



THURBER ENGINEERING LTD.

**FINAL
FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGHWAY 118 CULVERT AT STATION 21+086
DRAPER TOWNSHIP, ONTARIO
ASSIGNMENT NO.: 5017-E-0003
GWP 5011-19-00**

GEOCRES NO.: 31E03-003

Location: Lat: 45.001065°, Long: -79.169588°

Client Name: McIntosh Perry Consulting Engineers

Date: February 7, 2024

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PART 1. FACTUAL INFORMATION

1. INTRODUCTION

This section of the report presents the factual findings obtained from a foundation investigation completed by McIntosh Perry Consulting Engineers (MPCE) for the rehabilitation of the culvert that crosses Highway 118 near Station 21+086 within Draper Township in the District of Muskoka, Ontario. MPCE carried out the foundation investigation under Agreement No. 5017-E-0003. Thurber Engineering Ltd. (Thurber) carried out the preparation of the foundation investigation and design report on behalf of MPCE. It must be noted that MPCE is solely responsible for the accuracy of the subsurface information in their borehole logs and the field information provided to aid in the preparation of this report.

The purpose of this investigation carried out by MPCE was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile, laboratory test results, and a written description of the subsurface conditions. The stratigraphic profile of the subsurface conditions influencing design and construction was developed during the investigation.

A historical foundation investigation report was not available for this site within the online Geocres Library. In addition to the borehole records and laboratory test results, background information provided by MPCE included the DCP Contract Drawings of August 2023 and an email summarizing the existing and proposed culvert characteristics provided on October 27, 2023.

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



2. SITE DESCRIPTION

2.1 General

The culvert crosses Highway 118 approximately 11.8 km west of the intersection between Highway 118 and Highway 11 within Draper Township in the District of Muskoka. For project orientation purposes, Highway 118 is herein described as oriented east-west, and the culvert is described as oriented south-north.

At the location of the culvert, Highway 118 is a two-lane highway with a posted speed limit of 80 km/hr. The road surface is near elevation 295.2 m (MPCE email dated October 27, 2023) with the highway profile increasing east of the culvert. Traffic volumes on this section of Highway 118 are understood to have been 4,300 AADT in 2016. The shoulders are fully paved and a steel beam guiderail is present on the eastbound side.

The existing culvert is reported in the email dated October 27, 2023 provided by MPCE to be a 1,200 mm diameter, 23.0 m long structural plate corrugated steel pipe (SPCSP) culvert. Further, the culvert has a flat gradient (of 0.02%) with the invert of the culvert near elevation 292.0 m at both the inlet and outlet. The soil cover above the existing culvert is approximately 2.0 m near the highway centerline.

The highway is on a causeway approximately 100 m in length crossing a small bay of the South Branch Muskoka River. Water flows from south to north through the culvert which is located near the midpoint of the causeway. The culvert is at a skew of 95° to the highway alignment.

The embankment side slopes near the culvert are generally sloped at approximately 2H:1V. An ATV trail is present on the north sideslope and crosses over the culvert. MPCE examined the slopes in the field and did not observe any indications of slope instability. The embankment slopes and ditch line are mainly grass covered with small shrubs. A few residential dwellings are located within 100 m of the culvert site to both east and west. The lands beyond the causeway are heavily vegetated with coniferous and deciduous trees. Overhead utility lines are present near the westbound embankment toe and run parallel to the highway.

Photographs of the project area are included in Appendix D. These photographs were taken by MPCE and show the existing condition of the highway pavement and the culvert ends at the time of the field investigation.



2.2 Site Geology

According to Crins et al. 2009¹ the project area is described as Ecoregion 5E (Georgian Bay Ecoregion) within the Ontario Shield Ecozone. According to Wester et al. 2018² the ecoregion is subdivided into Ecodistrict 5E-8 (Huntsville Ecodistrict). The Huntsville Ecodistrict is characterized by shallow layers of morainal material and pockets of deeper glaciolacustrine sediment overlying Precambrian bedrock.

Bedrock Geology Map (MRD126)³ indicates the site is underlain by derived gneisses or felsic igneous rocks such as tonalite, granodiorite, monzonite, and syenite.

2.3 Existing Information

A historical foundation investigation report was not available for this site within the online Geocres Library. Geocres Report 31E00-400 for a foundation investigation conducted 2.4 km west of the culvert was reviewed for regional information only but has not been used further in the report.

3. SITE INVESTIGATION AND FIELD TESTING

The foundation investigation and field-testing program was carried out between September 13, 2022, and September 22, 2022, and consisted of three off-road boreholes identified as CL49-1, CL49-2, and CL49-3. The off-road/in-water boreholes were advanced with portable drilling equipment mounted on a raft. MPCE has confirmed that utility clearances were acquired in the vicinity of the borehole locations prior to commencement of drilling.

A summary of the borehole coordinates, elevations, and termination depths is provided within Table 3.1. The as-drilled borehole elevations were surveyed by MPCE with a Trimble R2 receiver with centimeter accuracy (vertical datum of CGVD28). Horizontal locations were measured by MPCE relative to existing site features with centimeter accuracy. 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 10.

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>

Table 3.1 Borehole Summary

BOREHOLE NO.	DRILLED LOCATION	NORTHING (m)	EASTING (m)	GROUND SURFACE ELEVATION (m)	TERMINATION DEPTH (m)
CL 49-1	North of Culvert Outlet	4 984 629.0	330 837.1	292.2	9.0
CL 49-2	South of Culvert Inlet	4 984 601.4	330 859.7	290.5	9.3
CL 49-3	South of Culvert Inlet	4 984 597.3	330 860.2	291.1	9.2

The boreholes were advanced to depths ranging from 9.0 to 9.3 m below the existing ground surface (base elev. 283.2 to 281.2 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 full weight hammer was used in all the three Boreholes, and 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 less reliable.

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

MPCE has confirmed that following the completion of field investigation, the boreholes were decommissioned in general accordance with O.Reg. 903, as amended.

4. LABORATORY TESTING

Laboratory testing was selected in general accordance with the current MTO Guideline for Foundation Engineering Services, Section 5. MPCE has confirmed that geotechnical laboratory testing included a visual identification of all retained soil samples. Select soil samples were tested for moisture content, grain size distribution and, where appropriate, Atterberg Limits testing in accordance with MTO and ASTM standards. The results of these tests are summarized on the Record of Borehole sheets included in Appendix B.

MPCE selected one soil sample and submitted for analytical testing of corrosivity parameters.

All laboratory test results from the 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 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 secondary components as outlined in the MTO Guideline for Foundation Engineering Services Manual (April 2022). It must be noted that MPCE is solely responsible for the accuracy of the subsurface information in their borehole logs.

In general terms, the encountered stratigraphy beneath the surficial standing water consisted of organic sediment over sand underlain by a silt layer. Bedrock was not proven within the depth of investigation.

5.1 Organic Sediment and Organic Sand

A sand layer containing organics was observed at ground surface in Borehole CL49-1 with a recorded thickness of 0.6 m (base elev. 291.6 m). The layer also contained gravel. A single SPT N-value of 2 was recorded, indicating a very loose relative density.

A native layer of organic sediment was encountered below the standing water in Boreholes CL49-2 and CL49-3 with a recorded thickness of 0.1 and 0.3 (base elev. 290.4 and 290.7 m). SPT N-values of 15 and 21 blows were recorded but may have been impacted by the underlying soil. The organic sediment is described as very soft.

All recovered samples of the organic sediment and organic sand were noted to be wet.

5.2 Sand

A deposit consisting of sand with varying amounts of silt, clay and gravel was encountered below the organic sand in Borehole CL49-1. The sand was 6.1 m thick (base elev. 285.5 m). SPT N-values obtained in the sand layer ranged from 3 to 53 blows, indicating a very loose to very dense relative density. A cobble was noted at approximate elevation 290.6 m.

A single moisture content of 21% was recorded. The results of the gradation analyses completed on two samples of the sand layer are illustrated on Figures C1 and C2 of Appendix C. The results of the tests are summarized below and on the Record of Borehole sheet in Appendix B.

SOIL PARTICLE	PERCENTAGE (%)	
Gravel	2 – 8	
Sand	68 – 70	
Silt	29	22
Clay	1	

5.3 Silt

A deposit of silt with varying amounts of clay and sand was encountered below the sand layer in Borehole CL49-1 and below the organic sediment in Boreholes CL49-2 and CL49-3. Sand seams were noted throughout the layer. All boreholes were terminated within the silt layer at a depth of 9.0 to 9.3 m below the existing ground surface (base elev. 283.2 to 281.2 m). The SPT N-values obtained in the silt layer ranged from 11 to 105, indicating a compact to very dense relative density.

The recorded moisture contents ranged from 23 to 28%. The results of the gradation analyses completed on five samples of the silt layer are illustrated on Figures C3 to C7 of Appendix C. The results of the tests are summarized below and on the Record of Borehole sheets in Appendix B.

SOIL PARTICLE	PERCENTAGE (%)	
Gravel	0	
Sand	2 – 17	
Silt	68 – 81	83 – 97
Clay	15 – 28	

A sixth gradation test was completed on a sample from a sand seam in Borehole CL49-3 and yielded 79% sand and 21% fines, see Figure C8 of Appendix C.

Results of Atterberg Limit testing carried out on two samples with one test yielding a “Non-Plastic” result. The second test result is illustrated in Figure C9 of Appendix C and summarized below and on the Record of Borehole sheet. The laboratory results indicate that the silt exhibits non plastic to low plastic behavior (ML).



PARAMETER	VALUE
Liquid Limit	23
Plastic Limit	21
Plasticity Index	2

5.4 Groundwater Level

Surface water was measured at approximate elevations of 292.8 to 292.9 m at the time of the site visit in September 2022. The water depth upstream of the culvert was reported to range from 1.8 to 2.3 m and downstream of the culvert to be approximately 0.6 m.

In addition, it is noted that the water level in the South Branch Muskoka River is controlled by the Ontario Power Generation facility at Matthiasville Falls which is located approximately 3 km west of the site. Site observations indicate the water level was dropping during the July investigation. As per information provided by MPCE in an email dated February 6, 2024, the historical water levels at the Matthias Reservoir range from a low water zone of elev. 291.5 m to flood damage zone of elev. 293.7 m throughout the year. Daily water level statistics show that the water levels measure at approx. 292.8 m year round.

5.5 Analytical Testing

One soil sample was submitted for analytical testing. The analysis results are included in Appendix C and are summarized in the following table.

Table 5.1 Analytical Test Results

BOREHOLE	CL 49-2
SAMPLE	SS2
DEPTH (ft/m)	9.5 – 11.5 2.8 – 3.5
ELEVATION (m)	289.3
SOIL TYPE	Silt
pH	7.34
RESISTIVITY (Ohm-cm)	11,700
CHLORIDE (µg/g)	<5
SULPHATE (µg/g)	<5



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6. MISCELLANEOUS

The as-drilled locations and ground surface elevation were measured by MPCE following completion of the field program. 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 Robinson Haulage of Kilworthy, Ontario. The field investigation was supervised on a full-time basis by Mr. Mizral Hameem, EIT.

Interpretation of the data and preparation of this report were carried out by I. Khan, EIT and K. Walker, P.Eng. The report was reviewed by S. Peters, P. Eng and F. Griffiths, P.Eng. the Designated Principal Contact for MTO Foundation Projects.

Thurber Engineering Ltd.

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PART 2. ENGINEERING DISCUSSION AND RECOMMENDATIONS

7. GENERAL

This section of the report provides an interpretation of the factual data from Part 1 of this report and presents foundation design recommendations to assist the project team in the design of the rehabilitation of the culvert located on Highway 118 near Station 21+086 within Draper Township in the District of Muskoka, Ontario. McIntosh Perry Consulting Engineers (MPCE) carried out the field and laboratory investigations under Agreement No. 5017-E-0003. Thurber Engineering Ltd. (Thurber) prepared the foundation investigation and design report on behalf of MPCE. The discussion and recommendations presented in this report are based on information provided by MPCE and the factual data obtained during the field investigation. It must be noted that MPCE is solely responsible for the accuracy of the subsurface information in their borehole logs and the field information provided to aid in the preparation of this report.

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

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.



7.1 Background Information

In addition to the borehole records and laboratory test results, background information provided by MPCE included the DCP Contract Drawings of August 2023 and an email summarizing the existing and proposed culvert characteristics provided on October 27, 2023.

The culvert crosses Highway 118 approximately 11.8 km west of the intersection between Highway 118 and Highway 11. The road surface is near elevation 295.2 m with the highway profile increasing east of the culvert. The culvert has a flat gradient (of 0.02%) with the invert of the culvert near elevation 292.0 m at both the inlet and outlet. The soil cover above the existing culvert is approximately 2.0 m near the highway centerline. Water flows through the culvert from south to north into the South Branch Muskoka River. The existing culvert is reported in drawings provided by MPCE to be a 1.2 m diameter, 23.0 m long structural plate corrugated steel pipe (SPCSP) culvert. Ponded water and river surface water to the south and north of the highway ranged from approximate elevations of 292.8 to 292.9 m at the time of the site visit. The water depth upstream of the culvert was reported to range from 1.8 to 2.3 m and downstream of the culvert to be approximately 0.6 m.

In general terms, the encountered stratigraphy consisted of organic sediment over a sand layer underlain by a silt layer. Bedrock was not proven within the depth of investigation.

7.2 Proposed Work

The proposed works for this culvert is indicated in the MPCE Foundation Engineering request for services dated October 5, 2023, with the approach recommended by MPCE to be culvert rehabilitation by slip lining.

As per Sheet 20 of the DCP Drawings, the existing culvert will be lined with a new 900 mm Ultra Flow Liner. As per email from MPCE dated October 27, 2023, the proposed invert of the rehabilitated lined culvert is at elevation 292.2 m at the inlet and outlet. The cover above the existing culvert will remain unchanged at approximately 2.0 m at the highway centerline.

8. CEMENT TYPE AND CORROSION POTENTIAL

Analytical tests were completed to determine the potential for degradation of concrete in the presence of soluble sulphates and the potential for corrosion of exposed steel used in buried infrastructure. The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater at the site. Soluble sulphate concentrations less than 1000 µg/g generally indicate that a low degree of sulphate attack is expected for concrete in contact with soil and groundwater. The sulphate



content in the soils is $<5 \mu\text{g/g}$, see Section 5.5. The selection for class of concrete should include consideration of the effects of road de-icing salts.

The pH, resistivity, and chloride concentration provide an indication of the degree of corrosiveness of the sub-surface environment. The tests results provided in Section 5.5 may be used to aid in the selection of coatings and corrosion protection systems for buried steel objects. The corrosive effects of road de-icing salts should also be considered.

9. CONSTRUCTION CONSIDERATIONS

9.1 Excavation

If required, all excavation must be conducted in accordance with the requirements of the Occupational Health & Safety Act & Regulations (OHSA) for Construction Projects. The sand and silt may be classified as Type 3 soils. Organic sediment and very loose to loose sand, gravel and organic materials may be classified as Type 4 soils. *Where an excavation is within more than one soil type, the entire excavation must be completed in accordance with the more stringent requirement as per the requirements of the regulation.*

Excavations, if needed, must be planned and carried out in a manner that does not impact on the stability of the existing roadway. Where present, temporary cut slopes may have to be protected from precipitation and runoff to avoid surficial instabilities. The duration of temporary open excavations and cut slopes should be minimized to reduce the likelihood of causing instability concerns. Temporary embankment and cut slope stability is the responsibility of the Contractor.

Material stockpiling is a temporary construction measure and the associated stability implications are the responsibility of the Contractor. The selection and placement of construction equipment (such as cranes) and construction of temporary construction access roads are also the Contractor's responsibility. Placement of the crane or temporary stockpiling must not destabilize the embankment slopes (existing, temporary, or new).

At locations where there are space restrictions or where a slope has to be retained, the excavations will need to be carried out within a protection system. Further discussion on temporary protection systems (TPS) is presented in Section 9.2.

If existing embankments are disturbed during construction, embankment reinstatement after installation of the culvert liner should be carried out in accordance with OPSS.PROV 206 with materials similar to the existing. If constructed using Select Subgrade Material (SSM) or Granular B Type I, the embankment should be constructed with side slopes of 2H:1V (or flatter).

The granular fill should be placed and compacted in accordance with OPSS.PROV 501. Where newly placed embankment fill is placed against existing embankment slopes or on a sloping ground surface steeper than 3H:1V, benching of the existing slope should be carried out in accordance with OPSD 208.010.

9.2 Temporary Protection Systems

If required, Temporary Protection Systems (TPS) must be implemented in accordance with OPSS.PROV 539 as amended by SP 105S09. Performance Level 2 (maximum 25 mm horizontal deflection) is considered appropriate where the protection supports the existing highway. More stringent performance levels may be required if the protection system is intended to support existing structures or utilities. The actual pressure distribution acting on the shoring system is a function of the construction sequence and the relative flexibility of the wall, and these factors must be considered when designing the shoring system.

The measured surface water level observed during the investigation was approximately elevation 292.8 to 292.9 m at the time of the site visit. The water level will fluctuate and the minimum groundwater elevation for the site at the time of the excavation should be taken as the expected highwater level defined in SP 517F01 and SP FOUN0003.

For conceptual design purposes, driven sheet piles are recommended for TPS at this site. However, the selection and design of temporary protection is the responsibility of the Contractor. All protection systems should be designed by a licensed Professional Engineer experienced in such designs and retained by the Contractor. The design of the temporary protection system must incorporate surcharge loading due to traffic, construction equipment and operations. An anchoring and/or internal bracing system may need to be incorporated into the temporary protection design to resist lateral earth pressure loadings.

The lateral earth pressure coefficients for the native soils are given below for a vertical wall and a horizontal backslope. Unit weights provided herein are to be adjusted for applications below the groundwater level. Unbalanced hydrostatic pressures must be considered in the design of the protection systems.



Table 9-1 Static Earth Pressure Coefficients for Existing Soils

MATERIAL	UNIT^(*) WEIGHT (kN/m³)	K_A (-)	K_p (-)	S_u (kPa)	GROUND SURFACE BEHIND WALL
Native Organic Soils	18	0.36	2.8	-	Horizontal
Native Sand	20	0.33	3.0	-	Horizontal
Native Silt	19	0.36	2.8	-	Horizontal

Note: () to be adjusted when below water level*

It is recommended that the protection systems in the vicinity of the culvert (within 3 m from the edge of the culvert) should be left in place and cut off in accordance with OPSS.PROV 539.

9.3 Surface and Groundwater Control

The measured surface water level observed during the investigation was approximately elevation 292.8 to 292.9 m at the time of the site visit. The water level will fluctuate and the minimum groundwater elevation for the site at the time of the excavation should be taken as the expected highwater level defined in SP 517F01 and SP FOUN0003. It is proposed to rehabilitate the existing 1.2 m diameter SPCSP culvert by inserting a new 0.9 m diameter liner and grouting the annulus. The existing and proposed culvert inverts at the outlet are at approximate elevation 292.0 and 292.2 m, respectively. The liner installation must be completed in a dry and stable environment.

It is noted that organic soils were encountered at ground surface in all three off-road boreholes drilled at this site. It is anticipated that these materials will not provide a suitable working surface. Design and preparation of an appropriate temporary work surface is the responsibility of the contractor. Consideration could be given to placement of a clear stone pad. The contract should include a notice to the contractor of the potential need for this preparatory work.

Based on the conditions at the time of the investigation, the work will require flow passage and dewatering systems to control surface water and groundwater and may include cofferdams, flow diversion, pumping etc. The Contract Documents must alert the Contractor to this responsibility and to design the systems in accordance with SP 517F01 which amends OPSS.PROV 517.

It is anticipated that flow passage will be achieved by pumping around the culvert. The design of flow passage systems is the responsibility of the Contractor. Given the site conditions and anticipated works, the Designer Fill-In ***** in SP 517F01 Table A for flow passage systems

should be “No; the design Engineer and design-checking Engineer do not need a minimum of 5 years of experience in designing similar flow passage systems.

The dewatering system will be required to remain operational and effective throughout the culvert liner insertion and grout installation and then should be decommissioned and removed. The design of dewatering systems is the responsibility of the Contractor. Given the site conditions and anticipated works, the Designer Fill-In ***** in SP 517F01 Table A for dewatering systems should be “No”; the design Engineer and design-checking Engineer do not need a minimum of 5 years of experience in designing similar dewatering systems. The possibility of basal heave due to unbalanced hydrostatic pressures must be considered in the dewatering design due to the presence of interlayered silt and sand deposits. The dewatering plan must also be designed to support the temporary excavation slope assumptions, where needed. A preconstruction survey is not recommended, thus Designer Fill-In ** in SP 517F01 should be “N/A”.

For conceptual design purposes, watertight sheet piles or sandbags are recommended for cofferdams. The lateral earth pressure coefficients and relevant design recommendations provided in Section 9.2 for Temporary Protection Systems are also applicable to Cofferdams. It is anticipated that sump pumps will likely be sufficient to extract water from the work area isolated with sheet pile or sandbag cofferdams installed near the culvert inlet and outlet. Pumping should continue until control of inflow is achieved and the liner is installed and grouted in a dry, stable environment. More than one pump may be required.

Additional recommendations can be provided concerning dewatering should deeper excavations be required.

Further assessment of dewatering requirements and the need for registration on the Environmental Activity and Sector Registry (EASR) or a Permit to take Water (PTTW) should be carried out by specialists experienced in this field.

10. CONSTRUCTION CONCERNS

All work, including the grouting of the annulus, shall be carried out in dry conditions. It will be necessary to divert flow around the work area, to isolate the work area with coffer dams and dewater the work area. It is noted that some preparatory work may be required to create a temporary work surface at either end of the culvert.

The successful performance of the project will depend largely upon good workmanship and quality control during construction.



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11. CLOSURE

As noted above, McIntosh Perry Consulting Engineers (MPCE) carried out the field and laboratory investigations under Agreement No. 5017-E-0003. Thurber Engineering Ltd. (Thurber) prepared the foundation investigation and design report on behalf of MPCE. The discussion and recommendations presented in this report are based on information provided by MPCE and the factual data obtained during the field investigation. It must be noted that MPCE is solely responsible for the accuracy of the subsurface information in their borehole logs and the field information provided to aid in the preparation of this report.

Engineering analysis and preparation of this report were carried out by K. Walker, P.Eng. The report was reviewed by S. Peters, P.Eng. and F. Griffiths, P.Eng., a Designated Principal Contact for MTO Foundation Projects.

Thurber Engineering Ltd.
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LIMITATIONS OF REPORT

McIntosh Perry Consulting Engineers Ltd. (McIntosh Perry) carried out the geotechnical field investigation. This document is an integral part of the Foundation Investigation and Design report presented.

The conclusions and recommendations provided in this report are based on the information obtained at the borehole locations where the tests were conducted. Subsurface and groundwater conditions between and beyond the boreholes may differ from those encountered at the specific locations where tests were conducted and conditions may become apparent during construction, which were not detected and could not be anticipated at the time of the site investigation. The benchmark level used and borehole elevations presented in this report are primarily to establish relative differences in elevations between the borehole locations and should not be used for other purposes such as to establish elevations for grading, depth of excavations or for planning construction.

The recommendations presented in this report for design are applicable only to the intended structure and the project described in the scope of the work, and if constructed in accordance with the details outlined in the report. Unless otherwise noted, the information contained in this report does not reflect on any environmental aspects of either the site or the subsurface conditions.

The comments or recommendation provided in this report on potential construction problems and possible construction methods are intended only to guide the designer. The number of boreholes advanced at this site may not be sufficient or adequate to reveal all the subsurface information or factors that may affect the method and cost of construction. The contractors who are undertaking the construction shall make their own interpretation of the factual data presented in this report and make their conclusions, as to how the subsurface conditions of the site may affect their construction work.

The boundaries between soil strata presented in the report are based on information obtained at the borehole locations. The boundaries of the soil strata between borehole locations are assumed from geological evidences. If differing site conditions are encountered, or if the Client becomes aware of any additional information that differs from or is relevant to the McIntosh Perry findings, the Client agrees to immediately advise McIntosh Perry so that the conclusions presented in this report may be re-evaluated.

Under no circumstances shall the liability of McIntosh Perry for any claim in contract or in tort, related to the services provided and/or the content and recommendations in this report, exceed the extent that such liability is covered by such professional liability insurance from time to time in effect including the deductible therein, and which is available to indemnify McIntosh Perry. Such errors and omissions policies are available for inspection by the Client at all times upon request, and if the Client desires to obtain further insurance to protect it against any risks beyond the coverage provided by such policies, McIntosh Perry will co-operate with the Client to obtain such insurance.

McIntosh Perry prepared this report for the exclusive use of the Client. Any use which a third party makes of this report, or any reliance on or decision to be made based on it, are the responsibility of such third parties. McIntosh Perry accepts no responsibility and will not be liable for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

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

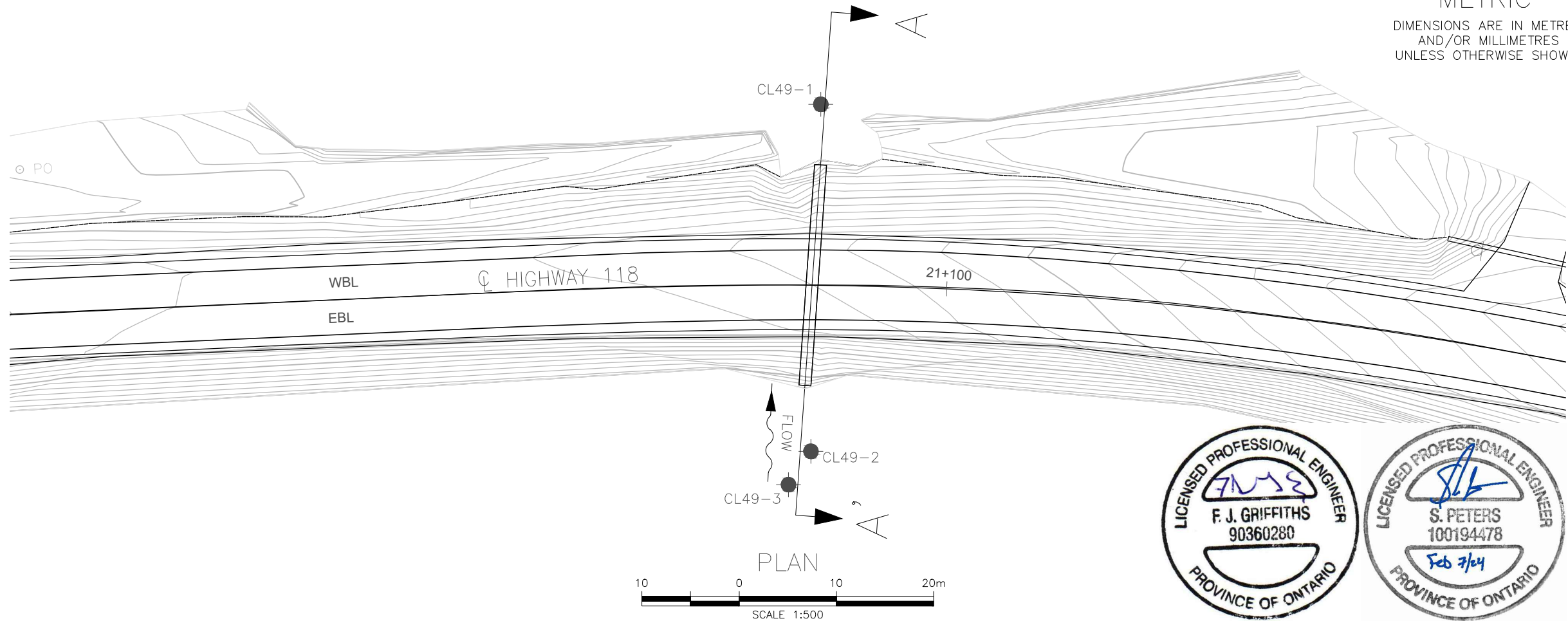
Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, 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

Borehole Locations and Strata Drawing



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

CONT No 2022-5007
GWP No 5011-19-00

HIGHWAY 118
TOWNSHIP OF DRAPER
CULVERT AT 21+086
BOREHOLE LOCATIONS AND SOIL STRATA

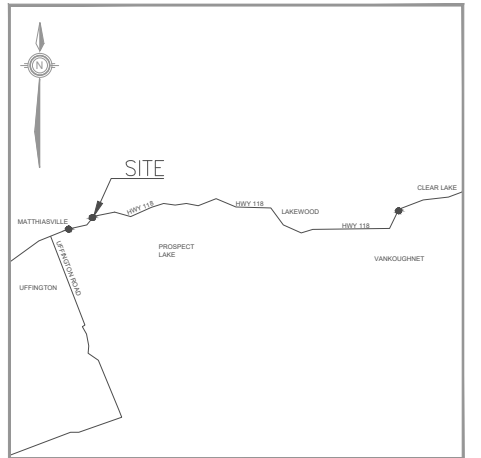


SHEET

McINTOSH PERRY



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

●	Current Borehole by MPCE
●	Previous Borehole by Others (Approx.)
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

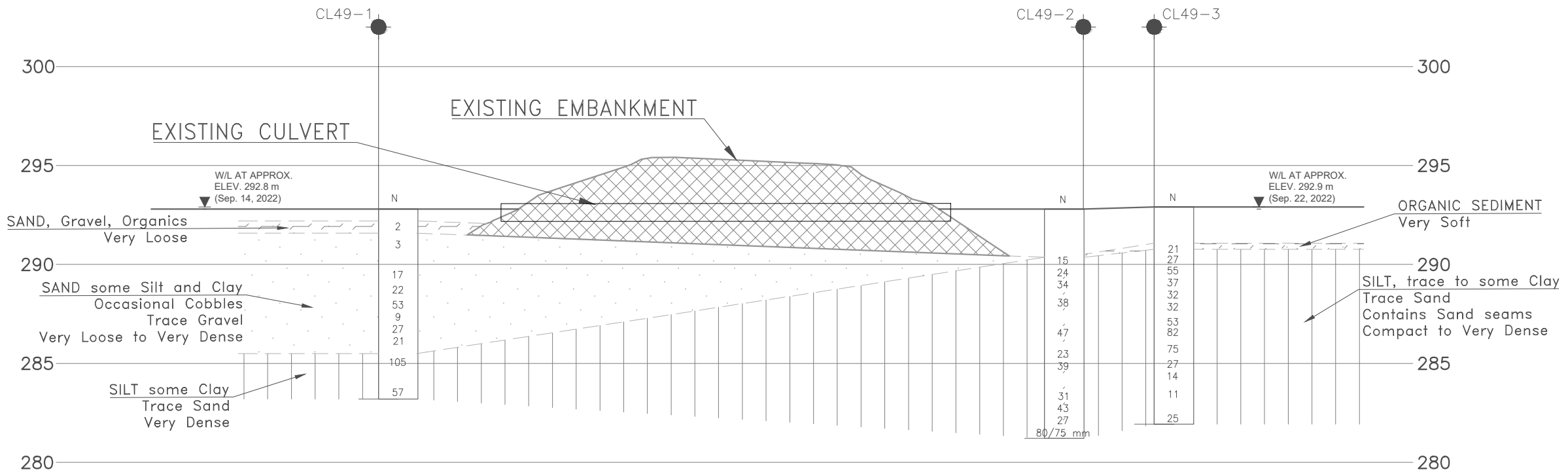
NO	ELEVATION	NORTHING	EASTING
CL49-1	292.2	4 984 629.0	330 837.1
CL49-2	290.5	4 984 601.4	330 859.7
CL49-3	291.1	4 984 597.3	330 860.2

NOTES-

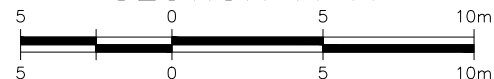
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Coordinate system is MTM NAD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

GEOCRES No.

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	AO	CHK KW	CODE
DRAWN	JEM	CHK KW	TO
			LOAD
			DATE
			NOV. 2023
			STRUCT
			DWG 1



SECTION A-A'



H 1:250

V 1:250

APPENDIX B

Symbols and Terms

Record of Boreholes Sheets (MPCE)

EXPLANATION OF TERMS USED IN REPORT

N-VALUE: THE STANDARD PENETRATION TEST (SPT) N-VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5 kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N-VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N-VALUE IS DENOTED THUS N.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

C_u (kPa)	0 – 12	12 – 25	25 – 50	50 – 100	100 – 200	>200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 – 5	5 – 10	10 – 30	30 – 50	>50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY IS:

RQD (%)	0 – 25	25 – 50	50 – 75	75 – 90	90 – 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINT AND BEDDING:

SPACING	50mm	50 – 300mm	0.3m – 1m	1m – 3m	>3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
c_c	1	COMPRESSION INDEX
c_s	1	SWELLING INDEX
c_a	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{v0}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
Φ_i	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
Φ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = c_u / τ_r

PHYSICAL PROPERTIES OF SOIL

P_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{\min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
P_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	s_r	%	DEGREE OF SATURATION	D_n	mm	N PERCENT – DIAMETER
P	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
P_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $(W_L - W_P)$	v	m/s	DISCHARGE VELOCITY
P_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $(W - W_P) / I_p$	i	1	HYDAULIC GRADIENT
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_c	1	CONSISTENCY INDEX = $(W_L - W) / I_p$	k	m/s	HYDRAULIC CONDUCTIVITY
P'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{\max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

METRIC

● ³, × ³: Numbers refer to Sensitivity ○ ³% STRAIN AT FAILURE

METRIC

● ³, × ³: Numbers refer to Sensitivity ○ ³% STRAIN AT FAILURE

MP MTO GINT HWY118 CL47 AND 49 BRACEBRIDGE.GPJ MP OTTAWA FOUNDATIONS.GDT 23-12-14

RECORD OF BOREHOLE No CL49-2

2 OF 2

METRIC

W.P. 5011-19-00 / MP: OKM-17-7060-11 LOCATION E330859.7 N4984601.4 / 45.000921 -79.169452 ORIGINATED BY MH-MPCE
 DIST NER HWY Hwy 118 BOREHOLE TYPE Portable SPT (full weight) COMPILED BY MH-MPCE
 DATUM Geodetic(Trimble R2) DATE 2022-09-19 CHECKED BY MA-MPCE

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			
	Silt, trace sand to with sand, grey, compact to dense, moist. (continued)		9	SS	43												
			10	SS	27												
			11	SS	80/ 3												
281.2 11.6	END OF BOREHOLE																

RECORD OF BOREHOLE No CL49-3

1 OF 2

METRIC

W.P. 5011-19-00 / MP: OKM-17-7060-11 LOCATION E330860.2 N4984597.3 / 45.000885 -79.169445 ORIGINATED BY MH-MPCE
 DIST NER HWY Hwy 118 BOREHOLE TYPE Portable SPT (full weight) COMPILED BY MH-MPCE
 DATUM Geodetic(Trimble R2) DATE 2022-09-21 - 2022-09-22 CHECKED BY MA-MPCE

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									
								20	40	60	80	100					
292.9 0.0	Water						20	40	60	80	100						GR SA SI CL
	Water: 1.8 m																
291.1 1.8	Sediment: Organic, dark brown, very soft, wet.																
290.7 2.1	Silt, trace sand, grey, compact to very dense, moist.		1	SS	21												
	Sand seam =====		2	SS	27												0 79 (21)
	Sand seam =====		3	SS	55												
			4	SS	37												
			5	SS	32											0 4 68 28	
			6	SS	32												
			7	SS	53												
			8	SS	82												
			9	SS	75											0 3 (97)	
			10	SS	27												
			11	SS	14												
			12	SS	11												

Continued Next Page

3, X 3: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No CL49-3

2 OF 2

METRIC

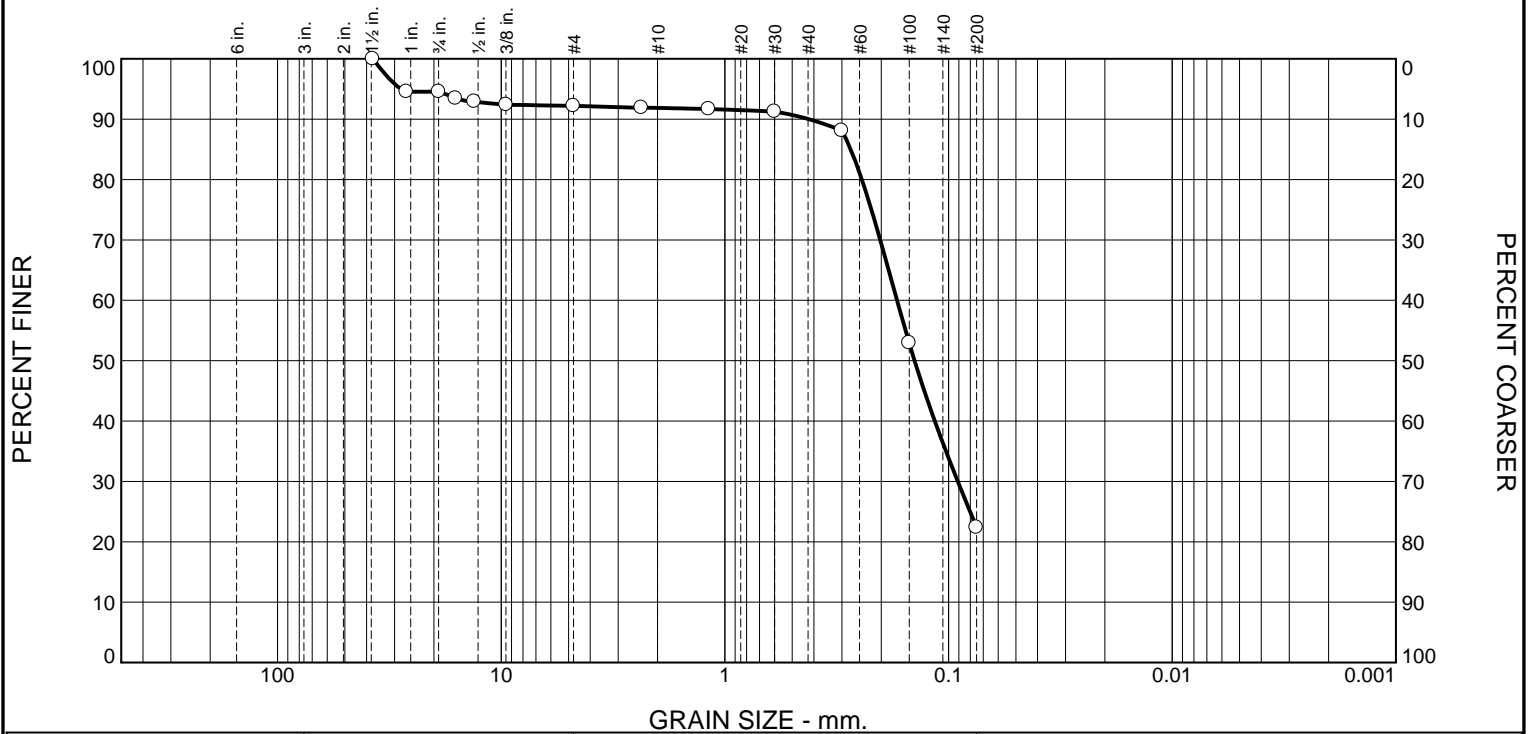
W.P. 5011-19-00 / MP: OKM-17-7060-11 LOCATION E330860.2 N4984597.3 / 45.000885 -79.169445 ORIGINATED BY MH-MPCE
 DIST NER HWY Hwy 118 BOREHOLE TYPE Portable SPT (full weight) COMPILED BY MH-MPCE
 DATUM Geodetic(Trimble R2) DATE 2022-09-21 - 2022-09-22 CHECKED BY MA-MPCE

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			
281.9	Silt, trace sand, grey, compact to very dense, moist. (continued)		13	SS	25												
11.0	END OF BOREHOLE																

APPENDIX C

Particle Size Analysis Figures
Atterberg Limit Test Results
Analytical Testing Results

Particle Size Distribution Report



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	5.4	2.4	0.3	1.9	67.6	22.4	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
37.5mm	100.0		
26.5mm	94.6		
19.0mm	94.6		
16.0mm	93.5		
13.2mm	92.9		
9.5mm	92.4		
4.75mm	92.2		
2.36mm	91.9		
1.18mm	91.7		
0.600mm	91.3		
0.300mm	88.1		
0.150mm	52.9		
0.075mm	22.4		

* (no specification provided)

Material Description		
Fine Sand with Silt/Clay trace Gravel		
Atterberg Limits (ASTM D 4318)		
PL=	LL=	PI=
Classification		
USCS (D 2487)=	AASHTO (M 145)=	
Coefficients		
D ₉₀ = 0.4210	D ₈₅ = 0.2736	D ₆₀ = 0.1701
D ₅₀ = 0.1419	D ₃₀ = 0.0910	D ₁₅ =
D ₁₀ =	C _u =	C _c =
F.M.=1.05		
Remarks		
Date Received: Sept 28,2022 Date Tested: Oct 5,2022		
Tested By: JHJ		
Checked By: J.Hopwood-Jones		
Title: Lab Manager		

Location: CL49-1 SS-4
Sample Number: SS-4

Depth: 12'6"-14'6"

Date Sampled: Sept 22,2022

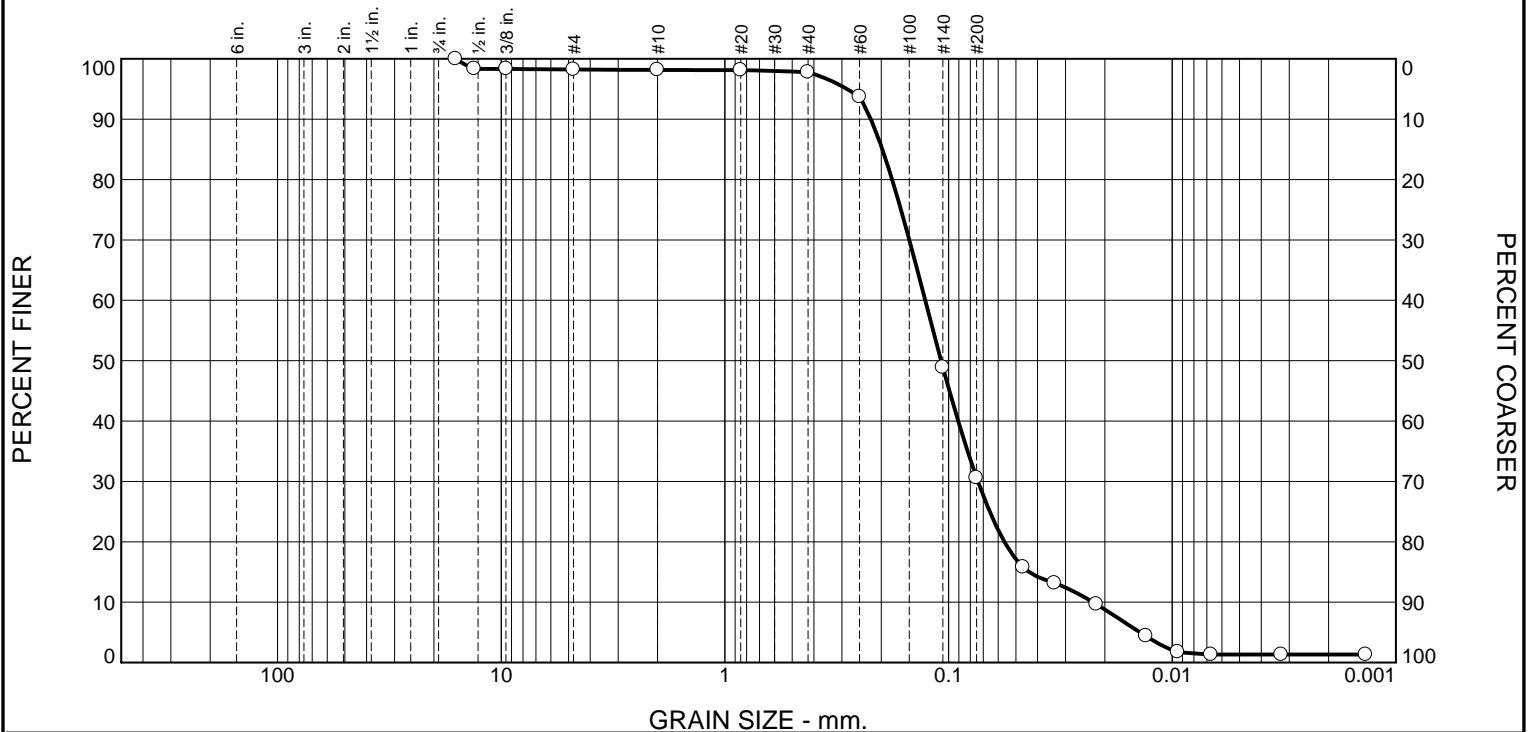
McINTOSH PERRY

Client: MTO Northeastern Region
Project: HWY 118

Project No: CCO-177060-11

Figure C1

Particle Size Distribution Report



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.8	0.0	0.4	67.2	29.3	1.3

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
16.0mm	100.0		
13.2mm	98.3		
9.5mm	98.3		
4.75mm	98.2		
2.00mm	98.2		
0.850mm	98.1		
0.425mm	97.8		
0.250mm	93.7		
0.106mm	48.9		
0.075mm	30.6		
0.0464 mm.	15.8		
0.0336 mm.	13.2		
0.0218 mm.	9.7		
0.0131 mm.	4.4		
0.0094 mm.	1.8		
0.0067 mm.	1.3		
0.0033 mm.	1.3		
0.0014 mm.	1.3		

* (no specification provided)

Material Description Fine Sand with Silt trace fine Gravel trace Clay		
Atterberg Limits (ASTM D 4318) PL= _____ LL= _____ PI= _____		
Classification USCS (D 2487)= _____ AASHTO (M 145)= _____		
Coefficients D ₉₀ = 0.2225 D ₈₅ = 0.1976 D ₆₀ = 0.1272 D ₅₀ = 0.1080 D ₃₀ = 0.0740 D ₁₅ = 0.0437 D ₁₀ = 0.0226 C _u = 5.62 C _c = 1.90		
Remarks Note: Specific Gravity of soil is assumed.F.M.=0.44		
Date Received: _____		Date Tested: Oct 6,2022
Tested By: R.C		
Checked By: J.Hopwood-Jones		
Title: Lab Manager		

Location: CL49-1 SS-5
 Sample Number: SS-5

Depth: 15'-17'

Date Sampled: Sept 22,2022

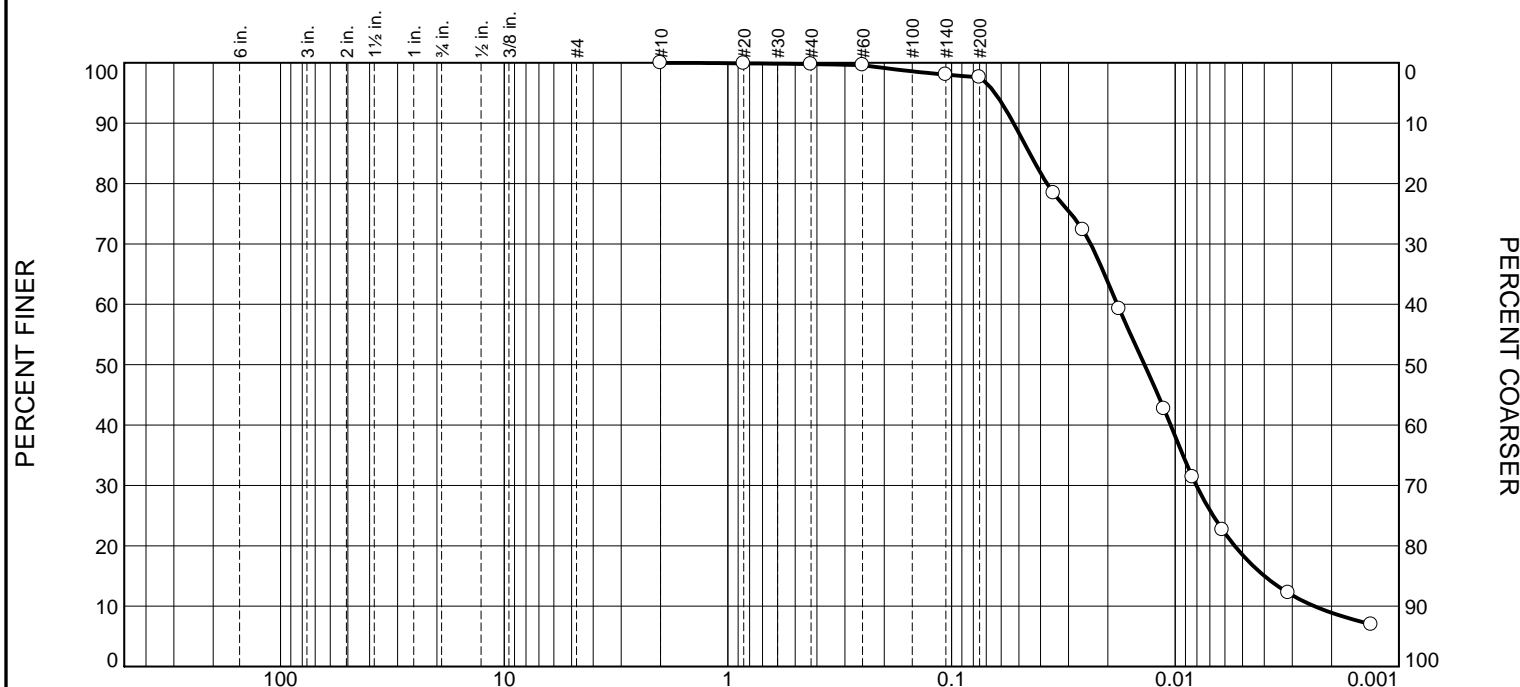
McINTOSH PERRY

Client: MTO Northeastern Region
 Project: HWY 118

Project No: CCO-177060-11

Figure C2

Particle Size Distribution Report



GRAIN SIZE - mm.

% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	2.2	79.1	18.5

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2.00mm	100.0		
0.850mm	99.9		
0.425mm	99.8		
0.250mm	99.6		
0.106mm	98.0		
0.075mm	97.6		
0.0350 mm.	78.4		
0.0259 mm.	72.3		
0.0178 mm.	59.2		
0.0112 mm.	42.7		
0.0084 mm.	31.4		
0.0061 mm.	22.7		
0.0031 mm.	12.2		
0.0013 mm.	7.0		

* (no specification provided)

Material Description

Silt some Clay trace fine Sand

Atterberg Limits (ASTM D 4318)

PL= 21.4 LL= 23.3 PI= 1.9

Classification

USCS (D 2487)= ML AASHTO (M 145)= A-4(1)

Coefficients

D₉₀= 0.0528 D₈₅= 0.0447 D₆₀= 0.0182
D₅₀= 0.0137 D₃₀= 0.0080 D₁₅= 0.0040
D₁₀= 0.0024 C_u= 7.60 C_c= 1.49

Remarks

Note: Specific Gravity of soil is assumed.F.M.=0.02

Date Received: Sept 28,2022 Date Tested: Oct 6,2022

Tested By: R.C

Checked By: J.Hopwood-Jones

Title: Lab Manager

Location: CL49-1 SS-9
Sample Number: SS-9

Depth: 20'-22'

Date Sampled: Sept 22,2022

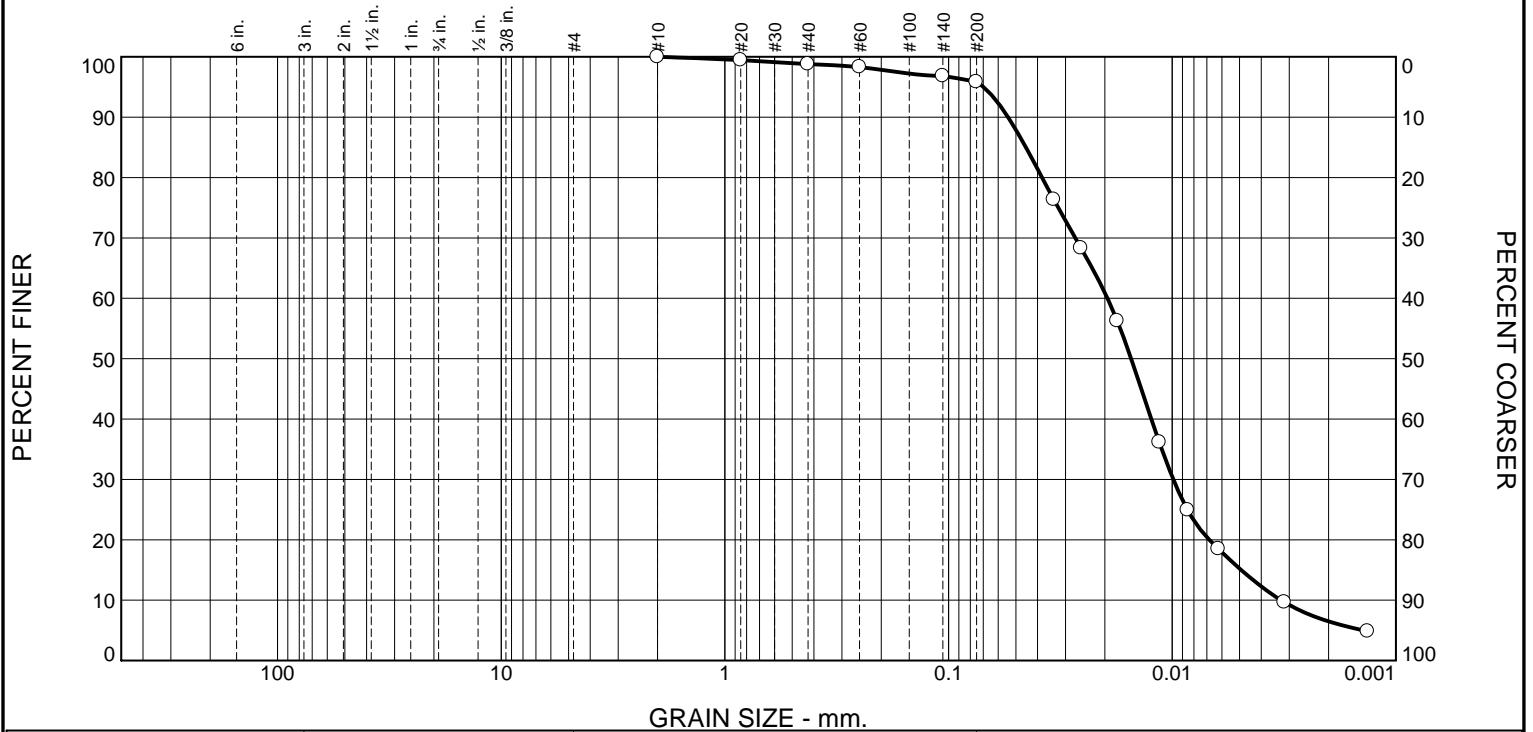
McINTOSH PERRY

Client: MTO Northeastern Region
Project: HWY 118

Project No: CCO-177060-11

Figure C3

Particle Size Distribution Report



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.2	2.9	80.7	15.2

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2.00mm	100.0		
0.850mm	99.5		
0.425mm	98.8		
0.250mm	98.3		
0.106mm	96.8		
0.075mm	95.9		
0.0338 mm.	76.4		
0.0256 mm.	68.3		
0.0176 mm.	56.3		
0.0114 mm.	36.2		
0.0085 mm.	24.9		
0.0062 mm.	18.5		
0.0031 mm.	9.6		
0.0013 mm.	4.8		

* (no specification provided)

Material Description
 Silt some Clay trace Sand

Atterberg Limits (ASTM D 4318)
 PL= 21.7 LL= 21.0 PI= NP

Classification
 USCS (D 2487)= ML AASHTO (M 145)= A-4(0)

Coefficients
 D₉₀= 0.0542 D₈₅= 0.0451 D₆₀= 0.0195
 D₅₀= 0.0153 D₃₀= 0.0099 D₁₅= 0.0049
 D₁₀= 0.0033 C_u= 5.97 C_c= 1.54

Remarks
 Note: Specific Gravity of soil is assumed.F.M.=0.05

Date Received: Sept 28,2022 Date Tested: Oct 6,2022
 Tested By: R.C
 Checked By: J.Hopwood-Jones
 Title: Lab Manager

Location: CL49-2 SS-2
Sample Number: SS-2

Depth: 9'6"-11'6"

Date Sampled: Sept 22,2022

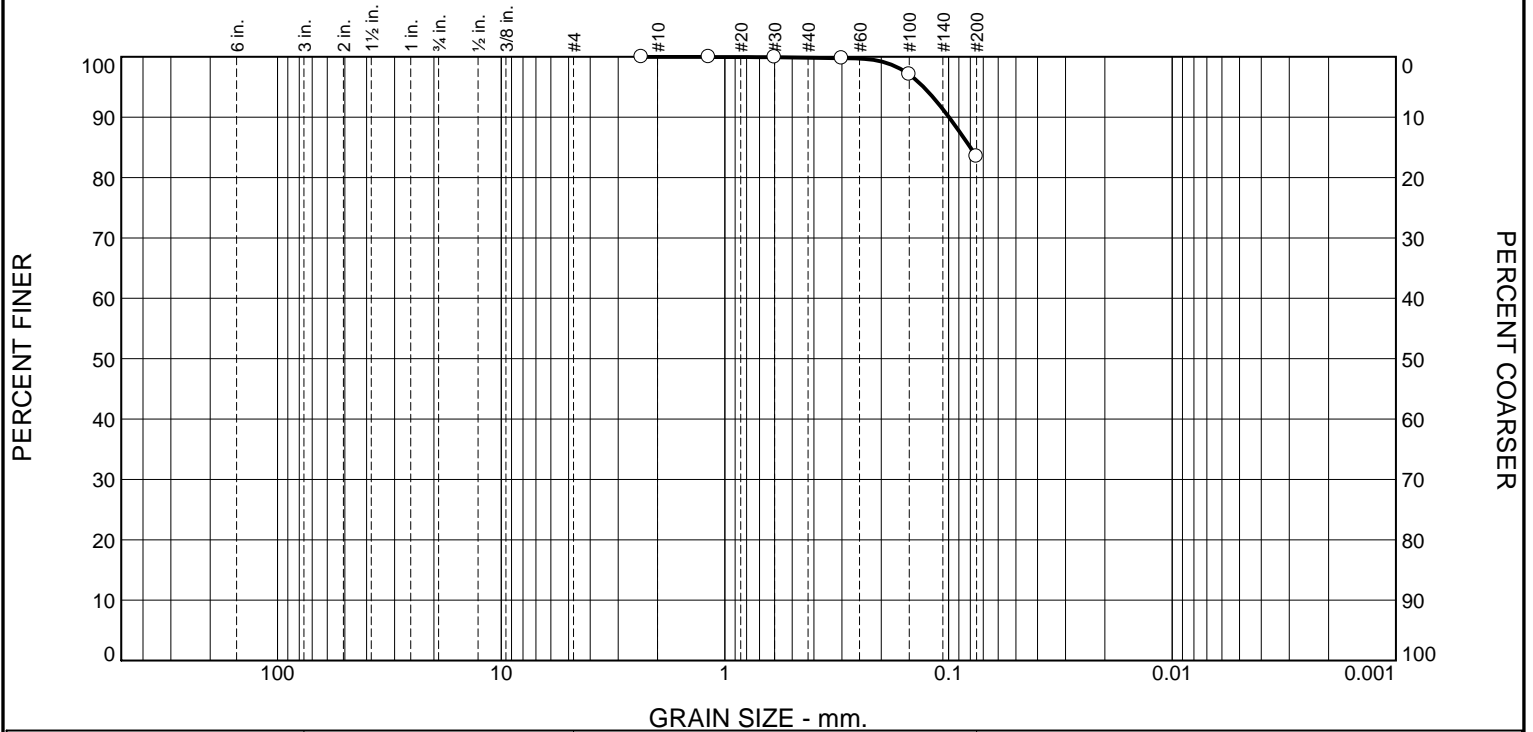
McINTOSH PERRY

Client: MTO Northeastern Region
Project: HWY 118

Project No: CCO-177060-11

Figure C4

Particle Size Distribution Report



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	16.3	83.5	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2.36mm	100.0		
1.18mm	100.0		
0.600mm	99.9		
0.300mm	99.8		
0.150mm	97.1		
0.075mm	83.5		

* (no specification provided)

Material Description		
Silt/Clay some fine Sand		
Atterberg Limits (ASTM D 4318)		
PL=	LL=	PI=
Classification		
USCS (D 2487)=	AASHTO (M 145)=	
Coefficients		
D ₉₀ = 0.0996	D ₈₅ = 0.0799	D ₆₀ =
D ₅₀ =	D ₃₀ =	D ₁₅ =
D ₁₀ =	C _u =	C _c =
F.M.=0.03		
Remarks		
Date Received: Sept 28,2022		Date Tested: Oct 6,2022
Tested By: JHJ		
Checked By: J.Hopwood-Jones		
Title: Lab Manager		

Location: CL49-2 SS-8
Sample Number: SS-8

Depth: 30'-32'

Date Sampled: Sept 22,2022

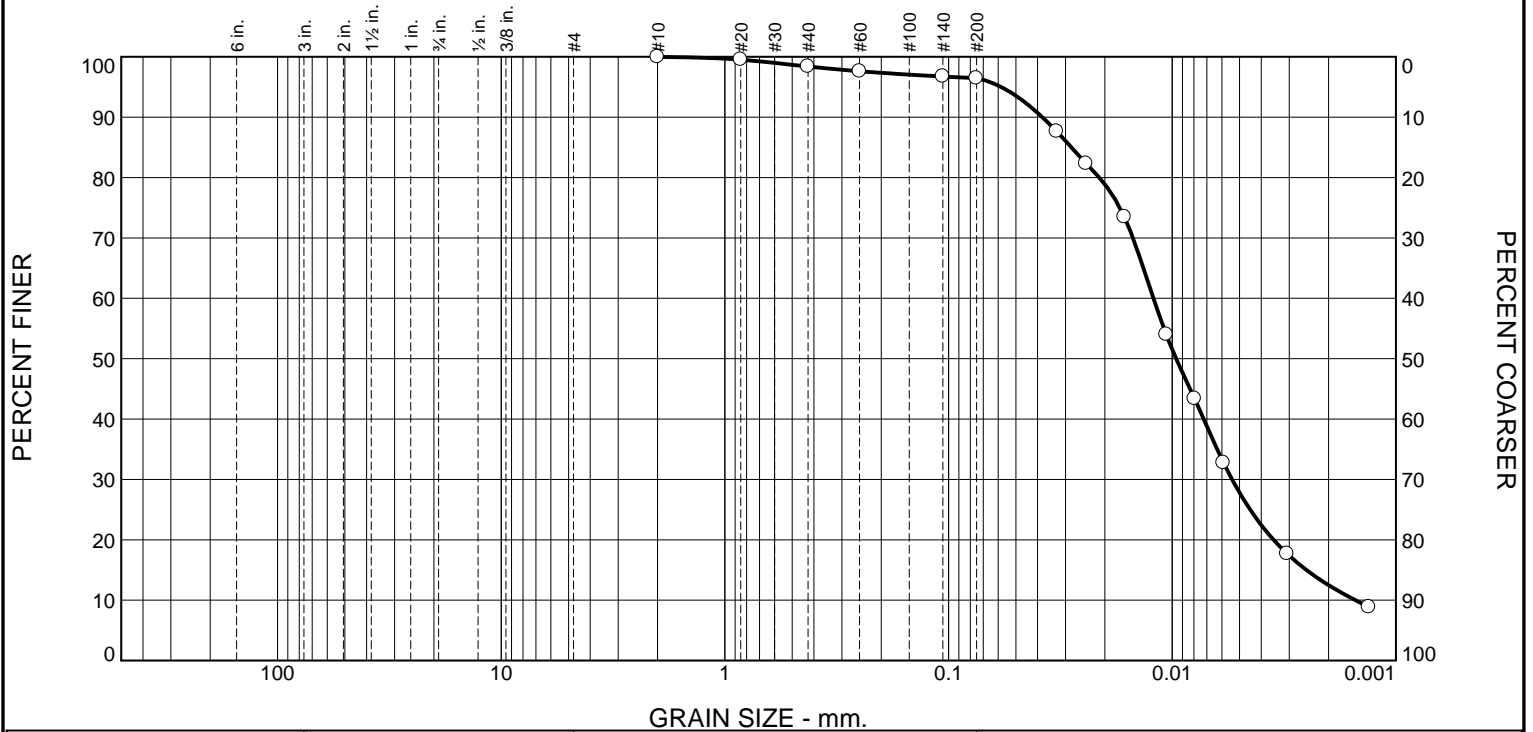
McINTOSH PERRY

Client: MTO Northeastern Region
Project: HWY 118

Project No: CCO-177060-11

Figure C5

Particle Size Distribution Report



GRAIN SIZE - mm.

% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.6	1.9	68.7	27.8

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2.00mm	100.0		
0.850mm	99.5		
0.425mm	98.4		
0.250mm	97.6		
0.106mm	96.7		
0.075mm	96.5		
0.0329 mm.	87.6		
0.0243 mm.	82.3		
0.0164 mm.	73.5		
0.0106 mm.	54.0		
0.0079 mm.	43.4		
0.0059 mm.	32.8		
0.0031 mm.	17.7		
0.0013 mm.	8.9		

* (no specification provided)

Material Description

Silt with Clay trace Sand

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D₉₀= 0.0381 D₈₅= 0.0283 D₆₀= 0.0121
D₅₀= 0.0096 D₃₀= 0.0054 D₁₅= 0.0025
D₁₀= 0.0015 C_u= 7.99 C_c= 1.59

Remarks

Note: Specific Gravity of soil is assumed.F.M.=0.06

Date Received: Sept 28,2022 Date Tested: Oct 6,2022

Tested By: R.C

Checked By: J.Hopwood-Jones

Title: Lab Manager

Location: CL49-3 SS-5
Sample Number: SS-5

Depth: 13'6"-15'6"

Date Sampled: Sept 22,2022

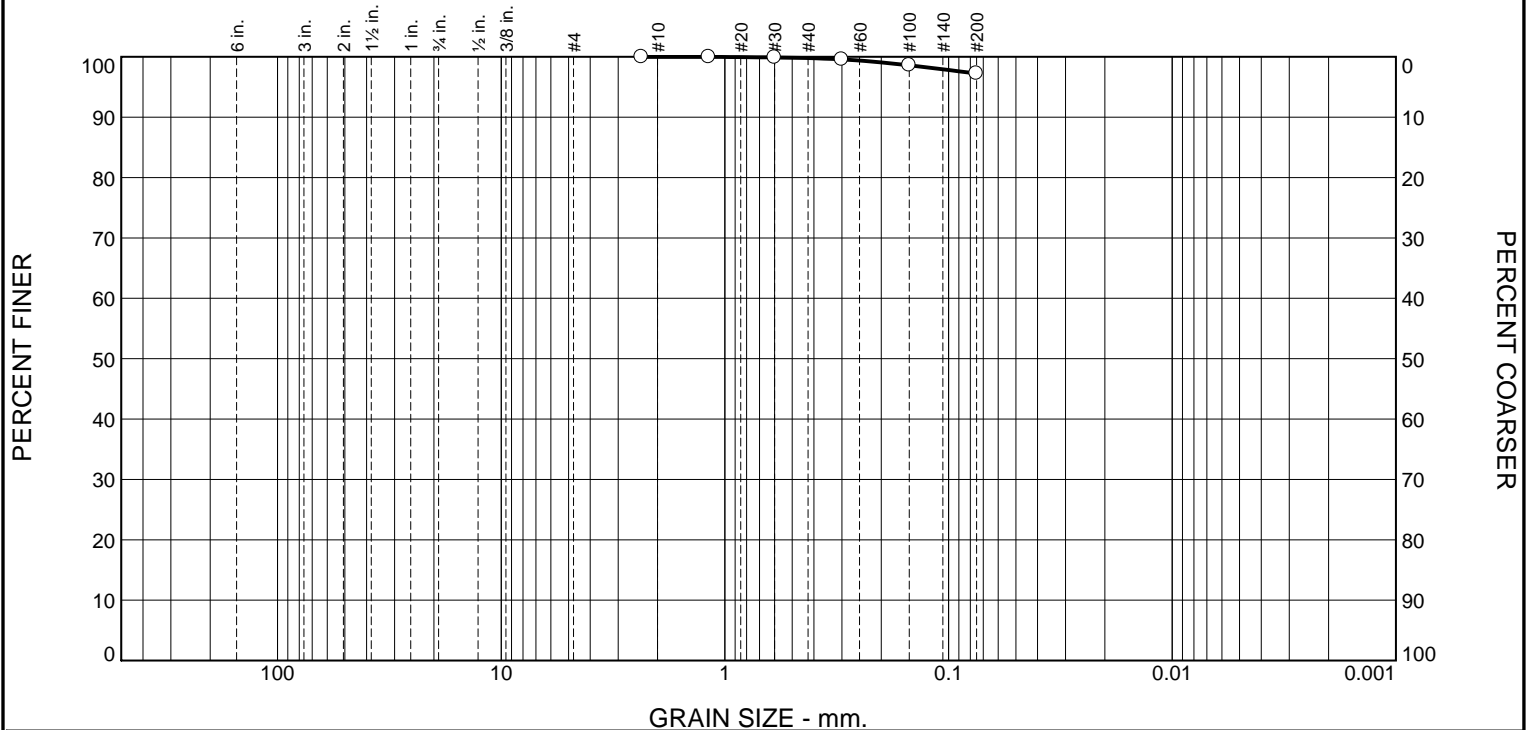
McINTOSH PERRY

Client: MTO Northeastern Region
Project: HWY 118

Project No: CCO-177060-11

Figure C6

Particle Size Distribution Report



GRAIN SIZE - mm.

% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	2.6	97.2	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2.36mm	100.0		
1.18mm	100.0		
0.600mm	99.9		
0.300mm	99.6		
0.150mm	98.6		
0.075mm	97.2		

* (no specification provided)

Material Description
Silt/Clay trace fine Sand

Atterberg Limits (ASTM D 4318)
PL= LL= PI=

Classification
USCS (D 2487)= AASHTO (M 145)=

Coefficients
D₉₀= D₈₅= D₆₀=
D₅₀= D₃₀= D₁₅=
D₁₀= C_u= C_c=

Remarks
F.M.=0.02

Date Received: Sept 28,2022 **Date Tested:** Oct 7,2022
Tested By: JHJ
Checked By: J.Hopwood-Jones
Title: Lab Manager

Location: CL49-3 SS-9
Sample Number: SS-9

Depth: 22'6"-24'6"

Date Sampled: Sept 22,2022

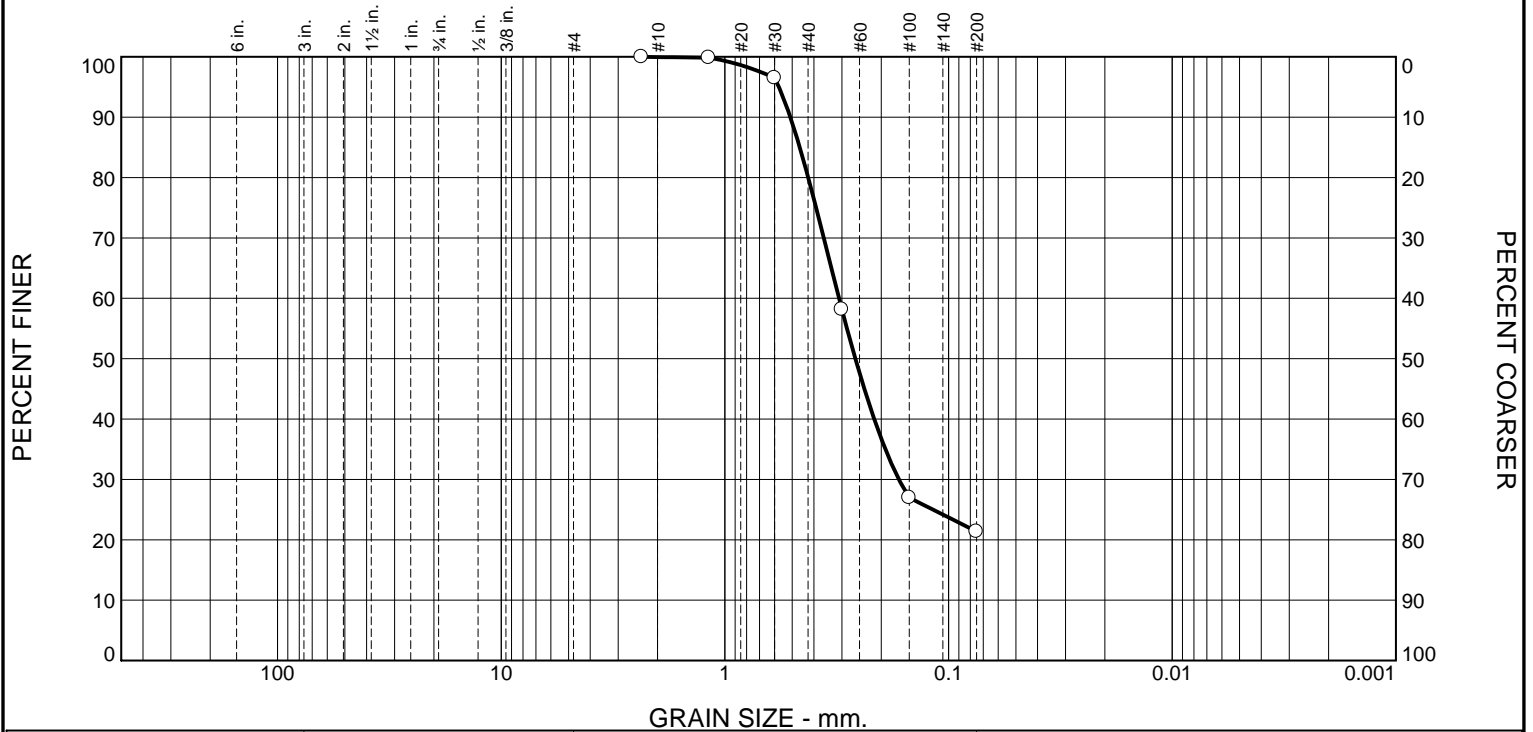
McINTOSH PERRY

Client: MTO Northeastern Region
Project: HWY 118

Project No: CCO-177060-11

Figure C7

Particle Size Distribution Report



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	19.9	58.7	21.4	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2.36mm	100.0		
1.18mm	99.9		
0.600mm	96.5		
0.300mm	58.2		
0.150mm	27.0		
0.075mm	21.4		

* (no specification provided)

Material Description		
Sand with Silt/Clay		
Atterberg Limits (ASTM D 4318)		
PL=	LL=	PI=
Classification		
USCS (D 2487)=	AASHTO (M 145)=	
Coefficients		
D ₉₀ = 0.5095	D ₈₅ = 0.4626	D ₆₀ = 0.3090
D ₅₀ = 0.2611	D ₃₀ = 0.1670	D ₁₅ =
D ₁₀ =	C _u =	C _c =
F.M.=1.18		
Remarks		
Date Received: Sept 28,2022		Date Tested: Oct 6,2022
Tested By: JHJ		
Checked By: J.Hopwood-Jones		
Title: Lab Manager		

Location: CL49-3 SS-2A
Sample Number: SS-2A

Depth: 8'-8 1/4"

Date Sampled: Sept 22,2022

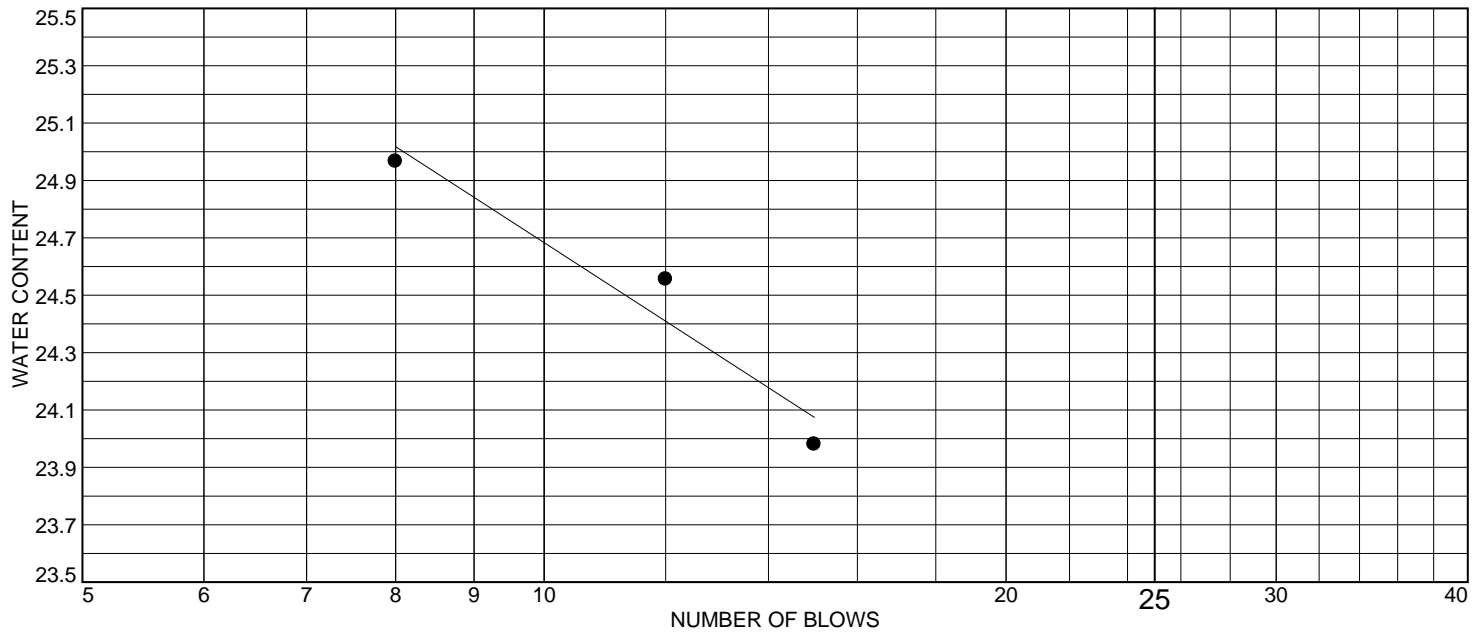
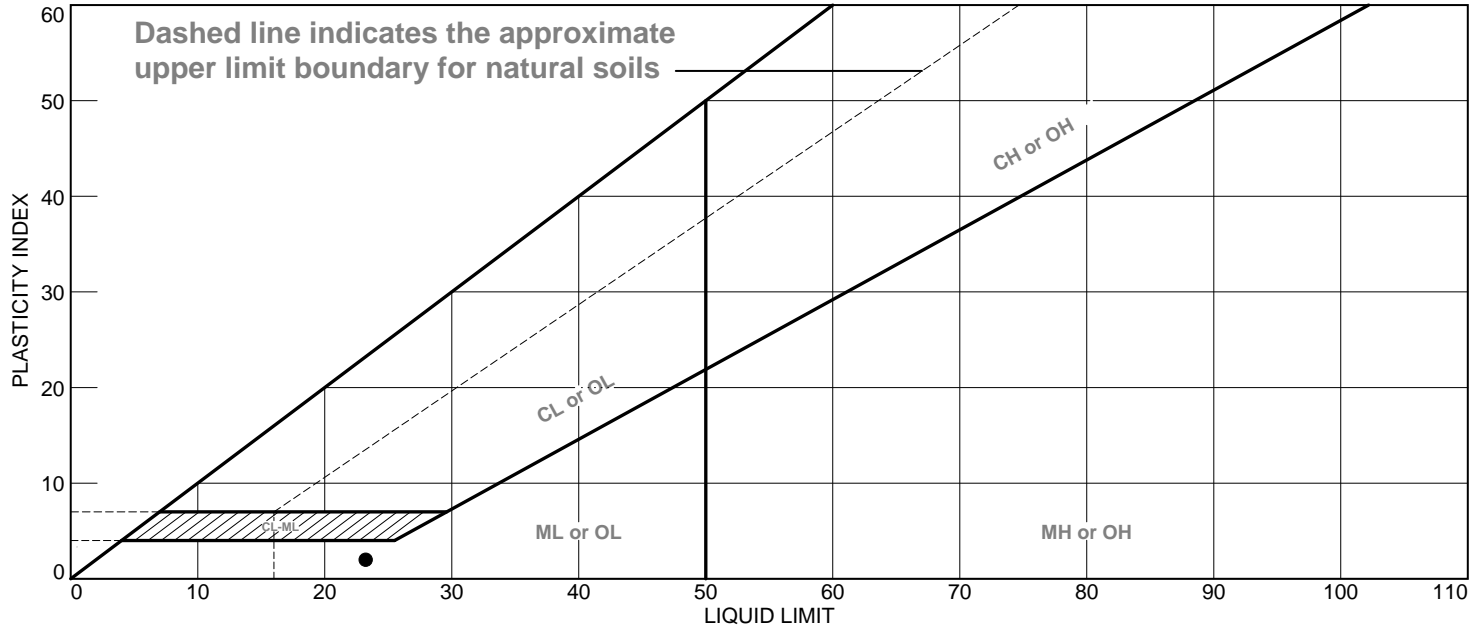
McINTOSH PERRY

Client: MTO Northeastern Region
Project: HWY 118

Project No: CCO-177060-11

Figure C8

LIQUID AND PLASTIC LIMITS TEST REPORT



MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
● Silt some Clay trace fine Sand	23.3	21.4	1.9	99.8	97.6	ML

Project No. CCO-177060- **Client:** MTO Northeastern Region
Project: HWY 118

Location: CL49-1 SS-9
Sample Number: SS-9 **Depth:** 20'-22'

Remarks:

McINTOSH PERRY

Figure C9

Tested By: JHJ **Checked By:** J.Hopwood-Jones

Certificate of Analysis

McIntosh Perry Consulting Eng. (Nepean)

215 Menten Place, Unit 104
Nepean, ON K2H 9C1
Attn: Jason Hopwood-Jones

Client PO: Hwy 118
Project: CCO-17-7060
Custody: 137243

Report Date: 13-Oct-2022
Order Date: 29-Sep-2022

Order #: 2240504

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

Paracel ID

2240504-01

Client ID

CL49-2 SS-2 (9 ½ - 11 ½)

Approved By:



Dale Robertson, BSc
Laboratory Director

Certificate of Analysis

Report Date: 13-Oct-2022

Client: McIntosh Perry Consulting Eng. (Nepean)

Order Date: 29-Sep-2022

Client PO: Hwy 118

Project Description: CCO-17-7060

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	12-Oct-22	12-Oct-22
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	12-Oct-22	12-Oct-22
Resistivity	EPA 120.1 - probe, water extraction	12-Oct-22	12-Oct-22
Solids, %	CWS Tier 1 - Gravimetric	11-Oct-22	12-Oct-22

Certificate of Analysis

Report Date: 13-Oct-2022

Client: McIntosh Perry Consulting Eng. (Nepean)

Order Date: 29-Sep-2022

Client PO: Hwy 118

Project Description: CCO-17-7060

Client ID:	CL49-2 SS-2 (9 ½ - 11 ½)	-	-	-
Sample Date:	19-Sep-22 10:00	-	-	-
Sample ID:	2240504-01	-	-	-
MDL/Units	Soil	-	-	-

Physical Characteristics

% Solids	0.1 % by Wt.	80.3	-	-	-
----------	--------------	------	---	---	---

General Inorganics

pH	0.05 pH Units	7.34	-	-	-
Resistivity	0.10 Ohm.m	117	-	-	-

Anions

Chloride	5 ug/g dry	<5	-	-	-
Sulphate	5 ug/g dry	<5	-	-	-

Certificate of Analysis

Report Date: 13-Oct-2022

Client: McIntosh Perry Consulting Eng. (Nepean)

Order Date: 29-Sep-2022

Client PO: Hwy 118

Project Description: CCO-17-7060

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	5	ug/g						
Sulphate	ND	5	ug/g						
General Inorganics									
Resistivity	ND	0.10	Ohm.m						

Certificate of Analysis

Report Date: 13-Oct-2022

Client: McIntosh Perry Consulting Eng. (Nepean)

Order Date: 29-Sep-2022

Client PO: Hwy 118

Project Description: CCO-17-7060

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	5	ug/g	ND			NC	20	
Sulphate	ND	5	ug/g	ND			NC	20	
General Inorganics									
pH	7.56	0.05	pH Units	7.41			2.0	10	
Resistivity	11.8	0.10	Ohm.m	11.8			0.3	20	
Physical Characteristics									
% Solids	76.4	0.1	% by Wt.	76.6			0.3	25	

Certificate of Analysis

Report Date: 13-Oct-2022

Client: McIntosh Perry Consulting Eng. (Nepean)

Order Date: 29-Sep-2022

Client PO: Hwy 118

Project Description: CCO-17-7060

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	10.2	5	ug/g	ND	100	82-118			
Sulphate	11.4	5	ug/g	ND	111	80-120			

Certificate of Analysis

Report Date: 13-Oct-2022

Client: McIntosh Perry Consulting Eng. (Nepean)

Order Date: 29-Sep-2022

Client PO: Hwy 118

Project Description: CCO-17-7060

Qualifier Notes:

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

Source Result: Data used as source for matrix and duplicate samples

%REC: Percent recovery.

RPD: Relative percent difference.

NC: Not Calculated

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.



2240504

No 137243

Client Name: McIntosh Perry	Project Ref: OKM-17-7060 Hwy 118	Page 1 of 1
Contact Name: Jason Hopwood-Jones	Quote #:	Turnaround Time <input type="checkbox"/> 1 day <input type="checkbox"/> 3 day <input type="checkbox"/> 2 day <input checked="" type="checkbox"/> Regular
Address: Unit 104-215 Menten Place Nepean, ON K2H9C1	PO #: CCO-17-7060-#06 E-mail: j.hopwood-jones@mcintoshperry.com	
Telephone: 613-453-0751	Date Required: _____	

<input type="checkbox"/> REG 153/04 <input type="checkbox"/> Table 1 <input type="checkbox"/> Table 2 <input type="checkbox"/> Table 3 <input type="checkbox"/> Table For RSC: <input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> REG 406/19 <input type="checkbox"/> Res/Park <input type="checkbox"/> Med/Fine <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse <input type="checkbox"/> Agri/Other	Other Regulation <input type="checkbox"/> REG 558 <input type="checkbox"/> CCME <input type="checkbox"/> SU - Sani <input type="checkbox"/> PWQO <input type="checkbox"/> MISA <input type="checkbox"/> SU - Storm Mun: _____ <input type="checkbox"/> Other: _____	Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)	Required Analysis															
Sample ID/Location Name			Matrix	Air Volume	# of Containers	Sample Taken Date Time		PHCs F1-F4+BTEX	VOCs	PAHs	Metals by ICP	Hg	CrVI	B (HWS)	Sensitivity Package				
1 CL 49-2 55-2 (9 1/2 - 11 1/2)			5	MP	1	09/19/22 10:00 AM									✓				
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			

Comments:		Method of Delivery: Drop Box	
Relinquished By (Sign): [Signature]	Received By Driver/Depot: [Signature]	Received at Lab: [Signature]	Verified by: [Signature]
Relinquished By (Print): Jason H. Jones	Date/Time: Sept 29/22 4:25	Date/Time: Sep 30/22 11:00	Date/Time: Sep 30/22 11:15
	Temperature: 20.9 °C	Temperature: 19.4 °C	pH Verified: N/A

APPENDIX D

Site Photographs



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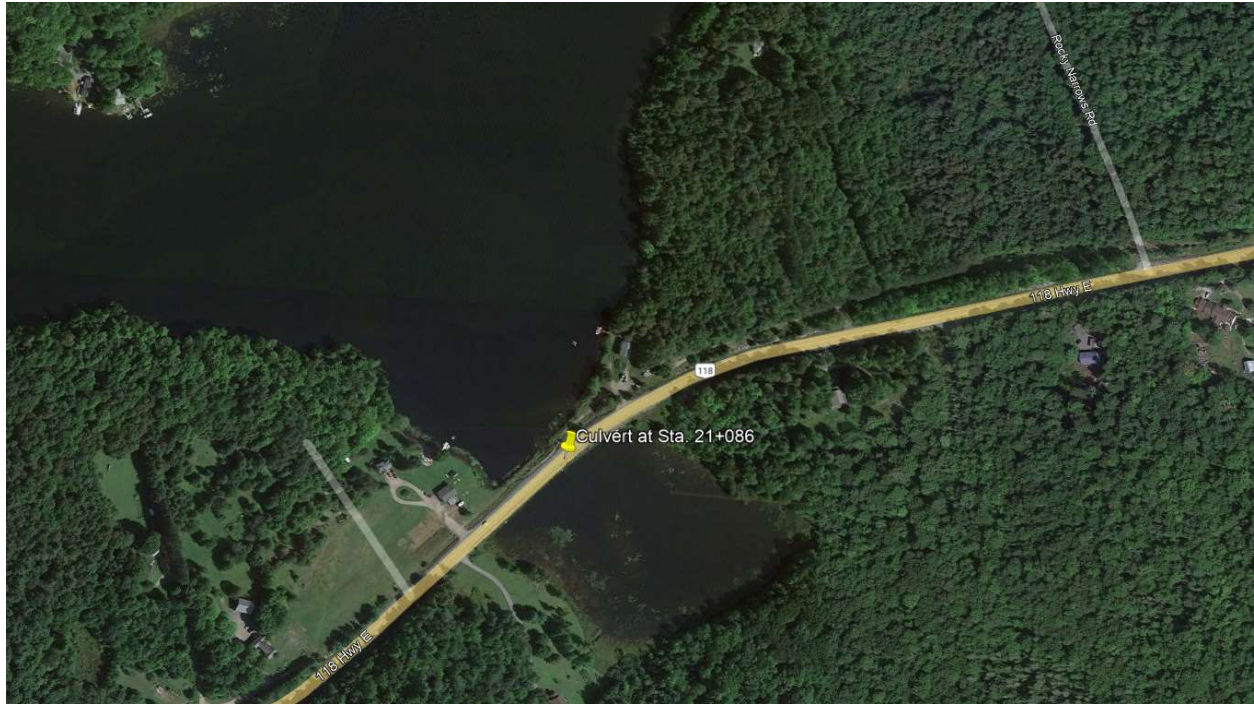


Photo 1: Plan View of Culvert at Sta.21+086 (Google Earth 1985)



Photo 2: Looking at inlet. STA 21+086 (MPCE) [Summer 2023]



Photo 3: Looking at outlet. STA 21+086 (MPCE) [Summer 2023]



Photo 4: Looking upstream. STA 21+086 (MPCE) [Summer 2023]



THURBER ENGINEERING LTD.



Photo 5: Looking downstream. STA 21+086 (MPCE) [Summer 2023]



Photo 6: Looking Northwest at road over culvert. STA 21+086 (MPCE) [Summer 2023]



THURBER ENGINEERING LTD.



***Photo 7: Looking Southeast at interior of the culvert. STA 21+086 (MPCE)
[Summer 2023]***

APPENDIX E

List of Referenced Specifications and Contract Provisions

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

- OPSS.PROV 206
- OPSS.PROV 501
- OPSS.PROV 517
- OPSS.PROV 539
- OPSS.PROV 1004
- OPSS.PROV 1860
- SP 517F01
- OPSD 208.010

2. Notice to Contractor – Presence of Soft Organic Soils in Temporary Work Areas

Soft, organic soils were encountered at ground surface in all three off-road boreholes drilled at this site. The Contractor is advised that the thickness and presence of organic deposits may extend to greater depths or be encountered at other locations between and beyond boreholes. It is anticipated that these materials will not provide a suitable temporary working surface. The Contractor may have to adjust his operations in areas with soft, organic soils.