MTO Agreement No. 5011-E-0010
WO No. 2011-11041
Proposed Sand/Salt Storage Facility and Office/Garage
Missanabie Corners Patrol Yard
Foundation Investigation Report

Geocres No. 41N-21

November 2012

Prepared for:
Ontario Ministry of Transportation
Northeastern Region
447 McKeown Avenue
North Bay, Ontario
CANADA P1B 9S9

Prepared by:
GENIVAR Inc.
294 Rink Street, Suite 103
Peterborough, Ontario K9J 2K2

Project No. 121-17876-00

GENIVAR

Project No. 121-17876-00

November 13, 2012

Mr. Jean-Pierre Perron, P. Eng.
MTO Project Manager
Ontario Ministry of Transportation
Northeastern Region
447 McKeown Avenue
North Bay, Ontario P1B 9S9

Re: MTO Agreement No. 5011-E-0010 / WO No.: 2011-11041
Proposed Sand/Salt Storage Facility and Office/Garage
Missanabie Corners Patrol Yard
Foundation Investigation Report (Geocres No. 41N-21)

Dear Mr. Perron:

We are pleased to submit our Foundation Investigation Report for the proposed Sand/Salt Storage Facility and Office/Garage at the Ontario Ministry of Transportation Northeastern Region (MTO) Missanabie Corners Patrol Yard in the Township of Nadjiwon, Ontario. A borehole and laboratory testing program was conducted to assess soil and groundwater conditions at the site and provide recommendations for foundation design for the proposed structure.

This report presents the investigation methodology and findings, and was completed in accordance with the Terms of Reference provided in MTO Agreement #5011-E-0010.

We trust that this report meets your current requirements. Please contact us if you have any questions.

Yours truly,
GENIVAR Inc.

J. Stephen Ash, P. Eng., P. Geo.
Director, Environment

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1. Introduction

GENIVAR Inc. (GENIVAR) was retained by the Ontario Ministry of Transportation Northeastern Region (MTO) to undertake a geotechnical investigation for the proposed construction of a sand/salt storage structure and office/garage at the Missanabie Corners Patrol Yard, located on Highway 651, approximately 300 m north of the Highway 651 / Highway 101 intersection, in the Township of Nadjiwon, Ontario. The purpose of the investigation was to assess subsurface conditions at the site and provide recommendations for foundation design at the designated structure location.

The geotechnical investigation was conducted in accordance with MTO Agreement #5011-E-0010. The Foundation Investigation Report is a factual report containing the results of the geotechnical investigation carried out at the Seabrook site, including the field and laboratory testing information. Subsurface conditions encountered at the site are described in detail in this report.

2. Site Description and Regional Geology

2.1 Site Description

The Missanabie Patrol Yard (site) is located on the east side of Highway 651, approximately 300 m north of the Highway 651 / Highway 101 intersection in the Township of Nadjiwon, Ontario. The site layout is shown in Drawing 1 and colour photographs of the site are included in Appendix C.

This is a vacant site that is intended for development as an MTO Patrol Yard. Currently there is an approximately 50 m by 50 m graded, granular surface approximately 30 m east of the western property boundary, with access to Highway 651. The site slopes to the south and is surrounded by low lying bog lands with mixed deciduous and coniferous trees. There are small streams on the north and south side of the site. The surrounding properties are treed with no structures or residences observed within a few kilometres of the site.

Drawing 1 indicates the proposed location of the sand/salt structure as well as the office/garage. Bedrock is at the surface within and on the eastern side of the office/garage footprint.

2.2 Regional Geology

Map 5010 '*Northern Ontario Engineering Geology Terrain Study Data Base Map – Michipicoten'* published by the Ministry of Natural Resources (MNR) was referred to for information on the area soils and bedrock.

Based on the mapping information, the site is reportedly in an area characterized by glaciofluvial outwash landforms, which are well-drained deposits of sand and gravel occupying low areas within the bedrock terrain. Rock knobs occur to a lesser extent in this area. Relief is low and the topography is level to undulating with normally dry drainage conditions. Overburden cover is often shallow (less than 1 m thick) but may thicken to as much as 3 m in localized areas. The outwash sand and gravel deposits are underlain by Early Precambrian bedrock. Felsic igneous and metamorphic rocks, including granite, gneissic tonalite and mafic metavolcanics, are the dominant lithologies.

3. Historic Report Review

No historic geotechnical reports were available from the MTO Geocres Library for the Missanabie Corners Patrol yard or locations close to the yard. The regional geology information taken from the sources quoted in Section 2 indicate that the site likely has shallow sand and gravel overburden overlying Precambrian igneous and metamorphic bedrock.

4. Investigation Procedures

4.1 Subsurface Investigation

A borehole investigation was performed at the subject site between June 11 and June 13, 2012. The investigation consisted of advancing six (6) exploratory boreholes, designated as BH12-1 through BH12-6, commencing from existing ground level. Borehole locations are shown on Drawing 1 and were located at each of the four corners of the proposed sand/salt storage structure and at opposite corners of the proposed office/garage, as required in the Terms of Reference.

MTO minimum requirements for the borehole investigation outlined a maximum drilling depth of 10.0 m for the sand/salt structure boreholes and 5.0 m for the office/garage, unless refusal was encountered at shallower depth, or justification for deeper drilling was authorized by the MTO Project Manager. As well, two (2) of the four (4) boreholes for the sand/salt structure and both of the office/garage boreholes were to include rock cores for a minimum of 3.0 m depth below the rock surface, if bedrock was encountered within the shallow foundation zone.

In all six boreholes augering was terminated at 0.3 m to 1.5 m below ground surface on bedrock. Bedrock coring was completed within the sand/salt structure footprint at boreholes BH12-1 and BH12-3 to a depth of 10.4 m and 4.4 m, respectively. Within the office/garage footprint, coring was completed at boreholes BH12-5 and BH12-6 to a depth of 4.3 m and 9.8 m, respectively. The bedrock coring in BH12-1 and BH12-6 was extended to approximately 10 m below ground surface to allow for the installation of monitoring wells as part of a concurrent hydrogeological investigation for a new water supply.

The longitude and latitude of the individual borehole locations were obtained using a hand-held GPS unit in the WGS 84 reference system. These coordinates were converted to MTO standard coordinates (Northing and Easting). As the site is currently vacant, borehole elevations were surveyed to an assumed benchmark: a nail placed into a tree, marked with paint and a flag. The benchmark was assigned an elevation of 100 m and the boreholes elevations were surveyed relative to this benchmark. Borehole elevations and coordinates are shown on Drawing 1, and are provided on the borehole logs included in Appendix A.

Drilling and soil sampling was completed using a truck-mounted drill rig operating under the supervision of an experienced GENIVAR soils technician. The boreholes were advanced to the soil sampling depths by means of continuous flight hollow stem augers. Standard Penetration Test (SPT) N values were recorded for the sampled intervals as the number of blows required to drive a split spoon sampler 305 mm into the soil, using a 63.5 kg drop hammer falling 750 mm (ASTM D1586 procedure). SPT N values are used in this report to assess consistency for cohesive soils and relative density for non-cohesive materials.

The sampled soil materials from discrete subsurface units were logged in the field using visual and tactile methods, and were then placed in labelled plastic bags for transport, future reference, possible laboratory testing, and storage. Soils for laboratory moisture content testing were placed in sealed laboratory jars for transport.

NQ-size coring equipment (47.6 mm diameter) was used to obtain bedrock core samples to depths noted above. Core recovery and rock quality index properties were determined by field inspection. Core samples were placed in labelled core boxes for transport, future reference and storage.

Groundwater conditions within the boreholes were observed during drilling, and prior to backfilling. In addition, two (2) groundwater monitoring wells were installed in boreholes BH12-1 and BH12-6 to measure static groundwater levels at the site. The monitoring wells were installed to meet Ontario Regulation (O. Reg.) 903 requirements, and consist of 51 mm (2 inch) outside diameter environmental grade PVC pipe, with a 1.5 m long No. 10 machine-slotted screen embedded within a sand pack. The

sand pack was installed from the bottom of the monitoring well to a depth of approximately 0.3 m above the well screen. A bentonite seal was then placed between the top of the sand pack and the ground surface. The monitoring wells may be used for long term monitors or they should be removed.

The remaining cored holes (BH12-3 and BH12-5) were backfilled with bentonite hole plug to the surface. The two (2) boreholes that were terminated on bedrock (BH12-2 and BH12-4) were backfilled with sand. The backfill material was compacted with the drill rig. As such, the boreholes are abandoned in accordance with O. Reg. 903 requirements, as amended. Table 4.1 below summarizes the borehole numbers and drilling depths and the surveyed elevations.

Table 4-1: Borehole Numbers, Drilling Depths and Elevations

Borehole No.	Drilling Depth Below Existing Ground Surface (m) / Elevation (m)	Monitoring Well	Comment
BH12-1	10.4 / 89.0	Monitoring well installed at 10.4 m depth / El 89.0 m	Cored into bedrock
BH12-2	0.5 / 98.6	-	
BH12-3	4.4 / 94.8	-	Cored into bedrock
BH12-4	1.2 / 98.1	-	
BH12-5	4.3 / 94.7	-	Cored into bedrock
BH12-6	9.8 / 89.3	Monitoring well installed at 9.8 m depth / El 89.3 m	Cored into bedrock

Note: Elevations are relative to cited temporary benchmark (Section 4.1).

4.2 Laboratory Testing

4.2.1 Soil Testing

The minimum number of laboratory tests was set at 25 percent of the samples, according to the MTO Terms of Reference. Low complexity soil tests were completed at GENIVAR's RAQ's certified laboratory in Peterborough. Laboratory testing results are presented on the borehole logs and in Appendix B.

Two (2) Particle Size Analyses (ASTM D422) and eight (8) Natural Moisture Content tests were completed for samples of the overburden material.

5. Subsurface Conditions

The subsurface conditions were explored at the six (6) borehole locations designated as BH12-1 to BH12-6. Borehole locations are shown on Drawing 1 while the subsurface stratigraphic profile for the site is shown on Drawing 2. Detailed borehole logs are provided in Appendix A, and laboratory test results are included in Appendix B.

5.1 Soil Profile Summary

All six (6) of the boreholes encountered a relatively thin layer of overburden overlying bedrock. The bedrock was cored at four (4) of the borehole locations to depths ranging from 4.3 m to 10.4 m below ground surface. Descriptions of the major subsurface units are provided in the following subsections.

5.1.1 Overburden

A 0.3 m to 1.5 m thick layer of overburden soil was encountered at each of the borehole locations. The overburden material consisted of brown sand and gravel to sand, some gravel with a trace to some silt extending to the depths (metres below ground surface, mbgs) and elevations (relative) shown below:

Borehole No.	Depth to Bottom of Overburden (Relative Elevation)
BH12-1	1.5 mbgs (97.9 m)
BH12-2	0.5 mbgs (98.6 m)
BH12-3	0.9 mbgs (98.3 m)
BH12-4	1.2 mbgs (98.1 m)
BH12-5	0.9 mbgs (98.1 m)
BH12-6	0.3 mbgs (98.7 m)

Laboratory particle size distribution analyses for two (2) samples of the overburden soil were completed, and results according to the Unified Soil Classification System (USCS) are summarized below, and shown on Figure B1 of Appendix B:

- Gravel (greater than 4.75 mm size) - 39 % to 43 %
- Sand (0.075 mm to 4.75 mm size) - 50 % to 59 %
- Silt and Clay (less than 0.075 mm size) - 2 % to 7 %

Standard Penetration Test results (N Values) in the overburden layer, where recorded, ranged between 19 and 30 blows per 305 mm of penetration, indicating compact relative density.

Laboratory determined moisture content of the overburden ranged from 2 % to 13 %, indicating moist material.

5.1.2 Bedrock

Boreholes BH12-1, BH12-3, BH12-5, and BH12-6 were cored and terminated in granitic gneiss bedrock. Boreholes BH12-3 and BH12-5 were terminated at 4.4 m and 4.3 m below ground surface, respectively. Boreholes BH12-1 and BH12-6 were terminated at depths of 10.4 m and 9.8 m, respectively, to accommodate installation of monitoring wells. Rock core photographs are included in Appendix C.

A description of the bedrock is provided in Table 5-1. Total Core Recovery (TCR) ranged from 83 % to 100 %. Apart from the first core sample in borehole BH12-3, which encountered fractured material, Rock Quality Designation (RQD) values ranged from 69 % to 100 %, which is described as fair to excellent.

Table 5-1: Rock Core (RC) Description, RQD, and Recovery Data

BH	RC #	Depth (m)	TCR (%)	RQD (%)	Depth (m)	Description
12-1	1	1.52 – 2.13	83	69	1.52 – 10.41	GRANITIC GNEISS, pink, grey, black with brown oxidation layers, fine to medium grained, medium to strongly foliated at subhorizontal to 60º to core axis, hard, strong, slightly weathered.
	2	2.13 – 2.94	100	100		
	3	2.94 – 4.42	97	91		
	4	4.42 – 5.95	98	86		
	5	5.95 – 7.39	100	88		
	6	7.39 – 8.91	100	100		
	7	8.91 – 10.41	97	91		
12-3	1	0.91 – 1.42	100	0	0.91 – 4.40	GRANITIC GNEISS, pink, grey, black with brown oxidation layers, fine to medium grained, medium to strongly foliated at subhorizontal to 60º to core axis, hard, strong, slightly weathered
	2	1.42 – 2.95	100	76		
	3	2.95 – 4.40	100	87		
12-5	1	0.91 – 1.35	100	76	0.91 – 4.34	GRANITIC GNEISS, pink, grey, black with brown oxidation layers, fine to medium grained, medium to strongly foliated at subhorizontal to 60º to core axis, hard, strong, slightly weathered
	2	1.35 – 2.87	100	79		
	3	2.87 – 4.34	100	71		
12-6	1	0.38 – 1.37	100	94	0.38 – 9.65	GRANITIC GNEISS, pink, grey, black with brown oxidation layers, fine to medium grained, medium to strongly foliated at subhorizontal to 60º to core axis, hard, strong, slightly weathered
	2	1.37 – 2.87	100	89		
	3	2.87 – 4.40	98	86		
	4	4.40 – 5.87	100	90		
	5	5.87 – 7.42	100	75		
	6	7.42 – 8.89	100	100		
	7	8.89 – 9.65	100	94		

5.2 Groundwater Conditions

Groundwater conditions were observed in the open boreholes upon completion of drilling. The static water levels in the two monitoring wells (BH12-1 and BH12-6) were measured at two different times after drilling was completed. Results are summarized in Table 5-2.

Table 5-2: Summary of Groundwater Levels

Location	Measured Groundwater Depth mbgs (relative elevation, m)	Date Measured
BH12-1 (MW)	1.65 (97.75)	15 June 2012
	1.89 (97.51)	19 June 2012
BH12-2	no GW observed	12 June 2012
BH12-3	no GW observed	12 June 2012
BH12-4	no GW observed	12 June 2012
BH12-5	no GW observed	12 June 2012
BH12-6 (MW)	2.43 (96.63)	15 June 2012
	1.43 (97.63)	19 June 2012

Note: mbgs = metres below ground surface; MW = monitoring well, GW = groundwater

Based on the water level measurements and moisture condition of the inspected soil samples, the depth of shallow groundwater within the footprint of the proposed structures, at the time of the field investigation, was generally below 1.5 m.

It should be noted that groundwater levels may fluctuate seasonally and in response to climatic conditions, and perched groundwater conditions can potentially develop over the shallow bedrock.

6. Miscellaneous Information

The following GENIVAR personnel and subcontractors responsible for completion of this geotechnical investigation are summarized in Table 6.1.

Table 6-1: Summary of Task Responsibilities and Personnel

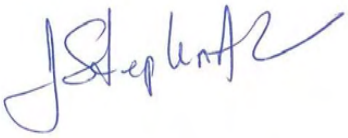
Task	Name	Address	Phone
Buried Utility Locates	Peter Flowerday Central Cable Contractors	Wanapitae, ON	705-694-5256
Drilling - Geotechnical	Kyle Gilmore Abraflex Drilling	Lively, ON	705-222-2272
Field Supervision	Dave Lembke, C.E.T., rcji GENIVAR Inc.	Peterborough, ON	705-743-6850
Project Coordinator	Jennifer Wales, P. Eng. and Beverly Leno, C.E.T., rcji GENIVAR Inc.	Peterborough, ON	705-743-6850
Laboratory - Soil Low Complexity	Kelly Whitney, C.E.T. GENIVAR Inc.	Peterborough, ON	705-743-6850
Report Preparation	Raid Khamis, P. Eng. GENIVAR Inc.	Brampton, ON	905-799-8220
Report Review	Steve Ash, P. Eng., P. Geo. GENIVAR Inc.	Peterborough, ON	705-743-6850
RAQ's Key Contact	Jason Balsdon, P. Eng. GENIVAR Inc.	Collingwood, ON	705-444-2788

7. Closure

The data presented in this geotechnical report, and the quality thereof, is based on a scope of work authorized by the Client. While we believe the borehole information to be representative of site conditions, subsurface conditions between and beyond the test hole locations may vary. GENIVAR accepts no liability for use of or reliance on the report information by third parties, without express written consent.

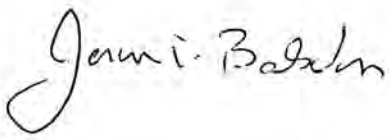
Prepared by:
GENIVAR Inc.

Raid Khamis, P.Eng.
Project Engineer



J. Stephen Ash, P. Eng., P. Geo.
Director, Environment

Reviewed by:



Jason T. Balsdon, M.A.Sc., P. Eng.
Director, Environment

Drawings

Drawing 1 – Borehole Location Plan

Drawing 2 – Soil Strata

METRIC

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

Agreement No.: 5011-E-0010
WO No.: 2011-11041

N

BOREHOLE LOCATION PLAN

PROPOSED SAND/SALT STORAGE FACILITY AND OFFICE / GARAGE
MISSANABIE CORNERS PATROL YARD
KING'S HIGHWAY 651

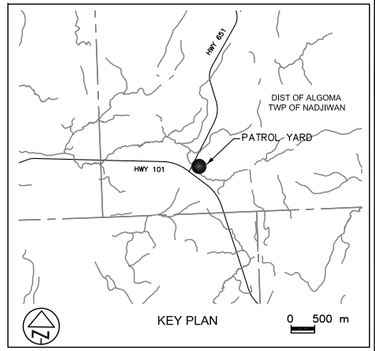
Client: MTO - Northeastern Region

DRAWING 1

PLAN VIEW

SCALE 1:1500

10 0 10 20 m



LEGEND

- Borehole
- Benchmark

NOTES:

1. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
2. COORDINATES AT BOREHOLE LOCATIONS WERE BY HANDHELD GPS.
3. BOREHOLE ELEVATIONS WERE SURVEYED RELATIVE TO A NAIL, PAINTED AND FLAGGED, IN A TREE (RELATIVE EL. 100.00 m).

BH No	ELEVATION (Relative m)	COORDINATES (NAD 83 Zone16) NORTHING	EASTING
12-1	99.4	5314093.7	715225.3
12-2	99.1	5314074.4	715215.2
12-3	99.2	5314067.2	715228.5
12-4	99.3	5314087.1	715238.3
12-5	99.0	5314062.9	715236.7
12-6	99.1	5314066.4	715247.1

– NOTE –

THE ACTUAL SOIL STRATIFICATION HAS BEEN VERIFIED FROM DATA OBTAINED AT THE BOREHOLE LOCATIONS ONLY. THE INFERRED CONTACTS SHOWN ARE BASED ON GEOLOGICAL EVIDENCE AND THESE MAY VARY FROM THOSE SHOWN BETWEEN BORINGS.

LICENSED PROFESSIONAL ENGINEER
J. S. Ash
PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER
J. T. Balsdon
PROVINCE OF ONTARIO

SITE PLAN MAPPING REF. NO.:
MTO PLAN H-380-2, DECEMBER 1070.

PROJECT: 121-17876-00 111-11

GENIVAR

REVISIONS

DATE	BY	DESCRIPTION

GEOCRES No. 41N-21

HWY No 651			DIST ALGOMA
SUBM'D --	CHECKED JSA	DATE NOVEMBER 2012	SITE --
DRAWN PLB	CHECKED --	APPROVED --	DWG --

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

Agreement No.: 5011-E-0010
WO No.: 2011-11041

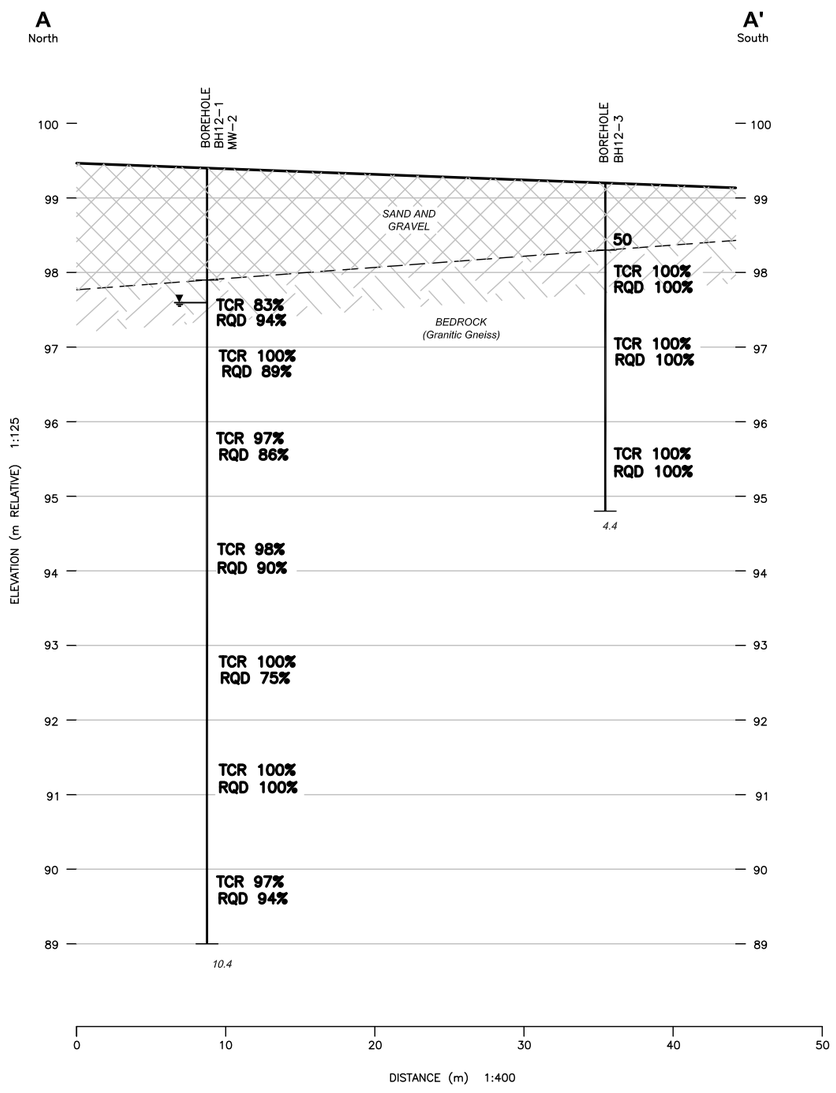
DRAWING 2

SOIL STRATA

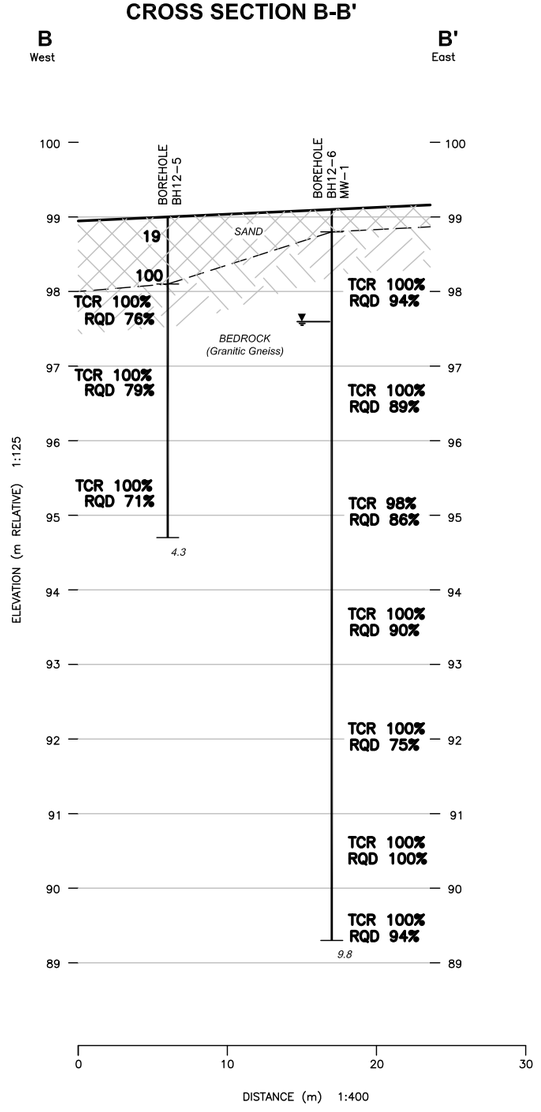
PROPOSED SAND/SALT STORAGE FACILITY AND OFFICE / GARAGE
MISSANABIE CORNERS PATROL YARD
KING'S HIGHWAY 651

Client: MTO - Northeastern Region

CROSS SECTION A-A'



CROSS SECTION B-B'



LEGEND

19	Blows/0.3m (Std. Pen Test, 475 J / blow)
▼	Water Level At Time Of Investigation

BH No	ELEVATION (Relative m)	COORDINATES (NAD 83 Zone18) NORTHING	EASTING
12-1	99.4	5314093.7	715225.3
12-2	99.1	5314074.4	715215.2
12-3	99.2	5314067.2	715228.5
12-4	99.3	5314087.1	715238.3
12-5	99.0	5314062.9	715236.7
12-6	99.1	5314066.4	715247.1

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LICENSED PROFESSIONAL ENGINEER
J. S. Ash
PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER
T. Balsdon
PROVINCE OF ONTARIO

PROJECT: 121-17876-00 111-11
GENIVAR

REVISIONS			
DATE	BY	DESCRIPTION	

GEOCRES No. 41N-21

HWY No 651			DIST ALGOMA
SUBM'D --	CHECKED JSA	DATE NOVEMBER 2012	SITE --
DRAWN PLB	CHECKED --	APPROVED --	DWG --

Appendix A

Borehole Explanation Forms

Borehole Logs

BOREHOLE LOG EXPLANATION FORM

This explanatory section provides the background to assist in the use of the borehole logs. Each of the headings used on the borehole log, is briefly explained.

DEPTH

This column gives the depth of interpreted geologic contacts in metres below ground surface.

STRATIGRAPHIC DESCRIPTION

This column gives a description of the soil based on a tactile examination of the samples and/or laboratory test results. Each stratum is described according to the following classification and terminology.

Soil Classification*		Terminology	Proportion
Clay	<0.002 mm		
Silt	0.002 to 0.06 mm	"trace" (e.g. trace sand)	<10%
Sand	0.06 to 2 mm	"some" (e.g. some sand)	10% - 20%
Gravel	2 to 60 mm	adjective (e.g. sandy)	20% - 35%
Cobbles	60 to 200 mm	"and" (e.g. and sand)	35% - 50%
Boulders	>200 mm	noun (e.g. sand)	>50%

* Extension of MIT Classification system unless otherwise noted.

The use of the geologic term "till" implies that both disseminated coarser grained (sand, gravel, cobbles or boulders) particles and finer grained (silt and clay) particles may occur within the described matrix.

The compactness of cohesionless soils and the consistency of cohesive soils are defined by the following:

COHESIONLESS SOIL		COHESIVE SOIL		
Compactness	Standard Penetration Resistance "N", Blows / 0.3 m	Consistency	Standard Penetration Resistance "N", Blows / 0.3 m	Undrained Shear Strength (cu) (kPa)
Very Loose	0 to 4	Very Soft	0 to 2	0 to 12
Loose	4 to 10	Soft	2 to 4	12 to 25
Compact	10 to 30	Firm	4 to 8	25 to 50
Dense	30 to 50	Stiff	8 to 15	50 to 100
Very Dense	Over 50	Very Stiff	15 to 30	100 to 200
		Hard	Over 30	Over 200

The moisture conditions of cohesionless and cohesive soils are defined as follows.

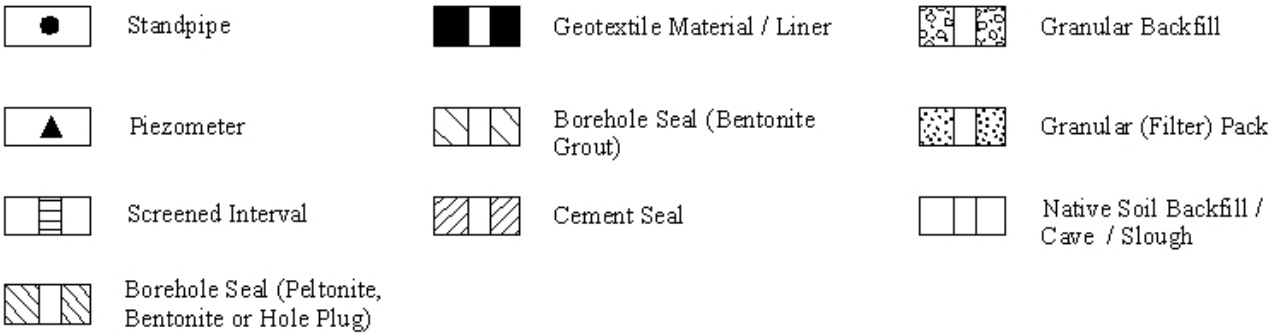
COHESIONLESS SOILS	COHESIVE SOILS		
Dry	DTPL	-	Drier Than Plastic Limit
Moist	APL	-	About Plastic Limit
Wet	WTPL	-	Wetter Than Plastic Limit
Saturated	MWTPL	-	Much Wetter Than Plastic Limit

STRATIGRAPHY

Symbols may be used to pictorially identify the interpreted stratigraphy of the soil and rock strata.

MONITOR DETAILS

This column shows the position and designation of standpipe and/or piezometer ground water monitors installed in the borehole. Also the water level may be shown for the date indicated.



Where monitors are placed in separate boreholes, these are shown individually in the "Monitor Details" column. Otherwise, monitors are in the same borehole. For further data regarding seals, screens, etc., the reader is referred to the summary of monitor details table.

SAMPLE

These columns describe the sample type and number, the "N" value, the water content, the percentage recovery, and Rock Quality Designation (RQD), of each sample obtained from the borehole where applicable. The information is recorded at the approximate depth at which the sample was obtained. The legend for sample type is explained below.

SS =	Split Spoon	GS =	Grab Sample
TW =	Thin Walled Shelby Tube	CS =	Channel Sample
AS =	Auger Flight Sample	WS =	Wash Sample
CC =	Continuous Core	RC =	Rock Core
PH =	TW Advanced Hydraulically		

$$\% \text{ Recovery} = \frac{\text{Length of Core Recovered Per Run}}{\text{Total Length of Run}} \times 100$$

Where rock drilling was carried out, the term RQD (Rock Quality Designation) is used. The RQD is an indirect measure of the number of fractures and soundness of the rock mass. It is obtained from the rock cores by summing the length of core recovered, counting only those pieces of sound core that are 100 mm or more in length. The RQD value is expressed as a percentage and is the ratio of the summed core lengths to the total length of core run. The classification based on the RQD value is given below.

RQD Classification	RQD (%)
Very poor quality	< 25
Poor quality	25 - 50
Fair quality	50 - 75
Good quality	75 - 90
Excellent quality	90 - 100

TEST DATA

The central section of the log provides graphs which are used to plot selected field and laboratory test results at the depth at which they were carried out. The plotting scales are shown at the head of the column.

Dynamic Penetration Resistance - The number of blows required to advance a 51 mm diameter, 60º steel cone fitted to the end of 45 mm OD drill rods, 0.3 m into the subsoil. The cone is driven with a 63.5 kg hammer over a fall of 750 mm.

Standard Penetration Resistance - Standard Penetration Test (SPT) "N" Value - The number of blows required to advance a 51 mm diameter standard split-spoon sampler 300 mm into the subsoil, driven by means of a 63.5 kg hammer falling freely a distance of 750 mm. In cases where the split spoon does not penetrate 300 mm, the number of blows over the distance of actual penetration in millimetres is shown as $\frac{xBlows}{mm}$

Water Content - The ratio of the mass of water to the mass of oven-dry solids in the soil expressed as a percentage.

W_P - Plastic Limit of a fine-grained soil expressed as a percentage as determined from the Atterberg Limit Test.

W_L - Liquid Limit of a fine-grained soil expressed as a percentage as determined from the Atterberg Limit Test.

REMARKS

The last column describes pertinent drilling details, field observations and/or provides an indication of other field or laboratory tests that were performed.

RECORD OF BOREHOLE No BH12-1

1 OF 1

METRIC

LOCATION MISSANABIE CORNERS PATROL YARD N 5 314 093.7 E 715 225.3 ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT, AND NQ CORING COMPILED BY DCL

DATUM RELATIVE BENCHMARK DATE 6.13.12 - 6.13.12 CHECKED BY JSA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
99.4											
0.0	**SAND AND GRAVEL:** SAND AND GRAVEL, TRACE SILT BROWN, MOIST		1	AS			99		○		39 59 (2)
97.9							98				
1.5	**BEDROCK:** PINK, GREY, AND BLACK BANDED GRANITIC GNEISS, FINE-MEDIUM GRAINED, MODERATE TO STRONG FOLIATION, HARD, STRONG, SLIGHTLY WEATHERED		1	RC	TCR 83%	▼					RQD = 69%
			2	RC	TCR 100%		97				RQD = 100%
			3	RC	TCR 97%		96				RQD = 91%
			4	RC	TCR 98%		95				RQD = 86%
			5	RC	TCR 100%		94				RQD = 88%
			6	RC	TCR 100%		93				RQD = 100%
			7	RC	TCR 97%		92				RQD = 91%
89.0							91				
10.4	END OF BOREHOLE						90				
							89				

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

ONTARIO MOT SEABROOK BHLOGS NEW.GPJ ONTARIO MOT.GDT 11/1/12

RECORD OF BOREHOLE No BH12-2 1 OF 1 METRIC

LOCATION MISSANABIE CORNERS PATROL YARD N 5 314 074.4 E 715 215.2 ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT, AND NQ CORING COMPILED BY DCL

DATUM RELATIVE BENCHMARK DATE 6.12.12 - 6.12.12 CHECKED BY JSA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
99.1											
0.0 / 98.6	**GRAVELLY SAND:** GRAVELLY SAND, SOME SILT BROWN, COMPACT, MOIST		1	SS	30		99		○		
0.5	END OF BOREHOLE										

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

ONTARIO MOT SEABROOK BHLOGS NEW.GPJ ONTARIO MOT.GDT 11/1/12

RECORD OF BOREHOLE No BH12-3

1 OF 1 **METRIC**

LOCATION MISSANABIE CORNERS PATROL YARD N 5 314 067.2 E 715 228.5 ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT, AND NQ CORING COMPILED BY DCL

DATUM RELATIVE BENCHMARK DATE 6.12.12 - 6.12.12 CHECKED BY JSA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
99.2											
0.0	**SAND AND GRAVEL** SAND AND GRAVEL, TRACE SILT BROWN, MOIST		1	AS			99		○		43 50 (7)
98.3			2	SS	50				○		
0.9	**BEDROCK** PINK, GREY, AND BLACK BANDED GRANITIC GNEISS, FINE-MEDIUM GRAINED, MODERATE TO STRONG FOLIATION, HARD, STRONG, SLIGHTLY WEATHERED		1	RC	TCR 100%		98				RQD = 0%
			2	RC	TCR 100%		97				RQD = 76%
			3	RC	TCR 100%		96				RQD = 87%
94.8							95				
4.4	END OF BOREHOLE										

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

ONTARIO MOT SEABROOK BHLOGS NEW.GPJ ONTARIO MOT.GDT 11/1/12

RECORD OF BOREHOLE No BH12-4

1 OF 1 **METRIC**

LOCATION MISSANABIE CORNERS PATROL YARD N 5 314 087.1 E 715 238.3 ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT, AND NQ CORING COMPILED BY DCL

DATUM RELATIVE BENCHMARK DATE 6.12.12 - 6.12.12 CHECKED BY JSA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
99.3											
0.0	**GRAVELLY SAND:** GRAVELLY SAND, SOME SILT BROWN, MOIST		1	AS			99		○		
98.1			2	SS	24				○		
1.2	END OF BOREHOLE										

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

ONTARIO MOT SEABROOK BHLOGS NEW.GPJ ONTARIO MOT.GDT 11/1/12

RECORD OF BOREHOLE No BH12-5

1 OF 1 **METRIC**

LOCATION MISSANABIE CORNERS PATROL YARD N 5 314 062.9 E 715 236.7 ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT, AND NQ CORING COMPILED BY DCL

DATUM RELATIVE BENCHMARK DATE 6.11.12 - 6.11.12 CHECKED BY JSA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
99.0											
0.0	**SAND:** FINE SAND, SOME GRAVEL BROWN, COMPACT, MOIST		1	SS	19				○		
98.1			2	SS	100		98				
0.9	**BEDROCK:** PINK, GREY, AND BLACK BANDED GRANITIC GNEISS, FINE-MEDIUM GRAINED, MODERATE TO STRONG FOLIATION, HARD, STRONG, SLIGHTLY WEATHERED		1	RC	TCR 100%						RQD = 76%
			2	RC	TCR 100%		97				RQD = 79%
							96				
			3	RC	TCR 100%						RQD = 71%
94.6							95				
4.3	END OF BOREHOLE										

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

ONTARIO MOT SEABROOK BHLOGS NEW.GPJ ONTARIO MOT.GDT 11/1/12

RECORD OF BOREHOLE No BH12-6

1 OF 1

METRIC

LOCATION MISSANABIE CORNERS PATROL YARD N 5 314 066.4 E 715 247.1 ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT, AND NQ CORING COMPILED BY DCL

DATUM RELATIVE BENCHMARK DATE 6.12.12 - 6.13.12 CHECKED BY JSA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
99.1											
0.0 98.7	**SAND:** FINE SAND, SOME GRAVEL, BROWN, MOIST		1	AS					○		
0.4	**BEDROCK:** PINK, GREY, AND BLACK BANDED GRANITIC GNEISS, FINE-MEDIUM GRAINED, MODERATE TO STRONG FOLIATION, HARD, STRONG, SLIGHTLY WEATHERED		1	RC	TCR 100%		98				RQD = 94%
			2	RC	TCR 100%	▼	97				RQD = 89%
			3	RC	TCR 98%		96				RQD = 86%
			4	RC	TCR 100%		95				RQD = 90%
			5	RC	TCR 100%		94				RQD = 75%
			6	RC	TCR 100%		93				RQD = 100%
89.4			7	RC	TCR 100%		92 91 90				RQD = 94%
9.7	END OF BOREHOLE										

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

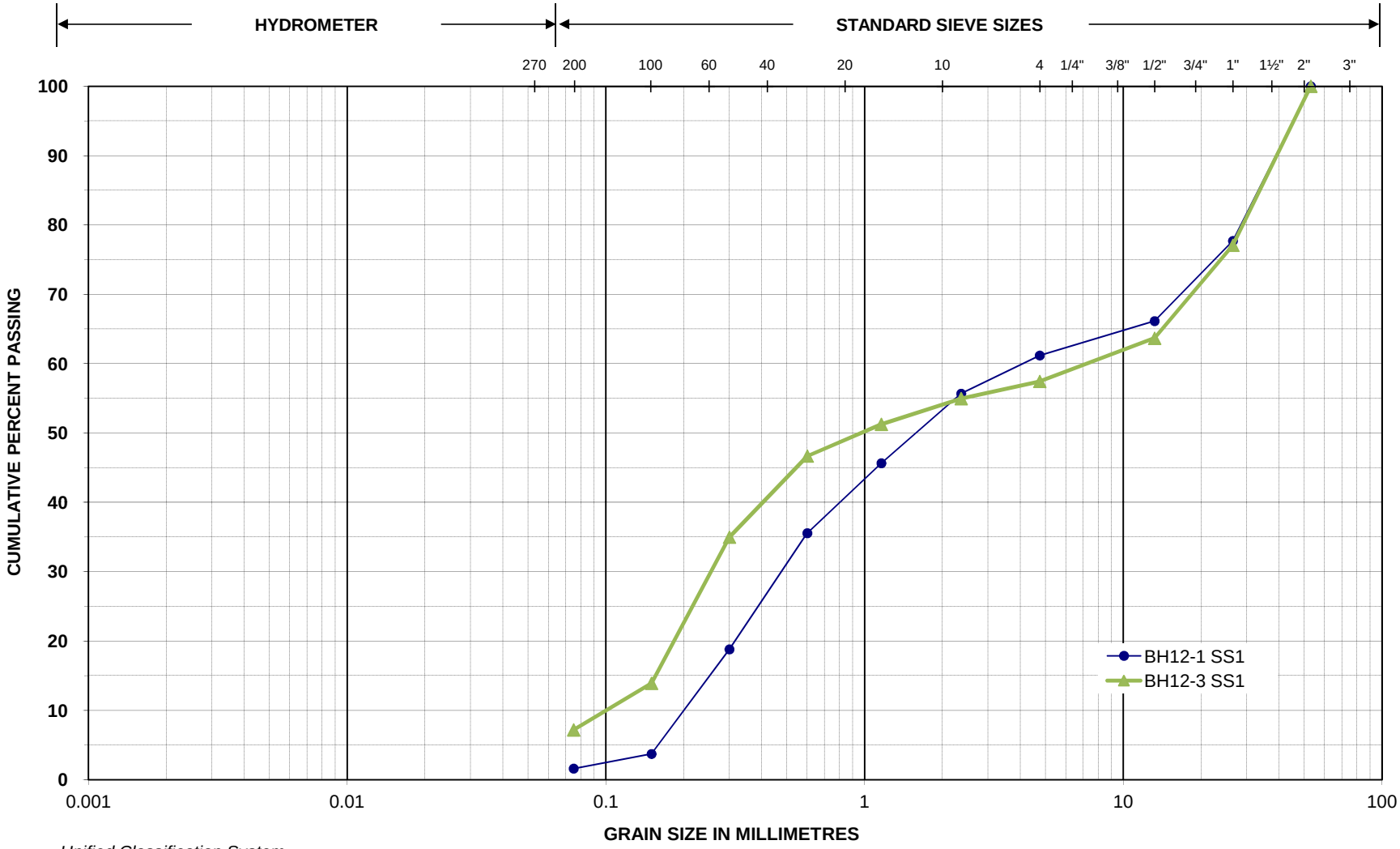
ONTARIO MOT SEABROOK BHLOGS NEW.GPJ ONTARIO MOT.GDT 11/1/12

Appendix B

Particle Size Distribution Analyses (Figure B1)

GENIVAR

PARTICLE SIZE DISTRIBUTION ASTM D422



Unified Classification System

SILT AND CLAY	SAND	GRAVEL

Project Name:	Missanabie Corners Patrol Yard	**Project No.:**	121-17876-00	**Figure No.:**	**B1**
Remarks	Sand and gravel, trace silt				

Appendix C

Site Photographs

Rock Core Photographs

Photograph 1: Site access and granular pad. Looking southwest.

Photograph 2: Granular pad and surrounding forest. Looking northwest.

Photograph 3: Granular pad. Looking south.

Photograph 4: Granular pad and drilling. Looking east.

Photograph 5: BH12-6 (MW1). Exposed bedrock. Looking south.

Photograph 6: BH12-1 (MW2). Looking north.

MTO AGREEMENT #5011-E-0010
MISSANABIE CORNERS PATROL YARD – ROCK CORE

Photograph 1: BH12-1 Rock Core (1.52 m to 4.04 m).

Photograph 2: BH12-1 Rock Core (4.04 m to 8.92 m).

MTO AGREEMENT #5011-E-0010
MISSANABIE CORNERS PATROL YARD – ROCK CORE

Photograph 3: BH12-1 Rock Core.

Photograph 4: BH12-1 Rock Core (8.92 m to 10.41 m).

Rock Cored June 11 TO June 13, 2012
Photographs taken July 26, 2012

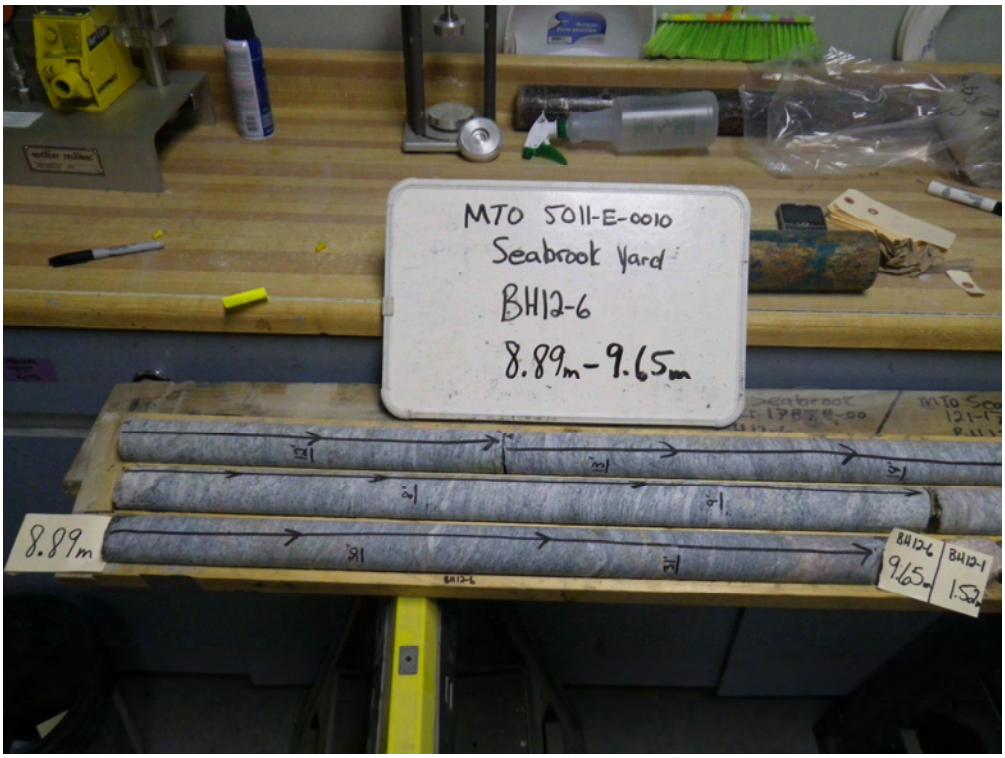
Photograph 5: BH12-3 Rock Core (0.91 m to 4.39 m).

Photograph 6: BH12-5 Rock Core (0.91 m to 4.34 m).

Photograph 7: BH12-6 Rock Core (0.38 m to 4.4 m).

Photograph 8: BH12-6 Rock Core.

Photograph 9: BH12-6 Rock Core (4.4 m to 8.89 m).



Photograph 10: BH12-6 Rock Core (8.89 m to 9.65 m).