TECHNICAL MEMORANDUM

DATE February 10, 2012 **PROJECT No.** 09-1111-6007 (8000)

TO Chris Schueler, P.Eng.
URS Canada Inc.

CC

FROM Nikol Kochmanová, Jorge Costa **EMAIL** Nikol_Kochmanova@golder.com

FOUNDATION INVESTIGATION
BRIDGELAND AVENUE RAPID BRIDGE REPLACEMENT – HAUL ROUTE
HIGHWAY 401 EBC REHABILITATION FROM JANE STREET TO AVENUE ROAD
TORONTO, ONTARIO
G.W.P. 2225-10-00, MTO AGREEMENT NO. 2009-E-0011
GEOCRES NO. 30M11-239

This technical memorandum summarizes the results of the subsurface investigation carried out along the proposed haul route for the Rapid Bridge Replacement (RBR) of the Highway 401 EB Collector W-N/S overpasss structure at Bridgeland Avenue.

Subsurface information from previous investigations and design associated with the Bridgeland Avenue structure is available from the following report and drawings and was provided by MTO:

- MTO GEOCRES No. 30M11-081: Report titled "Spadina Bridge # 1- W.P. 233-61-2-1, Spadina Bridge #2-W.P. 233-61-2-2, Spadina Bridge #3-W.P. 229-60," prepared by the MTO Foundations Section, dated March 27, 1963.
- Design Drawings by the Department of Highways Ontario –Bridge Division, titled "Spadina Bridge No. 1", W.P. 233-61-2-1, dated February, March and April, 1963; provided by URS.

1.0 SITE DESCRIPTION

The existing bridge is a single span structure approximately 16.2 m long and 15.8 m (at the west abutment) to 20.5 m (at the east abutment) wide, accommodating two lanes of traffic. Based on the 1963 design drawings and previous investigation as noted above, the original ground surface at the site was at approximately Elevation 191 m. According to the base plan provided by URS, the present Bridgeland Avenue road grade ranges from about Elevation 186.5 to 187.5 m at the bridge location. The Hwy 401 off-ramp road surface at the existing bridge and approach embankments varies from about Elevation 192.5 m to 193.5 m.

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2.0 INVESTIGATION PROCEDURES

The field work for this subsurface investigation was carried out between September 19 and November 4, 2011, at which time twelve boreholes (designated Borehole 1, 2, 4 to 8, 13, 14 and 16 to 18) were advanced along Bridgeland Avenue using a CME 75 Truck mount drill rig, supplied and operated by Geo-Environmental Drilling Inc. of Halton Hills, Ontario and a Mobile B-60 Truck mount drill rig, supplied and operated by Profile Drilling Inc. of Mississauga, Ontario. The boreholes advanced during the current investigation provide subsurface information along the proposed RBR haul route. The location of Boreholes 1, 2, 4 to 8, 13, 14, and 16 to 18, pertaining to the proposed RBR haul route, are shown on Drawing 1.

The boreholes were advanced using 70 mm inside diameter and 102 mm outer diameter hollow stem augers. Soil samples were obtained at 0.75 m and 1.5 m intervals of depth in the boreholes, using a 50 mm outside diameter split-spoon sampler in accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586) driven by an automatic hammer.

The groundwater conditions were observed in the open boreholes during and immediately following the drilling operations. A standpipe piezometer was installed in Borehole 2 to permit monitoring the groundwater level at the site. The piezometer consists of a 50 mm diameter, 3.0 m long PVC slotted screen installed within a filter sand pack, above which the borehole annulus was backfilled to ground surface with bentonite pellets. The details of the piezometer installation are shown on the Record of Borehole 2. The remaining boreholes were backfilled up to immediately below ground surface with bentonite pellets upon completion, in accordance with Ontario Regulation 903 (as amended).

The field work was observed 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 utilities, directed the drilling, sampling and in situ testing operations, and logged the boreholes. The soil samples were identified in the field, placed in labelled containers and transported to Golder's laboratory in Mississauga for further examination and laboratory testing. Index and classification tests (water contents, Atterberg limits and grain size distributions) were carried out on selected soil samples. All geotechnical laboratory testing was completed to ASTM and MTO LS standards, as applicable.

The borehole locations were measured on-site relative to the existing bridge and site features and the ground surface elevations were obtained from the Digital Terrain Model for the site, provided by URS. The borehole locations, relative to MTM NAD83 northing and easting coordinates and ground surface elevations referenced to geodetic datum, are presented on Drawing 1 and summarized below:

Borehole No.	MTM NAD83 Northing	MTM NAD83 Easting	Ground Surface Elevation	Borehole Depth
1	4,842,973.8	308,043.3	186.5 m	20.3 m
2	4,842,991.3	308,055.6	187.5 m	18.9 m
4	4,842,987.7	308,072.5	187.3 m	20.4 m
5	4,842,992.8	308,103.3	188.3 m	5.2 m
6	4,843,002.7	308,131.6	188.5 m	5.2 m
7	4,842,995.0	308,156.5	189.0 m	5.2 m
8	4,843,003.4	308,163.7	189.0 m	5.2 m
13	4,842,996.2	308,068.7	187.5 m	5.2 m
14	4,843,001.6	308,092.7	188.3 m	5.2 m

Borehole No.	MTM NAD83 Northing	MTM NAD83 Easting	Ground Surface Elevation	Borehole Depth
16	4,843,003.1	308,146.8	188.8 m	5.2 m
17	4,842,989.8	308,084.6	187.5 m	5.2 m
18	4,842,995.0	308,164.6	189.0 m	5.2 m

3.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

3.1 Regional Geology

This section of Highway 401 is located within the physiographic region known as the Peel Plain, according to *The Physiography of Southern Ontario* (Chapman and Putnam, 1984)[1].

A surficial till sheet, which generally follows the surface topography, is generally present throughout much of this area. The till is typically comprised of clayey silt to silty clay, with occasional sand to silt zones and is mapped in this area as the Halton Till. Shallow, localized deposits of loose sand and silt and/or soft clay can overlie this uppermost till sheet, and these represent relatively recent deposits, formed in small glacial melt water ponds scattered throughout the Peel Plain and concentrated near river valleys, such as the West Don River valley. The recent sand, silt and clay and uppermost till deposits in this area overlie and are interbedded with stratified deposits of sand, silt and clay.

3.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes advanced as part of the current investigation and the results of in situ and laboratory testing are given on the borehole records and presented on Figures 1 to 5 provided following the text of this technical memorandum. The interpreted stratigraphic conditions are shown on Drawing 1.

The stratigraphic boundaries shown on the borehole records and on the interpreted stratigraphic profile on Drawing 1 are inferred from 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.

In general, the subsurface conditions at the site consist of surficial layers of asphalt and roadway base granular fill underlain by a clayey silt till deposit. The clayey silt till deposit is underlain by a silty clay deposit and a sand and silt to silt deposit, in places underlain by a lower deposit of clayey silt to silty clay.

A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

3.2.1 Asphalt

An approximately 200 mm thick layer of asphalt was encountered immediately at the roadway surface in all boreholes.

[1] Chapman, L.J. and Putman, D.F., 1984. The Physiography of Southern Ontario, Ontario Geological Society, Special Volume 2, Third Edition. Accompanied by Map p. 2715, Scale 1:600,000.

3.2.2 Fill

A deposit of granular fill was encountered below the asphalt in all boreholes. The fill deposit consists of silty sand to sand and gravel, containing some silt, and the thickness of the deposit ranges from 0.4 m to 1.5 m.

The measured Standard Penetration Test (SPT) "N" values within the fill range from 16 blows to 29 blows per 0.3 m of penetration, indicating a compact relative density. SPT "N" values of 4 blows and 8 blows per 0.3 m of penetration were measured, in Boreholes 1 and 2 within fill recently removed in areas which had been excavated by vacuum methods in close proximity to existing underground services.

The laboratory water content measured on selected samples of the fill range between 3 per cent and 4 per cent.

3.2.3 Clayey Silt Till

A deposit of till comprised of clayey silt with sand, trace to some gravel was encountered underlying the fill in all boreholes. The top of the till deposit was encountered at depths ranging from 0.7 m to 1.5 m below ground surface, between Elevation 188.3 m and 185.0 m. Boreholes 5 to 8, 13, 14, and 16 to 18 terminated within this deposit, penetrating it for a depth of 4.4 m to 4.6 m. The thickness of the deposit in Boreholes 1, 2, and 4 ranges from 7.2 m to 8.7 m.

The measured SPT "N" values within this deposit range from 8 blows per 0.3 m of penetration to 100 blows per 0.13 m of penetration, suggesting a firm to hard consistency, but generally stiff to hard.

The results of grain size distribution tests completed on fifteen selected samples of the till deposit are shown on Figure 1A to 1C following the text of this memorandum.

Atterberg limits testing was carried out on 24 selected samples of the till and measured plastic limits between 9 per cent and 14 per cent, liquid limits between 17 per cent and 28 per cent, and plasticity indices between 7 per cent and 16 per cent. These test results, which are plotted on Figure 2A to 2C, confirm that the till consists of clayey silt of low plasticity.

The natural water content measured on selected samples of the till range from 5 per cent to 17 per cent.

3.2.4 Silty Clay

A deposit of silty clay, trace sand and gravel was encountered underlying the clayey silt till in Boreholes 1, 2, and 4. The silty clay deposit contains a sand and silt interlayer in Borehole 1 as described in Section 3.2.5. The top of the deposit was encountered at depths ranging from 8.7 m to 12.3 m below ground surface, corresponding to between Elevation 178.8 m to 174.2 m.

The measured SPT "N" values within the silty clay deposit range from 41 blows to 59 blows per 0.3 m of penetration, suggesting a hard consistency.

Grain size distribution testing was completed on two selected samples of the silty clay deposit and the results are shown on Figure 3 following the text of this memorandum.

Atterberg limits testing was carried out on two selected samples of the deposit and measured plastic limits of 15 per cent, liquid limits of 39 per cent and 40 per cent, and corresponding plasticity indices of 24 per cent and 25 per cent. These test results, which are plotted on Figure 4, confirm that the deposit consists of silty clay of intermediate plasticity.

The natural water content measured on selected samples of the silty clay deposit range from 16 per cent to 22 per cent.

3.2.5 Sand and Silt to Silt

A sand and silt to silt deposit was encountered as an interlayer between the clayey silt till and silty clay deposits in Borehole 1 and underlying the silty clay deposit in Boreholes 1, 2, and 4. The top of the granular interlayer was encountered at a depth of 10.2 m below ground surface, corresponding to Elevation 176.3 m, in Borehole 1. The deposit was encountered at depths between 15.9 m and 18.3 m below ground surface in the three boreholes between Elevation 171.6 m and 168.2 m. Borehole 1 was terminated within the sand and silt deposit, penetrating into the deposit for a depth of 2.0 m.

The measured SPT “N” values within the sand and silt to silt interlayers range from 93 blows and 159 blows per 0.3 m of penetration, indicating a very dense relative density.

Grain size distribution testing was completed on four selected samples of the sand and silt to silt interlayer/deposit and the results are shown on Figure 5 following the text of this memorandum.

The natural water content measured on selected samples of the sand and silt to silt interlayer/deposit range from 9 per cent to 17 per cent.

3.2.6 Clayey Silt to Silty Clay

A deposit of clayey silt to silty clay, trace to some sand and trace gravel was encountered underlying the sand and silt to silt deposit in Boreholes 2, and 4. The top of the deposit was encountered at depths of 18.3 m and 17.8 m below ground surface in Boreholes 2 and 4, respectively, corresponding to Elevation 169.2 m and 169.5 m.

The measured SPT “N” values within the clayey silt to silty clay deposit range from 43 blows to 53 blows per 0.3 m of penetration, suggesting a hard consistency.

Grain size distribution testing was completed on one selected samples of the clayey silt to silty clay deposit is shown on Figure 3 following the text of this memorandum.

Atterberg limits testing was carried out on two selected samples of the clayey silt to silty clay and measured plastic limits of 15 per cent and 16 per cent, liquid limits of 33 per cent and 39 per cent, and corresponding plasticity indices of 18 per cent and 23 per cent. These test results, which are plotted on Figure 4, confirm that the deposit consists of clayey silt to silty clay of intermediate plasticity.

The natural water content measured on two selected samples of the clayey silt to silty clay are 17 per cent and 19 per cent.

3.3 Groundwater Conditions

The observed water levels in the open boreholes following completion of drilling and the piezometer installed in Borehole 2 are shown on the Record of Borehole sheets and are summarized below.

Borehole Number	Ground Surface Elevation	Depth to Water Level below Ground Surface	Groundwater Elevation	Date
1	186.5 m	10.6 m	175.9 m	Oct. 25, 2011
2*	187.5 m	5.4 m	182.1 m	Jan 22, 2012
4	187.3 m	14.3 m	173.0 m	Oct. 27, 2011
5	188.3 m	dry	-	Sept. 19, 2011
6	188.5 m	dry	-	Oct. 31, 2011
7	189.0 m	dry	-	Sept. 19, 2011
8	189.0 m	dry	-	Nov. 4, 2011
13	187.5 m	dry	-	Oct. 31, 2011
14	188.3 m	dry	-	Oct. 31, 2011
16	188.8 m	4.3 m	184.5 m	Oct. 31, 2011
17	187.5 m	dry	-	Nov. 4, 2011
18	189.0 m	dry	-	Nov. 4, 2011

* Measured in the piezometer

The water levels presented above and on the Record of Borehole sheets may not represent stabilized groundwater conditions at the time of the investigation. 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.

CLOSURE

This technical memorandum was prepared by Ms. Nikol Kochmanová, P.Eng., and reviewed by Mr. Jorge Costa, P.Eng., a Designated MTO Contact and Principal with Golder.

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NK/JMAC/sm

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Attachments: Drawing 1 – Borehole Locations and Soil Strata
Record of Boreholes (1, 2, 4 to 8, 13, 14, and 16 to 18)
Figures 1A to 1C – Grain Size Distribution, Clayey Silt Till
Figures 2A to 2C – Plasticity Chart, Clayey Silt Till
Figure 3 – Grain Size Distribution, Clayey Silt to Silty Clay
Figure 4 – Plasticity Chart, Clayey Silt to Silty Clay
Figure 5 – Grain Size Distribution, Sand and Silt to Silt

MINISTRY OF TRANSPORTATION, ONTARIO

HIGHWAY 401 EB EXPRESS

HIGHWAY 401 EB COLLECTOR

BRIDGELAND AVE

DUFFERIN ST

N 4843100

N 4843000

N 4842900

E 307900

E 308000

E 308100

E 308200

E 308300

81-1

81-2

81-3

81-4

81-5

81-4A

PLAN

SCALE

15 0 15 30 m

METRIC

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

CONT No.

GWP No. 2225-10-00

HIGHWAY 401 EBC REHABILITATION

BRIDGELAND AVE. RBR HAUL ROUTE

BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Golder Associates

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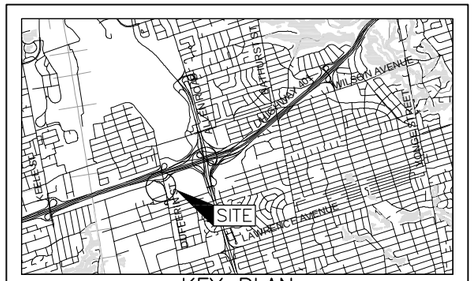
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

SCALE

1 0 1 2 km

LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- N — Standard Penetration Test Value (* – Not representative)
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer on October 28, 2011
- WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
1	186.5	4842973.8	308043.3
2	187.5	4842991.3	308055.6
4	187.3	4842987.7	308072.5
5	188.3	4842992.8	308103.3
6	188.5	4843002.7	308131.6
7	189.0	4842995.0	308156.5
8	189.0	4843003.4	308163.7
13	187.5	4842996.2	308068.7
14	188.3	4843001.6	308092.7
16	188.8	4843003.1	308146.8
17	187.5	4842989.8	308084.6
18	189.0	4842995.0	308164.6

REFERENCE

Base plans provided in digital format by URS, drawing file names. Hwy401_alignment.dwg, Hwy401_bgd.dwg, Hwy401_plan.dwg, Hwy401_x_pavmarkings.dwg and Hwy401_contours.dwg, received August 3, 2011 and August 10, 2011.

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 complete Foundation Investigation and 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.

195 / 190 / 185 / 180 / 175 / 170 / 165

1 o/s 4.7 m S — Asphalt — Sand and Silt Very dense — Sand and Silt to Silt Very dense

2 o/s 4.7 m N — Asphalt — Sand and Silt to Silt Very dense

13 o/s 4.8 m N — Asphalt — Sand and Silt to Silt Very dense

4 o/s 4.4 m S — Asphalt — Sand and Silt to Silt Very dense

17 o/s 5.0 m S — Asphalt — Sand and Silt to Silt Very dense

14 o/s 5.8 m N — Asphalt — Silty Clay Hard

5 o/s 3.7 m s — Silty Sand to Sand and Gravel Fill Compact — Silty Clay Hard

6 o/s 4.7 m N — Silty Sand to Sand and Gravel Fill Compact — Silty Clay Hard

16 o/s 4.2 m N — Asphalt — Clayey Silt with Sand Till Firm to hard

7 o/s 4.4 m S — Clayey Silt with Sand Till Firm to hard

8 o/s 3.6 m N — Clayey Silt with Sand Till Firm to hard

18 o/s 4.9 m S — Clayey Silt with Sand Till Firm to hard

A-A' / 1

PROFILE

HORIZONTAL SCALE

5 0 5 10 m

2.5 0 2.5 5 m

VERTICAL SCALE

LICENSED PROFESSIONAL ENGINEER — J. M. A. COSTAR — Feb. 08, 2012 — PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER — N. KOCHMAN — Feb. 08, 2012 — PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 30M11-239

HWY. 401	PROJECT NO. 09-1111-6007		DIST.
SUBM'D. NK	CHKD. KJB	DATE: 2/8/2012	SITE:
DRAWN: CD	CHKD. NK	APPD. JMAC	DWG. 1

PLOT DATE: February 8, 2012
FILENAME: T:\Projects\2009\09-1111-6007 (URS, Toronto)\-HB- (BRIDGELAND AVE) REPORT 2\09111160078B001.dwg

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
SS	Split-spoon
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, 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) 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.

V. MINOR SOIL CONSTITUENTS

Percent 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 (cohesionless) or With (cohesive)	Sand and Gravel / Silty Clay with sand / Clayey Silt with sand

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
in x,	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
F	factor of safety
V	volume
W	weight

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 ($\sigma' = \sigma - \mu$)
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
μ	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	liquid limit
w_p	plastic limit
I_p	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_a	coefficient of secondary consolidation
m_v	coefficient of volume change
c_v	coefficient of consolidation
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation pressure
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 Associates

RECORD OF BOREHOLE No 1

1 OF 2 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | DIST | HWY 401 | DATUM Geodetic

LOCATION N 4842973.8 ;E 308043.3 | BOREHOLE TYPE CME 75 Truck-mount, 70 mm Inner Diameter Hollow Stem Augers | DATE October 25, 2011

ORIGINATED BY MS | COMPILED BY NK | CHECKED BY KJB

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
186.5	GROUND SURFACE										
0.0	ASPHALT										
0.2	Silty sand and gravel (FILL) Brown Moist		1	SS	8*		186				
185.0											
1.5	CLAYEY SILT, with sand, trace to some gravel (TILL) Very stiff to hard Grey Moist		2	SS	29		185		○		
			3	SS	63		184				
			4	SS	28		183		○		
			5	SS	35						
			6	SS	32		182		○		5 32 44 19
			7	SS	20		181				
			8	SS	184		180		○		
			9	SS	100/0.13		179				
176.3							178				
10.2	SAND and SILT, some gravel, trace clay Very dense Grey Wet		10	SS	126	▽	177		○		20 37 39 4
174.2							176				
12.3	SILTY CLAY, trace sand Hard Grey Moist		11	SS	128		175		○		
			12	SS	57		174				
							173				
							172				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No 1

2 OF 2 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | DIST | HWY 401 | DATUM Geodetic

LOCATION N 4842973.8 ;E 308043.3 | BOREHOLE TYPE CME 75 Truck-mount, 70 mm Inner Diameter Hollow Stem Augers | DATE October 25, 2011

ORIGINATED BY MS | COMPILED BY NK | CHECKED BY KJB

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 ---										
	SILTY CLAY, trace sand Hard Grey Moist		13	SS	58		171		○		0 0 40 60
			14	SS	34		170				
168.2							169				
18.3	SAND and SILT, trace to some clay, containing silt seams Very dense Grey Moist		15	SS	146		168		○		0 56 37 7
							167				
166.2			16	SS	159						
20.3	END OF BOREHOLE * "N" Value considered not representative of in-situ conditions- See Note 1. NOTE: 1. The top 1.5 m of soil was removed using a vacuum truck and replaced prior to drilling the borehole given that the borehole was located in close proximity to existing underground services. The soil description in the upper 1.5 m is based on visual classification during field operations. 2. Water level in open borehole at at depth of 10.6 m (Elev. 175.9 m) on completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No 2

1 OF 2 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | LOCATION N 4842991.3 ;E 308055.6 | ORIGINATED BY MS

DIST | HWY 401 | BOREHOLE TYPE CME 75 Truck-mount, 70 mm Inner Diameter Hollow Stem Augers | COMPILED BY NK

DATUM Geodetic | DATE October 28, 2011 | CHECKED BY KJB

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 (20 40 60 80 100): ○ 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
187.5	GROUND SURFACE										
0.0	Asphalt										
0.2	Sand and gravel, some silt (FILL) Brown Moist		1	SS	4*		187				
186.0											
1.5	CLAYEY SILT with sand, trace to some gravel (TILL) Stiff to hard Grey Moist		2	SS	18		186				
			3	SS	10		185				8 30 46 16
			4	SS	17		184				
			5	SS	13		183				
			6	SS	17	▼	182				
			7	SS	16		181				
			8	SS	38		180				5 38 44 13
178.8											
8.7	SILTY CLAY, trace sand Hard Grey Moist		9	SS	45		179				
			10	SS	41		178				
			11	SS	47		177				
			12	SS	55		176				
							175				
							174				
							173				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No 2

2 OF 2 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | LOCATION N 4842991.3 ;E 308055.6 | ORIGINATED BY MS

DIST | HWY 401 | BOREHOLE TYPE CME 75 Truck-mount, 70 mm Inner Diameter Hollow Stem Augers | COMPILED BY NK

DATUM Geodetic | DATE October 28, 2011 | CHECKED BY KJB

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
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILTY CLAY, trace sand Hard Grey Moist		13	SS	53		172				
171.6 15.9	SILT, trace to some sand, trace to some clay Very dense Grey Wet		14	SS	112		171		○		0 9 81 10
169.2 18.3	SILTY CLAY, trace to some sand Hard Grey Wet		15	SS	50		170 169		○		
168.6 18.9	END OF BOREHOLE										

* "N" Value considered not representative of in-situ conditions- See Note 1.

NOTES:

1. The top 1.5 m of soil was removed using a vacuum truck and replaced given that the borehole was located in close proximity to existing underground services. The soil description in the upper 1.5 m is based on visual classification during field operations.

2. Water level in piezometer at a depth of 15.2 m (Elev. 172.3 m) on October 28, 2011.

3. Water level in piezometer at a depth of 5.4 m (Elev. 182.1 m) On January 22, 2012.

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

Golder Associates

RECORD OF BOREHOLE No 4

1 OF 2 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | DIST | HWY 401 | DATUM Geodetic

LOCATION N 4842987.7 ;E 308072.5 | BOREHOLE TYPE CME 75 Truck-mount, 70 mm Inner Diameter Hollow Stem Augers | DATE October 27, 2011

ORIGINATED BY MS | COMPILED BY NK | CHECKED BY KJB

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 (20 40 60 80 100): ○ 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
187.3	GROUND SURFACE						187				
0.0	Asphalt										
0.2	Sand and gravel, some silt (FILL) Compact Brown		1	SS	29						
186.6							186				
0.7	Moist CLAYEY SILT with sand, trace to some gravel (TILL) Firm to very stiff Grey Moist		2	SS	24						
			3	SS	9		185				
			4	SS	8						5 31 48 16
			5	SS	13		184				
			6	SS	16						
			7	SS	16		183				
							182				
			8	SS	25		181				
							180				
			9	SS	21						
178.2							179				
9.1	SILTY CLAY, trace to some sand, trace gravel Hard Grey Moist		10	SS	41		178				0 6 36 58
			11	SS	44		177				
			12	SS	59		176				
			13	SS	42	▽	175				
							174				
							173				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No 4

2 OF 2 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | LOCATION N 4842987.7 ;E 308072.5 | ORIGINATED BY MS

DIST | HWY 401 | BOREHOLE TYPE CME 75 Truck-mount, 70 mm Inner Diameter Hollow Stem Augers | COMPILED BY NK

DATUM Geodetic | DATE October 27, 2011 | CHECKED BY KJB

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
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILTY CLAY, trace to some sand, trace gravel Hard Grey Moist		14	SS	52		172				
171.0											
16.3	SAND and SILT, trace to some clay, containing silt interlayers Very dense Grey Wet		15	SS	93		171		○		0 34 60 6
169.5							170				
17.8	CLAYEY SILT, trace sand, trace gravel Hard Grey Wet		16	SS	43		169		○——		0 1 61 38
							168				
166.9			17	SS	53		167				
20.4	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 14.3 m (Elev. 173.0 m) on completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No 5

1 OF 1 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | DIST | HWY 401 | DATUM Geodetic

LOCATION N 4842992.8 ;E 308103.3 | BOREHOLE TYPE Mobile B-60 Truck-mount, 102 mm Outer Diameter Solid Stem Auger | DATE Sept. 19, 2011

ORIGINATED BY MS | COMPILED BY NK | CHECKED BY KJB

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) (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
188.3	GROUND SURFACE										
0.0	ASPHALT										
0.2	Silty sand, trace to some gravel (FILL)		1	AS	-		188		○		
187.7	Brown										
0.6	Moist										
	CLAYEY SILT with sand, trace to some gravel (TILL) Very stiff Brown becoming grey below a depth of 2.3 m Moist		2	SS	15		187				
			3	SS	22				○ ⊢		10 27 45 18
			4	SS	19		186				
			5	SS	19		185		○		
			6	SS	19		184				
			7	SS	20				○ ⊢		4 31 45 20
183.1											
5.2	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 6

1 OF 1 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | DIST | HWY 401 | DATUM Geodetic

LOCATION N 4843002.7 ;E 308131.6 | BOREHOLE TYPE CME-75 Truck Mount, 70 mm Inner Diameter Hollow Stem Augers | DATE October 31, 2011

ORIGINATED BY MS | COMPILED BY NK | CHECKED BY KJB

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
188.5	GROUND SURFACE										
0.0	ASPHALT										
0.2	Silty sand and gravel (FILL) Compact Brown		1	SS	25		188		○		
187.8											
0.7	Moist										
	CLAYEY SILT, with sand, trace gravel (TILL) Very stiff Brown to grey Moist		2	SS	23		187				
			3	SS	25				⊢●⊣		
			4	SS	19		186				
			5	SS	15				⊢●⊣		1 32 48 19
			6	SS	29		185				
			7	SS	24		184		○		
183.3											
5.2	END OF BOREHOLE										

NOTE:

1. Borehole dry on completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No 7

1 OF 1 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | DIST | HWY 401 | DATUM Geodetic

LOCATION N 4842995.0 ;E 308156.5 | BOREHOLE TYPE Mobile B-60 Truck-mount, 102 mm Outer Diameter Solid Stem Auger | DATE September 19, 2011

ORIGINATED BY MS | COMPILED BY NK | CHECKED BY KJB

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
189.0	GROUND SURFACE										
0.0	ASPHALT										
0.2	Silty sand, trace to some gravel Brown Moist		1	AS	-						
188.2							188				
0.8	CLAYEY SILT, some to with sand, trace gravel (TILL) Very stiff Brown becoming grey below a depth of 3.0 m Moist		2	SS	24						1 17 47 35
			3	SS	28		187				
			4	SS	22						
			5	SS	20		186				
			6	SS	23		185				4 31 44 21
			7	SS	24						
183.8							184				
5.2	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 8

1 OF 1 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | DIST | HWY 401 | DATUM Geodetic

LOCATION N 4843003.4 ;E 308163.7 | BOREHOLE TYPE CME-75 Truck Mount, 70 mm Inner Diameter Hollow Stem Augers | DATE November 4, 2011

ORIGINATED BY MS | COMPILED BY NK | CHECKED BY KJB

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
189.0	GROUND SURFACE										
0.0	ASPHALT										
0.2	Silty sand and gravel (FILL) Compact Brown		1	SS	18						
188.3											
0.7	Moist										
	CLAYEY SILT with sand, trace gravel (TILL) Very stiff to hard Brown to grey Moist		2	SS	21		188				2 28 48 22
			3	SS	21		187				
			4	SS	35						
			5	SS	19		186				
			6	SS	25		185				
			7	SS	18						
183.8							184				
5.2	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 13

1 OF 1 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | DIST | HWY 401 | DATUM Geodetic

LOCATION N 4842996.2 ;E 308068.7 | BOREHOLE TYPE CME-75 Truck Mount, 70 mm Inner Diameter Hollow Stem Augers | DATE October 31, 2011

ORIGINATED BY MS | COMPILED BY NK | CHECKED BY KJB

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
187.5	GROUND SURFACE										
0.0	ASPHALT										
0.1	Silty sand and gravel (FILL) Compact Brown Moist		1	SS	17		187		○		
186.8											
0.7	CLAYEY SILT with sand, trace to some gravel (TILL) Stiff to very stiff Grey Moist		2	SS	17						
			3	SS	16		186				
			4	SS	18		185				
			5	SS	19						5 32 43 20
			6	SS	13		184				
			7	SS	19		183		○		
182.3											
5.2	END OF BOREHOLE										

NOTE:

1. Borehole dry on completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No 14

1 OF 1 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | LOCATION N 4843001.6 ;E 308092.7 | ORIGINATED BY MS

DIST | HWY 401 | BOREHOLE TYPE CME-75 Truck Mount, 70 mm Inner Diameter Hollow Stem Augers | COMPILED BY NK

DATUM Geodetic | DATE October 31, 2011 | CHECKED BY KJB

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 (20 40 60 80 100): ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
188.3	GROUND SURFACE									
0.0	ASPHALT									
0.1	Silty sand and gravel (FILL) Compact Brown Moist		1	SS	23		188			
187.6										
0.7	CLAYEY SILT with sand, trace to some gravel (TILL) Stiff to very stiff Grey Moist		2	SS	24		187			
			3	SS	16					
			4	SS	12		186			2 31 49 18
			5	SS	16		185			
			6	SS	18		184			
183.1			7	SS	18					
5.2	END OF BOREHOLE									

NOTE:

1. Borehole dry on completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No 16

1 OF 1 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | DIST | HWY 401 | DATUM Geodetic

LOCATION N 4843003.1 ;E 308146.8 | BOREHOLE TYPE CME-75 Truck Mount, 70 mm Inner Diameter Hollow Stem Augers | DATE October 31, 2011

ORIGINATED BY MS | COMPILED BY NK | CHECKED BY KJB

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
188.8	GROUND SURFACE										
0.0	ASPHALT										
0.2	Silty sand and gravel (FILL) Compact Brown		1	SS	23						
188.1							188				
0.7	Moist CLAYEY SILT with sand, trace to some gravel (TILL) Stiff to hard Brown becoming grey below a depth of 3.1 m Moist to wet		2	SS	10						
			3	SS	17		187				
			4	SS	40		186				
			5	SS	22						
			6	SS	21	▽	185				4 30 49 17
			7	SS	22		184				
183.6											
5.2	END OF BOREHOLE										

NOTE:

1. Water level in open borehole at a depth of 4.3 m below ground surface (Elev. 184.5 m) on completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No 17

1 OF 1 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | DIST | HWY 401 | DATUM Geodetic

LOCATION N 4842989.8 ;E 308084.6 | BOREHOLE TYPE CME-75 Truck Mount, 70 mm Inner Diameter Hollow Stem Augers | DATE November 4, 2011

ORIGINATED BY MS | COMPILED BY NK | CHECKED BY KJB

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
187.5	GROUND SURFACE										
0.0	ASPHALT										
0.2	Silty sand and gravel (FILL) Compact Brown Moist		1	SS	16		187		○		
186.8 / 0.7	CLAYEY SILT with sand, trace to some gravel (TILL) Stiff to very stiff Grey Moist		2	SS	15						
			3	SS	9		186		○		
			4	SS	9		185				
			5	SS	9				○		2 25 45 28
			6	SS	14		184				
			7	SS	16		183		○		
182.3											
5.2	END OF BOREHOLE										

NOTE:

1. Borehole dry on completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No 18

1 OF 1 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | DIST | HWY 401 | DATUM Geodetic

LOCATION N 4842995.0 ;E 308164.6 | BOREHOLE TYPE CME-75 Truck Mount, 70 mm Inner Diameter Hollow Stem Augers | DATE November 4, 2011

ORIGINATED BY MS | COMPILED BY NK | CHECKED BY KJB

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
189.0	GROUND SURFACE									
0.0	ASPHALT									
0.2	Silty sand and gravel (FILL) Compact Brown		1	SS	21					
188.3							188			
0.7	Moist CLAYEY SILT with sand, trace to some gravel (TILL) Very stiff to hard Brown to grey Moist		2	SS	15					
			3	SS	16		187			2 27 46 25
			4	SS	24					
			5	SS	32		186			
			6	SS	26		185			
183.8			7	SS	25		184			
5.2	END OF BOREHOLE NOTE: 1. Borehole dry on completion of drilling.									

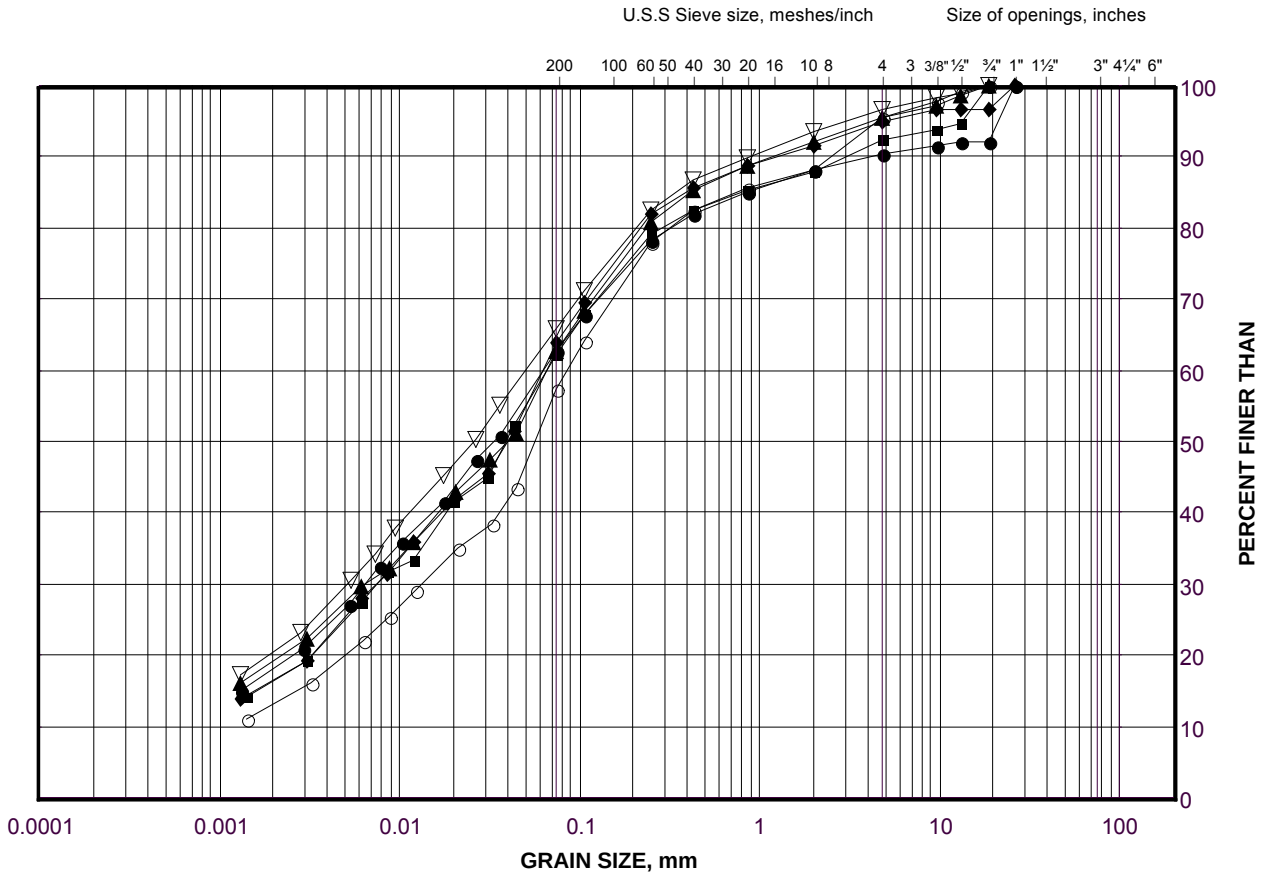
$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

GRAIN SIZE DISTRIBUTION

Clayey Silt Till

FIGURE 1A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	5	3	186.5
■	2	3	184.9
◆	4	4	184.7
▲	1	6	181.6
▽	5	7	183.4
❍	2	8	179.6

Project Number: 09-1111-6007

Checked By: JMAC

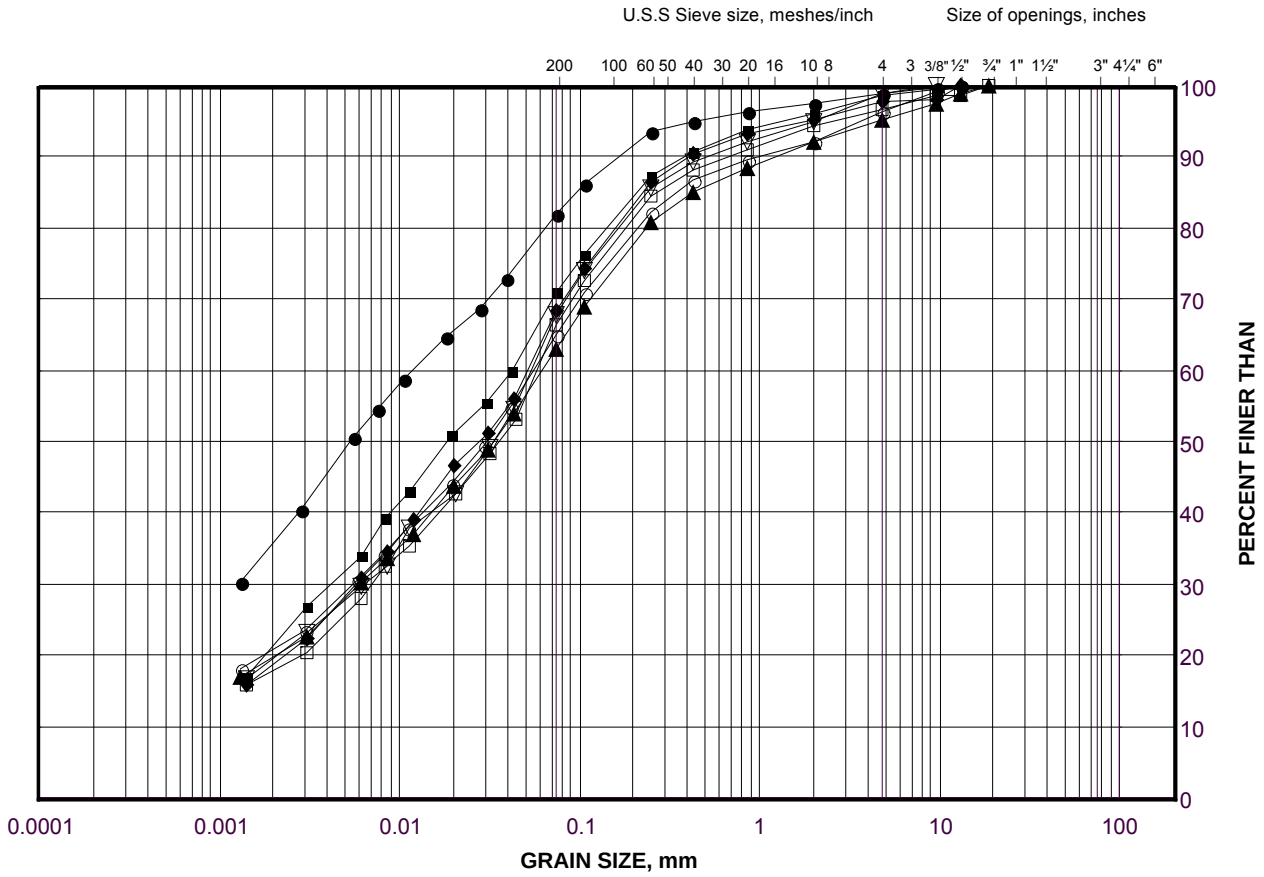
Golder Associates

Date: 23-Jan-12

GRAIN SIZE DISTRIBUTION

Clayey Silt Till

FIGURE 1B



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	7	2	187.9
■	8	2	187.9
◆	14	4	185.7
▲	13	5	184.1
▽	6	5	185.1
❍	7	6	184.9
□	16	6	184.7

Project Number: 09-1111-6007

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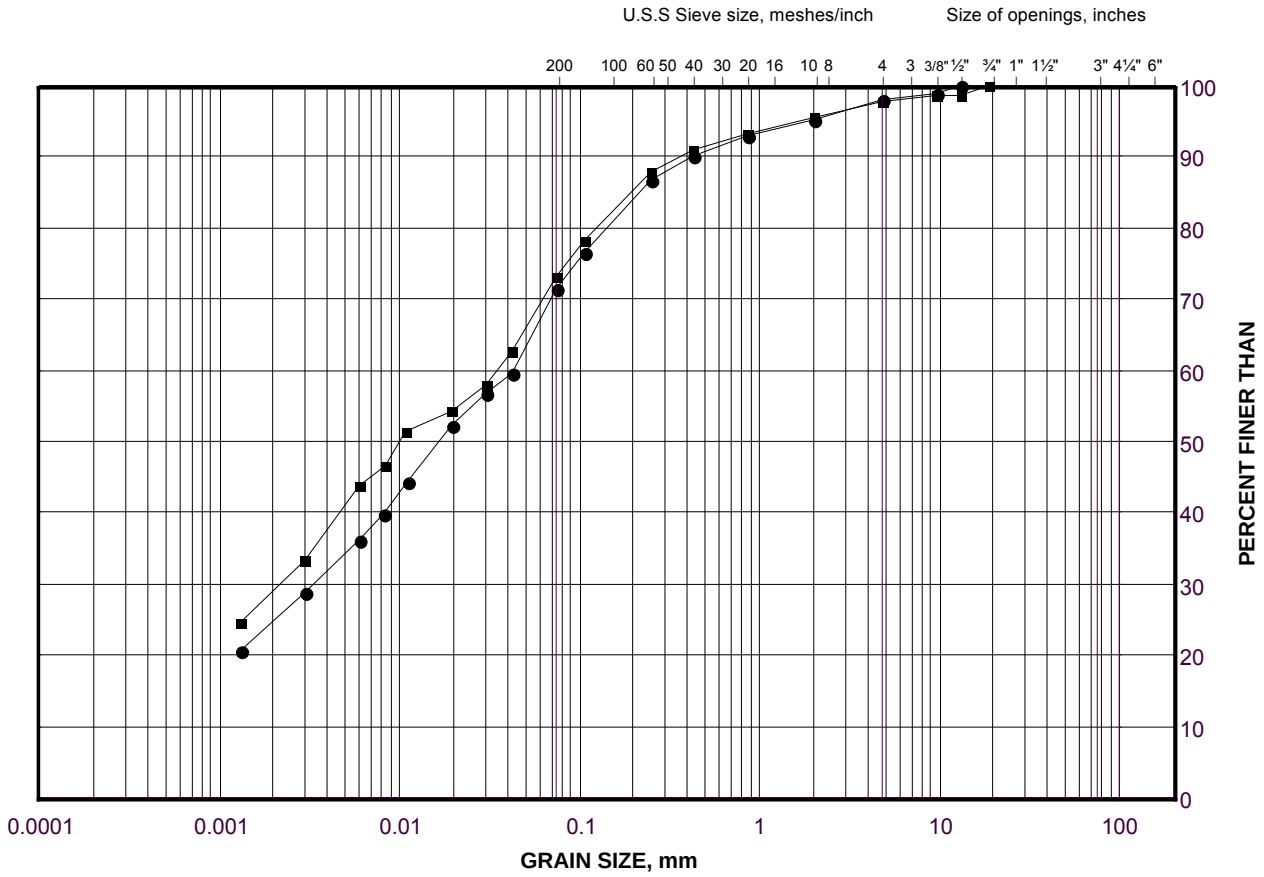
Date: 23-Jan-12

GRAIN SIZE DISTRIBUTION

Clayey Silt Till

FIGURE 1C



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	18	3	187.2
■	17	5	184.1

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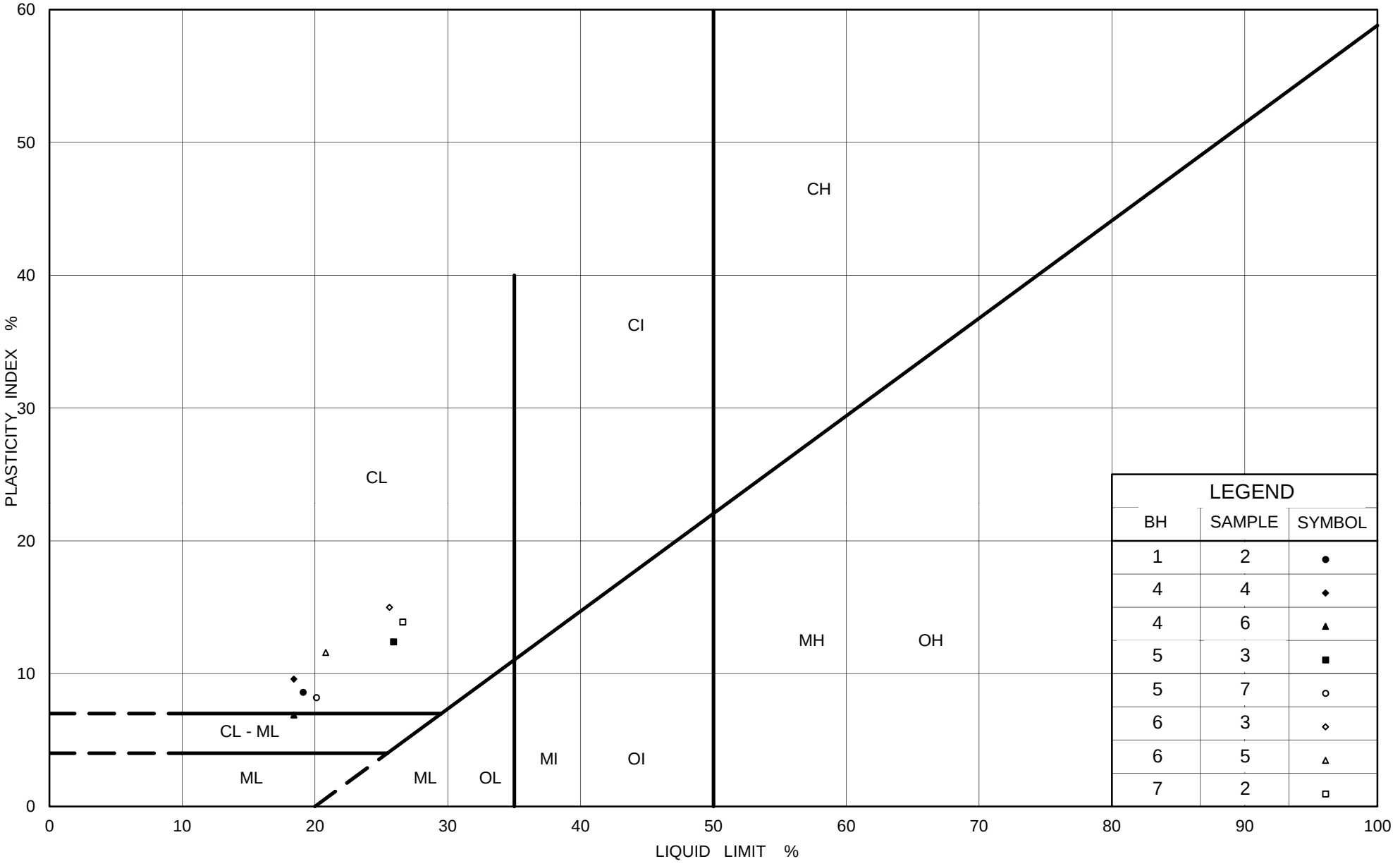


Ministry of Transportation

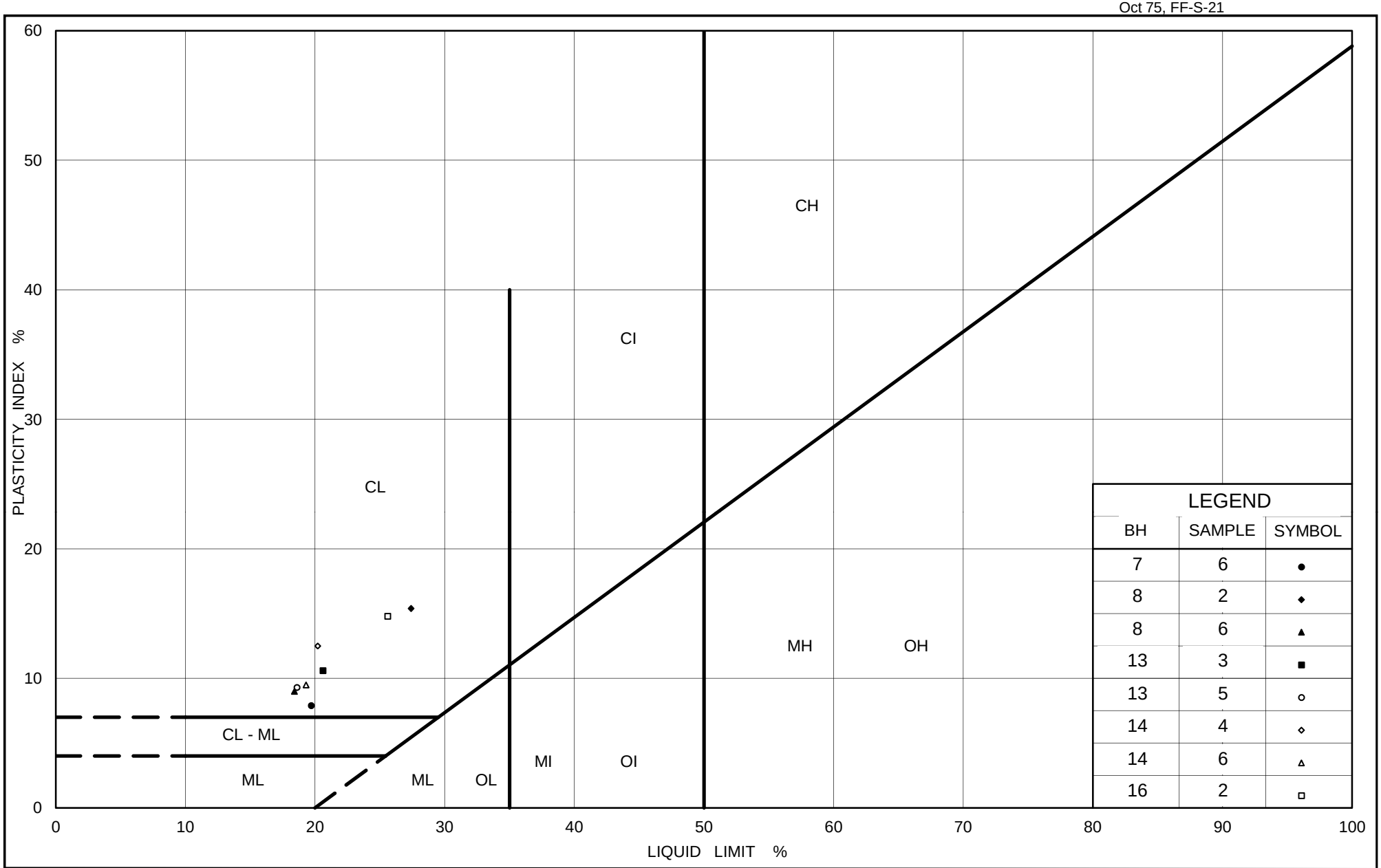
Ontario

PLASTICITY CHART
Clayey Silt Till

Figure No. 2A

Project No. 09-1111-6007

Checked By: JMAC



Ministry of Transportation

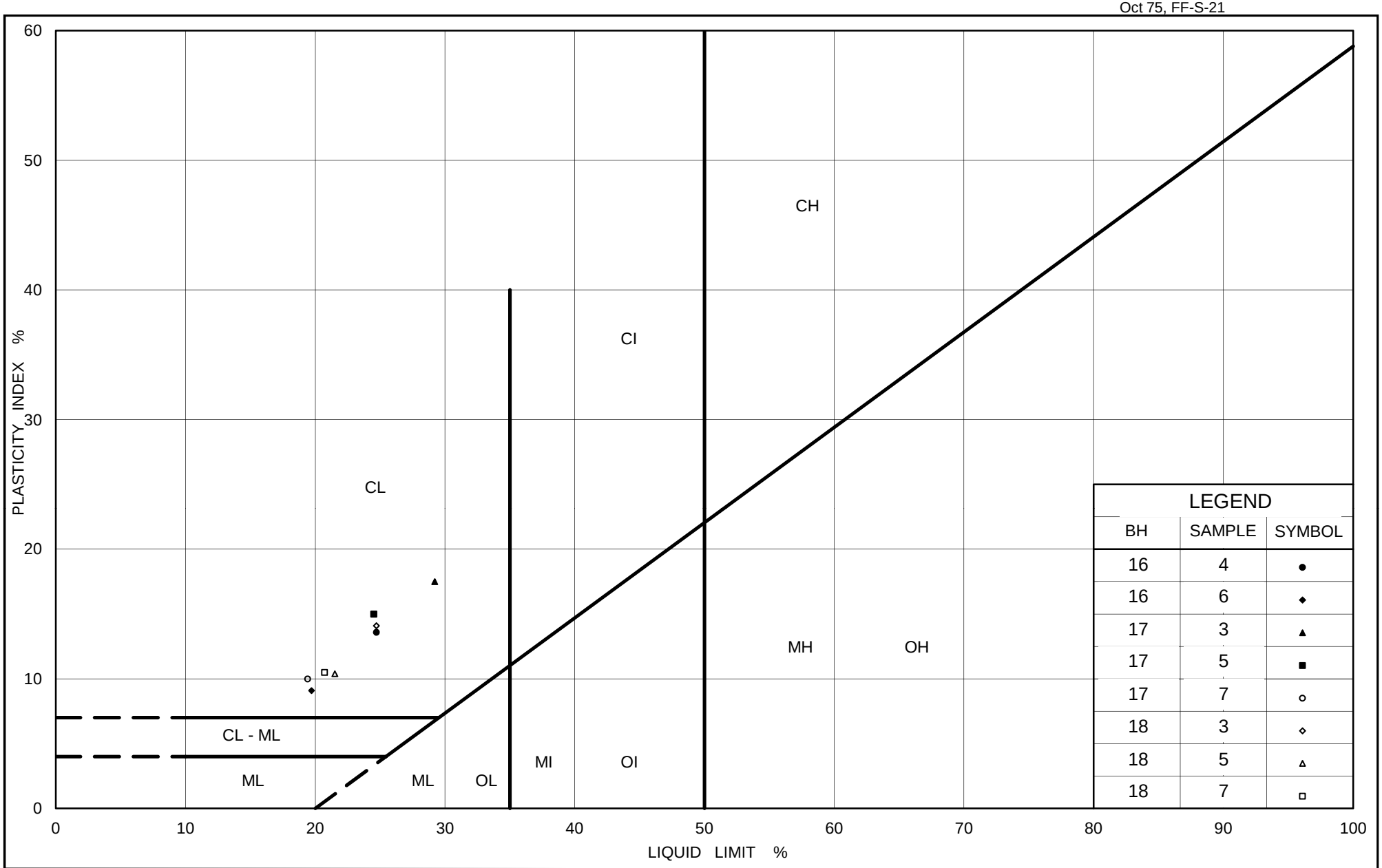
Ontario

PLASTICITY CHART
Clayey Silt Till

Figure No. 2B

Project No. 09-1111-6007

Checked By: JMAC



Ministry of Transportation

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PLASTICITY CHART
Clayey Silt Till

Figure No. 2C

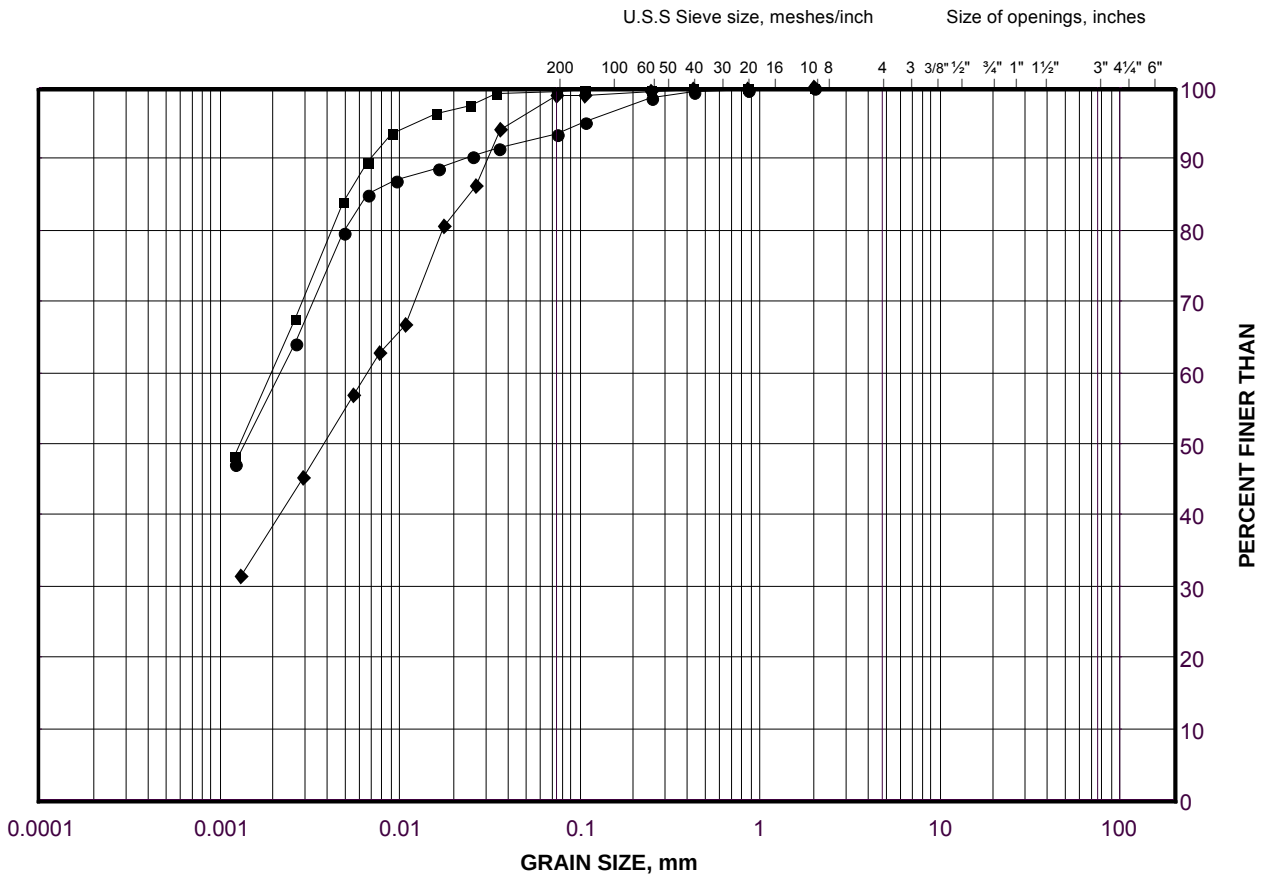
Project No. 09-1111-6007

Checked By: JMAC

GRAIN SIZE DISTRIBUTION

Clayey Silt to Silty Clay

FIGURE 3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	4	10	177.9
■	1	13	171.0
◆	4	16	168.7

Project Number: 09-1111-6007

Checked By:JMAC

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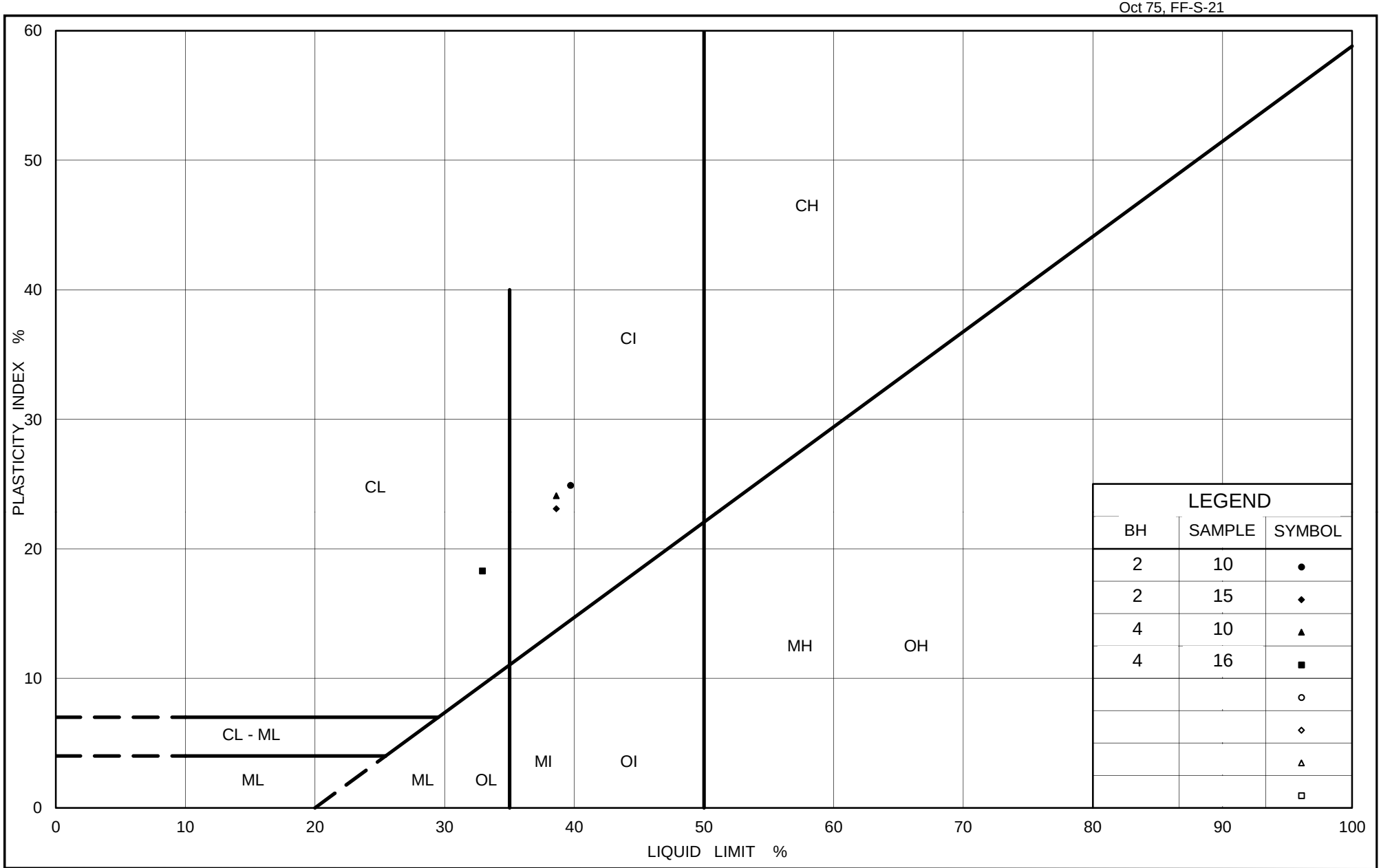
Date: 23-Jan-12



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PLASTICITY CHART
Clayey Silt to Silty Clay

Figure No. 4

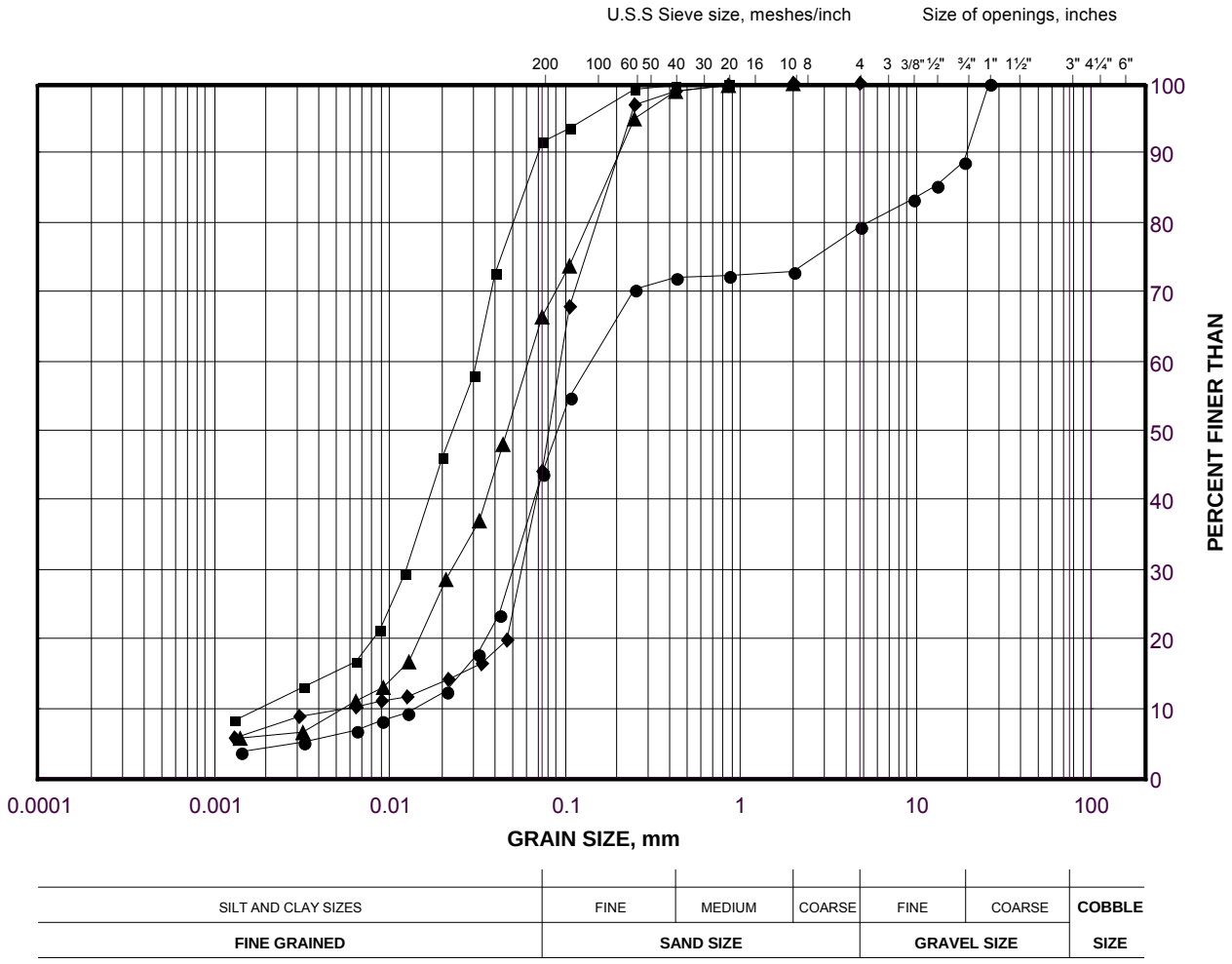
Project No. 09-1111-6007

Checked By: JMAC

GRAIN SIZE DISTRIBUTION

Sand and Silt to Silt

FIGURE 5



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	1	10	175.7
■	2	14	170.4
◆	1	15	168.0
▲	4	15	170.2

Project Number: 09-1111-6007

Checked By: JMAC

Golder Associates

Date: 23-Jan-12