

**MTO Agreement No. 5011-E-0010
WO No. 2011-11038
Proposed Sand/Salt Storage Facility
Gore Bay Patrol Yard
Foundation Investigation and Design
Report**

Geocres No. 41G-14

March 2013

Prepared for:
Ontario Ministry of Transportation
Northeastern Region
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Project No. 121-17876-00



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March 20, 2013

Mr. Jean-Pierre Perron, P. Eng.
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Northeastern Region
447 McKeown Avenue
North Bay, Ontario P1B 9S9

**Re: MTO Agreement No. 5011-E-0010 / WO No.: 2011-11038
Proposed Sand/Salt Storage Facility – Gore Bay Patrol Yard
Foundation Investigation and Design Report (Geocres No. 41G-14)**

Dear Mr. Perron:

We are pleased to submit our Foundation Investigation and Design Report for a proposed Sand/Salt Storage Facility to be constructed at the Ontario Ministry of Transportation Northeastern Region (MTO) Gore Bay Patrol Yard in Gore Bay, 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", written over a light blue circular stamp.

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 Gore Bay Patrol Yard, located on Highway 540B West, approximately 1.6 kilometres south of the town of Gore Bay, 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. This Foundation Investigation and Design Report includes factual results of the geotechnical investigation carried out at the Gore Bay site, including the field and laboratory testing information, and geotechnical recommendations for foundation design and construction, including a discussion on foundation design alternatives

2. Site Description and Regional Geology

2.1 Site Description

The Gore Bay Patrol Yard (site) is located on Highway 540B West, approximately 1.6 kilometres south of the town of Gore Bay, Ontario, on Manitoulin Island. A Site Plan is included as Drawing 1 and colour photographs of the site are included in Appendix C.

The site is fairly flat with a slight slope to the west. No standing water or visible drainage ditches were observed onsite. Access to the site is from Highway 540B West, and surrounding land uses are farmland to the east and west, residential to the south, and commercial to the north. No rock outcrops were visible onsite. Local vegetation consists of mixed conifers to the west and deciduous to the south.

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

- 4-bay garage / office;
- 1 small salt dome;
- 1 large sand dome;
- 2 small storage sheds;
- 1 septic bed;
- 1 propane tank;
- 1 oil / water separator;
- 1-2,200 L waste oil tank;
- 2-2,200 L above ground diesel fuel storage tanks; and
- 1-2,200 L above ground gasoline fuel storage tank.

The perimeter of the asphalt parking lot is grass covered, and there is a paved driveway from Highway 540B West extending back to the existing structures.

2.2 Regional Geology

The Physiography of Southern Ontario by Chapman and Putnam (1984) indicates that the project area is situated in the Manitoulin Island physiographic region, consisting mainly of limestone tablelands tilted slightly toward the southwest or south.

The Bedrock Geology of Ontario, Southern Sheet, Map 2544, issued by the Ministry of Northern Development and Mines in 1991 indicates that the bedrock in the site area consists of grey interbedded sandstone, shale, limestone, and siltstone of the middle and lower Silurian Age Amabel Formation. Generally, the bedrock on Manitoulin Island is covered with a thin layer of drift, and outcroppings are frequent.

Bedrock conditions at the site are further discussed in Sections 3, 4 and 5.

3. Historic Report Review

A previous geotechnical report for the Gore Bay Patrol yard was obtained from the MTO Geocres Library in Downsview, Ontario. This patrol yard was the subject of a geotechnical investigation in 1959 when the site was first developed as an MTO Patrol Yard. The results of the geotechnical investigation are summarized in a technical letter, dated May 1, 1961, titled *'Proposed Site of D.H.O. Patrol Garage at Gore Bay, Ont. – Dist. #17 (Geocres 41G-7)'*.

The historic geotechnical investigation consisted of sampling seven (7) boreholes supplemented by eight (8) dynamic cone penetration tests (DCPT). The soil stratigraphy at the site was found to be mostly uniform and consisted of a “mixed grain granular material followed by presumed limestone bedrock”. The density of the mixed grain granular material varied between locations and with depth. An average SPT N value of 8 blows per 305 millimetres (mm) was encountered in the top 3.0 m of the soil profile. Below this level, the density of the material quickly increased to a dense condition. Bedrock was encountered in one borehole at 10.0 m below the ground surface at elevation 208.0 metres above sea level (mASL). Presumed bedrock was also encountered at two (2) other boreholes at elevations of 203.7 mASL and 208.0 mASL. Bedrock was cored (near BH12-1), using an AX-size diamond drill. Coring revealed strong, hard limestone bedrock. At one of the boreholes, a DCPT was continued below borehole termination depth to refusal on presumed bedrock. The groundwater table was not encountered at the time of the investigation.

4. Investigation Procedures

4.1 Subsurface Investigation

A borehole investigation of the subject site was performed on June 5th and 6th, 2012 for the current assignment. 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. In all four boreholes, augering was terminated at 6.9 m to 10.1 m below ground surface on probable bedrock. Bedrock was investigated by coring 3.5 m to 3.0 m into the formations at boreholes BH12-2 and BH12-3; drilling was terminated at 10.4 m and 10.5 m below existing grade, at these locations.

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 subsequently converted to MTO standard coordinates (Northing and Easting). Borehole elevations were surveyed to a known benchmark: the concrete floor near the southwestern corner of easterly Bay Door at the garage, shown in Drawing 1, has a reported geodetic elevation of 218.69 metres above sea level (mASL). Borehole elevations and coordinates are shown on Drawing 1, and are also provided on the borehole logs included in Appendix A.

Drilling, soil sampling and rock coring was completed using a truck-mounted drill rig operating under the supervision of an experienced GENIVAR technician. Boreholes were advanced to 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 (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.

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.

NQ-size coring equipment (47.6 mm diameter) was used to obtain two (2) bedrock core samples 3.0 m to 3.5 m long, as 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, prior to backfilling. In addition, one (1) groundwater monitoring well was installed in borehole BH12-3 at a depth 4.8 m below the ground surface, to measure static groundwater levels at the site. The monitoring well was installed to meet Ontario Regulation (O. Reg.) 903 requirements, and consists 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 well is intended for temporary use only, and should be removed at the time of construction.

Remaining boreholes not completed as monitoring wells 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 are abandoned in accordance with O. Reg. 903 requirements. Table 4.1 below summarizes the borehole numbers, drilling depths and the surveyed elevations (geodetic).

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

Borehole No.	Drilling Depth Below Existing Ground Surface (m) / Elevation (mASL)	Comment
BH12-1	10.1 / 208.3	Met refusal on probable bedrock
BH12-2	10.4 / 208.1	Cored 3.5 m into bedrock
BH12-3	10.5 / 208.3	Cored 3.0 m into bedrock
BH12-4	8.5 / 210.2	Met refusal on probable bedrock

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 – Gore Bay Patrol Yard

Test	ASTM Standard	Number of Samples
Natural Moisture Content	ASTM D2216	33
Particle Size Analysis	ASTM D422	9

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 the summary Table B1 in Appendix B.

5. Subsurface Conditions

Subsurface conditions were assessed at the four (4) borehole locations designated as BH12-1 to BH12-4. Borehole locations are shown in Drawing 1. The subsurface stratigraphic profile for the site is indicated on two cross sections presented as 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

All four (4) of the boreholes encountered a thin layer of asphalt overlying dense to compact granular fill. A very loose to compact sand layer was encountered beneath the fill, overlying a compact to dense silty sand till layer, extending to the presumed surface of the bedrock at depths of 6.9 m to 10.1 m below ground surface. At boreholes BH12-2 and BH12-3 the bedrock was cored for lengths of 3.5 and 3.0 m respectively, after which the holes were terminated. Descriptions of the major subsurface units are provided in the following subsections.

5.1.1 Asphalt Pavement

A 25 mm to 85 mm thick layer of asphaltic concrete (hot laid mix) was encountered at the surface at each of the borehole locations.

5.1.2 Granular Fill

Below the asphalt pavement, the boreholes encountered a granular fill layer (pavement base/subbase) consisting of 0.10 m to 0.15 m of sand and gravel, underlain by sand with some gravel and some silt, extending to the depths (metres below ground surface, mbgs) and elevations (geodetic) shown below:

Borehole No.	Depth to Bottom of Fill Layer (Elevation)
BH12-1	1.4 mbgs (216.9 mASL)
BH12-2	1.4 mbgs (217.1 mASL)
BH12-3	1.4 mbgs (217.4 mASL)
BH12-4	1.8 mbgs (217.0 mASL)

Laboratory particle size distribution analyses for three (3) samples from the granular fill layer were completed, and results according to the Unified Soil Classification System (USCS) are summarized below and are shown on Figure B1 of Appendix B:

- Gravel (greater than 4.75 mm size) - 0 % to 40 %
- Sand (0.075 mm to 4.75 mm size) - 42 % to 77 %
- Silt and Clay (less than 0.075 mm size) - 15 % to 23 %

Standard Penetration Test results (N Values) recorded in the fill layer ranged between 10 and 34 blows per 305 mm of penetration, indicating compact to dense relative density.

Laboratory determined moisture contents ranged between 4 % and 10 % for samples of the fill, indicating moist material.

5.1.3 Sand

A layer of sand with trace silt, trace gravel was encountered beneath the granular fill layer in the boreholes at depths ranging between 1.4 m and 1.8 m below ground surface (mbgs), extending to the depths and geodetic elevations indicated below.

Borehole No.	Depth to Bottom of Sand Layer (Elevation)	Layer Thickness (m)
BH12-1	5.5 mbgs (212.8 mASL)	4.1
BH12-2	5.5 mbgs (213.0 mASL)	4.1
BH12-3	5.0 mbgs (213.8 mASL)	3.6
BH12-4	5.6 mbgs (213.2 mASL)	3.8

Laboratory particle size distribution analyses for three (3) samples from the sand layer were completed, and results according to the Unified Soil Classification System (USCS) are summarized below and are shown on Figure B2 of Appendix B:

- Gravel (greater than 4.75 mm size) - 1 % to 6 %
- Sand (0.075 mm to 4.75 mm size) - 86 % to 92 %
- Silt and Clay (less than 0.075 mm size) - 7 % to 9 %

A silty sand trace clay layer was encountered beneath the sand trace silt layer in borehole BH12-3, at a depth of 2.9 mbgs, extending to 3.7 mbgs. A laboratory particle size distribution analysis of a sample of the material was 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) - 63 %
- Silt (0.002 mm to 0.075 mm size) - 29 %
- Clay (less than 0.002 mm size) - 8 %

Standard Penetration Test results (N values) recorded for the sand trace silt (including the silty sand layer) ranged from 1 to 16 blows per 305 mm of penetration, indicating very loose to compact relative density (generally loose).

Laboratory determined moisture contents ranged between 5 % and 23 % for samples of the sand layer, indicating moist to wet material.

5.1.4 Till

Underlying the sand layer the boreholes penetrated glacial till material extending to the depths (mbgs), and elevations (geodetic) indicated below:

Borehole No.	Depth to Bottom of Till Layer (Elevation)	Layer Thickness (m)
BH12-1	10.1 mbgs (208.3 mASL)	4.6
BH12-2	6.9 mbgs (211.6 mASL)	1.4
BH12-3	7.5 mbgs (211.3 mASL)	2.5
BH12-4	8.5 mbgs (210.2 mASL)	2.9

The texture of the till material ranges from sand with some gravel, some silt and a trace of clay in boreholes BH12-1, BH12-3 and BH12-4, to gravelly sand with some silt and a trace of clay in borehole BH12-2.

Laboratory particle size distribution analyses for two (2) samples taken from the till deposit were completed, and results are summarized below and are shown in Figure B4 of Appendix B:

- Gravel (greater than 4.75 mm size) - 12 % to 30 %
- Sand (0.075 mm to 4.75 mm size) - 55 % to 72 %
- Silt (0.002 mm to 0.075 mm size) - 12 %
- Clay (less than 0.002 mm size) - 3 % to 4 %

Standard Penetration Test results (N Values) recorded in the till deposit ranged from 17 to over 50 blows per 305 mm of penetration, indicating compact to very dense relative density. It should be noted that frequent cobbles and boulders were encountered within the till layer during drilling operations, and auger refusal on presumed bedrock occurred at boreholes BH12-1 to BH12-4, at depths ranging from 6.9 mbgs (BH12-2) to 10.1 mbgs (BH12-1).

5.1.5 Bedrock

Bedrock was cored at boreholes BH12-2 and BH12-3 to lengths of 3.5 m and 3.0 m, respectively. Borehole BH12-2 was terminated at 10.4 mbgs (elevation 208.1 mASL) and BH12-3 was terminated at 10.5 mbgs (elevation 208.3 mASL). Photographs of the bedrock core samples obtained are included in Appendix C.

A description of the bedrock is provided in Table 5-1. Total Core Recovery (TCR) ranged from 89 % to 100 %. Rock Quality Designation (RQD) values for the core samples in borehole BH12-2 ranged from 91 % to 100 %, which is described as excellent rock quality. RQD values for borehole BH12-3 ranged between 86% and 89%, described as good quality.

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

BH	RC #	Depth (m)	TCR (%)	RQD (%)	Depth (m)	Description
12-2	1	6.9 – 7.7	89	91	6.9 – 10.4	LIMESTONE, grey, fine grained, massive bedded, medium hard, broken fracturing, fresh to slightly weathered
	2	7.7 – 9.05	100	100		
	3	9.05 – 10.4	100	100		
12-3	1	7.5 – 9.0	97	86	7.5 – 10.5	LIMESTONE, grey, fine grained, massive bedded, medium hard, broken fracturing, slightly weathered
	2	9.0 – 10.5	97	89		

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 (Elevation, mASL)	Date Measured
BH12-1	4.3 (214.0)	5 June 2012
BH12-2	4.0 (214.5)	5 June 2012
BH12-3(MW)	4.1 (214.7)	6 June 2012 (3 hours after completion)
BH12-4	4.5 (214.3)	6 June 2012

Note: mbgs = metres below ground surface; MW signifies monitoring well.

Based on the water level measurements and moisture conditions of the inspected soil samples, the inferred groundwater level within the footprint of the proposed structure, at the time of the field investigation, was estimated to be between 4.0 m and 4.5 m below ground surface, at elevations between 214.0 mASL and 214.7 mASL.

It should be noted that groundwater levels may fluctuate seasonally and in response to climatic conditions, and due to a potential for the development of perched groundwater lenses after wet seasons and periods of rainfall.

6. Geotechnical Design Considerations

The proposed sand/salt storage facility at Gore Bay Patrol Yard will replace an existing dome, and will have a rectangular footprint of approximate dimensions 40.2 m × 24.4 m. Foundation engineering guidelines presented in this section have been developed based on the soil conditions investigated and described in Section 5, and in accordance with the most recent edition of the Canadian Highway Bridge Design Code (CHBDC) and the most recent edition of the Canadian Building Code in effect for MTO projects.

Four (4) boreholes (BH12-1 to BH12-4) were drilled to assess the subsurface conditions at the proposed storage facility. The boreholes encountered a thin layer of asphalt overlying dense to compact granular fill. A very loose to compact sand to silty sand layer was encountered beneath the fill, overlying a compact to very dense sand till deposit. The till extends down to the presumed surface of the bedrock at depths of 6.9 m to 10.1 m below ground surface (elevations 211.6 mASL to 208.3 mASL). The bedrock was core sampled at boreholes BH12-2 and BH12-3.

Based on the water level measurements, the inferred groundwater level within the footprint of the proposed structure was estimated to be between 4.0 m and 4.5 m below ground surface, at elevations between 214.0 mASL and 214.7 mASL.

6.1 “Red Flag” Conditions and NSSP's

Subsurface conditions at the Gore Bay site may present some challenges for design and construction of the foundation for the new sand/salt storage facility.

As mentioned previously, the loose to compact sand layer beneath the granular fill may be easily disturbed by construction equipment and workers. Protective measures are required to maintain adequate excavation stability and foundation bearing capacity. Mitigation measures for shoring and excavation protection systems are discussed in Section 6.6.

The presence of cobbles and boulders should be anticipated, particularly within the sand till deposit, and may cause difficulties if excavations and/or installation of shoring units must extend into this zone. If boulders are encountered within foundation excavations and/or become dislodged they should be removed (and not be pushed back into place). Any voids created should be filled with concrete.

The following Non-standard Special Provisions (NSSP's) are presented to address “Red Flag” conditions.

- NSSP 1: The loose to compact sand layer beneath footing areas may be easily disturbed during excavations and construction. Therefore, it is recommended that a 50 mm to 100 mm thick mud mat be installed on the surface of the exposed sand layer, as a subgrade protection measure.
- NSSP 2: If boulders are encountered and/or removed during excavation and/or shoring procedures, the Contractor shall ensure that the integrity of the disturbed soil is restored so that there are no voids or loose soil zones created. Unshrinkable concrete fill shall be used when necessary.
- NSSP 3: The Contractor shall ensure that excavation shoring systems are installed to meet OPSS 539 requirements. Shoring systems shall be designed by a Professional Engineer licensed in Ontario.

6.2 Structure Foundation Design Options

Based on the results of this investigation, several foundation options are available, including shallow and deep foundations. The preferred foundation option should be determined in view of following factors:

- Existing Subsurface Conditions
- Serviceability
- Advantages\ Disadvantages
- Reliability
- Risk/ Consequences

Comments for consideration of foundation design alternatives are provided in Table 6-1.

Table 6-1: Foundation Design Alternatives

Foundation Type	Advantages/ Disadvantages	Reliability	Risks/ Consequences	Recommendations
Strip Footing on Native Sand Layer	Relatively low cost; lower foundation capacity and larger settlement potential versus deep foundation design.	Good, provided that good construction practices are used to minimize soil disturbance.	Risk of subgrade disturbance in wet conditions, subexcavation may be required; excavation shoring may be required.	Recommended, provided good construction practices are used. Foundation must be below frost or suitably insulated.
Strip Footing on Engineered Fill	Low to medium relative cost, higher foundation capacity compared to footing on native sand, more construction effort required.	Good, provided that good fill quality and compaction is used.	Risk of groundwater and subgrade disturbance; subexcavation may be needed; pumping may be required to control groundwater depending on seasonal conditions; excavation shoring may be necessary.	Recommended, provided that good quality fill and compaction efforts are used. 19 mm clear stone (OPSS 1004) wrapped in non-woven geotextile is an option. Insulation may be required to protect against frost heaving if footings or approved fill does not extend below frost depth.
Slab-on-Grade	Medium cost, medium geotechnical resistance; larger foundation settlement versus deep foundation.	Good. Insulation required and must extend beyond structure.	Removal of shallow deleterious material and/or existing soil improvement is required. Larger excavation/disturbed area required for insulation component.	Not Recommended due to economic and constructability reasons.

Foundation Type	Advantages/ Disadvantages	Reliability	Risks/ Consequences	Recommendations
Drilled and Cast-in-Place Concrete Foundation into Bedrock	High bearing resistance, negligible settlement, and protection of subgrade against cave in is required, use liners, high cost. Possibility of encountering cobbles and boulders during drilling.	Good	Must extend to bedrock. Liners may be required. Construction difficulties if boulders encountered during drilling.	Not Recommended due to economic and constructability reasons.
Steel H Piles on Bedrock	High bearing resistance, negligible settlement, protection of subgrade against disturbance not as critical as for shallow foundations, high cost. Possibility of encountering cobbles and boulders during driving and thus needing to pre-drill pile locations, use lower pile capacity, and/or drive additional piles.	Good	Must extend to deeper competent material or bedrock. Vibrations and/or soil disturbance may be an issue for nearby structures.	Not Recommended due to economic and constructability reasons.

6.3 Frost Penetration Depth

The recommended design frost protection depth for the site area is 1.8 m (Source: MTO Pavement Design and Rehabilitation Manual). Therefore, a permanent soil cover of about 1.8 m or its thermal equivalent of high density foam insulation (e.g. 50 mm thick of DOW Styrofoam HI60 or equivalent) is required for frost protection of foundations.

6.4 Preferred Foundation Option

Based on an assessment of foundation design alternatives, the preferred foundation design option is to construct the foundation using shallow strip footings based on the on native sand layer, between elevation 216.0 mASL and 217.0 mASL, at depths ranging between 1.8 m and 2.2 m below the ground surface.

It is preferable to construct the foundation in dry weather conditions when groundwater is expected to be deeper and moisture and runoff will have less of an effect on the granular bearing stratum. However, if groundwater and disturbance of the sand bearing surface becomes a concern, then the footing excavation can be widened and progressively backfilled with OPSS 1004 19 mm diameter clear stone fill wrapped in medium duty non-woven geotextile (e.g. Terrafix 270R or equivalent). In this case, the footing may be constructed at a higher elevation provided the stone extends below frost depth. The underside of footing in this design should be based no higher than elevation 217.4 mASL with the base of the stone at or below 216.4 mASL. Approximately 1 m of clear stone would be required below the footing grade and the stone fill would need to be at least 1.5 m wider than the footing width. Progressive backfill procedures will require that short sections of trench be excavated, lined with geotextile and filled with stone, to maintain stability of the granular soils.

The following geotechnical resistances are appropriate for strip footing with minimum 0.9 m width construction on the undisturbed sandy layer:

- Factored Geotechnical Resistance at Ultimate Limit State (ULS) = 140 kPa
- Geotechnical Resistance at Serviceability Limit State (SLS) = 100 kPa

Design resistances can be increased to 225 kPa (ULS)/150 kPa (SLS), if the widened clear stone base layer described above is used.

The Geotechnical Resistance at Serviceability Limit State (SLS) value is based on maximum total and differential settlements of 25 mm and 20 mm, respectively.

Existing fill materials overlying the native sand layer are not suitable as structural material and should be removed to full depth. The founding subsoil must be inspected by the Geotechnical Engineer to confirm that it is suitable to support the design loads, and to confirm that all disturbed or loose soils are properly removed from below all footing areas.

6.5 Resistance to Lateral Loads

Resistance to lateral forces/sliding between the concrete footings and subsoils should be calculated in accordance with Section 6.7.5 of the CHBDC. The coefficient of friction, $\tan \delta$, may be taken as 0.40 for cast in place concrete footings constructed on undisturbed loose to compact sand. In accordance with CHBDC, a factor of 0.8 is to be applied in calculating horizontal resistance. Resistance to lateral loads could be increased if necessary by constructing a shear key at the bottom of the footing. The design of shear keys would require a specific analysis taking into consideration the magnitude of the horizontal loading, the magnitude of the vertical loading, and any variations in the bearing pressure due to overturning moments.

The above guidelines assume that the subgrade materials will not be excessively disturbed by construction activities. Engineer approval is required.

6.6 Backfill and Lateral Earth Pressure

Backfill behind foundation and retaining walls should consist of non-frost susceptible, free-draining backfill materials (i.e. Granular 'A' or Granular 'B' Type I or II, with no more than 8 % passing the 0.75 mm sieve as per requirement of OPSS 1010 and its Amendment No. 110S13), and the provision of drain pipes and weep holes where required to prevent hydrostatic pressure build-up against the walls.

Computation of earth pressures acting against walls should be in accordance with the CHBDC. For design purposes, the properties outlined in Table 6-2 may be assumed for backfill.

Table 6-2: Typical Backfill Properties

Property	Compacted Granular 'A' or Granular 'B' Type II	Compacted Granular 'B' Type I
Angle of Internal Friction ϕ (unfactored)	35°	32°
Unit Weight γ	22 kN/m ³	21 kN/m ³
Coefficients of Lateral Earth Pressure		
K_a	0.27	0.31
K_b	0.35	0.41
K_o	0.43	0.47
K^*	0.45	0.57

Notes:

- K_a is the coefficient of active earth pressure.
- K_b is the backfill earth pressure coefficient for an unrestrained structure, including compaction effects.

- K_o is the coefficient of earth pressure at rest.
- K^* is the earth pressure coefficient for soil loadings on fully restrained structure and includes compaction effects.

Earth pressure coefficients are based on the assumption that the backfill behind retaining structures is free-draining granular material and adequate drainage is provided.

Should temporary shoring be required to support excavations, it must be designed by a Professional Engineer. In Ontario, shoring typically consists of soldier pile and timber lagging or sheet piling (with or without bracing/rakers). The shoring system should be designed so that the lateral movement of any portion of the supported excavation will not exceed the established criterion for the structural performance level.

Shoring walls below grade can be designed using the following expression:

$$P = K (\gamma h + q)$$

where:

P = lateral earth pressure (kPa) acting at depth h

K = earth pressure coefficient

γ = unit weight of backfill (kN/m³)

h = depth to point of interest in metres

q = equivalent value of surcharge on the ground surface in kPa

The coefficients of lateral earth pressure given in Table 6-3 may be used for the design of the temporary shoring systems, based on the borehole results, if required.

Table 6-3: Recommended Unfactored Parameters for Temporary Shoring Design

Soil Type	K_a	K_o	K_p	γ (kN/m ³)
Granular Fill	0.33	0.5	3.0	19.0
Loose to Compact Sand	0.35	0.52	2.8	18.0
Compact to Dense Till	0.30	0.45	3.4	19.5

6.7 Seismic Design

The Ontario Building Code (OBC) specifies that the structure should be designed to withstand forces due to earthquakes. For the purpose of earthquake design the information relevant to the geotechnical conditions at this site is the 'Site Class'. Based on the explored soil properties and in accordance with Table 4.1.8.4.A of the Ontario Building Code (2006), and in the absence of MASW tests it is recommended that Site Class 'D' (dense soil over bedrock) be applied for structural design at this site.

Seismic information for the Gore Bay site is provided below. Data from the 2005 National Building Code Seismic Hazard Calculation is provided in this table to be consistent with the 2006 Ontario Building Code.

Parameter	Gore Bay	Source
Site Class	D	2006 Ontario Building Code Table 4.1.8.4.A
$S_a(0.2)$	0.116	2005 National Building Code Seismic Hazard Calculation
$S_a(1.0)$	0.034	2005 National Building Code Seismic Hazard Calculation
F_a	1.3	2006 Ontario Building Code Table 4.1.8.4.B
F_v	1.4	2006 Ontario Building Code Table 4.1.8.4.C

Generally, the looser the sediment, and the higher the water table, the more susceptible the soil is to liquefaction. Zones of saturated, looser sandy soils up to about 1 m thick exist beneath the site and may be prone to liquefaction settlement under a severe earthquake. As such seismic bracing requirements for the building should be evaluated by the structural engineer. More detailed liquefaction assessments are beyond the scope of this report.

6.8 Dewatering and Drainage

It is anticipated that the groundwater table will be encountered at elevations between 214.0 mASL and 214.7 mASL relative to the recommended footing elevation between 216.0 mASL and 217.0 mASL. As such, the bottom of the foundation excavation is not expected to encounter significant wet soils or seepage. Fluctuating groundwater levels and/or perched groundwater may occur, however, and if possible construction should be scheduled during dry weather periods.

If excavations do encounter groundwater, we believe that the groundwater can be lowered by at least 0.5 m by pumping from strategically placed filtered sumps and/or gravity drainage. For more extensive drawdown, vacuum well points and/or deeper purge wells would be required. It is recommended that the Contractor be requested to submit any dewatering plans to the MTO Project Manager for review and approval, prior to construction. Dewatering procedures should follow the requirements and specifications of OPSS 517.

Soils encountered in the boreholes include granular fill underlain by sandy soils. The sandy soils generally exhibit characteristics of medium to high permeability, and potential seepage into excavations in wet materials could be rapid. Depending on the construction depths, relative groundwater conditions at the time of construction and the dewatering procedures to be used, the Contractor should obtain a Permit to Take Water under Section 34 of the Ontario Water Resources Act if he believes pumping rates will exceed 50,000 L/day.

6.9 Excavations and General Construction Consideration

Construction excavations are required for foundations and utility services. Temporary excavations must be carried out in accordance with the latest edition of Ontario Regulation (O.Reg.) 213/91 of the Occupational Health and Safety Act (OHSA) as well as MTO specifications OPSS 539 – Protection Systems and OPSS 902 – Excavations and Backfilling to Structure. The soils at the site may be classified as shown below, in accordance with the OHSA.

Table 6-4: Soil Classification for Excavations

Soil Type	Above Groundwater Level	Below Groundwater Level
Fill material	Type 3	Type 4
Loose to compact sand	Type 3	Type 4
Compact to dense sand till	Type 2	Type 3

Type 2 excavations may have vertical sides for the bottom 1.2 m of the excavation, and then should be cut with 1H:1V or flatter side slopes to grade. Type 3 excavations should be cut with 1H:1V or flatter side slopes. Type 4 excavations should be cut with 3H:1V or flatter side slopes. If the appropriate side slopes cannot be achieved, the excavations must be properly supported (shored). All excavation and grading procedures should follow the Provincial requirements and specifications, and management of excess material should follow the requirements of OPSS 180.

Regular inspections by qualified geotechnical engineering personnel must be conducted for any excavation in the bedrock to confirm that conditions are safe and consistent with the requirements of the OHSA.

Since the subject site was used for many years to store road salt, and will be used in the future for the same purpose, it is expected that the new foundation will be exposed to chloride, sodium and sulfate attack. To reduce damage potential and rate of deterioration, we recommend the use of high sulfate-resistant cement (Type HS as per CSA A.23) in the concrete mix design with water-cement ratio should not exceed 0.45.

7. Miscellaneous Information

The following GENIVAR personnel and subcontractors responsible for completion of this geotechnical investigation are summarized in Table 7-1.

Table 7-1: 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
Laboratory Medium Complexity	Marijana Manojlovic, B.Sc. Golder Associates	Mississauga, ON	905-567-4444
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, P. Eng. GENIVAR Inc.	Newmarket, ON	905-853-3303

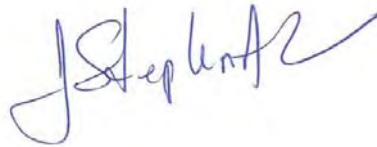
8. Closure

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.



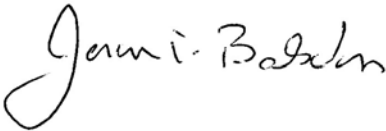
Raid Khamis, P. Eng., PMP.
Geotechnical Engineer



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



Reviewed by:

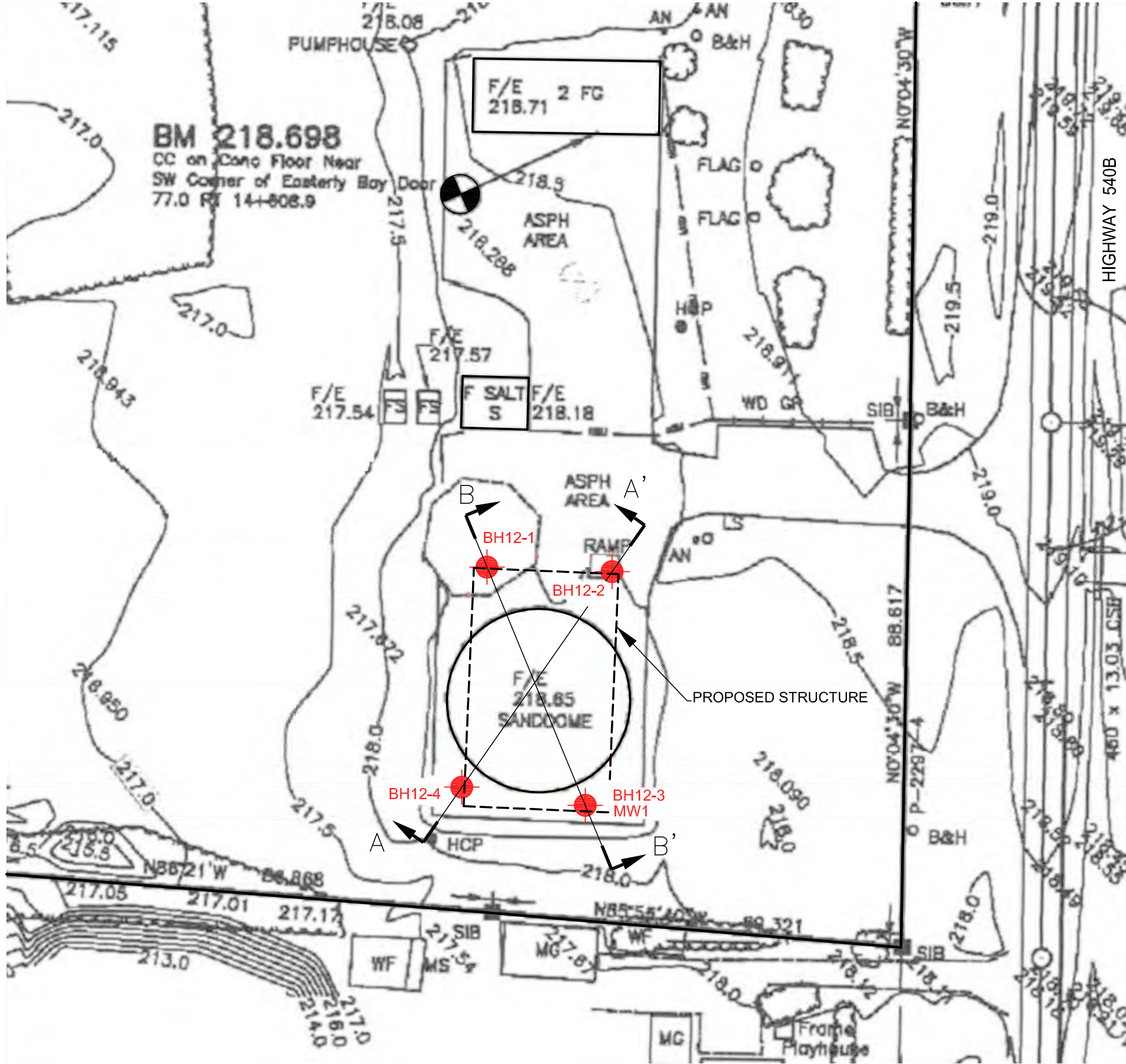


Jason Balsdon, M.A.Sc., P. Eng.
Director, Environment

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

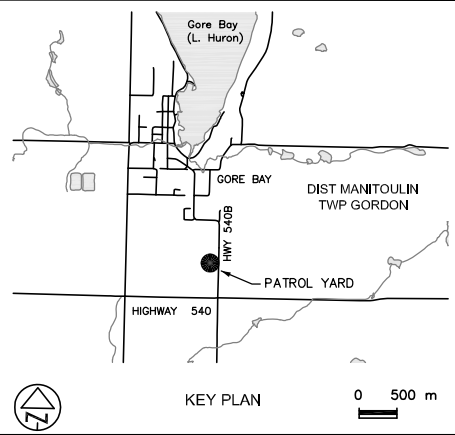
Agreement No.: 5011-E-0010
WO No.: 2011-11038

BOREHOLE LOCATION PLAN
PROPOSED SAND/SALT STORAGE
FACILITY
GORE BAY PATROL YARD
HIGHWAY 540B

Client: MTO - Northeastern Region

DRAWING

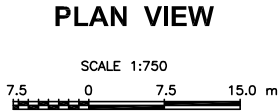
1



LEGEND

- Borehole
- Benchmark (218.698 mASL)
- Proposed Sand/Salt Storage Facility
- A — A' Line of Cross Section (See Figure 2)

BH No	ELEVATION (mASL)	COORDINATES (NAD 83 Zone17)	
		NORTHING	EASTING
12-1	218.316	5083968.4	387018.5
12-2	218.476	5083967.7	387039.7
12-3	218.796	5083928.3	387035.2
12-4	218.780	5083931.3	387014.3



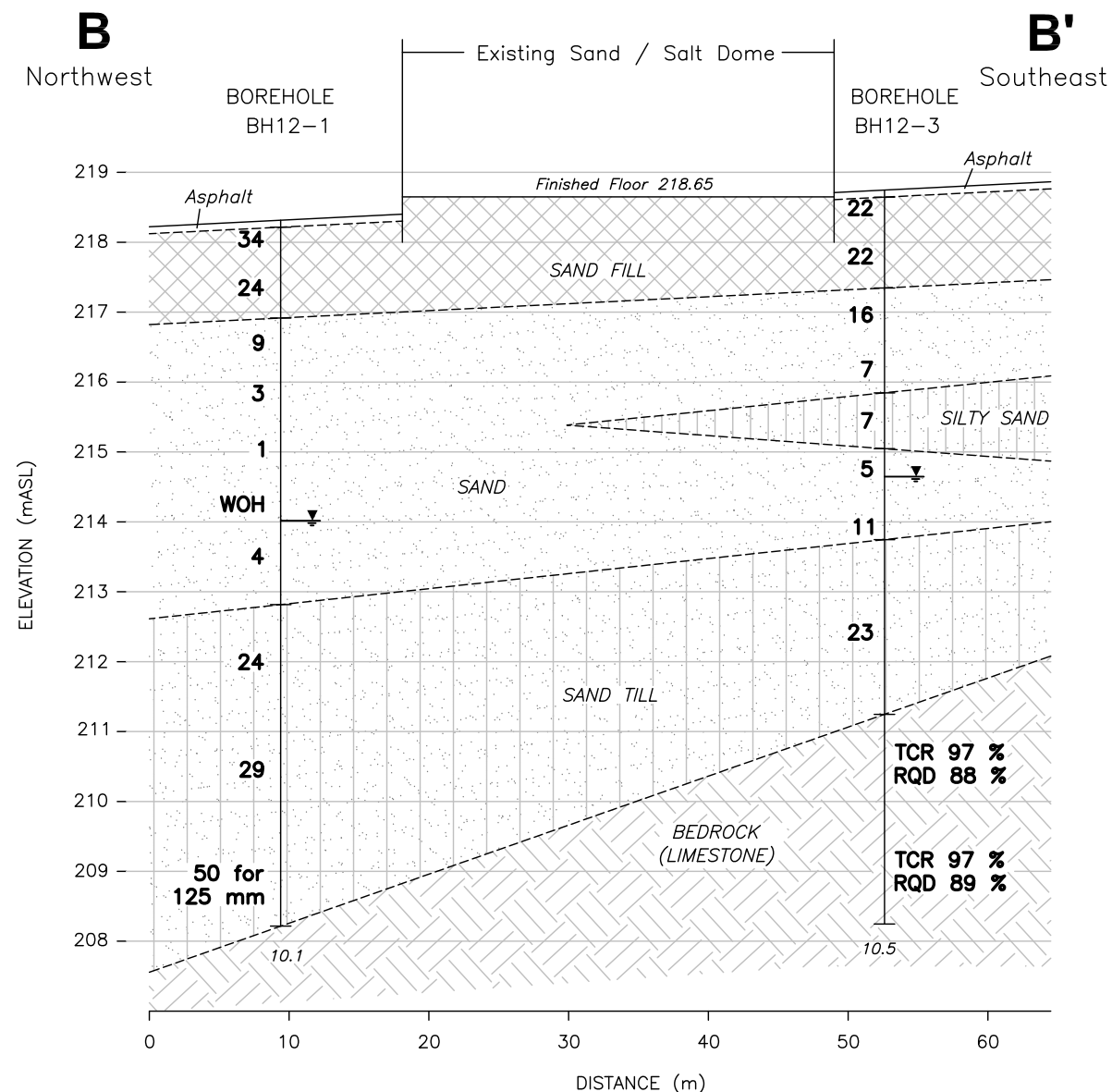
- NOTES:
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
 - COORDINATES AT BOREHOLE LOCATIONS WERE BY HANDHELD GPS.
 - BOREHOLE ELEVATIONS WERE SURVEYED FROM CUTCROSS BENCHMARK ON CONCRETE FLOOR NEAR SOUTHWEST CORNER OF EASTERLY BAY DOOR (EL. 218.698 mASL).

— 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. : 41G-14			
HWY No 540B	DIST MANITOULIN		
SUBM'D --	CHECKED JSA	DATE MARCH 2013	SITE --
DRAWN PLB	CHECKED --	APPROVED --	DWG --

CROSS SECTION B-B'



LEGEND

N	Blows/0.3m (Std. Pen Test, 475 J / blow)
CONE	Blow/0.3m (60° Cone, 475 J / blow)
WOH	Weight of Hammer (N<1)
	Inferred Water Level At Time Of Investigation

BH No	ELEVATION (mASL)	COORDINATES NORTHING	(NAD 83 Zone17) EASTING
12-1	218.316	5083968.4	387018.5
12-2	218.476	5083967.7	387039.7
12-3	218.796	5083928.3	387035.2
12-4	218.780	5083931.3	387014.3

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 FROM CUTCROSS BENCHMARK ON CONCRETE FLOOR NEAR SOUTHWEST CORNER OF EASTERLY BAY DOOR (EL. 218.698 mASL).

- 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. : 41G-14

HWY No 540B			DIST MANITOULIN
SUBM'D --	CHECKED JSA	DATE MARCH 2013	SITE --
DRAWN PLB	CHECKED --	APPROVED --	DWG --



PROJECT: 121-17876-00 111-9
SITE PLAN MAPPING REF. NO.:
MTO PLAN H-654-540B-1, FEB. 2002 SURVEY.

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 GORE BAY PATROL YARD N 5083968 4 : E 387018 5

ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT AUGERS

COMPILED BY JW

DATUM GEODETIC DATE 6.5.12 - 6.5.12

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100					
218.3																
216.9	ASPHALT: 25 mm THICK		1	SS	34											
	FILL: GRAVELLY SAND TO SAND FILL, TRACE TO SOME GRAVEL, TRACE TO SOME SILT		2	SS	24											9 76 (15)
216.9	BROWN, COMPACT TO DENSE, MOIST															
1.4	SAND: SAND, TRACE TO SOME SILT, TRACE GRAVEL		3	SS	9											
	BROWN, VERY LOOSE TO LOOSE, MOIST TO SATURATED		4	SS	3											
			5	SS	1											6 86 (8)
			6	SS	WOH											
	-SATURATED		7	SS	4											
	-BECOMING GREY															
212.8																
5.5	TILL: SAND TILL, SOME SILT, TRACE CLAY, TRACE GRAVEL		8	SS	24											
	BROWN, COMPACT TO VERY DENSE, SATURATED															
			9	SS	29											
			10	SS	50 for 125 mm											
208.3	END OF BOREHOLE AUGER REFUSAL ON PRESUMED BEDROCK.															
10.1																

RECORD OF BOREHOLE No BH12-2

1 OF 1

METRIC

LOCATION GORE BAY PATROL YARD N 5083967.7 ; E 387039.7

ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT AUGERS

COMPILED BY JW

DATUM GEODETIC DATE 6.5.12 - 6.5.12

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									
								20	40	60						80	100
								○ UNCONFINED	+	FIELD VANE						×	LAB VANE
218.5							20	40	60	80	100						
218.4	ASPHALT: 50 mm THICK		1	SS	22												
217.1	FILL: GRAVELLY SAND TO SAND FILL, SOME GRAVEL, SOME SILT, TRACE CLAY BROWN, COMPACT, MOIST		2	SS	10										77 19 4		
1.4	SAND: SAND, TRACE TO SOME SILT BROWN TO DARK BROWN, VERY LOOSE TO LOOSE, MOIST TO WET		3	SS	6												
			4	SS	3										1 92 (7)		
			5	SS	6												
			6	SS	3												
			7	SS	1												
213.0	TILL: SAND TILL, SOME SILT, TRACE CLAY, TRACE GRAVEL BROWN, COMPACT, MOIST		8	SS	27										1 76 19 4		
211.6	BEDROCK: LIMESTONE, APHANITIC, MASSIVE BEDDED, MEDIUM HARD, MASSIVE FRACTURING, FRESH TO SLIGHT WEATHERING GREY - ORANGE STAINING IN FRACTURES BETWEEN 7.9 m AND 8.9 m DEPTH		1	RC	TCR 89%										RQD 91%		
6.9			2	RC	TCR 100%										RQD 100%		
			3	RC	TCR 100%										RQD 100%		
208.1	END OF BOREHOLE BOREHOLE OPEN ON COMPLETION, DRY.																
10.4																	

ONTARIO MOT 121-17876-00 GORE BAY GINT.GPJ ONTARIO MOT.GDT 4/8/13

+ 3, X 3: Numbers refer to Sensitivity

O 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH12-3

1 OF 1

METRIC

LOCATION GORE BAY PATROL YARD N 5083928.3 : E 387035.2

ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT AUGERS

COMPILED BY JW

DATUM GEODETTIC DATE 6.5.12 - 6.6.12

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
218.8								20 40 60 80 100						
218.0	ASPHALT: 85 mm THICK		1	SS	22		218							40 42 (18)
	FILL: GRAVEL AND SAND TO SAND FILL, SOME GRAVEL, SOME SILT BROWN, COMPACT, MOIST		2	SS	22									
217.4														
14	SAND: FINE SAND, SOME SILT, TRACE CLAY BROWN TO DARK BROWN, LOOSE TO COMPACT, MOIST TO WET		3	SS	16		217							
			4	SS	7									
	SILTY SAND BROWN, LOOSE, WET		5	SS	7		216							63 29 8
			6	SS	5		215							
	FINE SAND SOME SILT BROWN, WET		7	SS	11		214							
213.8														
5.0	TILL: SAND TO SILTY SAND TILL, SOME GRAVEL, TRACE CLAY GREY TO BROWN, COMPACT, MOIST TO SATURATED		8	SS	23		213							
							212							
211.3														
7.5	BEDROCK: LIMESTONE, GREY, FINE GRAINED, MASSIVE BEDDED, MEDIUM HARD, BROKEN FRACTURING, SLIGHTLY WEATHERED		1	RC	TCR 97%		211							RQD 86%
			2	RC	TCR 97%		210							RQD 89%
208.3							209							
10.5	END OF BOREHOLE BOREHOLE OPEN ON COMPLETION													

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

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

RECORD OF BOREHOLE No BH12-4

1 OF 1

METRIC

LOCATION GORE BAY PATROL YARD N 5083931.3, E 387014.3

ORIGINATED BY DCL

BOREHOLE TYPE CONTINUOUS FLIGHT AUGERS

COMPILED BY JW

DATUM GEODETIC DATE 6.6.12 - 6.6.12

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							
218.8							20	40	60	80	100	10	20	30	GR	SA	SI	CL	
218.7	ASPHALT: 75 mm THICK		1	SS	34		218												
	FILL: GRAVELLY SAND TO SAND FILL, SOME GRAVEL, TRACE SILT, SOME ASPHALT BROWN, COMPACT TO DENSE, MOIST		2	SS	32														
217.0			3	SS	29														
18	SAND: FINE TO MEDIUM SAND, TRACE SILT, TRACE GRAVEL BROWN, LOOSE TO COMPACT, MOIST TO WET	4	SS	6				217											
		5	SS	5				216											1 90 (9)
		6	SS	9				215											
	-WET	7	SS	11				214											
213.2								213											
5.6	TILL: SAND SOME GRAVEL, SOME SILT, TRACE CLAY BROWN, COMPACT, MOIST		8	SS	17				212										12 72 12 4
			9	SS	28				211										
210.2	END OF BOREHOLE AUGER REFUSAL ON PRESUMED BEDROCK																		
8.5																			

ONTARIO MOT 121-17876-00 GORE BAY GINT 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)

Table B1: Summary of Grain Size Distribution

Borehole No.	Sample ID	Soil Description	Percentage Retained (%)			
			Gravel	Sand	Silt	Clay
BH12-1	SS2	Sand, some silt, trace gravel	9	76	15	
BH12-1	SS5	Sand, trace gravel, trace silt	6	86	8	
BH12-2	SS2	Sand, some silt, trace clay	0	77	19	4
BH12-2	SS4	Sand, trace gravel, trace silt	1	92	7	
BH12-2	SS8	Gravelly sand, some silt, trace clay	30	55	12	3
BH12-3	SS1	Sand and gravel, some silt	40	42	18	
BH12-3	SS5	Silty sand, trace clay	0	63	29	8
BH12-4	SS4	Sand, trace gravel, trace silt	1	90	9	
BH12-4	SS8	Sand, some gravel, some silt, trace clay	12	72	12	4

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%

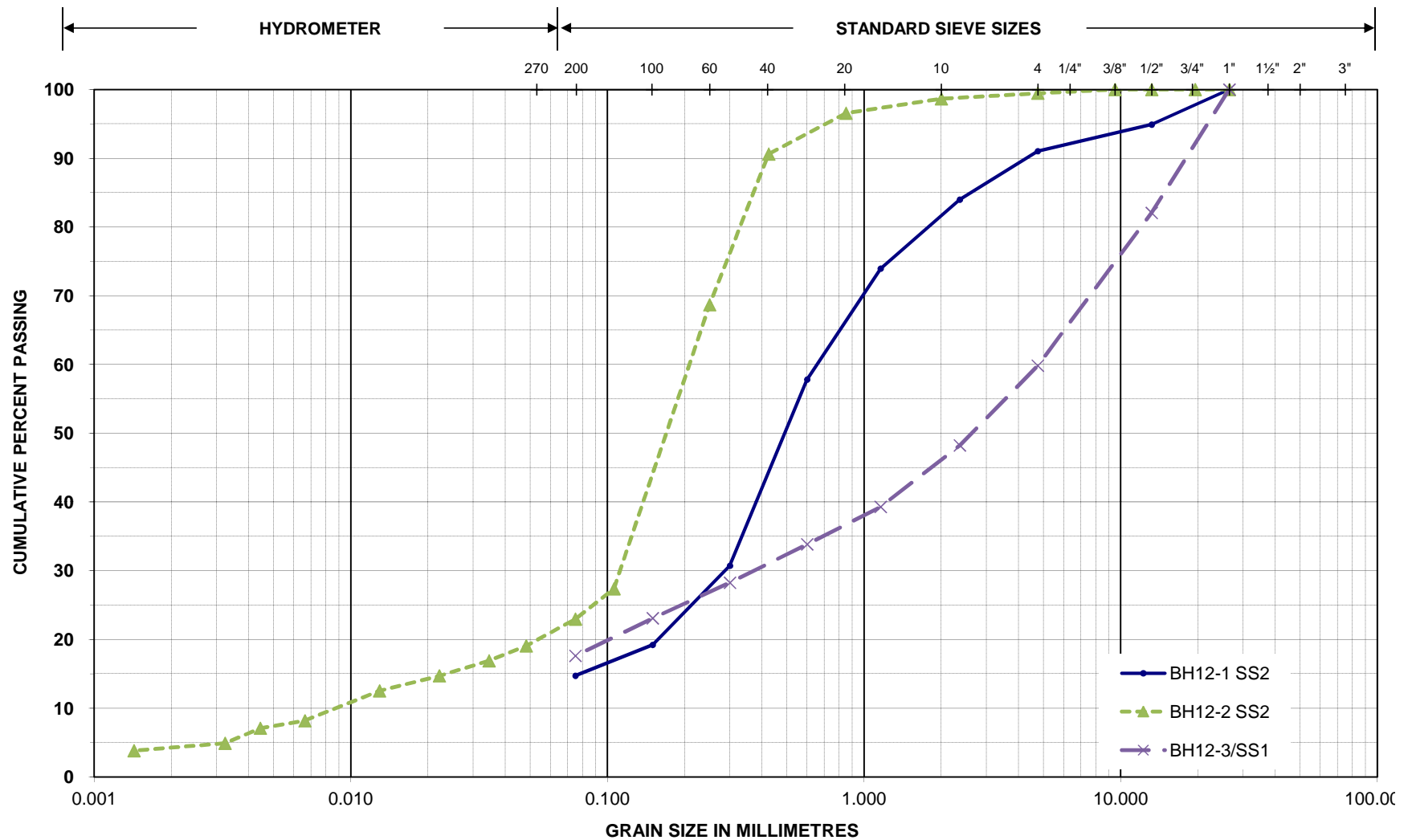
NOTE:

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 ASTM D422



Unified Classification System

SILT AND CLAY	SAND	GRAVEL
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Project Name: MTO Agreement #5011-E-0010 (Gore Bay)

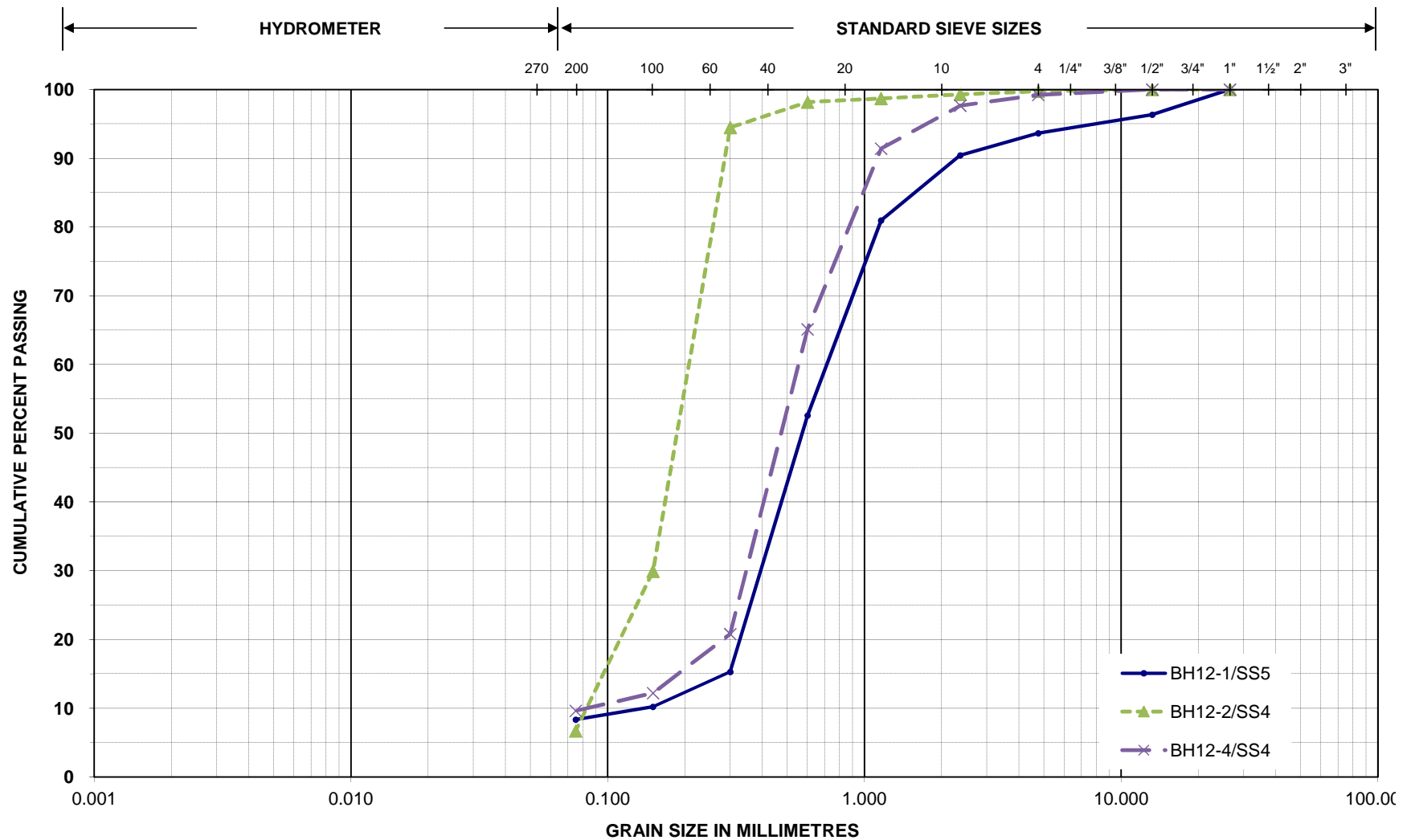
Project No.: 121-17876-00

Figure No.: B1

Remarks: Sand with some gravel, trace silt



PARTICLE SIZE DISTRIBUTION ASTM D422



Unified Classification System

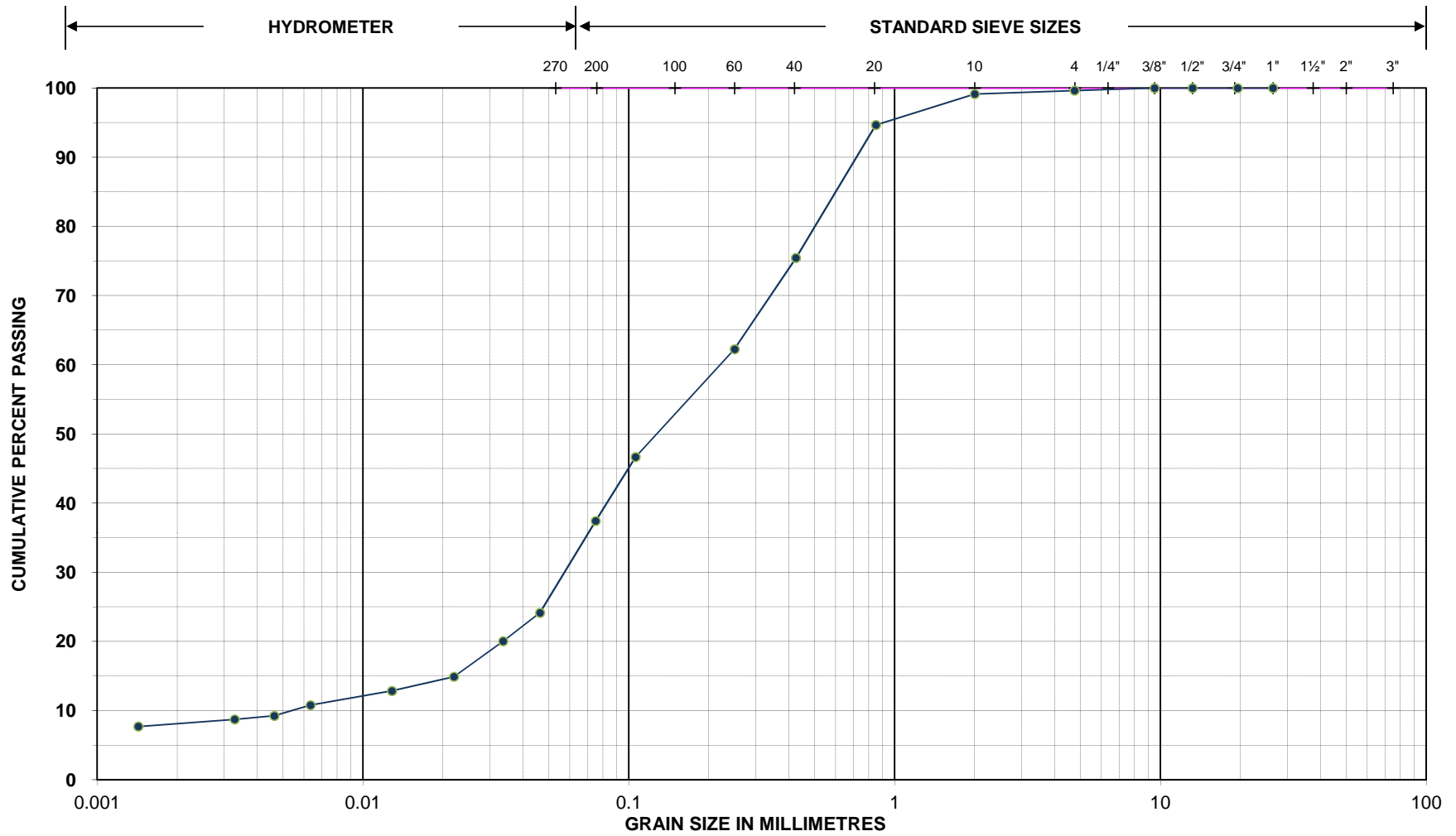
SILT AND CLAY	SAND	GRAVEL
---------------	------	--------

Project Name: MTO Agreement #5011-E-0010 (Gore Bay)

Project No.: 121-17876-00

Figure No.: B2

Remarks: Silty sand, trace clay



Project Name: MTO Agreement #5001-E-0010 Gore Bay Patrol Yard
Remarks: Silty sand, trace clay

Project No.: 121-17876-00

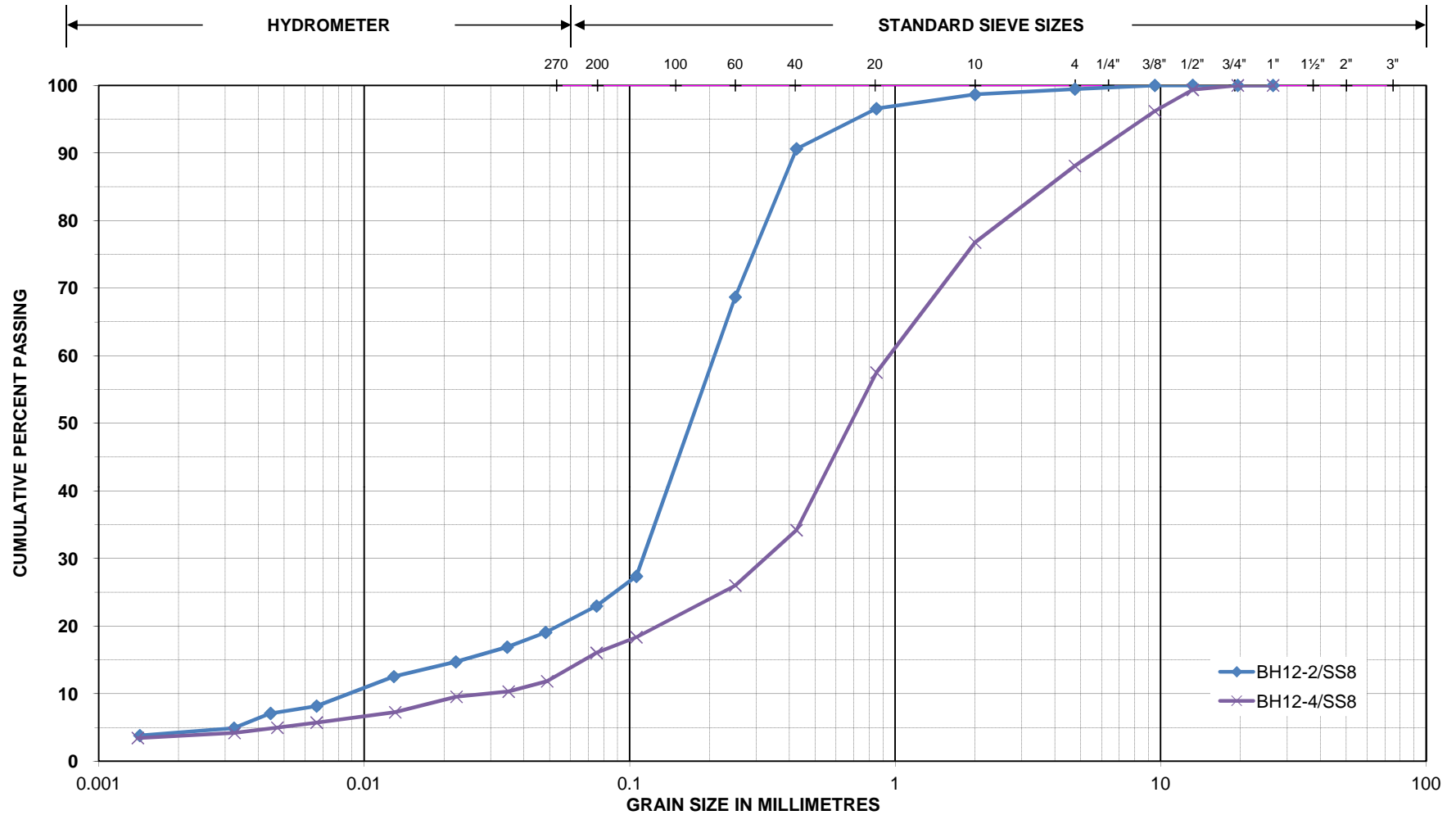
Figure No.: B3



GENIVAR

PARTICLE SIZE DISTRIBUTION

ASTM D422



Unified Classification System

SILT AND CLAY	SAND	GRAVEL
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Project Name: MTO Agreement #5001-E-0010 Gore Bay Patrol Yard

Project No.: 121-17876-00

Figure No.: B4

Remarks: Gravelly sand to sand some gravel, some silt, trace clay

Appendix C

Site Photographs

Bedrock Core Photographs

MTO AGREEMENT #5011-E-0010
GORE BAY PATROL YARD



Photograph 1: Borehole BH12-2. Looking south.



Photograph 2: Borehole BH12-3 (MW1). Looking northeast.

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GORE BAY PATROL YARD



Photograph 3: Borehole BH12-4. Looking east.



Photograph 4: Existing 5-bay garage. Looking north.

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GORE BAY PATROL YARD**



Photograph 5: Existing sheds. Looking northwest.



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

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



Photograph 1: BH12-2 Rock Core (6.75 m to 10.25 m).



Photograph 2: BH12-2 Rock Core (6.75 m to 10.25 m).

Rock Cored June 6, 2012
Photographs taken July 26, 2012

121-17876-00

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



Photograph 3: BH12-3 Rock Core (7.35 m to 10.35 m).



Photograph 4: BH12-3 Rock Core (7.35 m to 10.35 m).