REPORT

February 2012

FOUNDATION INVESTIGATION REPORT

TEMPORARY SUPPORTS AT BRIDGELAND AVENUE RAPID BRIDGE REPLACEMENT CONSTRUCTION STAGING AREA HIGHWAY 401 EASTBOUND COLLECTOR REHABILITATION FROM JANE STREET TO AVENUE ROAD TORONTO, ONTARIO G.W.P. 2225-10-00

Submitted to:
URS Canada Inc.
75 Commerce Valley Drive East
Markham, Ontario
L3T 7N9

GEOCRES No. 30M11-240

Report Number: 09-1111-6007 (8000)
Distribution:

1 Copy – MTO Foundations Section, Downsview, Ontario
3 Copies – URS Canada Inc., Markham, Ontario
2 Copies – Golder Associates Ltd., Mississauga, Ontario

Golder Associates

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by URS Canada Inc. on behalf of Ministry of Transportation, Ontario (MTO) to provide foundation engineering services in support of the rehabilitation of the Highway 401 eastbound collector lanes (EBC) between Jane Street and Avenue Road in Toronto, Ontario. Foundation engineering services are required under two phases:

- Phase 1: Foundation Engineering Assessment of existing foundations at six (6) structure locations, namely Keele Street Underpass; Dufferin Street Overpass; Ramp 401W – Dufferin Street N/S over Bridgeland Avenue; Ramp 401W – Yorkdale & Dufferin NB over Dufferin Street; Bathurst Street Overpass; and Avenue Road Underpass. This phase of the work has been completed and the results have been reported in a Technical Memorandum, dated July 21, 2010.
- Phase 2: Foundation Investigation, Design and Analyses under two components as follows:
  - Foundation Investigation and Design for:
    - Overhead Sign support structures; and
    - Temporary bridge deck support structure for Rapid Bridge Replacement (RBR) of Ramp 401W-Dufferen Street N/S bridge over Bridgeland Avenue
  - Foundation Investigation and/or Analysis and Design at six bridge structures: Keele Street Underpass; Dufferin Street Overpass; Ramp 401W – Dufferin Street N/S over Bridgeland Avenue; Ramp 401W – Yorkdale & Dufferin NB over Dufferin Street; Bathurst Street Overpass; and Avenue Road Underpass.

The terms of reference and scope of work for the foundation investigation are outlined in MTO's Request for Proposal (RFP) for Agreement No. 2009-E-0011, issued on December 16, 2009, MTO's revised Terms of Reference in the Addendum dated May 5, 2011, and in the Addendum dated November 23, 2011. The scope of work for the foundation engineering services is presented in Golder's letter dated May 19, 2011, and revised in Golder's scope change letter, dated December 13, 2011.

This report presents the subsurface conditions at the construction staging area for the temporary supports for the Rapid Bridge Replacement (RBR) of Ramp 401W-Dufferen Street N/S bridge over Bridgeland Avenue, associated with the Phase 2 component of the engineering services.

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.

The information contained in this Foundation Investigation Report is for planning and bidding purposes only and the Contractor shall satisfy himself as to the sufficiency of the information and supplement it with additional subsurface information through his own investigation, as he deems appropriate.

2.0 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 in Section 1.0, 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.

3.0 INVESTIGATION PROCEDURES

The field work for this subsurface investigation was carried out between November 13 and 15, 2011, at which time three boreholes (designated Boreholes 9, 10 and 15) were advanced using a CME 75 Truck mount drill rig, supplied and operated by Geo-Environmental Drilling Inc. of Halton Hills, Ontario. Boreholes 9, 10 and 15 pertain to the temporary RBR temporary support construction staging area were advanced at the locations shown on Drawing 1.

The boreholes were advanced using 70 mm inside 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. Field vane shear tests (ASTM D2573) using an MTO size 'N' vane were attempted in two of the boreholes, but were not able to be turned due to the very stiff to hard consistency of the soil strata.

The groundwater conditions were observed in the open boreholes during and immediately following the drilling operations. A standpipe piezometer was installed in Borehole 10 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 10. 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
9	4,843,015.3	308,114.8	190.8 m	18.9 m
10	4,843,025.3	308,148.0	191.3 m	18.4 m
15	4,843,014.1	308,120.9	190.8 m	5.2 m

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 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.

4.2 Subsurface Conditions

As part of the subsurface investigation, three boreholes (Boreholes 9, 10, and 15) were advanced at the temporary RBR work/storage area. The borehole locations, ground surface elevations and interpreted stratigraphic conditions are shown on Drawings 1.

The detailed subsurface soil and groundwater conditions encountered in the boreholes during this investigation and the results of in situ and laboratory testing are given on the borehole records contained in Appendix A; the results of geotechnical laboratory testing are also presented on Figures B1 to B5 contained in Appendix B.

The stratigraphic boundaries shown on the borehole records and on the interpreted stratigraphic profile on Drawing 1 are inferred observations of drilling progress and 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 deposit of cohesive fill underlain by a till deposit comprised of clayey silt. The clayey silt till deposit is underlain by a deposit of sand and silt, in turn underlain by a deposit of silty clay.

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

[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.

4.2.1 Fill

A deposit of cohesive fill was encountered immediately below ground surface in all boreholes. The fill deposit is between 2.2 m and 3.7 m thick, and consists of clayey silt, containing trace to some sand, trace gravel and organics.

The measured SPT "N"-values within the fill range from 4 blows to 20 blows per 0.3 m of penetration and one field vane test measured an undrained shear strength greater than 134 kPa. The SPT "N" values together with the vane test suggest that the fill deposit has a soft to very stiff consistency.

The natural water content measured on selected samples of the fill ranged from 12 per cent to 22 per cent.

4.2.2 Clayey Silt Till

A deposit of till comprised of clayey silt with sand, containing trace gravel was encountered underlying the fill in all boreholes. The top of the till deposit was encountered at depths ranging from 2.2 m to 3.7 m below ground surface, corresponding to between Elevation 188.6 m and 187.6 m. Borehole 15 terminated within this deposit, penetrating it for a depth of 3.0 m. The thickness of the deposit in the remaining boreholes is 11.1 m and 12.6 m.

The measured SPT "N"-values within this deposit range from 6 blows to 31 blows per 0.3 m of penetration and two field vane tests measured undrained shear strength greater than 134 kPa. However, the till deposit is generally very stiff to hard and it is noted that the firm to stiff zones (i.e. SPT "N"-values of 6 and 7) were encountered at the top of the deposit between approximately Elevation 187.5 m and Elevation 185.5 m in Borehole 10.

The results of grain size distribution tests completed on seven selected samples of the till deposit are shown on Figure B1 in Appendix B.

Atterberg limits testing was carried out on eight selected samples of the till and measured plastic limits between 10 per cent and 14 per cent, liquid limits between 18 per cent and 27 per cent, and plasticity indices between 8 per cent and 17 per cent. Atterberg limits testing carried out on one sample from the top of the till stratum in Borehole 10 measured a plastic limit of 14 per cent, a liquid limit of 37 per cent, and a corresponding plasticity index of 24 per cent. These test results, which are plotted on Figure B2 in Appendix B, indicate that the till deposit consists primarily of clayey silt of low plasticity while the upper portion of the deposit in Borehole 10 consists of silty clay of medium plasticity.

The natural water content measured on selected samples of the till range from 9 per cent to 22 per cent.

4.2.3 Sand and Silt

A sand and silt deposit containing trace to some clay and trace gravel was encountered underlying the clayey silt to silty clay till in Boreholes 9 and 10. The sand and silt deposit is interlayered between the clayey silt till and a silty clay deposit (described in Section 4.2.4) in Borehole 9. The top of the deposit was encountered at depths of 13.3 m and 16.3 m below ground surface in Boreholes 9 and 10, respectively, corresponding to Elevation

177.5 m and 175.0 m. Borehole 10 was terminated within this deposit, penetrating it for a thickness of approximately 2.1 m. The thickness of the interlayer in the Borehole 9 is 3.0 m.

The measured SPT "N" values within this interlayer range from 50 blows per 0.03 m of penetration to 50 blows per 0.1 m of penetration, indicating a very dense relative density.

The result of a grain size distribution test completed on one selected sample of the sand and silt deposit is shown on Figure B3 in Appendix B.

The natural water content measured on one selected sample of the sand and silt deposit is 9 per cent.

4.2.4 Silty Clay

A deposit of silty clay containing trace sand was encountered underlying the sand and silt deposit in Borehole 9. The top of the deposit was encountered at a depth of 16.3 m below ground surface, corresponding to Elevation 174.5 m. Borehole 9 terminated within this deposit, penetrating it for a thickness of approximately 2.6 m.

The measured SPT "N" values within the silty clay deposit are 42 blows and 89 blows per 0.3 m of penetration, suggesting a hard consistency.

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

Atterberg limits testing was carried out on one selected sample of the silty clay and measured a plastic limit of 17 per cent, a liquid limit of 39 per cent and a corresponding plasticity index of 22 per cent. The test results, which are plotted on Figure B5 in Appendix B, indicate that the sample consists of silty clay of intermediate plasticity.

The natural water content measured on one selected sample of the silty clay is 21 per cent.

4.2.5 Groundwater Conditions

The observed water levels in the open boreholes following completion of drilling 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
9	190.8 m	12.2 m	178.6 m	Nov. 14, 2011
10	191.3 m	7.1 m	184.2 m	Jan. 22, 2012
15	190.8 m	dry	n/a	Nov. 15, 2011

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.

5.0 CLOSURE

This Foundation Investigation Report was prepared by Mr. Matt Soderman, E.I.T., and reviewed by Ms. Nikol Kochmanová, P.Eng., a Geotechnical Engineer at Golder. Mr. Jorge Costa, P.Eng., a Designated MTO Contact and Principal with Golder, conducted an independent review and quality control audit of this report.

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n:\active\2009\1111\09-1111-6007 urs hwy 401 rehab toronto\9 - addendum bridgeland avenue\5 - reporting\3 - temporary supports at construction area storage area report\09-1111-6007 rpt01 12feb bridgeland ave - temporary support area.docx

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

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

CONT No.
GWP No. 2225-10-00

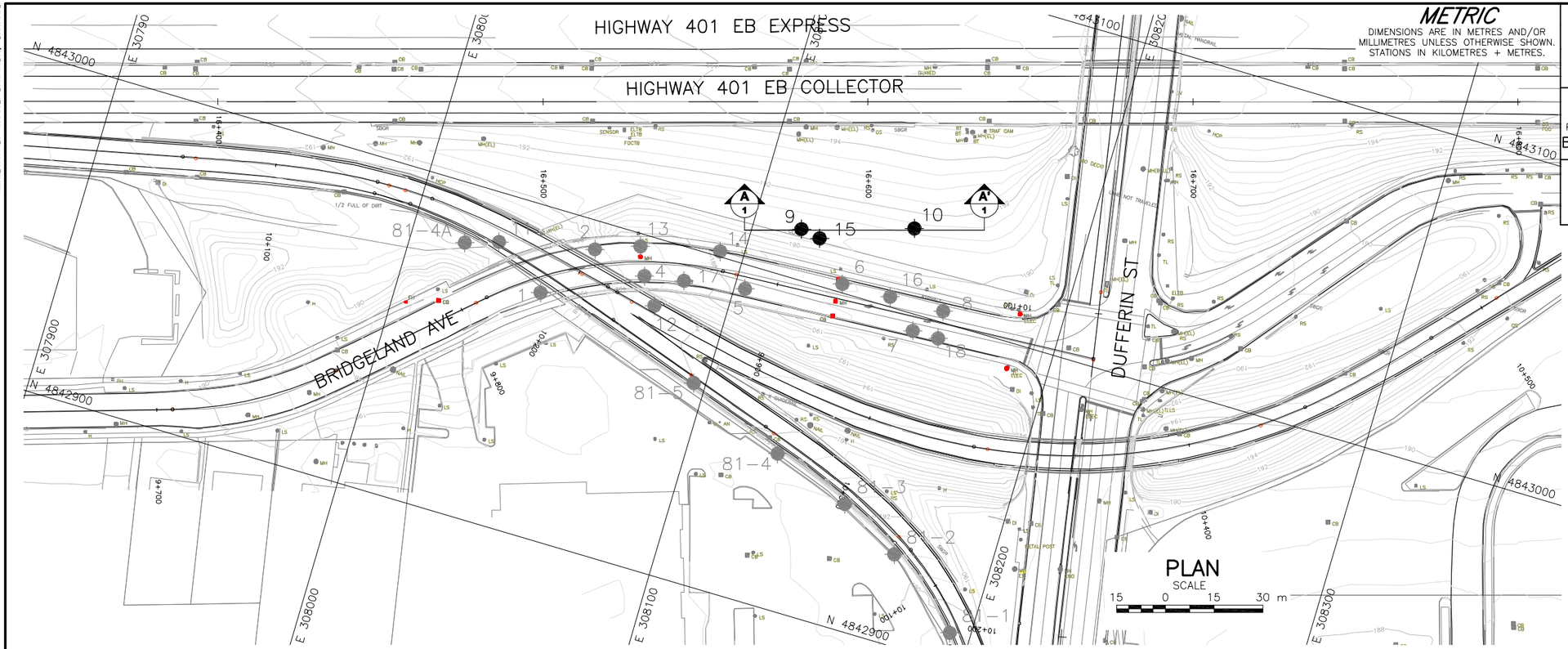
SHEET

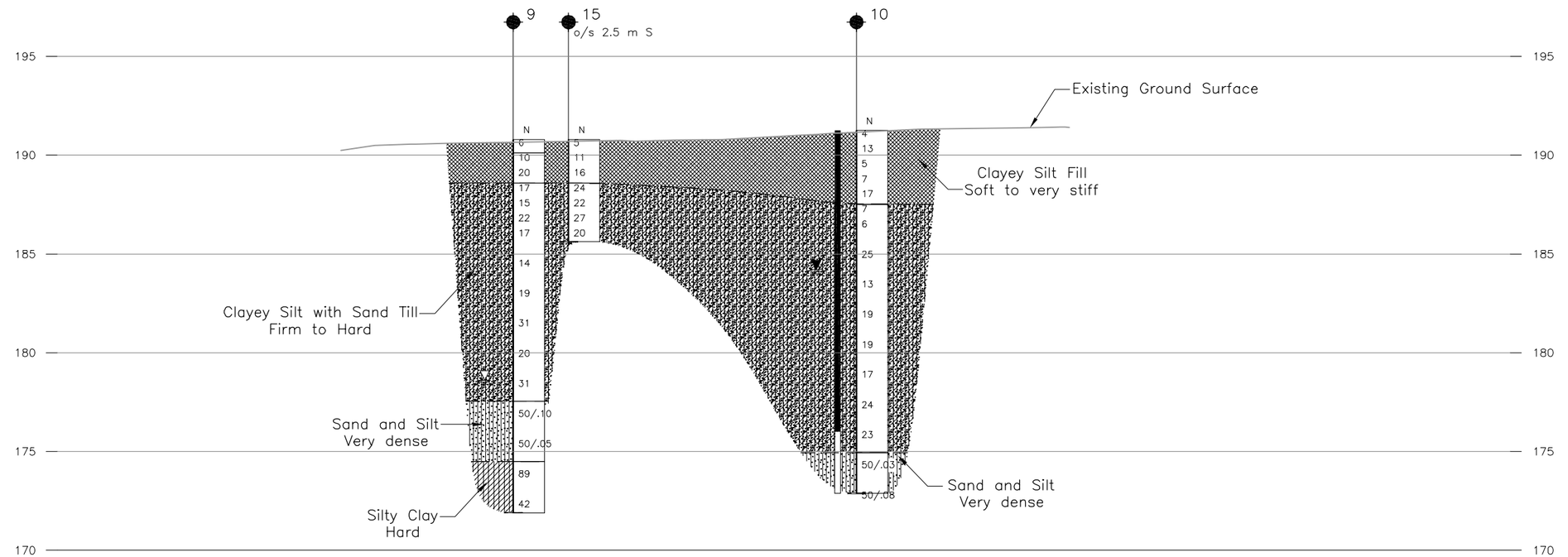
HIGHWAY 401 EBC REHABILITATION

HWY 401 W-N/S RAMP OVER BRIDGELAND AVE.
RBR TEMPORARY SUPPORT CONSTRUCTION STAGING AREA

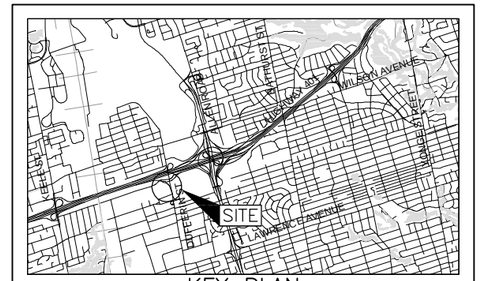
BOREHOLE LOCATIONS AND SOIL STRATA

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA





A-A'
1
PROFILE
HORIZONTAL SCALE
5 0 5 10 m
2.5 0 2.5 5 m
VERTICAL SCALE



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 on October 28, 2011
- WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
9	190.8	4843015.3	308114.8
10	191.3	4843025.3	308148.0
15	190.8	4843014.1	308120.9

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 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.

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

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

NO.	DATE	BY	REVISION

Geocres No. 30M11-240

HWY. 401	PROJECT NO. 09-1111-6007		DIST.
SUBM'D. NK	CHKD. KJB	DATE: 2/8/2012	SITE: 37-283
DRAWN: CD	CHKD. NK	APPD. JMAC	DWG. 1

PLOT DATE: February 8, 2012
FILENAME: I:\Projects\2009\09-1111-6007 (URS, Toronto)\-IB- (BRIDGELAN AVE) REPORT 3\09111160078B001.dwg

APPENDIX A

Record of Boreholes from Current Investigation

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 9

1 OF 2 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | LOCATION N 4843015.3 ;E 308114.8 | ORIGINATED BY TT

DIST | HWY 401 | BOREHOLE TYPE CME-55 Track Mount, 70 mm Inner Diameter Hollow Stem Augers | COMPILED BY NK

DATUM Geodetic | DATE November 14, 2011 | 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
190.8	GROUND SURFACE										
0.0	Clayey silt, trace to some sand, trace gravel, contains organics at a depth of 1.7 m (FILL) Firm to very stiff Brown to dark brown Moist		1	SS	6		190				
			2	SS	10						
			3	SS	20		189				
188.6											
2.2	CLAYEY SILT, some to with sand, trace gravel (TILL) Stiff to hard Brown becoming grey at a depth of 3.8 m Moist		4	SS	17		188				3 15 56 26
			5	SS	15						
			6	SS	22		187				3 28 46 23
			7	SS	17		186				
							185				
			8	SS	14						
							184		>134		
			9	SS	19		183				
							182				
			10	SS	31						
							181				
			11	SS	20		180				
						▽	179				
			12	SS	31						5 35 45 15
177.5							178				
13.3	SAND and SILT, trace clay, trace gravel Very dense Grey Moist		13	SS	50/0.10		177				
							176				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No 9

2 OF 2 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | LOCATION N 4843015.3 ;E 308114.8 | ORIGINATED BY TT

DIST | HWY 401 | BOREHOLE TYPE CME-55 Track Mount, 70 mm Inner Diameter Hollow Stem Augers | COMPILED BY NK

DATUM Geodetic | DATE November 14, 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 (○ 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 ---										
	SAND and SILT, trace clay, trace gravel Very dense Grey Moist		~~14~~	~~SS~~	~~50/0.05~~		175				
174.5											
16.3	SILTY CLAY, trace sand Hard Grey Moist		15	SS	89		174				
							173				
171.9			16	SS	42		172				0 2 30 68
18.9	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 12.2 m below ground surface (Elev. 178.6 m) on completion of drilling.										

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

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RECORD OF BOREHOLE No 10

1 OF 2 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | LOCATION N 4843025.3 ;E 308148.0 | ORIGINATED BY TT

DIST | HWY 401 | BOREHOLE TYPE CME-55 Track Mount, 70 mm Inner Diameter Hollow Stem Augers | COMPILED BY NK

DATUM Geodetic | DATE November 13, 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
191.3	GROUND SURFACE										
0.0	Clayey silt, trace to some sand, trace gravel, contains organics (FILL) Soft to very stiff Brown Moist		1	SS	4		191				
			2	SS	13		190				
			3	SS	5				>134		
			4	SS	7		189				
			5	SS	17		188				
187.6											
3.7	CLAYEY SILT to SILTY CLAY with sand, trace gravel (TILL) Firm to hard Brown to grey Moist		6	SS	7		187		>134		2 25 47 26
			7	SS	6		186				
			8	SS	25		185				
			9	SS	13		184				2 18 53 27
			10	SS	19		183				
			11	SS	19		182				
			12	SS	17		181				
			13	SS	24		180				3 34 46 17
							179				
							178				
							177				

Continued Next Page

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

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

Golder Associates

RECORD OF BOREHOLE No 10

2 OF 2 **METRIC**

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

LOCATION N 4843025.3 ;E 308148.0 | BOREHOLE TYPE CME-55 Track Mount, 70 mm Inner Diameter Hollow Stem Augers | DATE November 13, 2011

ORIGINATED BY TT | 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 ---										
	CLAYEY SILT to SILTY CLAY with sand, trace gravel (TILL) Firm to hard Brown to grey Moist		14	SS	23		176				
175.0											
16.3	SAND and SILT, some clay, trace gravel Very dense Grey Moist		15	SS	50/.03		175				
							174				
172.9			16	SS	50/.08		173				3 35 44 18
18.4	END OF BOREHOLE										

NOTE:

1. Borehole dry on completion of drilling.

2. Water level in piezometer measured at a depth of 7.1m below ground surface (Elev. 184.2 m) on January 22, 2012.

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

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

Golder Associates

RECORD OF BOREHOLE No 15

1 OF 1 **METRIC**

PROJECT 09-1111-6007 (8000) | G.W.P. 2225-10-00 | LOCATION N 4843014.1 ;E 308120.9 | ORIGINATED BY TT

DIST | HWY 401 | BOREHOLE TYPE CME-55 Track Mount, 70 mm Inner Diameter Hollow Stem Augers | COMPILED BY NK

DATUM Geodetic | DATE November 15, 2011 | 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
190.8	GROUND SURFACE										
0.0	Clayey silt, trace to some sand, trace gravel, contains organics to a depth of 0.3 m (FILL) Firm to very stiff Brown Moist		1	SS	5						
			2	SS	11		190				
			3	SS	16		189				
188.6											
2.2	CLAYEY SILT, with sand, trace gravel (TILL) Very stiff Brown becoming grey at a depth of 3.8 m Moist		4	SS	24		188				
			5	SS	22						
			6	SS	27		187				
			7	SS	20		186				0 30 48 22
185.6											
5.2	END OF BOREHOLE NOTE: 1. Borehole dry on completion of drilling.										

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

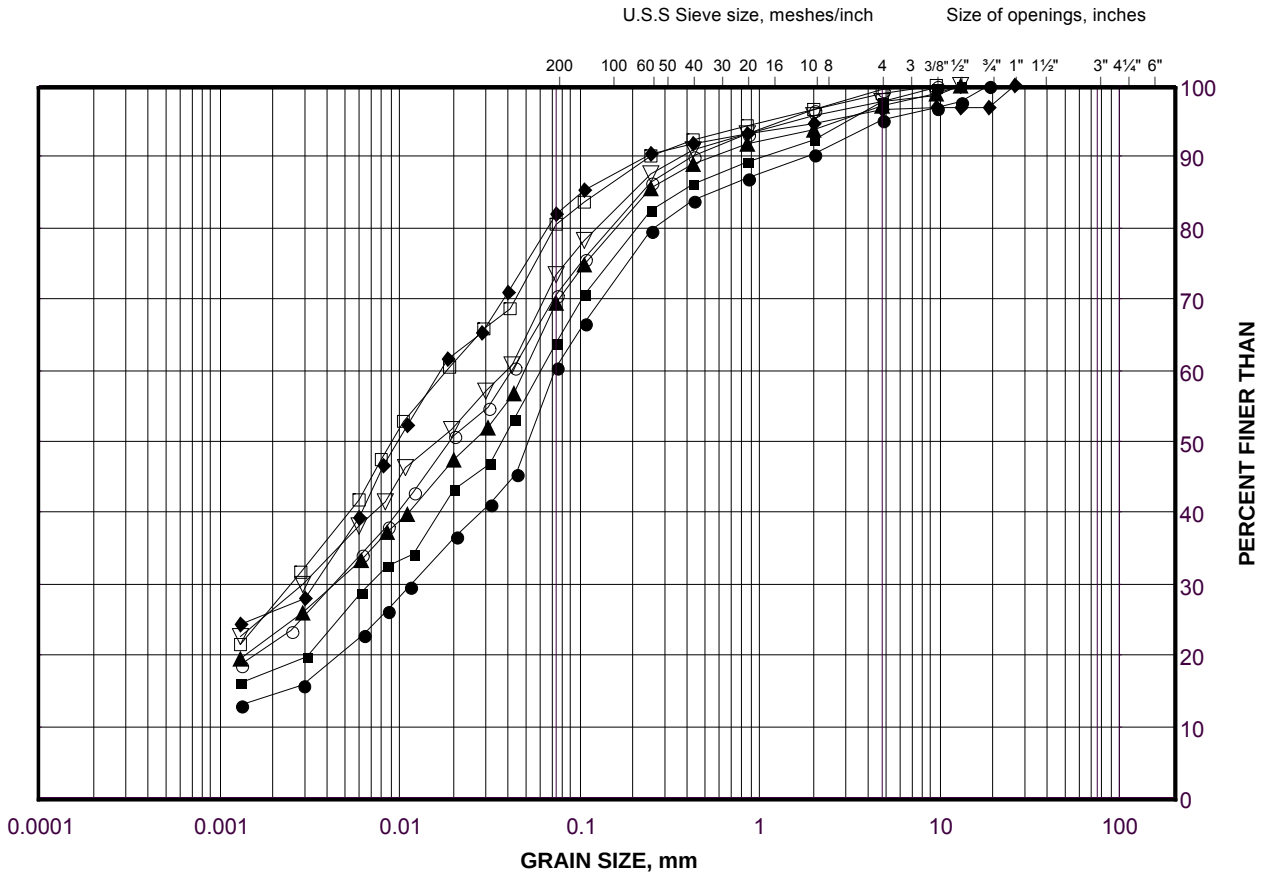
APPENDIX B

Laboratory Test Results

GRAIN SIZE DISTRIBUTION

Clayey Silt Till

FIGURE B1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	9	12	178.3
■	10	13	177.3
◆	9	4	188.2
▲	9	6	186.7
▽	10	6	187.2
❍	15	7	185.9
□	10	9	183.4

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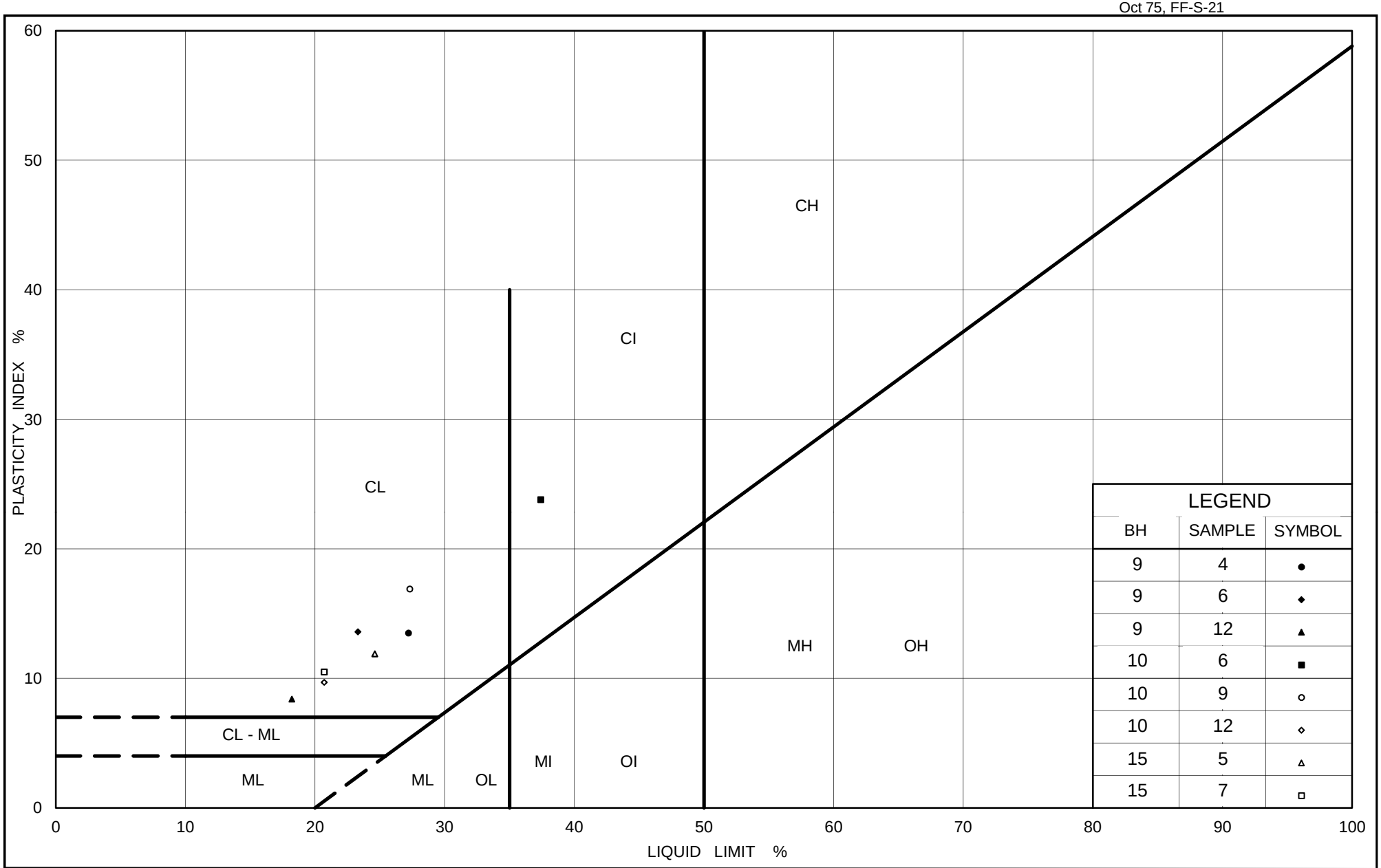
Date: 23-Jan-12



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PLASTICITY CHART
Clayey Silt Till

Figure No. B2

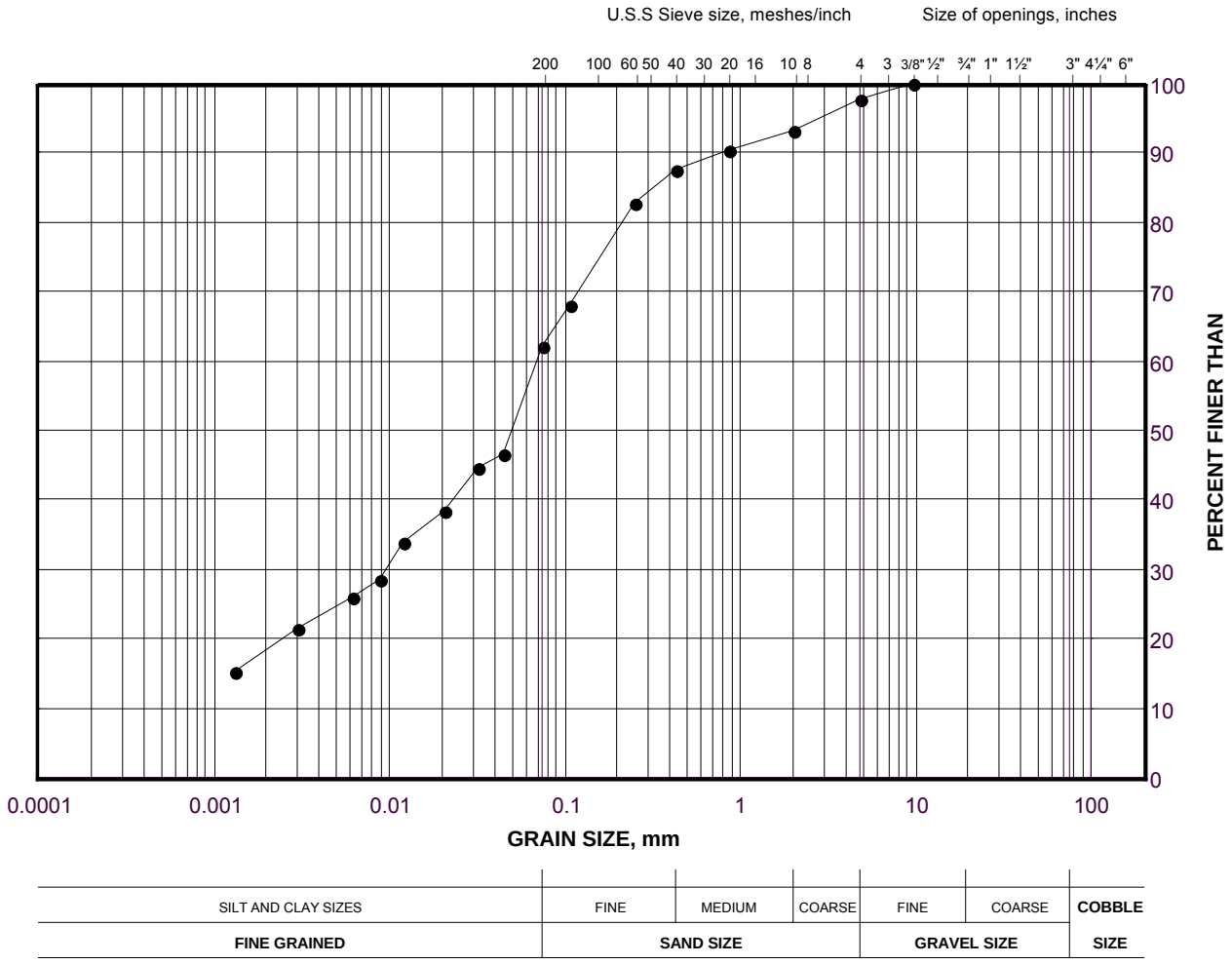
Project No. 09-1111-6007

Checked By: JMAC

GRAIN SIZE DISTRIBUTION

Sand and Silt

FIGURE B3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	10	16	173.0

Project Number: 09-1111-6007

Checked By: JMAC

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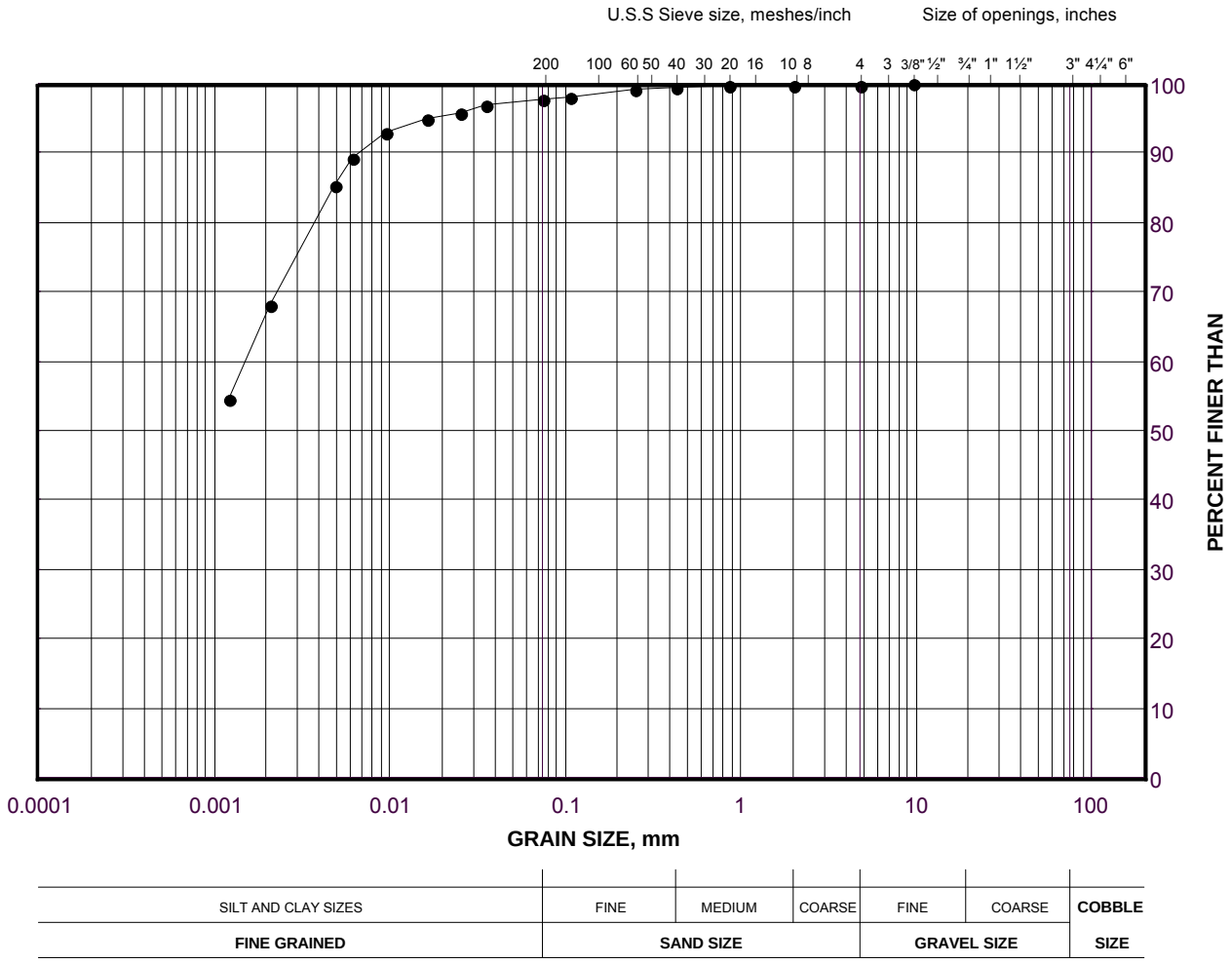
Date: 23-Jan-12

GRAIN SIZE DISTRIBUTION

Silty Clay

FIGURE B4



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	9	16	172.2

Project Number: 09-1111-6007

Checked By:JMAC

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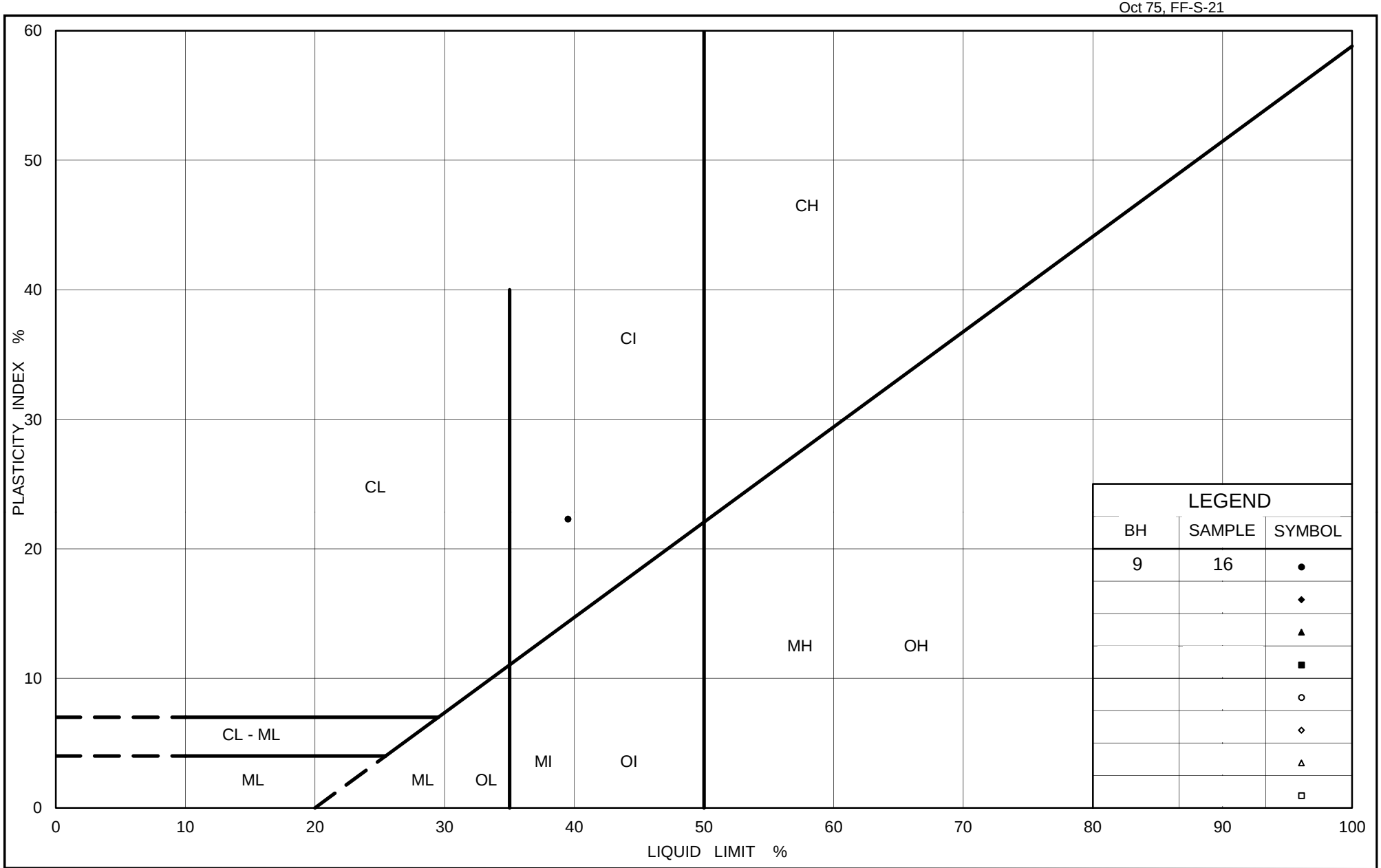
Date: 23-Jan-12



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PLASTICITY CHART
Silty Clay

Figure No. B5

Project No. 09-1111-6007

Checked By: JMAC

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