THURBER ENGINEERING LTD.

PRELIMINARY FOUNDATION INVESTIGATION REPORT
HIGHWAY 401 WIDENING, HIGHWAY 16 TO MAITLAND ROAD
EDWARD STREET UNDERPASS, SITE NO. 16X-0128/B0
GWP 4024-20-00 / ASSIGNMENT NO. 4019-E-0010.2

Geocres No.: 31B-111

Report to:

MTO c/o AECOM Canada Ltd.

Latitude: 44.723032°
Longitude: -75.524982°

September 2023
Thurber File No.: 29381

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PRELIMINARY FOUNDATION INVESTIGATION REPORT
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PART 1. FACTUAL INFORMATION

1 INTRODUCTION

Thurber Engineering Ltd. (Thurber) has been retained by AECOM Canada Ltd. (AECOM) on behalf of the Ministry of Transportation Ontario (MTO) under Assignment No. 4019-E-0010, Work Item No. 2, to carry out Foundation Investigations to support the Preliminary Design and Environmental Assessment for the widening of Highway 401 from Highway 16 to Maitland Road. The overall scope of work comprises replacement or rehabilitation of 14 existing structures, including 10 bridges and four structural culverts.

This report addresses the Highway 401 Underpass at Edward Street (Site 16X-0128/B0), located approximately 5.0 km west of Highway 416, in the town of Prescott, Ontario.

This section of the report presents the factual findings obtained from a foundation investigation completed at the site, as well as data from existing subsurface information pertinent to the site, obtained from the MTO's Foundation Library (Geocres No. 31B00-016).

The purpose of this investigation 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. A model of the subsurface conditions influencing design and replacement of the structure 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

Site 16X-0128/B0 is located on Highway 401 approximately 5.0 km west of Highway 416. The location of the structure is shown on the inset Key Plan on Drawing No. 1 in Appendix A.

The current structure carries four lanes of Edward Street traffic over Highway 401. The Ontario Structure Inspection Manual (OSIM) report prepared by MTO on March 7, 2018 indicates that the existing structure is a one-span structure with reinforced cast-in-place concrete box girders and was constructed in 1957. The inspection report indicates that the bridge deck is approximately 38 m long and 17 m wide, with an approximate 16-degree skew to the highway. It is noted that

for project orientation purposes, Highway 401 will be assumed to be oriented east-west and Edward Street to be oriented north-south.

Highway 401 at this location has two through lanes and one acceleration lane in each direction with paved shoulders. The eastbound and westbound lanes are separated by a paved median. There is a concrete barrier wall in the median and steel beam guide rails located along the outer lanes north-east and south-west of the underpass structure.

Within the project limits Edward Street has two lanes in each direction. On the approaches, concrete curb and gutter are present in both directions. Steel beam guiderail systems are present on the approaches. The existing approach embankments are up to approximately 7 m high with slopes that extend down at approximately 2H:1V (Horizontal:Vertical). The embankment slopes are vegetated with long grasses, shrubs, and occasional trees. At the time of the field investigation, the embankments did not show any visible signs of distress or other performance issues.

Based on published geological information in *The Physiography of Southern Ontario* by Chapman and Putnam (1984), the site lies within the physiographic region known as the Edwardsburg Sand Plain. The Edwardsburg Sand Plain is characterized by and is characterized by glaciofluvial (deposited by glacial meltwater) sand deposits overlying bedrock, till or clay. Terrain is relatively flat, with sand ridges and moraines providing some relief. The area is known to be underlain by dolostone and dolomitic sandstone bedrock of the Beekmantown Group.

The land south of the site generally consists of commercial properties and residential dwellings. A gas station, retail mall, and high school are present to the southeast, with a residential development to the southwest. The land north of the site generally consists of open or treed, undeveloped lands with the exception of a car dealership in the northwest quadrant. The terrain surrounding the site is relatively flat. Storm water drainage in the area is a combination of median storm sewers on Highway 401 and roadside ditches along Edward Street and the outsides of Highway 401.

Photographs showing the existing conditions at the site at the time of the field investigation are included in Appendix D for reference.

3 SITE INVESTIGATION AND FIELD TESTING

3.1 Previous Investigations

A foundation investigation report for the existing Highway 401 Edward Street Underpass (31B00-016, 1956) was obtained from the online Geocres library. The investigation included one unsampled dynamic cone penetration test (DCPT) at the north abutment and two sampled boreholes, one at each abutment. The stratigraphy encountered in the sampled boreholes consisted of a surficial silty sand deposit ranging in thickness from 4.3 m to 5.2 m overlying a deep clay deposit underlain by bedrock. The clay deposit was firm to very stiff in consistency based on vane shear testing. Atterberg Limits testing indicates the clay would be classified to be of intermediate plasticity (CI). Bedrock was cored at the north abutment with a surface elevation

of ~75.3 m and was inferred based on refusal in the south abutment borehole and north abutment DCPT at elevations of ~75.0 m and ~75.5 m, respectively.

3.2 Current Field Investigation

The current field investigation for this site included advancing three boreholes between November 22 and December 8, 2022. The approximate locations in MTM NAD83, Zone 9 coordinates and elevations of the boreholes are shown on Drawing No. 1 provided in Appendix A and are summarized in the table below.

Borehole No.	Location	Northing (m) (Latitude)	Easting (m) (Longitude)	Ground Surface Elevation (m)	Termination Depth (m)
128-22-01	South Abutment	4 954 109.0 (44.722821°)	382 060.9 (-75.524708°)	99.8	28.1
128-22-02	North Abutment	4 954 166.8 (44.723344°)	382 025.2 (-75.525150°)	99.2	27.6
128-22-03	Hwy 401 Median	4 954 148.4 (44.723176°)	382 057.1 (-75.524749°)	92.4	20.9

As a component of our standard procedures and due diligence, Thurber contacted Ontario One Call to obtain utility locates/clearances in advance of drilling.

The boreholes were advanced using a truck-mounted CME 55 drill rig equipped with hollow stem augers, NW casing, and NQ coring equipment. Split spoon samples were collected at regular depth intervals in the boreholes during the completion of Standard Penetration Tests (SPT), following the methods described in ASTM Standard D1586-11. In-situ vane shear testing was conducted in the cohesive deposits following ASTM Standard D2573-18. The drilling and sampling operations were supervised on a full-time basis by a member of Thurber's geotechnical staff. The drilling supervisor logged the boreholes and processed the recovered soil and bedrock samples for transport to Thurber's Ottawa geotechnical laboratory for further examination and testing.

A piezometer consisting of a 19 mm PVC pipe were installed in Borehole 128-22-01 to allow for measurement of the groundwater level at the site. The piezometer construction details are illustrated on the corresponding Record of Borehole sheet provided in Appendix B. The standpipe piezometer at Borehole 128-22-01 was decommissioned in accordance with MOE requirements on April 26, 2023.

Following completion of the field investigation, the boreholes without a piezometer were decommissioned in general accordance with O.Reg. 903, as amended and capped with granular material and cold patch asphalt to reinstate the pavement surface.

The as-drilled borehole elevations were surveyed by Thurber with a surveyor's level with a reported accuracy of ±1.5 mm, relative to survey benchmarks provided by AECOM. Borehole elevations were reviewed with reference to the topographic survey received from AECOM. Horizontal as-drilled locations were measured relative to several existing site features. The borehole coordinates and elevations are shown on the Borehole Location and Soil Strata Drawing in Appendix A and the individual Record of Borehole sheets in Appendix B.

4 LABORATORY TESTING

Laboratory testing was selected in 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 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.

All rock cores were photographed and their total core recovery (TCR), solid core recovery (SCR) and rock quality designation (RQD) were measured. One sample of intact rock core was submitted for Unconfined Compressive Strength (UCS) testing.

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 paragraphs. However, the factual data presented on the Borehole Records takes precedence over the Soil Strata Drawing and this general description for interpretation of site conditions. It must be recognized that the soil and groundwater conditions will vary between and beyond borehole locations. Soil classification is in accordance with ASTM D2487 with cohesive soils described as per current MTO Guidelines for Foundation Engineering Services, Version 3 (April 2022).

In general terms, the encountered stratigraphy consisted of pavement structure and granular embankment fill, overlying a native silty sand to silt with sand deposit, overlying a cohesive deposit ranging in composition from silty clay to clayey silt underlain by a thin discontinuous silt layer overlying dolostone bedrock.

5.1 Fill

Asphalt

Asphalt was encountered at the ground surface in all boreholes and ranged in thickness from 150 mm to 200 mm.

A layer of buried asphalt with a thickness of 150 mm was encountered below the wood fill at a depth of 8.5 m (Elev. 91.3 m) in Borehole 128-22-01.

Silty Sand with Gravel

A fill layer consisting of silty sand with gravel was encountered below asphalt layer in Boreholes 128-22-01 and 128-22-03. The silty sand with gravel fill layer ranged in thickness of from 0.1 to 1.3 m (base Elev. 92.1 to 98.3 m). A single SPT N-Value of 16 blows was obtained within this layer indicating a compact relative density.

The recorded moisture content within this layer was 8%. A gradation analysis completed on one sample of the silty sand with gravel fill indicate the sample contained 18% gravel, 42% sand and 40% silt and clay sized particles. The results are illustrated on Figure C1 of Appendix C and summarized on the corresponding Record of Borehole sheet in Appendix B.

Sand with Silt to Silty Sand

A fill layer ranging in composition from sand with silt to silty sand was encountered below the silty sand with gravel fill layer in Boreholes 128-22-01 and 128-22-03 and below the asphalt in Borehole 128-22-02. The sand with silt to silty sand fill layer had a thickness ranging from 2.0 to 7.9 meters (base Elev. 90.1 to 91.6 m). The SPT N-values obtained typically ranged from 2 to 35 blows for 0.3 m of penetration indicating a very loose to dense relative density. A single SPT N-value of 100 blows for 100 mm of penetration was obtained near the base of the layer in Borehole 128-22-02 but is attributed to the buried concrete encountered below the layer rather than the sand with silt to silty sand fill layer.

The recorded moisture contents within this layer ranged from 4 to 22%. The results of gradation analyses completed on five samples of the sand with silt to silty sand fill are illustrated on Figure C2 of Appendix C. The results of the tests are summarized below and on the Record of Boreholes sheets in Appendix B.

Soil Particle	Percentage (%)
Gravel	0 to 2
Sand	82 to 95
Silt	4 to 17
Clay	

Concrete

A layer of concrete with a thickness of 0.38 m was encountered below the sand with silt fill in Borehole 128-22-02 at a depth of 8.1 m (Elev. 91.1 m). Auger refusal was encountered at the surface of this layer and wash boring and coring techniques were required to advance the borehole.

Wood

A fill layer consisting primarily of wood with silty sand with gravel infills was encountered below the sand with silt fill in Borehole 128-22-01 and below the concrete in Borehole 128-22-02. The wood fill layer had a thickness ranging from 0.3 to 1.4 meters (base Elev. 89.3 to 91.3 m). The SPT N-values obtained in the wood fill layer ranged from 42 to 81 blows for 0.3 m of penetration but are not considered to be indicative of the relative density of the layer due to the wood. The recorded moisture contents within the wood fill layer ranged from 11 to 200%.

Silty Sand

A thin layer of silty sand fill was encountered below buried asphalt layer in Borehole 128-22-01. This layer had a thickness of 0.3 m (base Elev. 90.8 m) and a recorded moisture content of 18%.

5.2 Sandy Silt to Silt with Sand

A native layer ranging in composition from sandy silt to silt with sand was encountered below the fill in all boreholes. The thickness of this layer ranged from 2.3 to 3.6 meters (base Elev. 87.0 to 87.2 m). The SPT N-values in sandy silt ranged from 2 to 24 blows for 0.3m of penetration indicating a very loose to compact relative density; but typically, loose to compact.

The recorded moisture contents typically ranged from 20 to 26%. A single moisture content of 83% was recorded near the base of the sandy silt to silt with sand layer in Borehole 128-22-03. The results of gradation analyses completed on three samples of the sandy silt to sand with silt are illustrated on Figure C3 of Appendix C. The results of the tests are summarized below and on the Record of Boreholes sheets in Appendix B.

Soil Particle	Percentage (%)
Gravel	0
Sand	17 to 39
Silt	53 to 74
Clay	6 to 9

The results of Atterberg limit testing completed on three samples of the sandy silt to silt with sand found the material to be non-plastic.

5.3 Silty Clay to Clayey Silt

A layer of silty clay was encountered beneath the sandy silt to silt with sand layer in all boreholes. The thickness of this layer ranged from 10.9 to 11.7 meters (base Elev. 75.3 to 76.3 m). SPT N-values in the silty clay ranged from weight of hammer to 8 blows but are not considered an accurate indictor of undrained shear strength. A single SPT N-value of 100 blows for 125 mm of penetration was obtained at the base of the silty clay layer in Borehole 128-22-02 but is attributed to the underlying bedrock. Field vane tests performed within this layer ranged from 86 kPa to greater than 102 kPa in indicating a stiff to very stiff consistency. Sensitivity values recorded in

the silty clay to clayey silt range from 6.3 to 32 indicating the class of sensitivity to range from sensitive to quick clay based on the Canadian Foundation Engineering Manual, 4th Edition.

Recorded moisture contents ranged from 21 to 39%. The results of gradation analyses completed on five samples of the silty clay to clayey silt are illustrated on Figure C4 of Appendix C. The results of the tests are summarized below and on the Record of Boreholes sheets in Appendix B.

Soil Particle	Percentage (%)
Gravel	0
Sand	0 to 2
Silt	40 to 55
Clay	44 to 60

The results of Atterberg limit tests completed on five samples of the silty clay to clayey silt are illustrated on Figure C5 of Appendix C. The results of the tests are summarized below and on the Record of Boreholes sheets in Appendix B. The laboratory results indicate that the silty clay to clayey silt exhibits low to intermediate plasticity (CL to CI).

Parameter	Value (%)
Liquid Limit	34 to 43
Plastic Limit	17 to 24
Plasticity Index	14 to 19
Liquidity Index	0.4 to 1.1

5.4 Silt

A thin layer of silt was encountered beneath the silty clay to clayey silt deposit in Boreholes 128-22-01 and 128-22-03. The thickness of this layer ranged from 0.8 to 1.6 m (base Elev. 74.7 m to 74.8 m). SPT N-values in this layer ranged from 9 to 10 blows indicating a loose to compact relative density A single SPT N-value of 100 blows for 50 mm of penetration was obtained at the base of the layer in Borehole 128-22-03 but is attributed to the underlying bedrock.

The moisture contents ranged from 5% to 20%. The results of gradation analyses completed on two samples of the silt are illustrated on Figure C6 of Appendix C. The results of these tests are summarized below and on the Record of Boreholes sheet in Appendix B.

Soil Particle	Percentage (%)
Gravel	0
Sand	0 to 1
Silt	85 to 87
Clay	13 to 14

The results of Atterberg limit testing completed on two samples of the silt found the material to be non plastic.

5.5 Bedrock

The overburden materials were underlain by a grey dolostone bedrock. Bedrock was cored in all boreholes; the bedrock surface ranges from elevation 74.7 m to 75.3 m. Photographs of the bedrock core are provided in Appendix C. The table below summarizes the depths and elevations of the bedrock surface.

Location	Borehole	Ground Surface Elevation (m)	Depth Below Existing Grade (m)	Top of Bedrock Elevation (m)
South Abutment	128-22-01	99.8	25.1	74.7
North Abutment	128-22-02	99.2	23.9	75.3
Hwy 401 Median	128-22-03	92.4	17.6	74.8

All boreholes were advanced into the bedrock with NQ-size coring equipment.

The bedrock had a total core recovery ranging from 96% to 100%, a solid core recovery ranging from 71% to 100% and a Rock Quality Designation (RQD) ranging from 81% to 100%. Based on the RQD value the bedrock is classified as good to excellent quality.

Unconfined compressive strength (UCS) testing was carried out on a sample of the dolostone bedrock from Borehole 128-22-01. The results of this test indicated a UCS strength of 174 MPa indicating a very strong bedrock. The results of the UCS testing are included in Appendix C.

5.6 Groundwater

A standpipe piezometer was installed in Borehole 128-22-01 to monitor the groundwater level after completion of drilling. The measured groundwater levels are summarized in the table below.

Borehole No.	Bottom of Screen Elev. (m)	Screened Unit	Depth (mbgs)	Groundwater Elevation (m)	Date of Measurement
128-22-01	78.6	Silty Clay	8.3	91.5	December 18, 2022
			8.2	91.6	April 26, 2023

A water level depth of 8.7 m (Elev. 90.5 m) was also obtained at Borehole 128-22-02 within the open borehole drilling casing which was left in the ground over the weekend during the drilling investigation.

These observations are considered short term and it should be noted that the groundwater level at the time of construction may be different. Seasonal fluctuations are to be expected. In particular, the water level may be at a higher elevation after periods of significant and/or prolonged precipitation and spring snow melts.

6 MISCELLANEOUS

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

Downing Drilling of Hawkesbury, Ontario supplied and operated the truck mounted CME 55 drill rig to carry out the drilling, sampling, in-situ testing, standpipe piezometer installation and borehole decommissioning. Water for wash boring was transported and provided by T.G. Carroll Cartage of Carp, Ontario. Traffic control was performed in accordance with Ontario Book 7 for short duration closures; all signs, barrels, cones and traffic control personnel were provided by T.G. Carroll Cartage of Carp, Ontario. The field investigation was supervised on a full-time basis by Ibrahim Khan, EIT.

Routine geotechnical laboratory testing was completed by Thurber's laboratory in Ottawa, Ontario. Unconfined Compressive Strength Testing of the bedrock was carried out by Stantec's laboratory in Ottawa, Ontario. Overall project management and direction of the field investigation was provided by Matt Kennedy, P.Eng. Management of the field investigation was carried out by Katya Walker, P.Eng. Interpretation of the factual data and preparation of this report was completed out by Ibrahim Khan, EIT and Christopher Murray, P.Eng. The report was reviewed by Matt Kennedy, P.Eng. and Fred Griffiths, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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THURBER

STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

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

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

3. BASIS OF REPORT

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

4. USE OF THE REPORT

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

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

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

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

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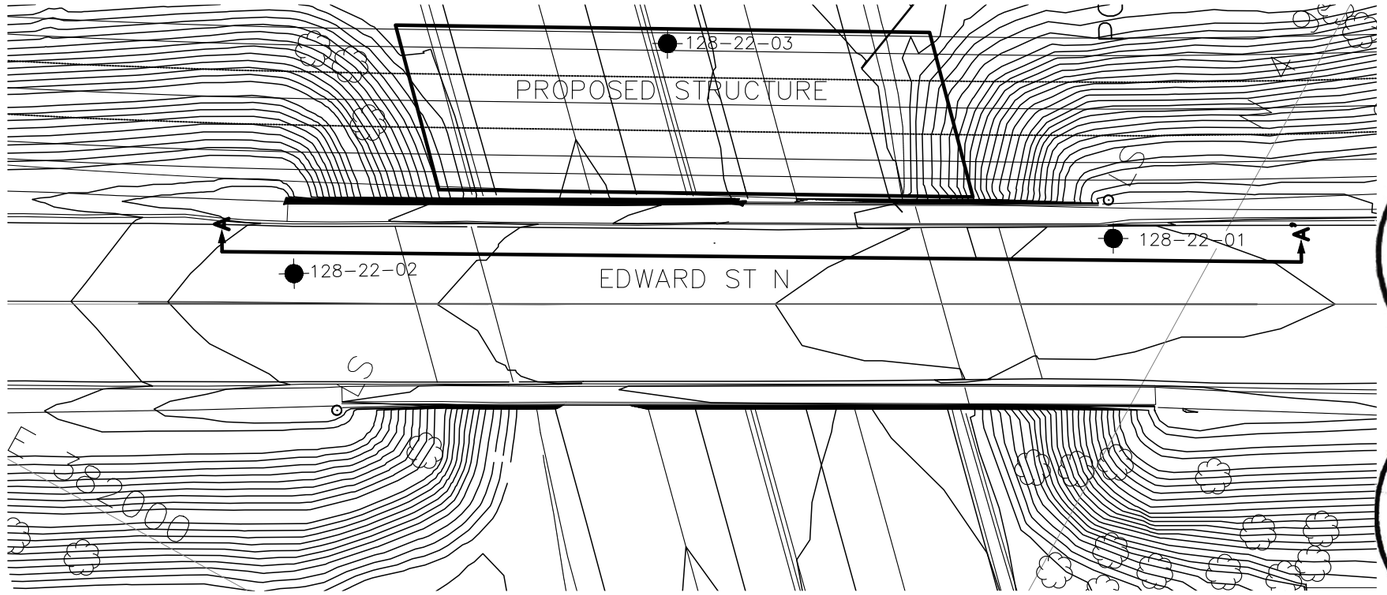
Appendix A.

Borehole Location Plan and Stratigraphic Drawing

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

10 0 10 20m

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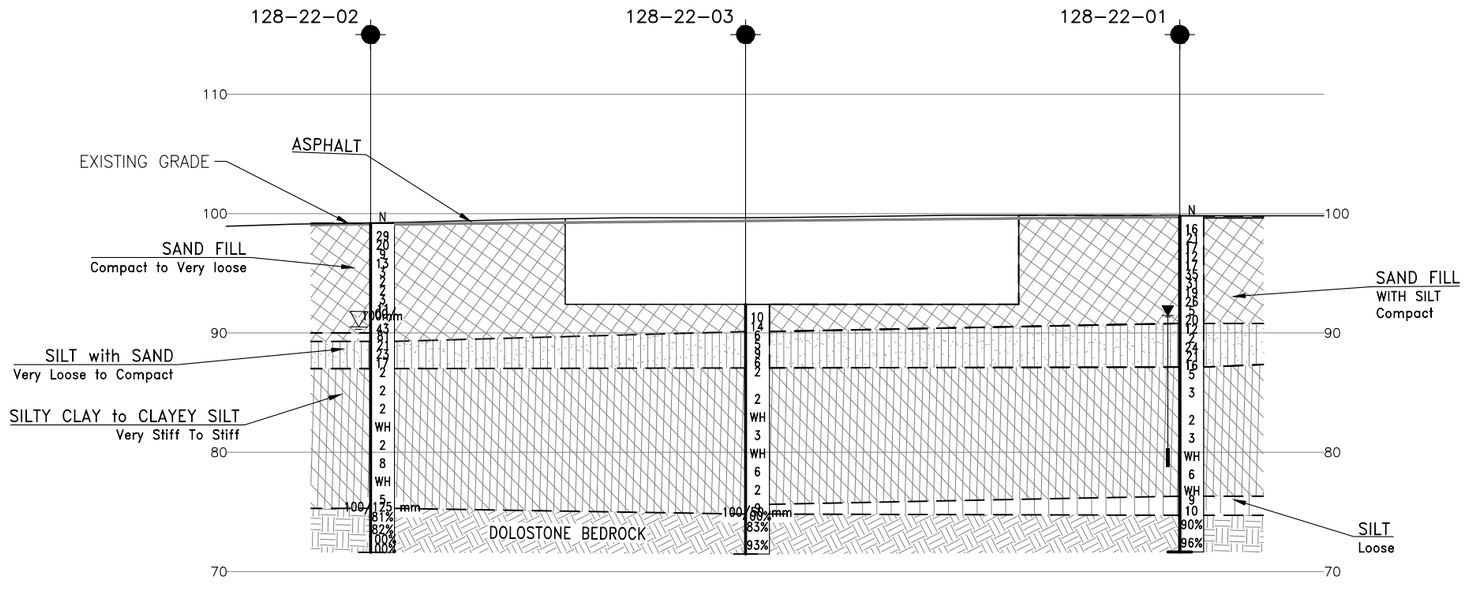

SECTION A-A

10 0 10 20m H 1:500

5 0 5 10m V 1:250

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
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100206832
Sept. 8, 2023
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
F. J. GRIFFITHS
90360280
Sept 8, 2023
PROVINCE OF ONTARIO

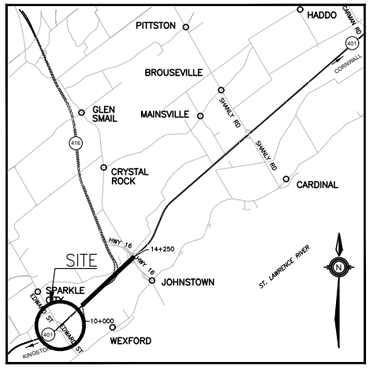
CONT No
GWP No 4024-20-00

HIGHWAY 401
EDWARD STREET UNDERPASS REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET 1

Ontario

THURBER ENGINEERING LTD.



KEYPLAN

	LEGEND
●	Borehole (Current Investigation)
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
128-22-01	99.8	4 954 109.0	382 060.9
128-22-02	99.2	4 954 166.8	382 025.2
128-22-03	92.4	4 954 148.4	382 057.1

-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 9.

GEOCRES No. 31B-111

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	MJK	CHK –	CODE	LOAD	DATE JUNE 203
DRAWN	JW	CHK MJK	SITE 16X-0128	STRUCT	DWG 1

FILENAME: T:\Drafting\29000\29381\TED-29381-BHPP(128).dwg
PLOTDATE: 8/28/2023 4:12 PM

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Appendix B.

Record of Borehole Sheets

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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:

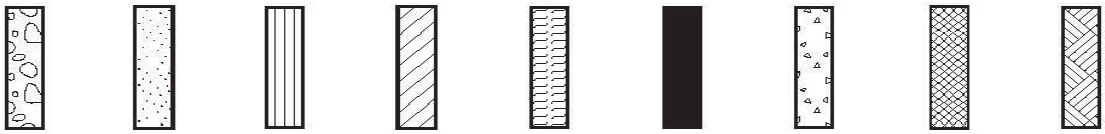
Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented,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

THURBER

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

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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

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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

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Ontario

THURBER

RECORD OF BOREHOLE No 128-22-01 1 OF 3 METRIC

GWP# 4024-20-00 LOCATION Lat: 44.722821°, Long: -75.524708° Edward Street Underpass, MTM z9: N 4 954 109.0 E 382 060.9 ORIGINATED BY IK

HWY 401 BOREHOLE TYPE CME 55 Truck Mount HSA / NW Casing / NQ Coring COMPILED BY RH

DATUM Geodetic DATE 2022.11.22 - 2022.11.24 CHECKED BY CM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
99.8	**Ground Surface**										
0.0	**ASPHALT (150 mm)**										
0.2	SILTY SAND with gravel compact brown **FILL**		1	SS	16		99		○		18 42 40 (SI+CL)
98.3											
1.5	SAND with silt loose to dense brown **FILL**		2	SS	21		98		○		
			3	SS	17		97		○		
			4	SS	12				○		0 94 6 (SI+CL)
			5	SS	17		96		○		
			6	SS	35		95		○		
			7	SS	31		94		○		
			8	SS	19				○		
			9	SS	26		93		○		0 92 8 (SI+CL)
			10	SS	5		92		○		
91.6											
8.2	WOOD with silty sand and gravel infills										
91.3	**FILL**										
8.5			11	SS	20				○		
8.7	**ASPHALT (150 mm)**						91				
90.8											
9.0	SILTY SAND compact grey **FILL**		12	SS	12						0 39 53 8
	SANDY SILT (ML) trace clay very loose to compact grey						90				

Continued Next Page

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

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

DOUBLE LINE 29381 EDWARD STREET UNDERPASS.GPJ 2012TEMPLATE(MTO).GDT 9-5-23

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 128-22-01 2 OF 3 METRIC

GWP# 4024-20-00 LOCATION Lat: 44.722821°, Long: -75.524708° Edward Street Underpass, MTM z9: N 4 954 109.0 E 382 060.9 ORIGINATED BY IK

HWY 401 BOREHOLE TYPE CME 55 Truck Mount HSA / NW Casing / NQ Coring COMPILED BY RH

DATUM Geodetic DATE 2022.11.22 - 2022.11.24 CHECKED BY CM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SANDY SILT (ML) trace clay very loose to compact grey		13	SS	2						
			14	SS	24		89				
			15	SS	21		88				
87.2			16	SS	16						
12.6	**SILTY CLAY (CI)** to **CLAYEY SILT (CL)** very stiff to stiff grey wet		17	SS	5		87				0 2 51 47
							86	>102kPa >102kPa			
			18	SS	3		85				
							84	>102kPa >102kPa			
			19	SS	2		83				
							82	>102kPa >102kPa			
			20	SS	3		81	12.0 9.2			
							80				

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

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

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THURBER

RECORD OF BOREHOLE No 128-22-01 3 OF 3 METRIC

GWP# 4024-20-00 LOCATION Lat: 44.722821°, Long: -75.524708° Edward Street Underpass, MTM z9: N 4 954 109.0 E 382 060.9 ORIGINATED BY IK

HWY 401 BOREHOLE TYPE CME 55 Truck Mount HSA / NW Casing / NQ Coring COMPILED BY RH

DATUM Geodetic DATE 2022.11.22 - 2022.11.24 CHECKED BY CM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILTY CLAY (CI) to **CLAYEY SILT (CL)** very stiff to stiff grey wet		21	SS	WH			32.0			
							79	16.8			
			22	SS	6						
							78	>102kPa			
								>102kPa			
76.3			23	SS	WH		77				0 1 48 51
23.5	**SILT (ML)** some clay loose to compact grey		24	SS	9		76				
			25	SS	10		75				0 0 87 13
74.7										FI	
25.1	**DOLOSTONE BEDROCK** occasional calcite infilled joints fresh fine to medium grained grey medium bedded very strong		1	RUN	-		74			2 0 0 3 2	RUN #1 TCR=100% SCR=91% RQD=90%
			2	RUN	-		73			0 1 1 2	RUN #2 TCR=100% SCR=93% RQD=96% UCS=174MPa
71.7							72			1	
28.1	**End of Borehole**										

Flushmount standpipe piezometer consists of a 19 mm diameter Schedule 40 PVC pipe with a 1.5-m slotted screen.

Water level readings:

DATE	DEPTH (m)	ELEV. (m)
2022.12.18	8.3	91.5
2023.04.26	8.2	91.6

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

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

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THURBER

RECORD OF BOREHOLE No 128-22-02 1 OF 3 METRIC

GWP# 4024-20-00 LOCATION Lat: 44.723344°, Long: -75.52515° Edward Street Underpass, MTM z9: N 4 954 166.8 E 382 025.2 ORIGINATED BY IK

HWY 401 BOREHOLE TYPE CME 55 Truck Mount HSA / NW Casing / NQ Coring COMPILED BY RH

DATUM Geodetic DATE 2022.11.24 - 2022.11.28 CHECKED BY CM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
99.2	**Ground Surface**										
0.0	**ASPHALT (150 mm)**										
0.2	SAND with silt compact to very loose brown **FILL**		1	SS	29		99		○		
			2	SS	20		98		○		
			3	SS	9		97		○		0 95 5 (SI+CL)
			4	SS	13		96		○		
			5	SS	3		95		○		
			6	SS	2		94		○		
			7	SS	2				○		
			8	SS	3		93		○		2 94 4 (SI+CL)
			9	SS	11		92		○		
			10	SS	100/ 100mm				○		
91.1	- Hollow stem auger refusal at 8.1 m										
8.1	**CONCRETE**		1	NQ	-		91				
90.7											
8.5	WOOD with silty sand and gravel infills **FILL**		11	SS	43	▼				200 ○	
			12	SS	81		90				
89.3											

Continued Next Page

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

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

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RECORD OF BOREHOLE No 128-22-02 2 OF 3 METRIC

GWP# 4024-20-00 LOCATION Lat: 44.723344°, Long: -75.52515° Edward Street Underpass, MTM z9: N 4 954 166.8 E 382 025.2 ORIGINATED BY IK

HWY 401 BOREHOLE TYPE CME 55 Truck Mount HSA / NW Casing / NQ Coring COMPILED BY RH

DATUM Geodetic DATE 2022.11.24 - 2022.11.28 CHECKED BY CM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
9.9	**SILT** with sand compact grey		13	SS	21		89		○		0 29 65 6
			14	SS	23		88		○		
			15	SS	17				○		
87.0							87				
12.2	**SILTY CLAY (Cl)** very stiff grey		16	SS	2			>102kPa	○		
							86	>102kPa			
			17	SS	2				⊢○⊣		0 1 49 50
							85	>102kPa			
								>102kPa			
			18	SS	2		84		○		
								>102kPa			
			19	SS	WH		83	>102kPa	○		
							82	>102kPa			
								>102kPa			
			20	SS	2		81		○		
							80	>102kPa			
								>102kPa			

Continued Next Page

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

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

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RECORD OF BOREHOLE No 128-22-02 3 OF 3 METRIC

GWP# 4024-20-00 LOCATION Lat: 44.723344°, Long: -75.52515° Edward Street Underpass, MTM z9: N 4 954 166.8 E 382 025.2 ORIGINATED BY IK

HWY 401 BOREHOLE TYPE CME 55 Truck Mount HSA / NW Casing / NQ Coring COMPILED BY RH

DATUM Geodetic DATE 2022.11.24 - 2022.11.28 CHECKED BY CM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
	SILTY CLAY (CI) very stiff grey		21	SS	8		79	>102kPa >102kPa			0 0 40 60
			22	SS	WH		78				
			23	SS	5		77	>102kPa >102kPa			
75.3			24	SS	100/ 125mm		76			FI	
23.9	**DOLOSTONE BEDROCK** fresh fine to medium grained grey medium bedded very strong		1	RUN	-		75			1 1 0 3	RUN #1 TCR=100% SCR=92% RQD=81%
			2	RUN	-		74			1 1 1	RUN #2 TCR=100% SCR=71% RQD=82%
			3	RUN	-		73			0 1 2	RUN #3 TCR=100% SCR=94% RQD=100%
			4	RUN	-		72			1 0	RUN #4 TCR=100% SCR=100% RQD=100%
71.6											
27.6	**End of Borehole** Water level after 60 hours at Elev. 90.5 m on completion of drilling									1	

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

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

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THURBER

RECORD OF BOREHOLE No 128-22-03 1 OF 3 METRIC

GWP# 4024-20-00 LOCATION Lat: 44.723176°, Long: -75.524749° Edward Street Underpass, MTM z9: N 4 954 148.4 E 382 057.1 ORIGINATED BY IK

HWY 401 BOREHOLE TYPE CME 55 Truck Mount HSA / NW Casing / NQ Coring COMPILED BY RH

DATUM Geodetic DATE 2022.12.07 - 2022.12.08 CHECKED BY CM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
92.4	**Ground Surface**										
0.0	**ASPHALT (200 mm)**										
92.1 0.2	SILTY SAND with gravel compact brown **FILL**										
0.3	SILTY SAND compact dark brown to brown **FILL**		1	SS	10						1 82 17 (SI+CL)
			2	SS	14						
90.1 2.3	**SILT** with sand loose grey		3	SS	6						
			4	SS	5						
			5	SS	9						
			6	SS	6				83		0 17 74 9
87.1 5.3	**CLAYEY SILT (CL)** very stiff to stiff grey		7	SS	2						0 1 55 44
			8	GS	-			>102kPa; >102kPa; >102kPa; >102kPa			
			9	SS	2			6.6; 16.0			
			10	SS	WH						

Continued Next Page

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

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

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THURBER

RECORD OF BOREHOLE No 128-22-03 2 OF 3 METRIC

GWP# 4024-20-00 LOCATION Lat: 44.723176°, Long: -75.524749° Edward Street Underpass, MTM z9: N 4 954 148.4 E 382 057.1 ORIGINATED BY IK

HWY 401 BOREHOLE TYPE CME 55 Truck Mount HSA / NW Casing / NQ Coring COMPILED BY RH

DATUM Geodetic DATE 2022.12.07 - 2022.12.08 CHECKED BY CM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	CLAYEY SILT (CL) very stiff to stiff grey						82	>102kPa >102kPa			
			11	SS	3						
							81	>102kPa >102kPa			
			12	SS	WH		80				
								>102kPa >102kPa			
			13	SS	6		79				
							78	>102kPa >102kPa			
			14	SS	2		77				
75.6								>102kPa >102kPa			
16.8	**SILT (ML)** loose grey		15	SS	9						
74.8			16	SS	100/		75			FI	0 1 85 14
17.6	**DOLOSTONE BEDROCK** fresh fine to medium grained grey medium bedded very strong		1	RUN	50mm -					1 1	RUN #1 TCR=100% SCR=100% RQD=100%
			2	RUN	-		74			2 0 3	RUN #2 TCR=100% SCR=98% RQD=83%
							73			1 0 1	RUN #3 TCR=96% SCR=93% RQD=93%

Continued Next Page

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 128-22-03 3 OF 3 METRIC

GWP# 4024-20-00 LOCATION Lat: 44.723176°, Long: -75.524749° Edward Street Underpass, MTM z9: N 4 954 148.4 E 382 057.1 ORIGINATED BY IK

HWY 401 BOREHOLE TYPE CME 55 Truck Mount HSA / NW Casing / NQ Coring COMPILED BY RH

DATUM Geodetic DATE 2022.12.07 - 2022.12.08 CHECKED BY CM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	DOLOSTONE BEDROCK fresh fine to medium grained grey medium bedded very strong		3	RUN	-		72			1 1 2	
71.5 20.9	**End of Borehole** A representative open-hole groundwater level measurement was not obtained due to the introduction of water during drilling.										

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+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

THURBER

Appendix C.

Laboratory Testing

THURBER

Appendix C.1

Particle Size Analysis Figures

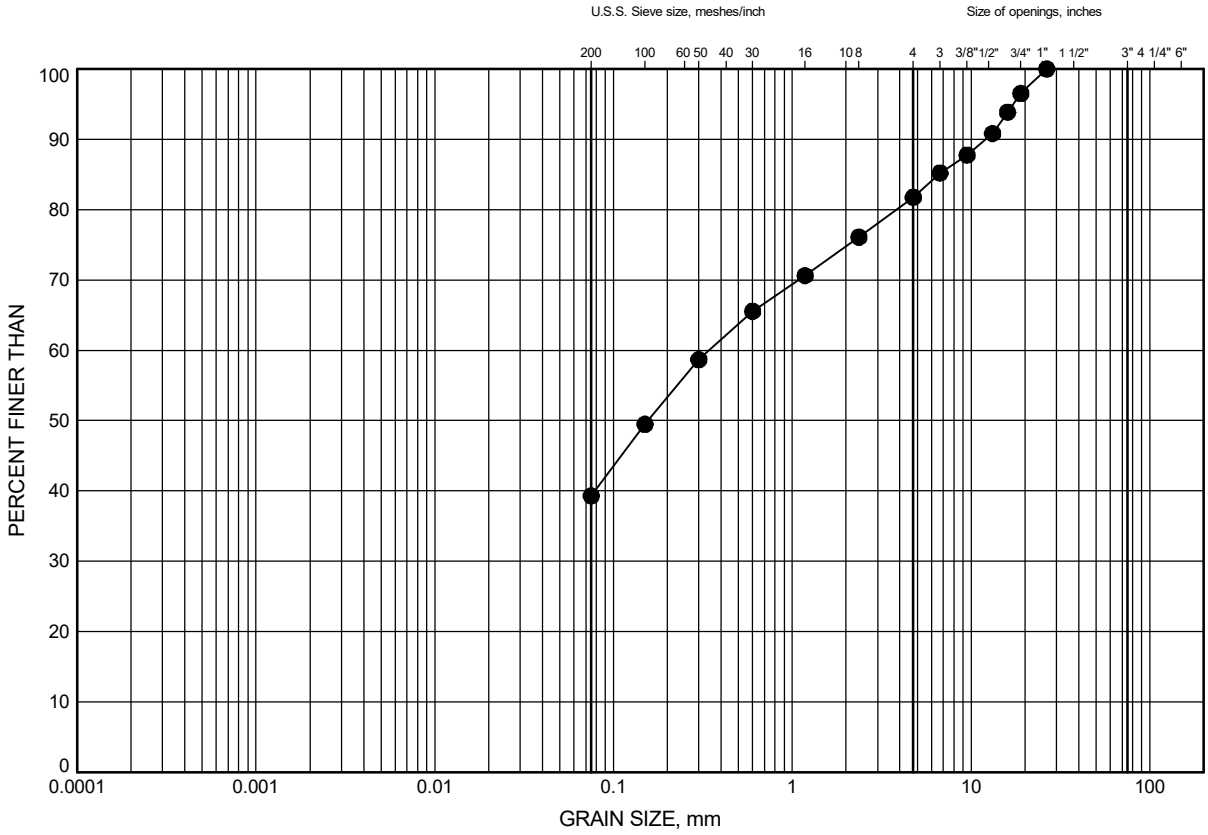
Atterberg Limit Test Results

Highway 401 Edward Street Underpass

GRAIN SIZE DISTRIBUTION

FIGURE C1

FILL: Silty Sand with Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	128-22-01	1.1	98.7

Date March 2023

GWP# 4024-20-00

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Chkd. CM

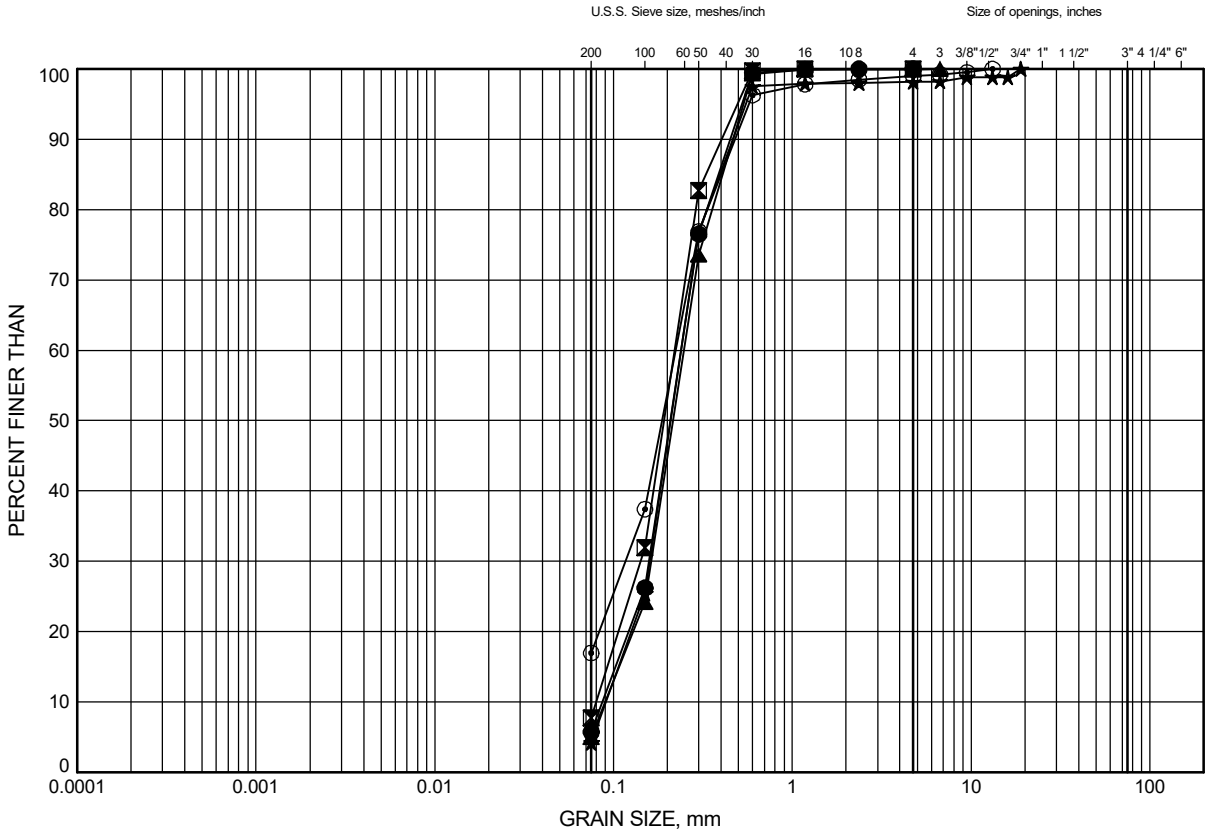
GRAIN SIZE DISTRIBUTION - THURBER 29381 EDWARD STREET UNDERPASS.GPJ 3-10-23

Highway 401 Edward Street Underpass

GRAIN SIZE DISTRIBUTION

FIGURE C2

FILL: Sand with Silt to Silty Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	128-22-01	3.4	96.4
⊠	128-22-01	7.2	92.6
▲	128-22-02	2.6	96.6
★	128-22-02	6.4	92.8
⊙	128-22-03	1.1	91.3

Date March 2023

GWP# 4024-20-00

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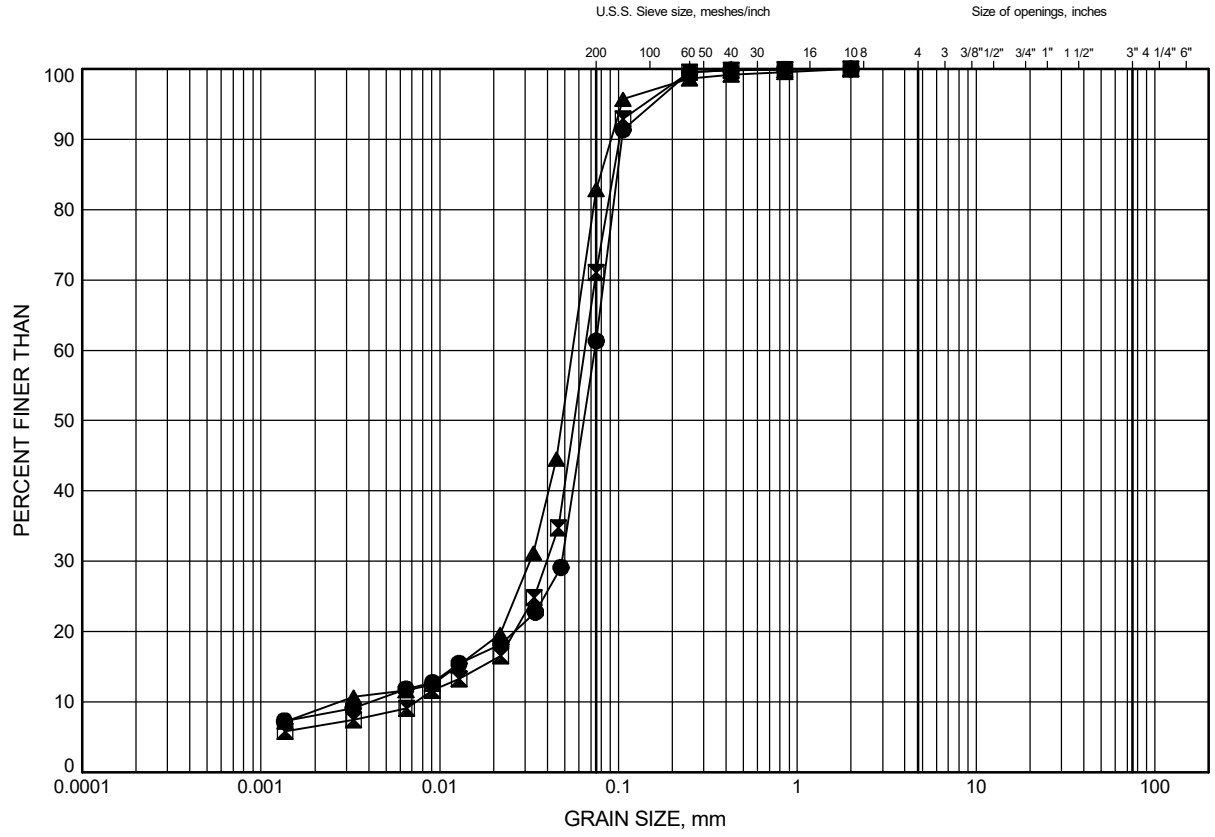
GRAIN SIZE DISTRIBUTION - THURBER 29381 EDWARD STREET UNDERPASS.GPJ 3-10-23

Highway 401 Edward Street Underpass

GRAIN SIZE DISTRIBUTION

FIGURE C3

Sandy Silt to Silt with Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	128-22-01	9.4	90.4
⊠	128-22-02	10.2	89.0
▲	128-22-03	4.9	87.5

Date March 2023

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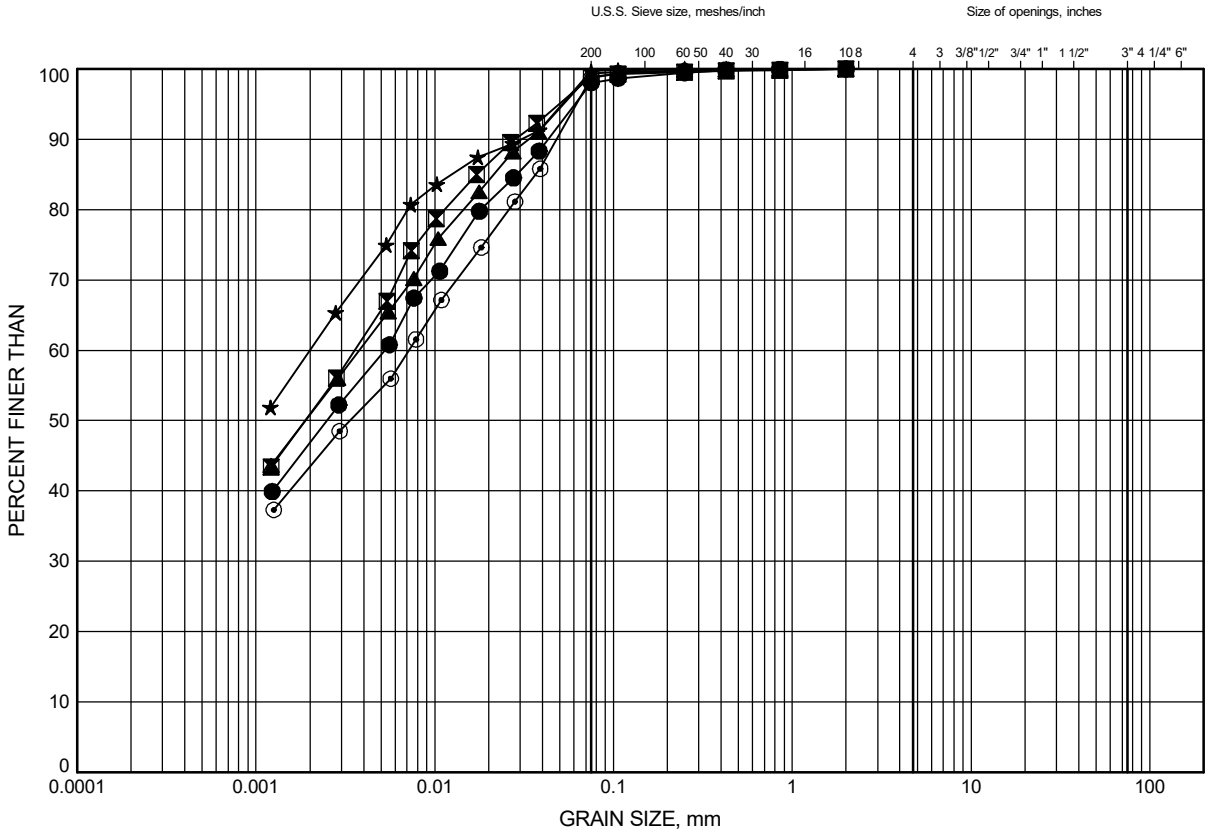
GRAIN SIZE DISTRIBUTION - THURBER 29381 EDWARD STREET UNDERPASS.GPJ 3-10-23

Highway 401 Edward Street Underpass

GRAIN SIZE DISTRIBUTION

FIGURE C4

Silty Clay to Clayey Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	128-22-01	13.3	86.5
⊠	128-22-01	23.0	76.8
▲	128-22-02	14.0	85.2
★	128-22-02	20.1	79.1
⊙	128-22-03	5.6	86.8

Date March 2023

GWP# 4024-20-00

THURBER

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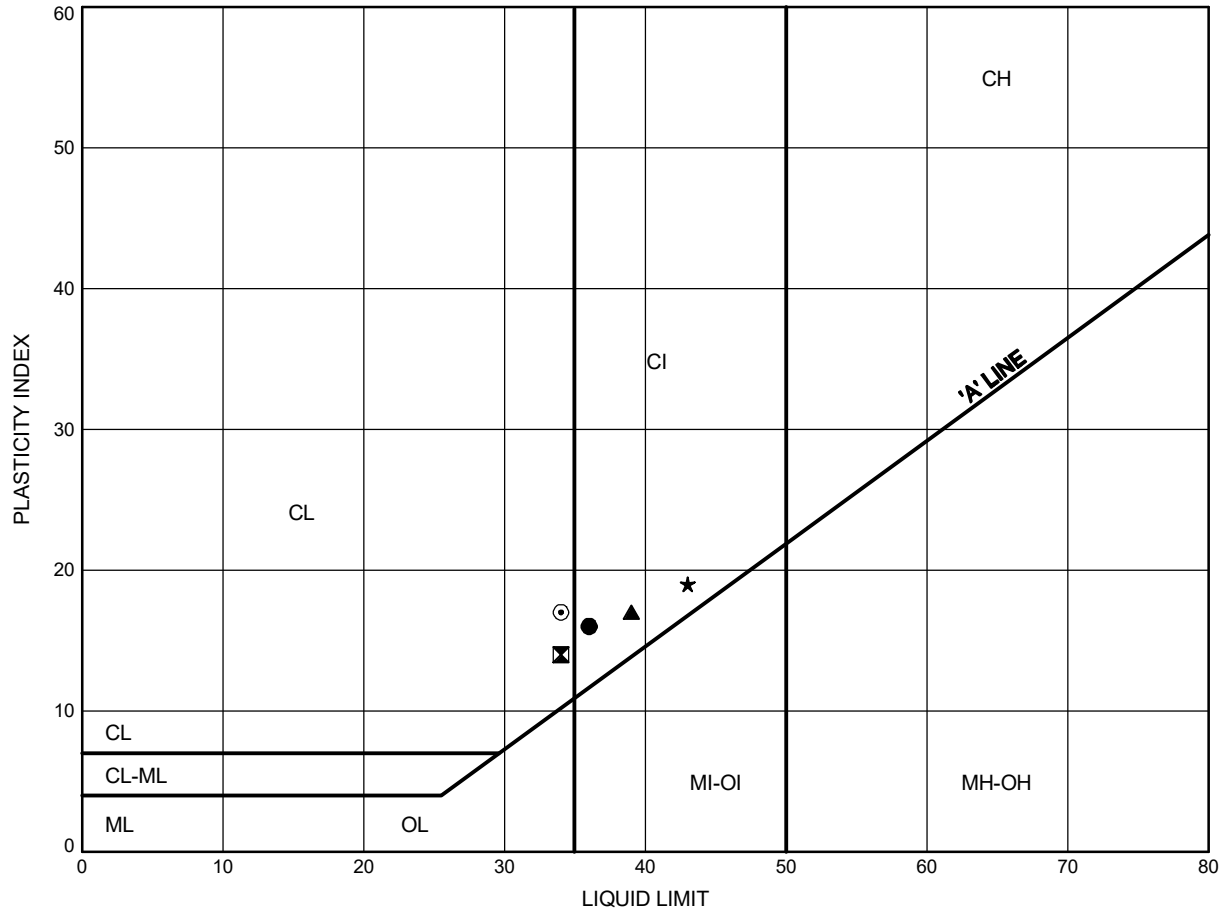
GRAIN SIZE DISTRIBUTION - THURBER 29381 EDWARD STREET UNDERPASS.GPJ 3-10-23

Highway 401 Edward Street Underpass

ATTERBERG LIMITS TEST RESULTS

FIGURE C5

Silty Clay to Clayey Silt



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	128-22-01	13.3	86.5
⊠	128-22-01	23.0	76.8
▲	128-22-02	14.0	85.2
★	128-22-02	20.1	79.1
⊙	128-22-03	5.6	86.8

Date March 2023

GWP# 4024-20-00

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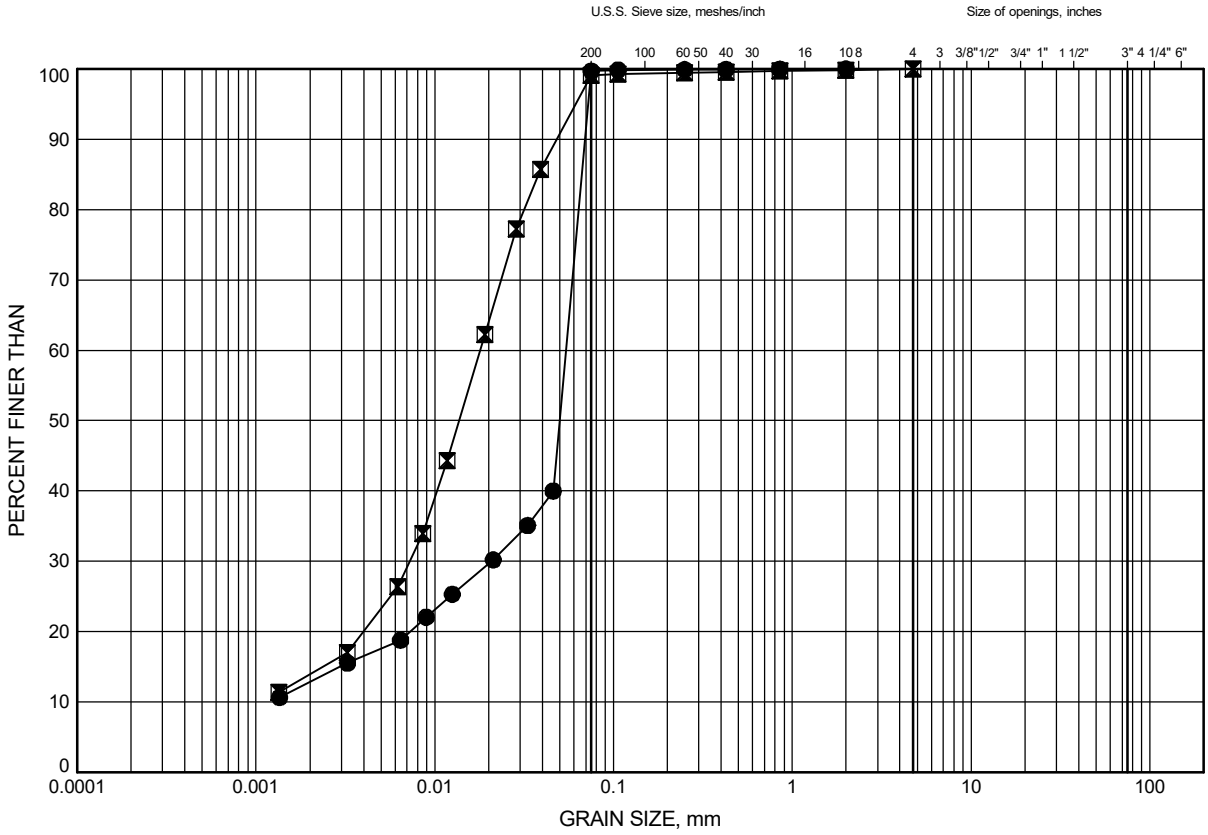
THURBALT 29381 EDWARD STREET UNDERPASS.GPJ 3-10-23

Highway 401 Edward Street Underpass

GRAIN SIZE DISTRIBUTION

FIGURE C6

SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	128-22-01	24.7	75.1
⊠	128-22-03	17.5	74.9

Date March 2023

GWP# 4024-20-00

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Appendix C.2

UCS Test Results

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

March 2, 2023
File: 122410864

Client: Thurber Engineering, File #29381

Reference: ASTM D7012, Method C, Unconfined Compressive Strength of Intact Rock Core
Hwy 401, Maitland

The following table summarizes unconfined compressive strength results for one intact rock core.

Location	Sample Depth	Compressive Strength (MPa)	Description of Break
BH128.22.1 Run-2	89'-89'7''	174.3	Well-formed cones at both ends

Sincerely,

Stantec Consulting Ltd.

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

v:\01216\active\laboratory_standing_offers\2023-laboratory standing offers\122410864 thurber engineering ltd\rock core\feb 23, one rock core, thurber#29831\rock_core_summary_letter.docx

THURBER

Appendix C.3

Bedrock Core Photographs

Borehole 128-22-01

RUN 1

Depth 25.1 m to 26.6 m

Elevation 74.7 m to 73.2 m

Dry Sample

Run 1 Start
elev. 74.7 m

Run 1 End
elev. 73.2 m

THURBER ENGINEERING LTD.

Highway 401 Underpass at Edward Street
(Site No. 16X-0128)
Assignment No. 4019-E-0010.2, GWP 4024-20-00

BH 128-22-01
Project No.: 29381

Borehole 128-22-01

RUN 1

Depth 25.1 m to 26.6 m

Elevation 74.7 m to 73.2 m

Wet Sample

Run 1 Start
elev. 74.7 m

Run 1 End
elev. 73.2 m

THURBER ENGINEERING LTD.

Highway 401 Underpass at Edward Street
(Site No. 16X-0128)
Assignment No. 4019-E-0010.2, GWP 4024-20-00

BH 128-22-01
Project No.: 29381

Borehole 128-22-01

RUN 2

Depth 26.6 m to 28.1 m

Elevation 73.2 m to 71.7 m

Dry Sample

Run 1 Start
elev. 73.2 m

Run 1 End
elev. 71.7 m

THURBER ENGINEERING LTD.

Highway 401 Underpass at Edward Street
(Site No. 16X-0128)
Assignment No. 4019-E-0010.2, GWP 4024-20-00

BH 128-22-01
Project No.: 29381

Borehole 128-22-01

RUN 2

Depth 26.6 m to 28.1 m

Elevation 73.2 m to 71.7 m

Wet Sample

Run 1 Start
elev. 73.2 m

Run 1 End
elev. 71.7 m

THURBER ENGINEERING LTD.

Highway 401 Underpass at Edward Street
(Site No. 16X-0128)
Assignment No. 4019-E-0010.2, GWP 4024-20-00

BH 128-22-01
Project No.: 29381

Borehole 128-22-02

NQ1 – Concrete Sample
Depth 8.1 m to 8.5 m
Elevation 91.1 m to 90.7 m
Dry Sample

NQ1 Start
elev. 91.1 m

NQ1 End
elev. 90.7 m

THURBER ENGINEERING LTD.

Highway 401 Underpass at Edward Street
(Site No. 16X-0128)
Assignment No. 4019-E-0010.2, GWP 4024-20-00

BH 128-22-02
Project No.: 29381

Borehole 128-22-02

RUN 1

Depth 23.9 m to 25.3 m

Elevation 75.3 m to 73.9 m

Dry Sample

Run 1 Start
elev. 75.3 m

Run 1 End
elev. 73.9 m

THURBER ENGINEERING LTD.

Highway 401 Underpass at Edward Street
(Site No. 16X-0128)
Assignment No. 4019-E-0010.2, GWP 4024-20-00

BH 128-22-02
Project No.: 29381

Borehole 128-22-02

RUN 1

Depth 23.9 m to 25.3 m

Elevation 75.3 m to 73.9 m

Wet Sample

Run 1 Start
elev. 75.3 m

Run 1 End
elev. 73.9 m

THURBER ENGINEERING LTD.

Highway 401 Underpass at Edward Street
(Site No. 16X-0128)
Assignment No. 4019-E-0010.2, GWP 4024-20-00

BH 128-22-02
Project No.: 29381

Borehole 128-22-02

RUNS 2, 3, and 4

Depth 25.3 m to 27.6 m

Elevation 73.9 m to 71.6 m

Dry Sample

Run 2 Start
elev. 73.9 m

Run 2 End
elev. 73.2 m

Run 3 Start
elev. 73.2 m

Run 3 End
elev. 72.3 m

Run 4 Start
elev. 72.3 m

Run 4 End
elev. 71.6 m

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Highway 401 Underpass at Edward Street
(Site No. 16X-0128)
Assignment No. 4019-E-0010.2, GWP 4024-20-00

BH 128-22-02
Project No.: 29381

Borehole 128-22-02

RUNS 2, 3, and 4
Depth 25.3 m to 27.6 m
Elevation 73.9 m to 71.6 m
Wet Sample

Run 2 Start
elev. 73.9 m

Run 2 End
elev. 73.2 m

Run 3 Start
elev. 73.2 m

Run 3 End
elev. 72.3 m

Run 4 Start
elev. 72.3 m

Run 4 End
elev. 71.6 m

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Highway 401 Underpass at Edward Street
(Site No. 16X-0128)
Assignment No. 4019-E-0010.2, GWP 4024-20-00

BH 128-22-02
Project No.: 29381

Borehole 128-22-03

RUNS 1 and 2
Depth 17.6 m to 19.4 m
Elevation 74.8 m to 73.0 m
Dry Sample

Run 1 Start
elev. 74.8 m

Run 1 End
elev. 74.5 m

Run 2 Start
elev. 74.5 m

Run 3 End
elev. 73.0 m

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Highway 401 Underpass at Edward Street
(Site No. 16X-0128)
Assignment No. 4019-E-0010.2, GWP 4024-20-00

BH 128-22-03
Project No.: 29381

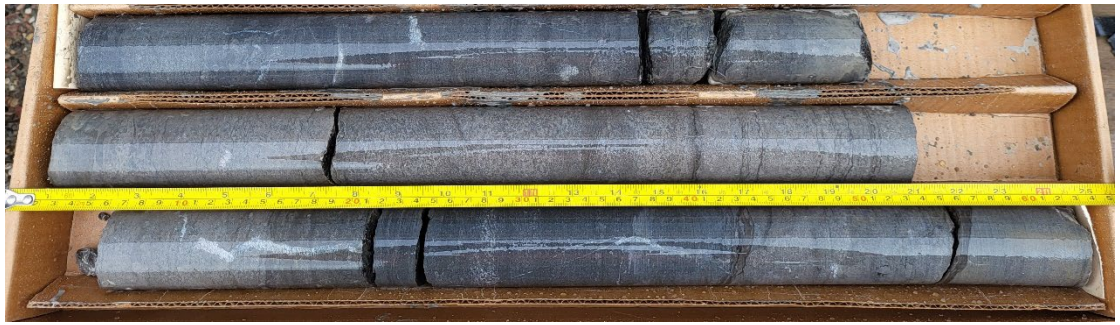
Borehole 128-22-03

RUNS 1 and 2
Depth 17.6 m to 19.4 m
Elevation 74.8 m to 73.0 m
Wet Sample

Run 1 Start
elev. 74.8 m

Run 1 End
elev. 74.5 m

Run 2 Start
elev. 74.5 m



Run 3 End
elev. 73.0 m

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Highway 401 Underpass at Edward Street
(Site No. 16X-0128)
Assignment No. 4019-E-0010.2, GWP 4024-20-00

BH 128-22-03
Project No.: 29381

Borehole 128-22-03

RUN 3

Depth 19.4 m to 20.9 m

Elevation 73.0 m to 71.5 m

Dry Sample

Run 3 Start
elev. 73.0 m

Run 3 End
elev. 71.5 m

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Highway 401 Underpass at Edward Street
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Assignment No. 4019-E-0010.2, GWP 4024-20-00

BH 128-22-03
Project No.: 29381

Borehole 128-22-03

RUN 3

Depth 19.4 m to 20.9 m

Elevation 73.0 m to 71.5 m

Wet Sample

Run 3 Start
elev. 73.0 m

Run 3 End
elev. 71.5 m

THURBER ENGINEERING LTD.

Highway 401 Underpass at Edward Street
(Site No. 16X-0128)
Assignment No. 4019-E-0010.2, GWP 4024-20-00

BH 128-22-03
Project No.: 29381

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Appendix D.

Selected Site Photographs

Photo 1: Looking southwest at bridge (2022/09/01)

Photo 2: Looking north along west side of bridge (2022/12/19)

Photo 3: Looking north along northbound Edward Street (2022/12/08)

Photo 4: Looking south along Edward Street (2022/09/01)

Photo 5: Looking west at northeast embankment side slope (2022/09/01)

Photo 6: Looking east at southwest embankment side slope (2022/12/19)

Photo 7: Looking north from east side of bridge (2022/12/19)