April 2010

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FOUNDATION INVESTIGATION REPORT

Fairchild Creek Culvert Replacement
Highway 8, City of Hamilton
MTO Central Region Retainer Assignment
Agreement No. 2009-E-0035
Assignment No. 4

Submitted to:
Ministry of Transportation
Central Region
5th Floor, 1201 Wilson Avenue
Downsview, Ontario, M3M 1J8
Attn. Mr. Steve Pozderka, P.Eng.

REPORT

Report Number: 09-1184-6030 Phase 4000
GEOCRES No. 30M5-279

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Ministry of Transportation, Ontario (MTO) to complete a foundation investigation for the proposed replacement of the Fairchild Creek culvert on Highway 8, in the City of Hamilton, Ontario.

The terms of reference for foundation investigation services are outlined in the Request for Quotation for the MTO Central Region Retainer Assignment, Agreement No. 2009-E-0035, dated September 23, 2009. The scope of work for this investigation was provided in MTO Assignment Order Form 7A, Agreement No. 2009-E-0035 – Assignment No. 4, dated March 22, 2010.

2.0 SITE DESCRIPTION

The culvert site is located on Highway 8 at Fairchild Creek, approximately 210 m west of Sixth Concession Road West in Flamborough Township, in the City of Hamilton, Ontario. The site location is shown in the key plan on Drawing 1 following the text of this report.

The natural ground surface in the area of the culvert is relatively flat, low-lying and poorly drained, with pasture, farming and rural residential land use. Highway 8 has been constructed on an embankment approximately 2.0 m high relative to the surrounding natural ground surface. The pavement grade at about Elevation 255.8 m to 255.7 m, declining toward the east, and the natural ground surface in the immediate vicinity of the culvert is between approximately Elevation 253.5 m and 254 m.

The existing Fairchild Creek culvert consists of a 4.3 m wide by 1.5 m high open footing concrete structure, approximately 26 m long. Two 1067 mm diameter corrugated steel pipe (CSP) culverts have been installed east of and parallel to the concrete culvert. According to the drawing provided by MTO Geotechnical Section ("Reconstruction, Station 15+500 to 15+850, W.P. 162-80-01", Sheet 8 from Contract 90-63), the invert of the concrete open footing culvert is at approximately Elevation 253.6 m, while that of the CSP culverts is at approximately Elevation 254.2 m and 254.3 m.

Observations of the existing Highway 8 pavement and embankment side slopes in the immediate vicinity of the culvert site at the time of the investigation indicate no evidence of settlement or instability-related distress to the existing pavement and embankment.

3.0 INVESTIGATION PROCEDURES

The field work for this foundation investigation was carried out on April 9, 2010, at which time a total of six boreholes (Boreholes 1, 1B, 2, 2B, 3 and 4) were advanced using a truck-mounted drill rig, supplied and operated by Geo-Environmental Drilling Inc. of Milton, Ontario.

All of the boreholes were advanced through the Highway 8 embankment, as access to the ends of the culvert at the embankments was not possible due to flooding conditions at the time of the investigation. The boreholes were drilled through the shoulders and travelled lanes of the highway at the approximate locations shown on Drawing 1.

The boreholes were drilled to depths of between 2.3 m and 2.9 m below the Highway 8 grade, to refusal on the bedrock surface. Soil samples were obtained at 0.75 m and 1.5 m intervals of depth where possible, using a 50 mm outside diameter split-spoon sampler in accordance with the Standard Penetration Test (SPT) procedure (ASTM D-1586). The water level in the open boreholes was observed during and immediately following completion of the drilling operations, and the conditions are noted on the Record of Borehole sheets following the text of this report. The boreholes were backfilled to the ground surface using bentonite pellets in accordance with Ontario Regulation 903 as amended by Ontario Regulation 372/07 of the Ontario Water Resources Act.

The field work was monitored full-time by a member of Golder's staff who located the boreholes in the field, arranged for service clearances, 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 Whitby 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.

In addition to the boreholes, four shallow test excavations were hand-dug in the ditch on the south side of Highway 8, approximately 7 m to 10 m east of the existing concrete culvert. The purpose of these test excavations was to expose and prove the bedrock surface, and to confirm the type of bedrock. A summary of the test excavations is provided in Table 1 following the text of this report.

The locations of the boreholes and test excavations were measured in the field relative to the existing culvert and edges of the highway, and are plotted on Drawing 1. The stations, offsets and elevations reported on the Record of Borehole sheets were measured from the horizontal and vertical alignment drawing provided by the MTO Geotechnical Section (Sheet 8 titled "Reconstruction – Station 15+500 to 15+860, W.P. 162-80-06) from MTO Contract 90-63.

4.0 SITE GEOLOGY AND STRATIGRAPHY

4.1 Regional Geological Conditions

As delineated in *The Physiography of Southern Ontario*[1], the study area for this assignment lies within the physiographic region known as the Flamborough Limestone Plain – an extensive limestone plain above the Niagara Escarpment, that is covered by a thin layer of soil.

The shallow overburden soils overlying the limestone bedrock consist mainly of bouldery glacial till or sand and gravel. A few drumlins are found scattered across this limestone plain, and swamps are plentiful.

4.2 Site Stratigraphy

As part of the subsurface investigation at the Fairchild Creek culvert site on Highway 8, six boreholes were advanced through the Highway 8 embankment adjacent to the existing culverts. The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of in situ and geotechnical laboratory testing are given on the borehole records following the text of this report. The laboratory test results are also

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

shown on Figures 1 to 3. The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsurface conditions will vary between and beyond the borehole locations.

In summary, the subsurface conditions encountered at the culvert site consist of granular fill (considered to be road base and sub-base fill) underlain by compact sand and gravel fill and stiff to very stiff clayey silt fill; both the sand and gravel fill and clayey silt fill contain cobbles and boulders. The embankment fill is underlain by limestone bedrock.

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

4.2.1 Asphalt

Asphalt was encountered at the existing ground surface in Boreholes 2 and 2B, which were advanced through the westbound lane of Highway 8. The asphalt is 170 mm thick in Borehole 2 and 180 mm thick in Borehole 2B.

4.2.2 Granular Fill

Approximately 300 mm of granular fill (considered to be Granular A base) was encountered below the asphalt in Boreholes 2 and 2B, which were drilled through the westbound lane of Highway 8. The Granular A fill is underlain by approximately 600 mm of granular fill (considered to be Granular B sub-base) as encountered in these two boreholes.

In Boreholes 1, 1B, 3 and 4, which were drilled through the highway shoulders, approximately 0.6 m to 0.9 m of granular base/sub-base fill was encountered immediately below the shoulder.

4.2.3 Sand and Gravel and Clayey Silt Embankment Fill

The asphalt and granular base/sub-base fill is underlain by 1.3 m to 1.8 m of embankment fill, which varies in composition from sand and gravel containing trace to some silt and trace clay, to clayey silt with sand and some gravel. The presence of cobbles and boulders was inferred within the granular fill based on observations of auger grinding, as noted on the attached Record of Borehole sheets.

The measured Standard Penetration Test (SPT) “N” values within the granular fill range from 18 to 25 blows per 0.3 m of penetration, and from 1 blow per 0.03 m of penetration to 12 blows per 0.25 m of penetration, indicating that the fill has a generally compact relative density. Where less than 0.3 m of penetration was recorded, the split-spoon sampler was “bouncing” on cobbles and/or boulders within the fill.

The results of grain size distribution tests on two selected samples of the sand and gravel fill and one selected sample of the clayey silt fill are shown on Figures 1 and 2, respectively. Atterberg limits testing was conducted on one selected sample of the clayey silt fill and measured a liquid limit of about 27 percent, a plastic limit of about 16 percent and a plasticity index of 11 percent. This result, which is plotted on a plasticity chart in Figure 3 following the text of this report, confirms that the cohesive fill is classified as a clayey silt of low plasticity.

4.2.4 Limestone Bedrock

The presence of bedrock at the borehole locations was inferred by auger refusal ("smooth" auger grinding) at depths of 2.3 m and 2.4 m below the Highway 8 grade at the culvert site, corresponding to Elevation 253.3 m to 253.4 m. In Borehole 1, the bedrock was penetrated for a depth of 0.5 m by augering, and the borehole was terminated at Elevation 252.9 m.

Four shallow test excavations were hand-dug in the ditch on the south side of Highway 8, approximately 7 m to 10 m east of the existing concrete culvert. The purpose of these test excavations was to expose the bedrock surface to prove that the auger refusal encountered in the boreholes was in fact on the bedrock surface, and to confirm the type of bedrock. These test excavations exposed limestone bedrock within a depth of approximately 0.4 m below the ditch level, confirming that the auger refusal in the boreholes is on the surface of the limestone bedrock. The subsurface conditions and depth to bedrock as encountered in the test excavations are summarized in Table 1 following the text of this report.

The shallow depth to the surface of the bedrock was corroborated by interviewing the resident of the residential property adjacent to the culvert location during the investigation.

4.3 Groundwater Conditions

The groundwater conditions were observed during and on completion of drilling and are noted on the Record of Borehole sheets following the text of this report. In general, the boreholes were dry on completion of drilling; however, some of the recovered soil samples were moist to wet, representing water "perched" within the embankment fill on the underlying bedrock or clayey silt fill soils.

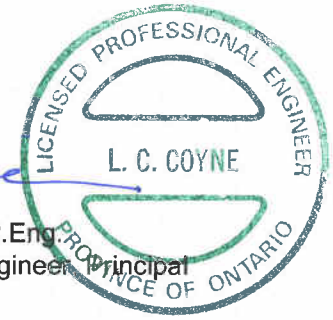
The groundwater level at the culvert site is expected to fluctuate seasonally in response to changes in precipitation and snow melt; the water level is expected to be higher during wetter periods of the year.

5.0 CLOSURE

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

GOLDER ASSOCIATES LTD.

Matt Kelly, EIT
Geotechnical Group



Lisa C. Coyne, P.Eng.
Geotechnical Engineer, Principal

Jorge M.A. Costa, P.Eng.
Designated MTO Foundation Contact, Principal

MWK/LCC/JMAC/mwk

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TABLE 1
SUMMARY OF SUBSURFACE CONDITIONS ENCOUNTERED IN TEST EXCAVATIONS
FAIRCHILD CREEK CULVERT REPLACEMENT, HIGHWAY 8

Test Hole No.	Location	Subsurface Conditions	
1	Station 15+679, Offset 13 m South	0 m - 0.1 m 0.1 m - 0.4 m 0.4 m	Topsoil Clayey silt with cobbles and boulders Limestone bedrock
2	Station 15+680, Offset 13 m South	0 m - 0.1 m 0.1 m - 0.4 m 0.4 m	Topsoil Clayey silt with cobbles and boulders Limestone bedrock
3	Station 15+681, Offset 13 m South	0 m - 0.1 m 0.1 m - 0.4 m 0.4 m	Topsoil Clayey silt with cobbles and boulders Limestone bedrock
4	Station15+682, Offset 13 m South	0 m - 0.1 m 0.1 m - 0.4 m 0.4 m	Topsoil Clayey silt with cobbles and boulders Limestone bedrock

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, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

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

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

III. SOIL DESCRIPTION

(a) Cohesionless Soils

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

(b) Cohesive Soils

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

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

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

LIST OF SYMBOLS

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

I. GENERAL

π	3.1416
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

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RECORD OF BOREHOLE No BH 1

1 OF 1 **METRIC**

PROJECT 09-1184-6030 (4000) | LOCATION Station 15+664, Offset 4.9 m North | ORIGINATED BY MWK

W.P. | DIST Central HWY 8 | BOREHOLE TYPE CME-75, 101 mm Internal Diameter Hollow Stem Augers | COMPILED BY MWK

DATUM Geodetic | DATE April 9, 2010 | CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (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
255.8	GROUND SURFACE										
0.0	Sand and gravel, trace to some silt (FILL) Brown Moist										
255.1											
0.7	Sand and gravel, trace to some silt, containing sandy silt layers, cobbles and boulders (FILL) Compact Brown Moist		1	AS	-		255				
			2	SS	25		254		○		54 33 10 3
	Auger grinding on cobbles and boulders between 2.0 m and 2.4 m depth										
253.4											
2.4	LIMESTONE (BEDROCK)						253				
252.9											
2.9	END OF BOREHOLE										

NOTE:

1. Open borehole dry on completion of drilling.

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

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

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RECORD OF BOREHOLE No BH 1B

1 OF 1 **METRIC**

PROJECT 09-1184-6030 (4000) | LOCATION Station 15+665, Offset 4.9 m North | ORIGINATED BY MWK

W.P. | DIST Central HWY 8 | BOREHOLE TYPE CME-75, 101 mm Internal Diameter Hollow Stem Augers | COMPILED BY MWK

DATUM Geodetic | DATE April 9, 2010 | CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (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
255.8	GROUND SURFACE										
0.0 / 255.2	Sand and gravel, trace to some silt (FILL)										
0.6 / 253.4	Sand and gravel, some silt, containing cobbles and boulders (FILL) Brown Moist Auger grinding on cobbles and boulders between 1.8 m and 2.4 m depth						255 254				
2.4	END OF BOREHOLE Auger refusal on bedrock NOTE: 1. Open borehole dry on completion of drilling.										

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

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RECORD OF BOREHOLE No BH 2

1 OF 1 **METRIC**

PROJECT 09-1184-6030 (4000) | LOCATION Station 15+677, Offset 1.9 m North | ORIGINATED BY MWK

W.P. | DIST Central HWY 8 | BOREHOLE TYPE CME-75, 101 mm Internal Diameter Hollow Stem Augers | COMPILED BY MWK

DATUM Geodetic | DATE April 9, 2010 | CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (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
255.7	GROUND SURFACE										
0.0 / 255.5	ASPHALT										
0.2 / 255.2	Sand and gravel, trace to some silt (FILL)		1	AS	-						
0.5 / 254.6	Sand and gravel, trace to some silt (FILL)		2	AS	2		255				
1.1 / 253.3	Silty sand, some gravel, containing cobbles and boulders (FILL) Loose Brown Moist		3	SS	4/0.13		254		○		36 49 12 3
2.4	END OF BOREHOLE Auger refusal on bedrock NOTE: 1. Open borehole dry on completion of drilling.										

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

MIS-MTO 001 09-1184-6030.GPJ GAL-MISS.GDT 16/4/10 DD

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RECORD OF BOREHOLE No BH 2B

1 OF 1 **METRIC**

PROJECT 09-1184-6030 (4000) | LOCATION Station 15+679, Offset 1.9 m North | ORIGINATED BY MWK

W.P. | DIST Central HWY 8 | BOREHOLE TYPE CME-75, 101 mm Internal Diameter Hollow Stem Augers | COMPILED BY MWK

DATUM Geodetic | DATE April 9, 2010 | CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
255.7	GROUND SURFACE										
0.0 / 255.5	ASPHALT										
0.2 / 255.2	Sand and gravel, trace to some silt (FILL)										
0.5 / 254.6	Sand and gravel, trace to some silt (FILL)						255				
1.1 / 253.3	Sand and gravel, some silt, containing cobbles and boulders (FILL) Brown Moist to wet Auger grinding on cobbles and boulders between 1.5 m and 2.4 m depth		1	SS	1/0.03		254				
2.4	END OF BOREHOLE Auger refusal on bedrock NOTE: 1. Open borehole dry on completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No BH 3

1 OF 1 **METRIC**

PROJECT 09-1184-6030 (4000) | LOCATION Station 15+678, Offset 4.7 m South | ORIGINATED BY MWK

W.P. | BOREHOLE TYPE CME-75, 101 mm Internal Diameter Hollow Stem Augers | COMPILED BY MWK

DIST Central HWY 8 | DATUM Geodetic | DATE April 9, 2010 | CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
255.7	GROUND SURFACE										
0.0	Sand and gravel, trace to some silt (FILL)		1	AS	-						
254.8							255				
0.9	Sand and gravel, trace silt (FILL)										
254.5											
1.2	Clayey silt, trace to some sand and gravel, containing organics, cobbles and boulders (FILL) Brown Moist		2	AS	-				w		26 30 32 12
	Auger grinding on cobbles and boulders between 1.8 m and 2.3 m depth		3	SS	12/0.25		254				
253.4											
2.3	END OF BOREHOLE Auger refusal on bedrock										

NOTE:

1. Open borehole dry on completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No BH 4

1 OF 1 **METRIC**

PROJECT 09-1184-6030 (4000) | LOCATION Station 15+665, Offset 4.7 m South | ORIGINATED BY MWK

W.P. | DIST Central HWY 8 | BOREHOLE TYPE CME-75, 101 mm Internal Diameter Hollow Stem Augers | COMPILED BY MWK

DATUM Geodetic | DATE April 9, 2010 | CHECKED BY LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
255.8	GROUND SURFACE										
0.0	Sand and gravel, trace to some silt (FILL)										
255.2											
0.6	Sand and gravel, some silt (FILL) Compact Brown Wet						255				
	Auger grinding on cobbles and boulders between 1.8 m and 2.0 m depth		1	SS	18		254		○		
253.8											
2.0	Clayey silt, some sand, trace to some gravel, containing cobbles and boulders (FILL) Brown Moist to wet										
253.4											
2.4	Auger grinding on cobbles and boulders between 2.0 m and 2.4 m depth										
	END OF BOREHOLE Auger refusal on bedrock										
	NOTE: 1. Open borehole dry on completion of drilling.										

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

MIS-MTO 001 09-1184-6030.GPJ GAL-MISS.GDT 16/4/10 DD

MINISTRY OF TRANSPORTATION, ONTARIO

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

CONT No.
WP No.

HIGHWAY 8
FAIRCHILD CREEK CULVERT REPLACEMENT
BOREHOLE LOCATIONS

SHEET

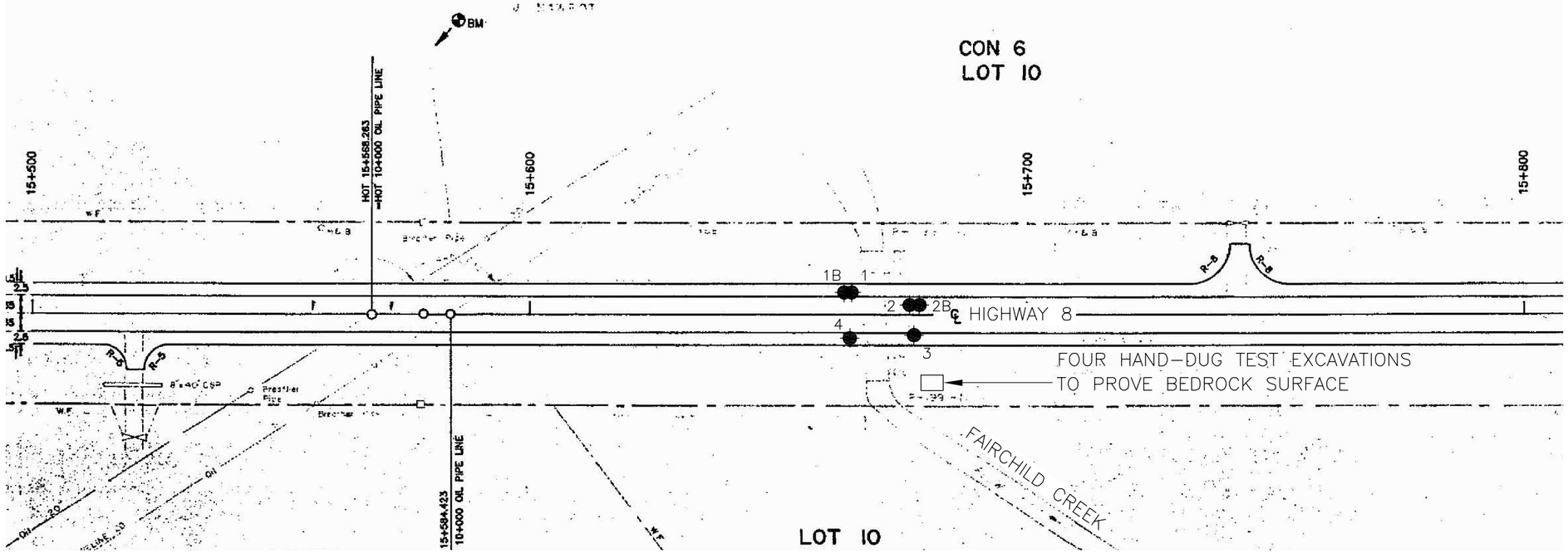
Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA

KEY PLAN
NOT TO SCALE

LEGEND

Borehole – Current Investigation

TOWNSHIP OF FLAMBOROUGH



FOUR HAND–DUG TEST EXCAVATIONS TO PROVE BEDROCK SURFACE

PLAN

SCALE
10 0 10 20 m

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contract Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

REFERENCE

Base plans provided in digital format by MTO Geotechnical Section – Drawing entitled "Reconstruction, Station 15+500 to 15+850", from contract 90–63, W.P. 162–80–01, Sheet No. 8.

NO.	DATE	BY	REVISION

Geocres No. 30M5–279

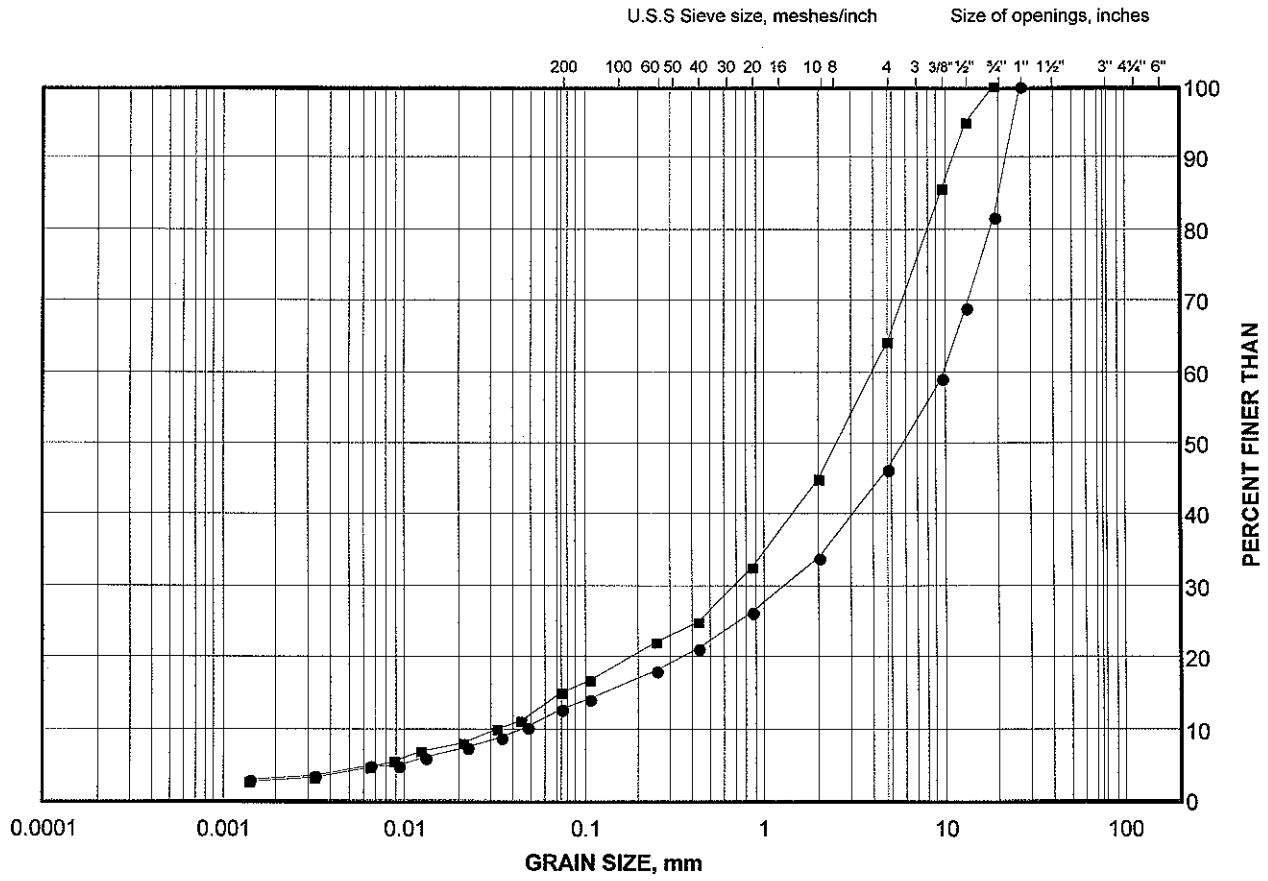
HWY.		PROJECT NO. 089–1184–6030	DIST. Central
SUBM'D. MWK	CHKD. MWK	DATE: 19–Apr–2010	SITE:
DRAWN: DD	CHKD. MWK	APPD. LCC	DWG. 1

PLOT DATE: April 19, 2010
FILENAME: T:\Projects\2009\08-1184-6030 (MTO, Ontario)\-Mr- (4000) – HWY 8 Culvert Replacement\09118460304001.dwg

GRAIN SIZE DISTRIBUTION TEST RESULTS

Sand and Gravel Fill

FIGURE 1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	1	2	254
■	2	3	254

Project Number: 09-1184-6030 (4000)

Checked By: _____

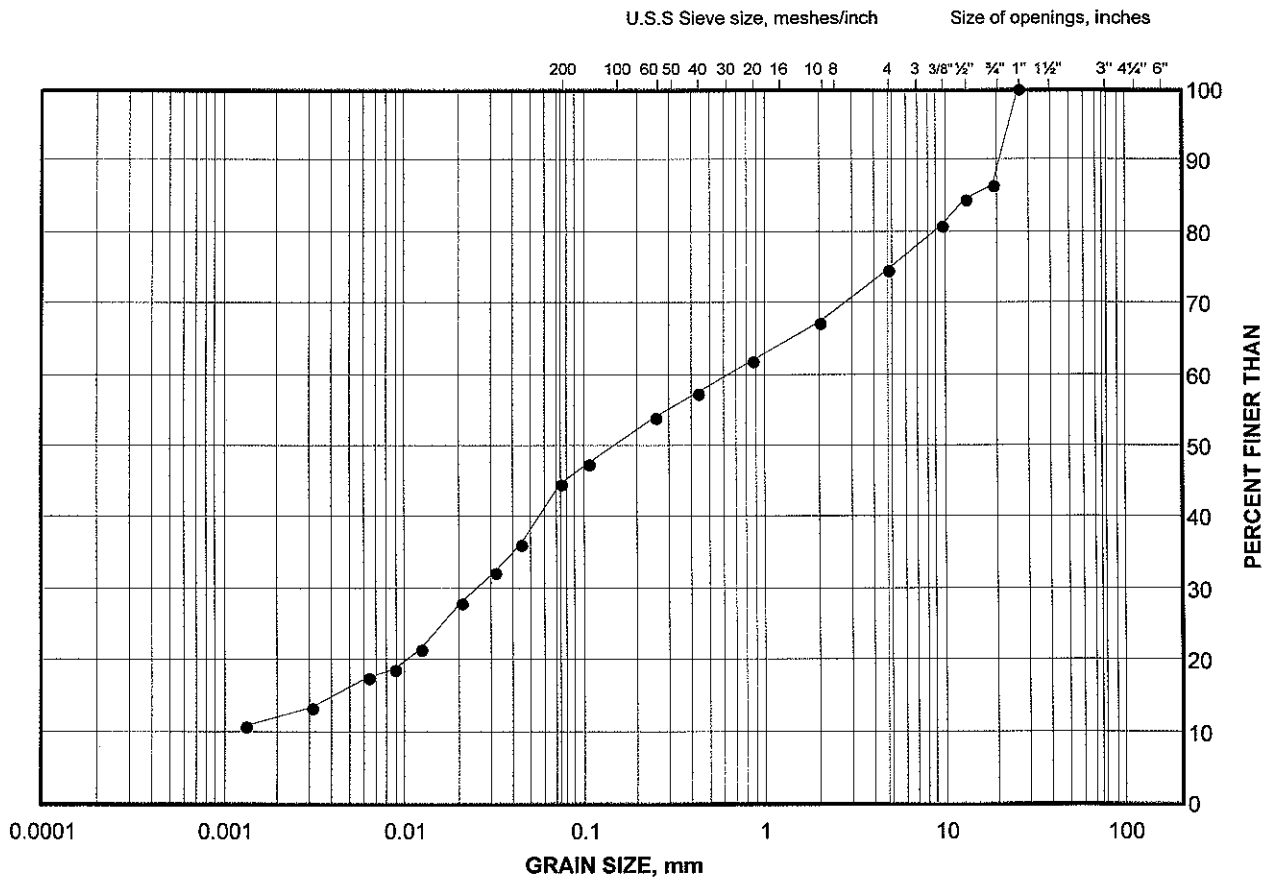
Golder Associates

Date: 15-Apr-10

GRAIN SIZE DISTRIBUTION TEST RESULT

Clayey Silt Fill

FIGURE 2



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	3	2	254.3

Project Number: 09-1184-6030 (4000)

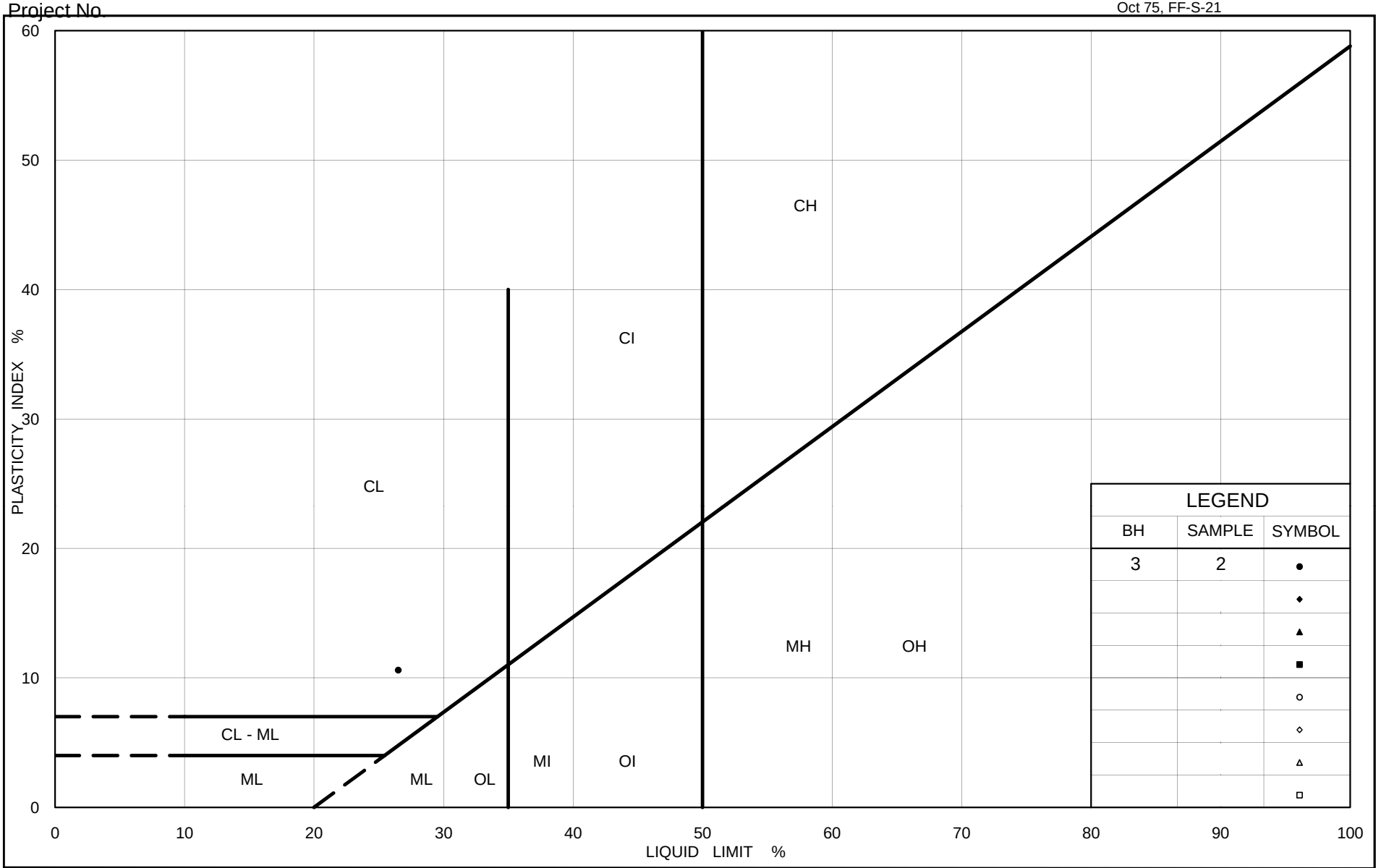
Checked By: _____

Golder Associates

Date: 15-Apr-10

Project No.

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt Fill

Figure No. 3

Project No. 09-1184-6030 (4000)

Checked By: AJ

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Africa	+ 27 11 254 4800
Asia	+ 852 2562 3658
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Ltd.
100, Scotia Court
Whitby, Ontario, L1N 8Y6
Canada
T: +1 (905) 723 2727

Golder Associates