Hardin Solar Energy II LLC
Case No. 18-1360-EL-BGN

Application Part 5 of 6

Part 5 includes:

- **Exhibit N Geotechnical Engineering Report**
- **Exhibit O Soil Reactivity Study January 2017**
- **Exhibit P U.S. Fish and Wildlife Service Communication June 2018**
- **Exhibit Q TRC Cultural Resources Records Report October 2018**

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Exhibit N

Geotechnical Engineering Report

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Exhibit N

Geotechnical Engineering Report
Hardin Wind Project
Hardin County, Ohio

Prepared for
Invenergy, LLC
Chicago, Illinois

January 2012

BARR

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Hardin Wind Project
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Table of Contents

1.0 Introduction 1
1.1 Site Location 1
1.2 Site Geology 1
1.3 Previous Investigation 2
2.0 Geotechnical Exploration Methods 3
2.1 Field Work 3
2.1.1 CPT Soundings 3
2.1.2 DMT Soundings 4
2.1.3 Soil Borings 5
2.1.4 Groundwater Piezometers 5
2.2 Soil Testing 6
2.3 Soil Electrical Resistivity Testing 6
2.4 Thermal Resistivity Testing 6
3.0 Results 8
3.1 Soil Lithology 8
3.1.1 Surficial Materials 8
3.1.2 Lacustrine Clay 8
3.1.3 Sand Layers 9
3.1.4 Glacial Till 9
3.1.5 Weathered Bedrock 10
3.2 Groundwater Conditions 10
3.3 General Laboratory Testing 10
3.3.1 Moisture Content 10
3.3.2 Atterberg Limits 10
3.3.3 Grain Size Analysis 11
3.3.4 Dry Density and In-Situ Unit Weight 11
3.3.5 Unconfined Compressive strength and UU Testing 11
3.4 Shear Strength 11
3.4.1 Design Value Determination 11
3.4.2 Low Strength Zones and Alternate Turbine Location Testing 12

3.5 Shear and Compression Wave Velocities 13
3.6 Compressibility 14
3.6.1 Compressibility Characteristics from DMT 14
3.6.1 Compressibility Characteristics from laboratory testing 14
3.7 Shrink/Swell Potential 15
3.8 Compaction and CBR Testing 15
3.9 Karst Potential 16
4.0 Analysis and Recommendations 18
4.1 Roadway Design 18
4.1.1 Surface Preparation for Roadways 18
4.1.2 Subgrade Preparation 18
4.1.3 Road Base Design Considerations 20
4.2 Excavation and Fill 22
4.2.1 Clearing and Grubbing 22
4.2.3 General Cut 22
4.2.4 General Fill 22
4.2.5 Excavation, Backfill and Compaction for Foundations 23
4.3 Groundwater and Dewatering 24
4.4 Wind Turbine Tower Foundation 25
4.4.1 Foundation Type 25
4.4.2 Bearing Capacity 25
4.4.3 Turbine Locations Requiring Soil Remediation 27
4.4.3.1 Engineered Fill 27
4.4.3.2 Stone Columns/Geopiers 28
4.4.3.3 Deep Pile Foundation System 29
4.4.3.4 Use of Alternate Location 29
4.4.4 Karst Risk Mitigation 29
4.4.5 Foundation Stiffness 30
4.4.6 Sliding Friction 30
4.4.7 Foundation Settlement 30
4.4.7.1 Immediate Settlement 30
4.4.7.2 Long-term Settlement from DMT 31
4.4.7.3 Long-term Settlement from Laboratory Consolidation Testing 33
4.4.7.4 Turbine Locations with Excessive Differential Settlement 34
4.4.8 Backfill Density 34
4.4.9 Soil Chemical Content and Cement Type 34
5.0 Limitations of Analysis 35
6.0 References 36

Tables

Table 1 Proposed Turbine Coordinates and Testing Summary
Table 2 Groundwater Levels from Standpipe Piezometers
Table 3 Mitigation Depth Summary
Table 4 Summary of Average Compression and Shear Wave Velocity and Poisson's Ratio
Table 5 Estimated Long-Term Settlement under Mean Operating Load Conditions
Table 6 Summary of General Laboratory Test Results
Table 7 Subgrade Compaction and Aggregate Thickness
Table 8 Summary of Geotechnical Parameters for Foundation Design

Figures

Figure 1 Site Location Map
Figure 2 Site Layout Map
Figure 3 Parent Material of Surface Soil Map
Figure 4 Soil Plasticity Map
Figure 5 Depth to Bedrock Map
Figure 6 Bedrock Geology
Figure 7 Karst Map
Figure 8 CPT & Seismic Test Locations Map
Figure 9 Borehole Test Locations and Piezometer Locations Map
Figure 10 DMT Test Locations Map
Figure 11 Electrical and Thermal Test Locations
Figure 12 Recommended Soil Remediation Sites
Figure 13 Undrained Shear Strength from CPT vs Depth Turbines 1-10
Figure 14 Undrained Shear Strength from CPT vs Depth Turbines 11-20
Figure 15 Undrained Shear Strength from CPT vs Depth Turbines 21-30
Figure 16 Undrained Shear Strength from CPT vs Depth Turbines 31-40
Figure 17 Undrained Shear Strength from CPT vs Depth Turbines 41-50
Figure 18 Undrained Shear Strength from CPT vs Depth Turbines 51-60
Figure 19 Undrained Shear Strength from CPT vs Depth Turbines 61-70
Figure 20 Undrained Shear Strength from CPT vs Depth Turbines 71-80
Figure 21 Undrained Shear Strength from CPT vs Depth Turbines 81-90
Figure 22 Undrained Shear Strength from CPT vs Depth Turbines 91-100
Figure 23 Undrained Shear Strength from CPT vs Depth Turbines 101-110
Figure 24 Undrained Shear Strength from CPT vs Depth Turbines 111-120
Figure 25 Undrained Shear Strength from CPT vs Depth Turbines 121-130
Figure 26 Undrained Shear Strength from CPT vs Depth Turbines 131-133

Appendices

Appendix A	CPT Sounding Logs
Appendix B	Shear and Compression Wave Velocity Test Results
Appendix C	Dilatometer (DMT) Test Results
Appendix D	Soil Boring Logs
Appendix E	Laboratory Test Results
Appendix F	Electrical Resistivity Report
Appendix G	Thermal Resistivity Report
Appendix H	Chemical Testing Results
Appendix I	CBRs for Roadways

1.0 Introduction

Barr Engineering Company (BARR), under authorization and contract with Invenergy, LLC (Invenergy), completed a design phase geotechnical investigation of the Hardin Wind Project site in Hardin County, Ohio.

Under subcontract to BARR, Minnesota GeoServices of St. Paul, Minnesota completed cone penetration testing (CPT) for 114 of 133 proposed turbine locations; 19 turbine locations were on hold at the time of the field investigation. Marchetti Dilatometer Testing (DMT) was performed at 13 proposed turbine locations in conjunction with CPT testing to evaluate settlement potential.

Under subcontract to BARR, GEOCON Professional Services of Frankfort, Illinois completed hollow-stem auger (HSA) drilling at fifteen proposed turbine locations and the switchyard, substation, and O&M building locations. Piezometers were installed at each of the proposed turbine locations investigated by HSA drilling.

A Barr representative was present during the explorations. Selected soil samples collected during the borings were tested by GEOCON and Soil Engineering Testing (SET) of Bloomington, Minnesota.

This report describes the geotechnical investigation and testing performed, presents the results of this work, and provides geotechnical analysis and conclusions for foundations to be designed and constructed for the proposed wind project.

1.1 Site Location

The proposed Hardin County Wind Project is located on rural farmland in Hardin County, Ohio, outside of the town of McGuffey (Figure 1). Figure 2 shows the proposed turbine locations and the numbering provided at the start of the investigation. The coordinates for each proposed turbine location and related geotechnical testing locations are included in Table 1.

The proposed turbines sites were located in agricultural fields. The majority of the site lies in the Scioto Marsh area which is a very flat area of former marsh land that formed in the glacial lake basin and resulted in approximately 2 to 10 feet of peat overlying the underlying lacustrine clay (Reference 19). Natural and man-made drainage waterways are located in low-lying areas of the site. It was reported that County Road 195 south of McGuffey has had numerous serviceability issue with respect to settlement in the area of the marsh. During the time of the geotechnical field investigation a portion of the road was closed. Increased topographic variation is present around the edges of the Scioto Marsh area.

1.2 Site Geology

The project site is located within a physiographic region known as the Eastern Lake and Till Plains Sections of the Central Lowland Province of the Interior Plains. This entire region is

glaciated, and most areas are dominated by ground moraines that are broken in places by lake plains, outwash plains, flood plains, and many recessional moraines (Reference 8).

More localized to the project area, surficial deposits are mostly ground and end moraines (glacial till), lake plain (lacustrine soils), and a covering of modern peat (organic soil) over deeper glacial deposits and bedrock. Ground moraine and end moraine deposits consist primarily of a clay matrix with interlayered sand, silt, and some gravel. Ground moraine areas are characterized by relatively flat to gently undulating topography, while end moraine areas occur as hummocky ridges. To the north of project site, the topography tends to have less relief. These areas are represented by lacustrine deposits consisting of primarily clay and silt (Reference 14). The soil origin (parent material) is described in Figure 3. Surficial USCS soil classifications are provided in Figure 4.

Water wells in the project area indicate a static water level of 10-feet to about 40-feet below ground surface. These wells produce from both glacial aquifers and bedrock aquifers. The glacial overburden probably represents a confining layer to the underlying bedrock aquifers and contains several confined aquifers within. The uppermost water table is likely to be shallow (5- to 20-feet below ground surface) across the entire project site (Reference 10).

Overburden thickness varies around the project area, from less than 50 feet (to the east) to over 200 feet (to the west) (Figure 5). To the west of the proposed switchyard somewhat in line with the Scioto River, there is a buried bedrock valley. Bedrock found beneath the overburden consists of Silurian-age dolomites and shale. The Tymochtee and Greenfield Dolomites overlay the Lockport Dolomite, which is found in the buried bedrock valley (Reference 9 and Reference 16) See Figure 6 for the bedrock geology map.

The State of Ohio maintains a database of oil and gas drilling and exploration activity (Reference 11) There are a few abandoned and plugged wells in the vicinity of the project, but no current oil and gas drilling activity. Similarly, state mapping of underground mines indicates no known underground mines in Hardin County (Reference 13).

Dolomite and limestone are the principle rock types that contain karst features. Karst features such as dissolution cavities, caves, and sinkholes can cause subsidence of the ground surface. Karst features have not been mapped in Hardin County. However the area is underlain by carbonate rocks and karst areas have been mapped in nearby northern Logan County and are known to occur throughout western Ohio. Karst in Ohio is particularly prevalent in areas with less than 20 ft of glacial drift or alluvium overlying the carbonate bedrock (Reference 12). Regional mapping indicates there is generally greater than 50 ft of overburden at the proposed project site so karst formation is unlikely at this time. However, there is still a risk of karst formation on site, particularly in areas with locally decreased overburden thicknesses (Reference 12).

1.3 Previous Investigation

Barr has completed two previous reports for the proposed Hardin Wind Project site. These include the switchyard geotechnical investigation report and the electrical resistivity report. Barr is not aware of any other investigations for the Hardin Wind Project site.

2.0 Geotechnical Exploration Methods

The geotechnical investigation for the Hardin Wind Project consisted of Seismic/Piezocone Penetration Testing (CPT), Marchetti Dilatometer Soundings (DMT), hollow stem auger (HSA) soil borings, standard penetration tests (SPT), piezometers, field tests, and laboratory tests. Figures 8 through 10 show the plan location of all soundings and borings completed for the project, as well as the layout of the turbines. The site investigation for the turbines was conducted in August, 2011. Laboratory testing for the turbines is ongoing. Coordinates of the proposed turbine locations and a list of testing performed at each turbine location are provided in Table 1. The turbine locations were located using hand-held GPS units during field activities at the direction of Invenergy.

2.1 Field Work

2.1.1 CPT Soundings

CPT soundings were performed at 114 potential turbine sites being considered for development at the time of this report (see Figure 8). CPT testing was performed in accordance with ASTM D5778, "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils." The CPT soundings generally reached a depth of greater than 30 feet below ground surface, with the exception of the following proposed turbine locations 12, 14, 18, 19, 26, 30, 31, 34, 35, 37-39, 117, 118, and 129. Logs of CPT soundings are in Appendix A.

All CPT soundings were conducted by Minnesota GeoServices of St. Paul, Minnesota. CPT soundings were performed with either a 20-ton truck mounted rig or 15-ton track mounted rig with an enclosed work space. All equipment was in accordance with ASTM D-5778. For the CPT test, a cylindrical cone is pushed vertically into the ground at a constant rate of penetration of 20 mm/sec. During penetration, measurements are made of the cone tip resistance (q_c), the side friction of the cylindrical shaft (f_s) just above the tip, and porewater pressure generated by cone penetration (u_2). The cones used in the investigation have a 15 cm^2 base area with a 60 degree apex angle. The sleeve area of the cones is 300 cm^2. The fluid used for saturation of the filter was glycerin. Minnesota GeoServices provided BARR with complete records of tip resistance, sleeve friction, pore pressure, and friction ratio of all CPT soundings. These records included a hard copy showing the graphical variations of all readings with depth.

The following describes the procedures and processes used to interpret the CPT data and the interpreted lithology.

CPT data reduction and interpretation were performed using an in-house program designed by Barr specifically for use on wind turbine projects. The in-house program has been cross-checked with CPTINT version 5.2 for quality assurance and has been found to be compliant. The program uses the soil behavior type classification system from CPT data proposed by Robertson et al. (1986). The classification system is based on the corrected tip resistance (q_t), the friction ratio (R_f), and pore-water pressure parameter (B_q), and includes a total of 12 soil behavior types.

These cone parameters are defined as follows:

$$q_t = q_c + (1 - a) \cdot u_2$$ (Reference 6, page 25)

$$R_f = \frac{f_s}{q_t} \cdot 100\%$$ (Reference 6, page xiv)

$$B_q = \frac{u_2 - u_0}{q_t - \sigma_{vo}}$$ (Reference 6, page 51)

where

q_c = tip resistance measured by the cone, load per area

a = the area ratio of the cone

u_2 = measured pore-water pressure during cone penetration, load per area

f_s = unit sleeve friction resistance, load per area

σ_{vo} = total overburden stress, load per area

u_o = in-situ pore water pressure, load per area

The cone was also equipped with a seismometer that measured the arrival time of shear and compression waves generated at the ground surface. The shear waves were generated at the ground surface, by the CPT rig, in the selected locations, and arrival times were measured at depth intervals of approximately 3 m (~10 ft.), to determine the interval shear wave velocity. In a similar manner, the compression waves were generated at the ground surface, by the CPT rig, in selected locations, and arrival times were measured at depth intervals of approximately 3 m (~10 ft.), to determine the interval compression wave velocity. Locations were selected to provide spatial coverage over the entire project site. The results of shear and compression wave testing can be found in Appendix B.

2.1.2 DMT Soundings

A total of 13 DMT soundings were performed at proposed turbine site locations 5, 45, 48, 51, 54, 64, 70, 78, 81, 89, 92, 107, 131 as illustrated in Figure 10. These locations were chosen for DMT testing to represent the settlement characteristics across the site and to evaluate the apparent lower strength materials encountered during CPT testing. The results of the DMT soundings performed during this investigation are included in Appendix C.

The Marchetti Dilatometer consists of a 95-mm stainless steel blade with a thin, flat, and expandable steel membrane (60-mm diameter) on the side. Performing a DMT test consists of pushing the dilatometer blade into the ground vertically to a desired test depth, measuring the thrust necessary to accomplish this penetration, and then using gas pressure to expand the circular steel membrane against the soil. The test operator obtains three readings: the A-pressure required to initiate movement of the membrane against the soil; the B-pressure required to move its center 1 mm into the soil; and the C-pressure during deflation of the membrane, which is related to the in-situ pore-water pressure in sands and penetration pore-water pressure in clays. The operator then pushes the blade to the next depth and repeats the test. A dilatometer sounding log consists of the results from all the measured and correlated parameters with depth.

The DMT parameter generally includes the measured material index I_d, dilatometer modulus E_d, horizontal stress index K_d, constrained modulus of soil compressibility M, and undrained shear strength s_u. The main objective for performing the DMT soundings was the determination of the constrained modulus of soil compressibility in order to evaluate settlement potential. The DMT has the advantage of providing quasi-continuous soil compressibility information as part of the field investigation. Traditionally, the compressibility soil parameters are obtained by performing a soil boring, taking an undisturbed Shelby tube sample, and performing a consolidation test in the laboratory. The use of the DMT results in obtaining required compressibility parameters much more quickly and comprehensively. The DMT test also is an in-situ test method which does not require sampling and transportation of soils to a testing laboratory.

2.1.3 Soil Borings

Hollow stem auger (HSA) borings were performed at proposed turbine locations 2, 14, 19, 31, 35, 39, 49, 51, 62, 72, 82, 88, 99, and 117 during the subsurface exploration. The boring locations were selected to spatially cover the site and evaluate several of the sites with shallow CPT refusal. The borings at turbine locations 2, 14, 19, 31, 35, 62, and 82 reached auger refusal at depths ranging from 18 to 45 feet below ground surface on limestone bedrock. The boring locations are indicated on Figure 9. The soil borings were performed by GEOCON Professional Services of Frankfort, Illinois with a track-mounted drill rig using hollow stem auger (HSA) techniques with split spoon sampling at maximum 5-foot intervals. The soil boring logs can be found in Appendix D.

Three-inch diameter Shelby tube samples were collected for laboratory testing in accordance with ASTM D1587. The split-spoon and Shelby tube samples were sealed and labeled in the field and delivered to GEOCON Testing Services in Frankfort, Illinois for testing physical properties and to Soil Engineering Testing (SET) laboratory in Richfield, Minnesota for laboratory testing of mechanical properties.

2.1.4 Groundwater Piezometers

PVC standpipe piezometers were installed at 13 of the proposed turbine locations investigated by HSA drilling. A record of the piezometer monitoring events to date is contained in Table 2. Groundwater generally ranged from 2.5 to 10 feet below ground surface in the piezometers.

2.2 Soil Testing

The following tests were performed or coordinated by GEOCON or SET:

- Moisture content tests were performed in accordance with ASTM D2216-05, "Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass"
- Soil unit weight tests in accordance with ASTM D7263 "Standard Test Method for Laboratory Determination of Density (Unit Weight) of Soil Specimens"
- Specific Gravity determinations in accordance with ASTM D854-05, "Standard Test Method for Specific Gravity of Soil Solids by Water Pycnometer"
- Unconfined compressive strength in accordance with ASTM D2166, "Standard Test Method for Unconfined Compressive Strength of Cohesive Soil"
- Triaxial (UU) compressive strength in accordance with ASTM D2850-03a, "Standard Test Method for Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils"
- Grain Size and Hydrometer analysis in accordance with ASTM D422-63(2007), "Standard Test Method for Particle-Size Analysis of Soils"
- Percent Fines (silt and clay) in accordance with ASTM D1140-00, "Standard Test Method for Amount of Material in Soils Finer Than the No. 200 Sieve"
- Atterberg Limit determinations in accordance with ASTM D4318-05, "Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils"
- Soil pH tests in accordance with ASTM D4972-01(2007) "Standard Test Method for pH of Soils"
- Soluble chloride and soluble sulfate of soils

All laboratory test results are provided in Appendix E and summarized on Tables 6.

2.3 Soil Electrical Resistivity Testing

Soil resistivity testing was completed in accordance with ASTM method G57-95a "Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method" (equivalent to IEEE Std. 81). Values were determined at turbine locations 2, 14, 35, 39, 49, 62, 66, 72, 82, 88, 99, and 117. At each location, measurements were taken to yield average soil resistivity at a-spacings of 2, 5, 10, 20 and 40 feet. The soil electrical resistivity is included in Appendix F.

2.4 Thermal Resistivity Testing

Bulk soil samples were collected at the project site for thermal resistivity testing. Samples were obtained from a depth of 3 to 5 feet below the surface and placed in sealed 5 gallon buckets. The samples were shipped to Soil Engineering Testing (SET) of Minnesota. Testing in accordance

with ASTM D:5334-08 “Guide to Thermal Conductivity of Soil and Soft Rock by Thermal Needle Probe Procedure” was ongoing at the time of this draft report. Laboratory tests included measurement of the soil’s moisture content, unit weight, and thermal dryout characteristics, which is a function of moisture content. The thermal resistivity report is included in Appendix G.

3.0 Results

This Section presents the data from testing and investigation in accordance with the field and laboratory investigation procedures described in Section 2, and provides further analysis of these results.

3.1 Soil Lithology

The results of the soil borings (Appendix D), laboratory testing, and CPT soundings (Appendix A) were compiled to obtain an understanding of the lithology of the study area.

The soil conditions encountered during drilling generally agreed with the soil information obtained from the information reviewed from the soil survey information. The existing conditions consist of topsoil underlain primarily by glacial till soils and bedrock at depths of approximately 15 to greater than 50 ft.

Detailed information for soil strata and groundwater conditions are contained in the following sections:

3.1.1 Surficial Materials

The topsoil consists primarily of organic silt to silty clay and is actively farmed. The thickness varies, depending upon the plowed zone and location. The boring logs indicate a range of topsoil thickness of approximately 12 to 18 inches. These soils appear to be reworked site soils with a moderate amount of organic materials. Deeper layers of highly organic soils and peat were encountered across the site, but these layers appeared to be confined to depths shallower than the proposed foundation embedment depth.

3.1.2 Lacustrine Clay

Very weak clay was encountered in many of the CPT soundings and borings. This clay was present across the site and extended to depths of greater than 50 feet in some locations. Based on the geologic history, these very weak clays were likely deposited in the glacial lake or marshes and depressions upon retreat of the glaciers and were not exposed to significant over consolidation.

Undrained shear strength of these clays from CPT generally ranged from 300 to 500 psf while SPT N-values as low as 0 to 2 bpf were observed in many locations.

Atterberg limit testing on samples of the glacial till indicated Plastic Limit values range from about 11 to 20 percent, Liquid Limit values range from about 17 to 42 percent, and Plasticity Index values range from 3.4 to 19 percent. Natural moisture contents ranged from about 10.5 to 24 percent, with a typical range of 12 to 18 percent. According to the Plasticity Chart (Reference 7, pg 7.1-18), these soils generally plot as CL (lean silty clay) according to the USCS Classification System.

Moist unit weights ranged from 120.5 to 140.5 pounds per cubic foot (pcf) with corresponding dry densities ranging from 76 to 120 pcf. Unconfined compressive strengths laboratory testing indicated unconfined compressive strengths ranging from 0.17 to 1.5 tsf. Grain Size test results are discussed in Section 3.3.3.

Laboratory consolidation test values indicated compression indexes ranging from 0.24 to 0.27, initial void ratios ranging from 1.02 to 1.16, and preconsolidation pressures (ie maximum past pressures) between 0.42 and 0.59 tsf. With these values for maximum past pressure, the samples appear underconsolidated. After extrusion from the Shelby tube samplers, the soils wanted to consolidate under their own weight prior to testing and were very difficult to keep undisturbed for testing purposes. This confirms the very soft and highly compressible nature indicated by both the CPT and DMT testing.

The gray silty clay soils tended to be softer and more compressible in the large area noted as "Marsh" on Figure 3. Slightly stiffer gray silty clay soils were noted on the margins of the "Marsh" area. Their appearance was similar except for the marginally higher strengths observed.

3.1.3 Sand Layers

Sand layers were encountered in borings at turbine locations 19, 35, 39, 62, 66, 72, and 117 at varying depths. These layers were generally silty to clayey fine to medium grained sand soils, with fines contents typically ranging from 40 to 50 percent as indicated by grain size test results.

SPT N-values ranged from 8 to54 bpf were observed in the sand soils indicating loose to dense conditions. The seams encountered appeared to be wet to saturated.

The majority of the CPT soundings indicated relatively thin layers of sand also at varying depths and of varying thickness.

3.1.4 Glacial Till

The glacial till soils were encountered below the topsoil extending to CPT and boring refusal on bedrock at depths as shallow as 15 to 20 feet. These soils consist primarily of lean clay with varying amounts of silt and trace sand and gravel though thicker deposits of clayey silt were also encountered.

SPT N-values were also highly variable and ranged from 4 to 66 blows per foot (bpf). Atterberg limit testing on samples of the glacial till indicated Plastic Limit values range from were all about 17 percent, Liquid Limit values range from about 22 to 32 percent, and Plasticity Index values range from 5 to 15 percent. According to the Plasticity Chart (Reference 7, pg 7.1-18), these soils generally plot as CL (lean silty clay) according to the USCS Classification System.

Moist unit weights ranged from about 129 to 141 pounds per cubic foot (pcf) and dry densities ranged from about 106.5 to 124.5 pcf. Natural moisture contents ranged from about 5 to 29 percent, with a typical range of 9 to 19 percent.

3.1.5 Weathered Bedrock

In borings 2, 14, 19, 31, 35, 62, and 82 intensely fractured limestone/dolostone bedrock was encountered at depths ranging from 18 to 45 feet below ground surface. The bedrock was hard, but could be drilled for a couple feet prior to auger refusal being encountered. Coring was used to extend borings 14 and 35 into the bedrock. RQD in the weathered bedrock were observed to be zero.

Based on encountering bedrock in these borings, the shallow CPT refusals at turbine locations 1-8, 16-19, 30-38, 39-41, 60-64, and 82 also likely indicate depth to weathered bedrock.

3.2 Groundwater Conditions

Due to the lack of significant granular deposits, the results of the CPT are not definitive enough with respect to pore water pressure to discern the depth of the groundwater table.

The groundwater level was measured in the PVC standpipe piezometers installed at the turbine locations during the HSA boring portion of the investigation. There were a total of 14 piezometers installed at the turbine locations. After a third piezometer monitoring event, the water levels measured from the piezometers averaged 1.5 feet below ground surface (BGS) with a minimum reading of 0.7 feet BGS (Table 2). These readings indicate that groundwater is present at or above proposed foundation bearing elevations for at least a portion of the year.

Many factors contribute to water level fluctuations, such as heavy rainfall events, dry periods, sand seams, and etc. Based on the observed water level readings, water likely will collect in and around the proposed turbine foundations and the foundation design will need to take buoyancy effects into consideration at all of the sites. Based on the readings, a groundwater depth of 0.5 ft below ground surface should be used for foundation design.

3.3 General Laboratory Testing

3.3.1 Moisture Content

As is summarized in Table 6, 86 moisture content tests were run on soil samples collected from the turbine soil borings and bulk samples. The soils tested included loess, silty clay to clayey silt glacial till soils, and weathered shale. The native soil had moisture contents ranging from about 5.2 percent (sandy soil) to 76.4 percent (organic clay), indicating that the soils are in a moist to very moist condition. In general, the moisture contents of the organic clay and lacustrine clay soils were the highest across the site. The glacial till soils exhibited moderate moisture contents and the sandy soils exhibited the lowest moisture contents across the site. The moisture content test results for the individual soil strata are discussed in Section 3.1. Moisture content test results are summarized in Table 6, included on the boring logs in Appendix D and provided in Appendix E.

3.3.2 Atterberg Limits

Atterberg limits were determined and used to identify soil behavior characteristics and classify the material encountered in the soil borings, as designated under the Unified Soil Classification

System (USCS) using the plasticity chart from NAVFAC Design Manual 7.1 (Reference 7). A total of 13 Atterberg limits tests were conducted on selected soil samples from the turbine borings. Results of the Atterberg limits tests indicate the soils on site have Liquid Limits generally ranging from 17 percent to 42 percent, Plastic Limits generally ranging from 11 to 22 percent, and Plasticity Indices varying between 5 and 22.7 percent. Atterberg limits test results for the individual soil strata are discussed in Section 3.1. Lab test results are summarized in Tables 6 and provided in Appendix E.

3.3.3 Grain Size Analysis

Grain size analyses were performed on 7 soil samples collected at various depths in the soil borings for the turbine sites and substation. Tests were performed on a silty sand soil, clayey glacial till, and lacustrine clay. The sand soils were considered silty to clayey sand soils (SM) with a fines contents of 26 percent. The glacial till soil test results indicated gravel content ranging from 6 to 27 percent, sand content ranging from 5 to 27 percent, and silt content ranging from 26 to 38 percent and clay content ranging from 20 to 32 percent. Test results on the lacustrine clay soils indicated 1 percent sand, 35 to 38 percent silt and 60 to 64 percent clay. Gradation test results are included on the boring logs provided in Appendix D and laboratory test results are included in Appendix E.

3.3.4 Dry Density and In-Situ Unit Weight

Dry density tests were performed on 28 soil samples from Shelby tube samplers. The dry density test results on the samples selected for testing ranged from 72.2 (organic clay) to 124.3 (glacial till) pounds per cubic foot. In-situ unit weight calculations were performed using the moisture content test results on samples which dry density testing was performed. The in-situ unit weight calculations on the samples with dry unit weight results ranged from 100.8 to 141.1 pounds per cubic foot. The lower density values were associated with the organic and lacustrine soils and the higher density values were associated with the glacial till soils. Density test results are summarized in Table 6, and lab test results are provided in Appendix E.

A recommended design value for in-situ density is 120 pounds per cubic foot (the approximate average of the calculated in-situ density values based on lab testing).

3.3.5 Unconfined Compressive strength and UU Testing

Unconfined compressive strength and unconsolidated undrained (UU) triaxial strength tests were performed on 16 soil samples. Tests were performed on Shelby tube samples on the lacustrine soils and glacial till. The test values range from about 0.14 to 1.71 tsf. The strength of lacustrine soils generally were much lower than the strength of the glacial till soils. In general, the results of the lab testing correlated fairly well with the strengths derived from CPT testing.

3.4 Shear Strength

3.4.1 Design Value Determination

For estimation of the allowable bearing capacity in glacial till the limiting design strength is that based on the undrained shear strength of the primarily clayey soil.

The undrained shear strength of the soil at various depths is calculated based on CPT data using the following equation:

$$s_u = \frac{q_t - \sigma_{vo}}{N_{kt}}$$ (Reference 6, page 64)

where:

s_u = undrained shear strength

N_{kt} = empirical cone factor (16 was used for this project based upon previous experience at similar sites). It is pointed out that common values for in situ soft intact clays are generally taken to be between 10 and 20. Further refinement of this value may be performed once laboratory testing is complete.

σ_{vo} = total in-situ vertical stress at the depth of interest, varying and directly available from recorded CPT data

q_t = corrected cone tip resistance at the depth of interest, varying and directly available from recorded CPT data

Figures 13 through 26 show the resulting undrained shear strengths calculated from CPT data for each proposed wind turbine site investigated to date. The values generally show two material types, with the lacustrine clay represented by undrained shear strengths of less than 500 psf and the glacial till by undrained shear strengths of typically greater than 1000 psf.

In many cases, however, the glacial till did exhibit undrained shear strengths of less than 1000 psf for significant thicknesses. As such, selection of the design undrained shear strength by typical methods (selection of a lower bound value) is not suitable for this site. To arrive at the minimum required shear strength for support of the proposed foundations we back-calculated the approximate undrained shear strength required to provide a minimum allowable bearing capacity of 3,000 psf under the extreme load. Based on our experience with similar soils and foundations a minimum undrained shear strength of 1,100 psf was therefore selected as the design value for preparation of this draft report.

3.4.2 Low Strength Zones and Alternate Turbine Location Testing

Ultimately, the shear strength of the soil is the primary factor in determining the allowable bearing capacity (Section 4.4.2) as well as for determining the need for soil remediation. A review of the undrained shear strengths determined from the CPT investigation was conducted to identify zones of weak soils. Of particular concern are weak soils near the turbine foundation depth (i.e. in the upper 15 feet of soils), as well as thicker zones of weak soils (i.e. several feet thick) at depths between 15 and 50 feet.

The results of the CPT investigation indicated significant deposits of very weak clay at 32 of the 114 proposed turbine locations investigated (8, 25, 26, 27, 28, 29, 30, 42, 45, 46, 47, 49, 50, 51,

52, 53, 54, 55, 56, 59, 65, 66, 67, 70, 71, 72, 76, 77, 122, 128, 131, and 133). The CPT results also indicate significant zones of lower strength clay at varying depths throughout the soil profile at 34 of the 114 proposed turbine locations investigated (7, 9, 10, 11, 13, 15, 18, 22, 23, 26, 27, 31, 39, 40, 41, 48, 60, 70, 78, 79, 80, 82, 83, 84, 85, 86, 87, 96, 110, 125, 127, 129, 130, and 132). These sites are based on a foundation embedment depth of 9 feet below existing grade. If embedment is to be less, additional turbine sites may require mitigation.

Of these sites, turbine locations 8, 9, 25, 28, 29, 45, 46, 47, 48, 49, 50, 51, 53, 66, 67, 71, 72, 76, 77, and 131 exhibited weak soils to depths beyond that typically considered suitable for mitigation (on the order of 30 feet below existing grade). These sites may require specialized deep mitigation or a deep foundation system if they are to be considered for development.

Table 3 summarizes the required mitigation depths at each proposed turbine location. Figure 12 also shows the locations of the sites requiring remediation. As illustrated on the figure, the sites requiring soil remediation are primarily located within the areas indicated as having peat or "marsh" soils according the the soil survey data. Further discussion on potential methods of soil remediation is contained in Section 4.4.3 of this report.

3.5 Shear and Compression Wave Velocities

The results of determination of the shear and compression wave velocities are contained in Appendix B. Shear wave velocity (interval average) results measured by a seismic cone penetrometer are summarized in Table 4. The interval shear wave velocities were measured from 6.6 ft (2 meters) to the depth of the sounding. The interval shear wave velocities (V_s) were used to compute the weighted average shear velocity from the assumed base of the foundation to the end of the sounding.

The weighted average shear wave velocity (V_s) of the underlying soil at 16 selected turbine locations varied from 635 ft/s to 1,377 ft/s (Table 4). The minimum average shear wave velocity of 635 ft/s corresponding to turbine location 41 is recommended as a design basis value for performing soil stiffness calculations as part of the structural foundation design. This value will be used in the remainder of the calculations in this report for consistency.

The compression wave velocity was also measured during this investigation at the same turbine locations. Table 4 summarizes the compression wave velocity (interval average) results measured by the seismic cone penetrometer at selected locations. The average compression wave velocity (V_p) measured at selected sites varied from 3,273 ft/s to 10,143 ft/s.

The compression and shear wave velocity information was used to compute the Poisson ratio (υ). The following equation relates shear and compression waves with Poisson ratio:

$$\nu = \left(\frac{Vp^2}{2Vs^2} - 1 \right) \Big/ \left(\frac{Vp^2}{Vs^2} - 1 \right)$$ (Reference 1, page 1108)

Table 4 summarizes the computed Poisson ratio values at the 16 locations where shear and compression wave velocities were both measured. The Poisson ratio ranges between 0.41 and 0.50. The minimum value of 0.41 is recommended as the design value.

3.6 Compressibility

3.6.1 Compressibility Characteristics from DMT

Flat-blade dilatometer testing (DMT) was performed at proposed turbine locations 5, 45, 48, 51, 54, 64, 70, 78, 81, 89, 92, 107, and 131. The DMT data was used to obtain the one-dimensional constraint modulus *M* as follows:

$$M = R_M * E_D$$ (Reference 18, page 20)

Where,

M = constrained modulus from DMT testing

R_M = Marchetti ratio factor relating M to E_D (calculated from horiz. stress index, K_D)

E_D = Dilatometer Modulus (calculated from DMT readings)

The one-dimensional constrained modulus *M* is related to the one-dimensional coefficient of volume compressibility m_v by the following equation:

$$M = 1/m_v$$

The constrained modulus values are used to compute the settlement of the proposed wind turbine foundations in a later section of this report.

3.6.1 Compressibility Characteristics from laboratory testing

Compressibility characteristics of soil at the site were evaluated using laboratory consolidation testing from Shelby tube samples. Consolidation testing was performed on three samples of lacustrine clay. The tests were performed according to ASTM D-2435 using the incremental loading test procedure. The void ratio vs. effective stress relationship and the deformation vs. time test results are in Appendix E.

Table 6 summarizes the consolidation test results in terms of the compression index C_c, recompression index C_r, initial void ratio e_o, and preconsolidation pressure.

The samples of lacustrine clay soil tested had preconsolidation pressures ranging from 0.42 to 0.59 tons per square foot (tsf). Initial void ratios varied from 1.02 to 1.16. The calculated compression index ranged from 0.24 to 0.27, while the recompression index ranged from 0.04 to 0.05 for all samples tested.

Based on the preconsolidation pressures from the lab testing, sample depths, and calculated overburden pressures, the lacustrine clay is normally consolidated to underconsolidated and all compression will be in the virgin compression range. Underconsolidated soils may also experience creep (settlement independent of new loads).

3.7 Shrink/Swell Potential

The shrink/swell potential of a soil is related to its liquid limit and plasticity index. Soils with Liquid Limit values less than 50 and Plasticity Index values less than 25 are considered to have low shrink-swell potential. Soils with Liquid Limit values of 50 to 60 and Plasticity Index values of 25 to 35 are considered to have moderate shrink-swell potential. Soils with Liquid Limit values greater than 60 and Plasticity Index values greater than 35 are considered to have high shrink-swell potential (Reference 2, page 63).

The Atterberg limits testing on the soils at this site indicated liquid limits ranging from 17 to 42 percent, plastic limits ranging from 11 to 22 percent, and plasticity indices ranging from 5 to 22.7 percent. Based on this testing, the site soils are considered to have low shrink-swell potential.

Soil survey mapping of the near surface soils also indicate that low plasticity clay dominates the site (Figure 4). Low plasticity clay also is considered to have low shrink-swell potential.

3.8 Compaction and CBR Testing

A total of 12 laboratory compaction tests were conducted on bulk soil samples collected across the site. Standard Proctor density testing was performed primarily on the lean and fat clay soils encountered below the topsoil across the site. One sample (T-66) appeared to be an organic clay, and widely different test results were obtained on the sample from that location. Test results on the lean to fat clay soils indicated the maximum dry densities ranged from 95.5 to 109.2 pcf, with an average of 103.1 pcf. The corresponding optimum moisture content varied from 16.8 to 25.8 percent.

Standard Proctor density testing on the sample of organic clay indicated a maximum dry density of 67.5 pcf and a corresponding optimum moisture content of 47.5 percent.

Using an in-situ moisture content of 15 percent to evaluate long term moist densities of compacted lean to fat clay soils, long term moist density values are anticipated to range from 104 to 119 pcf, with and average of 112.5 pcf. Based on these results, a minimum moist density of 110 pcf or 95% of maximum dry density as determined by Standard should be used for design and verified in the field during construction.

It should be noted that the density of the surficial organic soils and peat have a much lower dry density and use of these materials as covering backfill over the foundations is not recommended.

The results of the compaction testing can be found in Table 7.

Design for roads working areas is based in part on the strength of the subgrade that can be reasonably achieved. California Bearing Ratio (CBR) tests were completed on soil samples from the site to determine the field strength of the subgrade.

A total of 12 samples were collected from road borings across the site (Figure 8). The bulk samples were collected from soil immediately below the existing roadbeds at a depth of 1 to 4 feet below the surface. The soil samples were prepared to approximately 95 percent of the maximum standard Proctor density at the optimum moisture content. The results of the CBR testing can be found in Table 7.

Results from the samples collected below the topsoil indicate that corrected CBR values at 0.1 inch range from 0.8 to 3.2 percent, when compacted to 95 percent of the standard Proctor density at optimum moisture.

It should be noted that achieving 95 percent of a standard proctor value may be difficult with the lacustrine and organic soils and relatively high shallow moisture contents and groundwater levels across the site. It is anticipated that soil stabilization will be required, especially in the central marsh area of the site, to provide an adequate roadway subgrade.

A CBR value of 1.1 percent is recommended for road design in Section 4.1, reflecting that the very soft subgrades will be improved and should not be used as the basis for design of the entire site.

3.9 Karst Potential

Karst risk evaluation is a difficult task. While certain features may be visible at the ground surface, most of the features are hidden underground. Though not all soluble bedrock contains karst and karst like features can form in non-soluble bedrock, the presence of soluble bedrock is generally considered the key factor in determining that some risk may be present, and thereafter it is very difficult to completely eliminate that risk. The project area is underlain by bedrock that has been identified as having the potential for the development of dissolution features present elsewhere western Ohio.

The Ohio geological survey has completed an extensive mapping project to define the areas in which karst is present (Figure 7). While no karst has been mapped to date in the immediate vicinity of the project site it is present in the same geologic deposit in adjacent counties and has been identified as regularly occurring in areas with less than 20 ft of glacial till overburden. Shallow refusal was encountered within many of the CPT soundings performed on site, with refusal at 20 feet or less at proposed turbine locations 19, 35, 37, 38, and 117.

The major indicators for karst conditions are the presence of existing cave openings, sinkholes, or paleosinks. Though no sinkholes have been observed on site to date, the beginnings of a potential sinkhole consisting of raveling soils may be identified in a decrease in SPT or CPT tip resistance with depth, particularly in the immediate vicinity of tip refusal on bedrock. Though not definitive, decreasing and potentially decreasing equivalent SPT N-values were observed at proposed

turbine locations 2, 3, 5, 7, 8, 9, 10, 11, 16, 17, 19, 20, 25, 29, 30, 32, 33, 35, 37, 38, 41, 46, 52, 56, 59, 65, 66, 67, 70, 77, 78, 82, 83, 86, 89, 90, 109, 113, 116, 124, 125, 129, 130, and 133.

Considering the depth of refusal, a decrease in equivalent SPT N-value, and presence of weak soils zones above refusal, there is a concern of potential karst terrain underlying select turbine locations. Based on the review of the CPT and SPT data, proposed turbine locations 7, 8, 9, 25, 30, 77, 125, and 130 are of the highest concern for karst underlying the proposed foundation location. Proposed turbine locations 10, 17, 19, 20, 32, 33, 35, 37, 38, 56, 59, 65, 67, 72, 78, 82, 98, and 113 are potentially of concern as well. Options for additional evaluation and/or preventative measures that may be taken to reduce the risk of karst formation are discussed further in Section 4.4.4.

4.0 Analysis and Recommendations

Results of the field and laboratory investigation have been presented in Section 3. Based on these results, Section 4 provides analysis, conclusions and recommendations for the design and construction of wind turbine foundations and roads, as well as general construction considerations.

For roads, the primary factors addressed include gravel thickness and subgrade preparation. For foundations, the design factors addressed include bearing capacity, footing stiffness, foundation settlement, and sliding friction.

4.1 Roadway Design

Roadway design covers preparation of surface, preparation of subgrade, and materials necessary for roadway construction.

4.1.1 Surface Preparation for Roadways

Site preparation for roadways should be initiated by removing all surface vegetation, root zones, the upper layer of organic topsoil, and loose, soft or otherwise unsuitable materials. The organic-rich topsoil thickness generally ranges from 12 to 18 inches. Actual stripping depths will likely vary and should be evaluated by a geotechnical engineer at the time of construction.

Although significant thicknesses of peat were not encountered in the borings performed for the project, peat thicknesses of up to 10 feet are reported in the Scioto Marsh. Removal of the full depth of peat will not be feasible for roadway construction. Consideration to moving the roads outside of the deep peat deposits or construction using multiple layers of geogrid or geotextile in conjunction with a thick gravel section should be considered.

Topsoil removed during site stripping should be graded into existing site topography or used as fill materials in non-critical areas. Incorporation of topsoil in compacted fill which will support turbines, roadways, pavement, equipment pads, or other site structures is not recommended. The surficial soils shall be graded to prevent accumulation of surface water and to allow for proper drainage in the vicinity of the proposed roadways.

4.1.2 Subgrade Preparation

After stripping or excavating to rough grade is complete, the exposed subsurface along the entire roadway should be proof-rolled. Proof-rolling should be performed with a fully loaded tandem axle dump truck having a minimum gross weight of 25 tons. Proof-rolling will aid in identifying areas of unstable subgrade. Proof-rolling should be performed in the presence of a geotechnical engineer. Typical standards for proof-rolling should include no rutting greater than 1 to 1-1/2 inch, and no “pumping” of the soil behind the proof-roll. Proof-rolling is not an indication that the subgrade strength is adequate or that it meets design requirements, but simply highlights potentially unsuitable subgrade conditions. If the compacted subgrade soil conditions do not meet the required compaction test results, per the construction specifications, the deficient

materials shall be removed and replaced with the required thickness of additional road base material. Areas which fail proof-rolling tests should be sub-cut and replaced with suitable fill.

The clay to clayey silt glacial till and lacustrine clay soils likely will be easily disturbed by construction traffic or become unstable during proof-rolling and/or subsequent construction operations and some means of subgrade stabilization may be required to facilitate construction. Use of a vibratory roller is not recommended for cohesive soil subgrades.

In addition, with the low soil strengths, high moisture content, and high groundwater table, achieving 95 percent compaction of a Standard Proctor value is not anticipated in the marsh areas. An alternative method of subgrade stabilization likely will be needed to provide an adequate soil subbase for the project roadways. Alternatives for roadway subgrade stabilization include the following:

- **Removal and Replacement** – The inadequate materials can be removed and replaced with granular structural fill consisting of well-graded sand and gravel materials (similar to typical roadway base course materials). Compaction of this material is required to achieve a minimum of 95 percent of the laboratory maximum dry density measured according to Standard Proctor. The granular structural fill can be used in conjunction with a geotextile fabric or geogrid to potentially reduce depth of over excavation or to reduce the amount of granular materials required. However, the wet soft soil subgrades extend very deep on this site and compaction of engineered fill on the soils at the base of the overexcavation likely will be difficult to achieve. Removal and replacement in areas with engineered fill is not recommended in these areas. In areas where a thin extent of soft soils is encountered, removal and replacement could be considered as a option for stabilization.

- **Scarification and Re-compaction** – It may be feasible to scarify, dry, and re-compact the exposed soils. The success of this procedure would depend primarily upon favorable weather and sufficient time to dry the soils. Even with adequate time and weather, however, stable subgrades may not be achievable if the thickness of the soft soil is greater than 1 to 1-1/2 feet. The soil explorations indicated areas of deep, soft soils and potentially high groundwater levels. Therefore scarification and recompaction also is not recommended in these areas.

- **Soil Stabilization** – The use of cement, lime, or fly-ash as a soil stabilizing agent can be considered in lieu of removal and replacement or scarification and recompaction. The type and quantity of materials used to stabilize the soils will be dependent upon soil type. Typically lime stabilization is used for higher moisture content clay to clayey silt soils similar to those encountered at the site. Although, cement stabilization may be better suited to areas with higher organic content, such as sites were only limited topsoil removal is desired. Design of a soil stabilization program should be performed by a geotechnical engineer in conjunction with laboratory testing to provide the proper stabilizing agent, application rate, and depth of soils stabilized. Due to the wet, soft soils encountered on the site, soil stabilization appears to be the most favorable method to improve the soil subgrades.

Placed fill for subgrade stabilization shall be compacted with a sheepsfoot or pad-foot compactor at sites on cohesive material and a smooth drum roller for granular and gravel fill material. Native clay to clayey silt materials present across the site indicate the use of the sheepsfoot or pad-foot compactors. Vibratory versions of these compactors are acceptable, although not required for cohesive soils. Vibratory rollers likely will disturb the cohesive soils, especially those with higher moisture contents as encountered on this site. The number of passes required will vary depending upon the equipment used, fill material type, and moisture condition of the fill.

Imported fill material may consist of sand, silty sand, clayey sand, sandy lean clay, lean clay, or more granular materials, although the liquid limit of these materials should not exceed 45 and the plastic index should not exceed 20. Note that fine-grained fill soils may be particularly difficult to compact if wet or allowed to become wet, or if spread and compacted over wet or marginally stable subgrades. The majority of the on-site glacial till soils likely will be suitable as fill materials, however, additional testing may be necessary to determine the suitability of materials for use as fill.

After completion of proof-rolling, but prior to placement and compaction of granular fill, any soils loosened during the excavation activities should be re-compacted to a minimum of 95 percent of the standard Proctor maximum dry density at or near the optimum moisture content.

The roadway surfaces should be crowned or sloped to prevent water ponding on or around the roadway surfaces. The roadway crowns and slopes should have a 2 percent slope to promote drainage. Culverts should be used where needed to allow drainage underneath the roadways and to prevent ponding either over or on the side of the roadways. If rain occurs during roadway construction, the subgrade should be allowed to dry prior to continuing work.

4.1.3 Road Base Design Considerations

The design thickness of placed granular fill is determined using CBR values. Based on the results discussed in Section 3.8. a CBR value of 1.1 percent will be used for the non-modified roadway subgrade compacted to 95 percent of the standard Proctor maximum dry density. The required aggregate thickness was determined by SpectraPave3 using the Giroud-Han iterative equation:

$$h = \frac{0.868 + \left(0.661 - 1.006J^2\right)\left(\frac{r}{h}\right)^{1.5}\log N}{\left[1 + 0.204\left(\frac{3.48CBR_{bc}^{0.3}}{CBR_{sg}} - 1\right)\right]}\left(\sqrt{\frac{\frac{P}{\pi r^2}}{\frac{s}{f_s}\left[1 - 0.9e^{-\left\{\frac{r}{h}\right\}^2}\right]N_c f_c CBR_{sg}} - 1}\right)r$$

where;

h = required thickness (meters)

J = aperture stability modulus (m-N/degree)

P = wheel load = axle load/2

r = radius of tire print

N = number of axle passes

CBR_{sg} = Subgrade CBR = 1.1 %

CBR_{bc} = Aggregate CBR = (~5 x CBR_{sg})

f_s = rut depth factor = 75 mm (~ 3 inches)

s = maximum rut depth = 1.5 inches and 3 inches

N_c = bearing capacity factor (5.14 for geotextile reinforced pavements)

f_c = factor relating CBR of subgrade to equivalent c_u value = 30

Two traffic conditions were evaluated and analyzed for use of the road: (1) conditions during construction of the project and (2) maintenance traffic consisting of light duty trucks.

The construction condition assumes: a subgrade CBR value of 1.1 percent; a subbase CBR value of 8 percent; a maximum axle load of 25 kips; a tire pressure of 80 psi; 800 axle passes; and maximum allowable rut depths of 1.5 and 3.0 inches. The required aggregate thickness for the construction condition varies from 6 to 32 inches, depending on the level of subgrade compaction, aggregate reinforcement and maximum allowable rut depth. Recommended thickness of aggregates for roadways is provided in Table 8.

The maintenance condition assumes: a subgrade CBR value of 1.1 percent; a subbase CBR value of 8 percent; a maximum axle load of 3.5 kips; a tire pressure of 65 psi; 2000 axle passes; and maximum allowable rut depths of 1.5 and 3.0 inches. The required aggregate thickness for the maintenance condition varies from 6 to 12 inches, depending on the level of subgrade compaction, aggregate reinforcement and maximum allowable rut depth. Recommended thickness of aggregates for roadways is provided in Table 8.

It is recommended that a minimum of 6 inches of aggregate base be placed to compensate for topsoil stripping and for aggregate stability.

Please note that axle loads and/or axle passes in excess of the design values noted above may decrease the overall life of the road because of premature road deterioration. In the event of heavy traffic leading to excessive rutting or surface deterioration, it is recommended that 2 inches of gravel be added and re-graded to reestablish the road surface.

It is recommended that granular roadway material be placed on the roadways. The granular roadway surface should consist of crushed limestone gravel. To facilitate local purchase, this

aggregate should meet the requirements of Ohio Department of Transportation standards for typical roadway base course materials. Alternative road surface materials may be used depending upon availability and suitability. A smooth drum vibratory compactor should be used to compact the gravel roadway. The gravel roadway should be compacted to 95 percent of maximum standard Proctor dry density, as determined by ASTM D-698.

4.2 Excavation and Fill

The following sub-sections present general recommendations for site clearing, grading, and compaction for construction roads, wind turbine foundations, and laydown areas.

4.2.1 Clearing and Grubbing

The project site is predominantly farmland, and clearing and grubbing will generally be restricted to the removal of planted agricultural crops or remains of crops, grass, and topsoil. Based on the borings, the thickness of this organic material or topsoil typically varies from 12 to 18 inches at the boring locations.

The topsoil and organic material is usually mixed during the excavation process, and thus, should not be used for structural fill. This material should be placed separately away from the rest of the excavated material to avoid contamination. Topsoil removed during site stripping should be graded into existing site topography or used as fill in non-critical areas. This material could be used in grading non-structural fill such as fields, or service areas in which compressibility of the material does not have an impact on overlying structures or roadways.

4.2.3 General Cut

Due to the presence of very weak zones and shallow groundwater the glacial till soils should be considered Type C soils from OSHA soil classifications (29 CFR 1926 Subpart P-Excavations). It is the responsibility of the competent field personnel at the time of construction to verify the in-situ soil classification at each excavation and insure that the benching or slopes are adequate during construction (29 CFR 1926 Subpart P-Excavations).

Bedrock was encountered across the site but a depths greater than the anticipated turbine foundation embedment depth. Rock removal for the turbine foundations is not anticipated. Excavations extending greater than 15 feet below existing grade may require rock removal.

4.2.4 General Fill

In all common fill areas outside of foundation limits, lifts should be placed as close to horizontal as possible, stepped into the existing slope, with lift thickness not to exceed 12 inches in a loose condition.

Any soil placed as common fill should be an approved material classified by the unified soil classification system (USCS) as ML, CL, SM, SC or more granular, free of organic matter or debris, rocks greater than 3 inches in diameter, and have a liquid limit and plasticity index less than 45 and 20, respectively. High plasticity silt or clay (MH, CH) or organic soils should not be used as structural fill. Crushed rock must be graded such that the placement and compaction of the material results in no voids within the fill.

Fill should be placed in lifts not exceeding 12 inches in loose thickness or one third the diameter of the roller, whichever is less, and as appropriate for the equipment being used. We recommend that each lift be compacted to a minimum of 95 percent of the maximum dry density obtained in accordance with ASTM Specification D-698, Standard Proctor Method. In areas of fill greater than 5 ft in height the entire height of the fill should be compacted to a minimum 98 percent of the maximum dry density (ASTM D698). Similarly, any soil placed and compacted to support a proposed foundation should be compacted to a minimum 98 percent of the maximum dry density (ASTM D698).

Periodic sampling and material testing (including grain size analysis, moisture content and density testing) should be performed during the work at a minimum rate of 1 suite of tests per 2,500 cubic yards of backfill. Compaction tests should be performed at the rate of 1 per 2,500 square ft of each fill lift.

4.2.5 Excavation, Backfill and Compaction for Foundations

Compaction of native soils intended for support of the foundation base is not required, unless visual inspections indicate suitable soils become disturbed during construction activities. At many of the proposed turbine locations, the native subgrade soils should be firm, stable, and capable of providing sufficient support for the structure.

If in the course of excavating the foundation, the base of the excavation becomes rutted, damaged or is otherwise determined to be of inadequate character, the following actions should be performed:

1. Disturbed soils should be leveled, recompacted, and proof rolled. Compaction of this material is required to achieve at least 98 percent of the laboratory maximum dry density measured according to the standard Proctor method (ASTM D698). Testing should be performed to ensure proper support can be provided by the recompacted materials.

2. The inadequate materials are to be removed and replaced with granular structural fill consisting of well-graded sand and gravel materials with less than 10 percent fines (similar to typical roadway base course materials). The removal and replacement of materials shall be performed extending out from all sides of the excavation a minimum distance equal to the over excavation depth to create a 45 degree slope of replacement materials below the base of the foundation. Compaction of this material is required to achieve the greater of a minimum of 75 percent relative density or a minimum of

98 percent of the laboratory maximum dry density measured according to the standard Proctor method (ASTM D698).

Moisture content of the materials should be maintained within reasonable levels to allow for proper compaction. Compaction should only be carried out during favorable weather conditions, fill materials should not be allowed to freeze, and placed fill material subgrades should be firm and stable after placement and compaction.

In all cases of foundation excavation, the soil base shall be protected against damage by use of a flowable concrete mud mat after final excavation (or fill placement). If proper compaction of backfill or structural fill soils cannot be achieved, lean concrete (flowable fill) can be used as backfill in lieu of granular structural fill.

Based on results of Section 3.8, the native material utilized as backfill over the foundation should be compacted to achieve a minimum dry density corresponding to 95 percent of the maximum dry density as determined by a the standard Proctor method. The moist unit weight of the soils also shall meet or exceed the design value specified in the final foundation design plan and report.

Each lift should have a uniform thickness according to the equipment being used but not to exceed 12 inches in loose thickness. During construction, the top surface of the fill should be kept with sufficient slope (¼" per foot) to allow runoff of water during a rainfall without inducing erosion. Periodic inspection and testing in accordance with Section 4.2.4 should be performed during the work to verify that the recommended compaction has been achieved.

4.3 Groundwater and Dewatering

Based on the discussion presented in Section 3.2, significant groundwater seepage was generally not observed during drilling and not observed in the piezometer wells until after a significant stabilization time.

A system of sloped excavations with sump(s) and small pump(s) should be adequate to control water at the proposed turbine locations for short periods of time. Excavations allowed to remain open for longer durations of time may require more comprehensive dewatering methods, such as well points or a cut-off trench, depending on the soil conditions, to allow for construction to proceed in relatively dry conditions. In the event of heavy rainfall, the impermeable nature of the clay soils could limit water outflow from the excavation, which would also require the use of a sump and small pump for dewatering purposes. The excavations should be kept relatively free of accumulated water during construction to minimize softening of the subgrade soils. Other drainage elements such as sub-drains or fill instrumentation do not appear to be required. Water should not be allowed to pond in the base of the excavations during construction.

Long-term groundwater readings from piezometers indicated water levels as shallow as 0.7 feet below ground surface, with most groundwater levels at 1.5 to 2 feet below ground surfaec. Due to water levels at or above the proposed bearing elevation of the proposed turbines, a foundation

design accounting for buoyant forces is recommended for the site. A design groundwater level of 0.5 feet below existing ground surface is recommended. If multiple foundation design are desired in an attempt to take advantage of deeper groundwater levels at some turbine locations additional piezometer installation at every potential turbine location and subsequent measurement of groundwater levels would be required.

4.4 Wind Turbine Tower Foundation

4.4.1 Foundation Type

Investigation and testing of the proposed wind turbine locations generally found clayey glacial till at the proposed turbine locations. The recommended minimum design frost depth for the wind turbine locations is 35 inches (Reference 7). Based on these conditions and the analysis presented below, a conventional spread footing bearing on soil a minimum of 9 feet below grade is a feasible and cost effective foundation system to utilize at many of the proposed turbine sites included in this investigation. Due to water levels at or above the proposed bearing elevation of the turbine foundations, a buoyant design is recommended for all turbine foundations.

4.4.2 Bearing Capacity

Allowable soil bearing pressure for a spread footing is based on the shear strength obtained from testing and investigation. A brief discussion of shear strength was provided in Section 3.4. The following is a more detailed description of the procedure used to determine design shear strength and allowable bearing capacity.

Though both granular and cohesive soils are present on site, the limiting case with respect to bearing capacity is for a foundation overlying clayey glacial till or lacustrine clay subject to failure under the undrained strength condition. Based on our experience with similar sites and turbine loads a minimum allowable bearing capacities of approximately 3,000 psf under the extreme load and 2,300 psf under the normal load are required for support of the proposed foundations without mitigation of weak soils.

The ultimate bearing capacity of the soil supporting a spread footing can be determined using the Terzaghi-Meyerhoff equation as follows:

$$q_{ult} = \frac{1}{2}\gamma' B_{eff} N_\gamma F_{\gamma s} F_{\gamma i} + qN_q F_{qs} F_{qi} + s_u N_c F_{cs} F_{ci}$$ (Reference 17)

where:

q_{ult} = ultimate bearing pressure

γ = unit weight of the soil

B = average footing width over the length in bearing

N_γ = bearing capacity factor

q = surcharge at foundation level

N_q = bearing capacity factor

s_u = design undrained shear strength of the soil
N_c = bearing capacity factor

F = shape (subscript "s") and inclination (subscript "i") factors

The first term of the above equation is associated with granular soils which typically exhibit drained modes of failure (except under earthquake loading) and where excess pore pressures cannot build up in the soil when sheared. This term represents the ultimate drained bearing capacity.

The third term of the equation is associated with fine-grained/clayey soils which typically exhibit an undrained mode of failure and where excess pore pressures can build up in the soil when sheared. Since the soils encountered at the project site are pre-dominantly fine grained (clays), the critical mode of failure is associated with an undrained condition, the first term is dropped from the equation, and the second term reduces to the overburden pressure, representing the ultimate undrained bearing capacity shown as follows:

$$q_{ult} = q + s_u N_c F_{cs} F_{ci}$$ (Reference 17)

The following are formulas for the dimensionless factor, N_c, and shape (F_{cs}) and inclination (F_{ci}) factors above (Reference 17):

$$N_q = e^{\pi \tan\phi} \frac{1+\sin\phi}{1-\sin\phi} = 1 \text{ (for } \phi = 0)$$

$$N_c = (N_q - 1)\cot\phi = 5.14 \text{ (for } \phi = 0)$$

$$F_{cs} = 1 + 0.2\frac{B_{eff}}{L_{eff}}$$

$$F_{ci} = \frac{1}{2} + \frac{1}{2}\sqrt{1 - \frac{H_d}{A_{eff} s_u}}$$

where:

B_{eff} = average effective footing width

L_{eff} = average footing length

H_d = design horizontal load

A_{eff} = effective area as a result of a wind load causing a moment on the foundation

The allowable soil bearing pressure is then obtained by dividing the ultimate bearing capacity by an appropriate factor of safety. The following factors of safety are taken from Reference 1:

$$\text{Factor of safety} = \begin{cases} 2.26 & \textit{for extreme wind loading} \\ 3.0 & \textit{for normal operation loads} \end{cases}$$

Based on back calculation from the desired allowable bearing capacities of 3,000 and 2,300 psf under the extreme and normal loading conditions, respectively, a minimum undrained shear strength of 1,100 psf is required of the cohesive soils supporting the proposed foundations. Those proposed turbine locations with significant soil deposits of undrained shear strength less than 1,100 psf must be mitigated (Sections 3.4.2 and 4.4.3).

4.4.3 Turbine Locations Requiring Soil Remediation

All of the proposed turbine locations were analyzed for lower undrained shear strength soils near the turbine foundation depth (i.e. in the upper 15 feet of soils) or thicker zones of low strength soils (i.e. roughly 5 to 10 feet or more in thickness) at depths between 15 and 50 feet.

The results of the CPT investigation indicated significant deposits of weak clay at 20 of the 114 proposed turbine locations investigated (8, 9, 25, 28, 29, 45, 46, 47, 48, 49, 50, 51, 53, 66, 67, 71, 72, 76, 77, and 131) to depths beyond that typically considered suitable for mitigation (on the order of 30 feet below existing grade). These sites would require specialized deep mitigation or a deep foundation system if they are to be considered for development.

The CPT results also indicate significant deposits of weak clay that may be mitigated by standard means at 42 of the 114 proposed turbine locations investigated (7, 10, 11, 13, 15, 18, 22, 23, 26, 27, 30, 31, 39, 40, 41, 42, 54, 55, 56, 59, 60, 65, 70, 78, 79, 80, 82, 83, 84, 85, 86, 87, 96, 110, 122, 125, 127, 128, 129, 130, 132, and 133). These sites are based on a foundation embedment depth of 9 feet below existing grade. If embedment is to be less additional turbine sites will require mitigation. Table 3 summarizes the required mitigation depths and anticipated type of improvement at each proposed turbine location.

Options for soil remediation include: (1) engineered fill (2) stone columns/geopiers, (3) deep foundations, and (4) alternate turbine locations. Details regarding each option for soil remediation are discussed below.

4.4.3.1 Engineered Fill

At sites where relatively shallow soils exhibit low shear strength, one possible option for remediation is excavation of the soft material and backfill with adequate material.

It should be noted that these depths of overexcavation are based on shear strength values obtained from CPT testing, and may vary depending on the conditions encountered during construction. Other turbine sites also may require minor overexcavations of low strength soils, or excavations may need to be extended deeper to remove low strength soils. The base of every footing should

be inspected by the geotechnical engineer or a representative of the geotechnical engineer to evaluate the soil conditions at the bearing elevation or bottom of overexcavation elevation.

An engineered fill approach is generally undertaken when improvement depths are no greater than 15 feet below existing grade. At depths beyond 15 feet, the excavations may become too large and expensive as a result of the need for over sizing (as discussed below) and some equipment limitations. Engineered fill used to replace the shallow soft soils should be similar to that described by Ohio Department of Transportation standards for typical roadway base course materials and contain less than 10 percent by weight passing the number 200 sieve. Loose lifts should not to exceed 12 inches. The backfill should be compacted to the greater of a minimum of 98 percent of a maximum dry density as determined by standard Proctor method, or 75 percent relative density. The excavations and subsequent engineered fill should be oversized one (1) foot on all sides for each foot of excavation below the foundation embedment depth of 9 feet. For example, a one (1) foot excavation below the foundation depth will require a bottom of excavation width (and length) two (2) feet greater than a standard excavation width (one foot on each side of the footing).

It should also be noted that water was observed at depths as shallow as 2.5 feet below existing grade at piezometer locations after significant stabilization times. As a result, the presence of water could adversely affect the foundation over-excavation. Due to the presence of primarily fine grained soils (clays) encountered during the drilling operations, it is recommended that sumps be installed to prevent water from collecting in the foundation bottom. Depending on the amount of water seeping from the excavation sidewalls from silt or sand seams, it may also be necessary to install dewatering wells in the vicinity of the excavation.

Dewatering of the excavations will be crucial to achieving the specified level of compaction on the structural fill materials placed beneath the proposed turbine foundations. If the specified level of compaction cannot be achieved, lean concrete (flowable fill) can be used instead of granular structural fill materials.

4.4.3.2 Stone Columns/Geopiers

One possible ground improvement method for deeper or thicker low strength soil layers at the turbine locations is construction of stone columns or geopiers. Stone columns or geopiers are constructed by drilling to open a hole, then placing aggregate and using deep vibratory methods to densify the aggregate and surrounding native soils to increase the strength and stiffness of the aggregate and surrounding soil. Stone columns or geopiers are generally used when the depth of improvement ranges from 15 to 30 feet (although the upper limit is dependent on the relative proximity of an aggregate source to the site and the contractor's experience) and the lower limit is determined by improvement of the soils which can be attained. This method may be advantageous for the turbine sites where over-excavations are not feasible due to the depth of soil requiring remediation or the presence of shallow groundwater.

If selected for use on the site, stone columns or geopiers should be installed to improve the bearing capacity and settlement characteristics of the soils. Modulus tests should be conducted on the stone columns or geopiers to verify the bearing capacity of the improved soil stratum.

Stone columns and geopiers are generally provided on a design build basis.

4.4.3.3 Deep Pile Foundation System

Deep foundation systems are commonly comprised of steel pipe piling and installed either by a diesel hammer or auger-cast method. Typically, deep foundations are used at sites where the extent of low strength soil extend deep below the proposed bearing elevation of the foundations. At this depth, stone columns may become more expensive than a deep foundation system. Based on the results of the CPT soundings and soil borings, proposed turbine locations 8, 9, 25, 45, 46, 47, 49, 50, 51, 53, 66, 67, 71, 72, 76, 77, and 131 would likely require a deep foundation system for support.

4.4.3.4 Use of Alternate Location

A fourth option is to move the turbine locations requiring soil remediation for turbine foundation support and utilize alternate turbine locations. Review of the locations and depths of the turbine sites requiring remediation or deep foundations (see Figure 12) indicate that the soils surrounding the marsh will likely require less remediation for turbine support. It may be advantageous to select alternate sites outside of the marsh area to lessen the need for remediation. Taking into account site soil variability, if new (unexplored) turbine sites are selected which are greater than 50 feet from the current turbine locations, each new site should be evaluated for adequate foundation support by geotechnical explorations and engineering analysis of the test results. Evaluation at new turbine sites should generally consist of CPT soundings.

4.4.4 Karst Risk Mitigation

If a site has been identified as having a high or moderate risk for karst terrain, follow-up site visits are typically recommended to document features that could lead to subsurface failures. In the case of this site, however, the agricultural nature of the site results in disturbance of the surficial soils and obscuring any topography that would indicate karst is present. As such, other options for additional evaluation of karst potential include:

- Surveying the landowners regarding historic sinkholes, etc.
- Detailed geophysical investigation
- Borings extended into the underlying bedrock

In our opinion, a two-tiered should be considered, beginning with a survey of local persons (land owners, county highway departments, university professors, geological society members, cavers, etc…) followed by either a geophysical investigation or additional borings at the sites of highest concern. Due to the presence of high groundwater and variable overburden, however, geophysical testing may not be ideal for this site. While not a comprehensive evaluation of risk, this approach provides a cost effective method to minimize the risk posed by karst. As a general rule, the more

one tries to reduce the risk, the higher the costs. The site developer carries the risk and must ultimately decide what the balance point is for risk reduction and cost.

4.4.5 Foundation Stiffness

Elastic theory relates shear wave velocity with the shear modulus at small strain using the following equation:

$$G_o = \rho V_s^2$$ (Reference 6, page 74)

where

G_o = shear modulus at small strain

V_s = shear wave velocity using CPT seismic data

ρ = mass density of the soil. The mass density is the ratio of the unit weight (γ) and the acceleration of gravity, g (32.2 ft/s^2 or 9.81 m/s^2).

In order to calculate the design shear modulus, the minimum average shear wave velocity of 635 ft/s was selected as the design value (Section 3.5). All test locations either met or exceeded this value. Based on an assumed design moist unit weight of 120 lbs/ft^3 the shear modulus at small strain is computed to be 1,500 kips per square foot (ksf). This value corresponds to the small strain shear modulus. For foundation design, the structural engineer should reduce the shear modulus based upon the estimated level of soil stress caused by the foundation in order to account for large strain conditions. Once the shear modulus (G) is determined, other moduli such as Young's modulus (E) and bulk modulus (K) can be derived based on the relations $E = 2(1 + \upsilon)G$ and $K = E/(3(1 - 2\upsilon))$ where υ is the Poisson' ratio.

4.4.6 Sliding Friction

The friction coefficient between the clayey soil of the site and concrete should be taken as 0.68 in accordance with recommendations provided by Potyandy (Reference 15), assuming a smooth concrete surface.

4.4.7 Foundation Settlement

Immediate, long-term and differential settlements of the foundation were computed based on results of the geotechnical investigation and testing described here. GE limits the tilt of the foundation to 0.17 degrees (3mm/m) for soil settlement (Reference 5); however, a total settlement limit is not stipulated. Based on the anticipated turbine foundation, an allowable differential settlement of approximately 1 inch corresponds to 3mm/m under the normal operating load for a 60 ft diameter foundation.

4.4.7.1 Immediate Settlement

The immediate settlement can be computed based on the application of the mean wind load with buoyant conditions, using the following equation based on elastic theory:

$$S = \frac{B_{eff}\, q_o}{E_s}\left(1 - \upsilon^2\right) I$$ (Reference 4, page 7.16)

where:

S = immediate settlement

q_o = buoyant contact pressure (1,750 psf – estimated)

B_{eff} = effective foundation width (45 feet – estimated)

υ = Poisson's ratio = 0.41 (from Section 3.5)

E_s = elastic soil modulus = $2G_o$ $(1 + \upsilon)b$ = 1,269 ksf (G_o = 1,500 ksf from Section 4.4.5 and b = 0.3, typical reduction factor from small strain to one percent strain)

I = shape factor = 1.12 (Reference 4, page 7.17)

This formula allows for a quick estimate of the immediate settlements induced by the footing. From the parameters and values considered, an immediate settlement based on the native soils is anticipated to be less than 1 inch for the current buoyant foundation design. This settlement should be reevaluated during preparation of the final foundation design to account for any changes to the above assumed values.

4.4.7.2 Long-term Settlement from DMT

The long-term settlement was estimated using the data collected from the DMT test data. The procedure proposed by Schmertmann, which uses the one-dimensional constraint modulus *M,* was used to calculate the settlement. In this procedure, the soil strata under the proposed foundation are subdivided into several layers. Then the stress increment induced by the foundation load is calculated at the mid-point of each layer. The compression of each layer can be computed using the following equation:

$$s_t = \sum_i \Delta\sigma' \frac{\Delta H_i}{M_i}$$

where:

$\Delta\sigma'$ is the effective stress at the mid-point of the soil layer,

ΔH_i is the thickness of layer i, and

M_i is the average one-dimensional constraint modulus of the layer i.

M values derived from the DMT are discussed in Section 3.6.1. Using this equation, the settlement from the DMT results can be calculated based on the application of the mean operating load at the midpoint of each layer. To calculate the consolidation settlement, the soil is be split into several layers, with the total settlement calculated as the sum of the individual layer settlements.

Considering the time required for long-term settlement from cohesive soils, differential settlement will be realized as a function of the applied foundation load during normal operating conditions at the center of the affective bearing area, and at the edge of the turbine foundation. Based on the results of the settlement estimated from the consolidation testing and DMT testing, the differential settlement across the turbine foundation can be calculated using the following equation.

$$\Delta S = \frac{S - S_{edge}}{B_{mean}/2}$$

where:

ΔS = differential settlement

S = settlement due to mean operating load (calculated settlement at center of affective bearing area)

S_{edge} = settlement due to mean operating load (calculated settlement at edge of the foundation)

B_{mean} = Elliptical bearing area width (calculated from 2*(R-e_{mean}))

R = Foundation Radius

e_{mean} = Load eccentricity under mean operating conditions

The soil parameters over the footing width should remain constant, so only the applied load from the turbine differs from the center of the affective area to the edge of the turbine foundation.

The applied load from the wind turbine foundations at the center of the affective bearing area and at the edge of the foundation were calculated using the following formula:

$$\Delta\sigma = I * q$$

where,

$\Delta\sigma$ = applied foundation load at midpoint of soil layer(variable with depth and location)

I = Influence factor varying with depth and location beneath foundation

q = foundation bearing pressure for mean operating load condition

The influence factor at the center of the effective bearing area was calculated using the following equation:

$$I = 1 - \frac{1}{[(0.5B / (Dmid - Df))^2 + 1]^{3/2}}$$

(Reference 3, page 132)

Where,

B = foundation width

$Dmid$ = depth to midpoint of soil layer

Df = bearing depth of foundation

The influence factor for the edge of the foundation was calculated using the design figure, Influence Value for Vertical Stress Under Uniformly Loaded Circular Area (Reference 7 page 7.1-169), with an x/r value of 1.0, which is at the edge of the loaded area under mean loading conditions.

Influence values at the center of the area and at the edge of the foundation were calculated for at the midpoint of each layer where DMT settlement was analyzed and settlement was calculated using the appropriate formulas noted herein, for the type of test data used. The total and differential settlement at the test locations is provided in Table 5. These values are preliminary and should be revised during final foundation design to account for changes to the effective bearing area and load distribution from those values assumed herein.

4.4.7.3 Long-term Settlement from Laboratory Consolidation Testing

The long-term settlement of the foundation can be computed using the results of the consolidation test results and the following equation:

$$S = \frac{C_r}{1+e_o} * L * \log\left(\frac{\sigma'_p}{\sigma'_{vo}}\right) + \frac{C_c}{1+e_o} * L * \log\left(\frac{\sigma'_f}{\sigma'_p}\right)$$ (Reference 2, page 272)

where:

C_r = recompression index

C_c = compression index

e_o = initial void ratio

L = height of soil layer

σ'_p = minimum past effective stress where soil transitions from overconsolidated to normally consolidated

σ'_{vo} = original effective stress at the midpoint of the clay layer below foundation (mean operating load conditions)

σ'_f = final effective stress equal to $\sigma'_{vo} + \Delta\sigma$, where $\Delta\sigma$ = average pressure increase to the clay layer caused by the applied foundation load

Using this formula, the long-term consolidation settlements induced by the footing can be calculated, based on the application of the mean operating load. To calculate the consolidation settlement, the soil should be split into several layers, with the effective stress recalculated at the midpoint of each layer. Samples were obtained from the wet, gray lacustrine clay soils. The results of the consolidation testing indicate that the clay is normally consolidated to

underconsolidated and applied foundation loads will cause virgin (normally consolidated) compression of any of the soil layers.

Using the laboratory consolidation test values for turbine sites 49, 51, and 66 (three of which had lacustrine soils for the majority to all of the soil profile) indicates potential differential settlement on the order of about 6 to 7 inches. This will greatly exceed the 3mm/m threshold for the turbine foundations.

Considering that some of the clay soils appear underconsolidated, it may be appropriate to consider negative skin friction (downdrag) on the sides of piles, should they be used in foundation design.

4.4.7.4 Turbine Locations with Excessive Differential Settlement

Based on the calculations detailed in Section 4.4.6.2 of this report, of the thirteen proposed turbine locations tested by DMT, seven showed unacceptable levels of differential settlement (Table 5). These turbine locations correspond directly to the sites with lacustrine, marsh, or depression deposits extending significant depths beneath the turbine sites. These sites also were identified in Sections 3.4.2 and 4.4.3 as requiring mitigation for support of the proposed foundations due to low bearing capacity/strength concerns. The required mitigation for bearing capacity will also address the unacceptable levels of estimated differential settlement. As such, any site identified as either suitable with respect to bearing capacity without mitigation or suitable for bearing capacity following mitigation is suitable with respect to differential settlement as well, once the required mitigation has been completed.

4.4.8 Backfill Density

Standard Proctor testing performed as a part of this geotechnical evaluation was ongoing at the time of this draft report. In the interim an in-situ unit weight of 120 pcf is recommended for use in the ongoing foundation design pending the laboratory test results.

4.4.9 Soil Chemical Content and Cement Type

The results of the chemical testing from 12 samples (Appendix H) indicate that the soils have pH ranging from 6.0 to 7.7. The analytical laboratory testing results indicate that the soils contain 37 to 66 ppm of Chlorides (detection limit) and 55 to 3,500 ppm soluble sulfates. The laboratory test results are included in Appendix G.

The results from turbine sites 66 and 72 exceed 2,000 ppm which is considered severe sulfate exposure. The remaining test sites indicated negligible sulfate exposure (Reference 20, page 79.) As a result, Type V cement or a specialized mix design of Type II cement in conjunction with fly ash can be considered for use on this site.

5.0 Limitations of Analysis

The analysis and conclusions provided are based on the results of fieldwork which focused on investigation of 112 potential wind turbine locations for the Hardin Wind Project. Using generally accepted engineering methods and practices, both the investigation performed and the data gathered has made every reasonable effort to characterize the project site. However, the likelihood that conditions may vary from any specific location tested is still possible, and careful attention to soil conditions should be undertaken during the time of construction by qualified personnel.

During construction, if turbines are subsequently relocated to different locations, additional soil testing may be recommended to ensure that soil conditions at the relocated turbines sites are of similar characteristics to that assumed when designing this project. Based on the conditions encountered at the project site, turbine relocations greater than 50 feet from the existing soil sounding or boring location will require re-testing.

6.0 References

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Tables

Table 1
Proposed Turbine Coordinates and Testing Summary

Turbine Number	UTM Zone 17 NAD 83		WGS 84		CPT Testing	Seismic Testing		Soil Borings and Lab	DMT Testing	Electrical Resistivity Testing	Thermal Resistivity Testing
	East	North	WGS 84 Longitude	WGS 84 Latitude		Vs	Vp				
1	260491	4509449	-83.834914	40.701155							
2	260246	4509134	-83.837690	40.698250	X			X		X	X
3	260249	4508733	-83.837501	40.694643	X	X	X				
4	260574	4508357	-83.833516	40.691354							
5	261049	4509473	-83.828326	40.701533	X				X		
6	261128	4509183	-83.827282	40.698947	X						
7	261208	4508861	-83.826213	40.696073	X						
8	261360	4508570	-83.824306	40.693498	X						
9	261579	4508328	-83.821625	40.691384	X						
10	261702	4507886	-83.820003	40.687443	X						
11	261778	4507534	-83.818971	40.684298	X						
12	262525	4509245	-83.810789	40.699908	X	X	X				
13	262687	4508976	-83.808772	40.697535	X						
14	262825	4508706	-83.807039	40.695145	X			X		X	
15	260856	4507957	-83.830030	40.687837	X						
16	260862	4507603	-83.829824	40.684653	X						
17	260869	4507304	-83.829628	40.681965	X						
18	260956	4507020	-83.828491	40.679435	X						
19	261043	4506725	-83.827351	40.676806	X			X			X
20	260133	4507959	-83.838577	40.687645	X						
21	260266	4507700	-83.836906	40.685353	X						
22	261922	4506980	-83.817059	40.679354	X						
23	262059	4506685	-83.815328	40.676739	X	X	X				
24	262128	4506277	-83.814358	40.673088							
25	262144	4505900	-83.814026	40.669701	X						
26	262362	4505663	-83.811361	40.667631	X						
27	262919	4506205	-83.804983	40.672668	X						
28	262944	4505799	-83.804534	40.669022	X						
29	263086	4505398	-83.802705	40.665455	X						
30	261606	4505686	-83.820303	40.667620	X						
31	261529	4505067	-83.820978	40.662028	X			X			
32	260659	4505242	-83.831324	40.663351	X						
33	259497	4506173	-83.845410	40.671390	X	X	X				
34	259858	4506121	-83.841125	40.671027	X						
35	260246	4506091	-83.836528	40.670870	X			X		X	X
37	259494	4504345	-83.844746	40.654941	X						
38	260116	4504490	-83.837453	40.656427	X	X	X				
39	263844	4507759	-83.794636	40.686916	X			X		X	
40	263835	4507466	-83.794632	40.684277	X						

Turbine Number	UTM Zone 17 NAD 83		WGS 84		CPT Testing	Seismic Testing		Soil Borings and Lab	DMT Testing	Electrical Resistivity Testing	Thermal Resistivity Testing
			WGS 84	WGS 84		Vs	Vp				
	East	North	Longitude	Latitude							
41	263827	4507173	-83.794616	40.681639	X	X	X				
42	263818	4506880	-83.794613	40.679000	X						
43	263804	4506575	-83.794663	40.676251							
44	263838	4506218	-83.794127	40.673049							
45	263797	4505759	-83.794439	40.668907	X				X		
46	264092	4505590	-83.790890	40.667470	X						
47	264341	4505335	-83.787852	40.665247	X						
48	264366	4504981	-83.787423	40.662069	X	X	X		X		
49	263661	4504602	-83.795611	40.658457	X			X		X	X
50	263594	4504326	-83.796299	40.655954	X						
51	263477	4504005	-83.797561	40.653033	X			X	X		X
52	264012	4503894	-83.791198	40.652187	X						
53	263345	4503622	-83.798976	40.649549	X						
54	263375	4503270	-83.798489	40.646390	X				X		
55	263532	4502957	-83.796517	40.643618	X						
56	263605	4502615	-83.795526	40.640562	X						
57	263720	4502188	-83.794007	40.636753	X						
58	263946	4501959	-83.791252	40.634757	X						
59	264484	4503856	-83.785608	40.651980	X						
60	264525	4503558	-83.785012	40.649310	X						
61	264554	4503290	-83.784569	40.646907							
62	264596	4502930	-83.783938	40.643679	X			X		X	X
63	264834	4502684	-83.781035	40.641534	X	X	X				
64	264954	4502405	-83.779513	40.639057	X				X		
65	262701	4501657	-83.805843	40.631683	X						
66	262764	4501392	-83.804999	40.629316	X			X		X	
67	262837	4501104	-83.804029	40.626746	X						
68	262984	4500839	-83.802193	40.624404	X	X	X				
69	263063	4500513	-83.801137	40.621493							
70	262959	4500145	-83.802227	40.618152	X				X		
71	262264	4500477	-83.810559	40.620939	X						
72	262202	4500169	-83.811175	40.618150	X			X		X	
73	263571	4501308	-83.795437	40.628792	X						
74	263697	4500723	-83.793729	40.623564							
75	263826	4500509	-83.792126	40.621675							
76	265028	4507206	-83.780433	40.682278	X						
77	265224	4507002	-83.778040	40.680499	X						
78	265800	4507611	-83.771459	40.686142	X				X		
79	265946	4507349	-83.769636	40.683826	X						
80	266056	4507067	-83.768231	40.681320	X						
81	266085	4498110	-83.764558	40.600731	X				X		
82	266102	4506509	-83.767479	40.676312	X	X	X	X		X	

Turbine Number	UTM Zone 17 NAD 83		WGS 84		CPT Testing	Seismic Testing		Soil Borings and Lab	DMT Testing	Electrical Resistivity Testing	Thermal Resistivity Testing
			WGS 84	WGS 84		Vs	Vp				
	East	North	Longitude	Latitude							
83	265284	4508628	-83.777939	40.695147	X						
84	265631	4508545	-83.773806	40.694499	X						
85	266029	4508389	-83.769043	40.693208	X						
86	266285	4508195	-83.765944	40.691535	X						
87	266892	4508135	-83.758746	40.691167	X						
88	266792	4508520	-83.760071	40.694603	X	X	X	X		X	
89	265582	4496351	-83.769843	40.584760	X				X		
90	267549	4509260	-83.751396	40.701475	X						
91	267559	4508931	-83.751156	40.698518	X						
92	267705	4508527	-83.749280	40.694924	X				X		
93	268146	4509313	-83.744357	40.702120	X						
94	268349	4509090	-83.741874	40.700171	X						
95	265927	4496101	-83.765678	40.582608	X	X	X				
96	268296	4508559	-83.742305	40.695378	X						
97	269077	4508956	-83.733217	40.699169	X	X	X				
98	269069	4508649	-83.733199	40.696405	X						
99	265425	4496681	-83.771818	40.587685	X			X		X	
100	268345	4507995	-83.741517	40.690316							
101	267330	4507683	-83.753400	40.687223							
102	265955	4498613	-83.766280	40.605220	X						
103	267897	4507472	-83.746620	40.685484							
104	268175	4507355	-83.743291	40.684510							
105	268456	4507242	-83.739927	40.683572							
106	268735	4507123	-83.736586	40.682579							
107	269776	4506585	-83.724083	40.678029	X				X		
108	266963	4507110	-83.757526	40.681964	X						
109	267267	4506884	-83.753849	40.680016	X						
110	267526	4506629	-83.750693	40.677794	X						
111	270613	4509989	-83.715435	40.708894	X						
112	271441	4510527	-83.705839	40.713965	X						
113	271473	4509681	-83.705153	40.706361	X						
114	271543	4509456	-83.704243	40.704356							
115	272158	4509120	-83.696849	40.701502							
116	272141	4508780	-83.696926	40.698438	X						
117	270579	4508384	-83.715250	40.694441	X			X		X	
118	270668	4508105	-83.714095	40.691956	X	X	X				
119	265676	4499139	-83.769769	40.609874	X						
120	265900	4498897	-83.767034	40.607760	X	X	X				
121	267621	4507596	-83.749928	40.686522							
122	266036	4506777	-83.768359	40.678705	X						
123	267884	4508208	-83.747046	40.692103	X						
124	268306	4508818	-83.742282	40.697711	X						

Turbine Number	UTM Zone 17 NAD 83		WGS 84		CPT Testing	Seismic Testing		Soil Borings and Lab	DMT Testing	Electrical Resistivity Testing	Thermal Resistivity Testing
						Vs	Vp				
	East	North	WGS 84 Longitude	WGS 84 Latitude							
125	266199	4506137	-83.766194	40.672992	X						
126	266285	4505856	-83.765073	40.670488	X						
127	261775	4507236	-83.818894	40.681615	X						
128	265605	4504959	-83.772775	40.662224	X						
129	264311	4501585	-83.786801	40.631496	X	X	X				
130	267685	4506413	-83.748734	40.675895	X						
131	264430	4507160	-83.787484	40.681694	X				X		
132	262970	4506951	-83.804662	40.679395	X						
133	263033	4506622	-83.803793	40.676453	X						
SS-1	263766	4501718						X			
SS-2	263787	4501741						X		X	X
O&M-1	264012	4501767						X			
O&M-2	264079	4501775						X			

Table 2
Groundwater Levels from Standpipe Piezometers

Turbine ID	Soil Boring	Initial Water Condition (ft)	Second Reading		Third Reading	
			Date	Depth BGS (ft)	Date	Depth BGS (ft)
2	8/2/2011	Dry	8/4/2011	3.9	11/21/2011	1.4
14	8/10/2011	Dry	8/10/2011	4.3	11/21/2011	3
19	8/8/2011	Dry	8/10/2011	--	11/21/2011	1.8
31	8/9/2011	Dry	8/10/2011	5.1	11/21/2011	0.7
35	8/8/2011	12.6	8/10/2011	4.8	11/21/2011	1.9
39	8/15/2011	Dry	8/10/2011	9.1	11/21/2011	2.4
49	8/4/2011	Dry	8/10/2011	9.7	11/21/2011	damaged
51	8/15/2011	Dry	--	--	--	--
62	8/14/2011	Dry	--	--	--	--
66	8/3/2011	Dry	8/4/2011	7	11/21/2011	1.1
72	8/3/2011	Dry	8/4/2011	2.7	11/21/2011	1.9
82	8/9/2011	Dry	8/10/2011	7.6	11/21/2011	3.9
88	8/9/2011	13.53	8/10/2011	5.5	11/21/2011	1.6
99	8/4/2011	--	--	--	--	--
117	8/9/2011	Dry	8/10/2011	5.1	11/21/2011	2.6

Table 3
Mitigation Depth Summary

Turbine	Refusal (ft)	HSA Depth to Rock/ Refusal(ft)	Decreasing SPT (from CPT)	Weak Lacustrine Clay Depth (ft)	Significant Weak Zones < 1100 psf Below 9ft				Required Mitigation Depth (ft)	Anticipated Remediation Type	Karst Concern
1	--		--	--	--	--	--	--	--	--	--
2	33.45	45.3	Possible	--	--	--	--	--	--	--	--
3	34.09		Possible	--	29-31.5	--	--	--	--	None*	--
4	--		--	--	--	--	--	--	--	--	--
5	37.86		Possible	--	--	--	--	--	--	--	--
6	34.58		No	--	--	--	--	--	--	--	--
7	30.91		Yes	--	14.5-15	29.5-30	--	--	15	Geopier	Yes
8	32.91		Yes	27-33	15.5-17.5	27-33	--	--	33	Geopier/Piles	Yes
9	36.7		Possible-Yes	--	14.5-16.5	19.5-20.5	25-27.5	33-34.5	35	Geopier/Piles	Yes
10	50.03		Yes	--	15.5-16.5	19-22	--	--	22	Geopier	--
11	39.73		Possible- No	--	9-10.5	12-12.5	--	--	12.5	Geopier	--
12	26.18		No	--	--	--	--	--	--	--	--
13	30.4		No	--	11.5-12	--	--	--	12	Overexcavation	--
14	27.46	28	No	--	--	--	--	--	--	--	--
15	50.03		No	--	14.5-16.5	--	--	--	16.5	Geopier	--
16	39.73		Possible- No	--	33-34.5	--	--	--	--	None*	Maybe
17	36.29		Possible- No	--	24-25	33-34.5	--	--	--	None*	Maybe
18	25.51		No	--	11.5-12	--	--	--	12	Overexcavation	--
19	20	32	Possible- No	--	16-17.5	--	--	--	--	None*	Maybe
20	34.45		Yes	--	--	--	--	--	--	--	Maybe
21	44.03		No	--	26-27.5	37-38	--	--	--	None*	--
22	50.03		No	16	27-28	30-30.5	--	--	16	Geopier	--
23	34.61		No	11.5	23-25 very weak	--	--	--	25	Geopier	--
24	--		--	--	--	--	--	--	--	--	--
25	46.8		Possible	17.5	37-45 partially very weak		--	--	45	Geopier/Piles	Yes
26	28.46		No	16.5	--	--	--	--	16.5	Geopier	--
27	50.03		No	17	--	--	--	--	17	Geopier	--
28	50.05		No	20	27.5-29 very weak	--	--	--	29	Geopier/Piles	--
29	50.03		Possible- No	20.5	34.5-36	--	--	--	20.5	Geopier/Piles	--
30	25.72		Yes	9.5	11-12.5	23.5-25	--	--	12.5	Overexcavation	Yes
31	22.26	23.5	No	--	9-10.5	13.5-14.5	--	--	14.5	Overexc/Geopier	--
32	31.61		Yes	--	--	--	--	--	--	--	Maybe
33	30.43		Yes	--	--	--	--	--	--	--	Maybe
34	27.97		No	--	--	--	--	--	--	--	--
35	14.26	18	Yes	--	--	--	--	--	--	--	Maybe
36	--		--	--	--	--	--	--	--	--	--
37	20.8		Yes	--	--	--	--	--	--	--	Maybe
38	20.19		Yes	--	--	--	--	--	--	--	Maybe
39	29.56	33	No	--	14-23	--	--	--	23	Geopier	--
40	35.37		No	--	14-25	--	--	--	25	Geopier	--
41	38.78		Possible	--	15.5-20	--	--	--	20	Geopier	--
42	49.72		No	24	--	--	--	--	24	Geopier	--
43	--		--	--	--	--	--	--	--	--	--
44	--		--	--	--	--	--	--	--	--	--
45	50.03		No	44	--	--	--	--	44	Piles	--
46	50.03		Possible	35	--	--	--	--	35	Piles	--
47	50.05		No	31	--	--	--	--	31	Geopier/Piles	--
48	50.03		No	29	--	--	--	--	29	Geopier/Piles	--
49	50.03	>50	--	50+	--	--	--	--	50+	Piles	--
50	50.03		No	43	--	--	--	--	43	Piles	--
51	50.03	>50	--	50+	--	--	--	--	50+	Piles	--
52	50.05		Possible	28.5	--	--	--	--	28.5	Geopier	--
53	50.05		--	50+	--	--	--	--	50+	Piles	--
54	50.03		No	23.5	--	--	--	--	23.5	Geopier	--
55	35.25		Possible	22.5	--	--	--	--	22.5	Geopier	--
56	50.03		Possible	14.5	23.5-25.5	40-42	--	--	14.5	Overexc/Geopier	Maybe
57	38.12		No	--	--	--	--	--	--	--	--
58	50.03		No	--	--	--	--	--	--	--	--
59	50.03		Possible	15	44-45	--	--	--	15	Overexc/Geopier	Maybe
60	44.82			--	10.5-11.5	12.5-16	--	--	16	Geopier	--
61	--		--	--	--	--	--	--	--	--	--
62	41.73	44	No	--	12-12.5	--	--	--	--	None*	--
63	--		--	--	--	--	--	--	--	--	--
64	46.31		No	--	--	--	--	--	--	--	--
65	50.03		Yes	20	35.5-39.5	--	--	--	20	Geopier	Maybe
66	50.03	>50	Possible- No	35.5	42-44	--	--	--	44	Geopier/Piles	--
67	50.03		Possible- No	37	41.5-45 mixed	--	--	--	37	Geopier/Piles	Maybe
68	43.5		No	--	--	--	--	--	--	--	--
69	--		--	--	--	--	--	--	--	--	--
70	50.03		Possible	22	--	--	--	--	22	Geopier	--
71	50.02			50+	--	--	--	--	50+	Piles	--
72	50.05	>50	No	to 7	23.5-25	31-32.5	34-42.5	--	43	Piles	Maybe
73	50.03		No	--	27-28	--	--	--	--	None*	--
74	--		--	--	--	--	--	--	--	--	--
75	--		--	--	--	--	--	--	--	--	--
76	50.03		No	13.5	26.5-27	30-43.5			44	Geopier/Piles	--
77	50.03		Possible	21-34	11-13	15.5-18.5	21-33.5	44.5-46	34	Geopier/Piles	Yes
78	50.03		Possible- No	--	9.5-21.5	41.5-46.5 mixed	--	--	21.5	Geopier	Maybe
79	50.03		No	--	13.5-27 poss. peat	--		--	27	Geopier	--
80	50.03		No	--	7-15	--		--	15	Overexc/Geopier	--
81	50.03		No	--	--	--		--	--		--
82	30.51	34.2	Yes	--	6.5-11.5	14.5-15.5	--	--	15.5	Overexc/Geopier	Maybe

Turbine	Refusal (ft)	HSA Depth to Rock/ Refusal(ft)	Decreasing SPT (from CPT)	Weak Lacustrine Clay Depth (ft)	Significant Weak Zones < 1100 psf Below 9ft				Required Mitigation Depth (ft)	Anticipated Remediation Type	Karst Concern
83	50.02		Possible	--	4.5-12.5	--	--	--	12.5	Overexcavation	--
84	50.02		No	--	4.5-19.5	--	--	--	19.5	Geopier	--
85	41.72		No	--	7-11.5	--	--	--	11.5	Overexcavation	--
86	50.02		Possible	--	7-9.5	--	--	--	9.5	Overexcavation	--
87	50.02		No	--	14-18	--	--	--	18	Geopiers	--
88	35.38	>50	No	--	--	--	--	--	--	--	--
89	50.03		Possible	--	--	--	--	--	--	--	--
90	47.31		Possible	--	--	--	--	--	--	--	--
91	50.02		No	--	--	--	--	--	--	--	--
92	50.02		No	--	20.5-21.5	--	--	--	--	None*	--
93	48.46		No	--	--	--	--	--	--	--	--
94	50.02		No	--	--	--	--	--	--	--	--
95	50.03		No	--	--	--	--	--	--	--	--
96	43.47		No	--	10.5-11.5	--	--	--	11.5	Overexcavation	--
97	--		--	--	--	--	--	--	--	--	--
98	50.02		No	--	41.5-43	--	--	--	--	None*	Maybe
99	50.03	>50	No	--	--	--	--	--	--	--	--
100	--		--	--	--	--	--	--	--	--	--
101	--		--	--	--	--	--	--	--	--	--
102	50.03		No	--	--	--	--	--	--	--	--
103	--		--	--	--	--	--	--	--	--	--
104	--		--	--	--	--	--	--	--	--	--
105	--		--	--	--	--	--	--	--	--	--
106	--		--	--	--	--	--	--	--	--	--
107	48.13		No	--	13.5-14	--	--	--	--	None*	--
108	35.42		No	--	--	--	--	--	--	--	--
109	34.58		Possible- No	--	24.5-25.5	--	--	--	--	None*	--
110	33.28		No	--	10.5-11	--	--	--	11	Overexcavation	--
111	50.02		No	--	--	--	--	--	--	--	--
112	50.02		No	--	--	--	--	--	--	--	--
113	50.02		Possible- No	--	37-43.5	--	--	--	--	--	Maybe
114	--		--	--	--	--	--	--	--	--	--
115	--		--	--	--	--	--	--	--	--	--
116	50.02		Possible- No	--	29-29.5	--	--	--	--	--	--
117	19.57	>50	No	--	--	--	--	--	--	--	--
118	25.1		No	--	15-15.5	--	--	--	--	None*	--
119	50.03		No	--	--	--	--	--	--	--	--
120	50.03		No	--	--	--	--	--	--	--	--
121	--		--	--	--	--	--	--	--	--	--
122	50.03		No	11.5	17.5-23.5	--	--	--	23.5	Geopier	--
123	46.42		No	--	--	--	--	--	--	--	--
124	50.02		Possible- No	--	--	--	--	--	--	--	--
125	31.45		Possible-Yes	--	25-27.5 very weak	--	--	--	27.5	Geopier	Yes
126	34.1		No	--	--	--	--	--	--	--	--
127	48.92		No	--	8.5-11.5	21	--	--	11.5	Overexcavation	--
128	50.02		No	15.5	--	--	--	--	15.5	Geopier	--
129	29.17		Possible- No	--	9.5-10	--	--	--	10	Overexcavation	--
130	30.69		Yes	--	11.5-12.25	15.5-19	22.5-23.5	--	20	Geopier	Yes
131	50.03		No	38	--	--	--	--	38	Geopier/Piles	--
132	50.03		No	--	9-15	--	--	--	15	Overexc/Geopier	--
133	50.03		Possible	23	32.5-33.5	--	--	--	23	Geopier	--

*Suitable from multi-layer bearing capacity analysis - remediation not anticipated

Table 4
Summary of Average Compression and Shear Wave Velocity and Poisson's Ratio

Turbine	Vs (ft/s)	Vp (ft/s)	v
3	1189	5008	0.47
12	975	5881	0.49
23	1093	5423	0.48
33	1006	6568	0.49
38	1252	7007	0.48
41	635	10143	0.50
48	680	6071	0.49
63	1259	5948	0.48
68	1377	3598	0.41
82	872	6999	0.49
88	672	7069	0.50
95	1119	5257	0.48
97	1239	6569	0.48
118	1183	5674	0.48
120	1233	3273	0.42
129	1290	5095	0.47
Minimum	**635**	**3273**	**0.41**
Maximum	**1377**	**10143**	**0.50**
Average	**1067**	**5974**	**0.47**

Table 5
Estimated Long-term Settlement under Mean Operating Load Conditions

Turbine No.	5	45	48	51	54	64	70	78	81	89	92	107	131
Soil Survey Parent Materials	Lake/ Marsh	Marsh	Marsh	Marsh	Marsh	Moraine	Lake/ Marsh	Depression	Moraine	Moraine	Depression	Till/ Moraine	Lake/ Marsh
Tot. Settlement [in]	0.9	69.8	23.3	74.5	19.7	1.0	49.4	4.5	0.4	0.8	1.4	0.7	9.0
Diff Settlement [in]	0.4	36.6	12.4	37.4	10.3	0.5	25.3	2.0	0.2	0.3	0.6	0.3	4.7
Diff Settlement [in/ft]	0.0	1.2	0.4	1.2	0.3	0.0	0.8	0.1	0.0	0.0	0.0	0.0	0.2
Diff Settlement [mm/m]	1.1	101.8	34.5	104.0	28.5	1.4	70.3	5.5	0.5	0.9	1.8	1.0	13.1

Table 6
Summary of General Laboratory Test Results

Sample Location Boring No.	Depth	Approx Soil Type (1)	Moisture Content (%)	Dry Density (pcf)	Calc. Bulk Dens. (pcf)	Atterberg Limits (% moisture content) Liquid Limit	Plastic Limit	Plast. Index	Percent fines (%)	Unconfined/UU Compressive Strength (tsf)	Consolidation Test Data Cc	Cr	e_o	Pc (tsf)	pH	Soluble Sulfates (ppm)	Chlorides (ppm)
T-02	1	marsh	24.0														
	3	marsh	19.1	109.3	130.2										7.7	9.4	37
	12	till	14.9	120.4	138.3					1.19							
	15	till	13.6			25	17	8									
	25	till	14.1														
	30	till	18.5						46								
	35	till	8.6														
	45	till	13.4														
T-14	1	marsh	21.8														
	5	marsh	25.3														
	17	till	14.2														
	20	till	10.3			22	17	5									
	25	till	8.4														
T-19	1	marsh	30.2														
	3	marsh	24.2	96.6	120.0										7.4	330	55
	10	till	12.7														
	20	till	5.2														
	25	till	14.4			32	17	15									
	30	till	18.0														
T-31	1	lacustrine	27.9														
	5	lacustrine	24.9														
T-35	1	till	25.8														
	3	till	20.8	106.7	128.9										7.7	<50	37
	5	till	15.3														
	12	till	13.5	124.3	141.1					1.3							
	15	till	14.7						58								
T-39	1	marsh	19.7														
	5	marsh	21.4														
	12	marsh	22.5	102.3	125.3					0.79							
	20	marsh	26.2			38	22	16									
	30	till	27.7														
T-49	3	lacustrine	36.5	76.5	104.4										7.6	100	66
	5	lacustrine	32.1														
	12	lacustrine	39.4	78.5	109.4					0.23	0.27	0.05	1.092	0.56			
	22	lacustrine	41.6	80.1	113.4	41.5	19.7	21.8		0.17							
	47	lacustrine	38.5	83	115.0					0.28							
	50	lacustrine	6.0														
T-50	1	lacustrine	27.7														
T-51	3	lacustrine	39.4	81.6	113.8					0.14					7.7	220	48
	20	lacustrine	40.9	77.6	109.3	42	19.3	22.7		0.15	0.26	0.05	1.161	0.42			
	30	lacustrine	39.0														
	37	lacustrine	44.1	72.2	104.0					0.17							
	50	lacustrine	45.3														
T-62	3	marsh	36.9	73.6	100.8										7.6	690	<10
	15	till	12.1														
	20	till	11.5			22	17	5									
	22	till	17.5	113.7	133.6					0.73							
	30	till	19.4														
	35	till	15.2						88								

Table 6
Summary of General Laboratory Test Results

Sample Location Boring No.	Depth	Approx Soil Type (1)	Moisture Content (%)	Dry Density (pcf)	Calc. Bulk Dens. (pcf)	Atterberg Limits (% moisture content) Liquid Limit	Plastic Limit	Plast. Index	Percent fines (%)	Unconfined/UU Compressive Strength (tsf)	Consolidation Test Data Cc	Cr	e_o	Pc (tsf)	pH	Soluble Sulfates (ppm)	Chlorides (ppm)
	40	till	10.8														
	44	till	13.3														
T-66	1	lacustrine	76.4														
	3	lacustrine	41.3	78.7	111.2										7.6	3500	52
	12	lacustrine	36.7	82.2	112.4	38.4	20.1	18.3		0.29	0.24	0.04	1.020	0.59			
	25	lacustrine	51.9														
	35	lacustrine	43.4														
	40	lacustrine	26.8						99								
	43	lacustrine	23.9	101.6	125.9					0.82							
T-72	1	lacustrine	30.6														
	3	lacustrine	32.4	89.2	118.1										7.5	2000	50
	12	lacustrine	23.1	103.1	126.9					1.6							
T-82	1	lacustrine	23.1														
	3	lacustrine	20.8	105.7	127.7										7.4	250	57
	5	lacustrine	24.4														
	20	lacustrine	16.9														
	25	lacustrine	11.7			17	11	6									
	26	lacustrine	13.5	124	140.7	36	18	18		1.25							
T-88	1	lacustrine	24.8														
	3	lacustrine	31.4	87.2	114.6										7.2	55	53
	10	lacustrine	21.4														
	15	lacustrine	22.0						99								
	17	lacustrine	25.0	100.7	125.9					1.52							
	20	lacustrine	24.1			36	19	17									
	27	till	18.8	112.2	133.3	18.9	13.5	5.4		1.71							
	40	till	13.5														
	50	till	19.6														
T-99	3	till	16.6	112.2	130.8										7.2	59	49
T-117	1	laustrine	23.7														
	3	laustrine	23.2	99.4	122.5										6	<50	53
	10	till	23.4														
	15	till	13.0			28	18	10									
	25	till	14.4						70								
	30	till	15.8														
	40	till	29.7														
	50	till	10.7														
SS-2	3	depression	18.6	113.6	134.7												
Number of Tests			86	28	28	13	13	13	6	16	3	3	3	3	12	12	12
Minimum Values			5.2	72.2	100.8	17.0	11.0	5.0	46.0	0.14	0.24	0.04	1.02	0.42	6.0	9.4	37.0
Maximum Values			76.4	124.3	141.1	42.0	22.0	22.7	99.0	1.71	0.27	0.05	1.16	0.59	7.7	3500.0	66.0
Average Values			23.5	96.7	121.9	30.5	17.6	13.0	76.7	0.77	0.26	0.05	1.09	0.52	7.4	721.3	50.6
Standard Deviations			11.7	16.3	11.5	8.8	2.8	6.6	22.2	0.6	0.0	0.0	0.1	0.1	0.5	1143.1	8.3

Notes
(1) Approximate Soil Types - see boring logs for full description

Table 7
Summary of Standard Proctor and California Bearing Ratio Test Results

Turbine ID / Thermal Test Location	Depth [ft]	Standard Proctor Data		95% Compaction Moist Unit Wt. at Opt. Moisture (pcf)	In-situ Moisture (%)	95% Compaction Moist Unit Wt. at in-situ Moisture (pcf)	CBR Results
		Maximum Dry Density (pcf)	Optimum Moisture (%)				95% Compaction
T-2	1-4	102.2	22.5	118.9	24.0	120.4	1.6
T-14	1-4	109.2	16.8	121.2	21.8	126.4	2.7
T-19	1-4	95.5	25.8	114.1	30.2	118.1	1.1
T-31	1-4	96.9	25.1	115.2	27.9	117.7	0.8
T-35	1-4	102	21.3	117.5	25.8	121.9	1.8
T-39	1-4	108.9	17.9	122.0	19.7	123.8	3.2
T-50	1-4	103	21.4	118.8	27.7	125.0	2.1
T-66**	1-4	67.5	47.5	94.6	76.4	113.1	1.1
T-72	1-4	98.7	21	113.5	30.6	122.5	2.0
T-82	1-4	108.8	18.2	122.2	23.1	127.2	1.7
T-88	1-4	105.1	20.1	119.9	24.8	124.6	1.6
T-117	1-4	103.3	20.2	118.0	23.7	121.4	2.1
Mean		100.1	23.2	116.3		121.8	1.8
St. Dev.		11.2	8.1	7.4		4.0	0.7
Min.		67.5	16.8	94.6		113.1	0.8
Max		109.2	47.5	122.2		127.2	3.2

** Organic Clay soil

Table 8
Subgrade Compaction and Aggregate Thickness

1.5 Max Rut Depth		Compaction (% of Standard Proctor Max Dry Density) 95 or Greater	
Traffic Condition		Maint. Traffic	Const. Traffic
Unreinforced		12	32
Reinforced	Geotextile	8	22
	Type I**	7	18
	Type II***	6	13

3.0 Max Rut Depth		Compaction (% of Standard Proctor Max Dry Density) 95 or Greater	
Traffic Condition		Maint. Traffic	Const. Traffic
Unreinforced		8	21
Reinforced	Geotextile	6	12
	Type I**	6	9
	Type II***	6	8

*Note that a minimum of 6 to 12 inches of aggregate base is recommended for road design to compensate for topsoil stripping.
** Type I: Triaxial geogrid TX 140
*** Type II: Triaxial geogrid TX 160

Assumed Traffic Loading Conditions

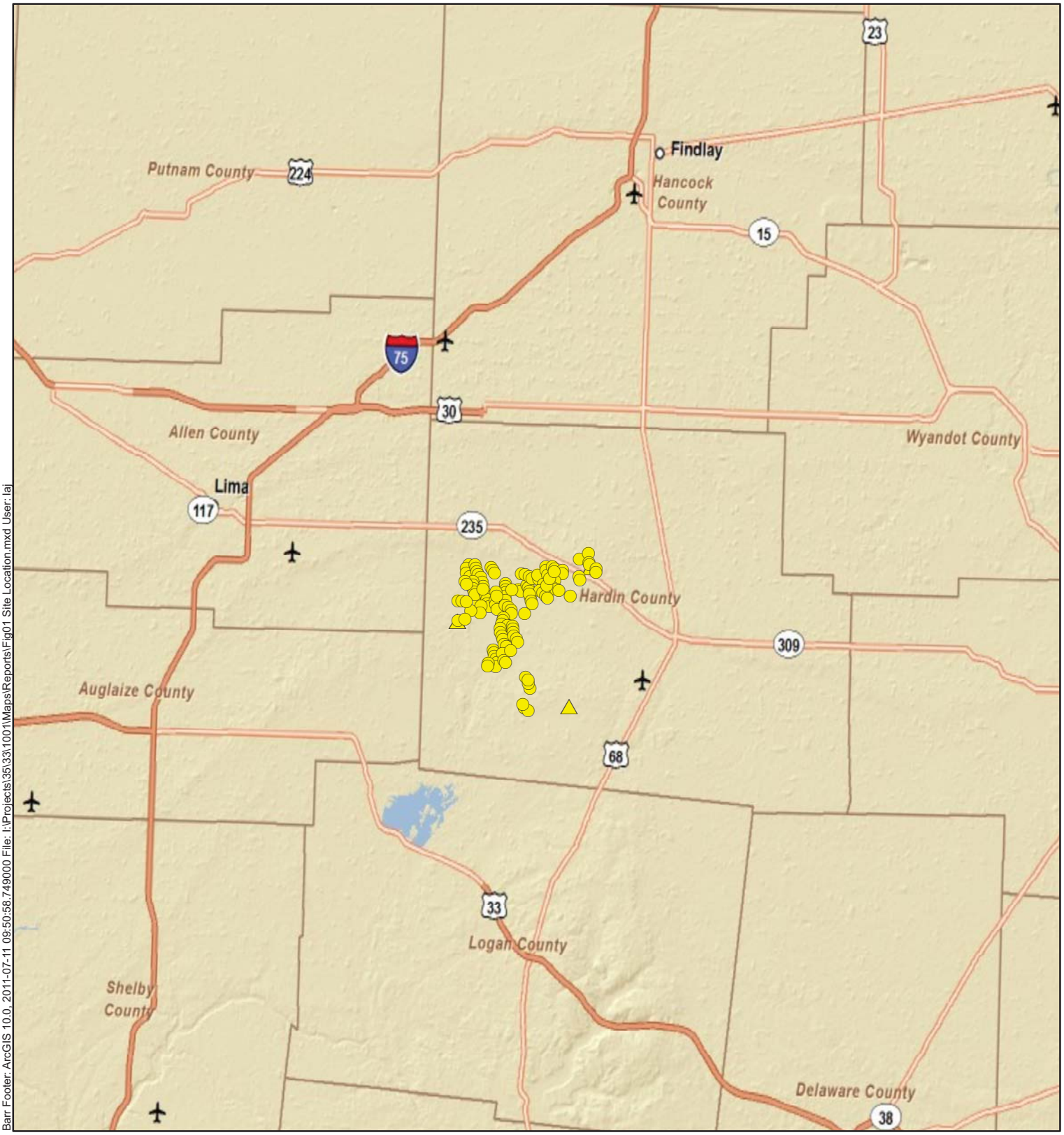
Construction	
Axle Load [kips]	25
Tire Pressure [psi]	80
Axle Passes [each]	800
Max Rut Depth [in]	1.5, 3

Maintenance	
Axle Load [kips]	3.5
Tire Pressure [psi]	65
Axle Passes [each]	2000
Max Rut Depth [in]	1.5, 3

Table 9
Summary of Geotechnical Parameters
for Foundation Design

Parameter	Value	Units
Undrained Soil Shear Strength (cohesive soil)	1,100	lb/ft^2
Min. Allowable Bearing Capacity, Normal Operating Load	2,300	lb/ft^2
Min. Allowable Bearing Capacity, Extreme Load	3,000	lb/ft^2
Min. Average Shear Wave Velocity	635	ft/s
Min. Design Small Strain Shear Modulus	1,500	$kips/ft^2$
Poisson Ratio	0.41	unitless
Min. Foundation/Soil Friction Factor	0.68	unitless
Backfill Density over Foundation (dry density = 95 pcf @ moisture content = 15 %)	100	lb/ft^3
Frost Depth	35	Inches

Figures



Barr Footer: ArcGIS 10.0, 2011-07-11 09:50:58.749000 File: I:\Projects\35\33\1001\Maps\Reports\Fig01 Site Location.mxd User: laj

Turbine Location
(7/7/2011 Coordinates)

Met Tower Location

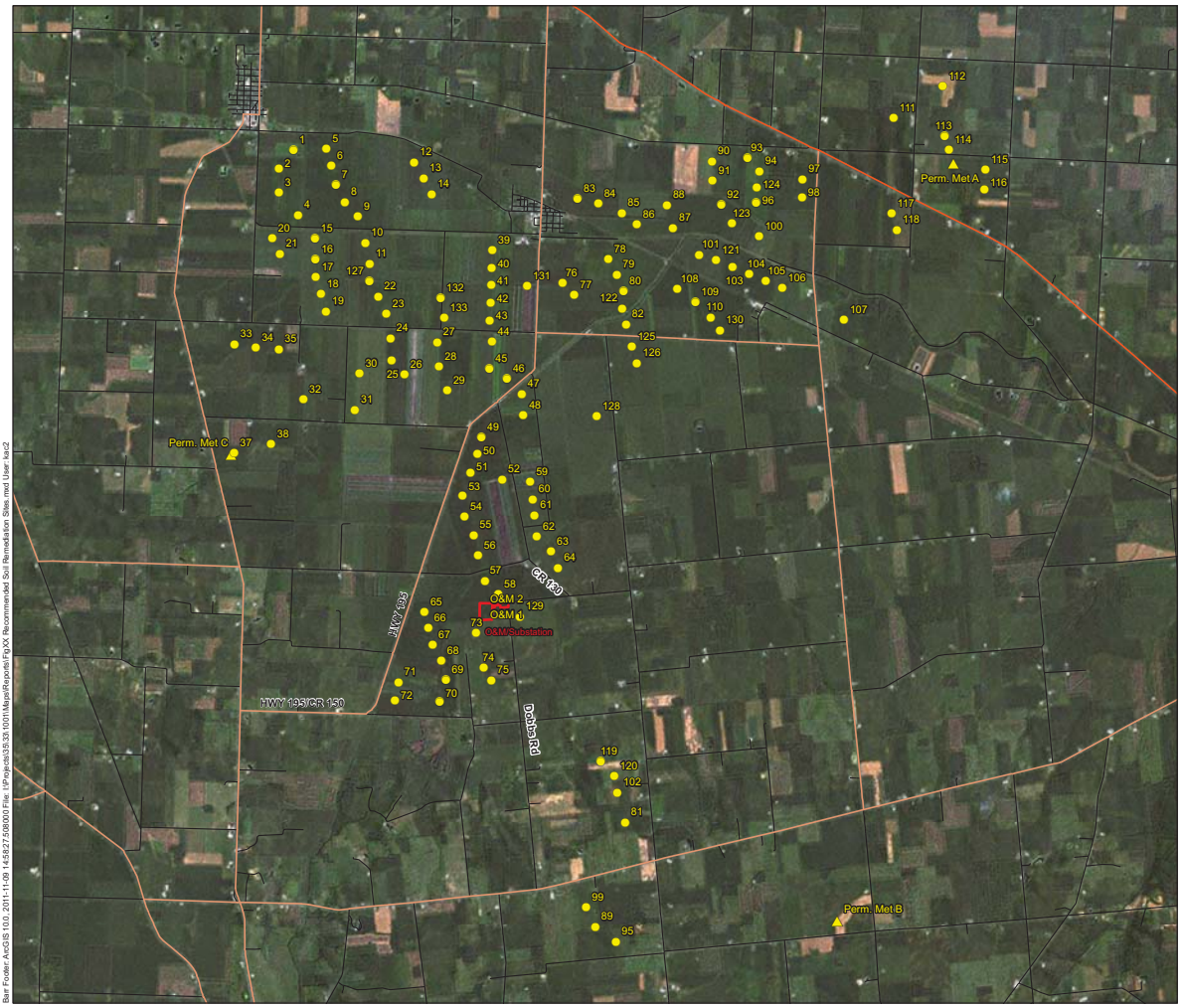
N

Miles
8 0 8

Kilometers
10 0 10

Figure 1

SITE LOCATION
Hardin County Wind Project
Inenvergy
Hardin County, Ohio



Turbine Location
(7/7/2011 Coordinates)

Met Tower Location

Switchyard Boundary
(Approximate)

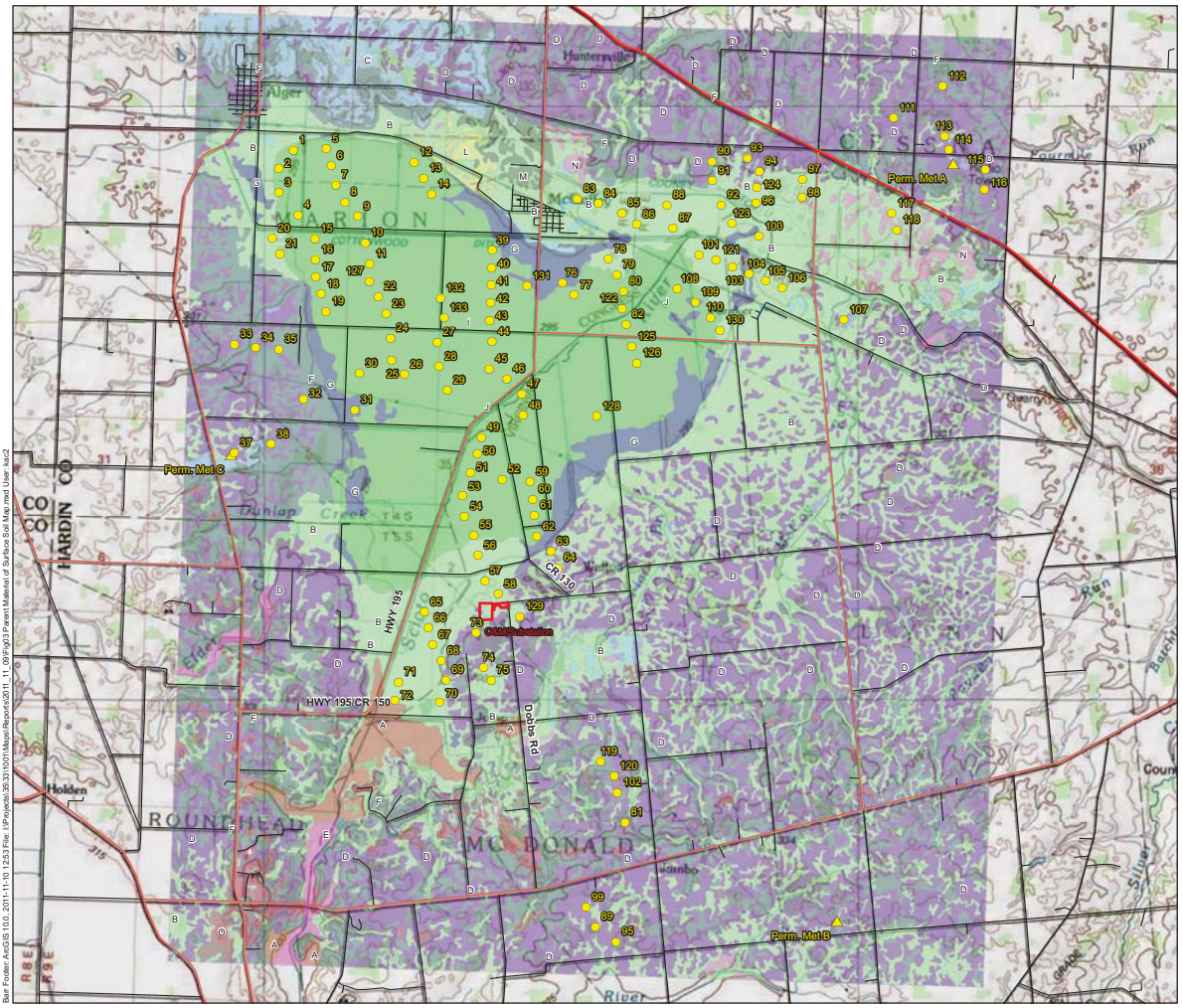
Kilometers
1 0 1 2

Miles
1 0 1

Figure 2

SITE LAYOUT
Hardin County Wind Project
Inenvergy
Hardin County, Ohio

Barr Foster A:\GIS 10.0_2011-11-09_14-58-27.59\800\File: I:\Projects\35\33.10\01\Maps\Reports\Fig XX Recommended Soil Remediation Sites.mxd User: kxr2



Turbine Location
(7/7/2011 Coordinates)

Met Tower Location

Switchyard Boundary (Approximate)

Soil Geomorphic Origin

- A, bogs
- B, depressions
- C: drainageways on ground moraines, drainageways on end moraines
- D: flats on ground moraines, rises on ground moraines, flats on end moraines, rises on end moraines
- E: floodplains
- F: ground moraines, end moraines
- G: lake plains
- H: lake plains, ground moraines, outwash plains, deltas
- I: lake plains, till plains
- J: marshes
- K: moraines, kames, eskers, outwash terraces
- L: outwash terraces, stream terraces, outwash plains
- M: terraces
- N: till plains
- O: till plains, moraines

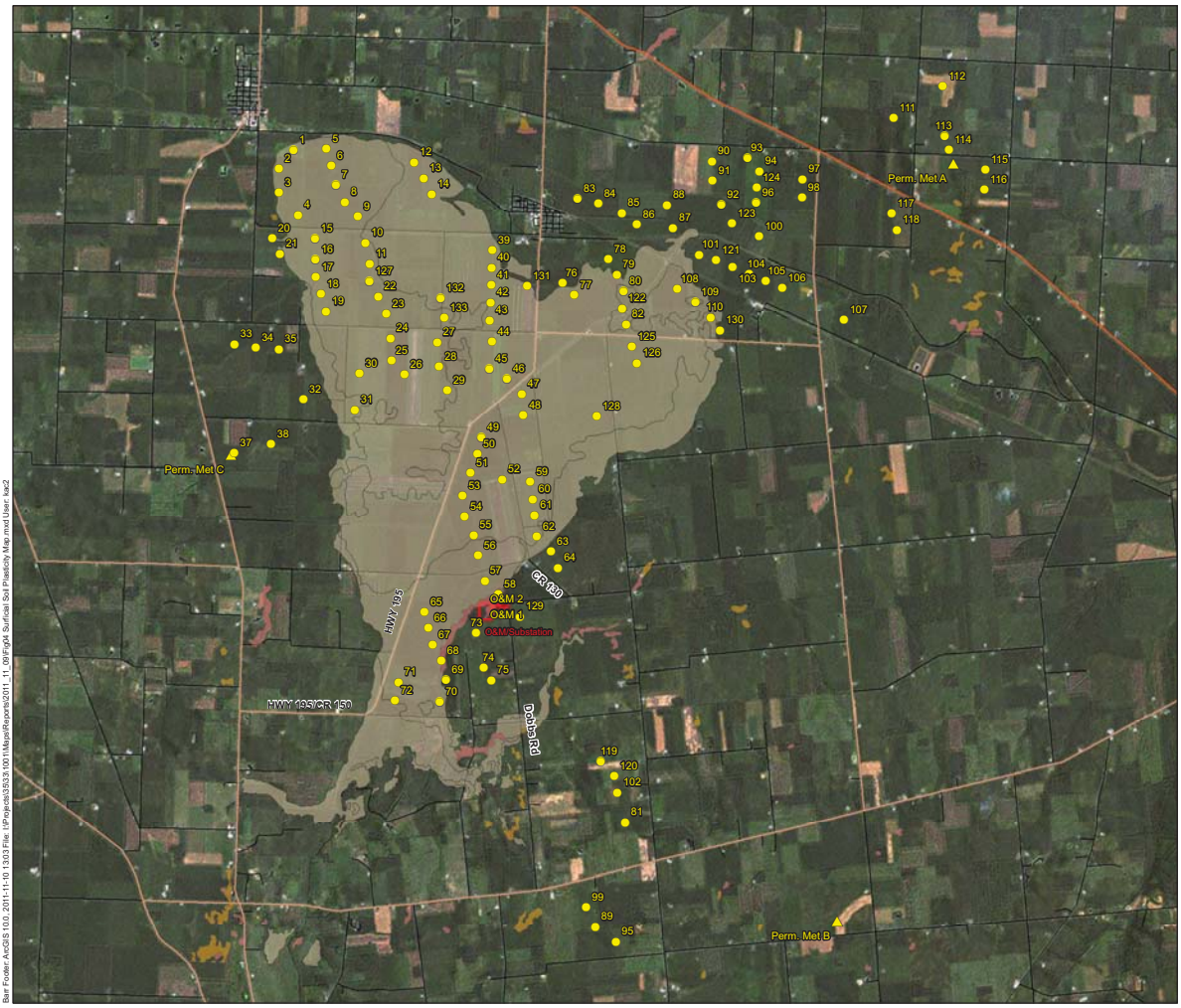
Kilometers
1 0 1 2

Miles
1 0 1

Figure 3

PARENT MATERIAL OF SURFACE SOIL
Hardin County Wind Project
Inenvergy
Hardin County, Ohio

Barr Foster A:\GIS 10.0_2011-11-10 12:53 File: I:\Projects\39,33\10\11\Maps\Reports\2011_11_09\Fig13 Parent Material of Surface Soil Map.mxd User: kkc2



Turbine Location
(7/7/2011 Coordinates)

Met Tower Location

Switchyard Boundary (Approximate)

USCS

CL-ML (Lean Clay/Silt)

ML (Silt)

PT (Peat)

Kilometers
1 0 1 2

Miles
1 0 1

Figure 4

SURFICIAL SOIL PLASTICITY
Hardin County Wind Project
Inenvergy
Hardin County, Ohio

Barr Foster ArcGIS 10.0, 2011-11-10 13:03 File: I:\Projects\35\33.100\Maps\Reports\2011_11_09\Fig04 Surficial Soil Plasticity Map.mxd User: kac2

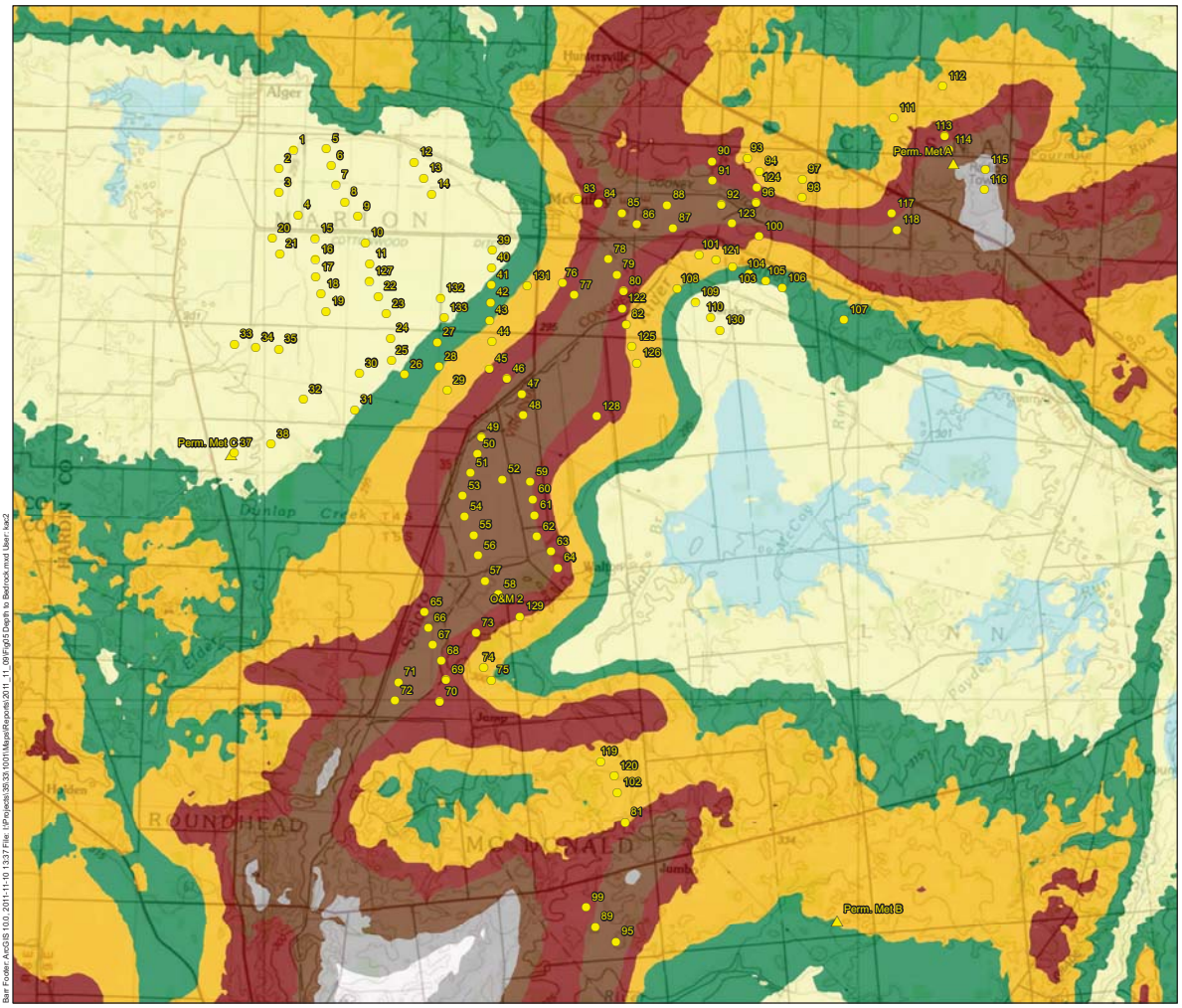
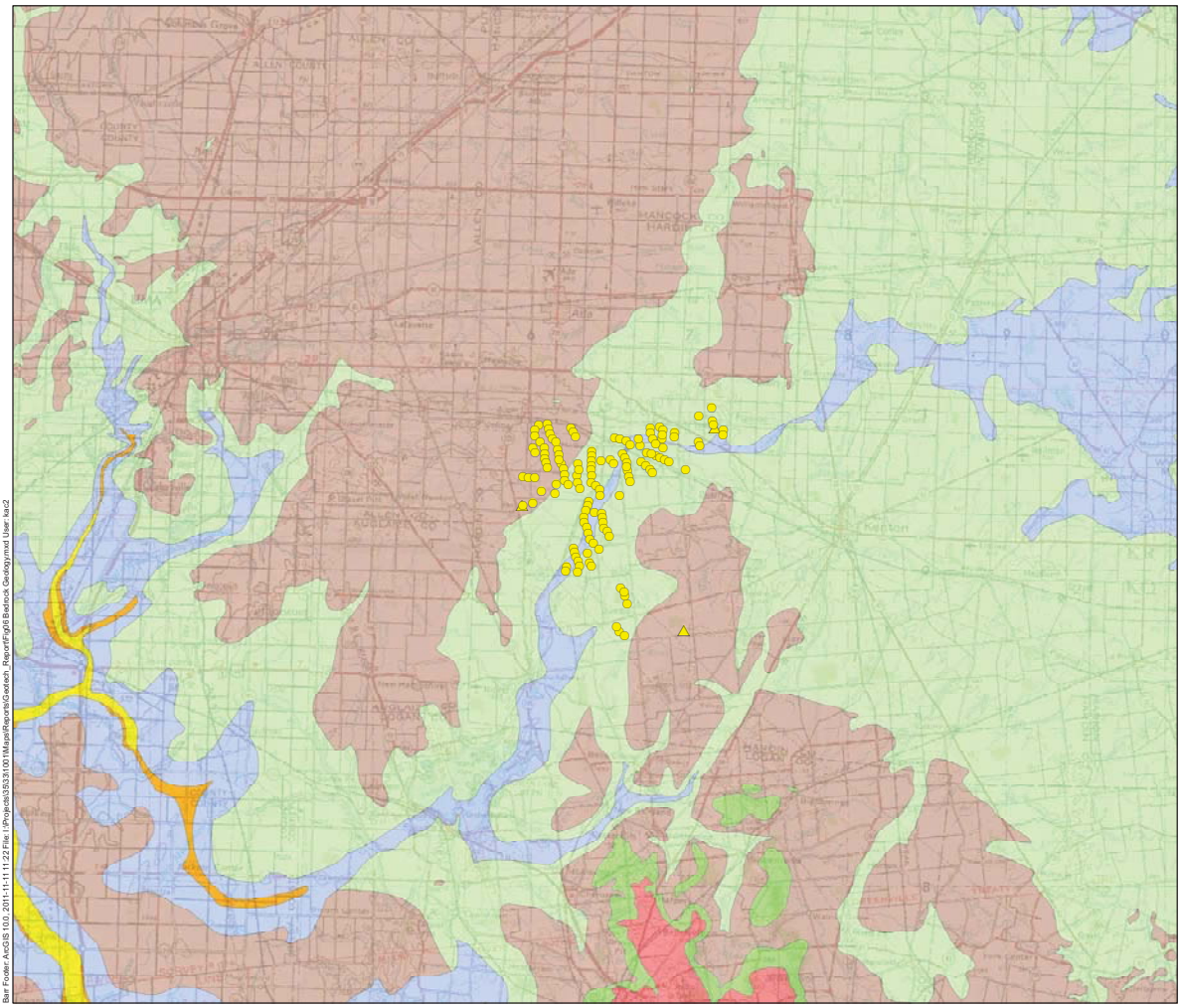


Figure 5

DEPTH TO BEDROCK
Hardin County Wind Project
Inenvergy
Hardin County, Ohio



Turbine Location
(7/7/2011 Coordinates)

Met Tower Location

Bedrock Geology

- Cincinnati Group
- Clinton and Cataract Groups, Undifferentiated
- Columbus Limestone and Detroit River Group, Undifferentiated
- Lockport Dolomite
- Ohio Shale
- Salina Group
- Tymochtee and Greenfield Dolomites, Undivided

Kilometers
5 0 5

Miles
4 0 4

Figure 6

BEDROCK GEOLOGY
Hardin County Wind Project
Inenvergy
Hardin County, Ohio

Barr Foster ArcGIS 10.0, 2011-11-11 11:22 File: I:\Projects\35\3\3100\1\Maps\Reports\Geotech_Report\Fig06 Bedrock Geology.mxd User: kar2

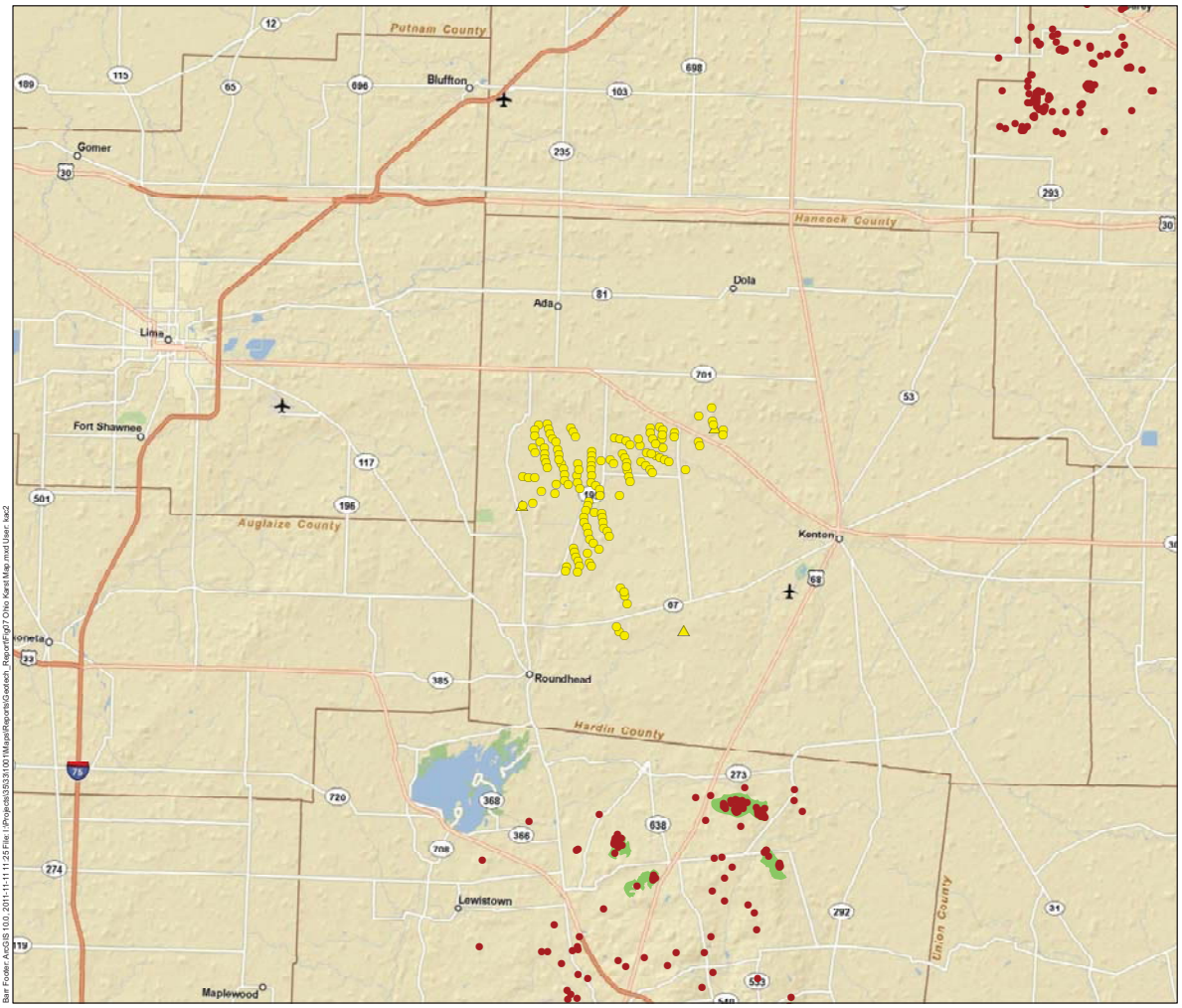
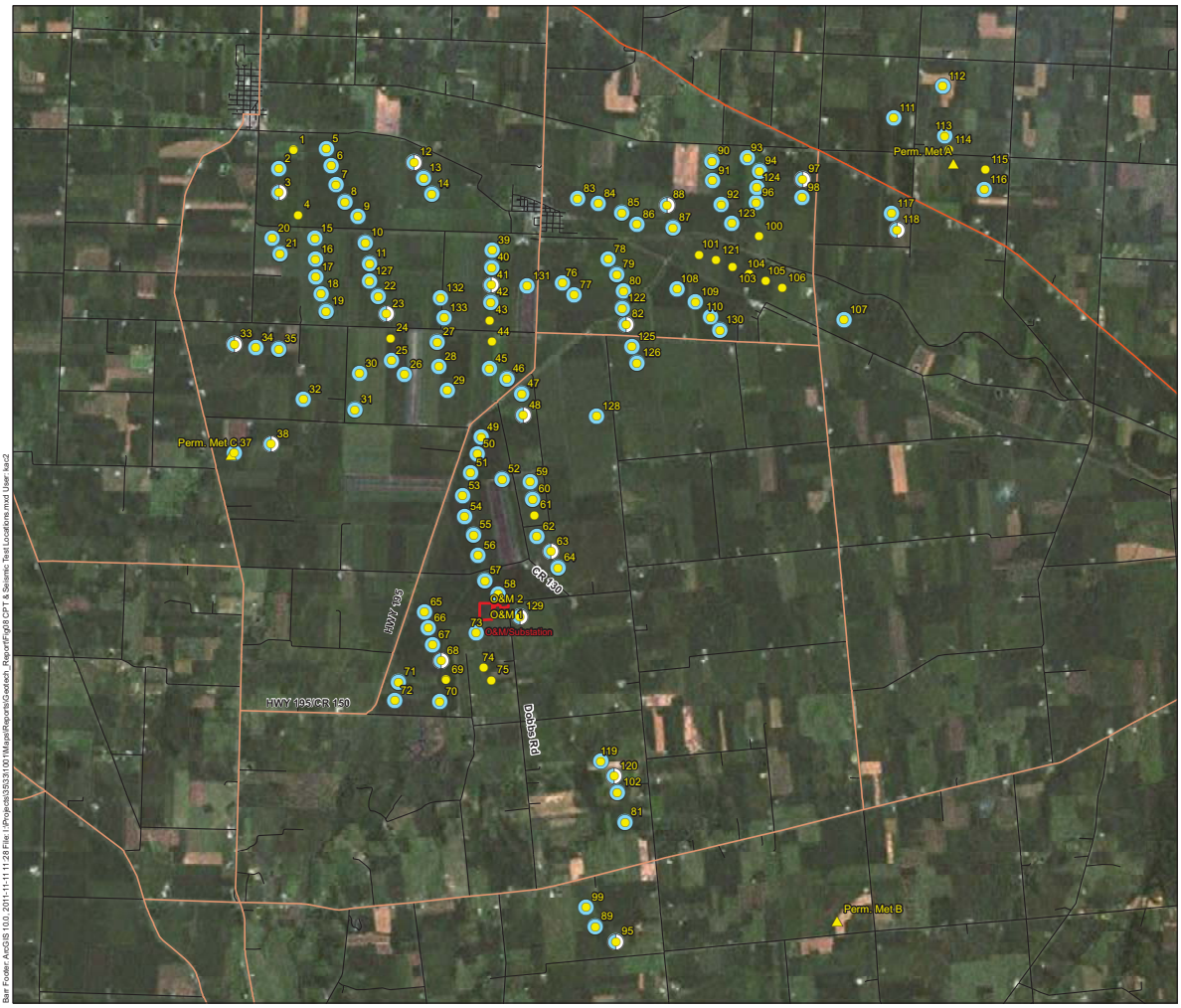


Figure 7

OHIO KARSTS
Hardin County Wind Project
Inenvergy
Hardin County, Ohio

Barr Foster ArcGIS 10.0, 2011-11-11 11:23 File: I:\Projects\35\35310\01\Maps\Reports\Geotech_Report\Fig07 Ohio Karst Map.mxd User: kxz2



Turbine Location
(7/7/2011 Coordinates)

Met Tower Location

CPT Location

CPT & Seismic Location

Switchyard Boundary (Approximate)

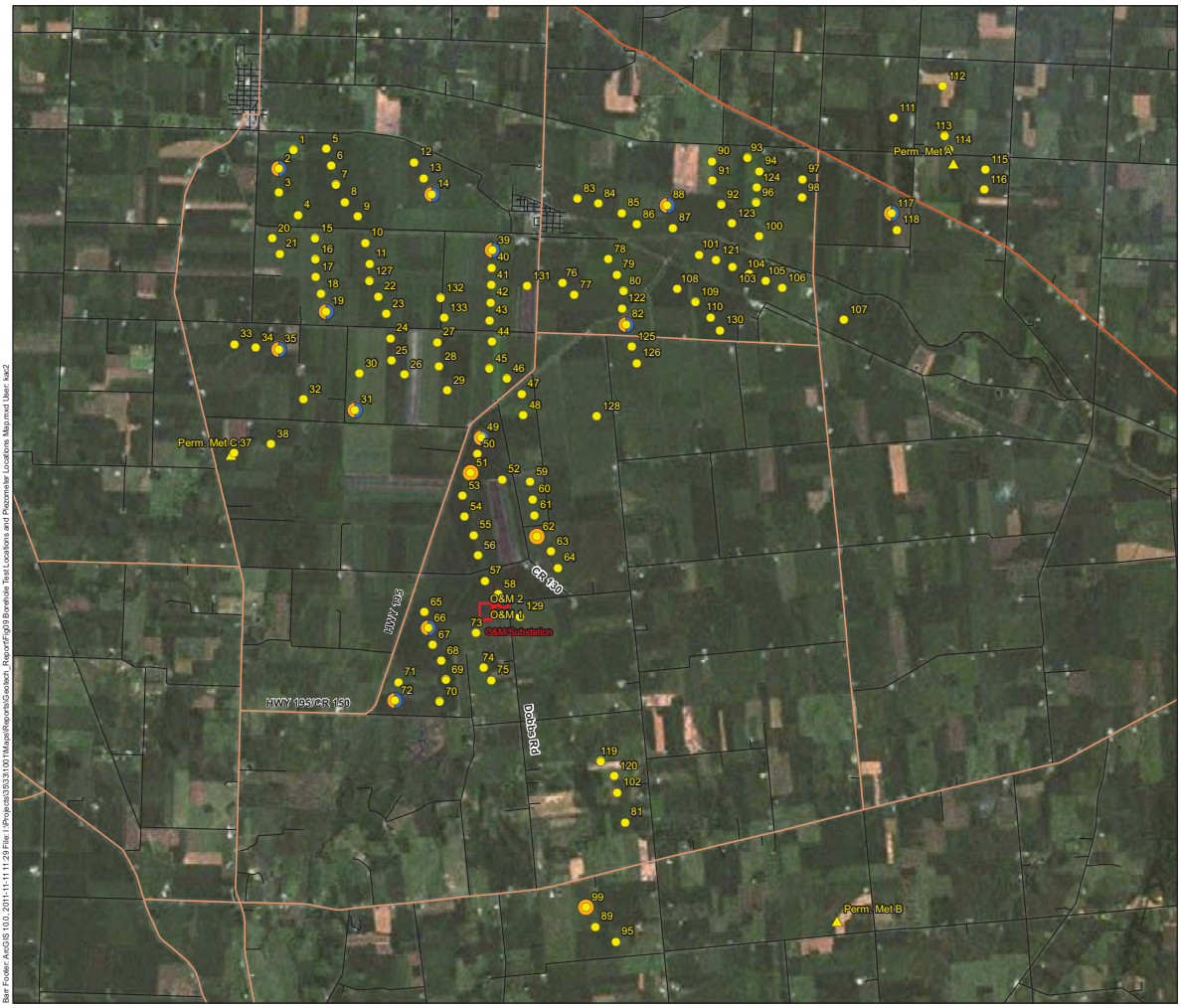
Kilometers
1 0 1 2

Miles
1 0 1

Figure 8

CPT AND SEISMIC TEST LOCATIONS
Hardin County Wind Project
Inenvergy
Hardin County, Ohio

Barr Foster ArcGIS 10.0, 2011-11-11 11:28 File: I:\Projects\335\331001\Maps\Reports\Geotech_Report\Fig05 CPT & Seismic Test Locations.mxd User: kxc2



Turbine Location
(7/7/2011 Coordinates)

Met Tower Location

Borehole Test Location

Borehole Test & Piezometer Location

Switchyard Boundary (Approximate)

Kilometers
1 0 1 2

Miles
1 0 1

Figure 9

BOREHOLE TEST AND
PIEZOMETER LOCATIONS
Hardin County Wind Project
Inenvergy
Hardin County, Ohio

Barr Foster ArcGIS 10.0, 2011-11-11 1:29 File: I:\Projects\35\33\100.1\Maps\Reports\Geotech_Report\Fig09 Borehole Test Locations and Piezometer Locations Mxd.mxd User: kar2

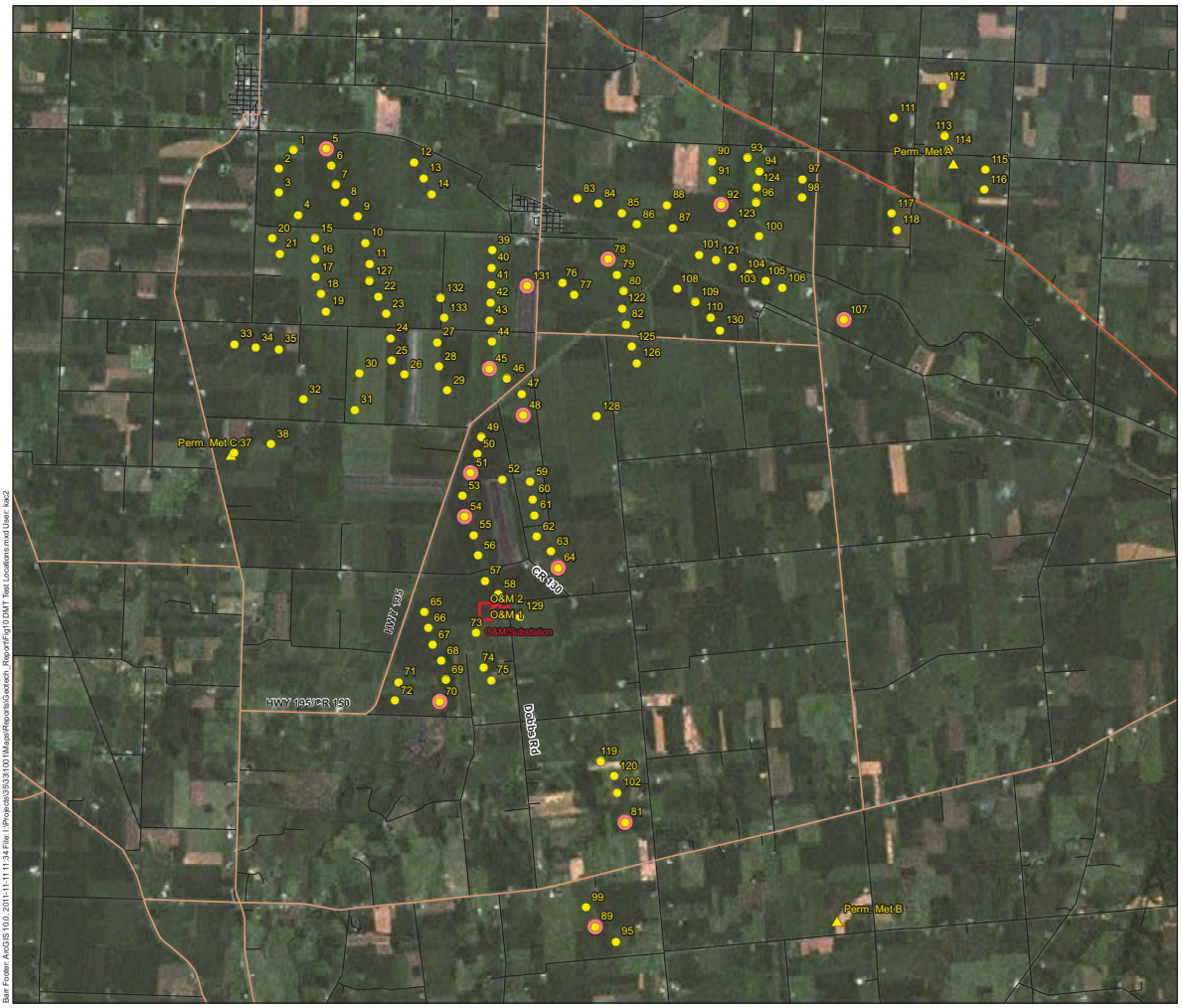
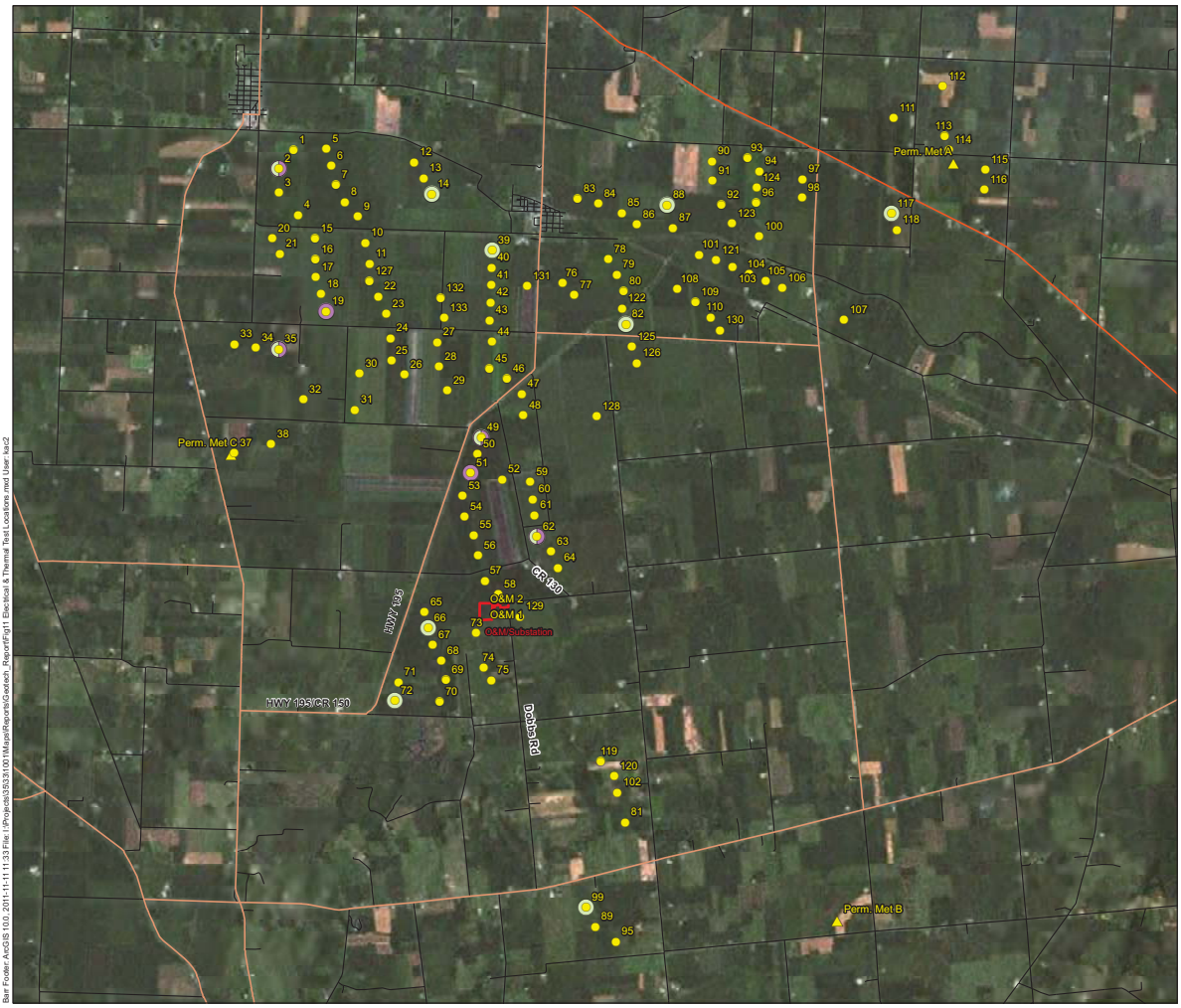


Figure 10

DMT TEST LOCATIONS
Hardin County Wind Project
Inenvergy
Hardin County, Ohio



Turbine Location
(7/7/2011 Coordinates)

Met Tower Location

Electrical Location

Thermal Location

Electrical & Thermal Location

Switchyard Boundary (Approximate)

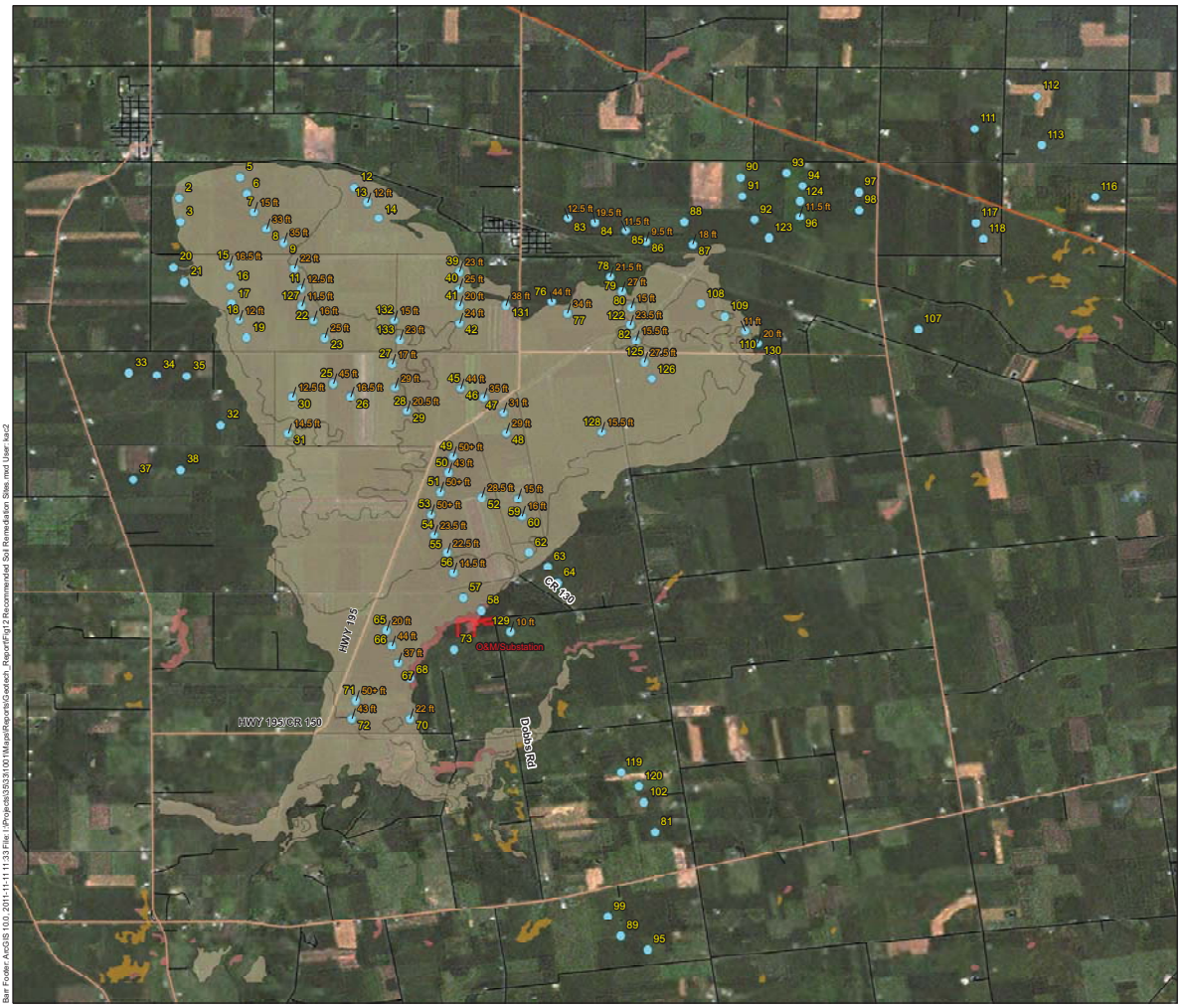
Kilometers
1 0 1 2

Miles
1 0 1

Figure 11

ELECTRICAL AND THERMAL TEST LOCATIONS
Hardin County Wind Project
Inenvergy
Hardin County, Ohio

Barr Foster ArcGIS 10.0, 2011-11-11 11:33 File: I:\Projects\35\33\100.1\Maps\Reports\Geotech_Report\Fig11 Electrical & Thermal Test Locations.mxd User: kac2



CPT Test Locations

15 Required Mitigation Depth (Feet)

Switchyard Boundary (Approximate)

USCS

CL-ML (Lean Clay/Silt)

ML (silt)

PT (peat)

Kilometers
1 0 1 2

Miles
1 0 1

Figure 12

RECOMMENDED SOIL REMEDIATION SITES
Hardin County Wind Project
Inenvergy
Hardin County, Ohio

Barr Foster ArcGIS 10.0, 2011-11-11 11:33 File: I:\Projects\35\33\100\Maps\Reports\Geotech_Report\Fig12 Recommended Soil Remediation Sites .mxd User: kxc2

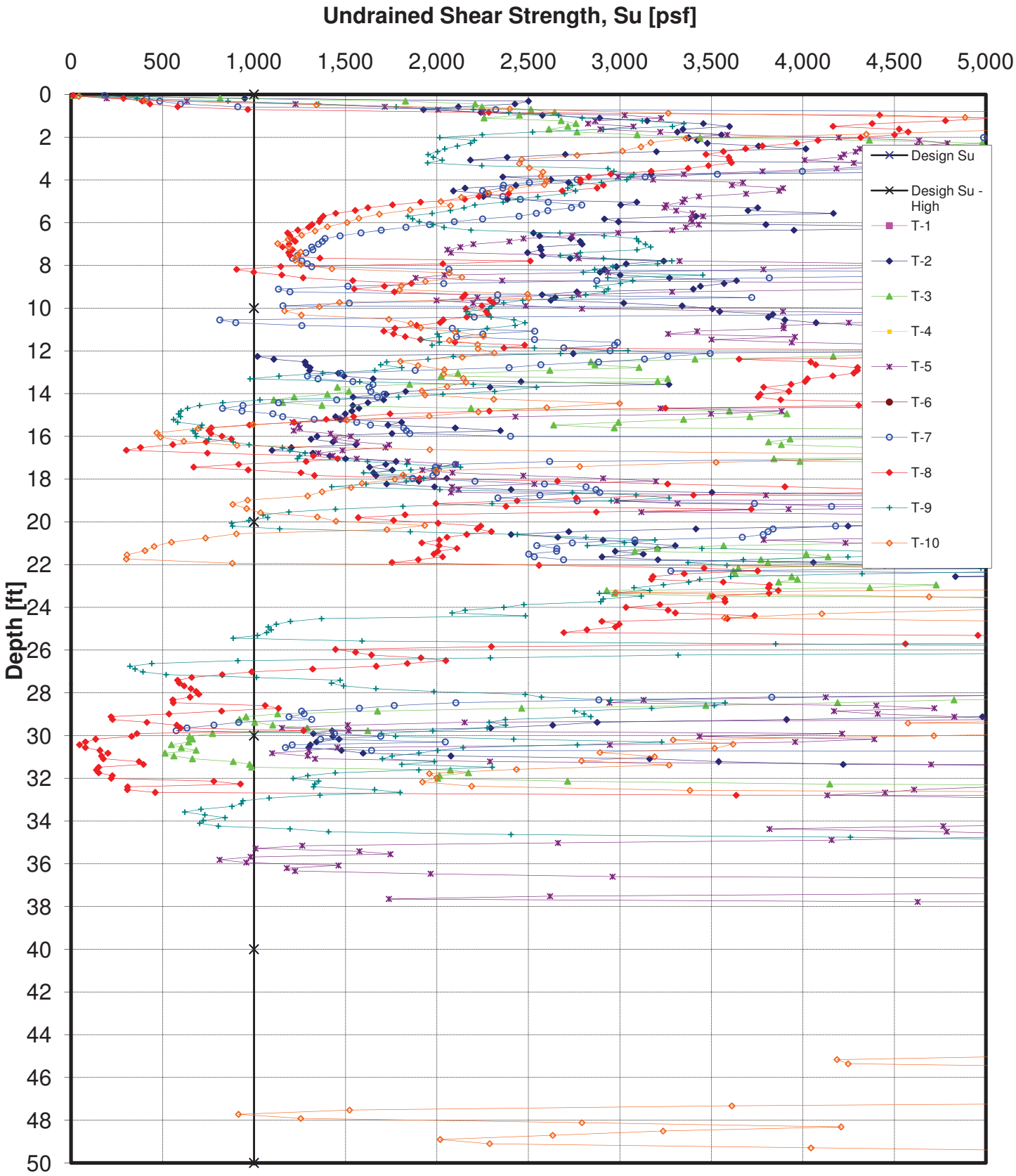


Figure 13. Undrained Shear Strength from CPT vs. Depth Turbines 1-10

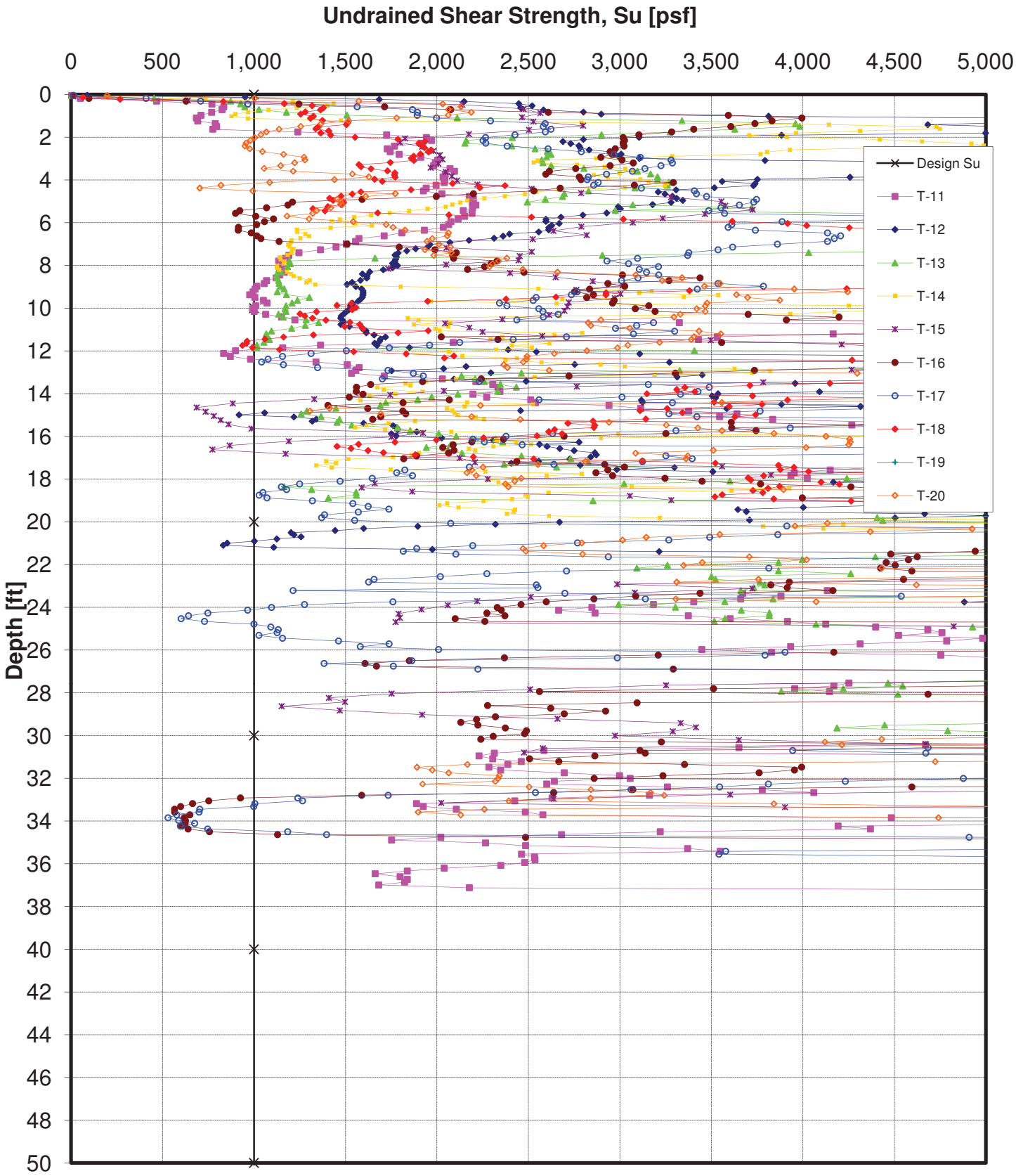


Figure 14. Undrained Shear Strength from CPT vs. Depth Turbines 11-20

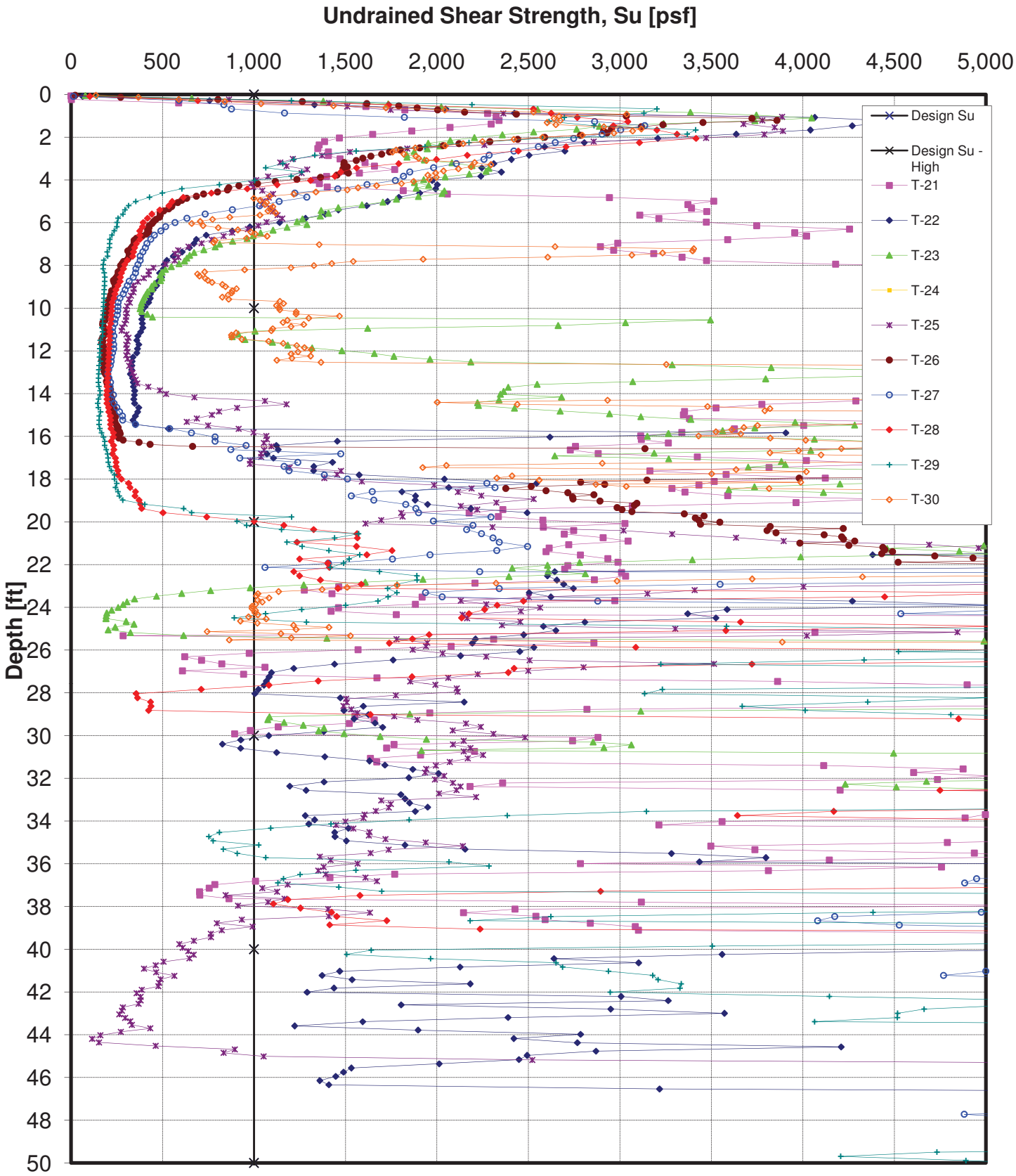


Figure 15. Undrained Shear Strength from CPT vs. Depth Turbines 21-30

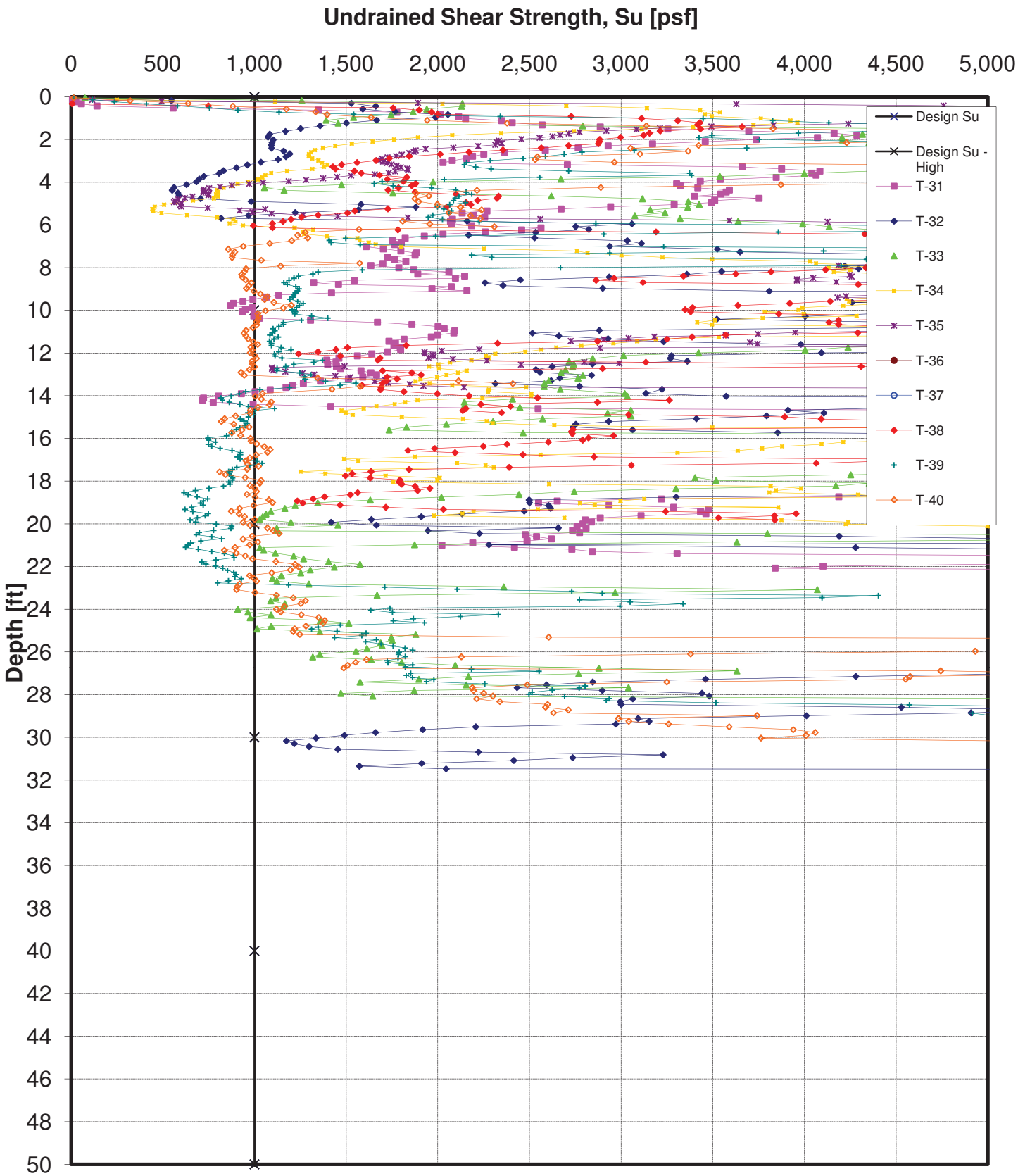


Figure 16. Undrained Shear Strength from CPT vs. Depth Turbines 31-40

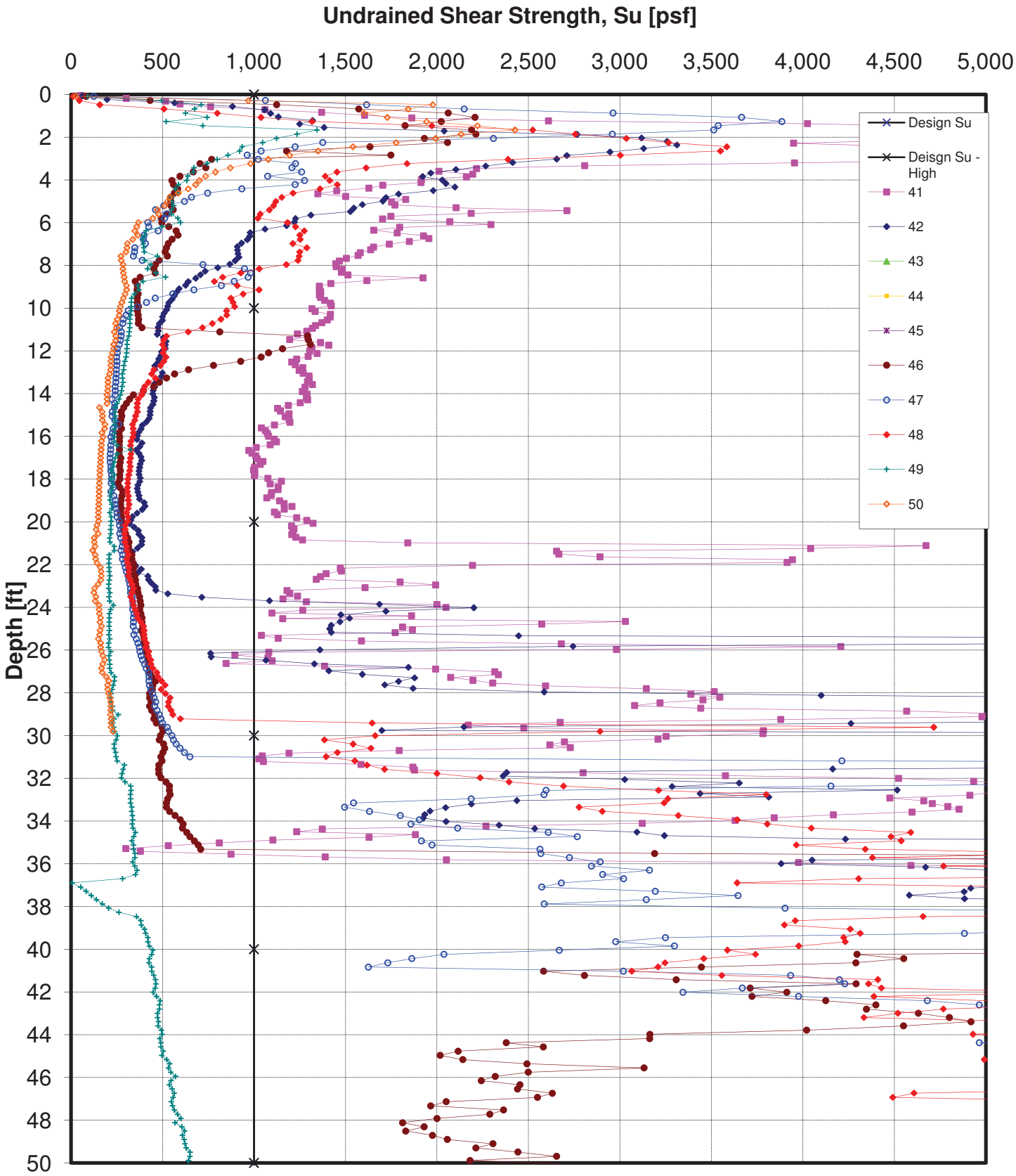


Figure 17. Undrained Shear Strength from CPT vs. Depth Turbines 41-50

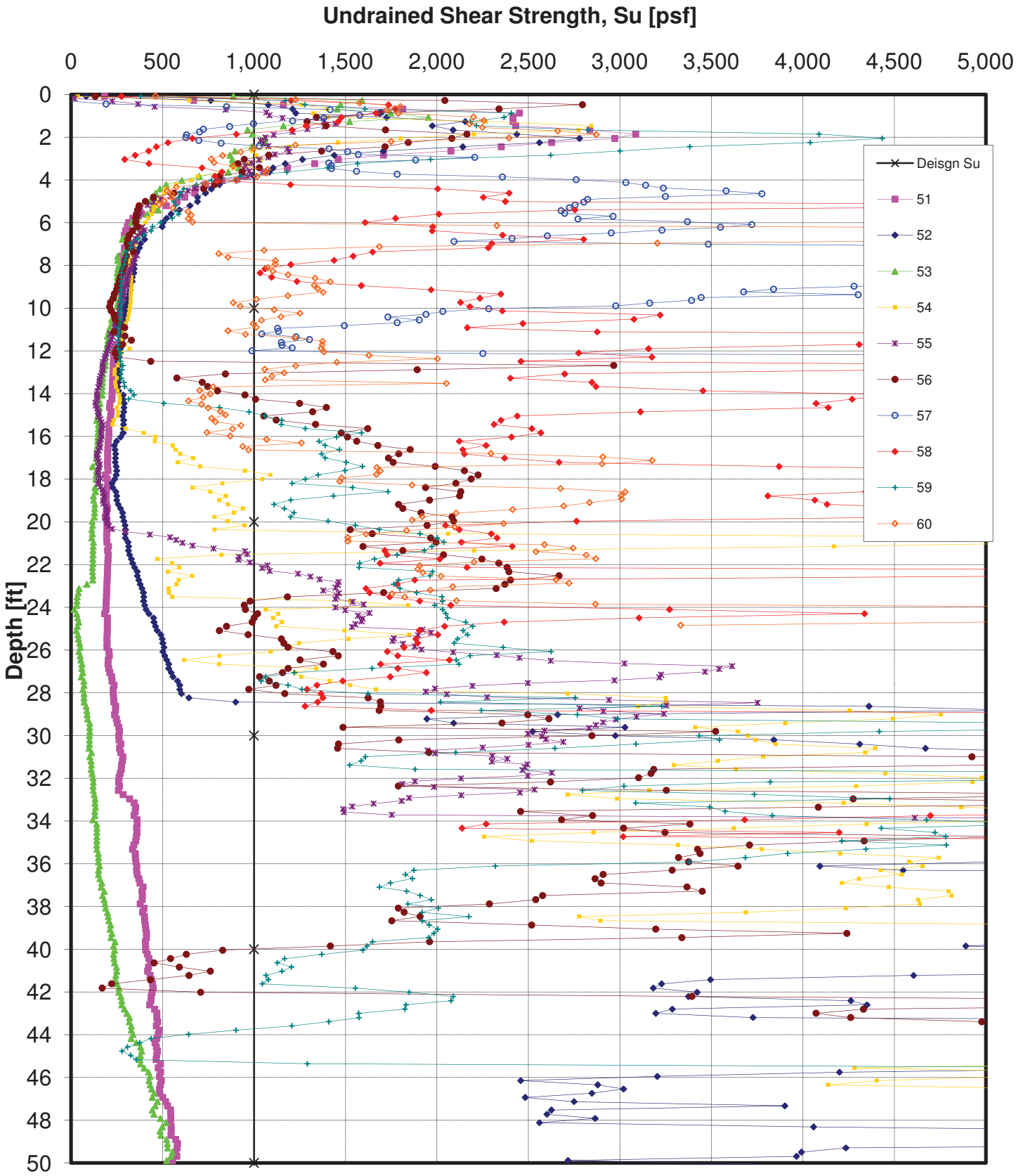


Figure 18. Undrained Shear Strength from CPT vs. Depth Turbines 51-60

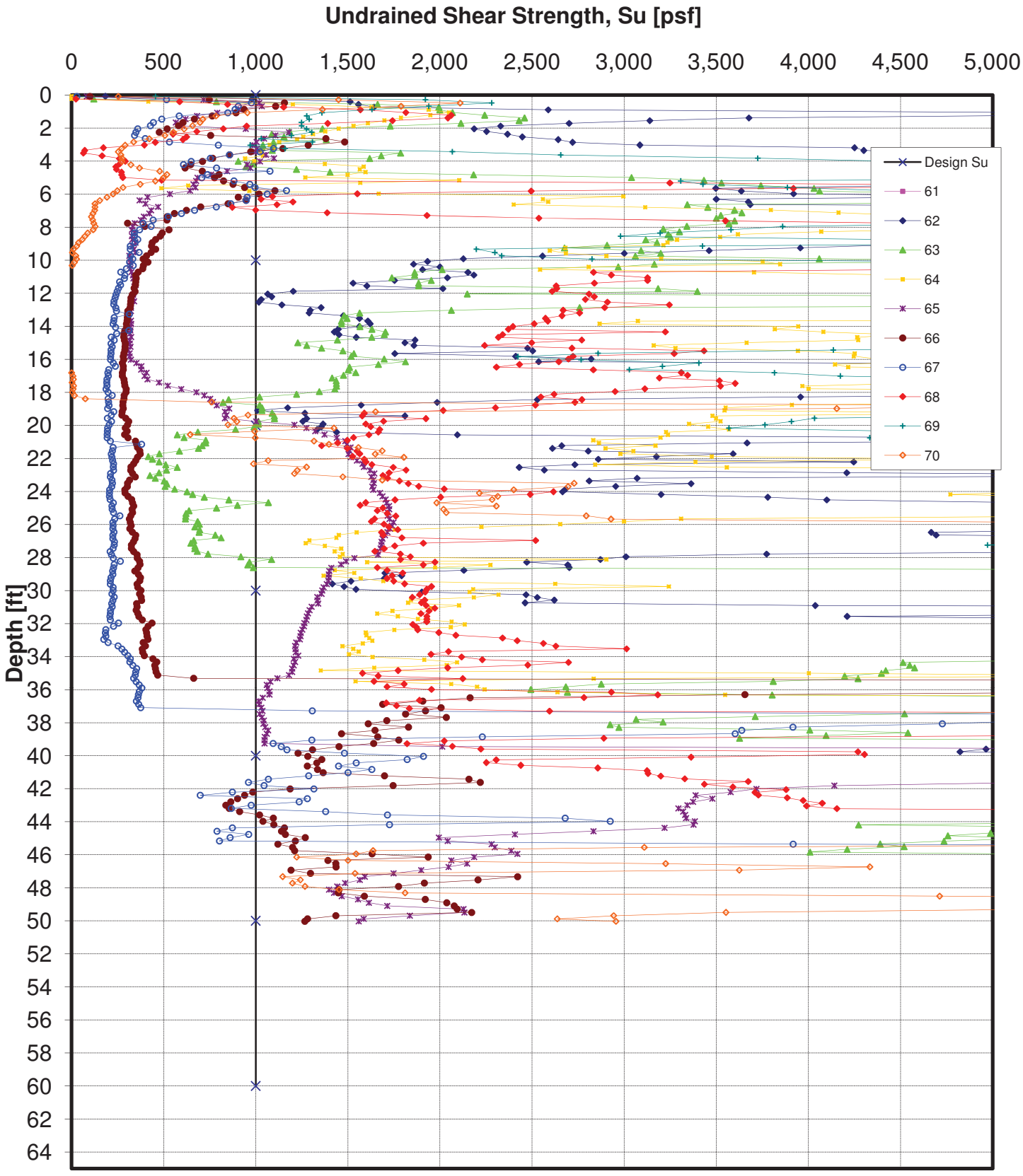


Figure 19. Undrained Shear Strength from CPT vs. Depth Turbines 61-70

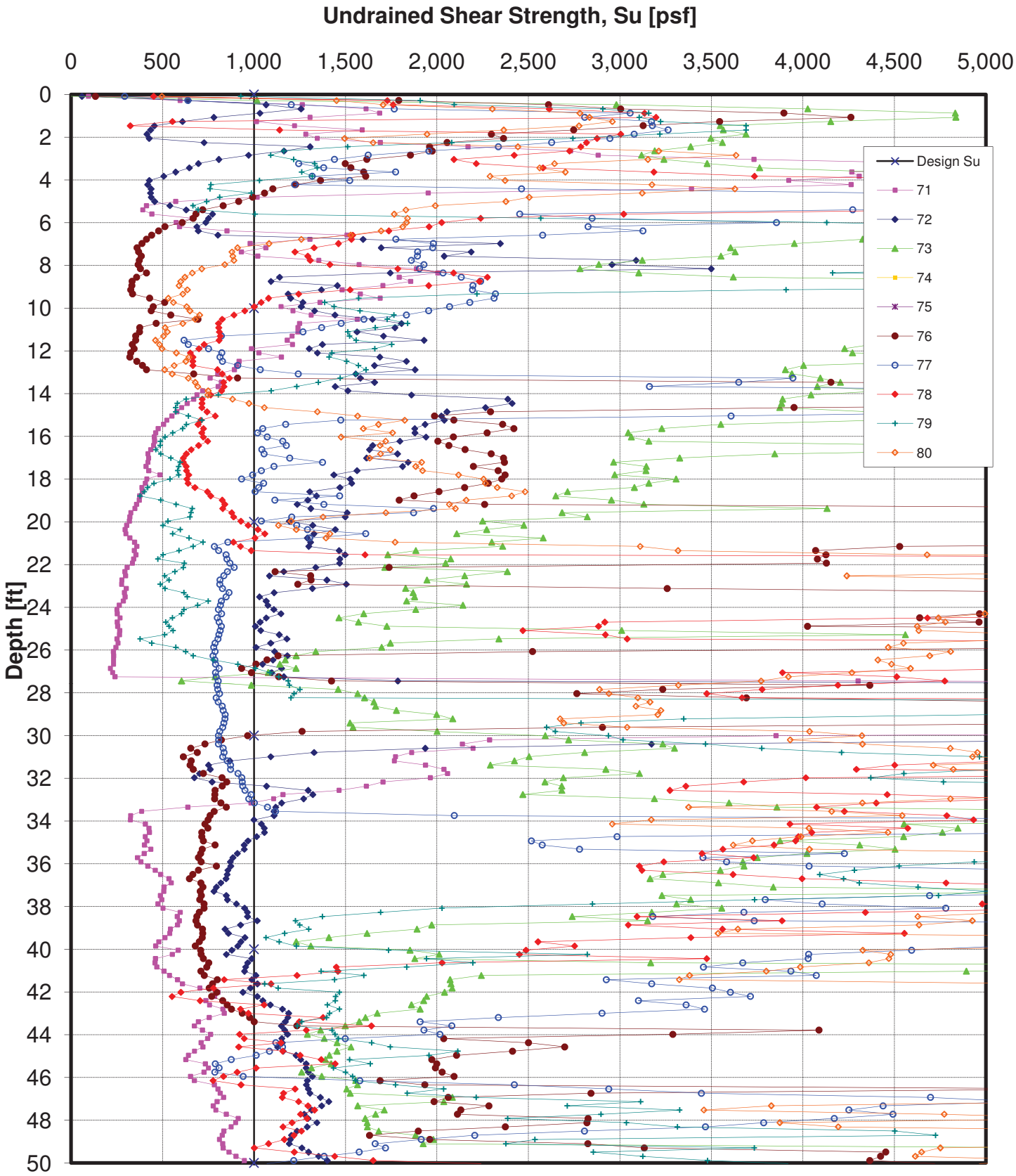


Figure 20. Undrained Shear Strength from CPT vs. Depth Turbines 71-80

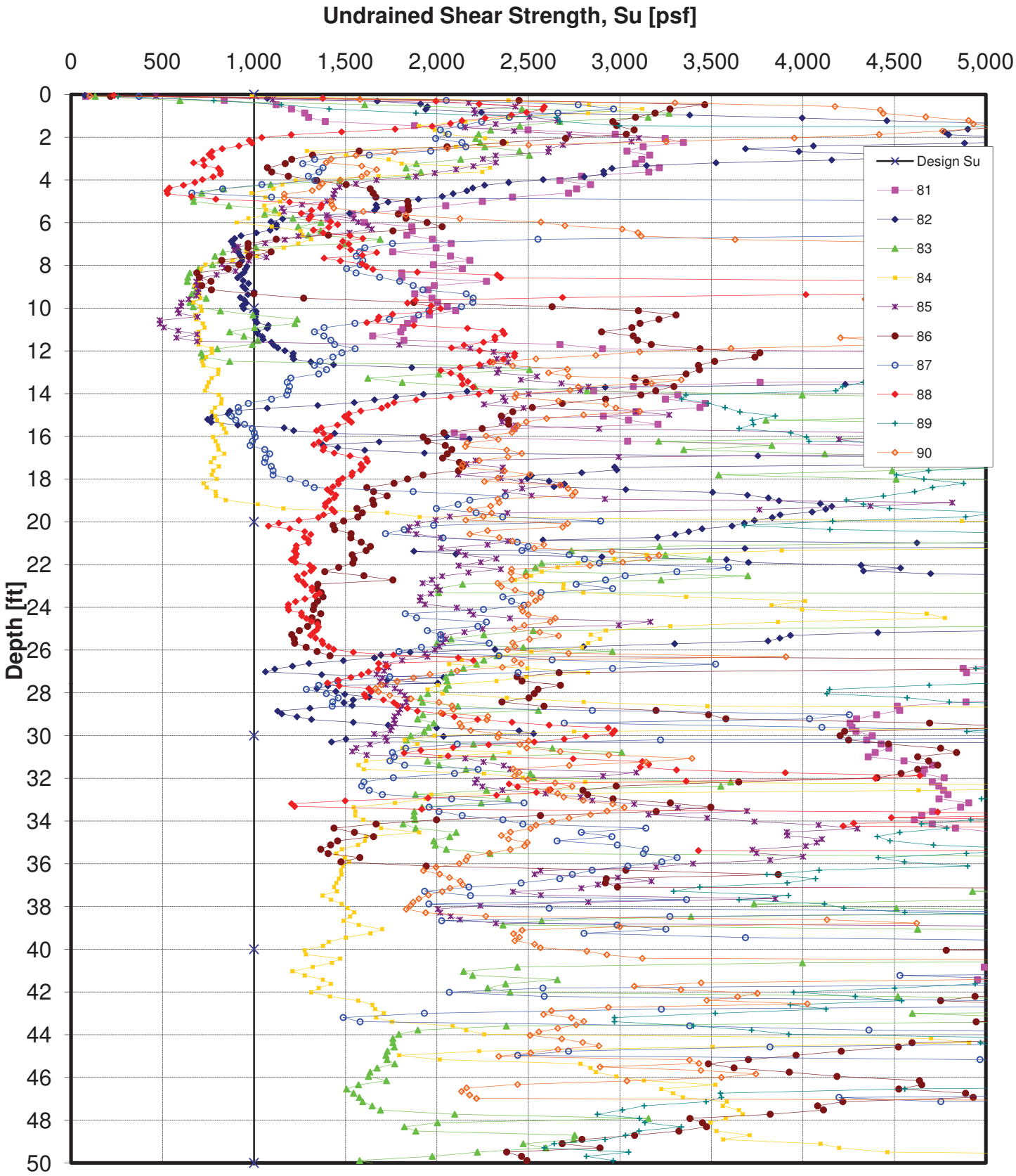


Figure 21. Undrained Shear Strength from CPT vs. Depth Turbines 81-90

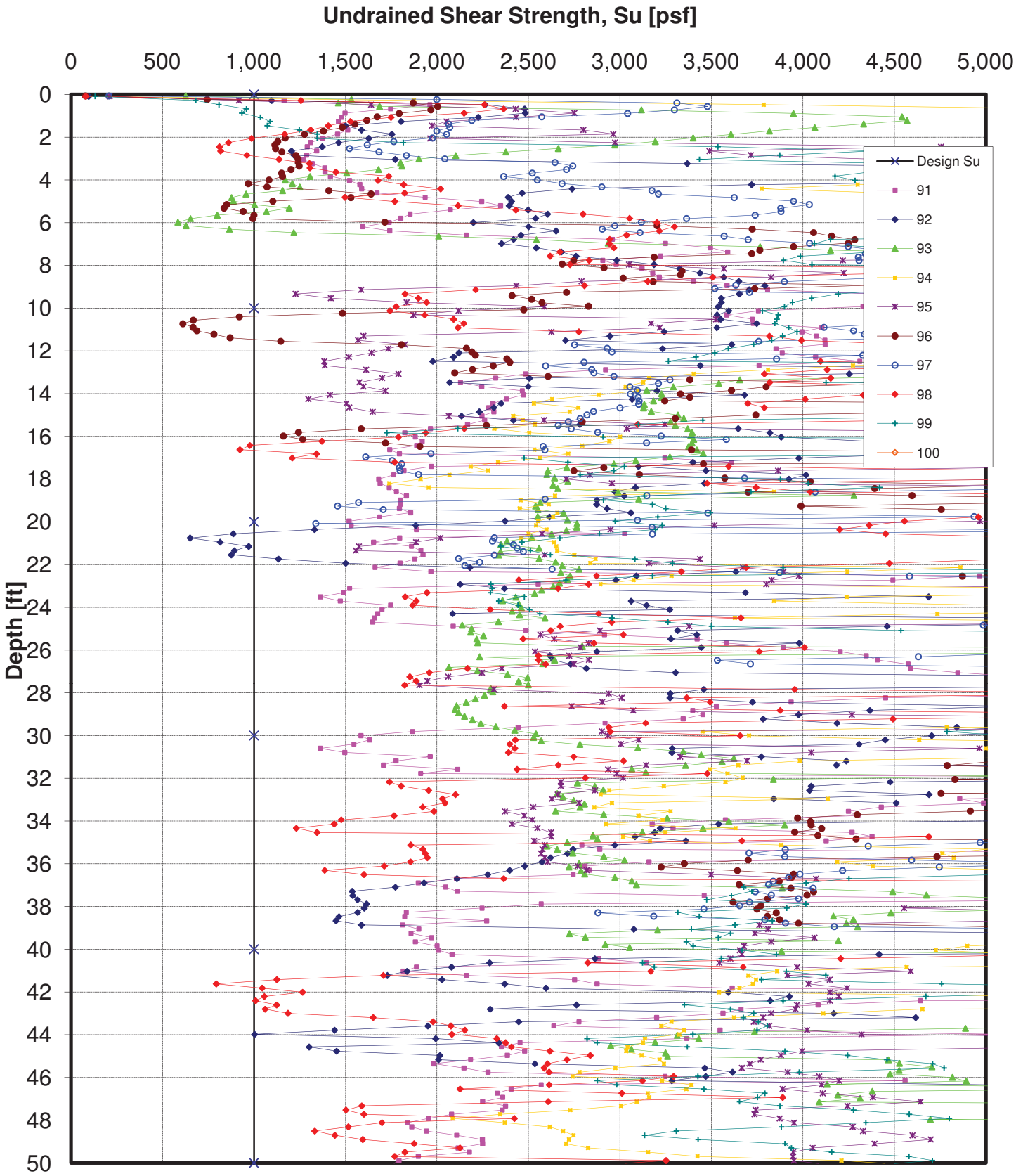


Figure 22. Undrained Shear Strength from CPT vs. Depth Turbines 91-100

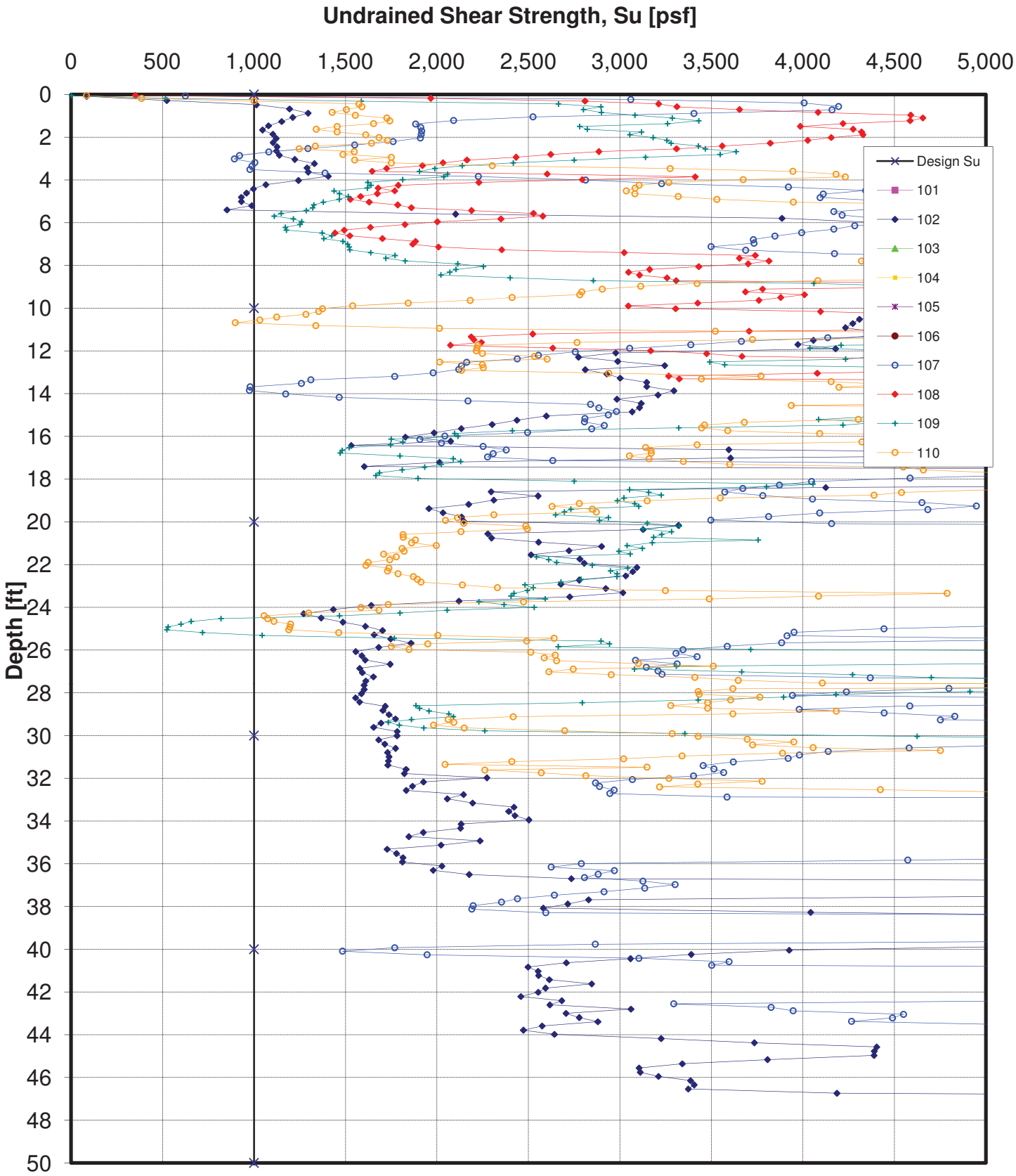


Figure 23. Undrained Shear Strength from CPT vs. Depth Turbines 101-110

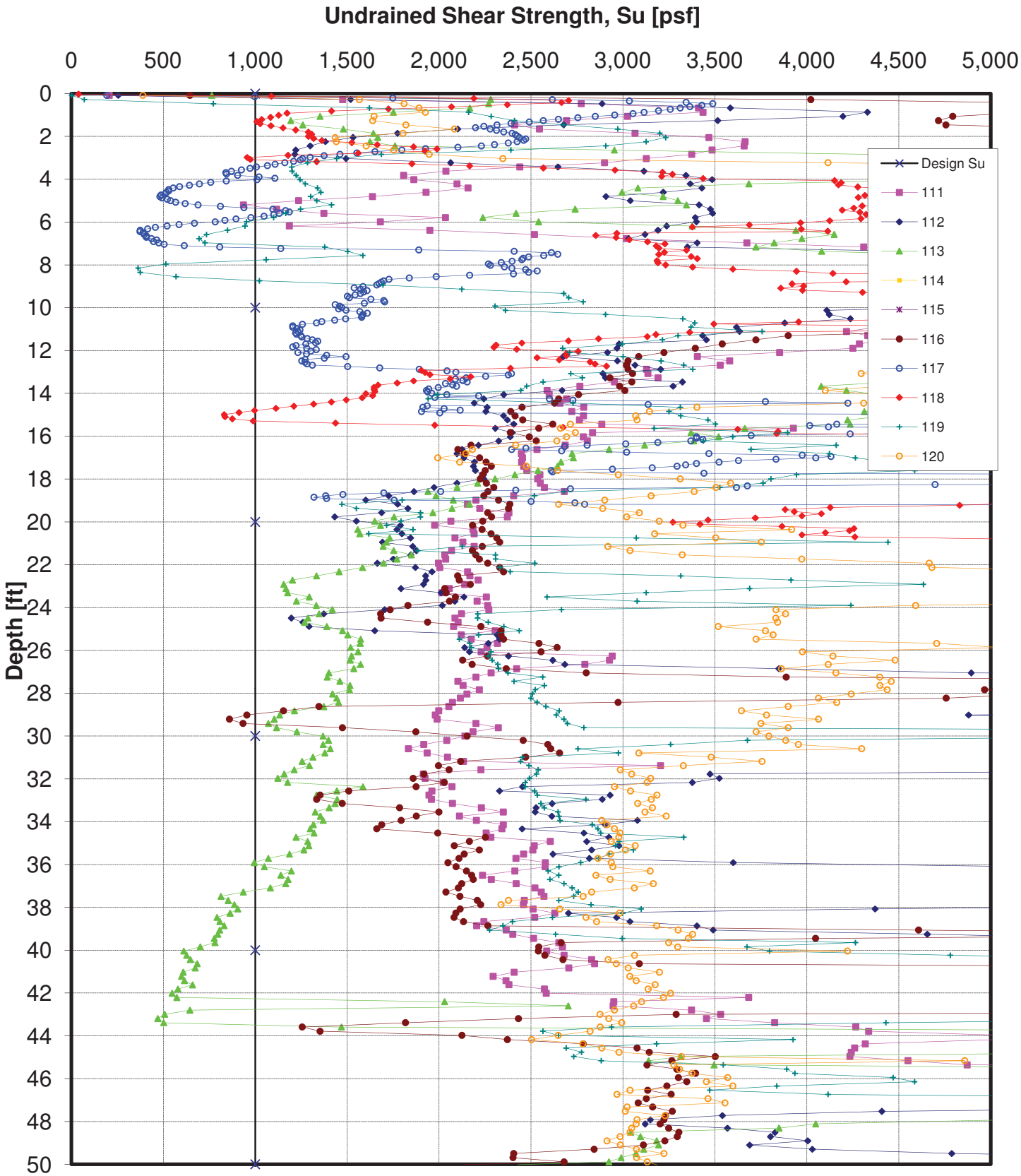


Figure 24. Undrained Shear Strength from CPT vs. Depth Turbine 111-120

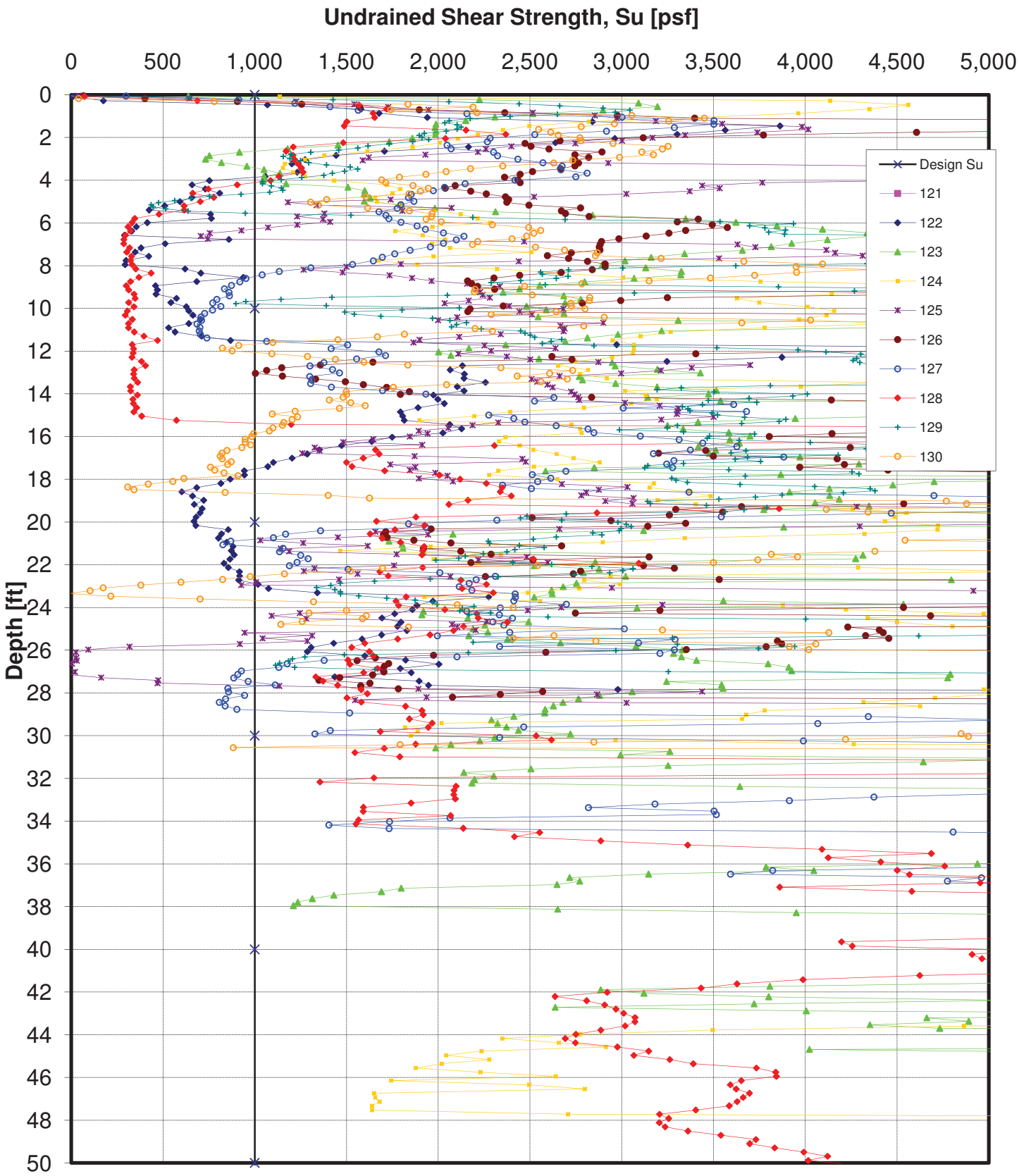


Figure 25. Undrained Shear Strength from CPT vs. Depth Turbines 121-130

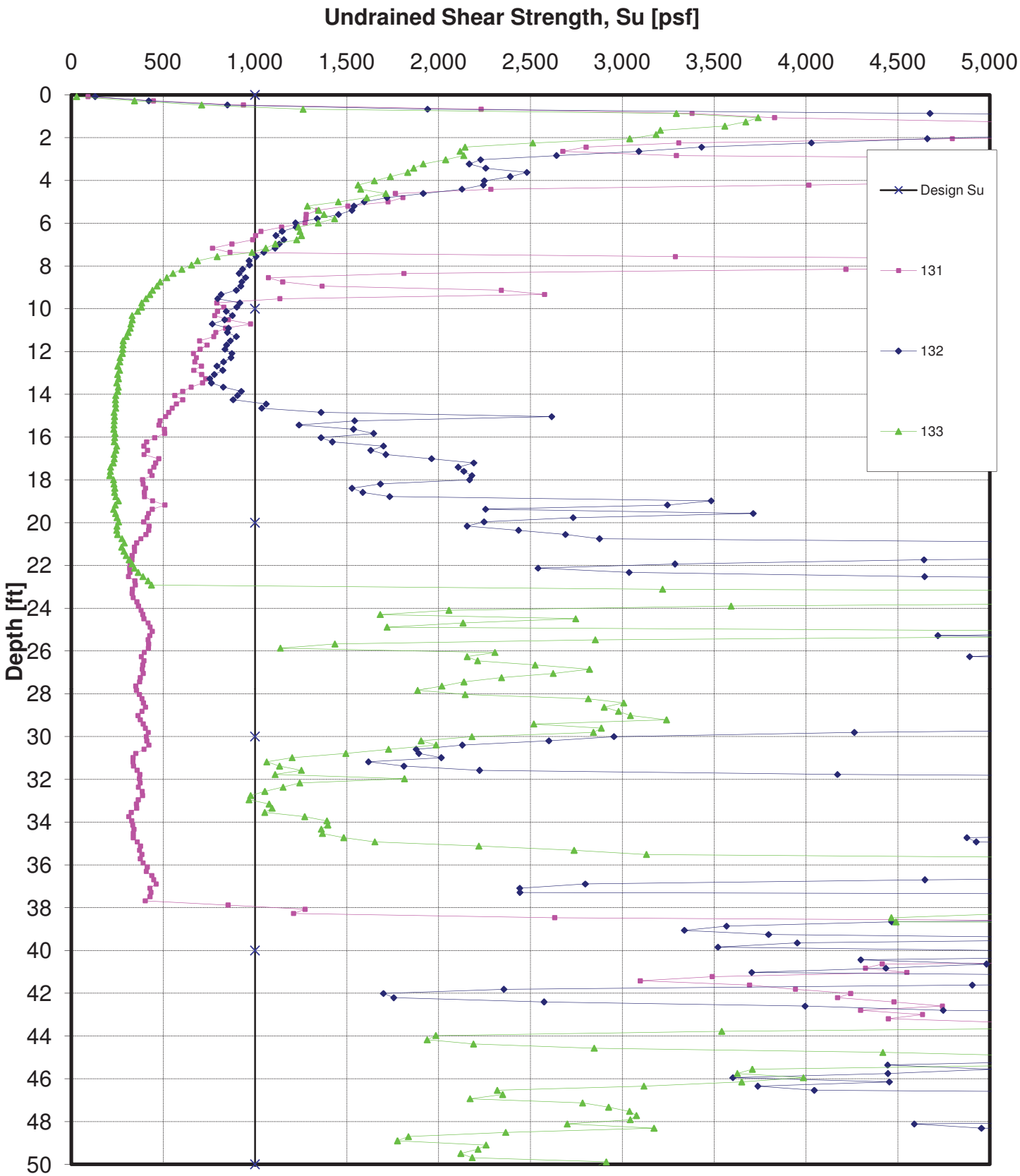
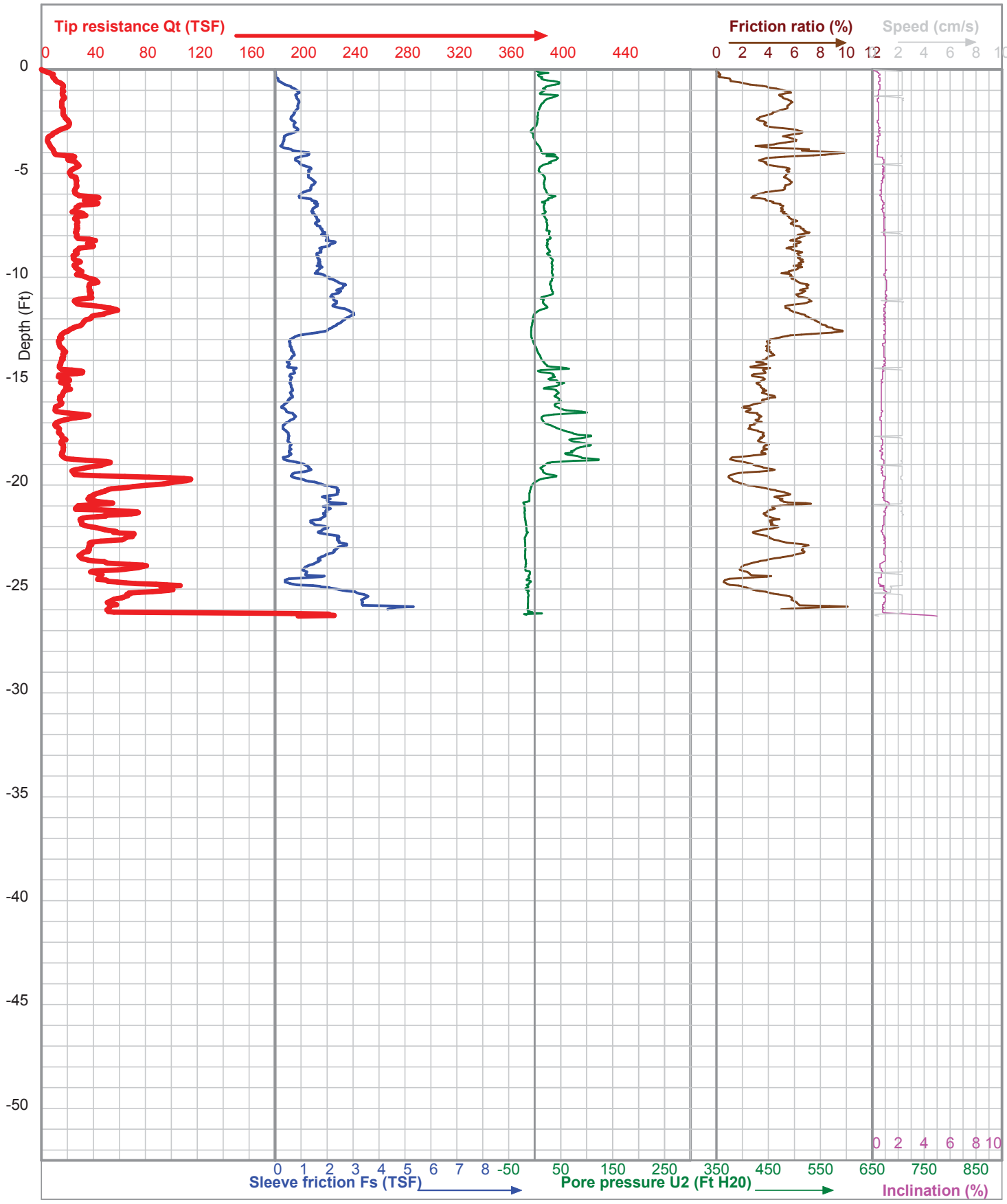


Figure 26. Undrained Shear Strength from CPT vs. Depth Turbines 131-133

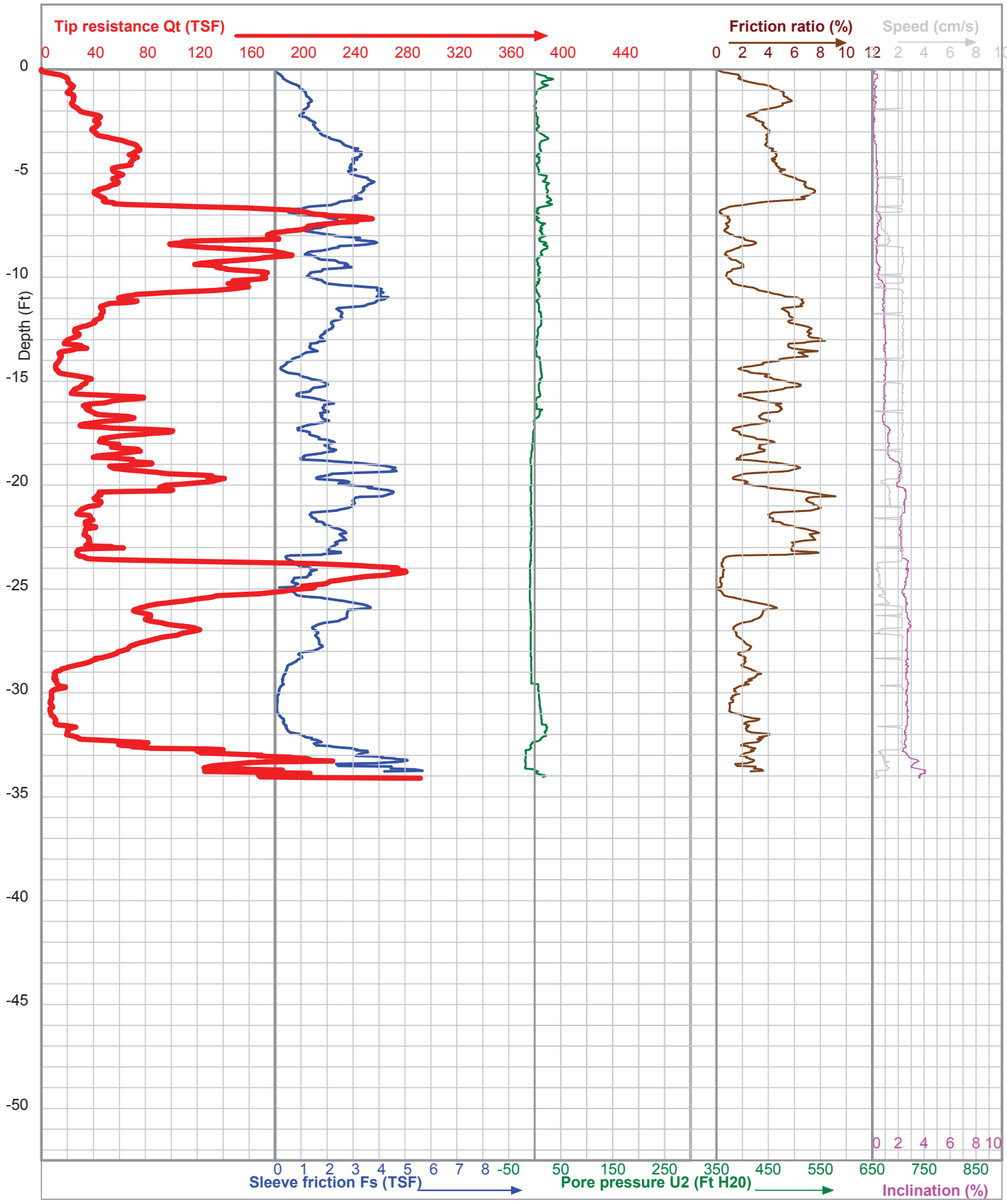
Appendices

Appendix A

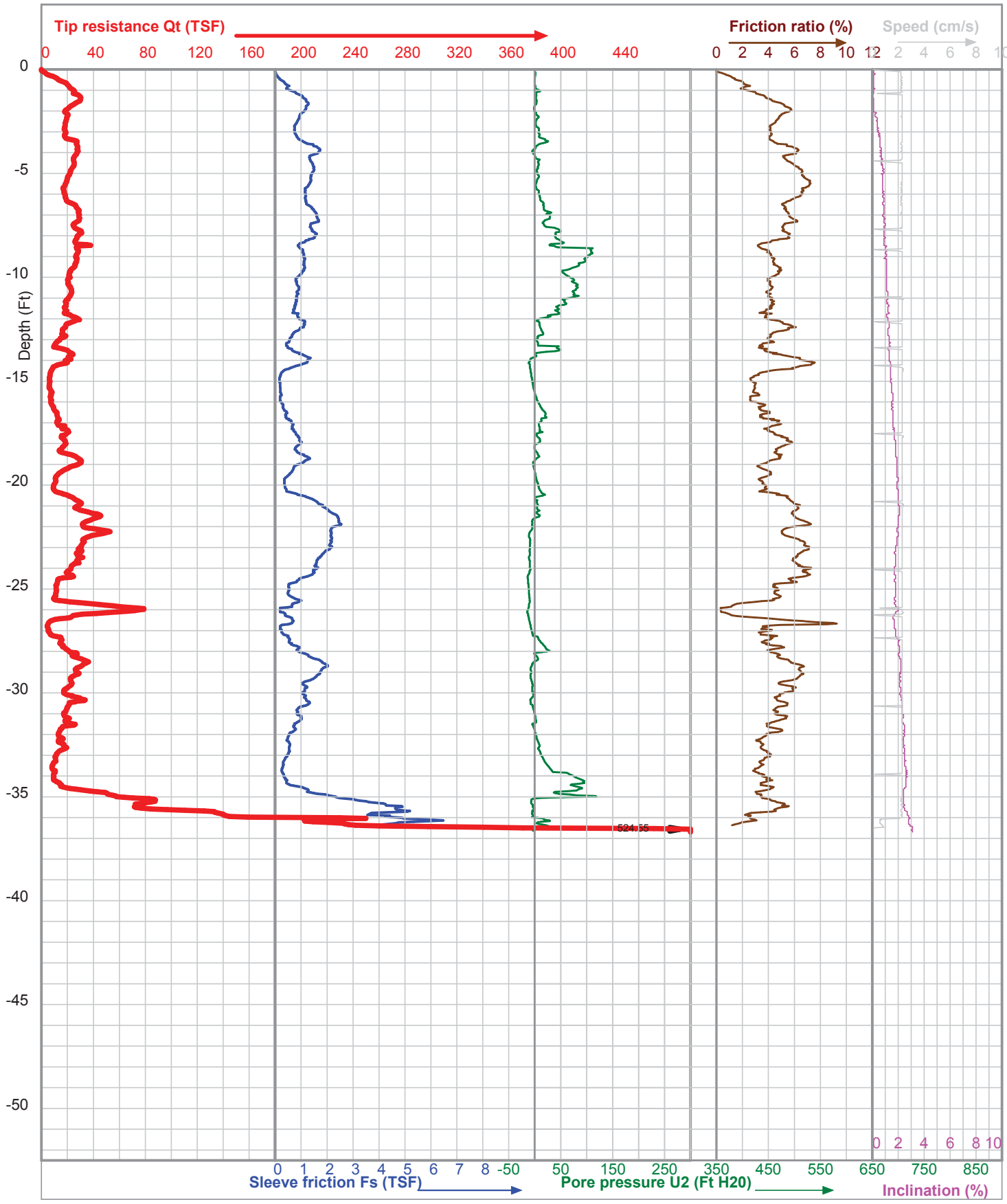
CPT Sounding Logs



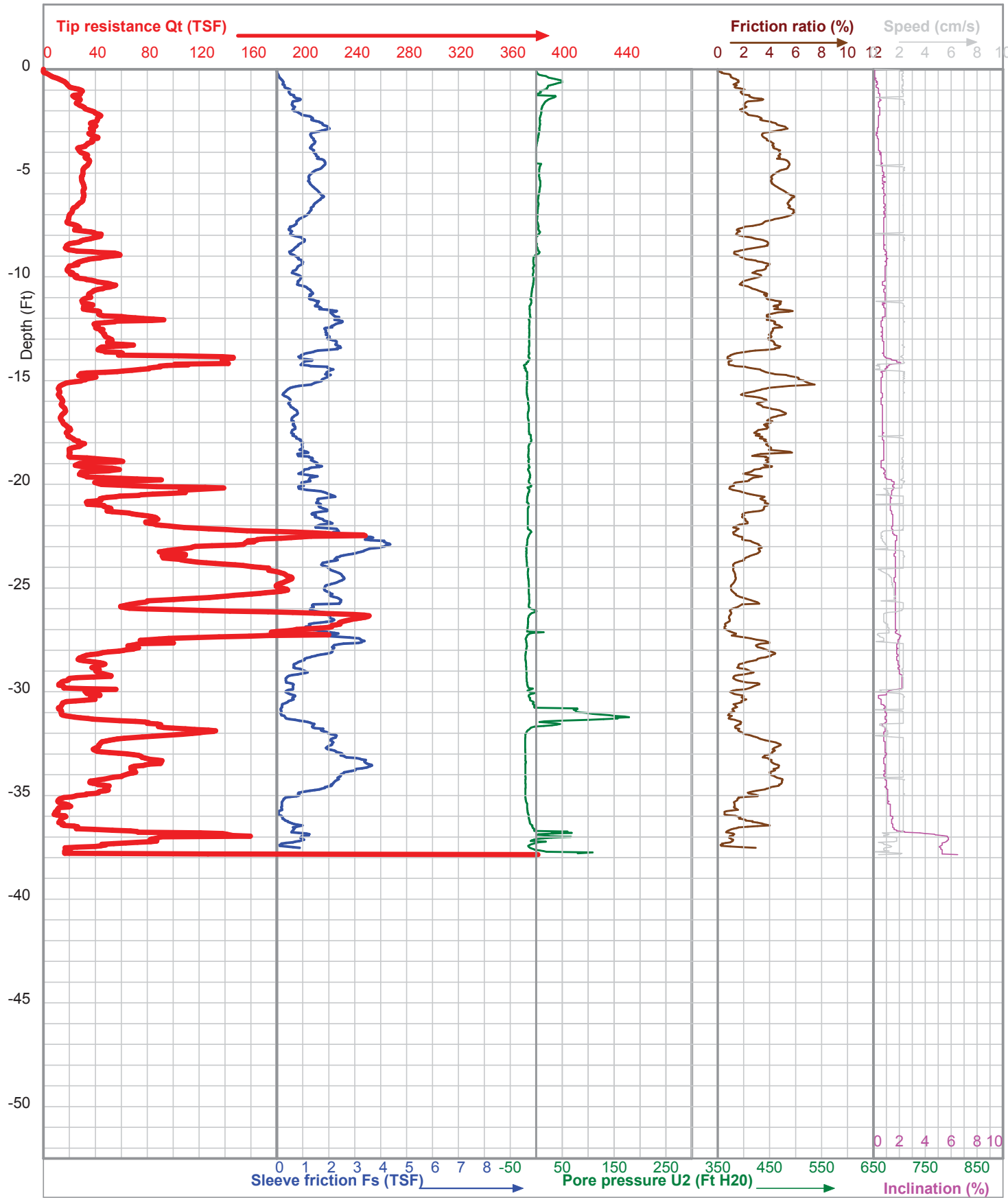
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 2	Cone Type	I-CFXYPP20-15		
Test Number	2	Cone ID	100624	X-Coord	40.69826
Client	Barr Engineering Co., Inc.	Start Time	7:28	Y-Coord	-83.83769
Boring Type	CPTU Sounding	Date	18-7-2011	Elev. Datum:	WGS 84



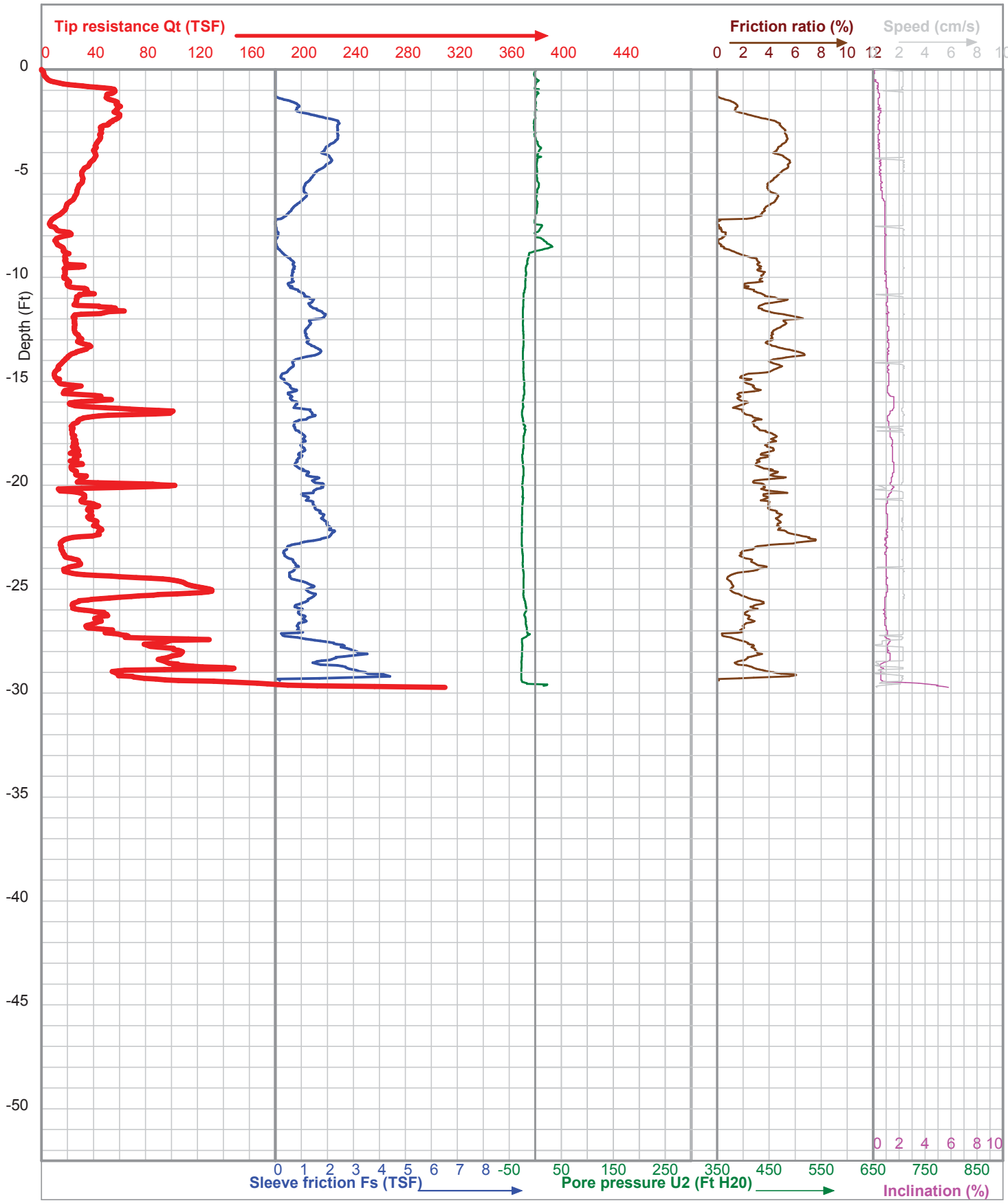
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 3	Cone Type	I-CFXYPP20-15		
Test Number	3	Cone ID	100624	X-Coord	40.69465
Client	Barr Engineering Co., Inc.	Start Time	13:05	Y-Coord	-83.83752
Boring Type	CPTU Sounding	Date	28-7-2011	Elev. Datum:	WGS 84



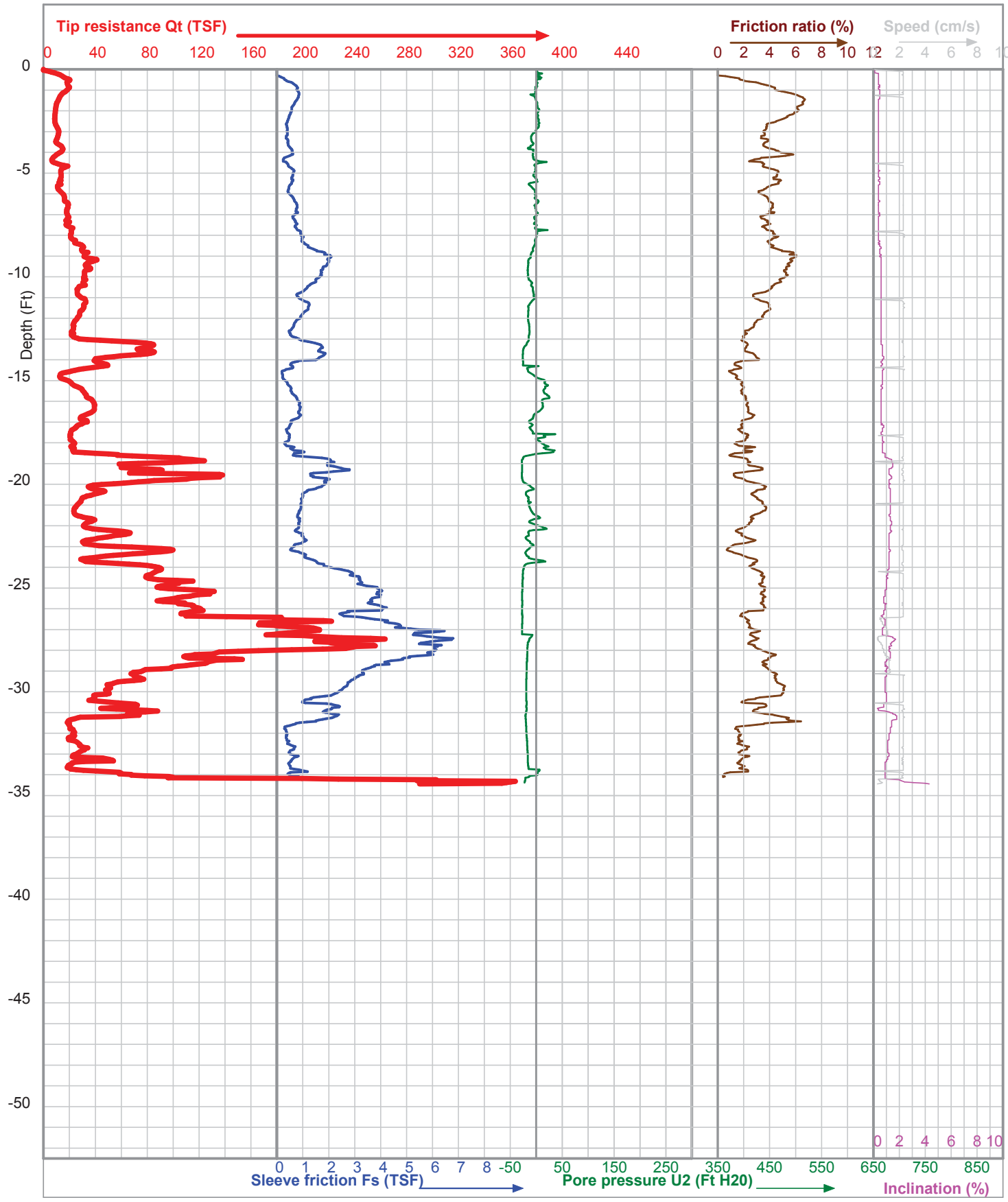
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 9	Cone Type	I-CFXYPP20-15		
Test Number	9	Cone ID	100624	X-Coord	40.69140
Client	Barr Engineering Co., Inc.	Start Time	10:27	Y-Coord	-83.82165
Boring Type	CPTU Sounding	Date	19-7-2011	Elev. Datum:	WGS 84



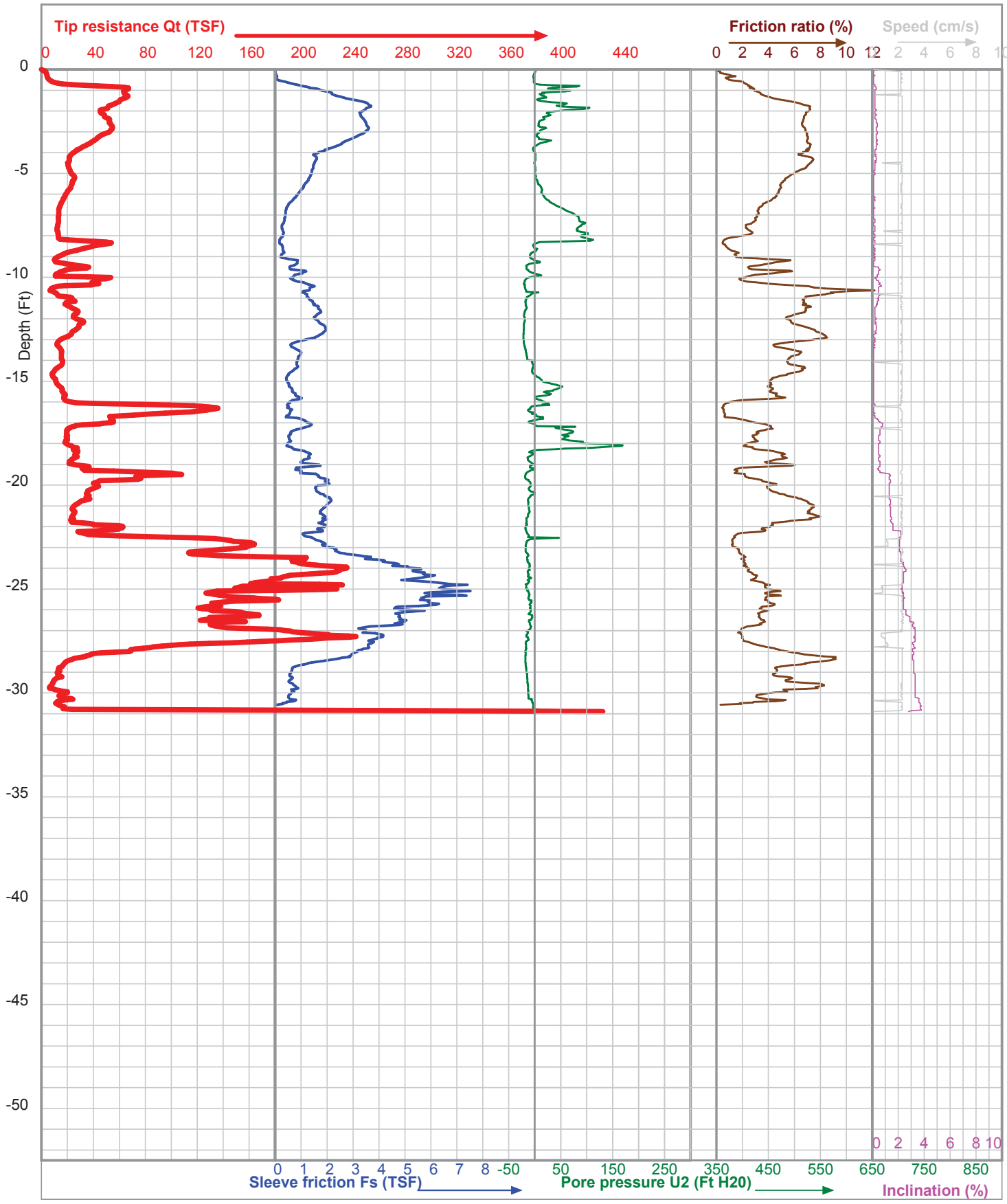
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 5	Cone Type	I-CFXYP20-15		
Test Number	5	Cone ID	090709	X-Coord	40.70152
Client	Barr Engineering Co., Inc.	Start Time	14:46	Y-Coord	-83.82834
Boring Type	CPTU Sounding	Date	18-7-2011	Elev. Datum:	WGS 84



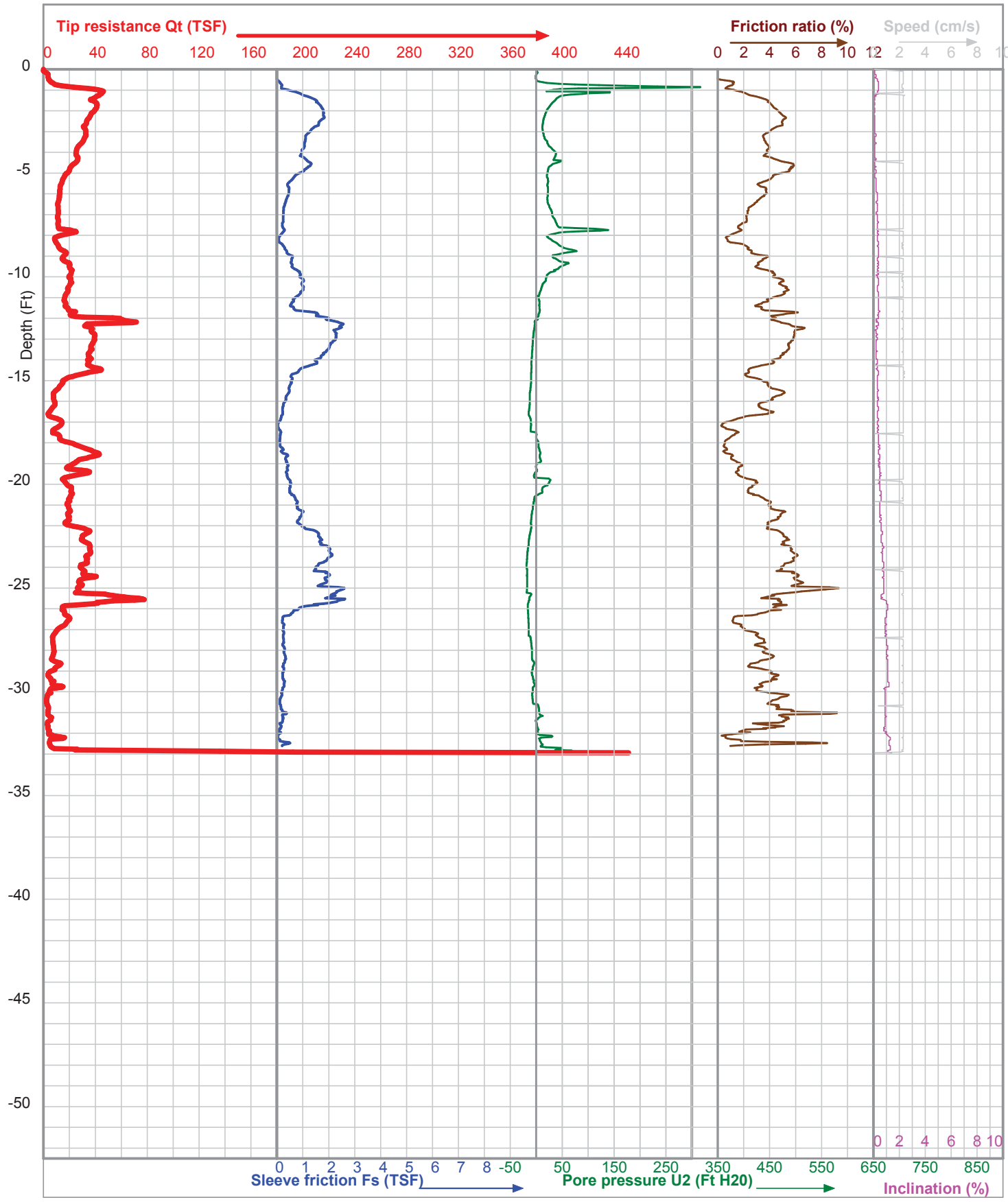
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 6	Cone Type	I-CFXYP20-15		
Test Number	6	Cone ID	090709	X-Coord	40.69897
Client	Barr Engineering Co., Inc.	Start Time	6:28	Y-Coord	-83.82735
Boring Type	CPTU Sounding	Date	19-7-2011	Elev. Datum:	WGS 84



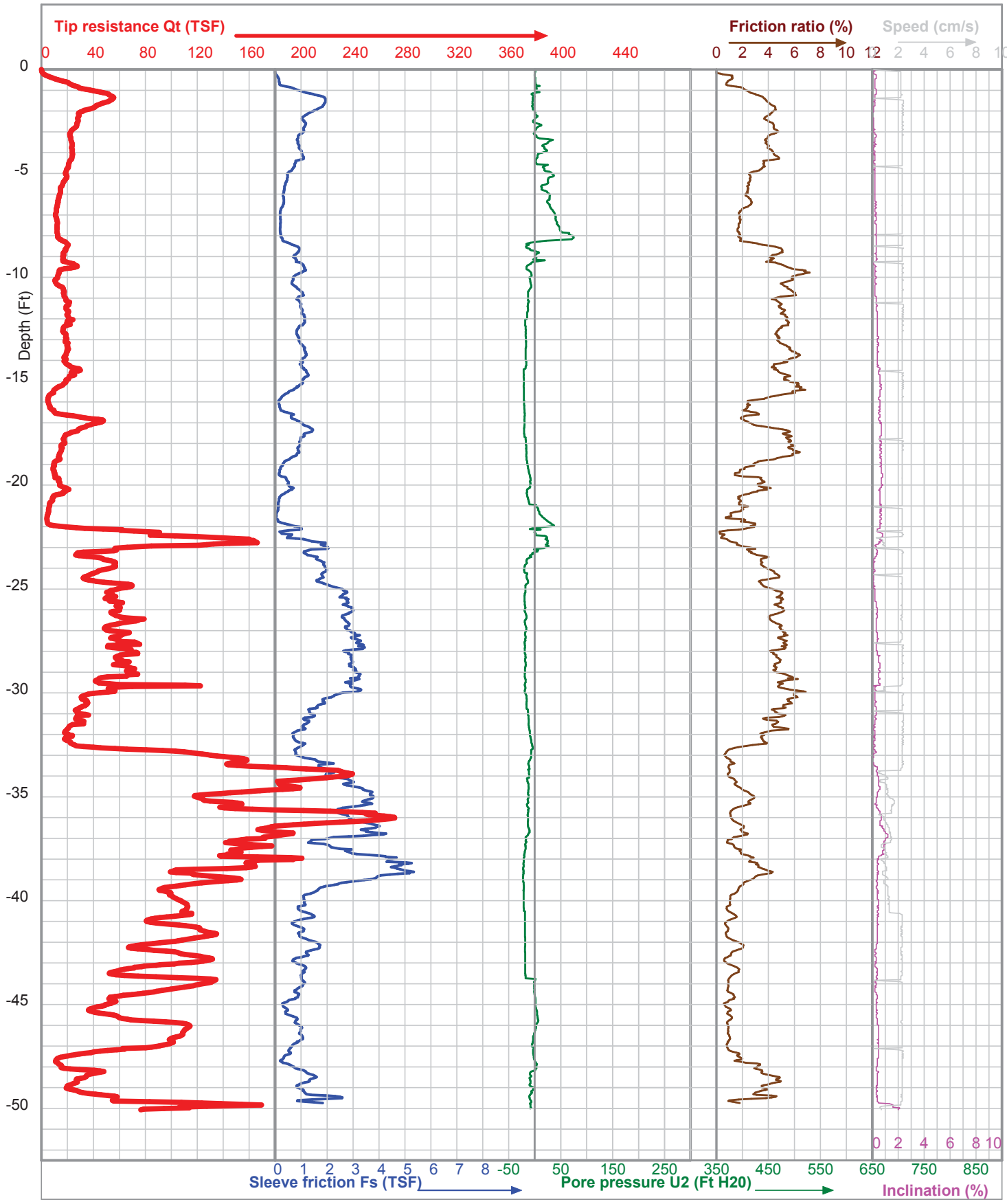
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 20	Cone Type	I-CFXYP20-15		
Test Number	20	Cone ID	090709	X-Coord	40.68765
Client	Barr Engineering Co., Inc.	Start Time	11:58	Y-Coord	-83.83855
Boring Type	CPTU Sounding	Date	19-7-2011	Elev. Datum:	WGS 84



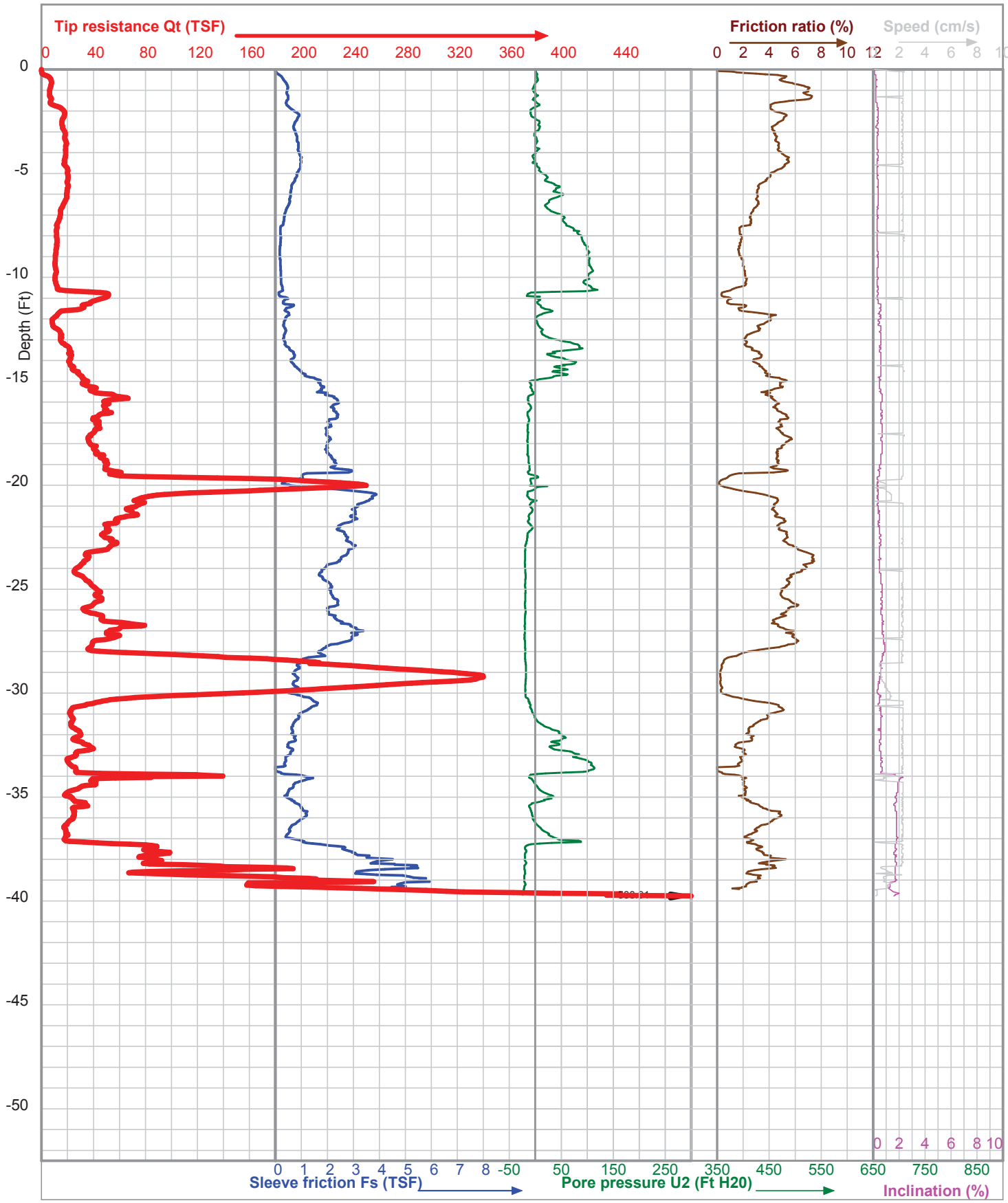
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 7	Cone Type	I-CFXYPP20-15		
Test Number	7	Cone ID	100624	X-Coord	40.69610
Client	Barr Engineering Co., Inc.	Start Time	8:18	Y-Coord	-83.82625
Boring Type	CPTU Sounding	Date	19-7-2011	Elev. Datum:	WGS 84



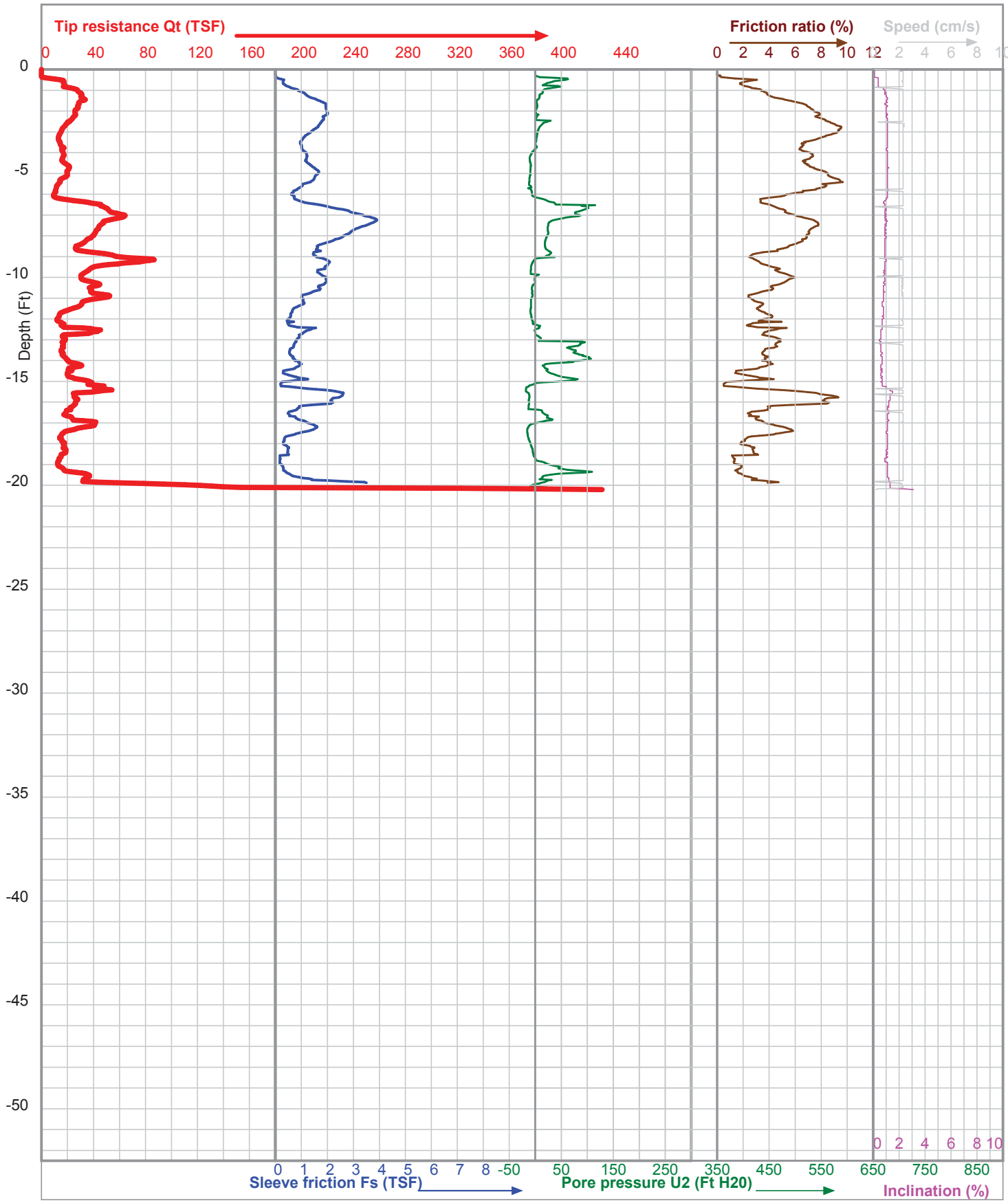
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 8	Cone Type	I-CFXYP20-15		
Test Number	8	Cone ID	090709	X-Coord	40.69349
Client	Barr Engineering Co., Inc.	Start Time	9:12	Y-Coord	-83.82432
Boring Type	CPTU Sounding	Date	19-7-2011	Elev. Datum:	WGS 84



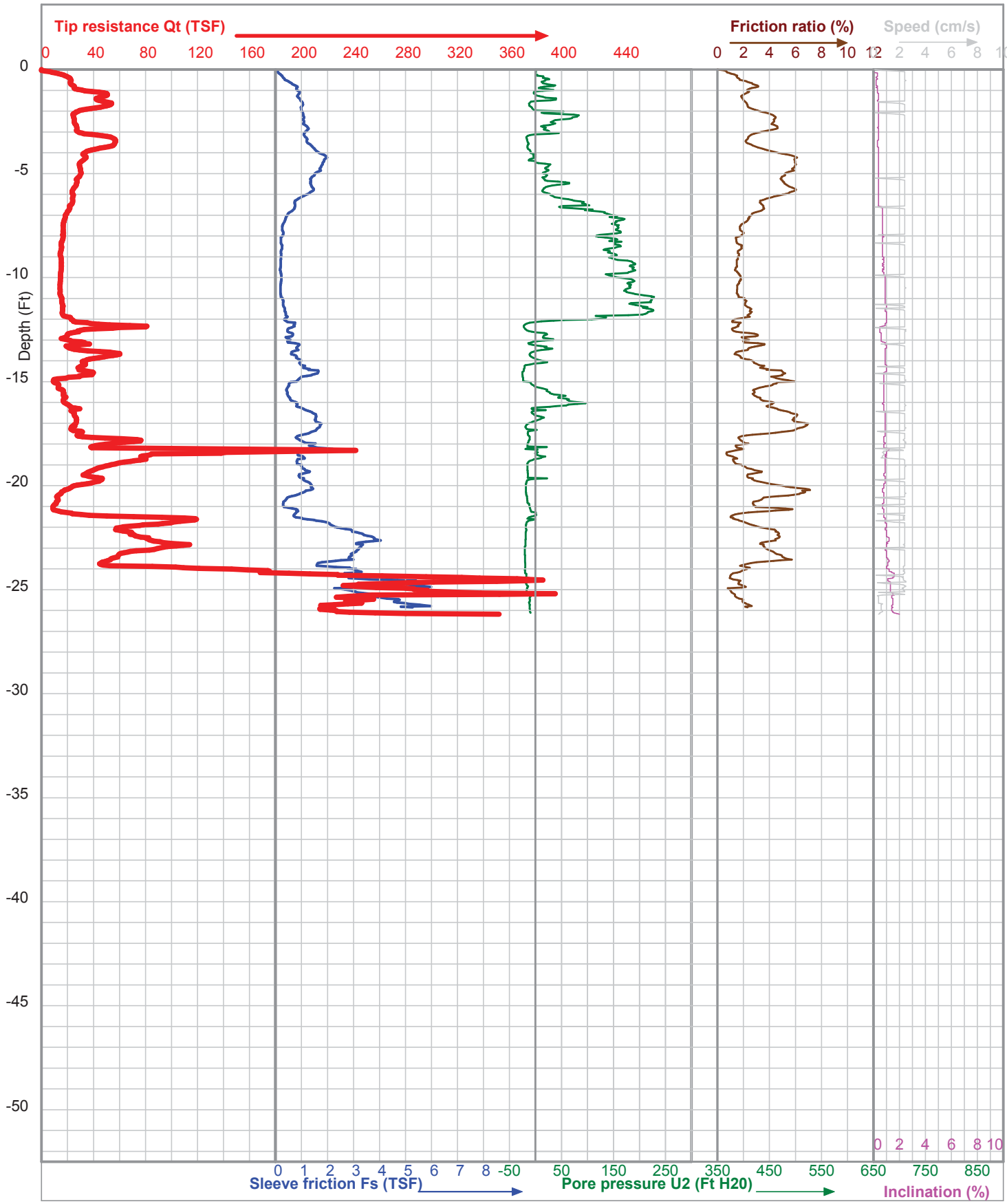
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 10	Cone Type	I-CFXYPP20-15		
Test Number	10	Cone ID	100624	X-Coord	40.68745
Client	Barr Engineering Co., Inc.	Start Time	11:32	Y-Coord	-83.81999
Boring Type	CPTU Sounding	Date	29-7-2011	Elev. Datum:	WGS 84



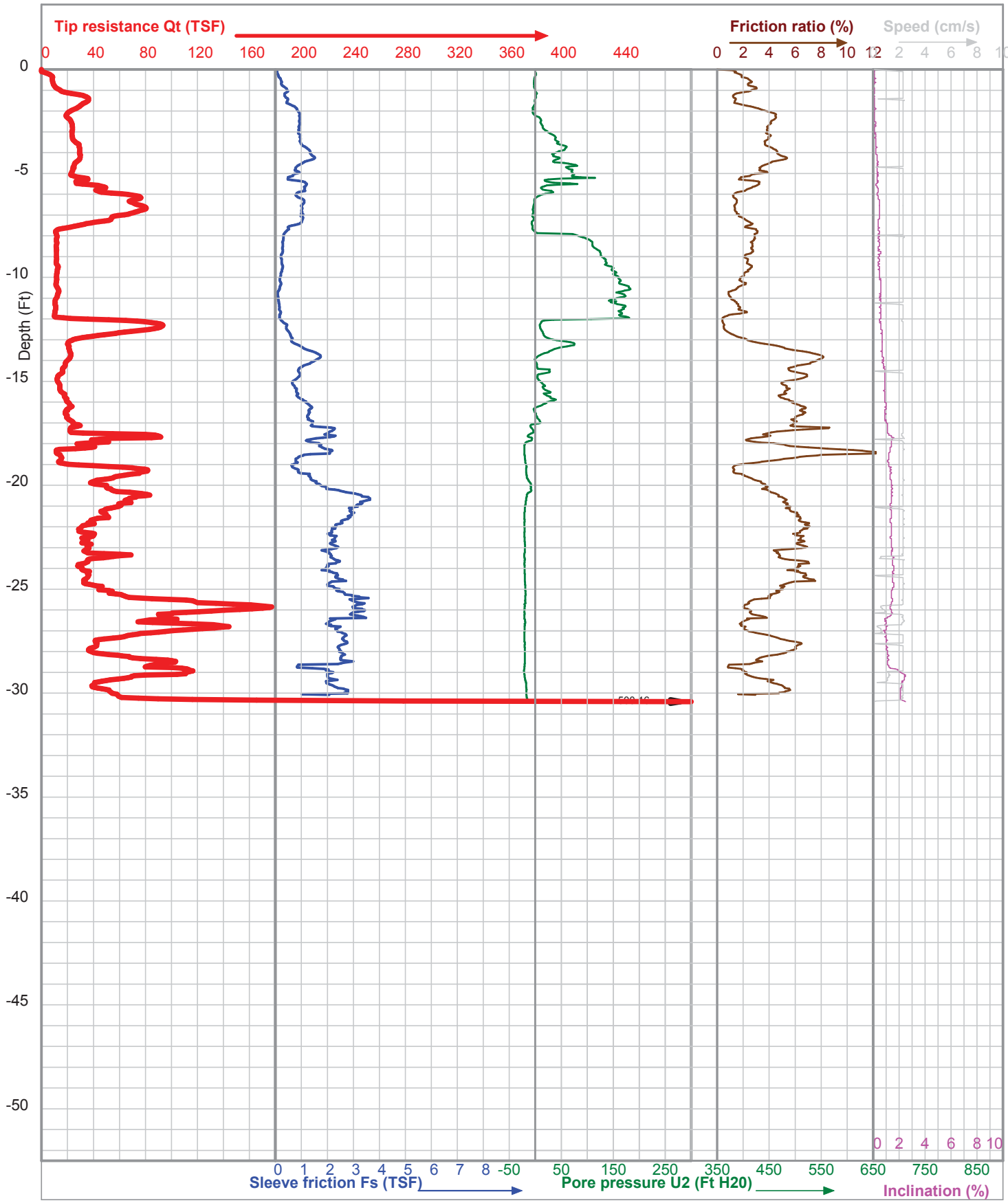
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 11	Cone Type	I-CFXYPP20-15		
Test Number	11	Cone ID	100624	X-Coord	40.68432
Client	Barr Engineering Co., Inc.	Start Time	10:30	Y-Coord	-83.81894
Boring Type	CPTU Sounding	Date	29-7-2011	Elev. Datum:	WGS 84



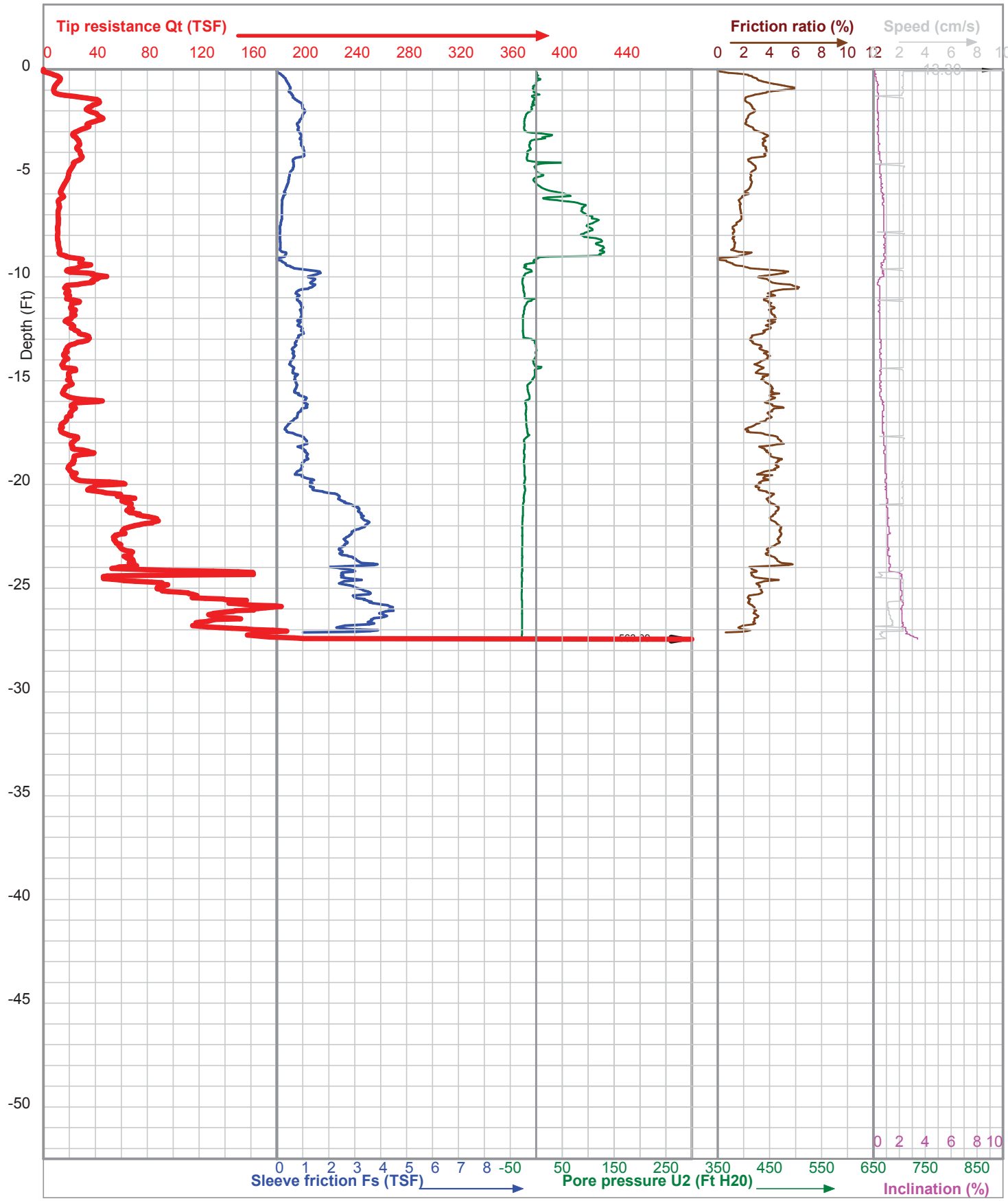
Project	Hardin County Wind	CPT Operator	b. willman	Elevation (Ft MSL)	
Location	Turbine 38	Cone Type	I-CFXYPP20-15		
Test Number	38	Cone ID	100624	X-Coord	40.65644
Client	Barr Engineering Co., Inc.	Start Time	13:59	Y-Coord	-83.83747
Boring Type	CPTU Sounding	Date	27-7-2011	Elev. Datum:	WGS 84



Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 12	Cone Type	I-CFXYP20-15		
Test Number	12	Cone ID	090710	X-Coord	40.69992
Client	Barr Engineering Co., Inc.	Start Time	9:58	Y-Coord	-83.81078
Boring Type	CPTU Sounding	Date	28-7-2011	Elev. Datum:	WGS 84



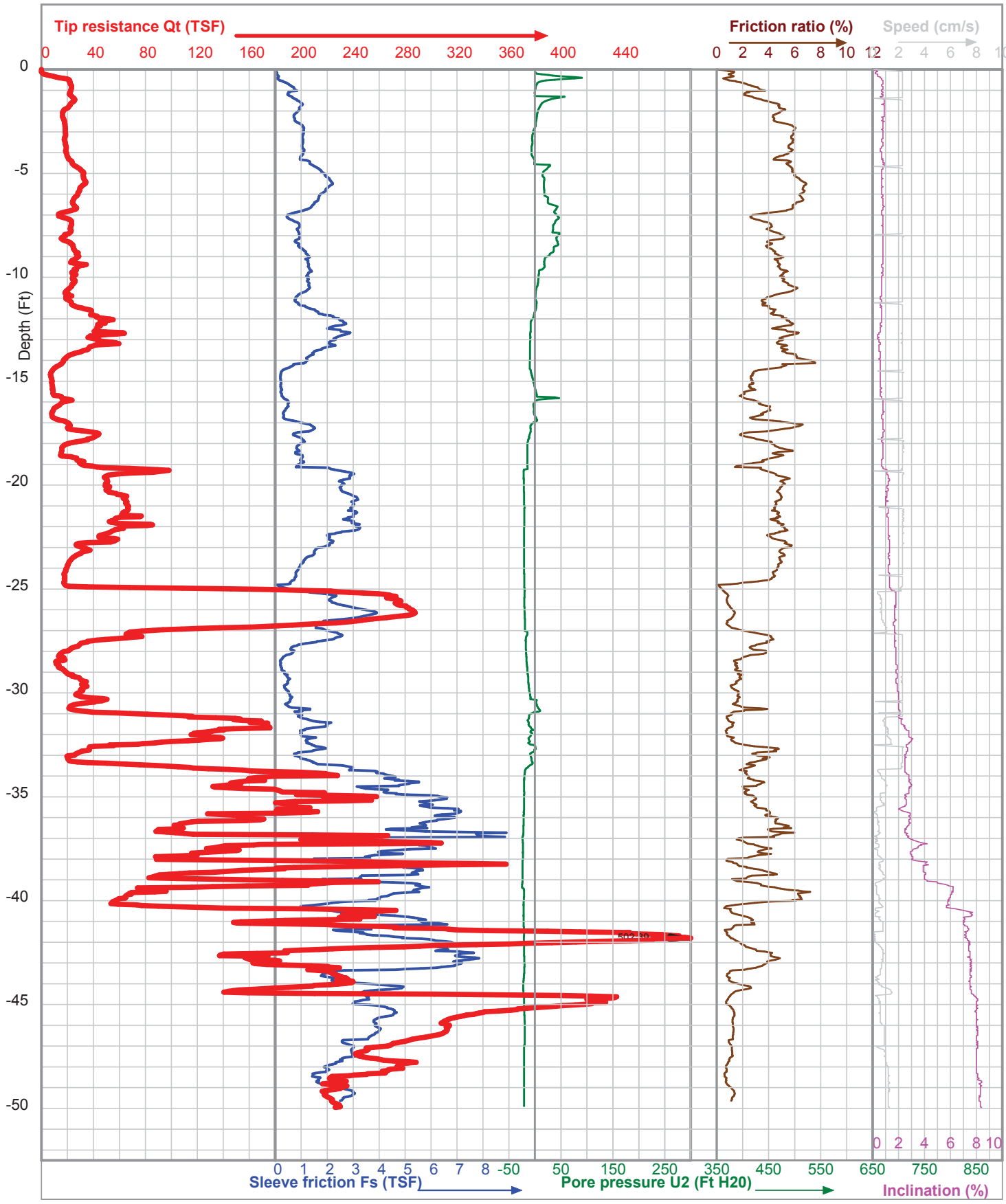
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 13	Cone Type	I-CFXYPP20-15		
Test Number	13	Cone ID	100624	X-Coord	40.69757
Client	Barr Engineering Co., Inc.	Start Time	11:45	Y-Coord	-83.80877
Boring Type	CPTU Sounding	Date	18-7-2011	Elev. Datum:	WGS 84



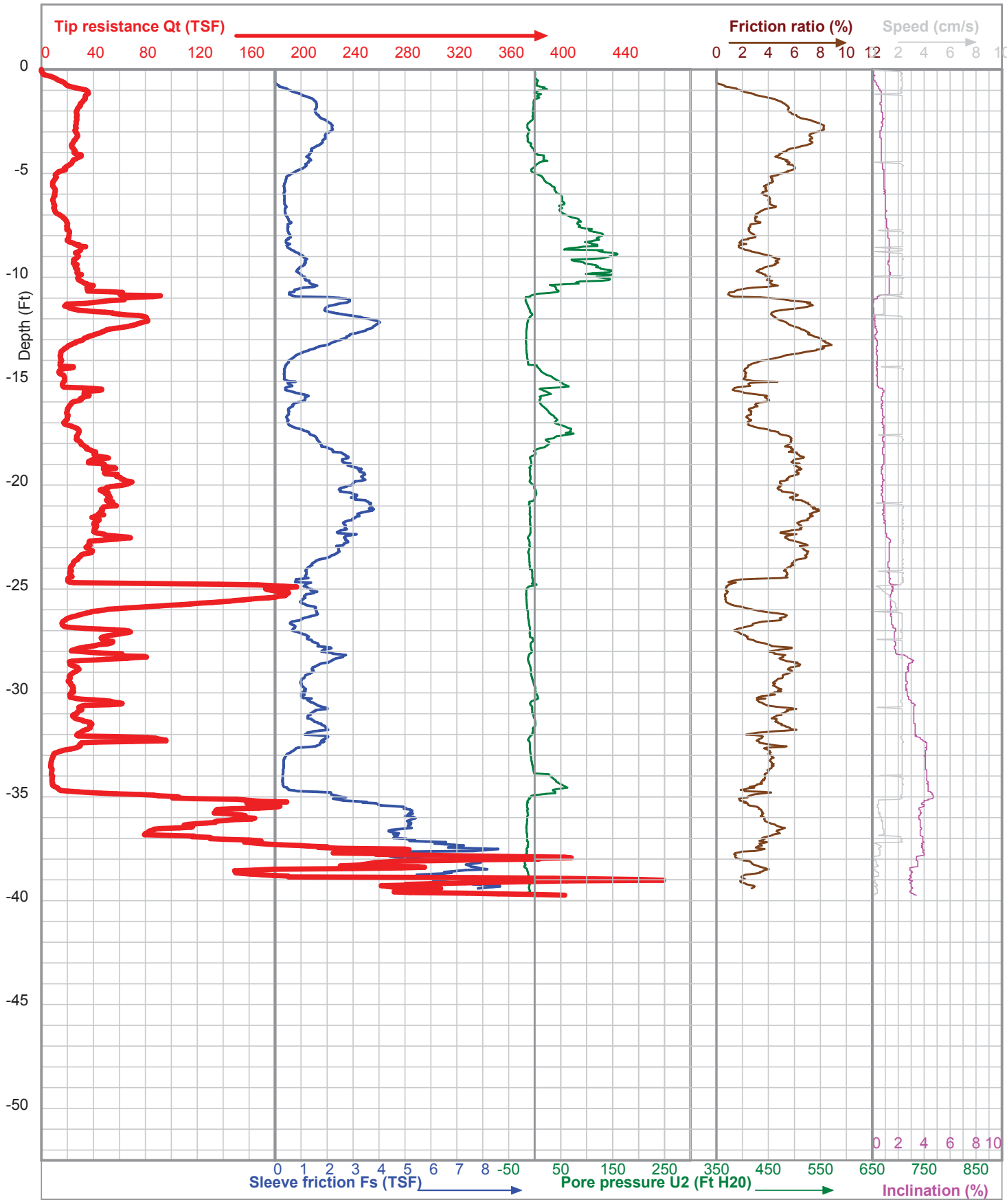
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 14	Cone Type	I-CFXYP20-15		
Test Number	14	Cone ID	090709	X-Coord	40.69514
Client	Barr Engineering Co., Inc.	Start Time	9:59	Y-Coord	-83.80709
Boring Type	CPTU Sounding	Date	18-7-2011	Elev. Datum:	WGS 84



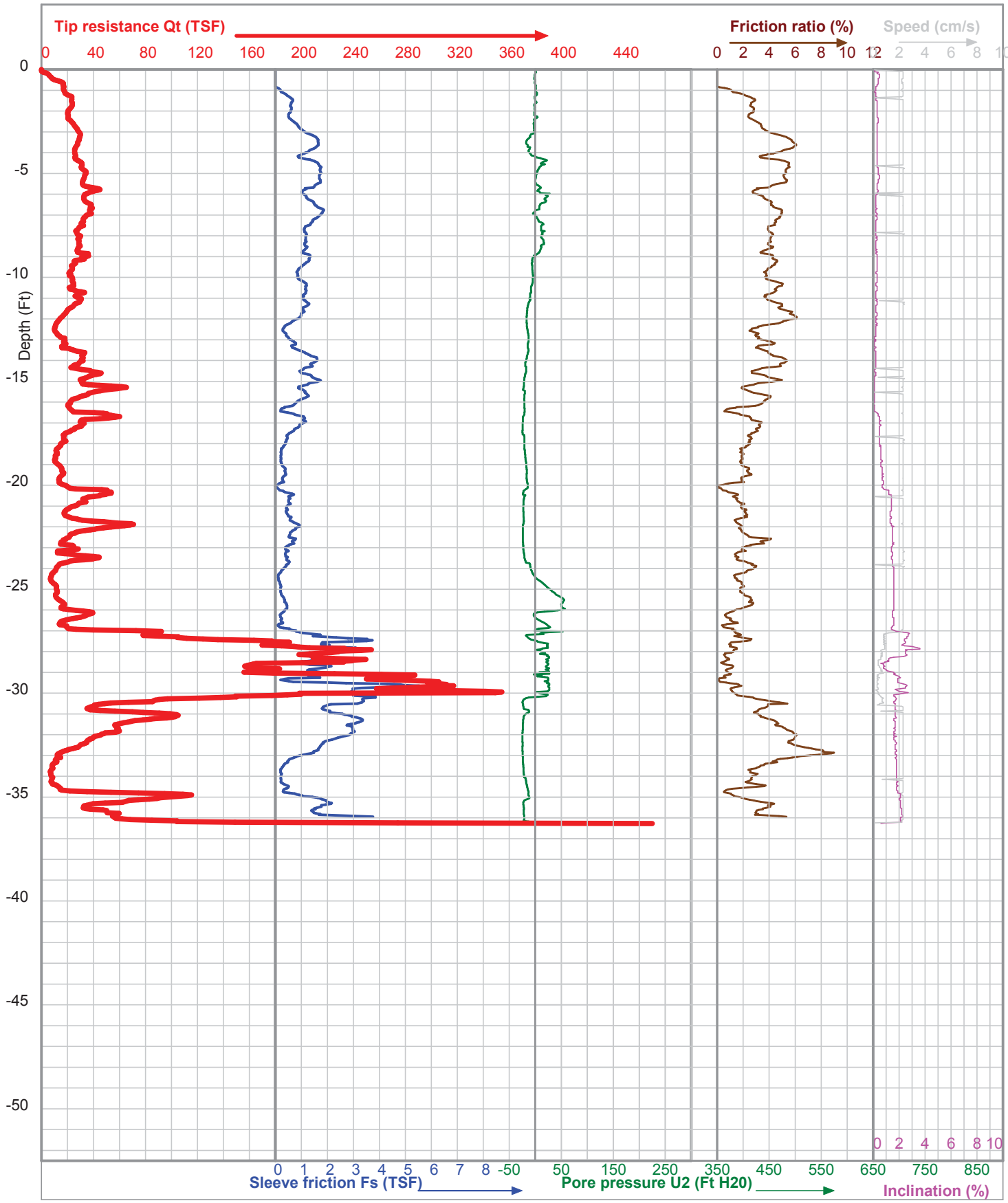
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 49	Cone Type	I-CFXYPP20-15		
Test Number	49	Cone ID	100624	X-Coord	40.65487
Client	Barr Engineering Co., Inc.	Start Time	15:30	Y-Coord	-83.79561
Boring Type	CPTU Sounding	Date	21-7-2011	Elev. Datum:	WGS 84



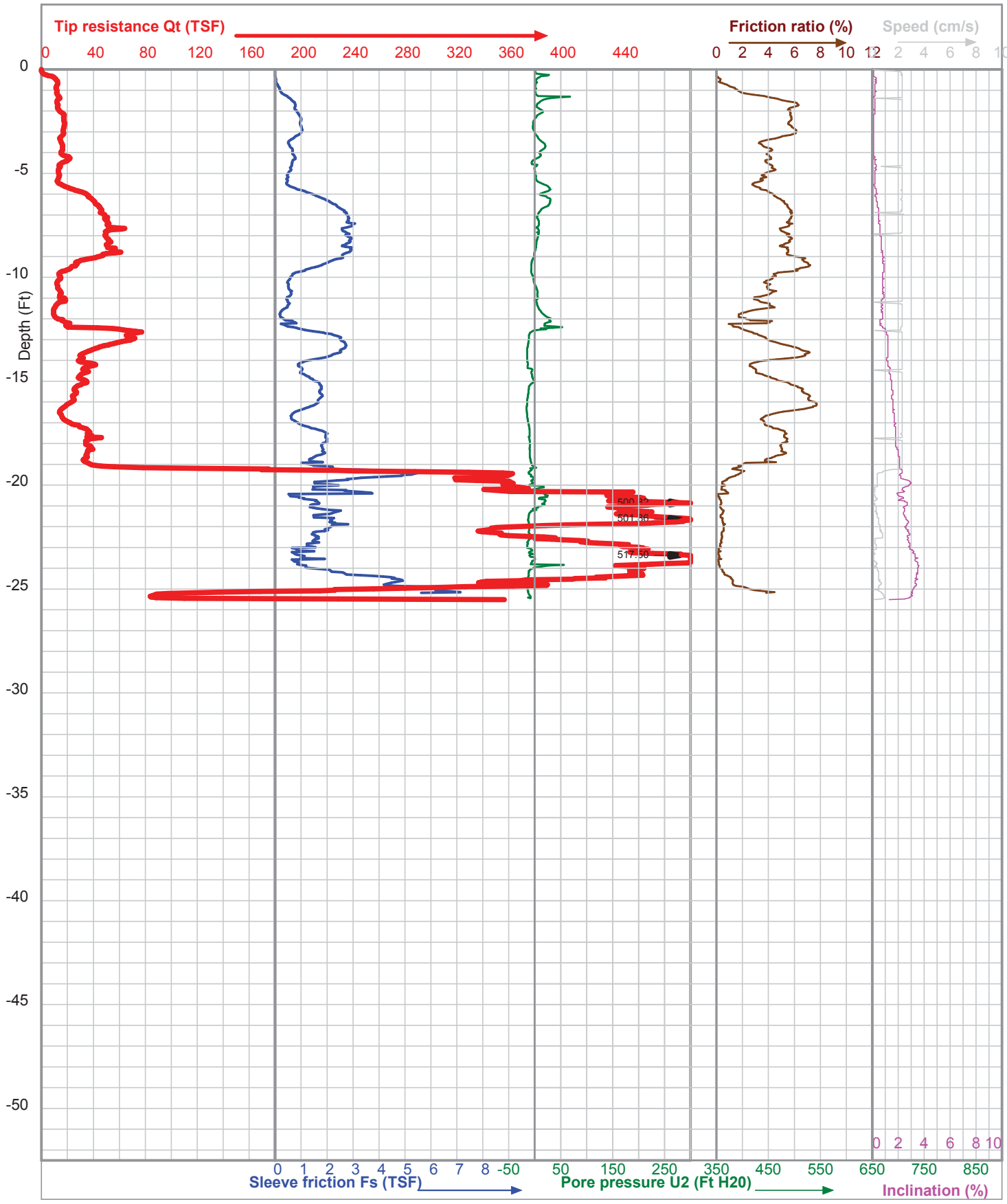
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 15	Cone Type	I-CFXYP20-15		
Test Number	15	Cone ID	090709	X-Coord	40.68783
Client	Barr Engineering Co., Inc.	Start Time	13:53	Y-Coord	-83.83004
Boring Type	CPTU Sounding	Date	20-7-2011	Elev. Datum:	WGS 84



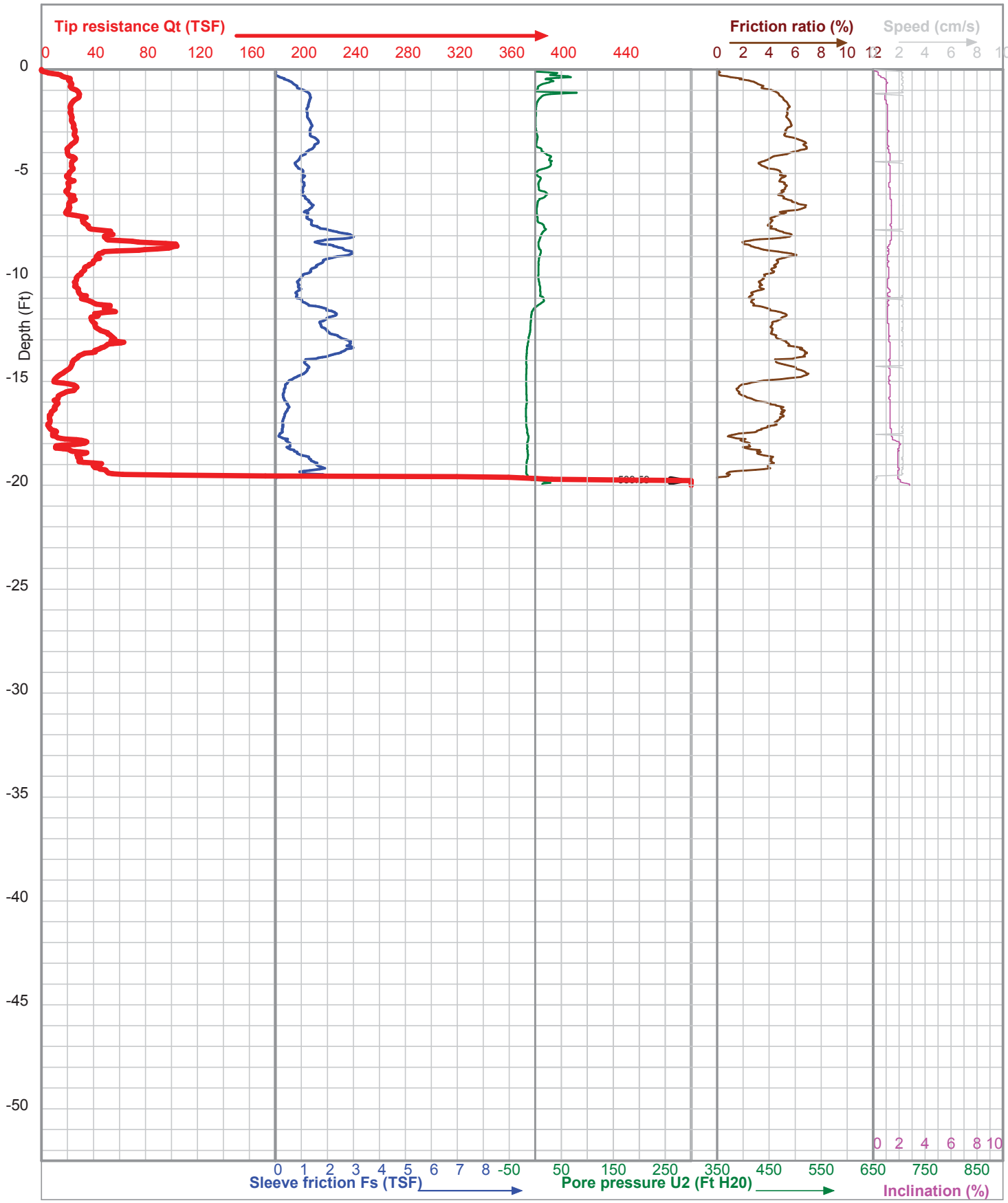
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 16	Cone Type	I-CFXYPP20-15		
Test Number	16	Cone ID	100624	X-Coord	40.68467
Client	Barr Engineering Co., Inc.	Start Time	12:23	Y-Coord	-83.82983
Boring Type	CPTU Sounding	Date	20-7-2011	Elev. Datum:	WGS 84



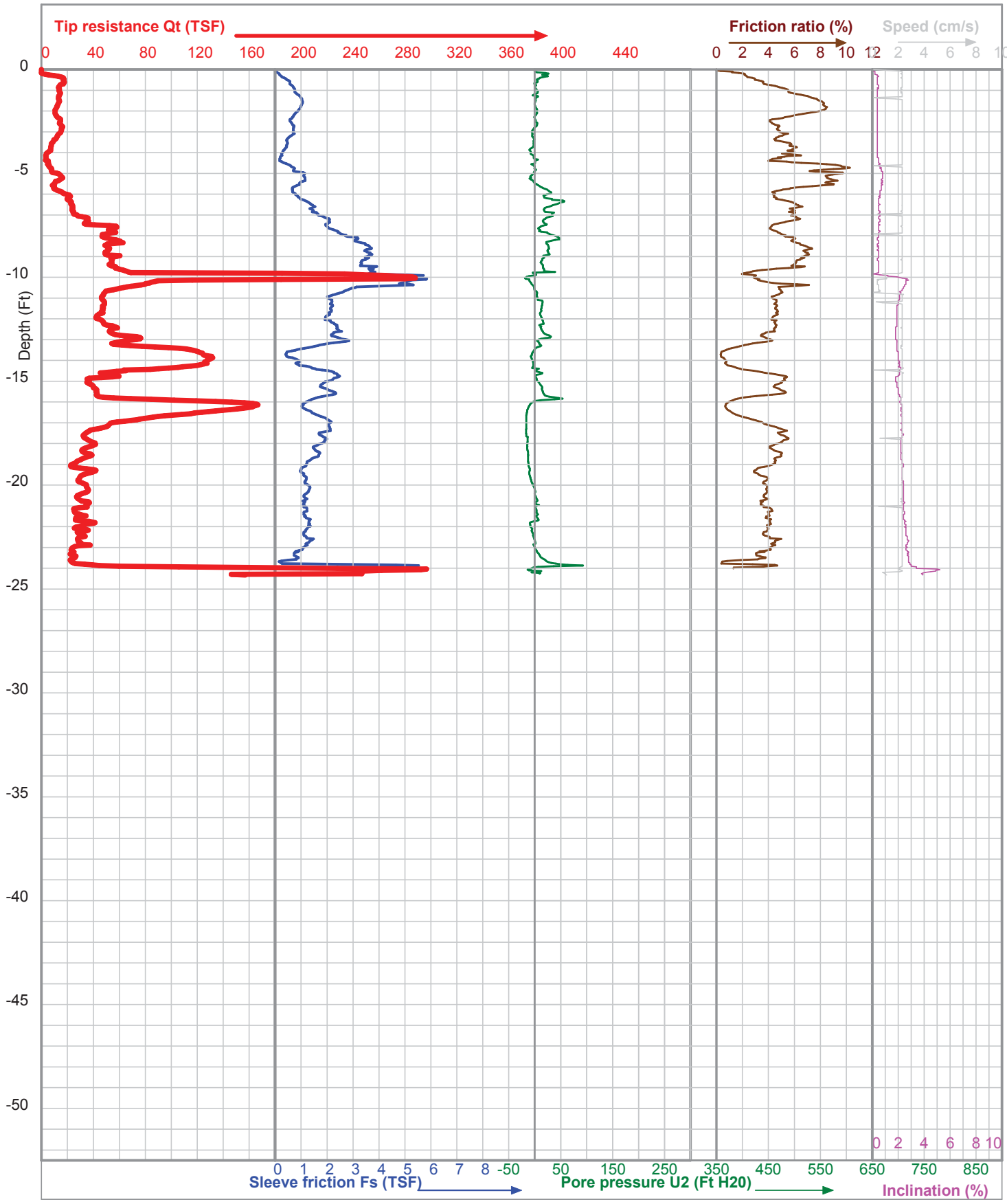
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 17	Cone Type	I-CFXYP20-15		
Test Number	17	Cone ID	090709	X-Coord	40.68194
Client	Barr Engineering Co., Inc.	Start Time	11:05	Y-Coord	-83.82965
Boring Type	CPTU Sounding	Date	20-7-2011	Elev. Datum:	WGS 84



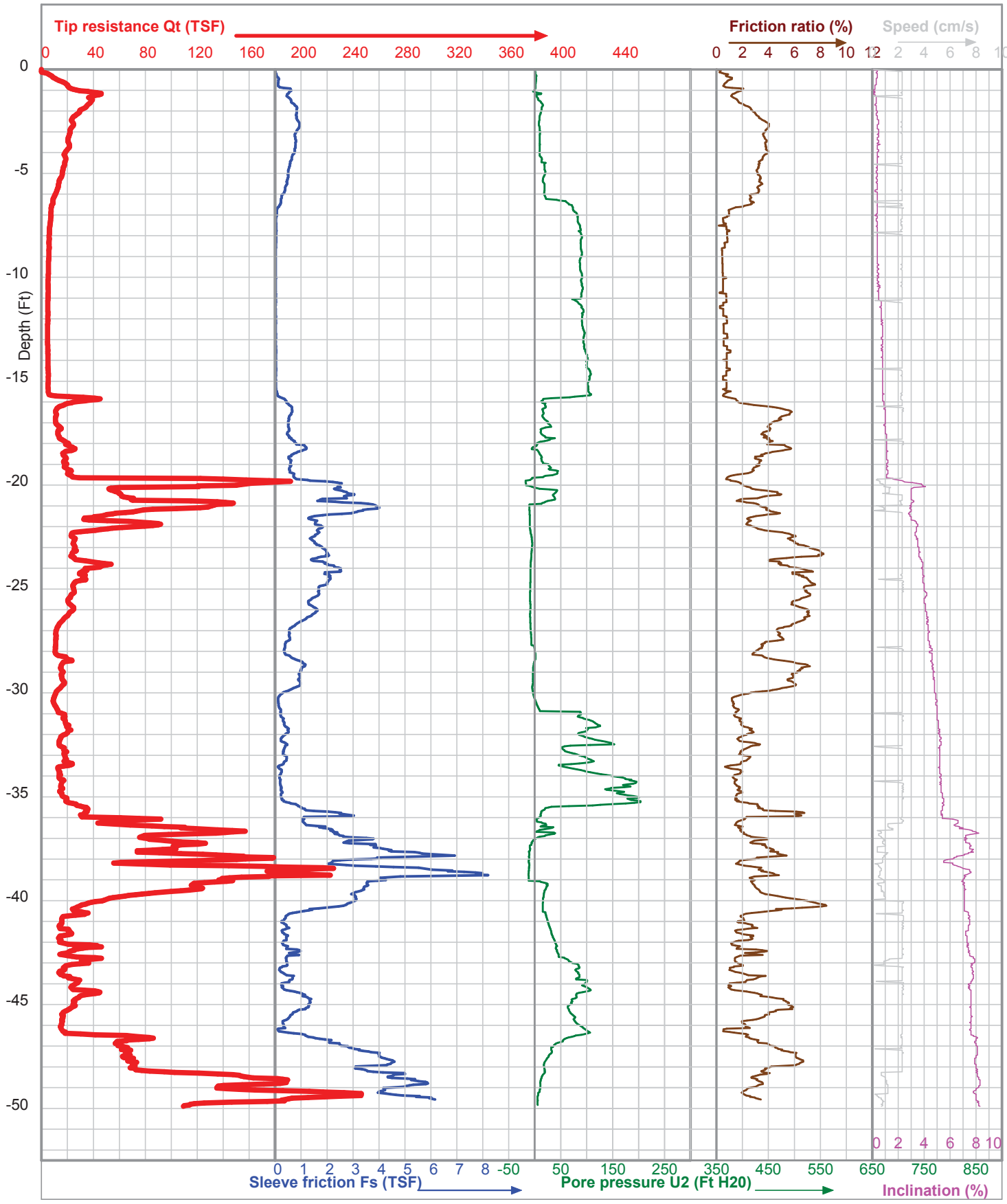
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 18	Cone Type	I-CFXYPP20-15		
Test Number	18	Cone ID	100624	X-Coord	40.67945
Client	Barr Engineering Co., Inc.	Start Time	9:56	Y-Coord	-83.82851
Boring Type	CPTU Sounding	Date	20-7-2011	Elev. Datum:	WGS 84



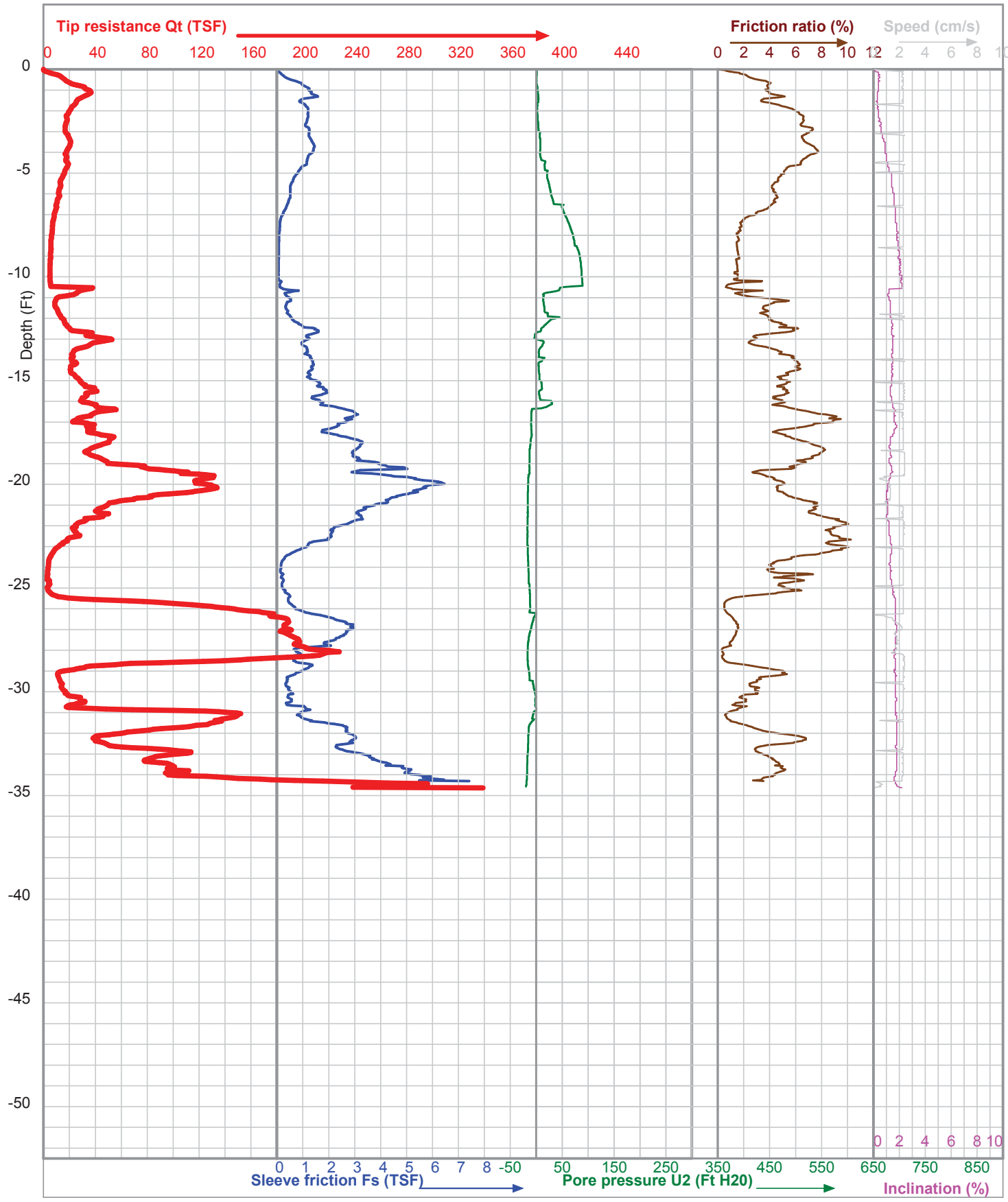
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 19	Cone Type	I-CFXYP20-15		
Test Number	19	Cone ID	090709	X-Coord	40.67675
Client	Barr Engineering Co., Inc.	Start Time	8:44	Y-Coord	-83.82733
Boring Type	CPTU Sounding	Date	20-7-2011	Elev. Datum:	WGS 84



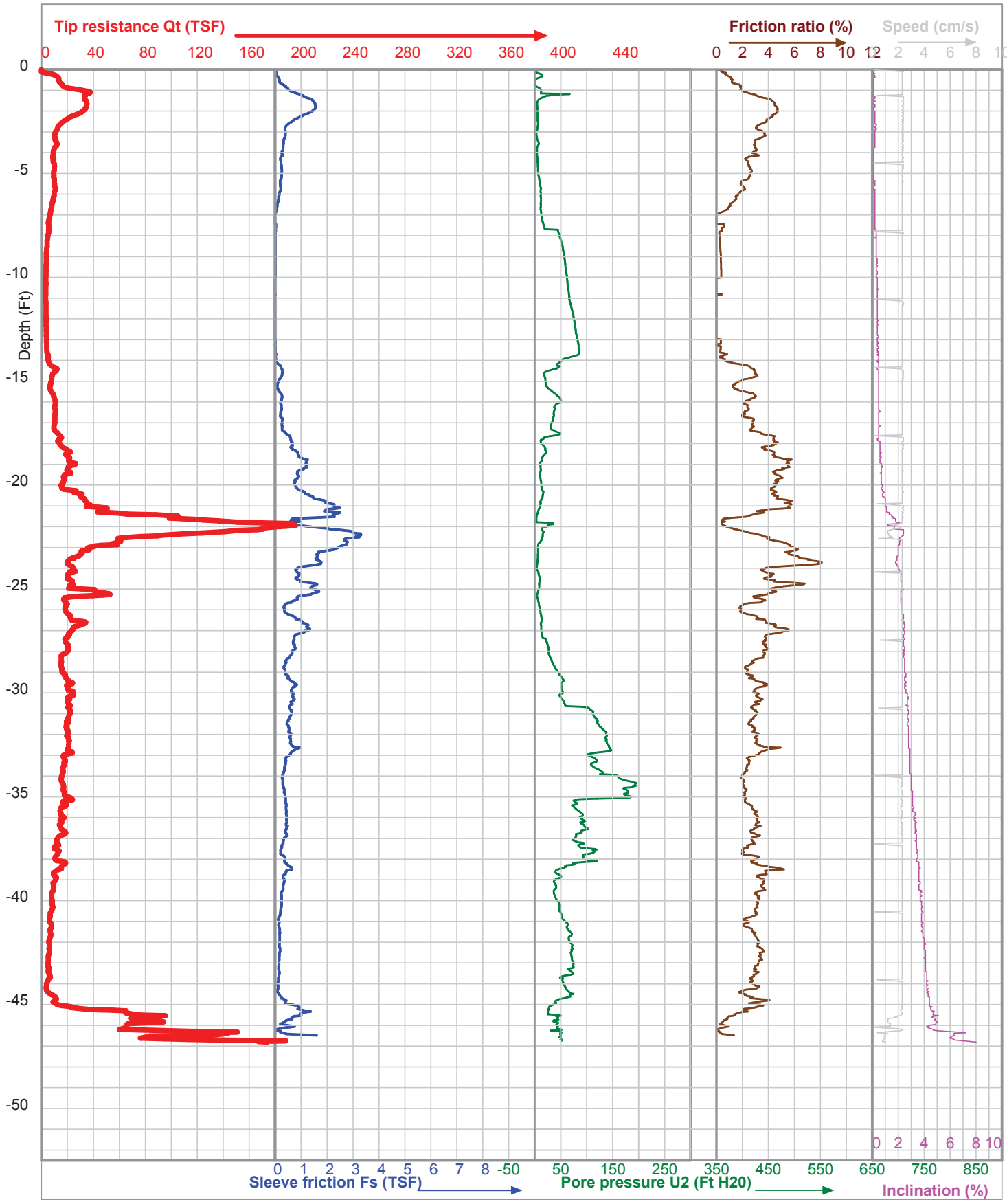
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 21	Cone Type	I-CFXYPP20-15		
Test Number	21	Cone ID	100624	X-Coord	40.68536
Client	Barr Engineering Co., Inc.	Start Time	13:12	Y-Coord	-83.83688
Boring Type	CPTU Sounding	Date	19-7-2011	Elev. Datum:	WGS 84



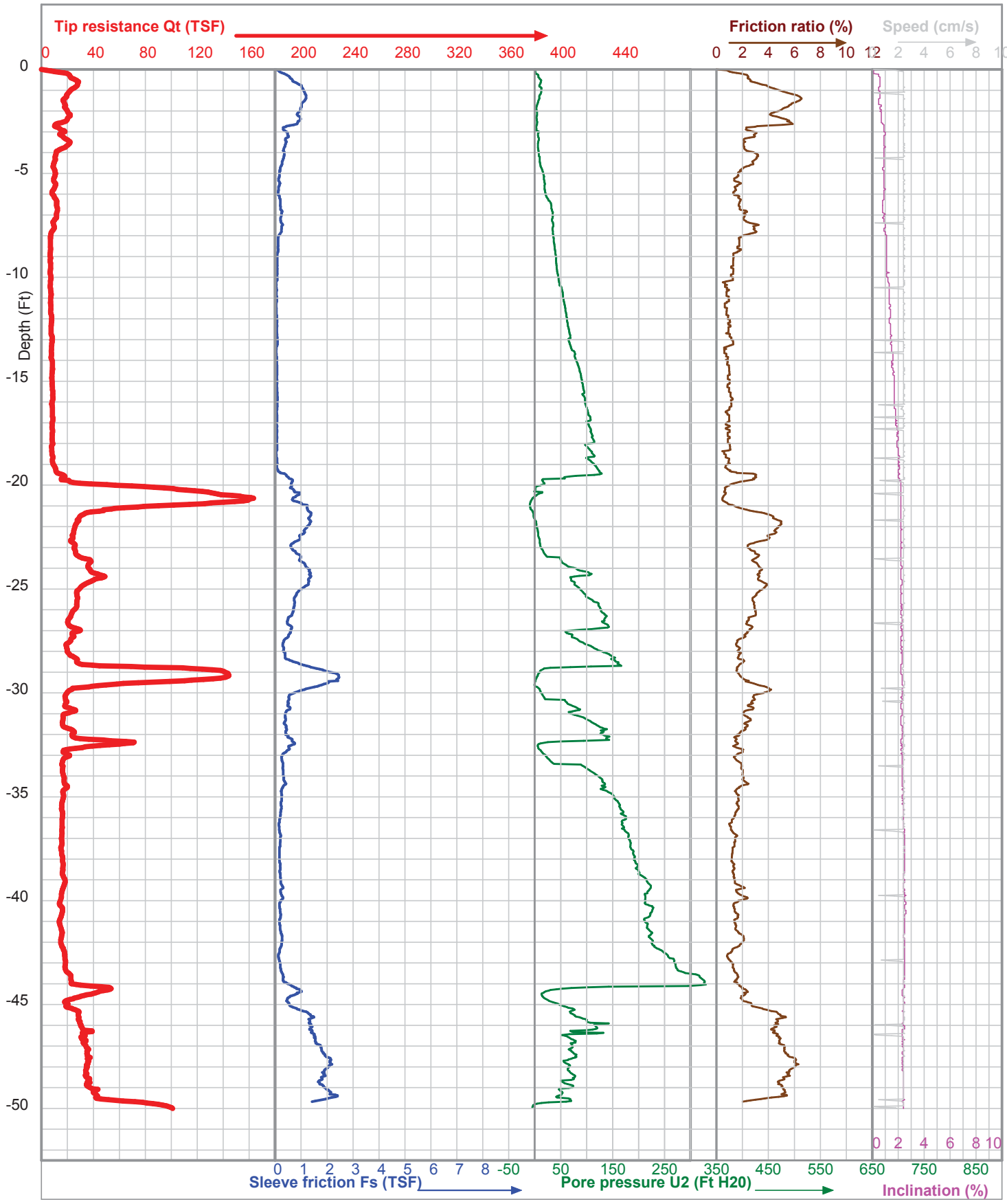
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 22	Cone Type	I-CFXYPP20-15		
Test Number	22	Cone ID	100624	X-Coord	40.67934
Client	Barr Engineering Co., Inc.	Start Time	7:42	Y-Coord	-83.81708
Boring Type	CPTU Sounding	Date	29-7-2011	Elev. Datum:	WGS 84



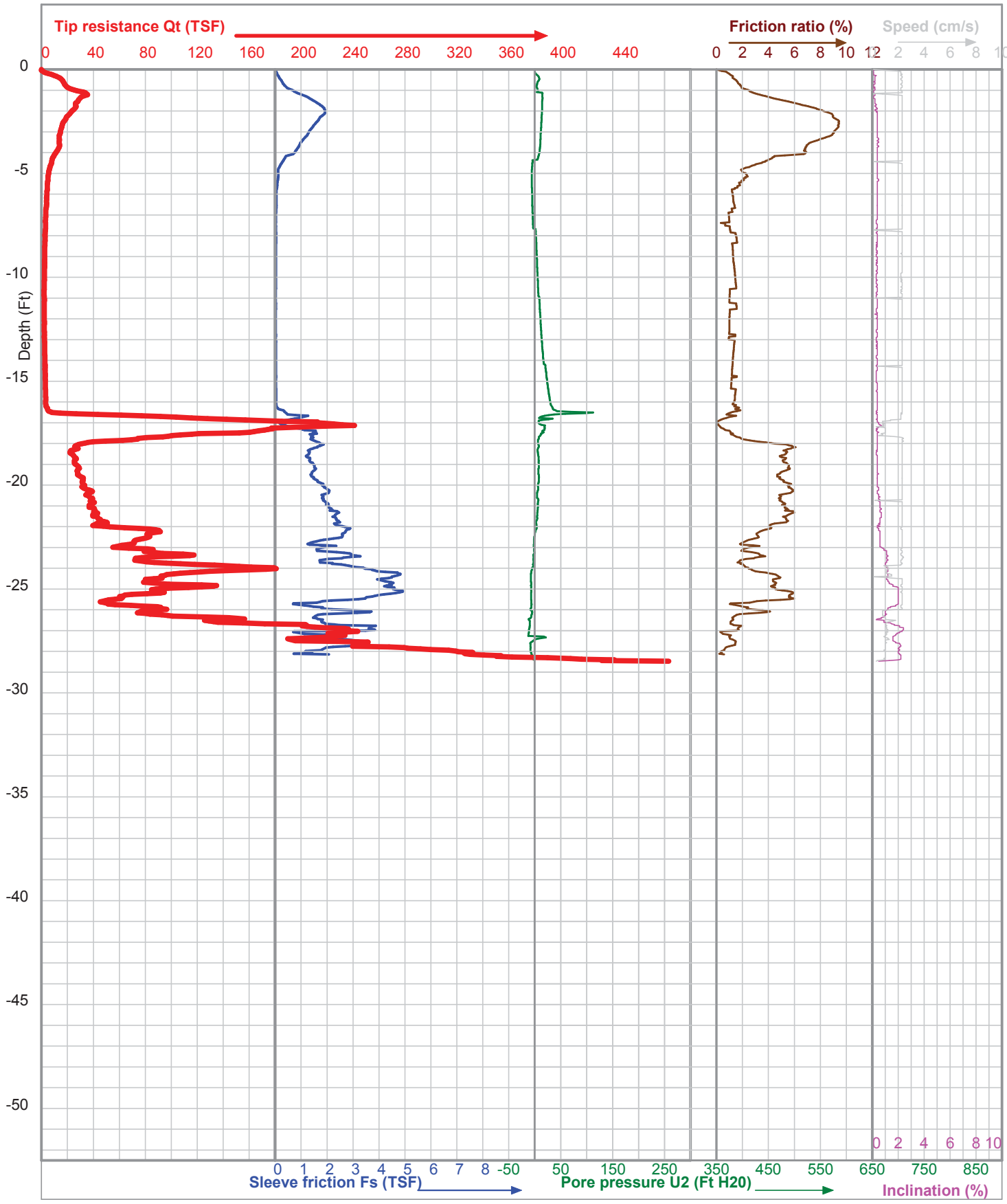
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 23	Cone Type	I-CFXYPP20-15		
Test Number	23	Cone ID	100624	X-Coord	40.67674
Client	Barr Engineering Co., Inc.	Start Time	6:13	Y-Coord	-83.81534
Boring Type	CPTU Sounding	Date	29-7-2011	Elev. Datum:	WGS 84



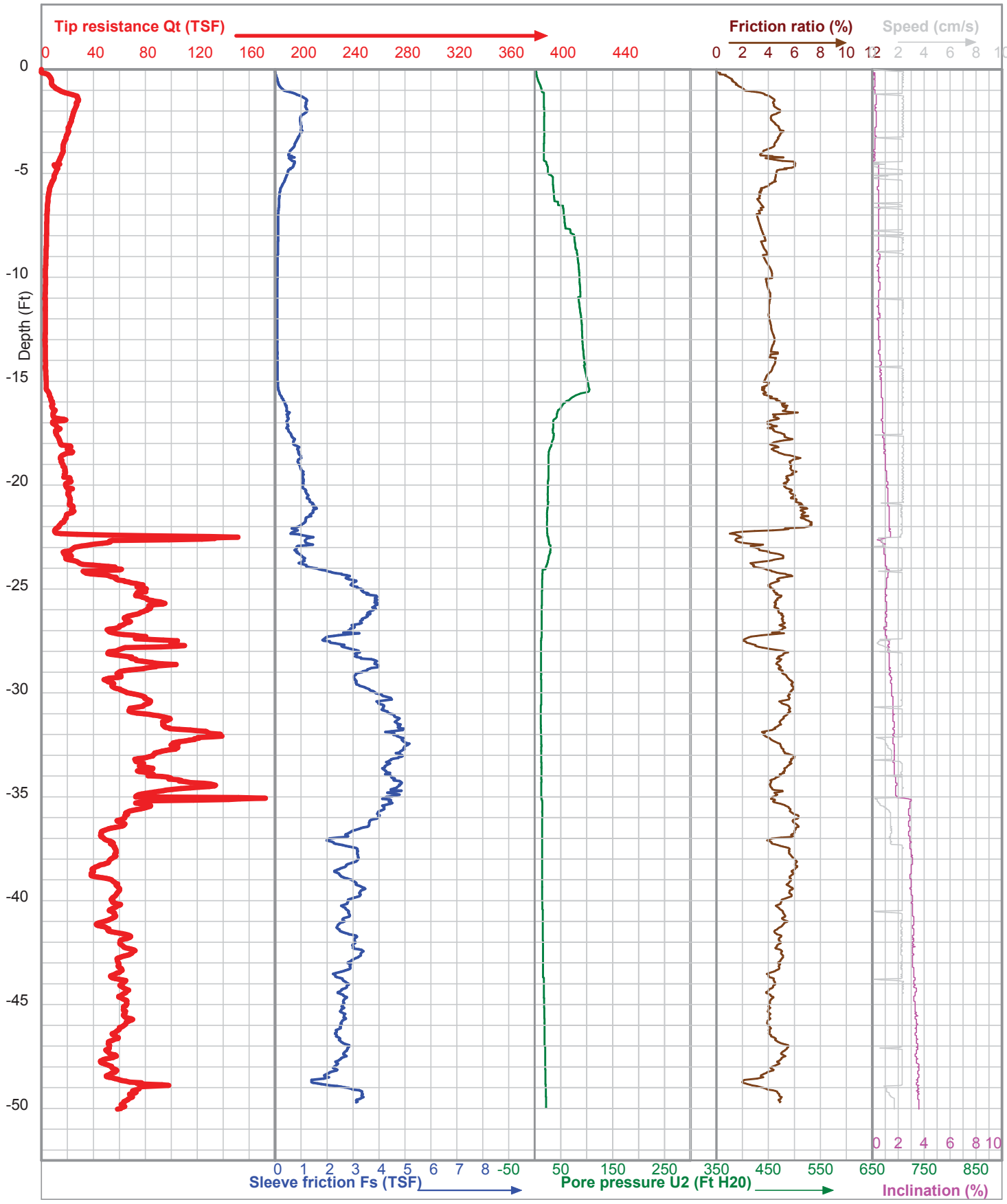
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 25	Cone Type	I-CFXYPP20-15		
Test Number	25	Cone ID	100624	X-Coord	40.66973
Client	Barr Engineering Co., Inc.	Start Time	10:53	Y-Coord	-83.81403
Boring Type	CPTU Sounding	Date	28-7-2011	Elev. Datum:	WGS 84



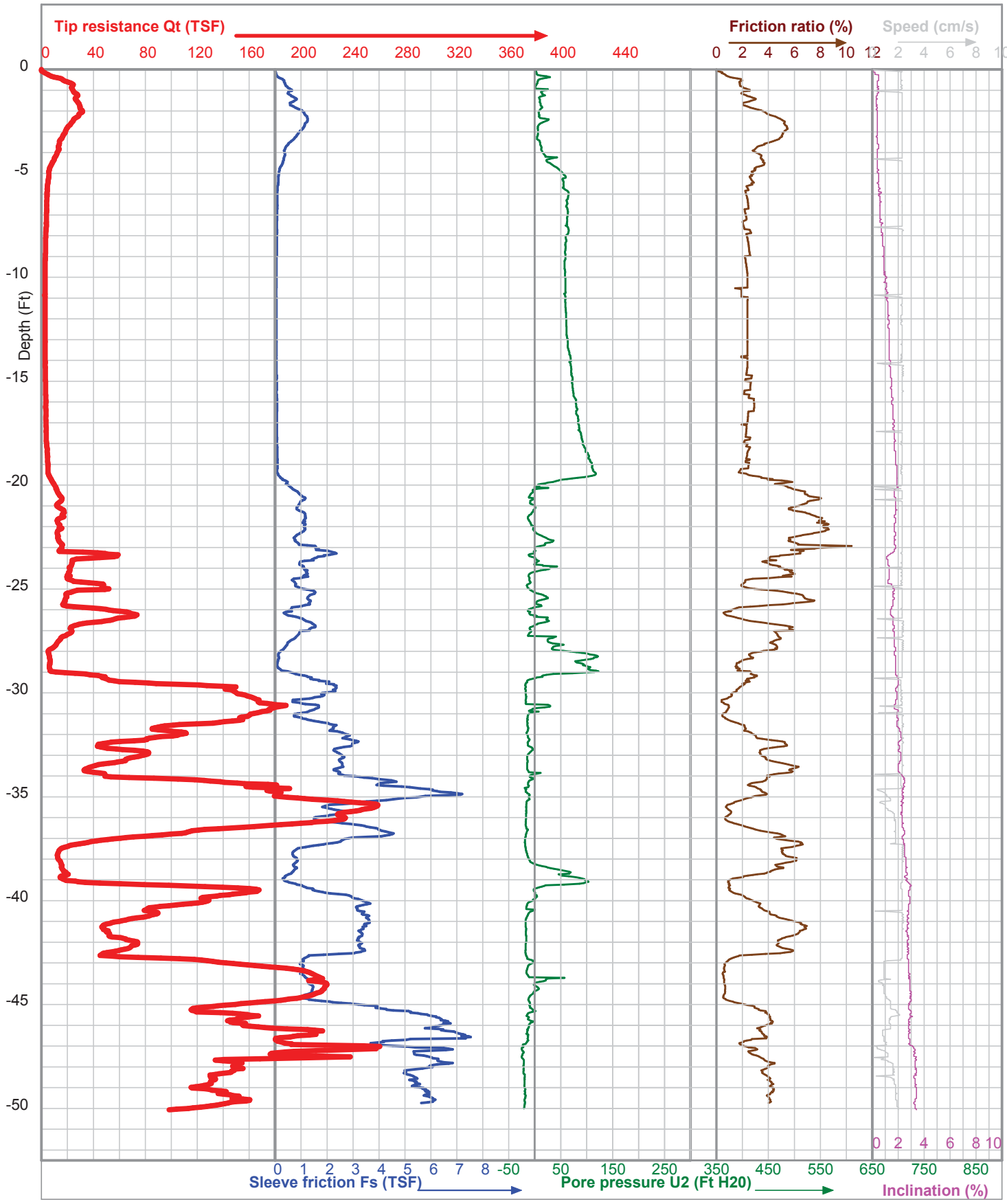
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 84	Cone Type	I-CFXYP20-15		
Test Number	84	Cone ID	090710	X-Coord	40.69449
Client	Barr Engineering Co., Inc.	Start Time	10:28	Y-Coord	-83.77381
Boring Type	CPTU Sounding	Date	31-7-2011	Elev. Datum:	WGS 84



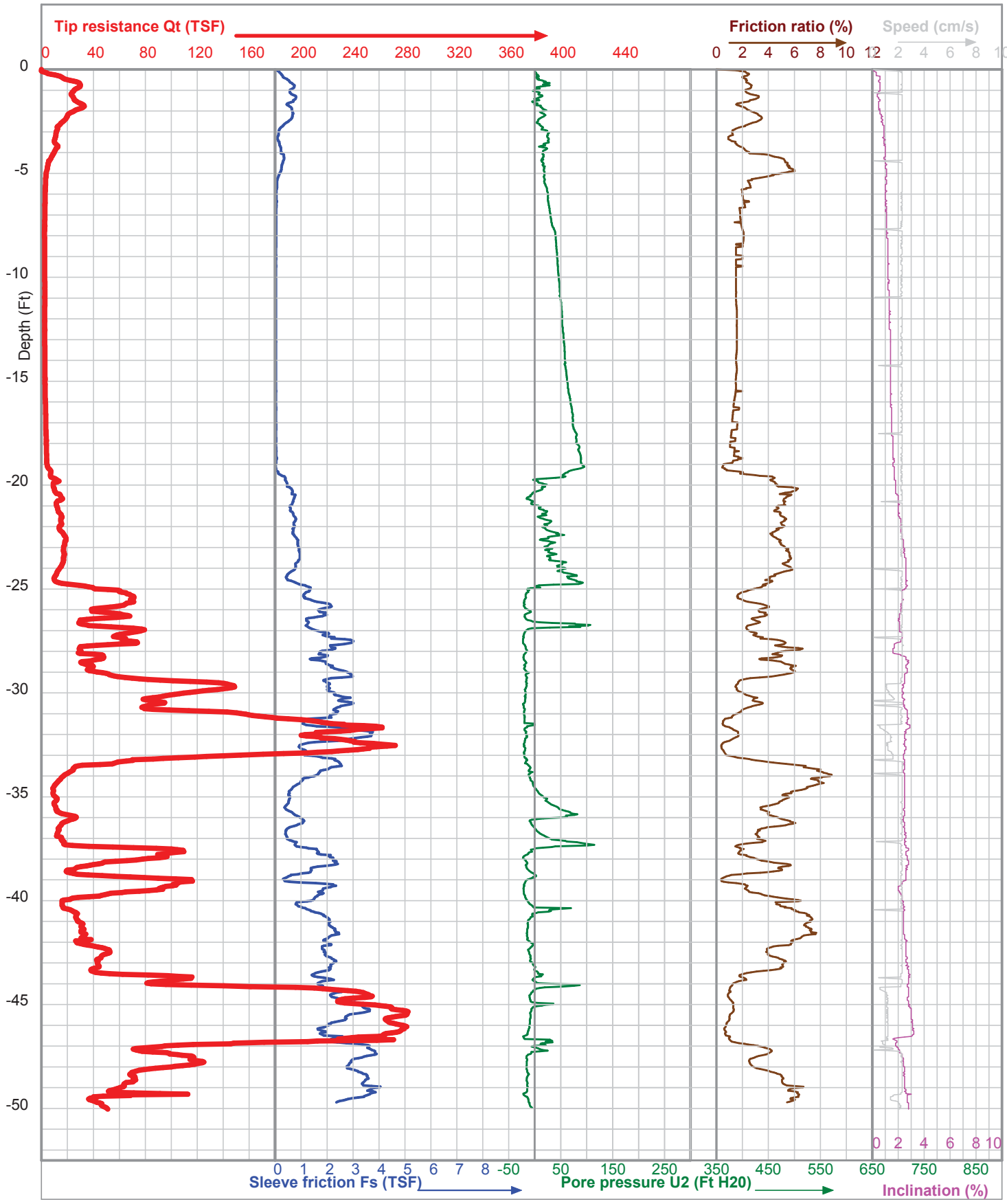
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 26	Cone Type	I-CFXYPP20-15		
Test Number	26	Cone ID	100624	X-Coord	40.66764
Client	Barr Engineering Co., Inc.	Start Time	9:59	Y-Coord	-83.81139
Boring Type	CPTU Sounding	Date	28-7-2011	Elev. Datum:	WGS 84



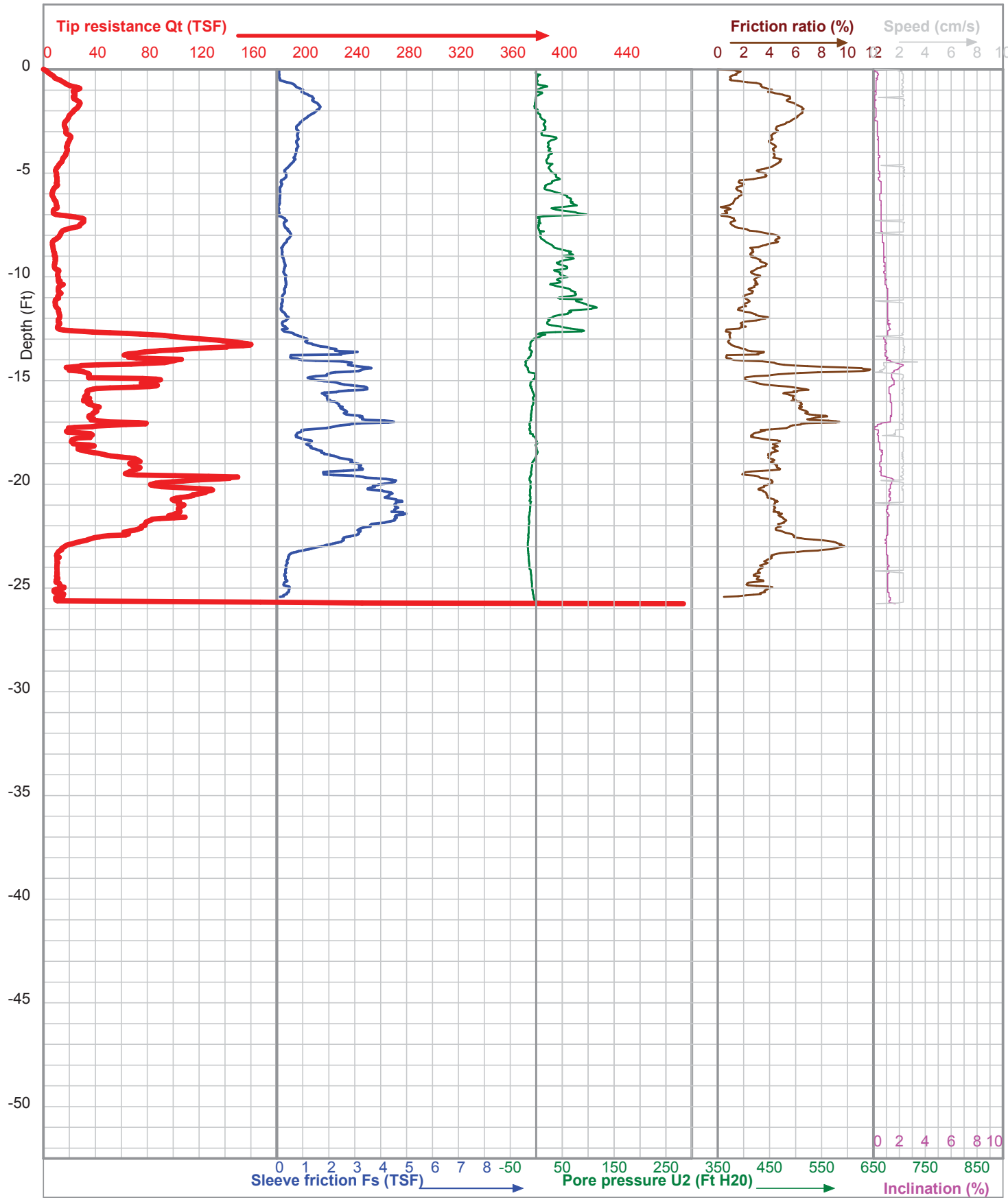
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 27	Cone Type	I-CFXYP20-15		
Test Number	27	Cone ID	090710	X-Coord	40.67270
Client	Barr Engineering Co., Inc.	Start Time	6:16	Y-Coord	-83.80493
Boring Type	CPTU Sounding	Date	28-7-2011	Elev. Datum:	WGS 84



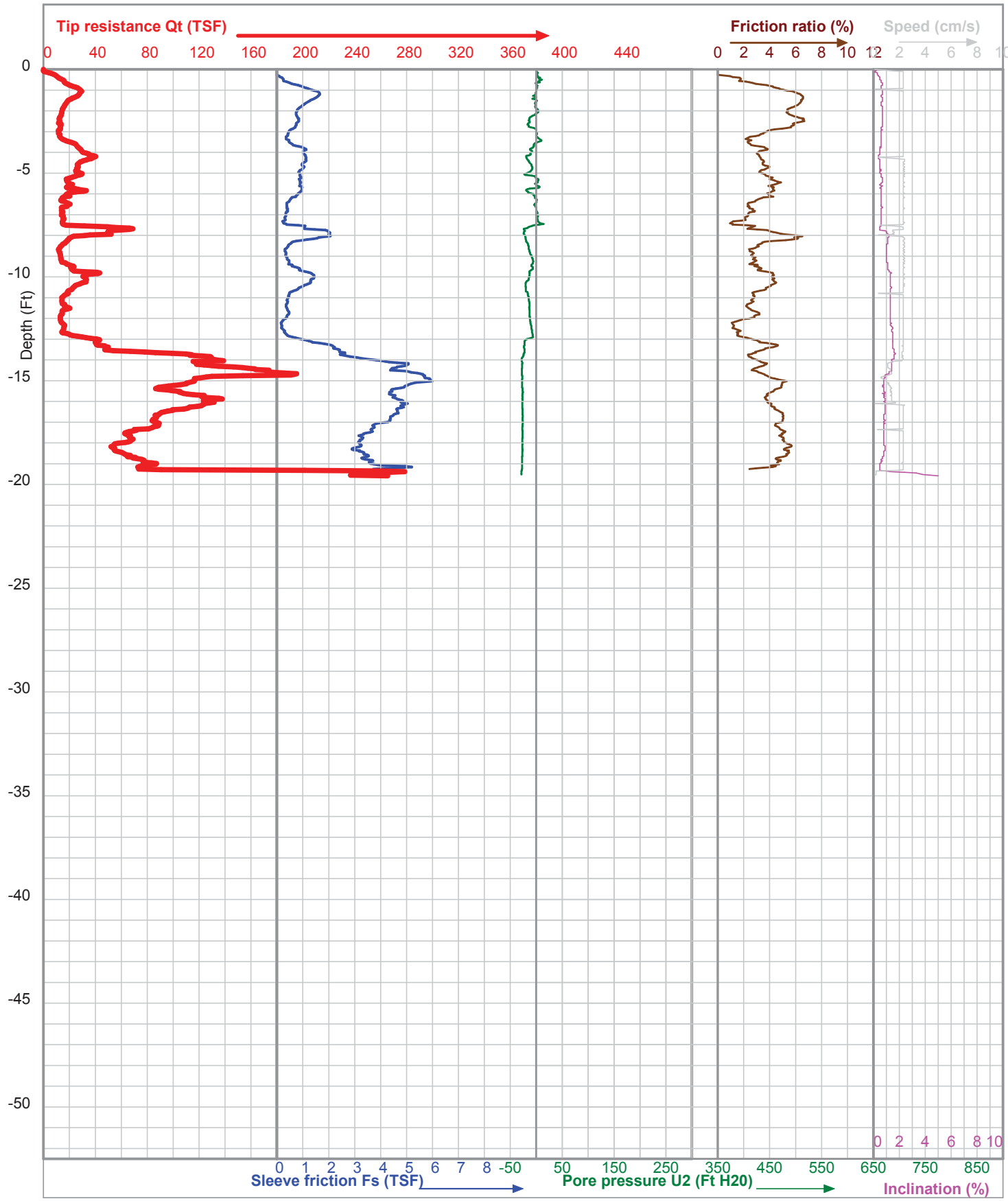
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 28	Cone Type	I-CFXYPP20-15		
Test Number	28	Cone ID	100624	X-Coord	40.66904
Client	Barr Engineering Co., Inc.	Start Time	7:14	Y-Coord	-83.80450
Boring Type	CPTU Sounding	Date	28-7-2011	Elev. Datum:	WGS 84



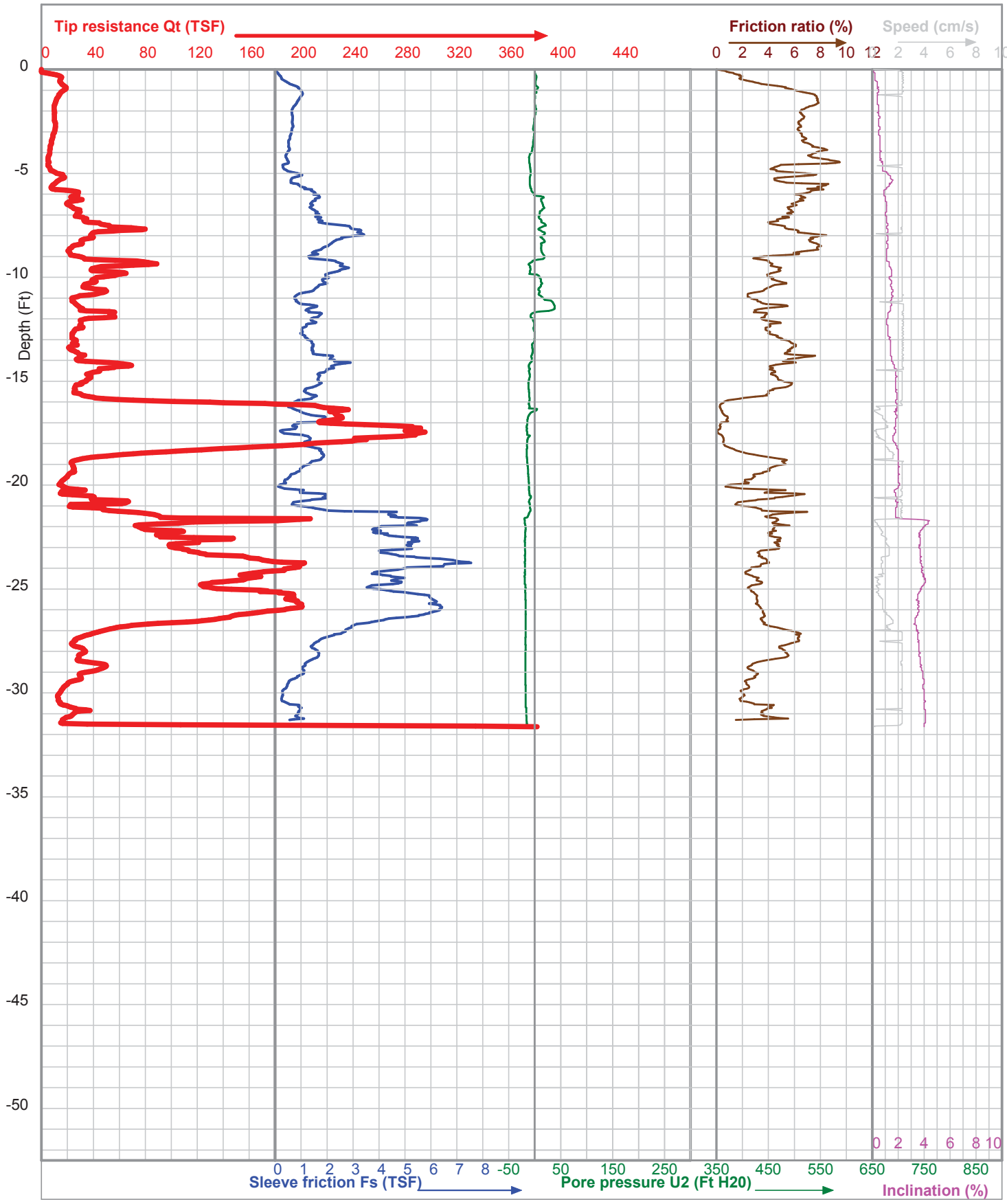
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 29	Cone Type	I-CFXYPP20-15		
Test Number	29	Cone ID	100624	X-Coord	40.66544
Client	Barr Engineering Co., Inc.	Start Time	8:52	Y-Coord	-83.80270
Boring Type	CPTU Sounding	Date	28-7-2011	Elev. Datum:	WGS 84



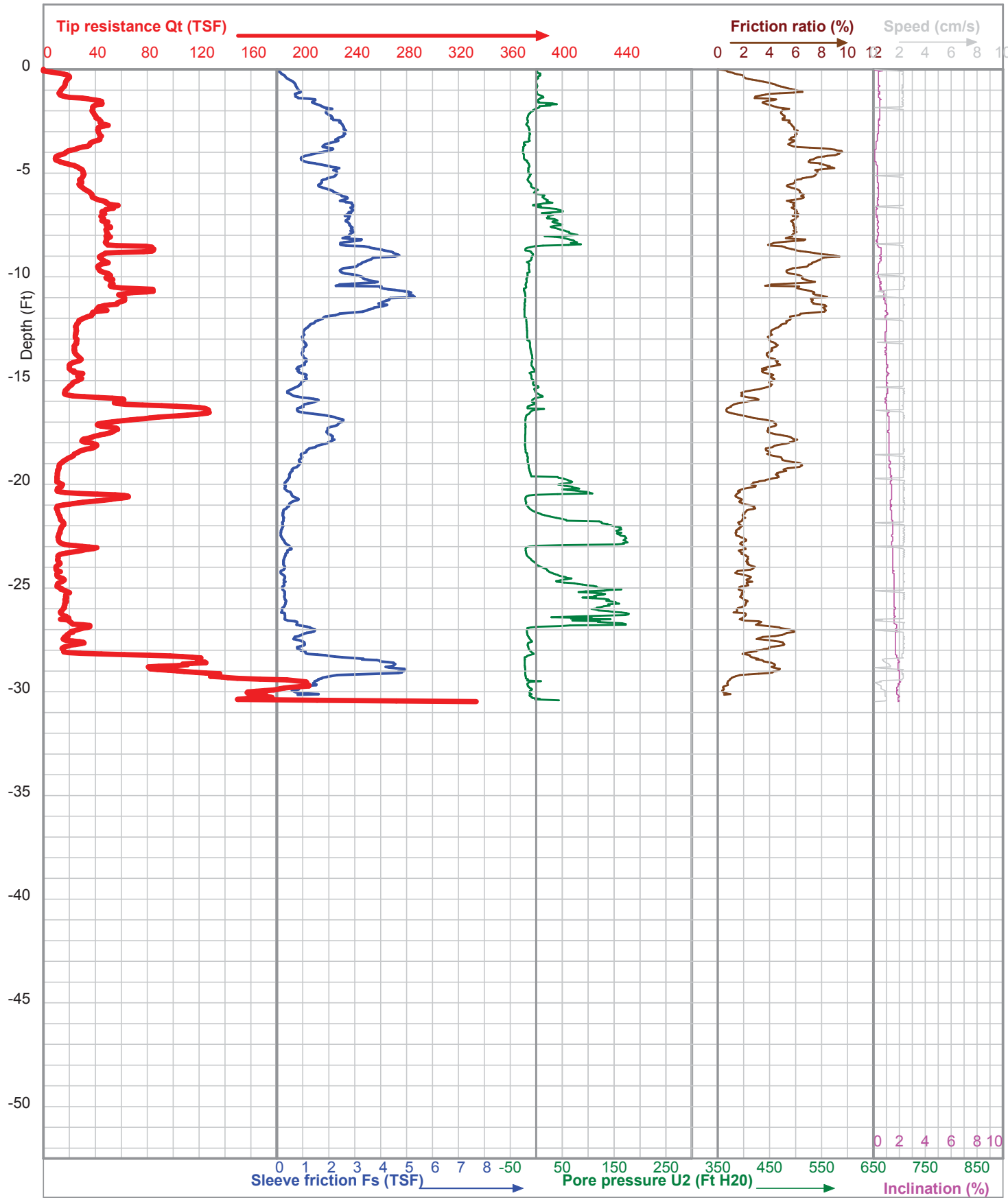
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 30	Cone Type	I-CFXYPP20-15		
Test Number	30	Cone ID	100624	X-Coord	40.66761
Client	Barr Engineering Co., Inc.	Start Time	16:03	Y-Coord	-83.82031
Boring Type	CPTU Sounding	Date	20-7-2011	Elev. Datum:	WGS 84



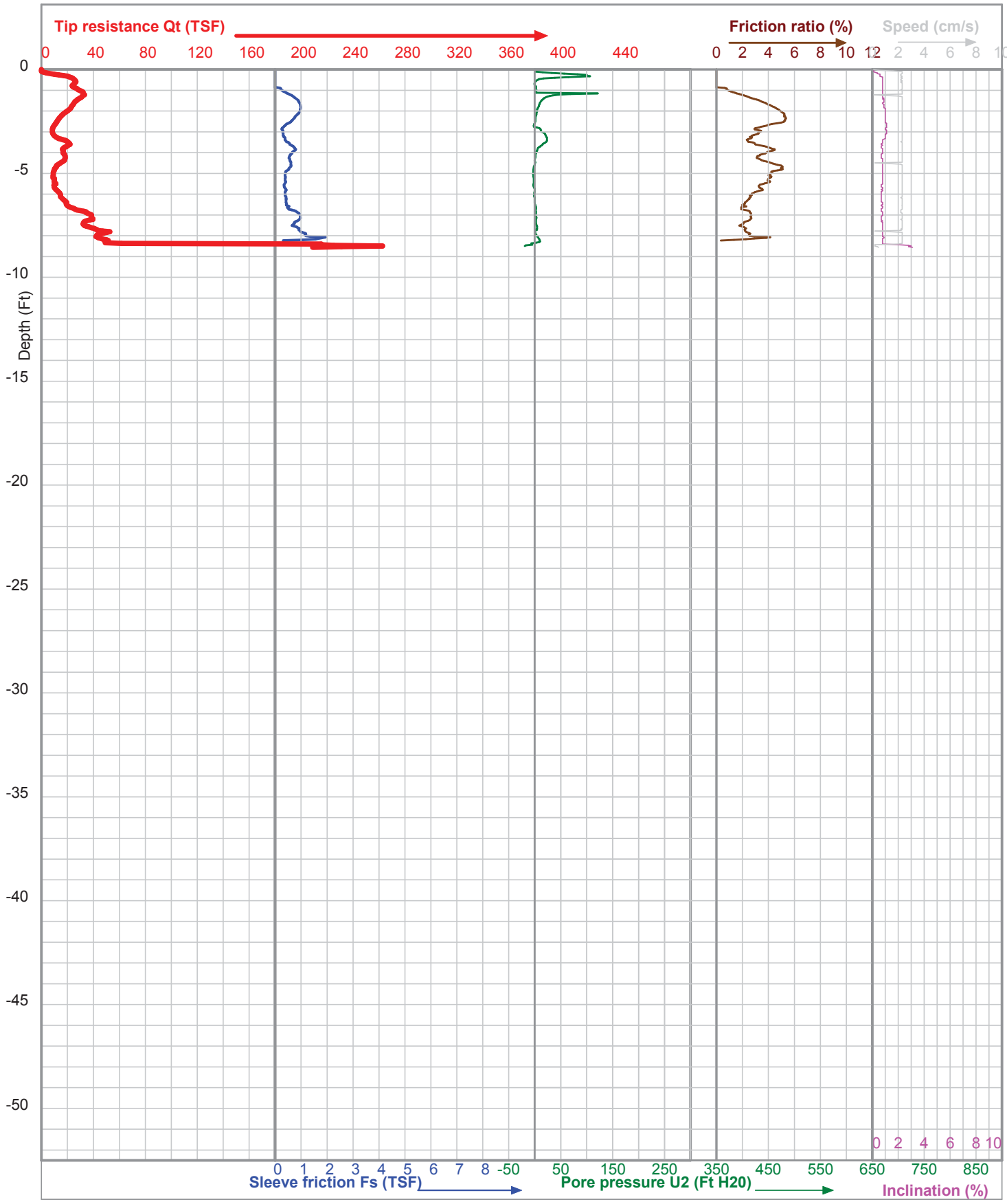
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 31	Cone Type	I-CFXYP20-15		
Test Number	31	Cone ID	090709	X-Coord	40.66202
Client	Barr Engineering Co., Inc.	Start Time	7:06	Y-Coord	-83.82098
Boring Type	CPTU Sounding	Date	21-7-2011	Elev. Datum:	WGS 84



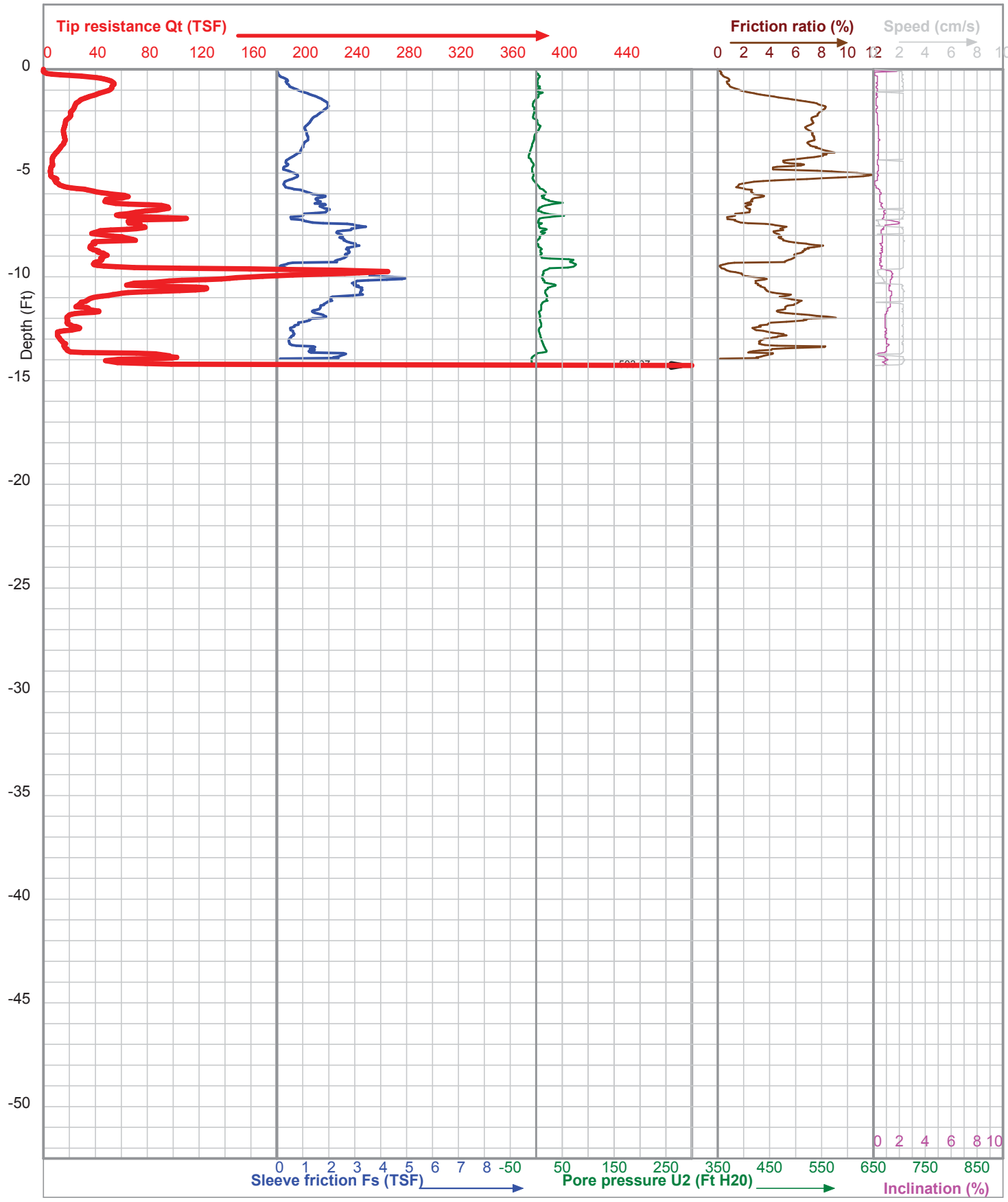
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 32	Cone Type	I-CFXYPP20-15		
Test Number	32	Cone ID	100624	X-Coord	40.66334
Client	Barr Engineering Co., Inc.	Start Time	11:33	Y-Coord	-83.83134
Boring Type	CPTU Sounding	Date	21-7-2011	Elev. Datum:	WGS 84



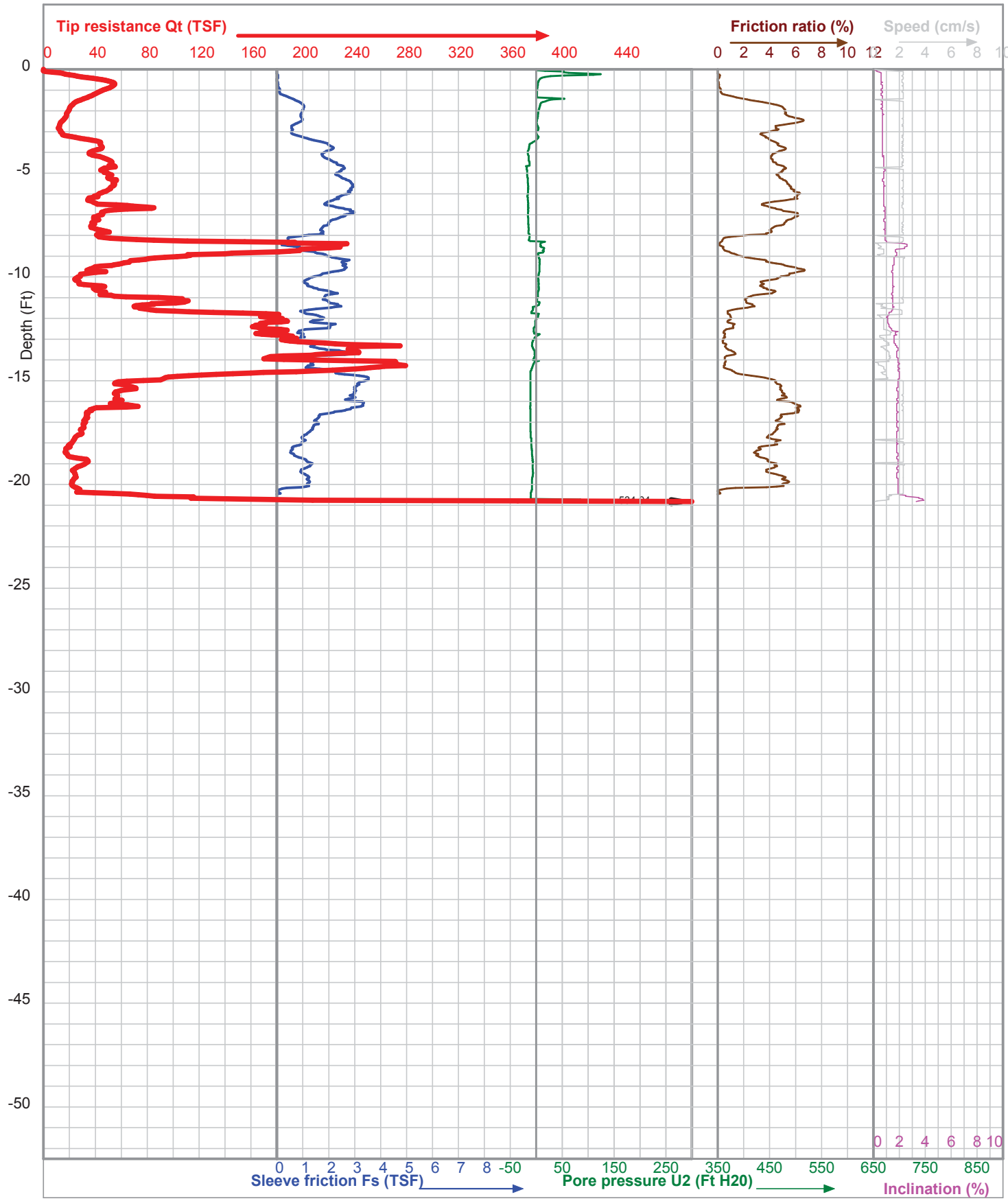
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 33	Cone Type	I-CFXYPP20-15		
Test Number	33	Cone ID	100624	X-Coord	40.67144
Client	Barr Engineering Co., Inc.	Start Time	14:32	Y-Coord	-83.84545
Boring Type	CPTU Sounding	Date	28-7-2011	Elev. Datum:	WGS 84



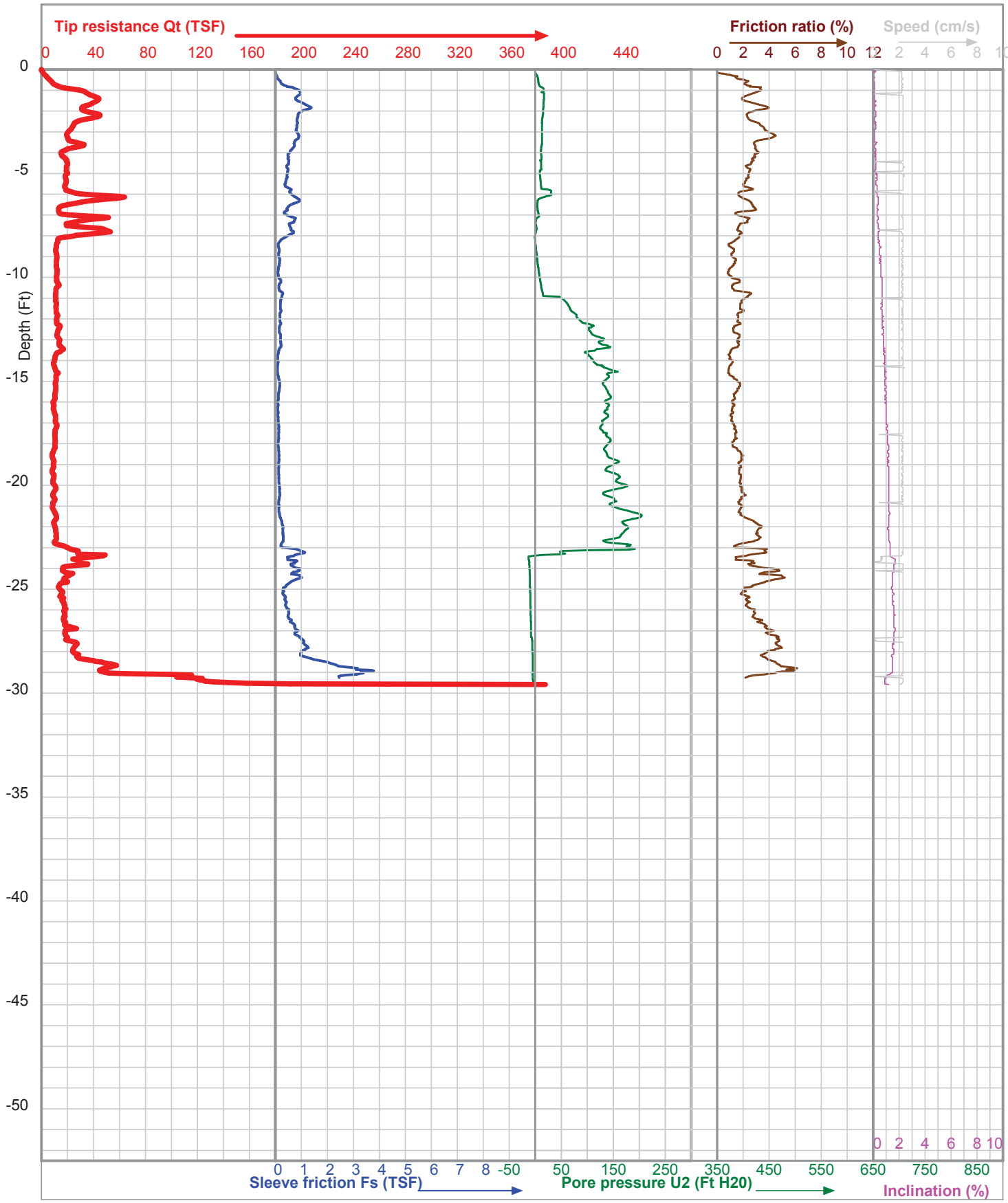
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 34	Cone Type	I-CFXYP20-15		
Test Number	34	Cone ID	090709	X-Coord	40.67102
Client	Barr Engineering Co., Inc.	Start Time	15:00	Y-Coord	-83.84107
Boring Type	CPTU Sounding	Date	19-7-2011	Elev. Datum:	WGS 84



Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 35	Cone Type	I-CFXYPP20-15		
Test Number	35	Cone ID	100624	X-Coord	40.67089
Client	Barr Engineering Co., Inc.	Start Time	7:00	Y-Coord	-83.83657
Boring Type	CPTU Sounding	Date	20-7-2011	Elev. Datum:	WGS 84



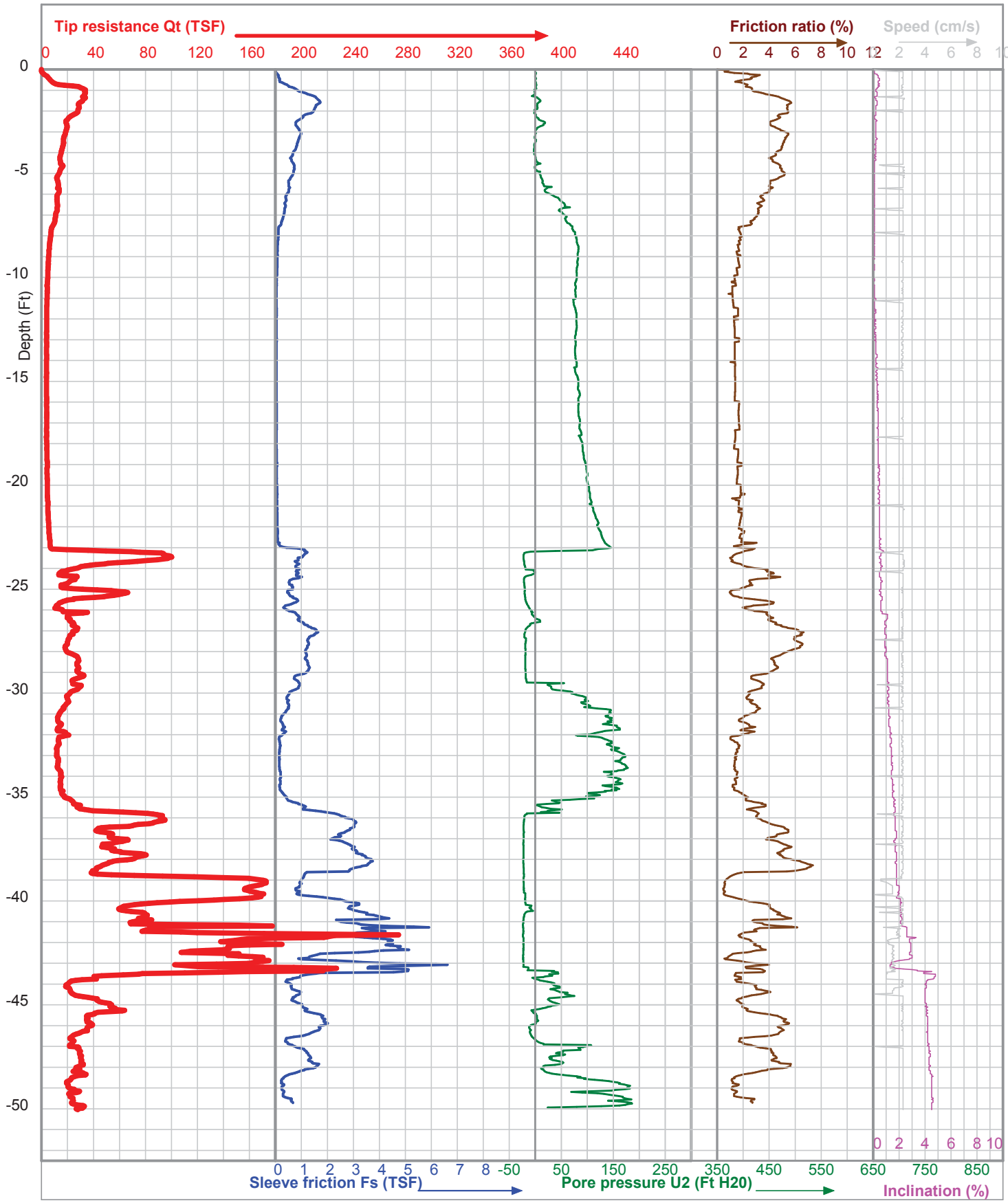
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 37	Cone Type	I-CFXYP20-15		
Test Number	37	Cone ID	090709	X-Coord	40.65493
Client	Barr Engineering Co., Inc.	Start Time	12:52	Y-Coord	-83.84473
Boring Type	CPTU Sounding	Date	21-7-2011	Elev. Datum:	WGS 84



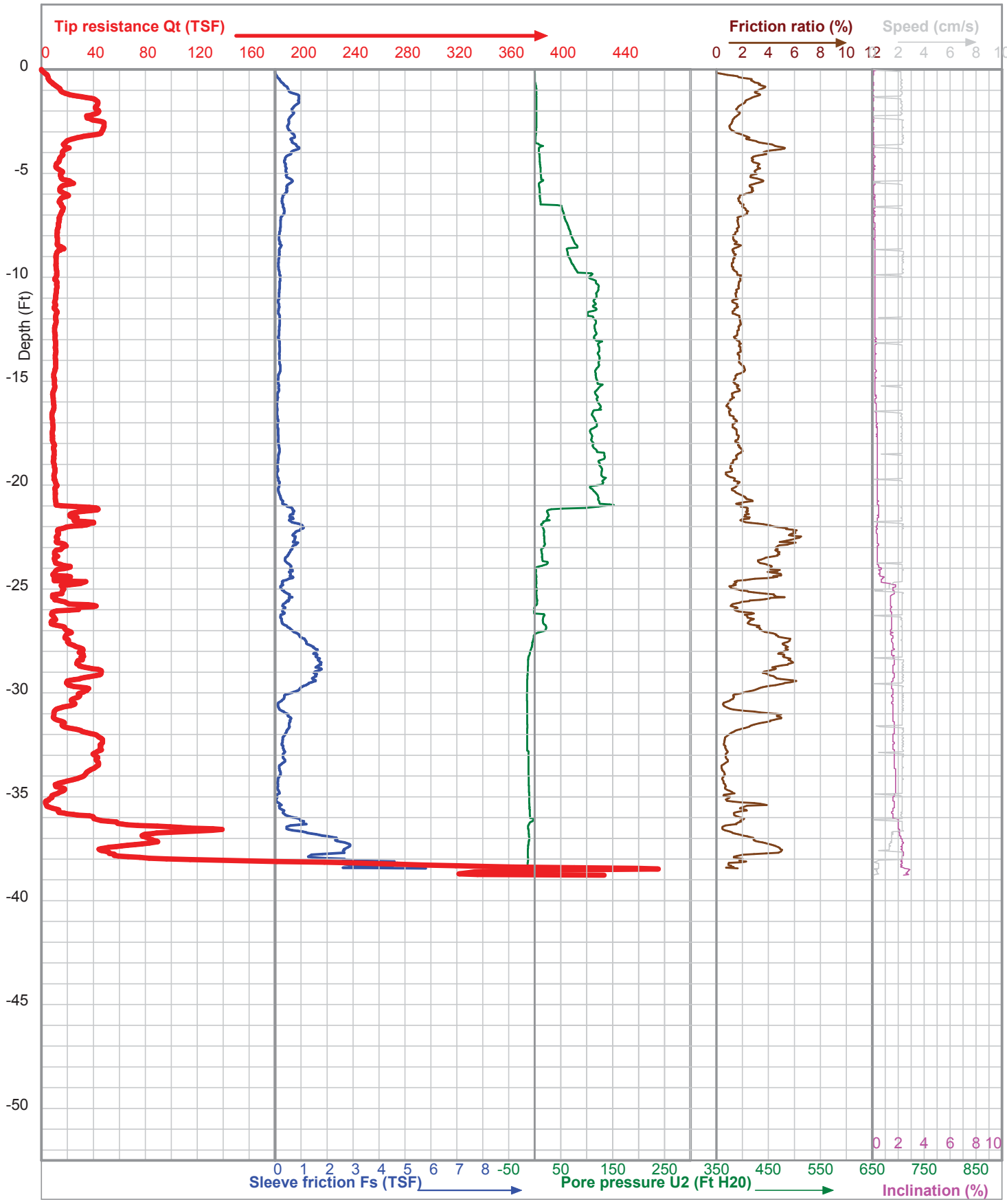
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 39	Cone Type	I-CFXYPP20-15		
Test Number	39	Cone ID	100624	X-Coord	40.68689
Client	Barr Engineering Co., Inc.	Start Time	6:15	Y-Coord	-83.79465
Boring Type	CPTU Sounding	Date	31-7-2011	Elev. Datum:	WGS 84



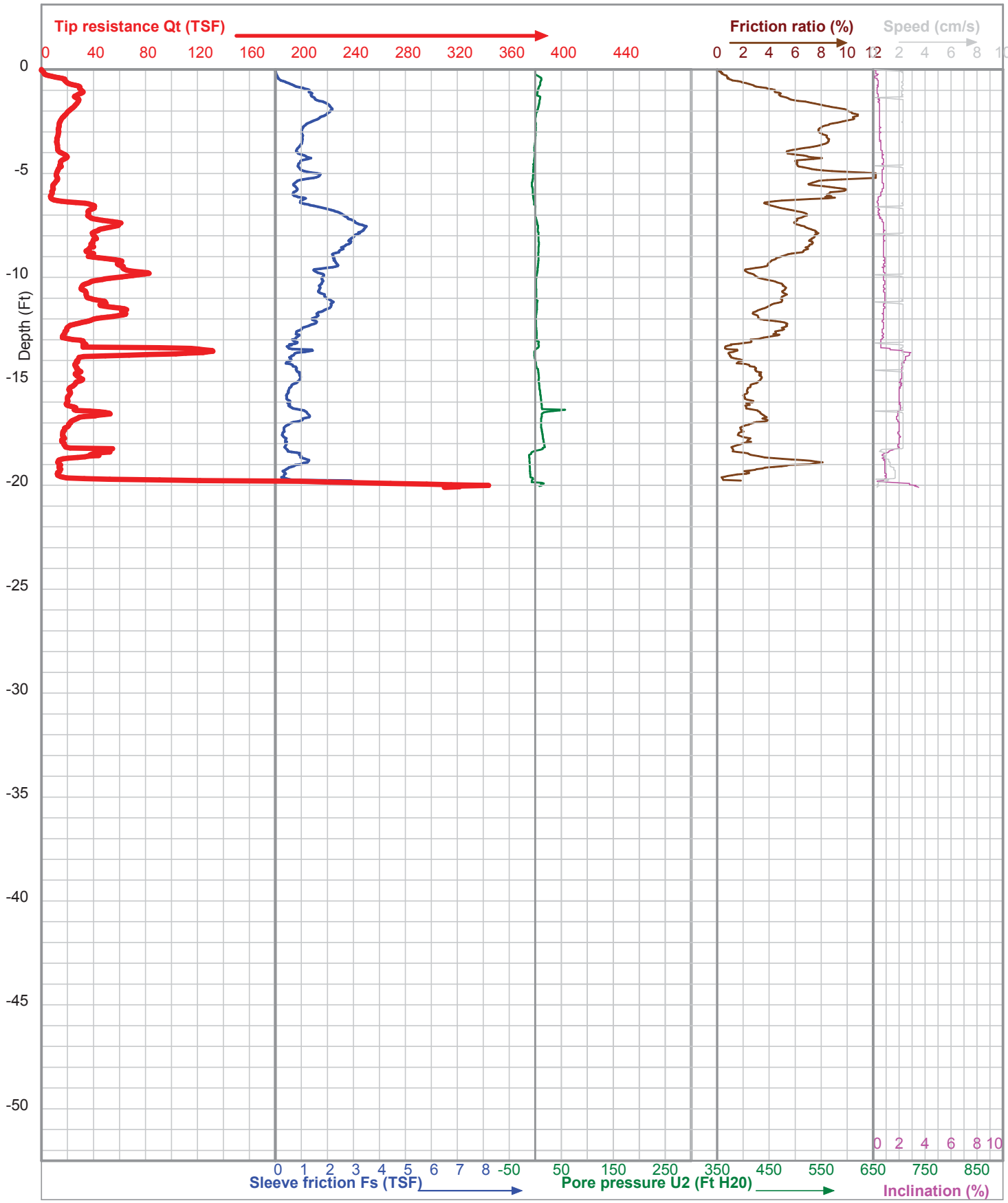
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 40	Cone Type	I-CFXYPP20-15		
Test Number	40	Cone ID	100624	X-Coord	40.68425
Client	Barr Engineering Co., Inc.	Start Time	7:04	Y-Coord	-83.79468
Boring Type	CPTU Sounding	Date	31-7-2011	Elev. Datum:	WGS 84



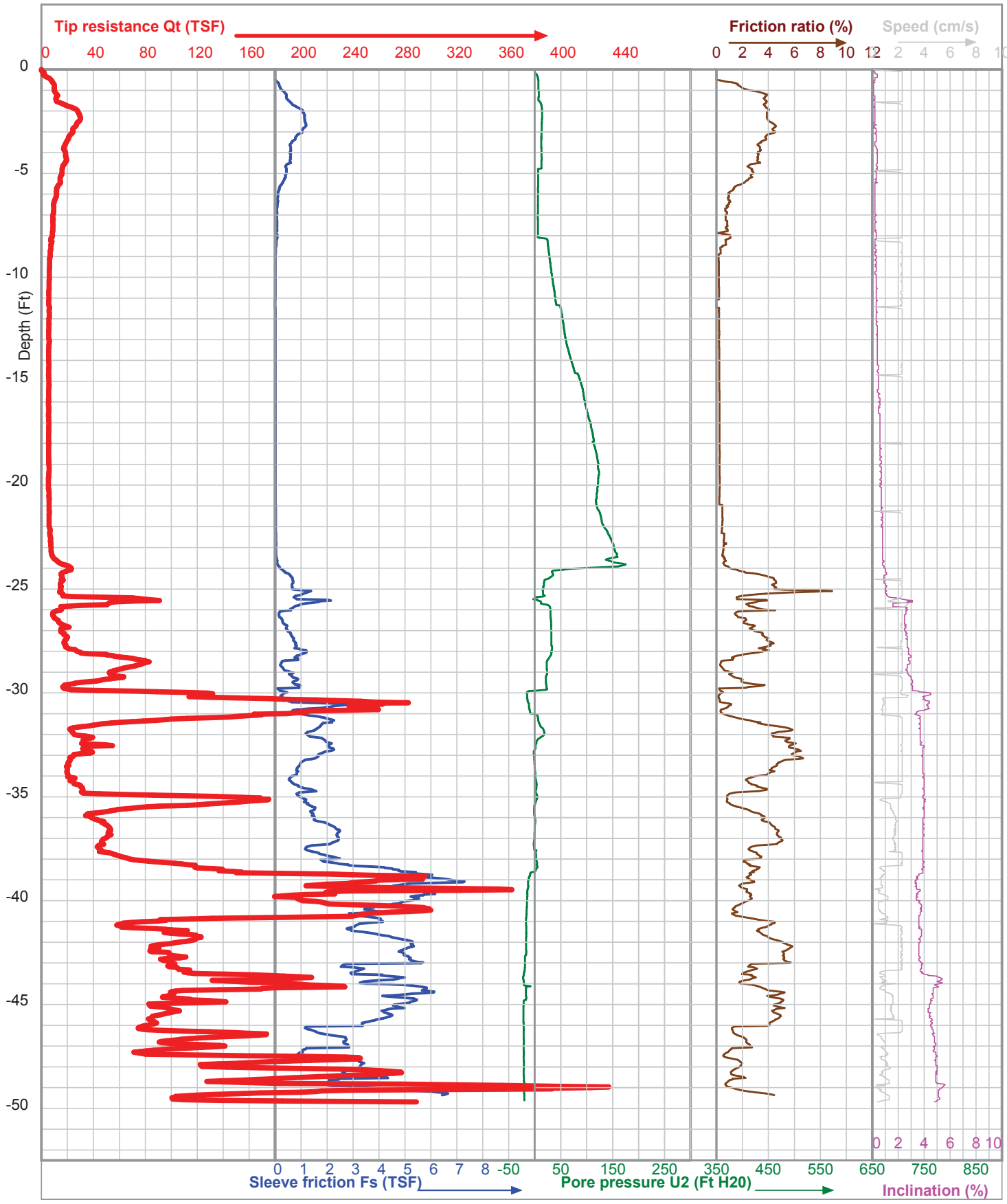
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 133	Cone Type	I-CFXYPP20-15		
Test Number	133	Cone ID	100624	X-Coord	40.67647
Client	Barr Engineering Co., Inc.	Start Time	14:57	Y-Coord	-83.80382
Boring Type	CPTU Sounding	Date	29-7-2011	Elev. Datum:	WGS 84



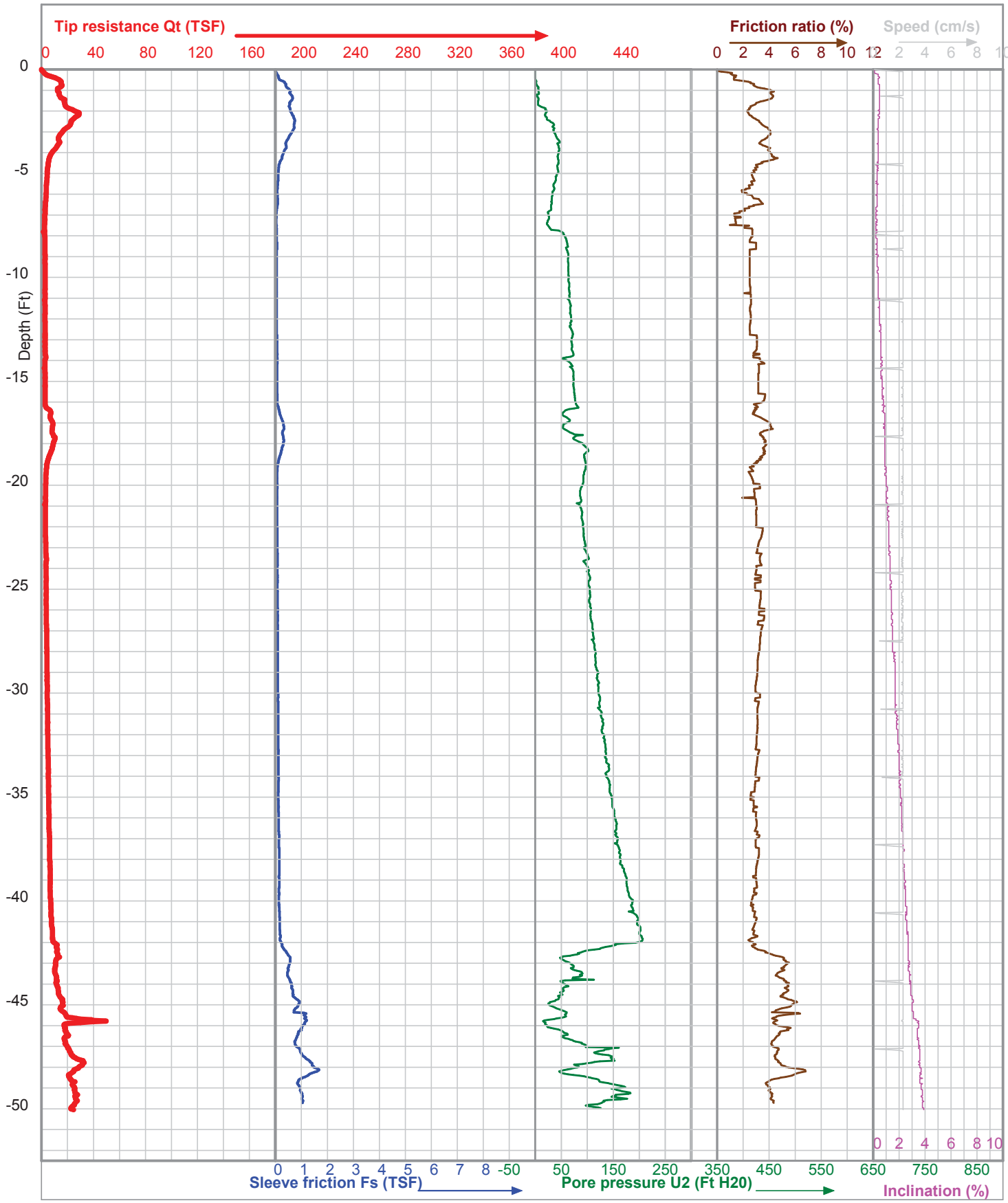
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 41	Cone Type	I-CFXYPP20-15		
Test Number	41	Cone ID	100624	X-Coord	40.68166
Client	Barr Engineering Co., Inc.	Start Time	9:43	Y-Coord	-83.79461
Boring Type	CPTU Sounding	Date	31-7-2011	Elev. Datum:	WGS 84



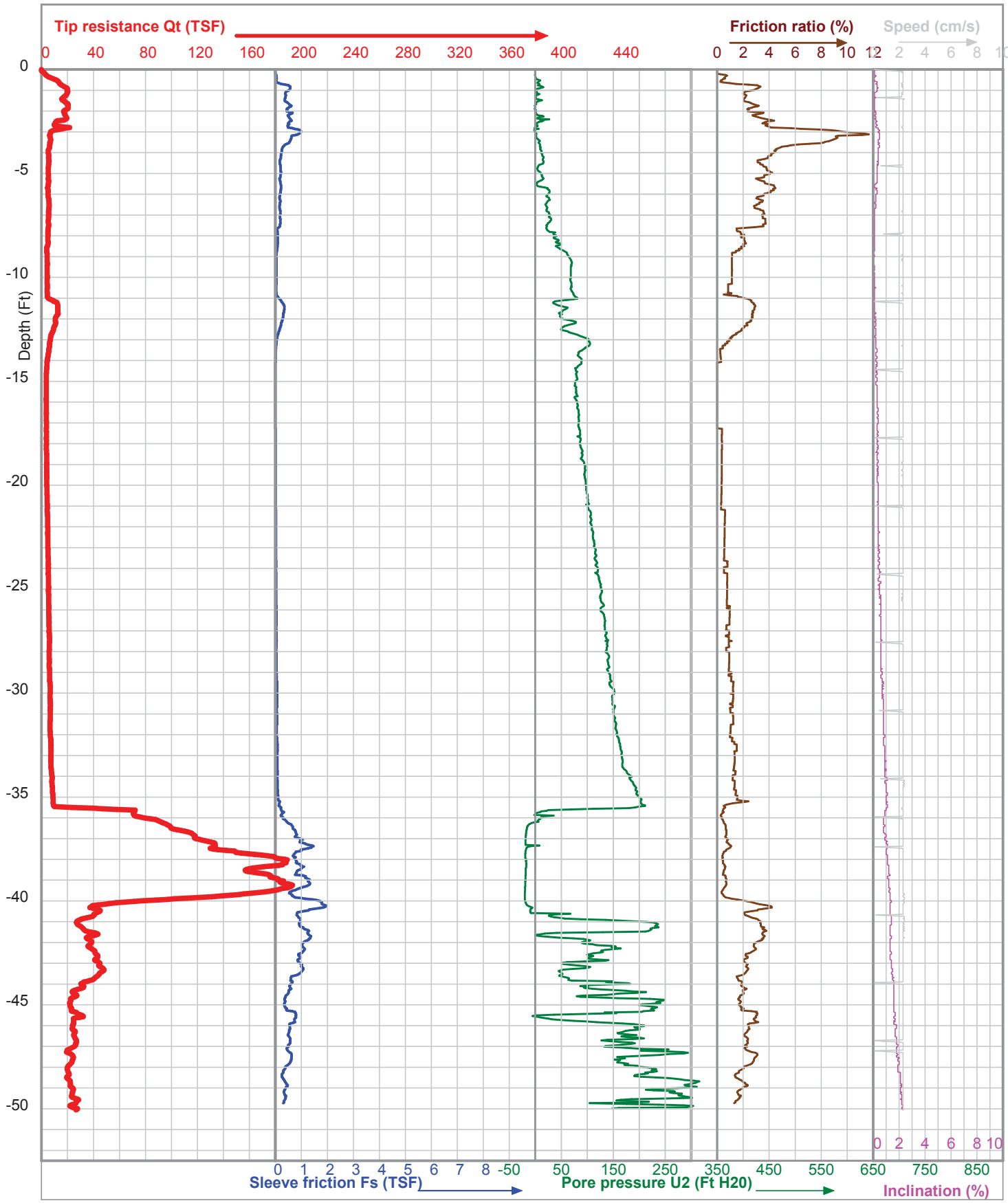
Project	Hardin County Wind	CPT Operator	b. willman	Elevation (Ft MSL)	
Location	Turbine 38	Cone Type	I-CFXYPP20-15		
Test Number	2038	Cone ID	100624	X-Coord	40.65645
Client	Barr Engineering Co., Inc.	Start Time	14:40	Y-Coord	-83.83748
Boring Type	CPTU Sounding	Date	27-7-2011	Elev. Datum:	WGS 84



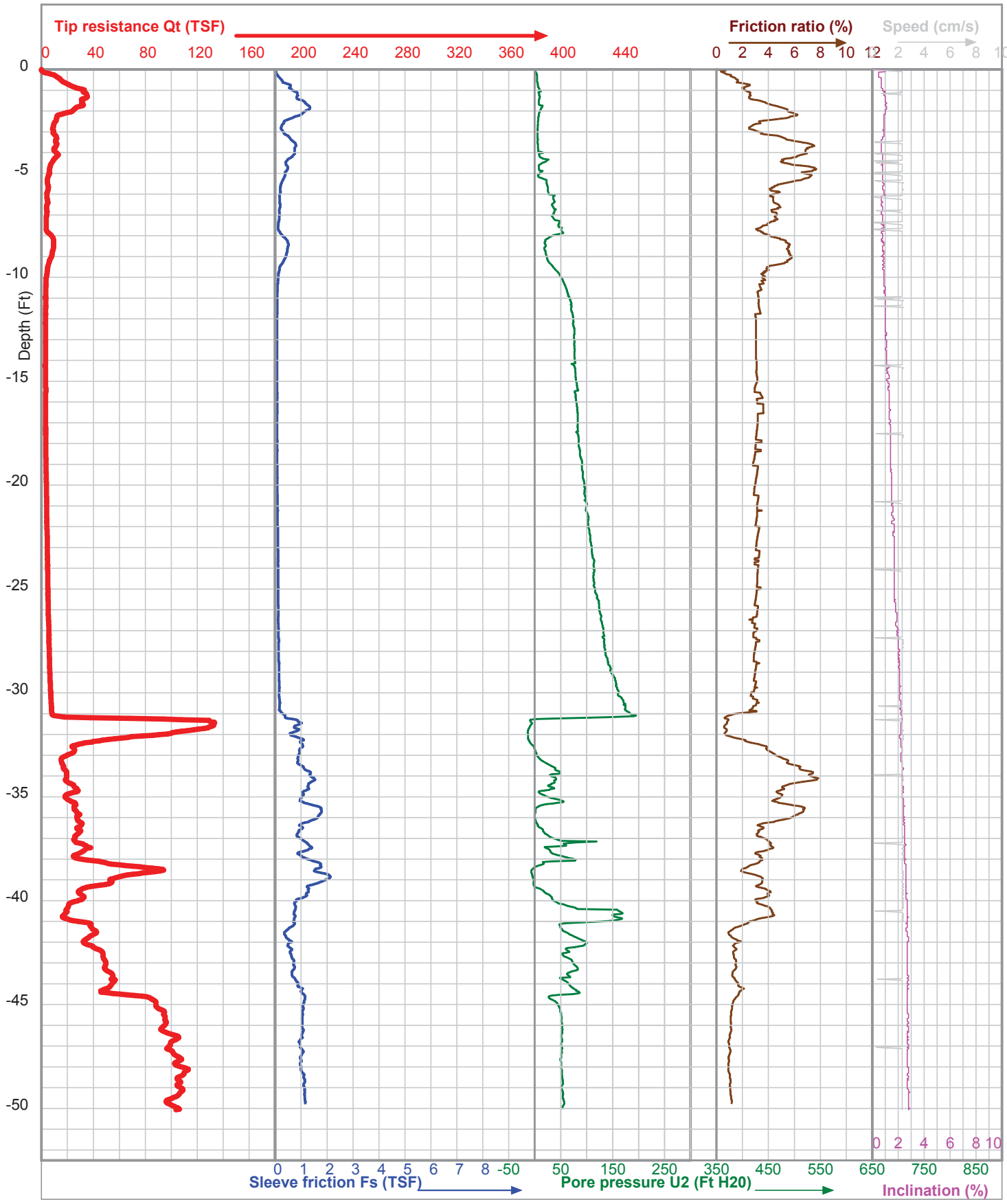
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 42	Cone Type	I-CFXYPP20-15		
Test Number	42	Cone ID	100624	X-Coord	40.67899
Client	Barr Engineering Co., Inc.	Start Time	7:59	Y-Coord	-83.79459
Boring Type	CPTU Sounding	Date	31-7-2011	Elev. Datum:	WGS 84



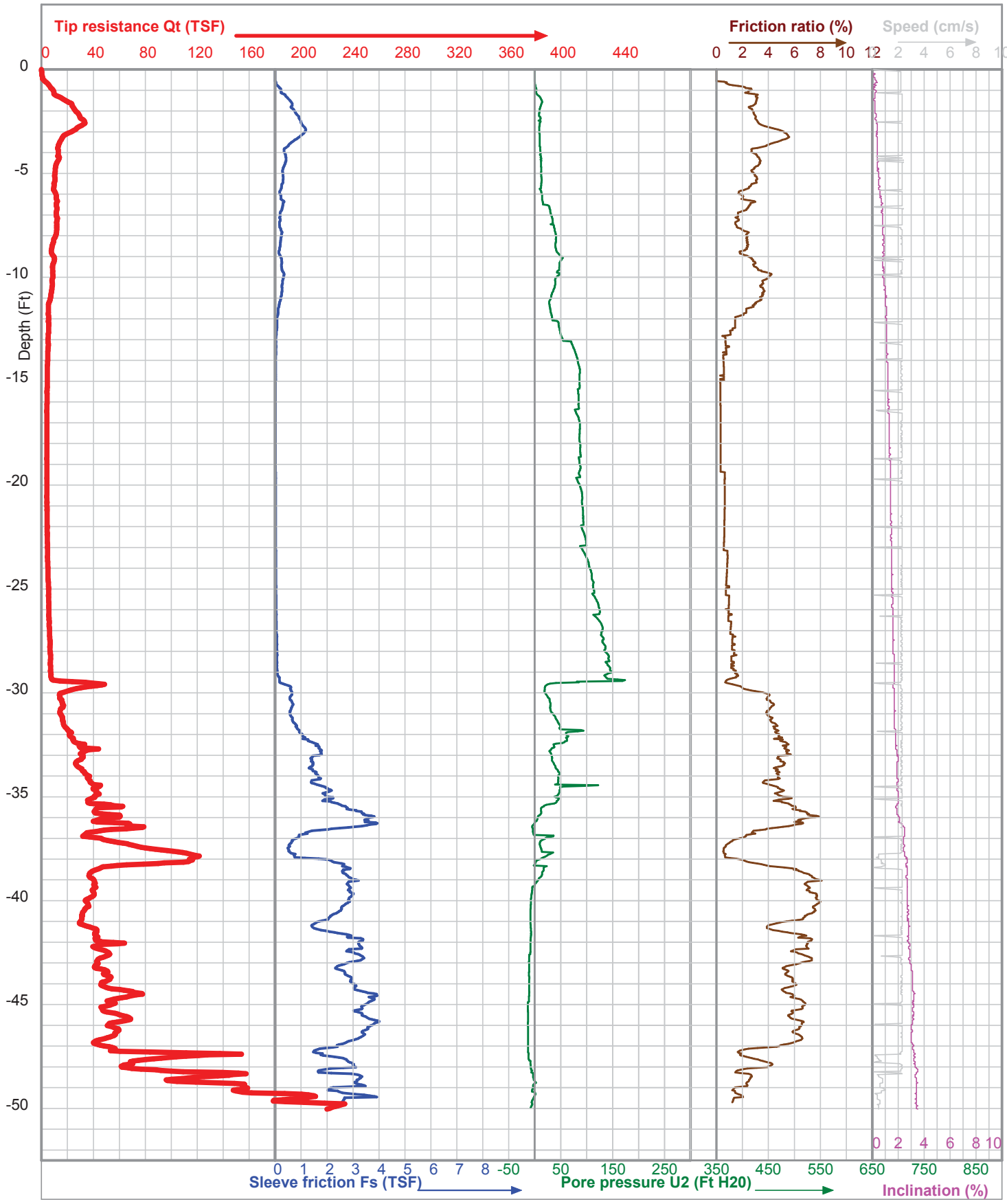
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 45	Cone Type	I-CFXYP20-15		
Test Number	45	Cone ID	090710	X-Coord	40.66895
Client	Barr Engineering Co., Inc.	Start Time	12:25	Y-Coord	-83.79439
Boring Type	CPTU Sounding	Date	27-7-2011	Elev. Datum:	WGS 84



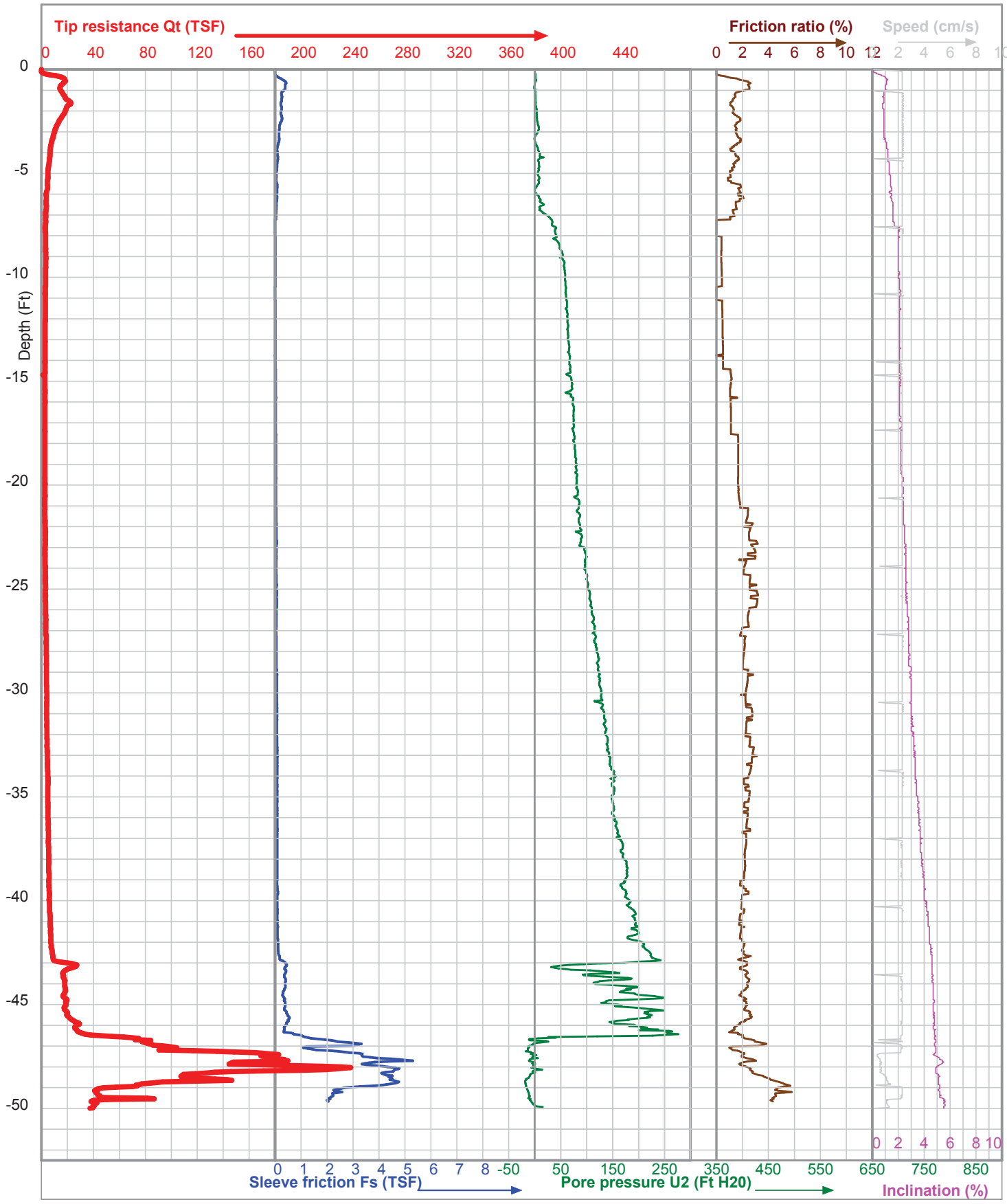
Project	Hardin County Wind	CPT Operator	b. willman	Elevation (Ft MSL)	
Location	Turbine 46	Cone Type	I-CFXYPP20-15		
Test Number	46	Cone ID	100624	X-Coord	40.66750
Client	Barr Engineering Co., Inc.	Start Time	11:31	Y-Coord	-83.79088
Boring Type	CPTU Sounding	Date	27-7-2011	Elev. Datum:	WGS 84



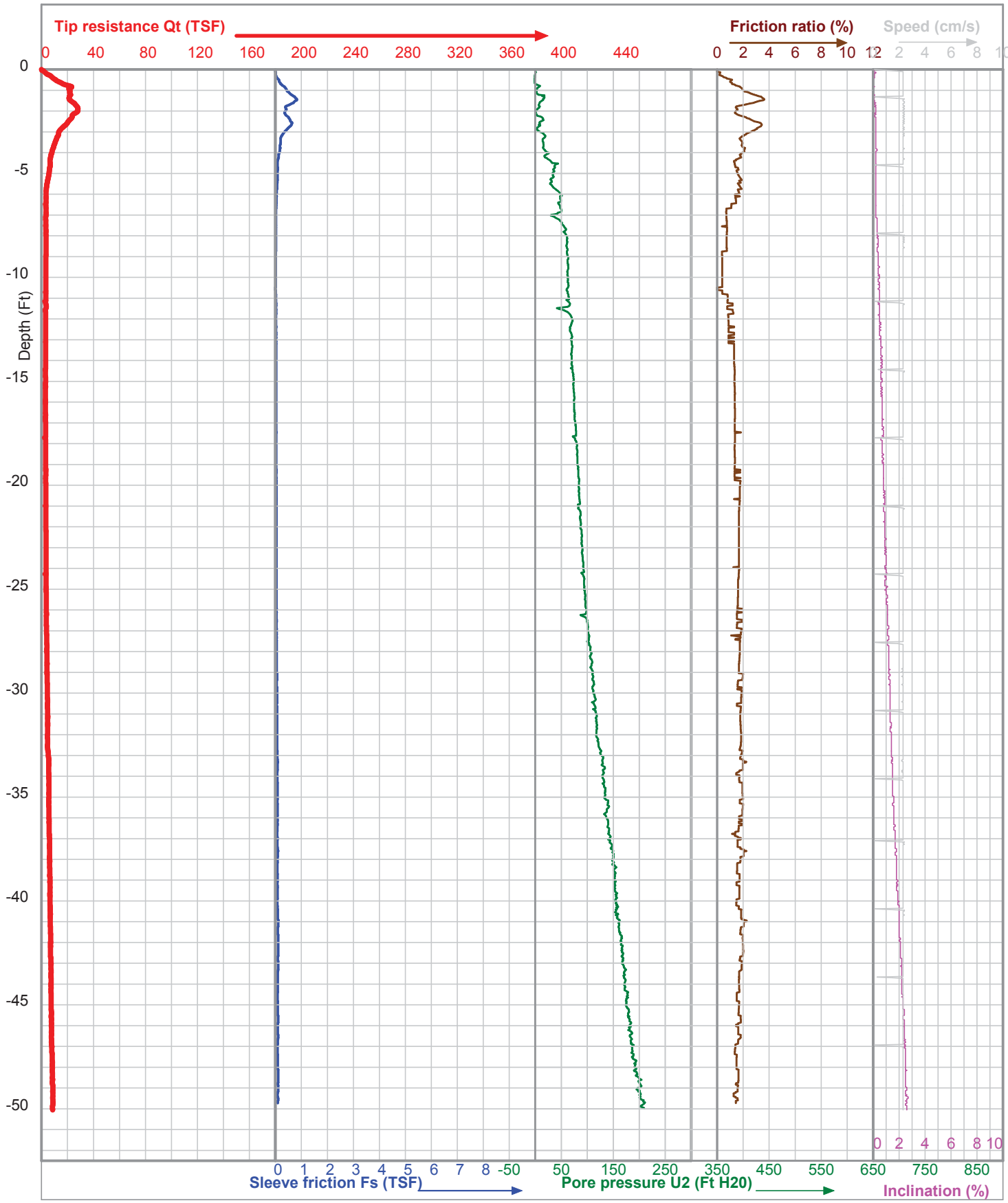
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 47	Cone Type	I-CFXYP20-15		
Test Number	47	Cone ID	090710	X-Coord	40.66523
Client	Barr Engineering Co., Inc.	Start Time	10:39	Y-Coord	-83.78783
Boring Type	CPTU Sounding	Date	27-7-2011	Elev. Datum:	WGS 84



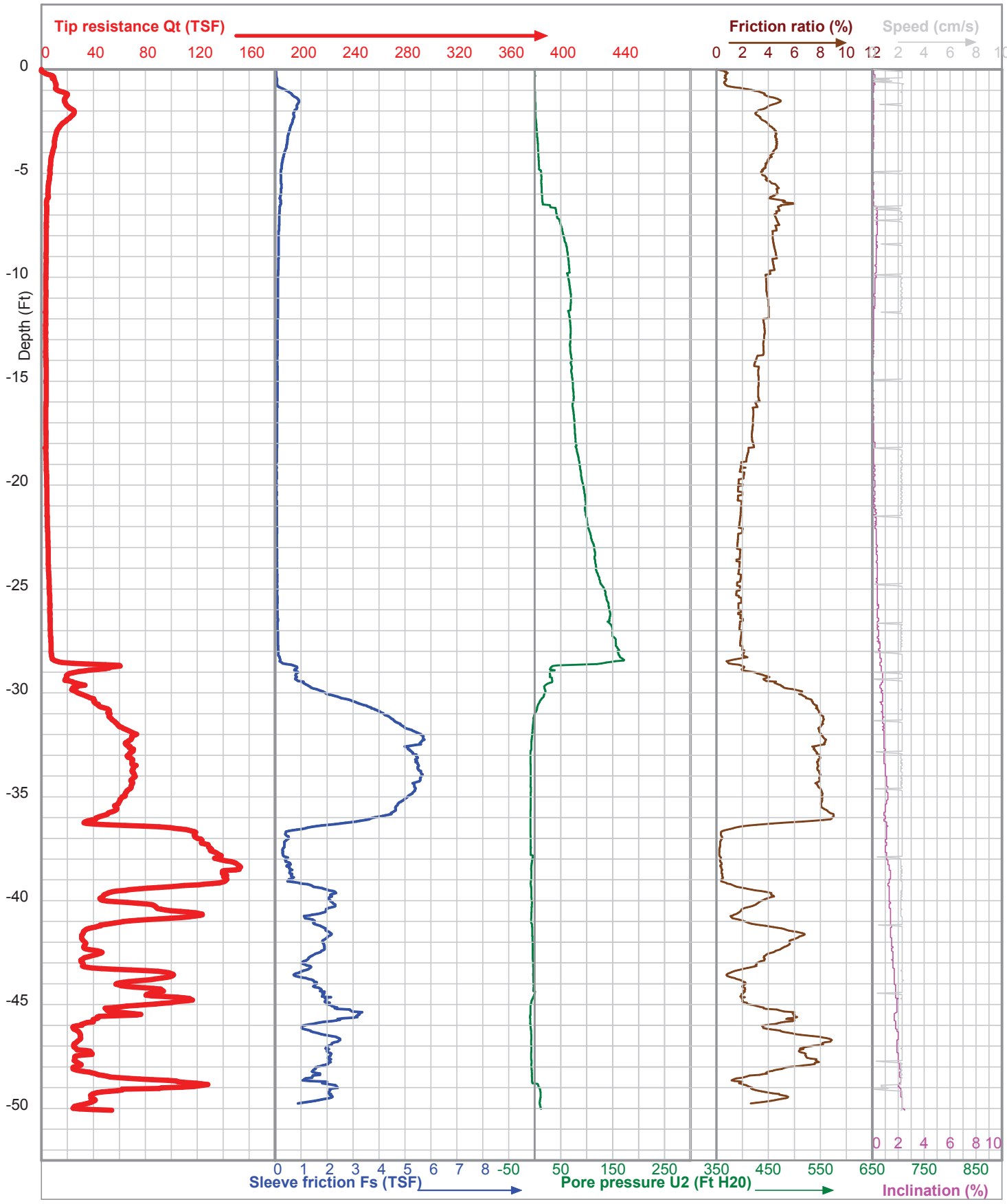
Project	Hardin County Wind	CPT Operator	b. willman	Elevation (Ft MSL)	
Location	Turbine 48	Cone Type	I-CFXYPP20-15		
Test Number	48	Cone ID	100624	X-Coord	40.66212
Client	Barr Engineering Co., Inc.	Start Time	9:23	Y-Coord	-83.78747
Boring Type	CPTU Sounding	Date	27-7-2011	Elev. Datum:	WGS 84



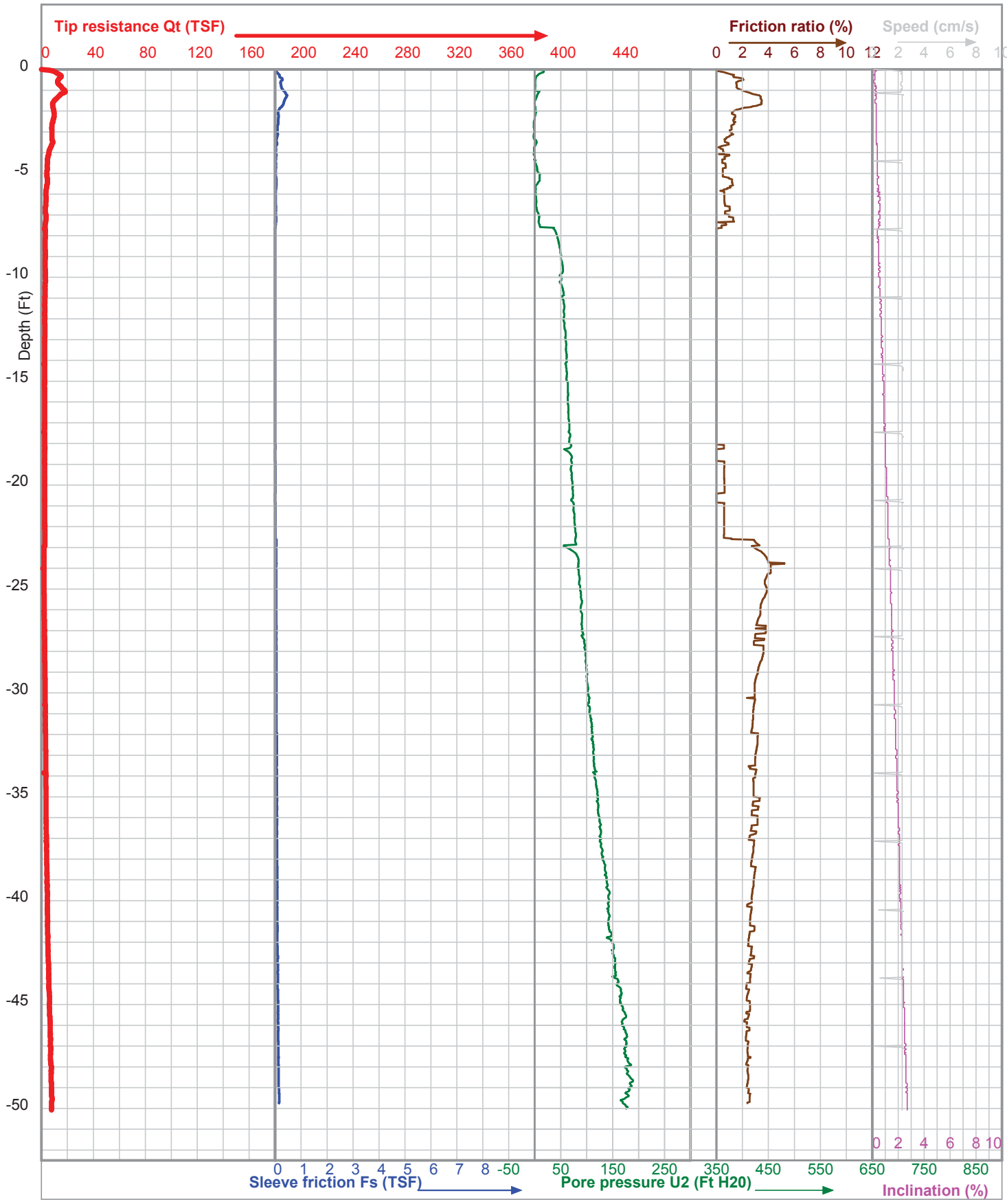
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 50	Cone Type	I-CFXYP20-15		
Test Number	50	Cone ID	090709	X-Coord	40.65597
Client	Barr Engineering Co., Inc.	Start Time	6:25	Y-Coord	-83.79634
Boring Type	CPTU Sounding	Date	22-7-2011	Elev. Datum:	WGS 84



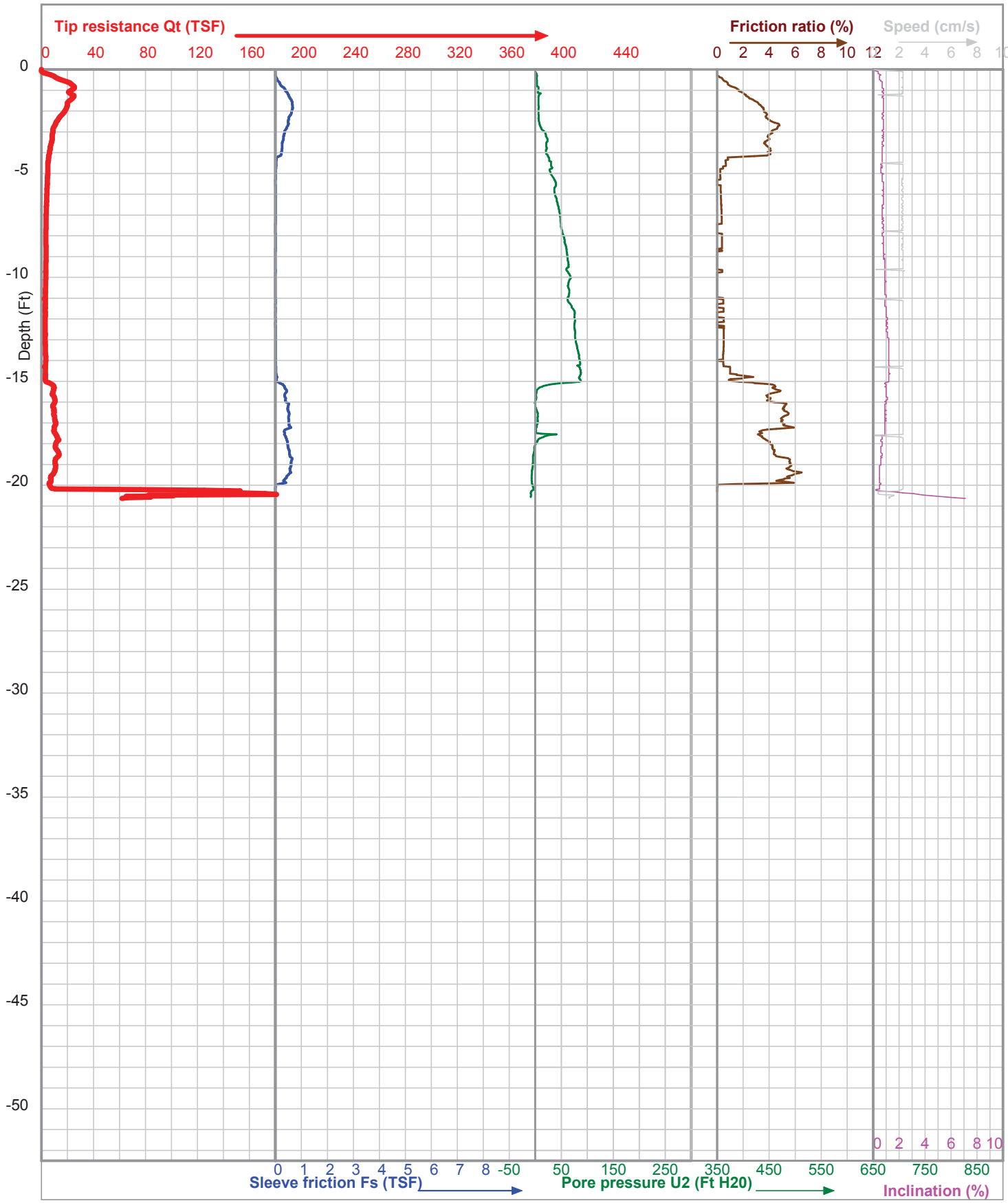
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 51	Cone Type	I-CFXYPP20-15		
Test Number	51	Cone ID	100624	X-Coord	40.65302
Client	Barr Engineering Co., Inc.	Start Time	7:39	Y-Coord	-83.79758
Boring Type	CPTU Sounding	Date	22-7-2011	Elev. Datum:	WGS 84



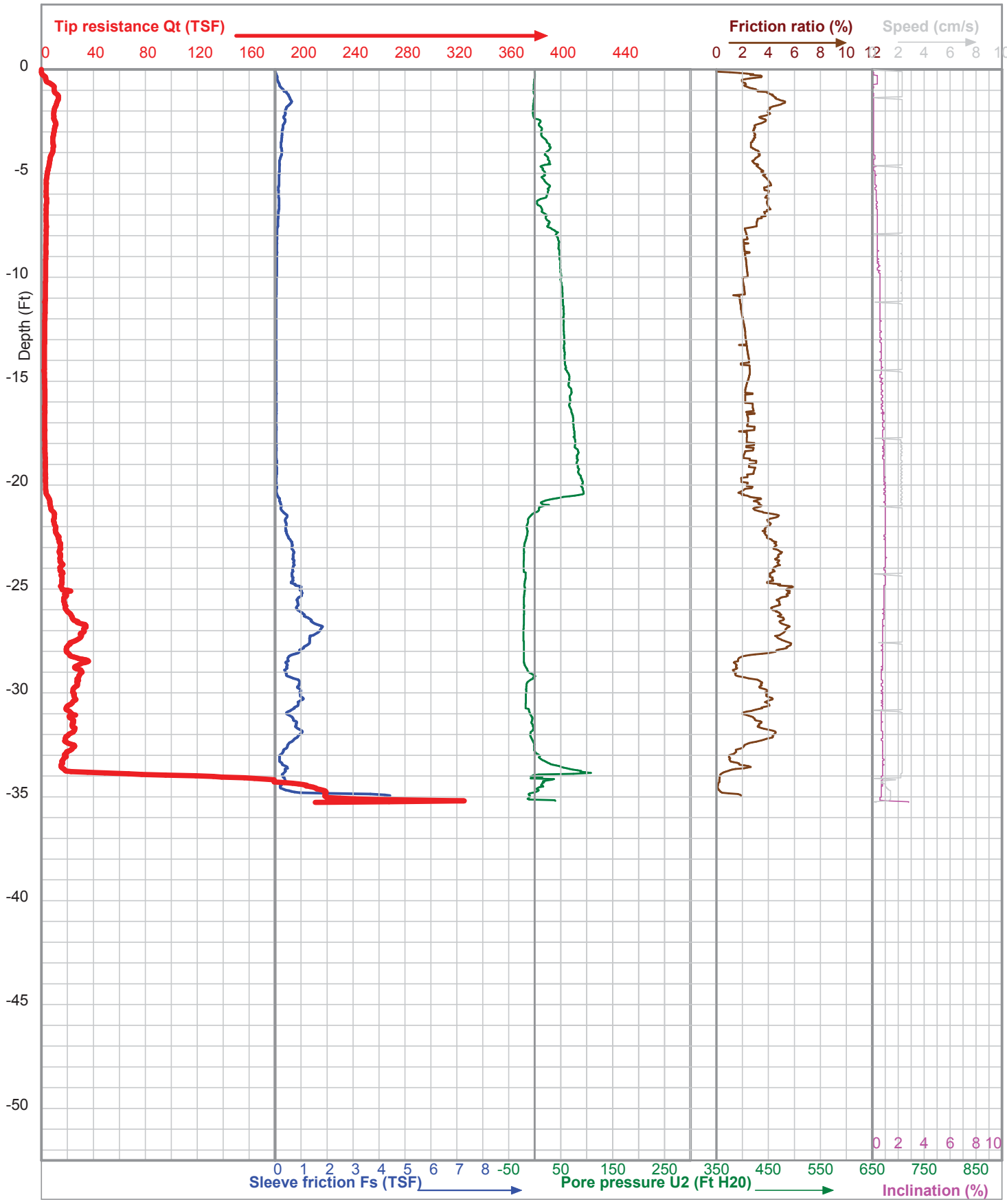
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 52	Cone Type	I-CFXYP20-15		
Test Number	52	Cone ID	090710	X-Coord	40.65224
Client	Barr Engineering Co., Inc.	Start Time	7:29	Y-Coord	-83.79115
Boring Type	CPTU Sounding	Date	27-7-2011	Elev. Datum:	WGS 84



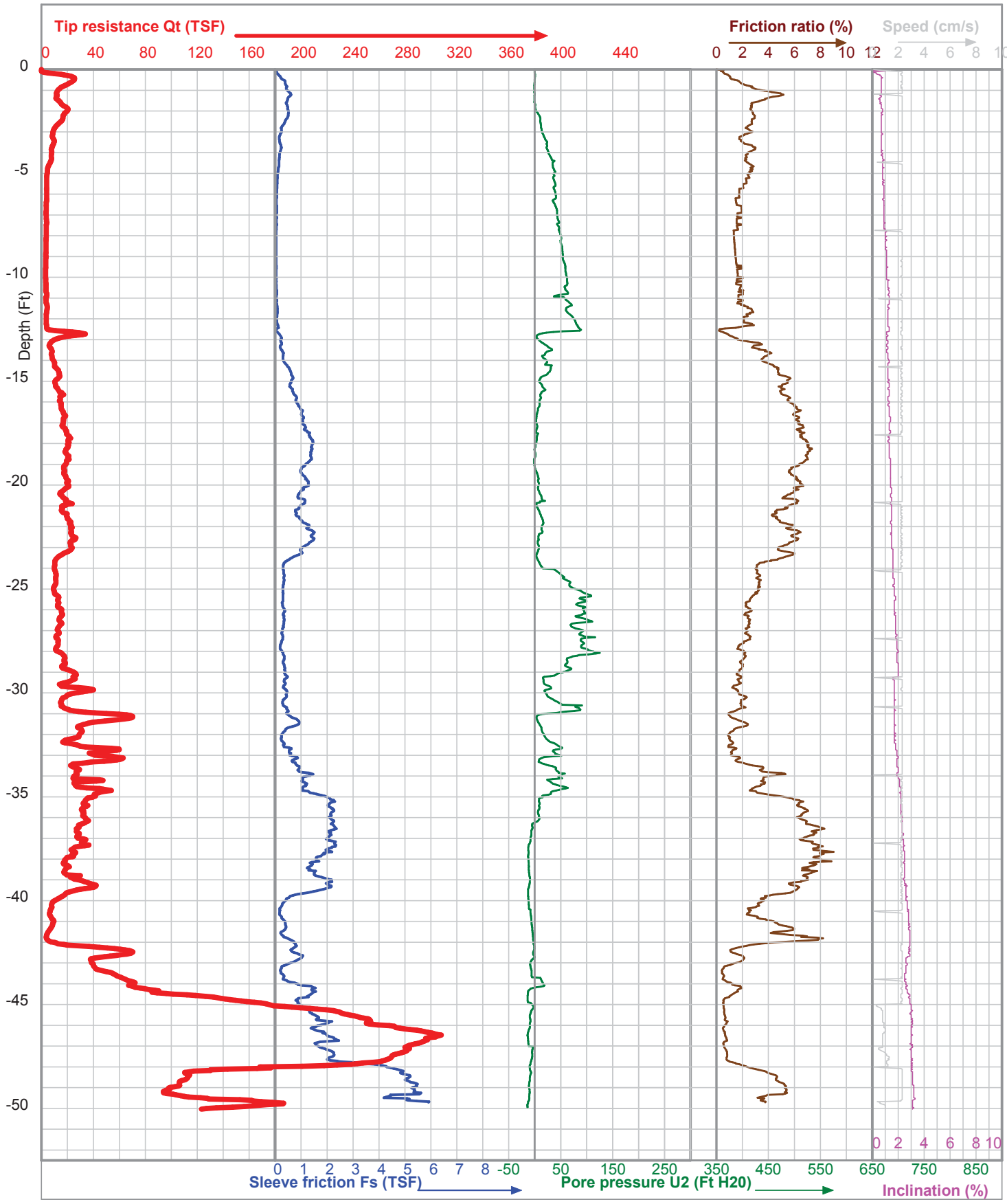
Project	Hardin County Wind	CPT Operator	b willman	Elevation (Ft MSL)	
Location	Turbine 53	Cone Type	I-CFXYP20-15		
Test Number	53	Cone ID	090709	X-Coord	40.64954
Client	Barr Engineering Co., Inc.	Start Time	9:00	Y-Coord	-83.79903
Boring Type	CPTU Sounding	Date	22-7-2011	Elev. Datum:	WGS 84



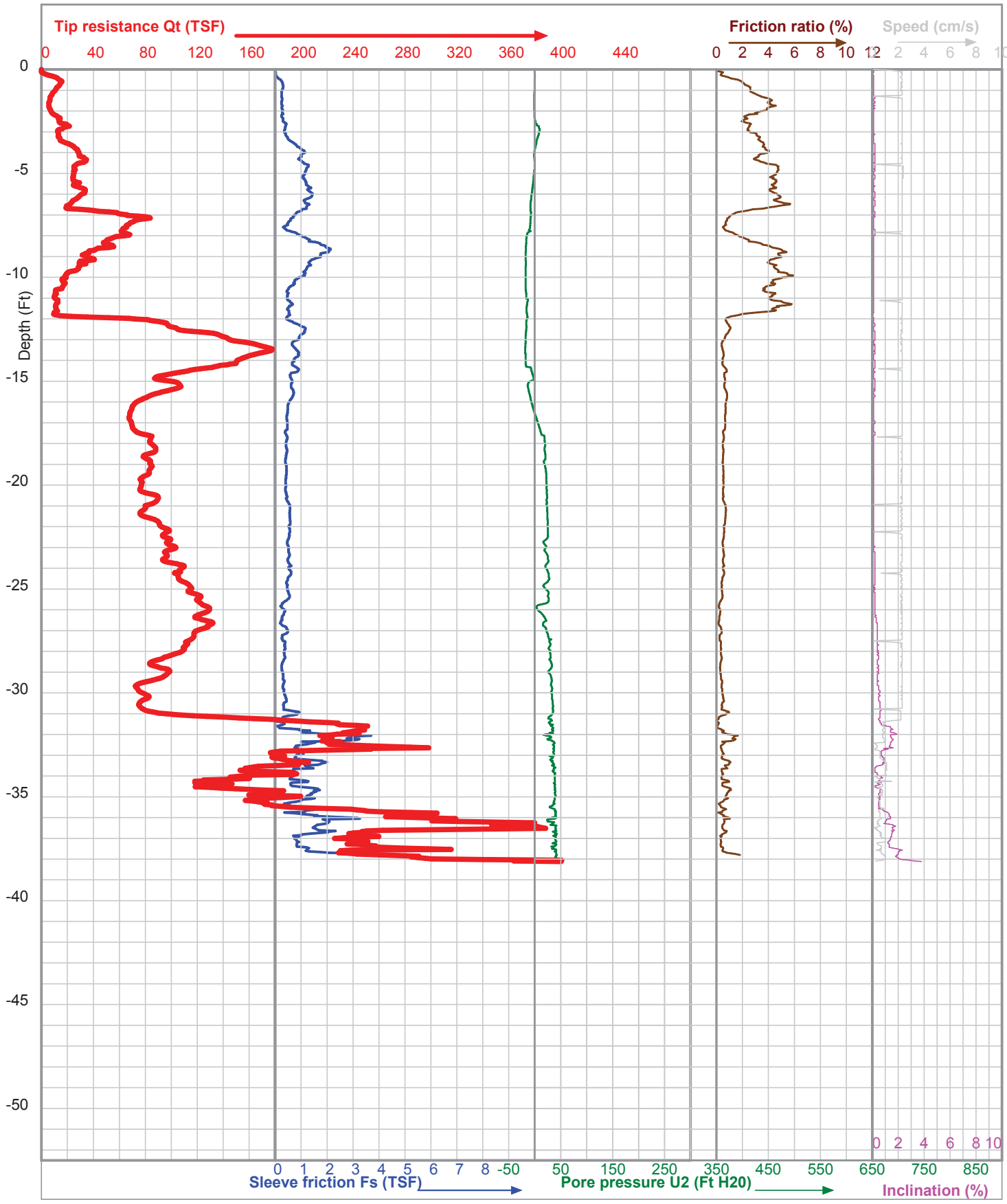
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 54	Cone Type	I-CFXYPP20-15		
Test Number	54	Cone ID	100624	X-Coord	40.64642
Client	Barr Engineering Co., Inc.	Start Time	10:14	Y-Coord	-83.79849
Boring Type	CPTU Sounding	Date	22-7-2011	Elev. Datum:	WGS 84



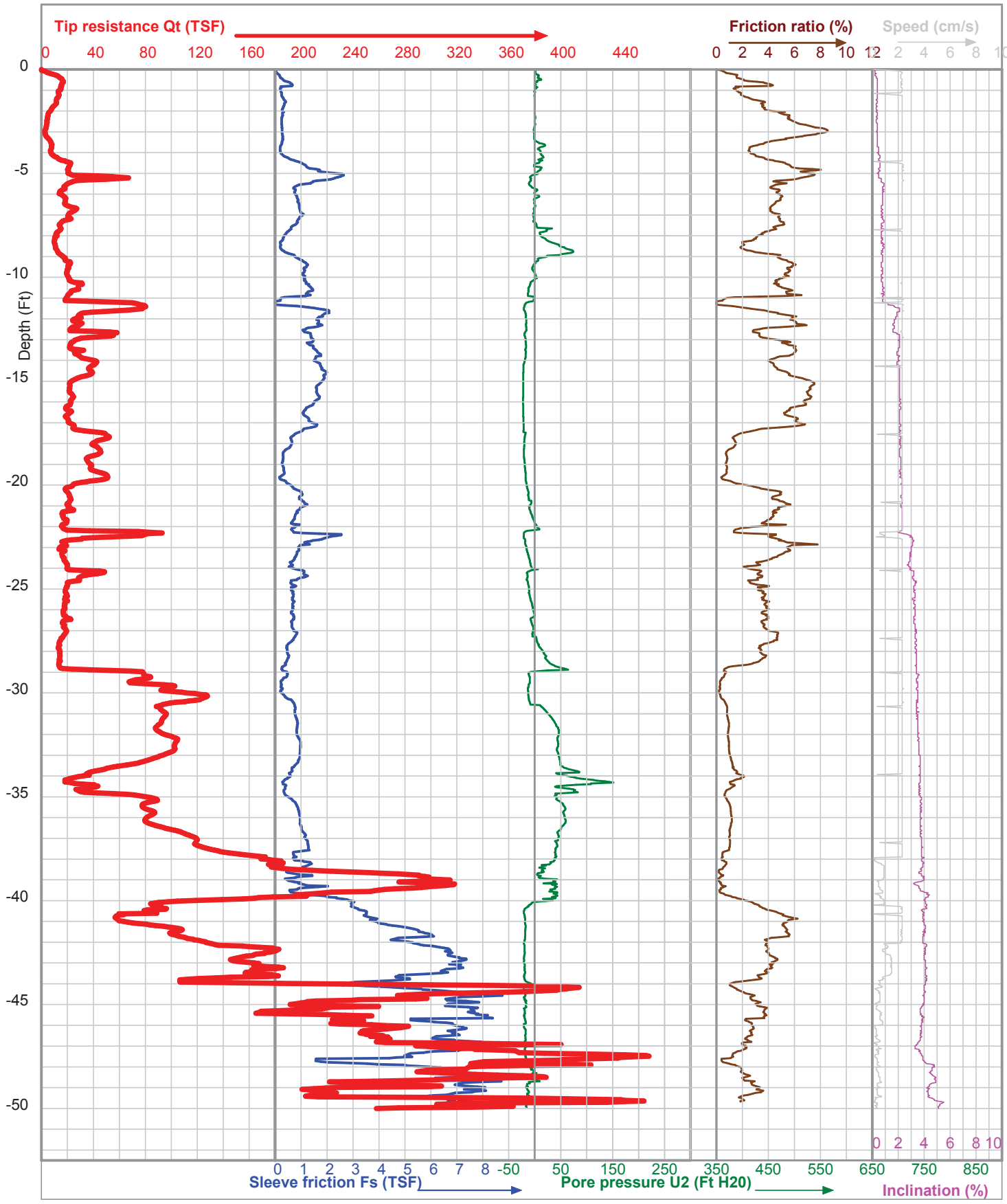
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 55	Cone Type	I-CFXYP20-15		
Test Number	55	Cone ID	090709	X-Coord	40.64363
Client	Barr Engineering Co., Inc.	Start Time	6:19	Y-Coord	-83.79653
Boring Type	CPTU Sounding	Date	23-7-2011	Elev. Datum:	WGS 84



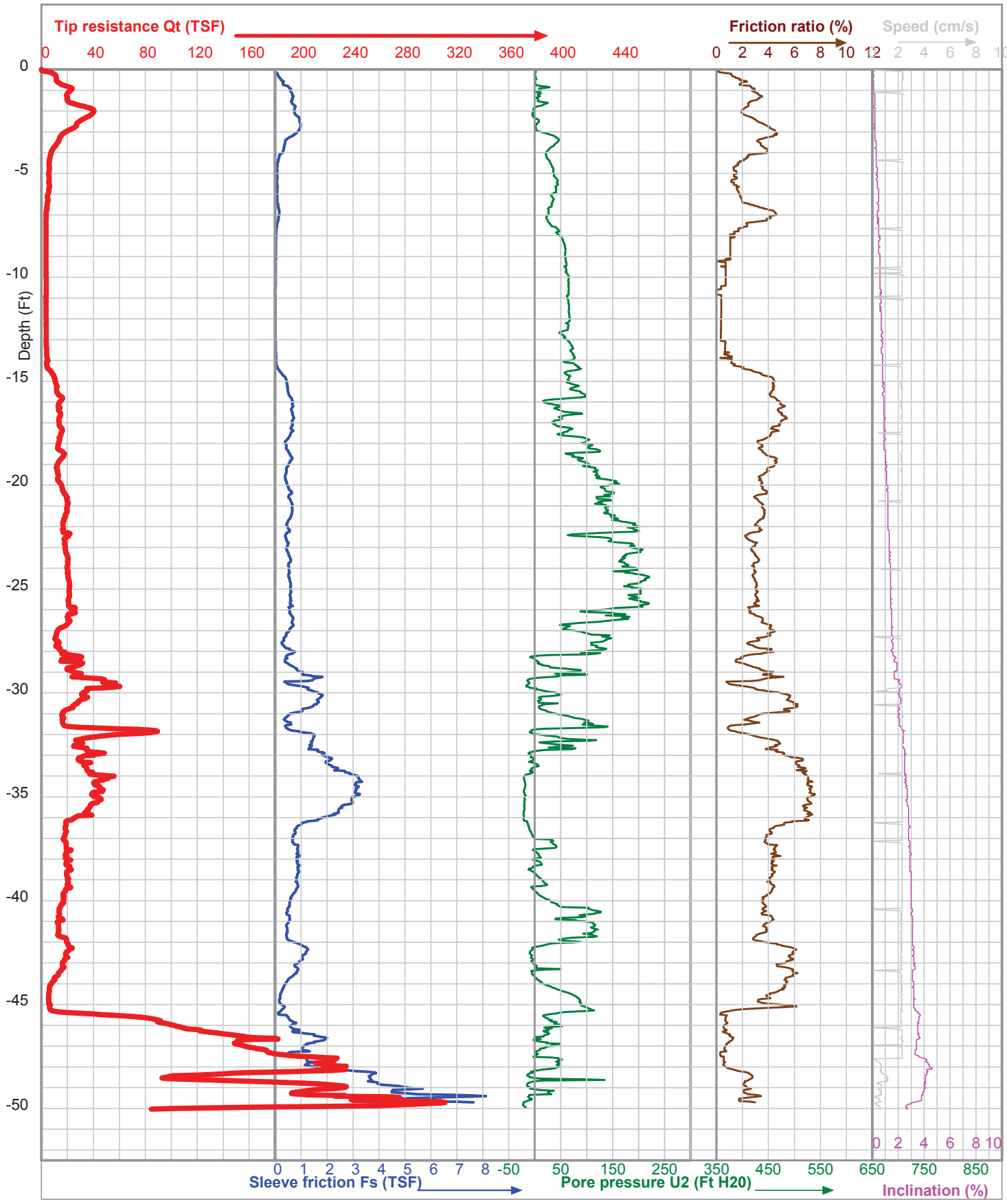
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 56	Cone Type	I-CFXYPP20-15		
Test Number	56	Cone ID	100624	X-Coord	40.64055
Client	Barr Engineering Co., Inc.	Start Time	6:53	Y-Coord	-83.79554
Boring Type	CPTU Sounding	Date	23-7-2011	Elev. Datum:	WGS 84



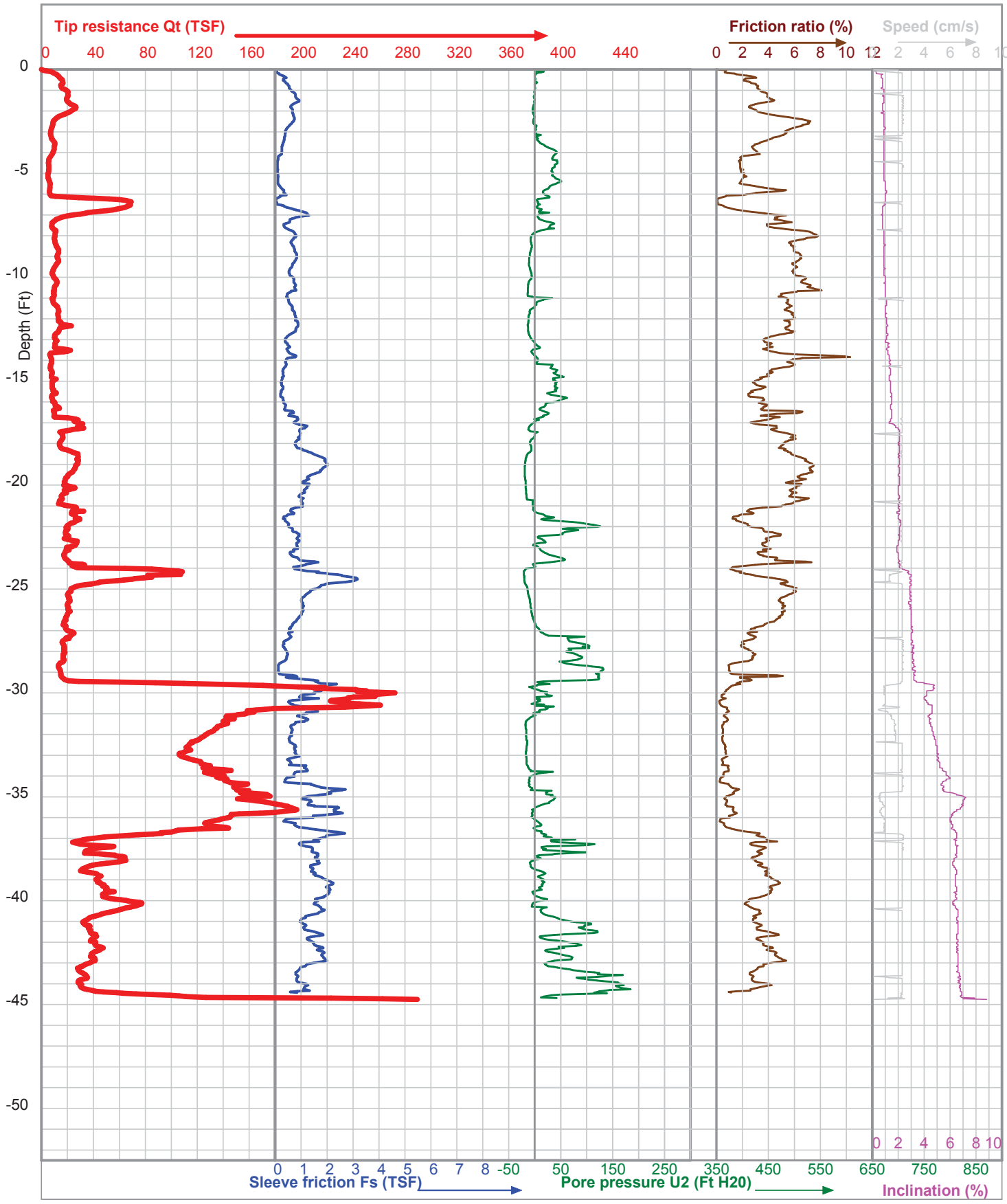
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 57	Cone Type	I-CFXYP20-15		
Test Number	57	Cone ID	090709	X-Coord	40.63676
Client	Barr Engineering Co., Inc.	Start Time	7:44	Y-Coord	-83.79401
Boring Type	CPTU Sounding	Date	23-7-2011	Elev. Datum:	WGS 84



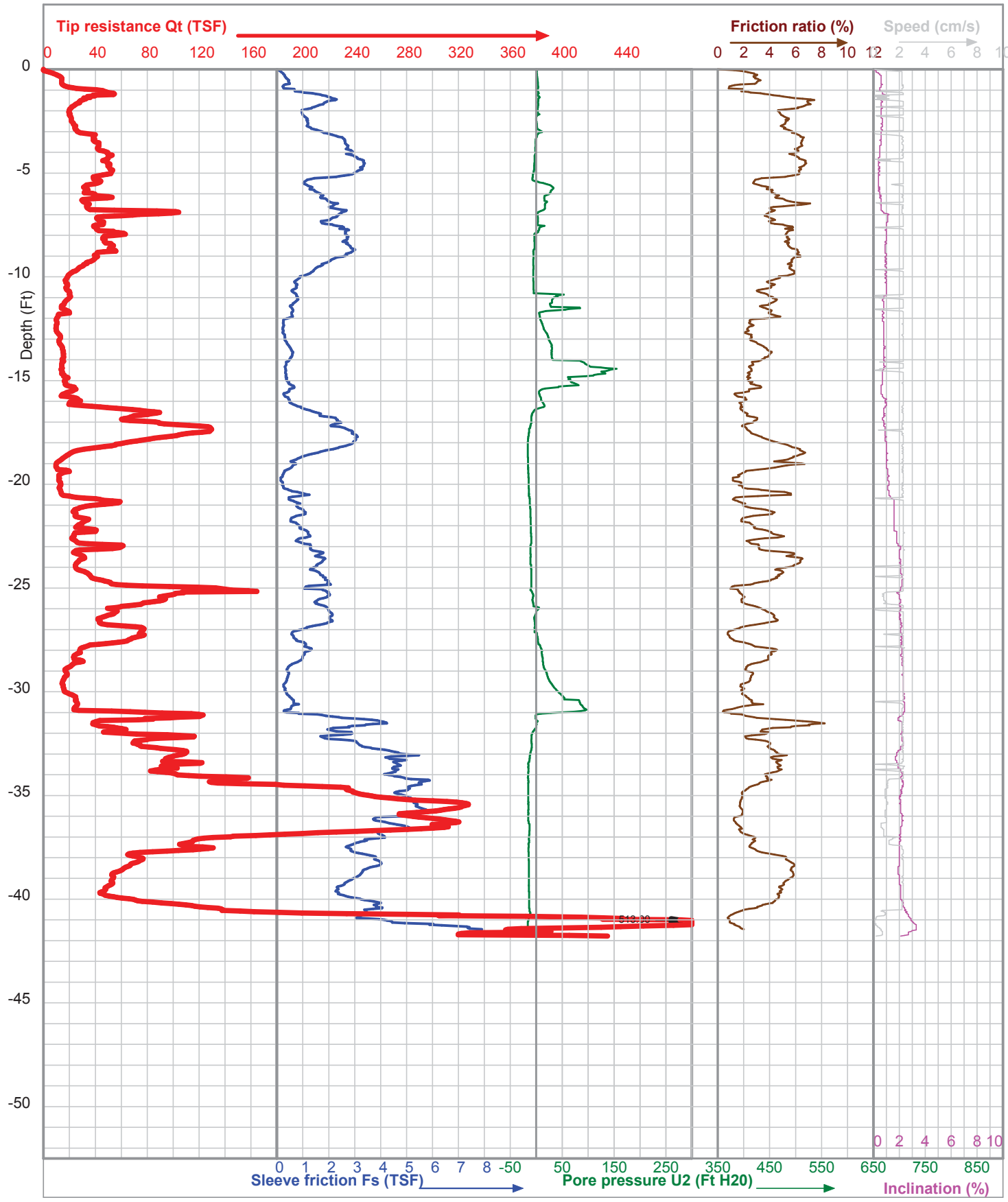
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 58	Cone Type	I-CFXYPP20-15		
Test Number	58	Cone ID	100624	X-Coord	40.63478
Client	Barr Engineering Co., Inc.	Start Time	8:29	Y-Coord	-83.79126
Boring Type	CPTU Sounding	Date	23-7-2011	Elev. Datum:	WGS 84



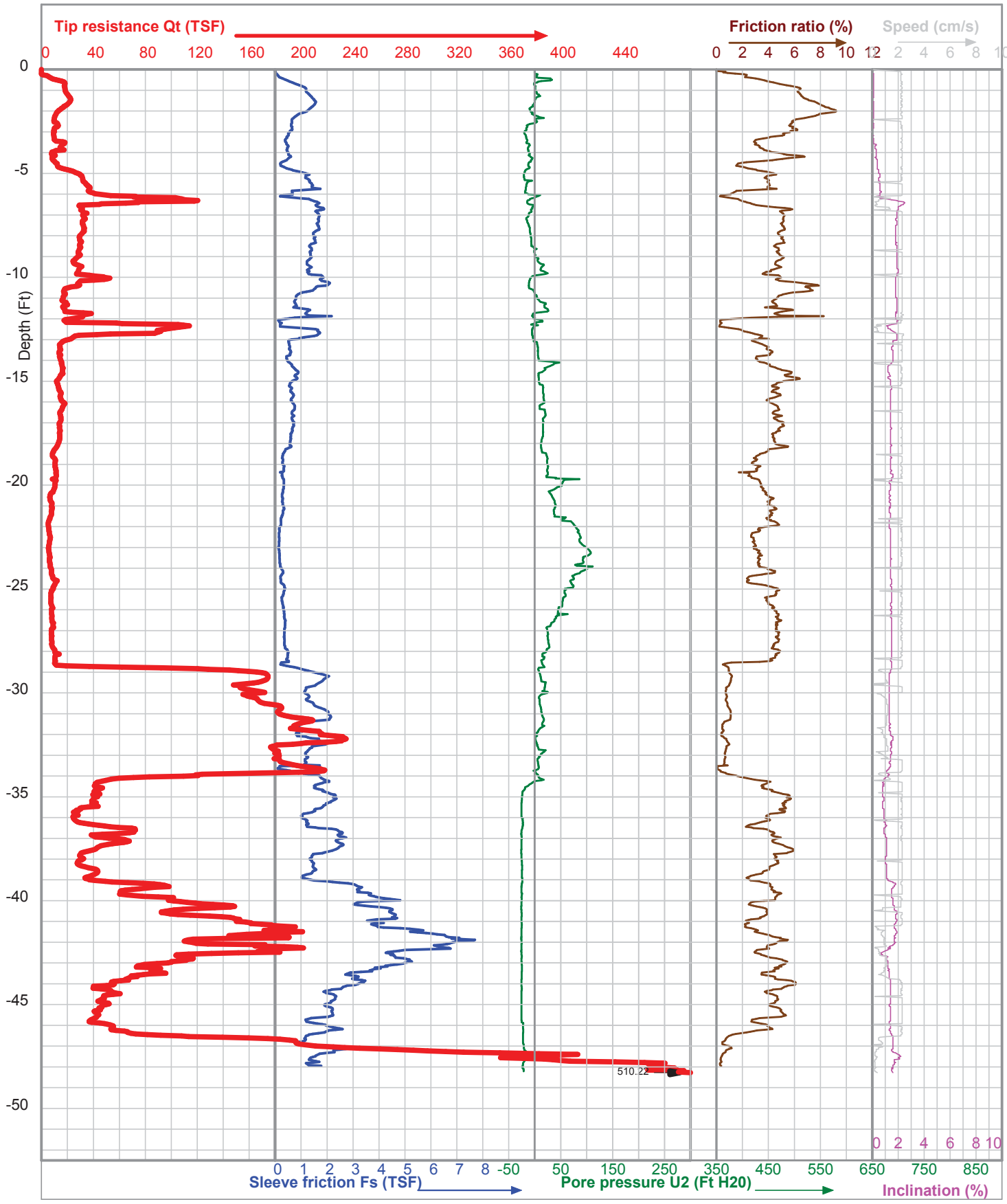
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 59	Cone Type	I-CFXYPP20-15		
Test Number	59	Cone ID	100624	X-Coord	40.65199
Client	Barr Engineering Co., Inc.	Start Time	6:25	Y-Coord	-83.78561
Boring Type	CPTU Sounding	Date	27-7-2011	Elev. Datum:	WGS 84



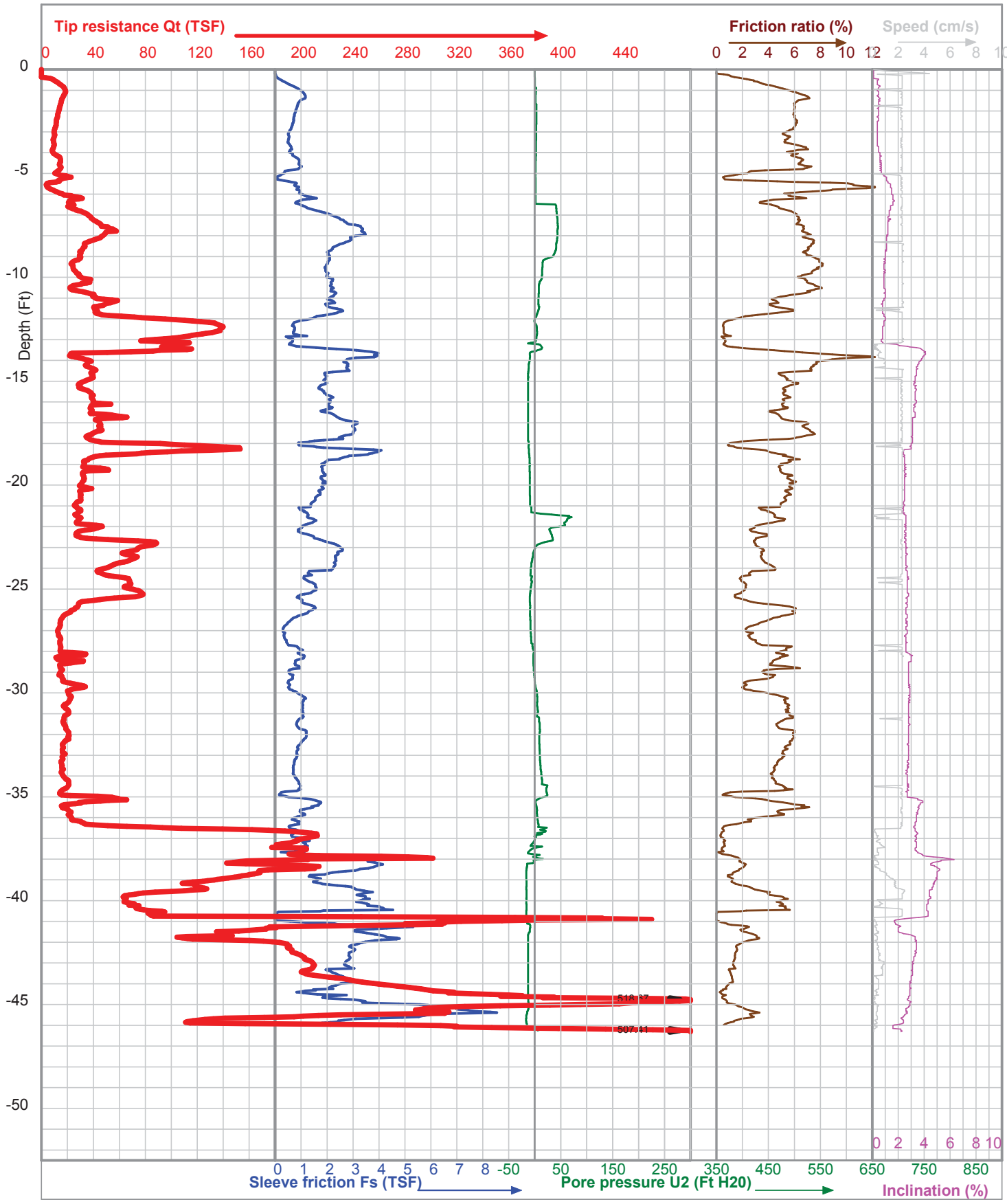
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 60	Cone Type	I-CFXYPP20-15		
Test Number	60	Cone ID	100624	X-Coord	40.64928
Client	Barr Engineering Co., Inc.	Start Time	16:44	Y-Coord	-83.78505
Boring Type	CPTU Sounding	Date	26-7-2011	Elev. Datum:	WGS 84



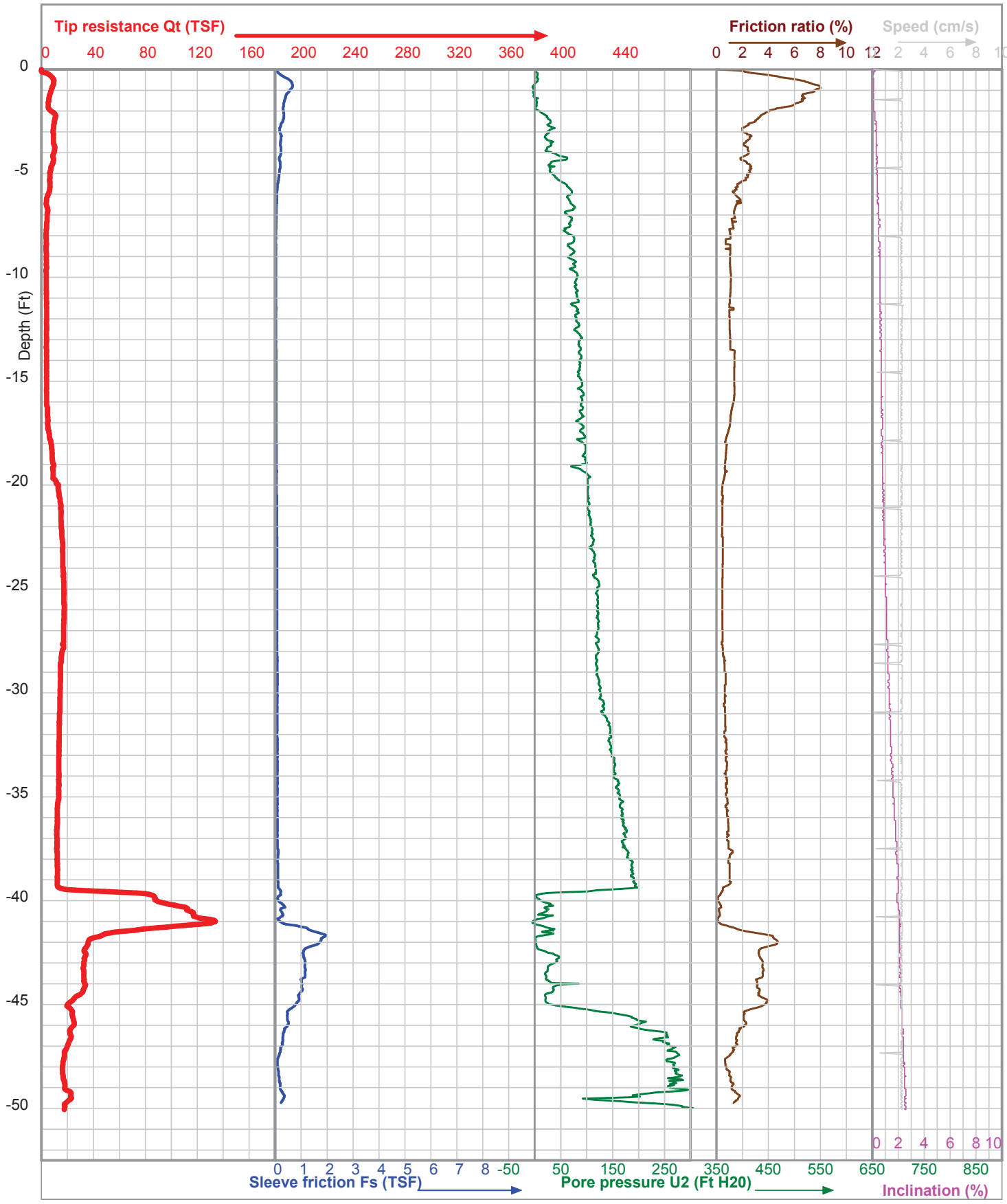
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 62	Cone Type	I-CFXYPP20-15		
Test Number	62	Cone ID	100624	X-Coord	40.64365
Client	Barr Engineering Co., Inc.	Start Time	15:13	Y-Coord	-83.78397
Boring Type	CPTU Sounding	Date	26-7-2011	Elev. Datum:	WGS 84



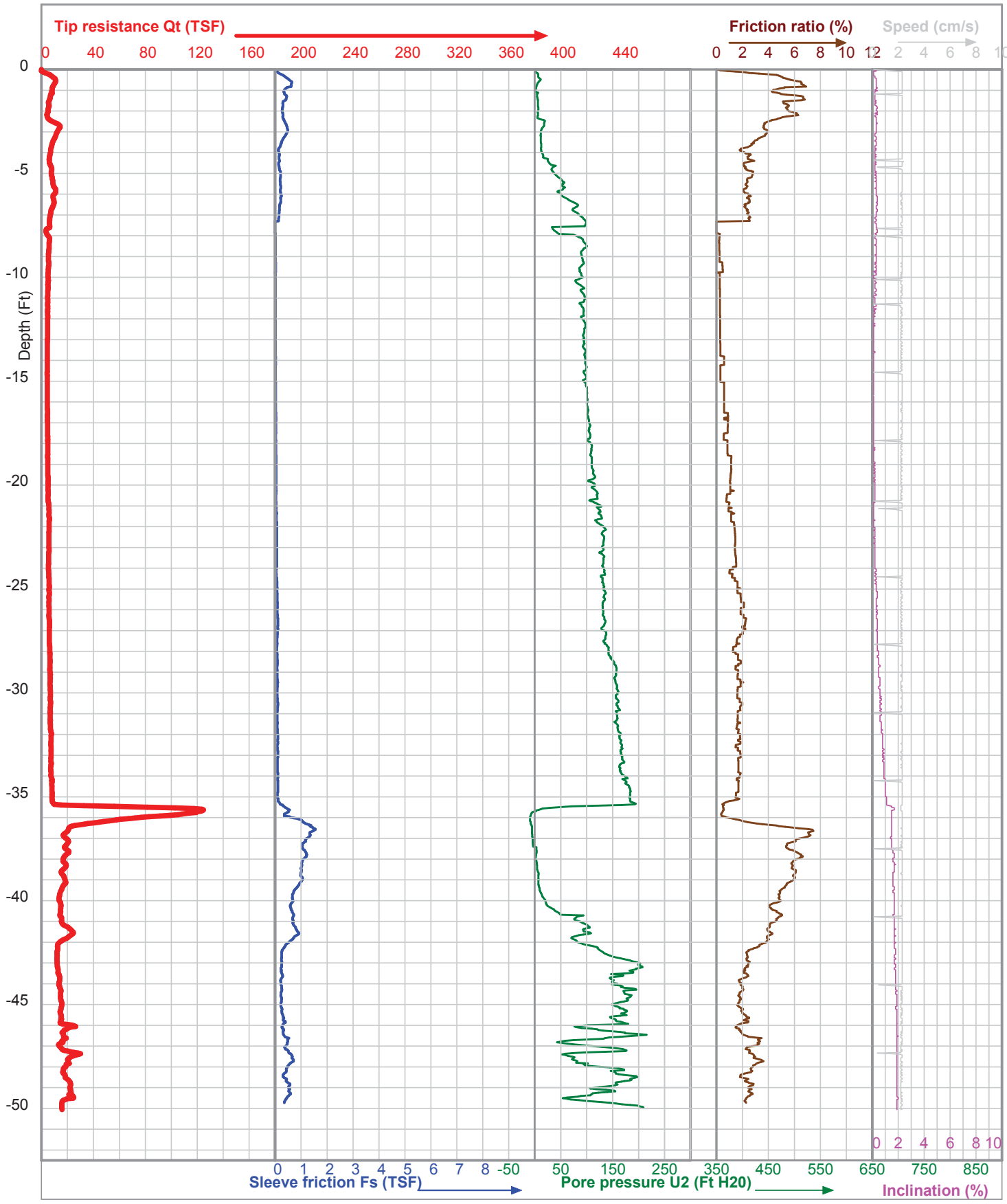
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 63	Cone Type	I-CFXYP20-15		
Test Number	63	Cone ID	090709	X-Coord	40.64154
Client	Barr Engineering Co., Inc.	Start Time	9:34	Y-Coord	-83.78102
Boring Type	CPTU Sounding	Date	26-7-2011	Elev. Datum:	WGS 84



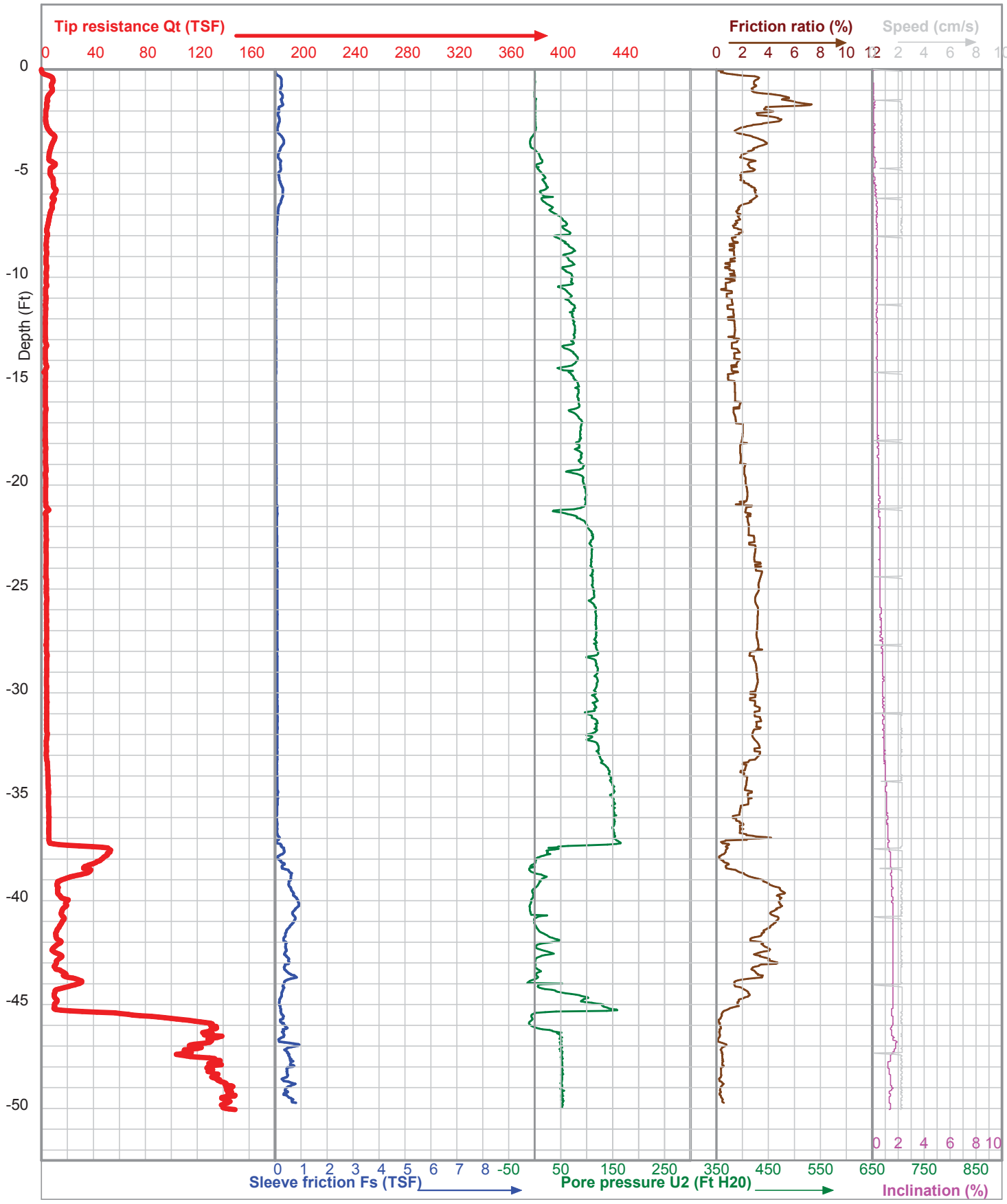
Project	Hardin County Wind	CPT Operator	b.willman	Elevation (Ft MSL)	
Location	Turbine 64	Cone Type	I-CFXYPP20-15		
Test Number	64	Cone ID	100624	X-Coord	40.63908
Client	Barr Engineering Co., Inc.	Start Time	7:39	Y-Coord	-83.77950
Boring Type	CPTU Sounding	Date	26-7-2011	Elev. Datum:	WGS 84



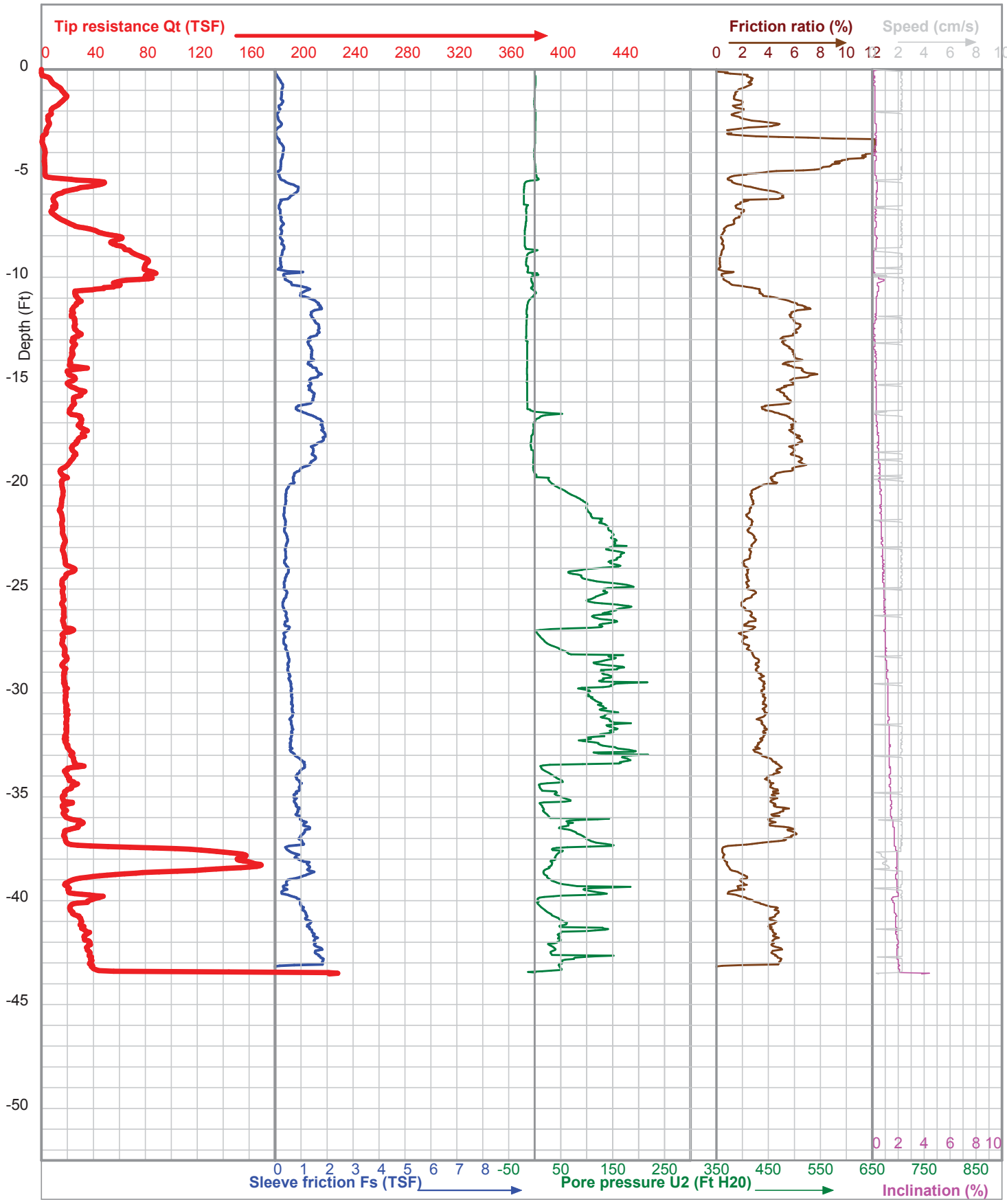
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 65	Cone Type	I-CFXYP20-15		
Test Number	65	Cone ID	090709	X-Coord	40.63166
Client	Barr Engineering Co., Inc.	Start Time	7:58	Y-Coord	-83.80581
Boring Type	CPTU Sounding	Date	24-7-2011	Elev. Datum:	WGS 84



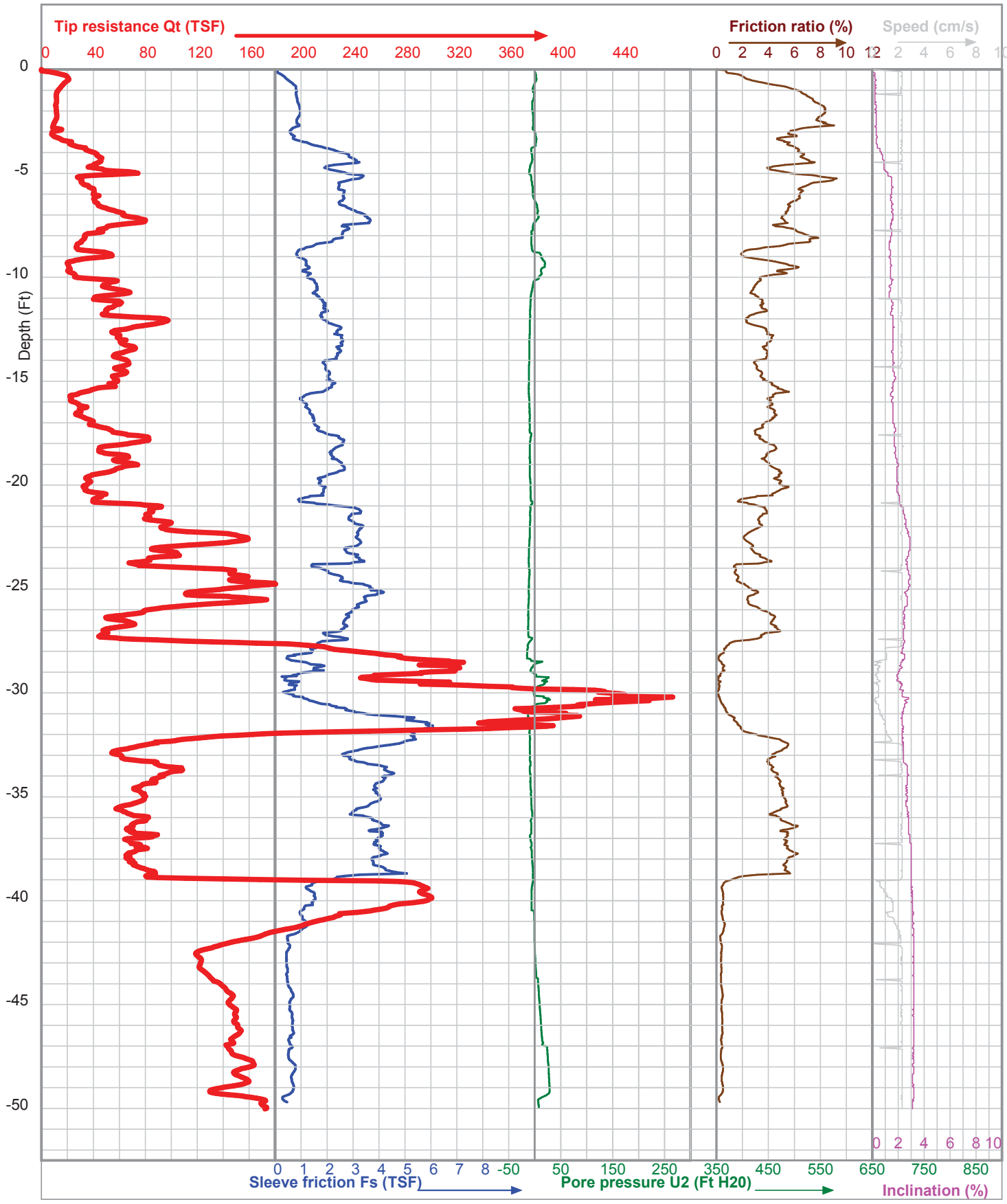
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 66	Cone Type	I-CFXYPP20-15		
Test Number	66	Cone ID	100624	X-Coord	40.62930
Client	Barr Engineering Co., Inc.	Start Time	7:17	Y-Coord	-83.80502
Boring Type	CPTU Sounding	Date	24-7-2011	Elev. Datum:	WGS 84



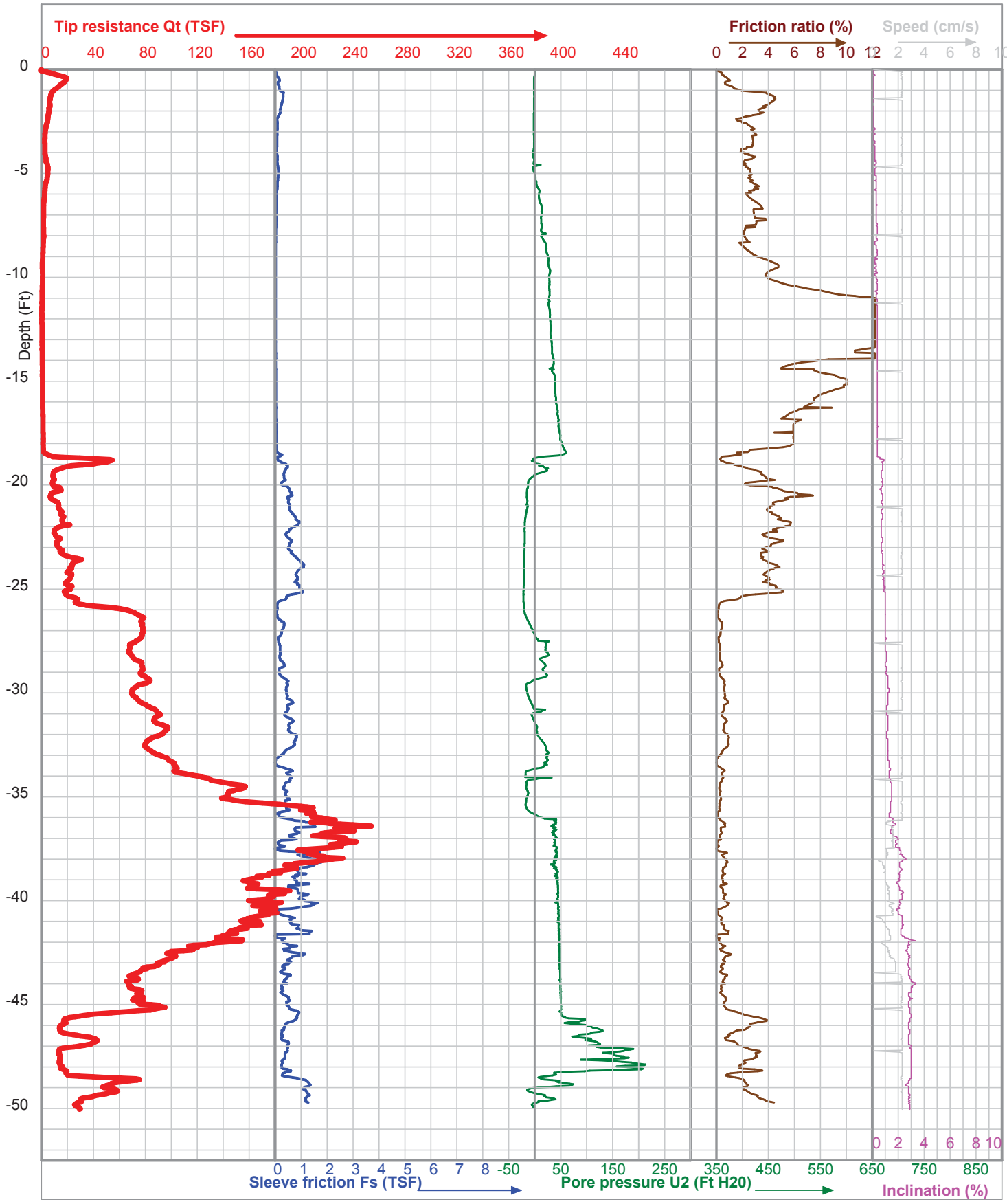
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 67	Cone Type	I-CFXYP20-15		
Test Number	67	Cone ID	090709	X-Coord	40.62679
Client	Barr Engineering Co., Inc.	Start Time	6:32	Y-Coord	-83.80405
Boring Type	CPTU Sounding	Date	24-7-2011	Elev. Datum:	WGS 84



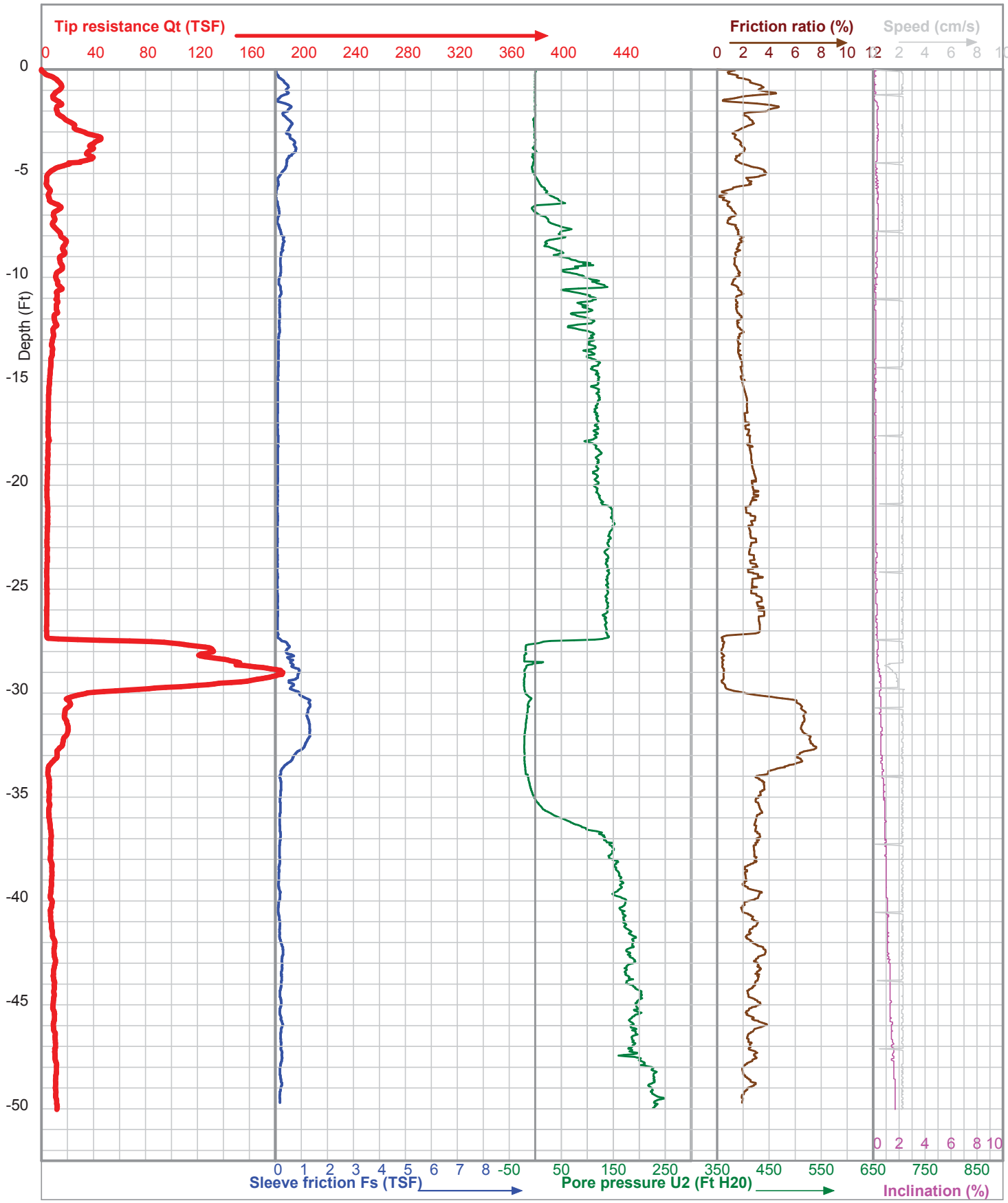
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 68	Cone Type	I-CFXYPP20-15		
Test Number	68	Cone ID	100624	X-Coord	40.62442
Client	Barr Engineering Co., Inc.	Start Time	12:010	Y-Coord	-83.80217
Boring Type	CPTU Sounding	Date	25-7-2011	Elev. Datum:	WGS 84



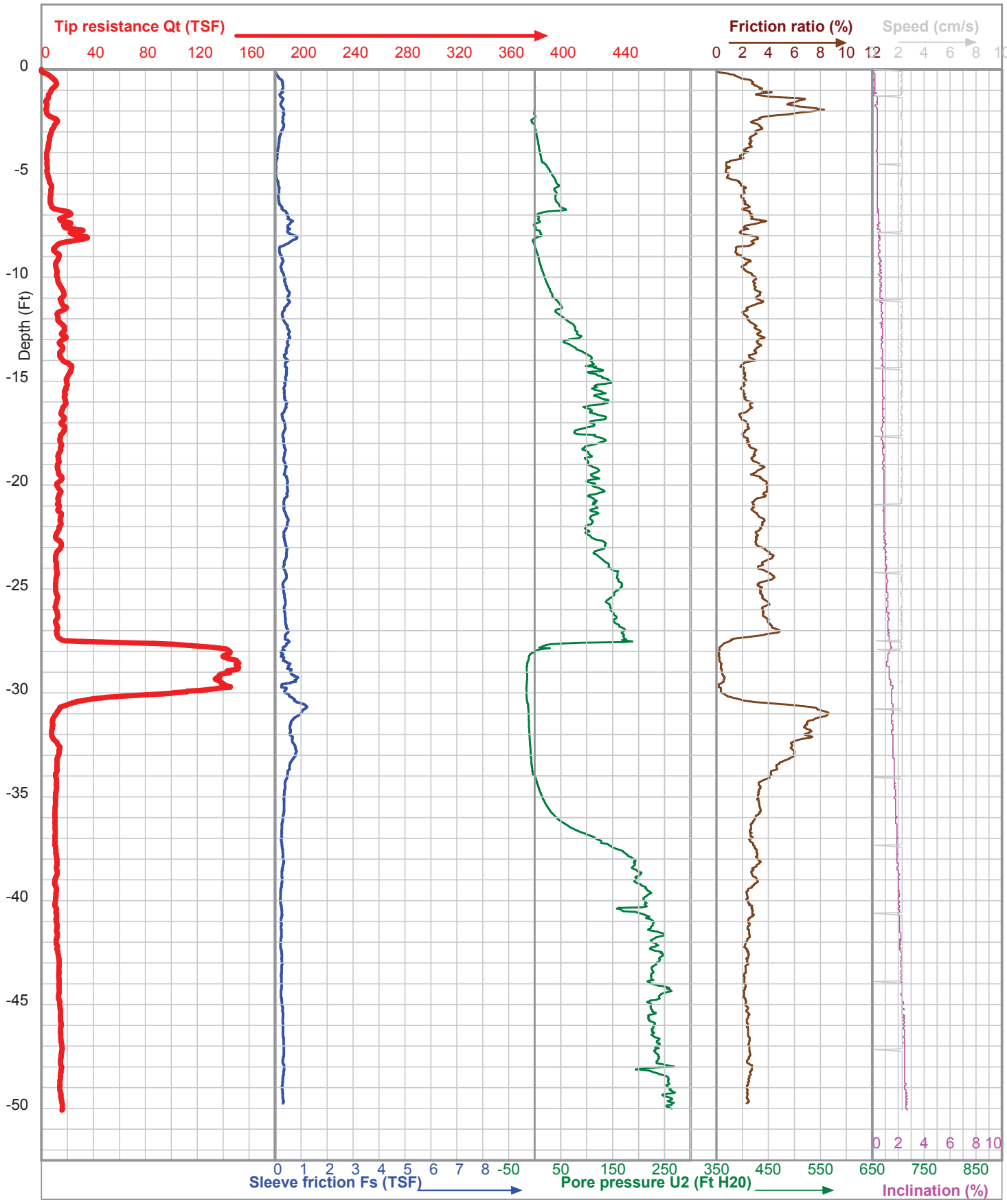
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 69	Cone Type	I-CFXYPP20-15		
Test Number	69	Cone ID	100624	X-Coord	40.62152
Client	Barr Engineering Co., Inc.	Start Time	11:06	Y-Coord	-83.80112
Boring Type	CPTU Sounding	Date	23-7-2011	Elev. Datum:	WGS 84



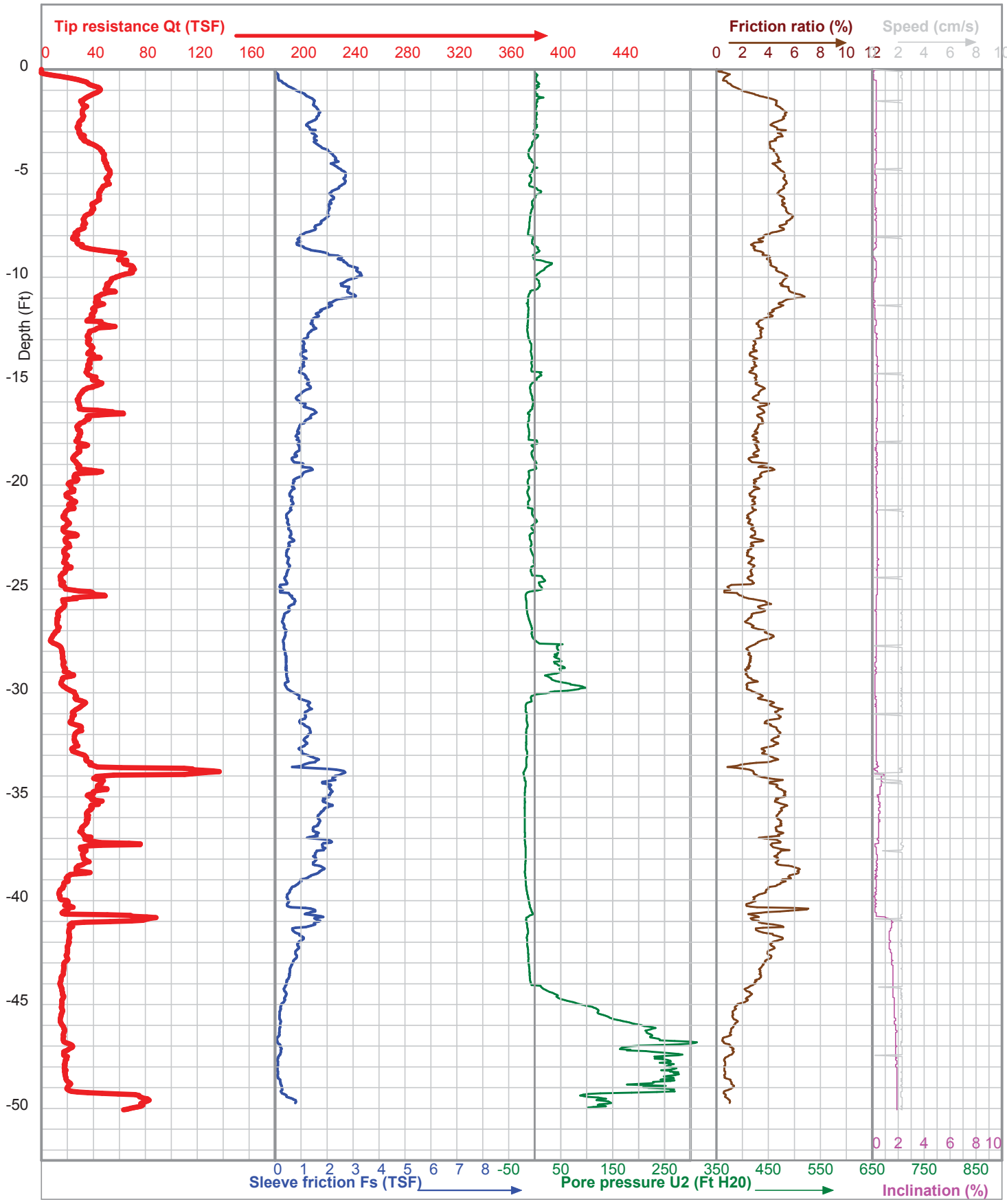
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 70	Cone Type	I-CFXYP20-15		
Test Number	70	Cone ID	090709	X-Coord	40.61820
Client	Barr Engineering Co., Inc.	Start Time	12:010	Y-Coord	-83.80226
Boring Type	CPTU Sounding	Date	23-7-2011	Elev. Datum:	WGS 84



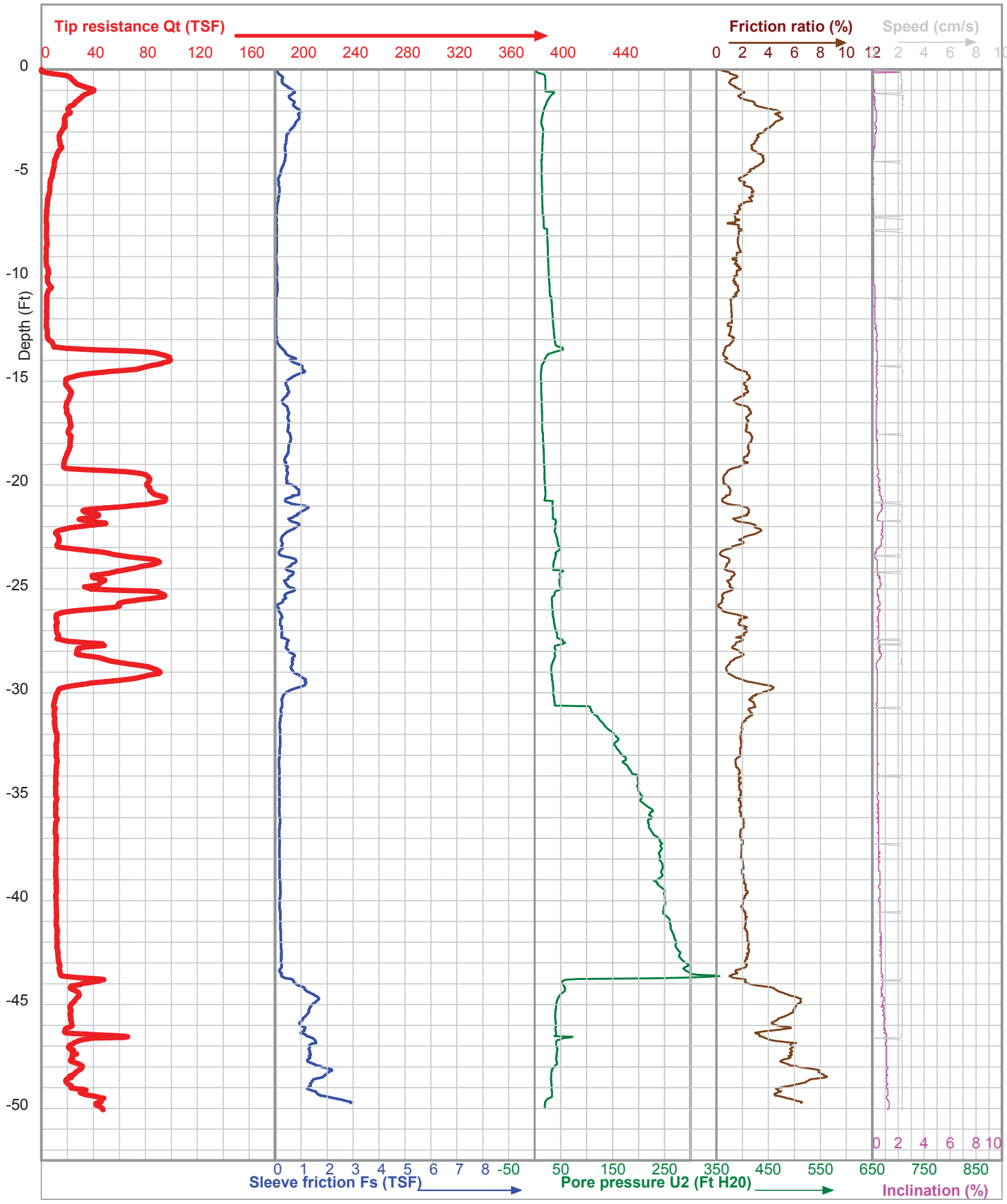
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 71	Cone Type	I-CFXYP20-15		
Test Number	71	Cone ID	090709	X-Coord	40.62101
Client	Barr Engineering Co., Inc.	Start Time	14:12	Y-Coord	-83.81049
Boring Type	CPTU Sounding	Date	23-7-2011	Elev. Datum:	WGS 84



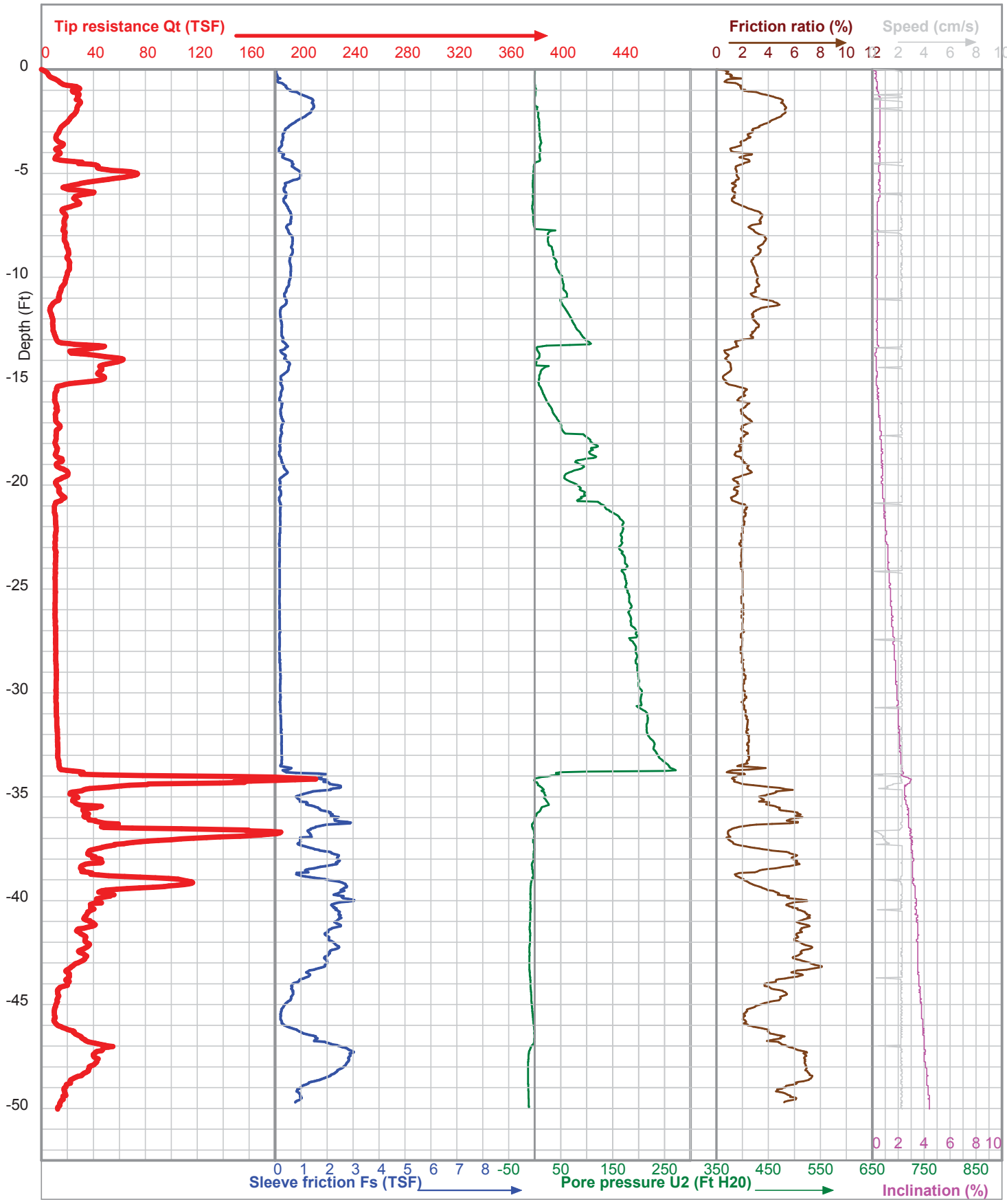
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 72	Cone Type	I-CFXYPP20-15		
Test Number	72	Cone ID	100624	X-Coord	40.61814
Client	Barr Engineering Co., Inc.	Start Time	13:17	Y-Coord	-83.81116
Boring Type	CPTU Sounding	Date	23-7-2011	Elev. Datum:	WGS 84



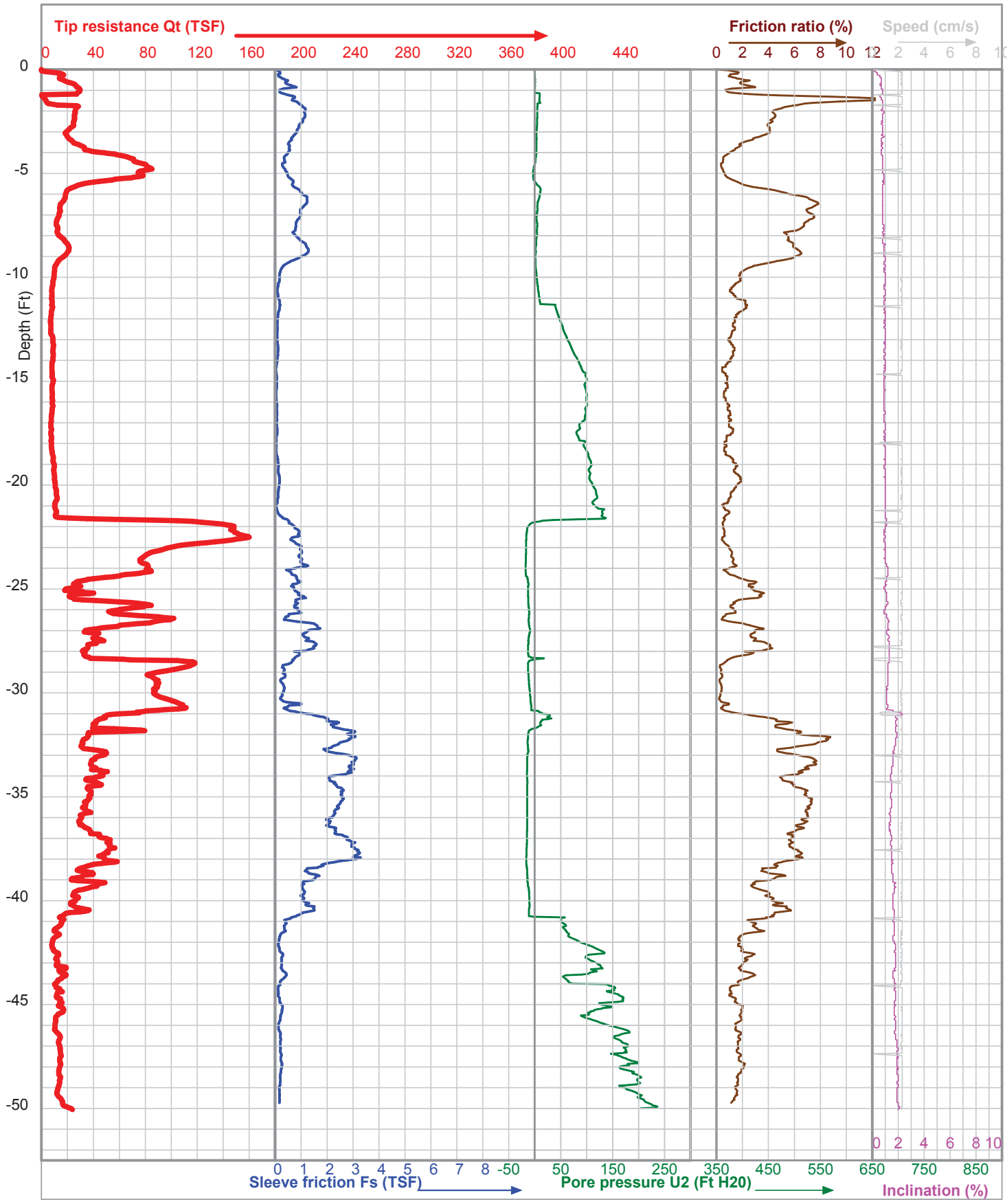
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 73	Cone Type	I-CFXYP20-15		
Test Number	73	Cone ID	090709	X-Coord	40.62880
Client	Barr Engineering Co., Inc.	Start Time	9:43	Y-Coord	-83.79543
Boring Type	CPTU Sounding	Date	23-7-2011	Elev. Datum:	WGS 84



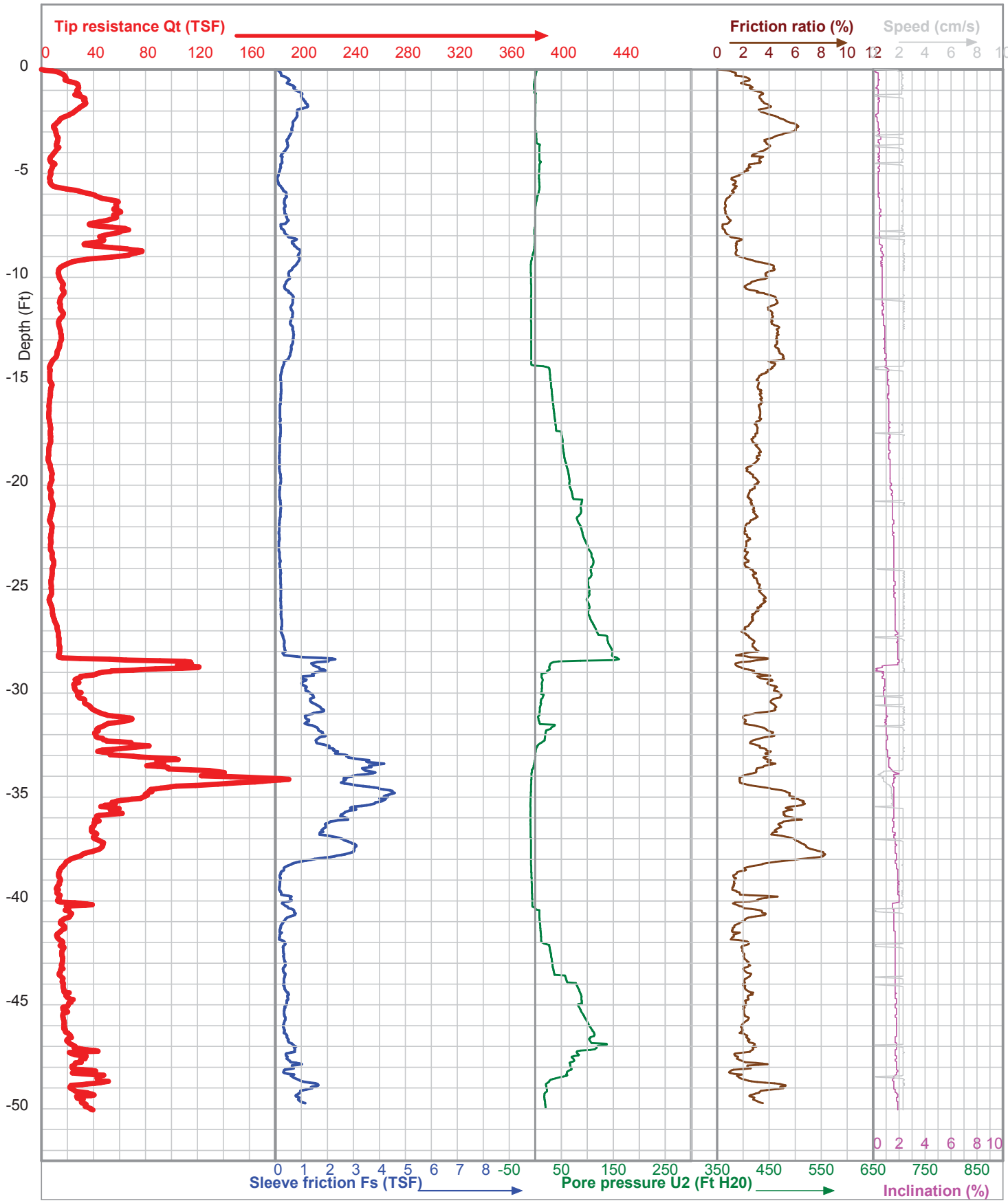
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 76	Cone Type	I-CFXYPP20-15		
Test Number	76	Cone ID	100624	X-Coord	40.68227
Client	Barr Engineering Co., Inc.	Start Time	6:53	Y-Coord	-83.78043
Boring Type	CPTU Sounding	Date	30-7-2011	Elev. Datum:	WGS 84



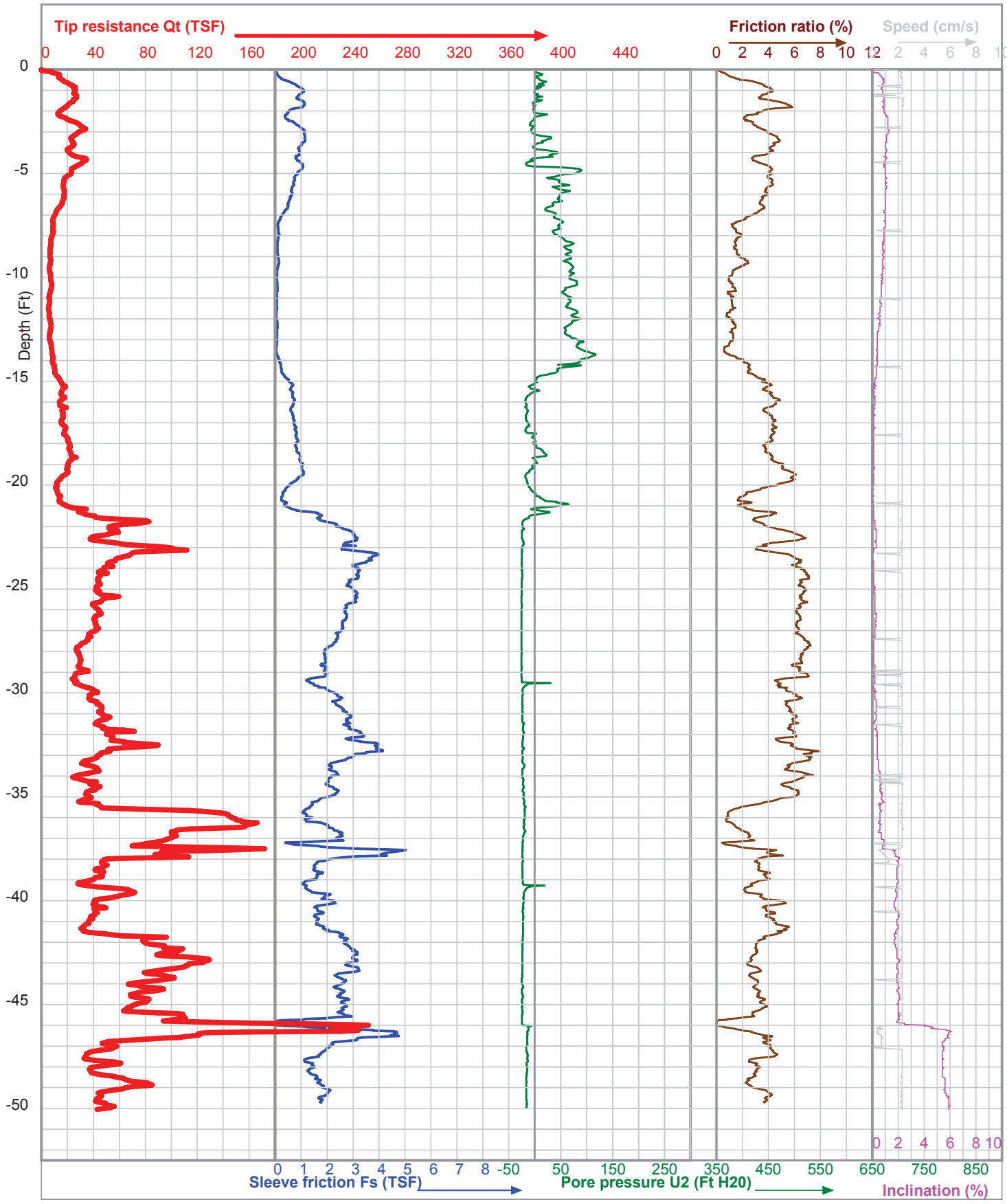
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 77	Cone Type	I-CFXYPP20-15		
Test Number	77	Cone ID	100624	X-Coord	40.68051
Client	Barr Engineering Co., Inc.	Start Time	7:50	Y-Coord	-83.77805
Boring Type	CPTU Sounding	Date	30-7-2011	Elev. Datum:	WGS 84



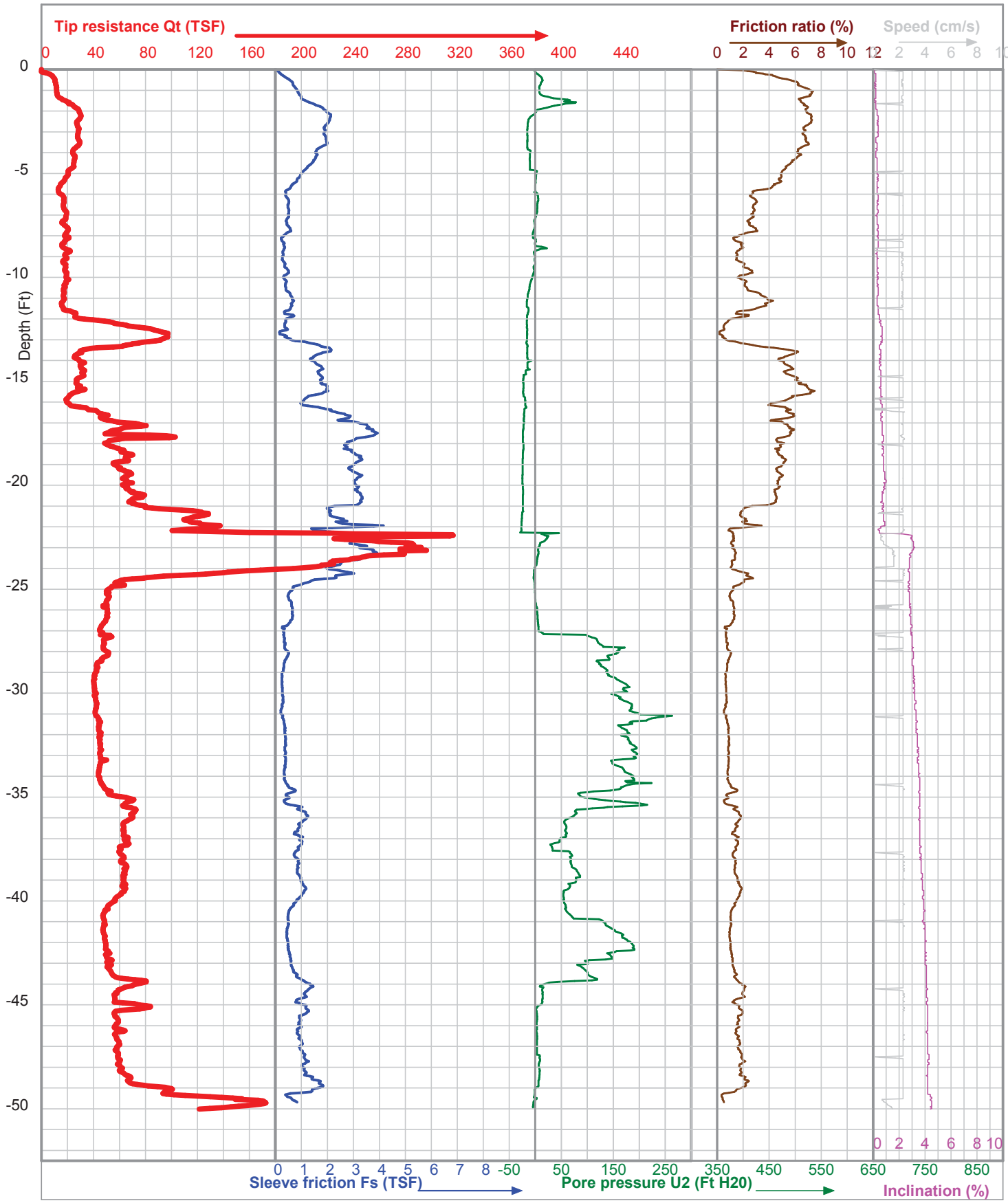
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 78	Cone Type	I-CFXYPP20-15		
Test Number	78	Cone ID	100624	X-Coord	40.68615
Client	Barr Engineering Co., Inc.	Start Time	9:04	Y-Coord	-83.77148
Boring Type	CPTU Sounding	Date	30-7-2011	Elev. Datum:	WGS 84



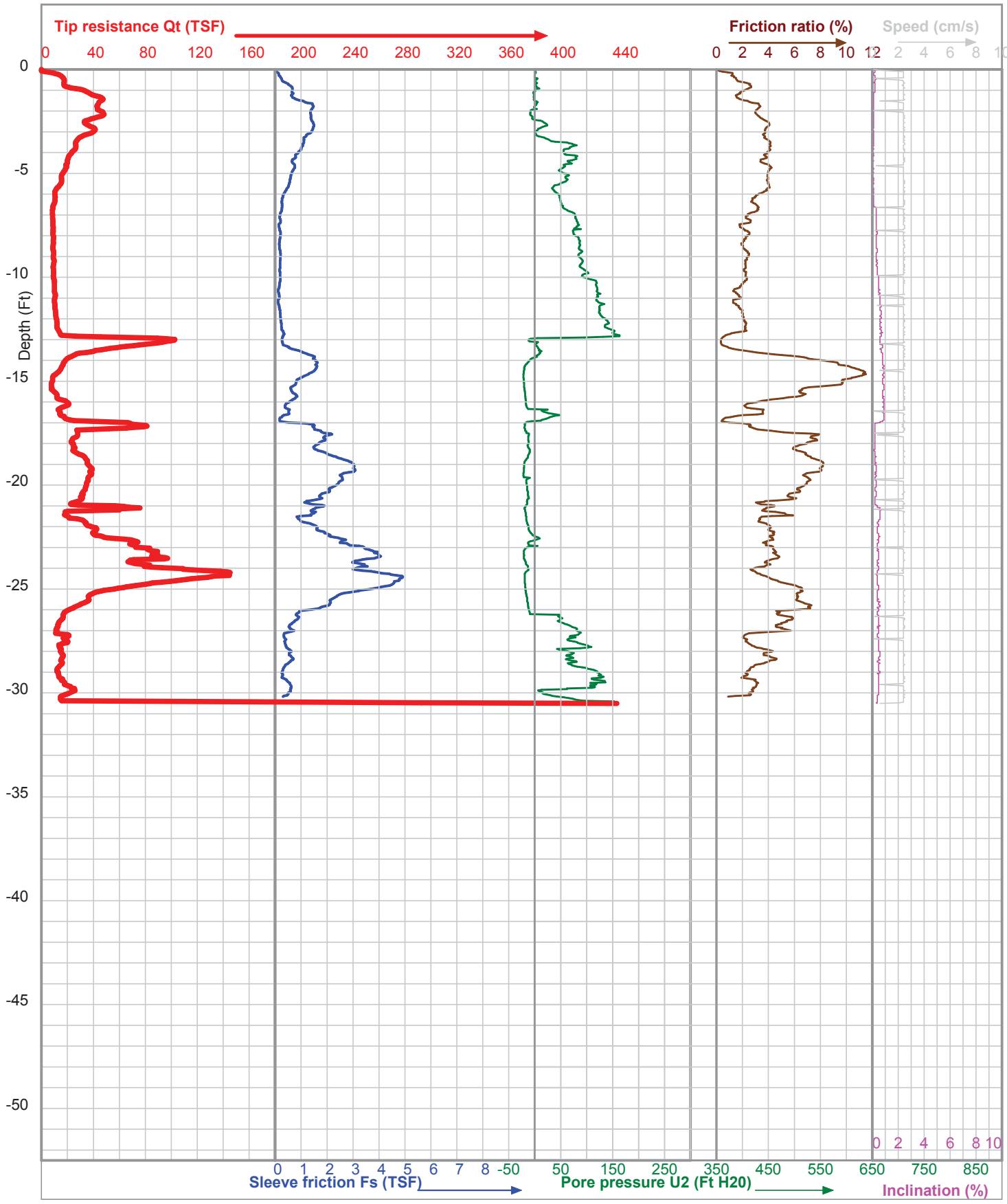
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 79	Cone Type	I-CFXYPP20-15		
Test Number	79	Cone ID	100624	X-Coord	40.68384
Client	Barr Engineering Co., Inc.	Start Time	10:15	Y-Coord	-83.76966
Boring Type	CPTU Sounding	Date	30-7-2011	Elev. Datum:	WGS 84



Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 80	Cone Type	I-CFXYPP20-15		
Test Number	80	Cone ID	100624	X-Coord	40.68129
Client	Barr Engineering Co., Inc.	Start Time	11:29	Y-Coord	-83.76822
Boring Type	CPTU Sounding	Date	30-7-2011	Elev. Datum:	WGS 84



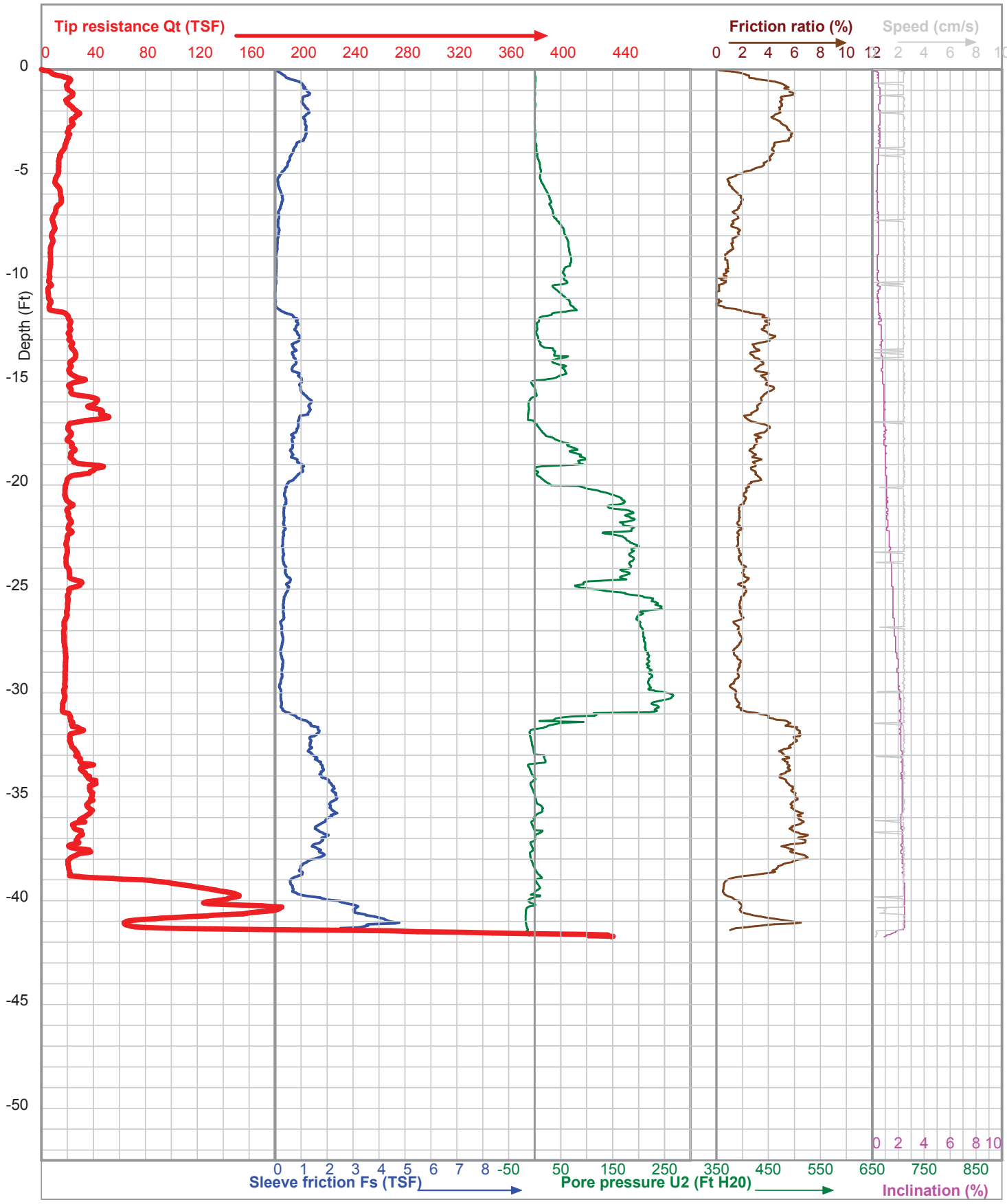
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 81	Cone Type	I-CFXYP20-15		
Test Number	81	Cone ID	090709	X-Coord	40.60079
Client	Barr Engineering Co., Inc.	Start Time	9:54	Y-Coord	-83.76453
Boring Type	CPTU Sounding	Date	25-7-2011	Elev. Datum:	WGS 84



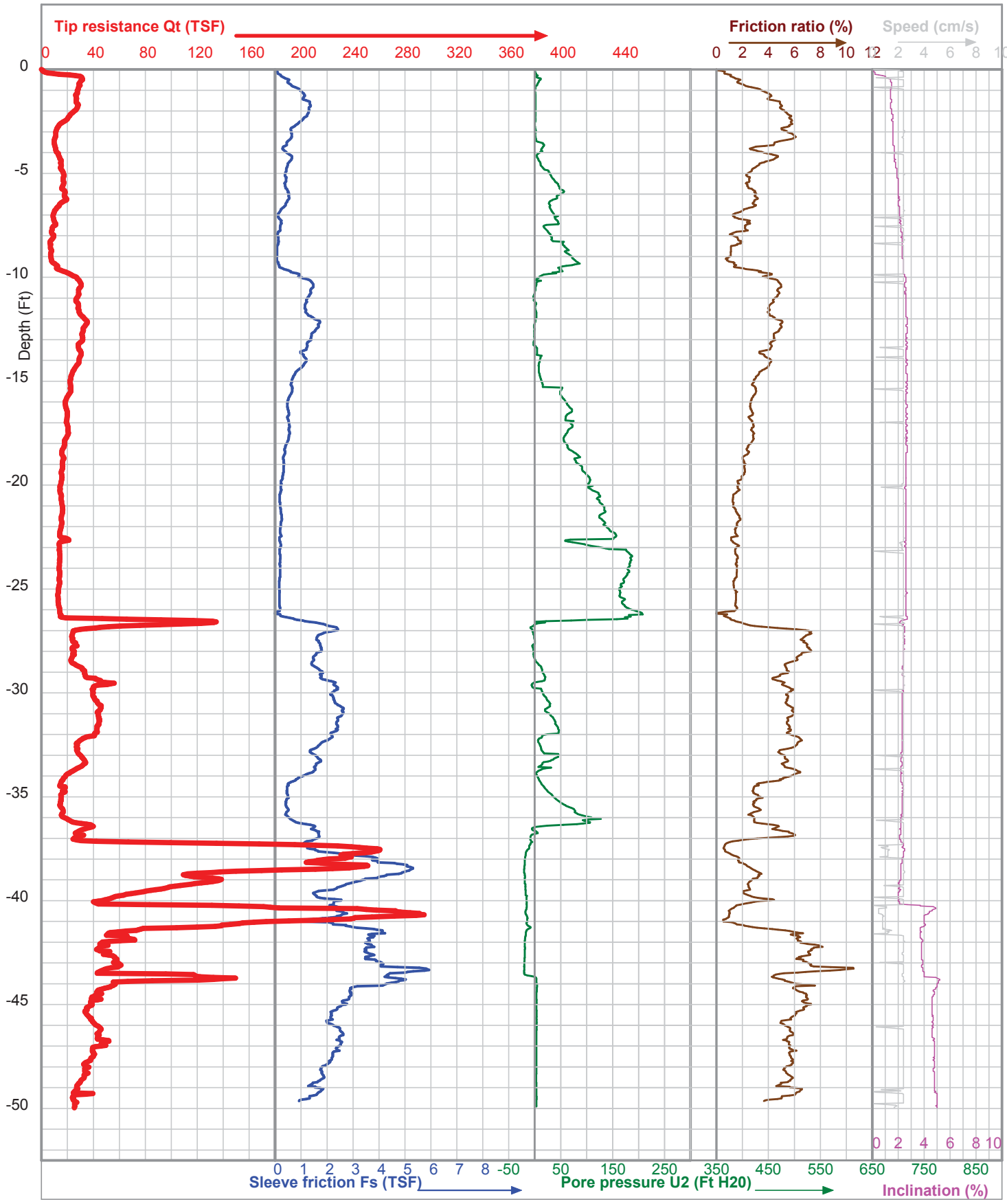
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 82	Cone Type	I-CFXYP20-15		
Test Number	82	Cone ID	090710	X-Coord	40.67631
Client	Barr Engineering Co., Inc.	Start Time	13:17	Y-Coord	-83.76747
Boring Type	CPTU Sounding	Date	29-7-2011	Elev. Datum:	WGS 84



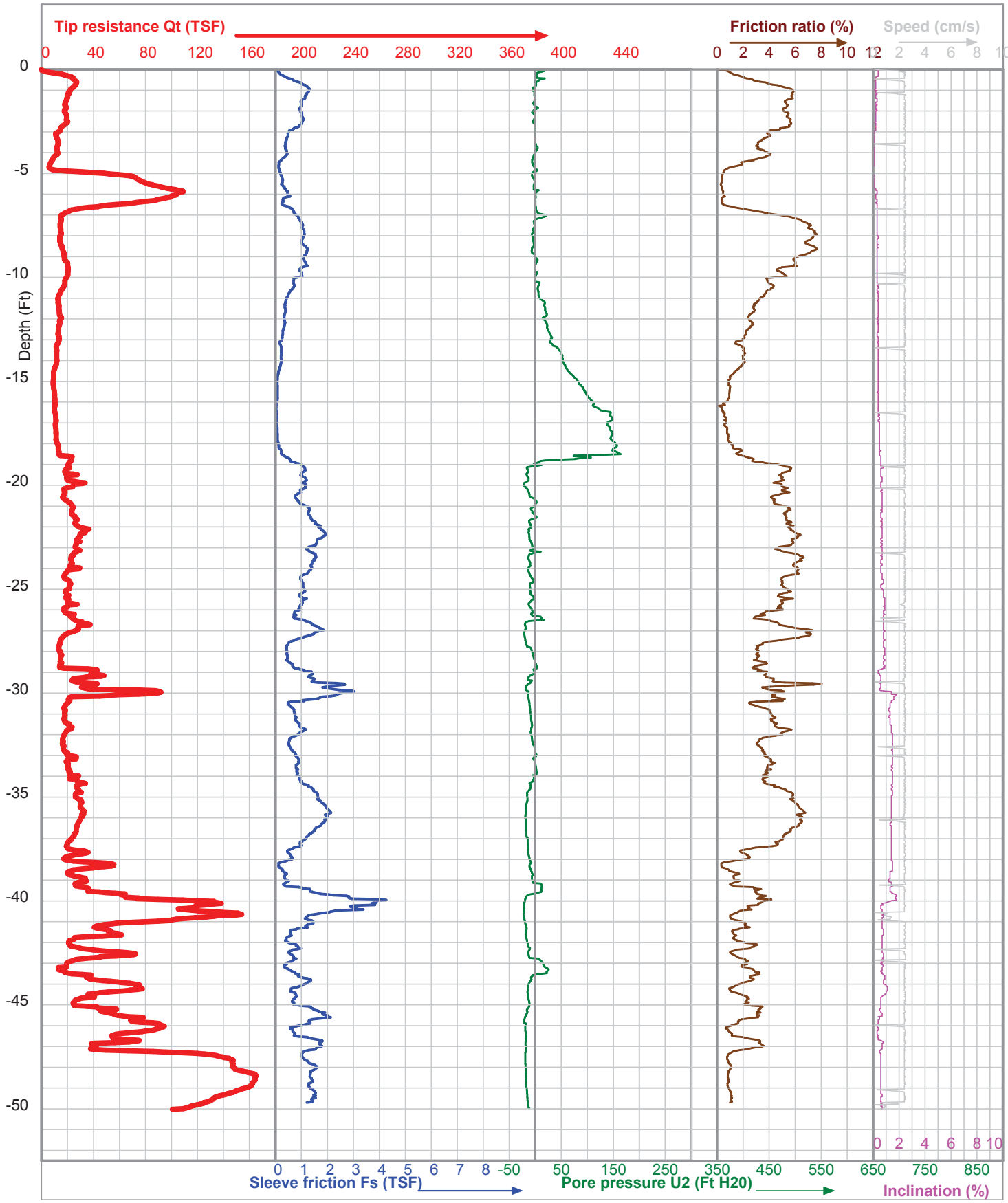
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 83	Cone Type	I-CFXYP20-15		
Test Number	83	Cone ID	090710	X-Coord	40.69517
Client	Barr Engineering Co., Inc.	Start Time	9:41	Y-Coord	-83.77795
Boring Type	CPTU Sounding	Date	31-7-2011	Elev. Datum:	WGS 84



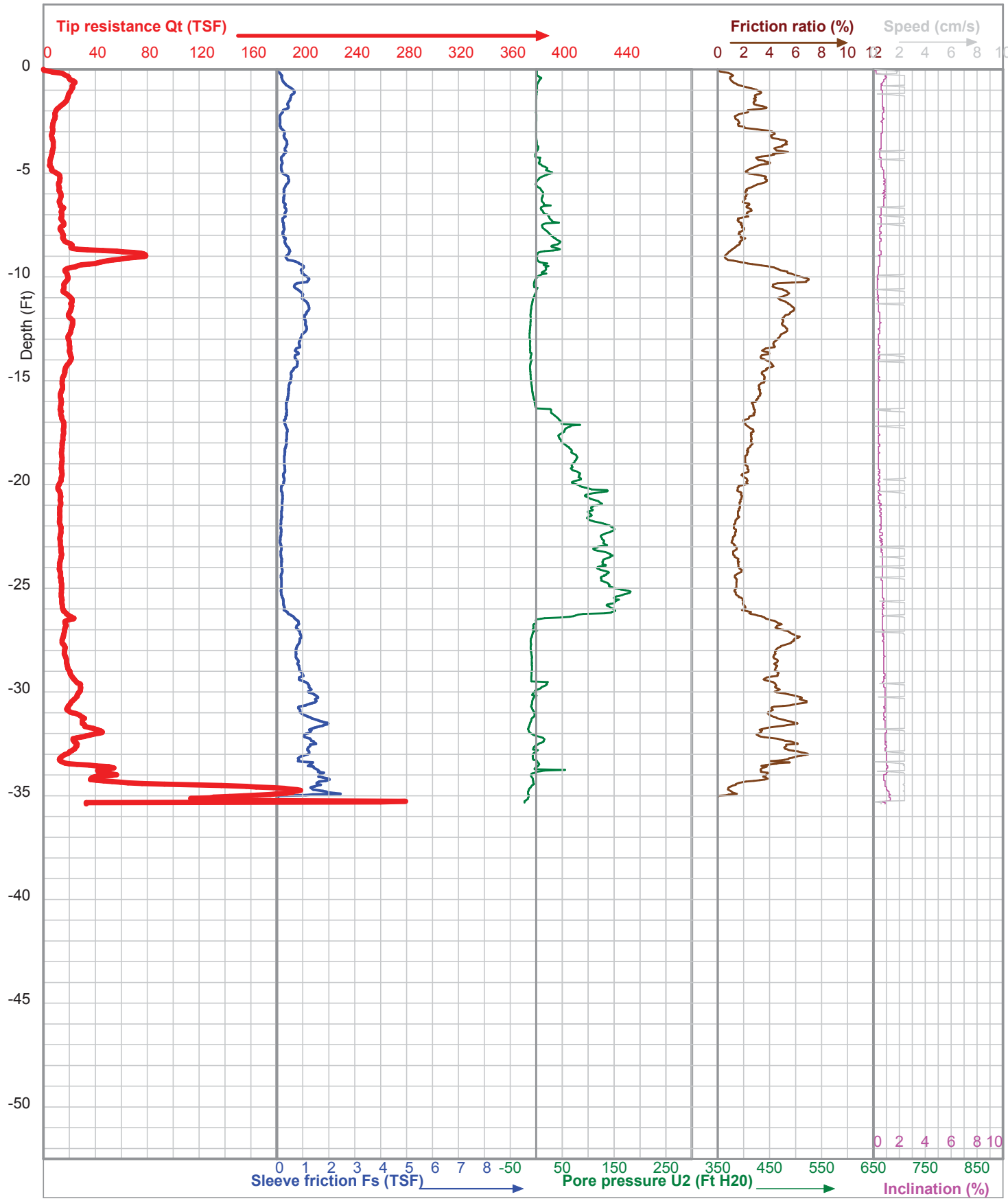
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 85	Cone Type	I-CFXYP20-15		
Test Number	85	Cone ID	090710	X-Coord	40.69320
Client	Barr Engineering Co., Inc.	Start Time	11:18	Y-Coord	-83.76903
Boring Type	CPTU Sounding	Date	31-7-2011	Elev. Datum:	WGS 84



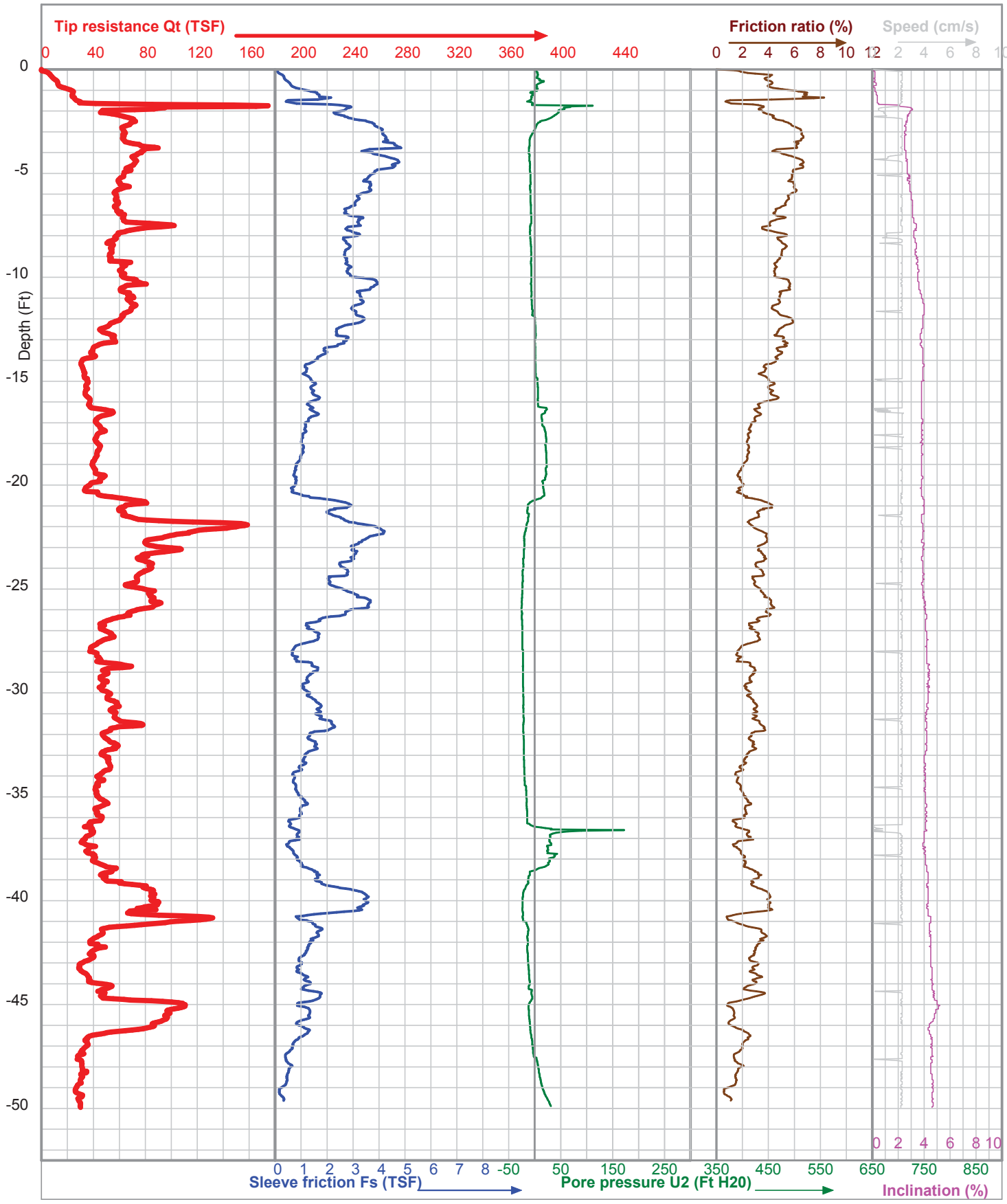
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 86	Cone Type	I-CFXYP20-15		
Test Number	86	Cone ID	090710	X-Coord	40.69156
Client	Barr Engineering Co., Inc.	Start Time	8:34	Y-Coord	-83.76596
Boring Type	CPTU Sounding	Date	31-7-2011	Elev. Datum:	WGS 84



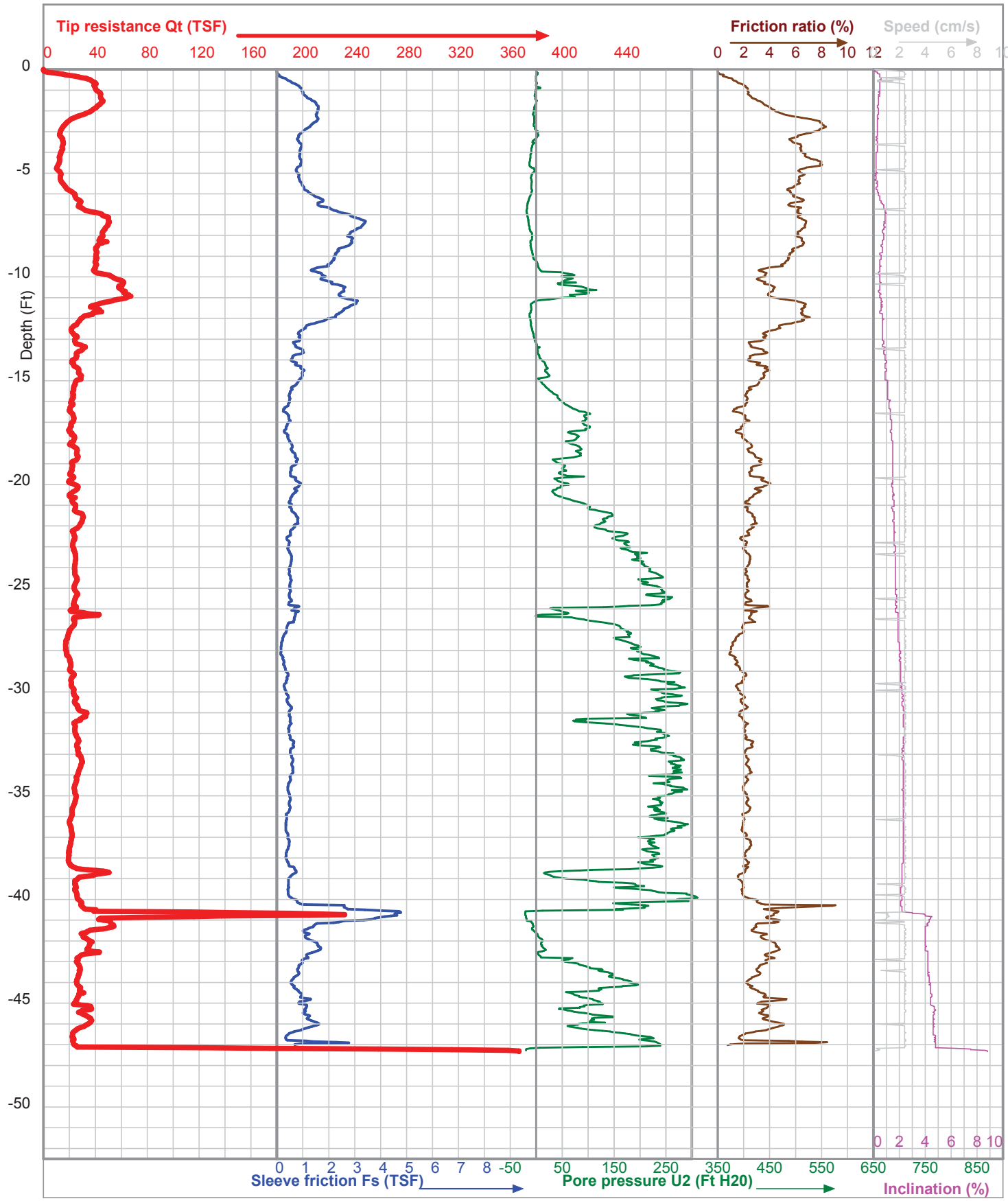
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 87	Cone Type	I-CFXYP20-15		
Test Number	87	Cone ID	090710	X-Coord	40.69115
Client	Barr Engineering Co., Inc.	Start Time	16:09	Y-Coord	-83.75871
Boring Type	CPTU Sounding	Date	30-7-2011	Elev. Datum:	WGS 84



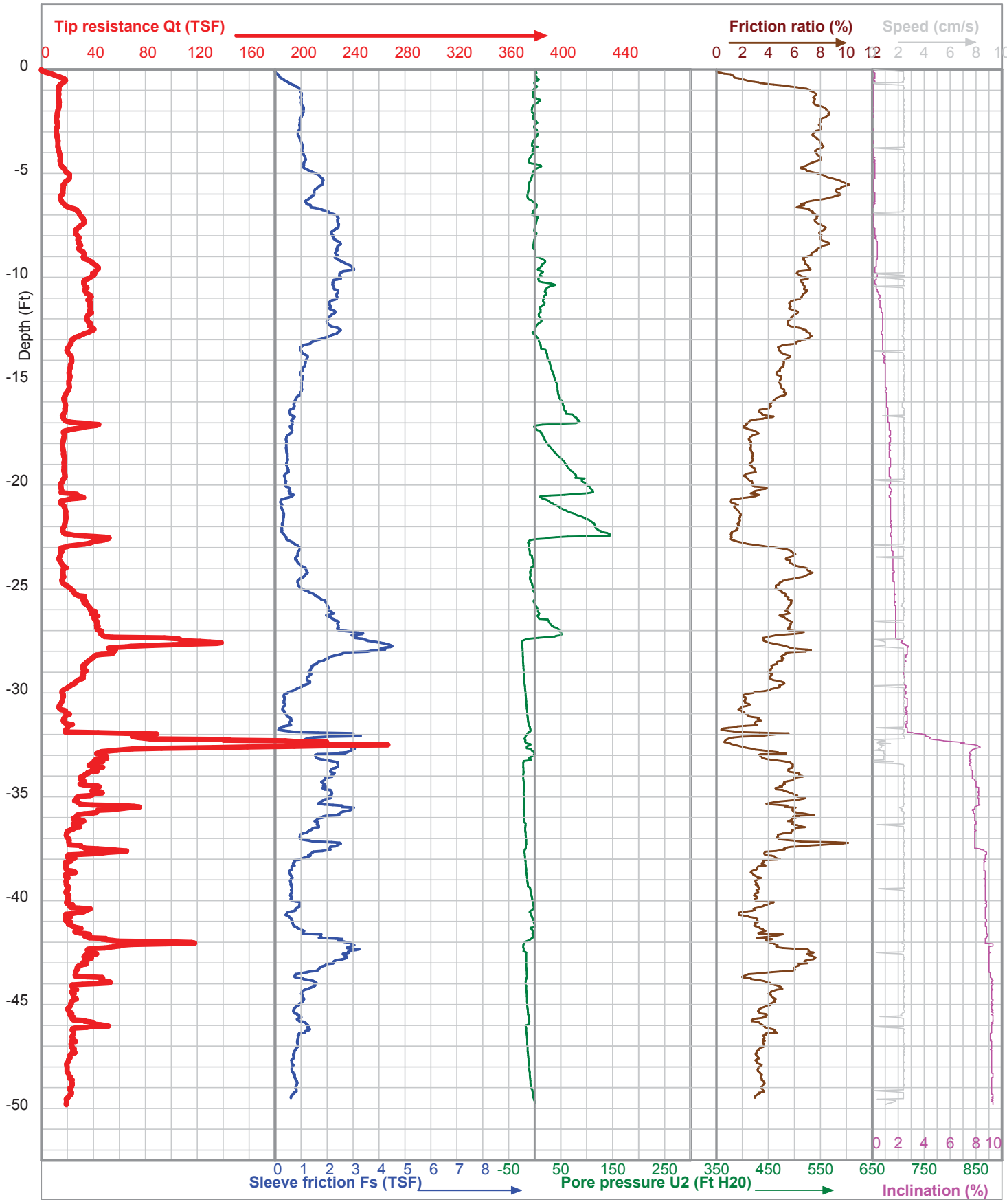
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 88	Cone Type	I-CFXYP20-15		
Test Number	88	Cone ID	090710	X-Coord	40.69460
Client	Barr Engineering Co., Inc.	Start Time	7:32	Y-Coord	-83.76006
Boring Type	CPTU Sounding	Date	31-7-2011	Elev. Datum:	WGS 84



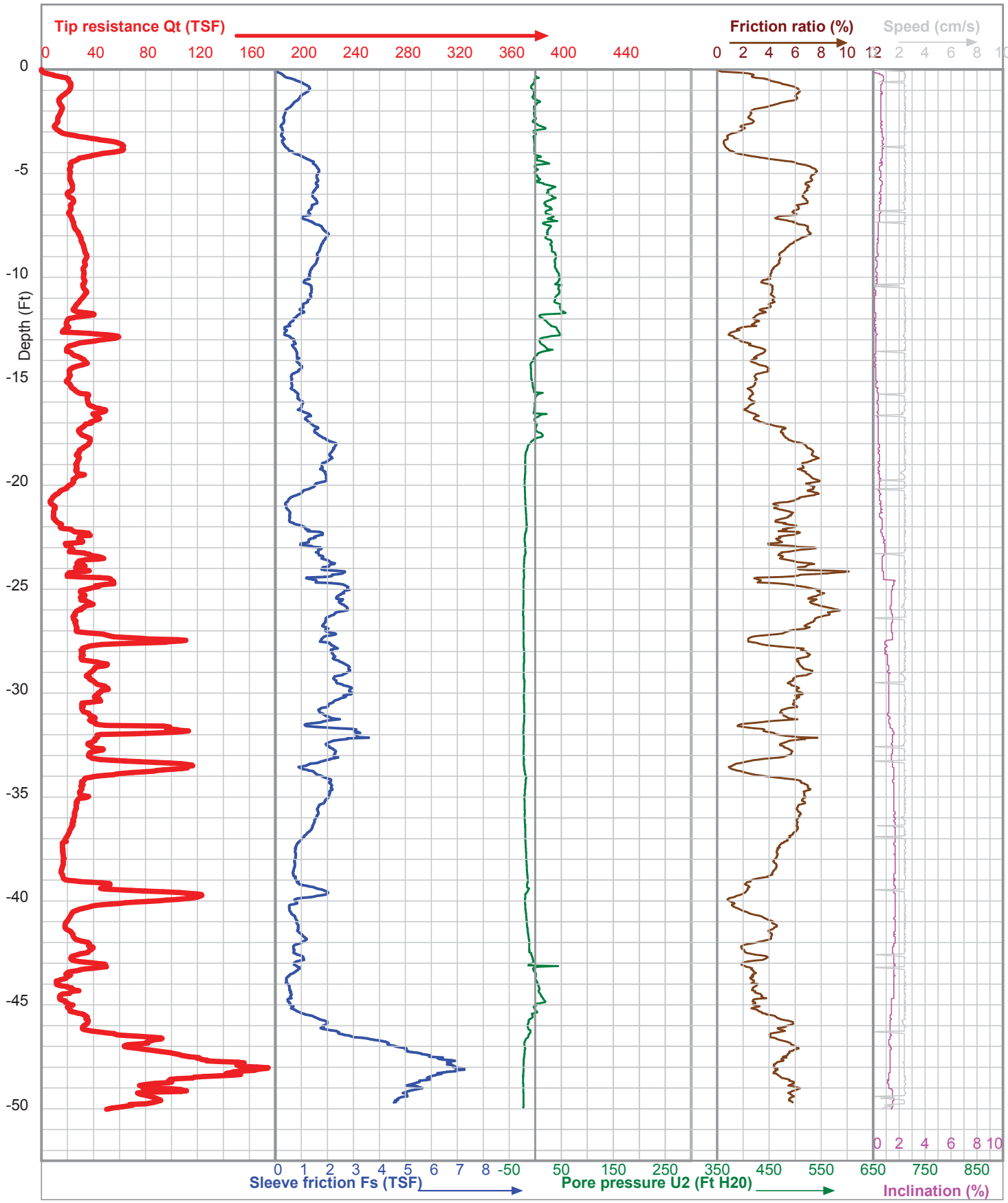
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 89	Cone Type	I-CFXYP20-15		
Test Number	89	Cone ID	090709	X-Coord	40.58477
Client	Barr Engineering Co., Inc.	Start Time	11:13	Y-Coord	-83.76984
Boring Type	CPTU Sounding	Date	24-7-2011	Elev. Datum:	WGS 84



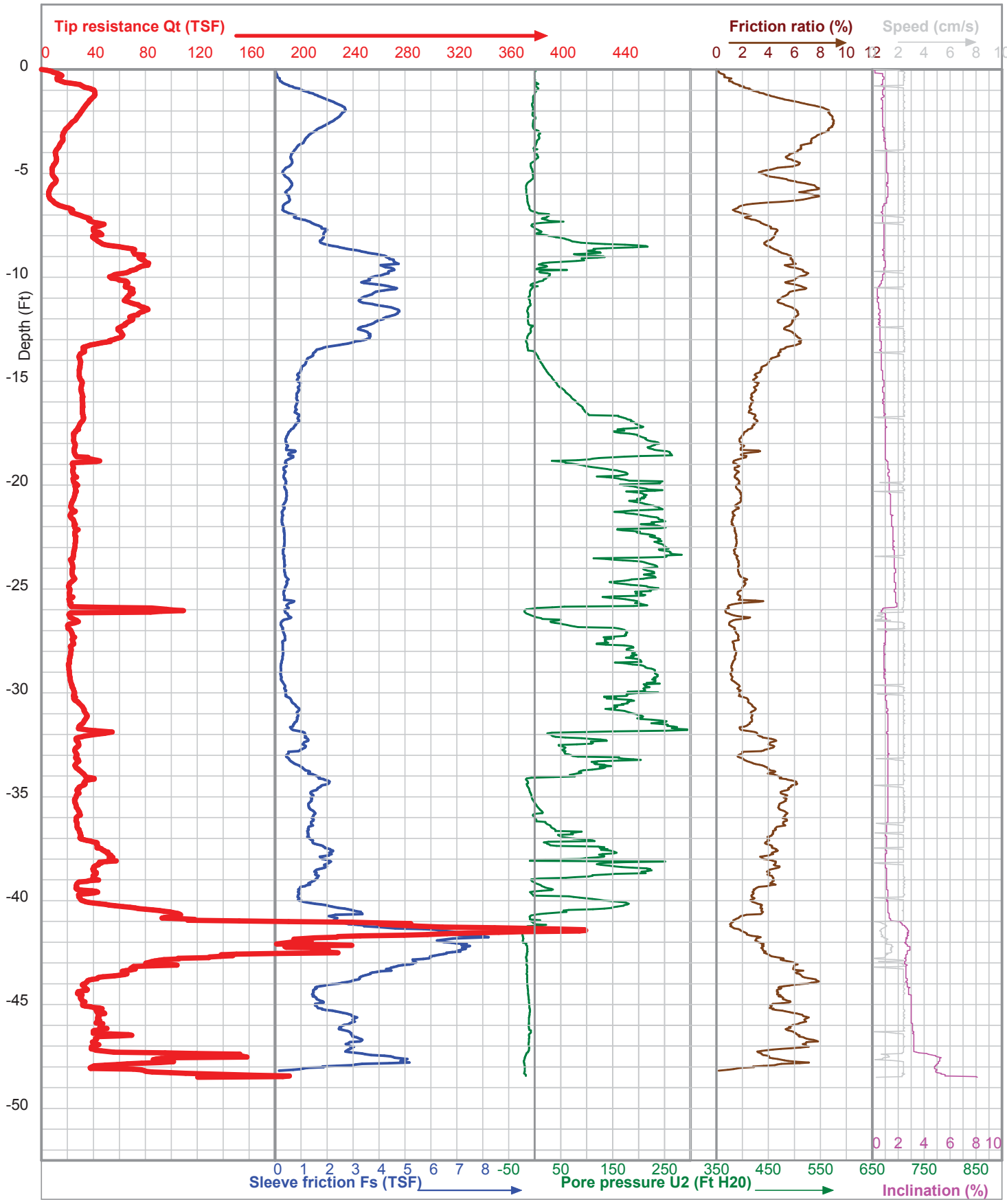
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 90	Cone Type	I-CFXYP20-15		
Test Number	90	Cone ID	090710	X-Coord	40.70147
Client	Barr Engineering Co., Inc.	Start Time	12:48	Y-Coord	-83.75142
Boring Type	CPTU Sounding	Date	30-7-2011	Elev. Datum:	WGS 84



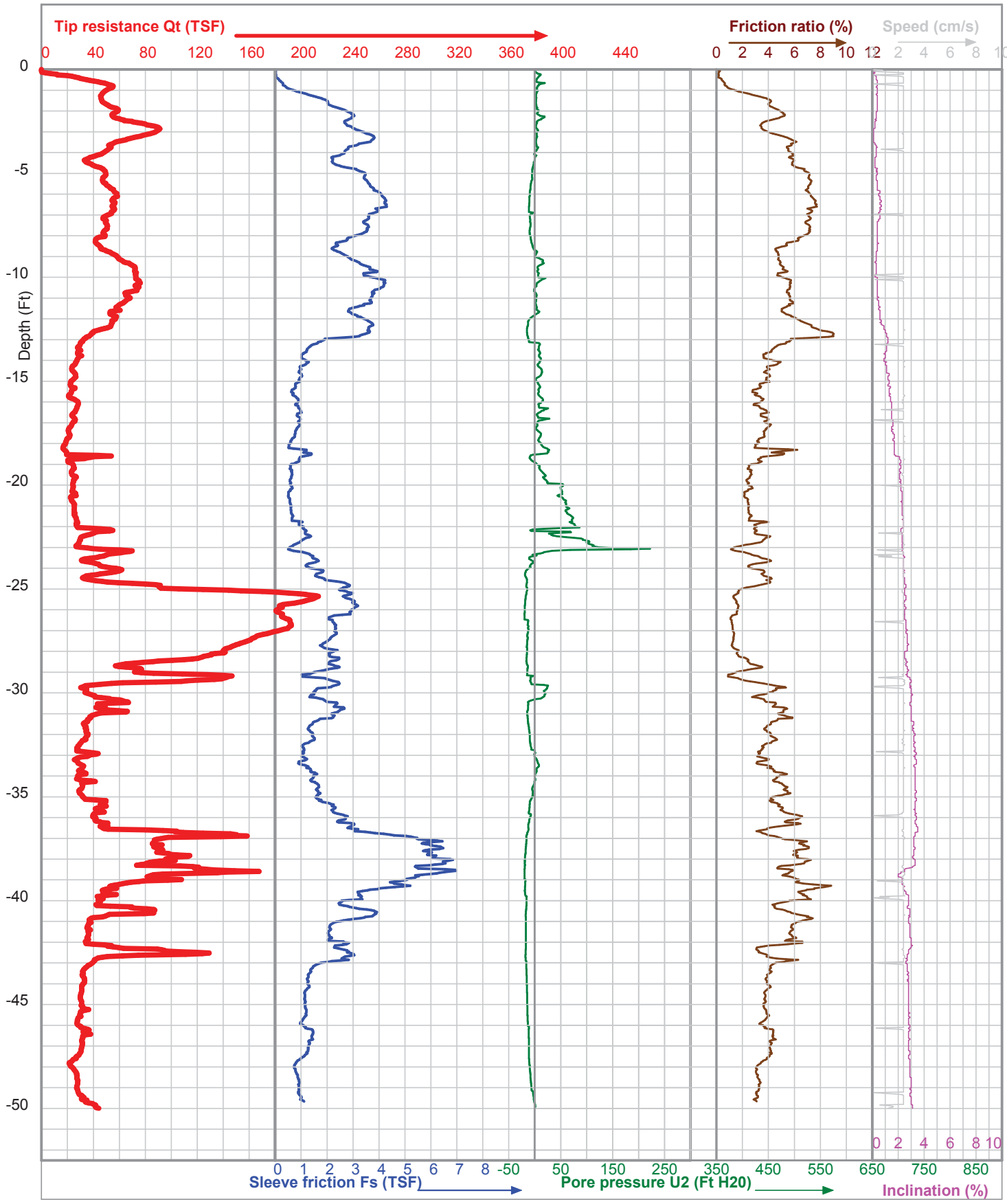
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 91	Cone Type	I-CFXYP20-15		
Test Number	91	Cone ID	090710	X-Coord	40.69854
Client	Barr Engineering Co., Inc.	Start Time	13:38	Y-Coord	-83.75119
Boring Type	CPTU Sounding	Date	30-7-2011	Elev. Datum:	WGS 84



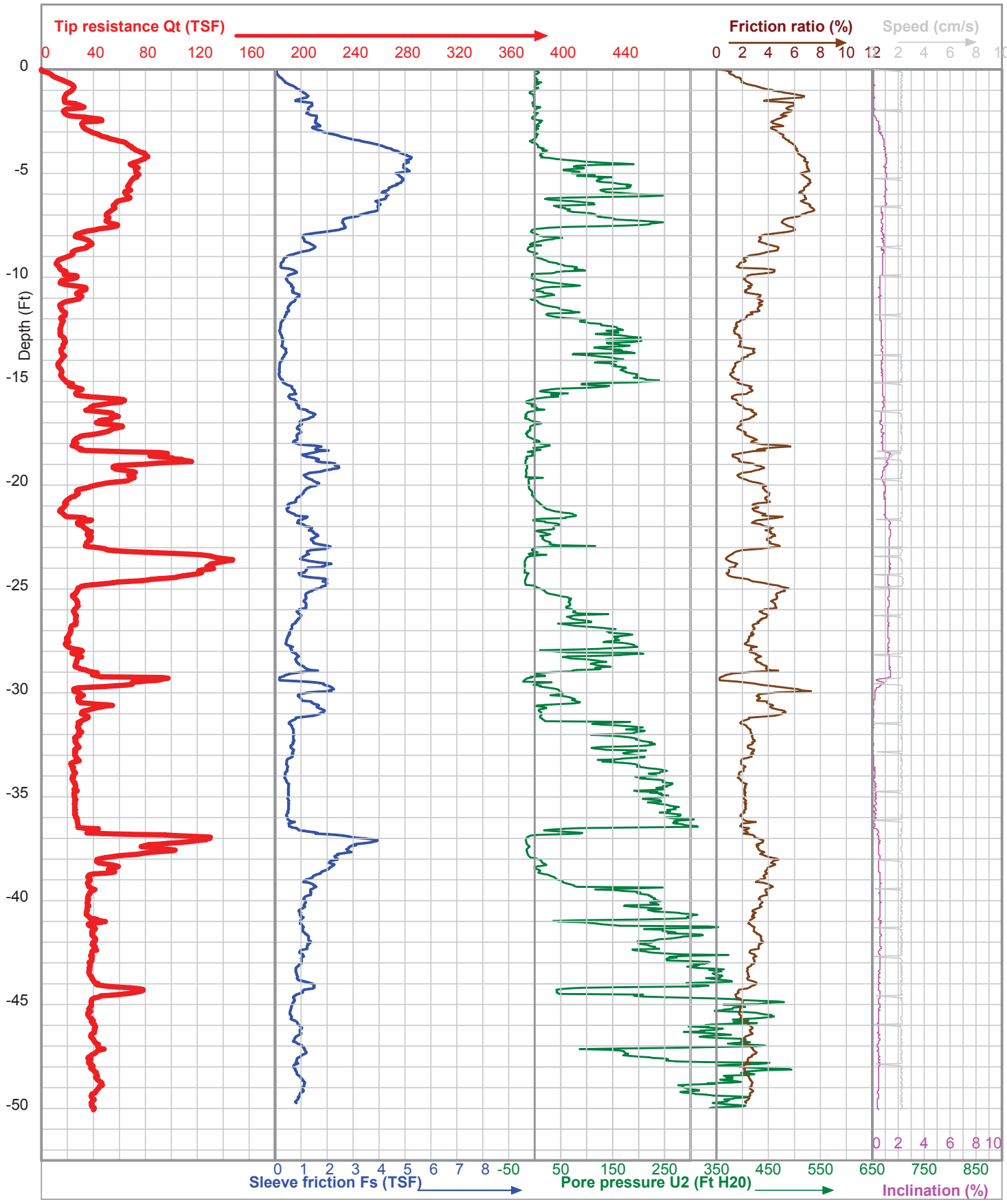
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 92	Cone Type	I-CFXYP20-15		
Test Number	92	Cone ID	090710	X-Coord	40.69492
Client	Barr Engineering Co., Inc.	Start Time	15:25	Y-Coord	-83.74931
Boring Type	CPTU Sounding	Date	30-7-2011	Elev. Datum:	WGS 84



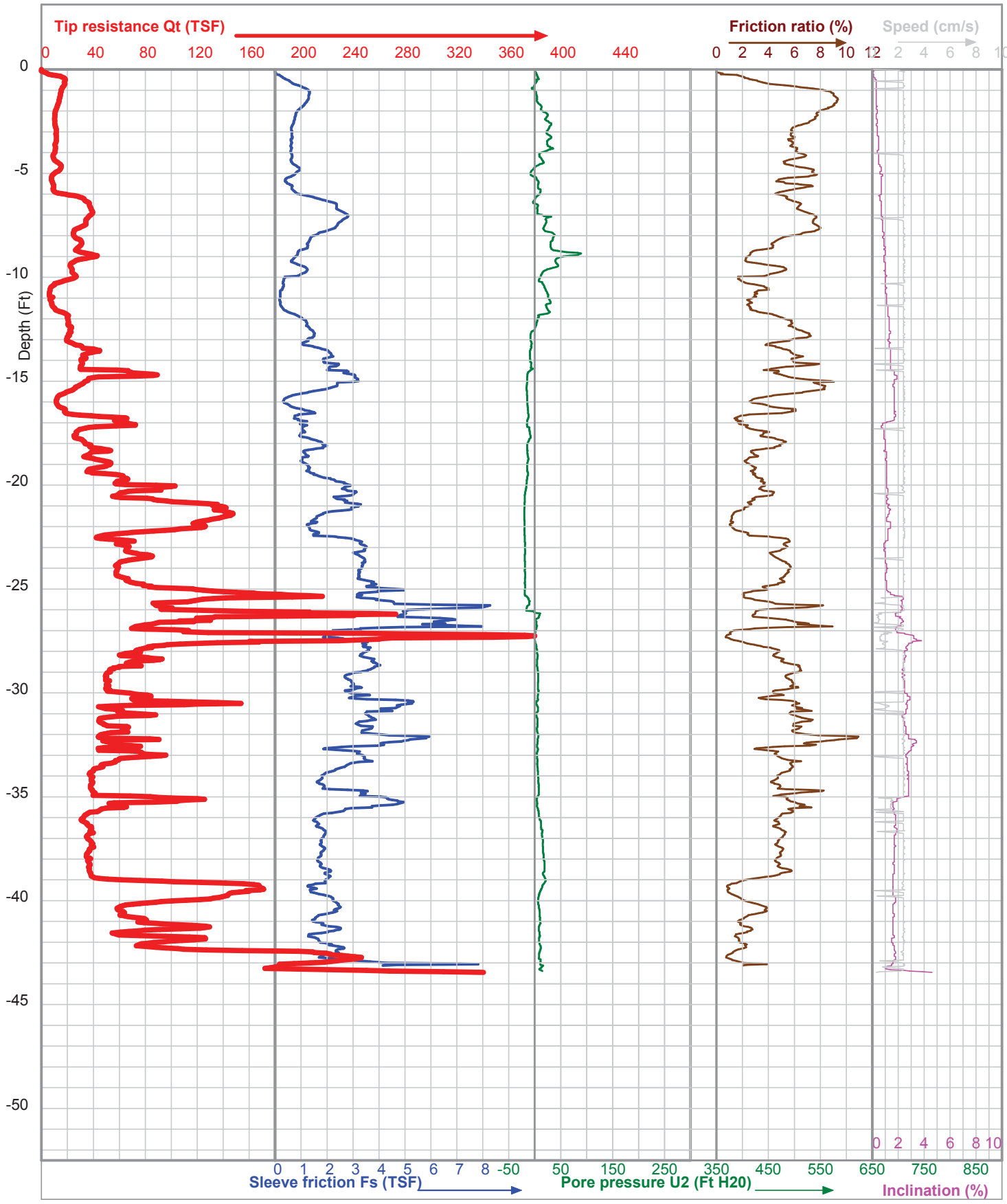
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 93	Cone Type	I-CFXYP20-15		
Test Number	93	Cone ID	090710	X-Coord	40.70211
Client	Barr Engineering Co., Inc.	Start Time	11:48	Y-Coord	-83.74438
Boring Type	CPTU Sounding	Date	30-7-2011	Elev. Datum:	WGS 84



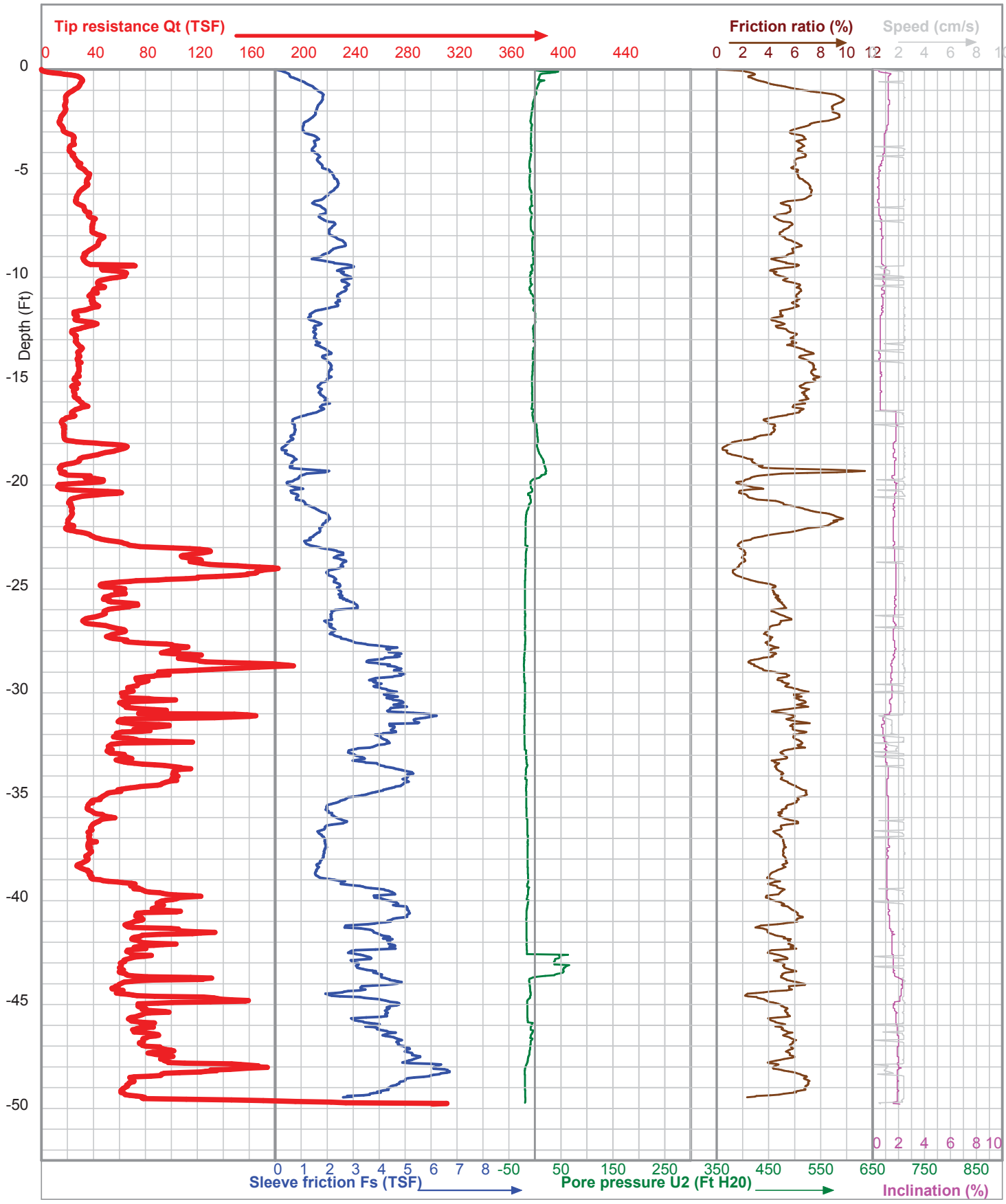
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 94	Cone Type	I-CFXYP20-15		
Test Number	94	Cone ID	090710	X-Coord	40.70020
Client	Barr Engineering Co., Inc.	Start Time	9:11	Y-Coord	-83.74189
Boring Type	CPTU Sounding	Date	30-7-2011	Elev. Datum:	WGS 84



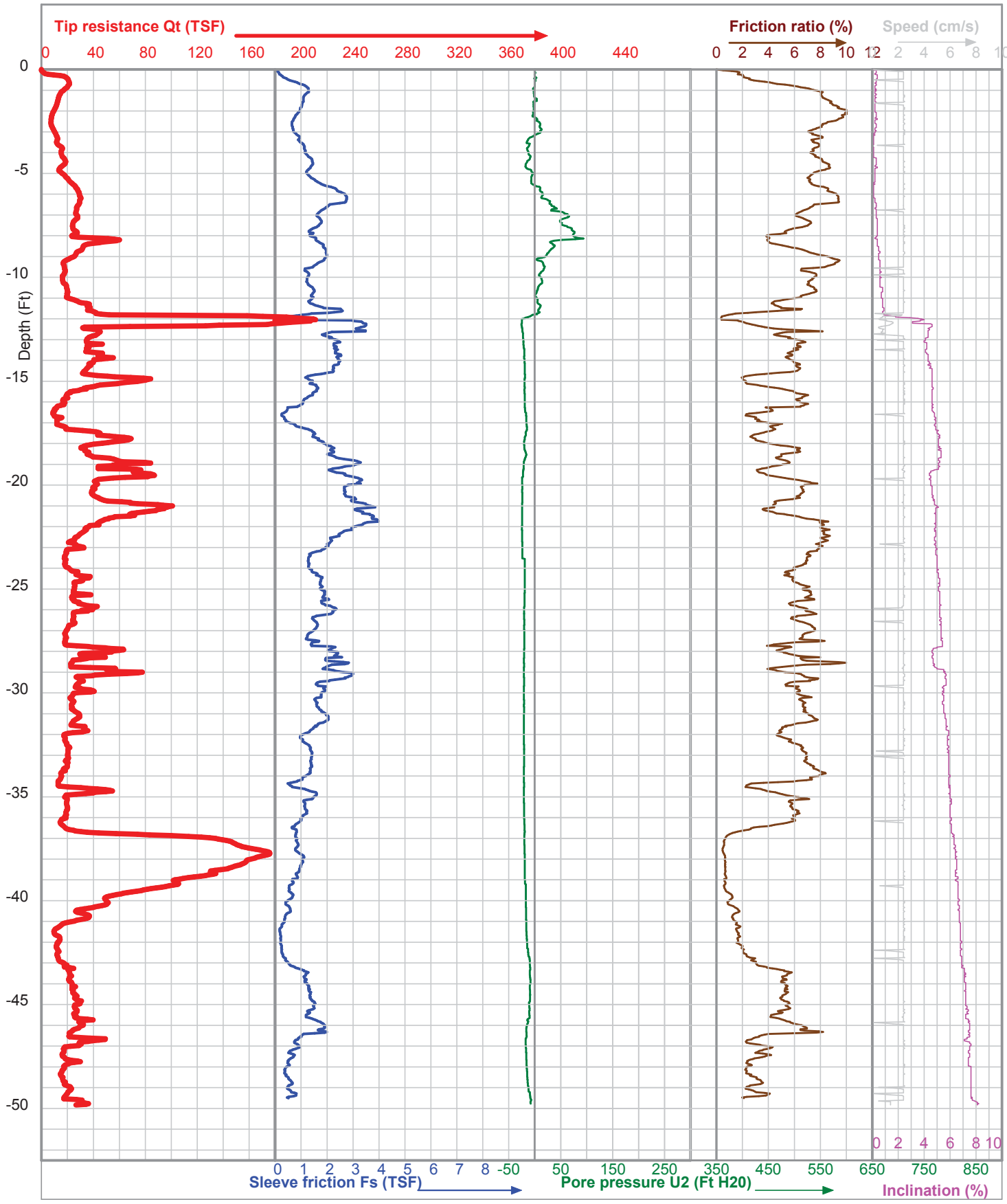
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 95	Cone Type	I-CFXYPP20-15		
Test Number	95	Cone ID	100624	X-Coord	40.58261
Client	Barr Engineering Co., Inc.	Start Time	12:44	Y-Coord	-83.76571
Boring Type	CPTU Sounding	Date	24-7-2011	Elev. Datum:	WGS 84



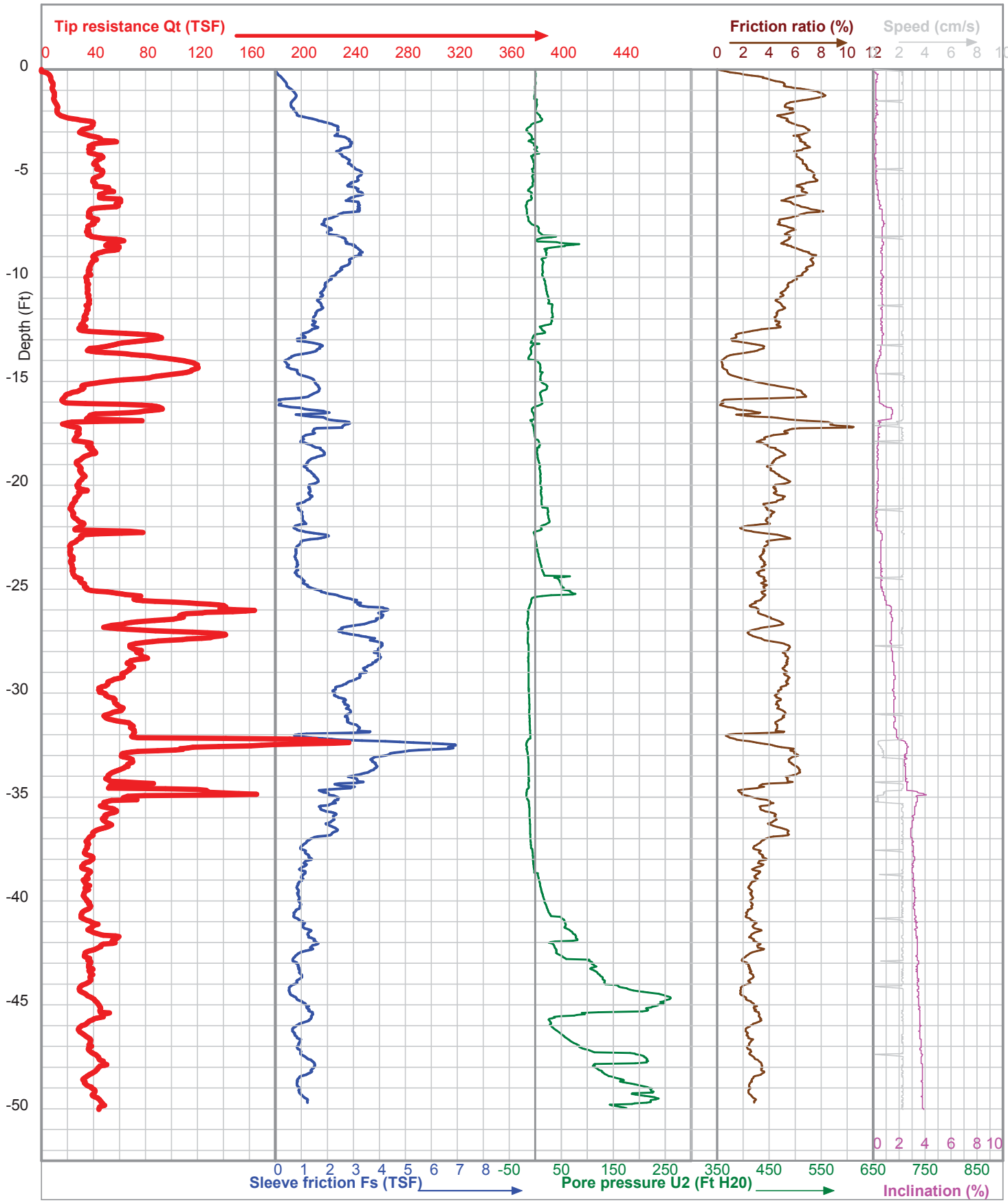
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 96	Cone Type	I-CFXYP20-15		
Test Number	96	Cone ID	090710	X-Coord	40.69539
Client	Barr Engineering Co., Inc.	Start Time	10:58	Y-Coord	-83.74233
Boring Type	CPTU Sounding	Date	30-7-2011	Elev. Datum:	WGS 84



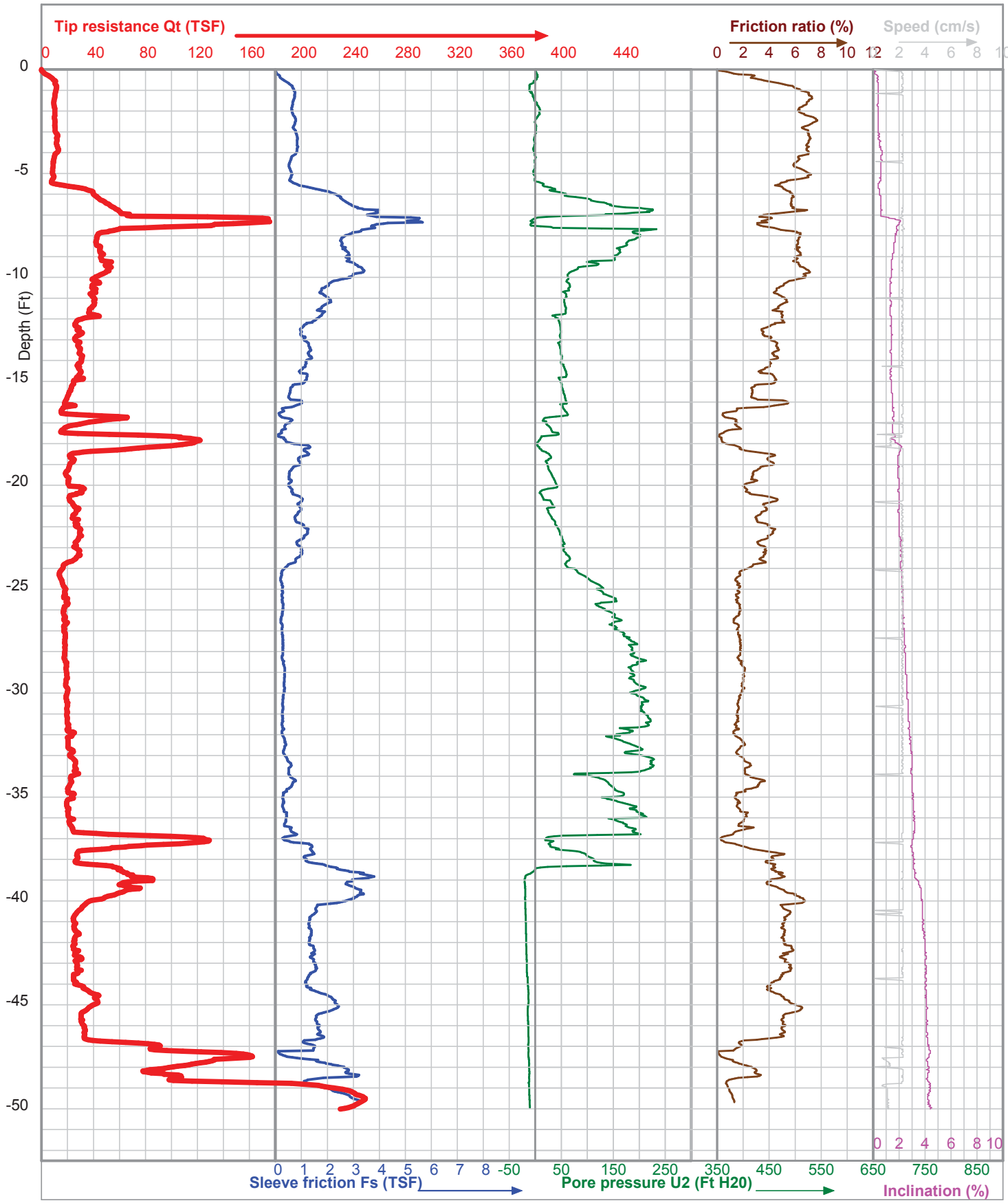
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 97	Cone Type	I-CFXYP20-15		
Test Number	97	Cone ID	090710	X-Coord	40.69922
Client	Barr Engineering Co., Inc.	Start Time	8:55	Y-Coord	-83.73323
Boring Type	CPTU Sounding	Date	29-7-2011	Elev. Datum:	WGS 84



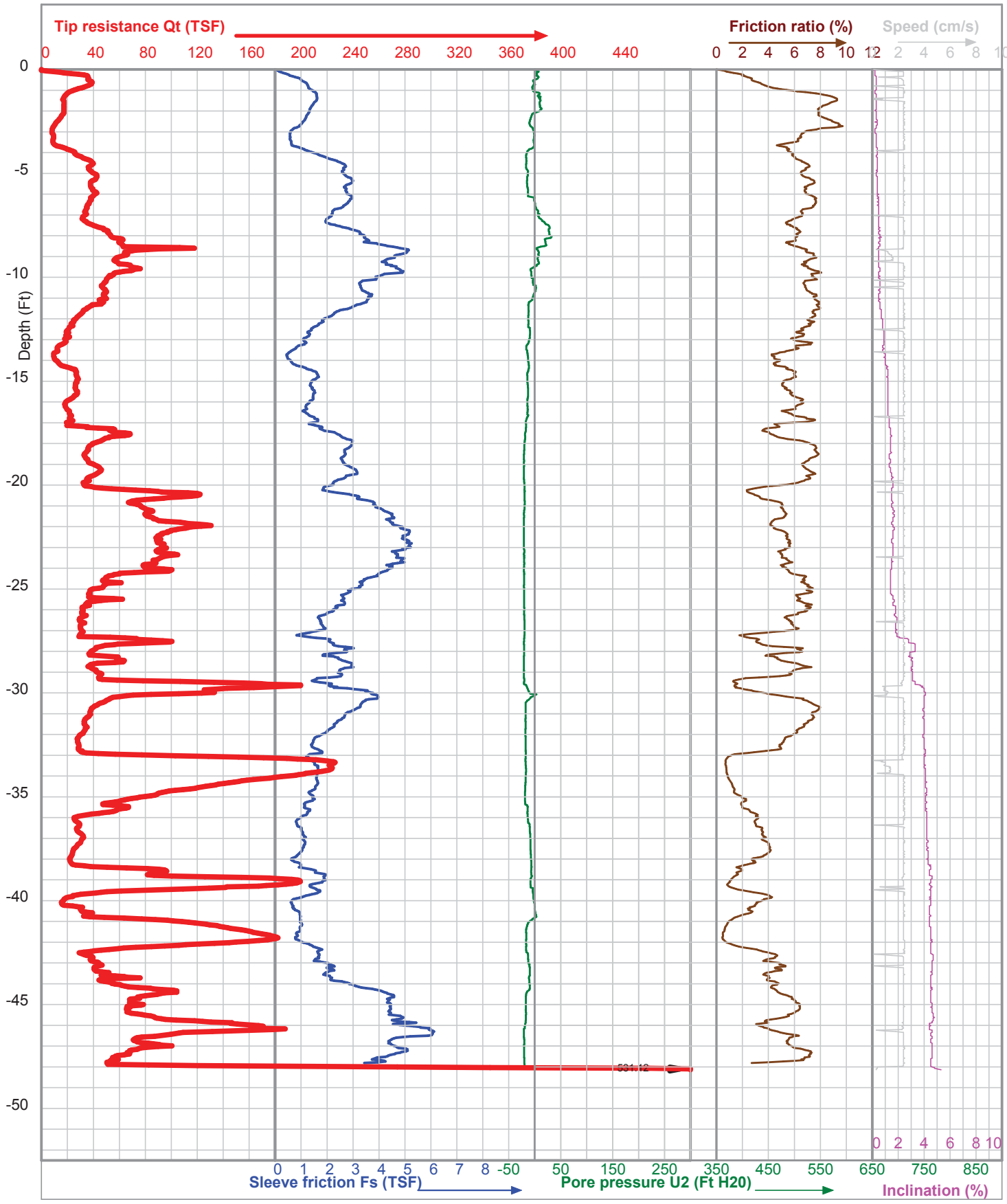
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 98	Cone Type	I-CFXYP20-15		
Test Number	98	Cone ID	090710	X-Coord	40.69643
Client	Barr Engineering Co., Inc.	Start Time	10:08	Y-Coord	-83.73321
Boring Type	CPTU Sounding	Date	29-7-2011	Elev. Datum:	WGS 84



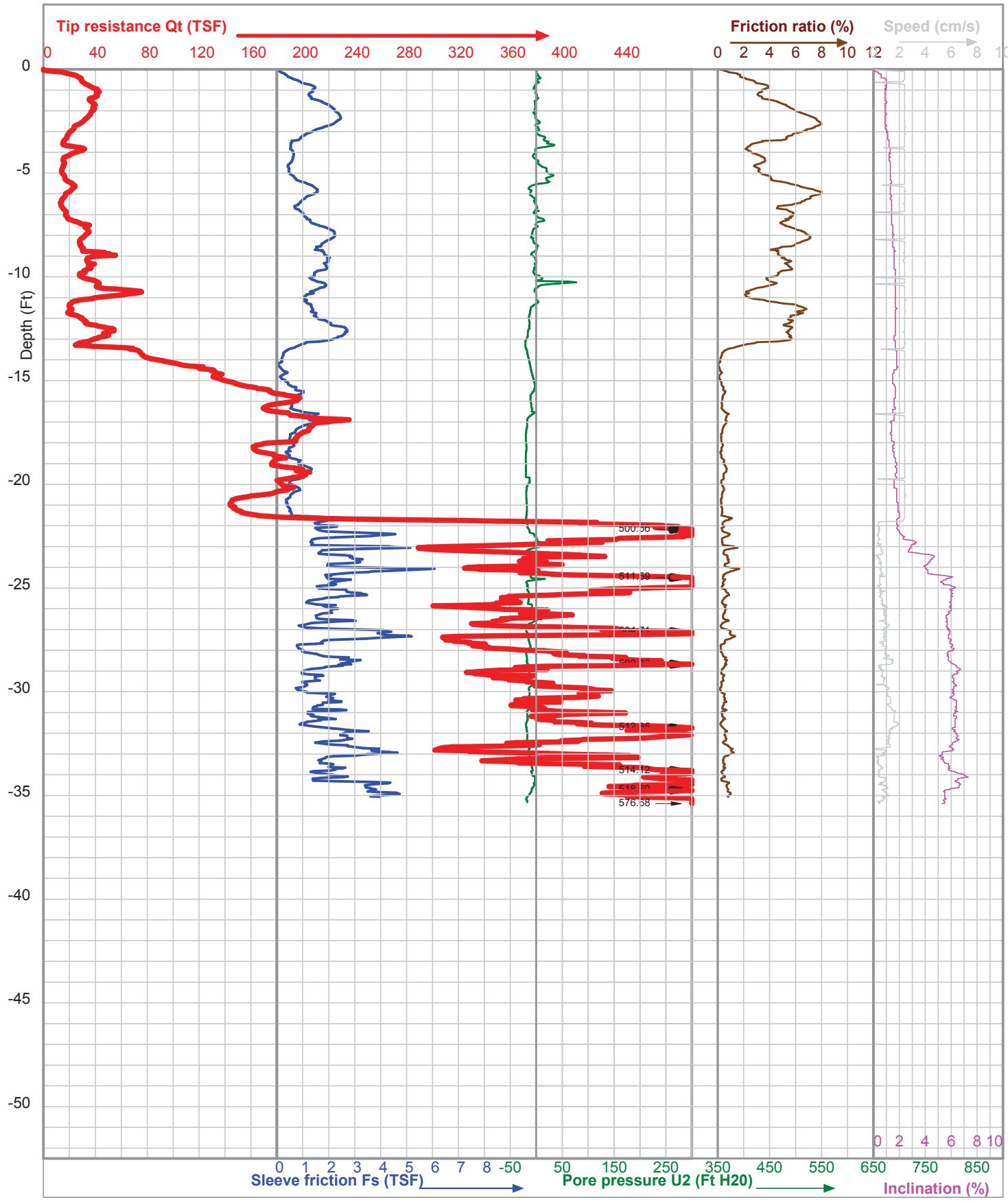
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 99	Cone Type	I-CFXYPP20-15		
Test Number	99	Cone ID	100624	X-Coord	40.58775
Client	Barr Engineering Co., Inc.	Start Time	10:18	Y-Coord	-83.77178
Boring Type	CPTU Sounding	Date	24-7-2011	Elev. Datum:	WGS 84



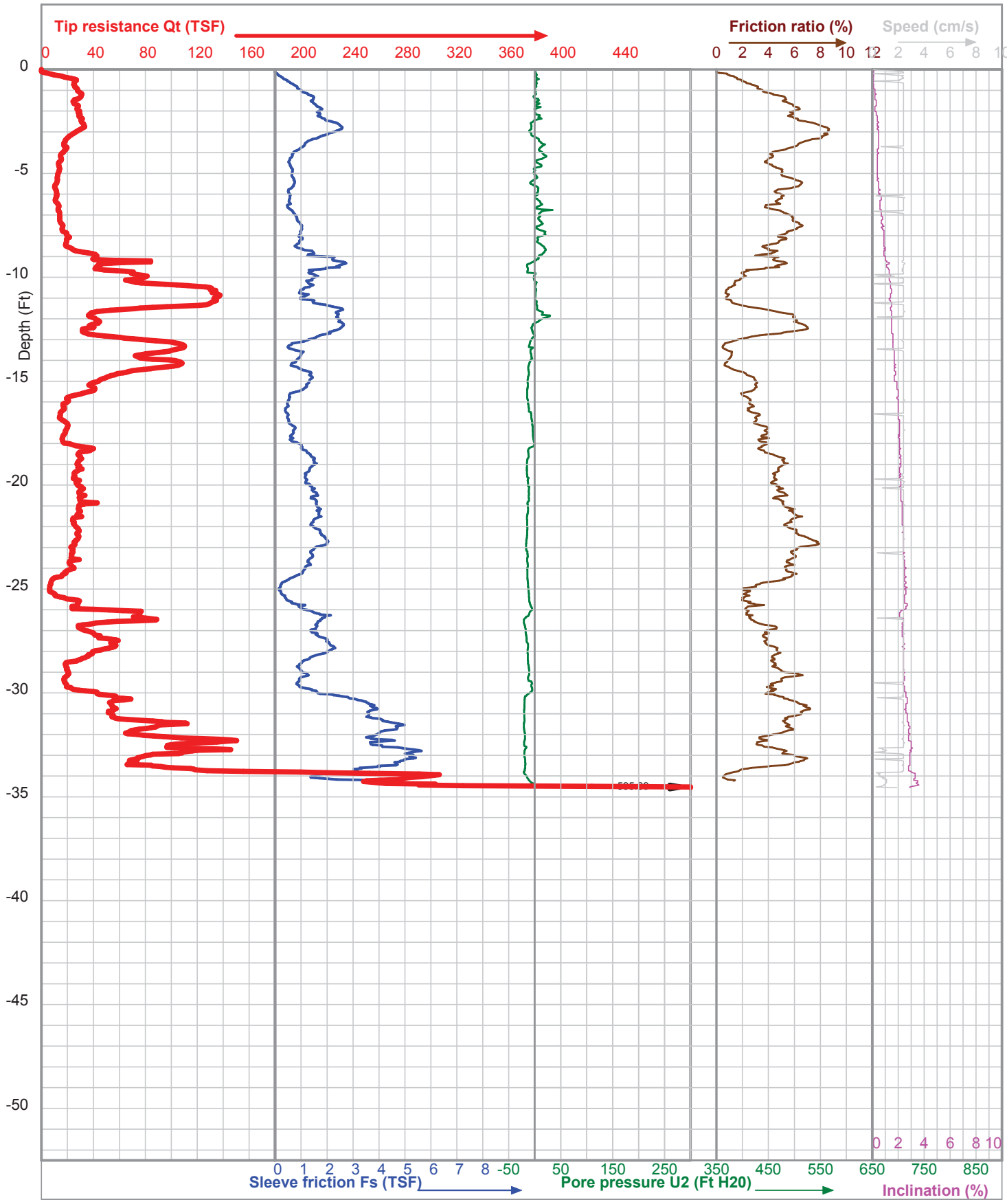
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 102	Cone Type	I-CFXYPP20-15		
Test Number	102	Cone ID	100624	X-Coord	40.60519
Client	Barr Engineering Co., Inc.	Start Time	9:07	Y-Coord	-83.76630
Boring Type	CPTU Sounding	Date	25-7-2011	Elev. Datum:	WGS 84



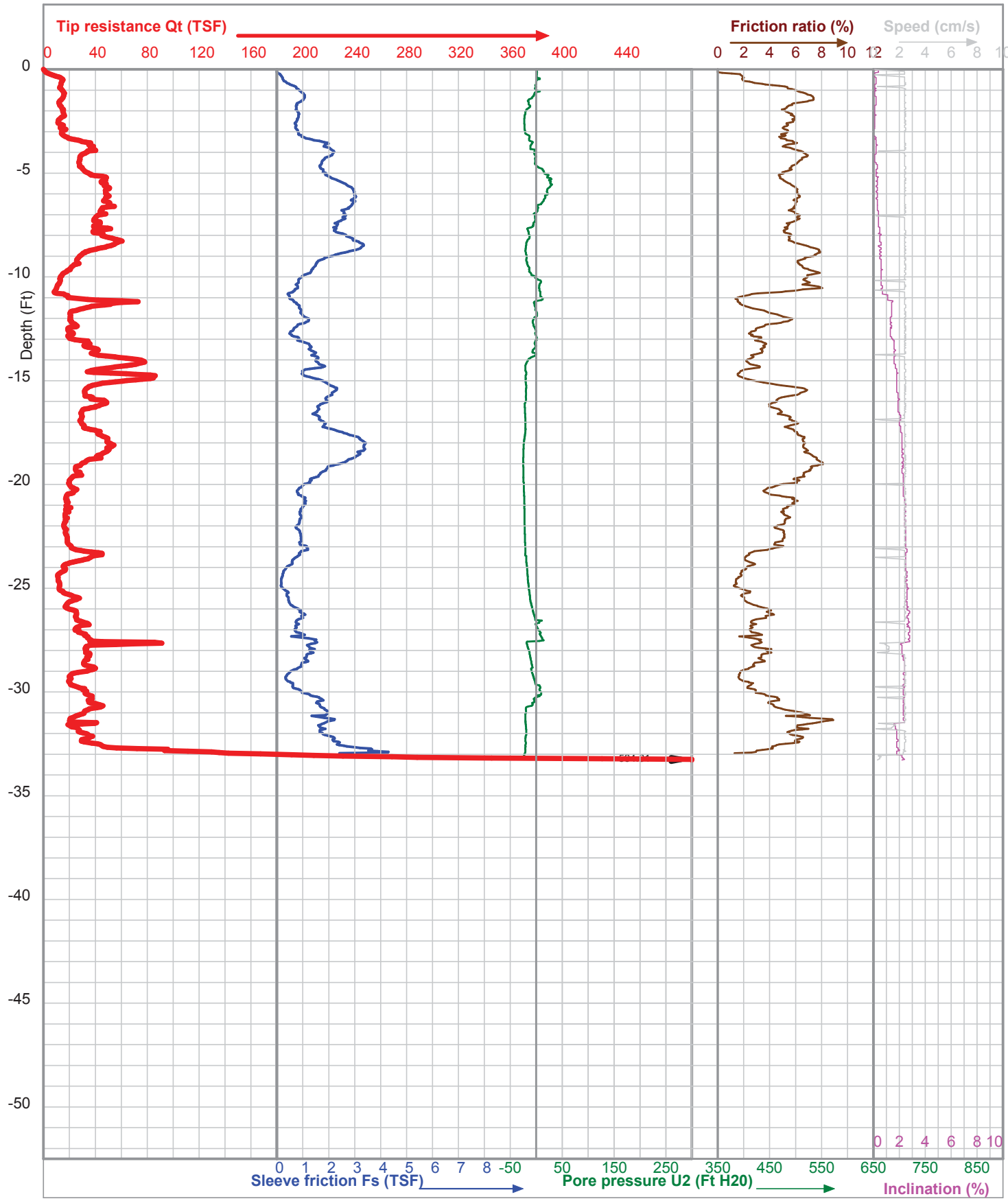
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 107	Cone Type	I-CFXYP20-15		
Test Number	107	Cone ID	090710	X-Coord	40.67803
Client	Barr Engineering Co., Inc.	Start Time	11:00	Y-Coord	-83.72410
Boring Type	CPTU Sounding	Date	29-7-2011	Elev. Datum:	WGS 84



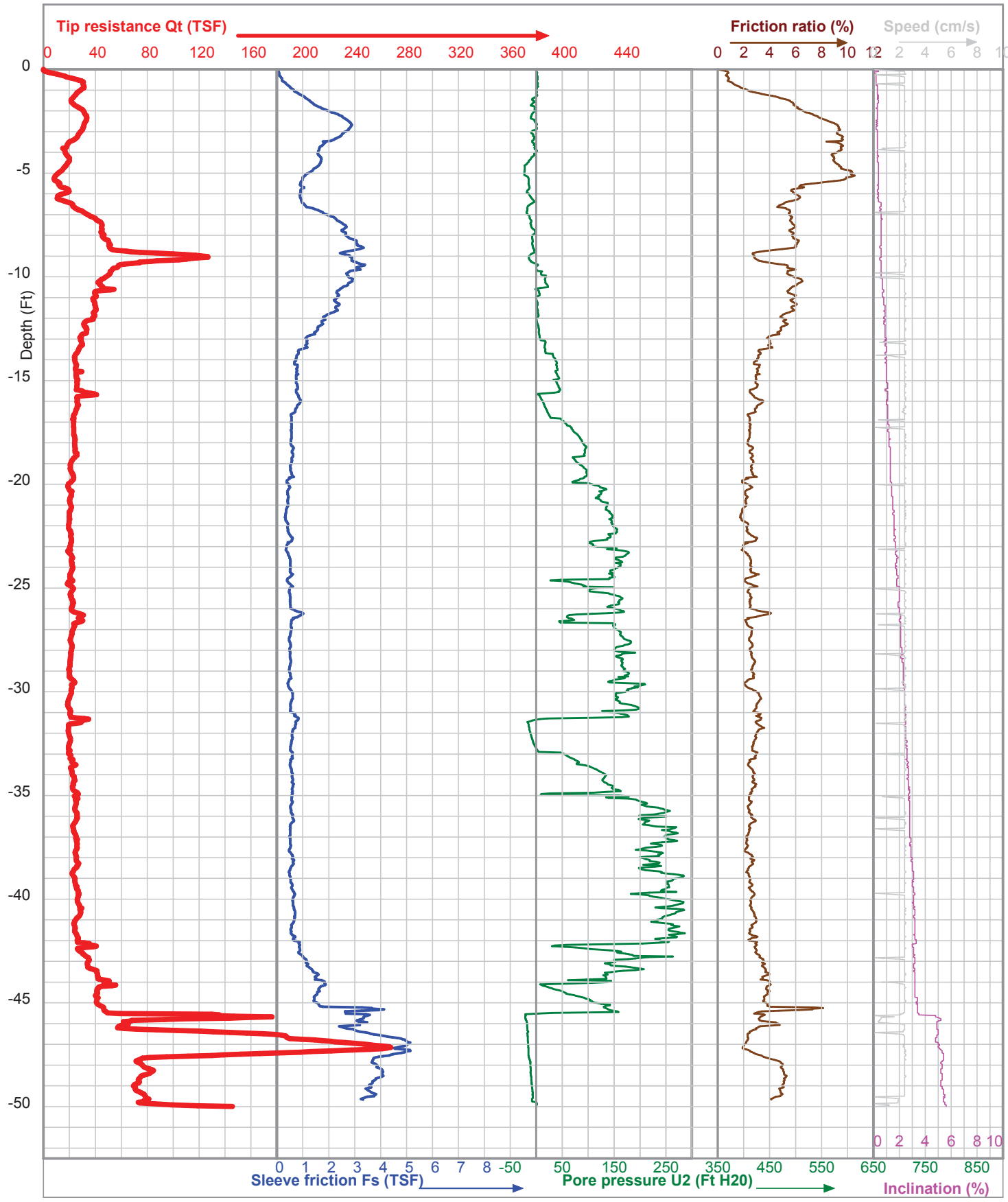
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 108	Cone Type	I-CFXYP20-15		
Test Number	108	Cone ID	090710	X-Coord	40.68198
Client	Barr Engineering Co., Inc.	Start Time	8:010	Y-Coord	-83.75747
Boring Type	CPTU Sounding	Date	30-7-2011	Elev. Datum:	WGS 84



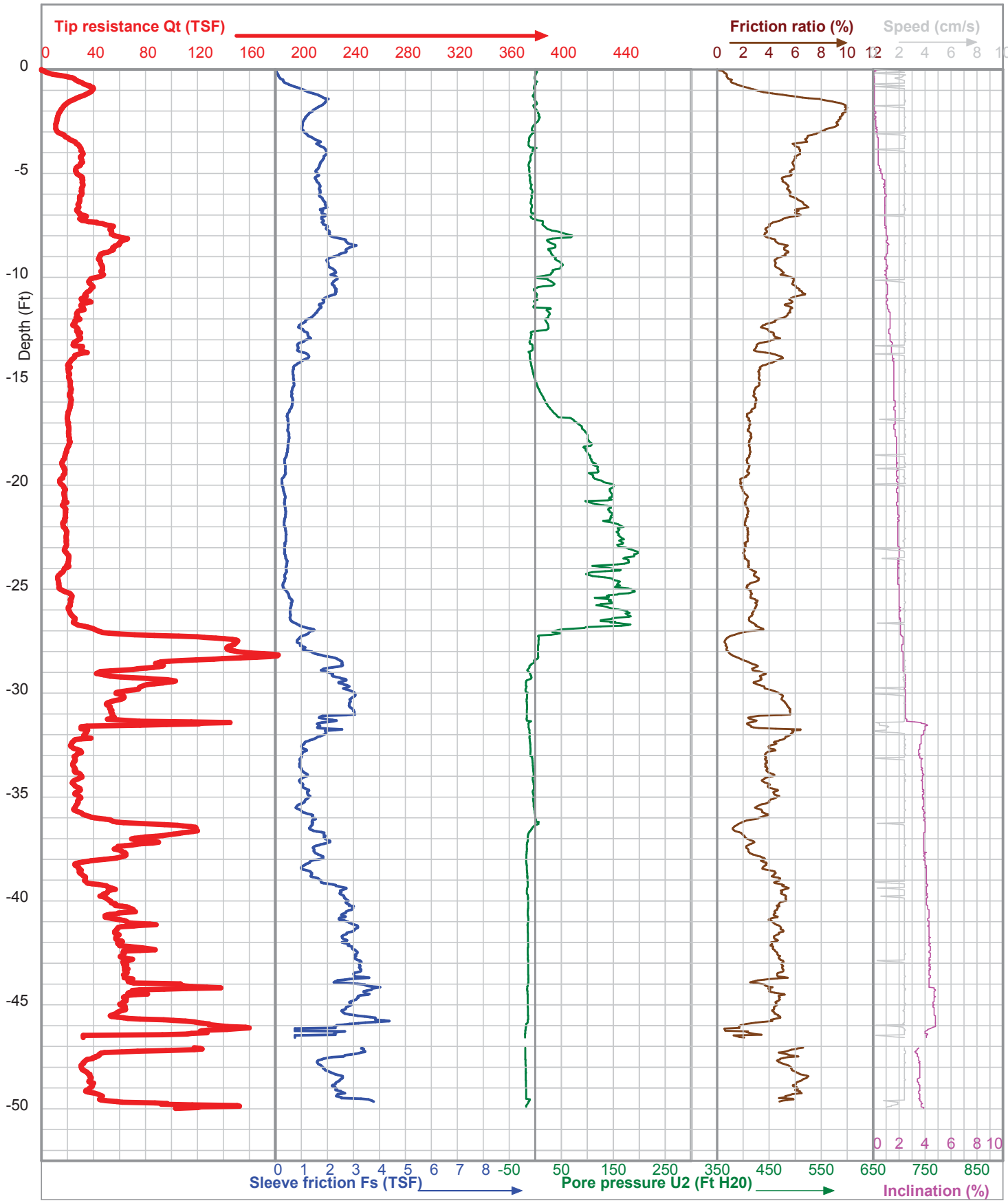
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 109	Cone Type	I-CFXYP20-15		
Test Number	109	Cone ID	090710	X-Coord	40.68000
Client	Barr Engineering Co., Inc.	Start Time	7:27	Y-Coord	-83.75389
Boring Type	CPTU Sounding	Date	30-7-2011	Elev. Datum:	WGS 84



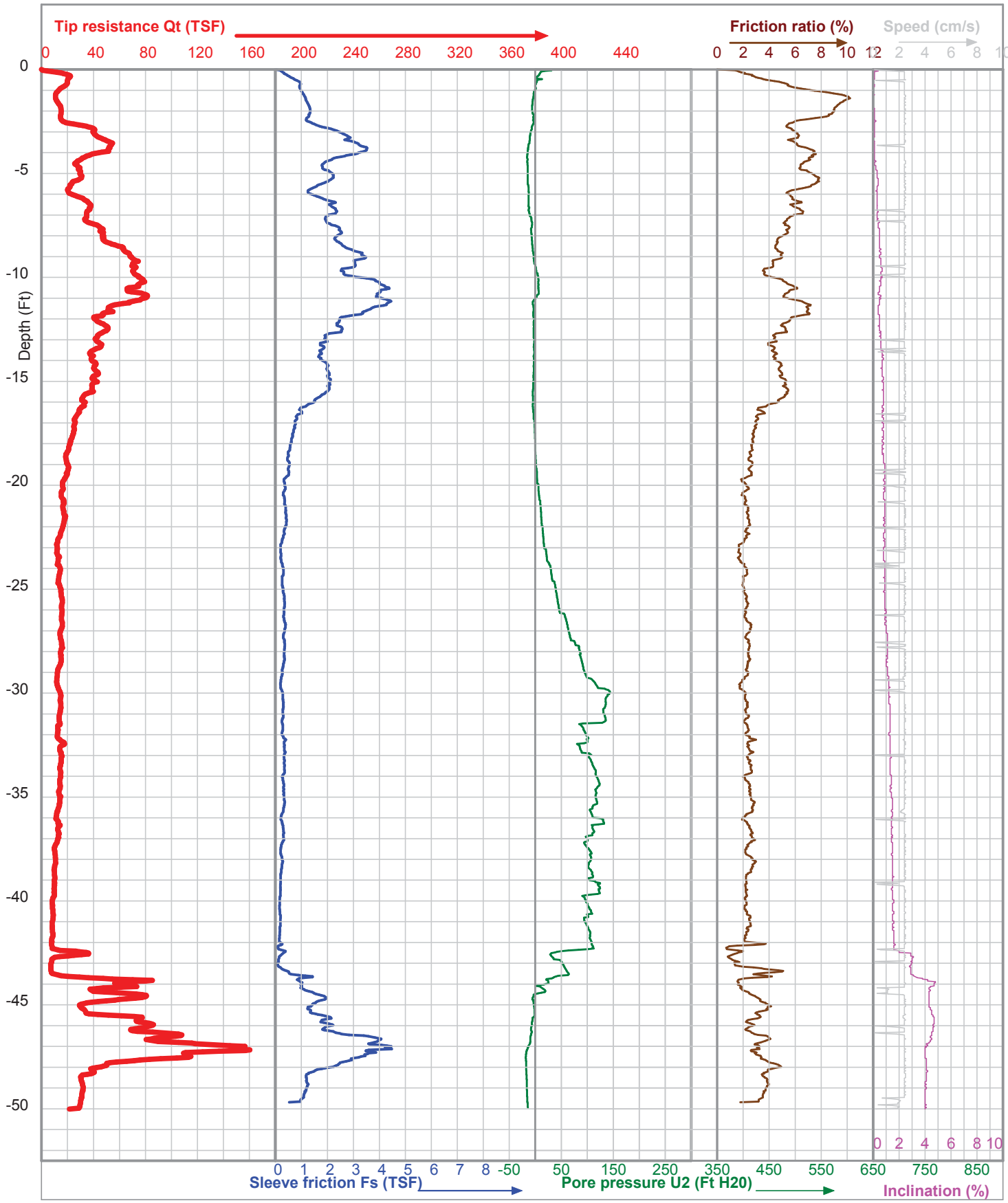
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 110	Cone Type	I-CFXYP20-15		
Test Number	110	Cone ID	090710	X-Coord	40.67783
Client	Barr Engineering Co., Inc.	Start Time	16:22	Y-Coord	-83.75074
Boring Type	CPTU Sounding	Date	29-7-2011	Elev. Datum:	WGS 84



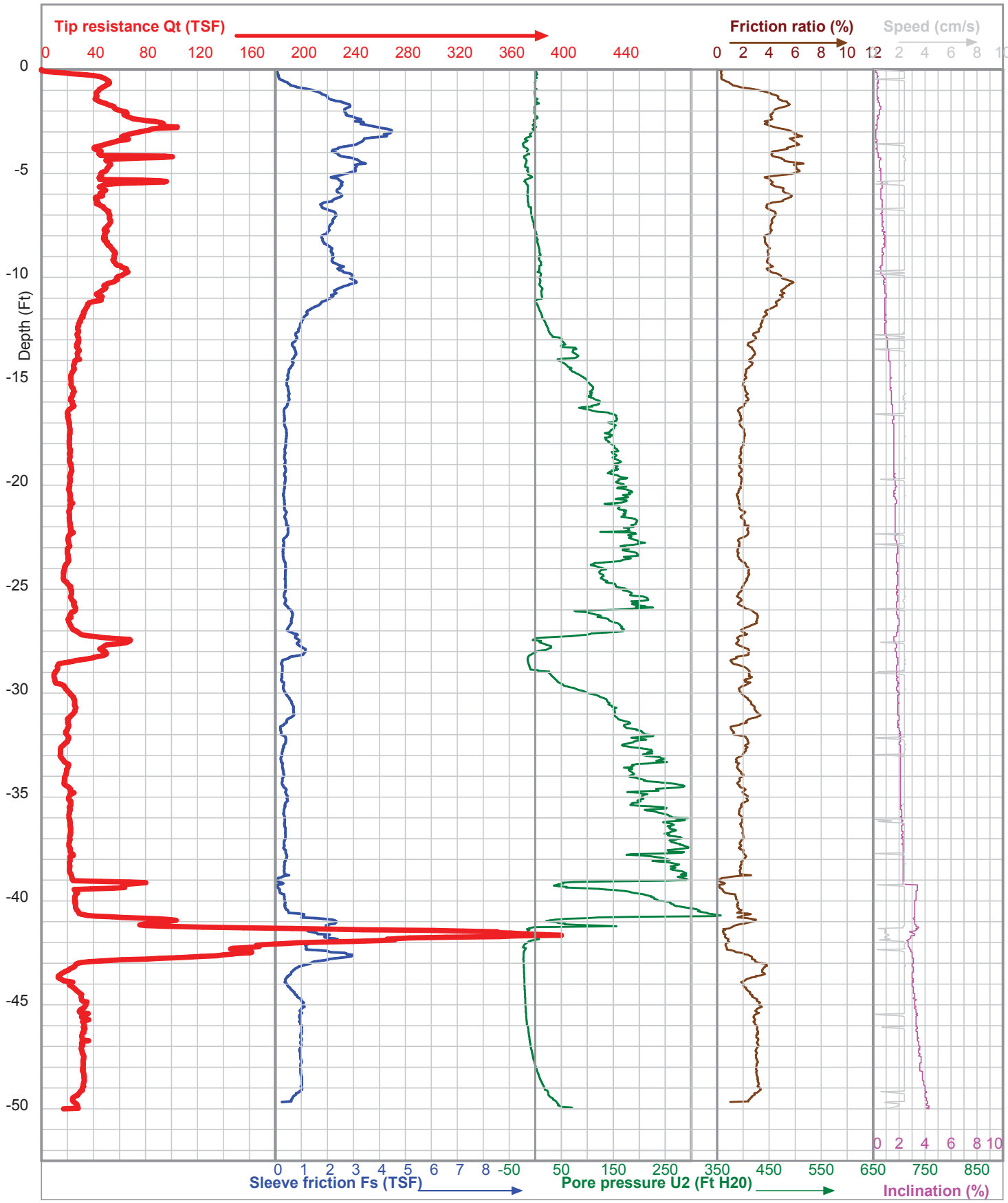
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 111	Cone Type	I-CFXYP20-15		
Test Number	111	Cone ID	090710	X-Coord	40.70890
Client	Barr Engineering Co., Inc.	Start Time	14:50	Y-Coord	-83.71547
Boring Type	CPTU Sounding	Date	28-7-2011	Elev. Datum:	WGS 84



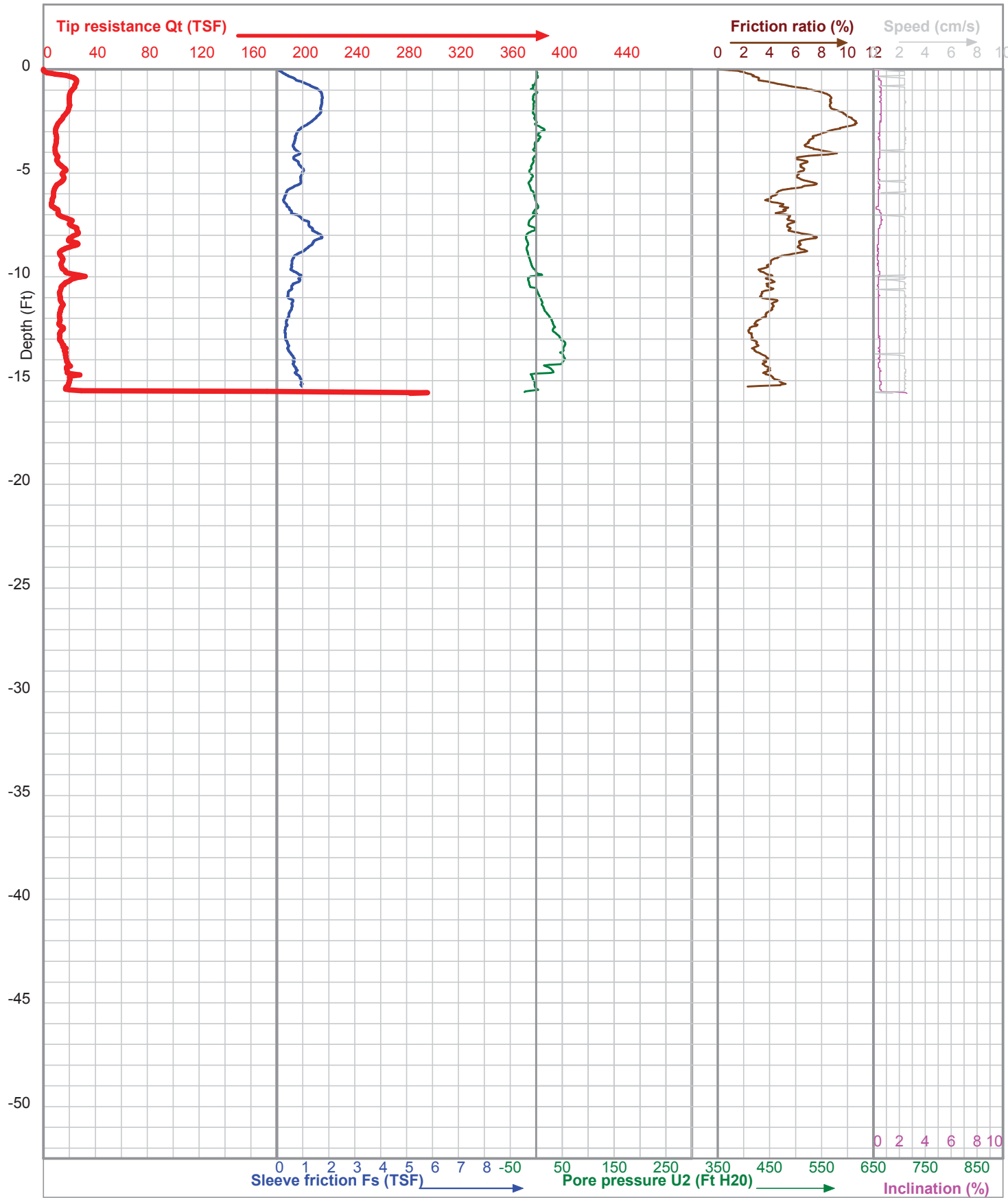
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 112	Cone Type	I-CFXYP20-15		
Test Number	112	Cone ID	090710	X-Coord	40.71395
Client	Barr Engineering Co., Inc.	Start Time	13:46	Y-Coord	-83.70587
Boring Type	CPTU Sounding	Date	28-7-2011	Elev. Datum:	WGS 84



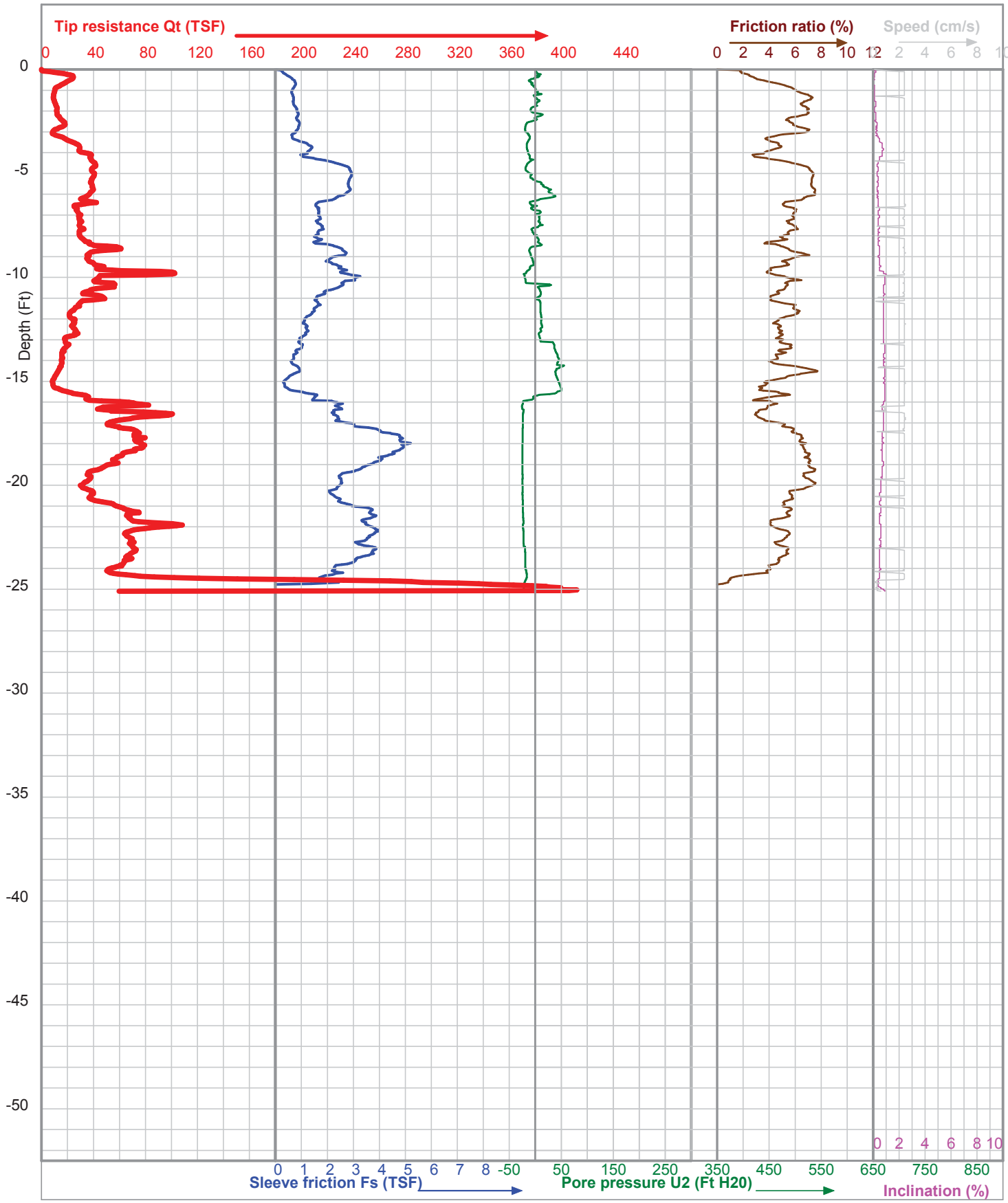
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 113	Cone Type	I-CFXYP20-15		
Test Number	113	Cone ID	090710	X-Coord	40.70638
Client	Barr Engineering Co., Inc.	Start Time	15:38	Y-Coord	-83.70514
Boring Type	CPTU Sounding	Date	28-7-2011	Elev. Datum:	WGS 84



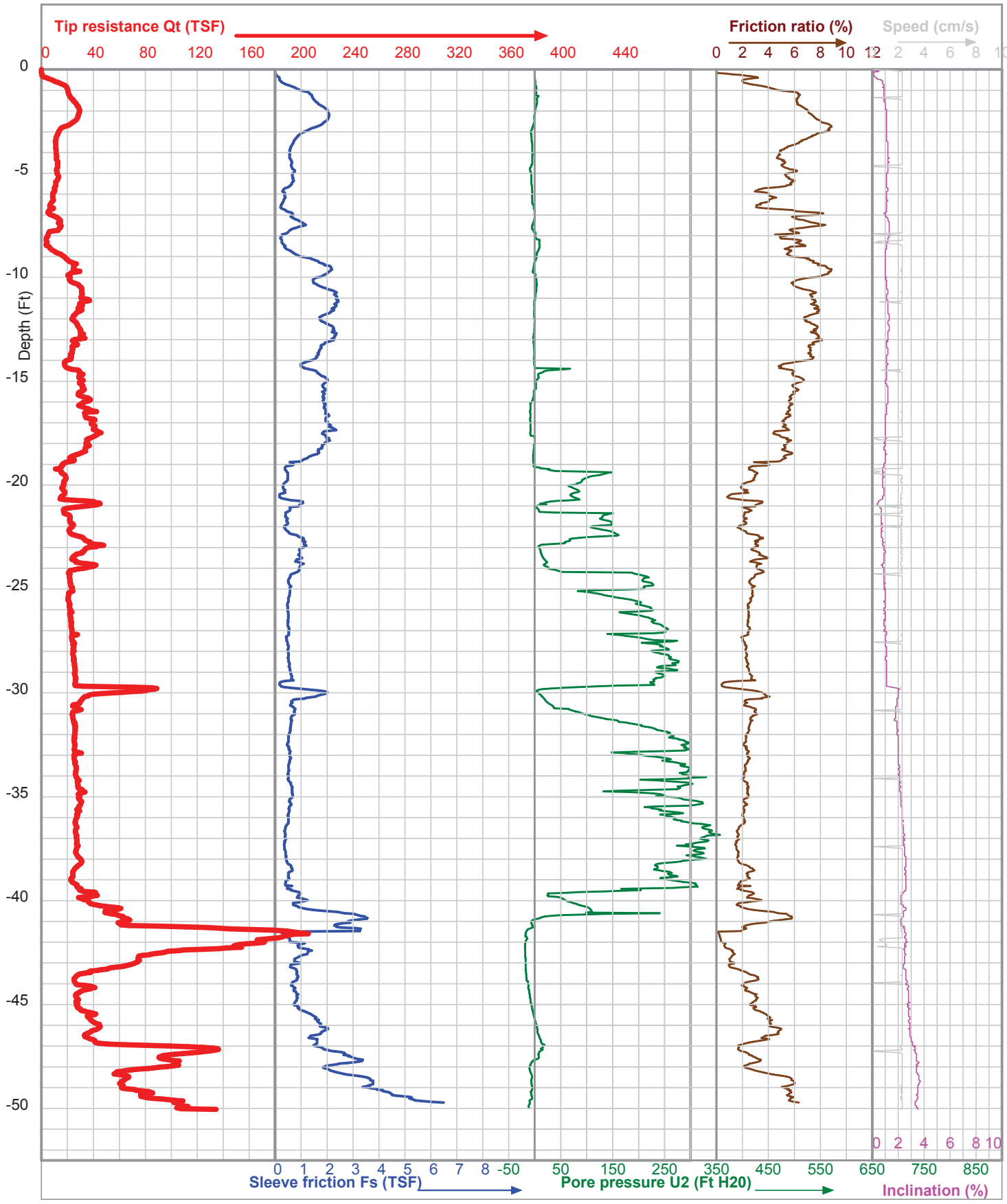
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 116	Cone Type	I-CFXYP20-15		
Test Number	116	Cone ID	090710	X-Coord	40.69847
Client	Barr Engineering Co., Inc.	Start Time	11:39	Y-Coord	-83.69693
Boring Type	CPTU Sounding	Date	28-7-2011	Elev. Datum:	WGS 84



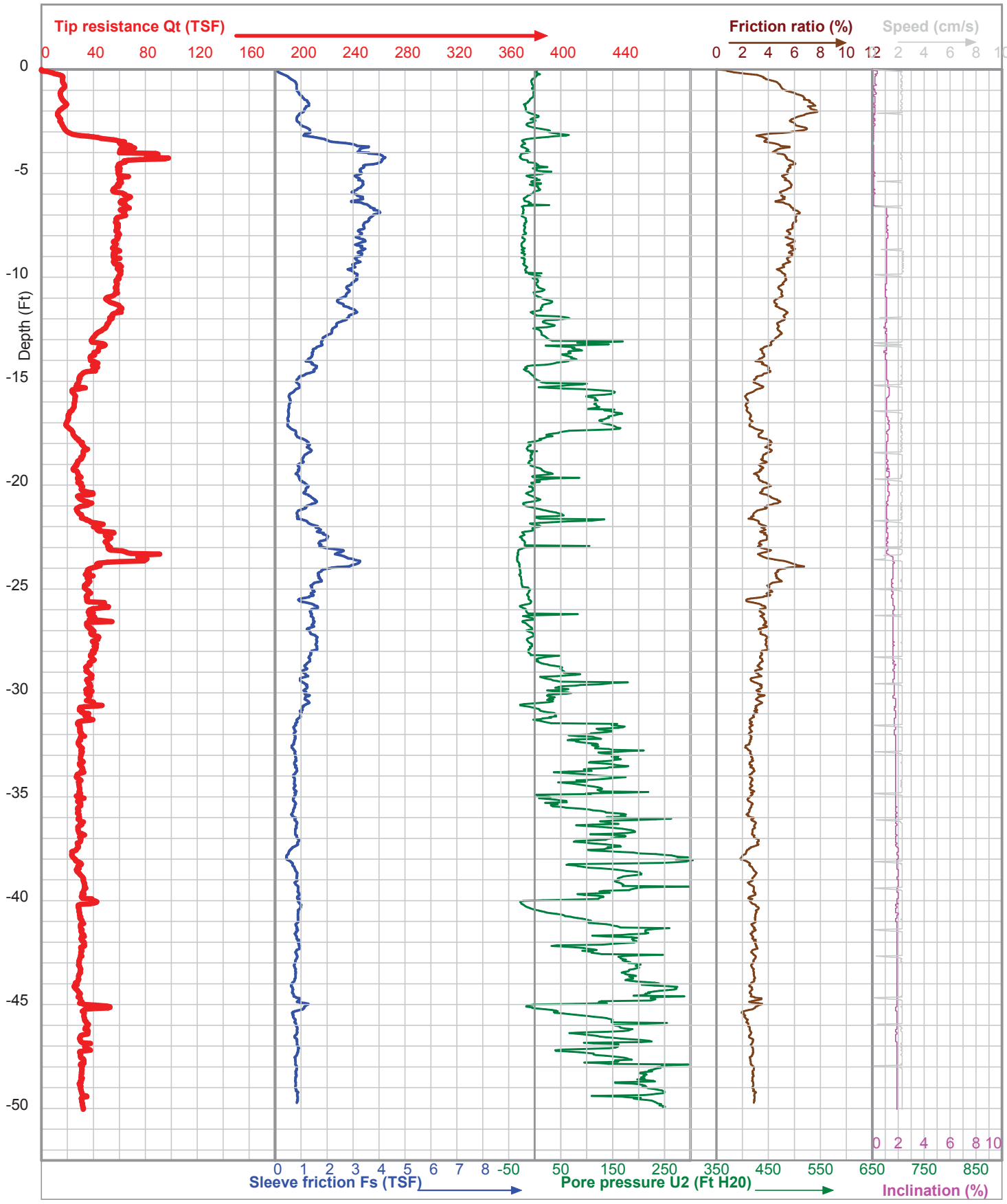
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 117	Cone Type	I-CFXYP20-15		
Test Number	117	Cone ID	090710	X-Coord	40.69445
Client	Barr Engineering Co., Inc.	Start Time	16:42	Y-Coord	-83.71531
Boring Type	CPTU Sounding	Date	28-7-2011	Elev. Datum:	WGS 84



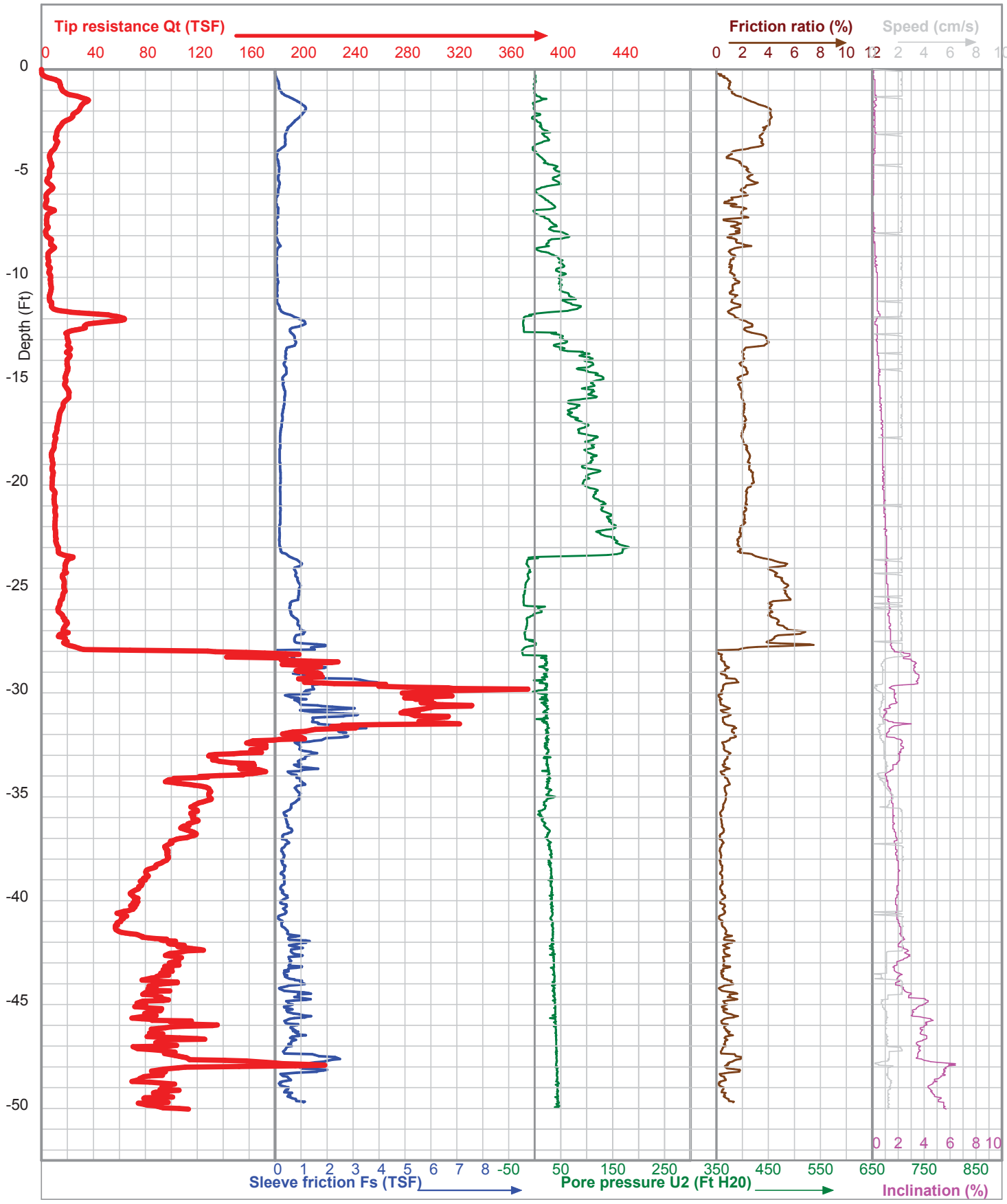
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 118	Cone Type	I-CFXYP20-15		
Test Number	118	Cone ID	090710	X-Coord	40.69196
Client	Barr Engineering Co., Inc.	Start Time	7:24	Y-Coord	-83.71410
Boring Type	CPTU Sounding	Date	29-7-2011	Elev. Datum:	WGS 84



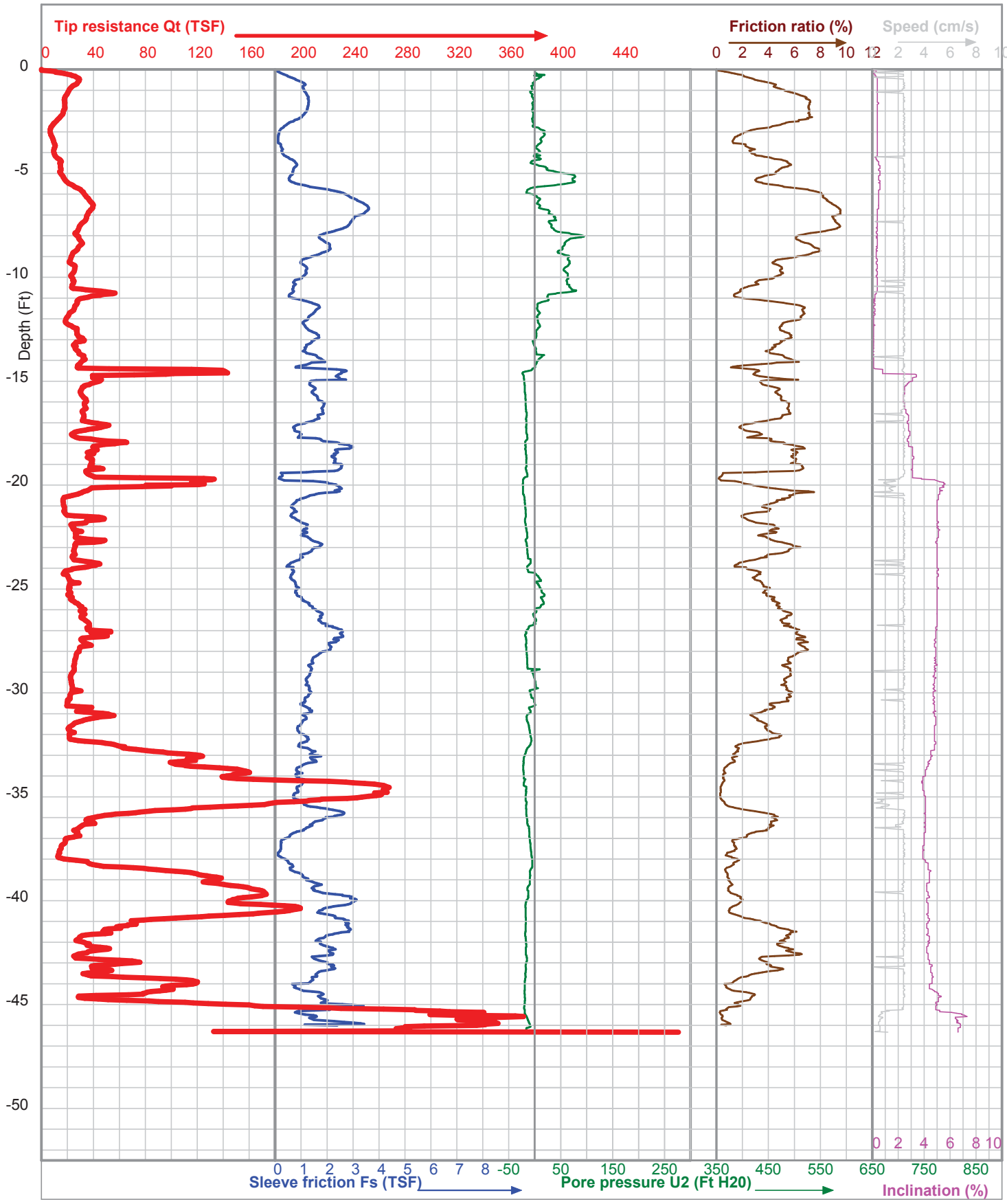
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 119	Cone Type	I-CFXYPP20-15		
Test Number	119	Cone ID	100624	X-Coord	40.60986
Client	Barr Engineering Co., Inc.	Start Time	7:13	Y-Coord	-83.76974
Boring Type	CPTU Sounding	Date	25-7-2011	Elev. Datum:	WGS 84



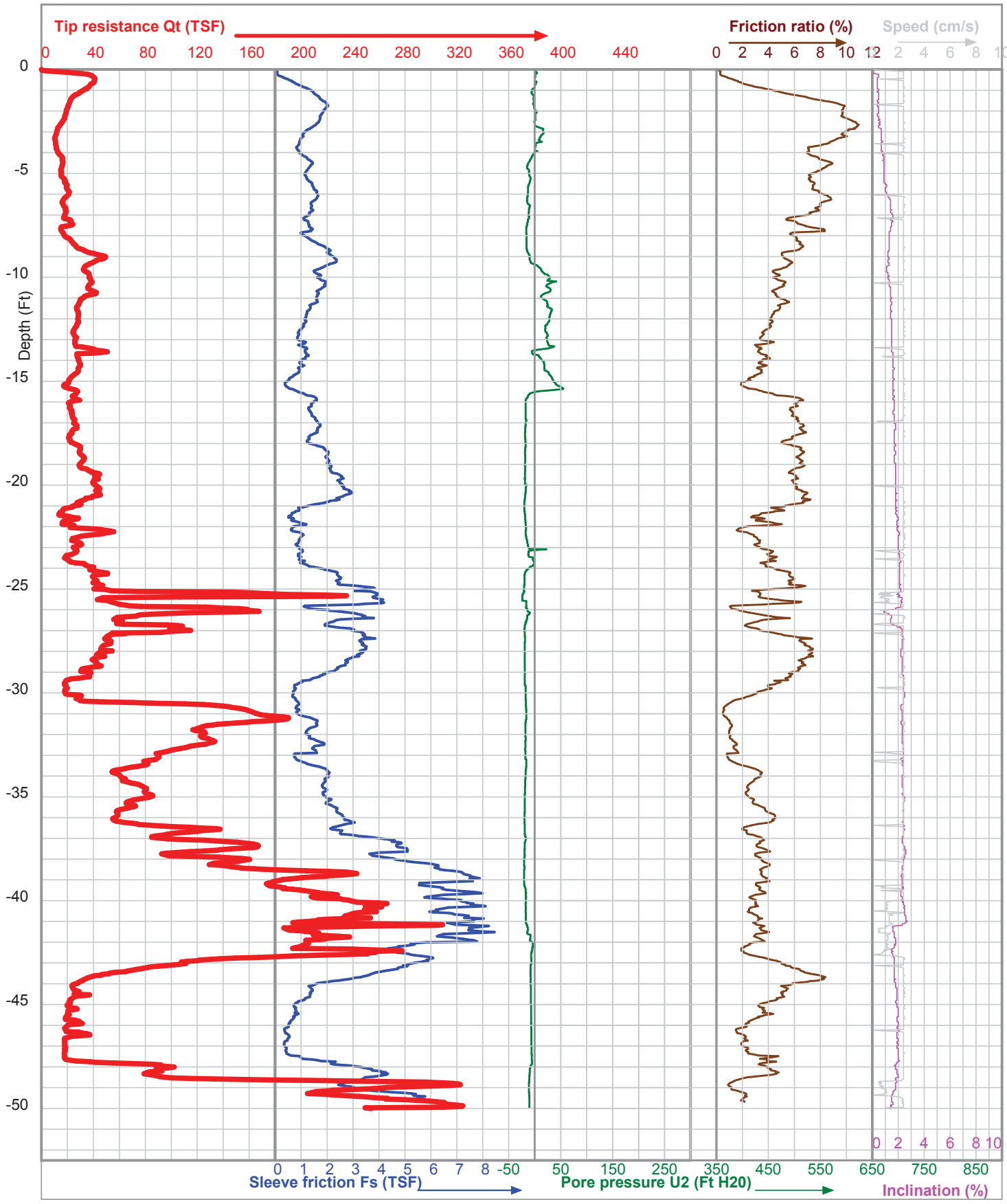
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 120	Cone Type	I-CFXYP20-15		
Test Number	120	Cone ID	090709	X-Coord	40.60778
Client	Barr Engineering Co., Inc.	Start Time	15:13	Y-Coord	-83.76706
Boring Type	CPTU Sounding	Date	24-7-2011	Elev. Datum:	WGS 84



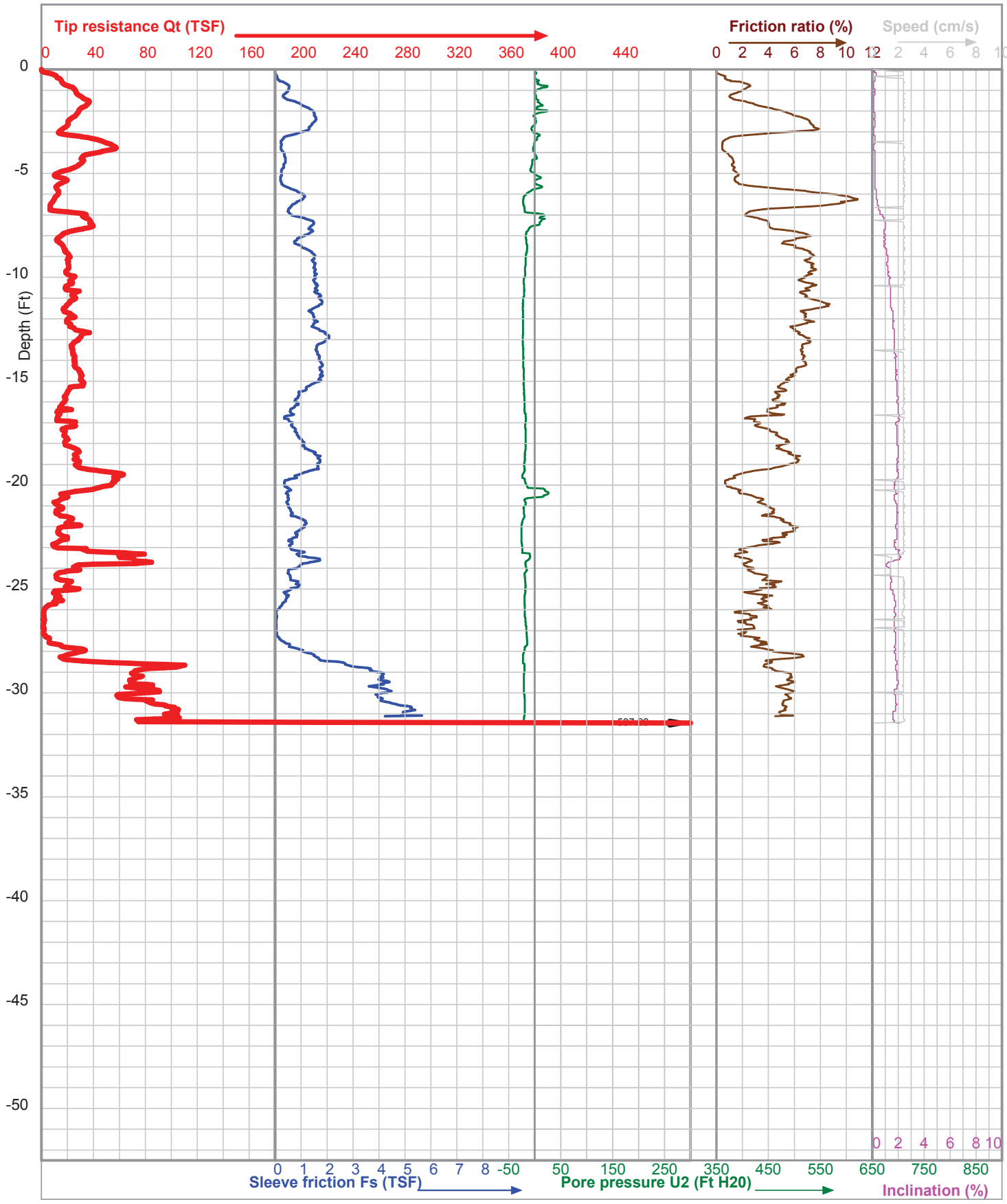
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 122	Cone Type	I-CFXYPP20-15		
Test Number	122	Cone ID	100624	X-Coord	40.67868
Client	Barr Engineering Co., Inc.	Start Time	12:33	Y-Coord	-83.76840
Boring Type	CPTU Sounding	Date	30-7-2011	Elev. Datum:	WGS 84



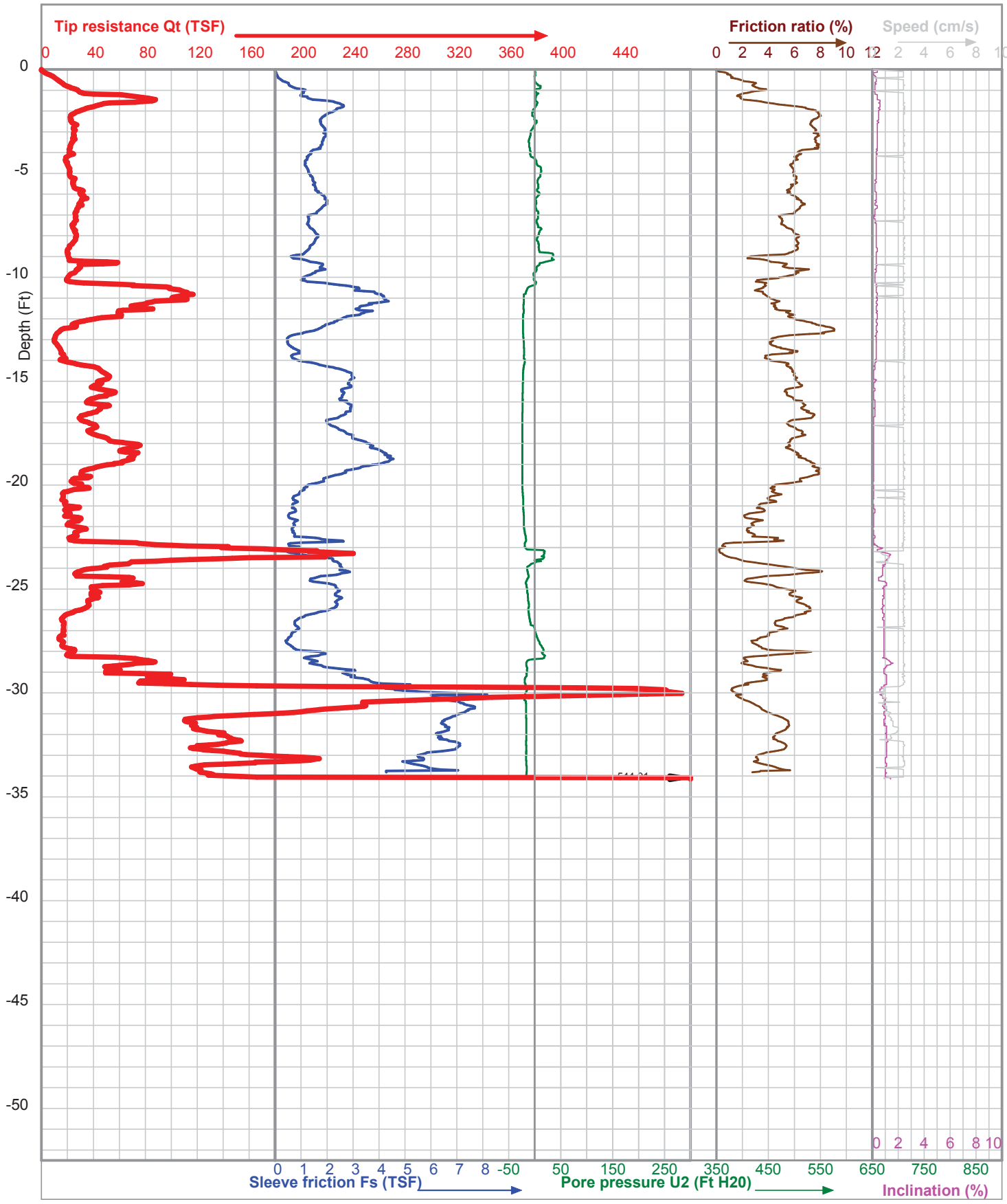
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 123	Cone Type	I-CFXYP20-15		
Test Number	123	Cone ID	090710	X-Coord	40.69209
Client	Barr Engineering Co., Inc.	Start Time	14:33	Y-Coord	-83.74701
Boring Type	CPTU Sounding	Date	30-7-2011	Elev. Datum:	WGS 84



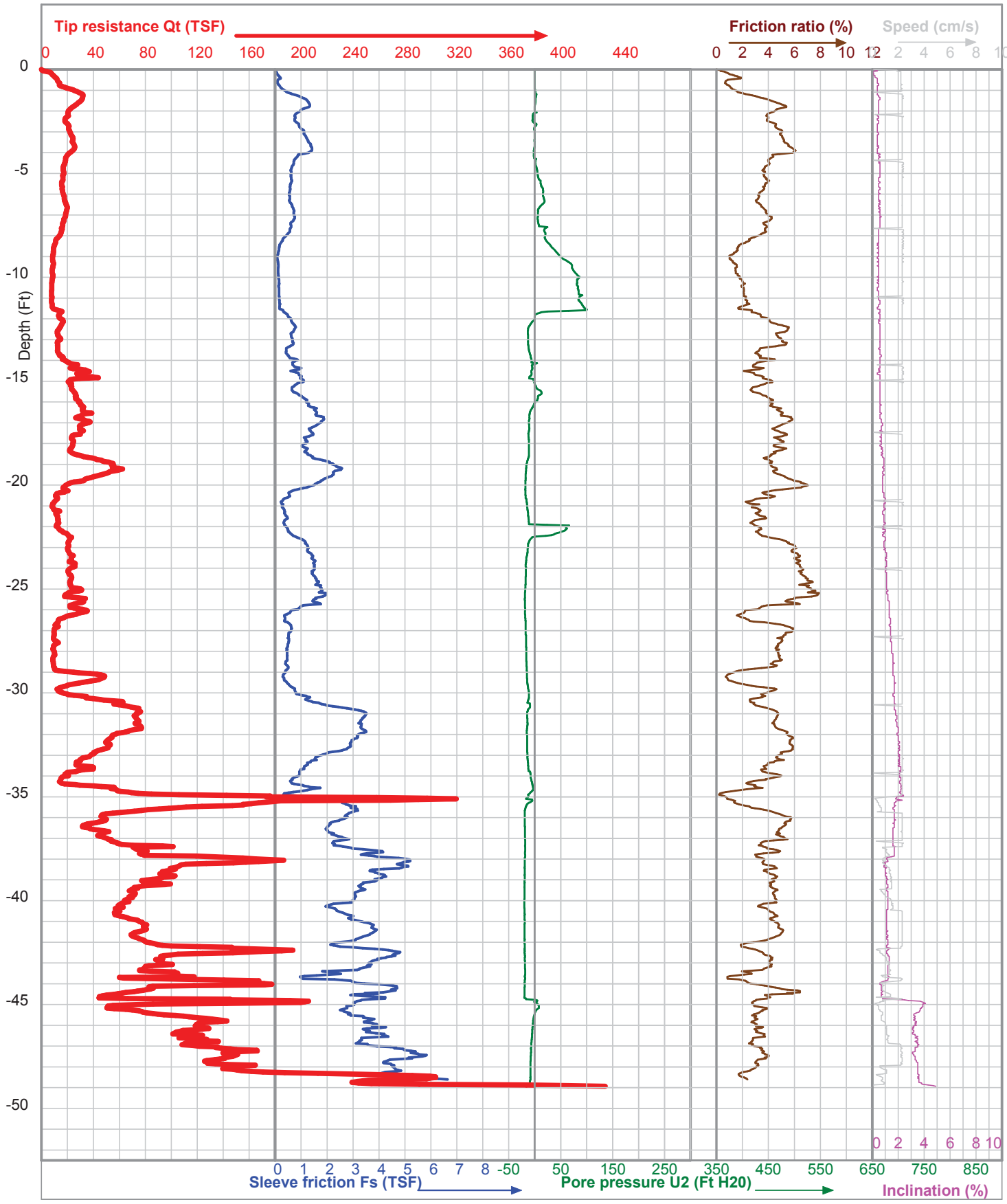
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 124	Cone Type	I-CFXYP20-15		
Test Number	124	Cone ID	090710	X-Coord	40.69773
Client	Barr Engineering Co., Inc.	Start Time	10:00	Y-Coord	-83.74225
Boring Type	CPTU Sounding	Date	30-7-2011	Elev. Datum:	WGS 84



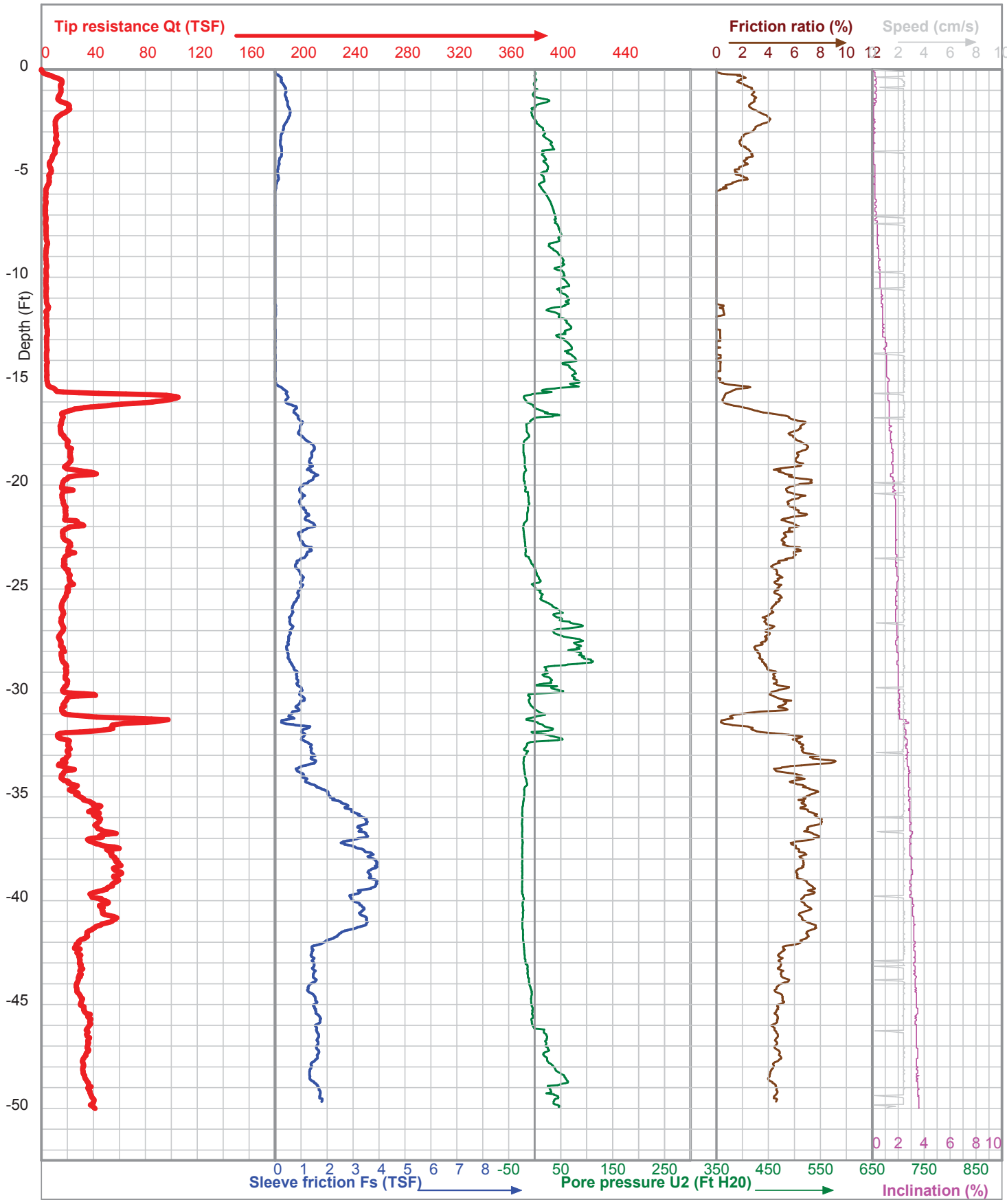
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 125	Cone Type	I-CFXYP20-15		
Test Number	125	Cone ID	090710	X-Coord	40.67298
Client	Barr Engineering Co., Inc.	Start Time	14:16	Y-Coord	-83.76622
Boring Type	CPTU Sounding	Date	29-7-2011	Elev. Datum:	WGS 84



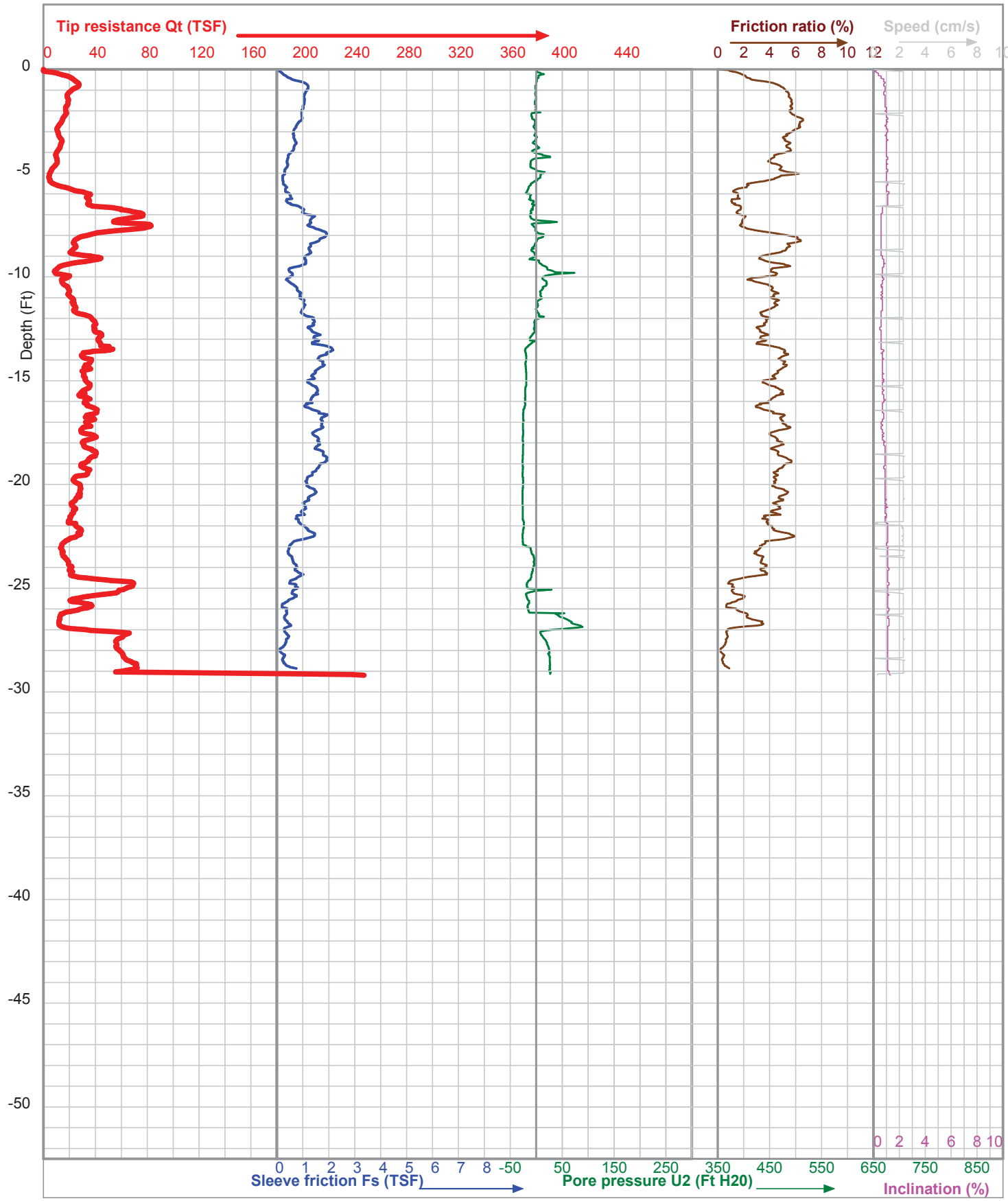
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 126	Cone Type	I-CFXYP20-15		
Test Number	126	Cone ID	090710	X-Coord	40.67046
Client	Barr Engineering Co., Inc.	Start Time	14:54	Y-Coord	-83.76510
Boring Type	CPTU Sounding	Date	29-7-2011	Elev. Datum:	WGS 84



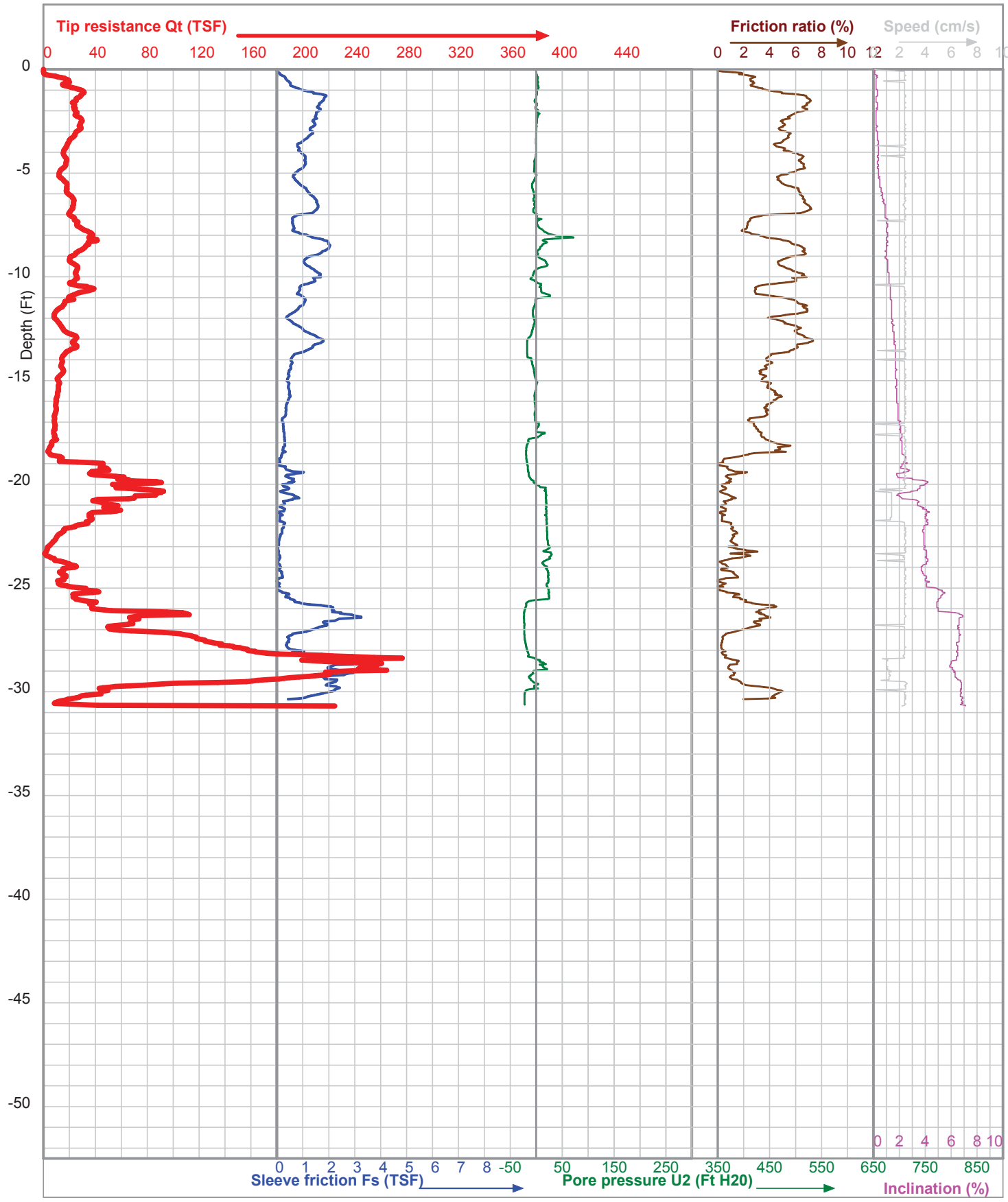
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 127	Cone Type	I-CFXYPP20-15		
Test Number	127	Cone ID	100624	X-Coord	40.68161
Client	Barr Engineering Co., Inc.	Start Time	9:26	Y-Coord	-83.81889
Boring Type	CPTU Sounding	Date	29-7-2011	Elev. Datum:	WGS 84



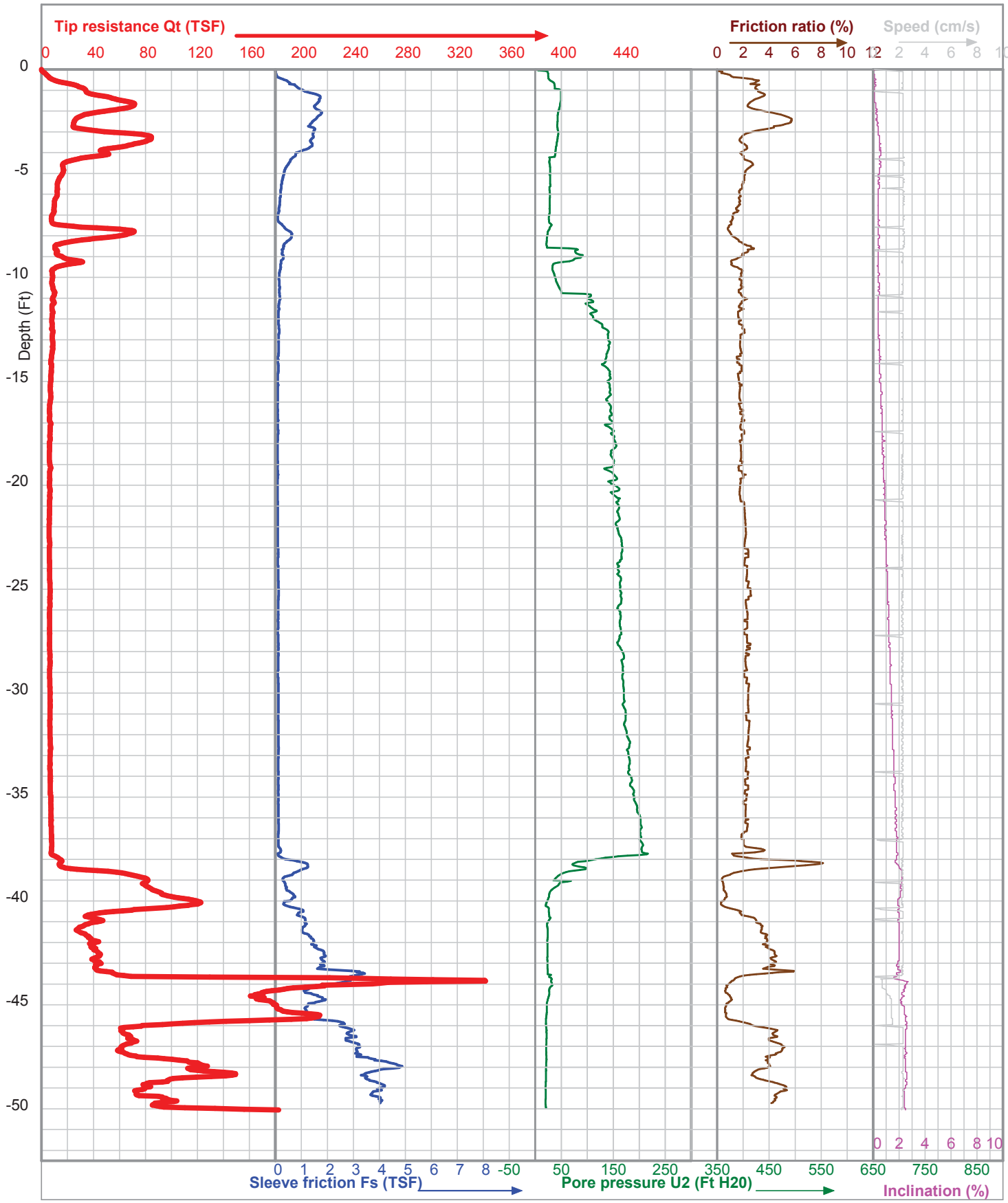
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 128	Cone Type	I-CFXYP20-15		
Test Number	128	Cone ID	090710	X-Coord	40.66221
Client	Barr Engineering Co., Inc.	Start Time	11:59	Y-Coord	-83.77277
Boring Type	CPTU Sounding	Date	29-7-2011	Elev. Datum:	WGS 84



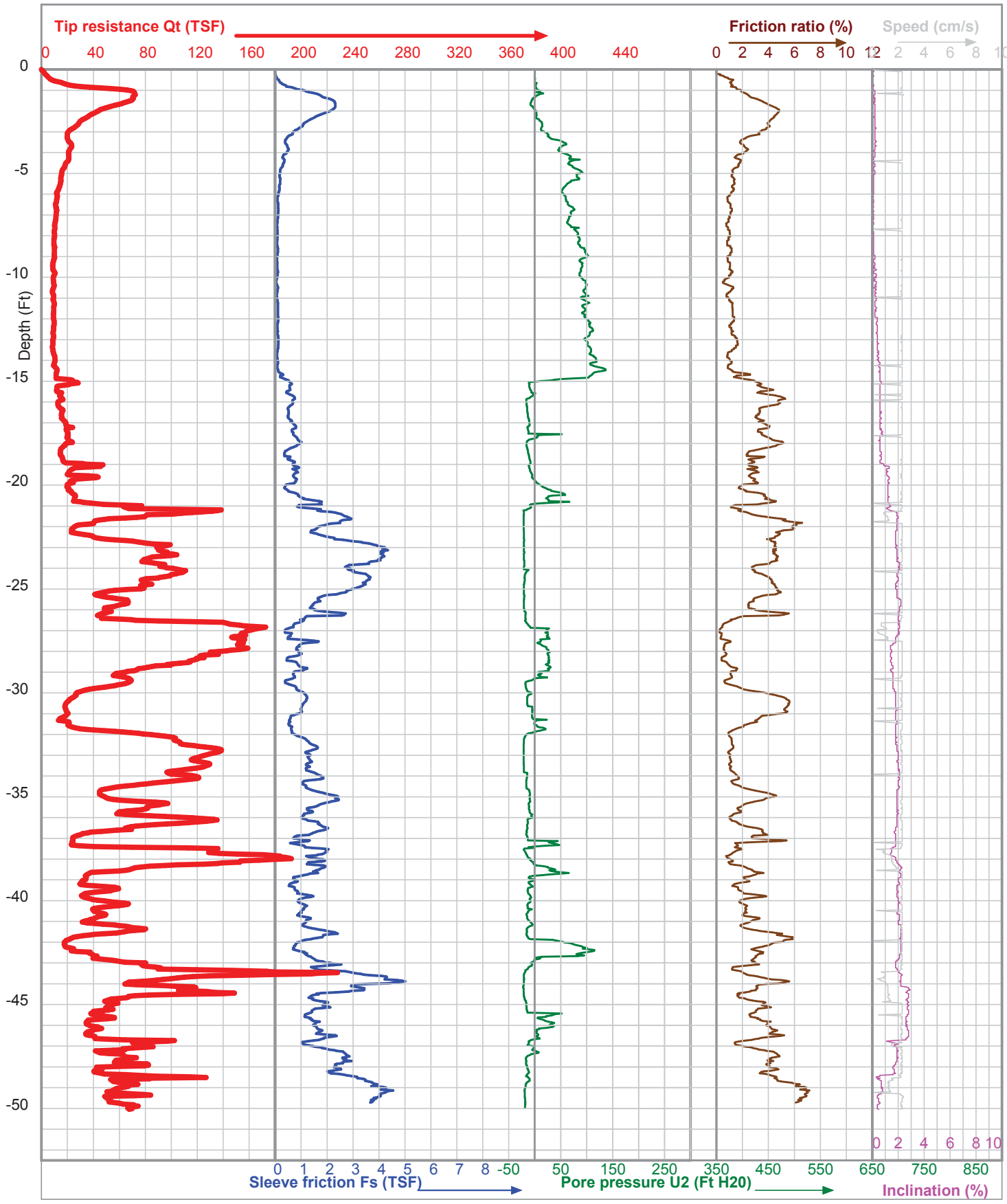
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 129	Cone Type	I-CFXYP20-15		
Test Number	129	Cone ID	090709	X-Coord	40.63151
Client	Barr Engineering Co., Inc.	Start Time	15:02	Y-Coord	-83.78682
Boring Type	CPTU Sounding	Date	25-7-2011	Elev. Datum:	WGS 84



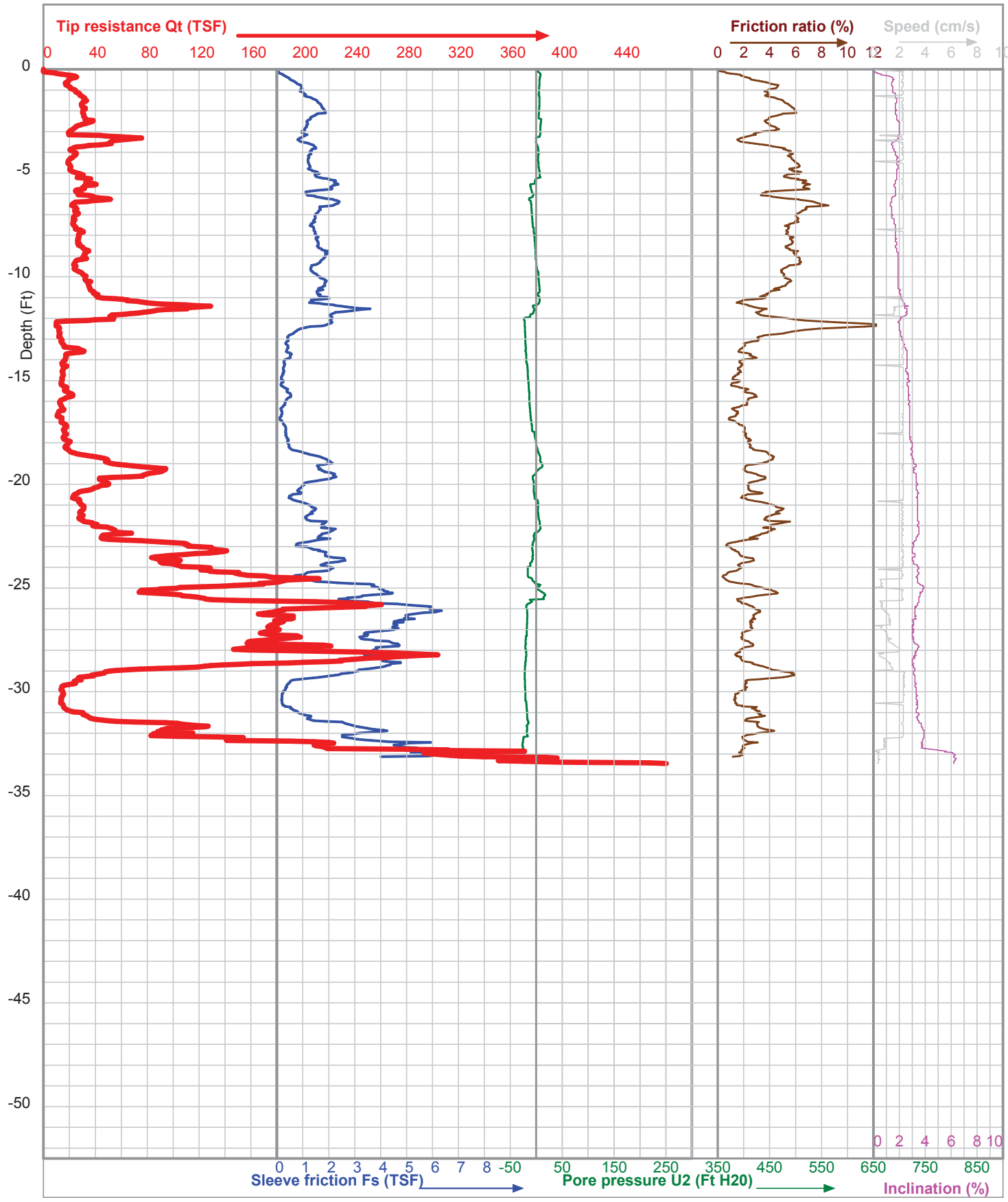
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 130	Cone Type	I-CFXYP20-15		
Test Number	130	Cone ID	090710	X-Coord	40.67589
Client	Barr Engineering Co., Inc.	Start Time	15:43	Y-Coord	-83.74876
Boring Type	CPTU Sounding	Date	29-7-2011	Elev. Datum:	WGS 84



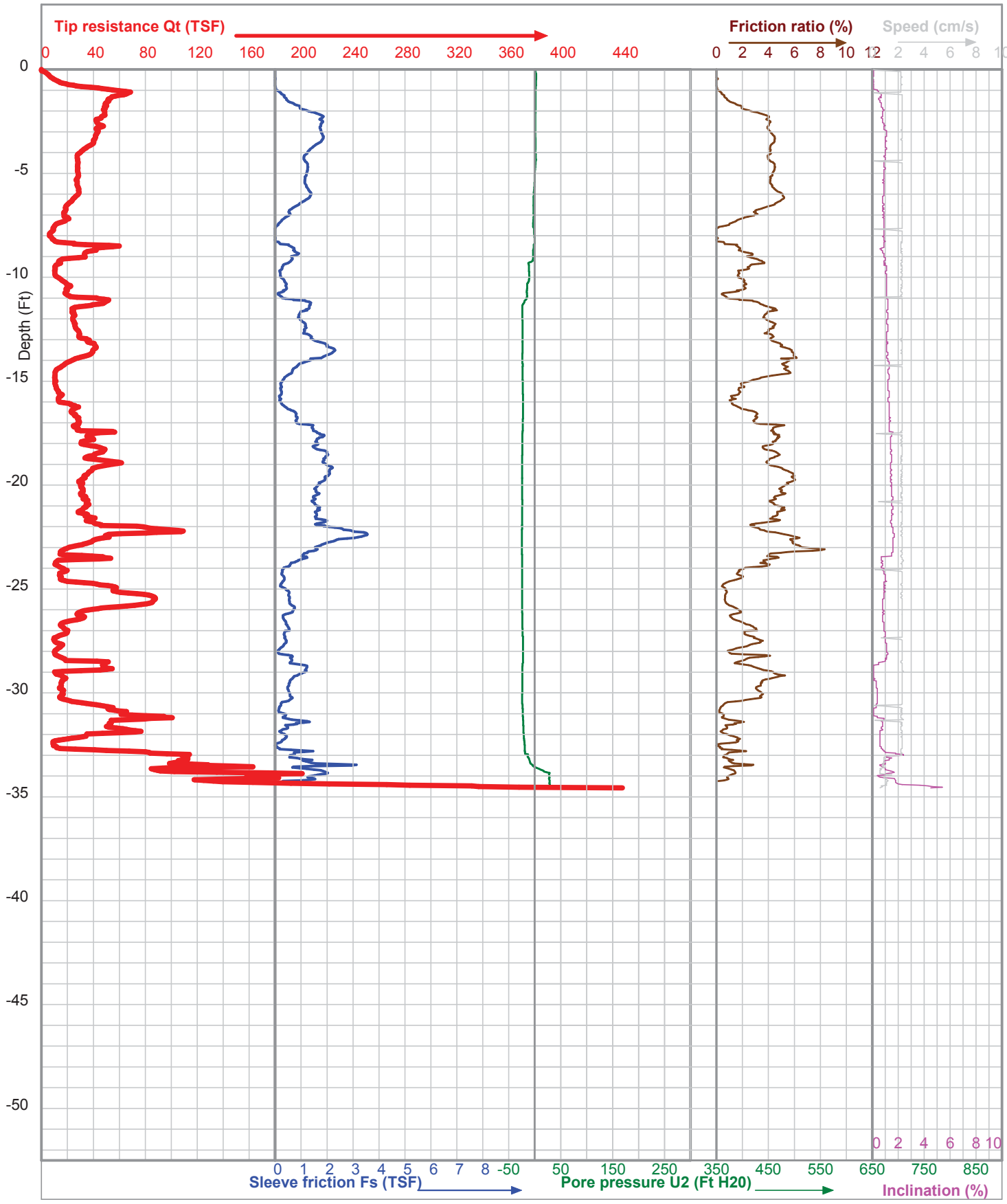
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 131	Cone Type	I-CFXYPP20-15		
Test Number	131	Cone ID	100624	X-Coord	40.68168
Client	Barr Engineering Co., Inc.	Start Time	14:41	Y-Coord	-83.78750
Boring Type	CPTU Sounding	Date	30-7-2011	Elev. Datum:	WGS 84



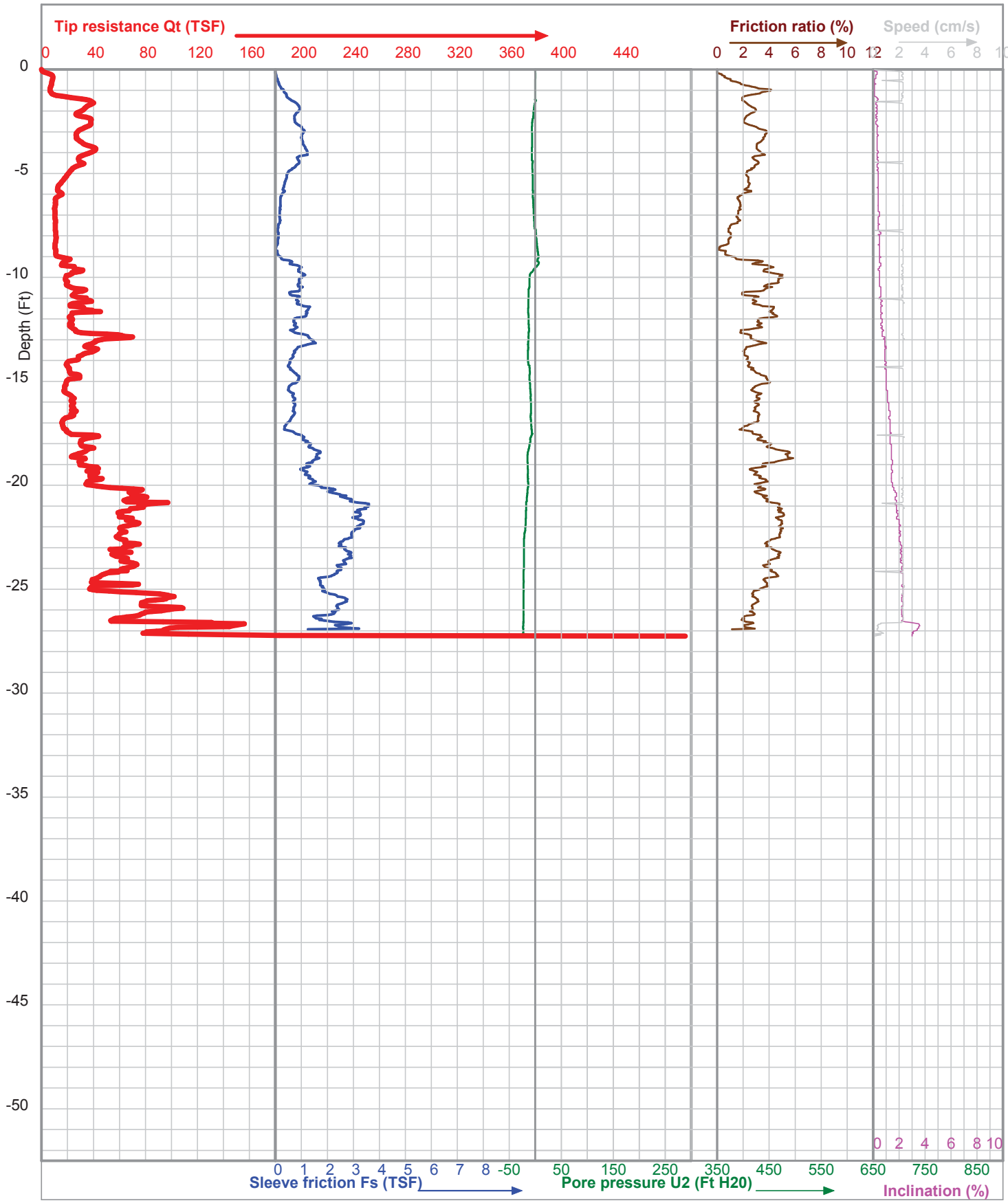
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 132	Cone Type	I-CFXYPP20-15		
Test Number	132	Cone ID	100624	X-Coord	40.67944
Client	Barr Engineering Co., Inc.	Start Time	13:37	Y-Coord	-83.80464
Boring Type	CPTU Sounding	Date	29-7-2011	Elev. Datum:	WGS 84



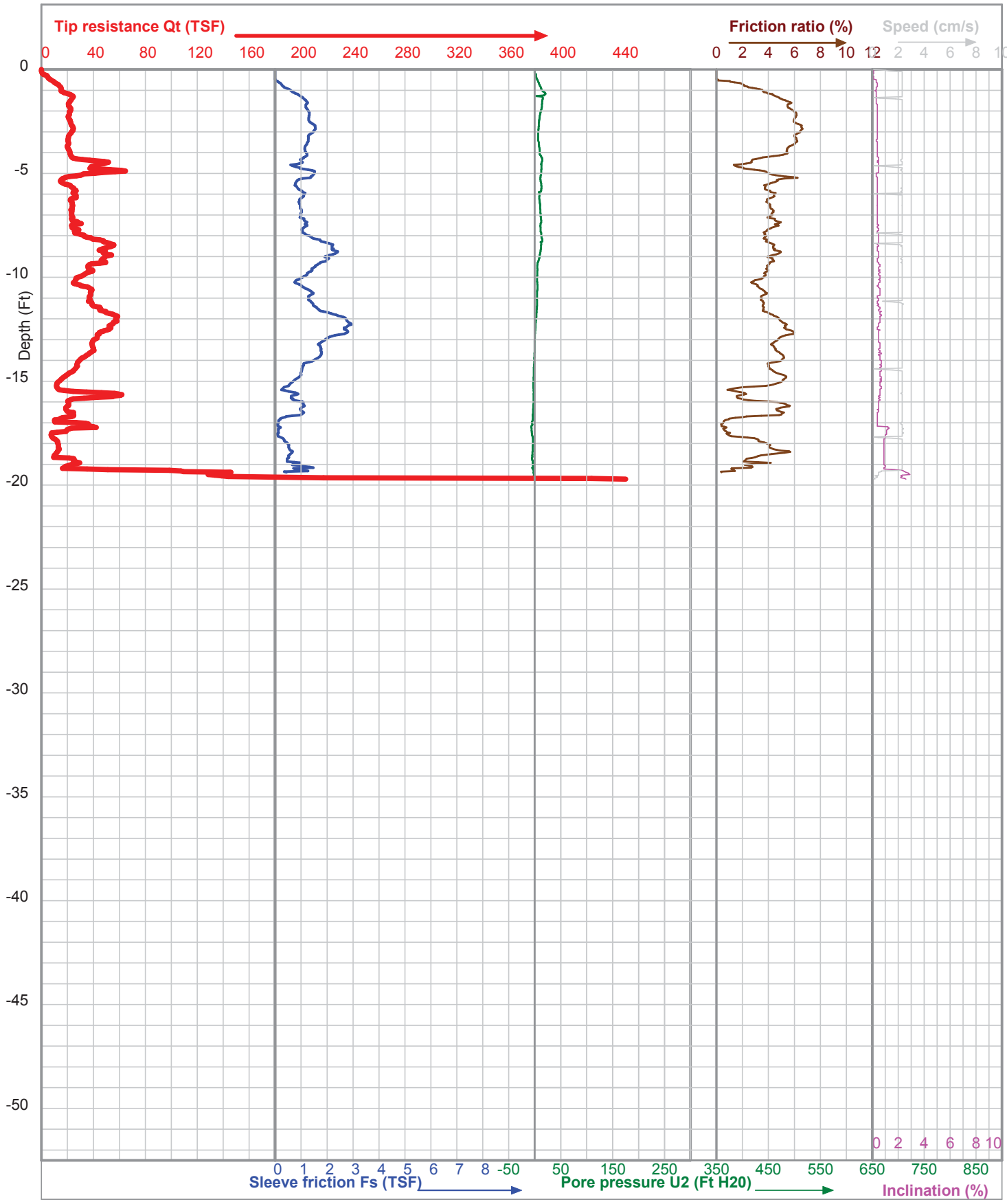
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 2	Cone Type	I-CFXYPP20-15		
Test Number	2002	Cone ID	100624	X-Coord	40.69823
Client	Barr Engineering Co., Inc.	Start Time	7:49	Y-Coord	-83.83768
Boring Type	CPTU Sounding	Date	18-7-2011	Elev. Datum:	WGS 84



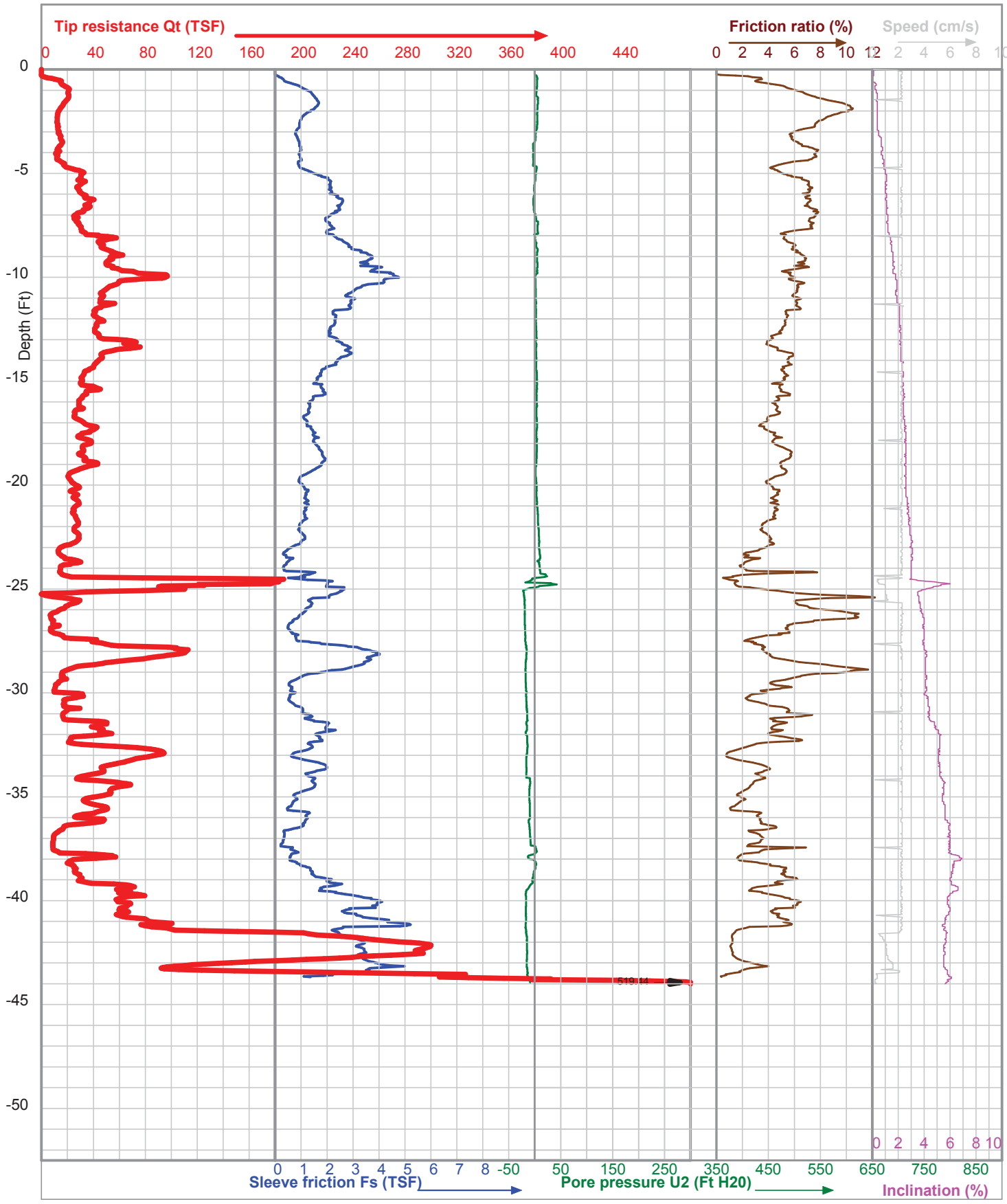
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 6	Cone Type	I-CFXYP20-15		
Test Number	2006	Cone ID	090709	X-Coord	40.69899
Client	Barr Engineering Co., Inc.	Start Time	6:49	Y-Coord	-83.82732
Boring Type	CPTU Sounding	Date	19-7-2011	Elev. Datum:	WGS 84



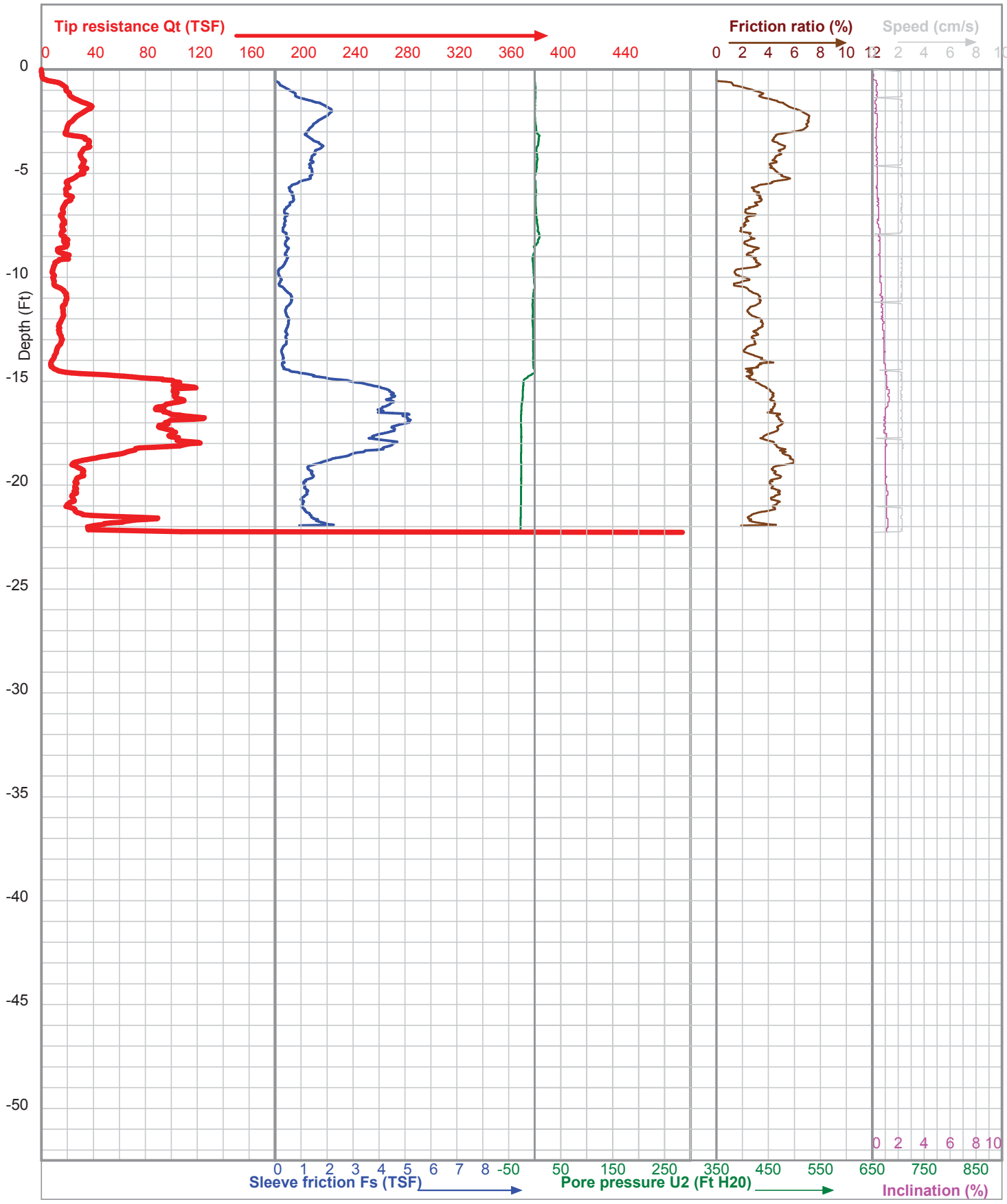
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 14	Cone Type	I-CFXYP20-15		
Test Number	2014	Cone ID	090709	X-Coord	40.69517
Client	Barr Engineering Co., Inc.	Start Time	10:21	Y-Coord	-83.80708
Boring Type	CPTU Sounding	Date	18-7-2011	Elev. Datum:	WGS 84



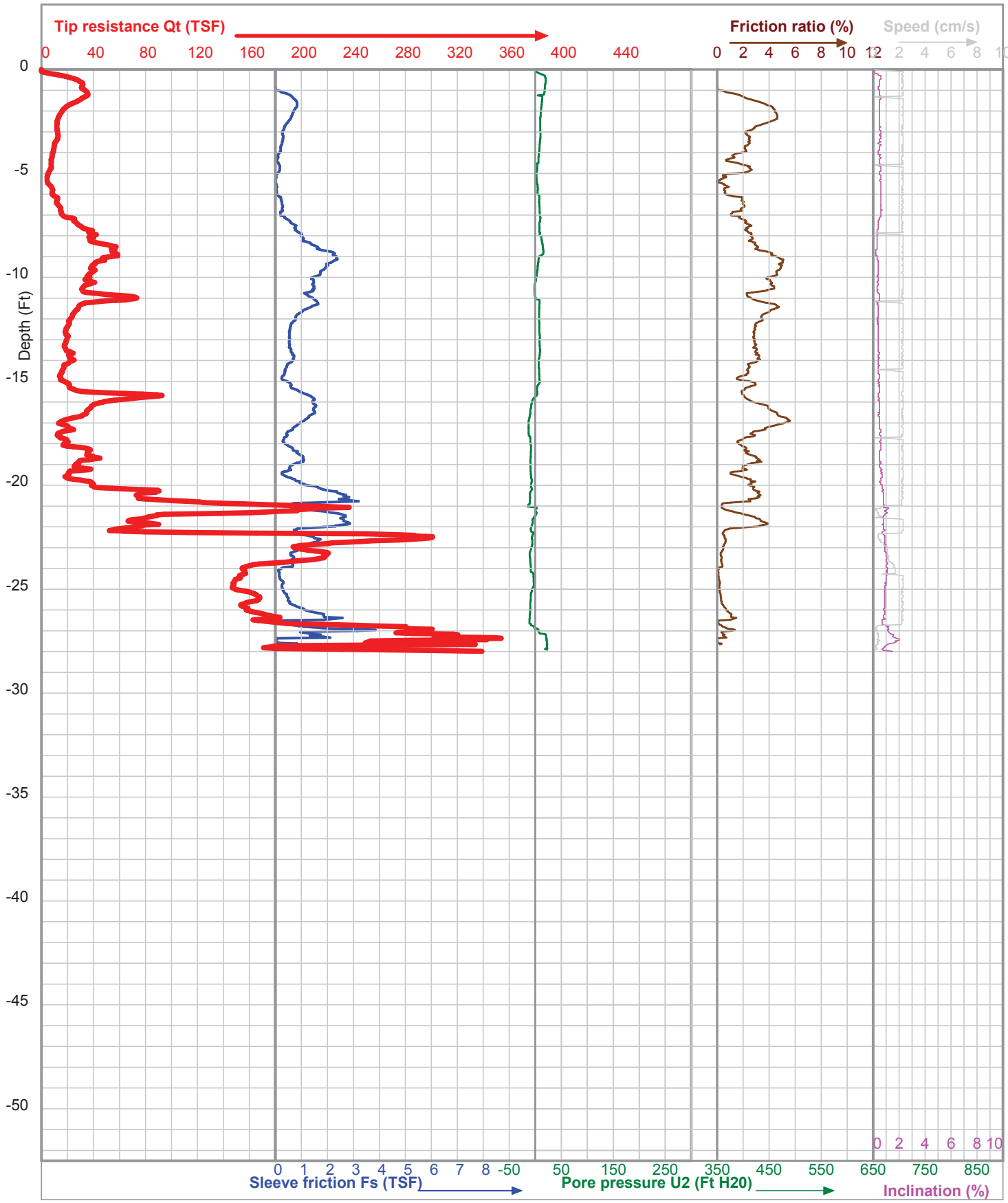
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 19	Cone Type	I-CFXYP20-15		
Test Number	2019	Cone ID	090709	X-Coord	40.67675
Client	Barr Engineering Co., Inc.	Start Time	9:02	Y-Coord	-83.82734
Boring Type	CPTU Sounding	Date	20-7-2011	Elev. Datum:	WGS 84



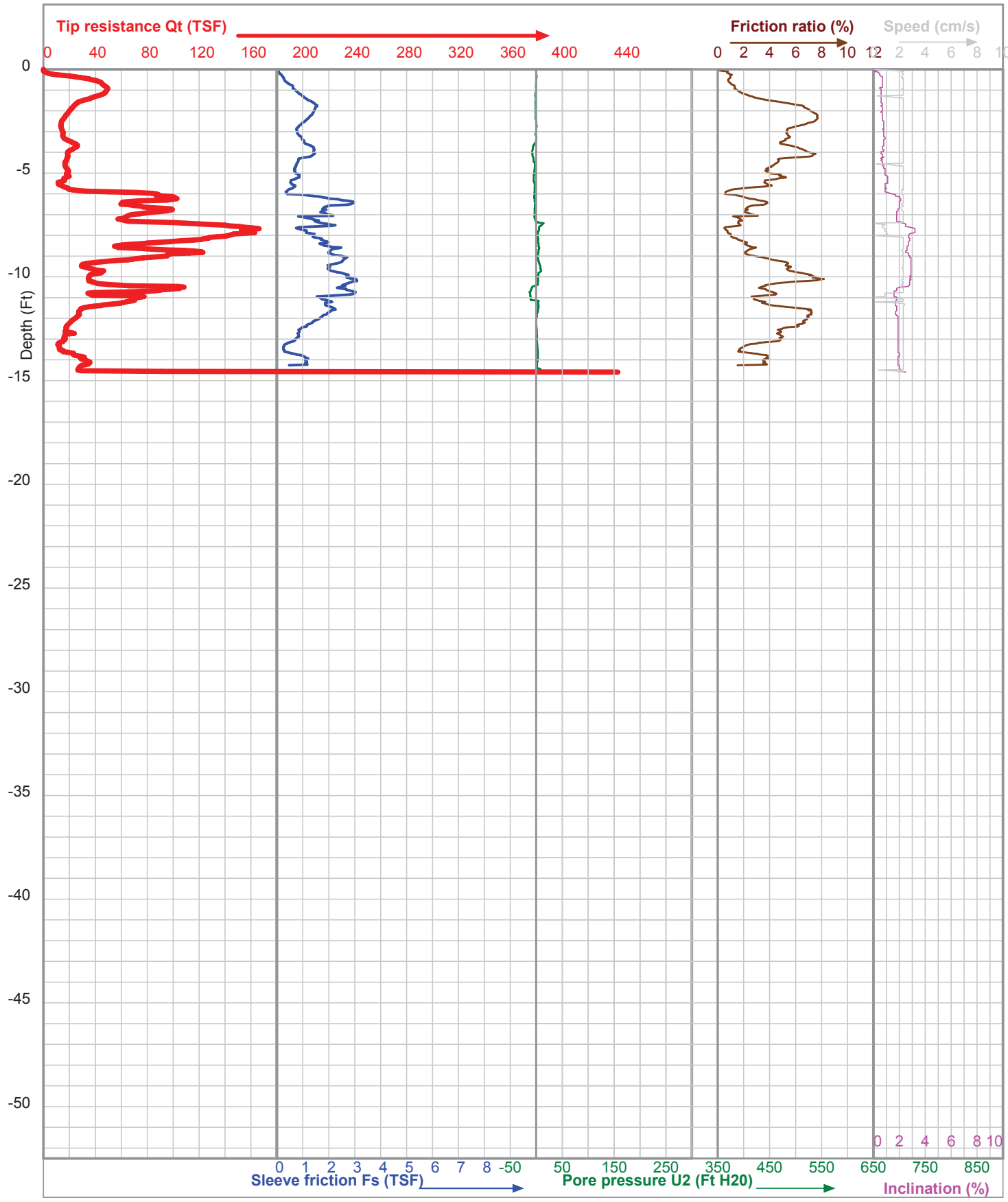
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 21	Cone Type	I-CFXYPP20-15		
Test Number	2021	Cone ID	100624	X-Coord	40.68537
Client	Barr Engineering Co., Inc.	Start Time	13:36	Y-Coord	-83.83688
Boring Type	CPTU Sounding	Date	19-7-2011	Elev. Datum:	WGS 84



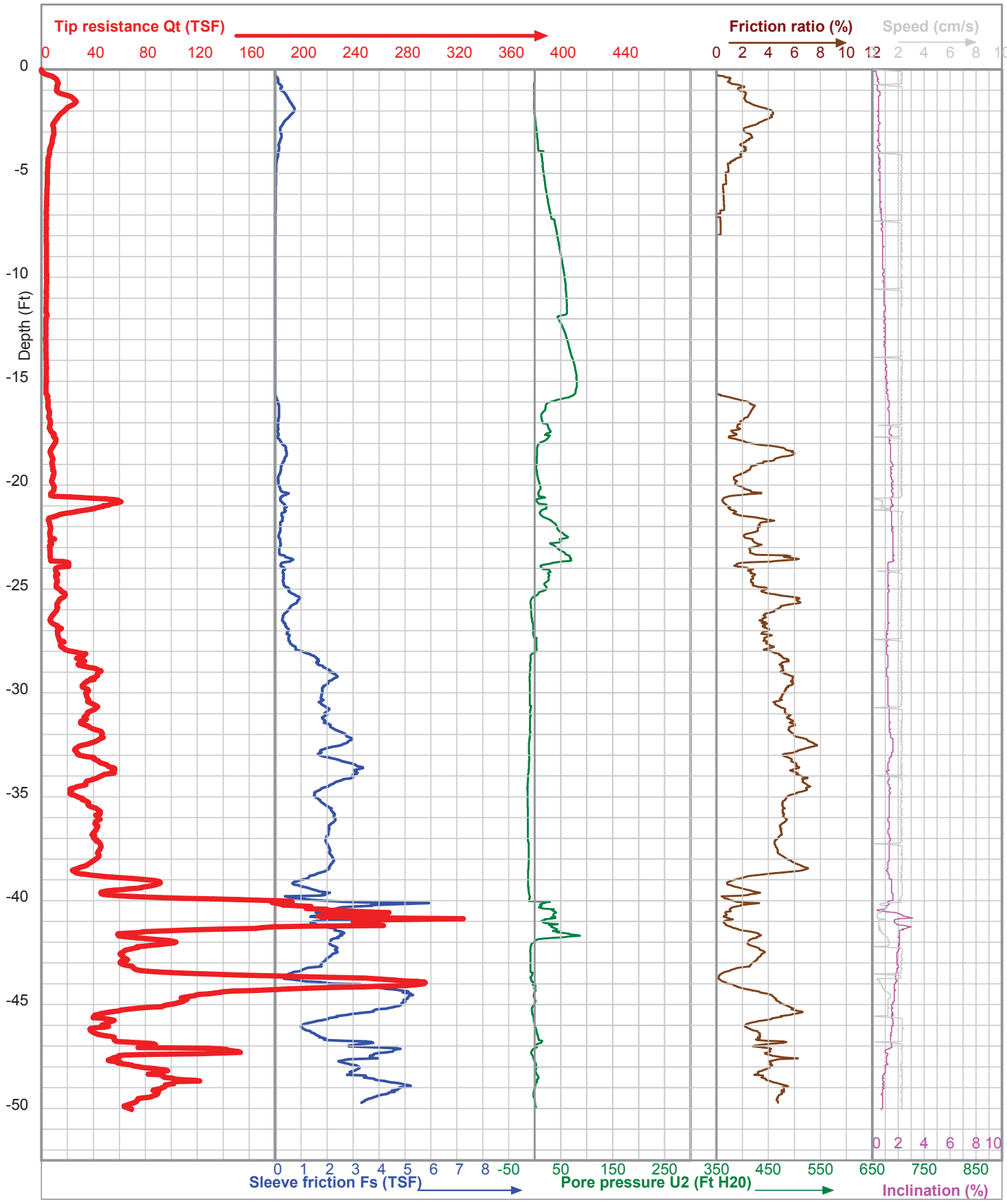
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 31	Cone Type	I-CFXYP20-15		
Test Number	2031	Cone ID	090709	X-Coord	40.66203
Client	Barr Engineering Co., Inc.	Start Time	7:23	Y-Coord	-83.82101
Boring Type	CPTU Sounding	Date	21-7-2011	Elev. Datum:	WGS 84



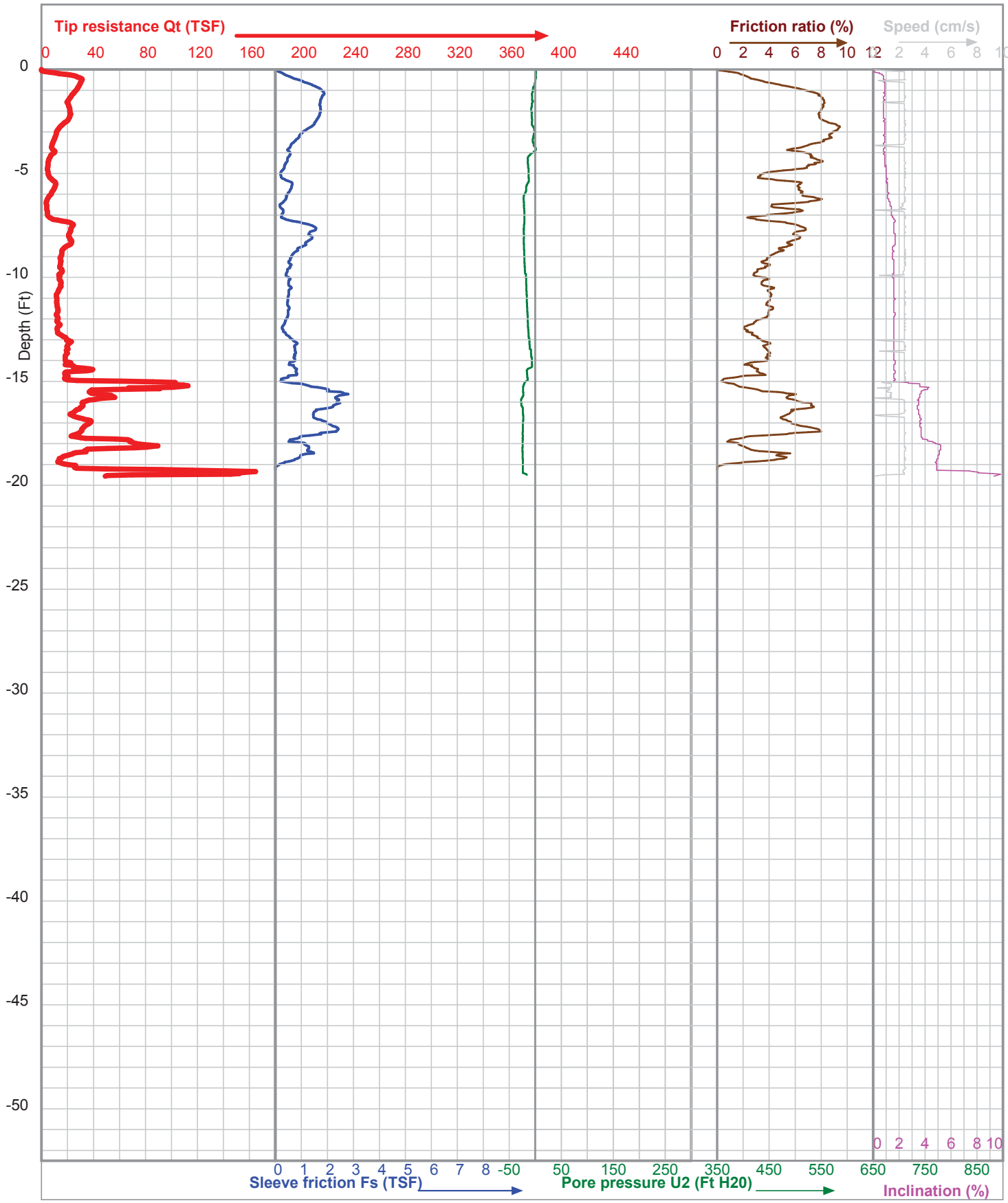
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 34	Cone Type	I-CFXYP20-15		
Test Number	2034	Cone ID	090709	X-Coord	40.67104
Client	Barr Engineering Co., Inc.	Start Time	15:11	Y-Coord	-83.84110
Boring Type	CPTU Sounding	Date	19-7-2011	Elev. Datum:	WGS 84



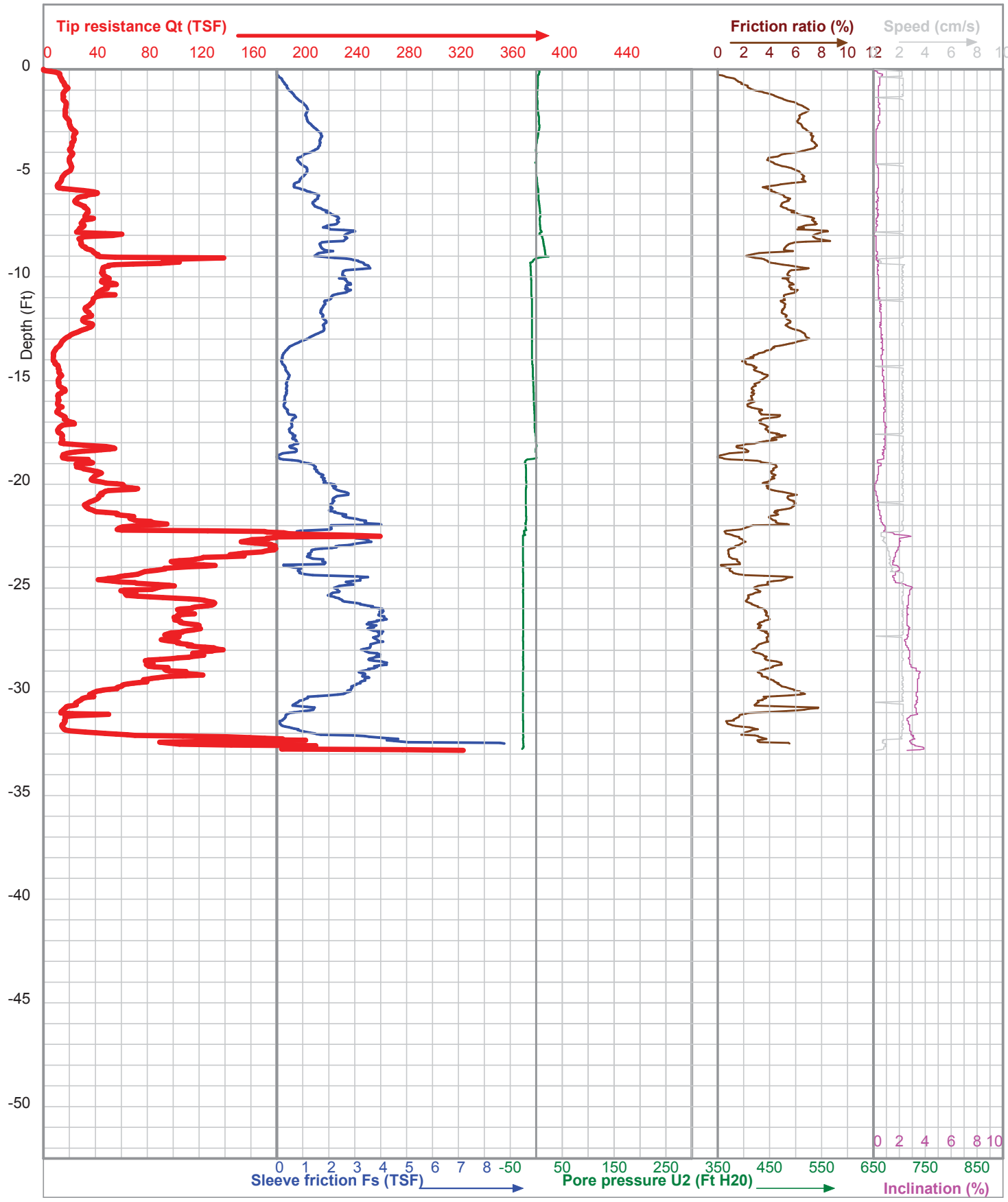
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 35	Cone Type	I-CFXYPP20-15		
Test Number	2035	Cone ID	100624	X-Coord	40.67088
Client	Barr Engineering Co., Inc.	Start Time	7:19	Y-Coord	-83.83655
Boring Type	CPTU Sounding	Date	20-7-2011	Elev. Datum:	WGS 84



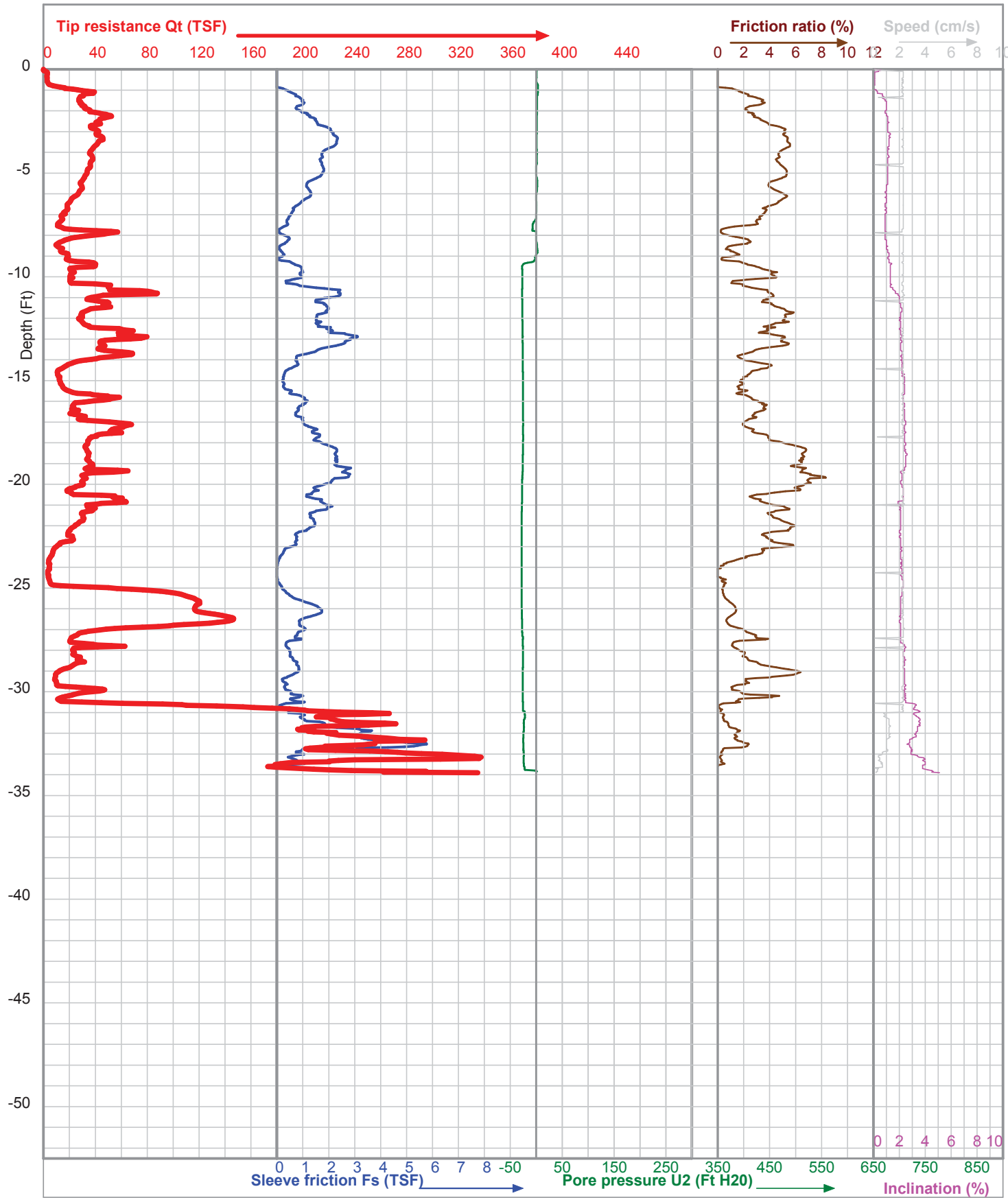
Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 54	Cone Type	I-CFXYPP20-15		
Test Number	2054	Cone ID	100624	X-Coord	40.64645
Client	Barr Engineering Co., Inc.	Start Time	10:38	Y-Coord	-83.79848
Boring Type	CPTU Sounding	Date	22-7-2011	Elev. Datum:	WGS 84



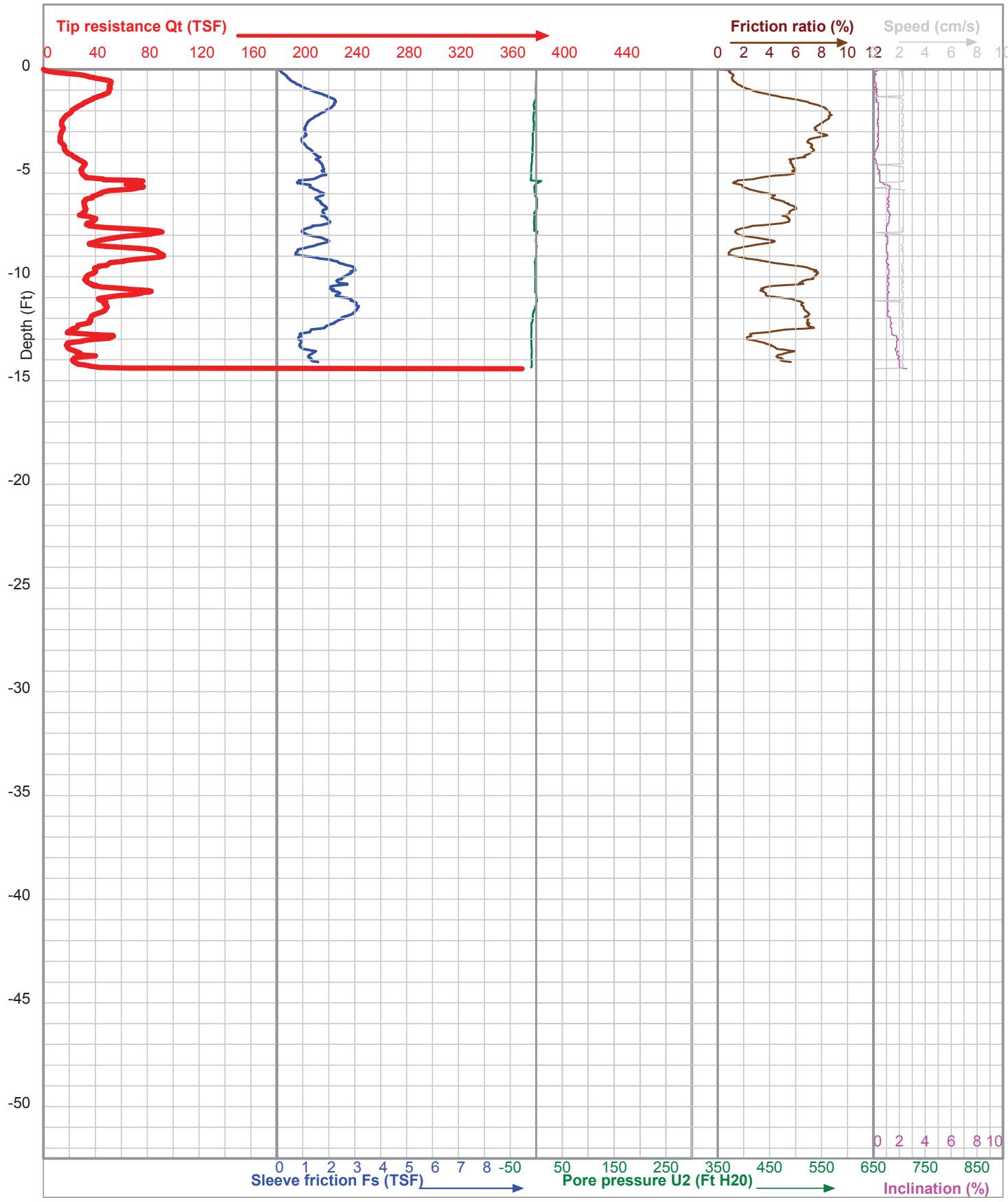
Project	Hardin County Wind	CPT Operator	M. Gulstrand	Elevation (Ft MSL)	
Location	Turbine 117	Cone Type	I-CFXYP20-15		
Test Number	2117	Cone ID	090710	X-Coord	40.69447
Client	Barr Engineering Co., Inc.	Start Time	16:57	Y-Coord	-83.71527
Boring Type	CPTU Sounding	Date	28-7-2011	Elev. Datum:	WGS 84



Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 2	Cone Type	I-CFXYPP20-15		
Test Number	3002	Cone ID	100624	X-Coord	40.69822
Client	Barr Engineering Co., Inc.	Start Time	8:18	Y-Coord	-83.83767
Boring Type	CPTU Sounding	Date	18-7-2011	Elev. Datum:	WGS 84



Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 6	Cone Type	I-CFXYP20-15		
Test Number	3006	Cone ID	090709	X-Coord	40.69898
Client	Barr Engineering Co., Inc.	Start Time	7:13	Y-Coord	-83.82728
Boring Type	CPTU Sounding	Date	19-7-2011	Elev. Datum:	WGS 84



Project	Hardin County Wind	CPT Operator	J. Strnad	Elevation (Ft MSL)	
Location	Turbine 35	Cone Type	I-CFXYPP20-15		
Test Number	3035	Cone ID	100624	X-Coord	40.67089
Client	Barr Engineering Co., Inc.	Start Time	7:31	Y-Coord	-83.83655
Boring Type	CPTU Sounding	Date	20-7-2011	Elev. Datum:	WGS 84

Appendix B

Shear and Compression Wave Velocity Test Results

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 118
Test #	118
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	29-7-2011
Time	7:24
Source Offset (ft):	4.50
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vs Interval Velocity (ft/s)
6.6	4.8	6.6				
9.9	8.1	9.3	3.3	2.95	6.5	907
13.2	11.4	12.3	3.3	2.20	9.8	1351
16.4	14.7	15.3	3.2	2.30	13.0	1333
19.7	17.9	18.5	3.3	3.30	16.3	958
23.0	21.2	21.7	3.3	2.80	19.6	1153
25.1	23.3	23.7	2.1	1.75	22.3	1157

Notes:

The Vs Interval velocity is the approximate estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

The combined error of the depth measurement and time cross-correlation estimate is generally +-50ft/s.

N/A indicates a value which MNGS, Inc. cannot determine by the data.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 12
Test #	12
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	28-7-2011
Time	9:58
Source Offset (ft):	4.50
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vs Interval Velocity (ft/s)
6.6	4.8	6.6				
9.8	8.1	9.3	3.3	3.35	6.5	797
13.2	11.4	12.3	3.3	4.35	9.7	690
16.4	14.7	15.3	3.2	3.90	13.0	786
19.7	17.9	18.5	3.3	2.85	16.3	1109
23.0	21.2	21.7	3.3	4.05	19.6	789
26.2	24.4	24.8	3.2	2.20	22.8	1433

Notes:

The Vs Interval velocity is the approximate estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

The combined error of the depth measurement and time cross-correlation estimate is generally +-50ft/s.

N/A indicates a value which MNGS, Inc. cannot determine by the data.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
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Project	Hardin County Wind
Sounding Location	Turbine 120
Test #	120
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	24-7-2011
Time	15:13
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vs Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.3	1.95	6.5	1068
13.1	11.4	13.8	3.3	2.20	9.7	1162
16.4	14.7	16.6	3.3	2.40	13.0	1172
19.7	17.9	19.5	3.3	2.90	16.3	1021
23.0	21.2	22.6	3.3	2.50	19.6	1219
26.2	24.5	25.7	3.3	2.70	22.9	1150
29.5	27.8	28.8	3.3	2.50	26.1	1258
32.8	31.1	32.0	3.3	2.00	29.4	1586
36.1	34.3	35.2	3.3	3.40	32.7	939
39.4	37.6	38.4	3.3	1.95	36.0	1644
42.6	40.9	41.6	3.3	2.65	39.3	1214
45.9	44.2	44.8	3.3	2.85	42.5	1132
50.1	48.3	48.9	4.1	3.20	46.2	1274

Notes:

The Vs Interval velocity is the approximate estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

The combined error of the depth measurement and time cross-correlation estimate is generally +-50ft/s.

N/A indicates a value which MNGS, Inc. cannot determine by the data.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
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Project	Hardin County Wind
Sounding Location	Turbine 129
Test #	129
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	25-7-2011
Time	15:02
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vs Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.3	6.00	6.5	347
13.1	11.4	13.8	3.3	1.00	9.7	2557
16.4	14.7	16.6	3.3	2.60	13.0	1082
19.7	17.9	19.5	3.3	2.55	16.3	1161
23.0	21.2	22.6	3.3	2.95	19.6	1033
26.2	24.5	25.7	3.3	3.20	22.9	970

Notes:

The Vs Interval velocity is the approximate estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

The combined error of the depth measurement and time cross-correlation estimate is generally +-50ft/s.

N/A indicates a value which MNGS, Inc. cannot determine by the data.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 23
Test #	23
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	29-7-2011
Time	6:13
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vs Interval Velocity (ft/s)
6.6	4.8	9.1				
12.0	10.2	12.8	5.4	6.95	7.5	533
13.9	12.2	14.4	2.0	2.60	11.2	622
16.4	14.7	16.6	2.5	1.85	13.4	1151
19.7	17.9	19.5	3.3	2.40	16.3	1233
23.0	21.2	22.6	3.3	2.90	19.6	1062
26.2	24.5	25.7	3.2	3.60	22.9	854
29.5	27.8	28.8	3.3	3.05	26.1	1031
32.8	31.1	32.0	3.3	2.65	29.4	1197
34.6	32.9	33.8	1.8	0.90	32.0	1983

Notes:

The Vs Interval velocity is the approximate estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

The combined error of the depth measurement and time cross-correlation estimate is generally +-50ft/s.

N/A indicates a value which MNGS, Inc. cannot determine by the data.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 3
Test #	3
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	28-7-2011
Time	13:05
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vs Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.3	0.40	6.5	5205
13.9	12.1	14.4	4.0	2.50	10.1	1275
16.4	14.7	16.6	2.5	1.15	13.4	1899
19.7	17.9	19.5	3.3	2.65	16.3	1117
23.0	21.2	22.6	3.3	2.60	19.6	1172
26.2	24.5	25.7	3.3	3.40	22.9	913
29.6	27.9	28.9	3.4	3.55	26.2	912
32.8	31.1	32.0	3.2	2.75	29.5	1119
34.1	32.4	33.3	1.3	0.90	31.7	1416

Notes:

The Vs Interval velocity is the approximate estimated velocity across the previous Tip Depth interval.
Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.
The combined error of the depth measurement and time cross-correlation estimate is generally +-50ft/s.
N/A indicates a value which MNGS, Inc. cannot determine by the data.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 33
Test #	33
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	28-7-2011
Time	14:32
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vs Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.3	0.85	6.5	2449
13.1	11.4	13.8	3.3	1.85	9.7	1382
16.4	14.7	16.6	3.3	3.00	13.0	938
19.7	17.9	19.5	3.3	3.30	16.3	897
23.0	21.2	22.6	3.3	3.80	19.6	802
27.0	25.2	26.4	4.0	3.75	23.2	1020
29.5	27.8	28.8	2.5	2.15	26.5	1127

Notes:

The Vs Interval velocity is the approximate estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

The combined error of the depth measurement and time cross-correlation estimate is generally +-50ft/s.

N/A indicates a value which MNGS, Inc. cannot determine by the data.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
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Project	Hardin County Wind
Sounding Location	Turbine 38
Test #	2038
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	27-7-2011
Time	14:40
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vs Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.3	5.90	6.5	353
13.1	11.4	13.8	3.3	2.10	9.7	1218
16.4	14.7	16.6	3.3	2.55	13.0	1103
19.7	17.9	19.5	3.3	1.90	16.3	1558

Notes:

The Vs Interval velocity is the approximate estimated velocity across the previous Tip Depth interval.
Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.
The combined error of the depth measurement and time cross-correlation estimate is generally +-50ft/s.
N/A indicates a value which MNGS, Inc. cannot determine by the data.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 38
Test #	38
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	27-7-2011
Time	13:59
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vs Interval Velocity (ft/s)
6.6	4.8	9.1				
9.9	8.2	11.3	3.3	0.15	6.5	14195
13.1	11.4	13.8	3.2	1.70	9.8	1476
16.4	14.7	16.6	3.3	2.40	13.0	1172
19.8	18.0	19.6	3.4	2.60	16.3	1173

Notes:

The Vs Interval velocity is the approximate estimated velocity across the previous Tip Depth interval.
Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.
The combined error of the depth measurement and time cross-correlation estimate is generally +-50ft/s.
N/A indicates a value which MNGS, Inc. cannot determine by the data.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 41
Test #	41
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	31-7-2011
Time	9:43
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vs Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.3	2.75	6.5	757
13.1	11.4	13.8	3.3	4.55	9.7	562
16.4	14.7	16.6	3.3	5.10	13.0	552
19.7	17.9	19.5	3.3	5.60	16.3	529
23.7	22.0	23.3	4.0	6.05	19.9	621
26.2	24.5	25.7	2.5	2.90	23.2	826
29.5	27.8	28.8	3.3	3.65	26.1	861
32.8	31.1	32.0	3.3	5.35	29.4	599
36.1	34.3	35.2	3.2	5.65	32.7	559

Notes:

The Vs Interval velocity is the approximate estimated velocity across the previous Tip Depth interval.
Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.
The combined error of the depth measurement and time cross-correlation estimate is generally +-50ft/s.
N/A indicates a value which MNGS, Inc. cannot determine by the data.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
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Project	Hardin County Wind
Sounding Location	Turbine 48
Test #	48
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	27-7-2011
Time	9:23
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vs Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.3	4.15	6.5	502
13.1	11.4	13.8	3.3	6.10	9.7	419
16.4	14.7	16.6	3.3	6.80	13.0	414
19.7	17.9	19.5	3.3	8.75	16.3	338
23.0	21.2	22.6	3.3	9.40	19.6	324
26.3	24.5	25.7	3.3	8.35	22.9	376
29.5	27.7	28.8	3.2	7.50	26.1	411
34.5	32.7	33.6	5.0	6.65	30.2	726
36.9	35.2	36.0	2.4	2.40	33.9	986
39.4	37.6	38.4	2.5	1.95	36.4	1234
42.6	40.9	41.6	3.3	3.65	39.3	882
45.9	44.2	44.8	3.3	3.25	42.5	993
50.1	48.3	48.9	4.1	3.80	46.2	1073

Notes:

The Vs Interval velocity is the approximate estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

The combined error of the depth measurement and time cross-correlation estimate is generally +-50ft/s.

N/A indicates a value which MNGS, Inc. cannot determine by the data.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 63
Test #	63
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	26-7-2011
Time	9:34
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vs Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.3	0.45	6.5	4626
13.2	11.4	13.8	3.3	1.65	9.7	1566
16.4	14.7	16.6	3.2	2.45	13.0	1137
19.7	17.9	19.5	3.3	3.40	16.3	870
23.9	22.2	23.5	4.3	4.25	20.1	935
26.2	24.5	25.7	2.3	2.55	23.3	854
29.5	27.8	28.8	3.3	5.30	26.1	593
32.8	31.1	32.0	3.3	3.50	29.4	906
36.1	34.3	35.2	3.3	3.25	32.7	982
39.7	37.9	38.7	3.6	2.95	36.1	1196
42.6	40.9	41.6	3.0	2.55	39.4	1136
45.9	44.2	44.8	3.3	0.80	42.5	4033
48.3	46.5	47.2	2.4	2.80	45.4	831

Notes:

The Vs Interval velocity is the approximate estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

The combined error of the depth measurement and time cross-correlation estimate is generally +-50ft/s.

N/A indicates a value which MNGS, Inc. cannot determine by the data.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 68
Test #	68
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	25-7-2011
Time	12:10
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vs Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.3	5.95	6.5	350
13.1	11.4	13.8	3.3	0.45	9.7	5682
16.4	14.7	16.6	3.3	2.60	13.0	1082
19.7	17.9	19.5	3.3	3.40	16.3	870
23.0	21.2	22.6	3.3	3.20	19.6	953
26.2	24.5	25.7	3.3	3.80	22.9	817
29.5	27.8	28.8	3.3	3.35	26.1	939
33.0	31.2	32.2	3.5	2.75	29.5	1223
36.1	34.3	35.2	3.1	2.45	32.8	1225
39.4	37.6	38.4	3.3	2.65	36.0	1210
42.7	40.9	41.7	3.3	3.35	39.3	970

Notes:

The Vs Interval velocity is the approximate estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

The combined error of the depth measurement and time cross-correlation estimate is generally +-50ft/s.

N/A indicates a value which MNGS, Inc. cannot determine by the data.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 82
Test #	82
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	29-7-2011
Time	13:17
Source Offset (ft):	4.50
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vs Interval Velocity (ft/s)
6.6	4.8	6.6				
9.9	8.1	9.3	3.3	6.40	6.5	418
13.2	11.4	12.3	3.3	8.20	9.8	363
16.4	14.7	15.3	3.2	6.50	13.0	472
19.7	17.9	18.5	3.3	3.40	16.3	930
23.0	21.2	21.7	3.3	3.95	19.6	809
26.3	24.5	24.9	3.3	2.60	22.9	1250
29.6	27.8	28.2	3.3	2.80	26.2	1154
30.5	28.8	29.1	1.0	0.75	28.3	1253

Notes:

The Vs Interval velocity is the approximate estimated velocity across the previous Tip Depth interval.
Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.
The combined error of the depth measurement and time cross-correlation estimate is generally +-50ft/s.
N/A indicates a value which MNGS, Inc. cannot determine by the data.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 88
Test #	88
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	31-7-2011
Time	7:32
Source Offset (ft):	4.50
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vs Interval Velocity (ft/s)
6.6	4.8	6.6				
9.9	8.1	9.3	3.3	3.35	6.5	799
16.4	14.7	15.3	6.5	10.05	11.4	601
19.7	18.0	18.5	3.3	5.15	16.3	620
23.0	21.2	21.7	3.2	5.10	19.6	620
26.3	24.5	24.9	3.3	5.50	22.9	591
29.6	27.8	28.2	3.3	5.20	26.2	622
32.8	31.1	31.4	3.3	3.85	29.4	842
35.3	33.5	33.8	2.5	2.65	32.3	919

Notes:

The Vs Interval velocity is the approximate estimated velocity across the previous Tip Depth interval.
Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.
The combined error of the depth measurement and time cross-correlation estimate is generally +-50ft/s.
N/A indicates a value which MNGS, Inc. cannot determine by the data.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 95
Test #	95
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	24-7-2011
Time	12:44
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vs Interval Velocity (ft/s)
6.6	4.8	9.1				
9.9	8.1	11.2	3.3	1.50	6.5	1404
13.7	12.0	14.3	3.8	3.65	10.0	829
16.4	14.7	16.6	2.7	3.00	13.3	774
19.7	17.9	19.5	3.3	3.10	16.3	955
23.0	21.2	22.6	3.3	3.00	19.6	1016
26.2	24.5	25.7	3.3	2.75	22.9	1129
29.5	27.8	28.8	3.3	2.80	26.1	1123
32.8	31.1	32.0	3.3	2.70	29.4	1175
36.1	34.3	35.2	3.3	2.70	32.7	1182
39.4	37.6	38.4	3.3	2.60	36.0	1246
42.6	40.9	41.6	3.2	2.65	39.3	1202
45.9	44.2	44.8	3.3	2.40	42.5	1344
50.1	48.3	48.9	4.1	3.10	46.2	1315

Notes:

The Vs Interval velocity is the approximate estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

The combined error of the depth measurement and time cross-correlation estimate is generally +-50ft/s.

N/A indicates a value which MNGS, Inc. cannot determine by the data.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 97
Test #	97
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	29-7-2011
Time	8:55
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vs Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.2	3.00	6.5	688
13.2	11.4	13.8	3.3	3.05	9.7	847
16.4	14.7	16.6	3.2	3.00	13.0	929
19.7	18.0	19.6	3.3	3.05	16.3	980
23.0	21.2	22.6	3.2	3.85	19.6	784
26.2	24.5	25.7	3.3	3.60	22.9	863
29.6	27.8	28.9	3.3	2.75	26.1	1155
32.8	31.1	32.0	3.2	2.05	29.4	1532
36.1	34.4	35.2	3.3	2.75	32.7	1172
39.4	37.6	38.4	3.3	2.25	36.0	1425
42.6	40.9	41.6	3.2	2.90	39.3	1098
45.9	44.2	44.8	3.3	1.90	42.5	1698
49.8	48.0	48.7	3.9	1.80	46.1	2120

Notes:

The Vs Interval velocity is the approximate estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

The combined error of the depth measurement and time cross-correlation estimate is generally +-50ft/s.

N/A indicates a value which MNGS, Inc. cannot determine by the data.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 3
Test #	3
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	28-7-2011
Time	13:05
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vp

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vp Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.3	0.75	6.5	2776
13.9	12.1	14.4	4.0	0.85	10.1	3749
16.4	14.7	16.6	2.5	0.55	13.4	3971
19.7	17.9	19.5	3.3	0.75	16.3	3946
23.0	21.2	22.6	3.3	0.45	19.6	6774
26.2	24.5	25.7	3.3	0.45	22.9	6901
29.6	27.9	28.9	3.4	0.50	26.2	6478
32.8	31.1	32.0	3.2	0.80	29.5	3846
34.1	32.4	33.3	1.3	0.50	31.7	2549

Notes:

The Vp Interval velocity is the estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

N/A indicates a value which MNGS, Inc. cannot verify by the data.

Highlighted results are likely distorted by groundwater influences or phase changes.

Minnesota GeoServices
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p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 12
Test #	12
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	28-7-2011
Time	9:58
Source Offset (ft):	4.45
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vp

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vp Interval Velocity (ft/s)
6.6	4.8	6.6				
9.8	8.1	9.2	3.3	1.15	6.5	2331
13.2	11.4	12.2	3.3	0.65	9.7	4627
16.4	14.7	15.3	3.2	0.50	13.0	6141
19.7	17.9	18.5	3.3	0.50	16.3	6326
23.0	21.2	21.7	3.3	0.40	19.6	7995
26.2	24.4	24.8	3.2	0.80	22.8	3943

Notes:

The Vp Interval velocity is the estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

N/A indicates a value which MNGS, Inc. cannot verify by the data.

Highlighted results are likely distorted by groundwater influences or phase changes.

Minnesota GeoServices
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p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 23
Test #	23
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	29-7-2011
Time	6:13
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vp

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vp Interval Velocity (ft/s)
6.6	4.8	9.1				
12.0	10.2	12.8	5.4	6.15	7.5	603
13.9	12.2	14.4	2.0	0.80	11.2	2022
16.4	14.7	16.6	2.5	0.45	13.4	4730
19.7	17.9	19.5	3.3	0.60	16.3	4933
23.0	21.2	22.6	3.3	0.35	19.6	8798
26.2	24.5	25.7	3.2	0.55	22.9	5590
29.5	27.8	28.8	3.3	0.50	26.1	6288
32.8	31.1	32.0	3.3	0.50	29.4	6343
34.6	32.9	33.8	1.8	0.50	32.0	3570

Notes:

The Vp Interval velocity is the estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

N/A indicates a value which MNGS, Inc. cannot verify by the data.

Highlighted results are likely distorted by groundwater influences or phase changes.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 33
Test #	33
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	28-7-2011
Time	14:32
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vp

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vp Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.3	1.05	6.5	1983
13.1	11.4	13.8	3.3	0.35	9.7	7305
16.4	14.7	16.6	3.3	0.40	13.0	7034
19.7	17.9	19.5	3.3	0.60	16.3	4933
23.0	21.2	22.6	3.3	0.45	19.6	6774
27.0	25.2	26.4	4.0	0.45	23.2	8502
29.5	27.8	28.8	2.5	0.60	26.5	4040

Notes:

The Vp Interval velocity is the estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

N/A indicates a value which MNGS, Inc. cannot verify by the data.

Highlighted results are likely distorted by groundwater influences or phase changes.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 38
Test #	2038
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	27-7-2011
Time	14:40
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vp

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vp Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.3	0.75	6.5	2776
13.1	11.4	13.8	3.3	0.55	9.7	4649
16.4	14.7	16.6	3.3	0.55	13.0	5116
19.7	17.9	19.5	3.3	0.50	16.3	5919

Notes:

The Vp Interval velocity is the estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

N/A indicates a value which MNGS, Inc. cannot verify by the data.

Highlighted results are likely distorted by groundwater influences or phase changes.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 38
Test #	38
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	27-7-2011
Time	13:59
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vp

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vp Interval Velocity (ft/s)
6.6	4.8	9.1				
9.9	8.2	11.3	3.3	4.75	6.5	448
13.1	11.4	13.8	3.2	0.50	9.8	5019
16.4	14.7	16.6	3.3	0.30	13.0	9379
19.8	18.0	19.6	3.4	0.50	16.3	6100

Notes:

The Vp Interval velocity is the estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

N/A indicates a value which MNGS, Inc. cannot verify by the data.

Highlighted results are likely distorted by groundwater influences or phase changes.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 41
Test #	41
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	31-7-2011
Time	9:43
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vp

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vp Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.3	10.25	6.5	203
13.1	11.4	13.8	3.3	0.35	9.7	7305
16.4	14.7	16.6	3.3	0.40	13.0	7034
19.7	17.9	19.5	3.3	0.35	16.3	8456
23.7	22.0	23.3	4.0	0.35	19.9	10738
26.2	24.5	25.7	2.5	0.35	23.2	6844
29.5	27.8	28.8	3.3	0.35	26.1	8983
32.8	31.1	32.0	3.3	0.35	29.4	9152
36.1	34.3	35.2	3.2	0.15	32.7	21063

Notes:

The Vp Interval velocity is the estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

N/A indicates a value which MNGS, Inc. cannot verify by the data.

Highlighted results are likely distorted by groundwater influences or phase changes.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 48
Test #	48
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	27-7-2011
Time	9:23
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vp

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vp Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.3	1.05	6.5	1983
13.1	11.4	13.8	3.3	0.35	9.7	7305
16.4	14.7	16.6	3.3	0.40	13.0	7034
19.7	17.9	19.5	3.3	0.50	16.3	5919
23.0	21.2	22.6	3.3	1.40	19.6	2177
26.3	24.5	25.7	3.3	0.25	22.9	12547
29.5	27.7	28.8	3.2	1.00	26.1	3081
34.5	32.7	33.6	5.0	0.85	30.2	5681
36.9	35.2	36.0	2.4	1.05	33.9	2254
39.4	37.6	38.4	2.5	0.50	36.4	4812
42.6	40.9	41.6	3.3	1.10	39.3	2925
45.9	44.2	44.8	3.3	1.20	42.5	2689
50.1	48.3	48.9	4.1	0.30	46.2	13586

Notes:

The Vp Interval velocity is the estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

N/A indicates a value which MNGS, Inc. cannot verify by the data.

Highlighted results are likely distorted by groundwater influences or phase changes.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 63
Test #	63
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	26-7-2011
Time	9:34
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vp

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vp Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.3	4.50	6.5	463
13.2	11.4	13.8	3.3	0.80	9.7	3230
16.4	14.7	16.6	3.2	0.60	13.0	4644
19.7	17.9	19.5	3.3	0.75	16.3	3946
23.9	22.2	23.5	4.3	0.35	20.1	11357
26.2	24.5	25.7	2.3	0.95	23.3	2293
29.5	27.8	28.8	3.3	0.55	26.1	5717
32.8	31.1	32.0	3.3	0.65	29.4	4879
36.1	34.3	35.2	3.3	0.60	32.7	5319
39.7	37.9	38.7	3.6	0.70	36.1	5039
42.6	40.9	41.6	3.0	0.50	39.4	5793
45.9	44.2	44.8	3.3	0.30	42.5	10756
48.3	46.5	47.2	2.4	0.50	45.4	4656

Notes:

The Vp Interval velocity is the estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

N/A indicates a value which MNGS, Inc. cannot verify by the data.

Highlighted results are likely distorted by groundwater influences or phase changes.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 68
Test #	68
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	25-7-2011
Time	12:10
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vp

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vp Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.3	4.95	6.5	421
13.1	11.4	13.8	3.3	0.85	9.7	3008
16.4	14.7	16.6	3.3	2.85	13.0	987
19.7	17.9	19.5	3.3	3.45	16.3	858
23.0	21.2	22.6	3.3	2.35	19.6	1297
26.2	24.5	25.7	3.3	2.85	22.9	1090
29.5	27.8	28.8	3.3	0.95	26.1	3310
33.0	31.2	32.2	3.5	0.65	29.5	5173
36.1	34.3	35.2	3.1	0.45	32.8	6667
39.4	37.6	38.4	3.3	0.60	36.0	5344
42.7	40.9	41.7	3.3	0.40	39.3	8125

Notes:

The Vp Interval velocity is the estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

N/A indicates a value which MNGS, Inc. cannot verify by the data.

Highlighted results are likely distorted by groundwater influences or phase changes.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 82
Test #	82
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	29-7-2011
Time	13:17
Source Offset (ft):	4.45
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vp

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vp Interval Velocity (ft/s)
6.6	4.8	6.6				
9.9	8.1	9.3	3.3	1.30	6.5	2065
13.2	11.4	12.2	3.3	0.30	9.8	9928
16.4	14.7	15.3	3.2	0.50	13.0	6141
19.7	17.9	18.5	3.3	0.50	16.3	6326
23.0	21.2	21.7	3.3	0.40	19.6	7995
26.3	24.5	24.9	3.3	1.00	22.9	3251
29.6	27.8	28.2	3.3	0.30	26.2	10778
30.5	28.8	29.1	1.0	0.65	28.3	1446

Notes:

The Vp Interval velocity is the estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

N/A indicates a value which MNGS, Inc. cannot verify by the data.

Highlighted results are likely distorted by groundwater influences or phase changes.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 88
Test #	88
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	31-7-2011
Time	7:32
Source Offset (ft):	4.45
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vp

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vp Interval Velocity (ft/s)
6.6	4.8	6.6				
9.9	8.1	9.3	3.3	0.30	6.5	8950
16.4	14.7	15.3	6.5	0.80	11.4	7561
19.7	18.0	18.5	3.3	0.60	16.3	5325
23.0	21.2	21.7	3.2	0.35	19.6	9046
26.3	24.5	24.9	3.3	0.40	22.9	8129
29.6	27.8	28.2	3.3	0.50	26.2	6467
32.8	31.1	31.4	3.3	0.45	29.4	7207
35.3	33.5	33.8	2.5	0.50	32.3	4874

Notes:

The Vp Interval velocity is the estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

N/A indicates a value which MNGS, Inc. cannot verify by the data.

Highlighted results are likely distorted by groundwater influences or phase changes.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 95
Test #	95
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	24-7-2011
Time	12:44
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vp

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vp Interval Velocity (ft/s)
6.6	4.8	9.1				
9.9	8.1	11.2	3.3	1.65	6.5	1276
13.7	12.0	14.3	3.8	3.40	10.0	890
16.4	14.7	16.6	2.7	0.50	13.3	4644
19.7	17.9	19.5	3.3	0.70	16.3	4228
23.0	21.2	22.6	3.3	1.00	19.6	3048
26.2	24.5	25.7	3.3	1.15	22.9	2700
29.5	27.8	28.8	3.3	3.35	26.1	939
32.8	31.1	32.0	3.3	1.35	29.4	2349
36.1	34.3	35.2	3.3	0.35	32.7	9118
39.4	37.6	38.4	3.3	0.55	36.0	5888
42.6	40.9	41.6	3.2	0.55	39.3	5792
45.9	44.2	44.8	3.3	0.25	42.5	12907
50.1	48.3	48.9	4.1	0.45	46.2	9057

Notes:

The Vp Interval velocity is the estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

N/A indicates a value which MNGS, Inc. cannot verify by the data.

Highlighted results are likely distorted by groundwater influences or phase changes.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 97
Test #	97
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	29-7-2011
Time	8:55
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vp

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vp Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.2	1.75	6.5	1180
13.2	11.4	13.8	3.3	1.25	9.7	2067
16.4	14.7	16.6	3.2	0.80	13.0	3483
19.7	18.0	19.6	3.3	0.80	16.3	3737
23.0	21.2	22.6	3.2	0.40	19.6	7546
26.2	24.5	25.7	3.3	0.35	22.9	8873
29.6	27.8	28.9	3.3	0.30	26.1	10586
32.8	31.1	32.0	3.2	0.45	29.4	6977
36.1	34.4	35.2	3.3	0.80	32.7	4029
39.4	37.6	38.4	3.3	0.25	36.0	12826
42.6	40.9	41.6	3.2	0.35	39.3	9102
45.9	44.2	44.8	3.3	0.75	42.5	4302
49.8	48.0	48.7	3.9	0.85	46.1	4490

Notes:

The Vp Interval velocity is the estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

N/A indicates a value which MNGS, Inc. cannot verify by the data.

Highlighted results are likely distorted by groundwater influences or phase changes.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 118
Test #	118
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	29-7-2011
Time	7:24
Source Offset (ft):	4.45
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vp

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vp Interval Velocity (ft/s)
6.6	4.8	6.6				
9.9	8.1	9.3	3.3	0.85	6.5	3159
13.2	11.4	12.2	3.3	0.65	9.8	4582
16.4	14.7	15.3	3.2	0.50	13.0	6141
19.7	17.9	18.5	3.3	0.90	16.3	3514
23.0	21.2	21.7	3.3	0.40	19.6	8075
25.1	23.3	23.7	2.1	0.35	22.3	5789

Notes:

The Vp Interval velocity is the estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

N/A indicates a value which MNGS, Inc. cannot verify by the data.

Highlighted results are likely distorted by groundwater influences or phase changes.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 120
Test #	120
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	24-7-2011
Time	15:13
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vp

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vp Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.3	6.05	6.5	344
13.1	11.4	13.8	3.3	1.75	9.7	1461
16.4	14.7	16.6	3.3	2.35	13.0	1197
19.7	17.9	19.5	3.3	2.35	16.3	1259
23.0	21.2	22.6	3.3	3.85	19.6	792
26.2	24.5	25.7	3.3	2.35	22.9	1321
29.5	27.8	28.8	3.3	0.95	26.1	3310
32.8	31.1	32.0	3.3	0.90	29.4	3524
36.1	34.3	35.2	3.3	1.20	32.7	2659
39.4	37.6	38.4	3.3	0.70	36.0	4580
42.6	40.9	41.6	3.3	0.55	39.3	5850
45.9	44.2	44.8	3.3	0.95	42.5	3397
50.1	48.3	48.9	4.1	0.50	46.2	8152

Notes:

The Vp Interval velocity is the estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

N/A indicates a value which MNGS, Inc. cannot verify by the data.

Highlighted results are likely distorted by groundwater influences or phase changes.

Minnesota GeoServices
1549 Minnehaha Avenue West / Saint Paul, MN 55104
p 651.261.2072 / f 651.645.7854

Project	Hardin County Wind
Sounding Location	Turbine 129
Test #	129
Project #	35110001
Site Location	Alger, OH
Date (day/month/year)	25-7-2011
Time	15:02
Source Offset (ft):	7.75
Source Depth (ft):	0.00
Geophone Offset (ft):	1.75

SEISMIC TEST RESULTS - Vp

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Depth Interval (ft)	Time Interval (ms)	Mid-Interval Depth (ft)	Vp Interval Velocity (ft/s)
6.6	4.8	9.1				
9.8	8.1	11.2	3.3	1.65	6.5	1262
13.1	11.4	13.8	3.3	1.35	9.7	1894
16.4	14.7	16.6	3.3	0.65	13.0	4329
19.7	17.9	19.5	3.3	0.55	16.3	5381
23.0	21.2	22.6	3.3	0.45	19.6	6774
26.2	24.5	25.7	3.3	0.50	22.9	6211

Notes:

The Vp Interval velocity is the estimated velocity across the previous Tip Depth interval.

Reduce the significant figures for the calculated Vs to 3 figures based on the precision of the depth interval.

N/A indicates a value which MNGS, Inc. cannot verify by the data.

Highlighted results are likely distorted by groundwater influences or phase changes.

Appendix C

Dilatometer (DMT) Test Results

Barr Engineering Company

DMT Spreadsheet- Data Summary
Hardin County Wind Project
35/33-1001
Sounding No: DMT5
August 2, 2011

Ground Water Depth (ft): 7

UTM, Zone 16N - NAD 83 (m)
Northing: 4509473.0
Easting: 261049.0

[1] Depth Below Existing Ground Surface
[2] Mayne, 1995
[3] Marchetti,1980
[4] Marchetti, 1997
[5] Campanella and Robertson, 1991
[6] Marchetti,1980
[7] Schmertman, 1981

Depth[1] (ft)	A (bar)	B (bar)	po	p1	u_o (psf)	s_{vo} (psf)	s_{vo}' (psf)	I_d	K_D	E_D (bar)	K_o	OCR[2]	OCR[3]	φ'[4] (deg)	φ'[5] (deg)	R_M	E_D (ksf)	s_u[6] (psf)	s_u[7] (psf)	M (ksf)
6.6	5.1	13.2	4.92	13.06	0	787	787	1.65	13.1	282	2.2			41.7	41.9	2.8	590			1623
7.6	2.95	10.6	2.80	10.46	40	917	877	2.76	6.6	266	1.4			38.6	40.4	2.1	556			1185
8.7	2.85	6.3	2.91	6.16	108	1047	939	1.14	6.3	113	1.4	3.2	6.1			2.0	236	875	596	483
9.8	3.9	6.45	4.00	6.31	177	1181	1004	0.59	8.1	80	1.6	4.1	8.9			2.3	167	1278	818	383
10.9	7.2	15.4	7.02	15.26	245	1311	1066	1.19	13.5	286	2.2	6.9	19.7			2.8	597	2556	1441	1664
12.0	3.7	15	3.36	14.86	312	1441	1128	3.58	5.9	399	1.3			38.0	40.1	2.0	833			1707
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
14.2	6.45	15.6	6.22	15.46	450	1705	1255	1.54	10.0	321	1.8			40.5	41.3	2.5	670			1674
15.3	4.05	5.35	4.21	5.21	517	1835	1317	0.25	6.3	35	1.4	3.2	6.0			2.0	72	1213	828	146
16.4	3.8	7.8	3.83	7.66	587	1969	1382	1.08	5.4	133	1.2	2.7	4.7			1.9	278	1043	741	522
17.5	4.15	8.2	4.18	8.06	654	2098	1444	1.01	5.6	135	1.3	2.8	5.0			1.9	282	1147	807	540
18.6	3.75	7.5	3.79	7.36	722	2228	1506	1.04	4.8	124	1.1	2.4	3.9			1.8	259	984	719	456
19.7	5.6	8.55	5.68	8.41	792	2362	1571	0.51	7.0	95	1.5	3.6	7.1			2.1	198	1669	1107	424
20.8	7.8	19.4	7.45	19.26	859	2492	1633	1.68	9.0	410	1.7			40.0	41.1	2.4	856			2054
21.9	5.65	22.4	5.04	22.26	927	2622	1695	3.75	5.7	598	1.3			37.8	40.0	2.0	1248			2503
23.0	11.4	34.6	10.47	34.46	996	2756	1760	2.40	11.9	833	2.0			41.3	41.7	2.7	1739			4628
24.0	6.65	29.4	5.74	29.26	1064	2886	1822	4.50	6.0	816	1.3			38.1	40.1	2.1	1705			3504
25.1	9.7	35	8.66	34.86	1131	3016	1884	3.23	9.0	909	1.7			40.0	41.1	2.4	1899			4573
26.2	8.4	16.6	8.22	16.46	1201	3150	1949	1.08	8.2	286	1.6	4.2	9.0			2.3	597	2498	1596	1375
27.3	9.1	35	8.03	34.86	1269	3280	2011	3.61	7.7	931	1.6			39.3	40.7	2.3	1944			4422
28.4	6	14.2	5.82	14.06	1336	3409	2073	1.59	5.2	286	1.2			37.4	39.8	1.9	597			1120
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
33.9	8.1	19.6	7.75	19.46	1678	4067	2389	1.68	6.1	406	1.3			38.2	40.2	2.0	848			1718
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
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0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!

Barr Engineering Company

DMT Spreadsheet- Data Summary

Hardin County Wind Project

35/33-1001

Sounding No: DMT45

August 1, 2011

Ground Water Depth (ft): 15

UTM, Zone 16N - NAD 83 (m)
Northing: 4505759.0
Easting: 263797.0

[1] Depth Below Existing Ground Surface
[2] Mayne, 1995
[3] Marchetti,1980
[4] Marchetti, 1997
[5] Campanella and Robertson, 1991
[6] Marchetti,1980
[7] Schmertman, 1981

Depth[1]	A	B	po	p1	u_o	s_{vo}	s_{vo}'			E_D				ϕ'[4]	ϕ'[5]		E_D	s_u[6]	s_u[7]	M
(ft)	(bar)	(bar)			(psf)	(psf)	(psf)	I_d	K_D	(bar)	K_o	OCR[2]	OCR[3]	(deg)	(deg)	R_M	(ksf)	(psf)	(psf)	(ksf)
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
7.6	1.6	2.1	1.81	1.86	0	917	917	0.03	4.1	2	1.0	2.1	3.1			1.6	4	497	378	6
8.7	1.6	2.15	1.81	1.91	0	1047	1047	0.06	3.6	4	0.9	1.8	2.5			1.5	8	480	377	11
9.8	1.7	2.2	1.91	1.96	0	1181	1181	0.03	3.4	2	0.9	1.7	2.3			1.4	4	499	398	5
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
12.0	1.75	2.35	1.95	2.11	0	1441	1441	0.08	2.8	5	0.7	1.4	1.7			1.2	11	489	408	14
13.1	1.75	2.35	1.95	2.11	0	1575	1575	0.08	2.6	5	0.7	1.3	1.5			1.1	11	478	408	13
14.2	1.95	2.5	2.16	2.26	0	1705	1705	0.05	2.6	4	0.7	1.3	1.5			1.1	8	531	450	9
15.3	1.95	2.75	2.14	2.51	18	1835	1817	0.17	2.5	13	0.7	1.2	1.4			1.1	27	516	446	28
16.4	1.85	2.55	2.05	2.31	88	1969	1881	0.13	2.2	9	0.6	1.1	1.2			1.0	19	473	419	18
17.5	2	2.6	2.20	2.36	155	2098	1943	0.07	2.3	5	0.6	1.2	1.2			1.0	11	506	444	11
18.6	3.35	5.2	3.49	4.96	223	2228	2006	0.43	3.5	51	0.9	1.8	2.4			1.4	107	895	707	152
19.7	3.7	4.95	3.87	4.71	292	2362	2070	0.23	3.8	29	0.9	1.9	2.7			1.5	61	1004	779	91
20.8	2.55	3.55	2.73	3.31	360	2492	2132	0.23	2.5	20	0.7	1.3	1.4			1.1	42	622	535	45
21.9	2.3	2.8	2.51	2.56	427	2622	2195	0.02	2.2	2	0.6	1.1	1.2			0.9	4	541	481	4
23.0	2.35	2.85	2.56	2.61	497	2756	2259	0.02	2.1	2	0.6	1.1	1.1			0.9	4	542	484	4
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
25.1	2.8	3.35	3.01	3.11	632	3016	2384	0.04	2.4	4	0.6	1.2	1.3			1.0	8	648	564	8
26.2	2.85	3.4	3.06	3.16	702	3150	2448	0.04	2.3	4	0.6	1.2	1.3			1.0	8	648	568	8
27.3	2.9	3.4	3.11	3.16	769	3280	2510	0.02	2.3	2	0.6	1.2	1.2			1.0	4	650	572	4
28.4	3.1	3.6	3.31	3.36	837	3409	2573	0.02	2.4	2	0.6	1.2	1.3			1.0	4	696	607	4
29.5	3.15	3.65	3.36	3.41	907	3543	2637	0.02	2.3	2	0.6	1.2	1.3			1.0	4	697	611	4
30.6	3.35	3.9	3.56	3.66	974	3673	2699	0.03	2.4	4	0.6	1.2	1.3			1.0	8	742	645	8
31.7	3.3	4.05	3.50	3.81	1042	3803	2762	0.11	2.3	11	0.6	1.2	1.2			1.0	23	710	626	22
32.8	3.5	4.1	3.70	3.86	1111	3937	2826	0.05	2.3	5	0.6	1.2	1.3			1.0	11	758	662	12
33.9	3.65	4.25	3.85	4.01	1179	4067	2888	0.05	2.4	5	0.6	1.2	1.3			1.0	11	789	687	12
35.0	4	4.7	4.20	4.46	1246	4197	2950	0.07	2.5	9	0.7	1.3	1.5			1.1	19	879	752	21
36.1	4	4.65	4.20	4.41	1316	4331	3015	0.06	2.5	7	0.7	1.3	1.4			1.1	15	865	746	16
37.2	4.15	4.8	4.35	4.56	1384	4461	3077	0.06	2.5	7	0.7	1.3	1.4			1.1	15	896	770	16
38.3	4.3	5.1	4.49	4.86	1451	4591	3139	0.10	2.5	13	0.7	1.3	1.4			1.1	27	925	793	29
39.4	4.55	5.15	4.75	4.91	1521	4724	3204	0.04	2.6	5	0.7	1.3	1.5			1.1	11	989	841	13
40.5	4.85	5.5	5.05	5.26	1588	4854	3266	0.05	2.7	7	0.7	1.4	1.6			1.2	15	1066	896	18
41.5	5.15	6	5.34	5.76	1656	4984	3328	0.09	2.9	15	0.8	1.5	1.7			1.2	30	1142	950	37
42.7	6.15	7.15	6.33	6.91	1725	5118	3393	0.10	3.4	20	0.9	1.7	2.3			1.4	42	1443	1150	58
43.7	5.7	8.9	5.77	8.66	1793	5248	3455	0.59	3.0	100	0.8	1.5	1.9			1.3	209	1246	1026	263
44.8	5.95	9.65	6.00	9.41	1861	5378	3517	0.67	3.0	118	0.8	1.5	1.9			1.3	247	1302	1067	317
45.9	7.45	10.6	7.53	10.36	1930	5512	3582	0.43	3.8	98	1.0	2.0	2.8			1.5	205	1786	1379	313
47.0	8.55	13.2	8.55	12.96	1998	5642	3644	0.58	4.4	153	1.0	2.2	3.4			1.6	320	2119	1586	526
48.1	8.85	14	8.83	13.76	2065	5772	3706	0.63	4.4	171	1.1	2.2	3.4			1.7	358	2194	1637	595
49.2	8.3	14.2	8.24	13.96	2135	5906	3771	0.79	4.0	199	1.0	2.0	2.9			1.6	415	1971	1507	652
50.3	9.5	15.8	9.42	15.56	2202	6035	3833	0.73	4.6	213	1.1	2.3	3.6			1.7	445	2361	1747	757

Barr Engineering Company

DMT Spreadsheet- Data Summary

Hardin County Wind Project

35/33-1001

Sounding No: **DMT48**

August 2, 2011

Ground Water Depth (ft): 7

UTM, Zone 16N - NAD 83 (m)
Northing: 4504981.0
Easting: 264366.0

[1] Depth Below Existing Ground Surface
[2] Mayne, 1995
[3] Marchetti,1980
[4] Marchetti, 1997
[5] Campanella and Robertson, 1991
[6] Marchetti,1980
[7] Schmertman, 1981

Depth[1]	A	B	po	p1	u_o	s_{vo}	s_{vo}'			E_D				ϕ'^4	ϕ'^5		E_D	s_u^6	s_u^7	M
(ft)	(bar)	(bar)			(psf)	(psf)	(psf)	I_d	K_D	(bar)	K_o	OCR[2]	OCR[3]	(deg)	(deg)	R_M	(ksf)	(psf)	(psf)	(ksf)
6.6	2.45	4.1	2.51	3.66	0	787	787	0.46	6.6	40	1.4	3.4	6.5			2.1	84	777	523	174
7.6	2.75	4.4	2.81	3.96	40	917	877	0.41	6.6	40	1.4	3.4	6.5			2.1	84	864	582	174
8.7	2.85	4.1	2.93	3.66	108	1047	939	0.26	6.4	26	1.4	3.3	6.1			2.0	53	882	600	109
9.8	3.05	4.05	3.14	3.61	177	1181	1004	0.15	6.4	16	1.4	3.2	6.1			2.0	34	936	638	70
10.9	2.75	3.65	2.84	3.21	245	1311	1066	0.13	5.3	13	1.2	2.7	4.6			1.9	27	800	569	49
12.0	2.7	3.35	2.81	2.91	312	1441	1128	0.04	4.9	4	1.1	2.5	4.1			1.8	8	764	555	13
13.1	2.45	3.35	2.54	2.91	382	1575	1193	0.16	4.1	13	1.0	2.1	3.1			1.6	27	650	493	42
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
16.4	2.5	3.25	2.60	2.81	587	1969	1382	0.09	3.5	7	0.9	1.8	2.4			1.4	15	613	484	22
17.5	2.45	3.15	2.55	2.71	654	2098	1444	0.07	3.2	5	0.8	1.6	2.1			1.3	11	580	468	15
18.6	2.55	3.2	2.66	2.76	722	2228	1506	0.05	3.2	4	0.8	1.6	2.1			1.3	8	597	482	10
19.7	2.6	3.2	2.71	2.76	792	2362	1571	0.02	3.1	2	0.8	1.6	2.0			1.3	4	597	486	5
20.8	2.55	3.3	2.65	2.86	859	2492	1633	0.09	2.9	7	0.8	1.5	1.8			1.2	15	563	468	19
21.9	2.75	3.35	2.86	2.91	927	2622	1695	0.02	3.0	2	0.8	1.5	1.9			1.3	4	612	504	5
23.0	2.75	3.6	2.85	3.16	996	2756	1760	0.13	2.8	11	0.7	1.4	1.7			1.2	23	592	495	27
24.0	3	3.8	3.10	3.36	1064	2886	1822	0.10	3.0	9	0.8	1.5	1.8			1.3	19	656	541	24
25.1	3.4	4.35	3.49	3.91	1131	3016	1884	0.14	3.3	15	0.8	1.7	2.2			1.4	30	766	616	41
26.2	3.75	4.7	3.84	4.26	1201	3150	1949	0.13	3.5	15	0.9	1.8	2.4			1.4	30	863	682	43
27.3	3.9	5.1	3.98	4.66	1269	3280	2011	0.20	3.5	24	0.9	1.8	2.4			1.4	49	891	704	70
28.4	3.25	6	3.25	5.56	1336	3409	2073	0.88	2.6	80	0.7	1.3	1.5			1.2	167	642	545	193
29.5	4.05	6.55	4.06	6.11	1406	3543	2138	0.60	3.3	71	0.9	1.7	2.2			1.4	148	883	708	203
30.6	5.1	10.6	4.96	10.16	1473	3673	2200	1.22	4.0	180	1.0			36.1	39.2	1.6	377			606
31.7	7.9	16.2	7.62	15.76	1541	3803	2262	1.18	6.4	282	1.4	3.2	6.1			2.1	590	2112	1438	1211
32.8	8.65	17.8	8.33	17.36	1610	3937	2327	1.19	6.8	313	1.4	3.5	6.7			2.1	654	2357	1579	1386
33.9	10	19.8	9.65	19.36	1678	4067	2389	1.10	7.7	337	1.6	3.9	8.2			2.2	704	2849	1847	1580
35.0	9.15	18	8.85	17.56	1746	4197	2451	1.09	6.8	302	1.4	3.5	6.8			2.1	632	2501	1673	1339
36.1	8.8	17.4	8.51	16.96	1815	4331	2516	1.11	6.3	293	1.4	3.2	6.1			2.0	613	2342	1595	1255
37.2	8.8	20.6	8.35	20.16	1883	4461	2578	1.59	6.0	410	1.3			38.1	40.2	2.0	856			1725
38.3	7.75	16.2	7.47	15.76	1950	4591	2640	1.27	5.2	288	1.2			37.3	39.8	1.9	601			1113
39.4	11.2	34	10.20	33.56	2020	4724	2705	2.53	7.1	811	1.5			38.9	40.6	2.2	1693			3717
40.5	7.1	14.6	6.86	14.16	2087	4854	2767	1.24	4.4	253	1.1			36.6	39.4	1.7	529			898
41.5	7.25	14.4	7.03	13.96	2155	4984	2829	1.16	4.4	240	1.1	2.3	3.5			1.7	502	1681	1253	851
42.7	7.85	17.2	7.52	16.76	2225	5118	2893	1.43	4.7	321	1.1			36.8	39.5	1.8	670			1178
43.7	11	22.2	10.58	21.76	2292	5248	2956	1.18	6.7	388	1.4	3.4	6.6			2.1	810	2946	1980	1705
44.8	17.4	30	16.91	29.56	2360	5378	3018	0.80	10.9	439	1.9	5.6	14.1			2.6	917	5541	3295	2369
45.9	11.2	35.2	10.14	34.76	2429	5512	3082	2.74	6.1	854	1.3			38.2	40.2	2.1	1784			3675
47.0	20.4	30	20.06	29.56	2497	5642	3145	0.50	12.5	330	2.1	6.4	17.5			2.7	689	6855	3939	1869
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!

Barr Engineering Company

DMT Spreadsheet- Data Summary

Hardin County Wind Project

35/33-1001

Sounding No: DMT51

August 21, 2011

Ground Water Depth (ft): 7

UTM, Zone 16N - NAD 83 (m)
Northing: 4504005.0
Easting: 263477.0

[1] Depth Below Existing Ground Surface
[2] Mayne, 1995
[3] Marchetti,1980
[4] Marchetti, 1997
[5] Campanella and Robertson, 1991
[6] Marchetti,1980
[7] Schmertman, 1981

Depth[1]	A	B	po	p1	u_o	s_{vo}	s_{vo}'			E_D				ϕ'[4]	ϕ'[5]		E_D	s_u[6]	s_u[7]	M
(ft)	(bar)	(bar)			(psf)	(psf)	(psf)	I_d	K_D	(bar)	K_o	OCR[2]	OCR[3]	(deg)	(deg)	R_M	(ksf)	(psf)	(psf)	(ksf)
6.6	1.35	2.4	1.44	1.86	0	787	787	0.29	3.8	15	1.0	1.9	2.7			1.5	30	389	301	46
7.6	1.65	2.45	1.75	1.91	40	917	877	0.09	4.1	5	1.0	2.1	3.1			1.6	11	477	362	18
8.7	1.8	2.5	1.91	1.96	108	1047	939	0.03	4.1	2	1.0	2.1	3.1			1.6	4	511	388	6
9.8	1.8	2.55	1.91	2.01	177	1181	1004	0.06	3.8	4	0.9	1.9	2.7			1.5	8	491	380	11
10.9	1.8	2.6	1.90	2.06	245	1311	1066	0.09	3.5	5	0.9	1.8	2.4			1.4	11	472	373	16
12.0	1.9	2.6	2.01	2.06	312	1441	1128	0.03	3.4	2	0.9	1.8	2.3			1.4	4	489	388	5
13.1	1.95	2.7	2.06	2.16	382	1575	1193	0.06	3.3	4	0.8	1.7	2.2			1.4	8	487	391	10
14.2	2	2.7	2.11	2.16	450	1705	1255	0.03	3.1	2	0.8	1.6	2.0			1.3	4	487	395	5
15.3	2	2.8	2.10	2.26	517	1835	1317	0.08	2.9	5	0.8	1.5	1.8			1.2	11	469	387	14
16.4	2.05	2.8	2.16	2.26	587	1969	1382	0.06	2.8	4	0.7	1.4	1.7			1.2	8	470	391	9
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
19.7	2.2	2.95	2.31	2.41	792	2362	1571	0.05	2.6	4	0.7	1.3	1.5			1.1	8	471	402	8
20.8	2.2	3	2.30	2.46	859	2492	1633	0.08	2.4	5	0.7	1.2	1.3			1.0	11	456	395	12
21.9	2.35	3.1	2.46	2.56	927	2622	1695	0.05	2.5	4	0.7	1.3	1.4			1.1	8	487	420	8
23.0	2.4	3.1	2.51	2.56	996	2756	1760	0.03	2.4	2	0.6	1.2	1.3			1.0	4	489	424	4
24.0	2.4	3.2	2.50	2.66	1064	2886	1822	0.08	2.3	5	0.6	1.2	1.2			1.0	11	473	416	11
25.1	2.55	3.3	2.66	2.76	1131	3016	1884	0.05	2.3	4	0.6	1.2	1.3			1.0	8	505	441	8
26.2	2.65	3.35	2.76	2.81	1201	3150	1949	0.02	2.3	2	0.6	1.2	1.3			1.0	4	521	456	4
27.3	2.65	3.45	2.75	2.91	1269	3280	2011	0.07	2.2	5	0.6	1.1	1.2			1.0	11	506	448	11
28.4	2.85	3.65	2.95	3.11	1336	3409	2073	0.07	2.3	5	0.6	1.2	1.3			1.0	11	552	483	11
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
30.6	3.1	3.9	3.20	3.36	1473	3673	2200	0.06	2.4	5	0.6	1.2	1.3			1.0	11	599	522	12
31.7	3.2	3.95	3.31	3.41	1541	3803	2262	0.04	2.4	4	0.6	1.2	1.3			1.0	8	615	536	8
32.8	3.3	4.1	3.40	3.56	1610	3937	2327	0.06	2.4	5	0.6	1.2	1.3			1.0	11	630	550	12
33.9	3.75	4.75	3.84	4.21	1678	4067	2389	0.12	2.7	13	0.7	1.4	1.6			1.1	27	750	635	30
35.0	3.8	4.7	3.90	4.16	1746	4197	2451	0.09	2.6	9	0.7	1.3	1.5			1.1	19	752	639	21
36.1	3.9	4.8	4.00	4.26	1815	4331	2516	0.08	2.6	9	0.7	1.3	1.5			1.1	19	767	653	21
37.2	4.1	5.1	4.19	4.56	1883	4461	2578	0.11	2.7	13	0.7	1.4	1.6			1.1	27	812	687	30
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
39.4	4.25	5.15	4.35	4.61	2020	4724	2705	0.08	2.6	9	0.7	1.3	1.5			1.1	19	830	706	21
40.5	4.6	5.55	4.70	5.01	2087	4854	2767	0.09	2.8	11	0.7	1.4	1.7			1.2	23	923	772	27
41.5	4.55	5.55	4.64	5.01	2155	4984	2829	0.10	2.7	13	0.7	1.4	1.6			1.1	27	891	754	30
42.7	4.75	5.7	4.85	5.16	2225	5118	2893	0.08	2.7	11	0.7	1.4	1.6			1.2	23	938	789	27
43.7	4.8	5.8	4.89	5.26	2292	5248	2956	0.10	2.7	13	0.7	1.4	1.6			1.2	27	938	793	31
44.8	4.85	5.9	4.94	5.36	2360	5378	3018	0.11	2.6	15	0.7	1.3	1.5			1.1	30	938	796	35
45.9	5.05	5.95	5.15	5.41	2429	5512	3082	0.07	2.7	9	0.7	1.4	1.6			1.2	19	987	832	22
47.0	5.2	6.25	5.29	5.71	2497	5642	3145	0.10	2.7	15	0.7	1.4	1.6			1.2	30	1016	855	35
48.1	5.45	6.25	5.55	5.71	2564	5772	3207	0.04	2.8	5	0.7	1.4	1.7			1.2	11	1082	903	14
49.2	5.55	6.8	5.63	6.26	2634	5906	3271	0.14	2.8	22	0.7	1.4	1.7			1.2	46	1091	912	54
50.3	5.8	7.1	5.88	6.56	2702	6035	3334	0.15	2.9	24	0.8	1.5	1.8			1.2	49	1153	957	60

Barr Engineering Company

DMT Spreadsheet- Data Summary

Hardin County Wind Project

35/33-1001

Sounding No: DMT54

August 1, 2011

Ground Water Depth (ft): 7

UTM, Zone 16N - NAD 83 (m)
Northing: 4503270.0
Easting: 263375.0

[1] Depth Below Existing Ground Surface
[2] Mayne, 1995
[3] Marchetti,1980
[4] Marchetti, 1997
[5] Campanella and Robertson, 1991
[6] Marchetti,1980
[7] Schmertman, 1981

Depth[1]	A	B	po	p1	u_o	s_{vo}	s_{vo}'			E_D				ϕ'^4	ϕ'^5		E_D	s_u^6	s_u^7	M
(ft)	(bar)	(bar)			(psf)	(psf)	(psf)	I_d	K_D	(bar)	K_o	OCR[2]	OCR[3]	(deg)	(deg)	R_M	(ksf)	(psf)	(psf)	(ksf)
6.6	1.2	1.85	1.40	1.61	0	787	787	0.15	3.7	7	0.9	1.9	2.6			1.5	15	375	292	23
7.6	1.55	2.15	1.75	1.91	40	917	877	0.09	4.1	5	1.0	2.1	3.1			1.6	11	477	362	18
8.7	1.8	2.45	2.00	2.21	108	1047	939	0.11	4.3	7	1.0	2.2	3.3			1.6	15	543	407	25
9.8	1.75	2.5	1.95	2.26	177	1181	1004	0.17	3.9	11	1.0	2.0	2.8			1.5	23	504	388	35
10.9	1.8	2.35	2.01	2.11	245	1311	1066	0.06	3.7	4	0.9	1.9	2.6			1.5	8	506	394	11
12.0	2	2.55	2.21	2.31	312	1441	1128	0.05	3.8	4	0.9	1.9	2.7			1.5	8	555	429	11
13.1	2.05	2.65	2.25	2.41	382	1575	1193	0.08	3.6	5	0.9	1.8	2.5			1.5	11	552	432	17
14.2	2.1	2.75	2.30	2.51	450	1705	1255	0.10	3.5	7	0.9	1.8	2.4			1.4	15	550	435	22
15.3	1.85	2.45	2.05	2.21	517	1835	1317	0.09	2.9	5	0.8	1.5	1.7			1.2	11	453	377	14
16.4	2.45	4.2	2.60	3.96	587	1969	1382	0.59	3.5	47	0.9	1.8	2.4			1.4	99	611	483	141
17.5	2.6	5.3	2.70	5.06	654	2098	1444	0.99	3.4	82	0.9	1.8	2.3			1.4	171	628	498	246
18.6	2.65	4.75	2.78	4.51	722	2228	1506	0.71	3.4	60	0.9	1.7	2.3			1.4	126	637	508	175
19.7	3.15	4.2	3.33	3.96	792	2362	1571	0.21	3.9	22	1.0	2.0	2.9			1.5	46	802	616	70
20.8	2.7	3.2	2.91	2.96	859	2492	1633	0.02	3.2	2	0.8	1.6	2.1			1.3	4	645	521	5
21.9	2.45	3.05	2.65	2.81	927	2622	1695	0.07	2.7	5	0.7	1.4	1.6			1.2	11	548	461	13
23.0	2.9	3.75	3.09	3.51	996	2756	1760	0.16	3.1	15	0.8	1.6	2.0			1.3	30	670	546	40
24.0	2.75	3.55	2.94	3.31	1064	2886	1822	0.15	2.8	13	0.7	1.4	1.7			1.2	27	607	508	32
25.1	3.25	4.95	3.40	4.71	1131	3016	1884	0.46	3.2	46	0.8	1.6	2.0			1.3	95	736	596	126
26.2	3.6	6.4	3.69	6.16	1201	3150	1949	0.79	3.3	86	0.9	1.7	2.2			1.4	179	814	651	249
27.3	3.55	5.85	3.67	5.61	1269	3280	2011	0.63	3.2	67	0.8	1.6	2.1			1.3	141	789	639	187
28.4	3.5	6.3	3.59	6.06	1336	3409	2073	0.84	3.0	86	0.8	1.5	1.9			1.3	179	749	617	228
29.5	4.05	6.15	4.18	5.91	1406	3543	2138	0.49	3.4	60	0.9	1.7	2.3			1.4	126	921	732	176
30.6	4.3	6.05	4.45	5.81	1473	3673	2200	0.37	3.6	47	0.9	1.8	2.4			1.4	99	992	781	142
31.7	5.9	11.8	5.84	11.56	1541	3803	2262	1.12	4.7	199	1.1	2.4	3.8			1.8	415	1451	1065	727
32.8	9.05	19.4	8.77	19.16	1610	3937	2327	1.30	7.2	361	1.5			39.0	40.6	2.2	753			1639
33.9	7.55	17.2	7.30	16.96	1678	4067	2389	1.49	5.7	335	1.3			37.8	40.0	2.0	700			1367
35.0	6.65	12.2	6.61	11.96	1746	4197	2451	0.93	4.9	186	1.1	2.5	4.1			1.8	388	1660	1205	694
36.1	9.35	17.6	9.17	17.36	1815	4331	2516	0.99	6.9	284	1.4	3.5	6.9			2.1	594	2598	1734	1263
37.2	12.6	23.2	12.30	22.96	1883	4461	2578	0.93	9.2	370	1.7	4.7	10.9			2.4	772	3840	2381	1869
38.3	11.2	21.4	10.92	21.16	1950	4591	2640	1.02	7.9	355	1.6	4.0	8.5			2.3	742	3235	2086	1681
39.4	10.8	25	10.32	24.76	2020	4724	2705	1.54	7.2	501	1.5			39.0	40.6	2.2	1046			2288
40.5	7.15	25.2	6.48	24.96	2087	4854	2767	3.37	4.1	641	1.0			36.2	39.2	1.7	1339			2321
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!

Barr Engineering Company

DMT Spreadsheet- Data Summary

Hardin County Wind Project

35/33-1001

Sounding No: DMT64

August 1, 2011

Ground Water Depth (ft): 7

UTM, Zone 16N - NAD 83 (m)
Northing: 4502405.0
Easting: 264954.0

[1] Depth Below Existing Ground Surface
[2] Mayne, 1995
[3] Marchetti,1980
[4] Marchetti, 1997
[5] Campanella and Robertson, 1991
[6] Marchetti,1980
[7] Schmertman, 1981

Depth[1]	A	B	po	p1	u_o	s_{vo}	s_{vo}'			E_D				ϕ'[4]	ϕ'[5]		E_D	s_u[6]	s_u[7]	M
(ft)	(bar)	(bar)			(psf)	(psf)	(psf)	I_d	K_D	(bar)	K_o	OCR[2]	OCR[3]	(deg)	(deg)	R_M	(ksf)	(psf)	(psf)	(ksf)
6.6	4.4	11.6	4.14	10.91	0	787	787	1.64	11.0	235	1.9			40.9	41.5	2.6	491			1270
7.6	4.2	9.7	4.02	9.01	40	917	877	1.25	9.5	173	1.8			40.3	41.2	2.5	361			887
8.7	6.2	15.2	5.85	14.51	108	1047	939	1.49	12.9	301	2.1			41.6	41.9	2.7	628			1720
9.8	4.6	11	4.38	10.31	177	1181	1004	1.38	8.9	206	1.7			40.0	41.1	2.4	430			1028
10.9	2.45	5.8	2.38	5.11	245	1311	1066	1.21	4.4	95	1.1			36.6	39.4	1.7	198			336
12.0	4.25	8.15	4.15	7.46	312	1441	1128	0.83	7.4	115	1.5	3.8	7.7			2.2	240	1276	836	527
13.1	4.05	11.4	3.78	10.71	382	1575	1193	1.93	6.3	240	1.4			38.3	40.3	2.1	502			1038
14.2	4.9	12.8	4.60	12.11	450	1705	1255	1.71	7.3	261	1.5			39.0	40.6	2.2	544			1197
15.3	4.8	11.4	4.57	10.71	517	1835	1317	1.42	6.8	213	1.4			38.7	40.5	2.1	445			949
16.4	4.55	10.6	4.35	9.91	587	1969	1382	1.37	6.1	193	1.3			38.2	40.2	2.0	403			817
17.5	7.25	14.2	7.00	13.51	654	2098	1444	0.97	9.7	226	1.8	4.9	11.7			2.5	472	2278	1397	1164
18.6	8.2	16.4	7.89	15.71	722	2228	1506	1.04	10.5	271	1.9	5.3	13.2			2.5	567	2620	1575	1441
19.7	9	15.8	8.76	15.11	792	2362	1571	0.76	11.1	220	2.0	5.7	14.6			2.6	460	2957	1750	1198
20.8	7.55	14.4	7.31	13.71	859	2492	1633	0.93	8.8	222	1.7	4.5	10.1			2.4	464	2295	1440	1102
21.9	8	14.6	7.77	13.91	927	2622	1695	0.84	9.0	213	1.7	4.6	10.5			2.4	445	2452	1530	1067
23.0	8	13.8	7.81	13.11	996	2756	1760	0.72	8.7	184	1.7	4.4	9.9			2.4	384	2432	1531	906
24.0	5.75	13	5.49	12.31	1064	2886	1822	1.37	5.7	237	1.3			37.8	40.0	2.0	495			966
25.1	6.05	18.6	5.52	17.91	1131	3016	1884	2.49	5.5	430	1.2			37.7	39.9	2.0	898			1763
26.2	7.85	13.8	7.65	13.11	1201	3150	1949	0.77	7.6	189	1.5	3.9	8.0			2.2	396	2268	1478	878
27.3	7.75	11.2	7.68	10.51	1269	3280	2011	0.40	7.3	98	1.5	3.7	7.6			2.2	205	2247	1476	449
28.4	6.55	10.8	6.44	10.11	1336	3409	2073	0.63	5.8	128	1.3	3.0	5.3			1.9	266	1740	1210	519
29.5	7.35	10.4	7.30	9.71	1406	3543	2138	0.36	6.5	84	1.4	3.3	6.2			2.1	175	2040	1383	359
30.6	10.8	30	9.94	29.31	1473	3673	2200	2.10	8.8	672	1.7			39.9	41.0	2.4	1404			3338
31.7	7.2	11.8	7.07	11.11	1541	3803	2262	0.64	5.8	140	1.3	3.0	5.3			2.0	293	1901	1322	571
32.8	6.45	9.45	6.40	8.76	1610	3937	2327	0.42	5.1	82	1.2	2.6	4.2			1.8	171	1629	1175	308
33.9	6.55	9.8	6.49	9.11	1678	4067	2389	0.46	5.0	91	1.2	2.5	4.1			1.8	190	1639	1187	339
35.0	6.45	9.3	6.41	8.61	1746	4197	2451	0.40	4.7	77	1.1	2.4	3.8			1.7	160	1588	1163	277
36.1	7.15	12.8	6.97	12.11	1815	4331	2516	0.84	5.1	179	1.2	2.6	4.3			1.8	373	1766	1273	676
37.2	6.15	10.6	6.03	9.91	1883	4461	2578	0.76	4.2	135	1.0	2.1	3.1			1.6	282	1413	1070	453
38.3	9.4	15.8	9.18	15.11	1950	4591	2640	0.72	6.5	206	1.4	3.3	6.3			2.1	430	2545	1722	888
39.4	6.2	11.8	6.02	11.11	2020	4724	2705	1.01	3.9	177	1.0	2.0	2.8			1.6	369	1371	1055	576
40.5	11.8	26.4	11.17	25.71	2087	4854	2767	1.43	7.7	505	1.6			39.3	40.7	2.2	1054			2364
41.5	8.65	27.8	7.79	27.11	2155	4984	2829	2.86	5.0	670	1.2			37.2	39.7	1.9	1400			2646
42.7	11.4	28	10.67	27.31	2225	5118	2893	1.73	6.9	577	1.5			38.8	40.5	2.2	1206			2595
43.7	14.8	30	14.14	29.31	2292	5248	2956	1.16	9.2	526	1.7	4.7	10.8			2.4	1100	4389	2723	2660

Barr Engineering Company

DMT Spreadsheet- Data Summary

Hardin County Wind Project

35/33-1001

Sounding No: **DMT70**

August 1, 2011

Ground Water Depth (ft): 7

UTM, Zone 16N - NAD 83 (m)
Northing: 4500145.0
Easting: 262959.0

[1] Depth Below Existing Ground Surface
[2] Mayne, 1995
[3] Marchetti,1980
[4] Marchetti, 1997
[5] Campanella and Robertson, 1991
[6] Marchetti,1980
[7] Schmertman, 1981

Depth[1]	A	B	po	p1	u_o	s_{vo}	s_{vo}'			E_D				ϕ'^4	ϕ'^5		E_D	s_u[6]	s_u[7]	M
(ft)	(bar)	(bar)			(psf)	(psf)	(psf)	I_d	K_D	(bar)	K_o	OCR[2]	OCR[3]	(deg)	(deg)	R_M	(ksf)	(psf)	(psf)	(ksf)
6.6	1.2	2.1	1.25	1.41	0	787	787	0.13	3.3	5	0.9	1.7	2.2			1.4	11	327	262	16
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
9.8	1.4	2.2	1.46	1.51	177	1181	1004	0.04	2.9	2	0.8	1.5	1.7			1.2	4	345	287	5
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
14.2	1.45	2.25	1.51	1.56	450	1705	1255	0.04	2.2	2	0.6	1.1	1.1			0.9	4	302	270	4
15.3	1.5	2.3	1.56	1.61	517	1835	1317	0.04	2.1	2	0.6	1.1	1.1			0.9	4	304	274	3
16.4	1.65	2.5	1.71	1.81	587	1969	1382	0.07	2.2	4	0.6	1.1	1.1			0.9	8	333	297	7
17.5	1.7	2.55	1.76	1.86	654	2098	1444	0.07	2.1	4	0.6	1.1	1.1			0.9	8	335	301	7
18.6	1.35	3.9	1.32	3.21	722	2228	1506	1.94	1.4	66	0.4			29.9	35.1	0.9	137			116
19.7	2.75	4.45	2.76	3.76	792	2362	1571	0.42	3.2	35	0.8	1.6	2.1			1.3	72	614	498	96
20.8	3.25	4.7	3.28	4.01	859	2492	1633	0.26	3.7	26	0.9	1.9	2.6			1.5	53	765	598	78
21.9	3.7	5.35	3.72	4.66	927	2622	1695	0.29	4.0	33	1.0	2.1	3.0			1.6	68	895	683	107
23.0	3.5	5.15	3.52	4.46	996	2756	1760	0.31	3.6	33	0.9	1.8	2.5			1.5	68	809	634	100
24.0	3.55	5.2	3.57	4.51	1064	2886	1822	0.31	3.5	33	0.9	1.8	2.4			1.4	68	808	638	98
25.1	3.55	5.25	3.56	4.56	1131	3016	1884	0.33	3.3	35	0.9	1.7	2.2			1.4	72	789	631	100
26.2	2.65	9.25	2.42	8.56	1201	3150	1949	3.33	2.0	213	0.5			32.1	36.9	1.1	445			486
27.3	4.1	13.8	3.71	13.11	1269	3280	2011	3.03	3.2	326	0.8			34.9	38.5	1.5	681			1033
28.4	4.35	14.2	3.96	13.51	1336	3409	2073	2.88	3.3	332	0.9			35.1	38.6	1.5	692			1066
29.5	4.55	16.2	4.07	15.51	1406	3543	2138	3.37	3.3	397	0.9			35.0	38.6	1.5	829			1278
30.6	5.1	16.4	4.63	15.71	1473	3673	2200	2.82	3.7	384	0.9			35.7	38.9	1.6	803			1310
31.7	4.8	17.2	4.28	16.51	1541	3803	2262	3.46	3.3	424	0.8			35.0	38.6	1.5	887			1355
32.8	5.7	15.8	5.29	15.11	1610	3937	2327	2.17	4.1	341	1.0			36.1	39.2	1.7	711			1187
33.9	4.05	14.4	3.63	13.71	1678	4067	2389	3.57	2.5	350	0.7			33.4	37.7	1.3	731			939
35.0	4.95	16.4	4.48	15.71	1746	4197	2451	3.09	3.1	390	0.8			34.7	38.4	1.5	814			1207
36.1	4.55	15	4.13	14.31	1815	4331	2516	3.13	2.7	353	0.7			33.9	38.0	1.4	738			1007
37.2	4.05	18	3.45	17.31	1883	4461	2578	5.44	2.1	481	0.6			32.4	37.1	1.1	1004			1135
38.3	3.95	17.6	3.37	16.91	1950	4591	2640	5.57	1.9	470	0.5			32.0	36.8	1.1	982			1048
39.4	2.65	7.9	2.49	7.21	2020	4724	2705	3.11	1.2	164	0.3			29.0	34.2	0.9	342			291
40.5	2.9	11.8	2.55	11.11	2087	4854	2767	5.51	1.2	297	0.3			29.0	34.2	0.9	620			527
41.5	2.4	6.25	2.31	5.56	2155	4984	2829	2.56	0.9	113	0.2			27.6	31.7	0.9	236			201
42.7	2.7	13.6	2.25	12.91	2225	5118	2893	8.98	0.9	370	0.2			27.0	29.6	0.9	772			657
43.7	3.75	9.8	3.55	9.11	2292	5248	2956	2.27	1.7	193	0.5			31.4	36.4	0.9	403			360
44.8	7.6	14.4	7.36	13.71	2360	5378	3018	1.02	4.3	220	1.0	2.2	3.3			1.7	460	1733	1301	764
45.9	8.75	15.8	8.50	15.11	2429	5512	3082	0.90	5.0	230	1.2	2.5	4.1			1.8	479	2115	1531	861
47.0	6.15	11.8	5.97	11.11	2497	5642	3145	1.08	3.2	179	0.8	1.6	2.0			1.4	373	1229	996	506
48.1	9.35	13.8	9.23	13.11	2564	5772	3207	0.49	5.2	135	1.2	2.7	4.5			1.8	282	2334	1670	516
49.2	10.6	17	10.38	16.31	2634	5906	3271	0.65	5.8	206	1.3	3.0	5.3			1.9	430	2735	1904	837
50.3	9.55	14.6	9.40	13.91	2702	6035	3334	0.56	5.1	157	1.2	2.6	4.3			1.8	327	2349	1692	591

Barr Engineering Company

DMT Spreadsheet- Data Summary

Hardin County Wind Project

35/33-1001

Sounding No: DMT78

August 14, 2010

Ground Water Depth (ft): 7

UTM, Zone 16N - NAD 83 (m)
Northing: 4507611.0
Easting: 265800.0

[1] Depth Below Existing Ground Surface
[2] Mayne, 1995
[3] Marchetti,1980
[4] Marchetti, 1997
[5] Campanella and Robertson, 1991
[6] Marchetti,1980
[7] Schmertman, 1981

Depth[1]	A	B	po	p1	u_o	s_{vo}	s_{vo}'			E_D				ϕ'[4]	ϕ'[5]		E_D	s_u[6]	s_u[7]	M
(ft)	(bar)	(bar)			(psf)	(psf)	(psf)	I_d	K_D	(bar)	K_o	OCR[2]	OCR[3]	(deg)	(deg)	R_M	(ksf)	(psf)	(psf)	(ksf)
6.6	2.85	5.6	2.88	5.11	0	787	787	0.78	7.6	77	1.5	3.9	8.1			2.2	162	924	601	360
7.6	3.9	6.7	3.93	6.21	40	917	877	0.58	9.3	79	1.8	4.7	11.0			2.4	166	1318	816	402
8.7	3.85	6.4	3.89	5.91	108	1047	939	0.53	8.5	70	1.7	4.3	9.6			2.3	146	1267	801	342
9.8	3.65	5.55	3.72	5.06	177	1181	1004	0.37	7.6	46	1.5	3.9	8.0			2.2	97	1165	759	215
10.9	3.7	5.6	3.77	5.11	245	1311	1066	0.37	7.2	46	1.5	3.6	7.3			2.2	97	1155	763	209
12.0	3.25	4.9	3.33	4.41	312	1441	1128	0.34	5.9	37	1.3	3.0	5.4			2.0	78	958	665	153
13.1	3.65	5.4	3.73	4.91	382	1575	1193	0.33	6.2	41	1.3	3.2	5.9			2.0	86	1081	741	172
14.2	4	5.7	4.08	5.21	450	1705	1255	0.29	6.4	39	1.4	3.3	6.2			2.0	82	1189	807	168
15.3	4.05	5.55	4.14	5.06	517	1835	1317	0.24	6.2	32	1.3	3.1	5.8			2.0	67	1186	813	134
16.4	4.05	5.85	4.13	5.36	587	1969	1382	0.32	5.8	43	1.3	3.0	5.3			1.9	89	1153	803	174
17.5	4.6	6.45	4.67	5.96	654	2098	1444	0.29	6.3	45	1.4	3.2	6.0			2.0	93	1335	911	189
18.6	4.65	6.6	4.72	6.11	722	2228	1506	0.32	6.1	48	1.3	3.1	5.6			2.0	101	1326	913	200
19.7	5.15	7.5	5.20	7.01	792	2362	1571	0.38	6.4	63	1.4	3.3	6.2			2.0	131	1481	1007	268
20.8	6.8	9.75	6.82	9.26	859	2492	1633	0.38	8.2	85	1.6	4.2	9.0			2.3	177	2094	1338	406
21.9	4	25.2	3.11	24.71	927	2622	1695	8.11	3.3	750	0.8			35.0	38.6	1.5	1566			2398
23.0	5.6	19	5.10	18.51	996	2756	1760	2.90	5.5	465	1.2			37.6	39.9	2.0	972			1919
24.0	1.8	4.9	1.81	4.41	1064	2886	1822	2.00	1.5	90	0.4			30.5	35.7	0.9	188			160
25.1	0.85	3.5	0.88	3.01	1131	3016	1884	6.22	0.4	74	-0.1			21.5	#NUM!	0.9	154			131
26.2	5.75	11.6	5.62	11.11	1201	3150	1949	1.09	5.4	190	1.2	2.8	4.7			1.9	398	1488	1054	751
27.3	6.9	13.2	6.75	12.71	1269	3280	2011	0.97	6.4	207	1.4	3.2	6.1			2.1	432	1886	1283	885
28.4	7.05	13.2	6.91	12.71	1336	3409	2073	0.93	6.3	201	1.4	3.2	6.0			2.0	420	1920	1309	857
29.5	5.2	8.25	5.21	7.76	1406	3543	2138	0.56	4.4	88	1.1	2.3	3.5			1.7	185	1273	948	308
30.6	24.2	40.4	23.56	39.91	1473	3673	2200	0.72	21.7	567	2.9	11.0	41.2			3.2	1185	9527	4772	3832
31.7	4.45	7.45	4.47	6.96	1541	3803	2262	0.67	3.4	87	0.9	1.8	2.3			1.4	181	981	779	255
32.8	4.9	7.55	4.93	7.06	1610	3937	2327	0.51	3.7	74	0.9	1.9	2.7			1.5	154	1118	869	230
33.9	2.85	6.6	2.83	6.11	1678	4067	2389	1.62	1.8	114	0.5			31.5	36.5	0.9	238			202
35.0	5.75	9.3	5.74	8.81	1746	4197	2451	0.63	4.2	107	1.0	2.1	3.2			1.6	223	1354	1024	358
36.1	5.6	10.8	5.51	10.31	1815	4331	2516	1.04	3.9	167	1.0	2.0	2.8			1.5	348	1255	968	539
37.2	7.25	13	7.13	12.51	1883	4461	2578	0.86	5.0	187	1.2	2.6	4.2			1.8	390	1803	1301	706
38.3	6.7	9.8	6.71	9.31	1950	4591	2640	0.45	4.6	90	1.1	2.3	3.6			1.7	188	1632	1207	320
39.4	5.8	11	5.71	10.51	2020	4724	2705	1.01	3.7	167	0.9	1.9	2.6			1.5	348	1266	990	521
40.5	5.7	10.8	5.61	10.31	2087	4854	2767	1.02	3.5	163	0.9	1.8	2.4			1.4	341	1217	963	493
41.5	5.55	6.8	5.65	6.31	2155	4984	2829	0.14	3.4	23	0.9	1.7	2.3			1.4	48	1214	965	66
42.7	5.3	6.6	5.40	6.11	2225	5118	2893	0.16	3.1	25	0.8	1.6	2.0			1.3	51	1114	906	67
43.7	6.15	7.2	6.26	6.71	2292	5248	2956	0.09	3.7	15	0.9	1.9	2.6			1.5	32	1380	1079	47
44.8	6.7	8	6.80	7.51	2360	5378	3018	0.12	3.9	25	1.0	2.0	2.9			1.5	51	1542	1184	79
45.9	6.55	7.65	6.66	7.16	2429	5512	3082	0.09	3.7	17	0.9	1.9	2.6			1.5	36	1476	1148	54
47.0	6.2	8.35	6.26	7.86	2497	5642	3145	0.32	3.4	56	0.9	1.7	2.2			1.4	116	1325	1057	160
48.1	6.4	8.85	6.44	8.36	2564	5772	3207	0.37	3.4	66	0.9	1.7	2.3			1.4	139	1368	1089	193

Barr Engineering Company

DMT Spreadsheet- Data Summary

Hardin County Wind Project

35/33-1001

Sounding No: **DMT81**

August 2, 2011

Ground Water Depth (ft): 7

UTM, Zone 16N - NAD 83 (m)
Northing: 4498110.0
Easting: 266085.0

[1] Depth Below Existing Ground Surface
[2] Mayne, 1995
[3] Marchetti,1980
[4] Marchetti, 1997
[5] Campanella and Robertson, 1991
[6] Marchetti,1980
[7] Schmertman, 1981

Depth[1]	A	B	po	p1	u_o	s_{vo}	s_{vo}'			E_D				ϕ'[4]	ϕ'[5]		E_D	s_u[6]	s_u[7]	M
(ft)	(bar)	(bar)			(psf)	(psf)	(psf)	I_d	K_D	(bar)	K_o	OCR[2]	OCR[3]	(deg)	(deg)	R_M	(ksf)	(psf)	(psf)	(ksf)
6.6	1.15	2.2	1.31	1.36	0	787	787	0.04	3.5	2	0.9	1.8	2.4			1.4	4	345	273	5
7.6	4.5	13.2	4.28	12.36	40	917	877	1.90	10.1	281	1.9			40.6	41.4	2.5	586			1472
8.7	5.45	11.6	5.35	10.76	108	1047	939	1.02	11.8	188	2.0	6.0	15.9			2.7	392	1897	1107	1041
9.8	20	30	19.71	29.16	177	1181	1004	0.48	40.8	328	4.1	20.8	110.6			3.8	685	9584	4099	2624
10.9	5.95	9.55	5.98	8.71	245	1311	1066	0.47	11.5	95	2.0	5.8	15.3			2.6	198	2085	1224	521
12.0	11.8	33.2	10.94	32.36	312	1441	1128	1.99	20.0	743	2.8			43.4	42.8	3.2	1552			4897
13.1	6.6	17.8	6.25	16.96	382	1575	1193	1.77	10.6	372	1.9			40.8	41.5	2.6	776			1985
14.2	10.4	30	9.63	29.16	450	1705	1255	2.07	15.7	678	2.4			42.4	42.3	2.9	1415			4140
15.3	10.2	30	9.42	29.16	517	1835	1317	2.15	14.5	685	2.3			42.1	42.1	2.9	1431			4084
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
17.5	8.2	14.6	8.09	13.76	654	2098	1444	0.73	11.2	197	2.0	5.7	14.8			2.6	411	2751	1624	1073
18.6	8.15	17	7.92	16.16	722	2228	1506	1.09	10.5	286	1.9	5.3	13.3			2.5	597	2633	1581	1521
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
21.9	14.8	30	14.25	29.16	927	2622	1695	1.08	17.0	517	2.5	8.7	28.2			3.0	1081	5417	2884	3245
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
29.5	10.4	30	9.63	29.16	1406	3543	2138	2.18	8.8	678	1.7			39.9	41.0	2.4	1415			3364
30.6	10.6	30	9.84	29.16	1473	3673	2200	2.12	8.7	670	1.7			39.8	41.0	2.4	1400			3316
31.7	10.4	30	9.63	29.16	1541	3803	2262	2.20	8.2	678	1.6			39.6	40.9	2.3	1415			3281
32.8	10.4	30	9.63	29.16	1610	3937	2327	2.20	8.0	678	1.6			39.4	40.8	2.3	1415			3240
33.9	10.4	30	9.63	29.16	1678	4067	2389	2.21	7.7	678	1.6			39.3	40.7	2.3	1415			3201
35.0	10.6	30	9.84	29.16	1746	4197	2451	2.15	7.7	670	1.6			39.3	40.7	2.3	1400			3157
36.1	11	30	10.26	29.16	1815	4331	2516	2.01	7.8	656	1.6			39.4	40.8	2.3	1370			3106
37.2	12	30	11.31	29.16	1883	4461	2578	1.71	8.4	619	1.7			39.7	40.9	2.3	1294			3024
38.3	10	30	9.21	29.16	1950	4591	2640	2.41	6.5	692	1.4			38.5	40.4	2.1	1446			3059
39.4	12	30	11.31	29.16	2020	4724	2705	1.73	8.0	619	1.6			39.5	40.8	2.3	1294			2957
40.5	11	30	10.26	29.16	2087	4854	2767	2.04	7.0	656	1.5			38.8	40.5	2.2	1370			2968
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
42.7	11.4	30	10.68	29.16	2225	5118	2893	1.92	6.9	641	1.5			38.8	40.5	2.2	1339			2889
43.7	11.2	30	10.47	29.16	2292	5248	2956	1.99	6.6	649	1.4			38.6	40.4	2.1	1355			2865
44.8	12	30	11.31	29.16	2360	5378	3018	1.75	7.0	619	1.5			38.9	40.5	2.2	1294			2804
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!

Barr Engineering Company

DMT Spreadsheet- Data Summary

Hardin County Wind Project

35/33-1001

Sounding No: **DMT89**

August 2, 2011

Ground Water Depth (ft): 7

UTM, Zone 16N - NAD 83 (m)
Northing: 4496351.0
Easting: 265582.0

[1] Depth Below Existing Ground Surface
[2] Mayne, 1995
[3] Marchetti,1980
[4] Marchetti, 1997
[5] Campanella and Robertson, 1991
[6] Marchetti,1980
[7] Schmertman, 1981

Depth[1]	A	B	po	p1	u_o	s_{vo}	s_{vo}'			E_D				ϕ'[4]	ϕ'[5]		E_D	s_u[6]	s_u[7]	M
(ft)	(bar)	(bar)			(psf)	(psf)	(psf)	I_d	K_D	(bar)	K_o	OCR[2]	OCR[3]	(deg)	(deg)	R_M	(ksf)	(psf)	(psf)	(ksf)
6.6	14.4	27.6	13.84	26.94	0	787	787	0.95	36.7	455	3.9	18.7	93.6			3.7	949	6579	2890	3542
7.6	13.8	26	13.29	25.34	40	917	877	0.91	31.6	418	3.6	16.1	74.1			3.6	873	6076	2771	3134
8.7	16.2	27.4	15.74	26.74	108	1047	939	0.70	34.9	382	3.8	17.7	86.4			3.7	797	7363	3276	2935
9.8	17	28.6	16.52	27.94	177	1181	1004	0.69	34.2	396	3.7	17.4	83.8			3.7	828	7676	3432	3032
10.9	18.2	31.2	17.65	30.54	245	1311	1066	0.74	34.3	447	3.8	17.5	84.4			3.7	934	8198	3661	3426
12.0	15	23.6	14.67	22.94	312	1441	1128	0.57	26.9	287	3.3	13.7	57.5			3.4	599	6385	3032	2059
13.1	16.2	31.6	15.53	30.94	382	1575	1193	1.00	26.9	535	3.3	13.7	57.5			3.4	1117	6748	3205	3837
14.2	14.2	25.6	13.73	24.94	450	1705	1255	0.83	22.5	389	3.0	11.4	43.6			3.3	812	5684	2822	2654
15.3	21.6	30	21.28	29.34	517	1835	1317	0.38	33.3	280	3.7	17.0	80.6			3.6	584	9762	4392	2126
16.4	12.2	19	11.96	18.34	587	1969	1382	0.55	17.6	221	2.6	9.0	29.9			3.0	462	4623	2438	1404
17.5	11.2	19.6	10.88	18.94	654	2098	1444	0.76	15.3	280	2.4	7.8	23.9			2.9	584	4034	2206	1694
18.6	13	19.6	12.77	18.94	722	2228	1506	0.50	17.2	214	2.5	8.8	28.7			3.0	447	4888	2594	1348
19.7	11	17	10.80	16.34	792	2362	1571	0.53	13.9	192	2.2	7.1	20.5			2.8	401	3882	2176	1127
20.8	12.4	22.6	11.99	21.94	859	2492	1633	0.86	14.8	345	2.3	7.5	22.7			2.9	721	4386	2417	2070
21.9	12.2	25.2	11.65	24.54	927	2622	1695	1.15	13.8	447	2.2	7.0	20.4			2.8	934	4171	2340	2620
23.0	10.4	22.6	9.89	21.94	996	2756	1760	1.28	11.2	418	2.0			41.0	41.6	2.6	873			2274
24.0	10.6	21.4	10.16	20.74	1064	2886	1822	1.10	11.1	367	2.0	5.6	14.4			2.6	767	3398	2015	1990
25.1	12.6	25	12.08	24.34	1131	3016	1884	1.06	12.8	425	2.1	6.5	18.1			2.7	888	4214	2409	2428
26.2	10.4	18.8	10.08	18.14	1201	3150	1949	0.85	10.2	280	1.9	5.2	12.7			2.5	584	3279	1984	1470
27.3	10.8	19.4	10.47	18.74	1269	3280	2011	0.84	10.2	287	1.9	5.2	12.8			2.5	599	3407	2059	1512
28.4	10.8	18.2	10.53	17.54	1336	3409	2073	0.71	10.0	243	1.8	5.1	12.2			2.5	508	3393	2065	1268
29.5	11.6	19.2	11.32	18.54	1406	3543	2138	0.68	10.4	250	1.9	5.3	13.1			2.5	523	3692	2223	1327
30.6	11.2	19.6	10.88	18.94	1473	3673	2200	0.79	9.7	280	1.8	4.9	11.7			2.5	584	3464	2124	1439
31.7	9.4	16.2	9.16	15.54	1541	3803	2262	0.76	7.8	221	1.6	4.0	8.3			2.2	462	2715	1758	1037
32.8	9.35	13.6	9.23	12.94	1610	3937	2327	0.44	7.6	128	1.5	3.9	8.0			2.2	268	2714	1767	595
33.9	10.8	17.6	10.56	16.94	1678	4067	2389	0.65	8.5	221	1.7	4.3	9.6			2.3	462	3220	2037	1080
35.0	8	15.4	7.73	14.74	1746	4197	2451	1.02	5.9	243	1.3	3.0	5.4			2.0	508	2072	1439	1000
36.1	10.4	18	10.12	17.34	1815	4331	2516	0.78	7.7	250	1.6	3.9	8.2			2.2	523	2974	1931	1168
37.2	10.8	18.6	10.51	17.94	1883	4461	2578	0.77	7.8	258	1.6	4.0	8.3			2.2	538	3099	2006	1209
38.3	9.35	14.6	9.18	13.94	1950	4591	2640	0.58	6.5	165	1.4	3.3	6.3			2.1	344	2547	1723	710
39.4	8.95	15.4	8.72	14.74	2020	4724	2705	0.77	6.0	209	1.3	3.0	5.5			2.0	436	2344	1620	863
40.5	9.35	17.4	9.04	16.74	2087	4854	2767	0.96	6.1	267	1.3	3.1	5.7			2.0	557	2439	1680	1115
41.5	9.65	23.2	9.07	22.54	2155	4984	2829	1.68	5.9	467	1.3			38.0	40.1	2.0	976			1953
42.7	12	24.2	11.49	23.54	2225	5118	2893	1.16	7.5	418	1.5	3.8	7.9			2.2	873	3334	2176	1937
43.7	11.2	22.2	10.75	21.54	2292	5248	2956	1.12	6.8	374	1.4	3.5	6.8			2.1	782	3012	2015	1658
44.8	12.2	21	11.86	20.34	2360	5378	3018	0.79	7.4	294	1.5	3.8	7.7			2.2	614	3420	2240	1351
45.9	12	21.6	11.62	20.94	2429	5512	3082	0.89	7.1	323	1.5	3.6	7.2			2.2	675	3294	2183	1454
47.0	14	23.2	13.64	22.54	2497	5642	3145	0.72	8.3	309	1.6	4.2	9.1			2.3	645	4075	2598	1487
48.1	11.8	18.2	11.58	17.54	2564	5772	3207	0.58	6.7	207	1.4	3.4	6.7			2.1	432	3221	2161	905
49.2	12	19.2	11.74	18.54	2634	5906	3271	0.65	6.7	236	1.4	3.4	6.6			2.1	493	3254	2188	1029
50.3	13.2	20	12.96	19.34	2702	6035	3334	0.55	7.3	221	1.5	3.7	7.5			2.2	462	3704	2436	1007

Barr Engineering Company

DMT Spreadsheet- Data Summary

Hardin County Wind Project

35/33-1001

Sounding No: **DMT92**

August 3, 2011

Ground Water Depth (ft): 7

UTM, Zone 16N - NAD 83 (m)
Northing: 4508527.0
Easting: 267705.0

[1] Depth Below Existing Ground Surface
[2] Mayne, 1995
[3] Marchetti,1980
[4] Marchetti, 1997
[5] Campanella and Robertson, 1991
[6] Marchetti,1980
[7] Schmertman, 1981

Depth[1]	A	B	po	p1	u_o	s_{vo}	s_{vo}'			E_D				ϕ'[4]	ϕ'[5]		E_D	s_u[6]	s_u[7]	M
(ft)	(bar)	(bar)			(psf)	(psf)	(psf)	I_d	K_D	(bar)	K_o	OCR[2]	OCR[3]	(deg)	(deg)	R_M	(ksf)	(psf)	(psf)	(ksf)
6.6	3.55	8.05	3.54	7.66	0	787	787	1.16	9.4	143	1.8	4.8	11.2			2.4	299	1197	739	728
7.6	2.55	5.9	2.60	5.51	40	917	877	1.13	6.1	101	1.3	3.1	5.7			2.0	211	784	538	426
8.7	2.55	5.25	2.63	4.86	108	1047	939	0.87	5.7	77	1.3	2.9	5.2			1.9	162	770	538	314
9.8	4.2	11.2	4.06	10.81	177	1181	1004	1.70	8.3	234	1.6			39.6	40.9	2.3	489			1134
10.9	5.05	10.4	5.00	10.01	245	1311	1066	1.03	9.6	174	1.8	4.9	11.5			2.5	363	1657	1019	892
12.0	6.05	10.6	6.04	10.21	312	1441	1128	0.71	10.9	145	1.9	5.5	14.1			2.6	302	2066	1229	781
13.1	5	10.6	4.93	10.21	382	1575	1193	1.11	8.3	183	1.6	4.2	9.2			2.3	382	1559	992	886
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
15.3	6.25	13.2	6.12	12.81	517	1835	1317	1.14	9.3	232	1.8	4.7	11.0			2.4	485	1980	1226	1178
16.4	8.2	22.4	7.70	22.01	587	1969	1382	1.93	11.2	496	2.0			41.0	41.6	2.6	1037			2705
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
18.6	5.05	12.6	4.89	12.21	722	2228	1506	1.61	6.3	254	1.4			38.3	40.3	2.1	531			1091
19.7	5.75	10.2	5.74	9.81	792	2362	1571	0.76	7.1	141	1.5	3.6	7.3			2.2	295	1693	1120	636
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
21.9	5.4	8.7	5.45	8.31	927	2622	1695	0.57	6.2	99	1.3	3.1	5.8			2.0	207	1524	1045	416
23.0	7.05	18.8	6.68	18.41	996	2756	1760	1.89	7.4	407	1.5			39.1	40.6	2.2	850			1881
24.0	7.8	15.4	7.63	15.01	1064	2886	1822	1.04	8.2	256	1.6	4.2	9.0			2.3	535	2327	1488	1229
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
27.3	7.1	13.2	7.01	12.81	1269	3280	2011	0.91	6.6	201	1.4	3.4	6.5			2.1	420	1986	1337	879
28.4	7	15.2	6.80	14.81	1336	3409	2073	1.30	6.2	278	1.3			38.3	40.2	2.0	580			1180
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
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36.1	6.25	9.3	6.31	8.91	1815	4331	2516	0.48	4.5	90	1.1	2.3	3.6			1.7	188	1533	1137	317
37.2	6.15	8.9	6.23	8.51	1883	4461	2578	0.43	4.3	79	1.0	2.2	3.3			1.6	166	1483	1112	271
38.3	6.25	9.05	6.32	8.66	1950	4591	2640	0.43	4.3	81	1.0	2.2	3.3			1.6	169	1496	1126	275
39.4	5.9	9.75	5.92	9.36	2020	4724	2705	0.69	3.8	119	1.0	1.9	2.8			1.5	249	1339	1035	379
40.5	6.45	9.7	6.50	9.31	2087	4854	2767	0.51	4.2	97	1.0	2.1	3.1			1.6	204	1517	1149	326
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
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45.9	11.6	20.2	11.38	19.81	2429	5512	3082	0.82	6.9	292	1.5	3.5	6.9			2.1	611	3203	2135	1300
47.0	12.4	24.2	12.02	23.81	2497	5642	3145	1.09	7.2	409	1.5	3.7	7.4			2.2	854	3426	2262	1856
48.1	13.8	27.4	13.33	27.01	2564	5772	3207	1.13	7.9	475	1.6	4.0	8.5			2.3	991	3919	2528	2244
49.2	9.35	17.2	9.17	16.81	2634	5906	3271	0.97	5.0	265	1.2	2.6	4.2			1.8	554	2291	1652	1005
50.3	9.05	18.4	8.80	18.01	2702	6035	3334	1.23	4.7	320	1.1			36.9	39.5	1.8	668			1173

Barr Engineering Company

DMT Spreadsheet- Data Summary

Hardin County Wind Project

35/33-1001

Sounding No: DMT107

August 3, 2011

Ground Water Depth (ft): 7

UTM, Zone 16N - NAD 83 (m)
Northing: 4496351.0
Easting: 265582.0

[1] Depth Below Existing Ground Surface
[2] Mayne, 1995
[3] Marchetti,1980
[4] Marchetti, 1997
[5] Campanella and Robertson, 1991
[6] Marchetti,1980
[7] Schmertman, 1981

Depth[1]	A	B	po	p1	u_o	s_{vo}	s_{vo}'			E_D				ϕ'^4	ϕ'^5		E_D	s_u[6]	s_u[7]	M
(ft)	(bar)	(bar)			(psf)	(psf)	(psf)	I_d	K_D	(bar)	K_o	OCR[2]	OCR[3]	(deg)	(deg)	R_M	(ksf)	(psf)	(psf)	(ksf)
6.6	4.65	10.6	4.52	10.06	0	787	787	1.23	12.0	192	2.1			41.3	41.7	2.7	401			1073
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
8.7	10.8	26.2	10.20	25.66	108	1047	939	1.52	22.6	537	3.0			43.9	43.1	3.3	1121			3664
9.8	14.6	25.4	14.23	24.86	177	1181	1004	0.75	29.4	369	3.5	15.0	66.3			3.5	770	6364	2954	2714
10.9	10.4	18.2	10.18	17.66	245	1311	1066	0.74	19.7	260	2.8	10.0	35.5			3.1	542	4096	2101	1704
12.0	6.85	13	6.71	12.46	312	1441	1128	0.88	12.1	199	2.1	6.2	16.7			2.7	417	2366	1370	1118
13.1	4.45	11.2	4.28	10.66	382	1575	1193	1.56	7.2	221	1.5			39.0	40.6	2.2	462			1008
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
15.3	5.9	12.2	5.75	11.66	517	1835	1317	1.07	8.7	205	1.7	4.4	10.0			2.4	428	1828	1150	1012
16.4	4.6	8.35	4.58	7.81	587	1969	1382	0.75	6.5	112	1.4	3.3	6.3			2.1	234	1327	898	483
17.5	4.65	8.4	4.63	7.86	654	2098	1444	0.75	6.2	112	1.4	3.2	5.9			2.0	234	1319	902	473
18.6	7.3	14.2	7.12	13.66	722	2228	1506	0.96	9.4	227	1.8	4.8	11.2			2.4	474	2293	1416	1155
19.7	6.6	11.2	6.54	10.66	792	2362	1571	0.67	8.2	143	1.6	4.2	9.0			2.3	299	2013	1286	686
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
21.9	12.4	30	11.69	29.46	927	2622	1695	1.58	13.9	617	2.2			41.9	42.0	2.8	1288			3617
23.0	13.2	30	12.53	29.46	996	2756	1760	1.40	14.3	588	2.3			42.1	42.1	2.8	1227			3483
24.0	9.2	27	8.48	26.46	1064	2886	1822	2.26	9.1	624	1.7			40.1	41.1	2.4	1303			3150
25.1	6.65	12.4	6.53	11.86	1131	3016	1884	0.89	6.6	185	1.4	3.4	6.5			2.1	386	1857	1251	806
26.2	5.2	14.6	4.90	14.06	1201	3150	1949	2.12	4.6	318	1.1			36.8	39.5	1.8	664			1187
27.3	3.85	9.25	3.75	8.71	1269	3280	2011	1.58	3.3	172	0.8			34.9	38.6	1.4	360			512
28.4	7.75	14.8	7.57	14.26	1336	3409	2073	0.97	7.0	232	1.5	3.6	7.0			2.1	485	2175	1447	1038
29.5	7.05	16.2	6.76	15.66	1406	3543	2138	1.46	5.9	309	1.3			38.0	40.1	2.0	645			1288
30.6	10.4	18.8	10.15	18.26	1473	3673	2200	0.86	9.0	281	1.7	4.6	10.4			2.4	588	3157	1972	1405
31.7	9.15	16.8	8.94	16.26	1541	3803	2262	0.89	7.6	254	1.5	3.9	8.0			2.2	531	2627	1712	1178
32.8	9.55	17.6	9.32	17.06	1610	3937	2327	0.91	7.7	269	1.6	3.9	8.1			2.2	561	2747	1785	1253
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
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38.3	7.45	12.5	7.37	11.96	1950	4591	2640	0.71	5.1	159	1.2	2.6	4.3			1.8	333	1866	1343	603
39.4	15.4	30	14.84	29.46	2020	4724	2705	1.05	10.7	507	1.9	5.5	13.7			2.6	1060	4848	2897	2718
40.5	8.75	19	8.41	18.46	2087	4854	2767	1.36	5.6	349	1.3			37.7	40.0	1.9	729			1408
41.5	6.45	14.2	6.23	13.66	2155	4984	2829	1.43	3.8	258	1.0			35.8	39.0	1.6	538			845
42.7	15.2	30	14.63	29.46	2225	5118	2893	1.09	9.8	515	1.8	5.0	11.9			2.5	1075	4635	2833	2665
43.7	14.2	30	13.58	29.46	2292	5248	2956	1.27	8.8	551	1.7			39.9	41.0	2.4	1151			2735
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
0.0	0	0			0	0	0	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!

Barr Engineering Company

DMT Spreadsheet- Data Summary

Hardin County Wind Project

35/33-1001

Sounding No: **DMT131**

August 3, 2011

Ground Water Depth (ft): 7

UTM, Zone 16N - NAD 83 (m)
Northing: 4507160.0
Easting: 264430.0

[1] Depth Below Existing Ground Surface
[2] Mayne, 1995
[3] Marchetti,1980
[4] Marchetti, 1997
[5] Campanella and Robertson, 1991
[6] Marchetti,1980
[7] Schmertman, 1981

Depth[1]	A	B	po	p1	u_o	s_{vo}	s_{vo}'			E_D				ϕ'[4]	ϕ'[5]		E_D	s_u[6]	s_u[7]	M
(ft)	(bar)	(bar)			(psf)	(psf)	(psf)	I_d	K_D	(bar)	K_o	OCR[2]	OCR[3]	(deg)	(deg)	R_M	(ksf)	(psf)	(psf)	(ksf)
6.6	2.35	3.55	2.47	3.31	0	787	787	0.34	6.6	29	1.4	3.3	6.4			2.1	61	763	516	126
7.6	1.65	2.55	1.79	2.31	40	917	877	0.30	4.2	18	1.0	2.1	3.2			1.6	38	488	369	61
8.7	2.85	3.75	2.99	3.51	108	1047	939	0.18	6.5	18	1.4	3.3	6.3			2.1	38	906	613	78
9.8	2.85	3.75	2.99	3.51	177	1181	1004	0.18	6.0	18	1.3	3.1	5.6			2.0	38	878	606	75
10.9	3	4.05	3.13	3.81	245	1311	1066	0.23	5.9	24	1.3	3.0	5.4			2.0	49	906	629	97
12.0	3.2	4.1	3.34	3.86	312	1441	1128	0.16	5.9	18	1.3	3.0	5.4			2.0	38	959	665	75
13.1	3.05	4	3.18	3.76	382	1575	1193	0.19	5.3	20	1.2	2.7	4.5			1.8	42	877	626	77
14.2	3.3	4.3	3.43	4.06	450	1705	1255	0.20	5.3	22	1.2	2.7	4.6			1.9	46	944	671	85
15.3	3.1	3.95	3.24	3.71	517	1835	1317	0.16	4.7	16	1.1	2.4	3.8			1.7	34	852	624	59
16.4	3	3.9	3.14	3.66	587	1969	1382	0.18	4.3	18	1.0	2.2	3.3			1.6	38	795	596	62
17.5	3.15	4	3.29	3.76	654	2098	1444	0.16	4.3	16	1.0	2.2	3.3			1.6	34	827	621	56
18.6	3.15	3.9	3.29	3.66	722	2228	1506	0.12	4.1	13	1.0	2.1	3.0			1.6	27	809	615	42
19.7	3.25	5.3	3.33	5.06	792	2362	1571	0.59	3.9	60	1.0	2.0	2.9			1.5	126	802	616	193
20.8	3.4	4.05	3.55	3.81	859	2492	1633	0.08	4.0	9	1.0	2.0	3.0			1.6	19	857	655	30
21.9	3.35	4.1	3.49	3.86	927	2622	1695	0.12	3.8	13	0.9	1.9	2.7			1.5	27	820	637	40
23.0	3.5	4.25	3.64	4.01	996	2756	1760	0.12	3.8	13	0.9	1.9	2.7			1.5	27	851	661	40
24.0	3.7	4.65	3.83	4.41	1064	2886	1822	0.17	3.8	20	0.9	1.9	2.7			1.5	42	897	694	63
25.1	3.8	4.55	3.94	4.31	1131	3016	1884	0.11	3.8	13	0.9	1.9	2.7			1.5	27	915	710	40
26.2	3.9	4.8	4.04	4.56	1201	3150	1949	0.15	3.7	18	0.9	1.9	2.6			1.5	38	928	723	56
27.3	3.9	4.9	4.03	4.66	1269	3280	2011	0.18	3.6	22	0.9	1.8	2.5			1.4	46	908	715	66
28.4	4.05	5.5	4.16	5.26	1336	3409	2073	0.31	3.5	38	0.9	1.8	2.4			1.4	80	932	735	115
29.5	4.4	5.15	4.54	4.91	1406	3543	2138	0.09	3.8	13	0.9	1.9	2.7			1.5	27	1042	808	40
30.6	4.5	5.35	4.64	5.11	1473	3673	2200	0.12	3.7	16	0.9	1.9	2.6			1.5	34	1056	821	51
31.7	5	5.9	5.14	5.66	1541	3803	2262	0.12	4.1	18	1.0	2.1	3.0			1.6	38	1206	918	60
32.8	5.8	7.2	5.91	6.96	1610	3937	2327	0.20	4.6	36	1.1	2.3	3.7			1.7	76	1455	1073	130
#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
35.0	4.6	14.2	4.30	13.96	1746	4197	2451	2.79	3.0	335	0.8			34.4	38.3	1.4	700			996
36.1	5.7	12.6	5.54	12.36	1815	4331	2516	1.46	3.9	237	1.0			35.9	39.0	1.6	495			782
37.2	6.85	25.4	6.10	25.16	1883	4461	2578	3.66	4.2	661	1.0			36.3	39.3	1.7	1381			2416
38.3	3.25	15.2	2.83	14.96	1950	4591	2640	6.39	1.5	421	0.4			30.5	35.7	0.9	879			750
39.4	2.25	9.45	2.07	9.21	2020	4724	2705	6.47	0.9	248	0.2			27.0	29.3	0.9	517			440
40.5	6.25	23	5.59	22.76	2087	4854	2767	3.74	3.5	596	0.9			35.3	38.7	1.6	1244			1966
41.5	4.8	9.9	4.73	9.66	2155	4984	2829	1.34	2.7	171	0.7			34.0	38.0	1.2	358			440
42.7	6.45	11	6.40	10.76	2225	5118	2893	0.82	3.9	151	1.0	2.0	2.8			1.5	316	1445	1115	485
43.7	7.55	22.8	6.97	22.56	2292	5248	2956	2.66	4.1	541	1.0			36.2	39.2	1.7	1130			1939
44.8	10.8	30	10.02	29.76	2360	5378	3018	2.22	6.2	685	1.3			38.2	40.2	2.1	1431			2938
45.9	9.15	26.6	8.46	26.36	2429	5512	3082	2.45	4.9	621	1.2			37.1	39.7	1.9	1297			2417
47.0	10.6	22.8	10.17	22.56	2497	5642	3145	1.38	6.0	430	1.3			38.1	40.1	2.0	898			1792
48.1	12.6	30	11.91	29.76	2564	5772	3207	1.67	7.0	619	1.5			38.8	40.5	2.2	1294			2786
49.2	10.6	30	9.81	29.76	2634	5906	3271	2.33	5.5	692	1.2			37.6	39.9	1.9	1446			2816
50.3	18.6	30	18.21	29.76	2702	6035	3334	0.68	10.6	401	1.9	5.4	13.5			2.6	837	5896	3533	2139

Appendix D

Soil Boring Logs

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING T-02

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Surface Elev.:

Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	
0	SILT (ML): dark brown; moist; loose; roots and organics.	
4.0	SILTY CLAY (CL): brownish gray; moist; stiff to very stiff; trace sand; trace gravel. (Glacial Till)	
15	14' - wet.	
21.0	SILTY CLAY (CL): brownish gray; moist; stiff to very stiff; trace sand; little gravel. (Glacial Till) 21.4' - 1" fine grained SP seam.	
34.0	SILTY CLAY (CL): brownish gray; moist; very stiff to hard; trace sand; little gravel. (Glacial Till)	
37.0	SILTY CLAY (CL): brownish gray; moist; stiff to very stiff; trace sand; little gravel. (Glacial Till)	
45.0	45.3' - Refusal.	

STANDARD PENETRATION TEST DATA (N in blows/ft): 12, 16, 19, 9, >>66, 33, 21

WATER CONTENT %: PL, LL; 17, 25

SIEVE ANALYSIS: GRAVEL, SAND, SILT, CLAY, FINES; 27.1, 54.2, 70.1

Depth, feet	WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
0							
4.0	19.1	109.3			1.75		
15	14.9	120.4		1.19	4.5		
15	13.6				1.5		
21.0					2.25		
21.0	14.1						
30	18.5						
34.0	8.6				4.5		
37.0					1.5		
45.0	13.4						

Completion Depth: 45.3
Date Boring Started: 8/2/11
Date Boring Completed: 8/2/11
Logged By: TDB
Drilling Contractor: Geocon
Drilling Method: HSA
Ground Surface Elevation:
Coordinates: 260246, 4509134 Datum: UTM 17N, meters, Elev in ft

Remarks:

SAMPLE TYPES: Auger Cuttings; Shelby Tube; Split Spoon

WATER LEVELS: While Drilling: 20; End of Drilling: DRY; hrs After Drilling: 3.86

LEGEND: MC Moisture Content; γ Dry Unit Weight; ϕ Friction Angle; Q_u Unconfined Compression; Q_p Hand Penetrometer UC; Gs Specific Gravity; RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING T-14

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)		Graphic Log	Sample Type & Rec.	STANDARD PENETRATION TEST DATA (N in blows/ft)	WATER CONTENT %	SIEVE ANALYSIS	Physical Properties: WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
		Surface Elev.:					PL LL	GRAVEL SAND SILT CLAY FINES							
	0	SILT (ML) TRACE CLAY: brown; moist; loose; roots and organics.													
	5	SILTY CLAY (CL): brownish gray; moist; stiff; trace sand; trace gravel. (Glacial Till)	2.5			9			25.3				1.5		
	10	SILTY CLAY (CL): dark brown; moist; stiff; trace sand; trace gravel. (Glacial Till)	8.0			6							1		
	15	CLAYEY SILT (CL-ML): dark brown; moist; very stiff to hard; trace to little gravel.	15.0			23			14.2				1.5		
	20	21.0' - 3" fine to medium grained SP seam.				23	17 22		10.3				3		
	25					32			8.4				4.5		
	30	LIMESTONE: Light gray, very intensely fractured.	28.0												0
	35	Auger refusal at 33 feet	33.0												
	40														
	45														
	50														
	55														

Completion Depth: 28.0
Date Boring Started: 8/2/11
Date Boring Completed: 8/2/11
Logged By: TDB
Drilling Contractor: Geocon
Drilling Method: HSA
Ground Surface Elevation:
Coordinates: 262825, 4508706 Datum: UTM 17N, meters, Elev in ft

Remarks: Refusal at 28 feet - return to core; Attempted 3T at 12 feet, no recovery

SAMPLE TYPES: Auger Cuttings; Shelby Tube; Split Spoon; Rock Core

WATER LEVELS: While Drilling: ; End of Drilling: DRY ; hrs After Drilling:

LEGEND: MC Moisture Content; γ Dry Unit Weight; ϕ Friction Angle; Q_u Unconfined Compression; Q_p Hand Penetrometer UC; Gs Specific Gravity; RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING T-19

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Surface Elev.:

Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	
0	Topsoil.	
	SILT (ML) WITH CLAY: brown; moist; stiff to very stiff.	1.2
10	SILTY CLAY (CL): gray; moist; stiff; little sand.	12.0
15	SANDY CLAY to CLAYEY SAND (SC) with sand layers: gray; saturated; fine to coarse-grained sand; trace gravel to cobbles, very dense. Rock fragments.	17.0
25	SILTY CLAY (CL): gray; moist; stiff to very stiff; trace sand; trace gravel. (Glacial Till)	27.0
30	LIMESTONE: weathered.	32.0
35	Auger refusal at 35 feet	35.0

STANDARD PENETRATION TEST DATA — N in blows/ft: 14, 16, 10, >>52, 41, 9, >>65/2

WATER CONTENT % — PL, LL; 17, 32

SIEVE ANALYSIS — GRAVEL, SAND, SILT, CLAY, FINES

Physical Properties	WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
	12.7				1.5		
	5.2						
	14.4						
	18						

Completion Depth:	35.0
Date Boring Started:	8/8/11
Date Boring Completed:	8/8/11
Logged By:	LAM2
Drilling Contractor:	Geocon
Drilling Method:	HSA
Ground Surface Elevation:	
Coordinates: 261029, 4506506	Datum: UTM 17N, meters, Elev in ft

Remarks: Installed piezometer on 8/9/2011.

SAMPLE TYPES: Auger Cuttings; Split Spoon

WATER LEVELS: While Drilling: 19; End of Drilling:; hrs After Drilling:

LEGEND: MC Moisture Content; γ Dry Unit Weight; ϕ Friction Angle; Q_u Unconfined Compression; Q_p Hand Penetrometer UC; Gs Specific Gravity; RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING T-31

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	Graphic Log	Sample Type & Rec.	STANDARD PENETRATION TEST DATA (N in blows/ft)	WATER CONTENT % (PL, LL)	SIEVE ANALYSIS (GRAVEL, SAND, SILT, CLAY, FINES)	Physical Properties: WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
	0	Surface Elev.:												
	0	TOPSOIL. 1.3												
	0	CLAY (CL): gray; moist; stiff, trace to little silt, (Lacustrine Clay).			12			24.9				1		
	5				8							1.5		
	10	Wet.			26							1.5		
	15				9							0.5		
	20	LIMESTONE. 23.5			>>50/4									
	25	Auger refusal at 26 feet 25.0												
	30													
	35													
	40													
	45													
	50													
	55													

Completion Depth:	25.0
Date Boring Started:	8/9/11
Date Boring Completed:	8/9/11
Logged By:	LAM2
Drilling Contractor:	Geocon
Drilling Method:	HSA
Ground Surface Elevation:	
Coordinates: 83.83111, 40.66199	Datum: UTM 17N, meters, Elev in ft

Remarks:

SAMPLE TYPES: Split Spoon; Shelby Tube

WATER LEVELS: While Drilling: 14; End of Drilling:; hrs After Drilling:

LEGEND: MC Moisture Content; γ Dry Unit Weight; ϕ Friction Angle; Q_u Unconfined Compression; Q_p Hand Penetrometer UC; Gs Specific Gravity; RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING T-35

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)		Graphic Log	Sample Type & Rec.	STANDARD PENETRATION TEST DATA (N in blows/ft)	WATER CONTENT % (PL — LL)	SIEVE ANALYSIS (GRAVEL / SAND / SILT / CLAY / FINES)	WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
		Surface Elev.:													
	0	SILTY CLAY (CL): brown; moist; very stiff; trace sand; trace gravel. (Glacial Till)													
	5					13			20.8	106.7			4.5		
									15.3						
	10	SILTY CLAY (CL): grayish brown; moist; stiff to very stiff; trace sand; trace gravel. (Glacial Till)	10.4			15			13.5	124.3		1.75	2.5		
	15	SILTY SAND to SANDY SILT(SM-ML): fine to medium grained; dark gray; wet; very dense. (Possible weathered siltstone)	15.0			>>50/3		5.2 / 42.2	14.7				1.75		
	20	LIMESTONE: light to dark gray; intensely fractured.	18.0												0
	25														0
	30	Auger refusal at 28 feet	28.0												
	35														
	40														
	45														
	50														
	55														

Physical Properties

Completion Depth:	18.0
Date Boring Started:	8/2/11
Date Boring Completed:	8/2/11
Logged By:	TDB
Drilling Contractor:	Geocon
Drilling Method:	HSA
Ground Surface Elevation:	
Coordinates: 260246, 4506091	Datum: UTM 17N, meters, Elev in ft

Remarks: Refusal at 18 feet - return to core

SAMPLE TYPES

Auger Cuttings | Shelby Tube | Split Spoon | Rock Core

WATER LEVELS

While Drilling: 12

End of Drilling: 12.6

hrs After Drilling:

LEGEND

MC Moisture Content | Q_u Unconfined Compression
γ Dry Unit Weight | Q_p Hand Penetrometer UC
ϕ Friction Angle | Gs Specific Gravity
RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING T-39

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	Graphic Log	Sample Type & Rec.	STANDARD PENETRATION TEST DATA (N in blows/ft)	WATER CONTENT % (PL – LL)	SIEVE ANALYSIS (GRAVEL SAND SILT CLAY / FINES)	WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
Surface Elev.:													
0	SILT (ML): black; moist; loose; roots and organics. 1.0												
5	LEAN CLAY (CL): gray; moist to wet; soft; some silt (Lacustrine/Marsh Clay) 5' - some large gravel.			17, 6, 5			21.4				2.5		
10											0.25		
15							22.5	102.3			0.25		
20	CLAY (CL): gray; moist to wet; soft, trace to little silt. 18.0 (Lacustrine/Marsh Clay)			8			26.2				0.25		
25	SANDY LEAN CLAY (CL): gray; wet; stiff; some coarse sand; some silt. 25.0			10									
30	CLAYEY SAND (SC): coarse grained; gray; wet; very dense; some silt. 31.0			>>50/4			27.7						
35	LIMESTONE. 33.0 Auger refusal at 33.5 feet 33.5			>>100/5									
40													
45													
50													
55													

Completion Depth:	33.5
Date Boring Started:	8/5/11
Date Boring Completed:	8/5/11
Logged By:	TDB
Drilling Contractor:	Geocon
Drilling Method:	HSA
Ground Surface Elevation:	
Coordinates: 263844, 4507759	Datum: UTM 17N, meters, Elev in ft

Remarks: Bedrock at 33.5 feet - no additional coring; bulk sample taken from 3 to 5 feet for thermal resistivity testing

SAMPLE TYPES: Auger Cuttings; Split Spoon; Shelby Tube

WATER LEVELS: While Drilling: ; End of Drilling: DRY ; hrs After Drilling:

LEGEND: MC Moisture Content; γ Dry Unit Weight; ϕ Friction Angle; Q_u Unconfined Compression; Q_p Hand Penetrometer UC; Gs Specific Gravity; RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING T-49

Sheet 1 of 1

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	Graphic Log	Sample Type & Rec.	STANDARD PENETRATION TEST DATA (N in blows/ft)	WATER CONTENT %	SIEVE ANALYSIS	WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
	0	Surface Elev.:												
		SILT (ML): black; moist; loose; roots and organics. 1.0												
	5	CLAY (CH): brown to gray; moist; very soft; trace silt (Lacustrine/Marsh Clay).			2			36.5	76.5			0.5		
								32.1						
	10	CLAY (CL): gray; moist to wet; soft; some silt (Lacustrine/Marsh Clay) 8.0			1							0.25		
								39.4	78.5		0.23	0.25		
	15				0							0.25		
	20				0	PL 19.7 — LL 41.5		41.6	80.1		0.17	0.25		
	25				0							0.25		
	30				1							0.25		
	35				2							0.25		
	40				3							0.25		
	45				3							0.25		
	50				5			38.5	83		0.28	0.25		
		50.5						6						
	55													

SIEVE ANALYSIS: GRAVEL | SAND | SILT | CLAY | FINES

Completion Depth:	50.5
Date Boring Started:	8/4/11
Date Boring Completed:	8/4/11
Logged By:	TDB
Drilling Contractor:	Geocon
Drilling Method:	HSA
Ground Surface Elevation:	
Coordinates: 263661, 4504602	Datum: UTM 17N, meters, Elev in ft

Remarks:

SAMPLE TYPES: Auger Cuttings | Shelby Tube | Split Spoon

WATER LEVELS: While Drilling: | End of Drilling: DRY | hrs After Drilling:

LEGEND: MC Moisture Content; γ Dry Unit Weight; ϕ Friction Angle; Q_u Unconfined Compression; Q_p Hand Penetrometer UC; Gs Specific Gravity; RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING T-51

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	Sample Type & Rec.	N in blows/ft	WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
0	Surface Elev.:									
0	SILT (ML): black; moist; loose; roots and organics.									
1.0	CLAY (CL): gray; moist to wet; soft; some silt (Lacustrine/Marsh Clay)									
5			5	39.4	81.6		0.14			
10			3							
15	15' - dark gray; wet.		0					0.25		
20			0	40.9	77.6		0.15	0.25		
25			0					0.25		
30			1	39				0.25		
35			2					0.25		
40			0	44.1	72.2		0.17	0.25		
45			2					0.25		
50			2	45.3				0.25		
50.0										
55										

WATER CONTENT %: PL 19.3, LL 42

SIEVE ANALYSIS: GRAVEL, SAND, SILT, CLAY, FINES

Completion Depth:	50.0
Date Boring Started:	8/5/11
Date Boring Completed:	8/5/11
Logged By:	TDB
Drilling Contractor:	Geocon
Drilling Method:	HSA
Ground Surface Elevation:	
Coordinates: 263477, 4504005	Datum: UTM 17N, meters, Elev in ft

Remarks:

SAMPLE TYPES: Auger Cuttings; Shelby Tube; Split Spoon

WATER LEVELS: While Drilling: | End of Drilling: DRY | hrs After Drilling:

LEGEND: MC Moisture Content; γ Dry Unit Weight; ϕ Friction Angle; Q_u Unconfined Compression; Q_p Hand Penetrometer UC; Gs Specific Gravity; RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING T-62

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Surface Elev.:

Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)		WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
0	SILT (ML): black; moist; loose; roots and organics.								
3.0	SILTY CLAY (CL): brownish gray; moist; stiff to very stiff; trace sand; trace gravel. (Glacial Till)		36.9	73.6			4.5		
10							2.5		
15	15' - moist to wet.		12.1				1		
20	20' - sand lenses		11.5				2.5		
23.5	GRAVEL LAYER (GM): small to large gravel; dark brown; wet.		17.5	113.7		.73			
24.5	SILTY SAND (SM): fine grained; dark brown; wet; medium dense.								
27.0	LEAN CLAY (CL): dark brown; wet; stiff; trace silt (Glacial Till) 30.5' - sand lenses		19.4				1.5		
31.5	SILTY SAND (SM): fine grained; brown; wet; very dense; some small gravel. 33' - hard drilling.		15.2						
38.0	SILTY CLAY (CL): brownish gray; moist; stiff to very stiff; trace sand; trace gravel. (Glacial Till)		10.8				4.5		
45.5	Auger refusal at 45.5 feet		13.3						

Graphic Log; Sample Type & Rec.; STANDARD PENETRATION TEST DATA (N in blows/ft); WATER CONTENT % (PL, LL); SIEVE ANALYSIS (GRAVEL, SAND, SILT, CLAY, FINES); Physical Properties

Completion Depth:	44.0
Date Boring Started:	8/4/11
Date Boring Completed:	8/4/11
Logged By:	TDB
Drilling Contractor:	Geocon
Drilling Method:	HSA
Ground Surface Elevation:	
Coordinates: 264596, 4502930	Datum: UTM 17N, meters, Elev in ft

Remarks:

SAMPLE TYPES: Auger Cuttings; Shelby Tube; Split Spoon

WATER LEVELS: While Drilling: ; End of Drilling: DRY ; hrs After Drilling:

LEGEND: MC Moisture Content; γ Dry Unit Weight; ϕ Friction Angle; Q_u Unconfined Compression; Q_p Hand Penetrometer UC; Gs Specific Gravity; RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING T-66

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	
	0	Surface Elev.:	
	0	SILT (ML): black; moist; loose; roots and organics.	
	2.5	CLAY (CL): gray; moist; medium stiff; some silt.	
	8.0	CLAY (CL): gray; moist to wet; soft; some silt with intermittent thin organic layers (Organic/Marsh Clay)	
	37.5	POORLY GRADED SAND (SP): brown; wet.	
	38.0	SILTY CLAY (CL): gray; wet; medium dense; some sand; some small gravel (Lacustrine Clay).	
	50.0		

Graphic Log; Sample Type & Rec.

STANDARD PENETRATION TEST DATA — N in blows/ft ◎ (10 20 30 40)

WATER CONTENT % — PL, LL (20 40 60)

SIEVE ANALYSIS — GRAVEL, SAND, SILT, CLAY, FINES (20 40 60 80)

Physical Properties

WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
				0.25		
				0.25		
36.7	82.2			0.25		0.29
				0.25		
				0.25		
51.9				0.25		
				0.25		
43.4				0.25		
26.8				1.5		
23.9	101.6			0.25		0.82
				0.5		

20.1 38.5

0.8 34.9

Completion Depth:	50.0
Date Boring Started:	8/3/11
Date Boring Completed:	8/3/11
Logged By:	TDB
Drilling Contractor:	Geocon
Drilling Method:	HSA
Ground Surface Elevation:	
Coordinates: 262764, 4501392	Datum: UTM 17N, meters, Elev in ft

Remarks:

SAMPLE TYPES: Auger Cuttings; Shelby Tube; Split Spoon

WATER LEVELS: While Drilling: ; End of Drilling: DRY ; hrs After Drilling: 6.97

LEGEND: MC Moisture Content; γ Dry Unit Weight; ϕ Friction Angle; Q_u Unconfined Compression; Q_p Hand Penetrometer UC; Gs Specific Gravity; RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING T-72

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	
	0	Surface Elev.:	
	0	CLAYEY SAND (SC): black; moist; loose; roots and organics.	
	3.5	LEAN CLAY (CL): gray; moist; soft; some silt.	
	4.0	CLAYEY SAND (SC): medium grained; gray; wet; loose; trace silt.	
	8.0	CLAYEY SILT (CL-ML): brown; moist; loose. 10' - 1" medium grained SP seam.	
	12.0	CLAY (CL): gray; moist; stiff, trace to little silt, (Lacustrine Clay).	
	28.5	POORLY GRADED SAND (SP): brown to gray; wet; medium dense; some silt.	
	32.0	CLAY (CL): gray; moist; stiff, trace to little silt, (Lacustrine Clay).	
	50.0		

Graphic Log | Sample Type & Rec. | STANDARD PENETRATION TEST DATA (N in blows/ft ◎: 4, 6, 13, 14, 7, 11, 5, 6, 9, 11) | WATER CONTENT % (PL, LL) | SIEVE ANALYSIS (GRAVEL, SAND, SILT, CLAY, FINES)

Physical Properties

Depth, feet	WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
0					0		
5					1		
10	23.1	103.1		1.6	2		
15					1.5		
20					0.5		
25							
30					0.5		
35					0.25		
40					0.5		
45					0.5		
50							
55							

Completion Depth:	50.0
Date Boring Started:	8/3/11
Date Boring Completed:	8/3/11
Logged By:	TDB
Drilling Contractor:	Geocon
Drilling Method:	HSA
Ground Surface Elevation:	
Coordinates: 262202, 4500169	Datum: UTM 17N, meters, Elev in ft

Remarks:

SAMPLE TYPES: Auger Cuttings; Shelby Tube; Split Spoon

WATER LEVELS: While Drilling: ; End of Drilling: DRY ; hrs After Drilling: 2.73

LEGEND: MC Moisture Content; γ Dry Unit Weight; ϕ Friction Angle; Q_u Unconfined Compression; Q_p Hand Penetrometer UC; Gs Specific Gravity; RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING T-82

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	Graphic Log	Sample Type & Rec.	STANDARD PENETRATION TEST DATA (N in blows/ft)	WATER CONTENT % (PL, LL)	SIEVE ANALYSIS (GRAVEL, SAND, SILT, CLAY, FINES)	WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
		Surface Elev.:												
	0	TOPSOIL.												
		CLAY (CL): gray; moist; medium. 1.5			7			24.4				1.5		
	5				5									
		CLAY (CL): gray; moist; stiff, trace to little silt, (Lacustrine/Marsh Clay). 8.5										0.5		
	10				6									
	15											1.5		
		Wet, trace coarse-grained sand.			17			16.9				1.75		
	20													
		Moist.			7	11 17		11.7				1.75		
	25					18 36		13.5	124		1.25	1		
	30													
		Driller noted refusal between 33 and 34 feet.			>>50/2									
	35	Refusal on probable Limestone Bedrock 34.2												
	40													
	45													
	50													
	55													

Completion Depth:	34.2
Date Boring Started:	8/9/11
Date Boring Completed:	8/9/11
Logged By:	LAM2
Drilling Contractor:	Geocon
Drilling Method:	HSA
Ground Surface Elevation:	
Coordinates: 83.76759, 40.67631	Datum: UTM 17N, meters, Elev in ft

Remarks: Thermal sample taken 3-5 feet bgs.

SAMPLE TYPES: Auger Cuttings; Split Spoon; Shelby Tube

WATER LEVELS: While Drilling: 13.5; End of Drilling:; hrs After Drilling:

LEGEND: MC Moisture Content; γ Dry Unit Weight; ϕ Friction Angle; Q_u Unconfined Compression; Q_p Hand Penetrometer UC; Gs Specific Gravity; RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING T-88

Sheet 1 of 1

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	Graphic Log	Sample Type & Rec.	STANDARD PENETRATION TEST DATA (N in blows/ft)	WATER CONTENT % (PL, LL)	SIEVE ANALYSIS (GRAVEL, SAND, SILT, CLAY, FINES)	WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
		Surface Elev.:			10 20 30 40	20 40 60	20 40 60 80							
	0	TOPSOIL.												
		SILTY CLAY (CL): gray; moist; stiff, trace to little silt, (Lacustrine Clay). 1.5			5							0.75		
	5				7									
		1" of fine to medium-grained sand.						21.4				1		
	10				8		0 6 38 9	22				2		
	15					19 36		25	100.7		1.52	1.5		
	20				9			24.1				1		
		CLAYEY SILT (CL-ML): gray; moist; medium to stiff. 22.0			7							1		
	25					13.5 18.9		18.8	112.2		1.71	1.5		
		SANDY CLAY (CL): gray; moist; very stiff, little silt, trace sand, trace gravel. 29.0			17							2		
	30				17							0.5		
	35				16			13.5				2.5		
	40				38							4		
	45				21									
		Gravelly lean clay. 50.0						19.6				3		
	50													
	55													

Completion Depth: 50.0
Date Boring Started: 8/9/11
Date Boring Completed: 8/9/11
Logged By: LAM2
Drilling Contractor: Geocon
Drilling Method: HSA
Ground Surface Elevation:
Coordinates: 83.76019, Datum: UTM 17N, meters, Elev in ft

Remarks: Thermal sample taken 3-5 feet bgs.

SAMPLE TYPES: Auger Cuttings; Split Spoon; Shelby Tube

WATER LEVELS: While Drilling: | End of Drilling: | hrs After Drilling:

LEGEND
MC Moisture Content; Q_u Unconfined Compression
γ Dry Unit Weight; Q_p Hand Penetrometer UC
ϕ Friction Angle; Gs Specific Gravity
RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING T-99

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	Graphic Log	Sample Type & Rec.	STANDARD PENETRATION TEST DATA (N in blows/ft)	WATER CONTENT % (PL – LL)	SIEVE ANALYSIS (GRAVEL, SAND, SILT, CLAY, FINES)	Physical Properties: WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
Surface Elev.:													
0	SILTY CLAY (CL): brown; moist; stiff to very stiff; trace sand; trace gravel. (Glacial Till)												
5				15							4.5		
7.0													
10	SILTY CLAY (CL): dark brownish gray; moist; stiff to very stiff; trace sand; trace gravel. (Glacial Till)			13							1.75		
15				6							2		
20				22									
24.0													
25	SILTY CLAY (CL): dark gray; moist; stiff to very stiff; trace sand; trace gravel. (Glacial Till)			16							4.5		
30				19							3.75		
35				14							4		
40				19							4.5		
45				18							3		
50				21							4.5		
50.0													
55													

Completion Depth: 50.0
Date Boring Started: 8/4/11
Date Boring Completed: 8/4/11
Logged By: TDB
Drilling Contractor: Geocon
Drilling Method: HSA
Ground Surface Elevation:
Coordinates: 265425, 4496681 Datum: UTM 17N, meters, Elev in ft

Remarks:

SAMPLE TYPES: Auger Cuttings; Shelby Tube; Split Spoon

WATER LEVELS: While Drilling: ; End of Drilling: DRY ; hrs After Drilling:

LEGEND: MC Moisture Content; γ Dry Unit Weight; ϕ Friction Angle; Q_u Unconfined Compression; Q_p Hand Penetrometer UC; Gs Specific Gravity; RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING T-117

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	Graphic Log	Sample Type & Rec.	STANDARD PENETRATION TEST DATA (N in blows/ft)	WATER CONTENT % (PL, LL)	SIEVE ANALYSIS (GRAVEL, SAND, SILT, CLAY, FINES)	WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
	0	Surface Elev.:												
	0	TOPSOIL.												
	1.5	SILTY CLAY (CL): light brown; moist; medium to stiff; trace to little gravel.			5, 7, 9	18, 28		23.4				0.5, 1, 1.5, 3		
	22.0	SILTY CLAY (CL): gray; moist to saturated; very stiff to hard, trace to little sand, little gravel.			20, 26, 40		6.1, 29.8, 67.7	14.4, 15.8				4, 4.5		
		Driller noted pushing rock.												
	38.5	CLAYEY SAND (SP-SC): grayish-black; saturated; fine-sand; loose.			8, 16			29.7				1		
	43.5	SANDY CLAY (CL): gray; saturated; very stiff to hard; little silt.			>>68/9			10.7						
	50.0													

Physical Properties

Completion Depth:	50.0
Date Boring Started:	8/8/11
Date Boring Completed:	8/9/11
Logged By:	LAM2
Drilling Contractor:	Geocon
Drilling Method:	HSA
Ground Surface Elevation:	
Coordinates: 83.7154, 40.69442	Datum: UTM 17N, meters, Elev in ft

Remarks: Thermal sample taken 3-5 feet bgs.

SAMPLE TYPES: Auger Cuttings; Split Spoon; Shelby Tube

WATER LEVELS: While Drilling: 25; End of Drilling:; hrs After Drilling:

LEGEND: MC Moisture Content; γ Dry Unit Weight; ϕ Friction Angle; Q_u Unconfined Compression; Q_p Hand Penetrometer UC; Gs Specific Gravity; RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING O&M1

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	Graphic Log	Sample Type & Rec.	STANDARD PENETRATION TEST DATA (N in blows/ft)	WATER CONTENT %	SIEVE ANALYSIS	Physical Properties: WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
	0	Surface Elev.:												
		SILTY CLAY (CL): brown; moist; medium dense; some gravel; little sand			19, 21, 23							4, 4, 4.5, 4.5		
	10				12									
		POORLY GRADED SAND WITH SILT (SP-SM): fine to medium grained; dark brown; moist to wet			16							1.25		
	15	13.0 / 14.0												
		SILTY CLAY (CL): dark brown; wet; medium dense; trace sand, trace gravel; 19' - 1" sand seam			11							1		
	20	19.0 / 20.0												
		LEAN CLAY WITH GRAVEL (CL): dark brown; wet; stiff; some gravel												
	25													
	30													
	35													
	40													
	45													
	50													
	55													

PL — LL (WATER CONTENT %); GRAVEL SAND SILT CLAY / FINES (SIEVE ANALYSIS)

Completion Depth:	20.0
Date Boring Started:	8/2/11
Date Boring Completed:	8/2/11
Logged By:	TDB
Drilling Contractor:	Geocon
Drilling Method:	HSA
Ground Surface Elevation:	
Coordinates: 264012, 4501767	Datum: UTM 17N, meters, Elev in ft

Remarks:

SAMPLE TYPES	WATER LEVELS	LEGEND
Split Spoon	While Drilling:	MC Moisture Content; Q_u Unconfined Compression
	End of Drilling:	γ Dry Unit Weight; Q_p Hand Penetrometer UC
	hrs After Drilling:	ϕ Friction Angle; Gs Specific Gravity; RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING O&M2

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	Graphic Log	Sample Type & Rec.	STANDARD PENETRATION TEST DATA (N in blows/ft)	WATER CONTENT %	SIEVE ANALYSIS	Physical Properties: WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
	0	Surface Elev.:												
	0	SILTY CLAY (CL): light brown; moist; medium dense; some small gravel; trace clay			19, 23, 25, 14							4.5, 4.5, 4.5, 2		
	12.0	SSILTY CLAY (CL): dark gray; moist; loose to medium dense; some large to small gravel; some clay			17, 8							2.5, 1.5		
	20.0													

Completion Depth: 20.0
Date Boring Started: 8/2/11
Date Boring Completed: 8/2/11
Logged By: TDB
Drilling Contractor: Geocon
Drilling Method: HSA
Ground Surface Elevation:
Coordinates: 264079, 4501775 Datum: UTM 17N, meters, Elev in ft

Remarks:

SAMPLE TYPES	WATER LEVELS	LEGEND
Split Spoon	While Drilling:	MC Moisture Content; Q_u Unconfined Compression
	End of Drilling:	γ Dry Unit Weight; Q_p Hand Penetrometer UC
	hrs After Drilling:	ϕ Friction Angle; Gs Specific Gravity; RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING SS-1

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	Graphic Log	Sample Type & Rec.	STANDARD PENETRATION TEST DATA (N in blows/ft)	WATER CONTENT % (PL, LL)	SIEVE ANALYSIS (GRAVEL, SAND, SILT, CLAY, FINES)	Physical Properties: WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
		Surface Elev.:												
	0	SILT (ML): black; moist; loose			5, 4									
	5	3.5' - 3" fine to medium grained SM layer			7, 9									
		3.7 LEAN CLAY (CL): gray; moist; soft to medium stiff; some silt												
	10	8.0 SILTY CLAY (CL): dark brown; moist; loose to medium dense; some gravel; some sand												
	15	15' - 3" fine to medium grained SP layer			13, 15									
	20	20.0												
	25													
	30													
	35													
	40													
	45													
	50													
	55													

Completion Depth:	20.0
Date Boring Started:	8/3/11
Date Boring Completed:	8/3/11
Logged By:	TDB
Drilling Contractor:	Geocon
Drilling Method:	HSA
Ground Surface Elevation:	
Coordinates: 263766, 4501718	Datum: UTM 17N, meters, Elev in ft

Remarks:

SAMPLE TYPES	WATER LEVELS	LEGEND
Split Spoon	While Drilling:	MC Moisture Content; Q_u Unconfined Compression
	End of Drilling:	γ Dry Unit Weight; Q_p Hand Penetrometer UC
	hrs After Drilling:	ϕ Friction Angle; Gs Specific Gravity; RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Barr Engineering Company
4700 W 77th St. Suite 200
Edina, MN 55435

LOG OF BORING SS-2

Project: Hardin County Wind | Location: Hardin County, Ohio | Client: Invenergy

Barr Project Number: 35/33-1001

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	Graphic Log	Sample Type & Rec.	STANDARD PENETRATION TEST DATA (N in blows/ft)	WATER CONTENT % (PL, LL)	SIEVE ANALYSIS (GRAVEL, SAND, SILT, CLAY, FINES)	Physical Properties: WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
		Surface Elev.:												
	0	SILTY CLAY (CL): dark brown; moist; medium dense to dense; some gravel; some sand			12							3.5		
	5				22			18.6	113.6			4		
		7.5' to 9.0' - trace fine sand			38							2.5		
	10													
	15				36							2.5		
	20	POORLY GRADED SAND (SP): fine to medium grained; dark brown; wet; medium dense; some silt (19.0 – 20.5)			21									
	25													
	30													
	35													
	40													
	45													
	50													
	55													

Completion Depth:	20.0
Date Boring Started:	8/2/11
Date Boring Completed:	8/2/11
Logged By:	TDB
Drilling Contractor:	Geocon
Drilling Method:	HSA
Ground Surface Elevation:	
Coordinates: 263787, 4501741	Datum: UTM 17N, meters, Elev in ft

Remarks:

SAMPLE TYPES	WATER LEVELS	LEGEND
⊠ Split Spoon	While Drilling:	MC Moisture Content; γ Dry Unit Weight; ϕ Friction Angle; Q_u Unconfined Compression; Q_p Hand Penetrometer UC; Gs Specific Gravity; RQD Rock Quality Designation
	End of Drilling:	
	hrs After Drilling:	

The stratification lines represent approximate boundaries. The transition may be gradual.

LOG BORING HORIZONTAL 8.5 X 11 GS GRAPH WITH COORDINATES SWITCHYARD DRAFT 2011-7-8_TDB BORINGS 2011-8-8.GPJ PENASCAL-TX WIND PROJECT.GPJ 1/24/12

Appendix E

Laboratory Test Results

GEOCON
PROFESSIONAL SERVICES

Laboratory Testing Narrative

Client: Barr Engineering Company
4700 W. 77th Street, Suite 200
Minneapolis, Minnesota

Project: Hardin County Wind Project
Hardin Co., Ohio

Date: September 16, 2011

GEOCON Project No.: 11-G292

Sample Notes:

T-14: Rock Qu – Core sample too fractured to test.

T-35: Rock Qu – Core sample too fractured to test.

T-31: Moisture Content @ 20 feet – No sample present.

T-31: Rock Qu – No sample box present.

T-51: Moisture Content @ 10 feet – No sample present.

T-82: Moisture Content @ 35 feet – No sample present.

SUMMARY OF LABORATORY RESULTS

PRINT DATE 9/16/2011

CLIENT Barr Engineering, Inc. **PROJECT NAME** Hardin County Wind Project

PROJECT NUMBER 11-G292 **PROJECT LOCATION** Hardin County, Ohio

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Comp. Strength (tsf)	Organic Content (%)	%<#200 Sieve	Class-ification
T-02	15.0	25	17	8	13.6						
T-02	25.0				14.1						
T-02	30.0				18.5					46	
T-02	35.0				8.6						
T-02	45.0				13.4						
T-117	10.0				23.4						
T-117	15.0	28	18	10	13.0						
T-117	25.0				14.4					70	
T-117	30.0				15.8						
T-117	40.0				29.7						
T-117	50.0				10.7						
T-14	5.0				25.3						
T-14	17.0				14.2						
T-14	20.0	22	17	5	10.3						
T-14	25.0				8.4						
T-19	10.0				12.7						
T-19	20.0				5.2						
T-19	25.0	32	17	15	14.4						
T-19	30.0				18.0						
T-31	5.0				24.9						
T-35	5.0				15.3						
T-35	15.0				14.7					58	
T-39	5.0				21.4						
T-39	20.0	38	22	16	26.2						
T-39	30.0				27.7						
T-49	5.0				32.1						
T-49	50.0				6.0						
T-51	30.0				39.0						
T-51	50.0				45.3						
T-62	15.0				12.1						
T-62	20.0	22	17	5	11.5						
T-62	30.0				19.4						
T-62	35.0				15.2					88	
T-62	40.0				10.8						
T-62	50.0				13.3						
T-66	25.0				51.9						
T-66	35.0				43.4						
T-66	40.0				26.8					99	
T-82	5.0				24.4						
T-82	20.0				16.9						
T-82	25.0	17	11	6	11.7						
T-88	10.0				21.4						
T-88	15.0				22.0					99	

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GPS LAB SUMMARY - GPS STD DATA TEMPLATE.GDT - 09/16/11 10:48 - Y:\GINT\PROJECTS\11-G292 HARDIN COUNTY OH.GPJ

GEOCON PROFESSIONAL SERVICES

SUMMARY OF LABORATORY RESULTS

PRINT DATE 9/16/2011

CLIENT Barr Engineering, Inc.

PROJECT NAME Hardin County Wind Project

PROJECT NUMBER 11-G292

PROJECT LOCATION Hardin County, Ohio

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Water Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Comp. Strength (tsf)	Organic Content (%)	%<#200 Sieve	Class-ification
T-88	20.0	36	19	17	24.1						
T-88	40.0				13.5						
T-88	50.0				19.6						

GPS LAB SUMMARY - GPS STD DATA TEMPLATE.GDT - 09/16/11 10:48 - Y:\GINT\PROJECTS\11-G292 HARDIN COUNTY OH.GPJ

ATTERBERG LIMITS' RESULTS

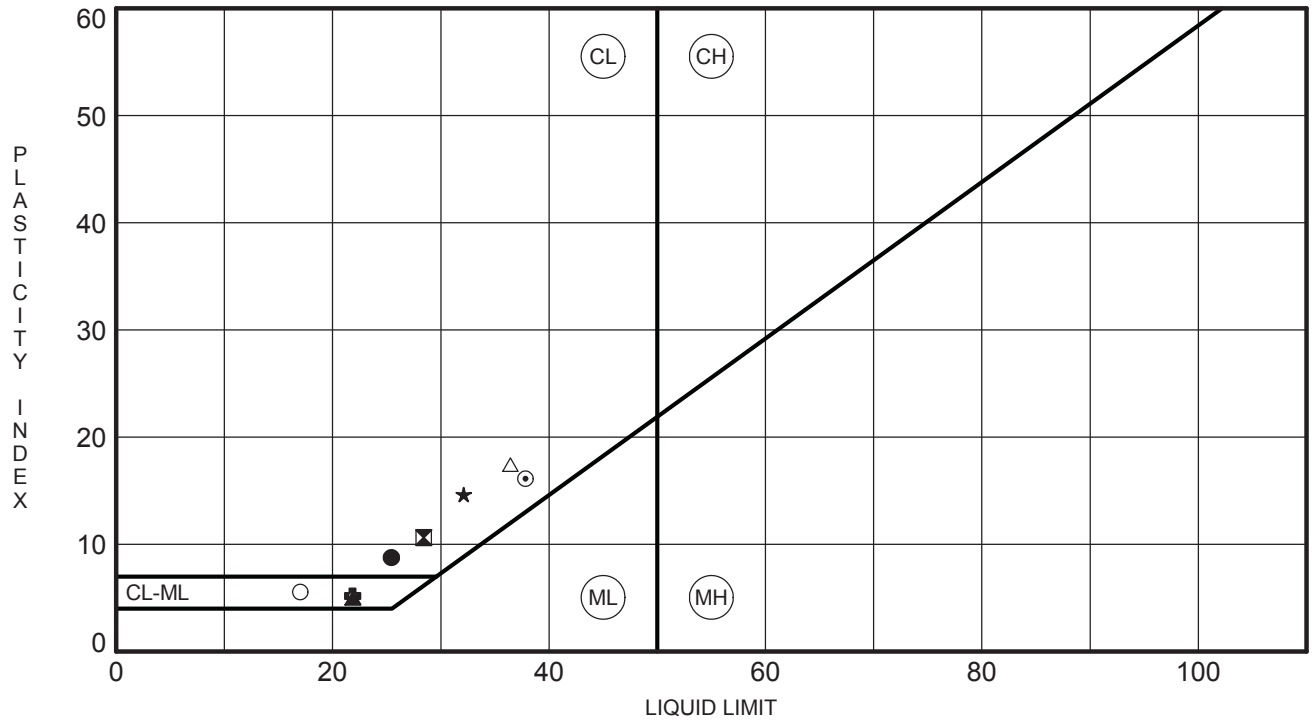
PRINT DATE 9/16/2011

CLIENT Barr Engineering, Inc.

PROJECT NAME Hardin County Wind Project

PROJECT NUMBER 11-G292

PROJECT LOCATION Hardin County, Ohio



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	T-02	15.0	25	17	8		
⊠	T-117	15.0	28	18	10		
▲	T-14	20.0	22	17	5		
★	T-19	25.0	32	17	15		
⊙	T-39	20.0	38	22	16		
✿	T-62	20.0	22	17	5		
○	T-82	25.0	17	11	6		
△	T-88	20.0	36	19	17		

ATTERBERG LIMITS - GPS STD DATA TEMPLATE.GDT - 09/16/11 10:49 - Y:\GINT\PROJECTS\11-G292 HARDIN COUNTY OH.GPJ

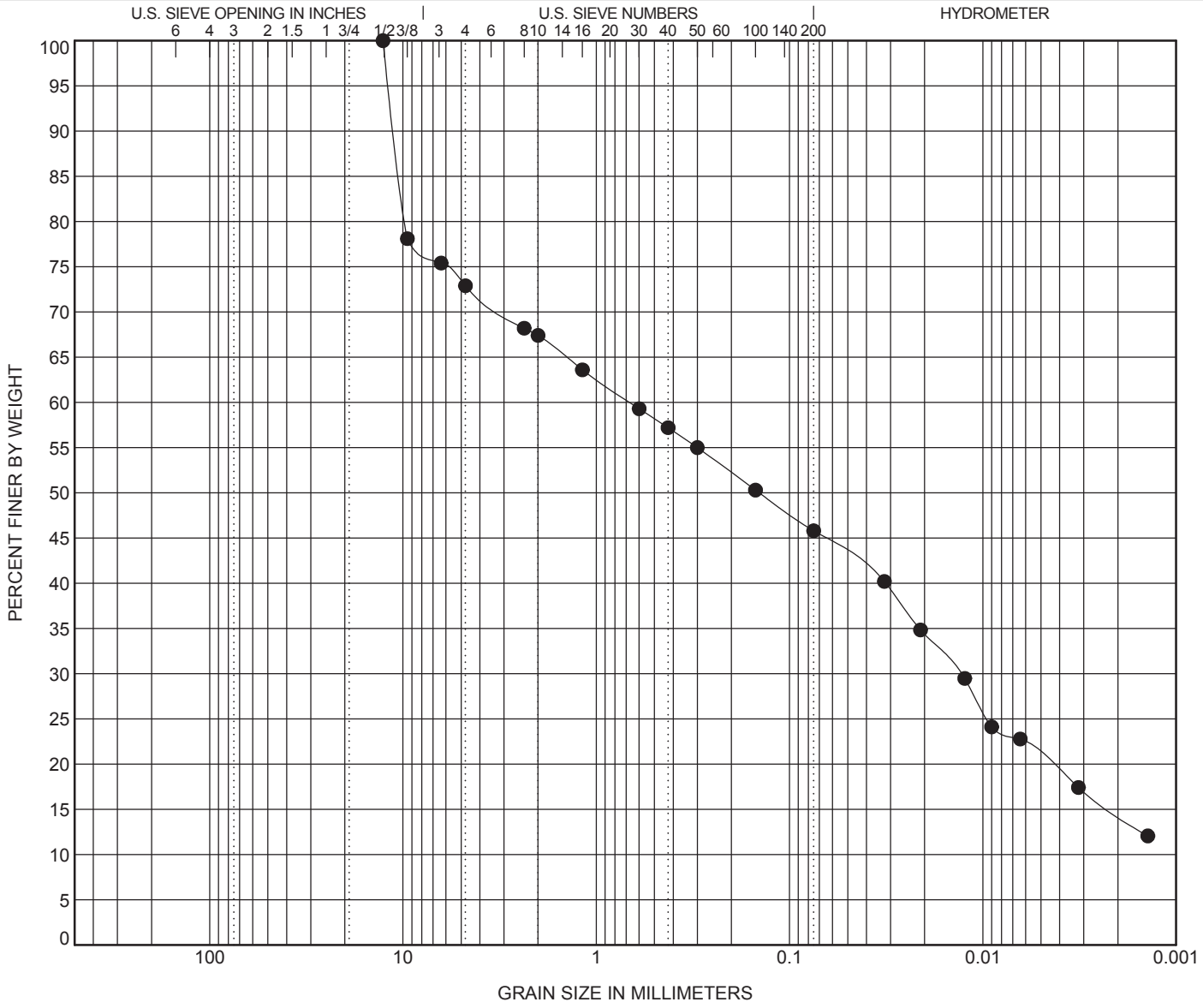
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GRAIN SIZE DISTRIBUTION

PRINT DATE 9/16/2011

CLIENT Barr Engineering, Inc. **PROJECT NAME** Hardin County Wind Project

PROJECT NUMBER 11-G292 **PROJECT LOCATION** Hardin County, Ohio



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**T-02**	**30.0**						

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**T-02**	**30.0**	**12.7**	**0.67**	**0.013**		**27.1**	**27.1**	**24.9**	**20.9**

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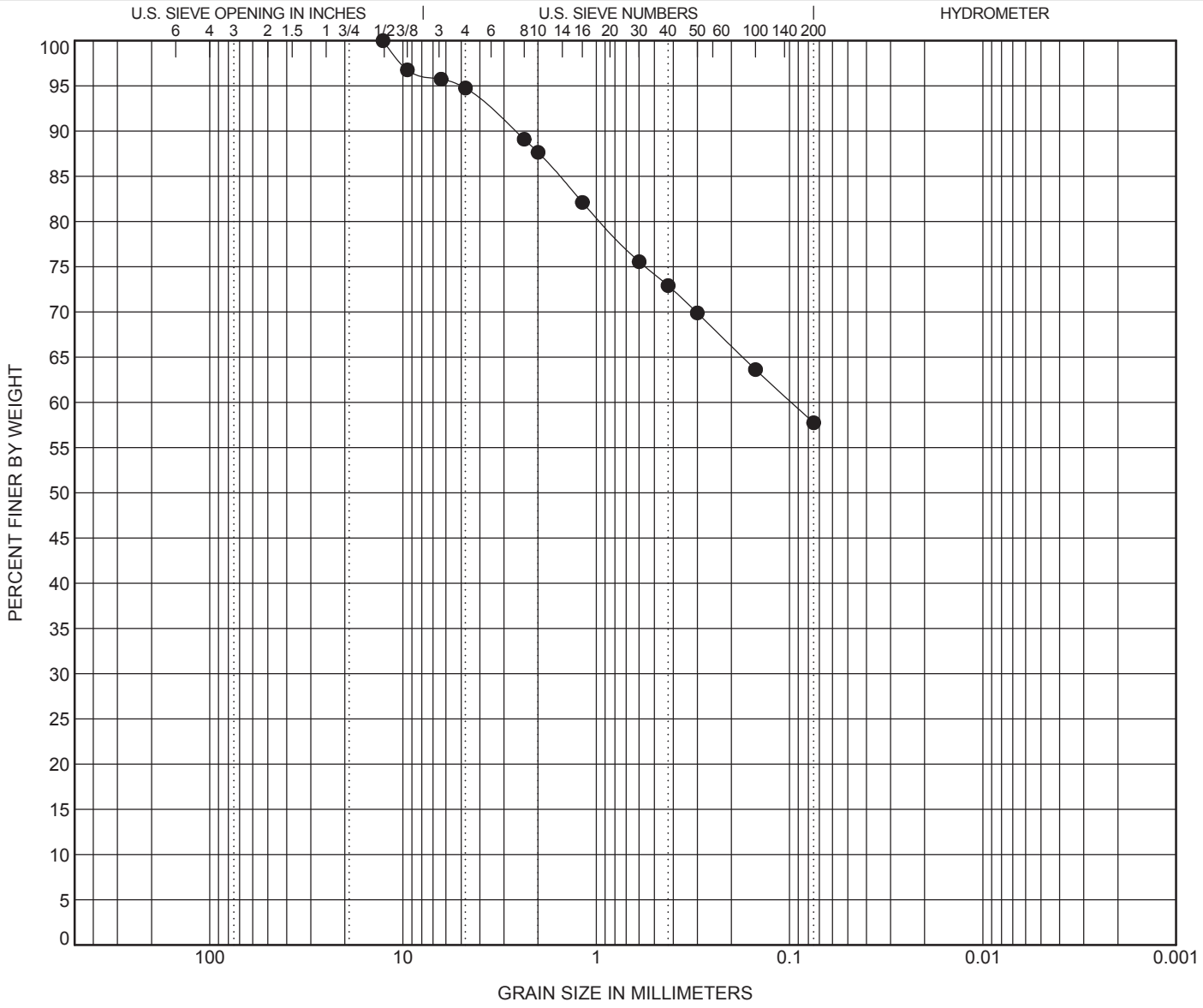
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GRAIN SIZE DISTRIBUTION

PRINT DATE 9/16/2011

CLIENT Barr Engineering, Inc. **PROJECT NAME** Hardin County Wind Project

PROJECT NUMBER 11-G292 **PROJECT LOCATION** Hardin County, Ohio



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**T-35**	**15.0**						

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**T-35**	**15.0**	**12.7**	**0.098**			**5.2**	**37.0**	**57.8**	

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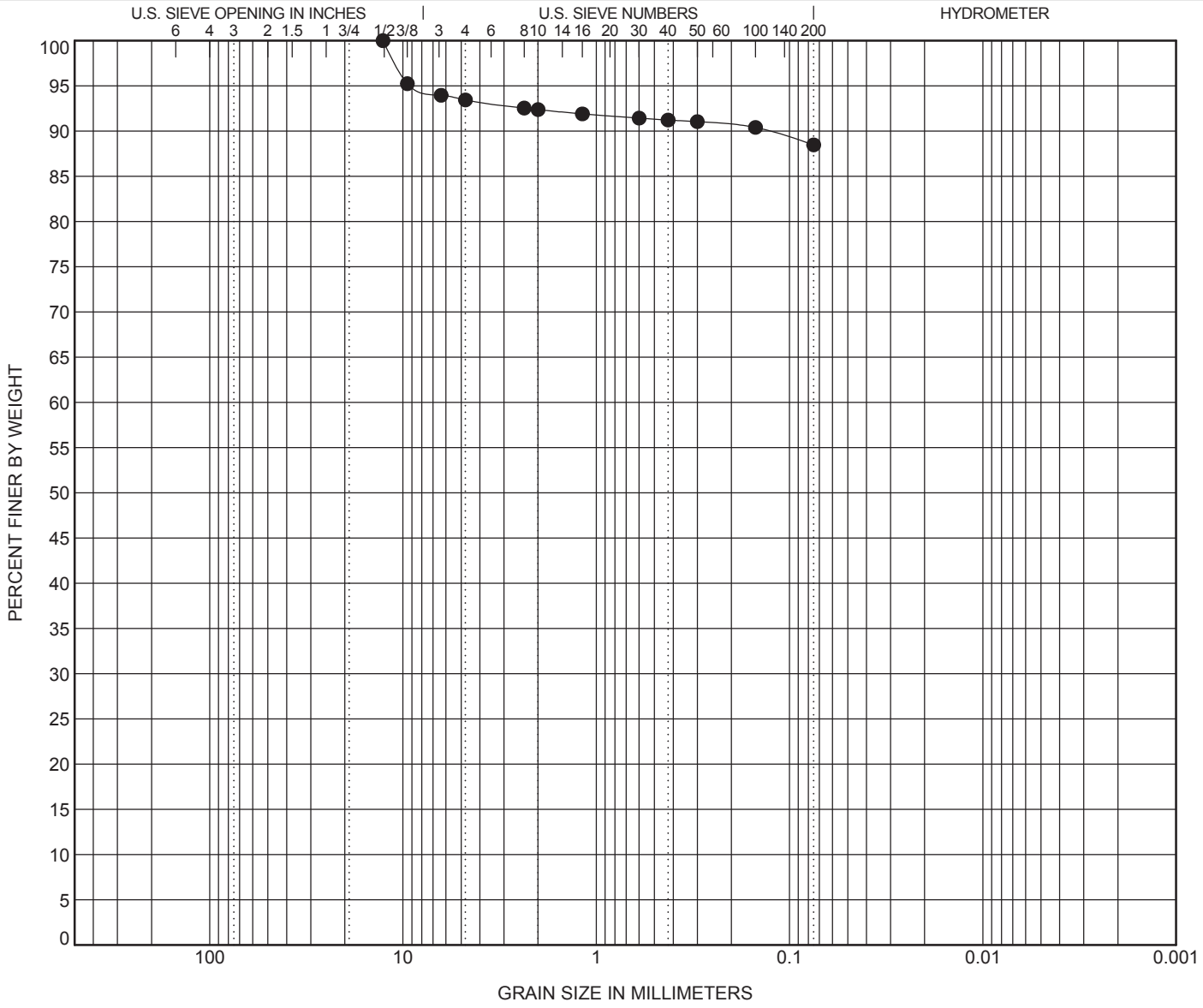
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GRAIN SIZE DISTRIBUTION

PRINT DATE 9/16/2011

CLIENT Barr Engineering, Inc. **PROJECT NAME** Hardin County Wind Project

PROJECT NUMBER 11-G292 **PROJECT LOCATION** Hardin County, Ohio



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**T-62**	**35.0**						

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**T-62**	**35.0**	**12.7**				**6.6**	**5.0**	**88.5**	

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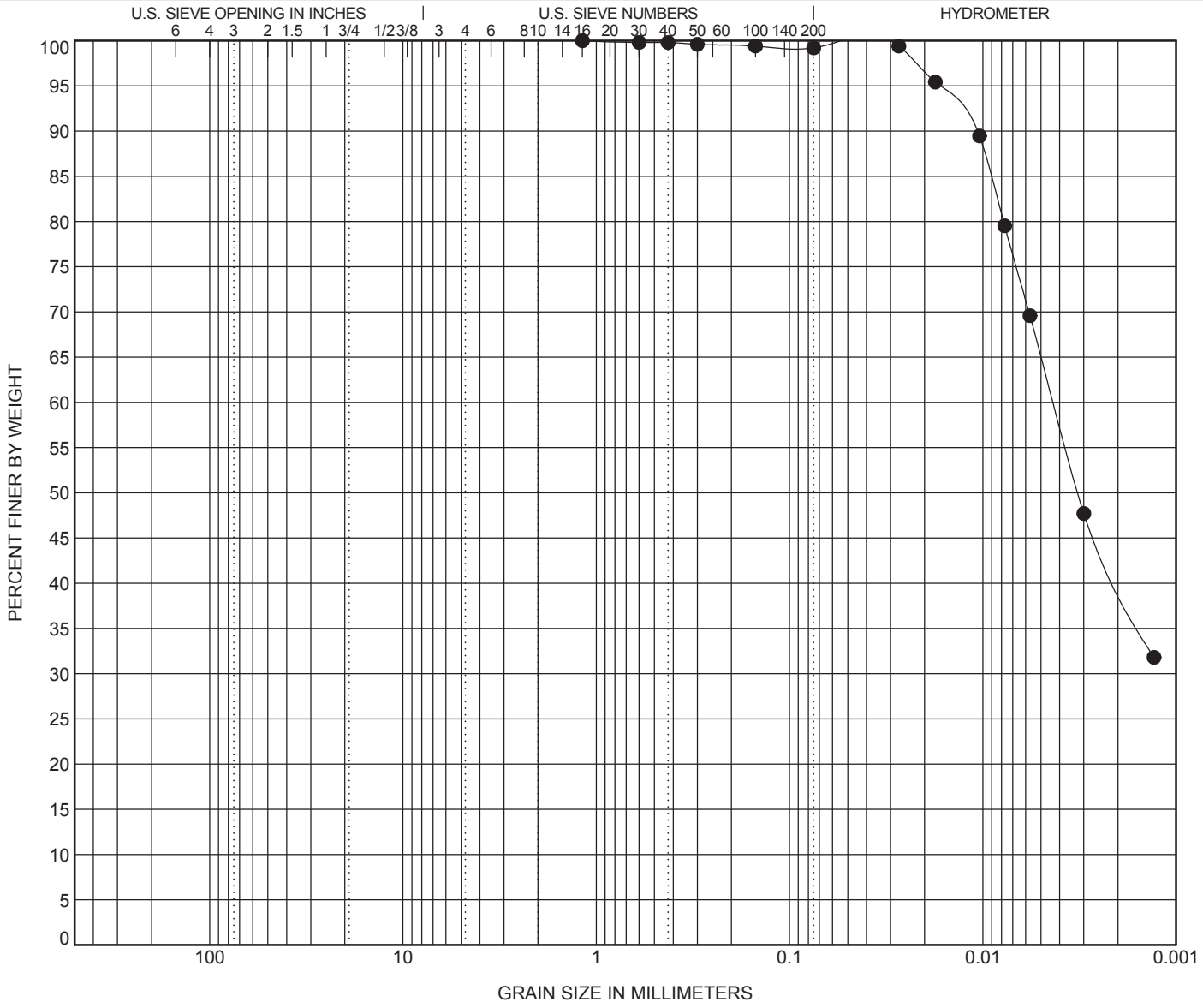
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CLIENT Barr Engineering, Inc. **PROJECT NAME** Hardin County Wind Project

PROJECT NUMBER 11-G292 **PROJECT LOCATION** Hardin County, Ohio



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**T-66**	**40.0**						

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**T-66**	**40.0**	**1.18**	**0.004**			**0.0**	**0.8**	**34.1**	**65.1**

GRAIN SIZE - GPS STD DATA TEMPLATE.GDT - 09/16/11 10:53 - Y:\GINT\PROJECTS\11-G292 HARDIN COUNTY OH.GPJ

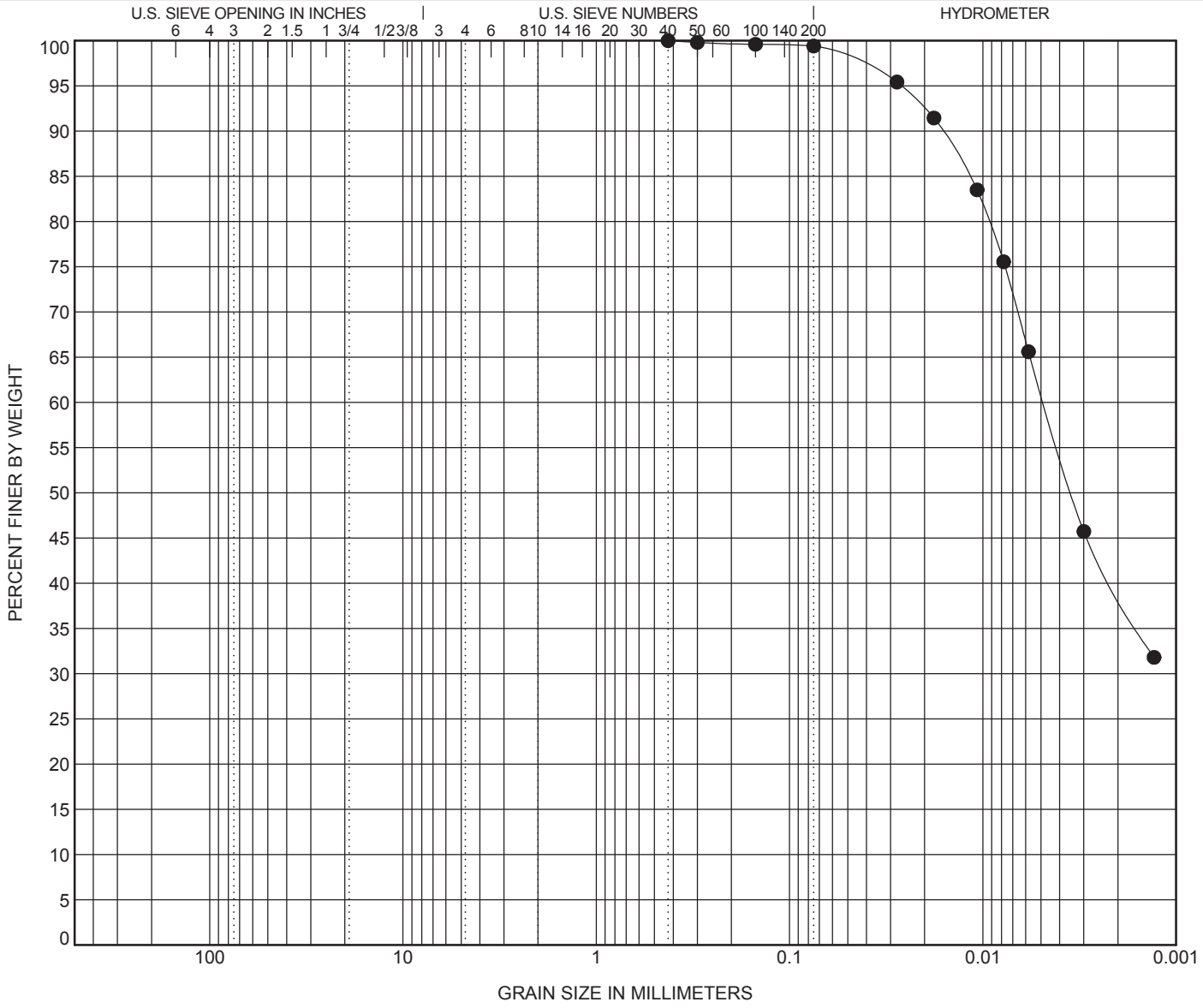
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GRAIN SIZE DISTRIBUTION

PRINT DATE 9/16/2011

CLIENT Barr Engineering, Inc. **PROJECT NAME** Hardin County Wind Project

PROJECT NUMBER 11-G292 **PROJECT LOCATION** Hardin County, Ohio



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**T-88**	**15.0**						

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**T-88**	**15.0**	**0.425**	**0.005**			**0.0**	**0.6**	**38.3**	**61.1**

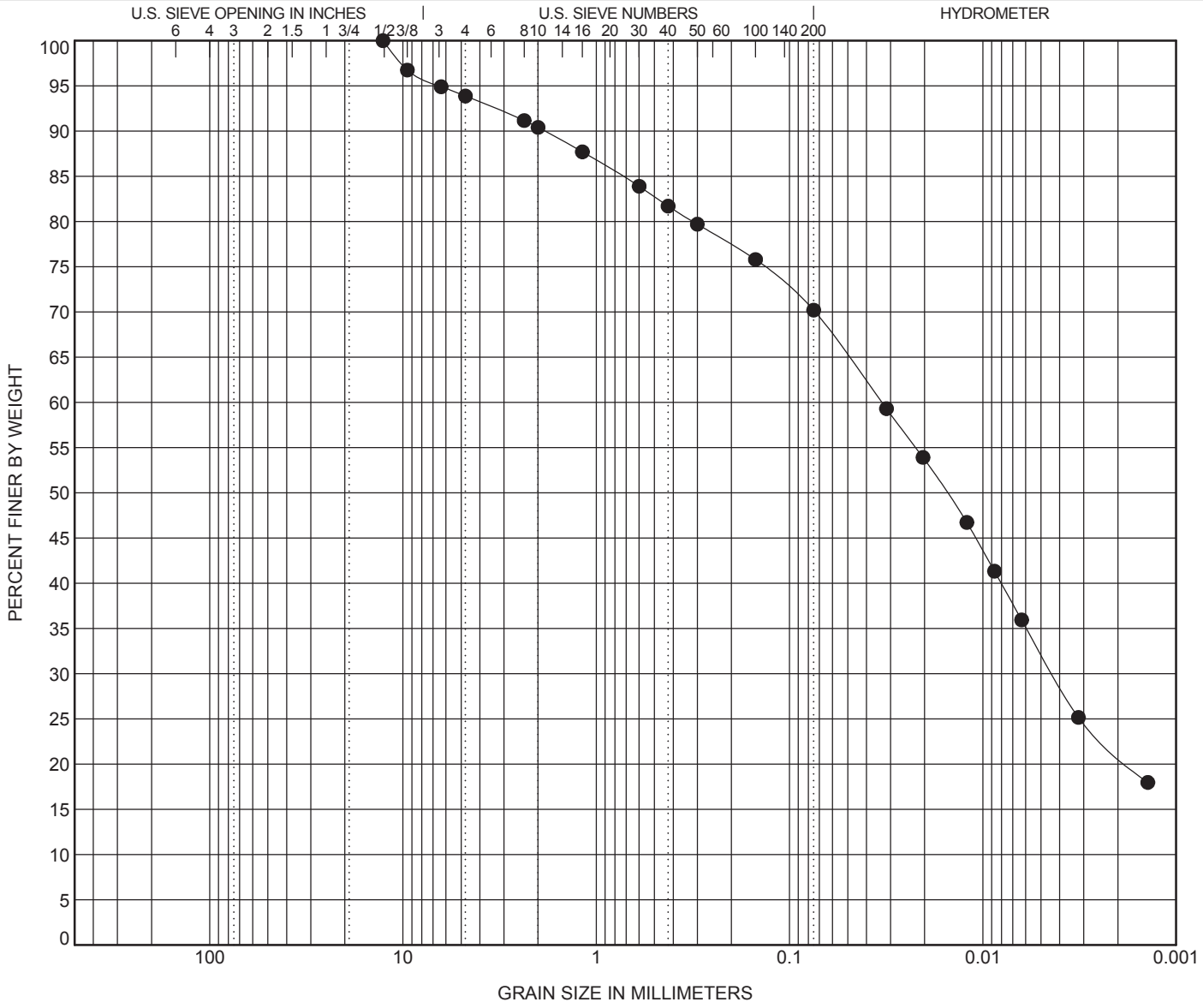
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GRAIN SIZE DISTRIBUTION

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CLIENT Barr Engineering, Inc. **PROJECT NAME** Hardin County Wind Project

PROJECT NUMBER 11-G292 **PROJECT LOCATION** Hardin County, Ohio



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**T-117**	**25.0**						

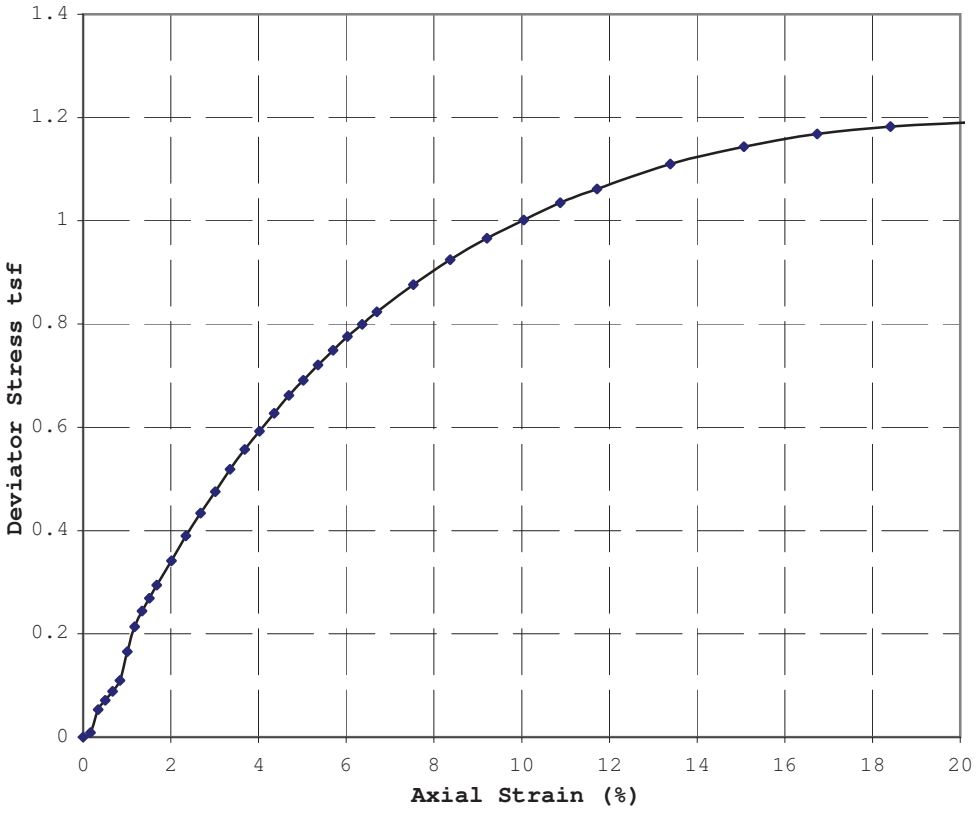
	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**T-117**	**25.0**	**12.7**	**0.033**	**0.004**		**6.1**	**23.7**	**37.9**	**32.3**

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GRAIN SIZE - GPS STD DATA TEMPLATE.GDT - 09/16/11 10:55 - Y:\GINT\PROJECTS\11-G292 HARDIN COUNTY OH.GPJ

Triaxial U-U Stress/Strain Curves

Project: Hardin County | Job: 8076
Client: Barr Engineering Company | Date: 9/27/11
Remarks:



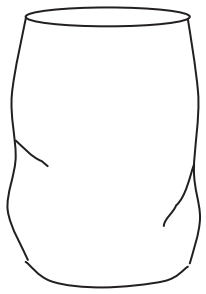
Boring: T-02 Depth: 12-14
Sample #:
Soil Type: Lean Clay w/a little gravel (CL)

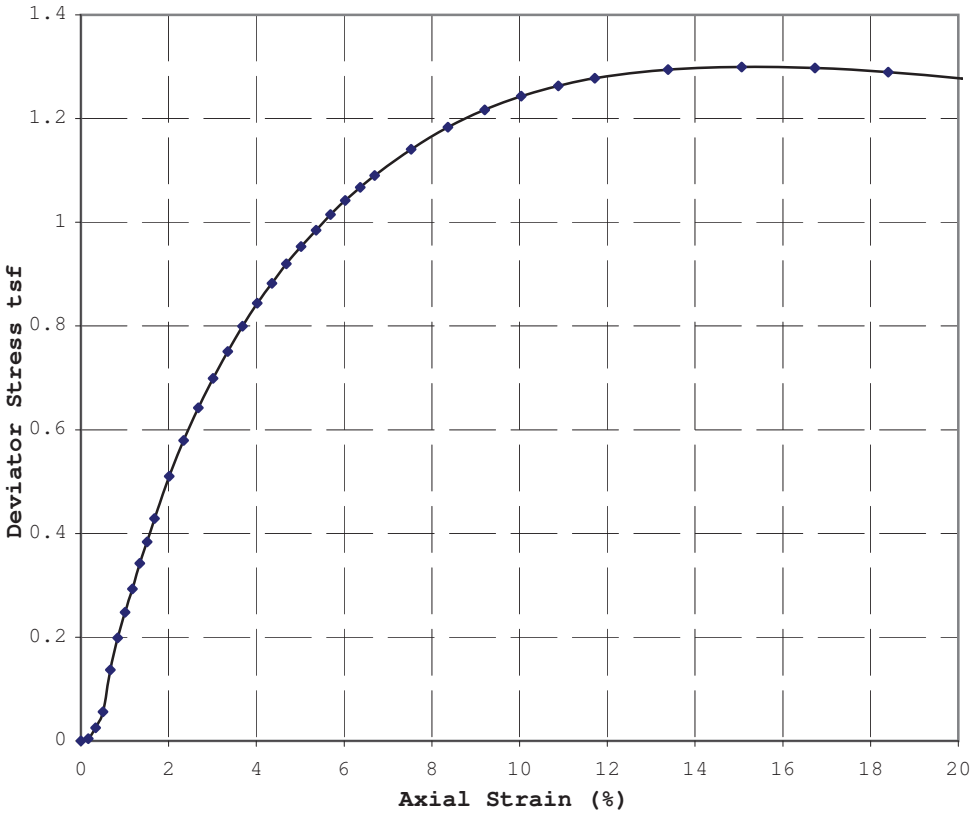
Strain Rate (in/min): 0.050
Sample Type: 3T
Dia. (in) 2.88 Ht. (in) 5.98
Height to Diameter Ratio: 2.1

Max Deviator Stress: 1.19 tsf
Strain at Failure (%): 20.45
Confining Pressure: 0.75 tsf

W.C. (%) 14.9
Yd (pcf): 120.4

Sketch of Specimen After Failure





Boring: T-35 Depth: 12-14
Sample #:
Soil Type: Lean Clay w/gravel (CL)

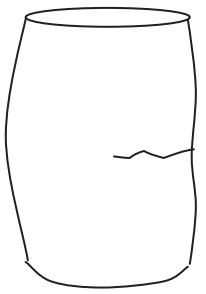
Strain Rate (in/min): 0.050
Sample Type: 3T

Dia. (in): 2.88 Ht. (in): 5.98
Height to Diameter Ratio: 2.1

Max Deviator Stress: 1.30 tsf
Strain at Failure (%): 15.06
Confining Pressure: 0.75 tsf

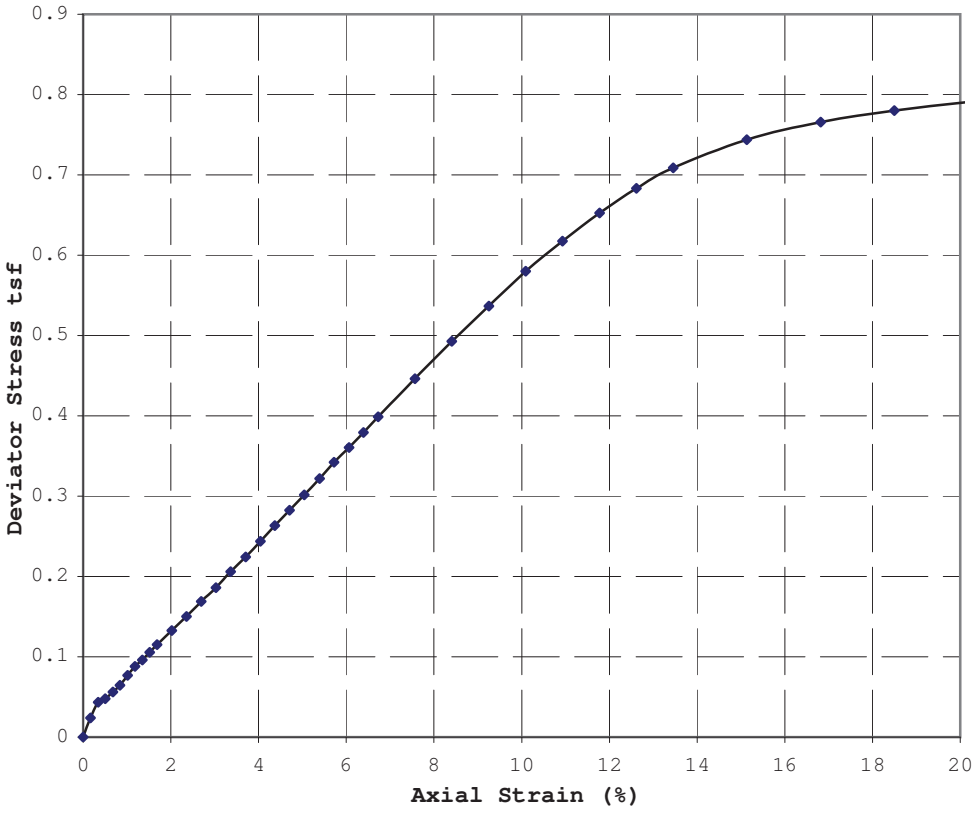
W.C. (%): 13.5
Yd (pcf): 124.3

Sketch of Specimen After Failure



Triaxial U-U Stress/Strain Curves

Project: Hardin County | Job: 8076
Client: Barr Engineering Company | Date: 9/27/11
Remarks:



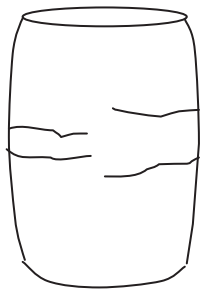
Boring: T-39 Depth: 12-14
Sample #:
Soil Type: Lean Clay (CL)

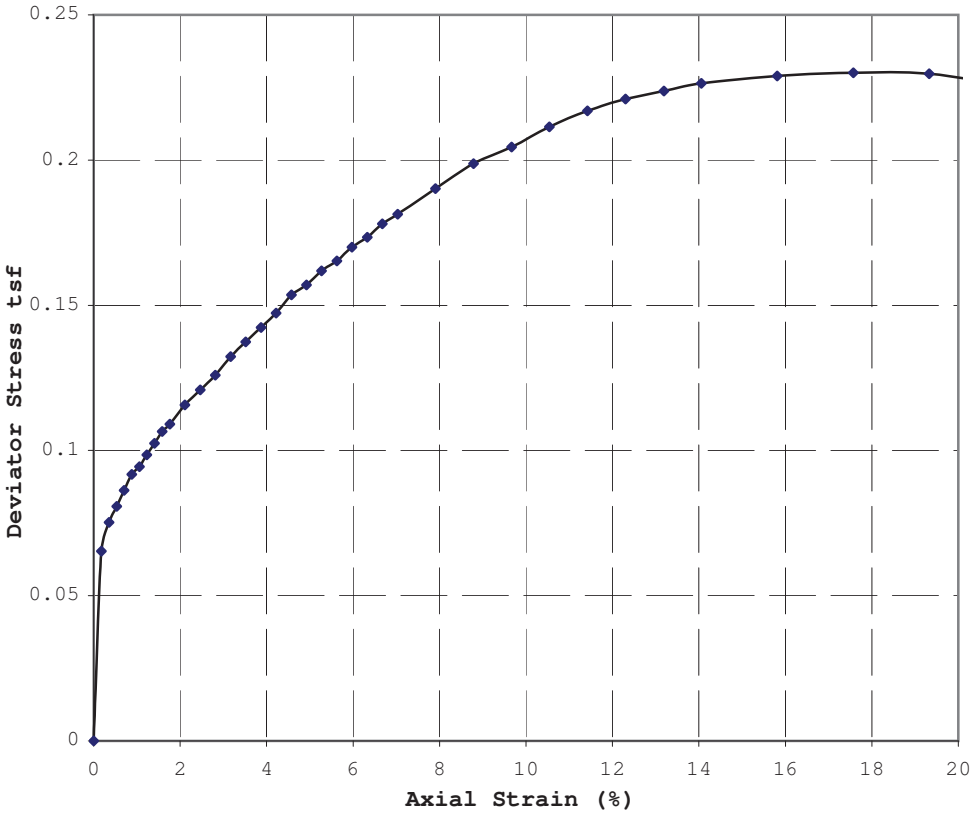
Strain Rate (in/min): 0.050
Sample Type: 3T
Dia. (in) 2.96 Ht. (in) 5.95
Height to Diameter Ratio: 2.0

Max Deviator Stress: 0.79 tsf
Strain at Failure (%): 20.13
Confining Pressure: 0.75 tsf

W.C. (%) 22.5
Yd (pcf): 102.3

Sketch of Specimen After Failure





Boring: T-49 Depth: 12-14
Sample #:
Soil Type: Lean Clay (CL)

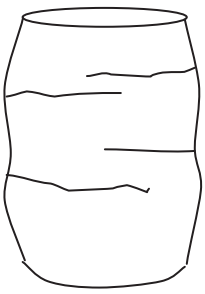
Strain Rate (in/min): 0.050
Sample Type: 3T

Dia. (in): 2.94 Ht. (in): 5.69
Height to Diameter Ratio: 1.9

Max Deviator Stress: 0.23 tsf
Strain at Failure (%): 17.57
Confining Pressure: 0.75 tsf

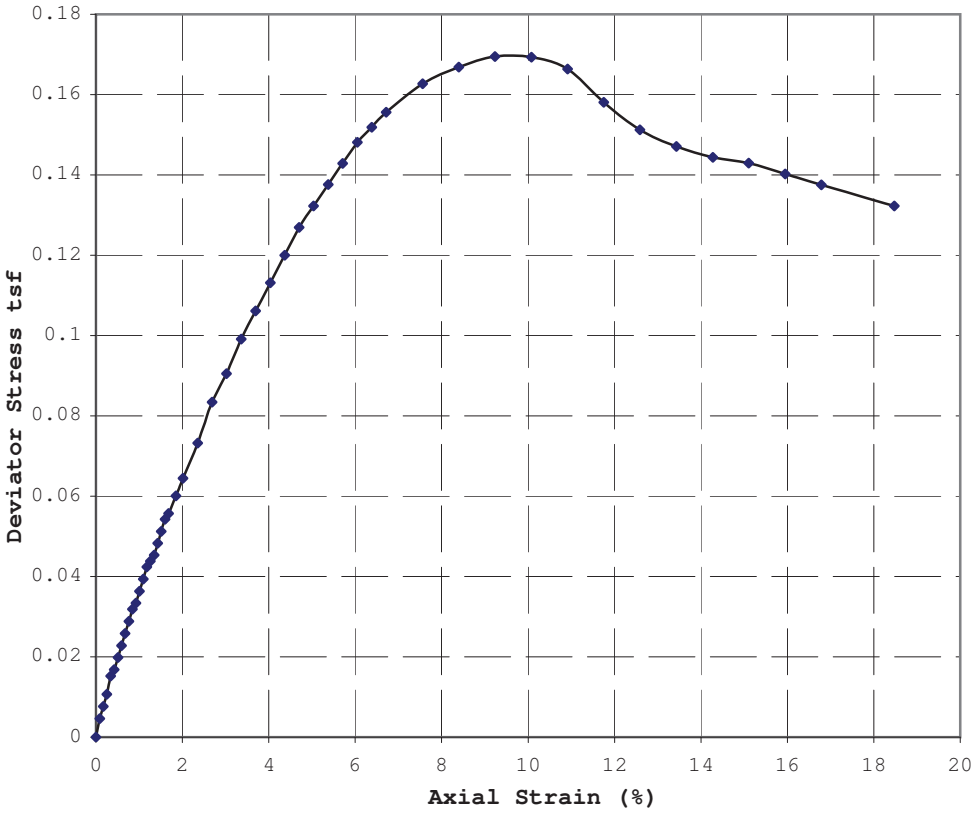
W.C. (%): 39.4
Yd (pcf): 78.5

Sketch of Specimen After Failure



Triaxial U-U Stress/Strain Curves

Project: Hardin County | Job: 8076
Client: Barr Engineering Company | Date: 9/27/11
Remarks: Specimens trimmed to given sizes; Allowed to adjust under applied confining pressures for about 10 minutes.



Boring: T-49 Depth: 22-24
Sample #:

Soil Type: Lean Clay (CL)

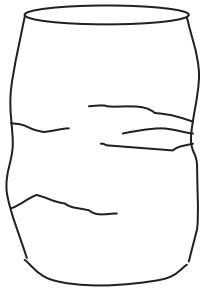
Strain Rate (in/min): 0.050
Sample Type: 3T
Dia. (in) 2.84 Ht. (in) 5.96
Height to Diameter Ratio: 2.10

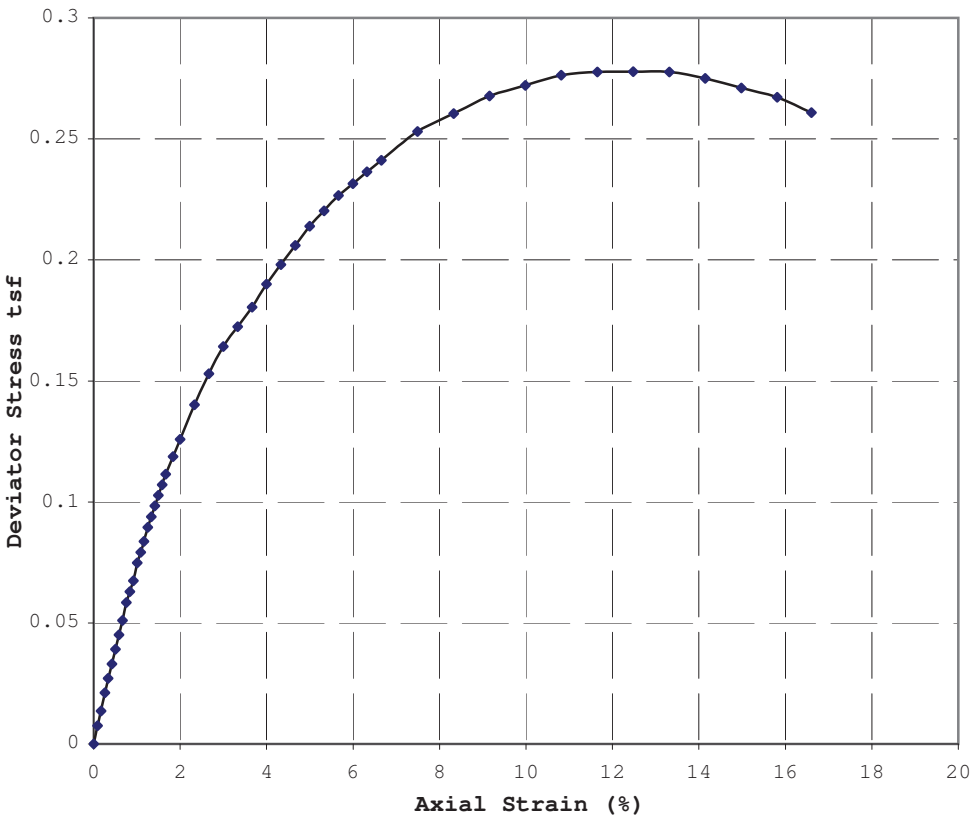
Max Deviator Stress: 0.17 tsf
Strain at Failure (%): 9.24
Confining Pressure: 1.25 tsf

W.C. (%) 41.6
Yd (pcf): 80.1

LL: 41.5
PL: 19.7
PI: 21.8

Sketch of Specimen After Failure





Boring: T-49 Depth: 47-49
Sample #:

Soil Type: Lean Clay (CL)

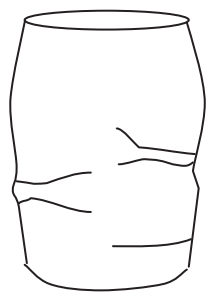
Strain Rate (in/min): 0.050
Sample Type: 3T

Dia. (in): 2.86 Ht. (in): 6.01
Height to Diameter Ratio: 2.10

Max Deviator Stress: 0.28 tsf
Strain at Failure (%): 12.48
Confining Pressure: 2.50 tsf

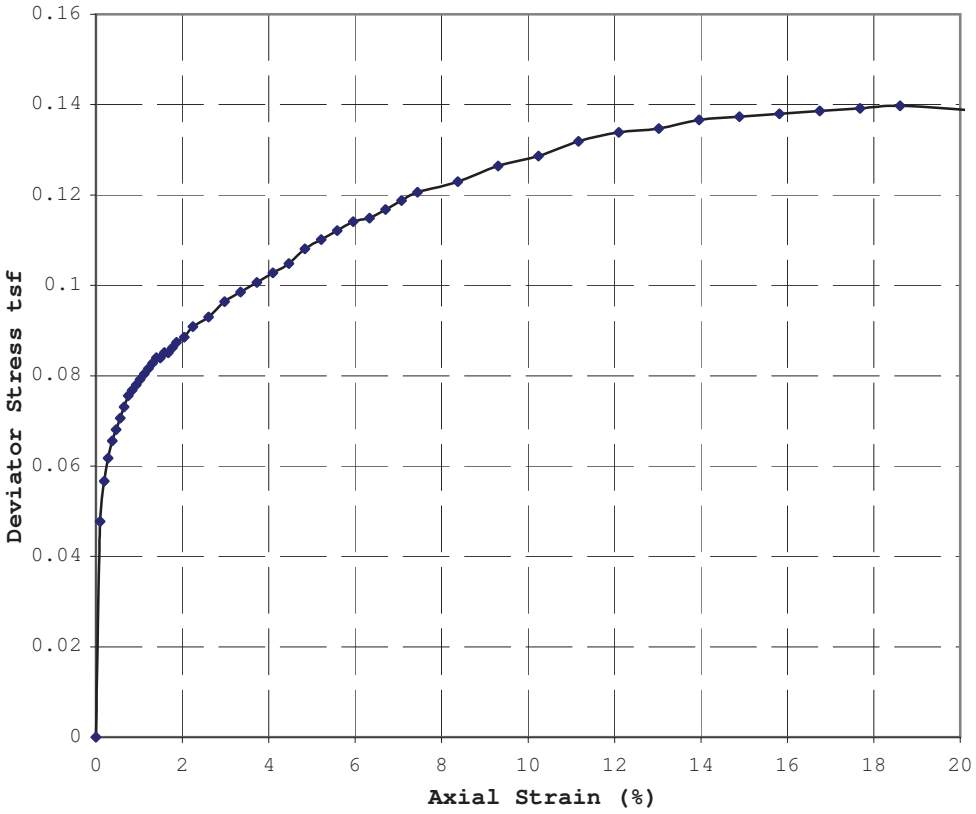
W.C. (%): 38.5
Yd (pcf): 83.0

Sketch of Specimen After Failure



Triaxial U-U Stress/Strain Curves

Project: Hardin County | Job: 8076
Client: Barr Engineering Company | Date: 9/27/11
Remarks: Specimens trimmed to given sizes; Allowed to adjust under applied confining pressures for about 10 minutes.



Boring: T-51 Depth: 3-5
Sample #:

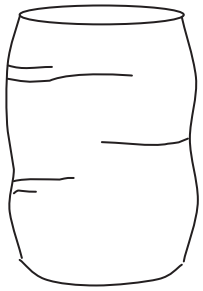
Soil Type: Lean Clay (CL)

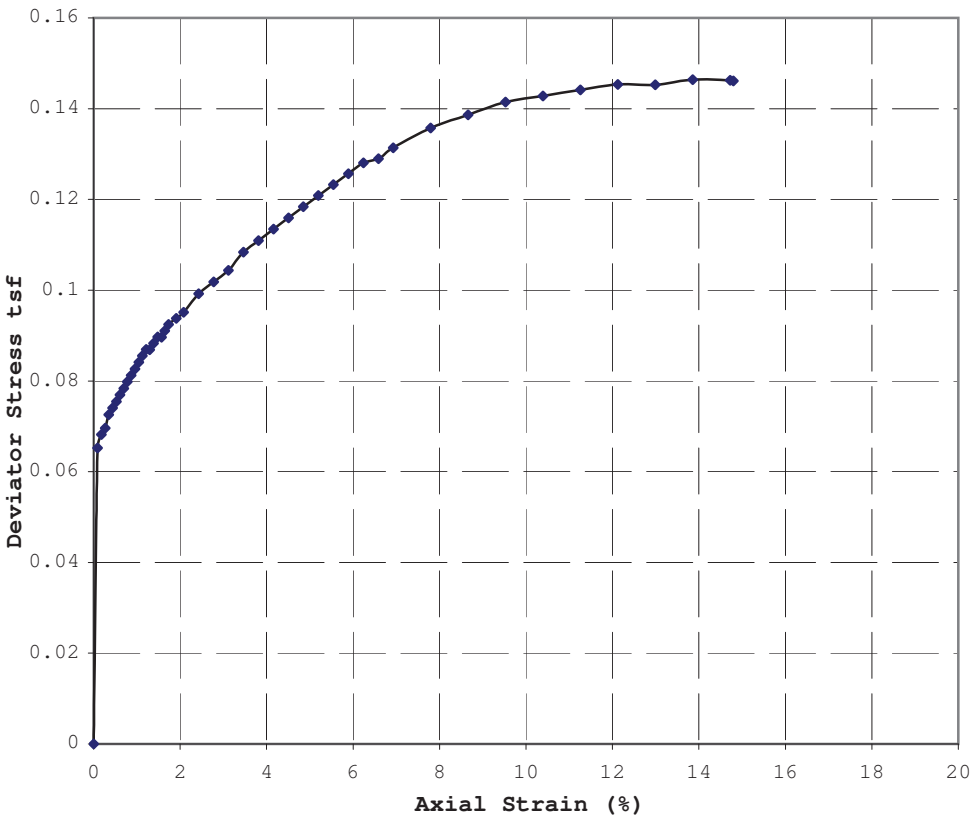
Strain Rate (in/min): 0.050
Sample Type: 3T
Dia. (in) 3.09 Ht. (in) 5.38
Height to Diameter Ratio: 1.74

Max Deviator Stress: 0.14 tsf
Strain at Failure (%): 18.61
Confining Pressure: 0.25 tsf

W.C. (%) 35.8
Yd (pcf): 82.5

Sketch of Specimen After Failure





Boring: T-51 Depth: 20-22
Sample #:

Soil Type: Lean Clay (CL)

Strain Rate (in/min): 0.050
Sample Type: 3T

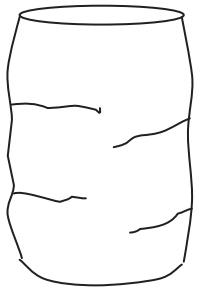
Dia. (in): 2.85 Ht. (in): 5.77
Height to Diameter Ratio: 2.03

Max Deviator Stress: 0.15 tsf
Strain at Failure (%): 13.86
Confining Pressure: 1.25 tsf

W.C. (%): 40.9
Yd (pcf): 77.6

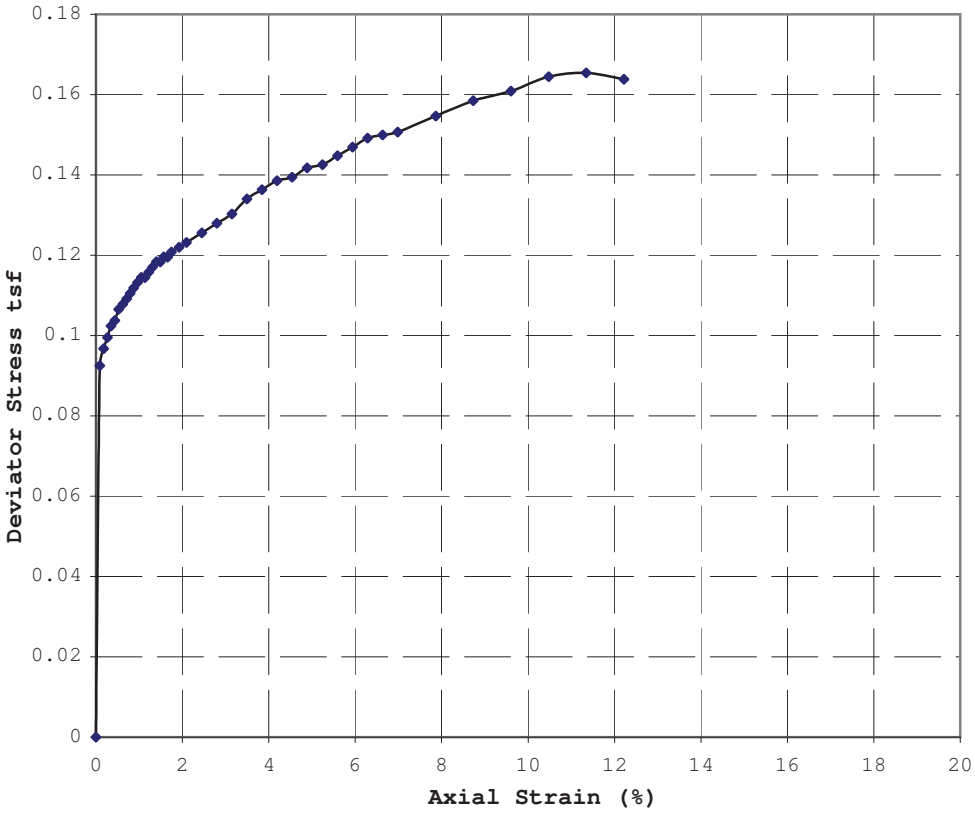
LL: 42
PL: 19.3
PI: 22.7

Sketch of Specimen After Failure



Triaxial U-U Stress/Strain Curves

Project: Hardin County | Job: 8076
Client: Barr Engineering Company | Date: 9/27/11
Remarks: Specimens trimmed to given sizes; Allowed to adjust under applied confining pressures for about 10 minutes.



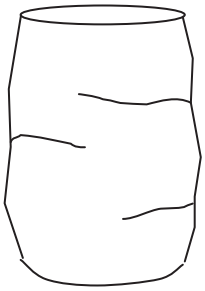
Boring: T-51 Depth: 37-39
Sample #:
Soil Type: Lean Clay (CL)

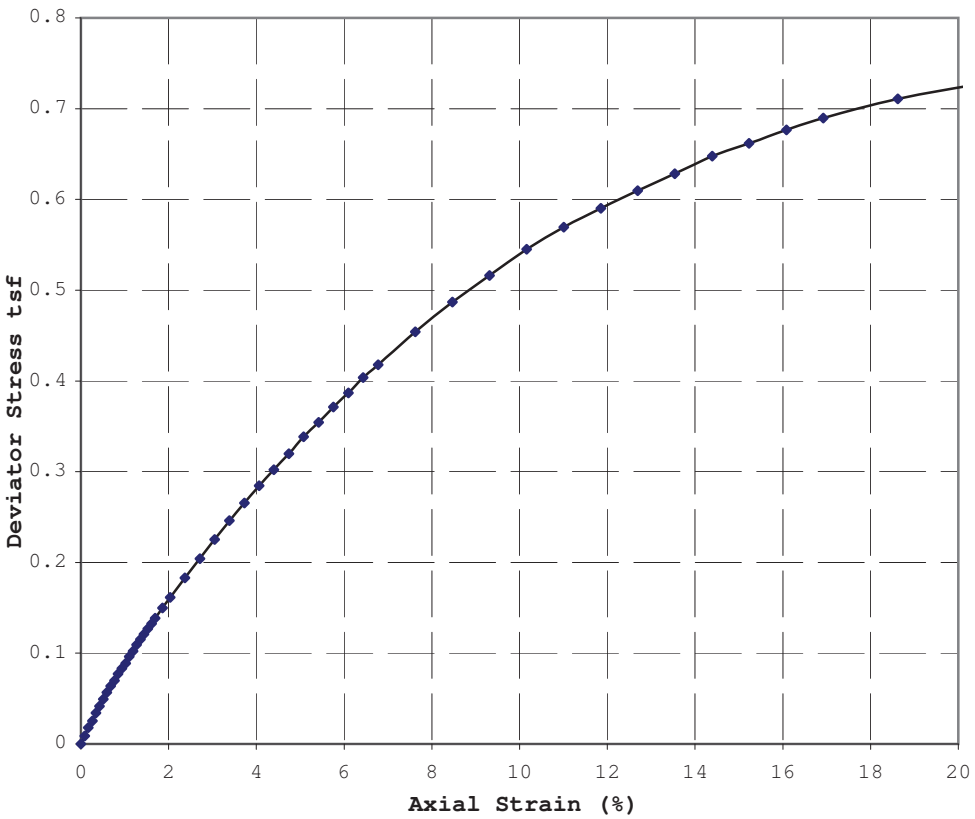
Strain Rate (in/min): 0.050
Sample Type: 3T
Dia. (in) 2.92 Ht. (in) 5.73
Height to Diameter Ratio: 1.96

Max Deviator Stress: 0.17 tsf
Strain at Failure (%): 11.35
Confining Pressure: 2.00 tsf

W.C. (%) 44.1
Yd (pcf): 72.2

Sketch of Specimen After Failure





Boring: T-62 Depth: 22-24
Sample #:
Soil Type: Lean Clay w/sand and a little gravel (CL)

Strain Rate (in/min): 0.050
Sample Type: 3T

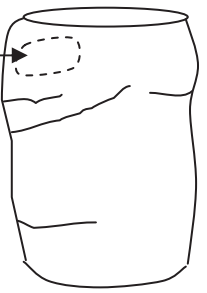
Dia. (in): 2.87 Ht. (in): 5.91
Height to Diameter Ratio: 2.06

Max Deviator Stress: 0.73 tsf
Strain at Failure (%): 20.47
Confining Pressure: 1.25 tsf

W.C. (%): 17.5
Yd (pcf): 113.7

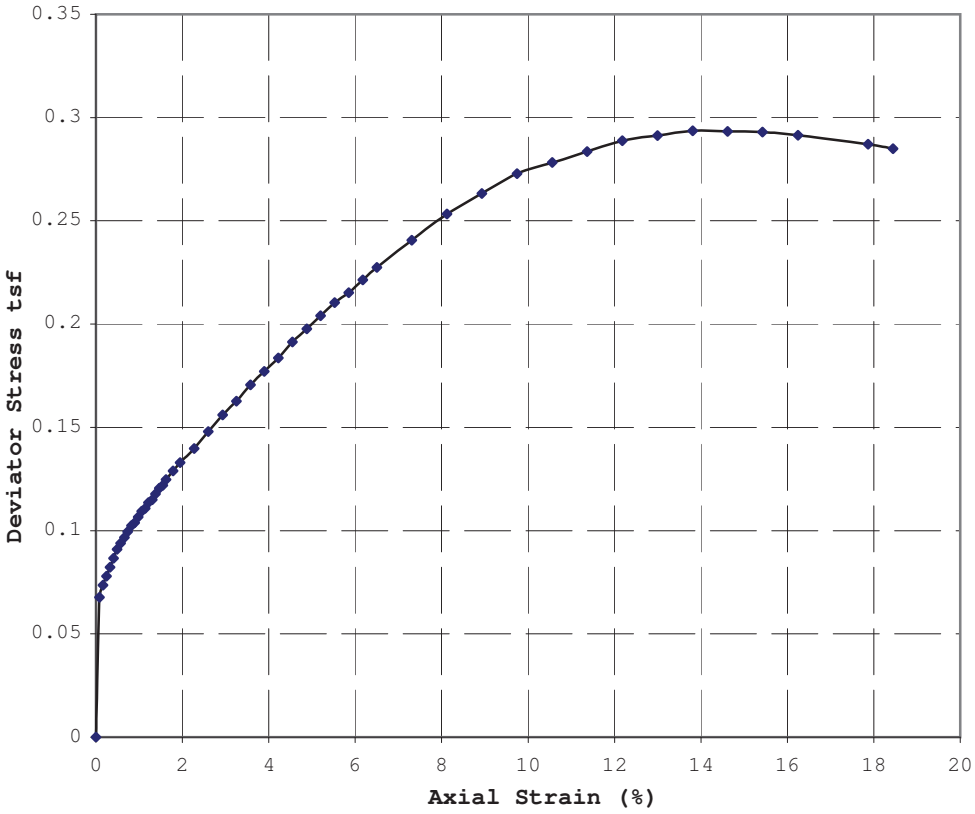
Sketch of Specimen After Failure

1" Piece of gravel



Triaxial U-U Stress/Strain Curves

Project: Hardin County | Job: 8076
Client: Barr Engineering Company | Date: 9/27/11
Remarks: Specimens trimmed to given sizes; Allowed to adjust under applied confining pressures for about 10 minutes.



Boring: T-66 Depth: 12-14
Sample #:
Soil Type: Lean Clay w/a trace of organic material (CL)

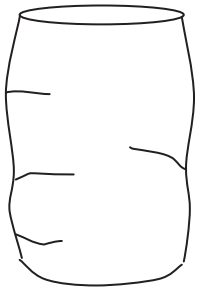
Strain Rate (in/min): 0.050
Sample Type: 3T
Dia. (in) 2.89 Ht. (in) 6.16
Height to Diameter Ratio: 2.13

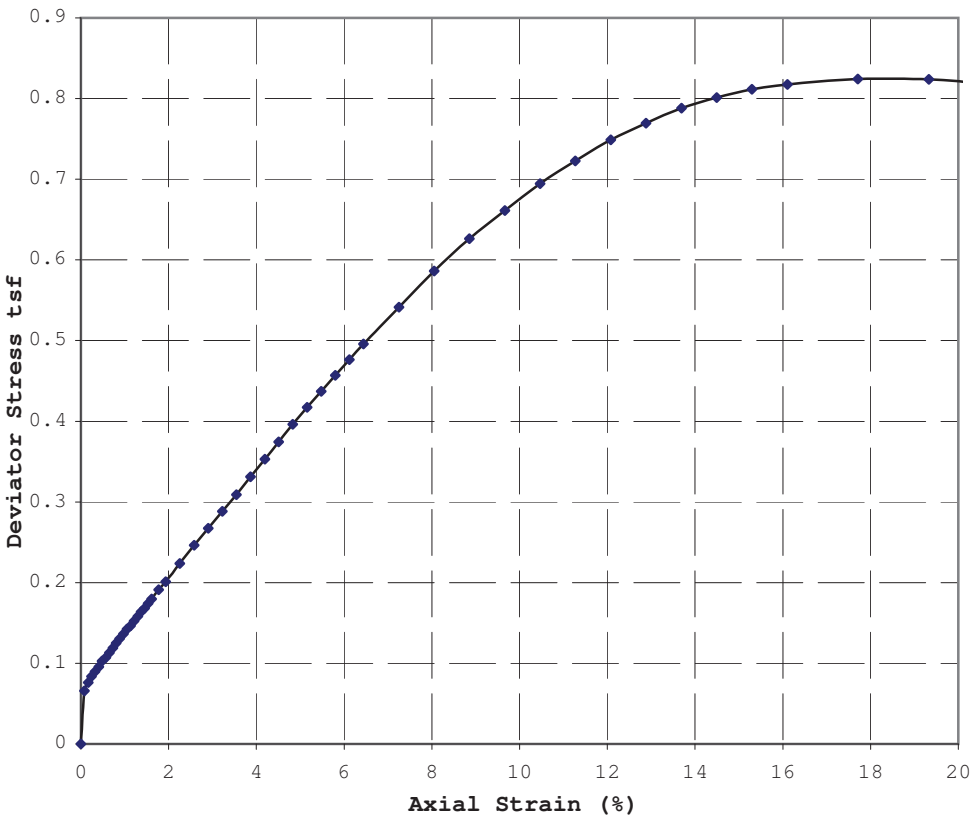
Max Deviator Stress: 0.29 tsf
Strain at Failure (%): 13.81
Confining Pressure: 0.75 tsf

W.C. (%) 36.7
Yd (pcf): 82.2

LL: 38.5
PL: 20.1
PI: 18.4
OC: 2.5%

Sketch of Specimen After Failure





Boring: T-66 Depth: 43-45
Sample #:
Soil Type: Lean Clay (CL)

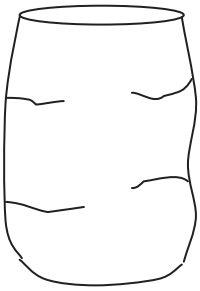
Strain Rate (in/min): 0.050
Sample Type: 3T

Dia. (in): 2.87 Ht. (in): 6.21
Height to Diameter Ratio: 2.16

Max Deviator Stress: 0.82 tsf
Strain at Failure (%): 17.71
Confining Pressure: 2.25 tsf

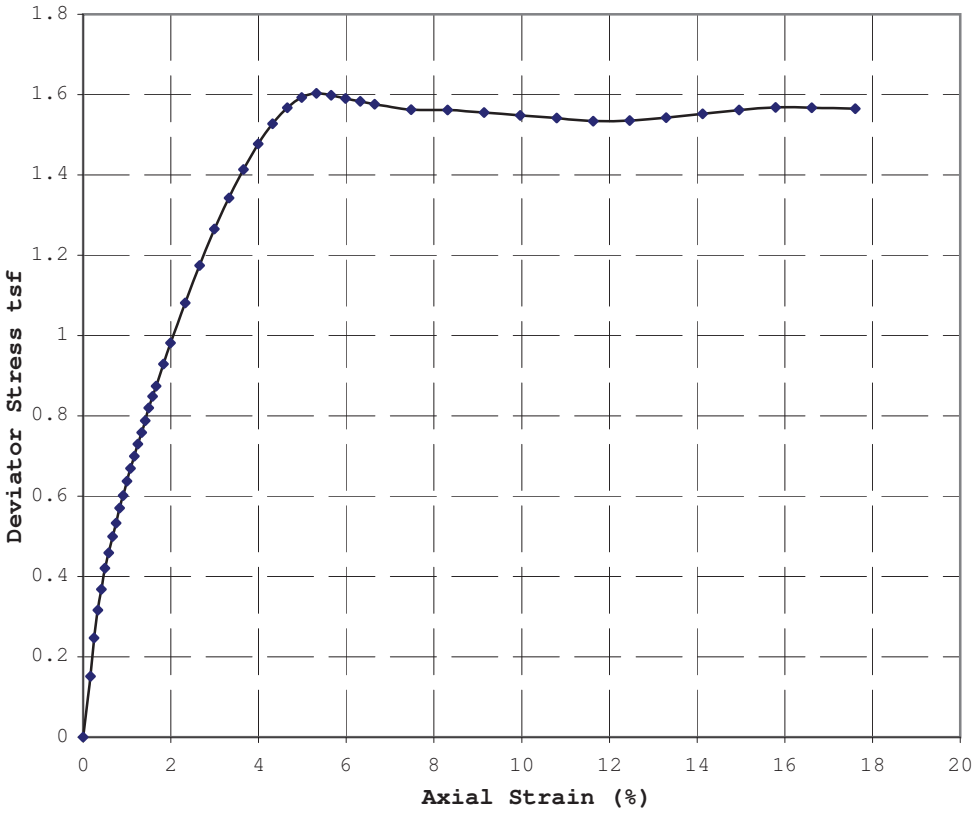
W.C. (%): 23.9
Yd (pcf): 101.6

Sketch of Specimen After Failure



Triaxial U-U Stress/Strain Curves

Project: Hardin County | Job: 8076
Client: Barr Engineering Company | Date: 9/27/11
Remarks: Specimens trimmed to given sizes; Allowed to adjust under applied confining pressures for about 10 minutes.



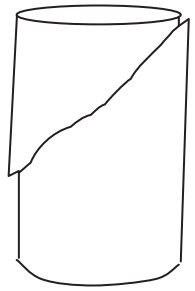
Boring: T-72 | Depth: 12-14
Sample #:
Soil Type: Lean Clay (CL)

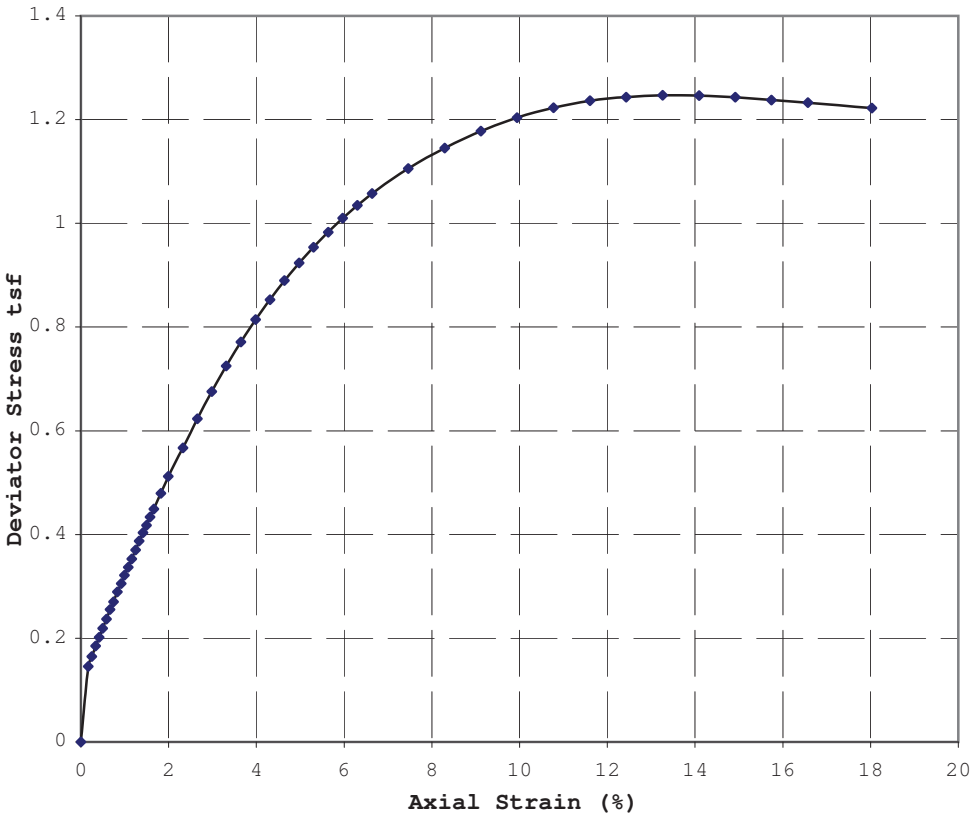
Strain Rate (in/min): 0.050
Sample Type: 3T
Dia. (in) 2.88 | Ht. (in) 6.02
Height to Diameter Ratio: 2.09

Max Deviator Stress: 1.60 tsf
Strain at Failure (%): 5.32
Confining Pressure: 0.75 tsf

W.C. (%) 23.1
Yd (pcf): 103.1

Sketch of Specimen After Failure





Boring: T-82 | Depth: 26-28
Sample #:
Soil Type: Lean Clay w/sand and a trace of gravel (CL)

Strain Rate (in/min): 0.050
Sample Type: 3T

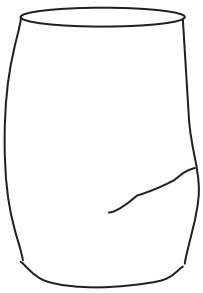
Dia. (in): 2.88 | Ht. (in): 6.03
Height to Diameter Ratio: 2.10

Max Deviator Stress: 1.25 tsf
Strain at Failure (%): 13.26
Confining Pressure: 1.25 tsf

W.C. (%): 13.5
Yd (pcf): 124.0

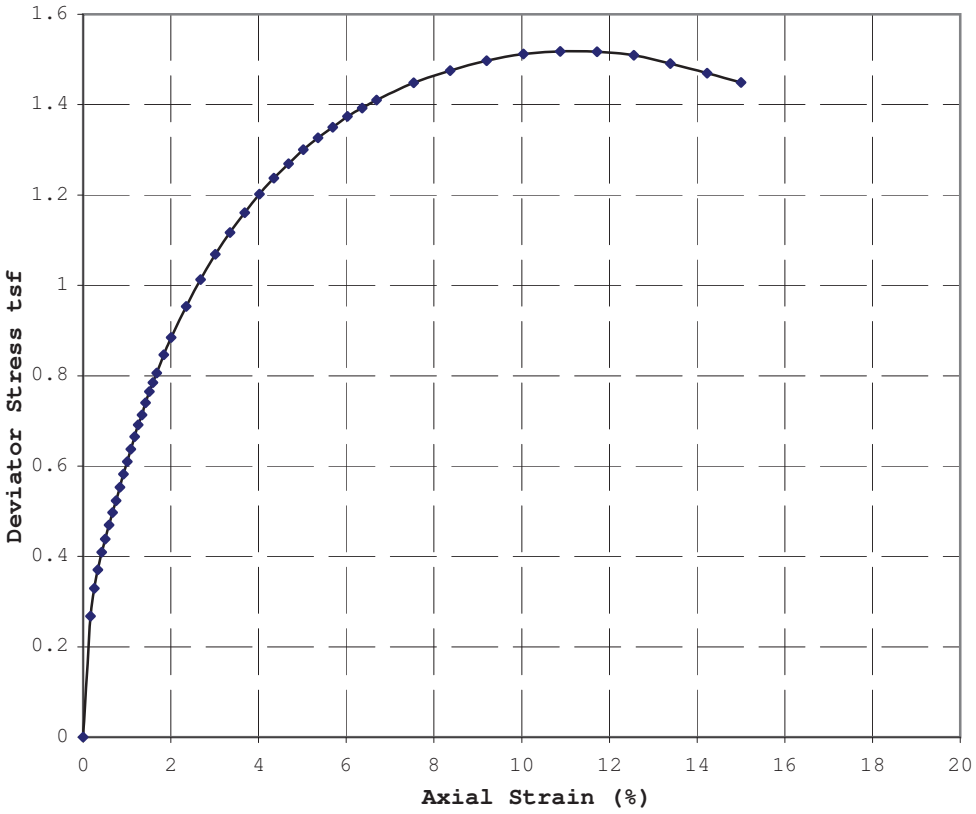
LL: 36.2
PL: 17.8
PI: 18.4

Sketch of Specimen After Failure



Triaxial U-U Stress/Strain Curves

Project: Hardin County — Job: 8076
Client: Barr Engineering Company — Date: 9/27/11
Remarks: Specimens trimmed to given sizes; Allowed to adjust under applied confining pressures for about 10 minutes.



Boring: T-88 — Depth: 17-19
Sample #:

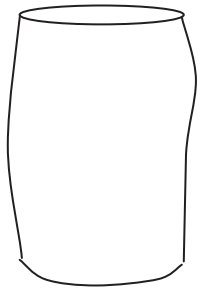
Soil Type: Lean Clay (CL)

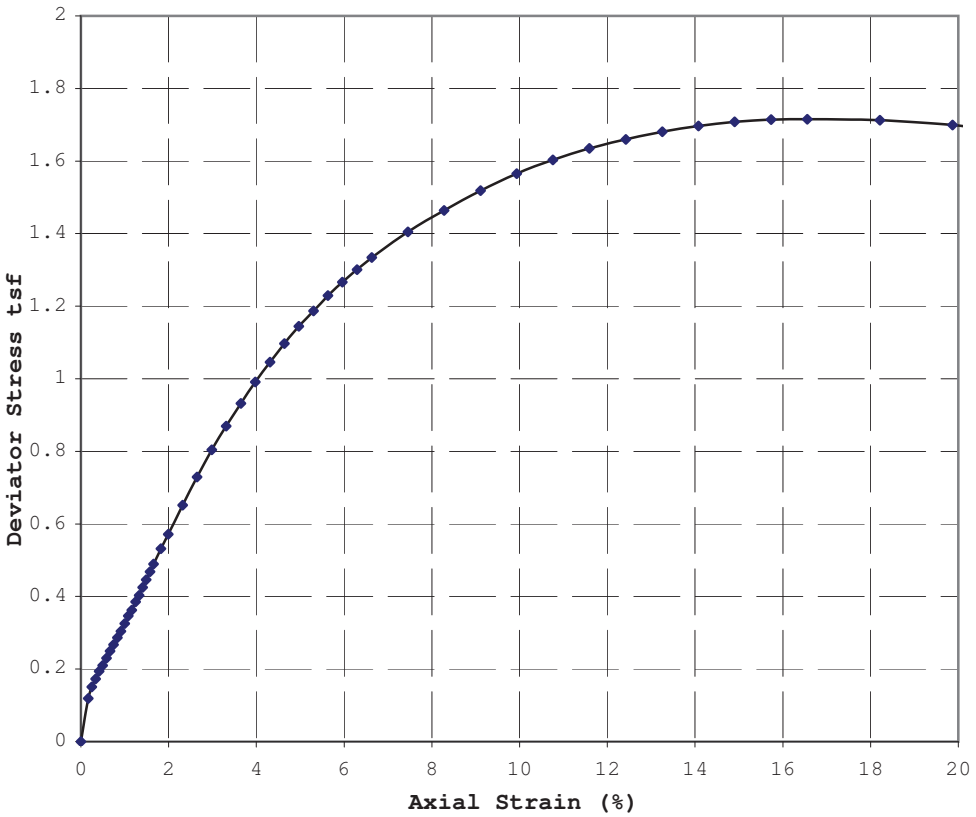
Strain Rate (in/min): 0.050
Sample Type: 3T
Dia. (in) 2.87 — Ht. (in) 5.98
Height to Diameter Ratio: 2.08

Max Deviator Stress: 1.52 tsf
Strain at Failure (%): 10.88
Confining Pressure: 1.00 tsf

W.C. (%) 25.0
Yd (pcf): 100.7

Sketch of Specimen After Failure





Boring: T-88 — Depth: 27-29
Sample #:

Soil Type: Silty Clay w/sand (CL-ML)

Strain Rate (in/min): 0.050
Sample Type: 3T

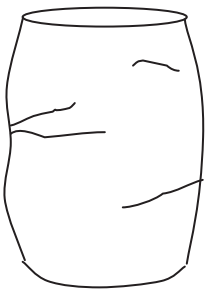
Dia. (in): 2.87 — Ht. (in): 6.04
Height to Diameter Ratio: 2.10

Max Deviator Stress: 1.71 tsf
Strain at Failure (%): 16.56
Confining Pressure: 1.50 tsf

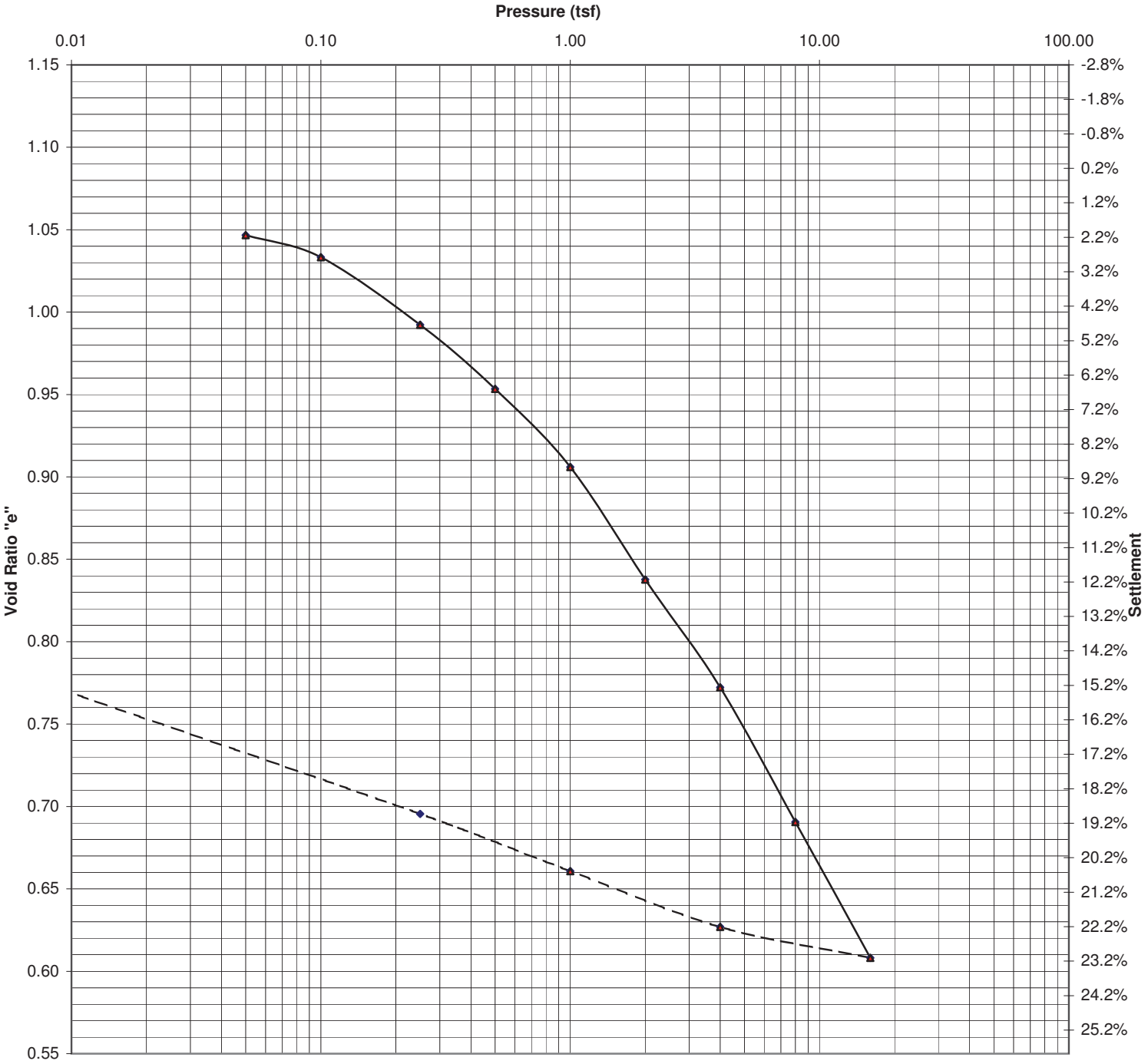
W.C. (%): 18.8
Yd (pcf): 112.2

LL: 18.9
PL: 13.5
PI: 5.4

Sketch of Specimen After Failure



Void Ratio and % Settlement vs. Log of Pressure

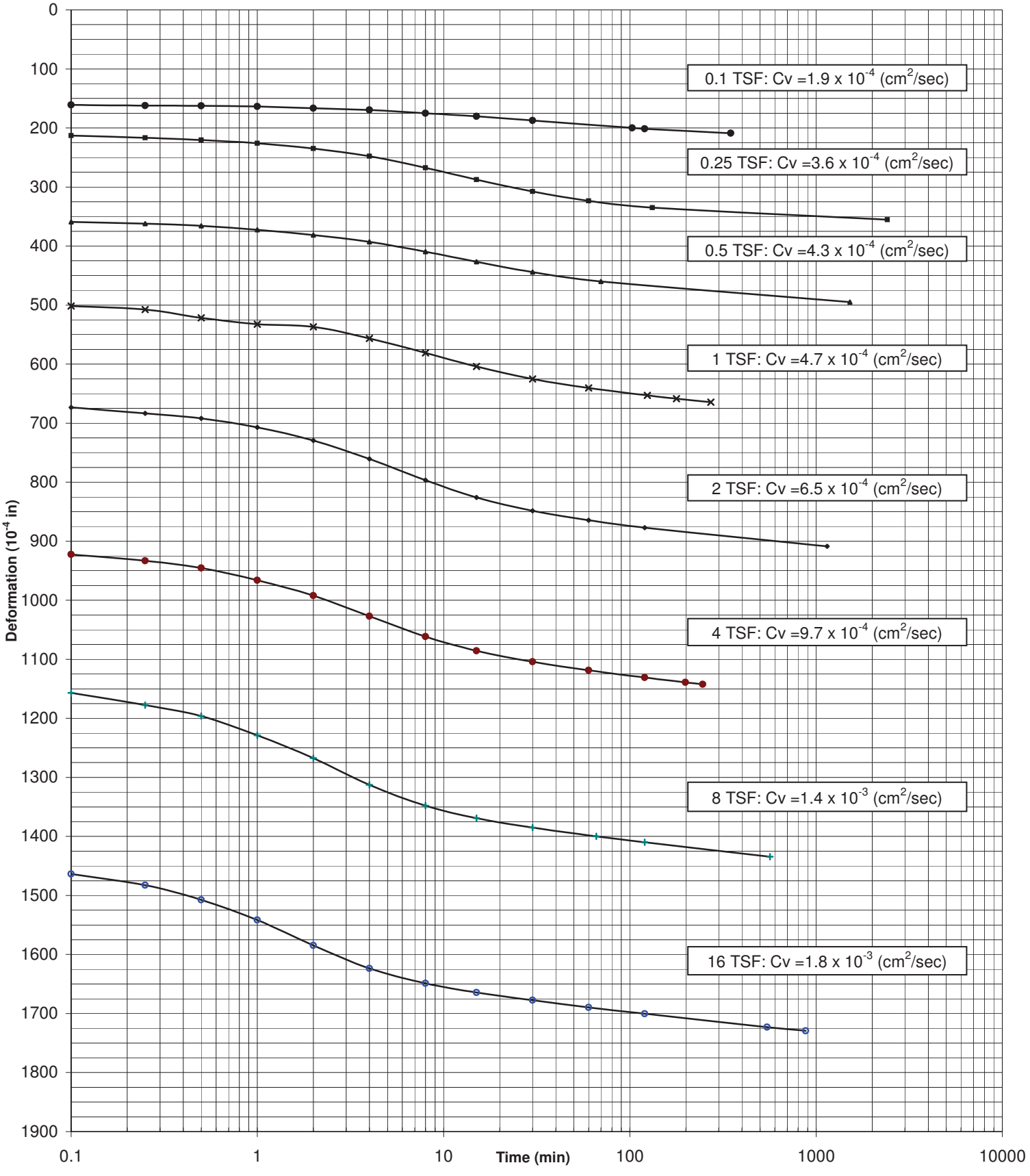


Project: Hardin County			Date: 10/3/11
Sample #:	Boring #: T-49	Depth ft: 12-14 (Mid)	Job #: 8076
Soil Type: Lean Clay (CL)			
Initial W/C (%): 41.4	Dry Density (pcf): 80.0	LL: PL: PI:	Gs: 2.68 (Assumed)
Organic Content (%):	Initial Height (in.): 0.748	Diameter (in.): 2.503	e_o= 1.092
Preconsolidation Pressure (Pc): 0.56 tsf	Compression Index (Cc): 0.27	Recompression Index (Cr): ≅ 0.05	
Remarks:			

2401 W 66th Street

Richfield, Minnesota 55423-2031

Consolidation Log of Time Curves

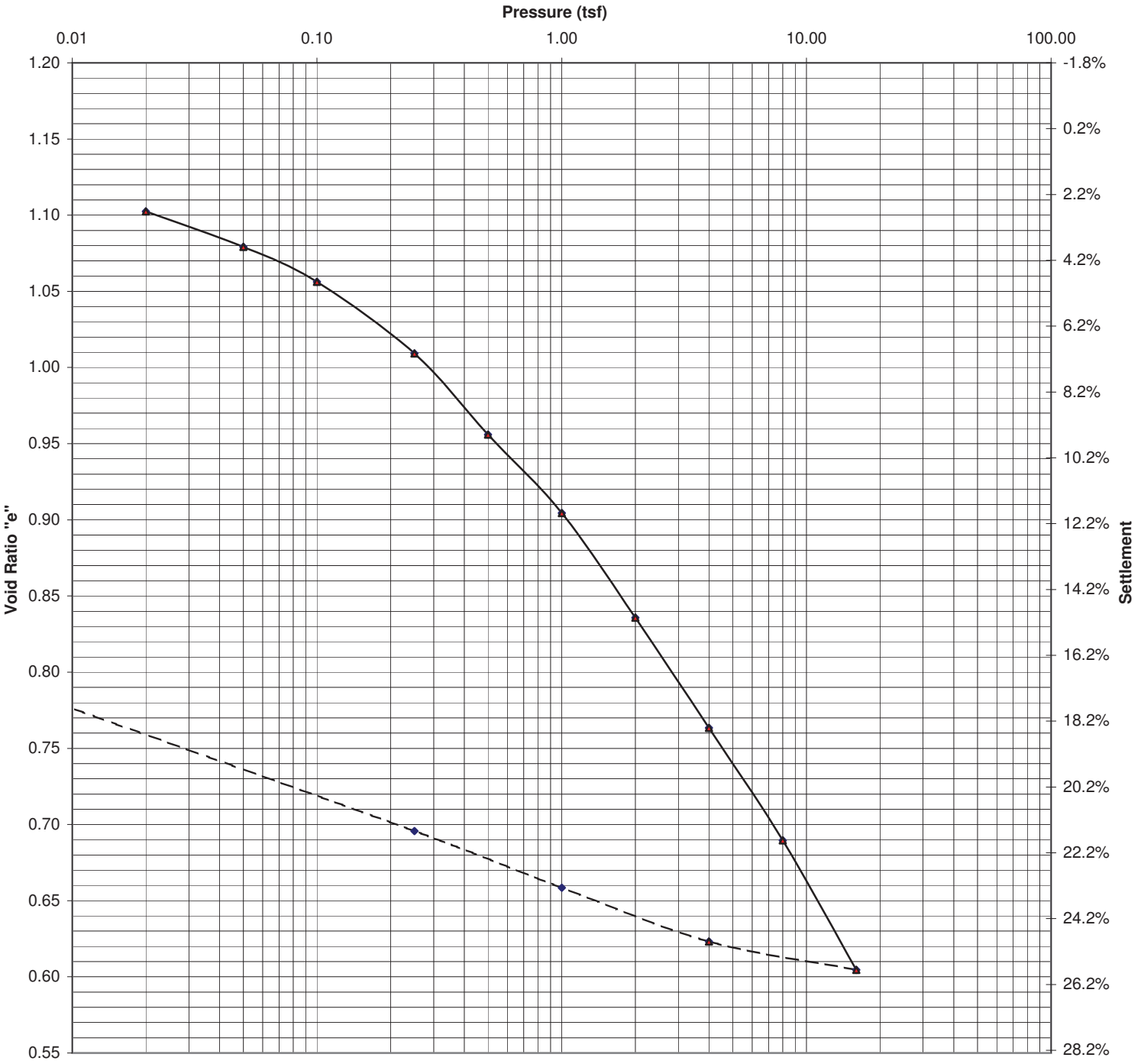


Project: Hardin County			Date: 10/3/11
Sample #:	Boring #: T-49	Depth ft: 12-14 (Mid)	Job #: 8076

2401 W 66th Street

Richfield, Minnesota 55423-2031

Void Ratio and % Settlement vs. Log of Pressure

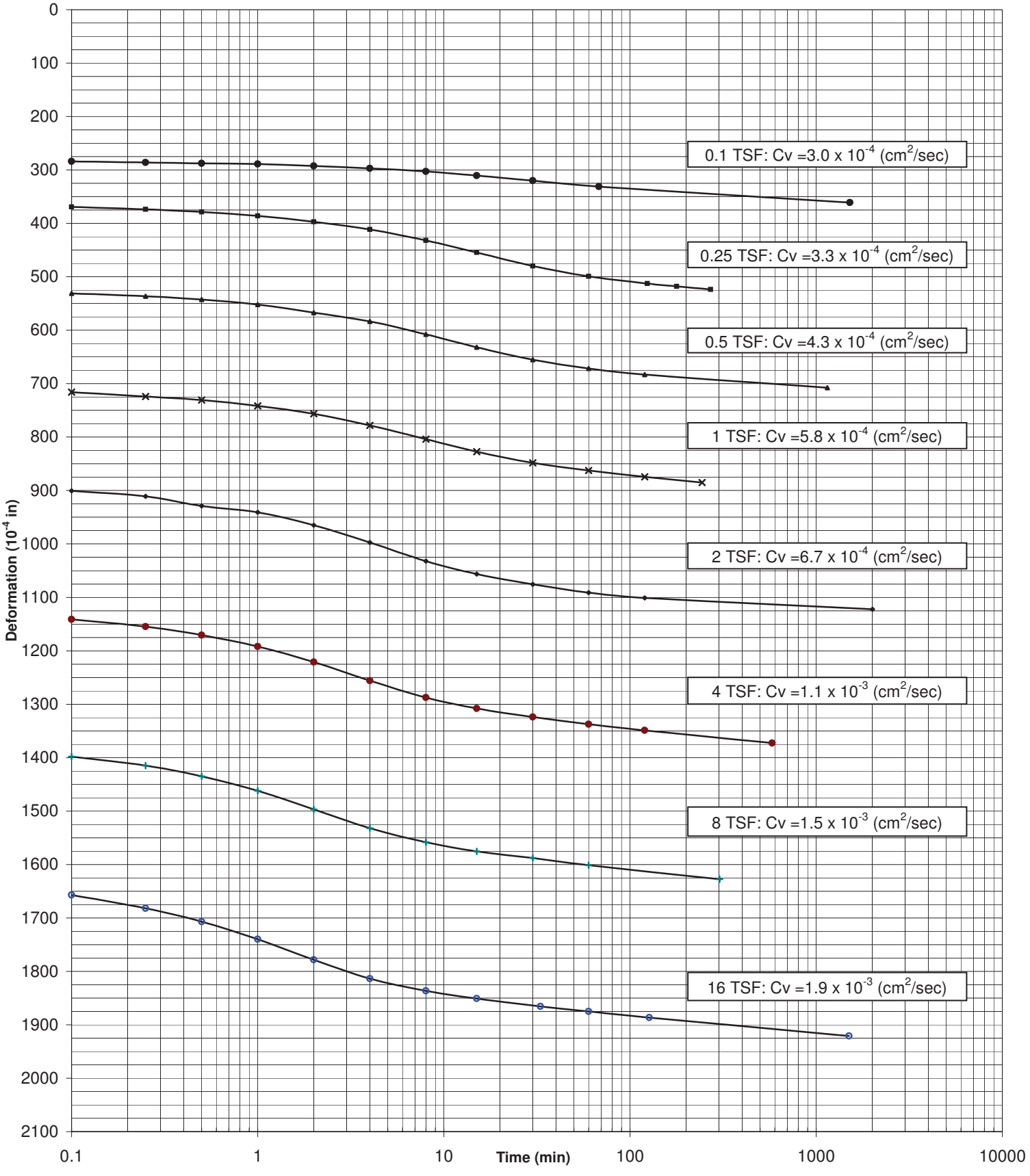


Project: Hardin County				Date: 10/3/11
Sample #:	Boring #: T-51	Depth ft: 20-22		Job #: 8076
Soil Type: Lean Clay (CL)				
Initial W/C (%): 42.0	Dry Density (pcf): 80.0	LL: 42.0	PL: 19.3 PI: 22.7	Gs: 2.77 (Assumed)
Organic Content (%):	Initial Height (in.): 0.746	Diameter (in.): 2.506	e_o= 1.161	
Preconsolidation Pressure (Pc): 0.42 tsf	Compression Index (Cc): 0.26	Recompression Index (Cr): ≅ 0.05		
Remarks:				

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Consolidation Log of Time Curves

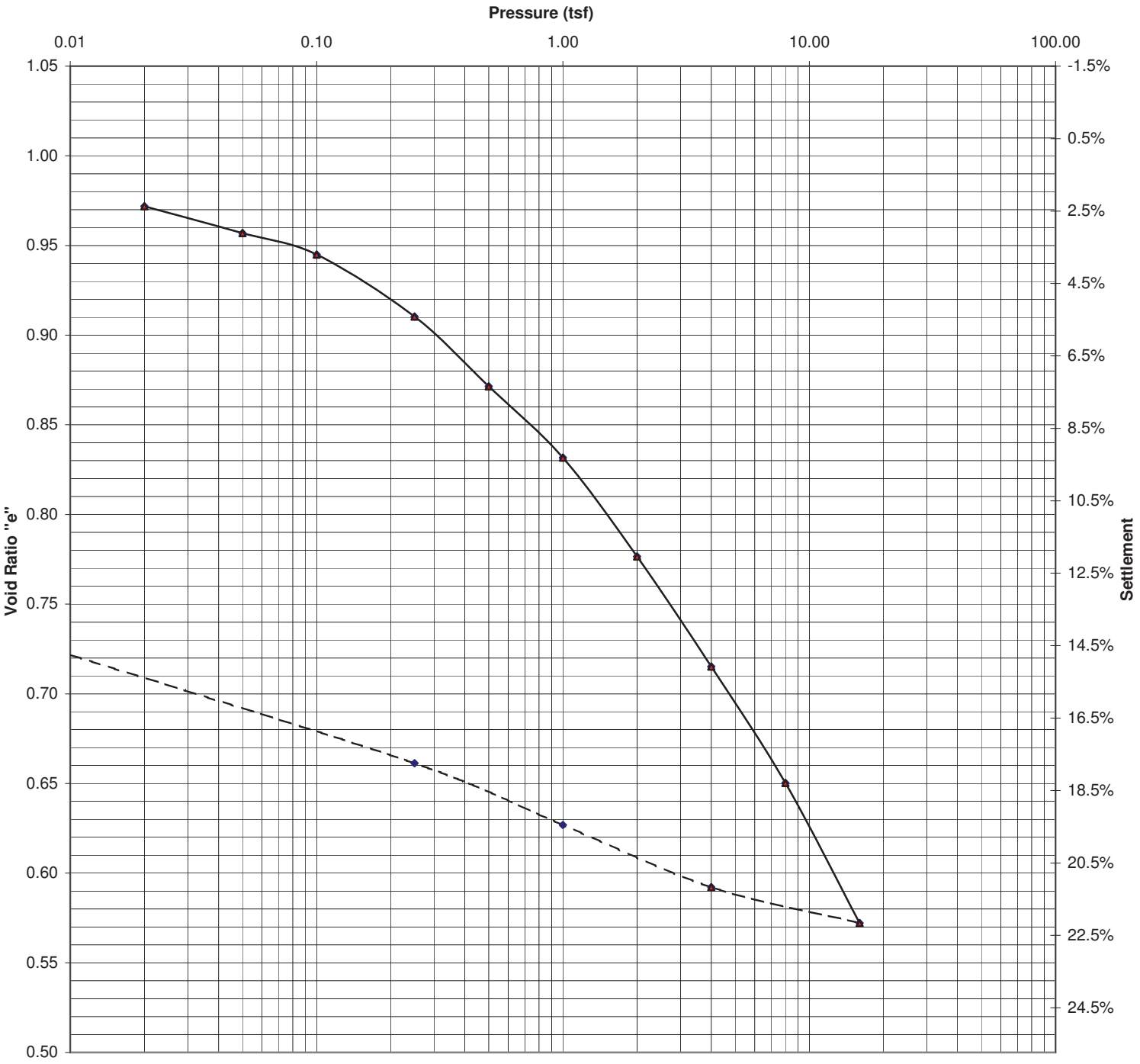


Project: Hardin County			Date: 10/3/11
Sample #:	Boring #: T-51	Depth ft: 20-22	Job #: 8076

2401 W 66th Street

Richfield, Minnesota 55423-2031

Void Ratio and % Settlement vs. Log of Pressure

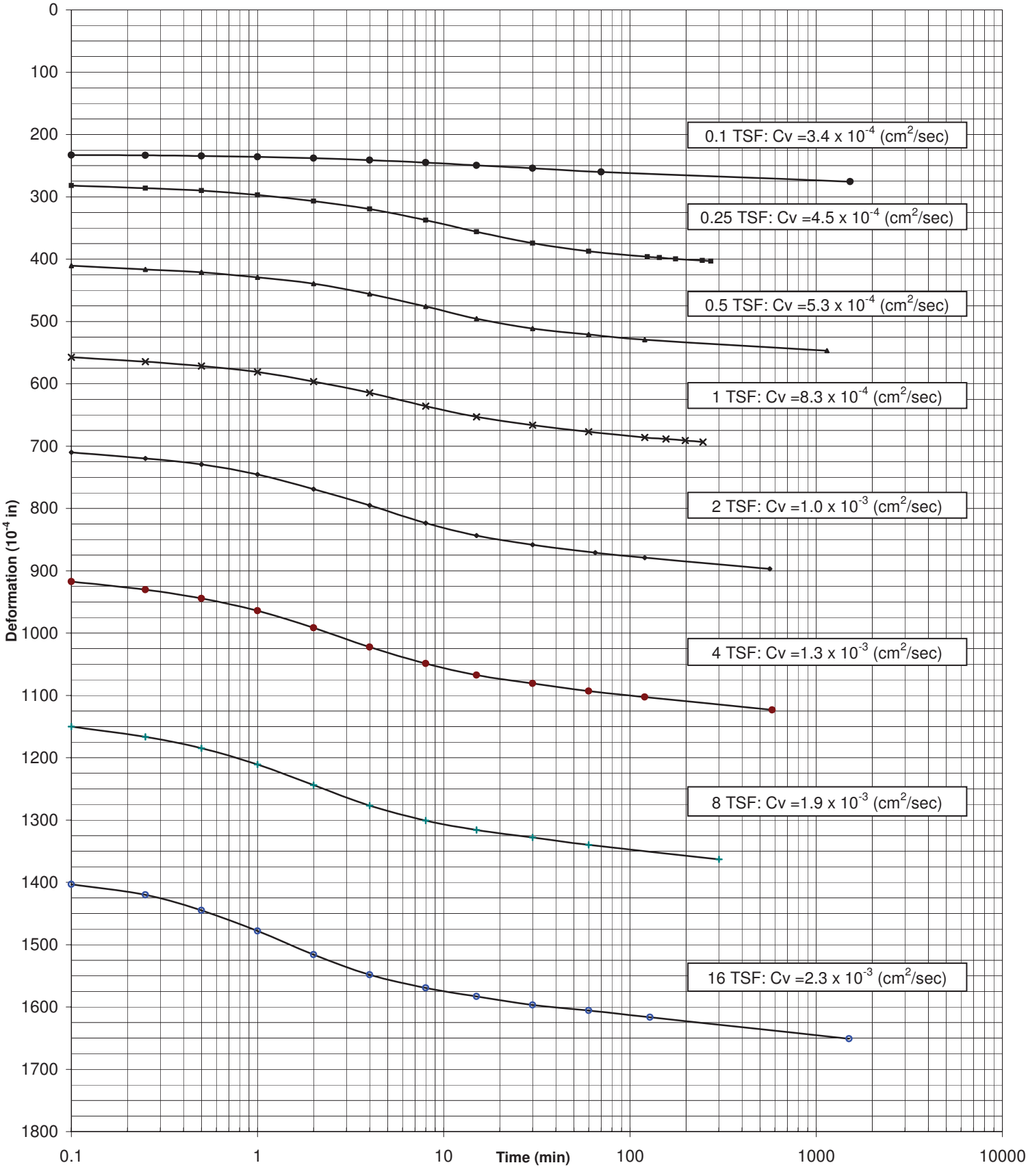


Project:	Hardin County							Date:	10/3/11
Sample #:		Boring #: T-66		Depth ft: 12-14				Job #:	8076
Soil Type:	Lean Clay w/a trace of organic material (CL)								
Initial W/C (%):	37.0	Dry Density (pcf):	85.3	LL:	38.4	PL:	20.1	PI:	18.4
Gs:	2.76	(Assumed)							
Organic Content (%):		Initial Height (in.):	0.745	Diameter (in.):	2.503	e_o=	1.020		
Preconsolidation Pressure (Pc):	0.59 tsf	Compression Index (Cc):	0.24	Recompression Index (Cr):	≅ 0.04				
Remarks:									

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Consolidation Log of Time Curves



Project: Hardin County			Date: 10/3/11
Sample #:	Boring #: T-66	Depth ft: 12-14	Job #: 8076

2401 W 66th Street

Richfield, Minnesota 55423-2031

Appendix F

Electrical Resistivity Testing Report

Barr Engineering Company
4700 West 77th Street • Minneapolis, MN 55435-4803
Phone: 952-832-2600 • Fax: 952-832-2601 • www.barr.com *An EEO Employer*

Minneapolis, MN • Hibbing, MN • Duluth, MN • Ann Arbor, MI • Jefferson City, MO • Bismarck, ND

November 10, 2011

Mr. Joseph Brisebois
Invenergy LLC.
One S. Wacker Drive,
Suite 1900
Chicago, IL 60606

Re: Soil Electrical Resistivity Testing
Hardin County Wind Project
Hardin County, Ohio

Dear Mr. Brisebois,

Barr Engineering Company (Barr) collected soil resistivity measurements at the Hardin County Wind Project site from August 2 to August 10, 2011. This letter presents the methods and results.

Methods

A total of 5 electrical resistivity tests were completed by Barr personnel. Tests were conducted at the proposed substation and at twelve (12) turbine locations. The specific locations of the tests were selected by Barr to provide information at the proposed substation and for spatial coverage across the project site.

Invenergy, LLC. (Invenergy) provided GPS coordinates of the investigation locations. The test sites were located based on the provided coordinates with a hand-held GPS unit. The test locations are indicated in Figure 1, which includes the most recent site layout provided by Invenergy. Coordinates of each test location and other pertinent information can be found in Table 1.

Table 1: Testing Conditions and Coordinates

Resistivity Testing Conditions			Coordinates [UTM, NAD83]	
Location ID	Sounding Number	Ambient Air Temperature (°F)	Easting	Northing
T-02	1	80	260246	4509134
T-14	10	74	262825	4508706
T-35	11	74	260246	4506091
T-39	8	85	263844	4507759
T-49	7	85	263661	4504602
T-62	6	90	264596	4502930
T-66	4	90	262764	4501392
T-72	3	80	262202	4500169
T-82	13	73	266102	4506509
T-88	12	74	266792	4508520
T-99	5	75	265425	4496681
T-117	9	75	270579	4508384
SS-2	2	80	263787	4501741

Barr conducted the work in accordance with ASTM method G57-06 "Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method" (equivalent to IEEE Std. 81).

A single resistivity array orientation was utilized and five resistivity measurements in the array orientation were obtained. Each measurement corresponded to one of five electrode ("a") spacings: 2, 5, 10, 20, and 40 feet.

The equipment used to collect the data consisted of a resistivity meter, four metal electrodes and connecting wire. A Mini-Res Ultra resistivity meter manufactured by L & R Instruments, Inc. was used to collect the data. The resistivity meter read in resistance (Ω) directly, and did not require the conversion of electrical potential (V) and inductance (I) to calculate resistance (V/I in Ω). Before and after each array was completed, the resistivity meter was connected to a resistor of known resistance, and the resulting values were compared to the known resistance value for quality assurance and quality control purposes. The meter was properly calibrated for all test locations and no instrument adjustments had to be made.

Co-linear arrays of four electrodes were placed in the ground for each measurement. Electrical current was input to the ground through the two outer electrodes of the array. The voltage drop produced by the resulting electrical field was measured across the two inner electrodes. The "a" spacing was increased with each measurement, expanding the array about a common center. Increasing the electrode separation increases the depth of investigation, and indicates vertical variation in resistivity.

In order to check the accuracy of the single resistivity array, a perpendicular array was set up at each test location for all electrode spacings.

Apparent resistivity (ρ_a) was calculated for each measurement and corresponding electrode spacing (a) using the resistance measurement (Ω) and the geometric factor (K) as follows:

$$\rho_a = K(V/I) \qquad \text{where } K = 2\pi a$$

All field results and calculated values are presented in the attachments.

Results and Discussion

Apparent resistivity measurements for all 13 locations at the site ranged from 1,075 to 13,608 ohm centimeters (Ωcm). The average apparent resistivity for the entire data set is 3,009 Ωcm.

Soil resistivity variations are likely associated with differences in soil type, layer thicknesses and degree of water saturation in the near surface soils. Higher moisture contents and higher clay contents generally reduce the electrical resistivity of a soil.

The resistivity measured across the site was generally between 1,400 and 5,000 Ωcm at all of the a-spacings. A noted anomaly was observed at turbine sites 2, 14, and 35 where the apparent resistivity at the 40-foot a-spacings ranged from 4,700 to 13,200 Ωcm. These test results likely reflect the shallow bedrock encountered at these sites.

Table 2: Apparent Resistivity versus Electrode Spacing

Electrode Spacing	Apparent Resistivity, Ω–cm		
(Feet)	Range	Mean	Standard Deviation
2	5819.6 - 1075.4	2668.40	1216.49
5	3961.5 - 1366.8	2227.38	783.17
10	4388.7 - 1310.3	2443.14	1025.37
20	7570.5 - 1402.2	3145.73	1573.78
40	13608.5 - 1823.7	4562.39	2907.39

Thank you for the opportunity to provide this service. Please call me at 952-832-2797 with questions or requests for additional information.

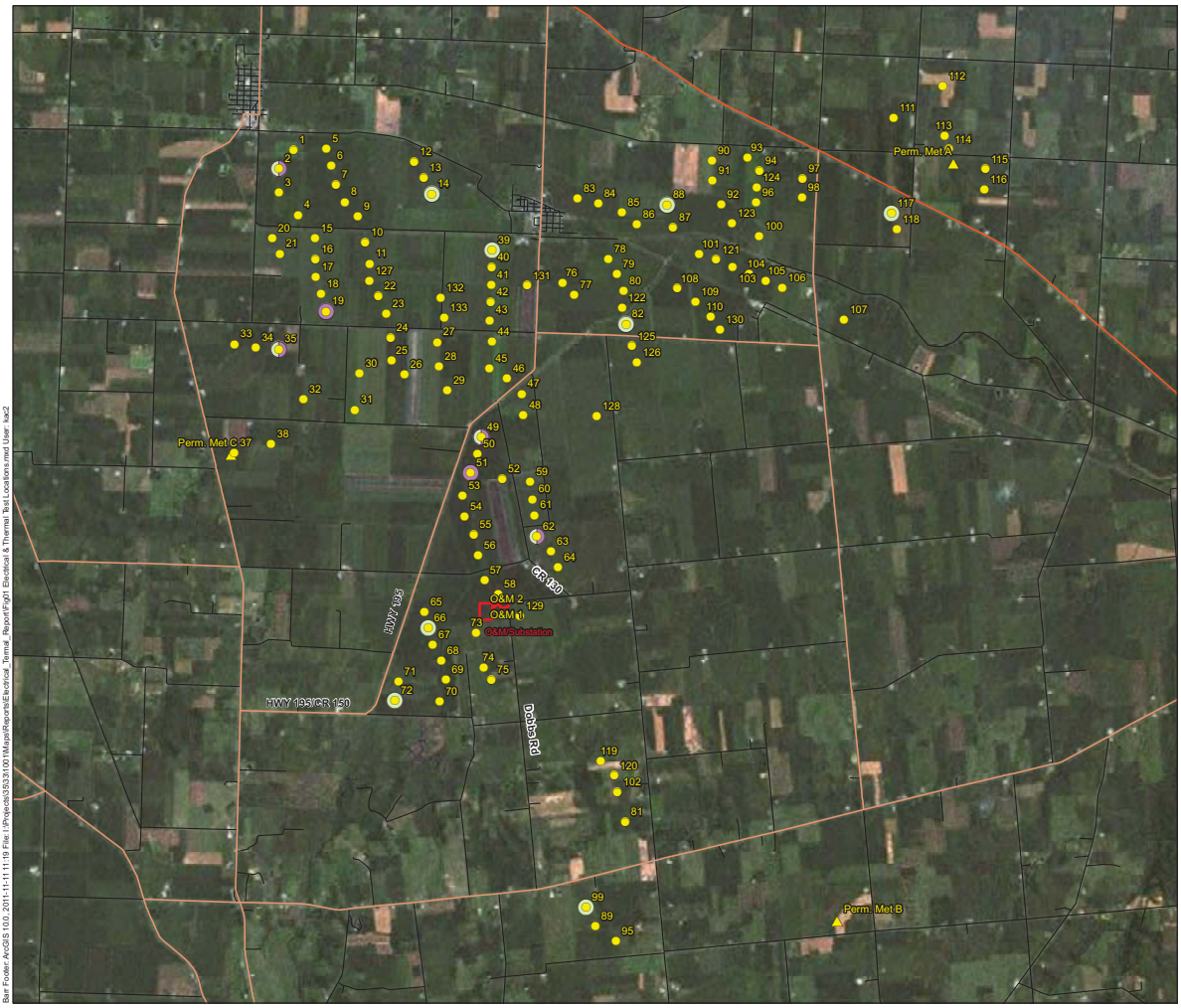
Sincerely,



Bill Kussmann

WWK
Attachment

Attachments:
Figure 1: Thermal and Electrical Resistivity Test locations
Electrical Resistivity Test Results



Turbine Location
(7/7/2011 Coordinates)

Met Tower Location

Electrical Location

Thermal Location

Electrical & Thermal Location

Switchyard Boundary (Approximate)

Kilometers
1 0 1 2

Miles
1 0 1

Figure 1

ELECTRICAL AND THERMAL TEST LOCATIONS
Hardin County Wind Project
Inenvergy
Hardin County, Ohio

Barr Foster ArcGIS 10.0, 2011-11-11 11:19 File: I:\Projects\335\33100\1\Maps\Reports\Electrical_Termal_Report\Fig01 Electrical & Thermal Test Locations.mxd User: kw2

WENNER SOUNDING

PROJECT: **Hardin County Wind Project**

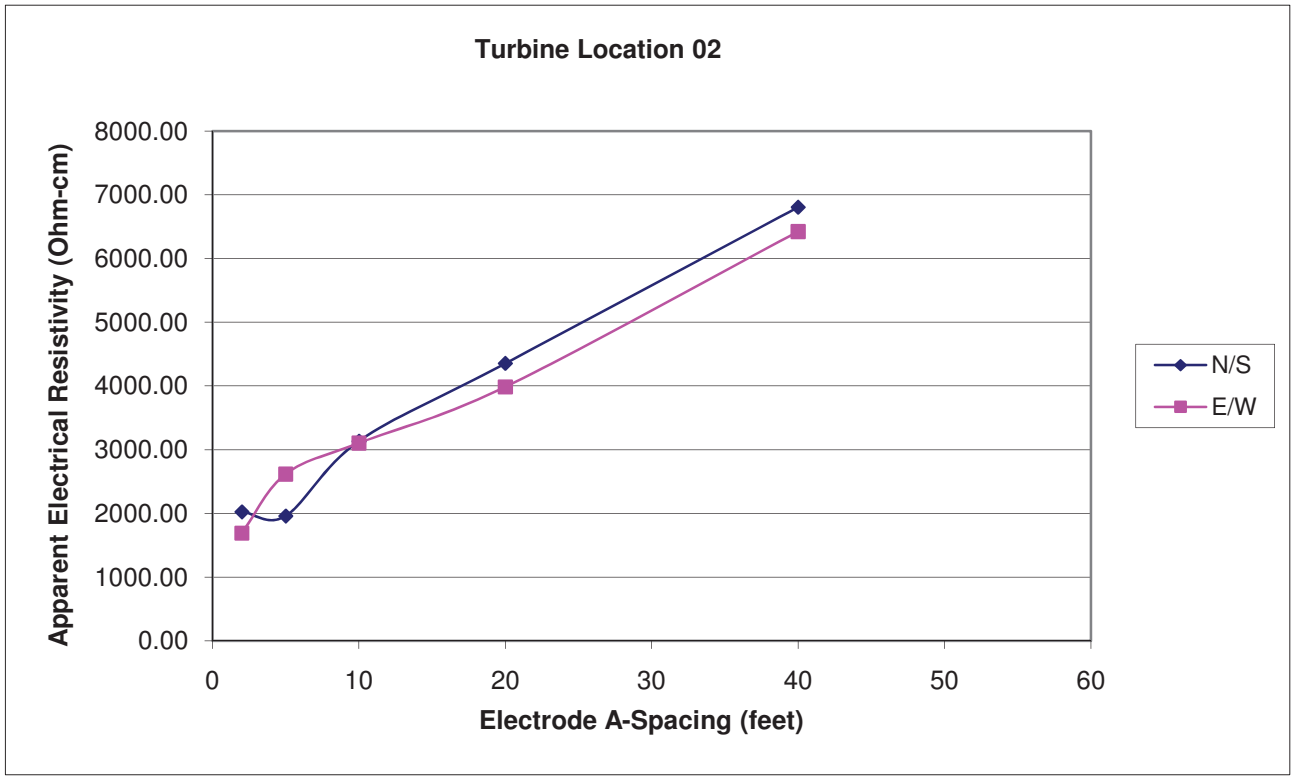
Sounding Number **1** **Date** **8/2/2011**

Observer **WWK**

Location **Turbine 02**

Electrode Spacing "a" feet	Resistance V/I Ohms	Geometric Factor $K=2\pi a$ feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-cm
N/S Orientation				
2	5.29	12.566	66.43	2025.18
5	2.05	31.416	64.25	1958.71
10	1.64	62.832	102.73	3132.02
20	1.14	125.664	142.75	4352.27
40	0.89	251.328	223.18	6804.25
E/W Orientation				
2	4.41	12.566	55.44	1690.33
5	2.73	31.416	85.80	2615.77
10	1.62	62.832	101.79	3103.29
20	1.04	125.664	130.69	3984.47
40	0.84	251.328	210.61	6421.12

Cultural Features	Flat
Ground Cover	Weeds/Dirt
Ambient Air Temp. (°F)	80
Line Bearing	NS/EW



WENNER SOUNDING

PROJECT: **Hardin County Wind Project**

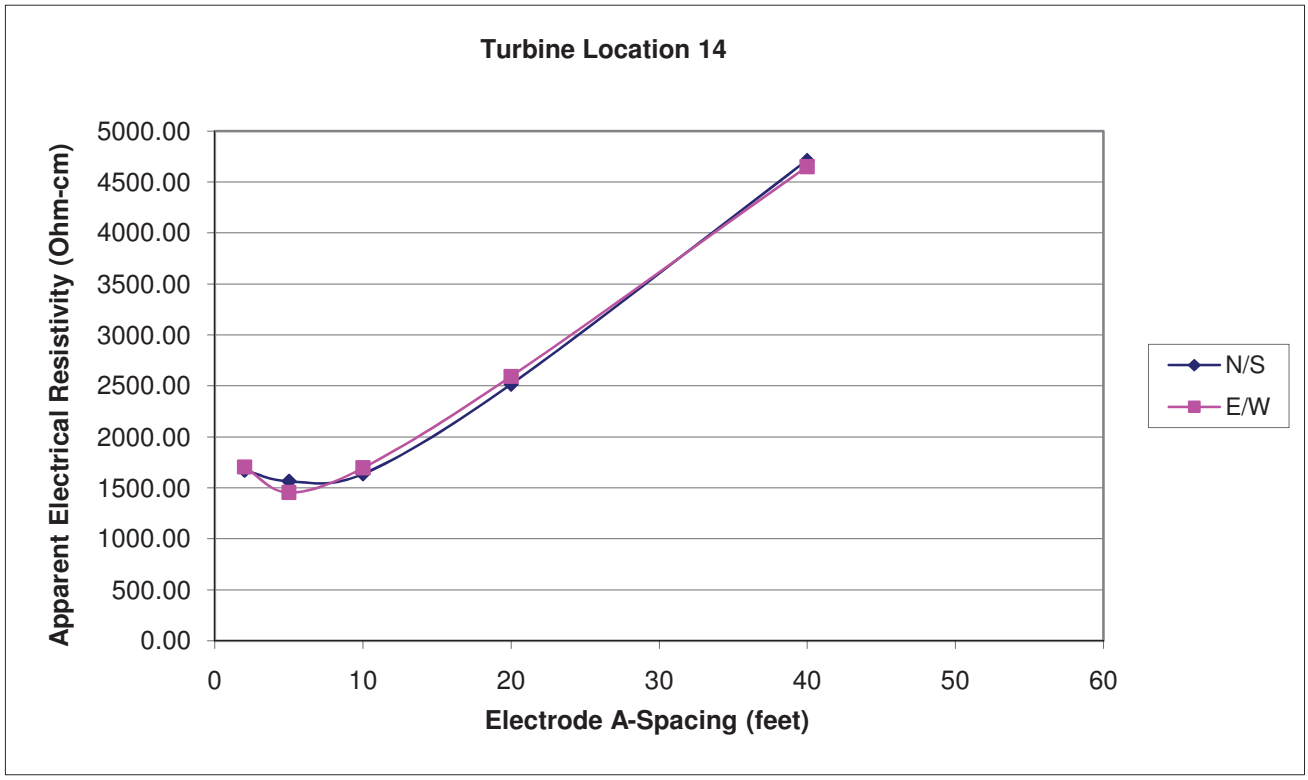
Sounding Number **10** **Date** **8/10/2011**

Observer **WWK**

Location **Turbine 14**

Electrode Spacing "a" feet	Resistance V/I Ohms	Geometric Factor $K=2\pi a$ feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-cm
N/S Orientation				
2	4.37	12.566	54.93	1674.63
5	1.64	31.416	51.37	1566.01
10	0.86	62.832	53.72	1637.85
20	0.66	125.664	82.56	2517.11
40	0.62	251.328	154.57	4712.40
E/W Orientation				
2	4.45	12.566	55.96	1706.04
5	1.52	31.416	47.75	1455.86
10	0.89	62.832	55.67	1697.23
20	0.68	125.664	85.07	2593.74
40	0.61	251.328	152.56	4651.10

Cultural Features	Flat
Ground Cover	Open Field
Ambient Air Temp. (°F)	74
Line Bearing	NS/EW



WENNER SOUNDING

PROJECT: **Hardin County Wind Project**

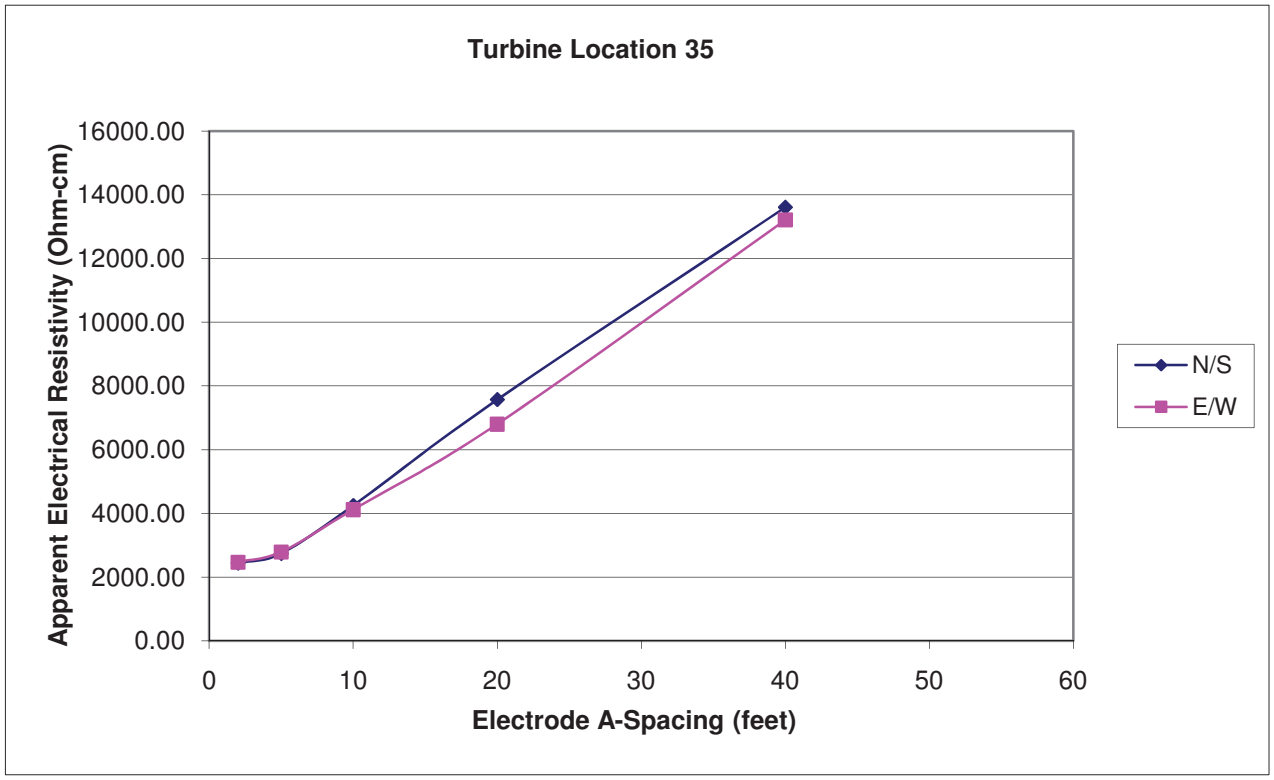
Sounding Number **11** **Date** **8/10/2011**

Observer **WWK**

Location **Turbine 35**

Electrode Spacing "a" feet	Resistance V/I Ohms	Geometric Factor $K=2\pi a$ feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-cm
N/S Orientation				
2	6.38	12.566	80.14	2443.17
5	2.87	31.416	90.07	2746.03
10	2.22	62.832	139.30	4246.91
20	1.98	125.664	248.31	7570.49
40	1.78	251.328	446.36	13608.49
E/W Orientation				
2	6.44	12.566	80.90	2466.54
5	2.91	31.416	91.45	2788.17
10	2.15	62.832	135.03	4116.65
20	1.78	125.664	223.05	6800.41
40	1.72	251.328	433.29	13210.04

Cultural Features	Flat
Ground Cover	Corn
Ambient Air Temp. (°F)	74
Line Bearing	NS/EW



WENNER SOUNDING

PROJECT: **Hardin County Wind Project**

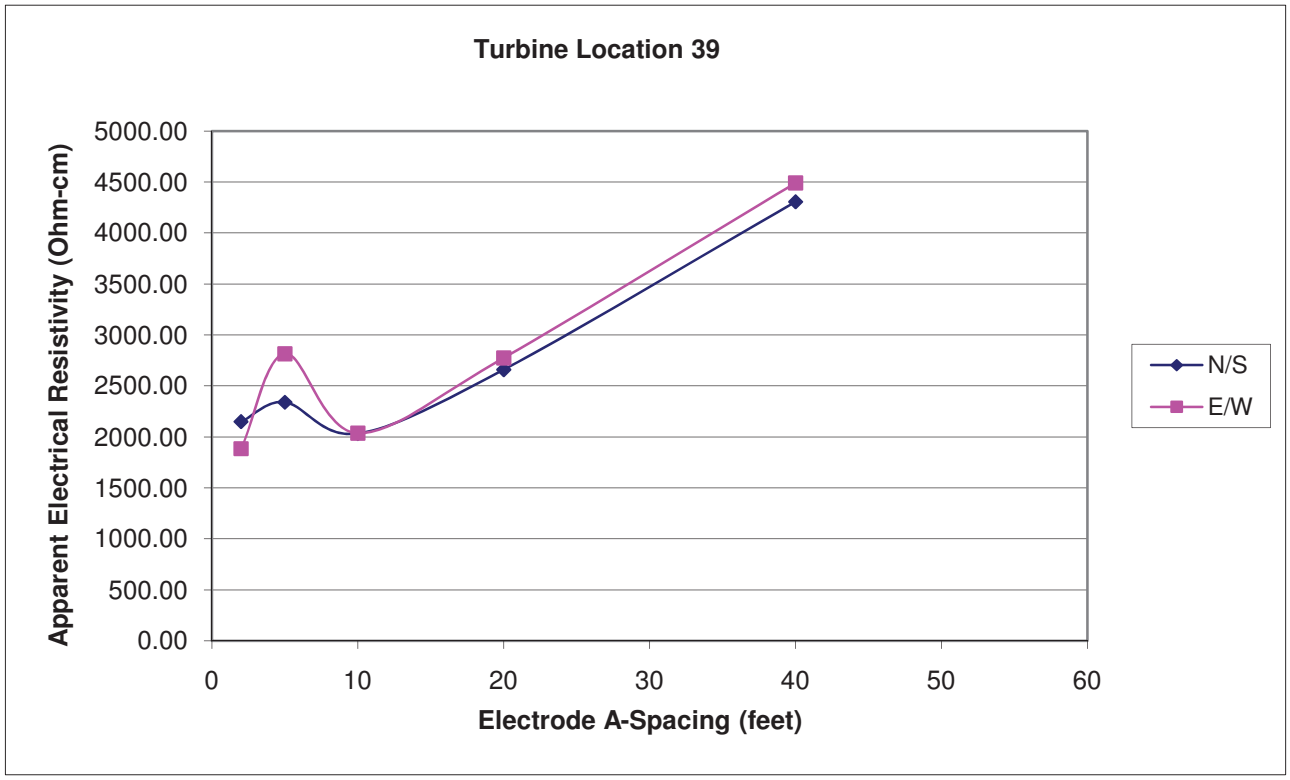
Sounding Number **8** **Date** **8/5/2011**

Observer **WWK**

Location **Turbine 39**

Electrode Spacing "a" feet	Resistance V/I Ohms	Geometric Factor $K=2\pi a$ feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-cm
N/S Orientation				
2	5.61	12.566	70.51	2149.70
5	2.44	31.416	76.72	2338.96
10	1.06	62.832	66.66	2032.46
20	0.69	125.664	87.21	2658.87
40	0.56	251.328	141.25	4306.29
E/W Orientation				
2	4.92	12.566	61.81	1884.58
5	2.94	31.416	92.33	2814.99
10	1.06	62.832	66.79	2036.29
20	0.72	125.664	90.98	2773.80
40	0.59	251.328	147.28	4490.19

Cultural Features	Flat
Ground Cover	Corn
Ambient Air Temp. (°F)	85
Line Bearing	NS/EW



WENNER SOUNDING

PROJECT: **Hardin County Wind Project**

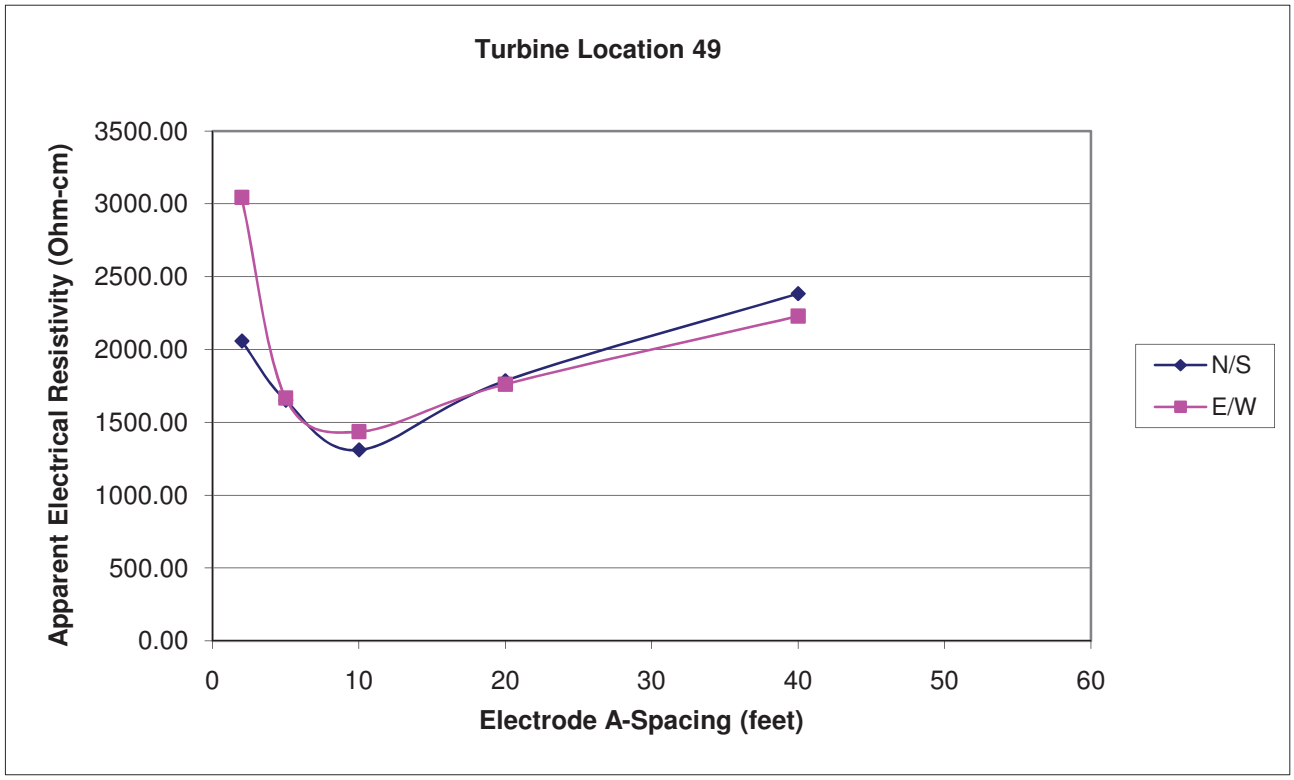
Sounding Number **7** **Date** **8/4/2011**

Observer **WWK**

Location **Turbine 49**

Electrode Spacing "a" feet	Resistance V/I Ohms	Geometric Factor $K=2\pi a$ feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-cm
N/S Orientation				
2	5.37	12.566	67.51	2058.13
5	1.72	31.416	54.16	1651.26
10	0.68	62.832	42.98	1310.28
20	0.47	125.664	58.56	1785.35
40	0.31	251.328	78.16	2383.02
E/W Orientation				
2	7.95	12.566	99.88	3045.05
5	1.74	31.416	54.70	1667.54
10	0.75	62.832	47.12	1436.71
20	0.46	125.664	57.81	1762.36
40	0.29	251.328	73.14	2229.77

Cultural Features	Flat
Ground Cover	Carrots
Ambient Air Temp. (°F)	85
Line Bearing	NS/EW



WENNER SOUNDING

PROJECT: **Hardin County Wind Project**

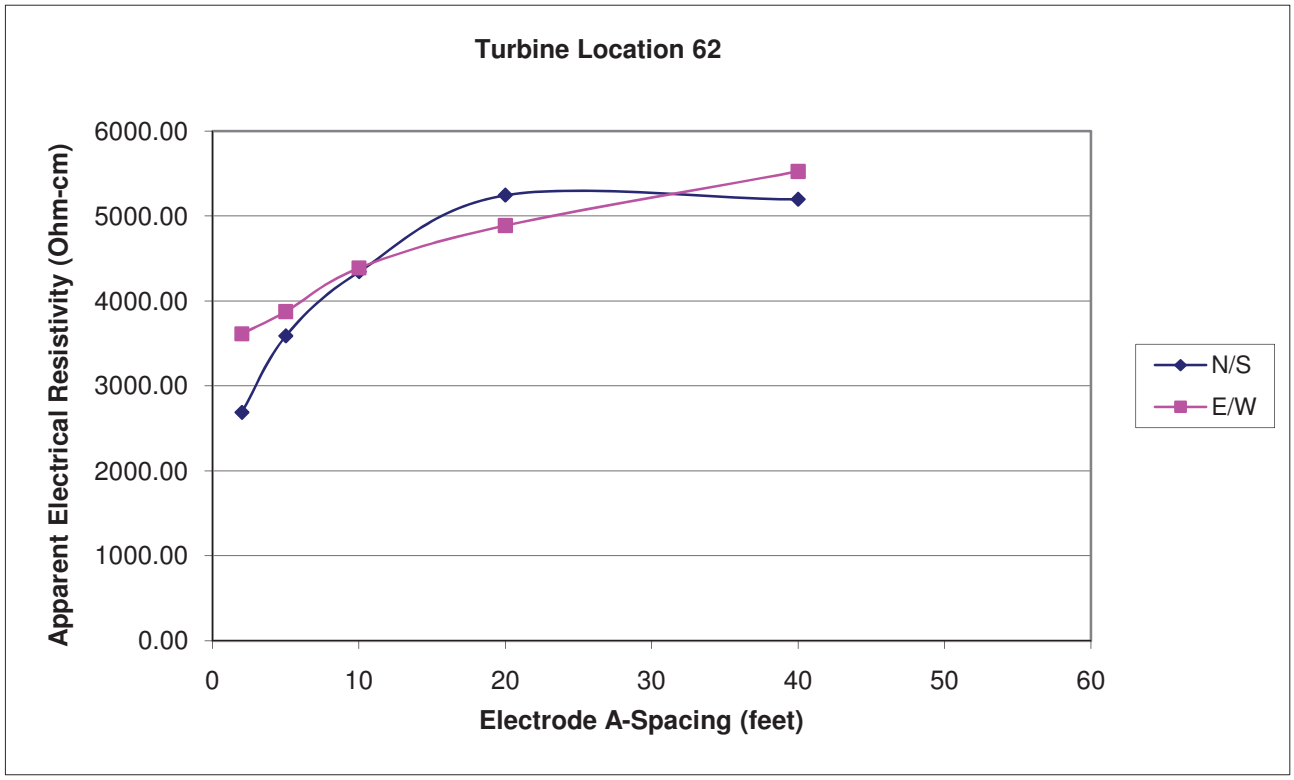
Sounding Number **6** **Date** **8/4/2011**

Observer **WWK**

Location **Turbine 62**

Electrode Spacing "a" feet	Resistance V/I Ohms	Geometric Factor $K=2\pi a$ feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-cm
N/S Orientation				
2	7.01	12.566	88.12	2686.45
5	3.75	31.416	117.65	3586.98
10	2.27	62.832	142.44	4342.69
20	1.37	125.664	172.03	5244.94
40	0.68	251.328	170.40	5195.13
E/W Orientation				
2	9.43	12.566	118.51	3613.22
5	4.05	31.416	127.14	3876.24
10	2.29	62.832	143.95	4388.66
20	1.28	125.664	160.35	4888.64
40	0.72	251.328	181.21	5524.62

Cultural Features	Flat
Ground Cover	Soybeans
Ambient Air Temp. (°F)	90
Line Bearing	NS/EW



WENNER SOUNDING

PROJECT: **Hardin County Wind Project**

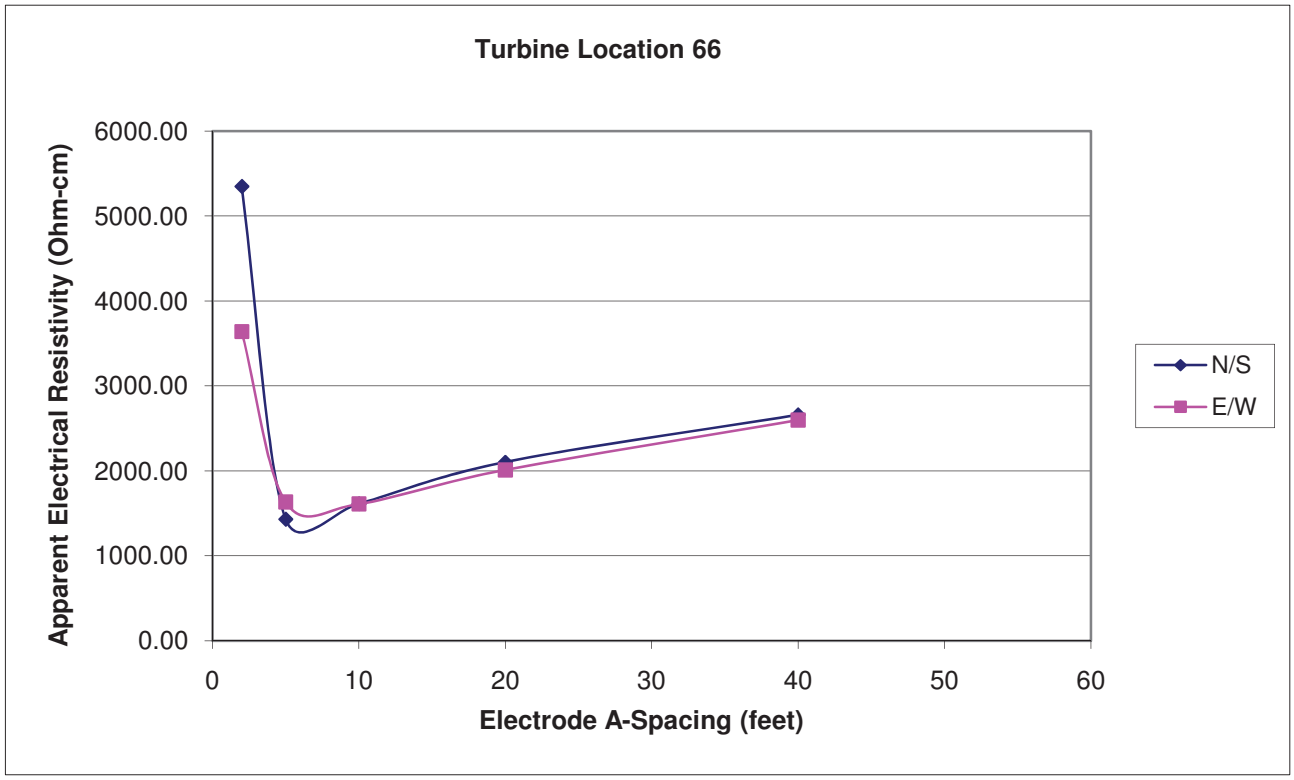
Sounding Number **4** **Date** **8/3/2011**

Observer **WWK**

Location **Turbine 66**

Electrode Spacing "a" feet	Resistance V/I Ohms	Geometric Factor $K=2\pi a$ feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-cm
N/S Orientation				
2	13.96	12.566	175.36	5346.47
5	1.50	31.416	46.97	1431.92
10	0.84	62.832	52.97	1614.86
20	0.55	125.664	68.99	2103.34
40	0.35	251.328	87.21	2658.87
E/W Orientation				
2	9.50	12.566	119.39	3640.04
5	1.71	31.416	53.63	1634.97
10	0.84	62.832	52.84	1611.03
20	0.53	125.664	65.97	2011.39
40	0.34	251.328	85.20	2597.57

Cultural Features	Flat
Ground Cover	Corn
Ambient Air Temp. (°F)	90
Line Bearing	NS/EW



WENNER SOUNDING

PROJECT: Hardin County Wind Project

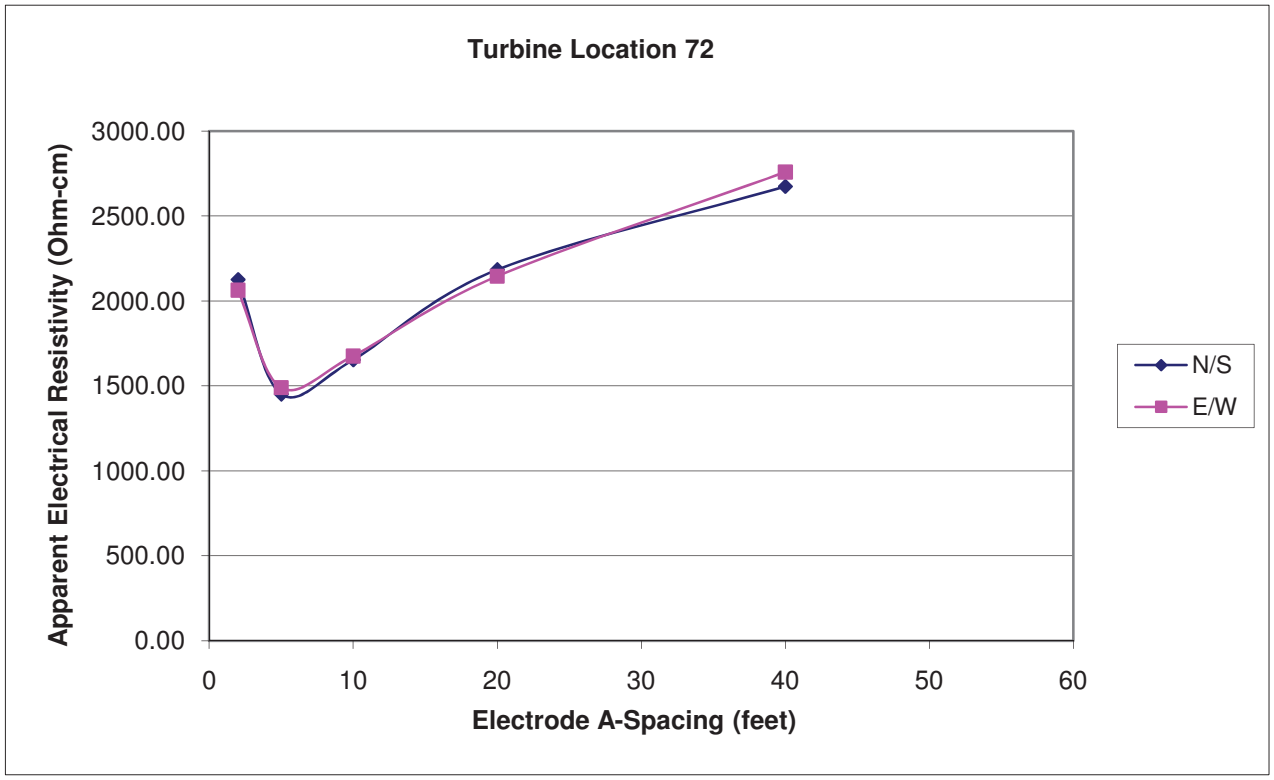
Sounding Number 3 **Date** 8/3/2011

Observer WWK

Location Turbine 72

Electrode Spacing "a" feet	Resistance V/I Ohms	Geometric Factor $K=2\pi a$ feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-cm
N/S Orientation				
2	5.55	12.566	69.76	2126.71
5	1.52	31.416	47.63	1452.03
10	0.86	62.832	54.22	1653.17
20	0.57	125.664	71.63	2183.80
40	0.35	251.328	87.71	2674.19
E/W Orientation				
2	5.39	12.566	67.67	2063.11
5	1.56	31.416	48.88	1490.34
10	0.88	62.832	54.98	1676.16
20	0.56	125.664	70.37	2145.48
40	0.36	251.328	90.48	2758.48

Cultural Features	Flat
Ground Cover	Carrots
Ambient Air Temp. (°F)	80
Line Bearing	NS/EW



WENNER SOUNDING

PROJECT: **Hardin County Wind Project**

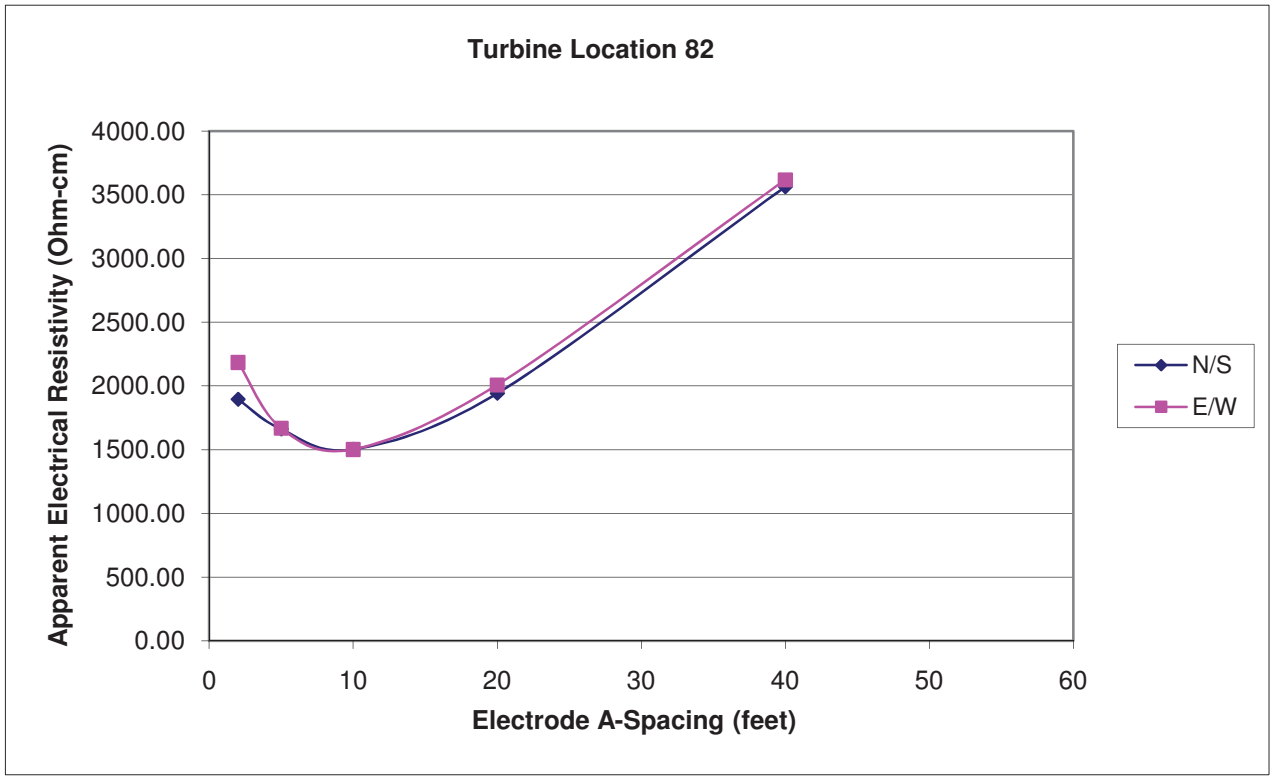
Sounding Number **13** **Date** **8/10/2011**

Observer **WWK**

Location **Turbine 82**

Electrode Spacing "a" feet	Resistance V/I Ohms	Geometric Factor $K=2\pi a$ feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-cm
N/S Orientation				
2	4.95	12.566	62.17	1895.30
5	1.74	31.416	54.54	1662.75
10	0.79	62.832	49.32	1503.75
20	0.51	125.664	63.71	1942.43
40	0.47	251.328	116.87	3563.03
E/W Orientation				
2	5.70	12.566	71.63	2183.80
5	1.74	31.416	54.73	1668.50
10	0.78	62.832	49.26	1501.84
20	0.52	125.664	65.85	2007.56
40	0.47	251.328	118.63	3616.67

Cultural Features	Flat
Ground Cover	Soybeans
Ambient Air Temp. (°F)	73
Line Bearing	NS/EW



WENNER SOUNDING

PROJECT: **Hardin County Wind Project**

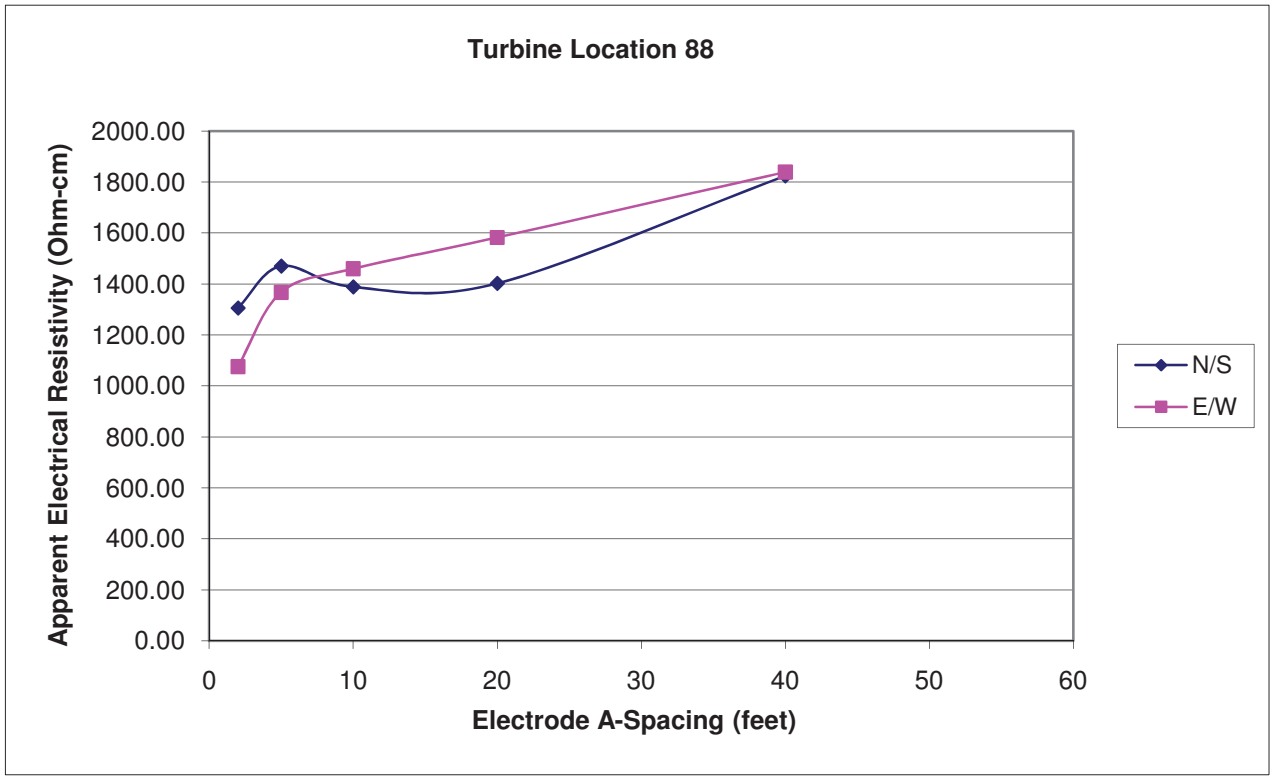
Sounding Number **12** **Date** **8/10/2011**

Observer **WWK**

Location **Turbine 88**

Electrode Spacing "a" feet	Resistance V/I Ohms	Geometric Factor $K=2\pi a$ feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-cm
N/S Orientation				
2	3.41	12.566	42.83	1305.68
5	1.54	31.416	48.22	1470.23
10	0.73	62.832	45.55	1388.82
20	0.37	125.664	45.99	1402.23
40	0.24	251.328	59.82	1823.66
E/W Orientation				
2	2.81	12.566	35.27	1075.42
5	1.43	31.416	44.83	1366.79
10	0.76	62.832	47.88	1459.69
20	0.41	125.664	51.90	1582.29
40	0.24	251.328	60.32	1838.99

Cultural Features	Flat
Ground Cover	Corn
Ambient Air Temp. (°F)	74
Line Bearing	NS/EW



WENNER SOUNDING

PROJECT: **Hardin County Wind Project**

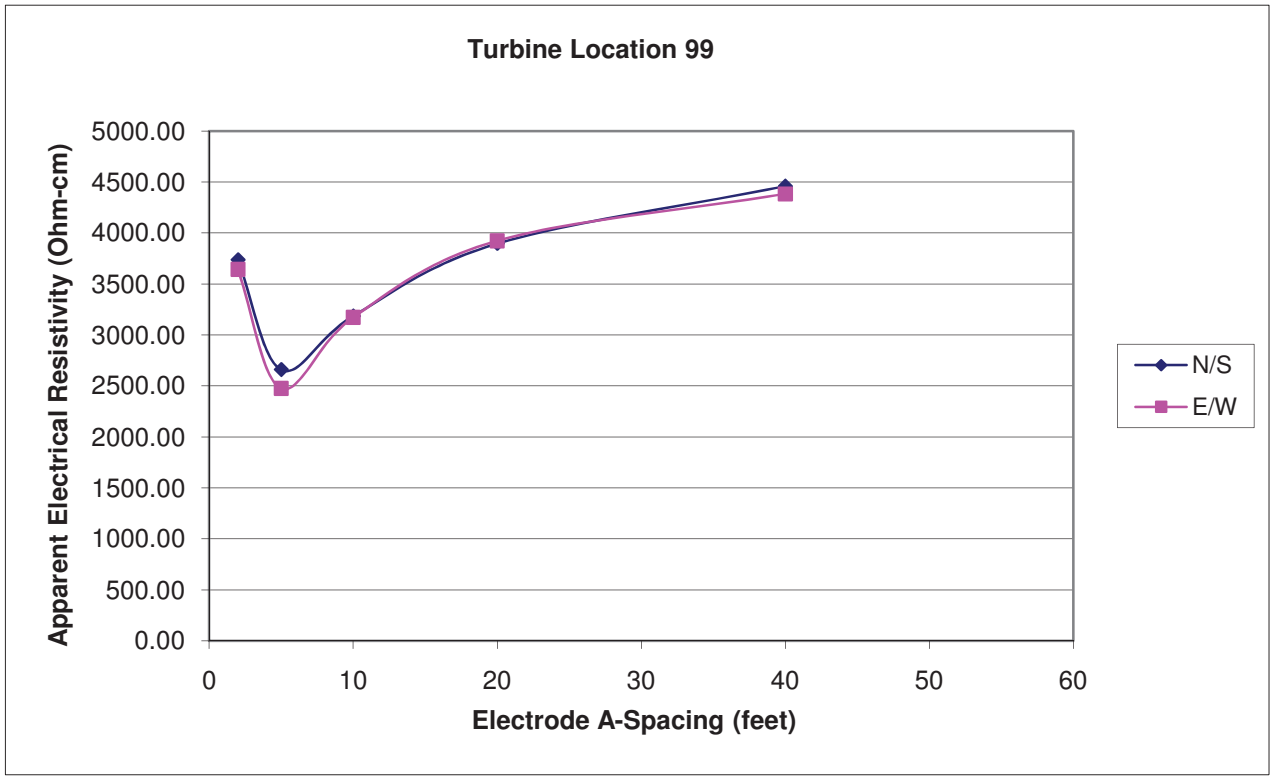
Sounding Number **5** **Date** **8/4/2011**

Observer **WWK**

Location **Turbine 99**

Electrode Spacing "a" feet	Resistance V/I Ohms	Geometric Factor $K=2\pi a$ feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-cm
N/S Orientation				
2	9.76	12.566	122.62	3738.50
5	2.78	31.416	87.27	2660.78
10	1.66	62.832	104.49	3185.66
20	1.02	125.664	127.80	3896.35
40	0.58	251.328	146.27	4459.54
E/W Orientation				
2	9.51	12.566	119.48	3642.72
5	2.59	31.416	81.24	2476.88
10	1.66	62.832	104.05	3172.25
20	1.02	125.664	128.68	3923.17
40	0.57	251.328	143.76	4382.92

Cultural Features	Flat
Ground Cover	Soybeans
Ambient Air Temp. (°F)	75
Line Bearing	NS/EW



WENNER SOUNDING

PROJECT: **Hardin County Wind Project**

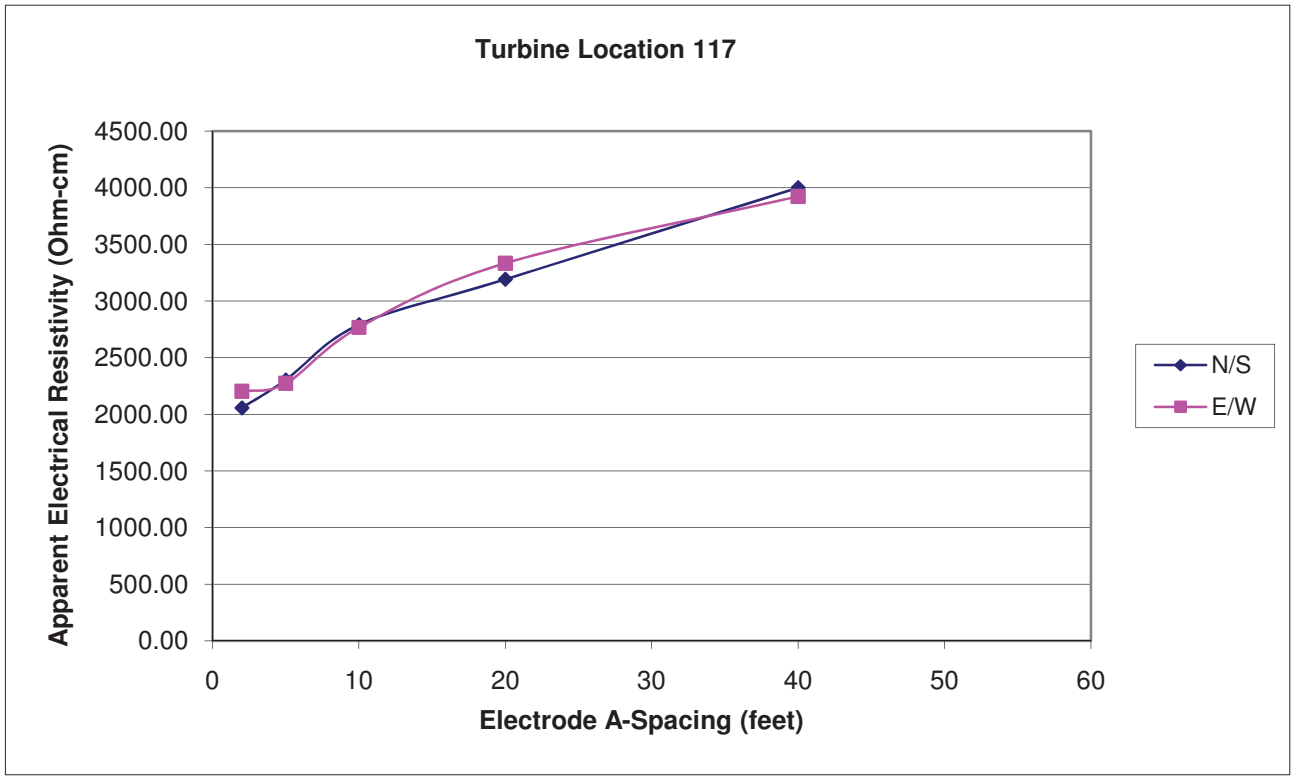
Sounding Number **9** **Date** **8/9/2011**

Observer **WWK**

Location **Turbine 117**

Electrode Spacing "a" feet	Resistance V/I Ohms	Geometric Factor $K=2\pi a$ feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-cm
N/S Orientation				
2	5.37	12.566	67.47	2056.98
5	2.40	31.416	75.52	2302.56
10	1.46	62.832	91.55	2791.04
20	0.83	125.664	104.68	3191.41
40	0.52	251.328	131.19	3999.79
E/W Orientation				
2	5.75	12.566	72.23	2202.18
5	2.37	31.416	74.55	2272.87
10	1.44	62.832	90.73	2766.14
20	0.87	125.664	109.33	3333.16
40	0.51	251.328	128.68	3923.17

Cultural Features	Flat
Ground Cover	Soybeans
Ambient Air Temp. (^{o}F)	75
Line Bearing	NS/EW



WENNER SOUNDING

PROJECT: **Hardin County Wind Project**

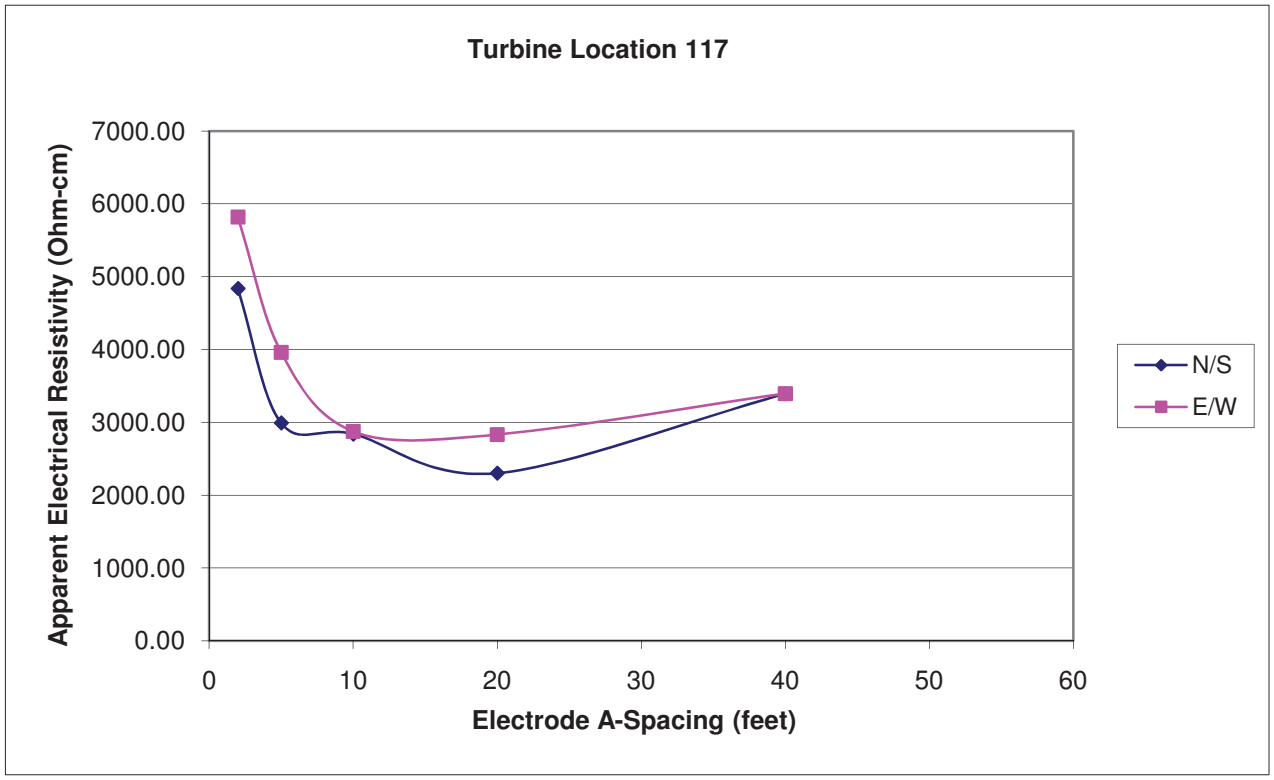
Sounding Number **2** **Date** **8/2/2011**

Observer **WWK**

Location **SS-2**

Electrode Spacing "a" feet	Resistance V/I Ohms	Geometric Factor $K=2\pi a$ feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-feet	Apparent Resistivity $\rho_a=K(V/I)$ Ohm-cm
N/S Orientation				
2	12.63	12.566	158.71	4838.83
5	3.13	31.416	98.18	2993.14
10	1.48	62.832	93.18	2840.85
20	0.60	125.664	75.52	2302.56
40	0.44	251.328	111.34	3394.46
E/W Orientation				
2	15.19	12.566	190.88	5819.62
5	4.14	31.416	129.94	3961.48
10	1.50	62.832	94.31	2875.33
20	0.74	125.664	92.87	2831.27
40	0.44	251.328	111.34	3394.46

Cultural Features	Flat
Ground Cover	Soybeans
Ambient Air Temp. (°F)	80
Line Bearing	NS/EW



Electrical Resistivity Test Results
Summary Table
Hardin County Wind Project
Hardin County, Ohio
35/33-1001

	'a' Spacing (ft)	Turbine 2 Resistivity ra=K(V/I) Ohm-cm	Turbine 14 Resistivity ra=K(V/I) Ohm-cm	Turbine 35 Resistivity ra=K(V/I) Ohm-cm	Turbine 39 Resistivity ra=K(V/I) Ohm-cm	Turbine 49 Resistivity ra=K(V/I) Ohm-cm	Turbine 62 Resistivity ra=K(V/I) Ohm-cm	Turbine 66 Resistivity ra=K(V/I) Ohm-cm	Turbine 72 Resistivity ra=K(V/I) Ohm-cm	Turbine 82 Resistivity ra=K(V/I) Ohm-cm	Turbine 88 Resistivity ra=K(V/I) Ohm-cm	Turbine 99 Resistivity ra=K(V/I) Ohm-cm	Turbine 117 Resistivity ra=K(V/I) Ohm-cm	Substation SS-2 Resistivity ra=K(V/I) Ohm-cm	Max	Min	Range (NS & EW)	Mean (NS & EW)	St Dev (NS & EW)
E/W Orientation	2	2025.2	1674.6	2443.2	2149.7	2058.1	2686.5	5346.5	2126.7	1895.3	1305.7	3738.5	2057.0	4838.8	5346.5	1305.7	5819.6 - 1075.4	2668.40	1216.49
	5	1958.7	1566.0	2746.0	2339.0	1651.3	3587.0	1431.9	1452.0	1662.7	1470.2	2660.8	2302.6	2993.1	3587.0	1431.9	3961.5 - 1366.8	2227.38	783.17
	10	3132.0	1637.8	4246.9	2032.5	1310.3	4342.7	1614.9	1653.2	1503.8	1388.8	3185.7	2791.0	2840.8	4342.7	1310.3	4388.7 - 1310.3	2443.14	1025.37
	20	4352.3	2517.1	7570.5	2658.9	1785.3	5244.9	2103.3	2183.8	1942.4	1402.2	3896.4	3191.4	2302.6	7570.5	1402.2	7570.5 - 1402.2	3145.73	1573.78
	40	6804.2	4712.4	13608.5	4306.3	2383.0	5195.1	2658.9	2674.2	3563.0	1823.7	4459.5	3999.8	3394.5	13608.5	1823.7	13608.5 - 1823.7	4562.39	2907.39
E/W Orientation	2	1690.3	1706.0	2466.5	1884.6	3045.1	3613.2	3640.0	2063.1	2183.8	1075.4	3642.7	2202.2	5819.6	5819.6	1075.4			
	5	2615.8	1455.9	2788.2	2815.0	1667.5	3876.2	1635.0	1490.3	1668.5	1366.8	2476.9	2272.9	3961.5	3961.5	1366.8			
	10	3103.3	1697.2	4116.6	2036.3	1436.7	4388.7	1611.0	1676.2	1501.8	1459.7	3172.2	2766.1	2875.3	4388.7	1436.7			
	20	3984.5	2593.7	6800.4	2773.8	1762.4	4888.6	2011.4	2145.5	2007.6	1582.3	3923.2	3333.2	2831.3	6800.4	1582.3			
	40	6421.1	4651.1	13210.0	4490.2	2229.8	5524.6	2597.6	2758.5	3616.7	1839.0	4382.9	3923.2	3394.5	13210.0	1839.0			
	Apparent Resistivity Average-Ohm-cm												3009.41						

Appendix G

Thermal Resistivity Testing Report

Barr Engineering Company
4700 West 77th Street • Minneapolis, MN 55435-4803
Phone: 952-832-2600 • Fax: 952-832-2601 • www.barr.com *An EEO Employer*

Minneapolis, MN • Hibbing, MN • Duluth, MN • Ann Arbor, MI • Jefferson City, MO • Bismarck, ND

November 10, 2011

Mr. Joseph Brisebois
Invenergy LLC.
One S. Wacker Drive,
Suite 1900
Chicago, IL 60606

Re: Thermal Resistivity Testing
Hardin County Wind Project
Hardin County, Ohio

Dear Mr. Brisebois,

This letter presents the soil thermal resistivity testing results. Barr Engineering Company (Barr) personnel collected soil samples at selected locations at the Settlers Trail Wind Project site in mid August, 2010. Thermal resistivity laboratory testing was completed on the samples in late September, 2010. The methods and results are summarized below.

Methods

A total of 10 soil samples were collected by Barr personnel during drilling by GEOCON Testing Services of Frankfort, Illinois, under the direction of Barr personnel. The samples were collected at proposed turbine locations and the proposed substation and for spatial coverage across the project site. These locations were selected by Barr to provide spatial coverage across the site.

Each sample was collected by hollow-stem augering to a depth of two feet below existing grade and then collecting a shelby tube sample from 3-5 feet. The samples were sealed in the field in order to preserve the in-situ moisture content. All samples were delivered to Soil Engineering Testing, Inc. (SET) of Richfield, Minnesota, for laboratory testing.

Invenergy, LLC. (Invenergy) provided GPS coordinates of the investigation locations provided GPS coordinates of the turbine locations, and a map of the proposed substation. The test sites were located based on the provided coordinates with a handheld GPS, and the provided map of the substation location. The test locations are indicated in Figure 1, which includes the most recent turbine locations. Coordinates of each test location and other pertinent information can be found in Table 1.

Table 1: Thermal Resistivity Sample Information

Turbine/Structure Number	Sample ID	Sample Depth (ft)	Coordinates [UTM, NAD83]	
			Northing (m)	Easting (m)
2	Shelby Tube	3.0-5.0	4509134	260246
19	Shelby Tube	3.0-5.0	4506725	261043
35	Shelby Tube	3.0-5.0	4506091	260246
49	Shelby Tube	3.0-5.0	4504602	263661
51	Shelby Tube	3.0-5.0	4504005	263477
62	Shelby Tube	3.0-5.0	4502930	264596
66	Shelby Tube	3.0-5.0	4501392	262764
72	Shelby Tube	3.0-5.0	4500169	262202
82	Shelby Tube	3.0-5.0	4506509	266102
88	Shelby Tube	3.0-5.0	4508520	266792
99	Shelby Tube	3.0-5.0	4496681	265425
117	Shelby Tube	3.0-5.0	4508384	270579
SS-2	Shelby Tube	3.0-5.0	4501741	263787

SET completed the testing in accordance with ASTM method D5334-08 “Standard Test Method for Determination of Thermal Conductivity of Soil and Soft Rock by Thermal Needle Probe Procedure.” Laboratory tests included measurement of the soil’s in-situ moisture content, standard Proctor density and optimum moisture content and thermal dryout characteristics, which is a function of moisture content. All of the samples were extruded from Shelby tube samples and directly into the testing apparatus.

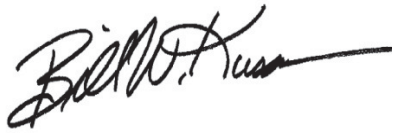
Thermal dryout characteristics were measured using a laboratory type thermal needle held central and vertical in the base plate. Thermal resistivity measurements were conducted starting at the existing moisture content of the soil sample to the totally dry condition. At the end of each drying stage, samples were sealed and brought to thermal equilibrium with the ambient air to ensure uniform moisture re-distribution through the sample. Tests were conducted using a KD2 Thermal Property Analyzer. The instrument was calibrated prior to testing.

Results

The resulting laboratory soil thermal resistivity measurements presented in tabular form with full dryout curves are included in the attached Thermal Resistivity Report by SET.

Thank you for the opportunity to provide this service. Please call me at 952-832-2797 with questions or requests for additional information.

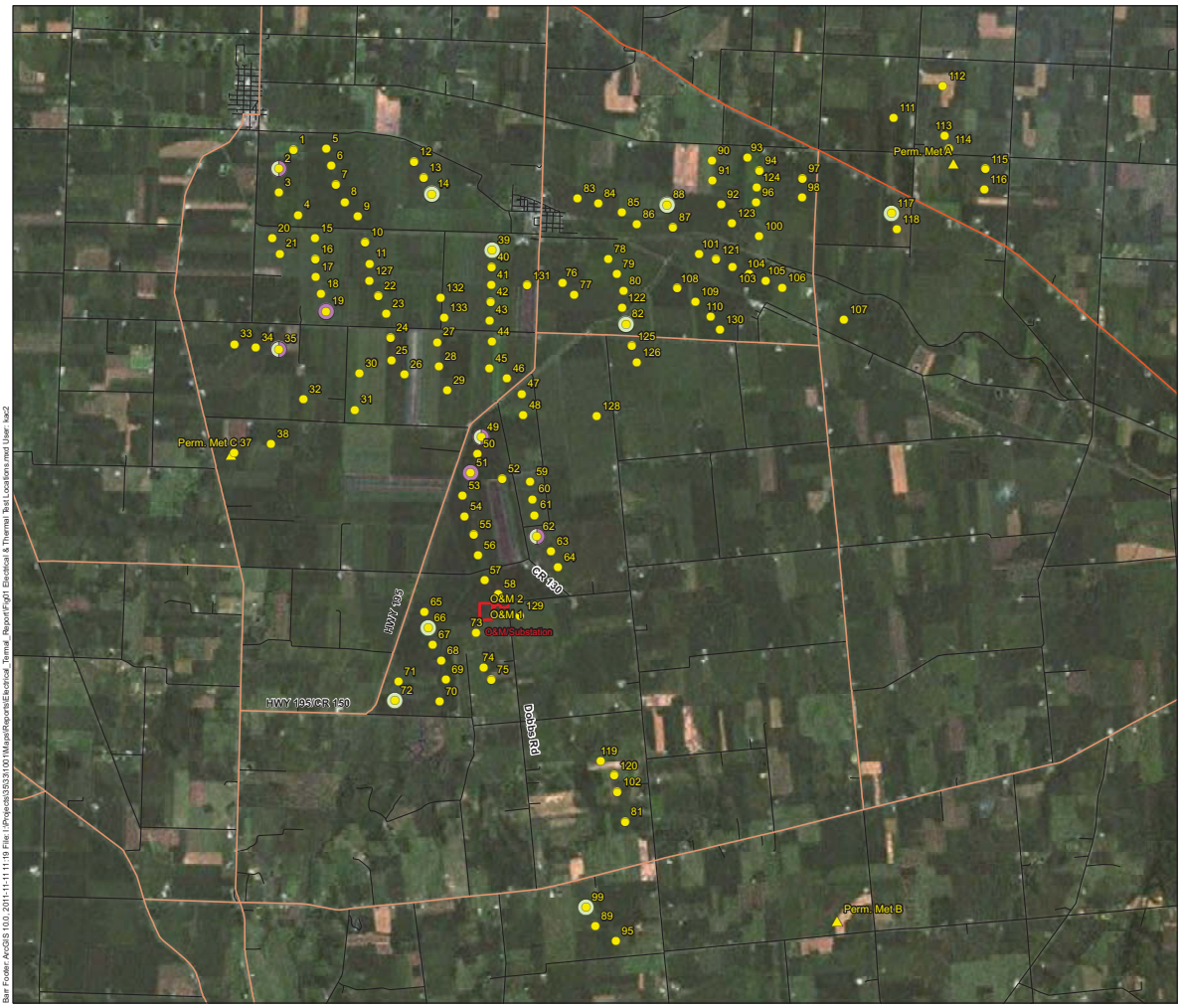
Sincerely,



Bill Kussmann, P.E.
Senior Geotechnical Engineer
Barr Engineering Co.

Attachments:

Figure 1: Thermal and Electrical Resistivity Test Locations
SET, Inc. Thermal Resistivity Test Results



Turbine Location
(7/7/2011 Coordinates)

Met Tower Location

Electrical Location

Thermal Location

Electrical & Thermal Location

Switchyard Boundary (Approximate)

Kilometers
1 0 1 2

Miles
1 0 1

Figure 1

ELECTRICAL AND THERMAL TEST LOCATIONS
Hardin County Wind Project
Inenvergy
Hardin County, Ohio

Barr Foster ArcGIS 10.0, 2011-11-11 11:19 File: I:\Projects\335\33100\1\Maps\Reports\Electrical_Termal_Report\Fig01 Electrical & Thermal Test Locations.mxd User: kw2

Thermal Resistivity Report ASTM D:5334

Project: **Hardin County** Job #: **8076**

Client: **Barr Engineering Company** Date: **9/21/11**

Boring	Specimen Condition	Depth	Type	Classification	Initial Conditions			Dry
					Dry Density (PCF)	WC (%)	Thermal Resistivity (ºC-cm/W)	Thermal Resistivity (ºC-cm/W)
SS-2	**Undisturbed**	**3-5**	**TWT**	**Sandy Lean Clay (CL)**	**113.6**	**18.6%**	**51**	**114**
T-2	**Undisturbed**	**3-5**	**TWT**	**Lean Clay with Sand (CL)**	**109.3**	**19.1%**	**56**	**165**
T-19	**Undisturbed**	**3-5**	**TWT**	**Lean Clay (CL)**	**96.6**	**24.2%**	**69**	**174**
T-35	**Undisturbed**	**3-5**	**TWT**	**Lean Clay with Sand (CL)**	**106.7**	**20.8%**	**61**	**164**
T-49	**Undisturbed**	**3-5**	**TWT**	**Organic Clay (OL)**	**76.5**	**36.5%**	**88**	**279**
T-51	**Undisturbed**	**3-5**	**TWT**	**Organic Clay (OL)**	**81.6**	**39.4%**	**74**	**252**
T-62	**Undisturbed**	**3-5**	**TWT**	**Organic Clay (OH)**	**73.6**	**36.9%**	**121**	**623**

Samples extruded and selected specimens trimmed for undisturbed tests.

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http://www.soilengineeringtesting.com

Thermal Resistivity Report ASTM D:5334

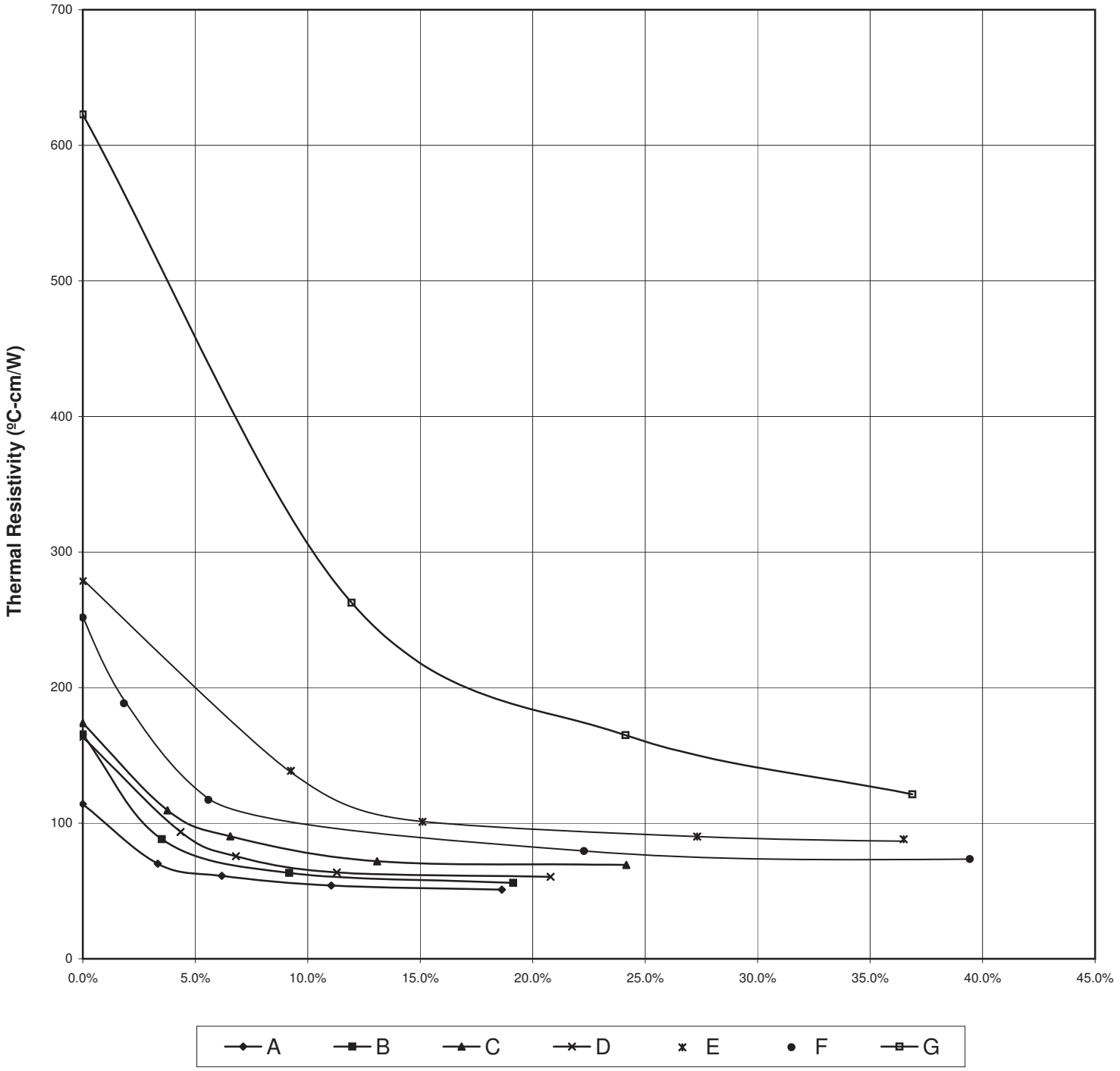
Project: Hardin County — Job: 8076

Client: Barr Engineering Company — Date: 9/21/11

	Boring	Depth (ft)
Specimen A:	SS-2	3 - 5
Specimen B:	T-2	3 - 5
Specimen C:	T-19	3 - 5
Specimen D:	T-35	3 - 5
Specimen E:	T-49	3 - 5

	Boring	Depth (ft)
Specimen F:	T-51	3 - 5
Specimen G:	T-62	3 - 5

Thermal Dryout Curves (Resistivity vs. Water Content)



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Richfield, MN 55423

http://www.soilengineeringtesting.com

Thermal Resistivity Report ASTM D:5334

Project: **Hardin County** Job #: **8076**

Client: **Barr Engineering Company** Date: **9/22/11**

Boring	Specimen Condition	Depth	Type	Classification	Initial Conditions			Dry
					Dry Density (PCF)	WC (%)	Thermal Resistivity (ºC-cm/W)	Thermal Resistivity (ºC-cm/W)
T-66	**Undisturbed**	**3-5**	**TWT**	**Lean Clay with a little organic material (CL/OL)**	**78.3**	**41.3%**	**75**	**273**
T-72	**Undisturbed**	**3-5**	**TWT**	**Lean Clay with a trace of organic material (CL)**	**89.2**	**32.4%**	**68**	**184**
T-82	**Undisturbed**	**3-5**	**TWT**	**Lean Clay with Sand (CL)**	**105.7**	**20.8%**	**53**	**138**
T-88	**Undisturbed**	**3-5**	**TWT**	**Lean Clay (CL)**	**87.2**	**31.4%**	**71**	**180**
T-99	**Undisturbed**	**3-5**	**TWT**	**Sandy Lean Clay (CL)**	**112.2**	**16.6%**	**47**	**101**
T-117	**Undisturbed**	**3-5**	**TWT**	**Lean Clay with Sand (CL)**	**99.4**	**23.2%**	**59**	**142**

Samples extruded and selected specimens trimmed for undisturbed tests.

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Thermal Resistivity Report ASTM D:5334

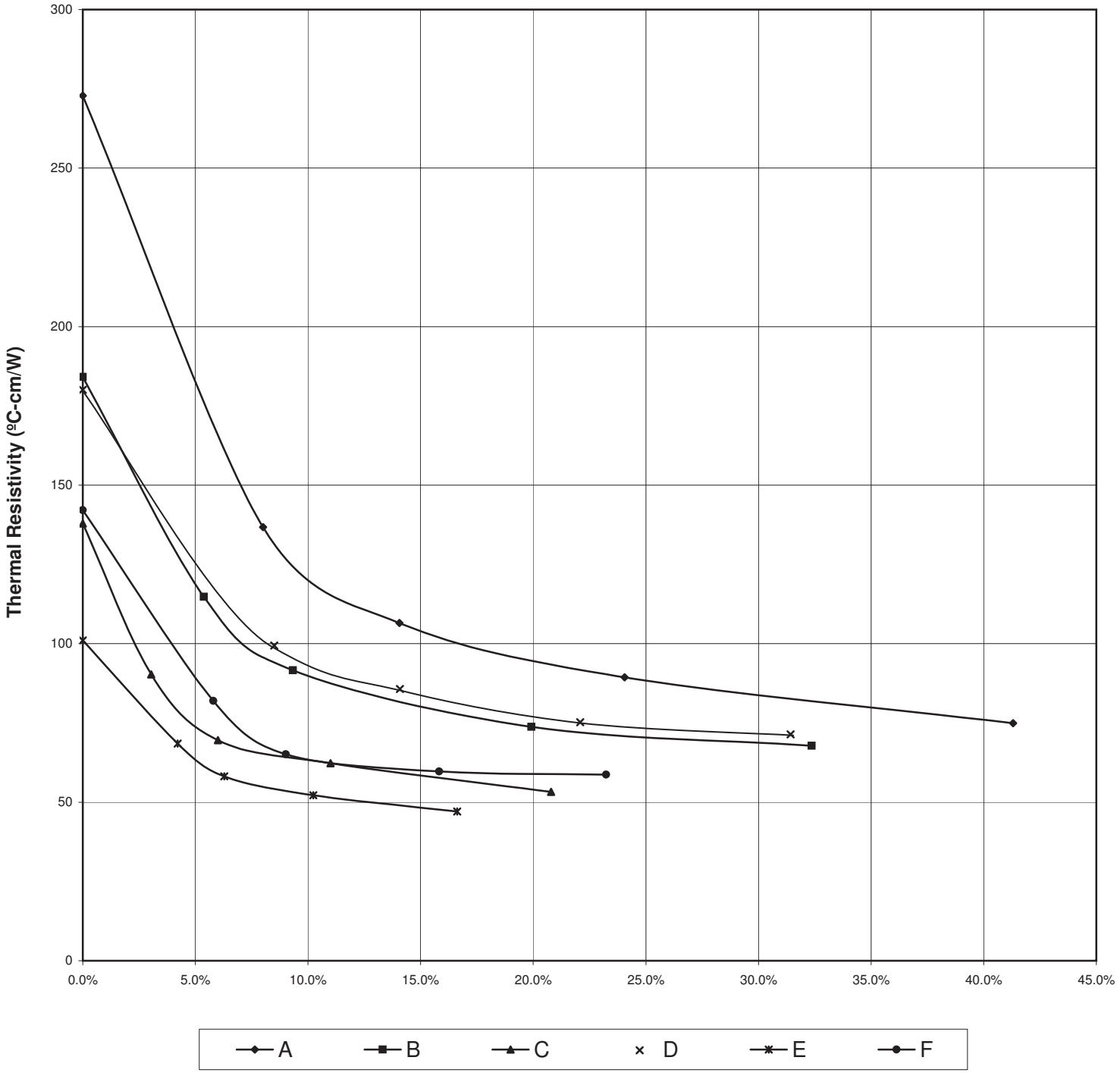
Project: Hardin County — Job: 8076

Client: Barr Engineering Company — Date: 9/22/11

	Boring	Depth (ft)
Specimen A:	T-66	3 - 5
Specimen B:	T-72	3 - 5
Specimen C:	T-82	3 - 5
Specimen D:	T-88	3 - 5
Specimen E:	T-99	3 - 5

	Boring	Depth (ft)
Specimen F:	T-117	3 - 5

Thermal Dryout Curves (Resistivity vs. Water Content)



2401 West 66th Street

Richfield, MN 55423

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Appendix H

Chemical Testing Results

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John Whelan
Soil Engineering Testing, Inc.
2401 West 66th Street
Richfield, MN 55423

Report Summary

Wednesday September 21, 2011

Report Number: L534906
Samples Received: 09/08/11
Client Project: 8076

Description: Hardin

The analytical results in this report are based upon information supplied by you, the client, and are for your exclusive use. If you have any questions regarding this data package, please do not hesitate to call.

Entire Report Reviewed By: John Hawkins

John Hawkins , ESC Representative

Laboratory Certification Numbers

A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - I-2327, CT - PH-0197, FL - E87487
GA - 923, IN - C-TN-01, KY - 90010, KYUST - 0016, NC - ENV375/DW21704, ND - R-140
NJ - TN002,NJ NELAP - TN002, SC - 84004, TN - 2006, VA - 00109, WV - 233
AZ - 0612, MN - 047-999-395, NY - 11742, WI - 998093910, NV - TN000032008A,
TX - T104704245, OK-9915

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Note: The use of the preparatory EPA Method 3511 is not approved or endorsed by the CA ELAP.

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REPORT OF ANALYSIS

John Whelan
Soil Engineering Testing, Inc.
2401 West 66th Street
Richfield, MN 55423

September 21, 2011

ESC Sample # : L534906-01

Date Received : September 08, 2011
Description : Hardin

Site ID :

Sample ID : T-2 3-5FT

Project # : 8076

Collected By :
Collection Date : 09/07/11 00:00

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Chloride	37.	10.	mg/kg	9056	09/13/11	1
Sulfate	94.	50.	mg/kg	9056	09/13/11	1

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
Note:
The reported analytical results relate only to the sample submitted.
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REPORT OF ANALYSIS

John Whelan
Soil Engineering Testing, Inc.
2401 West 66th Street
Richfield, MN 55423

September 21, 2011

ESC Sample # : L534906-02

Date Received : September 08, 2011
Description : Hardin

Site ID :

Sample ID : T-19 3-5FT

Project # : 8076

Collected By :
Collection Date : 09/07/11 00:00

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Chloride	55.	10.	mg/kg	9056	09/13/11	1
Sulfate	330	50.	mg/kg	9056	09/13/11	1

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
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REPORT OF ANALYSIS

John Whelan
Soil Engineering Testing, Inc.
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Richfield, MN 55423

September 21, 2011

ESC Sample # : L534906-03

Date Received : September 08, 2011
Description : Hardin

Site ID :

Sample ID : T-35 3-5FT

Project # : 8076

Collected By :
Collection Date : 09/07/11 00:00

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Chloride	37.	10.	mg/kg	9056	09/13/11	1
Sulfate	BDL	50.	mg/kg	9056	09/13/11	1

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
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REPORT OF ANALYSIS

John Whelan
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Richfield, MN 55423

September 21, 2011

ESC Sample # : L534906-04

Date Received : September 08, 2011
Description : Hardin

Site ID :

Sample ID : T-49 3-5FT

Project # : 8076

Collected By :
Collection Date : 09/07/11 00:00

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Chloride	66.	10.	mg/kg	9056	09/13/11	1
Sulfate	100	50.	mg/kg	9056	09/13/11	1

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
Note:
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REPORT OF ANALYSIS

John Whelan
Soil Engineering Testing, Inc.
2401 West 66th Street
Richfield, MN 55423

September 21, 2011

ESC Sample # : L534906-05

Date Received : September 08, 2011
Description : Hardin

Site ID :

Sample ID : T-51 3-5FT

Project # : 8076

Collected By :
Collection Date : 09/07/11 00:00

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Chloride	48.	10.	mg/kg	9056	09/13/11	1
Sulfate	220	50.	mg/kg	9056	09/13/11	1

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
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REPORT OF ANALYSIS

John Whelan
Soil Engineering Testing, Inc.
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Richfield, MN 55423

September 21, 2011

ESC Sample # : L534906-06

Date Received : September 08, 2011
Description : Hardin

Site ID :

Sample ID : T-62 3-5FT

Project # : 8076

Collected By :
Collection Date : 09/07/11 00:00

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Chloride	BDL	10.	mg/kg	9056	09/13/11	1
Sulfate	690	50.	mg/kg	9056	09/18/11	1

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
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REPORT OF ANALYSIS

John Whelan
Soil Engineering Testing, Inc.
2401 West 66th Street
Richfield, MN 55423

September 21, 2011

ESC Sample # : L534906-07

Date Received : September 08, 2011
Description : Hardin

Site ID :

Sample ID : T-66 3-5FT

Project # : 8076

Collected By :
Collection Date : 09/07/11 00:00

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Chloride	52.	10.	mg/kg	9056	09/13/11	1
Sulfate	3500	250	mg/kg	9056	09/14/11	5

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
Note:
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REPORT OF ANALYSIS

John Whelan
Soil Engineering Testing, Inc.
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Richfield, MN 55423

September 21, 2011

ESC Sample # : L534906-08

Date Received : September 08, 2011
Description : Hardin

Site ID :

Sample ID : T-72 3-5FT

Project # : 8076

Collected By :
Collection Date : 09/07/11 00:00

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Chloride	50.	10.	mg/kg	9056	09/13/11	1
Sulfate	2000	250	mg/kg	9056	09/14/11	5

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
Note:
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REPORT OF ANALYSIS

John Whelan
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September 21, 2011

ESC Sample # : L534906-09

Date Received : September 08, 2011
Description : Hardin

Site ID :

Sample ID : T-82 3-5FT

Project # : 8076

Collected By :
Collection Date : 09/07/11 00:00

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Chloride	57.	10.	mg/kg	9056	09/13/11	1
Sulfate	250	50.	mg/kg	9056	09/13/11	1

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
Note:
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REPORT OF ANALYSIS

John Whelan
Soil Engineering Testing, Inc.
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Richfield, MN 55423

September 21, 2011

ESC Sample # : L534906-10

Date Received : September 08, 2011
Description : Hardin

Site ID :

Sample ID : T-88 3-5FT

Project # : 8076

Collected By :
Collection Date : 09/07/11 00:00

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Chloride	53.	10.	mg/kg	9056	09/14/11	1
Sulfate	55.	50.	mg/kg	9056	09/14/11	1

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
Note:
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REPORT OF ANALYSIS

John Whelan
Soil Engineering Testing, Inc.
2401 West 66th Street
Richfield, MN 55423

September 21, 2011

ESC Sample # : L534906-11

Date Received : September 08, 2011
Description : Hardin

Site ID :

Sample ID : T-99 3-5FT

Project # : 8076

Collected By :
Collection Date : 09/07/11 00:00

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Chloride	49.	10.	mg/kg	9056	09/14/11	1
Sulfate	59.	50.	mg/kg	9056	09/14/11	1

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
Note:
The reported analytical results relate only to the sample submitted.
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REPORT OF ANALYSIS

John Whelan
Soil Engineering Testing, Inc.
2401 West 66th Street
Richfield, MN 55423

September 21, 2011

ESC Sample # : L534906-12

Date Received : September 08, 2011
Description : Hardin

Site ID :

Sample ID : T-117 3-5FT

Project # : 8076

Collected By :
Collection Date : 09/07/11 00:00

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
Chloride	53.	10.	mg/kg	9056	09/14/11	1
Sulfate	BDL	50.	mg/kg	9056	09/14/11	1

BDL - Below Detection Limit
Det. Limit - Practical Quantitation Limit(PQL)
Note:
The reported analytical results relate only to the sample submitted.
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Reported: 09/19/11 16:37 Revised: 09/21/11 11:06

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Soil Engineering Testing, Inc.
John Whelan
2401 West 66th Street
Richfield, MN 55423

Quality Assurance Report
Level II

L534906

September 21, 2011

Laboratory Blank

Analyte	Result	Units	% Rec	Limit	Batch	Date Analyzed
Chloride	< 10	mg/kg			WG554776	09/13/11 14:25
Sulfate	< 50	mg/kg			WG554776	09/13/11 14:25
Sulfate	< 50	mg/kg			WG555594	09/17/11 11:50

Duplicate

Analyte	Units	Result	Duplicate	RPD	Limit	Ref Samp	Batch
Chloride	mg/kg	36.0	37.0	2.74	20	L534906-03	WG554776
Sulfate	mg/kg	0	0	0	20	L534906-03	WG554776
Chloride	mg/kg	56.0	53.0	6.39	20	L534906-10	WG554776
Sulfate	mg/kg	52.0	55.0	6.38	20	L534906-10	WG554776
Sulfate	mg/kg	570.	690.	19.4	20	L534906-06	WG555594

Laboratory Control Sample

Analyte	Units	Known Val	Result	% Rec	Limit	Batch
Chloride	mg/kg	200	209.	105.	85-115	WG554776
Sulfate	mg/kg	200	208.	104.	85-115	WG554776
Sulfate	mg/kg	200	209.	105.	85-115	WG555594

Laboratory Control Sample Duplicate

Analyte	Units	Result	Ref	%Rec	Limit	RPD	Limit	Batch
Chloride	mg/kg	209.	209.	104.	85-115	0	20	WG554776
Sulfate	mg/kg	208.	208.	104.	85-115	0	20	WG554776
Sulfate	mg/kg	209.	209.	104.	85-115	0	20	WG555594

Matrix Spike

Analyte	Units	MS Res	Ref Res	TV	% Rec	Limit	Ref Samp	Batch
Chloride	mg/kg	551.	66.0	500	97.0	80-120	L534906-04	WG554776
Sulfate	mg/kg	611.	100.	500	102.	80-120	L534906-04	WG554776

Matrix Spike Duplicate

Analyte	Units	MSD	Ref	%Rec	Limit	RPD	Limit	Ref Samp	Batch
Chloride	mg/kg	563.	551.	99.4	80-120	2.15	20	L534906-04	WG554776
Sulfate	mg/kg	626.	611.	105.	80-120	2.43	20	L534906-04	WG554776

Batch number /Run number / Sample number cross reference

WG554776: R1858095: L534906-01 02 03 04 05 06 07 08 09 10 11 12
WG555288: R1861372: L534906-06
WG555594: R1863712: L534906-06

* * Calculations are performed prior to rounding of reported values.
* Performance of this Analyte is outside of established criteria.
For additional information, please see Attachment A 'List of Analytes with QC Qualifiers.'

pH Testing Summary Sheet

Project: **Hardin** Job: **8076**

Client: **Barr Engineering Company** Date: **9/13/2011**

Boring	Sample Type	Depth (ft)	pH	Visual Classification
T-2	**TWT**	**3 - 5**	**7.7**	**Lean clay with Sand (CL)**
T-19	**TWT**	**3 - 5**	**7.4**	**Lean Clay (CL)**
T-35	**TWT**	**3 - 5**	**7.7**	**Lean clay with Sand (CL)**
T-49	**TWT**	**3 - 5**	**7.6**	**Organic Clay (OL)**
T-51	**TWT**	**3 - 5**	**7.7**	**Organic Clay (OL)**
T-62	**TWT**	**3 - 5**	**7.6**	**Organic Clay (OH)**
T-66	**TWT**	**3 - 5**	**7.6**	**Lean Clay with a little organic material (CL)**
T-72	**TWT**	**3 - 5**	**7.5**	**Lean Clay with a trace of organic material (CL)**
T-82	**TWT**	**3 - 5**	**7.4**	**Lean clay with Sand (CL)**
T-88	**TWT**	**3 - 5**	**7.2**	**Lean Clay (CL)**
T-99	**TWT**	**3 - 5**	**7.2**	**Sandy Lean Clay (CL)**
T-117	**TWT**	**3 - 5**	**6.0**	**Lean clay with Sand (CL)**

12065 Lebanon Rd.
Mt. Juliet, TN 37122
(615) 758-5858
1-800-767-5859
Fax (615) 758-5859

Tax I.D. 62-0814289

Est. 1970

Soil Engineering Testing, Inc.
John Whelan
2401 West 66th Street

Richfield, MN 55423

Quality Assurance Report
Level II

L534906

September 21, 2011

The data package includes a summary of the analytic results of the quality control samples required by the SW-846 or CWA methods. The quality control samples include a method blank, a laboratory control sample, and the matrix spike/matrix spike duplicate analysis. If a target parameter is outside the method limits, every sample that is effected is flagged with the appropriate qualifier in Appendix B of the analytic report.

Method Blank - an aliquot of reagent water carried through the entire analytic process. The method blank results indicate if any possible contamination exposure during the sample handling, digestion or extraction process, and analysis. Concentrations of target analytes above the reporting limit in the method blank are qualified with the "B" qualifier.

Laboratory Control Sample - is a sample of known concentration that is carried through the digestion/extraction and analysis process. The percent recovery, expressed as a percentage of the theoretical concentration, has statistical control limits indicating that the analytic process is "in control". If a target analyte is outside the control limits for the laboratory control sample or any other control sample, the parameter is flagged with a "J4" qualifier for all effected samples.

Matrix Spike and Matrix Spike Duplicate - is two aliquots of an environmental sample that is spiked with known concentrations of target analytes. The percent recovery of the target analytes also has statistical control limits. If any recoveries that are outside the method control limits, the sample that was selected for matrix spike/matrix spike duplicate analysis is flagged with either a "J5" or a "J6". The relative percent difference (%RPD) between the matrix spike and the matrix spike duplicate recoveries is all calculated. If the RPD is above the method limit, the effected samples are flagged with a "J3" qualifier.

Appendix I

CBRs for Roadways

California Bearing Ratio ASTM:D1883

Project:	Hardin County	Job:	**8076-A**
Client:	Barr Engineering Company	Date:	12/7/11

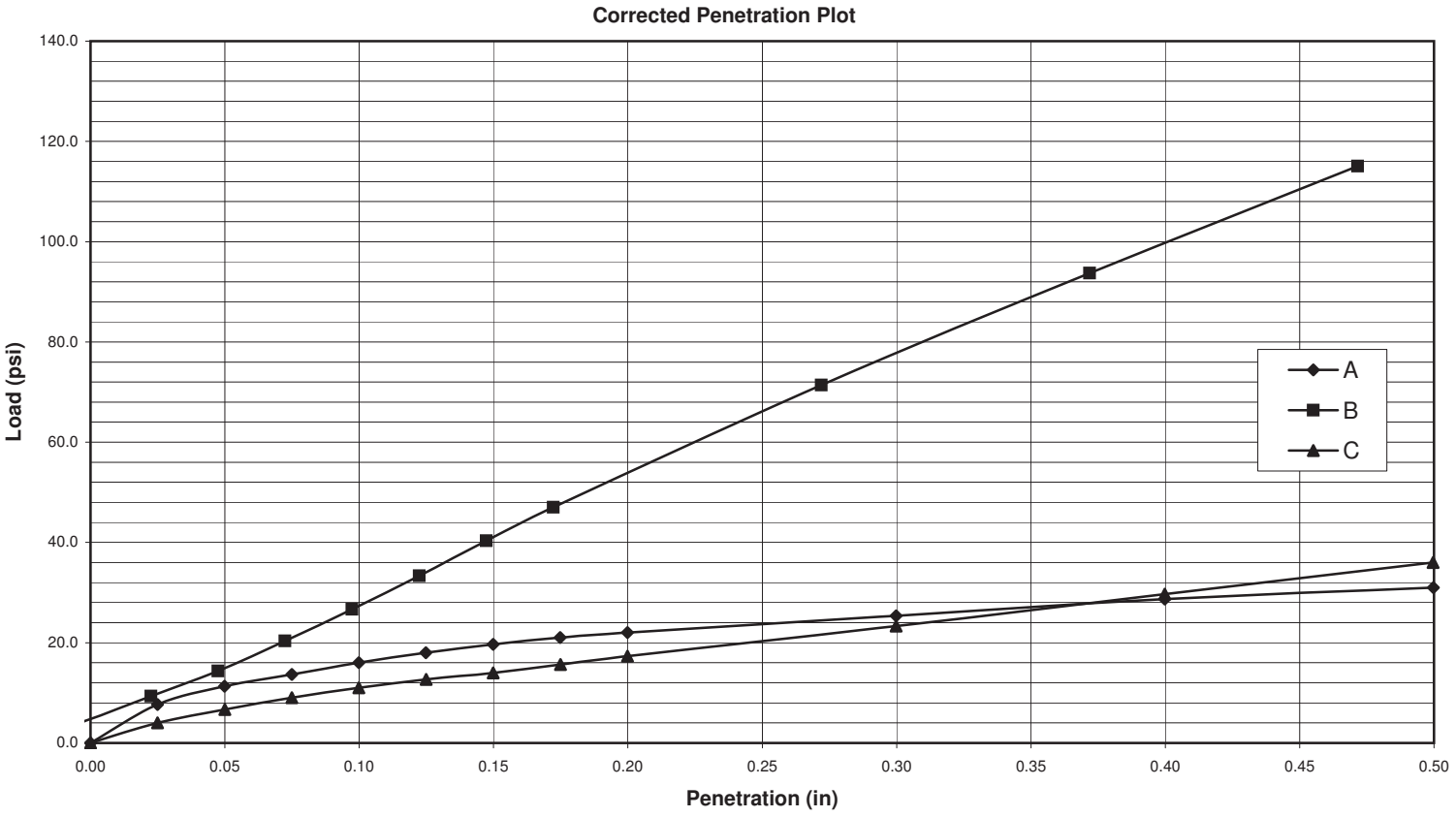
Boring #: T-02 - T-14 - T-19	Procedural Method:
Sample:	Specimens compacted to approximately 95% of maximum standard proctor density at optimum moisture content. Specimens soaked for a period of 4 days before CBR test was performed.
Depth (ft): Type: Bulk	
Location:	
Classification: Lean Clay w/sand (CL) - Lean Clay w/sand (CL) - Fat Clay (CH)	

Laboratory Moisture-Density Values		Index Properties	
Method:	ASTM:D698 Method B	LL:	Gs:
Maximum Dry Density (PCF):	102.2 - 109.2 - 95.5	PL:	Organic Content:
Optimum Water Content:	22.5% - 16.8% - 25.8%	PI:	pH:

Initial Molding Conditions

Boring	T-02	T-14	T-19
Specimen	A	B	C
Number of Layers:	3	3	3
Blows per Layer:	NA	NA	NA
Initial Moisture Content:	22.5%	16.8%	25.8%
Initial Dry Density (PCF)	97.3	104.0	90.9
Relative Compaction	95.2%	95.3%	95.1%
Soaking Phase			
Days Soaked	4	4	4
Surcharge (psf)	50	50	50
Total Swell (%)	0.1%	1.3%	3.2%
Penetration Phase			
Surcharge (psf)	50	50	50
Corrected CBR Values			
at 0.1 inch (%)	**1.6%**	**2.7%**	**1.1%**
at 0.2 inch (%)	1.5%	3.6%	1.2%
Moisture Content After Penetration			
Top 1" of Specimen:	20.7%	22.3%	30.9%
Average of specimen:	20.7%	20.6%	28.8%

Stress vs. Penetration Graph



California Bearing Ratio ASTM:D1883

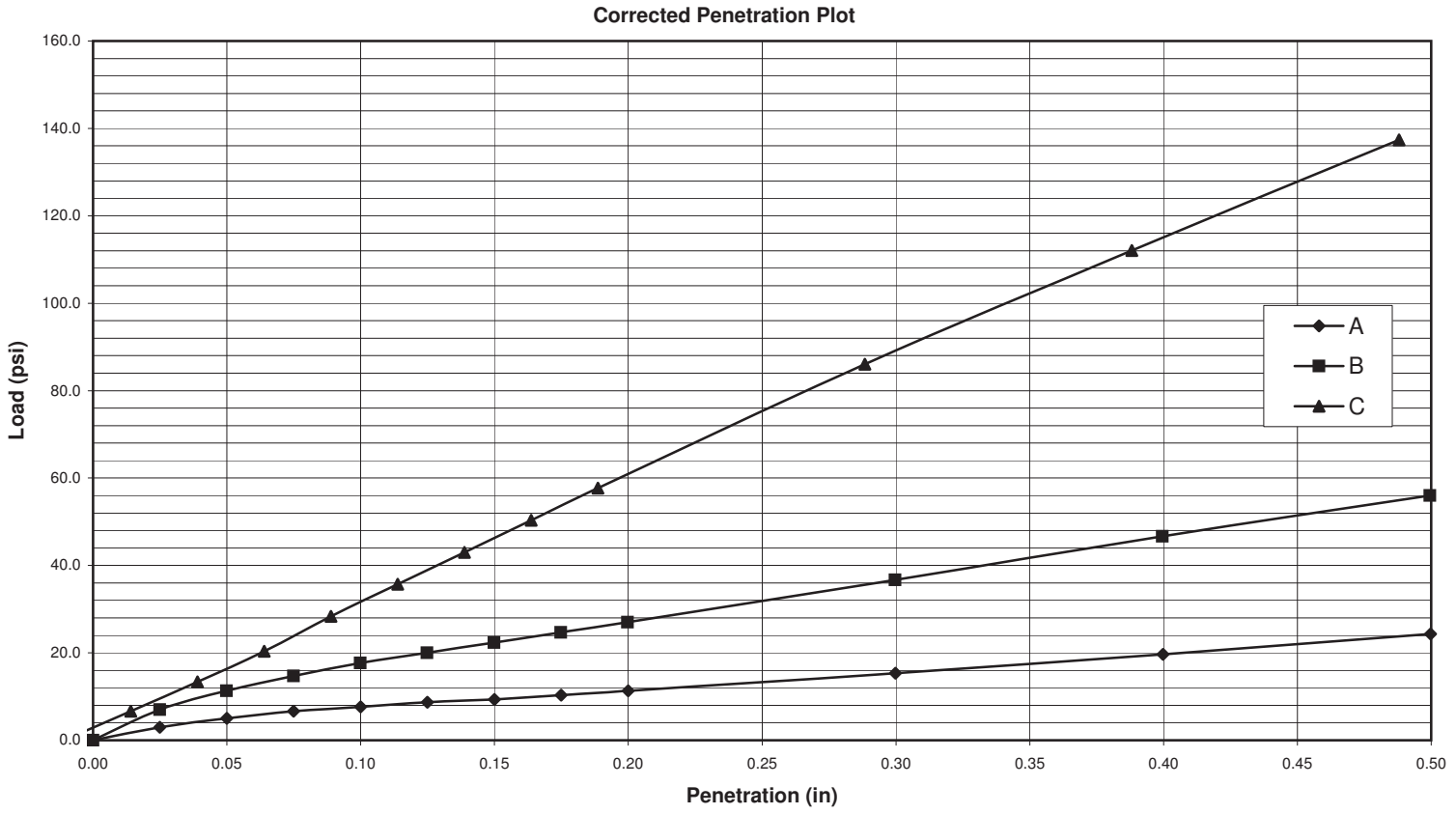
Project:	Hardin County	Job:	**8076-A**
Client:	Barr Engineering Company	Date:	12/7/11

Boring #: T-31 - T-35 - T-39	Procedural Method:
Sample:	Specimens compacted to approximately 95% of maximum standard proctor density at optimum moisture content. Specimens soaked for a period of 4 days before CBR test was performed.
Depth (ft): Type: Bulk	
Location:	
Classification: Fat Clay (CH) - Lean Clay w/sand (CL) - Lean Clay w/sand (CL)	

Laboratory Moisture-Density Values		Index Properties	
Method:	ASTM:D698 Method B	LL:	Gs:
Maximum Dry Density (PCF):	96.9 - 102.0 - 108.9	PL:	Organic Content:
Optimum Water Content:	25.1% - 21.3% - 17.9%	PI:	pH:

Initial Molding Conditions			
Boring	T-31	T-35	T-39
Specimen	A	B	C
Number of Layers:	3	3	3
Blows per Layer:	NA	NA	NA
Initial Moisture Content:	25.1%	21.3%	17.9%
Initial Dry Density (PCF)	92.4	97.1	103.7
Relative Compaction	95.3%	95.2%	95.3%
Soaking Phase			
Days Soaked	4	4	4
Surcharge (psf)	50	50	50
Total Swell (%)	4.5%	1.9%	1.0%
Penetration Phase			
Surcharge (psf)	50	50	50
Corrected CBR Values			
at 0.1 inch (%)	**0.8%**	**1.8%**	**3.2%**
at 0.2 inch (%)	0.8%	1.8%	4.1%
Moisture Content After Penetration			
Top 1" of Specimen:	31.3%	25.9%	21.8%
Average of specimen:	28.6%	23.4%	21.0%

Stress vs. Penetration Graph



California Bearing Ratio ASTM:D1883

Project:	Hardin County	Job:	**8076-A**
Client:	Barr Engineering Company	Date:	12/7/11

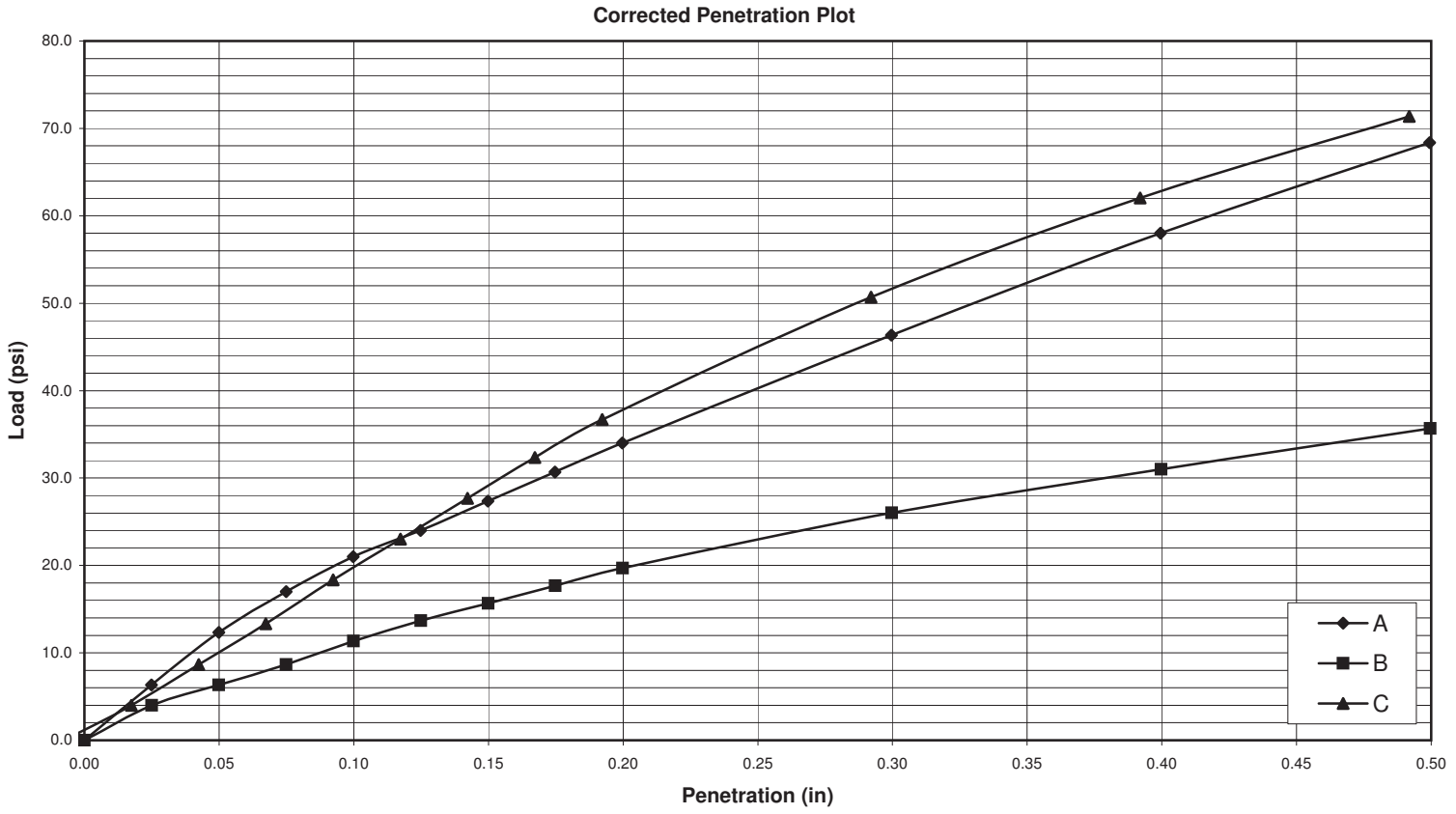
Boring #: T-50 - T-66 - T-72	Procedural Method:
Sample:	Specimens compacted to approximately 95% of maximum standard proctor density at optimum moisture content. Specimens soaked for a period of 4 days before CBR test was performed.
Depth (ft): Type: Bulk	
Location:	

Classification: Lean Clay w/sand (CL) - Organic Clay (OH) - Sandy Lean Clay w/organic material (CL)

Laboratory Moisture-Density Values		Index Properties	
Method:	ASTM:D698 Method B	LL:	Gs:
Maximum Dry Density (PCF):	103.0 - 67.5 - 98.7	PL:	Organic Content:
Optimum Water Content:	21.4% - 47.5% - 21.0%	PI:	pH:

Initial Molding Conditions			
Boring	T-50	T-66	T-72
Specimen	A	B	C
Number of Layers:	3	3	3
Blows per Layer:	NA	NA	NA
Initial Moisture Content:	21.4%	47.5%	21.0%
Initial Dry Density (PCF)	98.2	64.2	93.8
Relative Compaction	95.3%	95.1%	95.0%
Soaking Phase			
Days Soaked	4	4	4
Surcharge (psf)	50	50	50
Total Swell (%)	1.4%	4.6%	2.6%
Penetration Phase			
Surcharge (psf)	50	50	50
Corrected CBR Values			
at 0.1 inch (%)	**2.1%**	**1.1%**	**2.0%**
at 0.2 inch (%)	2.3%	1.3%	2.5%
Moisture Content After Penetration			
Top 1" of Specimen:	26.2%	62.0%	27.2%
Average of specimen:	23.9%	55.0%	25.0%

Stress vs. Penetration Graph



California Bearing Ratio ASTM:D1883

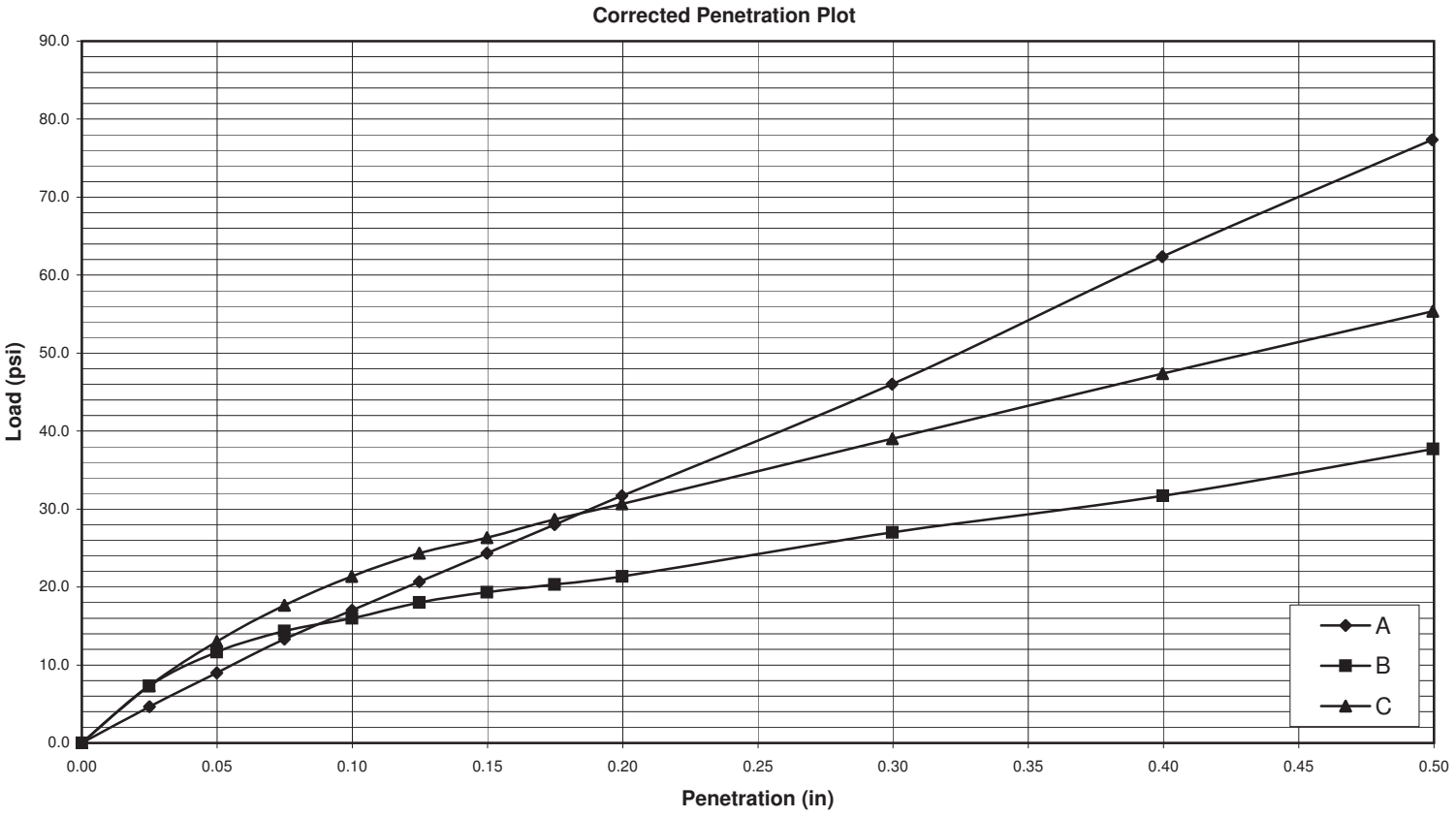
Project:	Hardin County	Job:	**8076-A**
Client:	Barr Engineering Company	Date:	12/7/11

Boring #: T-82 - T-88 - T-117	Procedural Method:
Sample:	Specimens compacted to approximately 95% of maximum standard proctor density at optimum moisture content. Specimens soaked for a period of 4 days before CBR test was performed.
Depth (ft): Type: Bulk	
Location:	
Classification: Lean Clay w/sand (CL) - Lean Clay w/sand (CL) - Lean Clay w/sand (CL)	

Laboratory Moisture-Density Values		Index Properties	
Method:	ASTM:D698 Method B	LL:	Gs:
Maximum Dry Density (PCF):	108.8 - 105.1 - 103.3	PL:	Organic Content:
Optimum Water Content:	18.2% - 20.1% - 20.2%	PI:	pH:

Initial Molding Conditions			
Boring	T-82	T-88	T-117
Specimen	A	B	C
Number of Layers:	3	3	3
Blows per Layer:	NA	NA	NA
Initial Moisture Content:	18.2%	20.1%	20.2%
Initial Dry Density (PCF)	103.6	100.2	98.5
Relative Compaction	95.3%	95.3%	95.3%
Soaking Phase			
Days Soaked	4	4	4
Surcharge (psf)	50	50	50
Total Swell (%)	1.4%	3.8%	2.5%
Penetration Phase			
Surcharge (psf)	50	50	50
Corrected CBR Values			
at 0.1 inch (%)	**1.7%**	**1.6%**	**2.1%**
at 0.2 inch (%)	2.1%	1.4%	2.0%
Moisture Content After Penetration			
Top 1" of Specimen:	23.2%	27.5%	25.8%
Average of specimen:	20.9%	23.8%	23.6%

Stress vs. Penetration Graph



Hardin Solar Energy II LLC
Case No. 18-1360-EL-BGN

Exhibit O

Soil Reactivity Study January 2017

Christine M.T. Pirik (0029759)
(Counsel of Record)
William V. Vorys (0093479)
Dickinson Wright PLLC
150 East Gay Street, Suite 2400
Columbus, Ohio 43215
Phone: (614) 591-5461
Email: cpirik@dickinsonwright.com
wvorys@dickinsonwright.com

Attorneys for Hardin Solar Energy II LLC

resourceful. naturally.
engineering and environmental consultants

BARR

January 23, 2017

Ms. Raquel Justa
Invenergy, LLC
One South Wacker Drive, Suite 1800
Chicago, IL 60606

Re: Soil Reactivity Study
Hardin County Solar Project
Hardin County, Ohio

Dear Ms. Justa:

Barr Engineering Co. (Barr), under authorization and contract with Invenergy, LLC (Invenergy), completed a limited field investigation to determine the potential for soil reactivity and corrosivity conditions at the Hardin Solar Project in Hardin County, Ohio. At the request of Invenergy, Barr performed sampling of the near surface soils at five locations within the solar array footprint. The locations are indicated in Figure 1, included in the attachments. A discussion of the testing and findings are provided in this supplemental report.

Based on Barr's experience with solar power generation facilities, it is anticipated that the foundations for the solar panel arrays will consist on shallow driven piles, and the foundations for the substation will consist of a concrete slab on grade and/or reinforced concrete drilled shafts.

Investigation Summary

Barr performed soil borings to a depth of about five feet at five locations. The soil borings and sampling were performed by TTL Associates, Inc. (TTL) or Toledo, Ohio. Modified California liner samples were collected from a depth of about 3 to 5 feet, in accordance with ASTM D3550, "Standard Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils". The samples were sealed in the field to preserve the in situ moisture content. Two brass liners were collected from each sample. All samples were delivered to Soil Engineering Testing, Inc. (SET) of Bloomington, Minnesota for laboratory testing.

SET completed the following laboratory testing in accordance with the referenced standards:

- Moisture content tests in accordance with ASTM D2116-05, "Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass"
- Dry unit weight tests in accordance with ASTM D7263, "Standard Test Method for Laboratory Determination of Density (Unit Weight) of Soil Specimen"

- Electrical resistivity tests in accordance with ASTM G187, "Standard Test Method for Measurement of Soil Resistivity Using the Two-Electrode Soil Box Method"
- Soil pH tests in accordance with ASTM D4972-01, "Standard Test Method for pH of Soils"
- Soil soluble sulfate and chloride content testing in accordance with USEPA methods

The results of the laboratory testing are provided in the attachments.

Results

Table 1 provides a summary of the results of the chemical and electrical resistivity testing performed by SET.

Table 1 Summary of Chemical and Resistivity Test Results

Test ID	pH	Chloride* [mg/kg]	Sulfate** [mg/kg]	Dry Density [pcf]	Moisture Content [pcf]	Electrical Resistivity*** (Ω-cm)
Chem 01-1	7.2	40	3480	102.0	23.8	1100
Chem 01-2	7.3	40	300	--	--	--
Chem 02-1	7.2	39	6540	110.2	16.1	2000
Chem 02-2	7.5	10	921	--	--	--
Chem 03-1	7.4	92	50	96.4	25.3	1300
Chem 03-2	7.5	76	50	--	--	--
Chem 04-1	6.9	43	2000	91.5	30.9	900
Chem 04-2	7.2	46	1700	--	--	--
Chem 05-1	5.8	44	2040	94.3	28.7	1000
Chem 05-2	7.1	41	2170	--	--	--
Mean	7.1	47	1925	98.9	25.0	1260
St. Dev.	0.50	22	1959	7.41	5.7	439
Min.	5.8	10	50	91.5	16.1	900
Max	7.5	92	6540	110.2	30.9	2000

*Test results for chlorides were below the detection limit for some tests. A value of 10 mg/kg will be used for analysis at those tests.

**Test results for some sulfates were below the detection limit. A value of 50 mg/kg will be used for analysis at that turbine.

***Electrical resistivity test performed on intact liner samples

Analysis and Recommendations

Based on the results of the chemical testing, the soil pH ranged from 5.8 to 7.5, the soluble chloride content ranged from below the detection limit of 10 to 92 mg/kg, and the soluble sulfate content ranged from below the detection limit of 50 to 6,540 mg/kg.

Depending on the sulfate content, the American Concrete Institute (ACI) recommends specific types of cement for use in design to prevent against sulfate attack (ACI, 2011). Based on the results of the sulfate testing, the soils at the site indicate that the sulfate exposure ranges from negligible to severe. Therefore, because the near surface soils have a sulfate content in excess of 2,000 mg/kg, Type V cement or other mix designs with specific resistance to sulfate exposure are recommended for use at the site in accordance with recommendations provided by Kosmatka and Panarese (1988).

The soils at the site exhibited pH values of 5.8 to 7.5. Values of pH below 5 are considered severe (ACI, 2006). The results of the test are not considered severe, but the concrete design should address the potential low pH test values, if required, to achieve the desired strength and durability.

The results of the laboratory electrical resistivity testing indicate that the electrical resistivity of the soils ranged from 900 to 2,000 Ω-cm. The tests were performed at the as-received moisture content of the sample, which was observed to be saturated. The laboratory tests agree relatively close with the field electrical resistivity testing performed during the geotechnical investigation for the nearby wind farm, which ranged from 1,075 to 5,820 Ω-cm, with a typical range of 1,300 to 2,500 Ω-cm. In general, an electrical resistivity of less than 2,000 Ω-cm indicates that the soil is typically considered corrosive when in direct contact with steel foundations. All laboratory tests performed indicated that the electrical resistivity was less than 2,000 Ω-cm. Therefore, the foundation design should take measures to protect the foundation. Protection may include corrosion resistant pile materials, corrosion inhibiting coatings, or concrete encasement.

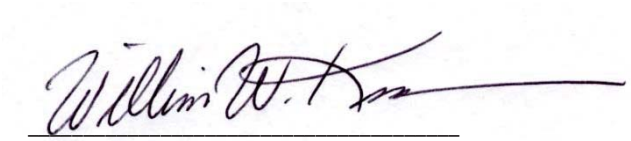
While not tested specifically at the project site, one of the risks with the proposed development will be frost heave of the soils. During the geotechnical investigation at the adjacent wind farm, Barr encountered several areas where highly organic material was observed below the topsoil. The highly organic material has a potential to heave due to frost action, which may stress the foundations and cause differential settlement.

If you have further questions, please contact me at 952-832-2797.

Sincerely,

BARR ENGINEERING CO.

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of Ohio.



William W. Kussmann



Date: January 23, 2017

License No.: PE.74783

Attachments

Figure 1 - Soil Testing Locations
Attachments - Laboratory Testing Results

ACI Code Requirements for Environmental Engineering Concrete Structures and Commentary (ACI 350-06), 2006.

ACI Standard, Building Code Requirements for Structures Concrete and Commentary, ACI 318-11, American Concrete Institute, 2011.

Kosmatka, S. H. and W. C. Panarese, W.C., 1988. PCA – Design and Control of Concrete Mixtures, 13th Edition.

Attachments



Soil Chemical Test Sample

Solar Project Boundary

Feet

1,200 0 1,200

Meters

400 0 400

Figure 1

PROPOSED GEOTECH - 10/10/2016

Hardin Solar Project
Invenergy LLC
Hardin County, Ohio

Barr Foster ArcGIS 10.4 2016-10-11 09:56 File: I:\Projects\35\33\1003\Maps\Basemaps\Hardin Solar Layout 20161010.mxd User: ms2

pH Testing Summary Sheet (ASTM:D4972)

Project: **Hardin Solar** Job: **10602**

Client: **Barr Engineering Company** Date: **12/9/2016**

Boring / Location	Sample	Sample Type	Depth (ft)	pH	Visual Classification
Chem 01	**1**	**Bag**		**7.2**	**Organic Clay with Sand, black (OH)**
Chem 01	**2**	**Bag**		**7.3**	**Lean Clay, gray (CL)**
Chem 02	**1**	**Bag**		**7.2**	**Lean Clay with a trace for Organic Material (CL)**
Chem 02	**2**	**Bag**		**7.5**	**Lean Clay with Sand, gray and black (CL)**
Chem 03	**1**	**Bag**		**7.4**	**Lean Clay with Sand, gray and brown (CL)**
Chem 03	**2**	**Bag**		**7.5**	**Lean Clay with a trace for Organic Material (CL)**
Chem 04	**1**	**Bag**		**6.9**	**Lean Clay, gray and some brown (CL)**
Chem 04	**2**	**Bag**		**7.2**	**Lean Clay and Organic Clay, gray and black (CL)**
Chem 05	**1**	**Bag**		**5.8**	**Lean Clay, gray and some brown (CL)**
Chem 05	**2**	**Bag**		**7.1**	**Lean Clay with a trace for Organic Material (CL)**

9530 James Ave South
SOIL ENGINEERING TESTING, INC.
Bloomington, MN 55431

ANALYTICAL REPORT

November 07, 2016

Soil Engineering Testing, Inc.

Sample Delivery Group:	L869121
Samples Received:	10/28/2016
Project Number:	10602
Description:	Hardin Solar

Report To:

John Whelan
9530 James Ave. South
Bloomington, MN 55431

Entire Report Reviewed By:

Jason Romer
Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.



[1]Cp: Cover Page 1

[2]Tc: Table of Contents 2

[3]Ss: Sample Summary 3

[4]Cn: Case Narrative 5

[5]Sr: Sample Results 6

CHEM 01-SAMPLE 1 L869121-01 6

CHEM 01-SAMPLE 2 L869121-02 7

CHEM 02-SAMPLE 1 L869121-03 8

CHEM 02-SAMPLE 2 L869121-04 9

CHEM 03-SAMPLE 1 L869121-05 10

CHEM 03-SAMPLE 2 L869121-06 11

CHEM 04-SAMPLE 1 L869121-07 12

CHEM 04-SAMPLE 2 L869121-08 13

CHEM 05-SAMPLE 1 L869121-09 14

CHEM 05-SAMPLE 2 L869121-10 15

[6]Qc: Quality Control Summary 16

Wet Chemistry by Method 9056A 16

[7]Gl: Glossary of Terms 22

[8]Al: Accreditations & Locations 23

[9]Sc: Chain of Custody 24

CHEM 01-SAMPLE 1 L869121-01 Solid

Collected by | Collected date/time 10/24/16 13:30 | Received date/time 10/28/16 09:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Wet Chemistry by Method 9056A	WG923165	1	11/03/16 11:08	11/03/16 17:44	SAM
Wet Chemistry by Method 9056A	WG923852	5	11/05/16 11:19	11/05/16 20:07	CM

CHEM 01-SAMPLE 2 L869121-02 Solid

Collected by | Collected date/time 10/24/16 13:30 | Received date/time 10/28/16 09:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Wet Chemistry by Method 9056A	WG923165	1	11/03/16 11:08	11/03/16 18:07	SAM

CHEM 02-SAMPLE 1 L869121-03 Solid

Collected by | Collected date/time 10/24/16 13:30 | Received date/time 10/28/16 09:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Wet Chemistry by Method 9056A	WG923165	1	11/03/16 11:08	11/03/16 18:30	CM
Wet Chemistry by Method 9056A	WG924100	10	11/07/16 09:45	11/07/16 13:34	CM

CHEM 02-SAMPLE 2 L869121-04 Solid

Collected by | Collected date/time 10/24/16 13:30 | Received date/time 10/28/16 09:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Wet Chemistry by Method 9056A	WG923165	1	11/03/16 11:08	11/03/16 19:39	SAM

CHEM 03-SAMPLE 1 L869121-05 Solid

Collected by | Collected date/time 10/24/16 13:30 | Received date/time 10/28/16 09:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Wet Chemistry by Method 9056A	WG923165	1	11/03/16 11:08	11/03/16 22:42	SAM

CHEM 03-SAMPLE 2 L869121-06 Solid

Collected by | Collected date/time 10/24/16 13:30 | Received date/time 10/28/16 09:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Wet Chemistry by Method 9056A	WG922730	1	11/02/16 10:00	11/02/16 13:41	SAM

CHEM 04-SAMPLE 1 L869121-07 Solid

Collected by | Collected date/time 10/24/16 13:30 | Received date/time 10/28/16 09:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Wet Chemistry by Method 9056A	WG922730	1	11/02/16 10:00	11/02/16 14:04	SAM
Wet Chemistry by Method 9056A	WG923183	5	11/03/16 14:09	11/04/16 09:02	SAM

CHEM 04-SAMPLE 2 L869121-08 Solid

Collected by | Collected date/time 10/24/16 13:30 | Received date/time 10/28/16 09:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Wet Chemistry by Method 9056A	WG922730	1	11/02/16 10:00	11/02/16 14:26	SAM
Wet Chemistry by Method 9056A	WG923183	2	11/03/16 14:09	11/04/16 09:24	SAM

CHEM 05-SAMPLE 1 L869121-09 Solid

Collected by	Collected date/time	Received date/time
	10/24/16 13:30	10/28/16 09:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Wet Chemistry by Method 9056A	WG922730	1	11/02/16 10:00	11/02/16 14:49	SAM
Wet Chemistry by Method 9056A	WG923183	5	11/03/16 14:09	11/04/16 09:47	SAM

CHEM 05-SAMPLE 2 L869121-10 Solid

Collected by	Collected date/time	Received date/time
	10/24/16 13:30	10/28/16 09:00

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst
Wet Chemistry by Method 9056A	WG922730	1	11/02/16 10:00	11/02/16 15:35	SAM
Wet Chemistry by Method 9056A	WG923183	5	11/03/16 14:09	11/04/16 10:10	SAM

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times. All MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.



Jason Romer
Technical Service Representative

Wet Chemistry by Method 9056A

Analyte	Result	Qualifier	RDL	Dilution	Analysis	Batch
	mg/kg		mg/kg		date / time	
Chloride	40.0		10.0	1	11/03/2016 17:44	WG923165
Sulfate	3480		250	5	11/05/2016 20:07	WG923852

Wet Chemistry by Method 9056A

Analyte	Result	Qualifier	RDL	Dilution	Analysis	Batch
	mg/kg		mg/kg		date / time	
Chloride	39.6		10.0	1	11/03/2016 18:07	WG923165
Sulfate	300		50.0	1	11/03/2016 18:07	WG923165

Wet Chemistry by Method 9056A

Analyte	Result	Qualifier	RDL	Dilution	Analysis	Batch
	mg/kg		mg/kg		date / time	
Chloride	39.3		10.0	1	11/03/2016 18:30	WG923165
Sulfate	6540		500	10	11/07/2016 13:34	WG924100

Wet Chemistry by Method 9056A

Analyte	Result	Qualifier	RDL	Dilution	Analysis	Batch
	mg/kg		mg/kg		date / time	
Chloride	ND		10.0	1	11/03/2016 19:39	WG923165
Sulfate	921		50.0	1	11/03/2016 19:39	WG923165

Wet Chemistry by Method 9056A

Analyte	Result	Qualifier	RDL	Dilution	Analysis	Batch
	mg/kg		mg/kg		date / time	
Chloride	92.3		10.0	1	11/03/2016 22:42	WG923165
Sulfate	ND		50.0	1	11/03/2016 22:42	WG923165

Wet Chemistry by Method 9056A

Analyte	Result	Qualifier	RDL	Dilution	Analysis	Batch
	mg/kg		mg/kg		date / time	
Chloride	75.8		10.0	1	11/02/2016 13:41	WG922730
Sulfate	ND		50.0	1	11/02/2016 13:41	WG922730

Wet Chemistry by Method 9056A

Analyte	Result	Qualifier	RDL	Dilution	Analysis	Batch
	mg/kg		mg/kg		date / time	
Chloride	42.5		10.0	1	11/02/2016 14:04	WG922730
Sulfate	2000		250	5	11/04/2016 09:02	WG923183

Wet Chemistry by Method 9056A

Analyte	Result	Qualifier	RDL	Dilution	Analysis	Batch
	mg/kg		mg/kg		date / time	
Chloride	46.3		10.0	1	11/02/2016 14:26	WG922730
Sulfate	1700		100	2	11/04/2016 09:24	WG923183

Wet Chemistry by Method 9056A

Analyte	Result	Qualifier	RDL	Dilution	Analysis	Batch
	mg/kg		mg/kg		date / time	
Chloride	43.8		10.0	1	11/02/2016 14:49	WG922730
Sulfate	2040		250	5	11/04/2016 09:47	WG923183

Wet Chemistry by Method 9056A

Analyte	Result	Qualifier	RDL	Dilution	Analysis	Batch
	mg/kg		mg/kg		date / time	
Chloride	40.6		10.0	1	11/02/2016 15:35	WG922730
Sulfate	2170		250	5	11/04/2016 10:10	WG923183

Method Blank (MB)

(MB) R3175477-1 11/02/16 11:42

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/kg		mg/kg	mg/kg
Chloride	U		0.795	10.0
Sulfate	U		0.57	50.0

L869121-09 Original Sample (OS) • Duplicate (DUP)

(OS) L869121-09 11/02/16 14:49 • (DUP) R3175477-4 11/02/16 15:12

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/kg	mg/kg		%		%
Chloride	43.8	45.7	1	4		15

L869340-02 Original Sample (OS) • Duplicate (DUP)

(OS) L869340-02 11/02/16 21:19 • (DUP) R3175477-7 11/02/16 21:42

Analyte	Original Result (dry)	DUP Result (dry)	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/kg	mg/kg		%		%
Chloride	U	51.9	1	8		15
Sulfate	U	11.6	1	20	J P1	15

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3175477-2 11/02/16 12:05 • (LCSD) R3175477-3 11/02/16 12:28

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	%	%	%			%	%
Chloride	200	213	213	106	107	80-120			0	15
Sulfate	200	223	222	111	111	80-120			0	15

L869121-10 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L869121-10 11/02/16 15:35 • (MS) R3175477-5 11/02/16 16:44 • (MSD) R3175477-6 11/02/16 17:07

Analyte	Spike Amount	Original Result	MS Result	MSD Result	MS Rec.	MSD Rec.	Dilution	Rec. Limits	MS Qualifier	MSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	mg/kg	%	%		%			%	%
Chloride	500	40.6	540	533	100	98	1	80-120			1	15

Method Blank (MB)

(MB) R3175762-1 11/03/16 11:50

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/kg		mg/kg	mg/kg
Chloride	U		0.795	10.0
Sulfate	U		0.57	50.0

L868989-21 Original Sample (OS) • Duplicate (DUP)

(OS) L868989-21 11/03/16 13:45 • (DUP) R3175762-4 11/03/16 14:08

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/kg	mg/kg		%		%
Chloride	180	191	1	6		15
Sulfate	54.0	54.3	1	0		15

L869381-06 Original Sample (OS) • Duplicate (DUP)

(OS) L869381-06 11/04/16 01:23 • (DUP) R3175762-7 11/04/16 01:46

Analyte	Original Result (dry)	DUP Result (dry)	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/kg	mg/kg		%		%
Sulfate	U	0	1	0		15

L869381-06 Original Sample (OS) • Duplicate (DUP)

(OS) L869381-06 11/04/16 02:09 • (DUP) R3175762-8 11/04/16 02:32

Analyte	Original Result (dry)	DUP Result (dry)	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/kg	mg/kg		%		%
Chloride	4280	4660	5	8		15

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3175762-2 11/03/16 12:13 • (LCSD) R3175762-3 11/03/16 12:36

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	%	%	%			%	%
Chloride	200	215	214	108	107	80-120			1	15
Sulfate	200	221	220	110	110	80-120			0	15

L869121-03 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L869121-03 11/03/16 18:30 • (MS) R3175762-5 11/03/16 18:53 • (MSD) R3175762-6 11/03/16 19:16

Analyte	Spike Amount	Original Result	MS Result	MSD Result	MS Rec.	MSD Rec.	Dilution	Rec. Limits	MS Qualifier	MSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	mg/kg	%	%		%			%	%
Chloride	500	39.3	523	524	97	97	1	80-120			0	15

Method Blank (MB)

(MB) R3175833-1 11/04/16 04:26

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/kg		mg/kg	mg/kg
Sulfate	U		0.57	50.0

L869381-08 Original Sample (OS) • Duplicate (DUP)

(OS) L869381-08 11/04/16 06:44 • (DUP) R3175833-4 11/04/16 07:07

Analyte	Original Result (dry)	DUP Result (dry)	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/kg	mg/kg		%		%
Sulfate	5.59	6.19	1	10	J	15

L869816-01 Original Sample (OS) • Duplicate (DUP)

(OS) L869816-01 11/04/16 18:52 • (DUP) R3175833-7 11/04/16 19:15

Analyte	Original Result (dry)	DUP Result (dry)	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/kg	mg/kg		%		%
Sulfate	17.9	19.9	1	11	J	15

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3175833-2 11/04/16 04:49 • (LCSD) R3175833-3 11/04/16 05:12

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	%	%	%			%	%
Sulfate	200	219	219	109	110	80-120			0	15

L869587-04 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L869587-04 11/04/16 15:26 • (MS) R3175833-5 11/04/16 15:48 • (MSD) R3175833-6 11/04/16 16:11

Analyte	Spike Amount	Original Result	MS Result	MSD Result	MS Rec.	MSD Rec.	Dilution	Rec. Limits	MS Qualifier	MSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	mg/kg	%	%		%			%	%
Sulfate	500	16.0	553	554	107	108	1	80-120			0	15

Method Blank (MB)

(MB) R3176145-1 11/05/16 11:40

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/kg		mg/kg	mg/kg
Sulfate	U		0.57	50.0

L869858-04 Original Sample (OS) • Duplicate (DUP)

(OS) L869858-04 11/05/16 15:55 • (DUP) R3176145-4 11/05/16 16:18

Analyte	Original Result (dry)	DUP Result (dry)	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/kg	mg/kg		%		%
Sulfate	184	189	1	3		15

L869858-18 Original Sample (OS) • Duplicate (DUP)

(OS) L869858-18 11/06/16 00:20 • (DUP) R3176145-7 11/06/16 00:43

Analyte	Original Result (dry)	DUP Result (dry)	Dilution	DUP RPD	DUP Qualifier	DUP RPD Limits
	mg/kg	mg/kg		%		%
Sulfate	16.7	16.3	1	2	J	15

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3176145-2 11/05/16 12:03 • (LCSD) R3176145-3 11/05/16 12:26

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	%	%	%			%	%
Sulfate	200	200	215	100	107	80-120			7	15

L869858-09 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L869858-09 11/05/16 18:36 • (MS) R3176145-5 11/05/16 18:59 • (MSD) R3176145-6 11/05/16 19:21

Analyte	Spike Amount (dry)	Original Result (dry)	MS Result (dry)	MSD Result (dry)	MS Rec.	MSD Rec.	Dilution	Rec. Limits	MS Qualifier	MSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	mg/kg	%	%		%			%	%
Sulfate	672	8.21	717	700	105	103	1	80-120			2	15

Method Blank (MB)

(MB) R3176275-1 11/07/16 10:57

Analyte	MB Result	MB Qualifier	MB MDL	MB RDL
	mg/kg		mg/kg	mg/kg
Sulfate	U		0.57	50.0

Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3176275-2 11/07/16 11:20 • (LCSD) R3176275-3 11/07/16 11:43

Analyte	Spike Amount	LCS Result	LCSD Result	LCS Rec.	LCSD Rec.	Rec. Limits	LCS Qualifier	LCSD Qualifier	RPD	RPD Limits
	mg/kg	mg/kg	mg/kg	%	%	%			%	%
Sulfate	200	203	203	101	101	80-120			0	15

Abbreviations and Definitions

SDG	Sample Delivery Group.
MDL	Method Detection Limit.
RDL	Reported Detection Limit.
ND	Not detected at the Reporting Limit (or MDL where applicable).
U	Not detected at the Reporting Limit (or MDL where applicable).
RPD	Relative Percent Difference.
(dry)	Results are reported based on the dry weight of the sample. [this will only be present on a dry report basis for soils].
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Rec.	Recovery.

Qualifier	Description
J	The identification of the analyte is acceptable; the reported value is an estimate.
P1	RPD value not applicable for sample concentrations less than 5 times the reporting limit.

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our "one location" design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be **YOUR LAB OF CHOICE.**

***** Not all certifications held by the laboratory are applicable to the results reported in the attached report.

State Accreditations

Alabama	40660	Nevada	TN-03-2002-34
Alaska	UST-080	New Hampshire	2975
Arizona	AZ0612	New Jersey–NELAP	TN002
Arkansas	88-0469	New Mexico	TN00003
California	01157CA	New York	11742
Colorado	TN00003	North Carolina	Env375
Conneticut	PH-0197	North Carolina [1]	DW21704
Florida	E87487	North Carolina [2]	41
Georgia	NELAP	North Dakota	R-140
Georgia [1]	923	Ohio–VAP	CL0069
Idaho	TN00003	Oklahoma	9915
Illinois	200008	Oregon	TN200002
Indiana	C-TN-01	Pennsylvania	68-02979
Iowa	364	Rhode Island	221
Kansas	E-10277	South Carolina	84004
Kentucky [1]	90010	South Dakota	n/a
Kentucky [2]	16	Tennessee [1 4]	2006
Louisiana	AI30792	Texas	T 104704245-07-TX
Maine	TN0002	Texas [5]	LAB0152
Maryland	324	Utah	6157585858
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	109
Minnesota	047-999-395	Washington	C1915
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	9980939910
Montana	CERT0086	Wyoming	A2LA
Nebraska	NE-OS-15-05		

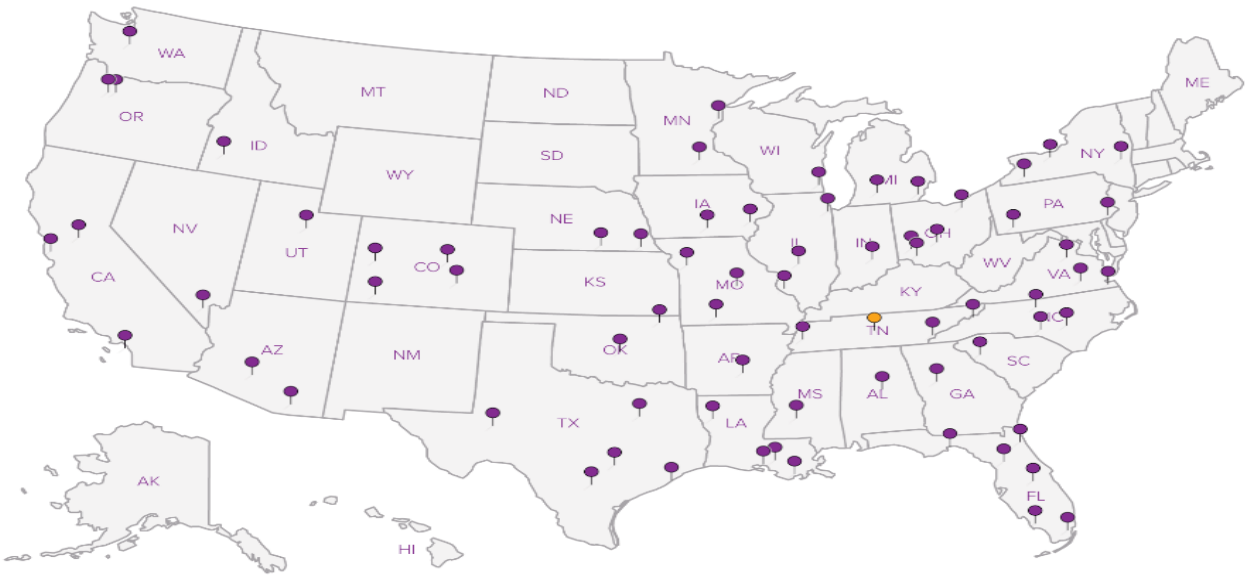
Third Party & Federal Accreditations

A2LA – ISO 17025	1461.01	AIHA	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	S-67674
EPA–Crypto	TN00003		

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [n/a] Accreditation not applicable

Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. **ESC Lab Sciences performs all testing at our central laboratory.**



Soil Engineering Testing, Inc.

9530 James Ave. South
Bloomington, MN 55431

Billing Information & Quote Number:

John Whelan
9530 James Ave. South
Bloomington, MN 55431

Report to: JOHN WHELAN

Email To: jwhelan@soilengineeringtesting.com

Project Description: HARDIN SOLAR

City/State Collected:

Phone: 952-884-6833
Fax: 952-884-6923

Client Project # 10602

Lab Project #

Collected by (print):

Site/Facility ID #

P.O. #

Collected by (signature):

Immediately Packed on Ice N ___ Y ___

Rush? (Lab MUST Be Notified)
___ Same Day 200%
___ Next Day 100%
___ Two Day 50%
___ Three Day 25%

Date Results Needed

Email? ___No X Yes
FAX? X No ___Yes

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	Sulfate Ion	Chloride Ion								Rem./Contaminant	Sample # (lab only)
CHEM #1 - SAMPLE 1		GS	—	10/24/16	13:30	1	X	X									-01
CHEM #1 - SAMPLE 2			—	10/24/16	13:30	1	X	X									-02
CHEM #2 - SAMPLE 1			—	10/24/16	13:30	1	X	X									-03
CHEM #2 - SAMPLE 2			—	10/24/16	13:30	1	X	X									-04
CHEM #3 - SAMPLE 1			—	10/24/16	13:30	1	X	X									-05
CHEM #3 - SAMPLE 2			—	10/24/16	13:30	1	X	X									-06
CHEM #4 - SAMPLE 1			—	10/24/16	13:30	1	X	X									-07
CHEM #4 - SAMPLE 2			—	10/24/16	13:30	1	X	X									-08
CHEM #5 - SAMPLE 1			—	10/24/16	13:30	1	X	X									-09
CHEM #5 - SAMPLE 2			—	10/24/16	13:30	1	X	X									-10

* Matrix: **SS** - Soil **GW** - Groundwater **WW** - WasteWater **DW** - Drinking Water **OT** - Other_____

Remarks:

pH _____ Temp _____

Flow _____ Other _____

7061664 78770

Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)
	10/24/16	15:00	
Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)
Relinquished by : (Signature)	Date:	Time:	Received for lab by: (Signature)

Samples returned via: ☐ UPS ☐ FedEx ☐ Courier ☐ _____

Temp: Amb °C Bottles Received: 10=bag

Date: 10.28.16 Time: 09:00

Hold #

Condition: OK (lab use only)

COC Seal Intact: ___Y ___N ___NA

pH Checked: NCF:

Chain of Custody Page ___ of ___

ESC LAB SCIENCES
YOUR LAB OF CHOICE
12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L# L869121
A243

Acctnum: SOIENGBMN
Template:
Prelogin:
TSR: 341 - John Hawkins
PB:
Shipped Via:

ESC
L·A·B S·C·I·E·N·C·E·S
YOUR LAB OF CHOICE

Cooler Receipt Form

Client: SOIENGRMN	SDG#	C869121
Cooler Received/Opened On: 10/28/2016	Temperature Upon Receipt:	AMB °c
Received By: Nikki Farmer		
Signature:		

Receipt Check List	Yes	No	N/A
Were custody seals on outside of cooler and intact?			✓
Were custody papers properly filled out?	✓		
Did all bottles arrive in good condition?	✓		
Were correct bottles used for the analyses requested?	✓		
Was sufficient amount of sample sent in each bottle?	✓		
Were all applicable sample containers correctly preserved and checked for preservation? (Any not in accepted range noted on COC)		✓	
If applicable, was an observable VOA headspace present?			✓
Non Conformance Generated. (If yes see attached NCF)			

Laboratory Test Summary

Job: **10602**

Project: **Hardin Solar**

Date: **11/29/2016**

Client: **Barr Engineering Company**

Sample Information & Classification

Boring	Chem 01	Chem 02	Chem 03	Chem 04
Sample	Top+Bot	Top+Bot	Top+Bot	Top+Bot
Depth (ft)				
Type or BPF	Liners	Liners	Liners	Liners
Soil Classification	Lean Clay (CL)	Sandy Lean Clay w/a little gravel (CL)	Lean Clay (CL)	Lean Clay (CL/CH)

Water Content & Density (Initial)

Water Content (%)	23.8	16.1	25.3	30.9
Dry Density (PCF)	102.0	110.2	96.4	91.5

Water Content & Density (Saturated)

Water Content (%)	**N/A**	**N/A**	**N/A**	**N/A**
Dry Density (PCF)	**N/A**	**N/A**	**N/A**	**N/A**

Resistivity (ohm-cm) (ASTM G187-05)

As Received Moisture Content Resistivity (ohm-cm)	**1,100**	**2,000**	**1,300**	**900**
Saturated Condition Resistivity (ohm-cm)	**Sample received in a saturated condition**	**Sample received in a saturated condition**	**Sample received in a saturated condition**	**Sample received in a saturated condition**

9530 James Ave South

SOIL ENGINEERING TESTING, INC.

Bloomington, MN 55431

Laboratory Test Summary

Job: **10602**

Project: **Hardin Solar**

Date: **11/29/2016**

Client: **Barr Engineering Company**

Sample Information & Classification

Boring	Chem 05			
Sample	Top+Bot			
Depth (ft)				
Type or BPF	Liners			
Soil Classification	Lean Clay (CL/CH)			

Water Content & Density (Initial)

Water Content (%)	28.7			
Dry Density (PCF)	94.3			

Water Content & Density (Saturated)

Water Content (%)	**N/A**			
Dry Density (PCF)	**N/A**			

Resistivity (ohm-cm) (ASTM G187-05)

As Received Moisture Content Resistivity (ohm-cm)	**1,000**			
Saturated Condition Resistivity (ohm-cm)	**Sample received in a saturated condition**			

9530 James Ave South

SOIL ENGINEERING TESTING, INC.

Bloomington, MN 55431

Hardin Solar Energy II LLC
Case No. 18-1360-EL-BGN

Exhibit P

U.S. Fish and Wildlife Service Communication
June 2018

Christine M.T. Pirik (0029759)
(Counsel of Record)
William V. Vorys (0093479)
Dickinson Wright PLLC
150 East Gay Street, Suite 2400
Columbus, Ohio 43215
Phone: (614) 591-5461
Email: cpirik@dickinsonwright.com
wvorys@dickinsonwright.com

Attorneys for Hardin Solar Energy II LLC

Exhibit P

Pitts, Justin

From: susan_zimmermann@fws.gov on behalf of Ohio, FW3 <ohio@fws.gov>
Sent: Monday, June 25, 2018 9:19 AM
To: Pitts, Justin
Cc: nathan.reardon@dnr.state.oh.us; kate.parsons@dnr.state.oh.us; Lori Stevenson; mretterer@pheasantsforever.org
Subject: Invenergy LLC, Hardin Solar II Energy Center Project, Hardin County
Attachments: Ohio Solar Site Pollinator Habitat Planning and Assessment Form v.9 FINAL_5_3_2018.pdf

UNITED STATES DEPARTMENT OF THE INTERIOR
U.S. Fish and Wildlife Service
Ecological Services Office
4625 Morse Road, Suite 104
Columbus, Ohio 43230
(614) 416-8993 / Fax (614) 416-8994

TAILS #03E15000-2018-TA-1543

Dear Mr. Pitts,

We have received your recent correspondence requesting information about the subject proposal. There are no federal wilderness areas, wildlife refuges or designated critical habitat within the vicinity of the project area. The following comments and recommendations will assist you in fulfilling the requirements for consultation under section 7 of the Endangered Species Act of 1973, as amended (ESA).

The U.S. Fish and Wildlife Service (Service) recommends that proposed developments avoid and minimize water quality impacts and impacts to high quality fish and wildlife habitat (e.g., forests, streams, wetlands). Additionally, natural buffers around streams and wetlands should be preserved to enhance beneficial functions. If streams or wetlands will be impacted, the Corps of Engineers should be contacted to determine whether a Clean Water Act section 404 permit is required. Best management practices should be used to minimize erosion, especially on slopes. All disturbed areas should be mulched and revegetated with native plant species. Prevention of non-native, invasive plant establishment is critical in maintaining high quality habitats.

FEDERALLY LISTED SPECIES COMMENTS: All projects in the State of Ohio lie within the range of the federally endangered **Indiana bat** (*Myotis sodalis*) and the federally threatened **northern long-eared bat** (*Myotis septentrionalis*). In Ohio, presence of the Indiana bat and northern long-eared bat is assumed wherever suitable habitat occurs unless a presence/absence survey has been performed to document absence. Suitable summer habitat for Indiana bats and northern long-eared bats consists of a wide variety of forested/wooded habitats where they roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats such as emergent wetlands and adjacent edges of agricultural fields, old fields and pastures. This includes forests and woodlots containing potential roosts (i.e., live trees and/or snags ≥3 inches diameter at breast height (dbh) that have any exfoliating bark, cracks, crevices, hollows and/or cavities), as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure. Individual trees may be considered suitable habitat when they exhibit the characteristics of a potential roost tree and are located within 1,000 feet (305 meters) of other forested/wooded habitat. Northern long-eared bats have also been observed roosting in human-made structures, such as buildings, barns, bridges, and bat houses; therefore, these structures should also be considered potential summer habitat. In the winter, Indiana bats and northern long-eared bats hibernate in caves and abandoned mines.

Should the proposed site contain trees ≥3 inches dbh, we recommend that trees be saved wherever possible. If any caves or abandoned mines may be disturbed, further coordination with this office is requested to determine if fall or spring portal surveys are warranted. If no caves or abandoned mines are present and trees ≥3 inches dbh cannot be avoided, we recommend that removal of any trees ≥3 inches dbh only occur between October 1 and March 31. Seasonal clearing is being recommended to avoid adverse effects to Indiana bats and northern long-eared bats. While incidental take of northern long-eared bats from most tree clearing is exempted by a 4(d) rule (see http://www.fws.gov/midwest/endangered/mammals/nleb/index.html), incidental take of Indiana bats is still prohibited without a project-specific exemption. Thus, seasonal clearing is recommended where Indiana bats are assumed present.

If implementation of this seasonal tree cutting recommendation is not possible, summer surveys may be conducted to document the presence or probable absence of Indiana bats within the project area during the summer. If a summer survey documents probable absence of Indiana bats, the 4(d) rule for the northern long-eared bat could be applied. Surveys must be conducted by an approved surveyor and be designed and conducted in coordination with the Endangered Species Coordinator for this office. Surveyors must have a valid federal permit. Please note that summer surveys may only be conducted between June 1 and August 15.

The Service is working closely with our partners at Ohio Pollinator Habitat Initiative (OPHI) to create and enhance pollinator habitat at solar power installations. Attached for your use is the Ohio Solar Site Pollinator Habitat Planning and Assessment Form. This form was developed by the OPHI Solar Pollinator Program Advisory Team. We recommend that the areas between the solar panels be planted with legumes and wildflowers (i.e. forbs) that are beneficial to pollinators and other wildlife instead of non-native grass. Pollinators are beneficial to agricultural communities like the project area because they pollinate many varieties of fruits and vegetables. The recommended legumes and forbs are short (low-growing) so as not to cast shadows on the solar panels and would only require one to two mowings a year for maintenance, which should allow the project proponent to minimize maintenance costs. For other areas of the installation where vegetation does not have to be low-growing, alternative pollinator mixes are available with a more diverse array of flowering plants. This perennial vegetation will provide beneficial foraging habitat to songbirds and pollinators (e.g., monarch butterfly and the federally listed rusty patched bumblebee) while reducing storm water runoff, standing water, and erosion. Native plants can act as host plants for insect larva while flowering plants provide nectar sources for adult butterflies as well as other pollinators such as hummingbirds. Seeds from these plants can also provide food for a wide variety of bird species. Please contact the Ohio Pollinator Habitat Initiative (http://www.ophi.info/, and specifically Mike Retterer mretterer@pheasantsforever.org) for further information on solar power facility pollinator plantings.

Recommended low-growing grasses and forbs may include:

Little Bluestem	*Schizachyrium scoparium*
Sideoats Grama	*Bouteloua curtipendula*
Alfalfa	*Medicago spp.*
Alsike Clover	*Trifollurn hybridum*
Brown-eyed Susan	*Rudbeckia triloba*
Butterfly Milkweed	*Asclepias tuberosa*
Lanceleaf Coreopsis	*Coreopsis lanceolata*
Partridge Pea	*Chamaecrista fasciculata*
Timothy	*Phelum pratense*
Orchardgrass	*Dactylis glomerata*

Crimson Clover	*Trifollum incarnetum*
Ladino or White Clover	*Trifollum repens*

If there is a federal nexus for the project (e.g., federal funding provided, federal permits required to construct), no tree clearing should occur on any portion of the project area until consultation under section 7 of the ESA, between the Service and the federal action agency, is completed. We recommend that the federal action agency submit a determination of effects to this office, relative to the Indiana bat and northern long-eared bat, for our review and concurrence.

Due to the project type, size, and location, we do not anticipate adverse effects to any other federally endangered, threatened, proposed, or candidate species. Should the project design change, or during the term of this action, additional information on listed or proposed species or their critical habitat become available, or if new information reveals effects of the action that were not previously considered, consultation with the Service should be initiated to assess any potential impacts.

These comments have been prepared under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), the ESA, and are consistent with the intent of the National Environmental Policy Act of 1969 and the Service's Mitigation Policy. This letter provides technical assistance only and does not serve as a completed section 7 consultation document. We recommend that the project be coordinated with the Ohio Department of Natural Resources due to the potential for the project to affect state listed species and/or state lands. Contact John Kessler, Environmental Services Administrator, at (614) 265-6621 or at john.kessler@dnr.state.oh.us.

If you have questions, or if we can be of further assistance in this matter, please contact our office at (614) 416-8993 or ohio@fws.gov.

Sincerely,

Scott Pruitt
Acting Field Office Supervisor

cc: Nathan Reardon, ODNR-DOW
Kate Parsons, ODNR-DOW
Mike Retterer, OPHI
Lori Stevenson, USFWS Partners Program

Exhibit Q

TRC Cultural Resources Records Report
October 2018

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(Counsel of Record)
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Liberty Technology Center
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CONFIDENTIAL BUSINESS INFORMATION

October 3, 2018

Gabe Klooster
Analyst, Business Development
Invenergy
One South Wacker Drive, Suite 1800
Chicago, IL 60606

Re: Cultural Resources Due Diligence Records Review
Hardin Solar II Energy Center
Hardin County, Ohio

Project Description

On behalf of Hardin Solar Energy II LLC, TRC Environmental Corporation (TRC) has prepared this Cultural Resources Due Diligence Records Review as part of the environmental studies conducted for the Hardin Solar II Energy Center Project located in Marion, McDonald, and Roundhead Townships, Hardin County, OH. This Project represents a second phase of the Hardin Solar Energy Center, consisting of a new Project Study Area which encompasses approximately 3,300 acres of primarily agricultural land and an additional 396 acres of underground collection corridors (Figure 1).

Database Review

TRC conducted a records review of the resources available from the State Historic Preservation Office (SHPO), i.e. Ohio Historic Preservation Office (OHPO) including the Ohio Historic Inventory (OHI), the Ohio Archaeological Inventory (OAI), and the National Register of Historic Places (NRHP) files, as well as information on historic cemeteries maintained by the Ohio Genealogical Society (OGS). As part of this records review, TRC examined all available cultural resources survey reports relating to previous investigations in the area. This review identified previously surveyed, National Register-eligible, or National Register-listed resource structures or districts and constituted the initial cultural background research and architectural (visual effects) Area of Potential Effects (APE) for both direct and indirect effects for the project.

The APE for architectural resources is based primarily on those resources and areas that could potentially fall within the line of sight of the proposed facility. It consisted of an 8-km (5-mi) radius buffer area surrounding the proposed Hardin Solar II Energy Center construction footprint (Figure 2). Based on topography, areas of potential site visibility, and areas of potential obstructed viewshed, TRC further refined the research area to include only those resources within a 1.6-km (1-mi) radius of the project footprint as well.

The APE for direct effects consists of the approximately 3,300 acres and an additional 396 acres of underground collection corridors which comprises all areas where the proposed construction will take place. This records review was conducted in accordance with the Secretary of the Interior's Standards for Archaeology and Historic Preservation (Federal Register Vol. 48, No. 190, Part IV, (1983)) and the OHPO's Archaeological Guidelines (1994).

The final task of the background research was to conduct a brief review of soils and topographic conditions. Archaeological sites in the area are known to be associated with certain environmental parameters, which can then be used to help assess the relative potential of the project for containing archaeological sites.

Historic Architectural Resources

Background research in the OHPO Online Mapping System revealed no previously-surveyed architectural resources or NRHP-listed or eligible resources located within the project area boundaries. However, a single NRHP-listed property was identified within the 5-mi radius architectural study area. The Zimmerman Kame Property is located approximately 3.5 miles south of the project location. There are, however, 251 architectural resources within the 5-mi radius that have been previously surveyed but have yet to be evaluated for listing in the NRHP (see Figure 2). In addition to these resources, 33 cemetery resources were identified within the 5-mile radius (see Figure 2). Based on topography, areas of potential site visibility, and areas of potential obstructed viewshed, the research area was further refined to include only those resources within a 1.6-km (1-mi) radius. There are 61 resources located within a 1-mile radius of the project area. Of these, 20 were identified within the project area, which are listed in the table below (Figure 3). None of these previously-surveyed resources have been evaluated for listing in the NRHP.

HISTORIC ARCHITECTURAL RESOURCES WITHIN THE APE		
OHI SURVEY ID#	**RESOURCE NAME/TYPE**	**DATE**
HAR0057705	**Doyle Helton House**	**c.1920**
HAR0061610	**Richard E & Teri Wyss Barn**	**c.1920**
HAR0067009	**Dean A & Sue A Clement**	**c.1910**
HAR0067109	**Sue Ann F Chafin House**	**c.1900**
HAR0067209	**Howard & Cristal Lyle House**	**c.1900**
HAR0067309	**Douglas L Dodds House**	**c.1910**
HAR0007109	**Tenant House**	**c.1910**
HAR0007209	**Tenant House**	**c.1910**
HAR0007309	**Tenant House**	**c.1910**
HAR0007409	**Shed**	**c.1910**
HAR0007509	**Chicken Coop**	**c.1910**
HAR0007609	**Storage**	**c.1910**
HAR0007709	**Livestock Barn**	**c.1910**
HAR0007809	**Dairy Barn**	**c.1910**
HAR0007909	**Brick Silo**	**c.1910**
HAR0008009	**Shed**	**c.1910**

HISTORIC ARCHITECTURAL RESOURCES WITHIN THE APE		
OHI SURVEY ID#	**RESOURCE NAME/TYPE**	**DATE**
HAR0008109	**Granary**	**c.1840**
HAR0008209	**Garage**	**c.1910**
HAR0008309	**Office**	**c.1910**
HAR0008409	**Brick Silo**	**c.1910**

Archaeological Resources

The file review revealed that 134 archaeological resources were previously documented within the 8-km (5-mi) radius of the project location (see Figure 2). A total of 120 of these resources are characterized as open habitation sites primarily dating to a prehistoric cultural temporal period. Of the remaining sites, five of these are characterized as prehistoric and historic multi-component resources, eight (8) are characterized as historic period sites, and one (1) site was documented with no cultural affiliation.

Of the 134 resources, 42 were identified within a 1.6-km (1-mi) radius of the project footprint, and three (3) of these previously recorded archaeological resources were identified within the boundaries of the proposed APE. These resources are listed in the table below and depicted in Figure 4. Similar to the sites identified throughout the region, all three (3) sites within the APE are characterized as open habitation settings; two (2) dating to an unknown prehistoric cultural temporal period, and one documented as a prehistoric and historic multi-component resource.

ARCHAEOLOGICAL RESOURCES WITHIN THE APE		
SITE #	**SITE NAME**	**SITE TYPE**
33HR0205	**Wyss 1 Site**	**Multi-Component: Prehistoric and Historic**
33HR0225	**Unnamed**	**Unknown Prehistoric**
33HR0263	**Unnamed**	**Unknown Prehistoric**

Previous Cultural Resource Surveys

During the file review of previously conducted survey records maintained by the SHPO, it was revealed that nine (9) areas within the 8-km (5-mi) radius of the project have been previously cleared for cultural resources (see Figure 2).

CULTURAL RESOURCES SURVEY WITHIN 5-MI RADIUS		
NADB #	**SURVEY NAME**	**SURVEY TYPE**
13058	**A Transect Corridor through the Headwaters of the Scioto River, Hardin Co, OH**	**Phase I Archaeological Survey**
13062	**FMHA Housing Complex, Alger, Hardin Co, OH**	**Phase I and II Archaeological Historical Survey**
14771	**DPL Energy's Proposed Harrod Electric Generating Facility, Auglaize Township, Allen Co, OH**	**Phase I Cultural Resource Survey**

CULTURAL RESOURCES SURVEY WITHIN 5-MI RADIUS		
NADB #	**SURVEY NAME**	**SURVEY TYPE**
17029	**Proposed Cell Tower (TOL-140-West Newton) in Auglaize Township, Allen County, Ohio**	**Phase I Cultural Resource Survey**
17788	**McGuffey/Village of McGuffey Wireless Cellular Tower in Marion Township, Hardin Co, OH**	**Phase I Cultural Resource Survey**
17897	**OH-Holden Telecommunications Tower Project Area, Roundhead Township, Butler Co, OH**	**Phase I Cultural Resource Survey**
19791	**Holden HNCC-153 Wireless Cellular Tower in the Unincorporated Community of Harrod, Roundhead Township, Hardin County, Ohio (CTL# 15510020COLa; Ensite No. 23201)**	**Phase I Archaeological Survey**
20184	**Marathon Harpster to Lima Pipeline Project, Allen, Hardin, and Wyandot Counties, Ohio**	**Phase I Cultural Resource Survey**
Not Yet Available	**Proposed Hardin Wind Farm, Townships of Cessna, Lyn, Marion, and McDonald, Hardin Co., OH.**	**Phase I Cultural Resource Survey**

Conclusions

The OHPO Online Mapping System revealed no previously surveyed architectural resources or NRHP-listed or eligible resources located within the APE boundaries; however, a single NRHP-listed property was identified within a 5-mi radius architectural study area. In addition to this resource, 33 cemetery resources were identified within the 5-mile radius. Based on topography, areas of potential site visibility and areas of potential obstructed viewshed, TRC further refined the research area to include only those resources within a 1.6-km (1-mi) radius of the project footprint. A total of 251 architectural resources were documented within the 5-mi radius, and 61 of these resources were within the 1-mile radius of the project area. Of these, 20 were identified within the project area boundaries. Currently, these resources have yet to be evaluated for listing in the NRHP.

The file review also revealed that 134 archaeological resources were previously documented within the 8-km (5-mi) radius of the project location, with 42 identified within a 1.6-km (1-mi) radius of the project footprint. A total of three (3) previously-recorded archaeological resources were identified within the boundaries of the proposed APE associated with the Hardin Solar II Energy Center project boundary. The majority of the resources within the general geographic region are characterized as open habitation sites dating to an unknown prehistoric cultural temporal periods.

This review was conducted by professionals who meet the 36 CFR 61 Secretary of the Interior's Professional Qualification Standards.

Sincerely,



Curtis L. Biondich, M.S., RPA
PPL Office Practice Leader/Practice Safety Lead
36CFR61-Qualified Archaeologist

References

DeRegnaucourt, Tony

1984 *An Archaeological Survey of a Transect Corridor through the Headwaters of the Scioto River, Hardin County, Ohio.*

Keener, Craig S.

2006 *Phase I Cultural Resource Management Survey of a Proposed Cell Tower (TOL-140-West Newton) in Auglaize Township, Allen County, Ohio*.

Lawhon, Cassandra, and Joel Brown

2015 *Phase I Archaeological Survey for the Holden HNCC-153 Wireless Cellular Tower in the Unincorporated Community of Harrod, Roundhead Township, Hardin County, Ohio (CTL# 15510020COLa; Ensite No. 23201).*

Meyer, Elaine

2008 *Phase I Cultural Resources Management Survey for the Proposed McGuffey/Village of McGuffey Wireless Cellular Tower in Marion Township, Hardin County, Ohio.*

Payette, Jacquie

2008 *Phase I Cultural Resources Investigation Survey of Proposed OH-Holden Telecommunications Tower Project Area, Roundhead Township, Butler County, Ohio.*

United States Geological Survey (USGS)

1962 Alger, Ohio 7.5-minute Quadrangle. Photorevised 1980.

1980 Roundhead, Ohio 7.5-minute Quadrangle. Photorevised 1983.

Wally, Scott A., and Rebecca A. Hawkins

1993 *Phase I and II Archaeological Historical Survey for the FMHA Housing Complex, Alger, Hardin County, Ohio.*

Wellspring, Adam L., et al.

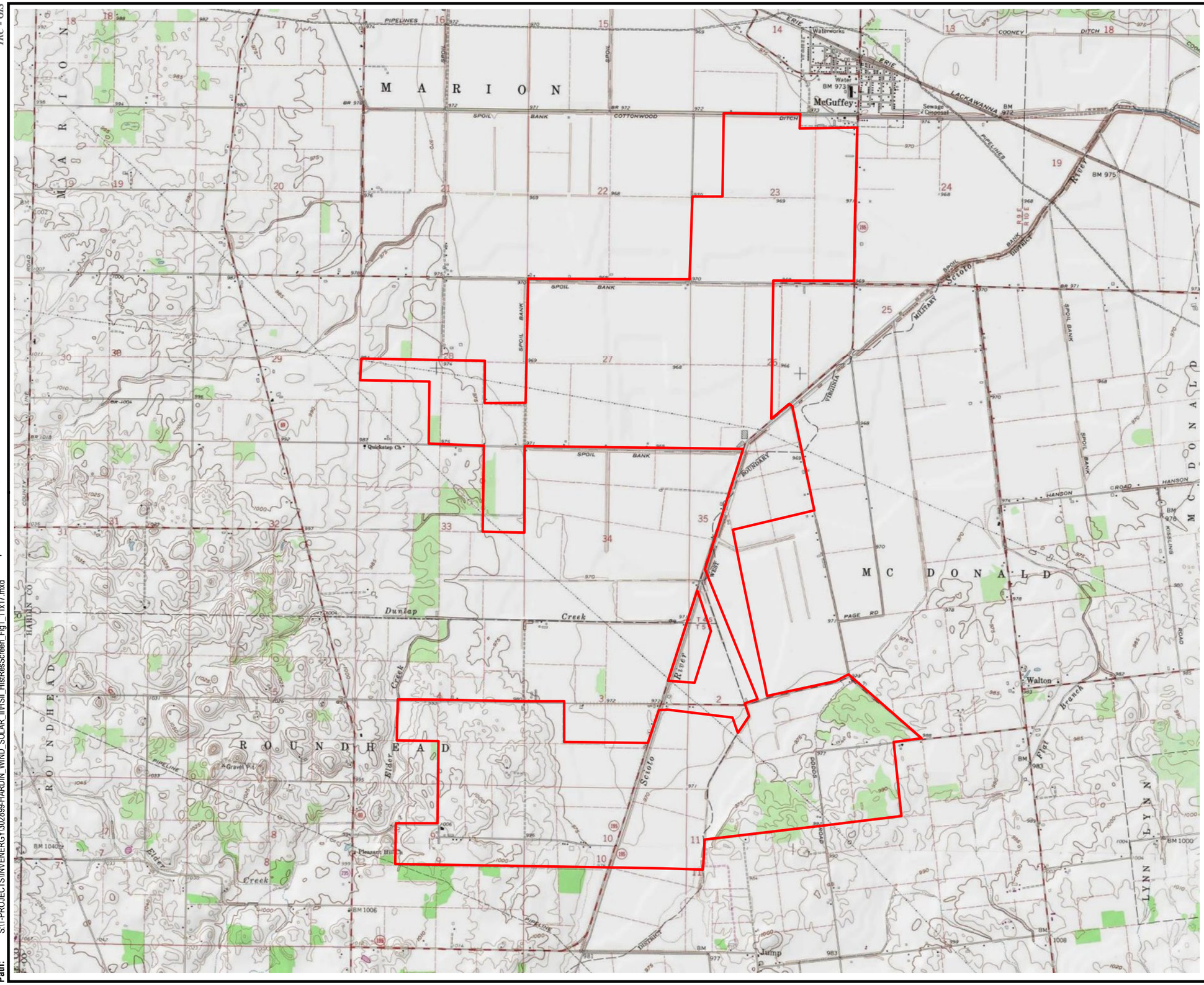
2016 *Phase I Cultural Resources Survey for the Marathon Harpster to Lima Pipeline Project, Allen, Hardin, and Wyandot Counties, Ohio.*

Wilson, James F. and Christopher A. Bergman

2000 *Phase I Cultural Resource Survey of DPL Energy's Proposed Harrod Electric Generating Facility, Auglaize Township, Allen County, Ohio.*

TRC - GIS

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Legend

Project Area (September 2018)

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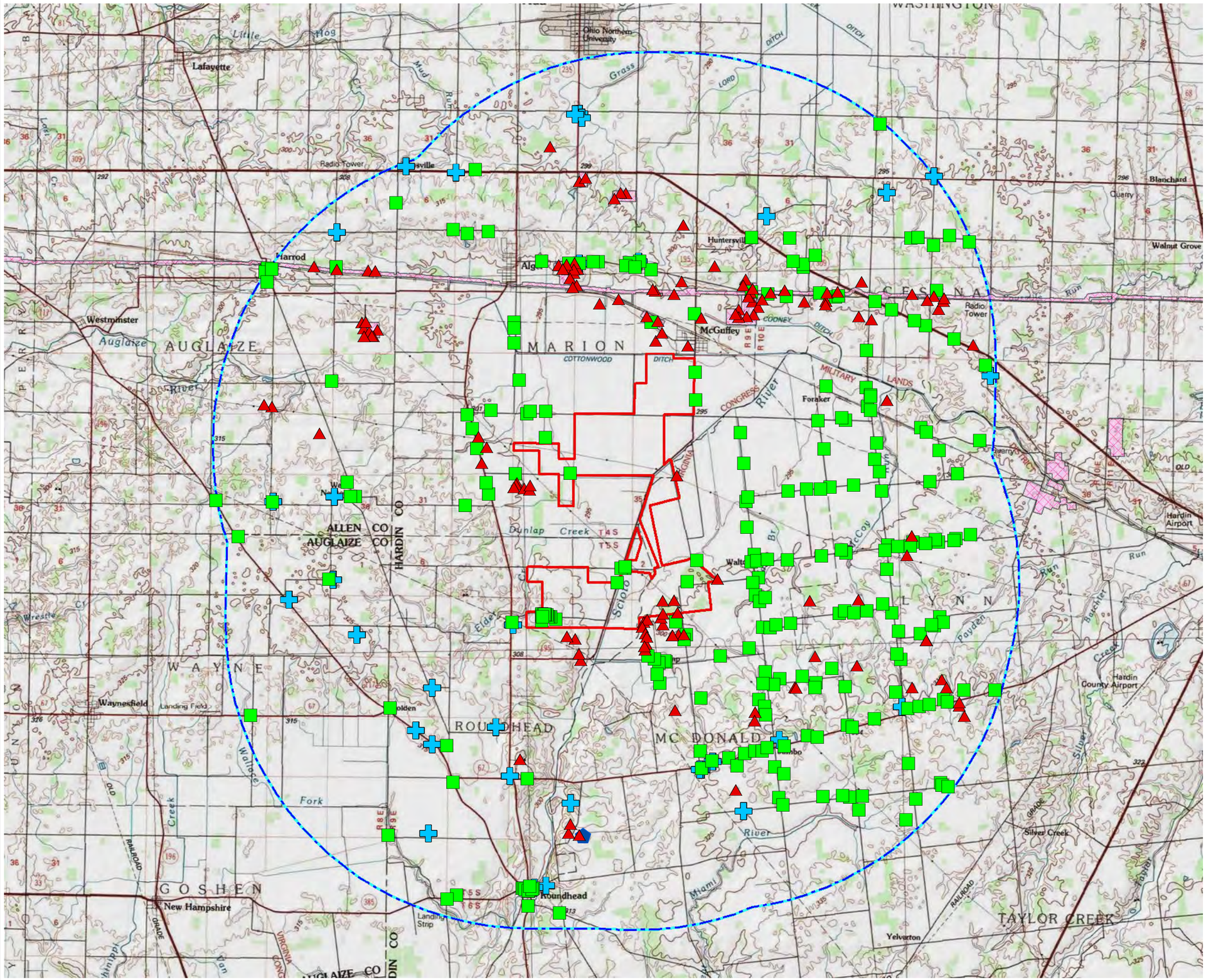
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HARDIN SOLAR ENERGY II, LLC
HARDIN SOLAR II ENERGY CENTER
CONFIDENTIAL BUSINESS INFORMATION

TITLE:
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DRAWN BY:	D. KENWORTHY	PROJ NO.:	302899.0000.0000
CHECKED BY:	J. PITTS		
APPROVED BY:	C. BIONDICH		**FIGURE 1**
DATE:	SEPTEMBER 2018		

TRC
921 Eastwind Drive, Suite 122
Westerville, OH 43081
Phone: 614.423.6334
www.trcsolutions.com

FILE NO.: HSII_HistResScreen_Fig1_11x17.mxd



Legend

- Project Area (September 2018)
- 5 Mile Project Area Radius
- Archaeological Site
- Historic Structure
- National Register Determination of Eligibility
- OGS Cemetery
- Previous Phase I Archaeological Survey

0 2 4 Miles

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1 " = 2 MILES
1:100,000

PROJECT:
HARDIN SOLAR ENERGY II, LLC
HARDIN SOLAR II ENERGY CENTER
CONFIDENTIAL BUSINESS INFORMATION

TITLE:
USGS TOPOGRAPHIC FIGURE
5 MILE RADIUS OF NR DETERMINATIONS OF ELIGIBILITY, ARCHAEOLOGICAL SITES, HISTORIC STRUCTURES, OGS CEMETERIES, AND PHASE I SURVEYS

DRAWN BY:	D. KENWORTHY	PROJ NO.:	302899.0000.0000
CHECKED BY:	J. PITTS		
APPROVED BY:	C. BIONDICH		
DATE:	OCTOBER 2018		

FIGURE 2

TRC
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Westerville, OH 43081
Phone: 614.423.6334
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FILE NO.: HSII_HistResScreen_Fig2a_11x17.mxd

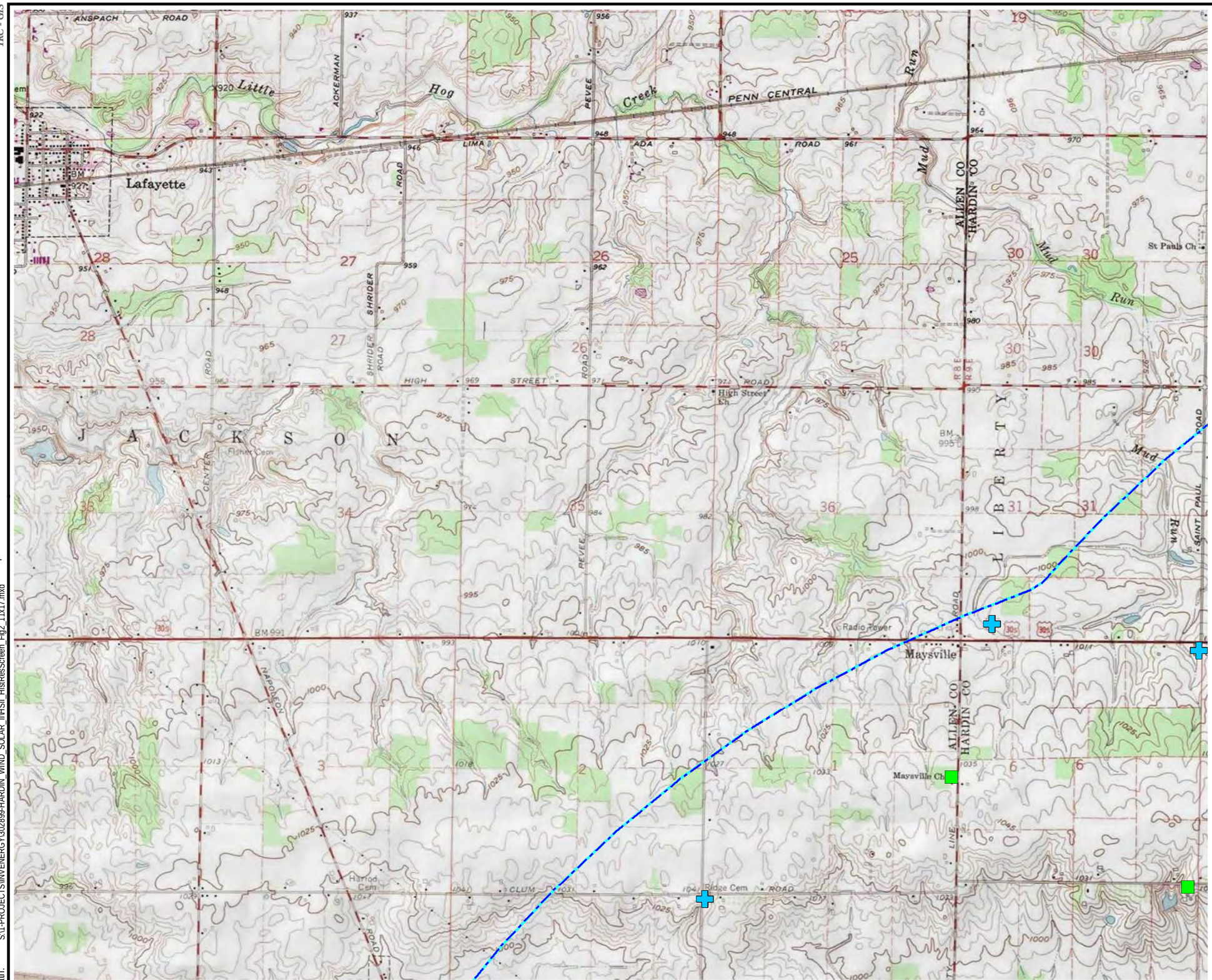
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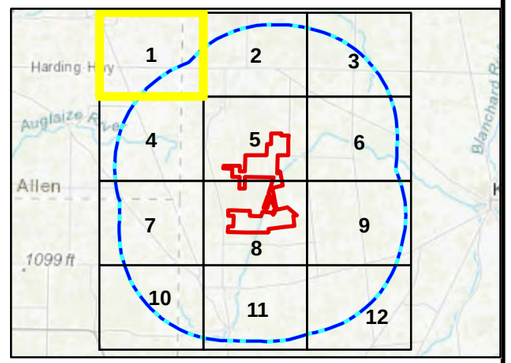
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Legend

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- OGS Cemetery
- Previous Phase I Archaeological Survey



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PROJECT:
HARDIN SOLAR ENERGY II, LLC
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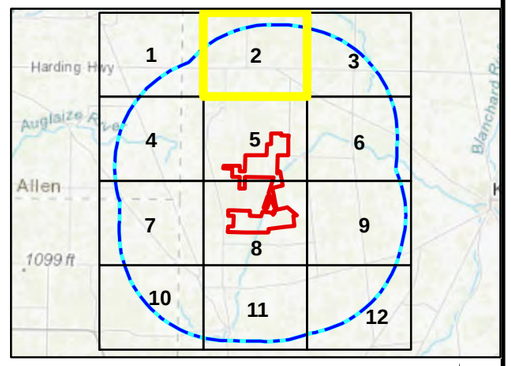
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DATE:	OCTOBER 2018		

FIGURE 2

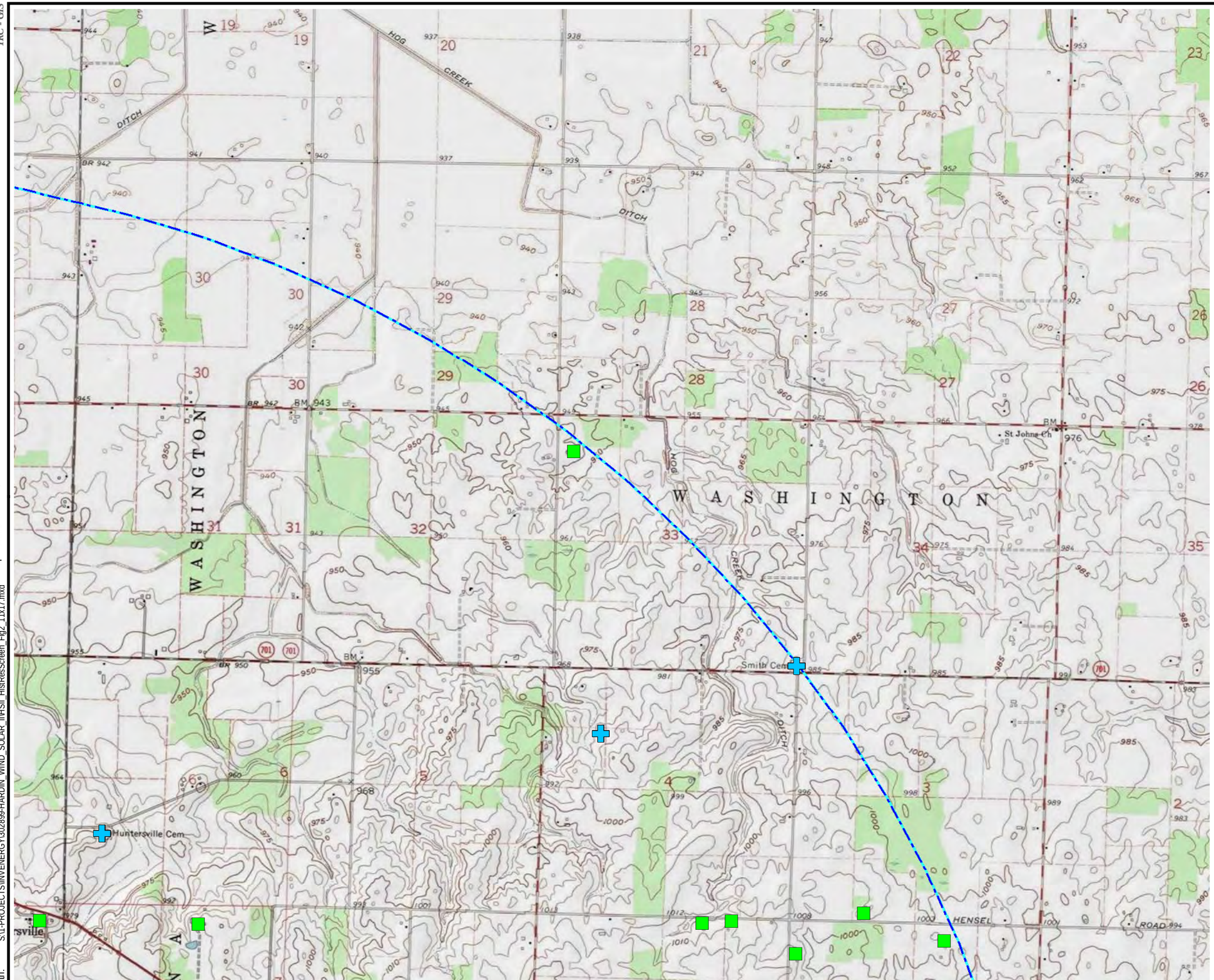
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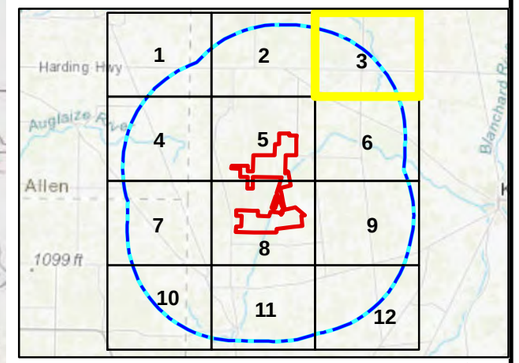
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5 MILE RADIUS OF NR DETERMINATIONS OF ELIGIBILITY, ARCHAEOLOGICAL SITES, HISTORIC STRUCTURES, OGS CEMETERIES, AND PHASE I SURVEYS

DRAWN BY:	D. KENWORTHY	PROJ NO.:	302899.0000.0000
CHECKED BY:	J. PITTS		
APPROVED BY:	C. BIONDICH		
DATE:	OCTOBER 2018		

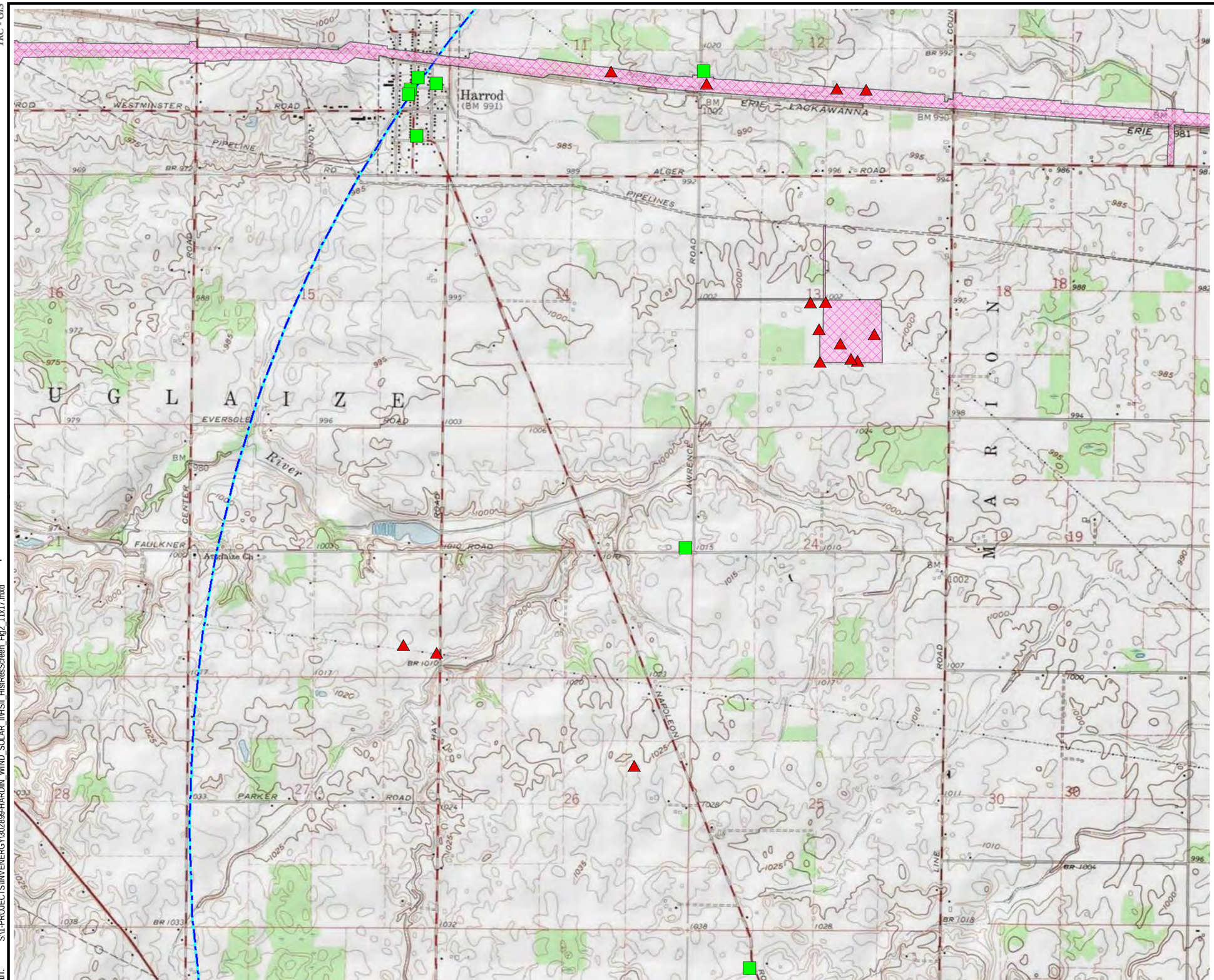
FIGURE 2

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FILE NO.: HSII_HistResScreen_Fig2_11x17.mxd

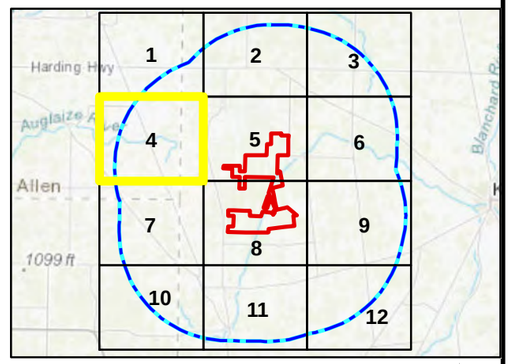
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Map ROtation: 0



Legend

- Project Area (September 2018)
- 5 Mile Project Area Radius
- Archaeological Site
- Historic Structure
- National Register Determination of Eligibility
- OGS Cemetery
- Previous Phase I Archaeological Survey



0 1,000 2,000 Feet

1 " = 2,000 '
1:24,000

N

PROJECT:
HARDIN SOLAR ENERGY II, LLC
HARDIN SOLAR II ENERGY CENTER
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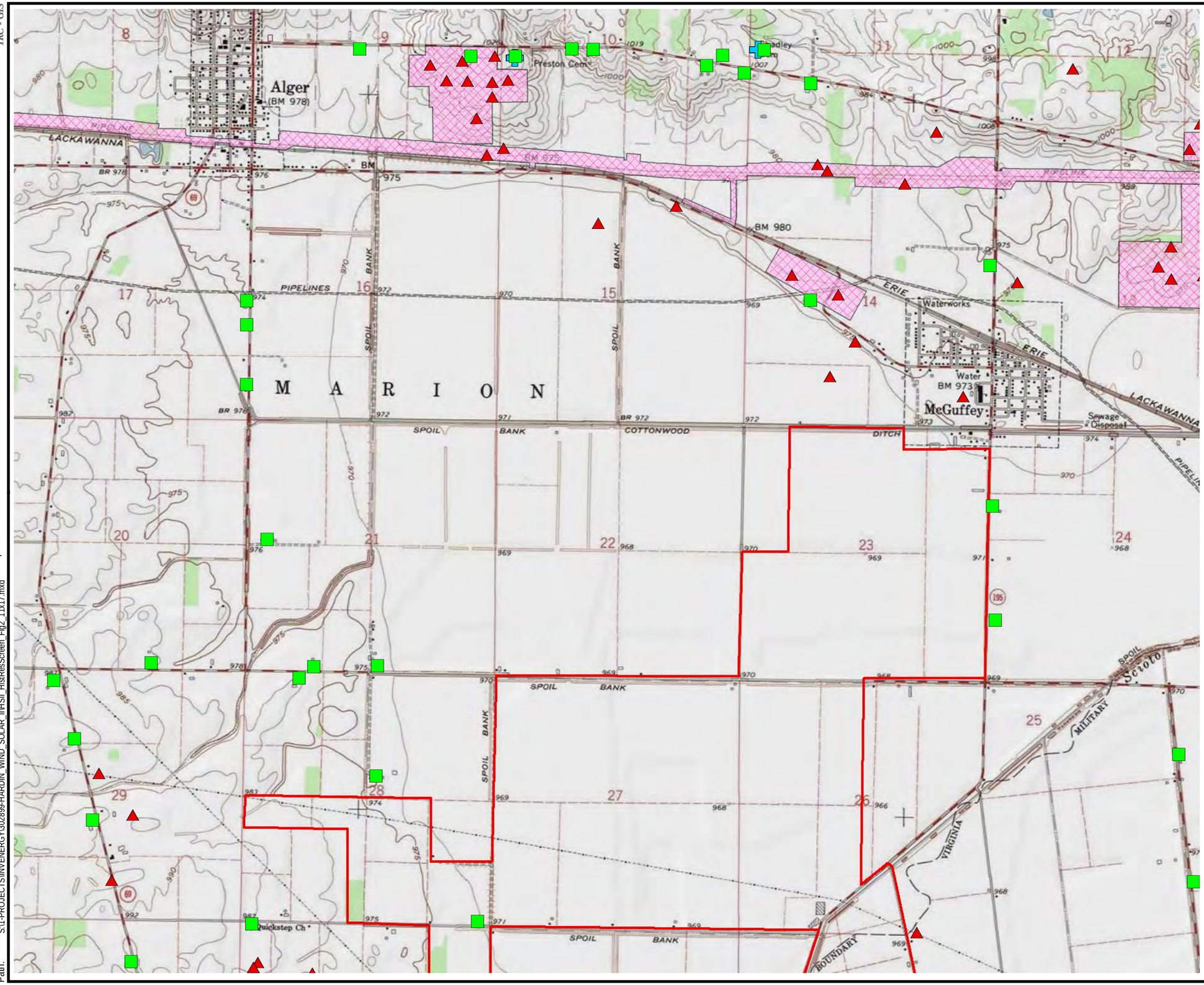
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USGS TOPOGRAPHIC FIGURE
5 MILE RADIUS OF NR DETERMINATIONS OF ELIGIBILITY, ARCHAEOLOGICAL SITES, HISTORIC STRUCTURES, OGS CEMETERIES, AND PHASE I SURVEYS

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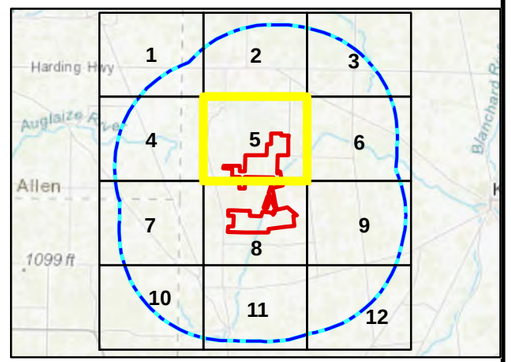
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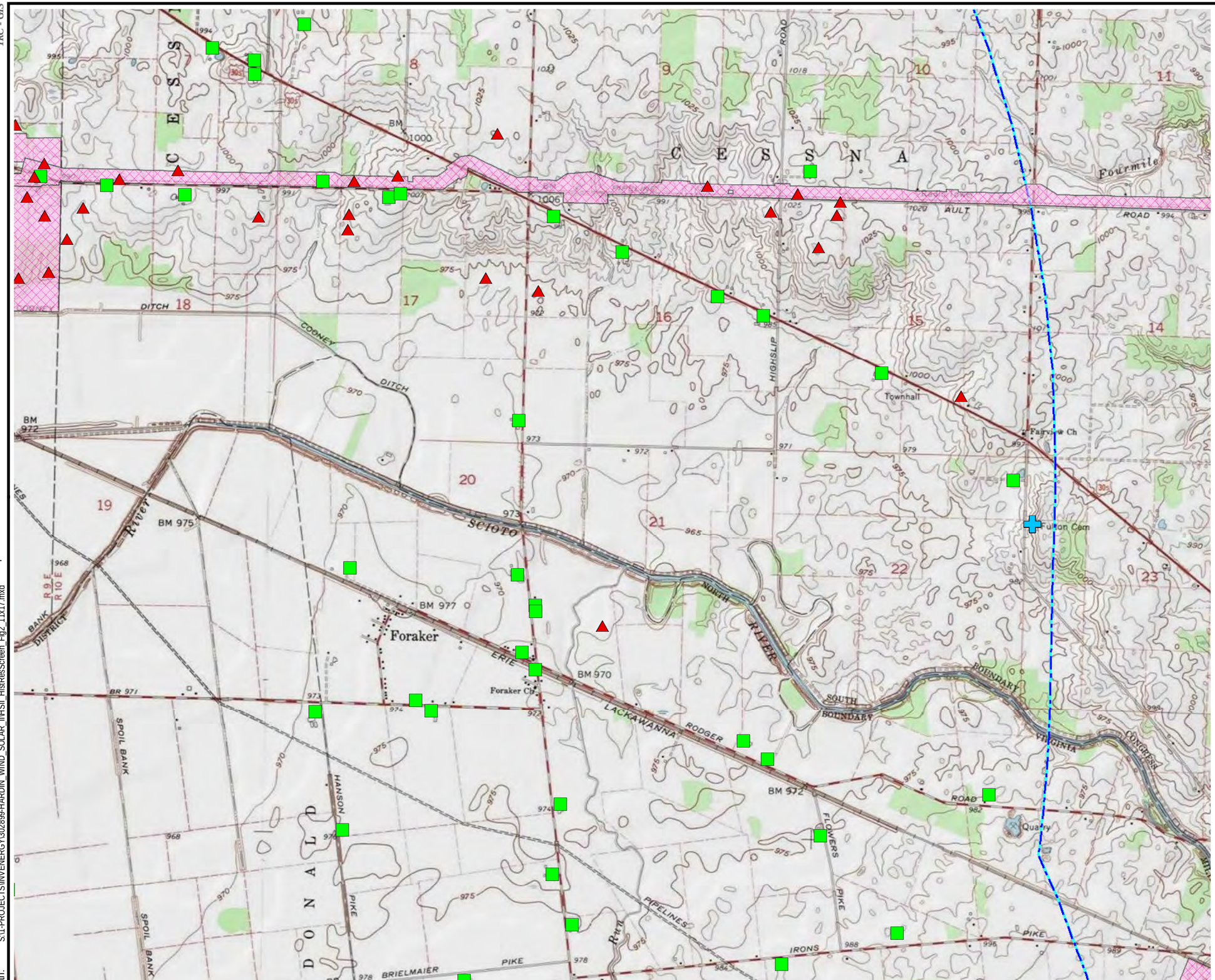
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Map Rotation: 0

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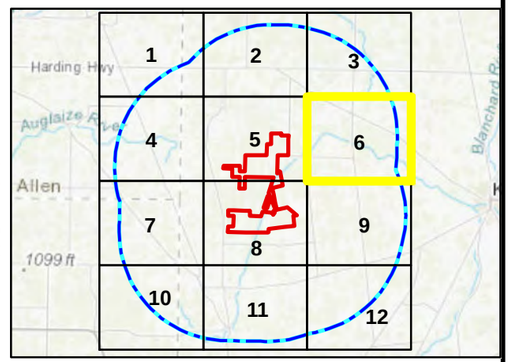
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Legend

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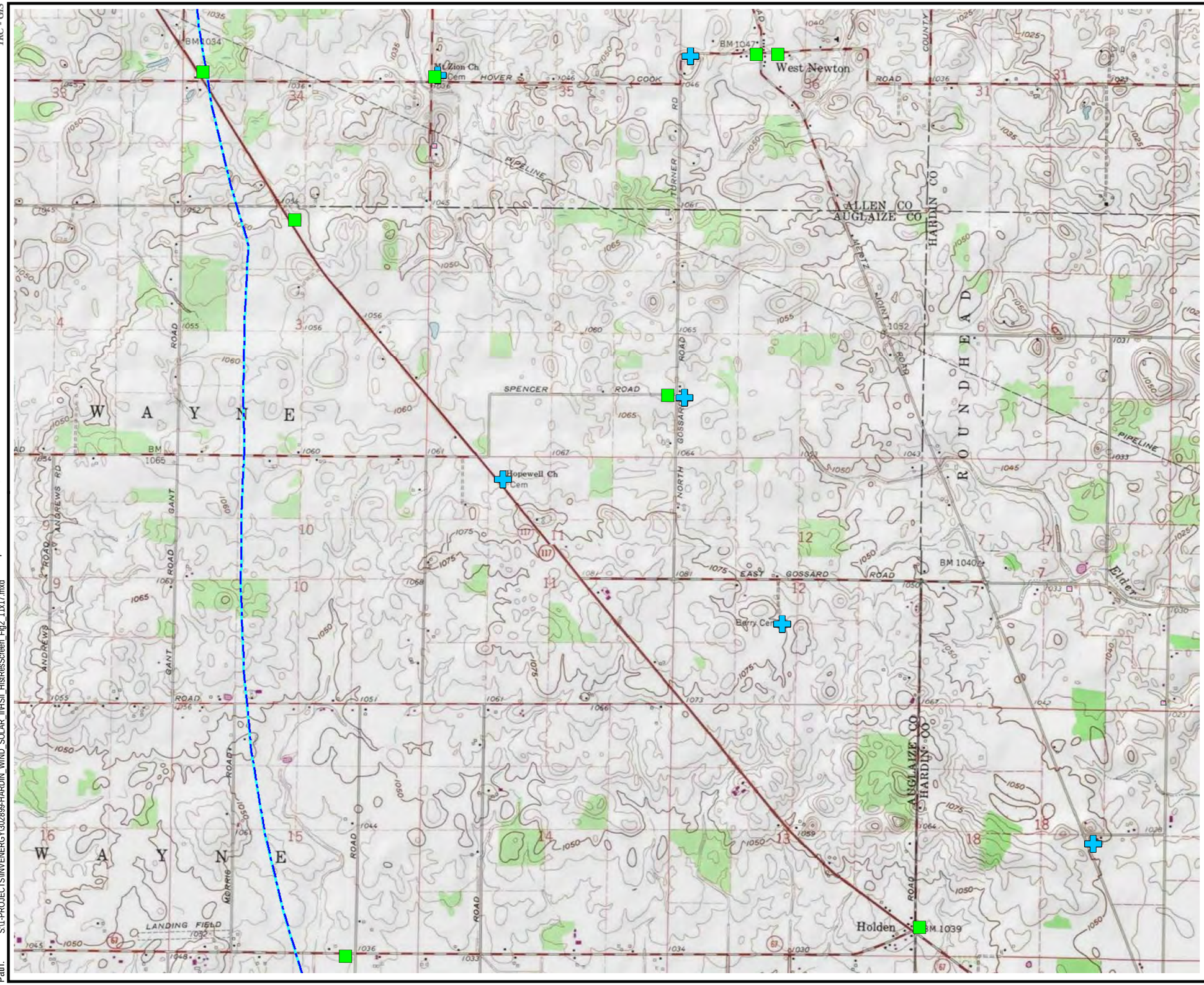
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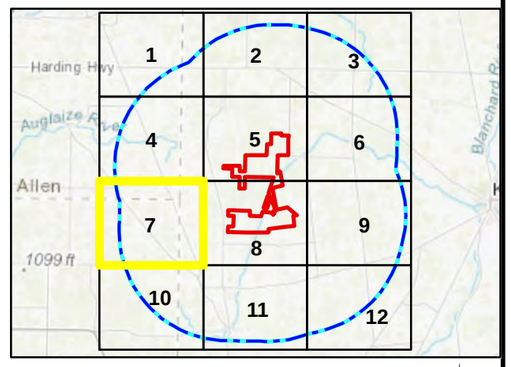
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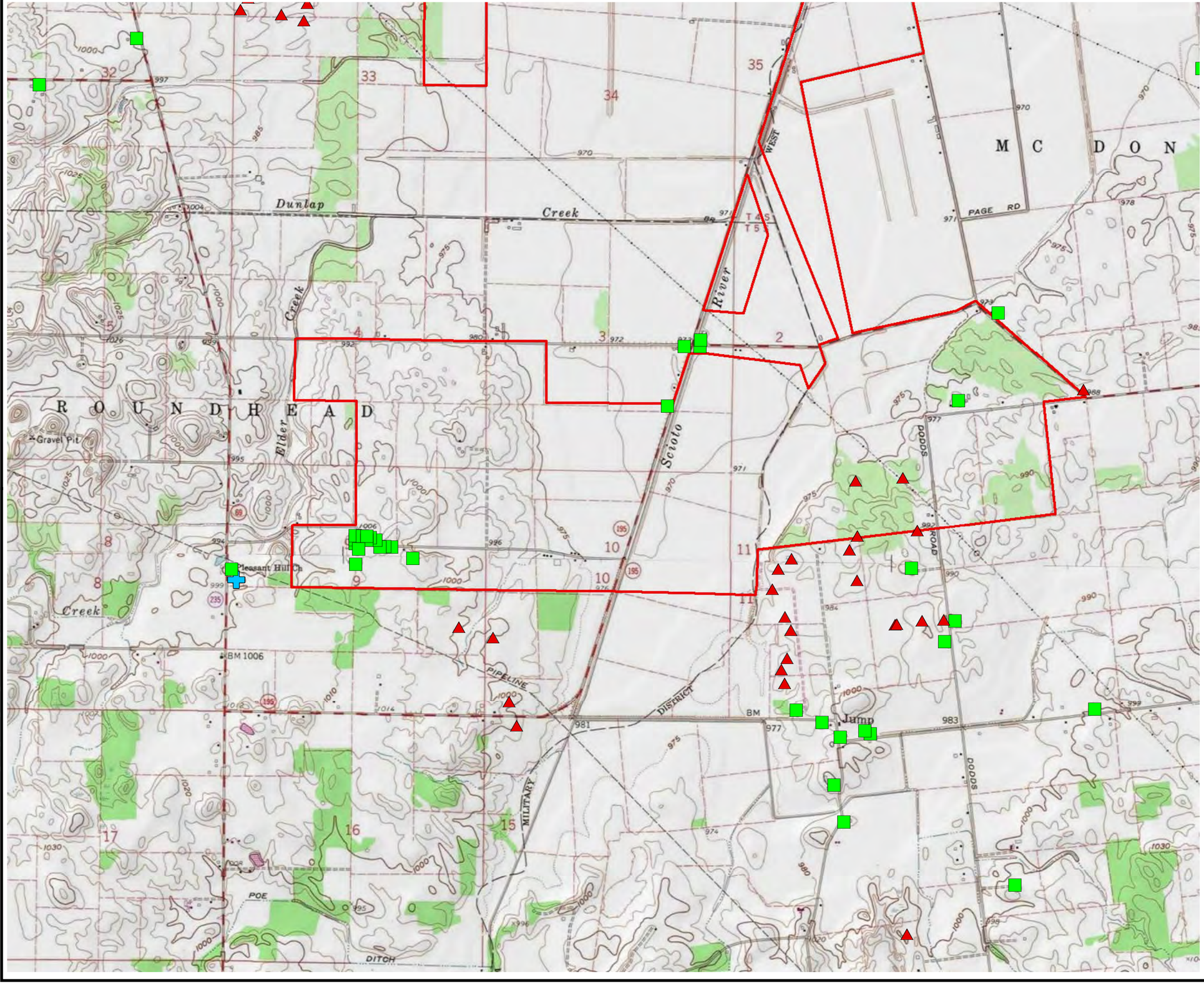
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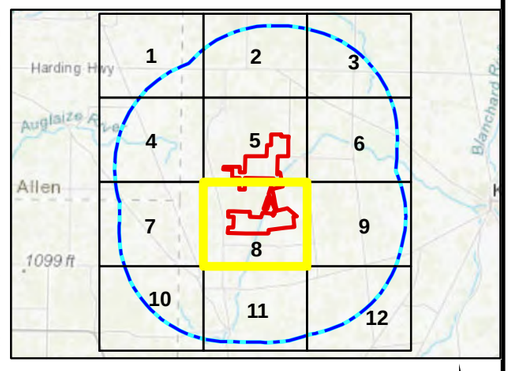
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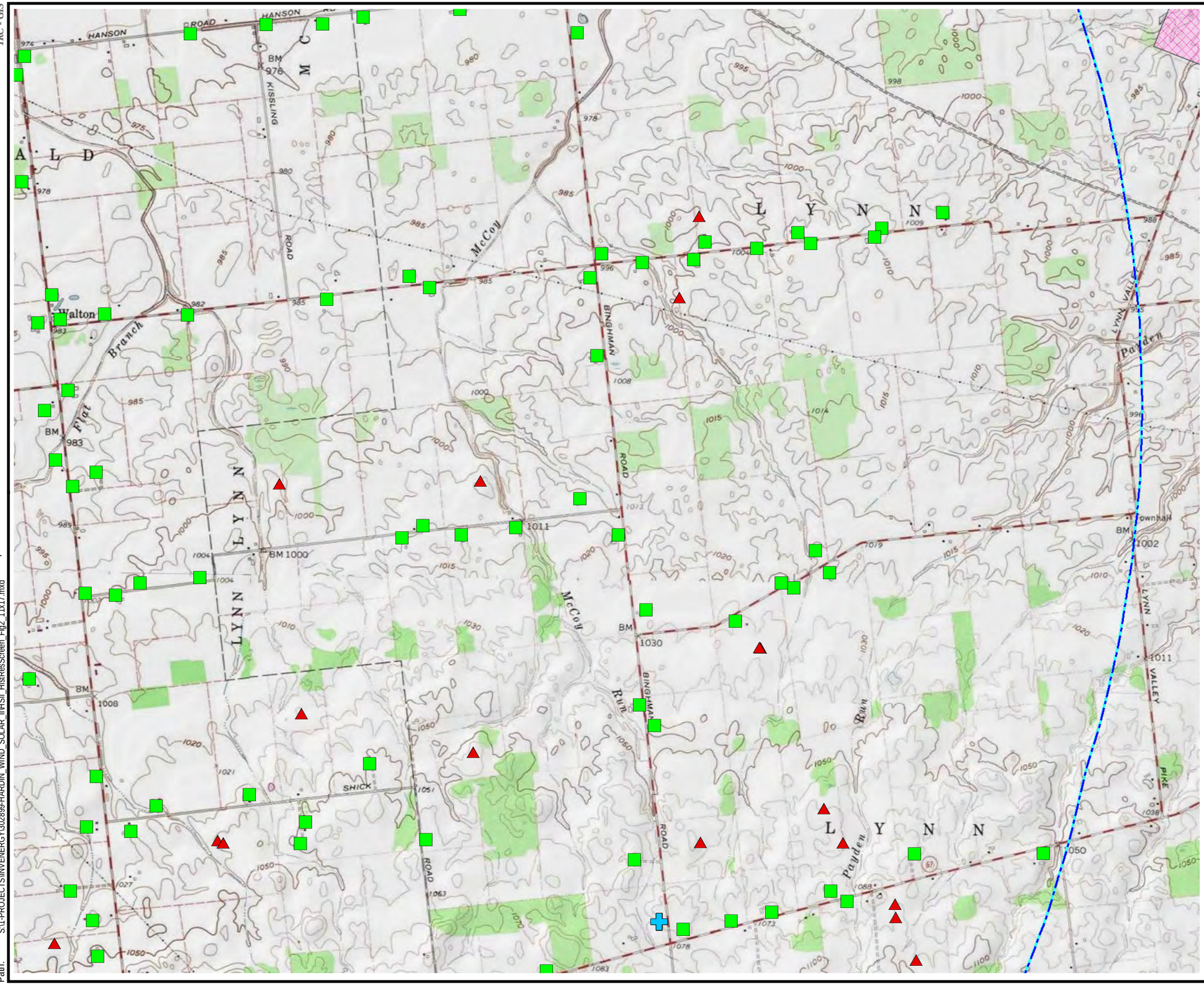
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CHECKED BY:	J. PITTS		**FIGURE 2**
APPROVED BY:	C. BIONDICH		Page 9 of 13
DATE:	OCTOBER 2018		

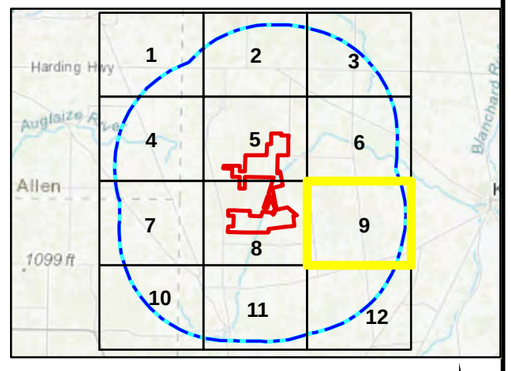
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DATE:	OCTOBER 2018		Page 10 of 13

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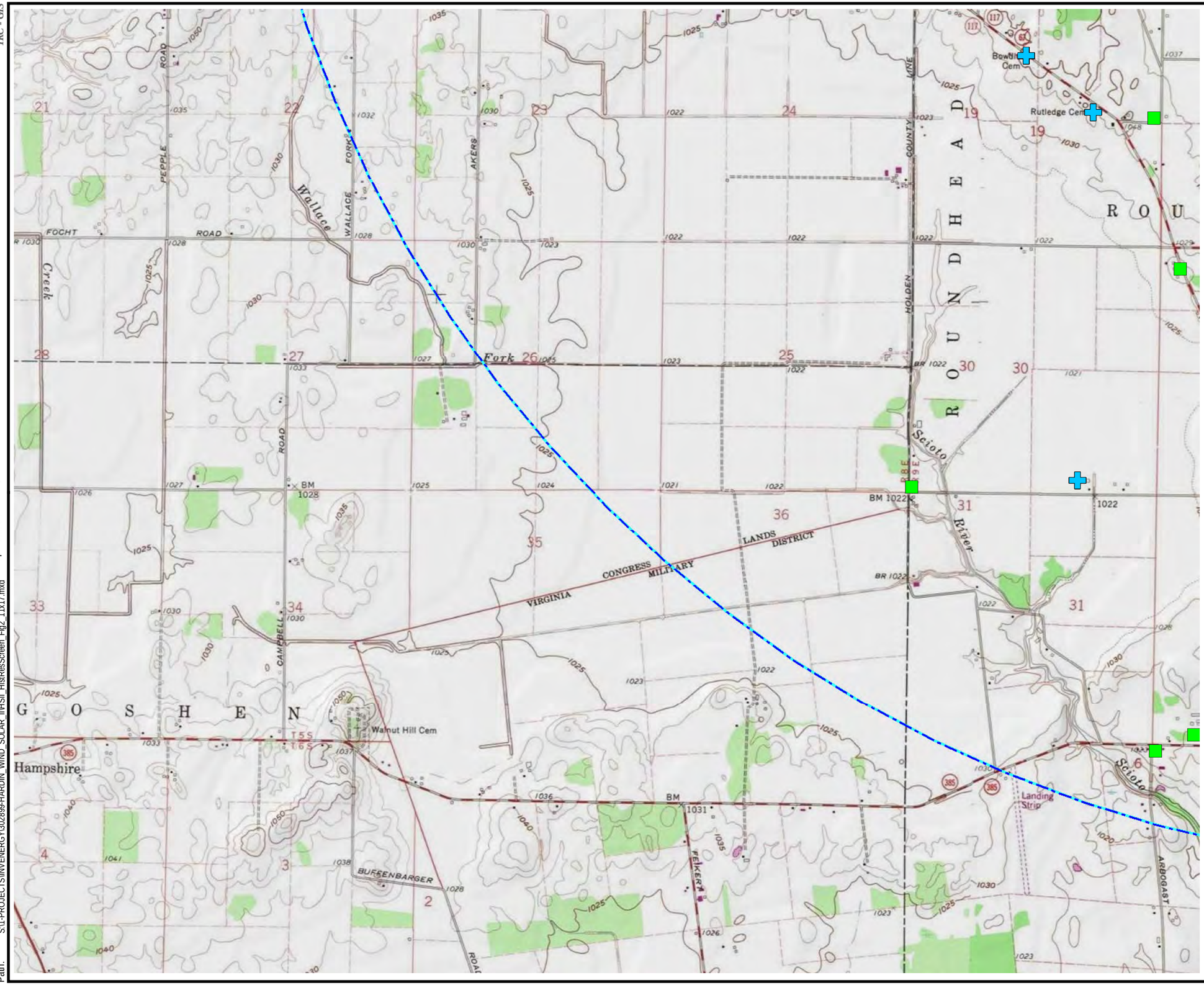
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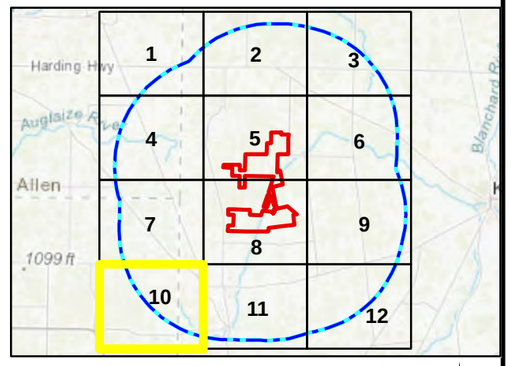
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0 1,000 2,000 Feet

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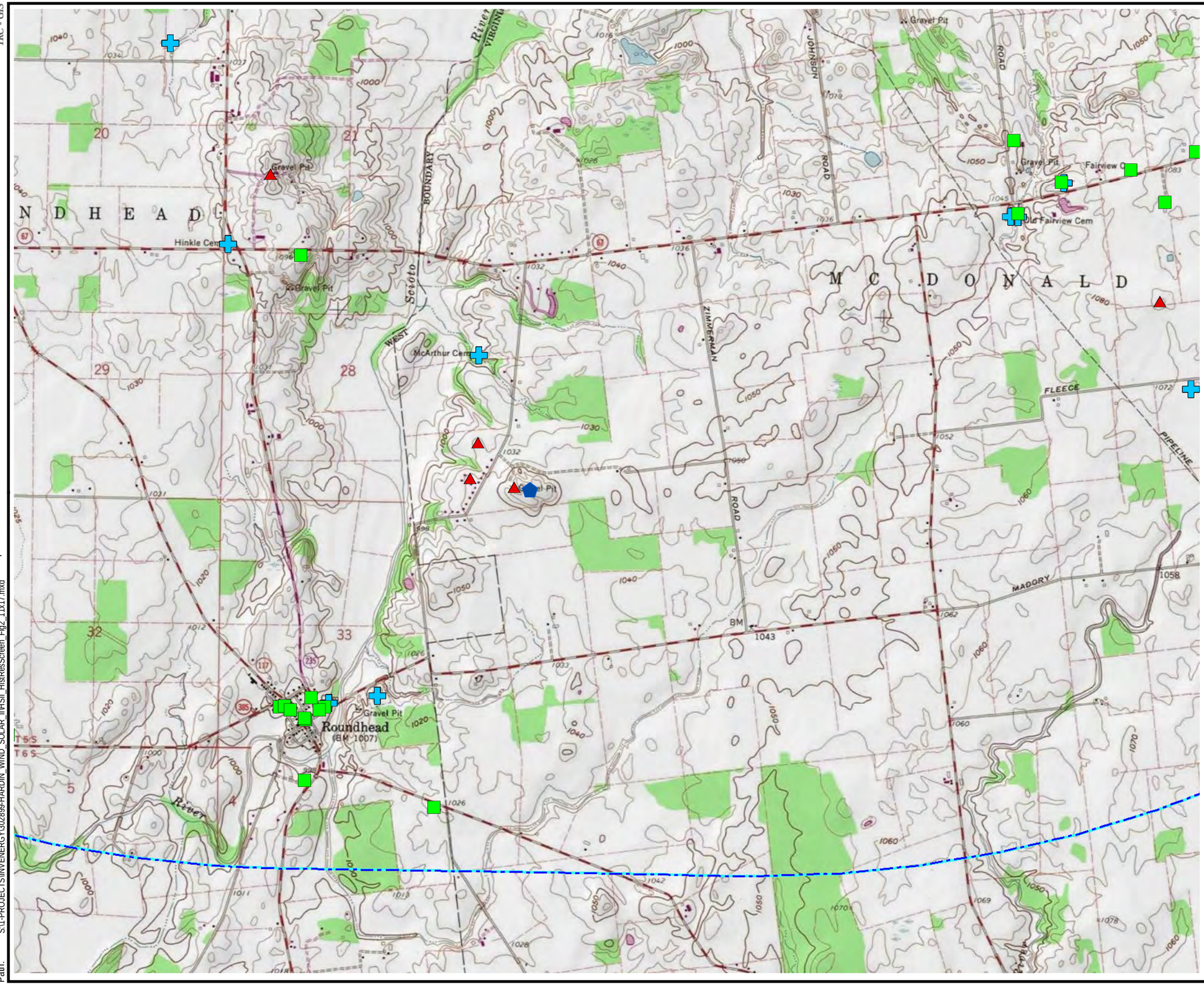
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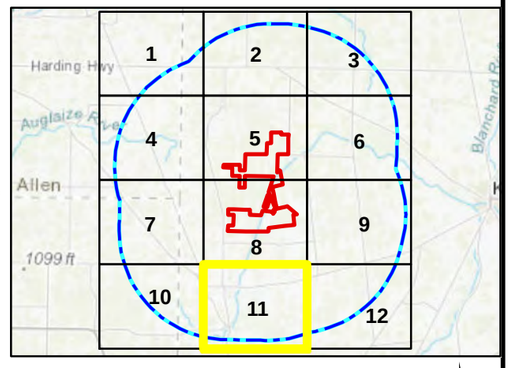
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PROJECT:

HARDIN SOLAR ENERGY II, LLC
HARDIN SOLAR II ENERGY CENTER
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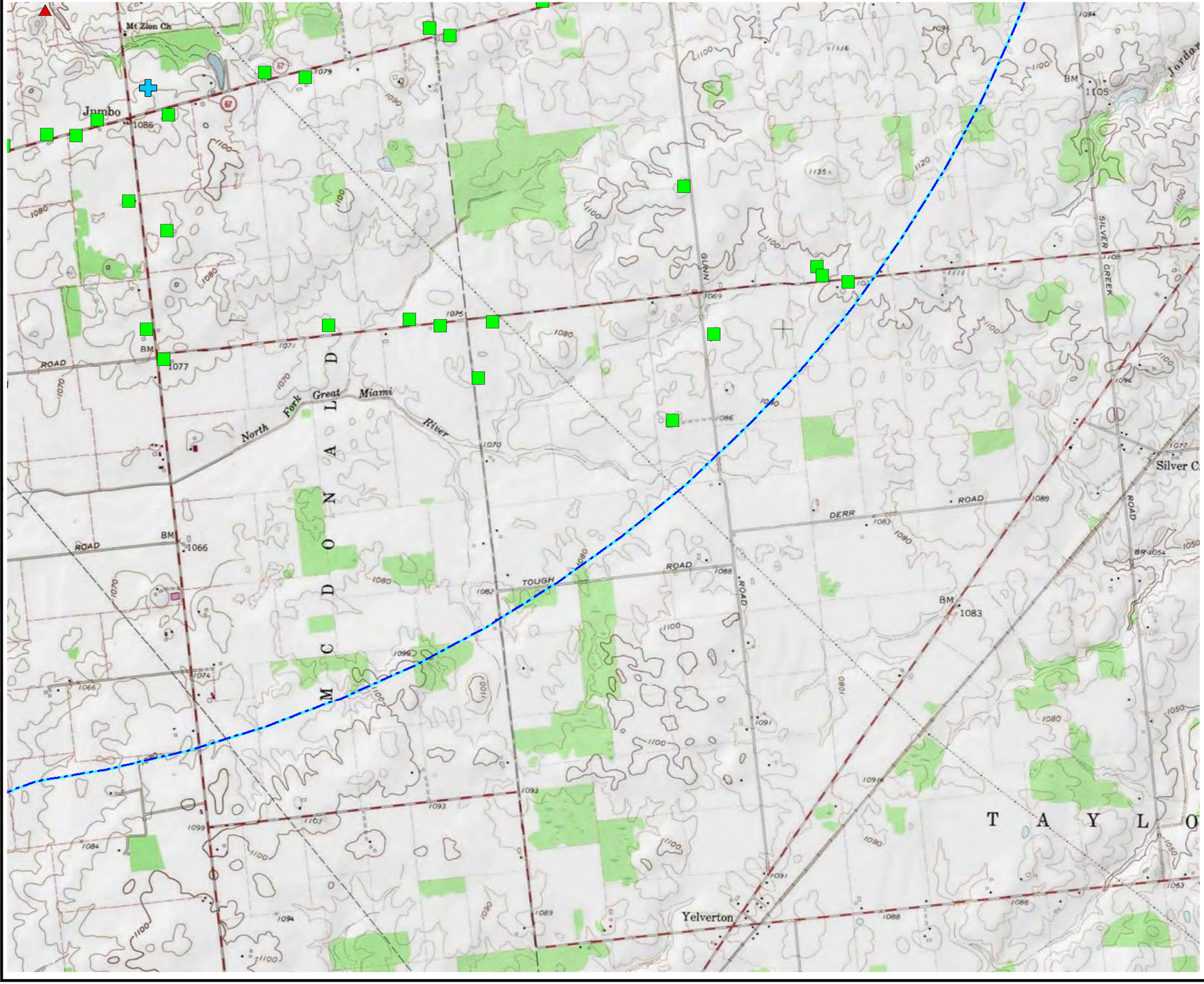
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APPROVED BY:	C. BIONDICH		**FIGURE 2**
DATE:	OCTOBER 2018		Page 12 of 13

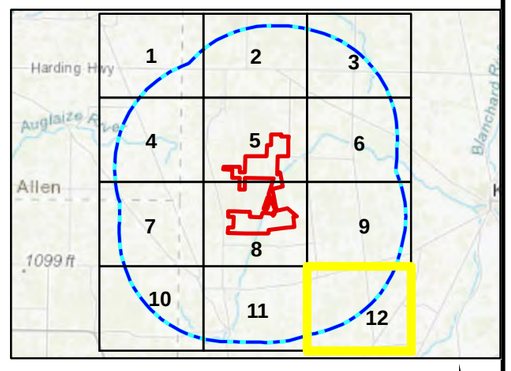
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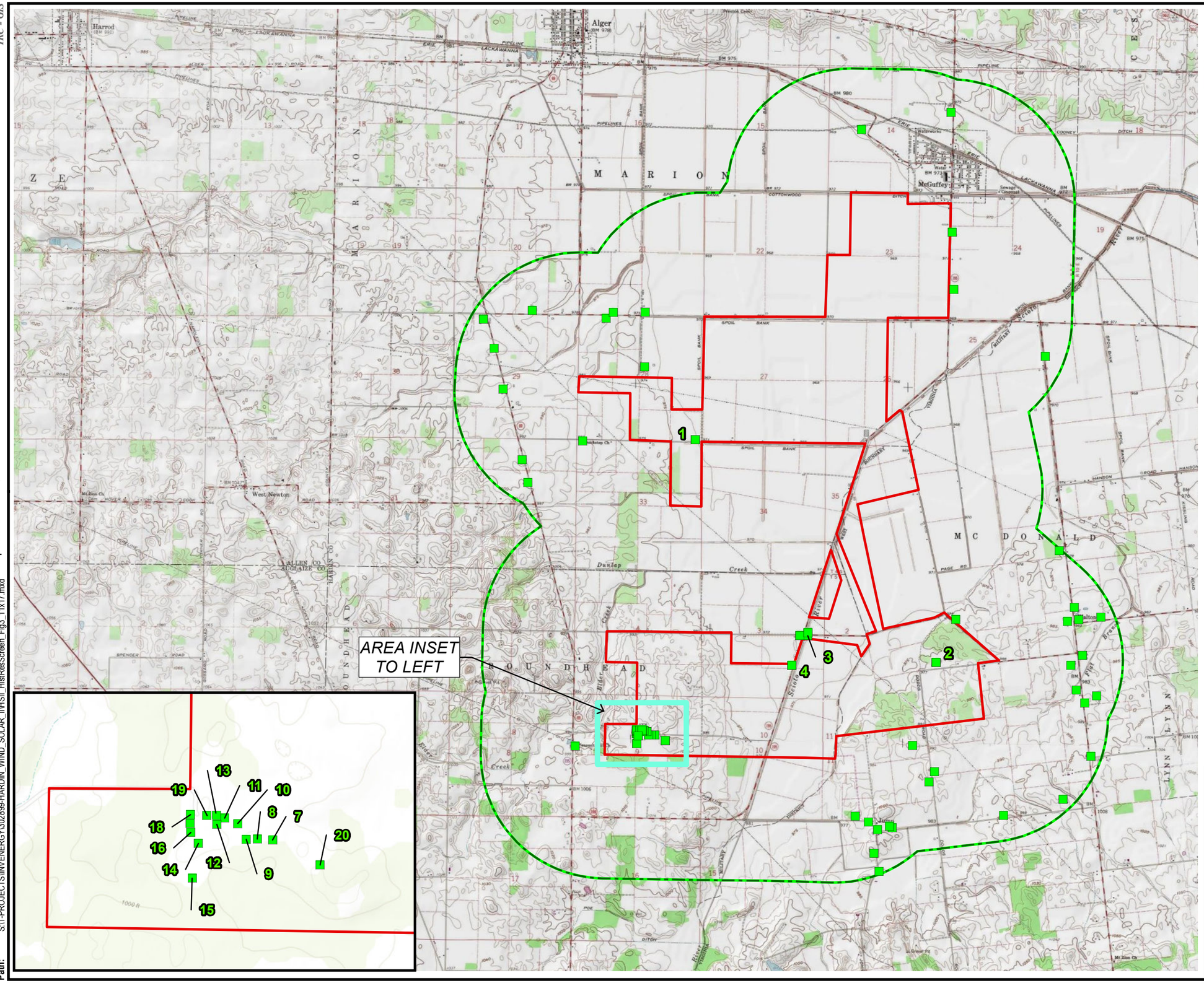
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Legend

- Project Area (September 2018)
- 1 Mile Project Area
- Historic Structure

Historic Structures Within Project Area

Map ID	OHPO Number
1	HAR0057705
2	HAR0061610
3	HAR0067009
4	HAR0067109
5	HAR0067209
6	HAR0067309
7	HAR0007109
8	HAR0007209
9	HAR0007309
10	HAR0007409
11	HAR0007509
12	HAR0007609
13	HAR0007709
14	HAR0007809
15	HAR0007909
16	HAR0008009
17	HAR0008109
18	HAR0008209
19	HAR0008309
20	HAR0008409

0 2,000 4,000 Feet

1 " = 4,000 '

1:48,000

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PROJECT:
HARDIN SOLAR ENERGY II, LLC
HARDIN SOLAR II ENERGY CENTER
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TITLE:
USGS TOPOGRAPHIC MAP HISTORIC STRUCTURES

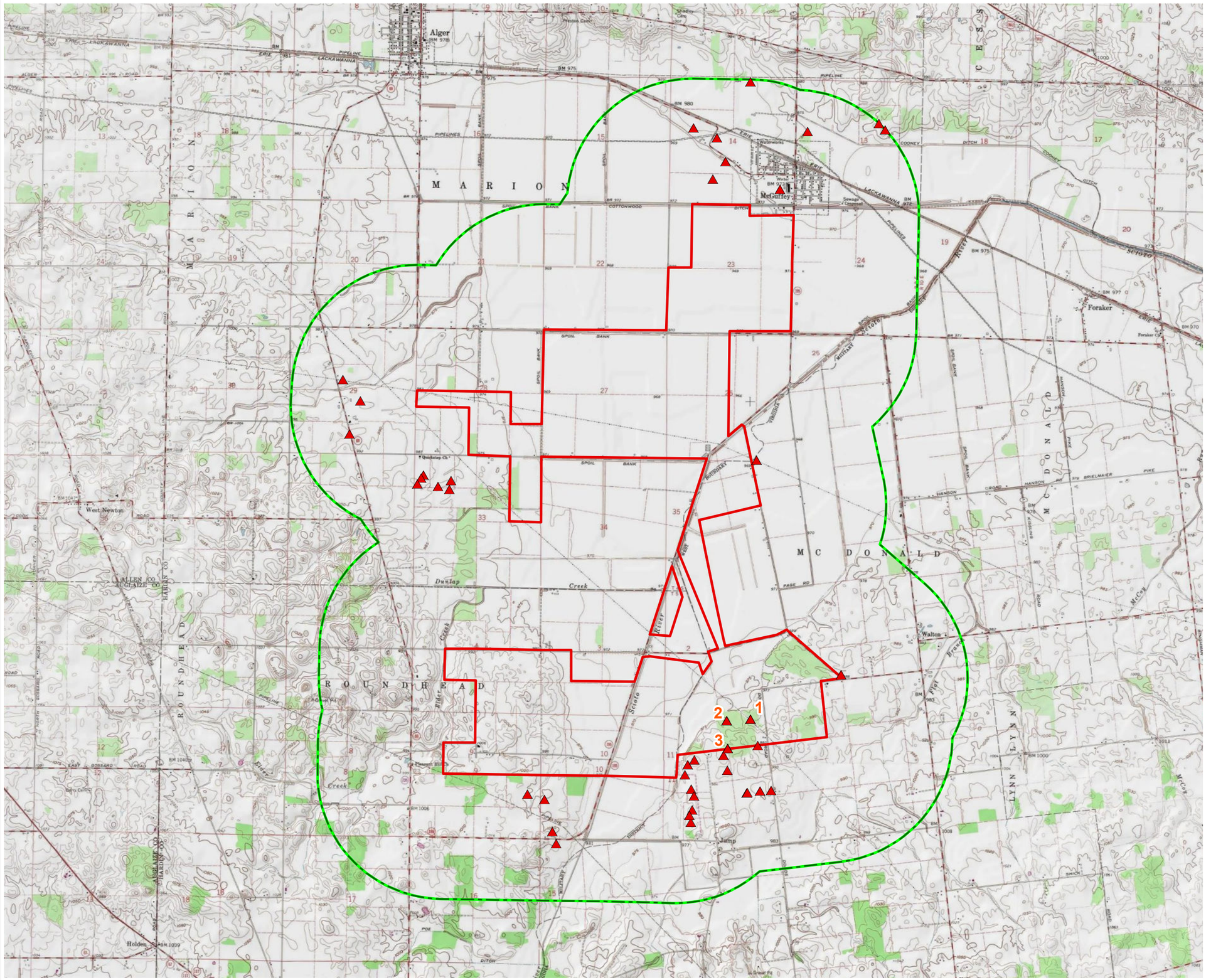
DRAWN BY:	D. KENWORTHY	PROJ NO.:	302899.0000.0000
CHECKED BY:	J. PITTS		
APPROVED BY:	C. BIONDICH		**FIGURE 3**
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Coordinate System: NAD 1983 2011 StatePlane Ohio South FIPS 3402 Ft US (Foot US)
Map Rotation: 0



Legend

- Project Area (September 2018)
- 1 Mile Project Area
- Archaeological Site

Archaeological Sites Within Project Area	
Map ID	**OHPO Number**
1	33HR0205
2	33HR0225
3	33HR0263

0 2,000 4,000 Feet

1 " = 4,000 '

1:48,000

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HARDIN SOLAR II ENERGY CENTER
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TITLE:
USGS TOPOGRAPHIC MAP ARCHAEOLOGICAL SITES

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CHECKED BY:	J. PITTS		
APPROVED BY:	C. BIONDICH		**FIGURE 4**
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FILE NO.: HSII_HistResScreen_Fig4_11x17.mxd

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in

Case No(s). 18-1360-EL-BGN

Summary: Application Part 5 of 6, Exhibits N through Q electronically filed by Christine M.T. Pirik on behalf of Hardin Solar Energy II LLC