REPORT

January 13, 2015

FOUNDATION INVESTIGATION REPORT

STORMWATER MANAGEMENT PONDS
HIGHWAY 400 WIDENING FROM
NORTH OF KING ROAD TO SOUTH CANAL ROAD
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 2025-13-00

Submitted to:
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GEOCRES NO.: 30M13-204

Report Number: 09-1111-0018-8

Distribution:

1 Electronic Copy - MTO Contracts Section
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Golder Associates

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by URS Canada Inc. (URS) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services in support of the detail design of the widening of Highway 400 from north of King Road to South Canal Road in the Regional Municipality of York, Ontario, including replacement of the 16th Side Road underpass, Lloydtown-Aurora Road underpass, Highway 9 underpass and the southbound and northbound South Canal bridges, culvert extensions and replacements, retaining walls, the widening of high fill embankments and deep cuts, stormwater management ponds, and high mast light poles and sign supports.

The Terms of Reference for the foundation engineering services are outlined in MTO's Request for Proposal, dated May 2008, that forms part of the Consultant's Agreement (No. 2007-E-0002) for this project. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for this project, dated October 2010.

This report addresses the investigation carried out for proposed stormwater management (SWM) Ponds 6 and 7 within Contract 1. The purpose of this investigation is to establish the subsurface conditions at the location of the proposed SWM ponds based on borehole drilling and geotechnical laboratory testing on selected samples.

2.0 SITE DESCRIPTION

SWM Ponds 6 and 7 are located on the west side of Highway 400, about 800 m south of Highway 9 and immediately south of South Canal Bank Road, respectively. Agricultural fields are present along the Highway 400 corridor in this area, with commercial facilities generally located near the Highway 9 interchange and South Canal Bank Road.

In general, the topography at and south of the Highway 9 interchange consists of rolling terrain, with the natural ground surface in the vicinity of SWM Pond 6 sloping downward from south to north, from about Elevation 254 m to 248 m. The southeastern tip (inlet) of SWM Pond 6 is located approximately 10 m west of the toe of the widened Highway 400 embankment, which is up to approximately 2.5 m to 3 m high at this location, and the main area of the pond is located between about 30 m and 40 m west of the toe of the embankment.

Immediately to the north of Highway 9, the natural ground surface and Highway 400 descend into the "Holland Marsh" (as described further in Section 4.1), where the ground surface is relatively flat. SWM Pond 7 is located on the south margin of the Holland Marsh, and the existing natural ground surface at the proposed pond location is between about Elevation 220 m and 222 m. The eastern tip of SWM Pond 7 is located within about 10 m of the proposed toe of the Highway 400/ramp embankment, but the nearest "cut" portion of SWM Pond 7 is located approximately 40 m west of the proposed toe of the widened embankment.

3.0 INVESTIGATION PROCEDURES

The field work for the foundation investigation at SWM Ponds 6 and 7 was carried out in November 2013, at which time a total of ten boreholes (five boreholes at each SWM pond location) were advanced at the proposed SWM pond sites. The locations of Boreholes SWM6-1 to SWM6-5 and SWM7-1 to SWM7-5 are shown on Drawings 1 and 2 for SWM Ponds 6 and 7, respectively.

The field investigation was carried out using a D-90 track-mounted drill rig, supplied and operated by Walker Drilling Inc. of Utopia, Ontario. The boreholes were advanced using 140 mm outside diameter continuous flight hollow stem augers, to minimize the potential for caving in non-cohesive deposits. 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 the Standard Penetration Test (SPT) procedure (ASTM D1586-08a). The boreholes were advanced to depths ranging from about 6.6 m to 12.8 m below existing ground surface.

The groundwater conditions in the open boreholes were observed during the drilling operations and a piezometer was installed in each of Borehole SWM6-3, SWM7-2 and SWM7-3 to permit monitoring of the water level at those locations. The piezometers consist of 50 mm diameter PVC pipe, with a slotted screen sealed at a selected depth within the boreholes. The borehole and annulus surrounding the piezometer pipe above the screen sand pack was backfilled to the ground surface with bentonite pellets/grout. Piezometer installation details and water level readings are described on the borehole records presented in Appendices A and C for SWM Ponds 6 and 7, respectively. All boreholes in which standpipe piezometers were not installed were backfilled to ground surface with bentonite upon completion, in accordance with Ontario Regulation 903 (as amended).

The field work was observed by members of Golder's engineering and technical staff, who located the boreholes, arranged for the clearance of underground utilities, directed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to Golder's geotechnical laboratory in Mississauga, Ontario where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO LS and/or ASTM standards, as appropriate. Classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected samples.

The borehole locations and the ground surface elevations were surveyed by Callon Dietz, a registered Ontario Land Surveyor. The borehole locations in MTM NAD 83 northing and easting coordinates, the ground surface elevations referenced to geodetic datum, and the drilled depths are summarized below and are shown on Drawings 1 and 2.

Borehole No.	Location (MTM NAD 83)		Ground Surface Elevation (m)	Drilled Depth (m)
	Northing (m)	Easting (m)		
SWM6-1	4,875,803.0	297,338.6	252.6	6.7
SWM6-2	4,875,778.0	297,274.7	252.8	7.6
SWM6-3	4,875,863.0	297,276.7	250.8	12.8
SWM6-4	4,875,900.0	297,284.7	250.0	6.7
SWM6-5	4,875,884.0	297,247.6	250.4	9.8
SWM7-1	4,876,959.0	297,103.1	221.7	6.7
SWM7-2	4,876,916.0	297,050.0	220.7	11.3
SWM7-3	4,876,883.0	297,051.7	224.5	6.6
SWM7-4	4,876,894.0	297,005.9	220.2	6.6
SWM7-5	4,876,969.0	297,052.2	219.7	6.7

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

This 23 km section of Highway 400 traverses, from south to north, the physiographic regions known as the South Slope, Oak Ridges Moraine and Simcoe Lowland (Chapman and Putman, 1984)[1]. Along Highway 400, the South Slope is present south of King Road; the Oak Ridge Moraines extends from north of King Road to south of Highway 9; and the Simcoe Lowlands occupy a 4 km wide strip extending from south of Highway 9 to Holland River. SWM Ponds 6 and 7 are located within the Simcoe Lowlands physiographic region.

The surficial soils of the South Slope region are generally cohesive tills. The Oak Ridges Moraine predominantly consists of sand and gravel, although in the King Township area these soils are often overlain by till. It is understood that during grading for the initial construction of Highway 400 through this area, deep cuts exposed up to about 10 m of till overlying the sand and gravel deposits.

The Holland River valley, which crosses Highway 400 in the vicinity of Highway 9 and South Canal Road, is located within the Simcoe Lowlands region. This valley extends to the southwest from Cook Bay at the south end of Lake Simcoe, and was once a shallow extension of the lake. The floor of the valley consists of peat, loose sands and soft clays. It is understood that during initial construction of Highway 400, a layer of peat about 2 m to 3 m thick was removed in order to construct the road upon the underlying sand and clay.

4.2 Overview of Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes, together with the results of the laboratory tests carried out on selected soil samples, are provided on the borehole records contained in Appendices A and B for SWM Pond 6, and Appendices C and D for SWM Pond 7. The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Variation in the stratigraphic boundaries between and beyond boreholes will exist and is to be expected.

In general, the subsoils at the proposed SWM Pond 6 site consist of a deposit of firm to very stiff clayey silt to silty clay containing trace organics, underlain by a deposit of clayey silt till. At the proposed SWM Pond 7 site, the subsoils generally consist of thin layers of topsoil, peat and surficial clayey silt and silt and sand, underlain by a deposit of clayey silt till. The clayey silt till deposit at both pond sites contains cobbles and boulders at various depths as inferred from grinding of the augers during drilling operations.

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

[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.

4.3 SWM Pond 6

4.3.1 Clayey Silt to Silty Clay

A deposit of clayey silt to silty clay was encountered immediately below the ground surface in all of the boreholes advanced at the proposed site for SWM Pond 6. The thickness of the deposit ranges from about 1.4 m to 8.5 m, with the base of the deposit between approximately 251.2 m and 242.3 m as encountered in the boreholes; the deposit base is higher in the south portion of the site, and lower in the central and north portion of the site.

The clayey silt to silty clay contains trace to some sand and trace gravel, as well as rootlets and organic material. The presence of cobbles and/or boulders within this deposit was inferred from grinding of the augers in Borehole SWM6-2. The results of grain size distribution test on seven selected samples from this deposit are shown on Figure B1 in Appendix B.

Atterberg limits tests were completed on eight selected samples of the clayey silt deposit and measured liquid limits ranging from about 29 per cent to 39 per cent, plastic limits ranging from about 16 per cent to 19 per cent, and plasticity indices ranging from about 12 per cent to 20 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B2 in Appendix B. These results confirm that the deposit is a clayey silt to silty clay of low to medium plasticity. The natural water content measured on samples within this deposit ranges from 18 per cent to 27 per cent.

The Standard Penetration Test (SPT) “N” values measured within this deposit range from 6 blows to 34 blows per 0.3 m of penetration, suggesting that the clayey silt to silty clay deposit ranges in consistency from firm to hard; however, the deposit typically has a stiff to very stiff consistency.

4.3.2 Clayey Silt Till

A till deposit was encountered in all of the boreholes at SWM Pond 6, underlying the clayey silt to silty clay deposit. The surface of this deposit was encountered at depths between 1.4 m and 8.5 m (Elevation 251.2 m to 242.3 m), generally declining from the south to the north end of the pond area. The till was not fully penetrated in any of the boreholes, with the deepest borehole extending to about Elevation 238.0 m.

The till consists of clayey silt with sand to some sand, trace gravel. Cobbles and/or boulders were inferred within this deposit based on grinding of the augers, as noted on the borehole records contained in Appendix A. Grain size distribution test results of five samples from this deposit are shown on Figure B3 in Appendix B.

Atterberg limits tests were completed on five selected samples of the till deposit and measured liquid limits ranging from about 20 per cent to 25 per cent, plastic limits ranging from about 12 per cent to 15 per cent, and plasticity indices ranging from about 9 per cent to 12 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B4 in Appendix B, and confirm that the material is a clayey silt of low plasticity. The natural water content measured on samples within this deposit ranges from 9 per cent to 17 per cent, generally near the plastic limit for this deposit.

The SPT “N” values measured within the clayey silt till range from 12 blows per 0.3 m of penetration to 105 blows per 0.2 m of penetration. The lower SPT “N” values of 12 blows to 21 blows per 0.3 m of penetration were generally measured in the upper 1 m to 2 m of the till deposit in some of the boreholes, and this upper portion of the till has a stiff to very stiff consistency. In general, however, the till has a very stiff to hard consistency.

4.4 SWM Pond 7

4.4.1 Peat

An approximately 0.3 m to 0.4 m thick layer of peat was encountered immediately below the existing ground surface in Boreholes SWM7-3 and SWM7-4.

One SPT "N" value of 6 blows per 0.3 m of penetration was measured in the peat, suggesting a firm consistency.

4.4.2 Clayey Silt

A clayey silt deposit was encountered below the peat in Borehole SWM7-3 (at a depth of 0.3 m), and immediately below the existing ground surface in Boreholes SWM7-1 and SWM7-5. The deposit consists of clayey silt with sand to trace sand, trace to some gravel; it also contains trace quantities of rootlets and organic materials. The deposit ranges in thickness from 1.2 m to 5.5 m, with its base encountered between about Elevation 218.9 m and 223.0 m.

Atterberg limits tests were completed on two selected samples of the deposit and measured liquid limits of about 16 per cent and 23 per cent, plastic limits of about 12 per cent and 14 per cent, and plasticity indices of about 4 per cent and 10 per cent. The results of the Atterberg limits tests are shown on a plasticity chart on Figure D1 in Appendix D, and indicate that the material varies from a clayey silt of low plasticity, to a silt of slight plasticity; based on these test results, the deposit is expected to exhibit cohesive/slightly plastic behaviour. The natural water content as measured on two samples of this deposit is approximately 9 per cent and 12 per cent, near the plastic limit for this deposit.

The SPT "N" values measured in the clayey silt deposit range from 3 blows to 24 blows per 0.3 m of penetration, suggesting a variable, soft to very stiff consistency.

4.4.3 Silt and Sand to Sand and Gravel

A thin non-cohesive soil deposit was encountered below the peat in Borehole SWM7-4, below the clayey silt in Boreholes SWM7-1 and SWM7-5, and immediately below the existing ground surface in Borehole SWM7-2. The surface of this deposit was encountered at depths of up to 1.4 m (Elevation 218.9 m). The thickness of the deposit ranges from about 0.7 m to 2.0 m, and the deposit base was encountered in the boreholes between Elevation 218.2 m and 219.6 m.

This deposit ranges in composition from silt and sand to silty sand containing trace clay, to sand and gravel; as these soils are non-cohesive, some caving of the soils was observed following removal of the augers at the completion of borehole drilling, as noted on the borehole records. Rootlets, wood fragments and organic material were observed in some of the recovered samples. Grain size distribution test results of two samples from this deposit are shown on Figure D2 in Appendix D. The natural water content measured on samples within this deposit ranges from 8 per cent to 23 per cent.

The SPT "N" values measured within this deposit range from 12 blows to 26 blows per 0.3 m of penetration, indicating a compact relative density.

4.4.4 Clayey Silt Till

A clayey silt till deposit was encountered in all of the boreholes at SWM Pond 7, underlying the clayey silt or silt and sand to sand and gravel deposits. The surface of this deposit was encountered at depths of about 1.1 m to 3.4 m (Elevation 223.0 m to 218.2 m) and it was not fully penetrated in any of the boreholes; the deepest of the boreholes extended to Elevation 209.4 m (a depth of 11.3 m).

The till deposit consists of clayey silt with sand to some sand, trace to some gravel. The presence of cobbles and boulders was inferred at various locations in this deposit based on grinding of the augers, as noted on the borehole records. Grain size distribution testing was completed on eight selected samples, and the results are shown on Figures D3A and D3B in Appendix D.

Atterberg limits tests were completed on nine specimens of the clayey silt till, and measured liquid limits ranging from about 18 per cent to 25 per cent, plastic limits ranging from about 11 per cent to 13 per cent, and plasticity indices ranging from about 6 per cent to 12 per cent. The results of the Atterberg limits tests are shown on a plasticity chart on Figures D4A and D4B in Appendix D; these test results confirm that the till is a clayey silt of low plasticity. The natural water content measured on selected samples of the till ranges from 8 per cent to 12 per cent, near the plastic limit for the material.

The SPT "N" values measured within the clayey silt till deposit range from 14 blows per 0.3 m of penetration to 98 blows per 0.23 m of penetration, suggesting a stiff to hard consistency.

4.5 Groundwater Conditions

The water levels were observed in the open boreholes following completion of drilling, and these observations are recorded on the borehole records contained in Appendices A and C; however, these measured levels are not considered to be representative of the stabilized groundwater levels at the proposed SWM pond sites.

A standpipe piezometer was installed in one borehole at the proposed SWM Pond 6 site, and in two boreholes at the proposed SWM Pond 7 site. The water levels measured in the piezometers are shown on the borehole records in Appendices A and C and summarized as follows:

Borehole No.	Date	Depth to Water Level (m)	Water Level Elevation (m)
SWM6-3	November 28, 2013	2.1	248.7
	December 9, 2013	2.0	248.8
	January 7, 2014	2.2	248.6
SWM7-2	November 28, 2013	8.1	212.6
	December 9, 2013	8.0	212.7
	January 7, 2014	7.6	213.1
SWM7-3*	November 28, 2013	1.0	223.5
	December 9, 2013	0.9	223.6
	January 7, 2014	0.9	223.6

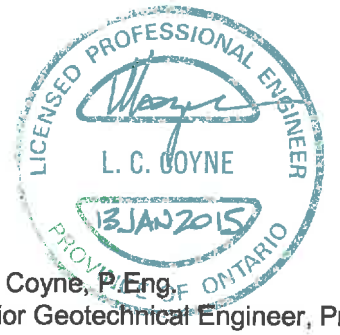
* Note that Borehole SWM7-3 is located outside of the footprint of the pond, and at a higher ground elevation (upslope) from Borehole SWM7-2.

The measurements summarized above are considered to represent the "stabilized" groundwater level at the SWM pond sites in fall/winter conditions. The water level is, however, expected to fluctuate seasonally and in response to changes in precipitation and snow melt, and is expected to be higher during the spring and other periods of heavy precipitation.

5.0 CLOSURE

This Foundation Investigation Report was prepared by Mr. Matthew Kelly, P.Eng., and reviewed by Ms. Lisa Coyne, P.Eng., a senior geotechnical engineer and Principal with Golder. Mr. Jorge Costa, P.Eng., Golder's Designated MTO Foundations Contact for this project and a Principal with Golder, conducted an independent quality control review of the report.

GOLDER ASSOCIATES LTD.



Lisa Coyne, P.Eng.
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Jorge M.A. Costa, P.Eng.
Designated MTO Foundations Contact, Principal

MWK/SMM/LCC/JMAC/sm

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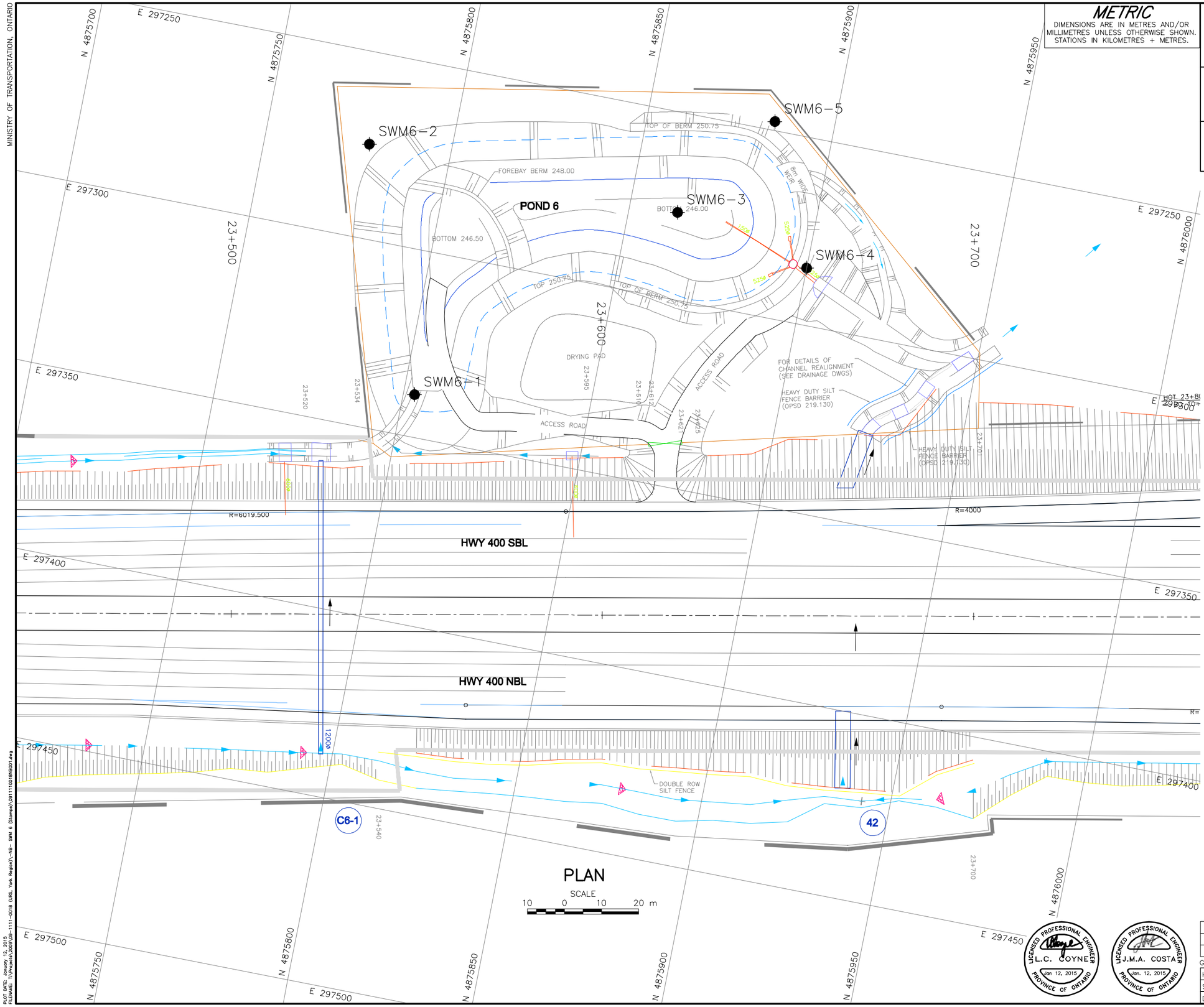
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN
SCALE
10 0 10 20 m

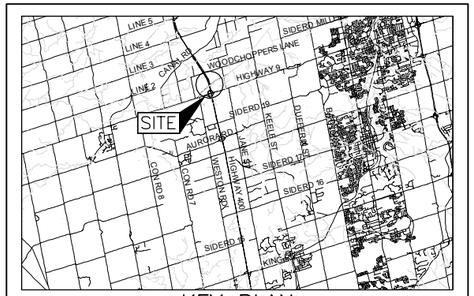
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No. 2015-2004
GWP No. 2025-13-00

SHEET

HIGHWAY 400 WIDENING
STORMWATER MANAGEMENT POND 6
BOREHOLE LOCATIONS

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN
SCALE
4 0 4 8 km

LEGEND
Borehole – Current Investigation

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
SWM6-1	252.6	4875803.0	297338.6
SWM6-2	252.8	4875778.0	297274.7
SWM6-3	250.8	4875863.0	297276.7
SWM6-4	250.0	4875900.0	297284.7
SWM6-5	250.4	4875884.0	297247.6

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 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 plan provided in digital format by URS, drawing files no. Hwy400_plan.dwg, received May 18, 2014.

LICENSED PROFESSIONAL ENGINEER
L.C. COYNER
Jan 12, 2015
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
J.M.A. COSTA
Jan. 12, 2015
PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 30M13-204

HWY. 400	PROJECT NO. 09-1111-0018		DIST. CENTRAL
SUBM'D. MWK	CHK'D. LCC	DATE: May 2014	SITE:
DRAWN: JFC	CHK'D. MWK	APP'D. LCC	DWG. 1

PLOT DATE: January 12, 2015
FILENAME: T:\Projects\2009\09-1111-0018 (URS, York Region)\-NB- SWM 6 (Stumps)\DS\1111001801B001.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

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

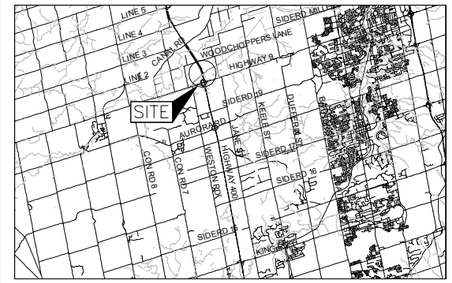
CONT No. 2015-2004
GWP No. 2025-13-00

SHEET

HIGHWAY 400 WIDENING
STORMWATER MANAGEMENT POND 7
BOREHOLE LOCATIONS

Golder Associates

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN
SCALE
4 0 4 8 km

LEGEND

● Borehole – Current Investigation

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
SWM7-1	221.7	4876959.0	297103.1
SWM7-2	220.7	4876916.0	297050.0
SWM7-3	224.5	4876883.0	297051.7
SWM7-4	220.2	4876894.0	297005.9
SWM7-5	219.7	4876969.0	297052.2

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NO.	DATE	BY	REVISION

Geocres No. 30M13-204

HWY. 400	PROJECT NO. 09-1111-0018		DIST. CENTRAL
SUBM'D. MWK	CHKD. LCC	DATE: May 2014	SITE:
DRAWN: JFC	CHKD. MWK	APPD. LCC	DWG. 2

PLOT DATE: January 12, 2015
FILENAME: I:\Projects\2009\09-1111-0018 (URS, York Region)\-08-SWM 7 (Stormsh)\09111100180801.dwg

APPENDIX A

Borehole Records – SWM Pond 6

LIST OF SYMBOLS

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

I. GENERAL

π	3.1416
ln x,	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

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

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan\delta$
c′	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan\phi'$

2 shear strength = (compressive strength)/2

LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance; N_d:

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60º cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Non-Cohesive (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

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

Golder Associates

RECORD OF BOREHOLE No SWM6-1

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0018

W.P. 2835-02-00 LOCATION N 4875803.0 ;E 297338.6 ORIGINATED BY BM

DIST Central HWY 400 BOREHOLE TYPE 140 mm O.D. Continuous Flight Hollow Stem Augers COMPILED BY MAS/AV

DATUM Geodetic DATE November 14, 2013 CHECKED BY SMM/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
252.6	GROUND SURFACE										
0.0	CLAYEY SILT, trace to some sand, trace gravel, containing rootlets Stiff Brown Moist to wet		1	SS	9		252				
251.2			2	SS	13						2 11 56 31
1.4	CLAYEY SILT with sand, trace gravel (TILL) Stiff to hard Brown to grey Moist		3	SS	12		251				
	Auger grinding at a depth of 2.4 m Possible cobbles		4	SS	35		250				
			5	SS	27		249				1 21 56 22
	Auger grinding at a depth of 4.0 m Possible cobbles		6	SS	43						
			7	SS	103/0.28		248				
						▽	247				
245.9			8	SS	105/0.20		246				
6.7	END OF BOREHOLE SPLIT-SPOON REFUSAL										

NOTE:

1. Water level in open borehole at a depth of 6.2 m below ground surface (Elev. 246.4 m) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No SWM6-2

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0018

W.P. 2835-02-00 LOCATION N 4875778.0 ;E 297274.7 ORIGINATED BY BM

DIST Central HWY 400 BOREHOLE TYPE 140 mm O.D. Continuous Flight Hollow Stem Augers COMPILED BY MAS/AV

DATUM Geodetic DATE November 13, 2013 CHECKED BY SMM/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
252.8	GROUND SURFACE										
0.0	CLAYEY SILT, trace sand, trace gravel, containing rootlets Stiff to very stiff Brown Moist to wet		1	SS	8						
	Auger grinding, possible cobbles at 1.1 m		2	SS	17		252				0 0 58 42
250.6			3	SS	12		251				
2.2	CLAYEY SILT with sand, trace gravel (TILL) Very stiff to hard Brown becoming grey below a depth of 6.1 m Moist		4	SS	16	▽	250				
	Auger grinding at depths of 2.3 m and 3.5 m Possible cobbles		5	SS	24		249				
			6	SS	19						3 26 47 24
			7	SS	32		248				
							247				
			8	SS	25						
245.2			9	SS	-*		246				
7.6	END OF BOREHOLE SPLIT-SPOON REFUSAL										

NOTES:

1. Water level in open borehole at a depth of 3.0 m below ground surface (Elev. 249.8 m) upon completion of drilling.

* SPLIT-SPOON Sampler Bouncing.

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

Golder Associates

RECORD OF BOREHOLE No SWM6-3 SHEET 1 OF 2 METRIC

PROJECT 09-1111-0018
W.P. 2835-02-00 LOCATION N 4875863.0 ;E 297276.7 ORIGINATED BY BM
DIST Central HWY 400 BOREHOLE TYPE 140 mm O.D. Continuous Flight Hollow Stem Augers COMPILED BY MAS/AV
DATUM Geodetic DATE November 13, 2013 CHECKED BY SMM/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
250.8	GROUND SURFACE										
0.0	CLAYEY SILT, trace sand, containing rootlets to a depth of 0.8 m Stiff to very stiff Brown becoming grey below a depth of 6.1 m Moist to wet		1	SS	14		250				
			2	SS	15						
			3	SS	17		249				0 1 72 27
			4	SS	21		248				
			5	SS	22						
			6	SS	20		247				
			7	SS	22		246				
							245				
			8	SS	29						0 1 65 34
							244				
242.3			9	SS	24		243				
8.5	CLAYEY SILT, some sand, trace gravel (TILL) Hard Grey Wet						242				
			10	SS	40		241				
			11	SS	37		240				5 15 46 34
							239				
238.0			12	SS	85		238				
12.8	END OF BOREHOLE										

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No SWM6-3

SHEET 2 OF 2

METRIC

PROJECT 09-1111-0018

W.P. 2835-02-00 LOCATION N 4875863.0 ;E 297276.7 ORIGINATED BY BM

DIST Central HWY 400 BOREHOLE TYPE 140 mm O.D. Continuous Flight Hollow Stem Augers COMPILED BY MAS/AV

DATUM Geodetic DATE November 13, 2013 CHECKED BY SMM/LCC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	NOTES: 1. Water level in open borehole at a depth of 5.9 m below ground surface (Elev. 244.9 m) upon completion of drilling. 2. Water level measurements in standpipe piezometer: Date (m) Depth (m) Elev. 28/11/13 2.1 248.7 09/12/13 2.0 248.8 07/01/14 2.2 248.6										

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

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RECORD OF BOREHOLE No SWM6-4

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0018

W.P. 2835-02-00 LOCATION N 4875900.0 ;E 297284.7 ORIGINATED BY BM

DIST Central HWY 400 BOREHOLE TYPE 140 mm O.D. Continuous Flight Hollow Stem Augers COMPILED BY MAS/AV

DATUM Geodetic DATE November 12, 2013 CHECKED BY SMM/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
250.0	GROUND SURFACE										
0.0	CLAYEY SILT, some sand, containing rootlets Stiff to very stiff Dark brown Moist to wet		1	SS	10						
			2	SS	25		249				
248.6											
1.5	CLAYEY SILT Very stiff to hard Brown becoming grey below a depth of 4.9 m Moist to wet		3	SS	27		248				
			4	SS	36						
			5	SS	27		247				0 0 56 44
			6	SS	18		246				
			7	SS	24		245				
244.4											
5.6	CLAYEY SILT, some sand, trace gravel (TILL) Very stiff Grey Wet		8	SS	21		244				3 18 50 29
243.3											
6.7	END OF BOREHOLE NOTE: 1. Open borehole dry upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No SWM6-5

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0018

W.P. 2835-02-00 LOCATION N 4875884.0 ;E 297247.6 ORIGINATED BY BM

DIST Central HWY 400 BOREHOLE TYPE 140 mm O.D. Continuous Flight Hollow Stem Augers COMPILED BY MAS/AV

DATUM Geodetic DATE November 12, 2013 CHECKED BY SMM/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
250.4	GROUND SURFACE										
0.0	CLAYEY SILT to SILTY CLAY, trace sand, trace gravel, containing rootlets Firm to very stiff Brown Moist to wet		1	SS	6		250				
			2	SS	23						1 1 51 47
249.0							249				
1.5	CLAYEY SILT, trace sand Stiff to hard Brown becoming grey below a depth of 5.0 m Moist		3	SS	15						
			4	SS	11		248				
			5	SS	10		247				
			6	SS	24						0 0 65 35
			7	SS	34		246				
244.8							245				
5.6	CLAYEY SILT with sand, trace to some gravel (TILL) Hard Grey Moist to wet		8	SS	41		244				
			9	SS	42	▽	243				15 21 46 18
	Auger grinding at a depth of 8.2 m Possible cobbles or boulder						242				
			10	SS	65		241				
240.7											
9.8	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 7.6 m below ground surface (Elev. 242.8 m) upon completion of drilling.										

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

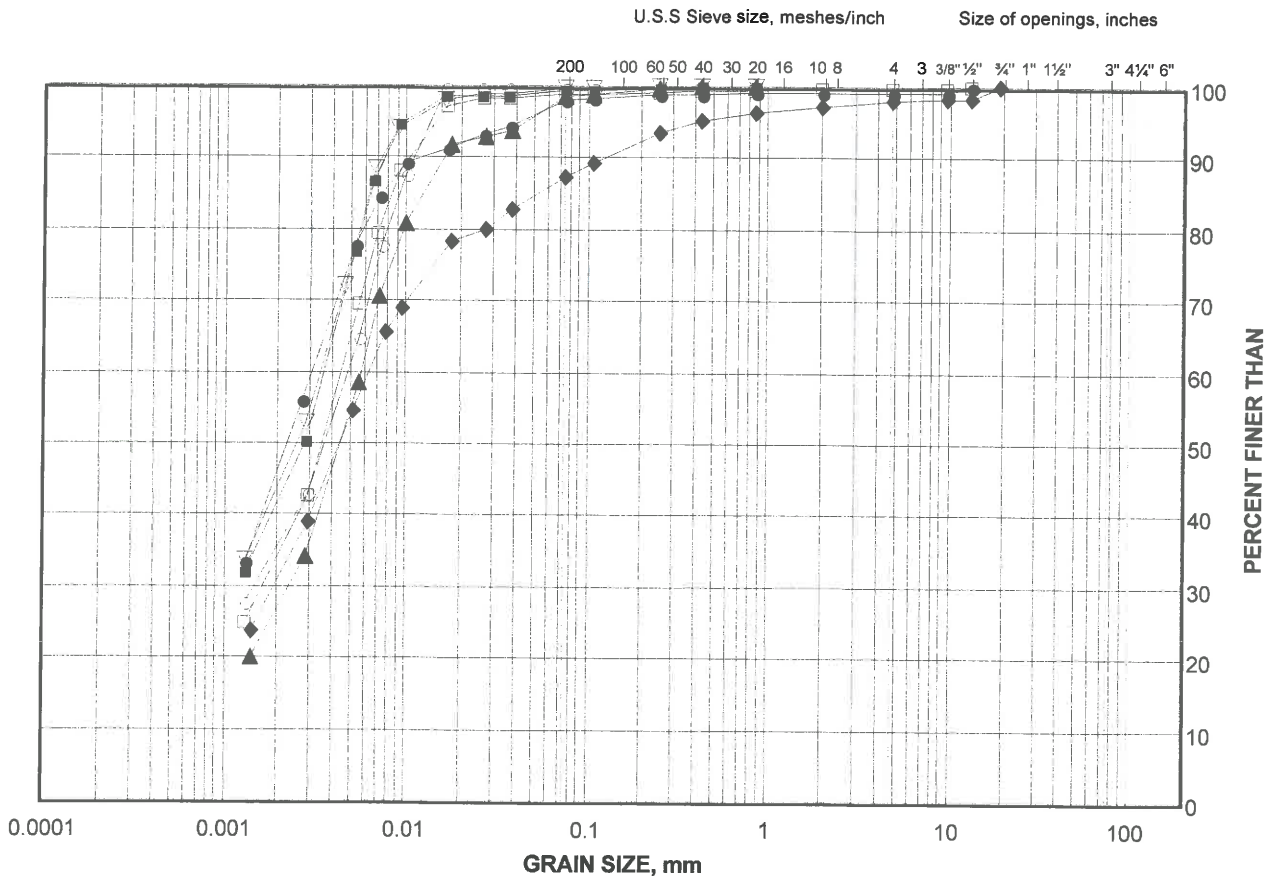
APPENDIX B

Laboratory Test Results – SWM Pond 6

GRAIN SIZE DISTRIBUTION

Clayey Silt to Silty Clay

FIGURE B1



LEGEND

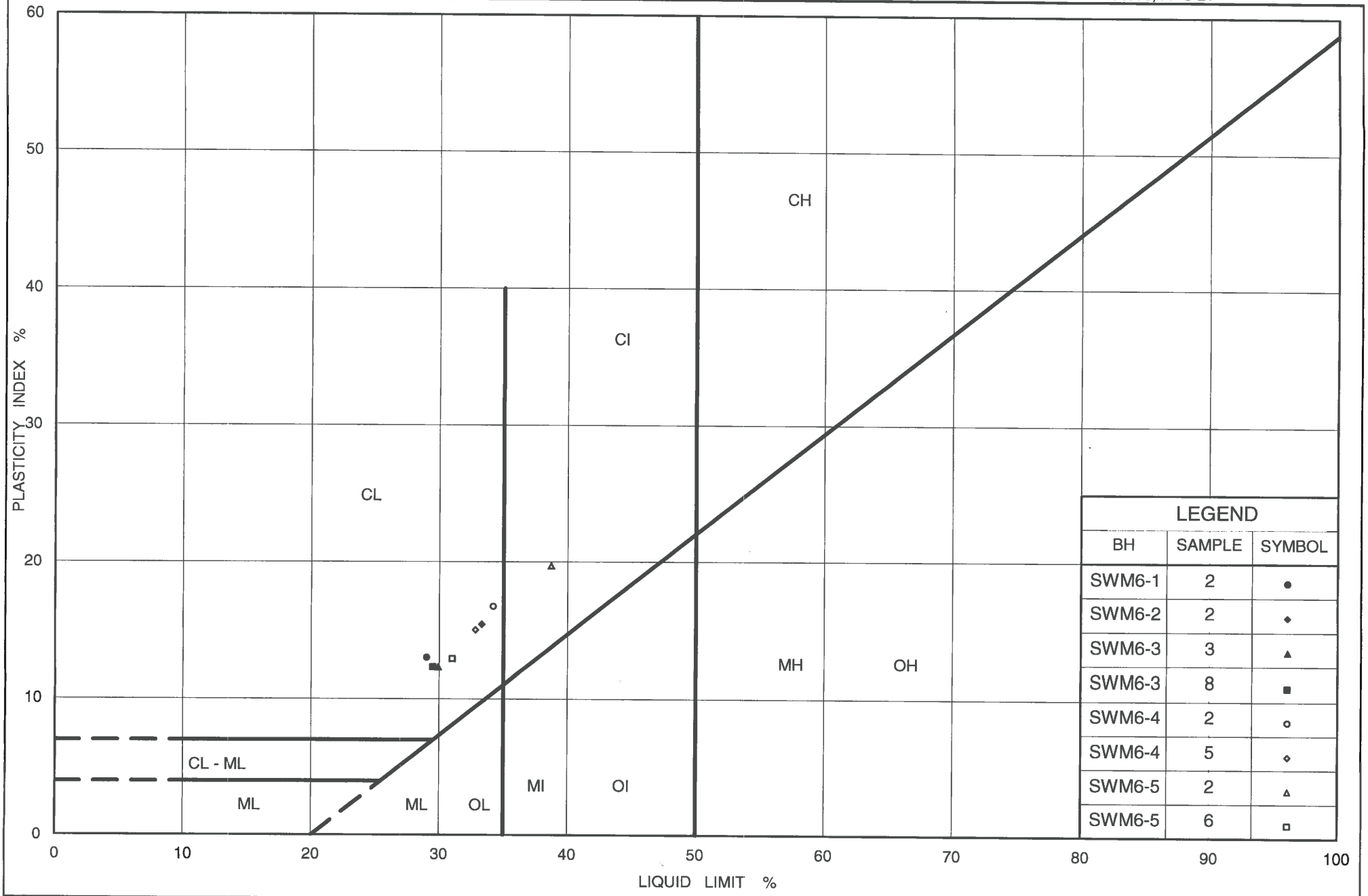
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	SWM6-5	2	249.3
■	SWM6-2	2	251.7
◆	SWM6-1	2	251.5
▲	SWM6-3	3	249.0
▽	SWM6-4	5	246.7
○	SWM6-5	6	246.3
□	SWM6-3	8	244.4

Project Number: 09-1111-0018

Checked By:

Golder Associates

Date: 30-Jul-14



Ministry of Transportation

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PLASTICITY CHART
Clayey Silt to Silty Clay

Figure No. B2

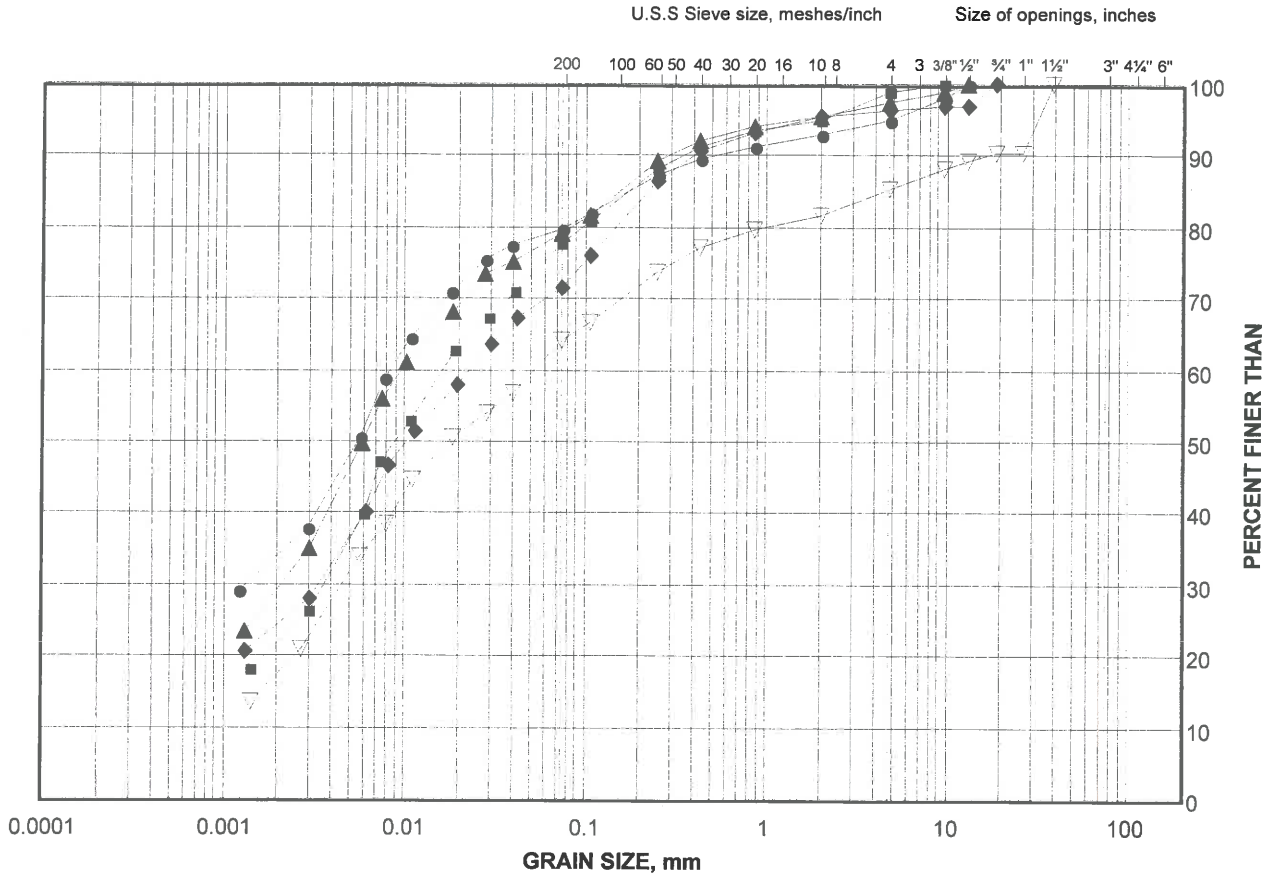
Project No. 09-1111-0018

Checked By:

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt Till

FIGURE B3



LEGEND

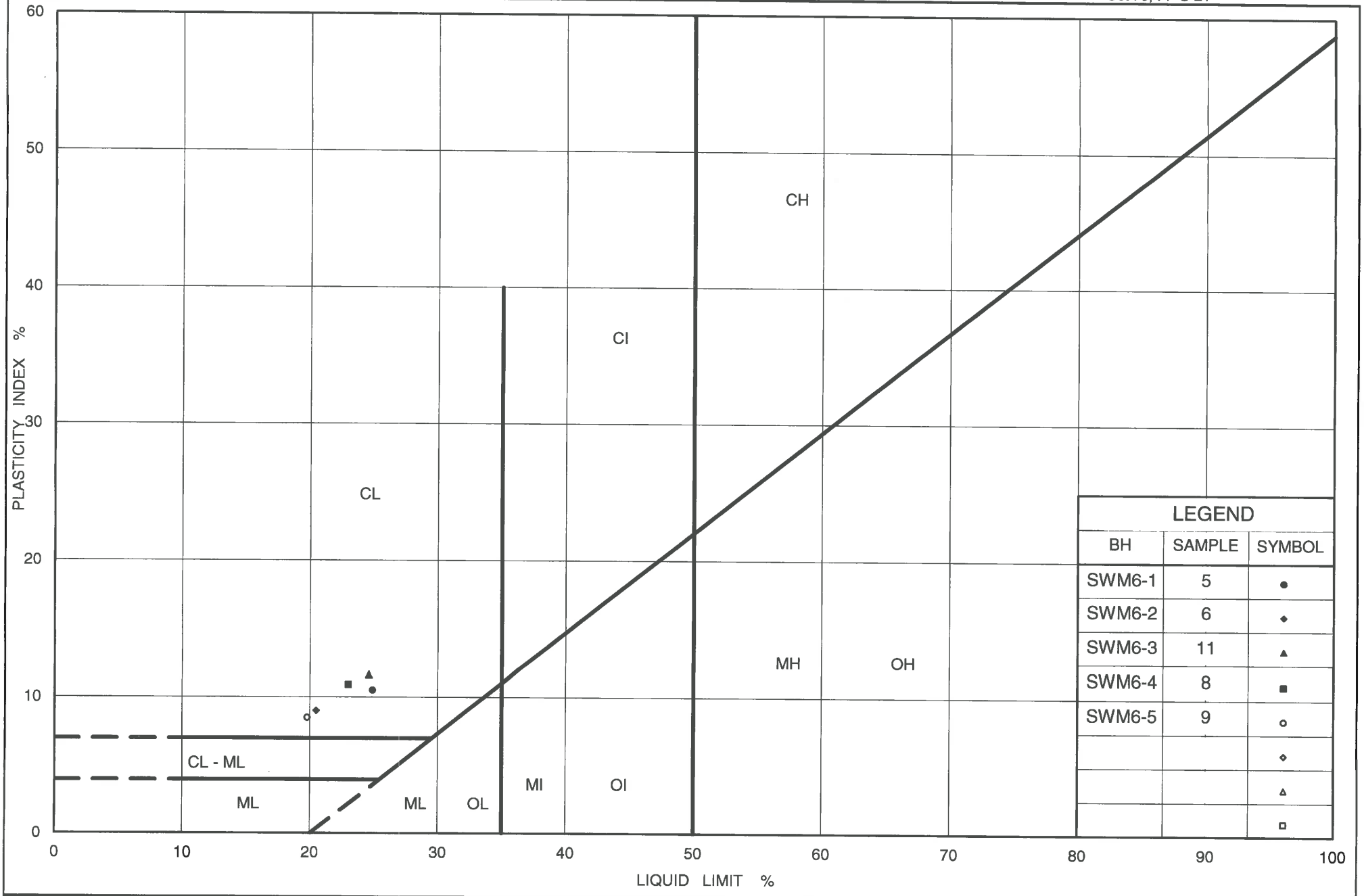
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	SWM6-3	11	239.8
■	SWM6-1	5	249.3
◆	SWM6-2	6	248.7
▲	SWM6-4	8	243.6
▽	SWM6-5	9	242.5

Project Number: 09-1111-0018

Checked By:

Golder Associates

Date: 30-Jul-14



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt Till

Figure No. B4

Project No. 09-1111-0018

Checked By:

APPENDIX C

Borehole Records – SWM Pond 7

Golder Associates

RECORD OF BOREHOLE No SWM7-1

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0018

W.P. 2835-02-00 LOCATION N 4876959.0 ;E 297103.1 ORIGINATED BY OS

DIST Central HWY 400 BOREHOLE TYPE 140 mm O.D. Continuous Flight Hollow Stem Augers COMPILED BY MWK/AV

DATUM Geodetic DATE November 19, 2013 CHECKED BY SMM/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
221.7	GROUND SURFACE										
0.0	CLAYEY SILT, trace to some sand, tracel gravel, containing organic material Soft to stiff Brown with oxidation staining Moist to wet		1	SS	3		221				
220.3			2	SS	9						
1.4	SILT and SAND, some gravel, trace to some clay Compact Brown becoming grey below a depth of 2.3 m Moist		3	SS	16		220				
218.3			4	SS	12		219				19 42 31 8
3.4	CLAYEY SILT with sand, trace gravel (TILL) Very stiff to hard Grey Moist to wet		5A 5B	SS	15		218				
			6	SS	23						3 28 49 20
			7	SS	26	▽	217				
							216				
215.0			8	SS	43						
6.7	END OF BOREHOLE						215				

NOTES:

1. Water level measured inside augers at a depth of 5.5 m below ground surface (Elev. 216.2 m) upon completion of drilling.

2. Borehole caved at a depth of 3.0 m below ground surface (Elev. 218.7 m) after removal of augers.

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

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 08/06/14 SIB

Golder Associates

RECORD OF BOREHOLE No SWM7-2

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0018

W.P. 2835-02-00 LOCATION N 4876916.0 ;E 297050.0 ORIGINATED BY OS

DIST Central HWY 400 BOREHOLE TYPE 140 mm O.D. Continuous Flight Hollow Stem Augers COMPILED BY MWK/AV

DATUM Geodetic DATE November 19/20, 2013 CHECKED BY SMM/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 + FIELD VANE ● QUICK TRIAXIAL × 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
220.7	GROUND SURFACE										
0.0	Silty SAND, containing roots and organic material Compact Brown and black Wet		1	SS	26		220				
219.6			2A 2B	SS	5						
1.1	CLAYEY SILT with sand, trace gravel (TILL) Stiff to hard Brown becoming grey below a depth of 2.6 m with oxidation staining between depths of 1.1 m and 2.4 m Moist to wet		3	SS	21		219				
			4	SS	14		218				2 25 50 23
			5	SS	16						
			6	SS	17		217				
			7	SS	18		216				
	Augers grinding at a depth of 5.5 m below ground surface Possible cobbles						215				
			8	SS	28		214				
			9	SS	65		213				2 20 50 28
			10	SS	75		212				
							211				
209.4			11	SS	63		210				
11.3	END OF BOREHOLE										

NOTES:

1. Water level measured at a depth of 8.5 m below ground surface (Elev. 212.2 m) upon completion of drilling.

2. Water level measurements in standpipe piezometer:

Date	Depth (m)	Elev. (m)
28/11/13	8.1	212.6
09/12/13	8.0	212.7
07/01/14	7.6	213.1

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

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 08/06/14 SIB

Golder Associates

RECORD OF BOREHOLE No SWM7-3

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0018

W.P. 2835-02-00 LOCATION N 4876883.0 ;E 297051.7 ORIGINATED BY OS

DIST Central HWY 400 BOREHOLE TYPE 140 mm O.D. Continuous Flight Hollow Stem Augers COMPILED BY MWK/AV

DATUM Geodetic DATE November 21, 2013 CHECKED BY SMM/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
224.5	GROUND SURFACE										
0.0 / 224.2	PEAT (Fibrous) Firm Black Wet		1A	SS	6		224				
0.3	CLAYEY SILT with sand, some gravel Very stiff Brown with oxidation staining Moist		1B			▼					
223.0			2	SS	20		223				
1.5	CLAYEY SILT with sand, trace to some gravel (TILL) Hard Brown becoming grey below a depth of 2.3 m Moist Augers grinding at a depth of 1.6 m Possible cobbles and/or boulder		3	SS	30						
			4	SS	113		222				7 21 55 17
			5	SS	98/0.23		221				
			6	SS	94						
			7	SS	88		220				
							219				
218.0			8	SS	75		218				2 26 48 24
6.6	END OF BOREHOLE										

NOTES:

1. Borehole dry on completion of drilling.

2. Water level measurements in standpipe piezometer:

Date	Depth (m)	Elev. (m)
28/11/13	1.0	223.5
09/12/13	0.9	223.6
07/01/14	0.9	223.6

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

Golder Associates

RECORD OF BOREHOLE No SWM7-4

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0018

W.P. 2835-02-00 LOCATION N 4876894.0 ;E 297005.9 ORIGINATED BY OS

DIST Central HWY 400 BOREHOLE TYPE 140 mm O.D. Continuous Flight Hollow Stem Augers COMPILED BY MWK/AV

DATUM Geodetic DATE November 20, 2013 CHECKED BY SMM/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
220.2	GROUND SURFACE										
0.0 / 219.8	PEAT (Fibrous) Firm Black Wet		1A 1B	SS	6		220				
0.4 / 219.0	SAND and GRAVEL, Compact Yellow Moist		2	SS	23		219		○		
1.2	CLAYEY SILT, with sand, trace gravel (TILL) Very stiff to hard Brown becoming grey below a depth of 3.2 m with oxidation staining between depths of 1.2 m and 3.1 m Moist Augers grinding at a depth of 2.0 m Possible cobbles and/or boulder		3	SS	63						
			4	SS	102		218		○ —		1 21 52 26
			5	SS	25		217				
			6	SS	58				○ —		2 24 50 24
			7	SS	58	▽	216				
							215				
213.7			8	SS	62		214		○		
6.6	END OF BOREHOLE										

NOTES:

1. Water level measured inside augers at a depth of 5.3 m below ground surface (Elev. 214.9 m) upon completion of drilling.

2. Borehole caved at a depth of 5.6 m below ground surface (Elev. 214.6 m) after removal of augers.

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

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RECORD OF BOREHOLE No SWM7-5

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0018

W.P. 2835-02-00 LOCATION N 4876969.0 ;E 297052.2 ORIGINATED BY OS

DIST Central HWY 400 BOREHOLE TYPE 140 mm O.D. Continuous Flight Hollow Stem Augers COMPILED BY MWK/AV

DATUM Geodetic DATE November 19, 2013 CHECKED BY SMM/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
219.7	GROUND SURFACE										
0.0	CLAYEY SILT, trace gravel, some sand, containing roots and organic material Soft Black Wet		1	SS	3		219				
218.9											
0.8	SILT and SAND, trace to some clay, containing wood fragments and rootlets Compact Brown Wet to moist		2A 2B	SS	15						0 34 60 6
218.2							218				
1.5	CLAYEY SILT with sand, trace to some gravel (TILL) Stiff to hard Brown becoming grey below a depth of 2.3 m Moist		3	SS	13						
			4	SS	14		217				
			5	SS	20						
			6	SS	23		216				1 22 49 28
			7	SS	24		215				
	Augers grinding at a depth of 5.5 m Possible cobbles and/or boulder						214				
213.0			8	SS	61						
6.7	END OF BOREHOLE						213				

NOTES:

1. Borehole dry upon completion of drilling.

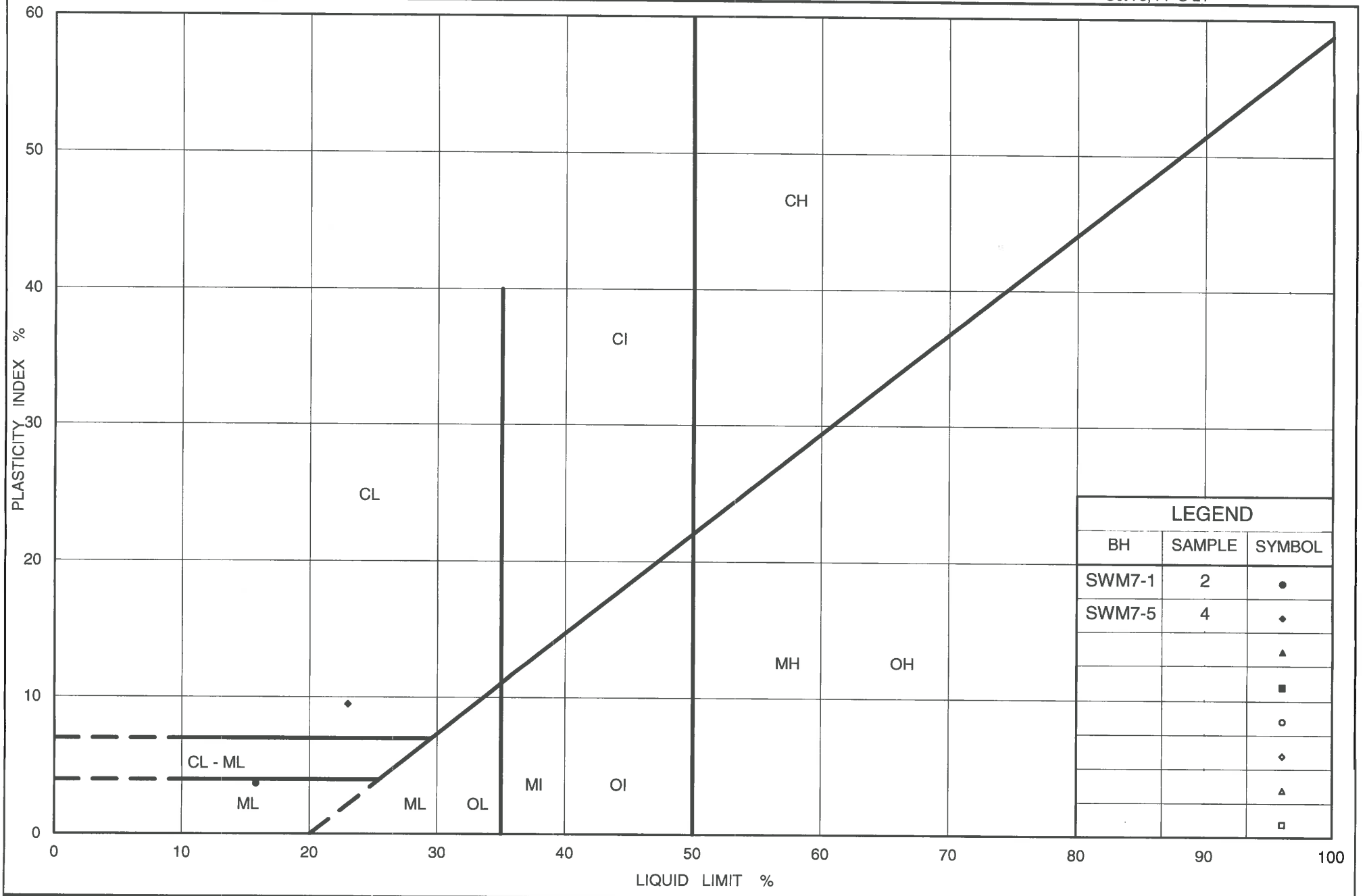
2. Borehole caved at a depth of 4.7 m below ground surface (Elev. 215.0 m) upon completion of drilling.

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

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 08/06/14 SIB

APPENDIX D

Laboratory Test Results – SWM Pond 7



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt

Figure No. D1

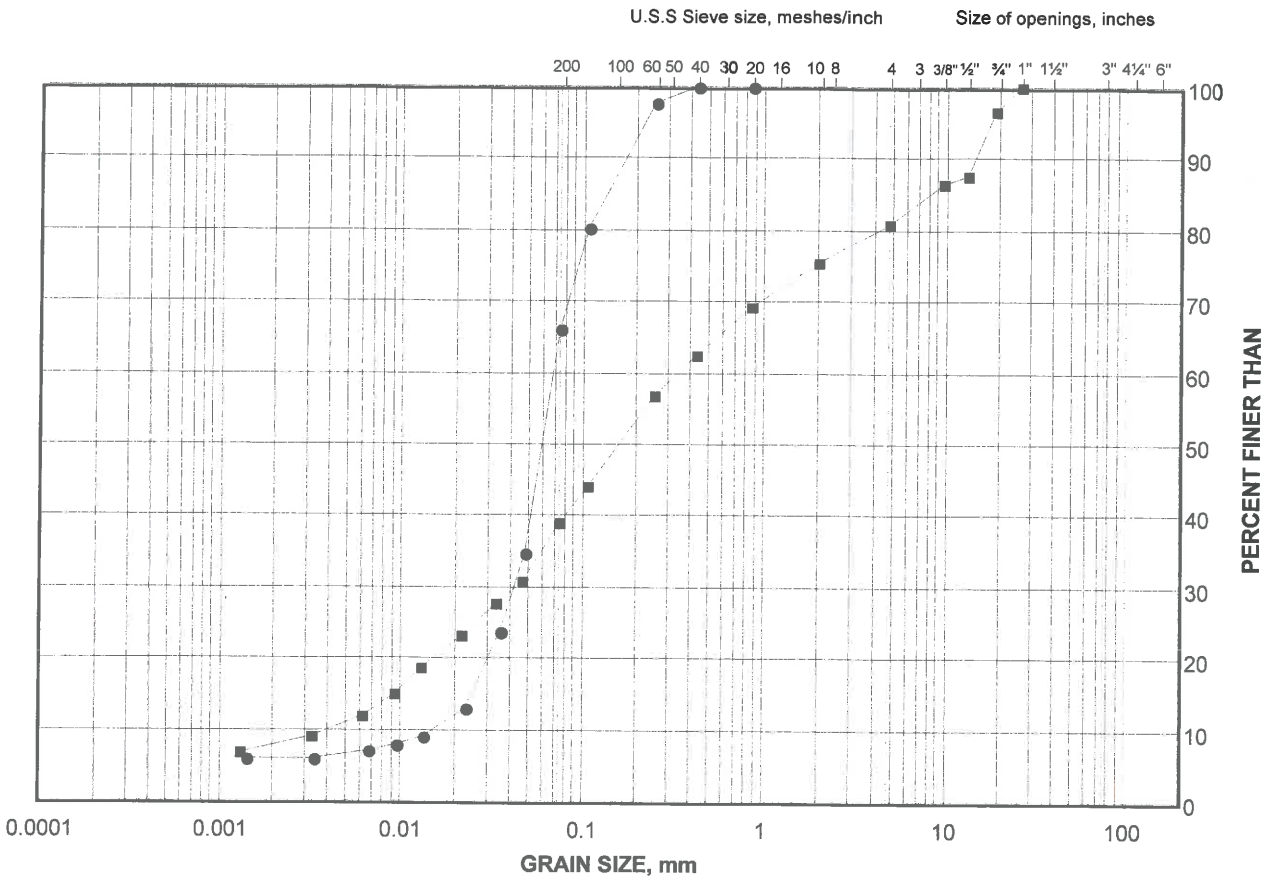
Project No. 09-1111-0018

Checked By:

GRAIN SIZE DISTRIBUTION TEST RESULTS

Silt and Sand

FIGURE D2



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	SWM7-5	2B	218.7
■	SWM7-1	4	219.1

Project Number: 09-1111-0018

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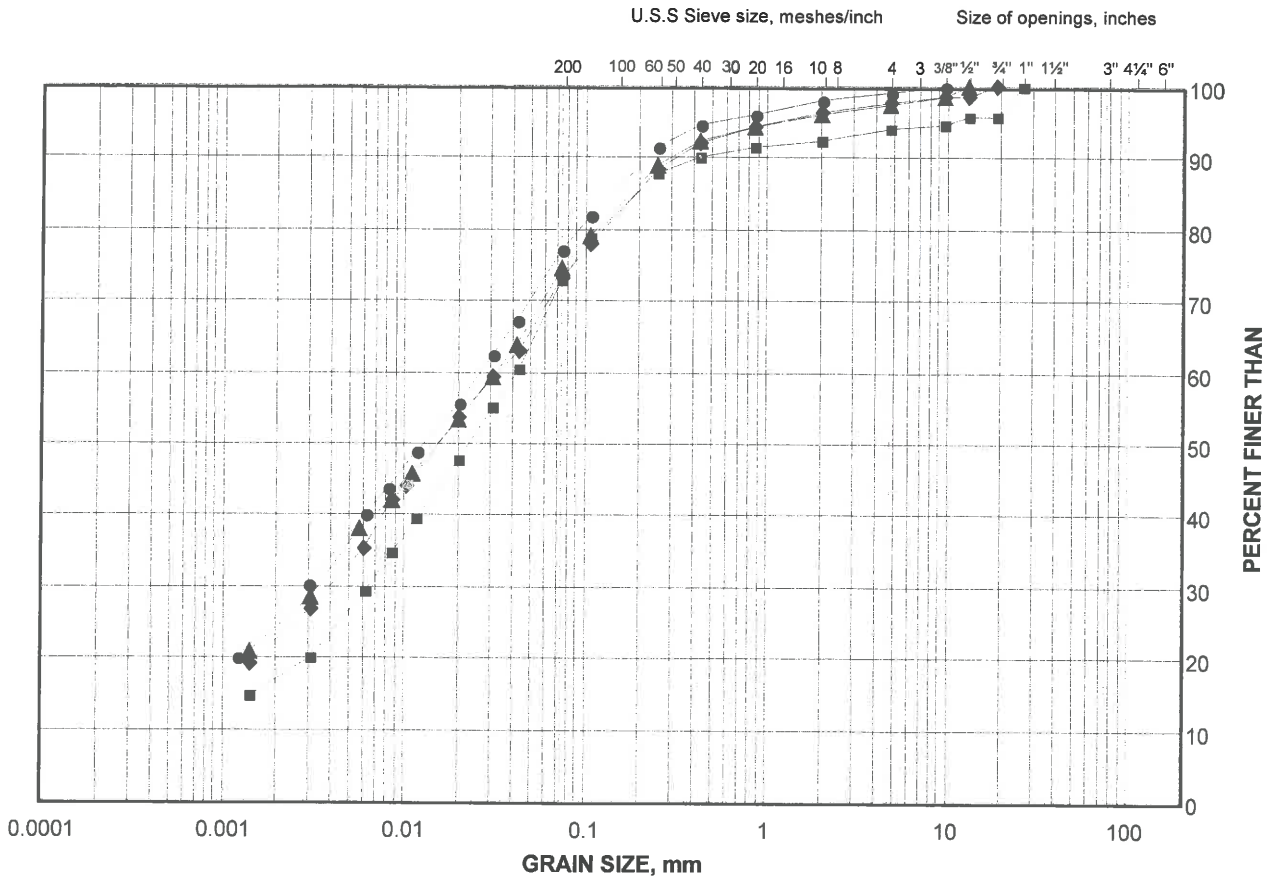
Golder Associates

Date: 30-Jul-14

GRAIN SIZE DISTRIBUTION

Clayey Silt Till

FIGURE D3A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	SWM7-4	4	217.8
■	SWM7-3	4	222.0
◆	SWM7-2	4	218.2
▲	SWM7-4	6	216.2

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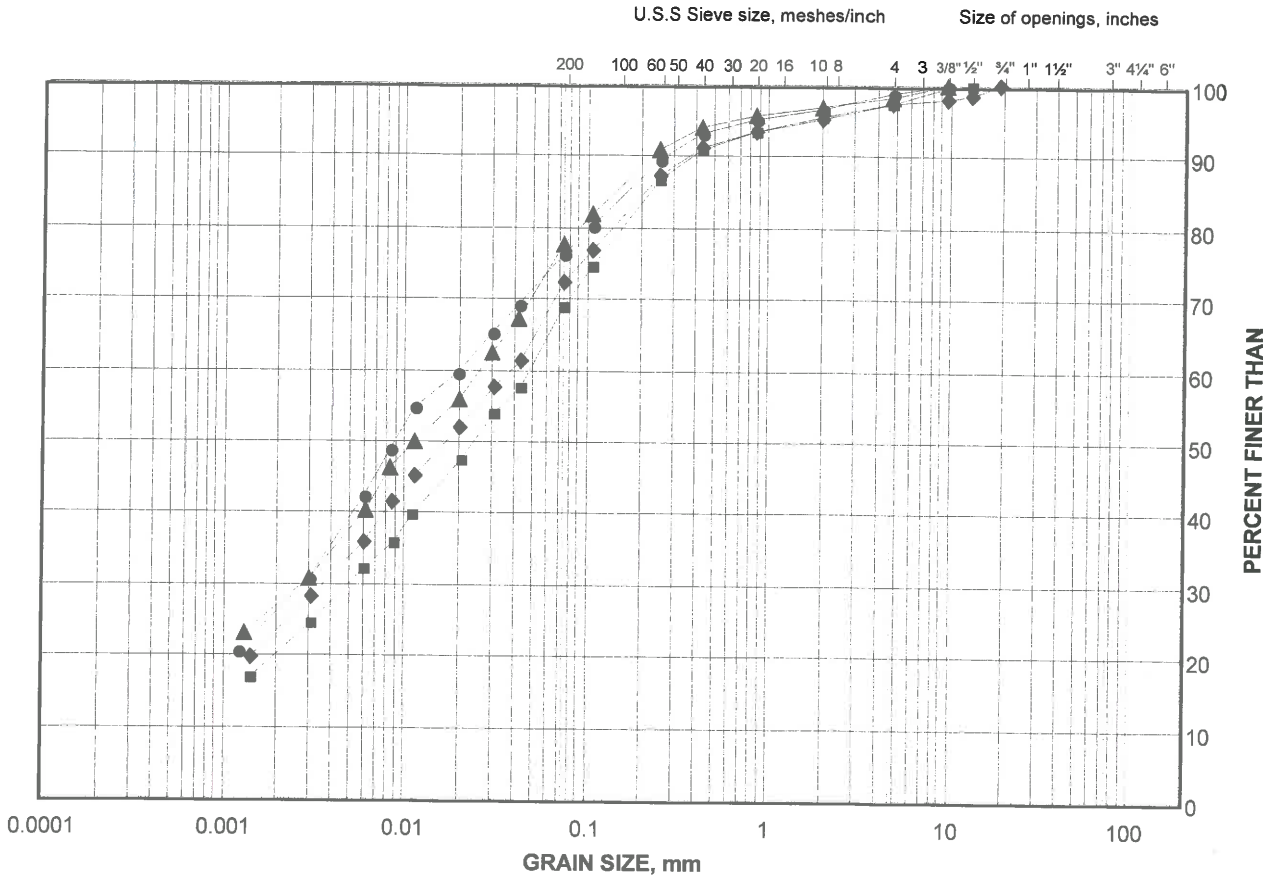
Golder Associates

Date: 30-Jul-14

GRAIN SIZE DISTRIBUTION

Clayey Silt Till

FIGURE D3B



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	SWM7-5	6	215.6
■	SWM7-1	6	217.6
◆	SWM7-3	8	218.1
▲	SWM7-2	9	212.8

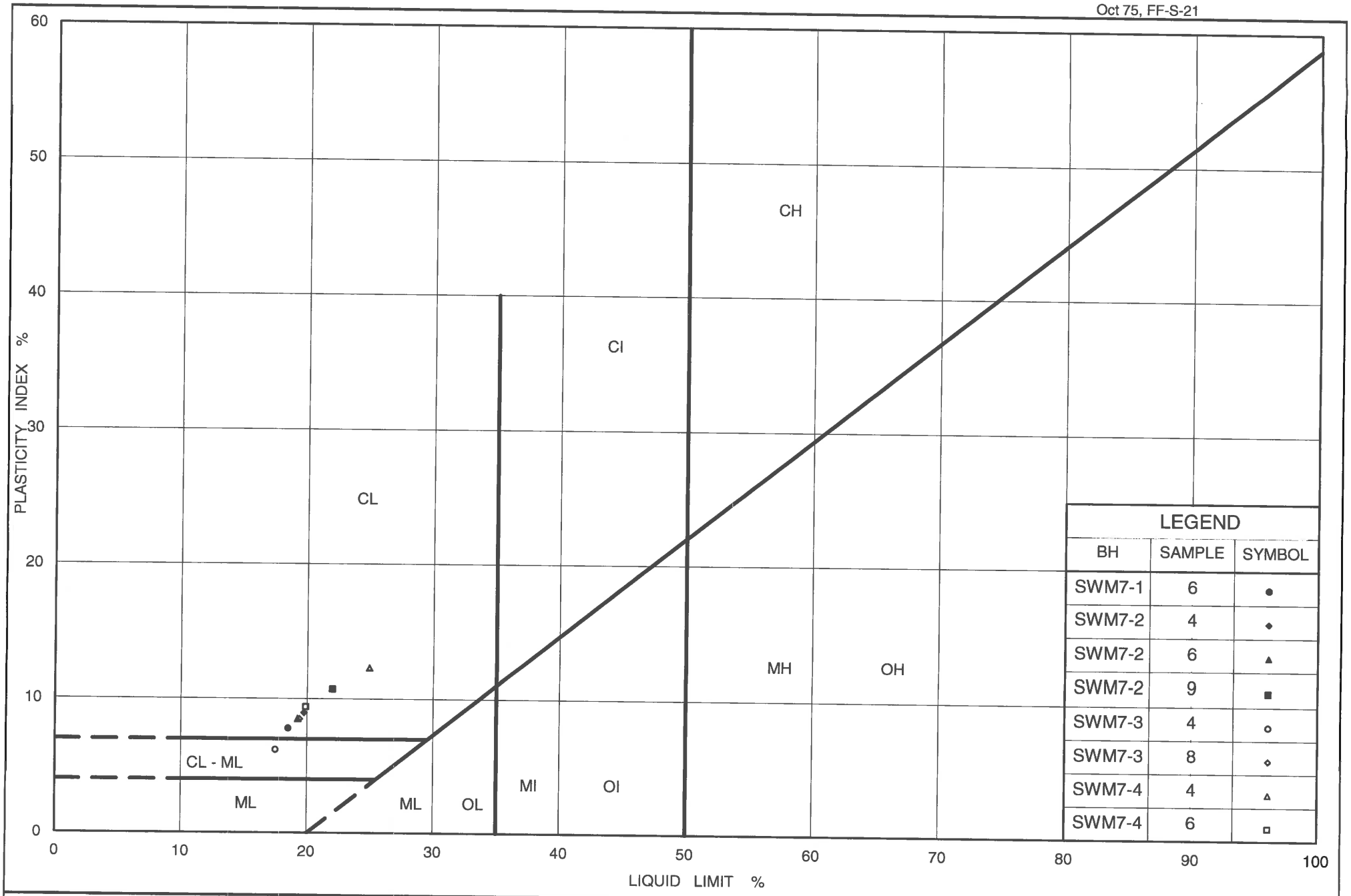
Project Number: 09-1111-0018

Checked By: _____

Golder Associates

Date: 30-Jul-14

Oct 75, FF-S-21



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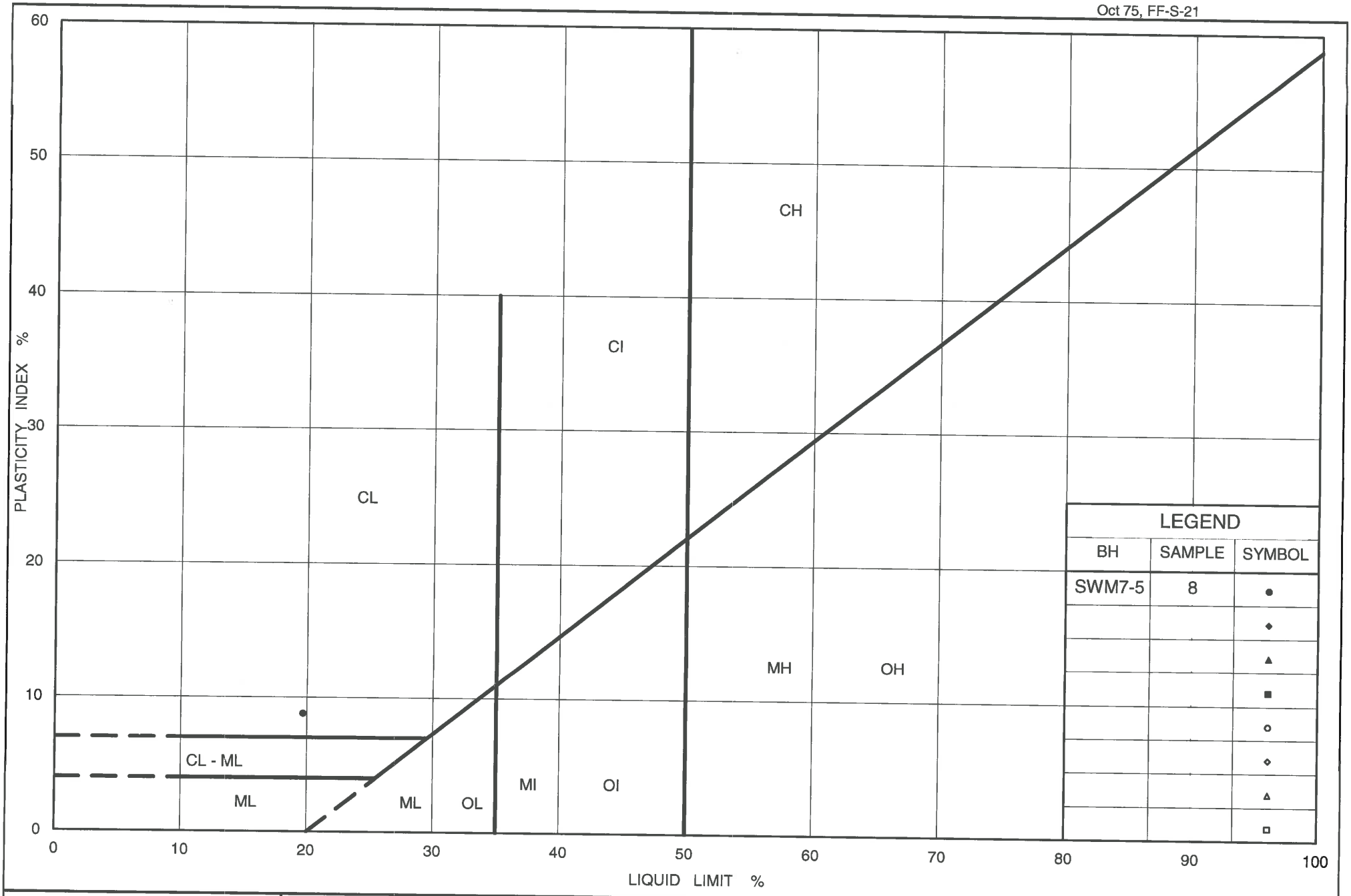
PLASTICITY CHART
Clayey Silt Till

Figure No. D4A

Project No. 09-1111-0018

Checked By:

Oct 75, FF-S-21



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PLASTICITY CHART
Clayey Silt Till

Figure No. D4B

Project No. 09-1111-0018

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At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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