REPORT

December 21, 2016

FOUNDATION INVESTIGATION REPORT

Highway 400 Culvert 97 Rehabilitation Inlet End Gabion Basket Wall Barrie, Ontario G.W.P. 2184-10-00 Agreement No.: 4014-E-0012 Assignment No. 10

Submitted to:
Ministry of Transportation Ontario
Foundation Engineering Section
145 Sir William Hearst Avenue
Downsview, Ontario M3M 0B6

GEOCRES No.: 31D-667

Report Number: 1413191-10

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HIGHWAY 400 CULVERT 97 GABION BASKET WALL
BARRIE, ONTARIO
AGREEMENT NO. 4014-E-0012 – ASSIGNMENT NO. 10
G.W.P. 2184-10-00

December 21, 2016
Report No. 1413191-10

Golder Associates

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by the Ministry of Transportation, Ontario (MTO) under MTO's Eastern Region Foundation Engineering Retainer (Agreement No. 4014-E-0012) to provide foundation engineering services for a proposed gabion basket retaining wall / head wall at the inlet (west side of the SBL embankment) of Culvert 97 crossing under Highway 400 at approximately Station 24+327, which is located approximately 920 m south of Mapleview Drive in the City of Barrie, Ontario. The general location of the culvert is shown on the Key Plan on Drawing 1.

The Terms of Reference and Scope of Work for the foundation investigation are outlined in MTO Work Item Form No. 10 of Agreement No. 4014-E-0012, which was sent to Golder via email on August 2, 2016 and the detailed scope of work is presented in Golder's Understanding of the Scope letter dated August 6, 2016. Authorization to proceed was received from MTO via an email on August 12, 2016.

2.0 SITE AND PROJECT DESCRIPTION

Culvert 97 crossing under Highway 400 is located at STA 24+327, approximately 920 m south of Mapleview Drive in the City of Barrie, Ontario. The existing culvert is oriented east to west, with the inlet on the west side of the highway embankment and the outlet on the east side of the embankment. The invert of the inlet and outlet of the existing culvert are at approximately Elevation 289 m and 288 m, respectively. The existing culvert is a 1220 x 900 mm reinforced concrete open footing culvert and is approximately 50 m in length. The Highway 400 road surface is at between approximately Elevation 293.4 m and 294 m sloping downward from west to east and the highway embankment is approximately 4.5 m high relative to the ground surface at the toe adjacent to the culvert.

3.0 INVESTIGATION PROCEDURES

The field work was carried out on September 26 and 27, 2016, during which time a total of two boreholes (Boreholes C97-1 and C97-2) were advanced on the west side of Highway 400: one borehole at the crest of the embankment through the Highway 400 southbound lane right shoulder; and one borehole near the inlet of Culvert 97 on the west side of the Highway 400 embankment. Boreholes C97-1 and C97-2 were advanced to depths of 11.1 m and 6.6 m below ground surface, respectively. The borehole locations are shown in plan on Drawing 1.

The borehole investigation was carried out using a D-50 track-mounted drill rig supplied and operated by Walker Drilling of Utopia, Ontario. The boreholes were advanced through the overburden using 210 mm outside diameter (O.D.) continuous flight hollow-stem augers. Soil samples were obtained at intervals of depth of about 0.75 m and 1.5 m, using a 50 mm outside diameter split-spoon sampler driven by an automatic hammer in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586 – Standard Test Method for Standard Penetration Test).

The groundwater conditions were noted in open boreholes during and upon completion of drilling. All boreholes were backfilled to the ground surface upon completion of the drilling operations using bentonite pellets, in accordance with Ontario Regulation 903, as amended. The borehole located on the shoulder of Highway 400 was patched at the surface with cold mix asphalt.

The field work for this investigation was observed by a member of our engineering staff who arranged for underground service locates, observed the drilling and sampling operations, and logged the boreholes. The soil samples were identified in the field, placed in appropriate containers, labelled and transported to Golder's Mississauga geotechnical laboratory where samples underwent further visual examination and laboratory testing including natural water content testing and selected classification testing (i.e. sieve and hydrometer and Atterberg limits).

The as-drilled boreholes were located in the field by Golder, relative to existing site features on the site plan and profile drawings titled "New Construction, STA 24+300 to STA 25+000", dated July 13, 2016, provided by MTO on August 2, 2016. The ground surface elevations and coordinates of the boreholes were obtained by Golder from a Global Positioning System (GPS). The borehole locations in MTM NAD83 Zone 17 northing and easting coordinates, the ground surface elevations referenced to Geodetic datum and the borehole drilled depths are summarized in the table below. The MTM NAD83 coordinates and ground surface elevations are also presented on the borehole records.

Borehole Number	Location (MTM NAD 83)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m)	Easting (m)		
C97-1	4909673.1	290209.8	293.3	11.1
C97-2	4909681.7	290198.2	290.8	6.6

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

As delineated in *The Physiography of Southern Ontario*[1], this section of Highway 400 lies within the Peterborough Drumlin Field physiographic region which consists primarily of sandy till deposits and sand to sand and gravel deposits. Deposits of silt, clay or peat may also be found in the low-lying areas between drumlins and eskers.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes advanced as part of the investigation, together with the results of in situ and laboratory testing are presented on the Record of Borehole sheets and laboratory test summary figures provided in Appendices A and B, respectively. The results of the in situ field tests (i.e. SPT 'N'-values) as presented on the Record of Borehole sheets and in Section 4.2 are uncorrected.

The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from observations of drilling progress and non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

[1] Chapman, L. J. and Putnam, D. F., 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey. Special Volume 2, Third Edition. Accompanied by Map P.2715, Scale 1:600,000. Ontario Ministry of Natural Resources.

In general, the subsurface conditions on the west side of the Highway 400 southbound lanes at Culvert 97 consist of asphalt or topsoil underlain by gravelly sand and/or silty sand fill. The fill layers are underlain by a deposit of silty sand at one borehole location and by a deposit of silty clay. The silty clay deposit in turn is underlain by a deposit of sand. A detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.1 Asphalt

A 230 mm thick layer of asphalt was encountered at ground surface in Borehole C97-1.

4.2.2 Topsoil

An approximately 100 mm thick layer of topsoil was encountered at ground surface of Borehole C97-2.

4.2.3 Gravelly Sand Fill

A 0.5 m thick layer of gravelly sand fill was encountered below the asphalt in Borehole C97-1 at a depth of 0.2 m below ground surface (Elevation 293.1 m). The gravelly sand fill contains some silt and trace clay.

One SPT 'N'-value of 16 blows per 0.3 m of penetration was measured within the gravelly sand fill layer, indicating a compact relative density.

4.2.4 Silty Sand Fill

A 3.7 m and 2.0 m thick deposit of silty sand fill was encountered below the gravelly sand fill deposit in Borehole C97-1 and below the topsoil in Borehole C97-2 at depths of 0.7 m and 0.1 m (Elevation 292.6 m and 290.7 m), respectively. The silty sand fill contains trace to some clay and trace gravel. Trace organics and pockets of clayey silt were noted to be present within the silty sand fill in Borehole C97-2.

The measured SPT "N"-values within the silty sand fill deposit range from 4 blows to 26 blows per 0.3 m of penetration indicating a loose to compact relative density.

The water content measured on two samples of the silty sand fill material were 8 per cent and 9 per cent.

The result of a grain size distribution test completed on one sample of the silty sand fill deposit is shown on Figure B1 in Appendix B.

4.2.5 Silty Sand containing organics

A deposit of silty sand containing trace organics, trace gravel and trace clay was encountered below the silty sand fill deposit in Borehole C97-1 at a depth of 4.4 m below ground surface (Elevation 288.9 m) and the deposit is 1.2 m thick.

One SPT 'N' value of 6 blows per 0.3 m of penetration was measured within the silty sand deposit, indicating a compact relative density.

4.2.6 Silty Clay

A 1.5 m and 2.2 m thick deposit of silty clay was encountered below the silty sand deposit in Borehole C97-1 and below the silty sand fill deposit in Borehole C97-2 at depths of 5.6 m and 2.1 m (Elevation 287.7 m and 288.7 m), respectively. The silty clay deposit contains trace sand and is laminated.

The measured SPT "N"-values within the silty clay deposit range from 12 blows to 39 blows per 0.3 m of penetration, suggesting a stiff to hard consistency.

The water content measured on three samples of the silty clay range from 22 per cent to 28 per cent.

Atterberg limits testing was carried out on two samples of the silty clay and measured liquid limits of 32 per cent and 38 per cent, plastic limits of 17 per cent and 18 per cent and plasticity indices of 15 per cent and 20 per cent. The test results, which are plotted on a plasticity chart on Figure B2 in Appendix B, indicate that the material is a silty clay of intermediate plasticity.

The result of a grain size distribution test completed on one sample of the silty clay deposit is shown on Figure B3 in Appendix B.

4.2.7 Sand

A deposit of sand was encountered below the silty clay deposit in Boreholes C97-1 and C97-2 at depths of 7.1 m and 4.3 m (Elevation 286.2 m and 286.5 m), respectively. Boreholes C97-1 and C97-2 were terminated within the sand deposit at depths of 11.1 m and 6.6 m (Elevation 282.2 m and 284.2 m) after penetrating 4.0 m and 2.3 m into the deposit, respectively. The sand deposit contains trace to some gravel, trace to some silt and trace clay.

The measured SPT "N"-values within the sand deposit range from 41 blows to 82 blows per 0.3 m of penetration, with on SPT "N"-value of 86 blows per 0.25 m of penetration, indicating a dense to very dense relative density.

The water content measured on three samples of sand ranges from 2 per cent to 3 per cent.

The result of a grain size distribution test completed on one sample of the sand deposit is shown on Figure B4 in Appendix B.

4.2.8 Groundwater Conditions

Boreholes C97-1 and C97-2 were noted to be dry upon completion of drilling, however, the base of the fill and silty sand containing organics material encountered in the boreholes was noted to be wet, which is attributed to ground water "perched" on the underlying, less permeable layers. The groundwater 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.

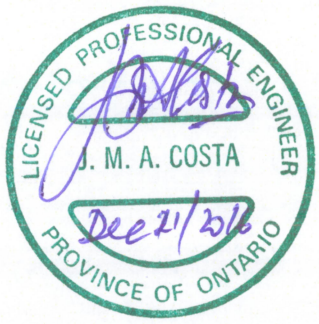
5.0 CLOSURE

This Foundation Investigation Report was prepared by Ted Beadle and Al Varshoi from Golder Geotechnical Group. Jorge M. A. Costa, P.Eng., a Designated MTO Foundation Contact and Senior Consultant of Golder, conducted an independent quality review of the report.

Report Signature Page

GOLDER ASSOCIATES LTD.

Al Varshoi, P.Eng.
Geotechnical Engineer



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

TWB/ARV/JMAC/sm/arv

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REFERENCES

Canadian Geotechnical Society. 2006. *Canadian Foundation Engineering Manual*, 4th Edition. The Canadian Geotechnical Society, BiTech Publisher Ltd., British Columbia.

Canadian Standards Association (CSA). 2014. *Canadian Highway Bridge Design Code* and *Commentary on CAN/CSA-S6-06*. CSA Special Publication, S6.1 06.

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

Kulhawy, F.H. and Mayne, P.W. 1990. *Manual on Estimating Soil Properties for Foundation Design*. EL 6800, Research Project 1493 6. Prepared for Electric Power Research Institute, Palo Alto, California.

Ontario Provincial Standard Specifications (OPSS)

OPSS 512	Construction Specification for Installation of Gabions
OPSS 1359	Material Specification for Unshrinkable Fill
OPSS 1403	Material Specification for Gabion Baskets and Mats
OPSS 1004	Material Specification for Aggregate - Miscellaneous
OPSS.PROV 1010	Material Specification for Aggregates – Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1860	Material Specification for Geotextiles
OPSS.PROV 539	Construction Specification for Temporary Protection Systems

ASTM International

ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split Barrel Sampling of Soils

Ontario Water Resources Act

Ontario Regulation 903 Wells (as amended)

Ontario Occupational Health and Safety Act

Ontario Regulation 213 Construction Projects (as amended)

Commercial Software

Slide (Version 6.0) by Rocscience Inc.

Settle3D (Version 4.0) by Rocscience Inc.

TABLE 1 – Summary Details of Existing Culvert

Culvert	Height of Embankment	Existing Culvert			Approximate Inlet / Outlet Invert
		Type	Span / Height	Length	
#97 STA 24+327	4.5 m	Open Footing	1220 mm x 900 mm	50 m	Elev. 289.0 m (west end) Elev. 288.0 m (east end)

MINISTRY OF TRANSPORTATION, ONTARIO

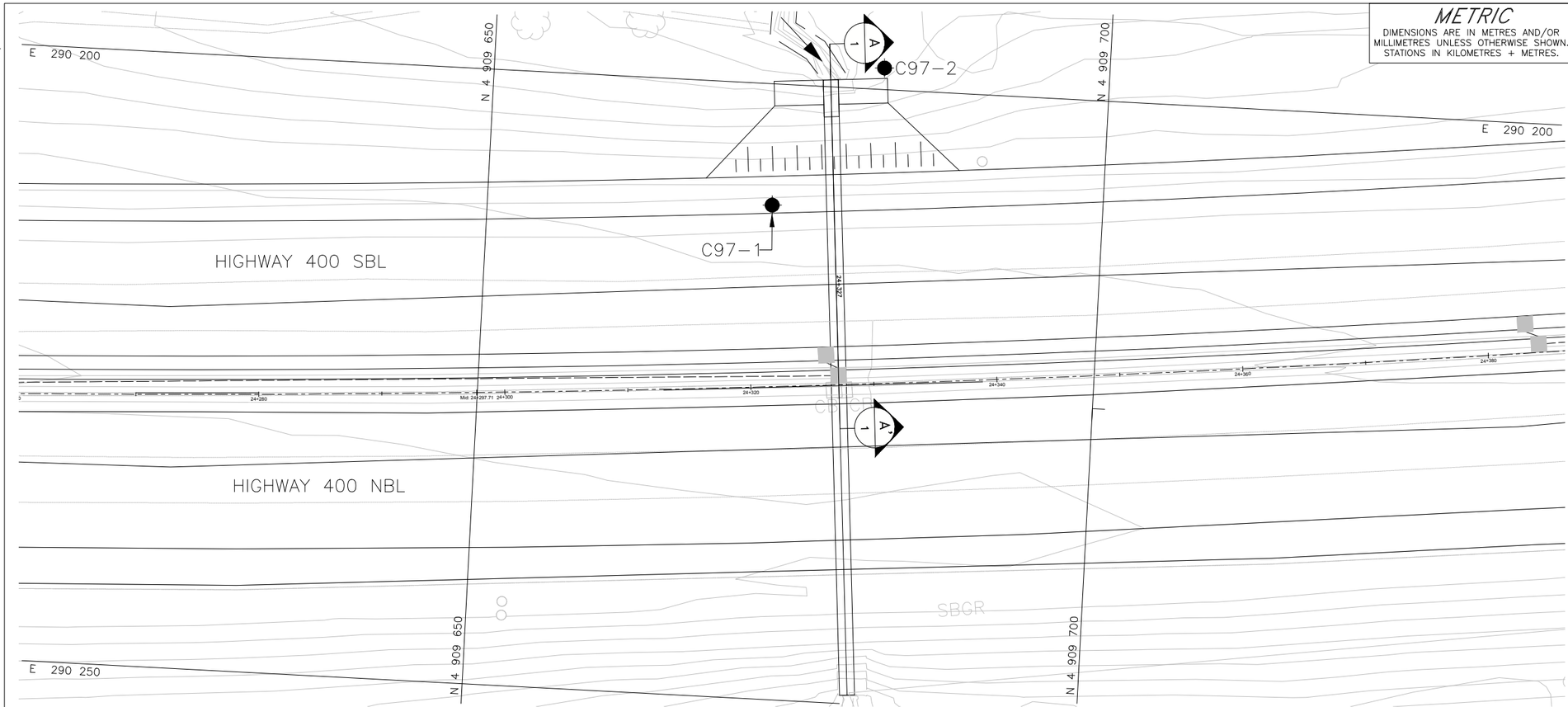
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

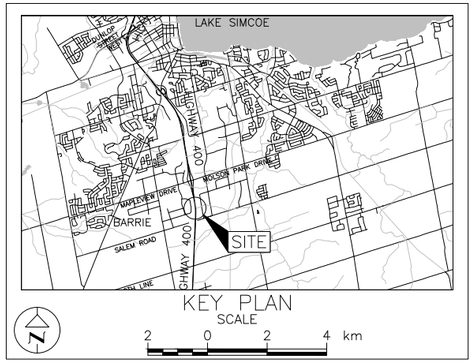
CONT No.
GWP No. 2184-10-00

CULVERT 97 STA. 24+327
HIGHWAY 400
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Golder Associates



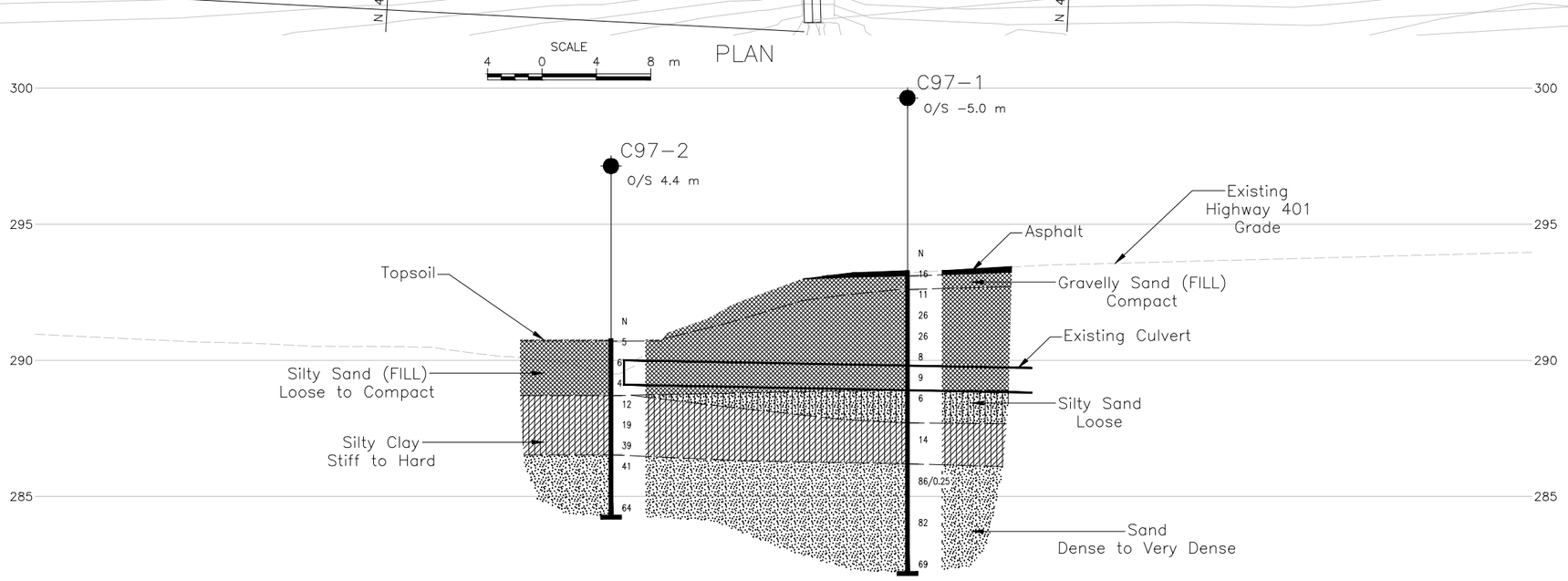


KEY PLAN
SCALE
2 0 2 4 km

LEGEND

- Borehole – Golder (2016)
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
C97-1	293.3	4909673.1	290209.8
C97-2	290.8	4909681.7	290198.2



A-A / 1 PROFILE A-A'
STA. 24+327

HORIZONTAL SCALE
2 0 2 4 m

VERTICAL SCALE
2 0 2 4 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.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans, culvert plan and profile, and surface data provided in digital format by URS, drawing file nos. Culvert 97 & 99 Plan View.dwg, 1.Culvert 97 Profile (from 60% Dwgs).pdf, and HWY 400-BASE PLAN SURFACE.dwg, received Oct. 17, 2016.

LICENSED PROFESSIONAL ENGINEER
J. M. A. COSTA
Dec. 22, 2016
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
A. VARSHOI
100208085
Dec. 22, 2016
PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 31D-667

HWY. 400		PROJECT NO. 1413191	DIST. CENTRAL
SUBM'D. TWB	CHKD. TWB	DATE: 10/25/2016	SITE: .
DRAWN: DD/MR	CHKD. JMAC	APPD. JMAC	DWG. 1

PLOT DATE: December 22, 2016
FILENAME: S:\Clients\MTO\Hwy_400\99_PROJ\1413191_Geotech_Invest\40_PROD\0002_Assignment_#10\1413191-0002-BG-0001.dwg

APPENDIX A

List of Symbols
List of Abbreviations
Record of Borehole C97-1 and C97-2

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
DO	Drive open
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
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, 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

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) Cohesionless 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.

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

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
σ_1, σ_2, σ_3	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

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

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

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
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

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RECORD OF BOREHOLE No 97-1

SHEET 1 OF 1 **METRIC**

PROJECT 1413191 (1100)
G.W.P. 2184-10-00 LOCATION N 4909673.1 ;E 290209.8 ORIGINATED BY IK
DIST Central HWY 400 BOREHOLE TYPE D-50 Track Mount, 210 mm Outer Diameter Hollow Stem Augers, Auto Hammer COMPILED BY PKS/AJS
DATUM Geodetic DATE September 26 and 27, 2016 CHECKED BY LCC

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
293.3	GROUND SURFACE										
0.0	ASPHALT (230 mm)										
0.2	Gravelly sand, some silt, trace clay (FILL) Compact		1	SS	16		293				
292.6											
0.7	Brown Moist		2	SS	11						
	Silty sand, trace to some clay, trace gravel (FILL) Loose to compact Brown Moist, becoming wet at base of stratum		3	SS	26		292		○		5 67 22 6
			4	SS	26		291				
			5	SS	8		290		○		
			6	SS	9						
288.9							289				
4.4	Silty SAND, trace gravel, trace clay, trace organics Loose Dark grey Wet		7	SS	6						
287.7							288				
5.6	SILTY CLAY, trace sand Stiff Laminated dark grey to grey Moist		8	SS	14		287				
286.2							286				
7.1	SAND, trace to some silt, trace clay, trace gravel Very dense Light brown Moist		9	SS	86/0.25				○		3 87 8 2
			10	SS	82		285				
							284				
							283				
282.2			11	SS	69				○		
11.1	END OF BOREHOLE										

NOTE:

1. Borehole dry on completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No 97-2

SHEET 1 OF 1 **METRIC**

PROJECT 1413191 (1100)
G.W.P. 2184-10-00 LOCATION N 4909681.7 ;E 290198.2 ORIGINATED BY IK
DIST Central HWY 400 BOREHOLE TYPE D-50 Track Mount, 210 mm Outer Diameter Hollow Stem Augers, Auto Hammer COMPILED BY PKS/AJS
DATUM Geodetic DATE September 27, 2016 CHECKED BY LCC

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
290.8	GROUND SURFACE										
0.0	TOPSOIL										
0.1	Silty sand, trace gravel, trace clay, trace organics and rootlets, pockets of clayey silt (FILL) Loose Brown Moist, becoming wet at base of stratum		1	SS	5		290				
			2	SS	6						
288.7			3	SS	4		289				
2.1	SILTY CLAY, trace sand Stiff to hard Laminated dark grey to grey Moist		4	SS	12				○		
			5	SS	19		288				0 2 51 47
286.5			6	SS	39		287				
4.3	SAND, some gravel, trace to some silt, trace clay Dense to very dense Light brown Moist		7	SS	41		286				
							285				
284.2			8	SS	64				○		15 78 6 1
6.6	END OF BOREHOLE NOTE: 1. Borehole dry on completion of drilling.										

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

GTA-MTO 001 S:\CLIENTS\MTO\HWY_400\02_DATA\GINT\GEOTECH_INVEST_A#10_HWY_400_RETAINER\HWY_400_1413191_1100.GPJ GAL-GTA.GDT 12/22/16

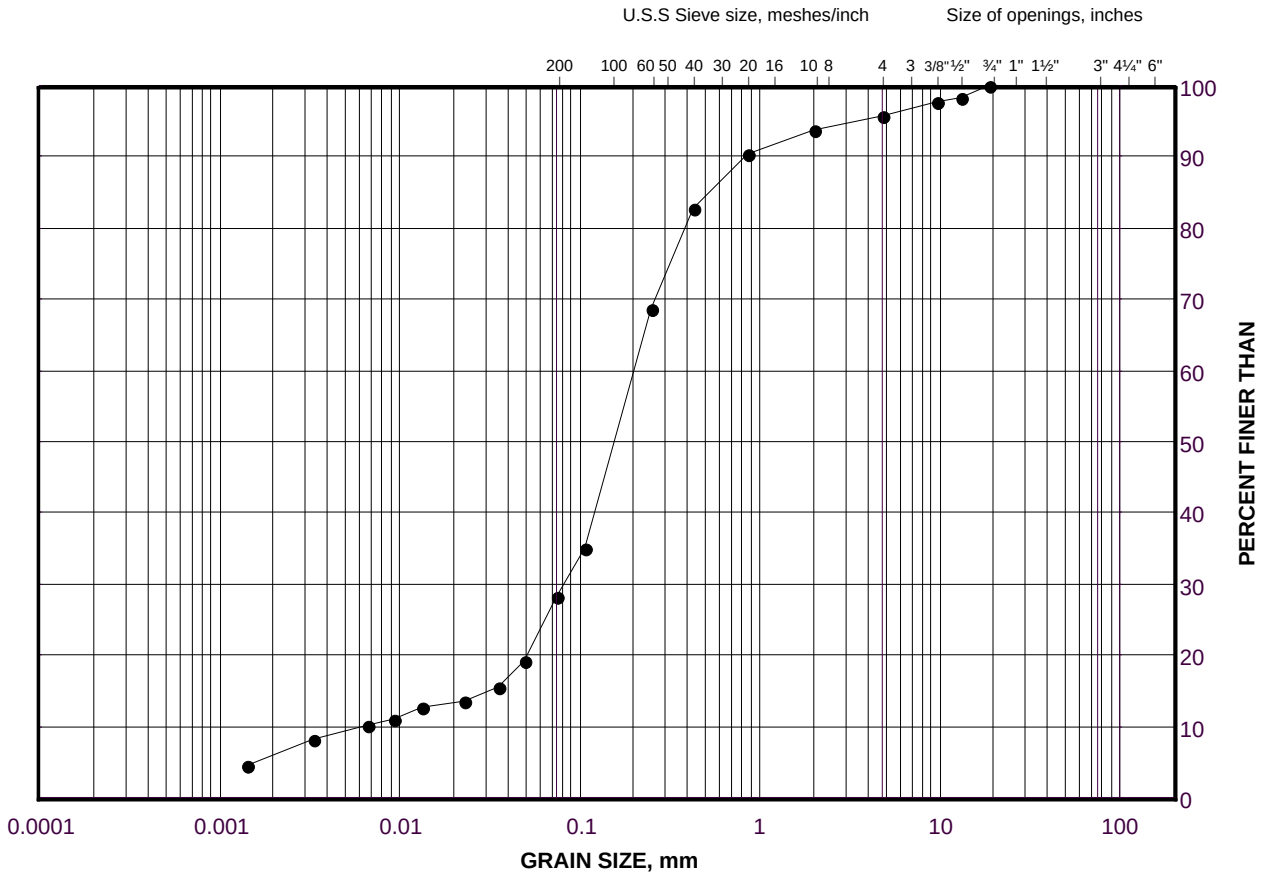
APPENDIX B

Laboratory Test Results

GRAIN SIZE DISTRIBUTION

Silty Sand (Fill)

FIGURE B1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C 97-1	3	291.5

Project Number: 1413191

Checked By: TWB

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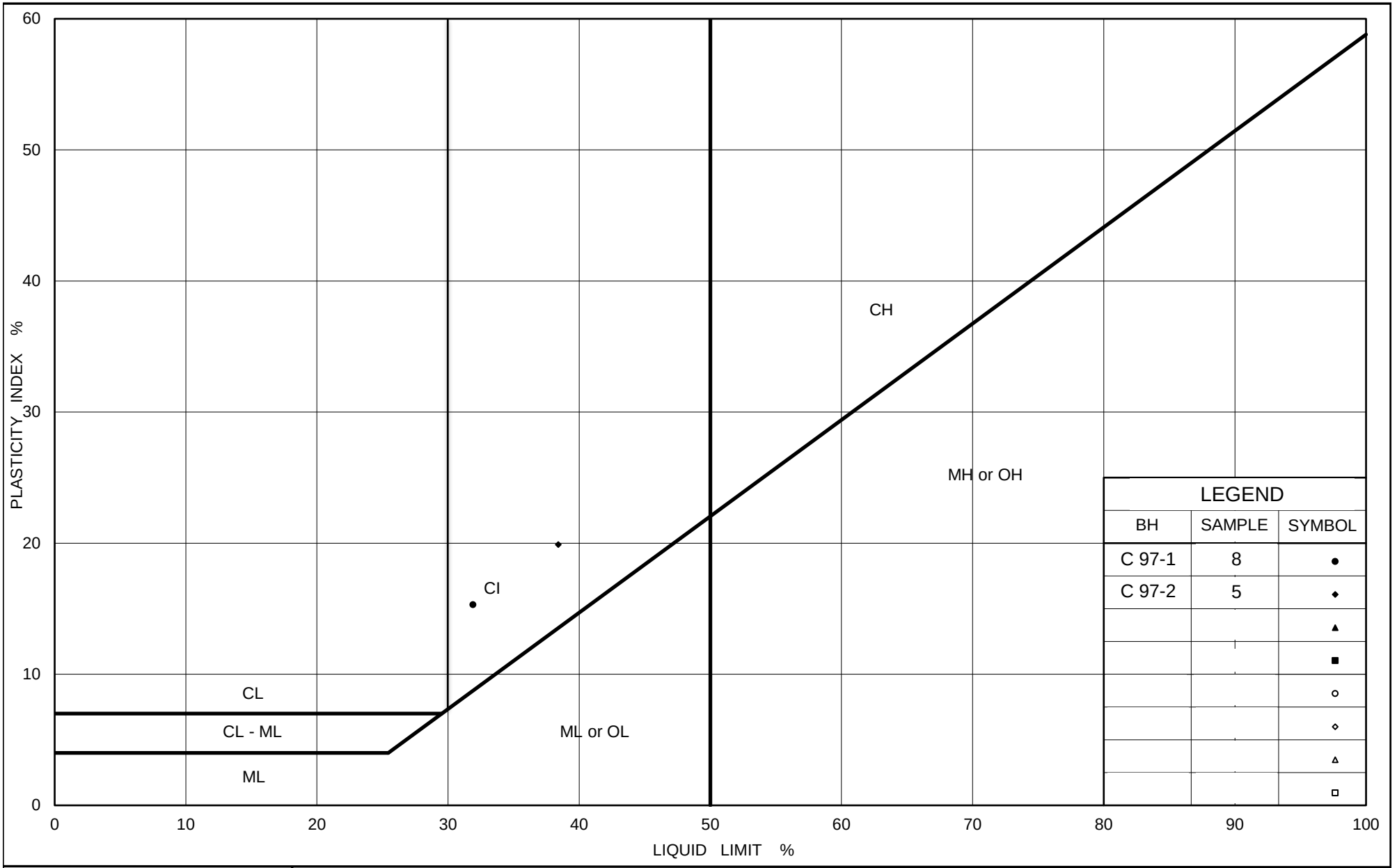
Date: 24-Oct-16



PLASTICITY CHART
Silty Clay

Figure No. B2

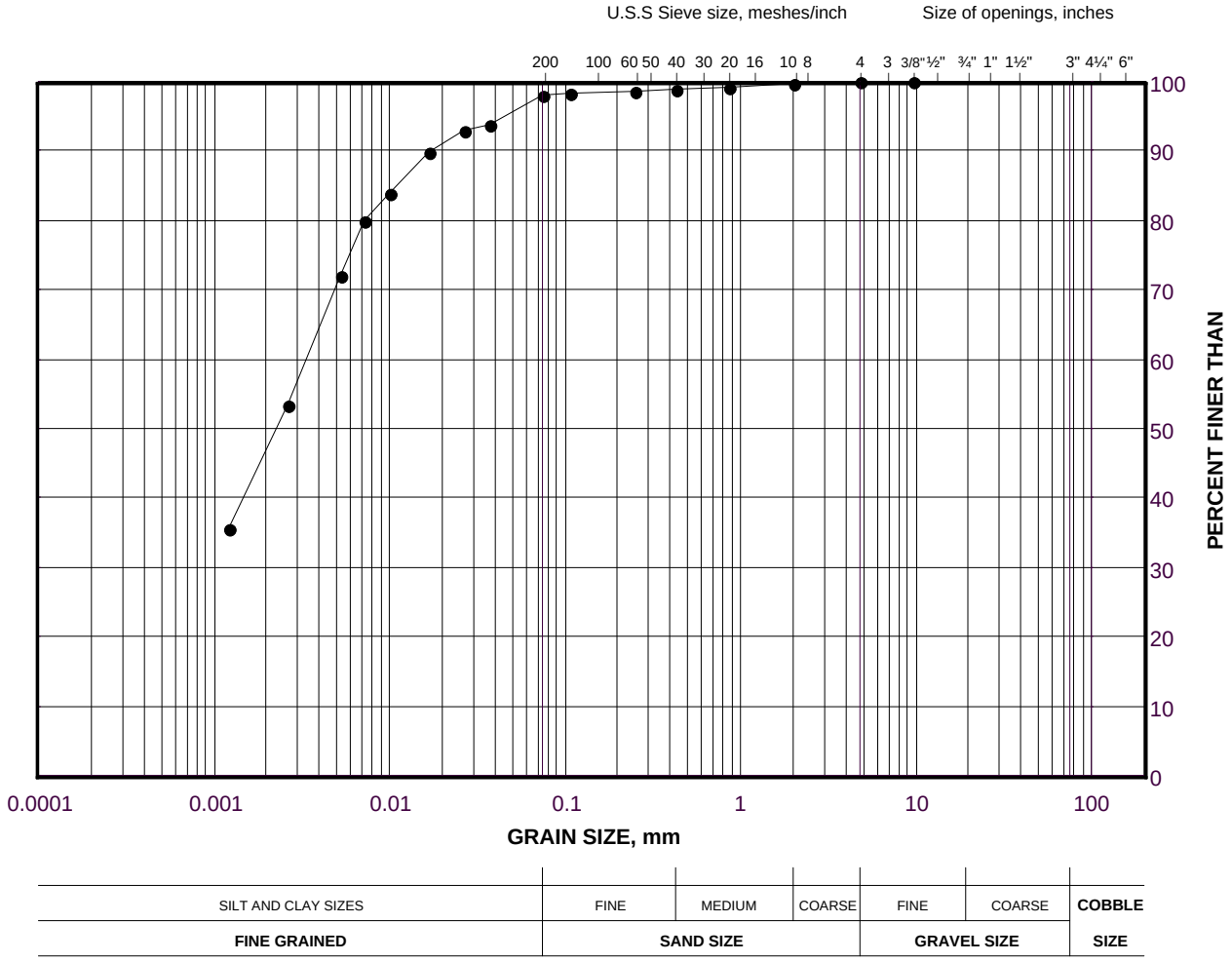
Project No. 1413191 (1100)

Checked By: TWB

GRAIN SIZE DISTRIBUTION

Silty Clay

FIGURE B3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C 97-2	5	287.5

Project Number: 1413191

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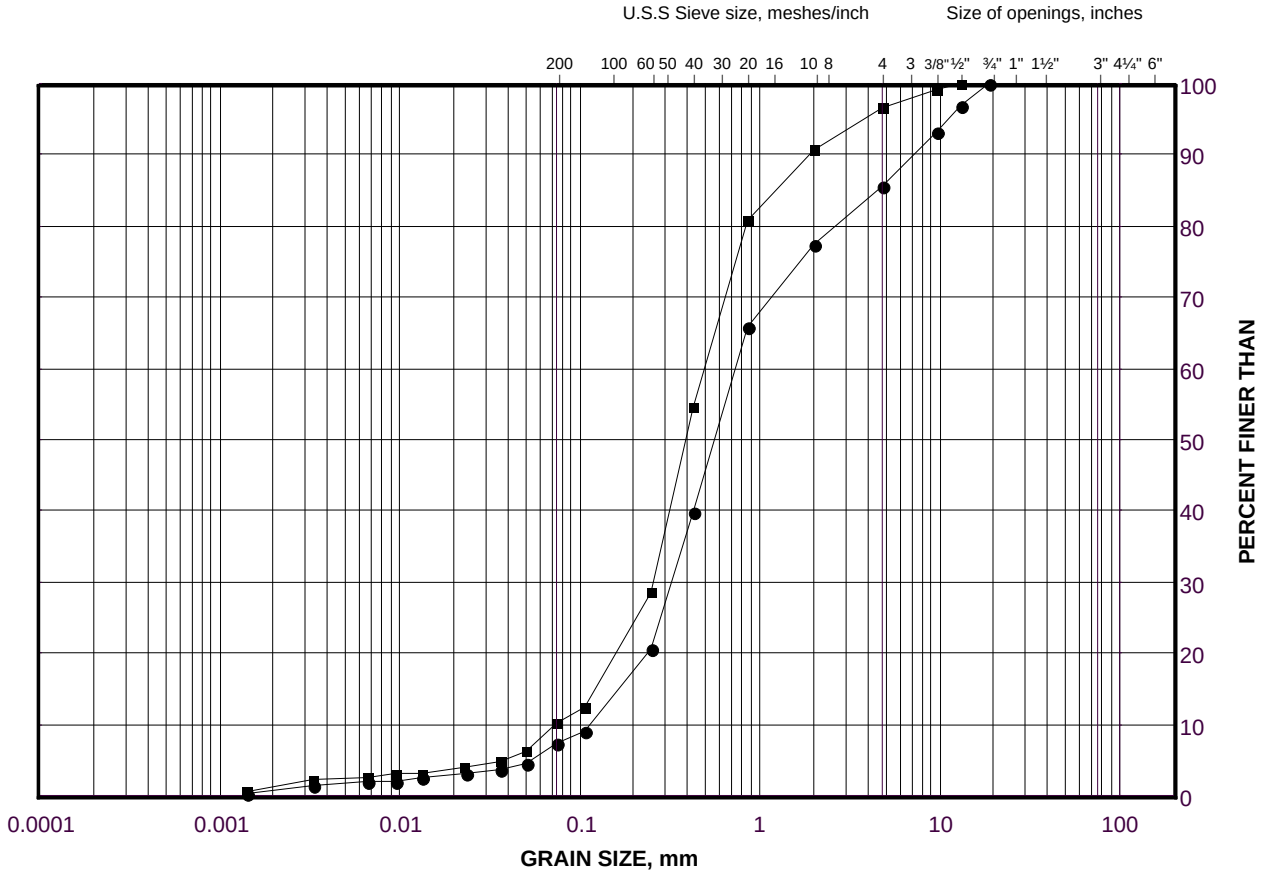
Date: 24-Oct-16

GRAIN SIZE DISTRIBUTION

Sand

FIGURE B4



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	C 97-2	8	284.5
■	C 97-1	9	285.4

Project Number: 1413191

Checked By: TWB

Golder Associates

Date: 24-Oct-16

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.

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