WWW.THURBER.CA

THURBER

Detailed Foundation Investigation and Design Report
Hewitson Creek Culvert Replacement

Highway 17 Realignment, 9.3 to 13.3 km West of the Township of Schreiber
Northwestern Region, Ontario
G.W.P. 6333-14-00, Site No. 48C-0026/C0
Latitude: 48.837787°, Longitude: -87.407203°
GEOCRES No. 42D14-002

Client Name: Hatch
Date: December 12, 2024
File: 37996

Suite 202 - 1908 Ironoak Way, Oakville, ON L6H 0N1 | Phone: (905) 829-8666

THURBER

TABLE OF CONTENTS

PART 1: FACTUAL INFORMATION

PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

IN-TEXT TABLES

IN-TEXT FIGURES

APPENDICES

APPENDIX A

Stratigraphic Plan and Profile Drawings

APPENDIX B

Record of Borehole Sheets

APPENDIX C

Soil Laboratory Figures and Well Test Results

APPENDIX D

Bedrock Laboratory Test Results and Rock Core Photographs

APPENDIX E

Analytical Laboratory Test Results

APPENDIX F

Site Photographs

APPENDIX G

Slope Stability Analysis Figures

APPENDIX H

List of OPSS and OPSD Documents and Suggested Wording for NSSPs

APPENDIX I

Figures

THURBER

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, Site No. 48C-0026/C0
LATITUDE: 48.837787°, LONGITUDE: -87.407203°

GEOCRES No. 42D14-002

PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual findings obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the proposed Hewitson Creek Culvert replacement, as part of the Highway 17 Curve Realignment from 9.3 to 13.3 km west of the Township of Schreiber, Ontario.

The project includes an approximately 4 km long realignment of Highway 17, starting 9.3 km west of the Township of Schreiber. This report pertains to the construction of a new structural culvert where the realigned Highway 17 crosses Hewitson Creek. The project scope includes the detailed design of the Hewitson Creek Culvert and the associated high fill approach embankments.

A separate investigation was completed for construction of new high fill embankments and deep cut sections for the new alignment, as well as the installation of new non-structural culverts in two locations. The high fill and deep cut foundations report is discussed in a separate report entitled:

"Detailed Foundation Investigation and Design 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", File: 37996, Dated October 22, 2024 (Reference 1).

The purpose of Thurber's investigation was to explore the subsurface conditions at the proposed structural culvert and approach embankment locations, 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.

2. SITE DESCRIPTION

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. A 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. Bedrock was observed at the ground surface locally near the east and west ends of the proposed alignment near the existing highway.

The Hewitson Creek valley is steep and heavily forested. The creek bed elevation at the culvert site ranges from approximately 204 to 205 m, while the top of the creek valley slopes are at approximate Elev. 222 m on the west side (Sta. 10+930), and 230 m on the east side (Sta. 11+150), indicating that the valley slopes are approximately 17 to 25 m high. Hewitson Creek generally flows from north to south, and the surface water level in the creek is approximately Elev. 206 to 206.5 m.

Typical photographs of the Hewitson Creek Culvert site are included in Appendix F.

2.2 Existing Subsurface Information

A preliminary foundation investigation was previously completed by Thurber for the Hewitson Creek Culvert Replacement. The preliminary foundation investigation report for this site is available within the online Geocres Library.

- Geocres 42D-071
    - Preliminary Foundation Investigation Report, Highway 17 Realignment and Hewitson Creek Culvert, 9.3 to 13.3 Km West of Township of Schreiber, Northwestern Region, Ontario, G.W.P. 6333-14-00, Dated March 27, 2023

The historical borehole locations have been included in the borehole plan in Appendix A. The borehole program for the culvert structure and approach embankments included two boreholes

identified as HEW-01 and HEW-02. The boreholes were advanced to depths of 5.6 and 4.3 m (Elev. 201.0 m and 201.9 m) near the west edge of the proposed culvert location. The stratigraphy was described as topsoil overlying silty sand to sand and gravel with frequent cobbles and boulders. The historical borehole logs are included in Appendix B.

2.3 Regional Geology

Quaternary geological mapping[1] indicates that the proposed Hewitson Creek culvert primarily lies within 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, indicating the presence of igneous or metamorphic rock at surface or below discontinuous and thin layers of drift.

Bedrock mapping[2] in this area indicates the bedrock is typically comprised of the 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[3].

3. SITE INVESTIGATION AND FIELD TESTING

The scope of the detailed foundation investigation at the Hewitson Creek site consisted of a field drilling program of advancing 11 boreholes at the locations of the proposed structural culvert and high fill approaches. The field investigation for these areas was carried out in two phases. One borehole (HF2A-01) was advanced during the track-mounted drilling from March 2 to 3, 2024. The remaining Hewitson Creek and high fill boreholes were drilled between March 23 to April 17, 2024. The previous phase of the investigation completed along the high fill and deep cut sections was conducted between March 1 and 18, 2024 and included 21 boreholes.

The boreholes completed for the Hewitson Creek investigation, along with the locations, assigned nomenclature and depths / base elevations are summarized in Table 3.1.

[1] *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.*

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

[3] *Carter, M. W. 1988: Geology of Schreiber-Terrace Bay area, District of Thunder Bay; Ontario Geological Survey, Open File Report 5692*

Table 3.1: Summary of Investigation Program

Location and Assigned Nomenclature	Approximate Station	Boreholes	Borehole Depth / Base Elevation (m)
West Approach Embankment / High Fill 2A (HF2A)	10+940 to 10+990	HF2A-01 to HF2A-02	9.5 to 19.0 / 202.3 to 198.0
Hewitson Creek Structural Culvert (HCC)	10+990 to 11+020	HCC-01 to HCC-06	11.6 to 19.5 / 195.2 to 185.5
East Approach Embankment / High Fill 2B (HF2B)	11+020 to 11+130	HF2B-01 to HF2B-03	13.2 to 21.6 / 205.6 to 183.1

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 Appendix B.

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.

Access for a drill rig to the base of the >25 m valley was difficult without an appropriately designed access road. Hence, all boreholes, except for Borehole HF2A-01, were advanced using a Boart Longyear LF-70, Heli-portable drill rig. The drilling methodology used was wash boring with HWT casing and HQ coring methods. Borehole HF2A-01 was advanced using a track-mounted drill rig with solid and hollow stem augers, wash boring with NW casing, and NQ coring methods. All drilling equipment was 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 Heli-portable drill rig and all drilling equipment were transported across the site by a Bell 407 Helicopter (Aircraft Identification: C-GKTN, C-FKOP). The helicopters and all related equipment were provided by Wisk Air Helicopters of Thunder Bay, Ontario.

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. Monitoring wells were installed in Boreholes HCC-01 and HCC-05. Both wells consisted of 50 mm

Schedule 40 PVC pipe with a 3 m long slotted screen, enclosed in a column of filter sand to permit groundwater level monitoring. Monitoring well installation details, groundwater level observations and water level readings are shown on the Record of Borehole sheets. A sample of the groundwater was obtained from the well at Borehole HCC-01 and submitted to a specialist analytical laboratory under chain of custody procedures for testing for a suite of water quality parameters. Single well response tests ("slug") tests were carried out in the wells installed in both Boreholes HCC-01 and HCC-05. The monitoring wells were decommissioned as per O. Reg. 903 at the completion of the well testing. All other boreholes were backfilled with bentonite upon completion of drilling in general accordance with O. Reg. 903.

4. LABORATORY TESTING

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) and Unconfined Compressive Strength (UCS) Testing. The laboratory test results are summarized on the Record of Borehole sheets included in Appendix B, and presented on the figures included in Appendices C and D.

Selected soil and surface water samples for the proposed Hewitson Creek Culvert location were submitted for analytical testing to assess the potential for sulphate attack on concrete foundations, as well as the potential for corrosion associated with the structure. In order to assess the quality of the groundwater for disposal purposes, a water sample was collected from the well installed in Borehole HCC-01. 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 Sections 6 and 7 and the laboratory Certificates of Analysis are included in Appendix E.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

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 Appendix B.

A general description of the soil stratigraphy 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, bedrock and groundwater conditions 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, frequently containing cobbles and boulders. Granite to granodiorite bedrock was encountered below the overburden soils.

5.1 Surficial Topsoil and Organics

Topsoil or surficial organics were encountered at the ground surface in all HCC and HF2 boreholes. Topsoil was encountered in HCC-05, HCC-06, and HF2B-01. Organic materials were observed at surface in boreholes HCC-01 to HCC-04, HF2A-01, HF2A-02, HF2B-02 and HF2B-03. The layer thickness ranged from 150 to 700 mm at the borehole locations (base Elev. from 221.1 to 204.5 m). Topsoil and surficial organics thickness may vary between and beyond the boreholes.

The surficial organics observed on site were described as loose, dark brown to black, and occasionally containing rootlets and wood fibres.

SPT 'N' values recorded in the organic materials ranged from 7 to 12 blows per 0.3 m penetration, indicating a loose to compact relative density. Natural moisture contents in the topsoil and organics ranged from 53 to 236%.

5.2 Sand and Gravel to Gravel

A 1.7 to 8.0 m thick deposit of sand and gravel to gravel was encountered in Boreholes HCC-01 to HCC-03, HCC-05, HCC-06, HF2A-01, HF2A-02, HF2B-02, and HF2B-03. The sand and gravel to gravel material was encountered below the surficial organics and topsoil, and occasionally interbedded with the silty sand to silt and sand layers. Occasional fine seams of silty sand were encountered throughout the deposit.

The sand and gravel to gravel layer frequently contained cobbles and boulders with diameters ranging from 75 mm to 350 mm. The cobble and boulder details are provided on the Record of Borehole sheets in Appendix B. Photographs of the cored cobbles and boreholes are provided in Appendix D.

The top of the sand and gravel layers were encountered at depths ranging from 0.2 m to 5.6 m (Elev. 215.7 to 200.3 m), and the base of the layers extended to depths of 2.5 to 13.2 m (Elev. 212.6 to 197.0 m).

Sand and gravel layers that were interbedded with sand and silt layers were encountered at depths from 4.4 m to 13.3 m (Elev. 202.4 m to 192.2 m) and extended to depths from 8.5 to 14.9 m (Elev. 198.3 to 190.6 m) in Boreholes HCC-01, HCC-02, and HCC-05.

SPT 'N' values recorded in this deposit ranged from 12 blows per 0.3 m penetration to greater than 50 blows per 0.075 m penetration, indicating a compact to very dense relative density. The natural moisture contents measured typically ranged from 1 to 27%, locally up to 49% in Borehole HCC-03 below the surficial organics.

The results of grain size analyses conducted on samples of the Sand and Gravel to Gravel are provided on the Record of Borehole sheets in Appendix B and illustrated on Figures C1 and C2 of Appendix C. The results are summarized as follows:

Soil Particle	Percentage (%)	
	Gravel	Sandy Gravel to Sand and Gravel
Gravel	63 to 80	39 to 57
Sand	19 to 31	30 to 50
Silt and Clay	1 to 6	4 to 17

5.3 Silty Sand to Sandy Silt

A layer of silty sand to sandy silt, containing trace gravel and clay was encountered throughout the site underlying topsoil, organics, or a sand and gravel to gravel layer. Silty sand to sandy silt was encountered in boreholes HCC-01, HCC-04, HCC-05, HCC-06, HF2A-01, HF2B-01, and HF2B-02 at depths ranging from 0.2 to 10.5 m (Elev. 221.1 to 194.5 m). The layers of silty sand, silt and sand, and sandy silt were typically interbedded. Individual layers of each ranged in thickness from 1.4 to 11.8 m and were occasionally interbedded with the sand and gravel to gravelly sand. Localized gravelly layers were occasionally encountered throughout the deposit. The base of the silty sand to sandy silt layer was encountered at depths ranging from 4.4 to 15.1 m (Elev. 208.1 to 189.8 m).

The silty sand to sandy silt deposit contained occasional cobbles and boulders throughout the site. The cobble and boulder diameters ranged from 75 mm to 280 mm. The cobble and boulder details are provided on the Record of Borehole sheets in Appendix B and photographs of the cored cobbles and boulders are provided in Appendix D.

SPT ‘N’ values recorded in the silty sand to sandy silt ranged from 13 blows per 0.3 m penetration to greater than 100 m for 0.1 m penetration, indicating a compact to very dense relative density. Natural moisture contents typically ranged from 7 to 30%.

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 B and illustrated on Figures C3 and C4 of Appendix C. The results are summarized as follows:

Soil Particle	Percentage (%)	
	Silty Sand	Silt and Sand to Sandy Silt
Gravel	0 to 17	0 to 8
Sand	59 to 76	25 to 51
Silt	20 to 34	46 to 74
Clay	1 to 3	1 to 4

5.4 Sand

Localized deposits of sand, containing trace to some silt and trace to some gravel were encountered underlying the organic materials at depths ranging from 0.2 m to 0.7 m (Elev. 209.8 to 204.5 m) in Boreholes HF2A-02, HF2B-01, and HF2B-02. The sand deposit was also encountered interbedded within the sand and gravel to gravel deposit in HCC-02 and below the silt and sand to sandy silt deposit in HCC-04 at depths of 4.4 m and 12.0 m (Elev. 201.8 and 198.0 m), respectively. The sand deposit ranged in thickness from 1.8 to 5.7 m, and the base encountered at depths from 2.5 to 15.0 m (Elev. 205.0 to 195.0 m).

The sand deposit contained occasional cobbles throughout the site. The details regarding the thickness and location of the cobbles are provided on the Record of Borehole sheets in Appendix B. Photographs of the cored cobbles are provided in Appendix D.

SPT 'N' values recorded in the sand ranged from 10 blows per 0.3 m penetration to greater than 50 blows for 0.0 m of penetration, indicating a compact to very dense relative density (typically compact). Natural moisture contents in the sand ranged from 2 to 36%, locally up to 52% in HF2B-01 below the surficial topsoil.

The results of grain size analyses conducted on samples of the sand are provided on the Record of Borehole sheets in Appendix B and illustrated in Figure C5 of Appendix C. The results are summarized as follows:

Soil Particle	Percentage (%)	
Gravel	1 to 8	
Sand	79 to 91	
Silt	8	13
Clay	0	

5.5 Silt

Localized silt deposits containing trace to some clay, trace to some sand, and trace gravel were encountered underlying the silty sand to sandy silt deposit. Occasional cobbles from 100 to 175 mm in diameter were encountered within the silt in HF2B-03. The top of the silt ranged in depth from 1.8 m to 15.1 m (Elev. 219.5 to 189.8 m) in Boreholes HCC-06, HF2A-01 and HF2B-02. Silt was also encountered at 0.2 m depth (Elev. 218.6 m) below the surficial organic materials in Borehole HF2B-03.

The silt layers ranged in thickness from 1.4 to 5.0 m, with the base encountered at depths from 5.2 to 18.6 m (Elev. 215.7 to 186.1 m) upon the underlying bedrock, or locally in HF2B-03 upon the underlying sand and gravel.

SPT 'N' values recorded in the silt typically ranged from 6 blows per 0.3 m penetration to greater

than 100 blows per 0.025 m of penetration, indicating a loose to very dense relative density (typically compact to very dense). Natural moisture contents in the silt ranged from 17 to 28%.

The results of grain size analyses conducted on samples of the silt are provided on the Record of Borehole sheets in Appendix B and illustrated in Figure C6 of Appendix C. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	0
Sand	6 to 18
Silt	76 to 86
Clay	5 to 15

The results of an Atterberg Limits test conducted on a sample of the silt are provided on the Record of Borehole sheets in Appendix B and illustrated on Figure C7 of Appendix C. The results are summarized as follows:

Index Property	Percentage (%)
Liquid Limit	22
Plasticity Index	3

The results of the Atterberg Limits test indicates that the material can be characterized as a non-plastic silt (ML).

5.6 Bedrock

Bedrock was encountered below the overburden materials in Boreholes HCC-01 to HCC-06, HF2A-01, HF2A-02, HF2B-01, and HF2A-02. The top of bedrock was encountered at depths between 6.5 m and 18.6 m (Elev. 205.7 to 186.1 m). The bedrock depths and elevations are shown on Table 5.1 below.

Table 5.1: Bedrock Depths

Borehole ID	Bedrock Depth (m)	Bedrock Elevation (m)
HCC-01	8.5	198.3
HCC-02	10.2	196.0
HCC-03	8.6	197.0
HCC-04	15.0	195.0
HCC-05	14.9	190.6

Borehole ID	Bedrock Depth (m)	Bedrock Elevation (m)
HCC-06	16.5	188.5
HF2A-01	15.6	205.7
HF2A-02	6.5	201.0
HF2B-01	13.0	197.0
HF2B-02	18.6	186.1

The bedrock was proven by coring 3 to 3.4 m below the rock surface. The bedrock was visually identified as granite in Boreholes HCC-01 to HCC-03, HCC-05, HCC-06, HF2A-02, and HF2B-02 and was described as red, typically slightly weathered to fresh, and medium to coarse grained. Granodiorite was visually identified in Boreholes HCC-04, HF2A-01, and HF2B-01 and was grey with occasional slightly red zones, slightly weathered to fresh, and medium to coarse grained.

Fracture index (FI), measured as the total number of fractures per 0.3 m of rock core length, were typically between 0 and 5, occasionally increasing to or exceeding 10 fractures in rubble zones. Total Core Recovery (TCR) values measured on recovered bedrock samples ranged from 94 to 100%. Solid Core Recovery (SCR) values ranged from 25 to 100% but typically exceeded 70%. Rock Quality Designation (RQD) values varied from 10 to 100% indicating a range from poor to excellent quality rock (average of 66%).

Unconfined compressive strength (UCS) tests were conducted on 5 samples. The testing results varied from 78 to 230 MPa. Estimated rock strength values were also interpreted from Point Load Tests conducted on the rock core. The average UCS values per core run from the point load tests ranged from 44 to 275 MPa. The results of the UCS and Point Load Tests indicate that the bedrock is typically very strong with localized zones ranging from medium strong to strong. The results of the rock tests and photographs of the rock core samples are presented in Appendix D.

5.7 Groundwater Conditions

The groundwater levels were observed throughout drilling and monitoring wells were installed in Boreholes HCC-01 and HCC-05 to monitor the groundwater table. The measured groundwater levels are summarized in Table 5.2 below.

Table 5.2: Hewitson Creek Culvert Groundwater Measurements

Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
HCC-01	April 4, 2024	2.3	204.5	Monitoring Well
	April 8, 2024	2.3	204.5	
	April 11, 2024	2.4	204.4	

Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
	April 13, 2024	2.4	204.4	
HCC-02	March 28, 2024	1.0	205.2	Open Borehole
HCC-03	March 26, 2024	1.6	204.0	Open Borehole
HCC-04	April 4, 2024	6.4	203.6	Open Borehole
HCC-05	April 11, 2024	6.1	199.4	Monitoring Well
	April 13, 2024	6.2	199.3	
	April 15, 2024	6.3	199.2	
HCC-06	April 12, 2024	2.7	202.3	Open Borehole
HF2A-02	April 1, 2024	2.9	204.6	Open Borehole
HF2B-01	April 6, 2024	6.5	203.5	Open Borehole
HF2B-02	April 15, 2024	2.4	202.3	Open Borehole
HF2B-03	April 16, 2024	9.4	209.4	Open Borehole

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.

6. CORROSIVITY AND SULPHATE TEST RESULTS

Two soil samples and one surface water sample were collected from near the proposed culvert location and 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 E.

Table 6.1 Corrosivity Test Results

Parameter	Units (Soil)	Units (Water)	HCC-03 SS4 (8.5'-10.5')	HCC-04 SS5 (11'-13')	Hewitson Creek
			Sand and Gravel 2.6 to 3.2 m	Silt and Sand to Sandy Silt 3.3 to 4.0 m	Surface Water
Redox Potential	mV	mV	298	272	254
Resistivity*	ohms.cm	ohms.cm	12300*	19200*	27800*
Chloride	µg/g	mg/L	12	1.6	4.5
Sulphate	µg/g	mg/L	3.3	0.6	2.2
Sulphide	%	µg/L	< 0.01	< 0.01	< 6
Conductivity	mS/cm	uS/cm	81	52	36
pH	-	-	7.66	7.66	6.88

* Calculated based on conductivity result

7. WATER QUALITY

For screening of the general groundwater quality at the culvert site, a sample of the groundwater from the monitoring well at Borehole HCC-01 was collected on April 18, 2024. The water sample was analyzed for selected inorganic parameters included in the Ontario Provincial Water Quality Objectives (PWQO), as well as Total Suspended Solids. A filtered sample was also tested for dissolved metal parameters for comparison purposes. The analytical test results are presented in Appendix E.

The analytical results of the water testing were compared to limits for the PWQO for surface water discharge. The concentrations of all parameters tested that did not meet the criteria established in the PWQO are listed below in Table 7.1. The Total Suspended Solids concentration was 4 mg/L.

Table 7.1: Water Parameters Exceeding PWQO Criteria

Sample ID	Parameter	Criteria	Parameter Limit (µg/L)	Result
HCC-01	Total Cobalt	PWQO	0.9	1.28
	Total Copper	PWQO	5	6
	Total Iron	PWQO	300	6000
	Total Phosphorus	PWQO	10	23
	Total Silver	PWQO	0.1	0.9
HCC-01 Dissolved Solution (Filtered sample)	Dissolved Cobalt	PWQO	0.9	1.16
	Dissolved Iron	PWQO	300	5680
	Dissolved Phosphorus	PWQO	10	18

8. SINGLE WELL RESPONSE TEST RESULTS

8.1 Test Procedure

Single well response tests (SWRT) (“slug” tests) were carried out in the 50 mm diameter wells installed in Boreholes HCC-01 and HCC-05. The well installed in Borehole HCC-01 was screened across silty sand and sandy gravel to sand and gravel. The well installed in Borehole HCC-05 was screened across silt and sand, gravel, and granite bedrock. The tests were completed using the following method:

- The static water level was measured and recorded, and a datalogger was inserted into the well below the water level. The datalogger was set to record water levels every 0.5 to 0.5 seconds, based on the anticipated rate of recovery of the wells.

- A slug of groundwater was removed from the well with a dedicated bailer to induce a change in hydraulic head (rising head test).
- Manual and electronic measurements were recorded until the water level in the well recovered sufficiently.
- Manual measurements were compared to electronic measurements for quality control of the data.

8.2 Hydraulic Conductivity

The slug tests were completed and analyzed using the Hvorslev method. The plots of the slug test results are included in Appendix C. The hydraulic conductivity values calculated from the in-situ slug tests are summarized in Table 8.1:

Table 8.1: Hydraulic Conductivity

Monitoring Well	Hydraulic Conductivity (m/s)	Screened Formation
HCC-01	1.8×10^{-6}	silty sand; sandy gravel to sand and gravel
HCC-05	3.2×10^{-5}	silt and sand; gravel; granite bedrock

9. CLOSURE

The field investigation was supervised on a full-time basis by Mr. George Azzopardi and Mr. Matthew Macaskill, 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

Date: December 12, 2024
File: 37996

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

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, Site No. 48C-0026/C0
LATITUDE: 48.837787°, LONGITUDE: -87.407203°

GEOCRES No. 42D14-002

PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

10. GENERAL

This section of the report provides an interpretation of the factual data from Part 1 of this report and presents foundation recommendations to assist the project team for detailed design of the proposed Hewitson Creek structural culvert replacement. The proposed replacement includes construction of a new concrete arch culvert where the realigned Highway 17 crosses Hewitson Creek, as well as new high fill approach embankments. The discussion and recommendations presented in this report are based on the information provided by Hatch and Ministry of Transportation (MTO) and on the factual data obtained during the course of the investigation. Thurber Engineering Ltd. (Thurber) carried out the assignment as a sub-consultant to Hatch, under the MTO Assignment No. 6023-E-0007.

This foundation investigation and design report with the interpretation and recommendations are intended for the use of Hatch and the Ministry of Transportation of Ontario, and shall not be used or relied upon for any other purposes or by any other parties including the construction or design-build contractor. The contractor must make their own interpretations based on the factual data in Part 1 of the report. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project. Contractors must make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

10.1 Proposed Structure

Based on the August 29, 2024 General Arrangement (GA) drawing provided by Hatch (copy provided in Appendix I), the realigned Highway 17 embankment will be in the order of 23 m high and constructed with rock fill to allow for side slope inclinations as steep as 1.25H:1V. The proposed structure shown on the GA drawing crosses Highway 17 at Sta. 11+006 with an approximate 10-degree skew. The structure is an open-bottom, precast segmental concrete arch culvert with a span and rise of 14.630 and 8.026 m, respectively, and an overall length of 74.456 m. The culvert is indicated to be founded on concrete spread footings, with founding elevation from approximately 205.0 to 203.3 m at the inlet to the outlet, respectively.

The north end (inlet end) of the culvert is adjacent to an existing Hydro One corridor resulting in a reduced right-of-way. To reduce the highway embankment footprint, the north/inlet end of the embankment is indicated to be retained with an 8 m high Retained Soils System (RSS) wall constructed above Elev. 208.550 m with a length of 14.4 and 8.0 m east and west of the culvert, respectively, and with reinforcements extending 13.0 m into the embankment.

10.2 Applicable Codes and Design Considerations

The geotechnical assessment presented below has been prepared based on the available data regarding the proposed foundations and existing ground conditions in accordance with the current Canadian Highway Bridge Design Code (CHBDC). In accordance with the CHBDC, the analysis and design of structures takes into consideration the importance of the structure and the consequences associated with exceeding limit states. The importance category and consequence classification are defined by the Regulatory Authority, which in this case is the Ministry of Transportation, Ontario (MTO).

It is understood that the MTO has designated this bridge as Major-Route Bridge with a Typical Consequence. Accordingly, a consequence factor (Ψ) of 1.0, as per Table 6.1 of the CHBDC, has been used in assessing factored geotechnical resistances. If this consequence classification changes, the geotechnical assessment and recommendations provided within this report will need to be reviewed and revised.

As per Section 6.5.3.2 of the CHBDC, the degree of site prediction model understanding is considered to be Typical based on the current information.

The frost penetration depth and associated recommendations are provided in Section 11.5.

11. CULVERT DESIGN

11.1 Summary of Subsurface Conditions

The creek bed elevation at the new culvert site ranges from approximately 204 to 205 m, while the crests of the creek valley slopes are at approximate Elev. 222 m on the west side (Sta. 10+930), and 230 m on the east side (Sta. 11+150), indicating that the valley slopes are approximately 17 to 25 m high. As indicated earlier the access to the deep valley is difficult and construction of appropriate access road will be required to reach the creek level to construction the culvert. Hewitson Creek generally flows from north to south, and the surface water level in the creek is approximately Elev. 206 to 206.5 m. The proposed Highway 17 grade level through the Hewitson Creek valley ranges from approximate Elev. 226 to 230 m, with proposed embankment fills of up to 23 m in height, including 13 m of cover above the top of the proposed culvert.

In general, the subsurface conditions encountered in the boreholes at this site consisted of topsoil or organic material overlying interbedded cohesionless soils consisting of typically compact to

very dense sand, silt and gravel deposits, frequently containing cobbles and boulders. Granite to granodiorite bedrock was encountered below the overburden soils at depths ranging from 6.5 m and 18.6 m (Elev. 205.7 to 186.1 m).

The groundwater level in the open boreholes and monitoring wells generally ranged from approximate Elev. 199 to 205 m (typically approximate Elev. 204 to 205 m).

11.2 Subgrade Preparation

Foundation design aspects for the proposed culvert include subgrade conditions and preparation, construction of engineering fill pads, geotechnical capacities, settlement of foundation soils under footings and embankment fills, lateral earth pressures, excavations, groundwater control, seismic considerations, and stability and settlement of the highway approach embankments.

Concrete footings founded below the frost depth at this site (see Section 11.5) would require large excavations in cohesionless soil below the groundwater level. Controlling the large groundwater flows to maintain dry excavations for footing construction is anticipated to be difficult and will likely require a Permit to Take Water. Accordingly, constructing shallower footings on engineered rock fill pads, excavated and placed below the groundwater level, is proposed as an alternative to allow for construction on less frost susceptible soils and to reduce the dewatering efforts in cohesionless soils. The engineered rock fill pads will also provide good geotechnical resistance to support the loads imposed by the arch culvert and the overlying embankment fill.

The anticipated subgrade soils at the proposed footing level generally consist of compact to very dense sand and gravel or sandy silt to silty sand containing cobbles and boulders. In order to provide sufficient support for the culvert, the footings should be founded on a minimum 1.5 m thick engineered rock fill pads.

The rock fill pads will be constructed below the groundwater level. As dewatering the cohesionless soils is not expected to be practical at this site, it is anticipated that preparing the subgrade and constructing the engineered rock fill pads in wet conditions will be required. This approach will still require full-time diversion of the creek flow and surface water so that the excavations can be carried out within stagnant water.

For construction of engineered fill pads below the water level, the gradation of the rock fill should be as recommended in the following Table 11.1:

Table 11.1 Rock Fill Pad Gradation

Sieve Size (mm)	Percent Passing (%)
150	100
106	50 – 100
75	15 – 80
26.5	0 – 15
0.075	0 - 2

The rock fill in Table 11.1 shall be well graded with the gradation determined as provided in Note 2 of Table 8 within OPSS.PROV 1004 (November 2012). The rock fill must be derived from crushed rock and the rock fill particles shall be durable and have a minimum unconfined compressive strength (UCS) of 100 MPa and meet the physical property requirements of “Rock Protection” as provided in Table 7 within OPSS.PROV 1004 (November 2012). Weak rocks such as Shales and Sandstones, or cobbles and boulders are not acceptable as rock fill. Suggested wording for an NSSP on rock fill pads is included in Appendix H.

The base of the rock fill pads should be placed on the undisturbed native compact to very dense sand and gravel or sandy silt to silty sand. Any peat, organic soil, excessively soft or very loose soil, large cobbles and boulders, or other deleterious material encountered within the footprint of the fill pads during subgrade preparation should be sub-excavated and replaced by select rock fill to provide a uniformly competent subgrade condition. All tree stumps should be adequately removed. As soon as practical the excavation should be backfilled.

Adequate preparation of the subgrade will be essential for performance of the culvert. A separation layer consisting of a non-woven geotextile should be placed between the native foundation soils and the overlying rock fill. The geotextile should meet the specifications for the OPSS.PROV 1860 Class II, and have a fabric opening size (FOS) not greater than 212 µm. The rock fill pads should be completely wrapped with the geotextile to minimize migration of the fines into the rock fill.

Rock fill used below the water level may be placed by end dumping. The rock fill placement below the water level should follow OPSS.PROV 209 (Embankments over Swamps and Compressible Soils).

Rock fill placed above the water level should be placed in a controlled manner (not end dumped) including blading, dozing and chinking of the rock to minimize voids and bridging. Rock fill above the water level must be compacted as per OPSS.PROV 206. The rock fill surface must be blinded with spall material and rock fill chinking shall be in accordance with OPSS.PROV 206. To help provide a level surface for placement of the concrete footings, a 150 mm thick layer of OPSS.PROV 1004 19 mm Type II clear stone may be used on top of the rock fill pads.

If the contractor chooses to construct the culvert footings in the dry in dewatered temporary excavations, the rock fill beneath the footings must be placed in maximum 300 mm thick lifts and thoroughly compacted with a minimum of 8 passes of a tractor bulldozer, crawler type as specified in Section 206.07.05.02.01 of OPSS.PROV 206.

11.3 Geotechnical Resistances for Spread Footings

As indicated earlier, concrete spread footings on rock fill pads have been chosen as the foundation options for the arch culvert. Deep foundations were ruled out due to the presence of frequent cobbles and boulders in the foundation soils and relatively high cost of pile foundations. Additionally, access could be difficult for specialized equipment.

Recommended geotechnical resistances for varying footing widths constructed on minimum 1.5 m thick engineered fill pads as described herein are provided in Table 11.2. These values are based on the SPT profile with depth shown in Figure 1. The base of the fill pads are assumed to be founded directly on the undisturbed native compact to very dense soils. SLS resistances for 25 and 35 mm of settlement are provided. Settlement is in addition to the settlements induced by embankment loading.

Table 11.2 Recommended Geotechnical Resistances for Concrete Spread Footings

Footing Width (m)	Geotechnical Resistance		
	Factored Geotechnical Resistance at ULS	Geotechnical Resistance at SLS *(for up to 25 mm settlement)*	Geotechnical Resistance at SLS *(for up to 35 mm settlement)*
3.0	830	825	will not govern
3.5	880	750	880
4.0	930	675	930
4.5	980	650	902
5.0	1,030	625	875

A consequence factor of 1.0 was utilized in estimating the geotechnical resistance, adopting the typical consequence level. The geotechnical resistance factor of 0.5 for bearing and 0.8 for settlement, both adopted for typical degree of understanding, were used to obtain the above values, as per CHBDC 2019, Section 6.9.

The factored ultimate resistance and settlement are dependent on the footing size, configuration and applied loads; the geotechnical resistances should, therefore, be reviewed if the footing widths or founding elevations differ significantly from that given above.

The above geotechnical resistances are for vertical, concentric loads. Where eccentric or inclined loads are applied, the resistance values used in design must be reduced in accordance with CHBDC 2019, Clause 6.10.5.3.

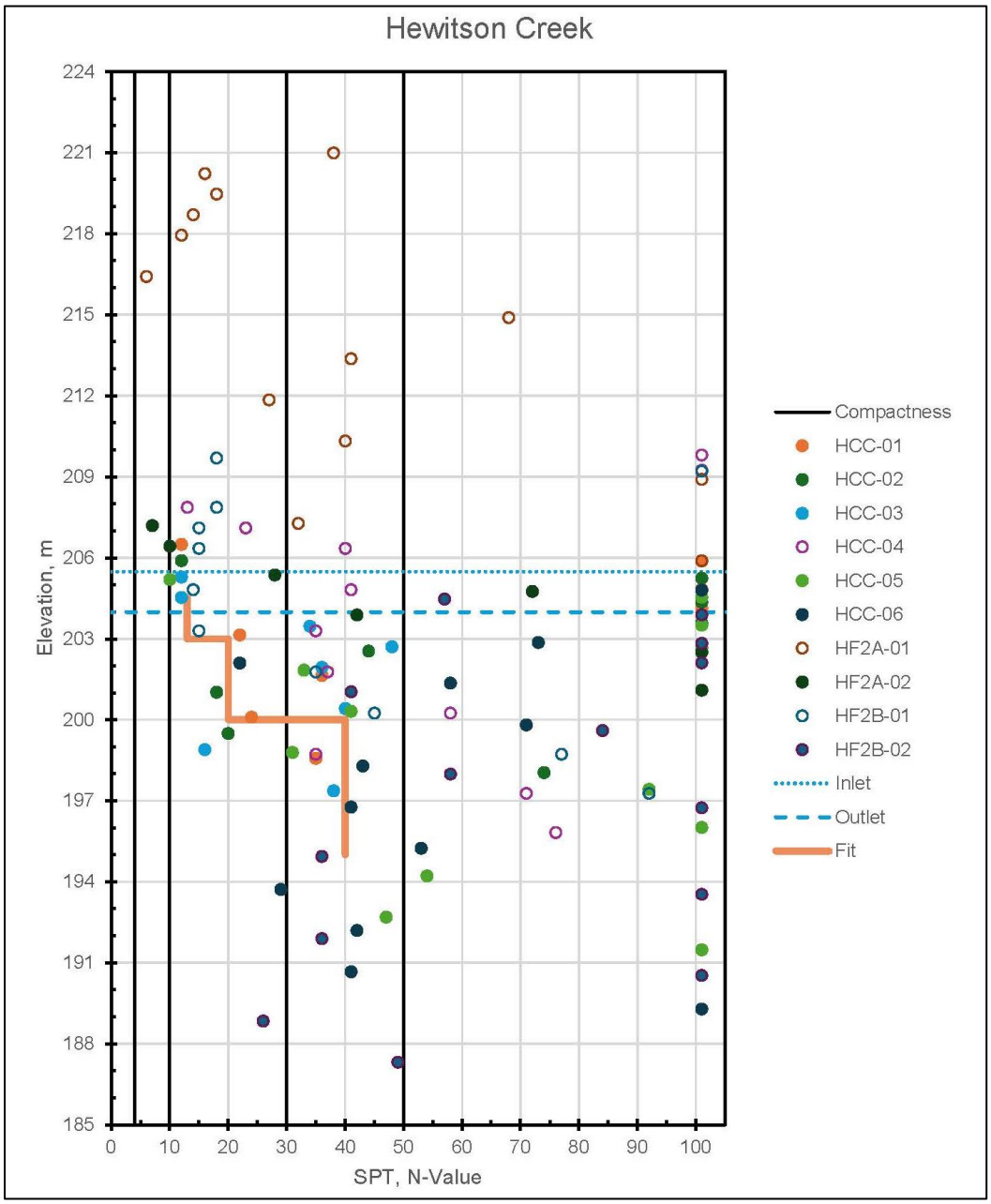


Figure 1: SPT N-Value vs Elevation Plot

Resistance to sliding between the concrete and the underlying rock fill pads should be calculated assuming a factored coefficient of friction of 0.5. A resistance factor of 0.8 has been applied.

Heavy compaction equipment, used adjacent to or directly above the culvert and culvert extension, must be restricted in accordance with OPSS.PROV 501 to protect the culvert from damage.

The culvert should be designed to resist external loadings including frost forces, lateral earth pressures, hydrostatic pressure, weight of embankment fill, traffic loadings and surcharge due to construction equipment.

11.4 Assessment of Footing Settlement

It is important to assess the total and differential settlement of the footings for this arch culvert. Estimated magnitudes of settlement for different footing widths for varying applied loads at each borehole location was carried out and provided in Figure 2. The settlement was estimated using Settle3 (Rocscience) and the total settlement ranged from 5 mm for a footing load of 100 kPa to 55 mm for a footing load of 1,000 kPa. Hatch used these settlement estimates to assess the differential settlements along the length of the culvert and the differential settlements across the width of the culvert. The results of the assessments are shown on Figures I-1 and I-2 in Appendix I. Consideration was given to utilizing fixed footing widths of 5 m along the entire culvert, or tapered footings which range from 3 m wide at the ends of the culvert to 5 m wide under the travelled portion of the highway (where the overlying fill is highest). A schematic of the tapered footing option is shown on Figure I-3 in Appendix I. Hatch's assessment indicated differential settlements (longitudinal or transverse) of up to 0.1% for both 5 m fixed width (Figure I-1) and 3 to 5 m tapered width (Figure I-2) footings. Based on the CHBDC Table 7.7 requirements shown on Figures I-1 and I-2, Hatch concluded that these differential settlements are acceptable.

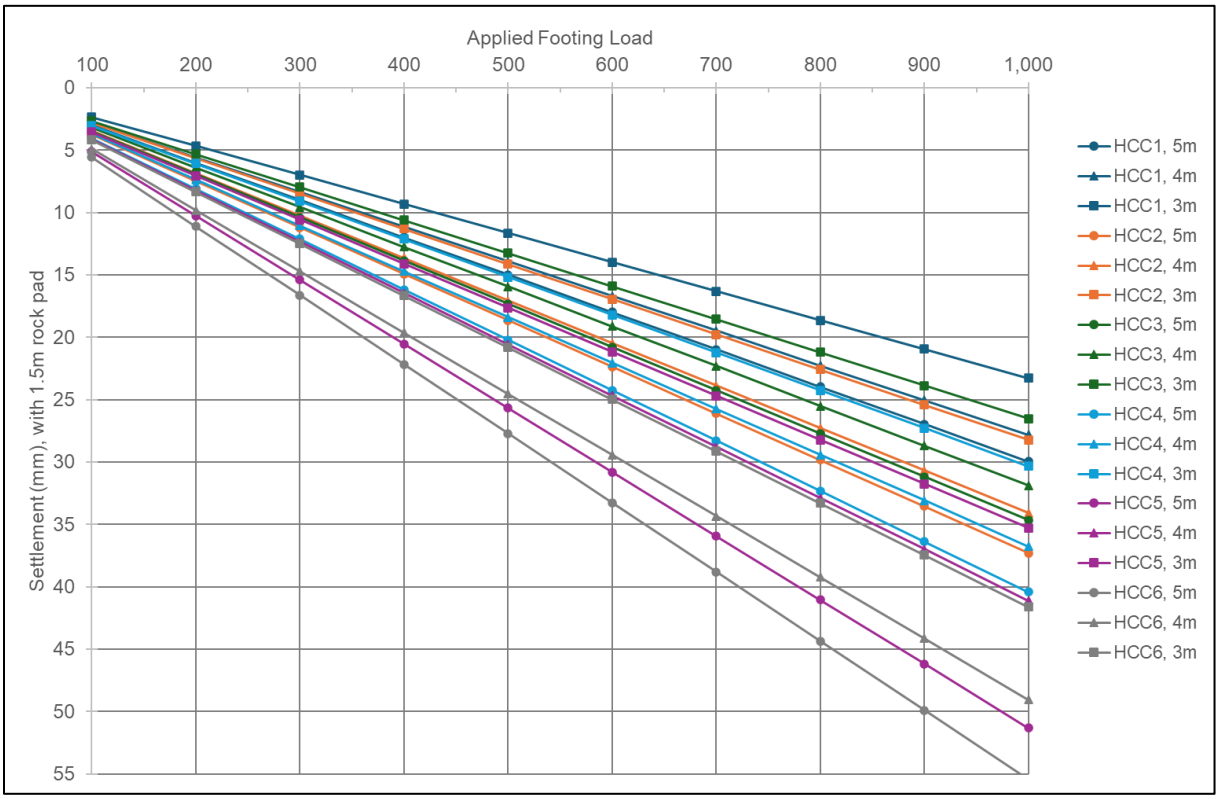


Figure 2: Hewitson Creek Culvert Settlement Plot

11.5 Frost Cover

The depth of frost penetration at this site is approximately 2.2 m based on OPSD 3090.100. The base of any footings would require a minimum of 2.2 m of earth cover as protection against frost action. The earth cover should be measured perpendicular to the ground surface. Soils within the frost depth should be neglected in design from providing lateral resistance forces.

However, a spread footing founded on minimum 1.5 m thick engineered rock fill pads, would not need to be placed below the depth of frost.

12. RETAINED SOIL SYSTEM (RSS) WALLS

RSS retaining walls are proposed to retain the embankment fill at both the northeast and northwest corners of the new culvert inlet. Based on the drawings provided by Hatch, the RSS walls are approximately 8 m high, and 8 to 14.4 m long at the northwest and northeast corners, respectively. The base of the RSS walls are indicated to be founded above the culvert footings at elevation 208.55 m. The walls are founded on rock fill to raise the wall above the floodplain so that they are not submerged. Rock fill will also be abutted against the sides and back of the RSS walls as the wall transitions to embankment fill.

The embedment of the proprietary RSS retaining wall should follow the recommendation provided in the most recent version of MTO's RSS Design Guidelines manual. The Geometry, Appearance and Performance of an RSS wall shall follow the requirements outlined in the manual. The RSS supplier/designer may specify more stringent criteria or other requirements related to the particular design. The internal stability of the RSS wall should be analysed by the supplier/designer of the proprietary product selected for this site. The entire block of reinforced earth must be designed against various modes of failure including, but not limited to, sliding and overturning. Preliminary assessment from Hatch indicates that the reinforcements will be in the order of 13 m in length in order to retain the steep embankment slopes. The global stability of the RSS wall is discussed in Section 18.

The RSS mass should be founded on engineered granular fill pads placed over rock fill and the engineered granular pads shall consist of OPSS Granular A or Granular B Type II and should be placed and compacted in accordance with OPSS.PROV 501. The engineered pads should be a minimum of 0.5 m thick and extend at least 0.5 m beyond the limits of the entire RSS mass. The RSS foundation should be constructed in the dry. The base of the engineered pad should be kept above the water level. Any topsoil, organics, loose fill, and any soft/wet material should be stripped from the footprint of the RSS. Care should be taken not to disturb the foundation subgrade during excavation. Where the engineered pad is constructed on native materials, the subgrade should be constructed of rock fill, and the rock fill surface must be blinded with spall material, with rock fill chinking in accordance with OPSS.PROV 206 prior to placement of granular fill. To minimize

loss of fines into the underlying rock fill, a separation layer consisting of a non-woven geotextile should be placed above the rock fill. The geotextile should meet the specifications for the OPSS.PROV 1860 Class II, and have a fabric opening size (FOS) not greater than 212 µm.

Rock fill used below the water level may be placed by end dumping. The rock fill placement below the water level should follow OPSS.PROV 209 (Embankments over Swamps and Compressible Soils).

Rock fill placed above the water level must be placed in maximum 300 mm thick lifts and thoroughly compacted with a minimum of 8 passes of a tractor bulldozer, crawler type as specified in Section 206.07.05.02.01 of OPSS.PROV 206.

RSS walls founded on an engineered pad as described herein may be designed using the following geotechnical resistances:

Table 12.1 Recommended Geotechnical Resistances for RSS Walls

	Geotechnical Resistance (kPa)
Factored Geotechnical Resistance at ULS	930
Geotechnical Reaction at SLS	675

The geotechnical resistances at SLS correspond to settlement up to 25 mm at the base of the RSS wall. The geotechnical resistance is for vertical, concentric loads. Where eccentric or inclined loads are applied, the resistance used in design should be reduced in accordance with the CHBDC 2019, Clause 6.10.5.3. It should be noted that the RSS wall will be retaining a high rock fill embankment with slopes inclined as steep as 1.25H:1V. The wall designer shall be alerted that the RSS wall must be designed for high earth pressures as a result.

The entire block of reinforced earth should be designed against various modes of failure including sliding and overturning. Sliding resistance along the base of the wall may be estimated using an factored friction coefficient of 0.5 for an engineered granular fill subgrade. A resistance factor of 0.8 has been applied.

13. BACKFILL AND LATERAL EARTH PRESSURES

Backfill to the concrete arch culvert and behind the RSS retaining walls should be placed in accordance with OPSS.PROV 902. All backfill for the culvert, cover and the RSS wall backfill should consist of free-draining, non-frost susceptible granular materials such as Granular A or B Type II conforming to the requirements of OPSS PROV 1010. The backfill should be placed and compacted in simultaneous lifts as per OPSS.PROV 902. The compaction equipment to be used adjacent to the culvert should be restricted in accordance with OPSS.PROV 501. Subdrains should be incorporated by the RSS proprietary designer, where required.

Granular backfill shall not be placed below the water level. As indicated in Sections 11.2 and 12, rock fill pads should be constructed below the culvert footings and RSS wall. Once the rock fill has been placed to approximately 500 mm above the water level, placement and compaction of granular backfill material, as indicated above, may take place. The rock fill surface must be blinded with spall material and rock fill chinking shall be in accordance with OPSS.PROV 206 prior to placement of granular fill.

Lateral earth pressures acting on the structure and retaining walls may be assumed to be distributed triangularly and to be governed by the characteristics of the backfill. For a fully drained condition, the pressures should be computed in accordance with the CHBDC 2019, but are generally given by the expression:

$$p_h = K(\gamma h + q)$$

where,

p_h = horizontal pressure on the wall at depth h (kPa)
K = earth pressure coefficient (see table below)
γ = bulk unit weight of retained soil (see table below) adjusted below water level
h = depth below top of fill where pressure is computed (m)
q = value of any surcharge (kPa)

A lateral earth pressure due to backfill compaction should be added to the calculated lateral earth pressure in accordance with Clause 6.12.3 of the CHBDC. Typical earth pressure coefficients for vertical walls are shown in Table 13.1 below.

Table 13.1 Lateral Earth Pressure Coefficients (K)

Loading Condition	OPSS Granular A or Granular B Type II $\phi = 35°$; $\gamma = 22.8$ kN/m^3		Rock Fill $\phi = 42°$; $\gamma = 19$ kN/m^3	
	Horizontal Backfill	Sloping Backfill (2H:1V)	Horizontal Backfill	Sloping Backfill (1.25H:1V)
Active, K_A (Unrestrained Wall)	0.27	0.40	0.20	0.35
At-rest, K_0 (Restrained Wall)	0.43	-	0.33	-
Passive, K_P	3.7	-	5.0	-

Note: Submerged unit weight should be used below the groundwater level/high creek level.

The parameters in the table correspond to full mobilization of active and passive earth pressures and require certain relative movements between the wall and adjacent soil to produce these conditions. Figure C6.27 and Table C6.12 of the Commentary to the CHBDC indicates the relative

movement required to fully mobilize the active earth pressure. Where ground surfaces are sloped at 2H:1V and 1.25H:1V behind the walls, the corresponding coefficients provided in Table 13.1 should be used.

If lateral movement is not permissible and/or the wall is restrained, the at rest earth pressure coefficient should be used. If the wall design allows lateral movement, the active earth pressures should be used.

A geotechnical resistance factor of 0.5 (ϕ_{gu}) should be applied in static design to the passive earth pressures in accordance with Table 6.2 of the CHBDC (static analysis typical understanding). The soils within the depth of frost should be ignored from providing passive lateral resistance; however, the equivalent surcharge loading from the weight of the soils above the frost depth should be incorporated into the lower soil layers.

14. EXCAVATION AND GROUNDWATER CONTROL

All excavations should be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the native cohesionless soils including sand and gravel, sandy silt to silty sand, sand, and silt at this site are classified as a Type 3 soil above the water table and Type 4 soil below the water table. *If an excavation penetrates more than one soil type, the entire excavation must be completed in accordance with the more stringent requirement as per the requirements of the regulation.*

Excavations for the footing excavations must be carried out in accordance with OPSS.PROV 902 and SP109S61. Excavations will be carried out through native sands, gravels and silts that contain frequent cobbles and boulders that may obstruct the excavations. Suggested wording for an NSSP on obstructions is included in Appendix H.

Selection of the method of excavation is the responsibility of the Contractor and should be based on the Contractor's experience, equipment, and interpretation of the site conditions.

Diversion of the creek flow around excavations will be required. Furthermore, groundwater and surface runoff will tend to seep into and accumulate in the excavations. Due to the presence of the water-bearing cohesionless soil layers, full dewatering to the base of the temporary excavations using conventional sump pumping will not be effective at this site. Furthermore, due to the presence of cobbles and boulders in the subsurface soils, it is anticipated that installation of a sheet pile cofferdam to create a watertight enclosure will be difficult to form an effective groundwater flow cut-off for dewatering purposes. Dewatering to the base of the temporary excavations would require the Contractor to retain a dewatering specialist to design a robust and effective dewatering scheme that is suitable for the subsurface conditions at this site, such as well

points. In lieu of this, it will likely be necessary to construct the culvert footings in the wet, as described in Section 11. Further discussion on dewatering is provided in Section 15.

If dewatering is to be conducted at this site, the dewatering must be carried out in accordance with OPSS.PROV 517 and SP517F01. The design of any dewatering systems is the responsibility of the Contractor. The Contract Documents must alert the Contractor to this responsibility. The dewatering design engineer and design-checking engineer must have a minimum of 5 years of experience in designing systems of a similar nature. It is recommended that a preconstruction survey be conducted.

Suggesting wording for an NSSP on Dewatering is included in Appendix H.

15. DEWATERING ASSESSMENT

Groundwater taking for construction dewatering is governed by the Ontario Water Resources Act (OWRA), Environmental Protection Act (EPA) and the Water Taking and Transfer Regulation 387/04, a regulation under the OWRA.

If the water taking rate will be greater than 50,000 L/day and less than 400,000 L/day then registration on the Environmental Activity and Sector Registry (EASR) will be required. If the water taking rate will be greater than 400,000 L/day, then a Category 3 Permit to Take Water (PTTW) will be required.

Should the concrete culvert footings be constructed in the wet, then the need for significant dewatering is not anticipated. However, for comparison purposes, the dewatering assessment assumes that the culvert spread footings will be constructed with dewatering to below the base of the excavation. It is assumed that one footing will be constructed at a time; however, if both footings are constructed simultaneously, there would be a small increase in the total flow rate as the excavation area has a relatively small impact on flow rate. It is further assumed that creek flow will be diverted around the work area during construction such that surface water will not enter the excavation at a significant rate. The dimensions and conditions that were assumed for the dewatering assessment are provided in Table 15.1 below. For full dewatering to the base of the temporary excavation, the geologic units that will need to be dewatered are sand & gravel to gravelly sand / sandy gravel and sand & silt to silty sand / sandy silt.

Table 15.1 Assumed Excavation Dimensions and Ground Conditions

Structure	Assumed Excavation Footprint (m)	Lowest Assumed Elevation of Excavation (m)	Assumed Groundwater Elevation (m)	Geologic Units to Dewater
Concrete arch culvert spread footing	15 x 70	201.5	205	Sand & Gravel to Gravelly Sand / Sandy Gravel, Sand & Silt to Silty Sand / Sandy Silt

The water taking will be temporary in nature for the purpose of construction dewatering for installation of the culvert and its footings. Dewatering rates were estimated using the Dupuit analytical solution. The radius of influence was calculated using the Sichardt equation. It is assumed the water level will be required to be lowered to about 1 m below the proposed excavations, in order to facilitate a dry, stable work area.

The preliminary peak water taking rates were estimated to be greater than 1,200,000 litres per day, which includes a safety factor and rainfall allowance. The preliminary radius of influence was estimated to be approximately 80 m from the edge of the excavation. This preliminary water taking rate is not sufficient for the contractor to design a dewatering system. If the contractor decides to undertake dewatering, they shall retain a dewatering specialist to assess the rate of water for design of a dewatering system.

Controlling this volume of groundwater flow would require significant dewatering effort, and a Category 3 Permit to Take Water, since the estimated peak water taking rate is greater than 400,000 L/day. A Hydrogeological Study would be required to provide the necessary data and analysis for application to the Ministry of the Environment, Conservation and Parks (MOECP). The Hydrogeological Study would need to include an impact assessment as well as mitigation measures, a monitoring plan, and a contingency plan. The requirement for potential additional field work would need to be assessed. The duration required to receive the permit from MOECP once the application has been received in good order is typically 3 to 5 months, assuming no further field work or significant revisions are required. MTO is in the process of obtaining a Draft Category 3 Permit to Take Water for this project.

Based on the above factors, it is recommended that consideration be given to constructing the culvert footings in the wet. If the Contractor chooses to construct the footings in the dry, they must retain a dewatering specialist to design a robust and effective dewatering scheme for dewatering the temporary footing excavations, as described in Section 14. An NSSP is this regard is included in Appendix H.

16. WATER QUALITY

For screening of the general groundwater quality at the culvert site, a sample of the groundwater from the monitoring well at Borehole HCC-01 was collected. As noted in Section 7, the water sample was tested, and the results were compared to the Ontario Provincial Water Quality Objectives (PWQO). A filtered sample was also tested for dissolved metal parameters for comparison purposes. The water sample test results are summarized in Table 7.1.

The test results indicate that five of the metals parameters tested exceeded the PWQO criteria for total concentrations. Testing of a filtered sample to remove Total Suspended Solids (TSS) indicated typically reduced metals concentrations for the dissolved solution, however three parameters exceeded the PWQO criteria.

If dewatering is used at this site, the groundwater should not be discharged to surface water without pre-treatment or additional testing due to the observed presence of parameters that exceed the PWQO criteria. Discharge to the land surface may be considered if the surrounding property is free of contamination from industrial or commercial processes. Typically, this would require that the discharge water does not contain significant TSS (less than 25 mg/L), and that the discharge point is located at least 30 m away from the creek, where it will infiltrate and ultimately return to the watercourse. Consultation with the Rainbow Falls Provincial Park, where the culvert site is located, may be required prior to selection of a discharge point.

If dewatering is used at this site, additional testing and assessment would be required to confirm dewatering volumes, the water quality and determine the appropriate groundwater discharge options and treatment methods. Additional water samples may also need to be collected and tested during construction to monitor the quality of discharge water to meet PTTW requirements.

17. SEISMIC CONSIDERATIONS

In accordance with the CHBDC 2019, the selection of the seismic site classification is based on the soil conditions encountered in the upper 30 m of the stratigraphy. Based on the presence of generally compact to very dense native soils, the site is classified as Seismic Site Class D in accordance with Table 4.1, Clause 4.4.3.2 of the CHBDC. The peak ground acceleration, PGA, for a 2,475-year return period seismic event (2% probability of being exceeded in 50 years) at this site is 0.0645 g as per the National Building Code of Canada (NBCC 2020).

In view of the low PGA for seismic activity in the area and the relative density of the foundation soils, liquefaction is not considered to be a concern at this site.

The coefficients of horizontal earth pressures for seismic loading on walls assuming a level backfill, a Site Class D, and a reference PGA of 0.065 are presented in Table 17.1 below. The vertical acceleration coefficient k_v has been ignored ($k_v = 0$).

Table 17.1 Seismic Earth Pressure Parameters

Loading Condition	Seismic Earth Pressure Coefficients (K_{AE})	
	OPSS Granular A or Granular B Type II $\phi = 35°$, $\gamma = 22.8$ kN/m^3	Rock Fill $\phi = 42°$; $\gamma = 19$ kN/m^3
Active (Unrestrained Wall)	0.29	0.21
Active (Restrained Wall)	0.31	0.23

18. HIGH FILL APPROACH EMBANKMENTS

The foundation stability, settlement magnitude and duration and their impacts on the construction schedule and the long-term performance of the proposed embankments have been analyzed for the high fill approaches. The embankment fill height and slope geometry used for analysis noted in this report are based on the drawings provided by Hatch, including cross-sections received on July 25, 2024.

For the purpose of preparing foundation design recommendations, a number of assumptions have been made that are consistent with MTO's standard highway design practices, including:

- Peat, topsoil, organic deposits, and other deleterious material will be stripped prior to constructing embankments as per OPSS.PROV 206.
- Where new fill is placed against an existing earth or granular embankment slope or on a sloping ground surface steeper than 3H:1V, the existing slope will be benched as per OPSD 208.010.
- The high fill approach embankments will be constructed using rock fill. Suggested wording for an NSSP on rock fill is included in Appendix H.
- Rock fill embankments will be constructed with side slopes not steeper than 1.25H:1V.
- Rock fill embankment slopes at or greater than 10 m high will be provided with a 2 m wide mid-height bench. Two benches will be required for embankments at or greater than 20 m high.
- Embankment construction will be carried out in accordance with OPSS.PROV 206. Rock size should be controlled in accordance with OPSS.PROV 206.

- Rock fill placed above the water table should be constructed in a controlled manner (not end dumped) including blading, dozing and chinking of the rock to minimize voids and bridging. Rock fill must be compacted as per OPSS.PROV 206. Rock fill used to backfill sub-excavated areas below the water table may be placed by end dumping.
- At the pavement subgrade level or where granular fill is to be placed over rock fill, the rock fill subgrade must be blinded with spall material and rock fill chinking should be in accordance with OPSS.PROV 206.

Subsurface models were prepared for stability and settlement analyses based on a compilation of borehole logs and available field and laboratory testing data. Engineering parameters were selected based on the results of the field and laboratory testing.

Slope stability analysis was performed to assess the global stability of the 1.25H:1V rock fill slopes as well as the RSS mass. The stability analysis was performed using the commercially available software Slope/W, developed by GEO-SLOPE International Ltd. Static and seismic analyses were performed using the Morgenstern-Price method. As the foundations soils were predominantly cohesionless at the critical sections, long-term / drained conditions were assumed for static effective stress analysis.

The analyses under seismic loading were performed using a pseudo-static slope stability analysis using a horizontal seismic coefficient based on CHBDC 2019 Site Class D (Section 4.4.3.2 of CHBDC 2019). Therefore, a horizontal seismic coefficient, k_h, of 0.032g (one-half of the corresponding site peak ground acceleration in accordance with Section 6.14.9.1 of CHBDC 2019) was used for the seismic stability analysis. The site peak ground acceleration was calculated through the Natural Resource Canada's 2020 National Building Code Seismic Hazard Calculation tool.

The results of the stability analyses are presented on figures in Appendix G. The computed Factors of Safety (FOS) against slope instability typically meet the minimum FOS required by MTO for typical degree of understanding for static analysis of permanent slopes and for pseudo-static seismic analysis.

Settlement analyses were carried out to estimate the magnitude of settlement of the foundation soils occurring during construction and post-construction (long term) under the weight of the embankment fill and to estimate the magnitude of the embankment fill compression. An assessment of the self-weight compression of the embankment fill materials was also completed. Settlement of the road grade on compacted rock is expected to continue at a decreasing rate with time, due to particle re-orientation and degradation of the interparticle contacts.

The estimated magnitudes settlement are considered approximate and may vary along and across the highway alignment subject to the thickness of overburden layers at a particular

location, variations in the consolidation characteristics of the deposits with depth and location, layer boundary conditions, variations in the relative density of cohesionless soils, the presence of organics or silt/sand/clay partings within the various strata, the depth to bedrock, the height of embankment, and degree of compaction achieved in the fill. It is estimated that the foundation soils will settle in the order of 115 mm and the embankment self-compression will be in the order of 230 mm. The majority of the foundation settlements are expected to occur immediately as embankment construction takes place and be predominantly completed by the end of construction. To mitigate the effects of the settlement due to embankment fill compression, it is recommended that the new embankments be constructed as early as possible. Paving should be delayed by at least 3 months.

The embankment and platform width design should be overbuilt and allow for the anticipated foundation and embankment compression settlements and allow for placement of additional fill to the grade level at the end of the preloading period prior to paving.

19. SCOUR AND EROSION PROTECTION

Erosion protection should be provided at the culvert inlet and outlet and along the spread footings to prevent loss of soils in front of the footings.

Design of the erosion protection measures should consider hydrologic and hydraulic factors and should be carried out by specialists experienced in this field in accordance with OPSD 810.010, OPSS.PROV 511 and OPSS.PROV 1004.

Typically, rock protection should be provided over all surfaces with which creek water is likely to be in contact. A vegetation cover should be established on all other exposed earth surfaces to protect against surficial erosion, in general accordance with OPSS.PROV 804.

Selection of streambed material should be in accordance with OPSS.PROV 1005.

As the rock fill pads and concrete spread footings will be located close to the creek channel, the forward face of the footings and foundation pads must be provided with sufficient protection against scour and erosion to ensure adequate performance of the foundations / engineered fill pads.

20. CORROSION AND SULPHATE ATTACK POTENTIAL

The results of the corrosivity and sulphate content analytical tests conducted on the soil and surface water samples indicate the following conditions at the locations tested:

- The potential for corrosion or sulphate attack on concrete from the surrounding sand and gravel or sandy silt to silty sand or surface water is considered to be negligible due to the low concentration of sulphate and chloride in the samples tested. The effect of road deicing salt should be considering while selecting the class of concrete.
- The potential for soil corrosion on metal is considered to be mild to very mild.
- Appropriate protection measures are recommended for metal or concrete structural elements. The effect of road deicing salt should be considered while selecting the corrosion protection measures.

21. CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to:

- The water level in the creek may fluctuate and be at a higher elevation at the time of construction than indicated in the report.
- Full dewatering to below the base of the culvert footing excavations may not be practical at this site and would also require a Category 3 Permit to Take Water. Accordingly, appropriate methods for constructing in the wet should be developed. MTO is in the process of obtaining a Draft Category 3 Permit to Take Water for this project. An NSSP on Dewatering is provided in Appendix H.
- Obstructions such as cobbles and boulders were noted to be present within the existing native soils, which may impede the excavations. An NSSP on Obstructions is provided in Appendix H.
- Site access will be difficult, and an appropriate access road will need to be constructed.

22. CLOSURE

Engineering analysis and preparation of the design report was carried out by Mr. Mark Farrant, P.Eng., and Mr. Stephen Peters, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

THURBER ENGINEERING LTD.

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

Stephen Peters, P.Eng.
Associate, Geotechnical Engineer

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

Date: December 12, 2024
File: 37996

THURBER

STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

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.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

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.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

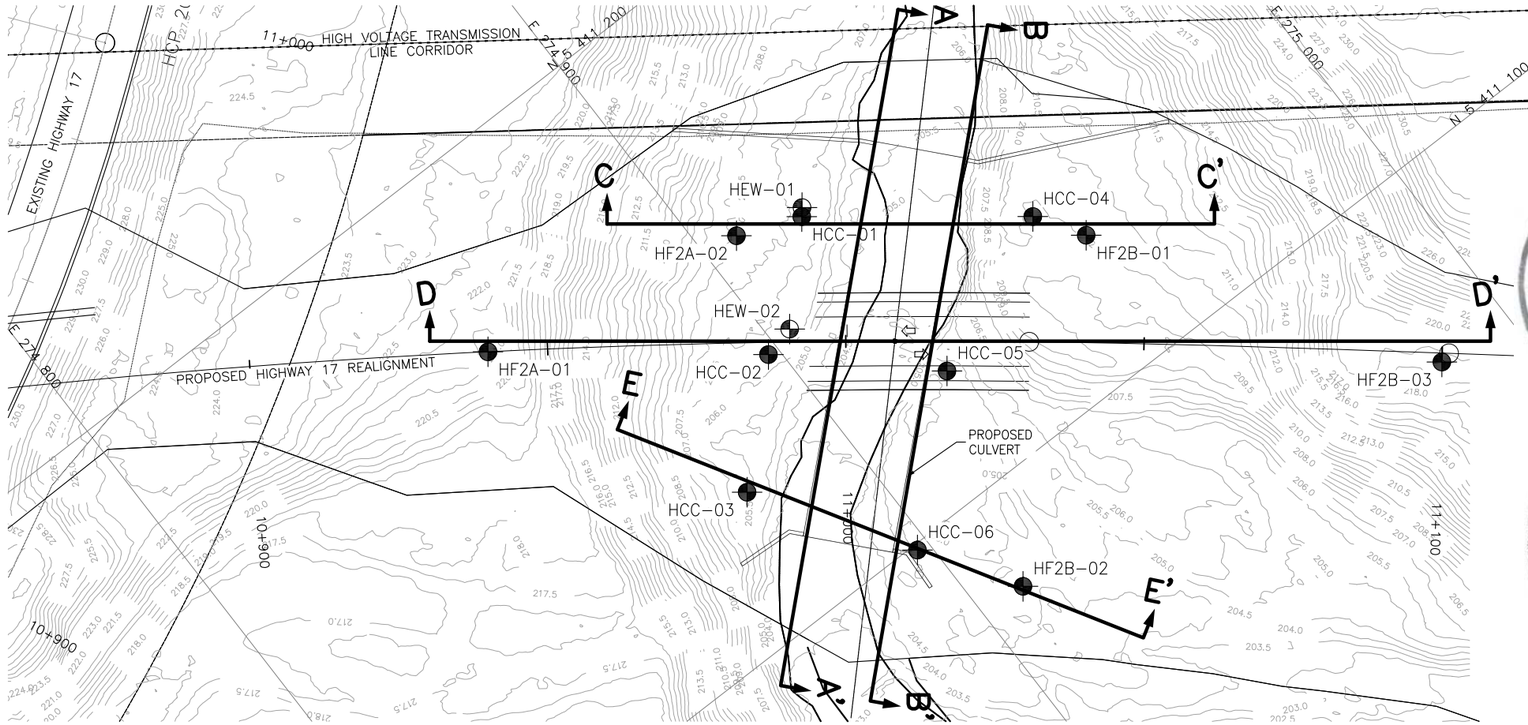
7. INDEPENDENT JUDGEMENTS OF CLIENT

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

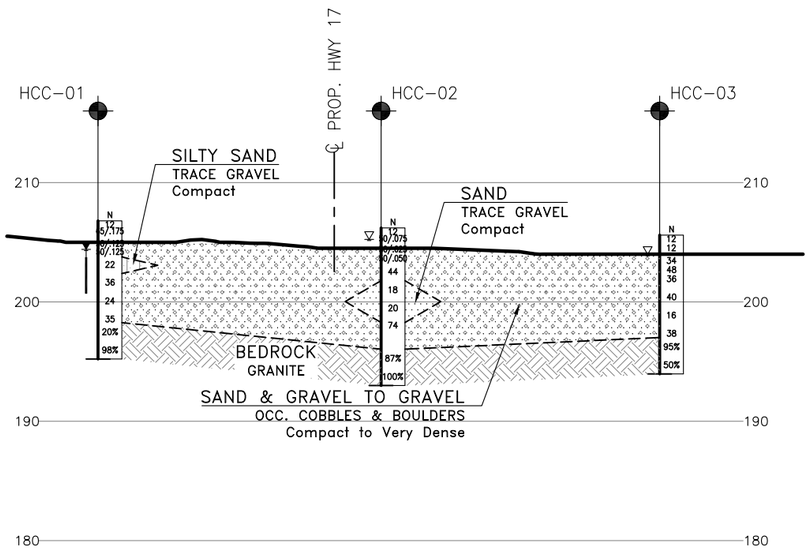
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

20 0 20 40m

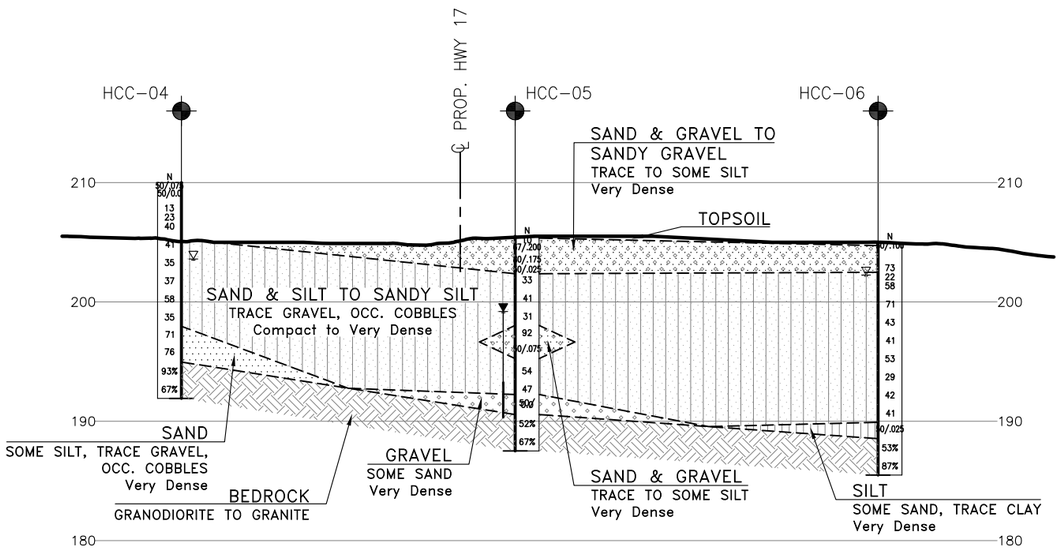
SCALE 1:1000



SECTION A–A'

10 0 10 20m

SCALE 1:500



SECTION B–B'

10 0 10 20m

SCALE 1:500

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Dec. 12, 2024
PROVINCE OF ONTARIO

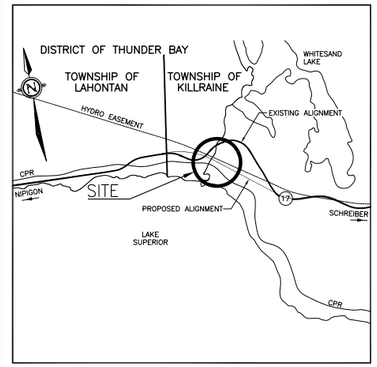
LICENSED PROFESSIONAL ENGINEER
M.E. FARRANT
100053767
Dec. 12, 2024
PROVINCE OF ONTARIO

CONT No
WP No 6333-14-00

SHEET

HIGHWAY 17
HEWITSON CREEK
CULVERT REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

THURBER



KEYPLAN

	LEGEND
⊕	Borehole (Current Investigation)
⊕	Borehole (Previous Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
▽	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
HCC-01	206.8	5 411 155.1	274 916.7
HCC-02	206.2	5 411 140.2	274 898.1
HCC-03	205.6	5 411 124.2	274 881.2
HCC-04	210.0	5 411 131.4	274 947.3
HCC-05	205.5	5 411 119.7	274 920.1
HCC-06	205.0	5 411 099.1	274 897.8
HEW-01	206.6	5 411 156.3	274 917.7
HEW-02	206.2	5 411 141.4	274 903.6
HF2A-01	221.3	5 411 169.4	274 861.3
HF2A-02	207.5	5 411 159.3	274 906.1
HF2B-01	210.0	5 411 123.4	274 952.5
HF2B-02	204.7	5 411 083.4	274 908.1
HF2B-03	218.8	5 411 070.1	274 986.6

-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.

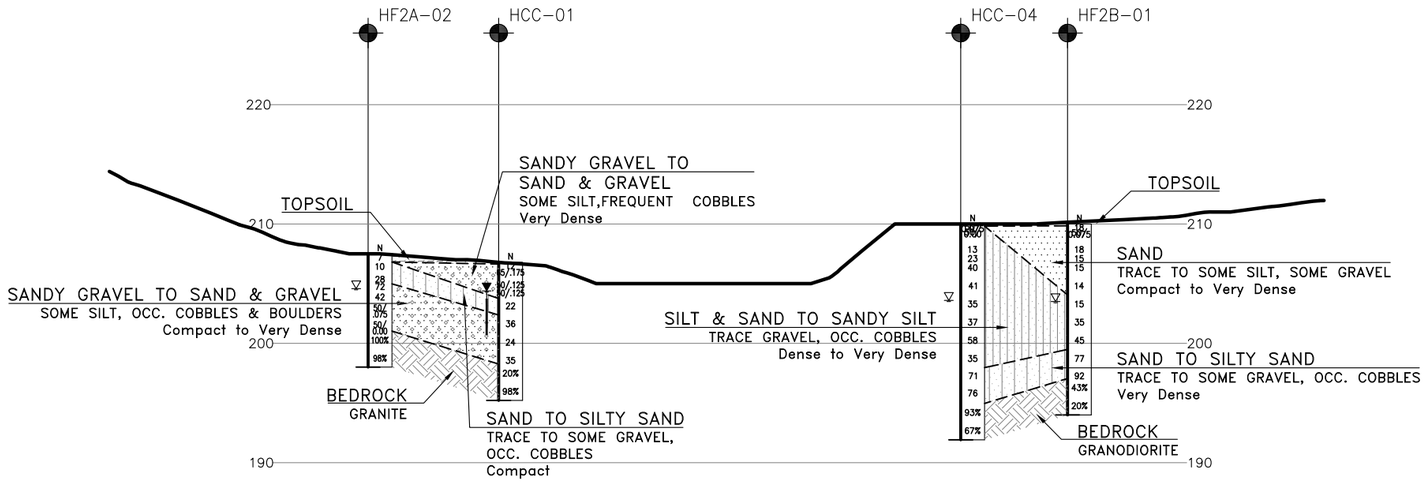
GEOCRES No. 42D14-002

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RB	CHK	MEF	CODE	LOAD	DATE	DEC 2024
DRAWN	AN	CHK	RB	SITE 48C-0026/C0	STRUCT	DWG	1

FILENAME: H:\Drafting\34000\34944\TED-37998-CULV.dwg
PLOTDATE: 12/11/2024 6:33 PM

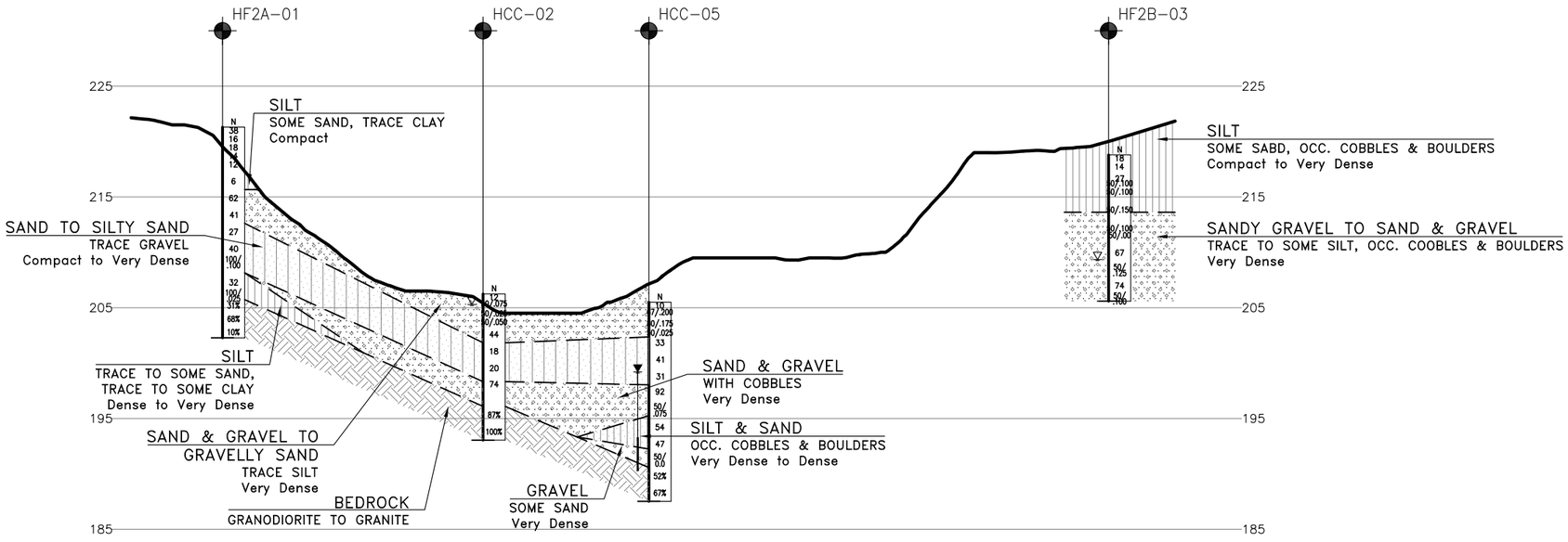
MINISTRY OF TRANSPORTATION, ONTARIO



SECTION C–C'

10 0 10 20m

SCALE 1:500



SECTION D–D'

20 0 20 40m H 1:1000

10 0 10 20m V 1:500

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Dec. 12, 2024
PROVINCE OF ONTARIO

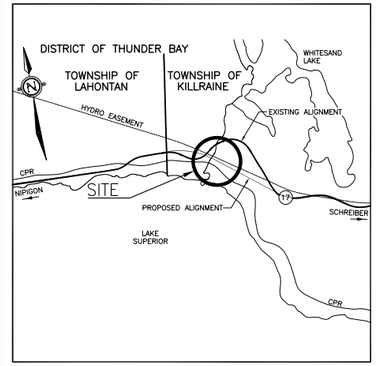
LICENSED PROFESSIONAL ENGINEER
M.E. FARRANT
100053767
Dec. 12, 2024
PROVINCE OF ONTARIO

CONT No
WP No 6333-14-00

HIGHWAY 17
HEWITSON CREEK
CULVERT REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

THURBER



KEYPLAN

LEGEND

⊕	Borehole (Current Investigation)
⊕	Borehole (Previous Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
▽	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
HCC-01	206.8	5 411 155.1	274 916.7
HCC-02	206.2	5 411 140.2	274 898.1
HCC-03	205.6	5 411 124.2	274 881.2
HCC-04	210.0	5 411 131.4	274 947.3
HCC-05	205.5	5 411 119.7	274 920.1
HCC-06	205.0	5 411 099.1	274 897.8
HEW-01	206.6	5 411 156.3	274 917.7
HEW-02	206.2	5 411 141.4	274 903.6
HF2A-01	221.3	5 411 169.4	274 861.3
HF2A-02	207.5	5 411 159.3	274 906.1
HF2B-01	210.0	5 411 123.4	274 952.5
HF2B-02	204.7	5 411 083.4	274 908.1
HF2B-03	218.8	5 411 070.1	274 986.6

-NOTES-

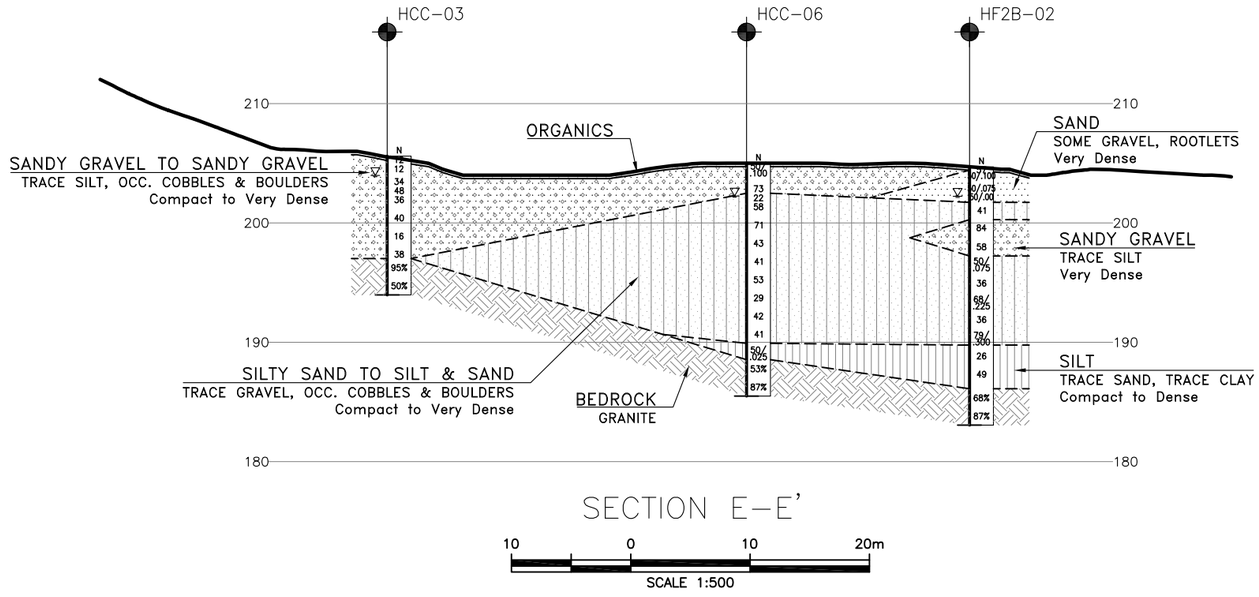
1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM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

GEOCRES No. 42D14-002

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RB	CHK MEF	CODE	LOAD	DATE DEC 2024
DRAWN	AN	CHK RB	SITE 48C-0026/CO	STRUCT	DWG 2

FILENAME: H:\Drafting\34000\34844\TED-37986-CULV.dwg
PLOTDATE: 12/11/2024 6:34 PM



SECTION E–E'

10 0 10 20m

SCALE 1:500

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

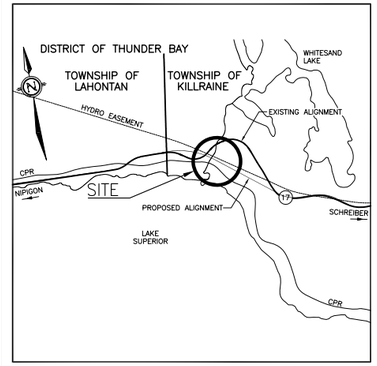
CONT No

WP No 6333-14-00

HIGHWAY 17
HEWITSON CREEK
CULVERT REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

THURBER



KEYPLAN

LEGEND

⊕	Borehole (Current Investigation)
⊕	Borehole (Previous Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
▽	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
HCC–01	206.8	5 411 155.1	274 916.7
HCC–02	206.2	5 411 140.2	274 898.1
HCC–03	205.6	5 411 124.2	274 881.2
HCC–04	210.0	5 411 131.4	274 947.3
HCC–05	205.5	5 411 119.7	274 920.1
HCC–06	205.0	5 411 099.1	274 897.8
HEW–01	206.6	5 411 156.3	274 917.7
HEW–02	206.2	5 411 141.4	274 903.6
HF2A–01	221.3	5 411 169.4	274 861.3
HF2A–02	207.5	5 411 159.3	274 906.1
HF2B–01	210.0	5 411 123.4	274 952.5
HF2B–02	204.7	5 411 083.4	274 908.1
HF2B–03	218.8	5 411 070.1	274 986.6

-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. 42D14-002

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RB	CHK	MEF	CODE	LOAD
DRAWN	AN	CHK	RB	SITE 48C–0026/C0	STRUCT

DATE DEC 2024
DWG 3

FILENAME: H:\Drafting\34000\34844\TED–37996–CULV.dwg
PLOTDATE: 12/11/2024 8:35 PM

APPENDIX B

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[(1)] '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

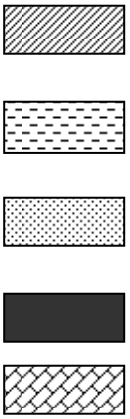
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, 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

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.

SYMBOLS



CLAYSTONE

SILTSTONE

SANDSTONE

COAL

Bedrock (general)

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

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.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
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

THURBER

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HCC-01 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 155.1 E 274 916.7 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.29 - 2024.03.31 LATITUDE 48.838040 LONGITUDE -87.407122 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
206.8	GROUND SURFACE										
0.0	**ORGANICS:** (150mm)										
0.2	Sandy **GRAVEL** to **SAND** and **GRAVEL**, some silt, frequent cobbles Very Dense Brown Wet		1	SS	12						
	Cobbles at 0.3m (150mm in dia.)		2	SS	65/ 0.175		206				
	Cobbles at 0.6m (90mm in dia.)										
	Boulders at 1.1m (250mm in dia.)		3	SS	50/ 0.125		205				
	Cobbles at 2.1m (90mm in dia.)										
	Boulders at 2.7m (215mm in dia.)		4	SS	50/ 0.125		204				
203.8											
3.0	Silty **SAND**, with trace gravel Compact Brown Wet		5	SS	22		203				
202.4	Cobbles at 4.3m (75mm in dia.)										
4.4	Sandy **GRAVEL** to **SAND** and **GRAVEL**, some silt, occasional cobbles Dense to Compact Grey Wet		6	SS	36		202				46 37 17 (SI+CL)
	Cobbles at 5.6m (100mm in dia.)						201				
	Cobbles at 6.1m (100mm in dia.)		7	SS	24		200				
			8	SS	35		199				57 30 13 (SI+CL)
198.3										FI	
8.5	**BEDROCK:** (Granite), slightly weathered to fresh, coarse grained, very strong, red Vertical fractures from 8.5m to 9.8m		1	RUN			198			1 1 1	RUN #1 TCR=100% SCR=70% RQD=20% UCS=107.7MPa (Point Load Ave.)
	Occasional healed fractures from						197			1 0	

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 8/6/24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HCC-01 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 155.1 E 274 916.7 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.29 - 2024.03.31 LATITUDE 48.838040 LONGITUDE -87.407122 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
195.2	9.4m to 10.1m		2	RUN			196			2 1 0 0 0	RUN #2 TCR=100% SCR=100% RQD=98% UCS=130.0MPa UCS=171.9MPa (Point Load Ave.)
11.6	END OF BOREHOLE AT 11.6m. BOREHOLE OPEN TO 11.6m. Well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2024.04.04 2.3 204.5 2024.04.08 2.3 204.5 2024.04.11 2.4 204.4 2024.04.13 2.4 204.4										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 8/6/24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HCC-02 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 140.2 E 274 898.1 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.28 - 2024.03.28 LATITUDE 48.837905 LONGITUDE -87.407374 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
206.2	GROUND SURFACE										
0.0	**ORGANICS:** (225mm)						206		236		
0.2	**SAND** and **GRAVEL**, trace organics, occasional cobbles and boulders Compact to Very Dense Grey Wet		1	SS	12						
			2	SS	50/ 0.075	▽	205		○		46 48 6 (SI+CL)
	Cobbles at 1.5m (100mm in dia.)										
	No recovery		3	SS	50/ 0.025		204				
	No recovery		4	SS	50/ 0.050						
	Cobbles at 2.5m (100mm in dia.)						203				
			5	SS	44				○		
201.8							202				
4.4	**SAND**, trace gravel, trace silt Compact Brown Wet										
			6	SS	18		201		○		1 91 8 0
	Cobbles at 4.7m (90mm in dia.)										
198.3							200				
			7	SS	20				○		
7.9	**SAND** and **GRAVEL**, frequent cobbles Very Dense Brown Wet		8	SS	74		199				
	Silty sand seam at 8.2m (300mm thick)						198		○		
	Cobbles at 8.4m (100mm in dia.)										
	Boulders at 8.7m (250mm in dia.)						197				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HCC-02 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 140.2 E 274 898.1 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.28 - 2024.03.28 LATITUDE 48.837905 LONGITUDE -87.407374 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.0	Continued From Previous Page									FI
10.2	**BEDROCK:** (Granite), slightly weathered to fresh, coarse grained, very strong, red to grey		1	RUN			196			1 2 1
							195			1 1
			2	RUN			194			0 0 0 0 0
193.0							193			
13.2	END OF BOREHOLE AT 13.2m. BOREHOLE OPEN TO 13.2m AND WATER LEVEL AT 1.0m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO GROUND SURFACE.									

RUN #1
TCR=100%
SCR=100%
RQD=87%
UCS=78.1MPa
UCS=189.0MPa
(Point Load Ave.)

RUN #2
TCR=100%
SCR=100%
RQD=100%
UCS=159.2MPa
(Point Load Ave.)

$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HCC-03 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 124.2 E 274 881.2 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.23 - 2024.03.26 LATITUDE 48.837760 LONGITUDE -87.407604 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
205.6	GROUND SURFACE										
0.0	**ORGANICS:** (700mm)		1	SS	12		205		167		
204.9											
0.7	**SAND** and **GRAVEL**, trace silt, occasional cobbles and boulders Compact to Dense Grey Wet Boulders at 1.4m (225mm in dia.)		2	SS	12	▽	204				
			3	SS	34		203				
			4	SS	48		202				39 50 11 (SI+CL)
			5	SS	36		201				
			6	SS	40		200				49 43 8 (SI+CL)
			7	SS	16		199				
			8	SS	38		198				57 35 8 (SI+CL)
197.0							197			FI	
8.6	**BEDROCK:** (Granite), slightly weathered to fresh, coarse grained, very strong, red to grey		1	RUN			196			1 3 4 2 2	RUN #1 TCR=100% SCR=100% RQD=95% UCS=143.6MPa (Point Load Ave.)

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HCC-03 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 124.2 E 274 881.2 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.23 - 2024.03.26 LATITUDE 48.837760 LONGITUDE -87.407604 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	Sub-vertical fracture at 10.1m Frequent healed fractures observed from 10.4m to 11.0m Frequent calcite veins (<5mm wide) from 11.0m to 11.6m		2	RUN			195			3 8 9 1	RUN #2 TCR=100% SCR=80% RQD=45% UCS=141.5MPa UCS=121.5MPa (Point Load Ave.)
194.0							194			5	
11.6	END OF BOREHOLE AT 11.6m. BOREHOLE OPEN TO 11.6m AND WATER LEVEL AT 1.6m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO GROUND SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 8/6/24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HCC-04 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 131.4 E 274 947.3 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.04.02 - 2024.04.04 LATITUDE 48.837828 LONGITUDE -87.406703 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
210.0	GROUND SURFACE										
0.0	**ORGANICS:** (175mm)		1	SS	50/ 0.075				159		
0.2	Black Wet										
	SILT and **SAND** to Sandy **SILT**, trace gravel, occasional cobbles Compact to Very Dense Grey Wet		2	SS	50/ 0.00		209				
	Cobbles at 0.9m (90mm in dia.)										
	Cobbles at 1.4m (100mm in dia.)		3	SS	13		208				3 37 59 1
			4	SS	23		207				
			5	SS	40						
							206				
			6	SS	41		205				8 30 60 2
						▽	204				
			7	SS	35		203				
	Cobbles at 7.5m (125mm in dia.)										
			8	SS	37		202				
							201				
			9	SS	58						

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HCC-04 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 131.4 E 274 947.3 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.04.02 - 2024.04.04 LATITUDE 48.837828 LONGITUDE -87.406703 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILT and **SAND** to Sandy **SILT**, trace gravel, occasional cobbles Dense to Very Dense Grey Wet										
			10	SS	35		199		○		0 25 74 1
198.0							198				
12.0	**SAND**, some silt, trace gravel, occasional cobbles Very Dense Grey Wet		11	SS	71		197		○		
			12	SS	76		196		○		8 79 13 (SI+CL)
195.0							195			FI	
15.0	**BEDROCK:** (Granodiorite), slightly weathered to fresh, medium grained, very strong, grey, frequent healed sub-vertical fractures Horizontal joint at 15.4m		1	RUN			194			0 1 0 0	RUN #1 TCR=100% SCR=93% RQD=93% UCS=143.1MPa (Point Load Ave.)
	Sub-vertical joint from 16.7 to 17.0m and 17.6m Horizontal joints at 17.1 and 17.7m		2	RUN			193			0 1 2 1 3	RUN #2 TCR=100% SCR=93% RQD=67% UCS=177.0MPa (Point Load Ave.)
191.9							192			0	
18.1	END OF BOREHOLE AT 18.1m. BOREHOLE OPEN TO 18.1m AND WATER LEVEL AT 6.4m. BOREHOLE CAVED TO 2.7m, THEN BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20
15 ⊕ 5
10 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 8/6/24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HCC-05 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 119.7 E 274 920.1 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.04.07 - 2024.04.10 LATITUDE 48.837722 LONGITUDE -87.407073 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
205.5	GROUND SURFACE										
0.0	**TOPSOIL:** (150mm)										
0.2	**SAND** and **GRAVEL**, trace silt, trace organics and rootlets to 0.7m Compact to Very Dense Brown Moist		1	SS	10		205		○		
			2	SS	67/ 0.200		204		○		
	Cobbles at 2.2m (100mm in dia.)		3	SS	80/ 0.175	▽	203		○		
			4	SS	50/ 0.025				○		
202.4											
3.1	Silty **SAND**, trace gravel Dense Grey Wet		5	SS	33		202		○		2 67 30 1
	Cobbles at 4.0m (125mm in dia.)		6	SS	41		201		○		
			7	SS	31	▼	200		○		6 59 34 1
198.0							199				
7.5	**SAND** and **GRAVEL**, trace to some silt Very Dense Grey Wet		8	SS	92		198		○		
	No recovery		9	SS	50/ 0.075		197				
							196				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 8/6/24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HCC-05 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 119.7 E 274 920.1 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.04.07 - 2024.04.10 LATITUDE 48.837722 LONGITUDE -87.407073 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page											
195.2												
10.3	**SILT** and **SAND**, trace gravel, occasional cobbles and blulders Very Dense to Dense Grey Wet						195					
			10	SS	54		194		○			1 51 46 2
			11	SS	47		193		○			
192.2	Boulders at 13.2m (330mm in dia.)						192					
13.3	**GRAVEL**, some sand Very Dense Grey Wet											
	Cobbles at 13.6m (up to 100mm in dia.)		~~12~~	~~SS~~	~~50/ 0.0~~		191					
190.6											FI	
14.9	**BEDROCK:** (Granite), fresh, coarse grained, very strong, red to grey		1	RUN			190				4 5 2 2 5	RUN #1 TCR=100% SCR=82% RQD=52% UCS=150.4MPa (Point Load Ave.)
			2	RUN			189				>10 3 4 3	RUN #2 TCR=100% SCR=83% RQD=67% UCS=161.2MPa (Point Load Ave.)
	Sub-vertical joint at 17.6m						188					
187.5											1	
18.0	END OF BOREHOLE AT 18.0m. BOREHOLE OPEN TO 18.0m AND WATER LEVEL AT 2.1m. Well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.											

WATER LEVEL READINGS

DATE	DEPTH(m)	ELEV.(m)
2024.04.11	6.1	199.4
2024.04.13	6.2	199.3
2024.04.15	6.3	199.2

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 8/6/24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HCC-06 1 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 099.1 E 274 897.8 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.04.10 - 2024.04.12 LATITUDE 48.837535 LONGITUDE -87.407375 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
205.0	GROUND SURFACE										
0.0 / 204.7	**TOPSOIL:** (280mm)		1	SS	50/ 0.100						
0.3	Sandy **GRAVEL**, some silt, occasional cobbles and boulders Very Dense Brown Wet Boulders at 0.4m (265mm in dia.) No recovery		2	SS			204				
			3	SS	73		203				
202.5											
2.5	Silty **SAND**, trace gravel, occasional cobbles and boulders Compact to Very Dense Brown to Grey Wet Cobbles at 2.4m (125mm in dia.)		4	SS	22	▽	202				
			5	SS	58		201				
			6	SS	71		200				3 76 20 1
	Cobbles at 5.5m (180mm in dia.) Cobbles at 5.7m (100mm in dia.)										
199.1											
5.9	Frequent gravel layers Cobbles at 6.1m (100mm in dia.)		7	SS	43		199				
	Boulders at 7.3m (280mm in dia.)						198				
			8	SS	41		197				
			9	SS	53		196				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HCC-06 2 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 099.1 E 274 897.8 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.04.10 - 2024.04.12 LATITUDE 48.837535 LONGITUDE -87.407375 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
194.5											
10.5	**SILT** and **SAND**, occasional cobbles and boulders Compact to Dense Brown Wet		10	SS	29		194				
			11	SS	42		193				1 51 47 1
			12	SS	41		192				
189.9							191				
15.1	**SILT**, some sand, trace clay Very Dense Brown Wet		13	SS	50/ 0.025		190				0 13 79 8
188.5							189			FI	
16.5	**BEDROCK:** (Granite), fresh, coarse grained, very strong, red Vertical fracture from 17.4m to 17.9m		1	RUN			188			4 0 >10 >10 0	RUN #1 TCR=100% SCR=58% RQD=53% UCS=168.4MPa (Point Load Ave.)
	Frequent healed sub-vertical fractures Sub-vertical fracture from 18.6m to 17.8m Vertical fracture from 18.9m to 19.3m		2	RUN			187 186			2 3 2 3	RUN #2 TCR=100% SCR=100% RQD=68% UCS=108.6MPa (Point Load Ave.)
185.5										2	
19.5	END OF BOREHOLE AT 19.5m. BOREHOLE OPEN TO 19.5m AND WATER LEVEL AT 2.7m.										

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 / 10 / 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HCC-06 3 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 099.1 E 274 897.8 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.04.10 - 2024.04.12 LATITUDE 48.837535 LONGITUDE -87.407375 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 8/6/24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF2A-01 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 169.4 E 274 861.3 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.02 - 2024.03.03 LATITUDE 48.838166 LONGITUDE -87.407878 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
221.3	GROUND SURFACE									
0.0	**ORGANICS:** (200mm)									
0.2	Silty **SAND**, trace to some gravel Compact to Dense Brown Moist		1	SS	38		221			
			2	SS	16					0 72 25 3
219.5							220			
1.8	**SILT**, some sand, trace clay Compact Grey Moist		3	SS	18					
			4	SS	14		219			
			5	SS	12		218			
	Loose		6	SS	6		217			0 14 81 5
215.7							216			
5.6	Gravelly **SAND**, trace silt Very Dense Brown Moist		7	SS	62		215			
			8	SS	41		214			
212.6							213			
8.7	Silty **SAND**, trace gravel Compact Brown Wet		9	SS	27		212			8 66 24 2

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 8/6/24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF2A-01 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 169.4 E 274 861.3 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.02 - 2024.03.03 LATITUDE 48.838166 LONGITUDE -87.407878 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **SAND**, trace gravel Dense to Very Dense Brown Wet						211				
			10	SS	40				○		
							210				
	Some gravel, occasional cobbles		11	SS	100/ 0.100		209		○		
208.1											
13.2	**SILT**, trace to some sand, trace to some clay Dense to Very Dense Grey Wet (ML)		12	SS	32		208		⊕		0 7 78 15
							207				
205.7			13	SS	100/ 0.025		206		○	FI	
15.6	**BEDROCK:** (Granodiorite), slightly weathered to fresh, medium grained, very strong, reddish grey to grey		1	RUN						>10 3 4	RUN #1 TCR=100% SCR=55% RQD=31% UCS=204MPa (Point Load Ave.)
							205			1 2	RUN #2 TCR=94% SCR=83% RQD=68% UCS=251MPa (Point Load Ave.)
			2	RUN			204			1 0	
			3	RUN			203			1 3 4 5	RUN #3 TCR=100% SCR=49% RQD=10% UCS=234MPa (Point Load Ave.)
202.3										3	
19.0	END OF BOREHOLE AT 19.0m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 8/6/24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF2A-02 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 159.3 E 274 906.1 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.04.01 - 2024.04.01 LATITUDE 48.838077 LONGITUDE -87.407267 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
207.5	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0	**ORGANICS**, rootlets, wood fibres Loose Dark Brown Wet		1	SS	7		207		132		
206.8	(700mm)										
0.7	**SAND**, trace silt, trace gravel, some organics Compact Brown to Grey Wet		2	SS	10				○		
	150mm thick wood layer at 1.8m		3	SS	28		206		○		
205.0							205				
2.5	**GRAVEL**, some sand to sandy, occasional cobbles and boulders Dense to Very Dense Brown to Grey Wet		4	SS	72	▽			○		63 31 6 (SI+CL)
	Cobbles (100mm in dia.) at 2.7m		5	SS	42		204				
	Boulder (350mm) at 5.2m		6	SS	50/0.075		203				80 19 1 (SI+CL)
201.0			7	SS	50/		202			FI	
6.5	**BEDROCK:** (Granite), slightly weathered to fresh, medium grained, very strong, reddish grey to grey		1	RUN	0.00		201			0 1 0 0 0	RUN #1 TCR=100% SCR=100% RQD=100% UCS=229.6MPa UCS=170.0MPa (Point Load Ave.)
			2	RUN			200			0 0 0 0 0	RUN #2 TCR=98% SCR=98% RQD=98% UCS=166.2MPa (Point Load Ave.)
198.0							199				
9.5	END OF BOREHOLE AT 9.5m. BOREHOLE OPEN TO 9.5m AND WATER LEVEL AT 2.9m.										

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF2A-02 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 159.3 E 274 906.1 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.04.01 - 2024.04.01 LATITUDE 48.838077 LONGITUDE -87.407267 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 8/6/24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF2B-01 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 123.4 E 274 952.5 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.04.05 - 2024.04.06 LATITUDE 48.837757 LONGITUDE -87.406632 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
210.0	GROUND SURFACE										
0.0	**TOPSOIL:** (150mm)										
0.2	**SAND**, trace to some silt, some gravel Compact to Very Dense Brown Moist to Wet		1	SS	18				○		
			2	SS	50/ 0.075		209		○		
	Cobbles (150mm in dia.) at 0.8m										
	Cobbles (100mm in dia.) at 1.4m		3	SS	18		208		○		
			4	SS	15		207		○		
			5	SS	15		206		○		
			6	SS	14		205		○		
204.1											
5.9	Sandy **SILT**, trace to some gravel, occasional cobbles and boulders Compact to Very Dense Brown Moist to Wet		7	SS	15	▽	204		○		
			8	SS	35		202		○		1 26 69 4
			9	SS	45		201		○		

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 8/6/24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF2B-01 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 123.4 E 274 952.5 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.04.05 - 2024.04.06 LATITUDE 48.837757 LONGITUDE -87.406632 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
199.5	Cobbles (125mm in dia.) at 10.4m										
10.5	Silty **SAND**, some gravel Very Dense Brown to Grey Wet		10	SS	77		199		○		17 60 21 2
							198				
197.0			11	SS	92				○	FI	
13.0	**BEDROCK:** (Granodiorite), slightly weathered to fresh, medium grained, strong, grey Sub-vertical joints at 13.1, 13.2, 13.3 and 13.4m		1	RUN			197			4 2 >10 3 2	RUN #1 TCR=100% SCR=78% RQD=43% UCS=176.0MPa (Point Load Ave.)
	Sub-vertical joints at 14.8 and 14.9m		2	RUN			196 195			2 >10 >10 >10	RUN #2 TCR=100% SCR=25% RQD=20% UCS=193.6MPa (Point Load Ave.)
194.0											
16.0	END OF BOREHOLE AT 16.0m. BOREHOLE OPEN TO 16.0m AND WATER LEVEL AT 6.5m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.						194				

$+^3$, $\times^3$: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 8/6/24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF2B-02 1 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 083.4 E 274 908.1 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.04.13 - 2024.04.15 LATITUDE 48.837395 LONGITUDE -87.407234 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
204.7	GROUND SURFACE										
0.0	**ORGANICS:** (150mm)										
0.2	**SAND**, some gravel, trace rootlets, occasional cobbles Very Dense Dark Brown Dry		1	SS	57		204		○		
	Cobbles (100mm in dia.) at 0.9m		2	SS	50/0.100				○		
			3	SS	50/0.075	▽	203		○		
	Cobbles										
	No recovery		4	SS	50/0.00		202				
201.7											
3.0	Silty **SAND**, trace gravel Dense Brown Moist		5	SS	41		201		○		1 73 24 2
200.3											
4.4	Sandy **GRAVEL**, trace silt Very Dense Brown Moist		6	SS	84		200		○		57 33 10 (SI+CL)
			7	SS	58		199				
197.2							198		○		
7.5	Silty **SAND**, trace gravel, occasional cobbles Dense to Very Dense Brown Moist		8	SS	50/0.075		197			○	
	Cobbles (100mm in dia.) at 9.0m						196				
			9	SS	36		195		○		

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF2B-02 2 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 083.4 E 274 908.1 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.04.13 - 2024.04.15 LATITUDE 48.837395 LONGITUDE -87.407234 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **SAND**, trace gravel Very Dense Brown Moist						194				
			10	SS	68/ 0.225		193		○		
			11	SS	36		192		○		2 68 28 2
			12	SS	79/ 0.300		191		○		
189.8							190				
14.9	**SILT**, trace sand, trace clay Compact to Dense Grey Wet		13	SS	26		189		○		0 6 86 8
			14	SS	49		188		○		
186.1							187				
18.6	**BEDROCK:** (Granite), slightly weathered to fresh, coarse grained, strong, red		1	RUN			186			FI 2 2 3 2	RUN #1 TCR=100% SCR=93% RQD=68% UCS=120.6MPa (Point Load Ave.)
							185				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 8/6/24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF2B-02 3 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 083.4 E 274 908.1 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.04.13 - 2024.04.15 LATITUDE 48.837395 LONGITUDE -87.407234 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Highly fractured from 20.2m to 20.3m		2	RUN			184			>10 >10 5 3 2 1	RUN #2 TCR=100% SCR=97% RQD=87% UCS=122MPa UCS=182.9MPa (Point Load Ave.)
183.1	Occasional calcite veinlets from 21.2m to 21.3m										
21.6	END OF BOREHOLE AT 21.6m. BOREHOLE OPEN TO 21.6m AND WATER LEVEL AT 2.4m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 8/6/24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF2B-03 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 070.1 E 274 986.6 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.04.16 - 2024.04.16 LATITUDE 48.837279 LONGITUDE -87.406163 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
218.8	GROUND SURFACE										
0.0	**ORGANICS:** (200mm)										
0.2	**SILT**, some sand, occasional wood fibres, occasional rootlets Compact to Very Dense Brown Moist		1	SS	18		218				
			2	SS	14						0 18 76 6
	Cobbles (175mm in dia.) at 1.5m		3	SS	27		217				
			4	SS	50/0.100		216				
	Cobbles (100mm in dia.) at 2.7m		5	SS	50/0.100		215				
213.6			6	SS	50/0.150		214				
5.2	Sandy **GRAVEL** to **SAND** and **GRAVEL**, trace to some silt, occasional cobbles and boulders Very Dense Brown Moist						213				
	Cobbles (75mm in dia.) at 5.4m		7	SS	50/0.100		212				
			8	SS	50/0.00						
	Boulders (300mm in dia.) at 7.3m						211				
	Boulders from 7.7m to 8.2m		9	SS	67	▽	210				
							209				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF2B-03 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-14: N 5 411 070.1 E 274 986.6 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE HWT Casing/HQ Casing/HQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.04.16 - 2024.04.16 LATITUDE 48.837279 LONGITUDE -87.406163 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Cobbles (100mm in dia.) at 10.0m		10	SS	50/ 0.125				○		
							208				
	Cobbles (125mm in dia.) at 11.0m		11	SS	74		207		○		52 44 4 (SI+CL)
							206				
205.6			12	SS	50/ 0.100						
13.2	END OF BOREHOLE AT 13.2m. BOREHOLE OPEN TO 13.2m AND WATER LEVEL AT 9.4m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 8/6/24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HEW-01 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM Zone 14: N 5 411 156.3 E 274 917.7 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE Portable Drilling, Wash Boring, BW Casing Advance, AW Coring COMPILED BY AN

DATUM Geodetic DATE 2023.01.14 - 2023.01.19 LATITUDE 48.838051 LONGITUDE -93.407109 CHECKED BY CN

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
206.6	GROUND SURFACE										
0.0	**TOPSOIL:** (75 mm)										
0.1	Silty **SAND**, some gravel to **SAND** and **GRAVEL**, trace silt, frequent cobbles and boulders Compact to Very Dense Brown Wet		1	SS	17		206				
			2	SS	35/0.150						
	AW coring intervals: 0.6 - 0.9 1.1 - 1.2 1.2 - 1.3		3	SS	25		205				
	1.7 - 2.0		4	SS	35/0.100						
	2.1 - 2.2 2.4 - 2.7		5	SS	35/0.150						
			6	SS	35/0.150		204				
			7	SS	14						1 77 21 1
			8	SS	56		203				
			9	SS	35/0.150		202				0 53 44 3
	AW coring from a depth of 4.9 to 5.3 m										
201.0			10	SS	35/0.150		201				
200.8	End of borehole at 5.6 m and start of DCPT										
5.6											
5.8	END OF DCPT AT 5.8 m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

NOTES:

1. A third-weight hammer was used to advance the split spoon sampler. The "N" values presented above have been adjusted to provide an estimate of the "N" value that would have been obtained with a standard hammer.

2. Water level after drilling was 3.1 m. Due to the introduction of water through the drilling methods, it is not representative of a stabilized water level.

3. The cored depth intervals and particle sizes of recovered gravels, cobbles and boulders are summarized as fellows:

Depth (m)	Recovered
0.6 - 0.9	1 x 190 mm, 1 x 70 mm
1.1 - 1.2	Gravels up to 75 mm
1.2 - 1.3	1 x 100 mm, and gravels up to 25 mm

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HEW-01 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM Zone 14: N 5 411 156.3 E 274 917.7 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE Portable Drilling, Wash Boring, BW Casing Advance, AW Coring COMPILED BY AN

DATUM Geodetic DATE 2023.01.14 - 2023.01.19 LATITUDE 48.838051 LONGITUDE -93.407109 CHECKED BY CN

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	1.7 - 2.0 1 x 230 mm, 1 x 100 mm 2.1 - 2.2 Gravels and cobbles up to 100 mm 2.4 - 2.7 1 x 220 mm, 1 x 100 mm, and gravels 4.9 - 5.3 Cobbles up to 120 mm 5.3 - 5.5 Gravels up to 20 mm										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \quad 5}$ (%) STRAIN AT FAILURE
$\frac{}{10}$

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HEW-02 1 OF 1 METRIC

GWP# 6333-14-00 LOCATION MTM Zone 14: N 5 411 141.4 E 274 903.6 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE Portable Drilling, Wash Boring, BW Casing Advance, AW Coring COMPILED BY AN

DATUM Geodetic DATE 2023.01.20 - 2023.01.24 LATITUDE 48.837916 LONGITUDE -93.407300 CHECKED BY CN

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa: UNCONFINED (○), FIELD VANE (+), QUICK TRIAXIAL (●), LAB VANE (×)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
206.2	GROUND SURFACE										
0.0	**TOPSOIL:** (150 mm)		1	SS	50/0.150		206				
0.2	Silty **SAND**, some gravel to **SAND** and **GRAVEL**, trace silt, frequent cobbles and boulders Dense to Very Dense Brown Wet		2	SS	50/0.0						
			3	SS	50/0.0		205				
	AW coring intervals: 0.3 - 0.6		4	SS	50/0.50						
	0.6 - 0.8 0.9 - 1.1 1.3 - 1.5		5	SS	50/0.150						
	1.8 - 2.1 2.1 - 2.3 2.3 - 2.5 2.5 - 2.6		6	SS	50/0.0		204				
			7	SS	33						
							203				
			8	SS	49						
	AW coring intervals: 3.8 - 4.0 4.2 - 4.3		9	SS	50/0.075		202				
201.9											
4.3	END OF BOREHOLE AT 4.3 m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

NOTES:

1. Water level after drilling was 1.9 m. Due to the introduction of water through the drilling methods, it is not representative of a stabilized water level.

2. The cored depth intervals and particle sizes of recovered gravels and cobbles are summarized as follows:

Depth (m)	Recovered
0.3 - 0.6	Gravels up to 75 mm
0.6 - 0.8	1 x 200 mm
0.9 - 1.1	Gravels up to 75 mm
1.3 - 1.5	1 x 140 mm, 1 x 100 mm, and 1 x 60 mm
1.8 - 2.1	Gravels up to 50 mm
2.1 - 2.3	1 x 130 mm, 1 x 80 mm
2.3 - 2.5	Gravels up to 75 mm
2.5 - 2.6	Gravels up to 30 mm
3.8 - 4.0	Gravels up to 40 mm
4.2 - 4.3	1 x 100 mm

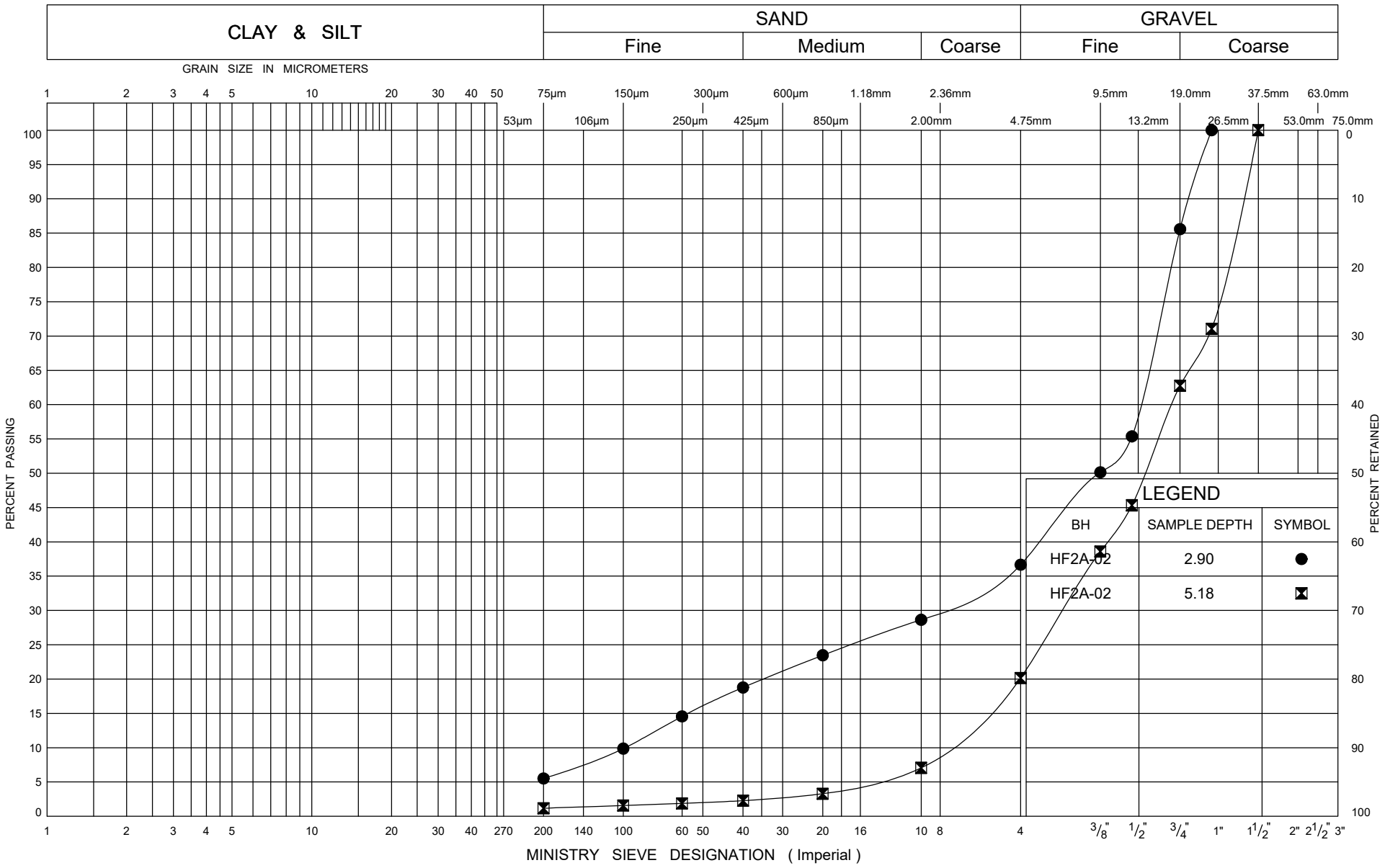
$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

THURBER

APPENDIX C

Soil Laboratory Figures and Well Test Results



Ministry of Transportation
Ontario

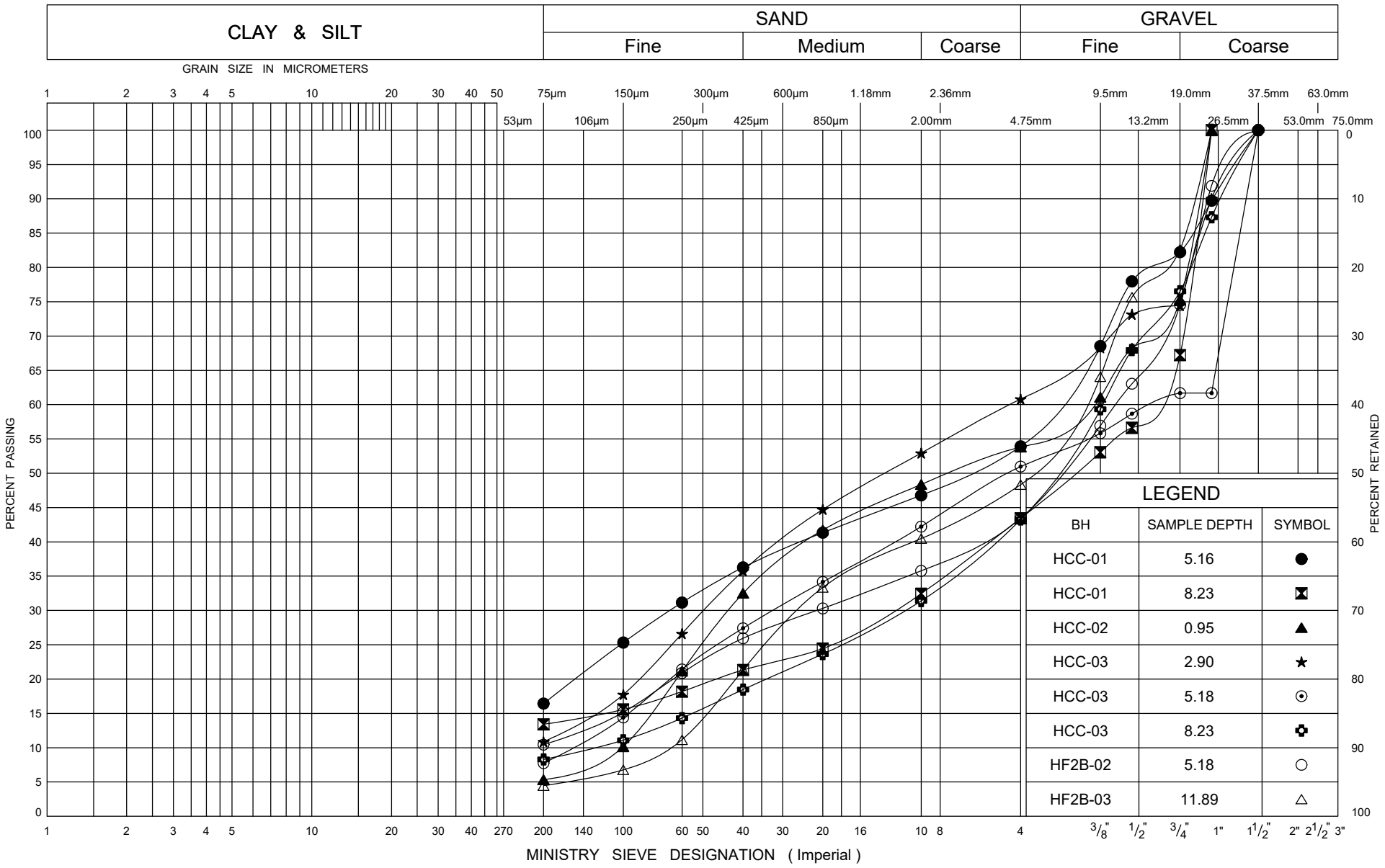
GRAIN SIZE DISTRIBUTION

GRAVEL

FIG No C1

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 7/22/24



Ministry of Transportation
Ontario

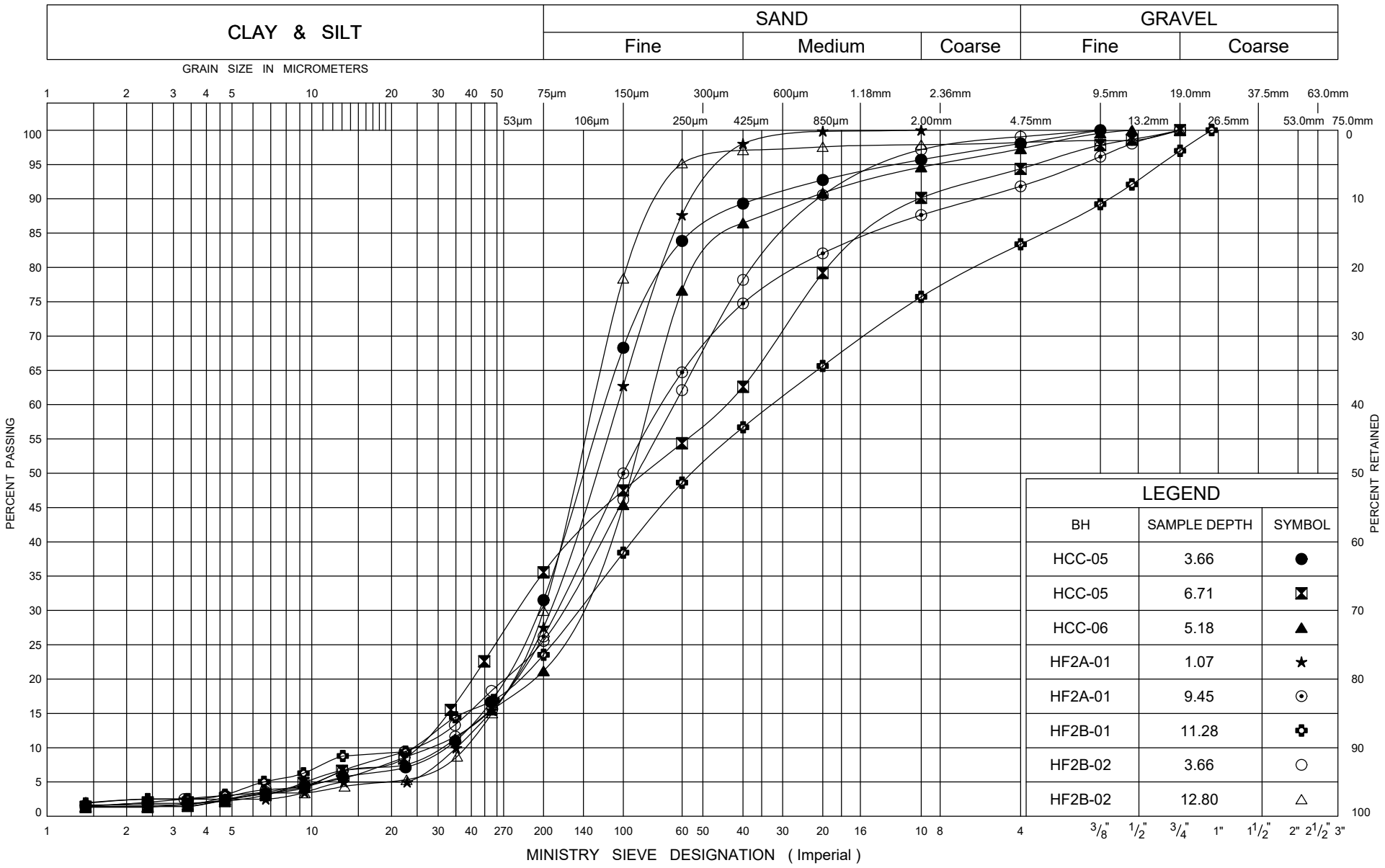
GRAIN SIZE DISTRIBUTION

Sandy GRAVEL to SAND and GRAVEL

FIG No C2

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 7/22/24



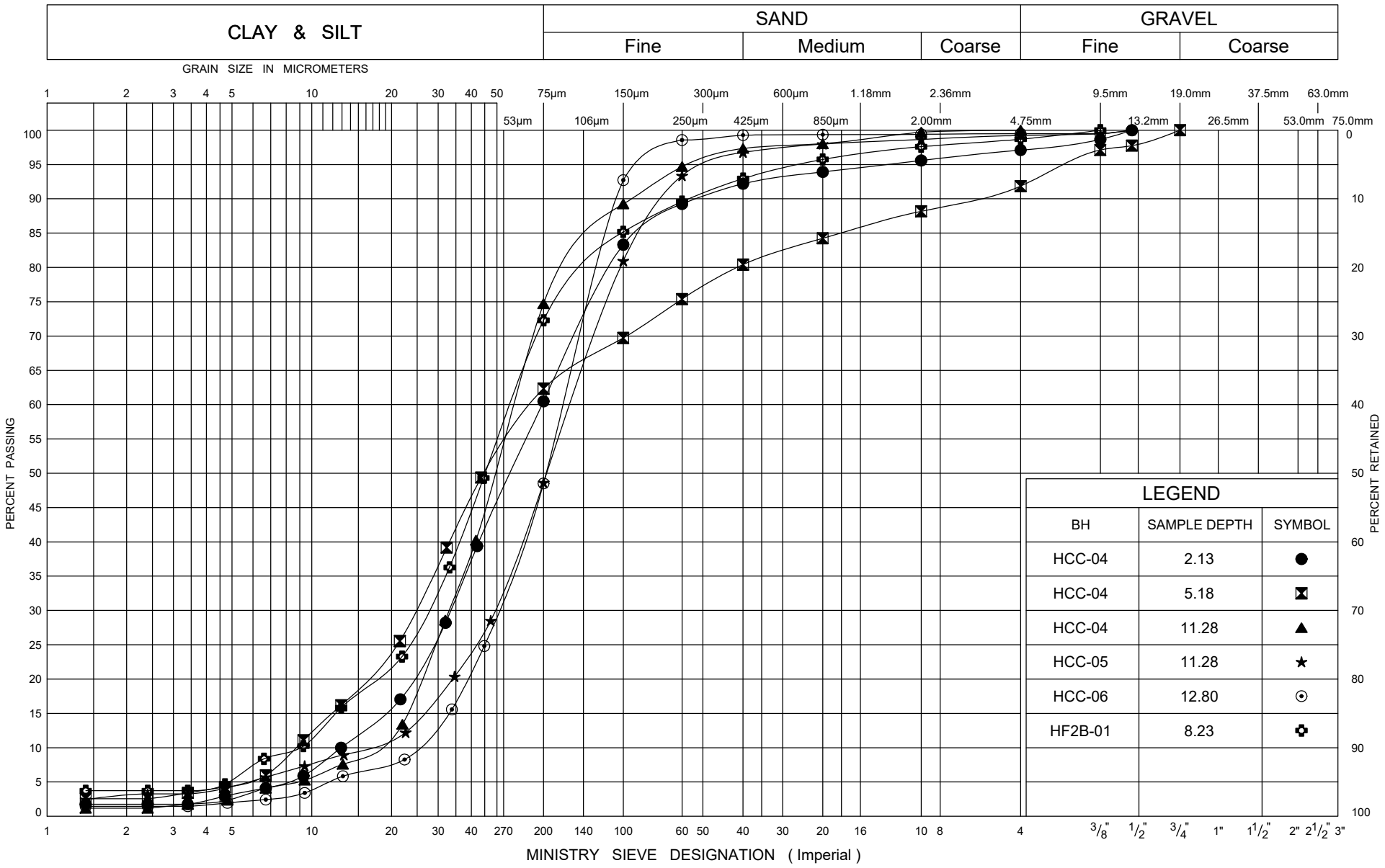
Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

Silty SAND

FIG No C3

GWP# 6333-14-00



Ministry of Transportation
Ontario

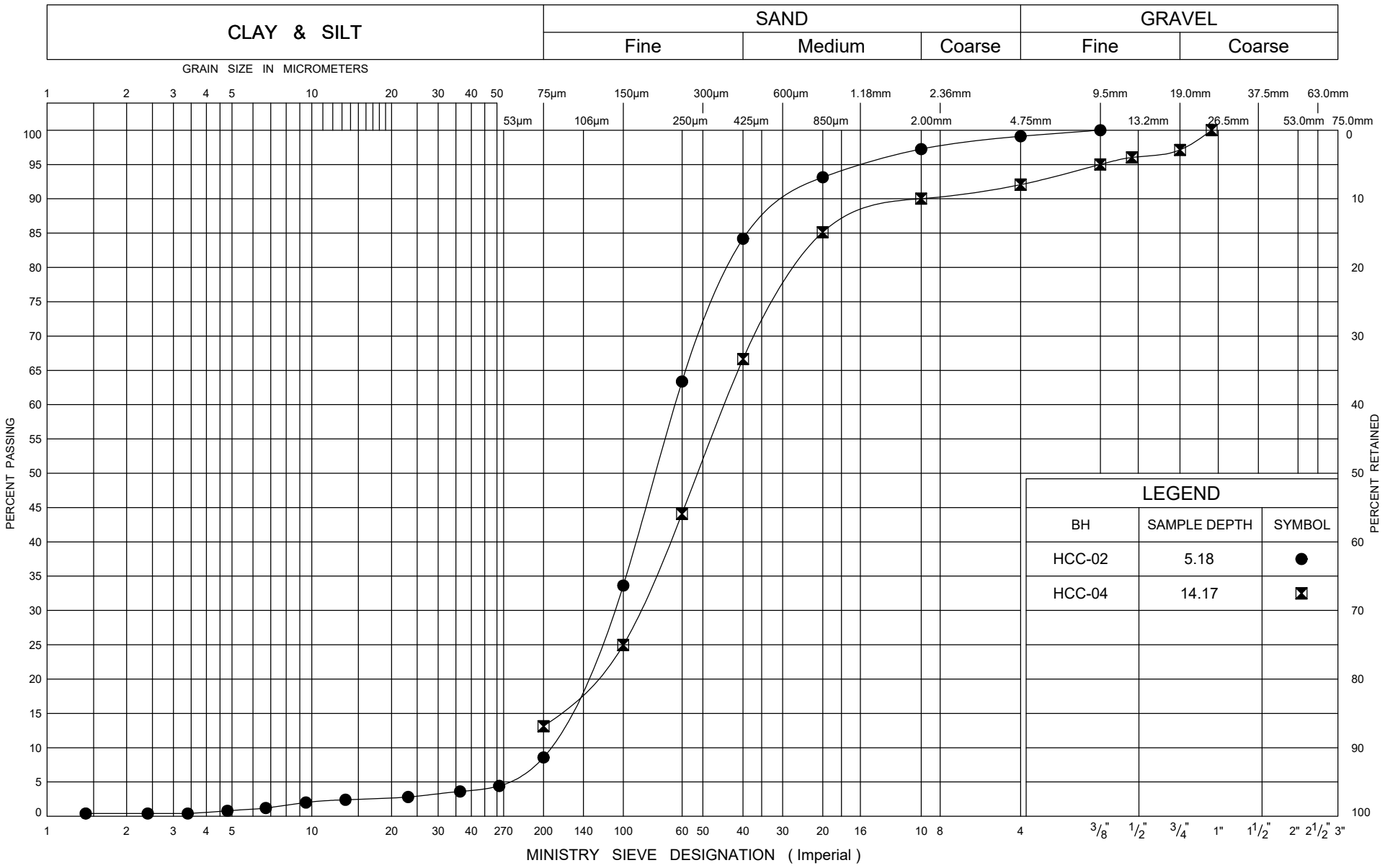
GRAIN SIZE DISTRIBUTION

SILT and SAND to Sandy SILT

FIG No C4

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 7/22/24



ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 7/22/24

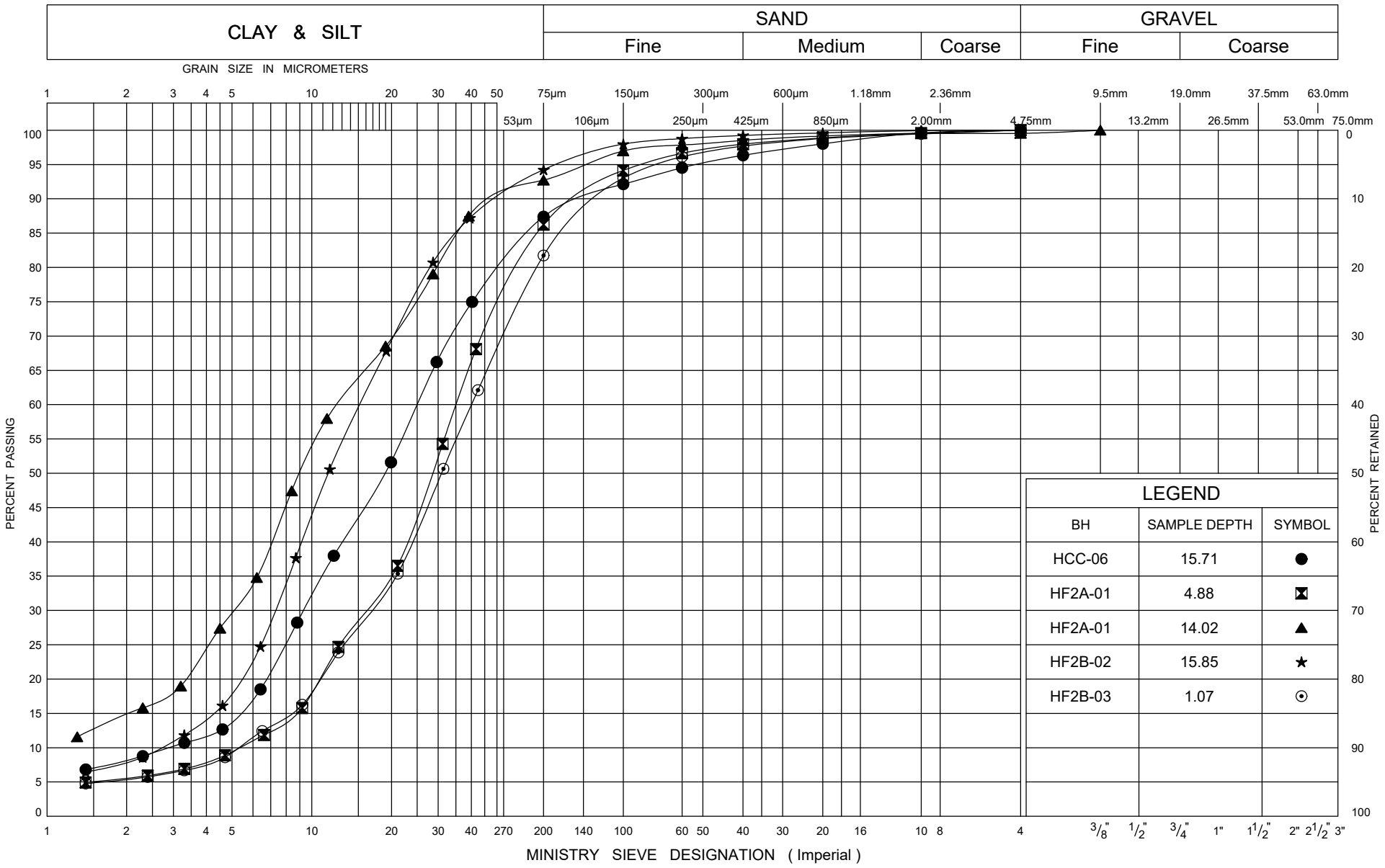
Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

SAND

FIG No C5

GWP# 6333-14-00



Ministry of Transportation
Ontario

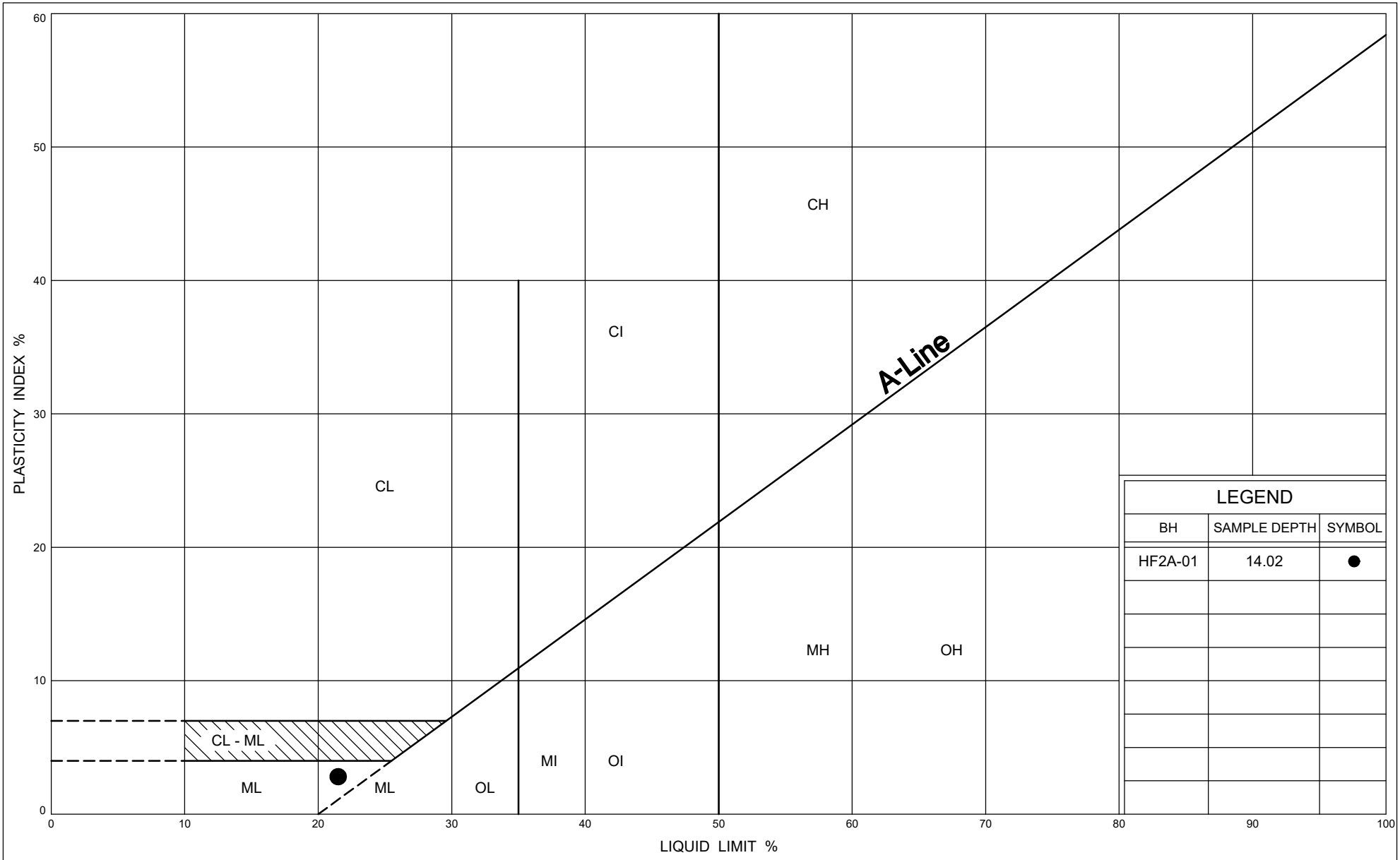
GRAIN SIZE DISTRIBUTION

SILT

FIG No C6

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 7/22/24



Ministry of Transportation
Ontario

PLASTICITY CHART

SILT

FIG No C7

GWP# 6333-14-00

ONTARIO MOT PLASTICITY CHART 2 MTO-37996.GPJ ONTARIO MOT.GDT 7/22/24

THURBER ENGINEERING LTD.

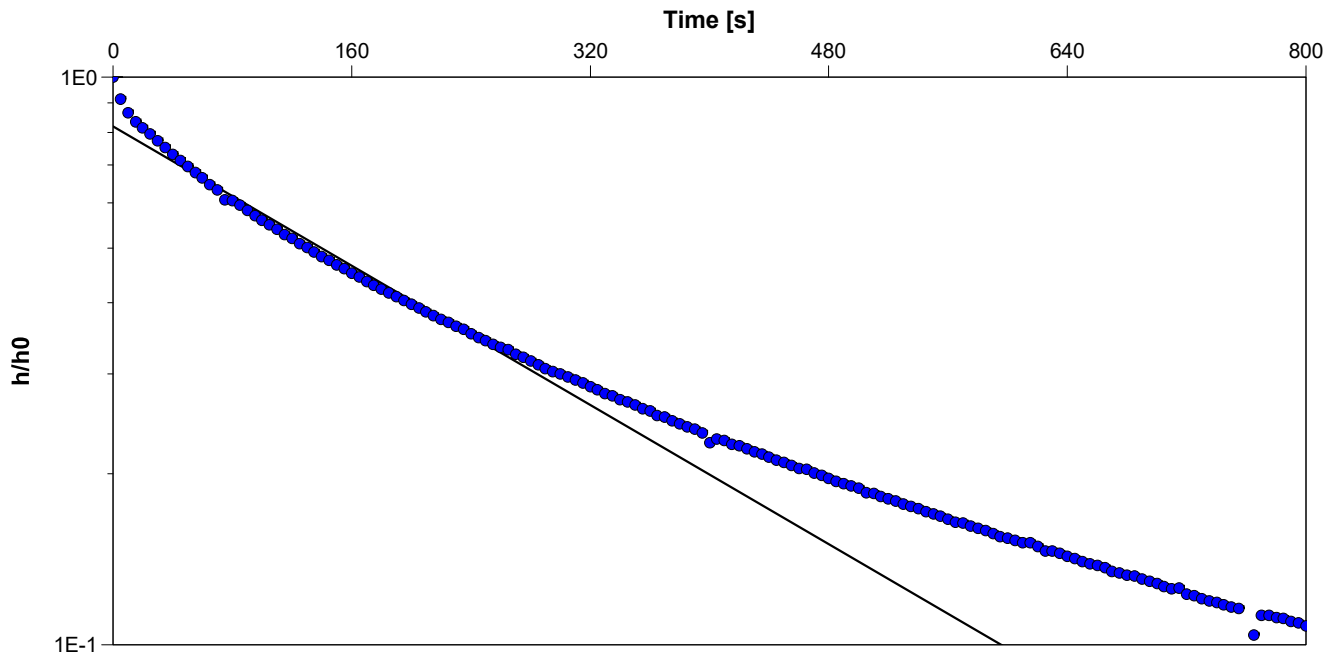
Slug Test Analysis Report

Project: Highway 17 - Hewiston Creek Culvert

Number: 37996

Client: Hatch

Location: Selim, Ontario	Slug Test: HCC-01	Test Well: HCC-01
Test Conducted by: GA		Test Date: 2024-04-19
Analysis Performed by: ES	HCC-01 SWRT Analysis	Analysis Date: 2024-05-10
Aquifer Thickness:		
	Checked By:DH	



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]	
HCC-01	1.8×10^{-6}	

THURBER ENGINEERING LTD.

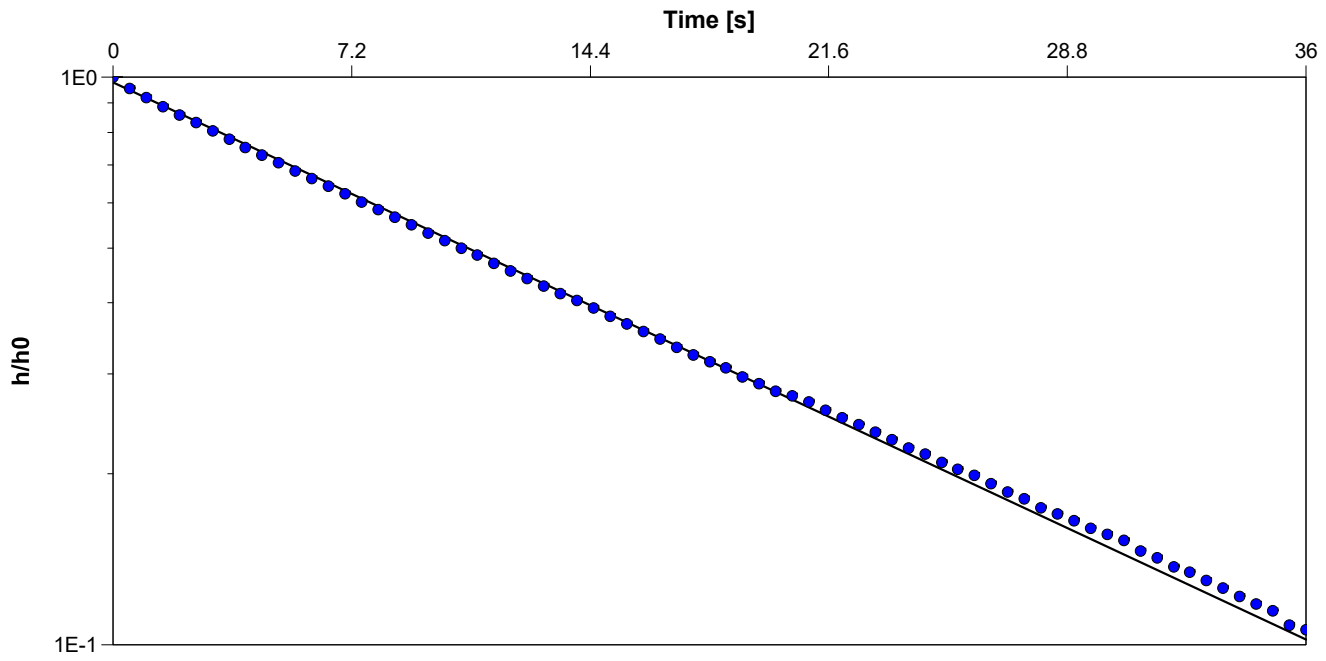
Slug Test Analysis Report

Project: Highway 17 - Hewiston Creek Culvert

Number: 37996

Client: Hatch

Location: Selim, Ontario	Slug Test: HCC-05	Test Well: HCC-05
Test Conducted by: GA		Test Date: 2024-04-19
Analysis Performed by: ES	HCC-05 SWRT Analysis	Analysis Date: 2024-05-10
Aquifer Thickness:		
	Checked BY: DH	



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]	
HCC-05	3.2×10^{-5}	

APPENDIX D

Bedrock Laboratory Test Results and Rock Core Photographs

THURBER ENGINEERING LTD.

Gravel, Cobble, and Boulder Core Photos

Borehole HCC-01

Borehole HCC-02

THURBER ENGINEERING LTD.

Gravel, Cobble, and Boulder Core Photos

Borehole HCC-04

Borehole HCC-05

THURBER ENGINEERING LTD.

Gravel, Cobble, and Boulder Core Photos

Borehole HCC-06

Borehole HF2A-01

THURBER ENGINEERING LTD.

Gravel, Cobble, and Boulder Core Photos

Borehole HF2B-01

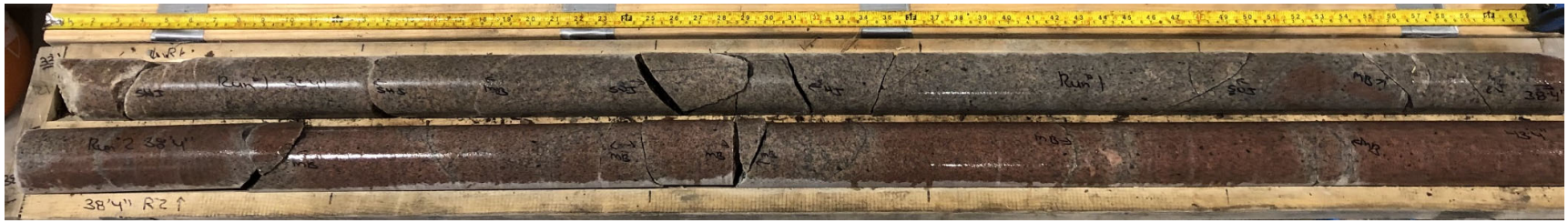
Borehole HF2B-02

THURBER ENGINEERING LTD.

Bedrock Core Photos

Borehole HCC-01, Runs 1 and 2: 8.5 to 11.6 (Elev. 198.4 to 195.3 m)

Borehole HCC-02, Runs 1 and 2: 10.2 to 13.2 (Elev. 196.0 to 193.0 m)



Borehole HCC-03, Runs 1 and 2: 8.6 to 11.6 (Elev. 196.9 to 193.9 m)

THURBER ENGINEERING LTD.

Bedrock Core Photos

Borehole HCC-04, Runs 1 and 2: 15.0 to 18.1 (Elev. 195.0 to 191.9 m)

Borehole HCC-05, Runs 1 and 2: 14.9 to 18.0 (Elev. 189.6 to 186.5 m)

Borehole HCC-06, Runs 1 and 2: 16.5 to 19.5 (Elev. 188.5 to 185.5 m)

THURBER ENGINEERING LTD.

Bedrock Core Photos

Borehole HF2A-01, Runs 1, 2, and 3: 15.6 to 19.0 (Elev. 205.4 to 202.0 m)

Borehole HF2A-02, Runs 1 and 2: 6.5 to 9.5 (Elev. 201.0 to 198.0 m)

Borehole HF2B-01, Runs 1 and 2: 13.0 to 16.0 (Elev. 197.0 to 194.0 m)

THURBER ENGINEERING LTD.

Bedrock Core Photos

Borehole HF2B-02, Runs 1 and 2: 18.6 to 21.6 (Elev. 186.1 to 183.1 m)

THURBER ENGINEERING LTD.

UNCONFINED COMPRESSION TEST REPORT

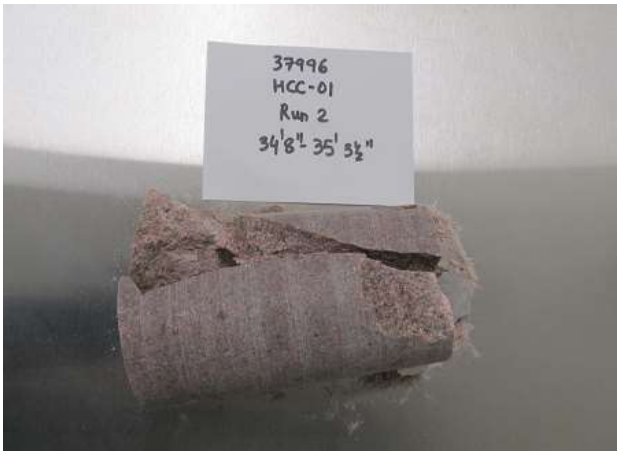
ASTM D7012-14

CLIENT:	MTO/Hatch	FILE NUMBER:	37996
PROJECT NAME:	Highway 17 Hewitson Creek	REPORT DATE:	11-Jul-24
BOREHOLE No.:	HCC-01	TEST DATE:	30-Apr-24
SAMPLE No.:	2		
SAMPLE DEPTH:	10.57 - 10.76 m		
DESCRIPTION:	Granite		

Avg. Height (cm):	13.2	Weight (g):	1083.1
Avg. Diameter (cm):	6.3	Wet Density (kg/m^3):	2,632
H. to Dia. Ratio**:	2.1:1	Dry Density (kg/m^3):	2,632
Cross Sectional Area (cm^2):	31.17	Moisture Content* (%):	N/A
Sample Volume (cm^3):	411.48		

ORIGINAL SPECIMEN

FRACTURED SPECIMEN



AVG. RATE OF STRAIN TO FAILURE:	0.250	MPa/s
MAXIMUM COMPRESSIVE LOAD:	405.3	kN
UNCONFINED COMPRESSIVE STRENGTH:	130.0	MPa

Note: * The moisture content was obtained before the test.
** Dimensions of Specimen conform to ASTM D 4543-04.

TEST DONE BY: GF
REVIEWED BY: WM

THURBER ENGINEERING LTD.

UNCONFINED COMPRESSION TEST REPORT

ASTM D7012-14

CLIENT:	MTO/Hatch	FILE NUMBER:	37996
PROJECT NAME:	Highway 17 Hewitson Creek	REPORT DATE:	11-Jul-24
BOREHOLE No.:	HCC-02	TEST DATE:	30-Apr-24
SAMPLE No.:	1		
SAMPLE DEPTH:	11.18 - 11.30 m		
DESCRIPTION:	Granite		

Avg. Height (cm):	13.0	Weight (g):	1070.8
Avg. Diameter (cm):	6.3	Wet Density (kg/m^3):	2,642
H. to Dia. Ratio**:	2.1:1	Dry Density (kg/m^3):	2,642
Cross Sectional Area (cm^2):	31.17	Moisture Content* (%):	N/A
Sample Volume (cm^3):	405.24		

ORIGINAL SPECIMEN

FRACTURED SPECIMEN

AVG. RATE OF STRAIN TO FAILURE:	0.250	MPa/s
MAXIMUM COMPRESSIVE LOAD:	243.4	kN
UNCONFINED COMPRESSIVE STRENGTH:	78.1	MPa

Note: * The moisture content was obtained before the test.
** Dimensions of Specimen conform to ASTM D 4543-04.

TEST DONE BY: GF
REVIEWED BY: WM

THURBER ENGINEERING LTD.

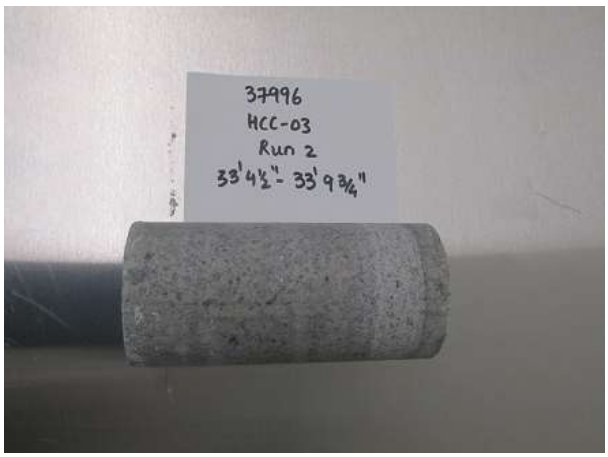
UNCONFINED COMPRESSION TEST REPORT

ASTM D7012-14

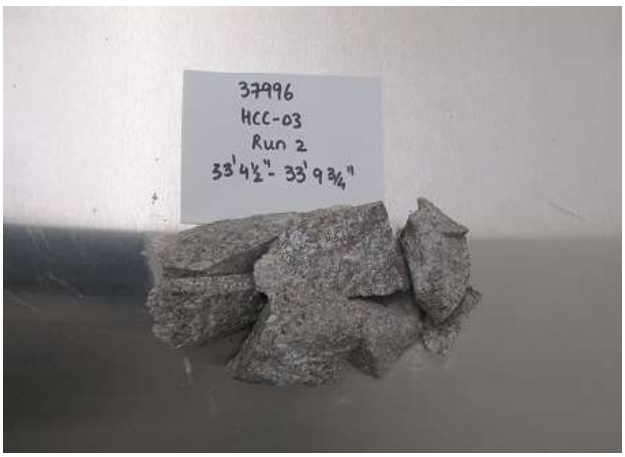
CLIENT:	MTO/Hatch	FILE NUMBER:	37996
PROJECT NAME:	Highway 17 Hewitson Creek	REPORT DATE:	11-Jul-24
BOREHOLE No.:	HCC-03	TEST DATE:	30-Apr-24
SAMPLE No.:	2		
SAMPLE DEPTH:	10.17 - 10.31 m		
DESCRIPTION:	Granite		

Avg. Height (cm):	13.0	Weight (g):	1063.4
Avg. Diameter (cm):	6.3	Wet Density (kg/m^3):	2,624
H. to Dia. Ratio**:	2.1:1	Dry Density (kg/m^3):	2,624
Cross Sectional Area (cm^2):	31.17	Moisture Content* (%):	N/A
Sample Volume (cm^3):	405.24		

ORIGINAL SPECIMEN



FRACTURED SPECIMEN



AVG. RATE OF STRAIN TO FAILURE:	0.250	MPa/s
MAXIMUM COMPRESSIVE LOAD:	441.2	kN
UNCONFINED COMPRESSIVE STRENGTH:	141.5	MPa

Note: * The moisture content was obtained before the test.
** Dimensions of Specimen conform to ASTM D 4543-04.

TEST DONE BY: GF
REVIEWED BY: WM

THURBER ENGINEERING LTD.

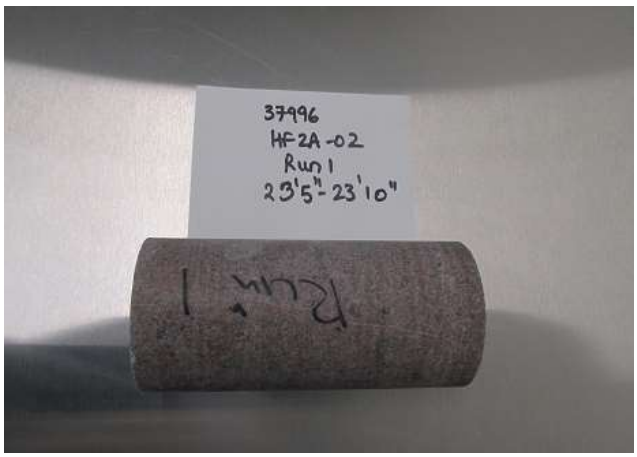
UNCONFINED COMPRESSION TEST REPORT

ASTM D7012-14

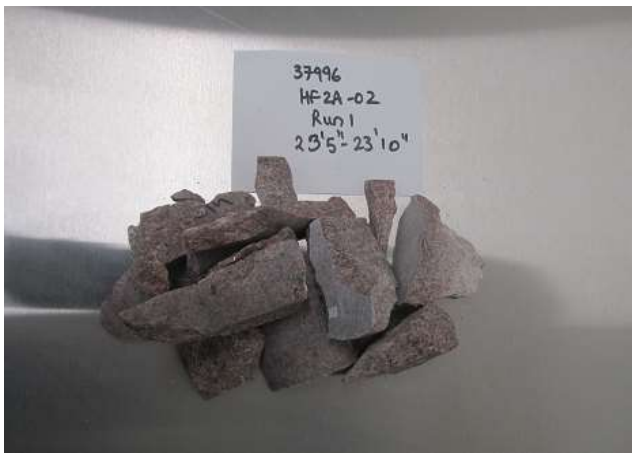
CLIENT:	MTO/Hatch	FILE NUMBER:	37996
PROJECT NAME:	Highway 17 Hewitson Creek	REPORT DATE:	11-Jul-24
BOREHOLE No.:	HF2A-02	TEST DATE:	30-Apr-24
SAMPLE No.:	1		
SAMPLE DEPTH:	7.14 - 7.26 m		
DESCRIPTION:	Granite		

Avg. Height (cm):	13.0	Weight (g):	1078.3
Avg. Diameter (cm):	6.3	Wet Density (kg/m^3):	2,661
H. to Dia. Ratio**:	2.1:1	Dry Density (kg/m^3):	2,661
Cross Sectional Area (cm^2):	31.17	Moisture Content* (%):	N/A
Sample Volume (cm^3):	405.24		

ORIGINAL SPECIMEN



FRACTURED SPECIMEN



AVG. RATE OF STRAIN TO FAILURE:	0.250	MPa/s
MAXIMUM COMPRESSIVE LOAD:	715.8	kN
UNCONFINED COMPRESSIVE STRENGTH:	229.6	MPa

Note: * The moisture content was obtained before the test.

** Dimensions of Specimen conform to ASTM D 4543-04.

TEST DONE BY: GF
REVIEWED BY: WM

THURBER ENGINEERING LTD.

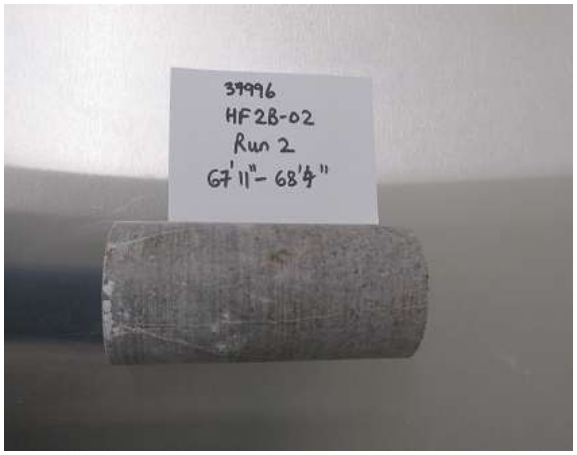
UNCONFINED COMPRESSION TEST REPORT

ASTM D7012-14

CLIENT:	MTO/Hatch	FILE NUMBER:	37996
PROJECT NAME:	Highway 17 Hewitson Creek	REPORT DATE:	11-Jul-24
BOREHOLE No.:	HF2B-02	TEST DATE:	30-Apr-24
SAMPLE No.:	2		
SAMPLE DEPTH:	20.70 - 20.83 m		
DESCRIPTION:	Granite		

Avg. Height (cm):	13.1	Weight (g):	1079.5
Avg. Diameter (cm):	6.3	Wet Density (kg/m^3):	2,644
H. to Dia. Ratio**:	2.1:1	Dry Density (kg/m^3):	2,644
Cross Sectional Area (cm^2):	31.17	Moisture Content* (%):	N/A
Sample Volume (cm^3):	408.36		

ORIGINAL SPECIMEN



FRACTURED SPECIMEN

AVG. RATE OF STRAIN TO FAILURE:	0.250	MPa/s
MAXIMUM COMPRESSIVE LOAD:	380.2	kN
UNCONFINED COMPRESSIVE STRENGTH:	122.0	MPa

Note: * The moisture content was obtained before the test.
** Dimensions of Specimen conform to ASTM D 4543-04.

TEST DONE BY: GF
REVIEWED BY: WM

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	37996	**Date Drilled:**	08-Mar-24
Project Name:	HWY 17 Hewitson Creek	**Date Tested:**	23-Apr-24
		Tester:	BS
Core Size:	HQ **BH No :** HCC-01	**Client:**	Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	9.9	D	14.4	63.1	111.4	3.8	91.1	Granite	Strong
2	1	10.0	A	22.5	63.1	59.4	5.2	124.3	Granite	Very Strong
3	2	10.2	D	**30.0**	62.9	203.4	8.0	191.1	Granite	Very Strong
4	2	10.5	A	**30.0**	63.0	61.4	6.7	161.6	Granite	Very Strong
5	2	11.0	A	**30.0**	63.0	60.0	6.8	164.4	Granite	Very Strong
6	2	11.2	D	**30.0**	63.0	114.7	7.9	190.7	Granite	Very Strong
7	2	11.5	A	**30.0**	63.0	66.6	6.3	151.6	Granite	Very Strong
8										
9										
10										
11						Run 1 Average:		107.7		Very Strong
12						Run 2 Average:		171.9		Very Strong
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
  Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
* Diametral Test should have 0.7 x D on either side of test point.
* Correlation factor to obtain UCS values is 24.
* **Bolded text indicates the PLT Gauge reached the maximum of 30 Mpa, and the core did not break**

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	37996	**Date Drilled:**	28-Mar-24
Project Name:	HWY 17 Hewitson Creek	**Date Tested:**	23-Apr-24
		Tester:	BS
Core Size:	HQ **BH No :** HCC-02	**Client:**	Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	10.4	D	**30.0**	62.7	130.4	8.0	192.2	Granite	Very Strong
2	1	10.5	A	29.9	62.8	61.5	6.7	161.4	Granite	Very Strong
3	1	10.9	D	12.9	32.6	98.1	9.5	228.1	Granite	Very Strong
4	1	11.3	D	**30.0**	62.6	126.4	8.0	192.7	Granite	Very Strong
5	1	11.6	A	**30.0**	62.8	57.4	7.1	170.5	Granite	Very Strong
6	2	11.9	D	**30.0**	62.5	120.9	8.1	193.4	Granite	Very Strong
7	2	12.2	A	23.6	62.8	64.2	5.1	123.1	Granite	Very Strong
8	2	12.4	D	19.4	62.7	165.6	5.2	124.4	Granite	Very Strong
9	2	12.9	A	**30.0**	62.6	60.8	6.8	163.4	Granite	Very Strong
10	2	14.7	D	**30.0**	62.8	117.9	8.0	191.8	Granite	Very Strong
11										
12						Run 1 Average:		189.0		Very Strong
13						Run 2 Average:		159.2		Very Strong
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
  Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
* Diametral Test should have 0.7 x D on either side of test point.
* Correlation factor to obtain UCS values is 24.
* **Bolded text indicates the PLT Gauge reached the maximum of 30 Mpa, and the core did not break**

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	37996	**Date Drilled:**	06-Mar-24
Project Name:	HWY 17 Hewitson Creek	**Date Tested:**	23-Apr-24
		Tester:	BS
Core Size:	HQ **BH No :** HCC-03	**Client:**	Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	8.7	D	**30.0**	62.8	100.9	8.0	191.8	Granite	Very Strong
2	1	9.1	A	8.4	62.7	63.8	1.8	44.1	Granite	Medium Strong
3	1	9.5	D	**30.0**	62.6	137.9	8.0	192.7	Granite	Very Strong
4	1	9.7	D	21.4	62.7	112.8	5.7	137.1	Granite	Very Strong
5	1	10.0	A	**30.0**	62.7	66.5	6.4	152.4	Granite	Very Strong
6	2	11.2	D	12.1	62.6	109.9	3.2	77.8	Granite	Strong
7	2	11.3	A	**30.0**	62.6	60.0	6.9	165.2	Granite	Very Strong
8										
9						Run 1 Average:		143.6		Very Strong
10						Run 2 Average:		121.5		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										

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
  Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
* Diametral Test should have 0.7 x D on either side of test point.
* Correlation factor to obtain UCS values is 24.
* **Bolded text indicates the PLT Gauge reached the maximum of 30 Mpa, and the core did not break**

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	37996	**Date Drilled:**	31-Mar-24
Project Name:	HWY 17 Hewitson Creek	**Date Tested:**	23-Apr-24
		Tester:	BS
Core Size:	HQ **BH No :** HCC-04	**Client:**	Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	15.9	D	19.9	62.3	105.1	5.4	129.1	Granite	Very Strong
2	1	16.0	A	**30.0**	62.4	64.2	6.5	157.1	Granite	Very Strong
3	2	17.1	A	**30.0**	62.3	65.0	6.5	155.8	Granite	Very Strong
4	2	17.4	D	**30.0**	62.4	119.1	8.1	193.6	Granite	Very Strong
5	2	17.6	A	**30.0**	62.4	60.1	6.9	165.3	Granite	Very Strong
6	2	17.7	D	**30.0**	62.5	106.2	8.0	193.2	Granite	Very Strong
7										
8										
9						Run 1 Average:		143.1		Very Strong
10						Run 2 Average:		177.0		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										

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
  Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
* Diametral Test should have 0.7 x D on either side of test point.
* Correlation factor to obtain UCS values is 24.
* **Bolded text indicates the PLT Gauge reached the maximum of 30 Mpa, and the core did not break**

Last Modified: September 14, 2016

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	37996	**Date Drilled:**	10-Apr-24
Project Name:	HWY 17 Hewitson Creek	**Date Tested:**	23-Apr-24
		Tester:	GA
Core Size:	HQ **BH No :** HCC-05	**Client:**	Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	15.2	D	**30.0**	62.1	140.2	8.1	195.1	Granite	Very Strong
2	1	15.6	A	**30.0**	62.1	68.1	6.3	150.5	Granite	Very Strong
3	1	15.8	D	**30.0**	62.2	152.9	8.1	194.6	Granite	Very Strong
4	1	16.1	A	13.0	62.3	73.5	2.6	61.2	Granite	Strong
5	2	16.8	D	**30.0**	62.3	142.8	8.1	194.1	Granite	Very Strong
6	2	17.0	A	**30.0**	62.4	61.9	6.7	161.6	Granite	Very Strong
7	2	17.4	A	**30.0**	62.3	62.1	6.7	161.5	Granite	Very Strong
8	2	17.3	D	19.7	62.4	132.2	5.3	127.4	Granite	Very Strong
9										
10						Run 1 Average:		150.4		Very Strong
11						Run 2 Average:		161.2		Very Strong
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
  Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
* Diametral Test should have 0.7 x D on either side of test point.
* Correlation factor to obtain UCS values is 24.
* **Bolded text indicates the PLT Gauge reached the maximum of 30 Mpa, and the core did not break**

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	37996	**Date Drilled:**	13-Apr-24
Project Name:	HWY 17 Hewitson Creek	**Date Tested:**	23-Apr-24
		Tester:	BS
Core Size:	HQ **BH No :** HCC-06	**Client:**	Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	16.6	D	26.0	62.2	163.4	7.0	168.4	Granite	Very Strong
2	2	18.1	D	**30.0**	62.4	200.1	8.1	193.9	Granite	Very Strong
3	2	18.5	A	12.4	62.4	62.5	2.8	66.4	Granite	Strong
4	2	18.9	D	19.1	62.4	148.9	5.1	123.3	Granite	Very Strong
5	2	19.3	A	10.4	62.5	69.8	2.1	50.8	Granite	Strong
6										
7						Run 1 Average:		168.4		Very Strong
8						Run 2 Average:		108.6		Very Strong
9										
10										
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										

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
  Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
* Diametral Test should have 0.7 x D on either side of test point.
* Correlation factor to obtain UCS values is 24.
* **Bolded text indicates the PLT Gauge reached the maximum of 30 Mpa, and the core did not break**

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	37996	**Date Drilled:**	03-Mar-24
Project Name:	HWY 17 Hewitson Creek	**Date Tested:**	15-Apr-24
		Tester:	BS
Core Size:	NQ **BH No :** HF2A-01	**Client:**	Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	15.7	D	13.6	47.3	80.1	5.6	135.3	Granite	Very Strong
2	1	16.1	D	20.2	47.3	70.5	8.3	200.4	Granite	Very Strong
3	1	16.4	D	27.8	47.3	75.0	11.5	275.7	Granite	Extremely Strong
4	2	16.8	D	25.2	47.3	72.8	10.4	249.9	Granite	Very Strong
5	2	17.0	D	27.2	47.3	67.1	11.2	269.8	Granite	Extremely Strong
6	2	17.3	D	21.5	47.3	75.0	8.9	213.2	Granite	Very Strong
7	2	17.6	D	27.3	47.3	71.7	11.3	270.8	Granite	Extremely Strong
8	3	18.2	D	22.5	47.4	71.7	9.3	222.4	Granite	Very Strong
9	3	18.6	D	24.1	47.3	65.3	10.0	239.0	Granite	Very Strong
10	3	18.8	D	24.3	47.4	71.0	10.0	240.2	Granite	Very Strong
11										
12					Run 1 Average:			203.8		Very Strong
13					Run 2 Average:			250.9		Extremely Strong
14					Run 3 Average:			233.9		Very Strong
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
  Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
* Diametral Test should have 0.7 x D on either side of test point.
* Correlation factor to obtain UCS values is 24.

Last Modified: September 14, 2016

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	37996	**Date Drilled:**	01-Apr-24
Project Name:	HWY 17 Hewitson Creek	**Date Tested:**	23-Apr-24
		Tester:	GA
Core Size:	HQ **BH No :** HF2A-02	**Client:**	Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	6.7	A	**30.0**	63.0	60.8	6.8	162.7	Granite	Very Strong
2	1	6.9	D	**30.0**	62.8	172.4	8.0	191.8	Granite	Very Strong
3	1	7.3	A	**30.0**	62.5	65.4	6.5	154.8	Granite	Very Strong
4	1	7.6	A	**30.0**	62.8	68.4	6.2	148.9	Granite	Very Strong
5	1	7.8	D	**30.0**	62.8	119.3	8.0	191.8	Granite	Very Strong
6	2	8.2	A	**30.0**	62.8	64.8	6.5	155.3	Granite	Very Strong
7	2	8.5	D	**30.0**	62.8	115.7	8.0	191.8	Granite	Very Strong
8	2	8.7	A	27.8	62.8	62.0	6.2	149.0	Granite	Very Strong
9	2	9.1	D	**30.0**	62.9	117.8	8.0	191.5	Granite	Very Strong
10	2	9.3	A	26.8	62.9	62.0	6.0	143.2	Granite	Very Strong
11										
12						Run 1 Average:		170.0		Very Strong
13						Run 2 Average:		166.2		Very Strong
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
  Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
* Diametral Test should have 0.7 x D on either side of test point.
* Correlation factor to obtain UCS values is 24.
* **Bolded text indicates the PLT Gauge reached the maximum of 30 Mpa, and the core did not break**

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	37996	**Date Drilled:**	06-Apr-24
Project Name:	HWY 17 Hewitson Creek	**Date Tested:**	23-Apr-24
		Tester:	GA
Core Size:	HQ **BH No :** HF2A-02	**Client:**	Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	13.6	D	**30.0**	62.6	131.3	8.0	192.7	Granite	Very Strong
2	1	13.8	D	**30.0**	62.5	100.9	8.0	193.1	Granite	Very Strong
3	1	13.9	A	**30.0**	63.5	61.2	6.7	160.9	Granite	Very Strong
4	1	14.4	A	**30.0**	62.4	64.2	6.5	157.2	Granite	Very Strong
5	2	14.6	D	**30.0**	62.4	117.5	8.1	193.6	Granite	Very Strong
6										
7						Run 1 Average:		176.0		Very Strong
8						Run 2 Average:		193.6		Very Strong
9										
10										
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										

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
  Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
* Diametral Test should have 0.7 x D on either side of test point.
* Correlation factor to obtain UCS values is 24.
* **Bolded text indicates the PLT Gauge reached the maximum of 30 Mpa, and the core did not break**

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	37996	**Date Drilled:**	15-Apr-24
Project Name:	HWY 17 Hewitson Creek	**Date Tested:**	23-Apr-24
		Tester:	GA
Core Size:	HQ **BH No :** HF2B-02	**Client:**	Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	18.8	A	23.4	62.0	61.1	5.3	128.2	Granite	Very Strong
2	1	19.0	D	15.9	61.9	58.1	4.3	104.0	Granite	Very Strong
3	1	19.2	A	**30.0**	61.9	64.1	6.6	158.2	Granite	Very Strong
4	1	19.6	D	17.2	62.1	104.1	4.7	111.7	Granite	Very Strong
5	1	19.8	A	18.2	62.1	60.0	4.2	101.0	Granite	Very Strong
6	2	21.1	D	**30.0**	62.2	151.4	8.1	194.7	Granite	Very Strong
7	2	21.4	A	**30.0**	62.2	63.2	6.6	159.4	Granite	Very Strong
8	2	21.5	D	**30.0**	62.2	124.2	8.1	194.4	Granite	Very Strong
9										
10						Run 1 Average:		120.6		Very Strong
11						Run 2 Average:		182.9		Very Strong
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
31										
32										
33										
34										
35										

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
  Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
* Diametral Test should have 0.7 x D on either side of test point.
* Correlation factor to obtain UCS values is 24.
* **Bolded text indicates the PLT Gauge reached the maximum of 30 Mpa, and the core did not break**

APPENDIX E

Analytical Laboratory Test Results

FINAL REPORT

CA14731-APR24 R1

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

CA14731-APR24 R1

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 (2)

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	CA14731-APR24
Received	04/19/2024
Approved	04/26/2024
Report Number	CA14731-APR24 R1
Date Reported	04/26/2024

COMMENTS

MAC - Maximum Acceptable Concentration
AO/OG - Aesthetic Objective / Operational Guideline
NR - Not reportable under applicable Provincial drinking water regulations as per client.

Temperature of Sample upon Receipt: 1 degrees C
Cooling Agent Present: YES
Custody Seal Present: YES

Chain of Custody Number:035940

SIGNATORIES

Maarit Wolfe, Hon.B.Sc

TABLE OF CONTENTS

Client: Thurber Engineering Ltd.
Project:
Project Manager: Rachel Bourassa
Samplers: Gazzopardi

MATRIX: WATER

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

			Sample Number	7	8
			Sample Name	HCC-01	HCC-01 Dissolved
			Sample Matrix	Solution	Solution
			Sample Date	18/04/2024	18/04/2024
Parameter	**Units**	**RL**	**L1**	**Result**	**Result**
General Chemistry					
Total Suspended Solids	mg/L	2		4	---
Alkalinity	mg/L as CaCO3	2		82	---
Bicarbonate	mg/L as CaCO3	2		82	---
Carbonate	mg/L as CaCO3	2		< 2	---
OH	mg/L as CaCO3	2		< 2	---
Colour	TCU	3		111	---
Conductivity	uS/cm	2		590	---
Turbidity	NTU	0.10		9.8	---
Ammonia+Ammonium (N)	as N mg/L	0.04		0.23	---
Total Reactive Phosphorous (o-phosphate as P)	mg/L	0.03		< 0.03	---
Total Organic Carbon	mg/L	1		12	---
Metals and Inorganics					
Fluoride	mg/L	0.06		0.12	---
Bromide	mg/L	0.3		< 0.3	---
Nitrite (as N)	as N mg/L	0.03		< 0.03	---
Nitrate (as N)	as N mg/L	0.06		< 0.06	---
Sulphate	mg/L	2		< 2	---
Aluminum (0.2µm)	mg/L	0.001	0.075	0.074	---
Hardness	mg/L as CaCO3	0.05		95.7	92.0
Aluminum (total)	mg/L	0.001		0.290	0.072

Client: Thurber Engineering Ltd.
Project:
Project Manager: Rachel Bourassa
Samplers: Gazzopardi

MATRIX: WATER

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

			Sample Number	7	8
			Sample Name	HCC-01	HCC-01 Dissolved
			Sample Matrix	Solution	Solution
			Sample Date	18/04/2024	18/04/2024
Parameter	**Units**	**RL**	**L1**	**Result**	**Result**
Metals and Inorganics (continued)					
Arsenic (total)	mg/L	0.0002	0.005	0.0003	0.0003
Boron (total)	mg/L	0.002	0.2	0.010	0.007
Barium (total)	mg/L	0.00008		0.0815	0.0771
Beryllium (total)	mg/L	0.000007	1.1	0.000029	0.000017
Cobalt (total)	mg/L	0.000004	0.0009	0.00128	0.00116
Calcium (total)	mg/L	0.01		29.2	28.2
Cadmium (total)	mg/L	0.000003	0.0001	0.000004	< 0.000003
Copper (total)	mg/L	0.001	0.005	0.006	< 0.001
Chromium (total)	mg/L	0.00008	0.1	0.00161	0.00086
Iron (total)	mg/L	0.007	0.3	6.00	5.68
Potassium (total)	mg/L	0.009		0.968	0.934
Magnesium (total)	mg/L	0.001		5.54	5.22
Manganese (total)	mg/L	0.00001		0.149	0.158
Molybdenum (total)	mg/L	0.0004	0.04	0.0017	0.0013
Nickel (total)	mg/L	0.0001	0.025	0.0033	0.0023
Sodium (total)	mg/L	0.01		86.3	84.4
Phosphorus (total)	mg/L	0.003	0.01	0.023	0.018
Lead (total)	mg/L	0.00009	0.005 0.025	0.00026	< 0.00009
Silicon (total)	mg/L	0.02		5.95	5.34
Silver (total)	mg/L	0.00005	0.0001	0.00090	< 0.00005

Client: Thurber Engineering Ltd.
Project:
Project Manager: Rachel Bourassa
Samplers: Gazzopardi

MATRIX: WATER

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

			Sample Number	7	8
			Sample Name	HCC-01	HCC-01 Dissolved
			Sample Matrix	Solution	Solution
			Sample Date	18/04/2024	18/04/2024
Parameter	**Units**	**RL**	**L1**	**Result**	**Result**
Metals and Inorganics (continued)					
Strontium (total)	mg/L	0.00008		0.0524	0.0514
Thallium (total)	mg/L	0.000005	0.0003	< 0.000005	< 0.000005
Tin (total)	mg/L	0.00006		0.0022	0.00178
Titanium (total)	mg/L	0.0001		0.0128	0.0016
Antimony (total)	mg/L	0.0009	0.02	< 0.0009	< 0.0009
Selenium (total)	mg/L	0.00004	0.1	0.00014	0.00011
Uranium (total)	mg/L	0.000002	0.005	0.000186	0.000149
Vanadium (total)	mg/L	0.00001	0.006	0.00342	0.00255
Zinc (total)	mg/L	0.002	0.02	0.005	0.007
Cation sum	meq/L	-9999		6.07	---
Anion Sum	meq/L	-9999		5.59	---
Anion-Cation Balance	% difference	-9999		4.11	---
Ion Ratio	-	-9999		1.09	---
Total Dissolved Solids (calculated)	mg/L	-9999		311	---
Conductivity (calculated)	uS/cm	-9999		583	---
Langeliers Index 4° C	@ 4° C	-9999		-1.09	---
Saturation pH 4°C	pHs @ 4°C	-9999		8.58	---

Client: Thurber Engineering Ltd.
Project:
Project Manager: Rachel Bourassa
Samplers: Gazzopardi

MATRIX: WATER

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

			Sample Number	7	8
			Sample Name	HCC-01	HCC-01 Dissolved
			Sample Matrix	Solution	Solution
			Sample Date	18/04/2024	18/04/2024
Parameter	**Units**	**RL**	**L1**	**Result**	**Result**
Other (ORP)					
pH	No unit	0.05	8.6	7.49	---
Chloride	mg/L	1		140	---
Mercury (dissolved)	mg/L	0.00001	0.0002	---	< 0.00001
Mercury (total)	mg/L	0.00001	0.0002	< 0.00001	---

EXCEEDANCE SUMMARY

Parameter	Method	Units	Result	PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E L1
HCC-01				
Cobalt	SM 3030/EPA 200.8	mg/L	0.00128	0.0009
Copper	SM 3030/EPA 200.8	mg/L	0.006	0.005
Iron	SM 3030/EPA 200.8	mg/L	6.00	0.3
Phosphorus	SM 3030/EPA 200.8	mg/L	0.023	0.01
Silver	SM 3030/EPA 200.8	mg/L	0.00090	0.0001
HCC-01 Dissolved				
Cobalt	SM 3030/EPA 200.8	mg/L	0.00116	0.0009
Iron	SM 3030/EPA 200.8	mg/L	5.68	0.3
Phosphorus	SM 3030/EPA 200.8	mg/L	0.018	0.01

QC SUMMARY

Alkalinity

Method: SM 2320 I Internal ref.: ME-CA-[ENV]EWL-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
Alkalinity	EWL0530-APR24	mg/L as CaCO3	2	< 2	2	20	102	80	120	NA		

Ammonia by SFA

Method: SM 4500 I Internal ref.: ME-CA-[ENV]SFA-LAK-AN-007

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
Ammonia+Ammonium (N)	SKA0235-APR24	mg/L	0.04	<0.04	ND	10	104	90	110	105	75	125

QC SUMMARY

Anions by discrete analyzer

Method: US EPA 325.2 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-026

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	DIO8069-APR24	mg/L	1	<1	0	20	95	80	120	100	75	125
Sulphate	DIO8069-APR24	mg/L	2	<2	0	20	105	80	120	91	75	125

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-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
Bromide	DIO0518-APR24	mg/L	0.3	<0.3	ND	20	105	90	110	92	75	125
Nitrite (as N)	DIO0518-APR24	mg/L	0.03	<0.03	0	20	99	90	110	98	75	125
Nitrate (as N)	DIO0518-APR24	mg/L	0.06	<0.06	0	20	99	90	110	89	75	125

QC SUMMARY

Carbon by SFA

Method: SM 5310 I Internal ref.: ME-CA-IENVISFA-LAK-AN-009

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
Total Organic Carbon	SKA0226-APR24	mg/L	1	<1	ND	20	99	90	110	99	75	125

Carbonate/Bicarbonate

Method: SM 2320 I 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
Carbonate	EWL0530-APR24	mg/L as CaCO3	2	< 2	ND	10	NA	90	110	NA		
Bicarbonate	EWL0530-APR24	mg/L as CaCO3	2	< 2	2	10	NA	90	110	NA		
OH	EWL0530-APR24	mg/L as CaCO3	2	< 2	ND	10	NA	90	110	NA		

QC SUMMARY

Colour

Method: SM 2120 I Internal ref.: ME-CA-IENVIEWL-LAK-AN-002

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
Colour	EWL0515-APR24	TCU	3	< 3	ND	10	105	80	120	NA		

Conductivity

Method: SM 2510 I 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	EWL0530-APR24	uS/cm	2	< 2	0	20	100	90	110	NA		

Fluoride by Specific Ion Electrode

Method: SM 4500 I Internal ref.: ME-CA-IENVIEWL-LAK-AN-014

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
Fluoride	EWL0509-APR24	mg/L	0.06	<0.06	2	10	99	90	110	NV	75	125

QC SUMMARY

Mercury by CVAAS

Method: EPA 7471A/SM 3112B | Internal ref.: ME-CA-[ENVISPE-LAK-AN-004

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
Mercury (total)	EHG0043-APR24	mg/L	0.00001	< 0.00001	ND	20	101	80	120	74	70	130

QC SUMMARY

Metals in aqueous samples - ICP-MS

Method: SM 3030/EPA 200.8 | Internal ref.: ME-CA-IENVISPE-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
Silver (total)	EMS0239-APR24	mg/L	0.00005	<0.00005	ND	20	99	90	110	91	70	130
Aluminum (total)	EMS0239-APR24	mg/L	0.001	<0.001	19	20	100	90	110	121	70	130
Aluminum (0.2µm)	EMS0239-APR24	mg/L	0.001	<0.001	19	20	100	90	110	121	70	130
Arsenic (total)	EMS0239-APR24	mg/L	0.0002	<0.0002	7	20	104	90	110	115	70	130
Barium (total)	EMS0239-APR24	mg/L	0.00008	<0.00008	2	20	97	90	110	75	70	130
Beryllium (total)	EMS0239-APR24	mg/L	0.000007	<0.000007	ND	20	99	90	110	101	70	130
Boron (total)	EMS0239-APR24	mg/L	0.002	<0.002	0	20	101	90	110	103	70	130
Calcium (total)	EMS0239-APR24	mg/L	0.01	<0.01	1	20	102	90	110	106	70	130
Cadmium (total)	EMS0239-APR24	mg/L	0.000003	<0.000003	5	20	97	90	110	99	70	130
Cobalt (total)	EMS0239-APR24	mg/L	0.000004	<0.000004	9	20	104	90	110	113	70	130
Chromium (total)	EMS0239-APR24	mg/L	0.00008	<0.00008	16	20	104	90	110	99	70	130
Copper (total)	EMS0239-APR24	mg/L	0.001	<0.001	ND	20	104	90	110	115	70	130
Iron (total)	EMS0239-APR24	mg/L	0.007	<0.007	15	20	103	90	110	100	70	130
Potassium (total)	EMS0239-APR24	mg/L	0.009	<0.009	2	20	102	90	110	106	70	130
Magnesium (total)	EMS0239-APR24	mg/L	0.001	<0.001	1	20	99	90	110	96	70	130
Manganese (total)	EMS0239-APR24	mg/L	0.00001	<0.00001	0	20	101	90	110	114	70	130
Molybdenum (total)	EMS0239-APR24	mg/L	0.0004	<0.0004	2	20	107	90	110	115	70	130
Sodium (total)	EMS0239-APR24	mg/L	0.01	<0.01	3	20	98	90	110	102	70	130
Nickel (total)	EMS0239-APR24	mg/L	0.0001	<0.0001	5	20	104	90	110	107	70	130
Lead (total)	EMS0239-APR24	mg/L	0.00009	<0.00009	ND	20	97	90	110	97	70	130

QC SUMMARY

Metals in aqueous samples - ICP-MS (continued)

Method: SM 3030/EPA 200.8 I Internal ref.: ME-CA-IENVISPE-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
Phosphorus (total)	EMS0239-APR24	mg/L	0.003	<0.003	18	20	97	90	110	NV	70	130
Antimony (total)	EMS0239-APR24	mg/L	0.0009	<0.0009	ND	20	108	90	110	111	70	130
Selenium (total)	EMS0239-APR24	mg/L	0.00004	<0.00004	13	20	98	90	110	116	70	130
Silicon (total)	EMS0239-APR24	mg/L	0.02	<0.02	5	20	92	90	110	NV	70	130
Tin (total)	EMS0239-APR24	mg/L	0.00006	<0.00006	ND	20	101	90	110	NV	70	130
Strontium (total)	EMS0239-APR24	mg/L	0.00008	<0.00008	2	20	99	90	110	99	70	130
Titanium (total)	EMS0239-APR24	mg/L	0.0001	<0.0001	5	20	104	90	110	NV	70	130
Thallium (total)	EMS0239-APR24	mg/L	0.000005	<0.000005	4	20	100	90	110	91	70	130
Uranium (total)	EMS0239-APR24	mg/L	0.000002	<0.000002	2	20	99	90	110	97	70	130
Vanadium (total)	EMS0239-APR24	mg/L	0.00001	<0.00001	3	20	103	90	110	114	70	130
Zinc (total)	EMS0239-APR24	mg/L	0.002	<0.002	ND	20	103	90	110	91	70	130

pH

Method: SM 4500 I 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
pH	EWL0530-APR24	No unit	0.05	NA	0		101			NA		

QC SUMMARY

Reactive Phosphorus by SFA

Method: SM 4500-P F | Internal ref.: ME-CA-[ENV]SFA-LAK-AN-004

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
Total Reactive Phosphorous (o-phosphate as P)	SKA0218-APR24	mg/L	0.03	<0.03	ND	10	99	90	110	82	75	125

Suspended Solids

Method: SM 2540D | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-004

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
Total Suspended Solids	EWL0507-APR24	mg/L	2	< 2	0	10	98	90	110	NA		

Turbidity

Method: SM 2130 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-003

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
Turbidity	EWL0492-APR24	NTU	0.10	< 0.10	0	10	100	90	110	NA		

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.

This report supersedes all previous versions.

-- End of Analytical Report --

SGS

Request for Laboratory Services and CHAIN OF CUSTODY

No: 035940

Industries & Environment - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

Page ____ of ____

Laboratory Information Section - Lab use only

Received By: Katelyn Midland
Received Date: APR 1 9 2024 (mm/dd/yy)
Received Time: 10 : 00 (hr : min)
Received By (signature): Ky
Custody Seal Present: Yes ☑ No ☐
Custody Seal Intact: Yes ☑ No ☐
Cooling Agent Present: Yes ☑ No ☐ Type: Ice
Temperature Upon Receipt (°C) 1 , 7 , 1
LAB LIMS #: CA15114-APR24 / CA14731-APR24

REPORT INFORMATION	INVOICE INFORMATION	
Company: Thurber Eng.	☒ (same as Report Information)	Quotation #:	P.O. #:
Contact: Rachel Bourassa	Company:	Project #:	Site Location/ID:
Address: 202-1003 Ironoak Way, Oakville, ON L6H-0N4	Contact:		
Phone: 905-829-8666	Address:		
Fax:	Phone:		
Email: RBourassa@thurber.ca	Email:		

TURNAROUND TIME (TAT) REQUIRED

☒ Regular TAT (5-7days)

TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day

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

REGULATIONS

☐ O.Reg 153/04: ☐ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table ____ ☐ Res/Park ☐ Ind/Com ☐ Agri/Other Appx. ____
Soil Texture: ☐ Coarse ☐ Medium/Fine
Soil Volume ☐ <350m3 ☐ >350m3

☐ O.Reg 406/19

Other Regulations: ☐ Reg 347/558 (3 Day min TAT) ☒ PWQO ☐ MMER ☐ CCME ☐ Other: ☐ MISA ☐ ODWS Not Reportable *See note

Sewer By-Law: ☐ Sanitary ☐ Storm Municipality: ____

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

ANALYSIS REQUESTED

#	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	M & I: Metals & Inorganics incl CrVI, CN, Hg pH, (B(HWS), EC, SAR-soil) (Cl, Na-water)	M & I: Full Metals Suite ICP metals plus B(HWS-soil only) Hg, CrVI	M & I: ICP Metals only Sb, As, Ba, Be, B, Cd, Cr, Co, Cu, Pb, Mo, Ni, Se, Ag, Tl, U, V, Zn	SVOC: PAHs only	SVOC: SVOCs all incl PAHs, ABNs, CPs	PCB: PCBs ☐ Total ☐ Aroclor	PHC: F1-F4 + BTEX	PHC: F1-F4 only no BTEX	VOC: VOCs all incl BTEX	VOC: BTEX only	Pest: Pesticides Organochlorine or specify other	Other: Chem General Water Pack	Other: [illegible]	Other: TSS	Other: Field Filtered Met (PWQO)	Sewer Use: Specify pkg:	Water Characterization Pkg ☐ General ☐ Extended	SPLP Specify tests ☐ Metals ☐ VOC ☐ 1,4-Dioxane ☐ OCP ☐ ABN	TCLP Specify tests ☐ M&I ☐ VOC ☐ PCB ☐ B(a)P ☐ ABN ☐ Ignit.	COMMENTS:
1	HF1	18/4/24	8:30	3	Liquid														✓							
2	HF3	18/4/24	9:45	3	Liquid														✓							
3	Hewiston Creek	18/4/24	8:45	3	Liquid														✓							
4	HCC-01	18/4/24	8:55	11	Liquid													✓		✓	✓					
5																										
6																										
7																										
8																										
9																										
10																										
11																										
12																										

Observations/Comments/Special Instructions

Sampled By (NAME): G. Azzopardi Signature: [signature] Date: 04 / 18 / 24 (mm/dd/yy) Pink Copy - Client

Relinquished by (NAME): G. Azzopardi Signature: [signature] Date: 04 / 18 / 24 (mm/dd/yy) Yellow & White Copy - SGS

Revision #: 1.7
Date of Issue: 07 JUNE 2023

FINAL REPORT

CA15114-APR24 R

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

CA15114-APR24 R

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Thurber Engineering Ltd.	Project Specialist	Jill Campbell, B.Sc.,GISAS
		Laboratory	SGS Canada Inc.
Address	1908 Ironoak Way, Suite 202 Oakville, ON L6H 0N1. Canada	Address	185 Concession St., Lakefield ON, K0L 2H0
Contact	Rachel Bourassa	Telephone	2165
Telephone	905-829-8666 x 263	Facsimile	705-652-6365
Facsimile		Email	jill.campbell@sgs.com
Email	rbourassa@thurber.ca	SGS Reference	CA15114-APR24
Project		Received	04/19/2024
Order Number		Approved	04/25/2024
Samples	Solution (3)	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

TABLE OF CONTENTS

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
General Chemistry						
Conductivity	uS/cm	2		26	194	36
Redox Potential	mV	no		226	192	254
Sulphide	µg/L	6		< 6	< 6	< 6
Metals and Inorganics						
Sulphate	mg/L	0.04		1.6	4.0	2.2
Other (ORP)						
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-[ENV]IC-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-[ENV]EWL-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		

QC SUMMARY

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

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

Sulphide by SFA

Method: SM 4500 I Internal ref.: ME-CA-[ENV]SFA-LAK-AN-008

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) 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.

This report supersedes all previous versions.

-- End of Analytical Report --

SGS

Request for Laboratory Services and CHAIN OF CUSTODY

No: 035940

Industries & Environment - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

Page ____ of ____

Laboratory Information Section - Lab use only

Received By: Katelyn Medland
Received Date: APR 1 8 2024 (mm/dd/yy)
Received Time: 10 : 00 (hr : min)
Received By (signature): Km
Custody Seal Present: Yes ☑ No ☐
Custody Seal Intact: Yes ☑ No ☐
Cooling Agent Present: Yes ☑ No ☐ Type: Ice
Temperature Upon Receipt (°C) 1 . 7 . 1
LAB LIMS #: CA15114-APR24 CA14731-APR24

REPORT INFORMATION

Company: Thurber Eng.
Contact: Rachel Bourassa
Address: 202-1908 Ironoak Way, Oakville, ON L6H-0N1
Phone: 905-829-8666
Fax:
Email: RBourassa@thurber.ca

INVOICE INFORMATION

☒ (same as Report Information)
Company:
Contact:
Address:
Phone:
Email:

Quotation #:
P.O. #:
Project #:
Site Location/ID:

TURNAROUND TIME (TAT) REQUIRED

☒ Regular TAT (5-7days)
TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day

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

REGULATIONS

☐ O.Reg 153/04 ☐ O.Reg 406/19
☐ Table 1 ☐ Res/Park Soil Texture:
☐ Table 2 ☐ Ind/Com ☐ Coarse
☐ Table 3 ☐ Agri/Other ☐ Medium/Fine
☐ Table ____ Appx. ____
Soil Volume ☐ <350m3 ☐ >350m3

Other Regulations:
☐ Reg 347/558 (3 Day min TAT)
☒ PWQO ☐ MMER
☐ CCME ☐ Other:
☐ MISA
☐ ODWS Not Reportable *See note

Sewer By-Law:
☐ Sanitary
☐ Storm
Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

ANALYSIS REQUESTED

#	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	M & I: Metals & Inorganics incl CrVI, CN, Hg pH, (B(HWS), EC, SAR-soil) (Cl, Na-water)	M & I: Full Metals Suite ICP metals plus B(HWS-soil only) Hg, CrVI	M & I: ICP Metals only Sb,As,Ba,Be,B,Cd, Cr,Co,Cu,Pb,Mo,Ni,Se,Ag,Tl,U,V,Zn	SVOC: PAHs only	SVOC: SVOCs all incl PAHs, ABNs, CPs	PCB: PCBs Total ☐ Aroclor ☐	PHC: F1-F4 + BTEX	PHC: F1-F4 only no BTEX	VOC: VOCs all incl BTEX	VOC: BTEX only	Pest: Pesticides Organochlorine or specify other	Other: ~~Chem~~ General Water Pack	Other: ~~Chem~~ ~~Pack~~ Alkalinity	Other: TSS	Other: Field Filtered Metals (PWQO)	Sewer Use: Specify pkg:	Water Characterization Pkg General ☐ Extended ☐	SPLP Specify tests ☐Metals ☐VOC ☐1,4-Dioxane ☐OCP ☐ABN	TCLP Specify tests ☐M&I ☐VOC ☐PCB ☐B(a)P ☐ABN ☐Ignit.	COMMENTS:
1	HF1	18/4/24	8:30	3	Liquid														✓							
2	HF3	18/4/24	9:45	3	Liquid														✓							
3	Hewiston Creek	18/4/24	8:45	3	Liquid														✓							
4	HCC-01	18/4/24	8:55	11	Liquid													✓		✓	✓					
5																										
6																										
7																										
8																										
9																										
10																										
11																										
12																										

Observations/Comments/Special Instructions

Sampled By (NAME): G. Azzopardi Signature: [signature] Date: 04 / 18 / 24 (mm/dd/yy) Pink Copy - Client
Relinquished by (NAME): G. Azzopardi Signature: [signature] Date: 04 / 18 / 24 (mm/dd/yy) Yellow & White Copy - SGS

Revision #: 1.7
Date of Issue: 07 JUNE 2023

FINAL REPORT

CA40086-MAY24 R1

37996, Hewitson Creek

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

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

TABLE OF CONTENTS

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
Sample Name			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")
Sample Matrix			Soil	Soil	Soil	Soil	Soil	Soil
Sample Date			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**
Corrosivity Index								
Corrosivity Index	none	1	1	1	4	1	1	1
Soil Redox Potential	mV	no	272	298	304	295	284	278
Sulphide (Na2CO3)	%	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
General Chemistry								
Conductivity	uS/cm	2	52	81	178	88	50	36
Metals and Inorganics								
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
Other (ORP)								
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-[ENV]IC-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-[ENV]ARD-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 (Na2CO3)	ECS0045-MAY24	%	0.01	< 0.01								

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-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 I Internal ref.: ME-CA-[ENV]EWL-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

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 report supersedes all previous versions.

-- End of Analytical Report --

Request for Laboratory Services and CHAIN OF CUSTODY

SGS Environment, Health & Safety - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

No:

Page 1 of 1

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):
Custody Seal Present: Yes ☑ No ☐
Custody Seal Intact: Yes ☐ No ☐
Cooling Agent Present: Yes ☑ No ☐ Type: ICE
Temperature Upon Receipt (°C) 4x3
LAB LIMS #: CA40086-MAY24

REPORT INFORMATION	INVOICE INFORMATION
Company: Thurber Engineering LTD	☒ (same as Report Information)
Contact: Rachel Bourassa	Company:
Address: 1908 Ironoak Way, Oakville, ON	Contact:
Suite 202, L6H 0N1	Address:
Phone: 416-523-1015	
Fax:	Phone:
Email: RBourassa@Thurber.ca	Email: accountingON@thurber.ca

Quotation #:
P.O. #:
Project #: 37996
Site Location/ID: Hewitson Creek

TURNAROUND TIME (TAT) REQUIRED

☒ Regular TAT (5-7days)

TAT's are quoted in business days (exclude statutory holidays & weekends).
Samples received after 6pm or on weekends: TAT begins next business day

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

REGULATIONS

☐ O.Reg 153/04 ☐ O.Reg 406/19
☐ Table 1 ☐ Res/Park Soil Texture: ☐ Coarse
☐ Table 2 ☐ Ind/Com ☐ Medium/Fine
☐ Table 3 ☐ Agri/Other
☐ Table ____
Soil Volume ☐ <350m3 ☐ >350m3

Other Regulations:
☐ Reg 347/558 (3 Day min TAT)
☐ PWQO ☐ MMER
☐ CCME ☐ Other: ____
☐ MISA
☐ ODWS Not Reportable *See note

Sewer By-Law:
☐ Sanitary
☐ Storm
Municipality: ____

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX
1	HCC-04 SS5(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' - 40'9")	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					

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

Observations/Comments/Special Instructions

Sampled By (NAME): Rachel Bourassa	**Signature:** Rachel Bourassa	Date: see above (mm/dd/yy)	Pink Copy - Client
Relinquished by (NAME): Rachel Bourassa	**Signature:** Rachel Bourassa	Date: 05/09/2023 (mm/dd/yy)	Yellow & White Copy - SGS

Revision #: 1.4
Date of Issue: 22 May. 2020

APPENDIX F

Site Photographs

THURBER ENGINEERING LTD.

SITE PHOTOS

Photo 1: Aerial view of Hewitson Creek Culvert site, looking southwest, photo taken March 4, 2024

SITE PHOTOS

Photo 2: Helicopter moving equipment at the Hewitson Creek Culvert site, near 25+255 CL, photo taken April 11, 2024

SITE PHOTOS

Photo 3: Helicopter moving equipment between borehole locations, photo taken March 26, 2024

SITE PHOTOS

Photo 4: Looking north at HCC-03 near Sta 10+982, west side of creek, photo taken April 10, 2024

Photo 5: Looking south at HCC-03, west side of creek, photo taken March 26, 2024

SITE PHOTOS

Photo 6: Looking East at Borehole HCC-02, west side of creek, photo taken March 26, 2024

Photo 7: Looking north along Hewitson Creek from the proposed culvert site near 11+017 CL, photo taken April 10, 2024

THURBER ENGINEERING LTD.

SITE PHOTOS

Photo 8: Looking upstream along Hewitson Creek from the proposed culvert site near 11+017 CL, photo taken April 10, 2024

SITE PHOTOS

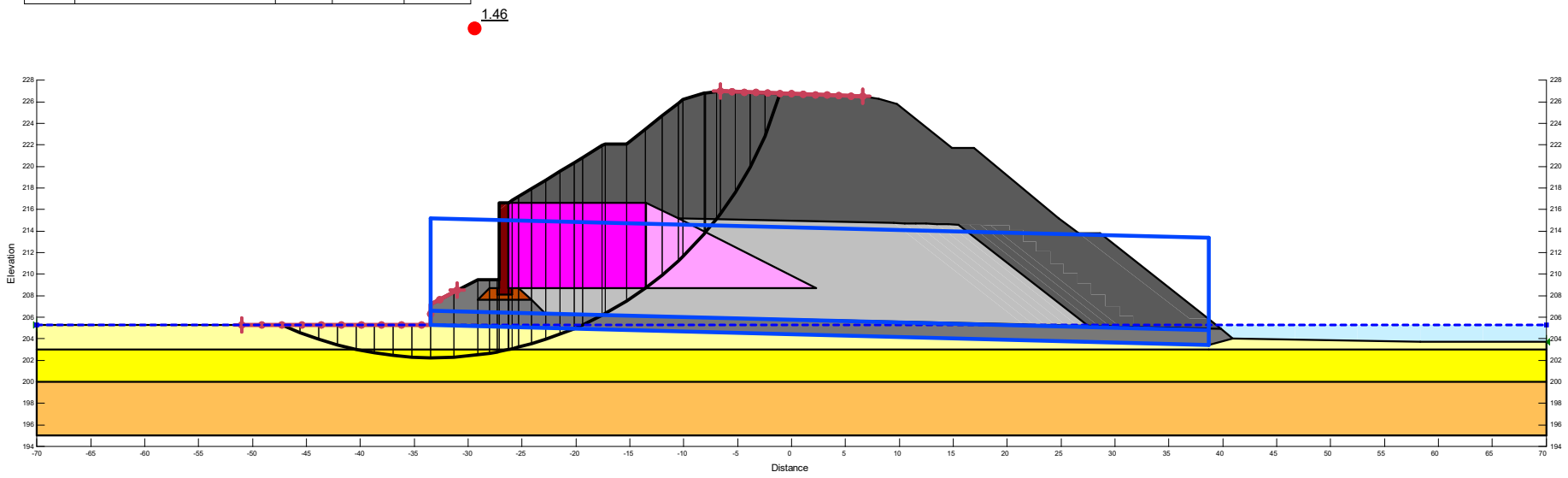
Photo 9: Looking northwest from Hewitson Creek from the proposed culvert site near 11+017 CL, photo taken April 10, 2024

Photo 10: Looking east towards drilling crew working at HCC-05, east side of creek, photo taken April 10, 2024

APPENDIX G

Slope Stability Analysis Figures

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	1A Concrete Wall	24	200	45
	1B Concrete Wall Granular Pad	21	0	35
	2A RSS Wall	22	200	45
	2B RSS Wall Granular Backfill	21	0	35
	3 Culvert Granular Backfill	21	0	35
	4 Culvert Rockfall Pad	19	0	42
	5 Rockfillll Embankment	19	0	42
	Native 1 (Compact)	21	0	32
	Native 2 (Compact)	21	0	35
	Native 3 (Dense)	21	0	36



THURBER

Project
37996 Hewiston Creek Culvert

Analysis
North

Seismic Coefficient
H: 0g, V: 0g

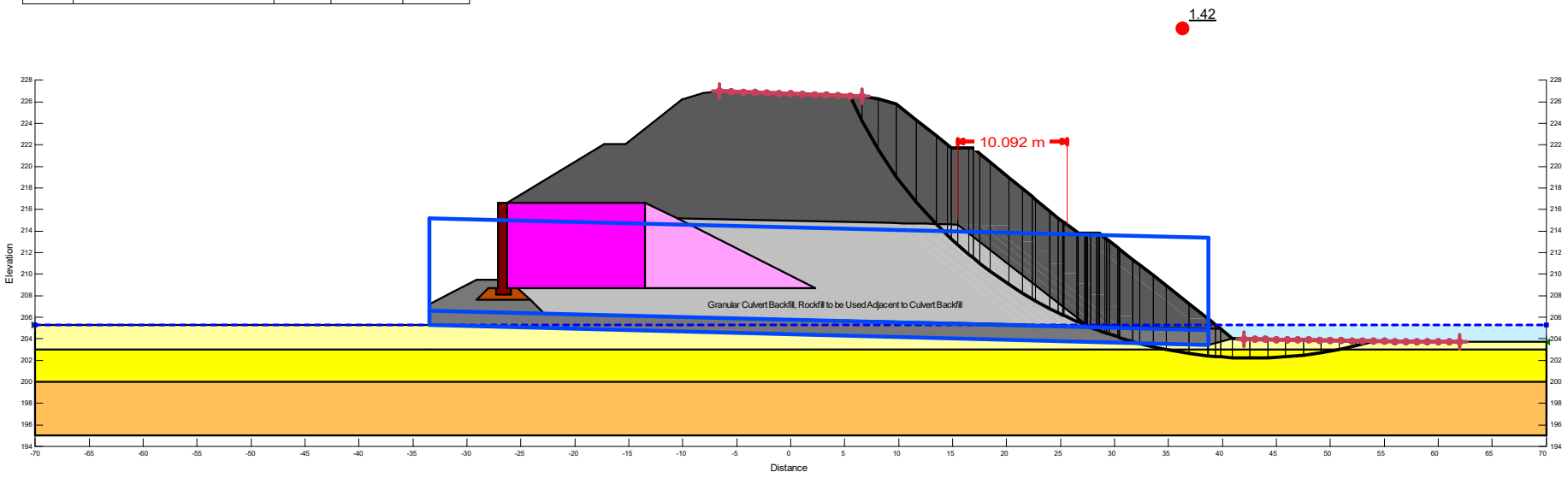
Last Run
08/09/2024, 02:50:27 PM

Scale
1:600

Additional Details
Name: 2D Geometry
Comments: Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (-47.296507, 205.3) m, Exit: (-1.1, 226.77883) m
Center: (-33.326559, 235.67251) m, Radius: 33.431252 m

Figure G1

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	1A Concrete Wall	24	200	45
	1B Concrete Wall Granular Pad	21	0	35
	2A RSS Wall	22	200	45
	2B RSS Wall Granular Backfill	21	0	35
	3 Culvert Granular Backfill	21	0	35
	4 Culvert Rockfall Pad	19	0	42
	5 Rockfill Embankment	19	0	42
	Native 1 (Compact)	21	0	32
	Native 2 (Compact)	21	0	35
	Native 3 (Dense)	21	0	36



THURBER

Project
37996 Hewiston Creek Culvert

Analysis
South

Seismic Coefficient
H: 0g, V: 0g

Last Run
08/09/2024, 02:50:19 PM

Scale
1:600

Additional Details
Name: 2D Geometry
Comments: Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (5.5, 226.53983) m, Exit: (53.99967, 203.77414) m
Center: (42.800966, 242.96092) m, Radius: 40.75554 m

Figure G2

THURBER

APPENDIX H

List of OPSS and OPSD Documents and Suggested Wording for NSSPs

1. The following Special Provisions and OPSS Documents are referenced in this report:

OPSS.PROV 206	Construction Specification for Grading
OPSS.PROV 209	Embankments over Swamps in Compressible Soils
OPSS.PROV 501	Construction Specification for Compacting
OPSS.PROV 511	Construction Specification for Rip-Rap, Rock Protection, and Granular Sheeting
OPSS.PROV 517	Construction Specification for Dewatering
SP 517F01	Amendment to OPSS 517, Dewatering System – Temporary Flow Passage System
OPSS.PROV 804	Construction Specification for Seed and Cover
OPSS.PROV 902	Construction Specification for Excavating and Backfilling Structures
SP 109S61	Amendment to OPSS 902, Dewatering and Protection Systems
OPSS.PROV 1004	Material Specification for Aggregates - Miscellaneous
OPSS.PROV 1005	Material Specification for Aggregates – Streambed Material
OPSS.PROV 1010	Material Specification for Aggregates Base, Subbase, Select Subgrade, and Backfill Material
OPSS.PROV 1205	Material Specification for Clay Seal
OPSS.PROV 1860	Material Specification for Geotextiles
OPSD 810.010	General Rip-Rap Layout for Sewer and Culvert Outlets
OPSD 3090.100	Foundation Frost Penetration Depths for Northern Ontario

2. Suggested Wording for NSSPs

- **Suggested Text for NSSP on Rock Fill**

  ROCK FILL PAD UNDER CULVERT FOOTINGS AND RSS WALL FOOTINGS

  The Contractor is advised that the rock fill pads under the culvert footings and the Retained Soil System (RSS) wall footings must meet the following gradation:

Sieve Size (mm)	Percent Passing (%)
150	100
106	50 – 100
75	15 – 80
26.5	0 – 15
0.075	0 - 2

The rock fill shall be well graded with the gradation determined as provided in Note 2 of Table 8 within OPSS.PROV 1004 (November 2012). The rock fill must be derived from crushed rock and the rock fill particles shall be durable and have a minimum unconfined compressive strength (UCS) of 100 MPa and meet the physical property requirements of "Rock Protection" as provided in Table 7 within OPSS.PROV 1004 (November 2012). Weak rocks such as Shales and Sandstones, as well as cobbles and boulders are not acceptable as rock fill.

If the rock fill pad is placed in a dewatered temporary excavation for the culvert footings, the rock fill must be placed in maximum 300 mm thick lifts and thoroughly compacted with a minimum of 8 passes of a tractor bulldozer, crawler type as specified in Section 206.07.05.02.01 of OPSS.PROV 206.

ROCK FILL FOR EMBANKMENT CONSTRUCTION

The construction of rock fill embankments shall follow the gradation, placement, lift thickness and compaction requirements as specified in the latest edition of OPSS.PROV 206. The rock fill must be derived from crushed rock and the rock fill particles shall be durable and have a minimum unconfined compressive strength (UCS) of 100 MPa and meet the physical property requirements of "Rock Protection" as provided in Table 7 within OPSS.PROV 1004 (November 2012). Weak rocks such as Shale and Sandstones, as well as cobbles and boulders are not acceptable as rock fill.

- **Suggested Text for NSSP on Obstructions**

Excavations may encounter obstructions such as wood, cobbles and boulders embedded in the native soils. Such obstructions may impede excavation progress. The Contractor shall be prepared to remove, drill through and/or penetrate these obstructions to achieve the design depths.

- **Suggested Text for NSSP on Dewatering**

It is anticipated that the culvert footings and the rock fill pads below the footings will be constructed in the wet. The Contractor is advised that the foundation soils at this site are predominantly highly permeable, cohesionless, interbedded sands, silts and gravel with

frequent cobbles and boulders, and that the groundwater level is close to the natural ground surface and influenced by the adjacent creek level. Dewatering to lower the groundwater level in the temporary excavations for constructing the culvert footings in the dry will be challenging at this site and is anticipated to produce discharges of over one million litres of water per day.

Dewatering, if chosen by the Contractor, is the responsibility of the Contractor. The Contractor is further advised that conventional sump pumping will not be effective at this site and due to the presence of cobbles and boulders in the foundation soils it may be difficult to drive sheet piles to create an enclosure for dewatering the footing excavations inside the enclosure. If the Contractor chooses to dewater the temporary excavations to construct the footings in the dry, they must retain a dewatering specialist to design a robust and effective dewatering scheme that is suitable for the subsurface conditions at this site. The selected dewatering method must be effective to lower the groundwater level to a minimum of 1.0 m below the final excavation base and maintain the groundwater at or below this level until the footings are constructed and the temporary excavations backfilled.

If dewatering, a Permit to Take Water (PTTW) will be required, as pumping greater than 400,000 L/day is anticipated. The Contractor is advised that the Ministry of Transportation of Ontario (MTO) has applied for a Draft Category 3 PTTW for this site from the Ministry of Environment, Conservation and Parks (MOECP). This draft PTTW and associated hydrogeology study will be provided to the Contractor. If the Contractor chooses to dewater, this information will be available for use. The Contractor is responsible for obtaining the final PTTW for the site from MOECP and for supplying MOECP with any further documentation that may be required on the dewatering scheme selected by the Contractor prior to issuing the final PTTW. The Contractor is also responsible for all MOECP requirements for discharge quality and monitoring quantity and quality of discharge water accumulated from their dewatering system.

The dewatering system, if employed, is to be designed in accordance with OPSS.PROV 517 and SP517F01. A preconstruction survey with a minimum radius of 100 m from the edges of the dewatered excavations is required. Considering the conditions on site, it is recommended that the dewatering engineer retained by the Contractor has a minimum of 5 years of experience in designing dewatering systems of this nature.

THURBER

APPENDIX I

Figures

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No. 2025-6024
WP No. 6333-14-01

HEWITSON CREEK CULVERT INSTALLATION

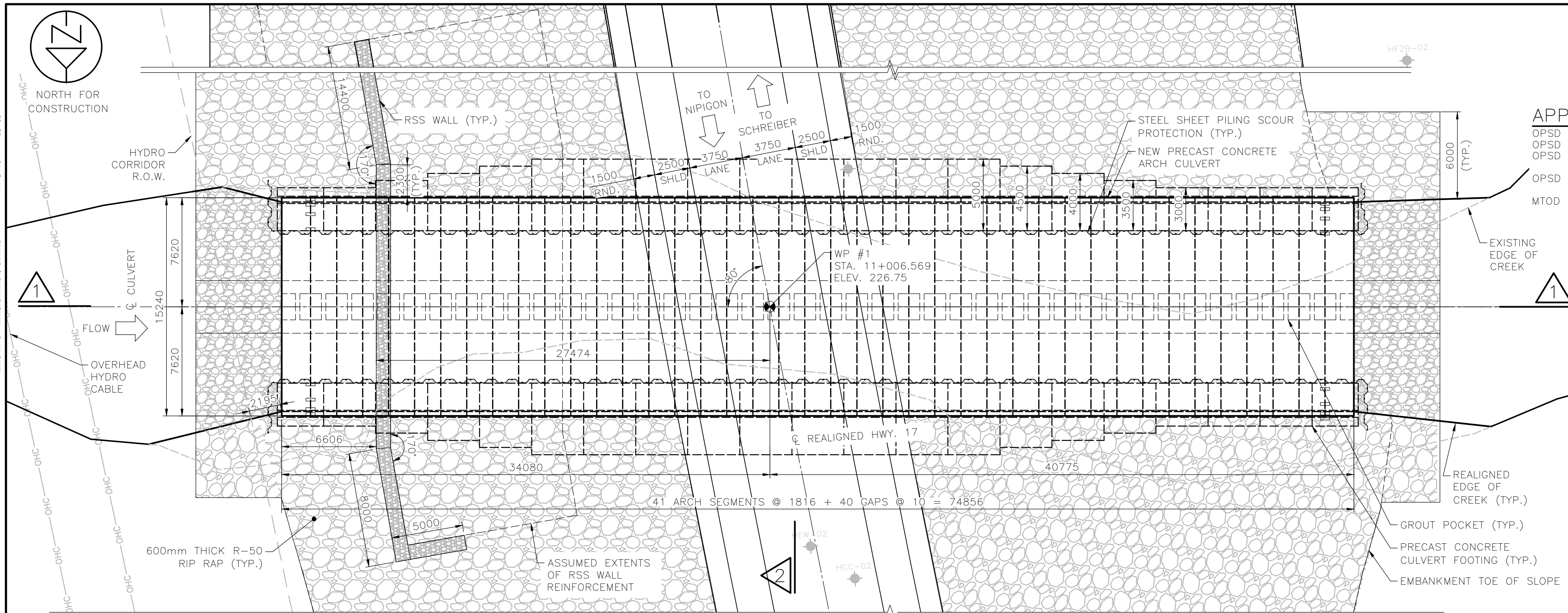
GENERAL ARRANGEMENT

SHEET 58

HATCH

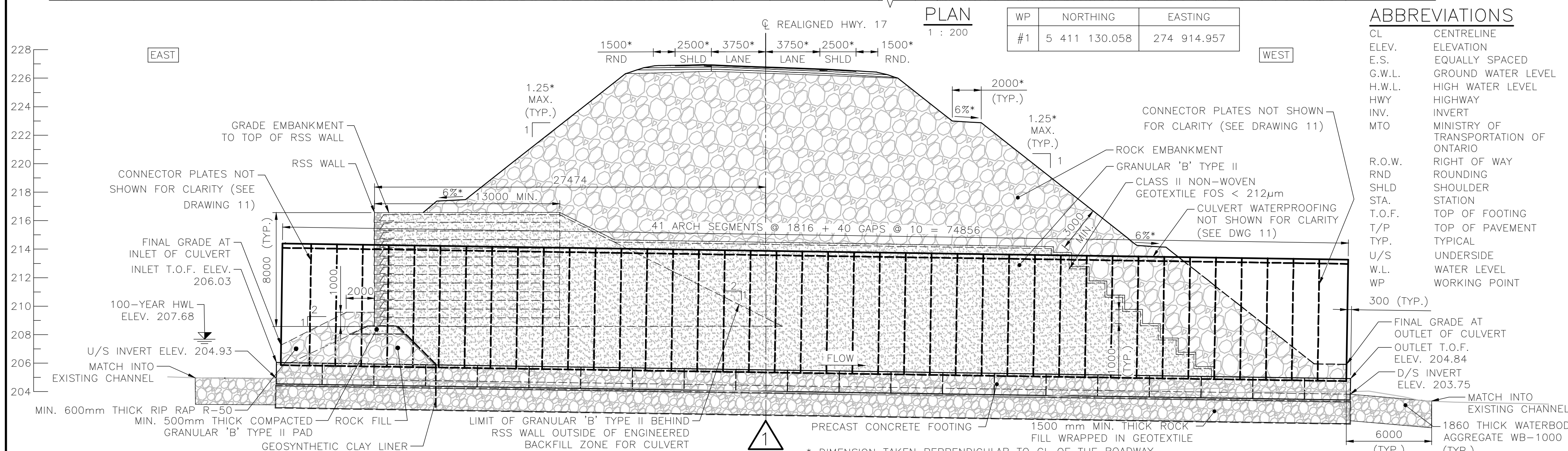
APPLICABLE STANDARD DRAWINGS

OPSD 219.110	LIGHT DUTY SILT FENCE BARRIER
OPSD 219.240	SEDIMENT TRAP FOR DEWATERING
OPSD 802.010	FLEXIBLE PIPE EMBEDMENT AND BACKFILL EARTH EXCAVATION
OPSD 810.010	GENERAL RIP-RAP LAYOUT FOR SEWER AND CULVERT OUTLETS
MTOD 3941.2100	FIGURES IN CONCRETE, SITE NUMBER AND DATE, LAYOUT



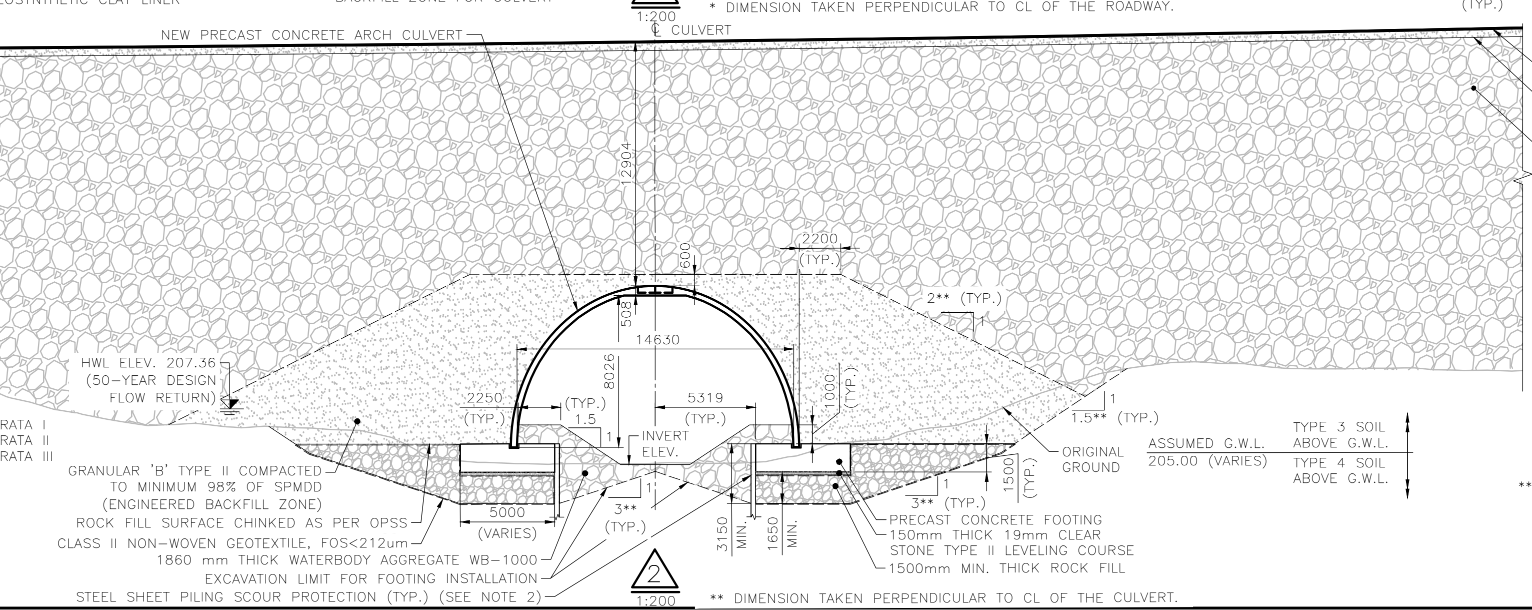
PLAN
1 : 200

WP	NORTHING	EASTING
#1	5 411 130.058	274 914.957



1
1:200

* DIMENSION TAKEN PERPENDICULAR TO CL OF THE ROADWAY.

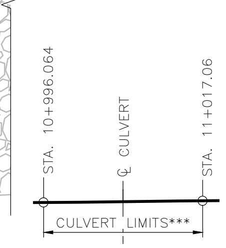


2
1:200

** DIMENSION TAKEN PERPENDICULAR TO CL OF THE CULVERT.

ABBREVIATIONS

CL	CENTRELINE
ELEV.	ELEVATION
E.S.	EQUALLY SPACED
G.W.L.	GROUND WATER LEVEL
H.W.L.	HIGH WATER LEVEL
HWY	HIGHWAY
INV.	INVERT
MTO	MINISTRY OF TRANSPORTATION OF ONTARIO
R.O.W.	RIGHT OF WAY
RND	ROUNDING
SHLD	SHOULDER
STA.	STATION
T.O.F.	TOP OF FOOTING
T/P	TOP OF PAVEMENT
TYP.	TYPICAL
U/S	UNDERSIDE
W.L.	WATER LEVEL
WP	WORKING POINT



ROAD PROFILE
N.T.S.

*** DIMENSION TAKEN ALONG CL OF THE ROADWAY.

GENERAL NOTES:

1. THIS CULVERT SHALL BE A PRECAST CONCRETE ARCH CULVERT WITH A 14630mm SPAN AND 8026mm RISE (MIN. WALL THICKNESS = 305mm). THE CONTRACTOR IS RESPONSIBLE TO DESIGN, SUPPLY, ASSEMBLE AND ERECT THE NEW CULVERT. THE CULVERT DIMENSIONS SHOWN ARE BASED ON THE C48T/8 ARCH CULVERT AVAILABLE FROM BEBO ARCH SOLUTIONS. USE OF AN ALTERNATE CULVERT SHAPE IS SUBJECT TO APPROVAL BY THE OWNER. IF AN ALTERNATE CULVERT SECTION IS SELECTED, THE CONTRACTOR IS RESPONSIBLE FOR VERIFICATION OF ALL DIMENSIONS AND SHALL REPORT ALL CHANGES TO THE CONTRACT ADMINISTRATOR FOR APPROVAL PRIOR TO ANY RELATED WORK COMMENCING. CULVERT DESIGN SHALL BE IN ACCORDANCE WITH CHBDC S6-19, LIVE LOAD SHALL BE CL-625-ONT.
2. SHEET PILES SHALL BE SECTION SKZ 21N OR APPROVED EQUIVALENT WITH A MINIMUM THICKNESS OF 9.5 mm. THE SHEET PILES ARE PERMANENT SCOUR PROTECTION FOR THE STRUCTURE AND SHALL EXTEND A MINIMUM OF 1500mm BELOW THE BASE ELEVATION OF THE CULVERT FOOTING. THE CONTRACTOR MAY ELECT TO EMBED THE SHEET PILES BELOW THE MINIMUM DEPTH TO FACILITATE THEIR MEANS AND METHODS OF CONSTRUCTION.

CLASS OF CONCRETE

PRECAST CONCRETE ARCH CULVERT.....................45MPa
PRECAST CONCRETE FOOTING................................60MPa

CLEAR COVER TO REINFORCEMENT

PRECAST CONCRETE ARCH CULVERT......................50mm+/-10
PRECAST CONCRETE FOOTING......... ....65mm+/-10

REINFORCEMENT

1. REINFORCING STEEL SHALL BE GRADE 400W.
2. UNLESS SHOWN OTHERWISE, LAP LENGTHS NOT INDICATED ON THE CONTRACT DRAWINGS SHALL BE CLASS 'B' LAPS AS PER CAN/CSA-S6-19.
3. GFRP BARS SHALL CONSIST OF CONTINUOUS GLASS FIBRE EMBEDDED IN A THERMOSETTING RESIN.
4. GLASS FIBRE REINFORCED POLYMER (GFRP) REINFORCING BARS SHALL BE IN ACCORDANCE WITH THE FOLLOWING TABLE:

GRADE	BAR DIA. (mm)	STRAIGHT BARS		BENT BARS*	
		MIN. SPECIFIED LONG TENSILE STRENGTH, kN	MIN. LONG MODULUS OF ELASTICITY, GPa	MIN. SPECIFIED LONG TENSILE STRENGTH, kN	MIN. LONG MODULUS OF ELASTICITY, GPa
III	15	199	60	199	50
	20	284		256	
	25	510		434	

*TENSILE STRENGTH AND MODULUS ARE GIVEN FOR THE STRAIGHT PORTION OF THE BENT BAR. MINIMUM STRENGTH AT THE BEND SHALL BE AT LEAST 40% OF THE MINIMUM STRENGTH OF THE STRAIGHT PORTION OF THE BENT BARS

5. BAR HOOKS SHALL HAVE STANDARD HOOK DIMENSIONS USING MINIMUM DIAMETERS, WHILE STIRRUPS AND TIES SHALL HAVE MINIMUM HOOK DIMENSIONS. ALL HOOKS SHALL BE IN ACCORDANCE WITH THE STRUCTURAL STANDARD DRAWING SSD 112-1 UNLESS INDICATED OTHERWISE.

CONSTRUCTION NOTES

1. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS OF THE PROPOSED WORK AND ALL DETAILS ON SITE AND REPORT ANY DISCREPANCIES TO THE CONTRACT ADMINISTRATOR BEFORE PROCEEDING WITH THE WORK.
2. INSTALLATION OF THE PRECAST CONCRETE ARCH SEGMENTS, PLACEMENT OF WATERPROOFING, AND PLACEMENT AND COMPACTION OF BACKFILL SHALL BE CARRIED OUT UNDER THE CULVERT MANUFACTURER'S SUPERVISION AND IN STRICT ACCORDANCE WITH THE CULVERT MANUFACTURER'S INSTRUCTIONS.
3. BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH SIDES OF THE CULVERT WITH LIFT HEIGHTS NOT EXCEEDING 200mm AND KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 200mm.
4. THE LOCATION AND LENGTH OF DEWATERING EQUIPMENT IS THE RESPONSIBILITY OF THE CONTRACTOR.
5. THE CONTRACTOR IS RESPONSIBLE FOR TEMPORARY DIVERSION OF THE FLOW AROUND THE SITE DURING CONSTRUCTION AS PER THE CONTRACT DOCUMENTS. ALL DETAILS OF THE TEMPORARY FLOW DIVERSION, INCLUDING EXCAVATION LIMITS, ARE SHOWN FOR INFORMATION PURPOSES ONLY.
6. THE CONTRACTOR IS RESPONSIBLE FOR THE DESIGN OF COFFERDAMS. DIMENSIONS AND DETAILS OF COFFERDAMS ARE SHOWN FOR INFORMATION PURPOSES ONLY. ACTUAL DIMENSIONS AND DETAILS TO BE DETERMINED BY THE CONTRACTOR FOR A MINIMUM 2-YEAR STORM EVENT OF 8.10 m3/s WITH A MINIMUM 0.3m FREEBOARD. THE CONTRACTOR SHALL SUBMIT A DETAILED PLAN FOR THE ISOLATION AND DEWATERING WORKS IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.
7. THE CONTRACTOR IS ADVISED NOT TO RELY ON THE WATER LEVEL OR EDGE OF WATER SHOWN ON DRAWINGS. THE WATER LEVEL IS SUBJECT TO VARIATION.
8. THE CONTRACTOR IS RESPONSIBLE FOR STABILITY OF BOTH EXISTING AND NEW STRUCTURES AT ALL TIMES THROUGHOUT CONSTRUCTION INCLUDING EXCAVATION, BACKFILL, REMOVALS, INSTALLATIONS ETC. THE CONTRACTOR IS TO DESIGN AND PROVIDE ANY TEMPORARY SUPPORT SYSTEMS FOR EXISTING, TEMPORARY AND NEW STRUCTURES AT VARIOUS STAGES OF CONSTRUCTION AS REQUIRED TO SUIT THEIR METHOD OF CONSTRUCTION.
9. THE CONTRACTOR SHALL ADHERE TO IN-WATER WORK DATES SPECIFIED IN THE CONTRACT DOCUMENTS.
10. FOR AREAS OF WATERBODY AGGREGATE, GRANULAR 'A' SHALL BE WASHED INTO THE VOIDS. GRANULAR 'A' MATERIAL SHALL CONFORM TO THE REQUIREMENTS OF OPSS PROV 1010. THE CONTRACTOR IS TO ENSURE THAT VOIDS WITHIN THE ENTIRE DEPTH OF WATERBODY AGGREGATE ARE FILLED WITH GRANULAR 'A'.
11. THE CONTRACTOR IS FULLY RESPONSIBLE FOR THE DESIGN, CONSTRUCTION METHODS AND PERFORMANCE OF THE TEMPORARY SLOPES, PROTECTION SYSTEM AND ASSOCIATED WORKS.
12. THE CONTRACTOR SHALL TAKE CARE DURING PLACEMENT OF THE ROCK EMBANKMENT AT CULVERT SIDES AND ON TOP OF CULVERTS TO ENSURE NO DAMAGE OCCURS TO THE CULVERT AND WATERPROOFING MEMBRANE.
13. THE CONTRACTOR SHALL ENSURE THAT THE STREAMBED MATERIAL AT THE INLET AND OUTLET PROVIDES A SMOOTH TRANSITION TO THE EXISTING STREAMBED.
14. THE CONTRACTOR SHALL ENSURE ANY METHODS FOR COFFERDAM OR TEMPORARY SUPPORT INSTALLATION AND REMOVAL DOES NOT IMPACT THE EXISTING STRUCTURE, NEW STRUCTURE OR FOUNDING SOILS.
15. CULVERT ASSEMBLY SHALL BE CARRIED OUT IN ACCORDANCE WITH THE SUPPLIERS RECOMMENDATIONS.
16. THE CONTRACTOR SHALL CONFIRM UTILITY LOCATIONS ON SITE. UTILITY PROTECTION, IF REQUIRED, IS THE RESPONSIBILITY OF THE CONTRACTOR.
17. THE CONTRACTOR SHALL ENSURE THAT THE WATERBODY MATERIAL AT THE INLET AND OUTLET OF THE NEW CULVERT PROVIDES A SMOOTH TRANSITION TO THE EXISTING STREAMBED AND THAT THE LOW FLOW CHANNEL TIES INTO THE EXISTING STREAMBED BASED ON CONSULTATION WITH THE FISHERIES CONTRACT SPECIALIST.
18. WHERE SUITABLE NATURAL SUBSTRATE IS PRESENT THE CONTRACTOR SHALL SALVAGE IT FOR PLACEMENT WITHIN THE CULVERT IN CONSULTATION WITH THE FISHERIES CONTRACT SPECIALIST.

LIST OF DRAWINGS

DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

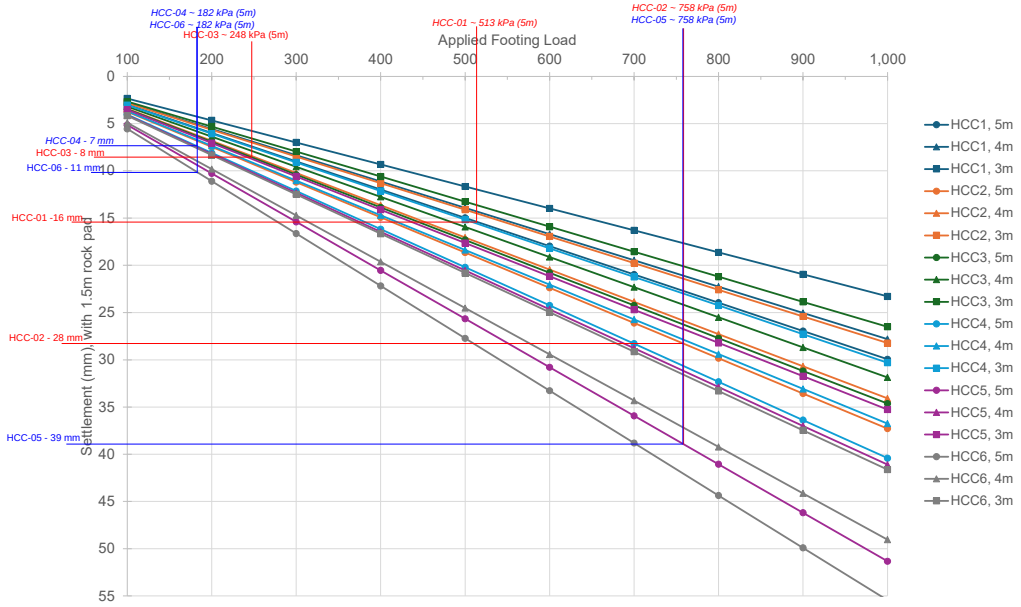
REVISIONS	DATE	REV.	DESCRIPTION
	24/12/17	0	DESIGN TEAM REVIEW

DESIGN JG/KK	CHK LB	CODE CAN/CSA S6-19	LOAD CL-625-ONT	DATE DEC. 2024	
DRAWN CR	CHK JG	SITE 48C-0026/C0		DWG	1

MINISTRY OF TRANSPORTATION, ONTARIO
Dec 17, 2024, 11:30am

Figure I-1: Differential Settlement - Fixed Width Footings

ALL FOOTINGS 5m WIDE



Longitudinal Settlement (dL)

HCC-02 / HCC-01 = (28 - 16 mm) / (27.6 m) = 0.04%
HCC-02 / HCC-03 = (28 - 8 mm) / (25.3 m) = 0.08%
HCC-05 / HCC-04 = (39 - 7 mm) / (32.5 m) = 0.10%
HCC-05 / HCC-06 = (39 - 11 mm) / (30.5 m) = 0.09%

Transverse Settlement (dt)

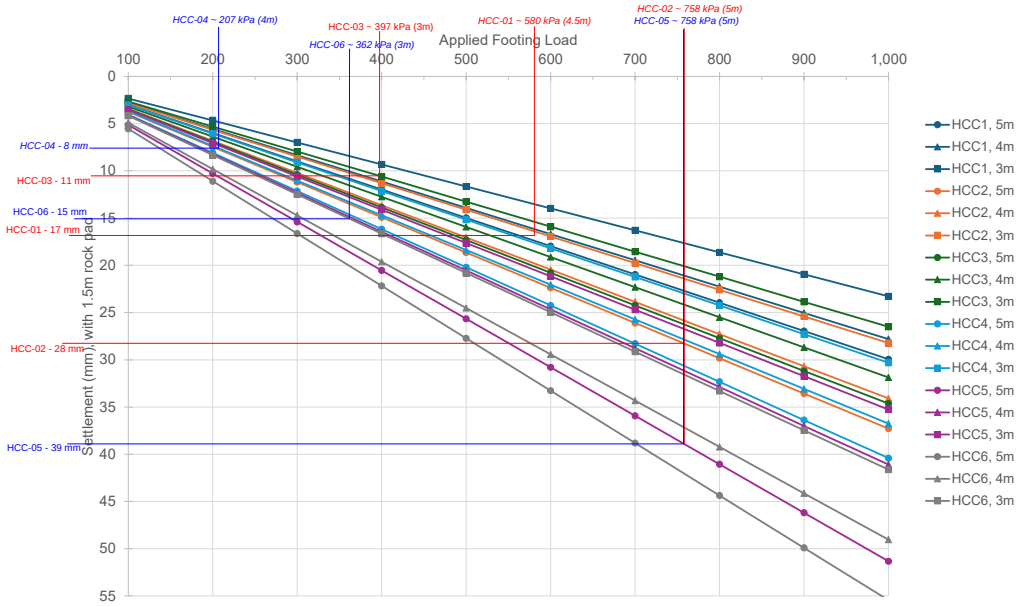
HCC-01 / HCC-04 = (16 - 7 mm) / (14.6 m) = 0.06%
HCC-02 / HCC-05 = (39 - 28 mm) / (14.6 m) = 0.07%
HCC-03 / HCC-06 = (11 - 8 mm) / (14.6 m) = 0.02%

Table 7.7
Settlement limits
(See Clause 7.5.7.7.1.)

Type	Metal	Concrete
Differential settlement of foundation along its length (d_L)	< 1%	< 0.5%
For open bottom structures, differential settlement between footings at any transverse section (d_t)	< 1% to a maximum of 50 mm	< 0.5% to a maximum of 50 mm
Differential settlement (d_b) between structure base and adjacent foundation material up to the limits of Zone 2	< 50 mm	< 50 mm
Total settlement	Satisfy Clause 6.4.1.3	Satisfy Clause 6.4.1.3

Figure I-2: Differential Settlement - Tapered Width Footings

TAPERED FOOTINGS



Longitudinal Settlement (dL)

HCC-02 / HCC-01 = (28 - 17 mm) / (27.6 m) = 0.04%
HCC-02 / HCC-03 = (28 - 11 mm) / (25.3 m) = 0.07%
HCC-05 / HCC-04 = (39 - 8 mm) / (32.5 m) = 0.10%
HCC-05 / HCC-06 = (39 - 15 mm) / (30.5 m) = 0.08%

Transverse Settlement (dt)

HCC-01 / HCC-04 = (17 - 8 mm) / (14.6 m) = 0.06%
HCC-02 / HCC-05 = (39 - 28 mm) / (14.6 m) = 0.08%
HCC-03 / HCC-06 = (15 - 11 mm) / (14.6 m) = 0.03%

Table 7.7
Settlement limits
(See Clause 7.5.7.7.1.)

Type	Metal	Concrete
Differential settlement of foundation along its length (d_L)	< 1%	< 0.5%
For open bottom structures, differential settlement between footings at any transverse section (d_t)	< 1% to a maximum of 50 mm	< 0.5% to a maximum of 50 mm
Differential settlement (d_b) between structure base and adjacent foundation material up to the limits of Zone 2	< 50 mm	< 50 mm
Total settlement	Satisfy Clause 6.4.1.3	Satisfy Clause 6.4.1.3

Figure I-3: Schematic of Tapered Width Footings