TULLOCH
ENGINEERING

GEOTECHNICAL REPORT

Nation Rise Wind Farm Project

MET Tower



January 2019

TULLOCH Project #: 18-4022

LICENSED PROFESSIONAL ENGINEER
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Jan. 24, 2019
PROVINCE OF ONTARIO

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September 19, 2018
18-4022

EDP Renewables North American LLC
808 Travis Street, Suite 700
Houston, Texas
ZIP: 77002

Attention: Ryan McDonner, Civil Engineering Manager

Re: Geotechnical Report for the Nation Rise Wind Farm Project

Dear Mr. McDonner:

Please find enclosed our Draft Geotechnical Report for the proposed 100 MW Nation Rise Wind Farm Project located in the Township of North Stormont, United Counties of Stormont, Dundas, and Glengarry, Ontario, Canada.

This report outlines the results of the geotechnical investigations, which were completed on the site and it provides geotechnical recommendations for foundation design and construction of the proposed MET tower.

We trust the enclosed is adequate for your needs at this time. If there is anything further we can assist, please contact us at your convenience.

Sincerely,
Tulloch Engineering Inc.

Sean Hinchberger, Ph.D., P.Eng.
General Manager, Geotechnical Specialist

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1 INTRODUCTION

The Nation Rise Wind Project is located 40 km southeast of Ottawa, Ontario, in the Municipality of North Stormont. The project comprises twenty-nine wind turbines Enercon E138 with an installed capacity of up to 99.76 MW and associated infrastructure including a 235 kV/34.5 kV Substation, a Hydro One Network Inc. (HONI) Interconnection structure, an expansion to an existing O&M building, one MET Tower, collector and transmission lines, and private and public access roads. The project is currently in the detailed engineering phase.

Tulloch Engineering Inc. (Tulloch) was retained by EDP Renewables (the Client) to complete geotechnical site investigations for the proposed MET Tower mast locations. The purpose of this geotechnical program was to evaluate the subsurface conditions at the proposed MET mast locations, and to provide engineering recommendations for site and foundation design.

This report provides the factual geotechnical investigation data and geotechnical design recommendations, which are based on the site investigation data, our understanding of the project scope and engineering experience. Appendix A shows the site location and borehole plan. A list of abbreviations, terminology and principal symbols used throughout this report are in Appendix B.

The following report sections describe the site geology, the investigation methodology, results and engineering recommendations.

2 SITE DESCRIPTION AND GEOLOGY

Based on the Surficial Geology of Southern Ontario Maps as published by the Ontario Geological Survey (i.e. OGS Map 2140A), the site surficial geology varies from exposed bedrock, to glacial till and fine-textured glaciomarine deposits. The bedrock consists of limestone, dolomite, shale, arkose and sandstone of the Ottawa Group (OGS 2011). The bedrock is exposed (i.e. outcropping) mainly along the western boundaries of the project in an area roughly bounded by Crysler, Cannamore and Connaught, ON. Bedrock is also locally exposed east of the South Nation River near Payne Crossing and along Berwick Rd. The glaciomarine deposits primarily consist of silt and clay, with minor sand and gravel; These sediments are massive to well laminated in structure and are found mainly along the South Nation River (OGS 2010) and its tributaries. The glacial till consists of poorly sorted clay, silt, sand and gravel with occasional cobbles and boulders.

3 SITE INVESTIGATIONS AND METHODOLOGY

3.1 Drilling Investigations

The geotechnical investigations were completed for the MET tower locations between April 29th and May 30th, 2018. The investigations consisted of advancing six (6) boreholes referenced as Boreholes BH-MET-01 to BH-MET-06 through the overburden to borehole termination at least 3m into bedrock at all locations, excluding BH-MET-05 which was terminated at 12.8 m depth.

The boreholes were advanced through the overburden and bedrock using a CME-55 track-mounted drill rig equipped with 200 mm diameter continuous flight hollow stem augers, standard soil sampling equipment, and N-size casing and double tube core barrels. The drilling program was carried out by Marathon Drilling Co. Ltd. Soil samples were obtained with a 51 mm outside diameter split spoon barrel in conjunction with Standard Penetration Tests (SPT) conducted according to ASTM D1586. The SPTs and sampling were conducted at 0.6-metre intervals in the upper 3.7 m, and 1.52 m intervals thereafter. Field vane tests (ASTM D2573) were also conducted in all boreholes using a standard 125 mm MTO (Ministry of Transportation of Ontario) vane to measure the undrained shear strength of the cohesive soil. Select boreholes were advanced at least 3 m into the bedrock; rock cores were retrieved with a double tube NQ core barrel.

The drilling and sampling program was completed under the full-time supervision of Tulloch representatives, who logged the drilling operations, identified the soil samples as they were retrieved and logged the bedrock core. Groundwater measurements were recorded immediately after the boreholes were completed. The recovered soil samples were sealed in plastic bags and the bedrock cores were placed in core boxes and both were transported to Tulloch's CCIL Certified Laboratory in Sault Ste Marie for detailed examination and testing. All samples will be stored in our laboratory for six (6) months and then disposed of unless directed otherwise. The results of the drilling investigations are summarized on the borehole logs in Appendix C.

3.2 Laboratory Tests

Table 3-1 summarizes the soil and rock laboratory tests conducted for this geotechnical investigation program and the corresponding ASTM standards. Select samples were also sent to ALS Laboratories for Corrosivity testing. Detailed laboratory test reports are attached in Appendix D.

Table 3-1: Summary of Soil/Rock Laboratory Testing Program

Item No.	Test	Number of Tests	ASTM Standard
1	Sieve Analysis	5	ASTM D422
2	Hydrometer Analysis	6	ASTM D422
3	Atterberg Limits	6	ASTM D4318
4	Moisture Content	43	ASTM D2216

4 SUBSURFACE CONDITIONS

4.1 General

Detailed subsurface profiles at each borehole are summarized in the borehole logs attached in Appendix C. The Unified Soil Classification System (USCS) was used for soil classification. Additionally, the soil boundaries indicated on the borehole logs are inferred from discontinuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones to support geotechnical design and they should not be interpreted as exact planes of geological change. Third parties relying on the data presented in the logs should account for the approximate nature of these boundaries during design.

Based on the geotechnical data collected, three geologic domains were encountered at the Nation Rise site as summarized below.

Domain 1 (Shallow Bedrock)**:** In this domain, the subsurface conditions consist of approximately 50 cm of topsoil overlying 1.62 to 5.18 m thick of either Clay Till (CL) with some sand and gravel and occasional cobbles, or soft low to high plasticity Clay (CL), trace to some silt, overlying shaly limestone bedrock. MET mast locations BH-MET-01 and BH-MET-04 are in this domain.

Domain 2 (Glacial Till Overlying Bedrock)**:** The subsurface conditions in Domain 2 consist of approximately 50 cm of top soil overlying an 6.71 to 10.06 m of firm to hard Clay Till (CL), Clay Silt Till (ML) or compact to dense Silt Till (ML) overlying shaly limestone bedrock. The MET mast boreholes BH-MET-02 and BH-MET-06 are in this domain.

Domain 3 (Soft Glaciomarine Clay over Till**):** The third domain comprises approximately 50 cm of top soil overlying 4.57 m to 12.80 of soft to firm Silty Clay (CL) overlying either glacial till over bedrock or directly overlying shaly limestone bedrock. The MET mast boreholes BH-MET-03 and BH-MET-05 are in this domain.

The geologic domains are described in detail in the following sections.

4.2 Domain 1 – Shallow Bedrock

Table 4-1 summarizes the stratigraphy in Domain 1. In this domain, the depth to bedrock varies from 1.62 m at BH-MET-04 to 5.18 m at BH-MET-01. The overburden soils overlying bedrock comprise a thin veneer of Clay (CL) with trace to some silt and Clay Till (CL) with some sand and gravel and occasional cobbles.

- At BH-MET-01, the Clay (CL) layer is soft to firm with vane shear strength of 48 kPa and SPT ranging from 4 to 7. This layer extends to a depth about 4.57 m. Below the Clay (CL) is a very dense granular till consisting of gravel with sand and silt trace clay.
- At BH-MET-04, the Clay (CL) layer is thin and extends to 1.62 m depth overlying bedrock. This layer is soft to stiff as per the SPT values from 3 to 9.

Grainsize testing and Atterberg limits results from samples in this domain can be found in Tables 4-2 and 4-3. The bedrock is generally of poor to excellent rock mass quality, with RQD improving with depth; detailed rock properties are discussed in Section 4.5.

Table 4-1: Summary of Soil and Rock Parameters in Domain 1

Borehole	Bedrock			Overburden Soil			
	Depth (m)	RQD	Rock Mass Quality	Type[1]	'N' Values	Layer Bottom Depth	Consistency
BH MET 1	5.18	37-100	Poor – Excellent	Clay (CL)	4 - 7	4.57	Soft to firm
				Till (SG)	58	5.18	Very dense
BH MET 4	1.62	68-100	Fair – Excellent	Till (CL)	3 - 9	14.62	Soft to firm

Note: [1]CL – Low to Intermediate Plasticity Clay; Till (CL) – Clayey Till; Till (SG) –Silt / Granular Till

Table 4-2: Grainsize Distribution Results – Granular Till (SG)

Borehole	Sample	Depth (m)	Gravel(%)	Sand (%)	Silt (%)	Clay (%)
BH-MET-01	SS5	4.57	35.4	29.1	25.6	9.9

Table 4-3: Atterberg Limit Results – Clay (CL) and Clay Till (CL)

Borehole	Sample	Depth (m)	Moisture	Liquid Limit	Plastic Limit	Plasticity Index
BH-MET-01	SS4	3.05	28.7	43	23	20
BH-MET-04	SS2	0.76	15.9	26	18	8

4.3 Domain 2 – Glacial Till Overlying Bedrock

Table 4-4 summarizes the stratigraphy in Domain 2; Tables 4-5 and 4-6 list the results of grainsize distribution tests and Atterberg limits tests on the Silt Till (ML) and Clay Silt Till (ML) materials encountered in this domain. The predominant soils in Domain 2 consists of glacial

till overlying relatively deep bedrock compared to Domain 1. Referring to Table 4-4, the depth to bedrock in this domain varies from 6.71 m at BH-MET-02 to 10.06 m at BH-MET-06.

The overburden in this domain consists of Clay (CL), Clay Till (CL) and Silt Till (ML). In general, the Clay (CL) layer is thin and extends to about 1.22 m. This layer is firm with SPT from 4 to 6. The Clay Till (CL) is firm to hard and Silt Till (ML) is compact to very dense, as shown in Table 4-4.

The bedrock rock mass quality varies from very poor to excellent; detailed rock properties are discussed in Section 4.5.

Table 4-4: Summary of Soil and Rock Parameters in Domain 2

Borehole	Bedrock			Overburden Soil			
	Depth (m)	RQD	Rock Mass Quality	Type[1]	'N' Values	Moisture Content (%)	Consistency
BH MET 2	6.71	20 - 92	Very poor-Excellent	Clay (CL, to 1.22 m depth) over	4 - 6	35	Firm
				Till (ML)	13 - 91	7.4-67.8	Compact to very dense
BH MET 6	10.06	59 - 74	Fair	Till (CL) and Till (ML)	7-42	8-56.9	Firm – hard

Note: [1]CL – Low to Intermediate Plastic Clay; Till (CL) – Clayey Till; Till (SG) – Granular Till; Till (ML) – Silt or Clayey Silt Till.

Table 4-5: Grainsize Distribution Results – Silt Till (ML) and Clay Silt Till (ML)

Borehole	Sample	Depth (m)	Gravel(%)	Sand (%)	Silt (%)	Clay (%)
BH-MET-02	SS7	4.57	9.8	8.6	71.4	10.2
BH-MET-06	SS8	7.62	8.1	13.1	45.7	33.1

Table 4-6: Atterberg Limit Results – Silt Till (ML) and Clay Till (CL)

Borehole	Sample	Depth (m)	Moisture	Liquid Limit	Plastic Limit	Plasticity Index
BH-MET-02	SS3	1.52 – 2.13	12.1	19	15	4
BH-MET-06	SS4	2.29 – 2.80	56.9	16	10	6

Note: [1]CL – Low to Intermediate Plastic Clay; Till (CL) – Clayey Till; Till (SG) – Granular Till; Till (ML) – Silt or Clayey Silt Till.

4.4 Domain 3 – Soft Glaciomarine Clay over Till

Table 4-7 summarizes the stratigraphy in Domain 3 and Table 4-8 lists the results of field vane tests performed in the upper very soft to stiff Clay (CL) materials. Summarizing, this domain consists of a Clay (CL) layer overlying Till (Clayey Till, Silt Till, or Gravelly Sand Till) and then Bedrock.

The Clay (CL) layer was encountered and extends to 3.05 m to 7.62 m in BH-MET-03 and BH-MET-05, respectively. This Clay layer is very soft to firm as per SPT values ranging from WH to 8. The field shear vane test yielded a undrained shear strength from 27 kPa to 38 kPa.

Below the Clay (CL) layer is a till deposit. The till deposit is firm to hard in BH-MET-05 and compact to very dense in BH-MET-03.

Based on RQDs in the bedrock, the rock mass quality generally varies from poor to good. The mechanical properties of the bedrock are discussed in Section 4.5

Table 4-2: Summary of Soil and Rock Parameters in Domain 3

Borehole	Bedrock			Overburden Soil				
	Depth (m)	RQD	Rock Mass Quality	Type[1]	Layer Bottom Depth	'N' Values	w_N (%)	Consistency
BH MET 3	7.62	29-90	Poor to Good	Clay (CL) over	3.05 m	4 - 8	35 - 49	Soft to firm
				Till (SG) and Till (ML)	7.62 m	16 - 87	7 - 16	Compact to very dense
BH MET 5	N/A	N/A	N/A	Clay (CL) over	7.62 m	WH - 4	29 - 59	V. soft to soft
				Till (CL)	12.80 m	6 - 76	7 - 15	Firm to Hard

Note: [1]CL – Low to Intermediate Plastic Clay; Till (CL) – Clayey Till; Till (SG) – Granular Till; Till (ML) – Silt or Clayey Silt Till.

Table 4-3: Field Vane Shear Test Results

Turbine	Depth (m)	Field Vane Strength (kPa)
BH MET 1	2.44	48
	2.74	48
BH MET 3	2.44	38
	2.74	96

Turbine	Depth (m)	Field Vane Strength (kPa)
BH MET 5	1.83	42
	2.13	38
	3.96	27
	4.27	31
	5.49	38

Table 4-4: Grainsize Distribution Results in Domain 3

Borehole	Sample	Material	Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH MET 3	SS3	CL	1.52	0	2.5	36.1	61.4
BH MET 3	SS4	Till (SG)	3.05	65.2	13.3	15.5	6
BH MET 3	SS11	Till (ML)	6.10	27.9	24.4	38.9	8.8
BH MET 5	SS5	CL	3.05	0	0.5	32	67.5

Table 4-5: Atterberg Limits - Silty Clay (CL) Deposit

Borehole	Sample	Depth	W_N	W_L	W_P	I_P
BH-MET-03	SS3	1.52 – 2.13	35.4	50	26	24
BH-MET-05	SS5	3.05 – 3.66	43.3	50	23	27

4.5 Bedrock Properties

The bedrock at the site consists of grey to black, thinly bedded, fine grained Shaly Limestone. Based on the rock core logs in Appendix C, the Rock Quality Designation (RQD) values vary significantly but are generally between 19-74% in the upper meter of the bedrock and between 59-100% below that. The Rock Mass Rating (RMR) rating for the rock mass is about 57 based the RMR classification system (Bieniawski, 1972). As a result, the rock mass quality is fair to good.

4.6 Ground Water

Table 4-11 summarizes the groundwater level observed upon the completion of drilling. It should be noted that the water level in Table 4-11 was in temporary state and may further rise with time.

As per the piezometer installed the wind turbine sites, the groundwater level varies from 0.44 m to 4.38 m depth below the ground surface as per the readings obtained on July 5, 2018 (see the report of 18-4022-02 WTG).

It should be noted that the groundwater level is subject to seasonal fluctuations with high levels occurring during wet weather conditions in the spring and fall and lower levels during dry weather conditions.

Table 4-6: Temporary Groundwater Levels*

Borehole	Groundwater Level Observation Upon Completion of Drilling
	(m)
BH-MET-01	4.98
BH-MET-02	N/A
BH-MET-03	3.05
BH-MET-04	N/A
BH-MET-05	6.10
BH-MET-06	6.10

Note: The groundwater level was as per field observation upon completion of borehole drilling. The groundwater level is temporary and is NOT stabilized.

5 GEOTECHNICAL RECOMMENDATIONS

This section provides engineering recommendations for the MET Tower foundation design and construction.

5.1 Geotechnical Parameters

5.1.1 Soil Unit Properties

Table 5-1 lists the unit weight, and effective strength parameters for the three main native soils and backfill materials.

Table 5-1: Key Design Parameters

Material	Saturated Unit Weight (kN/m^3)	Effective Submerged Unit Weight (kN/m^3)	Effective Strength Parameters		Active Earth Pressure Coefficient	Passive Earth Pressure Coefficient	Sliding Coefficient (Soil-Concrete)
			c' (kPa)	ϕ' (°)			
Clay (CL) / Clayey Till (CL)	17.5	7.7	0	28	0.36	2.8	0.25
Silt Till (ML)	20.5	10.7	0	34	0.28	3.5	0.35
Gravelly Sand Till (SG)	21	11.7	0	36	0.26	3.9	0.35
Compacted Backfill (Native Soil)	17	7.2	0	28	0.36	2.8	Not Applicable
Granular A / Granular B TYPE II	22.8	13	0	35	0.27	3.7	0.35
Granular B TYPE I	21.2	12.4	0	32	0.31	3.3	0.31

Note: Granular A and B should be placed in lifts and compacted as per the specification.

5.2 MET Tower Foundations

5.2.1 General

Various foundation options have been considered for support of the MET tower. Table 5-1 summarizes the foundation assessment for the six (6) borehole locations (Site 1 to Site 6).

- MET tower can be placed on native tills for the two sites of Site 2 and Site 6 with a reasonably competent bearing capacity.

- For Site 1 and Site 3, foundation soil (CL) has a relatively low bearing capacity. To achieve a higher bearing capacity for the two sites, an over-excavation is required down to the competent till layer (SG). The MET tower can be founded on a layer of compacted crusher-run Granular A overlying the competent till (SG) layer .
- For Site 4, MET tower can be placed directly on shallow bedrock a about 1.6 m depth. The bedrock depth may vary over the site. It should be noted that the foundation embedment depth is limited to the bedrock depth. The design engineer should review and assess the overburden to ensure adequate resistance to uplift loads.
- The Site 5 (BH-MET-05) likely requires deep foundation to support the MET tower due to the presence of a thick soft clay deposit. The cost of deep foundation is expected to be much higher than shallow foundations. As such, this site is considered not favorable for the MET tower foundation.

In summary, Site 2, Site 4 and Site 6 are more favorable to support MET tower than the other three sites considering the bearing capacity and construction cost. Site 4 has a thin overburden and the design engineer should review and assess the overburden condition to ensure adequate resistance to uplift loads.

At the time of preparing this report, the information on finished elevation, foundation elevation, and loads for the proposed MET tower was not available. A general bearing capacity was provided for vertical loads only (no inclination or no eccentricity). The given geotechnical resistance may vary depending on foundation elevation and load inclination, subject to interaction between the structural and geotechnical engineers during the detailed design process.

Table 5-2: Foundation Assessment Summary

Site No.	Borehole	Bearing Material	Minimum Foundation Depth	Bearing Capacity
		(m)	(m)	
1	BH-MET-01 (Near T25)	Option A: Clay (CL)	1.8*	P_{SLS} = 80 kPa P_{ULS} = 120 kPa
		Option B: Granular Till (SG) Higher Cost and Construction Dewatering Risk.	3	P_{SLS} = 200 kPa P_{ULS} = 300 kPa
2	BH-MET-02 (Near T32)	Silt Till (ML)	1.8*	P_{SLS} = 200 kPa P_{ULS} = 300 kPa
3	BH-MET-03 (Near T1)	Option A: Clay (CL)	1.8*	P_{SLS} = 80 kPa P_{ULS} = 120 kPa
		Option B: Granular Till (SG) Higher Cost and Construction Dewatering Risk.	4.5	P_{SLS} = 200 kPa P_{ULS} = 300 kPa
4	BH-MET-04 (Near T10)	Bedrock Noting thin overburden condition.	To bedrock (~ 1.6 m)	P_{SLS} (not govern) P_{ULS} = 1,000 kPa
5	BH-MET-05 (Near T18)	High Cost. Not recommended for MET Tower Foundation	N/A	N/A
6	BH-MET-06 (Near T58)	Clayey Till (CL)	1.8*	P_{SLS} = 150 kPa P_{ULS} = 250 kPa

Notes:

1. P_{SLS} represents the geotechnical resistance at Serviceability Limit State (SLS) for 25 mm settlement.
2. P_{SLS} represents the factored geotechnical resistance at Ultimate Limit State (ULS).
3. The bearing capacities in this table are “net” bearing capacity.
4. The footing size is assumed at least 1 m wide.
5. CL – Low to Intermediate Plastic Clay; Till (CL) – Clayey Till; Till (SG) – Granular Till; Till (ML) – Silt or Clayey Silt Till.
6. The embedded depth of 1.8 m* is for frost protection purpose.

5.2.2 Shallow Foundations on Clay or Till (Sites 1, 2, 3 and 6)

The frost penetration depth at the site is estimated to be 1.8 m. Accordingly, all foundations must be embedded at least 1.8 m into the ground to ensure adequate soil cover to avoid frost heave. In areas requiring over excavation (for Site 1 and Site 3 if Option B is adopted), a layer

of compacted Granular A fill can be placed on the prepared subgrade and the MET tower foundation can be constructed on the Granular A fill.

Table 5-2 summarizes the bearing material and the estimated depth for each of the shallow foundations. The depths in this table are preliminary and will need to be verified during construction by the engineer of record.

All soft, loose, compressible and otherwise unsuitable material should be removed to expose undisturbed soil. Following grading, the exposed subgrade should be proof-rolled with a roller under the full time supervision of geotechnical personnel. Any soft spots detected during proof-rolling should be sub-excavated and replaced with approved materials compacted to minimum 98 % SPMDD. After preparing the foundation soil, a 150-200 mm thick lean concrete mud mat should be placed on the prepared subgrade to allow construction of the foundation and to protect the subgrade from disturbance.

Dewatering should be carried out together with excavation work so that the work generally proceeds in the dry. Where the groundwater is higher the excavation base, excavation dewatering should be implemented sufficiently ahead of the excavation to maintain the groundwater levels at least 1 to 2 feet below the bottom of the excavation.

Due to the fine-grained nature of the subgrade materials at the site, dewatering is expected to require only sump and pump techniques. Locally, however, water bearing sand layers may be encountered during the construction. These layers will have limited recharge and will yield water only temporarily until pumped dry. If encountered, contractors may need to excavate pits into these layers prior to executing the bulk excavation and pump the groundwater from the pits until the granular layers dry up.

5.2.3 Foundations on Bedrock (Site 4)

The MET tower foundation at Site 4 can consist of cast-in-place reinforced concrete gravity base foundations constructed either directly on the rock.

Given the laminated and bedded nature of the sedimentary bedrock, it should be feasible to excavate the bedrock using hydraulic excavators and hydraulic hoe-rams without requiring drill and blast methods. After excavating to the design foundation level, the exposed bedrock should be thoroughly cleaned, and power washed, and a lean concrete mud mat should be placed on the rock to enable foundation construction. Loose fragmented zones of the bedrock should be removed. Where such removals result in local over excavation, the over excavated zone should be backfilled with lean concrete.

Lastly, foundation excavations may extend below the groundwater table into fractured permeable bedrock. Contractors should be able to use conventional sump and pump techniques to dewater excavations; the quantity of water to be handled should diminish with time or eventually stop completely.

5.3 Backfill

Structural fill (Granular A or B) are recommended as backfill materials to provide uplift resistance. The backfill should be placed in lifts of maximum 300 mm and compacted to min. 95% SPMDD.

5.4 Foundation Buoyancy

Buoyant effects should be accounted for during the MET tower foundation designs.

The native foundation soil (clay and glacial tills) at the site generally has a low permeability. The backfill placed around and above foundations likely have higher permeability than the surrounding native soil. The backfill will likely become saturated over time.

As such, the effective unit weights (see Table 5-1) are recommended for the backfill in the calculations of uplift resistance and passive earth pressure for the MET tower foundations.

5.5 Construction Considerations

The exposed subgrade materials consist of glacial deposit that can include silty clay, clayey silt, silty sand with gravel soils. Due to the grain size and composition, some areas will be sensitive to disturbance and strength degradation in the presence of excess moisture and construction disturbance. These soils will also be frost susceptible if left exposed to inclement weather conditions during construction.

The site preparation work be performed during seasonally dry periods to minimize potential for degradation of the subgrade soils and undercuts which may become necessary to establish a stable base for construction.

For site preparation work including compaction and proof rolling, all efforts should be made to minimize the potential disturbance to the subgrade soils.

5.6 Frost Protection

The estimated frost depth at the site is 1.8 m. The soil type is moderately susceptible to frost action. As such, the footings on soil should be situated at 1.8m below ground surface to provide adequate insulation against frost heave. Alternatively, insulation can be used to raise the frost line.

5.7 Site Classification for Seismic Response

The parameters for determination of Site Classification for Seismic Site Response are set out the 2015 NBCC. The site classification is based on the average shear wave velocity in the top 30 meters of the site stratigraphy. If the average shear wave velocity is not known, the site class can be estimated from energy corrected Standard Penetration Resistance (N_{60}) and/or the average undrained shear strength of the soil in the top 30 meters. The following site classes apply for this project based on the 2015 NBCC:

- Site 4: Site Class A
- Site 1, 2, 3 and 6: Site Class D
- Site 5: Site Class E.

These seismic design parameters should be reviewed in detail by the structural engineer and incorporated into the design as required by 2015 NBCC.

6 CLOSURE

TULLOCH has prepared this geotechnical report for the exclusive use of EDP Renewables and their authorized agents for the construction of the proposed Nation Rise Wind Farm.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering, for the above noted location. Classification and identification of soils and geologic units have been based upon commonly accepted methods employed in professional geotechnical practice. Foundation design recommendations are based on standard accepted methods of analysis for these types of structures. No warranty or other conditions, expressed or implied, should be understood. Please refer to Appendix H, Report Limitations, and Guidelines for Use, which pertains to this report.

We trust that the information and recommendations in this draft report will be found to be complete and adequate for your consideration. Should further elaboration be required for any portion of this project, we would be pleased to provide assistance.

7 REFERENCES

National Building Code of Canada, NRC, 2015.

Ontario Geological Survey 2010. Surficial geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128-REV

Ontario Geological Survey 2011. 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release---Data 126-Revision 1.

Occupational Health and Safety Act (OHSA), Ontario Regulation 213/9, Construction Projects, January 1, 2010, Part III - Excavations, Section 226.

SENES Consultants, 2015

APPENDIX A

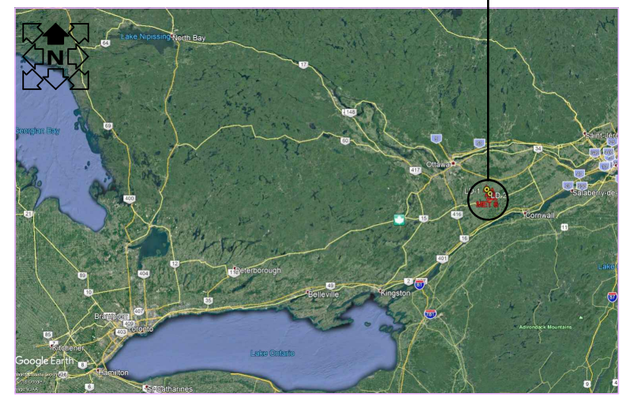
SITE LOCATION PLAN

SITE PLAN SHOWING BOREHOLE LOCATIONS

0.0 0.5 1.0 1.5 2.0 2.5 km

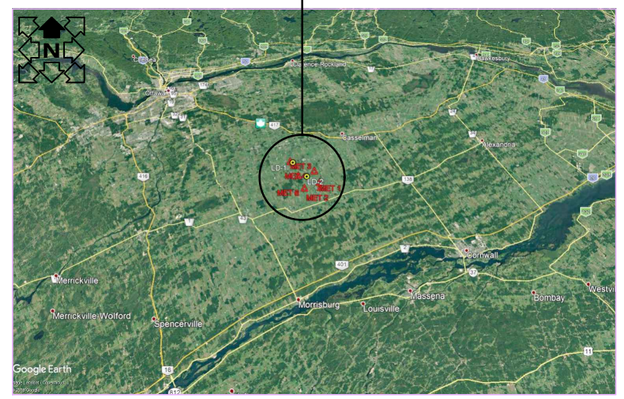
Scale: 1:50,000

PROJECT LOCATION



KEY PLAN

PROJECT LOCATION



SITE PLAN SHOWING PROJECT LOCATION

No.	DATE	BY	ISSUES / REVISIONS

TULLOCH ENGINEERING

DRAWING: Key Plan & Site Plan Showing Borehole Locations

PROJECT: **Geotechnical Investigation** **Nation Rise Wind Farm**

DRAWN BY:	CHECKED BY:	PROJECT No. :
D.A.M.	S.deB	18-4022
DESIGNED BY:	APPROVED BY:	DRAWING No. / REVISION No.
SCALE: As Noted	DATE: SEPT 12, 2018	BH1 / 0

APPENDIX B

ABBREVIATIONS, TERMINOLOGY, AND PRINCIPAL SYMBOLS USED

ABBREVIATIONS, TERMINOLOGY AND PRINCIPAL SYMBOLS USED IN REPORT AND BOREHOLE LOGS

Borehole & Test Pit Logs

Sampling method

AA	Auger Sample	**W**	Washed Sample
SS	Split Spoon Sample	**HQ**	Rock Core (63.5mm diam.)
ST	Thin Walled Shelby Tube	**NQ**	Rock Core (47.5mm diam.)
BS	Block Sample	**BQ**	Rock Core (36.5mm diam.)

In-Situ Soil Testing

Standard Penetration Test (SPT), "N" value is the number of blows required to drive a 51mm outside diameter split barrel sampler into the soil a distance of 300 mm with a 63.5kg weight free falling a distance of 760mm after an initial penetration of 150mm has been achieved. The SPT, "N" value is qualitative term used to interpret the compactness condition of cohesion less soils and is used only as a very approximation to estimate the consistency and undrained shear strength of cohesive soils.

Dynamic Cone Penetration Test (DCPT) is the number of blows required to drive a cone with a 60 degree apex attached to "A" size drill rods continuously into the soil for each 300mm penetration with a 63.5 kg weight free falling a distance of 760mm.

Cone Penetration Test (CPT) is an electronic cone point with a 10 cm^2 base area with a 60 degree apex pushed through the soil at a penetration rate of 2cm/s.

Field Vane Test (FVT) consists of a vane blade, a set of rods and torque measuring apparatus used to determine the undrained shear strength of cohesive soils.

Soil Descriptions

The soil descriptions and classifications are based on an expanded Unified Soil Classification System (USCS). The USCS classifies soils on the basis of engineering properties. The system divides soils into three major categories; coarse grained and highly organic soils. The soil is then subdivided based on either gradation or plasticity characteristics. The classification excludes particles larger than 75mm. To aid in quantifying materal amounts by eight within the respective grain size fractions the following terms have been included to expand the USCS:

Soil Classification		Terminology	Proportion
Clay	<0.002 mm		
Silt	0.002 to 0.06 mm	"trace", trace sand, etc.	1% to 10%
Sand	0.075 to 4.75 mm	"some", some sand, etc.	10% to 20%
Gravel	4.75 to 75 mm	Adjective, sandy, gravelly, or (with)	20% to 35%
Cobbles	75 to 200 mm	and, and gravel, and silt, etc.	>35%
Boulders	>200 mm	noun, Sand, Gravel, Silt, etc.	>35% and main fraction

Notes:

- Soil properties, such as strength, gradation, plasticity, structure, etcetera, dictate the soils engineering behaviour over grain size fractions;
- With the exception of soil samples tested for grain size distribution or plasticity, all soil samples have been classified based on visual and tactile observations. The accuracy of visual and tactile observation is not sufficient to differentiate between changes in soil classification or precise grain size and is therefore an approximate description.

The following table outlines the qualitative terms used to describe the relative density condition of cohesionless soil:

Cohesionless Soil	
Compactness Condition	**SPT N-Index (blows per 300 mm)**
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

The following table outlines the qualitative terms used to describe the consistency of cohesive soils related to undrained shear strength and SPT, N-Index:

Cohesive Soil		
Consistency	**Undrained Shear Strength (kPa)**	**SPT N-Index (blows per 300 mm)**
Very soft	<12	<2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

Note: Utilizing the SPT, N-value to correlate the consistency and undrained shear strength of cohesive soils is only very approximate and needs to be used with caution.

Soil & Rock Physical Properties

General

W	Natural water content or moisture content within the soil sample
γ	Unit weight
γ'	Effective unit weight
γ_d	Dry unit weight
γ_{sat}	Saturated unit weight
ρ	Density
ρ_s	Density of solid particles
ρ_w	Density of water
ρ_d	Dry density
ρ_{sat}	Saturated density
e	Void ratio
n	Porosity
S_r	Degree of saturation
E_{50}	Strain of 50% maximum stress (cohesive soil)

Consistency

W	Liquid limit
W_P	Plastic limit
I_p	Plasticity limit
W_s	Shrinkage limit
I_L	Liquidity index
I_C	Consistency index
e_{max}	Void ratio in loosest state
e_{min}	Void ratio in densest state
I_D	Density index (formerly relative density)

Shear Strength

C_u, S_u	Undrained shear strength parameter (total stress)
C'_d	Drained shear strength parameter (effective stress)
r	Remolded shear strenght
τp	Peak residual shear strength
τr	Residual shear strength
ø'	Angle of interface friction, coefficient of friction = tan ø'

Consolidation (One Dimensional)

Cc	Compression index (normally consolidated range)
Cr	Recompression index (over consolidated range)
Cs	Swelling index
mv	Coefficient of volume change
cv	Coefficient of consolidation
Tv	Time factor (vertical direction)
U	Degree of consolidation
s'o	Overburden pressure
s'p	Reconsolidation pressure (most probable)
OCR	Overconsolidation ratio

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Permeability

The following table outlines the terms used to describe the degree of permeability of soil and common soil types associated with the permeability rates:

Permeability (cm/s)	Degree of Permeability	Common Associated Soil Type
$>10^{-1}$	Very High	Clean Gravel
10^{-1} to 10^{-3}	High	Clean Sand, Clean Sand and Gravel
10^{-3} to 10^{-5}	Medium	Fine Sand to Silty Sand
10^{-5} to 10^{-7}	Low	Silt and Clayey Silt (low plasticity)
$<10^{-7}$	Practically Impermeable	Silty Clay (medium to high plasticity)

Rock Coring

Rock Quality Designation (RQD) is an indirect measure of the number of fractures within a rock mass, Deere et al. (1967). It is the sum of sound pieces of rock core equal to or greater than 100 mm recovered from the core run, divided by the total length of the core run, expressed as a percentage. If the core section is broken due to mechanical or handling, the pieces are fitted together and if 100 mm or greater included in the total sum.

RQD is calculated as follows:

$$\text{RQD (\%)} = \frac{\Sigma \text{ Length of core pieces} > 100 \text{ mm} \times 100}{\text{Total length of core run}}$$

The following is the Classification of Rock with Respect to RQD Value:

RQD Classification	RQD Value (%)
Very poor quality	<25
Poor quality	25 to 50
Fair quality	50 to 75
Good quality	75 to 90
Excellent quality	90 to 100

APPENDIX C

BOREHOLE LOGS

Borehole Log: BH MET 1

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **County Road 9, North Stormont, ON**
Client: **EDPR**

Logged By: **S.deBortoli**
Compiled By: **A.Byers**
Reviewed By: **E.Giles**

SUBSURFACE PROFILE					SAMPLE							Remarks
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Undrained Shear Strength (Cu, kPa) 25 50 75 100 125 150 175 / Standard Penetration Resistance Blows / 0.3m 10 20 30 40 50 60 70 80 90	Water Content Data (%) 20 40 60 80	Grain Size (%) Gr Sa Si Cl	
		0	Geodetic Ground Elevation	0.00								
			CLAYEY topsoil, trace ORGANICS,dark brown light brown, moist, soft		1	SS	58	6	6			
				-0.76								
		1	CLAY (CL), trace to some SILT, brown, moist, firm		2	SS	100	7	7	23		
				-1.52								
		2	CLAY (CL), to SILT, light brown, moist, firm		3	SS	100	5	5	37		
									48			
									48			
		3		-3.05								
			CLAY (CL), trace to some SILT, light brown, moist, soft		4	SS	100	4	4	29		Augered through cobbles and boulders 3.0 - 4.6 m BGS
		4		-4.57								
			GRAVEL TILL with SAND & SILT (GM), trace CLAY, and fractured rock, wet, dark brown, hard / dense.		5	SS	58	58	58	59	35.4 29.1 25.6 9.9	Water encountered at 4.98m BGS
		5		-5.18								Spoon Refusal @ 4.99m BGS
			End of Borehole									

Drilled By: **Marathon Drilling**

Drill Method: **CME 55**

Drill Date: **May 29, 2018**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
O- SPT(Standard Penetration Test)
WH - Weight Of Hammer

Datum:

Location: **UTM 18T**
E=488139
N=5001456

Sheet: **1 of 1**

Borehole Log: BH MET 1R

TULLOCH ENGINEERING

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **County Road 9, North Stormont, ON**
Client: **EDPR**

Logged By: **S.deBortoli**
Compiled By: **K. Kortekaas**
Reviewed By: **E. Giles**

SUBSURFACE PROFILE					SAMPLE						
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	TCR (cm)	RQD (%)	Run Length (cm)	Run Depth Elevation (m)	Unconfined Compressive Strength (MPa) △ 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 △	Remarks
		0	Geodetic Rock Elevation	-5.18							
			Shaley LIMESTONE, grey / black, fine grained, laminated, broken zone at top of run, horizontal fractures at shale interfaces with some weathering.	-6.07	1	89	37	89	-6.07		
		1	Shaley LIMESTONE, grey / black, fine grained, very thinly bedded in some sections of the core, broken zone at top of run, horizontal fractures at shale interfaces with some weathering.	-7.59	2	150	94	150	-7.59		
		2									
		3	Shaley LIMESTONE, grey / black, fine grained, very thinly bedded to laminated, broken zone at top of run, horizontal fractures at shale interfaces with some weathering.	-9.14	3	155	100	155	-9.14		
		4	End of Rock Core								
		5									

Drilled By: **Marathon Drilling**

Drill Method: **Casing / NQ Core**

Drill Date: **May 29, 2018**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ- Rock Core
W - Water Content
WL - Liquid Limit
WP - Plastic Content
△ - Unconfined Compressive Strength

w - Wash
o - SPT(Standard Penetration Test)
TCR - Total Core Recovery
RQD - Rock Quality Designation

Datum:

Location: **UTM 18T**
E=488139
N=5001456

Sheet: **1 of 1**

Borehole Log: BH MET 2

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **Concessions 4-5, North Stormont, ON**
Client: **EDPR**

Logged By: **S.deBortoli**
Compiled By: **A.Byers**
Reviewed By: **E.Giles**

SUBSURFACE PROFILE					SAMPLE						Remarks
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Undrained Shear Strength (Cu, kPa) △ 25 50 75 100 125 150 175 △ / Standard Penetration Resistance Blows / 0.3m ○ 10 20 30 40 50 60 70 80 90 ○	Water Content Data (%) ● 20 40 60 80 ●	Grain Size (%) Gr Sa Si Cl
		0	Geodetic Ground Elevation	0.00							
			CLAYEY topsoil, trace ORGANICS, light brown, moist, soft to firm	-0.61	1	SS	58	6			
		1	CLAY (CL), trace SILT, trace ORGANICS, light brown, moist, firm	-1.22	2	SS	54	4		35	
			CLAYEY SILT TILL (ML), trace GRAVEL, light brown, moist, stiff	-1.83	3	SS	83	13		12	
		2	SILT TILL (ML), trace GRAVEL, trace CLAY, light brown, moist, hard	-2.44	4	SS	54	34		11	
			SILT TILL (ML), trace to some GRAVEL, light grey, moist to dry, hard	-3.05	5	SS	50	14		14	
		3	SILT TILL (ML), trace to some GRAVEL, light grey, moist to dry, hard	-4.57	6	SS	83	40			Water encountered at 3.05m BGS
		4									
		5			7	SS	58	91		68	9.8 8.6 71.4 10.2

Drilled By: **Marathon Drilling**

Drill Method: **CME 55**

Drill Date: **May 30, 2018**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

WP W WL

Datum:

Location: **UTM 18T**
E=488397
N=5000020

Sheet: **1 of 2**

Borehole Log: BH MET 2

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **Concessions 4-5, North Stormont, ON**
Client: **EDPR**

Logged By: **S.deBortoli**
Compiled By: **A.Byers**
Reviewed By: **E.Giles**

SUBSURFACE PROFILE					SAMPLE				Undrained Shear Strength (Cu, kPa) △ 25 50 75 100 125 150 175 △ / Standard Penetration Resistance Blows / 0.3m ○ 10 20 30 40 50 60 70 80 90 ○	Water Content Data (%) ● 20 40 60 80 ●	Remarks / Grain Size (%) Gr Sa Si Cl
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m			
		6	SILT TILL (ML) some CLAY, trace GRAVEL, trace SAND, light grey, moist to dry, hard							7	Spoon Refusal @ 6.0m BGS
				-6.71							
			End of Borehole								
		7									
		8									
		9									
		10									
		11									

Drilled By: **Marathon Drilling**

Drill Method: **CME 55**

Drill Date: **May 30, 2018**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
O- SPT(Standard Penetration Test)
WH - Weight Of Hammer

WP W WL

Datum:

Location: **UTM 18T**
E=488397
N=5000020

Sheet: **2 of 2**

Borehole Log: BH MET 2R

TULLOCH ENGINEERING

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **Concession 4-5, North Stormont, ON**
Client: **EDPR**

Logged By: **S.deBortoli**
Compiled By: **K. Kortekaas**
Reviewed By: **E. Giles**

SUBSURFACE PROFILE					SAMPLE						
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	TCR (cm)	RQD (%)	Run Length (cm)	Run Depth Elevation (m)	Unconfined Compressive Strength (MPa) △ 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 △	Remarks
		0	Geodetic Rock Elevation	-6.71							
			Shaley LIMESTONE, grey / black, fine grained, laminated, broken zone at top of run, weathered rock with horizontal and vertical fractures	-7.32	1	61	19.6	61	-7.32		
		1	Shaley LIMESTONE, grey / black, fine grained, very thinly bedded to laminated, some weathering present at horzontal fractures		2	149	85.5	152			
		2		-8.84					-8.84		
		3	Shaley LIMESTONE, grey / black, fine grained, very thinly bedded to laminated,minimal weathering, turbidites present		3	147	91.8	147.5			
				-10.32					-10.32		
			End of Rock Core								
		4									
		5									

Drilled By: **Marathon Drilling**

Drill Method: **Casing / NQ Core**

Drill Date: **May 30, 2018**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ- Rock Core
W - Water Content
WL - Liquid Limit
WP - Plastic Content
△ - Unconfined Compressive Strength

w - Wash
o - SPT(Standard Penetration Test)
TCR - Total Core Recovery
RQD - Rock Quality Designation

Datum:

Location: **UTM 18T**
E=488397
N=5000020

Sheet: **1 of 1**

Borehole Log: BH MET 3

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **Marionville Road, North Stormont, ON**
Client: **EDPR**

Logged By: **S.deBortoli**
Compiled By: **D.A.Mousseau**
Reviewed By: **E.Giles**

SUBSURFACE PROFILE					SAMPLE						Remarks
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Undrained Shear Strength (Cu, kPa) 25 50 75 100 125 150 175; Standard Penetration Resistance Blows / 0.3m 10 20 30 40 50 60 70 80 90	Water Content Data (%) 20 40 60 80	Grain Size (%) Gr Sa Si Cl
		0	Geodetic Ground Elevation	0.00							
			CLAY topsoil, trace ORGANICS, trace GRAVEL, light brown, moist to dry, firm		1	SS	25	5			
				-0.76							
		1	CLAY (CL), trace to some SILT, brown, moist, firm		2	SS	75	8		49	
				-1.52							
		2	CLAY (CL), some SILT, trace SAND, light brown, moist, soft		3	SS	100	4	38 96	35	0.0 2.5 36.1 61.4
		3		-3.05							
			GRAVEL (GM), some SAND, some SILT, trace CLAY, dark brown to black, wet, compact		4	SS	54	16		16	65.2 13.3 15.5 6.0
		4		-4.57							Water Encountered @ 3.66m BGS
		5			5	SS	71	87		13	Spoon & Auger Refusal @ 4.97m BGS

Drilled By: **Marathon Drilling**

Drill Method: **HSA / SS**

Drill Date: **May 18, 2018**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
O- SPT(Standard Penetration Test)
WH - Weight Of Hammer

Datum:

Location: **UTM 18T**
E=480717
N=5007343

Sheet: **1 of 2**

Borehole Log: BH MET 3

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **Marionville Road, North Stormont, ON**
Client: **EDPR**

Logged By: **S.deBortoli**
Compiled By: **D.A.Mousseau**
Reviewed By: **E.Giles**

SUBSURFACE PROFILE					SAMPLE						Remarks
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Undrained Shear Strength (Cu, kPa) / Standard Penetration Resistance Blows / 0.3m	Water Content Data (%)	Grain Size (%) Gr Sa Si Cl
		6	SILT TILL (ML) with SAND & GRAVEL, trace CLAY, dark brown to dark grey / black, wet to moist, very dense to hard								
		7			6	SS	73	77		7	27.9 24.4 38.9 8.8
				-7.62							
		8	End of Borehole See BH Log 18-4022 MET 3R For Rock Core Data								
		9									
		10									
		11									

Undrained Shear Strength (Cu, kPa): △ 25 50 75 100 125 150 175 △

Standard Penetration Resistance Blows / 0.3m: ○ 10 20 30 40 50 60 70 80 90 ○

Water Content Data (%): ● 20 40 60 80 ●

Drilled By: **Marathon Drilling**

Drill Method: **HSA / SS**

Drill Date: **May 18, 2018**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
O- SPT(Standard Penetration Test)
WH - Weight Of Hammer

WP W WL

Datum:

Location: **UTM 18T**
E=480717
N=5007343

Sheet: **2 of 2**

Borehole Log: BH MET 3R

TULLOCH ENGINEERING

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **Marionville Road, North Stormont, ON**
Client: **EDPR**

Logged By: **S.deBortoli**
Compiled By: **D.A.Mousseau**
Reviewed By: **E. Giles**

SUBSURFACE PROFILE					SAMPLE						
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	TCR (cm)	RQD (%)	Run Length (cm)	Run Depth Elevation (m)	Unconfined Compressive Strength (MPa) △ 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 △	Remarks
		0	Geodetic Rock Elevation	-8.81					-8.81		
		1	Shaley LIMESTONE, black / grey, fine grained, thinly laminated to laminated, broken area at top of run for 33cm, extremely weathered / broken section 82cm from top of run (56cm total length measured in core box)	-10.31	1	137	29	150	-10.31		
		2	Shaley LIMESTONE, black / grey, fine grained, thinly laminated to laminated, weathering present at discontinuities (horizontal & vertical fractures present)	-11.81	2	148	78	150	-11.81		
		3	Shaley LIMESTONE, black / grey, fine grained, thinly laminated to laminated, some weathering at discontinuities, mechanical fractures present at shale layers	-13.21	3	140	90	140	-13.21		
		4	End of Rock Core								
		5									
		6									
		7									
		8									

Drilled By: **Marathon Drilling**

Drill Method: **Casing / NQ Core**

Drill Date: **May 18, 2018**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ- Rock Core
W - Water Content
WL - Liquid Limit
WP - Plastic Content
△ - Unconfined Compressive Strength

w - Wash
o - SPT(Standard Penetration Test)
TCR - Total Core Recovery
RQD - Rock Quality Designation

Datum:

Location: **UTM 18T**
E=480717
N=5007343

Sheet: **1 of 1**

Borehole Log: BH MET 4

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **County Road 13, North Stormont, ON**
Client: **EDPR**

Logged By: **S.deBortoli**
Compiled By: **D.A.Mousseau**
Reviewed By: **E.Giles**

SUBSURFACE PROFILE					SAMPLE						Remarks
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Undrained Shear Strength (Cu, kPa) △ 25 50 75 100 125 150 175 △ / Standard Penetration Resistance Blows / 0.3m ○ 10 20 30 40 50 60 70 80 90 ○	Water Content Data (%) ● 20 40 60 80 ●	Grain Size (%) Gr Sa Si Cl
		0	Geodetic Ground Elevation	0.00							
			CLAY topsoil, trace ORGANICS, trace GRAVEL, light brown, moist, stiff		1	SS	33	9			
				-0.76							
		1	CLAY TILL (CL), trace to some SILT, trace GRAVEL, light brown, moist, soft to hard		2	SS	33	3		16	
				-1.62	3			100+			
			End of Borehole								Spoon & Auger Refusal @ 1.83m BGS
		2	See BH Log 18-4022 MET 4R For Rock Core Data								
		3									
		4									
		5									

Drilled By: **Marathon Drilling**

Drill Method: **HSA / SS**

Drill Date: **May 19, 2018**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

Datum:

Location: **UTM 18T**
E=483029
N=5003139

Sheet: **1 of 1**

Borehole Log: BH MET 4R

TULLOCH ENGINEERING

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **County Road 13 Access, North Stormont, ON**
Client: **EDPR**

Logged By: **S.deBortoli**
Compiled By: **D.A.Mousseau**
Reviewed By: **E. Giles**

SUBSURFACE PROFILE					SAMPLE						
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	TCR (cm)	RQD (%)	Run Length (cm)	Run Depth Elevation (m)	Unconfined Compressive Strength (MPa) 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150	Remarks
		0	Geodetic Rock Elevation	-1.62							
			Shaley LIMESTONE, black / grey, fine grained, thinly laminated to laminated, horizontal fracture with moderate weathering present at discontinuities		1	95	68	95			
				-2.57					-2.57		
		1	Shaley LIMESTONE, black / grey, fine grained, thinly laminated to laminated to very thinly laminated, horizontal & vertical fracturing with some weathering present at discontinuities		2	160	88	170			
		2		-4.27					-4.27		
		3	Shaley LIMESTONE, black / grey, fine grained, very thinly bedded, thinly laminated to laminated in sections, 3 discontinuities (likely mechanical fractures) minimal weathering, excellent rock		3	157.5	100	157.5			
		4		-5.84					-5.84		
			End of Rock Core								
		5									

Drilled By: **Marathon Drilling**

Drill Method: **Casing / NQ Core**

Drill Date: **May 18, 2018**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ- Rock Core
W - Water Content
WL - Liquid Limit
WP - Plastic Content
△ - Unconfined Compressive Strength

w - Wash
o - SPT(Standard Penetration Test)
TCR - Total Core Recovery
RQD - Rock Quality Designation

Datum:

Location: **UTM 18T**
E=483029
N=5003139

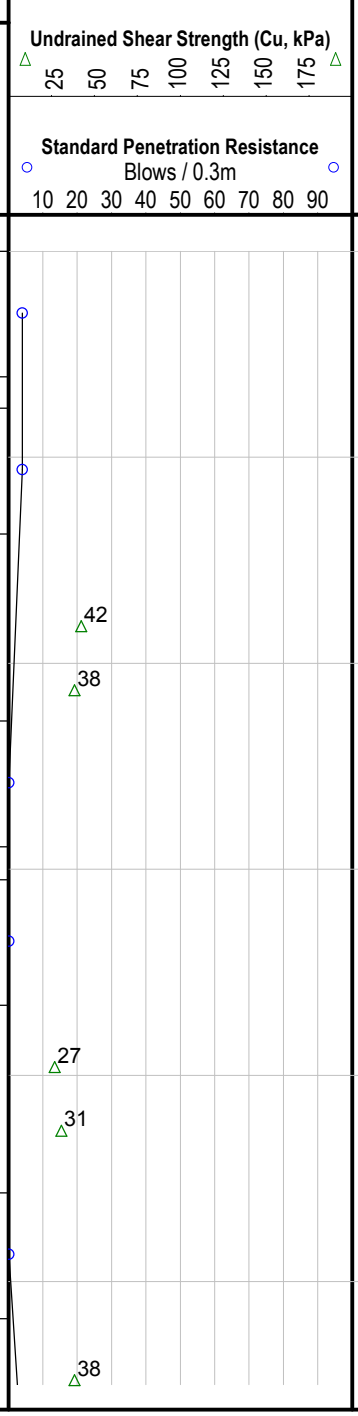
Sheet: **1 of 1**

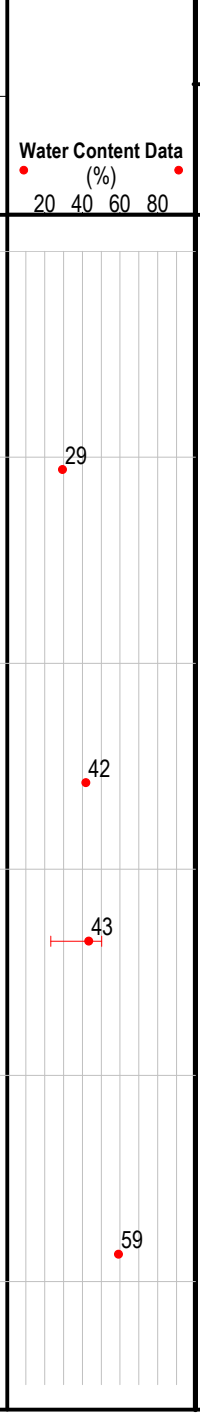
Borehole Log: BH MET 5

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **County Road 13, North Stormont, Ontario**
Client: **EDPR**

Logged By: **S.deBortoli**
Compiled By: **D.A.Mousseau**
Reviewed By: **E.Giles**

SUBSURFACE PROFILE					SAMPLE						Remarks
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Undrained Shear Strength (Cu, kPa) / Standard Penetration Resistance Blows / 0.3m	Water Content Data (%)	Grain Size (%) Gr Sa Si Cl
		0	Geodetic Ground Elevation	0.00							
			CLAY topsoil, trace organics, brown, moist, soft		1	SS	29	4			
				-0.76							
		1			2	SS	88	4			
		2			4	SS	100	WH			Water Encountered @ 2.28m BGS
		3	CLAY (CL) with SILT, trace SAND, brown to moist, soft to very soft		5	SS	100	WH			0.0 0.5 32.0 67.5
		4			6	SS	100	WH			
		5									





Drilled By: **Marathon Drilling**

Drill Method: **HSA / SS**

Drill Date: **April 29, 2018**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
O- SPT(Standard Penetration Test)
WH - Weight Of Hammer

Datum:

Location: **UTM 18T**
E=486736
N=5004816

Sheet: **1 of 3**

Borehole Log: BH MET 5

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **County Road 13, North Stormont, Ontario**
Client: **EDPR**

Logged By: **S.deBortoli**
Compiled By: **D.A.Mousseau**
Reviewed By: **E.Giles**

SUBSURFACE PROFILE					SAMPLE				Undrained Shear Strength (Cu, kPa) △ 25 50 75 100 125 150 175 △ / Standard Penetration Resistance Blows / 0.3m ○ 10 20 30 40 50 60 70 80 90 ○	Water Content Data (%) ● 20 40 60 80 ●	Remarks / Grain Size (%) Gr Sa Si Cl
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m			
		6		-6.10							Could Not Turn Vane From 5.79m BGS Due To Hard Soils
		7	SILTY CLAY TILL (CL), trace GRAVEL, brown, moist to wet, firm	-7.62	7	SS	29	6		15	Cobbles / Boulders While Augering From 6.1m-7.6m BGS
		8			8	SS	38	20		11	
		9			9	SS	54	20		7	
		10	SILTY CLAY TILL (CL), some GRAVEL, brown, wet / moist, very to very hard		10	SS	29	31		10	
		11									

Drilled By: **Marathon Drilling**

Drill Method: **HSA / SS**

Drill Date: **April 29, 2018**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

Datum:

Location: **UTM 18T**
E=486736
N=5004816

Sheet: **2 of 3**

Borehole Log: BH MET 5

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **County Road 13, North Stormont, Ontario**
Client: **EDPR**

Logged By: **S.deBortoli**
Compiled By: **D.A.Mousseau**
Reviewed By: **E.Giles**

SUBSURFACE PROFILE					SAMPLE				Undrained Shear Strength (Cu, kPa) △ 25 50 75 100 125 150 175 △ / Standard Penetration Resistance Blows / 0.3m ○ 10 20 30 40 50 60 70 80 90 ○	Water Content Data (%) ● 20 40 60 80 ●	Remarks / Grain Size (%)
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m			Gr Sa Si Cl
		12									
					11	SS	-	76			
				-12.80							
			End of Borehole								
		13									
		14									
		15									
		16									

Drilled By: **Marathon Drilling**

Drill Method: **HSA / SS**

Drill Date: **April 29, 2018**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

Datum:

Location: **UTM 18T**
E=486736
N=5004816

Sheet: **3 of 3**

TULLOCH
ENGINEERING

GEOTECHNICAL REPORT

Nation Rise Wind Farm Project

MET Tower



January 2019

TULLOCH Project #: 18-4022

LICENSED PROFESSIONAL ENGINEER
G. QU
100155630
Jan. 24, 2019
PROVINCE OF ONTARIO

Jan 22, 2018	A	Issued for Permit	G.Qu	S. Hinchberger	S. Hinchberger	R. McDonner
Aug 12, 2018	A	Issued Draft	S. deBortoli, G.Qu	S. Hinchberger	S. Hinchberger	R. McDonner
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**

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September 19, 2018
18-4022

EDP Renewables North American LLC
808 Travis Street, Suite 700
Houston, Texas
ZIP: 77002

Attention: Ryan McDonner, Civil Engineering Manager

Re: Geotechnical Report for the Nation Rise Wind Farm Project

Dear Mr. McDonner:

Please find enclosed our Draft Geotechnical Report for the proposed 100 MW Nation Rise Wind Farm Project located in the Township of North Stormont, United Counties of Stormont, Dundas, and Glengarry, Ontario, Canada.

This report outlines the results of the geotechnical investigations, which were completed on the site and it provides geotechnical recommendations for foundation design and construction of the proposed MET tower.

We trust the enclosed is adequate for your needs at this time. If there is anything further we can assist, please contact us at your convenience.

Sincerely,
Tulloch Engineering Inc.

Sean Hinchberger, Ph.D., P.Eng.
General Manager, Geotechnical Specialist

TABLE OF CONTENTS

LIST OF APPENDICES

1 INTRODUCTION

The Nation Rise Wind Project is located 40 km southeast of Ottawa, Ontario, in the Municipality of North Stormont. The project comprises twenty-nine wind turbines Enercon E138 with an installed capacity of up to 99.76 MW and associated infrastructure including a 235 kV/34.5 kV Substation, a Hydro One Network Inc. (HONI) Interconnection structure, an expansion to an existing O&M building, one MET Tower, collector and transmission lines, and private and public access roads. The project is currently in the detailed engineering phase.

Tulloch Engineering Inc. (Tulloch) was retained by EDP Renewables (the Client) to complete geotechnical site investigations for the proposed MET Tower mast locations. The purpose of this geotechnical program was to evaluate the subsurface conditions at the proposed MET mast locations, and to provide engineering recommendations for site and foundation design.

This report provides the factual geotechnical investigation data and geotechnical design recommendations, which are based on the site investigation data, our understanding of the project scope and engineering experience. Appendix A shows the site location and borehole plan. A list of abbreviations, terminology and principal symbols used throughout this report are in Appendix B.

The following report sections describe the site geology, the investigation methodology, results and engineering recommendations.

2 SITE DESCRIPTION AND GEOLOGY

Based on the Surficial Geology of Southern Ontario Maps as published by the Ontario Geological Survey (i.e. OGS Map 2140A), the site surficial geology varies from exposed bedrock, to glacial till and fine-textured glaciomarine deposits. The bedrock consists of limestone, dolomite, shale, arkose and sandstone of the Ottawa Group (OGS 2011). The bedrock is exposed (i.e. outcropping) mainly along the western boundaries of the project in an area roughly bounded by Crysler, Cannamore and Connaught, ON. Bedrock is also locally exposed east of the South Nation River near Payne Crossing and along Berwick Rd. The glaciomarine deposits primarily consist of silt and clay, with minor sand and gravel; These sediments are massive to well laminated in structure and are found mainly along the South Nation River (OGS 2010) and its tributaries. The glacial till consists of poorly sorted clay, silt, sand and gravel with occasional cobbles and boulders.

3 SITE INVESTIGATIONS AND METHODOLOGY

3.1 Drilling Investigations

The geotechnical investigations were completed for the MET tower locations between April 29th and May 30th, 2018. The investigations consisted of advancing six (6) boreholes referenced as Boreholes BH-MET-01 to BH-MET-06 through the overburden to borehole termination at least 3m into bedrock at all locations, excluding BH-MET-05 which was terminated at 12.8 m depth.

The boreholes were advanced through the overburden and bedrock using a CME-55 track-mounted drill rig equipped with 200 mm diameter continuous flight hollow stem augers, standard soil sampling equipment, and N-size casing and double tube core barrels. The drilling program was carried out by Marathon Drilling Co. Ltd. Soil samples were obtained with a 51 mm outside diameter split spoon barrel in conjunction with Standard Penetration Tests (SPT) conducted according to ASTM D1586. The SPTs and sampling were conducted at 0.6-metre intervals in the upper 3.7 m, and 1.52 m intervals thereafter. Field vane tests (ASTM D2573) were also conducted in all boreholes using a standard 125 mm MTO (Ministry of Transportation of Ontario) vane to measure the undrained shear strength of the cohesive soil. Select boreholes were advanced at least 3 m into the bedrock; rock cores were retrieved with a double tube NQ core barrel.

The drilling and sampling program was completed under the full-time supervision of Tulloch representatives, who logged the drilling operations, identified the soil samples as they were retrieved and logged the bedrock core. Groundwater measurements were recorded immediately after the boreholes were completed. The recovered soil samples were sealed in plastic bags and the bedrock cores were placed in core boxes and both were transported to Tulloch's CCIL Certified Laboratory in Sault Ste Marie for detailed examination and testing. All samples will be stored in our laboratory for six (6) months and then disposed of unless directed otherwise. The results of the drilling investigations are summarized on the borehole logs in Appendix C.

3.2 Laboratory Tests

Table 3-1 summarizes the soil and rock laboratory tests conducted for this geotechnical investigation program and the corresponding ASTM standards. Select samples were also sent to ALS Laboratories for Corrosivity testing. Detailed laboratory test reports are attached in Appendix D.

Table 3-1: Summary of Soil/Rock Laboratory Testing Program

Item No.	Test	Number of Tests	ASTM Standard
1	Sieve Analysis	5	ASTM D422
2	Hydrometer Analysis	6	ASTM D422
3	Atterberg Limits	6	ASTM D4318
4	Moisture Content	43	ASTM D2216

4 SUBSURFACE CONDITIONS

4.1 General

Detailed subsurface profiles at each borehole are summarized in the borehole logs attached in Appendix C. The Unified Soil Classification System (USCS) was used for soil classification. Additionally, the soil boundaries indicated on the borehole logs are inferred from discontinuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones to support geotechnical design and they should not be interpreted as exact planes of geological change. Third parties relying on the data presented in the logs should account for the approximate nature of these boundaries during design.

Based on the geotechnical data collected, three geologic domains were encountered at the Nation Rise site as summarized below.

Domain 1 (Shallow Bedrock)**:** In this domain, the subsurface conditions consist of approximately 50 cm of topsoil overlying 1.62 to 5.18 m thick of either Clay Till (CL) with some sand and gravel and occasional cobbles, or soft low to high plasticity Clay (CL), trace to some silt, overlying shaly limestone bedrock. MET mast locations BH-MET-01 and BH-MET-04 are in this domain.

Domain 2 (Glacial Till Overlying Bedrock)**:** The subsurface conditions in Domain 2 consist of approximately 50 cm of top soil overlying an 6.71 to 10.06 m of firm to hard Clay Till (CL), Clay Silt Till (ML) or compact to dense Silt Till (ML) overlying shaly limestone bedrock. The MET mast boreholes BH-MET-02 and BH-MET-06 are in this domain.

Domain 3 (Soft Glaciomarine Clay over Till**):** The third domain comprises approximately 50 cm of top soil overlying 4.57 m to 12.80 of soft to firm Silty Clay (CL) overlying either glacial till over bedrock or directly overlying shaly limestone bedrock. The MET mast boreholes BH-MET-03 and BH-MET-05 are in this domain.

The geologic domains are described in detail in the following sections.

4.2 Domain 1 – Shallow Bedrock

Table 4-1 summarizes the stratigraphy in Domain 1. In this domain, the depth to bedrock varies from 1.62 m at BH-MET-04 to 5.18 m at BH-MET-01. The overburden soils overlying bedrock comprise a thin veneer of Clay (CL) with trace to some silt and Clay Till (CL) with some sand and gravel and occasional cobbles.

- At BH-MET-01, the Clay (CL) layer is soft to firm with vane shear strength of 48 kPa and SPT ranging from 4 to 7. This layer extends to a depth about 4.57 m. Below the Clay (CL) is a very dense granular till consisting of gravel with sand and silt trace clay.
- At BH-MET-04, the Clay (CL) layer is thin and extends to 1.62 m depth overlying bedrock. This layer is soft to stiff as per the SPT values from 3 to 9.

Grainsize testing and Atterberg limits results from samples in this domain can be found in Tables 4-2 and 4-3. The bedrock is generally of poor to excellent rock mass quality, with RQD improving with depth; detailed rock properties are discussed in Section 4.5.

Table 4-1: Summary of Soil and Rock Parameters in Domain 1

Borehole	Bedrock			Overburden Soil			
	Depth (m)	RQD	Rock Mass Quality	Type[1]	'N' Values	Layer Bottom Depth	Consistency
BH MET 1	5.18	37-100	Poor – Excellent	Clay (CL)	4 - 7	4.57	Soft to firm
				Till (SG)	58	5.18	Very dense
BH MET 4	1.62	68-100	Fair – Excellent	Till (CL)	3 - 9	14.62	Soft to firm

Note: [1]CL – Low to Intermediate Plasticity Clay; Till (CL) – Clayey Till; Till (SG) –Silt / Granular Till

Table 4-2: Grainsize Distribution Results – Granular Till (SG)

Borehole	Sample	Depth (m)	Gravel(%)	Sand (%)	Silt (%)	Clay (%)
BH-MET-01	SS5	4.57	35.4	29.1	25.6	9.9

Table 4-3: Atterberg Limit Results – Clay (CL) and Clay Till (CL)

Borehole	Sample	Depth (m)	Moisture	Liquid Limit	Plastic Limit	Plasticity Index
BH-MET-01	SS4	3.05	28.7	43	23	20
BH-MET-04	SS2	0.76	15.9	26	18	8

4.3 Domain 2 – Glacial Till Overlying Bedrock

Table 4-4 summarizes the stratigraphy in Domain 2; Tables 4-5 and 4-6 list the results of grainsize distribution tests and Atterberg limits tests on the Silt Till (ML) and Clay Silt Till (ML) materials encountered in this domain. The predominant soils in Domain 2 consists of glacial

till overlying relatively deep bedrock compared to Domain 1. Referring to Table 4-4, the depth to bedrock in this domain varies from 6.71 m at BH-MET-02 to 10.06 m at BH-MET-06.

The overburden in this domain consists of Clay (CL), Clay Till (CL) and Silt Till (ML). In general, the Clay (CL) layer is thin and extends to about 1.22 m. This layer is firm with SPT from 4 to 6. The Clay Till (CL) is firm to hard and Silt Till (ML) is compact to very dense, as shown in Table 4-4.

The bedrock rock mass quality varies from very poor to excellent; detailed rock properties are discussed in Section 4.5.

Table 4-4: Summary of Soil and Rock Parameters in Domain 2

Borehole	Bedrock			Overburden Soil			
	Depth (m)	RQD	Rock Mass Quality	Type[1]	'N' Values	Moisture Content (%)	Consistency
BH MET 2	6.71	20 - 92	Very poor-Excellent	Clay (CL, to 1.22 m depth) over	4 - 6	35	Firm
				Till (ML)	13 - 91	7.4-67.8	Compact to very dense
BH MET 6	10.06	59 - 74	Fair	Till (CL) and Till (ML)	7-42	8-56.9	Firm – hard

Note: [1]CL – Low to Intermediate Plastic Clay; Till (CL) – Clayey Till; Till (SG) – Granular Till; Till (ML) – Silt or Clayey Silt Till.

Table 4-5: Grainsize Distribution Results – Silt Till (ML) and Clay Silt Till (ML)

Borehole	Sample	Depth (m)	Gravel(%)	Sand (%)	Silt (%)	Clay (%)
BH-MET-02	SS7	4.57	9.8	8.6	71.4	10.2
BH-MET-06	SS8	7.62	8.1	13.1	45.7	33.1

Table 4-6: Atterberg Limit Results – Silt Till (ML) and Clay Till (CL)

Borehole	Sample	Depth (m)	Moisture	Liquid Limit	Plastic Limit	Plasticity Index
BH-MET-02	SS3	1.52 – 2.13	12.1	19	15	4
BH-MET-06	SS4	2.29 – 2.80	56.9	16	10	6

Note: [1]CL – Low to Intermediate Plastic Clay; Till (CL) – Clayey Till; Till (SG) – Granular Till; Till (ML) – Silt or Clayey Silt Till.

4.4 Domain 3 – Soft Glaciomarine Clay over Till

Table 4-7 summarizes the stratigraphy in Domain 3 and Table 4-8 lists the results of field vane tests performed in the upper very soft to stiff Clay (CL) materials. Summarizing, this domain consists of a Clay (CL) layer overlying Till (Clayey Till, Silt Till, or Gravelly Sand Till) and then Bedrock.

The Clay (CL) layer was encountered and extends to 3.05 m to 7.62 m in BH-MET-03 and BH-MET-05, respectively. This Clay layer is very soft to firm as per SPT values ranging from WH to 8. The field shear vane test yielded a undrained shear strength from 27 kPa to 38 kPa.

Below the Clay (CL) layer is a till deposit. The till deposit is firm to hard in BH-MET-05 and compact to very dense in BH-MET-03.

Based on RQDs in the bedrock, the rock mass quality generally varies from poor to good. The mechanical properties of the bedrock are discussed in Section 4.5

Table 4-2: Summary of Soil and Rock Parameters in Domain 3

Borehole	Bedrock			Overburden Soil				
	Depth (m)	RQD	Rock Mass Quality	Type[1]	Layer Bottom Depth	'N' Values	w_N (%)	Consistency
BH MET 3	7.62	29-90	Poor to Good	Clay (CL) over	3.05 m	4 - 8	35 - 49	Soft to firm
				Till (SG) and Till (ML)	7.62 m	16 - 87	7 - 16	Compact to very dense
BH MET 5	N/A	N/A	N/A	Clay (CL) over	7.62 m	WH - 4	29 - 59	V. soft to soft
				Till (CL)	12.80 m	6 - 76	7 - 15	Firm to Hard

Note: [1]CL – Low to Intermediate Plastic Clay; Till (CL) – Clayey Till; Till (SG) – Granular Till; Till (ML) – Silt or Clayey Silt Till.

Table 4-3: Field Vane Shear Test Results

Turbine	Depth (m)	Field Vane Strength (kPa)
BH MET 1	2.44	48
	2.74	48
BH MET 3	2.44	38
	2.74	96

Turbine	Depth (m)	Field Vane Strength (kPa)
BH MET 5	1.83	42
	2.13	38
	3.96	27
	4.27	31
	5.49	38

Table 4-4: Grainsize Distribution Results in Domain 3

Borehole	Sample	Material	Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH MET 3	SS3	CL	1.52	0	2.5	36.1	61.4
BH MET 3	SS4	Till (SG)	3.05	65.2	13.3	15.5	6
BH MET 3	SS11	Till (ML)	6.10	27.9	24.4	38.9	8.8
BH MET 5	SS5	CL	3.05	0	0.5	32	67.5

Table 4-5: Atterberg Limits - Silty Clay (CL) Deposit

Borehole	Sample	Depth	W_N	W_L	W_P	I_P
BH-MET-03	SS3	1.52 – 2.13	35.4	50	26	24
BH-MET-05	SS5	3.05 – 3.66	43.3	50	23	27

4.5 Bedrock Properties

The bedrock at the site consists of grey to black, thinly bedded, fine grained Shaly Limestone. Based on the rock core logs in Appendix C, the Rock Quality Designation (RQD) values vary significantly but are generally between 19-74% in the upper meter of the bedrock and between 59-100% below that. The Rock Mass Rating (RMR) rating for the rock mass is about 57 based the RMR classification system (Bieniawski, 1972). As a result, the rock mass quality is fair to good.

4.6 Ground Water

Table 4-11 summarizes the groundwater level observed upon the completion of drilling. It should be noted that the water level in Table 4-11 was in temporary state and may further rise with time.

As per the piezometer installed the wind turbine sites, the groundwater level varies from 0.44 m to 4.38 m depth below the ground surface as per the readings obtained on July 5, 2018 (see the report of 18-4022-02 WTG).

It should be noted that the groundwater level is subject to seasonal fluctuations with high levels occurring during wet weather conditions in the spring and fall and lower levels during dry weather conditions.

Table 4-6: Temporary Groundwater Levels*

Borehole	Groundwater Level Observation Upon Completion of Drilling
	(m)
BH-MET-01	4.98
BH-MET-02	N/A
BH-MET-03	3.05
BH-MET-04	N/A
BH-MET-05	6.10
BH-MET-06	6.10

Note: The groundwater level was as per field observation upon completion of borehole drilling. The groundwater level is temporary and is NOT stabilized.

5 GEOTECHNICAL RECOMMENDATIONS

This section provides engineering recommendations for the MET Tower foundation design and construction.

5.1 Geotechnical Parameters

5.1.1 Soil Unit Properties

Table 5-1 lists the unit weight, and effective strength parameters for the three main native soils and backfill materials.

Table 5-1: Key Design Parameters

Material	Saturated Unit Weight (kN/m^3)	Effective Submerged Unit Weight (kN/m^3)	Effective Strength Parameters		Active Earth Pressure Coefficient	Passive Earth Pressure Coefficient	Sliding Coefficient (Soil-Concrete)
			c' (kPa)	ϕ' (°)			
Clay (CL) / Clayey Till (CL)	17.5	7.7	0	28	0.36	2.8	0.25
Silt Till (ML)	20.5	10.7	0	34	0.28	3.5	0.35
Gravelly Sand Till (SG)	21	11.7	0	36	0.26	3.9	0.35
Compacted Backfill (Native Soil)	17	7.2	0	28	0.36	2.8	Not Applicable
Granular A / Granular B TYPE II	22.8	13	0	35	0.27	3.7	0.35
Granular B TYPE I	21.2	12.4	0	32	0.31	3.3	0.31

Note: Granular A and B should be placed in lifts and compacted as per the specification.

5.2 MET Tower Foundations

5.2.1 General

Various foundation options have been considered for support of the MET tower. Table 5-1 summarizes the foundation assessment for the six (6) borehole locations (Site 1 to Site 6).

- MET tower can be placed on native tills for the two sites of Site 2 and Site 6 with a reasonably competent bearing capacity.

- For Site 1 and Site 3, foundation soil (CL) has a relatively low bearing capacity. To achieve a higher bearing capacity for the two sites, an over-excavation is required down to the competent till layer (SG). The MET tower can be founded on a layer of compacted crusher-run Granular A overlying the competent till (SG) layer .
- For Site 4, MET tower can be placed directly on shallow bedrock a about 1.6 m depth. The bedrock depth may vary over the site. It should be noted that the foundation embedment depth is limited to the bedrock depth. The design engineer should review and assess the overburden to ensure adequate resistance to uplift loads.
- The Site 5 (BH-MET-05) likely requires deep foundation to support the MET tower due to the presence of a thick soft clay deposit. The cost of deep foundation is expected to be much higher than shallow foundations. As such, this site is considered not favorable for the MET tower foundation.

In summary, Site 2, Site 4 and Site 6 are more favorable to support MET tower than the other three sites considering the bearing capacity and construction cost. Site 4 has a thin overburden and the design engineer should review and assess the overburden condition to ensure adequate resistance to uplift loads.

At the time of preparing this report, the information on finished elevation, foundation elevation, and loads for the proposed MET tower was not available. A general bearing capacity was provided for vertical loads only (no inclination or no eccentricity). The given geotechnical resistance may vary depending on foundation elevation and load inclination, subject to interaction between the structural and geotechnical engineers during the detailed design process.

Table 5-2: Foundation Assessment Summary

Site No.	Borehole	Bearing Material	Minimum Foundation Depth	Bearing Capacity
		(m)	(m)	
1	BH-MET-01 (Near T25)	Option A: Clay (CL)	1.8*	P_{SLS} = 80 kPa P_{ULS} = 120 kPa
		Option B: Granular Till (SG) Higher Cost and Construction Dewatering Risk.	3	P_{SLS} = 200 kPa P_{ULS} = 300 kPa
2	BH-MET-02 (Near T32)	Silt Till (ML)	1.8*	P_{SLS} = 200 kPa P_{ULS} = 300 kPa
3	BH-MET-03 (Near T1)	Option A: Clay (CL)	1.8*	P_{SLS} = 80 kPa P_{ULS} = 120 kPa
		Option B: Granular Till (SG) Higher Cost and Construction Dewatering Risk.	4.5	P_{SLS} = 200 kPa P_{ULS} = 300 kPa
4	BH-MET-04 (Near T10)	Bedrock Noting thin overburden condition.	To bedrock (~ 1.6 m)	P_{SLS} (not govern) P_{ULS} = 1,000 kPa
5	BH-MET-05 (Near T18)	High Cost. Not recommended for MET Tower Foundation	N/A	N/A
6	BH-MET-06 (Near T58)	Clayey Till (CL)	1.8*	P_{SLS} = 150 kPa P_{ULS} = 250 kPa

Notes:

1. P_{SLS} represents the geotechnical resistance at Serviceability Limit State (SLS) for 25 mm settlement.
2. P_{SLS} represents the factored geotechnical resistance at Ultimate Limit State (ULS).
3. The bearing capacities in this table are “net” bearing capacity.
4. The footing size is assumed at least 1 m wide.
5. CL – Low to Intermediate Plastic Clay; Till (CL) – Clayey Till; Till (SG) – Granular Till; Till (ML) – Silt or Clayey Silt Till.
6. The embedded depth of 1.8 m* is for frost protection purpose.

5.2.2 Shallow Foundations on Clay or Till (Sites 1, 2, 3 and 6)

The frost penetration depth at the site is estimated to be 1.8 m. Accordingly, all foundations must be embedded at least 1.8 m into the ground to ensure adequate soil cover to avoid frost heave. In areas requiring over excavation (for Site 1 and Site 3 if Option B is adopted), a layer

of compacted Granular A fill can be placed on the prepared subgrade and the MET tower foundation can be constructed on the Granular A fill.

Table 5-2 summarizes the bearing material and the estimated depth for each of the shallow foundations. The depths in this table are preliminary and will need to be verified during construction by the engineer of record.

All soft, loose, compressible and otherwise unsuitable material should be removed to expose undisturbed soil. Following grading, the exposed subgrade should be proof-rolled with a roller under the full time supervision of geotechnical personnel. Any soft spots detected during proof-rolling should be sub-excavated and replaced with approved materials compacted to minimum 98 % SPMDD. After preparing the foundation soil, a 150-200 mm thick lean concrete mud mat should be placed on the prepared subgrade to allow construction of the foundation and to protect the subgrade from disturbance.

Dewatering should be carried out together with excavation work so that the work generally proceeds in the dry. Where the groundwater is higher the excavation base, excavation dewatering should be implemented sufficiently ahead of the excavation to maintain the groundwater levels at least 1 to 2 feet below the bottom of the excavation.

Due to the fine-grained nature of the subgrade materials at the site, dewatering is expected to require only sump and pump techniques. Locally, however, water bearing sand layers may be encountered during the construction. These layers will have limited recharge and will yield water only temporarily until pumped dry. If encountered, contractors may need to excavate pits into these layers prior to executing the bulk excavation and pump the groundwater from the pits until the granular layers dry up.

5.2.3 Foundations on Bedrock (Site 4)

The MET tower foundation at Site 4 can consist of cast-in-place reinforced concrete gravity base foundations constructed either directly on the rock.

Given the laminated and bedded nature of the sedimentary bedrock, it should be feasible to excavate the bedrock using hydraulic excavators and hydraulic hoe-rams without requiring drill and blast methods. After excavating to the design foundation level, the exposed bedrock should be thoroughly cleaned, and power washed, and a lean concrete mud mat should be placed on the rock to enable foundation construction. Loose fragmented zones of the bedrock should be removed. Where such removals result in local over excavation, the over excavated zone should be backfilled with lean concrete.

Lastly, foundation excavations may extend below the groundwater table into fractured permeable bedrock. Contractors should be able to use conventional sump and pump techniques to dewater excavations; the quantity of water to be handled should diminish with time or eventually stop completely.

5.3 Backfill

Structural fill (Granular A or B) are recommended as backfill materials to provide uplift resistance. The backfill should be placed in lifts of maximum 300 mm and compacted to min. 95% SPMDD.

5.4 Foundation Buoyancy

Buoyant effects should be accounted for during the MET tower foundation designs.

The native foundation soil (clay and glacial tills) at the site generally has a low permeability. The backfill placed around and above foundations likely have higher permeability than the surrounding native soil. The backfill will likely become saturated over time.

As such, the effective unit weights (see Table 5-1) are recommended for the backfill in the calculations of uplift resistance and passive earth pressure for the MET tower foundations.

5.5 Construction Considerations

The exposed subgrade materials consist of glacial deposit that can include silty clay, clayey silt, silty sand with gravel soils. Due to the grain size and composition, some areas will be sensitive to disturbance and strength degradation in the presence of excess moisture and construction disturbance. These soils will also be frost susceptible if left exposed to inclement weather conditions during construction.

The site preparation work be performed during seasonally dry periods to minimize potential for degradation of the subgrade soils and undercuts which may become necessary to establish a stable base for construction.

For site preparation work including compaction and proof rolling, all efforts should be made to minimize the potential disturbance to the subgrade soils.

5.6 Frost Protection

The estimated frost depth at the site is 1.8 m. The soil type is moderately susceptible to frost action. As such, the footings on soil should be situated at 1.8m below ground surface to provide adequate insulation against frost heave. Alternatively, insulation can be used to raise the frost line.

5.7 Site Classification for Seismic Response

The parameters for determination of Site Classification for Seismic Site Response are set out the 2015 NBCC. The site classification is based on the average shear wave velocity in the top 30 meters of the site stratigraphy. If the average shear wave velocity is not known, the site class can be estimated from energy corrected Standard Penetration Resistance (N_{60}) and/or the average undrained shear strength of the soil in the top 30 meters. The following site classes apply for this project based on the 2015 NBCC:

- Site 4: Site Class A
- Site 1, 2, 3 and 6: Site Class D
- Site 5: Site Class E.

These seismic design parameters should be reviewed in detail by the structural engineer and incorporated into the design as required by 2015 NBCC.

6 CLOSURE

TULLOCH has prepared this geotechnical report for the exclusive use of EDP Renewables and their authorized agents for the construction of the proposed Nation Rise Wind Farm.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering, for the above noted location. Classification and identification of soils and geologic units have been based upon commonly accepted methods employed in professional geotechnical practice. Foundation design recommendations are based on standard accepted methods of analysis for these types of structures. No warranty or other conditions, expressed or implied, should be understood. Please refer to Appendix H, Report Limitations, and Guidelines for Use, which pertains to this report.

We trust that the information and recommendations in this draft report will be found to be complete and adequate for your consideration. Should further elaboration be required for any portion of this project, we would be pleased to provide assistance.

7 REFERENCES

National Building Code of Canada, NRC, 2015.

Ontario Geological Survey 2010. Surficial geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128-REV

Ontario Geological Survey 2011. 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release---Data 126-Revision 1.

Occupational Health and Safety Act (OHSA), Ontario Regulation 213/9, Construction Projects, January 1, 2010, Part III - Excavations, Section 226.

SENES Consultants, 2015

Borehole Log: BH MET 6

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **Murphy Road, North Stormont, ON**
Client: **EDPR**

Logged By: **S.deBortoli**
Compiled By: **D.A.Mousseau**
Reviewed By: **E.Giles**

SUBSURFACE PROFILE					SAMPLE						Remarks
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Undrained Shear Strength (Cu, kPa) / Standard Penetration Resistance Blows / 0.3m	Water Content Data (%)	Grain Size (%) Gr Sa Si Cl
		0	Geodetic Ground Elevation	0.00							
			TOPSOIL / ORGANICS, dark brown, moist, firm		1	SS	25	7			
				-0.76							
		1	CLAY (CL), trace to some SILT, trace GRAVEL, some fractured rock, light brown, moist, hard		2	SS	79	42		20	
				-1.52							
		2	CLAY TILL (CL), trace SILT, some GRAVEL, brown, moist, hard to stiff		3	SS	100	34		11	
					4	SS	75	13		57	
		3		-3.05							
			CLAY (CL), trace to some SILT, trace GRAVEL, dark grey / brown, moist to wet, stiff to firm		5	SS	58	11		15	
		4									
					6	SS	75	8		15	
		5									

Undrained Shear Strength (Cu, kPa): △ 25 50 75 100 125 150 175 △

Standard Penetration Resistance Blows / 0.3m: ○ 10 20 30 40 50 60 70 80 90 ○

Water Content Data (%): ● 20 40 60 80 ●

Drilled By: **Marathon Drilling**

Drill Method: **HSA / SS**

Drill Date: **May 23, 2018**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
○- SPT(Standard Penetration Test)
WH - Weight Of Hammer

WP W WL

Datum:

Location: **UTM 18T**
E=484760
N=4999587

Sheet: **1 of 2**

Borehole Log: BH MET 6

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **Murphy Road, North Stormont, ON**
Client: **EDPR**

Logged By: **S.deBortoli**
Compiled By: **D.A.Mousseau**
Reviewed By: **E.Giles**

SUBSURFACE PROFILE					SAMPLE							Remarks
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	Sample Type	Recovery (%)	Blows / 0.3m	Undrained Shear Strength (Cu, kPa) 25 50 75 100 125 150 175 / Standard Penetration Resistance Blows / 0.3m 10 20 30 40 50 60 70 80 90	Water Content Data (%) 20 40 60 80	Grain Size (%) Gr Sa Si Cl	
		6		-6.10								
			CLAY TILL (CL), trace SILT, interbedded with 50mm SAND seams, some GRAVEL, dark grey, moist to wet, very stiff		7	SS	67	19		20		Water Encountered In Borehole @ 6.1m BGS
		7		-7.62								
			SILT TILL (ML) with CLAY, some SAND, trace GRAVEL, dark grey, moist to wet, very stiff		8	SS	79	29		16	8.1 13.1 45.7 33.1	
		8										
		9		-9.14								
			SILTY CLAY TILL (CL), some GRAVEL, dark grey, moist to wet, very stiff		9	SS	71	23		9		
		10		-10.06								Auger Refusal @ 10.06m BGS
			End of Borehole									
			See BH Log 18-4022 MET 6R For Rock Core Data									
		11										

Drilled By: **Marathon Drilling**

Drill Method: **HSA / SS**

Drill Date: **May 23, 2018**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ - Rock Core
W - Water Content
WL- Liquid Limit
WP- Plastic Limit
△ - Field Vane

w - Wash
O- SPT(Standard Penetration Test)
WH - Weight Of Hammer

WP W WL

Datum:

Location: **UTM 18T**
E=484760
N=4999587

Sheet: **2 of 2**

Borehole Log: BH MET 6R

TULLOCH ENGINEERING

Project No: **18-4022**
Project: **Nation Rise Wind Farm**
Site Location: **Murphy Road, North Stormont, ON**
Client: **EDPR**

Logged By: **S.deBortoli**
Compiled By: **D.A.Mousseau**
Reviewed By: **E. Giles**

SUBSURFACE PROFILE					SAMPLE						
Well	Strata Plot (m)	Depth (m)	DESCRIPTION	Elevation (m)	Sample Number	TCR (cm)	RQD (%)	Run Length (cm)	Run Depth Elevation (m)	Unconfined Compressive Strength (MPa) △ 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 △	Remarks
		0	Geodetic Rock Elevation	-10.06							
			Shaley LIMESTONE, black / grey, thinly laminated to laminated, very thinly bedded in some sections, horizontal fractures with some weathering present at discontinuities, breaks in core occur along weaker shaley sections		1	177	74	183			
		1		-11.89					-11.89		
		2	Shaley LIMESTONE, black / grey, fine grained, very thinly bedded to laminated, vertical fracturing near top of run, horizontal fractures with some weathering at disconinuities, very weathered section a bottom of run		2	152	59	152			
		3		-13.41					-13.41		
			End of Rock Core								
		4									
		5									

Drilled By: **Marathon Drilling**

Drill Method: **Casing / NQ Core**

Drill Date: **May 23, 2018**

Sample Type
AS - Auger Sample
SS - Split Spoon
TWS - Thin Walled Shelby Tube
BS - Block Sample
NQ- Rock Core
W - Water Content
WL - Liquid Limit
WP - Plastic Content
△ - Unconfined Compressive Strength

w - Wash
o - SPT(Standard Penetration Test)
TCR - Total Core Recovery
RQD - Rock Quality Designation

Datum:

Location: **UTM 18T**
E=484760
N=4999587

Sheet: **1 of 1**

APPENDIX D

LAB RESULTS

TULLOCH ENGINEERING

CSA A283 Certified Laboratory for Concrete Testing
CIL Certified Laboratory for Aggregates and Asphalt Test
CSA/CCIL Certified Technicians

Canadian Council of Independent Laboratories | Conseil canadien des laboratoires indépendants

WATER CONTENT TEST

TEST METHOD: LS 701 / ASTM C 566 / D 2216

CONTRACT NO: 18-4022 DATE SAMPLED: varies

PROJECT: Nation Rise - MET towers SOURCE: Boreholes

DATE TESTED: 7/16/18 TESTED BY: S.Hoffman

Tare ID	Sample ID	Depth (m)	SA #	Wet Weight	Dry Weight	TARE	Mass Lost	Water %
	BH-MET1-2	0.76-1.37		94.26	75.61	13.76	18.65	23.2%
	BH-MET1-4	3.05-3.66		458.80	372.20	156.60	86.60	28.7%
	BH-MET1-5	4.57-5.18		438.30	268.40	150.60	169.90	59.1%
	BH-MET2-3	1.52-2.13		462.50	426.80	166.60	35.70	12.1%
	BH-MET2-6	4.57-5.18		471.00	269.60	173.90	201.40	67.8%
	BH-MET2-7	6.1-6.76		132.67	123.84	13.77	8.83	7.4%
	BH-MET3-3	1.52-2.13		520.70	390.20	151.70	130.50	35.4%
	BH-MET3-4	3.05-3.66		96.89	83.77	13.82	13.12	15.8%
	BH-MET3-6	7.01-7.62		350.90	337.50	162.00	13.40	7.1%
	BH-MET4-2	.76-1.37		442.60	396.20	150.30	46.40	15.9%
	BH-MET5-2	0.76-1.37		93.42	70.05	13.94	23.37	29.4%
	BH-MET5-5	3.05-3.66		547.10	379.20	158.90	167.90	43.3%
	BH-MET5-7	6.1-6.76		89.09	77.88	14.61	11.21	15.1%
	BH-MET5-9	9.14-9.75		99.93	93.58	13.73	6.35	7.4%
	BH-MET5-10	10.67-11.28		128.64	117.01	14.93	11.63	10.2%
	BH-MET6-4	2.29-2.80		581.60	339.40	155.60	242.20	56.9%
	BH-MET6-6	4.57-5.18		111.49	96.77	13.74	14.72	15.1%
	BH-MET6-8	7.62-8.23		510.30	464.70	223.20	45.60	15.9%

REMARKS:

CLIENT:

COPIES TO:

Tulloch Engineering, Materials Testing Laboratory, 71 Black Road - Unit 3, Sault Ste. Marie, ON. Canada P6B 0A3
Tel: (705) 949-1457 Fax: (705) 945-5092 email: adam.byers@tulloch.ca

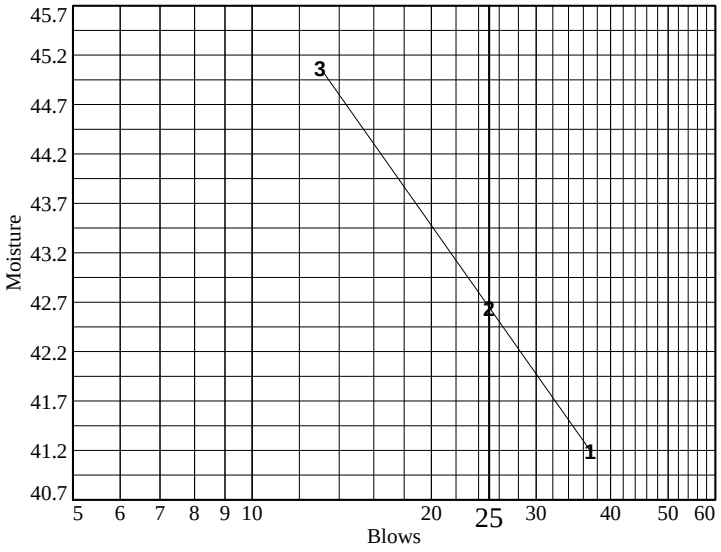
LIQUID AND PLASTIC LIMIT TEST DATA

7/25/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: MET 1-4
Depth: 3.05m - 3.66m **Sample Number:** 4
Tested by: S.Hoffman **Checked by:** S.Hoffman

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	31.26	34.52	31.56			
Dry+Tare	26.11	28.32	26.02			
Tare	13.61	13.78	13.73			
# Blows	37	25	13			
Moisture	41.2	42.6	45.1			

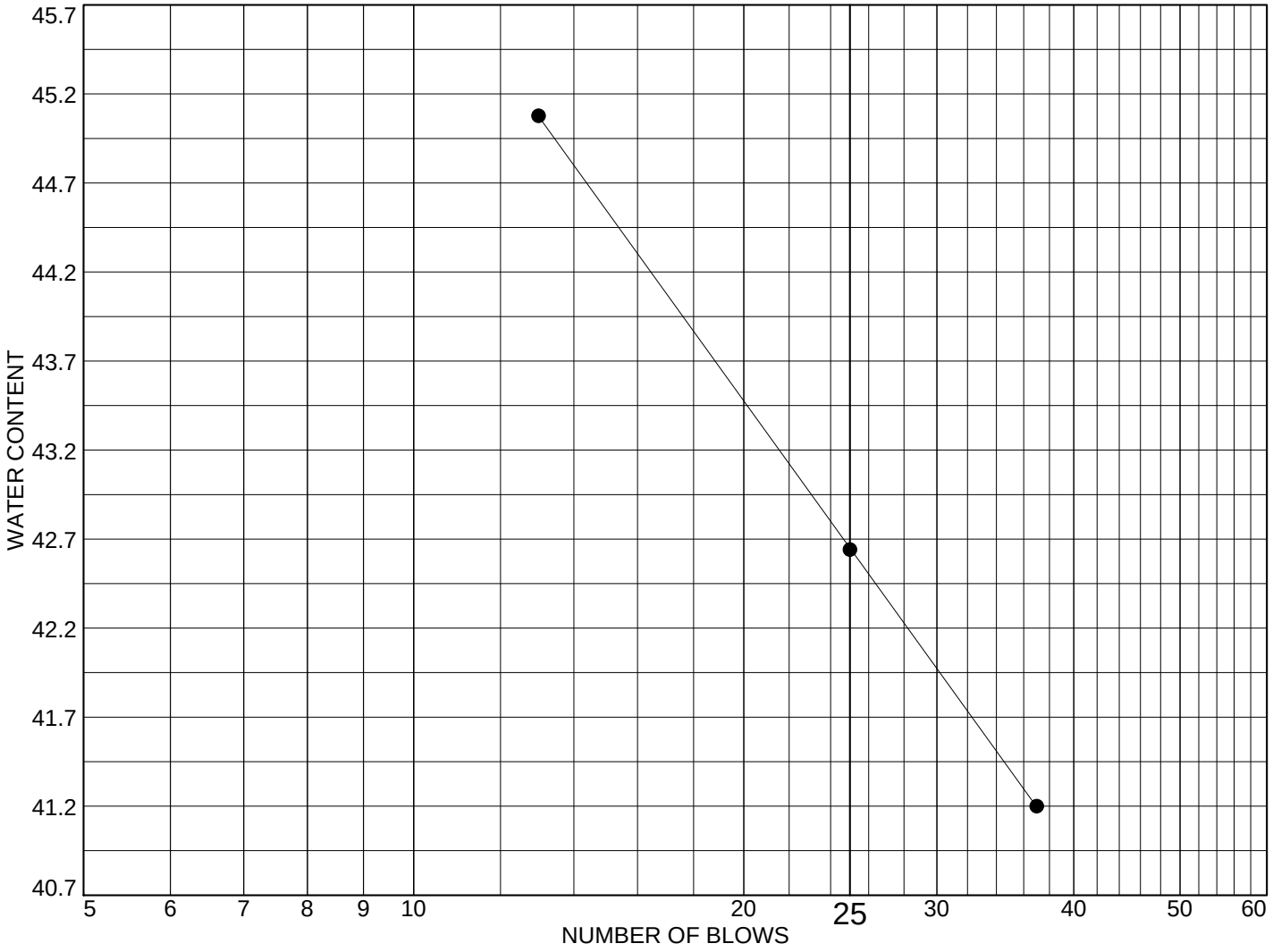


Liquid Limit= 43
Plastic Limit= 23
Plasticity Index= 20
Natural Moisture= 28.7
Liquidity Index= 0.3

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	26.62	26.27			
Dry+Tare	24.23	23.95			
Tare	13.74	13.65			
Moisture	22.8	22.5			

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	MET 1-4	4	3.05m - 3.66m	28.7	23	43	20	

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Client: EDP
Project: Nation Rise Wind Farm

Project No.: 18-4022

Tested By: S.Hoffman **Checked By:** S.Hoffman

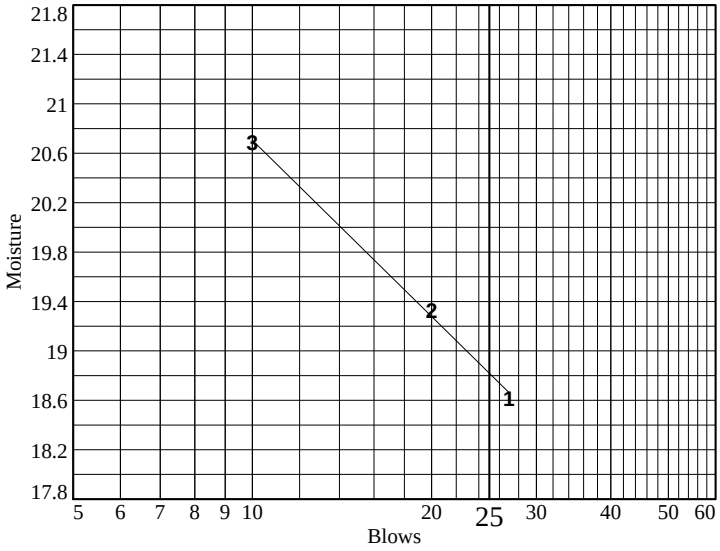
LIQUID AND PLASTIC LIMIT TEST DATA

7/25/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: MET 2-3
Depth: 1.52m - 2.13m
Sample Number: 3
Tested by: S.Hoffman
Checked by: S.Hoffman

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	37.26	33.03	38.57			
Dry+Tare	33.74	30.08	34.55			
Tare	14.84	14.82	15.12			
# Blows	27	20	10			
Moisture	18.6	19.3	20.7			

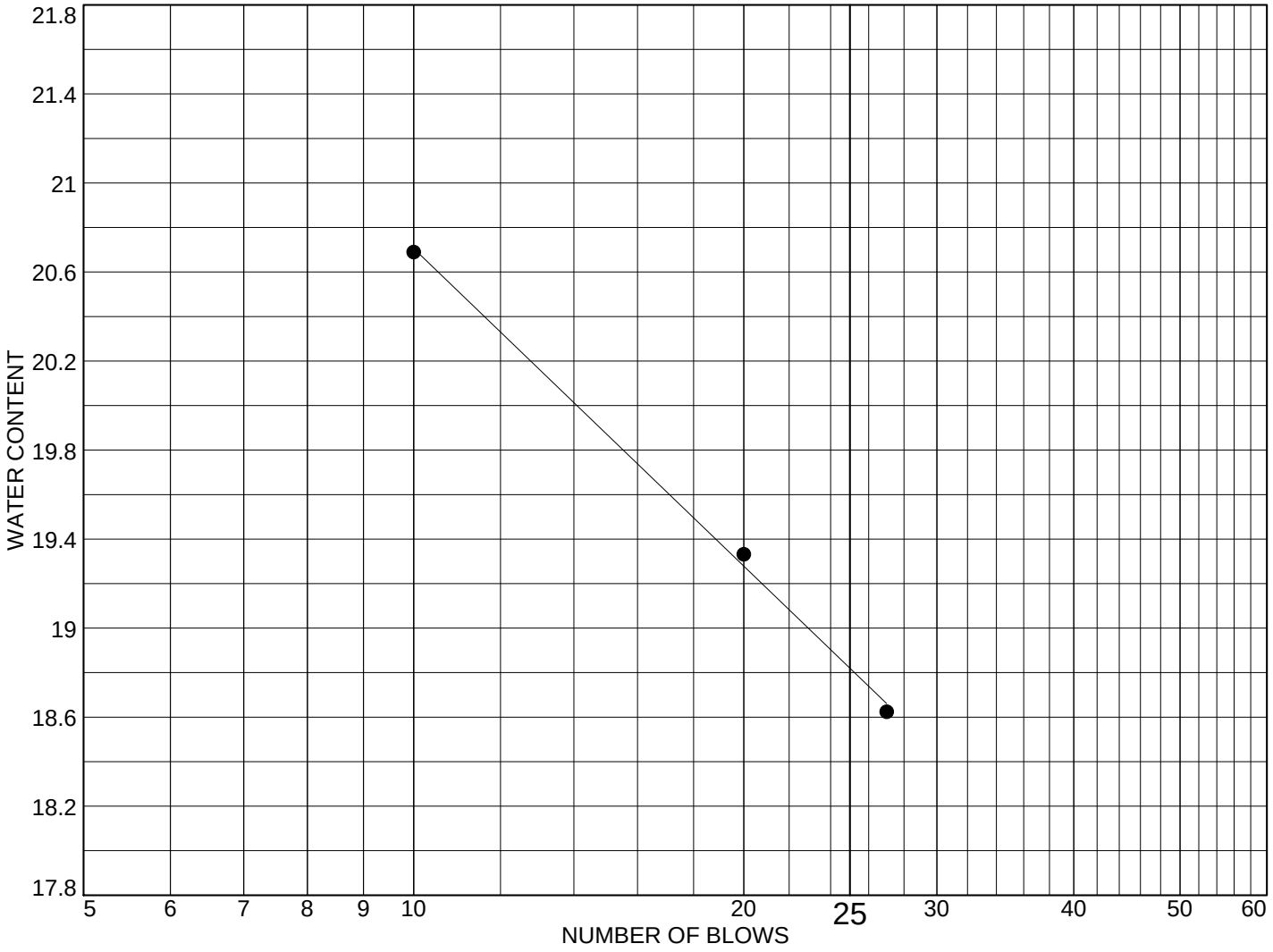


Liquid Limit= 19
Plastic Limit= 15
Plasticity Index= 4
Natural Moisture= 12.1
Liquidity Index= -0.7

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	31.28	32.89			
Dry+Tare	29.12	30.48			
Tare	15.06	14.88			
Moisture	15.4	15.4			

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	MET 2-3	3	1.52m - 2.13m	12.1	15	19	4	

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Client: EDP
Project: Nation Rise Wind Farm
Project No.: 18-4022

Tested By: S.Hoffman **Checked By:** S.Hoffman

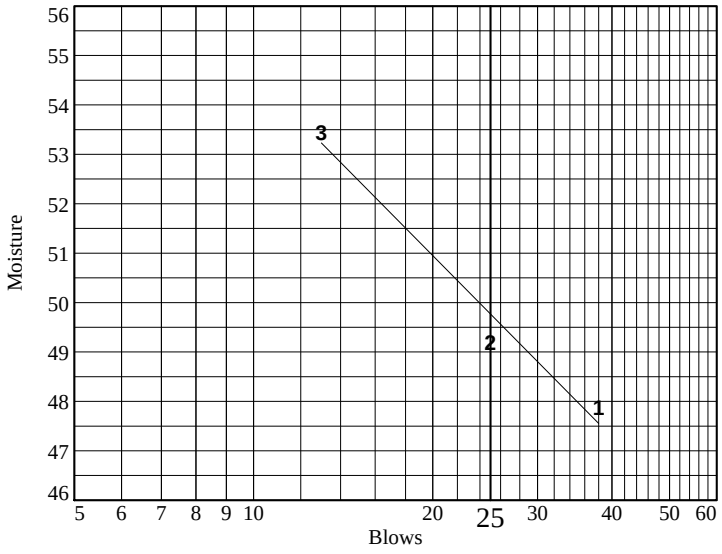
LIQUID AND PLASTIC LIMIT TEST DATA

7/25/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: MET 5-5
Depth: 1.52m - 2.13m
Sample Number: 3
Tested by: S.Hoffman
Checked by: S.Hoffman

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	28.07	27.99	28.52			
Dry+Tare	23.85	23.69	23.72			
Tare	15.04	14.95	14.74			
# Blows	38	25	13			
Moisture	47.9	49.2	53.5			

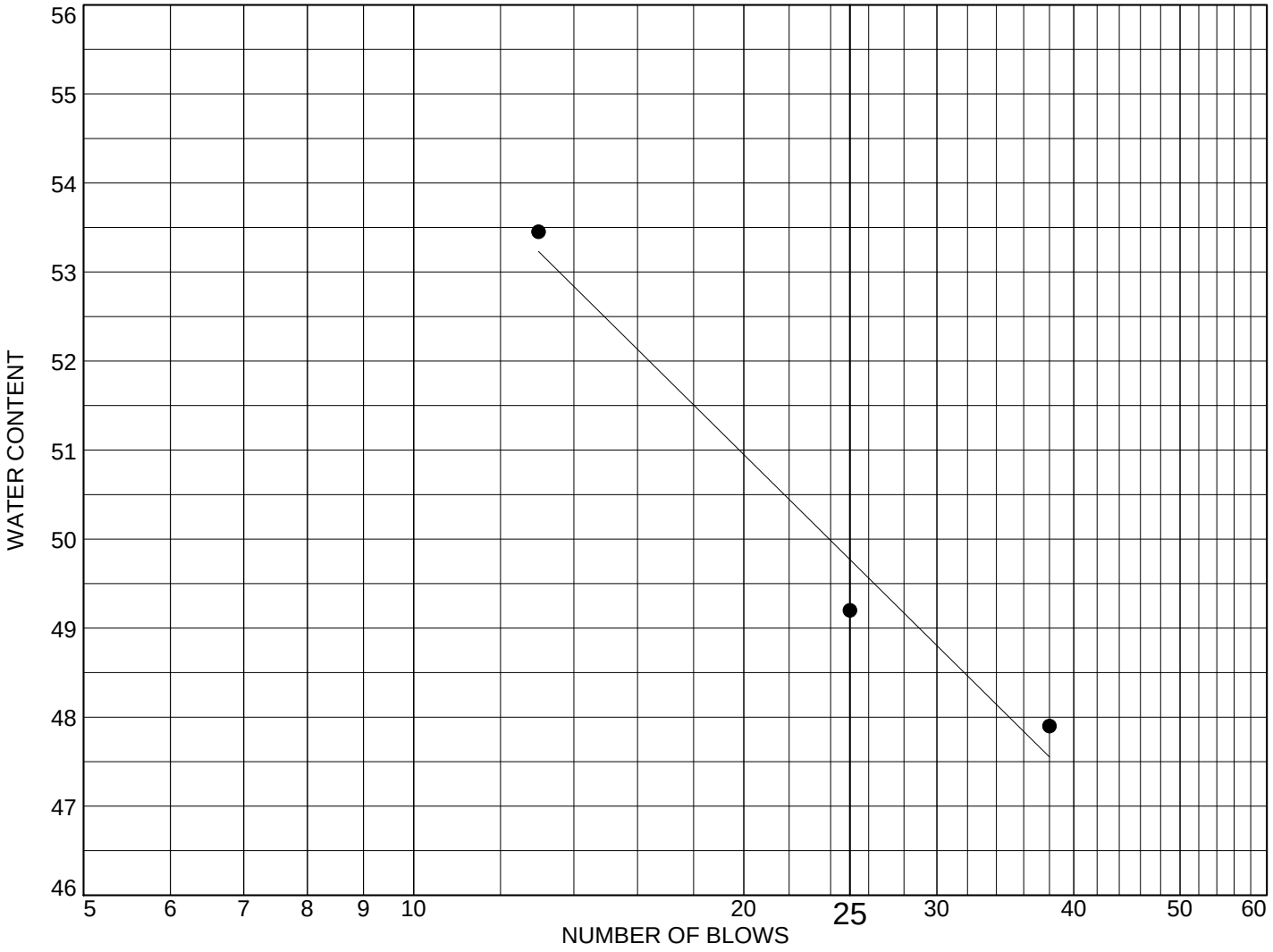


Liquid Limit= 50
Plastic Limit= 26
Plasticity Index= 24
Natural Moisture= 35.4
Liquidity Index= 0.4

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	24.58	20.87			
Dry+Tare	22.50	19.69			
Tare	14.75	14.96			
Moisture	26.8	24.9			

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	MET 5-5	3	1.52m - 2.13m	35.4	26	50	24	

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Client: EDP
Project: Nation Rise Wind Farm

Project No.: 18-4022

Tested By: S.Hoffman **Checked By:** S.Hoffman

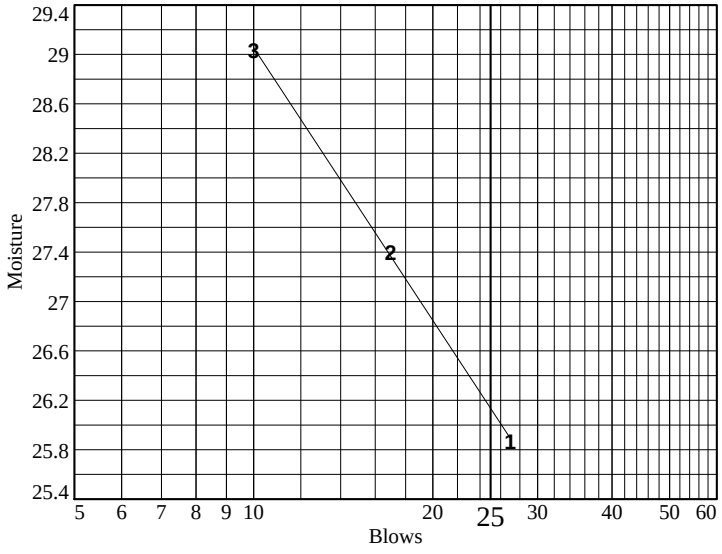
LIQUID AND PLASTIC LIMIT TEST DATA

7/25/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: MET 4-2
Depth: 0.76m - 1.37m
Sample Number: 2
Tested by: S.Hoffman
Checked by: S.Hoffman

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	30.38	30.37	31.71			
Dry+Tare	26.96	26.78	27.70			
Tare	13.74	13.68	13.89			
# Blows	27	17	10			
Moisture	25.9	27.4	29.0			

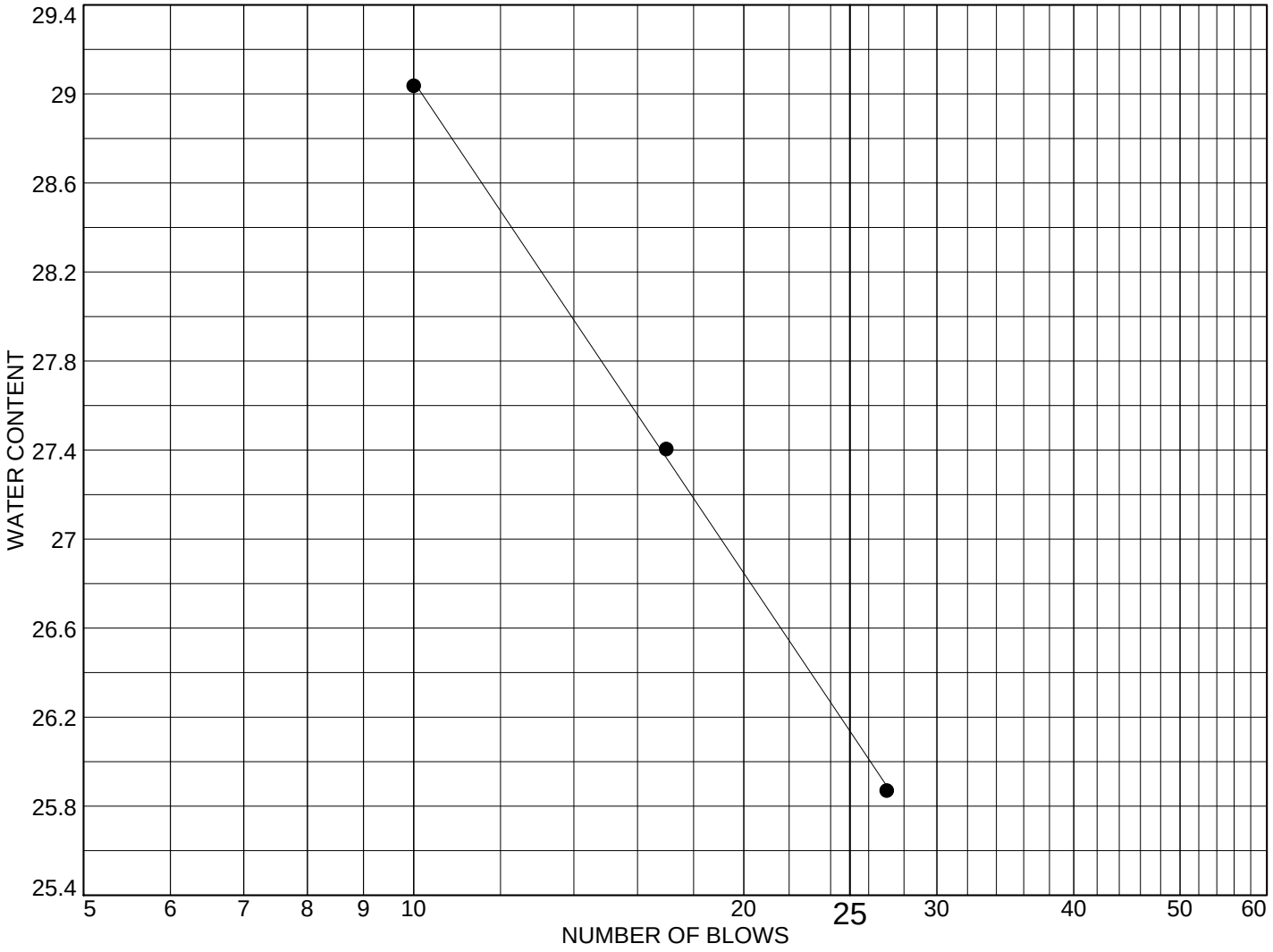


Liquid Limit= 26
Plastic Limit= 18
Plasticity Index= 8
Natural Moisture= 15.9
Liquidity Index= -0.3

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	24.29	27.28			
Dry+Tare	22.66	25.20			
Tare	13.76	13.89			
Moisture	18.3	18.4			

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	MET 4-2	2	0.76m - 1.37m	15.9	18	26	8	

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Client: EDP
Project: Nation Rise Wind Farm
Project No.: 18-4022

Tested By: S.Hoffman **Checked By:** S.Hoffman

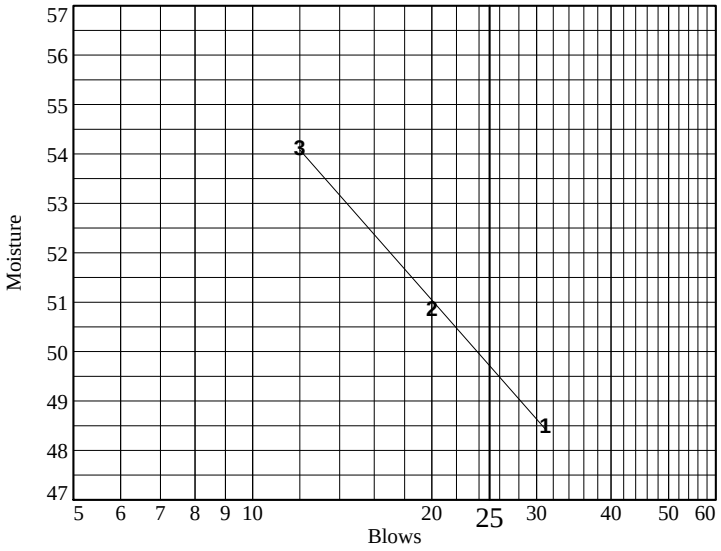
LIQUID AND PLASTIC LIMIT TEST DATA

7/25/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: MET 5-5
Depth: 3.05m - 3.66m
Sample Number: 5
Tested by: S.Hoffman
Checked by: S.Hoffman

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	29.78	30.86	35.67			
Dry+Tare	24.53	25.13	27.91			
Tare	13.71	13.87	13.58			
# Blows	31	20	12			
Moisture	48.5	50.9	54.2			

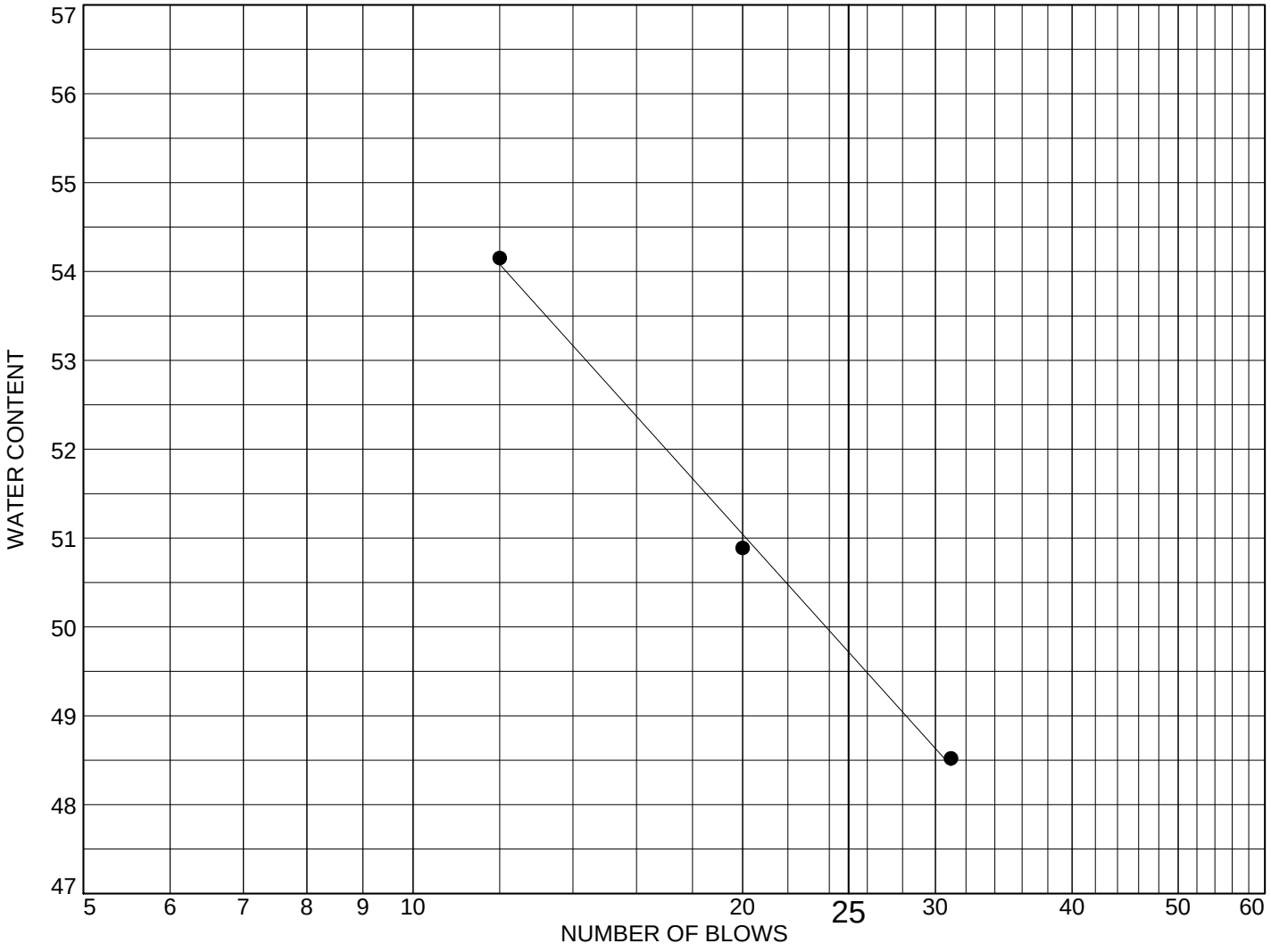


Liquid Limit= 50
Plastic Limit= 23
Plasticity Index= 27
Natural Moisture= 43.3
Liquidity Index= 0.8

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	19.84	20.83			
Dry+Tare	18.66	19.49			
Tare	13.65	13.75			
Moisture	23.6	23.3			

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	MET 5-5	5	3.05m - 3.66m	43.3	23	50	27	

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Client: EDP
Project: Nation Rise Wind Farm

Project No.: 18-4022

Tested By: S.Hoffman **Checked By:** S.Hoffman

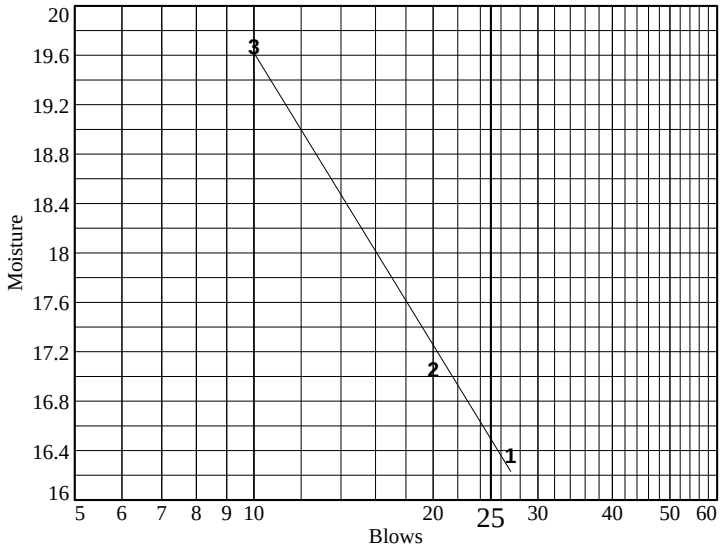
LIQUID AND PLASTIC LIMIT TEST DATA

7/25/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: MET 6-4
Depth: 2.29m - 2.80m
Sample Number: 4
Tested by: S.Hoffman
Checked by: S.Hoffman

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	32.49	30.16	32.72			
Dry+Tare	30.04	27.93	29.78			
Tare	15.07	14.86	14.84			
# Blows	27	20	10			
Moisture	16.4	17.1	19.7			

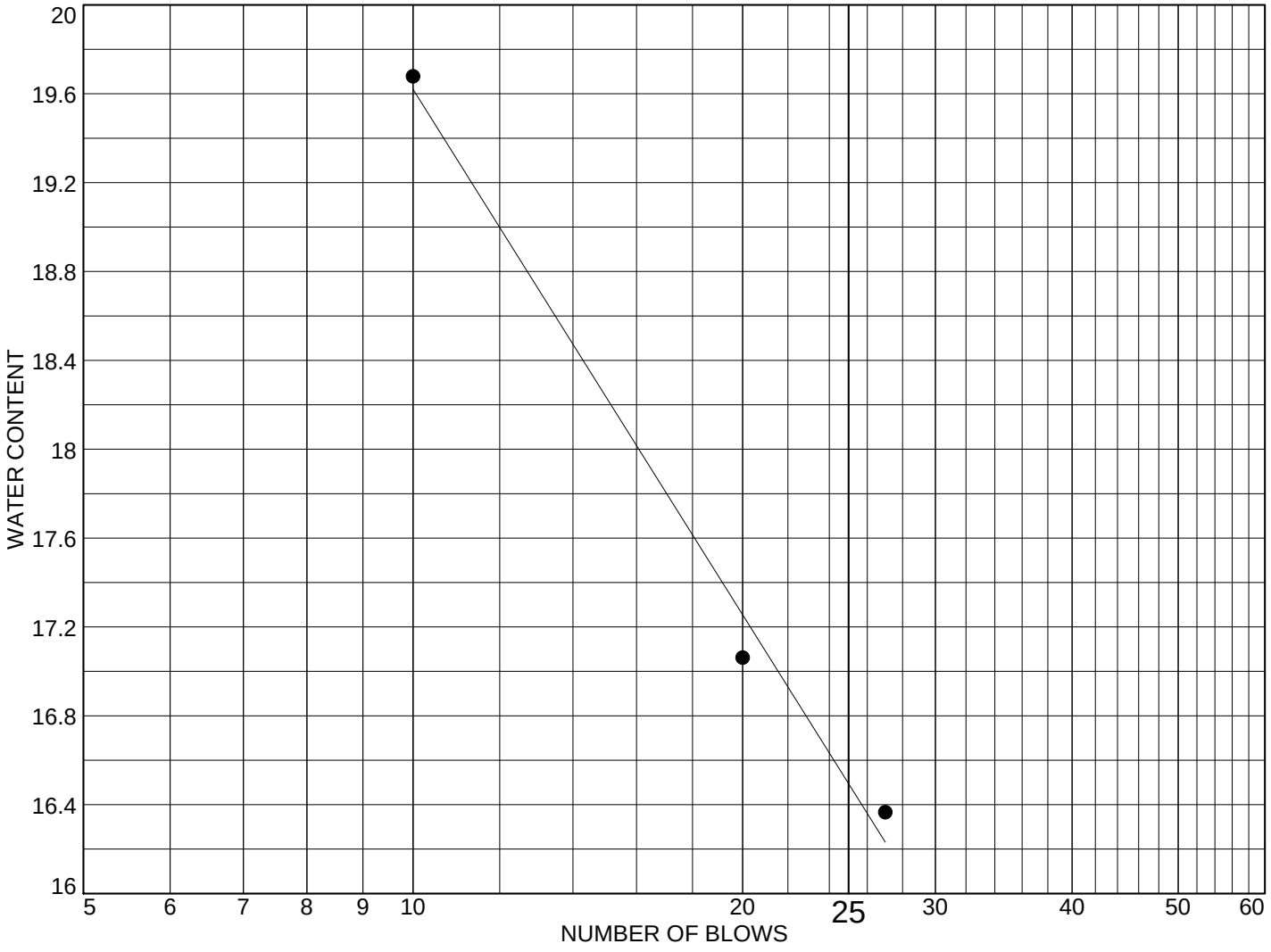


Liquid Limit= 16
Plastic Limit= 10
Plasticity Index= 6
Natural Moisture= 56.9
Liquidity Index= 7.8

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	22.26	22.45			
Dry+Tare	21.46	21.62			
Tare	13.75	13.65			
Moisture	10.4	10.4			

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	MET 6-4	4	2.29m - 2.80m	56.9	10	16	6	

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Client: EDP
Project: Nation Rise Wind Farm
Project No.: 18-4022

Tested By: S.Hoffman **Checked By:** S.Hoffman

GRAIN SIZE DISTRIBUTION TEST DATA

7/24/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: MET 1-5
Depth: 4.52m - 5.13m **Sample Number:** 5
Date Tested: 7/20/18
Tested by: T.Nott **Checked by:** S.Hoffman

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
356.80	0.00	26.5mm	0.00	0.00	100.0	0.0
		19mm	50.40	0.00	85.9	14.1
		16mm	0.00	0.00	85.9	14.1
		13.2mm	0.00	0.00	85.9	14.1
		9.5mm	11.40	0.00	82.7	17.3
		#4	29.70	0.00	74.4	25.6
		#8	29.30	0.00	66.1	33.9
76.60	0.00	#16	7.60	0.00	59.6	40.4
		#30	8.80	0.00	52.0	48.0
		#40	3.40	0.00	49.0	51.0
		#50	3.60	0.00	45.9	54.1
		#60	1.80	0.00	44.4	55.6
		#100	4.60	0.00	40.4	59.6
		#200	5.70	0.00	35.5	64.5

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 59.6
Weight of hydrometer sample =76.6
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.6
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	26.4	40.0	36.8	0.0128	39.0	9.9	0.0404	29.0	71.0
2.00	26.4	35.0	31.8	0.0128	34.0	10.7	0.0297	25.0	75.0
5.00	26.4	33.0	29.8	0.0128	32.0	11.0	0.0191	23.5	76.5
15.00	26.4	29.0	25.8	0.0128	28.0	11.7	0.0113	20.3	79.7
30.00	26.3	26.0	22.8	0.0128	25.0	12.2	0.0082	17.9	82.1
60.00	26.2	23.0	19.7	0.0129	22.0	12.7	0.0059	15.5	84.5
250.00	27.2	18.0	15.2	0.0127	17.0	13.5	0.0030	11.9	88.1
1440.00	25.8	13.0	9.6	0.0129	12.0	14.3	0.0013	7.5	92.5

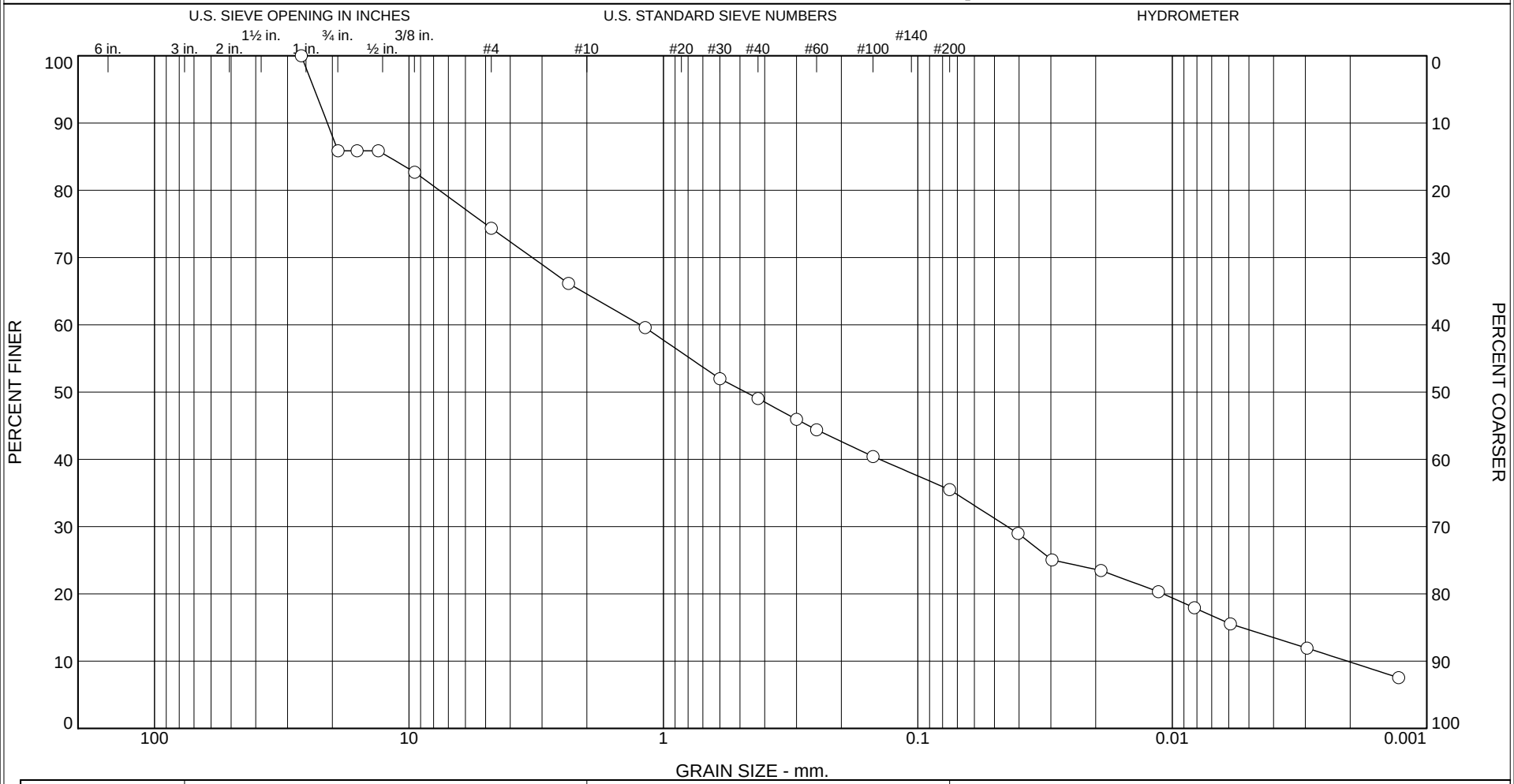
Fractional Components

Cobbles	Gravel	Sand			Fines		
		Coarse	Fine	Total	Silt	Clay	Total
0.0	35.4	15.6	13.5	29.1	25.6	9.9	35.5

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0021	0.0053	0.0109	0.0445	0.1416	0.4754	1.2334	7.6002	12.0636	20.9389	23.5559

Fineness Modulus	C_u	C_c
2.93	600.73	0.78

Particle Size Distribution Report



	% +75mm	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	35.4	15.6	13.5	25.6	9.9

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: MET 1-5 Depth: 4.52m - 5.13m Sample Number: 5			7/20/18

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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Tested By: T.Nott **Checked By:** S.Hoffman

GRAIN SIZE DISTRIBUTION TEST DATA

7/24/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: MET 2-6
Depth: 4.57m - 5.18m **Sample Number:** 6
Date Sampled: 5/30/18 **Date Tested:** 7/20/18
Tested by: T.Linley **Checked by:** S.Hoffman

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
95.70	0.00	13.2mm	0.00	0.00	100.0	0.0
		9.5mm	2.30	0.00	97.6	2.4
		#4	6.80	0.00	90.5	9.5
		#8	0.00	0.00	90.5	9.5
		#16	1.00	0.00	89.4	10.6
		#30	1.40	0.00	88.0	12.0
		#40	0.80	0.00	87.1	12.9
		#50	0.60	0.00	86.5	13.5
		#60	0.60	0.00	85.9	14.1
		#100	1.20	0.00	84.6	15.4
		#200	2.90	0.00	81.6	18.4

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 90.5
Weight of hydrometer sample =77.5
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.6
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	26.5	53.0	49.8	0.0128	52.0	7.8	0.0357	58.9	41.1
2.00	26.5	49.0	45.8	0.0128	48.0	8.4	0.0263	54.2	45.8
5.00	26.4	39.0	35.8	0.0128	38.0	10.1	0.0182	42.3	57.7
15.00	26.6	29.0	25.9	0.0128	28.0	11.7	0.0113	30.6	69.4
30.00	26.5	24.0	20.8	0.0128	23.0	12.5	0.0083	24.6	75.4
60.00	26.7	20.0	16.9	0.0128	19.0	13.2	0.0060	20.0	80.0
250.00	27.0	14.0	11.1	0.0127	13.0	14.2	0.0030	13.1	86.9
1440.00	26.2	9.5	6.2	0.0129	8.5	14.9	0.0013	7.4	92.6

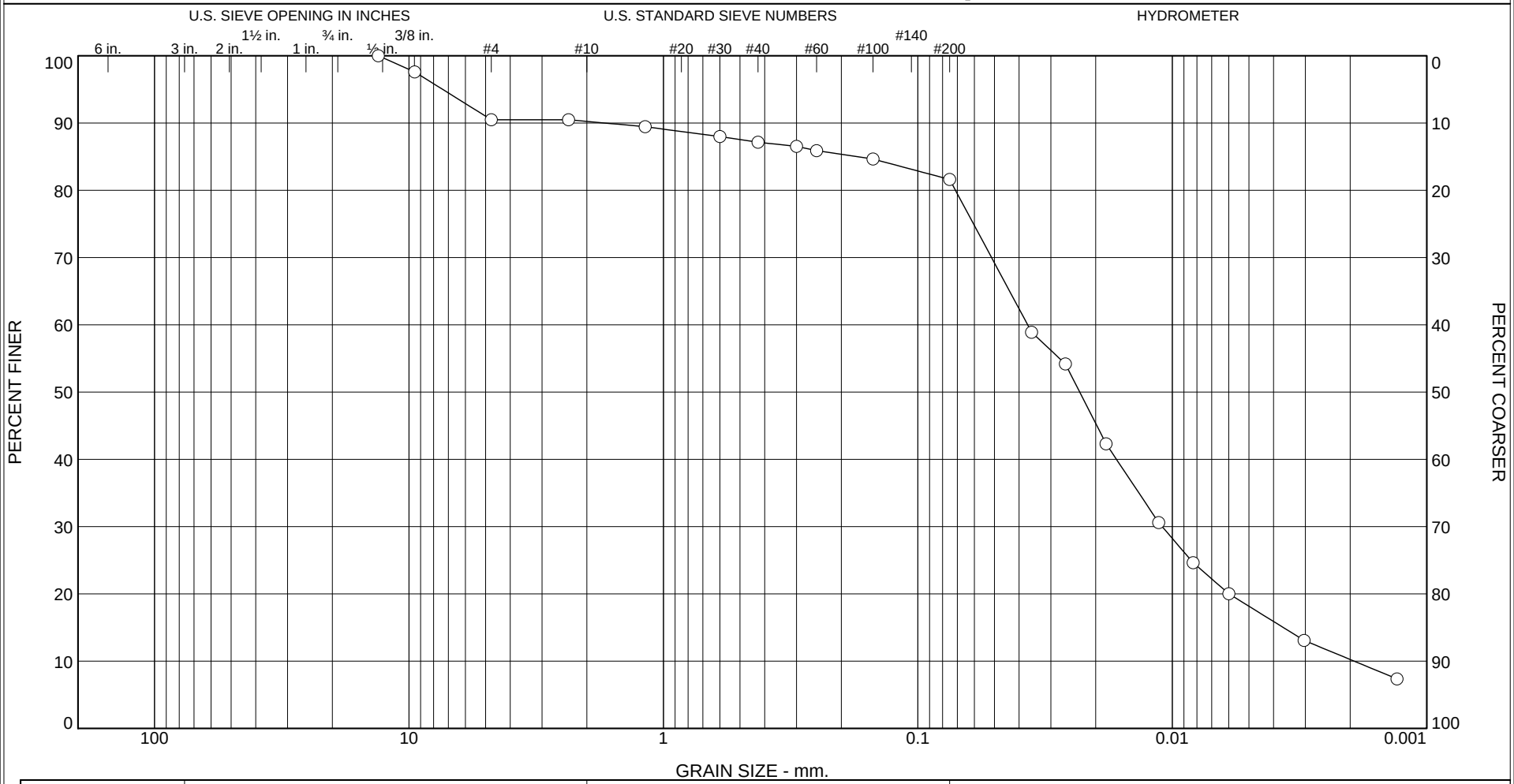
Fractional Components

Cobbles	Gravel	Sand			Fines		
		Coarse	Fine	Total	Silt	Clay	Total
0.0	9.8	3.1	5.5	8.6	71.4	10.2	81.6

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
	0.0019	0.0037	0.0060	0.0110	0.0166	0.0231	0.0370	0.0712	0.1737	1.7038	7.3742

Fineness Modulus	C_u	C_c
0.73	19.18	1.68

Particle Size Distribution Report



% +75mm	% Gravel	% Sand		% Fines	
		Coarse	Fine	Silt	Clay
0.0	9.8	3.1	5.5	71.4	10.2

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: MET 2-6 Depth: 4.57m - 5.18m Sample Number: 6	5/30/18		7/20/18

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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Tested By: T.Linley **Checked By:** S.Hoffman

GRAIN SIZE DISTRIBUTION TEST DATA

7/24/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: MET3-3
Depth: 1.52m - 2.13m **Sample Number:** 3
Date Tested: 7/18/18
Tested by: J.Draper **Checked by:** S.Hoffman

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
238.50	0.00	9.5mm	0.00	0.00	100.0	0.0
		#4	0.00	0.00	100.0	0.0
		#8	0.00	0.00	100.0	0.0
		#10	0.00	0.00	100.0	0.0
		#16	0.20	0.00	99.9	0.1
		#30	0.50	0.00	99.7	0.3
		#40	0.30	0.00	99.6	0.4
		#50	0.40	0.00	99.4	0.6
		#60	0.30	0.00	99.3	0.7
		#100	1.30	0.00	98.7	1.3
		#200	3.00	0.00	97.5	2.5

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 100.0
Weight of hydrometer sample =76.2
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.6
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	25.9	72.0	68.6	0.0129	71.0	4.7	0.0278	91.1	8.9
2.00	25.9	70.0	66.6	0.0129	69.0	5.0	0.0204	88.4	11.6
5.00	25.9	68.0	64.6	0.0129	67.0	5.3	0.0133	85.8	14.2
15.00	25.9	65.0	61.6	0.0129	64.0	5.8	0.0080	81.8	18.2
30.00	26.0	64.0	60.6	0.0129	63.0	6.0	0.0057	80.5	19.5
60.00	26.0	60.0	56.6	0.0129	59.0	6.6	0.0043	75.2	24.8
250.00	26.0	52.0	48.6	0.0129	51.0	7.9	0.0023	64.6	35.4
1440.00	26.0	39.0	35.6	0.0129	38.0	10.1	0.0011	47.3	52.7

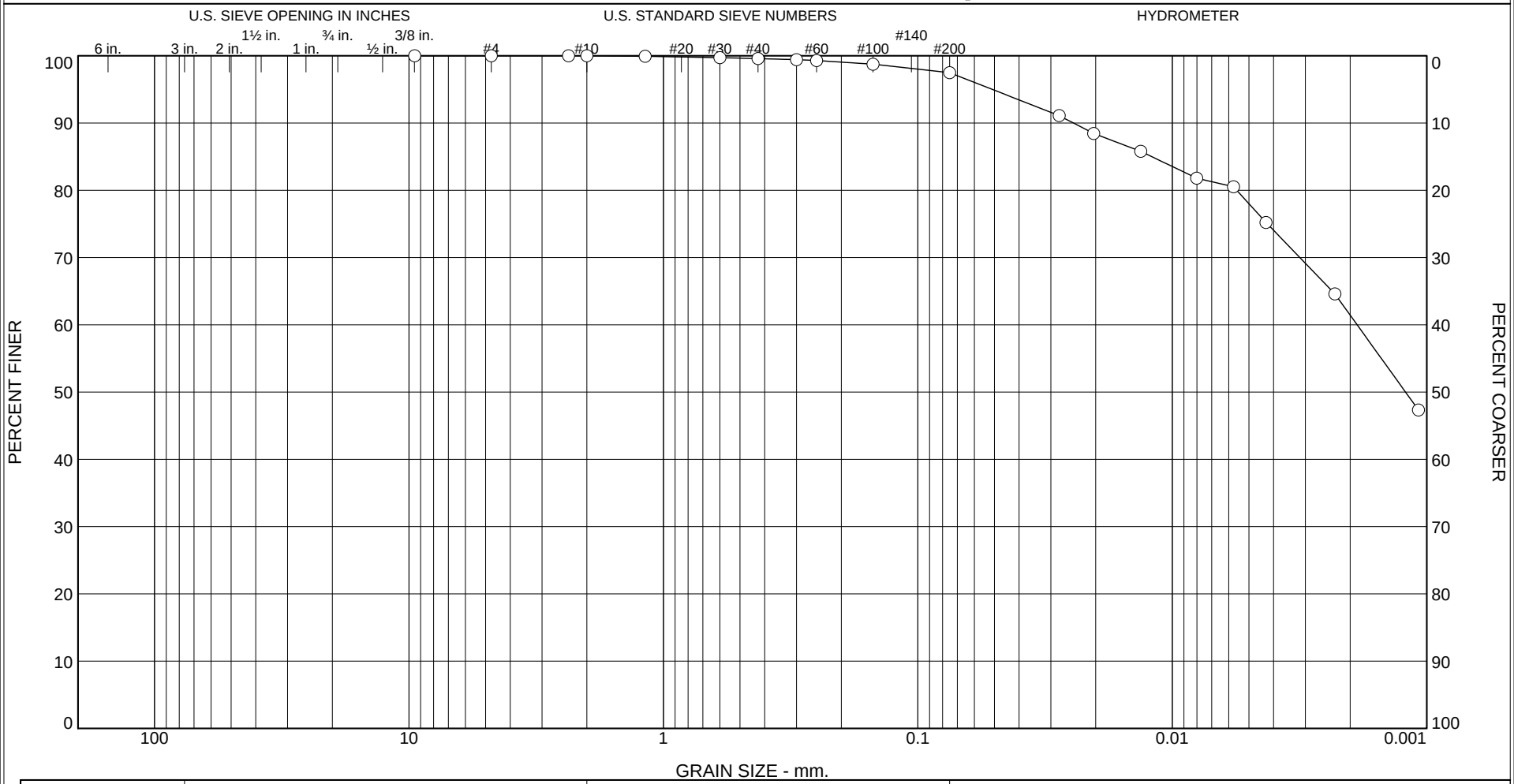
Fractional Components

Cobbles	Gravel	Sand			Fines		
		Coarse	Fine	Total	Silt	Clay	Total
0.0	0.0	0.4	2.1	2.5	36.1	61.4	97.5

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
						0.0012	0.0019	0.0056	0.0120	0.0245	0.0510

Fineness Modulus
0.02

Particle Size Distribution Report



	% +75mm	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	0.0	0.4	2.1	36.1	61.4

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: MET3-3 Depth: 1.52m - 2.13m Sample Number: 3			7/18/18

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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Tested By: J.Draper **Checked By:** S.Hoffman

GRAIN SIZE DISTRIBUTION TEST DATA

7/24/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: PSR 3-5
Depth: 3.05m - 3.66m **Sample Number:** 5
Date Sampled: 5/7/18 **Date Tested:** 7/24/18
Tested by: T.Linley **Checked by:** S.Hoffman

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
430.70	0.00	37.5mm	0.00	0.00	100.0	0.0
		26.5mm	75.90	0.00	82.4	17.6
		19mm	32.10	0.00	74.9	25.1
		16mm	45.20	0.00	64.4	35.6
		13.2mm	6.10	0.00	63.0	37.0
		9.5mm	27.70	0.00	56.6	43.4
		#4	44.20	0.00	46.3	53.7
		#8	47.00	0.00	35.4	64.6
73.20	0.00	#16	4.90	0.00	33.0	67.0
		#30	6.10	0.00	30.1	69.9
		#40	2.80	0.00	28.7	71.3
		#50	3.00	0.00	27.3	72.7
		#60	1.50	0.00	26.6	73.4
		#100	4.90	0.00	24.2	75.8
		#200	5.50	0.00	21.5	78.5

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 33.0
Weight of hydrometer sample =73.2
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.6
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	26.3	42.5	39.3	0.0128	41.5	9.5	0.0396	17.9	82.1
2.00	26.3	40.0	36.8	0.0128	39.0	9.9	0.0286	16.8	83.2
5.00	26.4	38.0	34.8	0.0128	37.0	10.2	0.0184	15.9	84.1
15.00	26.3	33.0	29.8	0.0128	32.0	11.0	0.0110	13.6	86.4
30.00	26.3	30.0	26.8	0.0128	29.0	11.5	0.0080	12.2	87.8
60.00	26.3	26.0	22.8	0.0128	25.0	12.2	0.0058	10.4	89.6
250.00	27.2	19.0	16.2	0.0127	18.0	13.3	0.0029	7.4	92.6
1440.00	25.9	13.0	9.6	0.0129	12.0	14.3	0.0013	4.4	95.6

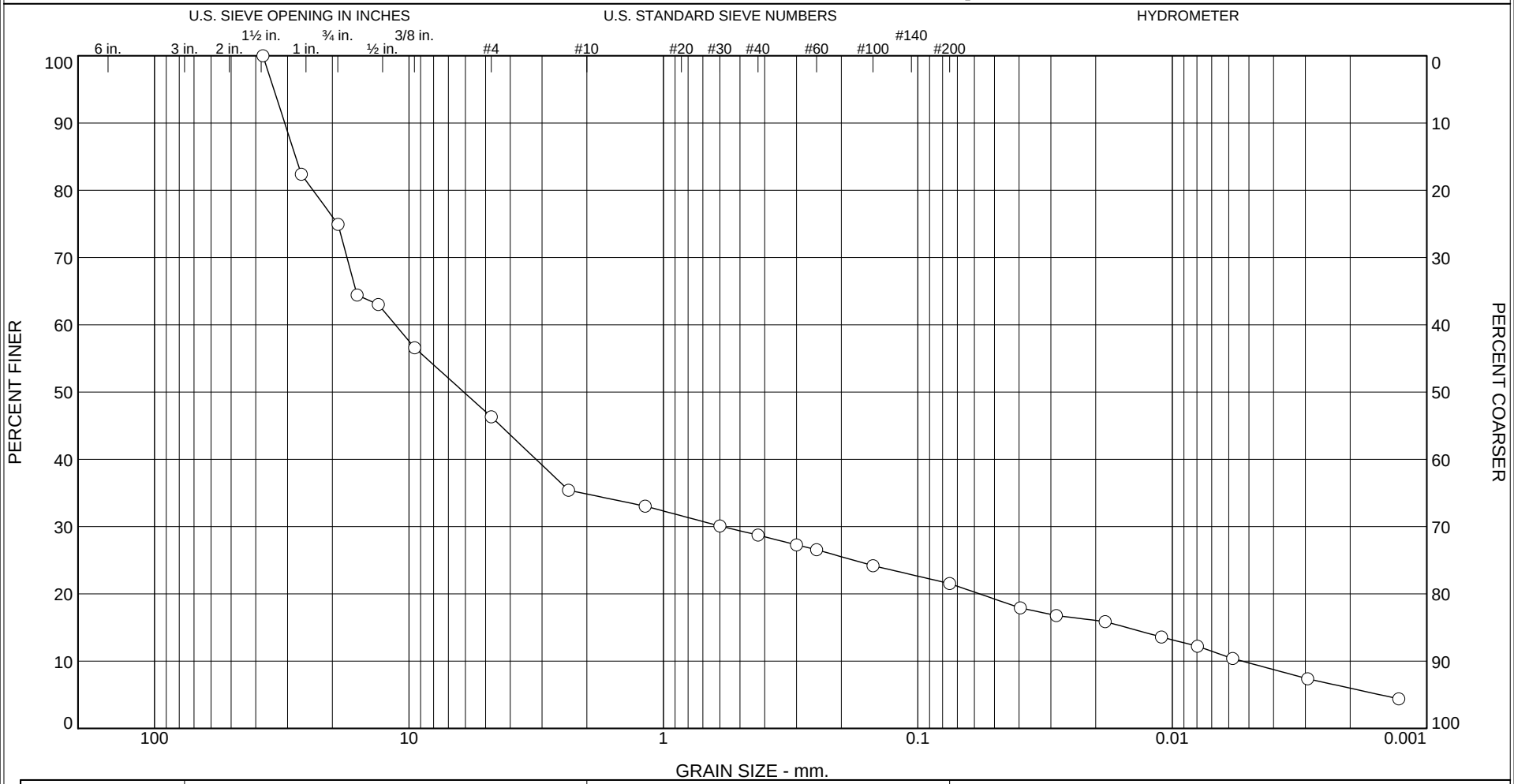
Fractional Components

Cobbles	Gravel	Sand			Fines		
		Coarse	Fine	Total	Silt	Clay	Total
0.0	65.2	6.1	7.2	13.3	15.5	6.0	21.5

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.0015	0.0053	0.0151	0.0573	0.5869	3.1678	6.0903	11.3145	23.8316	27.9052	30.7941	33.9820

Fineness Modulus	C_u	C_c
4.72	2129.73	5.73

Particle Size Distribution Report



	% +75mm	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	65.2	6.1	7.2	15.5	6.0

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: PSR 3-5 Depth: 3.05m - 3.66m Sample Number: 5	5/7/18		7/24/18

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

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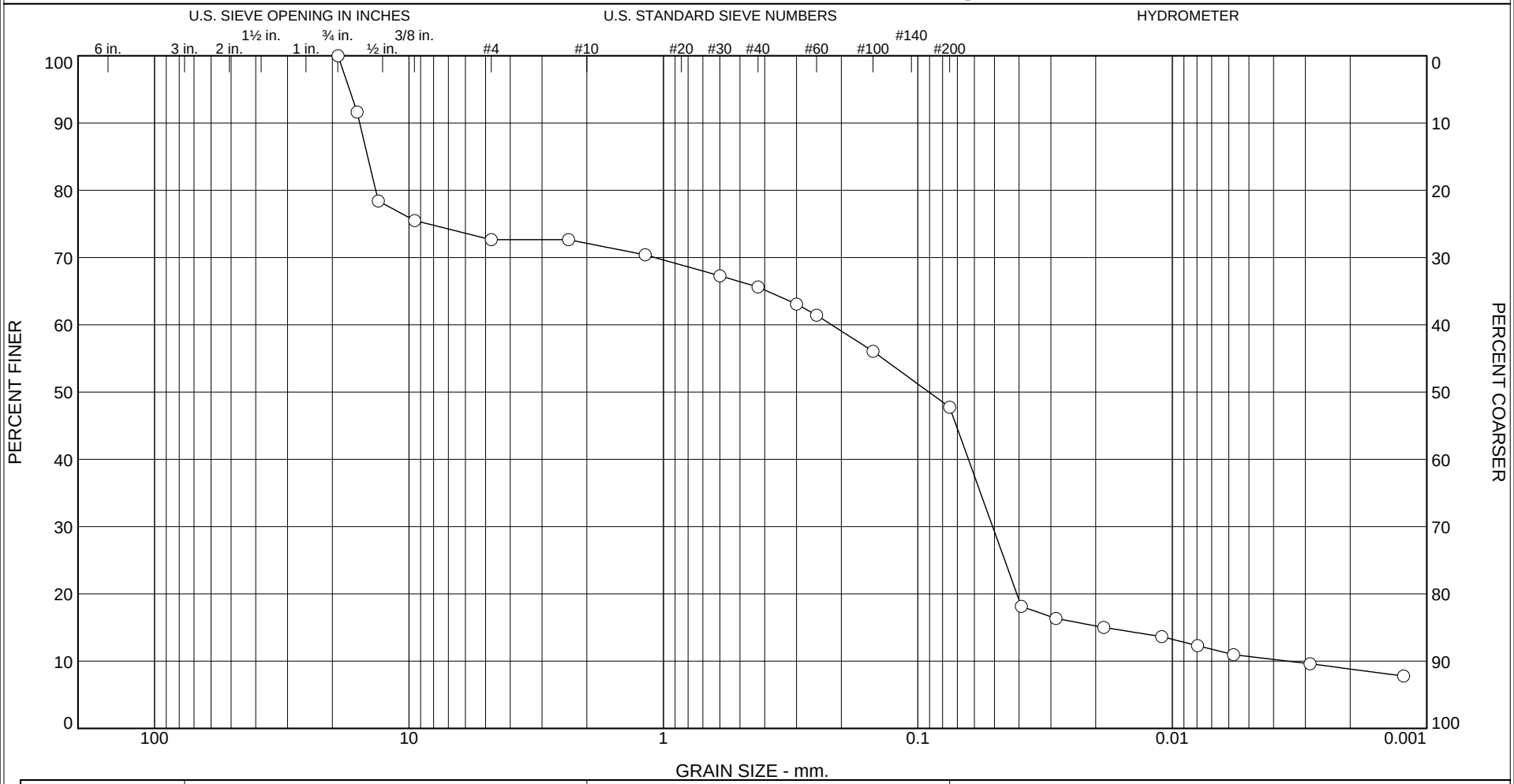
Tested By: T.Linley **Checked By:** S.Hoffman

Particle Size Distribution Report



	% +75mm	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	27.9	6.5	17.9	38.9	8.8

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: MET 3-6 Depth: 7.01m - 7.62m Sample Number: 6	5/18/18		7/19/18

Client EDP

Project Nation Rise Wind Farm

Project No. 18-4022

TULLOCH ENGINEERING

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adam.byers@TULLOCH.ca

Tested By: T.Linley **Checked By:** S.Hoffman

GRAIN SIZE DISTRIBUTION TEST DATA

7/25/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: MET 5-5
Depth: 3.05m - 3.66m **Sample Number:** 5
Date Sampled: 4/29/18
Tested by: T.Nott **Checked by:** S.Hoffman

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
220.30	0.00	9.5mm	0.00	0.00	100.0	0.0
		#4	0.00	0.00	100.0	0.0
		#8	0.00	0.00	100.0	0.0
		#10	0.00	0.00	100.0	0.0
		#16	0.20	0.00	99.9	0.1
		#30	0.10	0.00	99.9	0.1
		#40	0.10	0.00	99.8	0.2
		#50	0.10	0.00	99.8	0.2
		#60	0.10	0.00	99.7	0.3
		#100	0.20	0.00	99.6	0.4
		#200	0.30	0.00	99.5	0.5

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 100.0
Weight of hydrometer sample =78.1
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.6
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	26.0	73.0	69.6	0.0129	72.0	4.5	0.0273	90.2	9.8
2.00	26.0	71.0	67.6	0.0129	70.0	4.8	0.0200	87.6	12.4
5.00	26.0	70.0	66.6	0.0129	69.0	5.0	0.0129	86.3	13.7
15.00	26.0	70.0	66.6	0.0129	69.0	5.0	0.0074	86.3	13.7
30.00	26.0	70.0	66.6	0.0129	69.0	5.0	0.0053	86.3	13.7
60.00	26.0	65.0	61.6	0.0129	64.0	5.8	0.0040	79.9	20.1
250.00	25.9	57.0	53.6	0.0129	56.0	7.1	0.0022	69.4	30.6
1440.00	25.7	44.0	40.5	0.0129	43.0	9.2	0.0010	52.5	47.5

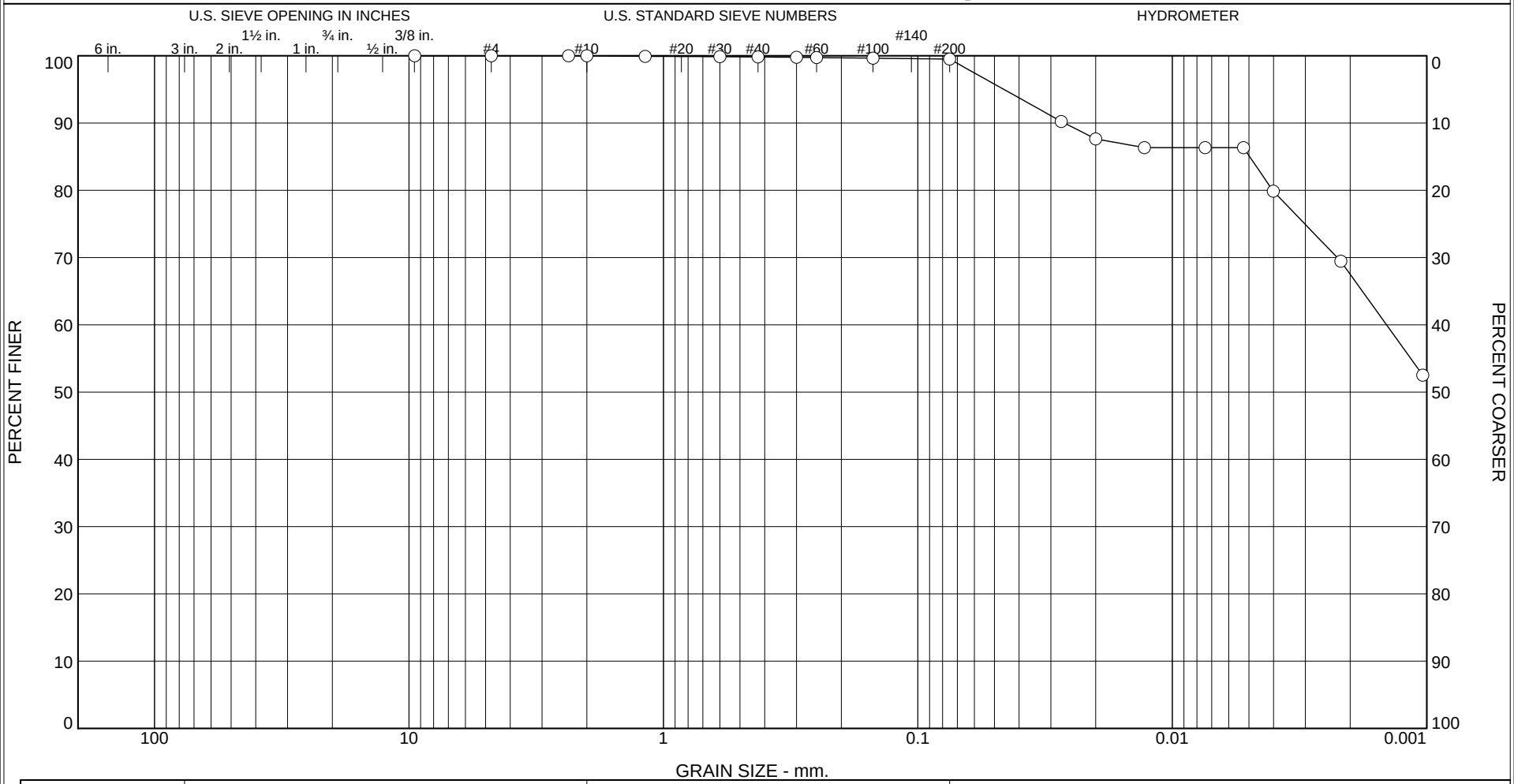
Fractional Components

Cobbles	Gravel	Sand			Fines		
		Coarse	Fine	Total	Silt	Clay	Total
0.0	0.0	0.2	0.3	0.5	32.0	67.5	99.5

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
							0.0014	0.0040	0.0050	0.0266	0.0459

Fineness Modulus
0.01

Particle Size Distribution Report



	% +75mm	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	0.0	0.2	0.3	32.0	67.5

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: MET 5-5 Depth: 3.05m - 3.66m Sample Number: 5	4/29/18		

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Tested By: T.Nott **Checked By:** S.Hoffman

GRAIN SIZE DISTRIBUTION TEST DATA

7/25/2018

Client: EDP
Project: Nation Rise Wind Farm
Project Number: 18-4022
Location: MET 6-8
Depth: 7.62m - 8.23m **Sample Number:** 8
Date Sampled: 5/23/18 **Date Tested:** 7/19/18
Tested by: T.Linley **Checked by:** S.Hoffman

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Sieve Opening Size	Weight Retained (grams)	Sieve Weight (grams)	Percent Finer	Percent Retained
241.50	0.00	9.5mm	0.00	0.00	100.0	0.0
		#4	8.90	0.00	96.3	3.7
		#10	10.60	0.00	91.9	8.1
79.80	0.00	#16	2.50	0.00	89.0	11.0
		#30	2.50	0.00	86.2	13.8
		#40	0.90	0.00	85.1	14.9
		#50	1.30	0.00	83.6	16.4
		#60	0.80	0.00	82.7	17.3
		#100	1.70	0.00	80.8	19.2
		#200	1.70	0.00	78.8	21.2

Hydrometer Test Data

Hydrometer test uses material passing #10
Percent passing #10 based upon complete sample = 91.9
Weight of hydrometer sample =79.8
Automatic temperature correction
Composite correction (fluid density and meniscus height) at 20 deg. C = -5
Meniscus correction only = -1.0
Specific gravity of solids = 2.6
Hydrometer type = 152H
Hydrometer effective depth equation: L = 16.294964 **-** 0.164 **x Rm**

Elapsed Time (min.)	Temp. (deg. C.)	Actual Reading	Corrected Reading	K	Rm	Eff. Depth	Diameter (mm.)	Percent Finer	Percent Retained
1.00	26.7	69.0	65.9	0.0128	68.0	5.1	0.0290	76.8	23.2
2.00	26.6	67.0	63.9	0.0128	66.0	5.5	0.0212	74.5	25.5
5.00	26.6	66.0	62.9	0.0128	65.0	5.6	0.0136	73.3	26.7
15.00	26.6	61.0	57.9	0.0128	60.0	6.5	0.0084	67.5	32.5
30.00	26.6	56.0	52.9	0.0128	55.0	7.3	0.0063	61.6	38.4
60.00	26.3	50.0	46.8	0.0128	49.0	8.3	0.0048	54.5	45.5
250.00	26.3	37.0	33.8	0.0128	36.0	10.4	0.0026	39.4	60.6
1440.00	25.8	22.0	18.6	0.0129	21.0	12.9	0.0012	21.6	78.4

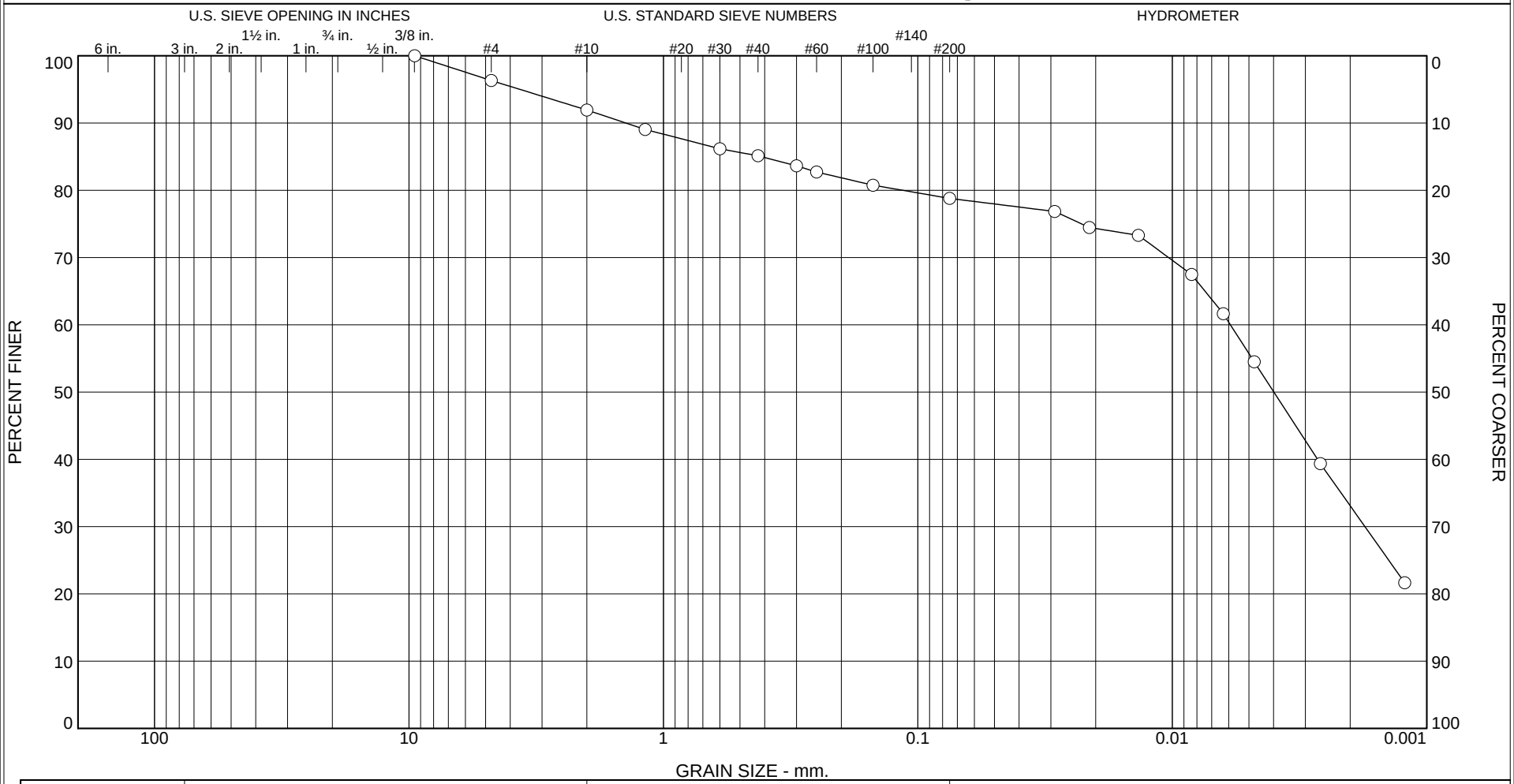
Fractional Components

Cobbles	Gravel	Sand			Fines		
		Coarse	Fine	Total	Silt	Clay	Total
0.0	8.1	6.8	6.3	13.1	45.7	33.1	78.8

D_5	D_{10}	D_{15}	D_{20}	D_{30}	D_{40}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
				0.0018	0.0027	0.0040	0.0059	0.1150	0.4124	1.4055	3.6658

Fineness Modulus
0.71

Particle Size Distribution Report



	% +75mm	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	8.1	6.8	6.3	45.7	33.1

Identification	Date Sampled	Date Received	Date Tested
Source of Sample: MET 6-8 Depth: 7.62m - 8.23m Sample Number: 8	5/23/18		7/19/18

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APPENDIX H

REPORT LIMITATIONS AND GUIDELINES FOR USE

REPORT LIMITATIONS AND GUIDELINES FOR USE

This information has been provided to help manage risks with respect to the use of this report.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS, AND PROJECTS

This geotechnical report has been prepared for the exclusive use of the client, their authorized agents, and other members of the design team. It is not intended for use by others, and the information contained herein is not applicable to other sites, or for purposes other than those specified in the report.

Tulloch Engineering (Tulloch) cannot be held responsible for reliance on the information contained in this report, by persons other than the client or 'authorized' agent without prior written approval.

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical investigation report is based on existing conditions at the time the study was performed, and our opinion of soil conditions are strictly based on soil samples collected at specific borehole locations. The findings and conclusions of our reports may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations.

LIMITATIONS TO PROFESSIONAL OPINIONS

Interpretations of subsurface conditions are based on field observations from boreholes and/or test pits that were spaced to capture a 'representative' snapshot of subsurface conditions. Site exploration identifies subsurface conditions only at points of sampling. Tulloch reviews field and laboratory data and then applies our professional judgment to formulate an opinion of subsurface conditions throughout the site. Actual subsurface conditions may differ, between sampling locations, from those indicated in this report.

LIMITATIONS OF RECOMMENDATIONS

Subsurface soil conditions should be verified by a qualified geotechnical engineer during construction. Tulloch should be notified if any discrepancies to this report or unusual conditions are found during construction.

Sufficient monitoring, testing, and consultation should be provided by Tulloch during construction and/or excavation activities, to confirm that the conditions encountered are consistent with those indicated by the borehole and/or test pit investigation, and to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated. In addition, monitoring, testing, and consultation by Tulloch should be completed to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining Tulloch for construction

observation for this project is the most effective method of managing the risks associated with unanticipated conditions. However, please be advised that any construction/excavation observations by Tulloch is over and above the mandate of this geotechnical investigation and therefore, additional fees would apply.

MISINTERPRETATION OF GEOTECHNICAL ENGINEERING REPORT

Misinterpretation of our report by other design team members can result in costly problems. You could lower that risk by having Tulloch confer with appropriate members of the design team after submitting the report. Also, retain Tulloch to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having Tulloch participate in pre-bid and pre-construction conferences, and by providing construction observation. Please be advised that retaining Tulloch to participation in any 'other' activities associated with this project is over and above the mandate of this geotechnical investigation and therefore, additional fees would apply.

CONTRACTORS RESPONSIBILITY FOR SITE SAFETY

This geotechnical report is not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties. It is ultimately the contractor's responsibility that the Ontario Occupational Health and Safety Act is adhered to, and site conditions satisfy all 'other' acts, regulations and/or legislation that may be mandated by federal, provincial and/or municipal authorities.

SUBSURFACE SOIL AND/OR GROUNDWATER CONTAMINATION

This report is geotechnical in nature and specifically excludes the investigation, detection, prevention or assessment of the presence of subsurface contaminants. Accordingly, the scope of services does not include any interpretations, recommendations, findings, or conclusions regarding the detection, assessment, prevention or abatement of contaminants, and no conclusions or inferences should be drawn regarding contamination, as they may relate to this project. The term "contamination" includes, but is not limited to, molds, fungi, spores, bacteria, viruses, PCBs, petroleum hydrocarbons, inorganics, pesticides/insecticides, volatile organic compounds, polycyclic aromatic hydrocarbons and/or any of their byproducts.