FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 2020-5160

REPORT NO. 3

Ministry Of Transportation

Ontario

FOUNDATION INVESTIGATION REPORT

Highway 66, Station 12+420, Township of Lebel
Culvert Replacement
Ministry of Transportation, Ontario
GWP 5210-14-00

Submitted to:

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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 about Station 12+420, in the Township of Lebel, District of Timiskaming, Ontario, approximately 10.5 km northwest of the intersection with Crystal Beach Road. 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 the 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 from north to south, discharging into Gull Lake.

The existing culvert is comprised of a 1300 mm wide by 700 mm high Creosote Timber Culvert (CTC) southern (outlet) 20.7 m long section and a 1000 mm diameter corrugated steel pipe (CSP) northern (inlet) 16.4 m long section. The culvert inlet (north end) and outlet (south end) inverts are approximate Elevations 320.4 m and 320.0 m, respectively. In general, the topography to the north of the culvert consists of forested hills and bedrock outcrops, and Gull Lake south of the culvert. At the time of subsurface exploration field work in May 2019, the culvert outlet was submerged.

The culvert site is located near the northwest side of the Gull Lake, approximate 2.0 km from the Trans Canada trail crossing Highway 66, and the highway grade at the culvert centreline is approximately Elevation 322.2 m. The thickness of the soil cover over the CSP and the CTC sections of the culvert is about 0.5 m and 1.3 m, respectively. The existing north side slope of the embankment at the culvert location is inclined at about 1.7 Horizontal to 1 Vertical (1.7H:1V) and the embankment is about 1.5 m high relative to the culvert invert at the inlet and about 2.0 m high at the outlet. The existing south side slope of the embankment at the culvert location inclined at about 2H:1V and the embankment is about 2.0 m high relative to the culvert invert at the outlet. The embankment/side slopes appear to be performing well, with no visible signs of slope instability or roadway settlement issues, but a longitudinal crack of the roadway pavement extends along the eastbound lane over and to both sides of the culvert. The ground surface conditions at select locations near the culvert are shown on Photographs 1 to 4.

3.0 INVESTIGATION PROCEDURES

Field work for this subsurface exploration was carried out on December 12, 2018, and May 8, 2019, during which time three boreholes, designated as Boreholes C209-1 to C209-3, were advanced at the approximate locations shown on Drawing 1. Boreholes C209-1 and C209-2 were advanced through the roadway near the north and south shoulders, respectively, and Borehole C209-3 was advanced near the toe of the north side slope of the bypass road adjacent to the culvert inlet. All boreholes were advanced using a rubber tire CME-550 Buggy drilling 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.

Borehole C209-1 was originally advanced through the roadway using 108 mm I.D. Hollow Stem Augers to a depth of 2.2 m below the roadway surface, at which depth it encountered refusal to further auger advancement and was advanced by NW casing with wash boring techniques, and NQ coring. The borehole was re-located to 0.5 m north and 0.5 m east of the original location and drilled to a depth of 10.2 m below ground surface to refusal on bedrock and the bedrock was cored. Boreholes C209-2 and C209-3 were advanced using NW casing with wash boring techniques, and NQ coring. Water for the wash boring and coring operations was obtained from the adjacent creek or Gull Lake.

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 a full weight automatic 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 the undrained shear strength, in accordance with Standard Test Method for Field Vane Shear Test (ASTM 2573) using an MTO standard "N"-size vane. The groundwater level in the casing was observed and recorded after the completion of bedrock coring operations and in the open borehole upon removal of the casing. The bedrock cored length of the boreholes was backfilled with bentonite pellets to the bedrock surface and the remainder of the borehole was backfilled in accordance with Ontario Regulation 903 (wells), as amended. The roadway pavement at Boreholes C209-1 and C209-2 was capped at ground 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, coring, and sampling operations; logged the boreholes; and examined the soil samples and bedrock cores. 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, Atterberg Limits, and organic content 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 from Borehole C209-1 was submitted to Bureau Veritas Laboratories (formerly Maxxam) of Sudbury, an accredited analytical laboratory, for testing a suite of corrosivity indicator parameters.

The as-drilled borehole locations were measured by a member of our technical staff relative to highway chainages/station marked on the pavement and converted into northing/easting coordinates on the plan drawing. The ground surface elevation at the borehole locations was surveyed by Golder, relative to the highway and culvert centreline, with the elevation of the centreline was 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 record of borehole sheets in Appendix A and summarized below.

Borehole No.	MTM NAD 83 Northing (m) (Latitude)	MTM NAD 83 Easting (m) (Longitude)	Ground Surface Elevation (m)	Borehole Depth (m)
C209-1	5,336,586.7 (48.163704)	379,758.3 (-79.992244)	322.2	13.2*
C209-2	5,336,578.3 (48.163631)	379,749.2 (-79.992367)	322.1	13.5*
C209-3	5,336,603.3 (48.163855)	379,747.7 (-79.992383)	321.1	4.3*

*Including bedrock coring for lengths of 3.0 m, 3.0 m and 3.2 m, in the respective boreholes.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on Northern Ontario Engineering Geology Terrain Study (NOEGTS)[1] mapping, the subsoils in the vicinity of the culvert site are glacially derived ground moraine comprising primarily of till.

Based on geological mapping (MNDM)[2], the site is underlain by coarse clastic metasedimentary rocks and/or diorite monzondiorite granodiorite suite (diorite) 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 undrained 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 profile 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.

[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

4.2.1 Asphalt/Fill

An approximately 100 mm to 120 mm thick layer of asphalt pavement was encountered in Boreholes C209-1 and C209-2, at Elevations 322.2 m and 322.1 m, respectively. A 2.3 m to 3.6 m thick layer of embankment fill consisting of an upper 0.6 m thick layer of sand and gravel underlain by a layers of sand to gravelly sand to sand and gravel, and a layer of organic silty sand at Borehole C209-1, was encountered below the asphalt in Boreholes C209-1 and C209-2.

Cobbles ranging in size from 100 mm to 300 mm were encountered within the lower fill layer in Boreholes C209-1 and C209-2; and a 400 mm boulder was encountered within the lower fill layer in Borehole C209-1.

The SPT “N”-values measured within the sand to sand and gravel to gravel fill range between 29 blows to 80 blows per 0.3 m of penetration, indicating a compact to very dense compactness condition. One SPT “N”-value of 5 blows per 0.3 m penetration was measured in the organic silty sand fill layer indicating a loose compactness condition.

The natural moisture content measured on one sample of organic silty sand fill layer in Borehole C209-1 is about 40 per cent and an organic content test carried out on the same sample measured 5.6 per cent organic content.

4.2.2 Topsoil

A 0.7 m thick layer of clayey silt topsoil was encountered at ground surface in Borehole C209-3 at Elevation 321.1 m. An SPT “N”-value of 3 blows per 0.3 m penetration was recorded within the topsoil, indicating a very soft consistency.

4.2.3 Silt and Sand to Sandy Silt and Gravel

A 0.8 m and 2.1 m thick layer of silt and sand was encountered below the fill in Boreholes C209-1 and C209-2 at Elevations 318.5 m and 319.7 m, respectively. A 0.5 m thick layer of sandy silt and gravel was encountered below the topsoil layer in Borehole C209-3 at Elevation 320.4 m.

The SPT “N”-values measured within the silt and sand deposit range from 0 blows (i.e., weight of hammer - WH) to 42 blows per 0.3 m of penetration, indicating that the deposit has a very loose to dense compactness condition. An SPT “N”- value measured within the sandy sit and gravel layer in Borehole C209-3 is 115 blows for 0.18 m of penetration and is likely influenced by the underlying bedrock.

Grain size distribution testing was carried out on three samples of the silt and sand deposit and sandy silt and gravel layer and the results are presented on Figures B-1A and B-1B in Appendix B. The natural moisture content measured on two samples of the silt and sand deposit is about 19 per cent to 28 per cent and one sample of the sandy silt and gravel is about 14 per cent. An Atterberg limits test carried out on one sample of the silt and sand deposit recorded a non-plastic result.

4.2.4 Clayey Silt

A 3.1 m and 3.0 m thick deposit of clayey silt was encountered in Boreholes C209-1 and C209-2 at approximately Elevations 317.7 m and 317.6 m, respectively.

The SPT “N”-values measured within the deposit range between 1 blow and 3 blows per 0.3 m of penetration. In situ field vane tests carried out with this deposit measured undrained shear strengths ranging from about 24 kPa to 38 kPa, with sensitivity values of 2 to 4. The SPT “N”- values together with in-situ undrained shear strength suggest that the deposit has a soft to firm consistency. The natural moisture content measured on three samples of the deposit ranges from about 30 per cent to 40 per cent.

Grain size distribution testing was carried out on one sample of the clayey silt deposit and the result is presented on Figure B-2 in Appendix B. Atterberg limits testing was carried out on two samples of clayey silt and measured liquid limits of about 30 per cent and 32 per cent, plastic limits of about 19 per cent and 20 per cent and plasticity indices of 11 per cent and 12 per cent. The Atterberg limits test results are presented on Figure B-3 in Appendix B and indicate that the material is a clayey silt of low plasticity.

4.2.5 Silt

A 0.6 m and 1.0 m thick deposit of silt was encountered underlying the clayey silt deposit in Boreholes C209-1 and C209-2, respectively, at approximately Elevation 314.6 m.

The SPT “N”-values measured within this deposit are 15 blows and 34 blows per 0.3 m of penetration, indicating a compact to dense compactness condition.

4.2.6 Till

A 2.0 m thick deposit of till comprised of non-cohesive silty sand, trace to some gravel was encountered underlying the silt deposit in Boreholes C209-1 and C209-2 at approximately Elevations 314.0 m and 313.6 m, respectively. Cobbles of 100 mm and 200 mm in diameter were encountered within the till deposit at depths of 9.4 m and 8.5 m (Elevations 312.8 m and 313.6 m) in Boreholes C209-1 and C209-2, respectively.

Two SPT “N”-values measured within the till deposit are 20 blows and 53 blows per 0.3 m of penetration indicating a compact to very dense compactness condition.

4.2.6 Bedrock

Bedrock was encountered in Boreholes C209-1 to C209-3 at depths ranging from 1.1 m to 10.5 m below existing ground surface (between Elevations 320.0 m and 311.6 m), and was cored for lengths between 3.0 m and 3.2 m.

The retrieved bedrock cores are described as very fine to fine grained, fresh to slightly weathered, grey metasedimentary / metasedimentary conglomerate, as described on the Record of Drillholes presented in Appendix A. Photographs of the retrieved bedrock core samples are shown on Figures B-4A and B-4B in Appendix B. The Total Core Recovery (TCR) of the bedrock samples ranges from 97 per cent to 100 per cent and the Solid Core Recovery (SCR) ranges from 85 per cent to 100 per cent. The Rock Quality Designation (RQD) of the bedrock core samples ranges between 70 per cent and 100 per cent and based on the Classification of Rock with respect to RQD in Table 3.10 of CFEM (2006)[3], the bedrock is considered of fair to excellent quality.

[3] Canadian Geotechnical Society. 2006. Canadian Foundation Engineering Manual, 4th Edition.

4.3 Groundwater Conditions

The unstabilized groundwater levels, relative to the creek and ground surface measured in the open boreholes upon removal of or within the casing are summarized below. The water level of Gull Lake surveyed by Callon Dietz in June 2019 was approximately Elevation 320.4 m. Groundwater and creek / Lake water levels in the area are subject to seasonal fluctuations and variations due to precipitation events.

Borehole No.	Depth to Unstabilized Groundwater Level below ground surface (m)	Approximate Groundwater Elevation (m)
C209-1	1.5 (Open Borehole)	320.7
C209-2	1.3 (Open Borehole)	320.8
C209-3	Ground Surface (Inside casing)	321.1

4.4 Analytical Laboratory Testing Results

A sample of gravelly sand to sand and gravel fill recovered from Borehole C209-1 was submitted to Bureau Veritas Laboratories for analysis of parameters used to assess the potential corrosivity of the site soil to steel and concrete. The analytical laboratory test results are summarized below, and the detailed analytical laboratory test results are included in Appendix B.

Borehole No.	Sample No.	Depth (m)	Parameters					
			Resistivity (ohm-cm)	Electrical Conductivity (µmho/cm)	Soluble Sulphate (SO4) Content (µg/g)	Chloride (Cl) Content (µg/g)	Sulphide (µg/g)	pH
C209-1	SA1	0.76 – 1.37	2,300	443	<20[1]	220	1.49	6.65

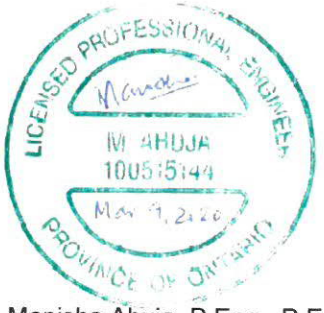
Note:
1. The sulphate concentration is below the reportable detection limit of 20 µg/g.

5.0 CLOSURE

The field drilling program was carried out under the supervision of Mr. Yusuf Soliman, under the overall direction of Mr. André Bom, P.Eng., an Associate of Golder. This Foundation Investigation Report was prepared by Ms. Manisha Ahuja, P.Eng., P.E. and Ms. Sarah Poot, P.Eng., a senior geotechnical engineer with Golder, carried out 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

Golder Associates Ltd.



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Senior Geotechnical Engineer, Associate

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

MA/SEMP/JMAC/ca

MINISTRY OF TRANSPORTATION, ONTARIO

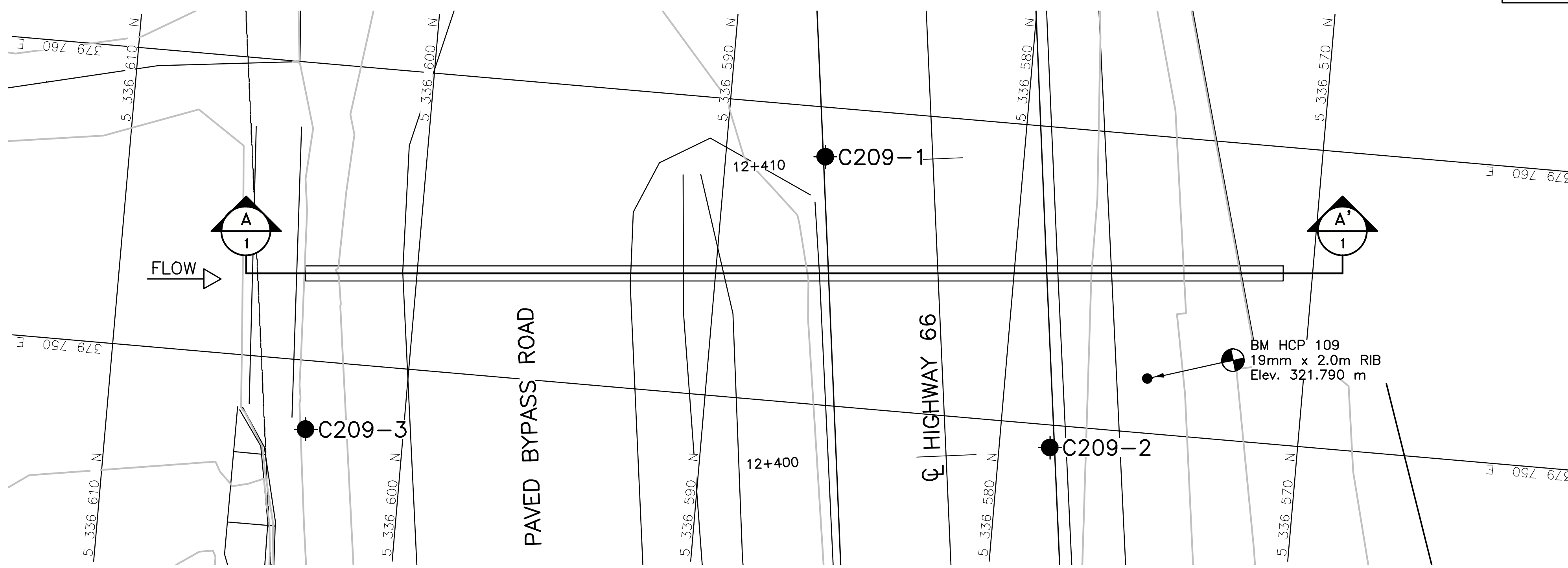
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 5210-14-00

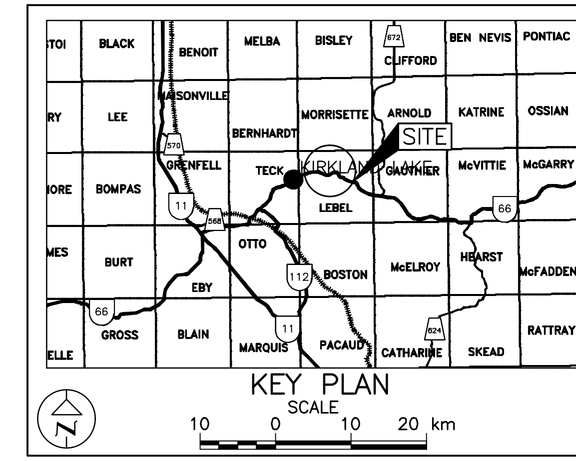
SHEET

HIGHWAY 66
STATION 12+420
TOWNSHIP OF LEBEL CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA

GOLDER



PLAN
SCALE
2 0 2 4 m

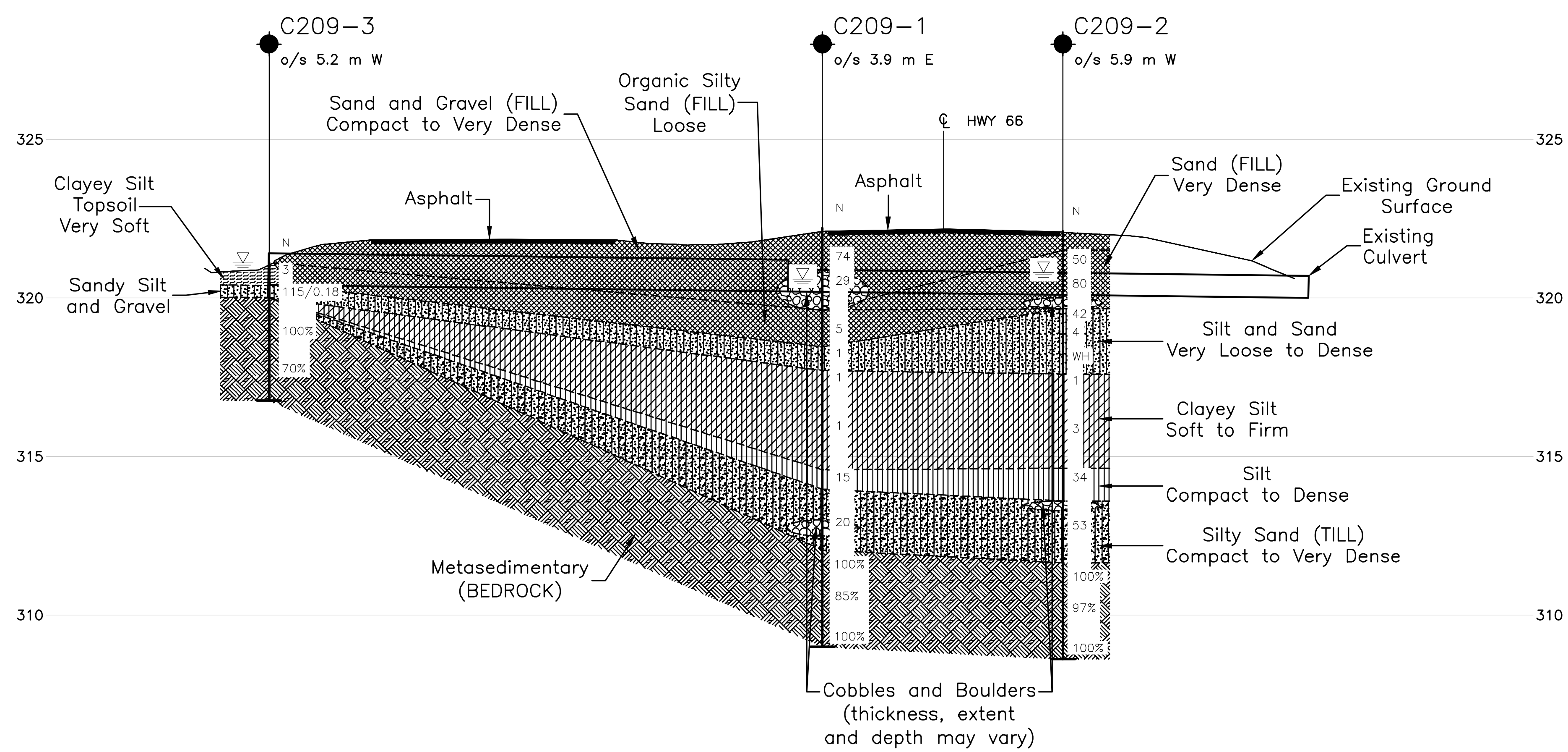


LEGEND

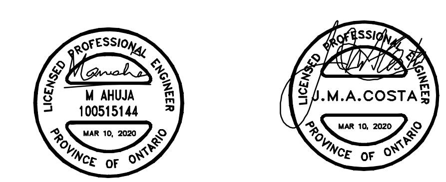
●	Borehole – Current Investigation
N	Standard Penetration Test Value
16	Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
100%	Rock Quality Designation (RQD)
▽	WL upon completion of drilling

BOREHOLE CO-ORDINATES (NAD 83 MTM ZONE 12)

No.	ELEVATION	NORTHING	EASTING
C209-1	322.2	5336586.7	379758.3
C209-2	322.1	5336578.3	379749.2
C209-3	321.1	5336603.3	379747.7



A-A'
1
CULVERT CENTERLINE PROFILE
HORIZONTAL SCALE
2 0 2 4 m
2 0 2 4 m
VERTICAL SCALE



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.

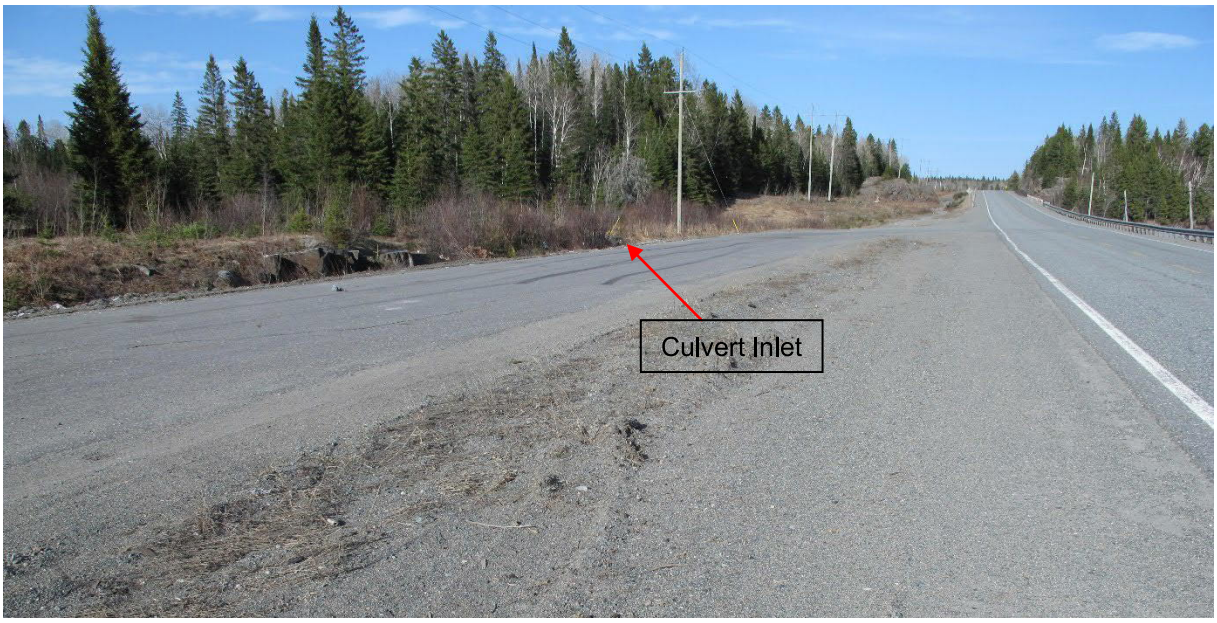
REFERENCE
Base plans provided in digital format by CALLON DIETZ LTD. drawing file no. gwp52101400a.gwp, received AUGUST 14, 2019.

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 32D-32

HWY. 66	PROJECT NO. 1896349		DIST.
SUBM'D.	CHKD. TB	DATE: 3/10/2020	SITE:
DRAWN: TR	CHKD. MA/AB	APPD. JMAC	DWG. 1

PLOT DATE: March 10, 2020



Photograph 1: Bypass Road Along North Side of Highway 66 Near Culvert Inlet – Looking East (May 2018)

Photograph 2: South End (Outlet) of Culvert – Gull Lake (May 2018)

Photograph 3: North End (Inlet) of Culvert (May 2019)

Photograph 4: Borehole C209-2, South Edge of Highway 66 EBL Near Culvert Outlet (May 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.e.,* SAND and gravel)
> 20 to 35	Primary soil name prefixed with "gravelly, sandy" as applicable
> 10 to 20	some (*i.e.,* some sand)
≤ 10	trace (*i.e.,* 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 cm^2 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, Gs)
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)
γ	unit weight

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

COARSE-GRAINED SOILS

Compactness[1]

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 grainsize. 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.

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
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma$ - u)
σ'_{vo}	initial effective overburden stress
σ_1, σ_2, σ_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 = σ'_p / σ'_{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 δ
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 $\tau = c' + \sigma' \tan \phi'$
2 shear strength = (compressive strength)/2

WEATHERINGS STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^{o} angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN	Joint	PL	Planar
FLT	Fault	CU	Curved
SH	Shear	UN	Undulating
VN	Vein	IR	Irregular
FR	Fracture	K	Slickensided
SY	Stylolite	PO	Polished
BD	Bedding	SM	Smooth
FO	Foliation	SR	Slightly Rough
CO	Contact	RO	Rough
AXJ	Axial Joint	VR	Very Rough
KV	Karstic Void		
MB	Mechanical Break		

GOLDER

RECORD OF BOREHOLE No C209-1

1 OF 2 **METRIC**

PROJECT 1896349
G.W.P. 5210-14-00
DIST ____ HWY 66
DATUM GEODETIC

LOCATION N 5336586.7; E 379758.3 NAD83 MTM ZONE 12 (LAT. 48.163704; LONG. -79.992244)
BOREHOLE TYPE NW Casing, Wash Boring and NQ Coring
DATE December 12, 2018

ORIGINATED BY MR
COMPILED BY TR
CHECKED BY AB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
322.2	GROUND SURFACE							
0.0	ASPHALT (100 mm)							
0.1	Sand and gravel (FILL) Brown Frozen							
321.6								
0.6	Gravelly sand to sand and gravel (FILL) Compact to very dense Brown to orange brown Frozen to wet		1	SS	74			
	Cobbles encountered as follows: Depth (m) Size (mm) 1.4 100 1.5 130 1.9 180		2	SS	29			
			-	RC	-			
319.6	- 400 mm diameter boulder encountered from 2.2 m to 2.6 m depth.							
2.6	Organic silty sand (FILL) Loose Grey Wet		3	SS	5		OC=5.6%	
318.5								
3.7	SILT and SAND, some clay, trace organics Very Loose Grey Wet		4	SS	1		NP	0 35 48 17
317.7								
4.5	CLAYEY SILT, with silt laminations Soft Grey Wet		5	SS	1			
			6	SS	1			
314.6								
7.6	SILT, trace gravel, trace sand Compact Grey Wet		7	SS	15			
314.0								
8.2	Silty SAND, trace gravel (TILL) Compact Grey Wet							
	Cobble encountered as follows: Depth (m) Size (mm) 9.4 100		8	SS	20			
312.0								
10.2	Metasedimentary (BEDROCK) For coring details see Record of Drillhole C209-1.		1	RC	REC 100%			RQD = 100%
			2	RC	REC 100%			RQD = 85%
			3	RC				RQD = 100%

ELEVATION SCALE: 322, 321, 320, 319, 318, 317, 316, 315, 314, 313, 312, 311

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
20 40 60

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

Continued Next Page

GOLDER

RECORD OF BOREHOLE No C209-1

2 OF 2 **METRIC**

PROJECT 1896349
G.W.P. 5210-14-00
DIST HWY 66
DATUM GEODETIC

LOCATION N 5336586.7; E 379758.3 NAD83 MTM ZONE 12 (LAT. 48.163704; LONG. -79.992244)
BOREHOLE TYPE NW Casing, Wash Boring and NQ Coring
DATE December 12, 2018

ORIGINATED BY MR
COMPILED BY TR
CHECKED BY AB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
	Metasedimentary (BEDROCK) For coring details see Record of Drillhole C209-1.		3	RC	REC 100%		310				RQD = 100%
309.0											
13.2	END OF BOREHOLE NOTES: 1. Auger refusal at a depth of 2.2 m below ground surface (Elev. 320.0 m). Relocated borehole 0.5 m North and 0.5 m East and advanced borehole using NW casing. 2. Water level measured at a depth of 1.6 m below ground surface (Elev. 320.6 m) upon completion of coring and at a depth of 1.5 m below ground surface (Elev. 320.7 m) upon removal of casing.						309				

$+^3, \times^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

PROJECT: 1896349

RECORD OF DRILLHOLE: C209-1

SHEET 1 OF 1

LOCATION: N 5336586.7; E 379758.3

NAD83 MTM ZONE 12 (LAT. 48.163704; LONG. -79.992244)

INCLINATION: -90° AZIMUTH: —

DRILLING DATE: December 12, 2018

DRILL RIG: CME550 Buggy

DRILLING CONTRACTOR: Landcore Drilling

DATUM: GEODETIC

JN - Joint; FLT - Fault; SHR - Shear; VN - Vein; CJ - Conjugate

BD - Bedding; FO - Foliation; CO - Contact; OR - Orthogonal; CL - Cleavage

PL - Planar; CU - Curved; UN - Undulating; ST - Stepped; IR - Irregular

PO - Polished; K - Slickensided; SM - Smooth; Ro - Rough; MB - Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR / % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	DISCONTINUITY DATA: Jr	DISCONTINUITY DATA: Ja	DISCONTINUITY DATA: Jn	HYDRAULIC CONDUCTIVITY k, cm/s	Diametral Point Load Index (MPa)	RMC -Q' AVG.
		GROUND SURFACE		312.0															
11	NW; NQ Coring; December 12, 2018	Metasedimentary Fresh to slightly weathered Grey Fine grained		10.2	1	Grey 100													
					2	Grey 100													
12												•	JNIRRo						
13				309.0	3	Grey 100													
		END OF DRILLHOLE		13.2															
14																			
15																			
16																			
17																			
18																			
19																			
20																			
21																			
22																			

DEPTH SCALE

1 : 60

GOLDER

LOGGED: MR

CHECKED: AB

SUD-MTO-RCK S:\CLIENTS\MTO\HWY65&66\02_DATA\GINT\1896349.GPJ GAL-MISS.GDT 12-16-19 TR

GOLDER

RECORD OF BOREHOLE No C209-2

1 OF 2 **METRIC**

PROJECT 1896349
G.W.P. 5210-14-00
DIST _____ HWY 66
DATUM GEODETIC
LOCATION N 5336578.3; E 379749.2 NAD83 MTM ZONE 12 (LAT. 48.163631; LONG. -79.992367)
BOREHOLE TYPE NW Casing, Wash Boring and NQ Coring
DATE May 8, 2019
ORIGINATED BY YS
COMPILED BY TR
CHECKED BY AB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
322.1	GROUND SURFACE							
0.0	ASPHALT (120 mm)						322	
0.1	Sand and gravel (FILL) Grey Moist							
321.5								
0.6	Sand, trace gravel to gravel, some sand (FILL) Dense to very dense Grey Moist to wet		1	SS	50	▽	321	
			2	SS	80			
	- 300 mm diameter boulder encountered from 2.1 m to 2.4 m depth		-	NQ	-		320	
319.7								
2.4	SILT and SAND, some clay Very loose to dense Grey Wet		3	SS	42			
			4	SS	4		319	0 45 42 13
			5	SS	WH			
317.6							318	
4.5	CLAYEY SILT, with silt laminations, trace sand Firm Grey Wet		6	SS	1			0 3 59 38
							317	
			7	SS	3		316	
314.6								
7.5	SILT Dense Grey Wet		8	SS	34		315	
313.6								
8.5	Silty SAND, some gravel (TILL) Very dense Grey Wet						314	
	- 200 mm diameter cobble encountered from 8.5 m to 8.7 m depth		9	SS	53		313	
311.6								
10.5	Metasedimentary (BEDROCK) For coring details see Record of Drillhole C209-2.		1	RC	REC 100%		312	RQD = 100%
			2	RC	REC 97%		311	RQD = 97%

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH kPa (20 40 60 80 100)
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (20 40 60)

UNIT WEIGHT γ kN/m³

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

Continued Next Page

GOLDER

PROJECT 1896349

RECORD OF BOREHOLE No C209-2

2 OF 2 **METRIC**

G.W.P. 5210-14-00 LOCATION N 5336578.3; E 379749.2 NAD83 MTM ZONE 12 (LAT. 48.163631; LONG. -79.992367) ORIGINATED BY YS

DIST HWY 66 BOREHOLE TYPE NW Casing, Wash Boring and NQ Coring COMPILED BY TR

DATUM GEODETIC DATE May 8, 2019 CHECKED BY AB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Metasedimentary (BEDROCK) For coring details see Record of Drillhole C209-2.		3	RC	REC 100%		310				RQD = 100%
308.6							309				
13.5	END OF BOREHOLE NOTE: 1. Water level measured at a depth of 1.1 m below ground surface (Elev. 321.0 m) upon completion of coring and at a depth of 1.3 m below ground surface (Elev. 320.8 m) upon removal of casing.										

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

PROJECT: 1896349

RECORD OF DRILLHOLE: C209-2

SHEET 1 OF 1

LOCATION: N 5336578.3; E 379749.2

NAD83 MTM ZONE 12 (LAT. 48.163631; LONG. -79.992367)

INCLINATION: -90° AZIMUTH: —

DRILLING DATE: May 8, 2019

DRILL RIG: CME550 Buggy

DRILLING CONTRACTOR: Landcore Drilling

DATUM: GEODETIC

JN - Joint; FLT - Fault; SHR - Shear; VN - Vein; CJ - Conjugate
BD - Bedding; FO - Foliation; CO - Contact; OR - Orthogonal; CL - Cleavage
PL - Planar; CU - Curved; UN - Undulating; ST - Stepped; IR - Irregular
PO - Polished; K - Slickensided; SM - Smooth; Ro - Rough; MB - Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR / % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY k, cm/s	Diametral Point Load Index (MPa)	RMC -Q' AVG.
		GROUND SURFACE		311.6															
11	NW; NQ Coring; May 8, 2019	Metasedimentary Fresh Grey Very fine grained		10.5	1	Grey 100													
					2	Grey 100							JNIRRo JNIRRo						
12																			
13					3	Grey 100													
				308.6															
		END OF DRILLHOLE		13.5															
14																			
15																			
16																			
17																			
18																			
19																			
20																			
21																			
22																			

DEPTH SCALE
1 : 60

GOLDER

LOGGED: YS
CHECKED: AB

SUD-MTO-RCK S:\CLIENTS\MTO\HWY65&66\02_DATA\GINT\1896349.GPJ GAL-MISS.GDT 12-16-19 TR

GOLDER

RECORD OF BOREHOLE No C209-3

1 OF 1 **METRIC**

PROJECT 1896349

G.W.P. 5210-14-00 LOCATION N 5336603.3; E 379747.7 NAD83 MTM ZONE 12 (LAT. 48.163855; LONG. -79.992383) ORIGINATED BY YS

DIST HWY 66 BOREHOLE TYPE 76 mm I.D. Hollow Stem Augers, NW Casing, Wash Boring and NQ Coring COMPILED BY TR

DATUM GEODETIC DATE May 8, 2019 CHECKED BY AB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
321.1	GROUND SURFACE										
0.0	Clayey silt TOPSOIL Soft Dark brown Wet		1	SS	3		321				
320.4											
0.7	Sandy SILT and GRAVEL Grey Wet		2	SS	115/0.18				○		34 28 26 12
320.0							320				
1.1	Metasedimentary conglomerate (BEDROCK) For coring details see Record of Drillhole C209-3.		1	RC	REC 100%						RQD = 100%
							319				
			2	RC	REC 100%		318				RQD = 70%
316.8							317				
4.3	END OF BOREHOLE NOTE: 1. Water level measured at ground surface (Elev. 321.1 m) upon completion of coring.										

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

SUD-MTO 001 S:\CLIENTS\MTO\HWY65&66\02_DATA\GINT\1896349.GPJ GAL-MISS.GDT 12-16-19 TR

PROJECT: 1896349

RECORD OF DRILLHOLE: C209-3

SHEET 1 OF 1

LOCATION: N 5336603.3; E 379747.7

NAD83 MTM ZONE 12 (LAT. 48.163855; LONG. -79.992383)

INCLINATION: -90° AZIMUTH: —

DRILLING DATE: May 8, 2019

DRILL RIG: CME550 Buggy

DRILLING CONTRACTOR: Landcore Drilling

DATUM: GEODETIC

JN - Joint; FLT - Fault; SHR - Shear; VN - Vein; CJ - Conjugate

BD - Bedding; FO - Foliation; CO - Contact; OR - Orthogonal; CL - Cleavage

PL - Planar; CU - Curved; UN - Undulating; ST - Stepped; IR - Irregular

PO - Polished; K - Slickensided; SM - Smooth; Ro - Rough; MB - Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR / % RETURN	FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY k, cm/s	Diametral Point Load Index (MPa)	RMC -Q' AVG.
		GROUND SURFACE		320.0																
2	NW; NQ Coring; May 8, 2019	Metasedimentary conglomerate Fresh Grey Fine grained		1.1	1	Grey 100								JNIRRo						
3					2	Grey 100								JNIRRo JNIRRo JNIRRo JNIRRo JNIRRo JNIRRo						
4				316.8																
		END OF DRILLHOLE		4.3																
5																				
6																				
7																				
8																				
9																				
10																				
11																				
12																				
13																				

SUD-MTO-RCK S:\CLIENTS\MTO\HWY65&66\02_DATA\GINT\1896349.GPJ GAL-MISS.GDT 12-16-19 TR

DEPTH SCALE

1 : 60

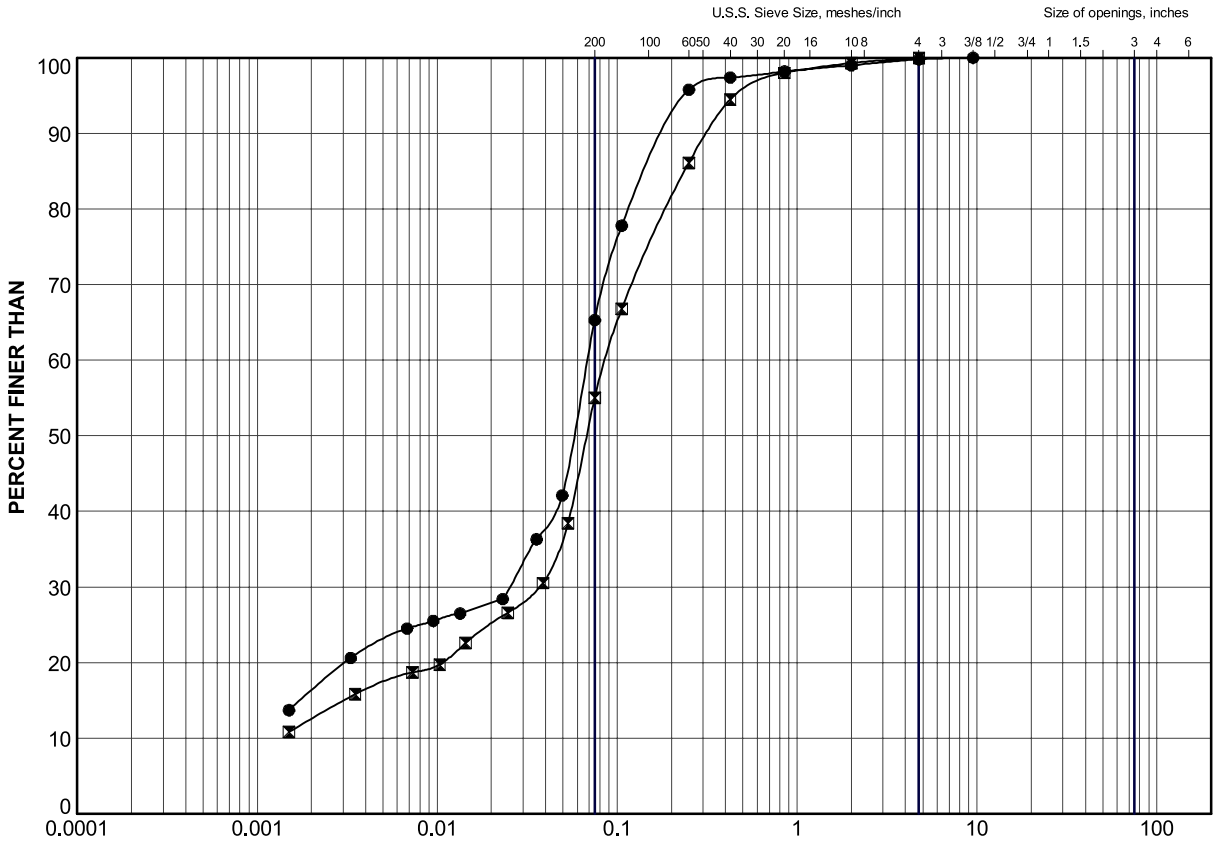
GOLDER

LOGGED: YS

CHECKED: AB

APPENDIX B

Laboratory Test Results



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C209-1	4	318.1
⊠	C209-2	4	318.7

PROJECT

HIGHWAY 66
STATION 12+420
TOWNSHIP OF LEBEL CULVERT

TITLE

GRAIN SIZE DISTRIBUTION

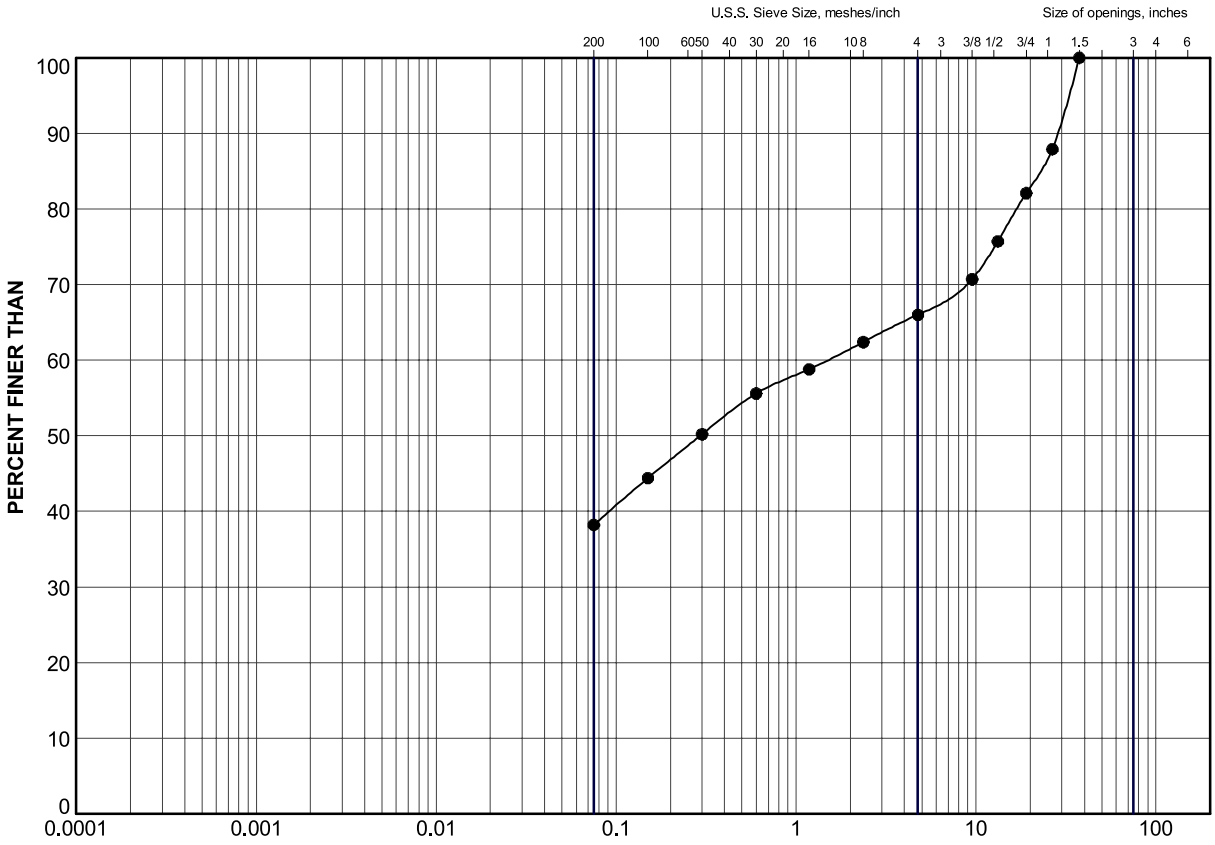
SILT and SAND

GOLDER
SUDBURY, ONTARIO

PROJECT No.		1896349	FILE No.		1896349.GPJ
DRAWN	TR	Dec 2019	SCALE	N/A	REV.
CHECK	AB	Dec 2019			
APPR	JMAC	Dec 2019			

FIGURE B-1A

SUD-MTO GSD GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C209-3	2	320.0

PROJECT

HIGHWAY 66
STATION 12+420
TOWNSHIP OF LEBEL CULVERT

TITLE

GRAIN SIZE DISTRIBUTION

Sandy SILT and GRAVEL

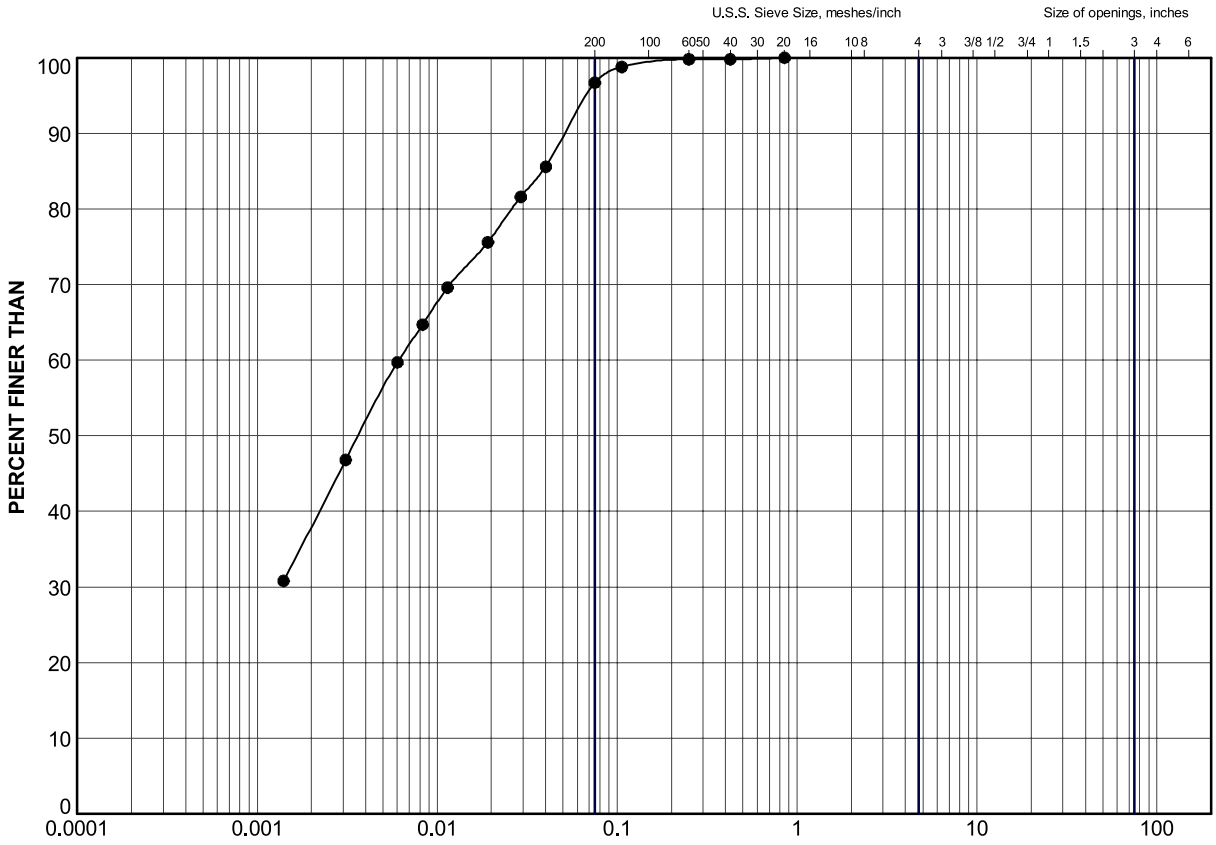
GOLDER

SUDBURY, ONTARIO

PROJECT No.		1896349	FILE No.	1896349.GPJ	
DRAWN	TR	Dec 2019	SCALE	N/A	REV.
CHECK	AB	Dec 2019			
APPR	JMAC	Dec 2019			

FIGURE B-1B

SUD-MTO GSD GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C209-2	6	317.2

PROJECT

HIGHWAY 66
STATION 12+420
TOWNSHIP OF LEBEL CULVERT

TITLE

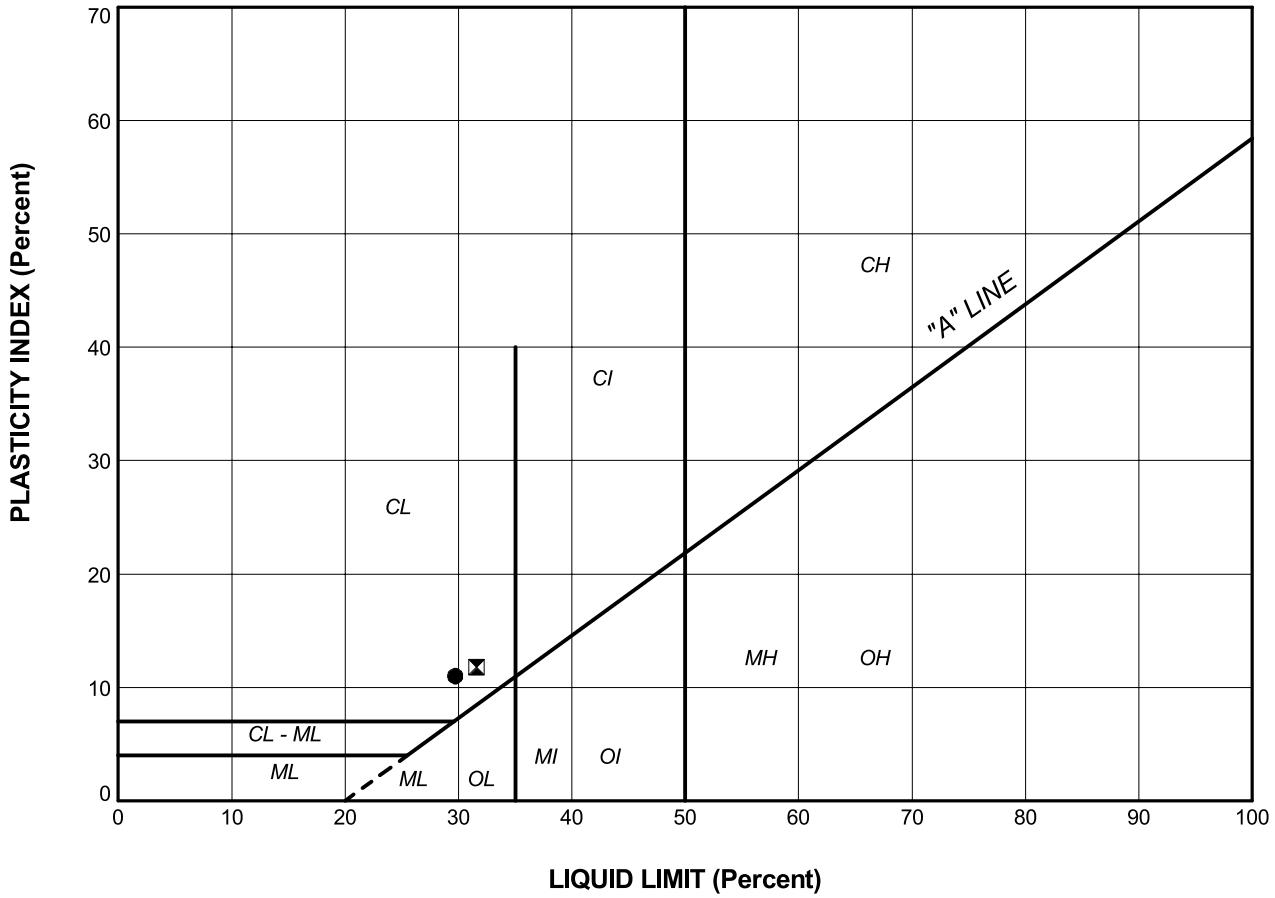
GRAIN SIZE DISTRIBUTION

CLAYEY SILT

GOLDER
SUDBURY, ONTARIO

PROJECT No.		1896349	FILE No.		1896349.GPJ
DRAWN	TR	Dec 2019	SCALE	N/A	REV.
CHECK	AB	Dec 2019			
APPR	JMAC	Dec 2019	FIGURE		B-2

SUD-MTO GSD GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	C209-1	6	29.7	18.7	11.0
⊠	C209-2	7	31.6	19.8	11.8

PROJECT
HIGHWAY 66
STATION 12+420
TOWNSHIP OF LEBEL CULVERT

TITLE
PLASTICITY CHART
CLAYEY SILT

GOLDER
SUDBURY, ONTARIO

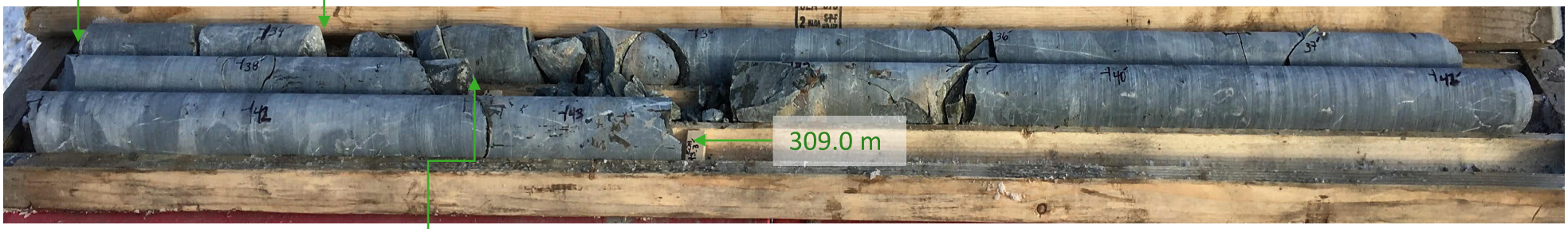
PROJECT No.	1896349		FILE No.	1896349.GPJ
DRAWN	TR	Dec 2019	SCALE N/A	REV.
CHECK	AB	Dec 2019		
APPR	JMAC	Dec 2019	**FIGURE B-3**	

SUD-MTO PL GLDR_LDN.GDT

Bedrock Core Photographs

Figure B-4A

Highway 66, Station 12+420, Township of Lebel Culvert



Borehole C209-1

Elevations 312.1 to 309.0m

Borehole C209-2

Elevations 311.7 m to 308.6 m

0 m — 0.75 m — 1.5 m

Bedrock Core Photographs

Figure B-4B

Highway 66, Station 12+420, Township of Lebel Culvert

Borehole C209-3

Elevations 320.0 m to 316.8 m

Maxxam Job #: B8X6867
Report Date: 2019/01/02

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

RESULTS OF ANALYSES OF SOIL

Maxxam ID		IOM456			IOM456			IOM457		
Sampling Date		2018/12/12 11:15			2018/12/12 11:15			2018/12/12 10:30		
COC Number		62181			62181			62181		
	UNITS	C209-1A SA1	RDL	QC Batch	C209-1A SA1 Lab-Dup	RDL	QC Batch	C207-1 SA1	RDL	QC Batch
CONVENTIONALS										
Sulphide	ug/g	1.49 (1)	0.50	5910060				<0.50 (1)	0.50	5910060
Calculated Parameters										
Resistivity	ohm-cm	2300		5892786				5000		5892786
CONVENTIONALS										
Redox Potential	mV	240	N/A	5899469				240	N/A	5899469
Inorganics										
Soluble (20:1) Chloride (Cl-)	ug/g	220	20	5896372				39	20	5896372
Conductivity	umho/cm	443	2	5898721	447	2	5898721	201	2	5898721
Available (CaCl2) pH	pH	6.65		5898742				7.19		5898742
Soluble (20:1) Sulphate (SO4)	ug/g	<20	20	5896374				<20	20	5896374
Physical Testing										
Moisture-Subcontracted	%	20	0.30	5910059				18	0.30	5910059

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable
(1) The soil extract was prepared in the Maxxam Burnaby facility. The analysis was performed in the Maxxam Calgary facility.

Maxxam ID		IOM457	
Sampling Date		2018/12/12 10:30	
COC Number		62181	
	UNITS	C207-1 SA1 Lab-Dup	QC Batch
Inorganics			
Available (CaCl2) pH	pH	7.24	5898742

QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

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