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REPORT ON

**DETAIL DESIGN
FOUNDATION INVESTIGATION AND DESIGN
DEEP CUTS AND HIGH FILLS
HIGHWAY 10 WIDENING FROM 1 KM NORTH OF REGIONAL ROAD 24 NORTHERLY
TO HIGHWAY 9
TOWN OF CALEDON, ONTARIO
W.P. 27-97-00
MINISTRY OF TRANSPORTATION, ONTARIO**

Submitted to:

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GEOCRES NO: 40P16-20

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December 2006



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LIST OF DRAWINGS

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Morrison Hershfield Ltd. (Morrison Hershfield) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out a foundation investigation as part of the detailed design for the proposed widening of Highway 10 from 1 kilometre north of Regional Road 24 northerly to Highway 9 in the Town of Caledon, Ontario.

The terms of reference for the scope of work are outlined in Golder's proposal P31-1093, dated March 2003, and supplemental letter "Revision to Borehole Drilling Program", dated November 20, 2003.

This report addresses the deep cut and high fill embankment areas as part of the highway widening project from approximate Station 24+800 to Station 25+600 on Highway 10. The foundation investigation and design recommendations for the proposed bridge widening structures and culvert extensions/replacements are reported separately. The work was carried out in accordance with the Quality Control Plan for this project dated July 2003. A digital file of the site plan and proposed highway cross-sections were provided to Golder by Morrison Hershfield in January 2004.

2.0 SITE DESCRIPTION

The high fill/deep cut site is located in the vicinity of the intersection between Highway 10 and Highpoint Sideroad South (see key plan on Drawing 1) in the Town of Caledon, Ontario. The proposed high fill area extends from about Station 24+800 to Station 24+900, and the proposed deep cut area extends from about Station 24+900 to Station 25+600. Highway 10 in this area is presently three lanes; with two lanes in the southbound direction and one lane in the northbound direction.

The lands in the area generally consists of rolling hills with grassy fields to the west and forest with grassy areas to the east. The present highway grade at the site generally declines from south to north, toward the low-lying Credit River valley located north of the site. The existing highway grade ranges from about Elevation 442 m to 416 m within the project limits (i.e. Station 24+800 to 25+600). Several private entrances and one intersection at Highpoint Sideroad South are located along Highway 10 in this section of roadway.

3.0 INVESTIGATION PROCEDURES

3.1 Foundation Investigation

The field work for this investigation was carried out between September 26, 2003 and January 7, 2004 at which time nine (9) boreholes (03-1, 03-3 to 03-7, 03-9, C6A, and C6B) were advanced and one (1) test pit (03-2) was excavated. The borehole and the test pit locations are shown in plan on Drawing 1.

The boreholes were typically advanced within the proposed embankment fill footprint or within the deep cut areas located within the right-of-way. Subsurface soil information directly below the existing roadway was obtained in the pavement investigation task entitled "Pavement Design Report, Highway 10 from 1 km North of Regional Road 24 Northerly to Highway 9" performed concurrently with this investigation.

The current field investigation was carried out using track-mounted CME 55 drill rigs supplied and operated by two companies, namely Walker Drilling Ltd. of Utopia, Ontario in December 2003 and Groundwork Drilling Inc. of Etobicoke, Ontario in September 2003. The boreholes were advanced using 108 mm inside diameter (I.D.) continuous flight hollow stem augers and 108 mm outside diameter (O.D.) solid stem augers. Soil samples were obtained at intervals ranging from 0.75 m to 1.5 m in depth, using a 50 mm O.D. split-spoon sampler in accordance with Standard Penetration Test (SPT) procedures.

The boreholes were advanced to depths ranging from 3.8 m to 17.2 m below the existing ground surface. The groundwater conditions in the open boreholes were observed during the drilling operations, with piezometers installed in selected boreholes to permit more long-term monitoring of the groundwater levels. The piezometers consist of a 25 mm outside diameter solid PVC pipe with a slotted screen sealed at a select depth within the boreholes. The holes were backfilled with a bentonite slurry. The standpipe piezometer installation details and water level readings are described on the Record of Borehole sheets that follow the text of this report.

The field work was supervised by members of our engineering and technical staff who, located the boreholes, 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 detailed visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards as appropriate. Classification testing (water content, Atterberg Limits, and grain size distribution) was carried out on select samples.

The approximate borehole locations were staked in the field by Callon-Dietz personnel prior to drilling operations. Upon completion of the fieldwork, the locations of the completed boreholes were surveyed by Callon-Dietz Inc. using the NAD 83 MTM co-ordinate system and the geodetic datum for elevation.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The site is located within the intersection of two physiographic regions known as the Hillsburgh Sandhills and Guelph Drumlin Field (Chapman and Putnam, "The Physiography of Southern Ontario", 3rd Edition, 1984). The Hillsburgh Sandhills are described as having rough topography, sandy materials, and flat-bottomed swampy valleys running through the moraine from Orangeville to Hillsburgh. The Guelph Drumlin Field is predominantly composed of stony tills of the drumlins and deep gravel terraces of the old meltwater spillways; usually having a shallow veneer of loam. The ground conditions in the vicinity of the site are described to consist of kame moraines and spillways consisting of gravel terraces and swamps.

4.2 Subsoil Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced during this investigation, together with the results of the laboratory tests carried out on selected soil samples, are given on the attached Record of Borehole sheets and in Appendix A following the text of this report.

The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests (SPTs). 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 subsoils at the site typically consist of a surficial deposit of topsoil underlain by interlayered silty sand, sand, sandy silt and silt deposits. A layer of clayey silt till was encountered within the interlayered deposit at the northern limit of the site. Deposits of sand and gravel to sandy gravel were encountered below the topsoil and within the interlayered deposit at some areas of the site. A more detailed description of the subsurface conditions encountered in the boreholes located within the high fill and deep cut areas is provided in the following sections.

4.3 High Fills

Boreholes C6A and C6B were drilled near the east and west toes of the existing Highway 10 embankment, and within the proposed new widening embankment footprint. High fill areas are present between approximate Station 24+800 to Station 24+900.

The subsoils located adjacent to the existing embankment within the proposed high fill area typically comprise of a surficial deposit of topsoil and silty clay with organics, overlying a deposit of sand, sand and gravel, and sandy gravel. The data from the boreholes drilled during the pavement investigation indicate the existing embankment consists predominantly of sand, sand and gravel, silty sand and sandy silt containing cobbles. A more detailed description of the subsurface conditions encountered in the boreholes located within this area is provided in the following sections.

4.3.1 Topsoil / Silty Clay with Organics

Silty clay with organics and topsoil was encountered at the existing ground surface in Boreholes C6A and C6B, respectively. The dark brown topsoil and silty clay with organics deposit typically contained some sand and trace gravel. The existing ground surface was at Elevation 433.1 m and 427.7 m and the topsoil and silty clay with organics deposit was 1 m and 0.9 m thick for Boreholes C6A and C6B respectively.

Standard Penetration Testing (SPT) 'N' values recorded within the topsoil and silty clay with organics layer were 4 blows and 5 blows per 0.3 m of penetration, indicating a soft to firm consistency.

Natural water contents measured on samples of the topsoil and silty clay with organics were 19 and 23 percent.

4.3.2 Sand / Sand and Gravel / Sandy Gravel with silt

A deposit of sand and gravel to sandy gravel with silt was encountered below the topsoil and silty clay with organics in the high fill area. The sand and gravel to sandy gravel with silt deposit typically contained variable amounts of silt and trace to some clay. Cobbles and boulders were encountered throughout the sand and gravel to sandy gravel deposit. A 0.5 m thick sand layer was encountered directly below the silty clay with organics layer encountered in Borehole C6A, which was underlain by the sand and gravel deposit. Cobbles and boulders were encountered throughout the sand and gravel / sandy gravel deposit.

The top of the sand, sand and gravel and sandy gravel with silt deposit was encountered at 1.0 m (Elevation 432.1 m) and 0.9 m (Elevation 426.8 m) depths for Boreholes C6A and C6B respectively. The boreholes were terminated upon encountering auger refusal within the sand and gravel deposit which contained cobbles and boulders at depths of 6.2 m (Elevation 426.9 m) and 3.8 m (423.9 m) for Boreholes C6A and C6B respectively.

Standard Penetration Testing (SPT) 'N' values recorded within the sand, sand and gravel, and sandy gravel with silt deposit typically ranged from 20 blows per 0.3 m to over 50 blows per 0.1 m of penetration, indicating a compact to very dense state of packing.

The natural water content measured on samples taken within the sand, sand and gravel, and sandy gravel with silt deposit typically ranged between 6 and 16 percent. A grain size distribution curve for one sample of the sandy gravel with silt deposit is shown on Figure A1.

4.4 Deep Cuts

Boreholes 03-1, 03-3, 03-4, 03-5, 03-6, 03-7, 03-9 and Test Pit 03-2 were put down adjacent to the existing Highway 10 roadway and within the proposed new highway widening right-of-way. The deep cut area extends from approximate Station 24+900 to Station 25+600 and typically the boreholes were advanced near the crest of the existing cut side-slopes.

In general, the subsoils along the proposed new Highway 10 widening in this deep cut area are comprised of topsoil underlain by interlayers of sand, silty sand, sandy silt and silt. Layers of clayey silt till and sand and gravel were encountered within the interlayered deposit in some areas of the site. A more detailed description of the subsurface conditions encountered in the boreholes located within the deep cut area is provided in the following sections.

4.4.1 Topsoil

Topsoil was encountered at the existing ground surface in Boreholes 03-3, 03-4, 03-5, 03-6, 03-7, 03-9 and Test Pit 03-2. The existing ground surface ranged between Elevation 423.8 m to 448.8 m with the topsoil ranging from 0.1 m to 0.8 m thick. Occasional wood fragments were noted within the topsoil layer in Borehole 03-4.

Standard Penetration Testing (SPT) measured 'N' values within the topsoil ranged from 3 blows to 9 blows per 0.3 m of penetration, indicating a soft to stiff consistency.

Natural water contents measured on samples of the topsoil ranged between 17 and 28 percent.

4.4.2 Silty Clay with Organics / Silty Clay Fill

A deposit of silty clay with organics was encountered at the existing ground surface in Borehole 03-1, and a silty clay fill deposit containing occasional rootlets was encountered below the topsoil in Borehole 03-3. The silty clay with organics and silty clay fill deposits typically contained some sand, trace gravel and occasional wood fragments and rootlets. The top of the silty clay with organics deposit at Borehole 03-1 was at Elevation 444.2 m, and measured 0.8 m thick. The

top of the silty clay fill deposit within Borehole 03-3 was encountered at a depth of 0.3 m (Elevation 448.5) and measured 0.5 m thick.

Standard Penetration Tests (SPT) 'N' values recorded within the silty clay with organics deposit and silty clay fill were 6 blows and 9 blows per 0.3 m of penetration, indicating a firm to stiff consistency.

The natural water content measured on selected samples of the silty clay with organics and silty clay fill deposits were 17 and 21 percent respectively.

4.4.3 Interlayered Sand / Silty Sand / Sandy Silt / Silt

Interlayered deposits of sand, silty sand, sandy silt, and silt were encountered below the topsoil and silty clay deposits in Boreholes 03-1, 03-3, 03-4, 03-5, 03-6, and Test Pit 03-2. The cohesionless deposits typically contained trace clay. The top of the cohesionless deposits was encountered at depths ranging between 0.1 m and 2.3 m below ground surface. The elevation of the top of the cohesionless deposits ranged from Elevation 433.7 m to 447.3 m and the thickness of the interlayered cohesionless deposit was over 15.7 m. Boreholes 03-1, 03-3, 03-4, 03-5, and 03-6 were terminated within this interlayered cohesionless deposit at depths of 8.1 m (Elevation 436.1 m), 17.2 m (Elevation 431.6 m), 11.1 m (Elevation 434.7 m), 11.1 m (Elevation 428.7 m), and 11.1 m (Elevation 424.9 m) respectively. Test Pit 03-2 was terminated within the interlayered deposit at a depth of 0.5 m (Elevation 441.1 m).

Standard Penetration Test (SPT) 'N' values recorded within the interlayered sand, silty sand, sandy silt, and silt deposit ranged between 7 and 60 blows per 0.3 m of penetration, indicating a loose to very dense state of packing. The SPT 'N' values were found to increase with depth, with the 'N' value of 7 recorded at a depth of about 1.1 m in Borehole 03-5, and with the 'N' value of 60 recorded in Borehole 03-3 at a depth of 17.1 m. For reference, the mean, median, and standard deviation of the 'N' values within this deposit was 33, 32, and 14. The mean and median values reflect a deposit exhibiting a dense relative density.

The natural water content measured on samples of the interlayered silt, sandy silt, silty sand, and sand deposit varied between 4 and 23 percent. Grain size distribution curves on selected samples of the silt, sandy silt, and sand and silt interlayers are shown on Figures A2, A3 and A4 respectively, in Appendix A.

4.4.4 Sand / Sand and Gravel

Layers of sand to sand and gravel were encountered below the topsoil in Boreholes 03-6, 03-7 and 03-9, and below the topsoil and silty clay fill in Borehole 03-3. The sand and gravel typically

contained trace to some silt and the sand layers typically contained trace to some silt, trace gravel. Trace organics were noted in the upper zone of the sand deposit in Borehole 03-9.

The top of the sand to sand and gravel layer was encountered at a depth ranging between 0.2 m and 0.8 m within these boreholes. The elevation of the top of the sand to sand and gravel layers ranged from Elevation 423.6 m to 448.1 m, with the thickness varying from 0.7 m to 4.4 m.

In Boreholes 03-7 and 03-9, an interlayer of clayey silt till was present within the sand to sand and gravel deposit at both borehole locations. The sand to sand and gravel layer was 4.4 m and 1.5 m thick above the clayey silt till interlayer for Boreholes 03-7 and 03-9 respectively. Below the clayey silt till interlayer, the sand to sand gravel deposit extended from a depth of 6.1 m (Elevation 418.3 m) and 6.3 m (Elevation 417.6) to the termination of the boreholes which was at 9.3 m (Elevation 415.1 m) and 9.2 m (Elevation 414.6 m) for Boreholes 03-7 and 03-9 respectively. Cobbles were present within the sand to sand and gravel deposits below the clayey silt till layer in Boreholes 03-7 and 03-9.

Standard Penetration Testing (SPT) 'N' values recorded within the sand to sand and gravel deposits ranged between 6 blows per 0.3 m of penetration to over 100 blows per 0.2 m of penetration, indicating a loose to very dense state of packing.

The natural water content measured on samples of the sand to sand and gravel deposits ranged between 3 and 19 percent.

4.4.5 Clayey Silt Till

A layer of clayey silt till was encountered below the topsoil and sand to sand and gravel layers in Boreholes 03-7 and 03-9. The clayey silt till typically contains trace to some sand and gravel, as well as cobbles and boulders. The top of the till layer was encountered at a depth of 4.6 m (Elevation 419.8 m) and 1.7 m (422.1 m) for Boreholes 03-7 and 03-9, respectively. The thickness of the till layer was 1.5 m and 4.6 m for Boreholes 03-7 and 03-9 respectively.

Standard Penetration Testing (SPT) 'N' values recorded within the clayey silt till deposit ranged between 29 blows and greater than 50 blows per 0.15 m of penetration, indicating a very stiff to hard consistency.

The natural water content measured on samples of the clayey silt till varied between 8 and 12 percent. Atterberg Limits testing carried out on a sample of the clayey silt till showed a plastic limit (w_p) of 14 and a liquid limit (w_l) of 23 as shown on Figure A5. The results of the Atterberg Limits testing classify the clayey silt till sample as low plasticity.

4.4.6 Groundwater Conditions

The boreholes were generally dry during and upon completion of the drilling operations with the exception of Borehole 03-7 where water was at a depth of 4.3 m (Elevation 420.1 m) upon completion of drilling operations. Piezometers were installed in Boreholes 03-5 and 03-6 to permit monitoring of groundwater conditions. The piezometer installed in Borehole 03-5 was sealed in the sand interlayer and the piezometer installed in Borehole 03-6 was sealed in the sandy silt interlayer. Details of the piezometer installations are shown in the Record of Borehole Sheets following the text of this report. Both piezometers were found to be dry; the water level in the open Borehole 03-7 and piezometer details are summarized in the table below:

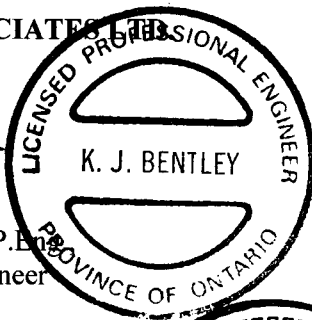
Borehole	Installation	Ground Surface Elevation (m)	Piezometer Tip Level Depth (m)	Water Level Depth (m)	Water Level Elevation (m)	Date
03-5	Piezometer	439.9	11.0	Dry	-	Jan. 7, 2004
03-6	Piezometer	436.0	11.0	Dry	-	Jan. 7, 2004
03-7	Open Borehole	424.4	-	4.3	420.1	Sept. 29, 2003

Based on the results of other piezometer installations for this project, the groundwater level in this area generally declines from south to north towards the Credit River water level, which was at about Elevation 402 m in December 2003. The Credit River is located at approximate Station 25+700 which is about 100 m north of the limit of the deep cut area near Station 25+600. It should also be emphasized that groundwater levels in the area are subject to seasonal fluctuations.

GOLDER ASSOCIATES LTD.



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KJB/RS/ASP/FJH/sm

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5.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

This section of the report provides our recommendations on the geotechnical aspects of design for the permanent high fill and deep cut sections of the proposed Highway 10 widening project. The recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the investigation at this site. The interpretation and recommendations provided are intended only for the guidance of the design engineer. As such, 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 methods, scheduling and the like.

5.1 General

It is understood that the proposed widening of Highway 10 involves lowering the existing Highway 10 centreline grade by up to 2.2 m in some areas between Stations 24+800 and 25+600. We also understand that the highway is to be widened to at least four lanes between these stations. The proposed widening will involve fill placement to construct new embankment side slopes, and excavation into the existing cut slopes to form new cut slopes within the existing Highway 10 right-of-way. According to the drawings provided to us by Morrison Hershfield, the proposed widened fill embankments between Stations 24+800 and 24+900 will be up to about 13 m in height. In the area of the deep cuts between Stations 24+900 and 25+600, the proposed grade lowering and road widening results in total cut slope heights of up to 14 m.

The following table summarizes the locations of the proposed cut and fill areas within the project limits of the highway widening and grade change.

<i>Location (Relative to Existing Hwy 10)</i>	<i>Proposed Works</i>
Station 24+800 to 24+900 - East Side	High Fill: road widening results in overall fill embankment height up to 7 m with fill depth on side slopes of up to 4.5 m
Station 24+800 to 24+900 - West Side	High Fill: road widening results in overall fill embankment height up to 13 m with fill depth on side slopes of up to 2 m
Station 24+900 to 25+600 - East Side	Deep Cut: road widening and up to 2 m lowering of road grade results in overall cut slope height up to 14 m with cut depth on side slope of up to 8 m
Station 24+900 to 25+600 - West Side	Deep Cut: road widening and up to 2 m lowering of road grade results in overall cut slope height up to 14 m with cut depth on side slope of up to 7 m

5.2 High Fill

The existing Highway 10 fill embankments in the area of the proposed widening presently measure up to 13 m high and have side slope profiles of approximately 2 horizontal to 1 vertical (2H:1V). These embankments appear to be primarily composed of sand and gravel, sands, and silts based on the results of the pavement investigation performed by Golder at the site. Currently, the embankment side slopes do not have a mid-height berm/bench.

Based on the borehole information, the subsoils encountered near the toe of the existing embankment (i.e., within the proposed embankment widening footprint) consist of about 1 m of topsoil or silty clay with organics, underlain by predominantly compact to very dense sand, sand and gravel, and sandy gravel with silt.

5.2.1 Fill Embankment Construction

The silty clay with organics, topsoil, and any other deleterious material should be stripped from the foundation footprint of the proposed embankment areas prior to fill placement. In areas where fill is to be placed on top of the existing embankment fill, the existing embankments should be stripped of all vegetative cover, topsoil, and deleterious material. Construction of the embankment widening above the prepared subgrade may be carried out using clean earth fill meeting specification OPSS 212 or Select Subgrade Material meeting OPSS 1010, depending on material availability. All embankment fill should be placed in regular loose lifts not exceeding 300 mm, and compacted to at least 95 percent of the material Standard Proctor maximum dry density. The final lift prior to placement of the granular subbase or base course should be compacted to 100 percent of the Standard Proctor maximum dry density. In areas where the new embankment is to be constructed over the existing embankment, the existing embankment should be benched according to OPSD 208.010.

Inspection and field density testing should be carried out by qualified geotechnical personnel during all fill placement operations to ensure that appropriate materials are used and that adequate levels of compaction have been achieved.

All construction work should be carried out in accordance with the guidelines outlined in the latest edition of the Occupational Health and Safety Act and Regulations for Construction Projects.

Following placement and compaction of the fill materials, a vegetative cover should be established on all slope faces to protect against surficial erosion, as outlined in OPSS 572.

5.2.2 Stability

The permanent soil slopes of the proposed embankment widening should be maintained not steeper than 2H:1V. For the widened embankments with total fill height up to 13 m, assuming side slopes formed at 2H:1V and with fill placed and compacted according to Section 5.2.1, the factor of safety against deep-seated failure of the slope will be greater than 1.5.

The road widening in some areas will require adding only a relatively thin “veneer” of fill on top of the existing embankment side slope. In these areas, special care must be taken to ensure the existing embankment is stripped, benched, and fill compacted to the specifications described previously, in order to maintain stability of the veneer of fill. In areas where earth fill embankments will exceed a height of 8 m, a 2 m wide mid-height berm is recommended.

5.2.3 Settlement

Provided that the surficial deposits of topsoil and silty clay with organics are removed prior to the new embankment fill placement, the settlement of the compact to very dense sand, sand and gravel, sand and gravel with silt foundation soils beneath the footprint of the proposed embankment widening is considered to be less than 25 mm. These settlements are expected to occur very quickly (i.e. during or shortly after construction). In addition to the above foundation soil settlements, embankment settlement due to compression of the earth fill itself should also be expected (i.e. during or shortly after construction).

Differential settlement up to about 25 mm may also be expected where the new embankment fills are placed adjacent to, or on top of the existing roadway embankment. It is once again emphasized that all organic material be removed from within the embankment footprint (including the existing side slopes) prior to constructing the embankments to limit the magnitude of differential settlement.

To minimize the impact of differential settlement of the newly widened roadways, it is recommended that new embankment fills be constructed as early as possible within the construction schedule. This approach would allow as much time as possible for the settlement of the embankment and fill materials to occur prior to initiating placement of the pavement structure on the new roadway.

5.3 Deep Cut Design

The existing Highway 10 cut slope section in the area of the proposed widening is up to 12 m deep, and has side slope profiles of approximately 2H:1V. These slopes have been formed without a mid-height berm/bench.

Based on the borehole information from the current investigation, the proposed permanent cut within the existing side-slopes will be formed predominantly within the loose to very dense interlayered sand, silty sand, sandy silt, silt deposit, the loose to very dense sand, sand and gravel deposit containing cobbles and boulders, and also within the very stiff to hard clayey silt till deposit which was found to contain cobbles and boulders.

It is not anticipated that the cut slopes will extend below the groundwater table; a water level which was at Elevation 420 m was noted in Borehole 03-7 at about Station 25+430 during drilling operations. It should be emphasized, however, that there may be areas where perched is present within the interlayered deposits; this water seepage could probably be dealt with during construction by allowing it to drain. Furthermore, although not encountered during the current investigation, artesian water conditions and associated water seepage through the subsurface soils is common in the area.

In this regard, all cut slopes should be inspected prior to and following the cut operations to check for evidence of water seepage which could affect surficial stability. It is recommended that provision be made in the contract to allow for implementation of remedial measures such as installation of granular blanket, drainage pipes, etc. in areas of seepage to promote drainage, safeguard stability, and control surface erosion.

A 2 m wide bench should be incorporated into the slopes at the approximate mid-height for the full length of the cut slope which are up to about 14 m in height. Although the slope is considered stable without the bench, inclusion of the bench will allow for control of erosion and sloughing of surficial soils, especially during the early stages of reinstating vegetation. Depending on the topography and overland flow drainage paths beyond the crest of the proposed cut slope, a drainage ditch may be required near the crest to divert water away from the cut slope to prevent wash out and erosion.

Following excavation of the final cut profile and after inspection for drainage measure requirements, vegetation cover should be established on all slope faces to protect against surficial erosion as outlined in OPSS 572.

5.3.1 Cut Slope Construction

Cobbles and boulders were encountered during drilling operations at the northern limit of the site. The treatment of boulders encountered during excavation should follow the requirements outlined in OPSD 204.01.

All excavation work should be carried out in accordance with the guidelines outlined in the latest edition of the Occupational Health and Safety Act and Regulations for Construction Projects.

5.3.2 Stability

Limit equilibrium slope stability analyses were performed using the commercially available program SLOPE/W, produced by Geo-Slope International Ltd., employing the Morgenstern-Price method of analysis, to check that a minimum factor of safety of 1.3 is achieved for the proposed fill embankment height and geometry under static conditions. This minimum factor of safety is considered appropriate for the embankments at this site considering the design requirements and the available field and laboratory testing data.

The subsoils encountered in the area of the deep cut section are composed primarily of cohesionless soils. For these soils, effective stress parameters were employed in the analysis assuming drained conditions and the parameters were estimated from empirical correlations using the results of in situ Standard Penetration Tests (SPT), visual classification, and laboratory data. The groundwater level was assumed to be below the base of the cut based on the conditions encountered during drilling and in the piezometers installed in the deep cut section. Static slope stability analyses were carried out using the following parameters based on field and laboratory test data and accepted correlations:

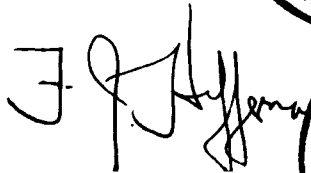
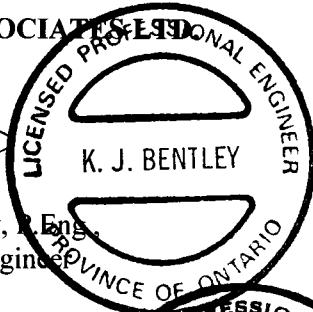
<i>Soil Deposit</i>	<i>Bulk Unit Weight</i>	<i>Effective Friction Angle</i>	<i>Undrained Shear Strength</i>
Interlayered Silty Sand, Sandy Silt, Silt and Sand (Upper deposits)	20 kN/m ³	32°	—
Interlayered Silt Sand, Sandy Silt, Silt and Sand (Lower deposits)	21 kN/m ³	34°	—

The new permanent cut slopes should be formed at 2H:1V. Assuming side-slopes are formed at this gradient, and a maximum cut slope height of about 14 m, the factor of safety against deep-seated failure of the slope will be at least 1.5 as shown on Figure 1.

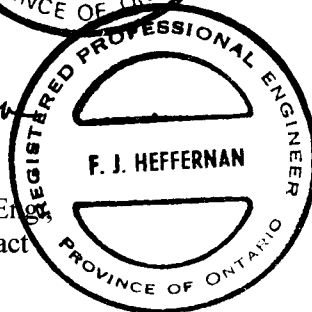
GOLDER ASSOCIATES LTD.



Kevin J. Bentley, P.Eng.,
Geotechnical Engineer



Fintan J. Heffernan, P.Eng.,
Designated MTO Contact



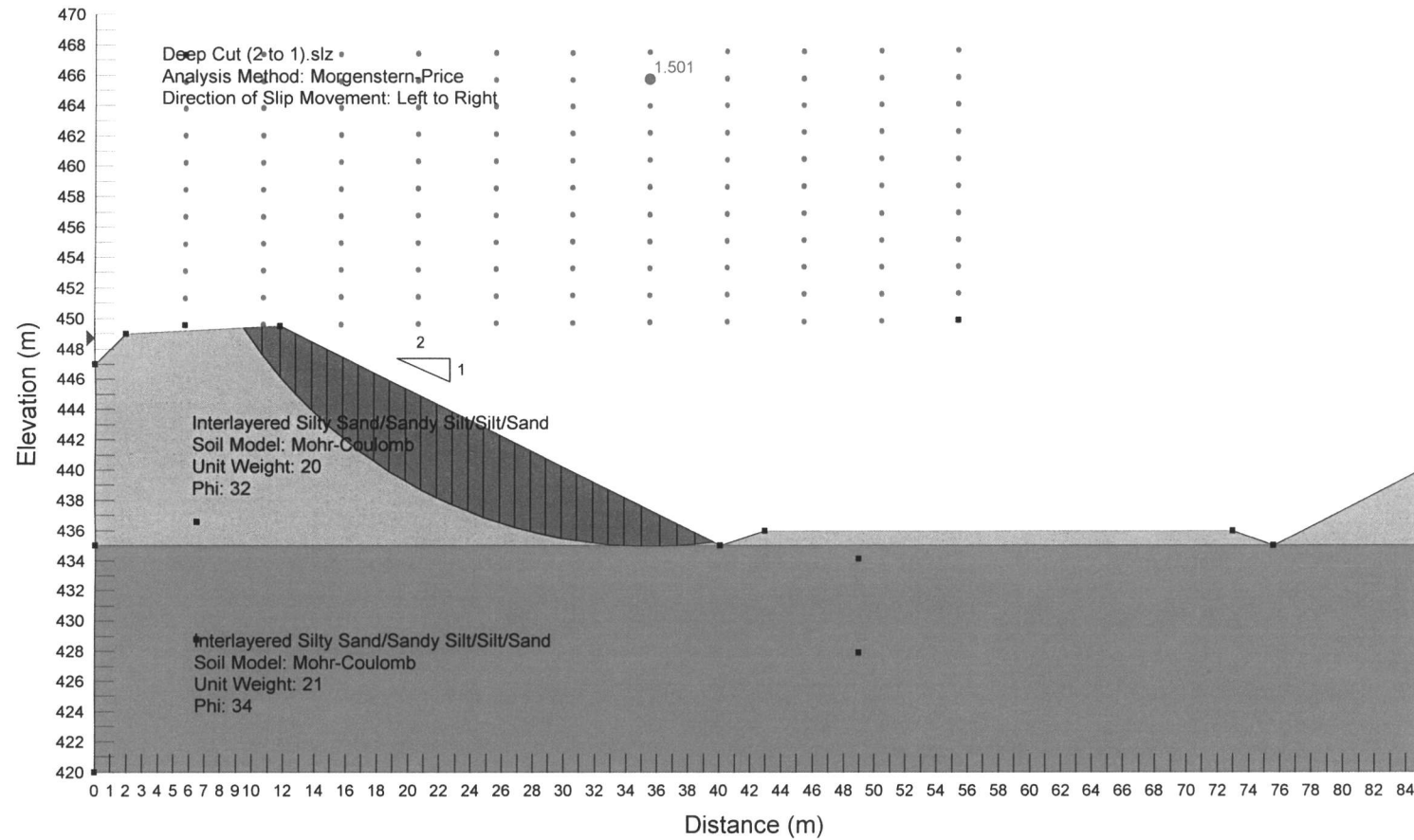
Anne S. Poschmann, P.Eng.,
Principal

KJB/RS/ASP/FJH/sm

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PERMANENT CUT SLOPE

FIGURE 1



Date: December, 2006
 Project: 03-1111-023

Golder Associates

Drawn: KG
 Checked: KJB

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
DO Drive open
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.)

(b) Cohesive Soils

Consistency	c_u, s_u kPa	psf
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

Dynamic Cone Penetration Resistance; N_4 :

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 test¹
CIU consolidated isotropically undrained triaxial test with porewater pressure measurement¹
 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
SO₄ 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.

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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_{us}, 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 $= (\text{compressive strength})/2$
 * density symbol is ρ . Unit weight symbol is γ where
 $\gamma = \rho g$ (i.e. mass density \times acceleration due to gravity)



PROJECT 03-1111-023		RECORD OF BOREHOLE No C6A				1 OF 1 METRIC										
W.P. 27-97-00		LOCATION N 4861717.4 :E 261062.1				ORIGINATED BY GD										
DIST _____ HWY 10		BOREHOLE TYPE POWER AUGERING USING 108 mm I.D. HOLLOW STEM AUGERS				COMPILED BY KG										
DATUM Geodetic		DATE October 9, 2003				CHECKED BY KJB										
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							WATER CONTENT (%)	
433.1	GROUND SURFACE						20	40	60	80	100					
0.0	Silty Sand with organics, some clay, contains rootlets Loose Dark brown Moist		1	SS	5											
432.1			2	SS	7											
1.0	Sand, trace gravel Loose Brown Moist															
431.6			3	SS	20											
1.5	Sand and Gravel, trace silt, contains cobbles Compact to dense Brown Moist		4	SS	36											
			5	SS	38											
			6	SS	50											
			7	SS	42											
426.9	End of Borehole		8	SS	50/100											
6.2	Auger and spoon refusal Notes: 1. Borehole open and dry upon completion of drilling operations. 2. Effective auger and split spoon refusal on probable cobble/boulder at 6.2 m depth. 3. Piezometer dry on January 7, 2004.															

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PROJECT <u>03-1111-023</u>		RECORD OF BOREHOLE No C6B				1 OF 1 METRIC	
W.P. <u>27-97-00</u>		LOCATION <u>N 4861690.5 ; E 260999.4</u>				ORIGINATED BY <u>GD</u>	
DIST <u> </u> HWY <u>10</u>		BOREHOLE TYPE <u>POWER AUGERING USING 108 mm O.D. HOLLOW STEM AUGERS</u>				COMPILED BY <u>KG</u>	
DATUM <u>Geodetic</u>		DATE <u>December 18, 2003</u>				CHECKED BY <u>KB</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	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80	100	20	40
427.7	GROUND SURFACE																		
0.0	Topsoil Soft Dark brown Moist		1	SS	4														
426.8	Sandy Gravel with silt, trace to some clay, contains cobbles/boulders Dense to very dense Brown Moist		2	SS	50/0.15														
0.9																			
425.6	Sand and Gravel, trace silt and clay, contains cobbles/boulders Very dense Brown Moist		3	SS	35														
2.2																			
425.6			4	SS	50/0.15														
			5	SS	21/0.15														
423.9																			
3.8	End of Borehole Auger and Spoon Refusal Notes: 1. Auger refusal at 3.8 m depth. 2. Split spoon sampler bouncing on probable cobble/bedrock for Sample Numbers 2, 4, and 5. 3. Moved borehole location five times (within 5m radius) to reach depth of 3.8 m due to auger refusal on probable cobbles/boulders.																		

PROJECT <u>03-1111-023</u>		RECORD OF BOREHOLE No 03-1		1 OF 1 METRIC																	
W.P. <u>27-97-00</u>		LOCATION <u>N 4861825.7 : E 260955.9</u>		ORIGINATED BY <u>GD</u>																	
DIST <u>HWY 10</u>		BOREHOLE TYPE <u>POWER AUGERING USING 108 mm O.D. HOLLOW STEM AUGERS</u>		COMPILED BY <u>KG</u>																	
DATUM <u>Geodetic</u>		DATE <u>December 10, 2003</u>		CHECKED BY <u>KJB</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	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20	40	60	80
444.2	GROUND SURFACE																				
0.0	Silty Clay with organics, some sand, trace wood fragments Firm Brown Moist		1	SS	6																
443.4																					
0.8	Sand, some silt, trace clay and gravel Compact Brown Moist		2	SS	13																
			3	SS	16																
			4	SS	20																
441.2																					
3.0	Sandy Silt, trace clay Loose to compact Brown Moist		5	SS	10																
			6	SS	22																
			7	SS	23																
438.1																					
6.1	Silty Sand, trace clay Dense Brown Moist		8	SS	39																
436.1			9	SS	36																
8.1	End of Borehole Notes: 1. Borehole open and dry upon completion of drilling.																				

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PROJECT 03-1111-023

RECORD OF BOREHOLE No 03-3

1 OF 2 METRIC

W.P. 27-97-00

LOCATION N 4861893.9 :E 2600813.7

ORIGINATED BY GD

DIST HWY 10

BOREHOLE TYPE POWER AUGERING USING 108 mm I.D. HOLLOW STEM AUGERS

COMPILED BY KG

DATUM Geodetic

DATE December 16, 2003

CHECKED BY KJB

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						
448.8	GROUND SURFACE							20 40 60 80 100						
0.0	Topsoil		1	SS	9									
448.5														
448.1	Silty clay, some sand, trace gravel, occasional rootlets (FILL)													
0.8	Loose Dark brown Moist		2	SS	46									
447.3	Sand and Gravel, some silt Dense Brown Moist													
1.5	Silty Sand, trace gravel and clay Dense Brown Moist		3	SS	36									
			4	SS	33									
445.3			5	SS	47									
3.5	Silt, some sand, trace clay Dense Brown Moist to wet		6	SS	34									
			7	SS	48									
			8	SS	49									
			9	SS	48									
			10	SS	41									
			11	SS	49									
			12	SS	34									
435.1														
13.7	Sand, some silt Very dense Brown Wet to moist		13	SS	57									

Continued Next Page

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



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

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PROJECT 03-1111-023

RECORD OF BOREHOLE No 03-4

1 OF 1 METRIC

W.P. 27-97-00

LOCATION N 4861990.4 ; E 260801.9

ORIGINATED BY GD

DIST HWY 10

BOREHOLE TYPE POWER AUGERING USING 108 mm O.D. SOLID STEM AUGERS

COMPILED BY KG

DATUM Geodetic

DATE December 17, 2003

CHECKED BY KJB

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 Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
445.8	GROUND SURFACE													
0.0	Topsoil, occasional wood fragments Soft to firm Dark brown Moist		1	SS	4									
445.1														
0.8	Sandy Silt, occasional sand seams and silty clay seams Compact Brown Moist		2	SS	16									
			3	SS	16									
			4	SS	15									
			5	SS	23									
			6	SS	58									
441.3														
4.6	Silty Sand Very dense to compact Brown Moist		7	SS	53									
			8	SS	32									
			9	SS	28									
			10	SS	41									
			11	SS	28									
434.7	End of Borehole													
11.1	Notes: 1. Borehole open and dry upon completion of drilling.													

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PROJECT 03-1111-023

RECORD OF BOREHOLE No 03-5

1 OF 1 METRIC

W.P. 27-97-00

LOCATION N 4862008.2; E 260711.5

ORIGINATED BY GD

DIST _____ HWY 10

BOREHOLE TYPE POWER AUGERING USING 108 mm O.D. SOLID STEM AUGERS

COMPILED BY KG

DATUM Geodetic

DATE December 18, 2003

CHECKED BY KJB

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						
							20 40 60 80 100	20 40 60 80 100	10 20 30					
							○ UNCONFINED	+ FIELD VANE						
							● QUICK TRIAXIAL	× REMOULDED						
439.9	GROUND SURFACE													
0.0	Topsoil		1	SS	4									
439.6	Soft to firm													
0.3	Dark brown													
	Moist													
	Silty Sand, occasional silt		2	SS	7									
	interlayers													
	Loose to compact													
	Brown		3	SS	20									
	Moist													
			4	SS	24									
			5	SS	30									
			6	SS	29									
435.3	Sand and Silt, trace clay		7	SS	27									
4.6	Compact to dense													
	Brown													
	Moist to dry													
			8	SS	41									
			9	SS	43									
			10	SS	50									
			11	SS	44									
428.7	End of Borehole													
11.1	Notes:													
	1. Borehole open and dry upon completion of drilling.													
	2. Piezometer dry when checked on January 7, 2004.													

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PROJECT 03-1111-023		RECORD OF BOREHOLE No 03-6				1 OF 1 METRIC						
W.P. 27-97-00		LOCATION N 4862120.7 E 260677.4				ORIGINATED BY GD						
DIST HWY 10		BOREHOLE TYPE POWER AUGERING USING 108 mm O.D. SOLID STEM AUGERS				COMPILED BY KG						
DATUM Geodetic		DATE December 17, 2003				CHECKED BY KJB						
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W _p W W _L			WATER CONTENT (%)
436.0	GROUND SURFACE											
0.0	Topsoil Soft Dark brown Moist		1	SS	3							
435.2												
0.8	Sand and Gravel, occasional clayey silt seams Compact to dense Brown Moist		2	SS	25							
			3	SS	48							
433.7												
2.3	Sand, trace silt, occasional sandy silt seams Dense to compact Brown Moist		4	SS	38							
			5	SS	28							
			6	SS	21							
431.2												
4.8	Sandy Silt, trace clay, occasional silty sand interlayers Dense Brown Moist		7	SS	35							
			8	SS	27							
			9	SS	28							
			10	SS	26							
424.9												
11.1	End of Borehole		11	SS	28							
Notes: 1. Borehole open and dry upon completion of drilling. 2. Piezometer dry when checked on January 7, 2004.												

MIS-MTO.001 031111023AAGDR.GPJ GAL-MISS.GDT 4/12/06

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

PROJECT 03-1111-023		RECORD OF BOREHOLE No 03-7		1 OF 1 METRIC												
W.P. 27-97-00		LOCATION N 4862169.8 :E 260613.9		ORIGINATED BY GD												
DIST _____ HWY 10		BOREHOLE TYPE POWER AUGERING USING 108 mm I.D. HOLLOW STEM AUGERS		COMPILED BY KG												
DATUM Geodetic		DATE September 29, 2003		CHECKED BY KJB												
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								
424.4	GROUND SURFACE						20	40	60	80	100					
0.0	Topsoil		1	SS	6											
0.2	Sand, trace to some silt, trace gravel Loose to compact Brown Moist		2	SS	12											
			3	SS	7											
			4	SS	23											
421.4																
3.1	Sand and Gravel, trace silt Very dense Brown Moist		5	SS	51											
420.4																
4.0	Sand, trace gravel and silt Compact Brown Moist		6	SS	15											
419.8																
4.6	Clayey Silt, some sand, trace gravel, contains cobbles/boulders (TILL) Very stiff Brown Moist		7	SS	29											
418.3																
6.1	Sand and Gravel, trace to some silt, trace clay, contains cobbles Very dense Brown Moist		8	SS	50/0.28											
			9	SS	100											
415.1																
9.3	End of Borehole		10	SS	50/0.13											
	Notes: 1. Water level at 4.3 m depth (Elev. 420.1 m) upon completion of drilling.															

MIS-MTO 001 031111023AAGDR.GPJ GAL-MISS.GDT 4/12/06

PROJECT 03-1111-023		RECORD OF BOREHOLE No 03-9		1 OF 1 METRIC								
W.P. 27-97-00		LOCATION N 4862249.7 E 260545.8		ORIGINATED BY GD								
DIST HWY 10		BOREHOLE TYPE POWER AUGERING USING 108 mm O.D. SOLID STEM AUGERS		COMPILED BY KG								
DATUM Geodetic		DATE September 26, 2003		CHECKED BY KJB								
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					
423.8	GROUND SURFACE											
0.0	Topsoil		1	SS	9				o			
0.2	Sand, some silt, trace gravel, trace organics in upper zone Loose to compact Brown Moist to dry		2	SS	22				o			
422.1	Clayey Silt, trace to some sand and gravel, frequent cobbles/boulders (TILL) Hard Brown to grey Moist		3	SS	70				o			
1.7			4	SS	37				o			
421			5	SS	47				o			
420			6	SS	50/2				o			
419												
418												
417.6	Sand and Gravel, trace silt, contains cobbles Very dense Brown Moist		7	SS	50/15				o			
6.3												
416.2	Sand, trace silt and gravel, contains cobbles Very Dense Brown Moist		8	SS	50/08				o			
7.6												
414.6	End of Borehole		9	SS	50/08							
9.2	Notes: 1. Borehole open and dry upon completion of drilling operations. 2. Auger refusal at 3.7 m depth. Borehole moved 3m North and sampling continued at 3.8 m depth. 3. Split Spoon and auger refusal on cobble/boulder at 4.3 m depth. Borehole moved 3m North and sampling continued at 6.1 m depth.											

MIS-MTO 001 031111023AAGDR.GPJ GAL-MISS.GDT 4/12/06

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JOB NUMBER:	03-1111-023	JOB NAME:	MH / Highway 10 / Caledon	DATE:	January 7, 2004
TEST PIT NUMBER:	03-2	TEST PIT SIZE:	0.5 m x 0.5 m (plan area)	ELEVATION:	441.6 m
MACHINE TYPE:	Hand Shovel	CONTRACTOR:	Golder	DATUM:	Geodetic
TEMPERATURE:	-10 °C	WEATHER:	Overcast	LOCATION:	N 4861878.6 E 260906.0

Depth		Soil Description	Samples		Pocket Penetrometer Results		Remarks
From (m)	To (m)		No.	Depth (m)	Depth (m)	q_u (kg/cm ²)	
0.0	0.1	Topsoil, dark brown					
0.1	0.4	Sand, some silt, trace gravel and organics, brown to dark brown					
0.4	0.5	Sand, trace silt, brown					

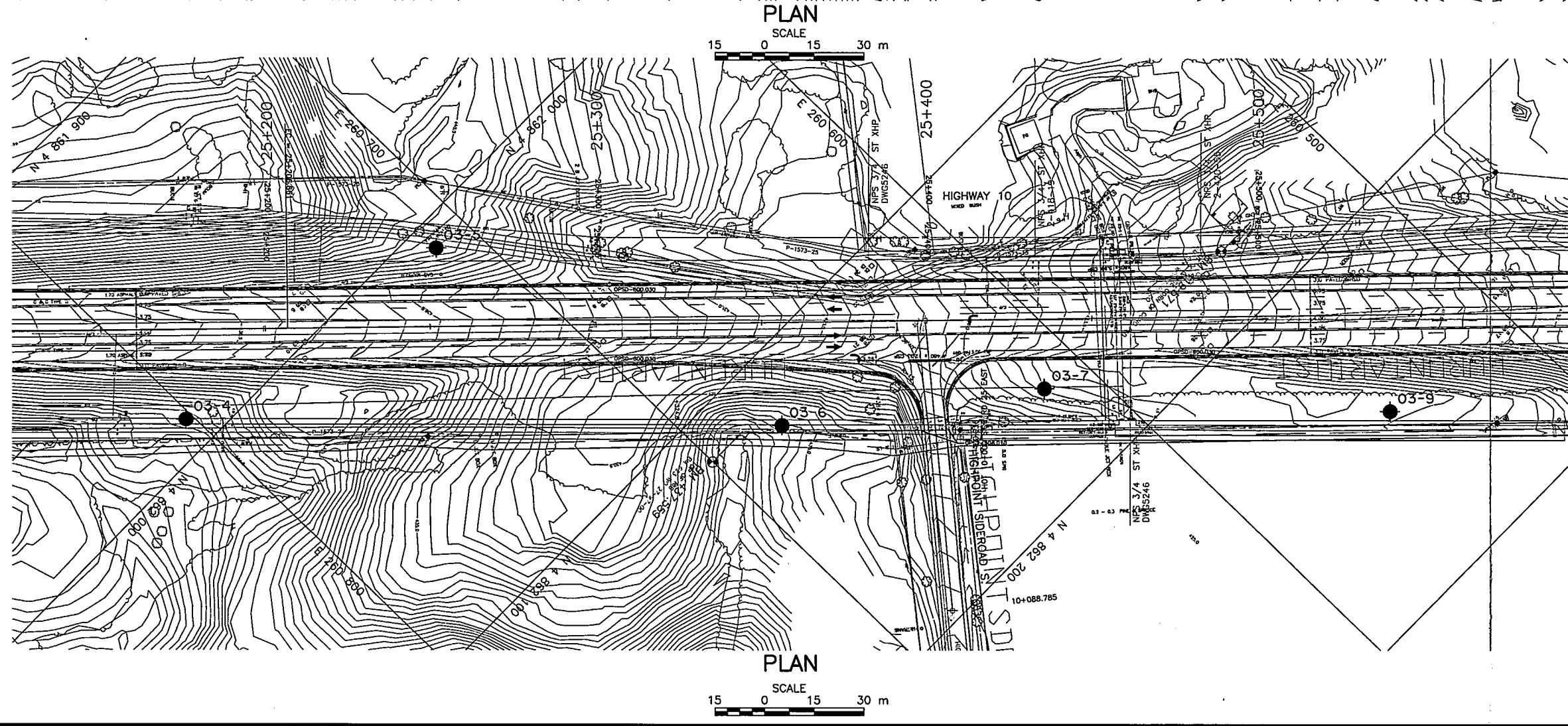
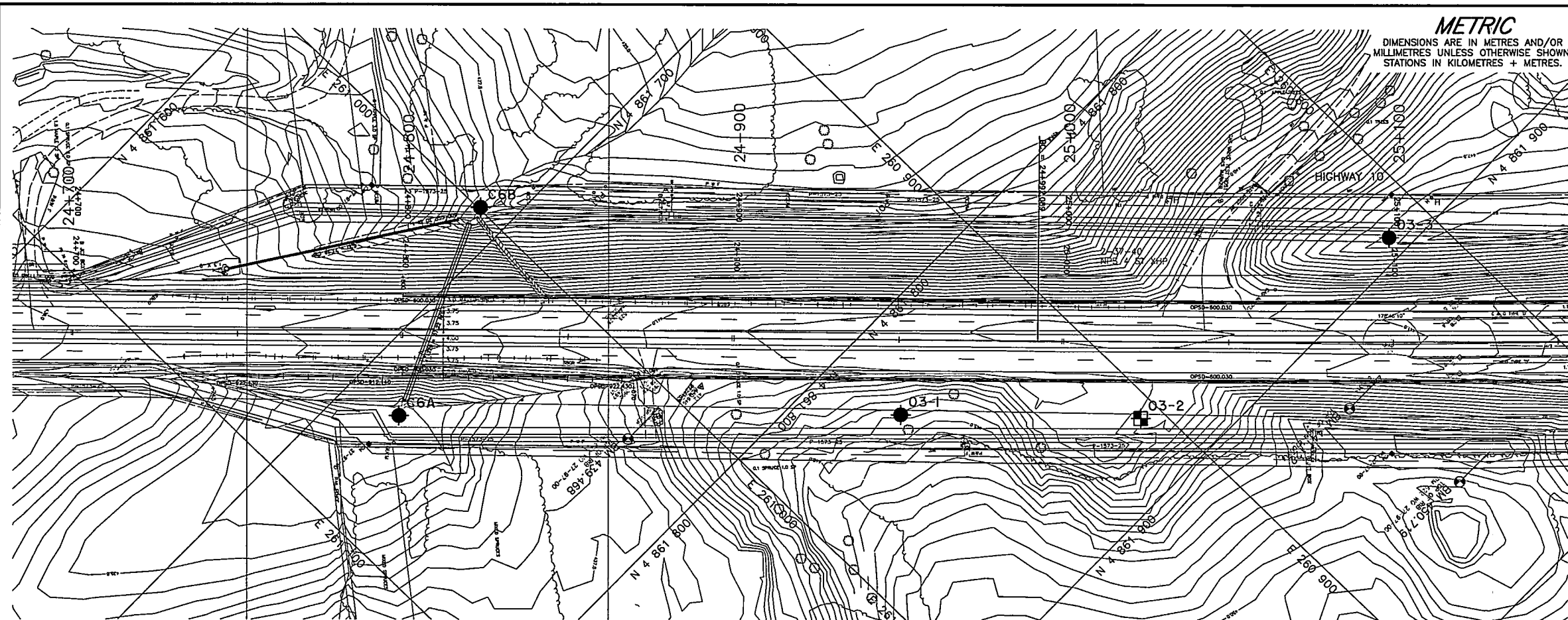
Comments:

Water Conditions in Test Pit:

End of Test Pit at 0.5 m below ground surface.

☒ Test Pit Dry

JOB No. 03-1111-023
TEST PIT No.: 03-2
ENGINEER: KJB



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

CONT No.
 WP No.27-97-00

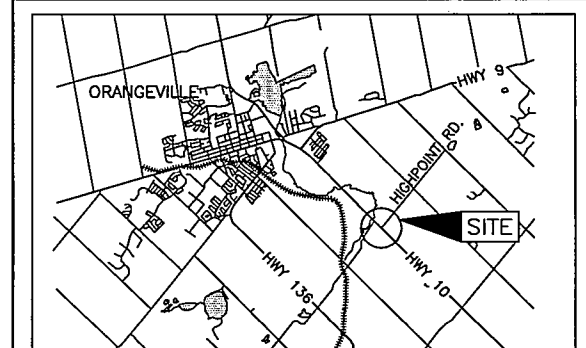


HWY 10
 HIGH FILL/DEEP CUT
 (STN 24+800 TO 25+600)
 BOREHOLE LOCATIONS

SHEET



Golder Associates Ltd.
 MISSISSAUGA, ONTARIO, CANADA



KEY PLAN
 SCALE
 2 0 2 km

LEGEND

- Borehole - Current Investigation
- ⊕ Test Pit

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
03-1	444.2	4861825.7	260955.9
03-2	441.6	4861878.6	260906.0
03-3	448.8	4861893.9	260813.7
03-4	445.8	4861990.4	260801.9
03-5	439.9	4862008.2	260711.5
03-6	436.0	4862120.7	260677.4
03-7	424.4	4862169.8	260614.0
03-9	423.8	4862249.7	260545.8
03-C6A	433.1	4861717.4	261062.1
03-C6B	427.7	4861690.5	260999.4

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

Base plans provided in digital format by Morrison Hershfield Ltd., received September 09, 2003.

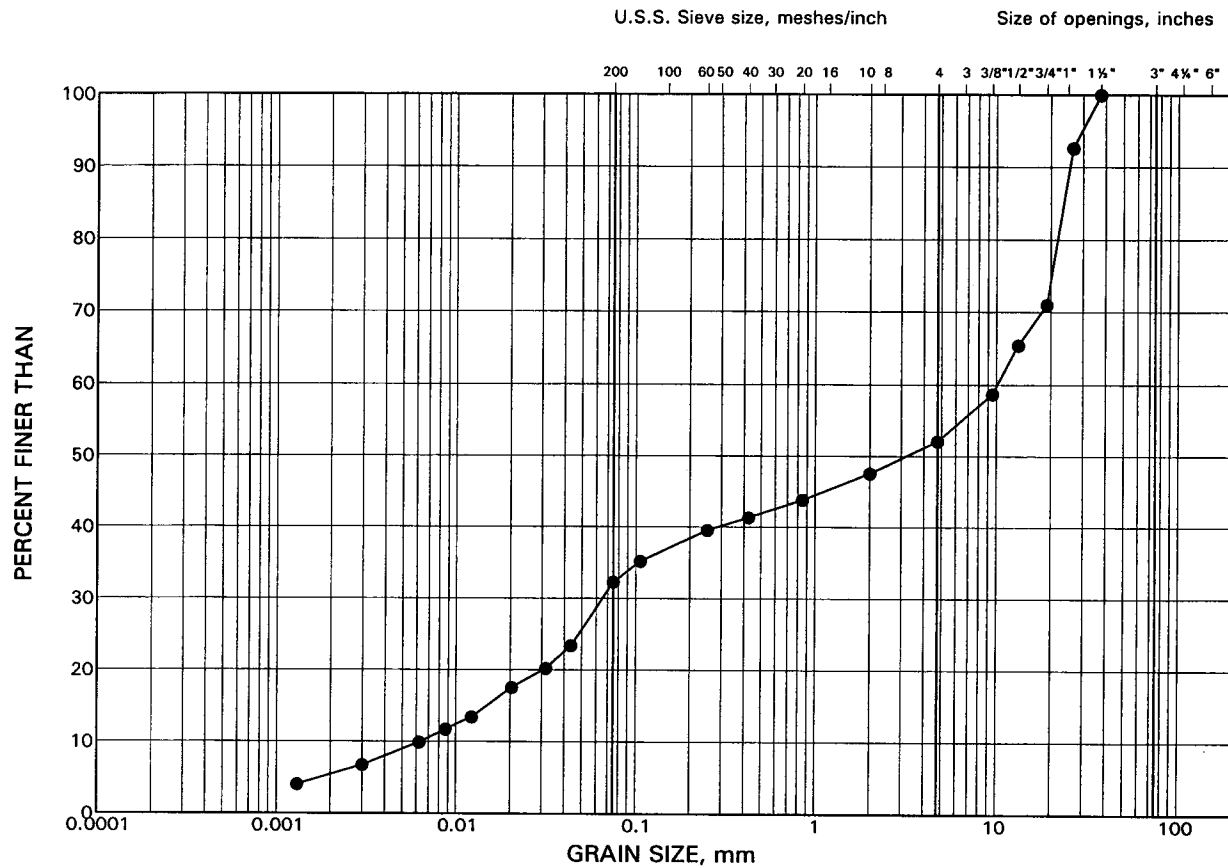
NO.	DATE	BY	REVISION
Geocres No. 40P16-20			
HWY. 10			PROJECT NO. 03-1111-023
SUBM'D.	CHKD.	DATE: FEB., 2004	SITE:
DRAWN: JDR	CHKD.	APPD.	DWG. 1

APPENDIX A
LABORATORY TEST DATA

GRAIN SIZE DISTRIBUTION

Sandy Gravel with Silt

FIGURE A1



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

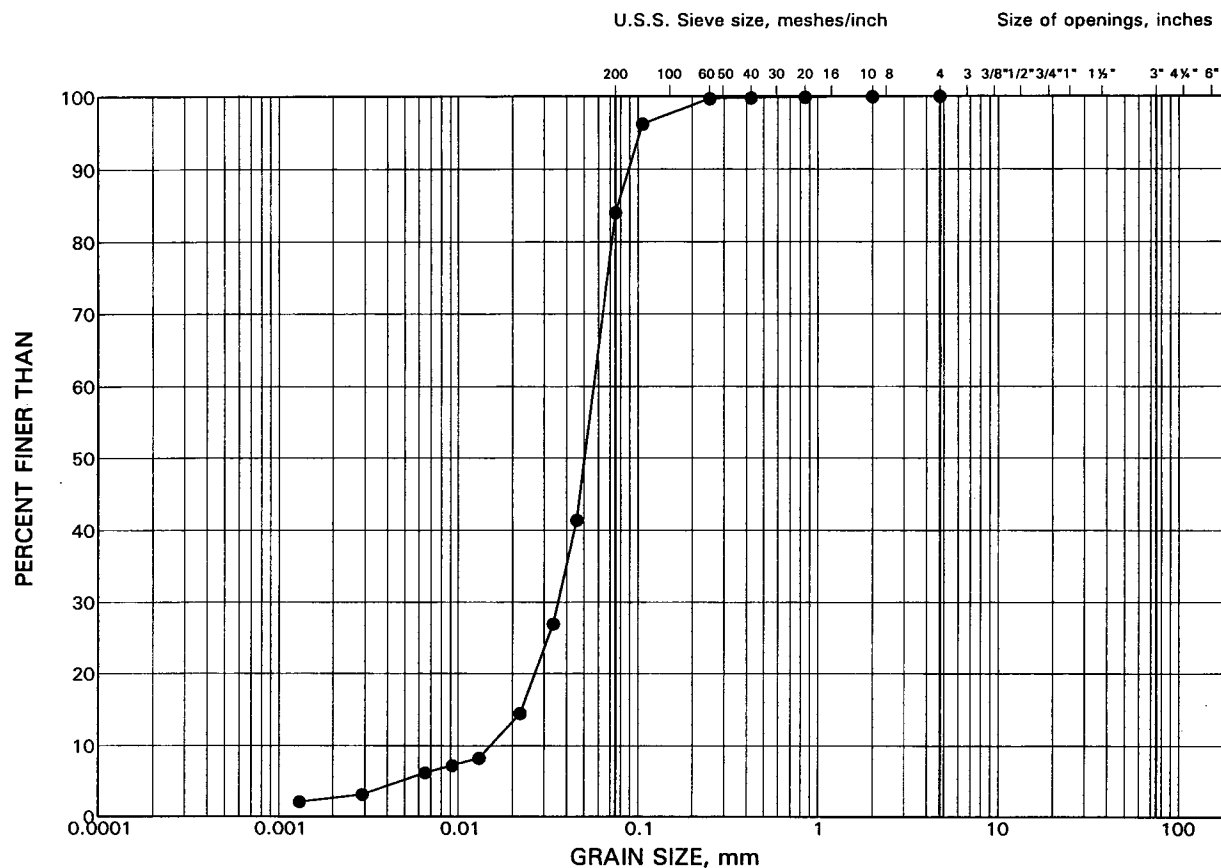
LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH (m)
•	C6B	3	1.5-2.0

GRAIN SIZE DISTRIBUTION

Silt

FIGURE A2



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

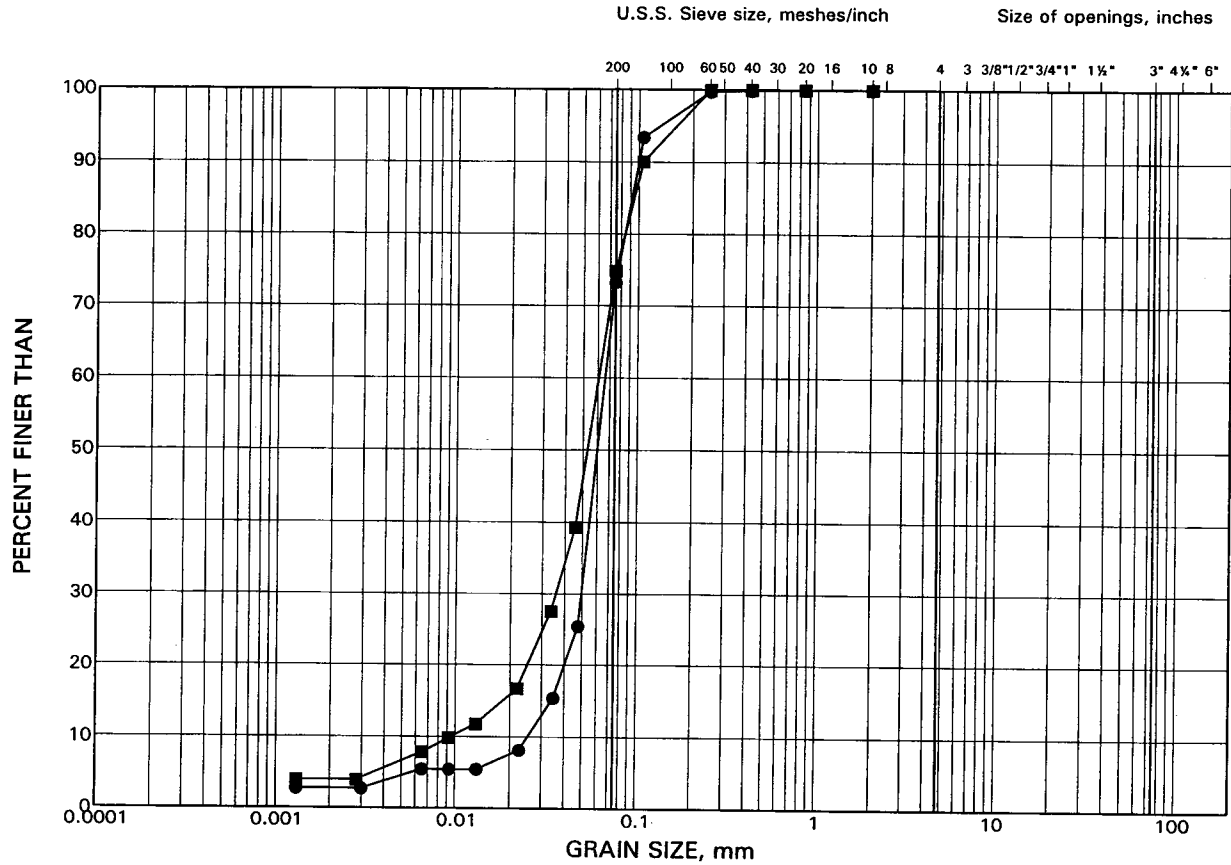
LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH (m)
•	3	6	3.8-4.3

GRAIN SIZE DISTRIBUTION

Sandy Silt

FIGURE A3

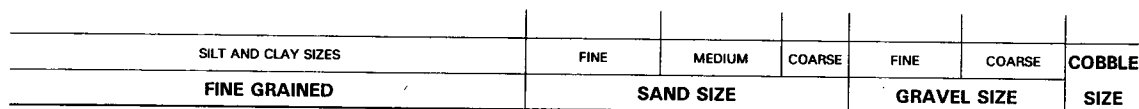


SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

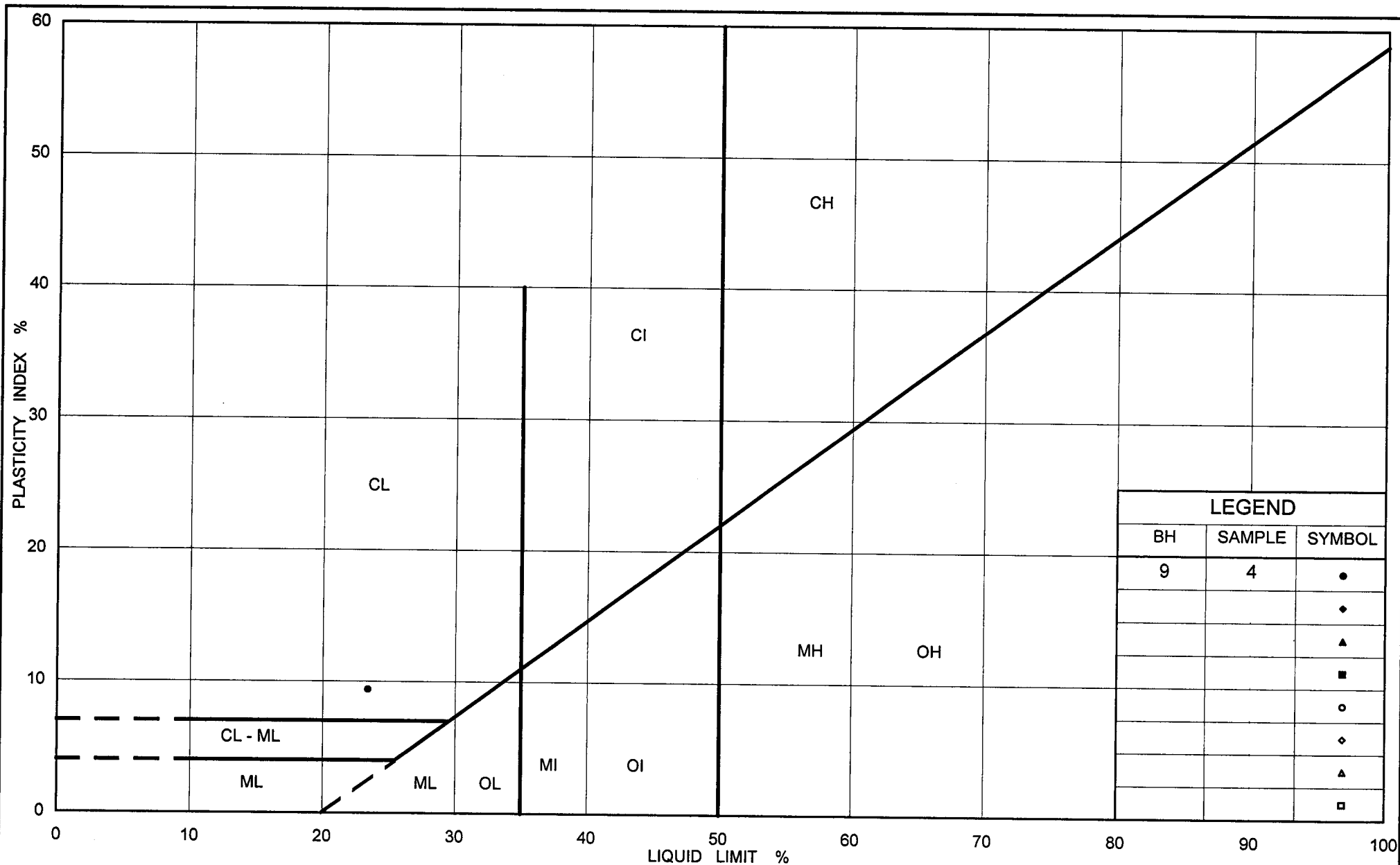
LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH (m)
●	1	5	3.0-3.5
■	6	7	4.6-5.0

FIGURE A4



SYMBOL	BOREHOLE	SAMPLE	DEPTH (m)
●	5	9	7.6-8.1



Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt (Till)

FIG No. A5

Project No. 03-1111-023C

Checked By: KJB

Golder Associates Ltd.

2390 Argentia Road
Mississauga, Ontario, Canada L5N 5Z7
Telephone 905-567-4444
Fax 905-567-6561



REPORT ON

**FOUNDATION INVESTIGATION
DEEP CUTS AND HIGH FILLS
HIGHWAY 10 WIDENING FROM 1 KM NORTH OF REGIONAL ROAD 24 NORTHERLY
TO HIGHWAY 9
TOWN OF CALEDON, ONTARIO
W.P. 27-97-00
MINISTRY OF TRANSPORTATION, ONTARIO**

Submitted to:

Morrison Hershfield Ltd.
Suite 600, 235 Yorkland Blvd.
Toronto, Ontario
M2J 1T1

GEOCRES NO: 40P16-20

DISTRIBUTION

- 1 Copy - Ministry of Transportation, Ontario,
Downsview, Ontario (Central Region)
- 1 Copy - Morrison Hershfield Ltd.
Toronto, Ontario
- 1 Copy - Golder Associates Ltd.,
Mississauga, Ontario



03-1111-023C

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In Order
Following Page 10

Lists of Abbreviations and Symbols

Record of Borehole Sheets (C6A, C6B, 03-1, 03-3, 03-4, 03-5, 03-6, 03-7, 03-9)

Record of Test Pit Logs (03-2)

Drawing 1

Appendix A

LIST OF DRAWINGS

Drawing 1 Borehole Locations

LIST OF APPENDICES

Appendix A Laboratory Test Data

 Figure A1 Grain Size Distribution – Sandy Gravel with silt

 Figure A2 Grain Size Distribution – Silt

 Figure A3 Grain Size Distribution – Sandy Silt

 Figure A4 Grain Size Distribution – Sand and Silt

 Figure A5 Plasticity Chart – Clayey Silt (Till)

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Morrison Hershfield Ltd. (Morrison Hershfield) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out a foundation investigation as part of the detailed design for the proposed widening of Highway 10 from 1 kilometre north of Regional Road 24 northerly to Highway 9 in the Town of Caledon, Ontario.

The terms of reference for the scope of work are outlined in Golder's proposal P31-1093, dated March 2003, and supplemental letter "Revision to Borehole Drilling Program", dated November 20, 2003.

This report addresses the deep cut and high fill embankment areas as part of the highway widening project from approximate Station 24+800 to Station 25+600 on Highway 10. The foundation investigation and design recommendations for the proposed bridge widening structures and culvert extensions/replacements are reported separately. The work was carried out in accordance with the Quality Control Plan for this project dated July 2003. A digital file of the site plan and proposed highway cross-sections were provided to Golder by Morrison Hershfield in January 2004.

2.0 SITE DESCRIPTION

The high fill/deep cut site is located in the vicinity of the intersection between Highway 10 and Highpoint Sideroad South (see key plan on Drawing 1) in the Town of Caledon, Ontario. The proposed high fill area extends from about Station 24+800 to Station 24+900, and the proposed deep cut area extends from about Station 24+900 to Station 25+600. Highway 10 in this area is presently three lanes; with two lanes in the southbound direction and one lane in the northbound direction.

The lands in the area generally consists of rolling hills with grassy fields to the west and forest with grassy areas to the east. The present highway grade at the site generally declines from south to north, toward the low-lying Credit River valley located north of the site. The existing highway grade ranges from about Elevation 442 m to 416 m within the project limits (i.e. Station 24+800 to 25+600). Several private entrances and one intersection at Highpoint Sideroad South are located along Highway 10 in this section of roadway.

3.0 INVESTIGATION PROCEDURES

3.1 Foundation Investigation

The field work for this investigation was carried out between September 26, 2003 and January 7, 2004 at which time nine (9) boreholes (03-1, 03-3 to 03-7, 03-9, C6A, and C6B) were advanced and one (1) test pit (03-2) was excavated. The borehole and the test pit locations are shown in plan on Drawing 1.

The boreholes were typically advanced within the proposed embankment fill footprint or within the deep cut areas located within the right-of-way. Subsurface soil information directly below the existing roadway was obtained in the pavement investigation task entitled "Pavement Design Report, Highway 10 from 1 km North of Regional Road 24 Northerly to Highway 9" performed concurrently with this investigation.

The current field investigation was carried out using track-mounted CME 55 drill rigs supplied and operated by two companies, namely Walker Drilling Ltd. of Utopia, Ontario in December 2003 and Groundwork Drilling Inc. of Etobicoke, Ontario in September 2003. The boreholes were advanced using 108 mm inside diameter (I.D.) continuous flight hollow stem augers and 108 mm outside diameter (O.D.) solid stem augers. Soil samples were obtained at intervals ranging from 0.75 m to 1.5 m in depth, using a 50 mm O.D. split-spoon sampler in accordance with Standard Penetration Test (SPT) procedures.

The boreholes were advanced to depths ranging from 3.8 m to 17.2 m below the existing ground surface. The groundwater conditions in the open boreholes were observed during the drilling operations, with piezometers installed in selected boreholes to permit more long-term monitoring of the groundwater levels. The piezometers consist of a 25 mm outside diameter solid PVC pipe with a slotted screen sealed at a select depth within the boreholes. The holes were backfilled with a bentonite slurry. The standpipe piezometer installation details and water level readings are described on the Record of Borehole sheets that follow the text of this report.

The field work was supervised by members of our engineering and technical staff who, located the boreholes, 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 detailed visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards as appropriate. Classification testing (water content, Atterberg Limits, and grain size distribution) was carried out on select samples.

The approximate borehole locations were staked in the field by Callon-Dietz personnel prior to drilling operations. Upon completion of the fieldwork, the locations of the completed boreholes were surveyed by Callon-Dietz Inc. using the NAD 83 MTM co-ordinate system and the geodetic datum for elevation.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The site is located within the intersection of two physiographic regions known as the Hillsburgh Sandhills and Guelph Drumlin Field (Chapman and Putnam, "The Physiography of Southern Ontario", 3rd Edition, 1984). The Hillsburgh Sandhills are described as having rough topography, sandy materials, and flat-bottomed swampy valleys running through the moraine from Orangeville to Hillburgh. The Guelph Drumlin Field is predominantly composed of stony tills of the drumlins and deep gravel terraces of the old meltwater spillways; usually having a shallow veneer of loam. The ground conditions in the vicinity of the site are described to consist of kame moraines and spillways consisting of gravel terraces and swamps.

4.2 Subsoil Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced during this investigation, together with the results of the laboratory tests carried out on selected soil samples, are given on the attached Record of Borehole sheets and in Appendix A following the text of this report.

The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests (SPTs). 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 subsoils at the site typically consist of a surficial deposit of topsoil underlain by interlayered silty sand, sand, sandy silt and silt deposits. A layer of clayey silt till was encountered within the interlayered deposit at the northern limit of the site. Deposits of sand and gravel to sandy gravel were encountered below the topsoil and within the interlayered deposit at some areas of the site. A more detailed description of the subsurface conditions encountered in the boreholes located within the high fill and deep cut areas is provided in the following sections.

4.3 High Fills

Boreholes C6A and C6B were drilled near the east and west toes of the existing Highway 10 embankment, and within the proposed new widening embankment footprint. High fill areas are present between approximate Station 24+800 to Station 24+900.

The subsoils located adjacent to the existing embankment within the proposed high fill area typically comprise of a surficial deposit of topsoil and silty clay with organics, overlying a deposit of sand, sand and gravel, and sandy gravel. The data from the boreholes drilled during the pavement investigation indicate the existing embankment consists predominantly of sand, sand and gravel, silty sand and sandy silt containing cobbles. A more detailed description of the subsurface conditions encountered in the boreholes located within this area is provided in the following sections.

4.3.1 Topsoil / Silty Clay with Organics

Silty clay with organics and topsoil was encountered at the existing ground surface in Boreholes C6A and C6B, respectively. The dark brown topsoil and silty clay with organics deposit typically contained some sand and trace gravel. The existing ground surface was at Elevation 433.1 m and 427.7 m and the topsoil and silty clay with organics deposit was 1 m and 0.9 m thick for Boreholes C6A and C6B respectively.

Standard Penetration Testing (SPT) 'N' values recorded within the topsoil and silty clay with organics layer were 4 blows and 5 blows per 0.3 m of penetration, indicating a soft to firm consistency.

Natural water contents measured on samples of the topsoil and silty clay with organics were 19 and 23 percent.

4.3.2 Sand / Sand and Gravel / Sandy Gravel with silt

A deposit of sand and gravel to sandy gravel with silt was encountered below the topsoil and silty clay with organics in the high fill area. The sand and gravel to sandy gravel with silt deposit typically contained variable amounts of silt and trace to some clay. Cobbles and boulders were encountered throughout the sand and gravel to sandy gravel deposit. A 0.5 m thick sand layer was encountered directly below the silty clay with organics layer encountered in Borehole C6A, which was underlain by the sand and gravel deposit. Cobbles and boulders were encountered throughout the sand and gravel / sandy gravel deposit.

The top of the sand, sand and gravel and sandy gravel with silt deposit was encountered at 1.0 m (Elevation 432.1 m) and 0.9 m (Elevation 426.8 m) depths for Boreholes C6A and C6B respectively. The boreholes were terminated upon encountering auger refusal within the sand and gravel deposit which contained cobbles and boulders at depths of 6.2 m (Elevation 426.9 m) and 3.8 m (423.9 m) for Boreholes C6A and C6B respectively.

Standard Penetration Testing (SPT) 'N' values recorded within the sand, sand and gravel, and sandy gravel with silt deposit typically ranged from 20 blows per 0.3 m to over 50 blows per 0.1 m of penetration, indicating a compact to very dense state of packing.

The natural water content measured on samples taken within the sand, sand and gravel, and sandy gravel with silt deposit typically ranged between 6 and 16 percent. A grain size distribution curve for one sample of the sandy gravel with silt deposit is shown on Figure A1.

4.4 Deep Cuts

Boreholes 03-1, 03-3, 03-4, 03-5, 03-6, 03-7, 03-9 and Test Pit 03-2 were put down adjacent to the existing Highway 10 roadway and within the proposed new highway widening right-of-way. The deep cut area extends from approximate Station 24+900 to Station 25+600 and typically the boreholes were advanced near the crest of the existing cut side-slopes.

In general, the subsoils along the proposed new Highway 10 widening in this deep cut area are comprised of topsoil underlain by interlayers of sand, silty sand, sandy silt and silt. Layers of clayey silt till and sand and gravel were encountered within the interlayered deposit in some areas of the site. A more detailed description of the subsurface conditions encountered in the boreholes located within the deep cut area is provided in the following sections.

4.4.1 Topsoil

Topsoil was encountered at the existing ground surface in Boreholes 03-3, 03-4, 03-5, 03-6, 03-7, 03-9 and Test Pit 03-2. The existing ground surface ranged between Elevation 423.8 m to 448.8 m with the topsoil ranging from 0.1 m to 0.8 m thick. Occasional wood fragments were noted within the topsoil layer in Borehole 03-4.

Standard Penetration Testing (SPT) measured 'N' values within the topsoil ranged from 3 blows to 9 blows per 0.3 m of penetration, indicating a soft to stiff consistency.

Natural water contents measured on samples of the topsoil ranged between 17 and 28 percent.

4.4.2 Silty Clay with Organics / Silty Clay Fill

A deposit of silty clay with organics was encountered at the existing ground surface in Borehole 03-1, and a silty clay fill deposit containing occasional rootlets was encountered below the topsoil in Borehole 03-3. The silty clay with organics and silty clay fill deposits typically contained some sand, trace gravel and occasional wood fragments and rootlets. The top of the silty clay with organics deposit at Borehole 03-1 was at Elevation 444.2 m, and measured 0.8 m thick. The

top of the silty clay fill deposit within Borehole 03-3 was encountered at a depth of 0.3 m (Elevation 448.5) and measured 0.5 m thick.

Standard Penetration Tests (SPT) 'N' values recorded within the silty clay with organics deposit and silty clay fill were 6 blows and 9 blows per 0.3 m of penetration, indicating a firm to stiff consistency.

The natural water content measured on selected samples of the silty clay with organics and silty clay fill deposits were 17 and 21 percent respectively.

4.4.3 Interlayered Sand / Silty Sand / Sandy Silt / Silt

Interlayered deposits of sand, silty sand, sandy silt, and silt were encountered below the topsoil and silty clay deposits in Boreholes 03-1, 03-3, 03-4, 03-5, 03-6, and Test Pit 03-2. The cohesionless deposits typically contained trace clay. The top of the cohesionless deposits was encountered at depths ranging between 0.1 m and 2.3 m below ground surface. The elevation of the top of the cohesionless deposits ranged from Elevation 433.7 m to 447.3 m and the thickness of the interlayered cohesionless deposit was over 15.7 m. Boreholes 03-1, 03-3, 03-4, 03-5, and 03-6 were terminated within this interlayered cohesionless deposit at depths of 8.1 m (Elevation 436.1 m), 17.2 m (Elevation 431.6 m), 11.1 m (Elevation 434.7 m), 11.1 m (Elevation 428.7 m), and 11.1 m (Elevation 424.9 m) respectively. Test Pit 03-2 was terminated within the interlayered deposit at a depth of 0.5 m (Elevation 441.1 m).

Standard Penetration Test (SPT) 'N' values recorded within the interlayered sand, silty sand, sandy silt, and silt deposit ranged between 7 and 60 blows per 0.3 m of penetration, indicating a loose to very dense state of packing. The SPT 'N' values were found to increase with depth, with the 'N' value of 7 recorded at a depth of about 1.1 m in Borehole 03-5, and with the 'N' value of 60 recorded in Borehole 03-3 at a depth of 17.1 m. For reference, the mean, median, and standard deviation of the 'N' values within this deposit was 33, 32, and 14. The mean and median values reflect a deposit exhibiting a dense relative density.

The natural water content measured on samples of the interlayered silt, sandy silt, silty sand, and sand deposit varied between 4 and 23 percent. Grain size distribution curves on selected samples of the silt, sandy silt, and sand and silt interlayers are shown on Figures A2, A3 and A4 respectively, in Appendix A.

4.4.4 Sand / Sand and Gravel

Layers of sand to sand and gravel were encountered below the topsoil in Boreholes 03-6, 03-7 and 03-9, and below the topsoil and silty clay fill in Borehole 03-3. The sand and gravel typically

contained trace to some silt and the sand layers typically contained trace to some silt, trace gravel. Trace organics were noted in the upper zone of the sand deposit in Borehole 03-9.

The top of the sand to sand and gravel layer was encountered at a depth ranging between 0.2 m and 0.8 m within these boreholes. The elevation of the top of the sand to sand and gravel layers ranged from Elevation 423.6 m to 448.1 m, with the thickness varying from 0.7 m to 4.4 m.

In Boreholes 03-7 and 03-9, an interlayer of clayey silt till was present within the sand to sand and gravel deposit at both borehole locations. The sand to sand and gravel layer was 4.4 m and 1.5 m thick above the clayey silt till interlayer for Boreholes 03-7 and 03-9 respectively. Below the clayey silt till interlayer, the sand to sand gravel deposit extended from a depth of 6.1 m (Elevation 418.3 m) and 6.3 m (Elevation 417.6) to the termination of the boreholes which was at 9.3 m (Elevation 415.1 m) and 9.2 m (Elevation 414.6 m) for Boreholes 03-7 and 03-9 respectively. Cobbles were present within the sand to sand and gravel deposits below the clayey silt till layer in Boreholes 03-7 and 03-9.

Standard Penetration Testing (SPT) 'N' values recorded within the sand to sand and gravel deposits ranged between 6 blows per 0.3 m of penetration to over 100 blows per 0.2 m of penetration, indicating a loose to very dense state of packing.

The natural water content measured on samples of the sand to sand and gravel deposits ranged between 3 and 19 percent.

4.4.5 Clayey Silt Till

A layer of clayey silt till was encountered below the topsoil and sand to sand and gravel layers in Boreholes 03-7 and 03-9. The clayey silt till typically contains trace to some sand and gravel, as well as cobbles and boulders. The top of the till layer was encountered at a depth of 4.6 m (Elevation 419.8 m) and 1.7 m (422.1 m) for Boreholes 03-7 and 03-9, respectively. The thickness of the till layer was 1.5 m and 4.6 m for Boreholes 03-7 and 03-9 respectively.

Standard Penetration Testing (SPT) 'N' values recorded within the clayey silt till deposit ranged between 29 blows and greater than 50 blows per 0.15 m of penetration, indicating a very stiff to hard consistency.

The natural water content measured on samples of the clayey silt till varied between 8 and 12 percent. Atterberg Limits testing carried out on a sample of the clayey silt till showed a plastic limit (w_p) of 14 and a liquid limit (w_l) of 23 as shown on Figure A5. The results of the Atterberg Limits testing classify the clayey silt till sample as low plasticity.

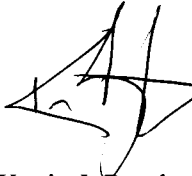
4.4.6 Groundwater Conditions

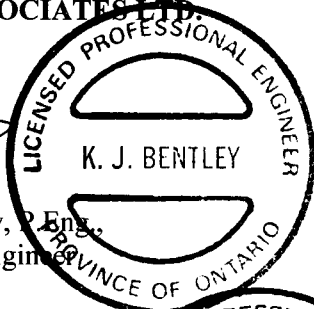
The boreholes were generally dry during and upon completion of the drilling operations with the exception of Borehole 03-7 where water was at a depth of 4.3 m (Elevation 420.1 m) upon completion of drilling operations. Piezometers were installed in Boreholes 03-5 and 03-6 to permit monitoring of groundwater conditions. The piezometer installed in Borehole 03-5 was sealed in the sand interlayer and the piezometer installed in Borehole 03-6 was sealed in the sandy silt interlayer. Details of the piezometer installations are shown in the Record of Borehole Sheets following the text of this report. Both piezometers were found to be dry; the water level in the open Borehole 03-7 and piezometer details are summarized in the table below:


Borehole	Installation	Ground Surface Elevation (m)	Piezometer Tip Level Depth (m)	Water Level Depth (m)	Water Level Elevation (m)	Date
03-5	Piezometer	439.9	11.0	Dry	-	Jan. 7, 2004
03-6	Piezometer	436.0	11.0	Dry	-	Jan. 7, 2004
03-7	Open Borehole	424.4	-	4.3	420.1	Sept. 29, 2003

Based on the results of other piezometer installations for this project, the groundwater level in this area generally declines from south to north towards the Credit River water level, which was at about Elevation 402 m in December 2003. The Credit River is located at approximate Station 25+700 which is about 100 m north of the limit of the deep cut area near Station 25+600. It should also be emphasized that groundwater levels in the area are subject to seasonal fluctuations.

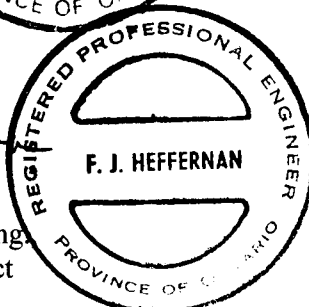
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KJB/RS/ASP/FJH/sm

N:\Active\2003\1111\03-1111-023 MH Hwy10\FINAL REPORTS\FINAL FIR\03-1111-023C Deep Cut - High Fill\03-1111-023C RPT 06 Dec FIR DeepCutHigh Fill.doc

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
DO Drive open
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.)

(b) Cohesive Soils

Consistency	c_u, s_u	
	kPa	psf
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

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 test¹
CIU consolidated isotropically undrained triaxial test with porewater pressure measurement¹
 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 $= (\text{compressive strength})/2$
 * density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density x acceleration due to gravity)



PROJECT 03-1111-023		RECORD OF BOREHOLE No C6A		1 OF 1 METRIC									
W.P. 27-97-00		LOCATION N 4861717.4 :E 261062.1		ORIGINATED BY GD									
DIST HWY 10		BOREHOLE TYPE POWER AUGERING USING 108 mm I.D. HOLLOW STEM AUGERS		COMPILED BY KG									
DATUM Geodetic		DATE October 9, 2003		CHECKED BY KJB									
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	20 40 60 80 100					
433.1	GROUND SURFACE												
0.0	Silty Sand with organics, some clay, contains rootlets Loose Dark brown Moist		1	SS	5								
432.1			2	SS	7								
1.0	Sand, trace gravel Loose Brown Moist												
431.6			3	SS	20								
1.5	Sand and Gravel, trace silt, contains cobbles Compact to dense Brown Moist												
			4	SS	36								
			5	SS	38								
			6	SS	50								
			7	SS	42								
426.9	End of Borehole		8	SS	50/008								
6.2	Auger and spoon refusal Notes: 1. Borehole open and dry upon completion of drilling operations. 2. Effective auger and split spoon refusal on probable cobble/boulder at 6.2 m depth. 3. Piezometer dry on January 7, 2004.												

MIS-MTO 001 031111023AAGDR.GPJ GAL-MISS.GDT 4/12/06

PROJECT 03-1111-023		RECORD OF BOREHOLE No C6B				1 OF 1 METRIC			
W.P. 27-97-00		LOCATION N 4861690.5 ; E 260999.4				ORIGINATED BY GD			
DIST _____ HWY 10		BOREHOLE TYPE POWER AUGERING USING 108 mm O.D. HOLLOW STEM AUGERS				COMPILED BY KG			
DATUM Geodetic		DATE December 18, 2003				CHECKED BY KB			
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE		
427.7	GROUND SURFACE								
0.0	Topsoil Soft Dark brown Moist		1	SS	4				
426.8	Sandy Gravel with silt, trace to some clay, contains cobbles/boulders Dense to very dense Brown Moist		2	SS	50/0.15				
0.9									
425.6	Sand and Gravel, trace silt and clay, contains cobbles/boulders Very dense Brown Moist		3	SS	35				
2.2									
423.9									
3.8	End of Borehole Auger and Spoon Refusal Notes: 1. Auger refusal at 3.8 m depth. 2. Split spoon sampler bouncing on probable cobble/bedrock for Sample Numbers 2, 4, and 5. 3. Moved borehole location five times (within 5m radius) to reach depth of 3.8 m due to auger refusal on probable cobbles/boulders.								

MIS-MTO 001 031111023AAGDR.GPJ GAL-MISS.GDT 4/12/06

PROJECT 03-1111-023

RECORD OF BOREHOLE No 03-1

1 OF 1 **METRIC**

W.P. 27-97-00

LOCATION N 4861825.7 E 260955.9

ORIGINATED BY GD

DIST HWY 10

BOREHOLE TYPE POWER AUGERING USING 108 mm O.D. HOLLOW STEM AUGERS

COMPILED BY KG

DATUM Geodetic

DATE December 10, 2003

CHECKED BY KJB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
444.2	GROUND SURFACE													
0.0	Silty Clay with organics, some sand, trace wood fragments Firm Brown Moist		1	SS	6		444							
443.4														
0.8	Sand, some silt, trace clay and gravel Compact Brown Moist		2	SS	13		443							
			3	SS	16		442							
			4	SS	20		441							
441.2														
3.0	Sandy Silt, trace clay Loose to compact Brown Moist		5	SS	10		440							
			6	SS	22		439							
			7	SS	23		438							
438.1														
6.1	Silty Sand, trace clay Dense Brown Moist		8	SS	39		437							
436.1			9	SS	36									
8.1	End of Borehole													
	Notes: 1. Borehole open and dry upon completion of drilling.													

MIS-MTO 001 031111023AAGDR.GPJ GAL-MISS.GDT 4/12/06

+ ³ , X ³ : Numbers refer to Sensitivity O 3% STRAIN AT FAILURE



PROJECT 03-1111-023

RECORD OF BOREHOLE No 03-3

1 OF 2 METRIC

W.P. 27-97-00

LOCATION N 4861893.9 : E 2600813.7

ORIGINATED BY GD

DIST HWY 10

BOREHOLE TYPE POWER AUGERING USING 108 mm I.D. HOLLOW STEM AUGERS

COMPILED BY KG

DATUM Geodetic

DATE December 16, 2003

CHECKED BY KJB

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			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
448.8	GROUND SURFACE														
0.0	Topsoil		1	SS	9										
448.5	Silty clay, some sand, trace gravel, occasional rootlets (FILL)														
448.1	Loose Dark brown Moist		2	SS	46		448								
0.8	Sand and Gravel, some silt														
447.3	Dense Brown Moist		3	SS	36		447								
1.5	Silty Sand, trace gravel and clay														
	Dense Brown Moist		4	SS	33		446								
			5	SS	47		445								
445.3	Silt, some sand, trace clay														
3.5	Dense Brown Moist to wet		6	SS	34		444								
			7	SS	48		443								
			8	SS	49		442								
			9	SS	48		441								
							440								
			10	SS	41		439								
			11	SS	49		438								
							437								
			12	SS	34		436								
							435								
435.1	Sand, some silt														
13.7	Very dense Brown Wet to moist		13	SS	57		434								

Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

MIS-MTO 001 031111023AAGDR.GPJ GAL-MISS.GDT 4/12/06



PROJECT 03-1111-023

RECORD OF BOREHOLE No 03-3

2 OF 2 METRIC

W.P. 27-97-00

LOCATION N 4861893.9 E 2600813.7

ORIGINATED BY GD

DIST HWY 10

BOREHOLE TYPE POWER AUGERING USING 108 mm I.D. HOLLOW STEM AUGERS

COMPILED BY KG

DATUM Geodetic

DATE December 16, 2003

CHECKED BY KJB

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					
— CONTINUED FROM PREVIOUS PAGE —																	
	Sand, some silt Very dense Brown Wet to moist		14	SS	59												
431.6			15	SS	60												
17.2	End of Borehole																
	Notes: 1. Borehole open and dry upon completion of drilling.																

MIS-MTO.D01 031111023AAGDR.GPJ GAL-MISS.GDT 4/12/06

+³, ×³. Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE



PROJECT 03-1111-023

RECORD OF BOREHOLE No 03-4

1 OF 1 METRIC

W.P. 27-97-00

LOCATION N 4861990.4 ; E 260801.9

ORIGINATED BY GD

DIST HWY 10

BOREHOLE TYPE POWER AUGERING USING 108 mm O.D. SOLID STEM AUGERS

COMPILED BY KG

DATUM Geodetic

DATE December 17, 2003

CHECKED BY KJB

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						
445.8	GROUND SURFACE													
0.0	Topsoil, occasional wood fragments Soft to firm Dark brown Moist		1	SS	4									
445.1														
0.8	Sandy Silt, occasional sand seams and silty clay seams Compact Brown Moist		2	SS	16									
			3	SS	16									
			4	SS	15									
			5	SS	23									
			6	SS	58									
441.3			7	SS	53									
4.6	Silty Sand Very dense to compact Brown Moist		8	SS	32									
			9	SS	28									
			10	SS	41									
434.7			11	SS	28									
11.1	End of Borehole													
	Notes: 1. Borehole open and dry upon completion of drilling.													

MIS-MTO 001 031111023AAGDR.GPJ GAL-MISS GDT 4/12/06



PROJECT 03-1111-023		RECORD OF BOREHOLE No 03-5		1 OF 1 METRIC	
W.P. 27-97-00	LOCATION N 4862008.2 E 260711.5	ORIGINATED BY GD			
DIST _____ HWY 10	BOREHOLE TYPE POWER AUGERING USING 108 mm O.D. SOLID STEM AUGERS	COMPILED BY KG			
DATUM Geodetic	DATE December 18, 2003	CHECKED BY KJB			

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								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	×						
								● QUICK TRIAXIAL	×	REMOULDED						
439.9	GROUND SURFACE						20	40	60	80	100					
0.0 439.8 0.3	Topsoil Soft to firm Dark brown Moist Silty Sand, occasional silt interlayers Loose to compact Brown Moist		1	SS	4											
			2	SS	7											
			3	SS	20											
			4	SS	24											
			5	SS	30											
			6	SS	29											
435.3 4.6	Sand and Silt, trace clay Compact to dense Brown Moist to dry		7	SS	27											
			8	SS	41											
			9	SS	43											
			10	SS	50											
428.7 11.1	End of Borehole Notes: 1. Borehole open and dry upon completion of drilling. 2. Piezometer dry when checked on January 7, 2004.		11	SS	44											

MIS-MTO 001 031111023AAGDR.GPJ GAL-MISS.GDT 4/12/06

PROJECT		03-1111-023		RECORD OF BOREHOLE No 03-6		1 OF 1		METRIC															
W.P.		27-97-00		LOCATION		N 4862120.7 ; E 260677.4		ORIGINATED BY															
DIST		HWY 10		BOREHOLE TYPE		POWER AUGERING USING 108 mm O.D. SOLID STEM AUGERS		COMPILED BY															
DATUM		Geodetic		DATE		December 17, 2003		CHECKED BY															
								KJB															
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			SHEAR STRENGTH kPa			WATER CONTENT (%)			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	γ	GR	SA	SI	CL						
436.0	GROUND SURFACE																						
0.0	Topsoil Soft Dark brown Moist		1	SS	3																		
435.2																							
0.8	Sand and Gravel, occasional clayey silt seams Compact to dense Brown Moist		2	SS	25		435																
			3	SS	48		434																
433.7																							
2.3	Sand, trace silt, occasional sandy silt seams Dense to compact Brown Moist		4	SS	38		433																
			5	SS	28		432																
			6	SS	21		431																
431.2			7	SS	35		430																
4.8	Sandy Silt, trace clay, occasional silty sand interlayers Dense Brown Moist		8	SS	27		429																
			9	SS	28		428																
			10	SS	26		427																
			11	SS	28		426																
424.9							425																
11.1	End of Borehole																						
Notes:																							
1. Borehole open and dry upon completion of drilling.																							
2. Piezometer dry when checked on January 7, 2004.																							

MIS-MTO 001 031111023AAGDR.GPJ GAL-MISS GDT 4/12/06

PROJECT 03-1111-023			RECORD OF BOREHOLE No 03-7			1 OF 1 METRIC											
W.P. 27-97-00		LOCATION N 4862169.8 E 260613.9		ORIGINATED BY GD													
DIST _____ HWY 10		BOREHOLE TYPE POWER AUGERING USING 108 mm I.D. HOLLOW STEM AUGERS		COMPILED BY KG													
DATUM Geodetic		DATE September 29, 2003		CHECKED BY KJB													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	γ	GR	SA	SI	CL
424.4	GROUND SURFACE																
0.0	Topsoil		1	SS	6		424										
0.2	Sand, trace to some silt, trace gravel Loose to compact Brown Moist		2	SS	12		423										
			3	SS	7		422										
			4	SS	23		421										
421.4	Sand and Gravel, trace silt Very dense Brown Moist		5	SS	51		420										
420.4	Sand, trace gravel and silt Compact Brown Moist		6	SS	15		419										
419.8	Clayey Silt, some sand, trace gravel, contains cobbles/boulders (TILL) Very stiff Brown Moist		7	SS	29		418										
418.3	Sand and Gravel, trace to some silt, trace clay, contains cobbles Very dense Brown Moist		8	SS	50/0.28		417										
			9	SS	100		416										
415.1	End of Borehole		10	SS	50/0.13												
9.3	Notes: 1. Water level at 4.3 m depth (Elev. 420.1 m) upon completion of drilling.																

MIS-MTO 001 031111023AAGDR.GPJ GAL-MISS.GDT 4/12/06



PROJECT 03-1111-023		RECORD OF BOREHOLE No 03-9		1 OF 1 METRIC	
W.P. 27-97-00		LOCATION N 4862249.7 ; E 260545.8		ORIGINATED BY GD	
DIST HWY 10		BOREHOLE TYPE POWER AUGERING USING 108 mm O.D. SOLID STEM AUGERS		COMPILED BY KG	
DATUM Geodetic		DATE September 26, 2003		CHECKED BY KJB	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x REMOULDED									
423.8	GROUND SURFACE							20	40	60	80	100					
0.0	Topsoil		1	SS	9		423										
0.2	Sand, some silt, trace gravel, trace organics in upper zone Loose to compact Brown Moist to dry		2	SS	22												
422.1																	
1.7	Clayey Silt, trace to some sand and gravel, frequent cobbles/boulders (TILL) Hard Brown to grey Moist		3	SS	70		422										
			4	SS	37		421										
			5	SS	47												
							420										
			6	SS	50/2												
							419										
							418										
417.6			7	SS	50/15		417										
6.3	Sand and Gravel, trace silt, contains cobbles Very dense Brown Moist																
416.2																	
7.6	Sand, trace silt and gravel, contains cobbles Very Dense Brown Moist		8	SS	50/08		416										
414.6							415										
9.2	End of Borehole																
	Notes: 1. Borehole open and dry upon completion of drilling operations. 2. Auger refusal at 3.7 m depth. Borehole moved 3m North and sampling continued at 3.8 m depth. 3. Split Spoon and auger refusal on cobble/boulder at 4.3 m depth. Borehole moved 3m North and sampling continued at 6.1 m depth.																

MIS-MTO 001 031111023AAGDR.GPJ GAL-MISS.GDT 4/12/06

FIELD TEST PIT LOG

JOB NUMBER:	03-1111-023	JOB NAME:	MH / Highway 10 / Caledon	DATE:	January 7, 2004
TEST PIT NUMBER:	03-2	TEST PIT SIZE:	0.5 m x 0.5 m (plan area)	ELEVATION:	441.6 m
MACHINE TYPE:	Hand Shovel	CONTRACTOR:	Golder	DATUM:	Geodetic
TEMPERATURE:	-10 °C	WEATHER:	Overcast	LOCATION:	N 4861878.6 E 260906.0

Depth		Soil Description	Samples		Pocket Penetrometer Results		Remarks
From (m)	To (m)		No.	Depth (m)	Depth (m)	q _a (kg/cm ²)	
0.0	0.1	Topsoil, dark brown					
0.1	0.4	Sand, some silt, trace gravel and organics, brown to dark brown					
0.4	0.5	Sand, trace silt, brown					

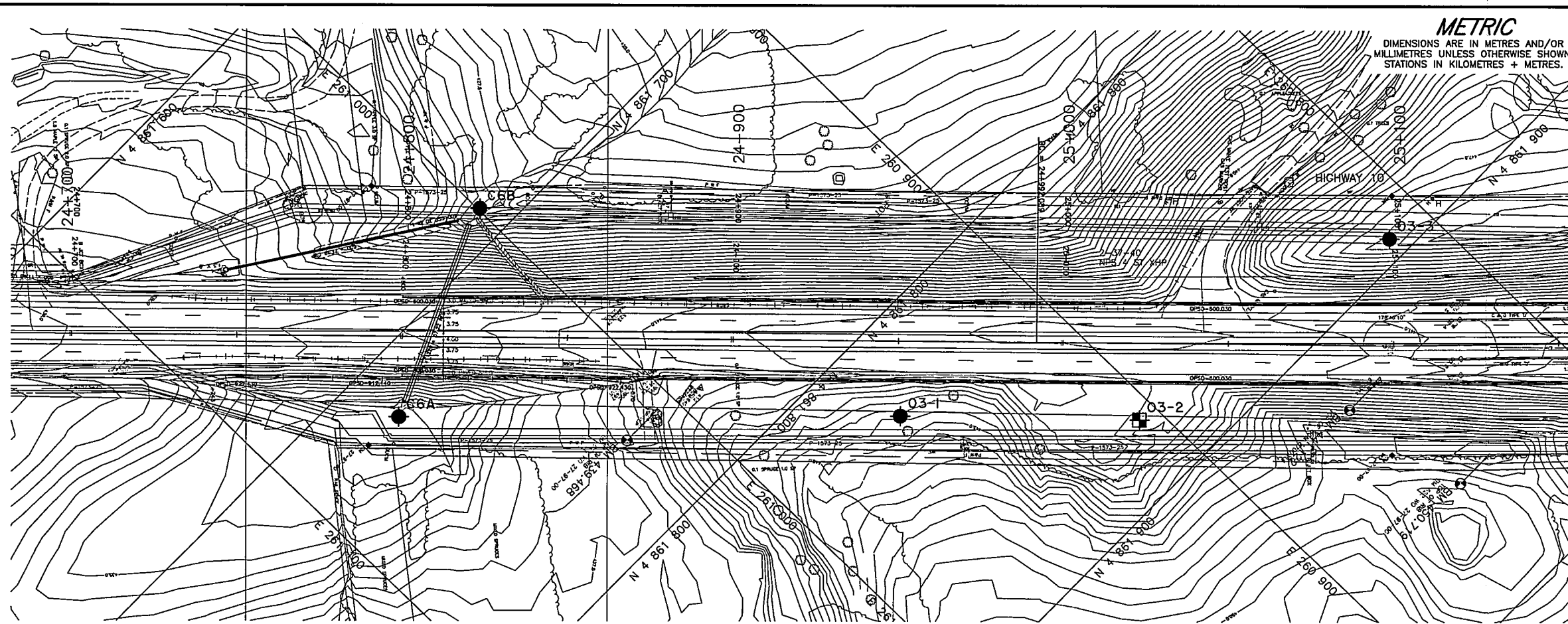
Comments:

Water Conditions in Test Pit:

End of Test Pit at 0.5 m below ground surface.

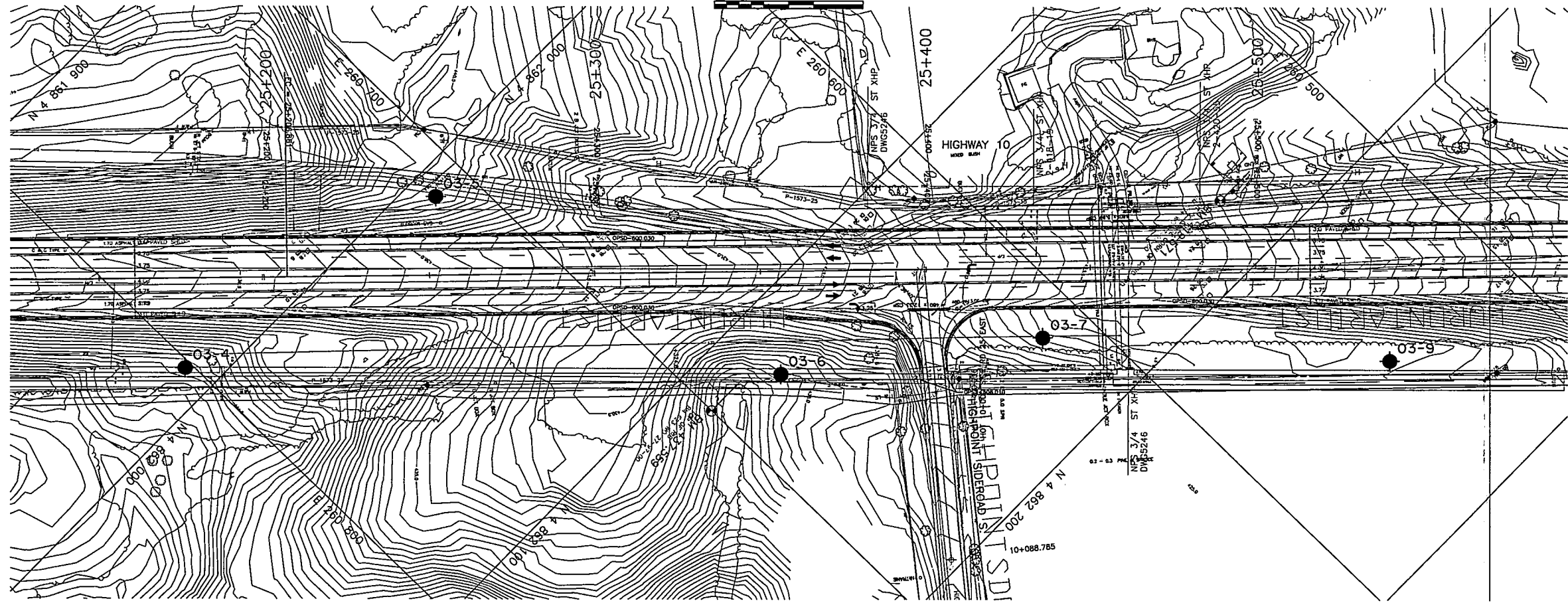
☒ Test Pit Dry

JOB No.	03-1111-023
TEST PIT No.:	03-2
ENGINEER:	KJB



PLAN

SCALE
0 15 30 m



PLAN

SCALE
0 15 30 m

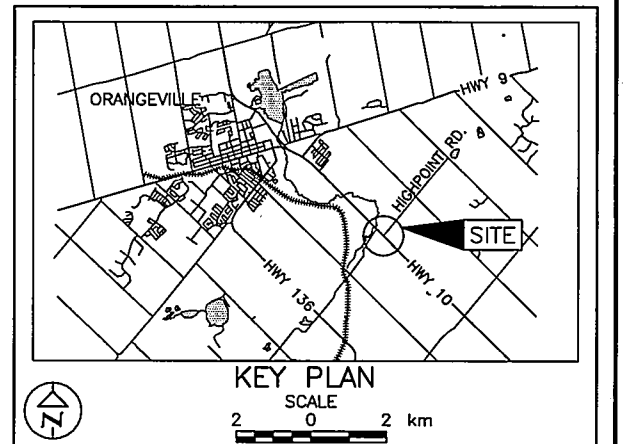
METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No.27-97-00

HWY 10
HIGH FILL/DEEP CUT
(STN 24+800 TO 25+600)
BOREHOLE LOCATIONS

SHEET

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



LEGEND

Borehole - Current Investigation
 Test Pit

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
03-1	444.2	4861825.7	260955.9
03-2	441.6	4861878.6	260906.0
03-3	448.8	4861893.9	260813.7
03-4	445.8	4861990.4	260801.9
03-5	439.9	4862008.2	260711.5
03-6	436.0	4862120.7	260877.4
03-7	424.4	4862169.8	260614.0
03-9	423.8	4862249.7	260545.8
03-C6A	433.1	4861717.4	261062.1
03-C6B	427.7	4861690.5	260999.4

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

Base plans provided in digital format by Morrison Hershfield Ltd., received September 09, 2003.

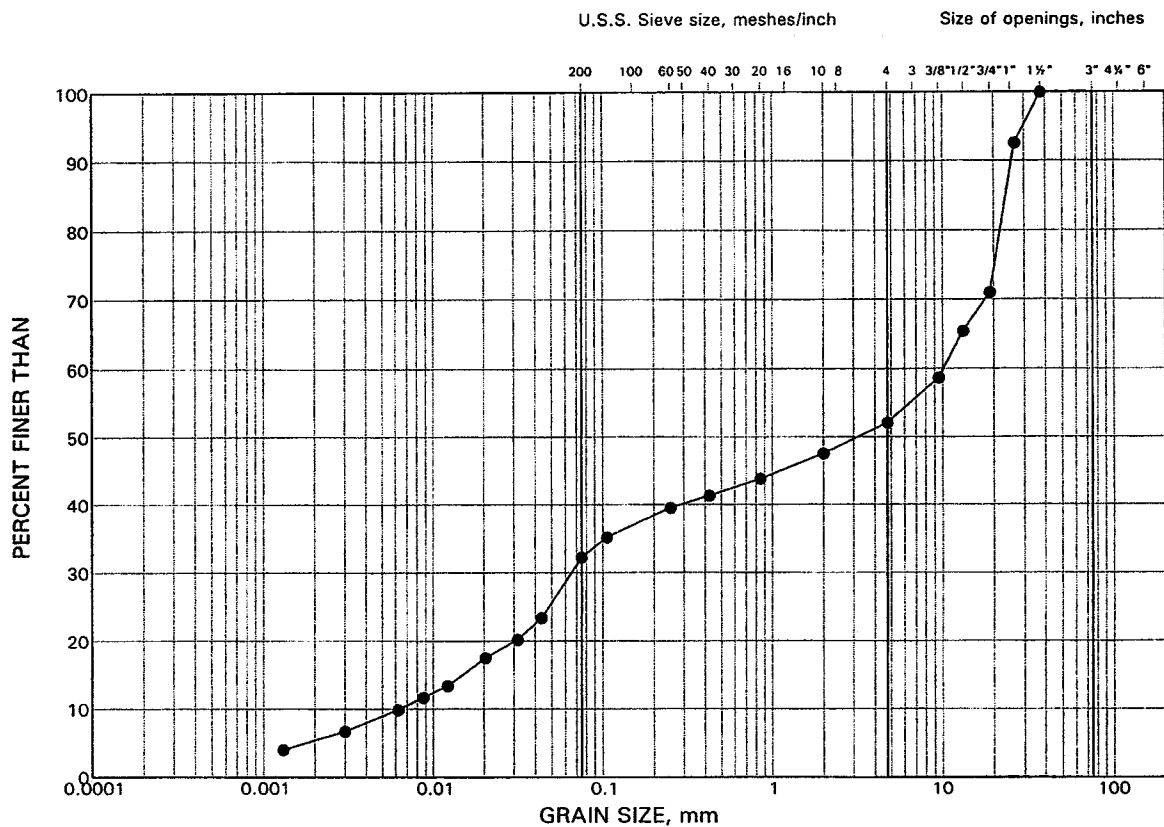
NO.	DATE	BY	REVISION
Geocres No. 40P16-20			
HWY. 10		PROJECT NO. 03-1111-023	DIST.
SUBM'D.	CHKD.	DATE: FEB., 2004	SITE:
DRAWN: JDR	CHKD.	APPD.	DWG. 1

APPENDIX A
LABORATORY TEST DATA

GRAIN SIZE DISTRIBUTION

Sandy Gravel with Silt

FIGURE A1



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH (m)
•	C6B	3	1.5-2.0

Date December, 2006
Project 03-1111-023\HF

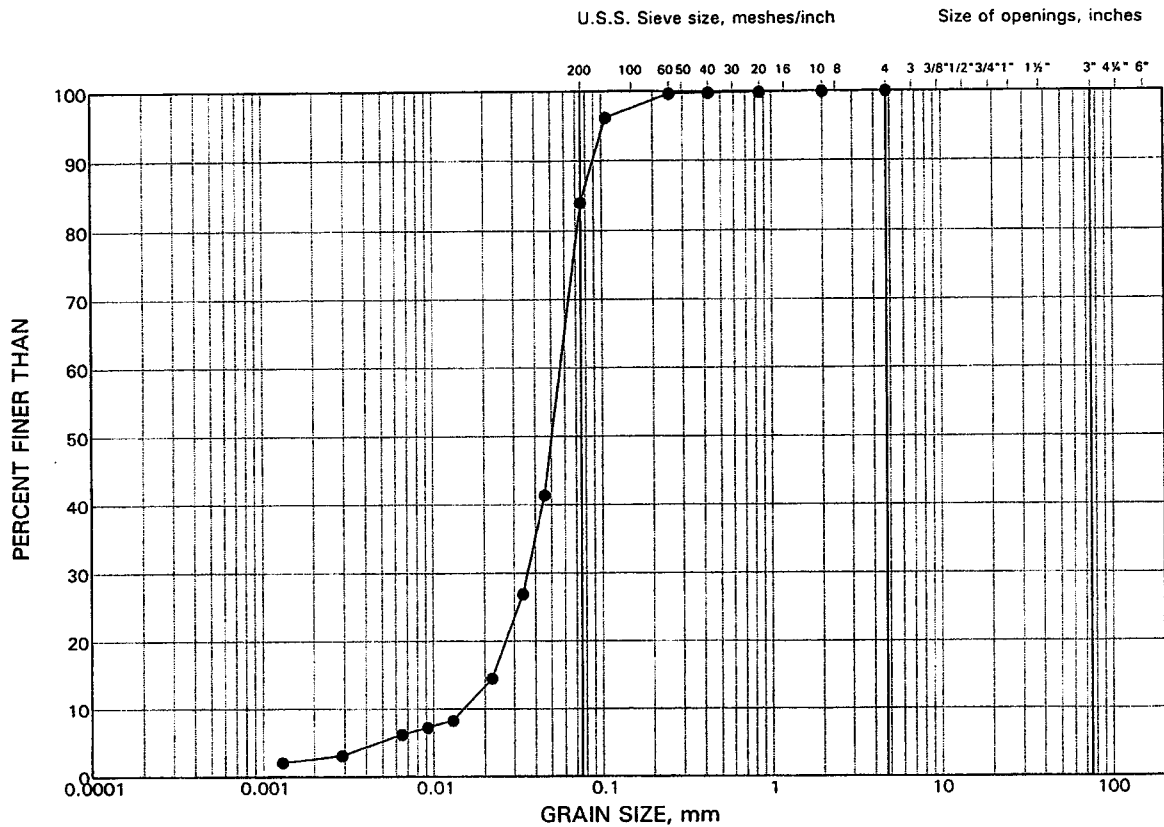
Golder Associates

Prepared by LG
Checked by KJB

GRAIN SIZE DISTRIBUTION

Silt

FIGURE A2



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

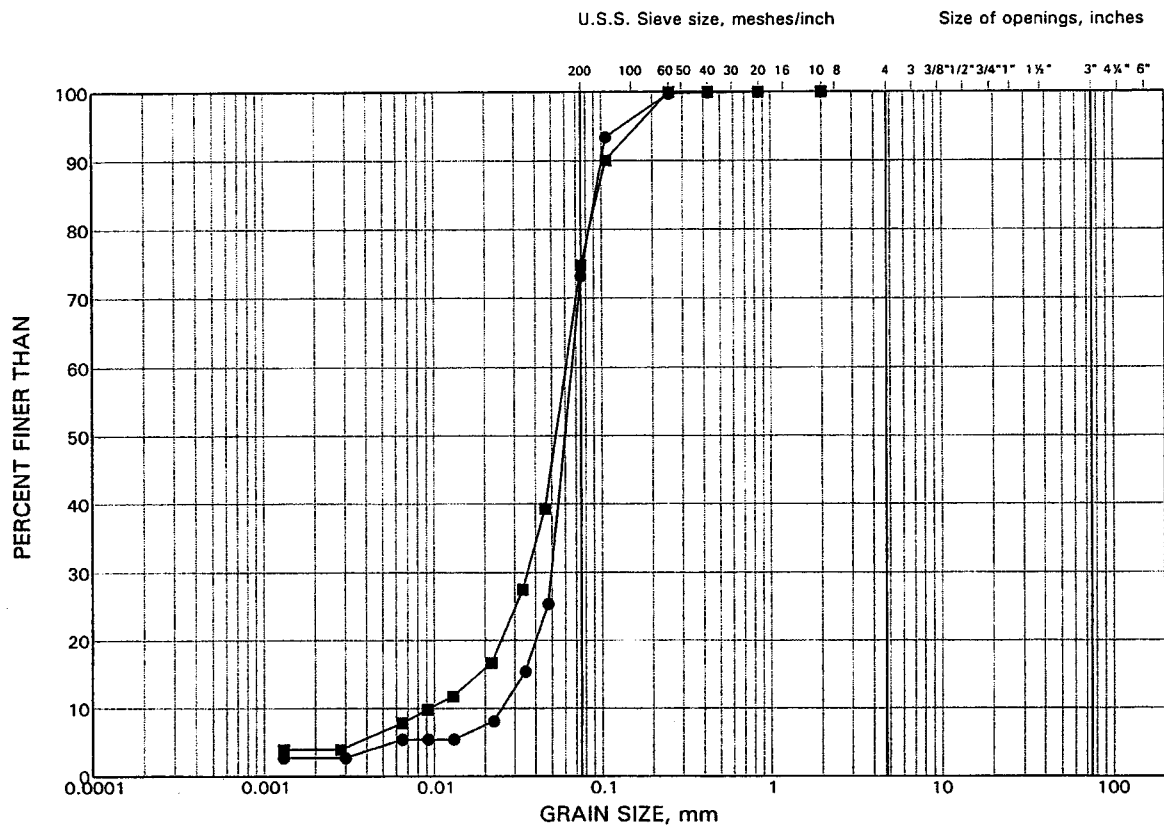
LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH (m)
•	3	6	3.8-4.3

GRAIN SIZE DISTRIBUTION

Sandy Silt

FIGURE A3



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH (m)
●	1	5	3.0-3.5
■	6	7	4.6-5.0

Date December, 2006
Project 03-1111-023\HF

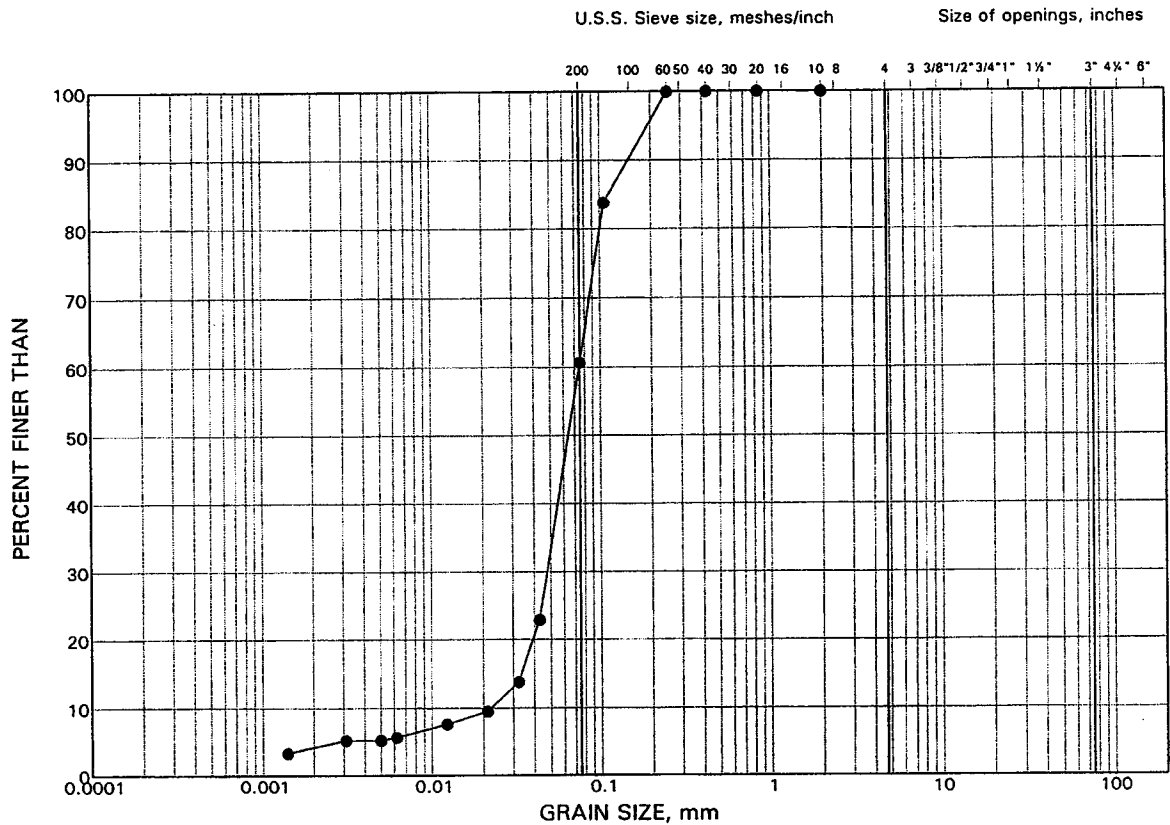
Golder Associates

Prepared by LG
Checked by KJB

GRAIN SIZE DISTRIBUTION

Sand and Silt

FIGURE A4



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

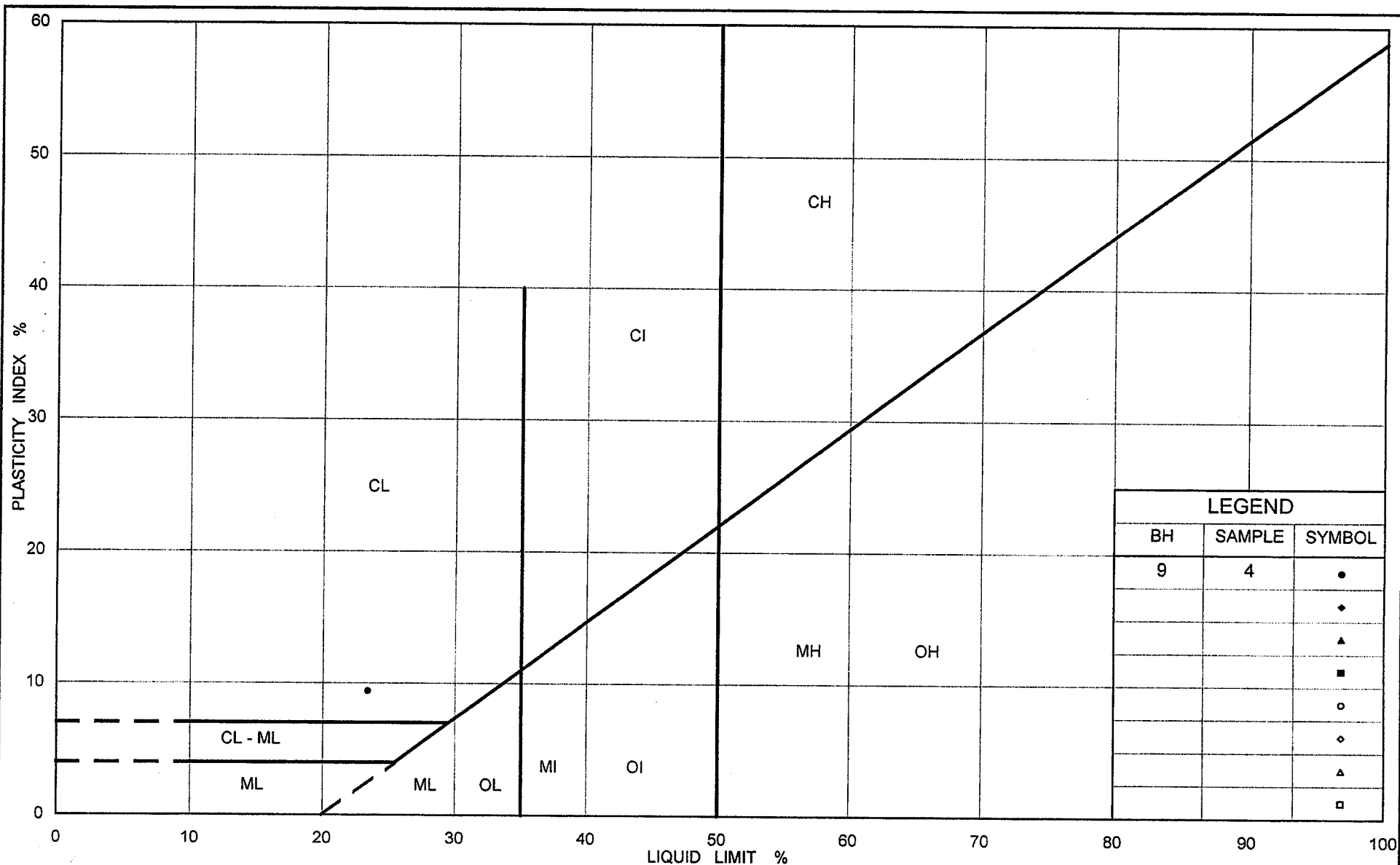
LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH (m)
•	5	9	7.6-8.1

Date December, 2006
Project 03-1111-023C

Golder Associates

Prepared by LG
Checked by IGB



LEGEND		
BH	SAMPLE	SYMBOL
9	4	•
		♦
		▲
		■
		◊
		◊
		▲
		◻



Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt (Till)

FIG No. A5

Project No. 03-1111-023C

Checked By: *ADJ*