April 2010

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FOUNDATION INVESTIGATION AND DESIGN REPORT

HIGH MAST LIGHT POLES AT HIGHWAY 403/WINSTON CHURCHILL BOULEVARD INTERCHANGE, GO TRANSIT - BUS RAPID TRANSIT WEST FROM WINSTON CHURCHILL BOULEVARD TO ERIN MILLS PARKWAY, MISSISSAUGA, ONTARIO

Submitted to:
Giffels Associates Limited/IBI Group
30 International Boulevard
Toronto, Ontario
M9W 5P3

30M12-304

Reference: Google Earth Pro Source: ©2010 TeleAtlas, Image©2010 DigitalGlobe, Imagery Date Plan August 31, 2009

Report Number: 09-1181-1045-9

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REPORT

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MISSISSAUGA, ONTARIO

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Giffels Associates Limited/IBI Group (Giffels/IBI) on behalf of GO Transit (GO) to provide geotechnical engineering services for the detail design of the GO Bus Rapid Transit West (GO BRT) between Winston Churchill Boulevard and Erin Mills Parkway, in the City of Mississauga, Ontario. The proposed GO BRT alignment will run parallel to and will be about 50 m north of the existing Highway 403. In addition to the busway itself, the GO BRT project involves bus stations at Winston Churchill Boulevard and at Erin Mills Parkway, ramps, five bridges, associated retaining walls, high mast lights and overhead signs.

This report addresses the geotechnical investigation carried out for five proposed GO BRT high mast light (HML) poles located along Highway 403 at the Winston Churchill Boulevard interchange.

This report addresses only the geotechnical (physical) aspects of the subsurface conditions at this site. The geo-environmental (chemical) aspects, including consequences of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources, are outside the terms of reference for this report.

The factual data and interpretation contained in this report pertain to a specific project as described in the report and are not applicable to any other project or site location. If the project is modified in concept, location or elevation, of if there are changes to site conditions, Golder should be given an opportunity to confirm that the recommendations are still valid.

This report should be read in conjunction with "Important Information and Limitations of This Report", following the text of this report. The reader's attention is specifically drawn to this information, as it is essential for the proper use and interpretation of this report.

The terms of reference for the foundation engineering services are outlined in GO Transit's Request for Proposal dated June 15, 2009. The scope of work for this component of the project is outlined in Golder's proposal P9-1181-1045, dated June 25, 2009.

2.0 SITE DESCRIPTION

The proposed GO BRT high mast light poles are located along the north side of Highway 403 at the Winston Churchill Boulevard interchange in the City of Mississauga, Ontario (see key plan on Drawing 1).

The ground surface in the vicinity of the interchange is generally flat to gently sloping toward the southeast. In the northwest and southeast quandrants of the interchange, the Highway 403 corridor is bounded by residential subdivisions. A hydro corridor parallels Highway 403 and the proposed GO BRT line along the north boundary of the highway right-of-way.

3.0 INVESTIGATION PROCEDURES

The field investigation for the proposed GO BRT HML poles at the Winston Churchill Boulevard interchange was carried out between February 4 and 10, 2010, at which time three boreholes (Boreholes EP114A, EP115A, and EP131A) were advanced at specific HML pole locations. Three additional boreholes (Boreholes RW201, RW205, and 7009) were advanced between February 11 and March 4, 2010 for the GO BRT Bridge structures, in the immediate vicinity of some of the proposed HML pole locations. The locations of the boreholes are shown on Drawing 1, following the text of this report.

The field investigation was carried out using truck- and track-mounted drill rigs supplied and operated by Walker Drilling Ltd. of Utopia, Ontario. The boreholes were advanced using 200 mm outside diameter hollow stem augers or 100 mm diameter solid stem augers, to depths ranging from 9.4 m to 18.4 m below the existing ground surface. Soil samples were obtained at 0.75 m and 1.5 m intervals of depth using 50 mm outside diameter split-spoon samplers driven by an automatic hammer in accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586). Bedrock coring was carried out using NQ-size coring equipment in Borehole EP114A.

The groundwater conditions in the open boreholes were observed throughout the drilling operations and a standpipe piezometer was installed in Borehole RW201 to permit monitoring of the groundwater level at the site. The piezometer consists of a 50 mm diameter PVC pipe with a slotted screen sealed at a selected depth within the borehole. A sand filter pack surrounds the screen, and the borehole and annulus surrounding the standpipe piezometer above the screen was backfilled to the surface with bentonite pellets. The piezometer installation and water level readings are detailed on the Record of Borehole RW201 following the text of this report. The remaining boreholes were backfilled with bentonite upon completion of drilling in accordance with Ontario Regulation 903 as amended by Ontario Regulation 372/07 of the Ontario Water Resources Act.

The field work was monitored full-time by a member of Golder's technical staff who arranged for service clearances and road occupancy permits, observed the drilling, sampling and in-situ testing operations, logged the boreholes and examined and cared for the soil samples. The soil samples were identified in the field, placed in labelled containers and transported to Golder's laboratory in Mississauga or Whitby for further examination and 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 soil samples.

The borehole locations were surveyed in the field by SCS Consulting Group Ltd. The as-drilled borehole locations (referenced to the MTM NAD83 coordinate system) and ground surface elevations (referenced to geodetic datum) are summarized below.

HML No.	Borehole	Northing (m)	Easting (m)	Ground Surface Elevation (m)
1	RW201	4822506.6	287732.1	173.8
2	EP131A	4822598.8	287802.6	172.3
3	7009	4822766.5	287925.5	171.4
4	EP115A	4822815.8	287994.1	171.5
	RW205	4822817.4	287985.5	171.4
5	EP114A	4822929.1	288077.8	167.8

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The study area for this investigation lies within the Trafalgar Moraine portion of the South Slope, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984). A surficial till sheet, which generally follows the surface topography, is present throughout much of this area. The till is variable in composition ranging from a cohesive till comprised of clayey silt/silty clay to a cohesionless sand and silt till.

The study area is underlain by Ordovician shales of the Queenston Formation (Ontario Geological Society, 1991). All major rivers in this area cut through the till deposit and into the shale; the valley walls formed within the shale often are almost perpendicular. In the vicinity of the Highway 407/403 interchange and the Erin Mills Parkway interchange, the depth to bedrock is fairly shallow; however, in the vicinity of Winston Churchill Boulevard, an infilled bedrock valley exists and the depth to the bedrock surface is much greater in this area. The bedrock valley is infilled with clayey silt, which is interpreted to have been deposited during the retreat of the glaciers.

4.2 Site Stratigraphy

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of in situ and laboratory testing are given on the Record of Borehole sheets following the text of this report. The results of the laboratory testing are also presented on Figures 1 to 5.

The stratigraphic boundaries shown on the borehole records 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. Subsoil conditions will vary between and beyond the borehole locations.

In summary, the subsoil conditions encountered at the site consist of fill associated with the existing Highway 403 and interchange ramps, underlain by a deposit of clayey silt to silty clay till, and in some locations a clayey silt deposit. A sand and silt till was encountered underlying the cohesive deposits. Where fully penetrated, the lower till deposit is underlain by residual soil and/or shale bedrock.

A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.1 Pavement Structure

A 0.1 m thick layer of asphalt was encountered at ground surface in Borehole RW201. The asphalt is underlain by a 1.3 m of sand and gravel fill, containing trace to some silt and trace clay. A 0.3 m thick layer of sand and gravel fill was encountered immediately below the ground surface in Borehole RW205.

4.2.2 Clayey Silt to Sandy Silt Fill

A 0.6 m to 1.5 m thick layer of fill was encountered immediately below the ground surface in Boreholes EP131A and 7008. The fill consists of clayey silt containing some sand and some gravel, and rootlets and/or organic materials were observed within the recovered samples.

The measured SPT 'N'-values within the fill range from 8 to 13 blows per 0.3 m of penetration, suggesting a stiff consistency.

The water content of one sample of the fill is about 23 percent.

4.2.3 Clayey Silt to Silty Clay Till

A deposit of clayey silt to silty clay till, containing trace to some sand and trace to some gravel, was encountered in all boreholes, either underlying the fill materials or immediately below the ground surface. The top of the till was encountered between Elevations 172.4 m and 167.8 m and the thickness of the deposit varies from 3.0 m to 7.2 m.

The measured SPT 'N'-values within the cohesive till deposit range from 5 to 55 blows per 0.3 m of penetration, with one 'N'-value of 100 blows per 0.05 m of penetration on a cobble/boulder, suggesting a firm to hard consistency.

The results of grain size distribution tests carried out on five selected samples of the clayey silt to silty clay till are provided on Figure 1. Atterberg limits tests carried out on thirteen samples of this till measured plastic limits ranging from 15 to 18 percent, liquid limits ranging from 24 to 32 percent, and plasticity indices ranging from 10 to 14 percent; for the one tested sample from Borehole EP115A, the measured plastic and liquid limits are 19 and 43 percent, respectively, with a plasticity index of 24 percent. These results, which are plotted on a plasticity chart on Figure 2, indicate that the till material is predominantly a clayey silt of low plasticity, although the till does vary to a silty clay of intermediate plasticity. The natural water content of samples of the clayey silt till range from 9 to 20 percent, generally below the plastic limit for the material.

4.2.4 Clayey Silt

A deposit of clayey silt was encountered below the clayey silt to silty clay till in Boreholes EP131A and 7009 in the central portion of the Winston Churchill Boulevard interchange site. The surface of the clayey silt deposit was encountered at Elevations 166.2 m and 166.9 m in Boreholes EP131A and 7009, respectively, and the deposit is 8.5 m thick in Borehole EP131A and 8.8 m thick in Borehole 7009.

The measured SPT 'N'-values within the clayey silt deposit range from 53 to 104 blows per 0.3 m of penetration, suggesting a hard consistency.

The clayey silt deposit contains trace sand and gravel. The result of a grain size distribution test carried out on one selected sample of the deposit is provided on Figure 3. Atterberg limits testing was carried out on three samples of this deposit and measured plastic limits ranging from 17 to 19 percent, liquid limits ranging from 26 to 28 percent, and plasticity indices ranging from 7 to 11 percent. These results, which are plotted on a plasticity chart on Figure 4, confirm that the deposit is a clayey silt of low plasticity. The natural water content of samples of the clayey silt deposit range from 11 to 18 percent, generally below the plastic limit for the deposit.

4.2.5 Silt Interlayer

A 0.6 m thick interlayer of silt, containing trace sand, was encountered at Elevation 159.7 m, within the clayey silt deposit in Borehole EP131A.

One SPT 'N'-value of 61 blows per 0.3 m of penetration was measured across the interface between the clayey silt stratum and the silt layer, indicating a very dense relative density.

4.2.6 Sand and Silt Till

A deposit of sand and silt till was encountered below the clayey silt to silty clay till and/or clayey silt deposits in all boreholes except Boreholes EP114A. The surface of the sand and silt till deposit was encountered between Elevations 168.2 m and 157.7 m, and is deepest near Winston Churchill Boulevard. The majority of the boreholes were terminated within this deposit; penetrating it for a thickness of 3.8 m to 3.9 m in Boreholes EP115A, RW201 and RW205. The deposit is 1.5 m and 1.7 m thick in Boreholes 7008 and EP131A, where it was fully penetrated..

The measured SPT 'N'-values within the sand and silt till deposit range from 65 blows per 0.3 m of penetration to 177 blows per 0.02 m of penetration, indicating a very dense relative density.

The sand and silt till contains trace to some gravel and trace to some clay. The results of grain size distribution tests carried out on four selected samples of the sand and silt till are provided on Figure 6. An Atterberg limits test on a sample of the sand and silt till indicates that the material is non-plastic. The natural water contents measured in samples of the till range between 6 and 11 percent.

4.2.7 Clayey Silt Residual Soil

A 0.7 m thick and 2.0 m thick layer of clayey silt residual soil was encountered at Elevation 164.8 m in Borehole EP114A and Elevation 156.6 m in Borehole 7009, underlying the clayey silt till deposit and sand and silt till deposit, respectively. The residual soil is derived from weathering of the underlying bedrock, and consists of clayey silt containing trace sand and varying amounts of siltstone, limestone and shale fragments.

The measured SPT 'N'-values within the residual soil layer are 64 blows per 0.3 m of penetration and 100 blows per 0.1 m of penetration, suggesting a hard consistency.

4.2.8 Shale Bedrock

Shale bedrock was encountered in Boreholes EP114A, EP131A, and 7009 at depths below ground surface of 3.7 m (Elevation 164.1 m), 16.3 m (Elevation 156.0 m) and 16.8 m (Elevation 154.6), respectively. Borehole EP114A was extended into the bedrock by augering and split-spoon sampling to a depth of 9.1 m below ground surface(Elevation 158.7 m), below which the bedrock was cored for a length of 3.1 m using NQ-size coring equipment. Boreholes EP131A and 7009 were extended into the bedrock by augering and split-spoon sampling for a thickness of 2.1 m and 0.1 m, respectively.

The measured SPT 'N'-values within the bedrock range from 100 blows per 0.15 m of penetration to 100 blows per 0.02 m of penetration.

The bedrock is described as reddish-brown shale containing limestone interlayers, and it is mapped in this area as the Queenston Formation. The bedrock is thinly laminated, with the shale beds weak and completely to moderately weathered. Limestone interlayers within the drilled/cored shale are weak to medium strong and moderately weathered. The measured rock quality designation (RQD) values range from 0 to 83 percent for the section of shale bedrock cored in Borehole EP114A.

4.2.9 Groundwater Conditions

The water levels were observed in the open boreholes during and immediately following completion of the drilling operations, and these observations are recorded on the Record of Borehole sheets. A standpipe piezometer was installed in Borehole RW201, sealed within the sand and silt till deposit, to permit monitoring of the groundwater level at the site. Details of the installation are shown in the Record of Borehole sheet following the text of this report. The water levels recorded in the piezometer are summarized below:

Borehole No.	Ground Surface Elevation	Depth to Groundwater Level	Groundwater Elevation	Date of Measurement
RW201	173.8 m	8.9 m	164.9 m	Upon completion
		5.1 m	168.7 m	March 12, 2010
		3.5 m	170.3 m	March 16, 2010
		1.4 m	172.4 m	April 12, 2010

Based on the above measurements and measurements in other piezometers installed in the vicinity as part of the geotechnical investigation for other components of this project at the Winston Churchill Boulevard interchange (i.e. Borehole RW204 near Boreholes RW205/EP115A), the stabilized groundwater level at the site is expected to be at a depth of approximately 1.5 m to 2 m below the natural ground surface. It should be noted that groundwater levels are expected to fluctuate seasonally and are expected to be higher during wet periods of the year.

5.0 CLOSURE

This Foundation Investigation Report was prepared by Ms. Nikol Kochmanová, E.I.T, and reviewed by Ms. Lisa Coyne, P.Eng. a geotechnical engineer and Principal with Golder. Mr. Jorge M. A. Costa, P.Eng. Golder's Designated MTO Contact for this project and a Principal with Golder, conducted an independent quality control review of the report.

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PART B

FOUNDATION DESIGN REPORT
HIGH MAST LIGHT POLES AT
HIGHWAY 403/WINSTON CHURCHILL BOULEVARD INTERCHANGE
GO TRANSIT – BUS RAPID TRANSIT WEST
FROM ERIN MILLS PARKWAY TO WINSTON CHURCHILL BOULEVARD
MISSISSAUGA, ONTARIO

Golder Associates

6.0 DISCUSSION AND ENGINEERING RECCOMENDATIONS

6.1 General

This section of the report provides geotechnical recommendations for the design of the proposed HML poles to be located along the proposed GO BRT roadway on the north side of Highway 403 at the Winston Churchill Boulevard interchange. The recommendations are based on interpretation of the factual data obtained during a subsurface investigation at the site. The interpretation and recommendations provided in this section are intended for use by the design engineer. Where comments are made on construction, they are provided only to highlight those aspects that could affect the design of the project, and for which special provisions or operational constraints may be required in the Contract Documents. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction method and scheduling.

6.2 Design of High Mast Light Pole Foundations

The subsoil conditions at or near the proposed high mast light pole locations consist of fill overlying very stiff to hard clayey silt to silty clay till, hard clayey silt, and very dense sand and silt till. The overburden soils are underlain by residual soil/shale bedrock.

The HML pole foundations should be designed in accordance with MTO's *Procedures for the Design of High Mast Pole Foundations*, dated May 2004.

The unfactored passive lateral earth pressure, P_p (kPa), distributed along the caisson for each HML pole may be calculated using the following equations, based on the stratigraphy and geotechnical design parameters given in Table 1 following the text of this report.

$$P_p = K_p \gamma d + 2 c_u / K_p \quad \text{above the groundwater table}$$

$$P_p = K_p \gamma d_w + K_p \gamma'(d - d_w) + 2 c_u / K_p \quad \text{below the groundwater table}$$

where K_p is the passive earth pressure coefficient, which must be adjusted where sloping ground is present adjacent to the HML foundation;

γ is the bulk unit weight (kN/m^3);

γ' is the effective unit weight below the groundwater level (kN/m^3);

d is the depth below the ground surface (m);

d_w is the depth to the groundwater level (m); and

c_u is the undrained shear strength (kPa).

In the design of the foundations, the passive resistance within the upper 1.2 m below final ground surface should be neglected to account for frost action. The unfactored lateral resistance should be calculated assuming an equivalent pile width equal to three times the caisson diameter. A resistance factor of 0.5 should be applied to this calculated lateral resistance in order to obtain the factored lateral geotechnical resistance, in accordance with Section 6.6.2.1 of the *CHBDC*.

Where an undrained shear strength, c_u, is provided, the undrained capacity of the caisson should be checked to determine whether the drained or undrained case will govern. In this case, the lateral resistance for the length of the caisson within cohesive soil should be calculated assuming an internal angle of friction, ϕ' = 0 degrees and an unfactored passive lateral pressure distribution equivalent to nine times the undrained shear strength acting over the actual width of the caisson. A resistance factor of 0.5 should be applied to this calculated lateral resistance in order to obtained the factored geotechnical lateral resistance, as noted above.

6.3 Construction Considerations

"Cohesionless" sand and silt till is present below the clayey silt to silty clay till and clayey silt deposits at the Winston Churchill Boulevard interchange, and these water-bearing soils could slough or ravel into the caisson hole during augering and caisson construction. Therefore, temporary liners are recommended to minimize ground loss during drilling and concrete placement for the caisson foundations.

In addition, the soil deposits at this site are glacially-derived and are therefore expected to contain cobbles and boulders as noted in some boreholes.

It is recommended that a Non-Standard Special Provision (NSSP) be included in the Contract Documents to warn the Contractor of these conditions, which may affect the installation of the caisson foundations for support of the HML poles at the Winston Churchill Boulevard interchange.

7.0 CLOSURE

This Foundation Design Report was prepared by Ms. Nikol Kochmanová, E.I.T, and reviewed by Ms. Lisa Coyne, P.Eng, a geotechnical engineer and Principal with Golder. Mr. Jorge M. A. Costa, P.Eng. Golder's Designated MTO Contact for this project and a Principal with Golder, conducted an independent quality control review of the report.

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TABLE 1: DESIGN PARAMETERS FOR HML FOUNDATIONS

HML No.	Borehole No.	Borehole Location	Stratum	Depth[1] (m)	Elevation[1] (m)	Design Parameters [2,3]					Groundwater Elevation [4]
						C_u	φ'	γ	γ'	K_p	
1	RW201	N 4822506.6 E 287732.1	Sand and gravel fill	0.0 – 1.4	173.8 – 172.4	-	30	20	10	3.0	170.5 m
			Clayey silt till	1.4 – 5.6	172.4 – 168.2	-	34	21	11	3.5	
			Sand and silt till	Below 5.6	Below 168.2	-	35	21	11	3.7	
2	EP131A	N 4822598.8 E 287802.6	Clayey silt fill	0.0 – 0.6	172.3 – 171.7	35	28	19	-	2.8	170.5 m
			Clayey silt till	0.6 – 6.1	171.7 – 166.2	-	34	21	11	3.5	
			Clayey silt including silt interlayer	6.1 – 14.6	166.2 – 157.7	-	35	21	11	3.7	
			Sand and silt till	14.6 – 16.3	157.7 – 156.0	-	35	21	11	3.7	
			Shale bedrock	Below 16.3	Below 156.0	-	38	23	13	4.2	
3	7009	N 4822766.5 E 287925.5	Clayey silt till	0.0 – 4.5	171.4 – 166.9	-	34	21	11	3.5	169 m
			Clayey silt	4.5 – 13.3	166.9 – 158.1	-	35	21	11	3.7	
			Sand and silt till and clayey silt residual soil	13.3 – 16.8	158.1 – 154.6	-	34	21	11	3.5	
			Shale bedrock	Below 16.8	Below 154.6	-	38	23	13	4.2	
4	EP115A / RW205	N 4822815.8 E 287994.1 / N 4822817.14 E 287985.5	Clayey silt to silty clay till	0.0 – 7.2	171.5 – 164.3	-	34	21	11	3.5	169 m
			Sand and silt till	Below 7.2	Below 164.3	-	35	21	11	3.7	
5	EP114A	N 4822929.1 E 288077.8	Clayey silt till and clayey silt residual soil	0.0 – 3.7	167.8 – 164.1	-	34	21	11	3.5	166 m
			Shale bedrock	Below 3.7	Below 164.1	-	38	23	13	4.2	

Reviewed: L.C. Coyne

NOTES:

1. Depth is given for the borehole location; the ground surface elevation at the borehole location should be compared to the ground surface elevation at the actual overhead sign support location, and the depths and/or elevations adjusted accordingly.
2. Design parameters: C_u = undrained shear strength (kPa);
   φ' = effective friction angle (degrees);
   γ = bulk unit weight (kN/m^3);
   γ' = effective unit weight below the groundwater level (kN/m^3); and,
   K_p = passive earth pressure coefficient.
3. Although the passive resistance in the upper 1.2 m is to be neglected to account for frost action, φ' and K_p parameters are given in the event that the ground surface elevation varies significantly between the borehole and sign support locations.
4. Assumed groundwater level based on the site stratigraphy, soil samples and nearby boreholes.

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Canadian Standards Association, 2006. *Canadian Highway Bridge Design Code*, CAN/CSA-56-06.

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Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder can not be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

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The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

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.)

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 cm^2 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.

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

(b) Cohesive Soils

Consistency	c_u, s_u kPa	c_u, s_u 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

IV. SOIL TESTS

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

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

LIST OF SYMBOLS

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

I. GENERAL

π	3.1416
in 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
υ	poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - \mu$)
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
μ	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

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

Notes: 1 $\tau = c' + \sigma' \tan\phi'$
2 shear strength = (compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)
The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)
The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)
The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index
A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis
The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

Description and Notes
An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN	Joint	PL	Planar
FLT	Fault	CU	Curved
SH	Shear	UN	Undulating
VN	Vein	IR	Irregular
FR	Fracture	K	Slickensided
SY	Stylolite	PO	Polished
BD	Bedding	SM	Smooth
FO	Foliation	SR	Slightly Rough
CO	Contact	RO	Rough
AXJ	Axial Joint	VR	Very Rough
KV	Karstic Void		
MB	Mechanical Break		

Golder Associates

RECORD OF BOREHOLE No EP114A

 METRIC

PROJECT	09-1181-1045		ORIGINATED BY MWK
G.W.P.		LOCATION N 4822929.1 ;E 288077.8	COMPILED BY PKS
DIST	HWY 403	BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers	CHECKED BY SMM/MC
DATUM	Geodetic	DATE February 4, 2010	

SOIL PROFILE

ELEV / DEPTH	DESCRIPTION
167.8	GROUND SURFACE
0.0	CLAYEY SILT, some sand, trace gravel (TILL) Firm to hard Brown Moist
164.8 / 3.0	CLAYEY SILT, some sand, containing shale and limestone fragments (RESIDUAL SOIL) Hard Reddish brown Moist
164.1 / 3.7	SHALE (BEDROCK), containing limestone interlayers Reddish brown
	Bedrock cored from 9.1 m to 12.2 m depth For bedrock coring details, refer to Record of Drillhole EP114A.
155.6 / 12.2	END OF BOREHOLE NOTE: 1. Borehole dry upon completion of overburden drilling operations.

SAMPLES

NUMBER	TYPE	"N" VALUES	Water content (%) / limits	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1	SS	5	w ≈ 20	
2	SS	30	w ≈ 11; W_p–W_L ≈ 13–19	
3	SS	44	w ≈ 10	
4	SS	31	w ≈ 10; W_p–W_L ≈ 12–18	5 18 49 28
5	SS	64		
6	SS	100/.15		
7	SS	100/.15		
8	SS	100/.08		
9	SS	100/.02		
1	RC	REC 67%		RQD = 0%
2	RC	REC 100%		RQD = 83%
3	RC	REC 97%		RQD = 82%

Elevation scale: 167 – 156

Column headings: STRAT PLOT; GROUND WATER CONDITIONS; ELEVATION SCALE; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED; 20 40 60 80 100); PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30; UNIT WEIGHT γ kN/m³

→ 100

$+^3, \times^3$: Numbers refer to Sensitivity   ○ 3% STRAIN AT FAILURE

PROJECT: 09-1181-1045

RECORD OF DRILLHOLE: EP114A

SHEET 1 OF 1

LOCATION: N 4822929.1 ;E 288077.8

DRILLING DATE: February 4, 2010

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: D-120 TRACK MOUNT

DRILLING CONTRACTOR: WALKER DRILLING

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	ROCK STRENGTH INDEX	WEATHERING INDEX	Q AVG.	NOTES WATER LEVELS INSTRUMENTATION
		CONTINUED FROM RECORD OF BOREHOLE EP114A		158.7																
	NW CASING	SHALE (BEDROCK) containing interbeds of slightly to moderately weathered, weak to medium strong limestone, 10 mm to 40 mm thick interlayers (QUEENSTON FORMATION) Completely to moderately weathered Reddish brown Weak Thinly laminated		9.1	1	Reddish brown 100%														
10	HQ RC February 4, 2010				2	Reddish brown 100%							jn,cu,sm be,un,ro be,un,sm be,un,sm be,un,ro jn,un,sm							
11					3	Reddish brown 100%							jn,cu,ro be,un,sm be,un,sm be,cu,sm jn,un,ro be,cu,sm be,un,sm be,un,ro be,un,sm be,un,ro be,cu,ro be,un,sm							
12				155.6 12.2																
		END OF DRILLHOLE																		
13																				
14																				
15																				
16																				
17																				
18																				
19																				

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: MWK

CHECKED: MC

Golder Associates

RECORD OF BOREHOLE No EP115A

 METRIC

PROJECT 09-1181-1045
G.W.P.
DIST HWY 403
DATUM Geodetic

LOCATION N 4822815.8 ;E 287994.1
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE February 10, 2010

ORIGINATED BY MWK
COMPILED BY PKS
CHECKED BY SMM

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
171.5	GROUND SURFACE						
0.0	CLAYEY SILT, some sand, trace to some gravel, containing cobbles (TILL) Very stiff Brown becoming grey at 3.8 m depth Moist	1	SS	15			
		2	SS	21			
		3	SS	27			
		4	SS	26			
		5	SS	27			
		6	SS	20			11 19 46 24
	Augers grinding between 4.3 m and 4.6 m depth	7	SS	24			
165.8 / 5.7	SILTY CLAY, some sand, trace to some gravel (TILL) Very stiff Grey Moist	8	SS	28	∇	43	
164.3 / 7.2	SAND and SILT, trace to some gravel, trace clay (TILL) Very dense Grey Wet	9	SS	100/.15			
		10	SS	100/.15			11 48 35 6
160.4		11	SS	152			
11.1	END OF BOREHOLE						

NOTE:
1. Borehole open to 7.3 m depth, and water level in borehole at a depth of 6.4 m below ground surface (Elev. 165.1 m) upon completion of drilling.

Elevation scale: 171, 170, 169, 168, 167, 166, 165, 164, 163, 162, 161

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100
PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30
UNIT WEIGHT γ kN/m³

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

Golder Associates

RECORD OF BOREHOLE No EP131A

 METRIC

PROJECT 09-1181-1045
G.W.P.
DIST HWY 403
DATUM Geodetic

LOCATION N 4822598.8 ;E 287802.6
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE February 10, 2010

ORIGINATED BY RS
COMPILED BY PKS
CHECKED BY SMM

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE
172.3	GROUND SURFACE				
0.0	Clayey silt, some sand, some gravel, containing rootlets and organics (FILL) Stiff Brown Moist	1	SS	11	172
171.7 0.6	CLAYEY SILT, some sand, trace to some gravel (TILL) Very stiff to hard Brown becoming grey below 3.7 m depth Moist	2	SS	15	171
		3	SS	30	170
		4	SS	40	
		5	SS	38	169
		6	SS	30	168
		7	SS	30	167
166.2 6.1	CLAYEY SILT, trace sand Hard Grey Moist	8	SS	104	166
					165
		9	SS	69	164
		10	SS	73	163
					162
		11	SS	53	161
					160
159.7 12.7	SILT, trace sand Very dense Grey Wet	12	SS	61	
159.0 13.3	CLAYEY SILT, trace sand Hard Grey Moist				159
		13	SS	70	158
157.7 14.6					

Column headings: SOIL PROFILE; STRAT PLOT; SAMPLES; GROUND WATER CONDITIONS; ELEVATION SCALE; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa: ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED (20 40 60 80 100); PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30; UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

Continued Next Page

$+^3, \times^3$: Numbers refer to Sensitivity $\bigcirc^{3\%}$ STRAIN AT FAILURE

Golder Associates

Foundation Design

RECORD OF BOREHOLE No EP131A

 METRIC

PROJECT 09-1181-1045

G.W.P.

LOCATION N 4822598.8 ;E 287802.6

ORIGINATED BY RS

DIST HWY 403

BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers

COMPILED BY PKS

DATUM Geodetic

DATE February 10, 2010

CHECKED BY SMM

ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SAND and SILT, some gravel, trace clay (TILL) Very dense Grey Wet		14	SS	124/.28		157				
156.0 16.3	SHALE (BEDROCK), containing limestone interlayers Reddish brown		15	SS	100/.1		156				
							155				
153.9 18.4	END OF BOREHOLE		16	SS	100/.1		154				

NOTE:
1. Borehole dry upon completion of drilling operations.

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

MIS-MTO 001 0911811045.GPJ GAL-MISS.GDT 20/4/10 JFC

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RECORD OF BOREHOLE No RW201

 METRIC

PROJECT 09-1181-1045
G.W.P.
DIST HWY 403
DATUM Geodetic

LOCATION N 4822506.6 ;E 287732.1
BOREHOLE TYPE 100 mm Outside Diameter Solid Stem Augers
DATE March 4, 2010

ORIGINATED BY MC
COMPILED BY MWK
CHECKED BY SMM/LCC

ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" VALUES	NATURAL MOISTURE CONTENT	UNIT WEIGHT (kN/m³)	GR	SA	SI	CL
173.8	GROUND SURFACE									
0.0	ASPHALT									
0.1	Sand and gravel, trace to some silt, trace clay (FILL) Compact Brown Moist to wet	1	AS	-						
		2	AS	-						
		3	SS	15						
172.4 / 1.4	CLAYEY SILT with sand to some sand, trace gravel (TILL) Very stiff Brown becoming grey at 4.5 m depth Moist	4	SS	15						
		5	SS	29						
		6	SS	27						
		7	SS	29						
		8	SS	25			6	26	41	27
168.2 / 5.6	SAND and SILT, trace to some clay, trace to some gravel (TILL) Very dense Grey Wet	9	SS	71			5	36	47	12
		10	SS	128						
164.4		11	SS	65		np	11	50	34	5
9.4	END OF BOREHOLE									

NOTES:

1. Water level in open borehole at a depth of 8.9 m below ground surface (Elev. 164.9 m) upon completion of drilling.

2 . Water Level Measurements

Date	Depth (m)	Elev. (m)
Mar. 12, 2010	5.1	168.7
Mar. 16, 2010	3.5	170.3
Apr. 12, 2010	1.4	172.4

Column headings: SOIL PROFILE; SAMPLES; GROUND WATER CONDITIONS; ELEVATION SCALE; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED; 20 40 60 80 100); PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30; UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

Elevation scale: 173, 172, 171, 170, 169, 168, 167, 166, 165

$+^3, \times^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No RW205

 METRIC

PROJECT 09-1181-1045
G.W.P.
DIST HWY 403
DATUM Geodetic

LOCATION N 4822817.4 ;E 287985.5
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
DATE February 11, 2010

ORIGINATED BY MWK
COMPILED BY SMM
CHECKED BY SMM/LCC

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
171.4	GROUND SURFACE						
0.0	Sand and gravel, trace silt (FILL) Dense Brown Moist	1	SS	40		171	
171.1 0.3	CLAYEY SILT with sand to some sand, trace to some gravel (TILL) Very stiff to hard Brown becoming grey at 4.3 m depth Moist	2	SS	18		170	
		3	SS	22			
		4	SS	24		169	8 26 41 25
		5	SS	32		168	
		6	SS	27		167	
		7	SS	43		166	
165.8 5.6	SAND and SILT, trace gravel, trace clay (TILL) Very dense Brown Moist	8	SS	100/.13		165	
						164	
		9	SS	100/.1	∇	163	3 42 50 5
162.0		10	SS	100/.13		162	
9.4	END OF BOREHOLE						

Column headings also include: STRAT PLOT; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, X REMOULDED; 20 40 60 80 100); PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30; UNIT WEIGHT γ kN/m³

NOTE:

1. Water level in open borehole at a depth of 7.9 m below ground surface (Elev.163.5 m) upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

Golder Associates

Foundation Design

RECORD OF BOREHOLE No 7009

 METRIC

PROJECT 09-1181-1045
G.W.P.
LOCATION N 4822766.5 ;E 287925.5
ORIGINATED BY MWK
DIST HWY 403
BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers
COMPILED BY PKS
DATUM Geodetic
DATE February 23, 2010
CHECKED BY SMM

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
171.4	GROUND SURFACE						
0.0	CLAYEY SILT with sand, trace to some gravel, occassional sand seams, containing cobbles (TILL) Stiff to hard Brown Moist	1	SS	8		171	
		2	SS	12		170	
		3	SS	50			
		4	SS	32		169	
		5	SS	55		168	7 24 36 33
		6	SS	100/.05			
166.9 / 4.5	CLAYEY SILT, trace sand Hard Grey Moist					167	
		7	SS	78		166	
		8	SS	73		165	0 1 67 32
		9	SS	74		164 / 163	
		10	SS	69		162 / 161	
		11	SS	57		160	
		12	SS	71		159	
158.1 / 13.3	SAND and SILT, some gravel, trace clay (TILL) Very dense Reddish brown Moist					158	
		13	SS	77/0.02	▽	157	
156.6 / 14.8							

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30
UNIT WEIGHT γ kN/m³

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No 7009

 METRIC

PROJECT 09-1181-1045			
G.W.P.	LOCATION N 4822766.5 ;E 287925.5		ORIGINATED BY MWK
DIST HWY 403	BOREHOLE TYPE 200 mm Outside Diameter Hollow Stem Augers		COMPILED BY PKS
DATUM Geodetic	DATE February 23, 2010		CHECKED BY SMM

ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	CLAYEY SILT, some sand, containing shale fragments (RESIDUAL SOIL) Hard Reddish brown Moist		14	SS	100/ 1		156				
							155				
154.6 / 16.9	SHALE (BEDROCK) Reddish brown		15	SS	100/ 1						
	END OF BOREHOLE										

*Spoon bouncing on possible cobble

NOTE:
1. Water level in open borehole at a depth of 14.3 m below ground surface (Elev. 157.1 m) upon completion of drilling.

MIS-MTO 001 0911811045.GPJ GAL-MISS.GDT 20/4/10 JFC

$+^3, \times^3$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

MINISTRY OF TRANSPORTATION, ONTARIO

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

CONT No.
WP No.

SHEET

GO TRANSIT BUS RAPID TRANSIT W.
HIGH MAST LIGHT POLES, HWY 403/WINSTON CHURCHILL BOULEVARD INTERCHANGE
BOREHOLE LOCATIONS

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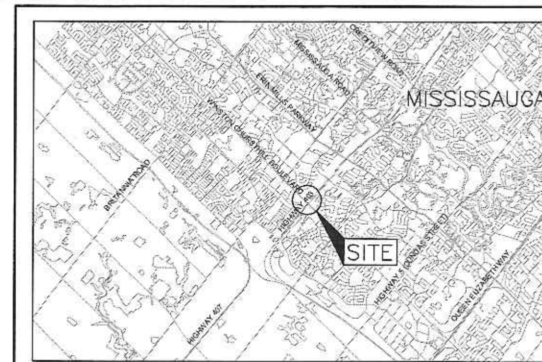
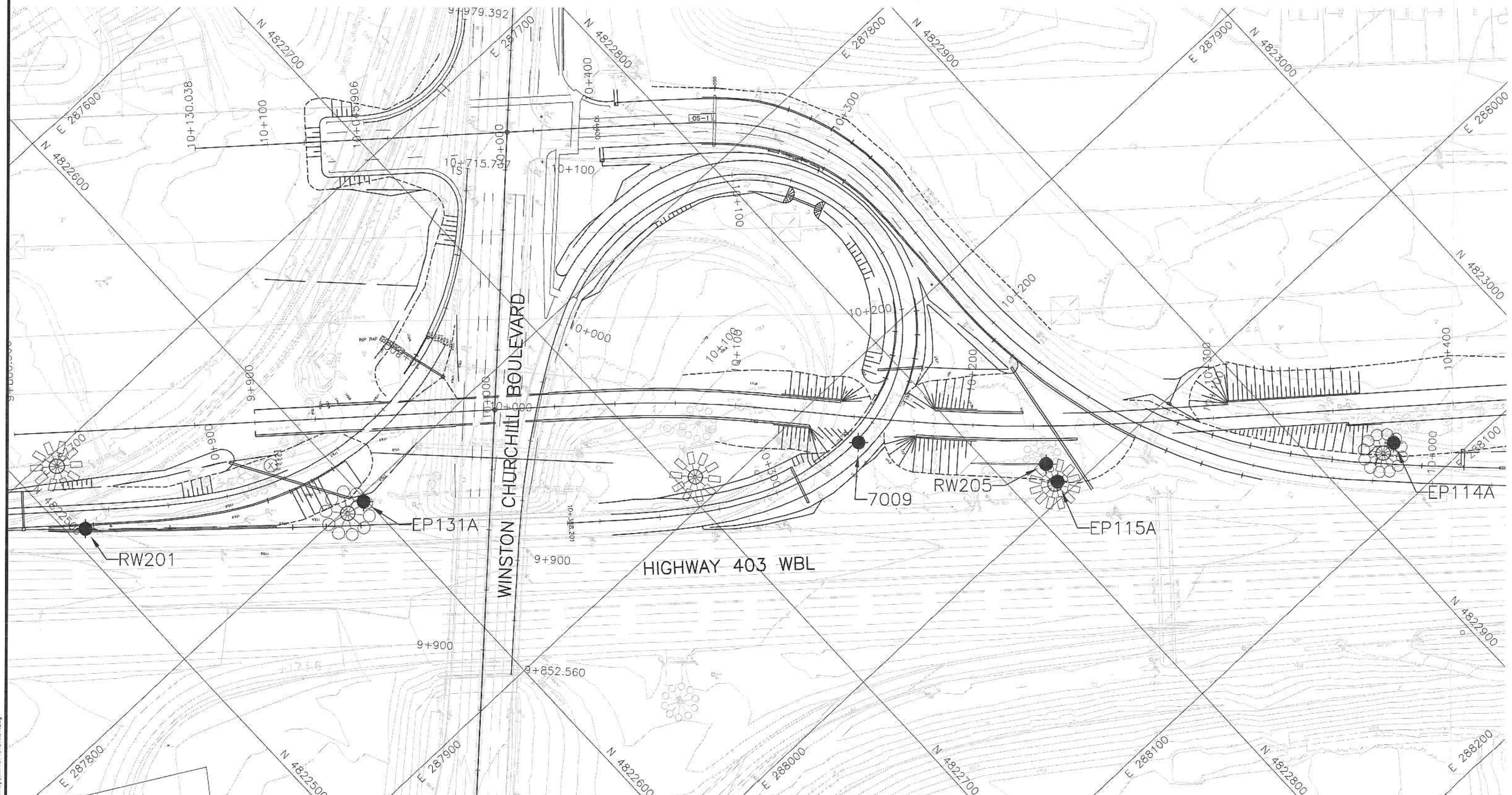
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN
SCALE
2 0 2 4 km



PLAN
SCALE
20 0 20 40 m

LEGEND

● Borehole – Current Investigation

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
7009	171.4	4822766.5	287925.5
EP114A	167.8	4822929.1	288077.8
EP115A	171.5	4822815.8	287994.1
EP131A	172.3	4822598.8	287802.6
RW201	173.8	4822506.6	287732.1
RW205	171.4	4822817.4	287985.5

NOTES
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

REFERENCE
Base plan provided in digital format by Giffels/IBI Group, drawing file no.'s 069770-C_Base.dwg and 069770-c_mnc.dwg. saved dated March 3, 2010.

LICENSED PROFESSIONAL ENGINEER J.M.A. COSTA April 19, 2010 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER L.C. COYNE April 19, 2010 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No.

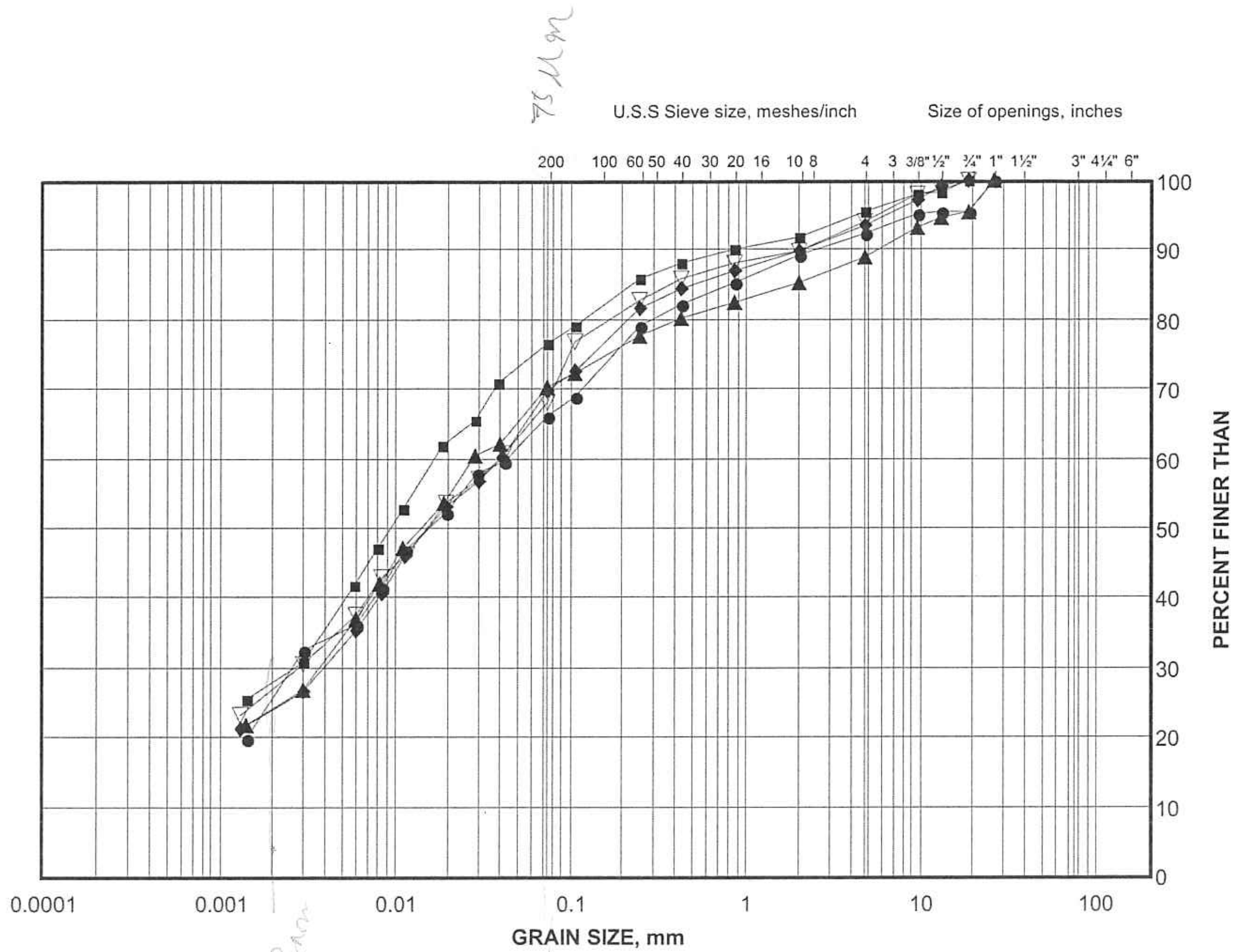
HWY. 403	PROJECT NO. 09-1181-1045-9	DIST.
SUBM'D. MWK	CHKD. NK	DATE: April 2010	SITE:
DRAWN: JFC	CHKD. LCC	APPD. JMAC	DWG. 1

PLOT DATE: April 20, 2010

GRAIN SIZE DISTRIBUTION

Clayey Silt to Silty Clay Till

FIGURE 1



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	RW205	4	168.8
■	EP114A	4	165.3
◆	7009	5	168.0
▲	EP115A	6	167.1
▽	RW201	8	168.9

Project Number: 09-1181-1045

Checked By: [signature]

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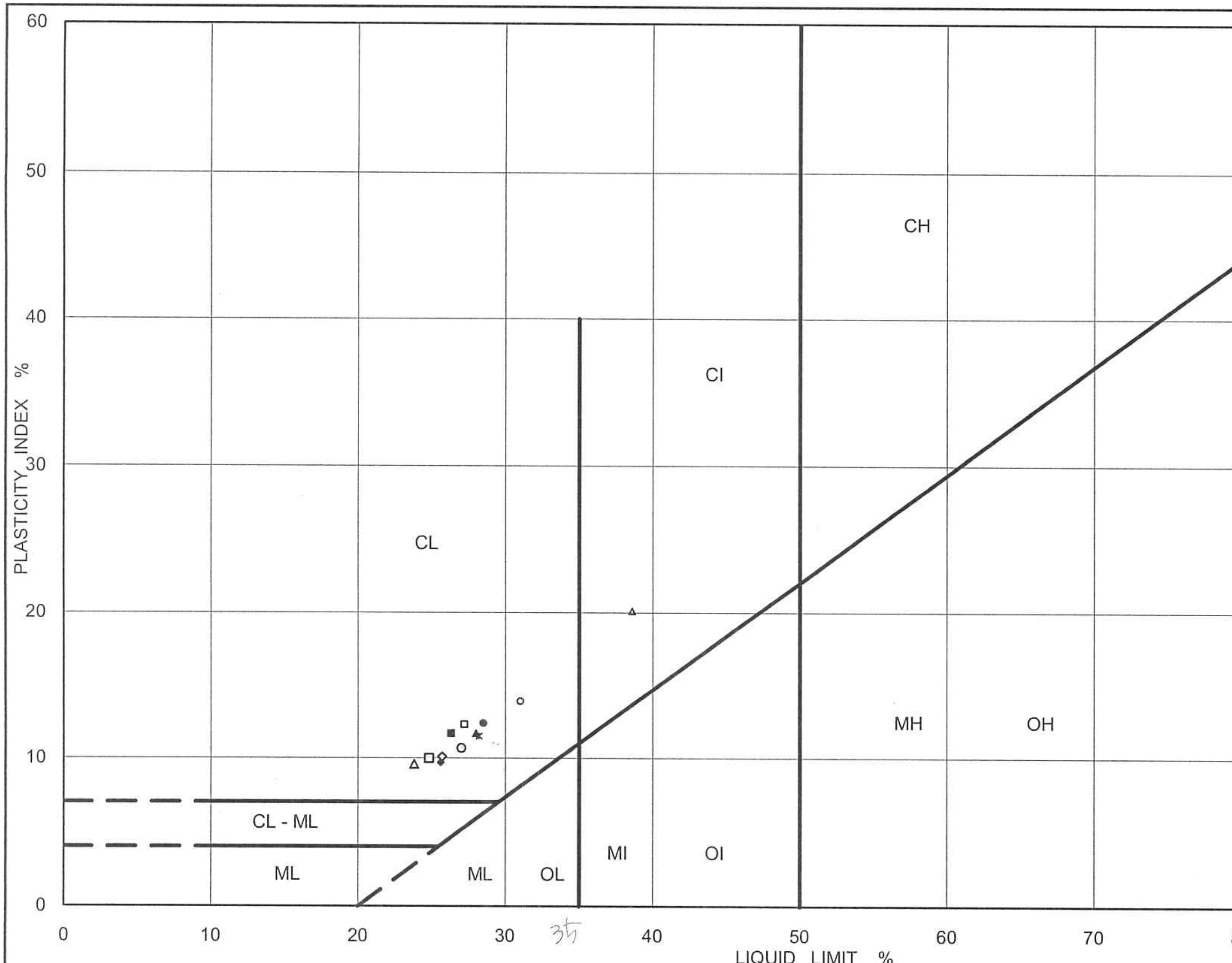
Date: 16-Apr-10

Oct 75, FF-S-21



BH	SAMPLE	SYMBOL
7009	3	●
7009	5	◆
EP114A	2	▲
EP114A	4	■
EP115A	3	○
EP115A	6	◇
EP115A	8	△
EP131A	4	□
EP131A	7	□
RW201	5	◇
RW201	8	△
RW205	4	○
RW205	5	×
		●
		×
		+
		◇
		△
		○
		■

Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt to Silty ClayTill

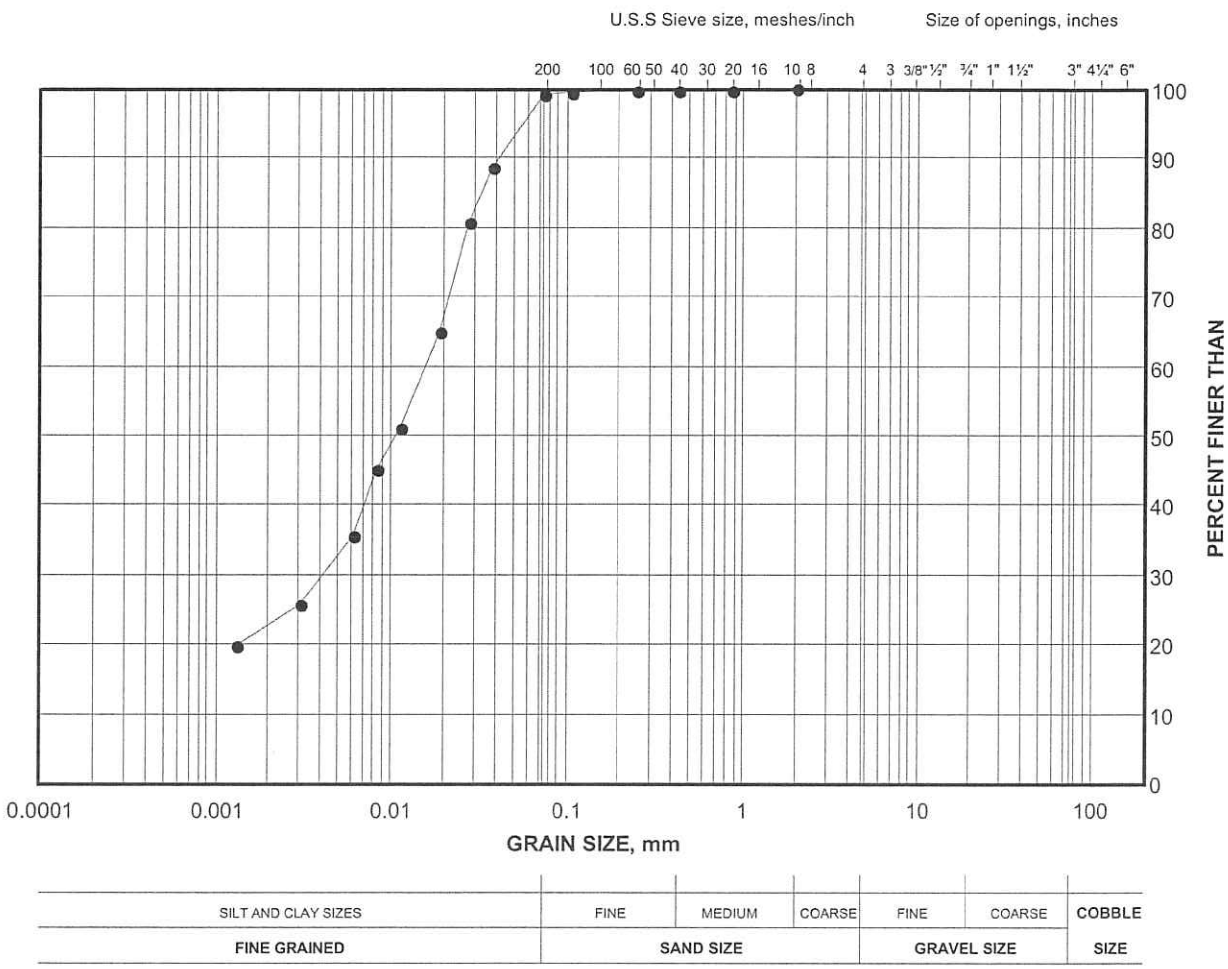
Figure No. 2

Project No. 09-1181-1045

Checked By: [signature]

GRAIN SIZE DISTRIBUTION
Clayey Silt

FIGURE 3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	7009	8	165.0

Project Number: 09-1181-1045

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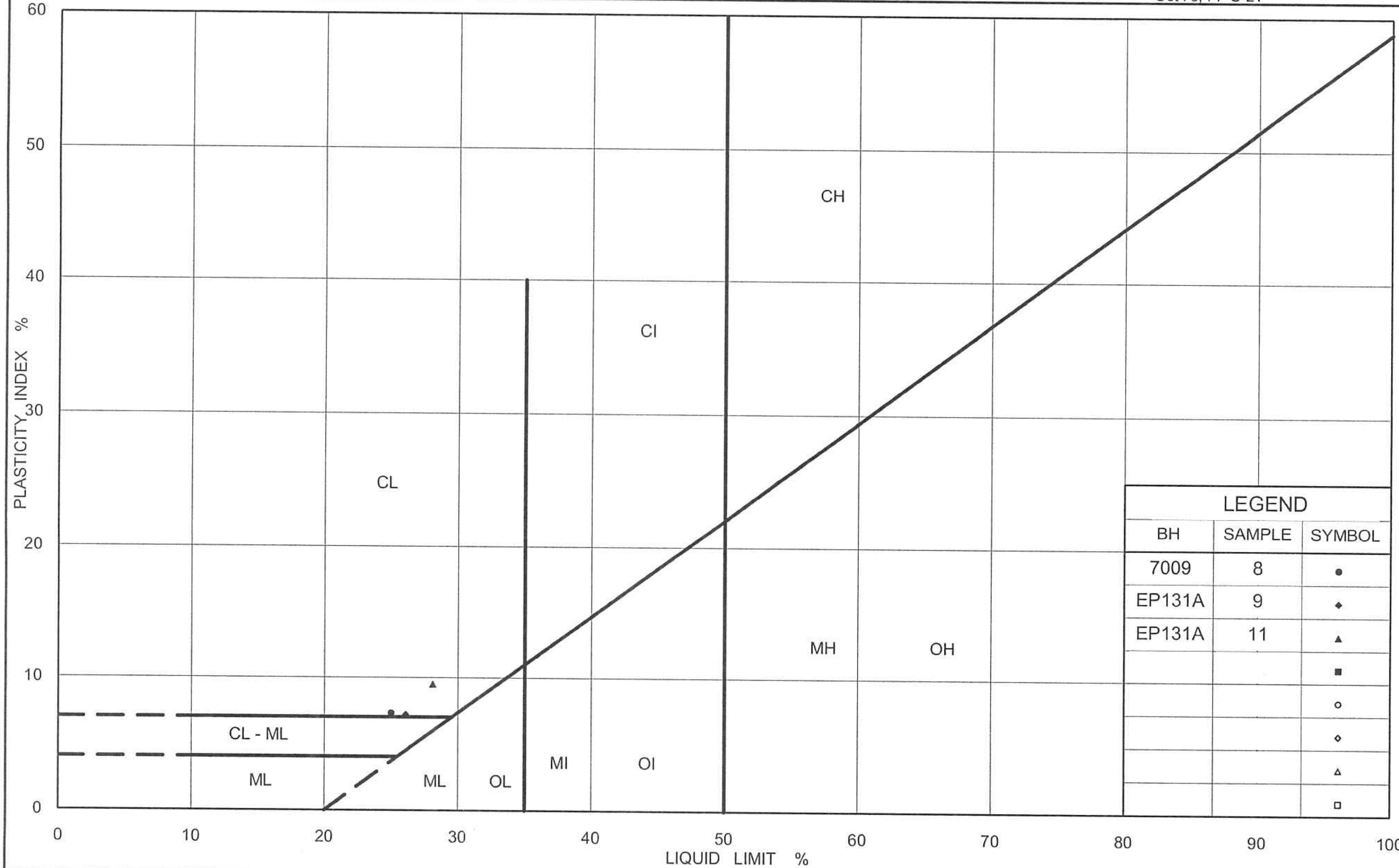
Date: 16-Apr-10

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt

Figure No. 4

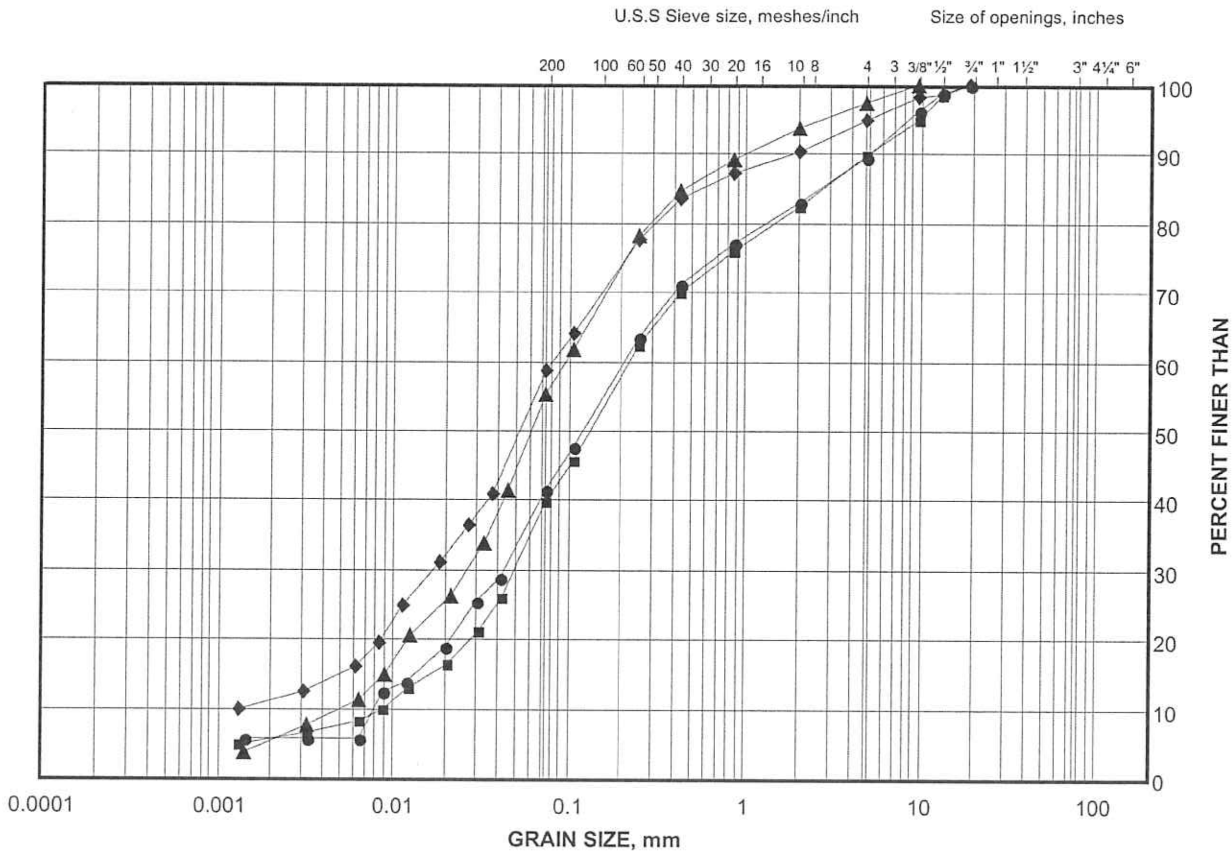
Project No. 09-1181-1045

Checked By:

GRAIN SIZE DISTRIBUTION

Sand and Silt Till

FIGURE 5



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	EP115A	10	162.4
■	RW201	11	164.4
◆	RW201	9	167.4
▲	RW205	9	163.7

Project Number: 09-1181-1045

Checked By: ____________

Golder Associates

Date: 16-Apr-10