



**THURBER** ENGINEERING LTD.

**FOUNDATION INVESTIGATION AND DESIGN REPORT  
TEMPORARY PROTECTION SYSTEM FOR HIGHWAY 556 CULVERT  
REHABILITATION AT STA 19+640 (TOWNSHIP OF VANKOUGHNET)  
REHABILITATION OF HIGHWAYS 556 & 532  
DISTRICT OF ALGOMA, ONTARIO  
ASSIGNMENT No.: 5020-E-0020  
G.W.P. 5221-18-00**

**LATITUDE: 46.706060°, LONGITUDE: -84.238638°**

**GEOCRES Number: 41K-126**

**Report**

to

**AECOM Canada Ltd.**

Date: April 24, 2023  
File: 31719



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STA 19+640 (TOWNSHIP OF VANKOUGHNET)  
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**PART A: FACTUAL INFORMATION**

**1. INTRODUCTION**

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for design of a temporary protection system for the proposed rehabilitation of a centreline culvert, located at STA 19+640 on Highway 556, in the Township of Vankoughnet, District of Algoma, Ontario.

The purpose of this investigation was to explore the subsurface conditions in the vicinity of the highway centreline near the culvert, and based on the data obtained, to provide a borehole location plan, stratigraphic profile, records of boreholes, laboratory test results, and a written description of the subsurface conditions.

Thurber carried out the investigation as a subconsultant to AECOM Canada Ltd. (AECOM), under the Ministry of Transportation, Ontario (MTO) Assignment No. 5020-E-0020.

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**

The existing culvert is located on Highway 556, approximately 5.2 km east of the intersection with Highway 552 and approximately 16.2 km west of the intersection with Highway 532 near Searchmont, Ontario. For project orientation purposes, Highway 556 is herein described as oriented east-west and the culvert is described as oriented north-south. Details of the existing culvert are as follows:

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Township and Station	Culvert Size and Type	Length of Culvert (m)	Invert Elevation at Inlet (m)	Invert Elevation at Outlet (m)
Vankoughnet 19+640	1000 mm dia. CSP	30.41 m long	279.5 (south)	276.9 (north)

The existing culvert allows flow in a south to north direction under the approximately 3.0 m high embankment cover over the existing culvert. Due to the steep terrain, the culvert features a concrete drop inlet (Photos 3 and 4, Appendix A). The highway pavement surface is at approximate Elev. 283.3 m. This section of highway is constructed partially in an earth/rock cut to the south and the terrain in the vicinity of the culvert, which includes the embankment slopes to the north and earth/rock cut to the south, is inclined at approximately 2H:1V.

Based on visual observations, no signs of slope instability of the highway embankment were noted near the inlet and outlet of the culvert site. The south side of the highway embankment, including the area of the culvert outlet, is generally surrounded by thick mixed forest. The ditch along the south shoulder is lightly vegetated with some visible cobbles and bedrock outcrops. Site photographs can be found in Appendix A.

Highway 556 consists of two, 3.25 m wide, paved lanes and narrow partially paved shoulders. The highway alignment in the immediate vicinity of the culvert is curved and rises from west to east. There is a guide rail along the north side of the highway. Overhead utility lines are present along the north side of the highway. It is understood that the projected 2023 AADT for Highway 556 is 540. A granular entrance to a rural property is located approximately 225 m west of the culvert.

Based on Northern Ontario Engineering Geology Terrain Study (NOEGTS) mapping, the site lies near an outwash plain and the primary materials are sandy and gravelly soils, with bedrock knobs and outcrops. The site topography in the immediate vicinity of the culvert is of moderate relief of a cliffy volcanic rock signature.

Based on the OGS Map MRD126 titled "Bedrock Geology of Ontario", dated 2011, the underlying bedrock at the site consists of mafic to intermediate metavolcanic rocks.

### 3. INVESTIGATION PROCEDURES

The field investigation and testing for this project was carried out between October 21 and November 3, 2022, and consisted of drilling and sampling two boreholes through the highway embankment, designated as Boreholes 19640-01 to 19640-02, to depths of 7.7 m and 6.6 m (Elev. 274.8 m and 277.5 m), respectively. The locations of the boreholes are presented on the



Record of Borehole sheets, included in Appendix B, and in the borehole location plan in Appendix D.

Utility clearances were obtained prior to mobilization to the site. The borehole co-ordinates were determined through off-set measurement from the highway centerline and existing culvert and as-drilled borehole elevations on the highway were obtained from the digital terrain model. The coordinate system MTM NAD 83, Zone 13 was used for the boreholes.

The boreholes were drilled using a truck-mounted CME 75 drill rig using wash boring technique with NW casing and NQ coring equipment. Soil samples were obtained at selected intervals using a split-spoon sampler in conjunction with Standard Penetration Testing (SPT) in general accordance with ASTM D1586.

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

The rock cores were logged, and the Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD) and Fracture Index (FI) were determined.

Groundwater conditions observed in open boreholes are not considered stabilized due to the introduction of water throughout the drilling and coring operation.

The borehole completion details are summarized below:

<b>Borehole</b>	<b>Depth and Elevation of Borehole Base (m)</b>	<b>Depth and Elevation of Well Tip (m)</b>	<b>Northing and Easting MTM NAD83 Zone 13</b>	<b>Completion Details</b>
19640-01	7.7 / 274.8	None Installed	N 5 174 082.9 E 286 541.7	Backfilled with bentonite holeplug and asphalt patch at surface.
19640-02	6.6 / 277.5	None Installed	N 5 174 077.5 E 286 562.2	Backfilled with bentonite holeplug and asphalt patch at surface.



#### **4. LABORATORY TESTING**

All recovered soil samples were subjected to visual identification (VI) and natural moisture content determination. Selected samples were subjected to grain size distribution analyses (sieve and hydrometer). The results of this testing program are summarized on the Record of Borehole sheets in Appendix B and are shown on the figures included in Appendix C.

Testing was carried out on a specimen of the bedrock to assess the potential for sulphate attack on buried concrete structures, as well as the potential for corrosion associated with buried steel elements. The results of the analytical testing are summarized in this report and presented in Appendix C.

#### **5. DESCRIPTION OF SUBSURFACE CONDITIONS**

Reference is made to the Record of Borehole sheets included in Appendix B. Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets and on the Borehole Locations and Soil Strata Drawing included in Appendix D. A 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 Record of Borehole sheets takes precedence over this general description and must be used for interpretation of the site conditions. It must be recognized and expected that soil conditions and the elevation of the soil-bedrock interface may vary between and beyond the borehole locations.

In general, the subsurface conditions encountered consisted of sand to gravelly silty sand embankment fill containing cobbles and possible boulders, underlain by a native deposit of silty sand. The overburden material was underlain by basalt bedrock.

##### **5.1 Asphalt**

Boreholes 19640-01 and 19640-02 were advanced through the paved portion of the Highway 556 embankment, and the thickness of asphalt was measured to be 45 mm and 50 mm, respectively.

##### **5.2 Embankment Fill**

Granular embankment fill consists of sand, some gravel, trace silt, trace clay to gravelly silty sand, containing cobbles and boulders was encountered underlying the asphalt in both boreholes. Cobbles and boulders were encountered at varying depths throughout the embankment fill, as shown in the borehole logs, and were cored using an 'NQ' size rock core barrel. Photographs of the gravels, cobbles, and boulders recovered during coring in the embankment fill are shown in



the Core Box Photographs in Appendix C. From the recovered soil cores and observations of embankment fill cuttings, the particle size ranges from 25 mm gravels to boulders up to about 205 mm.

The embankment fill extended to depths of 3.8 m and 2.9 m (Elev. 278.7 m and 281.2 m), in Borehole 19640-01 and 19640-02, respectively.

In general, the SPT 'N' values in the embankment fill ranged from 63 blows per 0.3 m of penetration to 50 blows for 0.03 m of penetration, indicating a very dense condition. A SPT 'N' value of 27 blows per 0.3 m of penetration was recorded in Borehole 19640-01, indicating the embankment fill is compact in places. The high SPT 'N' values and split-spoon refusal is attributed to presence of coarse gravels, cobbles, and boulders throughout the embankment fill. The measured moisture contents generally ranged from 1 percent to 15 percent.

The results of grain size analyses conducted on selected samples of the embankment fill are provided on the Record of Borehole sheets in Appendix B and plotted in Figure C-1 of Appendix C. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	12 to 46
Sand	42 to 78
Silt	10 to 15
Clay	0 to 1

### 5.3 Silty Sand

A deposit of silty sand, trace to some gravel, trace clay was encountered below the fill in Borehole 19640-01. The cohesionless deposit was 1.0 m thick and extends to a depth of 4.8 m (Elev. 277.7 m).

SPT 'N' values measured in the deposit were 13 blows per 0.3 m penetration and 50 blows per 0.05 m of penetration, indicating a compact to very dense condition. However, it should be noted that the high SPT 'N' value may be attributed to split-spoon refusal on bedrock. The measured moisture contents in the deposit generally ranged between about 13 percent and 19 percent.

The results of grain size analyses conducted on samples of the silty sand deposit are provided on the Record of Borehole sheets in Appendix B and plotted in Figure C-2 of Appendix C. The results summarized as follows:



Soil Particle	Percentage (%)
Gravel	9 to 17
Sand	41 to 44
Silt	39 to 41
Clay	3 to 6

Atterberg limit testing was completed on the fines portion of the samples of the deposit and was determined to be non-plastic.

#### 5.4 Bedrock

Bedrock was encountered at depths of 4.8 m and 2.9 m (Elev. 277.7 m and 281.2 m) in Boreholes 19640-01 and 19640-02, respectively, and was proven by coring. It should be noted that bedrock slopes downward from east to west.

The bedrock consisted of slightly weathered to fresh, strong to very strong basalt with quartz veins. The basalt is fine grained, massive, and grey in colour. Photographs of the bedrock core are provided in Appendix C. The rock core quality parameters are summarized below:

Rock Core Quality Parameters	Range (%)	Average (%)
Total Core Recovery (TCR), %	72 to 100	94
Solid Core Recovery (SCR), %	0 to 95	64
Rock Quality Designation (RQD), %	0 to 95	58
Fracture Index (FI), per 0.3 m	0 to >10	1

The Rock Quality Designation (RQD) varied from 0 percent to 95 percent, indicating a rock mass of poor to excellent quality, but generally was within the fair quality range.

#### 5.5 Groundwater Conditions

In general, water was introduced into the boreholes for drilling with wash boring methods and for coring and therefore, groundwater levels were not measured upon completion of drilling.

Water was measured to be at a depth of 3.6 m below the top of the drop inlet (Elev. 278.8 m). The water at the outlet was found to be surficial at approximately Elev. 276.9 m at the time of the investigation.





It should be noted that the groundwater levels may be at a higher elevation during spring and after periods of significant or prolonged precipitation.

## 6. ANALYTICAL LABORATORY TESTING

One sample of basalt bedrock was submitted for analytical testing for corrosivity analysis and sulphide content. The analytical test results for the soil are presented in Appendix C and are summarized below.

<b>Borehole Sample</b>	<b>19640-01 Run 2</b>
Depth (m)	5.7
Elevation (m)	276.8
Sulphide ( $\text{Na}_2\text{CO}_3$ ) %	<0.04
Chloride ( $\mu\text{g/g}$ )	23
Sulphate ( $\mu\text{g/g}$ )	10
pH	8.45
Conductivity ( $\mu\text{S/cm}$ )	308
Resistivity (Ohm-cm)	3,240

## 7. MISCELLANEOUS

Marathon Drilling of Greely, Ontario supplied and operated the drilling, sampling, and in-situ testing equipment for the field investigation. The field investigation was supervised on a full-time basis by Mr. Ian Ross, B.A.Sc. The overall management of the field program was conducted by Ms. Alysha Kobylinski, P.Eng.

Geotechnical laboratory testing on soil samples was carried out in Thurber's geotechnical laboratories. Analytical laboratory testing was carried out by Paracel Laboratories Ltd., a CALA accredited analytical laboratory in Richmond Hill, Ontario.

Interpretation of the field data and preparation of this report was carried out by Ms. Alysha Kobylinski, P.Eng. The report was reviewed by Messrs. Christopher Ng, P.Eng., and P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects at Thurber.



Thurber Engineering Ltd.

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**GEOCRES Number: 41K-126**

**PART B: ENGINEERING DISCUSSION AND RECOMMENDATIONS**

**8. GENERAL**

This report provides an interpretation of the geotechnical data in the foundation investigation report and presents foundation design recommendations for design of a temporary protection system for the proposed culvert rehabilitation at STA 19+640 on Highway 556 in the Township of Vankoughnet, Ontario.

This foundation investigation and design report with the interpretation and recommendations are intended for the use of the Ministry of Transportation, Ontario, and its designers, AECOM Canada Ltd. (AECOM), and shall not be used or relied upon for any other purposes or by any other parties including Contractors. Contractors must make their own interpretation based on the data provided in factual portion of the report (Part A). Where comments are made on construction, they are provided 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 information provided in Part A of this report as such interpretation may affect equipment selection, proposed construction methods, scheduling, and the like.

The subsurface stratigraphy observed in the boreholes drilled along Highway 556 near the proposed culvert rehabilitation consists of embankment fills and native overburden comprised of compact to very dense sand to silty sand fill containing cobbles and boulders extending to bedrock at shallow depths of 2.9 m and 4.8 m, corresponding to Elev. 281.2 m and 277.7 m, respectively.

Based on the 30% Design Contract Drawings, dated February 16, 2023, it is understood that the existing culvert will be rehabilitated by lining. Details of the existing culvert are summarized below.



Township and Station	Culvert Size and Type	Top of Drop Inlet Elevation (m)	Invert Elevation at Inlet (m)	Invert Elevation at Outlet (m)	Top of Pavement at Culvert (m) / Crown Cover of Culvert (m)
Vankoughnet 19+640	30.41 m long, 1000 mm dia. CSP	282.4	279.5 (south)	276.9 (north)	283.3 / 3.0

The discussion and recommendations presented in this report are based on information provided by AECOM, and on the subsurface information obtained from the foundation investigation and laboratory testing.

## 9. TEMPORARY ROADWAY PROTECTION SYSTEMS

Given the culvert is to be rehabilitated by lining, a temporary protection system is not anticipated to be needed as part of the work. However, should it be required, this section provides discussions on the design of temporary protection systems.

Design of the roadway protection system is the responsibility of the Contractor. The design of such systems must incorporate traffic loading and surcharge loading due to construction equipment operations. It is anticipated that the protection system will need to be extended through the embankment fill and native overburden and socketed into the bedrock to develop the required toe resistance. Installation of the temporary protection system should consider that the embankment fills contain frequent cobbles and boulders.

For conceptual planning and costing purposes, a soldier pile (socketed to bedrock) and lagging wall is considered a suitable option for temporary protection due to the presence of cobbles and boulders in the embankment fill and native soils as well as the relatively shallow bedrock at the culvert location. Driving of soldier piles may encounter refusal at varying depths in the embankment fill due to the presence of cobbles and boulders. As such, pre-drilling, coring, or by other means may be required to achieve an adequate depth of soldier pile embedment. As mentioned above, since the bedrock is of relatively shallow depth, socketing the soldier piles into very strong bedrock may be required for developing adequate lateral resistance for the protection system.

Driving of steel sheet piles within the embankment fill containing cobbles and boulders is not expected to be feasible and therefore, the use of sheet piles is not recommended at this site.

The parameters presented below may be used for the design of temporary protection systems:

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Stratigraphic Unit	Unit Weight of Material, $\gamma'$ (kN/m <sup>3</sup> )	Angle of Internal Friction, $\phi$ (kN/m <sup>3</sup> )	Coefficient of Static Lateral Earth Pressure	
			Active, $K_a$	Passive, $K_p$
Compact to Very Dense Sand to Gravelly Silty Sand Embankment Fill	20	34	0.28	3.5
Compact Silty Sand	20	32	0.31	3.3

**Note:**

1. The lateral earth pressure coefficients presented above are based on static loading conditions and level backfill/ground surface behind the protection system. Where there is sloping ground behind the protection system, the coefficient of lateral earth pressure must be adjusted to account for the slope.
2. The total passive resistance below the base of excavation, if required, may be calculated based on the values of  $K_p$  indicated above but reduced by an appropriate factor that considers the allowable wall movement in accordance with Figure C6.27 of the Canadian Highway Bridge Design Code (CHBDC, 2019) to account for the fact that a large strain would be required for mobilization of the full passive resistance.

Temporary protection systems should be designed and constructed in accordance with OPSS.PROV 539, as amended by Special Provision 105S09, and designed for Performance Level 2 with a maximum horizontal deflection of 25 mm. Should the temporary protection systems be left in place after completion of the installation, the top shall be removed to at least 1.2 m below the finished grade or ground level.

## 10. CORROSION POTENTIAL

Based on results of corrosivity testing on a sample of silty sand fill, the following statements can be made in reference to the MTO Gravity Pipe Design Guideline. However, the effects of road de-icing salts/chemicals should be considered when selecting pipe material and/or corrosion mitigation measures.

- The resistivity of the fill was measured to be 3,240 ohm-cm, which indicates the soil is of moderate corrosion potential (2,000 ohm-cm < R < 4,500 ohm-cm) according to Table 3.2 of the MTO Gravity Pipe Design Guideline.
- The sulphate concentration of the fill was measured to be 10 µg/g, which is considered to have a negligible degree of sulphate attack on concrete according to Table 7.2 of the MTO Gravity Pipe Design Guideline.
- The pH level of the fill was measured to be 8.45, and according to Section 7.1.1 of the MTO Gravity Pipe Design Guideline, pH levels between 5.5 and 8.5 in soil or water are not considered detrimental to the durability of the culvert.



## **11. OBSTRUCTIONS**

The existing embankment fill contains frequent cobbles, and boulders and that the bedrock may be encountered at a relatively shallow depth. As such, the temporary protection systems must be selected considering the presence of such obstructions in the embankment fill, as well as the relatively shallow depth to bedrock.

## **12. CLOSURE**

Engineering analysis and preparation of this report was carried out by Ms. Alysha Kobylinski, P.Eng. The report was reviewed by Messrs. Christopher Ng, P.Eng., Senior Geotechnical Engineer, and P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects at Thurber.



Thurber Engineering Ltd.



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## STATEMENT OF LIMITATIONS AND CONDITIONS

### 1. STANDARD OF CARE

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

### 2. COMPLETE REPORT

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

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

### 3. BASIS OF REPORT

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

### 4. USE OF THE REPORT

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

### 5. INTERPRETATION OF THE REPORT

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

### 6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

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

### 7. INDEPENDENT JUDGEMENTS OF CLIENT

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





## **Appendix A**

### **Site Photographs**



**Photograph #1** – Highway 556 near culvert location, facing East. Drop Inlet at ditch to the south. Rock outcrops visible on slope south of ditch (Google Streetview imagery, August 2018)



**Photograph #2** – Highway 556 near culvert location, facing West. Drop Inlet at ditch to the south. Rock outcrops visible on slope south of ditch near horizontal curve (Google Streetview imagery, August 2018)





**Photograph #3** – Safety grate over drop inlet at the culvert inlet (November 2022)



**Photograph #4** – Inside drop inlet (November 2022)





**Photograph #5** – Culvert outlet, surrounded by forest vegetation, facing south. (November 2022)



## **Appendix B**

### **Record of Borehole Sheets**

## SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

### 1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

### 2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

### 3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT <sup>(1)</sup> 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer



### 4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

### 5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$


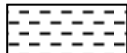



 Water Level  
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value      Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT              Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

# UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	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	SILTS AND CLAYS W <sub>L</sub> < 50%	ML	Inorganic silts and 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. (W <sub>L</sub> < 30%).
		CI	Inorganic clays of medium plasticity, silty clays. (30% < W <sub>L</sub> < 50%).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS W <sub>L</sub> > 50%	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

## EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>	
<b>Fresh (FR)</b>	No visible signs of weathering.		
<b>Fresh Jointed (FJ)</b>	Weathering limited to the surface of major discontinuities.		CLAYSTONE
<b>Slightly Weathered (SW)</b>	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
<b>Moderately Weathered (MW)</b>	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
<b>Highly Weathered (HW)</b>	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
<b>Completely Weathered (CW)</b>	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Very thinly bedded	20 to 60mm				
Laminated	6 to 20mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Thinly Laminated	Less than 6mm				

<u>TERMS</u>		Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
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 0.1m in length or larger as a percentage of total core run length.				
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				



# RECORD OF BOREHOLE No 19640-01

1 OF 2

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 174 082.9 E 286 541.7 ORIGINATED BY IR  
DIST Algoma HWY 556 BOREHOLE TYPE CME75, NW Casing Advance, NQ Coring COMPILED BY AK  
DATUM Geodetic DATE 2022.10.21 - 2022.10.21 LATITUDE 46.706081 LONGITUDE -84.238782 CHECKED BY CN

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
282.5	GROUND SURFACE						20 40 60 80 100	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>		GR SA SI CL
0.0	ASPHALT (45 mm)		1	SS	50/0.076			o				20 64 15 1
	SAND, some gravel, trace silt, trace clay, to SILTY SAND some gravel, trace silt, containing cobbles, and boulders Compact to Very Dense Grey Wet (FILL)		2	SS	50/0.050							
	Coring from a depth of 1.1 m to 2.1 m		1	NQ	-							
			3	SS	27			o				12 78 10 0
	Split spoon refusal at a depth of 3.1 m		4	SS	50/0.025							
	Coring from a depth of 3.1 m to 3.8 m		2	NQ	-							
278.7												
3.8	SILTY SAND trace to some gravel Compact to Very Dense Brown Wet		5	SS	13			o				9 44 41 6 Non-Plastic
	Split spoon refusal at a depth of 4.8 m		6	SS	50/0.050			o				17 41 39 3 Non-Plastic RUN #1 TCR=100% SCR=0% RQD=0%
277.7												
4.8	Slightly weathered to fresh, massive, fine grained, faintly porous, strong to very strong BASALT with quartz veins Grey		1	RUN	-							2 1 5 2 0 3 0 0 0
			2	RUN	-							RUN #2 TCR=100% SCR=54% RQD=30%
			3	RUN	-							RUN #3 TCR=100% SCR=95% RQD=95%
274.8												
7.7	END OF BOREHOLE AT 7.7 m. BOREHOLE BACKFILLED WITH BENTONITE AND SAND, ASPHALT PATCH AT SURFACE.											
	NOTES:  1. The cored depth intervals and particle sizes of recovered gravels, cobbles, and boulders are summarized as follows: Depth (m)      Recovered 1.1 - 2.1      1 x 205 mm, 1 x 90 mm, gravels up to 50 mm 3.1 - 3.8      no recovery											

Continued Next Page

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

## METRIC

[illegible]

# RECORD OF BOREHOLE No 19640-02

1 OF 1

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 174 077.5 E 286 562.2 ORIGINATED BY IR  
DIST Algoma HWY 556 BOREHOLE TYPE CME75, NW Casing Advance, NQ Coring COMPILED BY AK  
DATUM Geodetic DATE 2022.03.11 - 2022.03.11 LATITUDE 46.706033 LONGITUDE -84.238513 CHECKED BY CN

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)
								20 40 60 80 100					
								20 40 60					
284.1	GROUND SURFACE												
0.0	ASPHALT, (50 mm)												
	SAND and GRAVEL, to Silty GRAVEL and SAND, containing cobbles Very Dense Brown Wet (FILL)		1	SS	63							46 42 11 1	
	Split spoon refusal at a depth of 0.9 m		2	SS	50/0.152								
	Split spoon refusal at a depth of 1.6 m		3	SS	50/0.076								
	Split spoon refusal at a depth of 2.5 m and 2.7 m		4	SS	50/0.076								
	Split spoon refusal at a depth of 2.5 m and 2.7 m		5	SS	50/0.076								
281.2	Coring from a depth of 2.7 m 2.8 m		1	NQ	-								
2.9	Slightly weathered to fresh, massive, grey, fine grained, faintly porous, strong to very strong, BASALT with quartz veins		1	RUN	-							RUN #1 TCR=96% SCR=93% RQD=66%	
			2	RUN	-							RUN #2 TCR=100% SCR=86% RQD=86%	
			3	RUN	-							RUN #3 TCR=86% SCR=66% RQD=66%	
			4	RUN	-							RUN #4 TCR=72% SCR=27% RQD=27%	
			5	RUN	-							RUN #5 TCR=100% SCR=90% RQD=48%	
277.5	END OF BOREHOLE AT 6.6 m BOREHOLE BACKFILLED WITH BENTONITE AND SAND, ASPHALT PATCH AT SURFACE.												
6.6	NOTES:  1. The cored depth intervals and particle sizes of recovered gravels, cobbles, and boulders are summarized as follows: Depth (m)    Recovered 2.7 - 2.8    1x105 mm, gravels up to 25 mm  2. Water level not recorded in cased borehole upon completion of drilling due to introduction of water for rock coring.												

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

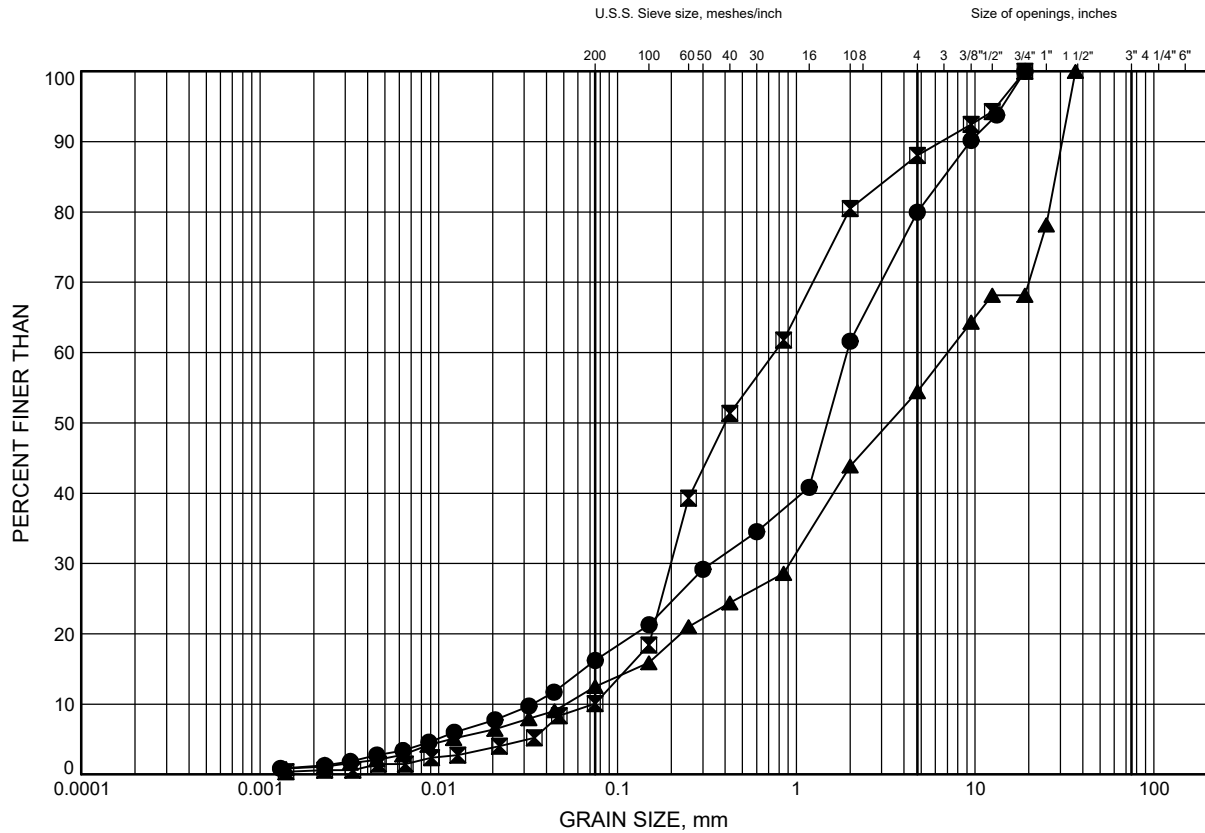


## **Appendix C**

### **Geotechnical and Analytical Laboratory Test Results, and Core Photographs**

# GRAIN SIZE DISTRIBUTION

## SAND to Gravelly Silty SAND (FILL)



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19640-01	0.4	282.1
⊠	19640-01	2.6	279.9
▲	19640-02	0.3	283.8

Date February 2023

W.P. 5221-18-00



Prep'd AN

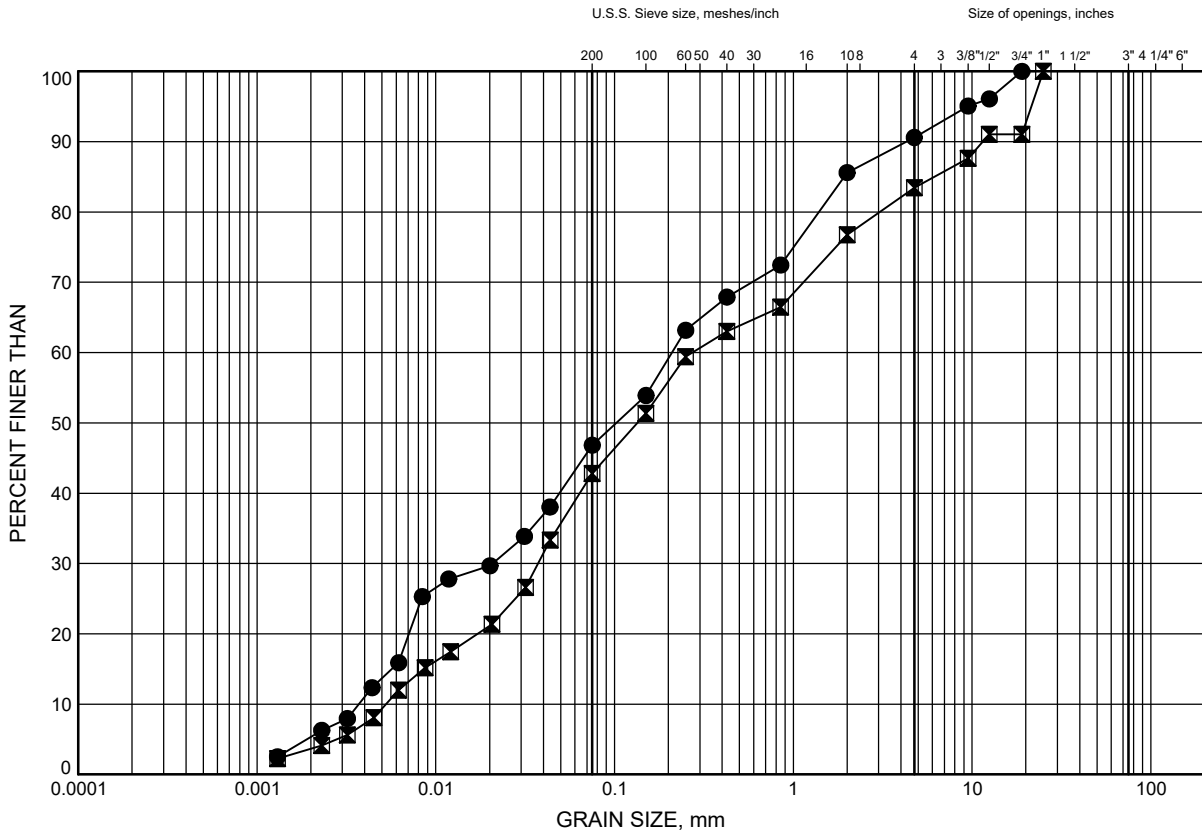
Chkd. AK

# HWY 556 Culvert Replacement at Sta. 19+640

## GRAIN SIZE DISTRIBUTION

FIGURE C2

### Silty SAND



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19640-01	4.1	278.4
⊠	19640-01	4.7	277.8

Date February 2023  
W.P. 5221-18-00

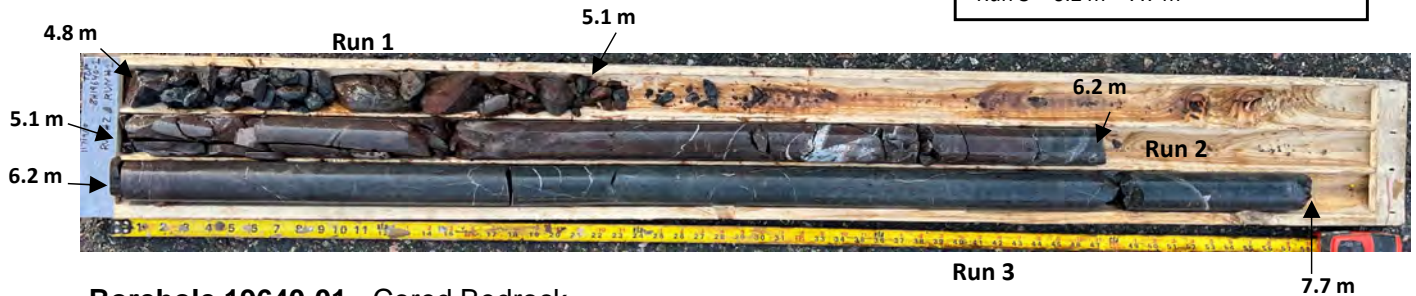


Prep'd AN  
Chkd. AK

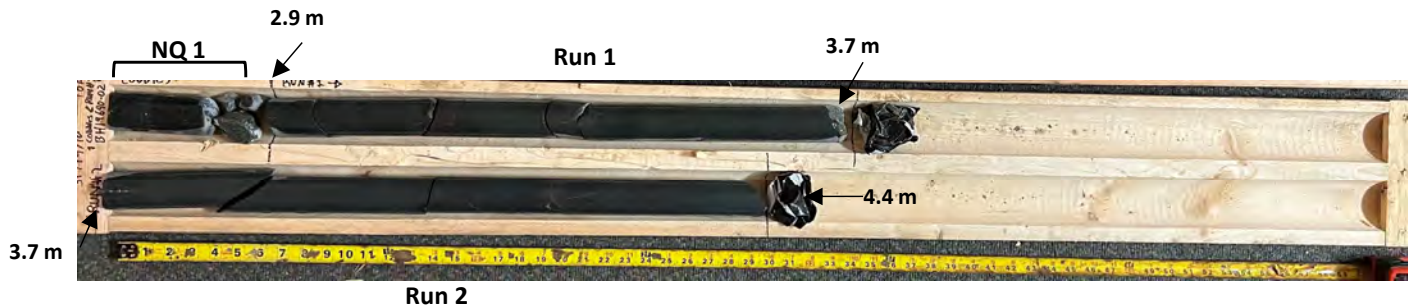


**Borehole 19640-01 - Cored Gravel and Cobbles**

NQ 1 – 1.1 m – 2.1 m  
NQ 2 – 3.1 m – 3.8 m (no recovery)  
Run 1 – 4.8 m – 5.1 m  
Run 2 – 5.1 m – 6.2 m  
Run 3 – 6.2 m – 7.7 m



**Borehole 19640-01 - Cored Bedrock**



**Borehole 19640-02 - Cored Gravel and Cobbles, Bedrock**

NQ 1 – 2.7 m – 2.8 m  
Run 1 – 2.9 m – 3.7 m  
Run 2 – 3.7 m – 4.4 m  
Run 3 – 4.4 m – 4.8 m  
Run 4 – 4.8 m – 5.3 m  
Run 5 – 5.3 m – 6.6 m



**Borehole 19640-02 – Cored Bedrock**

## Certificate of Analysis

**Thurber Engineering Ltd. (Pickering)**

1795 Ironstone Manor, Unit 1

Pickering, ON L1W 3W9

Attn: Ali Rajaei

Client PO: 31719/10

Project:

Custody: 65093

Report Date: 22-Nov-2022

Order Date: 4-Nov-2022

**Order #: 2245456**

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

Paracel ID	Client ID
2245456-01	18289-04 / SS#6
2245456-02	19640-01 / RUN#2
2245456-03	21258-03 / SS#9B

Approved By:



Milan Ralitsch, PhD

Senior Technical Manager



Certificate of Analysis

Report Date: 22-Nov-2022

Client: Thurber Engineering Ltd. (Pickering)

Order Date: 4-Nov-2022

Client PO: 31719/10

Project Description:

**Analysis Summary Table**

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	17-Nov-22	17-Nov-22
Conductivity	MOE E3138 - probe @25 °C, water ext	18-Nov-22	18-Nov-22
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	14-Nov-22	15-Nov-22
Resistivity	EPA 120.1 - probe, water extraction	18-Nov-22	22-Nov-22
Solids, %	CWS Tier 1 - Gravimetric	14-Nov-22	15-Nov-22

Certificate of Analysis

Report Date: 22-Nov-2022

Client: Thurber Engineering Ltd. (Pickering)

Order Date: 4-Nov-2022

Client PO: 31719/10

Project Description:

## Summary of Criteria Exceedances

(If this page is blank then there are no exceedances)

Only those criteria that a sample exceeds will be highlighted in red

**Regulatory Comparison:**

Paracel Laboratories has provided regulatory guidelines on this report for informational purposes only and makes no representations or warranties that the data is accurate or reflects the current regulatory values. The user is advised to consult with the appropriate official regulations to evaluate compliance. Sample results that are highlighted have exceeded the selected regulatory limit. Calculated uncertainty estimations have not been applied for determining regulatory exceedances.

Sample	Analyte	MDL / Units	Result	-	-
--------	---------	-------------	--------	---	---

Certificate of Analysis

Report Date: 22-Nov-2022

Client: Thurber Engineering Ltd. (Pickering)

Order Date: 4-Nov-2022

Client PO: 31719/10

Project Description:

<b>Client ID:</b>	18289-04 / SS#6	19640-01 / RUN#2	21258-03 / SS#9B	-	
<b>Sample Date:</b>	19-Oct-22 00:00	22-Oct-22 00:00	20-Oct-22 00:00	-	-
<b>Sample ID:</b>	2245456-01	2245456-02	2245456-03	-	
<b>Matrix:</b>	Rock	Rock	Soil	-	
<b>MDL/Units</b>					

**Physical Characteristics**

% Solids	0.1 % by Wt.	99.4	98.9	85.7	-	-
----------	--------------	------	------	------	---	---

**General Inorganics**

Conductivity	5 uS/cm	386 [1]	308	284	-	-
pH	0.05 pH Units	9.05	8.45	6.78	-	-
Resistivity	0.1 Ohm.m	25.9	32.4	35.2	-	-

**Anions**

Chloride	5 ug/g	68	23	26	-	-
Sulphate	5 ug/g	156	10	8	-	-

Certificate of Analysis

Report Date: 22-Nov-2022

Client: Thurber Engineering Ltd. (Pickering)

Order Date: 4-Nov-2022

Client PO: 31719/10

Project Description:

### Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>								
Chloride	ND	5	ug/g					
Sulphate	ND	5	ug/g					
<b>General Inorganics</b>								
Conductivity	ND	5	uS/cm					
Resistivity	ND	0.10	Ohm.m					

Certificate of Analysis

Report Date: 22-Nov-2022

Client: Thurber Engineering Ltd. (Pickering)

Order Date: 4-Nov-2022

Client PO: 31719/10

Project Description:

### Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Chloride	158	5	ug/g	160			1.7	20	
Sulphate	82.2	5	ug/g	82.8			0.6	20	
<b>General Inorganics</b>									
Conductivity	242	5	uS/cm	242			0.2	5	
pH	12.34	0.05	pH Units	12.33			0.1	10	
Resistivity	41.4	0.10	Ohm.m	41.3			0.2	20	
<b>Physical Characteristics</b>									
% Solids	82.0	0.1	% by Wt.	82.3			0.4	25	

Certificate of Analysis

Report Date: 22-Nov-2022

Client: Thurber Engineering Ltd. (Pickering)

Order Date: 4-Nov-2022

Client PO: 31719/10

Project Description:

### Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Chloride	252	5	ug/g	160	91.8	82-118			
Sulphate	201	5	ug/g	82.8	118	80-120			

Certificate of Analysis

Report Date: 22-Nov-2022

Client: Thurber Engineering Ltd. (Pickering)

Order Date: 4-Nov-2022

Client PO: 31719/10

Project Description:

**Qualifier Notes:****Sample Qualifiers :**

- 1: This analysis was conducted after the accepted holding time had been exceeded.

**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 unless otherwise noted.

Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

Any use of these results implies your agreement that our total liability in connection with this work, however arising, shall be limited to the amount paid by you for this work, and that our employees or agents shall not under any circumstances be liable to you in connection with this work.



Parcel Order Number

(Lab Use Only)

2245456

Chain Of Custody

(Lab Use Only)

No 65093

Client Name: <i>Thurber Engineering Ltd.</i>	Project Ref:	Page <u>  </u> of <u>  </u>
Contact Name: <i>Ali Rajaei</i>	Quote #: <i>22-754</i>	Turnaround Time <input type="checkbox"/> 1 day <input type="checkbox"/> 3 day <input type="checkbox"/> 2 day <input checked="" type="checkbox"/> Regular
Address: <i>Unit 1, 1795 Ironstone Manor, Pickering, ON, L1W 3W9</i>	PO #: <i>31719/10</i>	
Telephone: <i>416-575-9069</i>	E-mail: <i>ARAJAEI@THURBER.CA</i> <i>CC: AKOBYLINSKI@THURBER.CA</i>	
Date Required: _____		

<input type="checkbox"/> REG 153/04 <input type="checkbox"/> REG 406/19    Other Regulation:		Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)		Required Analysis																
<input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Med/Fine <input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse <input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/Other <input type="checkbox"/> Table _____ For RSC: <input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> REG 558 <input type="checkbox"/> PWQO <input type="checkbox"/> CCME <input type="checkbox"/> MISA <input type="checkbox"/> SU - Sani <input type="checkbox"/> SU - Storm Mun: _____ <input type="checkbox"/> Other: _____	Matrix	Air Volume	# of Containers	Sample Taken		PH	Resistivity	Chloride	Sulphide	Sulphate	Conductivity								
Sample ID/Location Name		Date	Time																	
1	18289-04/SS#6	Rock		1	Oct 19/22		✓	✓	✓	✓	✓	✓								
2	19640-01/RUN#2	Rock		1	Oct 22/22		✓	✓	✓	✓	✓	✓								
3	21258-03/SS#9B	Soil		1	Oct 20/22		✓	✓	✓	✓	✓	✓								
4																				
5																				
6																				
7																				
8																				
9																				
10																				

Comments: <i>Rock samples to be crushed/pulverized as per Paracel email (on Nov 2, 2022)</i>			Method of Delivery: <i>RABBEX</i>		
Relinquished By (Sign): <i>[Signature]</i>	Received By Driver/Depot: <i>[Signature]</i>	Received at Lab: <i>[Signature]</i>	Verified By: <i>[Signature]</i>		
Relinquished By (Print): <i>A. Rajaei</i>	Date/Time: <i>04-Nov-22 11:23</i>	Date/Time: <i>Nov 15/22 14:35</i>	Date/Time: <i>Nov 7 2022 8:36</i>		
Date/Time: <i>Nov 3, 2022</i>	Temperature: <i>21.4</i> °C	Temperature: <i>3.3</i> °C	pH Verified: <input type="checkbox"/> By: _____		



## Subcontracted Analysis

**Thurber Engineering Ltd. (Pickering)**

1795 Ironstone Manor, Unit 1  
Pickering, ON L1W 3W9  
Attn: Ali Rajaei

Paracel Report No. **2245456**

Client Project(s):

Client PO: **31719/10**

Reference: **#22-754 Corrosivity**

CoC Number: **65093**

Order Date: 04-Nov-22

Report Date: 25-Nov-22

Sample(s) from this project were subcontracted for the listed parameters. A copy of the subcontractor's report is attached

Paracel ID	Client ID	Analysis
2245456-01	18289-04 / SS#6	Sulphide, solid
2245456-02	19640-01 / RUN#2	Sulphide, solid
2245456-03	21258-03 / SS#9B	Sulphide, solid

**SGS Canada Inc.**

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

**Paracel Laboratories**

Attn : Dale Robertson

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

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

25-November-2022

**Date Rec. :** 15 November 2022  
**LR Report:** CA12656-NOV22  
**Reference:** Project#: 2245456

**Copy:** #1

## CERTIFICATE OF ANALYSIS

### Final Report

Sample ID	Sample Date & Time	Sulphide (Na <sub>2</sub> CO <sub>3</sub> ) %
1: Analysis Start Date		23-Nov-22
2: Analysis Start Time		15:05
3: Analysis Completed Date		25-Nov-22
4: Analysis Completed Time		09:27
5: QC - Blank		< 0.04
6: QC - STD % Recovery		118%
7: QC - DUP % RPD		10%
8: RL		0.02
9: 18289-04 / SS#6	19-Oct-22	0.09
10: 19640-01 / Run#2	22-Oct-22	< 0.04
11: 21258-03 / SS#9B	20-Oct-22	< 0.04

RL - SGS Reporting Limit

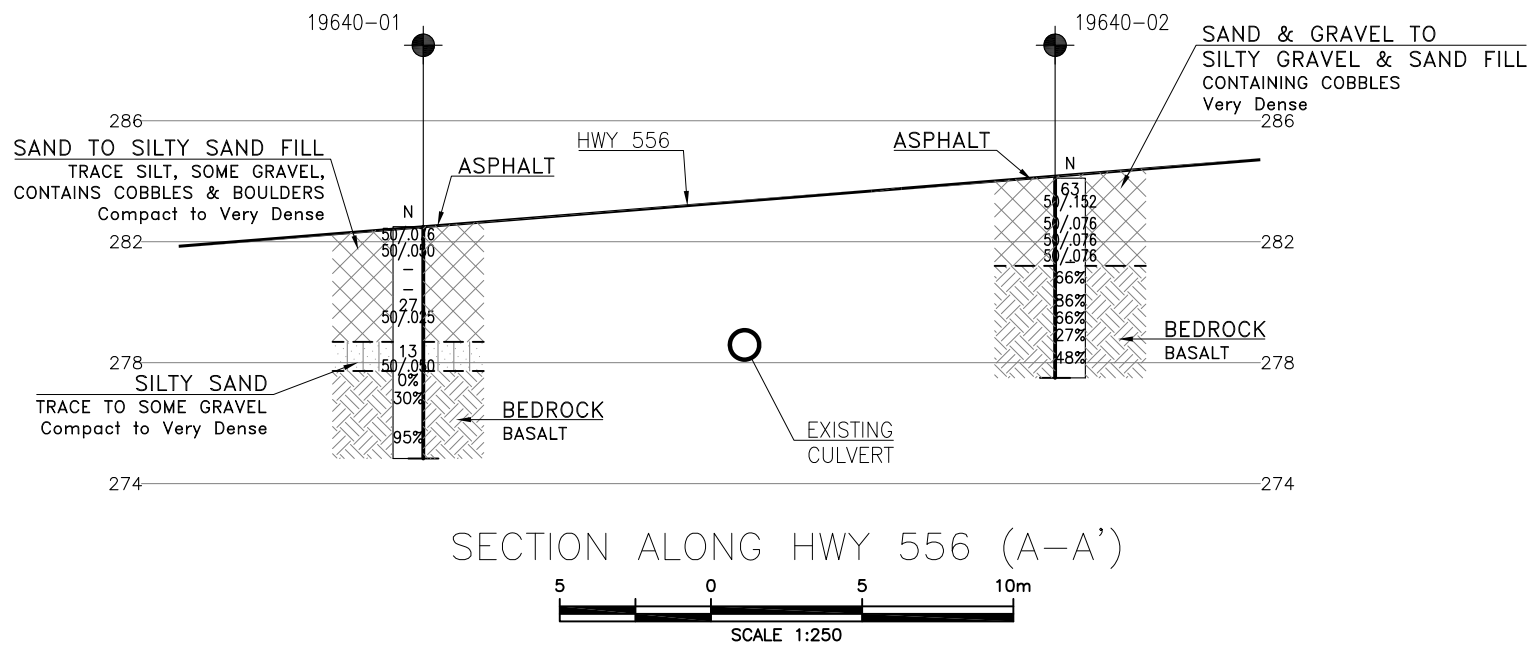
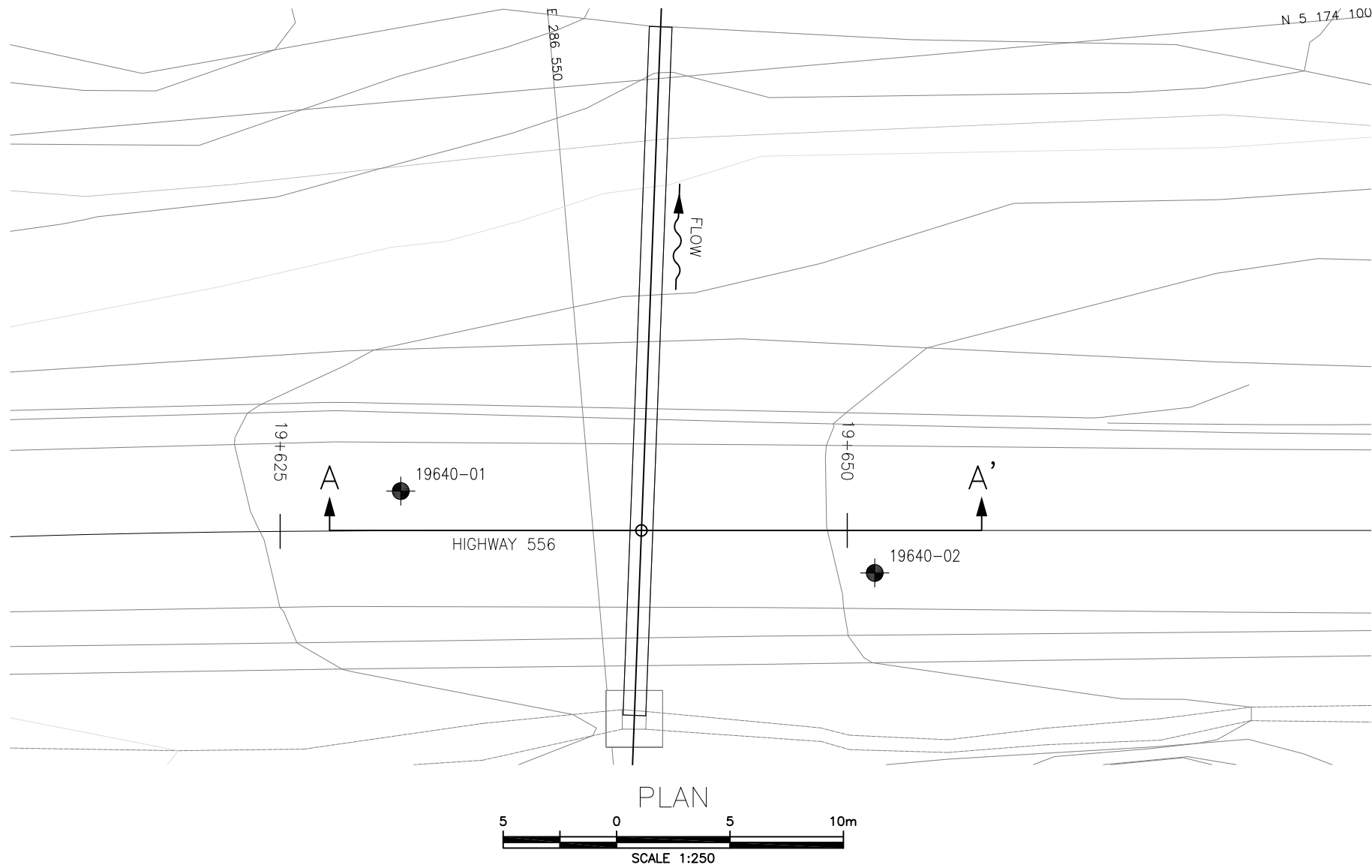
Note: Results may be unreliable if analysis was performed past the 28 day holding time.

Kimberley Didsbury  
Project Specialist,  
Environment, Health & Safety



## **Appendix D**

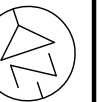
### **Borehole Locations and Soil Strata Drawing**



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

CONT No  
WP No 5221-18-00

HIGHWAY 556  
STATION 19+640  
CULVERT  
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
19640-01	282.5	5 174 082.9	286 541.7
19640-02	284.1	5 174 077.5	286 562.2

-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 13.

GEOCRES No. 41K-126



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	AK	CHK PKC	CODE
DRAWN	AN	CHK AK	SITE
LOAD			
STRUCT			
DWG	1		
DATE	APR 2023		