

**MTO Agreement No. 5011-E-0010
WO No. 2011-11032
Proposed Sand/Salt Storage Facility
Kenogami Patrol Yard
Foundation Investigation Report**

Geocres No. 42A-93

February 2013

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



Project No. 121-17876-00

February 20, 2013

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.: 2011-11032
Proposed Sand/Salt Storage Facility – Kenogami Patrol Yard
Foundation Investigation Report (Geocres No. 42A-93)**

Dear Mr. Perron:

We are pleased to submit our Foundation Investigation Report for the proposed Sand/Salt Storage Facility at the Ontario Ministry of Transportation Northeastern Region (MTO) Kenogami Patrol Yard in Kenogami, 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.

A handwritten signature in blue ink, appearing to read "J. Stephen Ash", with a stylized flourish at the end.

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

Table of Contents

Transmittal Letter
Table of Contents

1.	INTRODUCTION	1-1
2.	SITE DESCRIPTION AND REGIONAL GEOLOGY	2-1
2.1	Site Description	2-1
2.2	Regional Geology	2-1
3.	HISTORIC REPORT REVIEW	3-1
4.	INVESTIGATION PROCEDURES	4-1
4.1	Subsurface Investigation	4-1
4.2	Laboratory Testing	4-2
5.	SUBSURFACE CONDITIONS	5-1
5.1	Soil Profile Summary	5-1
5.1.1	Asphalt Pavement	5-1
5.1.2	Granular Fill	5-1
5.1.3	Till	5-1
5.1.4	Bedrock	5-2
5.2	Groundwater Conditions	5-2
6.	MISCELLANEOUS INFORMATION	6-1
7.	CLOSURE	7-1

Drawings

Drawing 1	Borehole Location Plan
Drawing 2	Soil Strata

Tables

Table 4-1	Borehole Numbers, Drilling Depths and Elevations	4-2
Table 4-2	Soil Testing Program – Kenogami Patrol Yard	4-2
Table 5-1	Rock Core (RC) Description, RQD, and Recovery Data	5-2
Table 5-2	Summary of Groundwater Levels	5-3
Table 6-1	Summary of Task Responsibilities and Personnel	6-1

Appendices

- Appendix A Borehole Explanation Forms, Borehole Logs
- Appendix B Summary of Particle Size Distribution Results (Table B1), Particle Size Distribution Analyses (Figures B1 to B3)
- Appendix C Site Photographs, Rock Core Photographs

1. Introduction

GENIVAR Inc. (GENIVAR) was retained by the Ontario Ministry of Transportation Northeastern Region (MTO) to undertake a foundation investigation for the proposed construction of a sand/salt storage facility at the Kenogami Patrol Yard, located on Highway 11, 0.5 kilometres north of the junction of Highway 11 and Highway 66 in Kenogami, 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 foundation investigation was conducted in accordance with MTO Agreement #5011-E-0010. The Foundation Investigation Report is a factual report containing the results of the foundation investigation carried out at the Kenogami 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 Kenogami Patrol Yard (site) is located 0.5 kilometres north of the junction of Highway 11 and Highway 66 in the Township of Eby, Ontario. A Site Plan is included as Drawing 1 and colour photographs of the site are included in Appendix C.

The site is level along the east and west sides, and gently slopes toward the centre to a ditch that drains along the north perimeter of the site to a swampy area in the east. There is ponded water to the east of the existing garage at the time of the investigation, and an elevated laydown area to the south. Access to the site is from Highway 11 and the surrounding land uses is rural (forested area consisting of mixed deciduous and coniferous trees). No exposed bedrock was visible onsite.

The site is an operational MTO Patrol Yard, and is currently occupied by a number of structures, including:

- 8-bay garage / office;
- 1 large sand dome;
- 1 small salt dome;
- 1 well;
- 1 horseshoe pit;
- 1 tile bed;
- 2 site trailers;
- 1 oil / water separator; and
- 1 above ground diesel fuel storage tank.

There is a paved driveway from Highway 11 to the garages and extending back to the sand / salt domes.

2.2 Regional Geology

Two different map sources were consulted to determine the regional geology in the Kenogami area: i) Geology and Map of Ontario published by the Ministry of Northern Development and Mines (Map 2543 east Central Sheet) ii) Miscellaneous Release Data 160 of 'Northern Ontario Engineering Geology Terrain Study Data Base Map' published by the Ministry of Natural Resources (MNR).

Based on the mapping information, the site is located within a ground moraine between a bedrock knob and a bedrock ridge. Local soil deposits are comprised of stony till underlain by ridged bedrock terrain. The local bedrock is Precambrian age and reportedly consists of mafic intrusive and clastic metasedimentary rocks. Conglomerate metasedimentary rock was encountered in two of the boreholes in the current site investigation, thereby confirming the actual bedrock types below the site and proposed structure.

3. Historic Report Review

Two (2) previous geotechnical reports for the Kenogami Patrol yard were obtained from the MTO Geocres Library in Downsview, Ontario. The first report, entitled '*Foundation Investigation Report for W.P. 24-82-02, Site 47-009, Blanche River Bridge in Kenogami, Highway 11, District 14, New Liskeard*' (Geocres 42A-34) was completed in 1982 as part of a foundation investigation for the proposed bridge replacement near the site. The second report, entitled '*Final Foundation Investigation Report – Culvert Station 15+675 – TWP. of Eby, GWP 162-98-00 MEL SITE A*' (Geocres 42A-80) was completed in 2010 as part of a subsurface investigation for the replacement of a single 610 millimetre (mm) diameter culvert.

The geotechnical investigation conducted in 1982 was completed at the Blanche River Highway 11 crossing. Work was comprised of sampling seven (7) boreholes supplemented by 13 dynamic cone penetration tests (DCPT's). The soil stratigraphy at the site consisted of a 1.7 metre (m) to 5.4 m thick silty sand and silt with occasional silty clay, underlain by bedrock. An average SPT N value of 2 per 300 mm was recorded in the top 1.5 m of the soil profile, increasing to 60 below. Bedrock was cored at all seven (7) locations at elevations between 295.9 metres above sea level (mASL) and 300.2 mASL, and was described as a slate like material with igneous and metamorphic rock fragments.

The geotechnical investigation conducted in 2010 consisted of sampling three (3) boreholes supplemented by the same number of DCPT. The soil stratigraphy at the site consisted of approximately 0.3 m to 0.8 m of peat, underlain by silt, silty clay, sand, and embankment fill. SPT N values between 6 and 44 blows per 300 mm were recorded on the silt layer, while SPT N values between 62 blows per 300 mm and 88 blows per 250 mm were recorded in the sand layer. No bedrock was encountered in the boreholes. Groundwater was observed in the boreholes at the time of the investigation, and elevations were recorded as 306.3 mASL and 306.4 mASL.

4. Investigation Procedures

4.1 Subsurface Investigation

A borehole investigation was performed at the subject site between September 17 and September 18, 2012. The investigation consisted of advancing four (4) exploratory boreholes, designated as BH12-1 through BH12-4, commencing from existing ground level. Borehole locations are shown on Drawing 1 and were located at each of the four corners of the proposed storage structure, as required by the Terms of Reference for the assignment.

MTO minimum requirements for the borehole investigation outlined a maximum drilling depth of 10.0 m, unless refusal was encountered at shallower depth, or justification for deeper drilling was authorized by the MTO Project Manager. The augering in boreholes BH12-1 to BH12-4, was terminated at a depth that ranged between 3.7 to 7.9 m at presumed bedrock or very dense glacial till material. Bedrock was core sampled at boreholes BH12-2 and BH12-3. Dynamic Cone Penetration Tests (DCPT's) were driven to refusal at borehole BH12-4, which occurred at 5.6 m below ground surface (mbgs).

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). Borehole elevations were surveyed to a temporary benchmark: an anchor nail set in the asphalt located east of borehole BH12-3 was used as a temporary bench mark with an elevation of 100.00 m. Borehole elevations and coordinates are shown on Drawing 1, and are provided on the borehole logs included in Appendix A.

Drilling and soil sampling were completed using a truck-mounted drill rig operating under the supervision of an experienced GENIVAR soils technician. The boreholes were advanced to the 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). Refusal depth for the purposes of this investigation was defined in the MTO Terms of Reference as the depth at which SPT N values exceed 100 blows for 305 mm of penetration. SPT N values are used in this report to assess consistency for cohesive soils and relative density for non-cohesive materials.

Soil samples were collected using SPT procedures at approximately 0.75 m intervals to 5.0 m depth, and at 1.5 m intervals thereafter to the termination depth, which was less than 20 m, as per the Terms of Reference. The sampled soil materials from discrete 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.

DCPT's were completed below 3.7 m depth in borehole BH12-4. In the DCPT, a 51 mm diameter, 60° Apex cone point, screw-attached to the tip of A-size rods, is driven into the ground using the same driving energy as in the SPT method. By recording the number of blows to drive the cone/rod assembly into the soil every 305 mm, a qualitative record of relative density/consistency is obtained. Although the interpretation of the test results may be difficult because no soil samples are obtained through this method, and the penetration resistances are not necessarily equivalent to N values or undrained shear strengths, useful information is gained by the continuity of the results and by the elimination of unbalanced hydrostatic effects which may affect SPT N values. In some deposits, soil adhesion to the drill rod assembly may affect DCPT results, and therefore should be taken into account in the geotechnical assessments. Groundwater conditions within the boreholes were observed during drilling, prior to backfilling

NQ-size coring equipment (47.6 mm diameter) was used to obtain 2.3 m and 3.2 m thick bedrock core samples at boreholes BH12-2 and BH12-3, respectively. 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.

All boreholes were backfilled with drill cuttings mixed with bentonite hole plug, and the top portion of the boreholes was sealed with emulsified asphalt. The backfill material was compacted with the drill rig. As such, the boreholes were 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) / Relative Elevation (m)	Dynamic Cone Penetration Test Depth (m)	Comment
BH12-1	7.9/ 92.1	-	-
BH12-2	5.1/ 94.8	-	Cored into bedrock (depth from 5.1 m to 7.4 m below existing grade)
BH12-3	5.7/ 94.2	-	Cored into bedrock (depth from 5.7 m to 8.9 m below existing grade)
BH12-4	3.7 / 96.2	3.7 m to 5.6 m	-

Note: Elevations are relative to benchmark described above on page 4-1.

4.2 Laboratory Testing

The following soil testing program, as summarized in Table 4.2, was completed on selected soil samples to confirm the textural classifications and provide geotechnical parameters of the encountered materials.

Table 4-2: Soil Testing Program – Kenogami Patrol Yard

Test	ASTM Standard	Number of Samples
Natural Moisture Content	ASTM D2216	22
Particle Size Analysis	ASTM D422	7

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.

5. Subsurface Conditions

The subsurface conditions were explored at the four (4) borehole locations designated as BH12-1 to BH12-4. Borehole locations are shown in Drawing 1 while the soil strata is provided in two cross sections presented on Drawing 2. Detailed borehole logs are provided in Appendix A, and laboratory test results with the summary tables are included in Appendix B.

5.1 Soil Profile Summary

The boreholes encountered a thin layer of asphalt overlying loose to compact granular fill overlying a compact to dense sand till consisting mainly of sand some silt to silty sand material which in turn is underlain by bedrock. Bedrock was core sampled in boreholes BH12-2 and BH12-3. Dynamic Cone Penetration Testing (DCPT) advanced in borehole BH12-4 from a depth of 3.7 m to 5.6 m below the ground surface indicates the same very dense deposit (presumed till). Descriptions of the individual soil units are provided in the following subsections.

5.1.1 Asphalt Pavement

A 65 mm thick layer of asphaltic concrete (hot laid mix) was encountered from the surface at boreholes BH12-1 and BH12-2.

5.1.2 Granular Fill

Below the asphalt pavement at boreholes BH12-1 to BH12-2 and at the surface of boreholes BH12-3 and BH12-4, a granular fill layer was encountered consisting of gravelly sand to sand with some gravel, extending to depths of between 0.8 m at borehole BH12-2 and 1.4 m at boreholes BH12-1, BH12-3 and BH12-4.

A laboratory particle size distribution analysis for a sample of the fill layer was 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) - 20 %
- Sand (0.075 mm to 4.75 mm size) - 75 %
- Silt and Clay (less than 0.075 mm size) - 5 %

Standard Penetration Test results (N Values) recorded in the fill layer ranged between 5 and 15 blows per 305 mm of penetration, indicating loose to compact relative density.

Laboratory determined moisture contents ranged between 9 % and 12 % for samples of the fill, indicating moist material.

5.1.3 Till

Underlying the granular fill layer in boreholes BH12-1 to BH12-4, a glacial till material was encountered extending to depths (metres below ground surface; mbgs) and relative elevations shown below:

<u>Borehole No.</u>	<u>Inferred Depth to Bottom of Till Layer (Relative Elevation)</u>
BH12-1	7.9 mbgs (92.1 m)
BH12-2	5.1 mbgs (94.8 m)
BH12-3	5.7 mbgs (94.2 m)
BH12-4	5.6 mbgs (94.3 m)

Based on sample inspections and testing, the texture of the till layer was predominantly sand with some silt, to silty sand with a trace to some gravel and clay. Boreholes BH12-2 and BH12-3 were terminated on the surface of the bedrock and subsequently cored. Boreholes BH12-1 and BH12-4 were terminated at depths 7.9 m and 3.7 m, respectively due to auger refusal. DCPT was performed below the borehole termination depth of 3.7 m at borehole BH12-4, and extended to a depth of 5.6 m below ground surface. Refusal, defined by MTO as 100 blows per 305 mm of penetration, was encountered at a depth of 5.6 m below ground surface (elevation 94.3 m) in very dense material.

Laboratory particle size distribution analyses for six (6) samples of the till material was completed, and results are summarized below and shown in Figures B2 and B3 of Appendix B:

- Gravel (greater than 4.75 mm size) - 6 % to 18 %
- Sand (0.075 mm to 4.75 mm size) - 51 % to 78 %
- Silt and Clay (less than 0.075 mm size) - 13 % to 41 %

Standard Penetration Test results (N Values) recorded in the till deposit ranged between 5 and 38 blows per 305 mm of penetration, indicating loose to dense relative density, but generally in compact condition.

5.1.4 Bedrock

Bedrock core samples were taken in boreholes BH12-2 and BH12-3, and were 2.3 m and 3.2 m long, respectively. Borehole BH12-2 was terminated at 7.4 m depth below ground surface (relative elevation 92.5 m) and BH12-3 was terminated at 8.9 m depth (relative elevation 91.0 m). Photographs of the bedrock cores are included in Appendix C.

Descriptions of the bedrock are provided in Table 5.1 and the borehole logs. Total Core Recovery (TCR) ranged from 92 % to 100 %. Rock Quality Designation (RQD) values for the core samples in borehole BH12-2 ranged from 45 % to 87 %, which is described as poor to good rock quality. The RQD values for borehole BH12-3 ranged between 0 % and 67%, described as very poor to fair rock quality.

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

BH	RC #	Depth (m)	TCR (%)	RQD (%)	Depth (m)	Description
12-2	1	5.1 – 5.9	100	45	5.1 – 7.4	CONGLOMERATE, grey with subangular to subrounded clasts in fine-grained matrix, occasional secondary quartz carbonate.
	2	5.9 – 7.4	100	87		
12-3	1	5.7 – 6.5	100	0	5.7 – 8.9	CONGLOMERATE, grey with subangular to subrounded clasts in fine-grained matrix, occasional secondary quartz carbonate
	2	6.5 – 7.5	92	67		
	3	7.5- 8.9	100	60		

5.2 Groundwater Conditions

Groundwater conditions were observed in the open boreholes upon completion of drilling. 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	2.4 (97.6)	17 September 2012
BH12-2	2.5 (97.3)	18 September 2012
BH12-3	2.5 (97.4)	18 September 2012
BH12-4	2.5 (97.4)	18 September 2012

Note: mbgs = metres below ground surface.

Based on the water level measurements, moisture conditions, and changing color and/or staining of the inspected soil samples, the groundwater level within the footprint of the proposed structure, at the time of the field investigation, was estimated to be at 2.5 m below ground surface (relative elevation 97.6 m to 97.3 m). It should be noted that groundwater levels may fluctuate seasonally and in response to climatic conditions.

6. Miscellaneous Information

The following GENIVAR personnel and subcontractors responsible for completion of this foundation 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	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 Low Complexity	Kelly Whitney, C.E.T. GENIVAR Inc.	Peterborough, ON	705-743-6850
Report Preparation	Raid Khamis, P. Eng., PMP. 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, M.A.Sc., P. Eng. GENIVAR Inc.	Newmarket, ON	905-853-3303

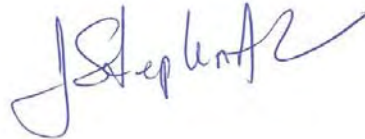
7. Closure

The data presented in this foundation investigation 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.



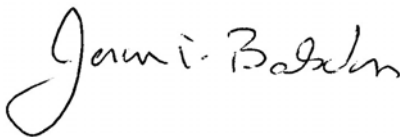
Raid Khamis, P. Eng., PMP.
Geotechnical Engineer



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



Reviewed by:

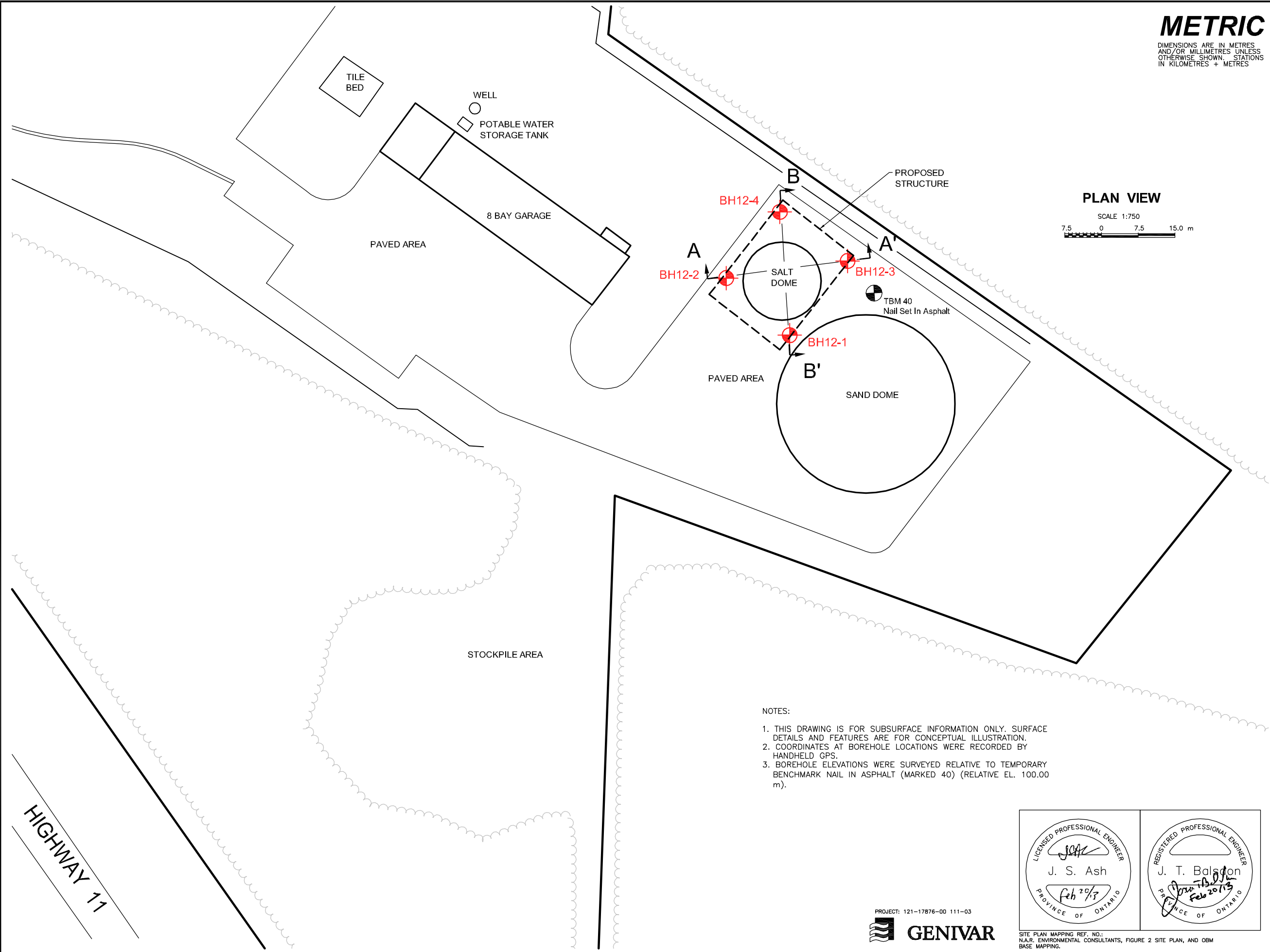


Jason Balsdon, M.A.Sc., P. Eng.
Director, Environment

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

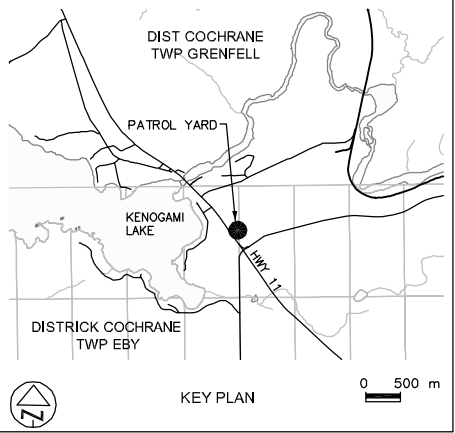
Agreement No.: 5011-E-0010
WO No.: 2011-11032

BOREHOLE LOCATION PLAN
PROPOSED SAND/SALT STORAGE
FACILITY
KENOGAMI PATROL YARD
HIGHWAY 11

Client: MTO - Northeastern Region

DRAWING

1



LEGEND

- Borehole and Cone
- Temporary Benchmark (Assumed 100.00 m)
- Proposed Sand/Salt Storage Facility
- A-A' Line of Cross Section (See Figure 2)

BH No	ELEVATION (Relative m)	COORDINATES (NAD 83 Zone17)	
		NORTHING	EASTING
12-1	99.995	5327387.5	560390.5
12-2	99.833	5327399.1	560377.6
12-3	99.985	5327402.6	560402.4
12-4	99.891	5327412.6	560388.5

- NOTES:
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
 - COORDINATES AT BOREHOLE LOCATIONS WERE RECORDED BY HANDHELD GPS.
 - BOREHOLE ELEVATIONS WERE SURVEYED RELATIVE TO TEMPORARY BENCHMARK NAIL IN ASPHALT (MARKED 40) (RELATIVE EL. 100.00 m).

LICENSED PROFESSIONAL ENGINEER
J. S. Ash
Feb 20/13
PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER
J. T. Balsdon
Feb 20/13
PROVINCE OF ONTARIO

— 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.

REVISIONS

DATE	BY	DESCRIPTION

GEOCRES No. 42A-93

HWY No 11

SUBM'D ---

DRAWN PLB

CHECKED JSA

CHECKED ---

CHECKED ---

DATE FEBRUARY 2013

APPROVED ---

APPROVED ---

SITE ---

DWG ---



SOIL STRATA
PROPOSED SAND/SALT STORAGE
FACILITY
KENOGAMI PATROL YARD
HIGHWAY 11

Client: MTO - Northeastern Region

DRAWING

2

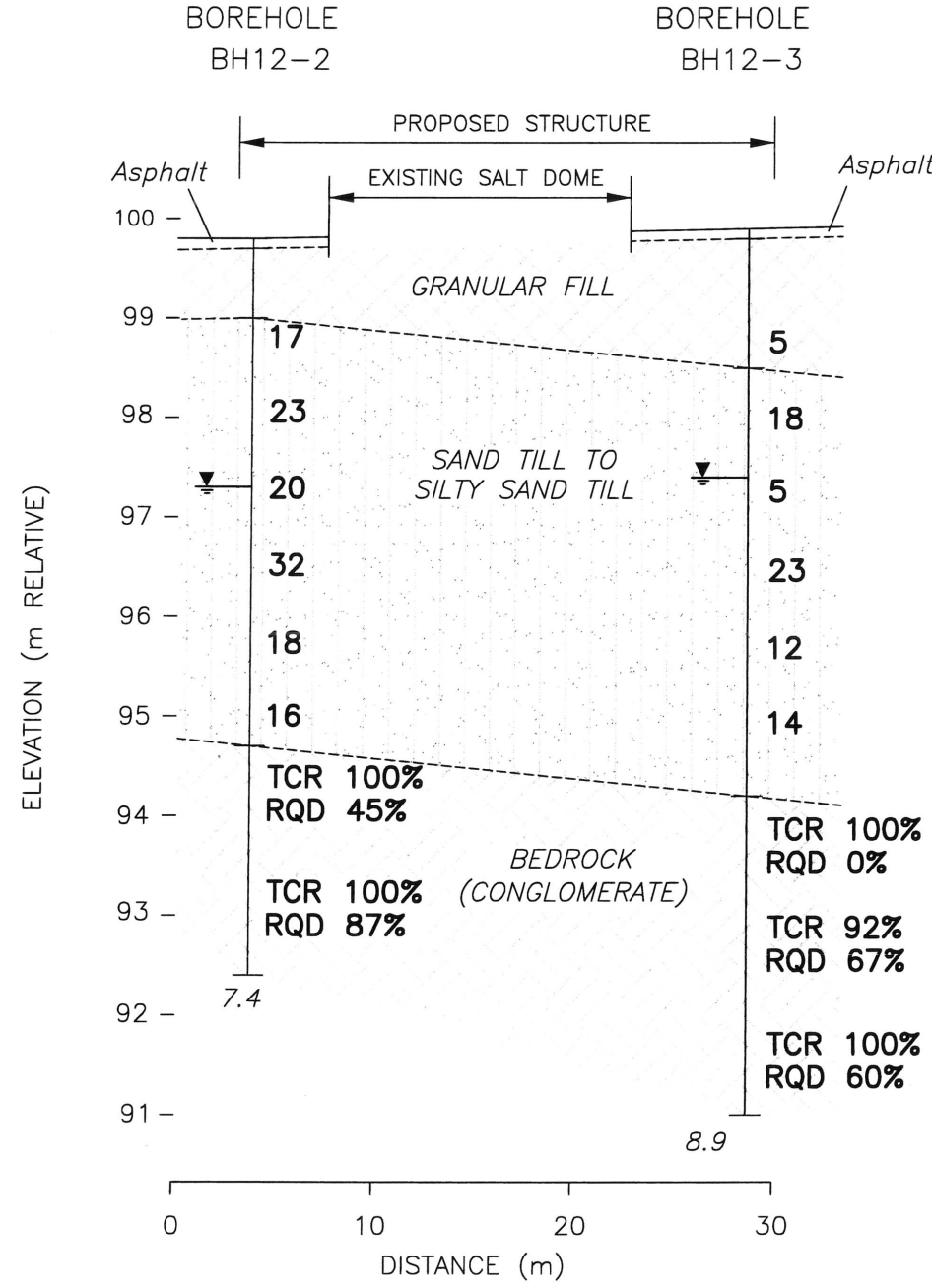
CROSS SECTION A-A'

A
West

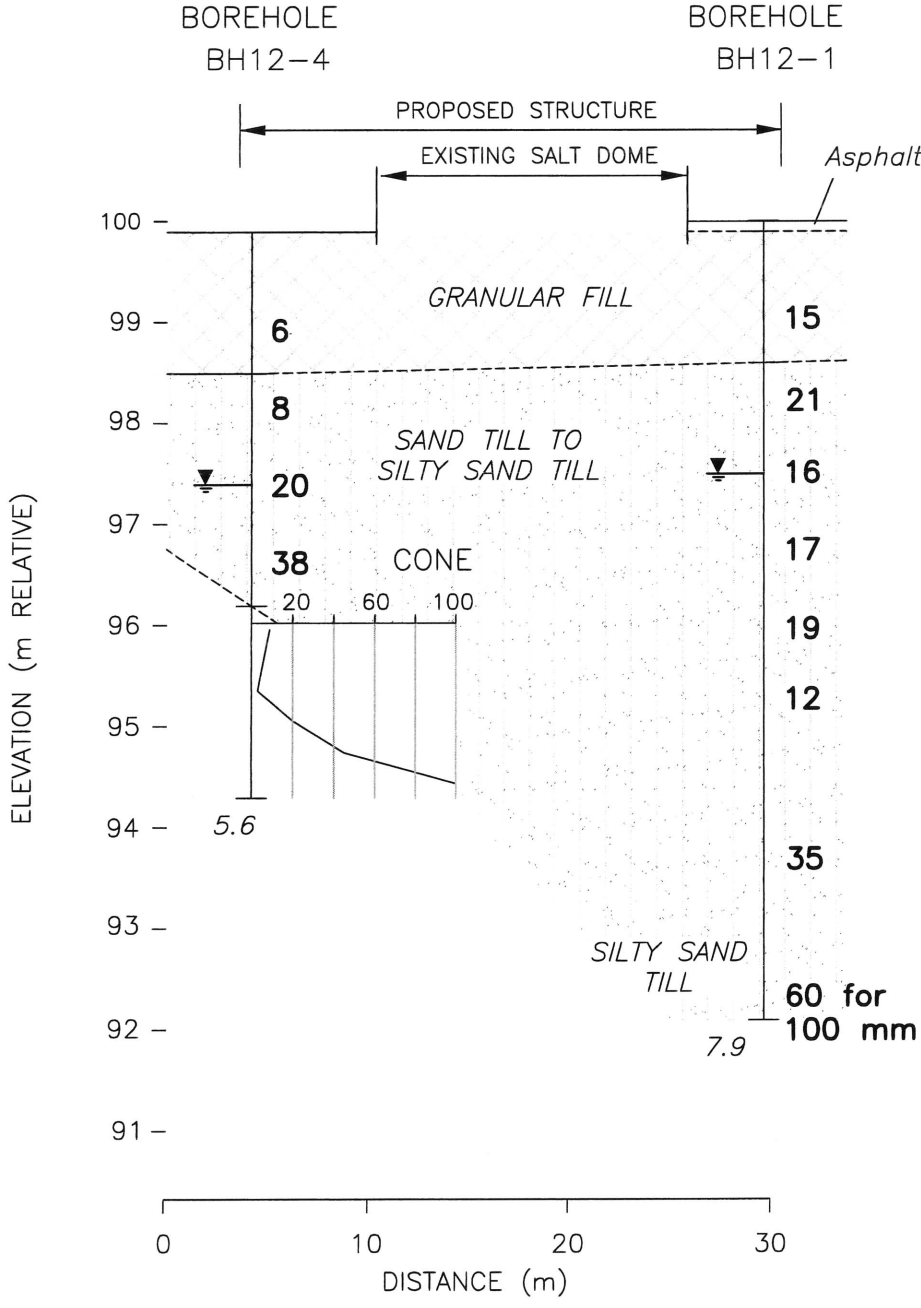
A'
East

B
North

B'
South



CROSS SECTION B-B'



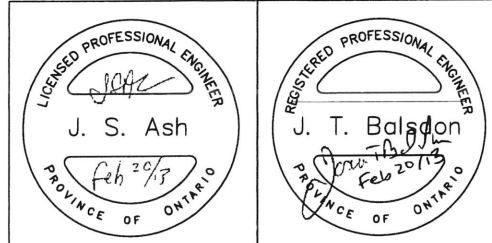
- NOTES:
1. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
 2. COORDINATES AT BOREHOLE LOCATIONS WERE RECORDED BY HANDHELD GPS.
 3. BOREHOLE ELEVATIONS WERE SURVEYED RELATIVE TO TEMPORARY BENCHMARK NAIL IN ASPHALT (MARKED 40) (RELATIVE EL. 100.00 m).

LEGEND			
N	Blows/0.3m (Std. Pen Test, 475 J / blow)		
CONE	Blow/0.3m (60' Cone, 475 J / blow)		
	Water Level At Time Of Investigation		
BH No	ELEVATION (Relative m)	COORDINATES (NAD 83 Zone17)	
		NORTHING	EASTING
12-1	99.995	5327387.5	560390.5
12-2	99.833	5327399.1	560377.6
12-3	99.985	5327402.6	560402.4
12-4	99.891	5327412.6	560388.5

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.

DATE	BY	DESCRIPTION

GEOQUES No. 42A-93			
HWY No 11	SITE		DIST COCHRANE
SUBMD	CHECKED JSA	DATE FEBRUARY 2013	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.

<u>Soil Classification*</u>		<u>Terminology</u>	<u>Proportion</u>
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:

<u>COHESIONLESS SOIL</u>		<u>COHESIVE SOIL</u>		
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

Dry
Moist
Wet
Saturated

COHESIVE SOILS











DTPL - Drier Than Plastic Limit
APL - About Plastic Limit
WTPL - Wetter Than Plastic Limit
MWTP - 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.

	Standpipe		Geotextile Material / Liner		Granular Backfill
	Piezometer		Borehole Seal (Bentonite Grout)		Granular (Filter) Pack
	Screened Interval		Cement Seal		Native Soil Backfill / Cave / Slough
	Borehole Seal (Peltonite, Bentonite or Hole Plug)				

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	TRC = Total Core Recovery

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

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 ClassificationRQD (%)

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, 60° 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 $\frac{x\text{Blows}}{\text{mm}}$

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 KENOGAMI PATROL YARD N 5327387 5; E 560390 5

ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT AND DCPT

COMPILED BY JW

DATUM GEODETTIC DATE 9 17 12 - 9 17 12

CHECKED BY RK

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 (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						× LAB VANE		
100.0																		
98.9	ASPHALT: 65 mm THICK		1	AS														
	GRANULAR FILL: GRAVELLY SAND BROWN, COMPACT, MOIST		2	SS	15													
98.6																		
1.4	SAND TILL: FINE SAND SOME SILT TO SILTY SAND, TRACE TO SOME GRAVEL, TRACE CLAY BROWN, COMPACT TO DENSE, SATURATED		3	SS	21													
			4	SS	16													
			5	SS	17													
			6	SS	19													
			7	SS	12													
			8	SS	35													

ONTARIO MOT 121-17876-Q3 KENOGAMI GINT GPJ ONTARIO MOT GDT 2/13/13

RECORD OF BOREHOLE No BH12-2

1 OF 1

METRIC

LOCATION KENOGAMI PATROL YARD N5327399 1: E 560377 6

ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT AND DCPT

COMPILED BY JW

DATUM GEODETTIC DATE 9.18.12 - 9.18.12

CHECKED BY RK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	W _p W W _L					
99.8	ASPHALT: 65 mm THICK			AS			20 40 60 80 100						GR SA SI CL	
99.1	GRANULAR FILL: GRAVELLY SAND BROWN, MOIST		1	SS	17		99							
0.8	SAND TILL: FINE SAND, SOME SILT TO SILTY SAND, TRACE TO SOME GRAVEL, TRACE CLAY BROWN TO GREY COMPACT TO DENSE, MOIST TO SATURATED - SATURATED BELOW 2.5 m DEPTH		2	SS	23		98							18 69 (13)
			3	SS	20		97							
			4	SS	32		96							
			5	SS	18		95							11 68 (21)
	- BECOMING GREY		6	SS	16		94							
94.8	BEDROCK: GREY CLASTIC METASEDIMENTARY ROCK (CONGLOMERATE) WITH GREY/PINK REDDISH SUBANGULAR TO SUBROUNDED CLASTS UP TO 3 CM IN FINE GRAINED MATRIX. FRACTURES AT 60 DEGREES TO CORE AXIS, WHITE QUARTZ-CARBONATE VEINS RUNNING ALONG CORE AXIS.	1	RC	TCR = 100%	93						RQD = 45%			
		2	RC	TCR = 100%							RQD = 87%			
92.5	END OF BOREHOLE													
7.4														

RECORD OF BOREHOLE No BH12-3

1 OF 1

METRIC

LOCATION KENOGAMI PATROL YARD N 532742 6: E 560402 4




ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT AND DCPT

COMPILED BY JW

DATUM GEODETIC DATE 9.18.12 - 9.18.12

CHECKED BY RK

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 (%)
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						
99.9 0.0	SAND FILL: SAND, SOME GRAVEL BROWN, LOOSE, MOIST			AS												
98.5 1.4	SAND TILL: FINE SAND, TRACE TO SOME SILT, TRACE GRAVEL, TRACE CLAY BROWN TO GREY, LOOSE TO COMPACT, SATURATED + BECOMING GREY		1	SS	5											
			2	SS	18										6 78 (16)	
			3	SS	5											
			4	SS	23											
			5	SS	12											
			6	SS	14											
94.2 5.7	BEDROCK: GREY CLASTIC METASEDIMENTARY ROCK (CONGLOMERATE) WITH GREY,PINK REDDISH SUBANGULAR TO SUBROUNDED CLASTS UP TO 2 TO 3 CM IN FINE GRAINED TO APHANITIC MATRIX FRACTURES AT 60 TO 70 DEGREES TO CORE AXIS		1	RC	TCR = 100%										RQD = 0%	
			2	RC	TCR = 92%										RQD = 67%	
			3	RC	TCR = 100%										RQD = 60%	
91.0 8.9	END OF BOREHOLE															

ONTARIO MOT 121-17876-00 KENOGAMI GINT GPJ ONTARIO MOT GDT 2/13/13

RECORD OF BOREHOLE No BH12-4

1 OF 1

METRIC

LOCATION KENOGAMI PATROL YARD N 5327412 6; E 560388 5

ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT AND DCPT

COMPILED BY JW

DATUM GEODETIC DATE 9 18 12 - 9 18 12

CHECKED BY RK

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								
99.9 0.0	GRANULAR FILL: GRAVELLY SAND, TRACE SILT BROWN, LOOSE, MOIST		1	AS									20 75 (5)
98.5			2	SS	6								
98.5 1.4	SAND TILL: FINE SAND, SOME SILT TO SILTY SAND, TRACE TO SOME GRAVEL, TRACE CLAY BROWN TO GREY, LOOSE TO DENSE, SATURATED		3	SS	8								
			4	SS	20								
			5	SS	38								
96.2 3.7	CONTINUOUS DYNAMIC CONE PENETRATION TEST BELOW 3.7 m DEPTH NO SOIL SAMPLING COMPLETED												13 65 (22)
94.3 5.6	END OF DCPT ON PRESUMED BEDROCK												

Appendix B

Summary of Particle Size Distribution
Results (Table B1)

Particle Size Distribution Analyses
(Figures B1 to B3)

Table B1: Summary of Grain Size Distribution

Borehole No.	Sample ID	Soil Description	Percentage Retained (%)			
			Gravel	Sand	Silt	Clay
BH12-1	SS6	Silty sand, trace gravel, trace clay	8	51	38	3
BH12-1	SS9	Sand and silt, trace gravel	7	62	31	
BH12-2	SS2	Silty sand, some gravel	18	69	13	
BH12-2	SS5	Silty sand, some gravel	11	68	21	
BH12-3	SS2	Sand, some silt, trace gravel	6	78	16	
BH12-4	SS2	Gravelly sand, trace silt	20	75	5	
BH12-4	SS5	Silty sand, some gravel	12	64	22	

Terminology	Proportion
--------------------	-------------------

"trace" (e.g. trace sand)	< 10%
"some" (e.g. some sand)	10% to 20%
adjective (e.g. sandy)	20% to 35%
"and" (e.g. and sand)	35% to 50%
Noun (e.g. sand)	> 50%

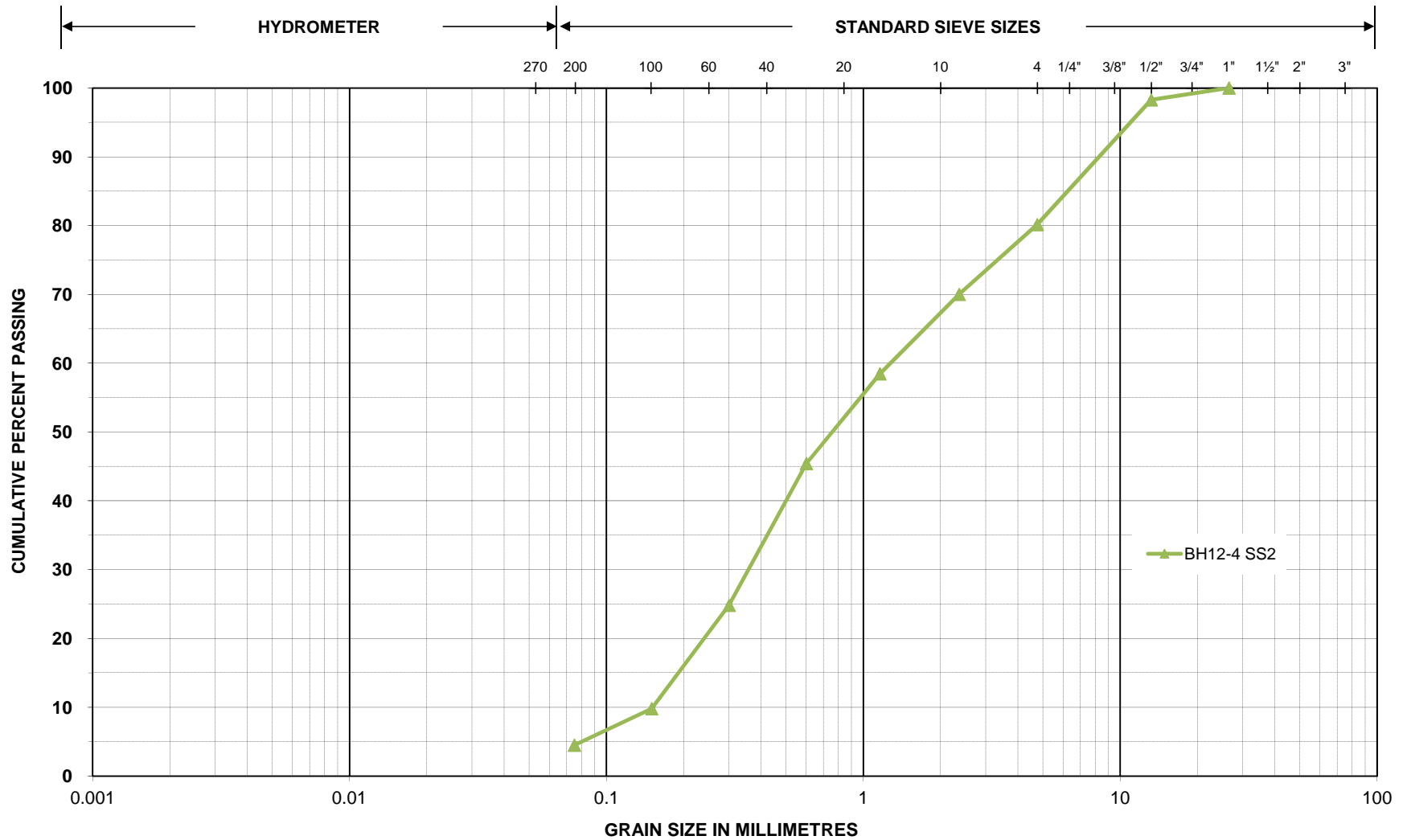
NOTE:

Division of Particle Sizes (USCS except clay based on MIT division)

- Gravel > 4.75 mm
- Sand 0.075 mm to 4.75 mm
- Silt 0.002 mm to 0.075 mm
- Clay < 0.002 mm



PARTICLE SIZE DISTRIBUTION



Unified Classification System

SILT AND CLAY	SAND	GRAVEL
---------------	------	--------

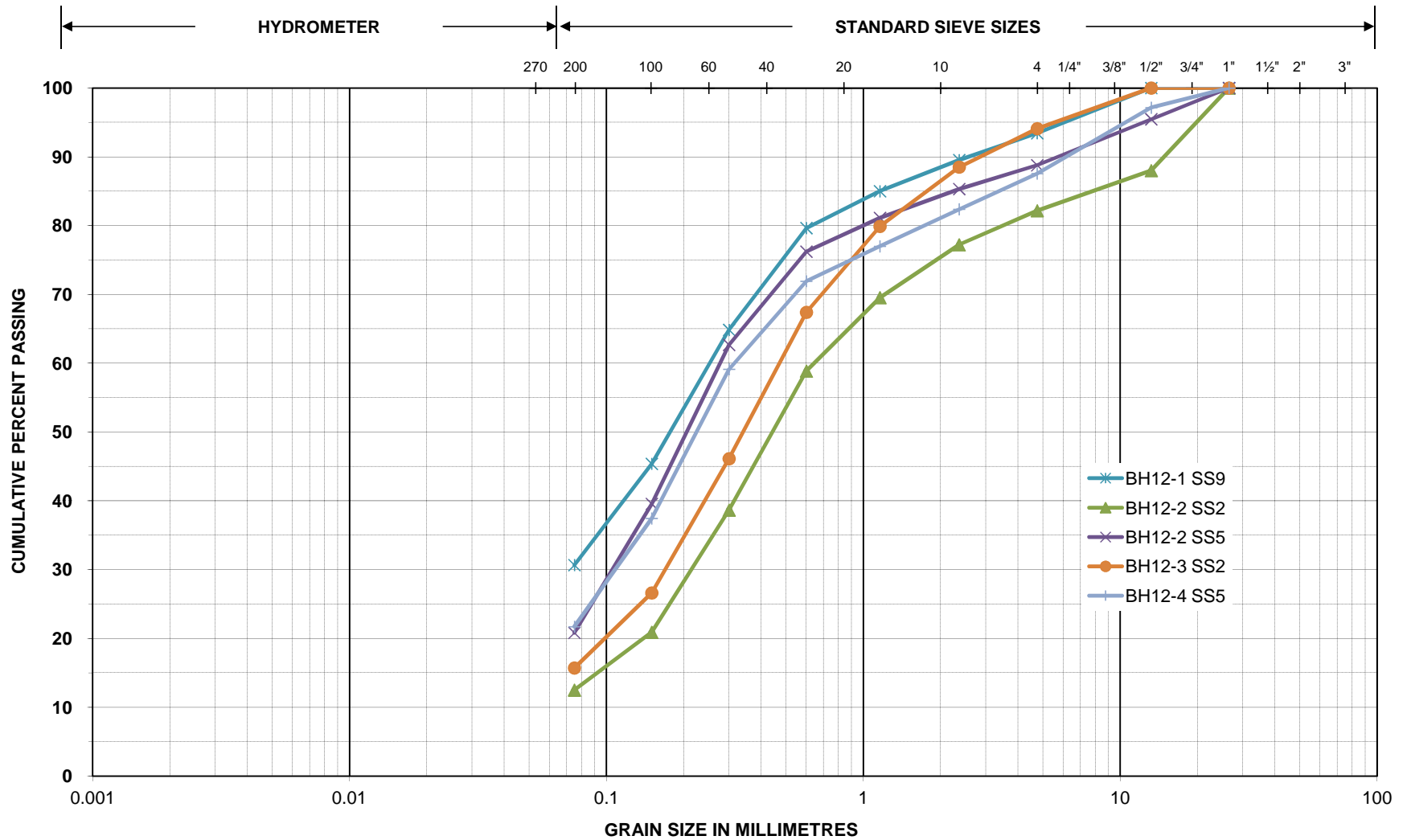
Project Name: MTO Agreement # 5011-E-0010 - Kenogami

Project No.: 121-17876-00

Figure No.: B1

Remarks: Gravelly sand, trace silt

PARTICLE SIZE DISTRIBUTION



Unified Classification System

SILT AND CLAY	SAND	GRAVEL
---------------	------	--------

Project Name: MTO Agreement # 5011-E-0010 - Kenogami
Remarks: Silty sand to sand and silt, some to trace gravel

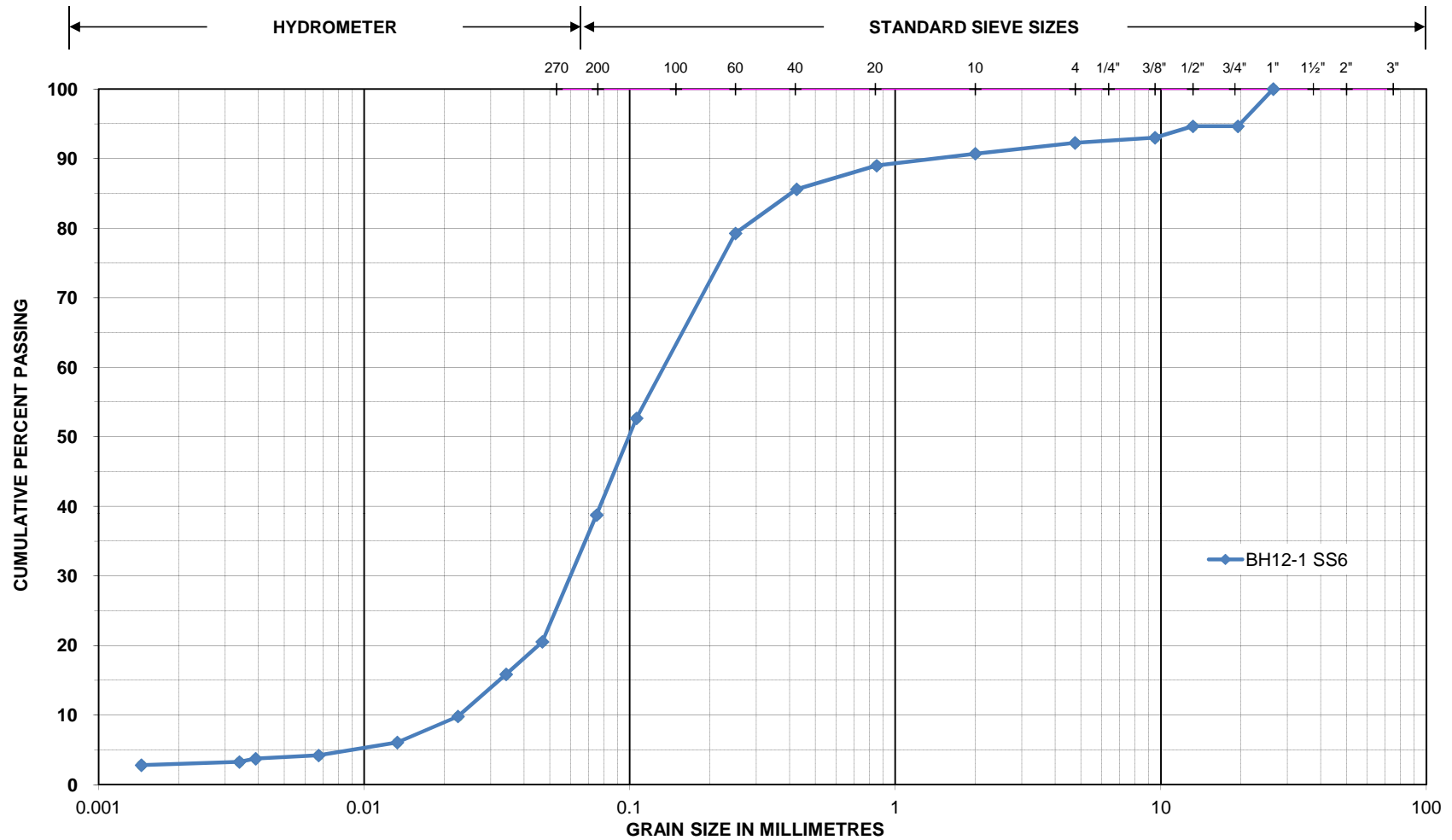
Project No.: 121-17876-00
Remarks: Silty sand, some gravel

Figure No.: B2



GENIVAR

PARTICLE SIZE DISTRIBUTION ASTM D422



Unified Classification System

SILT AND CLAY	SAND	GRAVEL
---------------	------	--------

Project Name: MTO Agreement #5011-E-0010 Kenogami

Project No.: 121-17876-00

Figure No.: B3

Remarks: Silty sand, trace gravel, trace clay

Appendix C

Site Photographs

Rock Core Photographs

**MTO AGREEMENT #5011-E-0010
KENOGAMI PATROL YARD**



Photograph 1: Borehole BH12-1. Looking northeast.



Photograph 2: Borehole BH12-2. Looking southeast.

**MTO AGREEMENT #5011-E-0010
KENOGAMI PATROL YARD**



Photograph 3: Borehole BH12-4. Looking east.



Photograph 4: Existing 8-bay garage and office. Facing west.

**MTO AGREEMENT #5011-E-0010
KENOGAMI PATROL YARD**



Photograph 5: Central drainage swale. Looking north.



Photograph 6: Existing salt (dome on left) and sand dome. Current salt dome is proposed location for sand/salt shed. Looking north.

**MTO AGREEMENT #5011-E-0010
KENOGAMI PATROL YARD – ROCK CORE**



Photograph 1: BH12-2 Rock Core (4.94 m to 7.33 m).



Photograph 2: BH12-2 Rock Core (4.94 m to 7.33 m).

**MTO AGREEMENT #5011-E-0010
KENOGAMI PATROL YARD – ROCK CORE**



Photograph 3: BH12-3 Rock Core (5.55 m to 8.85 m).



Photograph 4: BH12-3 Rock Core (5.55 m to 8.85 m).