



FOUNDATION INVESTIGATION REPORT

Alona Bay Creek Culvert Rehabilitation, Site No. 38S-0353/C0
Highway 17, Slater Township, Algoma District
Ministry of Transportation, Ontario
GWP 5376-11-00; WP 5170-16-01

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PART A

FOUNDATION INVESTIGATION REPORT
ALONA BAY CREEK CULVERT REHABILITATION, SITE NO. 38S-0353/C0
HIGHWAY 17, SLATER TOWNSHIP, ALGOMA DISTRICT
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5376-11-00; WP 5170-16-01

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by AECOM Canada Ltd. (AECOM) on behalf of the Ministry of Transportation, Ontario (MTO) to provide Foundation Engineering services for the rehabilitation of the existing Alona Bay Creek Culvert (Site No. 38S-0353/C0), located on Highway 17 in Slater Township, Algoma District, Ontario (GWP 5376-11-00, WP 5170-16-01).

The purpose of this investigation is to obtain subsurface soil, bedrock, and groundwater information at the site, by means of a limited number of boreholes and geotechnical and analytical laboratory testing. The investigation also included a review of available geotechnical information from a previous foundation investigation completed by others at the structure site, as presented in the following report:

- **MTO GEOCREs No. 41N-001:** “Highway 17 at Mile 17 Creek Crossing, Proposed Culvert at approximately Station 3770+20, Approx. 71 Miles North of Sault Ste. Marie, Dist. 18, WP 911-60, 60-F-33”, dated June 22, 1960.

The Terms of Reference (TOR) and the scope of work for the foundation investigation are outlined in MTO’s Request for Proposal (Assignment 5017-E-0018, dated October 2017), and the subsequent clarifications/addenda. Golder’s proposal dated January 26, 2018, for Foundation Engineering services associated with the rehabilitation of this structure is contained in Section 17.8 of AECOM’s technical proposal for this assignment. The work has been carried out in accordance with Golder’s Supplementary Specialty Plan for Foundation Engineering services for this project, dated April 11, 2018.

2.0 SITE DESCRIPTION

The Alona Bay Creek Culvert is located on Highway 17 at Station 18+094, in Slater Township, Algoma District, Ontario, approximately 41.2 km north of Highway 563 and 115 km south of the Highway 101, as shown on the Key Plan on Drawing 1. It should be noted that the orientation (i.e., north, south, east, west) stated in the text of the report, is typically referenced to project north and therefore may differ from magnetic north shown on the drawing. For the purpose of this report, Highway 17 is oriented in a north-south direction along this section of highway, with the culvert positioned on a slight skew from perpendicular to the highway in a generally east-west orientation.

The existing culvert consists of a twin cell reinforced cast-in-place concrete box, which was constructed in 1960. Alona Bay Creek is located at the east end of the culvert (inlet) and Lake Superior is located at the west end of the culvert (outlet). Based on the General Arrangement (GA) drawing provided by AECOM, each cell has a span of approximately 4.6 m, an internal height of approximately 3.7 m, and a length of approximately 51.1 m. The 1960 GA indicates that the existing culvert (inlet and outlet) and wingwalls are founded at Elevations 189.6 m and 189.5 m, respectively. However, the current project survey provided by AECOM determined that the existing culvert (inlet and outlet) and wingwalls are founded at Elevations 189.0 m and 188.9 m, respectively. Similarly, the 1960 GA indicates that the existing culvert invert (at the inlet and outlet) is at Elevation 190.1 m; however, the current project survey provided by AECOM determined the existing culvert invert (at the inlet and outlet) is at Elevation 189.5 m. Based on discussions with AECOM, we understand that the site has been resurveyed and the current project survey information is considered to be correct.

The highway grade at the site is understood to be about Elevation 200.9 m. The existing highway embankment is approximately 11.9 m and 9.9 m high, relative to the ground surface at the toes of the embankment side slopes at

the east and west creek banks, respectively. The side slope to the top of the west wingwalls is inclined at about 1.6 Horizontal to 1 Vertical (1.6H:1V) to 2H:1V and the side slope to the top of the east wingwalls is inclined at about 2H:1V to 3H:1V.

Based on the Ontario Structure Inspection Manual (OSIM) report, dated August 21, 2015, the existing culvert, wingwalls, and embankments are generally in good condition; however, the southwest wingwall has separated from the culvert and rotated forward by approximately 6 degrees. Based on our site observations at the time of the field investigation and a review of the available site photographs/satellite images, the existing embankments in the culvert area generally appear to be performing satisfactorily with little to no evidence of soil movement, tilted vegetation, or tension cracks near the embankment crest that would be indicative of instability; with the exception of the southwest embankment side slope where surficial embankment sloughing was noted along with signs of erosion in the upper portion of the embankment (i.e., due to surface water run-off).

The highway platform at the culvert location and ground surface conditions at the culvert inlet and outlet area (east and west ends, respectively) are shown on Photographs 1 to 6. In general, the topography in the area of the culvert structure consists of undulating/hilly terrain, which is heavily forested beyond the highway Right-of-Way (ROW).

3.0 INVESTIGATION PROCEDURES

The field exploration was carried out on May 8 and 9, 2019, and August 13 and 15, 2019, during which time four boreholes (designated as Boreholes AB-1 to AB-4) were advanced to depths of 9.8 m below ground surface. The boreholes were advanced on land, in the vicinity of the culvert inlet and outlet, as shown on Drawing 1.

The boreholes were advanced using NW casing with mud rotary drilling techniques and a CME 55 LC track-mounted drill rig supplied and operated by George Downing Estate Drilling of Grenville-Sur-La-Rouge, Quebec. Soil samples were obtained in the boreholes at 0.75 m and 1.5 m intervals of depth using 50 mm outer diameter split-spoon samplers driven by an automatic hammer, in accordance with the Standard Penetration Test (SPT) procedures (ASTM D1586)¹.

Due to the use of mud rotary drilling techniques (addition of drilling mud in the boreholes), the groundwater conditions in the open boreholes could not be observed during drilling. However, the depth to the water level (unstabilized) was measured inside the casing upon completion of drilling each borehole. The boreholes were backfilled upon completion, in accordance with Ontario Regulation 903 Wells (as amended).

Field work was monitored on a full-time basis by a member of Golder's technical staff who: located the boreholes in the field; arranged for the clearance of underground services; supervised the drilling and sampling operations; logged the boreholes; and examined the soil samples. The soil samples were identified in the field, placed in labelled containers and transported to Golder's geotechnical laboratory in Sudbury for further examination and laboratory testing. Index and classification testing consisting of water content determinations and grain size distributions were carried out on selected soil samples. The geotechnical laboratory testing was completed according to ASTM and MTO LS standards, as applicable. In addition, a select soil sample was submitted to a

¹ Standard Test Method for Standard Penetration Test and Split-Barrel Sampling of Soil, ASTM D1586

specialist analytical laboratory (Maxxam Analytics Inc.) under chain of custody procedures for testing for a suite of parameters including pH, resistivity, conductivity, sulphate, sulphide, and chloride.

The as-drilled borehole locations were measured by a member of our technical staff relative to the existing culvert structure and wingwalls using a measuring tape and converted into northing/easting coordinates on the plan drawing. Given the relatively short distances between the boreholes and the existing structures, the measurements are considered to be accurate to within 0.5 m horizontally. The ground surface elevation at the borehole locations were obtained using a survey level and rod and the borehole survey loop was closed to within 0.1 m vertically. The boreholes were surveyed relative to the centreline of the roadway, the elevation of which was obtained from the survey drawing (17SLA GWP 5376-11-00.dwg) provided by AECOM. The NAD 83 MTM Zone 13 northing and easting coordinates and World Geodetic System 1984 (WGS 84) geographical coordinates, ground surface elevations referenced to Geodetic datum, and borehole depths at each borehole location are presented on the Record of Borehole Sheets included in Appendix A and summarized below.

Borehole Number	Location (NAD 83, MTM Zone 13)		Location (WGS 84)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing	Easting	Latitude	Longitude		
AB-1	5225177.8	252402.9	47.163912	84.691119	192.3	9.8
AB-2	5225169.0	252394.9	47.163833	-84.691224	190.5	9.8
AB-3	5225192.1	252327.1	47.164035	-84.692121	189.3	9.8
AB-4	5225181.1	252326.7	47.163936	-84.692125	189.6	9.8

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on Northern Ontario Engineering Geology Terrain Study (NOEGTS)² mapping by the Ministry of Natural Resources, the Alona Bay Creek Culvert site is located within a raised (abandoned) beach form comprised of sand and gravel, bordered by jagged, rugged and cliffed bedrock knobs.

Based on geological mapping by the Ministry of Northern Development and Mines (MNDM)³, the overburden deposits are underlain by sandstone, shale, conglomerate, bordered by foliated tonalite suite bedrock.

² Ontario Ministry of Natural Resources and Forestry. Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Electronic Mapping. Map 41NSE

³ Ontario Ministry of Northern Development of Mines. Bedrock Geology of Ontario – East-Central Sheet, Ontario Geological Survey – Map 2543

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes are presented on the Record of Borehole Sheets in Appendix A. Geotechnical laboratory test results are provided in Appendix B and analytical laboratory test results are provided in Appendix C.

The results of the in-situ field tests (i.e., SPT 'N' values), as presented on the Record of Borehole sheets and in Section 4, are uncorrected. The stratigraphic boundaries shown on the borehole records and on the interpreted stratigraphic cross-sections on Drawing 1 are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsurface conditions will vary between and beyond the borehole locations.

The soil conditions encountered during the current investigation are generally consistent with those encountered in the previous 1960 investigation. In general, the native subsurface conditions encountered in the 2019 boreholes consist of a surficial loose to compact gravel deposit underlain by a compact to dense silty sand to sand deposit. A detailed description of the soil deposits and groundwater conditions encountered in the boreholes is provided in the following sections.

4.2.1 GRAVEL (GW-GM)

A 0.7 m to 1.5 m thick deposit of gravel and sand was encountered in all boreholes at ground surface and extends to depths ranging from 0.7 m to 1.5 m below ground surface (Elevations 191.6 m to 188.1 m). The gravel deposit is brown, moist to wet, and contains trace silt, trace organics, and cobbles (in Borehole AB-2). An approximately 100 mm size cobble was also encountered in Borehole AB-4.

The SPT 'N'-values measured within the gravel deposit range from 4 blows to 27 blows per 0.3 m of penetration, indicating a loose to compact compactness condition.

The in-situ moisture content measured on one sample of the deposit is about 11 per cent.

The result of a grain size distribution test completed on one sample of the gravel deposit is shown on Figure B-1 in Appendix B.

4.2.2 SILTY SAND (SM) to SAND (SP)

A 8.3 m to 9.1 m thick deposit of silty sand to sand was encountered underlying the gravel deposit in all boreholes. The deposit was encountered at depths ranging from 0.7 m to 1.5 m below ground surface (Elevations 191.6 m to 188.1 m) and extends to the borehole termination depths of 9.8 m below ground surface (Elevations 182.6 m to 179.5 m). A 2.1 m thick interlayer of silt was encountered within the silty sand to sand deposit in Borehole AB-2, at a depth of 3.5 m below ground surface (Elevation 187.0 m), as further described in Section 4.2.3. The silty sand to sand deposit ranges in gradation from silty sand to sand, some silt, to sand and contains trace gravel and trace clay. Cobbles and boulders should be anticipated in this deposit, as inferred from the grinding of the casing during drilling within this deposit in Boreholes AS-1 and AS-3. Heaving/flowing conditions were encountered during drilling through this deposit, as noted on the borehole records.

The SPT 'N'-values measured within the silty sand to sand deposit range from 16 blows to 54 blows per 0.3 m of penetration, indicating a compact to very dense compactness condition. It is noted that the measured

SPT 'N'-values below depths of about 6 m to 9 m below ground surface may have been taken in a disturbed stratum, due to heaving/flowing conditions under artesian groundwater pressure, as indicated on the borehole records.

The in-situ moisture content measured on fourteen samples of the silty sand to sand deposit ranges from about 20 to 25 per cent.

The results of grain size distribution tests completed on fourteen samples of the silty sand to sand deposit are shown on Figure B-2 in Appendix B.

4.2.3 SILT (ML) Interlayer

A 2.1 m thick interlayer of silt and sand was encountered within the silty sand to sand deposit in Borehole AB-2 at a depth of 3.5 m (Elevation 187.0 m).

The SPT 'N'-values measured within the silt interlayer are 19 blow and 20 blows per 0.3 m of penetration, indicating a compact condition.

The in-situ moisture content measured on one sample of the silt interlayer is about 20 per cent.

The result of a grain size distribution test completed on one sample of the silt interlayer is shown on Figure B-3 in Appendix B.

4.2.4 Groundwater/Surface Water Conditions

The unstabilized water level measured in the boreholes (within the casing) upon completion of mud rotary drilling ranges from 0.6 m above ground surface to 1.2 m below ground surface, ranging from Elevation 191.1 m to 189.1 m. It is noted that the unstabilized water level is likely influenced by the addition of water and mud for mud rotary drilling techniques and may not be representative of stabilized groundwater levels at the site. During drilling of Boreholes AB-2 to AB-4, water was observed flowing upward to above ground surface, between the borehole wall and the auger casing, suggesting an upward groundwater gradient (i.e., artesian conditions).

The water level within the culvert was at Elevation 190.8 m in June 2018, as surveyed by others. However, based on our understanding of site conditions, it is understood that this water level corresponds to about the creek water level at the culvert inlet. The creek water level at the culvert inlet, east end of the culvert, was at Elevation 190.6 m on May 9, 2019, as measured by Golder. Based on visual observations, and as shown on Photographs 3 and 4, the creek water level at the culvert outlet is estimated to be about 0.8 m lower than the culvert invert (i.e., 0.5 m lower than Elevation 189.5 m) and is estimated to be about Elevation 189.0 m in May 2019.

Further, it should be noted that the groundwater level at site and the water level of Alona Bay Creek and Lake Superior are subject to seasonal fluctuations and precipitation events and should be expected to be higher during wet periods of the year. Based on site observations in January 2018, as shown on Photographs 5 and 6, it is anticipated that due to the fast-flowing conditions of the creek at this site, the water at the east and west ends of the culvert (i.e., within the Alona Bay Creek and Lake Superior) does not freeze over during the winter season.

4.2.5 Analytical Test Results of Soil Samples

One soil sample was submitted for analytical testing to assess the potential for the soil to cause deterioration to buried concrete and corrosion to steel. The results of the analytical testing are provided in Appendix C and are summarized below.

Parameter	Units	Borehole AB-1, Sample 3
Resistivity	ohm-cm	24,000
Conductivity	µmho/cm	42
pH	pH	5.34
Sulphate	µg/g	<20 ¹
Chloride	µg/g	<20 ¹
Sulphide	µg/g	<0.30 ¹

Note: 1. Concentration is lower than respective Reportable Detection Limit (RDL).

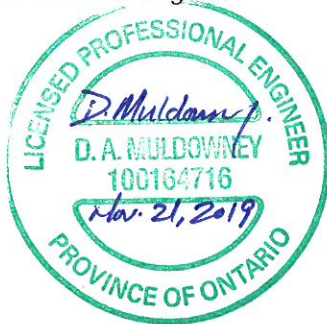
5.0 CLOSURE

The field drilling program was carried out under the supervision of Mr. Shane Albert, under the overall direction of Mr. David Muldowney, P.Eng. This Foundation Investigation Report was prepared by Ms. Anastasia Poliacik, P.Eng., and Mr. David Muldowney, P.Eng., provided a technical review of the report. Mr. Jorge Costa, P.Eng., an MTO Foundations Designated Contact and Senior Consultant for Golder, conducted an independent quality control review of this report.

Signature Page

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- Ministry of Northern Development of Mines. *Bedrock Geology of Ontario – East-Central Sheet*, Ontario Geological Survey – Map 2543.
- Ontario Ministry of Natural Resources and Forestry. Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Electronic Mapping. Map 41NSE
- Structural Manual 2014. Ministry of Transportation Provincial Highways Management Division, Highways Standards Branch, Bridge Office. August.
- Unified Facilities Criteria, NAVFAC, 1982. Foundations and Earth Structures Design Manual 7.2.

ASTM International

ASTM D1586 Standard Test Method for Standard Penetration Test and Split-Barrel Sampling of Soils

Ontario Provincial Standard Drawings (OPSD) OPSD 810.010 General Rip-Rap Layout for Sewer and Culvert Outlets

OPSD 3090.100 Foundation, Frost Penetration Depths for Northern Ontario

Ontario Provincial Standard Specifications (OPSS) – Provincial Oriented

OPSS.PROV 501	Construction Specification for Compacting
OPSS.PROV 517	Construction Specification for Dewatering
OPSS.PROV 539	Construction Specification for Temporary Protection Systems
OPSS 902	Construction Specification for Excavating and Backfilling - Structures
OPSS.PROV 1004	Material Specification for Aggregates – Miscellaneous
OPSS.PROV 1010	Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material

Special Provisions

SP 105S22	Amendment to OPSS 501
SP 109S12	Amendment to OPSS 902
SP 517F01	Dewatering System / Temporary Flow Passage System (Amendment to OPSS 517)

Ontario Water Resource Act

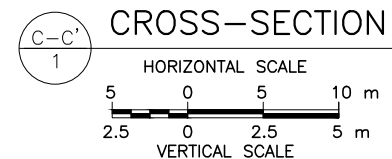
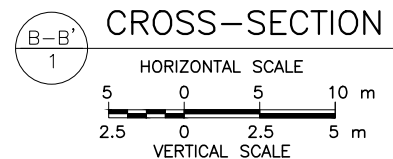
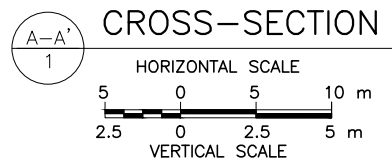
Regulation 903 Wells (as amended)

Ontario Occupational Health and Safety Act:

Ontario Regulation 213 Construction Projects (as amended)

Proprietary Software:

Rocscience Inc. SLIDE 2018



-	-	-	-	-	-
NO.	DATE	BY	REVISION		
Geocres No. 41N-34					
HWY. 17		PROJECT NO. 1790414		DIST. .	
SUBM'D.		CHKD. AP	DATE: 11/19/2019		SITE: 38S-0353/C0
DRAWN: TR		CHKD. DAM	APPD. JMAC		DWG. 1



Photograph 1: Highway 17 Roadway Platform, Facing Southwest (July 2019)



Photograph 2: Highway 17 Roadway Platform, Facing Northeast (July 2019)



Photograph 3: Culvert Inlet, Facing Northwest (July 2019)



Photograph 4: Culvert Outlet, Facing East (July 2019)



Photograph 5: Alona Bay Creek, Facing Northeast (January 2018)



Photograph 6: Culvert Outlet, Facing Northeast (January 2018)

APPENDIX A

Record of Borehole Sheets

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

MINISTRY OF TRANSPORTATION, ONTARIO

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
FINES	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY COMPONENTS^{1,2}

Percentage by Mass	Modifier
> 35	Use 'and' to combine primary and secondary component (<i>i.e.</i> , SAND and gravel)
> 20 to 35	Primary soil name prefixed with "gravelly, sandy" as applicable
> 10 to 20	some (<i>i.e.</i> , some sand)
≤ 10	trace (<i>i.e.</i> , trace fines)

1. Only applicable to components not described by Primary Group Name.

2. Classification of Primary Group Name based on Unified Soil Classification System (ASTM D2487) for coarse-grained soils; fine-grained soils described per current MTO Soil Classification System.

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (*q_t*), porewater pressure (*u*) and sleeve friction (*f_s*) are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC / SC	Rock core / Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample
OD / ID	Outer Diameter / Inner Diameter
HSA / SSA	Hollow-Stem Augers / Solid-Stem Augers

SOIL TESTS

w	water content
PL, w _p	plastic limit
LL, w _L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D _R	relative density (specific gravity, G _s)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO ₄	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
Y	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

COARSE-GRAINED SOILS

Compactness¹

Term	SPT 'N' (blows/0.3m) ²
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	≥ 50

3. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grain size. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

4. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.

FINE-GRAINED SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N' ^{1,2} (blows/0.3m)
Very Soft	< 12	0 to 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	> 200	> 30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

LIST OF SYMBOLS

MINISTRY OF TRANSPORTATION, ONTARIO

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
$\ln x$	natural logarithm of x
\log_{10}	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
U	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
E	void ratio
N	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index $= (w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index $= (w - w_p) / I_p$
I_C	consistency index $= (w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
C_v	coefficient of consolidation (vertical direction)
C_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

(d) Shear Strength




τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction $= \tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

* Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

Notes: 1
2

$$\tau = c' + \sigma' \tan \phi'$$





$$\text{shear strength} = (\text{compressive strength})/2$$

PROJECT 1790414		RECORD OF BOREHOLE No AB-1				1 OF 1 METRIC													
W.P. 5170-16-01		LOCATION N 5225177.8; E 252402.9 NAD83 MTM ZONE 13 (LAT. 47.163912; LONG. -84.691119)				ORIGINATED BY SA													
DIST _____ HWY 17		BOREHOLE TYPE 254 mm O.D. Hollow Stem Augers, Mud Rotary, NW Casing				COMPILED BY TR													
DATUM GEODETIC		DATE May 9, 2019				CHECKED BY DAM													
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)	
192.3	GROUND SURFACE							20	40	60	80	100							
0.0	GRAVEL (GW-GM) and sand, trace organics Loose Brown Wet		1	SS	4	▽	192												
191.6	SILTY SAND (SM), trace gravel, trace clay Compact Brown to grey Wet		2	SS	16		191											7 56 28 9	
0.7	- Some cobbles from 0.7 m to 3.0 m depth		3	SS	27		190												
	- Casing grinding on inferred cobbles / boulders from 2.3 m to 3.0 m depth		4	SS	26		189												
			5	SS	26		188												
			6	SS	21		187												
187.8	SAND (SP-SM) Compact to dense Grey Wet			7	SS		26*	186											0 95 (5)
4.5								185											
	- Approximately 150 mm of heave inside casing at 6.1 m depth			8	SS		35*	184											
	- Approximately 300 mm of heave inside casing at 7.6 m depth			9	SS		32*	183											
	- Approximately 300 mm of heave inside casing at 9.1 m depth			10	SS	40*													
182.6	END OF BOREHOLE																		
9.8	NOTES: 1. Mud rotary methods used below 3.0 m depth. 2. * Indicates "N" values may have been taken in a disturbed stratum due to flowing/heaving sand conditions. 3. Water level measured inside casing at a depth of 1.2 m below ground surface (Elev. 191.1 m) upon completion of drilling.																		

SUD-MTO 001 S:\CLIENTS\TOH\HWY17&101\02_DATA\GINT\1790414.GPJ GAL-MISS.GDT 11-19-19 TR






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

PROJECT <u>1790414</u>		RECORD OF BOREHOLE No AB-3		1 OF 1 METRIC	
W.P. <u>5170-16-01</u>		LOCATION <u>N 5225192.1; E 252327.1 NAD83 MTM ZONE 13 (LAT. 47.164035; LONG. -84.692121)</u>		ORIGINATED BY <u>SA</u>	
DIST <u> </u> HWY <u>17</u>		BOREHOLE TYPE <u>254 mm O.D. Hollow Stem Augers, Mud Rotary, NW Casing</u>		COMPILED BY <u>TR</u>	
DATUM <u>GEODETIC</u>		DATE <u>May 8, 2019</u>		CHECKED BY <u>DAM</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			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
								<div><div></div><div>20</div><div>40</div><div>60</div><div>80</div><div>100</div></div>	<div><div></div><div>20</div><div>40</div><div>60</div></div>	<div><div></div><div>20</div><div>40</div><div>60</div></div>	<div><div></div><div>20</div><div>40</div><div>60</div></div>	<div><div></div><div>20</div><div>40</div><div>60</div></div>								
189.3	GROUND SURFACE																			
0.0	GRAVEL (GW-GM) and sand, trace silt, trace organics Loose Brown Moist to wet		1	SS	4															
188.1			2A	SS	7															
1.2	SILTY SAND (SM), trace clay Compact to dense Brown to grey Wet		2B																	
			3	SS	18												0 63 30 7			
			4	SS	25															
	- Casing grinding on inferred cobbles / boulders from 3.0 m to 3.8 m depth		5	SS	33												0 56 37 7			
			6	SS	25												0 56 34 10			
			7	SS	27															
183.7	SAND (SP), trace silt Compact to dense Grey Wet																			
5.6	- Approximately 90 mm of heave inside casing at 6.1 m depth		8	SS	52*															
	- Approximately 75 mm of heave inside casing at 7.6 m depth		9	SS	27*															
	- Approximately 460 mm of heave inside casing at 9.1 m depth		10	SS	32*												0 96 (4)			
179.5	END OF BOREHOLE																			
9.8	NOTES: 1. Mud rotary methods used below 3.0 m depth. 2. * Indicates "N" values may have been taken in a disturbed stratum due to flowing/heaving sand conditions. 3. Water level measured in casing at a depth of 0.2 m below ground surface (Elev. 189.1 m) upon completion of drilling. Artesian condition noted at ground surface (Elev. 189.3 m) inside borehole and outside of casing at time of boreole abandonment.																			

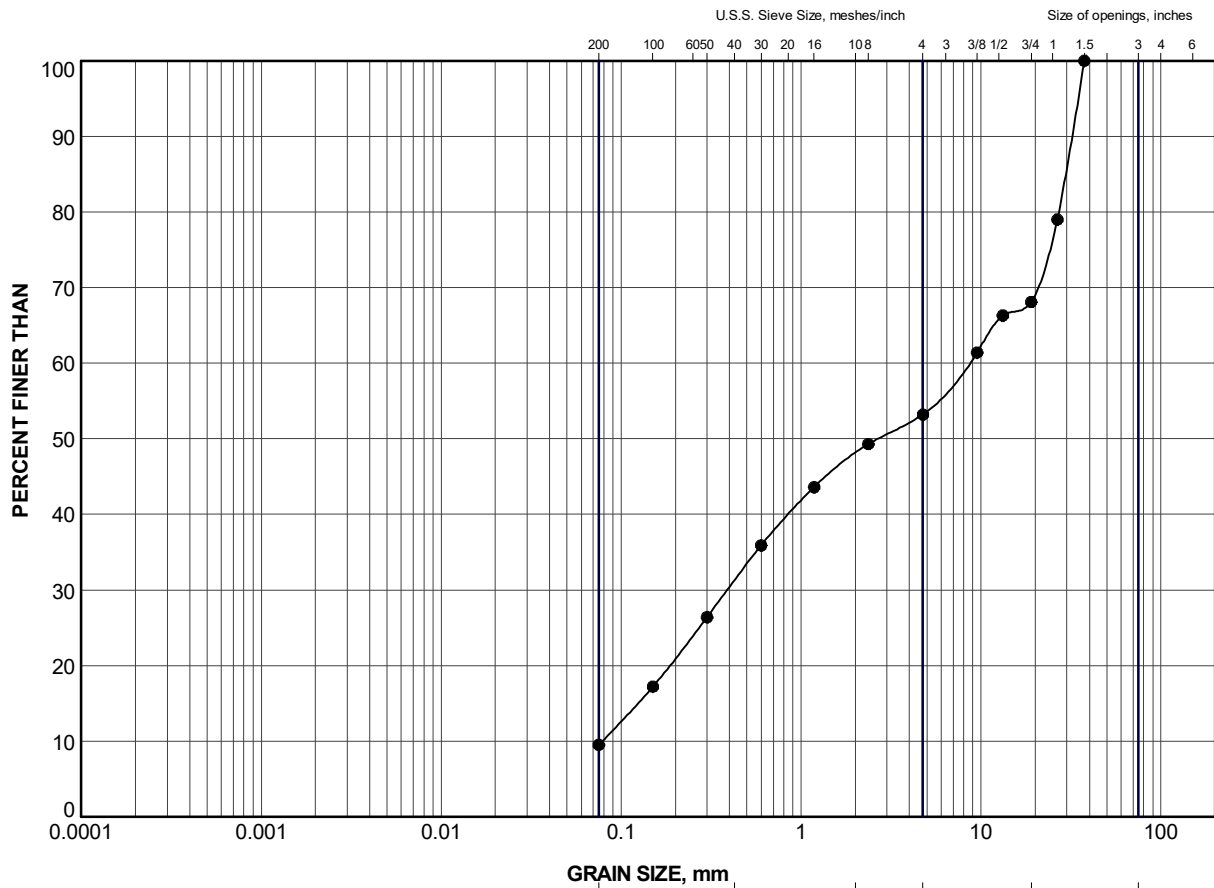
+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

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PROJECT 1790414		RECORD OF BOREHOLE No AB-4				1 OF 1 METRIC								
W.P. 5170-16-01		LOCATION N 5225181.1; E 252326.7 NAD83 MTM ZONE 13 (LAT. 47.163936; LONG. -84.692125)				ORIGINATED BY SA								
DIST _____ HWY 17		BOREHOLE TYPE 254 mm O.D. Hollow Stem Augers, Mud Rotary, NW Casing				COMPILED BY TR								
DATUM GEODETIC		DATE May 8, 2019				CHECKED BY DAM								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L		
189.6 0.0	GROUND SURFACE GRAVEL (GW-GM) and sand, trace organics Compact Brown Moist to wet - Approximately 100 mm diameter cobble encountered at 0.5 m depth		1	SS	16	189							47 43 (10)	
			2	SS	27									
188.1 1.5	SILTY SAND (SM), trace clay Compact Brown to grey Wet		3	SS	20	188							0 57 36 7	
187.4 2.2	SAND (SP), trace silt Compact to very dense Brown to grey Wet		4	SS	28	187							0 96 (4)	
			5	SS	54	186								
185.6 4.0	SILTY SAND (SM), trace clay Compact Brown to grey Wet		6A	SS	19	185							0 59 34 7	
			6B											
			7	SS	24	184								
184.0 5.6	SAND (SP-SM) Dense Grey Wet		8	SS	44*	183								
						182							0 88 (12)	
			9	SS	40*									
						181								
	- Approximately 300 mm of heave inside casing at 9.1 m depth		10	SS	31*	180								
179.8 9.8	END OF BOREHOLE													
NOTES: 1. Mud rotary methods used below 3.0 m depth. 2. * Indicates "N" values may have been taken in a disturbed stratum due to flowing/heaving sand conditions. 3. Water level measured inside casing at a depth of 0.1 m below ground surface (Elev. 189.5 m) upon completion of drilling. Artesian condition noted at ground surface (Elev. 189.6 m) inside borehole and outside of casing at time of borehole abandonment.														

APPENDIX B

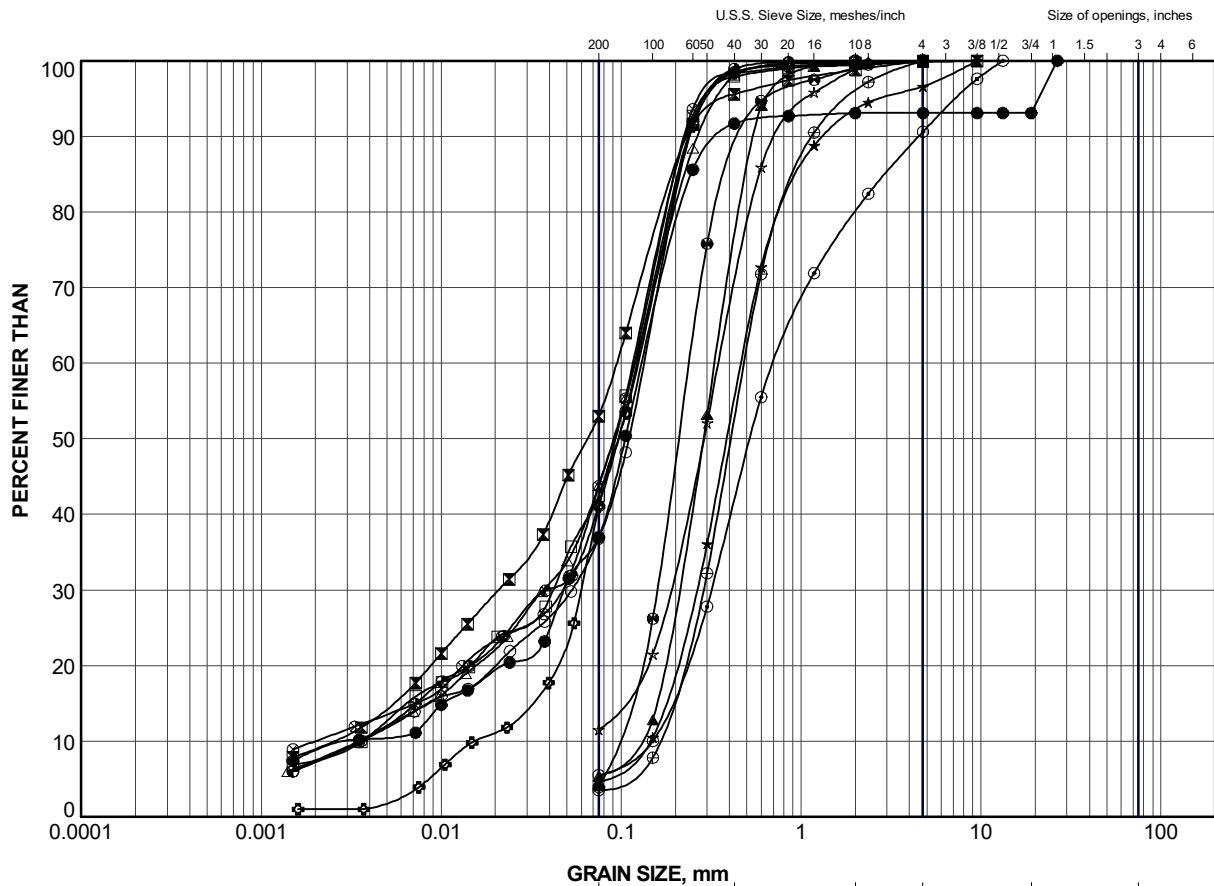
Geotechnical Laboratory Test Results



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	AB-4	1	189.3

PROJECT					
HIGHWAY 17 ALONA BAY CREEK CULVERT					
TITLE					
GRAIN SIZE DISTRIBUTION GRAVEL (GW-GM)					
PROJECT No. 1790414			FILE No. 1790414.GPJ		
DRAWN	TR	Oct 2019	SCALE	N/A	REV.
CHECK	DAM	Oct 2019			
APPR	JMAC	Oct 2019			
GOLDER			FIGURE B-1		
SUDBURY, ONTARIO					

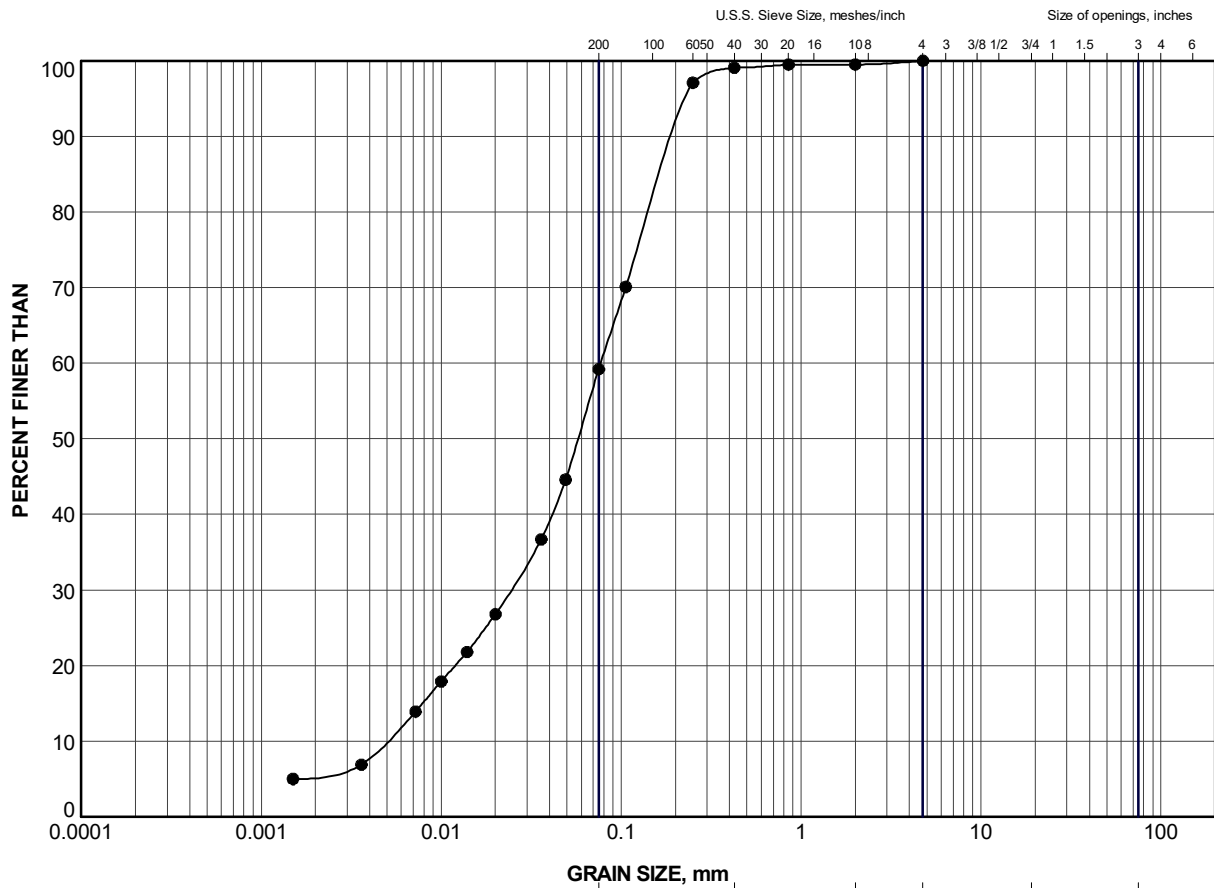


CLAY AND SILT	SAND SIZE			GRAVEL SIZE		Cobble Size
	fine	medium	coarse	fine	coarse	

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	AB-1	2	191.2
⊠	AB-1	4	189.7
▲	AB-1	7	187.4
★	AB-2	2	188.7
⊙	AB-2	4A	187.2
⊗	AB-2	7	184.1
○	AB-3	3	187.5
△	AB-3	5	186.0
⊗	AB-3	6	185.2
⊕	AB-3	10	179.9
□	AB-4	3	187.8
⊗	AB-4	5	186.3
⊙	AB-4	7	184.7
☆	AB-4	9	181.7

PROJECT					
HIGHWAY 17 ALONA BAY CREEK CULVERT					
TITLE					
GRAIN SIZE DISTRIBUTION SILTY SAND (SM) to SAND (SP)					
PROJECT No.		1790414		FILE No.	
DRAWN		TR		Oct 2019	
CHECK		DAM		Oct 2019	
APPR		JMAC		Oct 2019	
SCALE		N/A		REV.	
GOLDER		SUDBURY, ONTARIO		FIGURE B-2	



GRAVEL SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	AB-2	5	186.4

PROJECT					
HIGHWAY 17 ALONA BAY CREEK CULVERT					
TITLE					
GRAIN SIZE DISTRIBUTION SILT (ML) and SAND					
PROJECT No. 1790414			FILE No. 1790414.GPJ		
DRAWN	TR	Oct 2019	SCALE	N/A	REV.
CHECK	DAM	Oct 2019	FIGURE B-3		
APPR	JMAC	Oct 2019			
SUDBURY, ONTARIO					

APPENDIX C

Analytical Laboratory Test Results

Your Project #: 1790414
Your C.O.C. #: 712313-01-01

Attention: David Muldowney

Golder Associates Ltd
33 Mackenzie Street
Suite 100
Sudbury, ON
Canada P3C 4Y1

Report Date: 2019/05/29
Report #: R5729598
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B9C8163

Received: 2019/05/13, 15:20

Sample Matrix: Soil
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	3	2019/05/15	2019/05/16	CAM SOP-00463	SM 4500-Cl E m
Conductivity	3	2019/05/17	2019/05/17	CAM SOP-00414	OMOE E3530 v1 m
Moisture (Subcontracted) (1, 3)	3	2019/05/21	2019/05/21	BBY8SOP-00017	BCMOE BCLM Dec2000 m
Sulphide in Soil (1)	3	2019/05/21	2019/05/23	BBY6SOP-00052 BBY6SOP-00006	EPA-821-R-91-100 m
pH CaCl2 EXTRACT	3	2019/05/15	2019/05/15	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	3	2019/05/14	2019/05/17	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	3	2019/05/15	2019/05/16	CAM SOP-00464	EPA 375.4 m
Redox Potential (2, 4)	3	N/A	N/A		

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing. Maxxam is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested. When sampling is not conducted by Maxxam, results relate to the supplied samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

(1) This test was performed by Campo to Burnaby - Offsite

(2) This test was performed by Sub from Campo to Env. Testing Canada (Eurofins)

(3) Offsite analysis requires that subcontracted moisture be reported.

Your Project #: 1790414
Your C.O.C. #: 712313-01-01

Attention: David Muldowney

Golder Associates Ltd
33 Mackenzie Street
Suite 100
Sudbury, ON
Canada P3C 4Y1

Report Date: 2019/05/29
Report #: R5729598
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B9C8163

Received: 2019/05/13, 15:20

(4) Oxidation-Reduction Potential (ORP) values are determined using a Ag/AgCl reference electrode.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Alisha Williamson, Project Manager

Email: AWilliamson@maxxam.ca

Phone# (613)274-0573

=====

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

RESULTS OF ANALYSES OF SOIL

Maxxam ID		JSA209		JSA210			JSA210		
Sampling Date		2019/05/09 11:00		2019/05/11 10:30			2019/05/11 10:30		
COC Number		712313-01-01		712313-01-01			712313-01-01		
	UNITS	AB-1	QC Batch	NR-2	RDL	QC Batch	NR-2 Lab-Dup	RDL	QC Batch
CONVENTIONALS									
Sulphide	ug/g	<0.30	6139910	<0.30	0.30	6139910			
Calculated Parameters									
Resistivity	ohm-cm	24000	6120894	5800		6120894			
Inorganics									
Soluble (20:1) Chloride (Cl-)	ug/g	<20	6122300	60	20	6122300			
Conductivity	umho/cm	42	6127141	174	2	6127141	177	2	6127141
Available (CaCl2) pH	pH	5.34	6122353	6.96		6122355			
Soluble (20:1) Sulphate (SO4)	ug/g	<20	6122302	<20	20	6122302			
Physical Testing									
Moisture-Subcontracted	%	16	6139909	9.9	0.30	6139909			
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate									

Maxxam ID		JSA211			JSA211		
Sampling Date		2019/05/11 15:00			2019/05/11 15:00		
COC Number		712313-01-01			712313-01-01		
	UNITS	NR-5	RDL	QC Batch	NR-5 Lab-Dup	RDL	QC Batch
CONVENTIONALS							
Sulphide	ug/g	<0.50	0.50	6139910	<0.50	0.50	6139910
Calculated Parameters							
Resistivity	ohm-cm	8100		6120894			
Inorganics							
Soluble (20:1) Chloride (Cl-)	ug/g	41	20	6122300			
Conductivity	umho/cm	123	2	6127141			
Available (CaCl2) pH	pH	7.31		6122353			
Soluble (20:1) Sulphate (SO4)	ug/g	<20	20	6122302			
Physical Testing							
Moisture-Subcontracted	%	18	0.30	6139909			
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate							

TEST SUMMARY

Maxxam ID: JSA209
Sample ID: AB-1
Matrix: Soil

Collected: 2019/05/09
Shipped:
Received: 2019/05/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6122300	2019/05/15	2019/05/16	Deonarine Ramnarine
Conductivity	AT	6127141	2019/05/17	2019/05/17	Kazzandra Adeva
Moisture (Subcontracted)	BAL	6139909	2019/05/21	2019/05/21	William Zou
Sulphide in Soil	SPEC/UVVS	6139910	2019/05/21	2019/05/23	David Huang
pH CaCl2 EXTRACT	AT	6122353	2019/05/15	2019/05/15	Gnana Thomas
Resistivity of Soil		6120894	2019/05/17	2019/05/17	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	6122302	2019/05/15	2019/05/16	Deonarine Ramnarine
Redox Potential	COND	6146214	2019/05/29		Katherine Szozda

Maxxam ID: JSA210
Sample ID: NR-2
Matrix: Soil

Collected: 2019/05/11
Shipped:
Received: 2019/05/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6122300	2019/05/15	2019/05/16	Deonarine Ramnarine
Conductivity	AT	6127141	2019/05/17	2019/05/17	Kazzandra Adeva
Moisture (Subcontracted)	BAL	6139909	2019/05/21	2019/05/21	William Zou
Sulphide in Soil	SPEC/UVVS	6139910	2019/05/21	2019/05/23	David Huang
pH CaCl2 EXTRACT	AT	6122355	2019/05/15	2019/05/15	Gnana Thomas
Resistivity of Soil		6120894	2019/05/17	2019/05/17	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	6122302	2019/05/15	2019/05/16	Deonarine Ramnarine
Redox Potential	COND	6146214	2019/05/29		Katherine Szozda

Maxxam ID: JSA210 Dup
Sample ID: NR-2
Matrix: Soil

Collected: 2019/05/11
Shipped:
Received: 2019/05/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	6127141	2019/05/17	2019/05/17	Kazzandra Adeva

Maxxam ID: JSA211
Sample ID: NR-5
Matrix: Soil

Collected: 2019/05/11
Shipped:
Received: 2019/05/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6122300	2019/05/15	2019/05/16	Deonarine Ramnarine
Conductivity	AT	6127141	2019/05/17	2019/05/17	Kazzandra Adeva
Moisture (Subcontracted)	BAL	6139909	2019/05/21	2019/05/21	William Zou
Sulphide in Soil	SPEC/UVVS	6139910	2019/05/21	2019/05/23	David Huang
pH CaCl2 EXTRACT	AT	6122353	2019/05/15	2019/05/15	Gnana Thomas
Resistivity of Soil		6120894	2019/05/17	2019/05/17	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	6122302	2019/05/15	2019/05/16	Deonarine Ramnarine
Redox Potential	COND	6146214	2019/05/29		Katherine Szozda

TEST SUMMARY

Maxxam ID: JSA211 Dup
Sample ID: NR-5
Matrix: Soil

Collected: 2019/05/11
Shipped:
Received: 2019/05/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphide in Soil	SPEC/UVVS	6139910	2019/05/21	2019/05/23	David Huang

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	5.0°C
-----------	-------

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

Golder Associates Ltd
Client Project #: 1790414
Sampler Initials: SA

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
6122300	Soluble (20:1) Chloride (Cl-)	2019/05/16	114	70 - 130	106	70 - 130	<20	ug/g	NC	35
6122302	Soluble (20:1) Sulphate (SO4)	2019/05/16	101	70 - 130	101	70 - 130	<20	ug/g	20	35
6122353	Available (CaCl2) pH	2019/05/15			100	97 - 103			0.68	N/A
6122355	Available (CaCl2) pH	2019/05/15			100	97 - 103			0.025	N/A
6127141	Conductivity	2019/05/17			104	90 - 110	<2	umho/cm	1.8	10
6139909	Moisture-Subcontracted	2019/05/21					<0.30	%		
6139910	Sulphide	2019/05/23	89	75 - 125	107	75 - 125	<0.50	ug/g	NC	30

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Anastassia Hamanov, Scientific Specialist



David Huang, BBY Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

CHAIN OF CUSTODY RECORD

Page of

INVOICE TO:						REPORT TO:						PROJECT INFORMATION:						Laboratory Use Only:																	
Company Name: #7575 Golder Associates Ltd						Company Name: Golder Associates						Quotation #: B80683						Maxxam Job #:						Bottle Order #:											
Attention: Accounts Payable						Attention: David Muldowney						P.O. #:																							
Address: 33 Mackenzie Street Suite 100 Sudbury ON P3C 4Y1						Address: 33 Mackenzie St. Suite 100 Sudbury ON P3C 4Y1						Project: 1790414												712313											
Tel: (705) 524-6861 Fax: (705) 524-1984						Tel: 705 524-GBL Fax:						Project Name:						COC #:						Project Manager:											
Email: AP_CustomerService@golder.com						Email: D-Muldowney@golder.com						Site #:												Alisha Williamson											
												Sampled By:						CH712313-01-01																	
MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY																																			
Regulation 153 (2011)						Other Regulations						Special Instructions						Field Filtered (please circle): Metals / Hg / Cr VI						Soil Corrosivity Package						ANALYSIS REQUESTED (PLEASE BE SPECIFIC)					
<input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Medium/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"/> For RSC <input type="checkbox"/> Table _____						<input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw <input type="checkbox"/> Reg 558 <input type="checkbox"/> Storm Sewer Bylaw <input type="checkbox"/> MISA Municipality _____ <input type="checkbox"/> PWQO <input type="checkbox"/> Other _____																													
Include Criteria on Certificate of Analysis (Y/N)?																																			
	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix																														
1	AB-1	Along Bay CK Hwy 127 Culvert	May 09/19	11:00	Soil																														
2	NR-2	NAT RIVER Bridge Hwy 101	May 11/19	10:30	Soil																														
3	NR-5	NAT RIVER Bridge Hwy 101	May 11/19	15:00	Soil																														
4																																			
5																																			
6																																			
7																																			
8																																			
9																																			
10																																			
* RELINQUISHED BY: (Signature/Print)						Date: (YY/MM/DD)		Time		RECEIVED BY: (Signature/Print)						Date: (YY/MM/DD)		Time		# jars used and not submitted		Laboratory Use Only													
						19/05/13		15:20								20/05/13		15:20				Time Sensitive Temperature (°C) on Receipt 5.5, 5°C													
																20/05/14		08:56				Custody Seal Present Intact													
<p>* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.</p> <p>* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.</p> <p>** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/WP-CONTENT/UPLOADS/ONTARIO-COC.PDF.</p>																																			

13-May-19 15:20
 Alisha Williamson

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Received in Sudbury

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