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FOUNDATION INVESTIGATION REPORT

**SITE 9 ROAD UNDERPASS STRUCTURE, SITE NO. 44-444
HIGHWAY 69 FOUR-LANING
FROM 0.4 KM NORTH OF HIGHWAY 7182
(SHEBESHEKONG ROAD) NORTHERLY 11 KM
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5403-05-00, WP 5189-06-01**

Submitted to:
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GEOCRES No.: 41H-72

Report Number: 07-1191-020-B1

Distribution:

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REPORT



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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by MMM Group (MMM) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the detail design of the proposed Site 9 Road Underpass structure over the new four-laned Highway 69. The proposed work is part of the detail design of the four-laning of Highway 69 from 0.4 km north of Highway 7182 (Shebeshekong Road) northerly for a total distance of 11 km. The general location of this section of the Highway 69 four-laning alignment is as shown in the Contract Drawings.

The terms of reference and scope of work for the foundation investigation are outlined in MTO's Request for Proposal dated March 28, 2007. Golder's proposal (P7-1191-0020, dated April 24, 2007) for foundation engineering services associated with the structure is contained in Section 6.8 of MMM's Technical Proposal that forms part of the Consultant's Agreement (Purchase Order Number 5006-E-0031) for this project. The work was carried out in accordance with Golder's Supplemental Specialty Quality Control Plan for this project dated September 2007. The final General Arrangement (GA) Drawing, dated July 2010, for the proposed Site 9 Road Underpass structure was provided to Golder by MMM on July 17, 2010.

This report addresses the investigation carried out for the Site 9 Road Underpass structure and the associated approach embankments and Retained Soil System (RSS) walls. Separate reports will be submitted detailing the foundation investigations for the related swamp and pond crossings, culverts and other bridge structures for the project.

The purpose of this investigation is to establish the subsurface conditions at the proposed structure, including the associated approach embankments, by borehole drilling, rock coring and laboratory testing on selected samples. The area of the investigation is as shown in the Contract Drawings.

The investigation was supplemented with information contained in the available existing data supplied by the MTO, specifically:

- Preliminary Foundation and Design Report – Structural Areas, Foundation Investigation – 2, Highway 69 Route Selection Study, 3.5 km North of Highway 559 to 3.8 km North of Highway 522, GWP 5377-02-00, Highway 69, GEOCREC No. 41H-57, July, 2006, by AMEC Earth and Environmental (AMEC).

2.0 SITE DESCRIPTION

The proposed Site 9 Road Underpass structure is located at the intersection of Dumont Road and the existing Highway 69, approximately 900 m north of Highway 7182 (Shebeshekong Road). The existing Highway 69, which will become the future Southbound Lane (SBL) of the proposed four-lane highway, runs generally in a southeast-northwest direction.

In general, the topography in the area of the overall project limits consists of rolling terrain including densely treed areas and numerous bedrock outcrops separated by low-lying swamps. The proposed structure and associated approach embankments are to be situated on a relatively flat, moderately treed area. The ground surface at the borehole locations advanced within the limits of the proposed structure and approach embankment areas is between about Elevation 209.8 m and Elevation 213.3 m, referenced to Geodetic datum, and is gently sloping downward from east to west.



3.0 INVESTIGATION PROCEDURES

The fieldwork for the Site 9 Road Underpass structure investigation was carried out between January 6 and 23, 2009, during which time a total of eight (8) boreholes and three (3) Dynamic Cone Penetration Tests (DCPTs) were advanced: two (2) boreholes were advanced at the west abutment; three (3) boreholes and three (3) DCPTs were advanced at the centre pier; one (1) borehole was advanced at the east abutment; and two (2) boreholes were advanced at the approach embankments (i.e. one borehole at each approach). The boreholes are designated as Boreholes B1-1 to B1-8 and the DCPTs are designated as B1-DC2, B1-DC3 and B1-DC3a. Two (2) probeholes were advanced in July 2009 for the proposed RSS wall. In addition, one (1) borehole (S16-2) and a DCPT (S16-DC2) from the swamp investigations for this area were included to supplement the information for the RSS walls. The details are shown on the Record of Borehole and Drillhole, Record of Penetration Test and Record of Geotechnical Probehole sheets in Appendix A and the locations are as shown in the Contract Drawings.

The locations of two (2) boreholes and one (1) DCPT advanced by AMEC (AMEC, 2006) during the preliminary design phase of the project are also as shown in the Contract Drawings. Borehole ST-3 and ST-4 and DCPT ST-3, are located at the proposed east and west abutments. Copies of these Borehole and Penetration Test Sheets are provided in Appendix B.

The current field investigation was carried out using a track mounted CME-55 drill rig supplied by Landcore Drilling Inc. of Sudbury, Ontario. The boreholes were advanced through the overburden using either 108 mm inside diameter continuous flight hollow stem augers or NW casing and wash boring. Soil samples were obtained at intervals of depth of about 0.75 m, 1.5 m and 3.0 m, using a 50 mm outside diameter split-spoon sampler in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586-08a). Samples of the bedrock were obtained using an NQ size rock core barrel. All boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation (O.Reg.) 903 (as amended by O.Reg.372).

At least one borehole at each foundation element was advanced to the bedrock surface while the boreholes at the approach embankments were advanced to a depth approximately equal to the height of the proposed embankment. The depths of the boreholes range from about 2.8 m to 26.8 m below existing ground surface, including coring of between about 3.0 m and 3.9 m of bedrock at Boreholes B1-1 to B1-4.

The groundwater conditions in the open boreholes were observed during the drilling operations and piezometers were installed in Boreholes B1-1 and B1-4 to permit monitoring of the groundwater level at these locations. The piezometers consisted of 51 mm diameter PVC pipe, with a 1.5 m long slotted screen sealed at a selected depth within the boreholes. The non-instrumented boreholes and the annulus surrounding the piezometer pipe above the sand pack were backfilled to the surface with bentonite pellets/grout. The piezometer installation details and water level readings are described on the Record of Borehole sheets in Appendix A.

The fieldwork was observed by members of our engineering and technical staff, who located the boreholes in the field based on the survey carried out by MMM, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil and rock samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Sudbury geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected samples. Strength testing (uniaxial compression and point load index) was carried out on selected specimens of the rock core.



MMM surveyed the location of eight (8) boreholes at the site in December 2008, prior to drilling. Several boreholes were relocated from the original staked location due to uneven ground or overhead or underground utilities. Where boreholes were relocated from their original staked location, Golder laid out the new borehole location and surveyed the ground surface at the new location referencing the original staked location. The borehole locations as shown in the Contract Drawings and summarized below are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum.

Borehole	Location (m)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing	Easting		
B1-1	5046414.4	242674.9	209.9	26.8
B1-2	5046431.3	242708.4	211.0	6.0
B1-3	5046437.7	242699.1	212.3	8.6
B1-4	5046448.7	242742.1	213.3	15.8
B1-5	5046410.0	242657.2	209.8	9.8
B1-6	5046462.4	242760.6	213.3	11.3
B1-7	5046420.2	242665.2	209.9	16.8
B1-8	5046434.2	242704.3	211.4	2.8

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

As delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984¹), this section of Highway 69 lies within the physiographic region known as the Georgian Bay Fringe, which extends along the east side of Georgian Bay through the Parry Sound and Muskoka areas, then eastward from Muskoka in patches into the area north of the Kawartha Lakes.

This part of the Georgian Bay Fringe physiographic region was never submerged during periods of glacial recession. As a result, the surficial soils in this area consist of very shallow deposits of sand, silt and clay overlying metamorphic bedrock and numerous bare knobs and ridges of bedrock are present throughout the area. Localised low-lying swampy areas, containing peat and/or organic soils overlying soft/loose native soils, are present in valleys between the bedrock knobs and ridges.

The bedrock in the area consists typically of gneisses of the Britt Domain of the Central Gneiss Belt, a subdivision of the Grenville Structural Province, as described in *Geology of Ontario*, OGS Special Volume 4². Deposition of Paleozoic strata and later erosion during glaciation left behind these Precambrian rocks.

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.

² *Geology of Ontario*, 1991. Ontario Geological Survey Special Volume 4, Part 2. Ministry of Northern Development and Mines, Ontario.



4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced for this investigation, together with the results of the laboratory tests carried out on selected soil samples, are given on the attached Record of Borehole, Drillhole and Penetration Test sheets and Probehole in Appendix A. The results of the laboratory tests carried out on selected soil and rock samples are presented in Appendix C. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non continuous sampling, observations of drilling progress and the results of SPTs. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. It should be noted that the interpreted stratigraphy as shown in the Contract Drawings is a simplification of the subsurface conditions. Variation in the stratigraphic boundaries between boreholes will exist and is to be expected.

In general, the subsurface conditions in the area of the proposed underpass consist of a surficial layer of topsoil, underlain by a cohesionless deposit of sand to sand and silt. In Boreholes B1-1 and B1-7, a clayey silt seam was encountered at a depth of about 2.7 m within the granular deposit. In Boreholes B1-4 and B1-7, a layer of cobbles and boulders was found below the sand to sand and silt deposit. Gneiss bedrock was encountered in Boreholes B1-1 to B1-4 below the cohesionless deposit. The ground surface at the borehole locations varies between Elevation 209.8 m and Elevation 213.3 m decreasing towards the west.

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

4.2.1 Topsoil/Fill

Approximately 0.1 m to 0.6 m of topsoil was encountered immediately below ground surface in Boreholes B1-2 to B1-8.

A 1.0 m thick layer of brown fill comprising of sand, trace to some gravel, trace silt containing organics was encountered beneath the topsoil in Borehole B1-3 at Elevation 212.2 m. An SPT 'N'-value measured within the fill is 10 blows per 0.3 m of penetration, indicating a compact relative density.

The measured water content on one sample of the fill is about 32 percent.

4.2.2 Sand to Sand and Silt

A cohesionless deposit consisting of sand, silty sand, sand and silt, sandy silt and gravelly sand was encountered in all boreholes below the surficial topsoil/fill layer or from ground surface. In general, this deposit ranges from a sand to sand and silt. The deposit contained trace to some gravel and trace clay.

The top of this deposit was encountered between Elevation 209.2 m and Elevation 213.1 m and the deposit is between 1.9 m and 23.6 m thick, being thickest at the proposed west abutment and thinnest at the median (centre) pier. The lower approximately 4 m of the deposit in Borehole B1-1 and a 0.6 m thick layer at a depth of 4.6 m in Borehole B1-6 is comprised of gravelly sand and gravelly silty sand, respectively.



SPT 'N'-values measured within this deposit typically range from 3 blows to 37 blows per 0.3 m of penetration, indicating a very loose to dense relative density. The portion of this deposit between depths of about 15.2 m (Elevation 194.7 m) and 18.9 m (Elevation 191.0 m) in Borehole B1-1 and the lower portion of the deposit in Borehole B1-7 (located at the west abutment) have SPT 'N'-values greater than 100 blows per 0.3 m of penetration which would typically suggest a very dense relative density; however, in these boreholes, the higher 'N'-values are likely indicative of the presence of cobbles and boulders and/or gravelly layers.

Heaving sands were noted in several boreholes despite a full head of water being maintained inside the augers/casing. Lower SPT 'N'-values were typically recorded below the elevation where heaving sands were encountered, typically between depths of about 4.6 m and 5.6 m.

Difficult casing/auger advancement was noted near the base of the deposit in Boreholes B1-1, B1-3 and B1-5 to B1-8, inferred to be due to the presence of gravelly material or cobbles and boulders.

Grain size analyses were carried out on twenty-five (25) samples of this deposit and the results are presented on Figures C-1 to C-5 in Appendix C.

Measured water contents on samples of the sand to sand and silt deposit range from about 12 percent to 32 percent.

4.2.3 Clayey Silt

In Boreholes B1-1 and B1-7 (located at the proposed west abutment), a 0.1 m to 0.5 m layer of thick clayey silt was encountered at Elevations 207.1 m and 207.2 m, respectively, within the sand to sand and silt deposit.

Atterberg limits testing carried out on two samples of the clayey silt layer indicate liquid limits of about 31 percent and 33 percent and plastic limits of about 18 percent and 19 percent, yielding plasticity indices of about 12 percent and 15 percent. The results of the Atterberg limits testing are shown on the plasticity chart on Figure C-6, and indicate that the stratum is a clayey silt of low plasticity.

Measured water contents on samples of the clayey silt range from about 47 percent to 50 percent.

4.2.4 Cobbles and Boulders

A deposit of cobbles and boulders containing sand and gravel was encountered in Boreholes B1-4 and B1-7. The top of this layer was encountered at Elevation 201.3 m and Elevation 195.3 m and the layer is 0.2 m and 2.2 m thick in Borehole B1-4 and B1-7, respectively.

4.2.5 Bedrock/Refusal

Bedrock was encountered and core samples were recovered from Boreholes B1-1 to B1-4. Based on coring and refusal to auger advance, the depth to the bedrock surface is variable and ranges from 12.2 m (at the proposed east abutment) to 2.1 m (at the proposed centre pier) to 23.6 m (at the proposed west abutment) below ground surface. Between the centre pier and the west abutment (a distance of about 39 m), the bedrock surface



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elevation drops by about 20 m (approximately 2H:1V slope or a dip of approximately 27° from the horizontal). Between the centre pier and the east abutment (a distance of about 39 m), the bedrock surface elevation drops by about 9 m (approximately 4.5H:1V slope or a dip of approximately 13° from the horizontal). The presence of sloping bedrock was confirmed in Borehole B1-8 when auger refusal was encountered and the augers were noted to be sliding to the north. The depth to refusal/bedrock and corresponding refusal/bedrock surface elevation is summarised below.

Location	Boring No.	Depth to Refusal/Bedrock Surface (m)	Refusal/Bedrock Surface Elevation (m)	Refusal Type
Proposed West Approach	B1-5	N/A	N/A	N/A
Proposed West Abutment	B1-1 B1-7	23.6 N/A	186.3 N/A	Bedrock Cored N/A
Proposed Centre Pier	B1-2 B1-3 B1-8 B1-DC2 B1-DC3 B1-DC3a	2.1 5.6 2.8 2.6 4.3 5.9	208.9 206.7 208.6 208.4 207.7 206.9	Bedrock Cored Bedrock Cored Auger Refusal Cone Refusal Cone Refusal Cone Refusal
Proposed East Abutment	B1-4 ST-3(DCPT)	12.2 12.0	201.1 201.0	Bedrock Cored Cone Refusal
Proposed East Approach	B1-6	N/A	N/A	N/A

N/A: Refusal or bedrock not encountered to a drilled depth of 9.8 m at B1-5, 16.8 m at B1-7 and 11.3 m at B1-6.

Based on the cored bedrock samples, the bedrock generally consists of fresh to slightly weathered, fine to medium grained, pinkish grey gneiss. The Rock Quality Designation (RQD) measured on the core samples is between about 78 percent and 100 percent, indicating a rock mass of good to excellent quality. The Total Core Recovery (TCR) for all samples was 100 percent and the Solid Core Recovery (SCR) of the samples recovered was between 69 percent and 98 percent. In Borehole B1-2, the bedrock core is fractured between Elevations 207.3 m and 207.5 m.

Uniaxial Compressive Strength (UCS) tests carried out on selected samples of the gneiss bedrock obtained from Boreholes B1-1 to B1-4, measured strengths ranging from 64 MPa to 144 MPa, as summarised on Table C-1 in Appendix C.

Point load strength tests were performed on selected samples of the bedrock. Diametral point load strength index values are shown on the Record of Drillhole sheets and in Table C-2 in Appendix C. The diametral point load index (I_{s50}) results from the laboratory tests carried out on core samples of the bedrock range from 2.5 MPa to 10 MPa. These index values correspond to estimated UCS values ranging between 50 MPa and 197 MPa, based on a relationship between I_{s50} and UCS which is given by a correlation factor (K) in accordance with ASTM D5731-08, which varies depending on the size of the core samples and the strength of the rock. For this site, these UCS values are based on an estimated average correlation factor (K) of 20. These values have been given for comparison only and should be interpreted together with the results of the UCS tests.



Based on the laboratory UCS test and point load testing results, the estimated intact strength of the gneiss bedrock ranges from strong (R4, 50 MPa < UCS < 100 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa).

4.2.6 Groundwater Conditions

The water level in the boreholes was observed during and upon completion of drilling operations and was typically between Elevation 208.2 m and Elevation 212.0 m. In general, the samples of the overburden were noted to be moist to wet. An external source of water was pumped into each borehole as it was being advanced to maintain a constant head of water while obtaining SPT samples. However, several boreholes had sand flow into the augers and casing. In some boreholes, it was not possible to continue using hollow stem augers and NW casing with wash boring techniques was then used in order to advance the boreholes through the sand to sand and silt deposit.

Standpipe piezometers were installed in Boreholes B1-1 and B1-4 to permit monitoring of the water levels at this site. Details of the piezometer installations are shown the Record of Borehole sheets in Appendix A. The groundwater levels measured in the piezometer installations are summarised below.

Foundation Element	Borehole No.	Ground Surface Elevation (m)	Groundwater Elevation (m)	Date of Measurement
West Abutment	B1-1	209.9	209.1	March 20, 2009
East Abutment	B1-4	213.3	212.0	March 20, 2009

Groundwater levels in the area are subject to seasonal fluctuations and to fluctuations after precipitation events and snowmelt.

5.0 CLOSURE

The field drilling program was supervised by Mr. Ed Savard. This report was prepared by Mr. Evan Childerhose, B.Eng., and Mr. André Bom, P.Eng., and the technical aspects were reviewed by Ms. Sarah Coyne, P.Eng., Associate. Mr. Jorge M. A. Costa, P.Eng., Golder's Designated MTO Contact for this project and Principal with Golder, conducted a quality control review of the report.



Report Signature Page

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APPENDIX A

Record of Boreholes, Drillholes, Penetration Tests and Probeholes



LIST OF SYMBOLS

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

1. 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
V	volume
W	weight

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. stress: $\Delta\sigma$
ϵ	linear strain
ϵ_v	volumetric strain
η	coefficient of viscosity
ν	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	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 $= \sigma'_p / \sigma'_{vo}$

(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
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

Piezocone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² 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
	<u>kPa</u> <u>psf</u>
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.



LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of Major discontinuities

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock Mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock texture and structure are preserved.

BEDDING THICKNESS

<u>Description</u>	<u>Bedding Plane Spacing</u>
Very thickly bedded	> 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	< 6 mm

JOINT OR FOLIATION SPACING

<u>Description</u>	<u>Spacing</u>
Very wide	> 3 m
Wide	1 – 3 m
Moderately close	0.3 – 1 m
Close	50 – 300 mm
Very close	< 50 mm

GRAIN SIZE

<u>Terms</u>	<u>Size*</u>
Very Coarse Grained	> 60 mm
Coarse Grained	2 – 60 mm
Medium Grained	60 microns – 2 mm
Fine Grained	2 – 60 microns
Very Fine Grained	< 2 microns

* Note: Grains > 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separation) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to (W.R.T.) Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole, a discontinuity with a 90° angle is horizontal.

Description and Notes

An abbreviated description of the discontinuities, whether naturally occurring separation such as fractures, bedding planes and foliation planes or mechanically induced fractures caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

B - Bedding	⊥ - Perpendicular To
FO - Foliation / Schistosity	- Parallel To
CL - Cleavage	P - Polished
SH - Shear Plane / Zone	K - Slickensided
VN - Vein	SM - Smooth
F - Fault	R - Rough
CO - Contact	ST - Stepped
J - Joint	PL - Planar
FR - Fracture	U - Undulating
MF - Mechanical Fracture	C - Curved

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

PROJECT 07-1191-0020				RECORD OF BOREHOLE No B1-1				2 OF 2 METRIC									
W.P. 5189-06-01				LOCATION N 5046414.4; E 242674.9				ORIGINATED BY EHS									
DIST HWY 69				BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring				COMPILED BY MM									
DATUM Geodetic				DATE January 13 and 19, 2009				CHECKED BY AB									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
--- CONTINUED FROM PREVIOUS PAGE ---								20	40	60	80	100					
	SAND and SILT, some gravel Loose to very dense Brown Wet		14	SS	20/0.05												16 58 (26)
	Occasional cobbles and boulders below 15.4 m depth.						194										
			15	SS	75/0.2		193										
							192										
			16	SS	70/0.1		191										
	Advanced a bi-cone from 19.5 m depth to 21.3 m depth.						190										
189.9 20.0	Gravelly silty SAND Compact Brown Wet						189										
			17	SS	10		188										27 46 (27)
							187										
186.3 23.6	GNEISS (BEDROCK)						186										
	Bedrock cored from 23.6 m to 26.8 m depth.		1	RC	REC 100%		185										RQD = 89%
	For coring details refer to Record of Drillhole B1-1.		2	RC	REC 100%		184										RQD = 100%
183.1 26.8	End of Borehole																
	Notes: 1. Water level measured in open borehole at a depth of 0.5 m below ground surface (Elev. 209.4 m) upon completion of drilling. 2. Water level measured in piezometer at a depth of 0.8 m below ground surface (Elev. 209.1 m) on March 20, 2009.																

MIS-MTO 001 07-1191-0020 B1 BH LOGS METRIC.GPJ GAL-MISS.GDT 06/10/10 DATA INPUT:

PROJECT: 07-1191-0020

RECORD OF DRILLHOLE: B1-1

SHEET 1 OF 1

LOCATION: N 5046414.4 ; E 242674.9

DRILLING DATE: January 13 and 19, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 850

DRILLING CONTRACTOR: Landcore

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	JN - Joint FLT - Fault SHR- Shear VN - Vein CJ - Conjugate										BD- Bedding FO- Foliation CO- Contact OR- Orthogonal CL - Cleavage										PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular										PO- Polished K - Slickensided SM- Smooth Ro - Rough MB- Mechanical Break										BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
							RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA										HYDRAULIC CONDUCTIVITY		Diametral Point Load Index (MPa)	RMC -Q AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
							TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	K ₁ cm/sec	K ₂ cm/sec																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
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		Refer to Previous Page		186.3 23.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															</

UCS = 144 MPa

DEPTH SCALE

1 : 50



LOGGED: EHS

CHECKED: AB

SUD-RCK 07-1191-0020 B1 BH LOGS METRIC.GPJ GAL-MISS.GDT 06/10/10 DATA INPUT:

PROJECT 07-1191-0020			RECORD OF BOREHOLE No B1-2			1 OF 1 METRIC											
W.P. 5189-06-01			LOCATION N 5046431.3; E 242708.4			ORIGINATED BY EHS											
DIST _____ HWY 69			BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers			COMPILED BY MM											
DATUM Geodetic			DATE January 8 and 9, 2009			CHECKED BY AB											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
211.0	GROUND SURFACE						20	40	60	80	100						
0.0	TOPSOIL																
0.2	Brown Moist																
	SAND, trace to some silt, trace clay Loose to compact Brown Wet		1	SS	12												
			2	SS	8												
208.9																	
2.1	GNEISS (BEDROCK)																
	Bedrock cored from 2.1 m to 6.0 m depth. For coring details refer to Record of Drillhole B1-2.		1	RC	REC 100%												
			2	RC	REC 100%												
			3	RC	REC 100%												
205.0	End of Borehole																
6.0	Note: 1. Water level measured at ground surface upon completion of drilling.																

MIS-MTO 001 07-1191-0020 B1 BH LOGS METRIC.GPJ GAL-MISS.GDT 06/10/10 DATA INPUT:

PROJECT: 07-1191-0020

RECORD OF DRILLHOLE: B1-2

SHEET 1 OF 1

LOCATION: N 5046431.3 ; E 242708.4

DRILLING DATE: January 8 and 9, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 850

DRILLING CONTRACTOR: Landcore

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.	RUN No.	COLOUR % RETURN	FLUSH	RECOVERY		R.Q.D. %	FRACT INDEX PER 0.3 m	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY				Diametral Point Load Index (MPa)	RMC -Q AVG.			
				DEPTH (m)				TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	K, cm/sec	10 ⁻⁶			10 ⁻⁵	10 ⁻⁴	10 ⁻³
JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate		BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage		PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular		PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break		BR - Broken Rock																
NOTE: For additional abbreviations refer to list of abbreviations & symbols.																								
		Refer to Previous Page		208.9																				
	NQ Coring 01/09/2009	GNEISS Fine to medium grained Slightly weathered Very strong Pinkish grey		2.1	1	Grey 100%									J, U, R									
3		Heavily jointed from 3.5 m to 3.7 m depth.		2	Grey 100%										J, U, R J, U, R J, U, R J, U, R J, U, R J, FO, R					UCS = 129 MPa				
4				3	Grey 100%										J, U, R J, PL, R J, U, R J, U, R J, FO, R J, FO, R									
5																								
6		End of Drillhole		205.0 6.0											J, FO, R									
7																								
8																								
9																								
10																								
11																								
12																								

DEPTH SCALE

1 : 50



LOGGED: EHS

CHECKED: AB

SUD-RCK 07-1191-0020 B1 BH LOGS METRIC.GPJ GAL-MISS.GDT 06/10/10 DATA INPUT:

PROJECT 07-1191-0020			RECORD OF BOREHOLE No B1-3			1 OF 1 METRIC														
W.P. 5189-06-01			LOCATION N 5046437.7; E 242699.1			ORIGINATED BY EHS														
DIST HWY 69			BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers			COMPILED BY MM														
DATUM Geodetic			DATE January 12, 2009			CHECKED BY AB														
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%) W _p — W — W _L			γ	GR	SA	SI	CL
212.3	GROUND SURFACE							20	40	60	80	100								
0.0	TOPSOIL Brown Moist		1	AS	-		212													
211.2	Sand, trace to some gravel, trace silt, trace to some organics (FILL) Compact Brown Moist to wet		2	SS	10		211													
1.1	SAND to SANDY SILT, trace clay Loose to compact Brown Wet		3	SS	11		210													
			4	SS	12		209													
			5	SS	13		208													
			6	SS	5		207													
	Approximately 0.6 m of heaving sands at a depth of 4.6 m and 4.1 m of heaving sands at a depth of 5.6 m.		7	SS	4		206													
206.7	GNEISS (BEDROCK)						205													
5.6	Bedrock cored from 5.6 m to 8.6 m depth. For coring details refer to Record of Drillhole B1-3.		1	RC	REC 100%		204													
			2	RC	REC 100%															
203.7	End of Borehole																			
8.6	Notes: 1. Water level measured at a depth of 1.6 m below ground surface (Elev. 210.7 m) upon completion of drilling.																			

MIS-MTO 001 07-1191-0020 B1 BH LOGS METRIC.GPJ GAL-MISS.GDT 06/10/10 DATA INPUT:

PROJECT: 07-1191-0020

RECORD OF DRILLHOLE: B1-3

SHEET 1 OF 1

LOCATION: N 5046437.7 ; E 242699.1

DRILLING DATE: January 12, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 850

DRILLING CONTRACTOR: Landcore

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	RECOVERY				R.Q.D. %	FRACT INDEX PER 0.3 m	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY K, cm/sec				Diametral Point Load Index (MPa)	RMC -Q AVG.																				
								TOTAL CORE %	SOLID CORE %	B Angle	DIP w.r.t. CORE AXIS			TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴	10 ⁻³																						
																								JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate	BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage	PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular	PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break																
																												NOTE: For additional abbreviations refer to list of abbreviations & symbols.															
		Refer to Previous Page		206.7 5.6																																							
6	NQ Coring 01/12/2009	GNEISS Fine to medium grained Slightly weathered Very strong Grey			1	Grey 100%																																					
7																																											
8																																											
		End of Drillhole		203.7 8.6																																							
9																																											
10																																											
11																																											
12																																											
13																																											
14																																											
15																																											

DEPTH SCALE

1 : 50



LOGGED: EHS

CHECKED: AB

SUD-RCK 07-1191-0020 B1 BH LOGS METRIC.GPJ GAL-MISS.GDT 06/10/10 DATA INPUT:

PROJECT <u>07-1191-0020</u>				RECORD OF BOREHOLE No B1-4				1 OF 2 METRIC									
W.P. <u>5189-06-01</u>				LOCATION <u>N 5046448.7; E 242742.1</u>				ORIGINATED BY <u>EHS</u>									
DIST <u> </u> HWY <u>69</u>				BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring</u>				COMPILED BY <u>MM</u>									
DATUM <u>Geodetic</u>				DATE <u>January 7 and 8, 2009</u>				CHECKED BY <u>AB</u>									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
213.3	GROUND SURFACE																
0.0	TOPSOIL Brown Moist																
212.8	SAND, trace to some silt, trace to some gravel Very loose to compact Brown Moist to wet		1	SS	9												
0.5			2	SS	24												
			3	SS	15												0 86 (14)
			4	SS	9												
			5	SS	13												
	Approximately 0.9 m of heaving sands at a depth of 4.6 m. Switch to NW Casing, Wash Boring		6	SS	20												10 85 (5)
			7	SS	22												
			8	SS	6												0 90 9 1
			9	SS	3												
			10	SS	4												
201.3	COBBLES and BOULDERS GNEISS (BEDROCK)																
12.2	Bedrock cored from 12.2 m to 15.8 m depth. For coring details refer to Record of Drillhole B1-4.		1	RC	REC 100%												RQD = 81%
			2	RC	REC 100%												RQD = 97%

Continued Next Page

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

MIS-MTO 001 07-1191-0020 B1 BH LOGS METRIC.GPJ GAL-MISS.GDT 06/10/10 DATA INPUT:

PROJECT <u>07-1191-0020</u>			RECORD OF BOREHOLE No B1-4				2 OF 2 METRIC									
W.P. <u>5189-06-01</u>		LOCATION <u>N 5046448.7; E 242742.1</u>				ORIGINATED BY <u>EHS</u>										
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring</u>				COMPILED BY <u>MM</u>										
DATUM <u>Geodetic</u>		DATE <u>January 7 and 8, 2009</u>				CHECKED BY <u>AB</u>										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)			
	--- CONTINUED FROM PREVIOUS PAGE ---						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p W W _L 10 20 30				
197.5 15.8	End of Borehole		3	RC	REC 100%	198										
	Notes: 1. Water level measured in open borehole at a depth of 2.1 m below ground surface (Elev. 211.2 m) upon completion of drilling. 2. Water level measured in piezometer at a depth of 1.3 m below ground surface (Elev. 212.0 m) on March 20, 2009.															

MIS-MTO 001 07-1191-0020 B1 BH LOGS METRIC.GPJ GAL-MISS.GDT 06/10/10 DATA INPUT:

PROJECT: 07-1191-0020

RECORD OF DRILLHOLE: B1-4

SHEET 1 OF 1

LOCATION: N 5046448.7 ; E 242742.1

DRILLING DATE: January 7 and 8, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 850

DRILLING CONTRACTOR: Landcore

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.	RUN No.	COLOUR % RETURN	JN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate	BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage	PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular	PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break	BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.	DISCONTINUITY DATA										HYDRAULIC CONDUCTIVITY				Diameter Point Load Index (MPa)	RMC -Q AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
				DEPTH (m)								RECOVERY		R.Q.D. %	FRACT INDEX PER 0.3 m	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jh	K _v cm/sec	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴			10 ⁻³																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
				FLUSH								TOTAL CORE %	SOLID CORE %																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						

DEPTH SCALE

1 : 50



LOGGED: EHS

CHECKED: AB

SUD-RCK 07-1191-0020 B1 BH LOGS METRIC.GPJ GAL-MISS.GDT 06/10/10 DATA INPUT:

PROJECT 07-1191-0020		RECORD OF BOREHOLE No B1-5				1 OF 1 METRIC						
W.P. 5189-06-01		LOCATION N 5046410.0; E 242657.2				ORIGINATED BY EHS						
DIST _____ HWY 69		BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers				COMPILED BY MM						
DATUM Geodetic		DATE January 13, 2009				CHECKED BY AB						
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa				WATER CONTENT (%)
209.8	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100	10 20 30		
0.0	TOPSOIL Brown Wet											
209.2	SAND to SAND and SILT Loose to compact Brown Wet		1	SS	16		209					
0.6			2	SS	13		208					
			3	SS	8		207					
			4	SS	6		206					
			5	SS	12		205					
			6	SS	14		204					
			7	SS	25		203					
			8	SS	27		202					
							201					
	Difficult augering at 9.1 m depth.		9	SS	26		200					
200.0	End of Borehole											
9.8	Note: 1. Water level measured at a depth of 1.6 m below ground surface (Elev. 208.2 m) upon completion of drilling.											

MIS-MTO 001 07-1191-0020 B1 BH LOGS METRIC.GPJ GAL-MISS.GDT 06/10/10 DATA INPUT:

PROJECT 07-1191-0020			RECORD OF BOREHOLE No B1-6				1 OF 1 METRIC						
W.P. 5189-06-01			LOCATION N 5046462.4; E 242760.6				ORIGINATED BY EHS						
DIST HWY 69			BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring				COMPILED BY MM						
DATUM Geodetic			DATE January 6 and 7, 2009				CHECKED BY AB						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT <div style="display: flex; justify-content: space-around; font-size: small;"> 20 40 60 80 100 </div>	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
213.3	GROUND SURFACE												
0.0	TOPSOIL												
0.2	Brown Moist		1	SS	13		213						
	SAND to SAND and SILT												
	Loose to compact		2	SS	18		212						
	Brown to grey												
	Moist to wet		3	SS	18		211						0 66 (34)
													16 76 (8)
			4	SS	22		210						
			5	SS	9		209						
			6	SS	4		208						
	Approximately 0.6 m of heaving sands at a depth of 4.6 m. Switch to NW casing, Wash Boring.		7	SS	14		207						29 60 (11)
	Gravelly sand layer 0.6 m thick at 4.6 m depth. Advanced a bi-cone from a 5.8 m depth to a 6.1 m depth.		8	SS	10		206						
			9	SS	4		205						0 89 (11)
			10	SS	5		204						
	Difficulty advancing casing at 9.9 m depth.		11	SS	11		203						
202.0	End of Borehole						202						
11.3	Note: 1. Water level measured at a depth of 2.0 m below ground surface (Elev. 211.3 m) upon completion of drilling.												


MIS-MTO 001 07-1191-0020 B1 BH LOGS METRIC.GPJ GAL-MISS.GDT 06/10/10 DATA INPUT:

PROJECT 07-1191-0020			RECORD OF BOREHOLE No B1-7			1 OF 2 METRIC														
W.P. 5189-06-01			LOCATION N 5046420.2; E 242665.2			ORIGINATED BY EHS														
DIST HWY 69			BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring			COMPILED BY MM														
DATUM Geodetic			DATE January 22 and 23, 2009			CHECKED BY AB														
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL			
							20 40 60 80 100	○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× REMOULDED	W _p	W	W _L						
209.9	GROUND SURFACE																			
0.0	TOPSOIL Brown Moist		1	AS	-															
209.3																				
0.6	SAND to SAND and SILT Loose to very dense Brown Wet		2	SS	11		209													
			3	SS	13		208											0 81 (19)		
			4	SS	7		207													
207.2	CLAYEY SILT Firm Brown Wet		5	SS	7		206											0 42 (58)		
206.7			6	SS	12		205													
3.2	SAND to SAND and SILT Loose to very dense Brown Wet		7	SS	11		204													
			8	SS	26		203													
			9	SS	28		202											1 52 (47)		
	Approximately 1.2 m of heaving sands at a depth of 7.6 m. Switch to NW Casing, Wash Boring		10	SS	14		201													
			11	SS	35		200													
			12	SS	37		199													
			13	SS	102/0.25		198													
	Heaving sands in casing at 9.1 m and 12.2 m depths.						197													
							196											17 72 (11)		
	Difficulty advancing casing at 13.7 m depth due to gravelly layer.						195													
195.3	COBBLES and BOULDERS, some sand and gravel																			
14.6																				

Continued Next Page

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

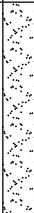
MIS-MTO 001 07-1191-0020 B1 BH LOGS METRIC.GPJ GAL-MISS.GDT 06/10/10 DATA INPUT:

PROJECT <u>07-1191-0020</u>		RECORD OF BOREHOLE No B1-7				2 OF 2 METRIC											
W.P. <u>5189-06-01</u>		LOCATION <u>N 5046420.2; E 242665.2</u>				ORIGINATED BY <u>EHS</u>											
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring</u>				COMPILED BY <u>MM</u>											
DATUM <u>Geodetic</u>		DATE <u>January 22 and 23, 2009</u>				CHECKED BY <u>AB</u>											
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)				
	--- CONTINUED FROM PREVIOUS PAGE ---						<div style="display: flex; justify-content: space-between; font-size: small;"> 20 40 60 80 100 DYNAMIC CONE PENETRATION RESISTANCE PLOT </div> <div style="display: flex; justify-content: space-between; font-size: small;"> 20 40 60 80 100 SHEAR STRENGTH kPa </div> <div style="display: flex; justify-content: space-between; font-size: x-small;"> ○ UNCONFINED + FIELD VANE </div> <div style="display: flex; justify-content: space-between; font-size: x-small;"> ● QUICK TRIAXIAL × REMOULDED </div>					<div style="display: flex; justify-content: space-between; font-size: small;"> 10 20 30 W_p W W_L </div> <div style="display: flex; justify-content: space-between; font-size: x-small;"> 10 20 30 WATER CONTENT (%) </div>					
193.1	COBBLES and BOULDERS, some sand and gravel					194											
16.8	End of Borehole Notes: 1. Water level measured at a depth of 0.5 m below ground surface (Elev. 209.4 m) upon completion of drilling. 2. Cored through a 0.5 m thick boulder at a depth of 14.9 m.																

MIS-MTO 001 07-1191-0020 B1 BH LOGS METRIC.GPJ GAL-MISS.GDT 06/10/10 DATA INPUT:

PROJECT		RECORD OF BOREHOLE No B1-8				1 OF 1 METRIC											
W.P. 5189-06-01		LOCATION N 5046434.2; E 242704.3				ORIGINATED BY EHS											
DIST _____ HWY 69		BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers				COMPILED BY MM											
DATUM Geodetic		DATE January 9, 2009				CHECKED BY AB											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m³	GR SA SI CL
							20 40 60 80 100	20 40 60 80 100	Wp	W	WL	10 20 30					
211.4	GROUND SURFACE																
0.0	TOPSOIL																
0.2	Brown Frozen		1	AS	-		211										
	SAND to Sandy SILT		2	SS	17		210										
	Compact to dense																
	Brown		3	SS	10												
	Wet																
208.6	Augers grinding at 2.6 m depth.		4	SS	34		209										
2.8	End of Borehole Auger Refusal																
	Note:																
	1. Water level at a depth of 1.1 m below ground surface (Elev. 210.3 m) upon completion of drilling.																
	2. Augers sliding to the north upon refusal.																

MIS-MTO 001 07-1191-0020 B1 BH LOGS METRIC.GPJ GAL-MISS.GDT 06/10/10 DATA INPUT:

PROJECT 07-1191-0020				RECORD OF BOREHOLE No S16-2				1 OF 1 METRIC									
W.P. 5403-05-00				LOCATION N 5046457.7; E 242724.4				ORIGINATED BY EC									
DIST HWY 69				BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers				COMPILED BY MM									
DATUM Geodetic				DATE February 19, 2008				CHECKED BY AB									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
213.1	GROUND SURFACE						20	40	60	80	100						
0.0	SAND, trace to some silt Compact Brown Wet		1	AS	-	∇	213										
			2	SS	11		212										
			3	SS	11		211										
211.0	SAND and SILT, trace clay Compact Brown Wet	4	SS	10	210												
		5	SS	20	209												
209.3	SAND, trace to some silt, trace to some gravel Very loose to very dense Brown Wet	6	SS	69	208												
		7	SS	27	207												
	Grinding of augers noted at 5.2 m depth.	8	SS	2	206												
205.5	Start of DCPT Approximately 1.5 m of heaving sands measured in augers at 7.6 m depth.						205										
203.8	End of DCPT Refusal to Further Penetration (Hammer Bouncing)						204										
9.3	Note: 1. Water level at a depth of 1.5 m below ground surface (Elev. 211.6 m) upon completion of drilling.																

MIS-MTO 001 07-1191-0020 S16 METRIC.GPJ GAL-MISS.GDT 07/10/10 DATA INPUT:



PROJECT		RECORD OF PENETRATION TEST				No B1-DC2		1 OF 1		METRIC							
W.P.		LOCATION				ORIGINATED BY		EHS									
DIST		BOREHOLE TYPE				COMPILED BY		MM									
DATUM		DATE				CHECKED BY		AB									
SOIL PROFILE		SAMPLES				DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa		WATER CONTENT (%)		γ		GR SA SI CL		
211.0	0.0	GROUND SURFACE							20 40 60 80 100	W _p W W _L	10 20 30						
								210									
								209									
208.4	2.6	End of DCPT Refusal to Further Penetration (Hammer Bouncing)															

MIS-MTO 001 07-1191-0020 B1 BH LOGS METRIC.GPJ GAL-MISS.GDT 06/10/10 DATA INPUT:

PROJECT <u>07-1191-0020</u>		RECORD OF PENETRATION TEST No B1-DC3				1 OF 1 METRIC							
W.P. <u>5189-06-01</u>		LOCATION <u>N 5046436.6; E 242696.8</u>				ORIGINATED BY <u>EHS</u>							
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Dynamic Cone Penetration Test</u>				COMPILED BY <u>MM</u>							
DATUM <u>Geodetic</u>		DATE <u>January 12, 2009</u>				CHECKED BY <u>AB</u>							
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa		W _p	W		
212.0 0.0	GROUND SURFACE						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE </div> <div style="display: flex; justify-content: space-between;"> ● QUICK TRIAXIAL × REMOULDED </div>						
207.7 4.3	End of DCPT Refusal to Further Penetration (Hammer Bouncing)												

MIS-MTO 001 07-1191-0020 B1 BH LOGS METRIC.GPJ GAL-MISS.GDT 06/10/10 DATA INPUT:



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

MIS-MTO001 07-1191-0020 B1 BH LOGS METRIC.GPJ GAL-MISS.GDT 06/10/10 DATA INPUT:

**RECORD OF GEOTECHNICAL PROBEHOLES
SITE 9 ROAD UNDERPASS STRUCTURE RSS WALLS
Station 18+655 and 18+730, Referenced to Hwy 69 Median C/L**

**07-1191-0020
July 2009**

Probehole 1

18+655 35.0 Rt C/L D+1.5 PA

0 - 240 Dk Br Sa Tps
240 - 1.80 Br Sa Tr Si Tr Gr, Moist, Comp*
1.80 - 3.00 Gr Sa Tr Si Tr Gr, Wet, Fr Wat
@1.90, Sat, Comp**
- 3.00 NFP Sloughing

* Sample Depth = 1.00 – 1.30

**Sample Depth = 2.00 – 2.30

W = 22 %

Passing 150 mm = 100 %

26.5 mm = 100 %

4.75 mm = 100 %

1.18 mm = 100 %

300 µm = 82 %

75 µm = 6 %

Probehole 2

18+730 35.0 Lt C/L D-3.0 PA

0 - 250 Dk Br Sa Tps
1.00 - 3.00 Gr Sa Tr Si Tr Gr, Wet, Fr Wat
@900, Sat, Comp*
- 3.00 NFP Sloughing

*Sample Depth = 1.00 – 1.30

W = 25 %

Passing 150 mm = 100 %

26.5 mm = 100 %

4.75 mm = 100 %

1.18 mm = 99 %

300 µm = 81 %

75 µm = 5 %

**Sample Depth = 2.00 – 2.30



APPENDIX B

AMEC Record of Boreholes and Penetration Tests

G.W.P. 5377-02-00		LOCATION Dumont Road, Township of the Archipelago, Co-ords: 5046453 N; 242742 E	ORIGINATED BY MAH
DIST 54	HWY 69	BOREHOLE TYPE Solid Stem Augering	COMPILED BY SN
DATUM Geodetic	DATE 30 January 2006		CHECKED BY IH
PROJECT Highway 69 Route Selection Study, from 3.5 km North of HWY 559 to 3.8 km North of HWY 522			JOB NO. TT53126

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

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	DEPTH m	ELEVATION m	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE				"N" VALUES	SHEAR STRENGTH kPa	W _p	W	W _L		
	SAND brown, very loose to very dense, moist to wet													
	with silt		7	SS	10									0 70 (30)
			8	SS	7									
201.5	End of Borehole		9	SS	50/0									
12.2	Auger refusal at 12.2 m depth													
201.3	Dynamic Cone Penetration Test was conducted below 12.2 m depth.													
12.4	Groundwater in open borehole on completion: 1.0 m End of DCPT Refusal to Dynamic Cone Penetration Test at 12.4 m depth due to possible bedrock DCPT was conducted in another location ST-3 (DCPT) located at 10 m west of ST-3. Borehole was backfilled with bentonite.													DCPT blow count = 100 / 20 cm at 12.4 m

RECORD OF BOREHOLE No ST-4

G.W.P. 5377-02-00 LOCATION Dumont Road, Township of the Archipelago, Co-ords: 5046413 N; 242663 E 1 OF 2
 DIST 54 HWY 69 BOREHOLE TYPE Solid Stem Augering ORIGINATED BY MAH
 DATUM Geodetic DATE 30 January 2006 COMPILED BY SN
 PROJECT Highway 69 Route Selection Study, from 3.5 km North of HWY 559 to 3.8 km North of HWY 522 CHECKED BY IH
 JOB NO. TT53126

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DEPTH m	ELEVATION SCALE m	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				20	40	60	80	100		
209.9 0.1	about 75 mm TOPSOIL trace rootlets SAND some organics and rootlets in SS1, trace silt brown, loose to compact, moist to wet		1	SS	9		1	209							
	some silt, trace clay		2	SS	14		2	208							0 77 20 3
							3	207							
206.0 4.0	SILTY SAND brown, compact, moist		4	SS	15		4	206							
							5	205							
204.4 5.5	SAND trace clay brown, dense, moist to wet		5	SS	48		6	204							0 58 40 2
							7	203							
			6	SS	45			202							

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

RECORD OF BOREHOLE No ST-4

G.W.P. 5377-02-00	LOCATION Dumont Road, Township of the Archipelago, Co-ords: 5046413 N; 242663 E	2 OF 2	ORIGINATED BY MAH
DIST 54 HWY 69	BOREHOLE TYPE Solid Stem Augering	COMPILED BY SN	
DATUM Geodetic	DATE 30 January 2006	CHECKED BY IH	
PROJECT Highway 69 Route Selection Study, from 3.5 km North of HWY 559 to 3.8 km North of HWY 522			JOB NO. TT53126

SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	DEPTH m	ELEVATION SCALE m	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa				WATER CONTENT (%)						
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE				w _p w w _L						
								20 40 60 80 100								
201.9 8.1	End of Borehole Groundwater in open borehole on completion: 1.0 m Dynamic Cone Penetration Test was conducted below 8.1 m depth.															
									</							

1 OF 2

G.W.P. 5377-02-00	LOCATION Dumont Road, Township of the Archipelago, Co-ords: 5046453 N; 242732 E	ORIGINATED BY JF
DIST 54 HWY 69	BOREHOLE TYPE Dynamic Cone Penetration	COMPILED BY SN
DATUM Geodetic	DATE 22 February 2006	CHECKED BY IH
PROJECT Highway 69 Route Selection Study, from 3.5 km North of HWY 559 to 3.8 km North of HWY 522		JOB NO. TT53126

SOIL PROFILE					
ELEV. DEPTH (m)	DESCRIPTION	STRAT PLOT	SAMPLES	GROUND WATER CONDITIONS	DEPTH
213.0			NUMBER	"N" VALUES	m
0.0	Dynamic cone penetration testing (DCPT) from ground surface				
<div>DYNAMIC CONE PENETRATION RESISTANCE PLOT<div><div>20406080100</div><div>20406080100</div><div>○ UNCONFINED + FIELD VANE● QUICK TRIAXIAL × LAB VANE</div><div>W_p W W_L</div><div>PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT</div><div>WATER CONTENT (%)</div><div>γ</div><div>kN/m³ GR SA SI CL</div></div></div>					

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

RECORD OF BOREHOLE No ST-3 (DCPT)

G.W.P. 5377-02-00	LOCATION Dumont Road, Township of the Archipelago, Co-ords: 5046453 N; 242732 E	2 OF 2	ORIGINATED BY JF
DIST 54 HWY 69	BOREHOLE TYPE Dynamic Cone Penetration	COMPILED BY SN	
DATUM Geodetic	DATE 22 February 2006	CHECKED BY IH	
PROJECT Highway 69 Route Selection Study, from 3.5 km North of HWY 559 to 3.8 km North of HWY 522		JOB NO.	TT53126

SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	DEPTH m	ELEVATION SCALE m	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa				WATER CONTENT (%)						
						20 40 60 80 100				20 40 60 80 100	20 40 60 80 100	PLASTIC LIMIT w _p			NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L
						○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE									
	DCPT															
201.0																
12.0	End of DCPT Refusal to Dynamic Cone Penetration Test at 12.1 m depth due to possible bedrock ST-3 (DCPT) was located at 10 m west of ST-3.													DCPT blow count = 100/15 cm at 12.0 m		



APPENDIX C

Laboratory Test Results

**TABLE C-1
UNIAXIAL COMPRESSION STRENGTH TEST RESULTS
SITE 9 ROAD UNDERPASS STRUCTURE
HIGHWAY 69, POINTE AU BARIL
GWP 5403-05-00**

Borehole Number	Sample Depth (m)	Sample Elevation (m)	Rock Type	Core Diameter (mm)	Load (kN)	Unconfined Compressive Strength (MPa)
B1-1	24.7	185.2	Gneiss	48.0	255.1	144
B1-2	3.0	208.0	Gneiss	48.0	228.5	129
B1-3	7.6	204.7	Gneiss	48.0	180.7	102
B1-4	12.7	200.6	Gneiss	48.0	113.9	64

Compiled by: EC
Checked by: SEMC

TABLE C-2
POINT LOAD STRENGTH TEST RESULTS
SITE 9 ROAD UNDERPASS STRUCTURE
HIGHWAY 69, POINTE AU BARIL
GWP 5403-05-00

Borehole Number	Sample Depth ¹ (m)	Sample Elevation (m)	Rock Type	Test Type ²	Core Diameter (mm)	Ram Pressure (MPa)	Load (kN)	I _s Diametral ² (MPa)	I _s 50 mm ² (MPa)	Approximate UCS ² (MPa)
B1-1	24.4	185.5	Gneiss	D	48	20.4	0.019	8.4	8.2	165
B1-1	25.3	184.6	Gneiss	D	48	19.7	0.019	8.1	8.0	159
B1-1	26.2	183.7	Gneiss	D	48	18.5	0.018	7.6	7.5	150
B1-2	2.6	208.4	Gneiss	D	48	12.9	0.012	5.3	5.2	104
B1-2	4.8	206.2	Gneiss	D	48	15.1	0.014	6.2	6.1	122
B1-2	5.5	205.5	Gneiss	D	48	24.4	0.023	10.0	9.9	197
B1-3	5.9	206.4	Gneiss	D	48	9.6	0.009	3.9	3.9	77
B1-3	6.8	205.5	Gneiss	D	48	11.9	0.011	4.9	4.8	96
B1-3	8.0	204.3	Gneiss	D	48	6.2	0.006	2.5	2.5	50
B1-4	13.0	200.3	Gneiss	D	48	14.6	0.014	6.0	5.9	118
B1-4	13.4	199.9	Gneiss	D	48	16.4	0.016	6.8	6.6	133
B1-4	14.9	198.4	Gneiss	D	48	16.6	0.016	6.8	6.7	134

NOTES:

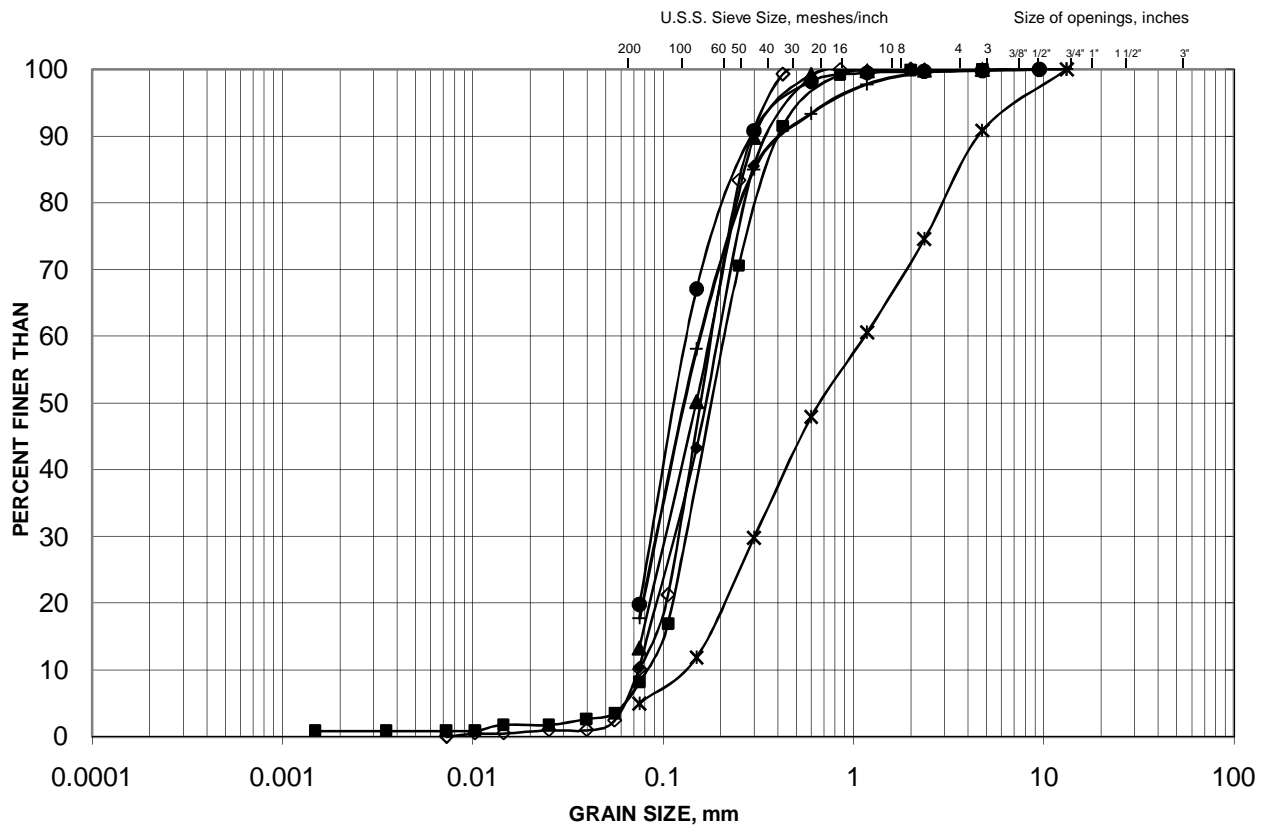
1. Depths are given below the ground surface at the borehole location.
2. Where: D = Diametral test;
I_s Diametral = Uncorrected point load strength;
I_s 50 mm = Corrected point load strength; and
UCS = Uniaxial compressive strength = I_s 50 mm X K. A value of 20 has been used, based on correlation with UCS for this site as per ASTM D5731-08 (cross-referenced to "Suggested Methods for Determining Point Load Strength", International Society for Rock Mechanics Commission on Testing Methods, Int. J. Rock Mech. Sci. and Geomechanical Abst., Vol 22, No. 2, 1985, pp. 51-60).

Compiled by: EC
Checked by: SEMC

GRAIN SIZE DISTRIBUTION

Sand

FIGURE C-1



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		

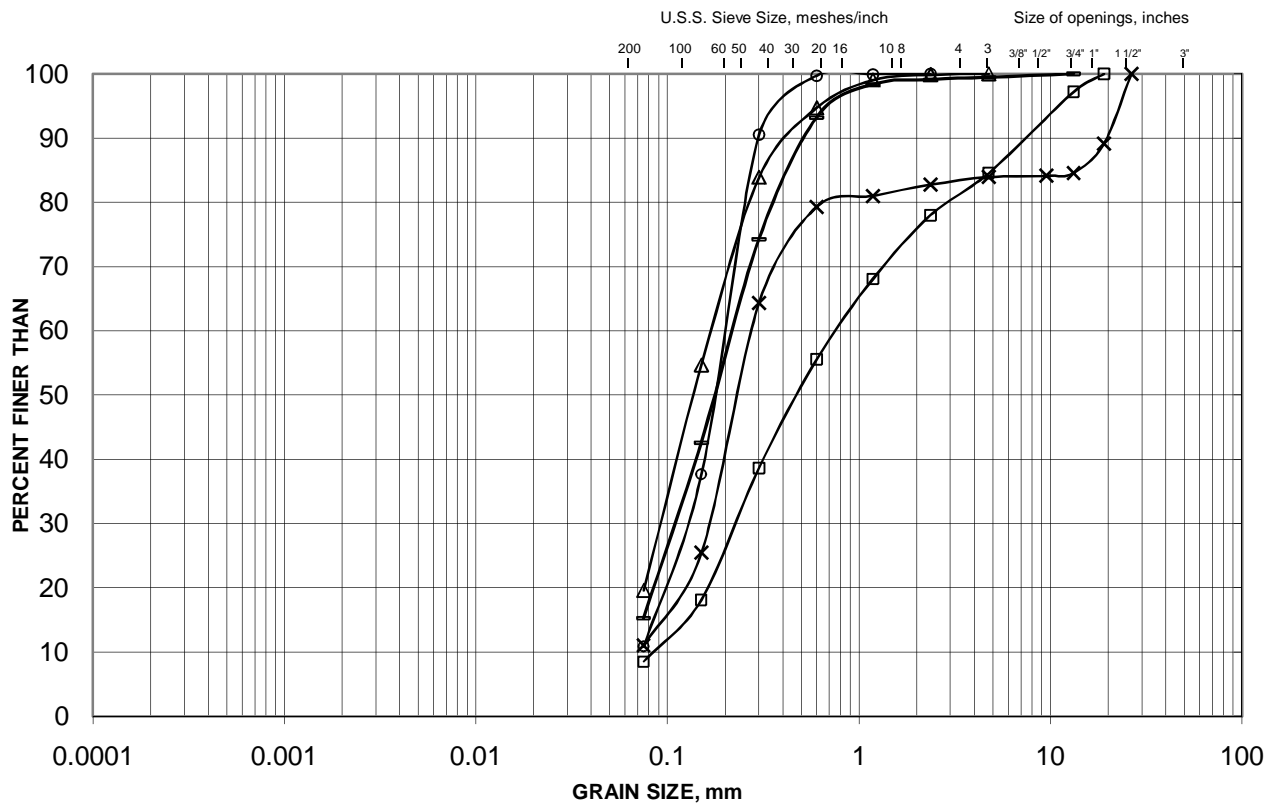
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
◆	B1-1	2	208.8
■	B1-2	2	209.2
●	B1-3	4	209.7
▲	B1-4	3	210.7
✱	B1-4	6	208.4
◇	B1-4	8	205.4
+	B1-5	3	207.2

GRAIN SIZE DISTRIBUTION

Sand (cont'd)

FIGURE C-1



SILT AND CLAY SIZES			FINE	MEDIUM	COARSE	FINE	COARSE
FINE GRAINED			SAND SIZE			GRAVEL SIZE	
						COBBLE SIZE	

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
—□—	B1-6	3b	211.3
—○—	B1-6	9	205.4
—△—	B1-7	3	208.1
—×—	B1-7	13	195.9
—+—	B1-8	3	209.6

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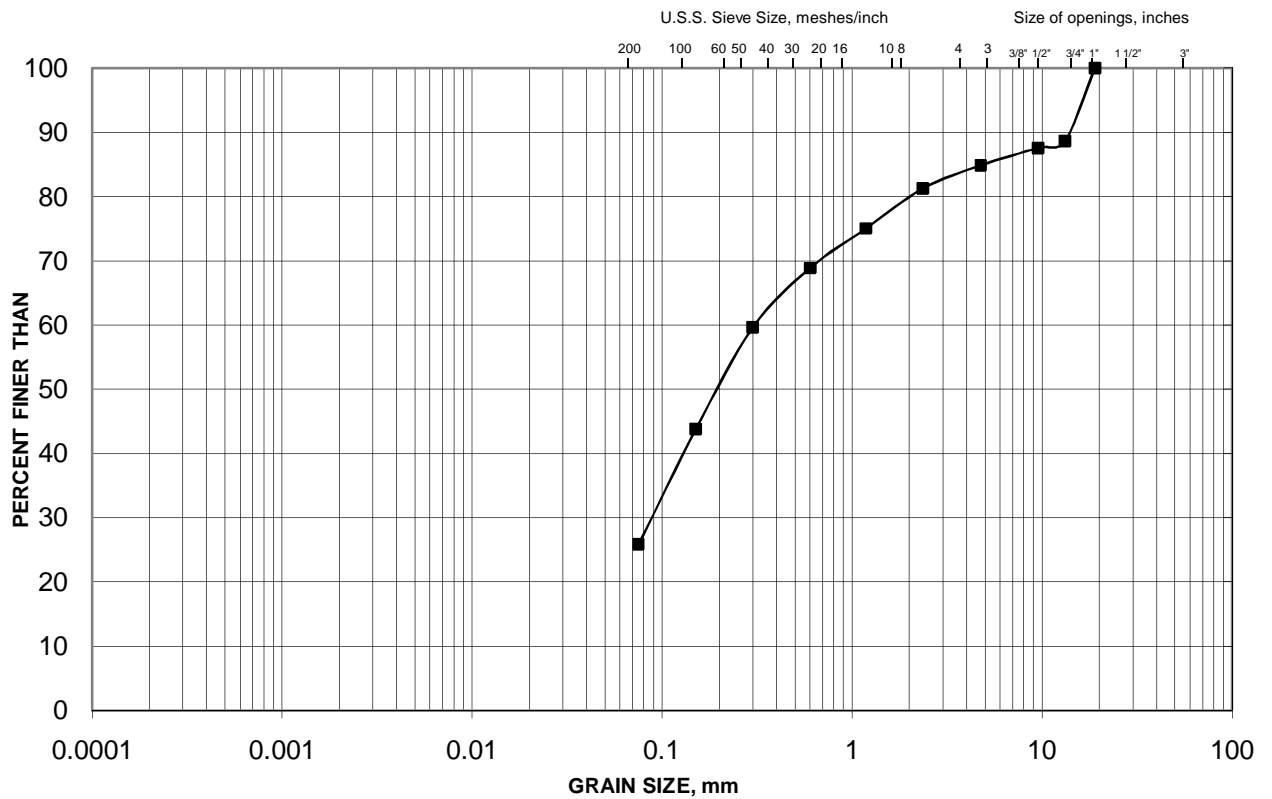
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GRAIN SIZE DISTRIBUTION

Silty Sand

FIGURE C-2



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
—■—	B1-1	14	194.6

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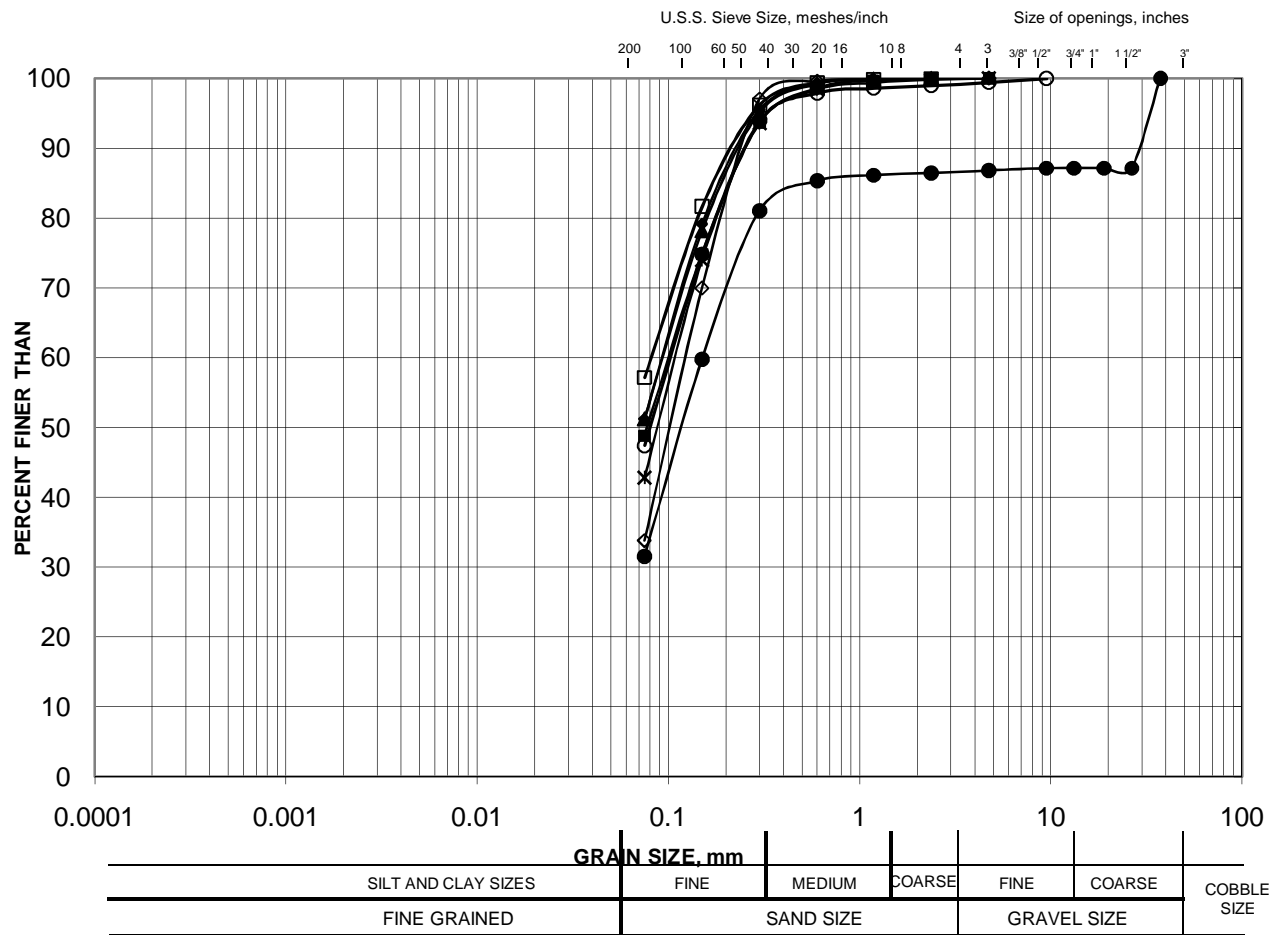
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GRAIN SIZE DISTRIBUTION

Sand and Silt

FIGURE C-3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
—◆—	B1-1	5	206.6
—■—	B1-1	8	203.5
—●—	B1-1	11	198.9
—▲—	B1-5	6	204.9
—*—	B1-5	8	201.9
—◇—	B1-6	3a	211.6
—□—	B1-7	5b	206.5
—○—	B1-7	9	202.0

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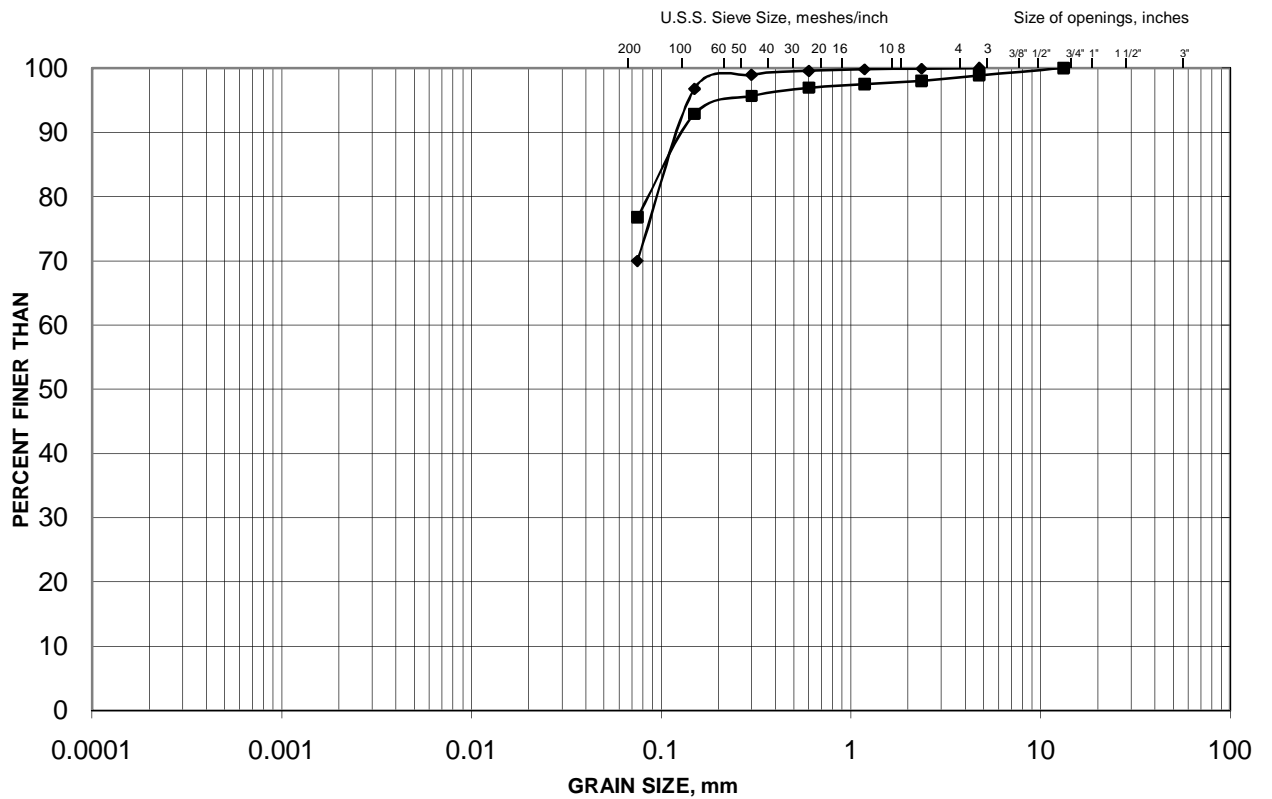
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GRAIN SIZE DISTRIBUTION

Sandy Silt

FIGURE C-4



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
◆	B1-3	6	208.2
■	B1-8	4	208.8

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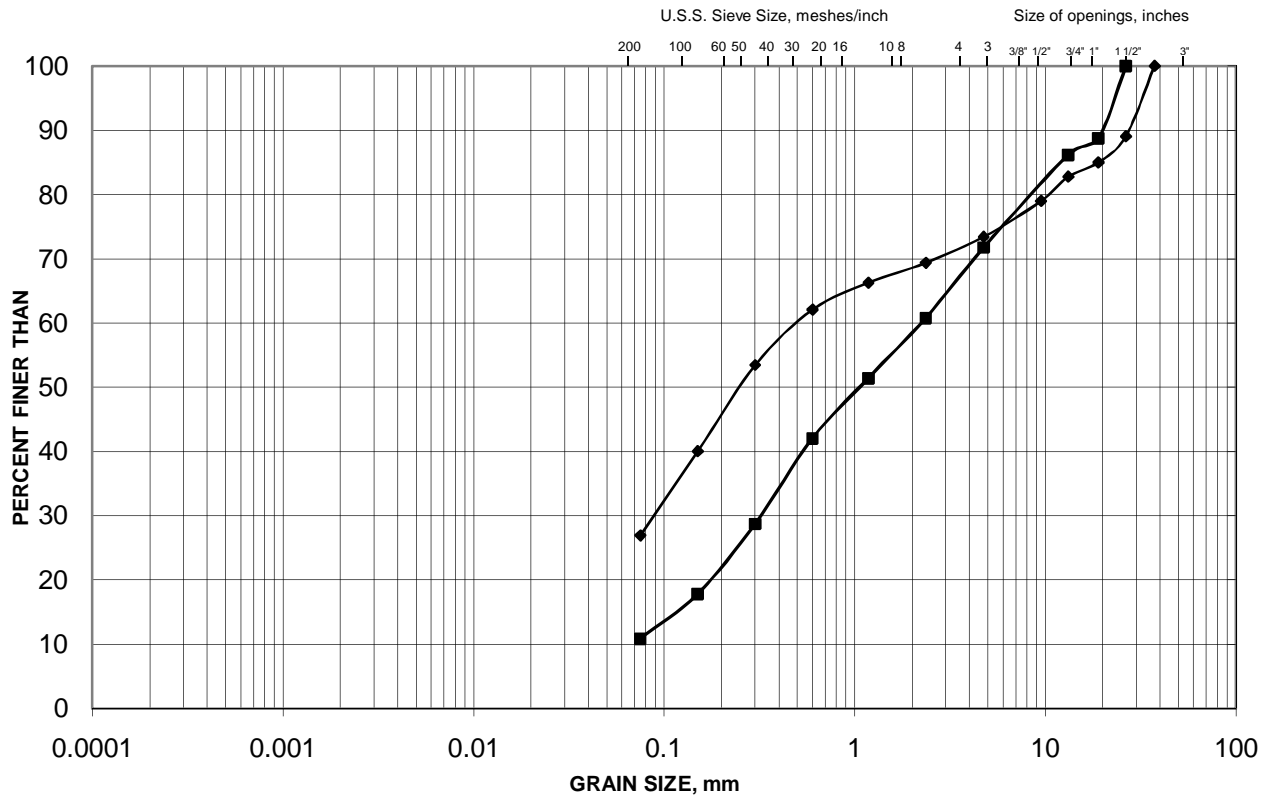
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GRAIN SIZE DISTRIBUTION

Gravelly Sand

FIGURE C-5



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		

LEGEND

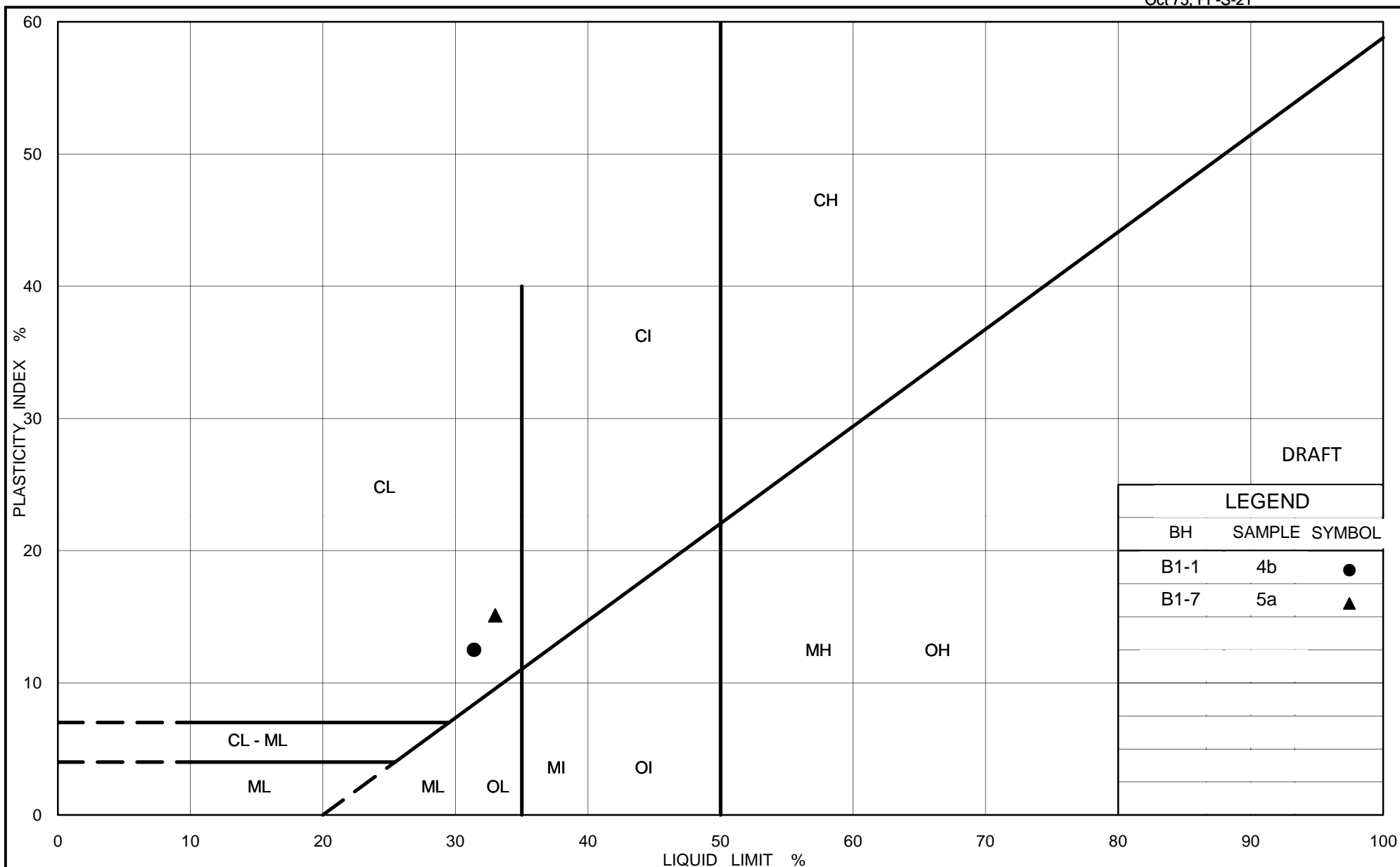
SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
◆	B1-1	17	188.3
■	B1-6	7	208.4

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Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt

Figure C-6

Project No. 07-1191-0020-B1

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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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