

**FINAL
FOUNDATION INVESTIGATION REPORT
REPLACEMENT OF THE HIGHWAY 401 OVERPASS AT
GANARASKA RIVER
NORTHUMBERLAND COUNTY – PORT HOPE, ONTARIO
ASSIGNMENT NO.: 4019-E-0021
GWP 4068-14-00**



THURBER ENGINEERING LTD.



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**SITE NO. 21X-0231/B0
GEOCRES NO.: 30M16-078**

**Report
to
MCINTOSH PERRY | LEA JOINT VENTURE**

Latitude: 43.969469°
Longitude: -78.294128°

August 2023
Thurber File No.: 33099



TABLE OF CONTENTS

PART 1. FACTUAL INFORMATION

1.	INTRODUCTION.....	1
2.	SITE DESCRIPTION.....	1
2.1	General.....	1
2.2	Site Geology.....	2
3.	EXISTING INFORMATION	2
4.	SITE INVESTIGATION AND FIELD TESTING	3
5.	LABORATORY TESTING	5
6.	DESCRIPTION OF SUBSURFACE CONDITIONS.....	6
6.1	Fill.....	6
6.2	Organic Silt (OL to ML-OL to MH-OH).....	8
6.3	Clayey Silt (CL)	9
6.4	Silty Sand to Sand with Silt (SM to SW-SM to SP-SM).....	9
6.5	Glacial Till.....	10
6.6	Bedrock	11
6.7	Analytical Test Results	12
6.8	Groundwater Level	12
7.	MISCELLANEOUS.....	13



APPENDICES

- Appendix A Drawings
 - Borehole Locations and Stratra Drawing
- Appendix B Field Investigation and Testing
 - Symbols and Terms
 - Record of Boreholes Sheets
- Appendix C Laboratory Testing
 - Particle Size Analysis Figures
 - Atterberg Limits Figures
 - Unconfined Compressive Strength Testing Results
 - Analytical Testing Results
 - Bedrock Core Photographs
- Appendix D Site Photographs



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PART 1. FACTUAL INFORMATION

1. INTRODUCTION

This section of the report presents the factual findings obtained from both a preliminary and detailed foundation investigation conducted by Thurber Engineering Ltd. (Thurber) for the replacement of the Highway 401 Ganaraska River overpass structure located in Port Hope, Ontario. Thurber carried out the preliminary foundation investigation as a subconsultant to WSP Canada (WSP) under Agreement No. 4014-E-0014 and the detailed foundation investigation as a subconsultant to a LEA Consulting (LEA) and McIntosh Perry Consulting Engineers (MPCE) joint venture under Agreement No. 4019-E-0021, Assignment No. 18.

A General Arrangement (GA) drawing and base plan mapping were provided by LEA for the preparation of this report.

The purpose of these investigations was to explore the subsurface conditions at the site and, based on this data, provide a borehole location plan, record of boreholes, stratigraphic profile, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions influencing design and construction of a replacement structure was developed in the course of the current investigation.

2. SITE DESCRIPTION

2.1 General

Site 21X-0231/B0 is located on Highway 401, approximately 0.45 km west of the Highway 401 County Road 28 underpass in Port Hope, Ontario. The location of the structure is shown on the inset Key Plan on Drawing No. 1 in Appendix A.

Highway 401 at the location of the overpass has three through lanes in each direction. Traffic volumes on this section of Highway 401 are understood to be 50,000 AADT (2016). It is noted



that for project orientation purposes, Highway 401 will be assumed to be oriented east-west and the Ganaraska River to be oriented north-south with river flow to the south. The eastbound and westbound lanes are separated by a median barrier wall. There are steel beam guide rails located along the outside lanes east and west of the bridge and a concrete barrier where the highway crosses over the river.

Based on the historical contract documents, the existing three-span, steel plate girder structure is approximately 73.0 m long, and 29.0 m wide.

The lands surrounding the site consist of the Port Hope Conservation Area to the north of Highway 401. Corbitt's Dam and residential properties are located to the south of Highway 401. Storm water drainage in the area is to existing catch basins and the Ganaraska River. Site photographs showing the general conditions at the site are presented along Highway 401 and the Ganaraska River are presented in Appendix D.

The existing approach embankments range in height from approximately 10.7 m to 12.1 m. The embankment side slopes extend down at approximately 2H:1V. The slopes are vegetated with a combination of long grass and brush.

2.2 Site Geology

The site is located within a physiographic region known as the Iroquois Plain. This area was formed by a body of water known as Lake Iroquois and is characterized by lacustrine deposits of sand, silts and clays. Along Highway 401, within the project limits, the principal overburden consists of till and clay with occasional drumlins (Chapman and Putnam, 1984).

3. EXISTING INFORMATION

The GEOCRE Report 30M16-7 dated July 12th, 1957 presents the results of the investigations carried out for the design and construction of the existing bridge structure and approach embankments. The investigation included six boreholes for the structure. A supplemental approach embankment investigation was also carried out that included three short boreholes to refusal and five auger probe holes; the results were included as an addendum to the original investigation report. Two of the structure boreholes were advanced approximately 3.0 m into the limestone bedrock while all approach boreholes were advanced to refusal on inferred bedrock.

Prior to construction of the bridge and Highway 401 in 1957, the stratigraphy in the area of the bridge was generally described as surficial deposits of organic silt, overlying a thin deposit of very dense silty coarse sand. The overburden soil at the site is underlain by sound limestone bedrock



based on AXT rock coring. The Borehole Logs indicated the bedrock surface at around elevation 295 to 297 feet (89.9 to 90.5 m).

The report noted concerns regarding the stability of the embankments. Failure of the underlying soil was predicted during placement of the embankment fill (up to 35 feet (10.7 m) of fill). It was recommended in the supplemental investigation letter that a trench 1.5 m (5 ft.) deep, 9.1 m (30 ft.) wide and 30.5 m (100 ft.) long be excavated and the excavated material be replaced with properly compacted granular fill before commencing the embankment fill placement. It is not known if this subgrade treatment was carried out.

A Preliminary Foundation Investigation for replacement of this structure was carried out by Thurber in 2016 under Assignment No. 4014-E-0014. The site investigation and field-testing program was carried out between May 30th and June 1st, 2016, and included advancing four boreholes labelled 401 through 404. The results of the preliminary investigation boreholes have been included in the description of subsurface conditions that follows.

4. SITE INVESTIGATION AND FIELD TESTING

A detailed site investigation and field testing program was carried out between March 17th and April 14th, 2022, to supplement the 2016 preliminary investigation and included advancing eight boreholes labelled GR22-01 through GR22-08. The northing, easting and elevation of the boreholes are shown on the Borehole Location and Soil Strata Drawing No. 1 in Appendix A and are summarized in Table 4-1. The site is within MTM Zone 10. The as-drilled locations of the boreholes below the existing bridge were measured relative to existing site features to decimeter accuracy; the elevations of the boreholes below the existing bridge were surveyed to centimeter accuracy using a Nikon AP-8 Auto-Level. The as-drilled locations and elevations of all other boreholes were surveyed using a Trimble Catalyst DA2 global positioning system antenna with centimeter accuracy. The elevations were surveyed relative to the first order vertical benchmarks HCP 108 and HCP 109 west and east of the Ganaraska River with geodetic elevations of 106.144 m and 103.019 m, respectively.

Table 4-1: Borehole Summary

Borehole No.	Drilled Location	Northing (m)	Easting (m)	Ground Surface Elevation (m)	Termination Depth (m)
401	West abutment – WB Lane 3	4 870 654.5	401 513.7	106.0	14.6

Borehole No.	Drilled Location	Northing (m)	Easting (m)	Ground Surface Elevation (m)	Termination Depth (m)
402	West abutment – EB Lane 3	4 870 631.4	401 517.2	106.0	19.7
403	East abutment – WB Lane 3	4 870 667.1	401 602.1	103.3	19.8
404	East abutment – EB Lane 3	4 870 645.1	401 606.0	103.4	15.3
GR22-01	West abutment – North end	4 870 676.0	401 511.2	98.7	7.0
GR22-02	West Pier – North end	4 870 679.1	401 532.2	97.6	9.4
GR22-03	East Pier – North end	4 870 686.5	401 576.5	95.5	9.8
GR22-04	East abutment – North end	4 870 692.2	401 597.9	95.2	10.5
GR22-05	West Pier – Below WB	4 870 660.2	401 535.4	98.1	7.8
GR22-06	East Pier – Below WB	4 870 666.1	401 579.9	97.2	7.7
GR22-07	West Pier – Below EB	4 870 641.0	401 537.7	97.9	10.7
GR22-08	East Pier – Below EB	4 870 647.3	401 582.9	96.7	10.5

Thurber contacted Ontario One Call in advance of the field investigation to obtain utility locates/clearances in the vicinity of the intended borehole locations. In addition, MTO traffic operations was contacted to obtain ATMS Fibre utility locates and RW Electric was contacted to obtain MTO electric locates for the project limits.

Boreholes 401 through 404 were advanced with a CME truck mounted drill rig equipped with hollow stem augers. Boreholes GR22-01 through GR22-08 were advanced with a portable exploration drill rig utilizing a half-weight hammer and NW size casing and wash boring. The subsurface stratigraphy encountered in the boreholes was recorded in the field by Thurber



personnel. Split spoon samples were collected at regular depth intervals in the boreholes via the completion of Standard Penetration Tests (SPT), following the methods described in ASTM Standard D1586-11. All soil samples recovered from the boreholes were placed in moisture-proof containers and the samples were transported to Thurber's Pickering geotechnical laboratory for further examination and testing. Bedrock was cored in Boreholes 402 and 403 with HQ size coring equipment and Boreholes GR22-02 through GR22-04, GR22-07 and GR22-08 with NQ size coring equipment following ASTM Standard D6032-08. Bedrock core samples were stored in core boxes for transport.

A 25 mm diameter standpipe piezometer was installed in Borehole 403 and 38 mm diameter standpipe piezometers were installed into Boreholes GR22-03 and GR22-07 to allow for the measurement of the groundwater level at the site. Piezometer construction details are illustrated on the respective Record of Borehole sheets, provided in Appendix B. The piezometer in Borehole 403 was decommissioned in accordance with Ontario MOE Regulation 903 on May 31, 2016, after the final water level measurement. The piezometers in Boreholes GR22-03 and GR22-07 were decommissioned in accordance with Ontario MOE Regulation 903 on June 22, 2023.

The boreholes without piezometer installations were backfilled with a low-permeability combination of soil cuttings and bentonite pellets in accordance with Ontario MOE Regulation 903 as amended. All on-road boreholes were capped with 150 mm of cold patch asphalt underlain by 150 mm layer of concrete.

5. 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. More than 25% of the recovered soil samples were tested for grain size distribution and, where appropriate, Organic Content and Atterberg Limits in accordance with MTO and ASTM standards. All rock cores were photographed and their total core recovery (TCR), solid core recovery (SCR) and rock quality designation (RQD) were measured. Selected samples of the rock core were submitted for unconfined compressive strength (UCS) testing. Chemical analysis for determination of pH, conductivity, resistivity, soluble sulphate, sulphide and chloride concentrations was carried out on seven soil samples.

The results of geotechnical tests are summarized on the Record of Borehole sheets included in Appendix B and laboratory results are presented on the figures included in Appendix C.



6. DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix B and the Borehole Location and Soil Strata Drawing included in Appendix A. Soil classification for the 2022 investigation is in accordance with ASTM D2487 with cohesive soils described as per current MTO Guidelines for Foundation Engineering Services. An overall description of the stratigraphy is given in the following sections, however, the factual data presented in the Record of Boreholes governs any interpretation of the site conditions. It must be recognized that soil and groundwater conditions may vary between and beyond sampled locations.

In general, the stratigraphy in the area of the boreholes is characterized by an asphalt pavement or topsoil underlain by embankment fill, overlying silty sand to sand with silt deposits and a native organic silt, overlying glacial till, which is underlain by limestone bedrock. The upper portion of the embankment fill generally consisted of silty sand with gravel with occasional cobbles. The lower portion of the embankment fill was more variable and included clay, silty sand some gravel, sandy silt, sandy clay and silty sand.

More detailed descriptions of the individual strata are presented below.

6.1 Fill

Asphalt

Four boreholes, numbered 401 through 404, were advanced through the existing Highway 401 pavement structure. The thickness of the asphalt measured at the borehole locations ranged from 240 mm to 350 mm.

Topsoil

Topsoil was encountered at surface in four boreholes, labelled GR22-01 through GR22-04, and ranged in thickness from 75 to 255 mm. It was noted that the topsoil was frozen at GR22-03.

Silty Sand with Gravel

Fill consisting predominantly of silty sand with varying amounts of gravel was encountered below the asphalt surface in Boreholes 401 through 404, below the topsoil in Boreholes GR22-01 and GR22-02 and at surface in Boreholes GR22-05 and GR22-08. The top of this layer ranged from elevation 105.7 m to 96.7 m. The thickness of this layer ranged from 1.9 m to 5.2 m. The SPT 'N' values ranged from 4 blows for 0.3 m of penetration to greater than 100 indicating a loose to very dense condition; but typically compact.



The moisture content of the samples tested ranged from 1% to 32%. The results of grain size analysis conducted on seven samples of this material are summarized in Table 6-1 and are illustrated on Figures C1 and C2 in Appendix C.

Table 6-1: Gradation Results for Silty Sand with Gravel Fill

Soil Particle	Percentage (%)	
Gravel	12 to 27	
Sand	43 to 68	
Silt	10 to 37	24
Clay		21

Variable Fill

The embankment fill encountered beneath the upper granular embankment fill at Boreholes 401 through 404, beneath the topsoil in Boreholes GR22-03 and GR22-04, and at surface in Boreholes GR22-06 and GR22-07 consisted of a mixture with varying compositions of silt, clay, sand and gravel with occurrences of organics and rock fragments. The top of this layer ranged from elevation 101.1 m to 95.0 m. The thickness of this layer ranged from 1.3 m to 7.6 m. The SPT 'N' values ranged from 7 for 0.3 m of penetration to greater than 100 indicating a loose to very dense condition; but typically compact to dense. The clay fill was identified as having a firm to very stiff consistency. Probable voids were noted within the variable fill layer in Borehole GR22-06 based on the low blow counts and very poor sample recovery between depths of 3.0 and 4.6 m (elev. 94.2 m to 92.6 m).

The moisture content of the samples tested ranged from 3% to 67%. The results of grain size analysis conducted on seven samples of this material are summarized in Table 6-2 and are illustrated on Figures C3 and C4 in Appendix C.

Table 6-2: Gradation Results for Variable Fill

Soil Particle	Percentage (%)	
Gravel	0 to 15	
Sand	9 to 93	
Silt	7 to 63	27 to 56
Clay		9 to 35



The results of Atterberg Limits testing completed on three samples of the fine-grained embankment fill are summarized in Table 6-3 and are illustrated on Figure C10 in Appendix C. It should be noted that one sample of embankment fill was found to be non-plastic.

Table 6-3: Atterberg Limit Results for Variable Fill

Parameter	Value
Liquid Limit	21 to 36
Plastic Limit	13 to 17
Plasticity Index	8 to 19

6.2 Organic Silt (OL to ML-OL to MH-OH)

A stratum of organic silt with varying amounts of sand and clay and occasional wood fibres was encountered beneath the fill layers in Boreholes 401 through 404, GR22-03 and GR22-04 and below the native sand layer in Boreholes GR22-01, GR22-02 and GR22-05. The top of this layer ranged from elevation 91.3 m to 94.1 m. The thickness of this layer ranged from 0.5 m to 3.6 m. The SPT 'N' values ranged from 3 blows for 0.3 m of penetration to greater than 100 indicating a very loose to very dense condition; but typically, loose to compact.

The moisture content of the samples tested ranged from 14% to 99%. The results of grain size analysis testing conducted on nine samples of this material are summarized in Table 6-4 and are illustrated on Figure C5 and C6 in Appendix C.

Table 6-4: Gradation Results for Organic Silt

Soil Particle	Percentage (%)
Gravel	0 to 3
Sand	3 to 46
Silt	35 to 82
Clay	3 to 28

The results of Atterberg Limits testing completed on seven samples of this material are summarized in Table 6-5 and are illustrated on Figures C11 and C12 in Appendix C. The test results indicate an organic silt ranging from non-plastic to high plasticity (ML-OL to MH-OH).

Table 6-5: Atterberg Limit Results for Organic Silt

Parameter	Value
Liquid Limit	25 to 61
Plastic Limit	21 to 42
Plasticity Index	4 to 19

The results of an organic content test on one sample of the organic silt resulted in an organic content of 1.0%.

6.3 Clayey Silt (CL)

A brown clayey silt deposit was encountered below the organic silt strata in Borehole 402. The top of this layer was identified at elevation 91.5 m. The thickness of this layer is 0.3 m.

The moisture content of the sample tested was 31%. The results of a grain size analysis tests indicated a gravel content of 0%, sand content of 16%, a silt content of 61% and a clay content 23%. Grain size analysis results are illustrated on Figure C7 in Appendix C.

The results of Atterberg Limits testing completed on this material indicated a liquid limit of 33, a plastic limit of 18, and a plasticity index of 15, indicating a clayey silt of low plasticity (CL). Atterberg Limits analysis results for the clay are illustrated on Figure C13 in Appendix C.

6.4 Silty Sand to Sand with Silt (SM to SW-SM to SP-SM)

A native deposit consisting primarily of sand with varying amounts of silt was encountered beneath the fill in Boreholes GR22-01, GR22-02, GR22-05, GR22-07 and GR22-08. Occasional cobbles and boulders were noted within this layer. The top of this layer, where observed, ranges from elevation 95.8 to 93.7 m. The thickness of this layer ranged from 1.3 to 3.8 m. The SPT 'N' values ranged from 10 blows for 0.3 m of penetration to greater than 100 indicating a compact to very dense condition.

The moisture content of the sample tested ranged from 1% to 15%. The results of a grain size analysis testing conducted on five samples of this material are summarized in Table 6-6 and are illustrated on Figure C8 in Appendix C.

Table 6-6: Gradation Results for Silty Sand to Sand

Soil Particle	Percentage (%)	
Gravel	1 to 14	
Sand	70 to 90	
Silt	9 to 28	4
Clay		9

6.5 Glacial Till

A stratum of glacial till consisting predominantly of silty sand and gravel was encountered beneath the fill in GR22-06, beneath the organic silt in Boreholes 403, 404, GR22-01, GR22-02, GR22-03 and GR22-04, beneath the native clay in Borehole 402, and beneath the native sand in Boreholes GR22-07 and GR22-08. Occasional to frequent cobbles and boulders were noted within the glacial till layer. Coring was required to get through this till layer in Borehole GR22-02. The top of this layer, where observed, ranges from elevation 92.7 m to 90.4 m. The thickness of this layer ranged from 0.2 m to 3.2 m. The SPT 'N' values ranged from 5 to greater than 100 indicating a loose to very dense condition; but typically compact to dense. Although cobbles or boulders were not encountered in all boreholes within the glacial till, it should be noted that glacial tills inherently contain cobbles and/or boulders.

The moisture content of the sample tested ranged from 4% to 27%. The results of a grain size analysis testing conducted on six samples of this material are summarized in Table 6-7 and are illustrated on Figures C9 in Appendix C.

Table 6-7: Gradation Results for Glacial Till

Soil Particle	Percentage (%)	
Gravel	9 to 36	
Sand	28 to 81	
Silt	3 to 31	33
Clay		11 to 12

The results of Atterberg Limits testing completed on two samples of the fines of this material found one sample to be non-plastic and the other to have a liquid limit of 21, a plastic limit of 15, and a plasticity index of 6, indicating silty, clayey sand (CL-ML) till in that instance. Atterberg Limit analysis results for the glacial till are illustrated on Figure C14 in Appendix C.

6.6 Bedrock

The overburden materials were underlain by a grey limestone bedrock. The bedrock surface ranges from elevation 87.1 m to 91.5 m in the boreholes where rock was cored. Photographs of the bedrock core are provided in Appendix B. Table 6-8 below summarizes the depths and elevations of the bedrock surface.

Table 6-8 Top of Bedrock Elevation

Location	Borehole	Ground Surface Elevation (m)	Depth Below Existing Grade (m)	Top of Bedrock Elevation (m)
West Abutment	401	106.0	14.5	91.5*
	402	106.0	15.0	91.0
	GR22-01	98.7	6.9	91.8*
West Pier	GR22-02	97.6	6.1	91.5
	GR22-05	98.1	7.3	90.8*
	GR22-07	97.9	7.4	90.5
East Abutment	403	103.3	15.7	87.6
	404	103.4	14.9	88.4*
	GR22-04	95.2	7.4	87.8
East Pier	GR22-03	95.5	6.5	89.0
	GR22-06	97.2	7.1	90.1*
	GR22-08	96.7	6.6	90.1

* Bedrock Inferred by SPT/auger refusal or short NQ core sample

Boreholes 402 and 403 were advanced into the bedrock by coring with HQ-size coring equipment and Boreholes GR22-02, GR22-03, GR22-04, GR22-07 and GR22-08 were advanced into the bedrock with NQ-size coring equipment. The bedrock within the top 0.5 m in Borehole 402 was moderately weathered and could be penetrated with the drill rig augers.

The bedrock encountered below the weathered bedrock in Borehole 402 and all other Boreholes had a total core recovery ranging from 44% to 100%, the solid core recovery ranging from 25% and 100% and the Rock Quality Designation (RQD) ranging from 0% to 100%. Based on the RQD value the bedrock is classified as very poor to excellent quality, but typically poor to fair.

The Unconfined Compressive Strength (UCS) of the limestone bedrock based on laboratory testing of selected samples ranged from 45.5 to 87.1 MPa, indicating medium strong to strong

bedrock based on the Canadian Foundation Engineering Manual, 4th Edition. The UCS testing results are included in Appendix C.

6.7 Analytical Test Results

Two samples of the fill encountered at the site were submitted to Paracel Laboratories in Ottawa, Ontario and five samples of the native soils encountered at the site were submitted to SGS Canada Inc. in Lakefield, Ontario for analysis of pH, water soluble sulphate, sulphide and chloride concentrations, conductivity and resistivity. The analysis results are summarized in the Table 6-9. A copy of the test results is provided in Appendix C.

Table 6-9: Results of Chemical Analysis

Borehole	Sample	Depth (m)	pH	Resistivity (Ohm-cm)	Conductivity (µS/cm)	Chloride (µg/g)	Sulphate (µg/g)	Sulphide (%)
401	SS4	2.6	8.44	1,280	782	365	21	-
403	SS3	1.8	8.26	826	1,210	758	76	-
GR22-02	SS6	4.1	7.57	1,820	550	170	46	< 0.04
GR22-03	SS5	3.4	8.00	1,610	622	160	66	< 0.04
GR22-04	SS4	4.9	7.15	2,240	447	290	140	< 0.04
GR22-07	SS5	3.3	8.67	719	1,390	330	11	< 0.04
GR22-08	SS5	3.4	8.75	2,090	479	89	16	< 0.04

6.8 Groundwater Level

The groundwater levels were measured in five standpipe piezometers installed in Boreholes 403, GR22-03 and GR22-07. The measurements are presented in the Record of Borehole sheets in Appendix B and in Table 6-10 below:

Table 6-10. Measured Water Levels

Borehole	Date of Reading	Water Depth / Elevation (m)	Comment
403	2016-05-31	8.4 / 94.9	Piezometer
GR22-03	2022-03-30	2.0 / 93.5	Piezometer
	2022-03-31	1.9 / 93.6	
	2022-08-23	1.8 / 93.7	
	2022-08-24	1.8 / 93.7	
GR22-07	2022-04-11	4.1 / 93.8	Piezometer
	2022-09-05	4.2 / 93.7	
	2022-09-09	4.2 / 93.7	

These observations are considered short term and it should be noted that the groundwater level at the time of construction may be different and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level is likely dependent on the dam controlled Ganaraska River and may be at a higher elevation after periods of significant and/or prolonged precipitation and spring snow melts.

The piezometer in Borehole 403 was decommissioned in accordance with Ontario MOE Regulation 903 on May 31, 2016. The piezometers in Boreholes GR22-03 and GR22-07 were decommissioned in accordance with Ontario MOE Regulation 903 on June 22, 2023.

7. MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. The as-drilled locations and ground surface elevation were measured by Thurber following completion of the field program.

Terex Drilling Solutions of Concord, Ontario supplied and operated the truck mounted CME drill rigs to carry out the drilling, sampling, and in-situ testing, standpipe piezometer installation and borehole decommissioning of the on-road boreholes. Marathon Underground of Ottawa, Ontario supplied and operated the portable drilling equipment to carry out the drilling, sampling, and in-situ testing, standpipe piezometer installation and borehole decommissioning of the off-road boreholes. Traffic control was performed in accordance with Ontario Book 7 for short duration closures; all signs, barrels, cones and traffic control personnel were provided by Direct Traffic Management of Mississauga, Ontario. The field investigations were supervised on a full-time basis by Mr. Justin Gray, P.Eng., Mr. Christopher Murray, P.Eng., and Mr. Joe Lin. Overall supervision of the field investigation program was provided by Mr. Christopher Murray, P.Eng.



Routine geotechnical laboratory testing was completed by Thurber's laboratory in Pickering, Ontario. Analytical testing was completed by Paracel Laboratories in Ottawa, Ontario and SGS Canada Inc. in Lakefield, Ontario. Unconfined compressive strength testing was carried out by Thurber's laboratory in Oakville, Ontario. Organic content testing was carried out by SGS Canada Inc. in Lakefield, Ontario. Interpretation of the factual data and preparation of this report was completed by Mrs. Katya Walker, P.Eng., and Mr. Christopher Murray, P.Eng. The report was reviewed by Mr. Paul Carnaffan, P.Eng. and Dr. P.K. Chatterji, P.Eng., the Designated Principal Contact for MTO Foundation Projects.

Thurber Engineering Ltd.

Report Prepared By:



Katya Walker, M.Eng., P.Eng.
Geotechnical Engineer



Christopher Murray, M.A.Sc., P.Eng.
Geotechnical Engineer



Paul Carnaffan, M.Eng., P.Eng.
Principal | Branch Manager
Senior Geotechnical Engineer



Dr. P.K. Chatterji, P.Eng.
Designated Principal Contact
Senior Geotechnical Engineer

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.

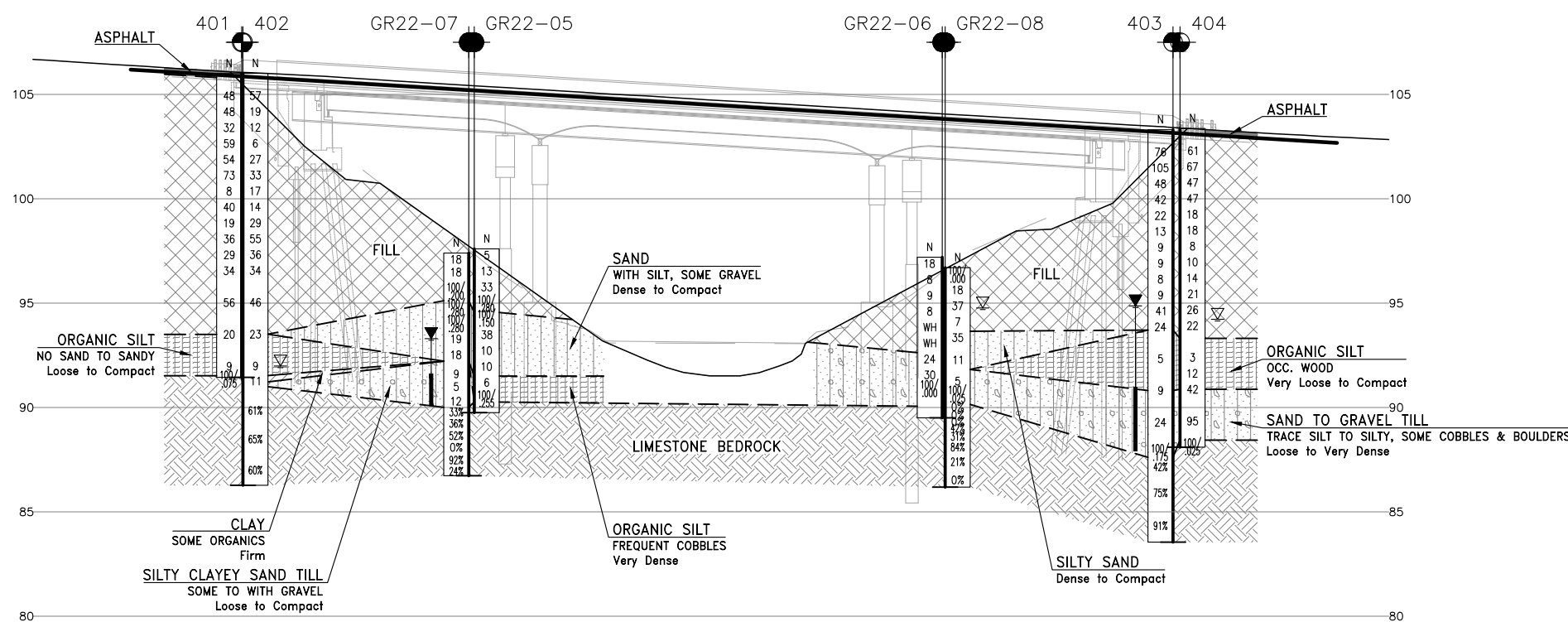
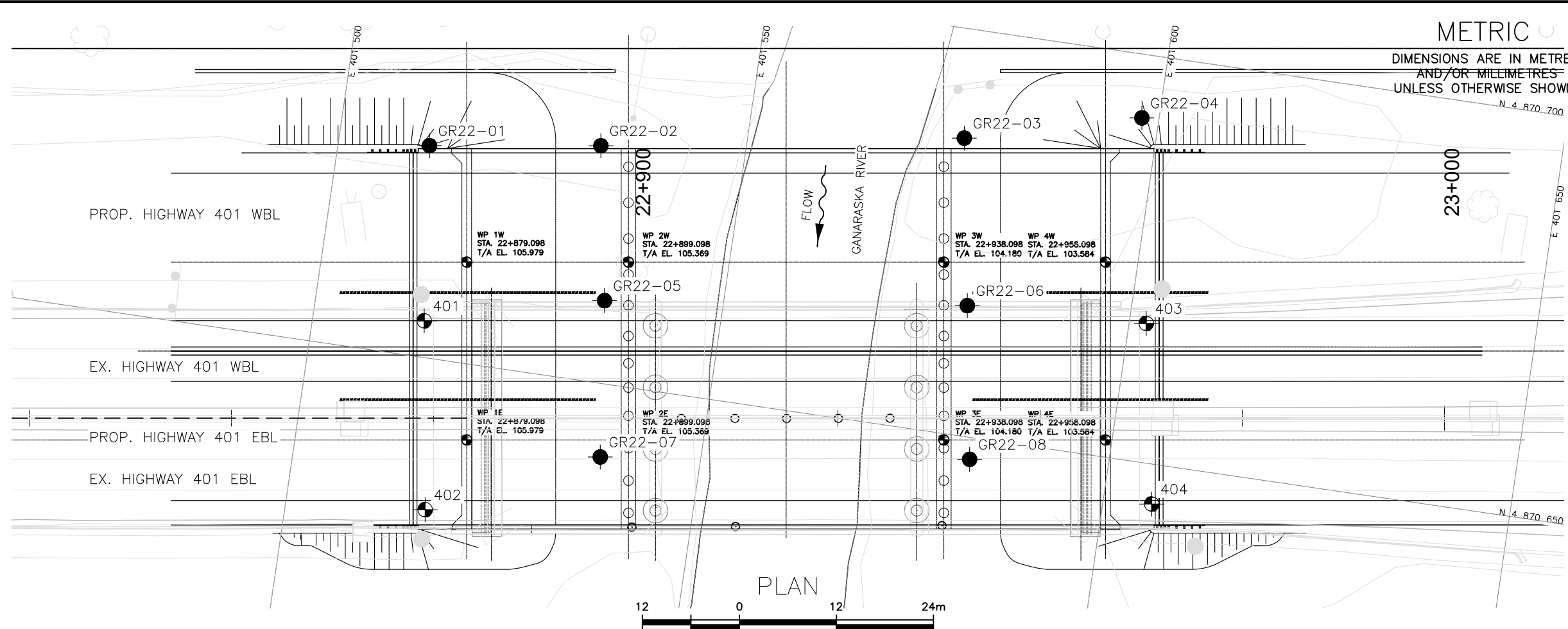
7. INDEPENDENT JUDGEMENTS OF CLIENT

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 Drawings

Borehole Locations and Stratra Drawing



PROFILE ALONG HIGHWAY 401 EBL



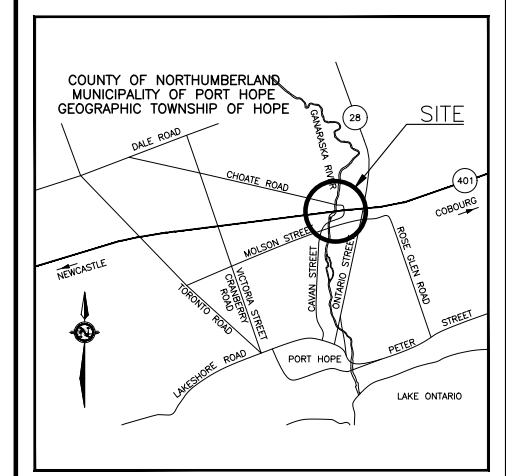
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AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No

HIGHWAY 401
GANARASKA RIVER
BRIDGE REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

Ontario

SHEET



KEYPLAN

LEGEND

●	Borehole (Current Investigation by Thurber)
●	Borehole (Previous Investigation by Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
▽	Head Artesian Water
⊥	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
GR22-01	98.2	4 870 676.0	401 511.2
GR22-02	97.1	4 870 679.1	401 532.2
GR22-03	94.9	4 870 686.5	401 576.5
GR22-04	94.7	4 870 692.2	401 597.9
GR22-05	97.6	4 870 660.2	401 535.4
GR22-06	97.2	4 870 666.1	401 579.9
GR22-07	97.4	4 870 641.0	401 537.7
GR22-08	96.7	4 870 647.3	401 582.9
401	106.0	4 870 654.5	401 513.7
402	106.0	4 870 631.4	401 517.2
403	103.3	4 870 667.1	401 602.1
404	103.4	4 870 645.1	401 606.0

NOTES

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 30M16-078

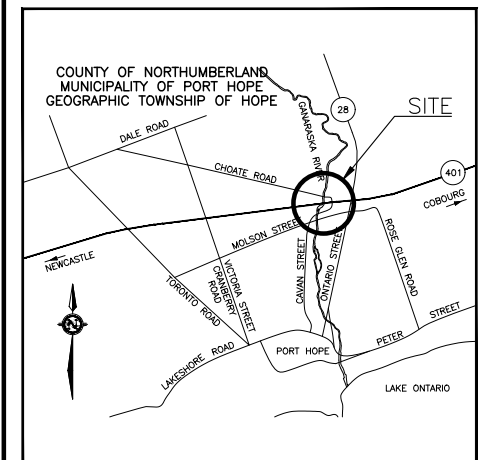
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DESIGN	CM	CHK -	CODE
DRAWN	MFA	CHK CM	SITE
LOAD	DATE	SEP 2022	
STRUCT	DWG	1	

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


CONT No
WP No

HIGHWAY 401
GANARASKA RIVER
BRIDGE REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA



KEYPLAN

LEGEND

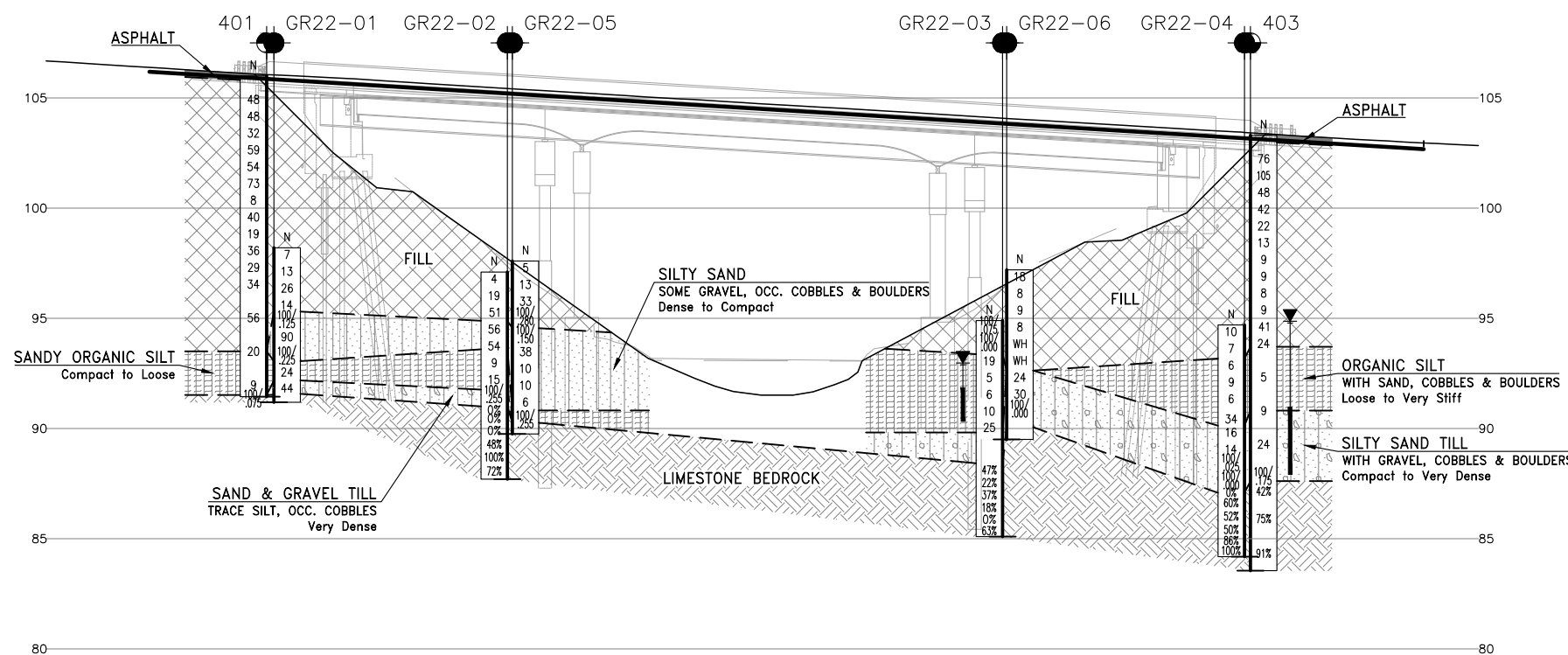
- | | |
|---|---|
|  | Borehole (Current Investigation by Thurber) |
|  | Borehole (Previous Investigation by Others) |
| N | Blows /0.3m (Std Pen Test, 475J/blow) |
| CONE | Blows /0.3m (60° Cone, 475J/blow) |
| PH | Pressure, Hydraulic |
|  | Water Level |
|  | Head Artesian Water |
|  | Piezometer |
| 90% | Rock Quality Designation (RQD) |
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NO	ELEVATION	NORTHING	EASTING
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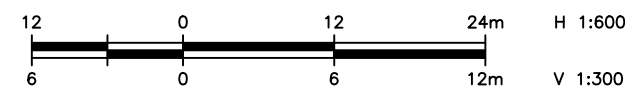
-NOTES-

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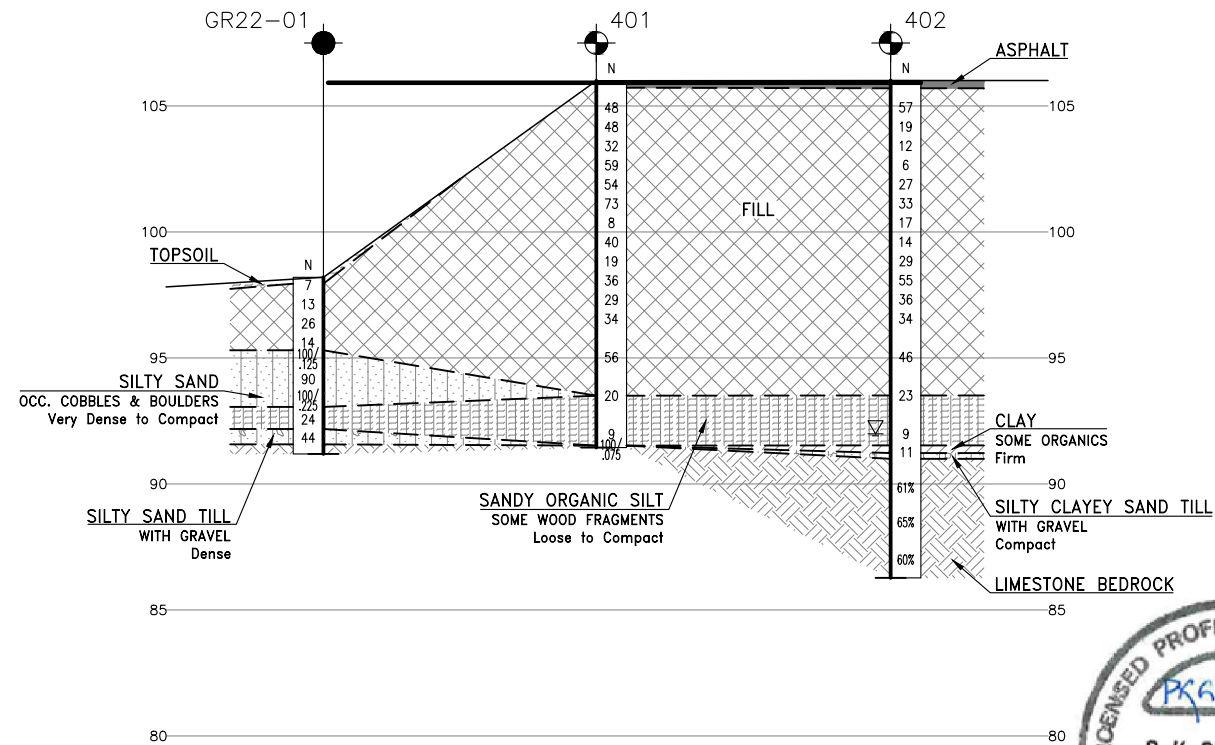
GEOCRES No. 30M16-078



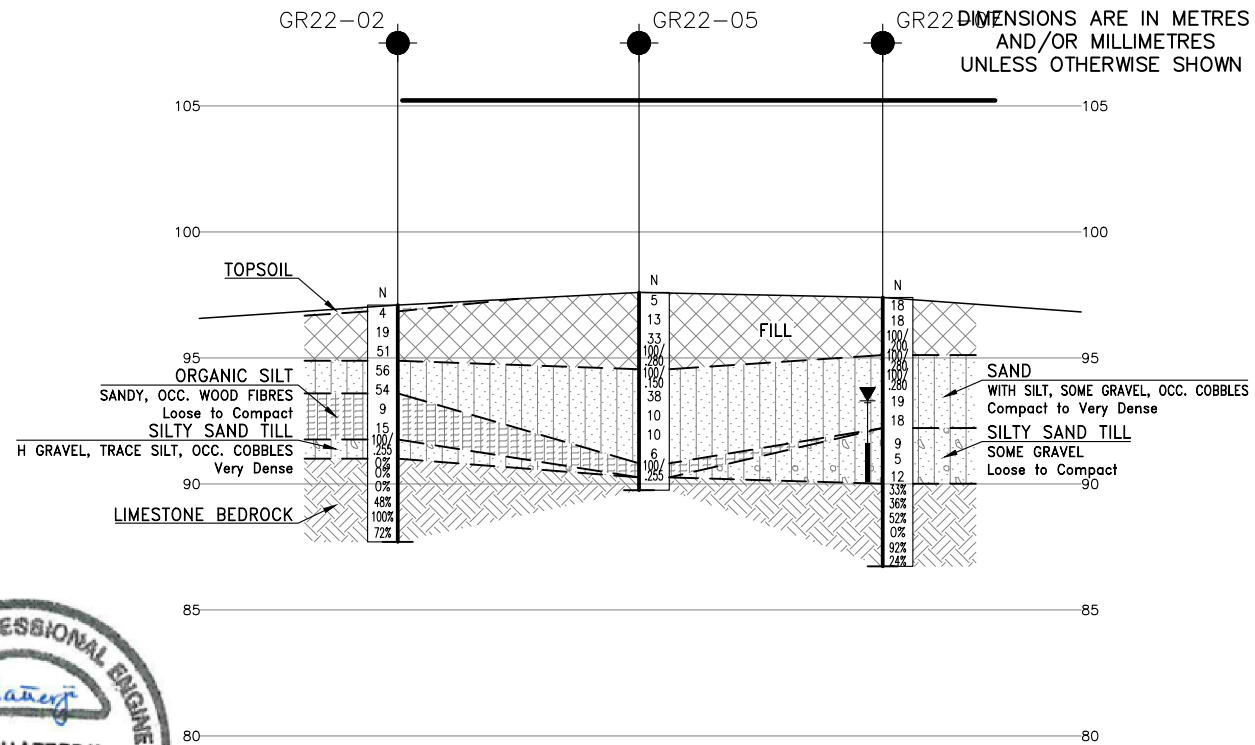
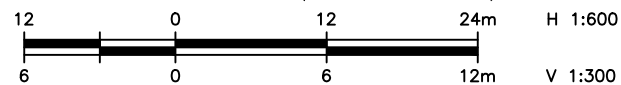
PROFILE ALONG HIGHWAY 401 WBL



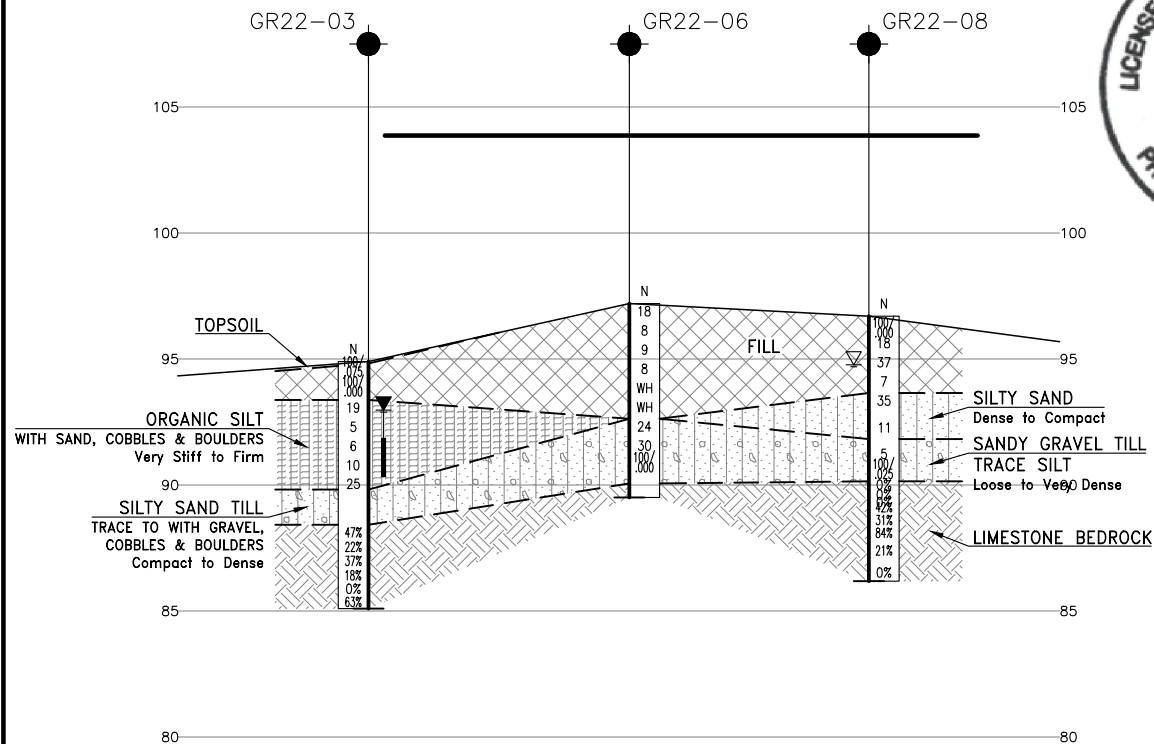
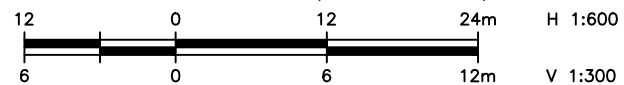
REVISIONS								
	DATE	BY	DESCRIPTION					
DESIGN	CM	CHK	-	CODE	LOAD	DATE	SEP 2022	
DRAWN	MFA	CHK	CM	SITE	STRUCT	DWG	2	



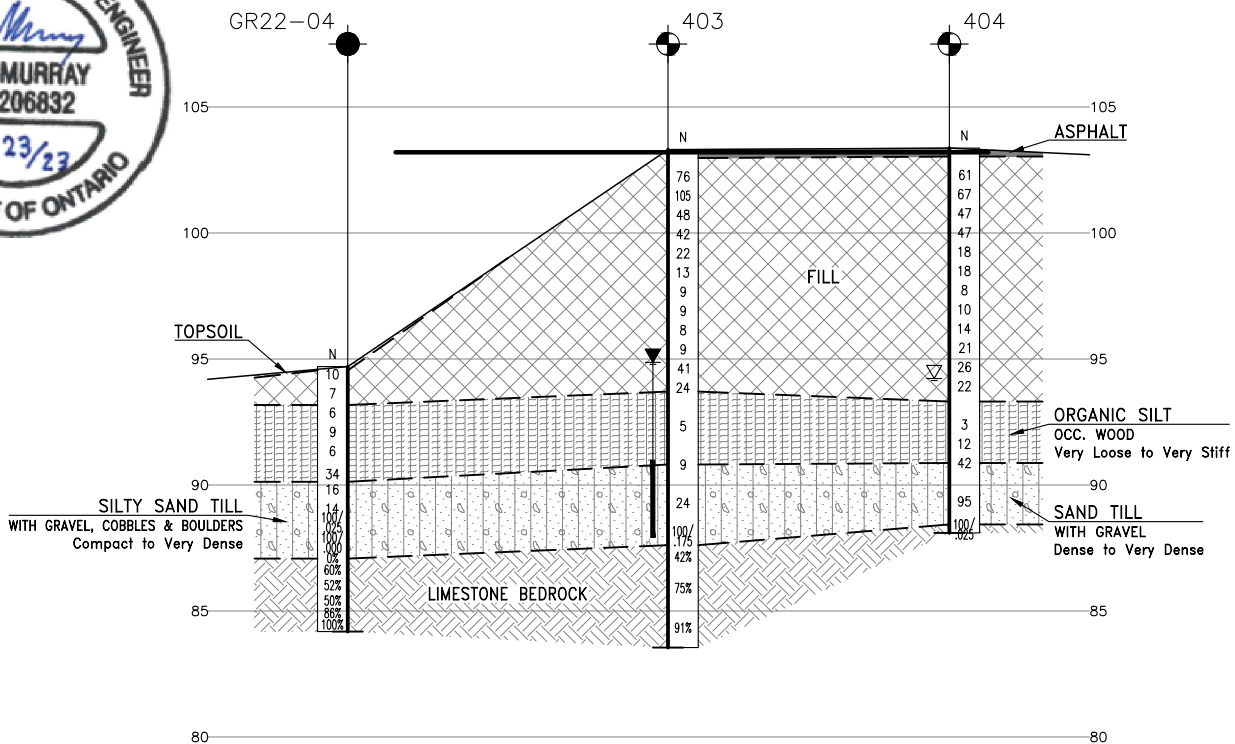
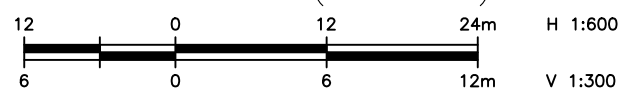
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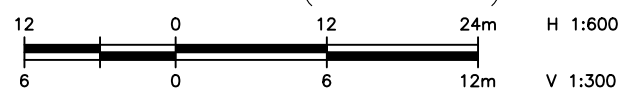
SECTION B-B (W. PIER)



SECTION C-C (E. PIER)



SECTION D-D (E. ABUT.)

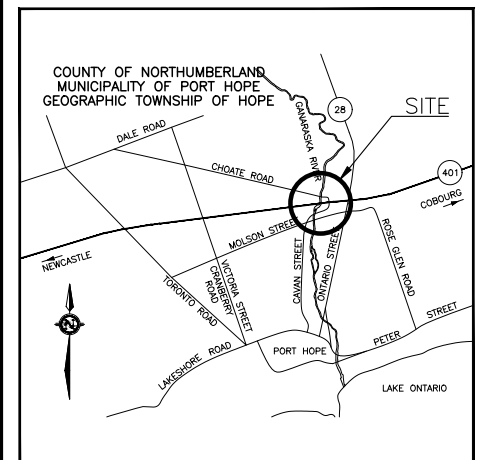


METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWNCONT No
WP NoHIGHWAY 401
GANARASKA RIVER
BRIDGE REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Ontario



KEYPLAN

LEGEND

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●	Borehole (Previous Investigation by Others)
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▽	Water Level
▽	Head Artesian Water
— —	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

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GEOCRES No. 30M16-078

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	CM	CHK -	CODE
DRAWN	MFA	CHK CM	SITE
LOAD	DATE	SEP 2022	
STRUCT	DWG	3	



Appendix B Field Investigation and Testing

Symbols and Terms
Record of Boreholes Sheets



SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in sizes from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services)

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

Desiccated	having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc.
Fissured	having cracks, and hence a blocky structure
Varved	composed of alternating layers of silt and clay
Stratified	composed of alternating successions of different soil types, e.g. silt and sand
Layer	> 75 mm in thickness
Seam	2 mm to 75 mm in thickness
Parting	< 2 mm in thickness

RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

N-VALUE:

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented, the number of blows are reported over the sampler penetration in millimetres (e.g. 50/75).

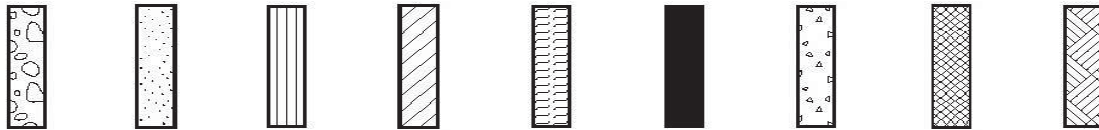
DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to an "A" size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.



STRATA PLOT:

Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders
Cobbles
Gravel Sand Silt Clay Organics Asphalt Concrete Fill Bedrock

TEXTURING CLASSIFICATION OF SOILS

Classification	Particle Size
Boulders	Greater than 200 mm
Cobbles	75 – 200 mm
Gravel	4.75 – 75 mm
Sand	0.075 – 4.75 mm
Silt	0.002 – 0.075 mm
Clay	Less than 0.002 mm

TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	12 or less
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

SAMPLE TYPES

SS	Split spoon samples
ST	Shelby tube or thin wall tube
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ etc.	Rock core sample obtained with the use of standard size diamond coring equipment

TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

Descriptive Term	SPT “N” Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50

MODIFIED UNIFIED SOIL CLASSIFICATION

Major Divisions		Group Symbol	Typical Description
COARSE GRAINED SOIL	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	SILT AND CLAY SOILS $W_L < 35\%$	ML	Inorganic silts, 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.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS $35\% < W_L < 50\%$	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other organic soils.

Note - W_L = Liquid Limit



EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock materials.
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 structures are preserved.

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 0.1 m in length or larger, as a percentage of total core length
Unconfined Compressive Strength: (UCS)	Axial stress required to break the specimen.
Fracture Index: (FI)	Frequency of natural fractures per 0.3 m of core run.

DISCONTINUITY SPACING

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

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)
Extremely Strong	Greater than 250
Very Strong	100 – 250
Strong	50 – 100
Medium Strong	25 – 50
Weak	5 – 25
Very Weak	1 – 5
Extremely Weak	0.25 – 1

RECORD OF BOREHOLE No 401

1 OF 2

METRIC

GWP# 4078-14-00 LOCATION Site 21-231, MTM Zone 10: N 4 870 654.5 E 401 513.7 ORIGINATED BY JAG
 HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JAG
 DATUM Geodetic DATE 2016.05.31 - 2016.05.31 CHECKED BY KCP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								WATER CONTENT (%)					
106.0													
0.0	280 mm ASPHALT												
105.7													
0.3	Silty sand with gravel Dense to very dense Brown FILL		1	GS									
			2	SS	48		105						20 67 13 (SH+CL)
			3	SS	48		104						
			4	SS	32		103						
	-gravel and cobbles												
			5	SS	59		102						
			6	SS	54		101						
	-gravel and cobbles		7	SS	73		100						
101.1													
4.9	Sandy silt to sandy clay Loose to dense Brown FILL		8	SS	8		99						
			9	SS	40		98						
			10	SS	19		97						
	-clayey												3 30 44 23
			11	SS	36								
			12	SS	29								
			13	SS	34								

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

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

RECORD OF BOREHOLE No 401

2 OF 2

METRIC

GWP# 4078-14-00 LOCATION Site 21-231, MTM Zone 10: N 4 870 654.5 E 401 513.7 ORIGINATED BY JAG
 HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JAG
 DATUM Geodetic DATE 2016.05.31 - 2016.05.31 CHECKED BY KCP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					
Continued From Previous Page							WATER CONTENT (%)						
							20 40 60						
95.6	Sand with silt Very dense Brown FILL												
10.4			14	SS	56		95						
93.5	Sandy Organic SILT (ML-OL) Compact to loose Dark brown - some wood fragments		15	SS	20								
12.5													
91.5													
91.5	Weathered Limestone Bedrock		17	SS	100								
14.6	End of Borehole on Inferred Bedrock				75mm								

ONTMT4S GANARASKA RIVER BRIDGE.GPJ 2012TEMPLATE(MTO).GDT 24/4/18

RECORD OF BOREHOLE No 402

1 OF 3

METRIC

GWP# 4078-14-00 LOCATION Site 21-231, MTM Zone 10: N 4 870 631.4 E 401 517.2 ORIGINATED BY JAG
 HWY 401 BOREHOLE TYPE Hollow Stem Auger / HQ Coring COMPILED BY JAG
 DATUM Geodetic DATE 2016.01.06 - 2016.01.06 CHECKED BY KCP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				W P W W L									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%)									
106.0								20	40	60	80	100									
0.0	300 mm ASPHALT																				
105.7																					
0.3	Silty sand with gravel, occasional cobbles Loose to very dense Brown FILL		1	GS																	
			2	SS	57		105														
			3	SS	19		104														
	- cobbles		4	SS	12																
			5	SS	6		103														
			6	SS	27		102														
			7	SS	33		101														
100.5																					
5.5	Silty sand with gravel, occasional cobbles Compact to very dense Brown to greyish-brown FILL		8	SS	17		100														
			9	SS	14																
			10	SS	29		99														
			11	SS	55		98														
			12	SS	36																
			13	SS	34		97														

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 402

2 OF 3

METRIC

GWP# 4078-14-00 LOCATION Site 21-231, MTM Zone 10: N 4 870 631.4 E 401 517.2 ORIGINATED BY JAG
 HWY 401 BOREHOLE TYPE Hollow Stem Auger / HQ Coring COMPILED BY JAG
 DATUM Geodetic DATE 2016.01.06 - 2016.01.06 CHECKED BY KCP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL × LAB VANE						
							20 40 60 80 100				PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT W _p W W _L			
							20 40 60 80 100				WATER CONTENT (%) 20 40 60			
95.5	Continued From Previous Page													
10.5	Silty sand Dense Brown to greyish-brown FILL		14	SS	46		95							
							94							
93.5														
12.5	Organic SILT (MH-OH) Loose to compact Greyish-brown to dark brown		15	SS	23		93							
							92							
			16	SS	9									0 6 67 27
91.5														
14.5	CLAY (CL), some organics													0 16 61 23
91.2	Firm													
14.8	Dark brown		17	SS	11		91							28 28 33 11
91.0														
15.0	Silty, Clayey SAND (SC-SM) with gravel TILL													
90.5	Compact Grey													
15.5	Moderately weathered BEDROCK - augered to 15.5 m													
	BEDROCK Limestone Slightly weathered Thinly to moderately bedded Fair Quality Grey		1	HQ			90							RUN #1 TCR=94% SCR=90% RQD=61%
							89							
			2	HQ										RUN #2 TCR=100% SCR=98% RQD=65%
							88							
			3	HQ			87							RUN #3 TCR=100% SCR=93% RQD=60%
86.3														
19.7	End of Borehole													

ONTMT4S GANARASKA RIVER BRIDGE.GPJ 2012TEMPLATE(MTO).GDT 24/4/18

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
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10

(%) STRAIN AT FAILURE

METRIC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa		W _P W W _L			
	Continued From Previous Page						20 40 60 80 100	○ UNCONFINED + FIELD VANE					
	Groundwater level was measured in open borehole at 14.0m BGS (elev. 92.0 m) on 2016/06/01						20 40 60 80 100	● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%)				
									20 40 60				

RECORD OF BOREHOLE No 403

1 OF 3

METRIC

GWP# 4078-14-00 LOCATION Site 21-231, MTM Zone 10: N 4 870 667.1 E 401 602.1 ORIGINATED BY JAG
 HWY 401 BOREHOLE TYPE Hollow Stem Auger / HQ Coring COMPILED BY JAG
 DATUM Geodetic DATE 2016.05.30 - 2016.05.30 CHECKED BY KCP

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					
								20 40 60 80 100					
103.3													
0.0	350 mm ASPHALT												
103.0													
0.3	Silty sand with gravel Compact to very dense Brown FILL		1	GS									
			2	SS	76								
			3	SS	105								
			4	SS	48								
			5	SS	42								
	-gravel and cobbles		6	SS	22								
			7	SS	13								
97.8													
5.5	Clay, trace sand Firm Brown to greyish-brown FILL		8	SS	9								
			9	SS	9								
			10	SS	8								
95.4			11	SS	9								
7.9	Silty sand some gravel Compact to dense Brown to greyish-brown FILL		12	SS	41								
			13	SS	24								
93.7													
9.6	Organic SILT (MH-OH) occasional wood pieces												

ONTMT4S GANARASKA RIVER BRIDGE.GPJ 2012TEMPLATE(MTO).GDT 24/4/18

Continued Next Page

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

RECORD OF BOREHOLE No 403

2 OF 3

METRIC

GWP# 4078-14-00 LOCATION Site 21-231, MTM Zone 10: N 4 870 667.1 E 401 602.1 ORIGINATED BY JAG
 HWY 401 BOREHOLE TYPE Hollow Stem Auger / HQ Coring COMPILED BY JAG
 DATUM Geodetic DATE 2016.05.30 - 2016.05.30 CHECKED BY KCP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
	Continued From Previous Page							20 40 60 80 100							
	Organic SILT (MH-OH) occasional wood pieces Loose to compact Grey to brown		14	SS	5		93								0 3 69 28
							92								
90.8			15	SS	9		91								
12.5	Silty SAND (SM) with gravel TILL Compact to very dense Brown to grey						90								
			16	SS	24		89								36 45 19 (SI+CL)
							88								
87.6			17	SS	100/175mm		87								RUN #1 TCR=100% SCR=83% RQD=42%
15.7	BEDROCK Limestone Moderately weathered to fresh Thinly to moderately bedded Poor to good quality Grey		1	HQ			86								RUN #2 TCR=100% SCR=100% RQD=75%
			2	HQ			85								
			3	HQ			84								RUN #3 TCR=100% SCR=100% RQD=91%
83.5															
19.8	End of Borehole														

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15 10 5 0
 (%) STRAIN AT FAILURE

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 404

1 OF 2

METRIC

GWP# 4078-14-00 LOCATION Site 21-231, MTM Zone 10: N 4 870 645.1 E 401 606.0 ORIGINATED BY JAG
 HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JAG
 DATUM Geodetic DATE 2016.01.06 - 2016.01.06 CHECKED BY KCP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					
								WATER CONTENT (%) P L W L					
103.4													
0.0	240 mm ASPHALT												
103.0													
0.3	Sand with silt and gravel Compact to dense Brown FILL		1	GS			103						
			2	SS	61		102						
			3	SS	67		101						
			4	SS	47		100						
			5	SS	47		99						
			6	SS	18		98						
			7	SS	18		97						
98.2			8	SS	8		96						
5.2	Clay Firm Brown FILL		9	SS	10		95						
			10	SS	14		94						
95.4			11	SS	21		93						
7.9	Sand with silt Compact Greyish-brown FILL		12	SS	26		92						
			13	SS	22		91						

Continued Next Page

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

RECORD OF BOREHOLE No 404

2 OF 2

METRIC

GWP# 4078-14-00 LOCATION Site 21-231, MTM Zone 10: N 4 870 645.1 E 401 606.0 ORIGINATED BY JAG
 HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JAG
 DATUM Geodetic DATE 2016.01.06 - 2016.01.06 CHECKED BY KCP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
								20 40 60 80 100							
								20 40 60 80 100							
93.3	Continued From Previous Page														
10.1	Organic SILT (MH-OH) Very loose to compact Dark brown		14	SS	3									0 3 74 23	
			15	SS	12										
90.9			16	SS	42										
12.5	SAND (SP) with gravel TILL Dense to very dense Brown to grey														
			17	SS	95										16 81 3 (SI+CL)
88.4															
14.9	Weathered Limestone BEDROCK - augered to 15.3 m		18	SS	100/										
88.1															
15.3	End of Borehole on inferred bedrock Groundwater level was measured in open borehole at 9.1 m BGS (elev. 94.3 m) on 2016/06/01				25mm										

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No GR22-01

1 OF 1

METRIC

GWP# 4068-14-00 LOCATION Lat: 43.9697101°, Long: -78.294713° Highway 401/ Ganaraska River, MTM z10: N 4 870 676.0 E 401 511.2 ORIGINATED BY JZL
 HWY 401 BOREHOLE TYPE Portable / NW Casing COMPILED BY AO
 DATUM Geodetic DATE 2022.04.13 - 2022.04.14 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	WATER CONTENT (%)					
98.7	Ground Surface						20	40	60	80	100						
0.0 98.4	TOPSOIL (255 mm)																
0.3	SILTY SAND some gravel Occasional Cobbles and Boulders Loose to compact Brown FILL		1	SS	7												
			2	SS	13												
			3	SS	26												
			4	SS	14												
95.8																	
2.9	SILTY SAND (SM) Occasional Cobbles and Boulders Very dense Brown		5	SS	100/ 125mm												
			6	SS	90												
			7	SS	100/ 225mm												
93.6																	
5.1	ORGANIC SILT Compact Dark grey		8	SS	24												
92.7																	
6.0	SILTY SAND with Gravel Dense Brown GLACIAL TILL		9	SS	44												
91.8																	
91.9 7.0	PROBABLE LIMESTONE BEDROCK		1	NO	-												
	End of Borehole Note: A half-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.																

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No GR22-02

1 OF 2

METRIC

GWP# 4068-14-00 LOCATION Lat: 43.969735°, Long: -78.294451° Highway 401/ Ganaraska River, MTM z10: N 4 870 679.1 E 401 532.2 ORIGINATED BY JZL
 HWY 401 BOREHOLE TYPE Portable / NW Casing / NQ Coring COMPILED BY AO
 DATUM Geodetic DATE 2022.04.12 - 2022.04.12 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%) W _P W W _L				
97.6	Ground Surface															
0.0 97.3	TOPSOIL (255 mm)															
0.3	SILTY SAND with gravel Occasional Cobbles Loose to very dense Brown FILL		1	SS	4											
			2	SS	19											
			3	SS	51											
95.4																
2.2	SAND (SP-SM) with silt Occasional Cobbles Very dense Brown-grey		4	SS	56											
			5	SS	54											
94.1																
3.5	ORGANIC SILT, Sandy Occasional wood fibres Loose to compact Dark grey		6	SS	9											
			7	SS	15											
92.3																
5.3	SILTY SAND with Gravel Occasional Cobbles Very dense Grey		8	SS	100/ 255mm											
91.5	GLACIAL TILL															
6.1	LIMESTONE BEDROCK Slightly weathered to fresh Grey Fine grained Thinly to medium bedded Strong to very strong		1	RUN	-											
			2	RUN	-											
			3	RUN	-											
			4	RUN	-											
			5	RUN	-											
			6	RUN	-											
88.2																
9.4	End of Borehole															

DOUBLE LINE 33059 - HWY 401 CHOATE AND GANARASKA DD.GPJ 2012TEMPLATE(MTO).GDT 22-9-2

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+³, ×³: Numbers refer to
Sensitivity

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15
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(%) STRAIN AT FAILURE

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No GR22-03

1 OF 2

METRIC

GWP# 4068-14-00 LOCATION Lat: 43.969796°, Long: -78.293898° Highway 401/ Ganaraska River, MTM z10: N 4 870 686.5 E 401 576.5 ORIGINATED BY JZL
 HWY 401 BOREHOLE TYPE Portable / NW Casing / NQ Coring COMPILED BY AO
 DATUM Geodetic DATE 2022.03.28 - 2022.03.28 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								WATER CONTENT (%)	
95.5	Ground Surface						20	40	60	80	100	20	40	60			
0.0	TOPSOIL (75mm) (frozen) SILTY SAND with organics frequent cobbles and boulders very dense FILL		1	SS	100/75mm												
0.1			2	SS	100/0mm												
94.0	ORGANIC SILT with sand Frequent Cobbles and Boulders to 2.1m Very stiff to firm Dark grey		3	SS	19								○				
1.5			4	SS	5									○		0 16 62 22	
			5	SS	6									○		Organic Content = 1.0%	
			6	SS	10									○			
			7	SS	25										○		
90.4			8	SS	10												15 40 33 12
5.1			SILTY SAND (SM) with gravel Frequent Cobbles and Boulders Dense Grey GLACIAL TILL		1	NQ	-										
	2	NQ			-												
	3	NQ			-												
89.0	LIMESTONE BEDROCK Moderately to slightly weathered Grey Fine grained Thinly to medium bedded Strong to very strong		4	RUN	-										FI	RUN #4 TCR=95% SCR=62% RQD=47%	
6.5			5	RUN	-											>10	RUN #5 TCR=59% SCR=35% RQD=22%
			6	RUN	-											5	RUN #6 TCR=100% SCR=85% RQD=37%
			7	RUN	-											10	RUN #7 TCR=97% SCR=90% RQD=18%
			8	RUN	-											4	RUN #8 TCR=87% SCR=75% RQD=0%
			9	RUN	-											10	RUN #9 TCR=100% SCR=100% RQD=63%
85.7																3	
9.8	End of Borehole																

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

METRIC

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+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No GR22-04

1 OF 2

METRIC

GWP# 4068-14-00 LOCATION Lat: 43.969844°, Long: -78.293631° Highway 401/ Ganaraska River, MTM z10: N 4 870 692.2 E 401 597.9 ORIGINATED BY JZL
 HWY 401 BOREHOLE TYPE Portable / NW Casing / NQ Coring COMPILED BY AO
 DATUM Geodetic DATE 2022.03.17 - 2022.03.18 CHECKED BY CM

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				
95.2	Ground Surface							20 40 60 80 100				
0.0	TOPSOIL (150 mm)							20 40 60 80 100				
0.2	CLAYEY SILT with sand Trace Organics Very stiff to stiff Dark brown-grey FILL		1	SS	10		95					
			2	SS	7		94					
93.7												
1.5	ORGANIC SILT Loose to dense Dark brown		3	SS	6		93					
			4	SS	9		92					
			5	SS	6		91					
			6	SS	34		90					
90.6												
4.6	SILTY SAND with Gravel Frequent Cobbles and Boulders Compact to very dense GLACIAL TILL		7	SS	16		89					
			8	SS	14		88					
			9	SS	100/ 25mm		87					
			10	SS	100/ 0mm		86					
87.8												
7.4	LIMESTONE BEDROCK Moderately weathered to fresh Grey Fine grained Thinly to medium bedded Strong to very strong		1	RUN	-							
			2	RUN	-							
			3	RUN	-							
			4	RUN	-							
			5	RUN	-							

DOUBLE LINE 33059 - HWY 401 CHOATE AND GANARASKA DD.GPJ 2012TEMPLATE(MTO).GDT 22-9-2

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+³, ×³: Numbers refer to
Sensitivity

20
15
10


(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No GR22-04

2 OF 2

METRIC

GWP# 4068-14-00 LOCATION Lat: 43.969844°, Long: -78.293631°
Highway 401/ Ganaraska River, MTM z10: N 4 870 692.2 E 401 597.9 ORIGINATED BY JZL
HWY 401 BOREHOLE TYPE Portable / NW Casing / NQ Coring COMPILED BY AO
DATUM Geodetic DATE 2022.03.17 - 2022.03.18 CHECKED BY CM





SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page							20	40	60	80	100					
	LIMESTONE BEDROCK		6	RUN	-		85										RQD=86% RUN #6 TCR=100% SCR=100%
84.7																	
10.5	End of Borehole																RQD=100%
	Note: A half-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.																

RECORD OF BOREHOLE No GR22-05

1 OF 1

METRIC

GWP# 4068-14-00 LOCATION Lat: 43.969564°, Long: -78.294415° Highway 401/ Ganaraska River, MTM z10: N 4 870 660.2 E 401 535.4 ORIGINATED BY JZL
 HWY 401 BOREHOLE TYPE Portable / NW Casing COMPILED BY AO
 DATUM Geodetic DATE 2022.04.11 - 2022.04.11 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						WATER CONTENT (%) w _p w w _L				
98.1	Ground Surface							20	40	60	80	100						
0.0	SILTY SAND with Gravel Occasional Cobbles Loose to compact Brown FILL		1	SS	5		98											
			2	SS	13		97											
			3	SS	33		96											
			4	SS	100/ 280mm													
95.1																		
3.0	SAND (SW-SM) with silt, some Gravel Dense to loose Grey		5	SS	100/ 150mm		95											
			6	SS	38		94											
			7	SS	10		93											
			8	SS	10		92											
			9	SS	6													
91.3																		
6.8	ORGANIC SILT, frequent Cobbles Very dense Dark grey		10	SS	100/ 255mm		91											
90.8																		
7.3	PROBABLE LIMESTONE BEDROCK		1	NQ	-													
90.3																		
7.8	End of Borehole Note: A half-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.																	

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

RECORD OF BOREHOLE No GR22-06

1 OF 1

METRIC

GWP# 4068-14-00 LOCATION Lat: 43.969611°, Long: -78.29386°
Highway 401/ Ganaraska River, MTM z10: N 4 870 666.1 E 401 579.9 ORIGINATED BY JZL
HWY 401 BOREHOLE TYPE Portable / NW Casing COMPILED BY AO
DATUM Geodetic DATE 2022.03.31 - 2022.03.31 CHECKED BY CM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80	100	W _P	W					
97.2	Ground Surface																		
0.0	SANDY CLAYEY SILT Occasional rock fragments Compact to loose Brown FILL		1	SS	18												2 35 63 (SI+CL)		
			2	SS	8														
95.7																			
1.5	SAND with silt Loose Brown FILL		3	SS	9													0 93 7 (SI+CL)	
			4	SS	8														
94.2																			
3.0	SAND with gravel, probable voids Occasional wood pieces Very loose Grey FILL		5	SS	1														
			6	SS	WH														
92.6																			
4.6	SILTY SAND (SM) trace gravel Compact to very dense Brown to grey GLACIAL TILL		7	SS	24														
			8	SS	30												9 67 24 (SI+CL)		
			9	SS	100/ 150mm														
	-Frequent Cobbles and Boulders below 6.2m																		
90.1																			
7.1	PROBABLE LIMESTONE BEDROCK		1	NQ	-														
89.5																			
7.7	End of Borehole																		
	Note: A half-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.																		

DOUBLE LINE 33059 - HWY 401 CHOATE AND GANARASKA DD.GPJ 2012TEMPLATE(MTO).GDT 22-9-2

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

RECORD OF BOREHOLE No GR22-07

1 OF 2

METRIC

GWP# 4068-14-00 LOCATION Lat: 43.969391°, Long: -78.2943901°
Highway 401/ Ganaraska River, MTM z10: N 4 870 641.0 E 401 537.7 ORIGINATED BY JZL
HWY 401 BOREHOLE TYPE Portable / NW Casing / NQ Coring COMPILED BY AO
DATUM Geodetic DATE 2022.04.06 - 2022.04.06 CHECKED BY CM

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												
97.9	Ground Surface							20	40	60	80	100								
0.0	CLAYEY SILT, sandy Occasional Rock fragments Compact to dense Brown FILL		1	SS	18															
			2	SS	18															
			3	SS	100/ 280mm															
95.6																				
2.3	SAND (SW-SM) with silt, some gravel Very dense to compact Grey-brown		4	SS	100/ 280mm															
			5	SS	100/ 280mm															
			6	SS	19															
			7	SS	18															
92.7																				
5.2	SILTY SAND (SM) some gravel Loose to compact Grey GLACIAL TILL		8	SS	9															
			9	SS	5															
			10	SS	12															
90.5																				
7.4	LIMESTONE BEDROCK Slightly weathered to fresh Grey Fine grained Thinly to medium bedded Strong to very strong		1	RUN	-															
			2	RUN	-															
			3	RUN	-															
			4	RUN	-															
			5	RUN	-															

Continued Next Page

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

METRIC

SOIL PROFILE					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES	GROUND WATER CONDITIONS	ELEVATION SCALE
			NUMBER	TYPE	"N" VALUES
	Continued From Previous Page				
	LIMESTONE BEDROCK		6	RUN	-
87.2					
10.7	End of Borehole				
	Monitoring well installed consists of 38-mm diameter Schedule 40 PVC pipe with a 1.5-m slotted screen.				
	Water level readings: DATE DEPTH (m) ELEV. (m) 2022.04.11 4.1 93.3				
	Note: A half-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.				

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No GR22-08

1 OF 2

METRIC

GWP# 4068-14-00 LOCATION Lat: 43.969442°, Long: -78.293825° Highway 401/ Ganaraska River, MTM z10: N 4 870 647.3 E 401 582.9 ORIGINATED BY JZL
 HWY 401 BOREHOLE TYPE Portable / NW Casing / NQ Coring COMPILED BY AO
 DATUM Geodetic DATE 2022.04.01 - 2022.04.01 CHECKED BY CM

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						
96.7	Ground Surface							20	40	60	80	100		
0.0	SILTY SAND with Gravel Occasional Rock fragments Loose to dense Brown FILL		1	SS	100/ 0mm									
			2	SS	18		96							
			3	SS	37		95							18 59 23 (SI+CL)
			4	SS	7		94							
93.7														
3.0	SILTY SAND (SM) Dense to compact Brown-grey		5	SS	35		93							
			6	SS	11		92							3 84 4 9
91.8														
4.9	GRAVEL with Sand trace Silt Loose to very dense Grey GLACIAL TILL		7	SS	5		91							
			8	SS	100/ 25mm									
90.1														
6.6	LIMESTONE BEDROCK Moderately weathered Grey Fine grained Thinly to medium bedded Strong to very strong		1	RUN	-		90							RUN #1 TCR=100% SCR=65% RQD=0%
			2	RUN	-									RUN #2 TCR=50% SCR=25% RQD=0%
			3	RUN	-									RUN #3 TCR=100% SCR=100% RQD=0%
			4	RUN	-		89							RUN #4 TCR=92% SCR=85% RQD=42%
			5	RUN	-									RUN #5 TCR=74% SCR=66% RQD=31%
			6	RUN	-		88							RUN #6 TCR=96% SCR=96% RQD=84%
			7	RUN	-		87							RUN #7 TCR=44% SCR=46%

Continued Next Page

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

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

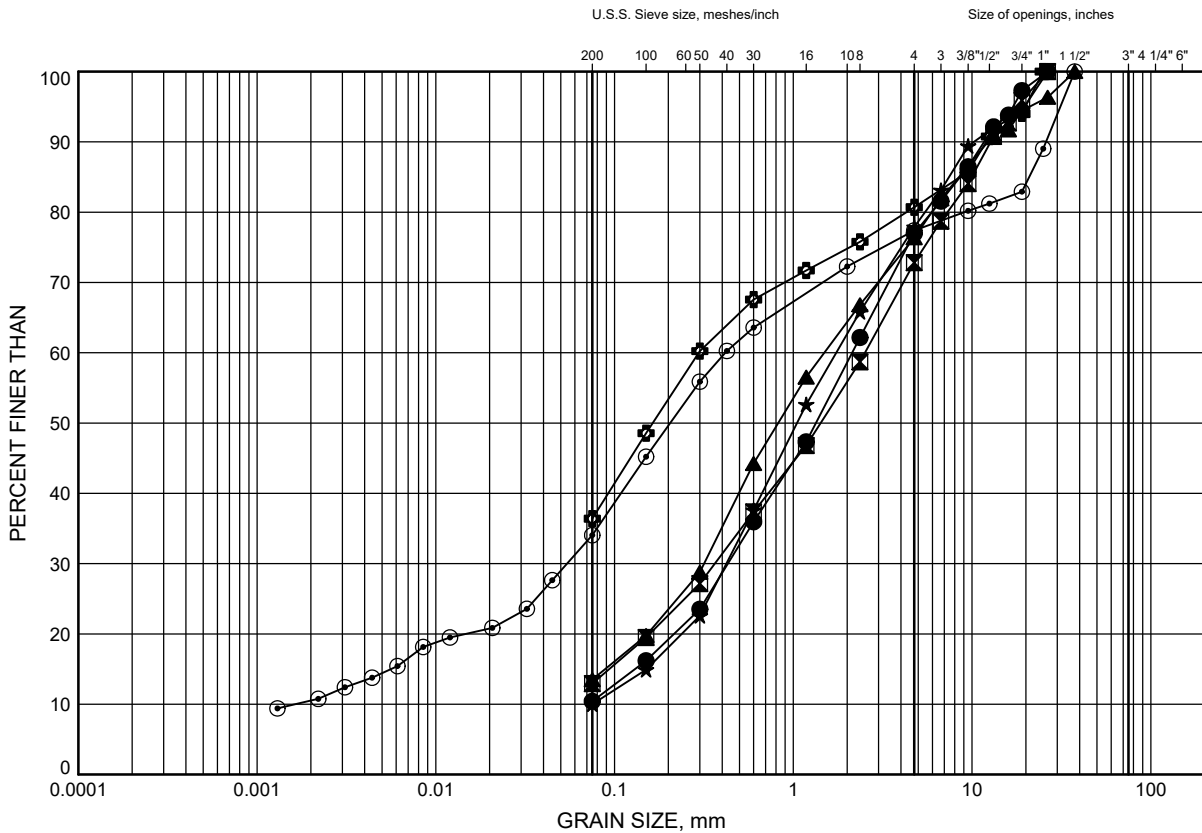


Appendix C Laboratory Testing

Particle Size Analysis Figures
Atterberg Limits Figures
Unconfined Compressive Strength Testing Results
Analytical Testing Results
Bedrock Core Photographs

GRAIN SIZE DISTRIBUTION

FILL: Silty Sand with Gravel



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	401	1.1	104.9
⊠	402	4.1	101.9
▲	403	2.6	100.7
★	404	3.4	100.0
⊙	GR22-01	1.8	96.9
⊕	GR22-02	1.1	96.5

Date September 2022

GWP# 4068-14-00

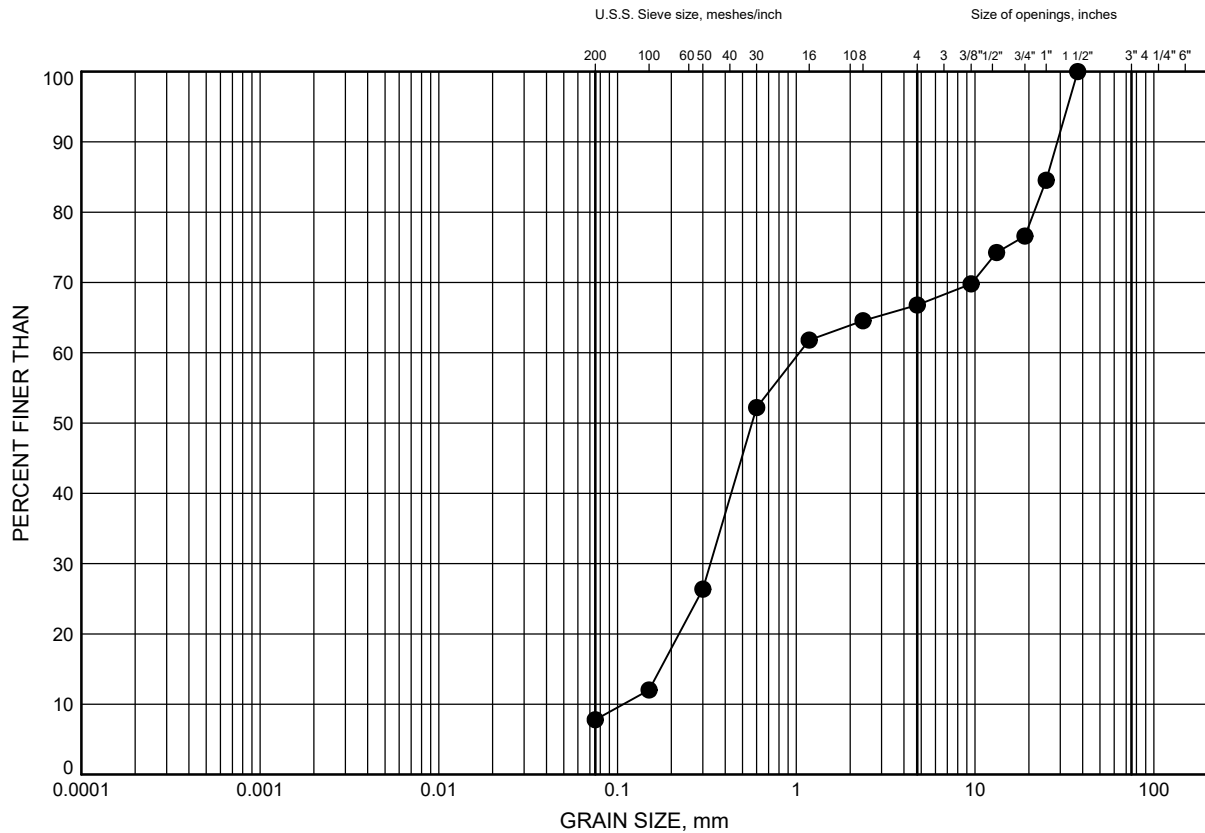


Prep'd AO

Chkd. CM

GRAIN SIZE DISTRIBUTION

FILL: Silty Sand with Gravel



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	GR22-08	1.8	94.9

Date September 2022

GWP# 4068-14-00

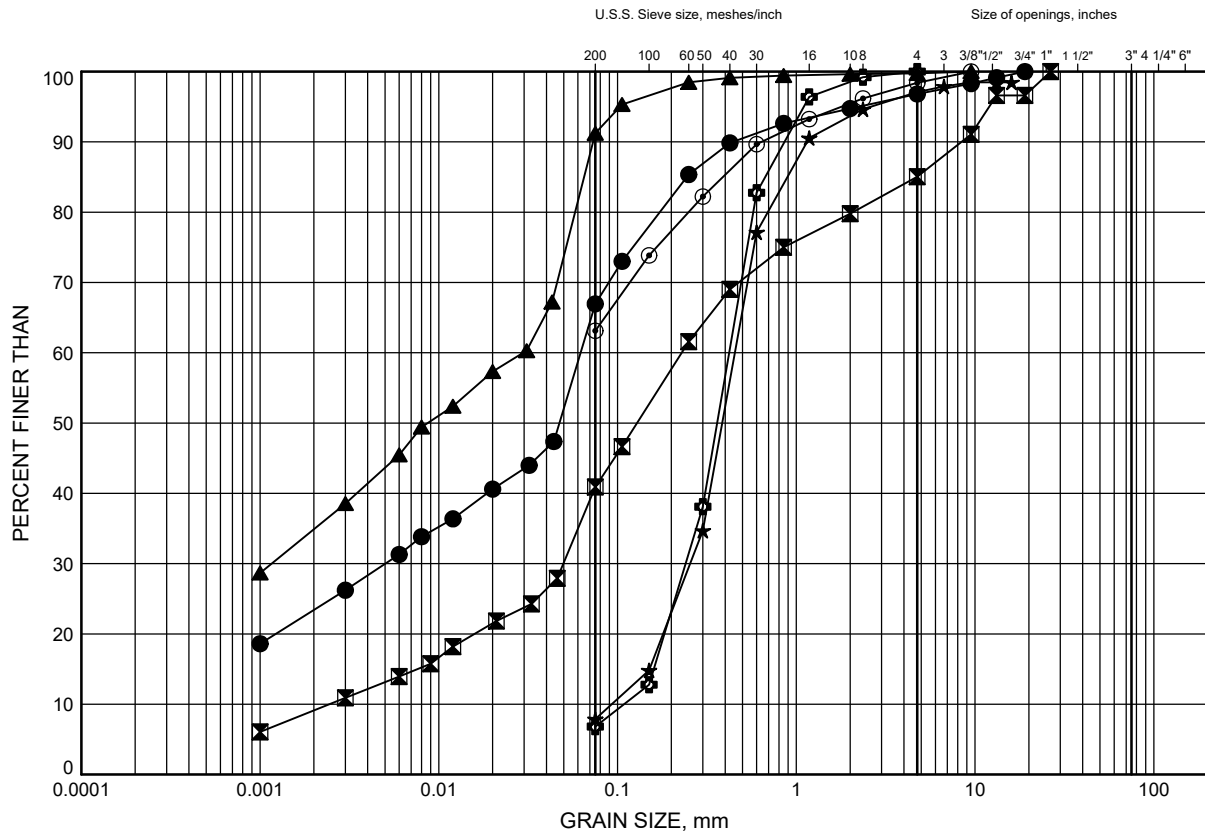


Prep'd AO

Chkd. CM

GRAIN SIZE DISTRIBUTION

FILL: Variable



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	401	7.2	98.8
⊠	402	8.7	97.3
▲	403	6.4	96.9
★	404	9.4	93.9
⊙	GR22-06	0.3	96.9
⊕	GR22-06	1.8	95.4

Date September 2022

GWP# 4068-14-00

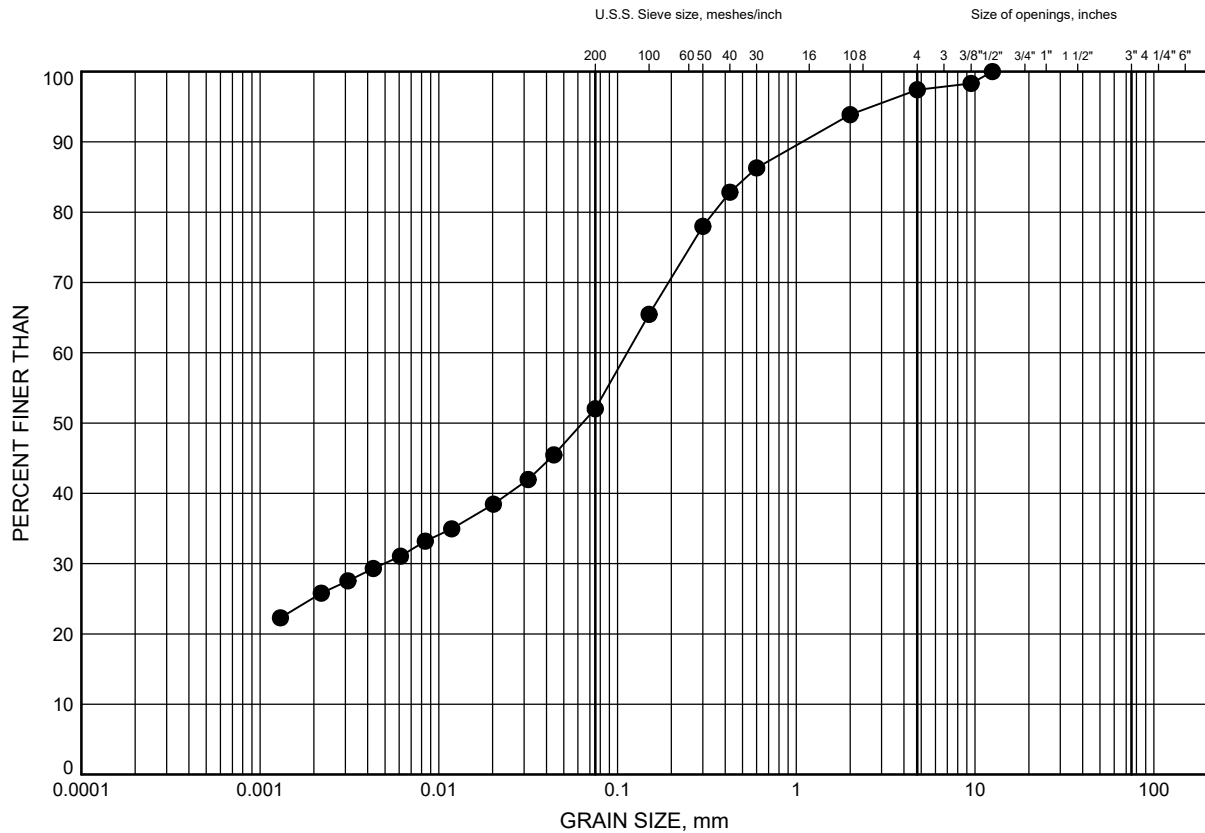


Prep'd AO

Chkd. CM

GRAIN SIZE DISTRIBUTION

FILL: Variable



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	GR22-07	1.1	96.8

Date September 2022

GWP# 4068-14-00

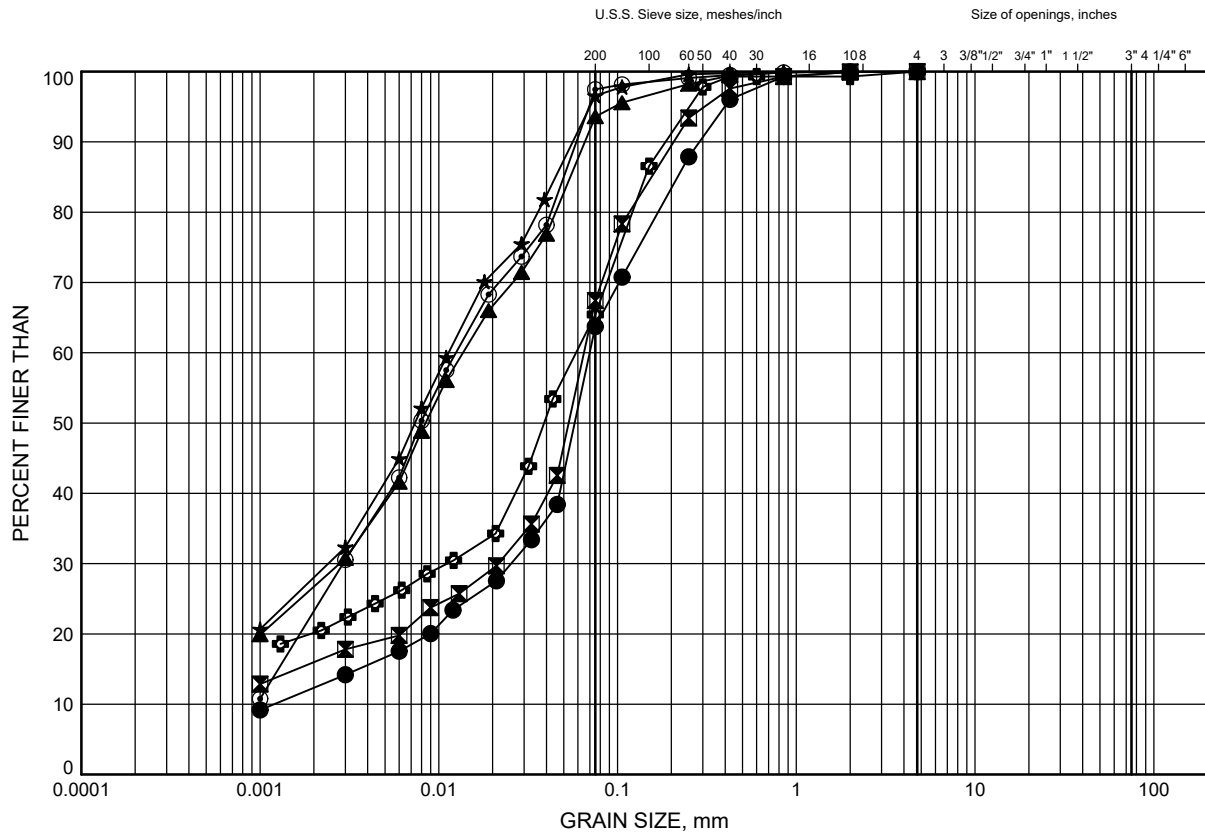


Prep'd AO

Chkd. CM

GRAIN SIZE DISTRIBUTION

Organic Silt (ML-OL to MH-OH)



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	401	12.6	93.3
⊠	401	14.0	92.0
▲	402	14.0	92.0
★	403	11.0	92.3
⊙	404	11.0	92.4
⊕	GR22-02	4.9	92.7

Date September 2022

GWP# 4068-14-00

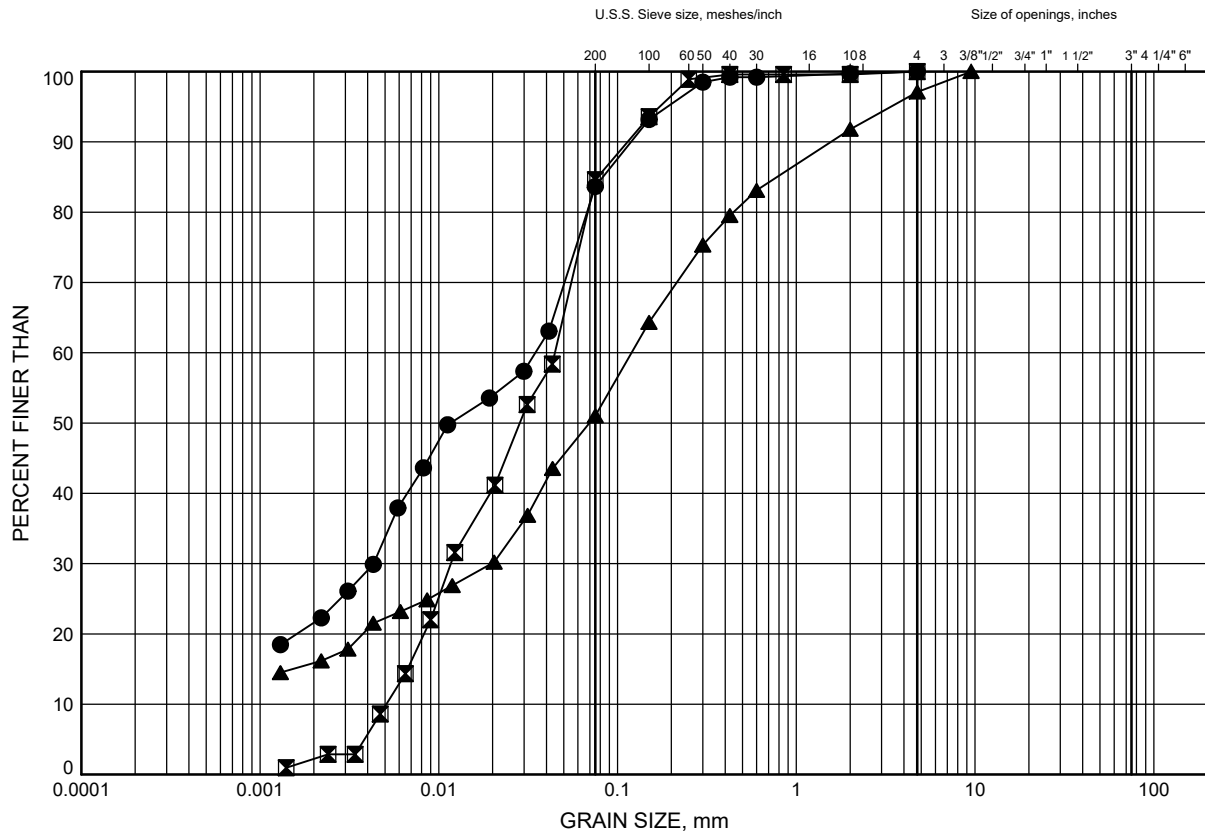


Prep'd AO

Chkd. CM

GRAIN SIZE DISTRIBUTION

Organic Silt (ML-OL to MH-OH)



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	GR22-03	2.6	92.9
⊠	GR22-04	1.8	93.4
▲	GR22-05	7.1	91.0

Date September 2022

GWP# 4068-14-00

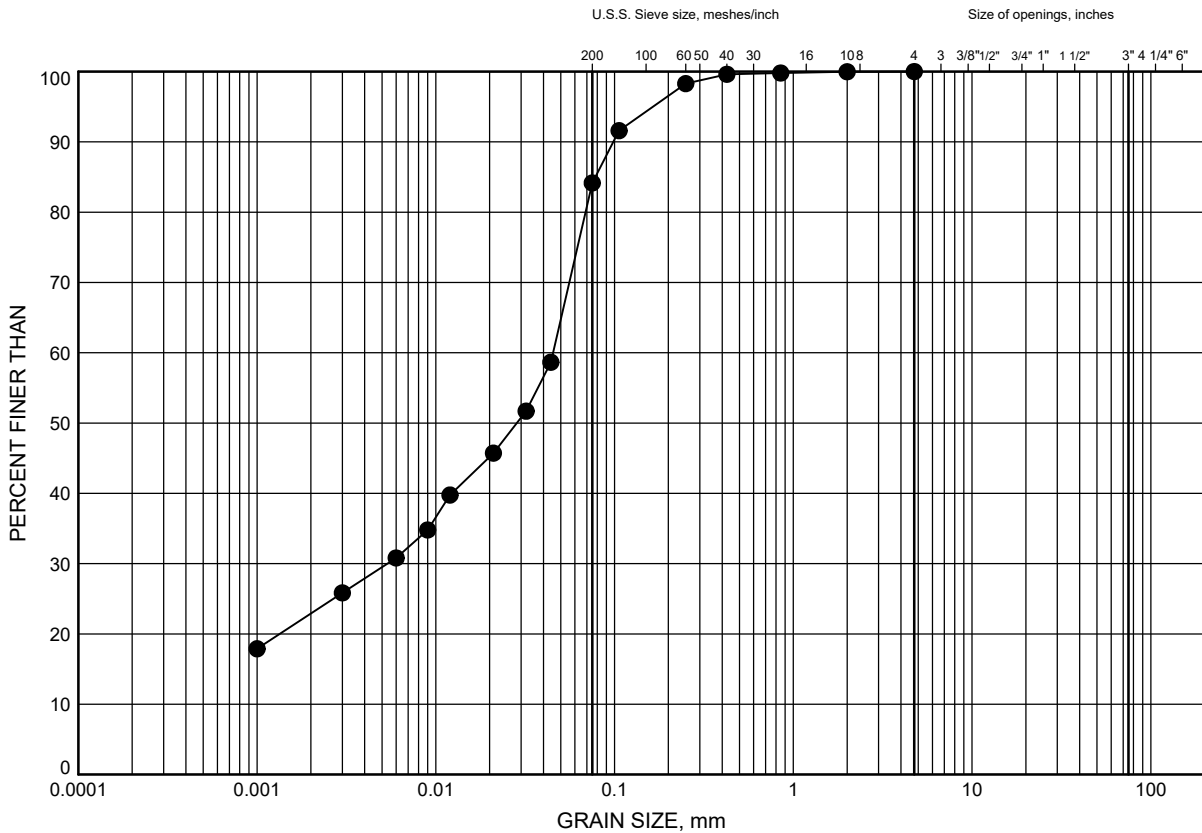


Prep'd AO

Chkd. CM

GRAIN SIZE DISTRIBUTION

Clayey Silt (CL)



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	402	14.6	91.4

Date September 2022

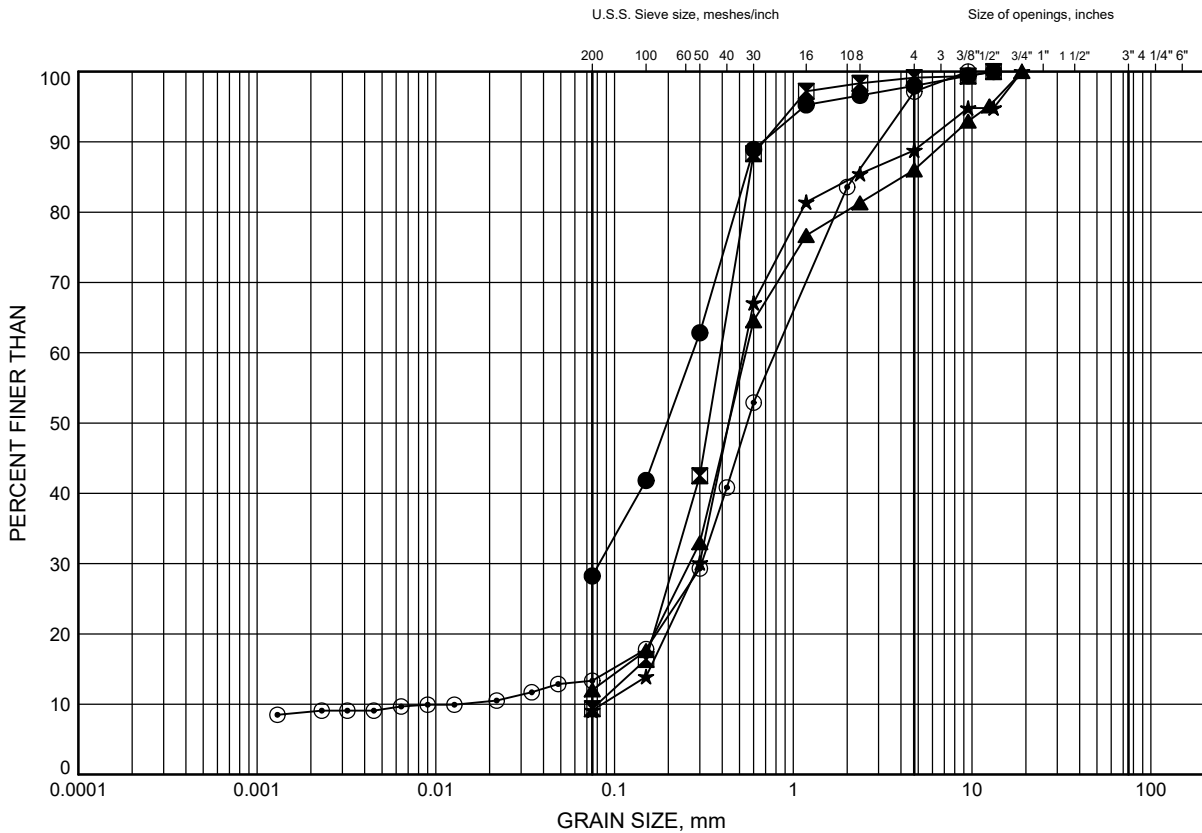
GWP# 4068-14-00



Prep'd AO

Chkd. CM

Silty Sand to Sand with silt (SM to SP-SM to SW-SM)



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	GR22-01	4.1	94.6
⊠	GR22-02	2.6	95.0
▲	GR22-05	4.1	94.0
★	GR22-07	4.9	93.0
⊙	GR22-08	4.4	92.3

Date September 2022

GWP# 4068-14-00

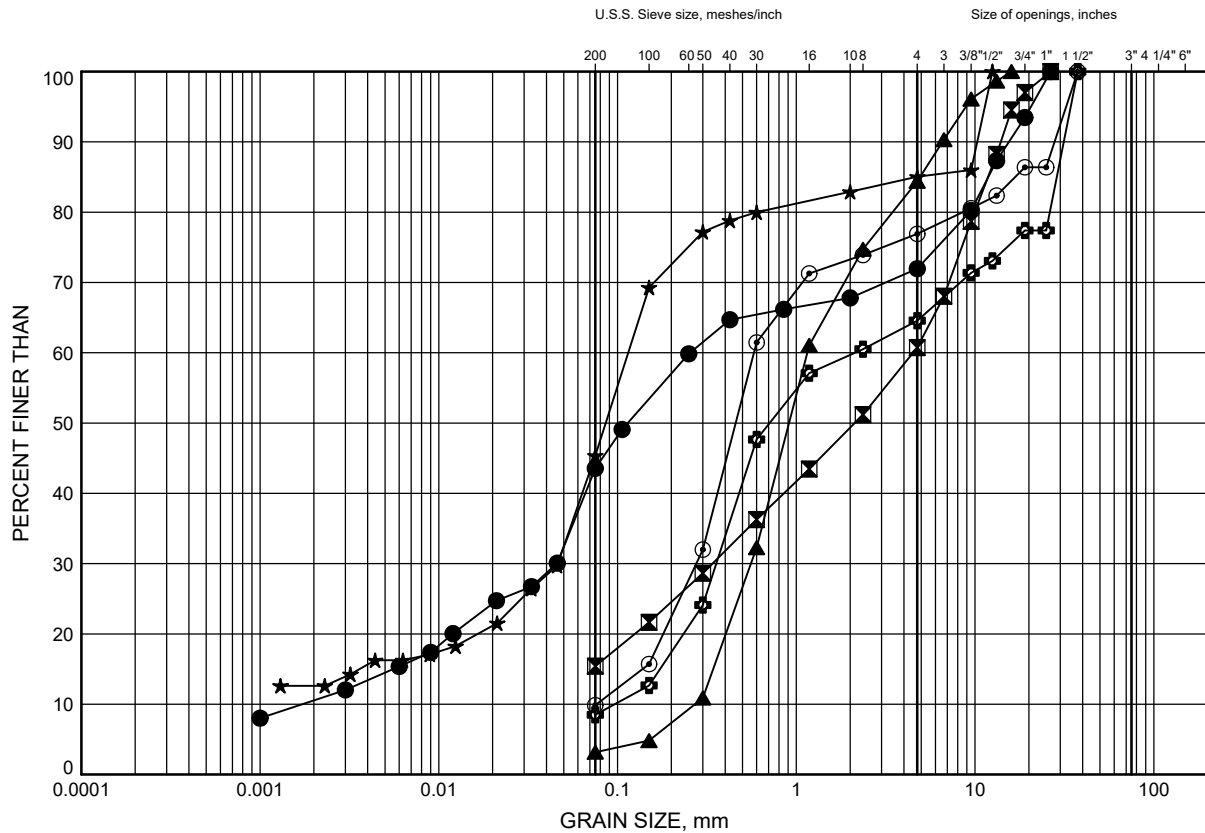


Prep'd AO

Chkd. CM

GRAIN SIZE DISTRIBUTION

Glacial Till



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	402	14.9	91.1
⊠	403	14.0	89.3
▲	404	13.7	89.7
★	GR22-03	5.1	90.4
⊙	GR22-06	5.6	91.6
⊕	GR22-07	6.4	91.5

Date September 2022

GWP# 4068-14-00



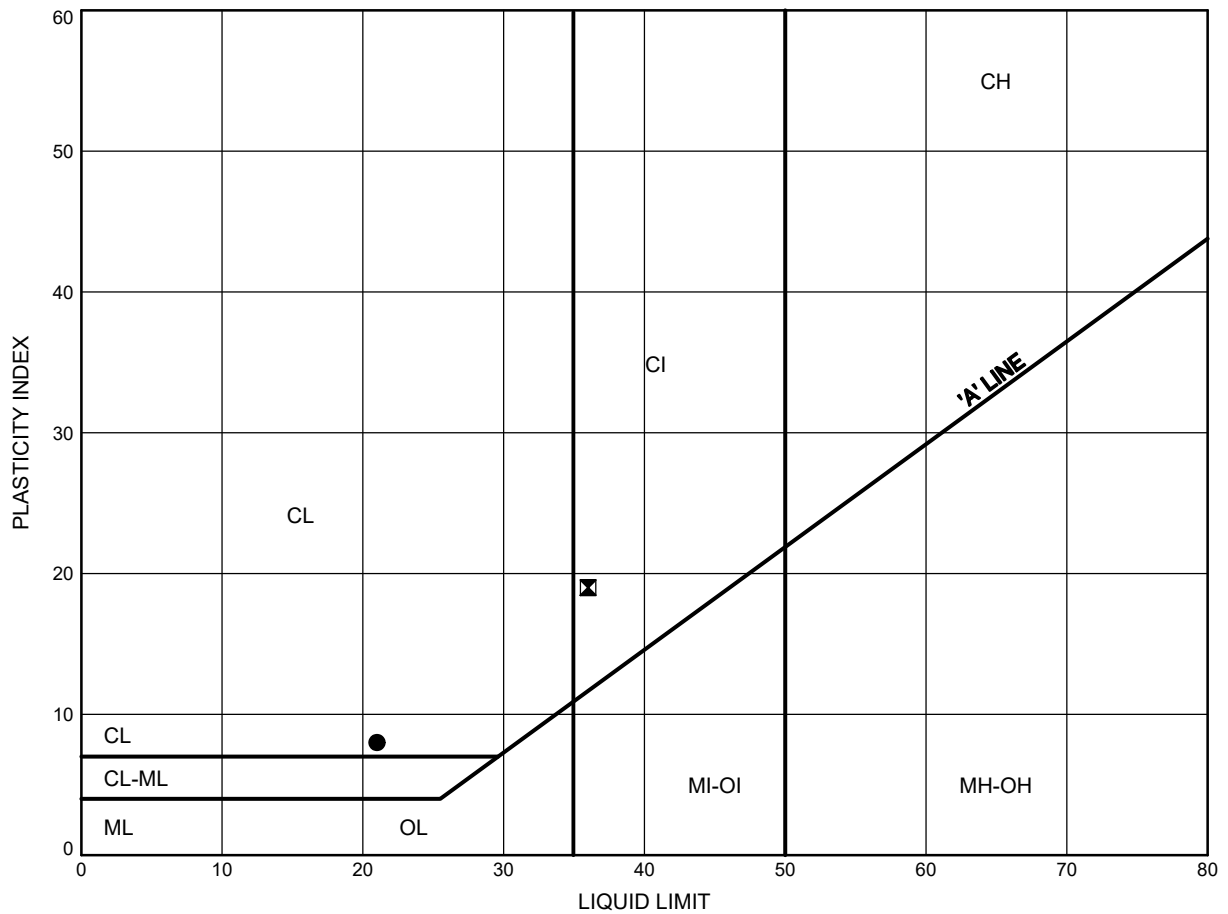
Prep'd AO

Chkd. CM

Highway 401 Choate and Ganaraska Detailed Design ATTERBERG LIMITS TEST RESULTS

FIGURE C10

Fill: Variable



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	401	7.2	98.8
⊠	403	6.4	96.9

Date September 2022

GWP# 4068-14-00



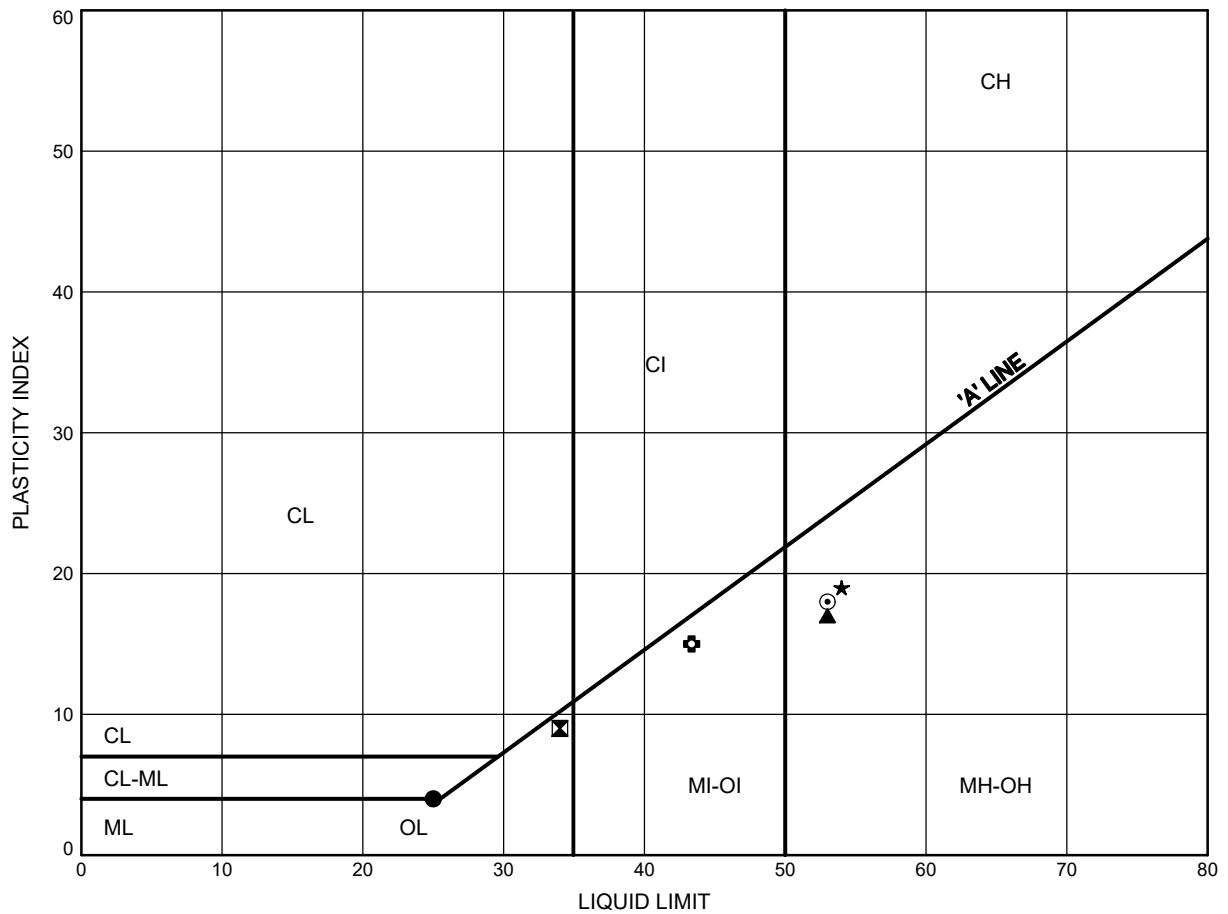
Prep'd AO

Chkd. CM

Highway 401 Choate and Ganaraska Detailed Design
ATTERBERG LIMITS TEST RESULTS

FIGURE C11

Organic Silt (ML-OL to MH-OH)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	401	12.6	93.3
⊠	401	14.0	92.0
▲	402	14.0	92.0
★	403	11.0	92.3
⊙	404	11.0	92.4
⊕	GR22-04	1.8	93.4

Date September 2022

GWP# 4068-14-00



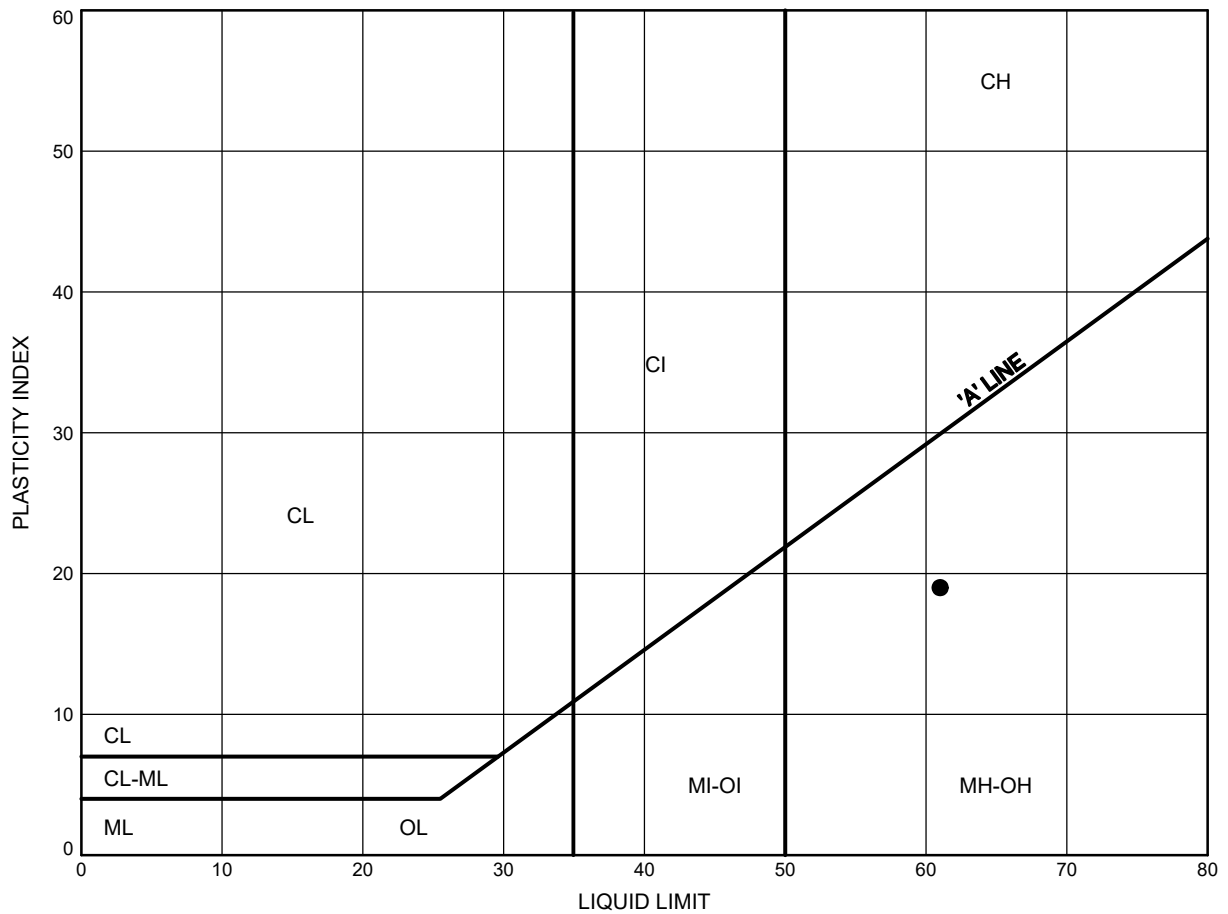
Prep'd AO

Chkd. CM

Highway 401 Choate and Ganaraska Detailed Design
ATTERBERG LIMITS TEST RESULTS

FIGURE C12

Organic Silt (ML-OL to MH-OH)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	GR22-04	2.6	92.6

Date September 2022

GWP# 4068-14-00



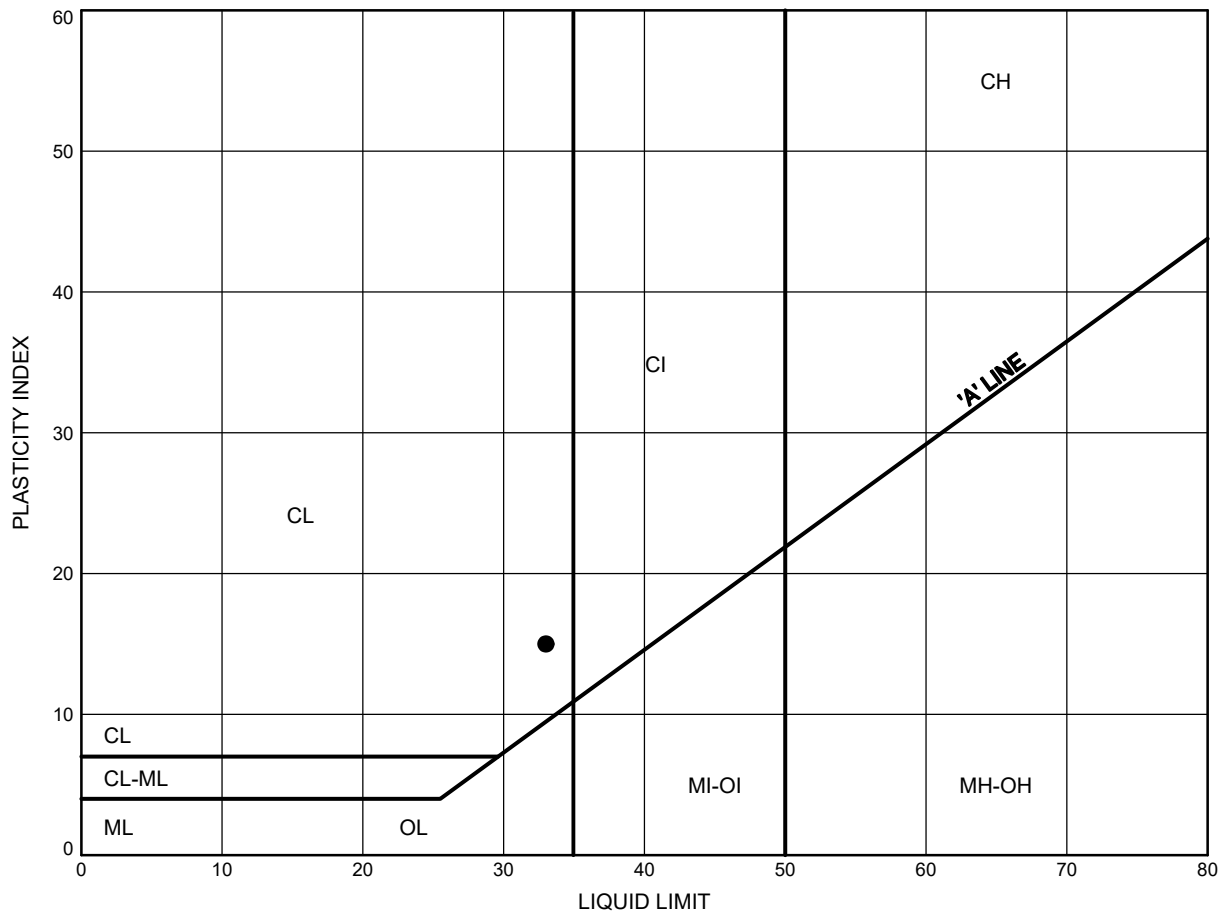
Prep'd AO

Chkd. CM

Highway 401 Choate and Ganaraska Detailed Design ATTERBERG LIMITS TEST RESULTS

FIGURE C13

Clay (CL)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	402	14.6	91.4

Date September 2022

GWP# 4068-14-00



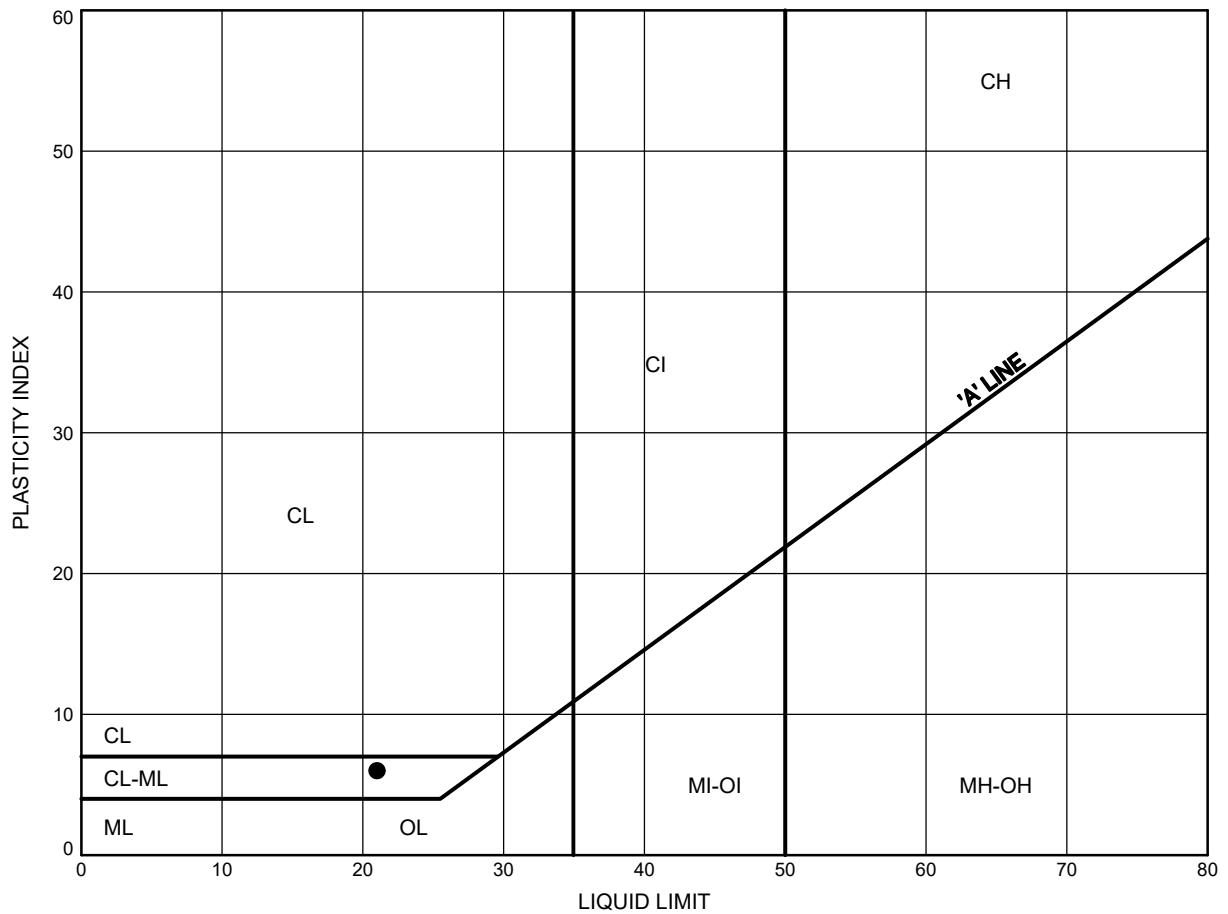
Prep'd AO

Chkd. CM

Highway 401 Choate and Ganaraska Detailed Design ATTERBERG LIMITS TEST RESULTS

FIGURE C14

Glacial Till



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	402	14.9	91.1

Date September 2022

GWP# 4068-14-00



Prep'd AO

Chkd. CM

Certificate of Analysis

Thurber Engineering Ltd.

2460 Lancaster Rd, Suite 104
Ottawa, ON K1B4S5
Attn: Chris Murray

Client PO:
Project: 19-5161-263
Custody: 27349

Report Date: 15-Jun-2016
Order Date: 13-Jun-2016

Order #: 1625054

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1625054-01	301 SS3 (5'-7')
1625054-02	304 SS4 (7'6"-9'6")
1625054-03	401 SS4 (7'6"-9'6")
1625054-04	403 SS3 (5'-7')

Approved By:



Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO:

Report Date: 15-Jun-2016
Order Date: 13-Jun-2016
Project Description: 19-5161-263

Client ID:		301 SS3 (5'-7')	304 SS4 (7'6"-9'6")	401 SS4 (7'6"-9'6")	403 SS3 (5'-7')
Sample Date:		31-May-16	01-Jun-16	31-May-16	30-May-16
Sample ID:		1625054-01	1625054-02	1625054-03	1625054-04
MDL/Units		Soil	Soil	Soil	Soil
Physical Characteristics					
% Solids	0.1 % by Wt.	90.5	91.9	95.2	97.5
General Inorganics					
Conductivity	5 uS/cm	1220	1260	782	1210
pH	0.05 pH Units	8.21	8.35	8.44	8.31
Resistivity	0.10 Ohm.m	8.17	7.96	12.8	8.26
Anions					
Chloride	5 ug/g dry	650	670	365	758
Sulphate	5 ug/g dry	27	48	21	76



FINAL REPORT

CA40013-APR22 R1

Client: Thurber Engineering Ltd.

Project: 33099,

Project Manager: Chris Murray

Samplers: Joe (Zhou) Lin

MATRIX: SOIL

Sample Number	5	6
Sample Name	HF-22-06-SS43	GR22-04-SS4
Sample Matrix	Soil	Soil
Sample Date	5/03/2022	15/03/2022

Parameter	Units	RL	Result	Result
Corrosivity Index				
Corrosivity Index	none	1	14	4
Soil Redox Potential	mV	no	237	169
Sulphide (Na2CO3)	%	0.04	< 0.04	< 0.04
pH	pH Units	0.05	8.51	7.15
Resistivity (calculated)	ohms.cm	-9999	1100	2240
General Chemistry				
Conductivity	uS/cm	2	905	447
Metals and Inorganics				
Moisture Content	%	0.1	20.0	38.0
Sulphate	µg/g	0.4	25	140
Other (ORP)				
Chloride	µg/g	0.4	510	290



FINAL REPORT

CA40225-JUL22 R1

Client: Thurber Engineering Ltd.

Project: 33099, Hwy 401 Choate and Ganaraska DD

Project Manager: Chris Murray

Samplers: Joe Lin

MATRIX: SOIL

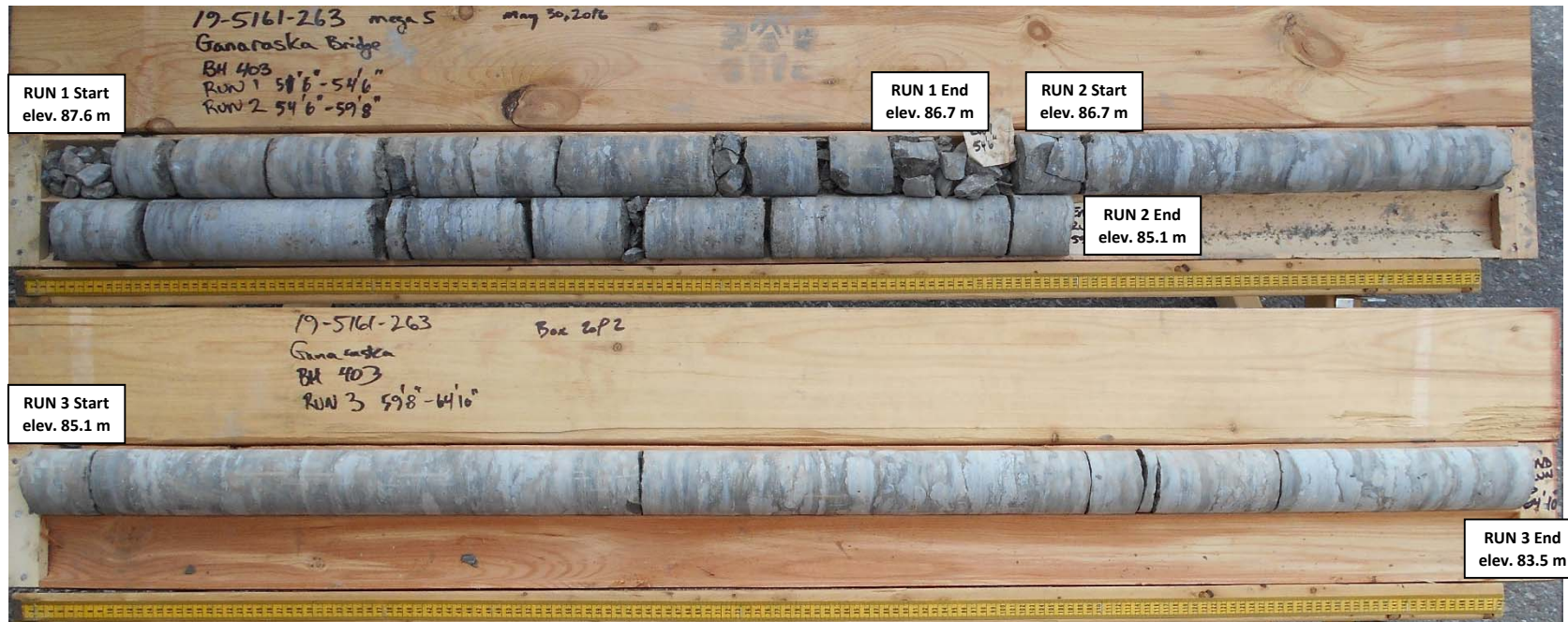
Sample Number	5	6	7	8	9	10	11	12
Sample Name	CR22-01 SS3 5'-7'	GR22-02 SS6 12'6"-14'6"	GR22-03 SS5 10'12'	GR22-07 SS5 10'-12'	GR22-08 SS5 10'-12'	DC22-05 SS10 30'-23'	DC22-07 SS3 5'-7'	DC22-11 SS10 25'27"
Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	17/05/2022	12/04/2022	28/03/2022	06/04/2022	11/04/2022	02/06/2022	19/05/2022	25/05/2022

Parameter	Units	RL	Result	Result	Result	Result	Result	Result	Result	Result
Corrosivity Index										
Corrosivity Index	none	1	14	6	9	14	9	6	4	4
Soil Redox Potential	mV	no	314	279	191	272	287	284	279	227
Sulphide (Na2CO3)	%	0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
pH	pH Units	0.05	8.34	7.57	8.00	8.67	8.75	8.41	8.34	8.77
Resistivity (calculated)	ohms.cm	-9999	1150	1820	1610	719	2090	2470	7630	4600
General Chemistry										
Conductivity	uS/cm	2	867	550	622	1390	479	405	131	222
Metals and Inorganics										
Moisture Content	%	0.1	22.6	30.5	20.6	9.7	12.2	17.0	8.4	10.2
Sulphate	µg/g	0.4	17	46	66	11	16	5.4	12	67
Other (ORP)										
Chloride	µg/g	0.4	340	170	160	330	89	5.4	13	8.4

Borehole 402
RUN 1 to 3 (of 3)
Elevation 90.5 m to 86.3 m



Borehole 403
RUN 1 to 3 (of 3)
Elevation 87.6 m to 83.5 m

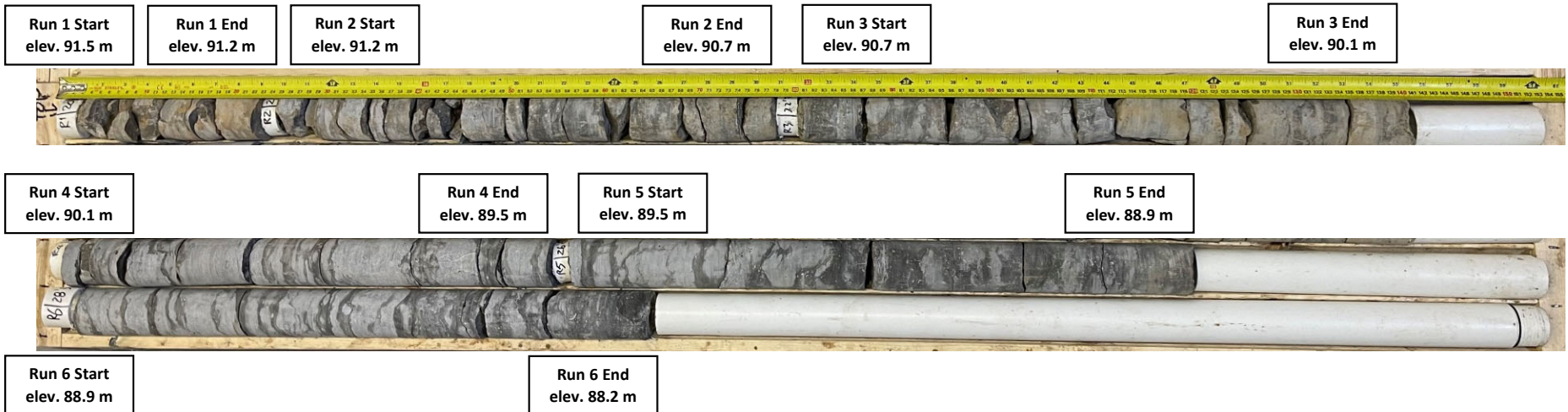


Borehole GR22-02

Runs 1 to 6

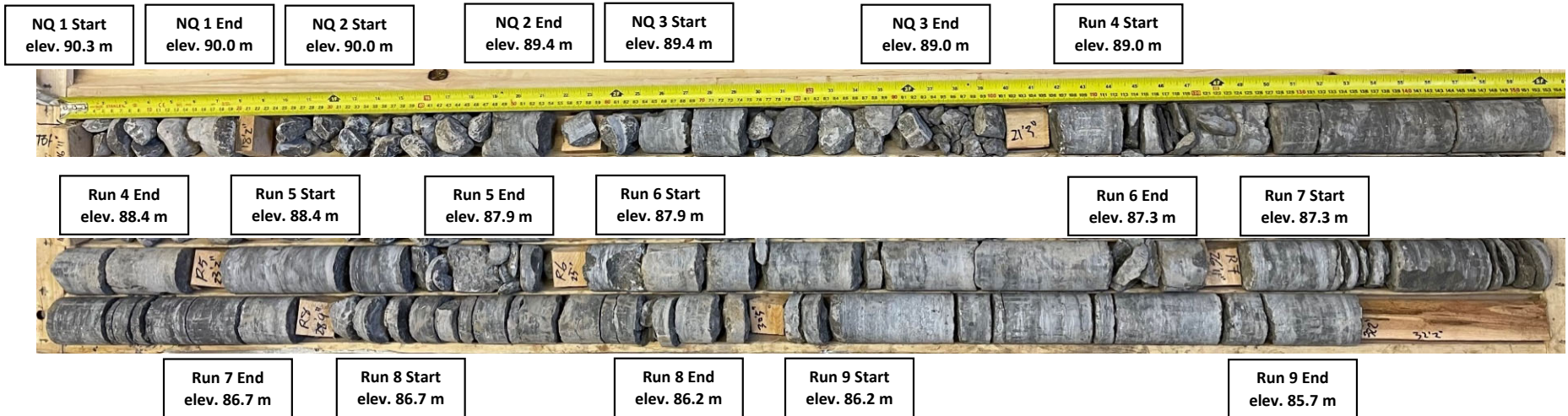
Depth 6.1 to 9.4 m

Elevation 91.5 to 88.2 m



Borehole GR22-03

NQ 1 to NQ3; Runs 4 to 9
Depth 5.1 to 9.8 m
Elevation 90.3 to 85.7 m

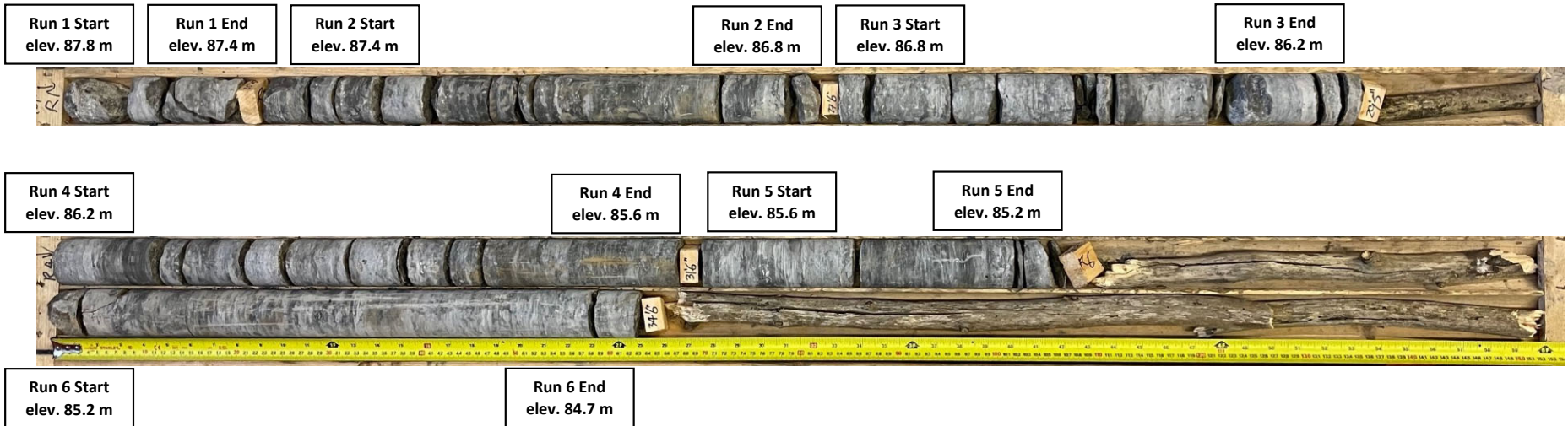


Borehole GR22-04

Runs 1 to 6

Depth 7.4 to 10.5 m

Elevation 87.8 to 84.7 m



THURBER ENGINEERING LTD.

Geotechnical Investigation
Highway 401 – Ganaraska River Bridge
Site 21X-0231/B0
Port Hope, Ontario

GWP: 4068-14-00
BH GR22-04
Project No.: 33099

Borehole GR22-05

NQ 1

Depth 7.3 to 7.8 m

Elevation 90.8 to 90.3 m

NQ 1 Start
elev. 90.8 m

NQ 1 End
elev. 90.3 m



Borehole GR22-06
NQ 1
Depth 7.1 to 7.7 m
Elevation 90.1 to 89.5 m

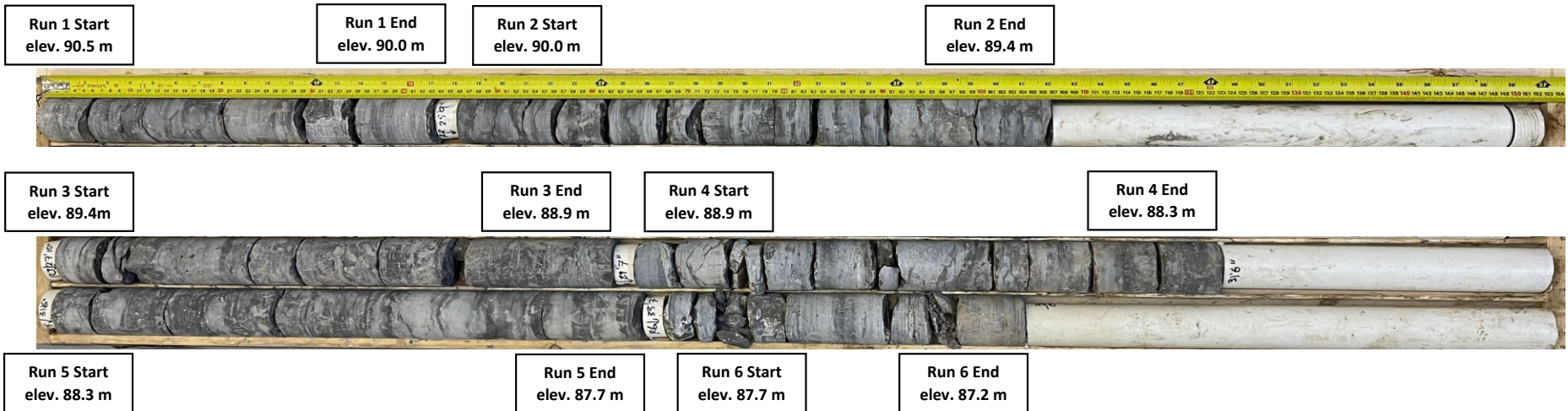
Run 1 Start
elev. 90.1 m

Run 1 End
elev. 89.5 m



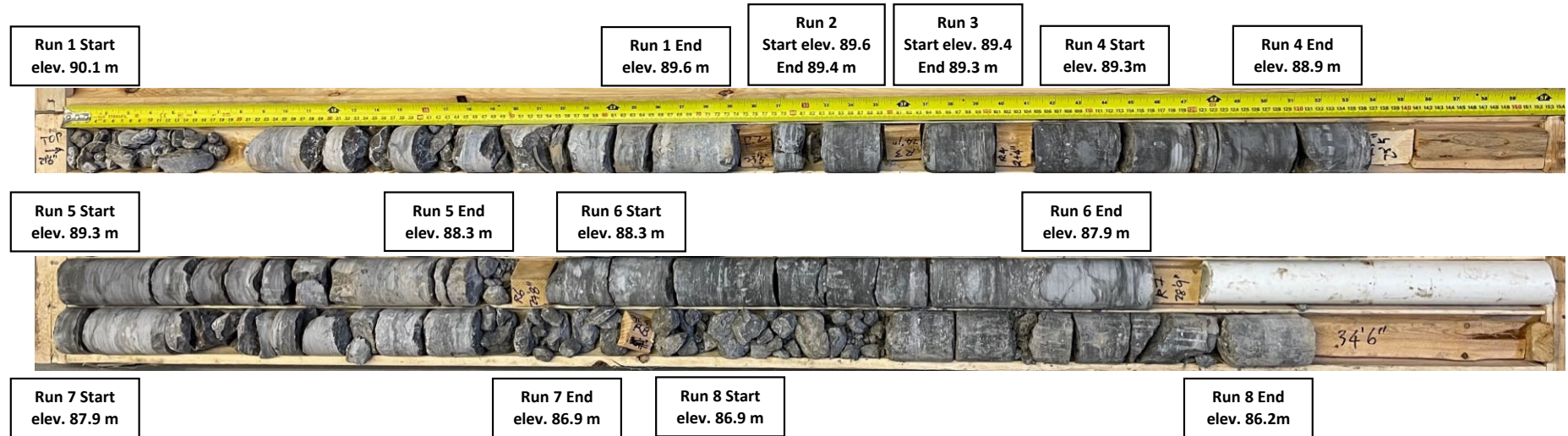
Borehole GR22-07

Runs 1 to 6
Depth 7.4 to 10.7 m
Elevation 90.5 to 87.2 m



Borehole GR22-08

Runs 1 to 8
Depth 6.6 to 10.5 m
Elevation 90.1 to 86.2 m



UNCONFINED COMPRESSION TEST REPORT

ASTM D7012-14

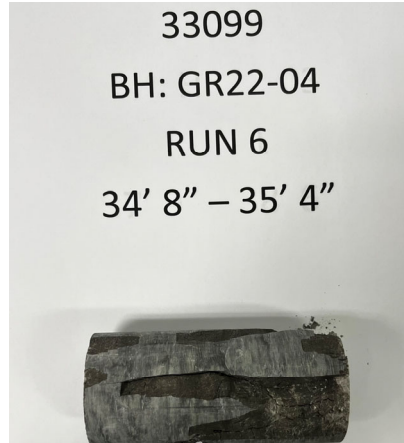
CLIENT:	McIntosh Perry	FILE NUMBER:	33099
PROJECT NAME:	Hwy 401 Choate & Ganaraska	REPORT DATE:	29-Aug-22
BOREHOLE No.:	GR22-04	TEST DATE:	16-Aug-22
SAMPLE No.:	Run 6		
SAMPLE DEPTH:	34' 8" - 35' 4"		
DESCRIPTION:	Limestone		

Avg. Height (cm):	10.7	Weight (g):	568.5
Avg. Diameter (cm):	5.1	Wet Density (kg/m ³):	2,653
H. to Dia. Ratio**:	2.1:1	Dry Density (kg/m ³):	2,642
Cross Sectional Area (cm ²):	20.03	Moisture Content* (%):	0.4
Sample Volume (cm ³):	214.32		

ORIGINAL SPECIMEN



FRACTURED SPECIMEN



AVG. RATE OF STRAIN TO FAILURE:	0.250 MPa/s
MAXIMUM COMPRESSIVE LOAD:	174.5 kN
UNCONFINED COMPRESSIVE STRENGTH:	87.1 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

33099 - UCS - GR22-04 Run 6 - August 17, 2022

UNCONFINED COMPRESSION TEST REPORT

ASTM D7012-14

CLIENT:	McIntosh Perry	FILE NUMBER:	33099
PROJECT NAME:	Hwy 401 Choate & Ganaraska	REPORT DATE:	29-Aug-22
BOREHOLE No.:	GR22-07	TEST DATE:	16-Aug-22
SAMPLE No.:	Run 5		
SAMPLE DEPTH:	32' 6" - 33' 2"		
DESCRIPTION:	Limestone		

Avg. Height (cm):	18.9	Weight (g):	999.3
Avg. Diameter (cm):	5.0	Wet Density (kg/m ³):	2,650
H. to Dia. Ratio**:	3.8:1	Dry Density (kg/m ³):	2,639
Cross Sectional Area (cm ²):	19.95	Moisture Content* (%):	0.4
Sample Volume (cm ³):	377.06		

ORIGINAL SPECIMEN



FRACTURED SPECIMEN



AVG. RATE OF STRAIN TO FAILURE:	0.250 MPa/s
MAXIMUM COMPRESSIVE LOAD:	102.8 kN
UNCONFINED COMPRESSIVE STRENGTH:	51.5 MPa

Note: * The moisture content was obtained before the test.
** Dimensions of Specimen do not conform to ASTM D 4543-04.

TEST DONE BY: GF
REVIEWED BY: WM

33099 - UCS - GR22-07 Run 5 - August 17, 2022

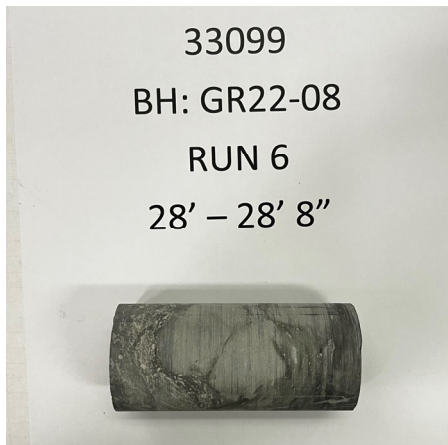
UNCONFINED COMPRESSION TEST REPORT

ASTM D7012-14

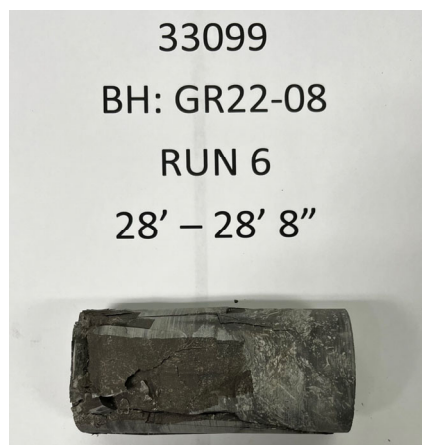
CLIENT:	McIntosh Perry	FILE NUMBER:	33099
PROJECT NAME:	Hwy 401 Choate & Ganaraska	REPORT DATE:	29-Aug-22
BOREHOLE No.:	GR22-08	TEST DATE:	16-Aug-22
SAMPLE No.:	Run 6		
SAMPLE DEPTH:	28' - 28' 8"		
DESCRIPTION:	Limestone		

Avg. Height (cm):	10.6	Weight (g):	556.3
Avg. Diameter (cm):	5.0	Wet Density (kg/m ³):	2,652
H. to Dia. Ratio**:	2.1:1	Dry Density (kg/m ³):	2,638
Cross Sectional Area (cm ²):	19.79	Moisture Content* (%):	0.5
Sample Volume (cm ³):	209.80		

ORIGINAL SPECIMEN



FRACTURED SPECIMEN



AVG. RATE OF STRAIN TO FAILURE:	0.250 MPa/s
MAXIMUM COMPRESSIVE LOAD:	90.0 kN
UNCONFINED COMPRESSIVE STRENGTH:	45.5 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

33099 - UCS - GR22-08 Run 6 - August 17, 2022



Appendix D Site Photographs



Photo 1: Looking east along the north side of the Hwy 401 Ganaraska River Bridge



Photo 2: Looking east along the north widening area at the Hwy 401 Ganaraska River Bridge



Photo 3: Looking east from the west foreslope under the Hwy 401 Ganaraska River Bridge





Photo 5: Highway 401 Overpass at The Ganaraska River east foreslope looking from the North



Photo 6: Highway 401 Overpass at The Ganaraska River west foreslope looking from the North



Photo 7: Gananaska River Bridge west foreslope looking from the river bank just north of the structure