, very weak to weak rock
			R = 93 RQD = 56										LIMESTONE, light gray, fine grained, slightly weathered, weak to moderately strong rock
	30		R = 50 RQD = 37										SHALE, gray, very fine grained, slightly to moderately weathered, very weak to weak rock
													Total Depth = 33 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. 41.181870, Long. -82.781886

LOG OF BORING T-47

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/29/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 15 ft.; NX Wet Rock Coring: 15 to 25 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													2 in. Topsoil
			N = 11										LEAN CLAY (CL), with Sand, brown, stiff to hard, moist
	5		N = 14	14									
			N = 26										
	10		N = 17	13									Grading gray
			N = 35	9									
	15		N = 50/6"										SHALE, gray, hard, dry to moist
			R = 88 RQD = 27										SHALE, gray, very fine grained, slightly to moderately weathered, very weak to weak rock
	20		R = 98 RQD = 78										
	25												Total Depth = 25 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. 41.176582, Long. -82.829454

LOG OF BORING T-48

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 12/18/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during drilling and measured at 31 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													2 in. Topsoil
			N = 23										LEAN CLAY (CL), trace Sand, brown, very stiff to hard, dry to moist
	5		N = 20	16									
			N = 26										
	10		N = 21	14									Grading with Sand, gray
			N = 24										Trace Gravel at 12 ft.
	15		N = 31										
	20		N = 44	18									SANDY LEAN CLAY (CL), trace Gravel, gray, moist, hard
	25		N = 39										
	30		N = 96/11"										SHALE, gray, very hard, dry to moist
	35		N = 50/3"										
			N = 50/3"										Auger Refusal at 39 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. 41.154781, Long. -82.811484

LOG OF BORING T-49

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 5/25/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													1 in. Topsoil
			N = 13										LEAN CLAY (CL), with Sand, brown, stiff to very stiff, dry to moist
	5		N = 14	13									Grading trace Sand
			N = 18										
	10		N = 28	16									
			N = 21										WEATHERED SHALE, gray, very stiff, dry to moist
	15		N = 18	13									
	20		N = 47										SHALE, gray, weathered to very hard, dry to moist
	25		N = 50/4"										
	30		N = 50/2"										
	35		N = 50/2"										
													Auger Refusal at 37 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. 41.151717, Long. -82.781455

LOG OF BORING T-50

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007
DATE(S) DRILLED: 12/12/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 9 ft. during drilling and measured at 4 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													2 in. Topsoil
	0		N = 24	16									LEAN CLAY (CL), with Sand, brown, very stiff to hard, dry to moist
	5		N = 24										Grading trace Sand
			N = 25	17									Grading with Sand, trace Gravel, brown to black
	10		N = 32										Grading gray
			N = 23	17									Grading moist to wet
	15		N = 52	14									SHALE, gray, hard to very hard, moist to wet
	20		N = 50/2"										
	25		N = 50/3"										
	30		N = 25/0"										
			N = 50/4"										Auger Refusal at 33 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. 41.150265, Long. -82.822230

LOG OF BORING T-51

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 12/13/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 22.5 ft.; Mud Rotary: 22.5 to 39.5 ft.

GROUNDWATER INFORMATION:
Groundwater encountered at 14 ft. during drilling prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													2 in. Topsoil
			N = 25										LEAN CLAY (CL), trace Sand, brown, very stiff to hard, dry to moist; trace Lignite at 1 ft.
	5		N = 19	16									
			N = 30										
	10		N = 33	15									
			N = 19	14	27	16	11					67	SANDY LEAN CLAY (CL), gray, very stiff, dry to moist
	15		N = 27										
	20		N = 50/4"	11									SHALE, olive gray, very hard, dry to moist
	25		N = 50/2"										
	30		N = 50/5"										
	35		N = 50/4"										
			N = 50/3"										Total Depth = 39.5 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. 41.148395, Long. -82.811766

LOG OF BORING T-52

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 12/16/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 25 ft.; Mud Rotary: 25 to 39 ft.

GROUNDWATER INFORMATION:
Groundwater encountered at 19 ft. during drilling prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

FIELD DATA | LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	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
													1 in. Topsoil
			N = 12	23									FAT CLAY (CH), trace Sand, light brown, stiff to very stiff, dry to moist
	5		N = 17	22									
			N = 19										
	10		N = 27										
			N = 20	14									Grading with Sand, gray
	15		N = 24										Trace Lignite at 14 ft.
	20		N = 37										LEAN CLAY (CL), trace Sand and Gravel, black, hard, dry to moist
	25		N = 50/4"										
	30		N = 25/0"										POORLY GRADED SAND (SP), dark gray, very dense, dry to moist, fine to coarse grained
	35		N = 25/0"										CLAYEY SAND (SC), dark gray, very dense, dry to moist, fine to coarse grained
			N = 25/0"										Total Depth = 39 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. 41.141995, Long. -82.832667

LOG OF BORING T-53

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 5/30/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 19 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													1 in. Topsoil
			N = 8	23									LEAN CLAY (CL), trace Sand, brown, medium stiff to very stiff, dry to moist
	5		N = 13										
			N = 17	12									Grading with Sand
	10		N = 28										
			N = 23										WEATHERED SHALE, brownish gray, stiff to very stiff, dry to moist
	15		N = 11	14									
	20		N = 50/4"	19									SHALE, dark gray, hard, dry to moist
	25		N = 50/5"										
	30		N = 50/4"										
													Auger Refusal at 31 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. 41.138732, Long. -82.832555

LOG OF BORING T-54

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007
DATE(S) DRILLED: 5/15/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													4 in. Topsoil
			N = 13	19									LEAN CLAY (CL), with Sand, brown, stiff to very stiff, moist
	5		N = 21	16									
			N = 18										
	10		N = 18	17									
			N = 16										
	15		N = 21	13									Grading trace Sand and Gravel, gray
	20		N = 33										
	25		N = 18	10									
	30		N = 25										
	35		N = 39										SANDY LEAN CLAY (CL), trace Gravel, dark gray, hard, dry to moist
	40		N = 36										
	45		N = 50/1"										
													Auger Refusal at 48 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. 41.139042, Long. -82.770782

LOG OF BORING T-56

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 5/14/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													1 in. Topsoil
			N = 21										LEAN CLAY (CL), trace Sand and Gravel, brown, very stiff to hard, dry to moist
	5		N = 23										
			N = 25	15									
	10		N = 33										
			N = 14	15									
	15		N = 21										
	20		N = 27	11									
	25		N = 46										Grading with Sand
	30		N = 50/4"	13									Grading moist
	35		N = 50/3"										SHALE, dark gray, hard, moist
	40		N = 50/1.5"										
													Auger Refusal at 43 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. 41.137179, Long. -82.791465

LOG OF BORING T-57

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 12/17/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 24.5 ft.; Mud Rotary: 24.5 to 39 ft.

GROUNDWATER INFORMATION:
Groundwater not encountered during drilling prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													1 in. Topsoil
			N = 18	22									LEAN CLAY (CL), trace Sand, light brown, very stiff to hard, dry to moist
	5		N = 28										Grading with Sand
			N = 35	16									
	10		N = 41										
			N = 31	15									Grading trace Gravel
	15		N = 73										SANDY LEAN CLAY (CL), brown, hard, dry to moist
	20		N = 50/6"	9									LEAN CLAY (CL), trace Sand and Gravel, dark gray, hard, dry to moist
	25		N = 50/4"										Grading with Sand, dark brown
	30		N = 25/0"										SHALE, dark gray, very hard, dry to moist
	35		N = 25/0"										
			N = 25/0"										Total Depth = 39 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. 41.136254, Long. -82.825618

LOG OF BORING T-58

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007
DATE(S) DRILLED: 12/18/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 24 ft. during drilling and measured at 23 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													3 in. Topsoil
			N = 6	23									LEAN CLAY (CL), trace Sand, light brown, medium stiff to hard, dry to moist
	5		N = 9	21									
			N = 19										Grading with Sand
	10		N = 11	13									Grading trace Sand
			P = 4.25	15	29	15	14	121	2.05	15.0	9.5	80	
	15		N = 9	17									
	20		N = 11	15									
			P = 3.5										
	25		N = 25										SANDY LEAN CLAY (CL), gray, very stiff to hard, moist to wet
	30		N = 32										
	35		N = 39										LEAN CLAY (CL), with Sand, gray, hard, moist to wet
	40		N = 46	11									SHALE, dark gray, medium hard to very hard, moist
	45		N = 25/0"										
	50		N = 50/3"										Grading gray
			N = 25/0"										
													Total Depth = 54 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. 41.132702, Long. -82.769033

LOG OF BORING T-59

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 5/12/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during drilling and measured at 5 ft. immediately after drilling and at 8.5 ft. 24 hours after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													6 in. Topsoil
			N = 13										LEAN CLAY (CL), with Sand, brown, stiff to very stiff
	5		N = 20	17									Grading trace Sand
			N = 20										SANDY LEAN CLAY (CL), brown, very stiff, dry to moist
	10		N = 27	12									LEAN CLAY (CL), with Sand, gray, very stiff, dry to moist
			N = 21										Grading trace Sand
	15		N = 44										SHALE, dark gray, medium hard to very hard, moist
	20		N = 50/2"										
	25		N = 50/2"	19									
													Auger Refusal at 28 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. 41.130820, Long. -82.822057

LOG OF BORING T-60

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007
DATE(S) DRILLED: 12/12/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
			N = 19										3 in. Topsoil LEAN CLAY (CL), trace Sand, light brown, very stiff to hard, dry to moist
	5		N = 17	17									
			N = 33										
	10		N = 36	17									
			N = 18	16									FAT CLAY (CH), trace Sand, light brown, stiff to very stiff, dry to moist
	15		P = 2.0										
	20		N = 30										
	25		N = 25	19									SILT (ML), trace Sand, gray, very stiff, moist
	30		N = 20										
	35		N = 50/3"										LEAN CLAY (CL), gray, hard, moist
			N = 50/3"										SHALE, gray, very hard, moist Auger Refusal at 35 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. 41.115596, Long. -82.744422

LOG OF BORING T-61

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 5/11/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater not encountered during drilling or immediately after drilling and measured at 6.5 ft. 24 hours after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: BLOWS, R: %, RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													2 in. Topsoil
			N = 14										LEAN CLAY (CL), with Sand, brown, stiff to very stiff, dry to moist
	5		N = 25										
			N = 24										
	10		N = 15	16	31	16	15					74	
			N = 16										Grading grayish brown
	15		N = 15										
	20		N = 19										
	25		N = 19	19									
	30		N = 25										
	35		N = 15										
	40		N = 35										
	45		N = 74										SHALE, dark gray, hard, moist
													Auger Refusal at 48 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. 41.113883, Long. -82.809371

LOG OF BORING T-62

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 12/11/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 52 ft. during drilling and measured at 40 ft. immediately after drilling

SURFACE ELEVATION (FT):

FIELD DATA | LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													3 in. Topsoil
			N = 18	16									LEAN CLAY (CL), trace Sand and Gravel, light brown, very stiff to hard, dry to moist
	5		N = 21										
			N = 28	15									Grading iron stained
	10		N = 30										Iron stains grade out
			N = 32	15									
	15		N = 39										
	20		N = 19	16									
	25		P = 4.5										
	30		N = 14	28								96	SILT (ML), trace Sand, brown, stiff to very stiff, moist to wet
	35		N = 18										Trace Gravel at 34 ft.
	40		N = 82										CLAYEY SAND (SC), dark gray, very dense, dry to moist, fine to medium grained
	45		N = 45										LEAN CLAY (CL), with Sand, dark gray, hard, dry to moist
	50		N = 51										
			N = 50/4"										Grading trace Sand and Gravel, gray, moist to wet
													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. 41.110964, Long. -82.744297

LOG OF BORING T-63

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 5/8/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													2 in. Topsoil
			N = 10										LEAN CLAY (CL), trace Sand, brown, stiff to very stiff, moist
	5		N = 21										
			N = 21	17									
	10		N = 24										
			N = 18										
	15		N = 12										
	20		N = 13	17									Grading to dark brown
	25		N = 16										
	30		N = 22										Grading with Sand, gray, dry to moist
	35		N = 25										
	40		N = 39	15								9	POORLY GRADED SAND (SP), gray to black, dense, wet, fine to coarse grained
	45		N = 56										LEAN CLAY (CL), trace Sand and Gravel, gray, hard, moist to wet
	50		N = 41										Gravel grades out
	55		N = 50/5"										
													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. 41.107601, Long. -82.807071

LOG OF BORING T-64

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 12/8/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 47 ft. during drilling and measured at 24 ft. immediately after drilling

SURFACE ELEVATION (FT):

FIELD DATA | LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
	0		N = 18										2 in. Topsoil LEAN CLAY (CL), trace Sand, light brown, very stiff to hard, dry to moist
	5		N = 33	16									
			N = 34										Grading trace Gravel
	10		N = 34	16									
			N = 33										
	15		N = 21	16									Grading gray
			P = 4.0										
	20		N = 24										
	25		N = 21	19									
	30		N = 25										
	35		N = 31										
	40		N = 87										SANDY LEAN CLAY (CL), trace Gravel, hard, dry to moist
	45		N = 50/4"										
			N = 50/4"										SHALE, dark gray, very hard, dry to moist Auger Refusal at 47 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. 41.098514, Long. -82.827851

LOG OF BORING T-65

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007
DATE(S) DRILLED: 5/9/2019 - 5/10/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	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
													2 in. Topsoil
			N = 12	16									LEAN CLAY (CL), with Sand, brown, stiff to hard, dry to moist
	5		N = 21										
			N = 20										
	10		N = 17	17									Grading trace Sand
			N = 24										
	15		N = 23	17									
	20		N = 22										
	25		N = 1.5	15				121	4.52	10.0	0.0		
	30		N = 24										Grading grayish brown, wet
	35		N = 58										
	40		N = 47										
	45		N = 30										
	50		N = 50/6"										SHALE, dark gray, hard, moist
	55		N = 50/4"										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. 41.096579, Long. -82.806805

LOG OF BORING T-66

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 5/3/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 13 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													2 in. Topsoil
			N = 6	22									SANDY LEAN CLAY (CL), light brown, medium stiff to very stiff, dry to moist
	5		N = 17	20									
			N = 15										
	10		N = 26										LEAN CLAY (CL), trace Sand and Gravel, dark brown, soft to hard, dry to moist
			N = 17	18									
	15		N = 15	14									
	20		N = 5	18	31	16	15					77	Gravel grades out; grading with Sand
	25		P = 2.25	17	29	17	12	117	2.77	14.9	19.0	91	Grading trace Sand
	30		N = 4	23									Wet from 29 to 34 ft.
	35		N = 17										
	40		N = 34										
	45		N = 20										
	50		N = 32										
	55		N = 18										
													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. 41.095647, Long. -82.763703

LOG OF BORING T-67

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 5/2/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													4 in. Topsoil
			N = 7										LEAN CLAY (CL), with Sand, brown, medium stiff to very stiff, moist
	5		N = 18										
			N = 28										Grading trace Sand, dry to moist
	10		N = 23										
			N = 21										Grading gray
	15		N = 12										
	20		N = 6	14									
	25		N = 6	19									CLAYEY SAND (SC), olive brown, loose, dry to moist, fine grained
	30		N = 15										LEAN CLAY (CL), trace Sand, dark gray, stiff to hard, dry to moist
	35		N = 25										Grading trace Gravel
	40		N = 20										
	45		N = 32										
	50		N = 26										CLAYEY SAND (SC), dark gray, medium dense, moist, fine grained
	55		N = 68										SANDY LEAN CLAY (CL), dark 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. 41.094265, Long. -82.770634

LOG OF BORING T-68

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 5/8/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													1.5 in. Topsoil
			N = 10										LEAN CLAY (CL), trace Sand, brown, stiff to very stiff, moist
	5		N = 16	16									
			N = 26										
	10		N = 16	14									
			N = 10	13									
	15		N = 11										
	20		N = 13										
	25		N = 14	17									Grading moist to wet
	30		N = 14										
	35		N = 38										CLAYEY SAND (SC), brownish gray, dense, moist to wet, fine to coarse grained
	40		N = 79										LEAN CLAY (CL), trace Sand, brown, hard, moist
	45		N = 31										
	50		N = 39										
	55		N = 38										
													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. 41.092712, Long. -82.777417

LOG OF BORING T-69

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 5/7/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 39 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													2 in. Topsoil
			N = 7										LEAN CLAY (CL), trace Sand, brown, medium stiff to very stiff, moist
	5		N = 11	20									
			N = 21										
	10		N = 14										Grading trace lignite
			N = 12	16									SANDY LEAN CLAY (CL), light reddish brown, stiff, moist
	15		N = 10	19									LEAN CLAY (CL), with Sand, grayish brown, stiff to hard, moist
	20		N = 17										Grading trace Sand, dry to moist
	25		N = 23										
	30		N = 9	16	26	17	9					75	Grading with Sand
	35		N = 32										
	40		N = 40										
	45		N = 37										
	50		N = 34										Grading trace Sand, moist
	55		N = 55										Grading moist to wet
													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. 41.091692, Long. -82.788934

LOG OF BORING T-70

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007
DATE(S) DRILLED: 5/10/2019 - 5/11/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													2 in. Topsoil
			N = 20	14									LEAN CLAY (CL), with Sand, brown, stiff to very stiff, dry to moist
	5		N = 23										
			N = 20	15									
	10		N = 21										
			N = 12	16									Grading trace Sand, gray
	15		N = 15										
	20		N = 22										
	25		N = 14	17									
	30		N = 11										SANDY LEAN CLAY (CL), gray, stiff to hard, moist to wet
	35		P = 3.5	15				121	3.66	15.1	0.0		
	40		N = 37										
	45		N = 30										LEAN CLAY (CL), with Sand, gray to brown, very stiff, moist to wet
	50		N = 24										
	55		N = 80/10"										SHALE, dark gray, very hard, moist, with trace Sand deposits
													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. 41.088115, Long. -82.817980

LOG OF BORING T-71

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 5/6/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 14.25 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													2 in. Topsoil
			N = 11										LEAN CLAY (CL), with Sand, brown, stiff to hard, dry to moist
	5		N = 22	15									
			N = 27										Grading trace Sand
	10		N = 31	16									
			N = 35										
	15		N = 37										
	20		N = 18	16									
	25		N = 17										
	30		N = 21										
	35		N = 48										Grading with Sand
	40		N = 27										SILTY SAND (SM), dark gray to black, medium dense to dense, wet, fine to medium grained
	45		N = 17										
	50		N = 33										
	55		N = 30										
													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. 41.087076, Long. -82.777013

LOG OF BORING T-72

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/23/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 8 ft.; NX Wet Rock Coring: 8 to 28 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													2 in. Topsoil
			N = 4	25									LEAN CLAY (CL), with Sand, brown, soft to hard, dry to moist
	5		N = 4										
			N = 50/5"	14									Grading trace Gravel
													LIMESTONE, gray, fine grained, moderately weathered, weak rock
	10		R = 89 RQD = 17										
	15		R = 100 RQD = 68										
	20		R = 98 RQD = 63										
	25		R = 98 RQD = 92										Grading fresh to slightly weathered
													Total Depth = 28 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. 41.317416, Long. -82.790099

LOG OF BORING T-73

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/18/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 8 ft.; NX Wet Rock Coring: 8 to 23 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
			N = 50/5"	17									1 in. Topsoil LEAN CLAY (CL), with Sand and Gravel, brown, hard, dry
	5		N = 50/1"										LIMESTONE, gray, hard, dry
			N = 50/2"	1									
	10		R = 90 RQD = 17										LIMESTONE, gray, fine grained, slightly to moderately weathered, weak rock
	15		R = 97 RQD = 72										
	20		R = 100 RQD = 87										
													Total Depth = 23 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. 41.309842, Long. -82.815969

LOG OF BORING T-74

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/17/2019 - 4/18/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 11 ft.; NQ Wet Rock Coring: 11 to 26 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	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
													4 in. Topsoil
			N = 6										LEAN CLAY (CL), with Sand, brown, medium stiff to hard, moist to wet
	5		N = 51	22									
			N = 17										
	10		N = 50/1"	17									
			N = 50/1"										LIMESTONE, gray, fine grained, moderately weathered, weak rock
	15		R = 92 RQD = 40										
			R = 99 RQD = 65										
	20												
			R = 100 RQD = 70										
	25												Total Depth = 26 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. 41.307049, Long. -82.817887

LOG OF BORING T-75

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/28/2019 - 4/29/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 13 ft.; NX Wet Rock Coring: 13 to 28 ft.

GROUNDWATER INFORMATION:
Groundwater encountered at 7 ft. during drilling prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													2 in. Topsoil
			N = 4										SANDY LEAN CLAY (CL), brown, soft, moist
	5		N = 8	19									LEAN CLAY (CL), with Sand, brown, medium stiff, moist
			N = 50/5"										SHALE, gray to black, very hard, moist to wet
	10		N = 50/3"	16									
			N = 50/4"										
	15		R = 75 RQD = 37					183*	1612.80		0.0		LIMESTONE, light gray, fine grained, slightly to moderately weathered, weak to moderately strong rock
	20		R = 100 RQD = 44										
	25		R = 100 RQD = 76										
													Total Depth = 28 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. 41.260506, Long. -82.803113
*Denotes Total Unit Weight

LOG OF BORING T-76

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/9/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 14 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													10 in. Topsoil
			N = 12										LEAN CLAY (CL), with Sand, brown, stiff to hard, moist
	5		N = 24	16									
			N = 33										
	10		N = 40	10									SHALE, gray, hard, dry to moist
			N = 50/2"	4									
	15		N = 50/2"										
	20		N = 50/1"										
	25		N = 50/1"										
	30		N = 50/1"										
	35		N = 50/1"										
	40		N = 50/1"										
			N = 50/1"										Auger Refusal = 44.5 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. 41.197831, Long. -82.755836

LOG OF BORING T-77

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 12/19/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 19 ft.; Mud Rotary: 19 to 39 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													2 in. Topsoil
			N = 27										LEAN CLAY (CL), trace Sand, brown, very stiff to hard, moist
	5		N = 16	15									
			N = 30	14									
	10		N = 47										Grading with Sand, moist to wet
			N = 94/11"										POORLY GRADED GRAVEL (GP), light brown, very dense, dry to moist, fine grained, angular
	15		N = 64	9									SHALE, gray, very hard, dry to moist
	20		N = 50/5"										
	25		N = 25/0"										
	30		N = 25/0"										
	35		N = 25/0"										
			N = 25/0"										Total Depth = 39 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. 41.197446, Long. -82.776172

LOG OF BORING T-78

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007
DATE(S) DRILLED: 5/14/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													1.5 in. Topsoil
			N = 10	25									LEAN CLAY (CL), with Sand, brown, stiff to very stiff, dry to moist
	5		N = 20										
			N = 25	17									Grading trace Sand, gray
	10		N = 75										SHALE, dark gray, medium hard to very hard, moist
			N = 33										
	15		N = 82/10"	14									
	20		N = 50/1"										
	25		N = 50/1.5"										Grading moist to wet
			N = 50/2"										
													Auger Refusal at 31 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. 41.133708, Long. -82.823198

LOG OF BORING T-79

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 12/11/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 40 ft. during drilling and measured at 30 ft. immediately after drilling

SURFACE ELEVATION (FT):

FIELD DATA | LABORATORY DATA

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													2 in. Topsoil
			N = 20										LEAN CLAY (CL), trace Sand, light brown, very stiff to hard, dry to moist
	5		N = 36	15									
			N = 35										
	10		N = 30	16									
			N = 40										
	15		N = 22	16									FAT CLAY (CH), trace Sand, gray, very stiff, dry to moist
	20		N = 22										
	25		N = 17	24									SILTY SAND (SM), gray, medium dense, moist, fine to medium grained
	30		P = +4.5										
	35		N = 33										SANDY FAT CLAY (CH), gray, hard, dry to moist
	40		N = 48										
	45		N = 50/4"										SHALE, gray, hard to very hard, moist to wet
	50		N = 60										
	55		N = 90/10"										
													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. 41.110892, Long. -82.740271

LOG OF BORING T-80

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 12/6/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	FIELD DATA: N: BLOWS/FT, P: TONS/SQ FT, T: BLOWS, R: %, RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
													3 in. Topsoil
			N = 18	16									FAT CLAY (CH), trace Sand, dark brown, very stiff to hard, dry to moist
	5		N = 40										
			N = 36										
	10		N = 35	17									
			N = 28										
	15		N = 22	16									
	20		N = 23	22									SILTY SAND (SM), brown, medium dense, dry to moist, fine to medium grained
	25		N = 17										FAT CLAY (CH), trace Sand, olive gray, stiff to very stiff, dry to moist
	30		N = 16	16									
	35		N = 19										
	40		N = 15										
	45		N = 15										
	50		N = 19										
	55		N = 26										
													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. 41.065264, Long. -82.824944

LOG OF BORING T-81

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 12/6/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 19 ft. during drilling and measured at 28 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	ATTERBERG LIMITS: PLASTIC LIMIT (PL)	ATTERBERG LIMITS: PLASTICITY INDEX (PI)	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
			N = 13										3 in. Topsoil FAT CLAY (CH), trace Sand, dark brown, stiff, dry to moist
	5		N = 18	16									LEAN CLAY (CL), trace Sand, light brown, very stiff, dry to moist
			N = 16	16									
	10		N = 21										
			N = 16	17									
	15		N = 25										SILTY SAND (SM), brown, medium dense, moist, fine to medium grained
	20		N = 14	17									SANDY LEAN CLAY (CL), gray, stiff to very stiff, dry to moist
	25		N = 16										
	30		N = 16										FAT CLAY (CH), with Sand, gray, stiff to very stiff, moist
	35		N = 21										Grading trace Sand
	40		N = 14	18									
	45		N = 13										
	50		N = 18										
	55		N = 19										
													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. 41.058500, Long. -82.824749

LOG OF BORING T-82

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 12/7/2019 - 12/8/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 29 ft. during drilling and measured at 16 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													2 in. Topsoil
			N = 12	22									LEAN CLAY (CL), trace Sand, brown, medium stiff to hard, dry to moist
	5		N = 24										
			N = 29	18									
	10		N = 31										
			N = 28										
	15		N = 19										
	20		N = 12	19									Grading gray
	25		P = 1.0	21	28	16	12	110	1.48	15.0	19.0	83	Grading with Sand
	30		N = 19										
	35		N = 21										
	40		N = 20	13									
	45		N = 19										
	50		N = 66										
	55		N = 87/10"										SHALE, dark gray to black, 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. 41.049640, Long. -82.827139

LOG OF BORING T-83

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 12/7/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 22 ft. during drilling and measured at 22 ft. immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	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
													1 in. Topsoil
			N = 24	16									LEAN CLAY (CL), trace Sand, very stiff to hard, dry to moist
	5		N = 41										Grading trace Gravel
			N = 51										Gravel grades out
	10		N = 34	18									
			N = 26										SANDY LEAN CLAY (CL), brown, very stiff, dry to moist
	15		N = 34										LEAN CLAY (CL), trace Sand, brown, stiff to hard, dry to moist
	20		N = 16										
			P = 1.5	▼ 18	29	16	13	115	1.46	15.0	16.0	89	
	25		N = 16										
	30		N = 14	21									Grading moist to wet
	35		N = 15										
	40		N = 23										CLAYEY SAND (SC), dark gray, medium dense, moist, fine to medium grained
	45		N = 26										LEAN CLAY (CL), trace Sand, dark gray, very stiff, moist
	50		N = 27										SANDY LEAN CLAY (CL), dark gray, very stiff, moist
	55		N = 51										LEAN CLAY (CL), trace Sand, dark 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. 41.048849, Long. -82.823246

LOG OF BORING T-87

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 5/21/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 7 ft.; NX Wet Rock Coring: 7 to 30 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	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
													1 in. Topsoil
			N = 8	18									LEAN CLAY (CL), with Sand, brown, medium stiff to hard, dry to moist
	5		N = 14	20									
			N = 50/1"										LIMESTONE, light brown, fine grained, slightly to moderately weathered, weak to moderately strong rock
			R = 48 RQD = 29										
	10							168*	784.08		0.0		
			R = 83 RQD = 49										
	15												
			R = 96 RQD = 46										
	20												
			R = 100 RQD = 63										
	25												
			R = 98 RQD = 94										
	30												Total Depth = 30 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. 41.241977, Long. -82.827098
*Denotes Total Unit Weight

LOG OF BORING SUB-1

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/28/2019

DRILLING METHOD(S):
Hollow Stem Auger: 0 to 9 ft.; NX Wet Rock Coring: 9 to 19 ft.

GROUNDWATER INFORMATION:
No groundwater encountered prior to the introduction of drilling fluid

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													8 in. Topsoil
			N = 6	31									LEAN CLAY (CL), with Sand, brown, medium stiff, moist
	5		N = 13	17									SANDY LEAN CLAY (CL), brown, stiff, moist
			N = 50/4" N = 50/2"										SHALE, dark gray, hard, dry to moist
	10		R = 93 RQD = 0										SHALE, dark gray, fine grained, slightly to moderately weathered, very weak to weak rock
	15		R = 65 RQD = 17										
													Total Depth = 19 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. 41.268959, Long. -82.764984

LOG OF BORING SUB-2

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/28/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													8 in. Topsoil
			N = 6										LEAN CLAY (CL), with Sand, brown, medium stiff to stiff, moist
	5		N = 12										
			N = 50/2"										SHALE, gray, very hard, dry to moist Auger Refusal at 6.25 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. 41.268962, Long. -82.763493

LOG OF BORING SUB-3

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/28/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													8 in. Topsoil
			N = 7										LEAN CLAY (CL), with Sand, brown, medium stiff to stiff, moist
	5		N = 10	23	43	20	23					83	
			N = 50/3"	8									SHALE, dark gray to black, very hard, dry to moist
													Auger Refusal at 6.25 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. 41.269448, Long. -82.763495

LOG OF BORING SUB-4

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/28/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													8 in. Topsoil
			N = 9										LEAN CLAY (CL), with Sand, light reddish brown, stiff to very stiff, dry to moist
	5		N = 22										Grading black
			N = 50/4"										SHALE, gray, very hard, dry to moist
													Auger Refusal = 8 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. 41.269444, Long. -82.764986

LOG OF BORING OM1

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/29/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater encountered at 7.5 ft. during drilling and not measured immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													2 in. Topsoil
			N = 8	28									FAT CLAY (CH), trace Sand, brown, medium stiff, dry to moist
	5		N = 7	30									LEAN CLAY (CL), with Sand, brown, medium stiff, dry to moist
			N = 50/4"										SHALE, dark gray, very hard, dry to moist
	10		N = 50/3"	4									
			N = 50/2"										
	15		N = 50/4"										Grading moist to wet
	20		N = 50/2"										
			N = 50/1"										Grading dry to moist
													Total Depth = 24.5 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. 41.252176, Long. -82.801635

LOG OF BORING OM2

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

DATE(S) DRILLED: 4/30/2019

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
No groundwater encountered during or immediately after drilling

SURFACE ELEVATION (FT):

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	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
													4 in. Topsoil
			N = 5										FAT CLAY (CH), trace Sand, brown, soft to medium stiff, moist
	5		N = 3	32	59	22	37					93	
			N = 50/3"	8									SHALE, gray to dark gray, hard, dry to moist
	10		N = 50/2"										
			N = 50/3"										
	15		N = 50/5"										
	20		N = 50/2"										
			N = 50/2"										Total Depth = 24.5 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. 41.251718, Long. -82.801880

www.RRCcompanies.com

3801 Doris Lane
Round Rock, TX 78664
512.992.2087

APPENDIX B

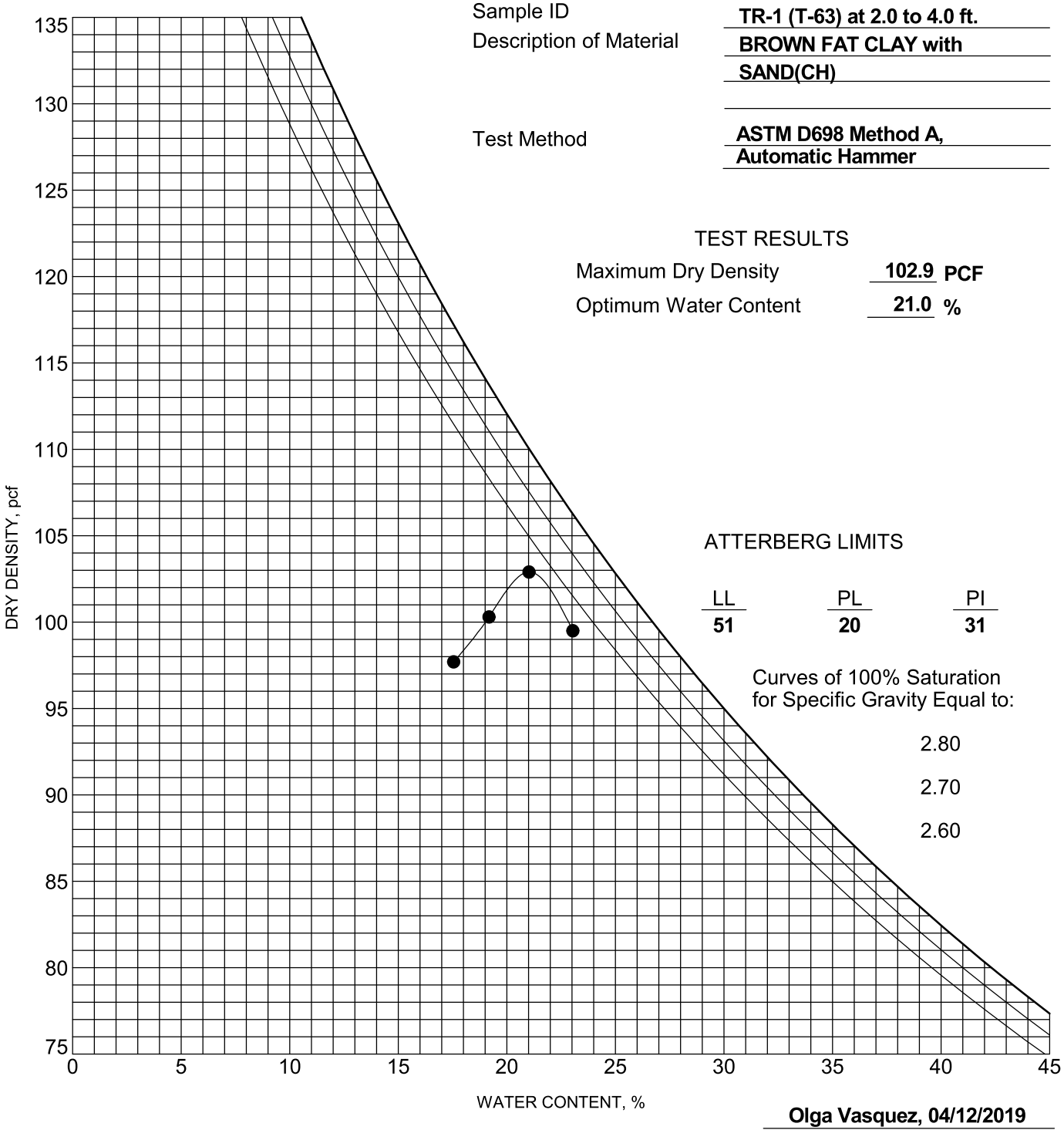
MOISTURE-DENSITY RELATIONSHIP

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

Sample ID: **TR-1 (T-63) at 2.0 to 4.0 ft.**
Description of Material: **BROWN FAT CLAY with SAND(CH)**

Test Method: **ASTM D698 Method A, Automatic Hammer**



TEST RESULTS

Maximum Dry Density	**102.9**	**PCF**
Optimum Water Content	**21.0**	**%**

ATTERBERG LIMITS

LL	PL	PI
51	**20**	**31**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80
2.70
2.60

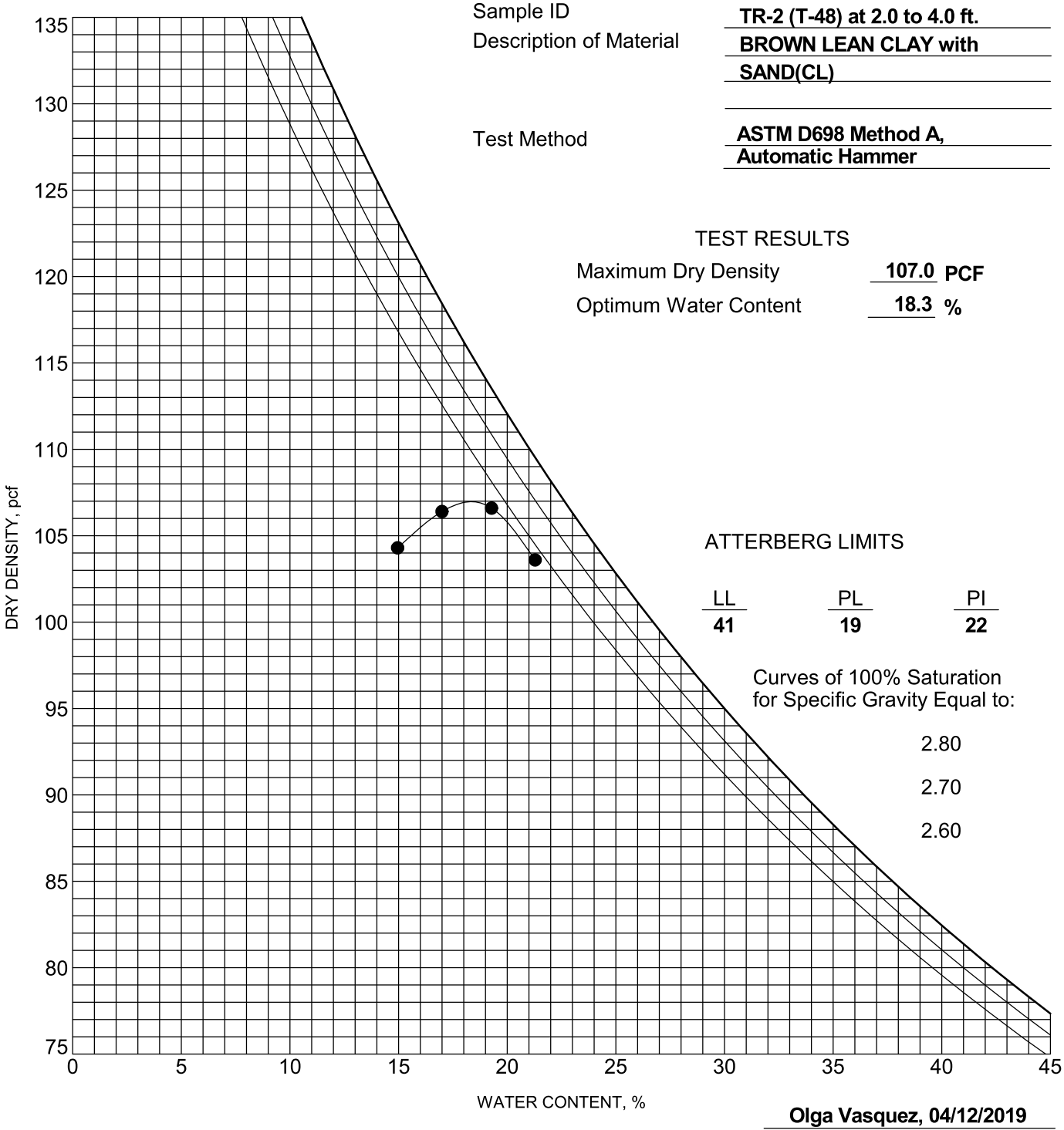
Olga Vasquez, 04/12/2019
Analysis & Quality Review/Date

Specimens prepared by: T.W.

MOISTURE-DENSITY RELATIONSHIP

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007



Sample ID: **TR-2 (T-48) at 2.0 to 4.0 ft.**

Description of Material: **BROWN LEAN CLAY with SAND(CL)**

Test Method: **ASTM D698 Method A, Automatic Hammer**

TEST RESULTS

Maximum Dry Density	**107.0**	**PCF**
Optimum Water Content	**18.3**	**%**

ATTERBERG LIMITS

LL	PL	PI
41	**19**	**22**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60

Olga Vasquez, 04/12/2019
Analysis & Quality Review/Date

Specimens prepared by: T.W.

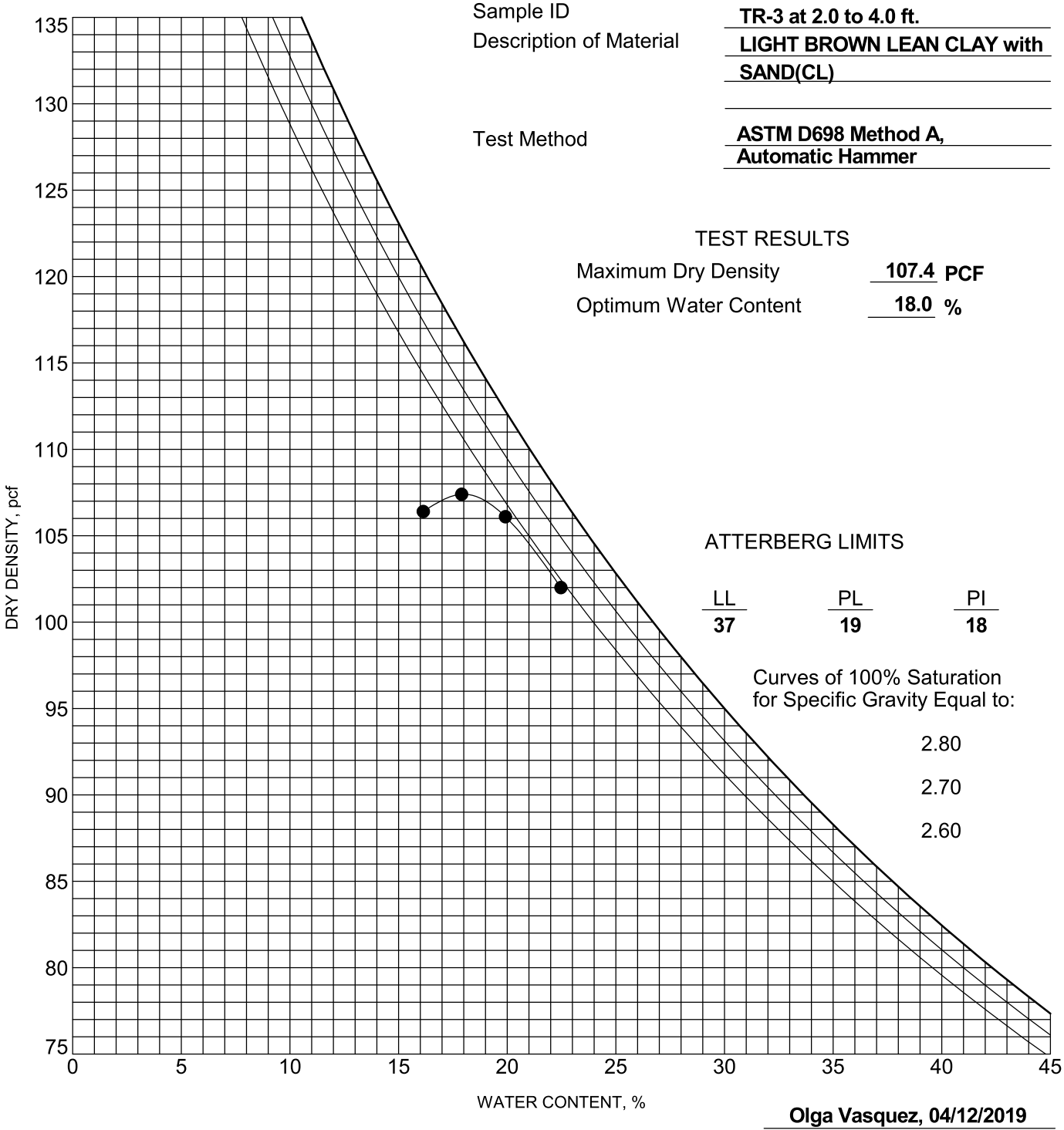
MOISTURE-DENSITY RELATIONSHIP

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

Sample ID: **TR-3 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**



TEST RESULTS

Maximum Dry Density	**107.4**	**PCF**
Optimum Water Content	**18.0**	**%**

ATTERBERG LIMITS

LL	PL	PI
37	**19**	**18**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80
2.70
2.60

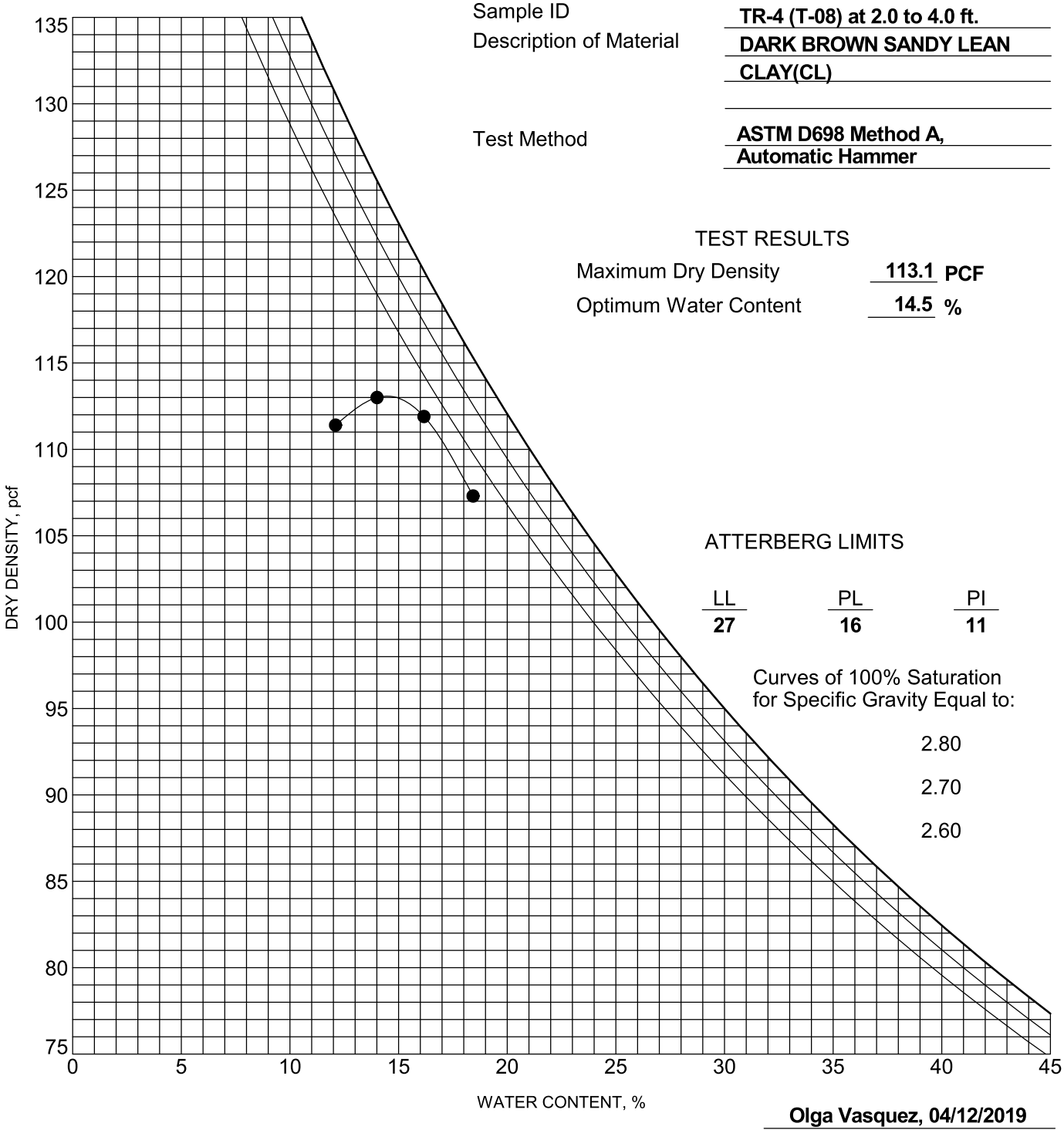
Olga Vasquez, 04/12/2019
Analysis & Quality Review/Date

Specimens prepared by: T.W.

MOISTURE-DENSITY RELATIONSHIP

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007



Sample ID: **TR-4 (T-08) 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: **113.1 PCF**

Optimum Water Content: **14.5 %**

ATTERBERG LIMITS

LL	PL	PI
27	16	11

Curves of 100% Saturation for Specific Gravity Equal to:

2.80

2.70

2.60

Olga Vasquez, 04/12/2019
Analysis & Quality Review/Date

Specimens prepared by: T.W.

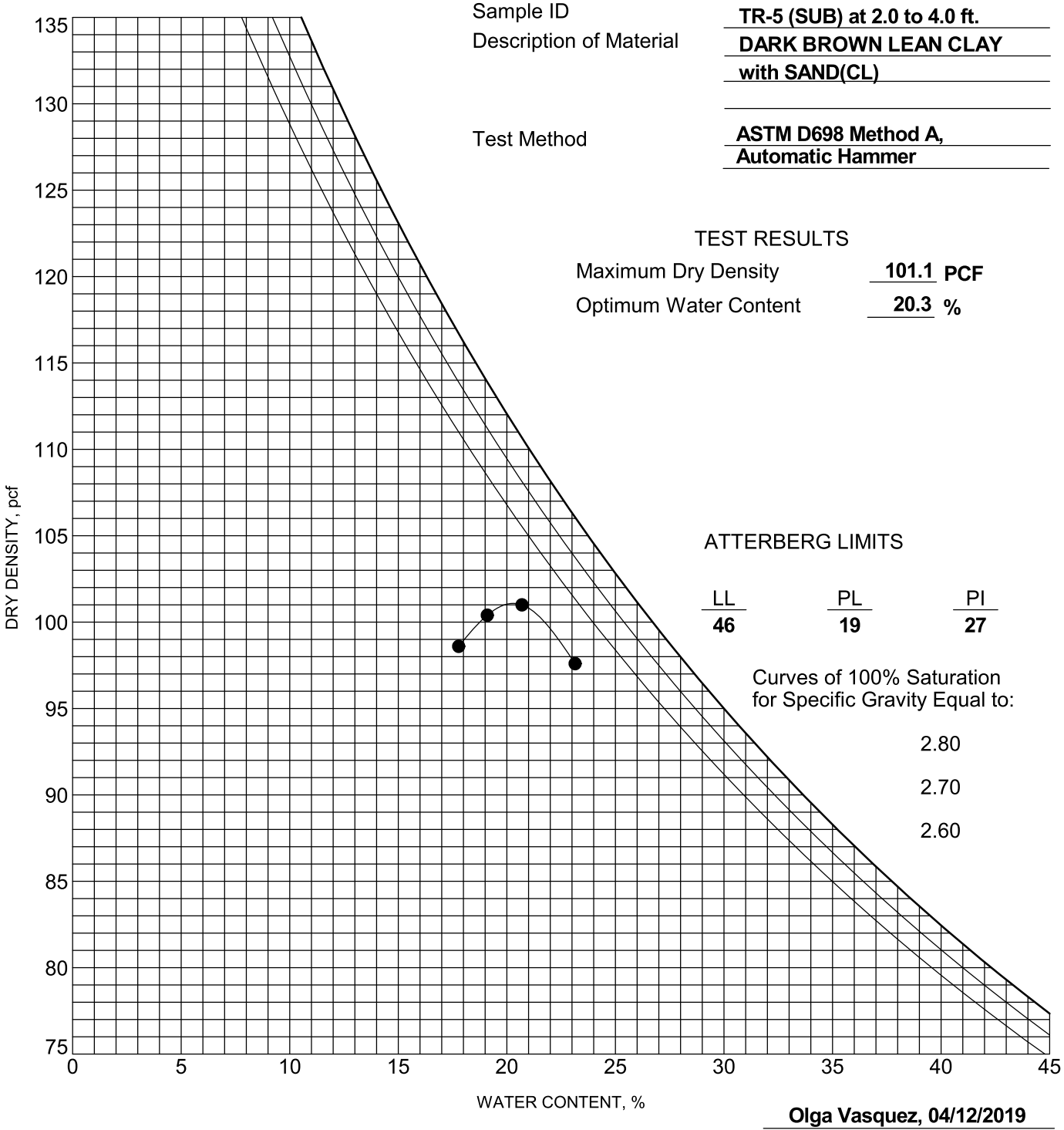
MOISTURE-DENSITY RELATIONSHIP

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

Sample ID: **TR-5 (SUB) at 2.0 to 4.0 ft.**
Description of Material: **DARK BROWN LEAN CLAY with SAND(CL)**

Test Method: **ASTM D698 Method A, Automatic Hammer**



TEST RESULTS

Maximum Dry Density	**101.1**	**PCF**
Optimum Water Content	**20.3**	**%**

ATTERBERG LIMITS

LL	PL	PI
46	**19**	**27**

Curves of 100% Saturation for Specific Gravity Equal to:

2.80
2.70
2.60

Olga Vasquez, 04/12/2019
Analysis & Quality Review/Date

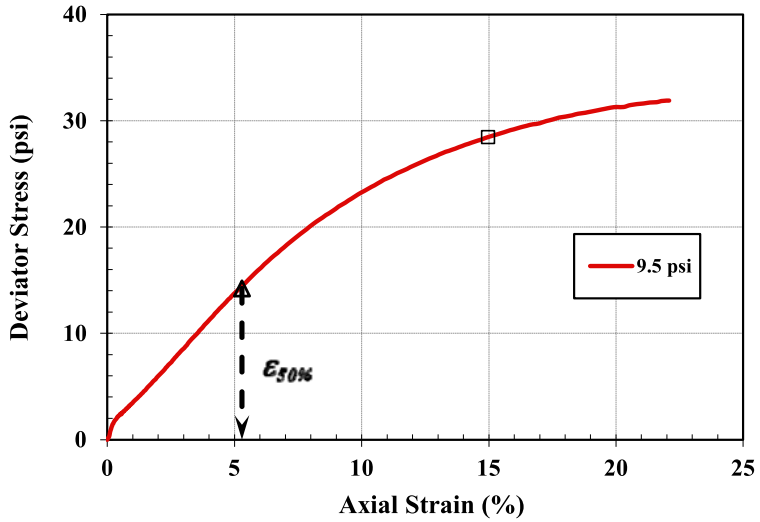
Specimens prepared by: T.W.

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

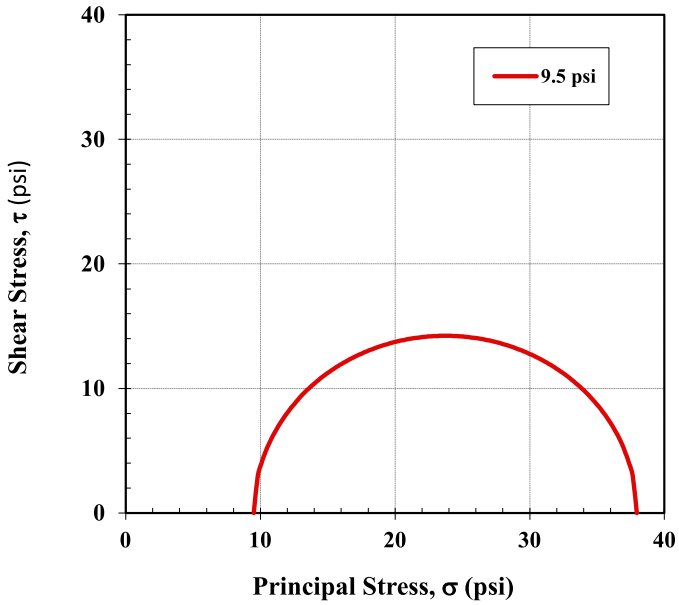
Unconsolidated-Undrained Triaxial Compression Test

Client: RRC Power & Energy, LLC.
RRC Project No.: MD1901007
Type of Specimen: Shelby Tube
Test Method: ASTM D2850
Strain Rate (%/min): 1 % / min
Project: Emerson Creek Wind Project
Test Date: 1/24/2020
Type of Test: Q-Test
Sample No.: T-58 at 12 ft

Principal Stress Difference vs. Axial Strain



Mohr Circles (Total Stress) for Peak Stress at Failure



Initial Specimen Conditions		
Confining Pressure (psi)		9.5
Avg. Diameter (in)	D_o	2.84
Avg. Height (in)	H_o	5.67
In-situ Water Content (%)	w_o	14.7
Total Unit Weight (pcf)	γ_{total}	138.7
Dry Unit Weight (pcf)	γ_{dry}	120.9
Saturation (%)	S_r	100
Void Ratio	e_o	0.39
Specific Gravity (Assumed)	G_s	2.70

Stresses at Failure	
Maximum Deviator Stress (psi)	28.5
Axial Strain at Failure (%)	15.0
Axial Strain at 50% of q_u , ε_{50} (%)	5.3
Total Stresses at Failure	
Major Principal Stress Corrected, σ_{1C} (psi)	38.0
Minor Principal Stress, σ_3 (psi)	9.5

Test Results	
Unconsolidated-Undrained Compressive Strength at Failure, $\sigma_{1C} - \sigma_3$ **(tsf)**	2.05

Note: The test specimen was nearly saturated; the Mohr-Coulomb failure envelope was taken as a horizontal straight line. Failure was taken to correspond to the deviator stress at 15 % axial strain.

Olga Vasquez, 02/04/20
Analysis & Quality Review/Date
Specimen Prepared by: T.D.

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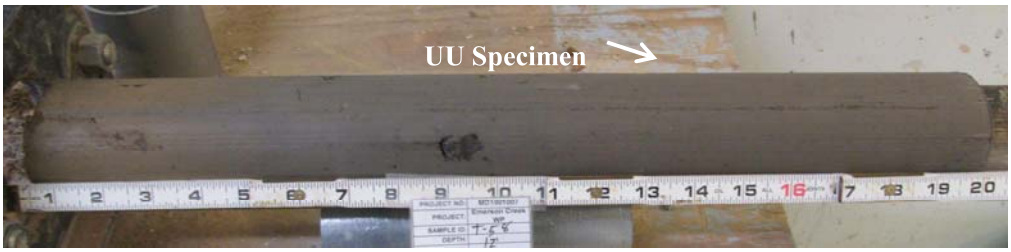
Unconsolidated-Undrained Triaxial Compression Test Appendix

Client: RRC Power & Energy, LLC.
Project: Emerson Creek Wind Project
Specimen: T-58 at 12 ft

RRC Project No.: MD1901007
Test Method: ASTM D2850
Test Date: 01/24/20



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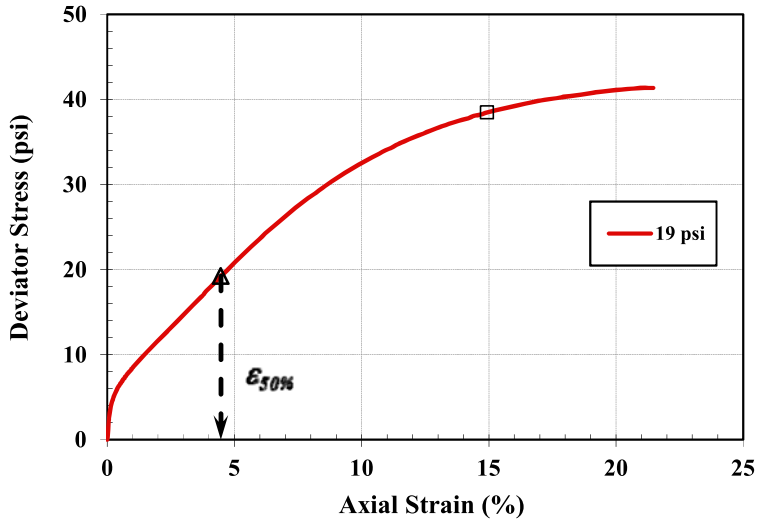
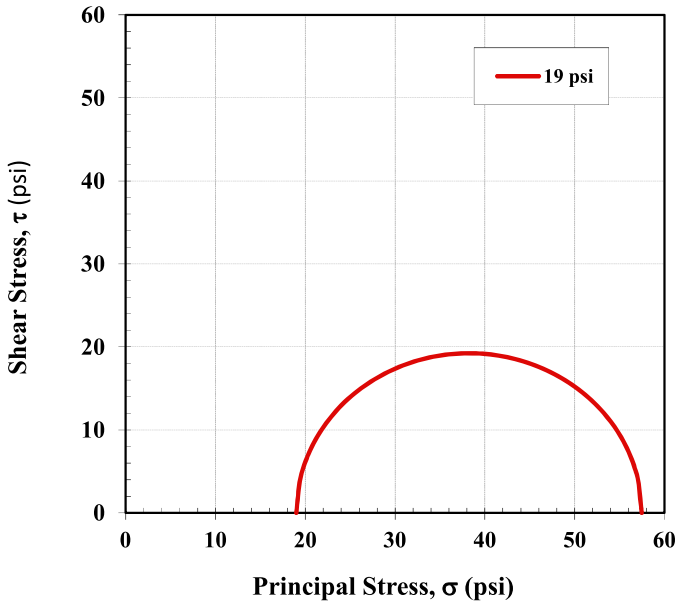
Unconsolidated-Undrained Triaxial Compression Test

Client: RRC Power & Energy, LLC.
RRC Project No.: MD1901007
Type of Specimen: Shelby Tube
Test Method: ASTM D2850
Strain Rate (%/min): 1 % / min
Project: Emerson Creek Wind Project
Test Date: 6/25/2019
Type of Test: Q-Test
Sample No.: T-66 at 24 ft

Principal Stress Difference vs. Axial Strain



Mohr Circles (Total Stress) for Peak Stress at Failure



Initial Specimen Conditions		
Confining Pressure (psi)		19.0
Avg. Diameter (in)	D_o	2.85
Avg. Height (in)	H_o	5.67
In-situ Water Content (%)	w_o	17.2
Total Unit Weight (pcf)	γ_{total}	136.7
Dry Unit Weight (pcf)	γ_{dry}	116.6
Saturation (%)	S_r	100
Void Ratio	e_o	0.45
Specific Gravity (Assumed)	G_s	2.70

Stresses at Failure	
Maximum Deviator Stress (psi)	38.5
Axial Strain at Failure (%)	14.9
Axial Strain at 50% of q_u , ε_{50} (%)	4.5
Total Stresses at Failure	
Major Principal Stress Corrected, σ_{1C} (psi)	57.5
Minor Principal Stress, σ_3 (psi)	19.0

Test Results	
Unconsolidated-Undrained Compressive Strength at Failure, $\sigma_{1C} - \sigma_3$ **(tsf)**	2.77

Note: The test specimen was nearly saturated; the Mohr-Coulomb failure envelope was taken as a horizontal straight line. Failure was taken to correspond to the deviator stress at 15 % axial strain.

Olga Vasquez, 07/22/19
Analysis & Quality Review/Date
Specimen Prepared by: T.D.

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Unconsolidated-Undrained Triaxial Compression Test Appendix

Client: RRC Power & Energy, LLC.
Project: Emerson Creek Wind Project
Specimen: T-66 at 24 ft

RRC Project No.: MD1901007
Test Method: ASTM D2850
Test Date: 06/25/19

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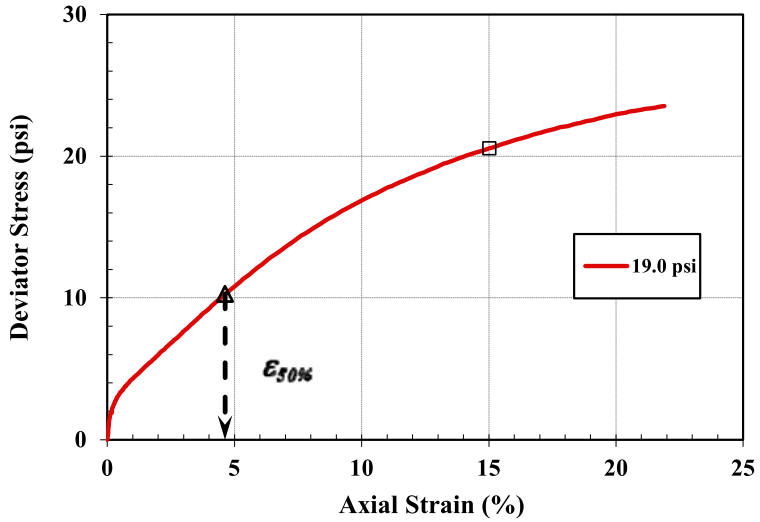
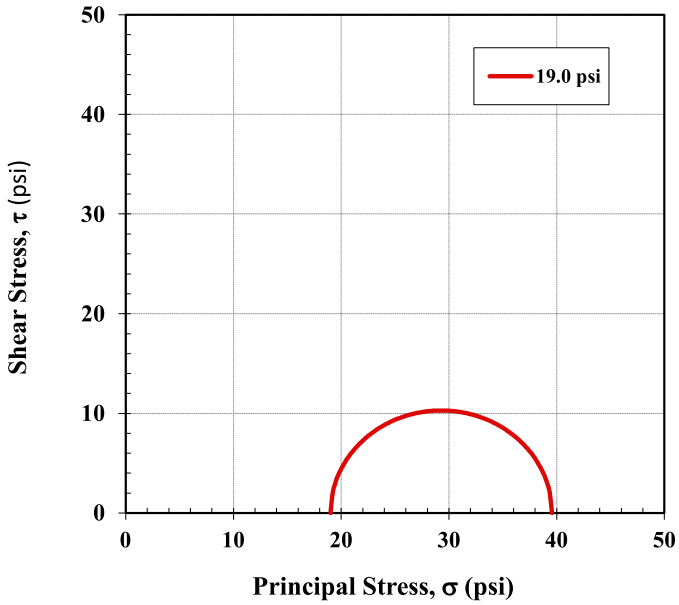
Unconsolidated-Undrained Triaxial Compression Test

Client: RRC Power & Energy, LLC.
RRC Project No.: MD1901007
Type of Specimen: Shelby Tube
Test Method: ASTM D2850
Strain Rate (%/min): 1 % / min
Project: Emerson Creek Wind Project
Test Date: 1/24/2020
Type of Test: Q-Test
Sample No.: T-82 at 24 ft

Principal Stress Difference vs. Axial Strain



Mohr Circles (Total Stress) for Peak Stress at Failure



Initial Specimen Conditions		
Confining Pressure (psi)		19.0
Avg. Diameter (in)	D_o	2.85
Avg. Height (in)	H_o	5.68
In-situ Water Content (%)	w_o	20.7
Total Unit Weight (pcf)	γ_{total}	133.2
Dry Unit Weight (pcf)	γ_{dry}	110.3
Saturation (%)	S_r	100
Void Ratio	e_o	0.53
Specific Gravity (Assumed)	G_s	2.70

Stresses at Failure	
Maximum Deviator Stress (psi)	20.6
Axial Strain at Failure (%)	15.0
Axial Strain at 50% of q_u , ε_{50} (%)	4.6
Total Stresses at Failure	
Major Principal Stress Corrected, σ_{1C} (psi)	39.6
Minor Principal Stress, σ_3 (psi)	19.0

Test Results	
Unconsolidated-Undrained Compressive Strength at Failure, $\sigma_{1C} - \sigma_3$ **(tsf)**	1.48

Note: The test specimen was nearly saturated; the Mohr-Coulomb failure envelope was taken as a horizontal straight line. Failure was taken to correspond to the deviator stress at 15 % axial strain.

Olga Vasquez, 02/04/20
Analysis & Quality Review/Date
Specimen Prepared by: T.D.

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Unconsolidated-Undrained Triaxial Compression Test Appendix

Client: RRC Power & Energy, LLC.
Project: Emerson Creek Wind Project
Specimen: T-82 at 24 ft

RRC Project No.: MD1901007
Test Method: ASTM D2850
Test Date: 01/24/20

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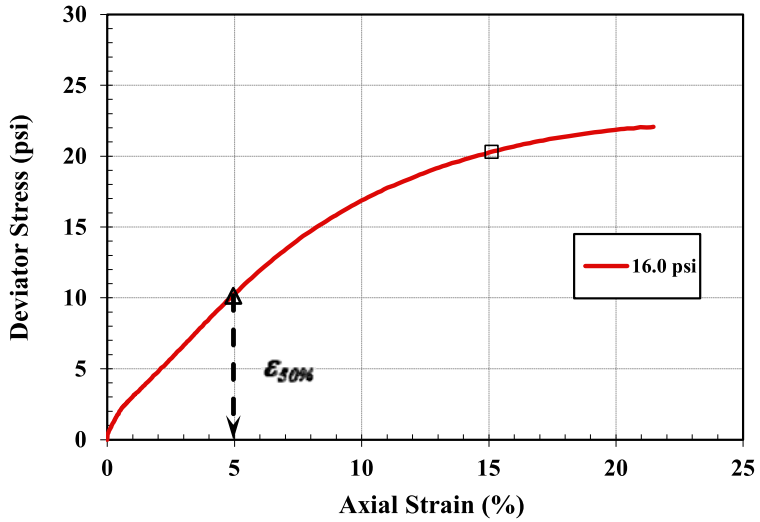
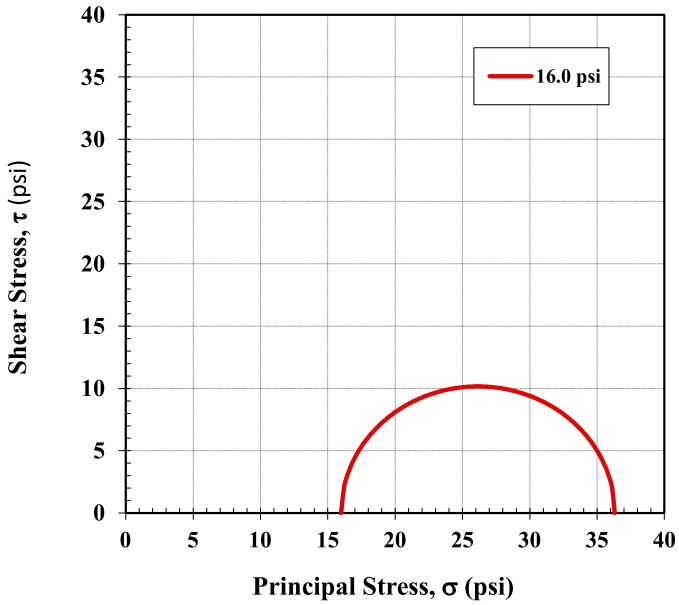
Unconsolidated-Undrained Triaxial Compression Test

Client: RRC Power & Energy, LLC.
RRC Project No.: MD1901007
Type of Specimen: Shelby Tube
Test Method: ASTM D2850
Strain Rate (%/min): 1 % / min
Project: Emerson Creek Wind Project
Test Date: 1/24/2020
Type of Test: Q-Test
Sample No.: T-83 at 21 ft

Principal Stress Difference vs. Axial Strain



Mohr Circles (Total Stress) for Peak Stress at Failure



Initial Specimen Conditions		
Confining Pressure (psi)		16.0
Avg. Diameter (in)	D_o	2.83
Avg. Height (in)	H_o	5.66
In-situ Water Content (%)	w_o	18.4
Total Unit Weight (pcf)	γ_{total}	136.1
Dry Unit Weight (pcf)	γ_{dry}	115.0
Saturation (%)	S_r	100
Void Ratio	e_o	0.47
Specific Gravity (Assumed)	G_s	2.70

Stresses at Failure	
Maximum Deviator Stress (psi)	20.3
Axial Strain at Failure (%)	15.0
Axial Strain at 50% of q_u , ε_{50} (%)	5.0
Total Stresses at Failure	
Major Principal Stress Corrected, σ_{1C} (psi)	36.3
Minor Principal Stress, σ_3 (psi)	16.0

Test Results	
Unconsolidated-Undrained Compressive Strength at Failure, $\sigma_{1C} - \sigma_3$ **(tsf)**	1.46

Note: The test specimen was nearly saturated; the Mohr-Coulomb failure envelope was taken as a horizontal straight line. Failure was taken to correspond to the deviator stress at 15 % axial strain.

Olga Vasquez, 02/04/20
Analysis & Quality Review/Date
Specimen Prepared by: T.D.

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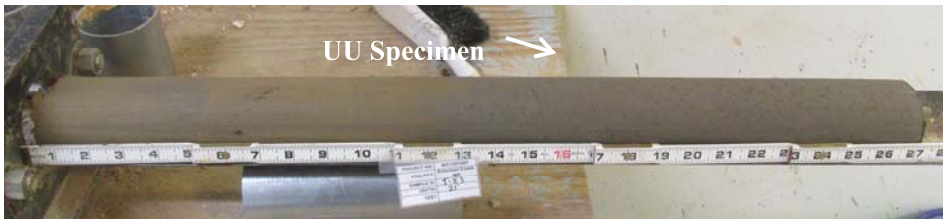
Unconsolidated-Undrained Triaxial Compression Test Appendix

Client: RRC Power & Energy, LLC.
Project: Emerson Creek Wind Project
Specimen: T-83 at 21 ft

RRC Project No.: MD1901007
Test Method: ASTM D2850
Test Date: 01/24/20



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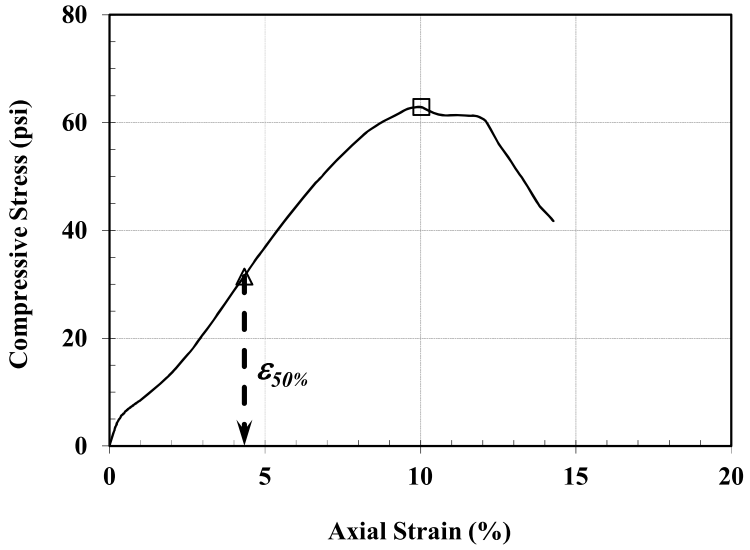
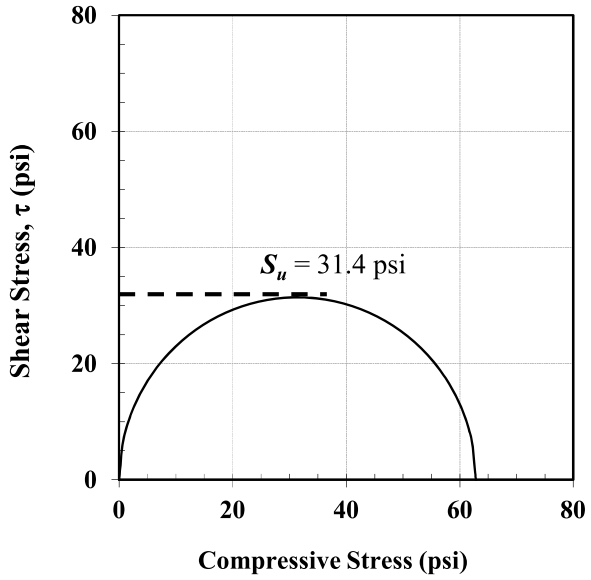
Unconfined Compression Test Report

Client: RRC Power & Energy, LLC. RRC Project No.: MD1901007 Type of Specimen: Shelby Tube
Project: Emerson Creek Wind Project Test Method: ASTM D2166 Strain Rate (%/min): 1 % / min
Sample I.D.: T-65 at 24 ft Test Date: 6/26/2019



Initial Specimen Conditions		
Avg. Diameter (in)	D_o	2.84
Avg. Height (in)	H_o	5.66
In-situ Moisture Content (%)	w_o	14.8
Total Unit Weight (pcf)	γ_{total}	138.7
Dry Unit Weight (pcf)	γ_{dry}	120.8
Saturation (%)	S_r	100
Void Ratio	e_o	0.40
Specific Gravity (Assumed)	G_s	2.70

Mohr Circles for Peak Stress at Failure



Stresses at Failure	
Unconfined Compressive Strength, q_u (psi)	62.8
Axial Strain at Failure (%)	10.0
Axial Strain at 50 % of q_u (%)	4.3
Total Stresses at Failure	
Major Principal Stress, σ_1 (psi)	62.8
Minor Principal Stress, σ_3 (psi)	0
Undrained Shear Strength, S_u (tsf)	2.26

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Olga Vasquez, 07/22/19
Quality Review/Date
Specimen prepared & tested by: T.D.

Beyond Engineering & Testing, LLC
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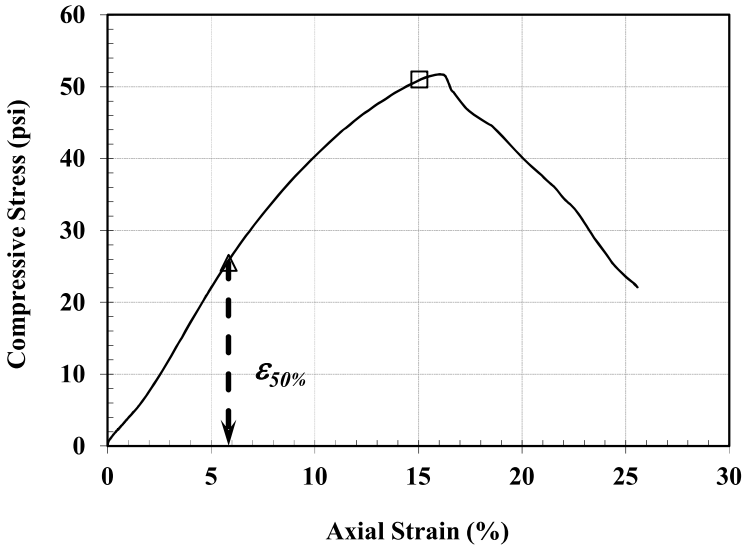
Unconfined Compression Test Report

Client: RRC Power & Energy, LLC.
Project: Emerson Creek Wind Project
Sample I.D.: T-70 at 34 ft

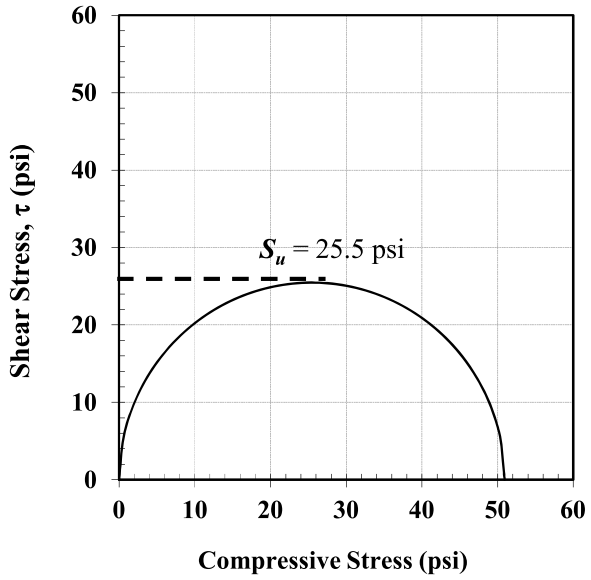
RRC Project No.: MD1901007
Test Method: ASTM D2166
Test Date: 6/26/2019

Type of Specimen: Shelby Tube
Strain Rate (%/min): 1 % / min



Initial Specimen Conditions		
Avg. Diameter (in)	D_o	2.84
Avg. Height (in)	H_o	5.67
In-situ Moisture Content (%)	w_o	15.4
Total Unit Weight (pcf)	γ_{total}	139.3
Dry Unit Weight (pcf)	γ_{dry}	120.7
Saturation (%)	S_r	100
Void Ratio	e_o	0.40
Specific Gravity (Assumed)	G_s	2.70

Mohr Circles for Peak Stress at Failure



Stresses at Failure	
Unconfined Compressive Strength, q_u (psi)	50.9
Axial Strain at Failure (%)	15.1
Axial Strain at 50 % of q_u (%)	5.8
Total Stresses at Failure	
Major Principal Stress, σ_1 (psi)	50.9
Minor Principal Stress, σ_3 (psi)	0
Undrained Shear Strength, S_u (tsf)	1.83

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whenever is obtained first.

Olga Vasquez, 07/22/19
Quality Review/Date
Specimen prepared & tested by: T.D.

Beyond Engineering & Testing, LLC
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Uniaxial Compressive Strength Test Report

Client: RRC Power & Energy, LLC. BET Project No.: MD1901007 Type of Specimen: Intact Rock Core
Project: Emerson Creek Wind Project Test Method: ASTM D7012, Method D Deformation Rate: 0.5 % / min
Sample I.D.: T-01 at 8 ft Test Date: 7/8/2019

Initial Specimen Conditions		
Avg. Diameter (in)	D_o	1.78
Avg. Height (in)	H_o	4.09
In-situ Water Content (%)	w_o	- -
Total Unit Weight (pcf)	γ_{total}	168.4
Dry Unit Weight (pcf)	γ_{dry}	- -

Stresses at Failure	
Uniaxial Compressive Strength, σ_u (psi)	14790.0
Axial Strain at Failure (%)	--
Axial Strain at 50% of σ_u (%)	--

Olga Vasquez, 07/23/19
Quality Review/Date
Specimen prepared & tested by: J.R.

Beyond Engineering & Testing, LLC
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Uniaxial Compressive Strength Test Report

Client: RRC Power & Energy, LLC. BET Project No.: MD1901007 Type of Specimen: Intact Rock Core
Project: Emerson Creek Wind Project Test Method: ASTM D7012, Method D Deformation Rate: 0.5 % / min
Sample I.D.: T-07 at 17 ft Test Date: 7/8/2019

Initial Specimen Conditions		
Avg. Diameter (in)	D_o	1.78
Avg. Height (in)	H_o	4.09
In-situ Water Content (%)	w_o	- -
Total Unit Weight (pcf)	γ_{total}	165.3
Dry Unit Weight (pcf)	γ_{dry}	- -

Stresses at Failure	
Uniaxial Compressive Strength, σ_u (psi)	15260.0
Axial Strain at Failure (%)	--
Axial Strain at 50% of σ_u (%)	--

Olga Vasquez, 07/23/19
Quality Review/Date
Specimen prepared & tested by: J.R.

Beyond Engineering & Testing, LLC
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Uniaxial Compressive Strength Test Report

Client: RRC Power & Energy, LLC. BET Project No.: MD1901007 Type of Specimen: Intact Rock Core

Project: Emerson Creek Wind Project Test Method: ASTM D7012, Method D Deformation Rate: 0.5 % / min

Sample I.D.: T-20B at 15 ft Test Date: 7/8/2019

Initial Specimen Conditions		
Avg. Diameter (in)	D_o	1.76
Avg. Height (in)	H_o	4.11
In-situ Water Content (%)	w_o	- -
Total Unit Weight (pcf)	γ_{total}	165.7
Dry Unit Weight (pcf)	γ_{dry}	- -

Stresses at Failure	
Uniaxial Compressive Strength, σ_u (psi)	12820.0
Axial Strain at Failure (%)	--
Axial Strain at 50% of σ_u (%)	--

Olga Vasquez, 07/23/19
Quality Review/Date

Specimen prepared & tested by: J.R.

Beyond Engineering & Testing, LLC
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Uniaxial Compressive Strength Test Report

Client: RRC Power & Energy, LLC. BET Project No.: MD1901007 Type of Specimen: Intact Rock Core
Project: Emerson Creek Wind Project Test Method: ASTM D7012, Method D Deformation Rate: 0.5 % / min
Sample I.D.: T-30 at 21 ft Test Date: 7/8/2019

Initial Specimen Conditions		
Avg. Diameter (in)	D_o	1.84
Avg. Height (in)	H_o	4.15
In-situ Water Content (%)	w_o	- -
Total Unit Weight (pcf)	γ_{total}	163.0
Dry Unit Weight (pcf)	γ_{dry}	- -

Stresses at Failure	
Uniaxial Compressive Strength, σ_u (psi)	4960.0
Axial Strain at Failure (%)	--
Axial Strain at 50% of σ_u (%)	--

Olga Vasquez, 07/23/19
Quality Review/Date
Specimen prepared & tested by: J.R.

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Uniaxial Compressive Strength Test Report

Client: RRC Power & Energy, LLC. BET Project No.: MD1901007 Type of Specimen: Intact Rock Core
Project: Emerson Creek Wind Project Test Method: ASTM D7012, Method D Deformation Rate: 0.5 % / min
Sample I.D.: T-34 at 12.5 ft Test Date: 7/8/2019

Initial Specimen Conditions		
Avg. Diameter (in)	D_o	1.79
Avg. Height (in)	H_o	4.09
In-situ Water Content (%)	w_o	- -
Total Unit Weight (pcf)	γ_{total}	164.3
Dry Unit Weight (pcf)	γ_{dry}	- -

Stresses at Failure	
Uniaxial Compressive Strength, σ_u (psi)	11790.0
Axial Strain at Failure (%)	--
Axial Strain at 50% of σ_u (%)	--

Olga Vasquez, 07/23/19
Quality Review/Date
Specimen prepared & tested by: J.R.

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Uniaxial Compressive Strength Test Report

Client: RRC Power & Energy, LLC. BET Project No.: MD1901007 Type of Specimen: Intact Rock Core
Project: Emerson Creek Wind Project Test Method: ASTM D7012, Method D Deformation Rate: 0.5 % / min
Sample I.D.: T-36 at 16 ft Test Date: 7/8/2019

Initial Specimen Conditions		
Avg. Diameter (in)	D_o	1.87
Avg. Height (in)	H_o	4.08
In-situ Water Content (%)	w_o	- -
Total Unit Weight (pcf)	γ_{total}	148.2
Dry Unit Weight (pcf)	γ_{dry}	- -

Stresses at Failure	
Uniaxial Compressive Strength, σ_u (psi)	12800.0
Axial Strain at Failure (%)	--
Axial Strain at 50% of σ_u (%)	--

Olga Vasquez, 07/23/19
Quality Review/Date
Specimen prepared & tested by: J.R.

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Uniaxial Compressive Strength Test Report

Client: RRC Power & Energy, LLC. BET Project No.: MD1901007 Type of Specimen: Intact Rock Core
Project: Emerson Creek Wind Project Test Method: ASTM D7012, Method D Deformation Rate: 0.5 % / min
Sample I.D.: T-43 at 16 ft Test Date: 7/8/2019

Initial Specimen Conditions		
Avg. Diameter (in)	D_o	1.87
Avg. Height (in)	H_o	4.09
In-situ Water Content (%)	w_o	- -
Total Unit Weight (pcf)	γ_{total}	174.7
Dry Unit Weight (pcf)	γ_{dry}	- -

Stresses at Failure	
Uniaxial Compressive Strength, σ_u (psi)	15170.0
Axial Strain at Failure (%)	--
Axial Strain at 50% of σ_u (%)	--

Olga Vasquez, 07/23/19
Quality Review/Date
Specimen prepared & tested by: J.R.

Beyond Engineering & Testing, LLC
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Uniaxial Compressive Strength Test Report

Client: RRC Power & Energy, LLC. BET Project No.: MD1901007 Type of Specimen: Intact Rock Core
Project: Emerson Creek Wind Project Test Method: ASTM D7012, Method D Deformation Rate: 0.5 % / min
Sample I.D.: T-45B at 29 ft Test Date: 7/8/2019

Initial Specimen Conditions		
Avg. Diameter (in)	D_o	1.77
Avg. Height (in)	H_o	4.14
In-situ Water Content (%)	w_o	- -
Total Unit Weight (pcf)	γ_{total}	153.7
Dry Unit Weight (pcf)	γ_{dry}	- -

Stresses at Failure	
Uniaxial Compressive Strength, σ_u (psi)	10200.0
Axial Strain at Failure (%)	--
Axial Strain at 50% of σ_u (%)	--

Olga Vasquez, 07/23/19
Quality Review/Date
Specimen prepared & tested by: J.R.

Beyond Engineering & Testing, LLC
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Uniaxial Compressive Strength Test Report

Client: RRC Power & Energy, LLC. BET Project No.: MD1901007 Type of Specimen: Intact Rock Core
Project: Emerson Creek Wind Project Test Method: ASTM D7012, Method D Deformation Rate: 0.5 % / min
Sample I.D.: T-75 at 13 ft Test Date: 7/8/2019

Initial Specimen Conditions		
Avg. Diameter (in)	D_o	1.81
Avg. Height (in)	H_o	4.12
In-situ Water Content (%)	w_o	- -
Total Unit Weight (pcf)	γ_{total}	182.7
Dry Unit Weight (pcf)	γ_{dry}	- -

Stresses at Failure	
Uniaxial Compressive Strength, σ_u (psi)	22400.0
Axial Strain at Failure (%)	--
Axial Strain at 50% of σ_u (%)	--

Olga Vasquez, 07/23/19
Quality Review/Date
Specimen prepared & tested by: J.R.

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Uniaxial Compressive Strength Test Report

Client: RRC Power & Energy, LLC. BET Project No.: MD1901007 Type of Specimen: Intact Rock Core
Project: Emerson Creek Wind Project Test Method: ASTM D7012, Method D Deformation Rate: 0.5 % / min
Sample I.D.: T-87 at 12.5 ft Test Date: 7/8/2019

Initial Specimen Conditions		
Avg. Diameter (in)	D_o	1.78
Avg. Height (in)	H_o	4.14
In-situ Water Content (%)	w_o	- -
Total Unit Weight (pcf)	γ_{total}	168.3
Dry Unit Weight (pcf)	γ_{dry}	- -

Stresses at Failure	
Uniaxial Compressive Strength, σ_u (psi)	10890.0
Axial Strain at Failure (%)	--
Axial Strain at 50% of σ_u (%)	--

Olga Vasquez, 07/23/19
Quality Review/Date
Specimen prepared & tested by: J.R.

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One-Dimensional Consolidation Properties of Soil

Client: RRC Power & Energy, LLC.
Project: Emerson Creek Wind Project
Specimen: T-66 at 24 ft

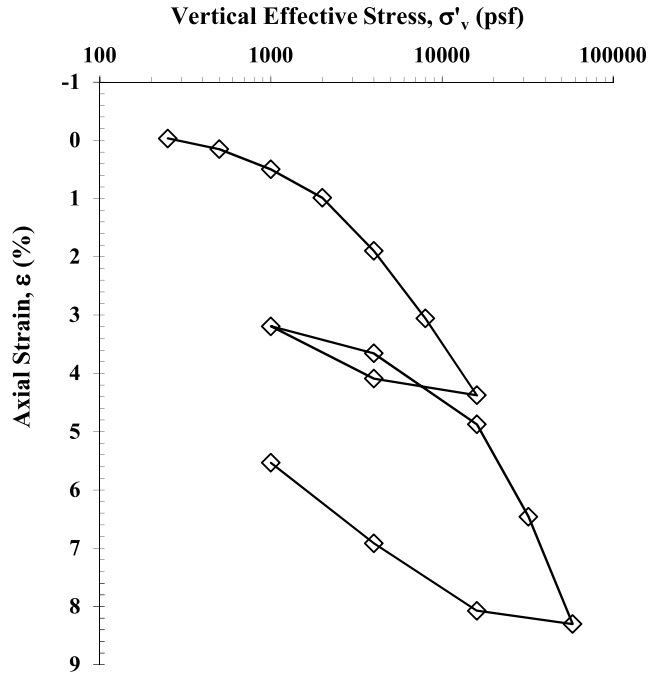
Beyond Project No.: MD1901007
Test Method: ASTM D2435, Method A
Test Date: 06/20/19

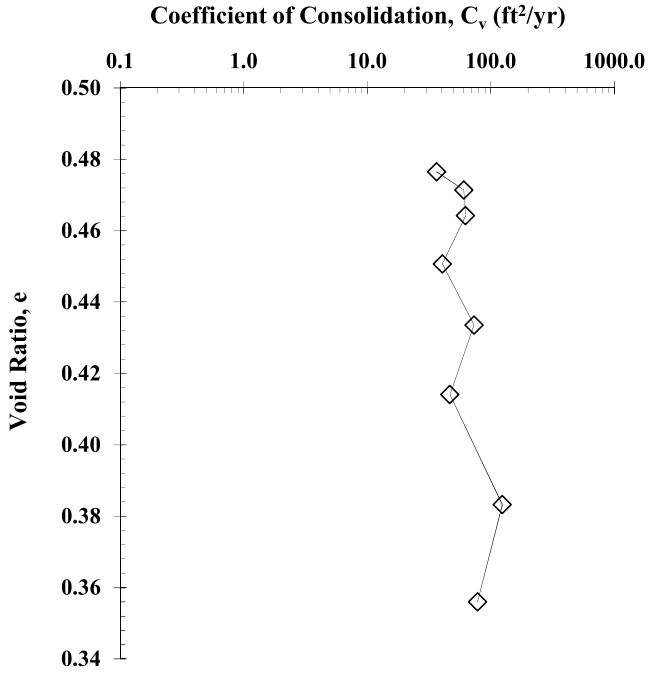
Soil Specimen Properties	
Initial Specimen Water Content (%)	17.9
Final Specimen Water Content (%)	16.5
Initial Specimen Height (in)	0.902
Final Specimen Height (in)	0.853
Initial Dry Unit Weight, γ_o (pcf)	113.1
Final Dry Unit Weight, γ_f (pcf)	119.5
Initial Void Ratio, e_o	0.479
Final Void Ratio, e_f	0.398
Initial Degree of Saturation (%)	100
Preconsolidation Pressure, p'_c (psf)	4200
Seating Load (psf)	250

Specimen was trimmed using a trimming turntable.
Specimen was inundated with tap water during testing.
Coefficient of Consolidation was determined using the Log Time Method. Loading increment duration was 24 hours. The calculation was included the machine deflections that measured in each loading steps. G_s assumed to be 2.68.

Preconsolidation pressure was determined by using the Casagrande construction technique.
Compression Index, C_c & Recompression Index, C_r calculated in accordance with void ratio (Δe).

Specimen Diameter: 2.497 inches





σ'_v (psf)	250	500	1000	2000	4000	8000	16000	4000	1000	4000	16000
C_v (ft²/yr)	- -	36.49	60.49	62.59	40.55	73.14	46.71	- -	- -	64.90	148.80
Axial Strain (%)	-0.03	0.15	0.50	0.99	1.90	3.06	4.37	4.09	3.19	3.66	4.88
e	0.479	0.477	0.471	0.464	0.451	0.434	0.414	0.418	0.432	0.425	0.407

σ'_v (psf)	32000	58000	16000	4000	1000
C_v (ft²/yr)	123.83	78.34	- -	- -	- -
Axial Strain (%)	6.46	8.30	8.07	6.92	5.53
e	0.383	0.356	0.359	0.376	0.397

Compression Index, C_c 0.103
Recompression Index, C_r (1st Rebound) 0.015
Recompression Index, C_r (2nd Rebound) 0.023

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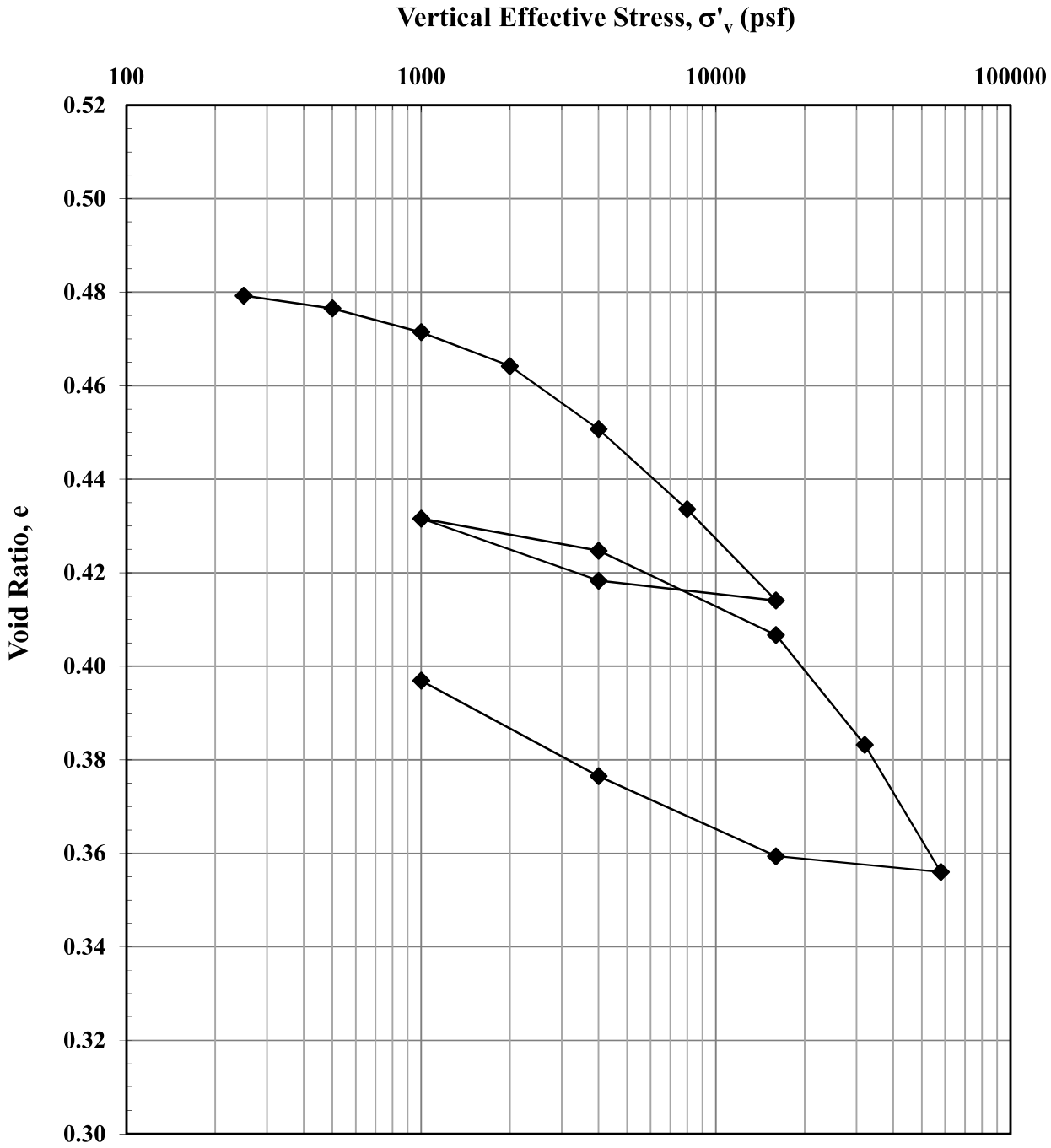
Beyond Project No.: MD1901007
Test Method: ASTM D2435, Method A
Test Date: 06/20/19



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Test Method: ASTM D2435, Method A
Test Date: 06/20/19

Cheng-Wei Chen, Ph.D. 07/11/19
Quality Review/Date

Sample Prepared by: T.D.

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Specimen: T-66 at 24 ft

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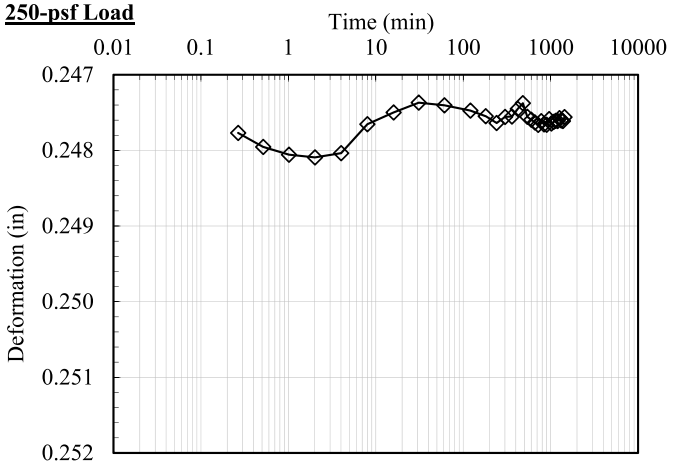
Test Date: 06/20/19

250-psf Load



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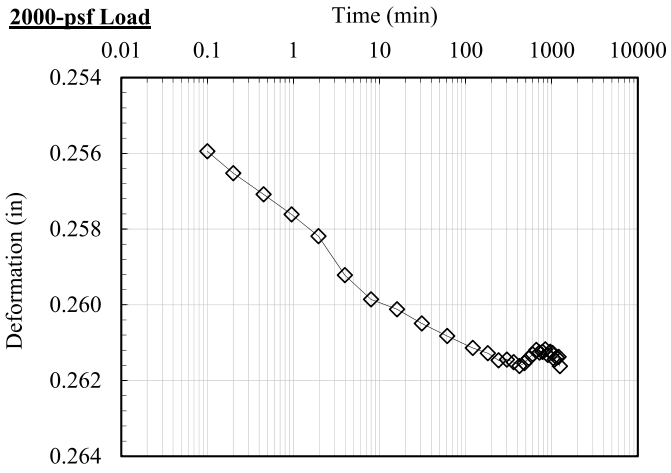

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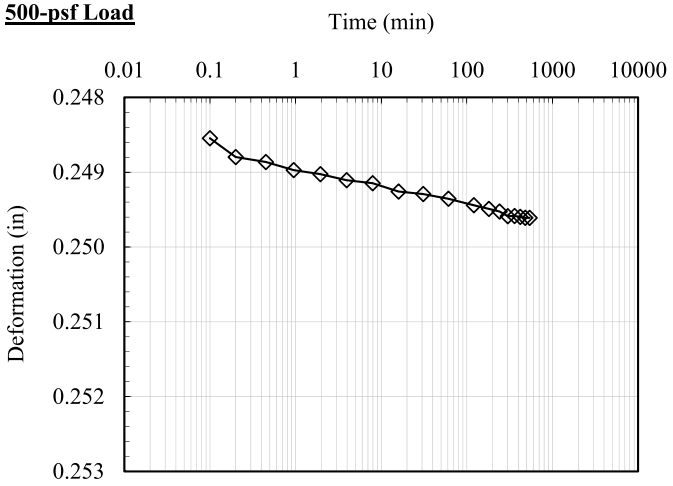

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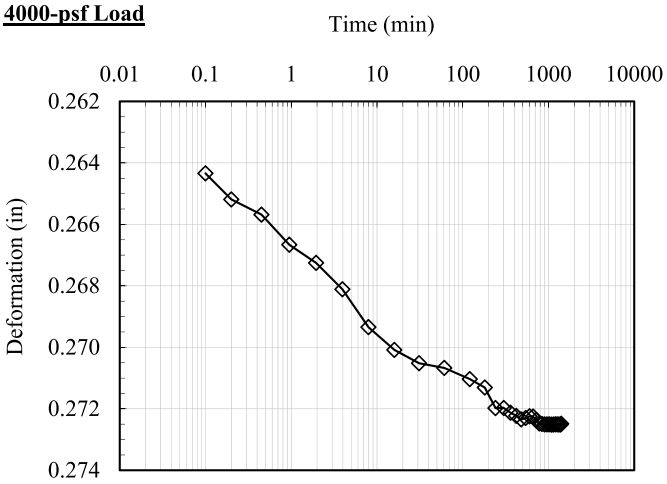

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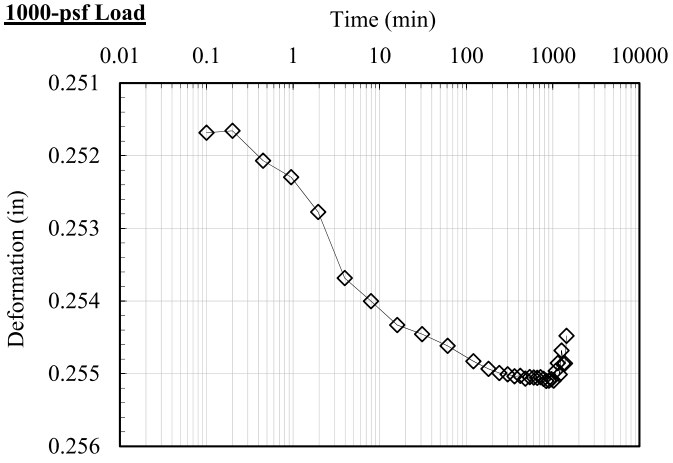

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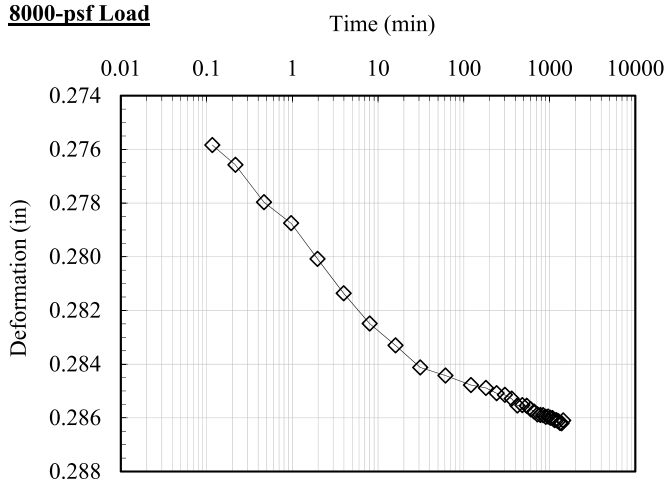

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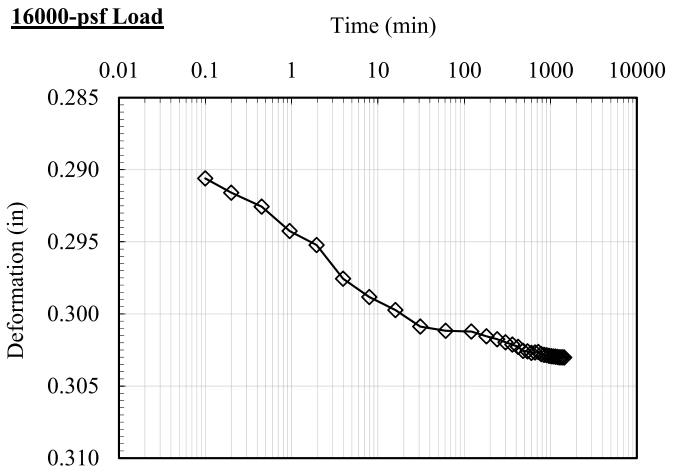
Test Method: ASTM D2435, Method A
Test Date: 06/20/19

16000-psf Load



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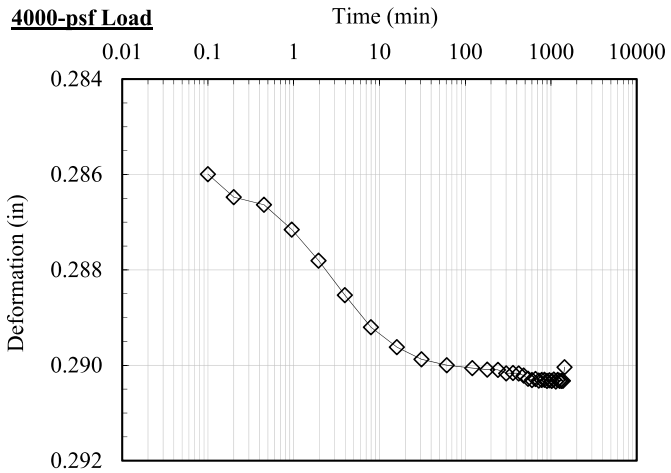

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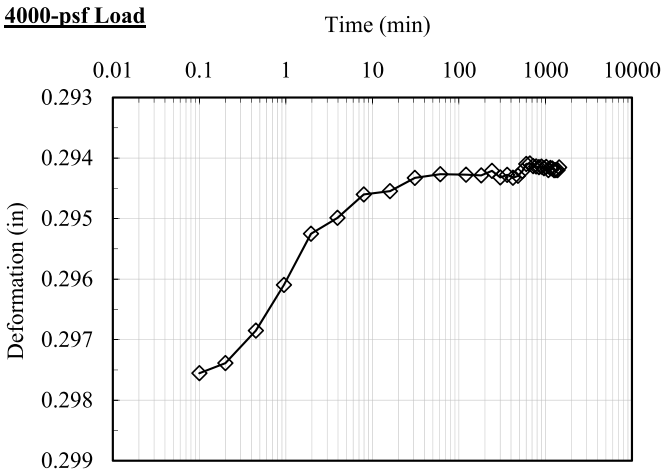

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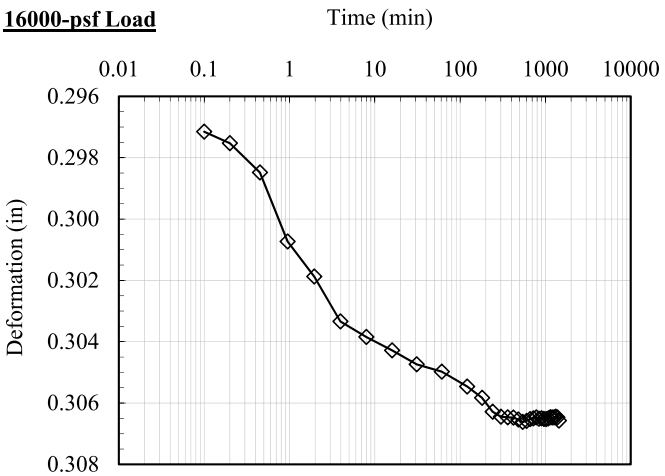

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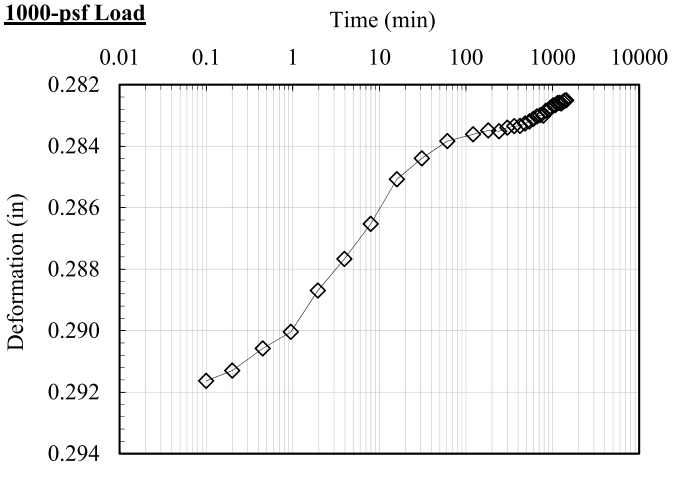

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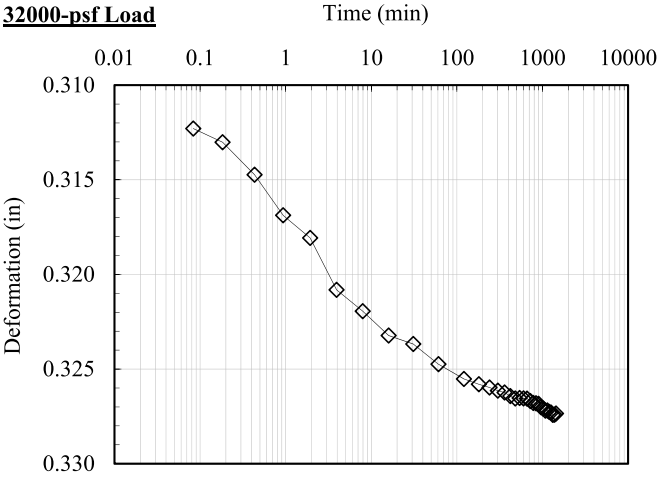

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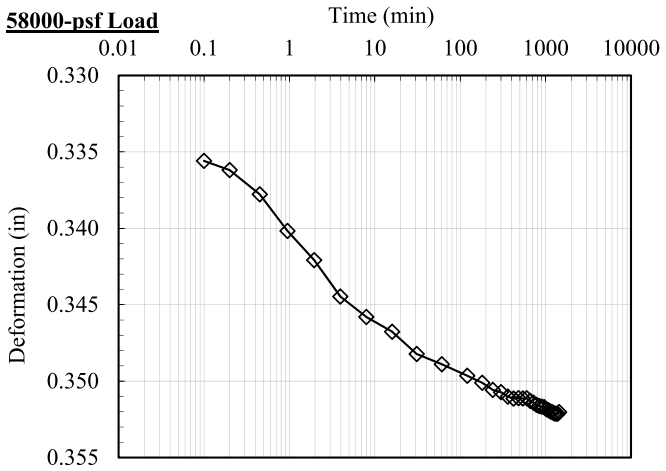
Test Method: ASTM D2435, Method A
Test Date: 06/20/19

58000-psf Load



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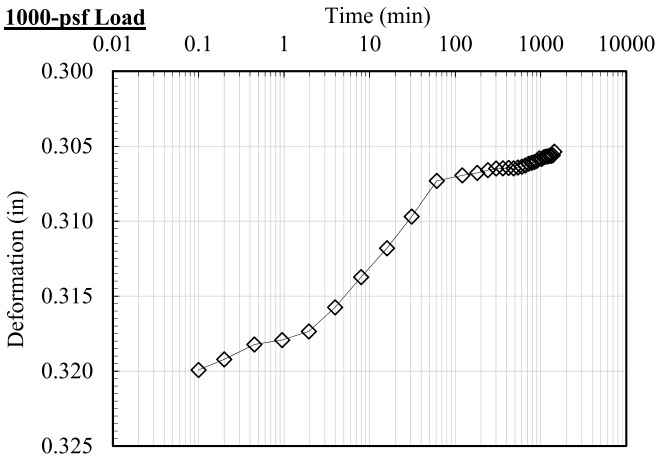

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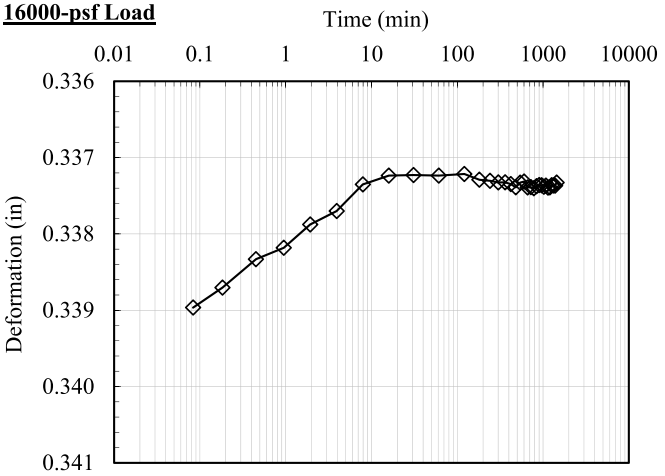

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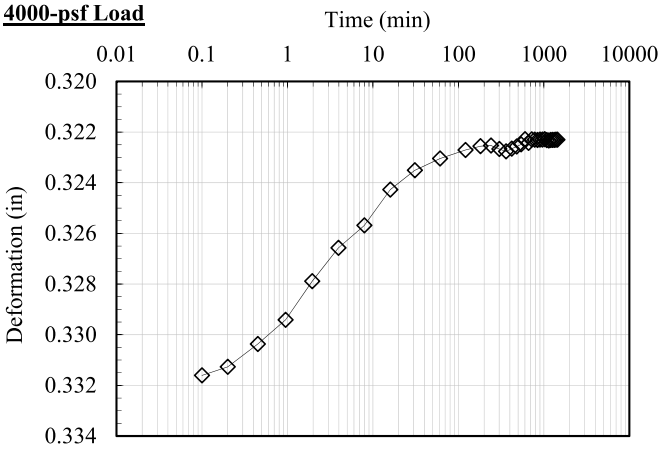

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One-Dimensional Consolidation Properties of Soil

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Specimen: T-82 at 24 ft

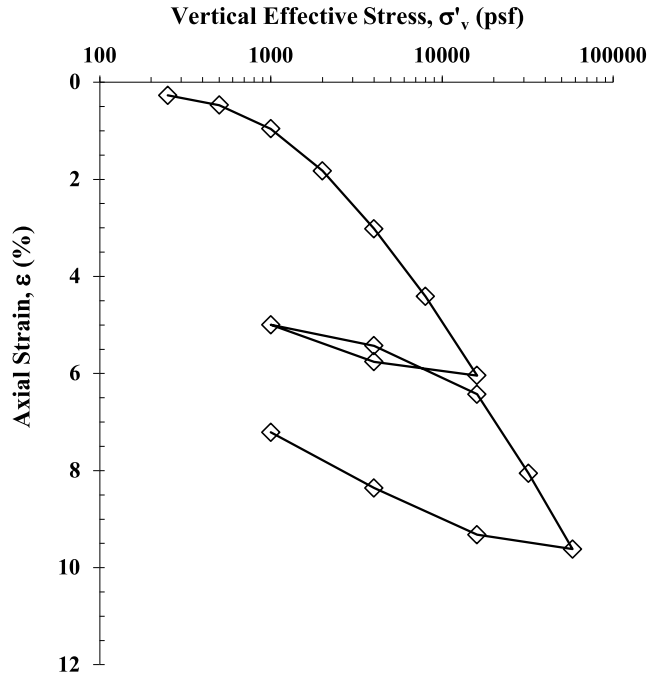
Beyond Project No.: MD1901007
Test Method: ASTM D2435, Method A
Test Date: 01/24/20

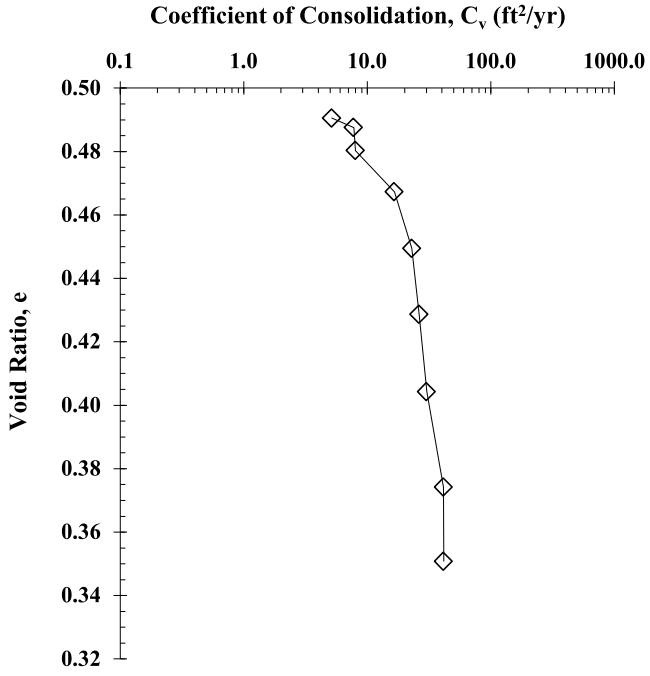
Soil Specimen Properties	
Initial Specimen Water Content (%)	18.0
Final Specimen Water Content (%)	14.6
Initial Specimen Height (in)	0.897
Final Specimen Height (in)	0.832
Initial Dry Unit Weight, γ_o (pcf)	111.9
Final Dry Unit Weight, γ_f (pcf)	120.6
Initial Void Ratio, e_o	0.495
Final Void Ratio, e_f	0.388
Initial Degree of Saturation (%)	97.4
Preconsolidation Pressure, p'_c (psf)	2300
Seating Load (psf)	250

Specimen was trimmed using a trimming turntable.
Specimen was inundated with tap water during testing.
Coefficient of Consolidation was determined using the Log Time Method. Loading increment duration was 24 hours. The calculation was included the machine deflections that measured in each loading steps. G_s assumed to be 2.68.

Preconsolidation pressure was determined by using the Casagrande construction technique.
Compression Index, C_c & Recompression Index, C_r calculated in accordance with void ratio (Δe).

Specimen Diameter: 2.499 inches





σ'_v (psf)	250	500	1000	2000	4000	8000	16000	4000	1000	4000	16000
C_v (ft²/yr)	5.15	7.75	8.00	16.53	22.93	26.27	30.18	- -	- -	36.06	125.37
Axial Strain (%)	0.27	0.47	0.96	1.83	3.02	4.41	6.04	5.76	5.00	5.43	6.43
e	0.491	0.488	0.480	0.467	0.449	0.429	0.404	0.409	0.420	0.413	0.399

σ'_v (psf)	32000	58000	16000	4000	1000
C_v (ft²/yr)	41.44	41.41	- -	- -	- -
Axial Strain (%)	8.06	9.62	9.32	8.36	7.21
e	0.374	0.351	0.355	0.370	0.387

Compression Index, C_c 0.097
Recompression Index, C_r (1st Rebound) 0.013
Recompression Index, C_r (2nd Rebound) 0.020

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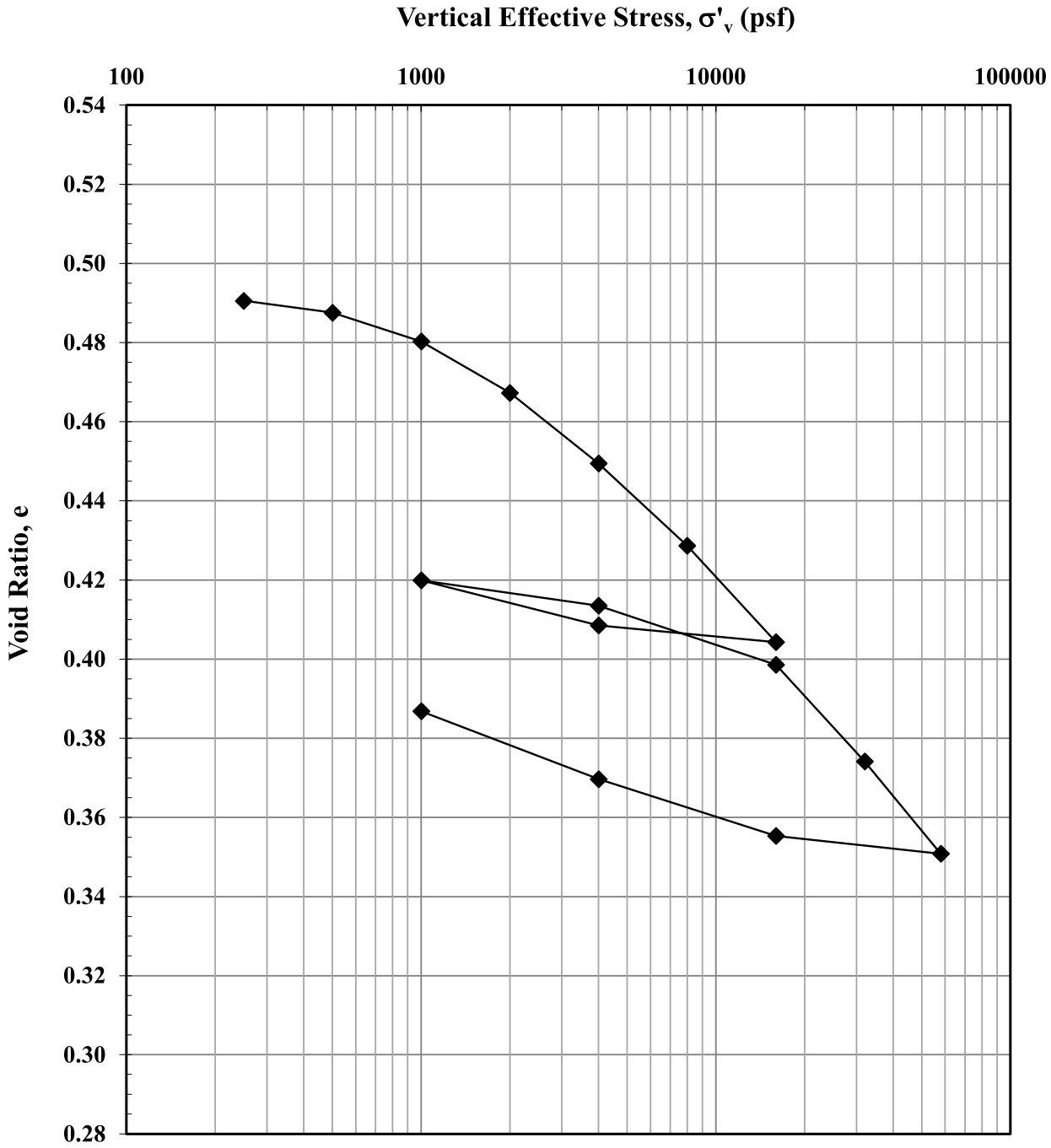
Test Date: 01/24/20



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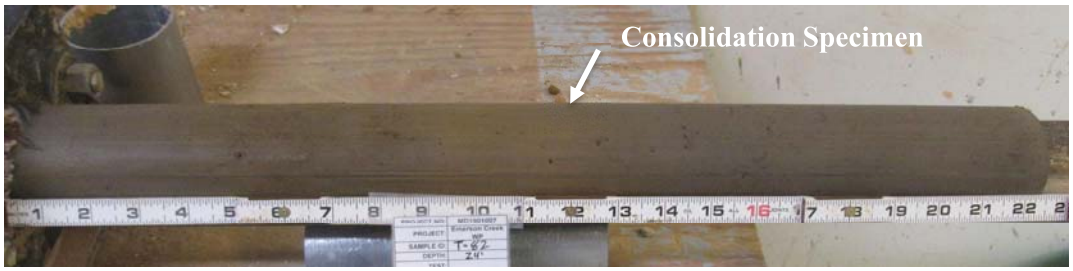

Cheng-Wei Chen, Ph.D. 02/19/20
Quality Review/Date

Sample Prepared by: T.D.

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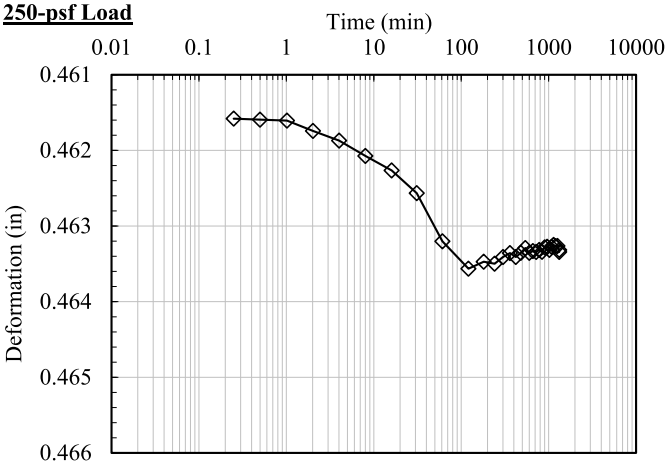
250-psf Load



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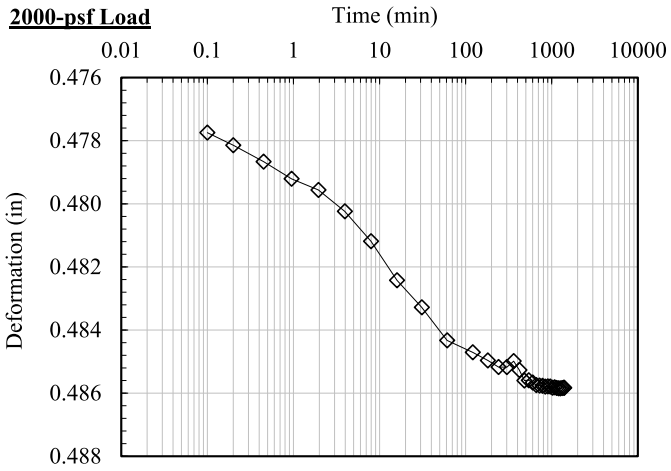

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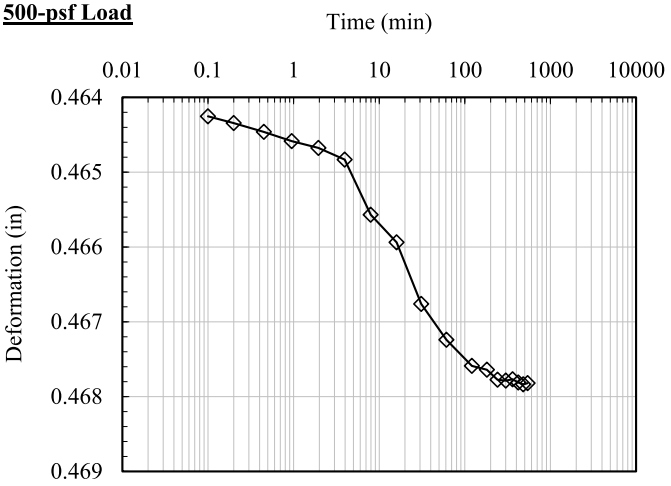

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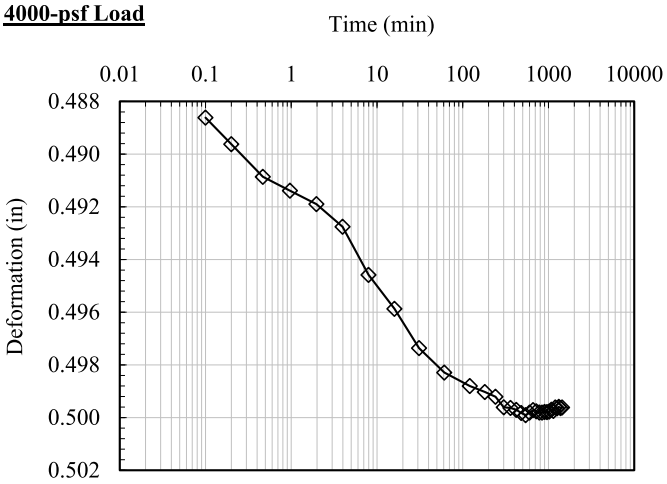

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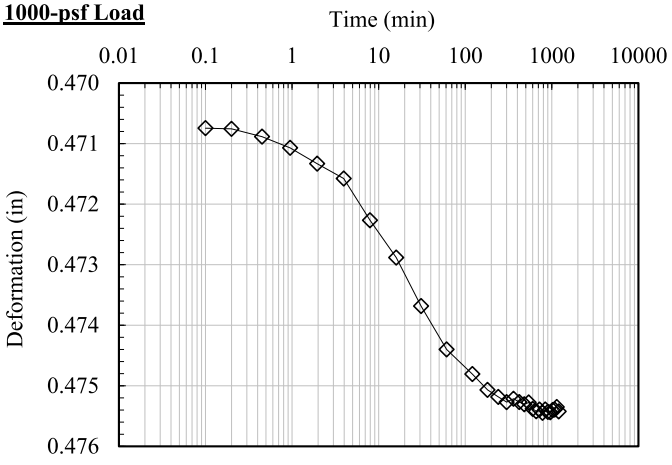

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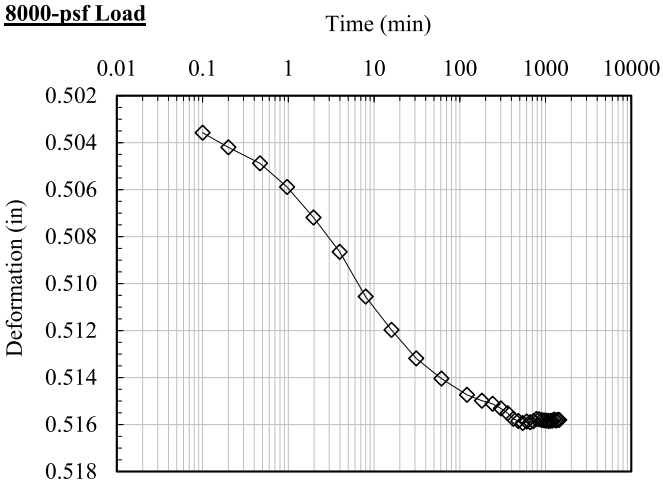

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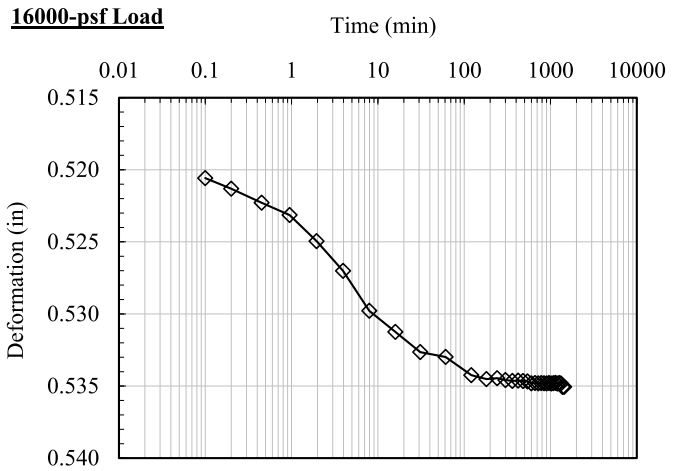
16000-psf Load



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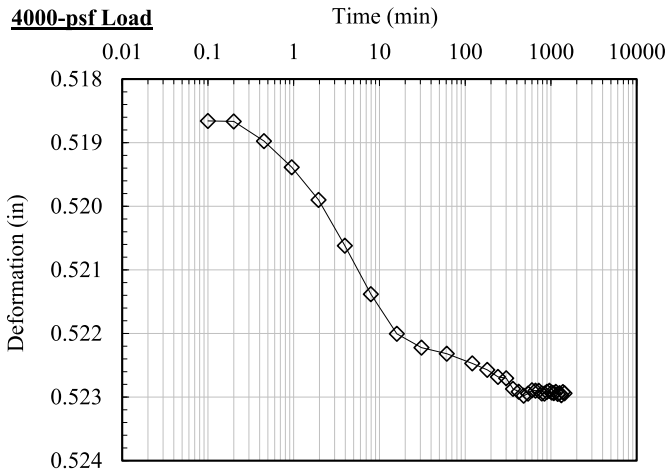

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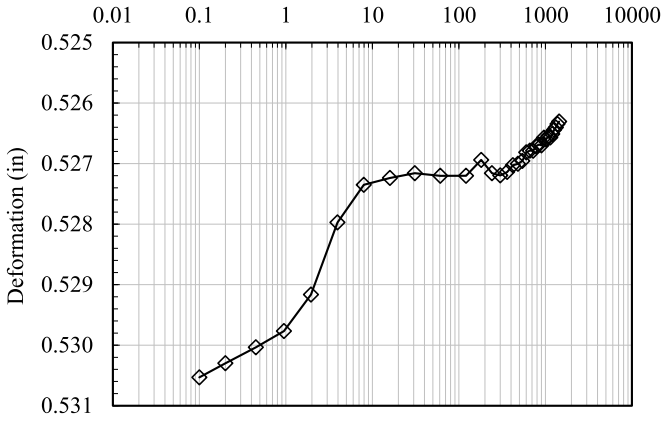

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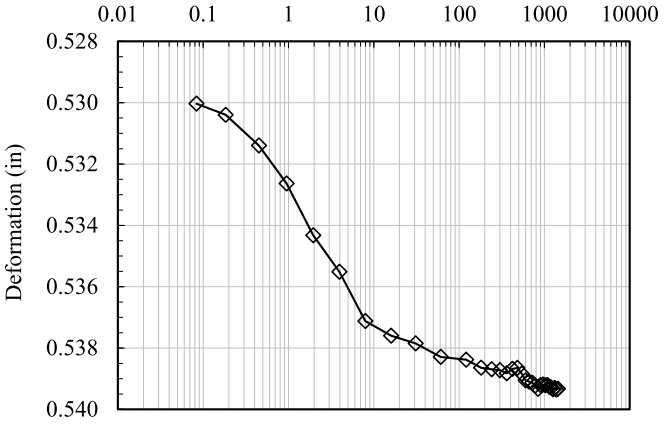

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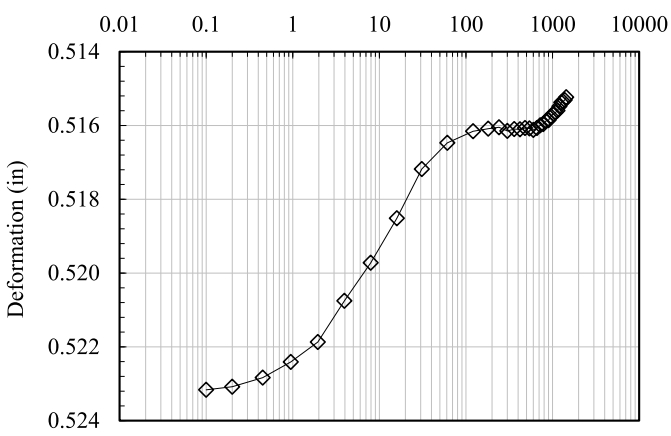

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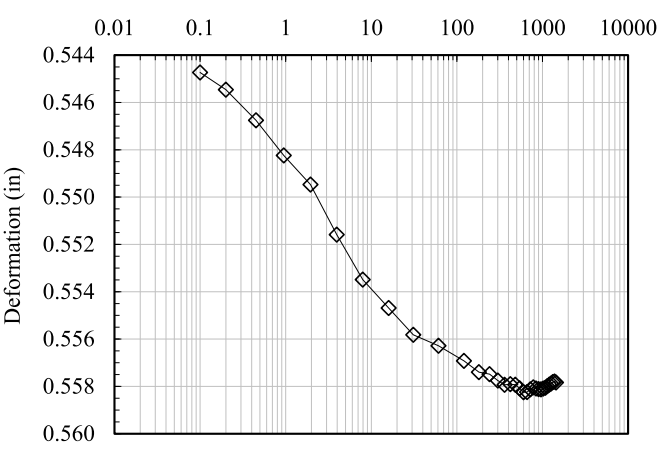

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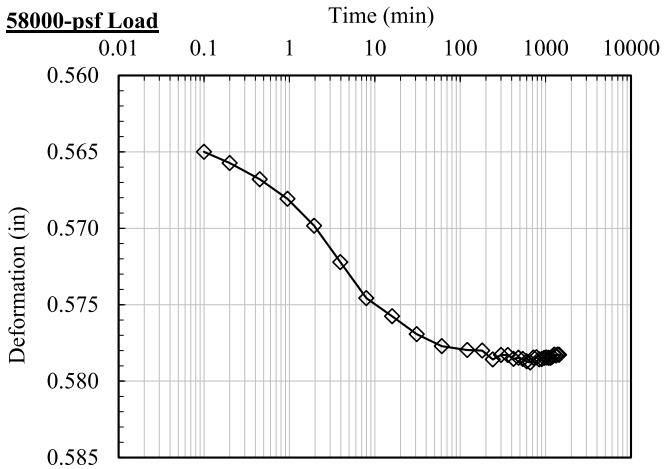

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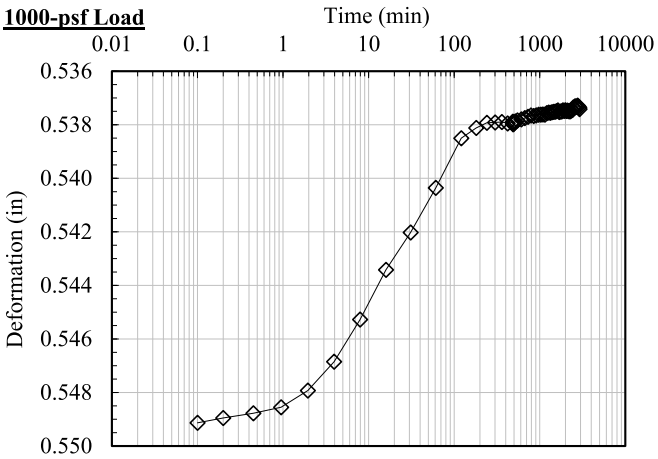

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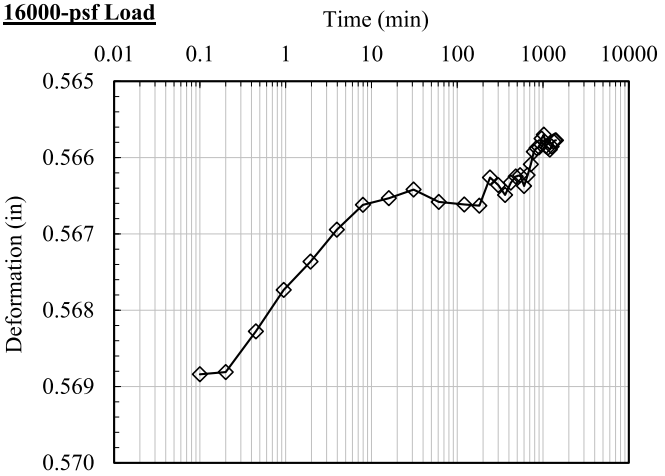
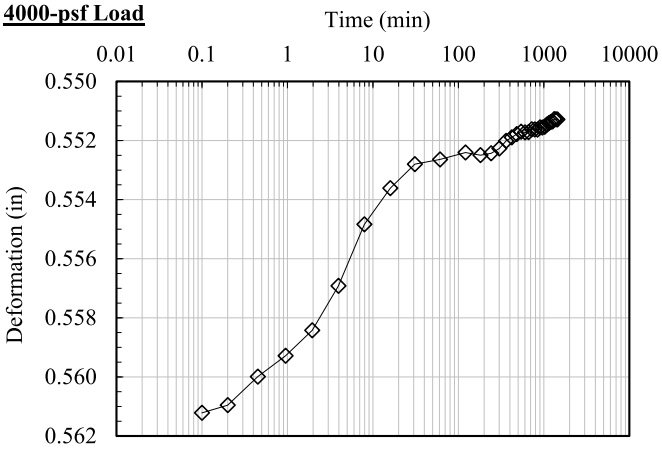


4000-psf Load



Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

Minimum Soil Resistivity

Client: RRC Power & Energy, LLC
Project: Emerson Creek Wind Project
Project No.: MD1901007
Sample ID: T-06 at 1 ft.

Test Method: ASTM G187
Test Date: 06/25/19
Resistivity Meter: Humboldt, H-4385
Calibrated Date: 8/20/2018
Multiplication Factor: 1.0

Distilled Water Added (mL)	Measured Resistance (ohms)
20	6460
40	1830
60	2110
80	2300

Minimum Resistivity: 1830 ohm-cm

pH of Soil for Use in Corrosion Testing

As-received conditions: 7.52
Temp: 25.0 °C

Test Method: ASTM G51
pH Meter: Hanna Instruments No. 99121

Tamika Vasquez, 07/1/19
Quality Review/Date
Tested by: E.P.

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

Minimum Soil Resistivity

Client: RRC Power & Energy, LLC
Project: Emerson Creek Wind Project
Project No.: MD1901007
Sample ID: T-26 at 1 ft.

Test Method: ASTM G187
Test Date: 06/25/19
Resistivity Meter: Humboldt, H-4385
Calibrated Date: 8/20/2018
Multiplication Factor: 1.0

Distilled Water Added (mL)	Measured Resistance (ohms)
20	5410
40	1480
60	1560
80	1760

Minimum Resistivity: 1480 ohm-cm

pH of Soil for Use in Corrosion Testing

As-received conditions: 7.43
Temp: 24.5 °C

Test Method: ASTM G51
pH Meter: Hanna Instruments No. 99121

Tamika Vasquez, 06/27/19
Quality Review/Date
Tested by: E.P.

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

Minimum Soil Resistivity

Client: RRC Power & Energy, LLC
Project: Emerson Creek Wind Project
Project No.: MD1901007
Sample ID: T-45A at 4 ft.

Test Method: ASTM G187
Test Date: 06/25/19
Resistivity Meter: Humboldt, H-4385
Calibrated Date: 8/20/2018
Multiplication Factor: 1.0

Distilled Water Added (mL)	Measured Resistance (ohms)
20	7180
40	2290
60	2320
80	2450

Minimum Resistivity: 2290 ohm-cm

pH of Soil for Use in Corrosion Testing

As-received conditions: 7.59
Temp: 25.1 °C

Test Method: ASTM G51
pH Meter: Hanna Instruments No. 99121

Tamika Vasquez, 06/27/19
Quality Review/Date
Tested by: E.P.

Beyond Engineering & Testing, LLC
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Round Rock, TX 78664
(512) 358-6048

Minimum Soil Resistivity

Client: RRC Power & Energy, LLC
Project: Emerson Creek Wind Project
Project No.: MD1901007
Sample ID: T-54 at 1 ft.

Test Method: ASTM G187
Test Date: 06/25/19
Resistivity Meter: Humboldt, H-4385
Calibrated Date: 8/20/2018
Multiplication Factor: 1.0

Distilled Water Added (mL)	Measured Resistance (ohms)
20	5780
40	1530
60	1370
80	1700
100	1820

Minimum Resistivity: 1370 ohm-cm

pH of Soil for Use in Corrosion Testing

As-received conditions: 7.65
Temp: 25.7 °C

Test Method: ASTM G51
pH Meter: Hanna Instruments No. 99121

Tamika Vasquez, 07/02/19
Quality Review/Date
Tested by: E.P.

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

Minimum Soil Resistivity

Client: RRC Power & Energy, LLC
Project: Emerson Creek Wind Project
Project No.: MD1901007
Sample ID: T-66 at 1 ft.

Test Method: ASTM G187
Test Date: 06/25/19
Resistivity Meter: Humboldt, H-4385
Calibrated Date: 8/20/2018
Multiplication Factor: 1.0

Distilled Water Added (mL)	Measured Resistance (ohms)
20	4980
40	2210
60	2030
80	2150
100	2210

Minimum Resistivity: 2030 ohm-cm

pH of Soil for Use in Corrosion Testing

As-received conditions: 7.44
Temp: 23.7 °C

Test Method: ASTM G51
pH Meter: Hanna Instruments No. 99121

Tamika Vasquez, 06/27/19
Quality Review/Date
Tested by: E.P.

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

Minimum Soil Resistivity

Client: RRC Power & Energy, LLC
Project: Emerson Creek Wind Project
Project No.: MD1901007
Sample ID: Sub-1 at 1 ft.

Test Method: ASTM G187
Test Date: 06/25/19
Resistivity Meter: Humboldt, H-4385
Calibrated Date: 8/20/2018
Multiplication Factor: 1.0

Distilled Water Added (mL)	Measured Resistance (ohms)
20	10100
40	2660
60	2740
80	2770

Minimum Resistivity: 2660 ohm-cm

pH of Soil for Use in Corrosion Testing

As-received conditions: 6.83
Temp: 25.3 °C

Test Method: ASTM G51
pH Meter: Hanna Instruments No. 99121

Tamika Vasquez, 07/25/19
Quality Review/Date
Tested by: E.P.

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

Client: RRC Power & Energy, LLC
Project: Emerson Creek Wind Project

RRC Project No.: MD1901007
Testing Method: ASTM C1580
AASHTO T 291,
Method B
Test Date: 7/3/2019

No.	Sample ID & Depth	Sulfate Content (mg SO_4/kg)	Chloride Content (mg/kg)
1	T-06 at 4 ft	20.9*	ND
2	T-26 at 4 ft	21.6*	ND
3	T-45A at 1 ft	111*	ND
4	T-54 at 4 ft	136*	13.6*
5	T-66 at 4 ft	48.0*	ND
6	Sub-1 at 4 ft	80.8*	ND
7			
8			
9			
10			

Note 1: Method Detection Limit (MDL) is 5 mg/L
Note 2: ND = No Detection, Below Method Detection Limit
Note 3: (*) = Sample analyzed outside of recommended hold time.
The chloride and sulfate MDLs are volumetric. Results are mass per mass of dry soil.

Olga Vasquez, 07/03/19
Quality Review/Date
Tested by: C.M.

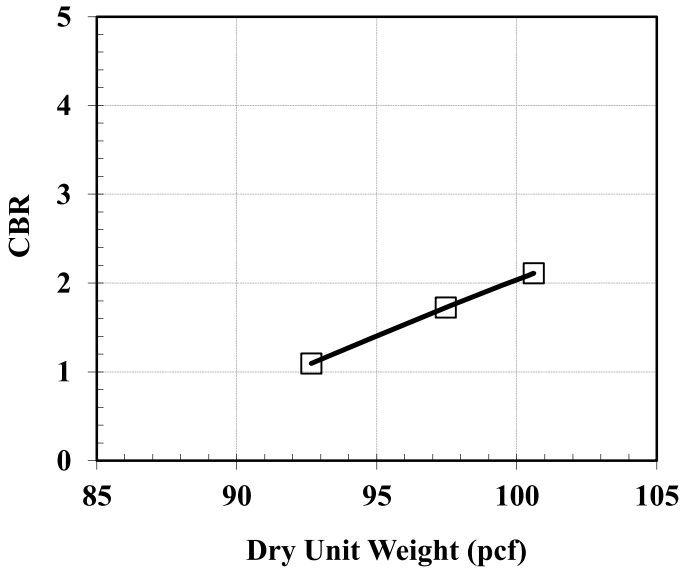
Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

CBR (California Bearing Ratio) Test

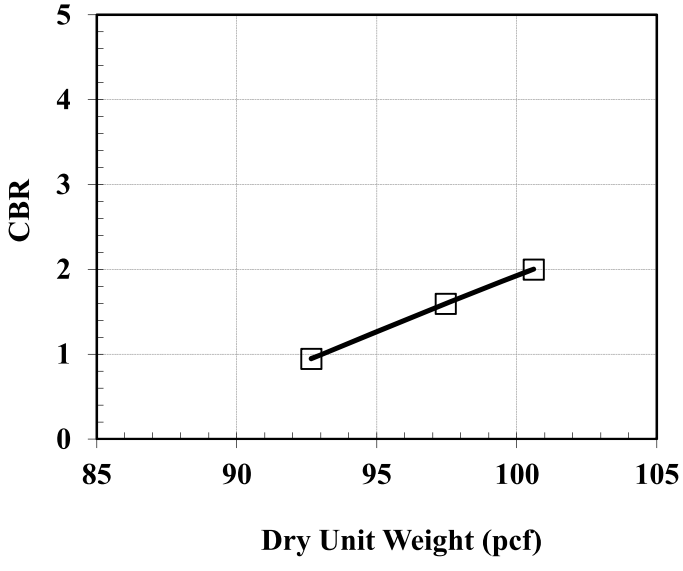
Client: RRC Power & Energy, LLC.
Project: Emerson Creek Wind Project
Sample No: TR-1 (T-63) at 2 to 4 ft

Beyond Project No.: MD1901007
Test Method: ASTM D1883
Test Date: 5/13/2019
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
Target Dry Unit Weight (pcf)	92.6	97.8	100.8
Condition of sample	soaked	soaked	soaked
Surcharge Weight (lbs)	10	10	10
Water Content (%)	21.3	21.3	21.7
Dry Unit Weight (pcf)	92.7	97.5	100.6
Final Conditions			
Water Content (%) at top 1-in layer after soaking	26.1	26.4	25.9
Swell (% of initial height)	0.4	0.7	0.4
Bearing Ratio of Sample at 0.100 in penetration	1.1	1.7	2.1
Bearing Ratio of Sample at 0.200 in penetration	0.9	1.6	2.0

Note: Soil specimens were remolded to a range of densities 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.

Olga Vasquez, 05/15/19
Analysis & Quality Review/Date
Specimens prepared and tested by: R.N.

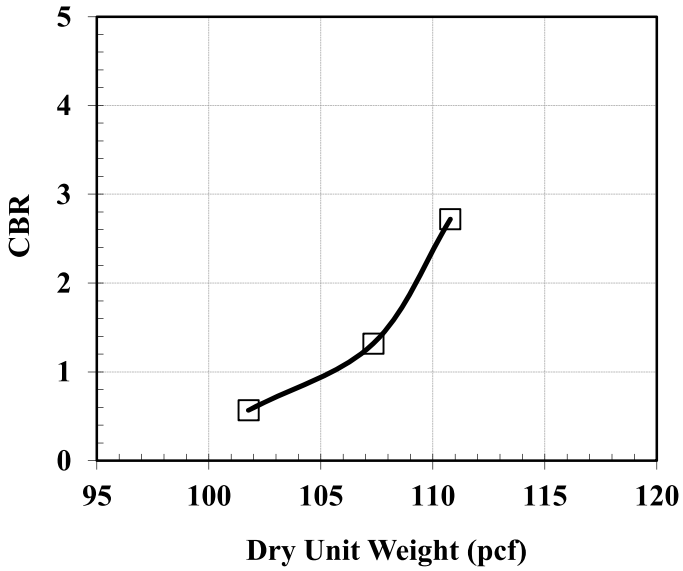
Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
(512) 358-6048

CBR (California Bearing Ratio) Test

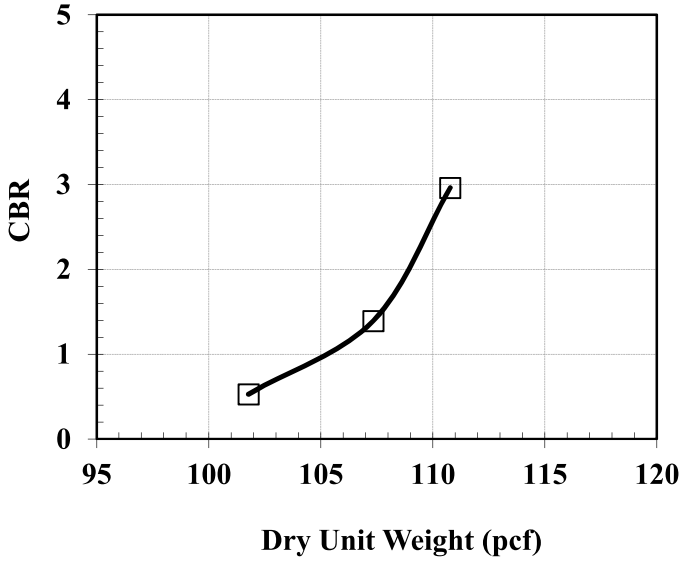
Client: RRC Power & Energy, LLC.
Project: Emerson Creek Wind Project
Sample No: TR-4 (T-08) at 2 to 4 ft

Beyond Project No.: MD1901007
Test Method: ASTM D1883
Test Date: 5/13/2019
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
Target Dry Unit Weight (pcf)	101.7	107.4	110.7
Condition of sample	soaked	soaked	soaked
Surcharge Weight (lbs)	10	10	10
Water Content (%)	14.1	14.2	14.2
Dry Unit Weight (pcf)	101.8	107.3	110.8
Final Conditions			
Water Content (%) at top 1-in layer after soaking	17.3	17.9	18.5
Swell (% of initial height)	0.2	0.5	0.6
Bearing Ratio of Sample at 0.100 in penetration	0.6	1.3	2.7
Bearing Ratio of Sample at 0.200 in penetration	0.5	1.4	3.0

Note: Soil specimens were remolded to a range of densities 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.

Olga Vasquez, 05/16/18
Analysis & Quality Review/Date
Specimens prepared and tested by: R.N.

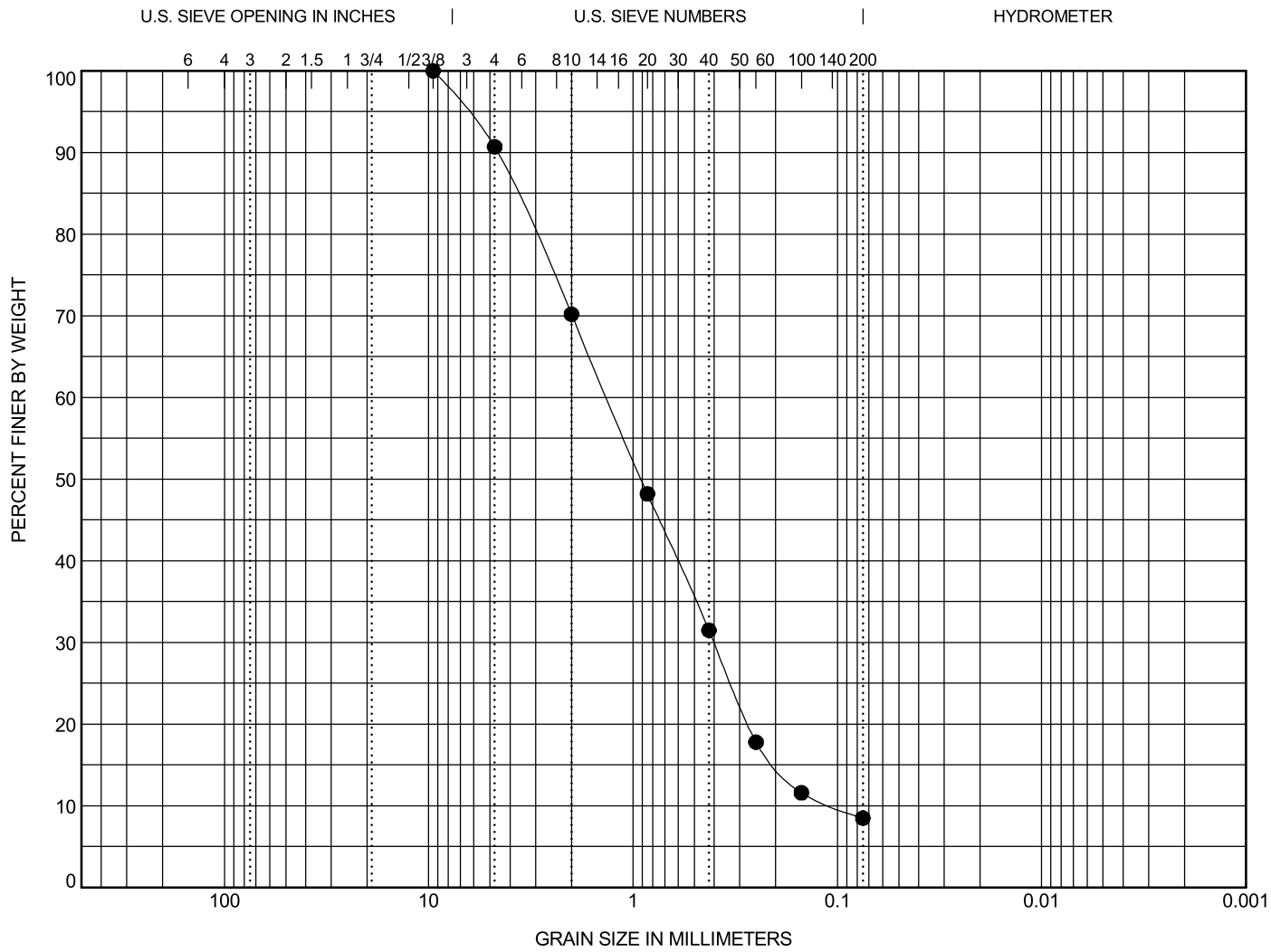
GRAIN SIZE DISTRIBUTION

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

Sample ID: **T-63 at 39.0 ft.** Date: 07/01/2019

Test Method: **ASTM D6913**



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Classification	LL	PL	PI	Cc	Cu
				1.14	**12.82**

D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
9.5	**1.345**	**0.401**	**0.105**	**9.3**	**82.2**	**8.5**	

Cheng-Wei Chen, 07/01/2019
Analysis & Quality Review/Date

Specimens prepared by: T.W.

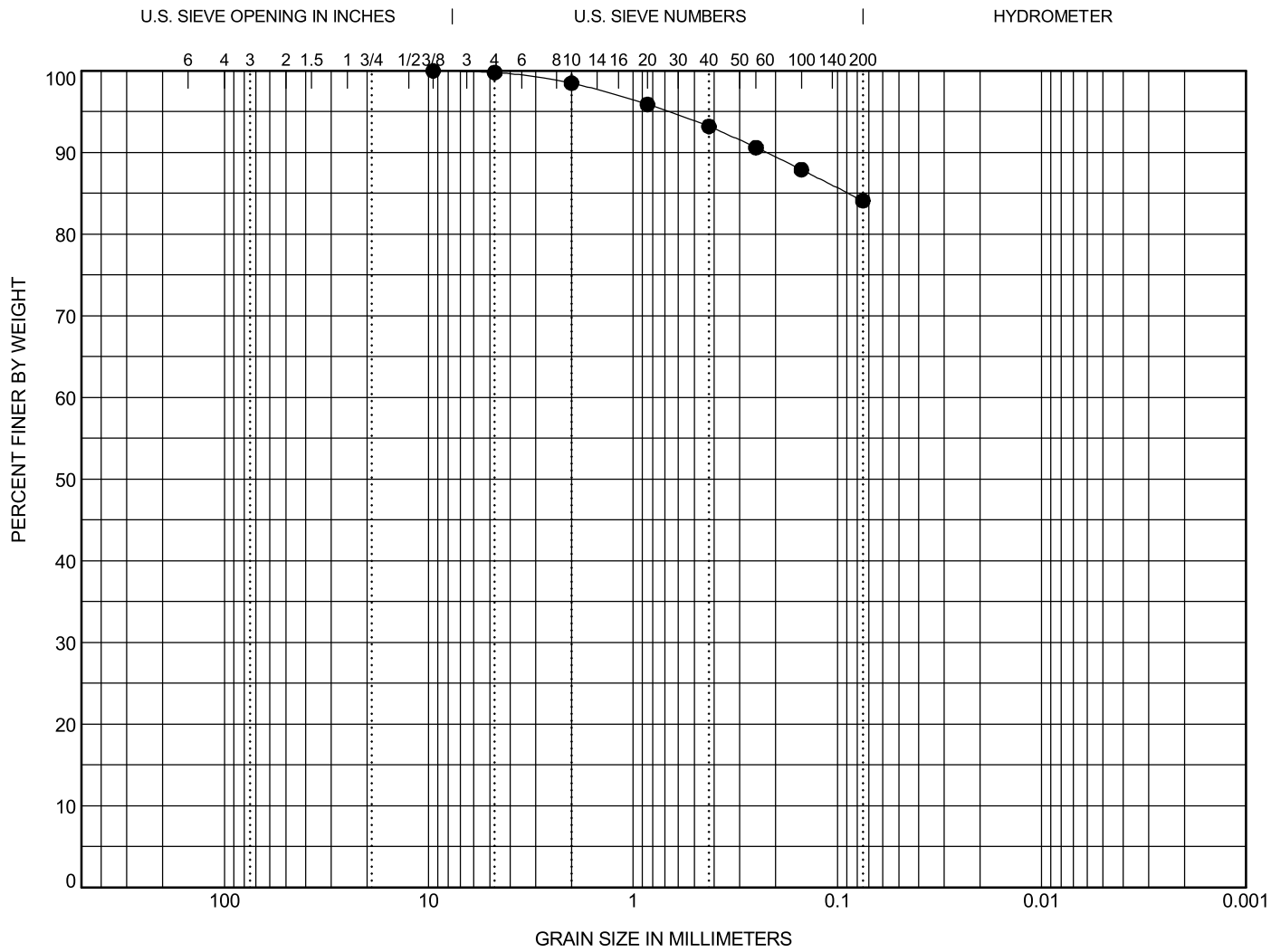
GRAIN SIZE DISTRIBUTION

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

Sample ID: **TR-1 (T-63) at 2.0 ft.** Date: 05/10/2019

Test Method: **ASTM D6913**



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Classification	LL	PL	PI	Cc	Cu
FAT CLAY with SAND(CH)	**51**	**20**	**31**		

D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
9.5				**0.2**	**15.7**	**84.1**	

Cheng-Wei Chen, 05/10/2019
Analysis & Quality Review/Date

Specimens prepared by: T.W.

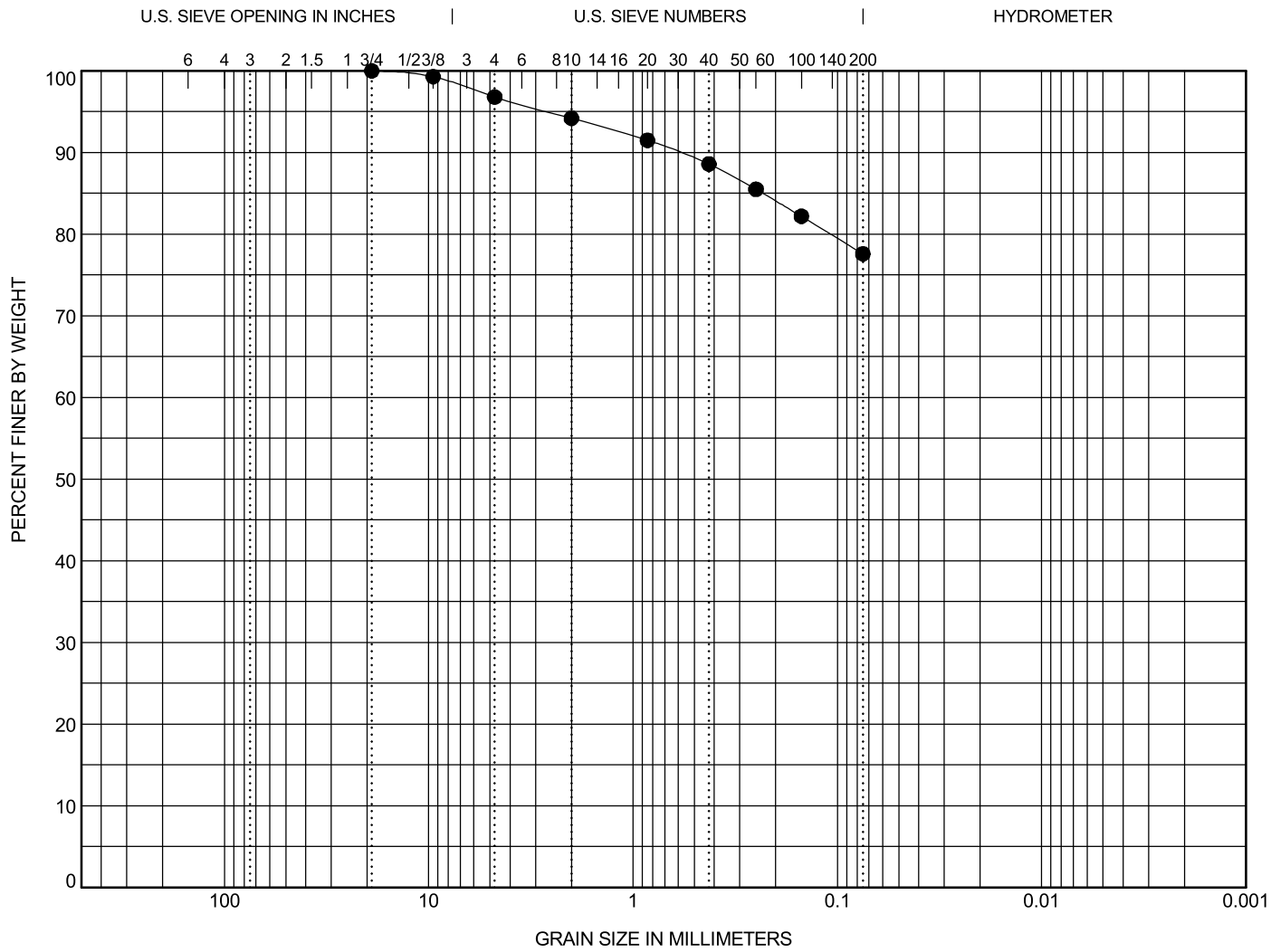
GRAIN SIZE DISTRIBUTION

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

Sample ID: **TR-2 (T-48) at 2.0 ft.** Date: 05/10/2019

Test Method: **ASTM D6913**



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Classification	LL	PL	PI	Cc	Cu
LEAN CLAY with SAND(CL)	**41**	**19**	**22**		

D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
19				**3.2**	**19.2**	**77.6**	

Cheng-Wei Chen, 05/10/2019
Analysis & Quality Review/Date

Specimens prepared by: T.W.

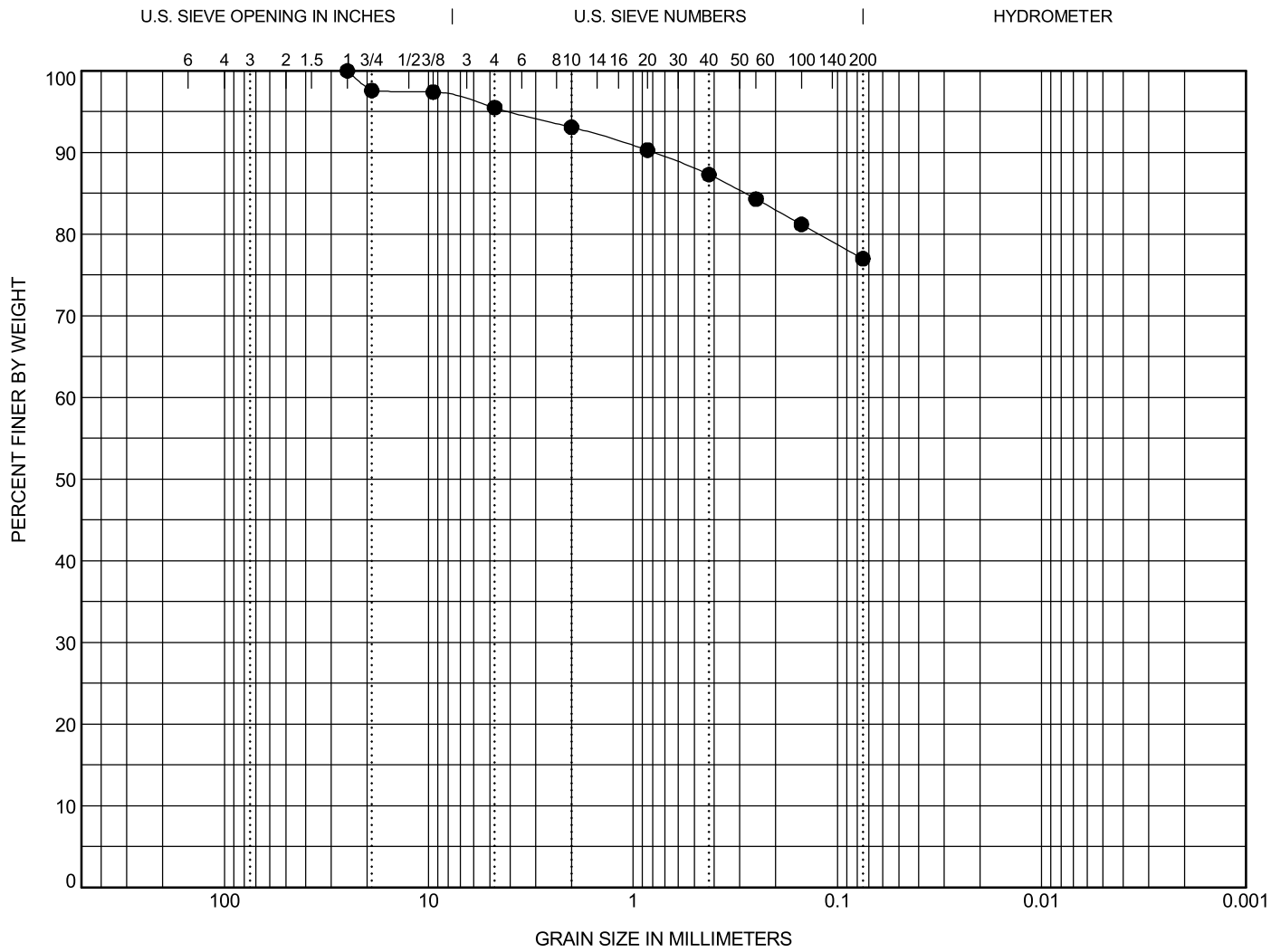
GRAIN SIZE DISTRIBUTION

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

Sample ID: **TR-3 at 2.0 ft.** Date: 05/10/2019

Test Method: **ASTM D6913**



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Classification	LL	PL	PI	Cc	Cu
LEAN CLAY with SAND(CL)	**37**	**19**	**18**		

D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
25				**4.5**	**18.5**	**77.0**	

Cheng-Wei Chen, 05/10/2019
Analysis & Quality Review/Date

Specimens prepared by: T.W.

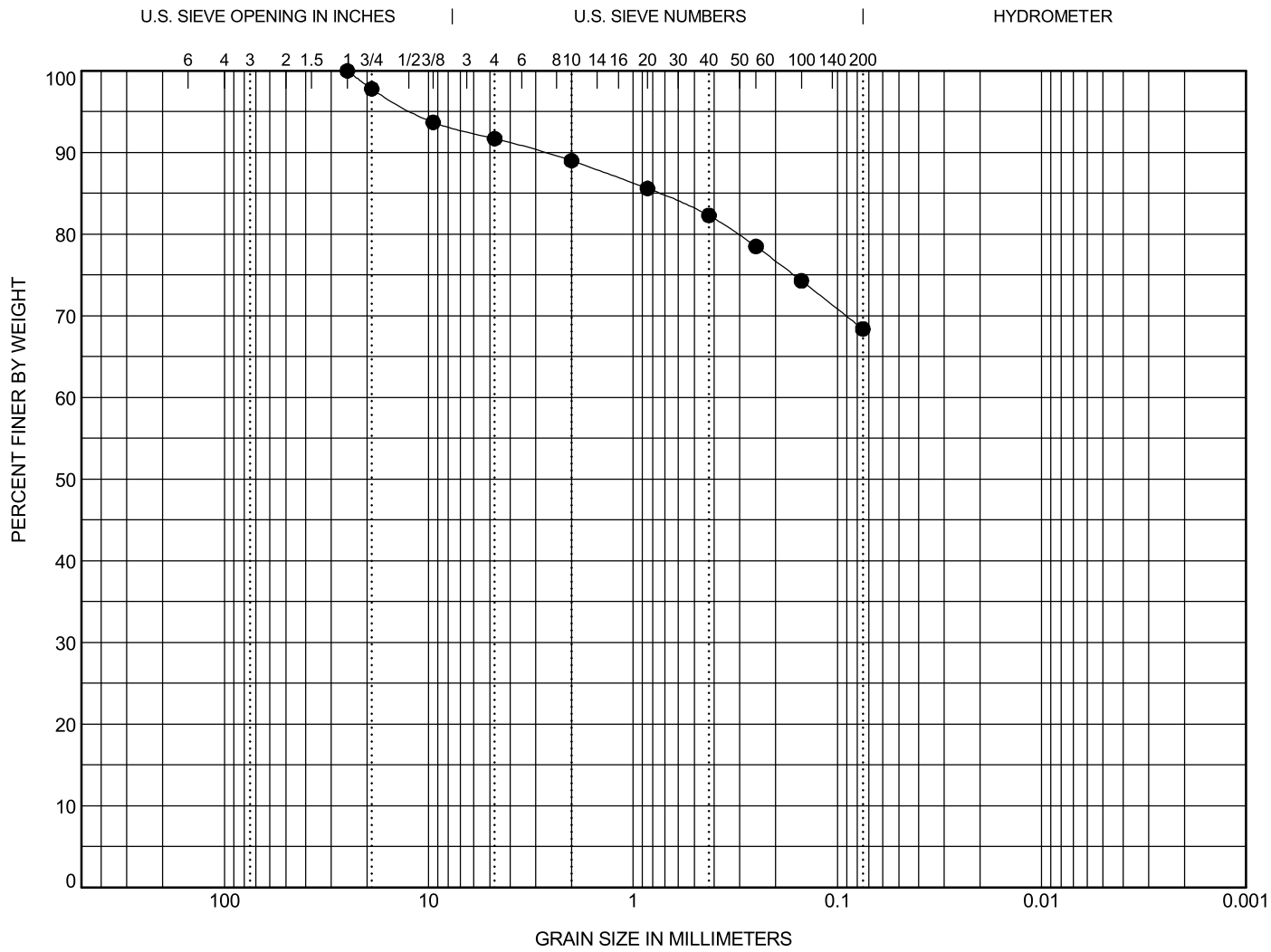
GRAIN SIZE DISTRIBUTION

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

Sample ID: **TR-4 (T-08) at 2.0 ft.** Date: 05/10/2019

Test Method: **ASTM D6913**



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Classification	LL	PL	PI	Cc	Cu
SANDY LEAN CLAY(CL)	**27**	**16**	**11**		

D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
25				**8.3**	**23.3**	**68.4**	

Cheng-Wei Chen, 05/10/2019
Analysis & Quality Review/Date

Specimens prepared by: T.W.

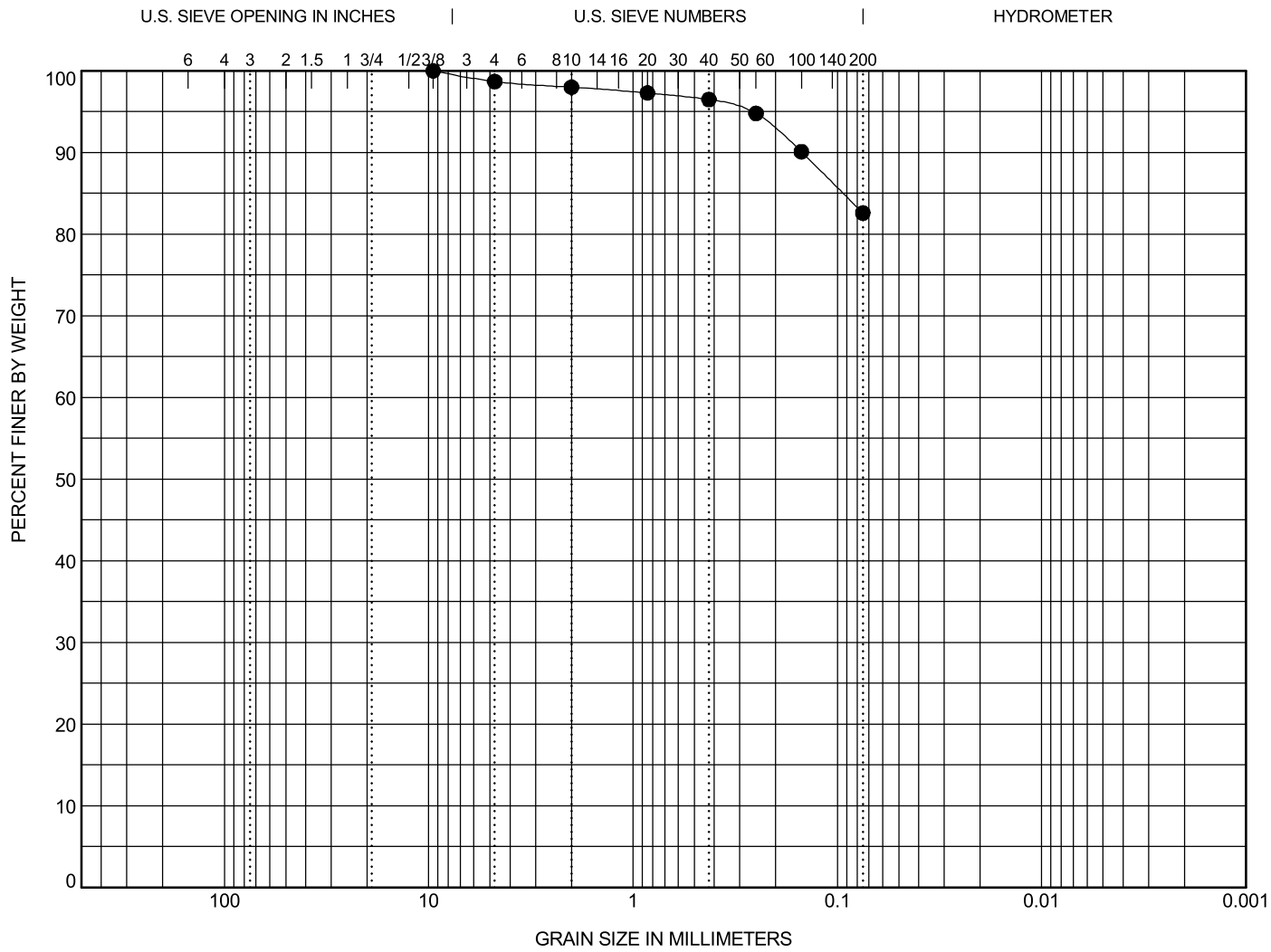
GRAIN SIZE DISTRIBUTION

Beyond Engineering & Testing, LLC
3801 Doris Lane, Suite B
Round Rock, TX 78664
Telephone: (512) 358-6048

CLIENT: RRC Power & Energy, LLC
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

Sample ID: **TR-5 (SUB) at 2.0 ft.** Date: 05/10/2019

Test Method: **ASTM D6913**



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Classification	LL	PL	PI	Cc	Cu
LEAN CLAY with SAND(CL)	**46**	**19**	**27**		

D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
9.5				**1.3**	**16.1**	**82.6**	

Cheng-Wei Chen, 05/10/2019
Analysis & Quality Review/Date

Specimens prepared by: T.W.

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

SUMMARY OF LABORATORY RESULTS

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

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)
T-01	1.0		32												
T-01	8.0			168*					1064.88		0.0				
T-03	1.0		40												
T-03	4.0		10												
T-03	9.0		4												
T-04	1.0		30												
T-04	7.0		3												
T-04	14.0		2												
T-06	1.0		17											7.5	1,830
T-06	4.0		13									ND	0.0021		
T-06	7.0		12												
T-07	1.0		19												
T-07	4.0		13												
T-07	17.0			165*					1098.72		0.0				
T-08	1.0		18												
T-08	4.0		11												
T-08	7.0		11												
T-09	4.0		17												
T-09	7.0		13												
T-09	9.0	CL	10		72	24	16	8							
T-10	4.0		15												
T-10	7.0		15												
T-10	9.0		9												
T-10	20.0		17												
T-11	1.0		21												
T-11	4.0		18												
T-11	12.0		12												
T-12	1.0		21												
T-12	7.0		16												
T-13	1.0		28												
T-13	7.0		19												

ND Not Detected; **D** Diluted;
*Denotes Total Unit Weight

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

SUMMARY OF LABORATORY RESULTS

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

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)
T-13	9.0		11												
T-13	14.0		16												
T-14	4.0		22												
T-14	7.0		26												
T-14	19.0		13												
T-15	1.0		16												
T-15	4.0		15												
T-15	14.0		10												
T-16	1.0		24												
T-16	4.0		16												
T-16	9.0		11												
T-16	29.0		5												
T-17	4.0		26												
T-17	9.0		14												
T-17	24.0	CL	11		65	28	18	10							
T-18	4.0		14												
T-18	9.0		6												
T-18	14.0		10												
T-18	34.0		16												
T-19	1.0		17												
T-19	7.0		15												
T-19	12.0		9												
T-19	24.0		9												
T-20	1.0		21												
T-20	4.0		4												
T-20	15.0			166*					923.04		0.0				
T-21	1.0		24												
T-22	1.0		24												
T-22	4.0		17												
T-22	9.0		30												
T-22	14.0		12												

ND Not Detected; **D** Diluted;
*Denotes Total Unit Weight

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

SUMMARY OF LABORATORY RESULTS

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

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)
T-23	1.0		25												
T-23	7.0		6												
T-24	1.0		15												
T-24	4.0		35												
T-25	1.0		18												
T-25	9.0		17												
T-26	1.0		27											7.4	1,480
T-26	4.0		31									ND	0.0022		
T-26	14.0		5												
T-27	1.0		21												
T-28	1.0		19												
T-28	4.0		21												
T-28	9.0	CL	9		90	25	15	10							
T-28	12.0		13												
T-28	14.0		11												
T-29	4.0		25												
T-29	9.0		16												
T-29	19.0		17												
T-30	1.0		23												
T-30	7.0		9												
T-30	21.0			163*					357.12		0.0				
T-31	4.0		20												
T-31	9.0		9												
T-31	15.0		20												
T-31	24.0		13												
T-32	4.0		11												
T-32	7.0		12												
T-32	19.0		7												
T-33	1.0		20												
T-33	7.0	SC-SM	25		49	22	15	7							
T-33	12.0		9												

ND Not Detected; **D** Diluted;
*Denotes Total Unit Weight

RRC Power & Energy, LLC
3801 Doris Lane
Round Rock, TX 78664
Telephone: (512) 992-2087
Fax: (512) 251-2518

SUMMARY OF LABORATORY RESULTS

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

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)
T-34	12.5			164					848.88		0.0				
T-35	1.0		24												
T-35	4.0		17												
T-35	7.0		16												
T-36	1.0		25												
T-36	4.0		23												
T-36	9.0		17												
T-36	16.0			148*					921.60		0.0				
T-37	1.0		17												
T-37	4.0		1												
T-39	4.0		15												
T-39	9.0		15												
T-39	14.0		17												
T-40	1.0		20												
T-40	4.0		18												
T-40	7.0		11												
T-41	1.0		22												
T-41	4.0		13												
T-41	9.0		11												
T-42	4.0		29												
T-42	12.0		20												
T-42	14.0		26												
T-43	1.0		19												
T-43	16.0			175*					1092.24		0.0				
T-44	1.0		14												
T-44	4.0		15												
T-44	9.0		10												
T-45A	1.0		20									ND	0.0111		
T-45A	4.0		15											7.6	2,290
T-45A	9.0		11												
T-45B	29.0			154*					734.40		0.0				

ND Not Detected; **D** Diluted;
*Denotes Total Unit Weight

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Fax: (512) 251-2518

SUMMARY OF LABORATORY RESULTS

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

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)
T-46	1.0		39												
T-46	7.0		10												
T-46	14.0		17												
T-47	4.0		14												
T-47	9.0		13												
T-47	12.0		9												
T-48	4.0		16												
T-48	9.0		14												
T-48	19.0		18												
T-49	4.0		13												
T-49	9.0		16												
T-49	14.0		13												
T-50	1.0		16												
T-50	7.0		17												
T-50	12.0		17												
T-50	14.0		14												
T-51	4.0		16												
T-51	9.0		15												
T-51	12.0	CL	14		67	27	16	11							
T-51	19.0		11												
T-52	1.0		23												
T-52	4.0		22												
T-52	12.0		14												
T-53	1.0		23												
T-53	7.0		12												
T-53	14.0		14												
T-53	19.0		19												
T-54	1.0		19											7.7	1,370
T-54	4.0		16									0.0014	0.0136		
T-54	9.0		17												
T-54	14.0		13												

ND Not Detected; **D** Diluted;
*Denotes Total Unit Weight

RRC Power & Energy, LLC
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SUMMARY OF LABORATORY RESULTS

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

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)
T-54	24.0		10												
T-56	7.0		15												
T-56	12.0		15												
T-56	19.0		11												
T-56	29.0		13												
T-57	1.0		22												
T-57	7.0		16												
T-57	12.0		15												
T-57	19.0		9												
T-58	1.0		23												
T-58	4.0		21												
T-58	9.0		13												
T-58	12.0	CL	15	121	80	29	15	14	2.05	15.0	9.5				
T-58	14.0		17												
T-58	19.0		15												
T-58	39.0		11												
T-59	4.0		17												
T-59	9.0		12												
T-59	24.0		19												
T-60	4.0		17												
T-60	9.0		17												
T-60	12.0		16												
T-60	24.0		19												
T-61	9.0	CL	16		74	31	16	15							
T-61	24.0		19												
T-62	1.0		16												
T-62	7.0		15												
T-62	12.0		15												
T-62	19.0		16												
T-62	29.0		28		96										
T-63	7.0		17												

ND Not Detected; **D** Diluted;
*Denotes Total Unit Weight

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Telephone: (512) 992-2087
Fax: (512) 251-2518

SUMMARY OF LABORATORY RESULTS

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

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)
T-63	19.0		17												
T-63	39.0		15		9										
T-64	4.0		16												
T-64	9.0		16												
T-64	14.0		16												
T-64	24.0		19												
T-65	1.0		16												
T-65	9.0		17												
T-65	14.0		17												
T-65	24.0		15	121					4.52	10.0	0.0				
T-66	1.0		22											7.4	2,030
T-66	4.0		20									ND	0.0048		
T-66	12.0		18												
T-66	14.0		14												
T-66	19.0	CL	18		77	31	16	15							
T-66	24.0	CL	17	117	91	29	17	12	2.77	14.9	19.0				
T-66	29.0		23												
T-67	19.0		14												
T-67	24.0		19												
T-68	4.0		16												
T-68	9.0		14												
T-68	12.0		13												
T-68	24.0		17												
T-69	4.0		20												
T-69	12.0		16												
T-69	14.0		19												
T-69	29.0	CL	16		75	26	17	9							
T-70	1.0		14												
T-70	7.0		15												
T-70	12.0		16												
T-70	24.0		17												

ND Not Detected; **D** Diluted;
*Denotes Total Unit Weight

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Fax: (512) 251-2518

SUMMARY OF LABORATORY RESULTS

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

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)
T-70	34.0		15	121					3.66	15.1	0.0				
T-71	4.0		15												
T-71	9.0		16												
T-71	19.0		16												
T-72	1.0		25												
T-72	7.0		14												
T-73	1.0		17												
T-73	7.0		1												
T-74	4.0		22												
T-74	9.0		17												
T-75	4.0		19												
T-75	9.0		16												
T-75	13.0			183*					1612.80		0.0				
T-76	4.0		16												
T-76	9.0		10												
T-76	12.0		4												
T-77	4.0		15												
T-77	7.0		14												
T-77	14.0		9												
T-78	1.0		25												
T-78	7.0		17												
T-78	14.0		14												
T-79	4.0		15												
T-79	9.0		16												
T-79	14.0		16												
T-79	24.0		24												
T-80	1.0		16												
T-80	9.0		17												
T-80	14.0		16												
T-80	19.0		22												
T-80	29.0		16												

ND Not Detected; **D** Diluted;
*Denotes Total Unit Weight

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Round Rock, TX 78664
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SUMMARY OF LABORATORY RESULTS

CLIENT: Apex Clean Energy, Inc
PROJECT: Emerson Creek Wind Project
LOCATION: Erie and Huron Counties, OH
NUMBER: MD1901007

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)
T-81	4.0		16												
T-81	7.0		16												
T-81	12.0		17												
T-81	19.0		17												
T-81	39.0		18												
T-82	1.0		22												
T-82	7.0		18												
T-82	19.0		19												
T-82	24.0	CL	21	110	83	28	16	12	1.48	15.0	19.0				
T-82	39.0		13												
T-83	1.0		16												
T-83	9.0		18												
T-83	21.0	CL	18	115	89	29	16	13	1.46	15.0	16.0				
T-83	29.0		21												
T-87	1.0		18												
T-87	4.0		20												
T-87	12.5			168*					784.08		0.0				
SUB-1	1.0		31											6.8	2,660
SUB-1	4.0		17									ND	0.0081		
SUB-3	4.0	CL	23		83	43	20	23							
SUB-3	6.0		8												
OM1	1.0		28												
OM1	4.0		30												
OM1	9.0		4												
OM2	4.0	CH	32		93	59	22	37							
OM2	7.0		8												
TR-1 (T-63)	2.0	CH	21		84	51	20	31							
TR-2 (T-48)	2.0	CL	16		78	41	19	22							
TR-3	2.0	CL	18		77	37	19	18							
TR-4 (T-08)	2.0	CL	19		68	27	16	11							
TR-5 (SUB)	2.0	CL	24		83	46	19	27							

ND Not Detected; **D** Diluted;
*Denotes Total Unit Weight

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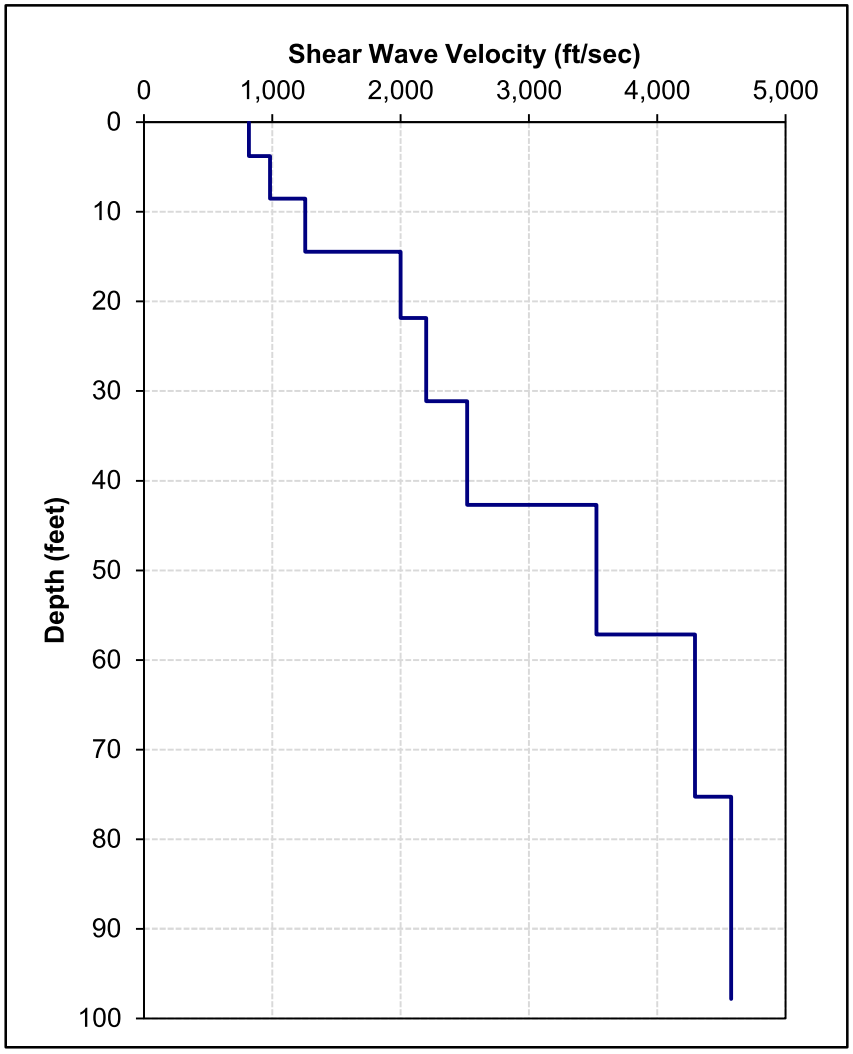
APPENDIX C

Multi-Channel Analysis of Surface Waves (MASW) Survey Results for WTG No. T-15

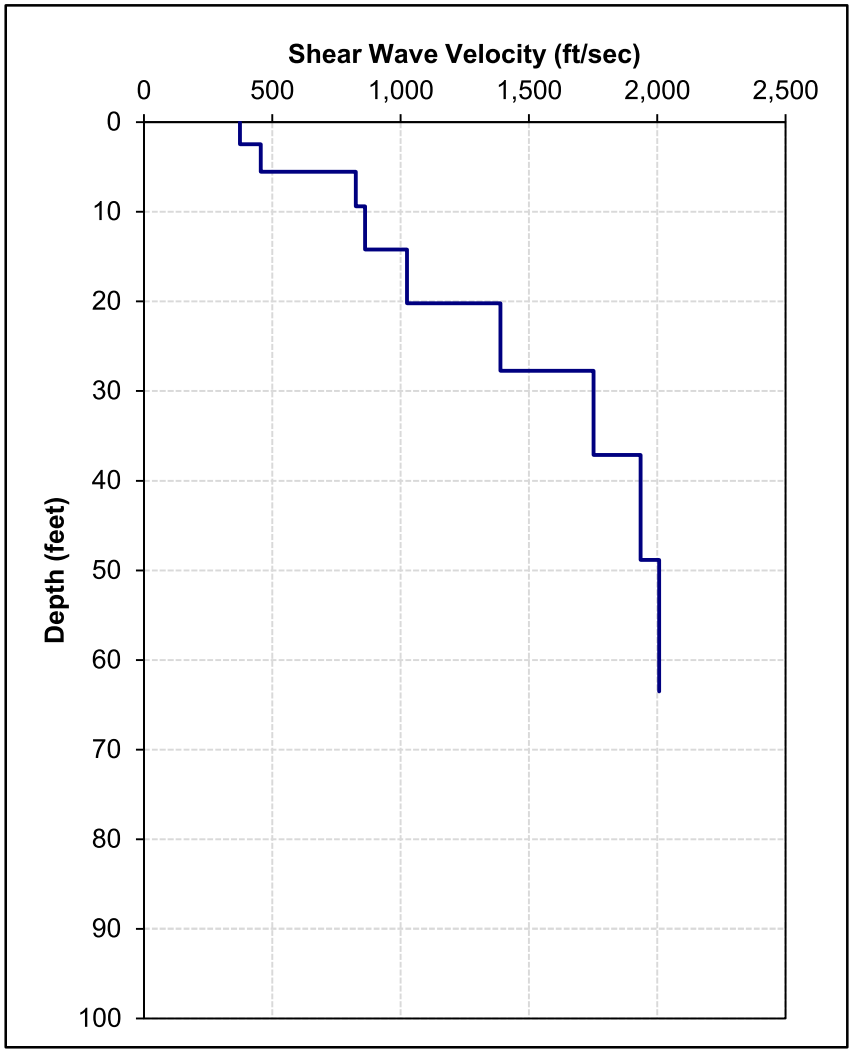
Depth (ft)	Shear Wave Velocity (ft/sec)
3.8	819
8.5	982
14.5	1,258
21.9	1,999
31.1	2,199
42.7	2,519
57.2	3,527
75.2	4,294
97.8	4,578



Note:
1. Data collected on January 20, 2020
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. T-42

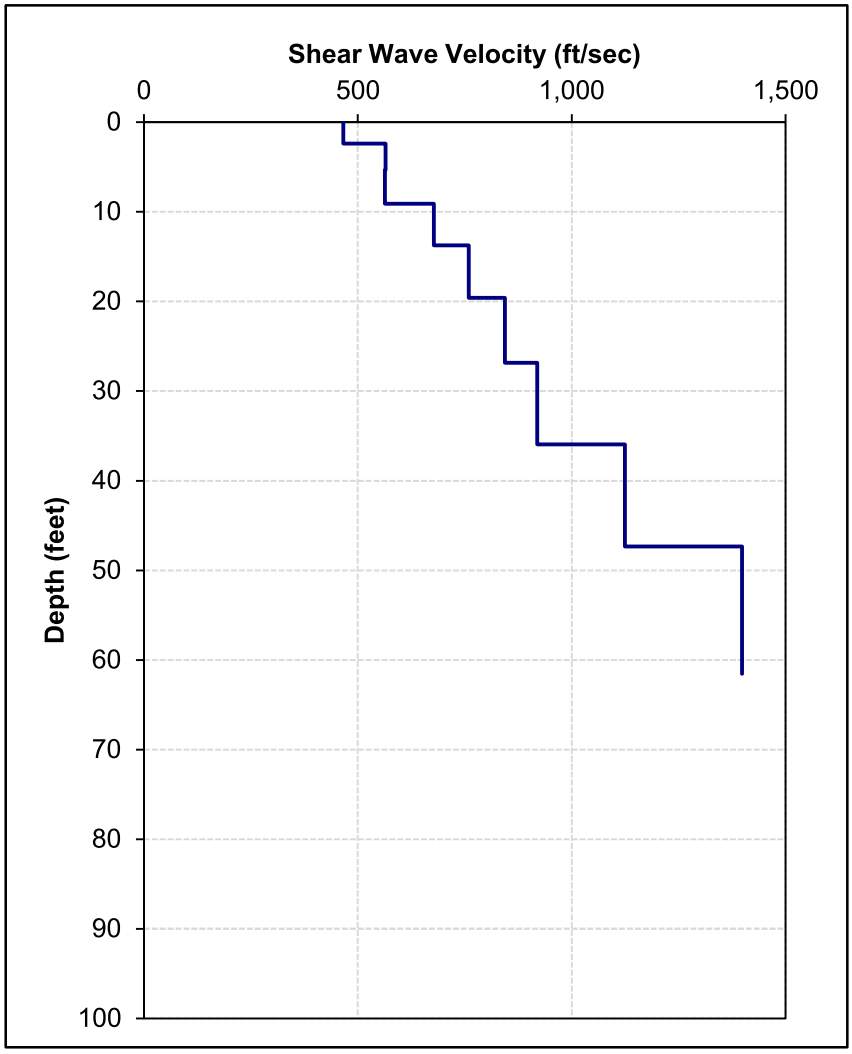
Depth (ft)	Shear Wave Velocity (ft/sec)
2.5	374
5.5	456
9.4	826
14.2	862
20.2	1,025
27.7	1,389
37.1	1,752
48.8	1,935
63.5	2,008



Note:
1. Data collected on January 20, 2020
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. T-67

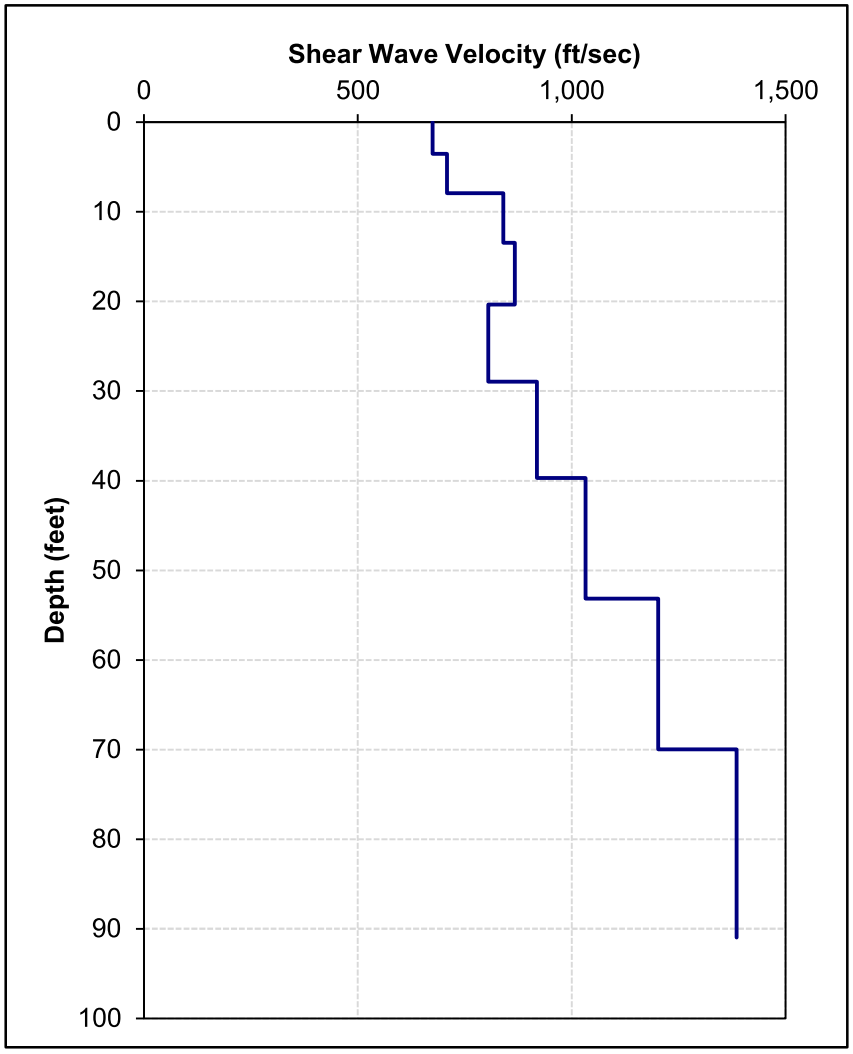
Depth (ft)	Shear Wave Velocity (ft/sec)
2.4	466
5.4	565
9.1	563
13.8	678
19.6	760
26.9	844
36.0	920
47.3	1,124
61.6	1,399



Note:
1. Data collected on January 20, 2020
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. T-80

Depth (ft)	Shear Wave Velocity (ft/sec)
3.5	675
7.9	708
13.4	840
20.3	867
28.9	805
39.7	919
53.2	1,033
70.0	1,203
91.0	1,386



Note:
1. Data collected on January 21, 2020
2. SurfSeis v. 4.2.4.5 computer software developed by Kansas Geological Survey was used to process the field data.

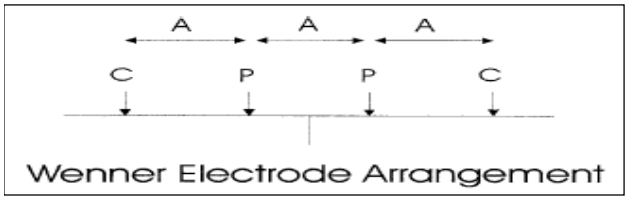
SOIL RESISTIVITY MEASURMENT DATA SHEET

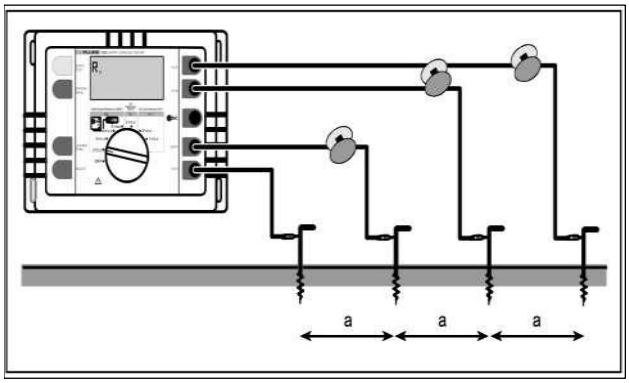
Survey ID ER T-15
DATE 1/22/2020
CLIENT Apex Clean Energy, Inc
PROJECT Emerson Creek Wind Project
Project No. MD1901007
LOCATION: Erie and Huron Counties, OH
LATITUDE : 41.303032
LONGITUDE : -82.68839
WEATHER: Parlty Cloudy
Temp. (°F) 23°F
TOP SOIL: Lean Clay(CL), With Sand, Light Brown, Dry
TYPE OF TEST : Wenner 4-Pin Method
EQUIPMENT: AEMC Ground Resistane Tester
SERIAL NO. 257543JJDV
MODEL: 4630
CALIBRATION DUE DATE: 7/8/2020
TEST PERFORMED BY : RRC

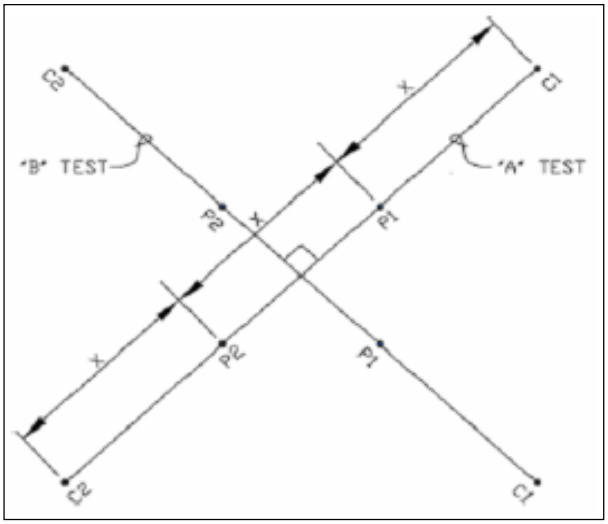
TEST SET RANGE
Meter Current: 1mA - 10mA
Meter Resistance: 1cOhm - 1.999 kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			E-W		N-S				Average Soil Resistivity (Ωm)
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	
2.5	4	2	31.500	150.74	38.400	183.76			167.25
5	4	2	25.000	239.27	25.900	247.88			243.57
10	12	6	14.740	282.14	15.390	294.59			288.37
20	12+	6	5.990	229.31	6.370	243.86			236.59
40	12+	6	1.850	141.65	1.810	138.58			140.12
60	12+	6	0.960	110.25	0.940	107.96			109.11

Notes:





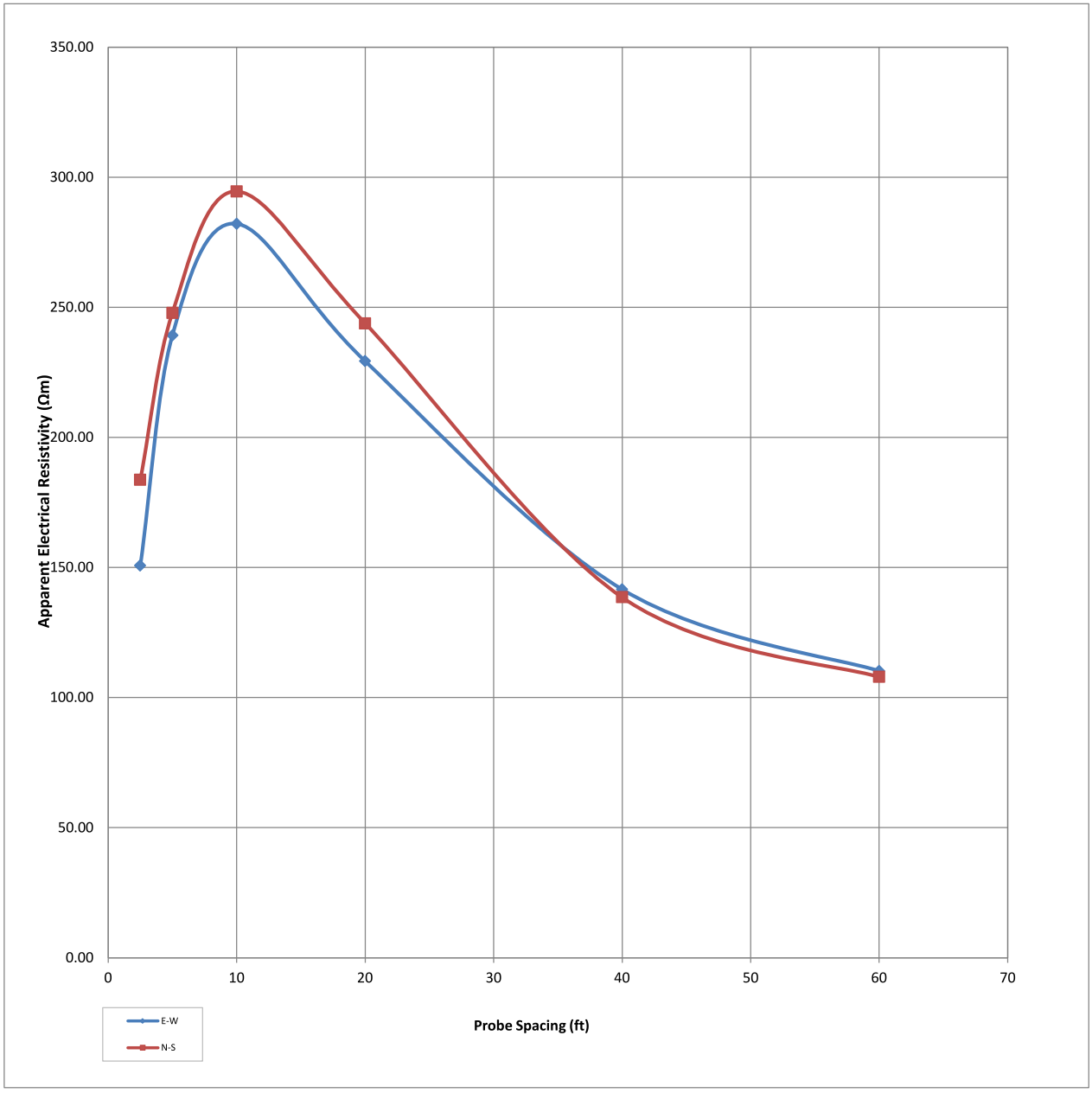


General Sketch of the test set up.

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.

Emerson Creek Wind Project

Electrical Resistivity Survey at ER T-15



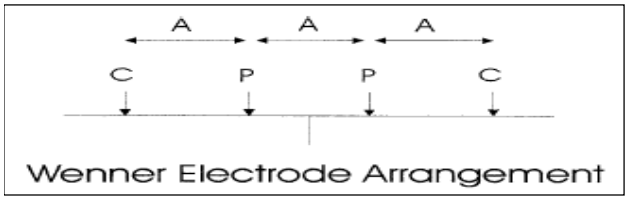
SOIL RESISTIVITY MEASURMENT DATA SHEET

Survey ID ER T-42
DATE 1/22/2020
CLIENT Apex Clean Energy, Inc
PROJECT Emerson Creek Wind Project
Project No. MD1901007
LOCATION: Erie and Huron Counties, OH
LATITUDE : 41.200378
LONGITUDE : -82.777286
WEATHER: Parlty Cloudy
Temp. (°F) 23°F
TOP SOIL: Lean Clay(CL), With Sand, Light Brown, Dry
TYPE OF TEST : Wenner 4-Pin Method
EQUIPMENT: AEMC Ground Resistane Tester
SERIAL NO. 257543JJDV
MODEL: 4630
CALIBRATION DUE DATE: 7/8/2020
TEST PERFORMED BY : RRC

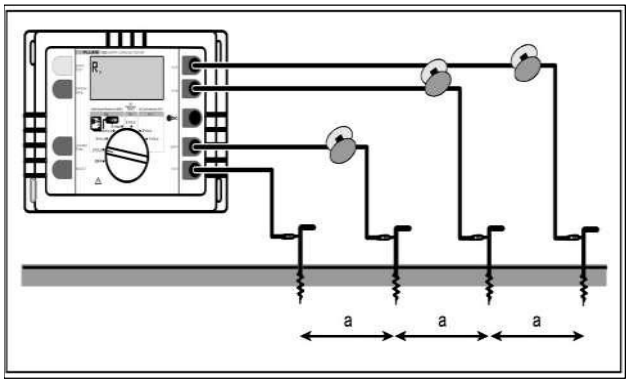
TEST SET RANGE
Meter Current: 1mA - 10mA
Meter Resistance: 1cOhm - 1.999 kOhm

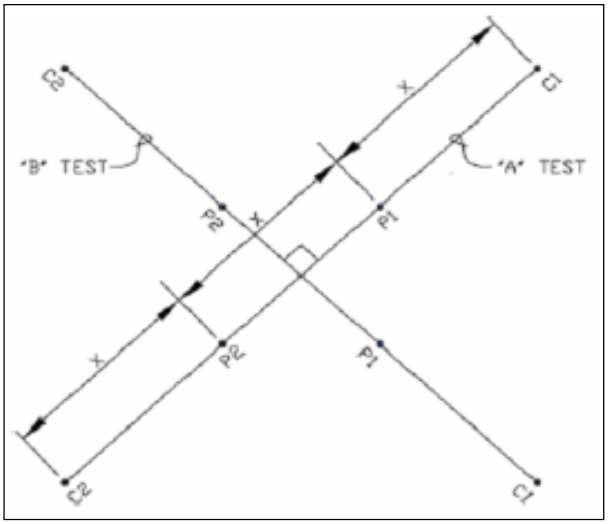
PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			E-W		N-S				Average Soil Resistivity (Ωm)
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	
2.5	4	2	10.110	48.38	10.070	48.19			48.28
5	4	2	5.900	56.47	5.900	56.47			56.47
10	12	6	3.840	73.50	3.780	72.35			72.93
20	12+	6	2.760	105.66	2.710	103.75			104.70
40	12+	6	1.840	140.88	1.860	142.41			141.65
60	12+	6	1.280	147.01	1.330	152.75			149.88

Notes:



Wenner Electrode Arrangement



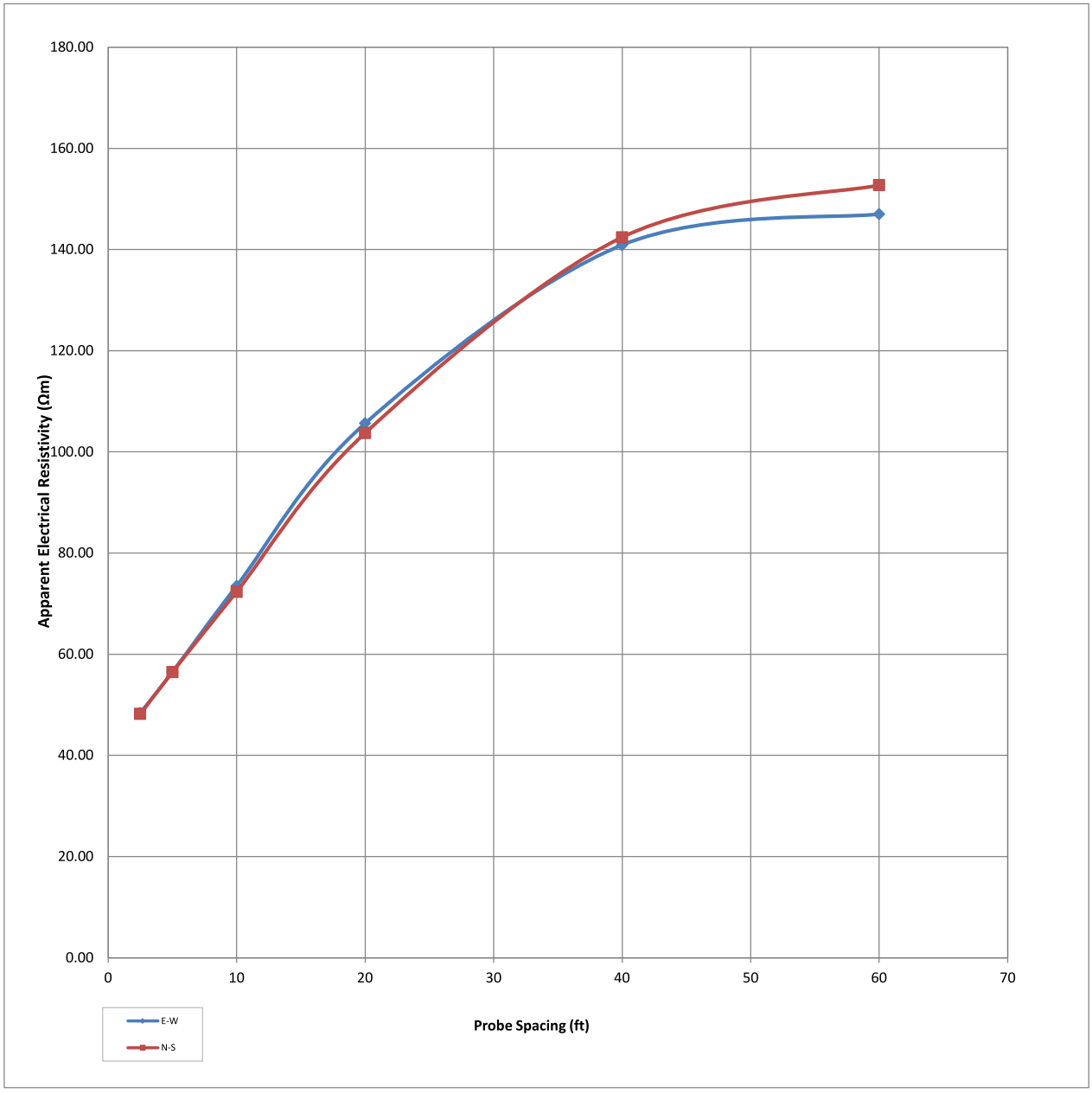


General Sketch of the test set up.

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.

Emerson Creek Wind Project

Electrical Resistivity Survey at ER T-42



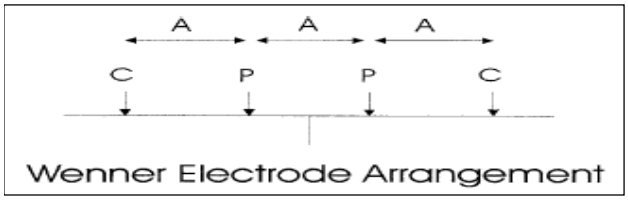
SOIL RESISTIVITY MEASURMENT DATA SHEET

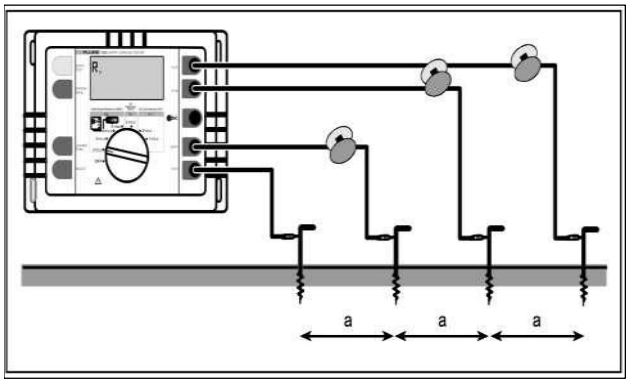
Survey ID ER T-53
DATE 1/21/2020
CLIENT Apex Clean Energy, Inc
PROJECT Emerson Creek Wind Project
Project No. MD1901007
LOCATION: Erie and Huron Counties, OH
LATITUDE : 41.138747
LONGITUDE : -82.832547
WEATHER: Parlty Cloudy
Temp. (°F) 26°F
TOP SOIL: Lean Clay(CL), With Sand, Light Brown, Dry
TYPE OF TEST : Wenner 4-Pin Method
EQUIPMENT: AEMC Ground Resistane Tester
SERIAL NO. 257543JJDV
MODEL: 4630
CALIBRATION DUE DATE: 7/8/2020
TEST PERFORMED BY : RRC

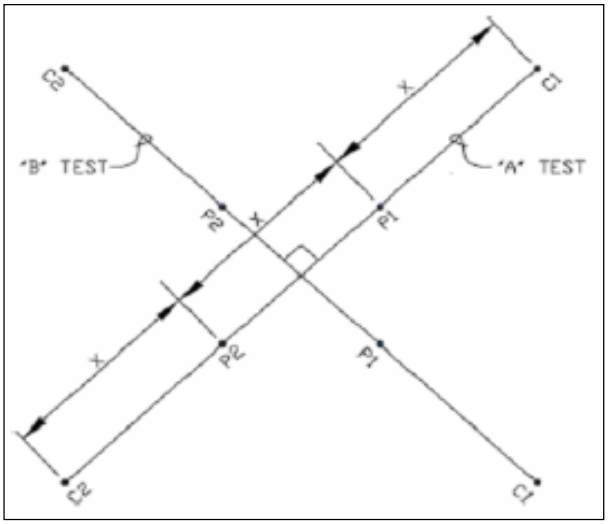
TEST SET RANGE
Meter Current: 1mA - 10mA
Meter Resistance: 1cOhm - 1.999 kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			E-W		N-S				Average Soil Resistivity (Ωm)
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	
2.5	4	2	9.210	44.07	9.650	46.18			45.13
5	4	2	3.020	28.90	3.110	29.76			29.33
10	12	6	1.440	27.56	1.420	27.18			27.37
20	12+	6	0.890	34.07	0.870	33.31			33.69
40	12+	6	0.680	52.06	0.670	51.30			51.68
60	12+	6	0.590	67.76	0.590	67.76			67.76

Notes:





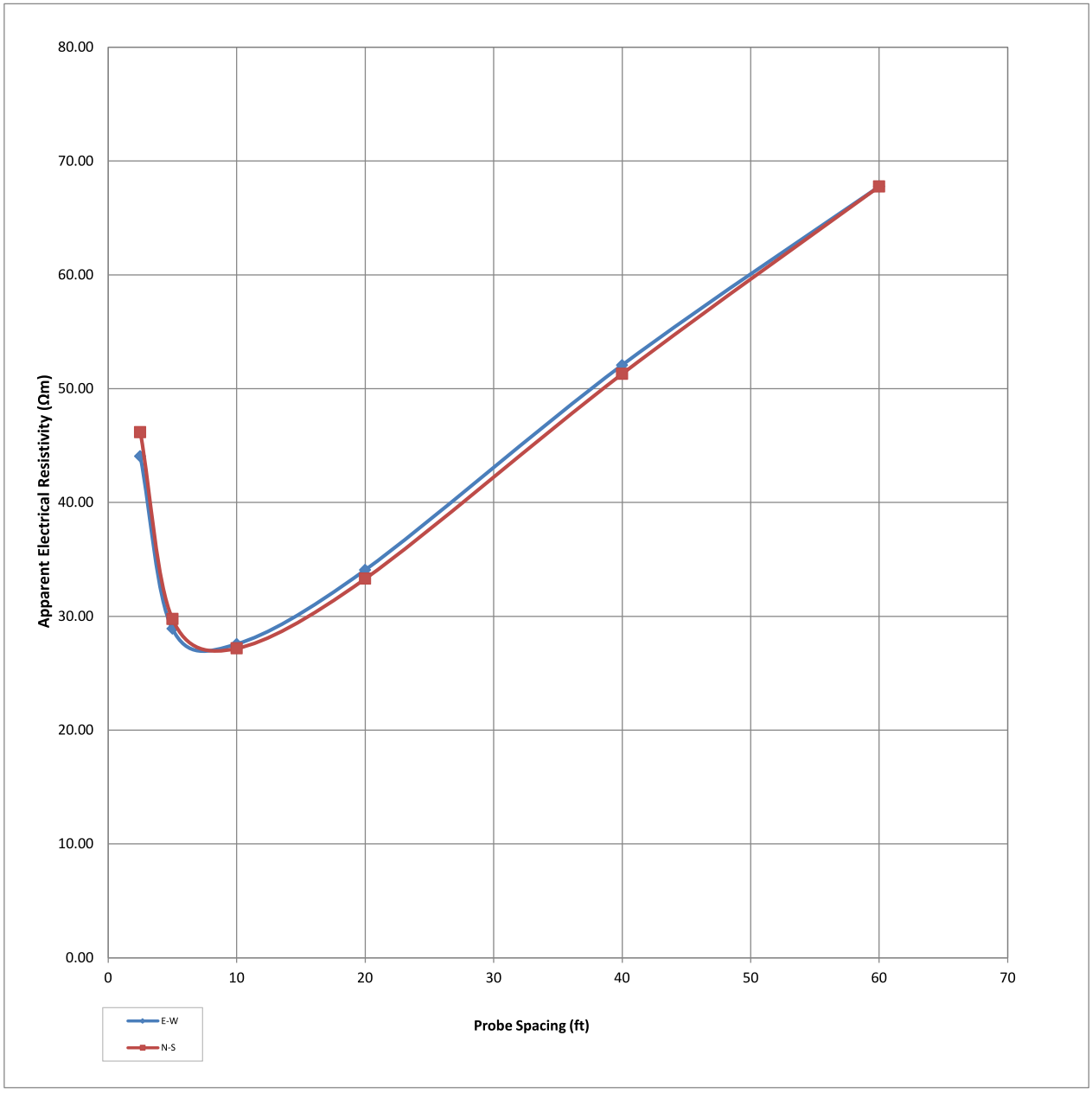


General Sketch of the test set up.

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.

Emerson Creek Wind Project

Electrical Resistivity Survey at ER T-53



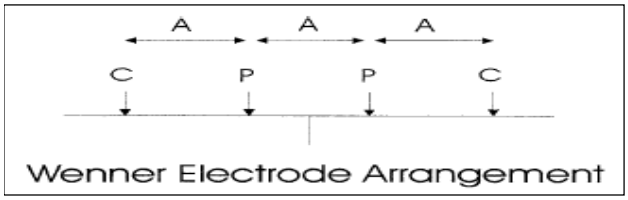
SOIL RESISTIVITY MEASURMENT DATA SHEET

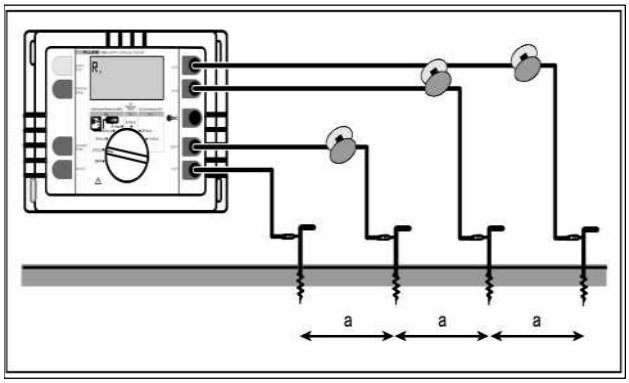
Survey ID ER T-67
DATE 1/21/2020
CLIENT Apex Clean Energy, Inc
PROJECT Emerson Creek Wind Project
Project No. MD1901007
LOCATION: Erie and Huron Counties, OH
LATITUDE : 41.094198
LONGITUDE : -82.770705
WEATHER: Parlty Cloudy
Temp. (°F) 32°F
TOP SOIL: Lean Clay(CL), Trace Sand, Light Brown, Dry
TYPE OF TEST : Wenner 4-Pin Method
EQUIPMENT: AEMC Ground Resistane Tester
SERIAL NO. 257543JJDV
MODEL: 4630
CALIBRATION DUE DATE: 7/8/2020
TEST PERFORMED BY : RRC

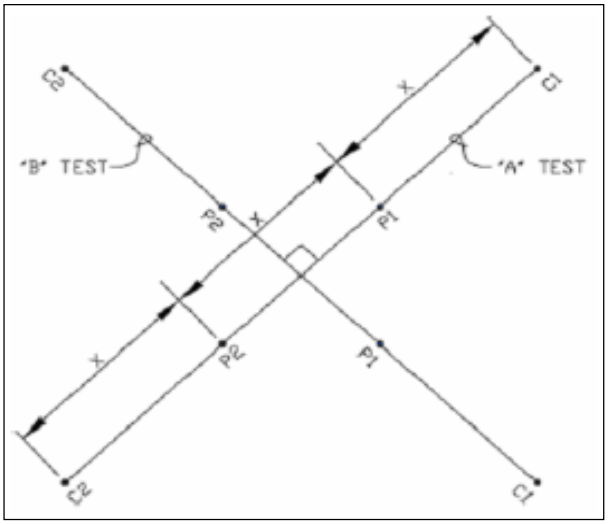
TEST SET RANGE
Meter Current: 1mA - 10mA
Meter Resistance: 1cOhm - 1.999 kOhm

PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			E-W		N-S				Average Soil Resistivity (Ωm)
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	
2.5	4	2	5.150	24.64	6.050	28.95			26.80
5	4	2	2.400	22.97	2.420	23.16			23.07
10	12	6	1.080	20.67	1.020	19.52			20.10
20	12+	6	0.470	17.99	0.510	19.52			18.76
40	12+	6	0.250	19.14	0.260	19.91			19.52
60	12+	6	0.190	21.82	0.190	21.82			21.82

Notes:





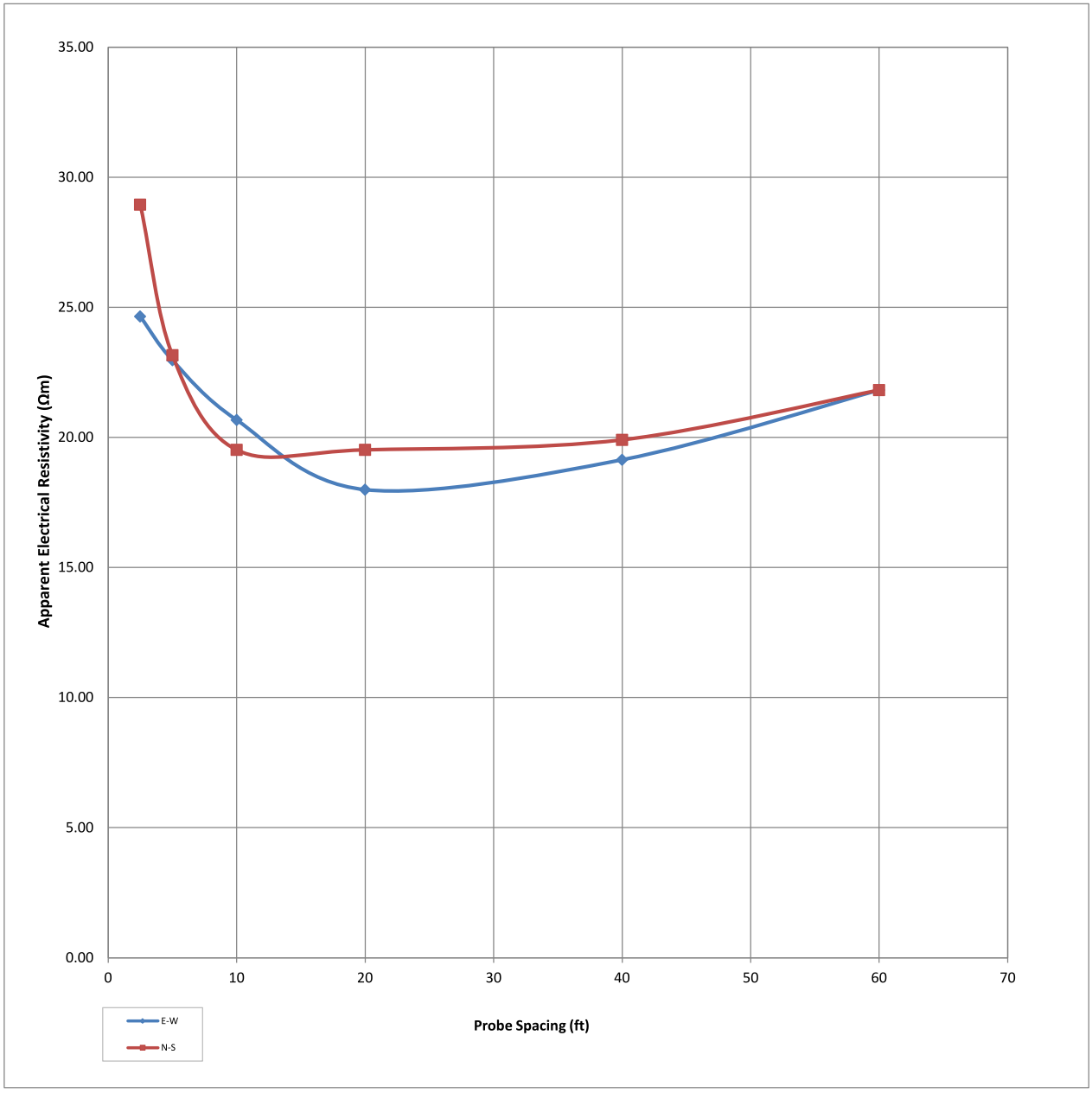


General Sketch of the test set up.

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.

Emerson Creek Wind Project

Electrical Resistivity Survey at ER T-67



SOIL RESISTIVITY MEASURMENT DATA SHEET

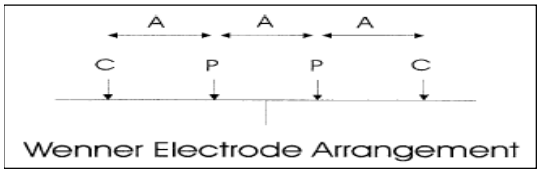
Survey ID ER Substation
DATE 1/22/2020
CLIENT Apex Clean Energy, Inc
PROJECT Emerson Creek Wind Project
Project No. MD1901007
LOCATION: Erie and Huron Counties, OH
LATITUDE : 41.268763
LONGITUDE : -82.764568
WEATHER: Cloudy
Temp. (°F) 33°F
TOP SOIL: Lean Clay(CL), With Sand, Light brown, Dry

TYPE OF TEST : Wenner 4-Pin Method
EQUIPMENT: AEMC Ground Resistane Tester
SERIAL NO. 257543JJDV
MODEL: 4630
CALIBRATION DUE DATE: 7/8/2020
TEST PERFORMED BY : RRC

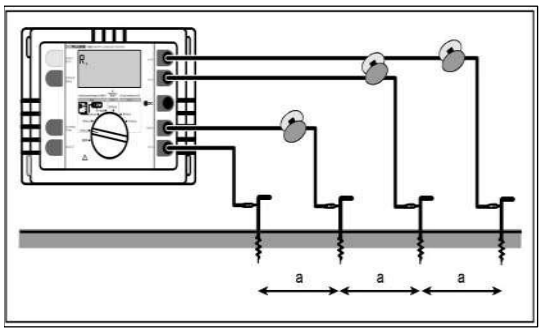
TEST SET RANGE
Meter Current: 1mA - 10mA
Meter Resistance: 1cOhm - 1.999 kOhm

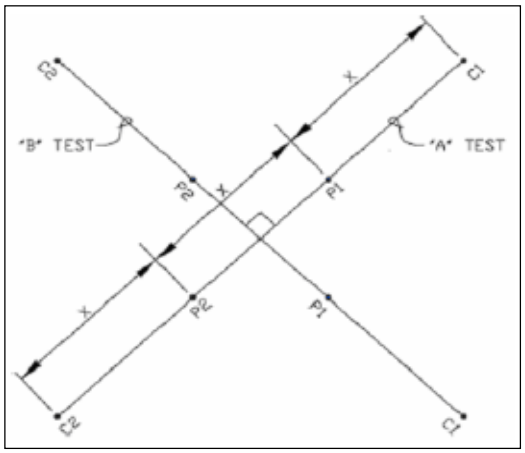
PROB Spacing (ft)	PROBE C DEPTH (Inches)	PROBE P DEPTH (Inches)	APPARENT ELECTRICAL RESISTIVITY						
			E-W		N-S				
			Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Meter reading (Ω)	Soil Resistivity (Ωm)	Average Soil Resistivity (Ωm)
0.5	4	2	96.400	92.26	112.600	107.77			100.01
1	4	2	55.000	105.28	58.200	111.40			108.34
1.5	4	2	32.700	93.89	34.600	99.34			96.62
2	4	2	22.700	86.90	23.300	89.20			88.05
3	4	2	17.270	99.17	17.850	102.50			100.84
5	4	2	11.250	107.67	12.140	116.19			111.93
7	12	6	8.220	110.14	9.900	132.65			121.40
10	12	6	7.020	134.37	7.450	142.60			138.49
15	12	6	5.090	146.14	5.260	151.03			148.59
20	12+	6	3.880	148.54	3.820	146.24			147.39
30	12+	6	2.640	151.60	2.620	150.45			151.03
45	12+	6	1.760	151.60	1.870	161.08			156.34
70	12+	6	1.320	176.87	1.310	175.53			176.20
100	12+	6+	1.010	193.33	1.010	193.33			193.33
150	12+	6+	0.710	203.86	0.690	198.11			200.99
200	12+	6+	0.490	187.59	0.510	195.24			191.41

Notes:



Wenner Electrode Arrangement



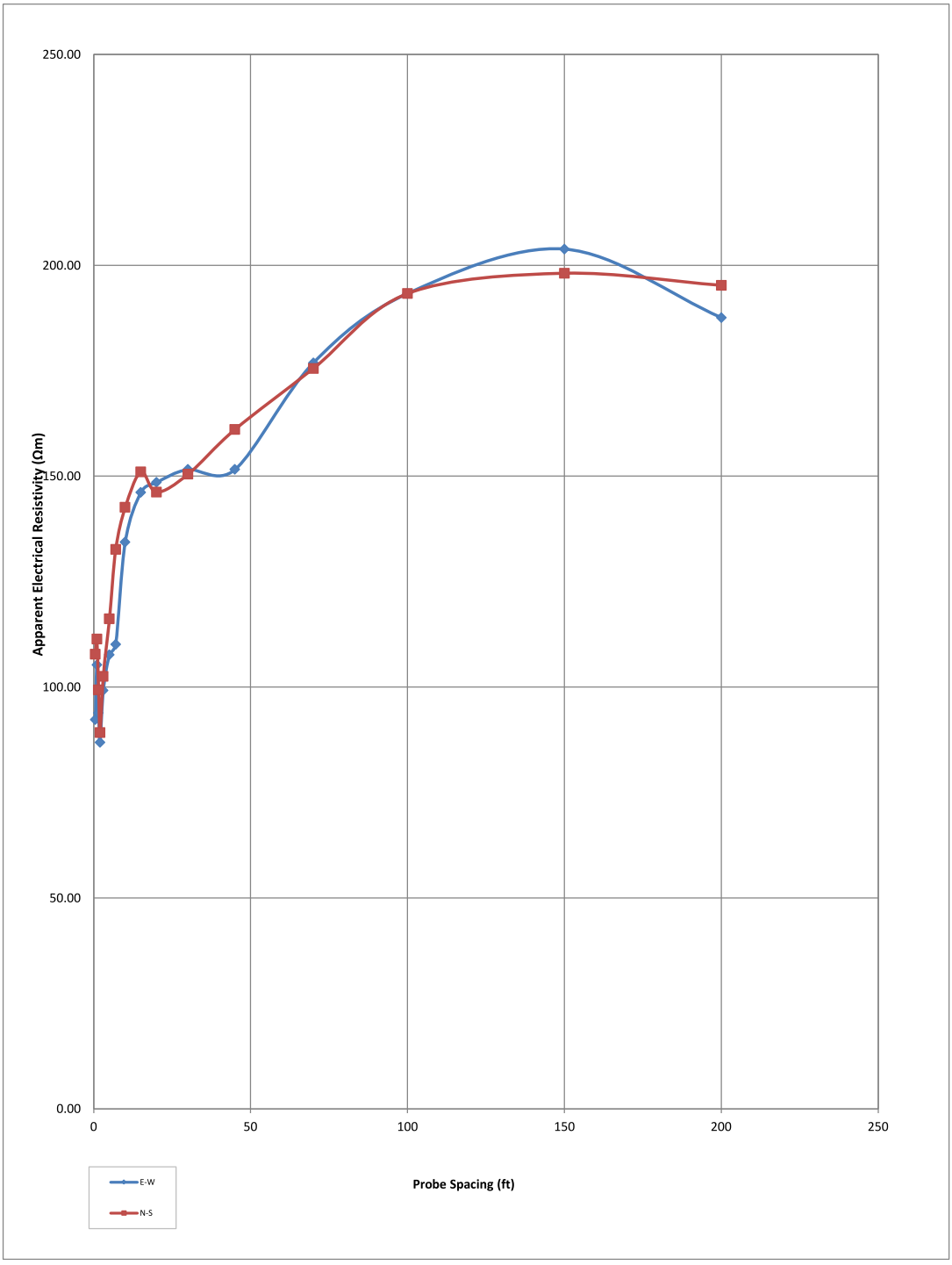


General Sketch of the test set up.

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.

Emerson Creek Wind Project

Electrical Resistivity Survey at ER Substation



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SOIL THERMAL SURVEY
EMERSON CREEK WIND FARM PROJECT
NEAR BELLEVUE, OHIO

MAY 2019

Prepared for:

RRC Power & Energy
3801 Doris Lane
Round Rock, TX 78664

Submitted by:

GEOTHERM USA, LLC

COOL SOLUTIONS FOR UNDERGROUND POWER CABLES
THERMAL SURVEYS, CORRECTIVE BACKFILLS & INSTRUMENTATION

Serving the electric power industry since 1978

INTRODUCTION

A field thermal resistivity survey of the native soils was performed for the proposed underground power cables at the **Emerson Creek Wind Farm Project near Bellevue, Ohio. RRC Companies** provided all the support services through a local contractor and their field personnel. This included identifying the test locations, obtaining permits, clearing underground services and providing a backhoe with operator to excavate all test pits.

Field Testing and Soil Sampling:

Thermal resistivity testing was performed at five (5) locations along the cable routes; on April 11th, 2019 **(Table 1)**. At each location, a backhoe was used to dig a 4-foot deep test-pit and thermal resistivity tests were performed at depths of 2, 3 and 4-feet below grade. In addition, samples for visual description, moisture content and thermal dry out characterization were taken. Test location coordinates were provided by **RRC**.

In-situ thermal resistivity and ambient temperature measurements were made using field thermal probes and the *Geotherm* **TPA-2000** run off a portable power source. All thermal testing was performed in accordance with the IEEE Standard (**IEEE 442-2017**). Laboratory geotechnical testing was conducted in accordance with **ASTM**.

The field thermal resistivity values were measured at the given soil moisture on that day. Depending on weather and environmental conditions; i.e. drying due to cable heat or other heat source, seasonal drying (drought), artificial draining, water demand of crops, etc., the soil may be drier at certain times of the year. Therefore, the design thermal resistivity for the native soils should be based on the driest expected conditions.

The attached table present factual information on the subsurface conditions at the specific test pit locations; no warrantee is expressed or implied that materials or conditions other than those described may not be encountered along the cable route.

Laboratory Testing:

The samples sent to us by RRC were tested at their 'as received' moisture content and at 92% of the MDD provided by ***RRC***. The tests were conducted in accordance with IEEE standard 442-2017. The test results are given in **Table 2** and the thermal dryout curves are presented in **Figure 1.**

Comments:

Ambient Temperature: In-situ testing was conducted at the time of the year when the earth ambient temperatures were not the highest. At the end of a warm summer, the ambient temperatures may increase significantly; especially at shallow depths. This should be taken into consideration for the cable rating. At the proposed cable burial depth of about 3-4 ft., temperature of about 25 ºC is suggested.

Geotherm believes a maximum ambient soil temperature of approximately 25 °C shall be adequate; however, the Engineer of Record will ultimately be responsible for the determination of appropriate soil temperature assumptions.

Please contact us if you have any questions or if we can be of further assistance.

Geotherm USA

Nimesh Patel

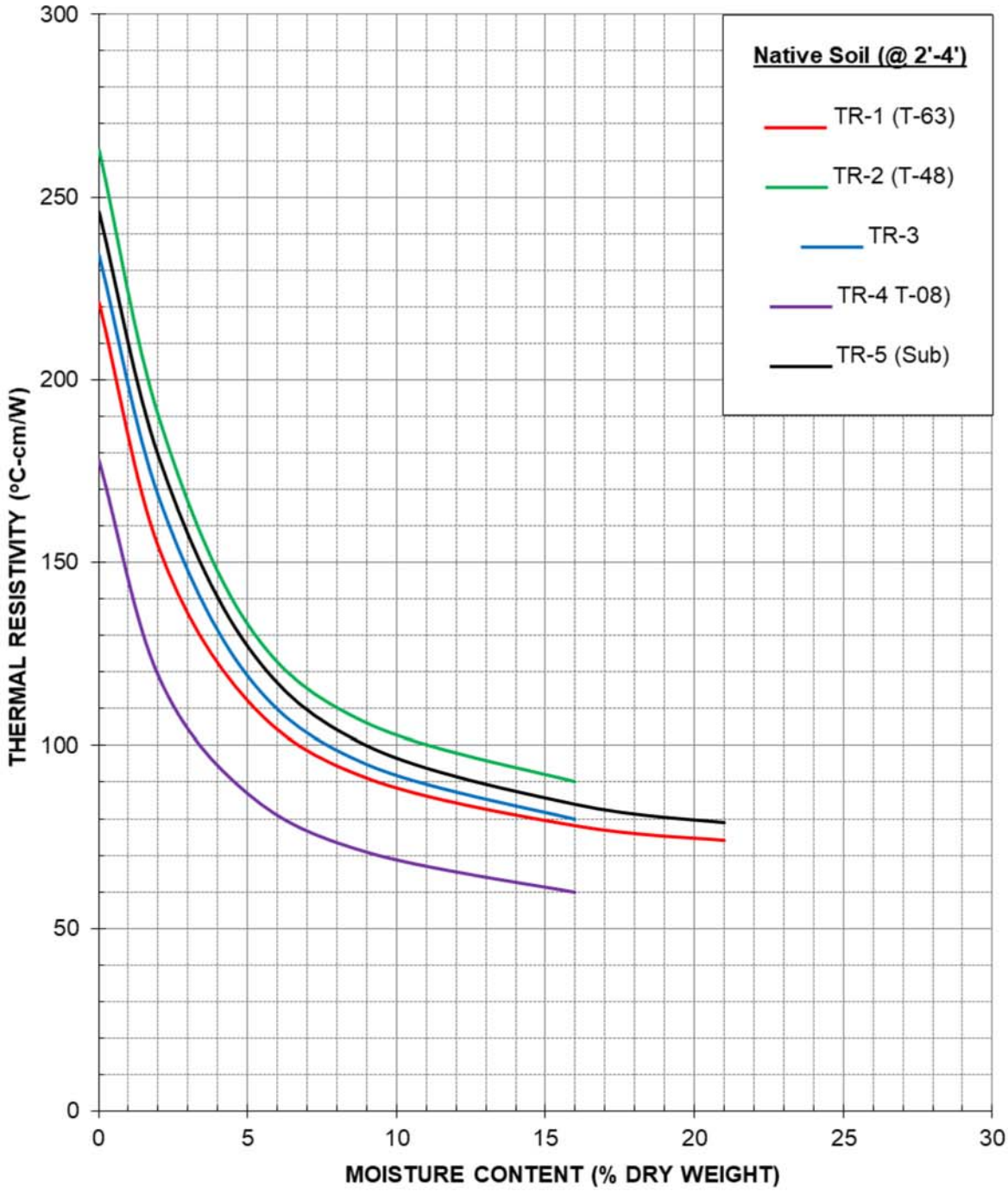
Table 1 - Field Test Results

Test Pit #	Latitude	Longitude	Test Depth (ft)	Ambient Temp. (°C)	In-situ Thermal Resistivity (°C-cm/W)	RRC Description
TR - 1 (T-63)	41.107602	-82.807065	2	6.0	62	Brown Fat Clay w/ Sand (CH)
			3	6.9	57	
			4	6.3	59	
TR - 2 (T-48)	41.154774	-82.811374	2	6.5	67	Brown Lean Clay w/ Sand (CL)
			3	7.6	69	
			4	7.1	63	
TR - 3	41.209883	-82.788517	2	5.8	60	Light Brown Lean Clay w/ Sand (CL)
			3	6.6	59	
			4	6.1	58	
TR - 4 (T-08)	41.316613	-82.776070	2	6.5	48	Dark Brown Sandy Lean Clay (CL)
			3	7.7	50	
			4	7.4	51	
TR - 5 (Sub)	41.268924	-82.765749	2	6.0	65	Dark Brown Lean Clay w/ Sand (CL)
			3	6.9	64	
			4	6.3	62	

Table 2 - Laboratory Test Results

Sample ID (@ 2'-4')	Description (RRC)	Thermal Resistivity (°C-cm/W)		Moisture Content (%)	Dry Density (lb/ft^3)
		Wet	Dry		
TR - 1 (T-63)	Brown Fat Clay w/ Sand (CH)	74	221	21	95
TR - 2 (T-48)	Brown Lean Clay w/ Sand (CL)	90	263	15	98
TR - 3	Light Brown Lean Clay w/ Sand (CL)	80	234	16	99
TR - 4 (T-08)	Dark Brown Sandy Lean Clay (CL)	60	178	17	104
TR - 5 (Sub)	Dark Brown Lean Clay w/ Sand (CL)	79	246	21	93

THERMAL DRYOUT CURVES



RRC Power & Energy (RRC No. MD1901007)

Thermal Analysis of Native Soil

Emerson Creek Wind Project

May 2019 **Figure 1**

www.RRCcompanies.com

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Round Rock, TX 78664
512.992.2087

APPENDIX D

Table D1.1 – LPILE Computer Program Parameters for Lateral Load Analysis for Substation

Soil Layer	Depth (feet)	LPILE Soil Type	K (pci)		γ'	C	ϕ	ε_{50}	E_{rm}	UCS	RQD	K_{rm}
			Static	Cyclic	(pcf)	(psf)	(degree)		(psi)	(psi)	(%)	
1*	0 to 3	Soft Clay (1)	--	--	120	--	--	--	--	--	--	--
2	3 to 7	Stiff Clay w/o Free Water (3)	--	--	120	1,580	--	0.007	--	--	--	--
3	7 to 10	Stiff Clay w/o Free Water (3)	--	--	120	5,900	--	0.004	--	--	--	--
4	10 to 15	Weak Rock (9)	--	--	130	--	--	--	120,000	1,000	20	0.0005
5	15 to 20	Weak Rock (9)	--	--	130	--	--	--	120,000	1,000	20	0.0005

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 Substation

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	γ	ϕ	C	C'_{Rock}	K_p	SPT N-Value (blows/ft)	Deformation Modulus (ksi)	Allowable Unit Skin Friction (FS=2.5)[1] (psf)	Allowable Bearing Pressure (FS=3) (psf)
			(pcf)	(degree)	(psf)	(psf)					
1*	0 to 3	Soft Clay	120	--	--	--	--	--	--	--	--
2	3 to 7	CL	120	--	1,580	--	2.98	12	1.4	340	4,200
3	7 to 10	CL	120	--	5,900	--	2.98	200	8.0	1,060	17,700
4	10 to 15	SHALE	130	31	--	2,000	--	--	100.0	3,100	19,200
5	15 to 20	SHALE	130	31	--	2,000	--	--	100.0	3,100	19,200

Table D1.3 – MFAD 5.1/HFAD 5.1 Rock Design Parameters for Substation

Soil Layer	Depth (feet)	USCS Soil & Rock Classification	Ultimate Rock/Concrete Bond Strength (psi)
1*	0 to 3	Soft Clay	--
2	3 to 7	CL	--
3	7 to 10	CL	--
4	10 to 15	SHALE	50
5	15 to 20	SHALE	50

Notes: Design depth to groundwater is 20 feet

*Upper 3 feet of soils should be neglected due to seasonal moisture change; Kp: Rankine Passive Earth Pressure Coefficient; γ': Effective Unit Weight ($\gamma' = \gamma_{Total} - 62.4$ pcf); ϕ: Angle of Internal Friction.

[1] For uplift resistance, the allowable skin friction provided in table above should be reduced by 25 percent.

[2] 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.

Summary: Testimony - Direct Testimony of Alfred Williams electronically filed by Christine M.T. Pirik on behalf of Firelands Wind, LLC