



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGHWAY 556 CULVERT REPLACEMENT AT STA 19+596
(TOWNSHIP OF DEROCHE)
REHABILITATION OF HIGHWAYS 556 & 532
DISTRICT OF ALGOMA, ONTARIO
ASSIGNMENT No.: 5020-E-0020
G.W.P. 5221-18-00**

LATITUDE: 46.742294°, LONGITUDE: -84.128221°

GEOCRES Number: 41K-124

Report

to

AECOM Canada Ltd.

Date: April 24, 2023
File: 31719



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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) at the site of a centreline culvert, located at STA 19+596 on Highway 556, in the Township of Deroche, District of Algoma, Ontario.

The purpose of this investigation was to explore the subsurface conditions at the culvert site 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) Agreement 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 5.0 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:



Township and Station	Culvert Size and Type	Length of Culvert (m)	Invert Elevation at Inlet (m)	Invert Elevation at Outlet (m)
Deroche 19+596	800 mm dia. CSP	27.0 m long	226.0 south	224.6 north

The existing culvert allows flow in a south to north direction under the approximately 5 m high embankment. The highway pavement surface is at approximate Elev. 229.7 m. In the area of the culvert, the north- and south-facing slopes are inclined at approximately 2H:1V and 1.8H:1V, respectively.

Based on visual observations, no signs of slope instability or erosion of the embankment were noted at the culvert site. The south and north sides of the embankment at the toe of the slope were surrounded by thick, mixed forest. In addition, the bottom of the existing culvert outlet was observed to be partially damaged by corrosion. 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 alignment in the immediate vicinity of the culvert is on a curve. The paved shoulders are narrow and are flanked by steel beam guiderails on both sides of the highway. Overhead utility lines are present on the south 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 12 m to the west of the culvert.

Based on Northern Ontario Engineering Geology Terrain Study (NOEGTS) mapping, the site lies in an outwash plain and valley train and the primary materials are sandy and gravelly soils, and bedrock knobs and outcrops. The site topography in the immediate vicinity of the culvert is of low relief consisting of plains and gullies and the surrounding area is generally described as 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 17 and November 27, 2022, and consisted of drilling and sampling five boreholes, designated as Boreholes 19596-01 to 19596-05, to depths of between 4.8 m and 15.8 m (Elev. 213.8 m and 222.2 m). Boreholes 19596-02 to 19596-04 were advanced through the existing highway



embankment, while Borehole 19596-01 and 19596-05 were advanced near the toe of the embankment near the existing outlet and inlet, respectively.

The Record of Borehole sheets for the boreholes are included in Appendix B. The approximate borehole locations are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix D.

Utility clearances were obtained prior to mobilization to the site. The as-drilled borehole elevations were surveyed in the field with a rod and level using a temporary benchmark identified as HCP 192 which is at an elevation of 230.817 m. The borehole co-ordinates were determined through off-set measurement from the highway centerline and existing culvert. The coordinate system MTM NAD 83, Zone 13 was used for the boreholes.

Boreholes 19596-02 to 19596-04 were drilled using a truck mounted CME 75 drill rig using wash boring technique with HW casing and NQ coring equipment, while Boreholes 19596-01 and 19596-05 were advanced with a portable drilling equipment also using wash boring technique but with BW casing and AW coring equipment. Soils samples were obtained at selected intervals using a split-spoon sampler in conjunction with Standard Penetration Testing (SPT) in general accordance with ASTM D1586. Soil sampling in Boreholes 19596-01 and 19596-05 employed the use of a manually lifted third-weight hammer and as such, a correction factor has been applied for the reported SPT N-values and thus, they are less reliable.

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 samples for transport to Thurber's laboratory for further examination and testing.

Groundwater conditions observed in the open boreholes are not considered stabilized due to the introduction of water throughout the drilling operation. A monitoring well was installed in Borehole 19596-01, which consisted of 32 mm diameter Schedule 40 PVC pipe with a 1.5 m slotted screen, to permit groundwater level monitoring. The well installation details, groundwater level observations and water level readings are shown on the Record of Borehole sheet. The boreholes completion details are summarized below:



Borehole	Depth and Elevation of Borehole Base (m)	Depth and Elevation of Well Tip (m)	Northing and Easting MTM NAD83 Zone 13	Completion Details
19596-01	5.2 / 219.4	5.1 / 219.5	N 5 178 102.9 E 295 003.8	32 mm diameter PVC pipe with a 1.5 m long slotted screen.
19596-02	15.8 / 213.8	None Installed	N 5 178 085.1 E 294 994.2	Backfilled with bentonite holeplug and asphalt patch at surface.
19596-03	11.3 / 218.6	None Installed	N 5 178 089.1 E 295 007.4	Backfilled with bentonite holeplug and asphalt patch at surface.
19596-04	15.8 / 214.2	None Installed	N 5 178 089.1 E 295 014.1	Backfilled with bentonite holeplug and asphalt patch at surface.
19596-05	4.8 / 222.2	None Installed	N 5 178 074.9 E 295 005.9	Backfilled with bentonite holeplug to 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/or 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.

Corrosivity testing was carried out on a sample of the native silty sand to assess the potential for sulphate attack on buried concrete structures, as well as the potential for corrosion associated with buried steel elements of the structures. 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 may vary between and beyond the borehole locations.

In general, the subsurface conditions encountered consisted of embankment fill, underlain by a native deposit of silty sand to silt, which in turn is underlain by a deposit of gravel and sand to gravelly sand. Beneath the gravel and sand to gravelly sand is a deposit of sand to silty sand. Coarse gravel (up to 75 mm in diameter) were encountered throughout the embankment fill, and native deposit. In addition, cobbles (up to 150 mm in diameter) were encountered in Borehole 19596-01 at depth of 1.4 m below grade (Elev. 223.2 m).

5.1 Asphalt

Boreholes 19596-02 to 19596-04 were advanced through the paved portion of Highway 556, and the thickness of the asphalt was measured to be between 40 and 50 mm.

5.2 Embankment Fill

Embankment fill ranging in composition from sandy gravel to sand and gravel to silty sand containing trace to some non-plastic fines was encountered below the asphalt layer in Boreholes 19596-02 to 19596-04. The embankment fill ranged in thickness from 3.6 m to 3.7 m and extended to a depth of 3.7 m in all boreholes (Elev. 226.3 m to 225.9 m).

SPT 'N' values in the embankment fill ranged from 8 blow per 0.3 m penetration to 50 blows per 0.1 m of penetration, indicating a compact to very dense condition; however, the fill was generally compact to dense. The SPT 'N' values varied widely as a result of split-spoon refusal on gravel, which were present throughout the fill. The measured moisture contents generally ranged from 1 percent to 29 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 Figures C-1A and C-1B of Appendix C. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	3 to 65
Sand	29 to 65
Silt	7 to 30
Clay	2
Silt & Clay	6 to 10

5.3 Silty Sand to Silt

A cohesionless soil layer consisting of silty sand to silt and sand to silt, some sand with trace amount of clay was encountered at the ground surface in Borehole 19596-01 and 19596-05, and beneath the embankment fill in Boreholes 19596-02 to 19596-04. In Boreholes 19596-01 and 19596-04, the deposit contains organics. Occasional wood fragments were noted in this unit in Borehole 19596-02. The deposit ranged in thickness from 1.4 m to 3.5 m and extended to depths of between 1.4 m and 7.2 m (Elev. 224.8 m to 222.4 m).

SPT 'N' values in the cohesionless deposit ranged from 4 to 14 blows per 0.3 m penetration, indicating a very loose to compact condition. In general, measured moisture contents in the cohesionless soils ranged from 10 percent to 56 percent. A moisture content of 94 percent was measured in a sample of silt in Borehole 19596-04, where the sample contained organics.

The results of grain size analyses conducted on selected samples of the silty sand to silt deposit are presented on Figure C-2 in Appendix C and summarized as follows:

Soil Particle	Percentage (%)
Gravel	0
Sand	11 to 60
Silt	33 to 83
Clay	3 to 12

Atterberg limits tests were carried out on the fines portion of two selected samples of the cohesionless deposit and both were determined to be non-plastic.



5.4 Gravel and Sand to Gravelly Sand

A gravel and sand to gravelly sand deposit containing cobbles was encountered beneath the silty sand to silt deposit in Boreholes 19596-01 to 19596-05. The granular deposit ranged in thickness from 1.5 m to 2.6 m (prior to borehole termination) and extended to depths between 3.4 m and 8.7 m (Elev. 222.2 m to 220.9 m). Cobbles up to 150 mm in diameter were encountered within the gravel and sand deposit in Borehole 19596-01 at depths between 1.7 m and 3.4 m (Elev. 222.9 m to 221.2 m). Coring was required to advance through this deposit. Photographs of the cobble cores are provided in Appendix C.

Borehole 19596-05 was terminated within this deposit at a depth of 4.8 m (Elev. 222.2 m).

In general, SPT 'N' values in the cohesionless deposit ranged from 16 to 26 blows per 0.3 m penetration, indicating a compact condition. Higher blow counts were noted in this deposit in Boreholes 19596-01 and 19596-05, which was attributed from the use of third-weight hammer. It should be noted that SPT 'N' values reported for Boreholes 19596-01 and 19596-05 were adjusted from third-weight hammer and therefore, may not be representative of the condition of the deposit. The measured moisture contents in the granular ranged from 7 percent to 15 percent.

The results of grain size analyses conducted on selected samples of the gravel and sand to gravelly sand layer are presented on Figure C-3, in Appendix C and summarized as follows:

Soil Particle	Percentage (%)
Gravel	27 to 53
Sand	44 to 69
Silt	4
Clay	0
Silt & Clay	3 to 4

5.5 Sand to Silty Sand

A sand to silty sand deposit was encountered beneath the gravel and sand to gravelly sand deposit in Boreholes 19596-01 to 19596-04. All four boreholes were terminated within this deposit which ranged in thickness from 1.8 m to 7.1 m prior to borehole termination.

In general, the SPT 'N' values in the sand to silty sand deposit ranged from 22 to 51 blows per 0.3 m penetration, indicating a compact to very dense condition. A SPT 'N' value of 32 blows per 0.1 m of penetration was measured in Borehole 19596-01; however, this 'N' value was adjusted



from third-weight hammer and may not be representative. The measured moisture contents in the cohesionless deposit ranged from 14 percent to 45 percent.

The results of grain size analyses conducted on selected samples of the lower sand deposit are presented on Figure C-4 in Appendix C and summarized as follows:

Soil Particle	Percentage (%)
Gravel	0 to 10
Sand	81 to 89
Silt	1 to 19
Clay	0 to 2

5.6 Groundwater Conditions

Details of the water level observed in the boreholes upon completion of drilling and in a piezometer installed in a borehole are presented on the record of boreholes and summarized below.

Borehole	Date of Measurement	Groundwater Level (m)		Remark
		Depth	Elevation	
19596-01	Nov. 26, 2022	1.0 m	223.6	Measurement in monitoring well
19596-02	-	-	-	Not measured. ^{Note 1}
19596-03	Oct. 21, 2022	4.6 m	225.3 m	Not stabilized. ^{Note 2}
19596-04	Oct. 17, 2022	4.0 m	226.0 m	Not stabilized. ^{Note 2}
19596-05	Nov. 27, 2022	1.2 m	225.8 m	Not stabilized. ^{Note 2}

Note 1: Introduced water into borehole for drilling with wash boring methods and therefore, groundwater level was not measured upon completion of drilling.

Note 2: Introduced water into borehole for drilling with wash boring methods and therefore, groundwater level at time of measurement was not considered stabilized.

A minor amount of water was observed ponded at both inlet and outlet (please see photographs in Appendix A) at the time of the completion of investigation. The water level was surveyed and found to be at approximately Elev. 224.6 m near the culvert outlet and at approximately Elev. 226.0 m at the inlet at the time of investigation.

These groundwater levels are short-term observations and seasonal fluctuations of the groundwater levels are to be expected. In particular, 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 the native silty sand 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.

Borehole	19596-02
Sample	SS7
Depth (m)	6.1 to 6.7
Elevation (m)	223.5
Sulphide (Na ₂ CO ₃) %	0.04
Chloride (µg/g)	24
Sulphate (µg/g)	7
pH	7.05
Conductivity (µS/cm)	78
Resistivity (Ohm-cm)	12,800

7. MISCELLANEOUS

Marathon Drilling of Greely, Ontario, OGS Inc. of Almonte, Ontario, and Forage Fusion Drilling of Hawkesbury, 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 Messrs. Arie Simpson, B.A.Sc., and 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 laboratory. Analytical laboratory testing was carried out by Paracel Laboratories Ltd., a CALA accredited analytical laboratory in Ottawa, Ontario.


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



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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.

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5. INTERPRETATION OF THE REPORT

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

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

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

7. INDEPENDENT JUDGEMENTS OF CLIENT

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



Appendix A

Site Photographs



Photograph #1 – Highway 556 at STA 19+596, looking East. Embankment slope facing north is sparsely vegetated (October 2022)



Photograph #2 – North-facing embankment slope at STA 19+596, looking North. Culvert visible in bottom (October 2022)



Photograph #3 – Culvert outlet at tow of slope surrounded by mixed forest (September 2022)



Photograph #4 – Toe of embankment slope at culvert outlet facing South (September 2022)



Photograph #5 – Culvert inlet, surrounded by vegetation (November 2022)



Photograph #6 – Culvert inlet, looking North (November 2022)



Photograph #7 – Culvert outlet, facing south (September 2022)



Photograph #8 – Creek downstream of the culvert (October 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 ⁽¹⁾ '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

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


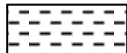



 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (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 _L < 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 _L < 30%).
		CI	Inorganic clays of medium plasticity, silty clays. (30% < W _L < 50%).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS W _L > 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>	
Fresh (FR)	No visible signs of weathering.		
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
Completely Weathered (CW)	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>		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
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 19596-01

1 OF 1

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 178 102.9 E 295 003.8 ORIGINATED BY AS
 DIST Algoma HWY 556 BOREHOLE TYPE Portable Drilling, Wash Boring, BW Casing Advance, AW Coring COMPILED BY AO
 DATUM Geodetic DATE 2022.11.24 - 2022.11.24 LATITUDE 46.742425 LONGITUDE -84.128201 CHECKED BY AR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				w _P w w _L				
								20 40 60 80 100				20 40 60				
224.6	GROUND SURFACE															
0.0	SAND , some gravel, trace organics Loose Brown Wet No recovery from a depth of 0.8 to 1.4 m.		1	GS	-											
			2	SS	5											
223.2																
1.4	GRAVEL and SAND , trace non-plastic fines, containing cobbles with particle size up to 150 mm. Very Dense Brown Wet		3	SS	32/0.12											
			1	AW	-											
221.3																
3.4	SAND , some gravel, trace silt Compact to Dense Light Brown Wet No recovery from a depth of 3.4 to 3.6 m. No recovery from a depth of 4.6 to 5.2 m.		4	SS	32/0.100											
			5	SS	29											
			6	SS	41											
219.4																
5.2	END OF BOREHOLE AT 5.2 m Monitoring well installation consists of 31.8 mm diameter Schedule 40 PVC pipe with 1.5 m slotted screen. NOTES: 1. A third-weight hammer was used to advance the split-spoon sampler. The "N" values presented above have been adjusted to provide an estimate of the "N" value that would have been obtained through a standard hammer 2. Borehole terminated at a depth of 5.2 m as a result of casing seizing within the sand layer. 3. Water level at a depth of 1.0 m below ground surface (Elev. 223.6 m) in open borehole upon removal of casing, prior to abandonment. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2022.11.26 1.0 223.6															

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

RECORD OF BOREHOLE No 19596-02

1 OF 2

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 178 085.1 E 294 994.2 ORIGINATED BY IR
DIST Algoma HWY 556 BOREHOLE TYPE CME 75, Wash Boring, HW Casing Advance, NQ Coring COMPILED BY AO
DATUM Geodetic DATE 2022.10.17 - 2022.10.17 LATITUDE 46.742264 LONGITUDE -84.128326 CHECKED BY AK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
229.6	GROUND SURFACE							20	40	60	80	100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
0.9	ASPHALT:(50 mm)							20	40	60	80	100	WATER CONTENT (%)			
	Sandy GRAVEL , trace non-plastic fines Very Dense Brown Moist (FILL)		1	GS	-		229									65 29 6 (SI+CL)
			1	SS	50/0.100											
	No sample recovery from 1.5 to 1.9 m.		2	SS	72/0.254		228									
			3	SS	55		227									
226.6	Gravelly SAND , some silt, trace clay Dense Brown Wet (FILL)		4	SS	35		226									23 63 12 2
225.9	Silty SAND , trace clay, occasional wood fragments Loose Brownish Grey Wet		5	SS	4		225									0 58 39 3
	No sample recovery from a depth of 3.8 to 4.4 m.		6	SS	10		224									
			7	SS	9		223									
222.4	GRAVEL and SAND , trace non-plastic fines Compact Brownish Grey Wet		8	SS	25		222									53 44 3 (SI+CL)
220.9	Silty SAND Compact to Dense Brownish Grey Wet		9	SS	28		221									
8.7							220									

Continued Next Page

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

RECORD OF BOREHOLE No 19596-02

2 OF 2

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 178 085.1 E 294 994.2 ORIGINATED BY IR
DIST Algoma HWY 556 BOREHOLE TYPE CME 75, Wash Boring, HW Casing Advance, NQ Coring COMPILED BY AO
DATUM Geodetic DATE 2022.10.17 - 2022.10.17 LATITUDE 46.742264 LONGITUDE -84.128326 CHECKED BY AK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
Continued From Previous Page							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				PLASTIC LIMIT W _P NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L			
213.8 														

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RECORD OF BOREHOLE No 19596-03

1 OF 2

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 178 089.1 E 295 007.4 ORIGINATED BY IR
DIST Algoma HWY 556 BOREHOLE TYPE CME 75, Wash Boring, HW Casing Advance, NQ Coring COMPILED BY AO
DATUM Geodetic DATE 2022.10.21 - 2022.10.21 LATITUDE 46.742300 LONGITUDE -84.128153 CHECKED BY AK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)						
229.9	GROUND SURFACE							20	40	60	80	100		W _P	W	W _L		
0.0	ASPHALT: (50 mm)																	
	SAND and GRAVEL, trace silt Compact to Very Dense Brown Moist (FILL)		1	SS	75									○				46 47 7 0
	No sample recovery from 0.8 to 1.4 m.		2	SS	29													
228.5																		
1.4	Silty SAND, trace gravel, trace clay Loose to Very Dense Brown Moist (FILL)		3	SS	29									○				3 65 30 2
	Wet below at depth of 2.3 m		4	SS	10									○				
			5	SS	74									○				
226.2																		
3.7	SILT, some sand, some clay Compact Brown Wet		6	SS	12										○			0 11 77 12
225.4																		
4.5	SILT and SAND, trace clay Loose to Compact Brown Wet		7	SS	9										○			0 44 53 3 Non-Plastic
			8	SS	14										○			
			9	SS	5													
222.7																		
7.2	Gravelly SAND, trace silt Compact Brown Wet		10	SS	16										○			27 69 4 0
221.2																		
8.7	Silty SAND, trace clay Compact to Very Dense Brown to Grey Wet		11	SS	51										○			

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 19596-03

2 OF 2

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 178 089.1 E 295 007.4 ORIGINATED BY IR
DIST Algoma HWY 556 BOREHOLE TYPE CME 75, Wash Boring, HW Casing Advance, NQ Coring COMPILED BY AO
DATUM Geodetic DATE 2022.10.21 - 2022.10.21 LATITUDE 46.742300 LONGITUDE -84.128153 CHECKED BY AK






SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
218.6	Silty SAND , trace clay Compact to Very Dense Brown to Grey Wet		12	SS	30		219									0 86 13 1	
11.3	END OF BOREHOLE AT 11.3 m BOREHOLE BACKFILLED WITH BENTONITE, ASPHALT PATCH AT SURFACE. NOTES: 1. Water level at a depth of 4.6 m below ground surface (Elev. 225.3 m) upon completion of drilling, but is not considered representative of the natural groundwater level due to the introduction of water for casing advancement.																

RECORD OF BOREHOLE No 19596-04

1 OF 2

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 178 089.1 E 295 014.1 ORIGINATED BY IR
DIST Algoma HWY 556 BOREHOLE TYPE CME 75, Wash Boring, HW Casing Advance, NQ Coring COMPILED BY AO
DATUM Geodetic DATE 2022.10.17 - 2022.11.01 LATITUDE 46.742301 LONGITUDE -84.128065 CHECKED BY AK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
230.0	GROUND SURFACE							20 40 60 80 100							
0.0	ASPHALT: (40 mm)							20 40 60 80 100							
0.2	SAND and GRAVEL, some non-plastic fines Dense to Very Dense Brownish Grey Moist (FILL) No sample recovery from a depth of 1.5 to 1.7 m.		1	GS	-		229							38 52 10 (SI+CL)	
			1	SS	50/0.100										
			2	SS	30/0.150										
			1	NQ	-										
			3	SS	44										
227.6															
2.4	Silty SAND, some gravel Loose Grey Wet (FILL)		4	SS	8		227							16 57 27 (SI+CL)	
			5	SS	38										
226.3															
3.7	SILT, some sand, trace clay, containing organics Loose Brown to Greyish Brown Wet No sample recovery from a depth of 3.8 m to 4.4 m		6	SS	5		226								
			7	SS	6										0 11 83 6
			8	SS	9										
222.8							223								
7.2	Gravelly SAND, trace non-plastic fines Compact Brownish Grey Wet		9	SS	26		222							30 66 4 (SI+CL)	
221.3															
8.7	SAND, some silt Compact to Dense Brownish Grey Wet		10	SS	28		221								

Continued Next Page

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

RECORD OF BOREHOLE No 19596-04

2 OF 2

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 178 089.1 E 295 014.1 ORIGINATED BY IR
DIST Algoma HWY 556 BOREHOLE TYPE CME 75, Wash Boring, HW Casing Advance, NQ Coring COMPILED BY AO
DATUM Geodetic DATE 2022.10.17 - 2022.11.01 LATITUDE 46.742301 LONGITUDE -84.128065 CHECKED BY AK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				GR	SA	SI	CL				
								20	40	60	80	100	W _p	W		W _L							
Continued From Previous Page																							
214.2 <																							

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RECORD OF BOREHOLE No 19596-05

1 OF 1

METRIC

W.P. 5221-18-00 LOCATION MTM Zone 13: N 5 178 074.9 E 295 005.9 ORIGINATED BY IR
 DIST Algoma HWY 556 BOREHOLE TYPE Portable Drilling, Wash Boring, BW Casing Advance, AW Coring COMPILED BY AO
 DATUM Geodetic DATE 2022.11.27 - 2022.11.27 LATITUDE 46.742173 LONGITUDE -84.128172 CHECKED BY AK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
227.0	GROUND SURFACE							20	40	60	80	100		
0.0	Silty SAND , trace clay Loose Light Brown Wet		1	GS	-									
			2	SS	7		226							
			3	SS	4		225							
224.8														
2.2	SAND and GRAVEL , some non-plastic fines Very Dense Brown Wet		4	SS	32/0.100		224							
	No sample recovery from a depth of 3.3 to 3.4 m.		5	SS	32/0.076									
							223							
222.2			6	SS	32/0.050									
4.8	END OF BOREHOLE AT 4.8 m BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.													
NOTES: 1. A third-weight hammer was used to advance the split-spoon sampler. the "N" values presented above have been adjusted to provide an estimate of the "N" value that would have been obtained with a standard hammer 2. Borehole terminated at depth of 4.9 m (Elev. 222.1 m) as a result of casing seizing within the sand and gravel layer 3. Water level at a depth of 1.2 m below ground surface (Elev. 225.8 m) upon completion of drilling, but is not considered representative of the natural groundwater level due to the introduction of water for casing advancement.														

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE



Appendix C

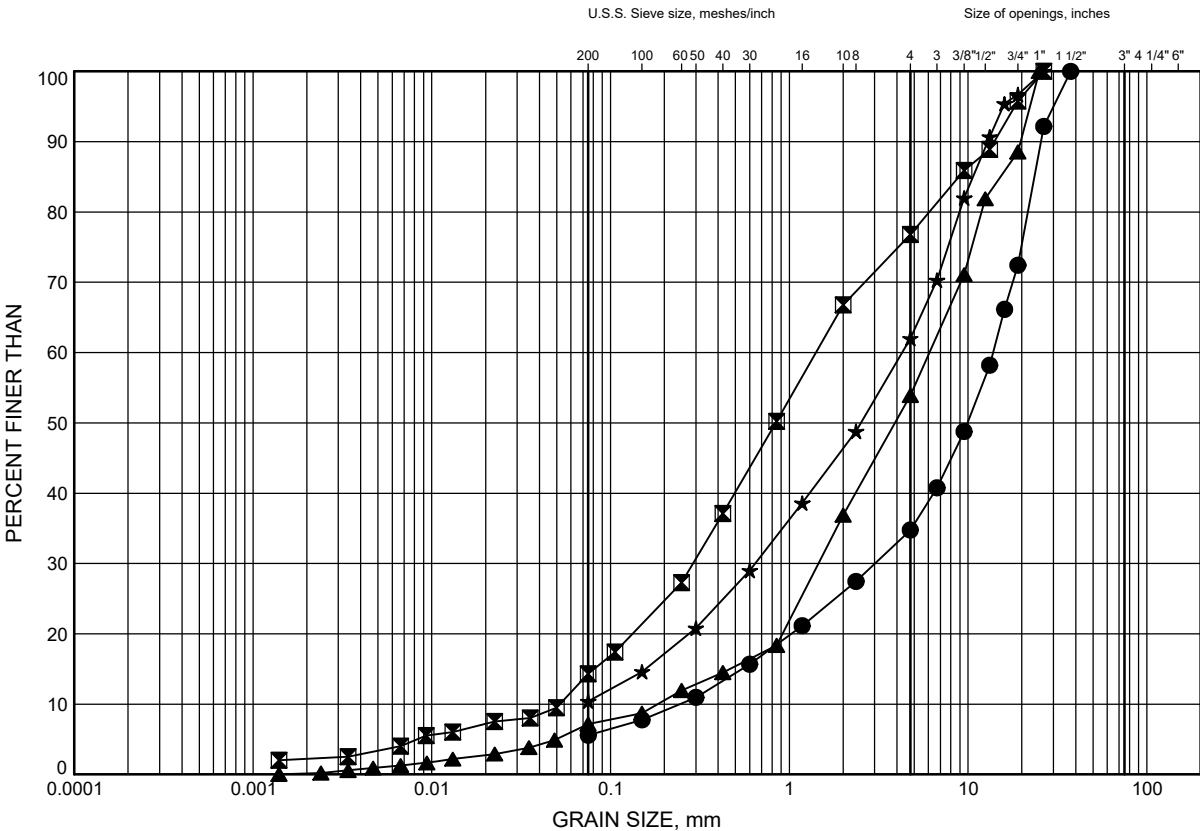
Geotechnical and Analytical Laboratory Test Results, and Core Photographs

Highway 556 Culvert Replacement at STA 19+596

GRAIN SIZE DISTRIBUTION

FIGURE C-1A

Sandy GRAVEL to Gravelly SAND (FILL)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19596-02	0.4	229.2
⊠	19596-02	3.4	226.2
▲	19596-03	0.4	229.5
★	19596-04	0.4	229.6

GRAIN SIZE DISTRIBUTION - THURBER MTO-31719.GPJ 2/10/23

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



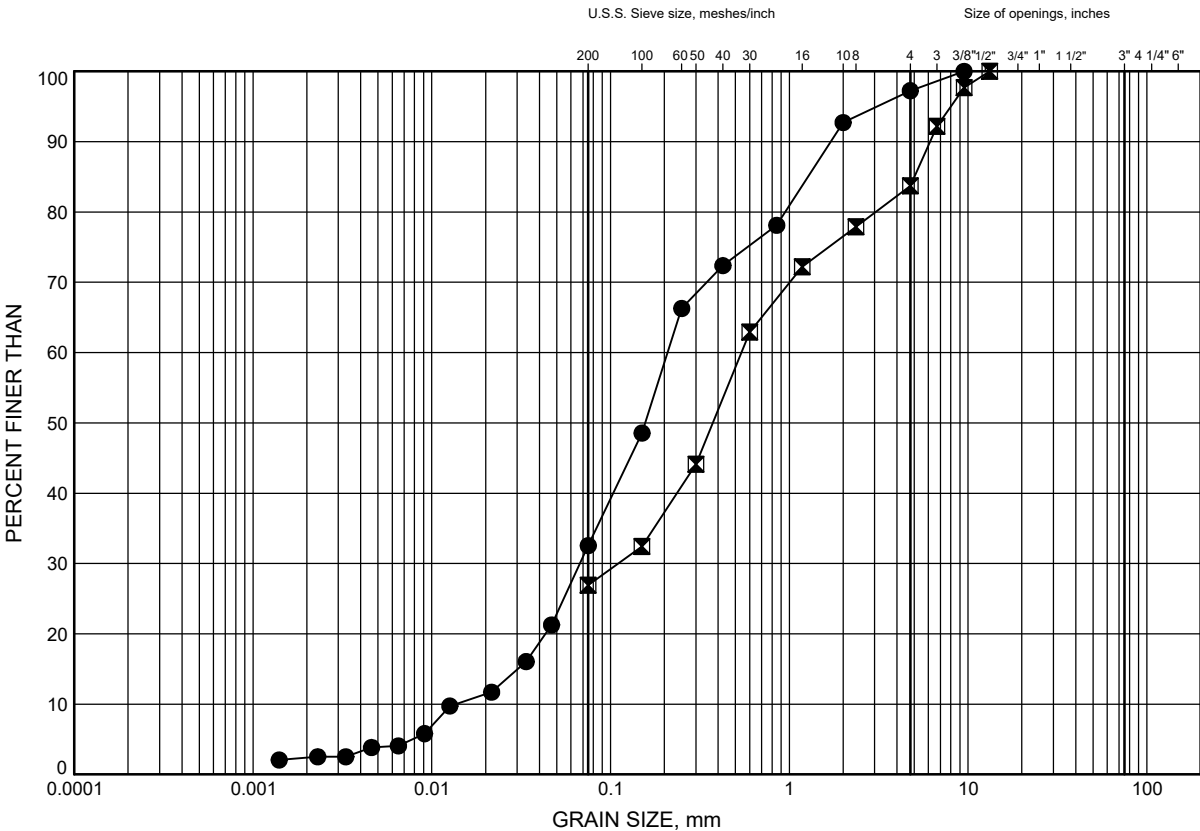
Prep'd AN
Chkd. AR

Highway 556 Culvert Replacement at STA 19+596

GRAIN SIZE DISTRIBUTION

FIGURE C-1B

Silty SAND (FILL)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19596-03	1.8	228.1
⊠	19596-04	2.5	227.5

GRAIN SIZE DISTRIBUTION - THURBER MTO-31719.GPJ 2/10/23

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

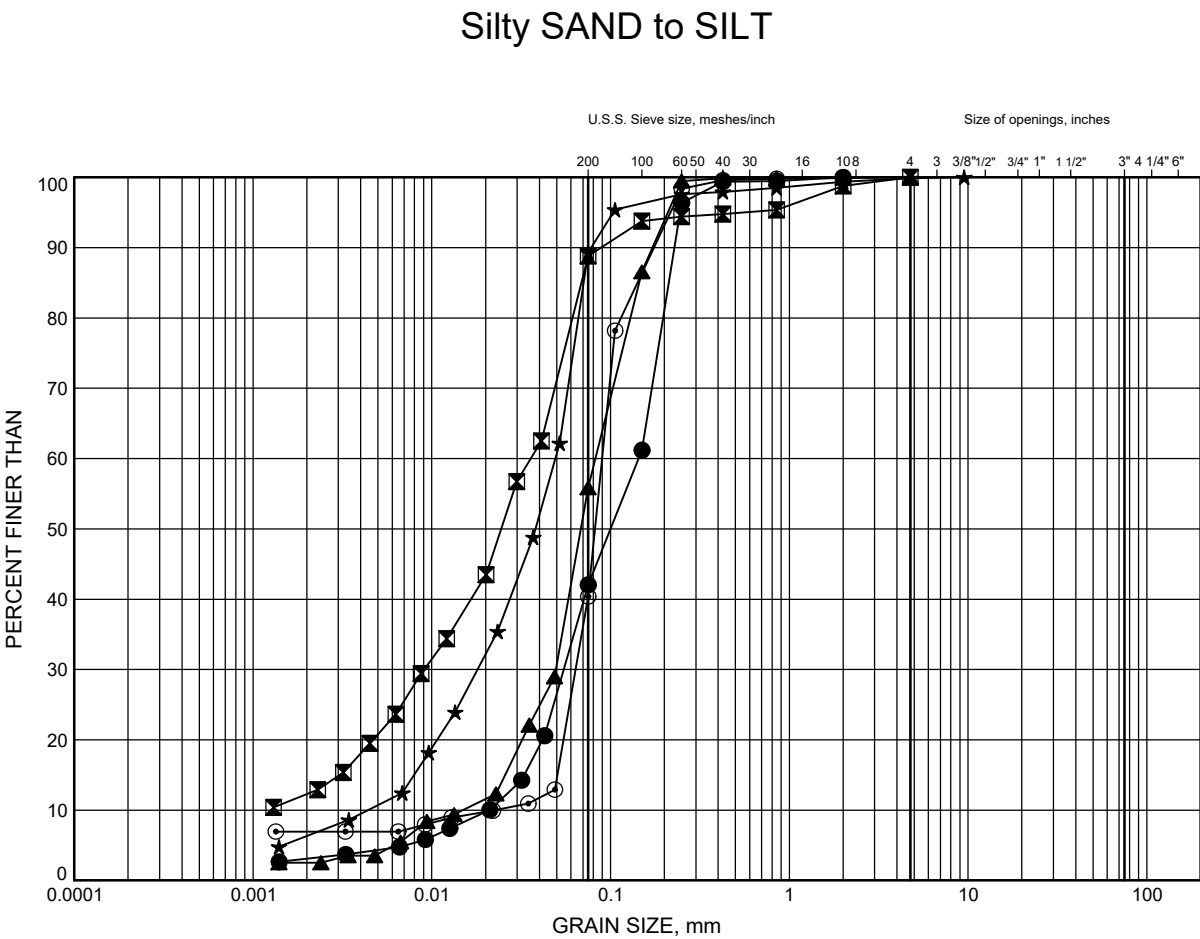


Prep'd AN
Chkd. AR

Highway 556 Culvert Replacement at STA 19+596

GRAIN SIZE DISTRIBUTION

FIGURE C-2



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19596-02	4.9	224.7
⊠	19596-03	4.1	225.8
▲	19596-03	4.9	225.0
★	19596-04	4.8	225.2
⊙	19596-05	1.8	225.2

GRAIN SIZE DISTRIBUTION - THURBER MTO-31719.GPJ 2/10/23

Date February 2023

W.P. 5221-18-00



Prep'd AN

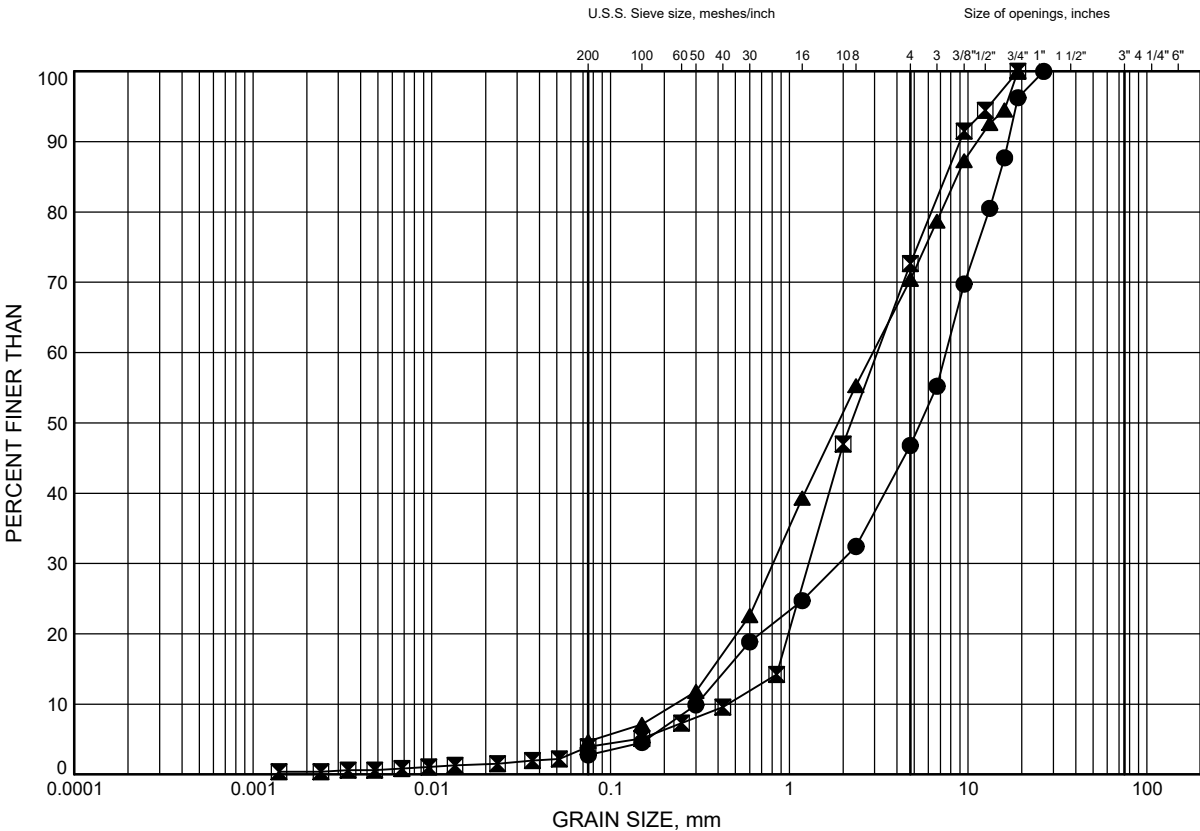
Chkd. AR

Highway 556 Culvert Replacement at STA 19+596

GRAIN SIZE DISTRIBUTION

FIGURE C-3

GRAVEL and SAND to Gravelly SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19596-02	7.9	221.7
⊠	19596-03	7.9	222.0
▲	19596-04	7.9	222.1

GRAIN SIZE DISTRIBUTION - THURBER MTO-31719.GPJ 2/10/23

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

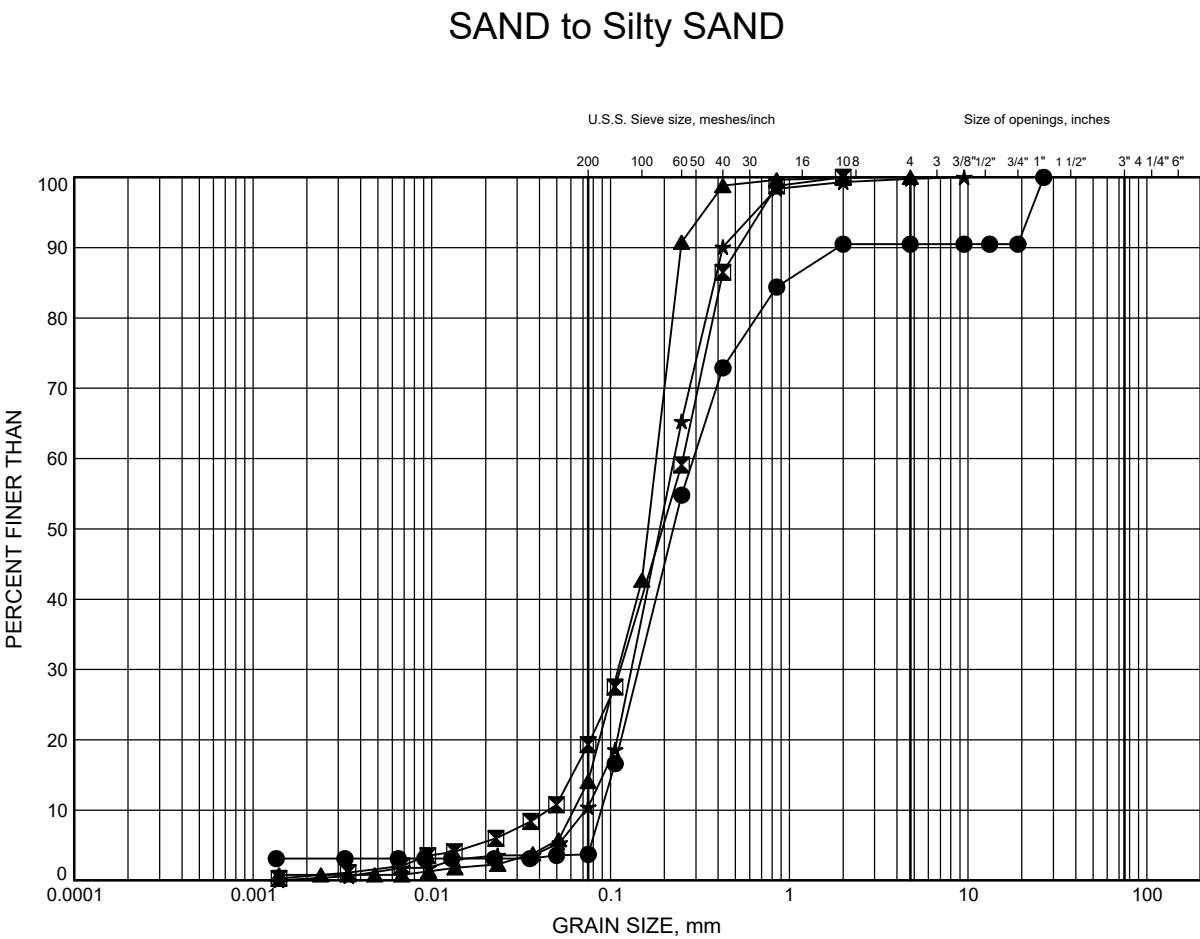


Prep'd AN
Chkd. AR

Highway 556 Culvert Replacement at STA 19+596

GRAIN SIZE DISTRIBUTION

FIGURE C-4



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	19596-01	4.3	220.3
⊠	19596-02	12.5	217.1
▲	19596-03	11.0	218.9
★	19596-04	11.0	219.0

GRAIN SIZE DISTRIBUTION - THURBER MTO-31719.GPJ 2/10/23

Date February 2023

W.P. 5221-18-00



Prep'd AN

Chkd. AR



Photograph #9 – Core sample AW1 from Borehole 19596-01. (November 2022)



Photograph #10 – Core sample AW1 from Borehole 19596-04. (February 2023)

Certificate of Analysis

Thurber Engineering Ltd.

2460 Lancaster Rd, Suite 104

Ottawa, ON K1B4S5

Attn: Alysha Kobylnski

Client PO:

Project: 31719 - Hwys 556 & 532

Custody: 69208

Report Date: 8-Nov-2022

Order Date: 28-Oct-2022

Order #: 2244541

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

Paracel ID	Client ID
2244541-01	19596-02 SS7 (20'-22')

Approved By:



Milan Ralitsch, PhD

Senior Technical Manager

Certificate of Analysis

Report Date: 08-Nov-2022

Client: Thurber Engineering Ltd.

Order Date: 28-Oct-2022

Client PO:

Project Description: 31719 - Hwys 556 & 532

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	7-Nov-22	7-Nov-22
Conductivity	MOE E3138 - probe @25 °C, water ext	7-Nov-22	7-Nov-22
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	3-Nov-22	4-Nov-22
Resistivity	EPA 120.1 - probe, water extraction	7-Nov-22	7-Nov-22
Solids, %	CWS Tier 1 - Gravimetric	8-Nov-22	8-Nov-22

Certificate of Analysis

Report Date: 08-Nov-2022

Client: Thurber Engineering Ltd.

Order Date: 28-Oct-2022

Client PO:

Project Description: 31719 - Hwys 556 & 532

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: 08-Nov-2022

Client: Thurber Engineering Ltd.

Order Date: 28-Oct-2022

Client PO:

Project Description: 31719 - Hwys 556 & 532

Client ID:	19596-02 SS7 (20'-22')	-	-	-	-
Sample Date:	18-Oct-22 09:00	-	-	-	-
Sample ID:	2244541-01	-	-	-	-
Matrix:	Soil	-	-	-	-
MDL/Units					

Physical Characteristics

% Solids	0.1 % by Wt.	79.0	-	-	-	-
----------	--------------	------	---	---	---	---

General Inorganics

Conductivity	5 uS/cm	78	-	-	-	-
pH	0.05 pH Units	7.05	-	-	-	-
Resistivity	0.1 Ohm.m	128	-	-	-	-

Anions

Chloride	5 ug/g	24	-	-	-	-
Sulphate	5 ug/g	7	-	-	-	-

Certificate of Analysis

Report Date: 08-Nov-2022

Client: Thurber Engineering Ltd.

Order Date: 28-Oct-2022

Client PO:

Project Description: 31719 - Hwys 556 & 532

Method Quality Control: Blank

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

Certificate of Analysis

Report Date: 08-Nov-2022

Client: Thurber Engineering Ltd.

Order Date: 28-Oct-2022

Client PO:

Project Description: 31719 - Hwys 556 & 532

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	143	5	ug/g	140			1.9	20	
Sulphate	356	5	ug/g	344			3.5	20	
General Inorganics									
Conductivity	364	5	uS/cm	365			0.3	5	
pH	7.53	0.05	pH Units	7.56			0.4	10	
Resistivity	27.5	0.10	Ohm.m	27.4			0.3	20	
Physical Characteristics									
% Solids	82.0	0.1	% by Wt.	82.3			0.4	25	

Certificate of Analysis

Report Date: 08-Nov-2022

Client: Thurber Engineering Ltd.

Order Date: 28-Oct-2022

Client PO:

Project Description: 31719 - Hwys 556 & 532

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	253	5	ug/g	140	113	82-118			
Sulphate	448	5	ug/g	344	104	80-120			

Certificate of Analysis

Report Date: 08-Nov-2022

Client: Thurber Engineering Ltd.

Order Date: 28-Oct-2022

Client PO:

Project Description: 31719 - Hwys 556 & 532

Qualifier Notes:**Sample Data Revisions:**

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

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

%REC: Percent recovery.

RPD: Relative percent difference.

NC: Not Calculated

Soil results are reported on a dry weight basis 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.



Client Name: Thurber Engineering	Project Ref: 31719 - Hwy 556 & 532	Page 1 of 1
Contact Name: Alysha Kobylinski	Quote #:	Turnaround Time <input type="checkbox"/> 1 day <input type="checkbox"/> 3 day <input type="checkbox"/> 2 day <input checked="" type="checkbox"/> Regular
Address: 104-2460 Lancaster Rd Ottawa, ON K1B 4S5	PO #:	
Telephone: 226-748-9593	E-mail: akobylinski@thurber.ca	
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												
				Date	Time																		
Sample ID/Location Name																							
1	19596-02 SS7 (20'-22')					S		1	OCT 18, 22			✓	✓	✓	✓	✓							
2																							
3																							
4																							
5																							
6																							
7																							
8																							
9																							
10																							

Comments:

Method of Delivery:

Relinquished By (Sign): A. Oliveira	Received By Driver/Depot:	Received By Lab: [Signature]	Method of Delivery: Walk in
Relinquished By (Print): Anderson de Oliveira	Date/Time:	Date/Time: OCT 28/22 3:44pm	Verified By: [Signature]
Date/Time: OCT 28, 22 @ 3:44pm	Temperature: _____ °C	Temperature: 20.0 °C	Date/Time: OCT 31 2022 9:57
Chain of Custody (Blank) xix		pH Verified: <input type="checkbox"/> By: _____	

Subcontracted Analysis

Thurber Engineering Ltd.

2460 Lancaster Rd, Suite 104

Ottawa, ON K1B4S5

Attn: Alysha Kobylinski

Paracel Report No. **2244541**

Client Project(s): **31719 - Hwys 556 & 532**

Client PO:

Reference: **Standing Offer**

CoC Number: **69208**

Order Date: 28-Oct-22

Report Date: 9-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
2244541-01	19596-02 SS7 (20'-22')	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

09-November-2022

Date Rec. : 01 November 2022
LR Report: CA13032-NOV22
Reference: Project#: 2244541

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Sample ID	Sample Date & Time	Sulphide (Na ₂ CO ₃) %
1: Analysis Start Date		09-Nov-22
2: Analysis Start Time		12:48
3: Analysis Completed Date		09-Nov-22
4: Analysis Completed Time		14:31
5: QC - Blank		< 0.04
6: QC - STD % Recovery		112%
7: QC - DUP % RPD		ND
8: RL		0.02
9: 19596-02 SS7 (20'-22')	18-Oct-22 09:00	0.04

RL - SGS Reporting Limit
ND - Not Detected

Kimberley Didsbury
Project Specialist,
Environment, Health & Safety








Appendix D

Borehole Locations and Soil Strata Drawing



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

[illegible]

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- 3) Coordinate system is MTM NAD 83 Zone 13.

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

