REPORT

June 12, 2017

FOUNDATION INVESTIGATION REPORT

Highway 401 Structural Culvert Rehabilitation/Replacement - Site No. 21-494/C Highway 35/115 and Highway 401 Ministry of Transportation, Ontario G.W.P. 2242-14-00

Submitted to:
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3 Copies - Ministry of Transportation, Ontario
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MINISTRY OF TRANSPORTATION, ONTARIO
G.W.P. 2242-14-00

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by D.M. Wills Associates Ltd. (D.M. Wills) on behalf of Ministry of Transportation, Ontario (MTO) to provide Foundation Engineering services for the replacement/rehabilitation of various culverts on Highway 35/115 and Highway 401 in the Region of Durham, Ontario.

The Terms of Reference and the Scope of Work for the foundation investigation are outlined in MTO's Request for Quotation, dated August 2015. Golder's proposal for the Foundation Engineering services associated with the culvert replacement is contained in Section 3.5 of D.M. Wills' Technical Proposal for this assignment. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundation engineering services for this project, dated December 1, 2016.

This report addresses the investigation carried out for the structural culvert at about STA 22+644 on Highway 401 (MTO Structure Site No. 21-494/C) which has been identified for rehabilitation or potential replacement. The foundation investigation associated with the other culverts, which forms part of the Foundation assignment are presented in separate reports.

2.0 SITE DESCRIPTION

The structural culvert at site No. 21-494/C (Culvert C6) requiring rehabilitation or replacement is located at STA 22+644 on Highway 401, approximately 1950 m east of Newtonville Road in Newtonville, Municipality of Clarington, Ontario as shown on the Key Plan on Drawing 1. The existing culvert is an open footing concrete structure about 74 m long (including a subsequent 4 m long extension to the south) and is about 3.05 m wide and 1.56 m high and is located within an approximately 9.2 m high fill embankment. Details of the existing culvert are also summarized in Table 1 following the text of this report.

In general, the topography in the area of the culvert consists of a relatively flat to gently rolling plain which has been developed for agricultural purposes. Along the water course leading to/from the culvert there are generally densely populated treed areas. The ground surface in the vicinity of the culvert is at about Elevation 121 m and the invert of the culvert is about Elevations 121.5 m and 120.9 m at the inlet (north end) and outlet (south end), respectively. The Highway 401 grade over the culvert is at about Elevation 130.1 m. The existing highway embankment consist of earth fill, up to about 7.3 m high over the culvert at the highway centreline, with side slopes inclined at approximately 2.5 horizontal to 1 vertical (2.5H:1V).

3.0 INVESTIGATION PROCEDURES

The fieldwork for the foundation investigation associated with structural culvert C6 (Site No. 21-494/C) at STA 22+644 was carried out between October 3 and 6 and on December 1, 2016 during which time a total of four boreholes were advanced at, or in the immediate vicinity of the culvert alignment as shown on Drawing 1.

The field investigation was carried out using track-mounted and truck-mounted drilling equipment supplied and operated by a specialist drilling contractor, Atcost Drilling Inc., of Gormley, Ontario. The boreholes were advanced through the overburden using 254 mm outer diameter (O.D.), 108 mm inner diameter (I.D.) hollow stem augers or 125 mm O.D. solid stem augers. Soil samples were obtained at intervals of depth of about 0.75 m and 1.5 m using

a 50 mm O.D. split-spoon sampler operated by an automatic hammer on the drill rig, performed in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586)[1].

A piezometer was installed in Borehole C6-4 to allow monitoring of the groundwater level at this site. The piezometer consist of a 50 mm diameter PVC pipe, with a slotted screen positioned within the silt till deposit. The borehole and annulus surrounding the piezometer pipe above the screen and sand pack were backfilled with bentonite pellets to ground surface. The piezometer installation details and water level readings are noted on the Record of Borehole C6-4 in Appendix A. All other boreholes were backfilled with bentonite upon completion of drilling in accordance with Ontario Regulation 903 (Wells) (as amended). The groundwater conditions and water levels in the open boreholes were observed during and immediately following the drilling operations and are described on the Record of Borehole sheets in Appendix A.

The fieldwork was observed by members of Golder's engineering and technical staff, who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined the soil samples. The soil samples were identified in the field, placed in appropriate containers, labelled and transported to our Mississauga geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO Laboratory Standards and/or ASTM Standards, as appropriate. Classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected soil samples. The results of the laboratory testing are summarized on the Record of Borehole sheets in Appendix A and provided on the laboratory test sheets in Appendix B.

A soil sample was obtained during the field investigation at about the culvert invert elevation, using appropriate sampling protocols, and was submitted to a specialist analytical laboratory under chain of custody procedures for chemical analysis of a suite of parameters (corrosivity package) to assess the potential for the soil to cause deterioration of buried concrete or corrosion to steel reinforcing elements. The results of the analytical testing are presented in Appendix C and are summarized in Section 4.3.

The as-drilled borehole locations were measured relative to existing site features and were subsequently converted into MTM NAD 83 coordinates in AutoCAD. The elevation of the boreholes was obtained by plotting the borehole locations on the topographic mapping provided by D.M. Wills on January 20, 2016. The borehole locations given on the Record of Borehole sheets and shown on Drawing 1 are positioned relative to MTM NAD 83 (Zone 10) northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations (including geographic coordinates), ground surface elevations and drilled depths are as follows:

[1] ASTM D1586-11 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils, ASTM International, West Conshohocken, PA, 2011

Borehole	Location (m)		Ground Surface Elevation (m)	Depth of Borehole (m)
	Northing	Easting		
C6-1	4866801.7 (43.936526)	387804.4 (-78.466115)	125.6	13.8
C6-2	4866792.6 (43.936431)	387845.2 (-78.465606)	130.0	19.9
C6-3	4866757.4 (43.936124)	387833.9 (-78.465756)	130.0	20.0
C6-4	4866739.4 (43.935959)	387857.0 (-78.465471)	121.9	10.8

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

This section of Highway 401 is located within the Iroquois Plain physiographic region, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984)[2] and *Urban Geology of Canadian Cities* (Karrow and White, 1998)[3]. The Iroquois Plain extends around the western shores of Lake Ontario. The Plain is comprised of the flat to undulating lakebed and beaches of the former glacial Lake Iroquois, which occupied this area during the last glacial recession.

The surficial soils in this area of the Iroquois Plain are typically comprised of glaciolacustrine clays, silts and sands to gravelly sands, which are underlain by an extensive till deposit that is mapped in this area as the Bowmanville Till.

4.2 General Overview of Local Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced during this investigation, together with the results of the laboratory tests carried out on selected soil samples, are presented on the Record of Borehole sheets and the laboratory test sheets in Appendices A and B, respectively. The stratigraphic boundaries shown on the Record of Boreholes sheets are inferred from non-continuous sampling, observations of drilling progress and in situ testing and are approximate. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary between and beyond the borehole locations.

The stratigraphy at the borehole locations at the culvert site generally consists of surficial layers of non-cohesive fill underlain by a silt deposit. The fill and granular deposits are generally underlain by a non-cohesive till deposit which is in turn underlain by a cohesive till deposit in places. A detailed description of the subsurface conditions at the culvert crossing is provided in the following section of this report. Where relatively significant thicknesses of overburden units were encountered, the various soil types are described in detail for each main deposit or stratum.

[2] Chapman, L.J., and Putnam, D.F., 1984. *The Physiography of Southern Ontario*, 3rd Edition. Ontario Geological Survey, Special Volume 2. Ontario Ministry of Natural Resources.

[3] Karrow, P. F., and White, O. L., 1998. *Urban Geology of Canadian Cities.* Geological Association of Canada Special Paper No. 42. St. John's, Nfld.

4.2.1 Asphalt and Road Base

Boreholes C6-2 and C6-3 were advanced through the existing Highway 401 roadway and penetrated an asphalt layer approximately 500 mm and 200 mm thick, respectively. The uppermost layer of road base material underlying the asphalt consists of sand and gravel and is 0.8 m and 0.6 m thick at the respective boreholes. The SPT 'N'-values measured in this layer are 60 blows for 0.3 m of penetration and 50 blows for 0.18 m of penetration, indicating a very dense relative density.

4.2.2 Topsoil

A 100 mm thick layer of topsoil was encountered at ground surface in Borehole C6-4.

4.2.3 Embankment Fill

Embankment fill, approximately 0.6 m to 7.9 m thick was encountered in all boreholes immediately below existing ground surface and underlying the topsoil or road base layer (where present). The embankment fill consists of sandy silt to silt and sand to sand and gravel. In Borehole C6-4 an upper 0.6 m thick layer of cohesive fill consisting of clayey silt, some sand, trace organics was encountered underlying the topsoil. Trace organics was also encountered throughout the non-cohesive fill deposit. Grinding of the augers was observed throughout the embankment fill deposit in all of the boreholes advanced at this site, suggesting the potential presence of cobbles; boulders and/or debris from abandoned temporary works associated with the original culvert construction may also be present buried within the fill and, and based on findings from other culvert sites, may consist of logs, stumps, and brush from the clearing and grubbing operations.

The SPT 'N'-values measured within the non-cohesive embankment fill deposit range between 13 blows and 58 blows per 0.3 m of penetration, indicating a generally compact to very dense relative density, with one 'N'-value of 3 blows per 0.3 m of penetration immediately below the cohesive fill, indication a loose relative density. One SPT 'N'-value measured in the non-cohesive embankment fill deposit is 3 blows per 0.3 m of penetration, suggesting a soft consistency.

The natural water content measured on seven samples of the non-cohesive embankment fill ranges between about 8 per cent and 17 per cent.

The results of grain size distribution tests completed on six samples of the sandy silt to silt and sand fill are shown on Figure B1 in Appendix B.

4.2.4 Silt

A 0.5 m to 2.8 m thick deposit of silt was encountered in Boreholes C6-2. C6-3 and C6-4 underlying the embankment fill, between Elevations 122.1 m and 120.1 m. Trace organics was encountered throughout the silt deposit in Borehole C6-2 and an organics content test measured 6.5 per cent organics on one sample of the deposit.

The SPT 'N'-values measured within the silt deposit range between 13 blows and 105 blows per 0.3 m of penetration, and 50 blows for 0.1 m of penetration at one sampling depth, indicating a compact to very dense relative density.

The natural water content measured on four samples of the silt deposit are between about 6 per cent and 16 per cent.

The results of grain size distribution tests completed on two samples of the silt deposit are shown on Figure B2 in Appendix B.

An Atterberg Limits test carried out on a sample of the silt deposit indicates that the material is non-plastic.

4.2.5 Silt to Silt and Sand Till

A till deposit comprised of silt to sandy silt to silt and sand, trace to some gravel, was encountered in all of the boreholes advanced at this site between depths of about 2.1 m and 11.5 m below ground surface, at between Elevations 123.5 m and 117.9 m, respectively, and the thickness of the deposit ranges between 6.8 m and 11.5 m but the deposit was not fully penetrated in Boreholes C6-2 to C6-4. Grinding of the augers was observed throughout the silt to silt and sand till deposit in some of the boreholes, suggesting the potential presence of cobbles and/or boulders.

The SPT 'N'-values measured within the silt to sandy silt till deposit range from 72 blows per 0.3 m of penetration to greater than 50 blows for 0.15 m of penetration, indicating a very dense relative density.

The natural water content measured on thirteen samples of this non-cohesive till deposit range between about 7 per cent and 15 per cent.

The results of grain size distribution tests completed on eight samples of the silt to sandy silt till deposit are shown on Figures B3 and B4 in Appendix B.

Atterberg limits tests carried out on two samples of the silt and sandy silt strata of the till deposit measured liquid limits of about 17 per cent and 13 per cent, plastic limits of about 15 per cent and 11 per cent and plasticity indices of about 2 per cent. These results, which are plotted on the plasticity chart on Figure B5, indicate that the fines of the till deposit are comprised of silt of slight plasticity.

4.2.6 Clayey Silt Till

A cohesive till deposit consisting of clayey silt, trace gravel was encountered in Borehole C6-1 underlying the silt and sand till deposit at a depths of 11.4 m below ground surface, corresponding to Elevation 114.2 m, and the deposit is 2.4 m thick but was not fully penetrated.

The SPT 'N'-values measured within the clayey silt till deposit are greater than 50 blows for 0.13 m of penetration, suggesting a hard consistency.

The natural water content measured on a sample of the clayey silt till is 11 per cent.

An Atterberg limits test carried out on one sample of the cohesive till deposit measured a liquid limit of about 17 per cent, a plastic limit of about 11 per cent and a plasticity index of about 6 per cent. The test result, which is plotted on the plasticity chart on Figure B6 in Appendix B, indicates that the material tested is a clayey silt of low plasticity.

4.2.7 Groundwater Conditions

The water level was measured in Borehole C6-1 and C6-2 upon completion of drilling operations at depths of 5.2 m and 10.7 below ground surface, corresponding to Elevations 120.4 m and 119.3 m.

A piezometer was installed in Borehole C6-4 on the south side of Highway 401 and the observed groundwater level is shown on the Record of Borehole sheet and summarized below.

Borehole	Depth to Water Level (m)	Groundwater Elevation (m)	Date of Measurement
C6-4	3.6	118.3	October 4, 2016
	-0.1	122.0	March 28, 2017

The water level observed in the boreholes during and/or upon completion of drilling may not represent the longer-term, stabilized groundwater level at the site. The water level at the site is expected to fluctuate seasonally in response to changes in precipitation and snow melt, and is expected to be higher during the spring and periods of precipitation.

4.3 Analytical Testing of Soil Sample

Analytical testing was carried out on a composite soil sample constituted from the SPT samples recovered from near the culvert invert elevation at Borehole C6-3. The analytical parameters include conductivity / resistivity, pH sulphate and chloride to allow for the assessment of the potential for the soil to cause deterioration of concrete and corrosion of steel. The laboratory test results are included in Appendix C and are summarized below.

Parameter	Test Result
Soil Resistivity	1200 ohm-cm
Soil Conductivity	824 umho/cm
Sulphate Concentration	23 ug/g
Chloride Concentration	450 ug/g
PH	7.95

5.0 CLOSURE

Ms. Amelia Jewison, supervised the borehole investigation program. This report was prepared by Mr. Matthew Kelly, P.Eng., a geotechnical engineer with Golder. Mr. Jorge Costa, P.Eng., a Senior Consultant with Golder and Designated MTO Foundations Contact conducted an independent quality control review of this report.

Report Signature Page

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Designated MTO Foundations Contact, Senior Consultant

MWK/JMAC/mck

n:\active\2015\3 proj\1540419 dm wills_culverts hwy35_on\culvert c6\reporting\final\1540419-6 fir 17june12 gwp 2242-14-00 - culvert 6 - part a only.docx

REFERENCES

Chapman, L. J., and Putnam, D.F., 1984. *The Physiography of Southern Ontario*, 3rd Edition. Ontario Geological Survey, Special Volume 2. Ontario Ministry of Natural Resources.

Karrow, P. F., and White, O. L., 1998. Urban Geology of Canadian Cities. Geological Association of Canada Special Paper No. 42. St. John's, Nfld.

Ontario Water Resources Act:

Ontario Regulation 372/9 Amendment to Ontario Regulation 903

ASTM

ASTM D1586-11 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils, ASTM International, West Conshohocken, PA, 2011

TABLES

Table 1: Summary of Existing Culvert Details

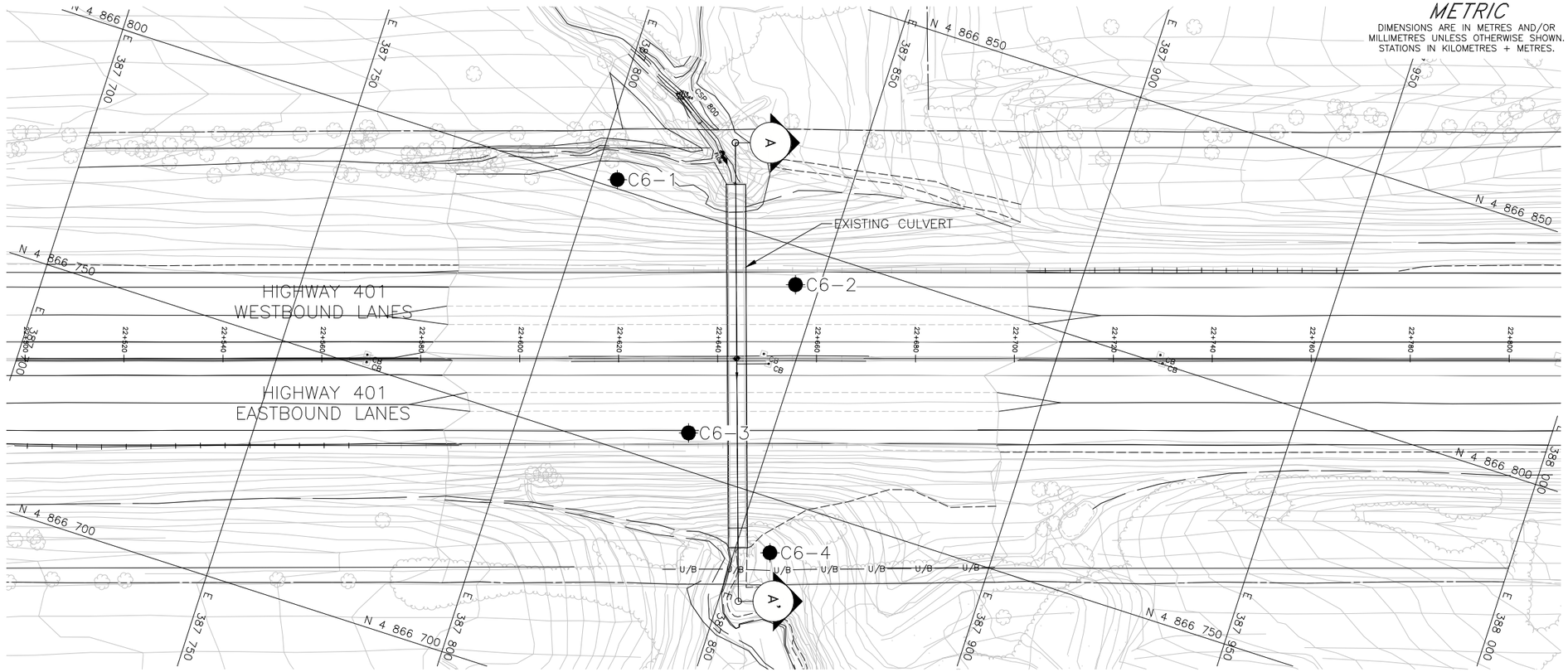
Culvert Location (Municipality)	Culvert ID / Site No.	Approximate Height of Embankment	Existing Culvert			Approximate Invert Elevation [2]		Boreholes
			Type	Approximate Dimension	Approximate Length	Inlet (North End)	Outlet (South End)	
STA 22+644 (Clarington)	C6 / 21-494/C	Up to about 9.2m	Open Footing	3.05 m wide x 1.56 m high	73.5 m	121.5 m	120.9 m	4 Boreholes (C6-1 to C6-4)

Notes: 1. Embankment height is relative to existing ground surface level at the toe of embankment adjacent to the culvert based on drawings provided by D.M. Wills dated August 22, 2016

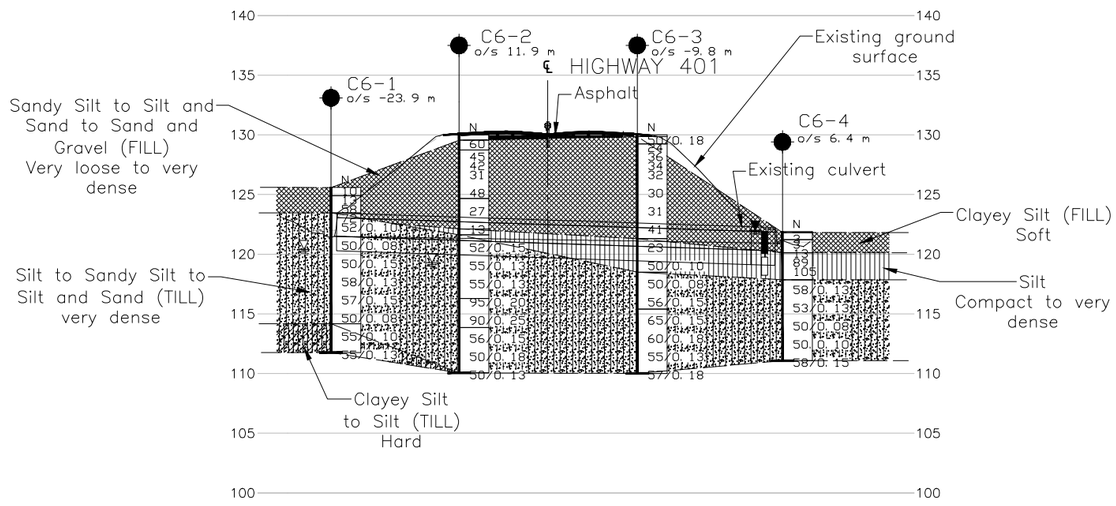
2. Culvert invert elevations are based on drawings provided by D.M. Wills dated August 22, 2016.

DRAWINGS

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN
SCALE
10 0 10 20 m



A-A' / 1 CULVERT C6
STA. 22+644

HORIZONTAL SCALE
10 0 10 20 m

VERTICAL SCALE
5 0 5 10 m

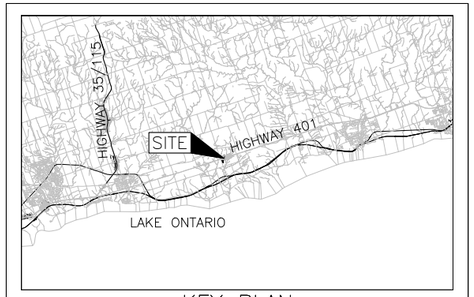
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No. 2017-2016
WP No. 2242-14-00

HIGHWAY 401
SITE 21-494/C
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET 11

Golder Associates



KEY PLAN
SCALE
6 0 6 12 km

LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer, measured on MAR. 28, 2017
- WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
C6-1	125.6	4866801.7	387804.4
C6-2	130.0	4866792.6	387845.2
C6-3	130.0	4866757.4	387833.9
C6-4	121.9	4866739.4	387857.0

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.

Geographic Coordinates of Culvert: Latitude 43.935910; Longitude -78.465670

REFERENCE

Base Plan and Contours provided in digital format by DM Wills, drawing file nos. 124234.dwg, received Jan. 20, 2016. Design Plan and Section provided in digital format by DM Wills, drawing file no. 4561-C6 GA.dwg, received Jan. 3, 2017.

LICENSED PROFESSIONAL ENGINEER M.W. KELLY 100125796 June 12, 2017 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER J. M. A. COSTA June 12, 2017 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 30M15-312

HWY. 401		PROJECT NO. 1540419	DIST.
SUBM'D. MCK	CHKD. MCK	DATE: 6/12/2017	SITE: 21-494/C
DRAWN: SMD	CHKD. MWK	APPD. JMAC	DWG. 1

PLOT DATE: June 14, 2017
FILENAME: S:\Clients\MTO\Hwy_401_&_Hwy35-115\09_PROJ\1540419_DM Wills_Culvert\active\MTO_PROD\0006_C6_Foundations\1540419-0006-BC-0001.dwg

APPENDIX A

Record of Boreholes

LIST OF SYMBOLS

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 = $(w_l - w_p)$
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

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. 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.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance; 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, 60º 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

Piezo-Cone Penetration Test (CPT)
A 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 (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Non-Cohesive Soils

Density Index / Relative Density	N Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils
Consistency

	c_u, s_u kPa	c_u, s_u psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, G_s)
DS	direct shear test
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	field vane (LV-laboratory vane test)
γ	unit weight

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

V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless))	Sand and Gravel
	or With (cohesive)	Silty Clay with sand / Clayey Silt with sand

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RECORD OF BOREHOLE No C6-1

SHEET 1 OF 2

METRIC

PROJECT 1540419

G.W.P. 2242-14-00 LOCATION N 4866801.7; E 387804.4 MTM ZONE 10 (LAT. 43.936526; LONG. -78.466115) ORIGINATED BY AJ

DIST HWY 401 BOREHOLE TYPE CME 75, 127 mm Dia. Solid Stem Augers (Automatic Hammer) COMPILED BY SZ

DATUM Geodetic DATE October 5, 2016 CHECKED BY MWK

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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
125.6	GROUND SURFACE										
0.0 / 124.9	Sandy silt, trace clay, trace gravel (FILL) Compact Brown		1	SS	10		125				
0.7	Moist										
	Gravelly silt and sand, trace to some clay (FILL) Compact to very dense Brown Moist		2	SS	13						
			3	SS	58		124		○		20 38 36 6
123.5 / 2.1	- Auger grinding between depths of 1.2 m and 1.5 m below ground surface (Elev. 124.4 m and 124.1 m)										
	SILT and SAND, trace to some gravel, trace to some clay (TILL) Very dense Brown to grey Moist		4	SS	72		123		○		
			5	SS	52/0.10						
	- Auger grinding at a depth of 3.4 m below ground surface (Elev. 122.2 m)						122				
	- Becoming wet below a depth of 4.6 m below ground surface (Elev. 121.0 m)		6	SS	50/0.08	▽	121		○		4 42 48 6
			7	SS	50/0.15		120				
	- Auger grinding at a depth of 6.4 m below ground surface (Elev. 119.2 m)						119				
			8	SS	58/0.13		118		○		9 39 47 5
			9	SS	57/0.15		117		○		
			10	SS	50/0.08		116				
114.2 / 11.4	CLAYEY SILT, trace sand (TILL) Hard Grey Moist						115				
			11	SS	55/0.10		114		○⊢		
							113				
111.8 / 13.8	END OF BOREHOLE		12	SS	55/0.13		112				

Continued Next Page

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

Golder Associates

PROJECT 1540419

RECORD OF BOREHOLE No C6-1

SHEET 2 OF 2

METRIC

G.W.P. 2242-14-00 LOCATION N 4866801.7; E 387804.4 MTM ZONE 10 (LAT. 43.936526; LONG. -78.466115) ORIGINATED BY AJ

DIST HWY 401 BOREHOLE TYPE CME 75, 127 mm Dia. Solid Stem Augers (Automatic Hammer) COMPILED BY SZ

DATUM Geodetic DATE October 5, 2016 CHECKED BY MWK

SOIL PROFILE			SAMPLES			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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	NOTE: 1. Water level in open borehole at a depth of 5.2 m below ground surface (Elev. 120.4 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No C6-2

SHEET 1 OF 2

METRIC

PROJECT 1540419

G.W.P. 2242-14-00 LOCATION N 4866792.6; E 387845.2 MTM ZONE 10 (LAT. 43.936431; LONG. -78.465606) ORIGINATED BY AJ

DIST HWY 401 BOREHOLE TYPE CME 75, 127 mm Dia. Solid Stem Augers (Automatic Hammer) COMPILED BY SZ

DATUM Geodetic DATE October 6, 2016 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
130.0	GROUND SURFACE										
0.0 / 129.5	ASPHALT										
0.5 / 128.7	Sand and gravel, trace silt (FILL) Very dense Brown Moist		1	SS	60		129				
1.3	Silt and sand, trace to some gravel, trace to some clay (FILL) Dense Brown Moist		2	SS	45		128				
			3	SS	42				○		10 45 39 6
			4	SS	31		127				
			5	SS	48		126		○		5 46 43 6
124.7							125				
5.3	Silty sand, trace gravel, trace clay, trace organics (FILL) Compact Grey to brown Moist		6	SS	27		124				
122.1			7A	SS	13		123				
7.9	SILT, some sand, trace organics (rootlets) Compact Brown Moist		7B				122		○	OC=6.5%	
121.6											
8.4	Sandy SILT, trace to some clay, trace gravel (TILL) Very dense Grey Moist		8	SS	52/0.15		121				
			9	SS	55/0.13	▽	120		○		0 22 71 7
			10	SS	55/0.13		119				
							118				
116.3							117				
13.7	SILT, trace to some sand, trace to some clay (TILL) Very dense Grey Wet		11	SS	95/0.20		116		⊕		0 15 75 10

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No C6-2

SHEET 2 OF 2 **METRIC**

PROJECT 1540419
G.W.P. 2242-14-00 LOCATION N 4866792.6; E 387845.2 MTM ZONE 10 (LAT. 43.936431; LONG. -78.465606) ORIGINATED BY AJ
DIST HWY 401 BOREHOLE TYPE CME 75, 127 mm Dia. Solid Stem Augers (Automatic Hammer) COMPILED BY SZ
DATUM Geodetic DATE October 6, 2016 CHECKED BY MWK

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 (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILT, trace to some sand, trace to some clay (TILL) Very dense Grey Wet		12	SS	90/0.25				○		
113.9							114				
16.2	Sandy SILT, trace to some gravel, some clay (TILL) Very dense Grey Wet		13	SS	56/0.15		113				
							112		○H		10 28 53 9
			14	SS	50/0.18		111				
110.1			15	SS	50/0.13						
19.9	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 10.7 m below ground surface (Elev. 119.3 m) upon completion of drilling.										

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

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RECORD OF BOREHOLE No C6-3

SHEET 1 OF 2

METRIC

PROJECT 1540419

G.W.P. 2242-14-00 LOCATION N 4866757.4; E 387833.9 MTM ZONE 10 (LAT. 43.936124; LONG. -78.465756) ORIGINATED BY AJ

DIST HWY 401 BOREHOLE TYPE CME 75, 208 mm O.D., 108 mm I.D. Hollow Stem Augers (Automatic Hammer) COMPILED BY SZ

DATUM Geodetic DATE December 1, 2016 CHECKED BY MWK

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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
130.0	GROUND SURFACE										
0.0	ASPHALT										
0.2	Sand and gravel (FILL) Very dense Brown		1	SS	50/0.18						
129.2	Moist						129				
0.8	Silt and sand, trace to some gravel, trace to some clay (FILL) Compact to dense Brown Moist		2	SS	24						
			3	SS	36		128		○		
			4	SS	34						
			5	SS	32		127				
	- Auger grinding between depths of 3.7 m and 4.0 m below ground surface (Elev.126.3 m and 126.0 m)						126				
			6	SS	30		125		○		10 42 43 5
	- Auger grinding at a depth of 5.2 m below ground surface (Elev.124.8 m)										
			7	SS	31		124				
			8	SS	41		123		○		5 39 51 5
	- Auger grinding at a depth of 8.2 m below ground surface (Elev.121.8 m)						122				
121.3											
8.7	SILT, trace to some sand, trace clay Compact to very dense Grey Wet		9	SS	23		121		○		
			10	SS	50/0.10		120		○		0 10 85 5
118.5							119				
11.5	SILT to SILT and SAND, trace to some gravel, trace to some clay (TILL) Very dense Grey Wet		11	SS	50/0.08		118				
							117				
			12	SS	56/0.15		116		○		7 34 46 13
115.4											
14.6											

Continued Next Page

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

Golder Associates

PROJECT 1540419

RECORD OF BOREHOLE No C6-3

SHEET 2 OF 2

METRIC

G.W.P. 2242-14-00 LOCATION N 4866757.4; E 387833.9 MTM ZONE 10 (LAT. 43.936124; LONG. -78.465756) ORIGINATED BY AJ

DIST HWY 401 BOREHOLE TYPE CME 75, 208 mm O.D., 108 mm I.D. Hollow Stem Augers (Automatic Hammer) COMPILED BY SZ

DATUM Geodetic DATE December 1, 2016 CHECKED BY MWK

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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILT, some sand, trace gravel, some clay (TILL) Hard Grey Wet		13	SS	65/0.15		114				
			14	SS	60/0.18		113		○		1 18 68 13
			15	SS	55/0.13		112				
110.0			16	SS	57/0.18		111		○		
20.0	END OF BOREHOLE NOTE: 1. Water level not established.										

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

Golder Associates

RECORD OF BOREHOLE No C6-4

SHEET 1 OF 1

METRIC

PROJECT 1540419

G.W.P. 2242-14-00 LOCATION N 4866739.4; E 387857.0 MTM ZONE 10 (LAT. 43.935959; LONG. -78.465471) ORIGINATED BY AJ/IK

DIST HWY 401 BOREHOLE TYPE CME 75, 178 mm O.D., 108 mm I.D. Hollow Stem Augers (Automatic Hammer) COMPILED BY SZ

DATUM Geodetic DATE October 3 and 4, 2016 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"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 (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
121.9	GROUND SURFACE										
0.0 / 0.1	TOPSOIL		1A								
	Clayey silt, some sand, trace gravel, trace organics (FILL)		1B	SS	3						
121.2 / 0.7	Soft Grey Moist										
	Sandy silt, some clay, trace gravel, trace organics (rootlets) (FILL)		2	SS	3		121		○		0 21 73 6
	Very loose Brown		3A								
120.1 / 1.8	Wet - Auger grinding at a depth of 1.5 m below ground surface (Elev. 120.4 m)		3B	SS	13		120				
	SILT, some clay, trace to some sand Compact to very dense Grey Moist		4	SS	89		119		○	NP	0 5 87 8
			5	SS	105						
117.9 / 4.0	Sandy SILT to SILT and SAND, trace to some gravel, trace to some clay (TILL) Very dense Grey Dry to moist		6	SS	58/0.13		118 117		○		7 18 62 13
			7	SS	53/0.13		116				
	- Auger grinding between depths of 6.7 m and 7.0 m below ground surface (Elev. 115.2 m and 114.9 m)		8	SS	50/0.08		115 114				
			9	SS	50/0.10		113		○		7 42 44 7
	- Auger grinding at a depth of 9.4 m below ground surface (Elev. 112.5 m)						112				
111.1 / 10.8	END OF BOREHOLE		10	SS	58/0.15				○		

NOTES:

1. Borehole caved to a depth of 8.2 m below ground surface.

2. Well installed 0.6 m west of Borehole C6-4.

3. Water level measured in piezometer:

Date	Depth(m)	Elev.(m)
04/10/16	3.6	118.3
28/03/17	-0.1	122.0

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

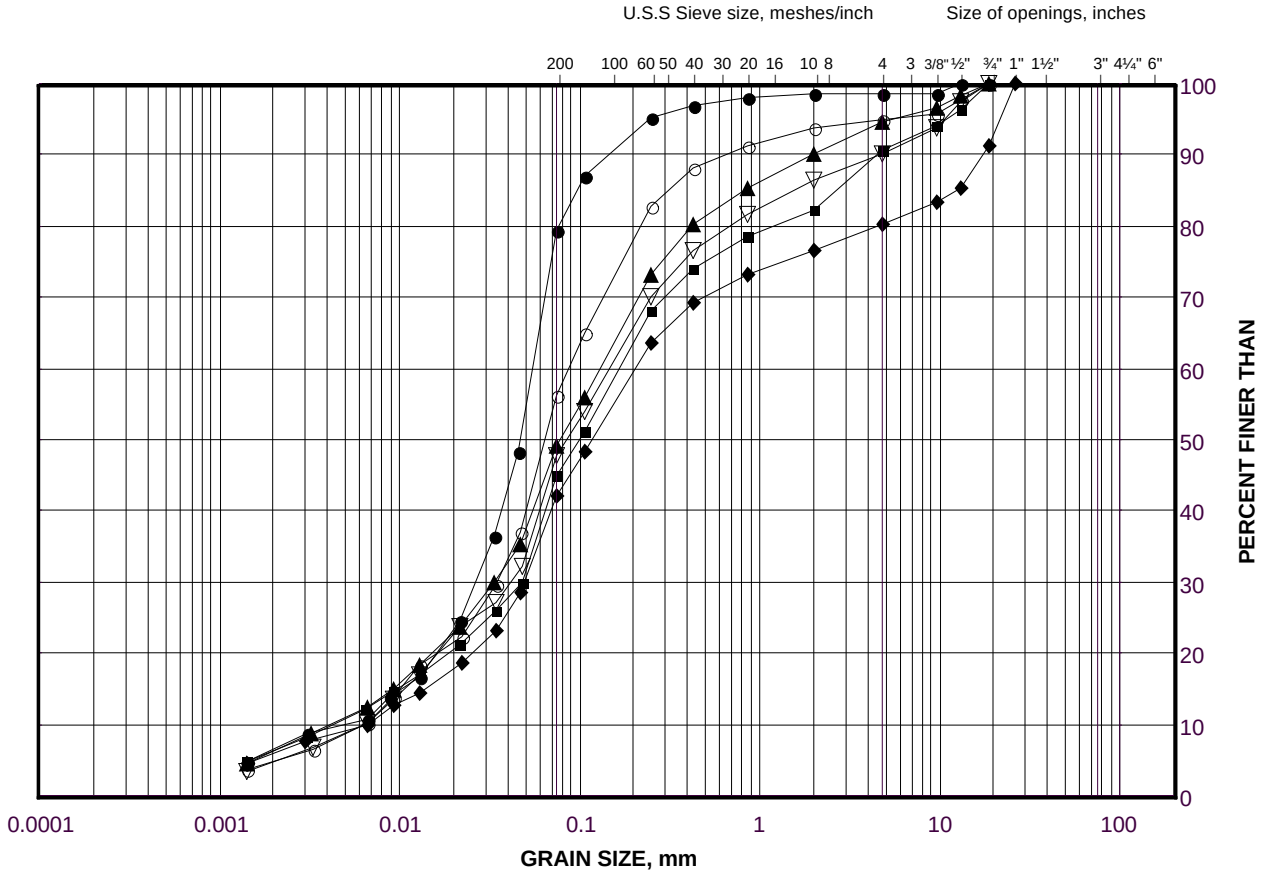
APPENDIX B

Laboratory Results

GRAIN SIZE DISTRIBUTION

Sandy Silt to Silt and Sand (Fill)

FIGURE B1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C6-4	2	120.9
■	C6-2	3	127.5
◆	C6-1	3	123.8
▲	C6-2	5	125.2
▽	C6-3	6	125.1
❍	C6-3	8	122.0

Project Number: 1540419

Checked By: MWK

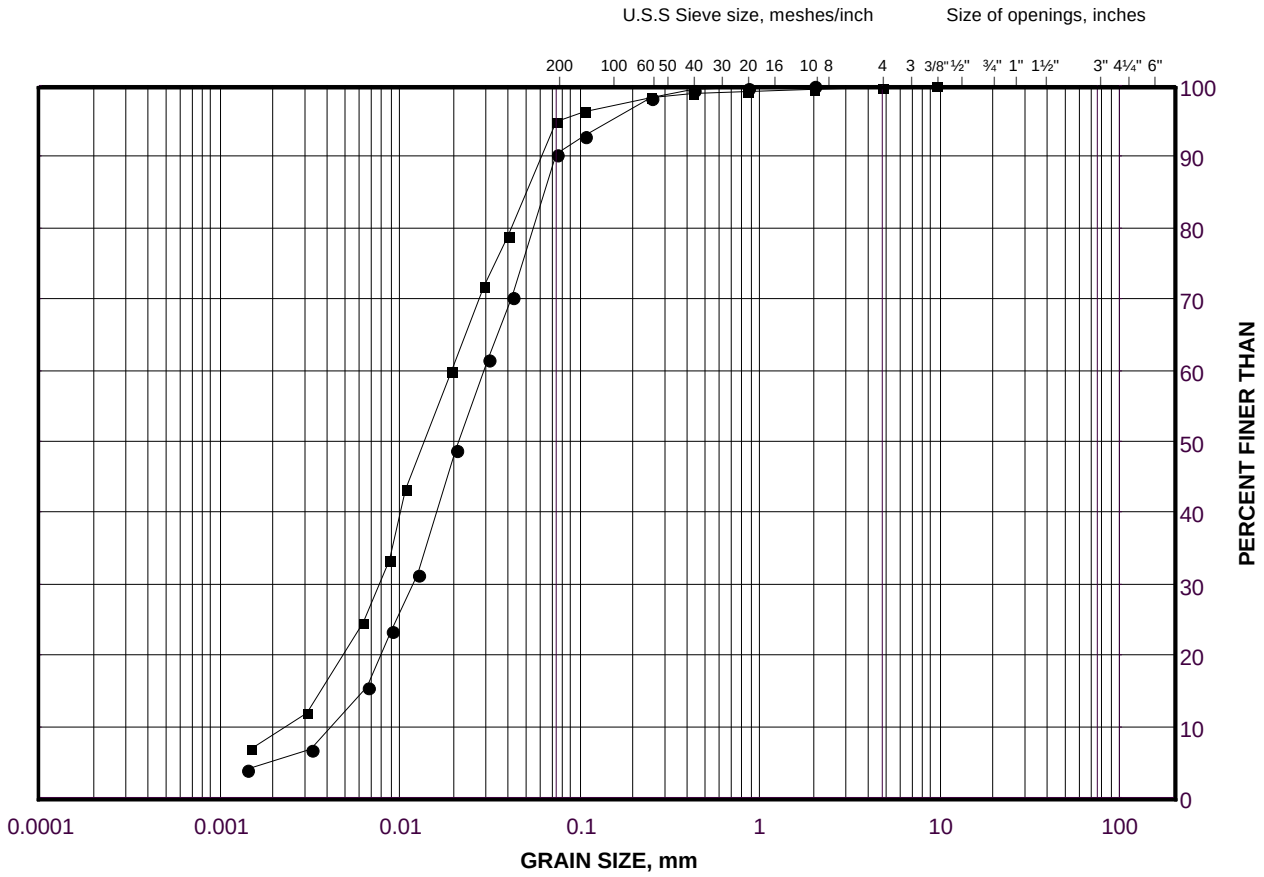
Golder Associates

Date: 31-Jan-17

GRAIN SIZE DISTRIBUTION

Silt

FIGURE B2



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	C6-3	10	119.1
■	C6-4	4	119.4

Project Number: 1540419

Checked By: MWK

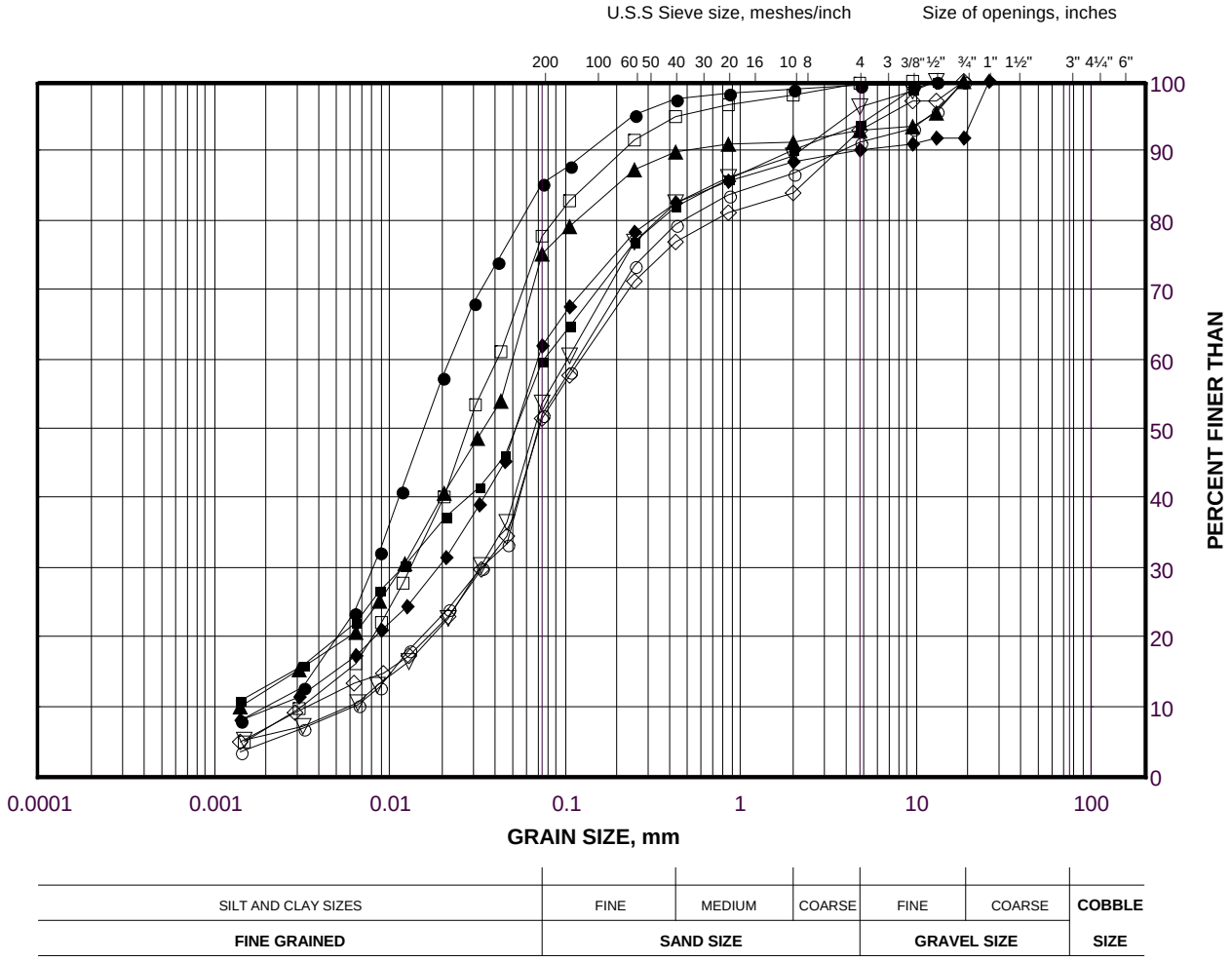
Golder Associates

Date: 31-Jan-17

GRAIN SIZE DISTRIBUTION

Sandy Silt to Silt and Sand (Till)

FIGURE B3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	C6-2	11	116.2
■	C6-3	12	116.2
◆	C6-2	14	111.6
◘	C6-4	6	117.2
⬩	C6-1	6	120.9
❍	C6-1	8	117.9
□	C6-2	9	119.2
❒	C6-4	9	112.8

Project Number: 1540419

Checked By: MWK

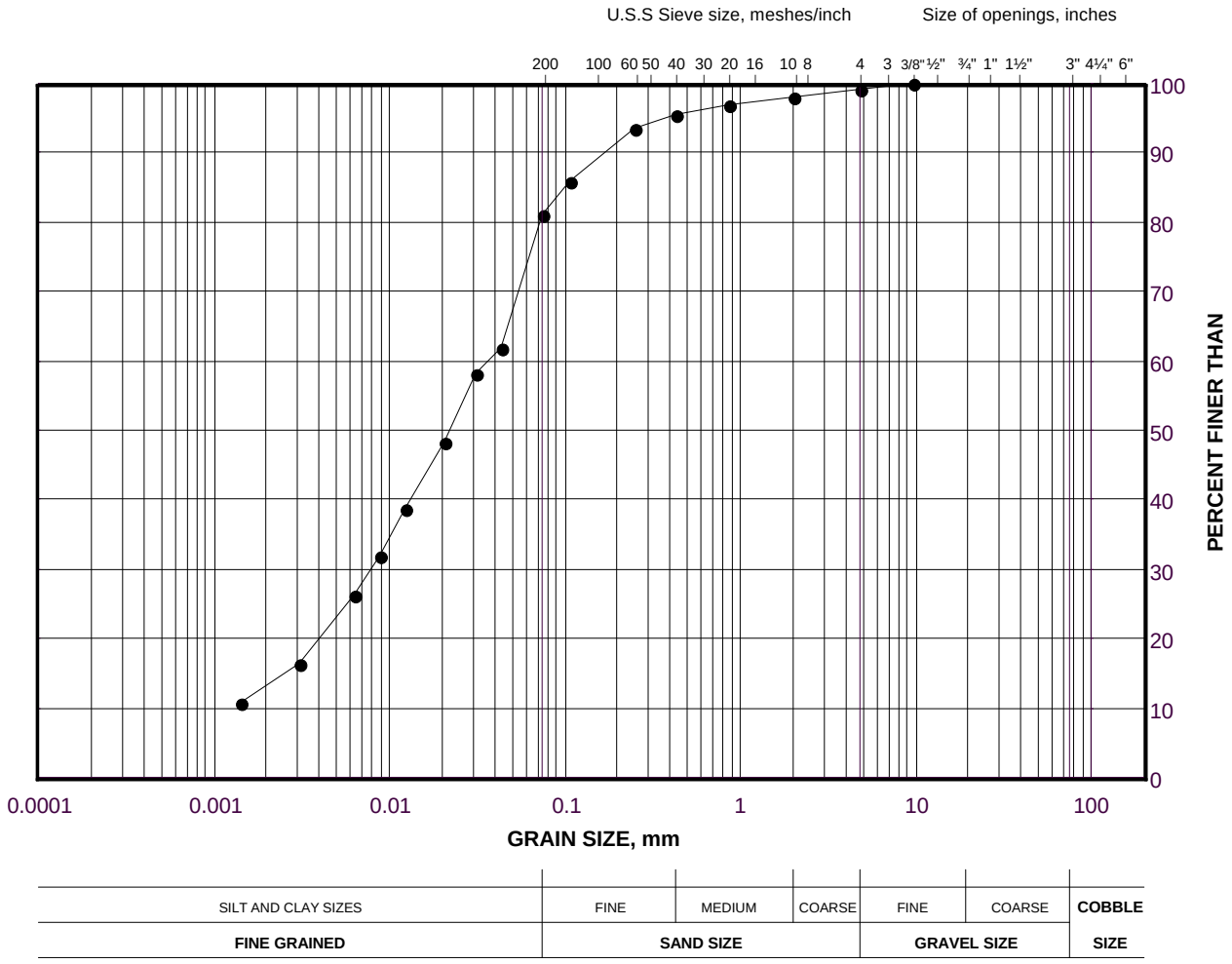
Golder Associates

Date: 02-Feb-17

GRAIN SIZE DISTRIBUTION

Silt (Till)

FIGURE B4



LEGEND

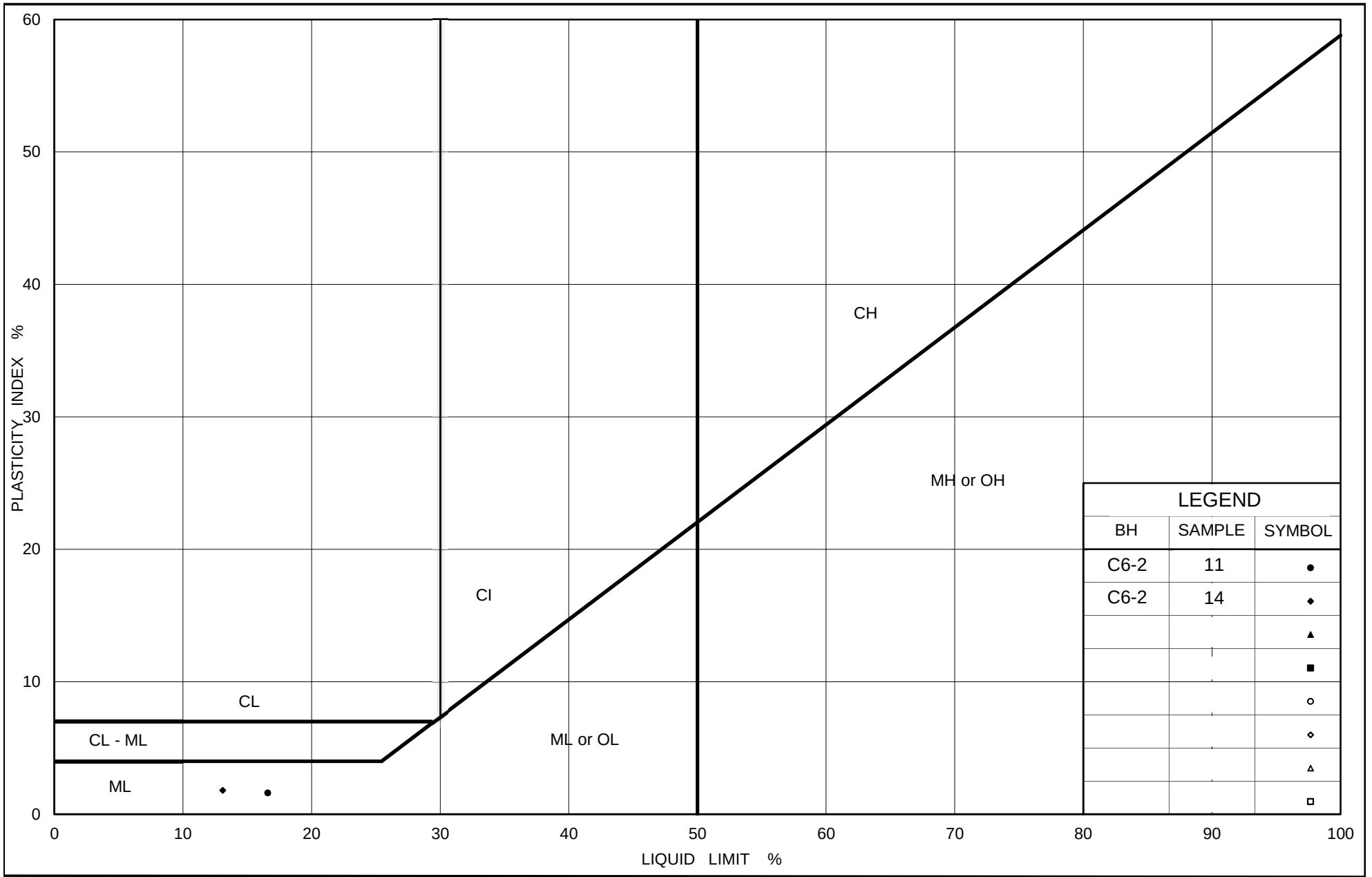
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C6-3	14	113.1

Project Number: 1540419

Checked By: MWK

Golder Associates

Date: 02-Feb-17



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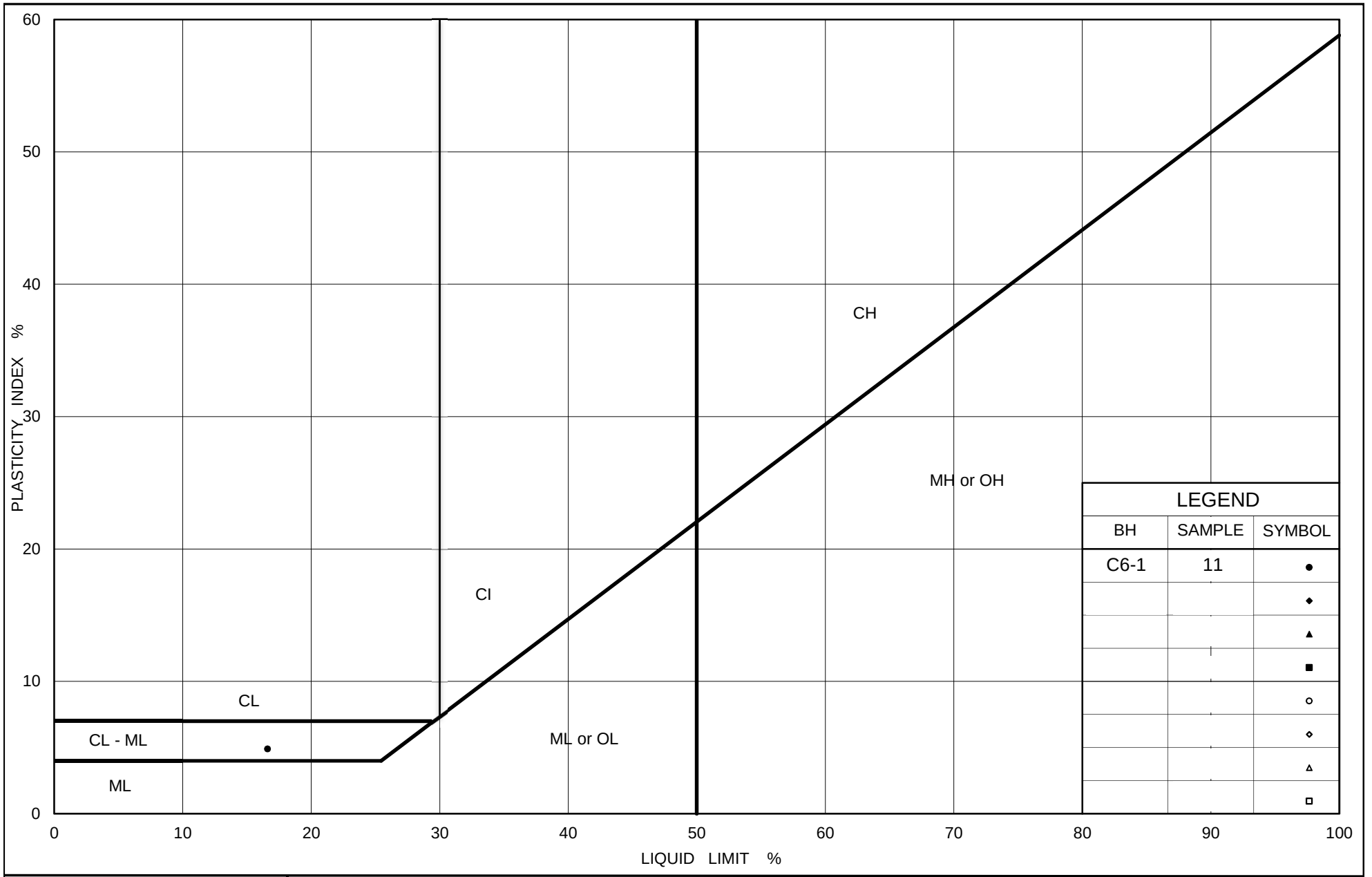
PLASTICITY CHART
Silt (Till)

Figure No. B5

Project No. 1540419

Checked By: MWK



Golder Associates

PLASTICITY CHART
Clayey Silt (Till)

Figure No. B6

Project No. 1540419

Checked By: MWK

APPENDIX C

Analytical Test Results

Your Project #: 1540419
Your C.O.C. #: 573330-02-01

Attention:Matt Kelly

Golder Associates Ltd
Mississauga - Standing Offer
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2016/12/22
Report #: R4298821
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B6R4426
Received: 2016/12/16, 15:25

Sample Matrix: Soil
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	3	N/A	2016/12/21	CAM SOP-00463	EPA 325.2 m
Conductivity	3	N/A	2016/12/21	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	3	2016/12/20	2016/12/20	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	3	2016/12/16	2016/12/22	CAM SOP-00414	SM 22 2510 m
Sulphate (20:1 Extract)	3	N/A	2016/12/21	CAM SOP-00464	EPA 375.4 m

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

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

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

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

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Your Project #: 1540419
Your C.O.C. #: 573330-02-01

Attention:Matt Kelly

Golder Associates Ltd
Mississauga - Standing Offer
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2016/12/22
Report #: R4298821
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B6R4426
Received: 2016/12/16, 15:25

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ema Gitej, Senior Project Manager
Email: EGitej@maxxam.ca
Phone# (905)817-5829

==========

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

Maxxam Job #: B6R4426
Report Date: 2016/12/22

Golder Associates Ltd
Client Project #: 1540419
Sampler Initials: AJ

RESULTS OF ANALYSES OF SOIL

Maxxam ID		DQK405	DQK406	DQK407		
Sampling Date		2016/11/27 04:00	2016/12/01 22:00	2016/12/06 03:00		
COC Number		573330-02-01	573330-02-01	573330-02-01		
	UNITS	C5	C6	C7	RDL	QC Batch
Calculated Parameters						
Resistivity	ohm-cm	1100	1200	2100		4796272
Inorganics						
Soluble (20:1) Chloride (Cl)	ug/g	340	450	180	20	4799839
Conductivity	umho/cm	889	824	467	2	4800256
Available (CaCl2) pH	pH	7.69	7.95	7.86		4798509
Soluble (20:1) Sulphate (SO4)	ug/g	240	23	49	20	4799840

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam Job #: B6R4426
Report Date: 2016/12/22

Golder Associates Ltd
Client Project #: 1540419
Sampler Initials: AJ

TEST SUMMARY

Maxxam ID: DQK405
Sample ID: C5
Matrix: Soil

Collected: 2016/11/27
Shipped:
Received: 2016/12/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4799839	N/A	2016/12/21	Deonarine Ramnarine
Conductivity	AT	4800256	N/A	2016/12/21	Tahir Anwar
pH CaCl2 EXTRACT	AT	4798509	2016/12/20	2016/12/20	Surinder Rai
Resistivity of Soil		4796272	2016/12/22	2016/12/22	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	4799840	N/A	2016/12/21	Deonarine Ramnarine

Maxxam ID: DQK406
Sample ID: C6
Matrix: Soil

Collected: 2016/12/01
Shipped:
Received: 2016/12/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4799839	N/A	2016/12/21	Deonarine Ramnarine
Conductivity	AT	4800256	N/A	2016/12/21	Tahir Anwar
pH CaCl2 EXTRACT	AT	4798509	2016/12/20	2016/12/20	Surinder Rai
Resistivity of Soil		4796272	2016/12/22	2016/12/22	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	4799840	N/A	2016/12/21	Deonarine Ramnarine

Maxxam ID: DQK407
Sample ID: C7
Matrix: Soil

Collected: 2016/12/06
Shipped:
Received: 2016/12/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4799839	N/A	2016/12/21	Deonarine Ramnarine
Conductivity	AT	4800256	N/A	2016/12/21	Tahir Anwar
pH CaCl2 EXTRACT	AT	4798509	2016/12/20	2016/12/20	Surinder Rai
Resistivity of Soil		4796272	2016/12/22	2016/12/22	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	4799840	N/A	2016/12/21	Deonarine Ramnarine

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam Job #: B6R4426
Report Date: 2016/12/22

Golder Associates Ltd
Client Project #: 1540419
Sampler Initials: AJ

GENERAL COMMENTS

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

Package 1	5.7°C

Results relate only to the items tested.

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Maxxam Job #: B6R4426
Report Date: 2016/12/22

QUALITY ASSURANCE REPORT

Golder Associates Ltd
Client Project #: 1540419
Sampler Initials: AJ

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
4798509	Available (CaCl2) pH	2016/12/20			98	97 - 103			1.4	N/A
4799839	Soluble (20:1) Chloride (Cl)	2016/12/21	115	70 - 130	106	70 - 130	<20	ug/g	NC	35
4799840	Soluble (20:1) Sulphate (SO4)	2016/12/21	NC	70 - 130	106	70 - 130	<20	ug/g	NC	35
4800256	Conductivity	2016/12/21			100	90 - 110	<2	umho/cm	1.6	10

N/A = Not Applicable

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

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

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

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

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

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Maxxam Job #: B6R4426
Report Date: 2016/12/22

Golder Associates Ltd
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Sampler Initials: AJ

VALIDATION SIGNATURE PAGE

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

Cristina Carriere

Cristina Carriere, Scientific Services

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

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CHAIN OF CUSTODY RECORD

Page of

INVOICE TO:
Company Name: #1326 Golder Associates Ltd
Attention: Central Acct:1112, 1113, 1118
Address: 6925 Century Ave Suite 100, Mississauga ON L5N 7K2
Tel: (905) 567-4444 Fax: (905) 567-6561
Email: Catherine_Guiao@golder.com, Rachel_Benjamin@gol

REPORT TO:
Company Name:
Attention: Matt Kelly ; Madison Kennedy
Address:
Tel: Fax:
Email: Matthew_Kelly@golder.com ; MadKennedy@golder.c

PROJECT INFORMATION:
Quotation #: B63104
P.O. #:
Project: 1540419
Project Name:
Site #:
Sampled By:

Laboratory Use Only:
Maxxam Job #:
Bottle Order #: 573330
COC #: C#573330-02-01
Project Manager: Ema Gitej

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011): ☐ Table 1 ☐ Res/Park ☐ Medium/Fine ☐ Table 2 ☐ Ind/Comm ☐ Coarse ☐ Table 3 ☐ Agri/Other ☐ For RSC ☐ Table ___

Other Regulations: ☐ CCME ☐ Sanitary Sewer Bylaw ☐ Reg 558 ☐ Storm Sewer Bylaw ☐ MISA Municipality ☐ PWQO ☐ Other

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ___

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT:
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests..
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: Time Required:
Rush Confirmation Number: *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	Corrosivity pkg (Cl, SO4, EC, Resistivity, pH)	# of Bottles	Comments
1		C5	2016/11/27	4:00 am	Soil	X		1	
2		C6	2016/12/01	10:00pm	Soil	X		1	
3		C7	2016/12/06	3:00am	Soil	X		1	
4									
5									
6									
7									
8									
9									
10									

16-Dec-16 15:25
Ema Gitej
B6R4426
SEL ENV-1146

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted	Laboratory Use Only: Time Sensitive	Temperature (°C) on Receipt	Custody Seal	Yes	No
Amelia Jewison	16/12/16	3:25	Tanvir Tanvir	2016/12/10	15:25			6/6/6	Present		
									Intact		

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

White: Maxxam Yellow: Client

Maxxam Analytics International Corporation o/a Maxxam Analytics

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

For more information, visit golder.com

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