FOUNDATION INVESTIGATION REPORT

Highway 66, Station 17+221, Township of Lebel
Culvert Replacement
Ministry of Transportation, Ontario
GWP 5210-14-00

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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 Station 17+221, in the Township of Lebel, approximately 1.4 km east of Bidgood Road near King Kirkland, 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 south to north direction.

The existing culvert consists of a 1.2 m diameter, 44 m long Corrugated Steel Pipe (CSP). The culvert invert, as taken from AECOM's centreline survey profile, at the inlet and outlet is approximately Elevations 316.4 m and 315.8 m, respectively. In general, the topography within the vicinity of the culvert consists of forested hills with exposed bedrock near the site. The culvert is located about 300 m southeast of Mud Lake. The embankment is approximately 6.8 m high relative to the culvert invert and the embankment/side slopes appear to be performing well, with no visible signs of slope instability or roadway settlement sources although the embankment slope surfaces appear to be undulating as a result of surface water runoff gullies / erosion, and there are longitudinal and transverse cracks in the roadway pavement in the culvert area. The ground surface conditions at select locations of the culvert area are shown on Photographs 1 to 4.

3.0 INVESTIGATION PROCEDURES

Field work for this subsurface exploration was carried out between May 6 and 8, and on May 29 and 30, 2019, during which time five boreholes (Boreholes C228-1 to C228-5) were advanced at the approximate locations shown on Drawing 1. Boreholes C228-1 to C228-3 were advanced through the roadway embankment and Borehole C228-5 was advanced near the north toe of the highway embankment adjacent to the culvert outlet using a track mounted CME-55LC drilling rig supplied and operated by George Downing Estate Drilling (Downing) of Grenville-Sur-La-Rouge, Quebec. Borehole C228-4 was advanced near the south toe of the highway embankment adjacent to the culvert inlet 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 C228-1 to C228-3 and C228-5 were advanced using 76 mm I.D. Hollow Stem Augers, NW casing with wash boring techniques, and NQ coring; and Borehole C228-4 was advanced using NW casing with wash boring techniques. Due to casing refusal at a depth of 3.0 m below ground surface at Borehole C228-4 the following additional exploration drilling was carried out:

- a Dynamic Cone Penetration Test (DCPT) was advanced from the bottom of the original borehole and refusal to further penetration was also encountered at 3.0 m depth
- a Dynamic Cone Penetration Test (DCPT) was advanced 1.0 m west of the original borehole and refusal to further penetration was encountered at 13.7 m depth
- a second borehole was attempted 1.3 m west of the original borehole and refusal to further penetration was encountered at 3.5 m depth (no sampling)
- a third borehole was attempted 0.5 m west of the original borehole and Sample 5 was obtained from 3.1 m to 3.7 m depth (as shown on the borehole record)

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 cathead hammer in accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586). The groundwater level inside the augers/casing was noted / recorded 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 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 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 Mississauga, 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 the borehole locations were 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)
C228-1	5335749.7 (48.155658)	384044.0 (-79.934791)	322.8	20.4
C228-2	5335759.6 (48.155748)	384031.4 (-79.934959)	323.1	15.9
C228-3	5335735.3 (48.155527)	384052.1 (-79.934685)	322.9	15.9
C228-4	5335727.8 (48.155461)	384044.6 (-79.934787)	318.1	3.7 (DCPT to 13.7 m Depth)
C228-5	5335772.2 (48.155861)	384044.2 (-79.934785)	318.2	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 subsoils in the vicinity of the culvert site are comprised primarily sands of outwash plain and valley train landforms.

Based on geological mapping (MNDM)[2], the site is underlain by foliated tonalite suite bedrock, or tonalite to granodiorite-foliated to massive bedrock.

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) 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.

[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

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 160 mm to 430 mm thick layer of asphalt pavement was encountered in the roadway boreholes C228-1 to C228-3 between surface Elevations 322.8 m and 323.1 m.

A 7.1 m to 8.3 m thick layer of embankment fill consisting of various layers of silt, sand, gravelly sand, and sand and gravel was encountered below the asphalt. Asphalt coated particles were encountered in Boreholes C228-1 and C228-2 between depths of 0.2 m to 0.4 m below the roadway surface. Cobbles and/or boulders were noted as follows in the various roadway boreholes:

- Borehole C228-1: Cobbles encountered from 1.5 m to 1.8 m depth; 2.7 m to 3.0 m depth; and 5.5 m to 5.7 m depth
- Borehole C228-2: 800 mm boulder encountered at 3.0 m depth and 400 mm boulder encountered at 3.9 m depth
- Borehole C228-3: Cobble encountered from 2.1 m to 2.3 m depth; 600 mm boulder at 2.7 m depth and 400 mm boulder at 3.3 m depth

An approximately 100 mm to 200 mm thick layer of organic silty sand or topsoil fill was encountered from ground surface in Boreholes C228-4 and C228-5 at Elevations 318.1 m and 318.2 m, respectively. A 2.1 m to 2.4 m thick layer of fill consisting of various layers of clayey silt, silt and sand, and sand and gravel was encountered below the organic fill. Cobbles and/or boulders were noted as follows in these two boreholes:

- Borehole C228-4: cobbles (and gravel) encountered within the clayey silt fill layer between depths of 0.7 m and 1.5 m
- Borehole C228-5: 300 mm boulder encountered at 2.3 m depth

The SPT “N”-values measured within the fill range from 2 blows to 70 blows per 0.3 m of penetration, indicating a loose to very dense compactness condition.

Grain size distribution testing was carried out on; three samples of sand to sand and gravel fill and the results are presented on Figure B-1 in Appendix B; and two samples of the silt to silt and sand fill and the results are presented on Figure B-2.

The natural moisture content measured on three samples of the sand and gravel to sand fill ranges from 9 per cent and 17 per cent. The natural moisture content measured on the two samples of the silt to silt and sand fill is 16 per cent and 31 per cent.

4.2.2 Silt to Clayey Silt

In Borehole C228-2, a 7.6 m thick deposit of silt to clayey silt was encountered underlying the fill deposit at Elevation 315.8 m.

The SPT “N”-values measured within the cohesive deposit range from 9 blows to 20 blows per 0.3 m of penetration, indicating that the deposit has a stiff to very stiff consistency / loose to compact compactness condition.

Atterberg limits tests completed on the deposit yielded a liquid limits of 26 per cent and 29 per cent, plastic limits of 19 per cent and 20 per cent, resulting in a plasticity indices of 7 per cent and 9 per cent. The tests indicated the material is classified as a clayey silt of low plasticity. The results of the test are presented on Figure B-3 in Appendix B.

Grain size distribution analysis was carried out on two samples of the silt to clayey silt deposit and the results are presented on Figure B-4 in Appendix B. The natural moisture content measured on samples of the deposit ranges from 22 per cent to 32 per cent.

4.2.3 Sand

A 7.5 m, 3.0 and 1.5 m thick deposit of sand was encountered in Boreholes C228-1, C228-3, and C228-4 at Elevations 315.5 m, 314.2 m, and 315.9 m, respectively. Cobbles were encountered within the sand deposit in Borehole C228-1 at depths of 8.7 m to 8.9 m, 10.2 m to 10.3 m, and 11.3 to 11.5 m. Borehole C228-4 was terminated within the sand deposit (potentially on a boulder) at 3.7 m depth due to split spoon refusal after penetrating 1.5 m into the deposit.

The SPT “N”-values measured within the sand deposit range from 13 blows to 34 blows per 0.3 m of penetration, indicating that the deposit has a compact to dense compactness condition.

Grain size distribution analysis was carried out on three samples of the sand deposit and the results are presented on Figure B-5 in Appendix B. The natural moisture content measured on samples of the sand deposit ranges from 18 per cent to 23 per cent.

4.2.4 Sand and Gravel

A 1.0 m to 7.2 m thick deposit of silty sand and gravel to sand and gravel to sandy gravel was encountered in Boreholes C228-1 to C228-3 and C228-5 between Elevations 315.6 m and 308.0 m. All four of these boreholes were terminated within the sand and gravel layer at depths between 9.8 m and 20.4 m below ground surface.

The SPT “N”-values measured within the overall sand and gravel deposit range from 10 blows and 54 blows per 0.3 m of penetration, indicating that the deposit has a compact to very dense compactness condition.

Grain size distribution analysis was carried out on three samples of the sandy gravel to sand and gravel portions of the deposit and the results are presented on Figure B-6 in Appendix B. The moisture contents measured on three samples of the sand and gravel deposit ranges from about 8 per cent to 23 per cent.

A DCPT was advanced from ground surface adjacent to Borehole C228-4 and penetrated to below the sand deposit, to a depth of 13.7 m below ground surface (Elevation 304.4 m). It is noted that the resistance to driving (increase in blows per 0.3 m of penetration) increases below a depth of about 10.9 m below ground surface (Elevation 307.2 m) suggesting the inference of the presence on sand and gravel deposit from this depth to the bottom of the DCPT at 13.7 m below ground surface.

4.3 Groundwater Conditions

The unstabilized groundwater levels relative to ground surface measured inside the casing or augers 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)
C228-1	5.2	317.6
C228-2	5.4	317.7
C228-3	4.5	318.4
C228-4	0.5	317.6
C228-5	2.3	315.9

4.4 Analytical Laboratory Testing Results

Analytical testing was carried out on a sample of sand recovered from Borehole C228-1 (Sample #7). 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 No.	Borehole 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
C228-1	7	7.6 – 8.2	12,000	84	<20[1]	29	<0.30[2]	6.56

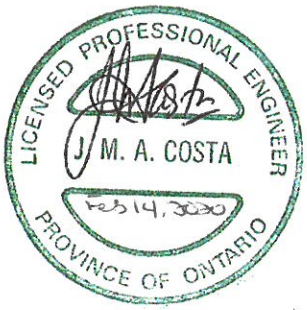
Note:
1. The sulphate concentration is below the reportable detection limit of 20 µg/g.
2. The sulphide was below the reportable detection limit of 0.30 µg/g.

5.0 CLOSURE

The field drilling program was carried out under the supervision of Mr. Mathew Riopelle and Yusuf Soliman, EIT, under the overall direction of Mr. André Bom, P.Eng., an Associate of Golder. This Foundation Investigation Report was prepared by Mr. Gavin Mundry, and Mr. André Bom provided a technical review of the report. Mr. Jorge Costa, P.Eng., an MTO Foundations Designated Contact and Senior Consultant for Golder, conducted an independent quality control review of this report

Signature Page

Golder Associates Ltd.



André Bom, P.Eng.
Senior Geotechnical Engineer, Associate

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

GM/TB/AB/JMAC/ca

MINISTRY OF TRANSPORTATION, ONTARIO

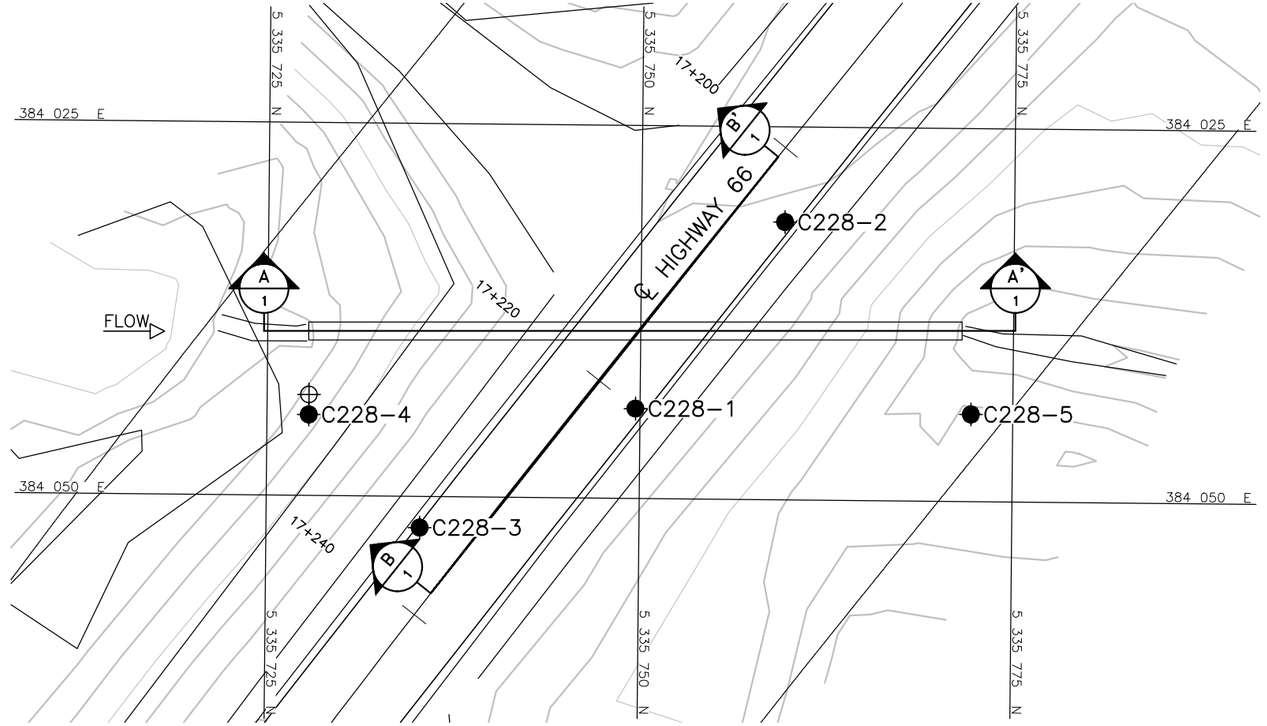
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 5210-14-00

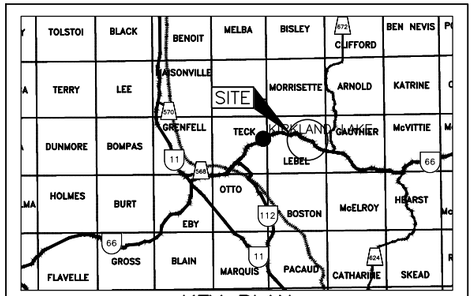
HIGHWAY 66
STATION 17+221
TOWNSHIP OF LEBEL CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

GOLDER



PLAN
SCALE
4 0 4 8 m



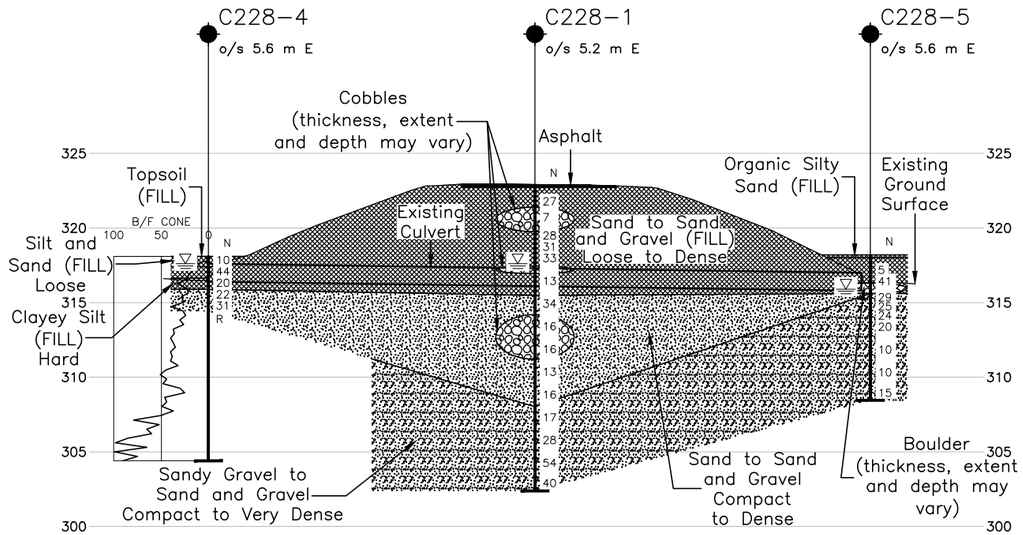
KEY PLAN
SCALE
10 0 10 20 km

LEGEND

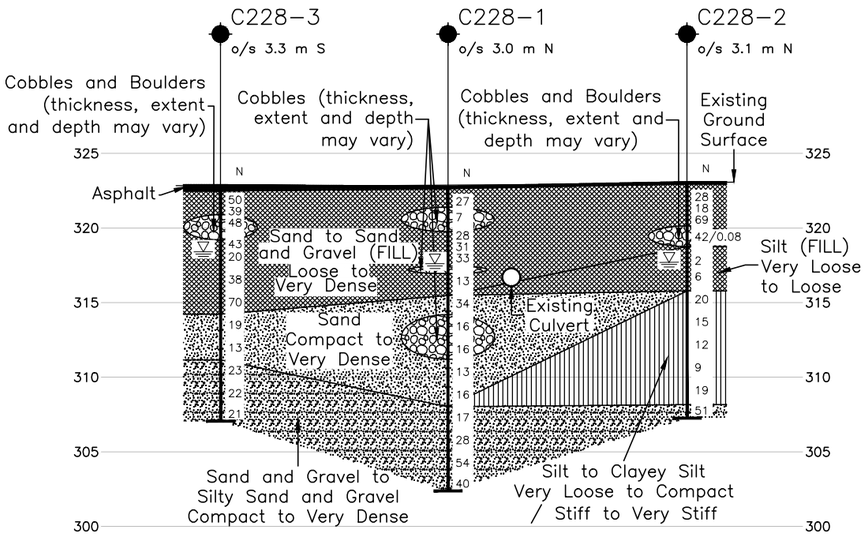
- Borehole – Current Investigation
- Dynamic Cone Penetration Test – Current Investigation
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- R — Refusal
- WL upon completion of drilling

BOREHOLE CO-ORDINATES (NAD 83 MTM ZONE 12)

No.	ELEVATION	NORTHING	EASTING
C228-1	322.8	5335749.7	384044.0
C228-2	323.1	5335759.6	384031.4
C228-3	322.9	5335735.3	384052.1
C228-4	318.1	5335727.8	384044.6
C228-5	318.2	5335772.2	384044.2



A-A' 1 CULVERT CENTERLINE PROFILE
HORIZONTAL SCALE
4 0 4 8 m
VERTICAL SCALE
4 0 4 8 m



B-B' 1 HIGHWAY CENTERLINE PROFILE
HORIZONTAL SCALE
4 0 4 8 m
VERTICAL SCALE
4 0 4 8 m

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.dwg, received AUG 14, 2019.

LICENSED PROFESSIONAL ENGINEER J.M.A.COSTA FEB 7, 2020 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER A.J.K. BOM 100075715 FEB 13, 2020 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
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Geocres No. 32D-25

HWY. 66	PROJECT NO. 1896349		DIST. .
SUBM'D. .	CHKD. TB	DATE: 2/7/2020	SITE: .
DRAWN: TR	CHKD. AB	APPD. JMAC	DWG. 1

PLOT DATE: February 13, 2020
FILENAME: S:\Clients\MTO\Hwy66s66\99_PRO\1896349_ACOM_Hwy65-66-566\45_PROD\0012_412_LEB228\1896349-0012-BS-0001.dwg

Photograph 1: Drilling Rig Positioned at Borehole C228-2, Facing West (May 2019)

Photograph 2: Embankment North Slope Near Culvert Outlet, Facing South East (May 2019)

Photograph 3: Culvert Outlet, North Side of Embankment (May 2019)

Photograph 4: Culvert Inlet, South Side of Embankment (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
$\sigma_1, \sigma_2, \sigma_3$	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 = 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

GOLDER

RECORD OF BOREHOLE No C228-1

1 OF 2 **METRIC**

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

LOCATION N 5335749.7; E 384044.0 NAD83 MTM ZONE 12 (LAT. 48.155658; LONG. -79.934791)
BOREHOLE TYPE 76 mm I.D. Hollow Stem Augers, NW Casing, NQ Coring
DATE May 8, 2019

ORIGINATED BY MR
COMPILED BY GM
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
322.8	GROUND SURFACE										
0.0	Asphalt (170 mm)										
0.2	Sand, some gravel to sand and gravel, trace silt (FILL) Loose to dense Brown Moist to wet										
	Asphalt coated particles from 0.2 m to 0.4 m depth		1	SS	27		322				
	- Two cobbles encountered from 1.5 m to 1.8 m depth		-	RC	-						
			2	SS	7		321				
	- Two cobbles encountered from 2.7 m to 3.0 m depth		-	RC	-		320				
			3	SS	28						
			4	SS	31		319				
			5	SS	33	▽	318				
	- Cobble encountered from 5.5 m to 5.7 m depth		-	RC	-						
			6	SS	13		317		○		17 79 (4)
315.5							316				
7.3	SAND, trace gravel, trace silt Compact to dense Brown Wet		7	SS	34		315				
	- Cobble encountered from 8.7 m to 8.9 m depth		-	RC	-		314				
			8	SS	16		313				
	- Cobble encountered from 10.2 m to 10.3 m depth		-	RC	-						
			9	SS	16		312		○		0 96 (4)
	- Two cobbles encountered from 11.3 m to 11.5 m depth		-	RC	-		311				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No C228-1

2 OF 2 **METRIC**

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

LOCATION N 5335749.7; E 384044.0 NAD83 MTM ZONE 12 (LAT. 48.155658; LONG. -79.934791)
BOREHOLE TYPE 76 mm I.D. Hollow Stem Augers, NW Casing, NQ Coring
DATE May 8, 2019

ORIGINATED BY MR
COMPILED BY GM
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
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SAND, trace gravel, trace silt Compact to dense Brown Wet		10	SS	13		310				
			11	SS	16		309				
308.0											
14.8	SAND and GRAVEL Compact to very dense Brown Wet		12	SS	17		308		○		32 64 (4)
			13	SS	28		307				
			14	SS	54		306				
			15	SS	40		305				
302.4							304				
20.4	END OF BOREHOLE NOTE: 1. Water level at a depth of 5.2 m below ground surface (Elev. 317.6 m) upon completion of drilling.						303				

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

GOLDER

RECORD OF BOREHOLE No C228-2

1 OF 2 **METRIC**

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

LOCATION N 5335759.6; E 384031.4 NAD83 MTM ZONE 12 (LAT. 48.155748; LONG. -79.934959)
BOREHOLE TYPE 76 mm I.D. Hollow Stem Augers, NW Casing, NQ Coring
DATE May 6, 2019

ORIGINATED BY MR
COMPILED BY GM
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
323.1	GROUND SURFACE						323				
0.0	ASPHALT (160 mm)										
0.2	Sand and gravel (FILL) Compact to very dense Brown Moist to wet										
	Asphalt coated particles from 0.2 m to 0.4 m depth		1	SS	28		322				
			2	SS	18						
			3	SS	69		321				
	- Approximate 800 mm diameter boulder encountered from 3.0 m to 3.8 m depth		-	RC	-		320				
			4	SS	42/0.08						
	- Approximate 400 mm diameter boulder encountered from 3.9 m to 4.3 m depth		-	RC	-		319				
318.8											
4.3	Silt, some sand, trace gravel, trace clay (FILL) Very loose to loose Brown Wet		5	SS	2	▽	318				
			6	SS	6		317		○		5 12 77 6
315.8							316				
7.3	SILT to CLAYEY SILT Loose to compact / stiff to very stiff Grey Wet		7	SS	20		315				
			8	SS	15		314		⊢●		0 5 68 27
			9	SS	12		313				
							312				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No C228-2

2 OF 2 **METRIC**

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

LOCATION N 5335759.6; E 384031.4 NAD83 MTM ZONE 12 (LAT. 48.155748; LONG. -79.934959)
BOREHOLE TYPE 76 mm I.D. Hollow Stem Augers, NW Casing, NQ Coring
DATE May 6, 2019

ORIGINATED BY MR
COMPILED BY GM
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
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILT to CLAYEY SILT Loose to compact / stiff to very stiff Grey Wet		10	SS	9		311				0 3 82 15
			11	SS	19		310				
308.2							309				
14.9	Silty SAND and GRAVEL Very dense Grey Wet		12	SS	51		308				
307.2											
15.9	END OF BOREHOLE NOTE: 1. Water level at a depth of 5.4 m below ground surface (Elev. 317.7 m) upon completion of drilling.										

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

GOLDER

PROJECT 1896349

RECORD OF BOREHOLE No C228-3

1 OF 2 **METRIC**

G.W.P. 5210-14-00 LOCATION N 5335735.3; E 384052.1 NAD83 MTM ZONE 12 (LAT. 48.155527; LONG. -79.934685) ORIGINATED BY MR

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

DATUM GEODETIC DATE May 7, 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
322.9	GROUND SURFACE										
0.0	ASPHALT (430 mm)										
322.5											
0.4	Gravelly sand to sand and gravel, some silt (FILL) Compact to dense Brown to grey Moist to wet		1	SS	50		322				
			2	SS	39		321				
	- Cobble encountered from 2.1 m to 2.3 m depth		-	RC	-						
			3	SS	48						
	- Approximate 600 mm diameter boulder encountered from 2.7 m to 3.3 m depth - Approximate 400 mm diameter boulder encountered from 3.3 m to 3.7 m depth		-	RC	-		320				
			4	SS	43		319				
			5	SS	20	▽	318		○		30 59 (11)
	- Poor recovery in Split-Spoon in Samples 5 and 6. Trace gravel recovered.		6	SS	38		317				
			7	SS	70		316				
314.2							315				
8.7	SAND, some gravel, trace silt Compact Brown Wet		8	SS	19		314		○		10 87 (3)
			9	SS	13		313				
311.2							312				
11.7							311				

Continued Next Page

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

GOLDER

RECORD OF BOREHOLE No C228-3

2 OF 2 **METRIC**

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

LOCATION N 5335735.3; E 384052.1 NAD83 MTM ZONE 12 (LAT. 48.155527; LONG. -79.934685)
BOREHOLE TYPE 76 mm I.D. Hollow Stem Augers, NW Casing, NQ Coring
DATE May 7, 2019

ORIGINATED BY MR
COMPILED BY GM
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
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SAND and GRAVEL, trace silt Compact Brown Wet		10	SS	23		310				
			11	SS	22		309		○		46 51 (3)
							308				
307.0			12	SS	21						
15.9	END OF BOREHOLE NOTE: 1. Water level at a depth of 4.5 m below ground surface (Elev. 318.4 m) upon completion of drilling.										

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

GOLDER

RECORD OF BOREHOLE No C228-4

1 OF 2 **METRIC**

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

LOCATION N 5335727.8; E 384044.6 NAD83 MTM ZONE 12 (LAT. 48.155461; LONG. -79.934787)
BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring
DATE May 29 and 30, 2019

ORIGINATED BY YS
COMPILED BY GM
CHECKED BY AB

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
318.1	GROUND SURFACE							
0.0	Topsoil (FILL)							
0.1	Silt and sand, trace gravel, trace clay, trace organics, trace rootlets (FILL) Loose Brown Moist	1	SS	10	2	37	59	2
317.4								
0.7	Clayey silt, with cobbles and gravel (FILL) Hard Brown Moist	2	SS	44				
316.6								
1.5	Sand and gravel (FILL) Compact Brown Wet	3	SS	20				
315.9								
2.2	SAND, trace gravel, trace silt Compact Brown Wet	4	SS	22	2	94	(4)	
		5	SS	31				
314.4								
3.7	END OF BOREHOLE SPLIT-SPOON REFUSAL							

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

ELEVATION SCALE: 318 317 316 315 314 313 312 311 310 309 308 307

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

Continued Next Page

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

SUD-MTO 001 S:\CLIENTS\MTO\HWY65&66\02_DATA\GINT\1896349.GPJ GAL-MISS.GDT 11-7-19 TR

GOLDER

PROJECT 1896349

RECORD OF BOREHOLE No C228-4

2 OF 2 **METRIC**

G.W.P. 5210-14-00 LOCATION N 5335727.8; E 384044.6 NAD83 MTM ZONE 12 (LAT. 48.155461; LONG. -79.934787) ORIGINATED BY YS

DIST HWY 66 BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring COMPILED BY GM

DATUM GEODETIC DATE May 29 and 30, 2019 CHECKED BY AB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---						306	20 40 60 80 100	20 40 60		
							305				
304.4											
13.7	END OF DCPT										

NOTE:

1. Samples 1 to 4 obtained at original borehole and refusal to further casing advancement at 3.0 m depth. Attempted DCPT from bottom of original borehole and refusal also at 3.0 m.

2. Advanced DCPT 1.0 m west of original borehole to 13.7 m depth.

3. A second borehole attempted 1.3 m west of original borehole and refusal at 3.5 m (no sampling).

4. Sample 5 obtained in third borehole attempted 0.5 m west of original borehole with refusal at 3.7 m depth.

5. Water level at a depth of 0.5 m below ground surface (Elev. 317.6 m) upon completion of drilling of third borehole.

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

GOLDER

RECORD OF BOREHOLE No C228-5

1 OF 1 **METRIC**

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

LOCATION N 5335772.2; E 384044.2 NAD83 MTM ZONE 12 (LAT. 48.155861; LONG. -79.934785)
BOREHOLE TYPE 76 mm I.D. Hollow Stem Augers, NW Casing, NQ Coring
DATE May 7, 2019

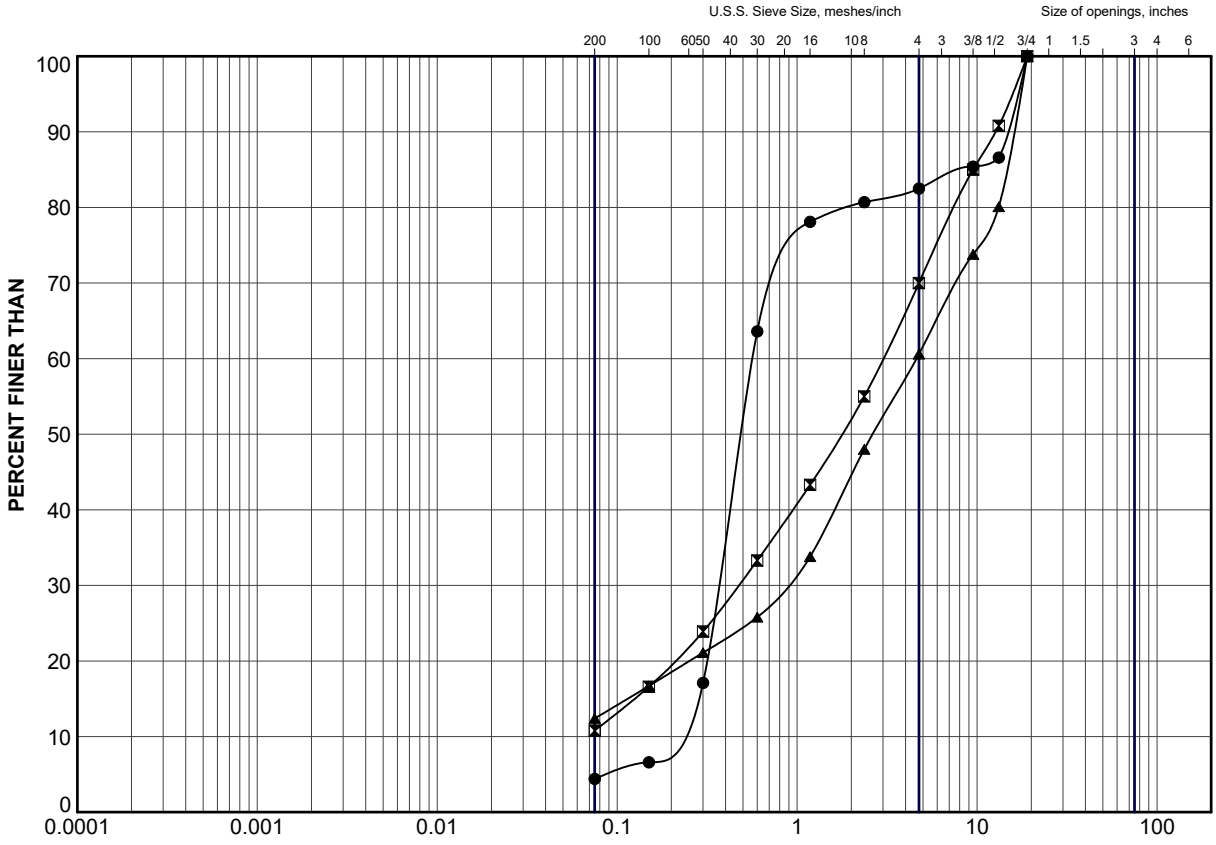
ORIGINATED BY MR
COMPILED BY GM
CHECKED BY AB

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
318.2	GROUND SURFACE										
0.0	Organic silty sand (FILL)										
0.2	Mottled brown and black Wet Sand and gravel, some silt (FILL) Loose to dense Brown Wet		1	SS	5		318				
			2	SS	41		317		○		39 49 (12)
	- Approximate 300 mm diameter boulder encountered from 2.3 m to 2.6 m depth		-	RC	-	▽	316				
315.6											
2.6	Sandy GRAVEL to SAND and GRAVEL Compact Brown Wet		3	SS	29		315				
			4	SS	25						
			5	SS	24		314				
			6	SS	20						
							313				
			7	SS	10		312		○		23 75 (2)
							311				
			8	SS	10		310				
							309				
308.4			9	SS	15						
9.8	END OF BOREHOLE NOTE: 1. Water level at a depth of 2.3 m below ground surface (Elev. 315.9 m) upon completion of drilling.										

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

APPENDIX B

Laboratory Test Results



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C228-1	6	316.4
⊠	C228-3	5	318.0
▲	C228-5	2	316.4

PROJECT

HIGHWAY 66
STATION 17+221
TOWNSHIP OF LEBEL CULVERT

TITLE

GRAIN SIZE DISTRIBUTION

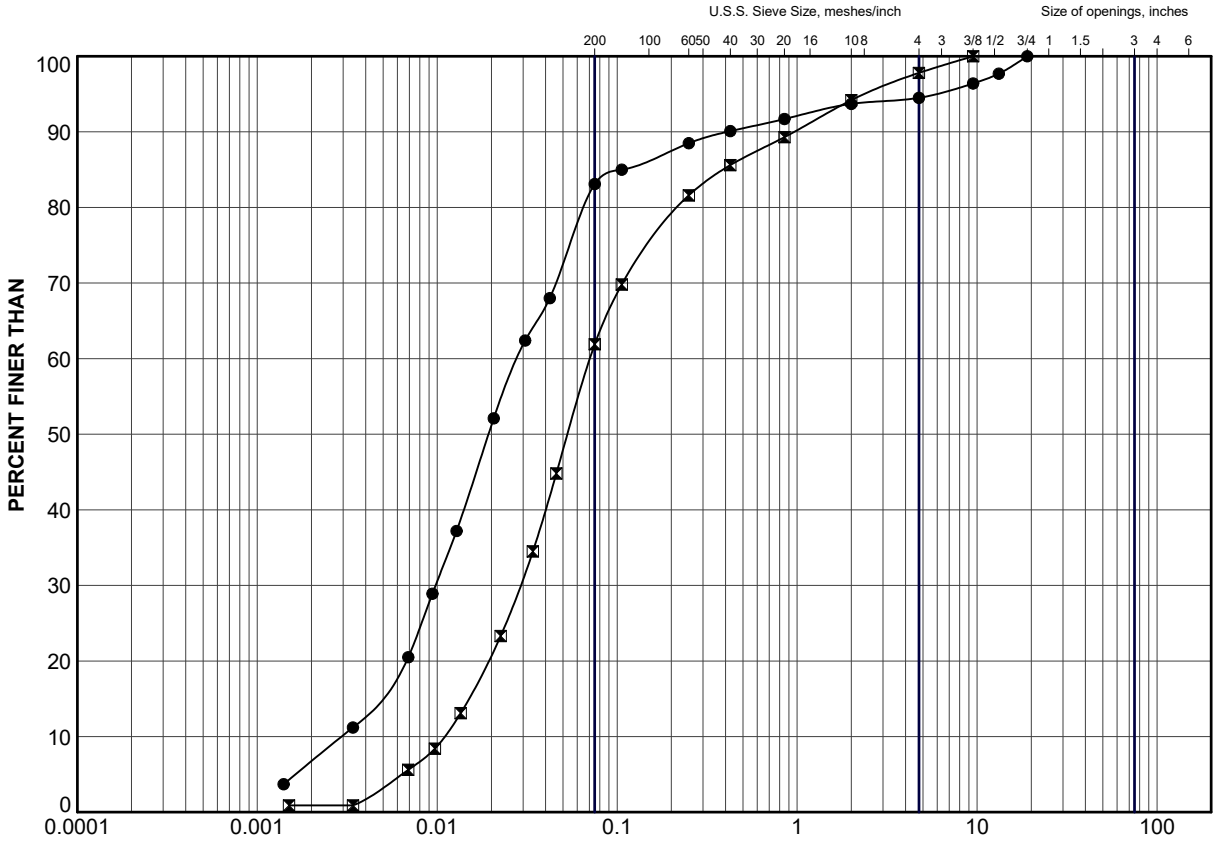
Sand to Sand and Gravel (FILL)

GOLDER

SUDBURY, ONTARIO

PROJECT No.		1896349	FILE No.	1896349.GPJ	
DRAWN	TR	Nov 2019	SCALE	N/A	REV.
CHECK	AB	Nov 2019			
APPR	JMAC	Nov 2019	**FIGURE**		**B-1**

SUD-MTO GSD GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C228-2	6	316.7
⊠	C228-4	1	317.8

PROJECT

HIGHWAY 66
STATION 17+221
TOWNSHIP OF LEBEL CULVERT

TITLE

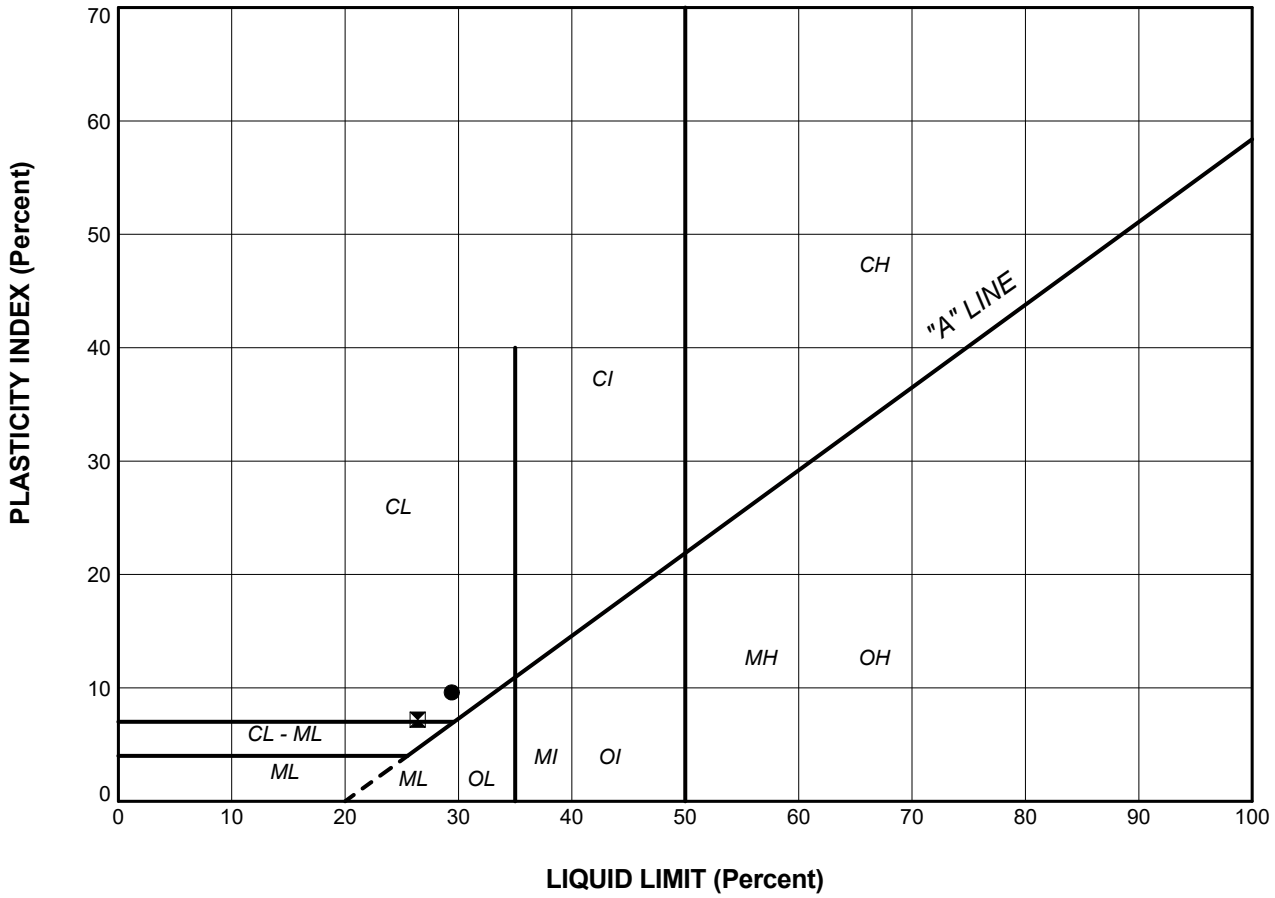
GRAIN SIZE DISTRIBUTION

Silt to Silt and Sand (FILL)

GOLDER
SUDBURY, ONTARIO

PROJECT No.		1896349	FILE No.	1896349.GPJ	
DRAWN	TR	Nov 2019	SCALE	N/A	REV.
CHECK	AB	Nov 2019			
APPR	JMAC	Nov 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
●	C228-2	8	29.4	19.8	9.6
⧓	C228-2	10	26.4	19.2	7.2

PROJECT

HIGHWAY 66
STATION 17+221
TOWNSHIP OF LEBEL CULVERT

TITLE

PLASTICITY CHART

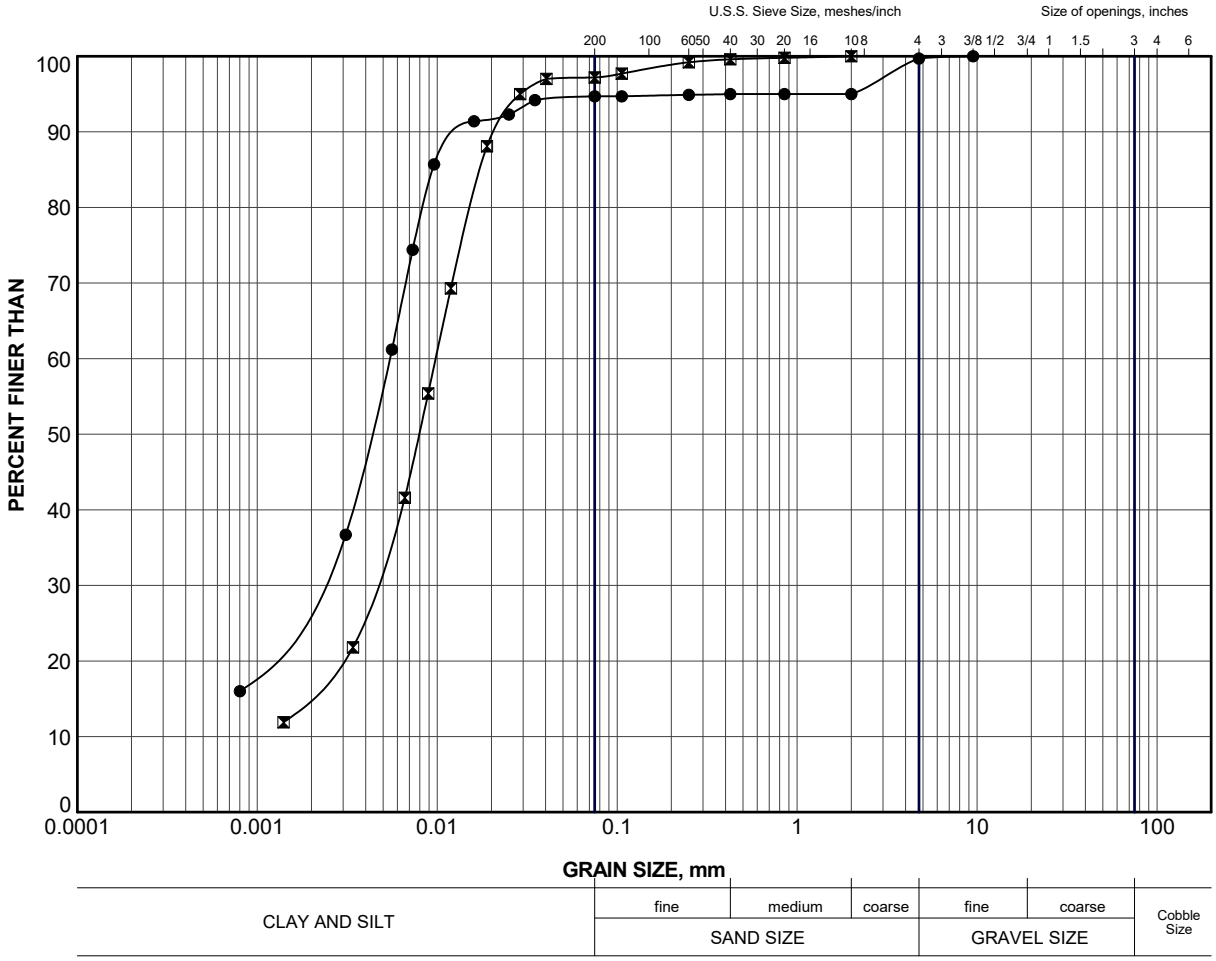
CLAYEY SILT

GOLDER

SUDBURY, ONTARIO

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

SUD-MTO PL GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C228-2	8	313.7
⊠	C228-2	10	310.6

PROJECT

HIGHWAY 66
STATION 17+221
TOWNSHIP OF LEBEL CULVERT

TITLE

GRAIN SIZE DISTRIBUTION

SILT to CLAYEY SILT

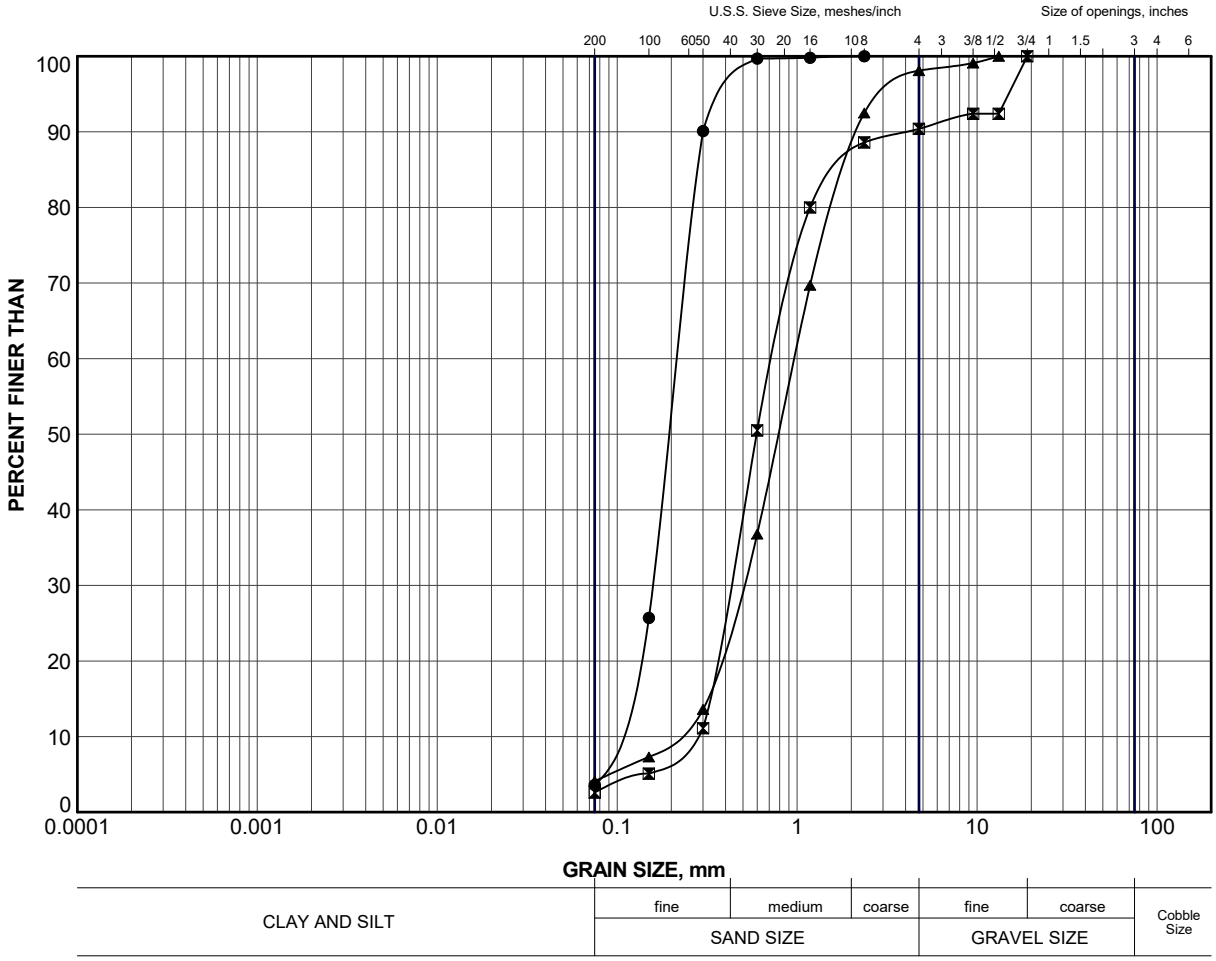
GOLDER

SUDBURY, ONTARIO

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

FIGURE B-4

SUD-MTO GSD_GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C228-1	9	311.8
⊠	C228-3	8	313.5
▲	C228-4	4	315.6

PROJECT

HIGHWAY 66
STATION 17+221
TOWNSHIP OF LEBEL CULVERT

TITLE

GRAIN SIZE DISTRIBUTION

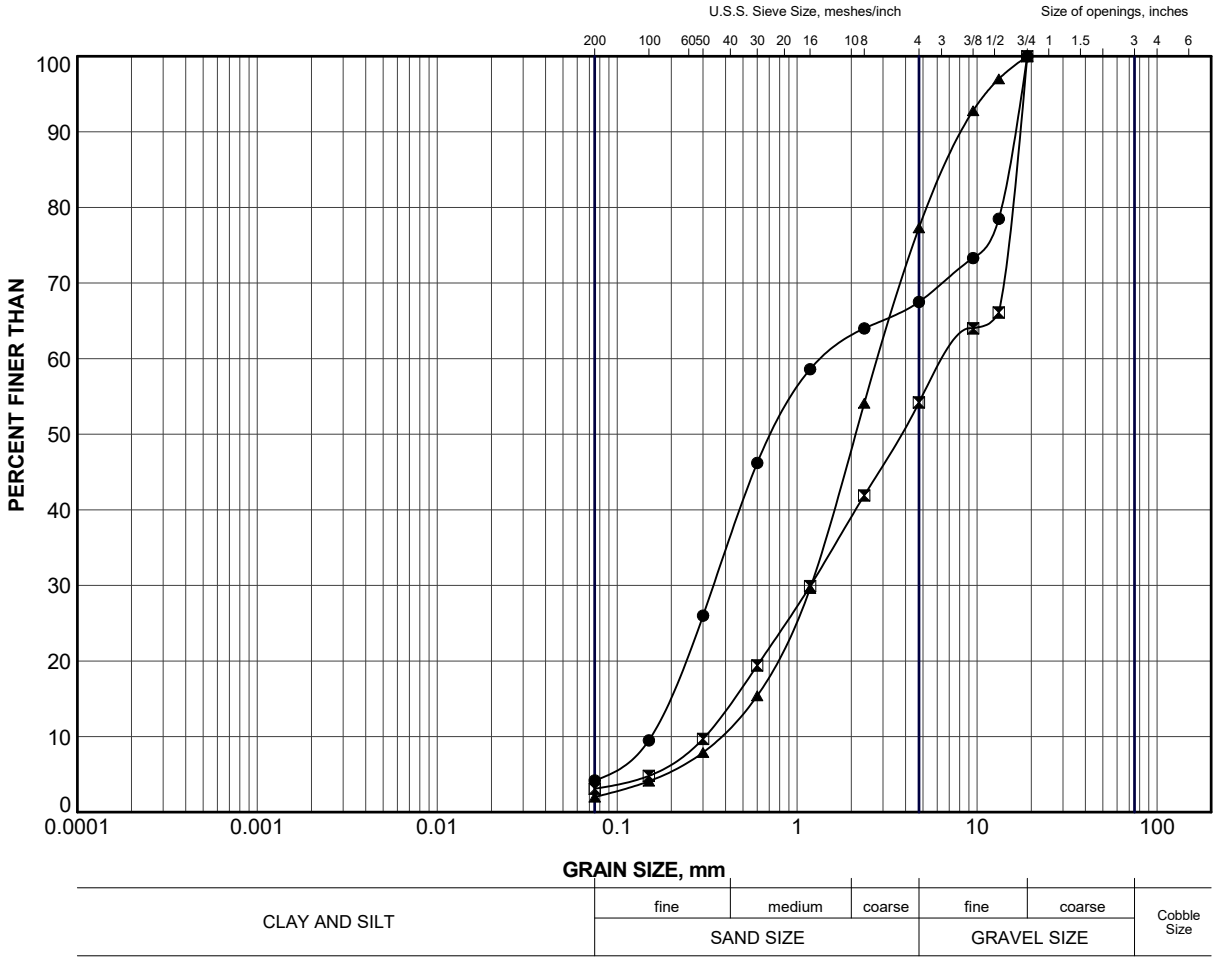
SAND

GOLDER

SUDBURY, ONTARIO

PROJECT No.		1896349	FILE No.	1896349.GPJ	
DRAWN	TR	Nov 2019	SCALE	N/A	REV.
CHECK	AB	Nov 2019			
APPR	JMAC	Nov 2019	**FIGURE**		**B-5**

SUD-MTO GSD_GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C228-1	12	307.3
⊠	C228-3	11	308.9
▲	C228-5	7	311.8

PROJECT

HIGHWAY 66
STATION 17+221
TOWNSHIP OF LEBEL CULVERT

TITLE

GRAIN SIZE DISTRIBUTION

Sandy GRAVEL to SAND and GRAVEL

GOLDER
SUDBURY, ONTARIO

PROJECT No.		1896349	FILE No.	1896349.GPJ
DRAWN	TR	Nov 2019	SCALE N/A	REV.
CHECK	AB	Nov 2019		
APPR	JMAC	Nov 2019	**FIGURE B-6**	

SUD-MTO GSD_GLDR_LDN.GDT

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		JTI432			JTI433	JTI434	JTI435	JTI436		
Sampling Date		2019/05/03 10:45			2019/05/04 14:47	2019/05/08 12:39	2019/05/11 16:36	2019/05/14 08:49		
COC Number		127611			127611	127611	127611	127611		
	UNITS	**C236-1 Lab-Dup**	**RDL**	**QC Batch**	**C267-1**	**C228-1**	**C227-1**	**C256-1**	**RDL**	**QC Batch**
CONVENTIONALS										
Sulphide	ug/g				<0.30	<0.30	<0.30	<0.30	0.30	6150574
Calculated Parameters										
Resistivity	ohm-cm				23000	12000	2500	22000		6129977
Inorganics										
Soluble (20:1) Chloride (Cl-)	ug/g				<20	29	250	<20	20	6133046
Conductivity	umho/cm				43	84	405	46	2	6135430
Available (CaCl2) pH	pH				7.74	6.56	7.00	6.30		6133358
Soluble (20:1) Sulphate (SO4)	ug/g				<20	<20	<20	<20	20	6133048
Physical Testing										
Moisture-Subcontracted	%	15	0.30	6150575	21	20	20	20	0.30	6150575

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

Bureau Veritas Laboratories 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

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