



March 14, 2012

FOUNDATION INVESTIGATION REPORT

**HIGHWAY 529 OVERPASS SBL STRUCTURE
HIGHWAY 69 FOUR-LANING FROM 0.4 KM NORTH OF HIGHWAY 7182
(SHEBESHEKONG ROAD) NORTHERLY 11 KM
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5005-08-00, WP 5192-06-01**

Submitted to:

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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 Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the proposed Highway 69 Southbound Lane (SBL) structure crossing the future Highway 529 (i.e. Highway 529 Overpass SBL). This project is part of the detail design for the four-laning of Highway 69 from 0.4 km north of Highway 7182 (Shebeshekong Road) northerly for 11 km. The general location of this section of the Highway 69 four-laning alignment is shown on the Key Plan on the Contract Drawings.

This report addresses the investigation carried out for the Highway 529 Overpass SBL structure, the associated approach embankments and the Retained Soil System (RSS) walls. Separate reports will be submitted detailing the foundation investigations for the Highway 529 Overpass NBL structure and other bridge structures, pond crossing and culverts for the project.

The purpose of this investigation is to establish the subsurface conditions at the proposed structure location, including the associated approach embankments and RSS walls, by borehole drilling, rock coring and laboratory testing on selected soil and rock core samples. The investigated areas are shown on the Contract Drawings.

2.0 SITE DESCRIPTION

The proposed Highway 529 Overpass SBL structure is a 90.2 m long 3-span structure, located in the Township of Harrison, about 800 m south of South Shore Road. The proposed grade at the new Highway 69 south and north approach embankments will be at Elevation 198.3 m and 199.7 m, respectively, which is up to about 6 m above the existing ground surface at the south approach and up to about 12 m above the existing ground surface at the north approach.

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 existing Highway 69 (future Highway 529) crossing is located in a bedrock “cut”. The ground surface at the borehole locations within the limits of the proposed structure and approach embankment areas ranges between Elevation 188.3 m and 196.2 m.

3.0 INVESTIGATION PROCEDURES

The fieldwork for the investigation at the proposed structure was carried out between January 19 and April 15, 2009, and on April 7 and 8, 2010, during which time a total of twenty-four (24) boreholes (designated as Boreholes B3-1 to B3-24) were advanced at the locations shown on the Contract Drawings following the text of this report. The locations of the boreholes are generally summarized as follows:

- Five boreholes were advanced for each abutment and pier;
- One borehole was advanced at each approach; and



- One borehole was advanced near the end of the proposed RSS wall on the east side of the south abutment and one borehole was advanced near the end of the proposed RSS wall on the west side of the north abutment.

Boreholes B3-1, B3-3 to B3-5 and B3-21 at the south abutment/approach were drilled using portable equipment supplied and operated by OGS Inc. (OGS) of Almonte, Ontario. Boreholes B3-6 to B3-8 at the south pier, Boreholes B3-11 and B3-13 to B3-15 at the north pier, and Boreholes B3-18 to B3-20 at the north abutment and Boreholes B3-23 and B3-24 at the ends of the retaining walls were advanced using a track- or truck-mounted CME-55 supplied and operated by Landcore Drilling Ltd. (Landcore) of Sudbury, Ontario.

The boreholes were advanced using 108 mm inside diameter (I.D.) continuous flight hollow stem augers, NW casing and wash boring methods. Soil samples were obtained, where possible, continuously or at intervals of depths of 0.75 m to 1.5 m, using a 50 mm outer diameter (O.D.) split-spoon sampler in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586) or with an 'NQ' size core barrel when coring through the overburden was required. Rock core samples were obtained using an 'NQ' size core barrel. The groundwater conditions in the open boreholes were observed during the drilling operations. All boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation (O.Reg.) 903 (as amended by O.Reg. 372).

Bedrock was exposed at ground surface in Boreholes B3-2, B3-9, B3-10, B3-12, B3-16, B3-17 and B3-22 and below a thin layer of organics in Borehole B3-21 which was advanced using a split-spoon sampler. The portable equipment and machine-drilled boreholes were advanced to auger/split-spoon refusal or cored into the bedrock to depths ranging from 0.3 m to 14.1 m below existing ground surface, including coring bedrock. The bedrock was cored in Boreholes B3-1, B3-3, B3-5, B3-6, B3-8, B3-13, B3-14, B3-18, B3-19 and B3-23 for lengths of between 2.8 m and 5.7 m.

The fieldwork was supervised throughout by members of our engineering and technical staff, who located the boreholes 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 and grain size distribution) was carried out on selected samples. Strength testing (uniaxial compression and point load index) was also carried out on selected specimens of the rock core.

The location of the boreholes was surveyed by MMM in December 2008 prior to drilling, excluding Boreholes B3-23 and B3-24 which were referenced to the staked highway alignment by Golder. Where boreholes were relocated from the original staked locations, Golder resurveyed and located the new boreholes relative to MMM's stakes. The borehole locations shown on the Contract Drawings are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole/drillhole locations and ground surface elevations are as follows:



Borehole	Location (m)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing	Easting		
B3-1	5050402.0	237060.5	193.1	3.5
B3-2	5050406.9	237059.7	192.4	0
B3-3	5050403.6	237055.2	194.8	3.3
B3-4	5050400.4	237050.6	196.2	0.8
B3-5	5050405.3	237049.8	196.0	3.3
B3-6	5050425.7	237056.7	191.8	4.2
B3-7	5050430.6	237055.8	191.7	1.8
B3-8	5050427.3	237051.3	190.9	4.9
B3-9	5050424.0	237046.8	193.7	0
B3-10	5050429.0	237046.0	192.2	0
B3-11	5050465.5	237051.0	189.9	0.4
B3-12	5050470.4	237050.1	190.0	0
B3-13	5050467.1	237045.6	190.5	6.0
B3-14	5050463.8	237041.1	190.8	5.3
B3-15	5050468.8	237040.3	190.7	2.6
B3-16	5050489.3	237047.7	193.3	0
B3-17	5050494.2	237046.9	196.0	0
B3-18	5050490.9	237042.4	189.9	8.7
B3-19	5050487.6	237037.9	188.8	14.1
B3-20	5050492.5	237037.1	188.3	6.3
B3-21	5050388.9	237057.7	195.0	0.3
B3-22	5050505.8	237040.5	190.0	0
B3-23	5050513.6	237018.8	187.0	8.7
B3-24	5050381.3	237079.4	192.5	3.8

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

As delineated in The Physiography of Southern Ontario (Chapman and Putnam, 1984)¹, 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

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.



area. Localized 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 4 (OGS, 1991)². Deposition of Paleozoic strata initially covered the bedrock and later erosion during glaciation exposed these Precambrian rocks.

4.2 Subsurface Conditions

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

A bedrock outcrop is present in the area of the proposed south approach abutment and pier and is covered in some areas by shallow organics or granular fill of the adjacent Highway 69 embankment. As the existing highway is in a rock cut, bedrock is exposed on the east side of the north approach and abutment. As the north abutment straddles the existing rock cut, the soils on the western portion of the north abutment consist of granular fill and/or native gravelly sand to sand and silt, gravel, cobbles and boulders. The total thickness of overburden is variable on the site, ranging from 8.4 m at the west side of the north abutment to none where bedrock is exposed on the east half of the north abutment, south and north piers and south abutment.

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

4.2.1 Fill

Fill was encountered at ground surface in various boreholes which were advanced through the existing roadway or ditches.

Boreholes B3-6, B3-7, B3-14 and B3-15 which were drilled from the roadway surface encountered between approximately 75 mm and 175 mm of asphalt. Underlying the asphalt in these boreholes and ground surface in Boreholes B3-8, B3-11, B3-13, B3-18, B3-19 and B3-24 and below the organics fill in Borehole B3-23, the boreholes penetrated the roadway fill which is generally comprised of sand to sand and gravel, trace to some silt, intermixed with blast rock (rock fill) at several locations. The ground surface/top of fill was encountered between Elevation 192.5 m and 188.8 m and the thickness of the embankment fill ranges in thickness from 0.4 m to 2.8 m.

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



SPT 'N'-values measured within the embankment fill layer range between 3 blows to 88 blows per 0.3 m of penetration and up to 50 blows per 0.1 m of penetration indicating a very loose to very dense relative density. In some boreholes, the fill was cored to penetrate through the rock fill.

A grain size distribution test was carried out on one sample of the granular roadway fill and the results are shown on Figure B-1.

The natural moisture content measured on a sample of granular fill layer is about 11 percent.

Borehole B3-23, advanced on the east side of the existing highway for the proposed north abutment west RSS wall, encountered a 0.5 m thick layer of organics fill at ground surface (Elevation 187.0 m). The natural moisture content measured on a sample of this deposit is 40 percent.

4.2.2 Organics

A deposit of moist, brown organics (topsoil and root mat) was encountered at ground surface at Boreholes B3-2, B3-4, B3-5, B3-9, B3-10, B3-12 and B3-21 and below the fill in Borehole B3-24. The thickness of the deposit ranges between less than 50 mm and 0.4 m. The bottom of this surficial organic deposit was defined by bedrock, confirmed either by coring or by exposing its surface, except in Boreholes B3-4 and B3-24, where the organics is underlain by sand and gravel.

4.2.3 Sand and Silt to Sand and Gravel, Gravel, Cobbles and Boulders

At the south abutment and associated southeast RSS wall, a deposit of moist, brown to grey, sand and gravel was encountered below the organics in Boreholes B3-4 and B3-24; the deposit is 0.4 m and 0.9 m thick at the respective boreholes and was encountered at Elevation 195.8 m and 189.6 m.

At the western portion of the north abutment and associated northwest RSS wall, an interlayered deposit of cohesionless soil was encountered below the roadway fill in Boreholes B3-18, B3-19 and B3-23 and from ground surface in Borehole B3-20. This deposit consists of moist to wet, brown to grey, sand and silt, silty sand, gravelly sand, gravel, cobbles and boulders. The top of the deposit was encountered between Elevation 189.0 m and 184.7 m and the thickness of the deposit ranges from 3.0 m to 6.3 m.

SPT 'N'-values measured within the gravel to gravelly sand layers range from 4 blows to 92 blows per 0.3 m of penetration indicating a loose to very dense relative density, with 'N'-values up to 50 blows per 0.05 m in the sand and silt layer, indicating a very dense relative density.

Grain size distribution tests were carried out on four (4) samples of the gravelly sand to sand and silt deposit and the results are shown on Figure B-2.

The natural moisture content measured on samples of this deposit ranges between about 15 percent and about 33 percent.



4.2.4 Refusal/Bedrock

Bedrock was encountered and cored in Boreholes B3-1, B3-3, B3-5, B3-6, B3-8, B3-13, B3-14, B3-18, B3-19 and B3-23. Bedrock was generally exposed at or was encountered below a thin layer of organics in Boreholes B3-2, B3-9, B3-10, B3-12, B3-16, B3-17 and B3-22. The bedrock surface was inferred from split-spoon and/or auger refusal in the remaining holes. The bedrock surface (inferred or actual) was encountered at depths ranging from ground surface to 8.4 m below ground surface, corresponding to Elevations 196.0 m to 180.4 m. Refusal depths and elevations to the bedrock surface are summarized in Table B-1.

Based on a review of the bedrock core samples, the majority of the bedrock at the site consists of gneiss and the core samples are described as grey to pinkish grey, fine to coarse grained and fresh to slightly weathered. In Borehole B3-19 the upper 2.8 m of the bedrock consists of grey to black, fine grained and slightly to highly weathered schist.

The Total Core Recovery (TCR) ranges from 80 percent to 100 percent for all core samples. The Rock Quality Designation (RQD) measured on the gneiss and schist core samples generally ranges from about 57 percent to 100 percent, indicating a rock mass of fair to excellent quality. Two core samples obtained from Borehole B3-23 yielded RQD values of 0 percent and 34 percent indicating a rock mass of very poor to poor quality. The RQD measured on the upper core sample of schist in Borehole B3-19 was 12 percent, indicating a rock mass of very poor quality. The Solid Core Recovery (SCR) of the gneiss and schist core samples ranges from about 48 percent to 100 percent and is 26 percent for the upper core sample of schist in Borehole B3-19.

Laboratory uniaxial compressive strength (UCS) testing was carried out on seven core samples of the gneiss bedrock and on one sample of the schist bedrock. The UCS ranges from about 76 MPa to 124 MPa for the gneiss samples and is 37 MPa for the schist sample as summarized in Table B-2, indicating strong to very strong rock for the gneiss samples and a medium strong rock for the schist sample.

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 are summarized in Table B-3. The diametral point load index (I_{s50}) results from the laboratory tests carried out on core samples of the gneiss range from slightly less than about 4 MPa to 8 MPa and for the schist is about 1 MPa. These index values correspond to estimated UCS values ranging between 61 MPa and 129 MPa for the gneiss and range from about 25 MPa to 37 MPa for the schist, as presented in Table B-3, based on a relationship between I_{s50} and UCS which is given by a correlation factor (K) in accordance with ASTM D5731, 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 17 for the gneiss and a (K) of 31 for the schist, which was calculated based on a comparison of the UCS test results and the point load strength test results. 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 tests and the point load strength test results, in accordance with Table 3.5 in CFEM (2006), the gneiss bedrock is classified as strong (R4, 50 MPa < UCS < 100 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa) while the schist bedrock is medium strong (R3, 25 MPa < UCS < 50 MPa).



4.2.5 Groundwater Conditions

The water levels were noted immediately after the drilling operations in the boreholes. In general, the soil samples taken in the boreholes were noted to be moist to wet. Where bedrock was either exposed or was encountered at shallow depth below ground surface, the open boreholes were dry. The water level measured in Boreholes B3-6 to B3-8, B3-18 to B3-20, B3-23 and B3-24 was at depths ranging between 0.4 m and 3.4 m below ground surface which corresponds to Elevations 191.3 m to 184.6 m. It should be noted that groundwater levels in the area are subject to seasonal fluctuations and precipitation events.

5.0 CLOSURE

The field personnel supervising the drilling program were Mr. Ed Savard, Mr. Indulis Dumpis and Mr. Trevor Moxam. This report was prepared by Mr. Evan Childerhose, P.Eng. and Mr. André Bom, P.Eng. The technical aspects were reviewed by Mr. Jorge M. A. Costa, P.Eng., Golder's Designated MTO Contact for this project, who also carried out a quality control review of the report.



Report Signature Page

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APPENDIX A

Record of Boreholes and Drillholes



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

Piezo-Cone Penetration Test (CPT)

A 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.

V. MINOR SOIL CONSTITUENTS

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

III. SOIL DESCRIPTION

(a) Cohesionless Soils

Density Index	N
Relative Density	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	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.



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

PROJECT <u>07-1191-0020</u>		RECORD OF BOREHOLE No B3- 1		1 OF 1 METRIC	
W.P. <u>5192-06-01</u>		LOCATION <u>N 5050402.0; E 237060.5</u>		ORIGINATED BY <u>ID</u>	
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment</u>		COMPILED BY <u>DA</u>	
DATUM <u>Geodetic</u>		DATE <u>January 21, 2009</u>		CHECKED BY <u>AB</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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 (%)				
								20	40	60	80	100	W _p	W	W _L		
193.1	GROUND SURFACE																
0.0	GNEISS (BEDROCK)																
	For coring details refer to Record of Drillhole B3-1.		1	RC	REC 98%											RQD = 76%	
			2	RC	REC 100%											RQD = 96%	
			3	RC	REC 100%											RQD = 88%	
189.6																	
3.5	End of Borehole																

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: OGS Inc.

CHECKED: AB

MSUD-RCK 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:



SUD-MTO 001 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

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

PROJECT <u>07-1191-0020</u>		RECORD OF BOREHOLE No B3-3		1 OF 1 METRIC	
W.P. <u>5192-06-01</u>		LOCATION <u>N 5050403.6; E 237055.2</u>		ORIGINATED BY <u>ID</u>	
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment</u>		COMPILED BY <u>DA</u>	
DATUM <u>Geodetic</u>		DATE <u>January 20, 2009</u>		CHECKED BY <u>AB</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL			
								20	40	60	80	100	20	40	60		80	100	10	20	30		
194.8	GROUND SURFACE																						
0.0	GNEISS (BEDROCK)																						
	For coring details refer to Record of Record of Drillhole B3-3.		1	RC	REC 100%																		RQD = 57%
			2	RC	REC 100%																		RQD = 100%
			3	RC	REC 100%																		RQD = 96%
191.5																							
3.3	End of Borehole																						

SUD-MTO 001 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:


SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: OGS Inc.

CHECKED: AB

MSUD-RCK 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

PROJECT <u>07-1191-0020</u>				RECORD OF BOREHOLE No B3- 4				1 OF 1 METRIC									
W.P. <u>5192-06-01</u>		LOCATION <u>N 5050400.4; E 237050.6</u>				ORIGINATED BY <u>ID</u>											
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment</u>				COMPILED BY <u>DA</u>											
DATUM <u>Geodetic</u>		DATE <u>January 21, 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	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
196.2	GROUND SURFACE							20	40	60	80	100					
0.0	ORGANICS (Topsoil and Root Mat)		1	SS	25		196										
195.8	Brown Moist																
195.4	SAND and GRAVEL, trace silt		2	SS	24/0.15												
0.8	Dense Brown Moist																
	End of Borehole Spoon Refusal																
	Note: 1. Borehole dry upon completion of drilling.																

SUD-MTO 001 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

PROJECT <u>07-1191-0020</u>				RECORD OF BOREHOLE No B3-5				1 OF 1 METRIC									
W.P. <u>5192-06-01</u>		LOCATION <u>N 5050405.3; E 237049.8</u>				ORIGINATED BY <u>ID</u>											
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Portable Equipment</u>				COMPILED BY <u>DA</u>											
DATUM <u>Geodetic</u>		DATE <u>January 19 and 20, 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 (%)				
196.0	GROUND SURFACE							20	40	60	80	100	W _p	W	W _L		
0.0	ORGANICS (Topsoil and Root Mat) Brown Moist	1	SS														
	GNEISS (BEDROCK)	1	RC		REC 100%												RQD = 78%
	For coring details refer to Record of Drillhole B3-5.	2	RC		REC 99%												RQD = 60%
		3	RC		REC 100%												RQD = 100%
192.7																	
3.3	End of Borehole																

SUD-MTO 001 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

PROJECT: 07-1191-0020

RECORD OF DRILLHOLE: B3- 5

SHEET 1 OF 1

LOCATION: N 5050405.3 ; E 237049.8

DRILLING DATE: January 19 and 20, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Equipment

DRILLING CONTRACTOR: OGS Inc.

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.	NOTES WATER LEVELS INSTRUMENTATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
				DEPTH (m)	FLUSH								RECOVERY		R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA					HYDRAULIC CONDUCTIVITY			Diameter 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, cm/s	10 ⁻⁶			10 ⁻⁵	10 ⁻⁴	10 ⁻³																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: AB



SUD-RCK 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

PROJECT 07-1191-0020				RECORD OF BOREHOLE No B3- 6				1 OF 1 METRIC									
W.P. 5192-06-01				LOCATION N 5050425.7; E 237056.7				ORIGINATED BY ID									
DIST HWY 69				BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing Wash Boring				COMPILED BY DA									
DATUM Geodetic				DATE March 31, 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
191.8	GROUND SURFACE							20	40	60	80	100					
0.9	ASPHALT																
	Sand, trace to some gravel (FILL)																
	Dense Brown Moist																
190.7	Blast rock (FILL)		1	SS	37/0.15		191										
190.4																	
1.4	GNEISS (BEDROCK)																
	For coring details refer to Record of Drillhole B3-6.		1	RC	REC 90%		190										RQD = 73%
			2	RC	REC 100%		189										
							188										
187.6																	
4.2	End of Borehole																
	Note: 1. Water level at a depth of 1.0 m below ground surface (Elev. 190.8 m) upon completion of drilling.																

SUD-MTO 001 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

PROJECT <u>07-1191-0020</u>				RECORD OF BOREHOLE No B3-7				1 OF 1 METRIC								
W.P. <u>5192-06-01</u>		LOCATION <u>N 5050430.6; E 237055.8</u>				ORIGINATED BY <u>ID</u>										
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers</u>				COMPILED BY <u>DA</u>										
DATUM <u>Geodetic</u>		DATE <u>March 30, 2009</u>				CHECKED BY <u>AB</u>										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)			
191.7	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;"> 10 20 30 10 20 30 </div>				
0.0	ASPHALT															
0.2	Sand and gravel (FILL) Very Dense Brown Moist					▽										
			1	SS	88											
189.9			2	SS	47/0.10											
1.8	End of Borehole Spoon and Auger Refusal Note: 1. Water level at a depth of 0.4 m below ground surface (Elev. 191.3 m) upon completion of drilling.															

SUD-MTO 001 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

PROJECT 07-1191-0020		RECORD OF BOREHOLE No B3- 8				1 OF 1 METRIC												
W.P. 5192-06-01		LOCATION N 5050427.3; E 237051.3				ORIGINATED BY ID												
DIST HWY 69		BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing Wash Boring				COMPILED BY DA												
DATUM Geodetic		DATE March 30, 2009				CHECKED BY AB												
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 (%)					
190.9 0.0	GROUND SURFACE Sandy gravel containing blast rock (FILL) Compact Brown Moist		1	SS	17/0.15		190											
189.7 1.2	GNEISS (BEDROCK) For coring details refer to Record of Drillhole B3-8.		1	RC	REC 96%		189											RQD = 65%
			2	RC	REC 100%		188											RQD = 70%
			3	RC	REC 100%		187											RQD = 78%
186.0 4.9	End of Borehole Note: 1. Water level at a depth of 0.9 m below ground surface (Elev. 190.0 m) upon completion of drilling.						186											

SUD-MTO 001 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

PROJECT: 07-1191-0020

RECORD OF DRILLHOLE: B3- 8

SHEET 1 OF 1

LOCATION: N 5050427.3 ; E 237051.3

DRILLING DATE: March 30, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Landcore Drilling

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										NOTES WATER LEVELS INSTRUMENTATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
							RECOVERY		R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA										HYDRAULIC CONDUCTIVITY		Diametral Point Load Index (MPa)	RMC -Q AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
							TOTAL CORE %	SOLID CORE %			TYPE AND SURFACE DESCRIPTION										k, cm/s																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
							FLUSH				B Angle	DIP w.r.t. CORE AXIS	Jr	Ja	Jn																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								

DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: AB

SUD-RCK 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:




SUD-MTO 001 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

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



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



SUD-MTO 001 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

PROJECT <u>07-1191-0020</u>		RECORD OF BOREHOLE No B3-11				1 OF 1 METRIC											
W.P. <u>5192-06-01</u>		LOCATION <u>N 5050465.5; E 237051.0</u>				ORIGINATED BY <u>TM</u>											
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers</u>				COMPILED BY <u>DA</u>											
DATUM <u>Geodetic</u>		DATE <u>April 1, 2009</u>				CHECKED BY <u>AB</u>											
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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 (%)				
189.9	GROUND SURFACE																
0.0	Sand and gravel containing blast rock (FILL)		1	AS	-												
189.5	Moist																
0.4	End of Borehole Auger Refusal																
	Note: 1. Borehole dry upon completion of drilling.																

SUD-MTO 001 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:



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

PROJECT		RECORD OF BOREHOLE No B3-13				1 OF 1 METRIC											
W.P. 07-1191-0020		LOCATION N 5050467.1; E 237045.6				ORIGINATED BY TM											
DIST HWY 69		BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing Wash Boring				COMPILED BY DA											
DATUM Geodetic		DATE April 1, 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
190.5	GROUND SURFACE							20	40	60	80	100					
0.0	Sand and gravel containing blast rock (FILL) Compact Brown Moist		1	AS	-		190										
			2	RC	-												
			3	SS	13		189										
188.7	GNEISS (BEDROCK)																
1.8	For coring details refer to Record of Drillhole B3-13.		1	RC	REC 80%		188										RQD = NA%
			2	RC	REC 100%		187										RQD = 98%
			3	RC	REC 100%		186										RQD = 100%
184.5	End of Borehole						185										
6.0	Note: 1. Borehole dry upon completion of drilling.																

SUD-MTO 001 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

PROJECT: 07-1191-0020

RECORD OF DRILLHOLE: B3-13

SHEET 1 OF 1

LOCATION: N 5050467.1 ; E 237045.6

DRILLING DATE: April 1, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Landcore Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH	COLOUR % RETURN	CORRELATION										DISCONTINUITY DATA										HYDRAULIC CONDUCTIVITY				Diametral Point Load Index (MPa)	RMC -Q AVG.	NOTES WATER LEVELS INSTRUMENTATION
								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										
								RECOVERY		R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY																		
								TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	k, cm/s	10	10	10	10												

		Refer to Previous Page		188.7																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							</
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DEPTH SCALE

1 : 50



LOGGED: TM

CHECKED: AB

SUD-RCK 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

PROJECT 07-1191-0020				RECORD OF BOREHOLE No B3-14				1 OF 1 METRIC									
W.P. 5192-06-01				LOCATION N 5050463.8; E 237041.1				ORIGINATED BY ID									
DIST _____ HWY 69				BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing Wash Boring				COMPILED BY DA									
DATUM Geodetic				DATE April 15, 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									
190.8	GROUND SURFACE							20	40	60	80	100					
0.0	ASPHALT																
0.2	Sand and gravel containing blast rock (FILL) Dense Brown Moist		1	SS	39/0.15		190										
			2	RC	REC 66%												
188.9	GNEISS (BEDROCK)						189										
1.9	For coring details refer to Record of Drillhole B3-14.		1	RC	REC 100%		188										RQD = 100%
			2	RC	REC 100%		187										RQD = 100%
			3	RC	REC 100%		186										RQD = 100%
185.5	End of Borehole																
5.3	Note: 1. Borehole dry upon completion of drilling.																

SUD-MTO 001 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

PROJECT: 07-1191-0020

RECORD OF DRILLHOLE: B3-14

SHEET 1 OF 1

LOCATION: N 5050463.8 ; E 237041.1

DRILLING DATE: April 15, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Landcore Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.	RUN No.	COLOUR % RETURN	FLUSH	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				NOTES WATER LEVELS INSTRUMENTATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
				DEPTH (m)				RECOVERY		R.Q.D. %	FRACT. INDEX METRES	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, cm/s																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: AB

SUD-RCK 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

PROJECT 07-1191-0020				RECORD OF BOREHOLE No B3-15				1 OF 1 METRIC										
W.P. 5192-06-01				LOCATION N 5050468.8; E 237040.3				ORIGINATED BY ID										
DIST _____ HWY 69				BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers				COMPILED BY DA										
DATUM Geodetic				DATE April 14, 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										
190.7	GROUND SURFACE																	
0.0	ASPHALT																	
	Sand and gravel, some silt containing blast rock (FILL) Loose to dense Brown Moist		1	SS	13													
			2	SS	6													
			3	SS	26/0.15													
188.1	End of Borehole Spoon and Auger Refusal																	
2.6	Note: 1. Borehole dry upon completion of drilling.																	

SUD-MTO 001 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:



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

PROJECT		RECORD OF BOREHOLE No B3-18				1 OF 1 METRIC											
W.P. 07-1191-0020		LOCATION N 5050490.9; E 237042.4				ORIGINATED BY TM											
DIST HWY 69		BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing Wash Boring				COMPILED BY DA											
DATUM Geodetic		DATE April 2, 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)
189.9	GROUND SURFACE						20	40	60	80	100						
0.0	Sand and gravel, some silt containing organics (FILL) Brown to black Moist		1	AS	-												
189.0			2	SS	50/0.1												
0.9	COBBLES and BOULDERS and GRAVEL		3	RC	REC 62%												
187.6																	
2.3	GRAVEL, some sand Loose to very dense Grey Wet		4	SS	8												
186.4			5	SS	92												
3.5	COBBLES and BOULDERS and GRAVEL		6	RC	REC 55%												
185.4																	
4.5	GNEISS (BEDROCK)		1	RC	REC 100%												RQD = 91%
	For coring details refer to Record of Drillhole B3-18.		2	RC	REC 100%												RQD = 80%
			3	RC	REC 100%												RQD = 88%
181.2																	
8.7	End of Borehole																
	Note: 1. Water level at a depth of 1.9 m below ground surface (Elev. 188.0 m) upon completion of drilling.																

SUD-MTO 001 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

PROJECT: 07-1191-0020

RECORD OF DRILLHOLE: B3-18

SHEET 1 OF 1

LOCATION: N 5050490.9; E 237042.4

DRILLING DATE: April 2, 2009

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Landcore Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH	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	NOTES WATER LEVELS INSTRUMENTATION
DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH	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	NOTES WATER LEVELS INSTRUMENTATION
		Refer to Previous Page		185.4									
5	NQ Coring 04/02/09	GNEISS Fine to coarse grained Slightly weathered Strong Pinkish grey		4.5	1								UCS = 97 MPa
6													
7					2								
8		Broken core from 7.2 m to 7.4 m depth.			3								
9		End of Drillhole		181.2 8.7									
10													
11													
12													
13													
14													

DEPTH SCALE

1 : 50



LOGGED: TM

CHECKED: AB

SUD-RCK 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

PROJECT <u>07-1191-0020</u>				RECORD OF BOREHOLE No B3-19				1 OF 2 METRIC									
W.P. <u>5192-06-01</u>				LOCATION <u>N 5050487.6; E 237037.9</u>				ORIGINATED BY <u>TM</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>DA</u>									
DATUM <u>Geodetic</u>				DATE <u>April 1 and 2, 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									
								20	40	60	80	100					
188.8	GROUND SURFACE																
0.0	Sand, trace to some gravel, trace silt, trace organics (FILL)		1	AS	-												
188.3	Moist Brown Blast Rock (FILL)		2	RC	REC 100%												
0.5																	
186.7																	
2.1	Gravelly SAND, some silt Loose to compact Grey Wet		3	SS	4												
			4	SS	18												
			5	SS	26												
			6	SS	23												
183.2	COBBLES and BOULDERS		7	RC	REC 80%												
182.4	SAND and SILT, some gravel with cobbles and boulders Very dense Grey Wet		8	SS	50/0.05												
6.4			9	SS	50/0.10												
180.4	SCHIST (BEDROCK)		1	RC	REC 100%												
8.4	Bedrock cored from 8.4 m depth to 14.1 m depth. For coring details refer to Record of Drillhole B3-19.		2	RC	REC 100%												
177.6	GNEISS (BEDROCK)		3	RC	REC 100%												
11.2			4	RC	REC 100%												
174.7																	
14.1																	

Continued Next Page

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

SUD-MTO 001 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 13/03/12 DATA INPUT:



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

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Landcore Drilling

CHECKED: AB

MSUD-RCK 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 13/03/12 DATA INPUT:

PROJECT <u>07-1191-0020</u>			RECORD OF BOREHOLE No B3-20			1 OF 1 METRIC														
W.P. <u>5192-06-01</u>			LOCATION <u>N 5050492.5; E 237037.1</u>			ORIGINATED BY <u>TM</u>														
DIST <u> </u> HWY <u>69</u>			BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers, BW Casing Wash Boring</u>			COMPILED BY <u>DA</u>														
DATUM <u>Geodetic</u>			DATE <u>April 6, 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										WATER CONTENT (%)		
								20	40	60	80	100						20	40	60
188.3	GROUND SURFACE																			
0.0	Silty SAND to Gravelly SAND with cobbles and boulders Compact to dense Brown to grey Moist to wet	▽	1	AS	-															
			2	RC	REC 23%															
			3	SS	19															
			4	SS	35															
			5	SS	62/0.2															
			6	RC	REC 15%															
			7	SS	22															
			8	RC	REC 17%															
			9	SS	63/0.8															
182.0	End of Borehole Spoon and Casing Refusal																			
6.3	Note: 1. Water level at a depth of 2.9 m below ground surface (Elev. 185.4 m) upon completion of drilling.																			



SUD-MTO 001 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:



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



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

PROJECT <u>07-1191-0020</u>				RECORD OF BOREHOLE No B3-23				1 OF 1 METRIC										
W.P. <u>5192-06-01</u>		LOCATION <u>N 5050513.6; E 237018.8</u>				ORIGINATED BY <u>ID</u>												
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>NW Casing, NQ Coring, Wash Boring</u>				COMPILED BY <u>JJL</u>												
DATUM <u>Geodetic</u>		DATE <u>April 8, 2010</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										WATER CONTENT (%)
187.0	GROUND SURFACE							20	40	60	80	100						
0.0	Organics (FILL) Brown Moist		1	AS	-	▽												
186.5	Blast rock (FILL)		-	RC	-													
0.5			2	SS	12/0.15													
		-	RC	-														
184.7		3	SS	17/0.11														
2.3	SAND and SILT, with cobbles and boulders Dense Brown Wet	-	RC	-														
		4	SS	34														
		5	SS	32														
		6	SS	56/0.15														
181.7																		
5.3	GNEISS (BEDROCK)		1	RC	REC 100%													
	For coring details refer to Record of Drillhole B3-23.		2	RC	REC 100%													
			3	RC	REC 100%													
			4	RC	REC 100%													
178.3																		
8.7	End of Borehole																	
	Note: 1. Water level at a depth of 2.4 m below ground surface (Elev. 184.6 m) upon completion of drilling.																	

SUD-MTO 001 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

PROJECT: 07-1191-0020

RECORD OF DRILLHOLE: B3-23

SHEET 1 OF 1

LOCATION: N 5050513.6 ; E 237018.8

DRILLING DATE: April 8, 2010

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Landcore Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	CORRELATION												NOTES WATER LEVELS INSTRUMENTATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
							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																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
							RECOVERY			FRACT. INDEX METRES			DISCONTINUITY DATA									HYDRAULIC CONDUCTIVITY		Diameter Point Load Index (MPa)		RMC -Q' AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
							TOTAL CORE %	SOLID CORE %	R.Q.D. %	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	g	k, cm/s	10°		10°	10°	10°	10°	10°																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
		Refer to Previous Page		181.7		FLUSH																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	</

DEPTH SCALE



1 : 50



LOGGED: ID

CHECKED: AB

SUD-RCK 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

PROJECT <u>07-1191-0020</u>		RECORD OF BOREHOLE No B3-24				1 OF 1 METRIC												
W.P. <u>5192-06-01</u>		LOCATION <u>N 5050381.3; E 237079.4</u>				ORIGINATED BY <u>ID</u>												
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers</u>				COMPILED BY <u>JJL</u>												
DATUM <u>Geodetic</u>		DATE <u>April 7, 2010</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										
192.5	GROUND SURFACE							20	40	60	80	100						
0.0	Sand and gravel to sand (FILL) Compact to very loose Brown Moist		1	SS	13	▽	192											
			2	SS	11		191											
			3	SS	10		190											
189.7			4	SS	3		189											
2.9	ORGANICS Black Wet		5	SS	52													
188.7	SAND and GRAVEL Very dense Brown Wet																	
3.8	End of Borehole Auger Refusal																	
Note: 1. Water level at a depth of 1.6 m below ground surface (Elev. 190.9 m) upon completion of drilling.																		

SUD-MTO 001 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 03/02/12 DATA INPUT:

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Landcore Drilling

CHECKED: AB

MSUD-RCK 07-1191-0020 B3 BH LOGS METRIC.GPJ GAL-MISS.GDT 13/03/12 DATA INPUT:



APPENDIX B

Laboratory Test Results

**TABLE B-1
REFUSAL/BEDROCK ELEVATIONS
HIGHWAY 529 OVERPASS SBL
GWP 5005-08-00**

Borehole	Depth to Refusal/Bedrock Surface (m)	Refusal/Bedrock Surface Elevation (m)	Comments
B3-1	0.0	193.1	Exposed Bedrock
B3-2	0.0	192.4	Exposed Bedrock
B3-3	0.0	194.8	Exposed Bedrock
B3-4	0.8	195.4	Split-Spoon Refusal
B3-5	0.1	195.9	Bedrock Surface
B3-6	1.4	190.4	Bedrock Surface
B3-7	1.8	189.9	Split-Spoon/Auger Refusal
B3-8	1.2	189.7	Bedrock Surface
B3-9	0.0	193.7	Exposed Bedrock
B3-10	0.0	192.2	Exposed Bedrock
B3-11	0.4	189.5	Auger Refusal
B3-12	0.0	190.0	Exposed Bedrock
B3-13	1.8	188.7	Bedrock Surface
B3-14	1.9	188.9	Bedrock Surface
B3-15	2.6	188.1	Split-Spoon/Auger Refusal
B3-16	0.0	193.3	Exposed Bedrock
B3-17	0.0	196.0	Exposed Bedrock
B3-18	4.5	185.4	Bedrock Surface
B3-19	8.4	180.4	Bedrock Surface
B3-20	6.3	182.0	Split-Spoon/Casing Refusal
B3-21	0.3	194.7	Spoon Refusal
B3-22	0.0	190.0	Exposed Bedrock
B3-23	5.3	181.7	Bedrock Surface
B3-24	3.8	188.7	Auger Refusal

Compiled by: EC
Checked by: AB
Reviewed by: JMAC

TABLE B-2
UNIAXIAL COMPRESSIVE STRENGTH TEST RESULTS
HIGHWAY 529 OVERPASS SBL
GWP 5005-08-00

Borehole Number	Sample Depth (m)	Sample Elevation (m)	Rock Type	Core Diameter (mm)	Uniaxial Compressive Strength (MPa)
B3-1	1.7	191.4	Gneiss	52	113
B3-3	3.2	191.6	Gneiss	51	90
B3-5	2.9	193.1	Gneiss	51	124
B3-6	2.3	189.0	Gneiss	48	76
B3-8	4.0	186.9	Gneiss	48	80
B3-13	4.1	186.4	Gneiss	48	95
B3-18	4.6	185.3	Gneiss	47	97
B3-19	11.1	177.7	Schist	47	37

Compiled by: EC
Checked by: AB
Reviewed by: JMAC

TABLE B-3
POINT LOAD STRENGTH TEST RESULTS
HIGHWAY 529 OVERPASS NBL - GWP 5005-08-00

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)
B3-1	0.8	192.3	Gneiss	D	52	21.2	0.020	7.5	7.6	129
B3-1	2.1	191.0	Gneiss	D	52	19.5	0.018	6.9	7.0	119
B3-1	3.2	189.9	Gneiss	D	52	14.1	0.013	4.9	5.0	85
B3-3	0.8	194.0	Gneiss	D	51	12.6	0.012	4.6	4.7	80
B3-3	2.1	192.7	Gneiss	D	51	16.9	0.016	6.1	6.2	105
B3-3	2.5	192.3	Gneiss	D	51	17.3	0.016	6.2	6.3	107
B3-5	0.7	195.3	Gneiss	D	51	9.7	0.009	3.5	3.6	61
B3-5	2.0	194.0	Gneiss	D	51	14.8	0.014	5.4	5.4	92
B3-5	3.2	192.8	Gneiss	D	51	16.4	0.016	6.0	6.0	102
B3-6	1.8	190.0	Gneiss	D	48	9.8	0.009	4.1	4.0	68
B3-6	2.9	188.9	Gneiss	D	48	15.9	0.015	6.7	6.5	111
B3-6	4.2	187.6	Gneiss	D	48	14.3	0.014	6.0	5.9	100
B3-8	2.7	188.2	Gneiss	D	48	13.5	0.013	5.7	5.6	95
B3-8	3.4	187.5	Gneiss	D	48	17.7	0.017	7.4	7.3	124
B3-8	4.6	186.3	Gneiss	D	48	15.0	0.014	6.3	6.2	105
B3-13	2.7	187.8	Gneiss	D	48	15.9	0.015	6.7	6.5	111
B3-13	4.6	185.9	Gneiss	D	48	15.2	0.014	6.4	6.3	107
B3-13	5.3	185.2	Gneiss	D	48	13.0	0.012	5.5	5.3	90
B3-18	5.3	184.6	Gneiss	D	47	10.4	0.010	4.4	4.3	73
B3-18	6.7	183.2	Gneiss	D	47	12.1	0.012	5.1	5.0	85
B3-18	8.2	181.7	Gneiss	D	47	16.3	0.015	6.9	6.7	115
B3-19	9.1	179.7	Schist	D	47	2.7	0.003	1.2	1.1	34
B3-19	9.3	179.5	Schist	D	47	2.0	0.002	0.8	0.8	25
B3-19	10.5	178.3	Schist	D	47	2.8	0.003	1.2	1.2	37
B3-19	12.7	176.1	Gneiss	D	47	10.0	0.010	4.3	4.2	71

NOTES:

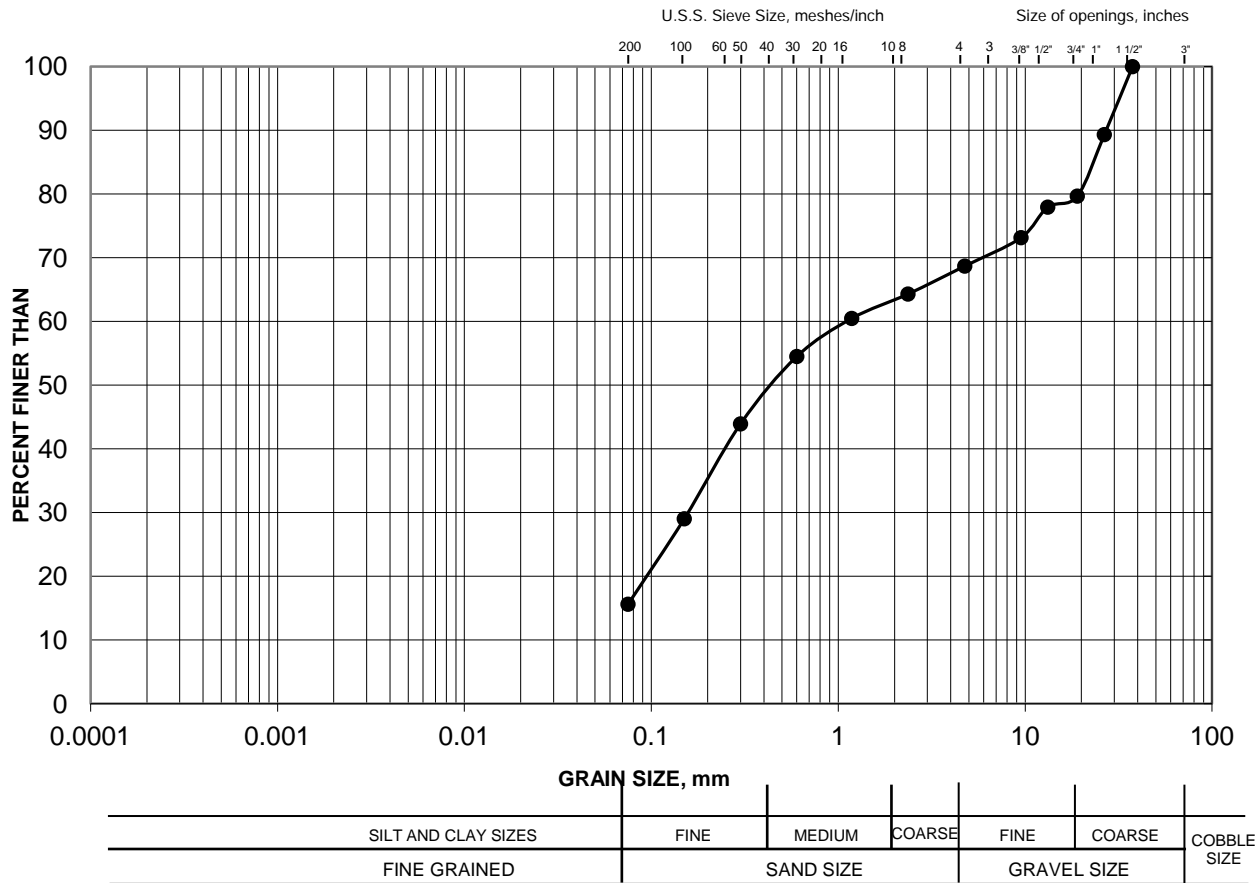
1. Depths are given below the ground surface at the borehole location.
2. Where: D = Diametral test;
I_s Diametral = Uncorrected point load strength;
I_s 50 mm = Corrected point load strength; and
UCS = Uniaxial compressive strength = I_s 50 mm X K. A K value of 17 has been used for the Gneiss while a value of 31 has been used for the Schist, based on correlation with UCS for this site as per ASTM D5731 (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).
K = Conversion factor from corrected point load strength to uniaxial compressive strength.

Compiled by: EC
Checked by: AB
Reviewed by: JMAC

GRAIN SIZE DISTRIBUTION

Sand and Gravel (FILL)

FIGURE
B-1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
	B3-15	1	189.6

Project Number: 07-1191-0020-B3

Checked By: AB

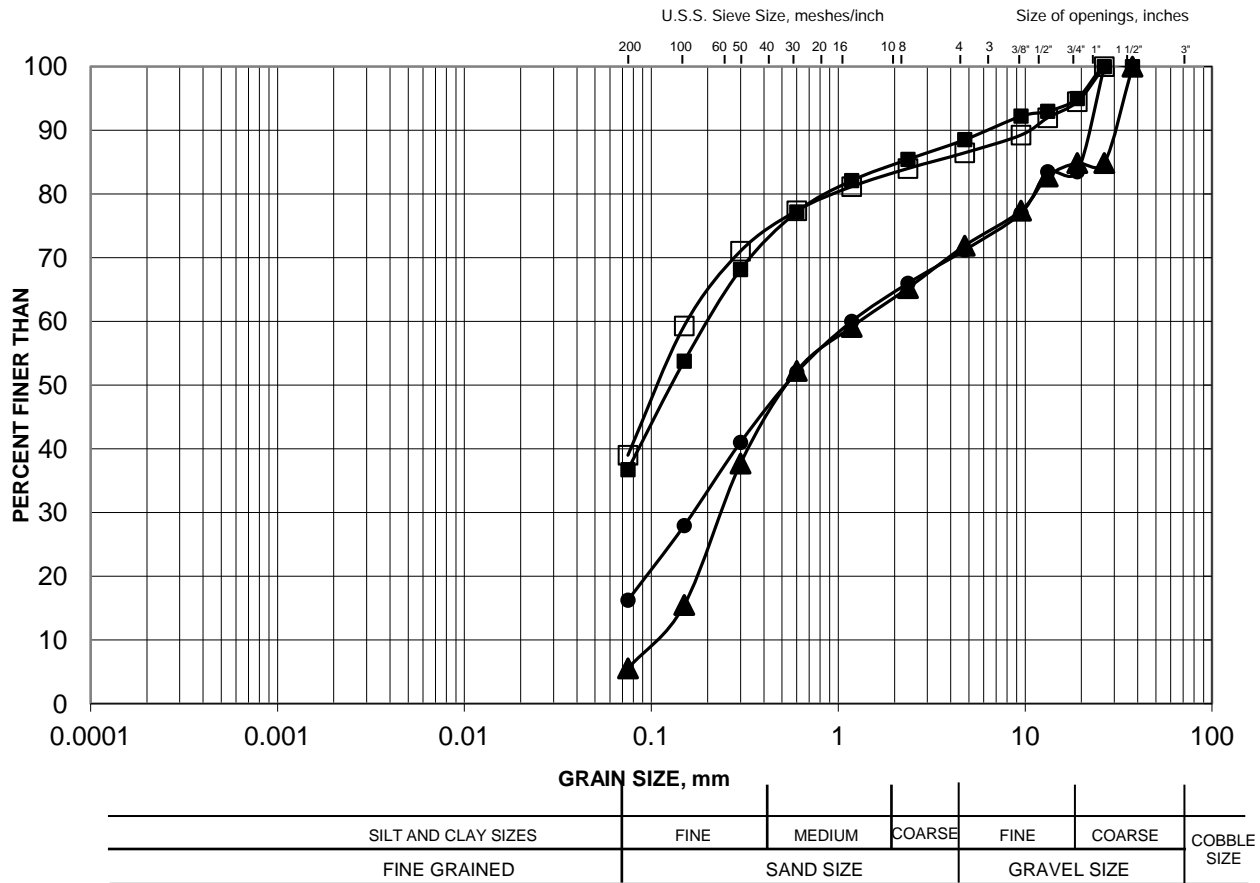
Golder Associates

Date: March 2012

GRAIN SIZE DISTRIBUTION

Sand and Silt to Gravelly Sand

FIGURE
B-2



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
●	B3-19	4	185.4
□	B3-19	8	182.3
▲	B3-20	7	183.4
■	B3-23	4	183.6

Project Number: 07-1191-0020-B3

Checked By: AB

Golder Associates

Date: March 2012

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