

MTO Agreement No. 5011-E-0010
WO No. 2011-11035
Proposed Sand/Salt Storage Facility
Detour Patrol Yard
Foundation Investigation Report
Geocres No. 42H-52
March 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

March 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.: 2011-11035
Proposed Sand/Salt Storage Facility Detour Patrol Yard
Foundation Investigation Report (Geocres No. 42H-52)**

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) Detour Patrol Yard in the Township of Tweed, 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".

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 foundation investigation for the proposed construction of a sand/salt storage facility at the Detour Patrol Yard, located on Michel Lake Road approximately 150 m north from its intersection with Highway 652, in the Township of Tweed, 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 Detour 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 Detour Patrol Yard (site) is located on Michel Lake Road approximately 150 m north from its intersection with Highway 652, in the Township of Tweed, Ontario. A Site Plan is included as Drawing 1 and colour photographs of the site are included in Appendix C.

The site is sloped to the middle of the property, and then to a dry drainage ditch that slopes to the west. Access to the site is from Highway 652, and surrounding land uses are rural and uninhabited, with a low lying swampy area to the northeast. The site is surrounded with mixed deciduous and coniferous forest. No bedrock outcrops were visible on the site or immediate surrounding area.

The site is an operational MTO Patrol Yard, and currently contains the following structures:

- 4-bay garage;
- 1 large sand dome; and
- 1 well (dry).

The perimeter of the site is grassed, and there is a paved driveway from Highway 652 to the garage and extending to the sand dome.

2.2 Regional Geology

Two different map sources were consulted to determine the regional geology in the Detour area: i) Geology and Principal Minerals Map of Ontario published by the Ontario Department of Mines, and ii) Miscellaneous Data Release 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, adjacent to an esker landform. Local soil deposits are comprised of peat and organic terrain underlain by stony till material, with sand and gravel material present within the eskers.

The glaciolacustrine sediments are underlain by Archean bedrock of the Stoughton Roquemaure Group, comprised of komatiitic and tholeiitic metavolcanic rocks. Bedrock was not encountered in the current site investigation, so actual bedrock types below the site and proposed structure are not known.

3. Historic Report Review

A previous geotechnical report for the Detour Patrol yard was obtained from the MTO Geocres Library in Downsview, Ontario. This patrol yard was the subject of a geotechnical investigation in 1981 when the site was first proposed as a bridge crossing over the South Floodwood River. The results of the geotechnical investigation are summarized in a technical letter, dated April 24, 1981, titled “*Foundation Investigation Report for Detour Lake Access Road Line ‘A’ – South Floodwood River Structure*” (Geocres 42H-18).

The geotechnical investigation consisted of sampling two (2) boreholes supplemented by the same number of dynamic cone penetration tests (DCPT). The soil stratigraphy at the site was found to be quite uniform and consisted of approximately 2.6 metres to 4.3 metres (m) of peat underlain by sandy silts and a granular till zone. Within the sandy silt layer, SPT N values ranged from 6 to 39 blows per 30 centimetres (cm), while SPT N values for the granular till zone exceeded 100 blows per 100 cm. No bedrock was noted to be encountered in the original investigation. The groundwater table was reported at an elevation of 500 metres above sea level (mASL).

4. Investigation Procedures

4.1 Subsurface Investigation

A borehole investigation was performed at the subject site between June 19 and June 20, 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 the perimeter of the proposed 37.8 m diameter storage dome, as required by the Terms of Reference for the assignment.

MTO minimum requirements for the borehole investigation list a maximum drilling depth of 15.0 m, unless refusal was encountered at shallower depth, or justification for deeper drilling was authorized by the MTO Project Manager. In boreholes BH12-1 to BH12-4, augering was terminated at a depth of 15.9 m, in firm to stiff silt. Below the final depth of augering, Dynamic Cone Penetration Tests (DCPTs) were driven to refusal, which occurred at depth of 21.0 m to 22.0 m below ground surface.

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 (Northings and Eastings). Borehole elevations were surveyed to a temporary benchmark; a steel pin anchored in the existing pavement located just north of the proposed structure was assigned a relative elevation of 100.00 metres. 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 kilogram drop hammer falling 750 mm (ASTM D1586 procedure). Refusal depth for the purposes of this investigation is 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 a depth of 5.0 m, 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 labeled 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.

In cohesive deposits, where the consistency of the soil permitted, relatively undisturbed samples were taken with 70 mm diameter thin-walled Shelby tubes, which were pushed into the bottom of the borehole using the hydraulic ram of the drill rig. The Shelby tube samples were preserved for transport and storage, inspection and laboratory testing. In situ undrained shear strength (c_u) of the soil was measured using an ASTM tapered field vane and standardized procedures.

DCPTs were completed below a depth of 15.9 m in boreholes BH12-1 to 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, and then all boreholes were backfilled with drill cuttings mixed with bentonite hole plug. The top portion of the boreholes was sealed with emulsified asphalt. 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 (mbgs)/ Relative Elevation (m)	Dynamic Cone Penetration Test Depth (m)
BH12-1	15.9/ 84.7	15.9 to 22.3
BH12-2	15.9/ 84.6	15.9 to 22.3
BH12-3	15.9/ 84.9	15.9 to 21.0
BH12-4	15.9/ 84.9	15.9 to 21.0

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 – Detour Patrol Yard

Test	ASTM Standard	Number of Samples
Natural Moisture Content	ASTM D2216	48
Particle Size Analysis	ASTM D422	13
Atterberg Limits	ASTM D4318	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 are 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 to loose granular fill. Very stiff to firm clayey sandy silt layer was encountered underneath the fill layer, which in turn was underlain by firm to very stiff clay and silts extending to the borehole termination depth of 15.9 m below ground surface (mbgs). DCPTs were advanced 21.0 mbgs to 22.3 mbgs and results are described in Section 5.1.6. Descriptions of the individual soil units are provided in the following subsections.

5.1.1 Asphalt Pavement

A 40 mm to 50 mm thick surficial layer of asphaltic concrete (hot laid mix) was encountered at the surface of boreholes BH12-1, BH12-2 and BH12-4.

5.1.2 Granular Fill

At the surface of borehole BH12-3 and below the asphalt pavement in boreholes BH12-1, BH12-2 and BH12-4, a granular fill layer (pavement base/subbase) was encountered, consisting of 0.15 m to 0.20 m of gravelly sand, underlain by sand to silty sand with traces of gravel. This layer extended to the depths and relative elevations shown below:

<u>Borehole No.</u>	<u>Depth to Bottom of Fill Layer, mbgs</u> <u>(Relative Elevation, m)</u>
BH12-1	1.5 (99.1)
BH12-2	1.5 (99.0)
BH12-3	1.5 (99.3)
BH12-4	1.2 (99.6)

Laboratory particle size distribution analysis for one (1) sample from 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) - 4 %
- Sand (0.075 mm to 4.75 mm size) - 87 %
- Silt and Clay (less than 0.075 mm size) - 9 %

Standard Penetration Test (SPT) results (N Values) recorded in the fill layer ranged between 8 and 12 blows per 305 mm of penetration, indicating loose to compact to very dense relative density.

Laboratory determined moisture contents ranged between 3 % and 12 % for samples of the fill, indicating moist material.

5.1.3 Clayey Sandy Silt

Clayey sandy silt with traces of fine gravel was encountered below the fill layer and extending to depths (mbgs) and elevations (relative) shown below:

<u>Borehole No.</u>	<u>Depth to Bottom of Clayey Sandy Silt Layer, mbgs</u> <u>(Relative Elevation, m)</u>
BH12-1	7.5 (93.1)
BH12-2	7.5 (93.0)
BH12-3	6.5 (94.3)
BH12-4	6.5 (94.3)

Thus, the thickness of the clayey sandy silt layer varied from 6.0 m at boreholes BH12-1 and BH12-2 to 5.0 m at borehole BH12-3 to 5.3 m at borehole BH12-4.

Laboratory particle size distribution analyses for six (6) samples from the clayey sandy silt layer were completed, and results according to USCS are summarized below and shown on Figure B2 of Appendix B:

- Gravel (greater than 4.75 mm size) - 0 % to 5 %
- Sand (0.075 mm to 4.75 mm size) - 18 % to 28 %
- Silt (0.002 mm to 0.075 mm size) - 39 % to 45 %
- Clay (less than 0.002 mm size) - 20 % to 39 %

SPT results (N values) recorded in the clayey sandy silt layer ranged from 6 to 23 blows per 305 mm of penetration. Undrained shear strengths, as measured by field vane methods, ranged from 50 kPa to greater than 100 kPa. Based on these results, the consistency of the clayey sandy silt deposit is described as firm to very stiff. The sensitivity of the clayey sandy silt ranged from 2.2 to 4.5 (medium sensitivity to sensitive clay soil). Undrained shear strength was also approximated from pocket penetrometer readings taken in split spoon samples of this layer. Calculated undrained shear strength values ranged from 60 kPa to 175 kPa.

Atterberg Limits tests performed on three (3) samples from the clayey sandy silt deposit yielded the following index values:

- Liquid Limit (W_L) - 22 % to 31 %
- Plastic Limit (W_P) - 14 %
- Plasticity Index (I_P) - 8 % to 17 %

From the USCS plasticity chart included as Figure B5 in Appendix B, the samples may be classified as inorganic clay of low plasticity (CL).

The natural moisture content of samples recovered from this layer ranged from 10 % to 22 % based on laboratory testing, indicating about plastic limit (APL) to wetter than plastic limit (WTPL) soil.

5.1.4 Clay with some Silt

A layer of clay with some silt was encountered beneath the clayey sandy silt in boreholes BH12-1 to BH12-4. The clay layer is 6.2 m to 7.2 m thick and extends to the depths (mbgs) and elevations (relative) shown below:

<u>Borehole No.</u>	<u>Depth to Bottom of Clay Layer, mbgs</u> <u>(Relative Elevation, m)</u>
BH12-1	13.7 (86.9)
BH12-2	13.7 (86.8)
BH12-3	13.0 (87.8)
BH12-4	13.7 (87.1)

Laboratory particle size distribution analyses for four (4) samples of the clay/silt layer were completed, and results are summarized below and shown on Figure B3 of Appendix B:

- Gravel (greater than 4.75 mm size) - 0 %
- Sand (0.075 mm to 4.75 mm size) - 1 % to 2 %
- Silt (0.002 mm to 0.075 mm size) - 15 % to 27 %
- Clay (less than 0.002 mm size) - 72 % to 83 %

SPT results (N values) recorded for the clay layer ranged from 2 to 7 blows per 305 mm of penetration. Undrained shear strength, as measured by field vane tests, ranged from 43 kPa to 100 kPa. Based on the field results, the consistency of the clay layer is described as firm to stiff. The sensitivity of the clay layer ranged between 2.0 to 4.5 (low to medium sensitivity).

Atterberg Limits tests for four (4) samples from the deposit yielded the following index values:

- Liquid Limit (w_L) - 41 % to 53 %
- Plastic Limit (w_P) - 18 % to 23 %
- Plasticity Index (I_P) - 23 % to 32 %

From the USCS plasticity chart included as Figure B6 in Appendix B, the sample may be classified as inorganic clay of medium plasticity (CI) to clay of high plasticity (CH).

Laboratory determined moisture content ranged between 17 % and 41 % for the clay samples, indicating APL to WTPL material with moisture content below the liquid limit.

5.1.5 Silt

Underlying the clay layer, a slightly plastic silt layer with a trace to some clay and a trace to some sand was encountered in boreholes BH12-1 to BH12-4, and extending to the end of boreholes at 15.9 m mbgs (relative elevations 84.6 m in borehole BH12-2 to 84.9 m in borehole BH12-3).

Laboratory particle size distribution analyses for two (2) samples of the material were completed; results are summarized below and shown in Figure B4 of Appendix B:

- Gravel (greater than 4.75 mm size) - 0 %
- Sand (0.075 mm to 4.75 mm size) - 1 % to 21 %
- Silt (0.002 mm to 0.075 mm size) - 72 % to 88 %
- Clay (less than 0.002 mm size) - 7 % to 11 %

Standard Penetration Test results (N Values) recorded in this deposit ranged between 4 and 9 blows per 305 mm of penetration, indicating firm to stiff consistency.

5.1.6 Dynamic Cone Penetration Testing

Dynamic cone penetration testing (DCPT) was performed below the borehole termination depths of 15.9 mbgs at boreholes BH12-1 through BH12-4. The DCPTs extended to depths of 23.2 mbgs at BH12-1 and BH12-2 to 21.0 mbgs at boreholes BH12-3 and BH12-4. Refusal, as defined by MTO as 100 blows per 305 mm of penetration, was encountered at depths of between 21.0 mbgs and 22.0 mbgs below ground surface. The DCPT results indicate that stiff to very stiff and/or compact to dense soil is present between 20.0 and 21.0 mbgs. DCPT's were terminated within the hard or very dense soil between relative elevations 78.3 m and 80.0 m.

5.2 Groundwater Conditions

Groundwater conditions were observed in the open boreholes upon completion of drilling. Results are summarized in Table 5.1.

Table 5-1: Summary of Groundwater Levels

Location	Measured Groundwater Depth, mbgs (Relative Elevation, m)	Date Measured
BH12-1	9.9 (90.7)	19 June 2012
BH12-2	12.2 (88.3)	19 June 2012
BH12-3	11.6 (89.2)	20 June 2012
BH12-4	10.0 (90.8)	20 June 2012

Note: mbgs = metres below ground surface; See Drawing 1 for temporary benchmark location (Relative Elevation)

Based on the moisture condition and colour 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 between 7.0 and 9.0 m below ground surface within or near the top of the clay unit.

It should be noted that groundwater levels may fluctuate seasonally and in response to climatic conditions. Due to the presence of fine-grained soils beneath the site, a potential for development of perched groundwater exists after wet seasons and periods of rainfall. It is possible that groundwater will become perched in the clayey sandy silt unit, above the clay unit, in wet seasonal periods (i.e. Spring).

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	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.

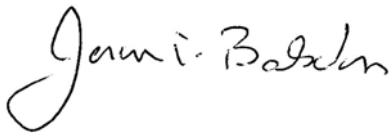


Raid Khamis, P. Eng., PMP.
Geotechnical Engineer



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.: 2011-11035

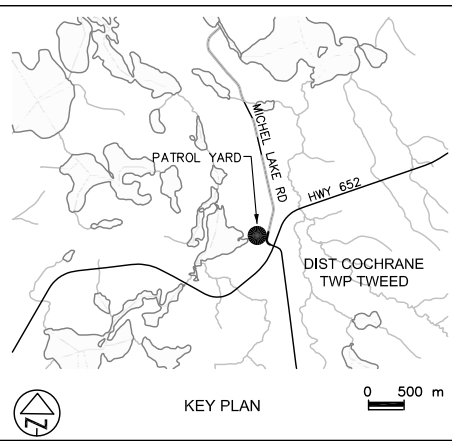


BOREHOLE LOCATION PLAN
PROPOSED SAND/SALT STORAGE
FACILITY
DETOUR PATROL YARD
HIGHWAY 652

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)

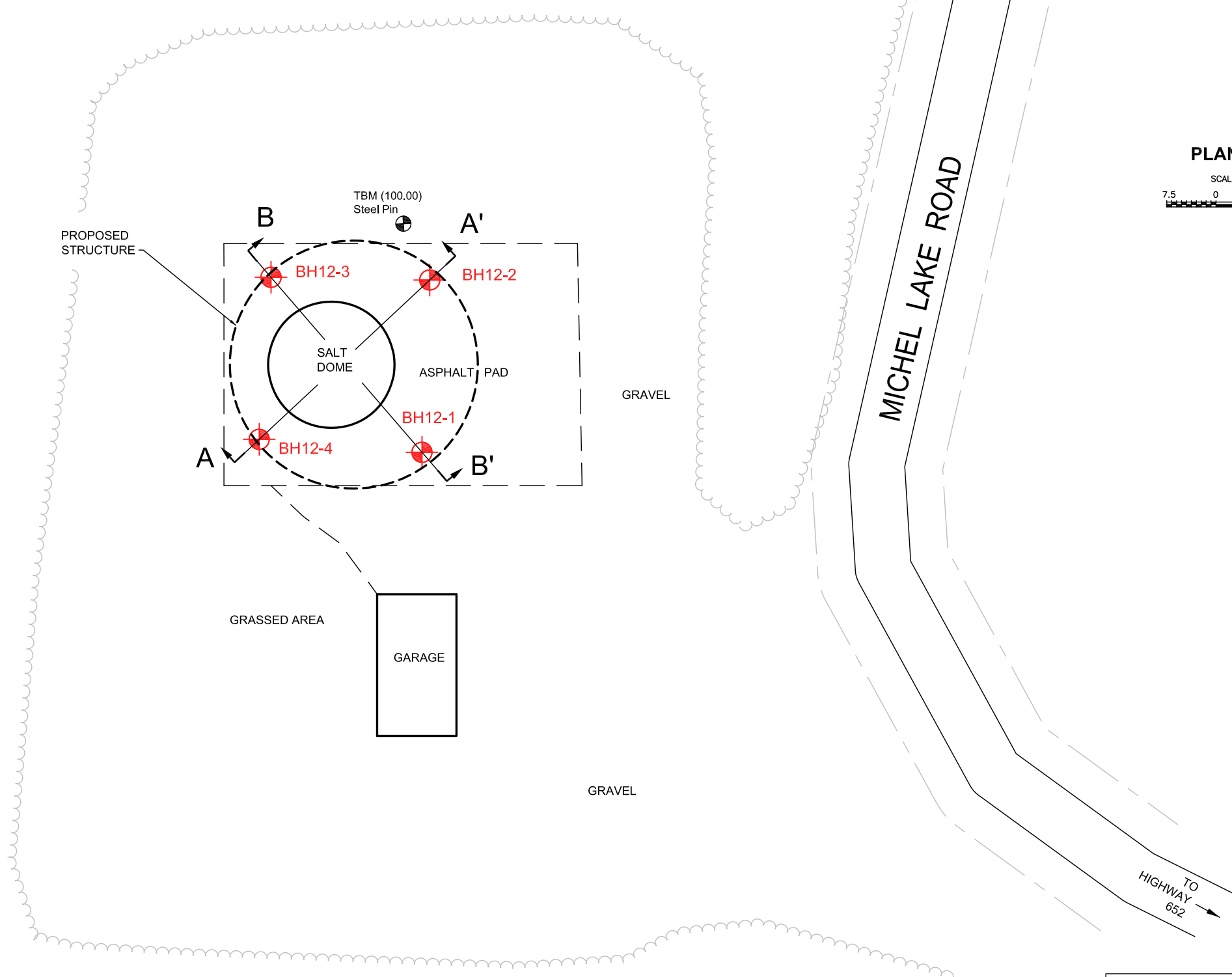
BH No	ELEVATION (Relative m)	COORDINATES (NAD 83 Zone17)	
		NORTHING	EASTING
12-1	100.579	5479240.6	541944.9
12-2	100.540	5479266.9	541946.1
12-3	100.797	5479226.3	541921.9
12-4	100.780	5479242.6	541920.1

— 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.

REVISIONS			
	DATE	BY	DESCRIPTION

GEOCRES No. 42H-52

HWY No 652			DIST COCHRANE
SUBM'D --	CHECKED JSA	DATE MARCH 2013	SITE --
DRAWN PLB	CHECKED --	APPROVED --	DWG --



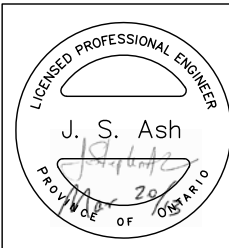
PLAN VIEW

SCALE 1:750
7.5 0 7.5 15.0 m

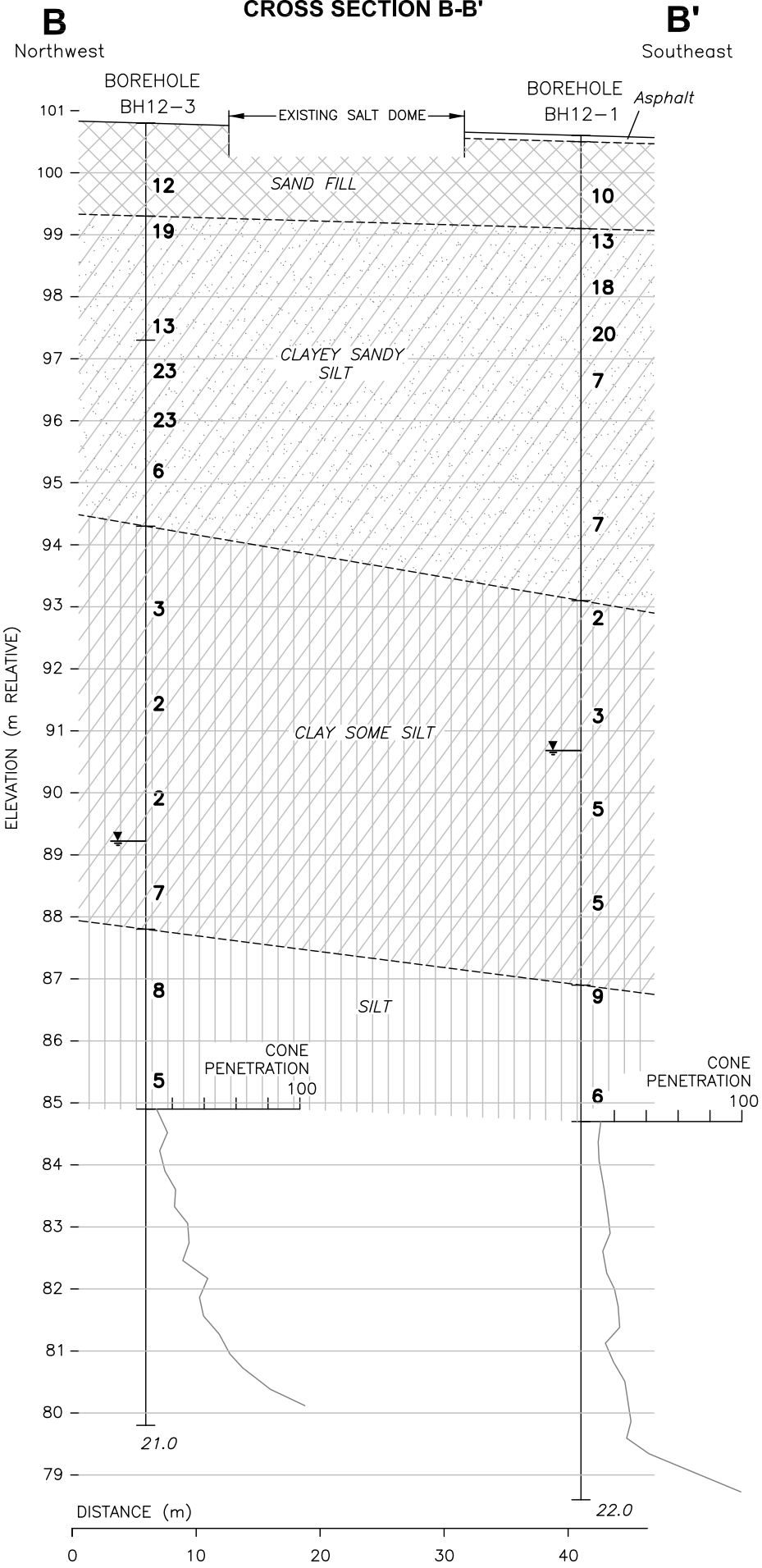
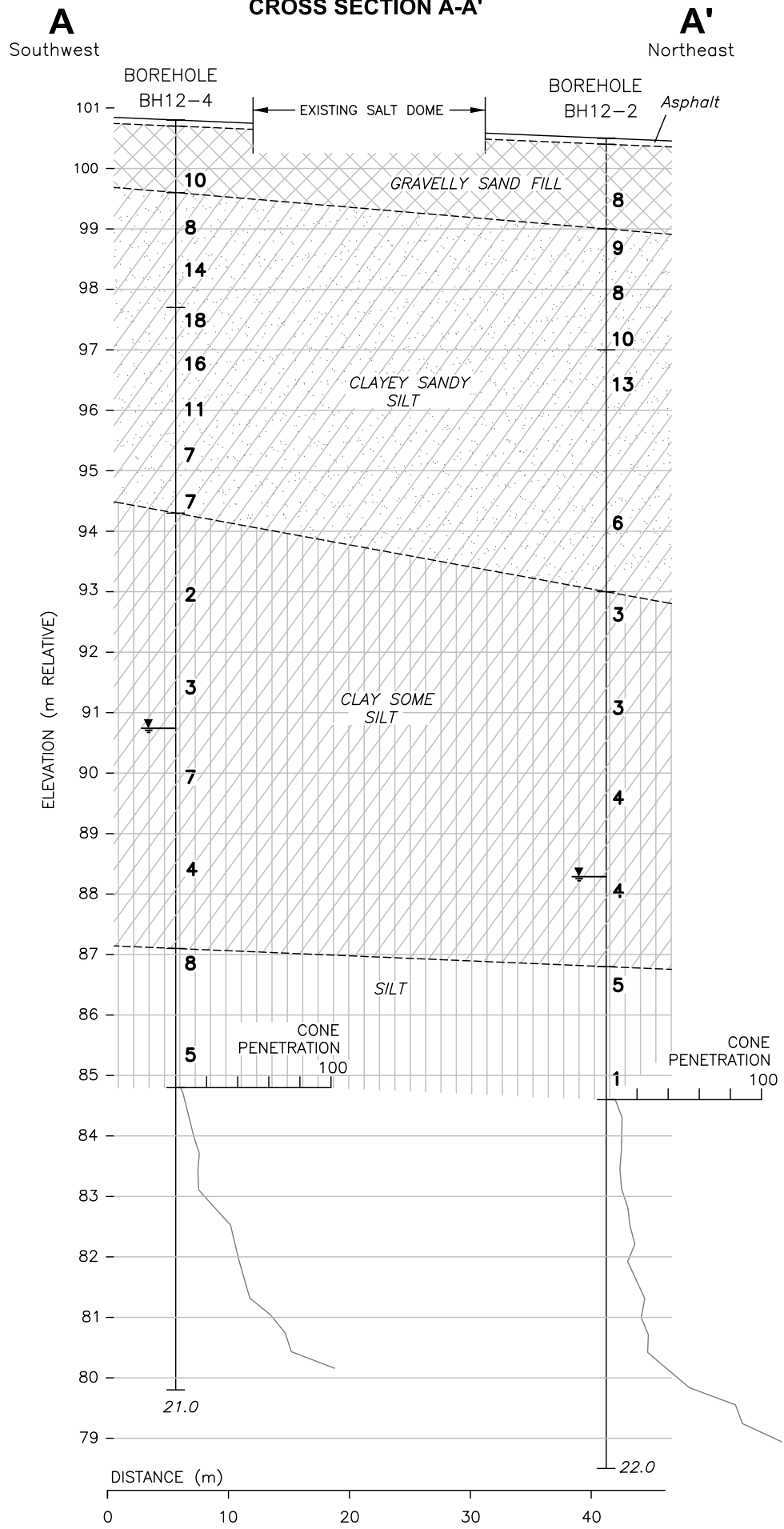
NOTES:

- 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 STEEL PIN NORTH OF BH12-2 (RELATIVE EL. 100.00 m).

PROJECT: 121-17876-00 111-06



SITE PLAN MAPPING REF. NO.:
SITE PLAN SKETCH, NOT TO SCALE.



METRIC

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

Agreement No.: 5011-E-0010
WO No.: 2011-11035



SOIL STRATA
PROPOSED SAND/SALT STORAGE
FACILITY
DETOUR PATROL YARD
HIGHWAY 652
Client: MTO - Northeastern Region

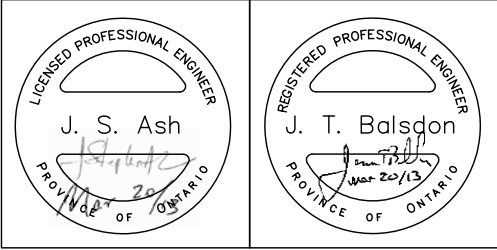
DRAWING
2

- 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 STEEL PIN NORTH OF BH12-2 (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	100.579	5479240.6	541944.9
12-2	100.540	5479266.9	541946.1
12-3	100.797	5479226.3	541921.9
12-4	100.780	5479242.6	541920.1

PROJECT: 121-17876-00 111-06

GENIVAR



SITE PLAN MAPPING REF. NO.:
SITE PLAN SKETCH, NOT TO SCALE.

— 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
GEOCRETS No. 42H-52			
HWY No. 652			DIST COCHRANE
SUBM'D --	CHECKED JSA	DATE MARCH 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 2

METRIC

LOCATION DETOUR PATROL YARD N 5479240.6 : E 541944.9

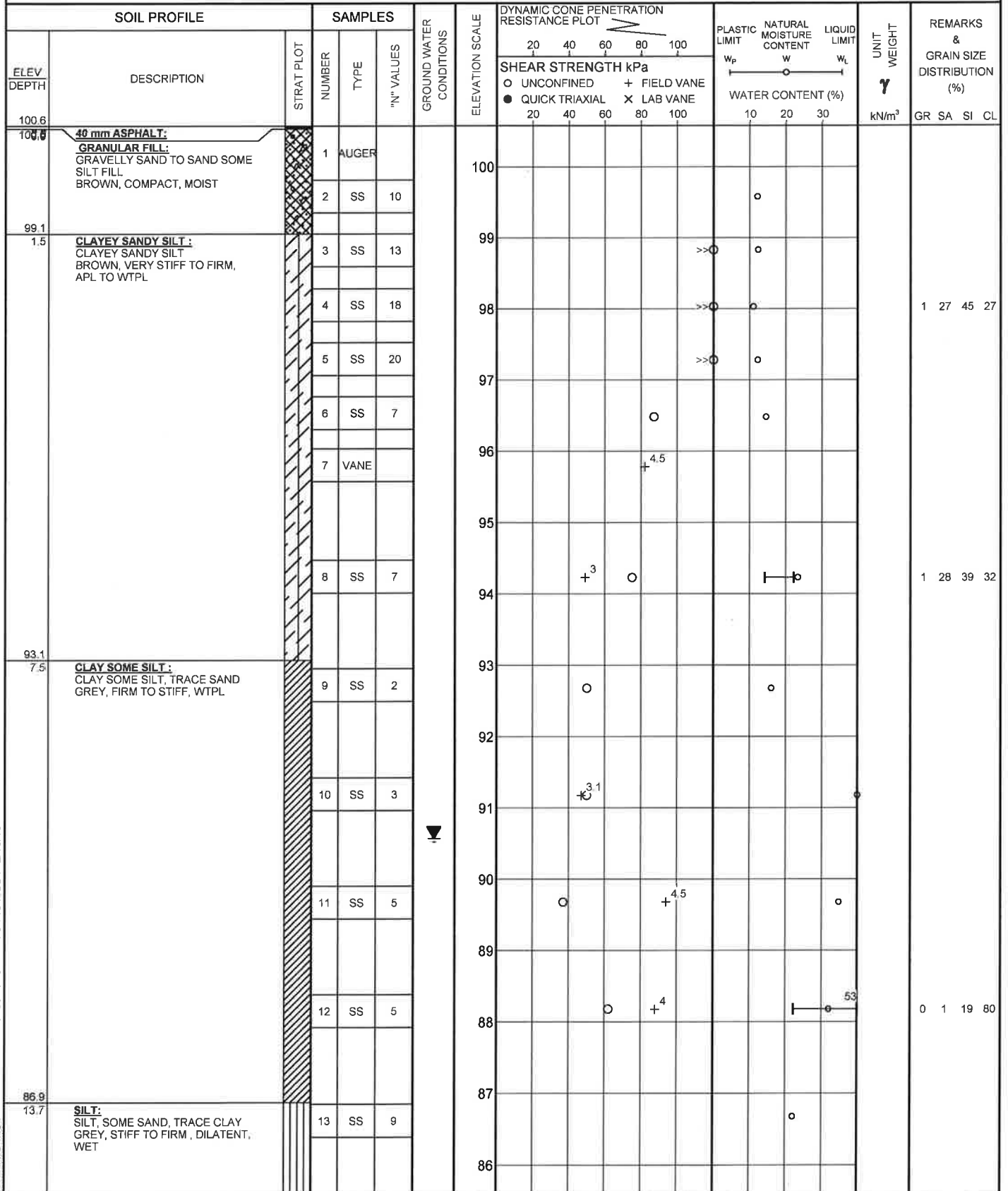
ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT AND DCPT

COMPILED BY DCL/BDL

DATUM GEODETTIC DATE 6.19.12 - 6.19.12

CHECKED BY RK



Continued Next Page

+³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

METRIC

CHECKED BY RK



RECORD OF BOREHOLE No BH12-2

1 OF 2

METRIC

LOCATION DETOUR PATROL YARD N 5479266 9 ; E 541946.1

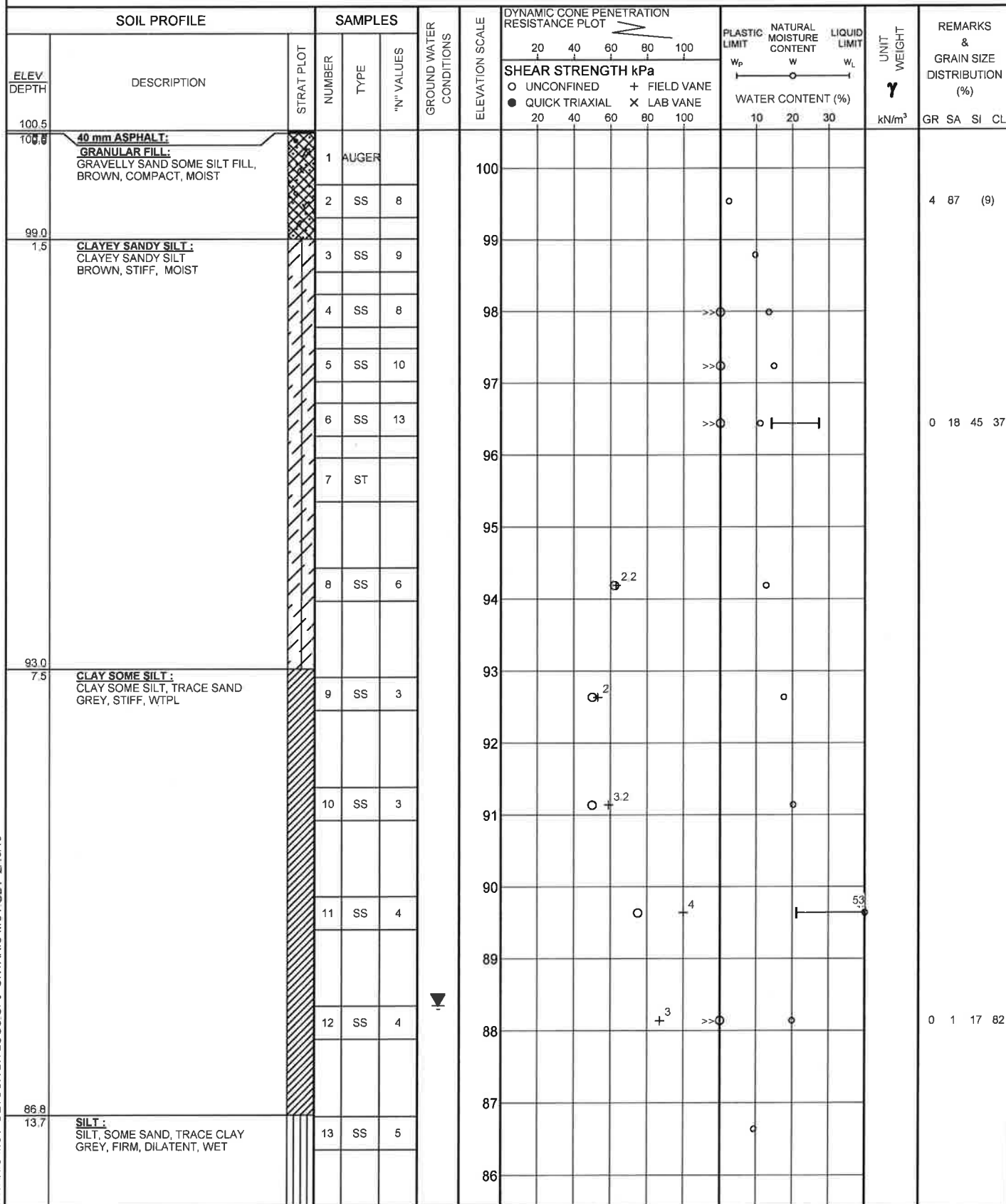
ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT AND DCPT

COMPILED BY DLC/BDL

DATUM GEODETTIC DATE 6.19.12 - 6.19.12

CHECKED BY RK



Continued Next Page

+³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH12-2

2 OF 2

METRIC

LOCATION DETOUR PATROL YARD N 5479266 9 : E 541946 1

ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT AND DCPT

COMPILED BY DLC/BDL

DATUM GEODETTIC DATE 6.19.12 - 6.19.12

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 x LAB VANE								
	<u>SILT</u> : SILT, SOME SAND, TRACE CLAY GREY, FIRM, DILATENT, WET <i>(continued)</i>		14	SS	4		85								
84.6 15.9	DYNAMIC CONE PENETRATION TEST BELOW 15.9 m DEPTH. NO SOIL SAMPLING COMPLETED.						84								
							83								
							82								
							81								
							80								
							79								
78.3	END OF BOREHOLE														
22.3	END OF BOREHOLE														

RECORD OF BOREHOLE No BH12-3

1 OF 2

METRIC

LOCATION DETOUR PATROL YARD N 5479226.3 : E 541921.9

ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT AND DCPT

COMPILED BY DCL/BDL

DATUM GEODETTIC DATE 6.20.12 - 6.20.12

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 (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L				
								○ UNCONFINED + FIELD VANE	WATER CONTENT (%)							
						● QUICK TRIAXIAL x LAB VANE										
100.8 0.0	GRANULAR FILL: SAND TO SANDY SILT FILL, SOME GRAVEL BROWN, COMPACT, MOIST		1	AUGER			100									
			2	SS	12											
99.3 1.5	CLAYEY SANDY SILT: CLAYEY SANDY SILT BROWN, STIFF TO VERY STIFF, MOIST	3	SS	19			99									1 37 42 20
		4	SS	8			98									
		5	SS	13			97									
		6	SS	23			96									1 21 39 39
		7	SS	23			95									
		8	SS	6			94									
94.3 6.5		CLAY SOME SILT: CLAY SOME SILT, TRACE SAND GREY, FIRM TO STIFF, WET	9	SS	3			93	2.7						52	
	10		SS	2			92									
	11		SS	2			90									
	12		SS	7			89									
87.8 13.0	SILT: SILT, SOME CLAY, TRACE SAND GREY, STIFF TO FIRM, DILATENT, WET		13	SS	8			87								0 1 88 11
							86									

Continued Next Page

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

ONTARIO MOT DETOUR BH LOGS GPJ ONTARIO MOT GDT 2/13/13

RECORD OF BOREHOLE No BH12-3

2 OF 2

METRIC

LOCATION DETOUR PATROL YARD N 5479226.3 ; E 541921.9

ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT AND DCPT

COMPILED BY DCL/BDL

DATUM GEODETIC DATE 6.20.12 - 6.20.12

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/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
84.9 15.9	<p>SILT: SILT, SOME CLAY, TRACE SAND GREY, STIFF TO FIRM, DILATENT, WET (continued)</p> <p>DYNAMIC CONE PENETRATION TEST BELOW 15.9 m DEPTH. NO SOIL SAMPLING COMPLETED.</p>		14	SS	5		<p>20 40 60 80 100</p> <p>SHEAR STRENGTH kPa</p> <p>○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE</p> <p>20 40 60 80 100</p> <p>10 20 30</p> <p>WATER CONTENT (%)</p>				
79.8 21.0	END OF BOREHOLE										

ONTARIO MOT DETOUR BH LOGS.GPJ ONTARIO.MOT.GDT 2/13/13

RECORD OF BOREHOLE No BH12-4

1 OF 2

METRIC

LOCATION DETOUR PATROL YARD N 5479242.6 ; E 541920.1

ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT AND DCPT

COMPILED BY DCL/BDL

DATUM GEODETTIC DATE 6.20.12 - 6.20.12

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
100.8								20 40 60 80 100		10 20 30				
100.4	50 mm ASPHALT:		1	AUGER										
	GRANULAR FILL:		2	SS	10									
	GRAVELLY SAND TO SANDY SILT													
	FILL													
	BROWN, COMPACT, MOIST													
99.6	CLAYEY SANDY SILT:		3	SS	8									
1.2	CLAYEY SANDY SILT		4	SS	14									5 27 42 26
	BROWN, VERY STIFF TO STIFF,		5	SS	18									
	APL TO WTPL		6	SS	16									
			7	SS	11									
			8	SS	7									
94.3	CLAY SOME SILT:		9	ST										
6.5	CLAY SOME SILT, TRACE SAND		10	SS	2									0 1 27 72
	GREY, STIFF, MOIST TO WET		11	SS	3									
			12	SS	7									
			13	SS	4									
87.1	SILT:		14	SS	8									
13.7	SILT, SOME SAND, TRACE CLAY													
	GREY, STIFF TO FIRM, DILATENT,													
	WET													

Continued Next Page

+³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH12-4

2 OF 2

METRIC

LOCATION DETOUR PATROL YARD N 5479242.6 ; E 541920.1

ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGERS WITH SPT AND DCPT

COMPILED BY DCL/BDL

DATUM GEODETTIC DATE 6.20.12 - 6.20.12

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								
84.9	SILT: SILT, SOME SAND, TRACE CLAY GREY, STIFF TO FIRM, DILATENT, WET (continued)		15	SS	5								0 21 72 7
15.9	DYNAMIC CONE PENETRATION TEST BELOW 15.9 m DEPTH. NO SOIL SAMPLING COMPLETED.												
79.8													
21.0	END OF BOREHOLE												

ONTARIO MOT DETOUR BH LOGS.GPJ ONTARIO MOT GDT 2/13/13

Appendix B

Summary of Particle Size Distribution
Results (Table B1)

Particle Size Distribution Analyses
(Figures B1 to B4)

Plasticity Chart
(Figures B5 and B6)

Table B1: Summary of Grain Size Distribution

Borehole No.	Sample ID	Soil Description	Percentage Retained (%)			
			Gravel	Sand	Silt	Clay
BH12-1	SS4	Clayey sandy silt, trace gravel	1	27	45	27
BH12-1	SS8	Clayey sandy silt, trace gravel	1	28	39	32
BH12-1	SS12	Clay, some silt, trace sand	0	1	19	80
BH12-2	SS2	Sand, trace silt, trace gravel	4	87	9	
BH12-2	SS6	Silt and clay, some sand	0	18	45	37
BH12-2	SS11	Silty clay, trace sand	0	1	17	82
BH12-3	SS3	Clayey silt and sand, trace gravel	1	37	42	20
BH12-3	SS6	Sandy clay and silt, trace gravel	1	21	39	39
BH12-3	SS9	Clay, some silt, trace sand	0	2	15	83
BH12-3	SS13	Silt, some clay, trace sand	0	1	88	11
BH12-4	SS4	Sandy clayey silt, trace gravel	5	27	42	26
BH12-4	SS10	Silty clay, trace sand	0	1	27	72
BH12-4	SS15	Sandy silt, trace clay	0	21	72	7

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:

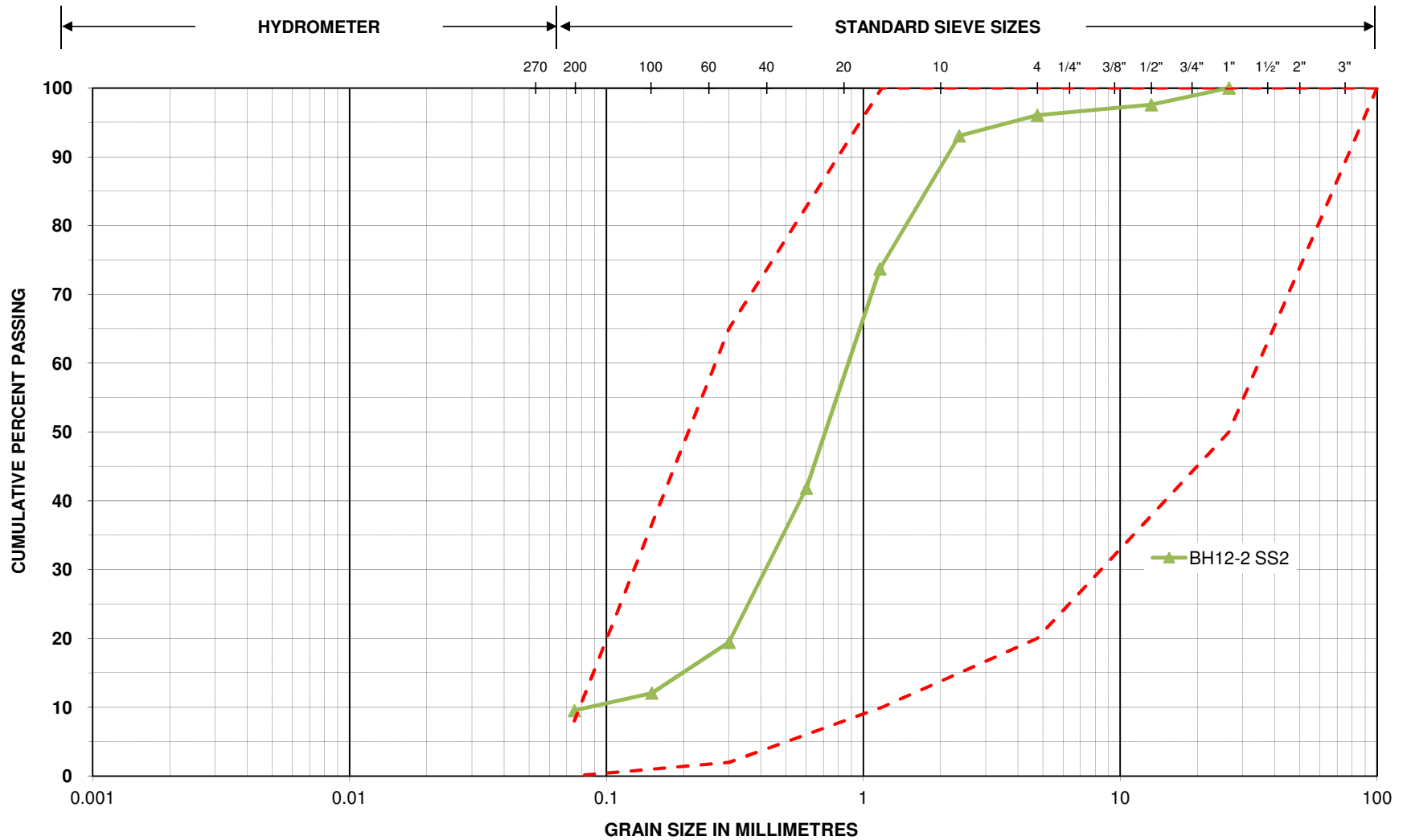
Division of Particle Sizes (USCS except clay based on MIT division)

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



GENIVAR

PARTICLE SIZE DISTRIBUTION



Unified Classification System

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

Project Name: MTO Agreement 5011-E-0010 - Detour Patrol Yard

Project No.: 121-17876-00

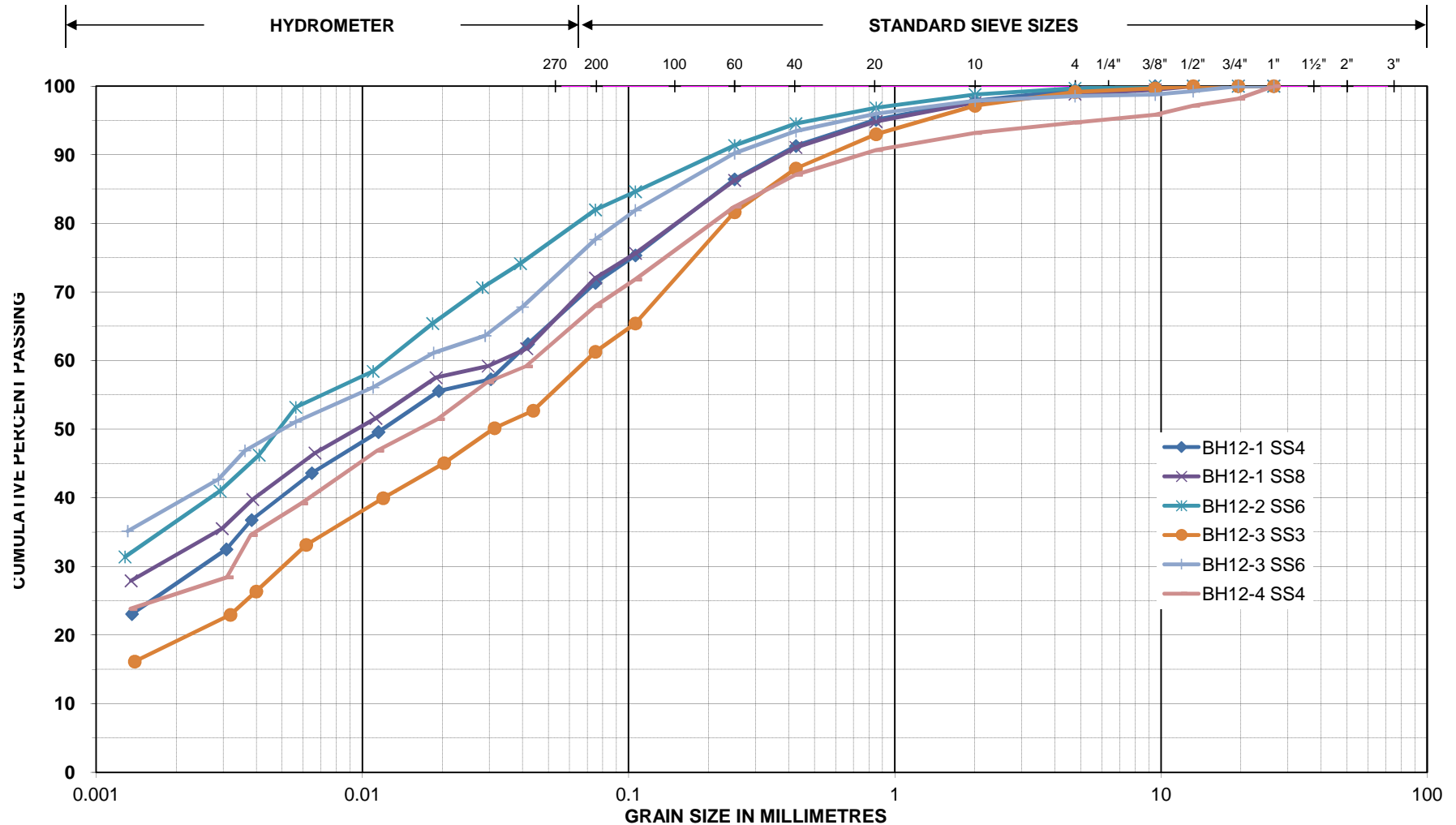
Figure No.: B1

Remarks: Sand, trace silt, trace gravel (Fill Layer)



GENIVAR

PARTICLE SIZE DISTRIBUTION ASTM D422



Unified Classification System

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

Project Name: MTO Agreement #5011-E-0010 - Detour Patrol Yard

Project No.: 121-17876-00

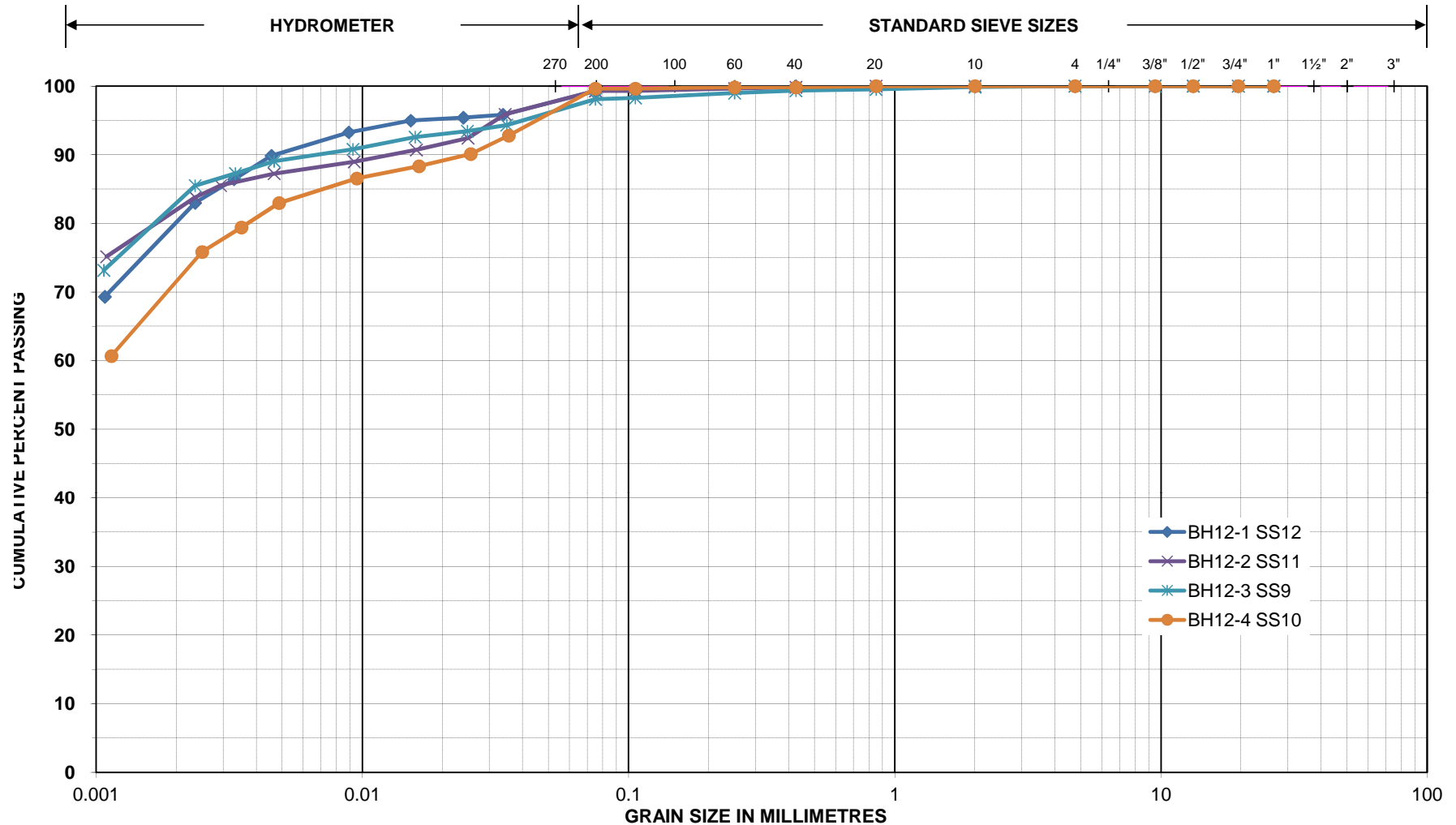
Figure No.: B2

Remarks: Clayey sandy silt, trace gravel



GENIVAR

PARTICLE SIZE DISTRIBUTION ASTM D422



Unified Classification System

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

Project Name: MTO Agreement #5011-E-0010 - Detour Patrol Yard

Project No.: 121-17876-00

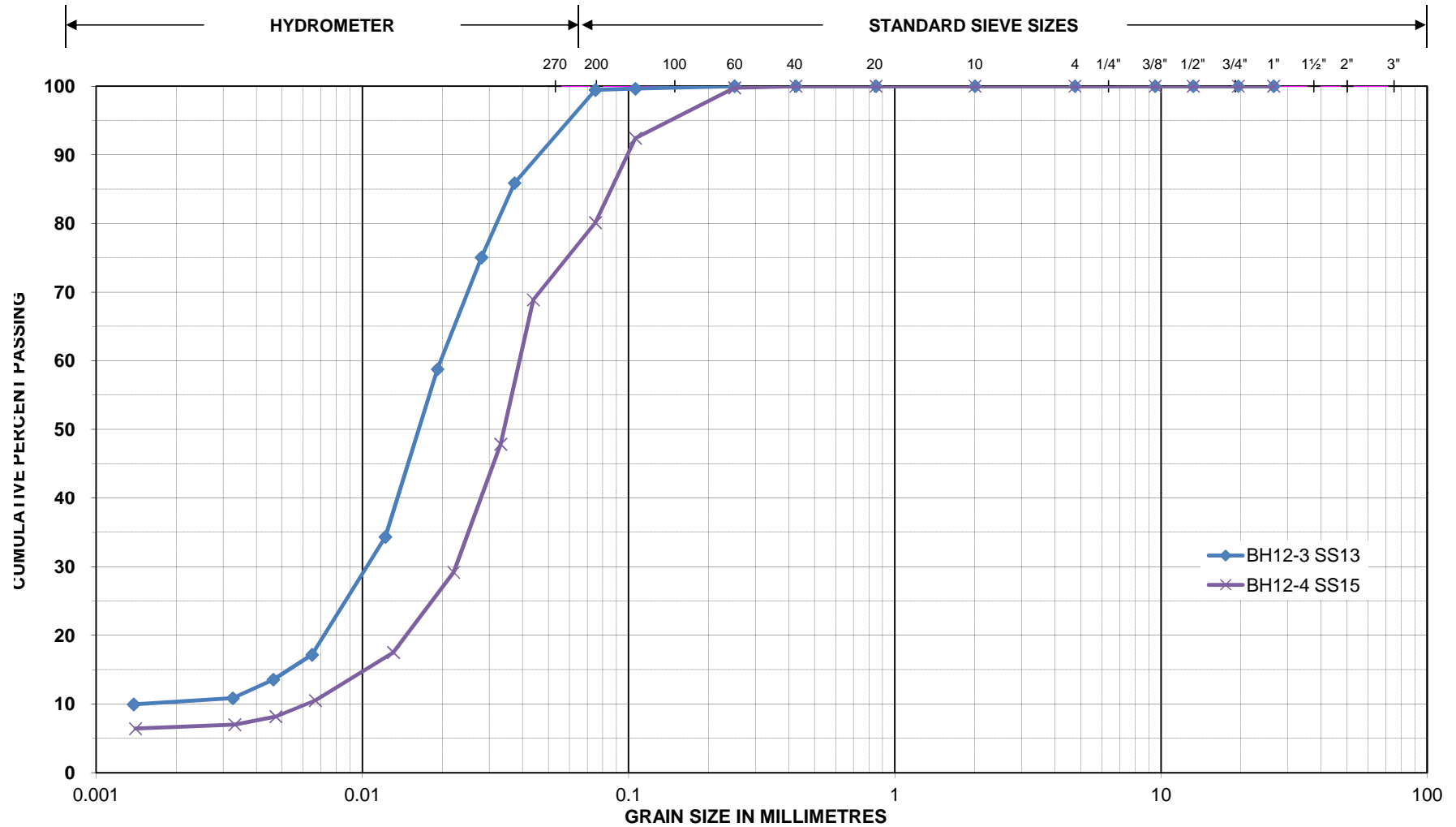
Figure No.: B3

Remarks: Clay, some silt, trace sand



GENIVAR

PARTICLE SIZE DISTRIBUTION ASTM D422



Unified Classification System

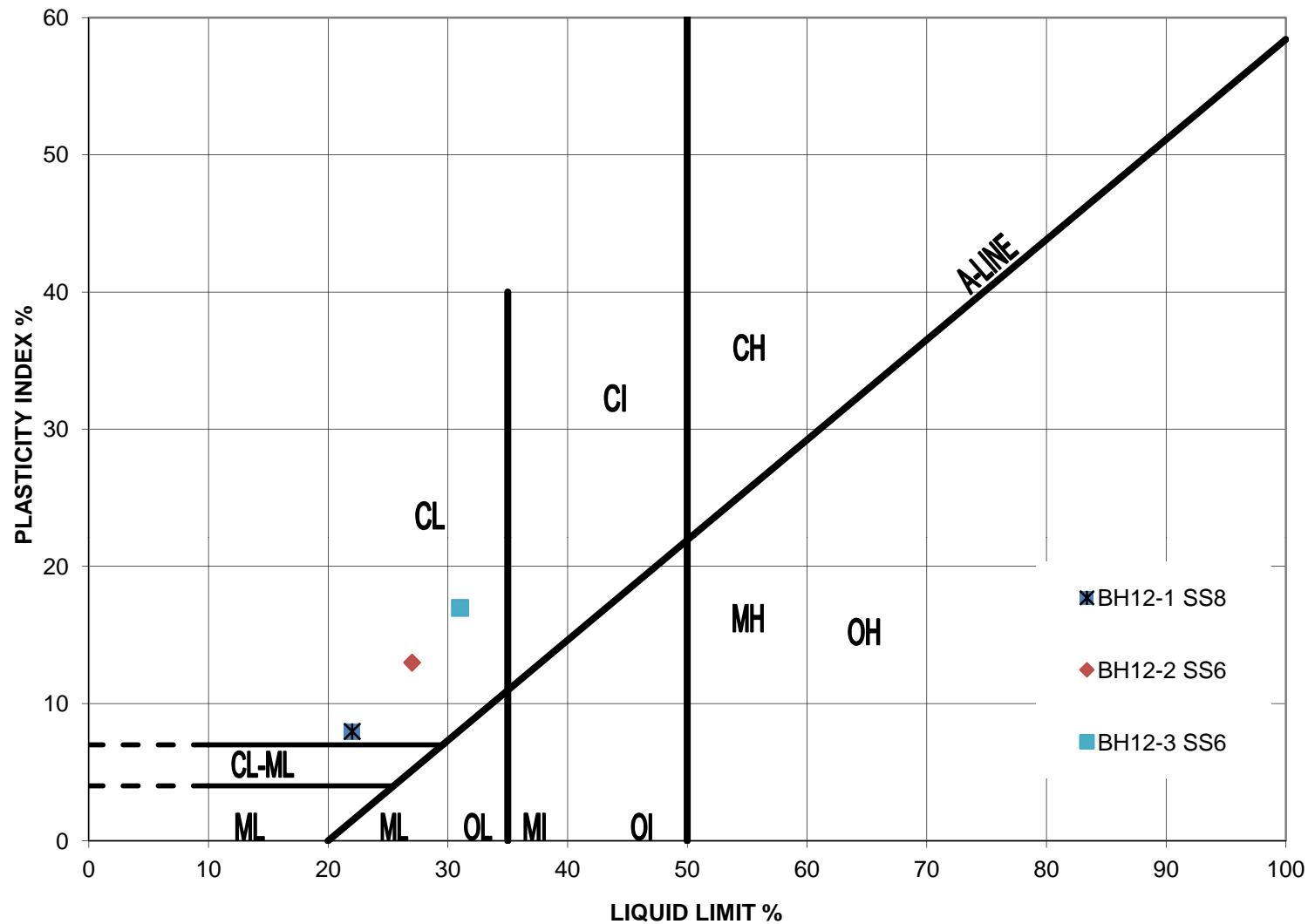
SILT AND CLAY	SAND	GRAVEL
---------------	------	--------

Project Name: MTO Agreement #5011-E-0010 - Detour Patrol Yard

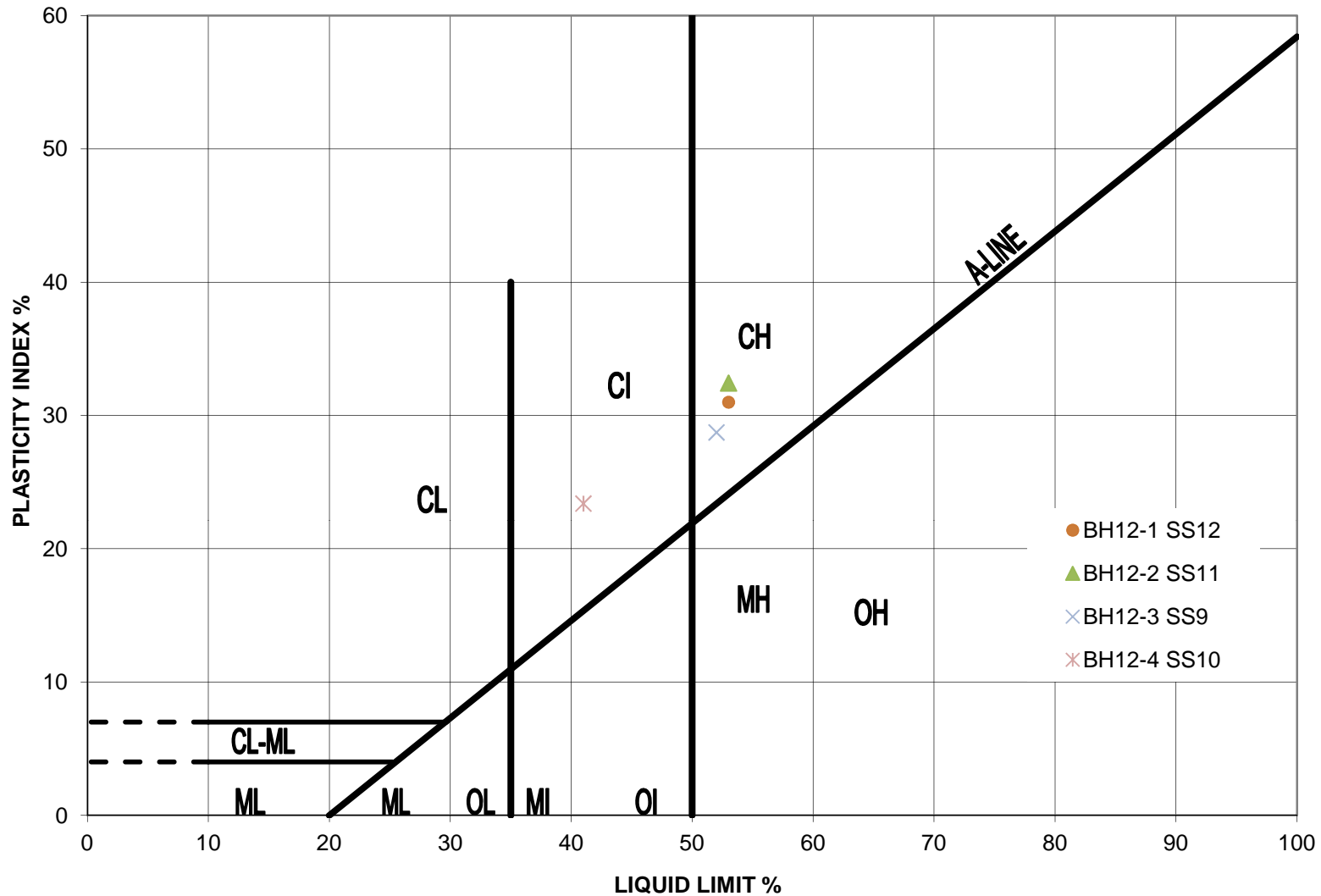
Project No.: 121-17876-00

Figure No.: B4

Remarks: Silt, some to trace clay, trace sand



PLASTICITY CHART
(Clayey Sandy Silt)



Appendix C

Site Photographs

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



Photograph 1: Borehole BH12-1. Looking northwest.



Photograph 2: Borehole BH12-2. Looking southwest.

MTO AGREEMENT #5011-E-0010
DETOUR PATROL YARD



Photograph 3: Borehole BH12-3. Looking southeast.



Photograph 4: Borehole BH12-4. Looking southeast.

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



Photograph 5: Existing 4 bay garage and salt domes. Looking northwest.



Photograph 6: Existing salt dome. Location of proposed sand/salt shed. Looking southwest.