



THURBER ENGINEERING LTD.

**FINAL
FOUNDATION INVESTIGATION REPORT
WESTBOUND VARIABLE MESSAGING SIGN ON HIGHWAY 11/17
SHABAQUA CORNERS, ONTARIO
AGREEMENT NO.: 6022-E-0038
ASSIGNMENT NO.: 3**

GEOCRES NO.: 52A12-001

Location: Lat: 48.589427°, Long: -89.865048°

Client Name: Ministry of Transportation

Date: December 22, 2023

File: 42414



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PART 1. FACTUAL INFORMATION

1. INTRODUCTION

This section of the report presents the factual findings obtained from a foundation investigation conducted by Thurber Engineering Ltd. (Thurber) for the relocation of a Variable Messaging Sign (VMS) on Highway 11/17 at Sta. 12+920 near Shabaqua Corners in Dawson Road Lots Township within the District of Thunder Bay, Ontario. Thurber carried out the foundation investigation for the Ontario Ministry of Transportation (MTO) under Retainer Agreement No. 6022-E-0038, Assignment No. 3.

The purpose of the investigation was to explore the subsurface conditions at the site and based on this data obtained, provide a borehole location plan, record of boreholes, stratigraphic profile, laboratory test results and a written description of the subsurface conditions. The stratigraphic profile of the subsurface conditions was developed during the current investigation.

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 General

The westbound VMS site is located on Highway 11/17 at Sta. 12+920 approximately 1,200 m east of Old Dawson Road near Shabaqua Corners, Ontario. The proposed VMS location is approximately 4 m north of the northern edge of pavement.

In the area of the VMS, Highway 11/17 is a two-lane highway with an additional passing lane in the east direction and has a posted speed limit of 90 km/h. The road surface near the VMS is at



approximate elevation 426.1 m. The shoulders to the highway are partially paved. The 2016 traffic volume for this section of Highway 11 is understood to be approximately 3,800 AADT.

The site is in a rural setting and the area adjacent to the highway is undeveloped and densely vegetated with mixed forests of coniferous and some deciduous trees and shrubs. Overhead utility lines were present along both sides of the highway.

Photographs of the project area are included in Appendix D. These photographs show the existing condition of the highway and VMS site at the time of the field investigation.

2.2 Site Geology

According to Crins et al. 2009¹ the project area is described as Ecoregion 3W (Lake Nipigon Ecoregion) within the Ontario Shield Ecozone. According to Wester et al. 2018² the ecoregion is subdivided into Ecodistrict 3W-2 (Savanne Ecodistrict). The project area is located in the south part of the ecodistrict, which is characterized by discontinuous morainal materials of variable depths, typically separated by bedrock outcrops. Bedrock Geology Map (M2542)³ indicates the site is underlain by mafic to intermediate metavolcanic rocks.

2.3 Existing Information

A historical foundation investigation report was not available for this site within the online Geocres Library.

Base plan mapping was provided by MTO for the preparation of this report.

3. SITE INVESTIGATION AND FIELD TESTING

The foundation investigation and field-testing program was carried out on October 20, 2023, and consisted of one off-road borehole drilled on the north side of the highway identified as 23-01. The borehole was advanced with a CME 55 track-mounted drill rig utilizing solid stem augers, NW casing and coring techniques. Prior to commencement of drilling, utility clearances were obtained in the vicinity of the borehole locations.

A summary of the borehole coordinates, elevations, and termination depths is provided in the table below. The as-drilled borehole elevations were estimated by Thurber following completion of the field program. Horizontal locations were measured by Thurber relative to existing site

¹ <https://files.ontario.ca/mnrf-ecosystemspart1-accessible-july2018-en-2020-01-16.pdf>

² <https://files.ontario.ca/ecosystems-ontario-part2-03262019.pdf>

³ <https://www.geologyontario.mndm.gov.on.ca/mndmfiles/pub/data/imaging/M2542//M2542.pdf>

features. The elevations and borehole coordinates were reviewed and referenced to the survey data provided by MTO. The borehole coordinates and elevations are shown on the Borehole Location and Soil Strata drawing included in Appendix A and on the individual Record of Borehole sheet included in Appendix B. The borehole coordinates are referenced to MTM Zone 15.

Table 3-1 Borehole Summary

Borehole	Northing (m)	Easting (m)	Ground Surface Elevation (m)	Termination Depth Below Ground Surface (m)
23-01	5,383,439.4	314,753.0	425.9	5.9

Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in general accordance with ASTM D 1586. Approximately 2.8 m of bedrock was cored in the borehole.

The drilling and sampling operations were supervised on a full-time basis by a member of Thurber’s technical staff. The drilling supervisor logged the boreholes and processed the recovered soil and rock samples for transport to Thurber’s Oakville laboratory for further examination and testing.

Following completion of the field investigation, the borehole was decommissioned in general in accordance with O. Reg. 903, as amended.

4. LABORATORY TESTING

Laboratory testing was selected in general accordance with the current MTO Guideline for Foundation Engineering Services, Section 5. Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all retained soil samples. Recovered soil samples were selected for grain size distribution testing in accordance with MTO and ASTM standards. The rock cores were photographed, and the total core recovery (TCR), solid core recovery (SCR), and rock quality designation (RQD) were measured. Unconfined compressive strength (UCS) and point load testing was carried out on select intact bedrock cores to assess the unconfined compressive strength (UCS) of the bedrock. The results of these tests are summarized on the Record of Borehole sheet included in Appendix B.

All laboratory test results from the field investigation are provided in Appendix C.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered subsurface conditions are presented on the Record of Borehole sheet included in Appendix B and on the Borehole Location and Soil Strata Drawing included in



Appendix A. A general description of the stratigraphy, based on the conditions encountered in the borehole, is given in the following sections. However, the factual data presented on the Record of Borehole sheet takes precedence over this general description for interpretation of the site conditions. It must be recognized that the soil and groundwater conditions may vary between and beyond borehole locations.

In general, the encountered stratigraphy consists of sand and gravel fill overlying silty sand fill underlain by native sandy silt over bedrock.

5.1 Fill

5.1.1 Sand and Gravel Fill

A fill layer consisting of sand and gravel was encountered at the ground surface in Borehole 23-01. The fill layer was 1.5 m thick (base elev. 424.4 m). SPT N-values in the fill ranged from 16 to 59 blows, indicating a compact to very dense relative density.

Moisture contents ranging from 3 to 4% were recorded in the sand and gravel fill. The results of a gradation analysis completed on a sample of the sand and gravel fill are illustrated on Figure C1 of Appendix C. The results of the test are summarized in the table below and on the Record of Borehole sheet in Appendix B.

Soil Particle	Percentage (%)
Gravel	42
Sand	50
Silt	8
Clay	

5.1.2 Silty Sand Fill

A layer of silty sand fill was encountered below the sand and gravel fill. The fill layer was 0.5 m thick (base elev. 423.9 m). A SPT N-value of 24 blows was recorded, indicating a compact relative density.

A moisture content of 13% was recorded in the silty sand fill. The results of a gradation analysis completed on a sample of the silty sand fill are illustrated on Figure C2 of Appendix C. The results of the test are summarized in the table below and on the Record of Borehole sheet in Appendix B.



Soil Particle	Percentage (%)
Gravel	18
Sand	47
Silt	29
Clay	6

5.2 Sandy Silt

A native layer of sandy silt was encountered below the fill in Borehole 23-01. The layer had a thickness of 1.1 m with an underside depth of 3.1 m (base elev. 422.8 m). Refusal blow counts were recorded in this layer, indicating a very dense relative density.

Moisture contents ranging from 4 to 8% were recorded.

5.3 Bedrock

Bedrock was proven by coring in Borehole 23-01. The bedrock encountered consisted of fresh jointed, grey, very strong gneiss. Photographs of the bedrock core are provided in Appendix C. The rock core quality measurements are summarized in the following table.

Table 5-1 Bedrock Details

Parameter	Range
Total Core Recovery (TCR), %	90 – 98
Solid Core Recovery (SCR), %	10 – 63
Rock Quality Designation (RQD), %	10 – 44
Fracture Index (fractures per 0.3 m)	1 – >10
Unconfined Compressive Strength Testing (MPa)	102 – 131

The upper 1 m of the bedrock is fractured. Based on the RQD, the bedrock quality is described as very poor to poor (CFEM 5th Edition, 2023). The results of UCS and point load testing indicate that the tested samples of the bedrock are very strong (CFEM 5th Edition, 2023). The results of the UCS and point load testing are included in Appendix C.

5.4 Groundwater Level

The groundwater level within Borehole 23-01 upon completion of drilling was at a depth of 1.0 m (elev. 424.9 m). This water level may not be representative since water was introduced into the borehole for bedrock coring.



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It should be noted that the above value is considered a short-term reading and may not reflect the groundwater level at the time of construction. Seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after periods of significant and/or prolonged precipitation events.

6. MISCELLANEOUS

The borehole locations reflect existing site features and access constraints. The as-drilled borehole locations and ground surface elevations were measured by Thurber following completion of the field program. RPM Drilling of Thunder Bay, Ontario, supplied and operated the drill rig used to drill, test, sample, and decommission the boreholes. Traffic control was performed in accordance with Ontario Book 7 and was provided by RPM Drilling of Thunder Bay, Ontario. The field investigation was supervised on a full-time basis by Mr. L. Scalena, EIT. Overall supervision of the field investigation program was provided by Mr. M. Eastman, P.Eng.

Routine geotechnical laboratory testing was completed by Thurber's laboratory in Oakville.

Interpretation of the factual data and preparation of this report was completed by M. Eastman, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundation Projects.



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Thurber Engineering Ltd.
Report Prepared By:



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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

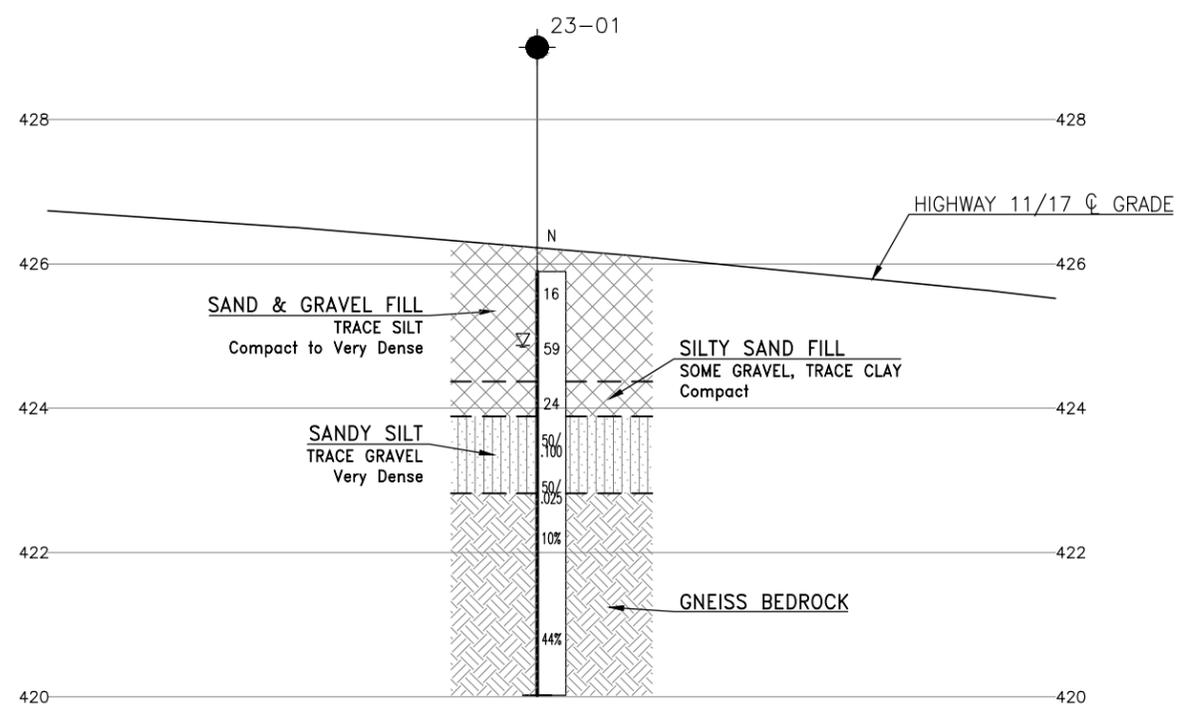
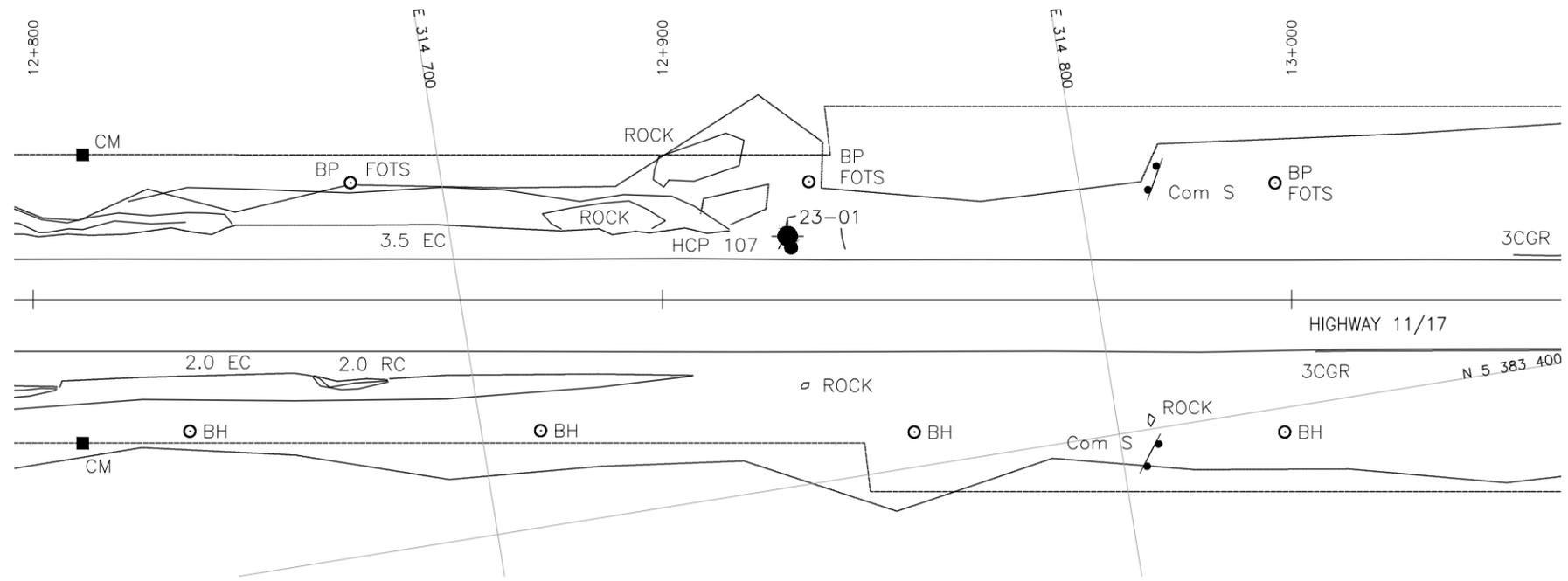
The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or 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.



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APPENDIX A

Borehole Locations and Strata Drawing



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

CONT No WP No 6022-E-0038	 SHEET
HIGHWAY 11/17 SHABAQUA WB VMS BOREHOLE LOCATIONS AND SOIL STRATA	



KEYPLAN
LEGEND

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

NO	ELEVATION	NORTHING	EASTING
23-01	425.9	5 383 439.4	314 753.0

-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 15.

GEOCRES No.



REVISIONS	DATE	BY	DESCRIPTION

DESIGN	MKE	CHK -	CODE	LOAD	DATE	NOV 2023
DRAWN	MFA	CHK MKE	SITE	STRUCT	DWG	1



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APPENDIX B

Record of Boreholes Sheet

RECORD OF BOREHOLE No 23-01

1 OF 1

METRIC

W.P. 6022-E-0038 LOCATION N 5 383 439.4 E 314 753.0 ORIGINATED BY LS
 DIST Thunder Bay HWY 11/17 BOREHOLE TYPE CME 55 Track-Mount, SSA (108 mm O.D.) / NW Casing / NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2023.10.20 - 2023.10.20 LATITUDE 48.589422 LONGITUDE -89.865070 CHECKED BY MKE

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE WATER CONTENT (%) 20 40 60									
425.9	GROUND SURFACE														
0.0	SAND and GRAVEL , trace silt Compact to Very Dense Dark Brown - Brown Moist (FILL)		1	SS	16	IV								42 50 8 (SI+CL)	
			2	SS	59										
424.4	Silty SAND , some gravel, trace clay Compact Brown - Grey Moist (FILL)		3	SS	24										18 47 29 6
423.9															
2.0	Sandy SILT , trace gravel Very Dense Grey Moist		4	SS	50/ 0.100										
422.8	GNEISS BEDROCK , very strong, fresh, thickly bedded, grey		5	SS	50/ 0.025								FI		
3.1	Horizontal fractures at 3.3, 3.7, 3.9 and 4.1m		1	RUN									>10	RUN #1 TCR=90% SCR=10% RQD=10%	
	Vertical fracture from 3.2 to 4.2m												7		
	Sub-vertical fractures (25mm) at 3.4, 3.5 and 3.6m												4		
	Vertical fracture (150mm) at 4.3m												5		
	Sub-vertical fractures (25mm to 50mm) at 4.4, 4.6, 4.7, 4.9, 5.5, 5.6, 5.7 and 5.8m		2	RUN									3	RUN #2 TCR=98% SCR=63% RQD=44% UCS=101.8MPa UCS=131.1MPa (PLT)	
421													1		
	Horizontal fractures at 5.0 and 5.3m												2		
420.0													3		
5.9	END OF BOREHOLE AT 5.9m. BOREHOLE OPEN TO 2.5m AND WATER LEVEL AT 1.0m UPON COMPLETION.														

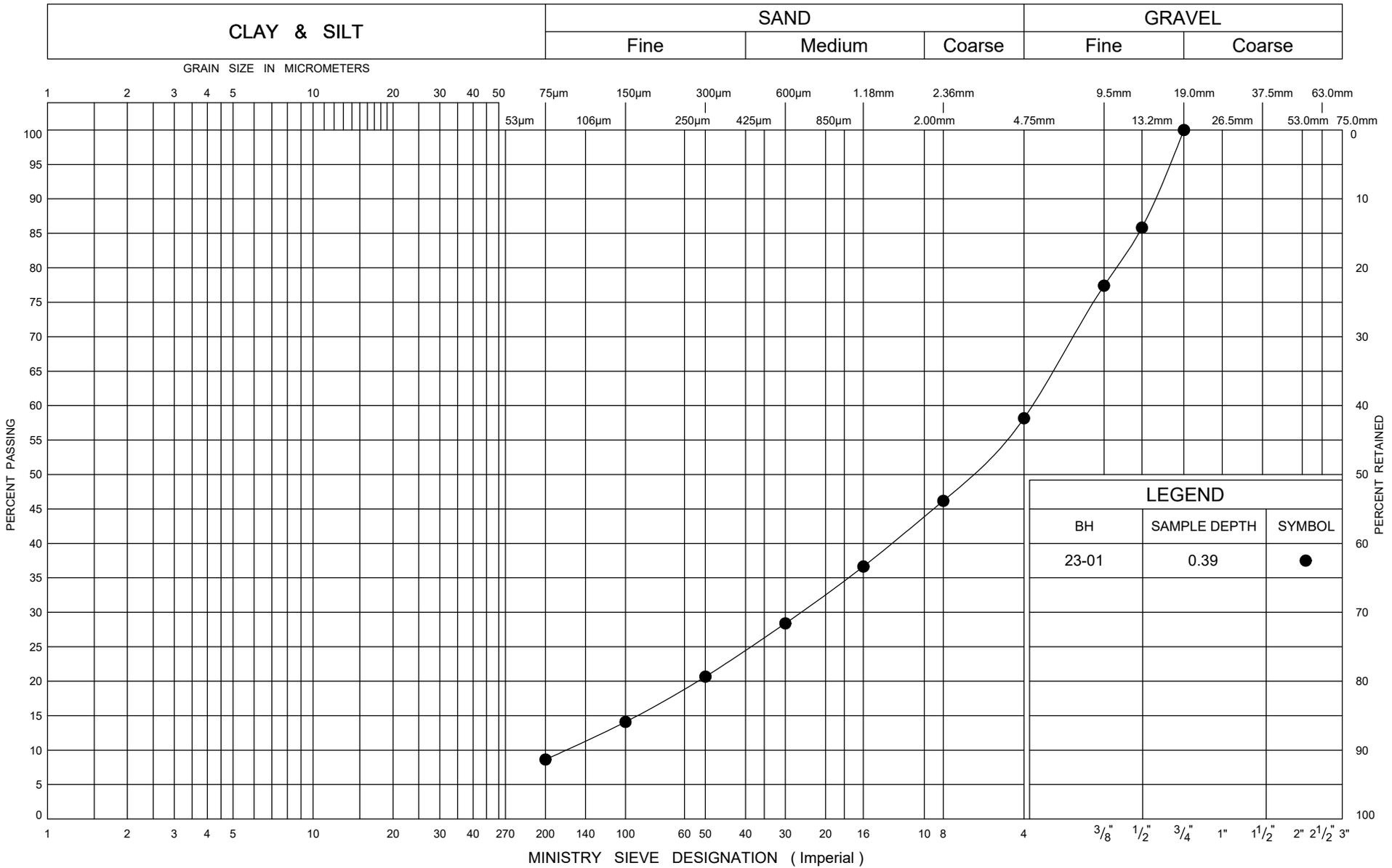
ONTMT452_2020LIBRARY(MTO) - COPY.GLB MTO-42414.GPJ 11/12/23



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APPENDIX C

Laboratory Test Results



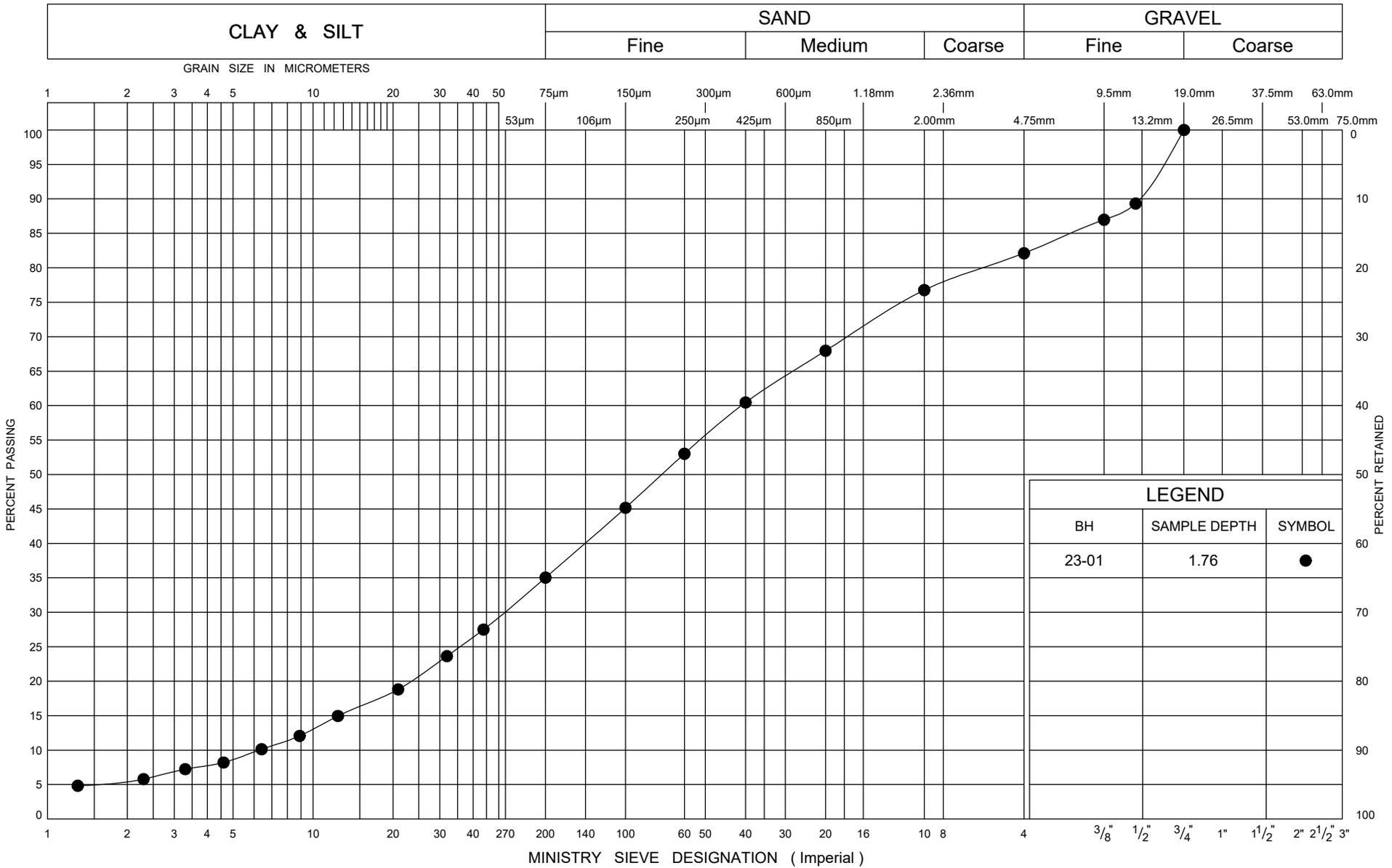
ONTARIO MOT GRAIN SIZE 3 MTO-42414.GPJ ONTARIO MOT.GDT 11/28/23



GRAIN SIZE DISTRIBUTION
SAND and GRAVEL FILL

FIG No C1

W.P. 6022-E-0038



ONTARIO MOT GRAIN SIZE 3 MTO-42414.GPJ ONTARIO MOT.GDT 11/28/23



GRAIN SIZE DISTRIBUTION
Silty SAND FILL

FIG No C2

W.P. 6022-E-0038



POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 42414

Date Drilled: 20-Oct-23

Project Name: Shabaqua WB VMS

Date Tested: 03-Nov-23

Core Size: NQ BH No : 23-01

Tester: BS

Client: MTO

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	2	5.7	D	13.3	47.5	64.6	5.5	131.1	Gneiss	Very Strong
2										
3										
4										
5										
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10										
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- * 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.

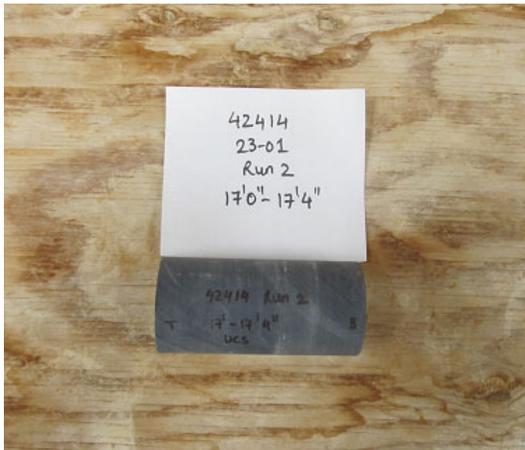
UNCONFINED COMPRESSION TEST REPORT

ASTM D7012-14

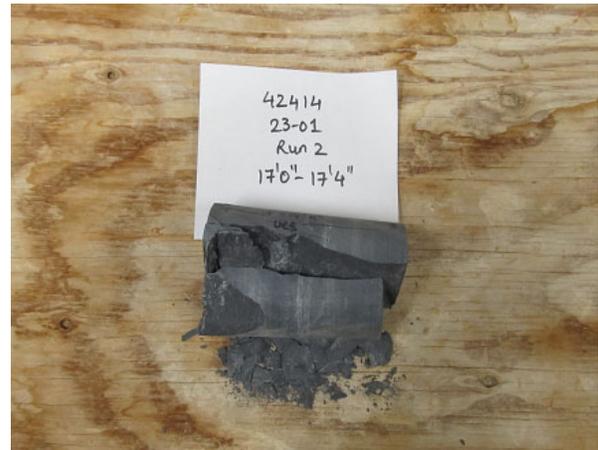
CLIENT:	Ministry Of Transportation, Ontario	FILE NUMBER:	42414
PROJECT NAME:	Shabaqua WB VMS	REPORT DATE:	1-Dec-23
BOREHOLE No.:	23-01	TEST DATE:	3-Nov-23
SAMPLE No.:	RUN 2		
SAMPLE DEPTH:	5.18-5.28 m		
DESCRIPTION:	Gneiss		

Avg. Height (cm):	9.7	Weight (g):	470.2
Avg. Diameter (cm):	4.7	Wet Density (kg/m ³):	2,794
H. to Dia. Ratio*:	2.1:1	Dry Density (kg/m ³):	2,550
Cross Sectional Area (cm ²):	17.35	Moisture Content (%):	N/A
Sample Volume (cm ³):	168.29		

ORIGINAL SPECIMEN



FRACTURED SPECIMEN



AVG. RATE OF STRAIN TO FAILURE:	1.5% / min
MAXIMUM COMPRESSIVE LOAD:	176.7 kN
UNCONFINED COMPRESSIVE STRENGTH:	101.8 MPa

Note:

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

TEST DONE BY: BS
REVIEWED BY: WM

23-01 Run 2 UCS



ROCK CORE PHOTOGRAPH

Borehole 23-01, Runs 1 and 2 (of 2), 3.1 to 5.9 m





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APPENDIX D

Site Photographs



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Photo 1: Looking west at traffic control set-up (taken on October 20, 2023)



Photo 2: Looking east at Borehole 23-01 during drilling (taken on October 20, 2023)