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REPORT ON

**FOUNDATION INVESTIGATION AND DESIGN
HIGHWAY 400, BAXTER TOWNSHIP
TRANSFER STATION ROAD
G.W.P 370-00-00
MINISTRY OF TRANSPORTATION, ONTARIO**

Submitted to:

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PART A

**FOUNDATION INVESTIGATION REPORT
HIGHWAY 400, BAXTER TOWNSHIP
TRANSFER STATION ROAD
G.W.P 370-00-00
MINISTRY OF TRANSPORTATION, ONTARIO**

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by URS Canada Inc. (URS) to carry out a detailed foundation investigation as part of the detailed design for the new Baxter Township Transfer Station Road being carried out for the Ministry of Transportation, Ontario (MTO). The proposed works consist of construction of a road connecting Muskoka Road 48/South Bay Road to the existing Transfer Road and includes associated embankments and four culverts.

This report addresses the foundation investigation for the four culverts, including the swamp crossing at Culvert No. 1 and high fill embankment at Culvert No. 4, which have total lengths of about 70 m and 30 m, respectively. The general location of the Transfer Station Road and culverts are shown on the Key Plan on Drawing 1. The plans and profiles detailing the proposed Station Road alignment and culvert locations were provided to Golder by URS in November, 2003. The locations of the four culvert sites within the project limits are shown in plan on Drawing 1.

2.0 SITE DESCRIPTION

The site is located about 300 m west of the existing Highway 400, extending from approximately the northwest corner of Lot 26, Concession 6 to the northwest corner of Lot 25, Concession 8 ending at South Bay Road. The four proposed culverts will cross underneath the future Transfer Station Road between Stations 8+215 m and 9+840 m.

The overall site of the project has been divided into four subsites (Culverts Nos. 1 – 4) for the purposes of design and description. In general, the overall site consists of rolling terrain including open fields, bush areas, swamp areas, and numerous rock outcrops at ground surface. The ground surface within the limits of the project area varies between Elevations 185 m and 200 m.

3.0 INVESTIGATION PROCEDURES

3.1 Foundation Investigation

Field investigation work was carried out by Golder Associates Ltd. between November 11 and 20, 2003 for Culverts No. 2 to 4 and on May 31, 2004 for Culvert No. 1. A total of eight boreholes were advanced during the November 2003 field investigation (three at Culvert No. 2, two at Culvert No. 3 and three at Culvert No. 4), with bedrock cored in six of the eight boreholes. The proposed boreholes at Culvert No. 1 were postponed given that suitable frozen conditions did not develop during the winter 2003/2004. Due to standing water throughout the area (with depths ranging from 0.3 m to 0.45 m), drilling with a draft mounted rig was not possible and four hand auger probes were completed in May 2004. The table below summarizes all four areas investigated.

The borehole investigation was carried out using a HILTI manual portable drill rig supplied and operated by Marathon Drilling Co. Ltd. of Ottawa, Ontario. Soil samples were obtained continuously using a 50 mm O.D. split-spoon sampler in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586-99). The boreholes were advanced to depths ranging from 0.8 m to 5.4 m below ground surface with depths to bedrock ranging from 0.3 m to 3.7 m below ground surface. The hand auger probes in the swamp crossing at Culvert No. 1 were advanced to refusal with depths ranging from 0.9 m to 2.4 m below ground surface.

BOREHOLE LOCATION SUMMARY

<i>Station</i>	<i>Culvert No.</i>	<i>Crossing</i>	<i>Swamp/High Fill Station</i>	<i>Foundation Holes</i>
8+215	3		-	BH C3-2 and BH C3-3
8+345	2		-	BH C2-1 to BH C2-3
9+600	1	Swamp	Sta 9+560 to 9+630	HP C1-1 to HP C1-4
9+840	4	High Fill	Sta 9+820 to 9+850	BH C4-1 to BH C4-3

The field work was supervised throughout by members of our engineering and technical staff, who located the boreholes and test holes, arranged for the clearance of underground service locations, supervised the drilling, sampling and in-situ testing operations, logged the boreholes, and examined and cared for the soil samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Mississauga geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards as relevant. Classification testing such as water content, grain size distribution and Atterberg Limits were carried out. The results of the laboratory testing are included in Appendix A.

The boreholes were located and measured by members of our engineering staff with reference to stationing and offsets from the proposed median centre-line as staked by URS. The northing and easting coordinates depicted on the Record of Borehole and Record of Drillhole sheets were derived from these station and off-set measurements and using the DTM (digital terrain map) for the project.

4.0 GENERAL SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

From published geologic information, the site is located in the physiographic region known as the Georgian Bay Fringe, a broad belt bordering Georgian Bay. This area forms the southern part of the Canadian Precambrian Shield, and part of the Grenville Province (The Physiography of Southern Ontario; OGS Special Volume 2). The Georgian Bay Fringe is characterized by very shallow, narrow strips of fine sand, silt and clay loams in valleys and bare rock knobs and ridges of granite and other rocks of Precambrian age.

4.2 General Overview of Local Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes and probeholes advanced during this investigation, together with the results of the laboratory tests carried out on selected soil samples, are given on the attached Table 1, Record of Borehole and Record of Drillhole sheets following the text of this report. The laboratory testing details are provided in Appendix A. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from observations of drilling progress and the results of Standard Penetration Tests (SPTs) and in situ testing. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary between and beyond the borehole locations.

The soil stratigraphy as encountered in the boreholes and hand probes in the culvert areas are shown on Drawings 1 and 2; stratigraphic sections for the high fill and swamp areas are shown on Drawing 3.

In general, the stratigraphy encountered at the areas investigated is similar; however, the overburden (soil materials) thickness is variable ranging from 0.3 m to about 3.7 m deep. The stratigraphy generally consists of:

- surficial layers of topsoil or fibrous peat ranging in thickness from about 0.1 m to 2.0 m, typically less than 1.0 m;
- relatively thin (up to 2.4 m thick) deposits of silt and sand in some areas, particularly at Stations 8+215 and 8+345;
- deposits of cohesive silt and clay ranging in thickness from about 0.3 m to about 1.5 m; and
- between the cohesive deposits and bedrock, silt and sand deposits were encountered with thicknesses from 0.1 m up to 1.3 m.

Detailed descriptions of the subsurface conditions at each investigated area are provided in the following sections.

4.3 Culvert No. 3 (Station 8+215)

The plan and centreline profile of Culvert No. 3 showing the borehole locations and interpreted stratigraphy between Stations 8+210 to 8+240 are shown on Drawing 1. A total of 2 boreholes (Boreholes BH C3-2 and C3-3) were completed to obtain information on the subsurface conditions within this area. The topography of this site is generally rolling with a beaver dam present in the northern portion of the area and the central and southern portions being tree covered and ponded water to the east of the area.

In general, the subsurface soils along the proposed main alignment of this section consist of thin alternating surficial deposits of sand/silty sands and silty clay overlying bedrock. Bedrock outcroppings were noted in the southern portion of the area and the deepest borehole at this site extended to 3.7 m below ground surface.

4.3.1 Sand / Silty Sand

A 0.6 m thick surficial layer of grey, medium to coarse sand was encountered in Borehole BH C3-3 at Station 8+210, 15 m east of the main alignment. Underlying this sand, a 0.6 m thick silty sand deposit was encountered with top at approximate Elevation 184.5 m.

Grey, fine to medium sand was encountered from ground surface and extending to 2.4 m depth approximate Elevation 183.6 m in Borehole BH C3-2 at Station 8+215.

Standard Penetration Testing (SPT) measured 'N' values ranging from 1 blow to 18 blows per 0.3 m of penetration, indicating a very loose to compact relative density within this layer. The natural water content measured on selected samples of this deposit ranged from 15 to 29 percent.

4.3.2 Silty Clay

Underlying the silty sand in Borehole C3-3 at Station 8+210, a 1.2 m thick deposit of brown and grey to grey silty clay with trace to some sand was encountered at approximate Elevation 183.9 m.

Standard Penetration Testing (SPT) measured 'N' values ranging from 11 blows to 15 blows per 0.3 m of penetration indicating a stiff consistency.

Atterberg limits testing carried out on two (2) samples of the silty clay gave liquid limits of about 45 and 49 percent, plastic limits of 16 and 18 percent, and plasticity indices of about 29 and 32 percent. The results are shown on Figure A-1 in Appendix A and indicate that the material is a clay of intermediate plasticity.

The natural water content measured on selected samples of this deposit ranged between 35 percent and 37 percent.

4.3.3 Sand

Below the silty clay in Borehole BH C3-3, a 0.7 m thick deposit of grey coarse sand was encountered, containing trace gravel, at approximate Elevation 182.7 m.

Standard Penetration Testing (SPT) carried out within this stratum measured an 'N' value of 2 blows per 0.3 m of penetration, indicating a very loose relative density.

4.3.4 Silty Sand

A lower, grey silty sand deposit (about 0.6 m thick) was encountered below the coarse sand at approximate Elevation 182.0 m. The lower silty sand contained trace amounts of gravel.

Standard Penetration Testing (SPT) carried out within this stratum measured an 'N' value of 15 blows per 0.3 m of penetration, indicating a compact relative density.

A natural water content of about 10 percent was measured on one sample of this deposit.

4.3.5 Bedrock

Bedrock was encountered at both Culvert No. 3 borehole locations. The depth to bedrock below ground surface was 2.4 m in Borehole C3-2 and 3.7 m in Borehole C3-3. The bedrock core samples retrieved from both boreholes are described as fresh, medium to fine grained, medium strong to strong granite. The RQD values measured on the core samples typically are greater than 60 per cent in Borehole C3-2 and greater than 75 per cent in Borehole C3-3 indicating fair to excellent rock quality.

4.3.6 Groundwater Conditions

In general, the samples taken in the boreholes were noted to be wet and the groundwater level was generally found to be at or near ground surface during drilling. It should be noted that groundwater levels in the area are subject to seasonal fluctuations and the groundwater level will vary depending on precipitation and local soil permeability.

4.4 Culvert No. 2 (Station 8+345)

The plan and centreline profile of Culvert No. 2 showing the borehole locations and interpreted stratigraphy are shown on Drawing 1. A total of 3 boreholes (Boreholes BH C2-1 to C2-3) were completed to the subsurface conditions within this area. The topography of this site is generally rolling with mostly mixed forest covering the area, and rock outcroppings to the south and north of the site.

In general, the subsurface soils along the proposed main alignment of this section consist of thin deposits of peat and/or topsoil underlain by surficial deposits of silty sand and silty clay. Bedrock outcrops to the north of the culvert and the deepest borehole at this site extended to 1.6 m below ground surface.

4.4.1 Topsoil

A 0.1 to 0.3 m thick surficial layer of topsoil was encountered in Borehole C2-1 at Station 8+340 (10 m west of main alignment), in Borehole C2-2 at Station 8+345 on centreline and in Borehole C2-3 at Station 8+350 (10 m east of the main alignment).

4.4.2 Sand and Silt / Silty Sand

A yellowish brown, sand and silt was encountered at approximate Elevations 192.3 m, with a thickness of 0.5 m.

A brown and grey, silty sand was encountered underlying the sand and silt in Borehole C2-1 and underlying the topsoil in Borehole C2-2 at approximate Elevations 191.8 m and 192.9 m, respectively.

Standard Penetration Testing (SPT) in Borehole C2-1 measured 'N' values ranging from 3 blows to 69 blows per 0.3 m of penetration, indicating a very loose to very dense relative density within this layer. Standard Penetration Testing (SPT) in Borehole C2-2 measured an 'N' value of 2 blows per 0.3 m of penetration, indicating a very loose relative density within this layer.

A natural water content of about 14 percent was measured on one selected sample of the sand and silt/silty sand deposits.

4.4.3 Silty Clay to Clay Till

Underlying the silty sand in Borehole C2-2, a 0.7 m thick deposit of brown and grey, silty clay to clay with trace to some sand was encountered at approximate Elevation 192.5 m.

Standard Penetration Testing (SPT) measured an 'N' value of 26 blows per 0.3 m of penetration indicating a very stiff consistency.

Atterberg limits testing was carried out on one (1) sample of the silty clay yielding a liquid limit of about 53 percent, a plastic limit of about 21 percent, and a plasticity index of about 32 percent. The results are shown on Figure A-1 in Appendix A and indicate that the material is a clay of high plasticity.

A natural water content of about 30 percent was measured on one selected sample of the silty clay deposit.

4.4.4 Silty Sand Till

In Borehole C2-2 a lower, brown and grey, silty sand deposit (about 0.4 m thick) with gravel was encountered below the silty clay at approximate Elevation 191.8 m.

Standard Penetration Testing (SPT) carried out within this stratum measured an 'N' value of 63 blows per 0.3 m of penetration, indicating a very dense relative density.

A natural water content of about 32 percent was measured on one sample of this deposit.

4.4.5 Bedrock

Refusal, typically defined by greater than 100 blows per 0.3 m penetration, was met at all three Culvert No. 2 borehole locations. The depth to bedrock below ground surface ranged from 0.3 m in Borehole C2-3 (approximate Elevation 192.7 m) to 1.6 m in Borehole C2-2 (approximate Elevation 191.4 m).

Bedrock was cored in two of the boreholes. The bedrock is described as fresh, massive, medium strong to strong granite (medium to fine grained) and/or pegmatite (large grained).

The RQD values measured on the core samples typically are greater than 60% in borehole C2-1 and range between 22% - 53% in borehole C2-3 indicating very poor to good quality.

4.4.6 Groundwater Conditions

In general, the samples taken in the boreholes were noted to be wet and the groundwater level was generally found to be at or near ground surface. It should be noted that groundwater levels in the area are subject to seasonal fluctuations. Furthermore, groundwater elevations will vary depending on precipitation and local soil permeability.

4.5 Culvert No. 1 (Station 9+600)/Swamp Crossing Station 9+560 to 9+630

The plan and centreline profile of Culvert No. 1 showing the borehole locations and interpreted stratigraphy are shown on Drawing 2. A total of 4 hand auger holes (HP C1-1 to C1-4) were completed to investigate the subsurface conditions within the area of this culvert. In addition, auger probes were also put down as part of the geotechnical investigation as shown on Drawing 3. The topography within this swamp covered area is generally flat.

In general, the subsurface soils along the proposed main alignment of this section consist of deposits of peat underlain by a deposit of silty clay, in turn overlying a thin layer of sand. Bedrock outcrops to the north and south of the swamp and the deepest hand probe at this site extended to 2.4 m depth below ground surface in the middle of the swamp.

4.5.1 Peat

A 0.8 m to 2.0 m thick surficial layer of peat was encountered in hand auger holes C1-1 to C1-4.

4.5.2 Silty Clay

A layer of soft, grey, silty clay was encountered at all hole locations ranging in thickness from 0.02 m to 0.3 m with top at approximate Elevations 186.8 m and 185.6 m, respectively.

4.5.3 Sand

Underlying the silty clay, a thin layer (less than 0.1 m thick) of compact, grey sand with trace silt was encountered.

4.5.4 Bedrock / Refusal

Refusal to further auger penetration was met at depths below ground surface ranging from 1.2 m in HPCI - 4 at Station 9+600, 11 m east (approximate Elevation 186.8 m) to 2.0 m IN HPCI - 1 at Station 9+600 m, 11 m west (approximate Elevation 185.2 m).

These refusal depths, while they do not necessarily confirm bedrock elevations, may be inferred to indicate potential proximity to the bedrock surface. Based on the results of the bedrock coring carried out in the boreholes at Culverts Nos. 2 to 4, the bedrock in the area can be described as fresh, medium strong to strong granite (medium to fine grained) and/or pegmatite (large grained).

4.5.5 Groundwater Conditions

In general, the water depth at the time of the investigation (May 2004) ranged from 0.3 m to 0.45 m at the borehole locations along Culvert No. 1 (Station 9+600). The water depth varies across the length of the swamp and is up to 1.5 m deep in areas. The groundwater level is influenced by the water level within the swamp which is subject to seasonal fluctuations and will vary depending on precipitation.

4.6 Culvert No. 4 (Station 9+840)

The plan and centreline profile of Culvert No. 4 showing the borehole locations and interpreted stratigraphy between Stations 9+820 to 9+850 are shown on Drawing 2. A total of 3 boreholes (Boreholes BH C4-1 to C4-3) were completed to investigate the subsurface conditions within this area. In addition, auger probes were put down as part of the geotechnical investigation in this area as shown on Drawing 3. The topography of this site is generally flat with bedrock outcroppings towards the southern and northern portions of the site.

In general, the subsurface soils along the proposed main alignment of this section consist of thin deposits of peat and/or topsoil underlain by surficial deposits of silty clay and fine sand/silty sand to the depth of refusal. Bedrock outcrops at the northern and southern limit of the site and the deepest borehole at this site extended to 2.1 m depth.

4.6.1 Peat / Topsoil

A 0.3 to 0.6 m thick surficial layer of peat/topsoil was encountered in Borehole C4-3 and Borehole C4-2.

Standard Penetration Testing (SPT) measured one 'N' value of 4 blows per 0.3 m of penetration, indicating a very loose state of packing.

4.6.2 Silty Clay to Clay

Underlying the peat/topsoil in Boreholes C4-2 and C4-3 and at ground surface in Borehole C4-1, a 0.3 m to 1.5 m thick deposit of brown and grey silty clay to clay with trace sand and gravel was encountered at approximate Elevations 187.4 m, 188.7 m and 188.0 m, respectively.

Standard Penetration Testing (SPT) measured 'N' values ranging from 3 blows to 14 blows per 0.3 m of penetration indicating a soft to stiff consistency.

Atterberg limits testing was carried out on two (2) selected samples of the silty clay. The liquid limit ranged from about 48 to 57 percent and the plastic limit ranged from 19 to 21 percent, and plasticity indices ranging from about 30 to 36 percent. The results are shown on Figure A-1 in Appendix A and indicate that the material is a silty clay of intermediate plasticity to clay of high plasticity.

The natural water content measured on selected samples of this deposit ranged between 35 percent and 54 percent.

4.6.3 Fine Sand / Silty Sand

A lower, brown and grey to grey fine sand/silty sand deposit with trace gravel (about 0.2 m thick) was encountered below the silty clay in Borehole C4-3 in Borehole C4-1 at approximate Elevations 188.4 m and 186.8 m, respectively.

Standard Penetration Testing (SPT) obtained for this layer were greater than 50 blows per 0.2 m due to the bedrock directly beneath this thin layer.

A natural water content of about 14 percent was measured on one sample of this deposit.

4.6.4 Bedrock

Refusal, typically defined by greater than 100 blows per 0.3 m penetration in the boreholes was met, at all three Culvert No. 4 borehole locations. The depth to bedrock below ground surface ranged from 0.8 m in Borehole C4-3 (approximate Elevation 188.2 m) to 2.1 m in Borehole C4-2 (approximate Elevation 185.9 m).

Bedrock was cored in two of the boreholes. The bedrock is described as fresh, medium to fine grained, medium strong to strong granite. The RQD values measured on the rock core samples were about 75% in Borehole C4-1 and about 55% in Borehole C4-2 indicating a fair to good rock quality.

4.6.5 Groundwater Conditions

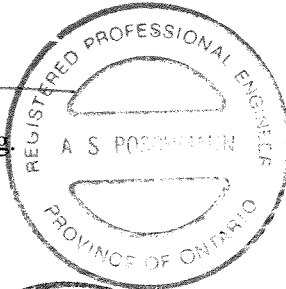
In general, the samples taken in the boreholes were noted to be wet and the groundwater level was generally found to be at or near ground surface. It should be noted that groundwater levels in the area are subject to seasonal fluctuations and will vary depending on precipitation and local soil permeability

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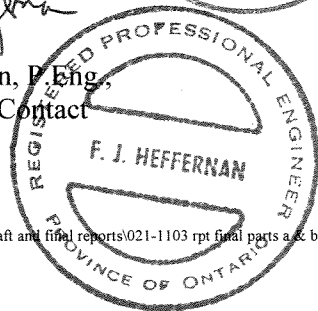
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PART B

**FOUNDATION DESIGN REPORT
HIGHWAY 400, BAXTER TOWNSHIP
TRANSFER STATION ROAD
G.W.P 370-00-00
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5.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

This section of the report provides recommendations on the foundation aspects of design of the proposed culverts based on interpretation of the factual information obtained during the investigation. It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction method and scheduling.

5.1 General

The project involves the design of the Baxter Township Transfer Station Access Road which will run in a north-south direction, about 300 m west of the existing Hwy 400, from approximately the northwest corner of Lot 26, Concession 6 to the northwest corner of Lot 25, Concession 8 ending at South Bay Road. The project includes the design of four culverts which will cross underneath the future Access Road; one of the culverts is within a swampy area and one is within an area classified as a high fill. The general area is currently characterized by bedrock outcroppings, forests and swamp/pond areas with occasional beaver dams.

The type, locations and design details of the culverts are given in the table below:

LOCATION AND DESIGN DETAILS OF CULVERTS NOS. 1 TO 4

<i>Station</i>	<i>Culvert No.</i>	<i>Crossing</i>	<i>Proposed Culvert Type</i>	<i>Proposed Culvert Length</i>	<i>Invert Elevation at West End</i>	<i>Invert Elevation at East End</i>	<i>Proposed Embankment Height Above Top of Culvert</i>
8+215	3	Beaver Pond (30 m long ponded water)	1500mm (Pipe Culvert)	35 m	187.5 m	186.4 m	2.5 m
8+345	2		1500mm (Pipe Culvert)	29 m	191.86 m	192.92 m	1.3 m
9+600	1	Swamp 70 m swamp crossing	2.0 x 1.2 m (Box Culvert)	22 m	187.93 m	187.88 m	1.9 m
9+840	4	High Fill	1500mm (Pipe Culvert)	39 m	187.36 m	188.61 m	5.9 m

5.2 Culvert Foundations

It should be noted that the elevations of the boreholes as given in this report were obtained from the DTM mapping in conjunction with site observations and measurement made with reference to the survey studies. Given the nature of the site, variations in subsoil conditions and bedrock depth should be expected and allowance made in the design and the contract document to deal with variations.

In general, the stratigraphy encountered in the boreholes at the culvert site is similar; however, the overburden (soil materials) thickness is variable ranging from 0.3 m to about 3.7 m deep. The stratigraphy at each of the culvert sites is summarized in the following sections in the context of founding conditions and subgrade preparation :

Based on the subsurface information obtained at the culvert locations, the use of deep foundations is not recommended at any of the culvert sites due to the presence of suitable material and/or bedrock at or just below the founding elevation of the culverts. Suitable foundation conditions for the pipe and box culverts will be obtained by subexcavation and replacement.

5.2.1 Culvert No. 1 and Swamp Treatment at Station 9+560 to 9+630

The swamp in this area extends from Station 9+560 to 9+630, with an overall length of about 70 m. At Culvert 1, at Station 9+600, a fill height of up to 1.9 m is required above the culvert and there is variable depth of overburden (mainly consisting of peat) along the length of the culvert.

The subsoils in this low-lying swamp area consist of up to 2.0 m of topsoil and/or peat underlain by up to 0.3 m of soft, silty clay. The clay is underlain by a thin layer (less than 0.1 m thick) of compact sand. Refusal was encountered between 0.9 m to 2.35 m depth. The standing water depth within the swamp crossing at the time of the investigation ranged from 0.3 m to 0.45 m. For details of the subsurface conditions, refer to Section 4.5.

Based on the subsurface information available at this culvert location, the peat and underlying layers are not considered suitable for support of the box culvert. The overburden materials will have to be subexcavated and replaced with rockfill/compacted granular fill placed on the exposed bedrock surface in order to provide suitable support to the culvert.

It is assumed that the subexcavation for the culvert would be carried out as part of the general subexcavation and replacement required for embankment construction within the swamp in accordance with OPSD 203.010. In this regard, excavation back slopes may be taken at 1 horizontal to 1 vertical through the peat for the depths required for “pay line” purposes.

The depth of subexcavation at the culvert location will vary from about 2.4 m at the west end of the culvert to about 0.9 m at the east end. The extent of subexcavation under the culvert should be in accordance to OPSD 203.040 (although this OPSD refers to pipe culverts). For the culvert foundation, a compacted granular pad at least 0.8 m thick should be provided along the full length of the culvert. This thickness is based on the depth of the bedrock below the base of the culvert at the east end of the culvert. The top surface of the rockfill must be properly chinked and a geotextile separator layer is required between the rockfill and overlying granular bedding. Alternatively, smaller size rockfill could be specified for placement along the culvert; the area of small size rockfill should extend at least 3 m beyond the edges of the culvert. The surface of the smaller size rockfill must still be chinked prior to placing the granular bedding; however, the geotextile layer is not required in this case. Groundwater and surface water control will be required to allow for proper compaction of the granular bedding.

The settlement of the culvert designed for the bearing capacity given in Section 5.2.5 will be governed more by the embankment loading than by the culvert loading itself. Settlement of the western two-thirds of the culvert underlain by rockfill will be greater than the portion which is underlain by compacted granular only. The magnitude of settlement of the culvert under the highest embankment loading is expected to be less than 75 mm where rockfill provides the support and less than 25 mm where the granular pad is placed on the bedrock.

Assuming the recommendations described above are followed for embankment and culvert construction, the embankment built to heights of up to 5 m as shown on the drawings provided by URS will have an adequate factor of safety (greater than 1.5) against instability.

5.2.2 Culvert No. 2

Based on the subsoils at the location of Culvert 2, the foundation of the culvert will be partially on silty sand and silty clay soils (the western and central portions of the culvert, respectively) and partially on granite bedrock (the eastern portion of the culvert). Since minimal settlement will occur under the portion of the culvert founded on the bedrock and some settlement may occur under the portion of the culvert founded on the silty clay, the culvert should be designed to accommodate this differential settlement. The magnitude of differential settlement is expected to be less than 15 mm.

Pipe bedding and surround should be in accordance with OPSD 802. Groundwater and surface water control will be required at all culvert locations to allow for proper compaction.

5.2.3 Culvert No. 3

At the location of Culvert 3, a fill height of up to 2.5 m is required over the culvert and there is up to about 4 m of variable subsoils under the culvert. This culvert is an overflow and will be a 1500

mm diameter pipe with invert about 1 m to 2 m above the existing native ground surface. The existing beaver dam is to be removed after construction of new “barrier” to maintain the water level in the adjacent pond. The grade will then be raised to the pipe subgrade level using rockfill.

Bedding and surround to the pipe should be in accordance with OPSD 802. Groundwater and surface water control will be required at all culvert locations to allow for proper compaction. The top surface of the rockfill must be properly chinked and a geotextile separator layer is required between the rockfill and overlying granular bedding. Alternatively, smaller size rockfill could be specified for placement along the culvert; the area of small size rockfill should extend at least 2 m each side of the pipe. The surface of the smaller size rockfill must still be chinked prior to placing the granular bedding; however, the geotextile layer is not required in this case.

The magnitude of settlement of the culvert under the highest embankment loading is expected to be less than 25 mm provided that the founding soils are not disturbed.

5.2.4 Culvert No. 4 and High Embankment at Station 9+820 to 9+850

At Culvert No. 4, a fill height of up to 5.9 m is required above the culvert and there is variable depths of overburden along the length of the culvert. Prior to the placement of any fill for the new embankment construction, all surface and near surface layers of topsoil and organic deposits should be stripped from the plan limits of the proposed works. Based on the subsurface information, excavation of peat through the area of the high embankment crossing will be necessary from approximately chainage 9+820 to 9+850, with estimated excavation depths ranging from 0.1 m to 0.6 m.

The borehole records for the holes in the area of the culvert at chainage 9+840 indicate topsoil/peat depths ranging from 0.3 m to 0.6 m. The culvert will be founded partially on silty clay soils and partially on bedrock. Pipe bedding and surround should be in accordance with OPSD 802. This may require some bedrock excavation depending on how variable the bedrock surface is along the length of the culvert. Groundwater and surface water control will be required at all culvert locations to allow for proper compaction.

Since minimal settlement will occur under the portion of the culvert founded on the bedrock (the eastern portion) and some settlement may occur under the portion of the culvert founded on the silty clay soil, the culvert should be designed to accommodate this differential. The greatest settlement will be within the central portion of the culvert where it is underlain by the greatest thickness of silty clay and the embankment loading is greatest. The magnitude of differential settlement is expected to be less than 50 mm.

Assuming that the peat and soft clay are removed from underneath the embankment, the embankment built to height of up to 8 m above existing ground surface will have an adequate

factor of safety (greater than 1.5) against instability. The settlement at the embankment will be mainly a function of the fill used for embankment construction, including the fill used as backfill to the subexcavation. For the proposed heights, settlements could be up to about 300 mm with about 60% of this occurring in the first year.

5.2.5 Axial Geotechnical Resistance

For the design of the box culvert (Culvert 1), a factored geotechnical resistances at Ultimate Limit States (ULS) of 250 kPa may be used, assuming that the founding strata are dry, undisturbed and properly prepared and given the culvert dimensions provided in Section 5.1. The settlement of the culvert will be governed by the settlement of the rockfill or granular under the embankment loading and as such the geotechnical resistance at SLS does not apply.

5.2.6 Resistance to Lateral Loads

Resistance to lateral forces / sliding resistance between the concrete and the compacted granular fill subgrade should be calculated in accordance with Section 6.7.5 of the CHBDC. The coefficient of friction, $\tan \phi'$ may be taken as 0.65. This represents an unfactored value; in accordance with the CHBDC, a factor of 0.8 is to be applied in calculating the horizontal resistance.

5.3 Bedding and Backfill

Pipe bedding, surround and backfill should be in accordance with the applicable OPSD 802. The bedding, backfill and levelling pad requirements for the concrete box culvert (Culvert 1) should be in accordance with OPSD 803.010 and 803.02. The culverts should be designed for the full overburden pressure and live load, assuming an embankment fill unit weight of 19 kN/m^3 assuming the use of rock fill for embankment construction below the pavement structure. A unit weight of 21 kN/m^3 should be used if the culvert is directly overlain by the pavement granulars.

For the culvert foundation at Culvert No. 1, the compacted granular pad at least 0.8 m thick should be provided along the full length of the culvert. This thickness is based on the depth of the bedrock below the base of the culvert at the east end of the culvert (ie. bedrock subexcavation is not proposed).

It should be noted that where rock fill is used for embankment construction, a filter fabric or suitable filter material will be required between the rock fill and the culvert backfill materials to minimize the potential for loss of fines into the rock fill.

5.4 Lateral Earth Pressures

The lateral pressures acting on the box culvert will depend on the type and method of placement of the backfill materials, on the nature of the soils behind the backfill, on the magnitude of surcharge including construction loadings, on the freedom of lateral movement of the structure and on the drainage conditions behind the walls.

The following recommendations are made concerning the design of the culvert in accordance with the OHBDC. It should be noted that these design recommendations and parameters assume level backfill and ground surface behind the culvert walls. The box structure should be designed to resist the at rest lateral earth pressures assuming a rigid structure .

- Select free-draining granular fill meeting the specifications of OPSS Granular 'A' or Granular 'B' Type II but with less than 5 per cent passing the 200 sieve should be used as backfill behind the walls. All granular fill should be compacted in lifts of loose thickness not greater than 200 mm to 95 per cent of the material's Standard Proctor maximum dry density in accordance with OPSS 501. Longitudinal drains and weep holes should be installed to provide positive drainage of the granular backfill. Other aspects of the culvert granular backfill requirements with respect to sub-drains and frost taper should be in accordance with OPSD 3501.00 and 3504.00.
- A minimum compaction surcharge equal to 12 kPa should be included in the lateral earth pressures for the structural design of the culvert, in accordance with CHBDC Section 6.9.3 and Figure 6.9.3. Compaction equipment should be used in accordance with OPSS 501.06. Other surcharge loadings should be accounted for in the design, as required.
- The granular fill should be placed within the wedge-shaped zone defined by a line drawn at 1.5 horizontal to 1 vertical (1.5H:1V) extending up and back from the rear face of the footing (Case II in Figure C6.9.1(1) of the *Commentary to the CHBDC*).
- For Case II, the pressures are based on the granular fill as placed and the following parameters (unfactored) may be assumed:

	GRANULAR 'A'	GRANULAR 'B' TYPE II
Soil unit weight:	22 kN/m ³	21 kN/m ³
Coefficient of static at rest lateral earth pressure K_0 :	0.43 (level ground)	0.47 (level ground)

5.5 Erosion Protection

Typically, the subsoils which will be left in place below the invert level of the culverts consist of very stiff cohesive (silty clay / clayey silt) deposits or compact cohesionless (sand and silt) deposits. The cohesive materials would be classified high scourability. The grain size distribution of the cohesionless deposits (at Culverts 2, 3 and 4) as shown on Figures A.2, A.4 and A.6 indicate that 70 percent to 90 per cent of the particles are smaller than 1 mm and the mean particle size is less than 0.1 mm. If the creek velocities warrant, provision should be made for scour and erosion protection.

In order to prevent creek water from flowing either beneath the culvert (potentially causing undermining and scouring) or around the culvert (creating seepage through the embankment fill, and potentially causing erosion and loss of fine soil particles), a clay seal or cut-off wall should be provided at the upstream end of the culvert. The clay seal should have a minimum thickness of 0.3 m. It should be keyed into the native subsoil where present or to the bedrock surface, and extended a minimum horizontal distance of 2 m on either side of the culvert inlet openings and a minimum vertical height equal to the high water level. The material for the clay seal should be in accordance with the requirements of OPSS 1205.

Erosion protection should be provided to the culvert as appropriate. Consideration could be given to the use of suitable non-woven geotextiles and rip-rap to provide erosion protection based on hydraulic requirements.

In addition, sediment control such as silt fences and / or erosion control blankets may be required during construction and diversion of the water course to mitigate migration of fine soil particles into the water courses.

5.6 Construction Considerations

5.6.1 Groundwater and Surface Water Control

The groundwater level at the culvert locations is generally found at or above ground surface. Where subexcavation to the bedrock surface is carried out, no significant groundwater control measures are required apart from maintaining the area dry for bedding and culvert placement. Where the culvert bedding is to be placed on the in situ soils, it should be noted that these soils are susceptible to disturbance due to upward seepage, water ponding and / or construction traffic. Groundwater flow into the excavations should be expected and measures will be required to maintain the excavation base dry and founding soils undisturbed. These measures may include pumping from properly filtered sumps located outside the proposed culvert limits as well as cofferdam placement.

5.6.2 Subgrade Preparation

It is noted that the soils in which the excavations will be formed are highly susceptible to disturbance from ponded water and construction traffic. For protection of the culvert founding soils, a working mat of lean concrete should be placed as soon as practical after reaching the base of the excavation and following inspection by qualified geotechnical personnel. This mat could be 150 mm thick and could serve as the bedding for the culverts provided that drainage under the culvert is not required and provided that an adequate level surface can be achieved with the lean concrete. Where drainage is required or where additional levelling is required, granular bedding should be provided.

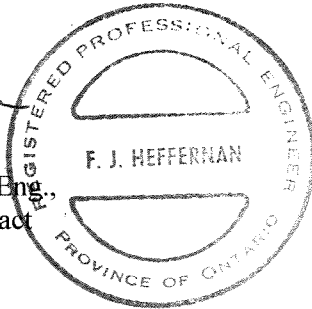
5.6.3 Excavations

Temporary excavations, for the subexcavation below the culverts, will extend through peat, fine sand, silt and silty clay. Excavations works should be carried out in accordance with the guidelines outlined in the latest edition of the Occupational Health and Safety Act (OHSA) for Construction Activities. The following table summarizes the expected soils and OHSA classification at each culvert.

Station	Anticipated Soils	OHSA Soil Type
Baxter 8+215	Loose to Compact Silty Sand, Very Stiff Silty Clay	Type 3
Baxter 8+345	Loose to Compact Sand to Silty Sand to Stiff Silty Clay	Type 3
Baxter 9+600	Peat/Muskeg to Soft Silty Clay to Compact Sand	Type 4
Baxter 9+840	Soft to Stiff Silty Clay	Type 3

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TABLE 1
SUMMARY OF SUBSOIL CONDITIONS AT
PROBE HOLE LOCATIONS – STATION 9+560 TO 9+630
CULVERT 1 / SWAMP CROSSING

Station		Borehole Number	Elevation (m)	Depth	Description
9+564	14 m Lt	A	189.0	0 – 1.2 m 1.2 – 1.6 m 1.6 m	Water Black organics, soft NFP bedrock
	C/L	B	188.0	0 – 1.2 m 1.2 – 1.4 m 1.4 m	Water Black organics, soft NFP bedrock
	14 m Rt	C	188.4	0 – 1.2 m 1.2 – 1.9 m 1.9 m	Water Black organics, soft NFP bedrock
9+600	11 m Lt	HPC1-1	188.0	0 – 0.45 m 0.45 – 2.5 m 2.5 – 2.7 m 2.7 – 2.8 m 2.8 m	Water Peat Grey silty clay, trace sand, soft Grey sand, trace silt, compact NFP bedrock
	C/L	HPC1-2	188.0	0 – 0.45 m 0.45 – 2.4 m 2.4 – 2.68 m 2.68 – 2.74 m 2.74 m	Water Peat Grey silty clay, trace sand, soft Grey sand, trace silt, compact NFP bedrock
	5.5 m Rt	HPC1-3	188.0	0 – 0.4 m 0.4 – 1.4 m 1.4 m	Water Peat NFP bedrock
	11 m Rt	HPC1-4	188.0	0 – 0.33 m 0.33 – 1.16 m 1.16 – 1.18 m 1.18 – 1.22 m 1.22 m	Water Peat Grey silty clay, soft overlying Grey sand, trace silt, compact NFP bedrock
9+620	12 m Lt	D	188.0	0 – 1.2 m 1.2 – 2.2 m 2.2 – 2.4 m 2.4 m	Water Muckamor, soft Grey sand with silt, trace gravel, compact NFP bedrock
	C/L	E	188.0	0 – 1.1 m 1.1 – 1.5 m 1.5 – 1.6 m 1.6 m	Water Black organics, soft Grey sand with silt, trace gravel, compact NFP bedrock
	12 m Rt	F	188.0	0 – 1.2 m 1.2 – 2.2 m 2.2 – 2.4 m 2.4 m	Water Muckamor, soft Grey sand with silt, trace gravel, compact NFP bedrock
9+630	C/L	G	189.1	0 – 0.25 m 0.25 – 0.5 m 0.5 – 0.6 m 0.6 m	Water Black organics, soft Grey sand with silt, trace gravel, compact NFP bedrock

Note: Refer to Figure 3 for Probe Hole Locations

TABLE 2
SUMMARY OF SUBSOIL CONDITIONS AT
PROBE HOLE LOCATIONS – STATION 9+818 TO 9+850
HIGH FILL

Station		Borehole Number	Elevation (m)	Depth	Description
9+818	C/L	H	193.0	0 m	Bedrock
9+840	C/L	L	188.0	0 – 0.3 m 0.3 – 0.8 m 0.8 – 2.0 m	Black organics, soft Brown sandy silt, trace clay, trace gravel, compact Brown silty clay with sand, stiff
9+850	14 m Lt	I	188.0	0 – 0.25 m 0.25 – 0.7 m 0.7 – 2.0 m	Black organics, soft Brown sandy silt, trace clay, trace gravel, compact Brown silty clay with sand, stiff
	C/L	J	190.0	0 – 0.1 m 0.1 m	Dark brown silt NFP bedrock
	14 m Rt	K	195.1	0 m	Bedrock

Note: Refer to Figure 3 for Probe Hole Locations

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
SS	Split-spoon
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

III. SOIL DESCRIPTION

(a) Cohesionless Soils

Density Index (Relative Density)	N Blows/300 mm or Blows/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

Consistency

	<u>kPa</u>	<u>psf</u>
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

(b) Cohesive Soils

c_u, s_u

Dynamic Cone Penetration Resistance; N_d :

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. General

π	3.1416
$\ln x$,	natural logarithm of x
\log_{10}	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
F	factor of safety
V	volume
W	weight

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ϵ	linear strain
ϵ_v	volumetric strain
η	coefficient of viscosity
ν	poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight*)
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_l	liquid limit
w_p	plastic limit
I_p	plasticity index $= (w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index $= (w - w_p) / I_p$
I_C	consistency index $= (w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_a	coefficient of secondary consolidation
m_v	coefficient of volume change
c_v	coefficient of consolidation
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation pressure
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction $= \tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 + \sigma_3)/2$ or $(\sigma'_1 + \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 + \sigma_3)$
S_t	sensitivity




- Notes:**
- 1 $\tau = c' + \sigma' \tan \phi'$
 - 2 shear strength = (compressive strength)/2
 - * density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density x acceleration due to gravity)

PROJECT		2021-1103		RECORD OF BOREHOLE No C2-1		1 OF 1		METRIC								
W.P.		370-00-00		LOCATION		N 4967290.8 ; E 285772.2		ORIGINATED BY								
DIST		52 HWY		BOREHOLE TYPE		HILTI Manual Portable Rig; Continuous Split Spoon Sampling		COMPILED BY								
DATUM		Geodetic		DATE		Nov. 11, 2003		CHECKED BY								
								CAB								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
192.4	GROUND SURFACE															
0.9	TOPSOIL															
191.8	SAND and SILT with roots, trace to some gravel		1	SS	3											
0.6	Very loose															
191.3	Yellowish brown		2	SS	69											
1.1	Moist															
	Silty SAND, trace gravel (TILL)															
	Very dense															
	Brown and grey															
	Moist															
	Granite (BEDROCK)															
	Fresh															
	Medium strong to strong															
	Grey															
189.7																
189.4	Pegmatite (BEDROCK)															
3.1	Fresh															
	Medium to strong															
	Pink															
	Bedrock cored from 1.1m to 2.7m depth.															
	For coring details see Record of Drillhole C2-1.															
	End of Borehole															
	NOTE:															
	1. Spoon refusal at 1.1m depth.															
	2. Culvert #2 (Sta. 8+340, 10 m WEST)															

PROJECT 021-1103		RECORD OF BOREHOLE No C2-2		1 OF 1	METRIC
W.P. 370-00-00		LOCATION N 4967296.1 ; E 285782.0		ORIGINATED BY SB	
DIST 52 HWY		BOREHOLE TYPE HILTI Manual Portable Rig; Continuous Split Spoon Sampling		COMPILED BY DD	
DATUM Geodetic		DATE Nov. 11, 2003		CHECKED BY CAB	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL LIMIT 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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED		WATER CONTENT (%) w _p w w _L				
193.0	GROUND SURFACE							20	40	60	80	100		
0.4	TOPSOIL													
192.5	Silty SAND with to gravel, trace clay Very loose Brown and grey Wet		1	SS	2									
0.5														
191.8	Silty CLAY, trace to some sand (TILL) Very stiff Brown and grey		2	SS	26									
191.4	Moist Silty SAND with gravel (TILL) Very dense Brown and grey Wet		3	SS	63									
1.6	End of Borehole													
NOTES: 1. Water level in open borehole at ground surface. 2. Spoon refusal at 1.6m depth below ground surface. 3. Culvert #2 (Sta. 8+345)														

PROJECT <u>021-1103</u>		RECORD OF BOREHOLE No C2-3		1 OF 1	METRIC
W.P. <u>370-00-00</u>		LOCATION <u>N 4967301.7 ; E 285791.7</u>		ORIGINATED BY <u>SB</u>	
DIST <u>52</u> HWY <u></u>		BOREHOLE TYPE <u>HILTI Manual Portable Rig; Continuous Split Spoon Sampling</u>		COMPILED BY <u>DD</u>	
DATUM <u>Geodetic</u>		DATE <u>Nov. 11, 2003</u>		CHECKED BY <u>CAB</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED						w _p w w _L							
193.0	GROUND SURFACE							20	40	60	80	100									
0.0	TOPSOIL																				
192.7																					
0.3	Pegmatite (BEDROCK) Fresh Medium strong to strong Pink																				
	Bedrock cored between 0.3m and 1.83m depth. For coring details, refer to Record of Drillhole C2-3.																				
191.2																					
	End of Borehole																				
1.8	NOTES: 1. No samples taken. 2. Hand dug with shovel. 3. Culvert #2 (Sta. 8+350, 10 m EAST)																				

PROJECT: 021-1103

RECORD OF DRILLHOLE: C2-3

SHEET 1 OF 1

LOCATION: Culvert #2 (Sta. 8+350, 10 m EAST)

DRILLING DATE: Nov. 13 & 14, 2003

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: HILTI Manual Portable Rig

DRILLING CONTRACTOR: Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	FLUSH	COLOUR % RETURN	JN - Joint FLT - Fault SHR- Shear VN - Vein CJ - Conjugate										BD- Bedding FO- Foliation CO- Contact OR- Orthogonal CL - Cleavage										PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular										PO- Polished K - Slickensided SM- Smooth Ro - Rough MB- Mechanical Break										BR - Broken Rock										NOTES WATER LEVELS INSTRUMENTATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
									RECOVERY										R.Q.D. %	FRACT. INDEX PER 1m	DISCONTINUITY DATA										HYDRAULIC CONDUCTIVITY K, cm/sec	Diameter Point Load Index (MPa)	RMC -Q- AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
									TOTAL CORE %	SOLID CORE %	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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DEPTH SCALE

1 : 50



LOGGED: SB

CHECKED: CAB

MISS-ROCK-2 0211103AARCK.GPJ GAL-CANADA.GDT 12/4/05

PROJECT <u>021-1103</u>		RECORD OF BOREHOLE No C3-2		1 OF 1	METRIC
W.P. <u>370-00-00</u>		LOCATION <u>N 4967168.9 ;E 285760.2</u>		ORIGINATED BY <u>SB</u>	
DIST <u>52</u> HWY <u></u>		BOREHOLE TYPE <u>HILTI Manual Portable Rig; Continuous Split Spoon Sampling</u>		COMPILED BY <u>DD</u>	
DATUM <u>Geodetic</u>		DATE <u>Nov. 17, 2003</u>		CHECKED BY <u>CAB</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80	100	W _p	W	W _L					
186.0	GROUND SURFACE																			
0.0	Fine to medium SAND with roots and some silt and gravel Very loose to compact Grey Wet		1	SS	2															
			2	SS	18															
			3	SS	14															
			4	SS	14															
183.6																				
2.4	Granite (BEDROCK) Fresh Medium strong Grey																			
182.6																				
3.5	Bedrock cored from 2.4m to 3.45m depth. For coring details, refer to Record of Drillhole C3-2. End of Borehole NOTE: 1. Spoon refusal at 2.44m depth. 2. Culvert #3 (Sta. 8+215)																			

NOTE:
1. Spoon refusal at 2.44m depth.
2. Culvert #3 (Sta. 8+215)

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon Drilling

CHECKED: CAB

MISS-ROCK-2 0211103AARCK.GPJ GAL-CANADA.GDT 12/4/05

PROJECT		2021-1103		RECORD OF BOREHOLE No C3-3		1 OF 1		METRIC					
W.P.		370-00-00		LOCATION		N 4967159.5 ; E 285769.3		ORIGINATED BY					
DIST		52		HWY		BOREHOLE TYPE		HILTI Manual Portable Rig; Continuous Split Spoon Sampling					
DATUM		Geodetic		DATE		Nov. 17, 2003		CHECKED BY					
								CAB					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)			
185.1	GROUND SURFACE												
0.0	Medium to coarse SAND, trace gravel		1	SS	1								
184.5	Very loose												
0.6	Grey												
183.9	Wet Silty SAND with gravel, trace roots		2	SS	6								
1.2	Loose												
182.7	Grey												
2.4	Wet Silty CLAY, trace to some sand		3	SS	11								
182.1	Stiff												
3.1	Brown and grey to grey		4	SS	15								
181.4	Moist												
3.7	Coarse SAND, trace gravel		5	SS	2								
	Very loose												
	Grey												
	Wet												
	Silty SAND, trace gravel		6	SS	15								
	Compact												
	Grey												
	Wet												
	Granite (BEDROCK)												
	Fresh												
	Medium strong to strong												
	Salt and pepper												
	Bedrock cored from 3.7m to 5.4m depth.												
	For coring details, refer to Record of Drillhole C3-3.												
179.7	End of Borehole												
5.4	NOTE: 1. Spoon refusal at 3.7m depth. 2. Culvert #3 (Sta. 8+210, 12 m EAST)												

SHEET 1 OF 1



DATUM: Geodetic

DRILLING CONTRACTOR: Marathon Drilling

CHECKED: CAB

MISS-ROCK-2 0211103AARCK.GPJ GAL-CANADA.GDT 12/4/05

PROJECT <u>021-1103</u>		RECORD OF BOREHOLE No C4-1		1 OF 1	METRIC
W.P. <u>370-00-00</u>		LOCATION <u>N 4968749.2 ; E 285434.6</u>		ORIGINATED BY <u>SB</u>	
DIST <u>52</u> HWY <u></u>		BOREHOLE TYPE <u>HILTI Manual Portable Rig; Continuous Split Spoon Sampling</u>		COMPILED BY <u>DD</u>	
DATUM <u>Geodetic</u>		DATE <u>Nov. 19, 2003</u>		CHECKED BY <u>CAB</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80	100	W _p	W	W _L					
188.0	GROUND SURFACE																			
0.0	Silty CLAY, trace sand and gravel Soft to stiff Brown and grey Moist		1	SS	3															
			2	SS	12															
186.8			3	SS	50/0.2															
1.4	Fine SAND, some silt, trace gravel Very dense Grey Wet																			
	Granite (BEDROCK) Fresh																			
185.6	Medium strong to strong Grey																			
2.4	Bedrock cored from 1.4m to 2.4m depth. For coring details, refer to Record of Drillhole C4-1. End of Borehole																			
	NOTE: 1. Culvert #4 (Sta. 9+850, 17.5 m WEST)																			

PROJECT: 021-1103

RECORD OF DRILLHOLE: C4-1

SHEET 1 OF 1

LOCATION: Culvert #4 (Sta. 9+850, 17.5 m WEST)

DRILLING DATE: Nov. 20, 2003

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: HILTI Manual Portable Rig

DRILLING CONTRACTOR: Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	FLUSH	COLOUR % RETURN	JN - Joint FLT - Fault SHR- Shear VN - Vein CJ - Conjugate BD- Bedding FO- Foliation CO- Contact OR- Orthogonal CL - Cleavage PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular PO- Polished K - Slickensided SM- Smooth Ro - Rough MB- Mechanical Break BR - Broken Rock										NOTE: For additional abbreviations refer to list of abbreviations & symbols.				NOTES WATER LEVELS INSTRUMENTATION	
									RECOVERY		R.Q.D. %	FRACT. INDEX PER 1m	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY K, cm/sec		Diameter Point Load Index (MPa)	RMC -Q ² AVG.				
									TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	10 ⁰	10 ⁻¹							
									00000	00000			00000	00000	00000	00000	00000	00000			00000	00000		00000
		Refer to previous page		186.65																				
2	BQ	Fresh, banded, grey with salt and pepper, medium to fine grained, medium strong to strong, GRANITE		1.35	1																			
		End of Drillhole		185.56																				
3				2.44																				
4																								
5																								
6																								
7																								
8																								
9																								
10																								
11																								

DEPTH SCALE

1 : 50



LOGGED: SB

CHECKED: CAB

MISS-ROCK-2 0211103AARCK.GPJ GAL-CANADA.GDT 12/4/05

PROJECT <u>021-1103</u>		RECORD OF BOREHOLE No C4-2		1 OF 1		METRIC	
W.P. <u>370-00-00</u>		LOCATION <u>N 4968744.1 ; E 285454.3</u>		ORIGINATED BY <u>SB</u>			
DIST <u>52</u> HWY <u></u>		BOREHOLE TYPE <u>HILTI Manual Portable Rig; Continuous Split Spoon Sampling</u>		COMPILED BY <u>DD</u>			
DATUM <u>Geodetic</u>		DATE <u>Nov. 19, 2003</u>		CHECKED BY <u>CAB</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
													20	40	60					
188.0	GROUND SURFACE																			
0.0	PEAT with roots		1	SS	4															
187.4	Loose Black Wet		2	SS	13															
0.6	Silty CLAY, trace sand		3	SS	14															
	Stiff Brown and grey Moist		4	SS	50/0.23															
185.9	Granite (BEDROCK)																			
2.1	Fresh Medium strong to strong Grey																			
184.7	Bedrock cored from 2.1m to 3.35m depth.																			
3.4	For coring details, refer to Record of Drillhole C4-2. End of Borehole																			
	NOTE: 1. Spoon refusal at 2.1m depth. 2. Culvert #4 (Sta. 9+840)																			

PROJECT: 021-1103

RECORD OF DRILLHOLE: C4-2

SHEET 1 OF 1

LOCATION: Culvert #4 (Sta. 9+840)

DRILLING DATE: Nov. 20, 2003

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: HILTI Manual Portable Rig

DRILLING CONTRACTOR: Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	PENETRATION RATE (mm/min)	FLUSH	COLOUR % RETURN	JN - Joint		BD - Bedding		PL - Planar		PO - Polished		BR - Broken Rock	NOTES: For additional abbreviations refer to list of abbreviations & symbols.	WATER LEVELS INSTRUMENTATION
								FLT - Fault	SHR - Shear	FO - Foliation	CO - Contact	CN - Curved	UN - Undulating	SM - Smooth	Ro - Rough			
								VN - Vein	CJ - Conjugate	OR - Orthogonal	CL - Cleavage	ST - Stepped	IR - Irregular	MB - Mechanical Break				
		Refer to previous page		185.94														
	BQ	Fresh, massive, grey with salt and pepper, medium to fine grained, medium strong to strong, GRANITE		2.06														
3					1													
		End of Drillhole		184.65														
				3.35														
4																		
5																		
6																		
7																		
8																		
9																		
10																		
11																		
12																		

DEPTH SCALE

1 : 50





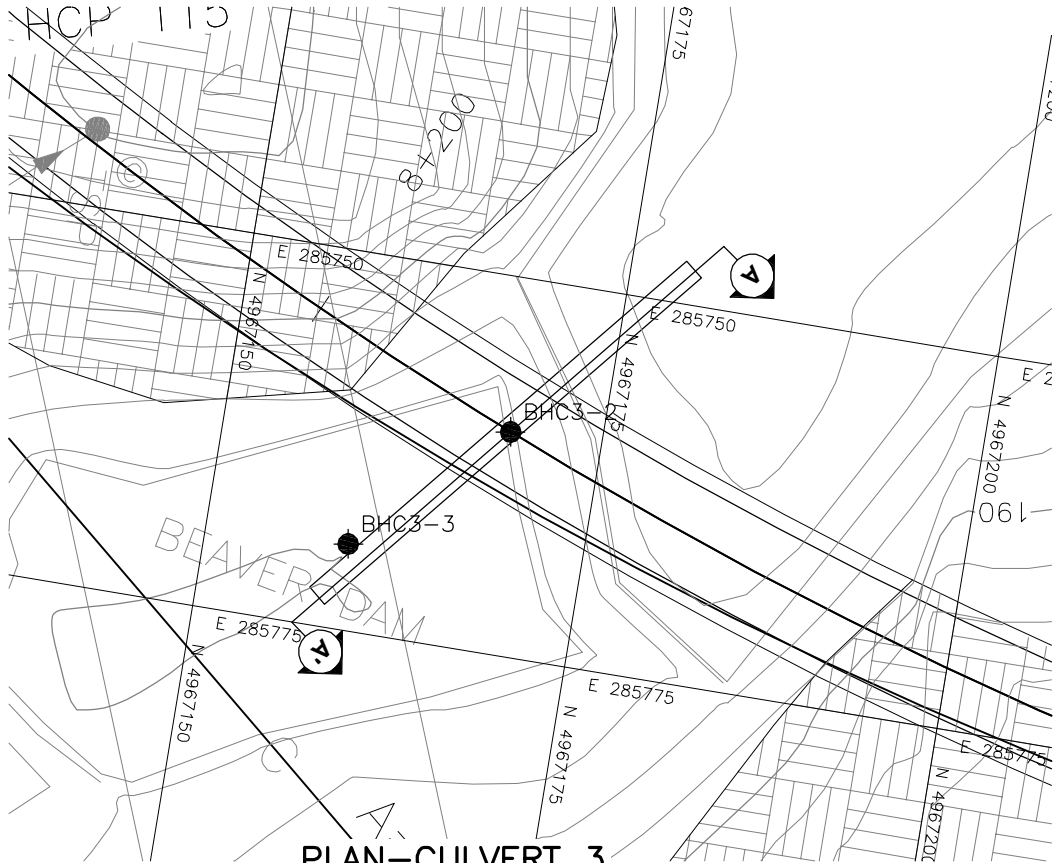
LOGGED: SB

CHECKED: CAB

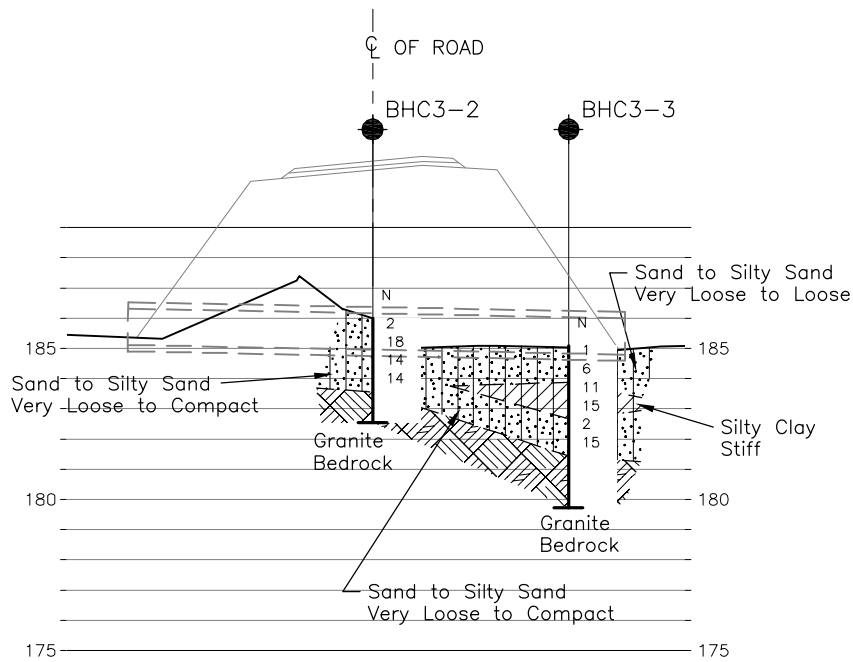
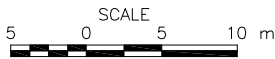
MISS-ROCK-2 0211103AARCK.GPJ GAL-CANADA.GDT 12/4/05

PROJECT <u>021-1103</u>		RECORD OF BOREHOLE No C4-3		1 OF 1		METRIC	
W.P. <u>370-00-00</u>		LOCATION <u>Culvert #4 (Sta. 9+830, 15 m EAST)</u>		ORIGINATED BY <u>SB</u>			
DIST <u>52</u> HWY <u></u>		BOREHOLE TYPE <u>HILTI Manual Portable Rig; Continuous Split Spoon Sampling</u>		COMPILED BY <u>DD</u>			
DATUM <u>Geodetic</u>		DATE <u>Nov. 19, 2003</u>		CHECKED BY <u>CAB</u>			

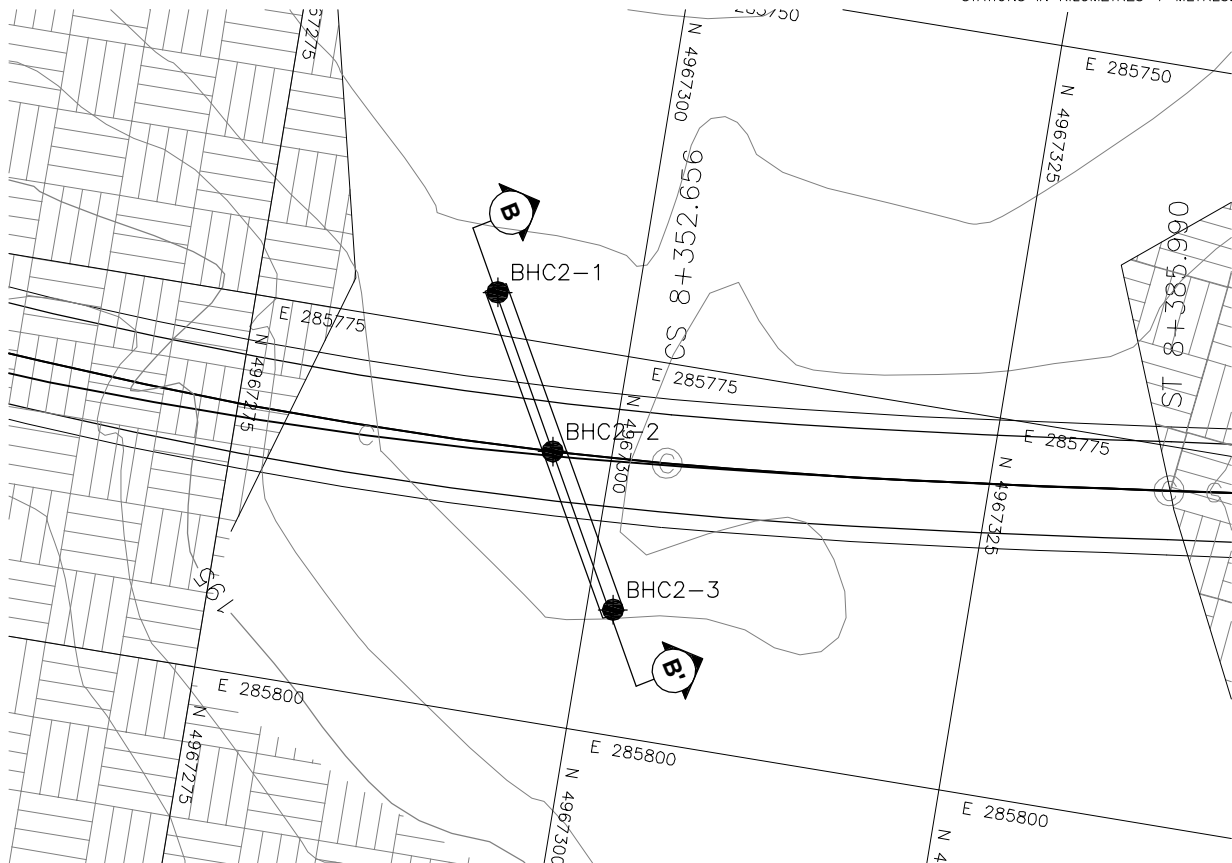
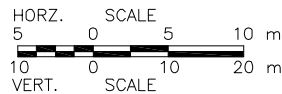
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT							PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED														
189.0	GROUND SURFACE																					
0.0	TOPSOIL		1	SS	3																	
188.7																						
188.4	Silty CLAY, trace sand and gravel Soft Brown and grey		2	SS	50/0.20																	
0.8	Moist Silty SAND, trace gravel Very dense Brown and grey to grey Moist to wet End of Borehole																					
NOTE: 1. Water level in open borehole at ground surface. 2. Spoon refusal at 0.8 m depth.																						



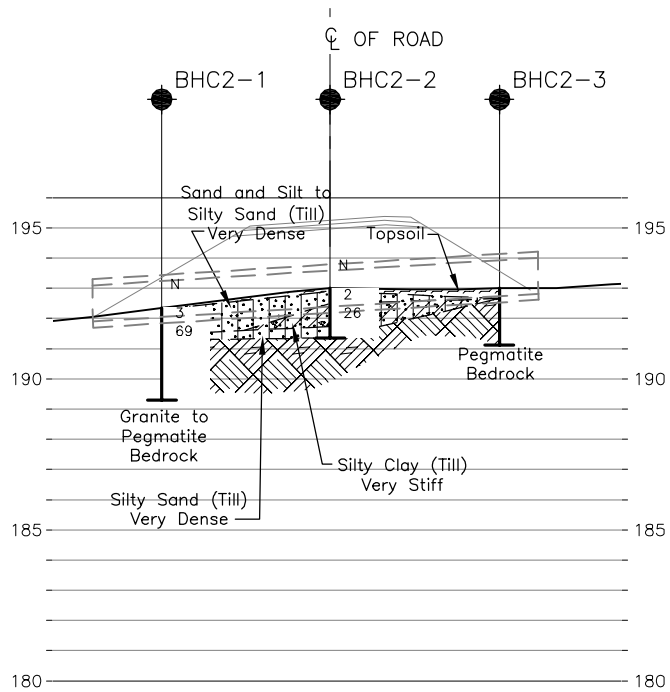
PLAN-CULVERT 3



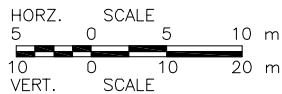
AA' PROFILE ALONG CULVERT 3 C/L



PLAN-CULVERT 2



BB' PROFILE ALONG CULVERT 2 C/L



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

CONT No.
WP No. 370-00-00

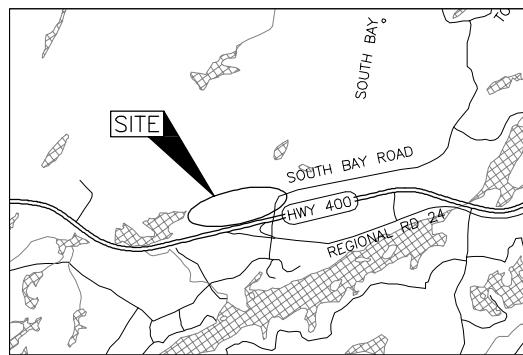
BAXTER TOWNSHIP TRANSFER STATION ROAD
CULVERT SECTIONS
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET



Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

SCALE
700 0 700 m

LEGEND

- Borehole - Current Investigation
- ⊕ Borehole - Golder Geotechnical/Pavement investigation
- ⊙ Probehole
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- ≡ WL upon completion of drilling

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
BHC2-1	192.4	4967290.8	285772.2
BHC2-2	193.0	4967296.1	285782.0
BHC2-3	193.0	4967301.7	285791.7
BHC3-2	186.0	4967168.9	285760.2
BHC3-3	185.1	4967159.5	285769.3

NOTES

The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

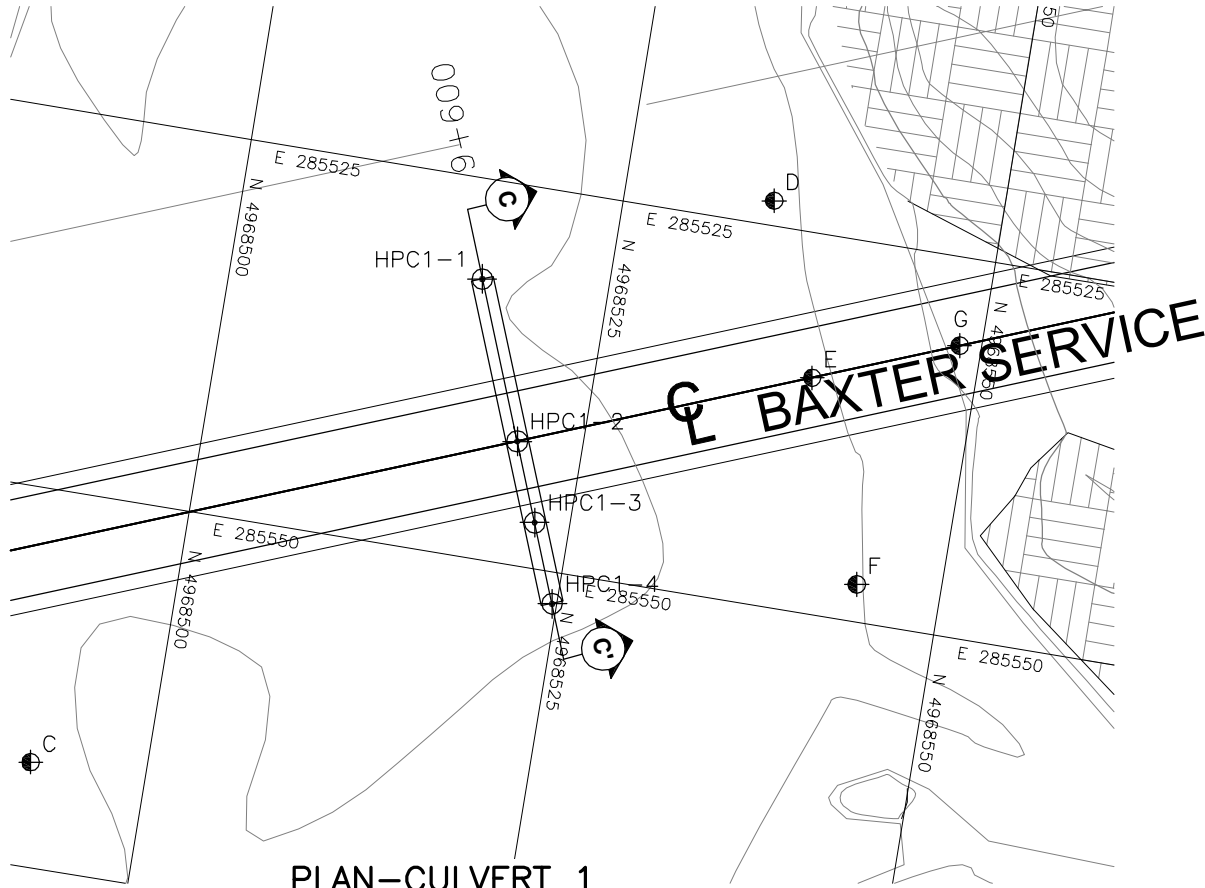
The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

For subsurface information only.

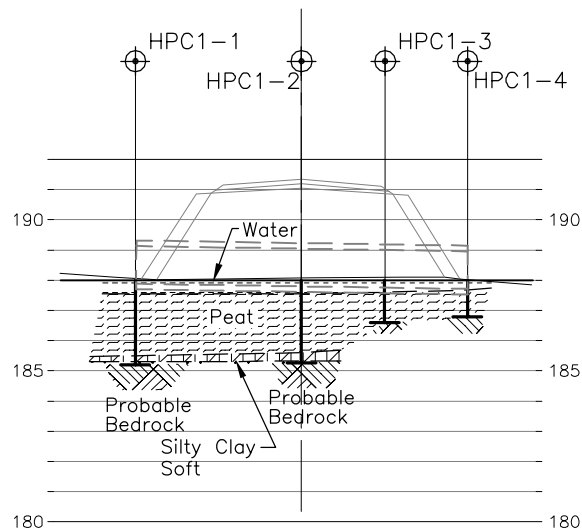
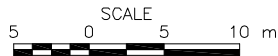
REFERENCE

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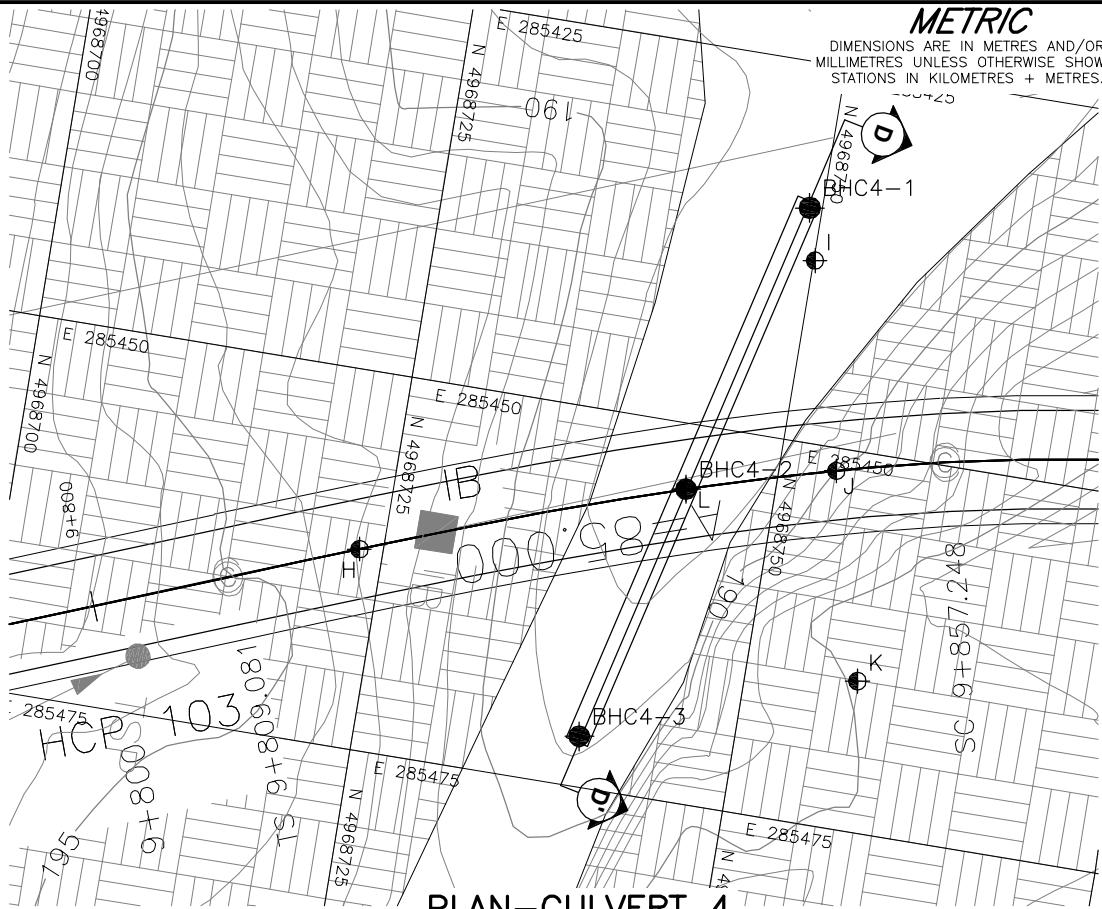
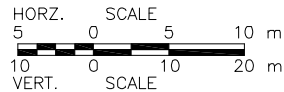
NO.	DATE	BY	REVISION
Geores No.			
HWY.	PROJECT NO. 021-1103		DIST.
SUBM'D. CAB	CHKD. CAB	DATE: JUL., 2004	SITE:
DRAWN: JDR	CHKD.	APPD.	DWG. 1



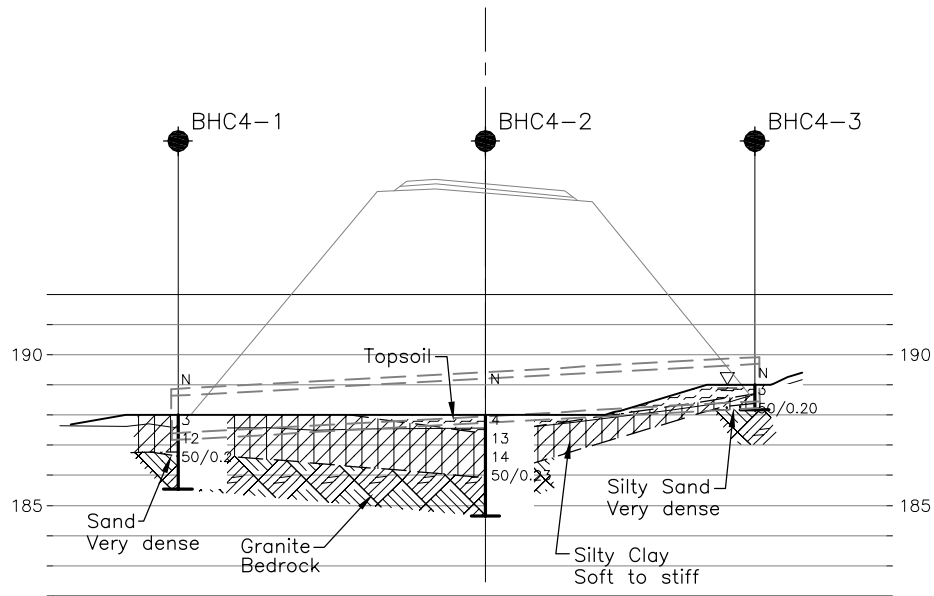
PLAN-CULVERT 1



CC' PROFILE ALONG CULVERT 1 C/L



PLAN-CULVERT 4



DD' PROFILE ALONG CULVERT 4 C/L



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

CONT No.
WP No. 370-00-00

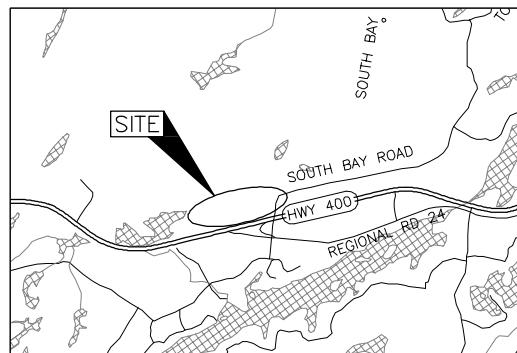
BAXTER TOWNSHIP TRANSFER STATION ROAD
CULVERT SECTIONS
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET



Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

SCALE
700 0 700 m

LEGEND

- Borehole - Current Investigation
- Borehole - Golder Geotechnical/Pavement investigation
- Probehole
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- WL upon completion of drilling

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
D	188.0	4968534.9	285523.4
E	188.0	4968539.3	285534.5
H	193.0	4968723.4	285461.8
I	188.0	4968750.1	285438.0
J	190.0	4968753.8	285451.5
K	195.1	4968757.4	285465.0
L	188.0	4968744.1	285454.3
BHC4-1	188.0	4968749.2	285434.6
BHC4-2	188.0	4968744.1	285454.3
BHC4-3	189.0	4968739.8	285471.7
HPC1-1	188.0	4968516.6	285531.6
HPC1-2	188.0	4968520.7	285541.9
HPC1-3	188.0	4968522.7	285547.0
HPC1-4	188.0	4968524.7	285552.1

NOTES

The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

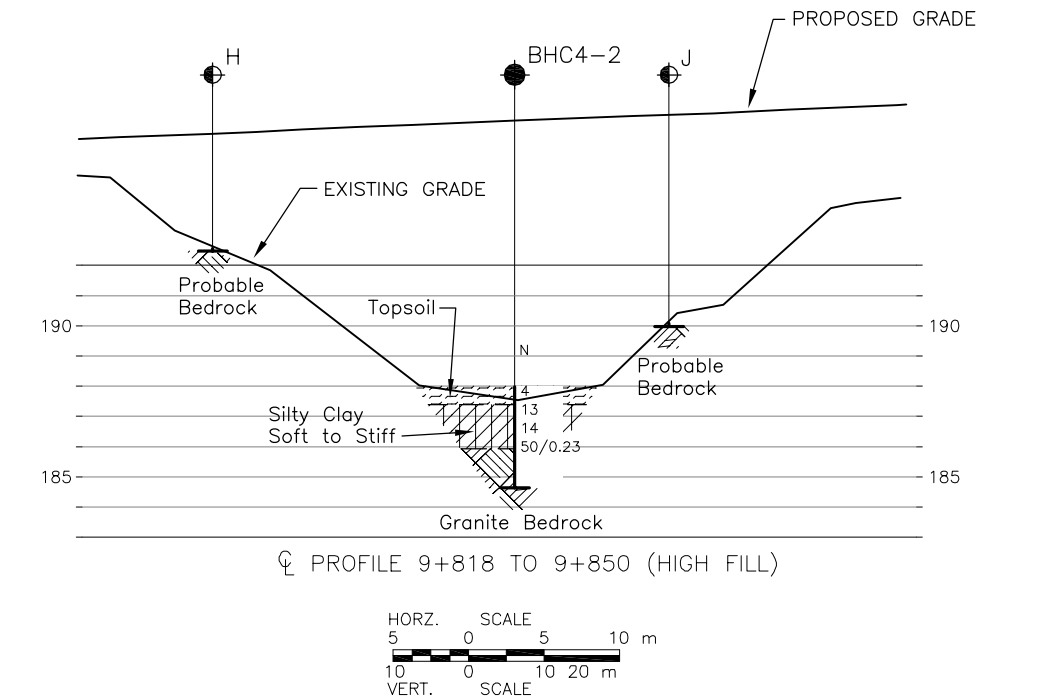
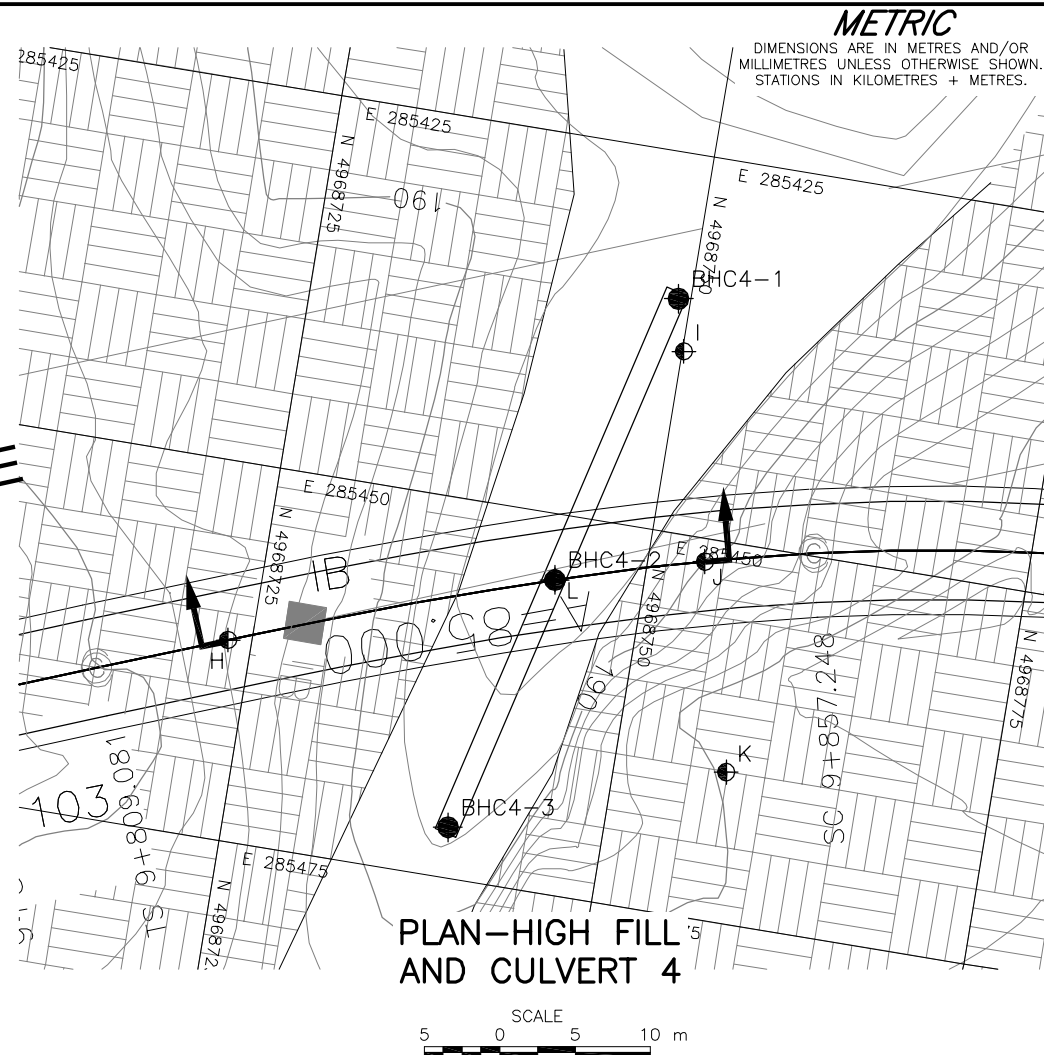
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REFERENCE

Base plans provided in digital format by URS Corporation, drawing file 'Baxter.dwg', received Nov. 04, 2003.

NO.	DATE	BY	REVISION
Geocres No.			
HWY.	PROJECT NO. 021-1103		DIST.
SUBM'D. CAB	CHKD. CAB	DATE: JUL., 2004	SITE:
DRAWN: JDR	CHKD.	APPD.	DWG. 2



LEGEND			
	Borehole — Current Investigation		
	Borehole — Golder Geotechnical/Pavement investigation		
	Probehole		
N	Standard Penetration Test Value		
16	Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)		
100%	Rock Quality Designation (RQD)		
	WL upon completion of drilling		
No.	ELEVATION	CO—ORDINATES	
		NORTHING	EASTING
A	189.0	4968482.0	285542.0
B	188.0	4968487.2	285555.1
C	188.4	4968492.3	285568.1
D	188.0	4968534.9	285523.4
E	188.0	4968539.3	285534.5
F	188.0	4968544.4	285547.5
G	189.1	4968548.6	285530.8
H	193.0	4968723.4	285461.8
I	188.0	4968750.1	285438.0
J	190.0	4968753.8	285451.5
K	195.1	4968757.4	285465.0
L	188.0	4968744.1	285454.3
BHC4—1	188.0	4968749.2	285434.6
BHC4—2	188.0	4968744.1	285454.3
BHC4—3	189.0	4968739.8	285471.7
HPC1—1	188.0	4968516.6	285531.6
HPC1—2	188.0	4968520.7	285541.9
HPC1—3	188.0	4968522.7	285547.0
HPC1—4	188.0	4968524.7	285552.1

NOTES

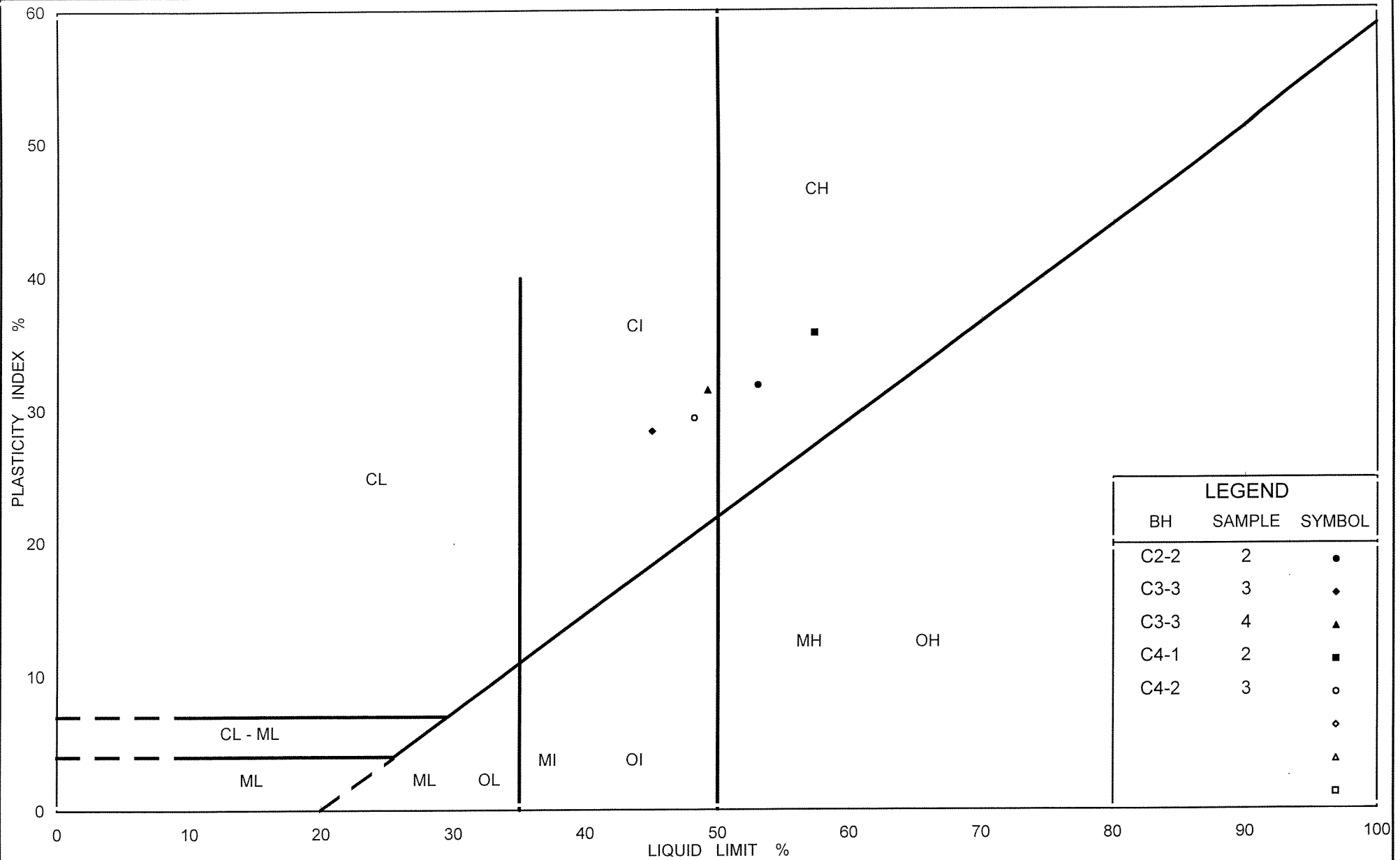
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For subsurface information only.

<h1 style="text-align: center;">REFERENCE</h1> <p style="text-align: center;">Base plans provided in digital format by URS Corporation, drawing file "Baxter.dwg", received Nov. 04, 2003.</p>			
NO.	DATE	BY	REVISION
Geacres No.			
HWY.		PROJECT NO. 021-1103	DIST.
SUBM'D. CAB		CHKD. CAB	DATE: JUL., 2004
DRAWN: JDR		CHKD.	APPD. DWG. 3

APPENDIX A LABORATORY TEST RESULTS



Ministry of Transportation

Ontario

PLASTICITY CHART Silty Clay to Clay

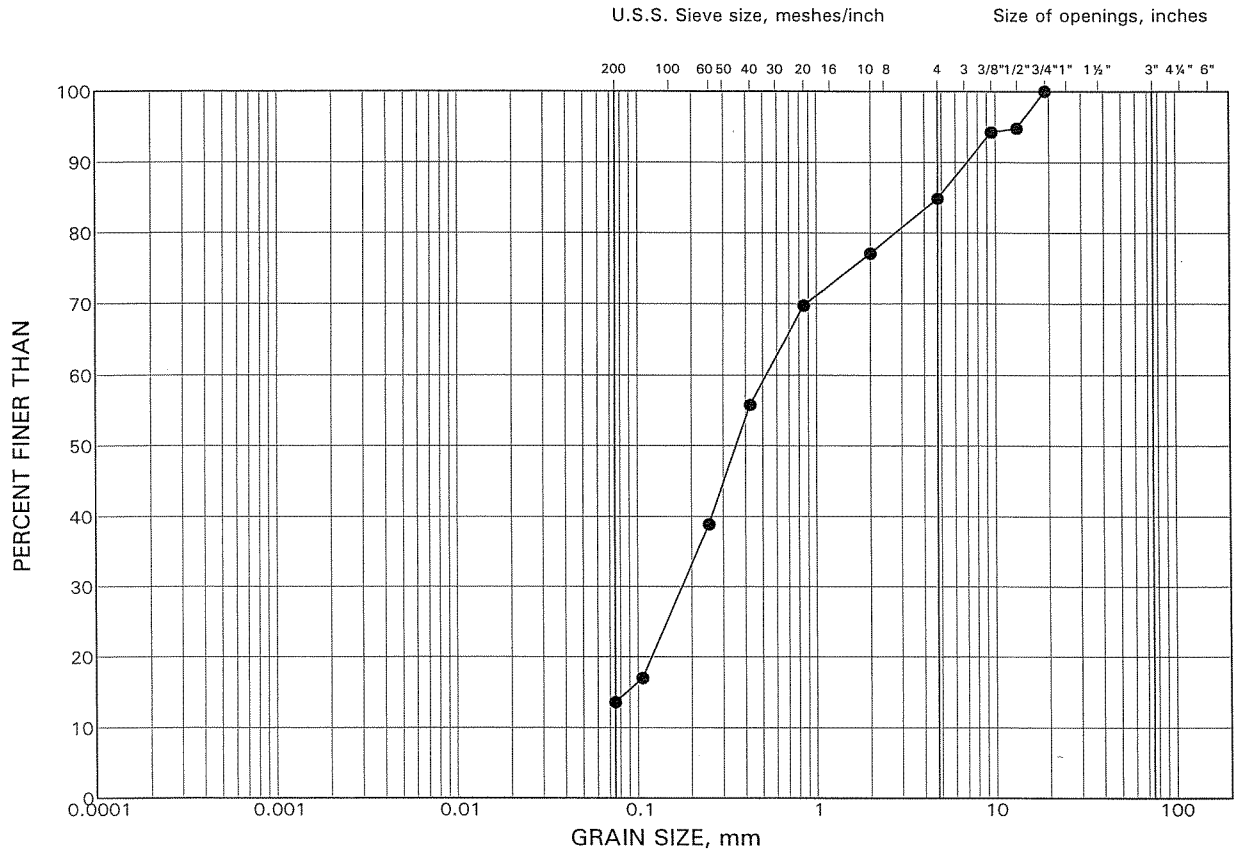
FIG No. A-1

Project No. 021-1103

GRAIN SIZE DISTRIBUTION

Sand

FIGURE A-2



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

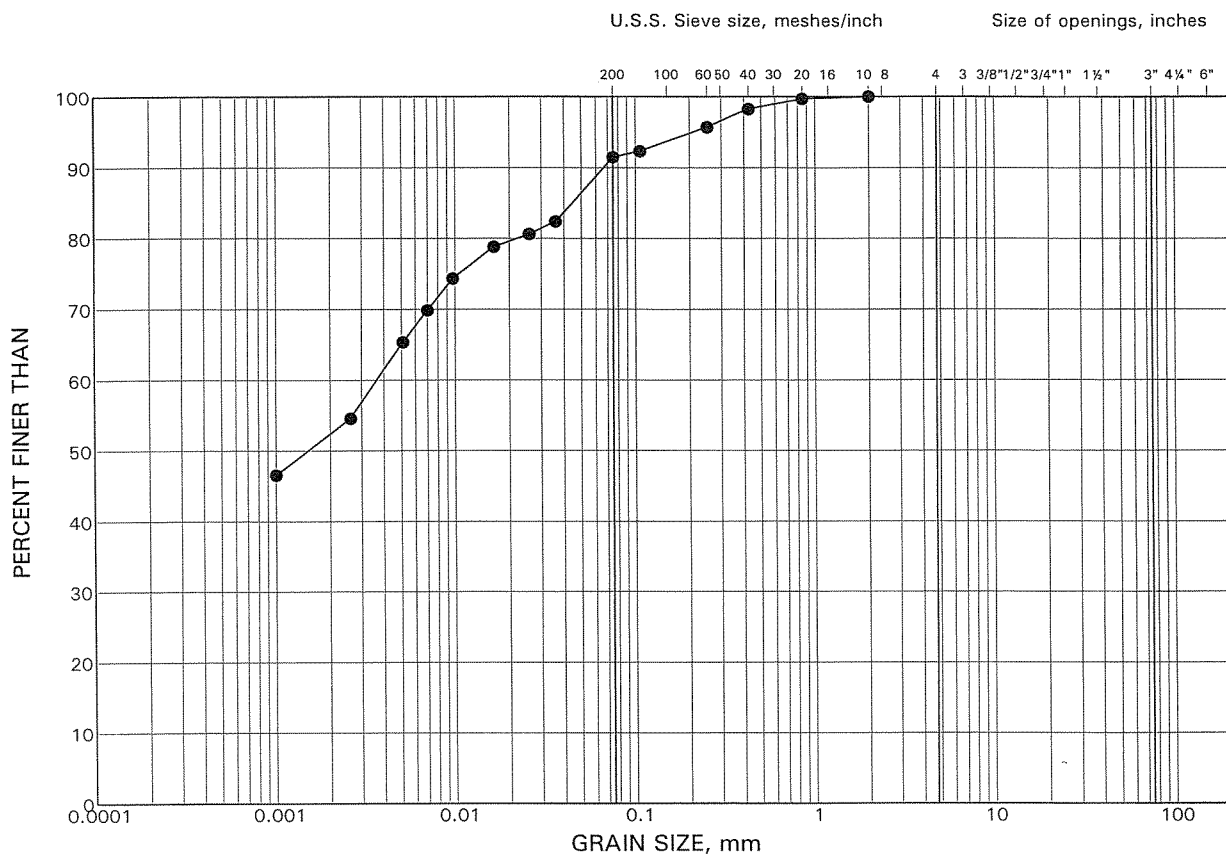
LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH (m)
•	C3-2	3	1.2-1.8

GRAIN SIZE DISTRIBUTION

Silty Clay

FIGURE A-3



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

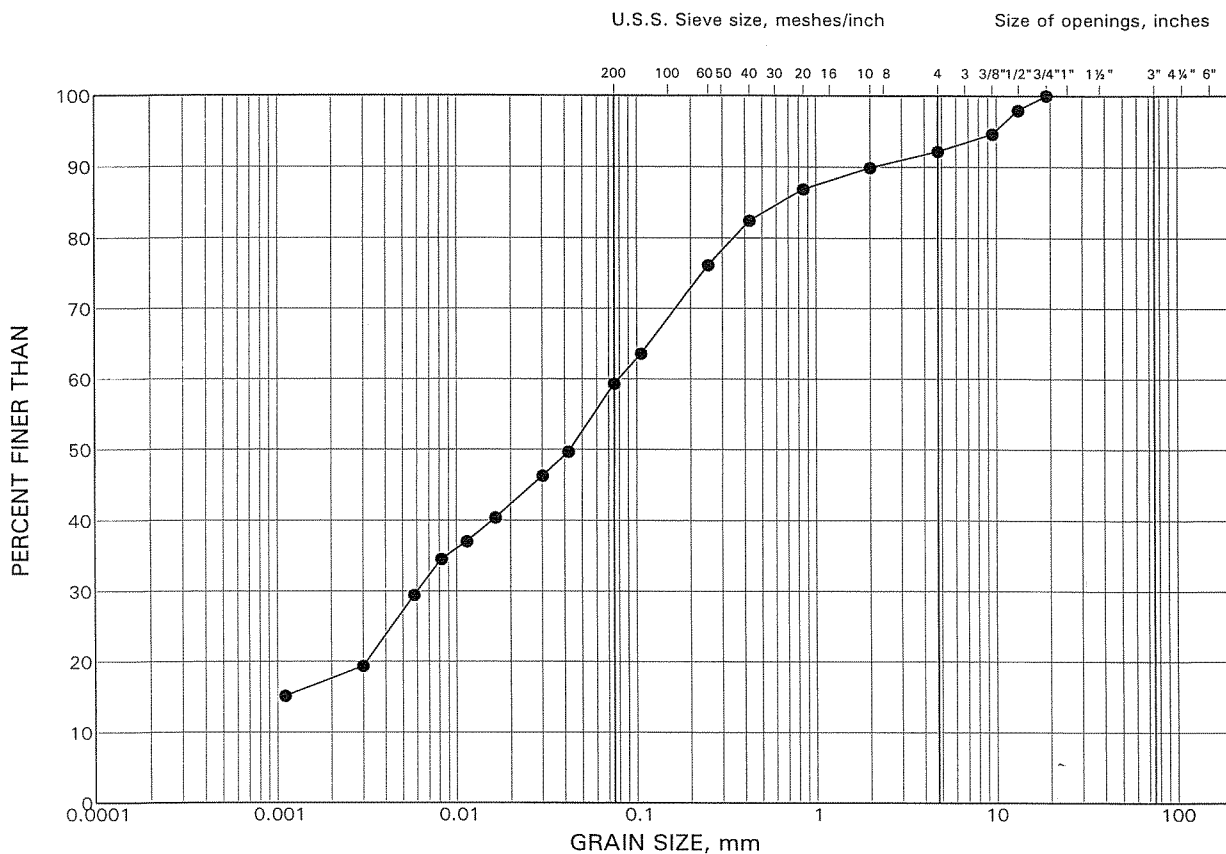
LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH (m)
●	C3-3	4	1.8-2.4

GRAIN SIZE DISTRIBUTION

Silty Sand

FIGURE A-4



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

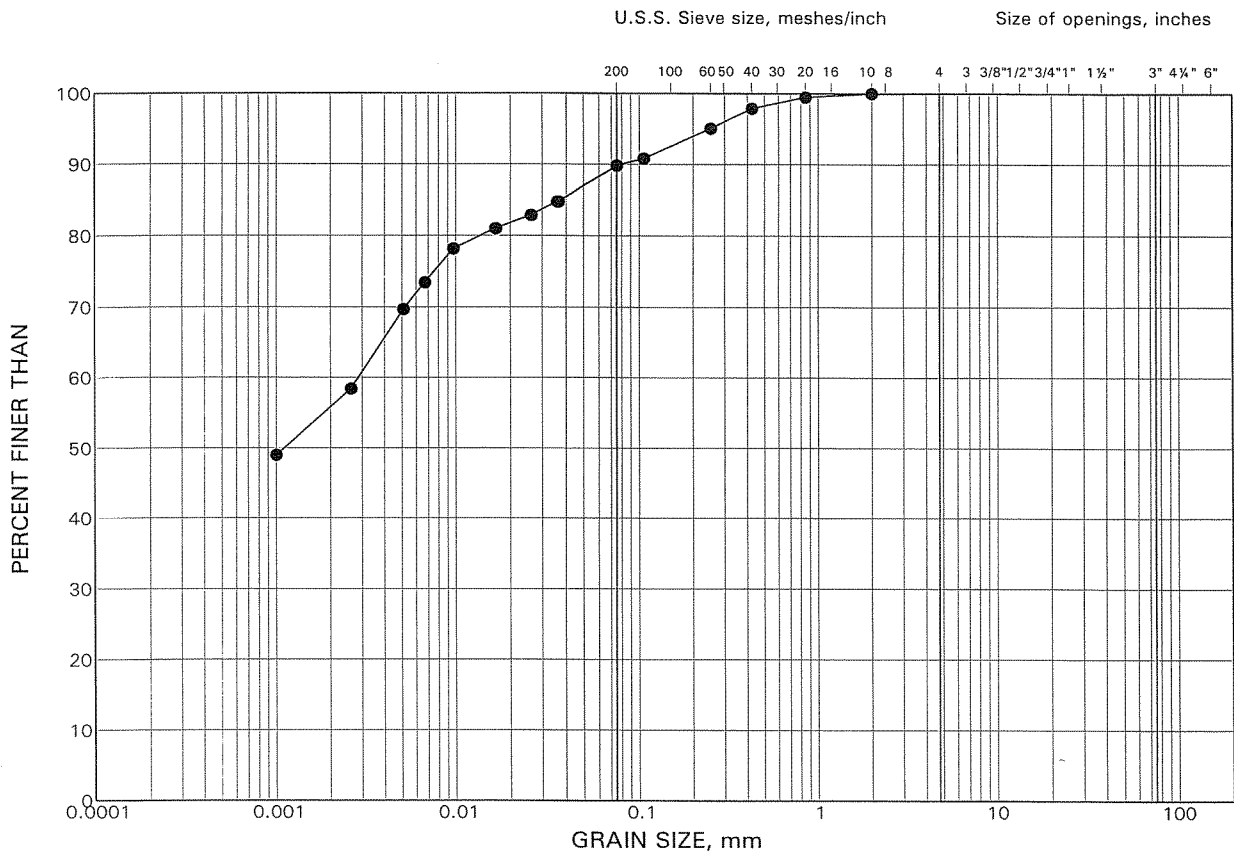
LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH (m)
•	C2-1	2	0.6-1.1

GRAIN SIZE DISTRIBUTION

Clay

FIGURE A-5



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

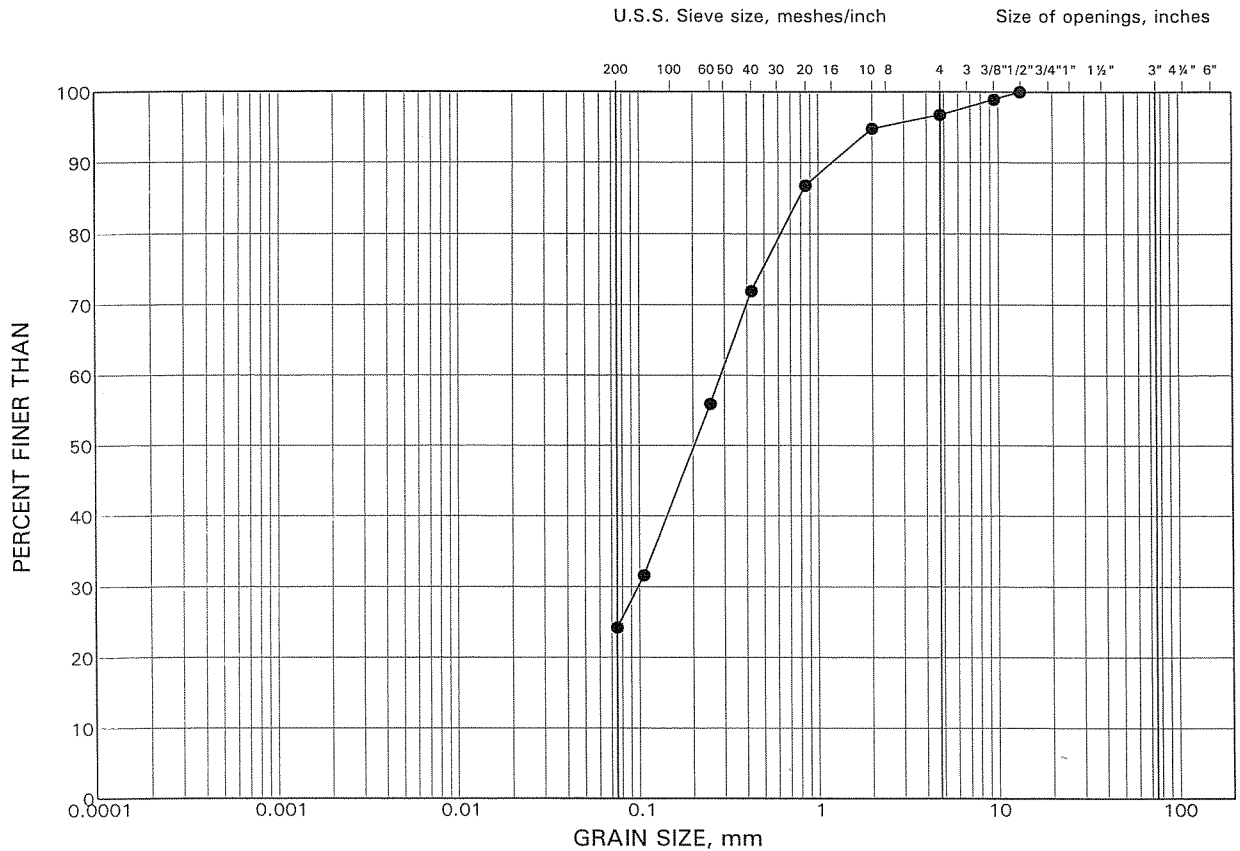
LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH (m)
•	C2-2	2	0.6-1.2

GRAIN SIZE DISTRIBUTION

Sand

FIGURE A-6



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

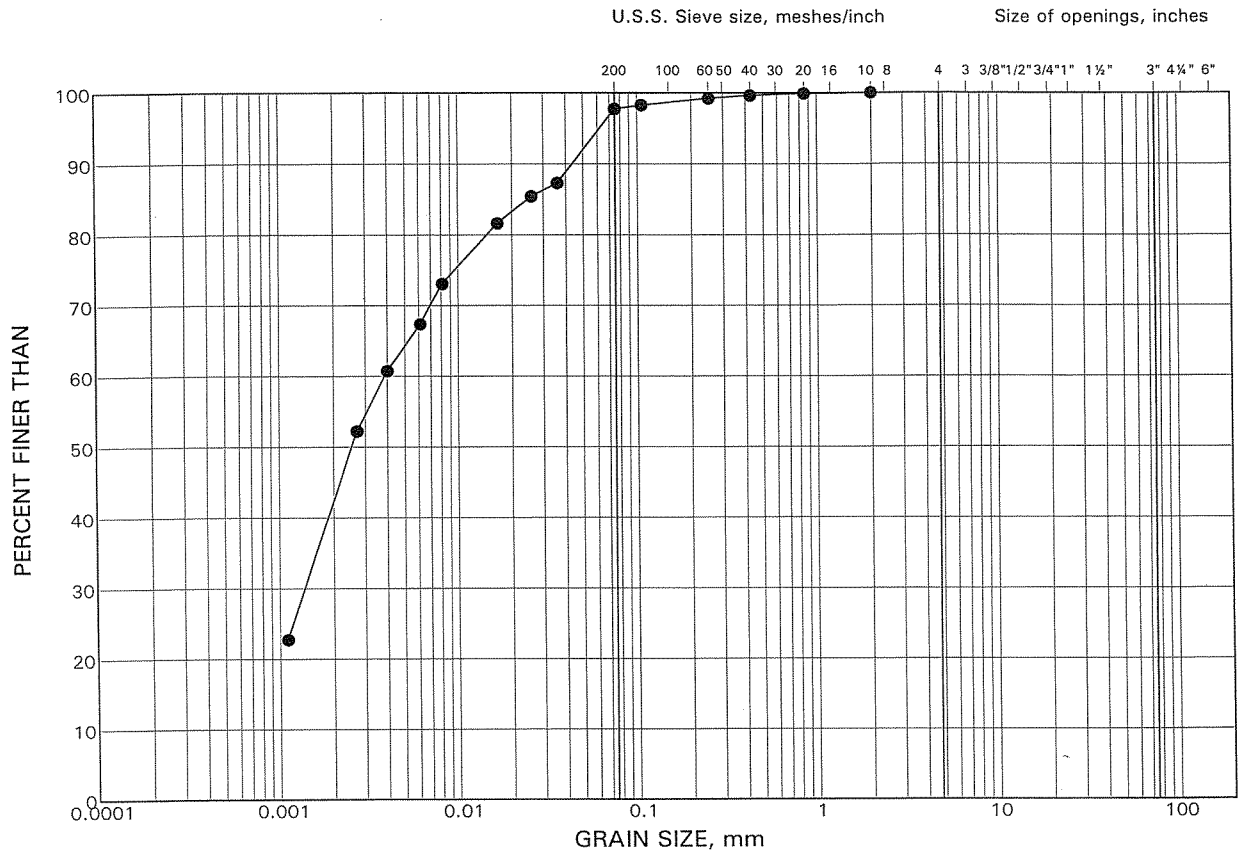
LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH (m)
•	C4-1	3	1.2-1.4

GRAIN SIZE DISTRIBUTION

Silty Clay

FIGURE A-7



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH (m)
•	C4-2	3	1.2-1.8