

April 9, 2026

Please note that the Geocres number for this report has been updated from 42D14-001 to **42D15-002**. Accordingly, the title sheet should reflect Geocres number 42D15-002 instead of 42D14-001.

All other content in the report remains unchanged.

MTO Foundations



# Detailed Foundation Investigation Report High Fill Embankments, Deep Cuts, and Non-Structural Culverts

Highway 17 Realignment, 9.3 to 13.3 km West of Township of Schreiber  
Northwestern Region, Ontario  
G.W.P. 6333-14-00, GEOCRES No. 42D14-001

**Client Name:** HATCH  
**Date:** October 22, 2024  
**File:** 37996

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**DETAILED FOUNDATION INVESTIGATION REPORT  
HIGH FILL EMBANKMENTS, DEEP CUTS, AND NON-STRUCTURAL CULVERTS  
HIGHWAY 17 REALIGNMENT, 9.3 TO 13.3 KM WEST OF TOWNSHIP OF SCHREIBER  
MTO NORTHWESTERN REGION, ONTARIO  
G.W.P. 6333-14-00**

**GEOCRES No. 42D14-001**

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## **1. INTRODUCTION**

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This report presents the factual findings obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the Highway 17 curve realignment from 9.3 to 13.3 km west of the Township of Schreiber, Ontario.

The project will include the Highway 17 curve realignment for approximately 4 km, starting 9.3 km west of the Township of Schreiber. The foundation aspects of the project include construction of new high fill embankments, deep cut sections for the new alignment, as well as the installation of new non-structural culverts in two locations. The project also includes construction of a new structural culvert where the realigned highway crosses Hewitson Creek. A separate investigation was completed for the detailed design of the Hewitson Creek Culvert and approach embankments. The Hewitson Creek site is discussed in a separate report entitled:

*“Detailed Foundation Investigation and Design Report, Hewitson Creek Culvert Replacement, Highway 17 Realignment, 9.3 to 13.3 km West of Township of Schreiber, MTO Northwestern Region, Ontario, G.W.P. 6333-14-00”, File: 37996 (Reference 1).*

In addition to the foundation investigations discussed herein and in Reference 1, a detailed level pavement investigation of the proposed highway realignment was previously completed by Thurber in 2023. The pavement investigation is discussed in a separate report entitled:

*“Pavement Design Report, Highway 17 Realignment at Hewitson Creek From 9.3 to 13.3 km West of Schreiber Township, Northwestern Region, Ontario”, File: 35697, Dated April 21, 2023 (Reference 2).*

The purpose of Thurber’s investigation was to explore the subsurface conditions along the alignment of the proposed high fill embankments, deep cuts, and culverts, and based on the data obtained, to provide borehole location plans, record of borehole sheets, stratigraphic profiles, laboratory test results and a written description of the subsurface conditions.

Thurber carried out the assignment as a sub-consultant to Hatch Ltd. (Hatch), under the Ministry of Transportation Ontario (MTO) Assignment No. 6023-E-0007.

It is a condition of this report that Thurber’s performance of its professional services is subject to the attached Statement of Limitations and Conditions.

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## **2. SITE DESCRIPTION**

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### **2.1 Existing and Proposed Highway 17**

The existing Highway 17 within the project limits is a two-lane, undivided roadway with at-grade intersections and an eastbound truck-climbing lane. For the purposes of this report, the existing and new highway alignments are considered to operate in an east/west direction. Three at-grade intersections are present within the project limits; at an unnamed access road for Hydro One near the west limit, at the Rainbow Falls Whitesand Lake Campground entrance, and at Ch. Hunter Road near the east limit.

The existing highway corridor is surrounded predominately by heavily wooded areas. The highway crosses a Hydro One high voltage transmission corridor west of Hewitson Creek and east of Rainbow Falls Provincial Park as well as the east project limits. A Canadian Pacific Kansas City (CPKC) rail corridor is located to the south of the highway, and an MTO gravel pit is located south of the highway near the east end of the proposed new alignment. The proposed new alignment is located south of the Hydro One corridor, north of the CPKC rail corridor, and crosses through Rainbow Falls Provincial Park.

Steep hills and creek valleys were noted throughout the existing and proposed alignment, particularly at the Hewitson Creek valley. Bedrock was observed at the ground surface locally near the east and west ends of the proposed alignment near the existing highway. Overall, the ground surface elevation increases by approximately 90 m from the west to east project limits.

Typical photographs of the site are included in Appendix H.

### **2.2 Regional Geology**

Quaternary geological mapping<sup>1</sup> indicates that the proposed highway alignment primarily crosses glaciolacustrine nearshore beach deposits consisting of gravelly sand to sand and gravel. Near the east and west ends of the proposed highway alignment, Precambrian bedrock was mapped<sup>2</sup>, indicating the presence of igneous or metamorphic rock at surface or below discontinuous and thin layers of drift. At the east end and near the west end of the proposed alignment, glaciofluvial

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<sup>1</sup> Ontario Geological Survey, Ministry of Northern Development and Mines, and Northeast Science and Information Section, Ministry of Natural Resources 2005. Digital Northern Ontario Engineering Geology Terrain Study (NOEGTS); Ontario Geological Survey, Miscellaneous Release--Data 160.

<sup>2</sup> Ontario Geological Survey 2011. 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release--Data 126 - Revision 1.

outwash deposits are mapped, consisting of gravel and sand.

The bedrock in this area is mapped as massive granodiorite to granite of the Whitesand Lake Batholith. This batholith is typically comprised of medium to coarse grained granite and includes a grey phase ranging in composition from monzodiorite to quartz monzonite<sup>3</sup>.

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### 3. SITE INVESTIGATION AND FIELD TESTING

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The scope of the detailed foundation investigation consisted of a field drilling program of advancing 21 boreholes along the proposed highway alignment where high fill embankments (fills of 4.5 m height or greater), deep cuts (cuts of 4.5 m deep or deeper) and culverts are planned. The field investigation for these areas was carried out between March 1 and 18, 2024. A subsequent phase of the investigation at the Hewitson Creek site included 11 boreholes that were completed on April 17, 2024 and are described in Reference 1. The boreholes completed for the high fill, deep cut and culvert investigation, along with the locations and assigned nomenclature are summarized in Table 3.1.

Only the areas investigated during this detailed high fill and deep cut investigation are addressed in this report. In addition to the deep cut in earth discussed in this report (Deep Cut 1), the separate pavement investigation from 2023 included a deep cut section in potential bedrock from approximate Sta. 10+390 to 10+800, which is described in Reference 2.

**Table 3.1: Summary of Investigation Program**

Location and Assigned Nomenclature	Approximate Station	Boreholes	Appendices
High Fill 1 and Non-Structural Culvert (HF1)	10+250 to 10+300	HF1-01 to HF1-04	B1, B2
High Fill 2A (HF2A)	10+940 to 10+990	HF2A-01 to HF2A-02	Refer to Reference 1
Hewitson Creek Structural Culvert (HCC)	10+990 to 11+020	HCC-01 to HCC-06	
High Fill 2B (HF2B)	11+020 to 11+130	HF2B-01 to HF2B-03	
High Fill 3 and Non-Structural Culvert (HF3)	11+600 to 11+650	HF3-01 to HF3-04	C1, C2
High Fill 4 (HF4)	12+050 to 12+300	HF4-01 to HF4-06	D1, D2
Deep Cut 1 (DC1)	12+375 to 12+650	DC1-01 to DC1-07	E1, E2

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<sup>3</sup> Carter, M. W. 1988: Geology of Schreiber-Terrace Bay area, District of Thunder Bay; Ontario Geological Survey, Open File Report 5692

The locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawings included in Appendix A. Details of the subsurface conditions encountered during the foundation investigation are presented in the Record of Borehole sheets in Appendices B1 to E1.

The centreline of the proposed new alignment was surveyed and staked on site by Hatch in advance of the drilling investigation. The borehole locations were established in the field based on measurements (stations and offset distances) from the staked centreline alignments. The horizontal coordinates and ground surface elevations at the borehole locations were established from the topographic data provided by Hatch. The coordinate system MTM NAD83, Zone 14 was used. Utility clearances were obtained prior to the start of drilling.

The boreholes were advanced using a track-mounted drill rig with solid and hollow stem augers, wash boring with NW casing, and NQ coring methods, supplied and operated by Eastern Ontario Diamond Drilling Ltd. of Hawkesbury, Ontario. Standard Penetration Testing (SPT) was carried out in accordance with ASTM D1586 at selected depth intervals.

The field investigation was supervised on a full-time basis by members of Thurber's technical staff who directed the drilling, sampling and in-situ testing operations, logged the boreholes and processed the recovered soil and rock samples for transport to Thurber's laboratory for further examination and testing.

The rock cores were logged, and the Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

Groundwater conditions were observed in the open boreholes throughout the drilling operation. Standpipe piezometers were installed in selected boreholes to permit measurement of groundwater levels at the site. All boreholes without a standpipe piezometer were backfilled upon completion of drilling in general accordance with O. Reg. 903. Piezometers were decommissioned as per O. Reg. 903 at the end of the field program.

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## **4. LABORATORY TESTING**

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The recovered soil samples were subjected to visual identification (VI) and to natural moisture content determination. Selected samples were subjected to grain size distribution analyses (sieve and/or hydrometer), and Atterberg Limits testing. Rock core samples were subjected to Point Load Testing (PLT). The laboratory test results are summarized on the Record of Borehole sheets included in Appendices B1 to E1, and presented on the figures included in Appendices B2 to E2 and F.

Selected soil and surface water samples for the proposed culvert locations were submitted for analytical testing to assess the corrosion potential of soil and water on metal culverts and the potential for sulphate attack on subsurface concrete structures. The analyses were carried out by

SGS Canada Inc. (SGS), an independent Canadian Association for Laboratory Accreditation (CALA) accredited laboratory. The results of the analytical testing are summarized in Section 6 and the laboratory Certificates of Analysis are included in Appendix G.

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## **5. DESCRIPTION OF SUBSURFACE CONDITIONS**

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Subsurface conditions encountered during the foundation investigation are shown on the Borehole Locations and Soil Strata Drawings in Appendix A. Detailed descriptions of individual soil stratum are presented on the Record of Borehole sheets included in Appendices B1 to E1.

A general description of the soil stratigraphy for each location investigated is given below. However, the factual data presented on the Record of Borehole sheets takes precedence over these general descriptions and must be used for interpretation of the site conditions. It should be recognized and expected that soil conditions may vary between and beyond borehole locations.

In general, the overburden soil across the site consists of topsoil or organic material overlying interbedded sand, silt and gravel deposits, often containing cobbles and boulders. Granite to granodiorite bedrock was encountered below the overburden soils.

### **5.1 High Fill 1 (HF1) (Sta. 10+250 to 10+300)**

Four (4) boreholes (HF1-01 to HF1-04) were advanced along the proposed new alignment between Stations 10+200 and 10+300 near the proposed high fill and non-structural culvert. The boreholes were advanced to depths from 12.0 to 20.1 m (Elev. 214.1 to 206.2 m). The locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing 2 included in Appendix A. The Record of Borehole Sheets are included in Appendix B1.

The soil conditions encountered generally consist of surficial organic deposits overlying deposits of sand, gravelly sand to sand and gravel, and a thick deposit of sand to silty sand. Underlying the sand deposits, a layer of clayey silt to silty clay was observed overlying the local granite bedrock.

#### **5.1.1 Organics**

Organics were encountered at the ground surface in Boreholes HF1-01, HF1-03, and HF1-04. The surficial organics thickness ranged from 150 mm to 300 mm at the borehole locations (base Elev. from 226.6 to 220.2 m). The organic material thickness may vary between and beyond the boreholes.

No SPT testing was completed entirely in the organic material, as all tests extended into the underlying sand. Natural moisture contents of the organic material ranged from 40 to 408%.

### 5.1.2 Sand

A deposit of sand was observed below the organics in Boreholes HF1-01 and HF1-03, which extended to depths ranging from 0.2 to 0.8 m (Elev. from 225.4 to 225.3 m). The sand deposit was typically described as brown and contained some silt and trace to some gravel. Occasional cobbles were also observed in the sand.

SPT 'N' values recorded in this deposit ranged from 17 to greater than 100 blows per 0.3 m penetration, indicating a compact to very dense relative density. The measured natural moisture contents ranged between 4 and 12%.

The results of grain size analyses conducted on a sample of the sand are provided on the Record of Borehole sheets in Appendix B1 and illustrated on Figure B1 of Appendix B2. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	2
Sand	77
Silt	19
Clay	2

### 5.1.3 Gravelly Sand to Sand and Gravel

A deposit of gravelly sand to sand and gravel was encountered in all HF1 Boreholes. The layer was encountered at the ground surface in HF1-02, below organics in HF1-04, and below the sand layer in HF1-01 and HF1-03. The deposit ranged in thickness from 0.6 to 4.3 m and extended to depths ranging from 0.8 to 4.6 m (Elev. 225.3 to 215.9 m).

The deposit was typically described as gravelly sand but ranged from gravelly sand to sand and gravel in Borehole HF1-04. The layer contained trace silt, with occasional boulders and cobbles encountered during drilling.

SPT 'N' values recorded in the gravelly sand to sand and gravel ranged from 4 to greater than 100 blows per 0.3 m penetration, indicating a range from very loose to very dense, typically compact to very dense. Natural moisture contents ranged from 1 to 18%.

The results of grain size analyses conducted on samples of the gravelly sand to sand and gravel are provided on the Record of Borehole sheets in Appendix B1 and illustrated on Figure B2 of Appendix B2. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	23 to 52
Sand	42 to 67
Silt and Clay	6 to 10

#### 5.1.4 Sand, Some Silt to Silty Sand

A thick deposit of sand with some silt ranging to silty sand was encountered below gravelly sand to sand and gravel layer in all of the HF1 boreholes. The deposit was described as brown to grey and typically contained trace gravel with occasional cobbles. The thickness of the deposit ranged from 4.1 to 17.5 m and the base was encountered at depths ranging from 7.2 to 17.8 m (Elev. 218.9 m to 208.3 m). A lower sand and silt layer was observed locally in Borehole HF1-03 at a depth of 17.8 m. The borehole was terminated within the sand and silt at a depth of 18.9 m (Elev. 207.2 m).

SPT 'N' values recorded in the sand to silty sand ranged from 4 blows to greater than 100 blows per 0.3 m of penetration, indicating a loose to very dense relative density, typically compact to dense. Natural moisture contents in the deposit ranged from 1 to 29%.

The results of grain size analyses conducted on samples collected in this deposit are provided on the Record of Borehole sheets in Appendix B1 and illustrated in Figures B3 and B4 of Appendix B2. The results are summarized as follows:

Soil Particle	Percentage (%)		
	Sand, Some Silt	Silty Sand	Lower Silt and Sand
Gravel	0 to 10	3 to 8	0
Sand	68 to 87	66 to 72	51
Silt	12 to 20	21 to 24	47
Clay	1 to 2	1 to 2	2
Silt and Clay	-	28	-

#### 5.1.5 Silt to Silty Clay

A lower deposit of silt to silty clay was observed below the sand to silty sand deposit in Boreholes HF1-01, HF1-02, and HF1-04. The silt to silty clay was typically described as brown to grey and contained trace to some sand. The silt to silty clay layer was 1.2 to 2.0 m thick and extended to depths from 8.4 m to 16.8 m (Elev. 217.7 to 209.8 m).

SPT 'N' values recorded in the silt to silty clay deposit ranged from 15 to 34 blows per 0.3 m penetration, indicating a stiff to hard relative density, or dense where mainly comprised of silt. Additional SPT 'N' values of greater than 100 blows per 0.3 m of penetration were recorded at the base of the boreholes due to split spoon refusal on bedrock. Natural moisture contents ranged from 18 to 22%.

The results of grain size analyses conducted on samples of the silt to silty clay are provided on the Record of Borehole sheets in Appendix B1 and illustrated on Figures B5 and B6 of Appendix B2. The results are summarized as follows:

Soil Particle	Percentage (%)	
	Silt	Silty Clay
Gravel	0	0
Sand	12	4 to 7
Silt	85	54 to 66
Clay	3	27 to 42

The results of the Atterberg Limits tests conducted on samples of the silty clay are provided on the Record of Borehole sheets in Appendix B1 and illustrated on Figure B7 of Appendix B2. The results are summarized as follows:

Index Property	Percentage (%)
Liquid Limit	26 to 36
Plasticity Index	9 to 16

The results of the Atterberg Limits tests indicate that the silty clay layer ranges from low to intermediate plasticity (CL to CI).

#### 5.1.6 Granite Bedrock

Bedrock was encountered underlying the overburden soils at depths from 8.4 to 16.8 m (Elev. 217.7 to 209.8 m) in Boreholes HF1-01, HF1-02 and HF1-04. Bedrock was not encountered in Borehole HF1-03.

The bedrock was described as slightly weathered to fresh and was visually identified as red granite. Where encountered, the bedrock was proven by coring from 3.3 to 3.6 m into the rock.

The Fracture Index (FI), measured as the total number of fractures per 0.3 m of rock core length, was between 0 and 7. Total Core Recovery (TCR) values measured on recovered bedrock samples was 100%. Solid Core Recovery (SCR) values ranged from 57 to 100%. Rock Quality Designation (RQD) values varied from 28 to 100% with most values exceeding 50% indicating fair to excellent quality (average of 69%).

Estimated rock strength values were interpreted from Point Load Tests conducted on the rock cores. The average uniaxial compressive strength (UCS) values per core run from the point load tests ranged from 111 to 242 MPa, indicating that the bedrock is very to extremely strong. The results of the point load tests and photographs of the rock core samples are presented in Appendix F.

#### 5.1.7 Groundwater Conditions

A standpipe piezometer was installed in Borehole HF1-04 to monitor the groundwater table. The description of the piezometer and the measured groundwater levels are summarized in Table 5.1

below.

**Table 5.1: HF1-04 Groundwater Measurements**

Borehole	Piezometer Details				Date	Water Level (m)	
	Top of Screen (m)	Top of Screen Elevation (m)	Bottom of Screen (m)	Bottom of Screen Elevation (m)		Depth	Elevation
HF1-04	7.65	212.9	10.7	209.8	March 17, 2024	4.2	216.3
					March 18, 2024	4.2	216.3
					April 8, 2024	3.5	217.0
					April 19, 2024	3.5	217.0

The groundwater levels above are short-term readings and seasonal fluctuations of the groundwater levels are to be expected. In particular, the groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation.

## 5.2 High Fill 3 (HF3) (Sta. 11+600 to 11+650)

Four (4) boreholes (HF3-01 to HF3-04) were advanced along the proposed new alignment between Stations 11+575 and 11+650 near the proposed high fill and non-structural culvert. The boreholes were advanced to depths from 21.5 to 26.3 m (Elev 231.5 and 225.0 m). The locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing 3 included in Appendix A. The Record of Borehole Sheets are included in Appendix C1.

The soil conditions encountered generally consist of topsoil overlying deposits of silty sand to sand and silt, sand and gravel, and a lower silty sand to silt. The overburden deposits are underlain by granite bedrock.

### 5.2.1 Topsoil

Topsoil was encountered at the ground surface in Boreholes HF3-01, HF3-03, and HF3-04. The topsoil thickness ranged from 500 to 800 m at the borehole locations. The topsoil was described as black or brown in colour and contained some sand and gravel in Boreholes HF3-03 and HF3-04.

SPT 'N' values recorded in the topsoil ranged from 15 to 61 per 0.3 m penetration, indicating a compact to very dense relative density, which is likely attributed to the presence of some sand and gravel within the organic deposit. Natural moisture contents ranged from 14 to 112%. The topsoil thickness may vary between and beyond the boreholes.

### 5.2.2 Upper Silty Sand to Sandy Silt

A deposit of silty sand to sandy silt was observed underlying the topsoil in Boreholes HF3-01 and HF3-04. The upper silty sand to sandy silt was also encountered under localized gravelly sand

layers in HF3-02 and HF3-03.

The silty sand to sandy silt deposit was encountered at depths ranging from 0.5 to 1.4 m (Elev. 251.6 to 249.9 m). The layer thickness ranged from 1.0 to 2.5 m in Boreholes HF3-01 and HF3-02 and from 10.2 to 12.3 m in Boreholes HF3-03 and HF3-04. The base of the silty sand to sandy silt deposit ranged from 2.2 m to 13.7 m depth (Elev. 245.8 to 239.3 m), generally dipping towards the southeast.

The silty sand to sandy silt deposit was described as brown or grey and contained trace gravel and occasionally trace clay. Occasional cobbles were also noted during drilling. SPT 'N' values recorded in the deposit ranged from 11 to greater than 100 blows per 0.3 m penetration, indicating a compact to very dense relative density. Natural moisture contents ranged from 9 to 24%.

The results of grain size analyses conducted on samples of the silty sand to sandy silt are provided on the Record of Borehole sheets in Appendix C1 and illustrated on Figures C1 to C3 of Appendix C2. The results are summarized as follows:

Soil Particle	Percentage (%)		
	Sand, Some Silt	Silty Sand	Sandy Silt
Gravel	0	8	0 to 2
Sand	78	60	30 to 39
Silt	20	30	57 to 65
Clay	2	2	3 to 5

### 5.2.3 Sand and Gravel

Sand and gravel deposits which ranged in composition from sandy gravel to gravelly sand were encountered at the ground surface in Borehole HF3-02, below the topsoil in Borehole HF3-03, and below the silty sand to sandy silt deposit in Boreholes HF3-01 to HF3-04. The deposit was described as brown and containing trace to some silt and occasional cobbles. A boulder was encountered in HF3-04 at a depth of 12.6 m.

A 0.7 to 1.2 m thick localized shallow sand and gravel layer was encountered above the silty sand to sandy silt deposit in Boreholes HF3-02 and HF3-03. The shallow layer extended to depths of 1.2 to 1.4 m (Elev. 251.6 to 246.8 m).

Below the upper silty sand to sandy silt deposit, the top of the sand and gravel was encountered at depths from 2.2 m to 3.0 m (Elev. 247.4 to 245.8 m) in Boreholes HF3-01 and HF3-02, and from 11.0 to 13.7 m (Elev. 240.3 to 239.3 m) in Boreholes HF3-03 and HF3-04, with the top of the deposit typically dipping towards the southeast. Where fully penetrated, the deposit ranged in thickness from 7.4 to 10.3 m and the base extended to depths from 11.5 to 18.4 m (Elev. 237.1 to 232.9 m). Borehole HF3-03 was terminated within the sand and gravel deposit at a depth of 21.5 m (Elev. 231.5 m).

Layers of finer materials were also occasionally encountered within the sand and gravel deposit in Boreholes HF3-01 and HF3-04. A sand layer was encountered from 5.5 to 7.2 m depth (Elev. 244.9 to 243.2 m) in Borehole HF3-01. A sandy silt layer containing trace gravel was encountered from 14.8 to 16.3 m depth (Elev. 235.0 to 236.5 m) in Borehole HF3-04.

SPT 'N' values of 8 to greater than 100 blows per 0.3 m of penetration were recorded in the sand and gravel, typically greater than 18 blows. The relative density of the soil ranged from loose to very dense, typically compact to very dense. SPT refusal of greater than 100 blows per 0.3 m of penetration was frequently reached upon cobbles, boulders, or the underlying bedrock. Rock coring measures were occasionally required to penetrate the deposit. Measured moisture contents in the sand and gravel typically ranged from 4 to 13%. Locally, a moisture content of 51% was measured in the surficial sample from Borehole HF3-02.

The results of grain size analyses conducted on samples of the sand and gravel are provided on the Record of Borehole sheets in Appendix C1 and illustrated on Figure C4 of Appendix C2. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	39 to 56
Sand	29 to 48
Silt and Clay	5 to 23

#### 5.2.4 Lower Silty Sand to Silt

A lower layer of silty sand to silt was encountered below the sand and gravel in Boreholes HF3-01, HF3-02, and HF3-04. The top of the silty sand to silt deposit was observed at depths from 11.5 m to 18.4 m (Elev. 237.1 to 232.9 m). The silty sand to silt layer ranged in thickness from 4.5 to 7 m and extended to the bedrock surface, which was encountered between 18.3 and 22.9 m depth (Elev. 232.1 to 228.4 m).

SPT 'N' values recorded in the silty sand to silt ranged from 23 to greater than 100 blows per 0.3 m penetration. The 'N' values indicate that the deposit ranges from compact to very dense. The natural moisture contents of the deposit ranged from 10 to 23%.

The results of grain size analyses conducted on samples of the silty sand to silt are provided on the Record of Borehole sheets in Appendix C1 and illustrated on Figures C2, C3 and C5 of Appendix C2. The results are summarized as follows:

Soil Particle	Percentage (%)		
	Silty Sand	Sandy Silt	Silt
Gravel	7	0	0
Sand	70	30	16
Silt	21	64	79
Clay	2	6	5

### 5.2.5 Bedrock

Bedrock was encountered underlying the overburden soils from 18.3 m to 22.9 m depth (Elev. 232.1 to 228.4 m) in Boreholes HF3-01, HF3-02, and HF3-04. Bedrock was not encountered in HF1-03.

The bedrock was slightly weathered to fresh and was visually identified as red granite. Where encountered, the bedrock was proven by coring from 3.2 to 3.6 m into the rock.

The Fracture Index (FI), measured as the total number of fractures per 0.3 m of rock core length, was typically between 0 and 4, locally greater than 10 in highly fractured zones found in HF3-01. Total Core Recovery (TCR) values measured on recovered bedrock samples was 100%. Solid Core Recovery (SCR) values ranged from 82 to 100%. Rock Quality Designation (RQD) values varied from 67 to 100% with most values exceeding 70% indicating fair to excellent quality (average of 89%).

Estimated rock strength values were interpreted from Point Load Tests conducted on the rock cores. The average uniaxial compressive strength (UCS) values per core run from the point load tests ranged from 159 to 256 MPa, indicating that the bedrock is very to extremely strong. The results of the point load tests and photographs of the rock core samples are presented in Appendix F.

### 5.2.6 Groundwater Conditions

A standpipe piezometer was installed in Borehole HF3-04 to monitor the groundwater level. The measured groundwater levels are summarized in Table 5.2 below.

**Table 5.2: HF3-04 Groundwater Measurements**

Borehole	Piezometer (m)				Date	Water Level (m)	
	Top of Screen Depth	Top of Screen Elevation	Bottom of Screen Depth	Bottom of Screen Elevation		Depth	Elevation
HF3-04	15.2	236.1	18.3	233.0	March 11, 2024	18.3	233.0
					March 19, 2024	Dry	-
					April 8, 2024	Dry	-

Considering that the piezometer was dry on subsequent measurements, it is likely that water added to the borehole for drilling and rock coring purposes had not fully dissipated by the initial measurement on March 11, 2024. Seasonal fluctuations of the groundwater levels are to be expected. The groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation.

### **5.3 High Fill 4 (HF4) (12+050 to 12+300)**

Six (6) high fill boreholes (HF4-01 to HF4-06) were advanced along the proposed alignment between Station 12+050 and 12+300. The boreholes were advanced to depths ranging from 7.7 to 11.3 m (Elev. 271.5 to 250.7 m). The locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing 4 included in Appendix A. The Record of Borehole Sheets are included in Appendix D1.

The soil conditions typically consist of topsoil overlying sand and gravel to gravelly sand. Occasional sand layers were encountered within the sand and gravel to gravelly sand in some boreholes.

#### **5.3.1 Topsoil**

A 225 mm thick topsoil layer was encountered at the ground surface in Borehole HF4-01. Topsoil was not noted in the other HF4 boreholes, where site access and tree clearing work had been done along the proposed highway centreline. However, some organics were noted in the upper part of the surficial soils in Boreholes HF4-02 and HF4-04. The topsoil thickness may vary between and beyond the boreholes.

#### **5.3.2 Sand and Gravel to Gravelly Sand**

A thick deposit of sand and gravel ranging to gravelly sand was encountered throughout the site below the topsoil in Borehole HF4-01 at a depth of 0.2 m and at the ground surface in Boreholes HF4-02 to HF4-06. The sand and gravel to gravelly sand was brown and contained trace silt and occasional cobbles. Organics were also occasionally present within the upper 1.5 m of the deposit.

Where fully penetrated, the deposit ranged in thickness and depth from 10.2 m (Elev. 255.6 m) in Borehole HF4-03, which was underlain by sand, and from 7.7 to 8.3 m (Elev. 271.5 to 261.1 m) in Boreholes HF4-04 and HF4-06, which were terminated upon auger refusal at the suspected base of the deposit. Boreholes HF4-01, HF4-02 and HF4-05 were terminated within the sand and gravel to gravelly sand deposit at depths from 10.8 to 11.3 m (Elev. 260.2 to 250.7 m).

SPT 'N' values recorded in the sand and gravel to gravelly sand ranged from 11 to greater than 100 blows per 0.3 m penetration, indicating that the deposit ranges from compact to very dense. Natural moisture contents ranged from 1 to 18%.

The results of grain size analyses conducted on samples of the sand and gravel to gravelly sand

are provided on the Record of Borehole sheets in Appendix D1 and illustrated on Figures D1 and D2 of Appendix D2. The results are summarized as follows:

Soil Particle	Percentage (%)	
	Gravelly Sand	Sand and Gravel
Gravel	27 to 37	44 to 58
Sand	56 to 66	33 to 49
Silt and Clay	6 to 7	5 to 9

### 5.3.3 Sand

Localized layers of sand containing trace silt, trace to some gravel and occasional cobbles were encountered in Boreholes HF4-02, HF4-03, and HF4-04 within or below the sand and gravel gravelly sand deposit. The sand layers were encountered at depths ranging from 1.5 to 10.2 m (Elev. 262.3 to 255.6 m). Where fully penetrated, the measured thickness of the sand ranged from 1.4 to 1.5 m and the base was encountered at depths from 3.0 to 5.6 m (Elev. 263.8 to 260.8 m). Borehole HF4-03 was terminated within a sand layer at a depth of 11.3 m (Elev. 254.5 m).

SPT 'N' values recorded in the sand ranged from 10 to 87 blows per 0.3 m penetration, indicating a compact to very dense relative density. Natural moisture contents ranged from 3 to 9%.

### 5.3.4 Silt and Sand

A localized layer of silt and sand was encountered in Borehole HF4-02 at 3.0 m depth (Elev. 260.8 m) below a sand layer and within the sand and gravel to gravelly sand deposit. The silt and sand was 1.1 m thick and extended to a depth of 4.1 m (Elev. 259.7 m).

One SPT 'N' value of 4 blows per 0.3 m penetration was recorded in the silt and sand, indicating a loose relative density. The measured natural moisture content was 25%.

The results of a grain size analyses conducted on a sample of the silt and sand are provided on the Record of Borehole sheets in Appendix D1 and illustrated on Figure D3 of Appendix D2. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	0
Sand	37
Silt	60
Clay	3

### 5.3.5 Groundwater Conditions

A standpipe Piezometer was installed Borehole HF4-02 upon completion of drilling. The groundwater levels measured in the piezometer are summarized in Table 5.3 below.

**Table 5.3: HF4-02 Groundwater Measurements**

Borehole	Piezometer (m)				Date	Water Level (m)	
	Top of Screen Depth	Top of Screen Elevation	Bottom of Screen Depth	Bottom of Screen Elevation		Depth	Elevation
HF4-02	7.6	256.2	10.7	253.1	March 6, 2024	Dry	-
					March 11, 2024	7.3	256.5
					March 18, 2024	Dry	-
					April 8, 2024	Dry	-
					April 19, 2024	Dry	-

Considering that the piezometer was dry on most measurements, it is likely that the measurement recorded on March 11, 2024 does not represent the stabilized groundwater level, which is anticipated to be deeper than the boreholes advanced at the HF4 site. Seasonal fluctuations of the groundwater levels are to be expected. The groundwater level may be at a higher elevation after periods of significant or prolonged precipitation.

#### 5.4 Deep Cut 1 (DC1) (Sta. 12+375 to 12+650)

Seven (7) boreholes (DC1-01 to DC1-07) were advanced along the proposed alignment deep cut section between Stations 12+375 to 12+650. The boreholes were drilled to depths from 9.4 to 17.4 m (Elev. 296.5 to 280.0 m). The locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing 5 included in Appendix A. The Record of Borehole Sheets are included in Appendix E1.

In the boreholes drilled on the existing highway, the soil conditions encountered generally consist of granular fill materials overlying native organics or native sand. The native soils throughout the site typically consisted of deposits of sand, sand and gravel to gravelly sand, and silty sand to sandy silt. Granodiorite to granite bedrock was encountered below the overburden materials in Boreholes DC1-05 and DC1-06.

##### 5.4.1 Asphalt

Boreholes DC1-05 to DC1-07 were drilled on the existing shoulders of Highway 17, where an asphalt layer of 50 to 100 mm thick was encountered at the ground surface.

##### 5.4.2 Embankment Fill

Embankment fill consisting of gravelly sand to sand and gravel with trace silt and occasional cobbles was encountered immediately below asphalt in Boreholes DC1-05 to DC1-07. A layer of silty sand fill with trace organics and clay was also encountered at the ground surface in Borehole DC1-04, which was drilled at an MTO driveway near the existing highway. The silty sand fill extended to a depth of 0.7 m (Elev. 305.3 m) and was underlain by sand and gravel fill.

The gravelly sand to sand and gravel fill was encountered below the asphalt and below the silty

sand fill. The layer ranged in thickness from 2.3 to 4.5 m and was penetrated at depths ranging from 3.0 to 4.6 m (Elev. 304.0 to 303.0 m).

SPT 'N' values recorded in the embankment fill ranged from 15 to greater than 100 blows per 0.3 m penetration, indicating a compact to very dense relative density. Natural moisture contents ranged from 2 to 25% in the gravelly sand to sand and gravel fill and from 22 to 31% in the silty sand fill.

The results of grain size analyses conducted on samples of the gravelly sand to sand and gravel fill are provided on the Record of Borehole sheets in Appendix E1 and illustrated on Figure of Appendix E2. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	33 to 48
Sand	49 to 56
Silt and Clay	3 to 11

#### 5.4.3 Organics

A layer of sandy organics with trace silt and wood was observed at the ground surface in Borehole DC1-03, which extended to 0.7 m depth (Elev. 305.8 m). A 0.9 m thick buried organic layer with some sand and trace silt was also observed below the fill materials in Borehole DC1-06 at 3.2 m depth (Elev. 303.8 m), which extended to 4.1 m (Elev. 302.9 m).

SPT 'N' values recorded in the organics to sandy organics ranged from 7 to 77 blows per 0.3 m penetration, indicating a loose to very dense relative density. The N value of 77 in the surficial organics is likely attributed to the presence of wood encountered in the sample. Natural moisture contents of the organics ranged from 23 to 114%.

#### 5.4.4 Sand

Sand was encountered throughout all of the DC1 boreholes except for DC1-01. The native sand was below the overlying fill, organics or surficial sand and gravel noted at Borehole DC1-02. The sand was brown and contained trace to some gravel and trace to some silt. Some organics were observed in the sand in Borehole DC1-07 below the fill materials. Occasional cobbles and boulders were also noted in the sand during drilling.

The top of the sand deposit was encountered at depths from 0.7 to 4.6 m (Elev. 305.8 to 302.9 m). Interstitial layers of sand and gravel to gravelly sand and silty sand to sandy silt were encountered within the deposit. Where fully penetrated, the overall thickness of the sand deposit ranged from 1.5 to 10.1 m and extended to depths between 5.6 m and 13.1 m (Elev. 301.4 to 293.9 m). Boreholes DC1-02 and DC1-04 were terminated within the sand layer at depths of 12.6 to 17.4 m (Elev. 293.4 to 285.6 m).

SPT 'N' values from 7 to greater than 100 blows per 0.3 m penetration were recorded in the sand, indicating that the relative density ranges from loose to very dense, typically compact to dense. Natural moisture contents of the sand ranged from 2 to 28%.

The results of grain size analyses conducted on samples of the sand are provided on the Record of Borehole sheets in Appendix E1 and illustrated on Figure E2 of Appendix E2. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	0 to 14
Sand	81 to 88
Silt	12 to 18
Clay	1 to 2
Silt and Clay	5 to 15

#### 5.4.5 Sand and Gravel to Gravelly Sand

Sand and gravel to gravelly sand was encountered in Boreholes DC1-01, DC1-02, DC1-06, and DC1-07. The deposit was encountered at the ground surface in DC1-01 and DC1-02, below the sand in DC1-06 at a depth of 5.6 m (Elev. 301.4 m), and within the larger sand deposit at depths of 8.7 m and 5.6 m (Elev. 302.2 and 294.3 m), in DC1-02 and DC1-07 respectively.

Where fully penetrated, the sand and gravel to gravelly sand ranged in thickness from 1.6 to 6.1 m, with the base ranging from 7.2 to 14.8 m depth (Elev. 300.6 to 288.2 m), except for a 0.7 m thick surficial layer in Borehole DC1-02. The deposit was thicker at Borehole DC1-01, which was terminated within the sand and gravel at a depth of 9.4 m (Elev. 280.0 m).

SPT 'N' values recorded in the sand and gravel to gravelly sand ranged from 7 to greater than 100 blows per 0.3 m of penetration, indicating that the relative density ranges from loose to very dense, typically compact to very dense. Natural moisture contents of the sand and gravel to gravelly sand ranged from 2 to 22%.

The results of grain size analyses conducted on samples of the deposit are provided on the Record of Borehole sheets in Appendix E1, and illustrated on Figure E3 of Appendix E2. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	36 to 52
Sand	45 to 54
Silt and Clay	3 to 13

#### 5.4.6 Silty Sand to Sandy Silt

A layer of silty sand to sandy silt, containing trace clay, trace to some gravel, and occasional cobbles was encountered within or below the native sand or underlying the sand and gravel in

Boreholes DC1-03 to DC1-07. The silty sand to sandy silt deposit was encountered at depths ranging from 7.6 m to 10.7 m (Elev. 299.4 to 296.5 m) and extended to depths of 10.2 to 16.0 (Elev 296.8 to 290.5 m). Where fully penetrated, the layer thickness ranged from 1.5 m to 6.0 m. Borehole DC1-07 was terminated within the sand silt at a depth of 11.3 m (Elev. 296.5 m). Borehole DC1-03, was terminated upon auger refusal at the base of the silty sand layer at a depth of 16.0 m (Elev. 290.5 m).

SPT 'N' values recorded in the silty sand to sandy silt ranged from 6 to greater than 100 blows per 0.3 m penetration, indicating a loose to very dense relative density. Natural moisture contents ranged from 9 to 25%.

The results of grain size analyses conducted on samples of the silty sand to sandy silt are provided on the Record of Borehole sheets in Appendix E1, and illustrated on Figure E4 of Appendix E2. The results are summarized as follows:

<b>Soil Particle</b>	<b>Percentage (%)</b>
Gravel	0 to 15
Sand	58 to 83
Silt	15 to 26
Clay	1 to 3

#### 5.4.7 Bedrock

Bedrock was encountered underlying the overburden soils at depths from 10.7 to 13.1 m (Elev. 296.3 to 293.9 m) in Boreholes DC1-05 and DC1-06.

The bedrock was described as slightly weathered to fresh and was visually identified as grey granodiorite in DC1-05, and as red to grey granodiorite to granite in DC1-06. The bedrock was proven by coring 3.5 m into the rock in each borehole.

The Fracture Index (FI), measured as the total number of fractures per 0.3 m of rock core length, was typically between 1 and 6 fractures. Total Core Recovery (TCR) values measured on recovered bedrock samples was 100%. Solid Core Recovery (SCR) values ranged from 29 to 100% (average of 65%). Rock Quality Designation (RQD) values varied from 0 to 76% indicating a range from poor to fair (average of 51%).

Estimated rock strength values were interpreted from Point Load Tests conducted on the rock cores. The average uniaxial compressive strength (UCS) values per core run from the point load tests ranged from 11 to 205 MPa, typically between 96 and 205, indicating that the bedrock is locally weak but typically medium strong to extremely strong. Photographs of the rock core samples and the results of the point load tests are presented in Appendix F.

#### 5.4.8 Groundwater Conditions

A standpipe piezometer was installed in Borehole DC1-04 to monitor the groundwater level. The measured groundwater levels are summarized in Table 5.4 below.

**Table 5.4: DC1-04 Groundwater Measurements**

Borehole	Piezometer (m)				Date	Water Level (m)	
	Top of Screen Depth	Top of Screen Elevation	Bottom of Screen Depth	Bottom of Screen Elevation		Depth	Elevation
DC1-04	9.5	296.5	12.6	293.4	March 2, 2024	3.4	302.6
					March 3, 2024	10.6	295.4
					March 4, 2024	9.88	296.1
					March 11, 2024	10.25	295.7
					March 14, 2024	10.25	295.7
					March 17, 2024	9.3	296.7
					March 18, 2024	9.78	296.2

Seasonal fluctuations of the groundwater levels are to be expected. The groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation.

## 6. CORROSIVITY AND SULPHATE TEST RESULTS

Four soil and two surface water samples collected from near the proposed culvert locations at HF1 and HF3 were submitted for analytical testing of corrosivity parameters and sulphate. The results of the analytical tests are summarized in Table 6.1 below and presented in Appendix G.

**Table 6.1 Corrosivity Test Results**

Parameter	Units (Soil)	Units (Water)	HF1-01 SS3 (5' - 7')	HF1-04 SS4 (7.5' - 9.5')	HF1	HF3-02 SS5 (10' - 12')	HF3-03 SS11 (40' - 40'9")	HF3
			Gravelly Sand 1.5 - 2.1 m	Gravelly Sand, 2.3 - 2.9 m	Water	Sand and Gravel, 3.0 - 3.7 m	Sandy Silt, 12.2 - 12.4 m	Water
Chloride	µg/g	mg/L	27	6.1	0.37	10	11	38
Sulfate	µg/g	mg/L	3	2.1	1.6	2.1	1	4.0
Sulfide	%	µg/L	< 0.01	< 0.01	<6	< 0.01	< 0.01	<6

Parameter	Units (Soil)	Units (Water)	HF1-01 SS3 (5' - 7')	HF1-04 SS4 (7.5' - 9.5')	HF1	HF3-02 SS5 (10' - 12')	HF3-03 SS11 (40' - 40'9")	HF3
			Gravelly Sand 1.5 - 2.1 m	Gravelly Sand, 2.3 - 2.9 m	Water	Sand and Gravel, 3.0 - 3.7 m	Sandy Silt, 12.2 - 12.4 m	Water
Electrical Conductivity	µS/cm	µS/cm	88	36	26	50	178	194
pH	-	-	6.05	6.32	6.8	7.13	8.78	7.78
Redox Potential	mV	mV	295	278	226	284	304	192
Resistivity*	ohm.cm	ohm.cm	11400*	27800*	38500*	20000*	5620*	5150*

\* Calculated based on conductivity result

## 7. CLOSURE

The field investigation was supervised on a full-time basis by Mr. Matthew Macaskill, E.I.T. of Thurber. Overall supervision of the field program was provided by Ms. Rachel Bourassa, E.I.T.

Interpretation of the field data and report preparation was carried out by Ms. Rachel Bourassa, E.I.T., and Mr. Mark Farrant, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a designated principal contact for MTO Foundations Projects.

Thurber Engineering Ltd.



Rachel Bourassa, E.I.T.  
Geotechnical Engineering Intern



Mark Farrant, P.Eng.  
Associate, Senior Geotechnical Engineer



P.K. Chatterji, P.Eng.  
Principal, Designated MTO Contact

Date: October 22, 2024  
File: 37996



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This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

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### 5. INTERPRETATION OF THE REPORT

- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
- c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.
- d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

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The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.



## **APPENDIX A**

Stratigraphic Plan and Profile Drawings

METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT No  
GWP No 6333-14-00



HIGHWAY 17  
CURVE REALIGNMENT  
OVERALL KEYPLAN  
SITE PLAN

SHEET



KEYPLAN

LEGEND

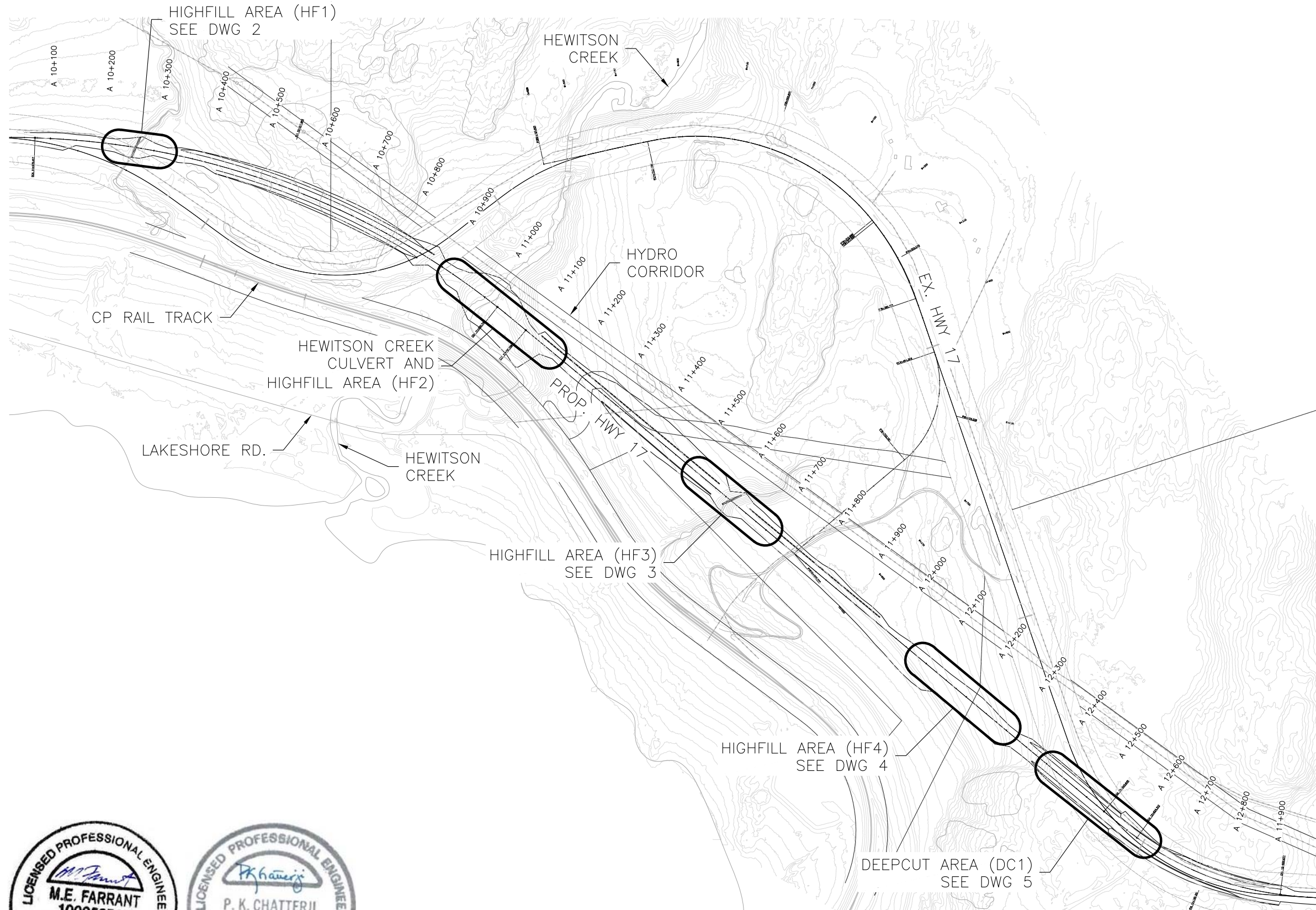
- Borehole
- Borehole and Cone
- Blows /0.3m (Std Pen Test, 475J/blow)
- Blows /0.3m (60' Cone, 475J/blow)
- Pressure, Hydraulic
- Water Level Upon Completion of Drilling
- Water Level in Monitoring Well/Piezometer
- Monitoring Well/Piezometer Screen
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING

-NOTES-

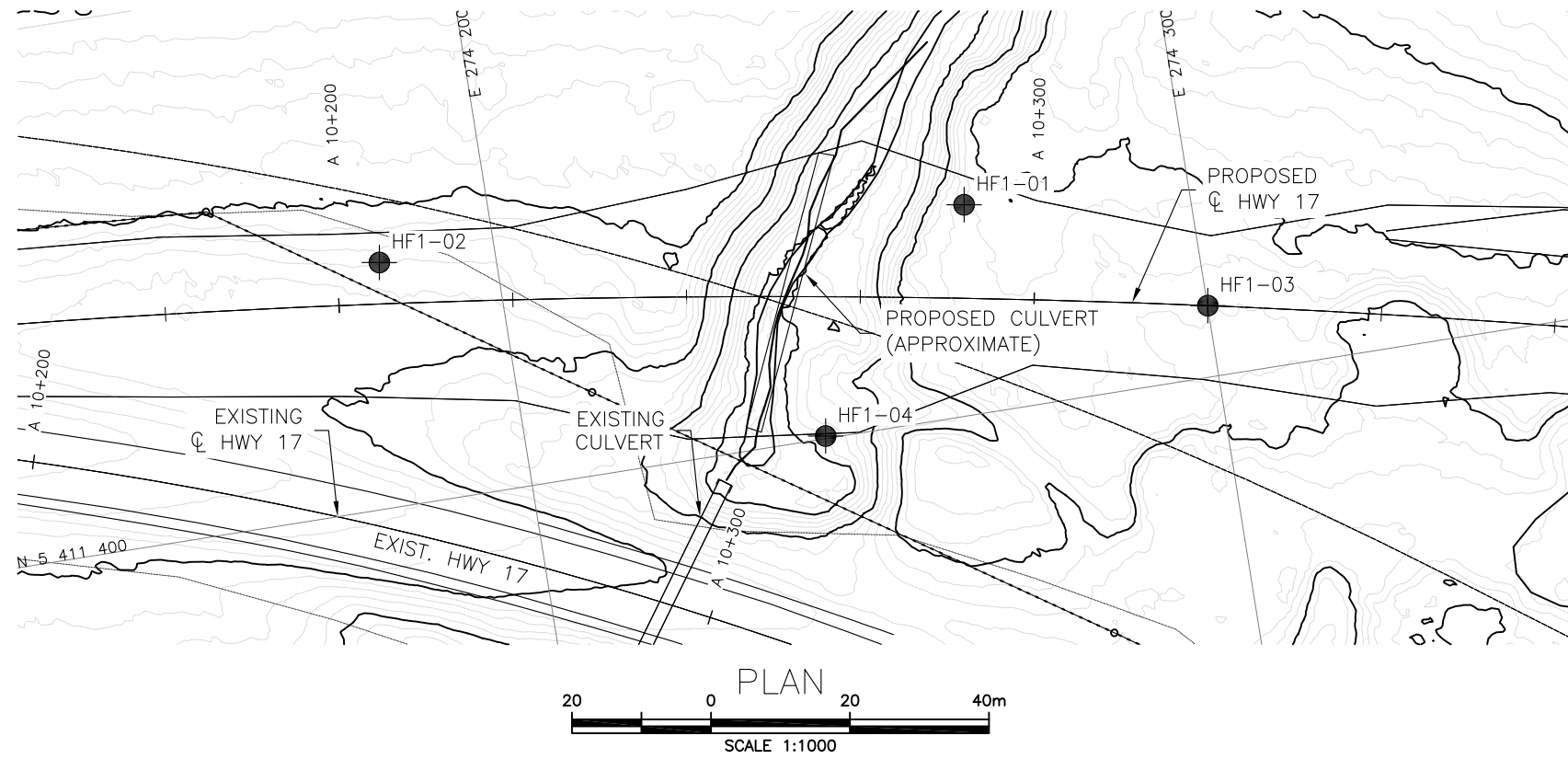
- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- 3) Coordinate system is MTM NAD 83 Zone 14.

GEOCRES No. 42D14-001



REVISIONS	DATE	BY	DESCRIPTION

DESIGN	CHK	MEF	CODE	LOAD	DATE	OCT 2024
DRAWN	AN	CHK	RB	SITE	STRUCT	DWG 1



**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER

*M.E. Farrant*

**M.E. FARRANT**  
100053767

October 22, 2024

PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER

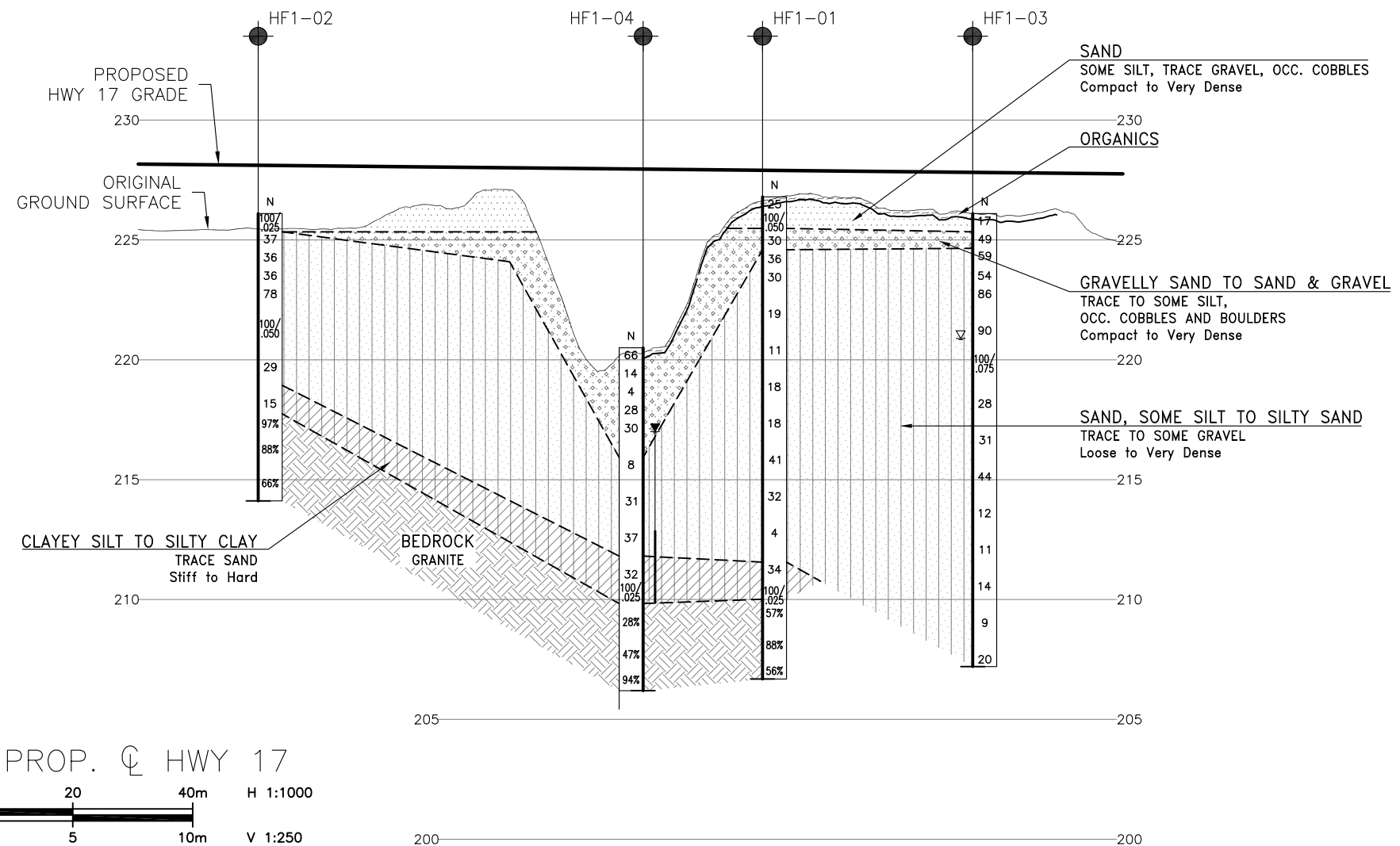
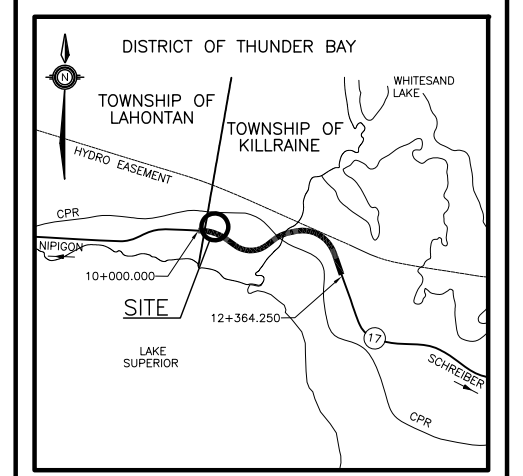
*P.K. Chatterji*

**P. K. CHATTERJI**

October 22, 2024

PROVINCE OF ONTARIO

CONT No GWP No 6333-14-00	
HIGHWAY 17 CURVE REALIGNMENT HIGH FILL AREA 1 BOREHOLE LOCATIONS AND SOIL STRATA	<b>SHEET</b>



**LEGEND**

●	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60' Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level Upon Completion of Drilling
▽	Water Level in Monitoring Well/Piezometer
	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
HF1-01	226.8	5 411 430.1	274 267.7
HF1-02	226.1	5 411 435.1	274 183.4
HF1-03	226.1	5 411 410.2	274 300.0
HF1-04	220.5	5 411 400.4	274 242.8

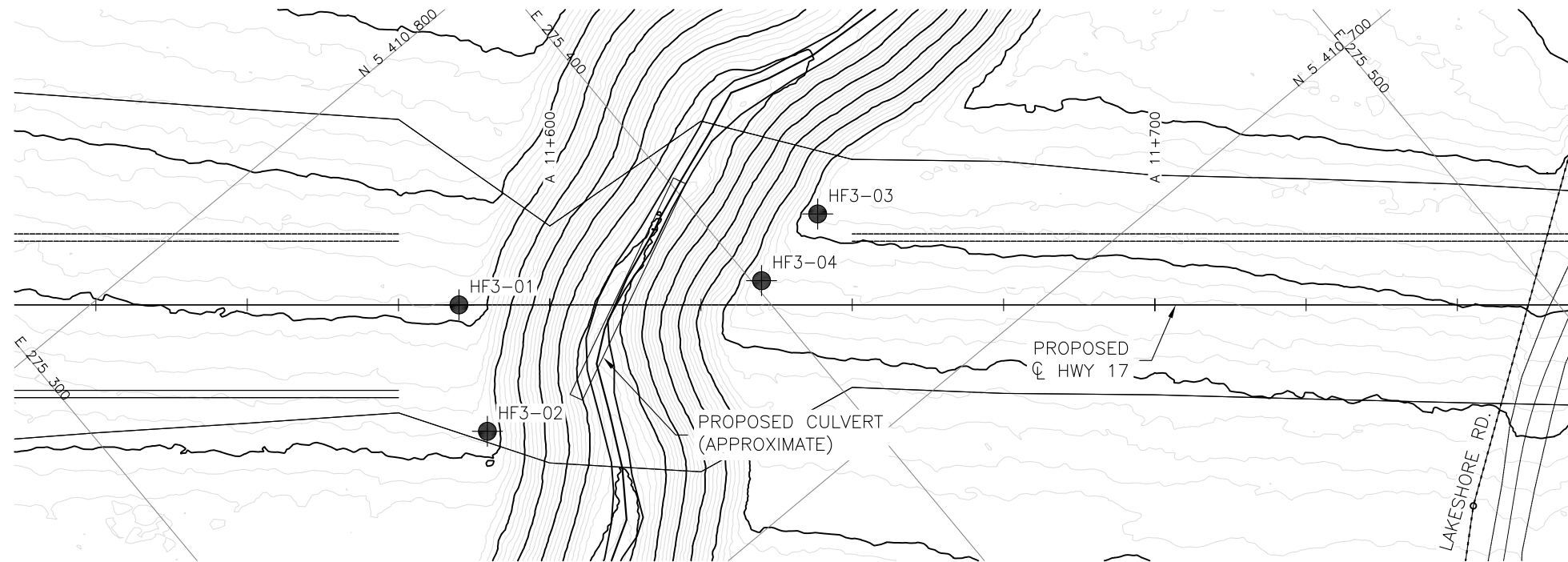
- NOTES-**
- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
  - 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
  - 3) Coordinate system is MTM NAD 83 Zone 14.

**GEOCREs No. 42D14-001**

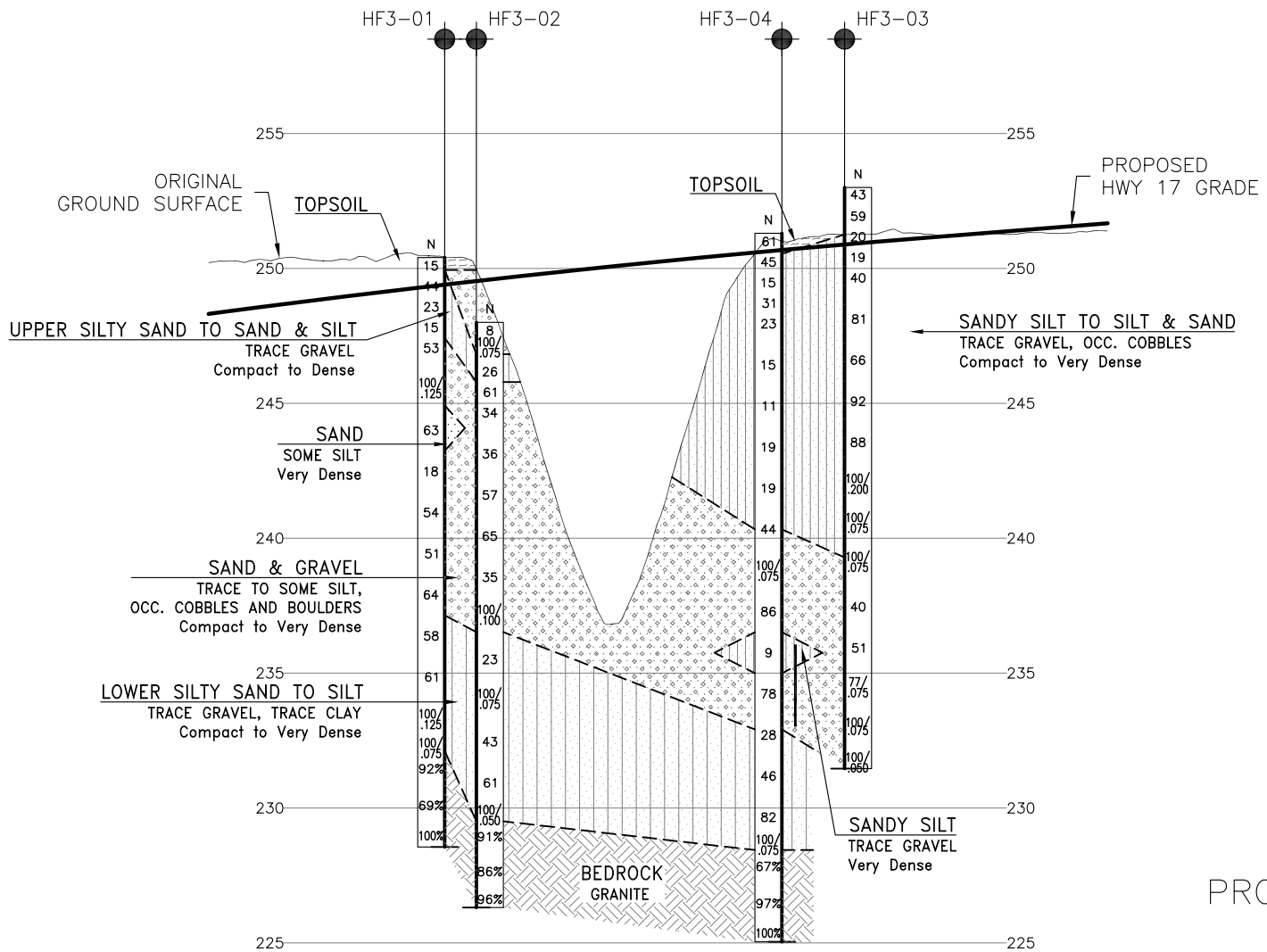
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DESIGN	RB	CHK	MEF	CODE	LOAD	DATE	OCT 2024
DRAWN	AN	CHK	RB	SITE	STRUCT	DWG	2

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN  
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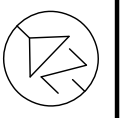


PROFILE ALONG PROP. CL HWY 17

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V 1:250

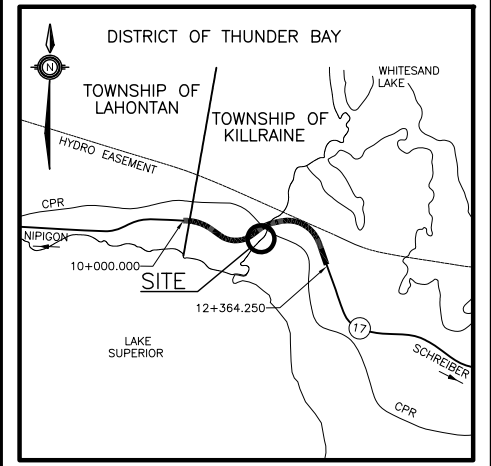
METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT No  
GWP No 6333-14-00



HIGHWAY 17  
CURVE REALIGNMENT  
HIGHFILL AREA 3  
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEYPLAN

LEGEND

- Borehole
- Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60' Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level Upon Completion of Drilling
- Water Level in Monitoring Well/Piezometer
- Monitoring Well/Piezometer Screen
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
HF3-01	250.4	5 410 761.0	275 360.3
HF3-02	248.0	5 410 741.9	275 350.6
HF3-03	253.0	5 410 734.6	275 415.5
HF3-04	251.3	5 410 732.1	275 401.3

-NOTES-

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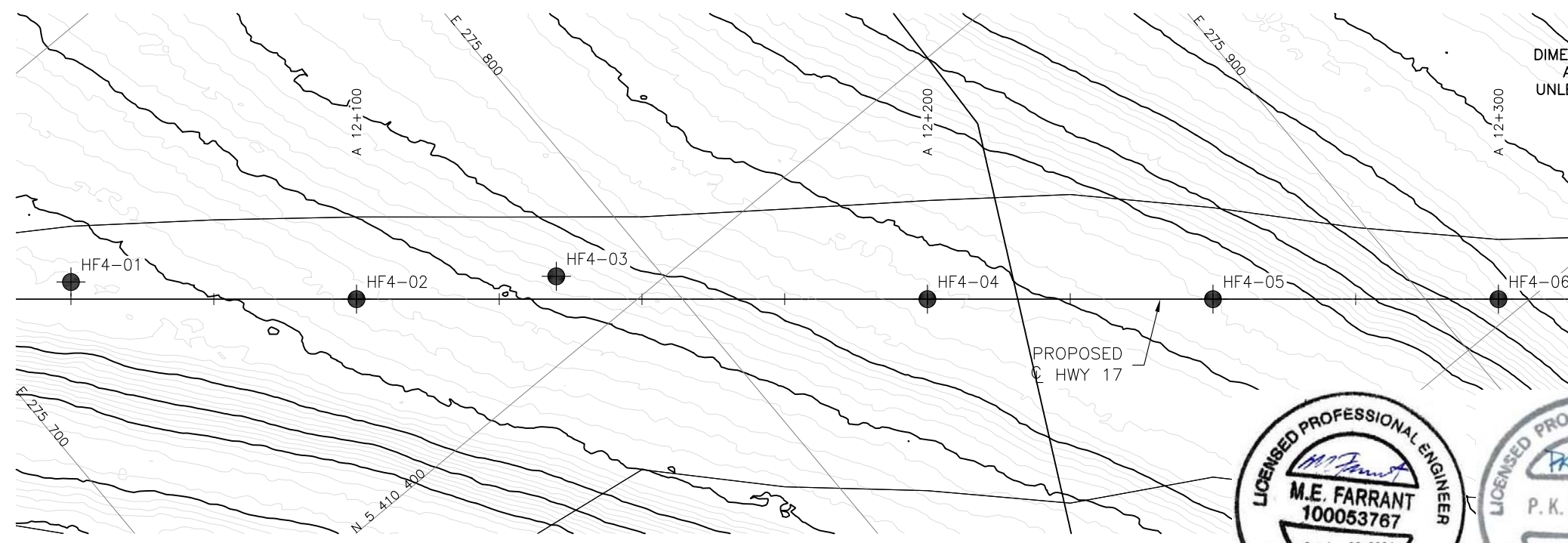
GEOCREs No. 42D14-001



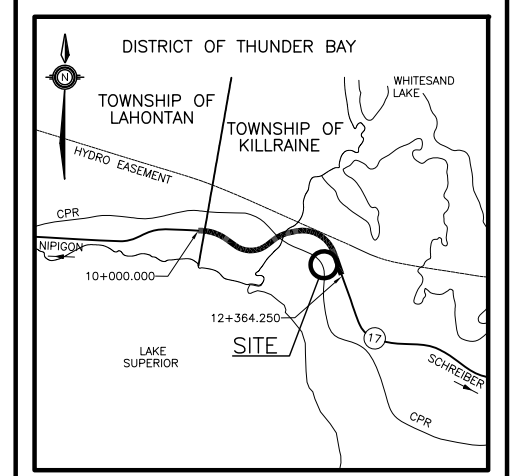
REVISIONS	DATE	BY	DESCRIPTION

DESIGN	CHK	MEF	CODE	LOAD	DATE	OCT 2024

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CONT No GWP No 6333-14-00	SHEET
HIGHWAY 17 CURVE REALIGNMENT HIGHFILL AREA 4 BOREHOLE LOCATIONS AND SOIL STRATA	



KEYPLAN

LEGEND

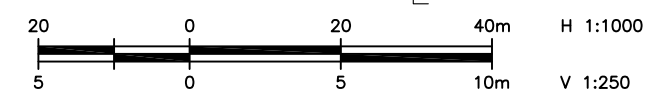
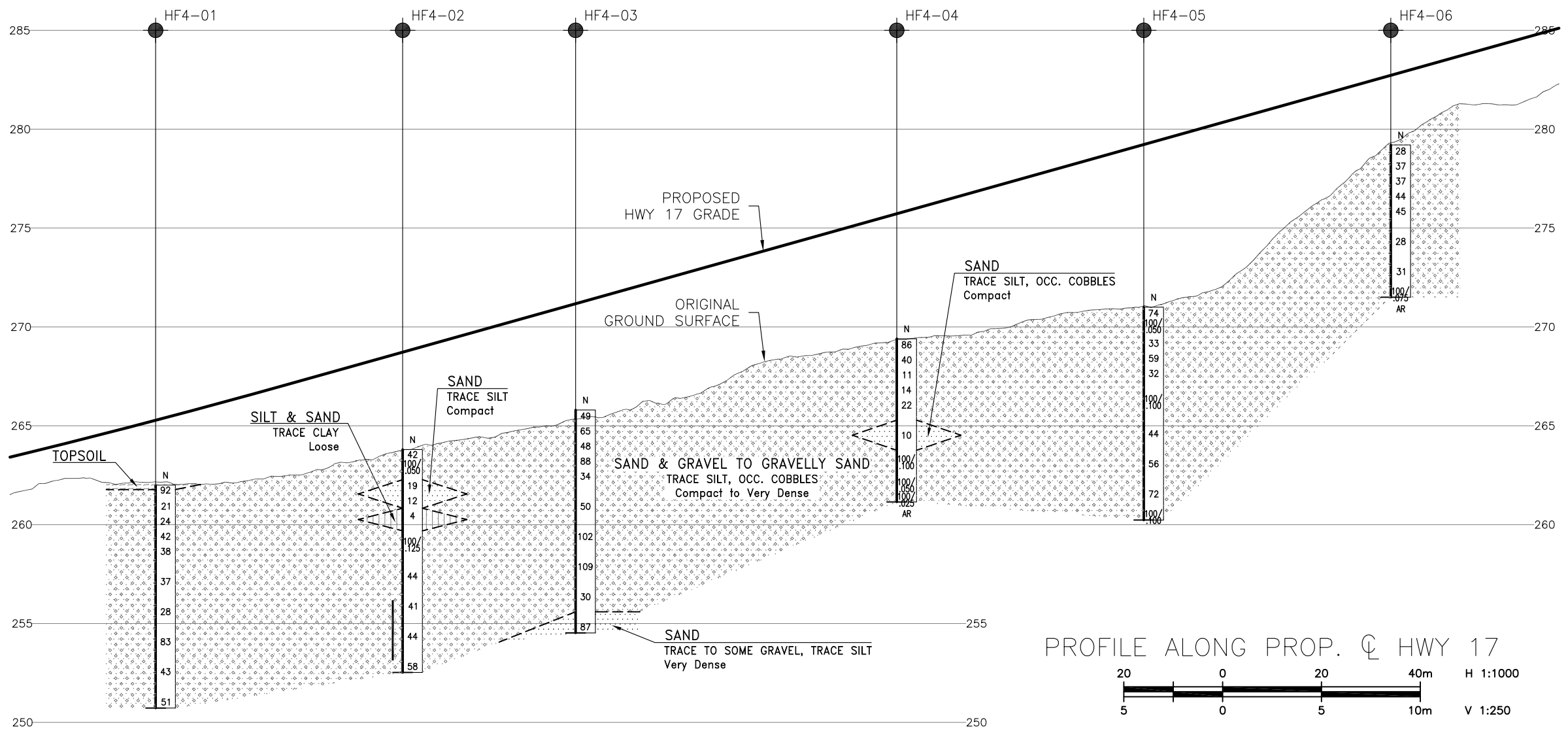
●	Borehole
⊙	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60' Cone, 475J/blow)
PH	Pressure, Hydraulic
∇	Water Level Upon Completion of Drilling
▽	Water Level in Monitoring Well/Piezometer
⊥	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
HF4-01	262.0	5 410 465.8	275 719.6
HF4-02	263.8	5 410 431.5	275 756.1
HF4-03	265.8	5 410 412.2	275 785.6
HF4-04	269.4	5 410 367.5	275 833.0
HF4-05	271.0	5 410 335.5	275 871.4
HF4-06	279.2	5 410 303.5	275 909.8

-NOTES-

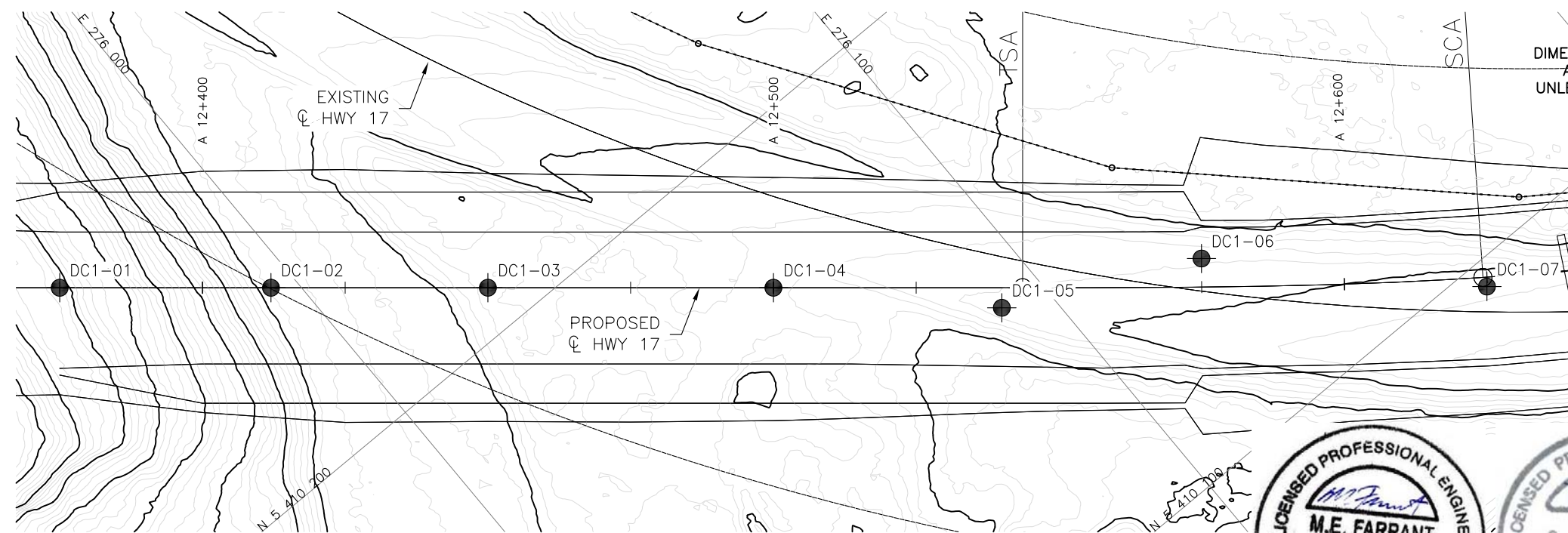
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GEOCRES No. 42D14-001



REVISIONS	DATE	BY	DESCRIPTION

DESIGN	RB	CHK	MEF	CODE	LOAD	DATE	OCT 2024
DRAWN	AN	CHK	RB	SITE	STRUCT	DWG	4



**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN



CONT No  
GWP No 6333-14-00

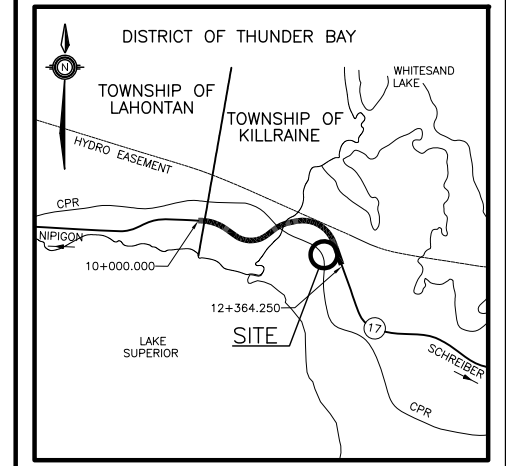


HIGHWAY 17  
CURVE REALIGNMENT  
DEEP CUT AREA 1  
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

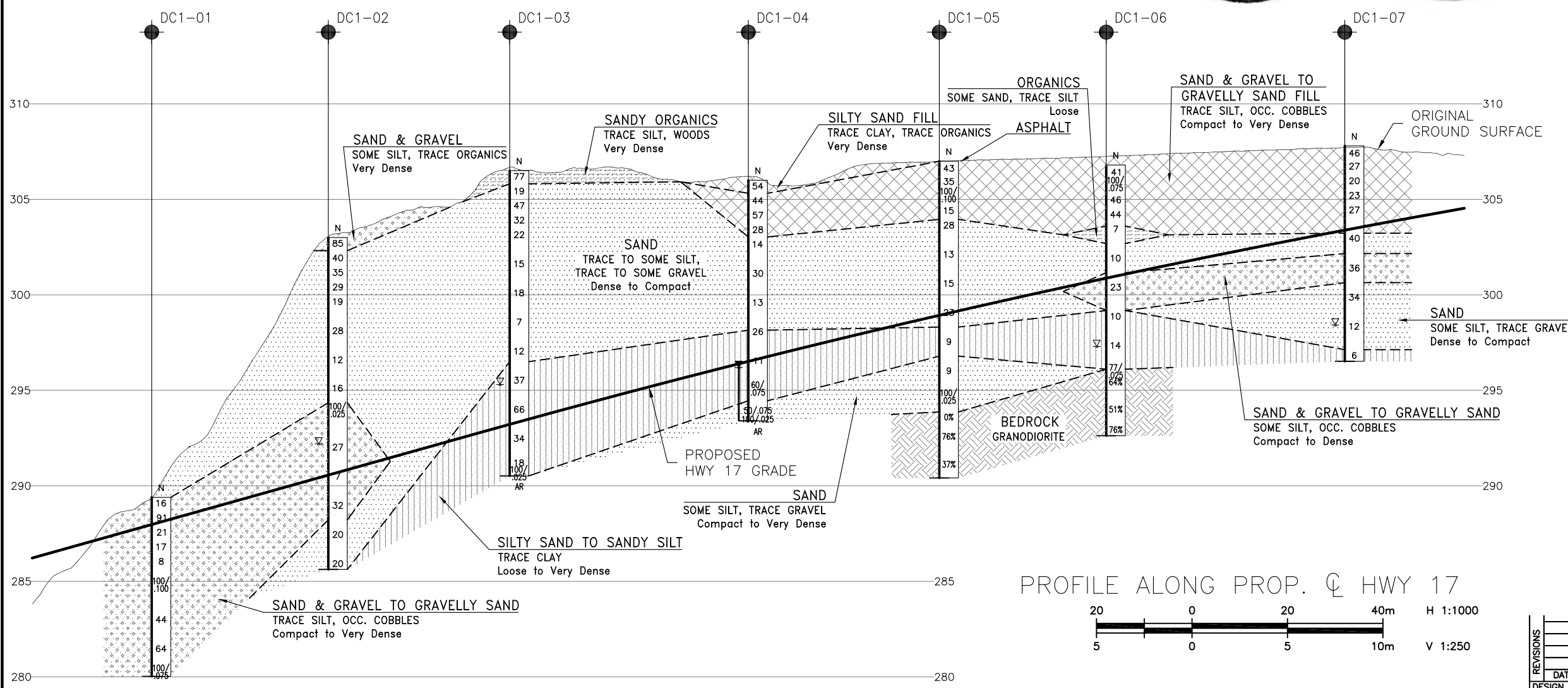
- Borehole
- ⊙ Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60' Cone, 475J/blow)
- PH Pressure, Hydraulic
- ▽ Water Level Upon Completion of Drilling
- ▽ Water Level in Monitoring Well/Piezometer
- ⊥ Monitoring Well/Piezometer Screen
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
DC1-01	289.4	5 410 255.5	275 967.5
DC1-02	303.0	5 410 231.9	275 995.9
DC1-03	306.5	5 410 207.5	276 025.1
DC1-04	306.0	5 410 175.6	276 063.5
DC1-05	307.0	5 410 147.3	276 092.0
DC1-06	306.8	5 410 131.5	276 124.4
DC1-07	307.8	5 410 095.7	276 159.7

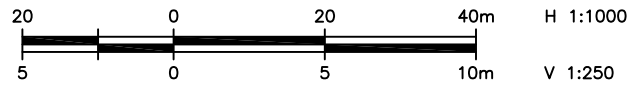
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GEOCREs No. 42D14-001



PROFILE ALONG PROP. CL HWY 17



REVISIONS	DATE	BY	DESCRIPTION

DESIGN	CHK	MEF	CODE	LOAD	DATE
RB	AN				OCT 2024

DRAWN	CHK	R/S	SITE	STRUCT	DWG
AN					5



## **APPENDIX B**

B1: High Fill 1 Record of Borehole Sheets

# SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

## 1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

## 2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

## 3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT <sup>(1)</sup> 'N' VALUE
Very Soft	12 or less	Less than 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	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer


## 4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

## 5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$


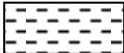



 Water Level  
 $C_{pen}$  Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ( $W_L < 30\%$ ).
		CI	Inorganic clays of medium plasticity, silty clays. ( $30\% < W_L < 50\%$ ).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS	Pt	Peat and other highly organic soils.	
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

## EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>			
<b>Fresh (FR)</b>	No visible signs of weathering.				
<b>Fresh Jointed (FJ)</b>	Weathering limited to the surface of major discontinuities.		CLAYSTONE		
<b>Slightly Weathered (SW)</b>	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE		
<b>Moderately Weathered (MW)</b>	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE		
<b>Highly Weathered (HW)</b>	Weathering extends throughout the rock mass and the rock is partly friable.		COAL		
<b>Completely Weathered (CW)</b>	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)		
<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
<u>TERMS</u>					
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

### RECORD OF BOREHOLE No HF1-01

1 OF 3

METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 411 430.1 E 274 267.7 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.16 - 2024.03.17 LATITUDE 48.840561 LONGITUDE -87.416171 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								W P
226.8	GROUND SURFACE															
0.0	ORGANICS: (150mm)															
0.2	SAND, some silt, trace gravel, occasional cobbles Compact to Very Dense Brown Moist		1	SS	25		226									2 77 19 2
225.4	Gravelly SAND, trace silt Dense Brown Dry to Moist		2	SS	100/ 0.050		225									
1.3	Gravelly SAND, trace silt Dense Brown Dry to Moist		3	SS	30		224									
224.5	Silty SAND, trace gravel, occasional cobbles Compact to Dense Brown to Grey Moist		4	SS	36		223									
2.2	Silty SAND, trace gravel, occasional cobbles Compact to Dense Brown to Grey Moist		5	SS	30		222									8 66 24 2
			6	SS	19		221									
			7	SS	11		220									
			8	SS	18		219									
			9	SS	18		218									
							217									

ONTMT4S2\_2020LIBRARY(MTO).GLB\_MTO-37996.GPJ\_7/25/24

Continued Next Page

+<sup>3</sup>, x<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE



### RECORD OF BOREHOLE No HF1-01

3 OF 3

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 411 430.1 E 274 267.7 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.16 - 2024.03.17 LATITUDE 48.840561 LONGITUDE -87.416171 CHECKED BY RB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
206.6	Continued From Previous Page	<input checked="" type="checkbox"/>														
20.1	END OF BOREHOLE AT 20.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.															

ONTMT452\_2020LIBRARY(MTO).GLB\_MTO-37996.GPJ\_7/25/24

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20  
15  
10 (%) STRAIN AT FAILURE

### RECORD OF BOREHOLE No HF1-02

1 OF 2

METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 411 435.2 E 274 183.4 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.18 - 2024.03.18 LATITUDE 48.840522 LONGITUDE -87.417134 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE WATER CONTENT (%) 20 40 60								
226.1	GROUND SURFACE													
0.0	Gravelly SAND, trace silt, occasional boulders Very Dense Brown Dry to Moist		1	SS	100/ 0.025									
225.3														
0.8	SAND, some silt, trace gravel, occasional cobbles Dense Brown Moist		2	SS	37									
			3	SS	36									
			4	SS	36									
223.1														
3.0	SAND, some silt to silty, trace gravel Very Dense to Compact Grey Moist		5	SS	78									
			6	SS	100/ 0.050									
			7	SS	29									
218.9														
7.2	Silty CLAY, trace sand Stiff Grey Moist (Cl)		8	SS	15									
217.7														
8.4	BEDROCK: (GRANITE), slightly weathered to fresh, red, very strong		1	RUN										
			2	RUN										

ONTMT452, 2020LIBRARY(MTO),GLB MTO-37996.GPJ 7/25/24

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

### RECORD OF BOREHOLE No HF1-02

2 OF 2

METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 411 435.2 E 274 183.4 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.18 - 2024.03.18 LATITUDE 48.840522 LONGITUDE -87.417134 CHECKED BY RB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)
	Continued From Previous Page						20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					20 40 60					
214.1			3	RUN		216											
						215											RUN #3 TCR=100% SCR=76% RQD=66% UCS=225MPa (Point Load Ave.)
12.0	END OF BOREHOLE AT 12.0m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.																

ONTMT452\_2020LIBRARY(MTO).GLB\_MTO-37996.GPJ\_7/25/24

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20  
15  
10 (%) STRAIN AT FAILURE



### RECORD OF BOREHOLE No HF1-03

2 OF 2

METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 411 410.2 E 274 300.0 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.17 - 2024.03.17 LATITUDE 48.840304 LONGITUDE -87.415542 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa 20 40 60 80 100							
214.4	Continued From Previous Page Silty SAND, trace gravel, occasional cobbles Dense Brown Wet		10	SS	44		216								
11.7	SAND, some silt Compact Brown Wet		11	SS*	12		214								
			12	SS*	11		212								
			13	SS*	14		211								0 87 12 1
			14	SS*	9		210								
208.3							209								
17.8	SAND and SILT Compact Grey Wet		15	SS	20		208								0 51 47 2
207.2															
18.9	END OF BOREHOLE AT 18.9m. WATER LEVEL AT 5.2m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.  * 3 Inch Spoon used														

ONT/MT/452, 2020/LIBRARY(MTO), GLB, MTO-37996, GPJ, 7/25/24

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No HF1-04

1 OF 2

METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 411 400.4 E 274 242.8 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.16 - 2024.03.16 LATITUDE 48.840213 LONGITUDE -87.416321 CHECKED BY RB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa							WATER CONTENT (%)			
						20	40	60	80	100	20	40	60	GR	SA	SI	CL	
220.5	GROUND SURFACE																	
0.0	<b>ORGANICS</b> , trace gravel, trace silt		1	SS	66													
220.2	Brown Moist																	
0.3	Gravelly <b>SAND</b> to <b>SAND</b> and <b>GRAVEL</b> , trace silt Very Dense to Compact Brown Moist to Wet		2	SS	14													
			3	SS	4													
	Occasional cobbles		4	SS	28													
			5	SS	30													
215.9	<b>Sandy SILT</b> Loose Grey Wet		6	SS	8													
4.6																		
			7	SS	31													
	Dense																	
			8	SS	37													
211.8	<b>Silty CLAY</b> , trace sand Hard Brown Moist (CL)																	
8.7																		
211.2																		
9.3	<b>SILT</b> , some sand Dense Grey		9	SS	32													

ONTMT452 2020LIBRARY(MTO).GLB MTO-37996.GPJ 7/25/24

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No HF1-04**

2 OF 2

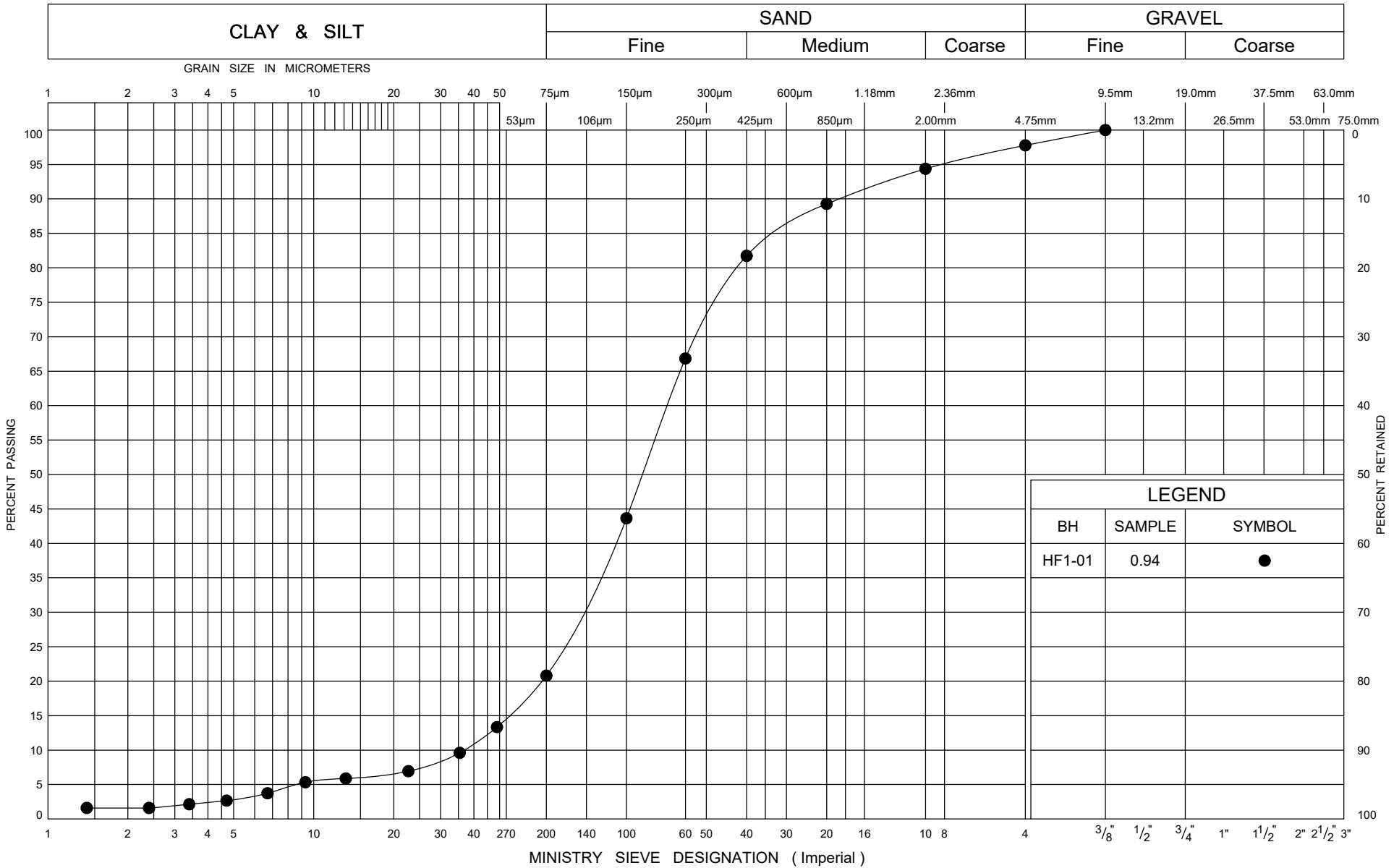
**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 411 400.4 E 274 242.8 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.16 - 2024.03.16 LATITUDE 48.840213 LONGITUDE -87.416321 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
	Continued From Previous Page							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
209.8	SILT, some sand Very Dense Grey Wet		SS		100%	0.025	210										FI	
10.7	BEDROCK: (GRANITE), slightly weathered to fresh, red, very strong		1	RUN			209										4	RUN #1 TCR=100% SCR=68% RQD=28% UCS=166MPa (Point Load Ave.)
			2	RUN			208										3	RUN #2 TCR=100% SCR=60% RQD=47% UCS=199MPa (Point Load Ave.)
			3	RUN			207										2	RUN #3 TCR=100% SCR=94% RQD=94% UCS=195MPa (Point Load Ave.)
206.2	END OF BOREHOLE AT 14.3m. Well installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.																	
14.3	WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2024.03.17 4.2 216.3 2024.03.18 4.2 216.3 2024.04.08 3.5 217.0 2024.04.19 3.5 217.0																	

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B2: High Fill 1 Geotechnical Laboratory Testing Results



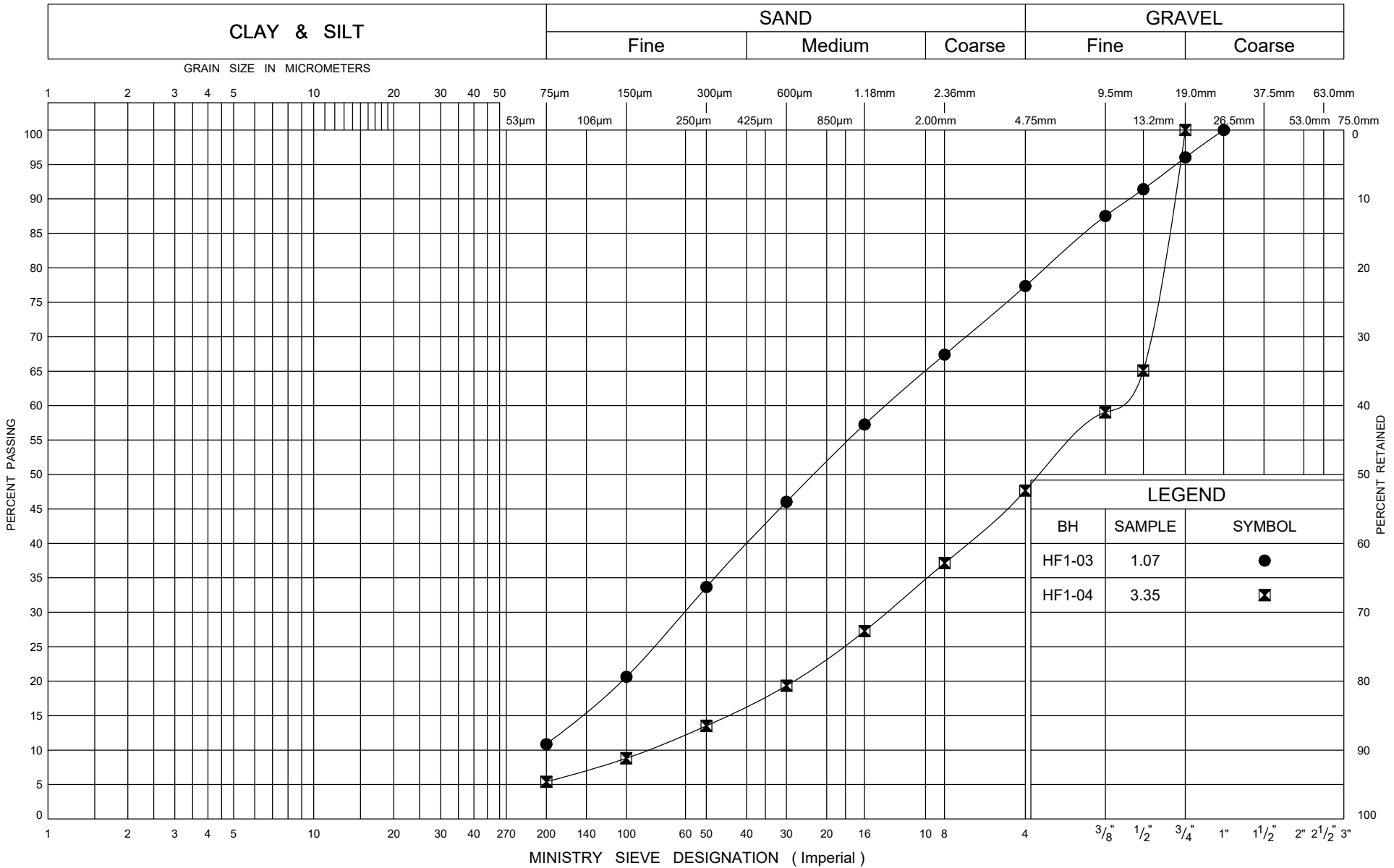
ONTARIO MOT GRAIN SIZE 2 MTO-37996.GPJ ONTARIO MOT.GDT 7/30/24



## GRAIN SIZE DISTRIBUTION SAND

FIG No B1

GWP# 6333-14-00



LEGEND		
BH	SAMPLE	SYMBOL
HF1-03	1.07	●
HF1-04	3.35	■

ONTARIO MOT GRAIN SIZE 2 MTO-37996.GPJ ONTARIO MOT.GDT 7/30/24

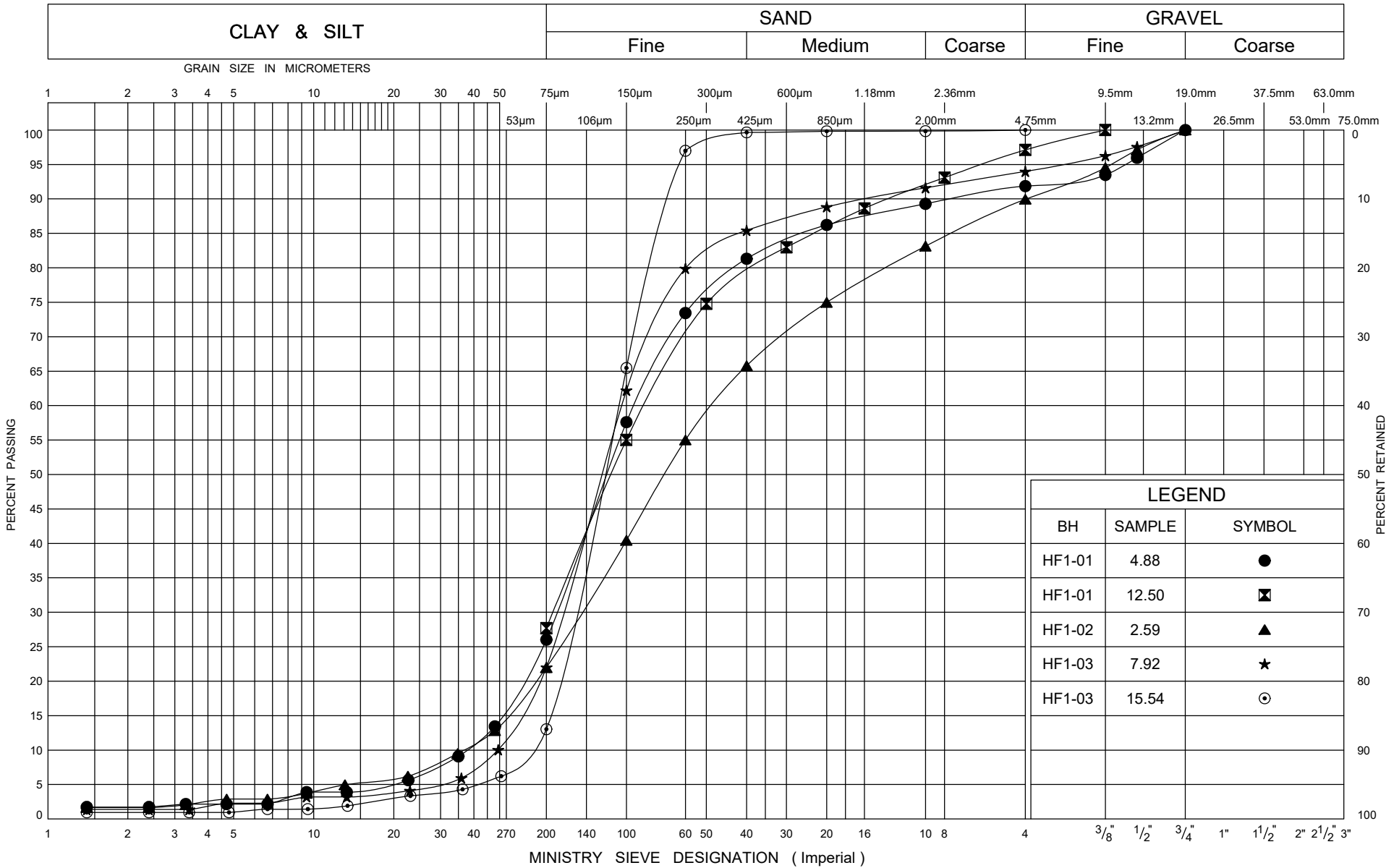


## GRAIN SIZE DISTRIBUTION

### Gravelly SAND to SAND and GRAVEL

FIG No B2

GWP# 6333-14-00



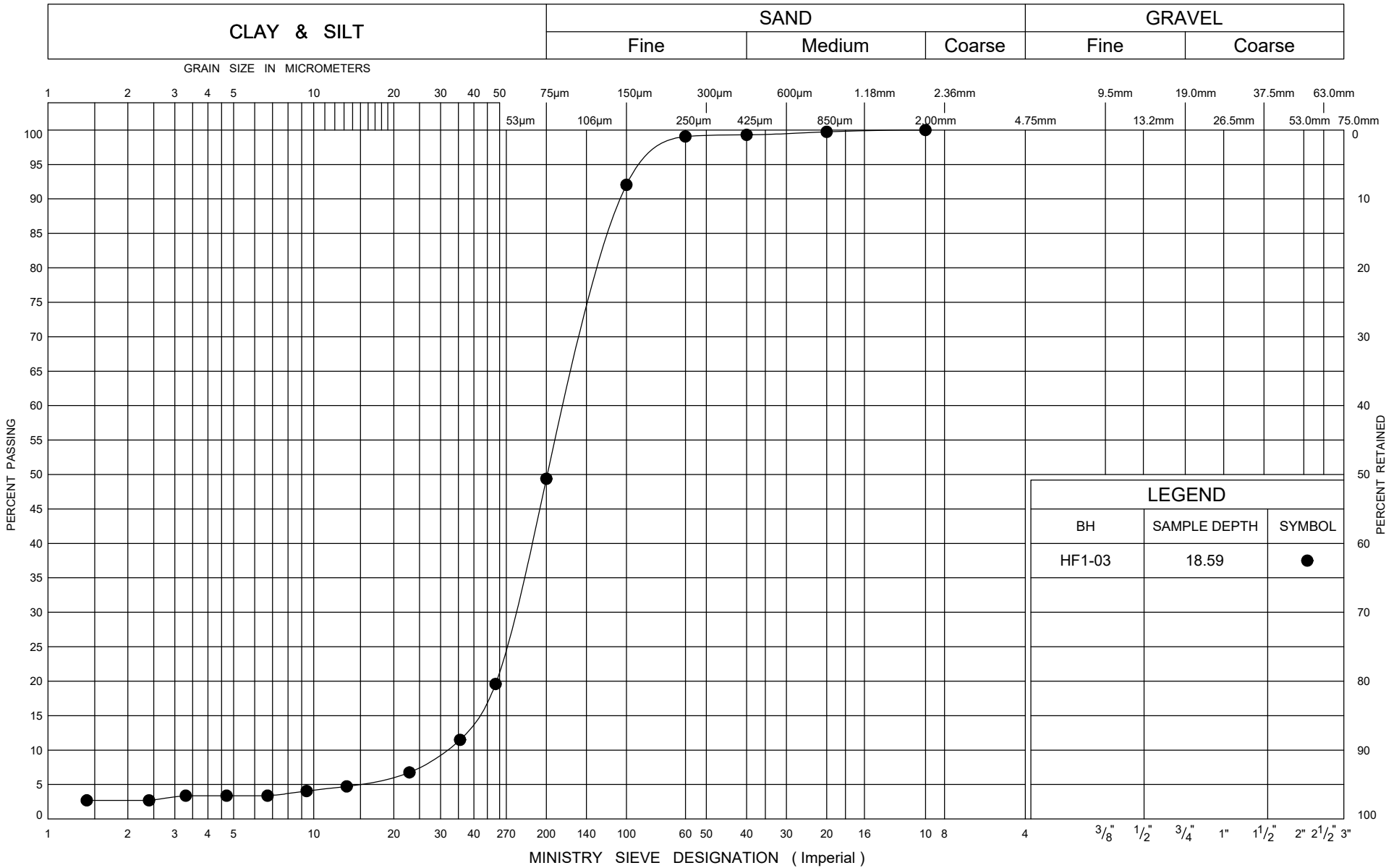
ONTARIO MOT GRAIN SIZE 2 MTO-37996.GPJ ONTARIO MOT.GDT 7/30/24



**GRAIN SIZE DISTRIBUTION**  
SAND, Some Silt to Silty SAND

FIG No B3

GWP# 6333-14-00



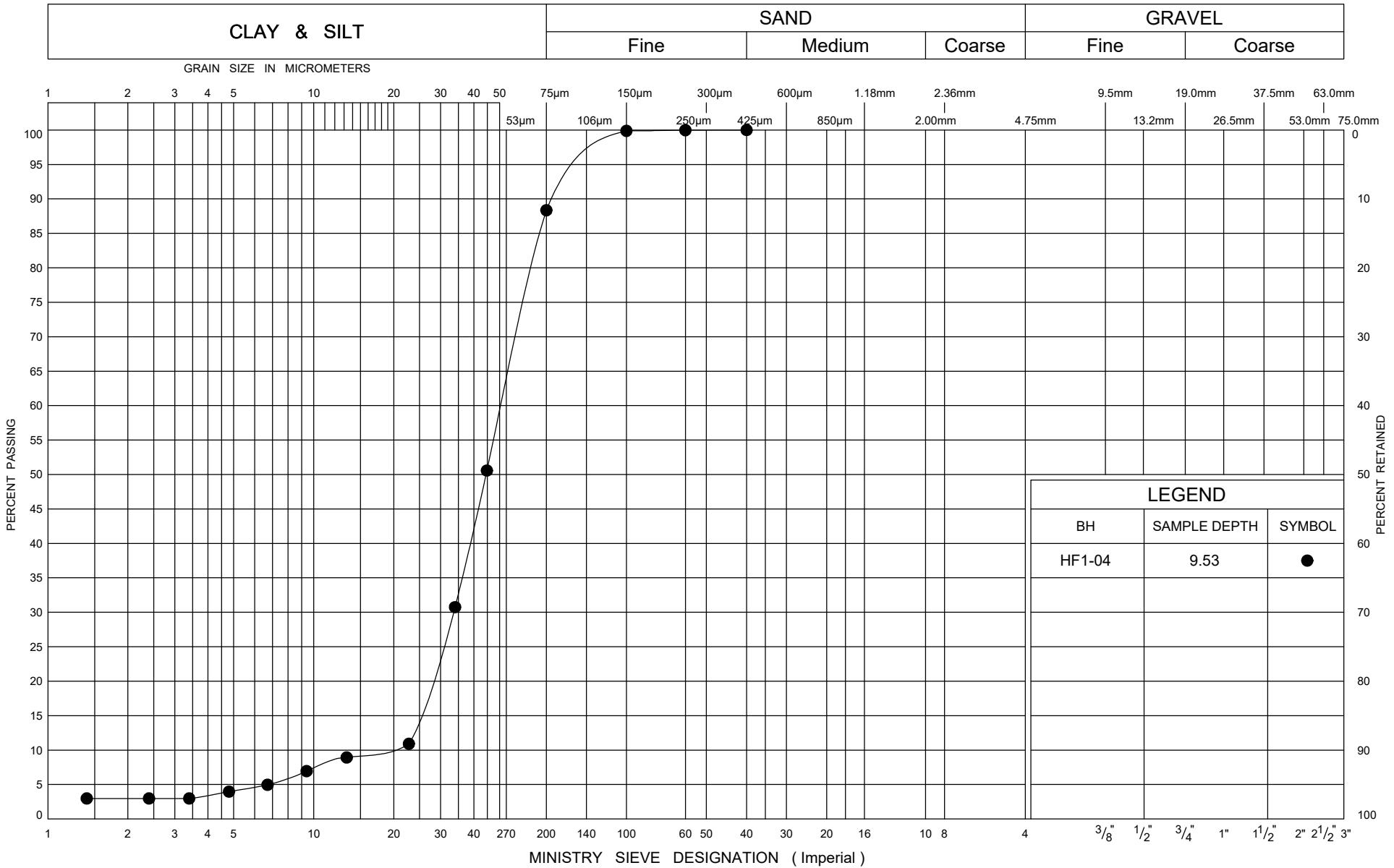
ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT\_GDT\_5/9/24



## GRAIN SIZE DISTRIBUTION SAND and SILT

FIG No B4

GWP# 6333-14-00



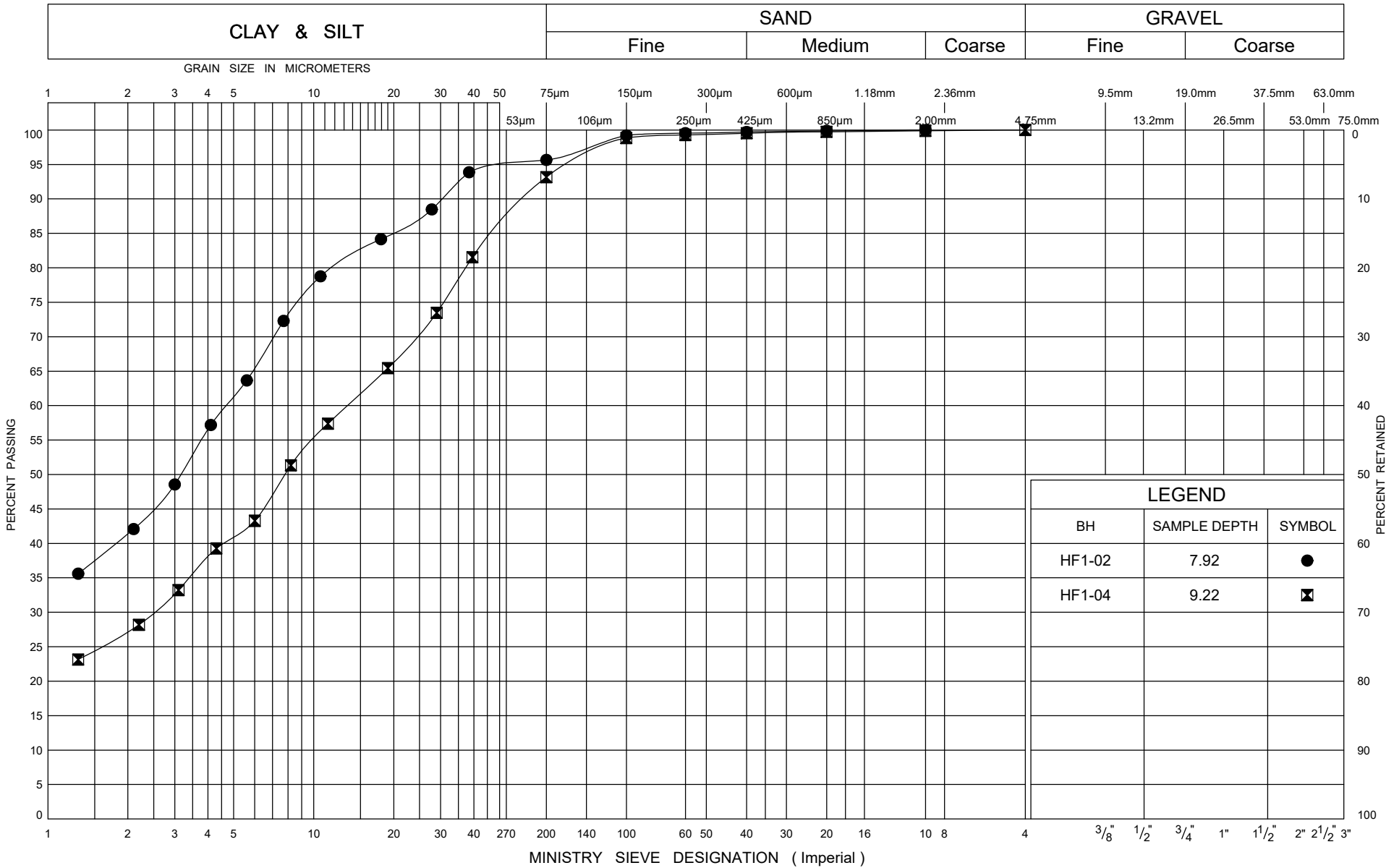
ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 5/9/24



## GRAIN SIZE DISTRIBUTION SILT

FIG No B5

GWP# 6333-14-00



LEGEND		
BH	SAMPLE DEPTH	SYMBOL
HF1-02	7.92	●
HF1-04	9.22	⊠

ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT\_GDT\_5/9/24

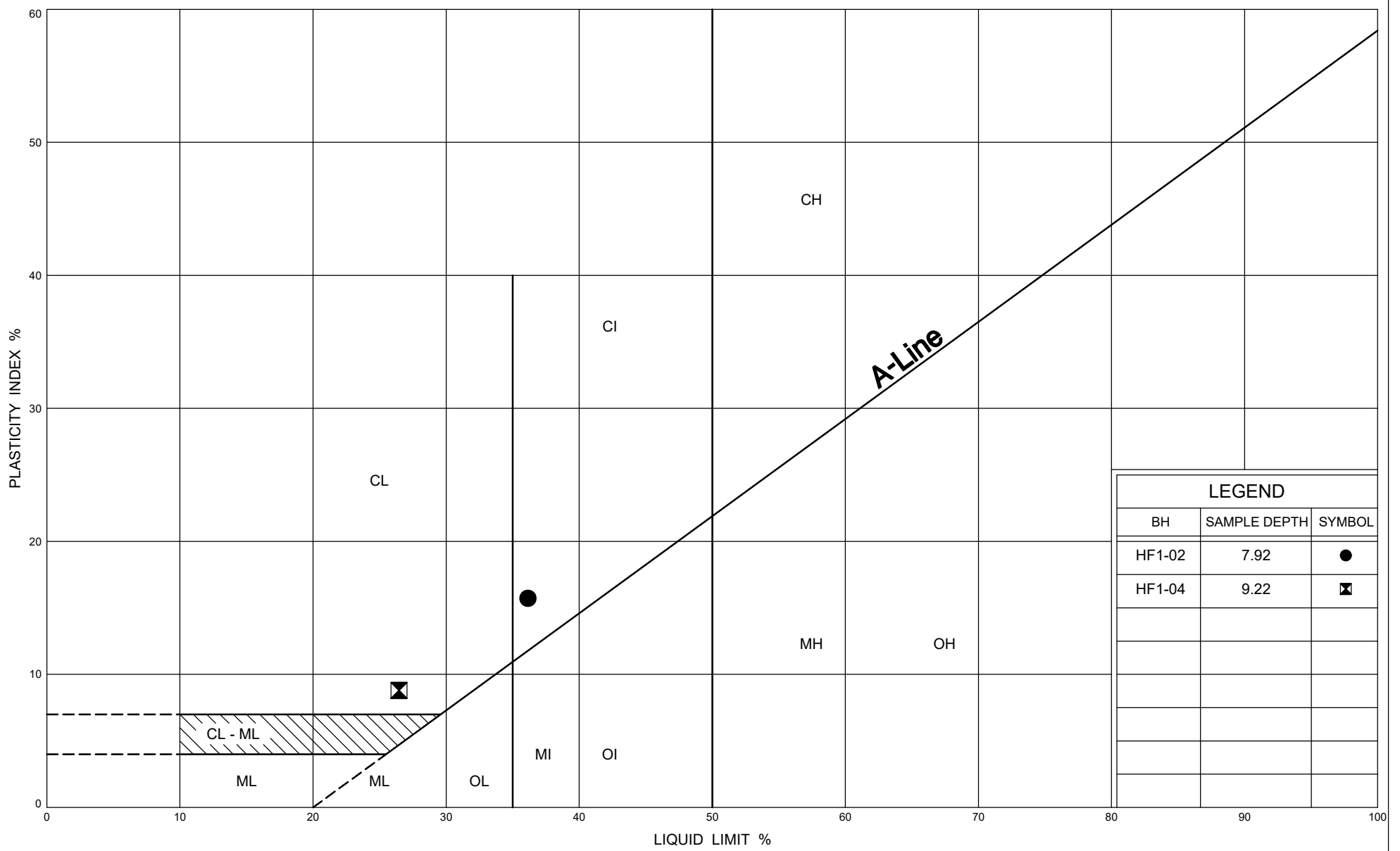


## GRAIN SIZE DISTRIBUTION

### Silty CLAY

FIG No B6

GWP# 6333-14-00



LEGEND		
BH	SAMPLE DEPTH	SYMBOL
HF1-02	7.92	●
HF1-04	9.22	⊠

ONTARIO MOT PLASTICITY CHART 2 MTO-37996.GPJ ONTARIO MOT.GDT 5/9/24



**PLASTICITY CHART**  
Silty CLAY

FIG No B7  
GWP# 6333-14-00



## **APPENDIX C**

C1: High Fill 3 Record of Borehole Sheets

# SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

## 1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

## 2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

## 3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT <sup>(1)</sup> 'N' VALUE
Very Soft	12 or less	Less than 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	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer


## 4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

## 5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$


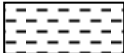



 Water Level  
 $C_{pen}$  Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ( $W_L < 30\%$ ).
		CI	Inorganic clays of medium plasticity, silty clays. ( $30\% < W_L < 50\%$ ).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS	Pt	Peat and other highly organic soils.	
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

## EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>			
<b>Fresh (FR)</b>	No visible signs of weathering.				
<b>Fresh Jointed (FJ)</b>	Weathering limited to the surface of major discontinuities.				CLAYSTONE
<b>Slightly Weathered (SW)</b>	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.				SILTSTONE
<b>Moderately Weathered (MW)</b>	Weathering extends throughout the rock mass, but the rock material is not friable.				SANDSTONE
<b>Highly Weathered (HW)</b>	Weathering extends throughout the rock mass and the rock is partly friable.				COAL
<b>Completely Weathered (CW)</b>	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.				Bedrock (general)
<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
<u>TERMS</u>					
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

### RECORD OF BOREHOLE No HF3-01

1 OF 3

METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 761.0 E 275 360.3 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.10 - 2024.03.11 LATITUDE 48.834517 LONGITUDE -87.401050 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE WATER CONTENT (%) 20 40 60									
250.4	GROUND SURFACE														
0.0	<b>TOPSOIL</b> Compact Black Moist		1	SS	15										
249.9	Silty <b>SAND</b> to <b>SAND</b> and <b>SILT</b> , trace clay Dense to Compact Brown Moist		2	SS	44									0 78 20 2	
0.5	Occasional cobbles encountered		3	SS	23										
			4	SS	15										
247.4	Sandy <b>GRAVEL</b> , some silt Very Dense Brown Wet		5	SS	53									48 29 23 (SI+CL)	
3.0			6	SS	100/ 0.125										
244.9	<b>SAND</b> , some silt Very Dense Brown Wet		7	SS	63										
5.5			8	SS	18										
243.2	<b>GRAVEL</b> and <b>SAND</b> , trace silt Compact to Very Dense Brown Wet		9	SS	54										
7.2															

ONTMT452\_2020LIBRARY(MTO).GLB\_MTO-37996.GPJ\_7/26/24

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20  
15 10 5 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No HF3-01**

2 OF 3

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 761.0 E 275 360.3 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.10 - 2024.03.11 LATITUDE 48.834517 LONGITUDE -87.401050 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			WATER CONTENT (%) 20 40 60				GR SA SI CL		
Continued From Previous Page															
237.1	GRAVEL and SAND, trace silt Very Dense Brown Wet		10	SS	51		240								
							239								
			11	SS	64		238							56 39 5 (SI+CL)	
13.3	Silty SAND, trace gravel, trace clay Very Dense Brown Wet		12	SS	58		237								
							236								
			13	SS	61		235								
							234								
			14	SS	100/ 0.125		233							7 70 21 2	
232.1			15	SS	100/		232								
18.3	BEDROCK: (GRANITE), red, slightly weathered to fresh, very strong to extremely strong				0.075		231								
			1	RUN										RUN #1 TCR=100% SCR=100% RQD=92% UCS=213MPa (Point Load Ave.)  RUN #2 TCR=100% SCR=82% RQD=69% UCS=253MPa (Point Load Ave.)	

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

ONTMT452\_2020LIBRARY(MTO).GLB\_MTO-37996.GPJ\_7/26/24

**RECORD OF BOREHOLE No HF3-01**

3 OF 3

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 761.0 E 275 360.3 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.10 - 2024.03.11 LATITUDE 48.834517 LONGITUDE -87.401050 CHECKED BY RB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
	Continued From Previous Page					20 40 60 80 100	20 40 60 80 100	20 40 60	W P	W	W L					
			2	RUN		230									>10	
			2	RUN		229									1	RUN #2
228.6															1	TCR=100%
21.8	END OF BOREHOLE AT 21.8m. BOREHOLE BACKFILLED WITH BENTONITE TO GROUND SURFACE.														1	SCR=100%
																RQD=100%
																UCS=254MPa (Point Load Ave.)

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### RECORD OF BOREHOLE No HF3-02

1 OF 3

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 741.9 E 275 350.6 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.11 - 2024.03.13 LATITUDE 48.834345 LONGITUDE -87.401182 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
248.0	GROUND SURFACE							20 40 60 80 100							
0.0	Gravelly <b>SAND</b> , frequent organics, trace silt Loose to Very Dense Black Wet No recovery		1	SS	8										
			2	SS	100/	0.075									
246.8							247								
1.2	Silty <b>SAND</b> , trace gravel, trace clay Compact Brown Wet		3	SS	26									8 60 30 2	
245.8							246								
2.2	<b>SAND</b> and <b>GRAVEL</b> , trace silt Very Dense to Dense Brown Wet		4	SS	61										
							245								
			5	SS	34										
							244								
			6	SS	36									45 48 7 (SI+CL)	
							243								
							242								
	Occasional cobbles and boulders		7	SS	57										
							241								
			8	SS	65									50 40 10 (SI+CL)	
							240								
							239								
			9	SS	35										

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Continued Next Page

+<sup>3</sup>, x<sup>3</sup>: Numbers refer to Sensitivity  $\frac{20}{15} \pm 5$  (%) STRAIN AT FAILURE



**RECORD OF BOREHOLE No HF3-02**

3 OF 3

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 741.9 E 275 350.6 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.11 - 2024.03.13 LATITUDE 48.834345 LONGITUDE -87.401182 CHECKED BY RB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)
	Continued From Previous Page						20	40	60	80	100	W P	W	W L			
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
226.3			2	RUN		227										1 1 2	RUN #2 TCR=100% SCR=86% RQD=86% UCS=223MPa (Point Load Ave.)
21.7	END OF BOREHOLE AT 21.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.		3	RUN												1	RUN #3 TCR=100% SCR=96% RQD=96% UCS=214MPa (Point Load Ave.)

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**RECORD OF BOREHOLE No HF3-03**

2 OF 3

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 734.6 E 275 415.5 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.09 - 2024.03.09 LATITUDE 48.834282 LONGITUDE -87.400297 CHECKED BY RB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa 20 40 60 80 100						
	Continued From Previous Page													
	Sandy SILT, trace clay Very Dense Grey Wet		10	SS	100/ 0.200									
						242								
						241								
			11	SS	100/ 0.075									
						240								
239.3	Occasional cobbles No recovery													
13.7	SAND and GRAVEL, some silt, trace clay Very Dense Brown Wet		12	SS	100/ 0.075									
						239								
						238								
			13	SS	40									
						237								
			14	SS*	51									
						236							39 44 17 (SH+CL)	
						235								
			15	SS*	77/ 0.075									
						234								
			16	SS	100/									

ONTMT452\_2020LIBRARY(MTO).GLB\_MTO-37996.GPJ\_7/26/24

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No HF3-03**

3 OF 3

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 734.6 E 275 415.5 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.09 - 2024.03.09 LATITUDE 48.834282 LONGITUDE -87.400297 CHECKED BY RB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20 40 60 80 100						W P	W	W L		
							○ UNCONFINED	+	FIELD VANE							
							● QUICK TRIAXIAL	×	LAB VANE							
							20 40 60 80 100					20 40 60				
	Continued From Previous Page				0.075											
	<b>SAND</b> and <b>GRAVEL</b> , some silt, trace clay Very Dense Brown Wet					232										
231.5			17	SS	100/											
21.5	END OF BOREHOLE AT 21.5m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.  * 3 Inch Spoon used				0.050											

ONTMT4S2\_2020LIBRARY(MTO).GLB\_MTO-37996.GPJ\_7/26/24

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

### RECORD OF BOREHOLE No HF3-04

1 OF 3

METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 732.1 E 275 401.3 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.07 - 2024.03.08 LATITUDE 48.834259 LONGITUDE -87.400490 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
251.3	GROUND SURFACE														
0.0	<b>TOPSOIL</b> , some sand, some gravel Very Dense Brown Moist		1	SS	61									112	
250.5	<b>SILT</b> and <b>SAND</b> , trace gravel, trace clay, occasional cobbles Compact to Dense Brown Moist		2	SS	45										
0.8			3	SS	15										1 39 57 3
			4	SS	31										
			5	SS	23										
			6	SS	15										
			7	SS	11										2 36 58 4
			8	SS	19										
			9	SS	19										

ONTMT4S2\_2020LIBRARY(MTO).GLB\_MTO-37996.GPJ\_7/26/24

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No HF3-04**

2 OF 3

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 732.1 E 275 401.3 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.07 - 2024.03.08 LATITUDE 48.834259 LONGITUDE -87.400490 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
240.3	Continued From Previous Page SILT and SAND, trace gravel, trace clay, occasional cobbles Dense Brown Moist														
11.0	GRAVEL and SAND, some silt Very Dense Brown Moist		10	SS	44										
	Boulder cored from 12.6m		11	SS	100/ 0.075									48 34 18 (SI+CL)	
			12	SS	86										
236.5	Sandy SILT, trace gravel Very Dense Brown Moist		13	SS	9										
235.0	SAND and GRAVEL, some silt Very Dense Brown Moist		14	SS	78										
232.9	SILT, some sand, trace clay Compact Grey Wet		15	SS	28										

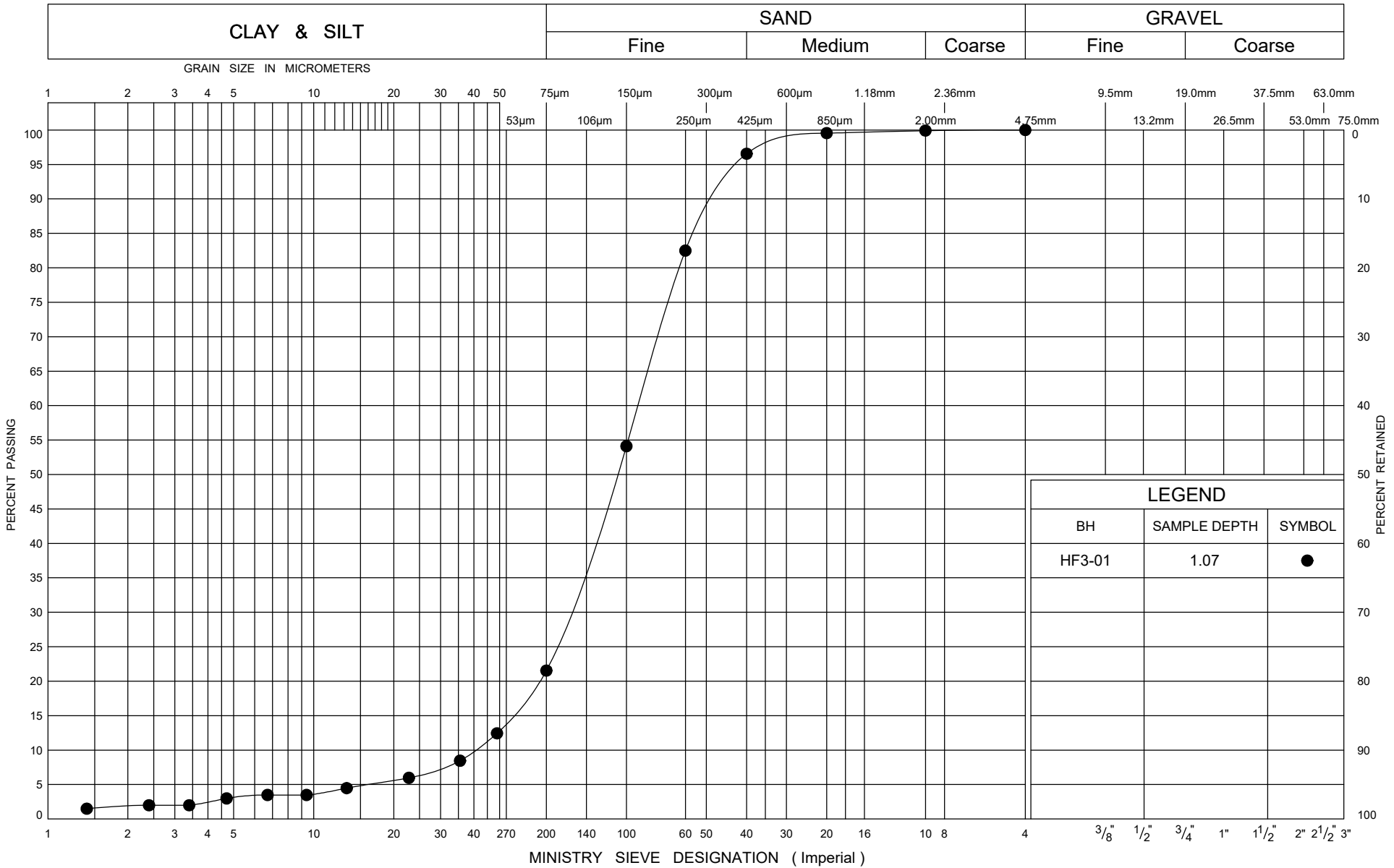
ONTMT452\_2020LIBRARY(MTO).GLB\_MTO-37996.GPJ\_7/26/24

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE



C2: High Fill 3 Geotechnical Laboratory Testing Figures



ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT\_GDT\_5/9/24

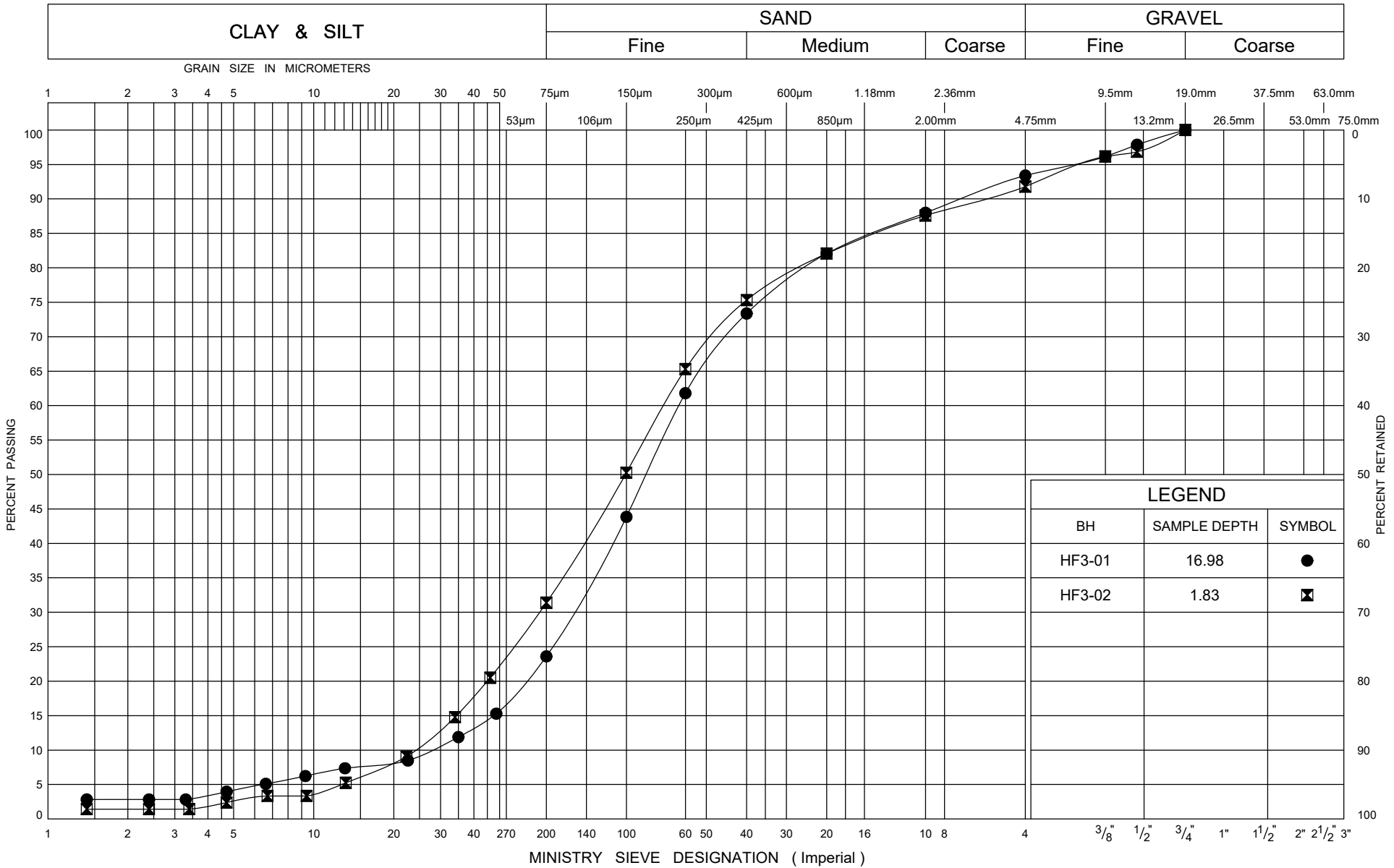


# GRAIN SIZE DISTRIBUTION

## SAND

FIG No C1

GWP# 6333-14-00



ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT\_GDT\_5/9/24

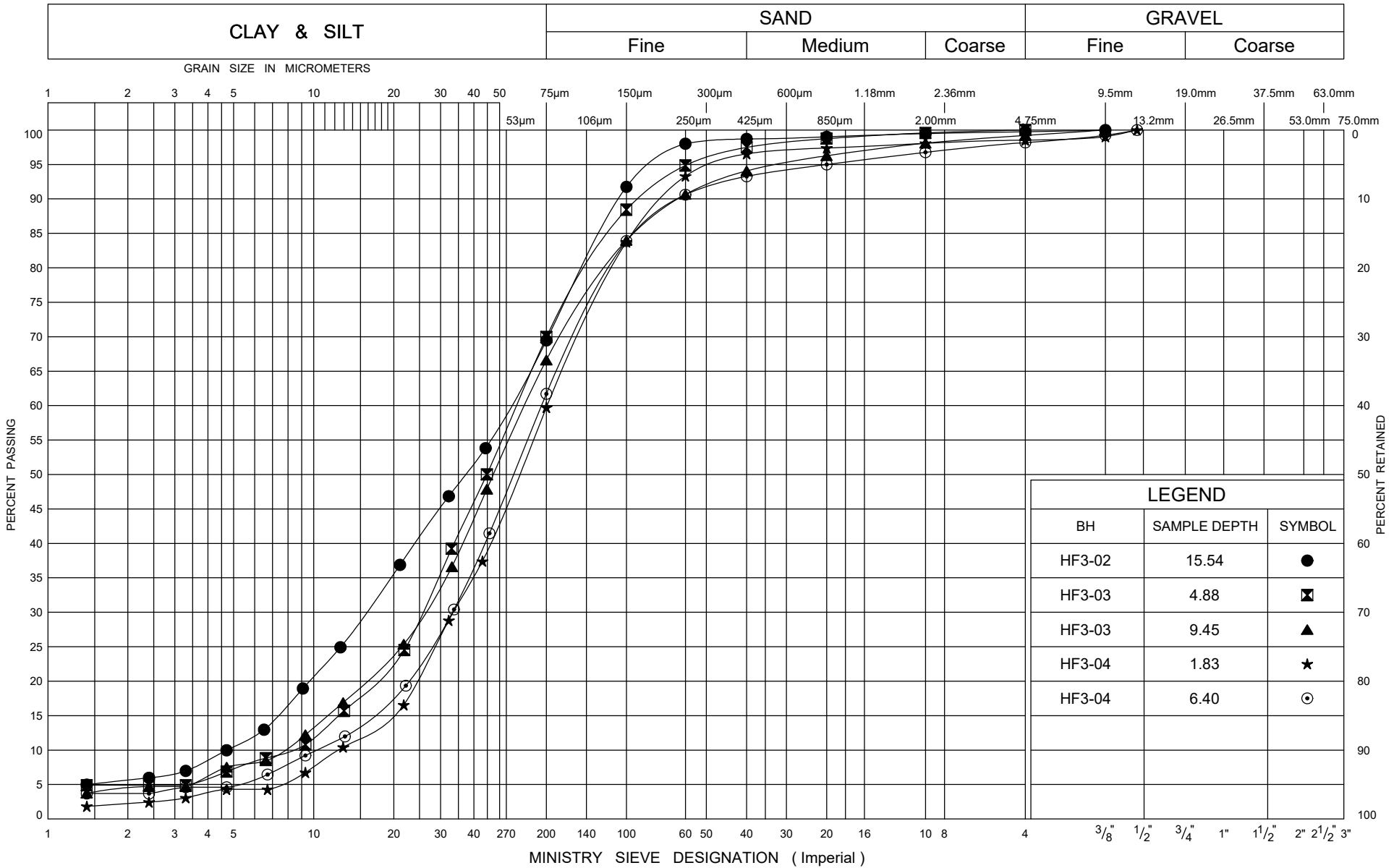


## GRAIN SIZE DISTRIBUTION

### Silty SAND

FIG No C2

GWP# 6333-14-00



ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 5/9/24

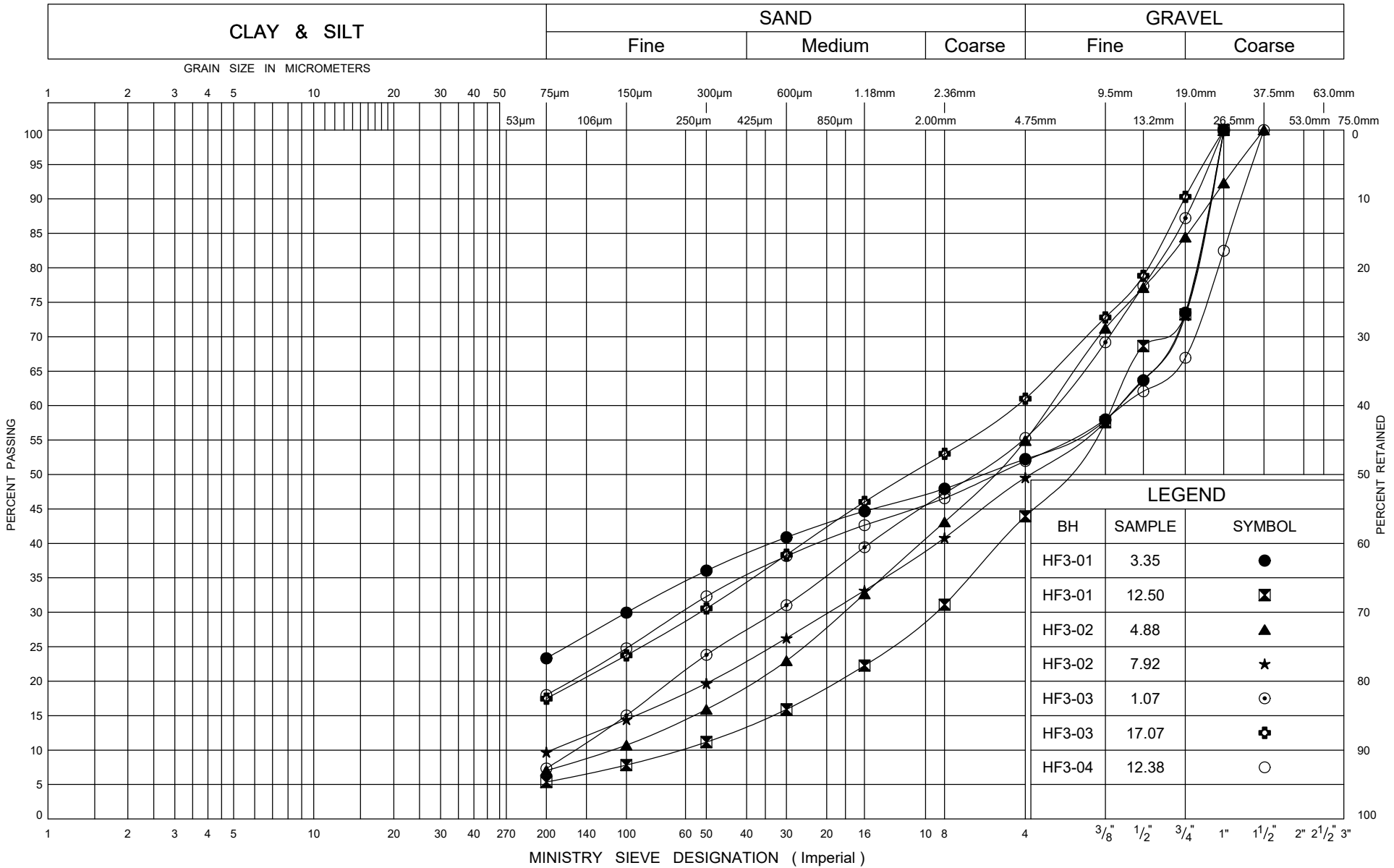


# GRAIN SIZE DISTRIBUTION

## Sandy SILT

FIG No C3

GWP# 6333-14-00



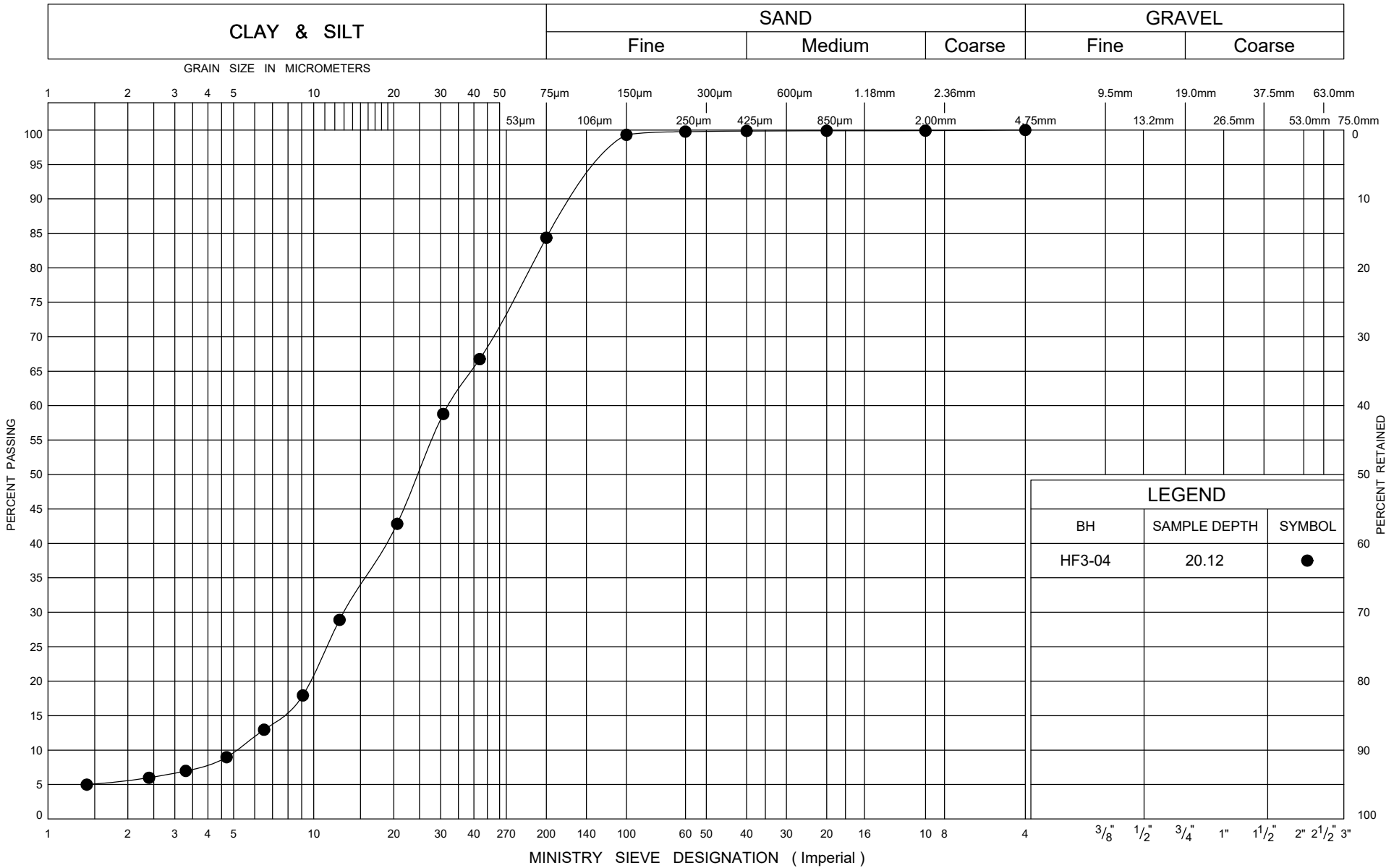
ONTARIO MOT GRAIN SIZE 2 MTO-37996.GPJ ONTARIO MOT\_GDT\_7/30/24



## GRAIN SIZE DISTRIBUTION SAND and GRAVEL

FIG No C4

GWP# 6333-14-00



ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 5/9/24



## GRAIN SIZE DISTRIBUTION SILT

FIG No C5

GWP# 6333-14-00



## **APPENDIX D**

D1: High Fill 4 Record of Borehole Sheets

# SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

## 1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

## 2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

## 3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT <sup>(1)</sup> 'N' VALUE
Very Soft	12 or less	Less than 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	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer

## 4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

## 5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

Water Level  
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ( $W_L < 30\%$ ).
		CI	Inorganic clays of medium plasticity, silty clays. ( $30\% < W_L < 50\%$ ).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS	Pt	Peat and other highly organic soils.	
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

### RECORD OF BOREHOLE No HF4-01

1 OF 2

METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 465.8 E 275 719.6 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.06 - 2024.03.06 LATITUDE 48.831879 LONGITUDE -87.396135 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
262.0	GROUND SURFACE						20 40 60 80 100								
0.0	TOPSOIL: (225mm)														
0.2	Gravelly SAND, trace silt, occasional cobbles Very Dense to Compact Brown Moist		1	SS	92										
			2	SS	21		261								
			3	SS	24		260							28 66 6 (SI+CL)	
	Auger grinding against cobbles from 2.4m to 3.0m depth		4	SS	42		259								
			5	SS	38		258								
	Gravel seam from 4.6m to 5.2m depth		6	SS	37		257							58 33 9 (SI+CL)	
			7	SS	28		256								
			8	SS	83		255								
	Occasional cobbles		9	SS	43		254								
							253								
							252								

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Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No HF4-01**

2 OF 2

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 465.8 E 275 719.6 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.06 - 2024.03.06 LATITUDE 48.831879 LONGITUDE -87.396135 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
250.7	Continued From Previous Page Gravelly <b>SAND</b> , trace silt, occasional cobbles Very Dense Brown Moist		10	SS	51												
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.																

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+<sup>3</sup>, x<sup>3</sup>: Numbers refer to Sensitivity 20  
15 5  
10 (%) STRAIN AT FAILURE

### RECORD OF BOREHOLE No HF4-02

1 OF 2

METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 431.5 E 275 756.1 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.06 - 2024.03.06 LATITUDE 48.831572 LONGITUDE -87.395635 CHECKED BY RB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						
						20 40 60 80 100								
						○ UNCONFINED + FIELD VANE								
						● QUICK TRIAXIAL × LAB VANE								
						20 40 60 80 100								
263.8	GROUND SURFACE													
0.0	Gravelly SAND, trace silt, some organics Dense to Very Dense Brown Moist  No recovery		1	SS	42									
			2	SS	100/ 0.050	263								
262.3														
1.5	SAND, trace silt Compact Brown Moist		3	SS	19	262								
			4	SS	12									
260.8						261								
3.0	SILT and SAND, trace clay Loose Brown Wet		5	SS	4								0 37 60 3	
						260								
259.7														
4.1	Gravelly SAND, trace silt Very Dense to Dense Brown Moist		6	SS	100/ 0.125	259								
						258								
						257								
						256								
						255								
						254							34 60 6 (SI+CL)	

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Continued Next Page

+<sup>3</sup> × 3<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No HF4-02**

2 OF 2

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 431.5 E 275 756.1 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.06 - 2024.03.06 LATITUDE 48.831572 LONGITUDE -87.395635 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page							20	40	60	80	100	W P	W	W L		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					20 40 60				
252.5	Gravelly SAND, trace silt Very Dense Brown Moist		10	SS	58		253										
11.3	END OF BOREHOLE AT 11.3m. Well installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.  WATER LEVEL READINGS DATE      DEPTH(m)    ELEV.(m) 2024.03.06    Dry                - 2024.03.11    7.3                256.5 2024.03.18    Dry                - 2024.04.08    Dry                - 2024.04.19    Dry                -																

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      20  
15  
10      (%) STRAIN AT FAILURE



**RECORD OF BOREHOLE No HF4-03**

2 OF 2

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 412.2 E 275 785.6 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.06 - 2024.03.06 LATITUDE 48.831400 LONGITUDE -87.395233 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)	
								20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE											
255.6	Continued From Previous Page																		
10.2	Gravelly SAND, trace silt Compact Brown Moist																		
254.5	SAND, trace to some gravel, trace silt Very Dense Brown Moist		10	SS	87		255												
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.																		

ONTMT4S2\_2020LIBRARY(MTO).GLB\_MTO-37996.GPJ\_7/26/24

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20  
15 5  
10 (%) STRAIN AT FAILURE

### RECORD OF BOREHOLE No HF4-04

1 OF 1

METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 367.5 E 275 833.0 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.05 - 2024.03.05 LATITUDE 48.831000 LONGITUDE -87.394584 CHECKED BY RB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa							
						20	40	60	80	100	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>		
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)			GR SA SI CL	
269.4	GROUND SURFACE														
0.0	SAND and GRAVEL, trace silt, some organics in upper 50mm Compact to Very Dense Brown Moist		1	SS	86										
			2	SS	40										44 48 8 (SI+CL)
			3	SS	11										
			4	SS	14										
			5	SS	22										51 44 5 (SI+CL)
265.3	SAND, trace silt, occasional cobbles Compact Brown Moist		6	SS	10										
263.8	Gravelly SAND, trace silt, occasional cobbles Very Dense Brown Moist		7	SS	100/ 0.100										
261.1	No recovery		8	SS	100/ 0.050										
8.3	END OF BOREHOLE AT 8.3m. UPON AUGER REFUSAL. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.		9	SS	100/ 0.025										

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20  
15  
10 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No HF4-05**

1 OF 2

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 335.5 E 275 871.4 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.05 - 2024.03.05 LATITUDE 48.830714 LONGITUDE -87.394058 CHECKED BY RB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
271.0	GROUND SURFACE															
0.0	SAND and GRAVEL, trace silt, occasional cobbles Very Dense to Dense Brown Moist		1	SS	74											
			2	SS	100/ 0.050											
			3	SS	33										55 40 5 (SI+CL)	
			4	SS	59											
			5	SS	32											
			6	SS	100/ 0.100											
			7	SS	44										44 49 7 (SI+CL)	
			8	SS	56											
			9	SS	72											
	No recovery															

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No HF4-05**

2 OF 2

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 335.5 E 275 871.4 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.05 - 2024.03.05 LATITUDE 48.830714 LONGITUDE -87.394058 CHECKED BY RB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)
	Continued From Previous Page						20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
							○ UNCONFINED	+	FIELD VANE								
							● QUICK TRIAXIAL	×	LAB VANE								
							20	40	60	80	100	20	40	60			
260.2			10	SS	100/												
10.8	END OF BOREHOLE AT 10.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.				0.100												

ONTMT452\_2020LIBRARY(MTO).GLB\_MTO-37996.GPJ\_7/26/24

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20  
15  
10 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No HF4-06**

1 OF 1

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 303.5 E 275 909.8 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.05 - 2024.03.05 LATITUDE 48.830428 LONGITUDE -87.393532 CHECKED BY RB

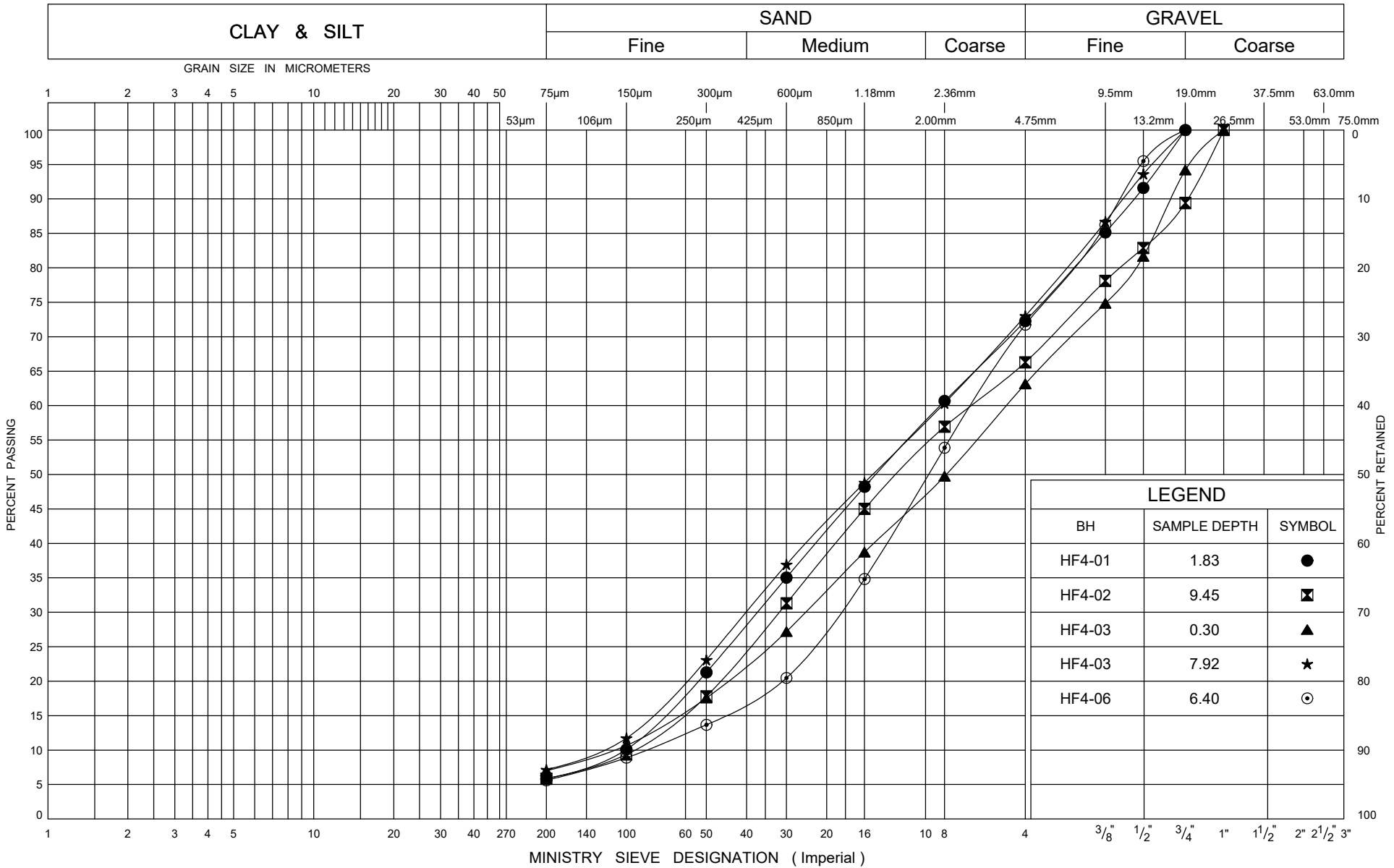
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT			
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)			GR SA SI CL		
						20	40	60	80	100	W P	W	W L			
279.2	GROUND SURFACE															
0.0	SAND and GRAVEL to Gravelly SAND, trace silt, occasional cobbles Compact to Dense Brown Moist		1	SS	28											
			2	SS	37											46 48 6 (SI+CL)
			3	SS	37											
			4	SS	44											
			5	SS	45											
			6	SS	28											
			7	SS	31											28 66 6 (SI+CL)
			8	SS	100/											
271.5	No recovery															
7.7	END OF BOREHOLE AT 7.7m UPON AUGER REFUSAL. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.				0.075											

ONTMT4S2\_2020LIBRARY(MTO).GLB\_MTO-37996.GPJ\_7/26/24

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20  
15 5  
10 (%) STRAIN AT FAILURE



D2: High Fill 4 Geotechnical Laboratory Testing Results



ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 5/9/24

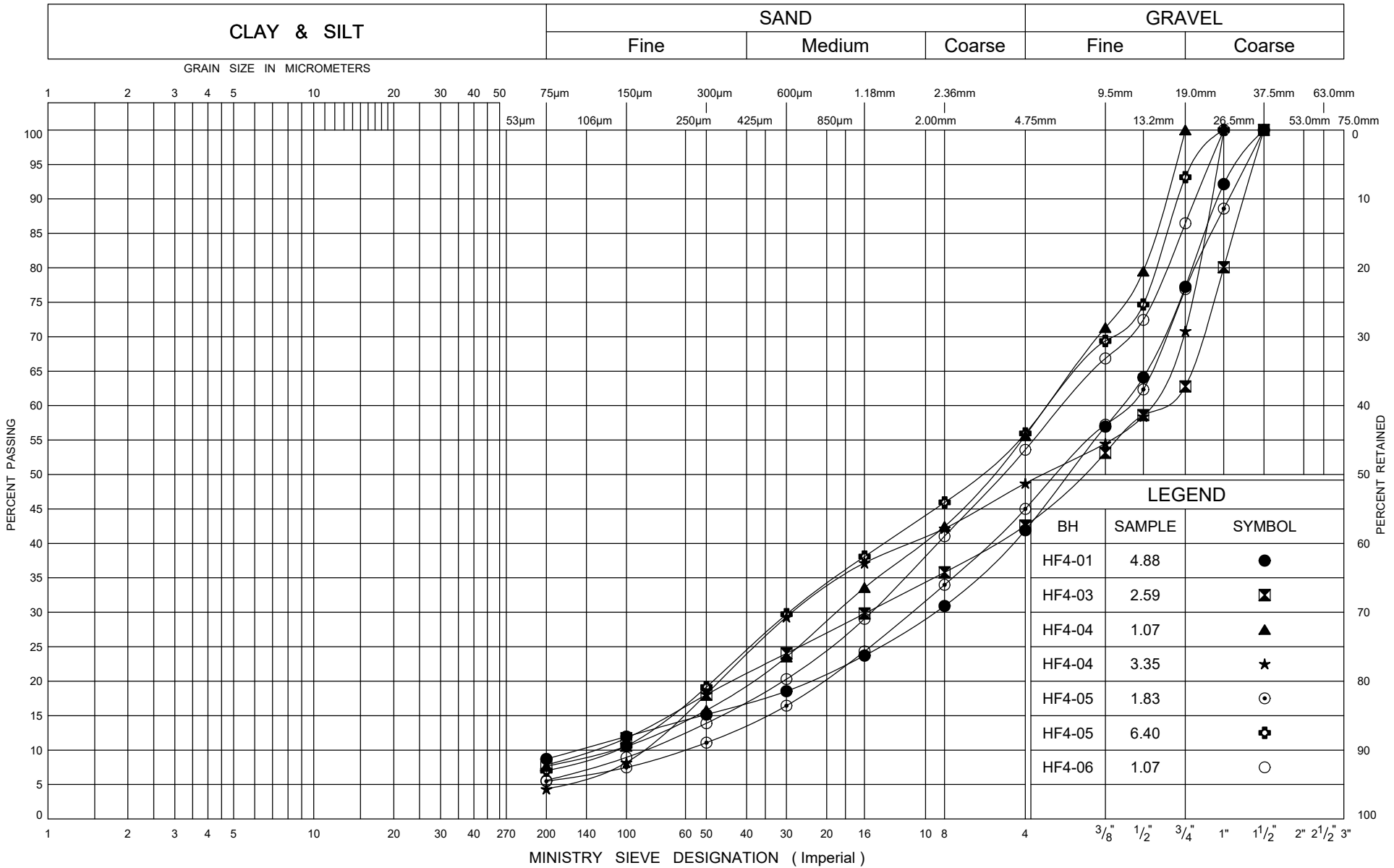


## GRAIN SIZE DISTRIBUTION

### Gravelly SAND

FIG No 0F

ÖWP# 1111111111



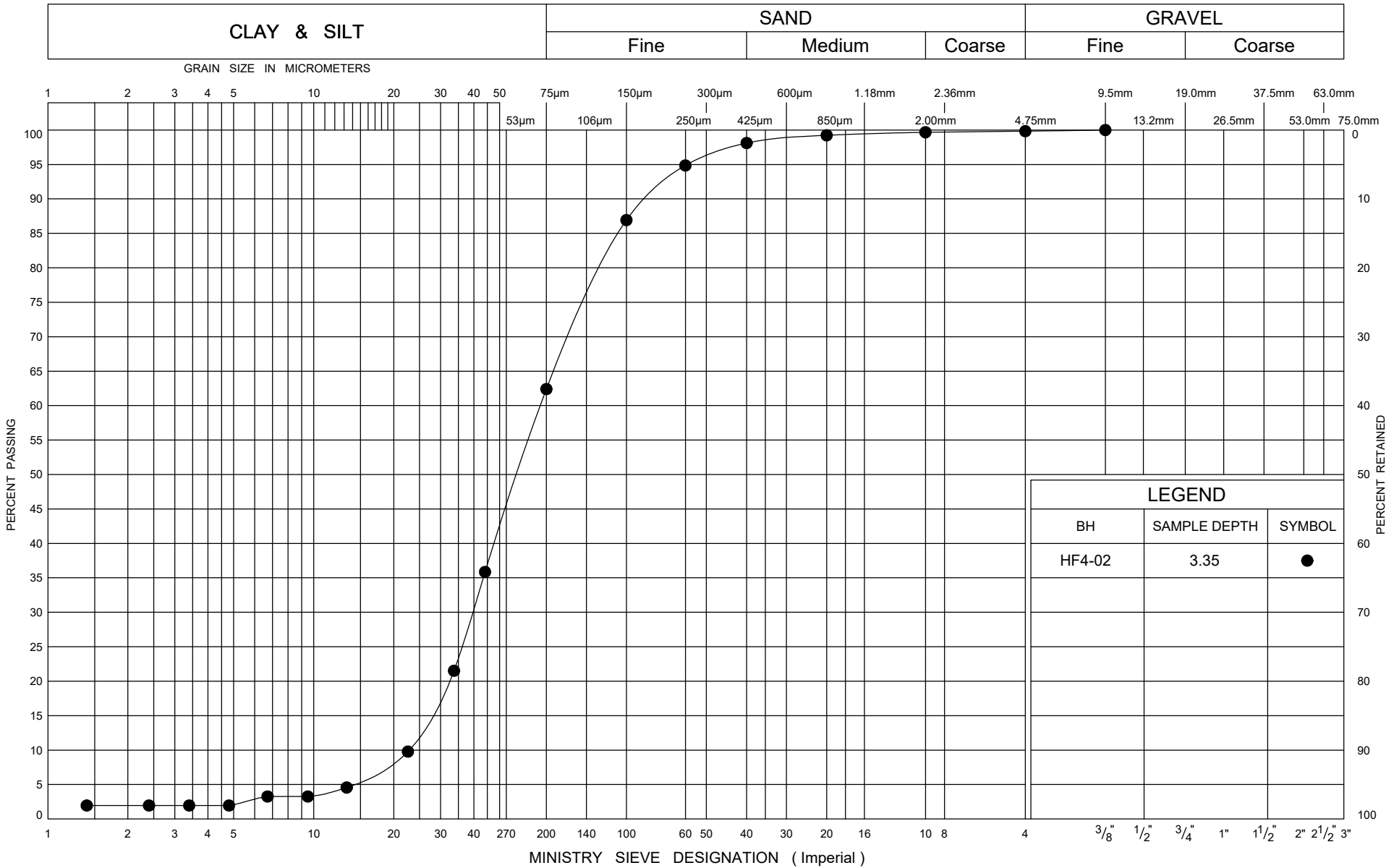
ONTARIO MOT GRAIN SIZE 2 MTO-37996.GPJ ONTARIO MOT.GDT 7/30/24



**GRAIN SIZE DISTRIBUTION**  
SAND and GRAVEL

FIG No D2

GWP# 6333-14-00



ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT\_GDT\_5/9/24



GRAIN SIZE DISTRIBUTION  
 SOB 03 a AUS

FIG No 0H

OWP# 111111



## **APPENDIX E**

E1: Deep Cut Section 1 Record of Borehole Sheets

# SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

## 1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

## 2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

## 3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT <sup>(1)</sup> 'N' VALUE
Very Soft	12 or less	Less than 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	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer


## 4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

## 5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$


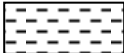



 Water Level  
 $C_{pen}$  Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ( $W_L < 30\%$ ).
		CI	Inorganic clays of medium plasticity, silty clays. ( $30\% < W_L < 50\%$ ).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS	Pt	Peat and other highly organic soils.	
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

## EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>		
<b>Fresh (FR)</b>	No visible signs of weathering.			
<b>Fresh Jointed (FJ)</b>	Weathering limited to the surface of major discontinuities.			CLAYSTONE
<b>Slightly Weathered (SW)</b>	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.			SILTSTONE
<b>Moderately Weathered (MW)</b>	Weathering extends throughout the rock mass, but the rock material is not friable.			SANDSTONE
<b>Highly Weathered (HW)</b>	Weathering extends throughout the rock mass and the rock is partly friable.			COAL
<b>Completely Weathered (CW)</b>	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.			Bedrock (general)
<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>		
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength (MPa)                  (psi)	Field Estimation of Hardness*
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250                  Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m			
Medium bedded	0.2 to 0.6m	Very Strong	100-250                  15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m			
Very thinly bedded	20 to 60mm	Strong	50-100                  7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm			
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0                  3,500 to 7,500	Breaks under single blow of geological hammer.
		Weak	5.0 to 25.0                  750 to 3,500	Can be peeled by a pocket knife with difficulty
		Very Weak	1.0 to 5.0                  150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
		Extremely Weak (Rock)	0.25 to 1.0                  35 to 150	Indented by thumbnail
<u>TERMS</u>				
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.			
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.			
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.			
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen			
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.			

### RECORD OF BOREHOLE No DC1-01

1 OF 1

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 255.5 E 275 967.5 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Lowell Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.04 - 2024.03.05 LATITUDE 48.830000 LONGITUDE -87.392744 CHECKED BY RB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa							
289.4	GROUND SURFACE					20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	W P	W	W L			
0.0	<b>SAND and GRAVEL</b> , trace silt, occasional cobbles Loose to Very Dense Brown Moist  Occasional cobbles  No recovery		1	SS	16										
				2	SS	91									36 54 10 (SI+CL)
				3	SS	21									
				4	SS	17									
				5	SS	8									
				6	SS	100/ 0.100									
				7	SS	44									42 52 6 (SI+CL)
				8	SS	64									
				9	SS	100/ 0.075									
280.0	END OF BOREHOLE AT 9.4m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.														

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE



**RECORD OF BOREHOLE No DC1-02**

2 OF 2

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 231.9 E 275 995.9 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.03 - 2024.03.04 LATITUDE 48.829788 LONGITUDE -87.392355 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											
	Continued From Previous Page						20	40	60	80	100								
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)							
							20	40	60	80	100	20	40	60					
	Gravelly SAND, trace silt Compact Brown Moist					▽													
	175mm thick layer of organics at 11.1m		10	SS	27		292												
	Trace oxidation Loose		11	SS	7		291												
			12	SS	32		290												
288.2																			
14.8	SAND, some gravel, trace silt Compact Grey Wet			13	SS		20	288											9 86 5 (SI+CL)
285.6																			
17.4	END OF BOREHOLE AT 17.4m. WATER LEVEL AT 10.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.		14	SS	20	286													

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No DC1-03**

1 OF 2

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 207.5 E 276 025.1 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.02 - 2024.03.02 LATITUDE 48.829571 LONGITUDE -87.391955 CHECKED BY RB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
306.5	GROUND SURFACE													
0.0	Sandy <b>ORGANICS</b> , trace silt, wood Very Dense Brown Moist		1	SS	77									
305.8														
0.7	<b>SAND</b> , trace gravel, trace to some silt, wood fragments Very Dense to Compact Brown Moist		2	SS	19								3 85 12 (SI+CL)	
	No recovery		3	SS	47									
			4	SS	32									
			5	SS	22									
			6	SS	15									
			7	SS	18									
			8	SS	7								1 85 12 2	
	Some silt		9	SS	12									
296.5														

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Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No DC1-03**

2 OF 2

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 207.5 E 276 025.1 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.02 - 2024.03.02 LATITUDE 48.829571 LONGITUDE -87.391955 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
10.0	Silty <b>SAND</b> , trace clay Compact to Very Dense Brown Moist	[Strat Plot Diagram]	10	SS	37	▽	296							0 73 26 1	
	Trace gravel Very Dense		11	SS	66		294								
	Dense		12	SS	34		293								
	Compact Very Dense		13	SS	18		291								
290.5			14	SS	100/										
16.0	END OF BOREHOLE AT 16.0m. UPON AUGER REFUSAL. WATER LEVEL AT 11.2m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.				0.025										

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20  
15  
10 (%) STRAIN AT FAILURE

### RECORD OF BOREHOLE No DC1-04

1 OF 2

METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 175.6 E 276 063.5 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.01 - 2024.03.01 LATITUDE 48.829285 LONGITUDE -87.391430 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa 20 40 60 80 100							
306.0	GROUND SURFACE														
0.0	Silty SAND, trace clay, trace organics Very Dense Brown Moist	[Cross-hatched pattern]	1	SS	54										
305.3	(FILL)														
0.7	SAND and GRAVEL, trace silt Compact to Very Dense Brown Moist (FILL)		2	SS	44										
			3	SS	57										
			4	SS	28									48 49 3 (SI+CL)	
303.0	SAND, trace to some gravel, trace silt Compact to Dense Brown Moist	[Dotted pattern]	5	SS	14										
3.0															
			6	SS	30										
			7	SS	13										
298.2	Gravelly sand layer	[Dotted pattern]													
7.8	Silty SAND Compact Brown Wet		8	SS	26										
			9	SS	11									0 83 15 2	

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Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No DC1-04**

2 OF 2

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 175.6 E 276 063.5 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.01 - 2024.03.01 LATITUDE 48.829285 LONGITUDE -87.391430 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
294.5	Continued From Previous Page Silty <b>SAND</b> Very Dense Brown Moist  Occasional cobbles		10	SS	60/ 0.075		295								
293.4	<b>SAND</b> , some gravel, trace silt Very Dense Brown Moist		11	SS	50/ 0.075		294							14	81 5 (SH+CL)
12.6	END OF BOREHOLE AT 12.6m. WATER LEVEL AT 11.7m. Well installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.  WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2024.03.02 3.4 302.6 2024.03.03 10.6 295.4 2024.03.04 9.9 296.1 2024.03.11 10.3 295.7 2024.03.14 10.3 295.7 2024.03.17 9.3 296.7 2024.03.18 9.8 296.2		12	SS	100/ 0.025										

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+<sup>3</sup>, x<sup>3</sup>: Numbers refer to Sensitivity 20  
15 5  
10 (%) STRAIN AT FAILURE

### RECORD OF BOREHOLE No DC1-05

1 OF 2

METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 147.3 E 276 092.0 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.15 - 2024.03.15 LATITUDE 48.829032 LONGITUDE -87.391040 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
							20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT				
								W P	W	W L				
								WATER CONTENT (%)						
								20 40 60						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
307.0	GROUND SURFACE													
0.0	ASPHALT: (100mm)													
0.1	SAND and GRAVEL, trace silt, occasional cobbles Dense Brown Moist (FILL)		1	SS	43									
			2	SS	35		306						41 50 9 (SI+CL)	
			3	SS	100/ 0.100		305							
	Occasional cobbles Compact		4	SS	15		304							
304.0														
3.0	SAND, some silt, some organics, occasional cobbles Compact Brown Moist		5	SS	28		303							
			6	SS	13		302							
301.4														
5.6	SAND, trace gravel, trace silt Compact Brown Moist		7	SS	15		301							
			8	SS	23		299							
298.3														
8.7	Sandy SILT, occasional cobbles Dense Grey Moist		9	SS	9		298							

ONTMT452\_2020LIBRARY(MTO).GLB\_MTO-37996.GPJ\_7/26/24

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No DC1-05**

2 OF 2

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 147.3 E 276 092.0 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.15 - 2024.03.15 LATITUDE 48.829032 LONGITUDE -87.391040 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
296.8	Continued From Previous Page														
10.2	SAND, some silt Loose Brown Wet		10	SS	9		296							0 81 18 1	
	Boulders from 12.2m to 12.4m		11	SS	100/0.025		295								
293.9							294						FI		
13.1	BEDROCK: (Granodiorite), grey, slightly weathered to fresh, weak to very strong		1	RUN			293						6	RUN #1 TCR=100% SCR=29% RQD=0% UCS=11MPa (Point Load Ave.)	
			2	RUN			292						2	RUN #2 TCR=100% SCR=76% RQD=76% UCS=96MPa (Point Load Ave.)	
			3	RUN			291						1		
													2	RUN #3 TCR=100% SCR=46% RQD=37% UCS=204MPa (Point Load Ave.)	
290.4													3		
16.6	END OF BOREHOLE AT 16.6m. BOREHOLE BACKFILLED WITH BENTONITE TO 0.3m, THEN ASPHALT TO GROUND SURFACE.														

ONTMT452\_2020LIBRARY(MTO).GLB\_MTO-37996.GPJ\_7/26/24

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

### RECORD OF BOREHOLE No DC1-06

1 OF 2

METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 131.5 E 276 124.4 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.14 - 2024.03.14 LATITUDE 48.828891 LONGITUDE -87.390597 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
						WATER CONTENT (%)							
						PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT					
						W <sub>p</sub>	W	W <sub>L</sub>					
307.0	GROUND SURFACE												
0.0	ASPHALT: (75mm)												
0.1	Gravelly SAND, trace silt, occasional cobbles Dense to Very Dense Brown Moist (FILL)		1	SS	41								
			2	SS	100/ 0.075								
			3	SS	46								
			4	SS	44								
303.8													
3.2	ORGANICS, some sand, trace silt Loose Brown Moist		5	SS	7								
302.9													
4.1	SAND, trace silt Compact Brown Moist		6	SS	10								
301.4													
5.6	SAND and GRAVEL, trace silt, occasional cobbles Dense Brown Wet		7	SS	23							52 45 3 (SI+CL)	
299.4													
7.6	Silty SAND, some gravel, trace clay Compact to Loose Brown/Grey Wet		8	SS	10							15 58 24 3	
			9	SS	14								

ONTMT4S2\_2020LIBRARY(MTO).GLB MTO-37996.GPJ 7/26/24

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No DC1-06**

2 OF 2

**METRIC**

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 131.5 E 276 124.4 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.14 - 2024.03.14 LATITUDE 48.828891 LONGITUDE -87.390597 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)	
							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>	20	40	60	GR SA SI CL	
296.3	Silty SAND, some gravel, trace clay Very Dense Grey Wet		10	SS	77/														
10.7	<b>BEDROCK:</b> (GRANODIORITE to GRANITE, moderately weathered to fresh, red to grey, calcite veins (up to 25mm width) from 10.7m to 13.5m, very strong		1	RUN	0.025		296												RUN #1 TCR=100% SCR=83% RQD=64% UCS=140MPa (Point Load Ave.)
			2	RUN			295												RUN #2 TCR=100% SCR=58% RQD=51% UCS=159MPa (Point Load Ave.)
			3	RUN			294												RUN #3 TCR=100% SCR=100% RQD=76% UCS=205MPa (Point Load Ave.)
292.8	END OF BOREHOLE AT 14.2m. WATER LEVEL AT 9.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.						293												
14.2																			

ONTMT4S2\_2020LIBRARY(MTO).GLB\_MTO-37996.GPJ\_7/26/24

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  $\frac{20}{15} \times \frac{5}{10}$  (%) STRAIN AT FAILURE



### RECORD OF BOREHOLE No DC1-07

2 OF 2

METRIC

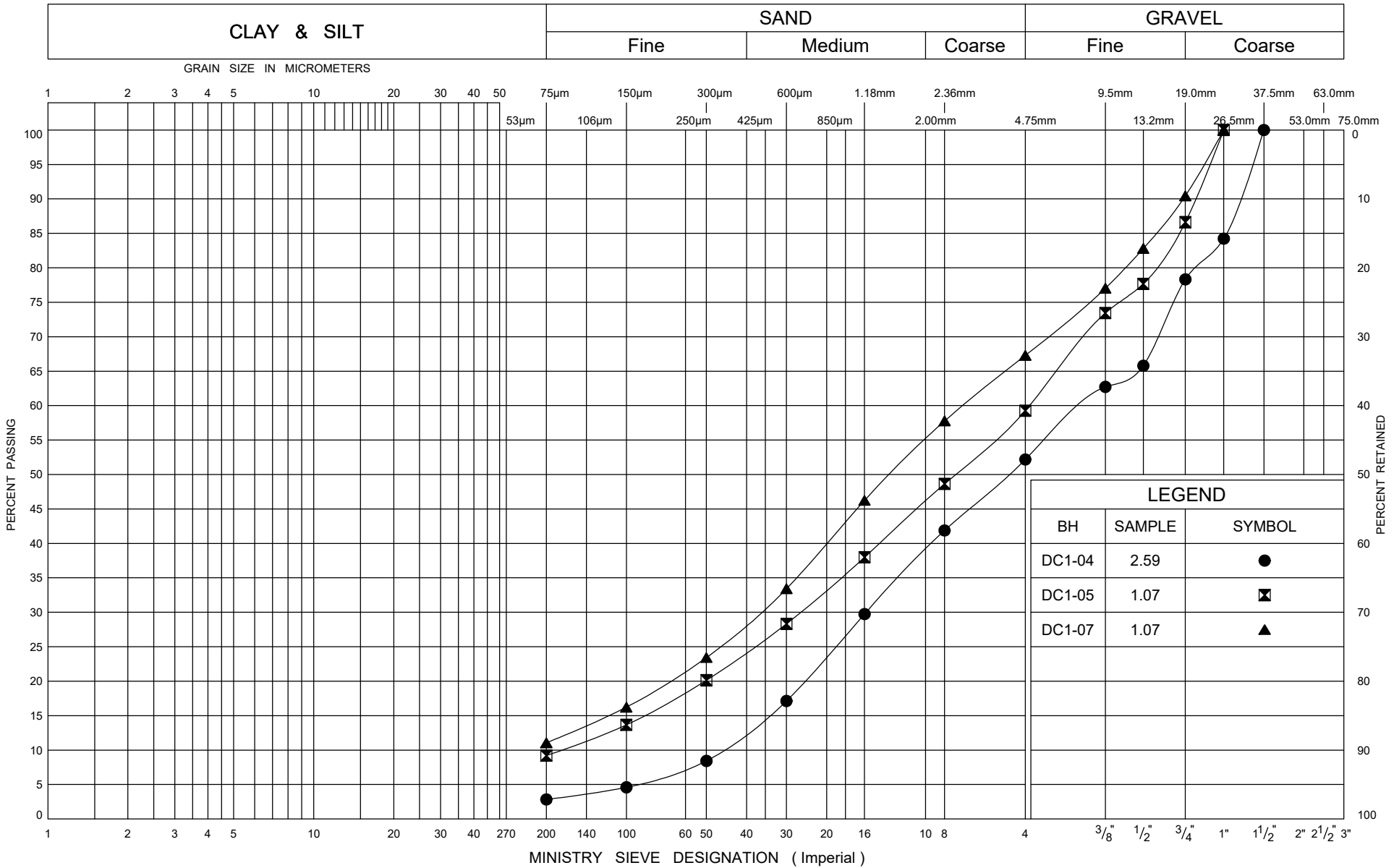
GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 095.7 E 276 159.7 ORIGINATED BY MM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2024.03.14 - 2024.03.14 LATITUDE 48.828572 LONGITUDE -87.390114 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
297.1	SAND, some silt, trace gravel Compact Brown Wet																
10.7 296.5	Sandy SILT Loose Brown Wet		10	SS	6		297										
11.3	END OF BOREHOLE AT 11.3m. WATER LEVEL AT 9.38m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.																

ONTMT4S2\_2020LIBRARY(MTO).GLB\_MTO-37996.GPJ\_7/26/24

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20  
15  
10 (%) STRAIN AT FAILURE

E2: Deep Cut Section 1 Geotechnical Laboratory Testing Results



LEGEND		
BH	SAMPLE	SYMBOL
DC1-04	2.59	●
DC1-05	1.07	⊠
DC1-07	1.07	▲

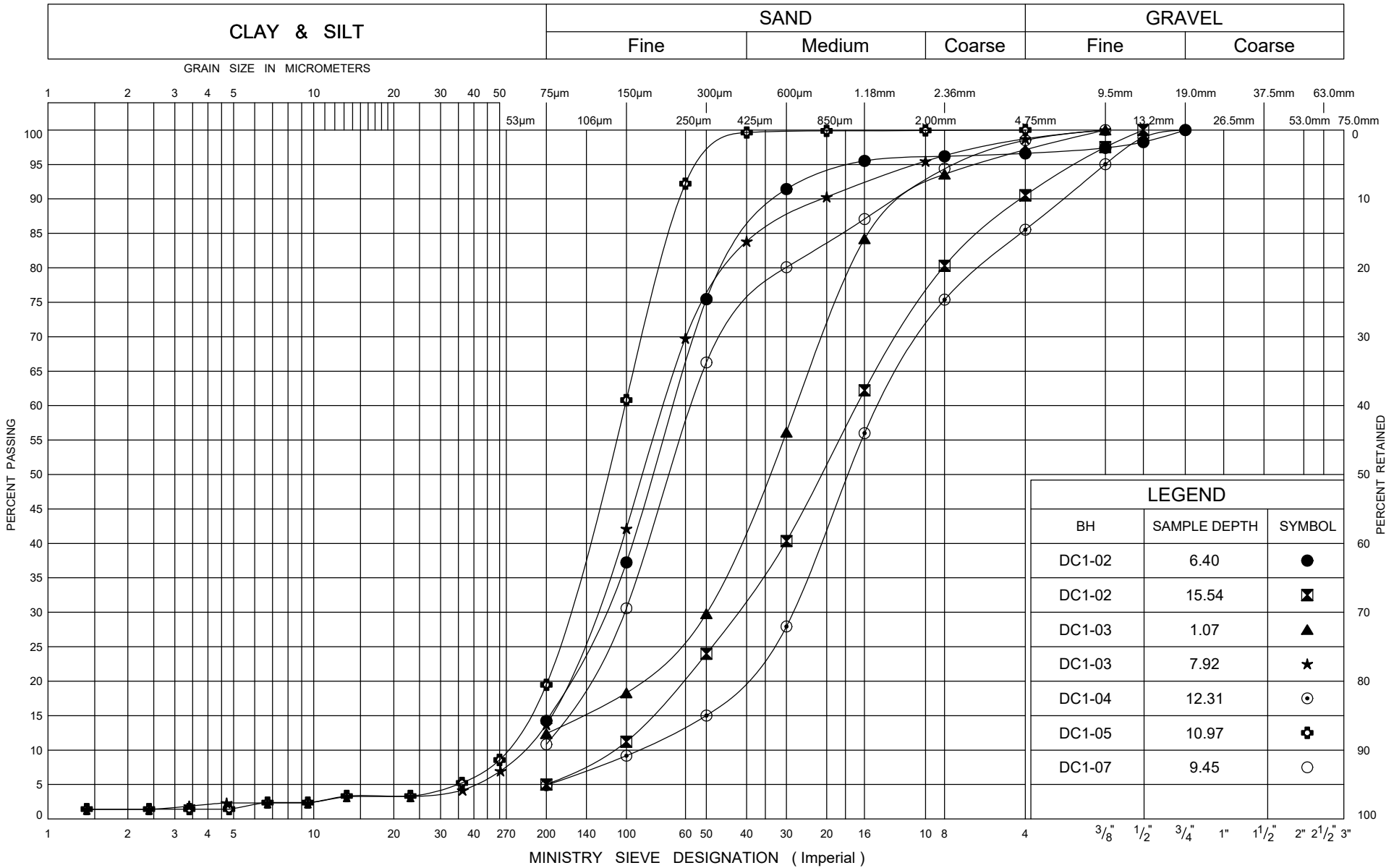
ONTARIO MOT GRAIN SIZE 2 MTO-37996.GPJ ONTARIO MOT.GDT 7/30/24



**GRAIN SIZE DISTRIBUTION**  
SAND and GRAVEL to Gravelly SAND FILL

FIG No E1

GWP# 6333-14-00



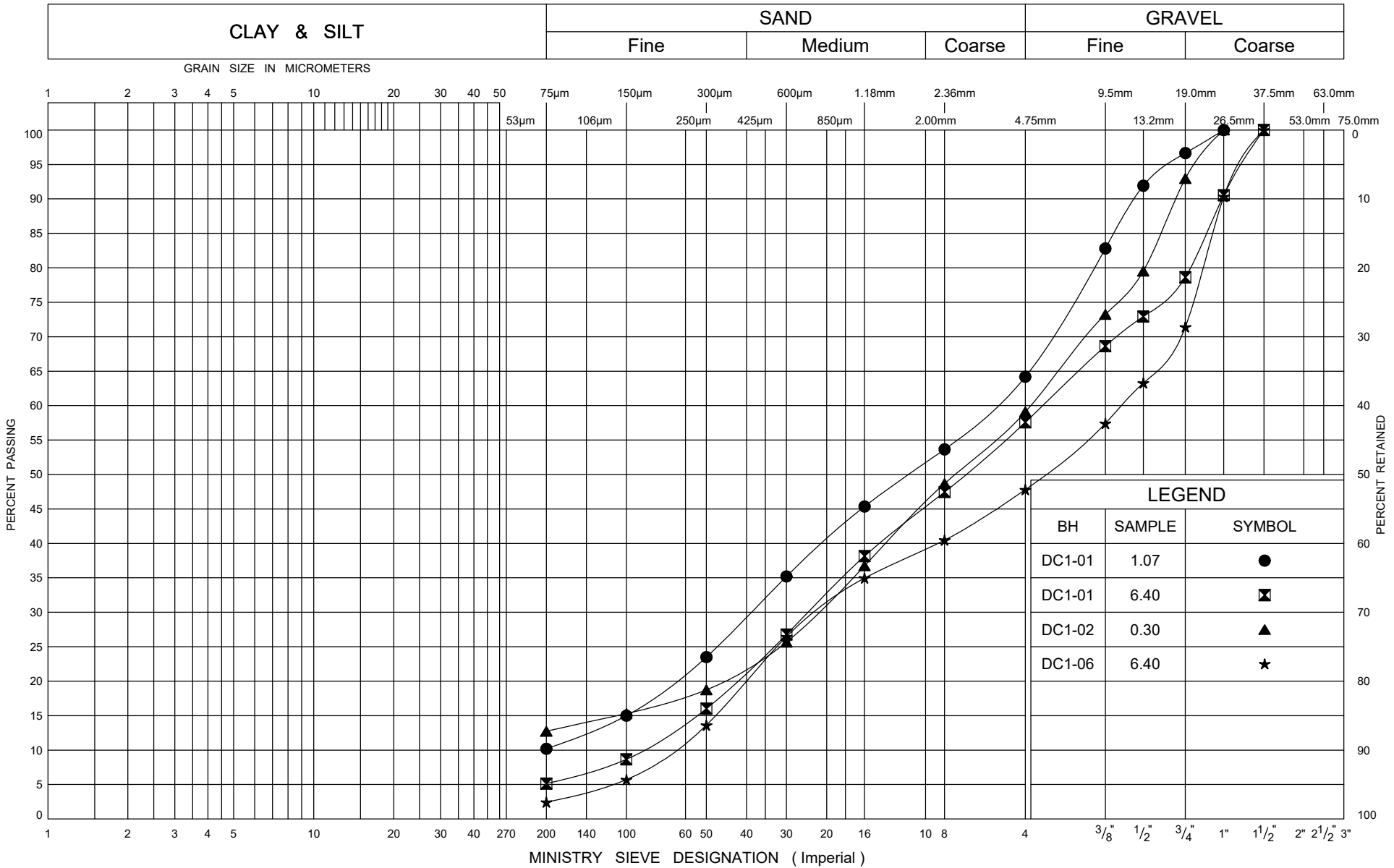
ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 5/9/24



## GRAIN SIZE DISTRIBUTION SAND

FIG No E2

GWP# 6333-14-00



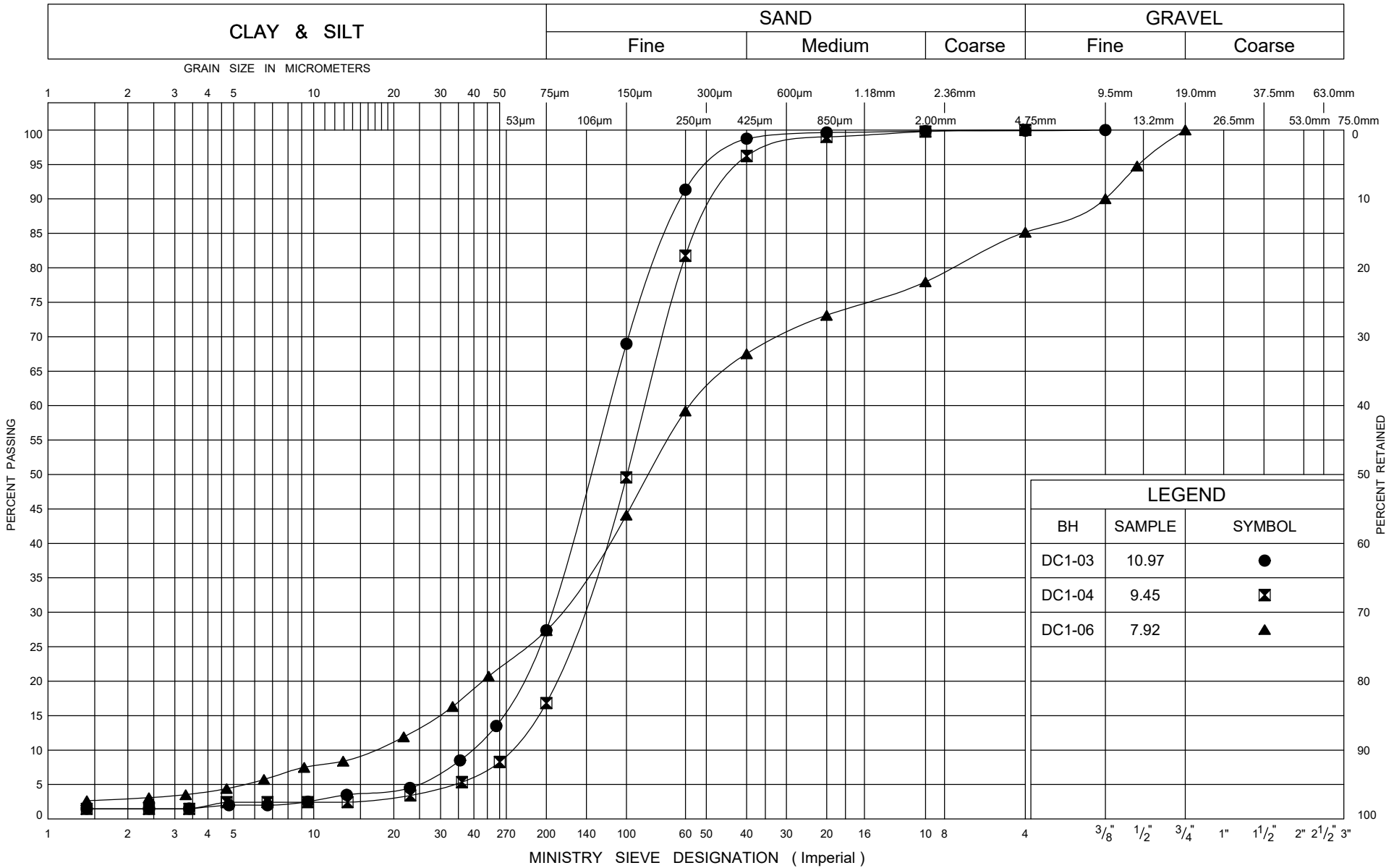
ONTARIO MOT GRAIN SIZE 2 MTO-37996.GPJ ONTARIO MOT.GDT 7/30/24



## GRAIN SIZE DISTRIBUTION SAND and GRAVEL

FIG No E3

GWP# 6333-14-00



LEGEND		
BH	SAMPLE	SYMBOL
DC1-03	10.97	●
DC1-04	9.45	⊠
DC1-06	7.92	▲

ONTARIO MOT GRAIN SIZE 2 MTO-37996.GPJ ONTARIO MOT.GDT 7/30/24



## GRAIN SIZE DISTRIBUTION

Silty SAND to Sandy SILT

FIG No E4

GWP# 6333-14-00

## **APPENDIX F**

Bedrock Laboratory Test Results and Rock Core Photographs











**THURBER ENGINEERING LTD.**

**POINT LOAD TEST SHEET**

**ASTM D5731-08**

**Job No:** 37996

**Date Drilled:** 13-Mar-24

**Project Name:** HWY 17 Hewitson Creek

**Date Tested:** 15-Apr-24

**Core Size:** NQ **BH No :** HF3-02

**Tester:** BS

**Client:** Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	I <sub>s(50)</sub> (MPa)	UCS (MPa)	Rock Type	Rock Strength <small>(after Hoek &amp; Brown, 1997)</small>
1	1	18.6	D	13.0	47.2	69.8	5.4	129.4	Granite	Very Strong
2	1	18.9	D	26.7	47.1	67.3	11.1	266.6	Granite	Extremely Strong
3	1	19.2	D	23.2	47.0	70.4	9.7	232.4	Granite	Very Strong
4	1	19.5	D	26.2	47.2	69.3	10.9	260.7	Granite	Extremely Strong
5	2	19.9	D	22.2	47.1	67.1	9.2	221.6	Granite	Very Strong
6	2	20.2	D	24.7	47.2	70.6	10.2	245.8	Granite	Very Strong
7	2	20.5	D	20.8	47.1	74.8	8.7	207.7	Granite	Very Strong
8	2	20.9	D	21.9	47.1	67.9	9.1	218.6	Granite	Very Strong
9	3	21.3	D	20.2	47.1	73.0	8.4	201.7	Granite	Very Strong
10	3	21.6	D	22.8	47.1	70.7	9.5	227.6	Granite	Very Strong
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										

Run 1 Average: 222.3 Very Strong

Run 2 Average: 223.4 Very Strong

Run 3 Average: 214.7 Very Strong







## Bedrock Core Photos

**Borehole HF1-01, Runs 1, 2, and 3: 16.8 to 20.1 (Elev. 203.8 to 200.5 m)**



**Borehole HF1-02, Runs 1, 2, and 3: 8.4 to 12.0 (Elev. 217.7 to 214.1 m)**



**Borehole HF1-04, Runs 1, 2, and 3: 10.7 to 14.3 (Elev. 209.8 to 206.2 m)**



## Bedrock Core Photos

**Borehole HF3-01, Runs 1, 2, and 3: 18.3 to 21.8 (Elev. 232.1 to 228.6 m)**



**Borehole HF3-02, Runs 1, 2, and 3: 18.5 to 21.7 (Elev. 229.5 to 226.3 m)**

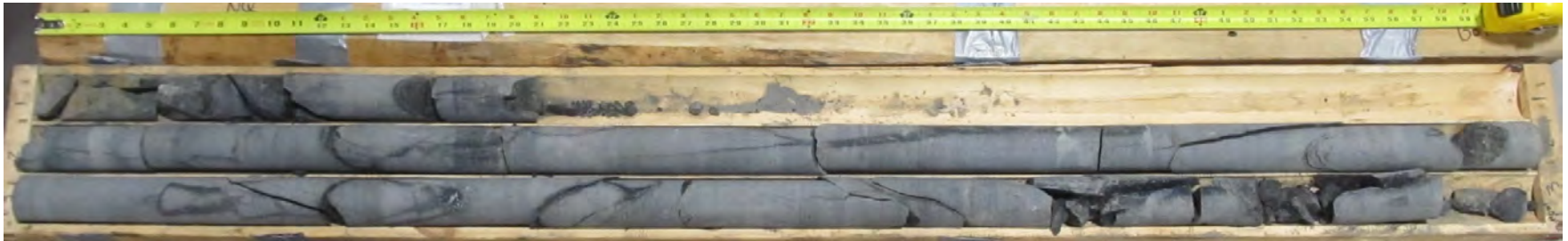


**Borehole HF3-04, Runs 1, 2, and 3: 22.9 to 26.3 (Elev. 228.4 to 225.0 m)**



## Bedrock Core Photos

**Borehole DC1-05, Run 1, 2, 3: 13.1 to 16.6 (Elev. 293.9 to 290.4 m)**



**Borehole DC1-06, Run 1, 2, 3: 10.7 to 14.2 (Elev. 296.3 to 292.8 m)**





## **APPENDIX G**

Analytical Laboratory Test Results



## FINAL REPORT

CA15114-APR24 R

Prepared for

**Thurber Engineering Ltd.**

## First Page

### CLIENT DETAILS

Client **Thurber Engineering Ltd.**

Address **1908 Ironoak Way, Suite 202  
Oakville, ON  
L6H 0N1, Canada**

Contact **Rachel Bourassa**

Telephone **905-829-8666 x 263**

Facsimile

Email **rbourassa@thurber.ca**

Project

Order Number

Samples **Solution (3)**

### LABORATORY DETAILS

Project Specialist **Jill Campbell, B.Sc.,GISAS**

Laboratory **SGS Canada Inc.**

Address **185 Concession St., Lakefield ON, K0L 2H0**

Telephone **2165**

Facsimile **705-652-6365**

Email **jill.campbell@sgs.com**

SGS Reference **CA15114-APR24**

Received **04/19/2024**

Approved **04/25/2024**

Report Number **CA15114-APR24 R**

Date Reported **04/25/2024**

### COMMENTS

Temperature of Sample upon Receipt: 1 degrees C

Cooling Agent Present: YES

Custody Seal Present: YES

Chain of Custody: 035940

### SIGNATORIES

Jill Campbell, B.Sc.,GISAS





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# FINAL REPORT

CA15114-APR24 R

**Client:** Thurber Engineering Ltd.

**Project:**

**Project Manager:** Rachel Bourassa

**Samplers:** G.Azzopardi

MATRIX: WATER

Sample Number	6	7	8
Sample Name	HF1	HF3	Hewiston Creek
Sample Matrix	Solution	Solution	Solution
Sample Date	18/04/2024	18/04/2024	18/04/2024

Parameter	Units	RL	Result	Result	Result
<b>General Chemistry</b>					
Conductivity	uS/cm	2	26	194	36
Redox Potential	mV	no	226	192	254
Sulphide	µg/L	6	< 6	< 6	< 6
<b>Metals and Inorganics</b>					
Sulphate	mg/L	0.04	1.6	4.0	2.2
<b>Other (ORP)</b>					
pH	No unit	0.05	6.80	7.78	6.88
Chloride	mg/L	0.04	0.37	38	4.5

## QC SUMMARY

### Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-IENVIIC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0477-APR24	mg/L	0.04	<0.04	4	20	98	90	110	103	75	125
Sulphate	DIO0477-APR24	mg/L	0.04	<0.04	1	20	98	90	110	101	75	125
Chloride	DIO0537-APR24	mg/L	0.04	<0.04	3	20	99	90	110	86	75	125
Sulphate	DIO0537-APR24	mg/L	0.04	<0.04	0	20	99	90	110	93	75	125

### Conductivity

Method: SM 2510 | Internal ref.: ME-CA-IENVIEWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0529-APR24	uS/cm	2	< 2	0	20	100	90	110	NA		
Conductivity	EWL0530-APR24	uS/cm	2	< 2	0	20	100	90	110	NA		



# FINAL REPORT

CA15114-APR24 R

## QC SUMMARY

### pH

Method: SM 4500 | Internal ref.: ME-CA-ENVIEWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0529-APR24	No unit	0.05	NA	0		101			NA		
pH	EWL0530-APR24	No unit	0.05	NA	0		101			NA		

### Redox Potential

Method: SM 2580 I

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Redox Potential	EWL0490-APR24	mV	no	NA	0	20	104	80	120	NA		

### Sulphide by SFA

Method: SM 4500 | Internal ref.: ME-CA-ENVISFA-LAK-AN-008

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide	SKA0241-APR24	ug/L	6	<0.006	ND	20	99	80	120	NA	75 125	

## QC SUMMARY

---

**Method Blank:** a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

**Duplicate:** Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

**LCS/Spike Blank:** Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

**Matrix Spike:** A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

**Reference Material:** a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

**RL:** Reporting limit

**RPD:** Relative percent difference

**AC:** Acceptance criteria

**Multielement Scan Qualifier:** as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

**Duplicate Qualifier:** for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

**Matrix Spike Qualifier:** for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

## LEGEND

---

### FOOTNOTES

- NSS** Insufficient sample for analysis.
- RL** Reporting Limit.
  - ↑ Reporting limit raised.
  - ↓ Reporting limit lowered.
- NA** The sample was not analysed for this analyte
- ND** Non Detect

Results relate only to the sample tested.

Data reported represent the sample as submitted to SGS. Solid samples expressed on a dry weight basis.

"Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the "Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act and Excess Soil Quality" published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated.

SGS Canada Inc. statement of conformity decision rule does not consider uncertainty when analytical results are compared to a specified standard or regulation.

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This report supersedes all previous versions.

-- End of Analytical Report --





## FINAL REPORT

CA40086-MAY24 R1

37996, Hewitson Creek

Prepared for

**Thurber Engineering Ltd.**

## First Page

### CLIENT DETAILS

Client **Thurber Engineering Ltd.**

Address **1908 Ironoak Way, Suite 202  
Oakville, ON  
L6H 0N1, Canada**

Contact **Rachel Bourassa**

Telephone **905-829-8666 x 263**

Facsimile

Email **rbourassa@thurber.ca**

Project **37996, Hewitson Creek**

Order Number

Samples **Soil (6)**

### LABORATORY DETAILS

Project Specialist **Maarit Wolfe, Hon.B.Sc**

Laboratory **SGS Canada Inc.**

Address **185 Concession St., Lakefield ON, K0L 2H0**

Telephone **705-652-2000**

Facsimile **705-652-6365**

Email **Maarit.Wolfe@sgs.com**

SGS Reference **CA40086-MAY24**

Received **05/09/2024**

Approved **05/21/2024**

Report Number **CA40086-MAY24 R1**

Date Reported **05/21/2024**

### COMMENTS

Temperature of Sample upon Receipt: 8 degrees C  
Cooling Agent Present: YES  
Custody Seal Present: YES

Chain of Custody Number: NA

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.

### SIGNATORIES

Maarit Wolfe, Hon.B.Sc



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# FINAL REPORT

CA40086-MAY24 R1

**Client:** Thurber Engineering Ltd.

**Project:** 37996, Hewitson Creek

**Project Manager:** Rachel Bourassa

**Samplers:** Rachel Bourassa

MATRIX: SOIL

Sample Number	5	6	7	8	9	10
<b>Sample Name</b>	HCC-04 SS5 (11'-13')	HCC-03 SS4 (8.5'-10.5')	HF3-03 SS11 (40'-40'9")	HF1-01 SS3 (5'-7')	HF3-02 SS5 (10'-12')	HF1-04 SS4 (7'6"-9'6")
<b>Sample Matrix</b>	Soil	Soil	Soil	Soil	Soil	Soil
<b>Sample Date</b>	03/04/2024	24/03/2024	09/03/2024	16/03/2024	11/03/2024	16/03/2024

Parameter	Units	RL	Result	Result	Result	Result	Result	Result	
<b>Corrosivity Index</b>									
Corrosivity Index	none	1	1	1	4	1	1	1	
Soil Redox Potential	mV	no	272	298	304	295	284	278	
Sulphide (Na <sub>2</sub> CO <sub>3</sub> )	%	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	
pH	pH Units	0.05	7.66	7.66	8.78	6.05	7.13	6.32	
Resistivity (calculated)	ohms.cm	-9999	19200	12300	5620	11400	20000	27800	
<b>General Chemistry</b>									
Conductivity	uS/cm	2	52	81	178	88	50	36	
<b>Metals and Inorganics</b>									
Moisture Content	%	0.1	11.6	8.4	12.8	7.3	11.3	8.4	
Sulphate	µg/g	0.4	0.6	3.3	1.0	3.0	2.1	2.1	
<b>Other (ORP)</b>									
Chloride	µg/g	0.4	1.6	12	11	27	10	6.1	

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-IENVIIC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0352-MAY24	µg/g	0.4	<0.4	11	35	105	80	120	103	75	125
Sulphate	DIO0352-MAY24	µg/g	0.4	<0.4	9	35	98	80	120	88	75	125

Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-IENVIARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide (Na <sub>2</sub> CO <sub>3</sub> )	ECS0045-MAY24	%	0.01	< 0.01								

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-IENVIEWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0387-MAY24	uS/cm	2	< 2	1	20	99	90	110	NA		

## QC SUMMARY

### pH

Method: SM 4500 | Internal ref.: ME-CA-ENVIEWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0364-MAY24	pH Units	0.05	NA	0		101			NA		

**Method Blank:** a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

**Duplicate:** Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

**LCS/Spike Blank:** Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

**Matrix Spike:** A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

**Reference Material:** a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

**RL:** Reporting limit

**RPD:** Relative percent difference

**AC:** Acceptance criteria

**Multielement Scan Qualifier:** as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

**Duplicate Qualifier:** for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

**Matrix Spike Qualifier:** for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

## LEGEND

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### FOOTNOTES

- NSS** Insufficient sample for analysis.
- RL** Reporting Limit.
  - ↑ Reporting limit raised.
  - ↓ Reporting limit lowered.
- NA** The sample was not analysed for this analyte
- ND** Non Detect

Results relate only to the sample tested.

Data reported represent the sample as submitted to SGS. Solid samples expressed on a dry weight basis.

"Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the "Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act and Excess Soil Quality" published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated.

SGS Canada Inc. statement of conformity decision rule does not consider uncertainty when analytical results are compared to a specified standard or regulation.

This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at [http://www.sgs.com/terms\\_and\\_conditions.htm](http://www.sgs.com/terms_and_conditions.htm).

The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents. Reproduction of this analytical report in full or in part is prohibited.

This report supersedes all previous versions.

-- End of Analytical Report --



**Request for Laboratory Services and CHAIN OF CUSTODY**

**Laboratory Information Section - Lab use only**

Received By: ED  
 Received Date: 5/9/24 (mm/dd/yy)  
 Received Time: 12:30 (hr : min)

Received By (signature): \_\_\_\_\_  
 Cooling Agent Present: Yes  No   
 Custody Seal Present: Yes  No   
 Custody Seal Intact: Yes  No   
 Temperature Upon Receipt (°C): 4.3 Type: ICE

LAB LIMS # 2410086-MAY24

**REPORT INFORMATION**

Company: Thurber Engineering LTD  
 Contact: Rachel Bourassa  
 Address: 1908 Ironoak Way, Oakville, ON  
 Suite 202, L6H 0N1  
 Phone: 416-523-1015  
 Fax: \_\_\_\_\_  
 Email: RBourassa@Thurber.ca

**INVOICE INFORMATION**

(same as Report Information)  
 Company: \_\_\_\_\_  
 Contact: \_\_\_\_\_  
 Address: \_\_\_\_\_  
 Phone: \_\_\_\_\_  
 Email: accountingON@thurber.ca

**REGULATIONS**

O.Reg 153/04  O.Reg 406/19  
 Table 1  Res/Parc  Soil Texture  
 Table 2  Ind/Com  Porose  
 Table 3  Agr/Other  Medium/Fine  
 Table \_\_\_\_\_  MISA  
 Soil Volume  <350m3  >350m3  
 Other Regulations: \_\_\_\_\_  
 Sewer By-Law: \_\_\_\_\_  
 Panlary  Storm  
 PWO  JMIR  
 CCME  Other  
 MISA  
 ODWS Not Reportable \*See note

Quotation # \_\_\_\_\_  
 Project # 37996  
 Regular TAT (5-7days)  
 RUSH TAT (Additional Charges May Apply):  1 Day  2 Days  3 Days  4 Days  
 PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION  
 Specify Due Date: \_\_\_\_\_  
 \*NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

**ANALYSIS REQUESTED**

M & I	SVOC	PCB	PHC	VOC	Pest	Other	TCLP
Field Filtered (Y/N)							
Metals & Inorganics <small>(incl CrVI, CN, Hg, pH, B(HWS), EC, SAR-soil) (Cl, Na-water)</small>							
Full Metals Suite <small>(CP metals plus B(HWS-soil only) Hg, CrVI)</small>							
ICP Metals only <small>Sb, As, Ba, Be, B, Cd, Cr, Co, Cu, Pb, Mo, Ni,</small>							
PAHs only							
SVOCs <small>all incl PAHs, ABNs, CPs</small>							
PCB <input type="checkbox"/> Total <input type="checkbox"/> Aroclor							
F1-F4 + BTEX							
F1-F4 only <small>no BTEX</small>							
VOCs <small>all incl BTEX</small>							
BTEX only							
Pesticides <small>Organochlorine or specify other</small>							
<u>Comsativity</u>							
Appendix 2: 406/19 Leachate Screening Levels Table:							
Sewer Use: <small>Specify pkg:</small>							
Water Characterization Pkg <small>General <input type="checkbox"/> Extended <input type="checkbox"/></small>							
TCLP <small>Specify tests</small>							
<input type="checkbox"/> TCLP <input type="checkbox"/> tests							
<input type="checkbox"/> VOC <input type="checkbox"/> PCB							
<input type="checkbox"/> M&I <input type="checkbox"/> Bio							
<input type="checkbox"/> ABN <input type="checkbox"/> Ignit							

**COMMENTS:**

SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX
1 HCC-04 SSE(11-13)	April 3, 2024		1	Soil
2 HCC-03 SS4 (8.5-10.5)	March 24, 2024		1	Soil
3 HF3-03 SS11 (40' - 409")	March 9, 2024		1	Soil
4 HF1-01 SS3 (5' - 7')	March 16, 2024		1	Soil
5 HF3-02 SS5 (10'-12')	March 11, 2024		1	Soil
6 HF1-04 SS4 (7'6" - 9'6")	March 16, 2024		1	Soil
7				
8				
9				
10				
11				
12				

Observations/Comments/Special Instructions

Sampled By (NAME): Rachel Bourassa Signature: Rachel Bourassa Date: 05/09/2023 (mm/dd/yy)  
 Relinquished by (NAME): Rachel Bourassa Signature: Rachel Bourassa Date: 05/09/2023 (mm/dd/yy)  
 Note: Submission of samples to SGS is acknowledgement that you have been provided direction on sample collection, handling and transportation of samples. (2) Submission of samples to SGS is considered authorization for completion of work. Signatures may appear on this form or the retained on file in the contract, or in an alternative format (e.g. shipping documents). (3) Results may be sent by email to an unlimited number of addresses for no additional cost. Fax is available upon request. This document is issued by the Company under its General Conditions of Service accessible at [http://www.sgs.com/terms\\_and\\_conditions.htm](http://www.sgs.com/terms_and_conditions.htm). (Printed copies are available upon request.) Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.



## **APPENDIX H**

Site Photographs



**Photo 1: Borehole HF1-01 after completion of drilling near Sta 10+275 looking south, photo taken March 18, 2024**



**Photo 2: Borehole HF1-02 near Sta 10+206 prior to borehole drilling looking west, photo taken March 4, 2024**



**Photo 3: Borehole HF1-04 prior to drilling at Sta. 10+270 (20 m south of proposed CL) looking west, photo taken March 4, 2024**



**Photo 4: Section HF3 looking southeast along CL near Sta. 11+550, photo taken March 13, 2024**



**Photo 5: Borehole HF3-02 near Sta. 11+600 (approximately 20 m south of CL) looking south, taken March 13, 2024**



**Photo 6: Section HF3 near Sta. 11+610 CL looking along watercourse, photo taken March 7, 2024**



**THURBER** ENGINEERING LTD.

## SITE PHOTOS



**Photo 7: Section HF4 looking west along CL near Sta 12+200, photo taken March 5, 2024**



**Photo 8: Section HF4 looking west along CL near Sta 12+300, photo taken August 16, 2023**



**Photo 9: Section DC1 looking west along CL from approx. Sta 12+425, photo taken April 10, 2024**



**Photo 10: Section DC1 looking east along CL from approx. Sta 12+475 towards Highway 17, photo taken August 16, 2023**



**THURBER** ENGINEERING LTD.

## SITE PHOTOS



**Photo 11: Borehole DC1-04 near Sta 12+500 looking east, photo taken March 1, 2024**



**Photo 12: Section DC1 looking west along Highway 17 near Sta 12+660, photo taken August 17, 2023**