



THURBER ENGINEERING LTD.

**FINAL
FOUNDATION INVESTIGATION REPORT
HIGHWAY 17 CULVERT AT STATION 14+332
DULHUT TOWNSHIP, ONTARIO
ASSIGNMENT NO.: 5020-E-0025
GWP 5207-18-00**

GEOCRES NO.: 41N00-038

Location: Lat: 47.845380°, Long: -84.886579°

Client Name: AECOM Canada Ltd.

Date: November 23, 2023

File: 31653



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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 replacement of the culvert that crosses Highway 17 at Sta. 14+332 in Dulhut Township, Ontario. Thurber carried out the foundation investigation as a subconsultant to AECOM Canada Ltd. (AECOM) under Agreement No. 5020-E-0025, Change Order 1.

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 culvert site crosses Highway 17 approximately 17.6 km south of the junction between Highway 17 and Highway 101. For project purposes, Highway 17 is herein described as oriented north-south, and the culvert is described as oriented east-west.

In the area of the culvert, Highway 17 is a two-lane highway and has a posted speed limit of 90 km/h. The road surface near the culvert is at approximate elevation 290.0 m. The culvert is located within a section of highway with a superelevated curve, and the highway alignment continues to curve east both north and south of the culvert site. The shoulders to the highway

are paved and steel cable guiderails on wooden posts are present along both northbound and southbound shoulders of the highway. The 2023 traffic volume projection for this section of Highway 17 is understood to be 2,200 AADT.

The existing culvert is reported in AutoCAD drawings provided by AECOM to be 2,400 mm diameter, 37.28 m long, corrugated steel pipe (CSP) culvert with a slight skew to the highway alignment. The culvert has a relatively flat gradient with the invert of the culvert near elevations 281.55 m and 281.20 m at the inlet and outlet, respectively. The water flows through the culvert from east to west. Approximately 0.6 m of ponded water was present at the culvert outlet and a beaver dam was present east of the culvert inlet. Ponded water, presumably due to observed beaver activity, was also observed at the culvert located approximately 90 m to the north of the site.

The cover above the existing culvert is approximately 6.1 m at the highway centerline. Embankment side slopes, in the vicinity of the culvert, are generally inclined at approximately 1.9H:1V but are locally as steep as 1.3H:1V. The existing highway embankment side slopes at the culvert site did not show any visible signs of global instability at the time of the investigation.

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 not present. Bedrock outcrops are present northwest of the culvert. Lake Superior is located approximately 1.9 km west of the highway alignment.

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

2.2 Site Geology

According to Crins et al. 2009¹ the project area is described as Ecoregion 4E (Lake Temagami Ecoregion) within the Ontario Shield Ecozone. According to Wester et al. 2018² the ecoregion is subdivided into Ecodistrict 4E-1 (Michipicoten Ecodistrict). The project area is located in the north part of the ecodistrict, which is characterized by glaciofluvial material sediments and morainal deposits overlying Precambrian bedrock. Bedrock Geology Map (MRD126)³ indicates the site is underlain by mafic to intermediate metavolcanic rocks: basalt and andesite.

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 <http://www.geologyontario.mndm.gov.on.ca/mines/data/google/mrd126/doc.kml>

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 AECOM for the preparation of this report.

3. SITE INVESTIGATION AND FIELD TESTING

The foundation investigation and field-testing program was carried out between May 9 and July 7th, 2023, and consisted of two on-road boreholes identified as 23-401 and 23-402 and two off-road boreholes identified as 23-403 and 23-404. The on-road boreholes were advanced with a CME 75 truck mounted drill rig utilizing NW casing and coring techniques. The off-road boreholes were advanced with portable drilling equipment. 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 within the table below. The as-drilled borehole elevations were surveyed by Thurber with a surveyor's level with a reported vertical accuracy of +/- 1.5 mm and were measured relative to BM HCP 178 (Elevation 288.9 m). Horizontal locations were measured by Thurber relative to existing site features. The elevations and borehole coordinates were reviewed and referenced to the survey data provided by AECOM. 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 sheets included in Appendix B. The borehole coordinates are referenced to MTM Zone 13.

Table 3-1 Borehole Summary

BOREHOLE NO.	DRILLED LOCATION	NORTHING (m)	EASTING (m)	GROUND SURFACE ELEVATION (m)	TERMINATION DEPTH (m)
23-401	Northbound lane	5 301 090.8	238 450.4	289.7	13.2
23-402	Southbound lane	5 301 074.2	238 446.1	290.3	14.7
23-403	West embankment toe	5 301 092.9	238 425.9	282.0	4.0
23-404	East embankment toe	5 301 092.9	238 469.1	283.5	4.2

The boreholes were advanced to depths ranging from 4.0 to 14.7 m (base elev. 279.3 to 275.6 m). 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. A third-weight hammer was used for SPT testing within Boreholes 23-403 and 23-404, and a hammer weight correction has been applied for the N-values on the borehole record. It is noted that an automatic

hammer could not be used with the portable drill thus the SPT N-values from the portable drilling equipment are considered to be less reliable.

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 Ottawa laboratory for further examination and testing.

A 32 mm diameter well was installed in each of Boreholes 23-403 and 23-404 to allow for measurements of the groundwater level after drilling. The details for the well are illustrated on the respective Record of Borehole sheets provided in Appendix B.

Following completion of the field investigation, the wells and boreholes were decommissioned in general in accordance with O.Reg. 903, as amended. Boreholes 23-401 and 23-402 were capped with cold patch asphalt to reinstate the pavement surface.

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 and, where appropriate, Atterberg Limit 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, and unconfined compressive strength (UCS) testing was carried out on select intact bedrock cores. The results of these tests are summarized on the Record of Borehole sheets included in Appendix B.

One soil sample was selected and submitted for analytical testing of corrosivity parameters and sulphate content.

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

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets 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 boreholes, is given in the following sections. However, the factual data presented on the Record

of Borehole sheets takes precedence over this general description for interpretation of the site conditions. It must be recognized that the soil and groundwater conditions will vary between and beyond borehole locations. Soil classification is in general accordance with ASTM D2487 with the description of cohesive soils and secondary components as outlined in the MTO Guideline for Foundation Engineering Services Manual (April 2022).

In general, the encountered stratigraphy consists of sand and gravel fill overlaying rockfill overlying silty sand to sand fill over bedrock. Native deposits of silty sand to gravelly sand were encountered at the ground surface in the off-road boreholes.

5.1 Surficial Materials

5.1.1 Asphalt

Asphalt was encountered at the ground surface in both on-road boreholes. The asphalt was measured to have a thickness of 115 mm to 125 mm.

5.2 Fill

5.2.1 Sand and Gravel Fill

A fill layer consisting of sand and gravel was encountered beneath the asphalt in Boreholes 23-401 and 23-402. The fill layer was 0.6 to 0.7 m thick (base elev. 289.5 m to 289.0 m). An SPT N-value of 78 blows was recorded, indicating a very dense relative density.

Moisture contents ranging from 4 to 7% were recorded. The results of gradation analyses completed on two samples of the layer are illustrated in Figure C1 of Appendix C. The results of the tests are summarized in the table below and on the Record of Borehole sheets in Appendix B.

SOIL PARTICLE	PERCENTAGE (%)
Gravel	40 – 52
Sand	45 – 55
Silt	3 – 5
Clay	

5.2.2 Rock Fill

A layer of gravel to cobble sized rockfill with inferred boulders was encountered below the sand and gravel fill in Boreholes 23-401 and 23-402. NQ coring techniques were required to penetrate

the rockfill layer resulting in less retained sample. Boulders were cored in the lower portion of Borehole 23-402. The rockfill layer was 8.0 to 8.6 m thick with an underside depth of 8.7 to 9.4 m (base elev. 281.0 to 280.9 m). SPT testing was attempted and, where obtainable, N-values ranged from 7 blows to refusal blow counts.

The recorded moisture contents of the non-cohesive infill ranged from 1 to 6%. A limited volume of sample was obtained, and the results of gradation analyses completed on two samples of the layer are illustrated in Figure C2 of Appendix C. The results of the tests are summarized in the table below and on the Record of Borehole sheets in Appendix B.

SOIL PARTICLE	PERCENTAGE (%)
Gravel	61 – 76
Sand	21 – 30
Silt	3 – 9
Clay	

5.2.3 Sand to Silty Sand Fill

A layer ranging from sand some gravel to silty sand some gravel was encountered below the rockfill in Boreholes 23-401 and 23-402. NQ coring techniques were required to penetrate this layer in Borehole 23-401, the layer is inferred to contain cobbles and boulders. The fill was 1.1 to 1.7 m thick with an underside depth of 9.8 to 11.1 m (base elev. 279.9 to 279.2 m). SPT N-values in the layer ranged from 14 to 17 blows, indicating a compact relative density. A refusal N-value was obtained in Borehole 23-401 which is attributed to the presence of cobbles/boulders.

The recorded moisture content ranged from 14 to 17%. The results of gradation analyses completed on two samples of the layer are illustrated in Figure C3 of Appendix C. The results of the tests are summarized in the table below and on the Record of Borehole sheets in Appendix B.

SOIL PARTICLE	PERCENTAGE (%)	
Gravel	19 – 20	
Sand	50 – 70	
Silt	29	10
Clay	2	

5.3 Sand

A deposit of sand some silt with organics was encountered below the ground surface in Borehole 23-403. NQ coring techniques were required to penetrate this layer, the layer is inferred to contain cobbles. The layer was 1.0 m thick (base elev. 281.0 m). An SPT N-value of 4 blows was recorded, indicating a loose relative density. A refusal N-value was also obtained but is attributed to the presence of cobbles.

A moisture content of 16% was recorded. The results of gradation analysis completed on a sample of the layer are illustrated in Figure C4 of Appendix C. The results of the tests are summarized in the table below and on the Record of Borehole sheets in Appendix B.

SOIL PARTICLE	PERCENTAGE (%)
Gravel	3
Sand	85
Silt	10
Clay	2

5.4 Gravelly Sand to Gravel

A deposit of gravelly sand some silt transitioning to gravel interbedded with sand was encountered below the ground surface in Borehole 23-404. NQ coring techniques were required to penetrate this layer, the layer is inferred to contain cobbles. The layer was 1.5 m thick (base elev. 282.0 m). An SPT N-value of 9 blows was recorded, indicating a loose relative density. A refusal N-value was obtained but is attributed to the presence of cobbles.

The moisture content of the samples tested ranged from 4 to 6%. The results of gradation analysis completed on a sample of the layer are illustrated in Figure C5 of Appendix C. The results of the tests are summarized in the table below and on the Record of Borehole sheets in Appendix B.

SOIL PARTICLE	PERCENTAGE (%)
Gravel	31
Sand	57
Silt	12
Clay	

5.5 Bedrock

Bedrock outcrops were observed in close proximity to the culvert site. Bedrock was proven by coring in all four boreholes. The depth to bedrock in the on-road boreholes was 9.8 m and 11.1 m (elev. 279.9 m and 279.2 m).

The bedrock encountered consisted of fine grained, dark greenish grey, very strong Greenschist containing calcite inclusions. Photographs of the bedrock cores 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), %	83 - 100
Solid Core Recovery (SCR), %	33 - 92
Rock Quality Designation (RQD), %	22 - 100
Fracture Index (fractures per 0.3 m) ⁽¹⁾	0 - >10
Unconfined Compressive Strength Testing (MPa) ⁽²⁾	152

Notes: (1) Indicated as "FI" on Borehole Logs
(2) Sample tested from Borehole 23-403, Run 1.

An RQD value encountered in the Borehole 23-402 was 22% indicating a very poor quality and the remaining RQD values were 48 to 100% generally indicating a bedrock of fair to excellent quality (CFEM, 2006). The result of an unconfined compressive strength testing (UCS) was 152 MPa, indicating that the tested sample of the bedrock is very strong (CFEM, 2006). The results of the UCS testing are included in Appendix C.

5.6 Groundwater Level

The measured groundwater levels from within the wells installed in Boreholes 23-403 and 23-404 are summarized in the following table.

A representative open-hole groundwater level measurement was not obtained due to the introduction of water during drilling in Boreholes 23-401 and 23-402.



Table 5-2 Measured Water Levels

Borehole	Bottom of Screen Depth /Elevation (m)	Soil in Zone of Screen	Groundwater Level		Date of Measurement
			Depth (mbgs)	Elevation (m)	
23-403	3.9 / 278.1	Bedrock	0.7	281.3	2023 07 11
			0.7	281.3	2023 07 12
			0.7	281.3	2023 07 15
23-404	4.1 / 279.4	Bedrock	0.8	282.7	2023 06 11
			1.7	281.8	2023 07 06
			2.1	281.4	2023 07 08
			1.8	281.7	2023 07 12
			1.8	281.7	2023 07 13
			1.8	281.7	2023 07 15

Ponded water was present near the culvert outlet. The surface water depth was recorded to be 0.6 m at the time of the field investigation.

It should be noted that the values shown above are considered short-term readings and may not reflect groundwater levels 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. The water level should also be expected to change based on the presence or removal of the beaver dam.

A Single Well Response Test (SWRT), or “slug test”, was carried out on July 15, 2023 in the monitoring wells installed in BH 23-403 and 23-404 by lowering the water level within the monitoring well and recording the recovery of the water level over time with a data logger. The slug tests were completed and analyzed using the Hvorslev method and the plots of the slug test results are included in Appendix B. The hydraulic conductivity values calculated from the in-situ slug tests are summarized in the following table.

Table 5-3 Single Well Response Test Results

Borehole /Monitoring Well	Bottom of Screen Depth /Elevation (m)	Soil in Zone of Screen	Estimated Hydraulic Conductivity (m/s)
23-403	3.9 / 278.1	Bedrock	3.1×10^{-8}
23-404	4.1 / 279.4	Bedrock	2.0×10^{-7}

The overburden thicknesses were too thin to adequately allow for the installation of a well; however, it should be expected that variations in hydraulic conductivity will exist within the various soil deposits that were encountered.

Both wells were decommissioned following the completion of the testing on July 15, 2023.

5.7 Analytical Testing

One soil sample was submitted for analytical testing. The analysis results are included in Appendix C and are summarized in Table 5-4.

Table 5-4 Analytical Test Results

BOREHOLE	23-404
SAMPLE	SS1
DEPTH (ft/m)	0'0" – 1'0" 0 – 0.3
ELEVATION (m)	283.2
SOIL TYPE	Gravelly Sand
CONDUCTIVITY (µS/cm)	75
pH	4.16
RESISTIVITY (Ohm-cm)	13,300
CHLORIDE (µg/g)	12
SULPHATE (µg/g)	15
SULPHIDE (%)	< 0.04

6. MISCELLANEOUS

The borehole locations reflect existing site features and access constraints. The as-drilled locations and ground surface elevation were measured by Thurber following completion of the field program. George Downing Estate Drilling Ltd. of Hawkesbury, Ontario, and Ohlmann Geotechnical Services Inc. of Almonte, Ontario, supplied and operated the drill rigs used to drill, test, sample, and decommission the boreholes. Traffic control was performed in accordance with Ontario Book 7 and was provided by J. Provost Contracting of Wawa, Ontario. The field investigation was supervised on a full-time basis by Mr. I. Khan, EIT and Mr. A. Simpson, EIT. Overall supervision of the field investigation program was provided by Mr. A. de Oliveira, EIT.



Routine geotechnical laboratory testing was completed by Thurber's laboratory in Ottawa. Analytical testing was completed by Paracel Laboratories Ltd. in Ottawa. UCS testing was carried out by Stantec.

Interpretation of the factual data and preparation of this report was completed by A. de Oliveira, EIT and S. Peters, P.Eng. The report was reviewed by Dr. F. Griffiths, P.Eng., a Designated Principal Contact for MTO Foundation Projects.

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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

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5. INTERPRETATION OF THE REPORT

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

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.

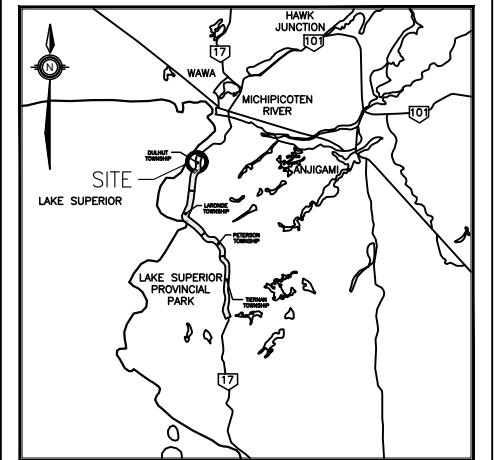


APPENDIX A

Borehole Locations and Strata Drawing






SHEET

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

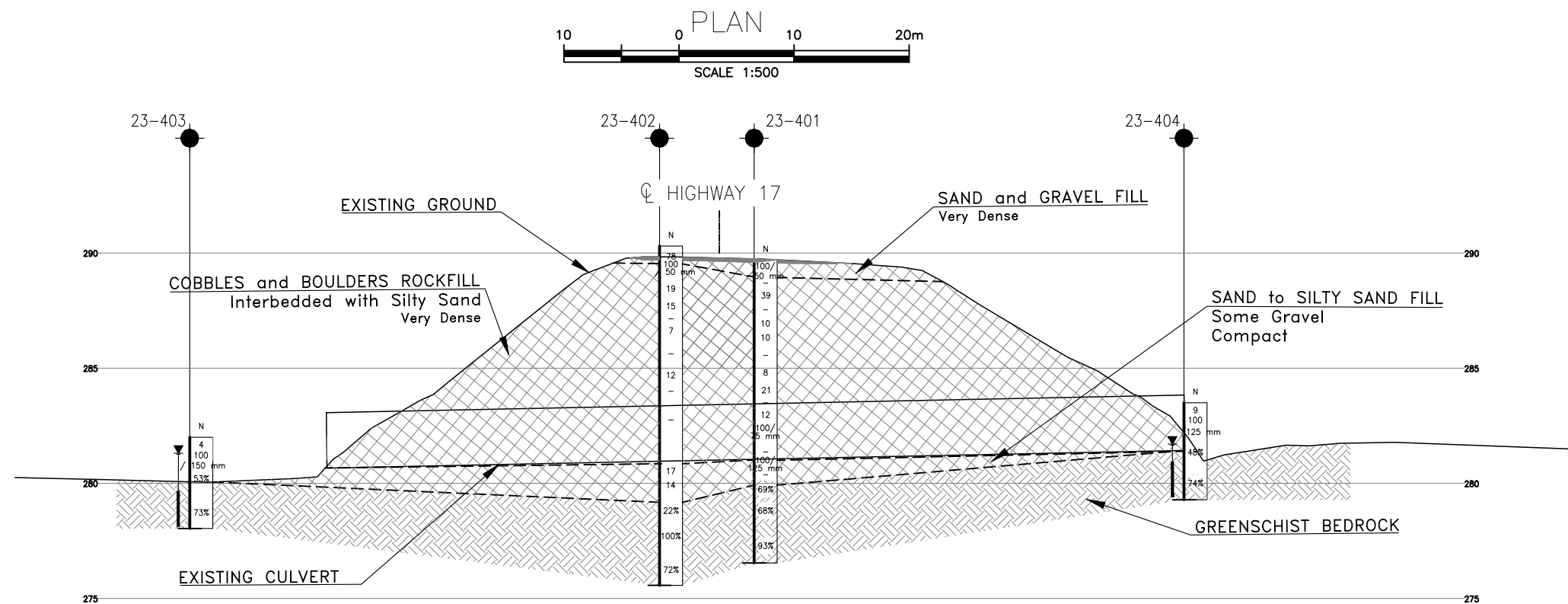
	Borehole
	Borehole (Previous Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level Upon Completion of Drilling
	Water Level in Monitoring Well/Piezometer
	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R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

NO	ELEVATION	NORTHING	EASTING
23-401	289.7	5 301 090.8	238 450.4
23-402	290.3	5 301 074.2	238 446.1
23-403	282.0	5 301 092.9	238 425.9
23-404	283.5	5 301 092.9	238 469.1

-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 13.

GEOCRES No. 41N00-038



SECTION A-A'

H 1:250

V 1:250

[illegible]

APPENDIX B

Symbols and Terms
Record of Boreholes Sheets
Single Well Response Test



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).

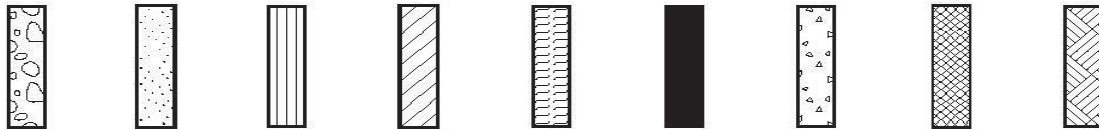
DYNAMIC CONE PENETRATION TEST (DCPT):

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 23-401

1 OF 2

METRIC

GWP# 5207-18-00 LOCATION Lat: 47.845423°, Long: -84.886551° Sta. 14+332, Duilut Township, MTM z13: N 5 301 090.8 E 238 450.4 ORIGINATED BY APS
 HWY 17 BOREHOLE TYPE CME 75 Truck Mounted / NW Casing / NQ Coring COMPILED BY RH
 DATUM Geodetic DATE 2023.05.11 - 2023.05.11 CHECKED BY AO

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										
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
289.7	Ground Surface						20	40	60	80	100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L				
0.0	ASPHALT (115 mm)						20	40	60	80	100	WATER CONTENT (%)						
0.1	SAND and GRAVEL very dense light brown		1	SS	100/ 50 mm							○			52	45	3 (SI+CL)	
289.0	FILL																	
0.7	GRAVEL and COBBLES inferred boulders ROCKFILL		2	NQ	-													
			3	SS	39								○			76	21	3 (SI+CL)
			4	NQ	-													
			5	SS	10								○					
			6	SS	10								○					
			7	NQ	-													
			8	SS	8								○					
			9	SS	21													
			10	NQ	-													
			11	SS	12													
			12	SS	100/ 75 mm													
			13	NQ	-													
281.0																		
8.7	SILTY SAND, some gravel contains cobbles and boulders very dense light brown FILL		14	SS	100/ 125 mm							○			19	50	29 2	
			15	NQ	-													
279.9																		
9.8	GREENSCHIST BEDROCK		1	RUN														

Continued Next Page

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

RECORD OF BOREHOLE No 23-401

2 OF 2

METRIC

GWP# 5207-18-00 LOCATION Lat: 47.845423°, Long: -84.886551° Sta. 14+332, Dulhut Township, MTM z13: N 5 301 090.8 E 238 450.4 ORIGINATED BY APS
HWY 17 BOREHOLE TYPE CME 75 Truck Mounted / NW Casing / NQ Coring COMPILED BY RH
DATUM Geodetic DATE 2023.05.11 - 2023.05.11 CHECKED BY AO

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				WATER CONTENT (%)					
								20 40 60 80 100				w _p w w _L					
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
Continued From Previous Page																	
276.5 13.2	GREENSCHIST BEDROCK contains calcite inclusions fresh fine grained dark greenish grey very strong		2	RUN			279								1	RUN #1 TCR=100% SCR=85% RQD=69% RUN #2 TCR=83% SCR=53% RQD=68% RUN #3 TCR=97% SCR=87% RQD=93%	
														1			
														>10			
														2			
														3			
														0			
			3	RUN			278							1			
														0			
							277							1			
														1			
	End of Borehole																

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

RECORD OF BOREHOLE No 23-402

1 OF 2

METRIC

GWP# 5207-18-00 LOCATION Lat: 47.845273°, Long: -84.886604° Sta. 14+332, Dulhut Township, MTM z13: N 5 301 074.2 E 238 446.1 ORIGINATED BY APS
 HWY 17 BOREHOLE TYPE CME 75 Truck Mounted / NW Casing / NQ Coring COMPILED BY RH
 DATUM Geodetic DATE 2023.05.09 - 2023.05.10 CHECKED BY AO

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 (%)			
								20 40 60 80 100						20 40 60			
290.3	Ground Surface																
0.0	ASPHALT (125 mm)																
0.1	SAND and GRAVEL very dense blackish brown		1	SS	78		290							40 55 5 (SI+CL)			
289.5	FILL																
0.8	GRAVEL and COBBLES interbedded with silty sand ROCKFILL		2	SS	100												
					50 mm		289										
			3	SS	19									61 30 9 (SI+CL)			
			4	SS	15		288										
			5	NQ	-		287										
			6	SS	7												
			7	NQ	-		286										
			8	SS	12		285										
284.5	COBBLES and BOULDERS ROCKFILL		9	NQ	-		284										
5.8	- 1.0 m boulder at a depth of 6.1 m																
	- 508 mm boulder at a depth of 7.0 m		10	NQ	-		283										
							282										
280.9	SAND, some gravel compact greyish brown FILL		10	SS	17		281										
9.4																	

Continued Next Page


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

RECORD OF BOREHOLE No 23-402

2 OF 2

METRIC

GWP# 5207-18-00 LOCATION Lat: 47.845273°, Long: -84.886604° Sta. 14+332, Duluth Township, MTM z13: N 5 301 074.2 E 238 446.1 ORIGINATED BY APS
 HWY 17 BOREHOLE TYPE CME 75 Truck Mounted / NW Casing / NQ Coring COMPILED BY RH
 DATUM Geodetic DATE 2023.05.09 - 2023.05.10 CHECKED BY AO

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 w _L											
Continued From Previous Page																				
279.2	SAND, some gravel compact greyish brown FILL		11	SS	14		280												20 70 10 (SI+CL)	
11.1	GREENSCHIST BEDROCK contains calcite inclusions fresh fine grained dark greenish grey very strong		1	RUN			279												RUN #1 TCR=100% SCR=33% RQD=22%	
			2	RUN			278												RUN #2 TCR=100% SCR=92% RQD=100%	
			3	RUN			277												RUN #3 TCR=92% SCR=62% RQD=72%	
275.6		End of Borehole					276													
14.7																				

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

RECORD OF BOREHOLE No 23-403

1 OF 1

METRIC

GWP# 5207-18-00 LOCATION Lat: 47.845439°, Long: -84.886878° Sta. 14+332, Dulhut Township, MTM z13: N 5 301 092.9 E 238 425.9 ORIGINATED BY IK
 HWY 17 BOREHOLE TYPE Portable / NW Casing / NQ Coring COMPILED BY RH
 DATUM Geodetic DATE 2023.07.06 - 2023.07.07 CHECKED BY AO

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20	40	60	80	100						
282.0	Ground Surface																	
0.0	SAND, some silt contains cobbles and organics loose brown		1	SS	4													
			2	NQ	-													
			3	SS	100													
281.0																		
1.0	GREENSCHIST BEDROCK contains calcite seams fresh jointed fine grained dark greenish grey very strong rusty colouration at joints				/ 150 mm													
			1	RUN														
	</																	

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

RECORD OF BOREHOLE No 23-404

1 OF 1

METRIC

GWP# 5207-18-00 LOCATION Lat: 47.845444°, Long: -84.886301° Sta. 14+332, Dulhut Township, MTM z13: N 5 301 092.9 E 238 469.1 ORIGINATED BY IK
 HWY 17 BOREHOLE TYPE Portable / NW Casing / NQ Coring COMPILED BY RH
 DATUM Geodetic DATE 2023.06.09 - 2023.06.11 CHECKED BY AO

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 (%)									
283.5	Ground Surface						20	40	60	80	100	W _P	W	W _L		GR	SA	SI	CL		
0.0	GRAVELLY SAND, some silt contains organics loose brown		1	SS	9											31	57	12 (SI+CL)			
282.9			2	NQ	-																
0.6	GRAVEL and COBBLES with silty sand infills very dense brown to grey		3	SS	100 /125 mm																
282.0																					
1.5	GREENSCHIST BEDROCK slightly weathered to fresh fine grained greenish grey very strong		1	RUN												FI 8 4 1	RUN #1 TCR=100% SCR=38% RQD=48%				

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



THURBER ENGINEERING LTD.

Slug Test Analysis Report

Project: Highway 17 and Old Woman River Bridge

Number: 31653

Client: AECOM

Location: Laronde Township, Ontario

Slug Test: 23-403

Test Well: 23-403

Test Conducted by: SM & IK

Test Date: 2023-07-15

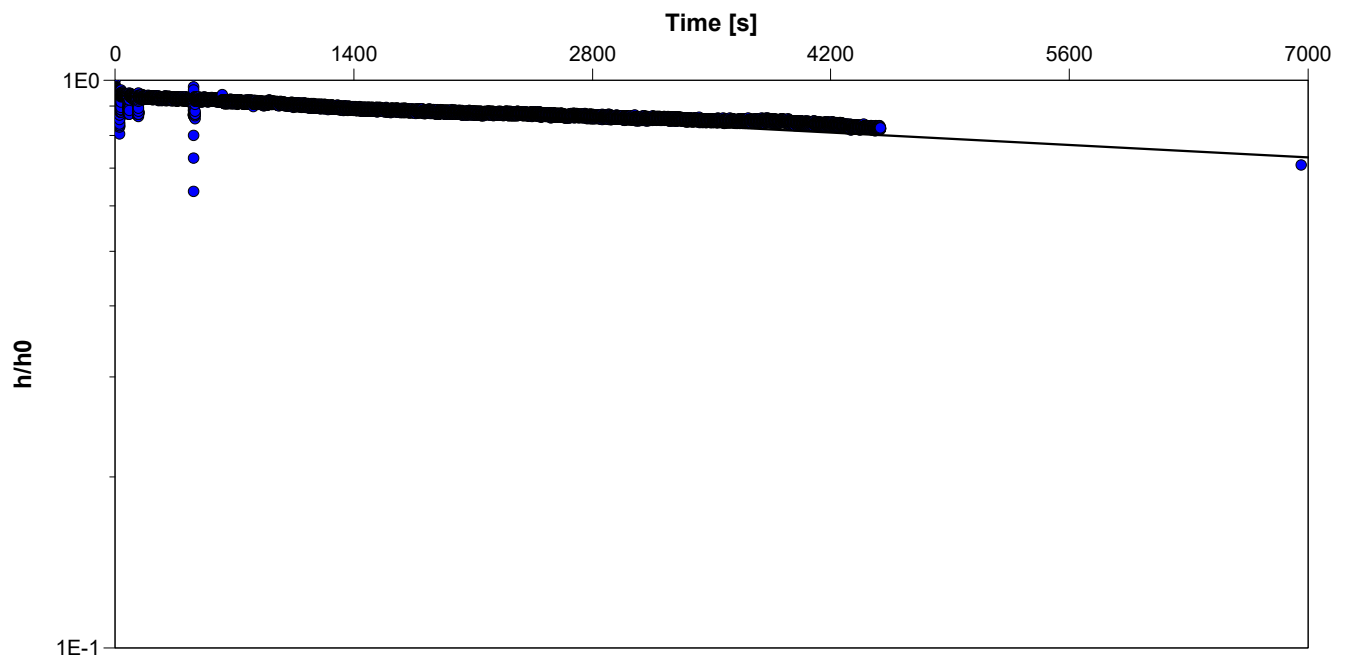
Analysis Performed by: SM

SWRT Analysis

Analysis Date: 2023-07-19

Aquifer Thickness:

Checked by: AH



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

23-403

3.1×10^{-8}



THURBER ENGINEERING LTD.

Slug Test Analysis Report

Project: Highway 17 and Old Woman River Bridge

Number: 31653

Client: AECOM

Location: Laronde Township, Ontario

Slug Test: 23-404

Test Well: 23-404

Test Conducted by: SM & IK

Test Date: 2023-07-15

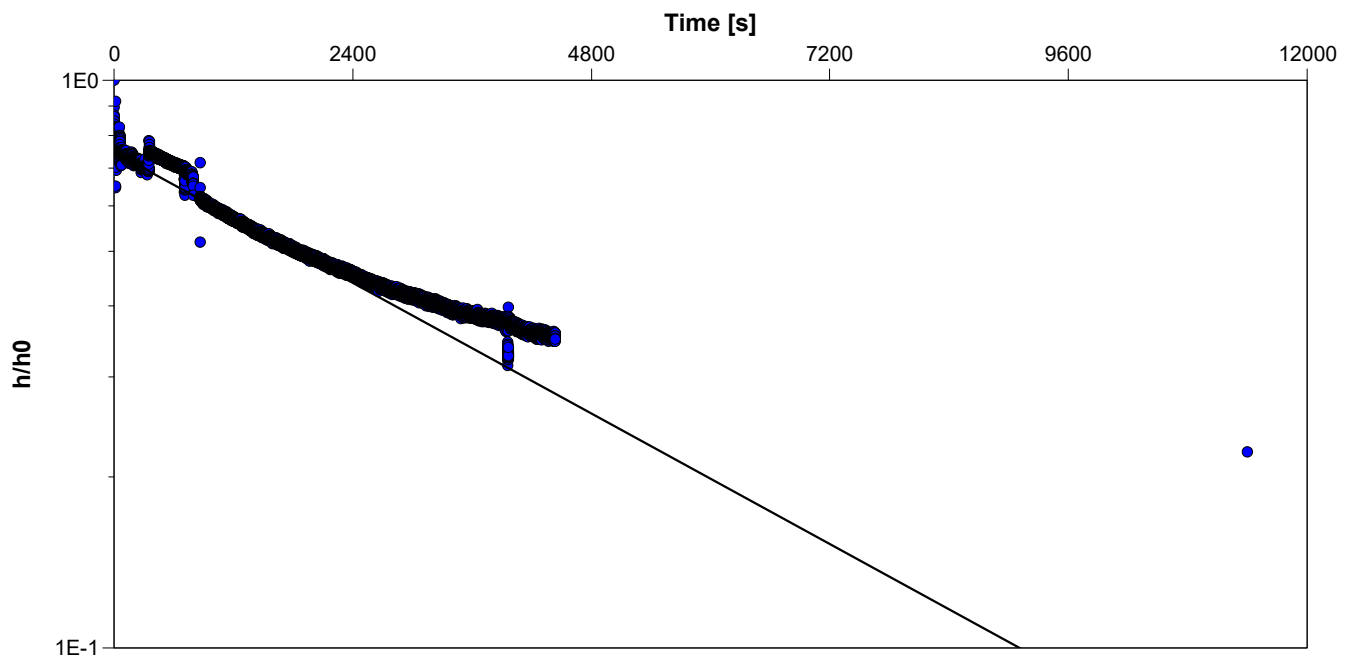
Analysis Performed by: SM

SWRT Analysis

Analysis Date: 2023-07-19

Aquifer Thickness:

Checked by: AH



Calculation using Hvorslev

Observation Well

Hydraulic Conductivity
[m/s]

23-404

2.0×10^{-7}

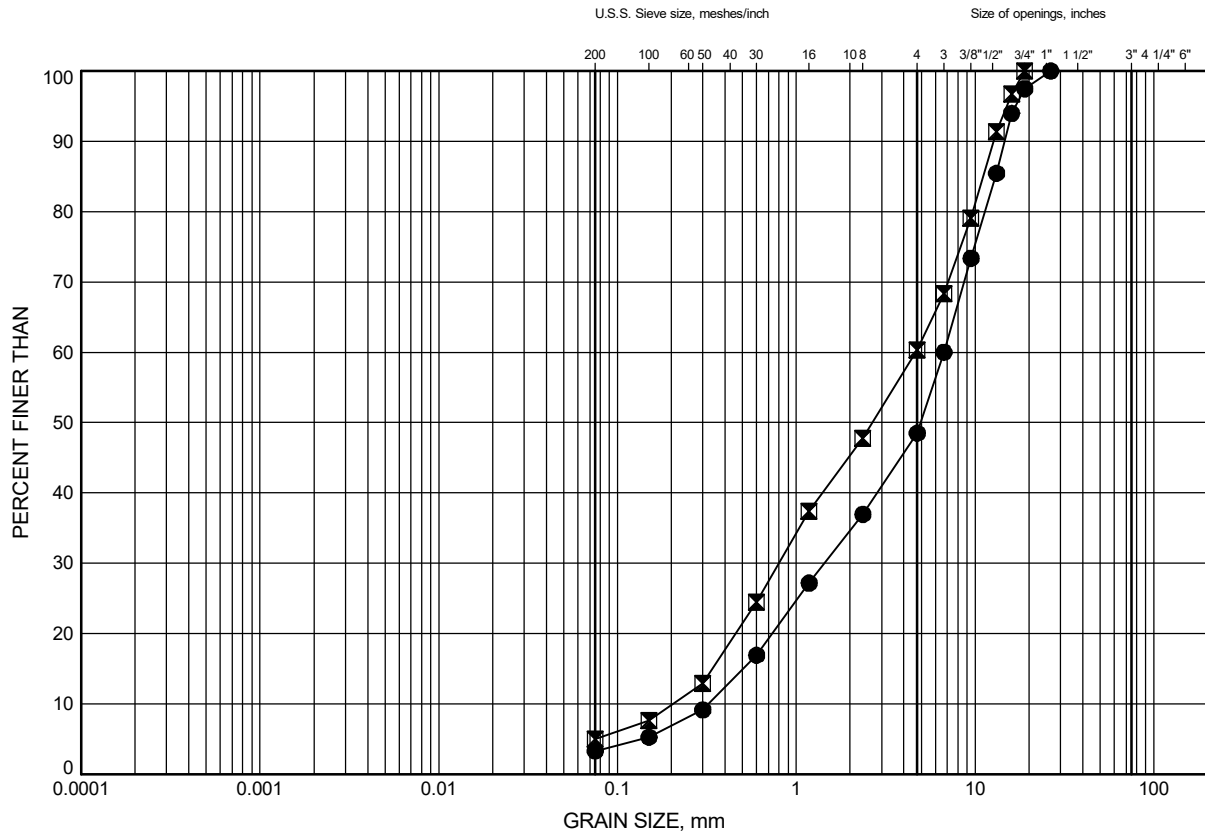
APPENDIX C

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

Hwy 17 Old Woman River GRAIN SIZE DISTRIBUTION

FIGURE C1

FILL: Sand and Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	23-401	0.2	289.5
⊠	23-402	0.4	289.9

Date August 2023
GWP# 5207-18-00

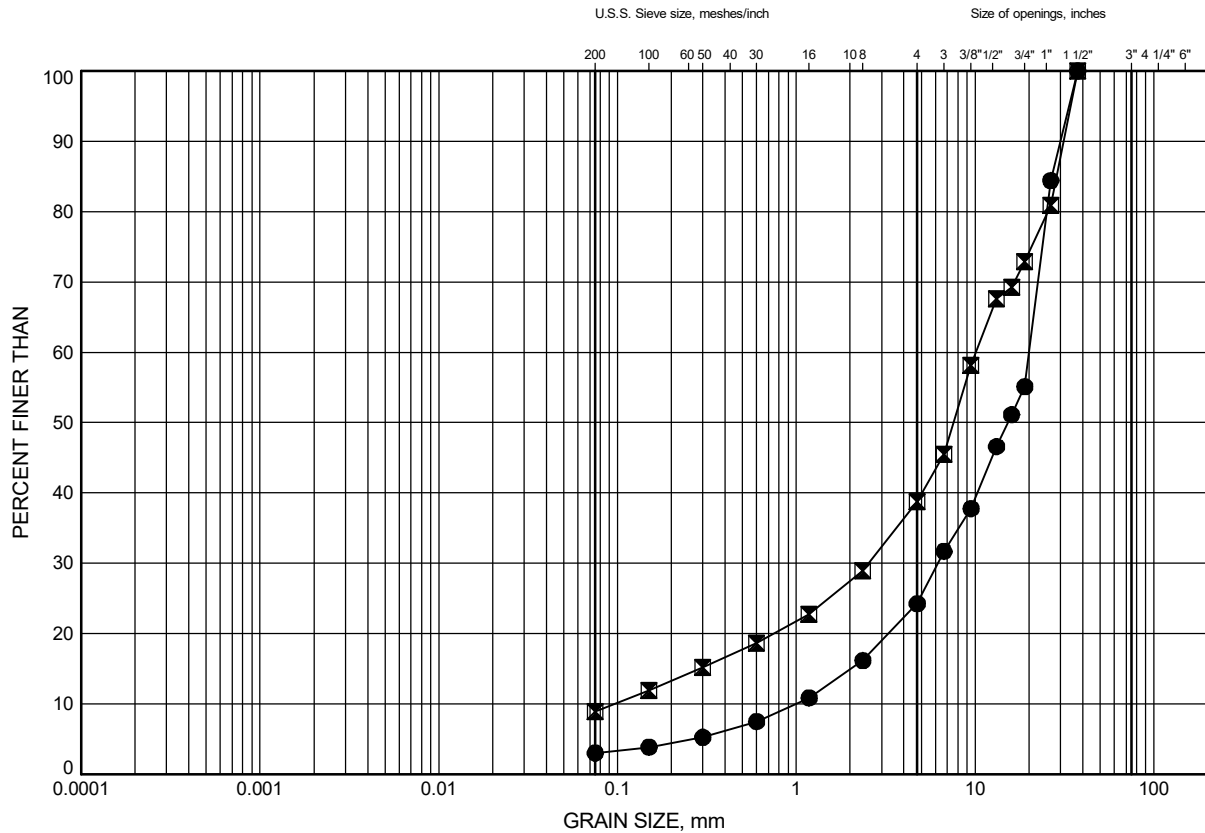


Prep'd RH
Chkd. AO

Hwy 17 Old Woman River GRAIN SIZE DISTRIBUTION

FIGURE C2

Rock Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	23-401	1.5	288.2
◻	23-402	1.8	288.5

Date August 2023
GWP# 5207-18-00



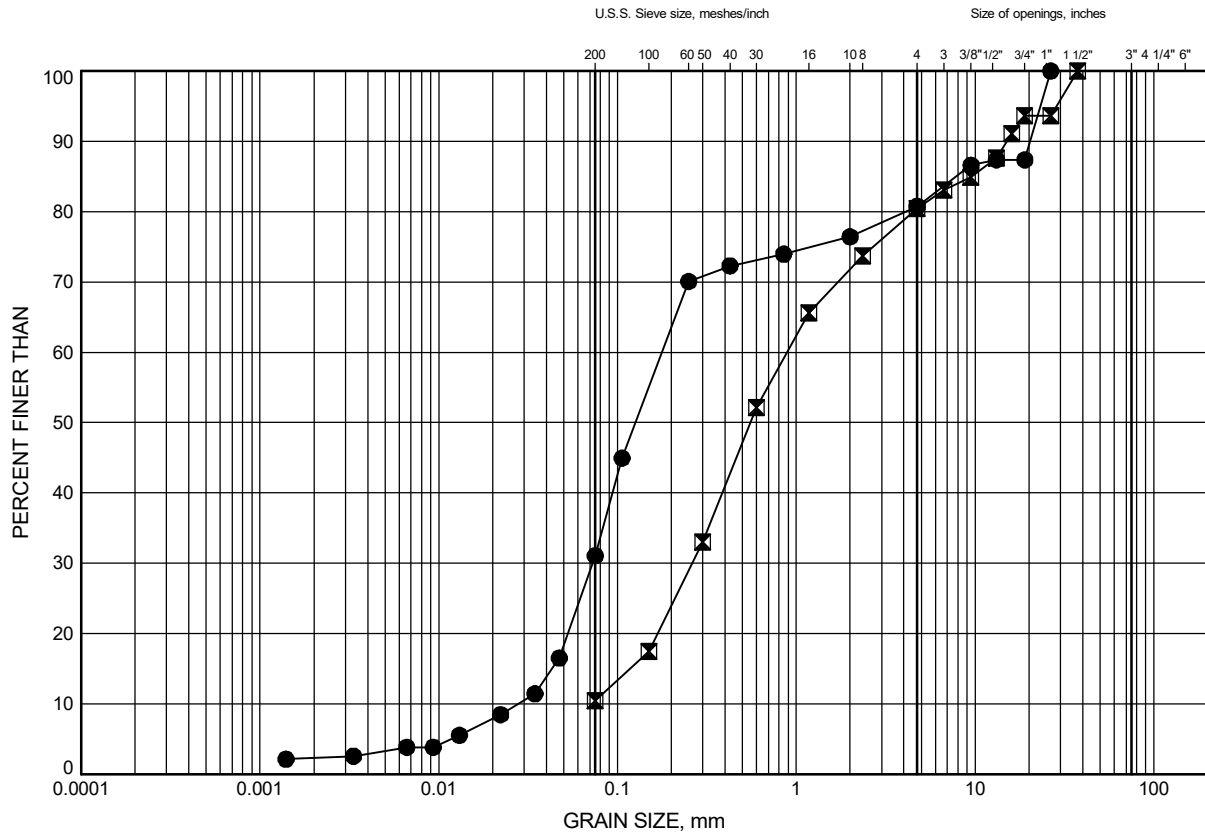
Prep'd RH
Chkd. AO

Hwy 17 Old Woman River

GRAIN SIZE DISTRIBUTION

FIGURE C3

FILL: Sand to Silty Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	23-401	8.8	280.9
⊠	23-402	10.4	279.9

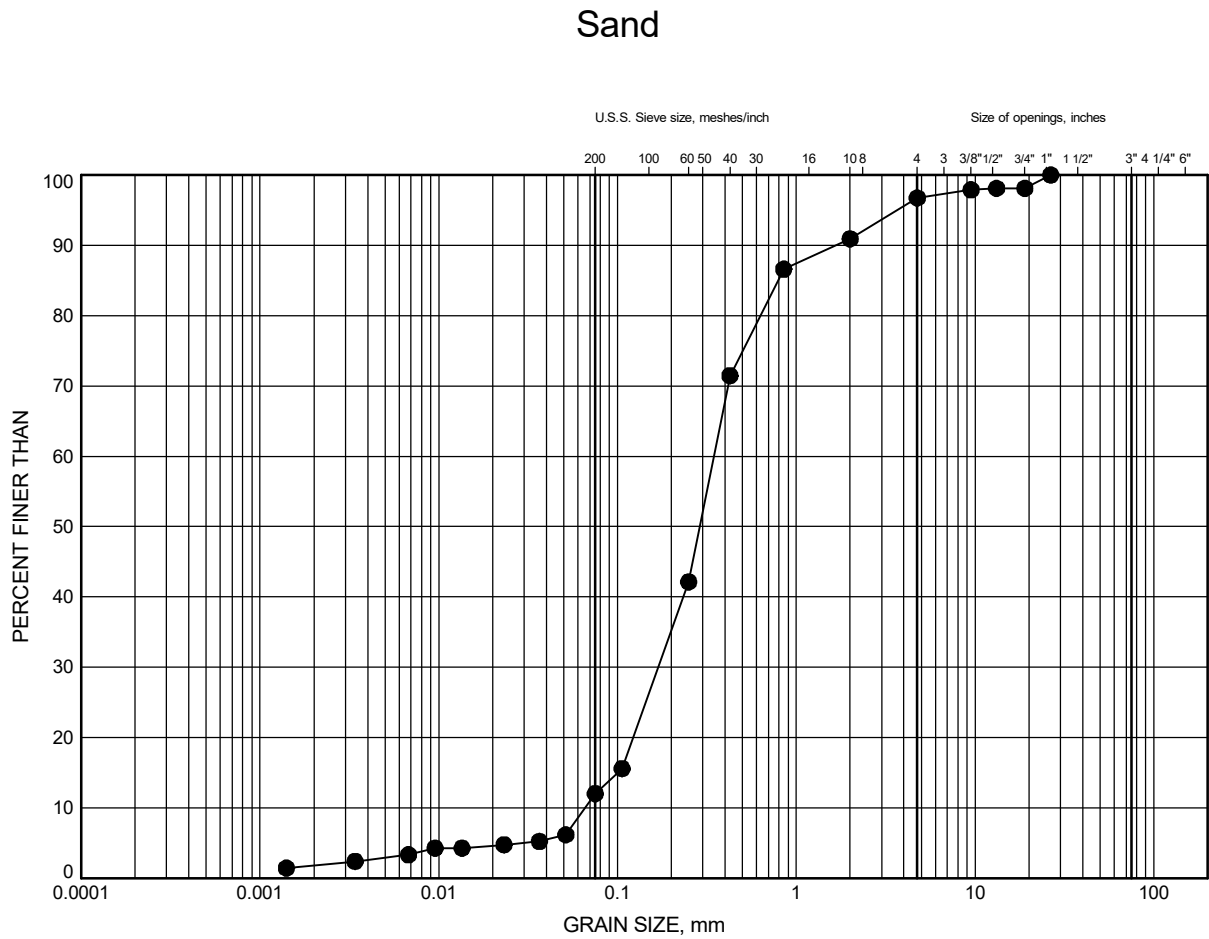
Date August 2023
GWP# 5207-18-00



Prep'd RH
Chkd. AO

Hwy 17 Old Woman River GRAIN SIZE DISTRIBUTION

FIGURE C4



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	23-403	0.3	281.7

Date August 2023
GWP# 5207-18-00

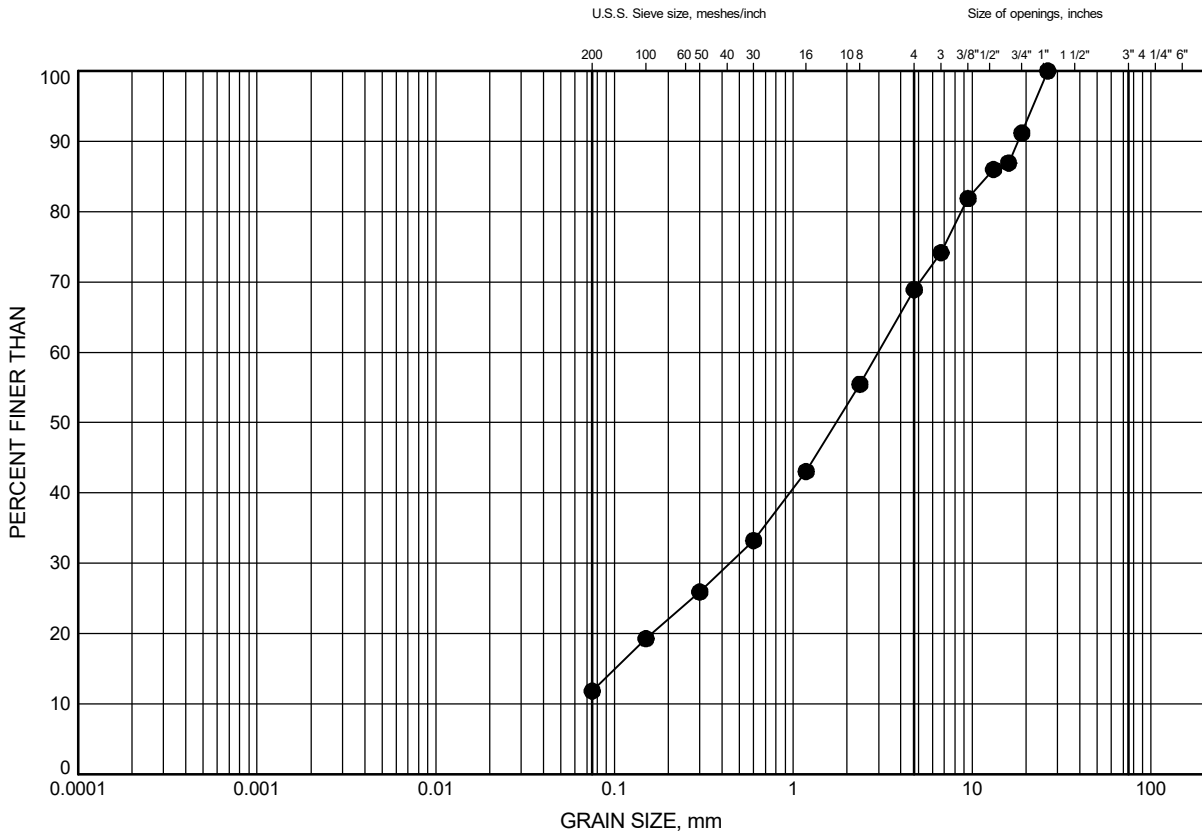


Prep'd RH
Chkd. AO

Hwy 17 Old Woman River GRAIN SIZE DISTRIBUTION

FIGURE C5

Gravelly Sand to Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	23-404	0.3	283.2

Date August 2023
GWP# 5207-18-00



Prep'd RH
Chkd. AO



Stantec Consulting Ltd.
2781 Lancaster Rd, Suite 100 A&B, Ottawa ON K1B 1A7

August 8, 2023
File: 122410864

Client: Thurber Engineering, File #31653.60

**Reference: ASTM D7012, Method C, Unconfined Compressive Strength of Intact Rock Core
Hwy 17-Old Woman River**

The following table summarizes unconfined compressive strength results for three intact rock cores.

Location	Sample Depth	Compressive Strength (MPa)	Description of Break
23-102 Run-2	35' 35'0"	161.8	Well formed cones at both ends.
23-403 Run-1	4'8"-5'5"	152.3	Vertical cracking
23-502 Run-1	37'4" 38'	93.7	Diagonal fracture

Sincerely,

Stantec Consulting Ltd.

Brian Prevost
Laboratory Supervisor
Tel: 613-738-6075
Fax: 613-722-2799
brian.prevost@stantec.com

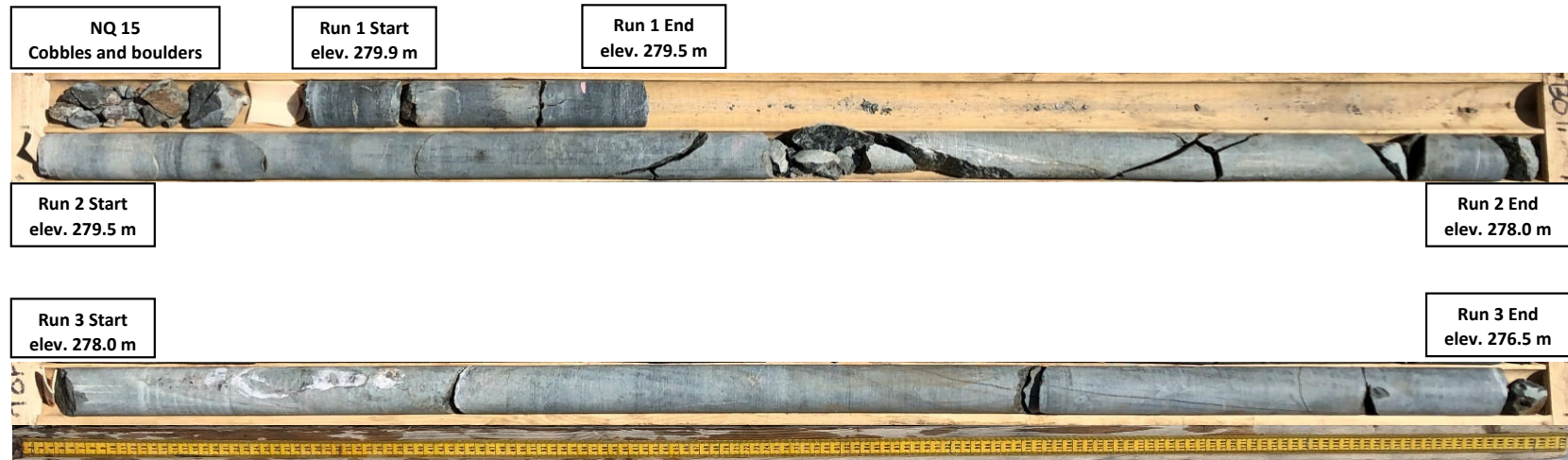
Borehole 23-401

Runs 1 to 3

Depth 9.8 m to 13.2 m

Elevation 279.9 m to 276.5 m

Dry Sample



THURBER ENGINEERING LTD.

Geotechnical Investigation
Highway 17 Old Woman River Bridge
Sta. 14+332, Dulhut Township

BH 23-401
Project No.: 31653

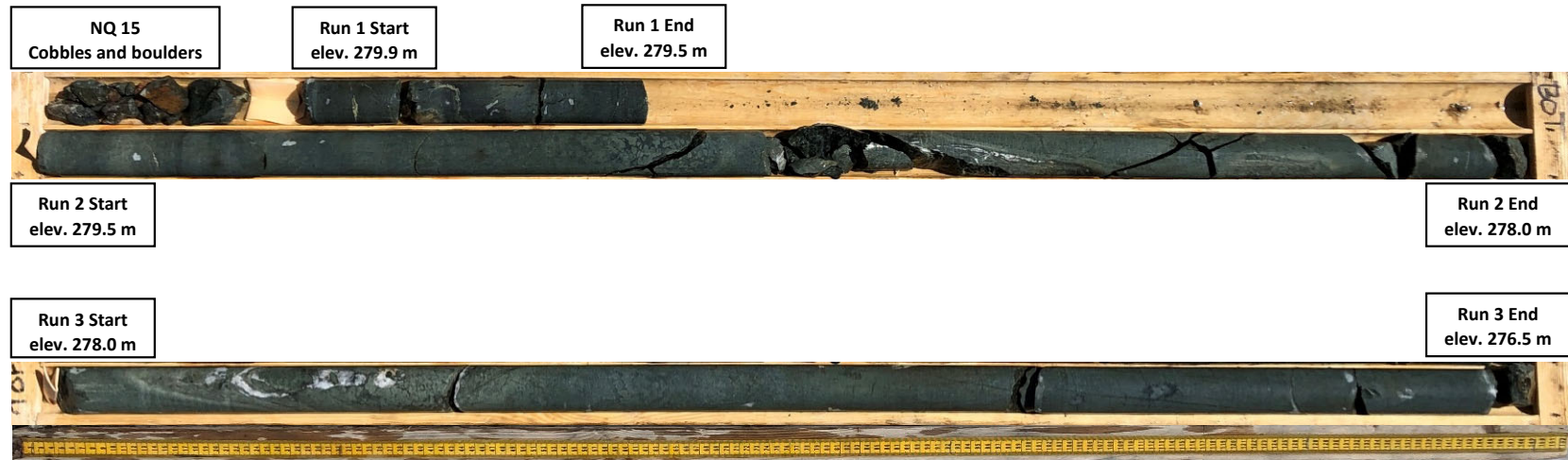
Borehole 23-401

Runs 1 to 3

Depth 9.8 m to 13.2 m

Elevation 279.9 m to 276.5 m

Wet Sample



THURBER ENGINEERING LTD.

Geotechnical Investigation
Highway 17 Old Woman River Bridge
Sta. 14+332, Dulhut Township

BH 23-401
Project No.: 31653

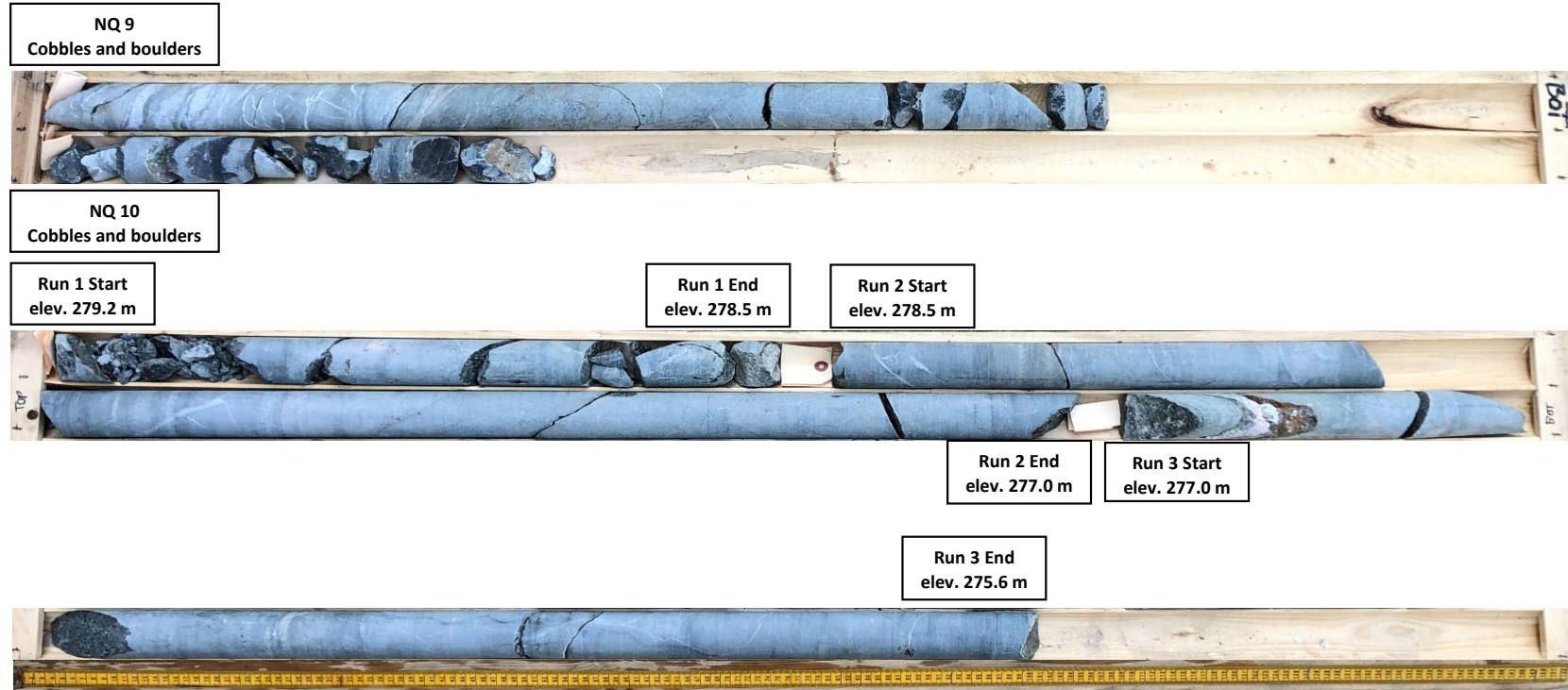
Borehole 23-402

Runs 1 to 3

Depth 11.1 m to 14.7 m

Elevation 279.2 m to 275.6 m

Dry Sample



THURBER ENGINEERING LTD.

Geotechnical Investigation
Highway 17 Old Woman River Bridge
Sta. 14+332, Dulhut Township

BH 23-402
Project No.: 31653

Borehole 23-402

Runs 1 to 3

Depth 11.1 m to 14.7 m

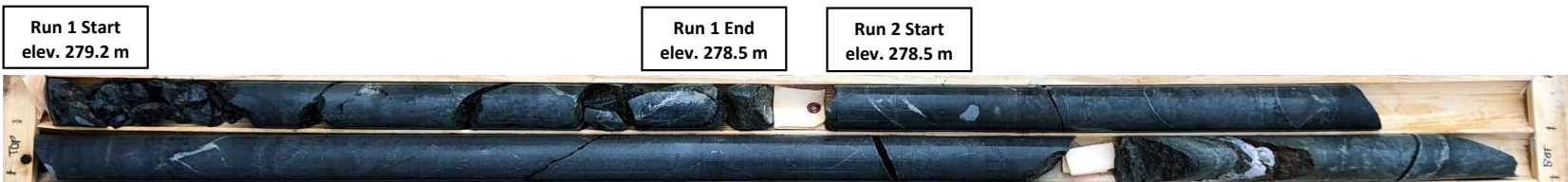
Elevation 279.2 m to 275.6 m

Wet Sample

NQ 9
Cobbles and boulders



NQ 10
Cobbles and boulders



Run 1 Start
elev. 279.2 m

Run 1 End
elev. 278.5 m

Run 2 Start
elev. 278.5 m

Run 2 End
elev. 277.0 m

Run 3 Start
elev. 277.0 m

Run 3 End
elev. 275.6 m



Borehole 23-403

Run 1

Depth 1.0 m to 2.5 m

Elevation 281.0 m to 279.5 m

Dry Sample

NQ 2 Cobbles and boulders

Run 1 Start
elev. 281.0 m



Run 1 End
elev. 279.5 m



THURBER ENGINEERING LTD.

Geotechnical Investigation
Highway 17 Old Woman River Bridge
Sta. 14+332, Dulhut Township

BH 23-403
Project No.: 31653

Borehole 23-403

Run 1

Depth 1.0 m to 2.5 m

Elevation 281.0 m to 279.5 m

Wet Sample

NQ 2 Cobbles and boulders

Run 1 Start
elev. 281.0 m



Run 1 End
elev. 279.5 m



THURBER ENGINEERING LTD.

Geotechnical Investigation
Highway 17 Old Woman River Bridge
Sta. 14+332, Dulhut Township

BH 23-403
Project No.: 31653

Borehole 23-403

Run 2

Depth 2.5 m to 4.0 m

Elevation 279.5 m to 278.0 m

Dry Sample

Run 2 Start
elev. 279.5 m



Run 2 End
elev. 278.0 m



THURBER ENGINEERING LTD.

Geotechnical Investigation
Highway 17 Old Woman River Bridge
Sta. 14+332, Dulhut Township

BH 23-403
Project No.: 31653

Borehole 23-403

Run 2

Depth 2.5 m to 4.0 m

Elevation 279.5 m to 278.0 m

Wet Sample

Run 2 Start
elev. 279.5 m



Run 2 End
elev. 278.0 m



THURBER ENGINEERING LTD.

Geotechnical Investigation
Highway 17 Old Woman River Bridge
Sta. 14+332, Dulhut Township

BH 23-403
Project No.: 31653

Borehole 23-404

Run 1

Depth 1.5 m to 2.7 m

Elevation 282.0 m to 280.8 m

Dry Sample

NQ 2 and 4 Gravel and Cobbles



Run 1 Start
elev. 282.0 m



Run 1 End
elev. 280.8 m



THURBER ENGINEERING LTD.

Geotechnical Investigation
Highway 17 Old Woman River Bridge
Sta. 14+332, Dulhut Township

BH 23-404
Project No.: 31653

Borehole 23-404

Run 1

Depth 1.5 m to 2.7 m

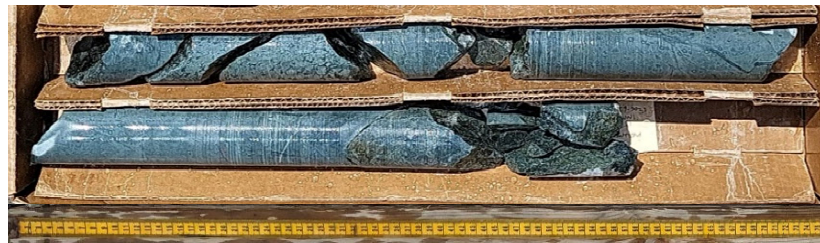
Elevation 282.0 m to 280.8 m

Wet Sample

NQ 2 and 4 Gravel and Cobbles



Run 1 Start
elev. 282.0 m



Run 1 End
elev. 280.8 m



THURBER ENGINEERING LTD.

Geotechnical Investigation
Highway 17 Old Woman River Bridge
Sta. 14+332, Dulhut Township

BH 23-404
Project No.: 31653

Borehole 23-404

Run 2

Depth 2.7 m to 4.2 m

Elevation 280.8 m to 279.3 m

Dry Sample

Run 2 Start
elev. 280.8 m



Run 2 End
elev. 279.3 m



THURBER ENGINEERING LTD.

Geotechnical Investigation
Highway 17 Old Woman River Bridge
Sta. 14+332, Dulhut Township

BH 23-404
Project No.: 31653

Borehole 23-404

Run 2

Depth 2.7 m to 4.2 m

Elevation 280.8 m to 279.3 m

Wet Sample

Run 2 Start
elev. xx m



Run 2 End
elev. xx m

Certificate of Analysis

Report Date: 07-Jul-2023

Client: Thurber Engineering Ltd.

Order Date: 28-Jun-2023

Client PO:

Project Description: 31653 Hwy 17 Old Woman River

Client ID:	23-404 GB1 (0'-1')	-	-	-
Sample Date:	09-Jun-23 09:00	-	-	-
Sample ID:	2326353-01	-	-	-
MDL/Units	Soil	-	-	-

Physical Characteristics

% Solids	0.1 % by Wt.	93.9	-	-	-
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General Inorganics

Conductivity	5 uS/cm	75	-	-	-
pH	0.05 pH Units	4.16	-	-	-
Resistivity	0.1 Ohm.m	133	-	-	-

Anions

Chloride	10 ug/g dry	12	-	-	-
Sulphate	10 ug/g dry	15	-	-	-

**SGS Canada Inc.**

P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - K0L 2H0
Phone: 705-652-2000 FAX: 705-652-6365

Paracel Laboratories

Attn : Dale Robertson

300-2319 St.Laurent Blvd.
Ottawa, ON
K1G 4K6, Canada

Phone: 613-731-9577
Fax:613-731-9064

26-July-2023

Date Rec. : 30 June 2023
LR Report: CA19633-JUN23
Reference: Project#: 2326353

Copy: #2

CERTIFICATE OF ANALYSIS

Final Report - Revised

Sample ID	Sample Date & Time	Sulphide (Na ₂ CO ₃) %
1: Analysis Start Date		18-Jul-23
2: Analysis Start Time		12:08
3: Analysis Completed Date		18-Jul-23
4: Analysis Completed Time		14:07
5: QC - Blank		< 0.04
6: QC - STD % Recovery		112%
7: QC - DUP % RPD		ND
8: RL		0.02
9: 23-404 GB1 (0'-1')	09-Jun-23 09:00	< 0.04

RL - SGS Reporting Limit
ND - Not Detected

Revised July 26, 2023 - Sample ID updated as per client request.

Kimberley Didsbury
Project Specialist,
Environment, Health & Safety

APPENDIX D

Site Photographs



Photo 1: Culvert inlet *(taken on June 11, 2023)*



Photo 2: Culvert outlet *(taken on July 06, 2023)*



Photo 3: Highway 17 north of the culvert alignment *(taken on May 12, 2023)*



Photo 4: Highway 17 south of the culvert alignment *(taken on May 09, 2023)*



Photo 5: Looking north at the northbound embankment *(taken on June 11, 2023)*



Photo 6: Looking south at the southbound embankment *(taken on July 11, 2023)*