



FOUNDATION INVESTIGATION REPORT

Highway 66, Station 18+839, Township of Gauthier Culvert Replacement Ministry of Transportation, Ontario GWP 5210-14-00

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PART A

FOUNDATION INVESTIGATION REPORT
HIGHWAY 66, STA 18+839, TOWNSHIP OF GAUTHIER
CULVERT REPLACEMENT
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5210-14-00

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 related to the replacement of the culvert on Highway 66 at Station 18+839, in the Township of Gauthier, approximately 1.8 km east of Yost Road near Larder Lake, Ontario. The Key Plan of the general location of this section of Highway 66 and the location of the investigated area are shown on Drawing 1.

The purpose of this investigation is to establish the subsurface conditions at the culvert replacement site by borehole drilling with laboratory testing carried out on selected soil samples.

The Terms of Reference (TOR) and the scope of work for the foundation investigation are outlined in MTO's Request for Proposal, dated February 2018, and the subsequent clarifications/addenda, which forms part of the Consultant's Assignment Number 5017-E-0039 for this project. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundation engineering services for this project dated November 2018.

2.0 SITE DESCRIPTION

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 Drawing 1. For the purpose of this report, Highway 66 is oriented in a west-east direction with the culvert positioned perpendicular to the highway generally in a north-south orientation. At the culvert location, the creek flows in a north to south direction.

The existing culvert consists of a 1200 mm diameter, 38.6 m long Structural Plate Corrugated Steel Pipe (SPCSP). The culvert invert as interpreted from AECOM's centreline survey profile drawing is approximately Elevation 273.7 m at both the inlet and outlet. In general, the topography within the vicinity of the culvert consists of forested hills. The culvert is located about 1.8 km east of Yost Road near Larder Lake, Ontario and the highway grade at the culvert centreline is Elevation 280.1 m. The embankment is approximately 6.4 m high relative to the culvert invert.

At the time of the subsurface exploration field work, the embankment side slopes appeared to be partially grass covered with some local vegetation growing adjacent to the toes of slope and exhibit some localized shallow erosion gullies. The culvert is in poor condition with a rusted bottom and sag along its alignment. The ground surface conditions at select locations of the culvert area are shown on Photographs 1 to 6.

3.0 INVESTIGATION PROCEDURES

Field work for this subsurface exploration was carried out between April 30 and June 4, 2019, during which time five boreholes (Boreholes C263-1 to C263-5) were advanced at the approximate locations shown on Drawing 1. Boreholes C263-1 to C263-3 were advanced from the roadway surface through the roadway embankment using a track mounted CME-55LC drilling rig supplied and operated by George Downing Estate Drilling (Downing) of Grenville-Sur-La-Rouge, Quebec; and Boreholes C263-4 and C263-5 were advanced near the south and north toes of the highway embankment, adjacent to the culvert inlet and outlet, respectively, using a portable tripod rig supplied and operated by Landcore Drilling (Landcore) of Chelmsford, Ontario. Traffic control, where required, was performed in accordance with MTO's Ontario Traffic Control Manual Book 7 – Temporary Conditions.

Boreholes C263-1 to C263-3 were advanced using 108 mm I.D. Hollow Stem Augers and Boreholes C263-4 and C263-5 were advanced using NW casing and wash boring techniques using water obtained from a water truck. 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 or manual hammer in accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586). In-situ vane shear tests were carried out in cohesive soils for determination of undrained shear strengths in accordance with Standard Test Method for Field Vane Shear Test in Saturated Fine Grained Soils (ASTM 2573), using an MTO standard "N"-size vane. The groundwater level inside the augers/casing was observed during and upon completion of the drilling operations. The boreholes were backfilled upon completion in accordance with Ontario Regulation 903 (wells) as amended. The roadway surface at the boreholes drilled through Highway 66 were capped at the roadway surface using cold patch asphalt.

Field work was supervised 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, grain size distributions, and Atterberg limits was carried out on selected soil samples. The geotechnical laboratory testing was completed according to ASTM and MTO LS standards, as applicable. One soil sample was submitted to Bureau Veritas Laboratories (formally Maxxam) of Sudbury, an accredited analytical laboratory, for testing a suite of corrosivity indicator parameters.

The as-drilled borehole locations were measured relative to highway chainages/station marked on the pavement by a member of our technical staff and converted into northing/easting coordinates on the plan drawing. The ground surface elevations at each borehole location was surveyed by Golder relative to the highway and culvert centreline, with the elevation of the centrelines provided by AECOM. The MTM NAD 83-CSRS CBN v6-2010.0 (Zone 12) northing and easting coordinates, geographical coordinates, ground surface elevations referenced to Geodetic datum, and borehole depths at each borehole location are presented on the borehole records in Appendix A and summarized below.

Borehole Number	MTM NAD 83 Northing (m) (Latitude)	MTM NAD 83 Easting (m) (Longitude)	Ground Surface Elevation (m)	Borehole Depth (m)
C263-1	5330726.0 (48.109023)	395012.5 (-79.788447)	280.1	20.4
C263-2	5330721.4 (48.108984)	394996.2 (-79.788667)	279.7	15.9
C263-3	5330734.2 (48.109096)	395020.5 (-79.788338)	280.4	15.9
C263-4	5330748.1 (48.109222)	395008.3 (-79.788498)	276.2	9.8
C263-5	5330709.9 (48.108881)	394994.3 (-79.788695)	274.7	9.8

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on Northern Ontario Engineering Geology Terrain Study (NOEGTS)¹ mapping, the culvert site is located within a glaciolacustrine plain, with the subsoils consisting primarily of clay.

Based on geological mapping (MNDM)², the site is underlain by mafic to intermediate metavolcanics rocks.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the summary results of in situ and laboratory testing are given on the Record of Borehole sheets contained in Appendix A. The plotted results of geotechnical laboratory testing are contained in Appendix B. The results of the in-situ field tests (i.e., SPT 'N'-values and in situ vane shear strengths) as presented on the Record of Borehole sheets and discussed in Section 4.2 are uncorrected. The stratigraphic boundaries shown on the Record of Borehole sheets and on the interpreted stratigraphic profiles shown on Drawing 1 are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The results of the analytical laboratory testing (by Bureau Veritas Laboratories) are summarized in Section 4.4 and the detailed laboratory testing report is included in Appendix B.

The subsurface conditions will vary between and beyond the borehole locations, however, the factual data presented on the Record of Borehole Sheets governs any interpretation of the site conditions. A summary description of the soil deposits and groundwater conditions encountered in the boreholes is provided below. It should be noted that the interpreted stratigraphy shown on Drawing 1 is a simplification of the subsurface conditions.

4.2.1 Asphalt/Fill

An approximately 100 mm to 120 mm thick layer of asphalt pavement was encountered in the roadway boreholes (Boreholes C263-1 to C263-3), between Elevations 280.4 m and 279.7 m. A 4.4 m to 5.9 m thick layer of embankment fill consisting of an upper 0.5 m thick layer of sand and gravel underlain by layers of sand to sand and silt to silt and sand to silt was (with depth) encountered below the asphalt; and a 0.7 m thick layer of sand fill was encountered at ground surface in Borehole C263-5.

Asphalt coated particles were encountered in Boreholes C263-1 and C263-3 between depths of 0.1 m to 0.3 m below the roadway surface. A 150 mm thick layer of asphalt was encountered within the fill in Borehole C263-3 at a depth of 3.5 m below ground surface (Elevation 276.9 m); and a 150 mm thick piece of wood was encountered in Borehole C263-3 at a depth of 4.6 m below ground surface (Elevation 275.8 m). The embankment fill contains trace asphalt at a depth of 3.0 m below ground surface (Elevation 276.7 m) in Borehole C263-2, and trace

¹ Ontario Ministry of Natural Resources and Forestry. Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Electronic Mapping. Map 41PNE.

² Ontario Ministry of Northern Development and Mines. Bedrock Geology of Ontario, East-Central Sheet. Map 2543.

organics below a depth of 3.7 m below ground surface (Elevation 276.7 m and 276.0 m) in Borehole C263-2 and C263-3, and trace organics in Borehole C263-4.

The SPT “N”-values measured within the fill layer ranges from 2 blows to 34 blows per 0.3 m of penetration, indicating a very loose to dense compactness condition.

Grain size distribution testing was carried out on three samples of the fill and the results are presented on Figure B-1 in Appendix B. The natural moisture content measured on three samples of the fill ranges from about 7 per cent to 21 per cent.

4.2.2 Organic Silt

A 0.5 m and 0.7 m thick layer of organic silt to sandy organic silt was encountered below the fill in Borehole C263-1 and at ground surface in Borehole C263-4, at Elevations 274.1 m and 276.2 m, respectively.

The SPT “N”-values measured within the organic silt deposit are 2 blows and 7 blows per 0.3 m of penetration indicating a very loose to loose compactness condition.

4.2.3 Silty Sand

A 0.3 m to 1.1 m thick deposit of silty sand was encountered underlying the fill (or organic silt, wood) in C263-1 to C263-3 between Elevations 275.7 m and 273.6 m. The silty sand deposit contains trace organics in Boreholes C263-1 and C263-3.

The SPT “N”-values measured within the silty sand deposit are 4 blows and 7 blows per 0.3 m of penetration, indicating that a very loose to loose compactness condition.

4.2.4 Varved Clay and Clayey Silt

A 5.0 m to 6.5 m thick cohesive deposit of varved clay and clayey silt was encountered below the silty sand deposit in Boreholes C263-1 to C263-3, below the sandy organic silt deposit in Borehole C263-4, and below the sand fill in Borehole C263-5, at depths between 0.7 m and 6.8 m below ground surface, between Elevations 275.5 m and 273.3 m. The clay and clayey silt varves range in thickness from about 5 mm to 20 mm.

The SPT “N”-values measured within the varved clay and clayey silt deposit range from 0 blows (weight of hammer – WH) to 5 blows per 0.3 m of penetration. In-situ field vane tests carried out within the deposit measured undrained shear strengths ranging from about 34 kPa to 77 kPa and sensitivity ranging from about 2 to 3. The SPN “N”-values, together with the field vane test results, suggest that the deposit has a firm to stiff consistency.

Grain size distribution testing was carried out on six samples of the combined clay and clayey silt varved deposit and the results are presented on Figure B-2A. Grain size distribution testing was also carried out on two samples of the clayey silt portion of the varved deposit and the results are presented on Figure B-2B. Atterberg limits testing was carried out on five samples of the combined clay and clayey silt portions of the varved deposit and the test results, which are plotted on Figure B-3A, indicate that the combined soil deposit consists of a silty clay of intermediate to high plasticity. Atterberg limits testing was also carried out on three sample of the clayey silt portion of the varved deposit, and on one sample of the clay portion of the varved deposit; the test results, which

are plotted on Figures B-3B and B-3C, indicate that the varves consist of clayey silt of low plasticity and clay of high plasticity, respectively. Typically, the liquid limit and plasticity index decreased with depth in this deposit. The Atterberg limits test results are summarized below with the natural moisture content testing results.

Soil Matrix	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Classification	Moisture Content (%)
Clay and Clayey Silt (Combined)	46 – 51	21 – 24	24 – 28	Intermediate to High Plasticity	44 – 52
Clayey Silt (Component)	26	18 and 19	7 and 8	Low Plasticity	24 to 36
Clay (Component)	75	26	49	High Plasticity	75

One laboratory consolidation (oedometer) test was carried out on a sample of the varved (combined) clay and clayey silt deposit obtained from Borehole C263-4 (Sample 5). The results of the consolidation test are provided on Figure B-4 in Appendix B and are summarized below.

Borehole / Sample No.	Sample Elevation (m)	W (%)	γ (kN/m ³)	σ_{vo}' (kPa)	σ_p' (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	e_o	C_c	C_r	C_v (cm ² /s)
C263-4 Sample 5	271.3	37.5	17.9	45	130	85	1.1	0.30	0.03	0.017

Note:

¹ Final vertical overburden pressure and coefficient of consolidation are dependent on final loading conditions at the site, and assume no embankment widening or grade raise at this stage.

Where: w_n Natural moisture content (%)
 γ Unit weight (kN/m³)
 σ_{vo}' Effective overburden pressure (kPa)
 σ_p' Preconsolidation pressure (kPa)
 e_o Initial void ratio
 C_c Compression index
 C_r Recompression index
 C_v Coefficient of consolidation in the normally consolidated range (cm²/s)

4.2.5 Silt

A 2.6 m to 8.2 m thick deposit of silt was encountered underlying the varved clay and clayey silt deposit in all boreholes, between Elevations 269.0 m and 267.9 m. All boreholes were terminated within the deposit at depths ranging from 9.8 m to 20.4 m below ground surface. The deposit contains trace to some clay and is sandy below depths of 17.7 m and 14.8 m in Boreholes C263-1 and C263-3, respectively.

The SPT “N”-values measured within the silt deposit range from 4 blows to 21 blows per 0.3 m of penetration, indicating that the deposit has a very loose to compact compactness condition.

Grain size distribution analysis was carried out on four samples of the silt deposit and the results are presented on Figure B-5 in Appendix B. Atterberg limits testing was carried out on three samples of the silt deposit and the results indicate that the deposit ranges from slightly plastic, with a liquid limit of about 24 per cent, a plastic limit of about 20 per cent, and a plasticity index of about 4 per cent, as plotted on Figure B-6, to non-plastic. The natural moisture content measured on samples of the silt deposit range from about 25 per cent to 31 per cent.

4.3 Groundwater Conditions

The unstabilized groundwater levels relative to ground surface measured inside the augers/casing upon completion of drilling are summarized below. Groundwater and creek water levels in the area are subject to seasonal fluctuations and variations due to precipitation events.

Borehole No.	Depth to Unstabilized Groundwater Level (m)	Approximate Groundwater Elevation (m)
C263-1	8.5	271.6
C263-2	8.5	271.2
C263-3	5.3	275.1
C263-4	0.7	275.5
C263-5	0.4	274.3

4.4 Analytical Laboratory Testing Results

Analytical testing was carried out on a sample of varved clay and clayey silt recovered from Borehole C263-1 (Sample 9). The soil sample was submitted to Bureau Veritas Laboratories of Mississauga, Ontario for corrosivity testing. The analytical laboratory test results are summarized below, and the detailed analytical laboratory test report is included in Appendix B.

Borehole / Sample No.	Sample Depth (Elevation) (m)	Parameters					
		Resistivity (ohm-cm)	Electrical Conductivity (µmho/cm)	Soluble Sulphate (SO ₄) Content (µg/g)	Chloride (Cl) Content (µg/g)	Sulphide (µg/g)	pH
C263-1 Sample 9	6.9 – 7.5 (272.9)	2,700	366	<20 ¹	120	<0.30 ¹	8.0

Note:

¹ The sulphate and sulphide concentrations are below the reportable detection limits of 20 µg/g and 0.30 µg/g, respectively.

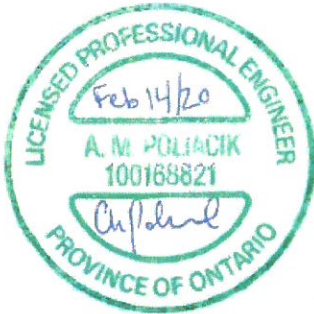
Redox potential testing was carried out on the sample noted above and yielded a value of -212.9 mV. The redox potential laboratory test reports, provided by Eurofins Environmental Testing, is included in Appendix B.

5.0 CLOSURE

The field drilling program was carried out under the supervision of Mr. Mathew Riopelle under the overall direction of Mr. André Bom, P.Eng., an Associate of Golder. This Foundation Investigation Report was prepared by Mr. Yusuf Soliman, a member of the geotechnical group with Golder, and by Ms. Anastasia Poliacik, P.Eng., a geotechnical engineer with Golder. Mr. André Bom, P.Eng., reviewed 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.

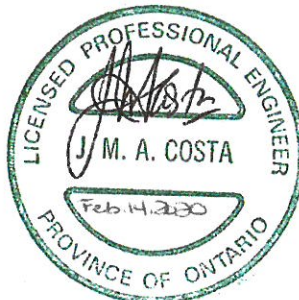
Signature Page

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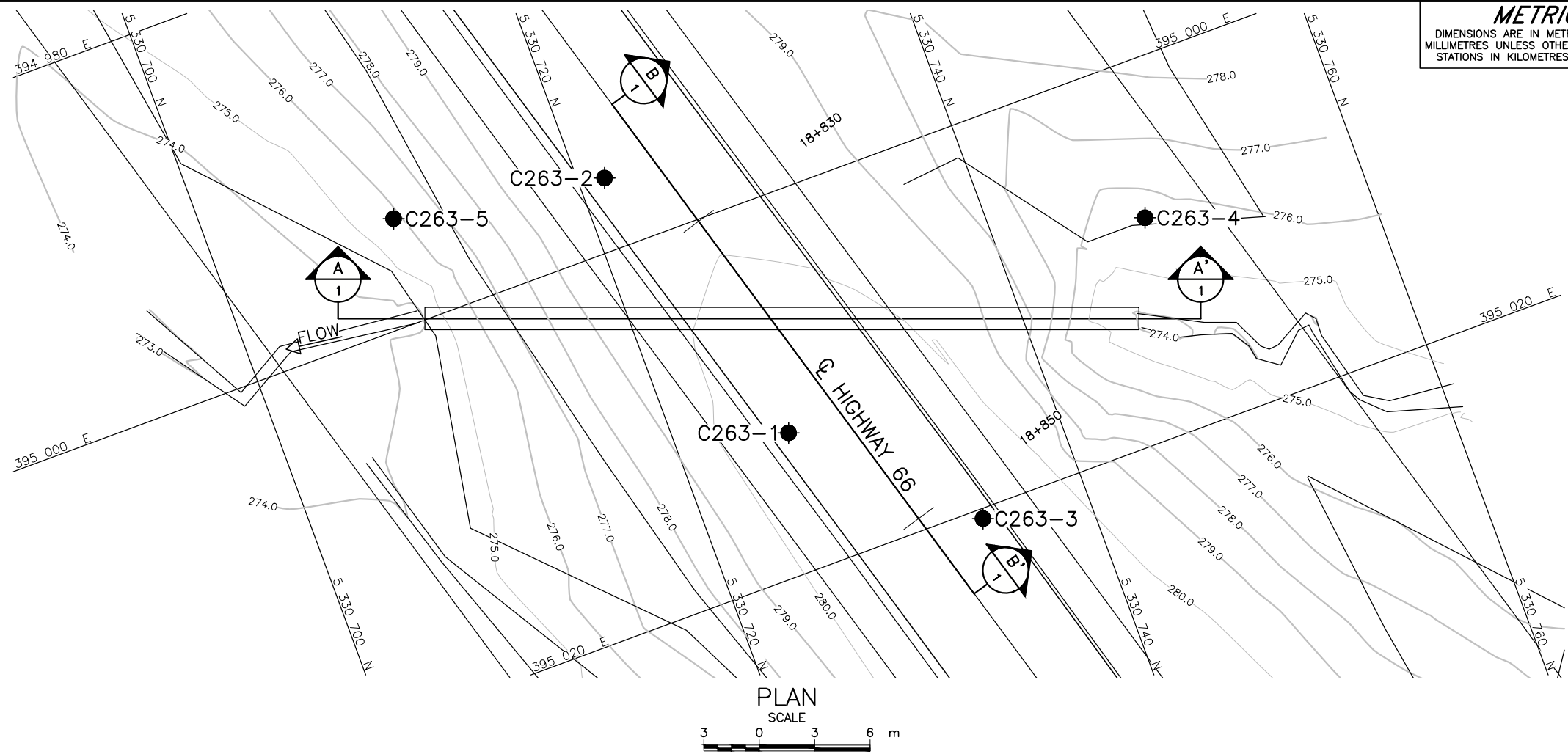


Jorge M. A. Costa, P.Eng.
MTO Foundations Designated Contact, Senior Consultant

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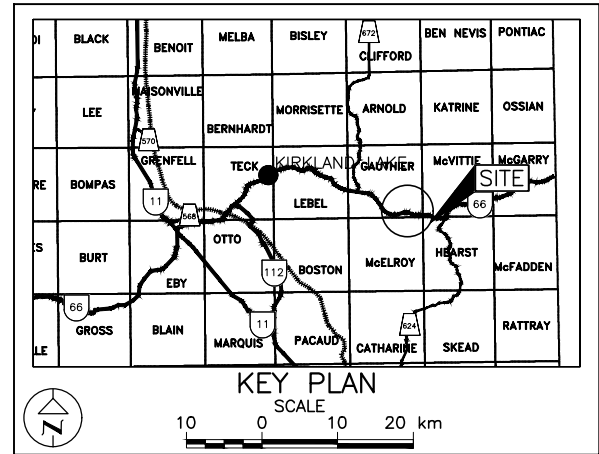
[https://golderassociates.sharepoint.com/sites/1809001/deliverables/foundations/2_reporting/r13 - gau 263 \(hf\)/3_final/1896349 r-rev0 aecom culvert c263 hwy 66 fir 14feb_2020.docx](https://golderassociates.sharepoint.com/sites/1809001/deliverables/foundations/2_reporting/r13_-_gau_263_(hf)/3_final/1896349_r-rev0_aecom_culvert_c263_hwy_66_fir_14feb_2020.docx)



METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 5210-14-00

HIGHWAY 66
STATION 18+839
TOWNSHIP OF GAUTHIER CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA



LEGEND

Borehole – Current Investigation

Standard Penetration Test Value

Blows/0.3m unless otherwise stated
(Std. Pen. Test, 475 j/blow)

WL upon completion of drilling

BOREHOLE CO-ORDINATES (NAD 83 MTM ZONE 12)			
No.	ELEVATION	NORTHING	EASTING
C263-1	280.1	5330726.0	395012.5
C263-2	279.7	5330721.4	394996.2
C263-3	280.4	5330734.2	395020.5
C263-4	276.2	5330748.1	395008.3
C263-5	274.7	5330709.9	394994.3



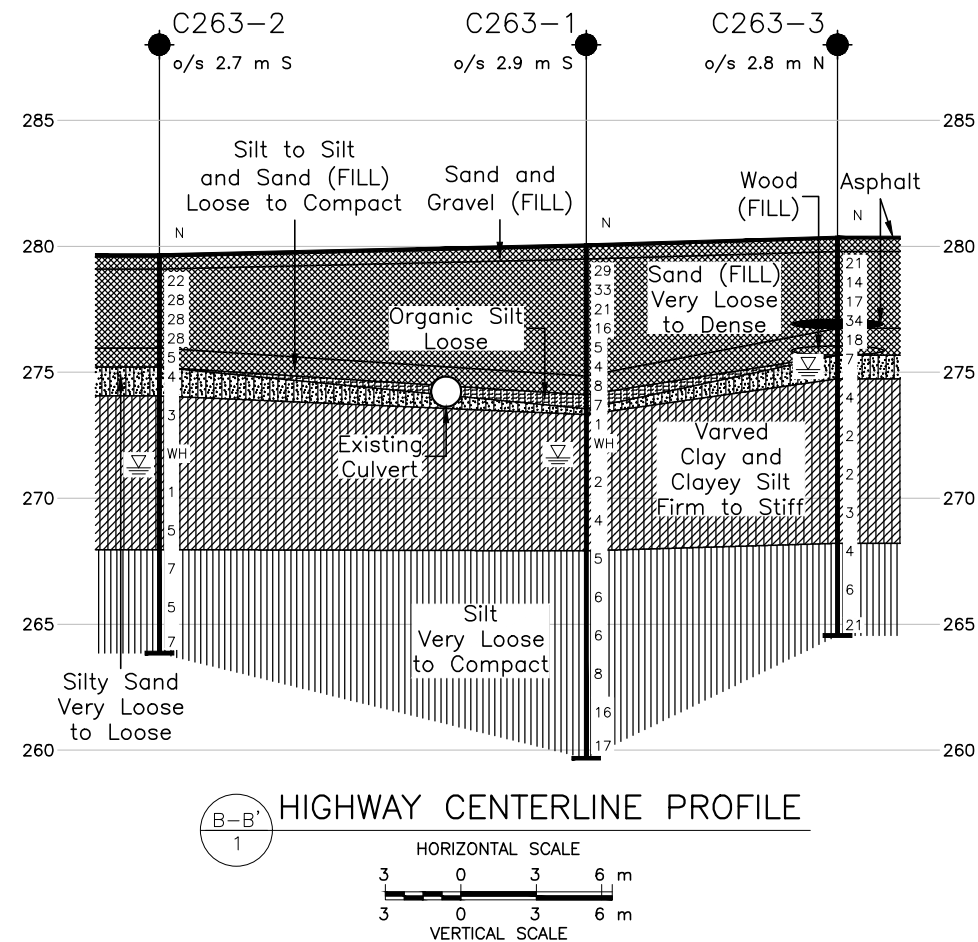
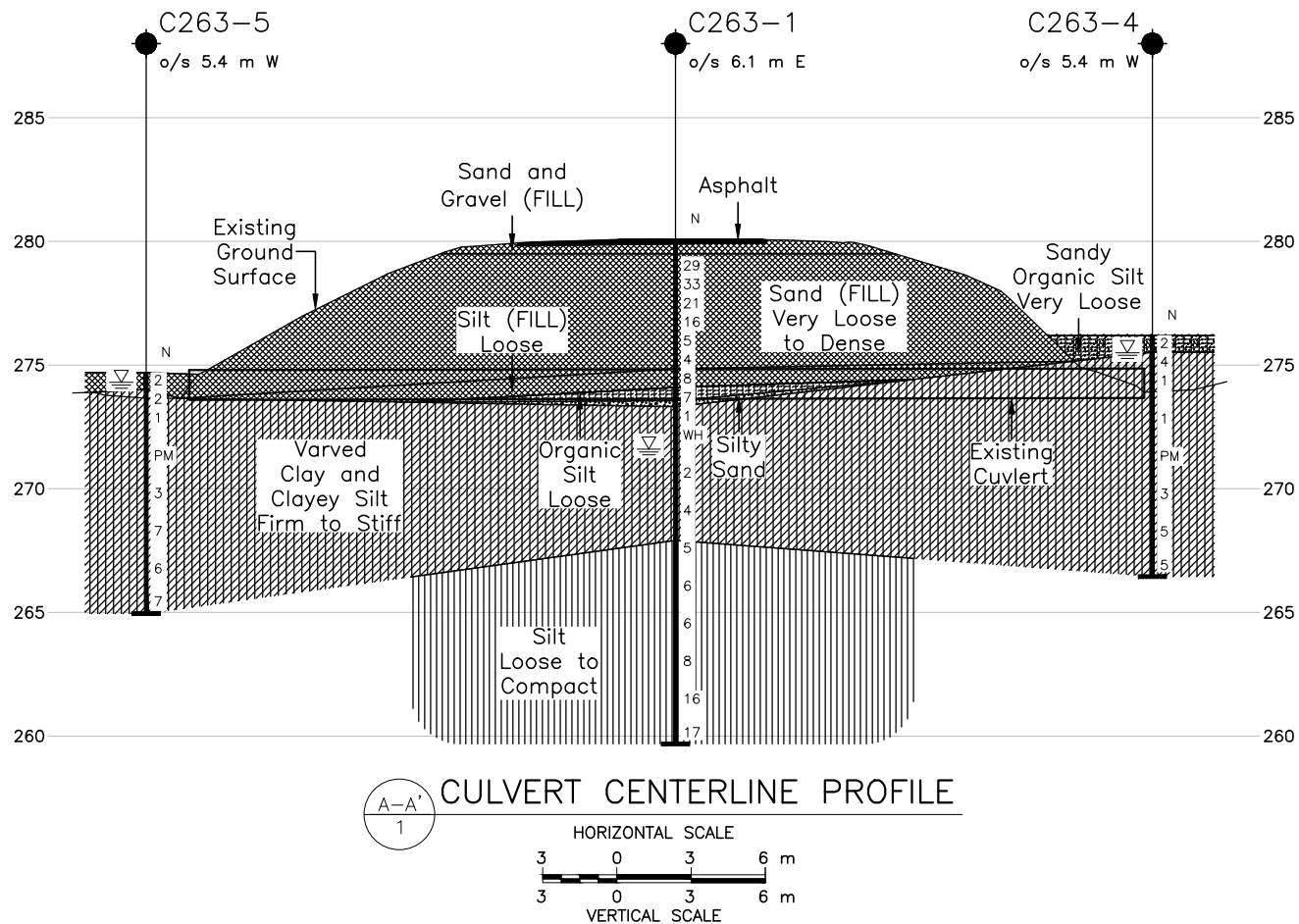
NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

REFERENCE

Base plans provided in digital format by CALLON DIETZ LTD. drawing file no. gwp52101400b.dwg, received AUGUST 14, 2019.



NO.	DATE	BY	REVISION
1	2/12/2020	TR	1

HWY. 66

SUBM'D. TB

DRAWN: TR

PROJECT NO. 1896349

CHKD. AP

CHKD. AB

DATE: 2/12/2020

APPD. JMAC

DIST. .

SITE: .

DWG. 1



Photograph 1: Drilling Rig Positioned at Borehole C263-3, Facing East (May 2019)



Photograph 2: Embankment South Slope and Culvert Outlet (April 2019)



Photograph 3: Portable Drilling Rig Positioned at Borehole C263-5 near Culvert Outlet (June 2019)



Photograph 4: Portable Drilling Rig Positioned at Borehole C263-4 near Culvert Inlet (June 2019)



Photograph 5: Embankment South Slope (June 2019)



Photograph 6: Embankment North Slope (June 2019)

APPENDIX A

Record of Boreholes

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

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

(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

Notes: 1
2

$\tau = c' + \sigma' \tan \phi'$
shear strength = (compressive strength)/2

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

PROJECT <u>1896349</u>		RECORD OF BOREHOLE No C263-1		2 OF 2 METRIC													
G.W.P. <u>5210-14-00</u>		LOCATION <u>N 5330726.0; E 395012.5 NAD83 MTM ZONE 12 (LAT. 48.109023; LONG. -79.788447)</u>		ORIGINATED BY <u>MR</u>													
DIST <u> </u> HWY <u>66</u>		BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers</u>		COMPILED BY <u>TR</u>													
DATUM <u>GEODETIC</u>		DATE <u>April 30, 2019</u>		CHECKED BY <u>AB</u>													
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)				
							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p — W — W _L 20 40 60					
--- CONTINUED FROM PREVIOUS PAGE ---																	
267.9		///					268										
12.2	SILT, trace to some clay, trace sand Loose to compact Grey Wet - Sandy below 17.7 m depth		13	SS	5		267										
							266										
			14	SS	6		265										
							264										
			15	SS	6		263										
							262										
			16	SS	8		261										
							260										
			17	SS	16												
			18	SS	17												
259.7																	
20.4	END OF BOREHOLE NOTE: 1. Water level measured inside augers at a depth of 8.5 m below ground surface (Elev. 271.6 m) upon completion of drilling. 2. Borehole caved to a depth of 4.6 m below ground surface (Elev. 275.5 m) upon removal of augers.																

PROJECT 1896349		RECORD OF BOREHOLE No C263-2		1 OF 2 METRIC																	
G.W.P. 5210-14-00		LOCATION N 5330721.4; E 394996.2 NAD83 MTM ZONE 12 (LAT. 48.108984; LONG. -79.788667)		ORIGINATED BY MR																	
DIST _____ HWY 66		BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers		COMPILED BY TR																	
DATUM GEODETIC		DATE April 30, 2019		CHECKED BY AB																	
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ			GR SA SI CL		
279.7	GROUND SURFACE							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p — W — W _L 20 40 60			kN/m ³					
0.0	ASPHALT (120 mm)																				
0.1	Sand and gravel (FILL)																				
279.1	Sand, trace gravel, trace silt (FILL)						279														
0.6	Loose to compact Brown Moist		1	SS	22																
			2	SS	28		278														
			3	SS	28		277														
	- Trace asphalt below 3.0 m depth		4	SS	28		276														
276.0	Silt and sand, trace clay, trace organics (FILL)																				
3.7	Loose Brown Wet		5	SS	5														1 47 47 5		
275.2	SILTY SAND, trace organics						275														
4.5	Very loose Grey / black Wet		6	SS	4																
274.1	CLAY and CLAYEY SILT, varved						274														
5.6	Firm to stiff Grey Wet		7	SS	3														0 0 41 59		
	- Approximately 5 mm to 20 mm varying thickness of clay and clayey silt varves throughout deposit						273														
			8	SS	WH		272														
							271														
			9	SS	1		270														
							269														
			10	SS	5														0 0 74 26		
268.0	SILT, trace to some clay, trace sand						268														
11.7																					

Continued Next Page

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

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PROJECT <u>1896349</u>		RECORD OF BOREHOLE No C263-2		2 OF 2 METRIC	
G.W.P. <u>5210-14-00</u>		LOCATION <u>N 5330721.4; E 394996.2 NAD83 MTM ZONE 12 (LAT. 48.108984; LONG. -79.788667)</u>		ORIGINATED BY <u>MR</u>	
DIST <u> </u> HWY <u>66</u>		BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers</u>		COMPILED BY <u>TR</u>	
DATUM <u>GEODETIC</u>		DATE <u>April 30, 2019</u>		CHECKED BY <u>AB</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
	---							○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED											
								20	40	60	80	100								
																	</			

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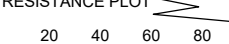
PROJECT 1896349		RECORD OF BOREHOLE No C263-3		1 OF 2 METRIC	
G.W.P. 5210-14-00		LOCATION N 5330734.2; E 395020.5 NAD83 MTM ZONE 12 (LAT. 48.109096; LONG. -79.788338)		ORIGINATED BY MR	
DIST _____ HWY 66		BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers		COMPILED BY TR	
DATUM GEODETIC		DATE May 1, 2019		CHECKED BY AB	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT 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></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div></div>	<div><div></div><div></div><div></div><div></div><div></div></div>					
280.4	GROUND SURFACE																			
0.0	ASPHALT (100 mm)																			
0.1	Sand and gravel (FILL)																			
279.8	Asphalt coated particles from 0.1 m to 0.3 m depth																			
0.6	Sand, trace gravel (FILL)																			
	Compact		1	SS	21															
	Brown																			
	Moist																			
			2	SS	14															
			3	SS	17															
			4A	SS	34															
276.9	ASPHALT (150 mm)		4B																	
3.7	Silt and sand, trace gravel, trace clay, trace organics (FILL)																			
	Compact		5	SS	18															
	Grey																			
	Wet																			
275.8	WOOD (150 mm)																			
4.7	SILTY SAND		6A	SS	7															
	Loose		6B																	
	Grey																			
	Wet																			
274.8	CLAY and CLAYEY SILT, varved																			
5.6	Firm to stiff																			
	Grey																			
	Wet																			
	- Approximately 5 mm to 20 mm varying thickness of clay and clayey silt varves throughout deposit		7	SS	4															
			8	SS	2															
			9	SS	2															
			10	SS	3															
268.6	SILT, some clay																			
11.8																				


Continued Next Page

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

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PROJECT <u>1896349</u>			RECORD OF BOREHOLE No C263-3				2 OF 2 METRIC					
G.W.P. <u>5210-14-00</u>			LOCATION <u>N 5330734.2; E 395020.5 NAD83 MTM ZONE 12 (LAT. 48.109096; LONG. -79.788338)</u>				ORIGINATED BY <u>MR</u>					
DIST <u> </u> HWY <u>66</u>			BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers</u>				COMPILED BY <u>TR</u>					
DATUM <u>GEODETIC</u>			DATE <u>May 1, 2019</u>				CHECKED BY <u>AB</u>					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT  SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES							
	--- CONTINUED FROM PREVIOUS PAGE ---											
	SILT, some clay Very loose to compact Grey Wet		11	SS	4		268				NP	0 0 86 14
							267					
			12	SS	6		266					
	- Sandy below 14.8 m depth						265					
264.5			13	SS	21							
15.9	END OF BOREHOLE NOTE: 1. Water level measured inside augers at a depth of 5.3 m below ground surface (Elev. 275.1 m) upon completion of drilling. 2. Borehole caved to a depth of 5.3 m below ground surface (Elev. 275.1 m) upon removal of augers.											

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PROJECT 1896349		RECORD OF BOREHOLE No C263-4				1 OF 1 METRIC												
G.W.P. 5210-14-00		LOCATION N 5330748.1; E 395008.3 NAD83 MTM ZONE 12 (LAT. 48.109222; LONG. -79.788498)				ORIGINATED BY MR												
DIST _____ HWY 66		BOREHOLE TYPE Portable Equipment, NW Casing				COMPILED BY TR												
DATUM GEODETIC		DATE June 4, 2019				CHECKED BY AB												
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 (%)
276.2	GROUND SURFACE							20	40	60	80	100						
0.0	Sandy ORGANIC SILT Very loose Dark brown Wet		1	SS	2	▽	276											
275.5	CLAY and CLAYEY SILT, varved Firm to stiff Brown to grey Wet - Approximately 5 mm to 20 mm varying thickness of clay and clayey silt varves throughout deposit		2	SS	4		275											0 0 55 45
0.7			3	SS	1		274											
							273											0 0 50 50
			4	SS	1		272											
			5A	TO	PM		271											
			5B				270											
			6	SS	3		269											
269.0	SILT, some clay Loose Grey Wet		7	SS	5		268										0 0 87 13	
7.2							267											
266.4	END OF BOREHOLE		8	SS	5													
9.8	NOTE: 1. Water level measured inside augers at a depth of 0.7 m below ground surface (Elev. 275.5 m) upon completion of drilling. 2. Borehole caved to a depth of 3.9 m below ground surface (Elev. 272.3 m) upon removal of augers.																	

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

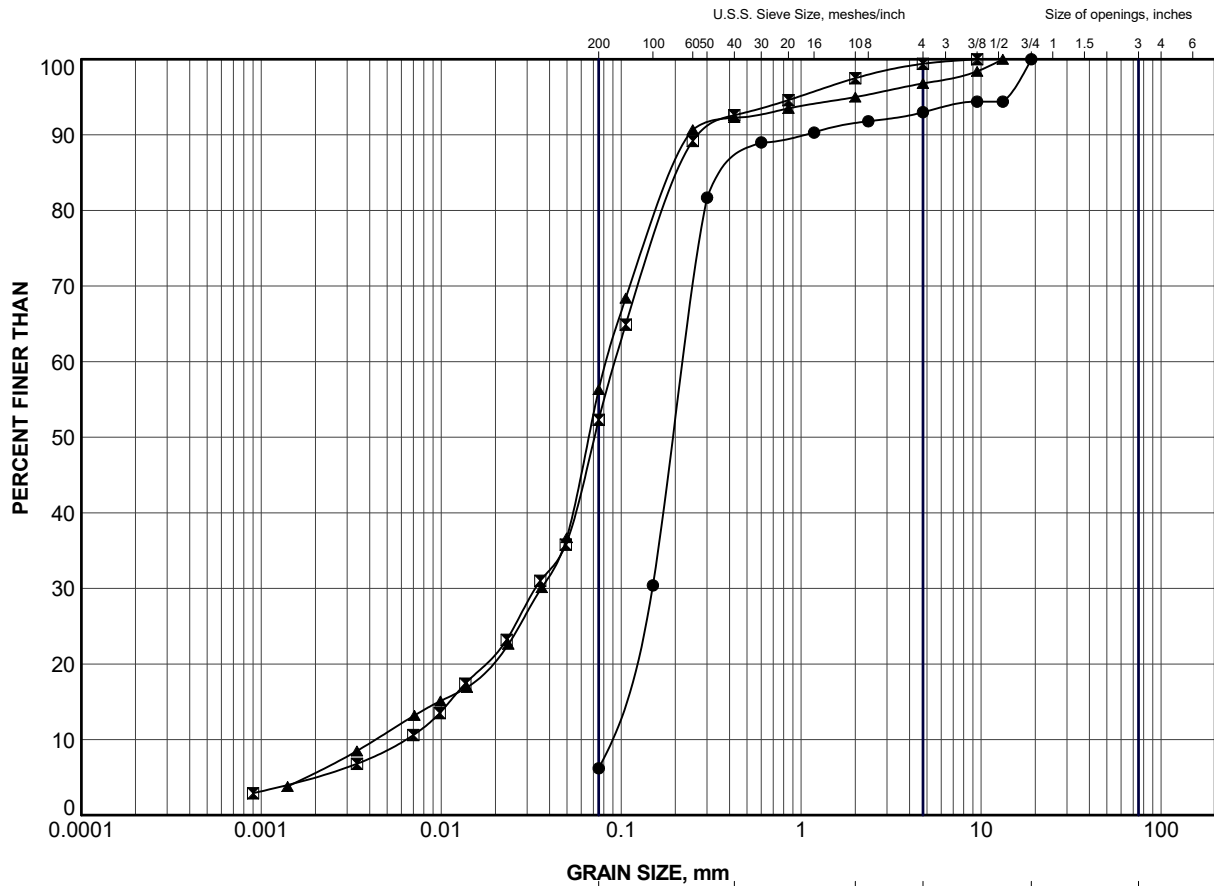
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PROJECT 1896349		RECORD OF BOREHOLE No C263-5				1 OF 1 METRIC												
G.W.P. 5210-14-00		LOCATION N 5330709.9; E 394994.3 NAD83 MTM ZONE 12 (LAT. 48.108881; LONG. -79.788695)				ORIGINATED BY MR												
DIST _____ HWY 66		BOREHOLE TYPE Portable Equipment, NW Casing				COMPILED BY TR												
DATUM GEODETIC		DATE June 4, 2019				CHECKED BY AB												
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 (%)
274.7	GROUND SURFACE							20	40	60	80	100						
0.0	Sand, trace gravel, trace organics (FILL) Very loose Brown Wet		1	SS	2		274											
274.0	CLAY and CLAYEY SILT, varved Firm to stiff Grey Wet		2	SS	2		273											
0.7	- Approximately 5 mm to 20 mm varying thickness of clay and clayey silt varves throughout deposit		3	SS	1		272											
			4	TO	PM		271											
			5	SS	3		270											
			6	SS	7		269											
			7	SS	6		268											
			8	SS	7		267											
269.0	SILT, trace to some clay Stiff / loose Grey Wet						269											
5.7							268											
							267											
							266											
							265											
264.9	END OF BOREHOLE																	
9.8	NOTE: 1. Water level measured inside augers at a depth of 0.4 m below ground surface (Elev. 274.3 m) upon completion of drilling. 2. Borehole caved to a depth of 8.6 m below ground surface (Elev. 266.1 m) upon removal of augers.																	

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APPENDIX B

Laboratory Test Results

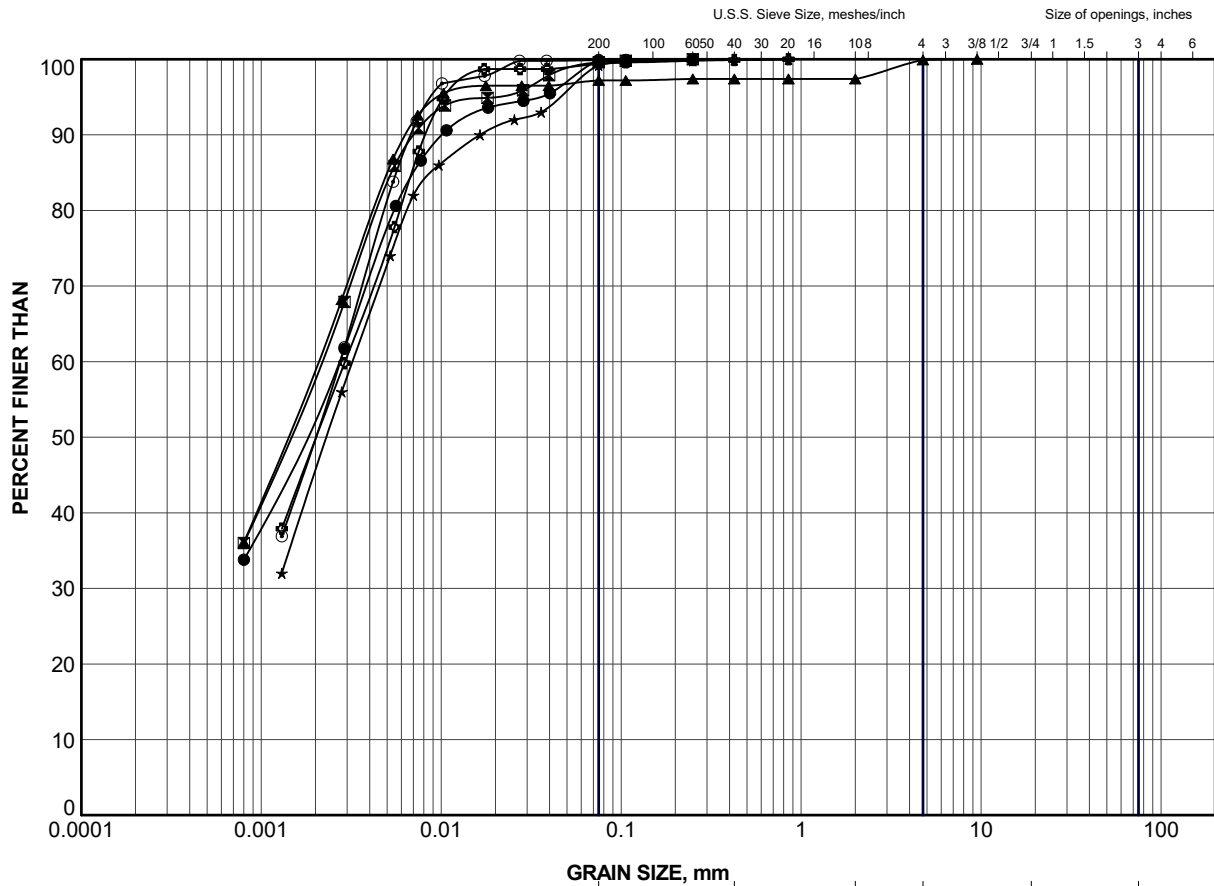


CLAY AND SILT	GRAVEL SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C263-1	6	275.2
■	C263-2	5	275.6
▲	C263-3	5	276.3


PROJECT						HIGHWAY 66 STATION 18+839 TOWNSHIP OF GAUTHIER CULVERT					
TITLE						GRAIN SIZE DISTRIBUTION Silt and Sand to Sand (FILL)					
PROJECT No.			1896349			FILE No.			1896349.GPJ		
DRAWN	TR	Nov 2019	SCALE	N/A	REV.	FIGURE B-1					
CHECK	AMP	Nov 2019									
APPR	JMAC	Nov 2019									
GOLDER						SUDBURY, ONTARIO					

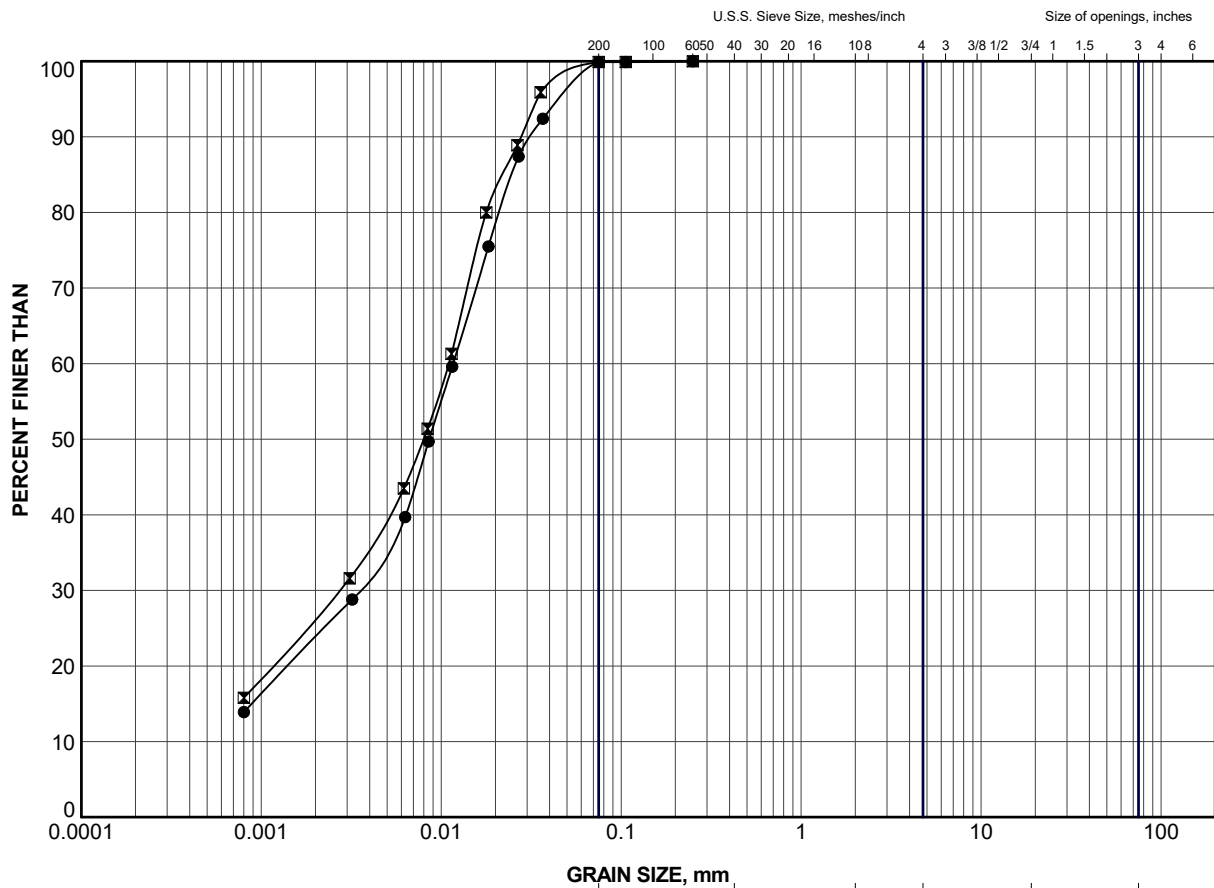


CLAY AND SILT	GRAVEL SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C263-1	9	272.9
⊠	C263-2	7	273.3
▲	C263-3	7	274.0
★	C263-4	2	275.1
⊙	C263-4	4	272.9
⊛	C263-5	3	272.9


PROJECT						HIGHWAY 66 STATION 18+839 TOWNSHIP OF GAUTHIER CULVERT					
TITLE						GRAIN SIZE DISTRIBUTION CLAY and CLAYEY SILT, varved (Combined Clay and Clayey Silt components)					
PROJECT No.			1896349			FILE No.			1896349.GPJ		
DRAWN	TR	Nov 2019		SCALE	N/A	REV.					
CHECK	AMP	Nov 2019									
APPR	JMAC	Nov 2019									
 GOLDER SUDBURY, ONTARIO						FIGURE B-2A					

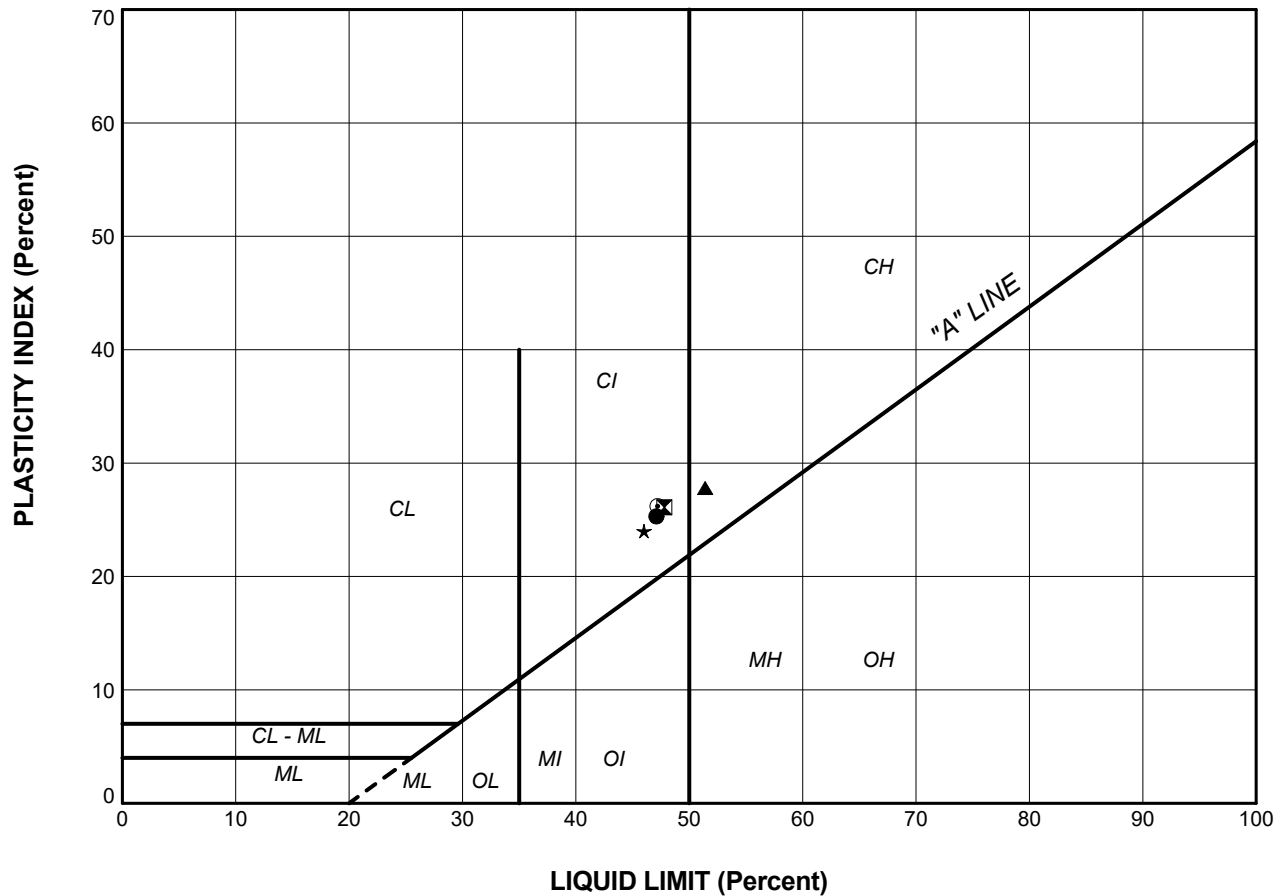


GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C263-1	12	269.1
⊠	C263-2	10	268.7

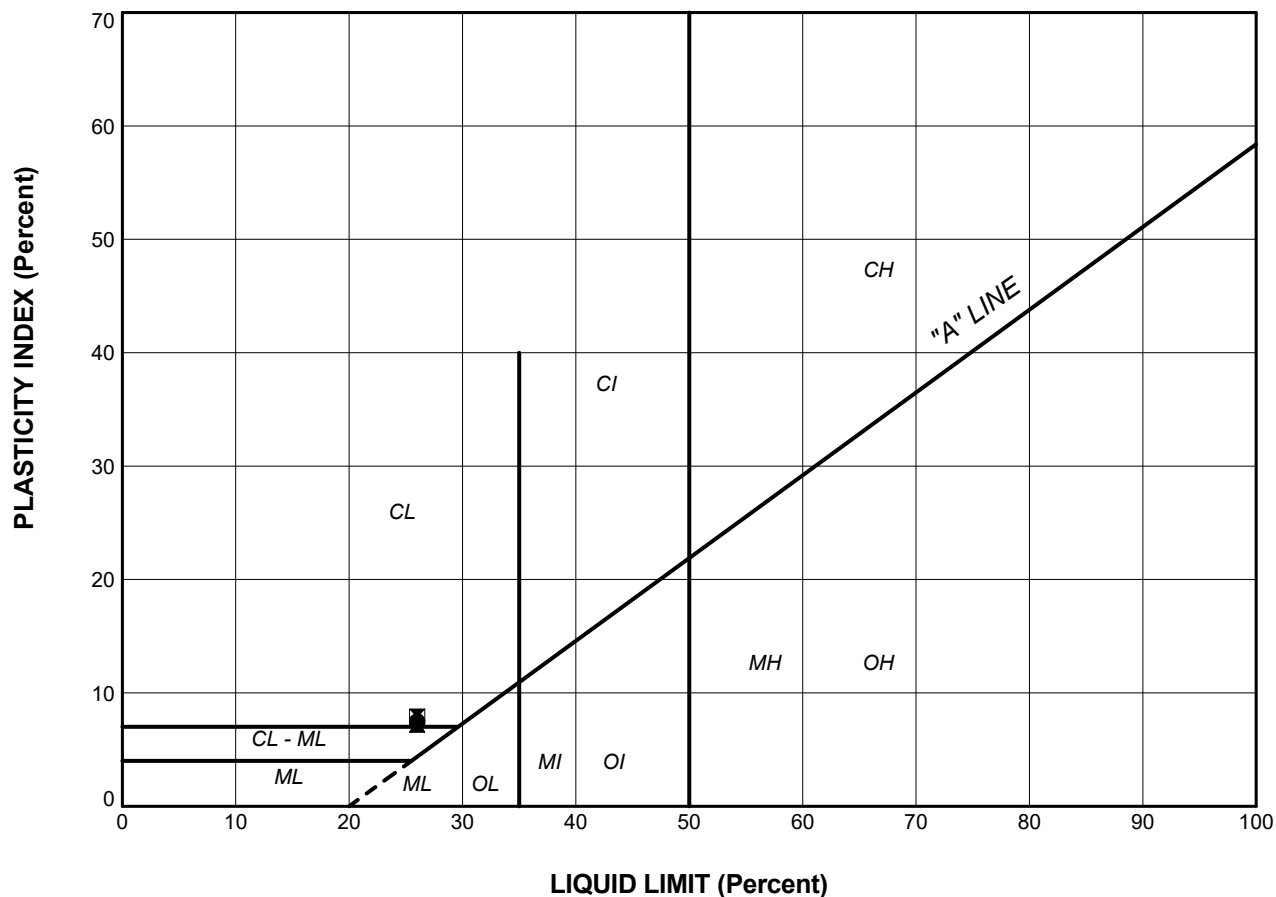
PROJECT						HIGHWAY 66 STATION 18+839 TOWNSHIP OF GAUTHIER CULVERT					
TITLE						GRAIN SIZE DISTRIBUTION CLAY and CLAYEY SILT, varved (Clayey Silt component)					
PROJECT No.			1896349			FILE No.			1896349.GPJ		
DRAWN	TR	Nov 2019	SCALE	N/A	REV.						
CHECK	AMP	Nov 2019									
APPR	JMAC	Nov 2019									
 GOLDER SUDBURY, ONTARIO						FIGURE B-2B					



LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	C263-1	9	47.1	21.8	25.3
⊠	C263-2	7	47.8	21.7	26.1
▲	C263-3	7	51.4	23.6	27.8
★	C263-4	4	46.0	22.0	24.0
⊙	C263-5	3	47.2	21.0	26.2

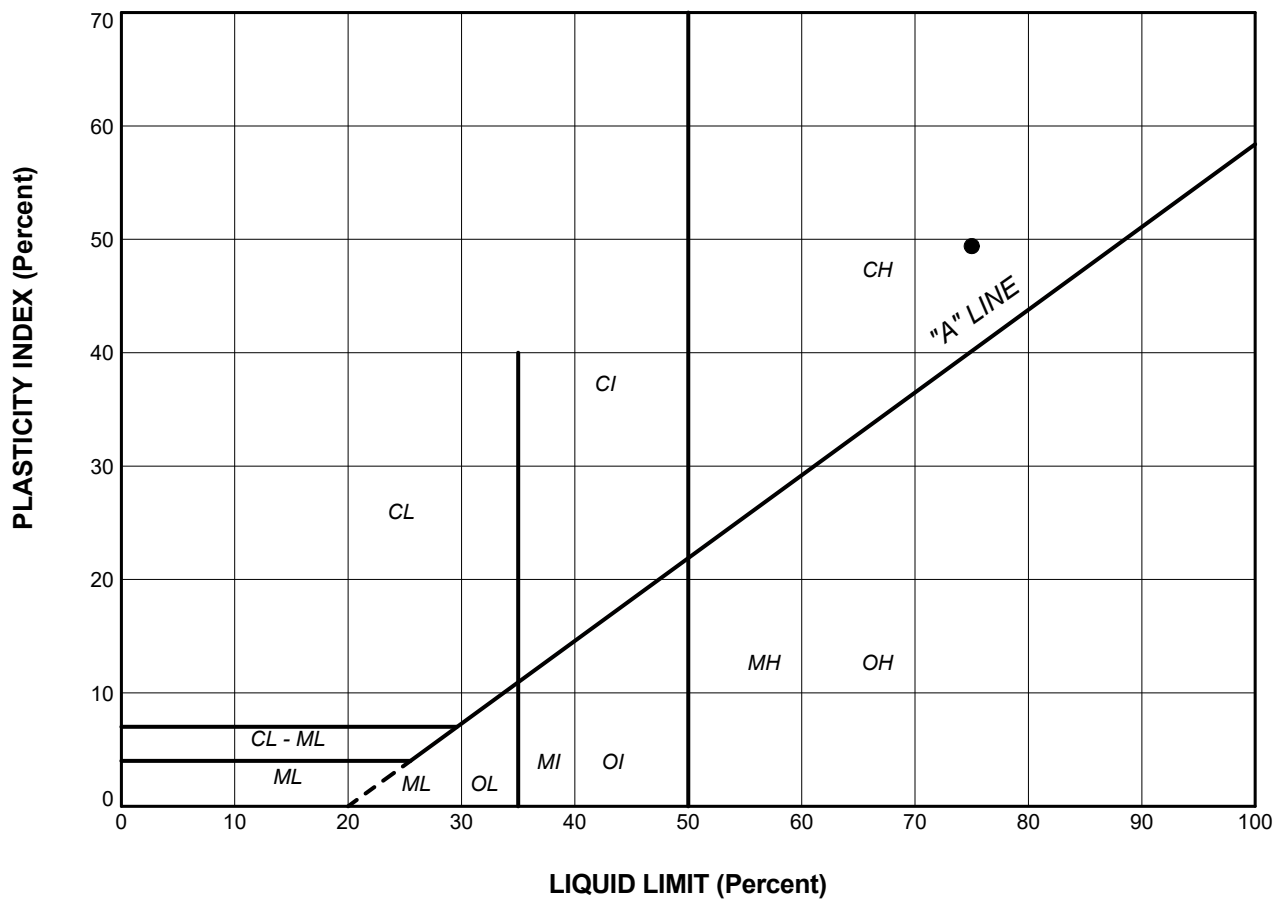
PROJECT						HIGHWAY 66 STATION 18+839 TOWNSHIP OF GAUTHIER CULVERT					
TITLE						PLASTICITY CHART CLAY and CLAYEY SILT, varved (Combined Clay and Clayey Silt components)					
PROJECT No.			1896349			FILE No.			1896349.GPJ		
DRAWN	TR	Nov 2019	CHECK	AMP	Nov 2019	SCALE	N/A	REV.			
APPR	JMAC	Nov 2019				FIGUREB-3A					
GOLDER SUDBURY, ONTARIO											



LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	C263-1	12	26.0	18.5	7.5
⊠	C263-2	10	26.0	18.1	7.9
▲	C263-4	5A	26.0	18.9	7.1

PROJECT		HIGHWAY 66 STATION 18+839 TOWNSHIP OF GAUTHIER CULVERT			
TITLE		PLASTICITY CHART CLAY and CLAYEY SILT, varved (Clayey Silt component)			
PROJECT No.		1896349		FILE No.	
DRAWN		TR		Nov 2019	
CHECK		AMP		Nov 2019	
APPR		JMAC		Nov 2019	
GOLDER		SUDBURY, ONTARIO		SCALE N/A REV. FIGUREB-3B	



PROJECT						HIGHWAY 66 STATION 18+839 TOWNSHIP OF GAUTHIER CULVERT					
TITLE						PLASTICITY CHART CLAY and CLAYEY SILT, varved (Clay component)					
PROJECT No.			1896349			FILE No.			1896349.GPJ		
DRAWN	TR	Nov 2019	SCALE		N/A	REV.					
CHECK	AMP	Nov 2019									
APPR	JMAC	Nov 2019									



GOLDER

SUDBURY, ONTARIO

FIGUREB-3C

CONSOLIDATION TEST SUMMARY

FIGURE B-4

Pg. 1 of 4

SAMPLE IDENTIFICATION

Project Number	1896349-2100	Sample Number	5
Borehole Number	C263-4	Sample Depth, m	4.9

TEST CONDITIONS

Test Method	B	Load Duration, hr	24
Oedometer Number	2	Load Increment Ratio	1
Date Started	June 27, 2019		
Date Completed	July 9, 2019		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.53	Unit Weight, kN/m ³	17.91
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m ³	13.02
Area, cm ²	31.67	Specific Gravity, measured	2.729
Volume, cm ³	80.09	Solids Height, cm	1.231
Water Content, %	37.49	Volume of Solids, cm ³	38.98
Wet Mass, g	146.25	Volume of Voids, cm ³	41.11
Dry Mass, g	106.37	Degree of Saturation, %	97.0

TEST COMPUTATIONS

Stress	End of Primary Deformation ¹	Specimen Height ²	End of Primary Void Ratio ³	Average Height	Time ¹	Coefficient of Consolidation	Modulus of Volume Compressibility	Hydraulic Conductivity ⁴	Total Work
σ_v'	ΔH_{EOP}	H_{EOI}	e_{EOP}	$(H_p + H_{EOI})/2$	t_{90}	c_v	m_v	k_v	w
kPa	mm	cm		cm	sec	cm ² /s	m ² /kN	cm/s	kJ/m ³
0	0.00	2.529	1.055	2.529					
9	0.05	2.518	1.051	2.524	60	2.25E-02	2.30E-04	5.07E-07	0
17	0.03	2.511	1.044	2.514	540	2.48E-03	4.08E-04	9.93E-08	0
34	0.03	2.499	1.038	2.505	60	2.22E-02	1.73E-04	3.75E-07	0
68	0.07	2.476	1.025	2.487	118	1.12E-02	1.86E-04	2.03E-07	0
137	0.18	2.419	0.997	2.447	135	9.41E-03	1.94E-04	1.79E-07	2
273	0.66	2.283	0.912	2.351	265	4.43E-03	3.06E-04	1.33E-07	11
545	0.59	2.189	0.807	2.236	265	4.01E-03	1.87E-04	7.35E-08	33
1091	0.44	2.113	0.742	2.151	101	9.67E-03	5.74E-05	5.44E-08	62
545	-0.07	2.117	0.720	2.115					
137	-0.16	2.128	0.729	2.123					
34	-0.17	2.140	0.738	2.134					
9	-0.13	2.149	0.746	2.144					

Note:

¹ Root Time Method (Taylor, 1942).

² Specimen height corrected for apparatus deformation and presented for end of increment.

³ Void ratio for unloading (i.e. rebound) calculated for the end of increment.

⁴ Hydraulic conductivity calculated using coefficient of consolidation based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	2.15	Unit Weight, kN/m ³	19.60
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m ³	15.33
Area, cm ²	31.67	Specific Gravity, measured	2.729
Volume, cm ³	68.05	Solids Height, cm	1.231
Water Content, %	27.86	Volume of Solids, cm ³	38.98
Wet Mass, g	136.01	Volume of Voids, cm ³	29.07
Dry Mass, g	106.37		



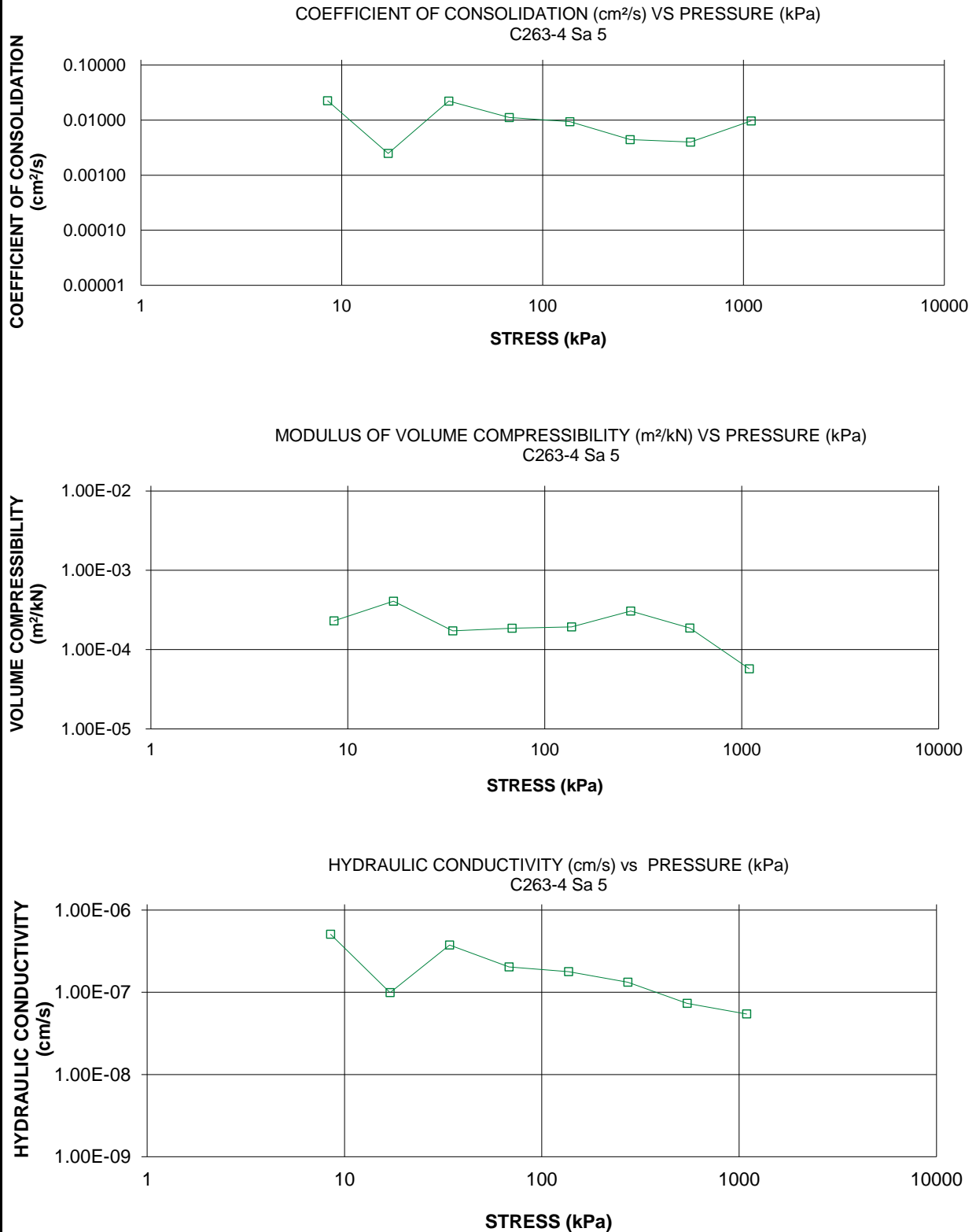
Prepared By: TG

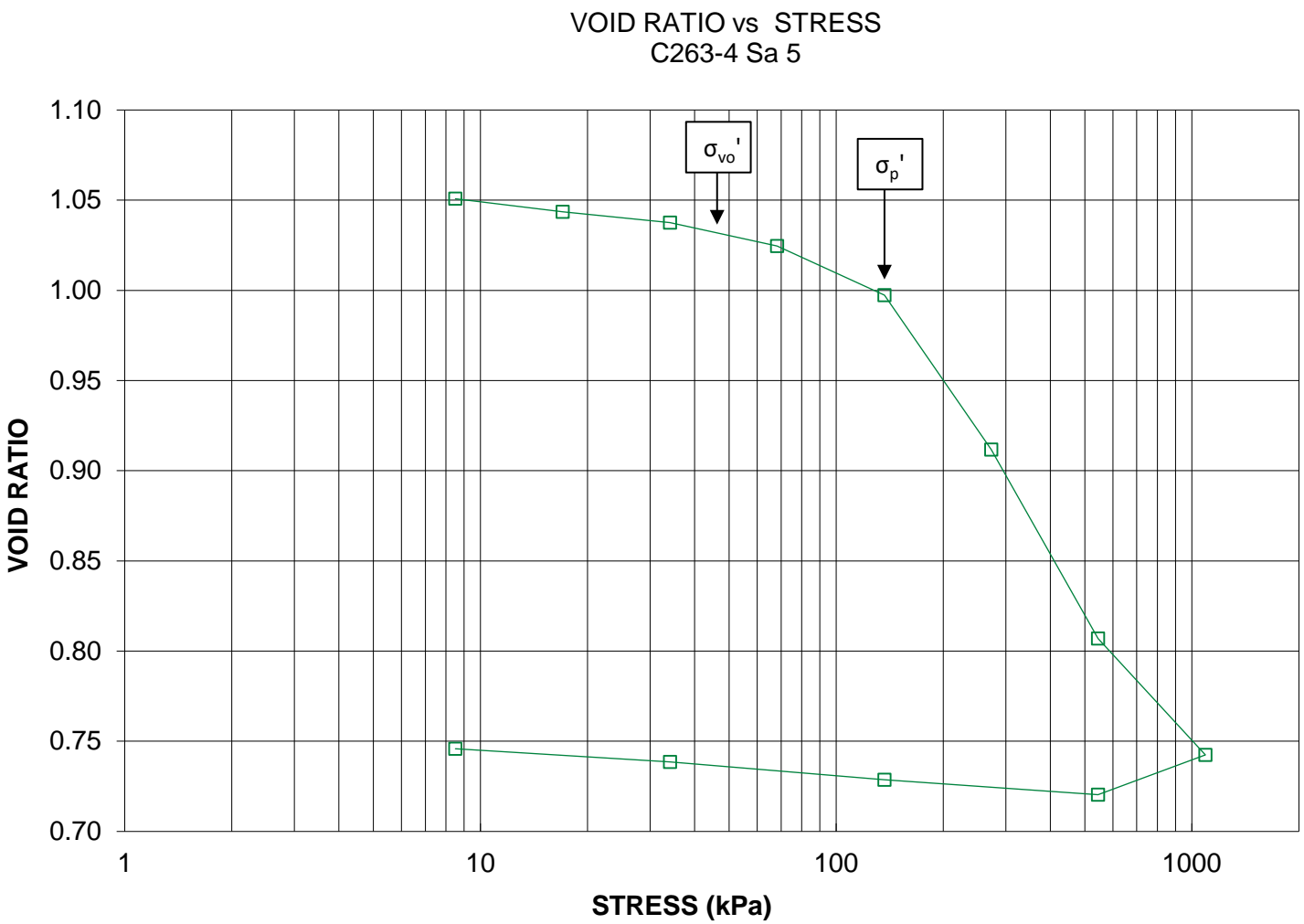
Checked By: AB

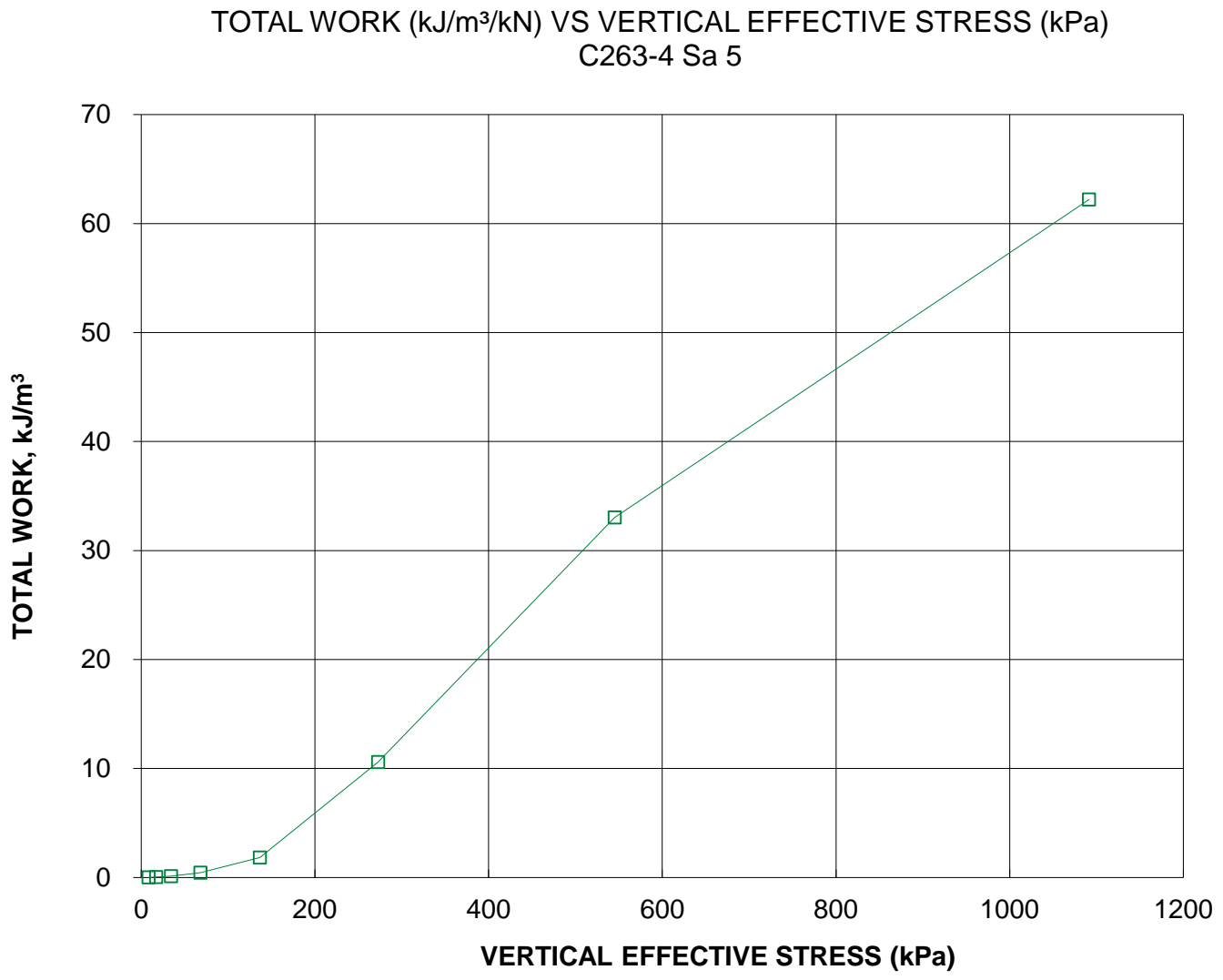
CONSOLIDATION TEST SUMMARY

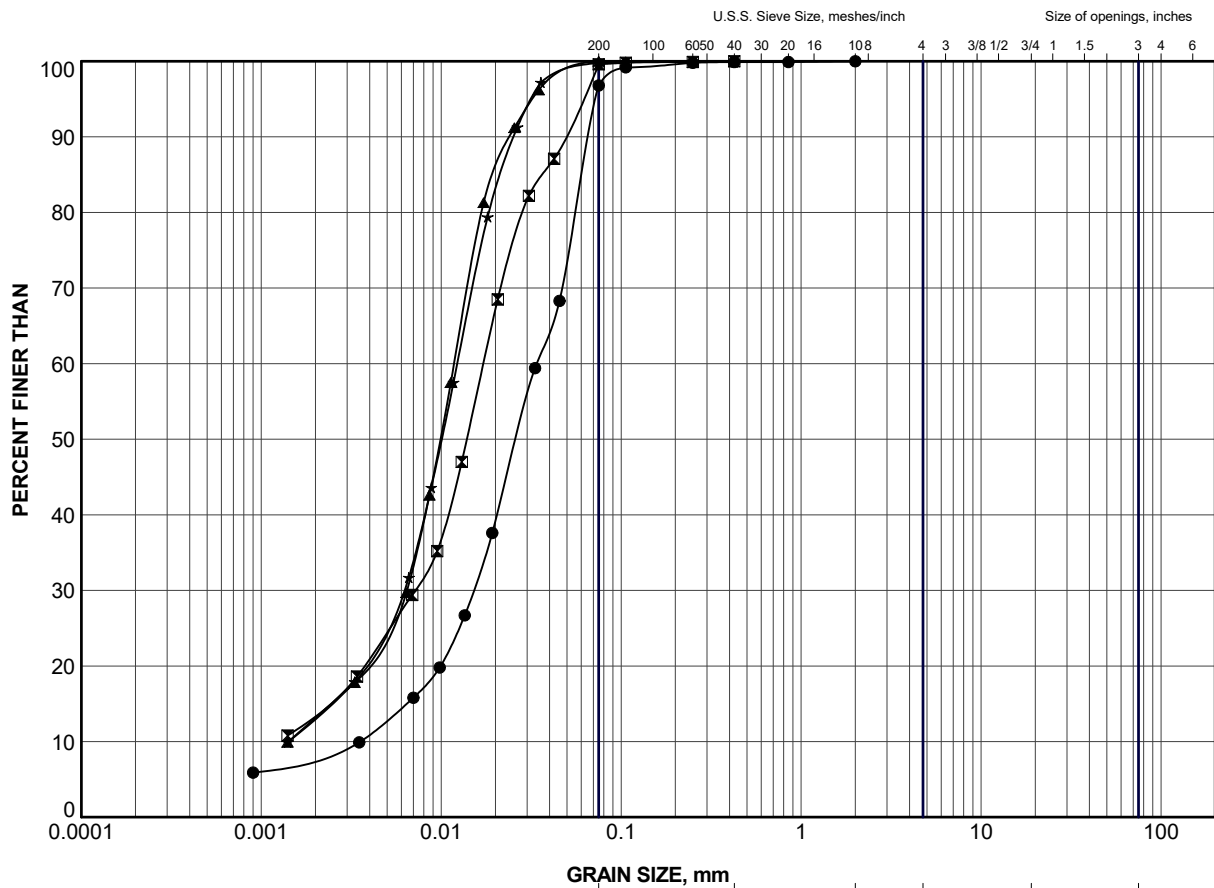
FIGURE B-4

Pg. 2 of 4








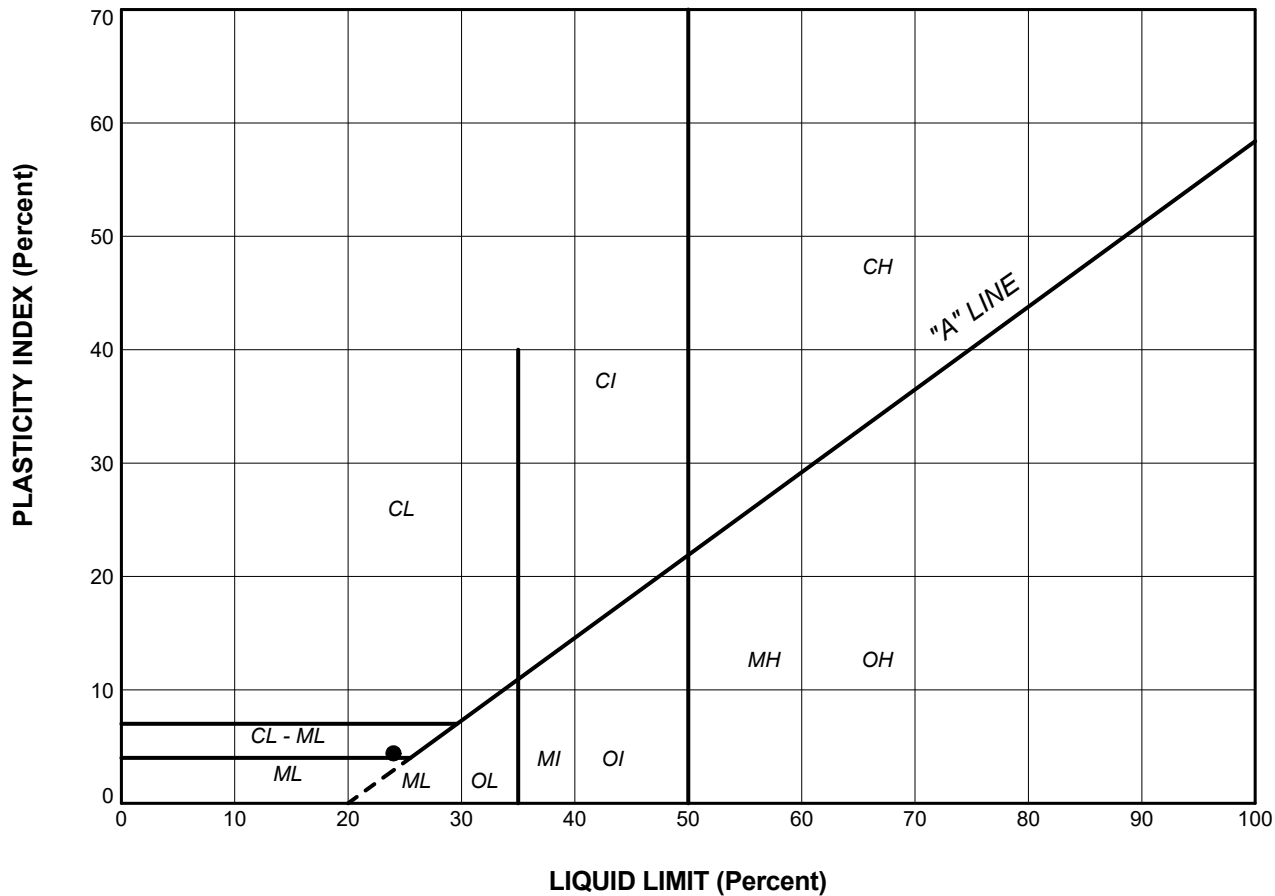


GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C263-1	15	264.6
⊠	C263-3	11	267.9
▲	C263-4	7	268.3
★	C263-5	6	268.3

PROJECT		HIGHWAY 66 STATION 18+839 TOWNSHIP OF GAUTHIER CULVERT			
TITLE		GRAIN SIZE DISTRIBUTION SILT			
PROJECT No.		1896349		FILE No. 1896349.GPJ	
DRAWN	TR	Nov 2019		SCALE	N/A
CHECK	AMP	Nov 2019		REV.	
APPR	JMAC	Nov 2019		FIGURE B-5	
 GOLDER SUDBURY, ONTARIO					



SOIL TYPE
 C = Clay
 M = Silt
 O = Organic

PLASTICITY
 L = Low
 I = Intermediate
 H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	C263-5	6	24.0	19.6	4.4

PROJECT						HIGHWAY 66 STATION 18+839 TOWNSHIP OF GAUTHIER CULVERT					
TITLE						PLASTICITY CHART SILT					
PROJECT No.			1896349			FILE No.			1896349.GPJ		
DRAWN	TR	Nov 2019	SCALE		N/A	REV.					
CHECK	AMP	Nov 2019									
APPR	JMAC	Nov 2019									



GOLDER

SUDBURY, ONTARIO

FIGURE B-6



BUREAU
VERITAS

BV Labs Job #: B9D3975
Report Date: 2019/06/03

Golder Associates Ltd
Client Project #: 1896349(2100)
Site Location: HWY 66
Sampler Initials: MR

RESULTS OF ANALYSES OF SOIL

BV Labs ID		JTI430			JTI430		JTI431	JTI432		
Sampling Date		2019/04/30 10:30			2019/04/30 10:30		2019/05/01 16:15	2019/05/03 10:45		
COC Number		127611			127611		127611	127611		
	UNITS	C263-1	RDL	QC Batch	C263-1 Lab-Dup	QC Batch	C260-1	C236-1	RDL	QC Batch
CONVENTIONALS										
Sulphide	ug/g	<0.30	0.30	6150574			<0.30	0.84	0.30	6150574
Calculated Parameters										
Resistivity	ohm-cm	2700		6129977			4000	2400		6129977
Inorganics										
Soluble (20:1) Chloride (Cl-)	ug/g	120	20	6133046			61	260	20	6133046
Conductivity	umho/cm	366	2	6135430			252	413	2	6135430
Available (CaCl2) pH	pH	7.95		6133358	8.09	6133358	8.05	6.31		6133358
Soluble (20:1) Sulphate (SO4)	ug/g	<20	20	6133048			<20	<20	20	6133048
Physical Testing										
Moisture-Subcontracted	%	33	0.30	6150575			31	15	0.30	6150575
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate										



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